**K-ESR-Z-00005**
**Rev. 0**
**April 2012**

# Saltstone Disposal Unit 6

# Geotechnical Investigation Report

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**Prepared for the U.S. Department of Energy under Contract DE-AC09-08SR22470**

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## 1. Introduction

The Saltstone Production Facility (SPF) immobilizes salt solution by blending it with a dry material mixture containing cement and fly ash to form a grout. The grout is pumped to the Saltstone Disposal Facility (SDF), which contains large storage disposal cells, where it is allowed to harden into a concrete-like solid waste-form called saltstone.

A new disposal unit, Saltstone Disposal Unit 6, will be constructed to store saltstone. Saltstone Disposal Unit 6 will be located approximately 700 feet west of Saltstone Disposal Unit 2 and approximately 750 feet south of Saltstone Disposal Units No. 3 and 5, currently under construction. See Figure 1 for location map. The SDU basic design consists of a cylindrical tank approximately 375 feet in diameter and 43 feet tall with a volume of approximately 32 million gallons. The cylindrical tank will be constructed of poured in place Class 3 sulfate resistant concrete mix walls on a poured in place Class 3 sulfate resistant concrete mix base slab. The concrete disposal cell will be encased in a High Density Polyethylene (HDPE) and will include a Geosynthetic Clay Liner (GCL) system (Ref. SRS 2012).

An excavation of approximately 400 feet by 450 feet, 10 to 17 feet deep, will be excavated during the construction process for Saltstone Disposal Unit 6. Saltstone Disposal Unit 6 will not be backfilled as part of the construction or operational processes. The final cover system will be installed after the operational life of the disposal units. The final cover system will include a soil cover that will provide long term protection of the disposal units.

The subsurface conditions in Z-Area were previously investigated and presented in reports prepared by WSRC and other geotechnical engineering consultants (Ref. SRS 1986, SRS 2006). A comprehensive geotechnical investigation was conducted for the Saltstone Disposal Unit No. 6 project site and the results are summarized in this report. The scope of this investigation included performing subsurface explorations to collect site-specific data, characterization of the subsurface conditions, laboratory testing, and calculations to determine: recommended soil properties, bearing capacity, liquefaction potential, liquefaction settlement, and settlement due to the compression of soft zones. The slope stability analysis for Vault 4 is considered valid for all disposal units until a final closure cap is designed.

This report is organized into six sections. Section 1 is the introduction, Section 2 describes the subsurface exploration, Section 3 describes the subsurface conditions, Section 4 discusses the engineering properties, Section 5 discusses engineering evaluations, and Section 6 provides the summary and conclusions. The following appendices are included with this report.

- Appendix A – Stratigraphy
- Appendix B – Test Data / Soil Properties
- Appendix C – Bearing Capacity and Static Settlement
- Appendix D – Liquefaction Analysis
- Appendix E – Soft Zone Analysis
- Appendix F – Slope Stability Analysis
- Appendix G – Laboratory Data

# 2. Subsurface Exploration

Prior to performing the subsurface investigation, the location is hand augered to a depth of 6 feet to check for underground interferences. In the case of cone penetration tests (CPTs) and standard penetration tests (SPTs), no data are collected in the upper 6 feet because the hole is the hand augered.

## 2.1 Cone Penetration Tests (CPTs)

Twenty-three (23) CPT soundings were performed for the Saltstone Disposal Unit 6 subsurface investigation. Of the 23 CPTs, six (6) were seismic cone penetration tests (SCPTs). The coordinates and elevations of the test locations are found in Table 1. Figure 2 provides a plan view of the locations. CPT logs, including shear wave velocity profiles, are included in Appendix B.

## 2.2 Geotechnical Boreholes

Five (5) geotechnical boreholes were drilled at the project site. Disturbed Standard Penetration Test (SPT) samples were taken in two boreholes, while undisturbed samples were collected in the other three boreholes. Boring logs are found in Appendix A.

### *2.2.1 Undisturbed Soil Samples*

Undisturbed soil samples were taken in Z-SDU6-B01, Z-SDU6-B02A, and Z-SDU6-B02B. Undisturbed soil samples included Shelby tube samples and fixed piston tube samples. Samples were taken in accordance with ASTM D 1587.

### *2.2.2 Standard Penetration Test*

SPT testing was performed in boreholes Z-SDU6-B03 and Z-SDU6-B04. In Z-SDU6-B03 SPT samples were taken continuously between 12 and 41 feet and on 5-foot intervals from 43 feet until termination at 150 feet. A 5-foot interval from 18 to 23 feet was mistakenly drilled through. In Z-SDU6-B04, SPT samples were taken continuously from 14 feet to 42 feet, on 5-foot intervals from 43 feet to 148 feet, and on 10-foot intervals until termination at 300 feet. Standard Penetration Tests were performed in accordance with ASTM D1586. SPT N-values were determined by adding the number of blows required to drive the split-spoon sampler the middle 12 inches of the standard 24-inch drive. The SPT energy measurements were taken for the same equipment and the average energy transferred was about 81 percent (Appendix B). However, for the purposes of computations, $N_{60}$ was taken to be equal to the measured N value.

## 2.3 Laboratory Tests

Laboratory tests were performed on the disturbed and undisturbed samples taken during this investigation. Lab tests included unit weights, Atterberg limits, consolidated undrained triaxial tests, and one-dimensional consolidation tests. Laboratory results are included in Appendix B.

## 3. Subsurface Conditions

The subsurface conditions were determined based upon the previous and current investigations, as well as, knowledge of the general and specific subsurface conditions in the General Separations Area (GSA) of the SRS. The GSA includes F-Area, H-Area, S-Area, and Z-Area, where Saltstone Saltstone Disposal Unit 6 will be located.

Subsurface conditions at the project site are described using an adaptation of the nomenclature developed by Mueser Rutledge Consulting Engineers and SRS geologic layers (Ref. SRS 1986). Appendix A defines engineering layers based on boreholes and CPT soundings. Table 2 provides the stratigraphy in terms of geologic and engineering layers.

The subsurface conditions at the project site are similar to the general subsurface conditions in the GSA. Cross section locations are illustrated in Figures 3 and 4. Cross sections of the subsurface at Saltstone Disposal Unit 6 are illustrated in Figures 5 through 14.

Table 1 provides the elevation of each engineering layer at each CPT and borehole location. The site stratigraphy (engineering layers) is described in the following sections in descending order from the ground surface.

### *3.1.1 Top Soil*

Top soil at the site is approximately 6 to 12 inches thick.

### *3.1.2 Fill*

No fill materials were encountered at the project site.

### *3.1.3 S1/2 Layer*

The S1/2 engineering layer consists of the Upland, the Tobacco Road, and the upper Dry Branch formations (geologic units). The contact between the Tobacco Road and Upper Dry Branch formations is generally difficult to distinguish. However, the engineering properties for these formations are similar.

The Upland formation (S1) generally consists of red-brown and gray medium dense to dense medium to fine sand, with some clay and occasional interbedding of fine sandy clay layers. It generally classifies as a clayey sand (SC) in the Unified Soil Classification System (USCS).

The Tobacco Road formation (S2 layer) consists of medium dense to very dense yellow-brown to red, fine to medium sand, with a trace of clay or silt. It generally classifies as a SM or SP-SM in the USCS.

The S2 layer also consists of the upper portion of the Dry Branch Formation (geologic unit). The Dry Branch Formation is present across the S2, C2, and S3 engineering layers, as described later.

### *3.1.4 C2 Layer*

The Tan Clay (C2) layer is part of the Dry Branch Formation. The C2 consists of medium dense yellow-brown and light green clayey fine sand interlayered with stiff yellow-brown silty clay. The material C2 classifies as CH soil in the USCS.

#### *3.1.5 S3 Layer*

From a geologic perspective, the S3 layer (lower Dry Branch Formation) can be subdivided into S3a and S3b as described below. Since engineering properties for the subdivided layers are similar, a single S3 layer was used for engineering purposes.

The combined S3 layer consists of medium dense to dense light brown to gray fine to medium sand with some clay and sandy clay layers and pockets. The material generally classifies as a SC in the USCS. The S3b layer consists of dense to very dense light brown and yellow-brown fine to medium sand with a trace of clay and silt. The material generally classifies as a SP, SP-SM, or SP-SC in the USCS.

#### *3.1.6 S4 Layer*

The S4 layer (Santee/Tinker formation) extends from the bottom of the S3 formation to the top of the M1 layer (Warley Hill formation). The material consists of dense to very dense light gray-green calcareous fine to medium sand with some clay, silt, and occasional limestone and shell fragments. The material generally classifies as a SC or SM in the USCS. The formation is characterized by alternating low and high penetration resistances indicating the presence of limestone layers within the calcareous sands.

#### *3.1.7 M1 Layer*

The M1 layer (Warley Hill formation) consists of a hard dark gray-green clayey silt to a very dense dark gray fine to medium sand with some clay or silt. The material generally classifies as a MH or SC in the USCS. A stratigraphic interpretation for the M1 layer was not determined during this evaluation.

#### *3.1.8 Congaree Formation*

The Congaree Formation generally consists of poorly graded coarse sands with silts. The material generally classified as SP-SM.

### 3.2 Groundwater

The average groundwater elevation in the vicinity of the project site is estimated to be between 215 and 220 feet, msl. Recent readings (February 2012) in new wells installed at Saltstone Vault 2 indicated a groundwater level of approximately 215 ft msl. For static computations an elevation of 220 ft, msl was used while an elevation of 225 ft, msl was used for liquefaction computations. The use of the higher water table provides a more conservative liquefaction analysis.

### 3.3 Soft Zones

Across the SRS, the soil from approximately 100 to 250 feet below the ground surface is a marine deposit laid down during the Middle Eocene epoch, which occurred about 35 to 50 million years ago. At the location of Saltstone Disposal Unit 6, these sediments occur within the Lower Dry Branch and Santee/Tinker Formations. Often found within these sediments are weak zones interspersed in stronger matrix materials. These weak zones, which vary in thickness and lateral extent, have been termed “soft zones”. Soft zones typically occur in the carbonate-bearing

sediments of the Santee Limestone, the Utley Limestone, and the Griffins Landing Member of the lower Dry Branch Formation.

For this project site, soft zones are indicated from SPT N-values less than 5 or CPT tip resistances (qt) less than 15 tons per square foot (tsf) within the S4 layer. The S3 layer contains a few lenses of less than 15 tsf material, but these occur higher in the soil column and are not considered soft zones associated with the dissolution of carbonate rich sediments.

## 4. Engineering Properties

The engineering properties (shear strength, compressibility, plasticity, etc) of the subsurface materials encountered were assessed based on the results of the field exploration, laboratory testing, theoretical relationships, empirical formulas, and historical information.

As presented in Section 2, field exploration included CPTs and geotechnical boreholes with SPTs and undisturbed samples. CPTs were conducted to acquire tip resistance, sleeve friction, shear and compression wave velocities, and pore pressure. SPTs were conducted to acquire blow counts and soil samples for classification purposes. Undisturbed soil samples were obtained for strength and consolidation testing from geotechnical boreholes. Laboratory tests were performed on selected soil samples obtained from undisturbed sampling and from SPT sampling. Laboratory tests include sieve analysis, determination of Atterberg Limits, unit weight, strength tests, and consolidation tests.

Appendix C provides the details of evaluating data from field exploration and laboratory testing, and empirical formulas and historical data were used to estimate subgrade modulus. Engineering properties are summarized in Appendix B.

# 5. Engineering Evaluations

Engineering evaluations were performed to determine bearing capacities, liquefaction potential, and slope stability. Appendix C provides the evaluation of bearing capacity and settlement, Appendix D provides the evaluation of liquefaction potential, Appendix E estimates subsidence associated with the compression of soft zones, and Appendix F provides an evaluation of slope stability.

## 5.1 Bearing Capacity

Ultimate bearing capacity and allowable bearing capacity were computed using site specific soil strength parameters. The design bearing capacity was computed using site specific soil strength parameters factored by the appropriate strength reduction factors. The allowable bearing capacity is used for design of foundations when the allowable stress design method is utilized. The design bearing capacity is used for the design of foundations when the strength method is utilized.

A more detailed analysis of bearing capacity is found in Appendix C.

### *5.1.1 Ultimate Bearing Capacity*

For a soil friction angle ($\phi$) greater than zero, the ultimate bearing capacity $q_u$ is computed using equations originally developed by Terzaghi and later modified by others. Several methods were used for the computation of the bearing capacity factors. Hansen's correction factors are recommended for analysis, as they result in lower values of bearing capacity (Ref. Bowles 1988). Further details on the computation of ultimate bearing capacity are found in Appendix C.

The 382-foot diameter tank foundation was analyzed as a square foundation of an equivalent area, or a 339-foot by 339-foot square. Using the method above, the ultimate bearing capacity, or pressure required to cause a bearing failure of the tank is 92,000 psf.

### *5.1.2 Allowable Bearing Capacity*

The allowable static bearing capacity $q_a$ is calculated by dividing the ultimate bearing capacity by a factor of safety. Considering a factor of safety of 3, the static allowable bearing capacity is 30,900 psf.

The allowable dynamic bearing capacity (temporary dynamic loading, natural phenomena hazard [NPH] loads other than seismic) is calculated by a ⅓ increase in allowable static bearing capacity. The allowable dynamic bearing capacity is 41,200 psf.

### *5.1.3 Design Bearing Capacity*

The design bearing capacity $q_\Phi$, used for Load and Resistance Factor Design (LRFD), was computed with the same equations as the ultimate bearing capacity, using reduced soil strength parameters. A strength reduction factor ($f_c$) of 0.5 was applied to the cohesion and a strength reduction factor ($f_\phi$) of 0.8 was applied to the tangent of $\phi$ such that (Ref. Fang 1991).

Considering an effective cohesion of 100 psf and an effective friction angle of 32°, the reduced cohesion, $c_{red}$, is 50 psf and the reduced friction angle, $\phi_{red}$, is 26.6 degrees.

The bearing capacity factors, shape factors, and depth factors are calculated using the reduced cohesion and reduced friction angle, resulting in a design bearing capacity of 38,800 psf.

The strength reduction factor, Φ, is the ratio of the design bearing capacity to the ultimate bearing capacity. The strength reduction factor is 0.42.

## 5.2 Settlement and Heave

The excavation needed to support the construction of Saltstone Disposal Unit 6 will range from 10 feet to 17 feet below the present ground surface. The removal of this overburden material represents a reduction in overburden stress ranging from approximately 1,200 to 2,040 psf. After operation of the Saltstone facility is complete, approximately 5,100 psf will have been added at elevation 265 ft, msl. After installation of the closure cap (20 feet thick) is completed, a total of 8,000 psf will have been added at elevation 265 ft, msl. Other loading conditions are summarized in Table 3.

Settlement and heave of the soil are summarized in the following sections. Appendix C contains more details of the computations.

### *5.2.1 Heave*

The Vault 2 disposal facility is located approximately 700 feet east of the Saltstone Disposal Unit 6 facility. The Vault 2 facility, which had 7 to 19 feet of overburden (900 to 2,300 psf) removed during excavation, experienced approximately ¼ inch to 1 inch of heave. Similar heave movements are expected during the Saltstone Disposal Unit 6 excavation.

### *5.2.2 Settlement Estimate by Subgrade Modulus*

Subgrade modulus, as discussed in Appendix C, was used to estimate heave and settlement values for Saltstone Disposal Unit 6. The values for the various loading conditions are summarized in the table below.

| | Minimum Settlement (inches) | Maximum Settlement (inches) | Average Settlement (inches) |
|---|---|---|---|
| Heave | -0.4 | -2.4 | -1.2 |
| Tank Half Full | 0.9 | 3.2 | 2.0 |
| End of Operations | 1.5 | 5.9 | 3.7 |
| Pre Closure | 1.7 | 6.4 | 4.0 |
| Post Closure | 2.4 | 9.3 | 5.8 |

### *5.2.3 Empirical Settlement Analysis*

#### *5.2.3.1. Burland and Burbidge Method*

The Burland and Burbidge method estimates the immediate settlement of cohesionless soils, $S_0$, based on SPT data. The soil is assumed to be consolidated to the overburden pressure prior to excavation (Ref. PICE 1985). Appendix C contains more details of the computations.

The depth of influence for the tank is approximately 120 feet using the Burland and Burbidge method. The immediate settlements were computed for each of the 3 borings within the footprint of the structure for loading conditions at the end of excavation (heave), the end of construction, the midpoint of operations, the end of operations, post closure, and 30 years after closure.

The lower bound, upper bound, and average settlements were computed using $I_{cmin}$, $I_{cmax}$, and $I_c$ as described earlier. The settlement values summarized below are the average of the three boring-specific settlements, i.e., the lower bound settlement presented is the average of the three lower bound settlements, etc. The calculated average settlements at the midpoint of operations ranged from 1.1 to 1.4 inches and from 2.6 to 3.2 inches at the end of operations.

| | **Lower Bound Settlement (inches)** | **Upper Bound Settlement (inches)** | **Average Settlement (inches)** |
|---|---|---|---|
| Heave | -0.1 | -0.4 | -0.2 |
| End of Construction | 0.1 | 0.3 | 0.1 |
| Tank Half Full | 0.6 | 2.8 | 1.2 |
| End of Operations | 1.4 | 6.4 | 2.8 |
| Post Closure | 2.3 | 10.8 | 4.8 |
| 30 Years Post Closure | 3.5 | 16.3 | 7.1 |

*5.2.3.2. Schmertmann Method*

The Schmertmann method estimates the immediate settlement $S_0$ based on CPT data (Ref. COE 1990): The average tip stress values were determined for each 1-foot layer beneath the foundation elevation. See Appendix C for further calculation details.

Previous analyses performed for the Vitrification Building, 221-S in S-Area found that the estimated Schmertmann settlements were more than double the measured settlements, likely due to the methodology underestimating the elastic modulus for the cohesionless soils present at SRS (Ref. SRS 2007). Realistic results may be obtained by dividing the Schmertmann result by a conservative adjustment factor of 2.

The Congaree Formation is located approximately 120 feet below the bottom of the excavation. During the investigation for Saltstone Disposal Unit 6, CPTs were unable to push further due to lack of reaction force before reaching the Congaree; however CPTs Z-SDU6-C20, Z-SDU6-C21, and Z-SDU6-C22 appear to have refused on the top of the Congaree Formation with tip stresses of approximately 500 tsf. SPT blow counts in the Congaree Formation and below refused (50 blows over 6 inch or less interval) excepting an N value of 45 and 21 at a depth of 240 and 250 feet in Z-SDU6-B04. Because of the high CPT tip stress and the SPT refusals, the Congaree is considered a rigid base and the Schmertmann settlement analysis was only performed for layers above the Congaree.

The Schmertmann settlement analysis was performed for all 23 CPTs and SCPTs. Average tip

stresses were computed on 1-foot intervals relative to the depth below the bottom of the tank foundation (i.e. 265 ft, msl). CPTs that terminated above the Congaree Formation were supplemented with the average tip stress values from the remaining CPTs for the corresponding 1-foot intervals.

The following table presents the settlement values using the Schmertmann method. Lower and upper bound settlements are the minimum and maximum CPT specific settlements, respectively. Only CPTs beneath the tank and adjacent to the tank (Z-SDU-C05 through Z-SDU6-C18) were used for statistical purposes as summarized in the table below. As applied, the Schmertmann methodology does not compute settlement for values less than the existing overburden stress; therefore no estimates for heave or settlement at the end of construction are presented in the table below.

| | **Minimum Settlement (inches)** | **Maximum Settlement (inches)** | **Average Settlement (inches)** |
|---|---|---|---|
| Tank Half Full | 0.2 | 0.5 | 0.3 |
| End of Operations | 0.7 | 2.1 | 1.2 |
| Post Closure | 1.5 | 4.4 | 2.5 |
| 30 Years Post Closure | 2.2 | 6.6 | 3.7 |

### *5.2.4 One-Dimensional Consolidation Theory*

Settlement of the soil column was computed using one dimensional consolidation theory. Early settlement estimates for DWPF in S Area, which has an average load similar to that of the fully loaded SDU6, ranged from 13 to 16 inches. Further analysis resulted in settlement predictions of 3 to 5 inches. The reduction in predicted settlement was based upon recompression of the soil column rather than virgin compression. The approach was validated by back-calculating settlements of similarly loaded existing H-Area structures. The DWPF engineers adopted a conservative approach in that half of the C2 layer would experience recompression and half would experience virgin compression (Ref. SRS 1984). To date DWPF has settled less than 3.5 inches (Ref. SRS 2011). Early 1980's analysis of the Z-Area vaults utilized soil consolidation properties from neighboring S Area based on similar index test results. However specific properties were developed for the C2 layer (Ref. SRS 1986).

At Saltstone Disposal Unit 6, the C2 average thickness is approximately 8 feet across the site. Beneath the northwestern portion of the tank, the C2 layer is approximately 12 to 18 feet thick, but thins back to a thickness of 5 to 8 feet at the northwestern perimeter of the excavation. The depth to the C2 layer from the bottom of the excavation ranges from 27 feet to 39 feet, and averages 30 feet.

Consolidation settlements were computed at each CPT location, based on the CPT-specific stratigraphic picks, using an approach similar to that employed at DWPF. See Appendix C for further computational details. Only CPTs beneath the tank and adjacent to the tank (Z-SDU-C05 through Z-SDU6-C18) were used for statistical purposes as summarized in the table below.

| | Minimum Settlement (inches) | Maximum Settlement (inches) | Average Settlement (inches) |
|---|---|---|---|
| Heave After Excavation | -1.2 | -1.5 | -1.4 |
| End of Construction | 0.5 | 0.6 | 0.5 |
| Tank Half Full | 2.6 | 4.3 | 3.2 |
| End of Operations | 4.7 | 8.0 | 5.8 |
| Post Closure | 10.2 | 16.3 | 12.8 |

Site experience in other areas on site also indicates that the rate of secondary consolidation for the site is small, on the order of ¼ inch over 30 years, for structural loading ranging from 3 to 6 ksf (Ref. SRS 2007).

### *5.2.5 Summary of Static Settlement and Heave*

Heave within the excavation for Saltstone Disposal Unit 6 is expected to be approximately 1 inch. Settlements were computed for the soil column above the Congaree formation (considered to be incompressible) for the methods described in the previous sections. Average settlement at the end of operations is expected to be approximately 4 inches with a differential settlement of 3.2 inches across a distance of 110 feet. The maximum static settlements are expected to occur along cross section BB; the distance between cross section BB and the adjacent parallel cross section CC is 110 feet. The maximum static settlements are expected to occur along cross-section BB. Total static settlements are summarized in the Table 4.

## 5.3 Dynamic (Seismic) Settlement

Dynamic (seismic) settlement includes the settlement due to liquefaction and/or partial liquefaction and the settlement due to the compression of soft zones. The following sections contain a summary of the liquefaction potential and the resulting settlements. Also contained in the following sections is an assessment of soft zone settlement potential. Appendix D and Appendix E contain the liquefaction and the soft zone calculations, respectively.

### *5.3.1 Liquefaction Potential*

The liquefaction potential for the Saltstone Disposal Unit 6 is evaluated using a modified version of the "Simplified Procedure for Evaluating Soil Liquefaction Potential" (Ref. Seed and Idriss 1971; NCEER, 1997; Youd et al. 2001). The simplified procedure calculates the liquefaction factor of safety as the ratio of Cyclic Resistance Ratio (CRR) to the Cyclic Stress Ratio (CSR) generated by the earthquake.

Liquefaction potential was computed using CPT tip resistances and shear wave velocity data to determine CRR values. CPT tip resistance determination of liquefaction potential was computed using SRS site-specific CRR curves. The shear wave velocity-determined CRR values were computed using the method developed by Andrus and Stokoe (2000) for uncemented, Holocene age soils. Both methods considered the Design Basis Earthquake (DBE) with a peak ground acceleration

(PGA) of 0.18g. The fines contents were determined using SRS-specific CPT correlations, which were corroborated with laboratory testing from this investigation.

Full liquefaction has been defined previously at SRS as occurring at factors of safety less than 1.15. Partial liquefaction occurs for factors of safety less than 2.2, but greater than 1.15. Once the factor of safety is determined, dynamic settlements are then calculated based on correlations between factor of safety and SRS site-specific volumetric strain curves.

Liquefaction potential based on shear wave velocities indicates that the site is generally not susceptible to liquefaction. The average factors of safety against liquefaction are in excess of 3.0 for each of the SCPTs considered. Appendix D contains further details on the computation of the factor of safety.

### *5.3.2 Settlement due to Liquefaction and Partial Liquefaction*

Settlements were calculated using the SRS site-specific volumetric strain curves for each of the 23 CPTs at Saltstone Disposal Unit 6. Figure 15 illustrates the relationship between factor of safety and volumetric strain. Settlements were computed for each of the magnitudes in the seismic hazard for SRS. Figure 16 illustrates the liquefaction induced settlement for CPT Z-SDU6-C10. Illustrations of the liquefaction-induced settlements for all other CPTs are found in Appendix E.

Settlement due to liquefaction, based on the SRS-specific CRR curves, ranges from ¼ inch to 2¼ inches for the magnitude 7.5 earthquake, see Table 5. All magnitude 7.5 settlements are less than 1.0 inch except for CPTs Z-SDU6-C09 (1.0 inch) and Z-SDU6-C10 (2.2 inches). The magnitude weighted average using the SRS hazard deaggregation is less than ½ inch for the 2,500 year earthquake.

### *5.3.3 Settlement due to the Compression of Soft Zones*

Soft zones were identified in three (3) CPTs beneath Saltstone Disposal Unit 6 during the subsurface investigation and no soft zone samples were obtained. Two (2) CPTs had total soft zone thicknesses of less than 1.5 feet and the third had 5.8 feet of soft zone material. Soft zone settlements are assumed to occur as a result of their potential compression due to a seismic event. The settlement was computed by applying consolidation theory to the soft zone and an empirical analysis using soft ground tunneling analogy to propagate the settlement to the surface. The soft zone was conservatively modeled with a thickness of 6 feet. See Appendix E for further calculation details.

Surface settlements for wide soft zones are calculated by superimposing settlement profiles for multiple narrow soft zones to simulate the desired width. For Saltstone Disposal Unit 6, a series of 5-foot wide soft zones were utilized to represent soft zones ranging in width from 25 feet to 150 feet.

The results of the soft zone analysis indicate that the maximum soft zone induced settlement is ½ inch and the maximum differential settlement is ½ inch. Maximum slope and curvature are 0.0006 ft/ft and 0.00003, respectively. Appendix E contains further details on the Saltstone Disposal Unit 6 soft zone analysis.

### *5.3.4 Summary of Dynamic (Seismic) Settlement*

Settlements resulting from liquefaction are expected to average less than ½ inch across the project

site. Maximum liquefaction induced settlements are predicted to occur in the vicinity of Z-SDU6-C09 and Z-SDU6-C10 which are along cross section CC. The maximum differential settlement is estimated at ½ inch. The maximum soft zone thickness was found in Z-SDU6-C10 and the resulting maximum predicted soft zone settlement is ½ inch. Total dynamic settlements are predicted at 1 inch, with a differential of 1 inch. The differential dynamic settlement, like the static settlement, is also taken across a distance of 110 feet (the approximate distance between cross sections BB-CC and CC-DD).

### 5.4 Subgrade Modulus

The subgrade modulus is a foundation specific-value and is not a specific soil property. The subgrade modulus depends on the size and shape of the loaded area. The subgrade modulus correlates foundation pressure and settlement by

$$k_s = \frac{p}{\Delta}$$

where $p$ = foundation contact pressure (pounds per square inch, psi)

$\Delta$ = soil settlement (inches)

The subscript $s$ refers to the foundation size. For example, $k_1$ refers to the subgrade modulus for a 1-foot square foundation. When no subscript is used, the value refers to the subgrade modulus for the entire foundation.

For Saltstone Disposal Unit 6, the subgrade modulus was determined using empirical methods and from back-calculated values from existing SRS structures. The back-calculated values are judged to be more appropriate than values empirically derived. The $k_1$ subgrade modulus estimated for Saltstone Disposal Unit 6, based on SRS settlement data for large structures, ranges from 25 to 100 pci. See Appendix C for further details on the computation of subgrade modulus.

### 5.5 Lateral Earth Pressure

Lateral earth pressures within the fill material resulting from compaction were calculated using the method presented by Duncan et al. (Ref. Duncan 1991, Duncan 1993). The method calculates $\sigma'_h$ graphically and considers compaction effort and the method of compaction. The compaction induced lateral earth pressures are summarized in Table 6 and presented in Figure 17. See Appendix C for further details on the computation of lateral earth pressures.

### 5.6 Post Closure Slope Stability

Until a final closure cap has been designed, the closure cap design for Vault 4 is considered applicable to all future disposal units. However, final design of the closure system will determine slope geometry. It is anticipated that further slope stability analysis will be performed during final design and that final slopes will be designed to remain stable for the DBE. Post-closure slope stability evaluation of Vault No. 4 was performed using the Spencer method. This method was chosen because it satisfies both force and moment equilibrium of a sliding mass of soil.

Two independent computer software programs, SLOPE/W and PCSTABL, were used to compute the results. Both programs produced comparable results. Appendix F provides the details of the

analysis; K-CLC-Z-00002 contains the SLOPE/W calculation and WSRC-TR-2003-00145 contains the PCSTABL summary.

The post-closure geometry used in the analysis assumes 20 feet of compacted fill will be placed with side slopes conservatively chosen to be 4 H to 1 V. For the analysis, it is assumed that the compacted fill will be taken from onsite borrow sources and will be placed and compacted to SRS standards, i.e., 95% of modified Proctor density per ASTM D-1557 in loose lifts not exceeding 12 inches.

Comparisons of subsurface conditions at Vault No. 4 (Appendix F, Figure 1) with those at Saltstone Disposal Unit 6 show good correlation between Saltstone Disposal Unit 6 and Vault No. 4 soils based on shear strength parameters. The acceptable safety factors were chosen based on past experience at the SRS and recommendations from the literature (Abramson et al 1996, Huang 1983, COE 1970). For the static and pseudostatic (seismic) cases, the minimum acceptable safety factors were chosen as 1.5 and 1.0, respectively.

The minimum required safety factor for static and dynamic (seismic) conditions is 1.5 and 1.0, respectively. The results in Tables 1 and 2 of Appendix F show that the stability of the assumed post-closure condition (4 H to 1 V) meets these requirements and is therefore stable under the conditions and assumptions analyzed. However, final design will dictate final slope geometry.

# 6. Summary and Conclusions

The geotechnical subsurface investigation for Saltstone Disposal Unit 6 collected information via standard penetration tests (SPT), undisturbed borings, cone penetrometer tests (CPT), and laboratory testing. Subsurface conditions were characterized and soil properties were determined using site-specific data, as well as existing data from nearby areas. Engineering evaluations were performed for bearing capacity, liquefaction potential, and lateral earth pressure coefficients. Settlements due to static loading, liquefaction, and soft zone compression were also computed.

## 6.1 Bearing Capacity

Bearing capacity for the Saltstone Disposal Unit 6 was determined for both allowable stress design and Load and Resistance Factored Design (LRFD) methods.

1. For allowable stress design
   - Ultimate Bearing Capacity 92,000 psf
   - Allowable Static Bearing Capacity 30,900 psf
   - Allowable Dynamic Bearing Capacity 41,200 psf
2. For LRFD design
   - Ultimate Bearing Capacity 92,000 psf
   - Design Bearing Capacity 38,800 psf
   - Strength Reduction Factor 0.42

The theoretical bearing capacity, in either design approach, is significantly higher than the expected loading, therefore the foundation will have sufficient margin of safety against bearing failure.

## 6.2 Settlement

Average settlement values are summarized below for static and dynamic evaluations.

### *6.2.1 Static Settlement*

Static settlement due to static loading.

- Heave during excavation 1 inch
- Operations complete 4 inches
- Closure Cap Complete 7 inches
- 30 Years after Closure 8 inches

### *6.2.2 Dynamic (Seismic) Settlement*

Dynamic settlement due to liquefaction and partial liquefaction and the compression of soft zones

- Liquefaction ½ inch
- Soft Zone Settlement ½ inch
- Total Dynamic Settlement 1 inch

The dynamic settlement will only occur after the design basis earthquake occurs, which has a low

probability of occurrence (0.0004/year, 2,500 year event). The project site is generally not susceptible to liquefaction, excepting isolated lenses at depth. Estimated liquefaction and partial liquefaction induced settlements range from ¼ inch to 2¼ inches. Compression of the soft zones is assumed to occur after the design basis earthquake, after which the compression will propagate to the ground surface causing surface settlement.

Total settlement after a design basis event can be determined by superimposing the static settlement with the total dynamic settlement. For example, total settlement 30 years after closure is estimated to be 9 inches.

#### *6.2.3 Differential Settlement*

The differential static settlement is estimated 3.2 inches across a distance of 110 feet. The differential settlement resulting from liquefaction is estimated to be ½ inch. The differential settlement resulting from the compression of soft zones is estimated to be ½ inch.

### 6.3 Subgrade Modulus

The recommended subgrade modulus, $k_1$, is 100 pci. A reduced value of 25 pci is also recommended for use where higher settlements are predicted along the northern portion of the tank.

### 6.4 Lateral Earth Pressures

Compaction induced lateral earth pressures are summarized in Table 6 and depicted in Figure 17. Below 22 feet, $K_0$ conditions control.

### 6.5 Slope Stability

Both static and pseudo-static slope stability analyses show that the assumed post-closure condition is stable with minimum computed safety factors well in excess of the required safety factors. In addition, the computed safety factors conservatively account for the soil strength and the application of the horizontal and vertical DBE seismic loads. However, additional stability analyses will be required once the final closure system configuration is determined. The analyses should take into account any geosynthetics and the interface shear resistance between the geosynthetic materials and the compacted fill. Based on the slopes being considered, it is not expected that static or dynamic slope stability will be an issue.

### 6.6 Monitoring and Inspection

Heave markers shall be installed prior to the beginning of excavation and settlement monitoring points shall be installed on the foundation. Settlement surveying shall be conducted as soon as the monitoring points are installed. Surveying results shall be evaluated to verify the estimated settlement.

A detailed footing inspection is highly recommended prior to forming or placing concrete for a mud mat or the mat foundation. This is particularly important where the excavated depth to the bottom of the foundation is less than 6 feet. In addition, a proof roll of the excavation shall be conducted prior to the placement of a mud mat or form work for the mat foundation.

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**Tables**

**Table 1: Summary of CPT Tests and Stratigraphy**

| ID | CPT Type | SRS Northing | SRS Easting | Elevation ft, msl | Elevation Top Pick (ft, msl) | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | C2 Layer | S3 Layer | S4 Layer | Congaree |
| Z-SDU6-C01 | CPT | 77413.3 | 66270.1 | 281.9 | 233 | 226 | 190 | |
| Z-SDU6-C02 | SCPT | 77448.1 | 66350.4 | 281.4 | 233 | 227 | 190 | |
| Z-SDU6-C03 | CPT | 77478.3 | 66494.3 | 281.6 | 233 | 225 | 190 | |
| Z-SDU6-C04 | CPT | 77503.3 | 66578.8 | 281.8 | 236 | 229 | 190 | |
| Z-SDU6-C05 | SCPT | 77624.5 | 66594.9 | 278.1 | 235 | 226 | 187 | |
| Z-SDU6-C06 | CPT | 77587.6 | 66472.8 | 278.6 | 234 | 227 | 189 | |
| Z-SDU6-C07 | CPT | 77546.9 | 66357.1 | 279.4 | 237 | 230 | 191 | |
| Z-SDU6-C08 | CPT | 77511.4 | 66258.9 | 279.7 | 236 | 230 | 186 | |
| Z-SDU6-C09 | CPT | 77621.8 | 66210.4 | 278.3 | 237 | 230 | 194 | |
| Z-SDU6-C10 | CPT | 77644.2 | 66285.6 | 278.0 | 237 | 230 | 190 | |
| Z-SDU6-C11 | CPT | 77663.3 | 66354.1 | 277.6 | 238 | 233 | 186 | |
| Z-SDU6-C12 | SCPT | 77682.6 | 66452.6 | 277.7 | 239 | 234 | 188 | |
| Z-SDU6-C13 | CPT | 77722.6 | 66523.4 | 276.3 | 234 | 228 | 188 | |
| Z-SDU6-C14 | CPT | 77720.6 | 66180.9 | 277.3 | 234 | 222 | 181 | |
| Z-SDU6-C15 | CPT | 77748.2 | 66249.8 | 276.8 | 232 | 217 | 192 | |
| Z-SDU6-C16 | SCPT | 77772.2 | 66312.2 | 276.7 | 234 | 216 | 184 | |
| Z-SDU6-C17 | CPT | 77796.3 | 66393.3 | 276.0 | 235 | 219 | 187 | |
| Z-SDU6-C18 | SCPT | 77819.4 | 66471.7 | 275.6 | 235 | 217 | 186 | |
| Z-SDU6-C19 | SCPT | 77869.3 | 66155.6 | 276.4 | 235 | 227 | 183 | |
| Z-SDU6-C20 | CPT | 77895.0 | 66236.9 | 276.0 | 226 | 219 | 176 | |
| Z-SDU6-C21 | CPT | 77920.9 | 66321.6 | 276.3 | 233 | 225 | 182 | |
| Z-SDU6-C22 | CPT | 77947.5 | 66415.1 | 276.5 | 237 | 230 | 187 | |
| Z-SDU6-C23 | CPT | 77967.7 | 66482.5 | 275.5 | 238 | 233 | 190 | |
| Z-SDU6-B01 | Boring | 77771.3 | 66309.1 | 276.6 | | | | |
| Z-SDU6-B02A | Boring | 77625.3 | 66594.8 | 278.0 | | | | |
| Z-SDU6-B02B | Boring | 77629.2 | 66588.9 | 278.1 | 234 | 227 | 191 | |
| Z-SDU6-B03 | Boring | 77769.6 | 66304.5 | 276.5 | 232 | 217 | 188 | 146 |
| Z-SDU6-B04 | Boring | 77663.9 | 66351.1 | 277.9 | 236 | 232 | 191 | 145 |

**Table 2: Summary of Engineering and Geologic Layers**

| General Description | Engineering Layer | Geologic Layer |
|---|---|---|
| Medium dense to dense red-brown clayey fine sand | S1/2 | Upland |
| Medium dense to very dense fine to medium sand, some silt | | Tobacco Road |
| Medium dense to dense medium sand with some clay and sandy clay layers | | Dry Branch |
| Medium dense clayey fine sand interlayered with stiff silty clay | C2 | |
| Medium dense to dense medium sand with some clay and sandy clay layers | S3 | |
| Dense to very dense calcareous fine to medium sand with some clay and silt | S4 | Santee Tinker |
| Hard clayey silt to very dense fine to medium sand | M1 | Warley Hill |
| Dense poorly graded sands with silts | CG | Congaree |

**Table 3: Summary of Loading SDU6 Loading Conditions**

| | Vertical Pressure at Elevation 265 ft, msl | | | | | | |
|---|---|---|---|---|---|---|---|
| | Existing | End of Excavation | End of Construction | Tank Half Full | End of Operations | Pre Closure | Post Closure |
| Minimum | 1,200 psf | 0 psf | 600 psf | 2,800 psf | 5,100 psf | 5,500 psf | 8,000 psf |
| Maximum | 2,040 psf | 0 psf | 600 psf | 2,800 psf | 5,100 psf | 5,500 psf | 8,000 psf |

**Table 4: Summary of Static Settlements**

| | Minimum Settlement (inches) | Maximum Settlement (inches) | Average Settlement (inches) |
|---|---|---|---|
| Heave | -0.2 | -1.3 | -1 |
| Tank Half Full | 0.3 | 3.0 | 2 |
| Operations Complete | 1.2 | 5.5 | 4 |
| Closure Cap Complete | 2.5 | 13.5 | 7 |

**Table 5: Summary of Liquefaction Induced Settlements –SRS CRR Curves**

| | Settlement (inches) | | | | | | |
|---|---|---|---|---|---|---|---|
| | $M_w$ = 4.75 | $M_w$ = 5.25 | $M_w$ = 5.75 | $M_w$ = 6.25 | $M_w$ = 6.75 | $M_w$ = 7.5 | 2,500 Yr Weighting |
| Z-SDU6-C01 | 0.00 | 0.00 | 0.00 | 0.03 | 0.11 | 0.68 | 0.33 |
| Z-SDU6-C02 | 0.00 | 0.00 | 0.00 | 0.01 | 0.04 | 0.30 | 0.14 |
| Z-SDU6-C03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.32 | 0.15 |
| Z-SDU6-C04 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.25 | 0.12 |
| Z-SDU6-C05 | 0.00 | 0.00 | 0.00 | 0.01 | 0.04 | 0.36 | 0.17 |
| Z-SDU6-C06 | 0.00 | 0.00 | 0.00 | 0.01 | 0.04 | 0.32 | 0.15 |
| Z-SDU6-C07 | 0.00 | 0.00 | 0.00 | 0.01 | 0.04 | 0.20 | 0.10 |
| Z-SDU6-C08 | 0.00 | 0.00 | 0.00 | 0.02 | 0.09 | 0.64 | 0.31 |
| Z-SDU6-C09 | 0.00 | 0.00 | 0.00 | 0.06 | 0.19 | 1.03 | 0.50 |
| Z-SDU6-C10 | 0.00 | 0.01 | 0.03 | 0.17 | 0.54 | 2.17 | 1.07 |
| Z-SDU6-C11 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.16 | 0.08 |
| Z-SDU6-C12 | 0.00 | 0.00 | 0.00 | 0.01 | 0.03 | 0.31 | 0.15 |
| Z-SDU6-C13 | 0.00 | 0.00 | 0.00 | 0.01 | 0.08 | 0.60 | 0.29 |
| Z-SDU6-C14 | 0.00 | 0.00 | 0.00 | 0.02 | 0.08 | 0.58 | 0.28 |
| Z-SDU6-C15 | 0.00 | 0.00 | 0.00 | 0.01 | 0.11 | 0.73 | 0.35 |
| Z-SDU6-C16 | 0.00 | 0.00 | 0.00 | 0.01 | 0.04 | 0.44 | 0.21 |
| Z-SDU6-C17 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.33 | 0.16 |
| Z-SDU6-C18 | 0.00 | 0.00 | 0.00 | 0.02 | 0.07 | 0.60 | 0.29 |
| Z-SDU6-C19 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.32 | 0.15 |
| Z-SDU6-C20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.04 | 0.62 | 0.29 |
| Z-SDU6-C21 | 0.00 | 0.00 | 0.00 | 0.01 | 0.07 | 0.68 | 0.33 |
| Z-SDU6-C22 | 0.00 | 0.00 | 0.00 | 0.01 | 0.10 | 0.89 | 0.43 |
| Z-SDU6-C23 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.26 | 0.12 |
| | | | | | | Average | 0.27 |
| | | | | | | Minimum | 0.08 |
| | | | | | | Maximum | 1.07 |
| | | | | | | Standard Deviation | 0.21 |

**Table 6: Compaction Induced Lateral Earth Pressures**

| Depth (feet) | $\sigma_{H\ Design}$ (psf) |
|---|---|
| 0 | 0 |
| 2 | 600 |
| 4 | 790 |
| 8 | 980 |
| 16 | 1,200 |
| 22 | 1,375 |
| 43 | 2,688 |

$K_0$ controls at 22 feet and below

**Figures**

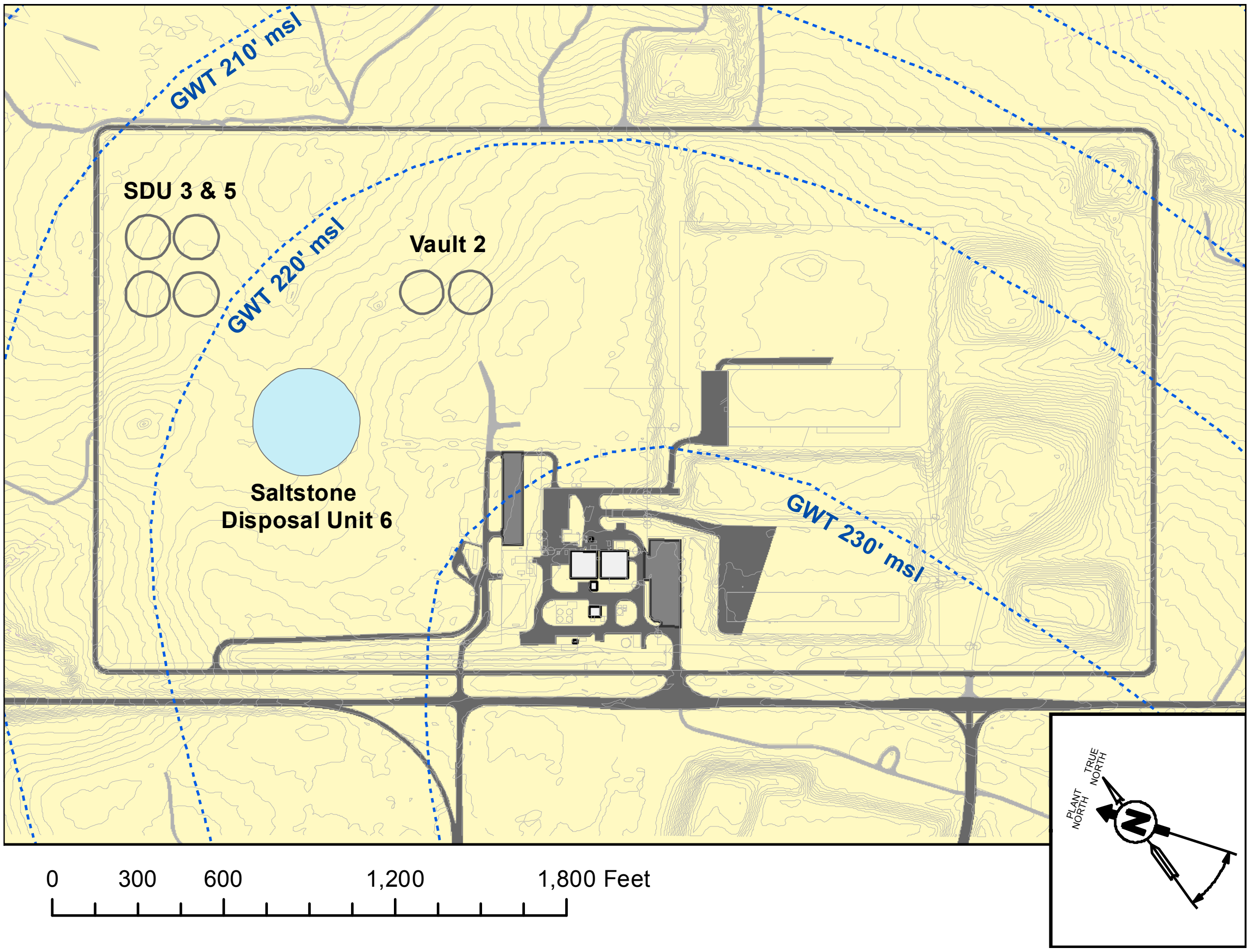



**Figure 1: Z Area Location Map**

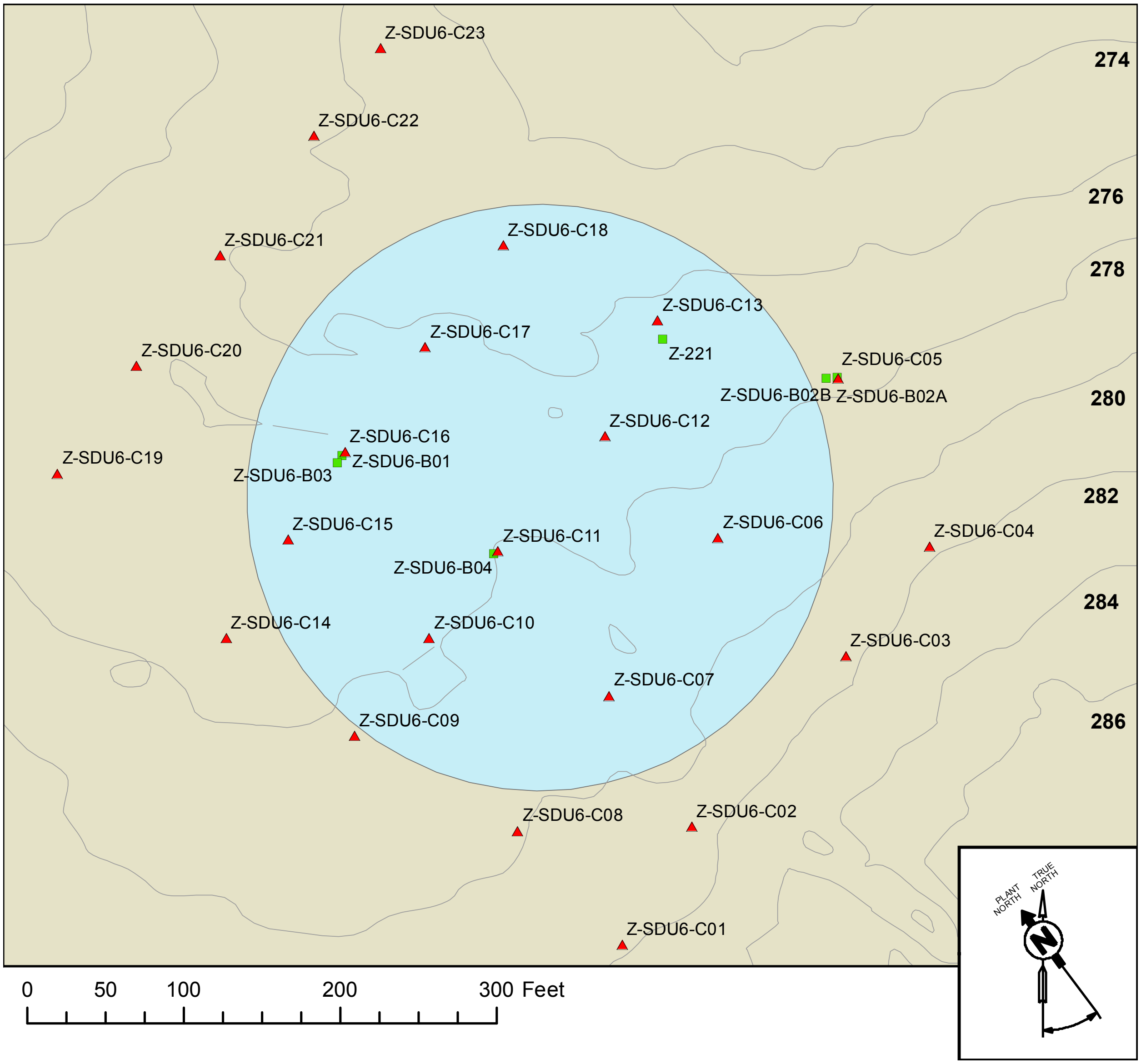



**Figure 2: Saltstone Disposal Unit 6 Location Map with Subsurface Investigation Locations**

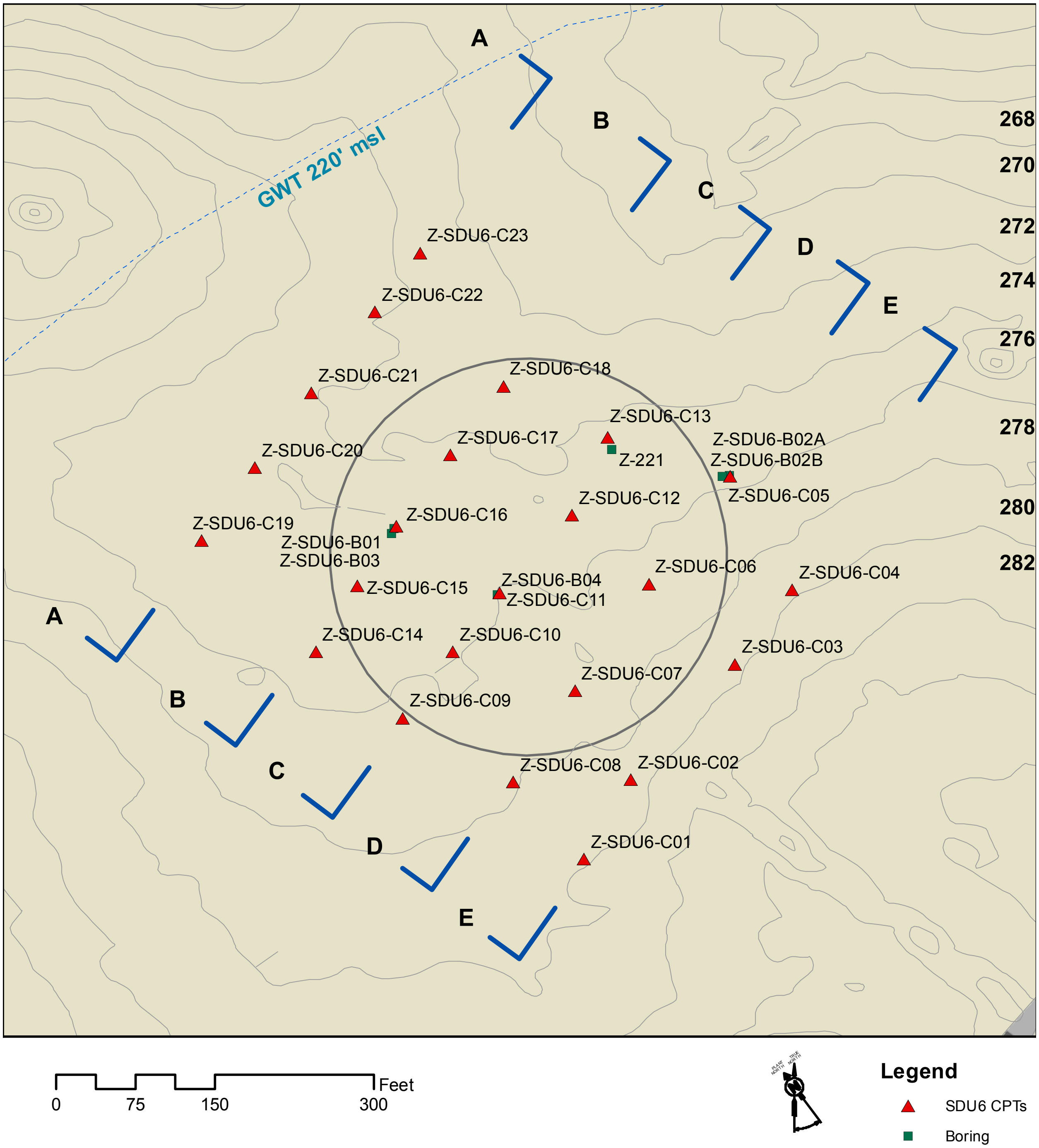



**Figure 3: Cross Sections AA through EE**

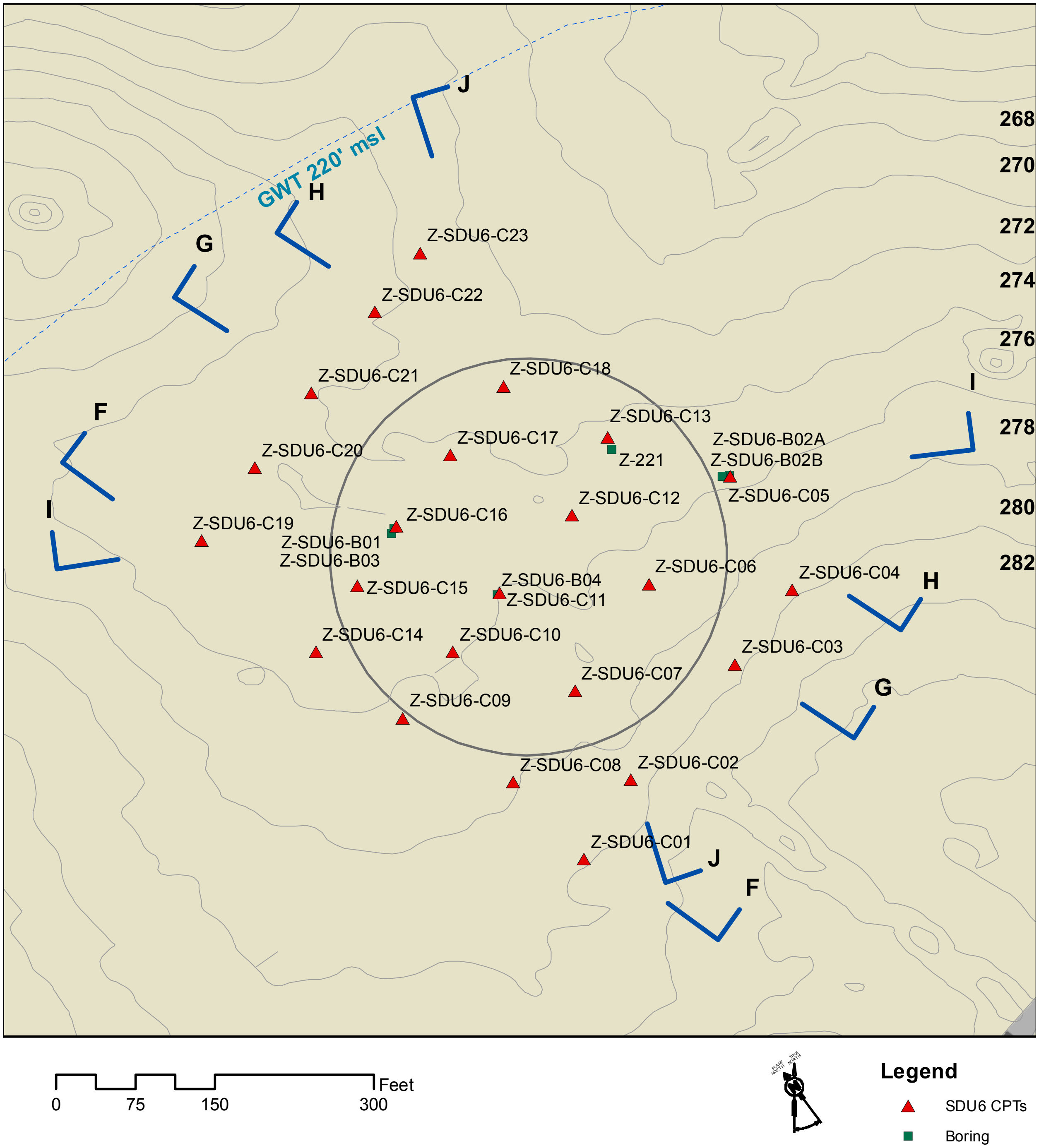



**Figure 4: Cross Sections FF through JJ**

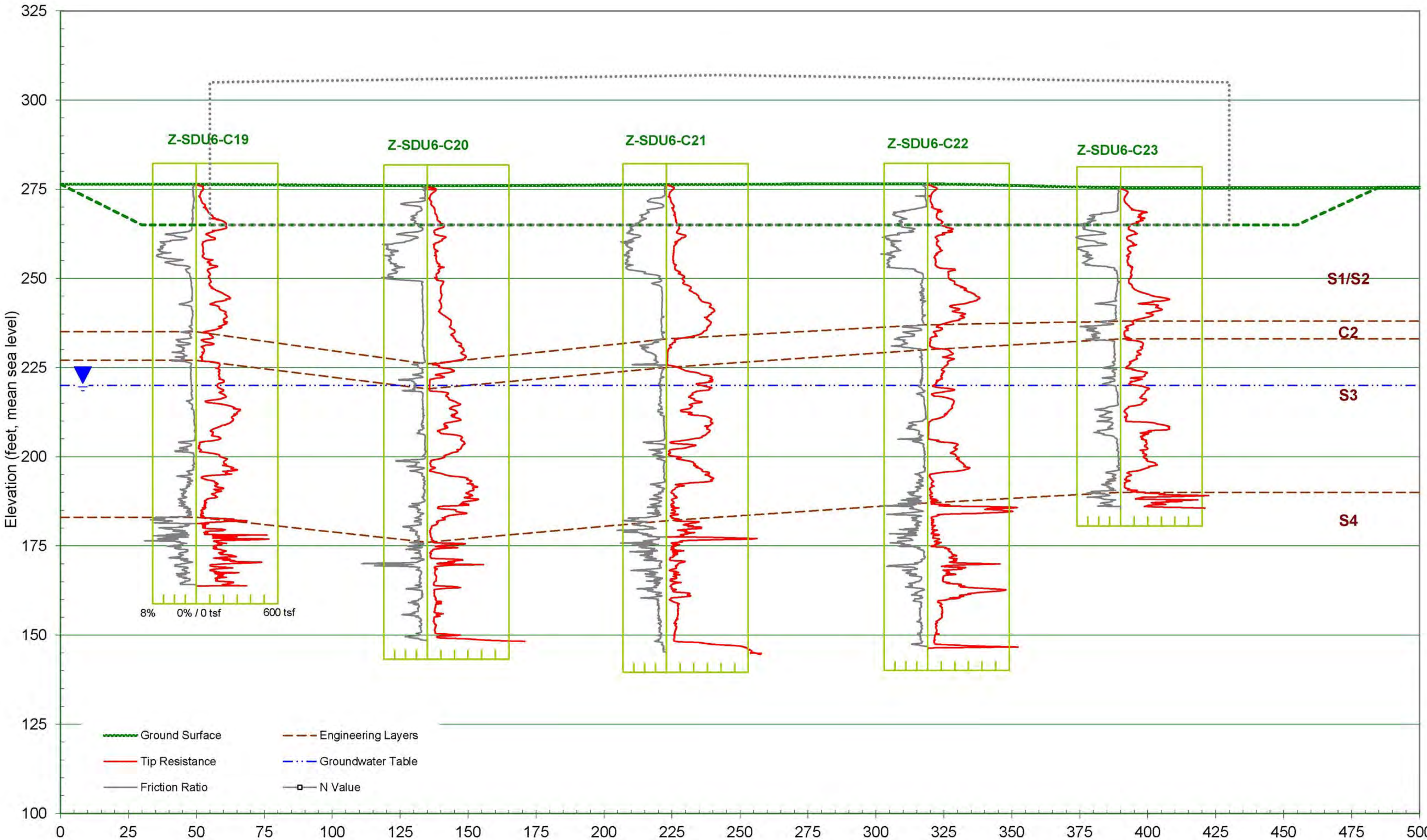



**Figure 5: Cross Section AA**

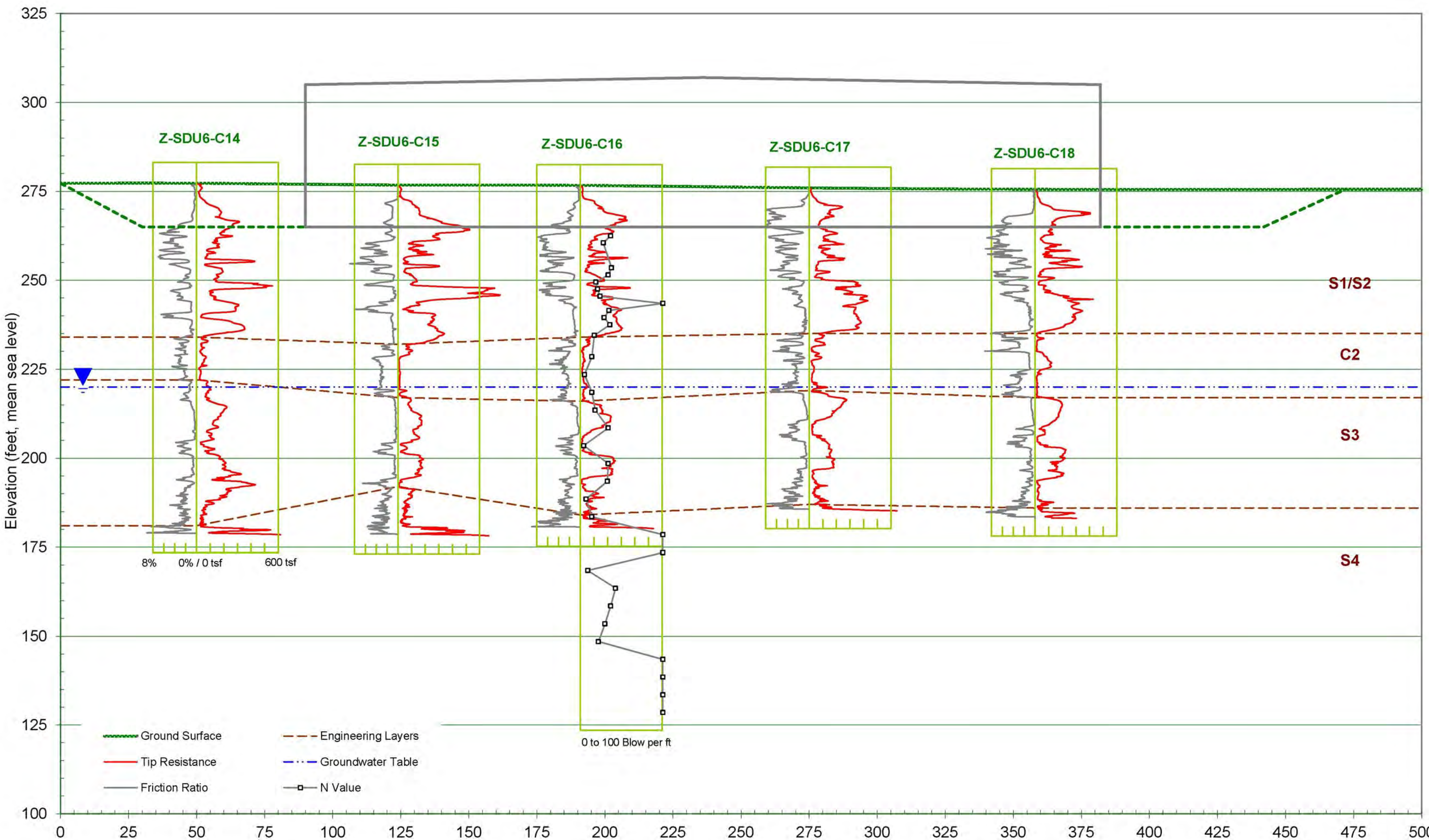



**Figure 6: Cross Section BB**

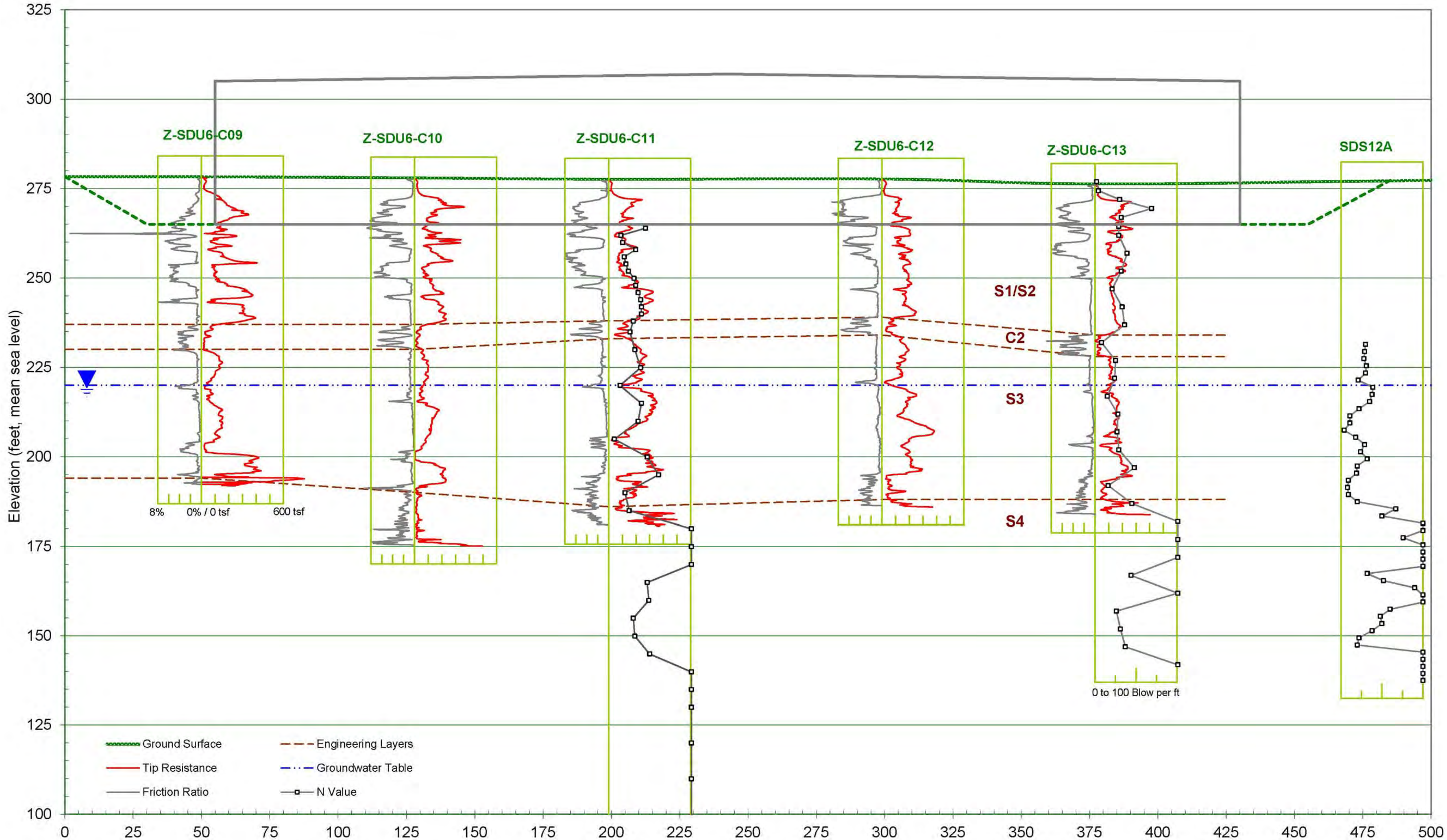



Figure 7: Cross Section CC

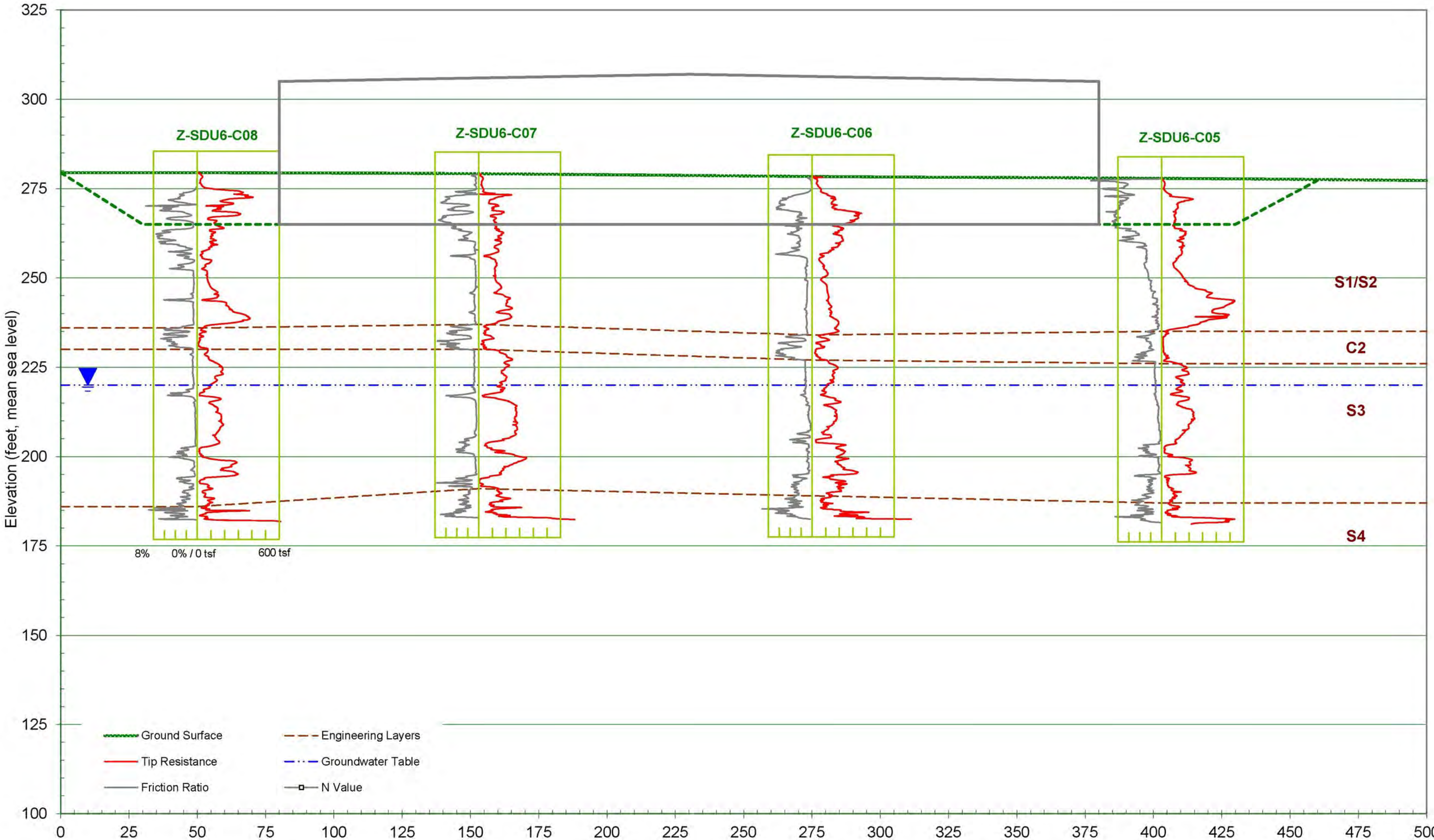



Figure 8: Cross Section DD

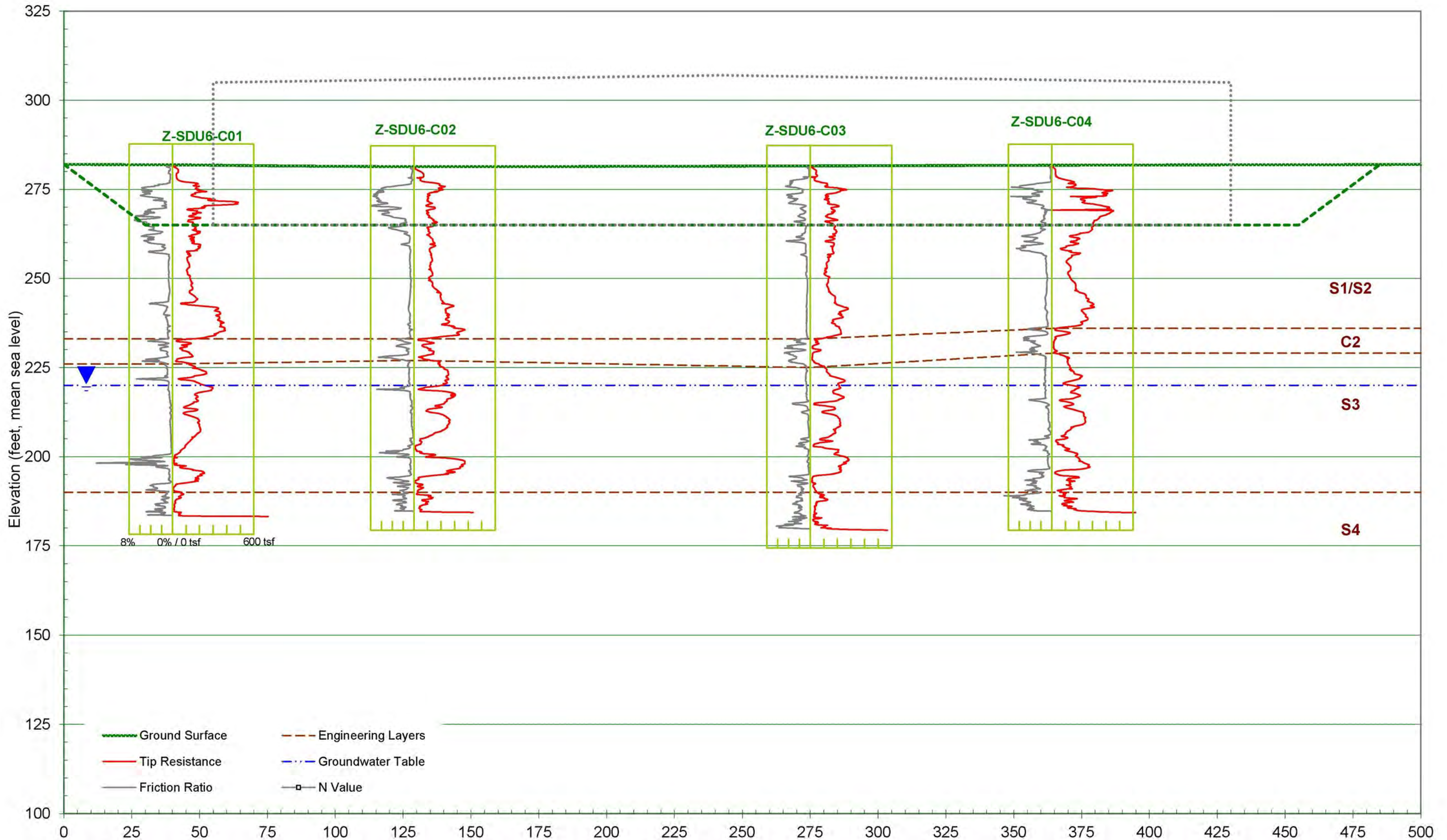



**Figure 9: Cross Section EE**

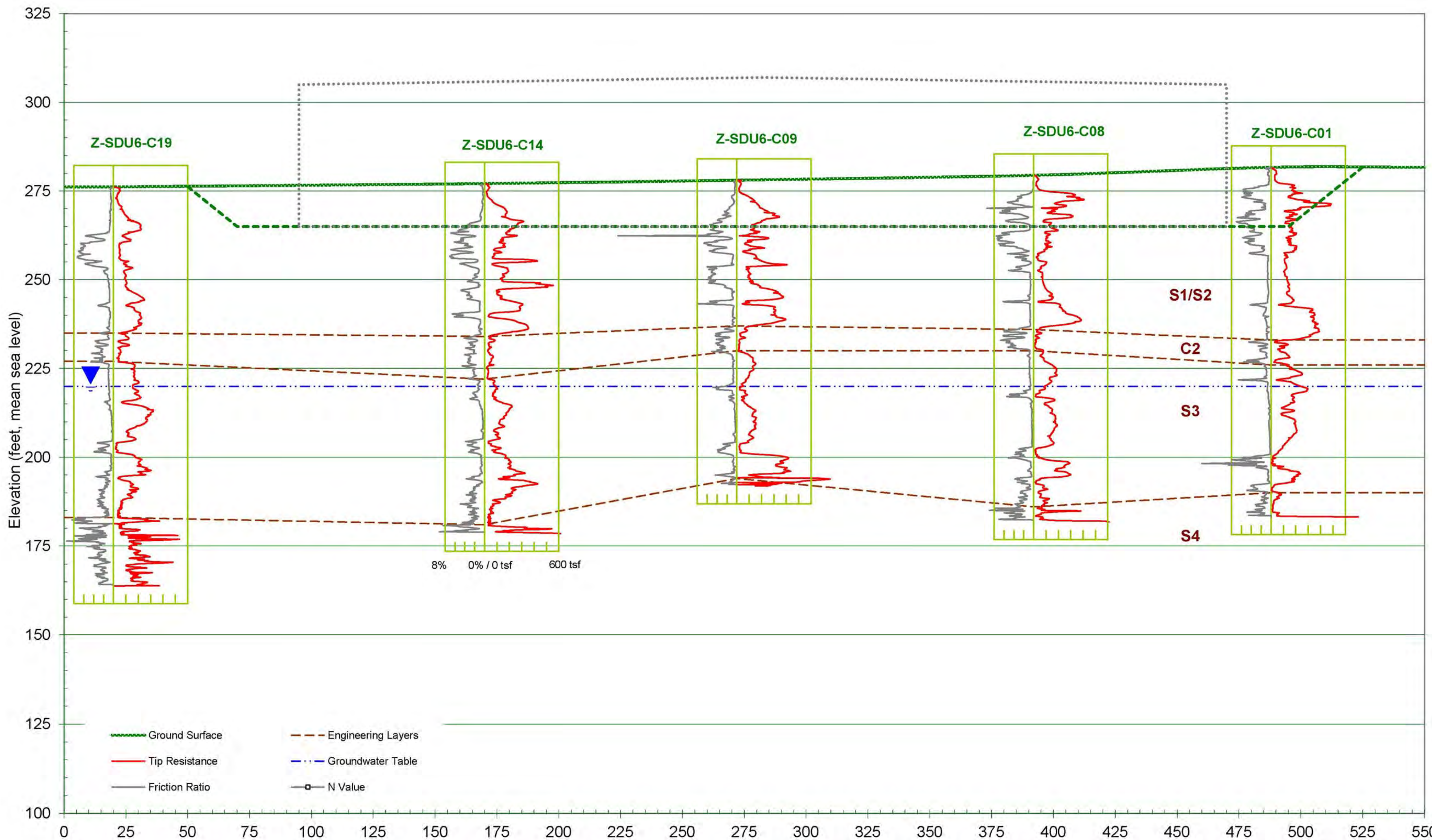



**Figure 10: Cross Section FF**

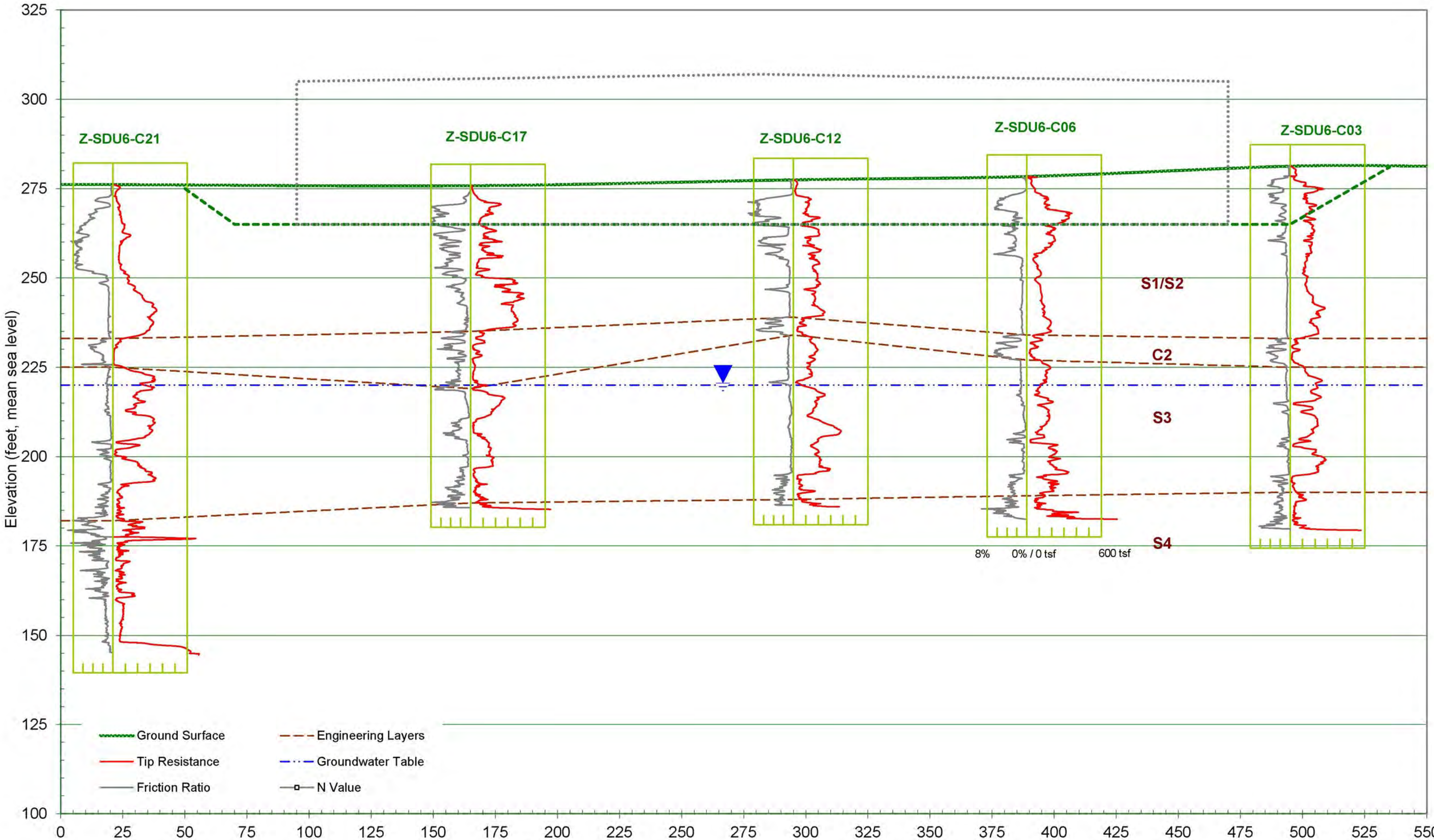



**Figure 11: Cross Section GG**

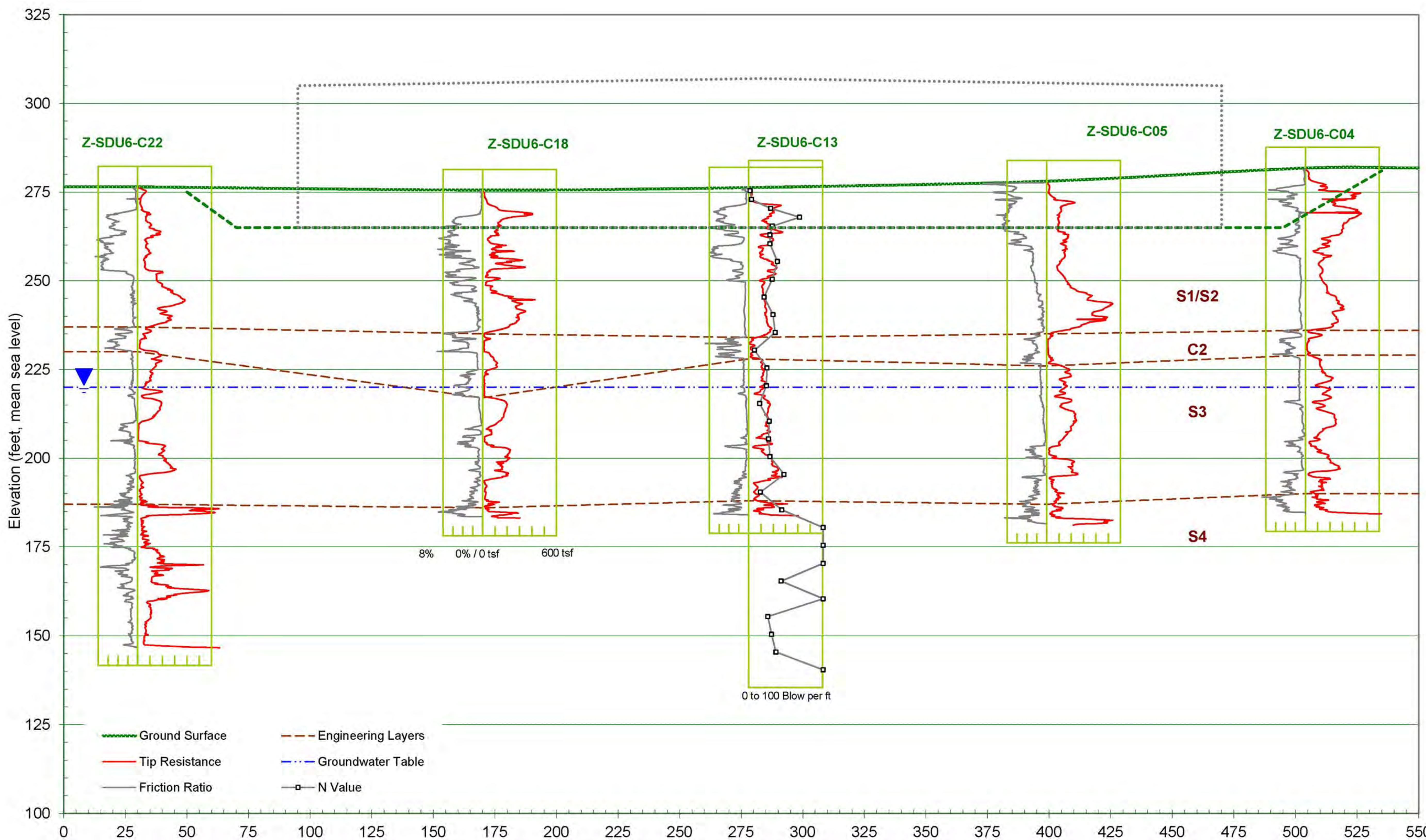



**Figure 12: Cross Section HH**

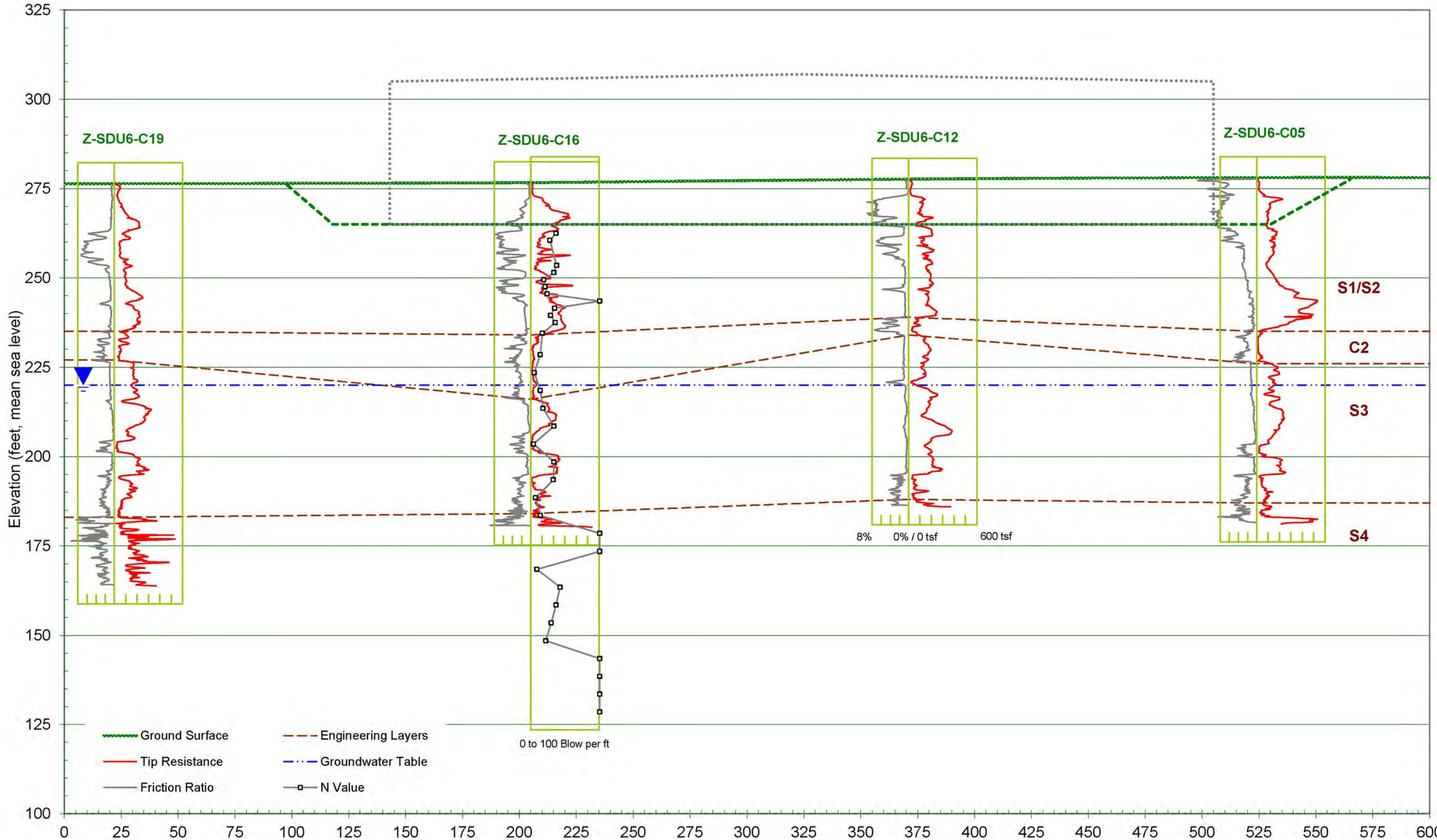



**Figure 13: Cross Section II**

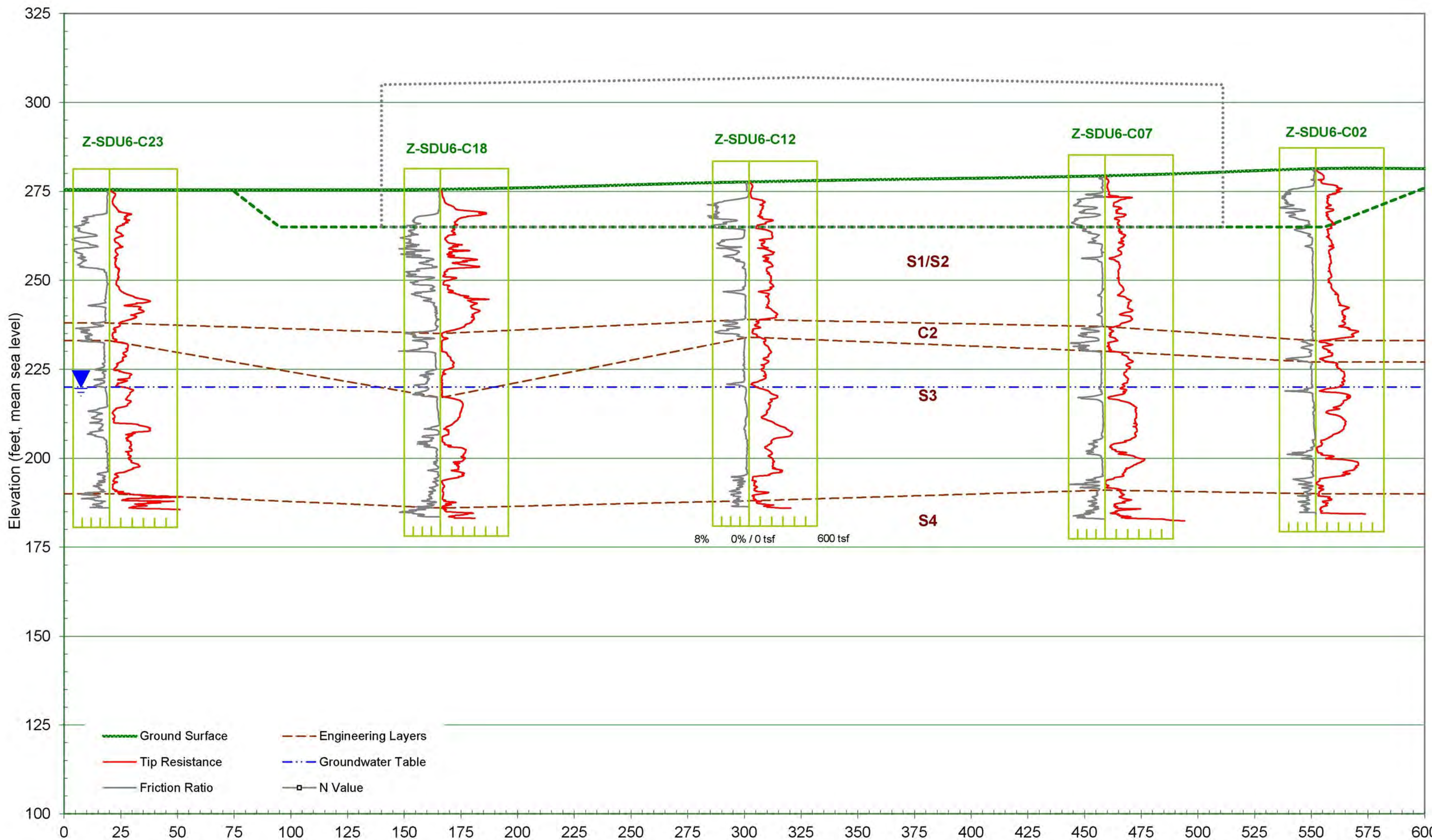



**Figure 14: Cross Section JJ**

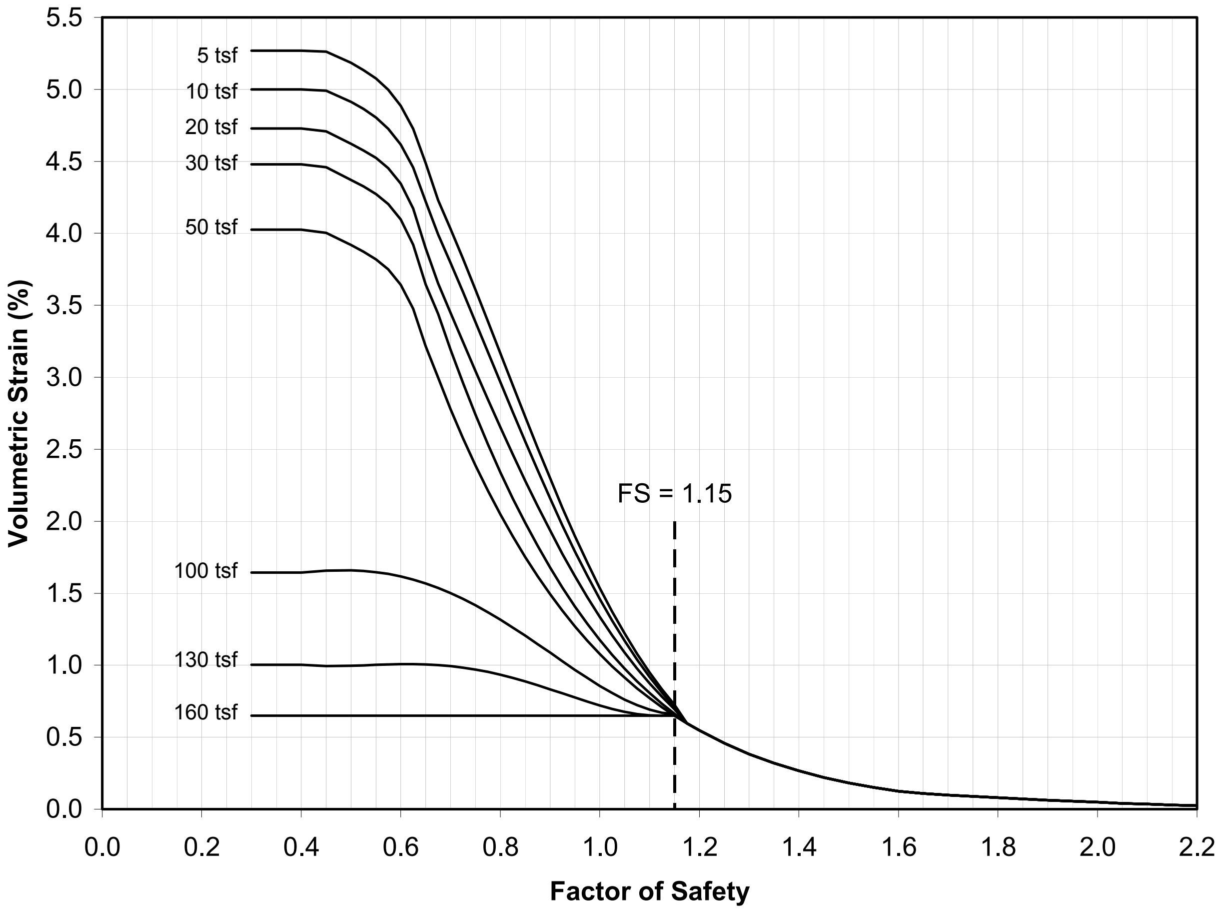
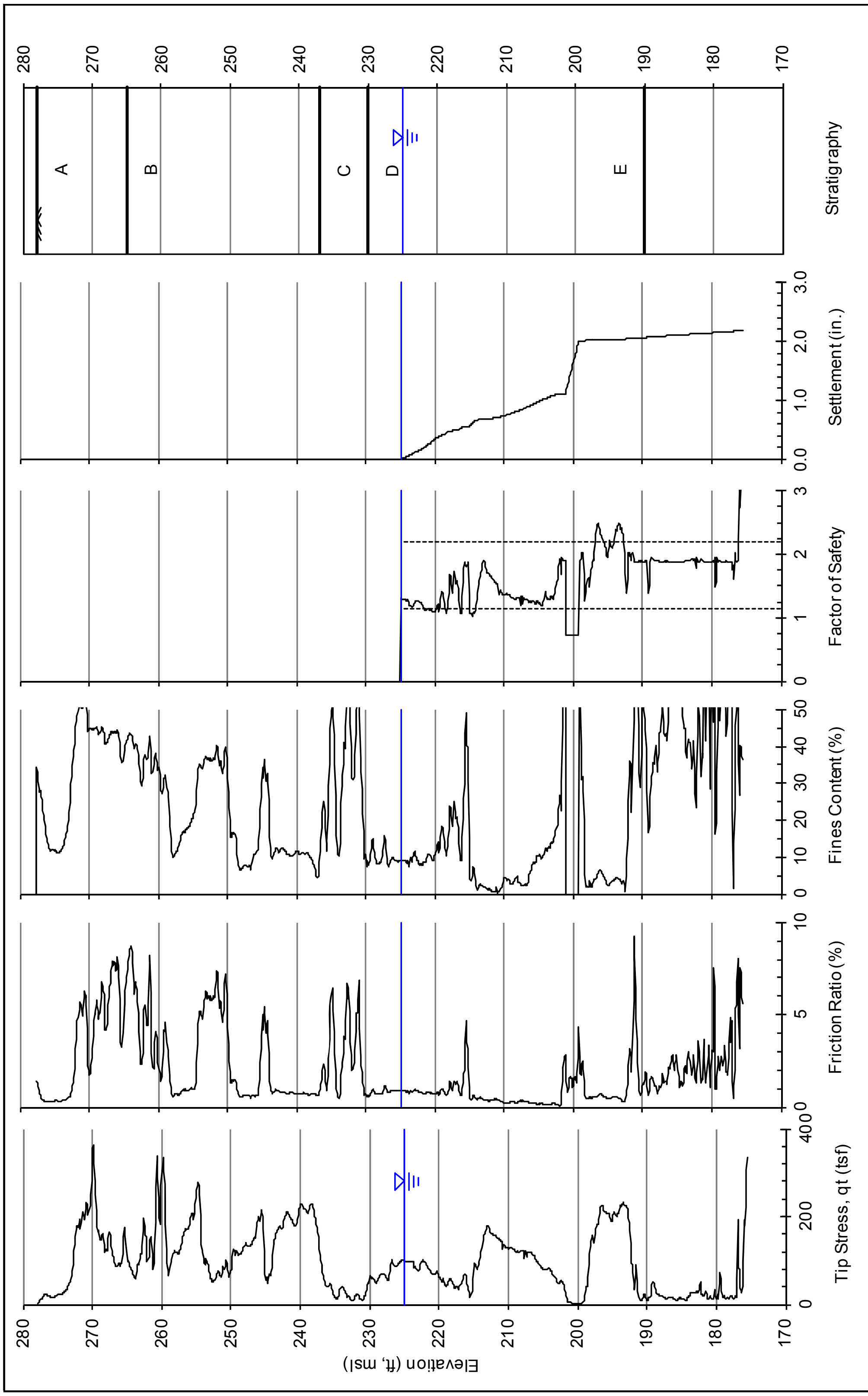



**Figure 15: SRS Volumetric Strain Curves for Liquefaction Analysis**




| Magnitude | 4.75 | 5.25 | 5.75 | 6.25 | 6.75 | 7.5 |
|---|---|---|---|---|---|---|
| Minimum Factor of Safety | 2.47 | 1.96 | 1.60 | 1.24 | 1.02 | 0.73 |
| Average Factor of Safety | 5.55 | 4.41 | 3.59 | 2.78 | 2.29 | 1.63 |
| Maximum Settlement | 0.00 in. | 0.01 in. | 0.03 in. | 0.17 in. | 0.54 in. | 2.17 in. |

| **2,500 Year Weighted Average Settlement** | 1.07 in. |
|---|---|

| Stratigraphy/Layer Description | |
|---|---|
| A | S1/S2 |
| B | Bottom of Excavation |
| C | C2 |
| D | S3 |
| E | S4 |

**Figure 16: Liquefaction Induced Settlement of CPT Z-SDU6-C10**

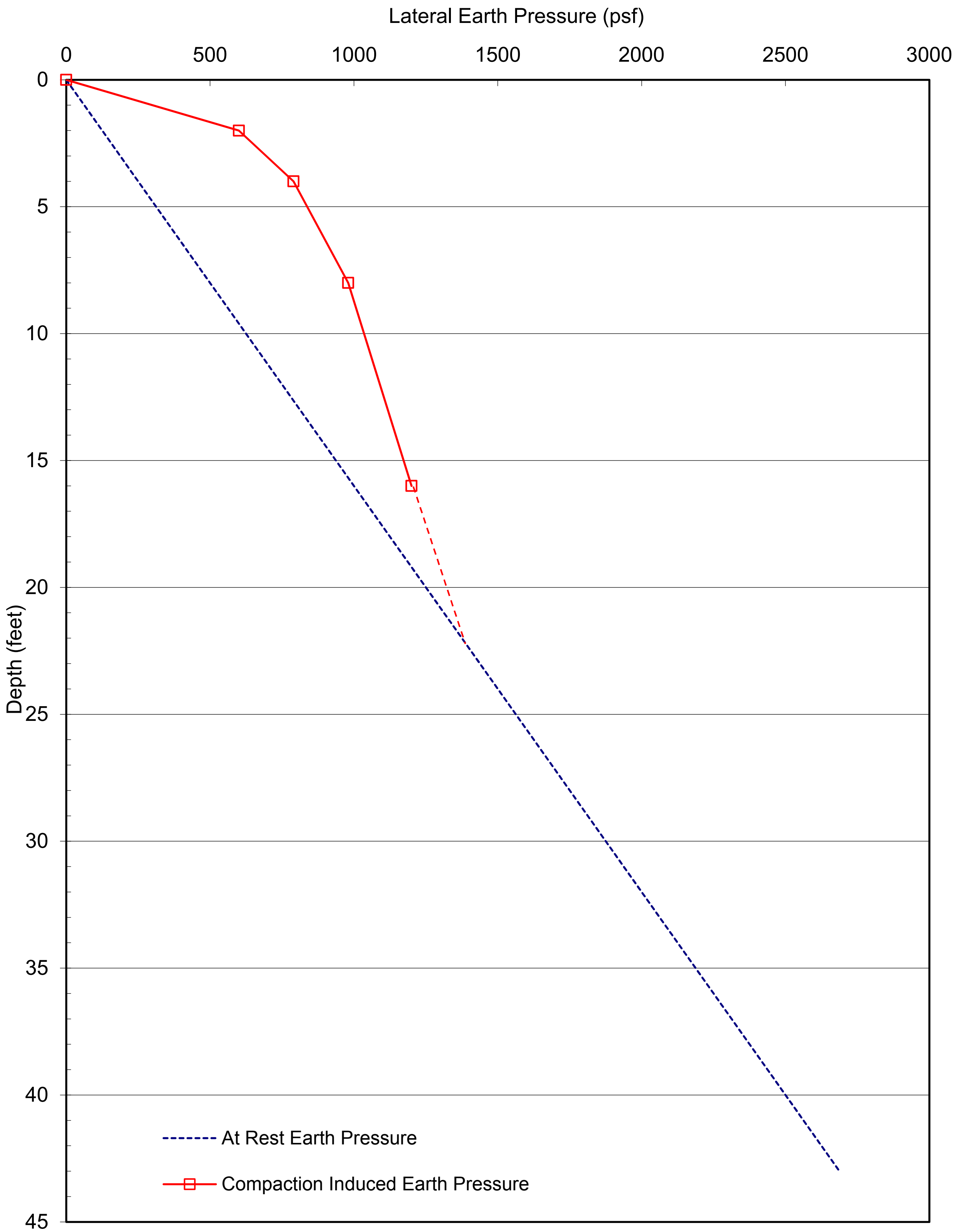



**Figure 17: Compaction Induced Lateral Earth Pressures**

# Appendix A - Stratigraphy

K-CLC-Z-00022, Rev. 0

March 2012

Stratigraphy for Saltstone Disposal Unit 6 (SDU6)

(202 pages)

## Calculation Cover Sheet

| Project/Task | Calculation No. | Project /Task No. |
|---|---|---|
| Saltstone Disposal Unit 6 | K-CLC-Z-00022 | SDU6 |
| **Title** Stratigraphy for Saltstone Disposal Unit 6 (SDU6) | **Functional Classification** PS | Sheet 1 of 201 |
| | **Discipline** Geotechnical | |
| **Calc Level** ☒ Type 1 ☐ Type 2 | **Type 1 Calc Status** ☐ Preliminary ☒ Confirmed | |
| **Computer Program No.** ☒ N/A | **Version / Release No.** N/A | |
| **Purpose and Objective** Develop engineering stratigraphy for SDU 6 for engineering analysis | **DC/RO** UNCLASSIFIED DOES NOT CONTAIN UNCLASSIFIED CONTROLLED NUCLEAR INFORMATION ADC & Reviewing Official Silip Amin / Engr. 3/19/12 (Name) Date: 3/19/12 | |

**Summary of Conclusion**

See the Results and Conclusions Section.

**Revisions**

| Rev. # | Revision Description |
|---|---|
| 0 | Original |
| | |

**Sign Off**

| Rev. # | Originator (Print) Sign / Date | Verification / Checking Method | Verifier/Checker (Print) Sign/Date | Manager (Print) Sign / Date |
|---|---|---|---|---|
| 0 | Patti Bennett<br>Patti Bennett / 3-15-2012 | ☐ Design Check (GS/PS Only)<br>☒ Document Review<br>☐ Qualification Testing<br>☐ Alternate Calculation<br>☐ Operational Testing | Rucker J. Williams<br>[signature] 3-15-12 | Nick Kennedy<br>[signature] 3.15.12 |
| | | ☐ Design Check (GS/PS Only)<br>☒ Document Review<br>☐ Qualification Testing<br>☐ Alternate Calculation<br>☐ Operational Testing | | |

| Additional Reviewer (Print) | Signature | Date |
|---|---|---|
| N/A | | |
| **Design Authority (Print)** N/A | **Signature** | **Date** |
| **Release to Outside Agency (Print)** N/A | **Signature** | **Date** |

**Security Classification of the Calculation**
Unclassified

## 1. INTRODUCTION

This calculation identifies engineering stratigraphic layers for Saltstone Disposal Unit 6 (SDU6). Engineering stratigraphic layers and nomenclature were based on previous subsurface investigations performed within Z Area by Mueser Rutledge Consulting Engineers (MRCE) and SRS. Figure 1 depicts the location of SDU6 within Z Area.

## 2. INPUT DATA

Subsurface data acquired for the SDU6 investigation included twenty-three (23) Cone Penetration Tests (CPT), six (6) of those included Seismic Piezocone Penetration Testing (SCPTU) (Ref 1). In addition, five (5) borings were performed, with the following data obtained:

- Borings B01 and B02A: Shelby Tube and Fixed Piston sampling only. No stratigraphic picks were made on these borings.
- Boring B02B: geophysical logs and Fixed Piston sampling
- Borings B03 and B04: geophysical logs, Standard Penetration Test and Split Spoon sampling

Locations of all cones and borings are depicted in Figure 2.

| Name | Type | Date | UTM_E | UTM_N | SRS_E | SRS_N |
|---|---|---|---|---|---|---|
| Z-SDU6-B01 | BORING | 12/23/2011 | 440115.9 | 3685200.1 | 66309.1 | 77771.3 |
| Z-SDU6-B02A | BORING | 12/29/2011 | 440212.4 | 3685215.3 | 66594.8 | 77625.3 |
| Z-SDU6-B02B | BORING | 1/4/2012 | 440210.3 | 3685215.3 | 66588.93 | 77629.21 |
| Z-SDU6-B03 | BORING | 1/11/2012 | 440115 | 3685198.8 | 66304.47 | 77769.57 |
| Z-SDU6-B04 | BORING | 1/25/2012 | 440145.5 | 3685181.2 | 66351.15 | 77663.86 |
| Z-SDU6-C01 | CPT | 11/9/2011 | 440170.4 | 3685104.9 | 66270.1 | 77413.3 |
| Z-SDU6-C02 | SCPTU | 11/9/2011 | 440184 | 3685127.9 | 66350.4 | 77448.1 |
| Z-SDU6-C03 | CPT | 11/8/2011 | 440214 | 3685161.1 | 66494.3 | 77478.3 |
| Z-SDU6-C04 | CPT | 11/7/2011 | 440230.4 | 3685182.4 | 66578.8 | 77503.3 |
| Z-SDU6-C05 | SCPTU | 11/7/2011 | 440212.6 | 3685215.2 | 66594.9 | 77624.5 |
| Z-SDU6-C06 | CPT | 11/4/2011 | 440189.1 | 3685184.2 | 66472.8 | 77587.6 |
| Z-SDU6-C07 | CPT | 11/8/2011 | 440167.9 | 3685153.4 | 66357.1 | 77546.9 |
| Z-SDU6-C08 | CPT | 11/8/2011 | 440150.1 | 3685127.1 | 66258.9 | 77511.4 |
| Z-SDU6-C09 | CPT | 11/3/2011 | 440118.4 | 3685145.6 | 66210.4 | 77621.8 |
| Z-SDU6-C10 | CPT | 11/3/2011 | 440132.9 | 3685164.6 | 66285.6 | 77644.2 |
| Z-SDU6-C11 | CPT | 11/3/2011 | 440146.3 | 3685181.5 | 66354.1 | 77663.3 |
| Z-SDU6-C12 | SCPTU | 11/4/2011 | 440167.1 | 3685204 | 66452.6 | 77682.6 |
| Z-SDU6-C13 | CPT | 11/4/2011 | 440177.4 | 3685226.5 | 66523.4 | 77722.6 |
| Z-SDU6-C14 | CPT | 11/2/2011 | 440093.4 | 3685164.6 | 66180.9 | 77720.6 |
| Z-SDU6-C15 | CPT | 11/2/2011 | 440105.4 | 3685183.8 | 66249.8 | 77748.2 |
| Z-SDU6-C16 | SCPTU | 11/2/2011 | 440116.5 | 3685200.9 | 66312.2 | 77772.2 |
| Z-SDU6-C17 | CPT | 11/2/2011 | 440132.1 | 3685221.3 | 66393.3 | 77796.3 |
| Z-SDU6-C18 | SCPTU | 11/3/2011 | 440147.3 | 3685241.1 | 66471.7 | 77819.4 |
| Z-SDU6-C19 | SCPTU | 10/31/2011 | 440060.5 | 3685196.7 | 66155.6 | 77869.3 |
| Z-SDU6-C20 | CPT | 10/31/2011 | 440075.9 | 3685217.6 | 66236.9 | 77895 |
| Z-SDU6-C21 | CPT | 11/1/2011 | 440092.1 | 3685239.2 | 66321.6 | 77920.9 |
| Z-SDU6-C22 | CPT | 11/1/2011 | 440110.4 | 3685262.5 | 66415.1 | 77947.5 |
| Z-SDU6-C23 | CPT | 11/1/2011 | 440123.4 | 3685279.6 | 66482.5 | 77967.7 |

## 3. METHOD FOR DETERMINATION OF ENGINEERING LAYERS

Engineering layers developed for the SDU 6 area followed a scheme previously used by other investigations in Z-Area (Refs 2, 3, 4, and 5). Utilization of this same layering provided a means to compare subsurface conditions between investigation sites. An S or C designation was used to divide layers into predominantly sand and clay units, respectively. The upper layer S1/2 exists from the surface to the C2 layer. The C2 layer corresponds to what has commonly been termed the "Tan Clay" layer. The S3 layer exists between the C2 layer and the S4 layer and corresponds to the lower portion of the Dry Branch Formation. The S4 layer corresponds to the Santee/Tinker Formation. This layering system was extended to the SDU6 area by correlating CPT curve signatures to the CPT curve signatures interpreted for previous investigations.

The Congaree Formation and Warley Hill formations were identified on borings B03 and B04 based primarily on the gamma curve readings. (Attachment 3)

Previous investigations' data also included Boring/Wells SDS12A (Ref 6) and Z-221 (Ref 2) located adjacent to the study area and are included in Cross-Section CC.

Descriptions of geological formations and associated soil properties as found in Aadland, et al (Ref 7) were utilized as a general interpretation resource.

## 4. RESULTS AND CONCLUSIONS

Engineering stratigraphy for SDU6 cones and borings are summarized in Table 1. Contact elevations on borings are approximate as SPT sampling was primarily performed on 2-foot and 5-foot intervals.

There is an area in the northwest portion of the SDU6 tank that shows a marked increase in the thickness of the C2 clay layer. A contour map representing the thickness of the C2 layer was generated using Surfer™ software, exported to ESRI™ shapefile, the attribution modified to include the thickness data and then overlaid onto the SDU6 GIS project (Figure 3). The C2 layer is thickest at cone C18, where the thickness is 18'. The other cones along that line (C14-C18) all show a thickness ranging from 12.4-18.0'. In contrast, the thickness of the rest of the cones in the SDU6 investigation area ranges from 4.0' - 8.9'.

Five (5) cross-sections were created along a southwest-northeast line, three (3) cross-sections were created along a northwest-southeast line and two (2) cross-sections were created that criss-cross diagonally to the other sections. The layout of these cross-sections is included as Figure 4. The cross-sections are included as Figures 5-12.

| ID | grnd elev | total depth | C2 | S3 | S4 | Warle y Hill | Congaree |
|---|---|---|---|---|---|---|---|
| Z-SDU6-B02B | 278.1 | 131 | 234 | 227 | 191 | | |
| Z-SDU6-B03 | 276.5 | 157 | 232 | 217 | 188 | 164 | 146 |
| Z-SDU6-B04 | 277.9 | 307 | 236 | 232 | 191 | 165 | 145 |
| Z-SDU6-C01 | 281.9 | 98.7 | 233 | 226 | 190 | | |
| Z-SDU6-C02 | 281.4 | 97.1 | 233 | 227 | 190 | | |
| Z-SDU6-C03 | 281.6 | 102.3 | 233 | 225 | 190 | | |
| Z-SDU6-C04 | 281.8 | 97.5 | 236 | 229 | 190 | | |
| Z-SDU6-C05 | 278.1 | 97 | 235 | 226 | 187 | | |
| Z-SDU6-C06 | 278.6 | 97 | 234 | 227 | 189 | | |
| Z-SDU6-C07 | 279.4 | 97 | 237 | 230 | 191 | | |
| Z-SDU6-C08 | 279.7 | 97.9 | 236 | 230 | 186 | | |
| Z-SDU6-C09 | 278.3 | 86.4 | 237 | 230 | 194 | | |
| Z-SDU6-C10 | 278 | 102.9 | 237 | 230 | 190 | | |
| Z-SDU6-C11 | 277.6 | 97 | 238 | 233 | 186 | | |
| Z-SDU6-C12 | 277.7 | 91.8 | 239 | 234 | 188 | | |
| Z-SDU6-C13 | 276.3 | 92.5 | 234 | 228 | 188 | | |
| Z-SDU6-C14 | 277.3 | 98.8 | 234 | 222 | 181 | | |
| Z-SDU6-C15 | 276.8 | 98.6 | 232 | 217 | 192 | | |
| Z-SDU6-C16 | 276.7 | 96.5 | 234 | 216 | 184 | | |
| Z-SDU6-C17 | 276 | 90.8 | 235 | 219 | 187 | | |
| Z-SDU6-C18 | 275.6 | 92.5 | 235 | 217 | 186 | | |
| Z-SDU6-C19 | 276.4 | 112.6 | 235 | 227 | 183 | | |
| Z-SDU6-C20 | 276 | 127.8 | 226 | 219 | 176 | | |
| Z-SDU6-C21 | 276.3 | 131.8 | 233 | 225 | 182 | | |
| Z-SDU6-C22 | 276.5 | 129.7 | 237 | 230 | 187 | | |
| Z-SDU6-C23 | 275.5 | 89.9 | 238 | 233 | 190 | | |

**Table 1 – Engineering Stratigraphy** -Tops of Stratigraphic Layers in feet msl.

## 5. REFERENCES


1. Subcontract No. 0000002744, Rev. 0, SUMMARY OF CONE PENETROMETER TEST SOUNDINGS FOR SALTSTONE DISPOSAL UNIT 6 , Document Control Package No. 34864, January 2012.

2. Z-SDF-2, Saltstone Disposal Z-Area, Mueser Rutledge Consulting Engineers, Geotechnical Engineering Files. Oct 14, 1986

3. K-CLC-Z-00005, Stratigraphy for the Saltstone Vault No. 2, Rev 0, July 2005

4. K-ESR-Z-00001, Saltstone Vault No. 2 Geotechnical Investigation Report, Rev 0.

5. K-CLC-Z-00012, Stratigraphy for Saltstone Vaults No. 3 and 5, Rev 0, July 2009

6. S-DWP-38, Boring and Instrument Installation DWPF Salt Disposal Site, D'Appalonia. Geotechnical Engineering Files. 1981

7. Aadland, R. K., Gellici, J. A., and Thayer, P. A., 1995. *Hydrogeologic Framework of West-Central South Carolina*. Report 5, Water Resources Division, South Carolina Department of Natural Resources, Columbia, SC.


## 6. LIST OF FIGURES



## 7. LIST OF TABLES



## 9. ATTACHMENTS

Attachment 1: CPT Data Curves (engineering strata indicated)
Attachment 2: Boring Logs (engineering strata indicated)
Attachment 3: Geophysical Logging Curves

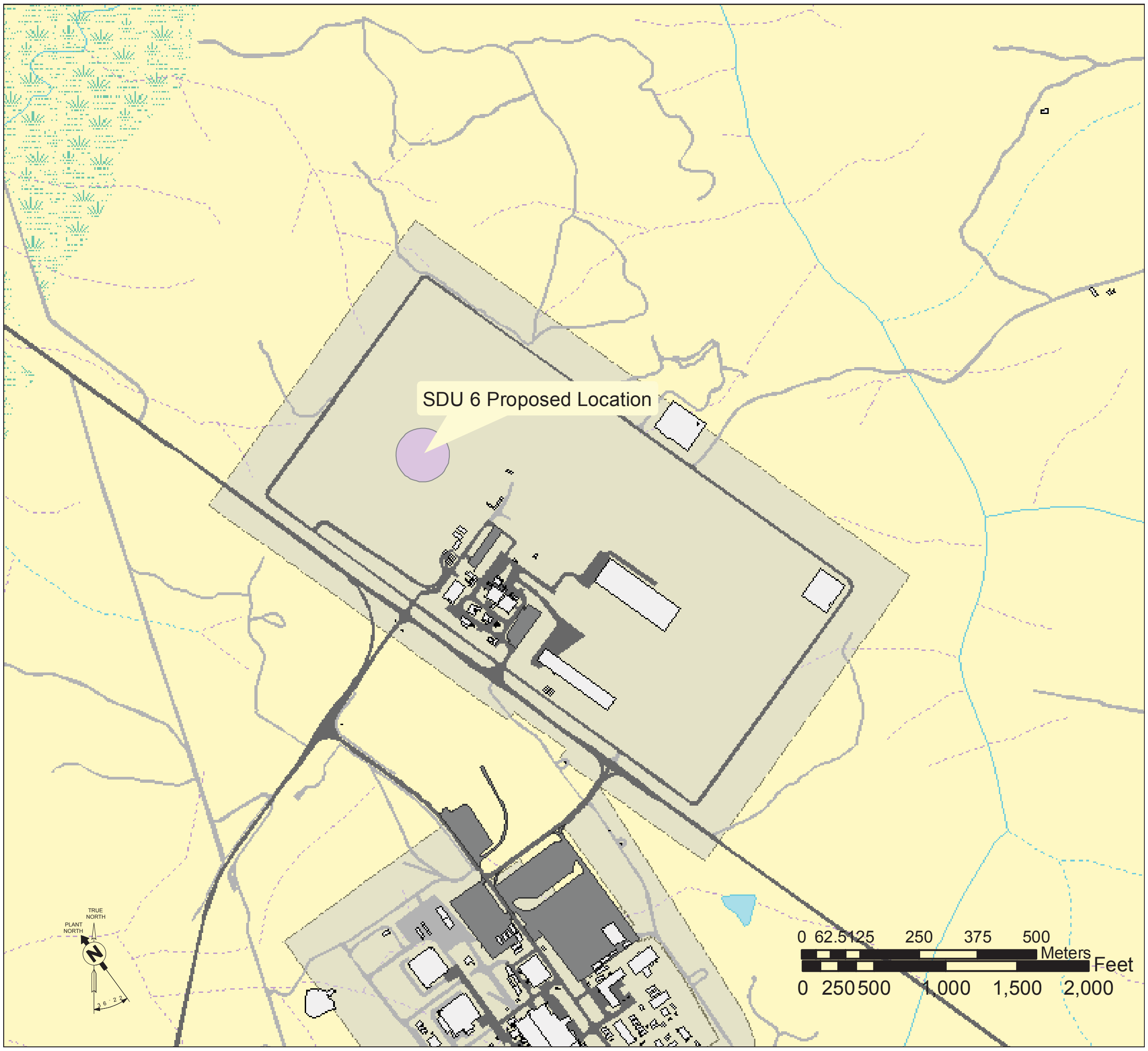



**Figure 1: SDU 6 Location Map**

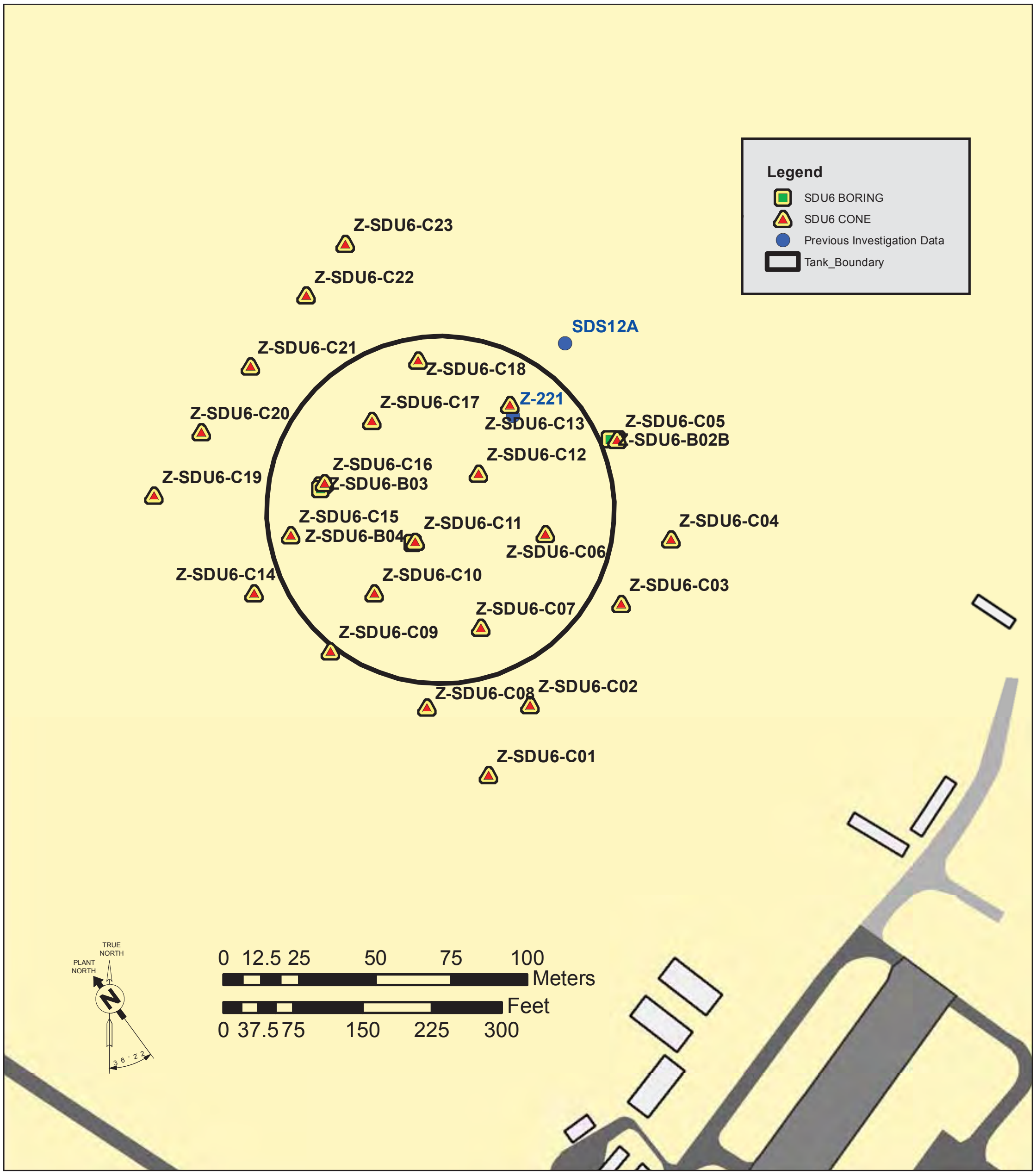



**Figure 2: Geotechnical Investigation Locations**

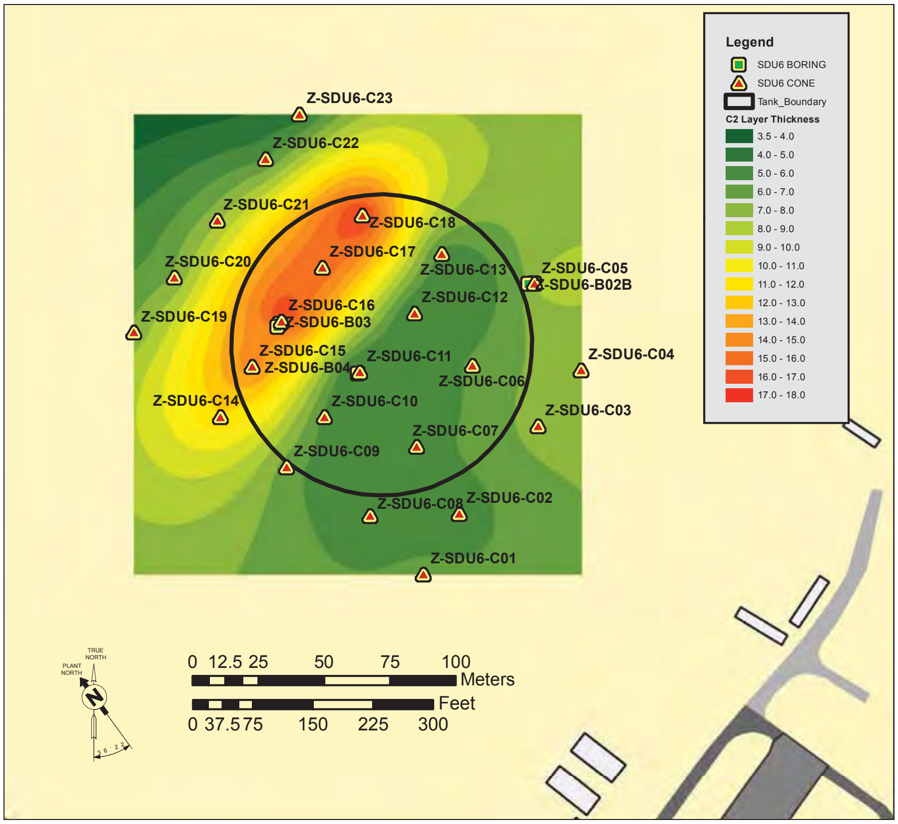



**Figure 3: Thickness of C2 Layer**

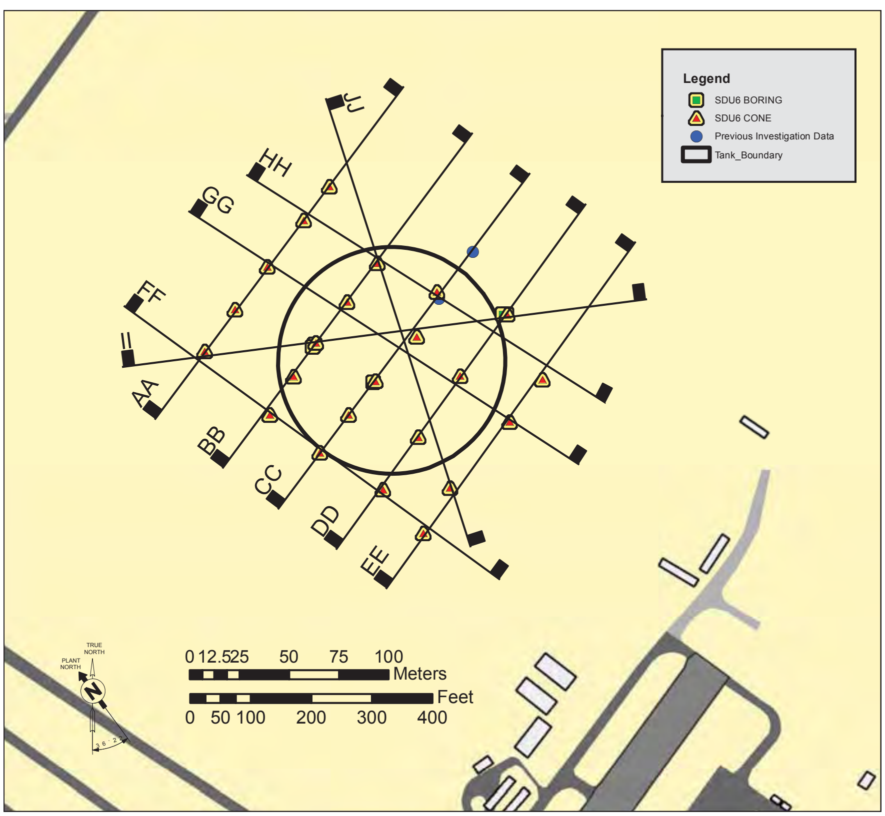



**Figure 4: Cross-Section Locations**

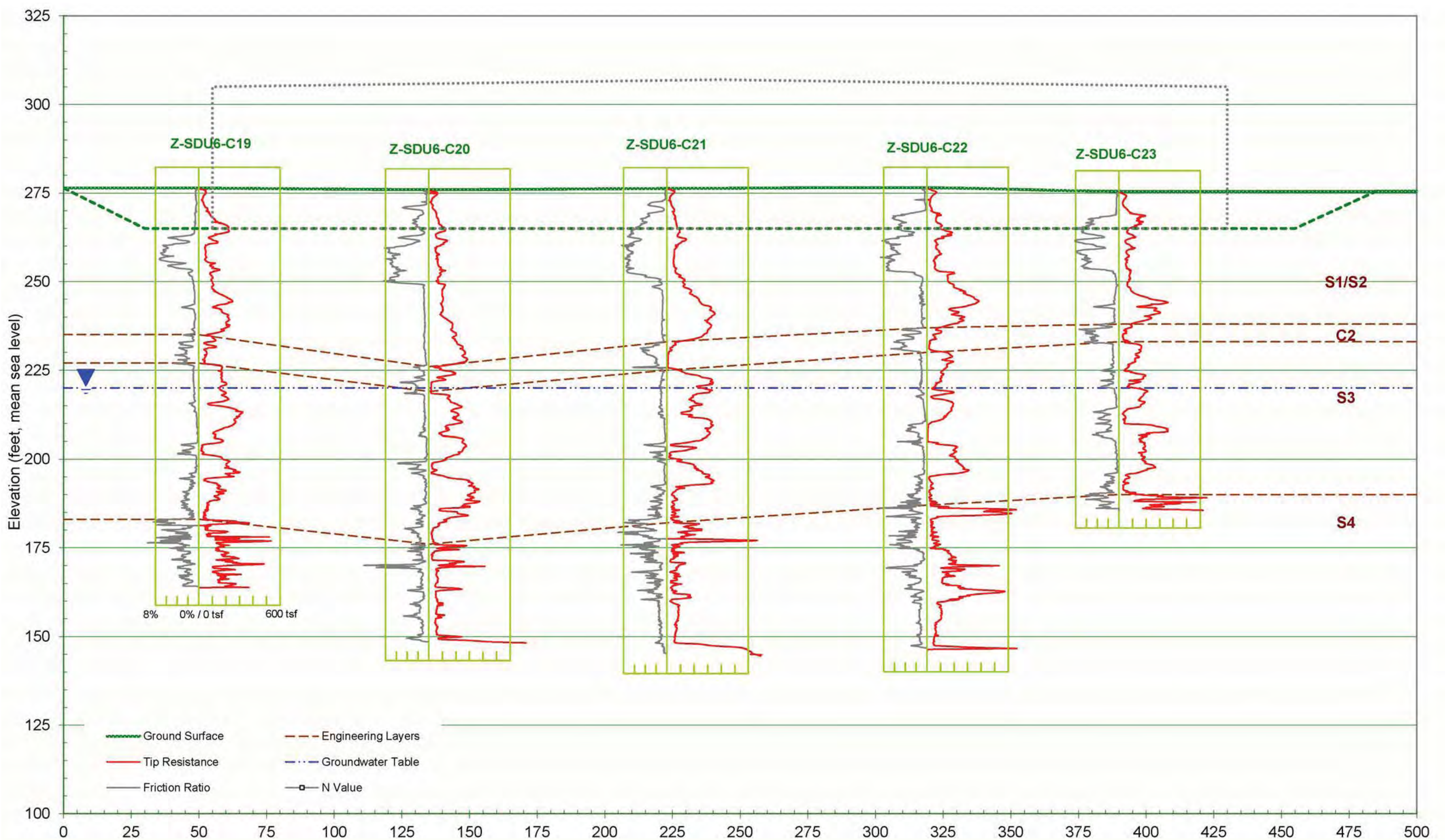



**Figure 5: Cross Section AA**

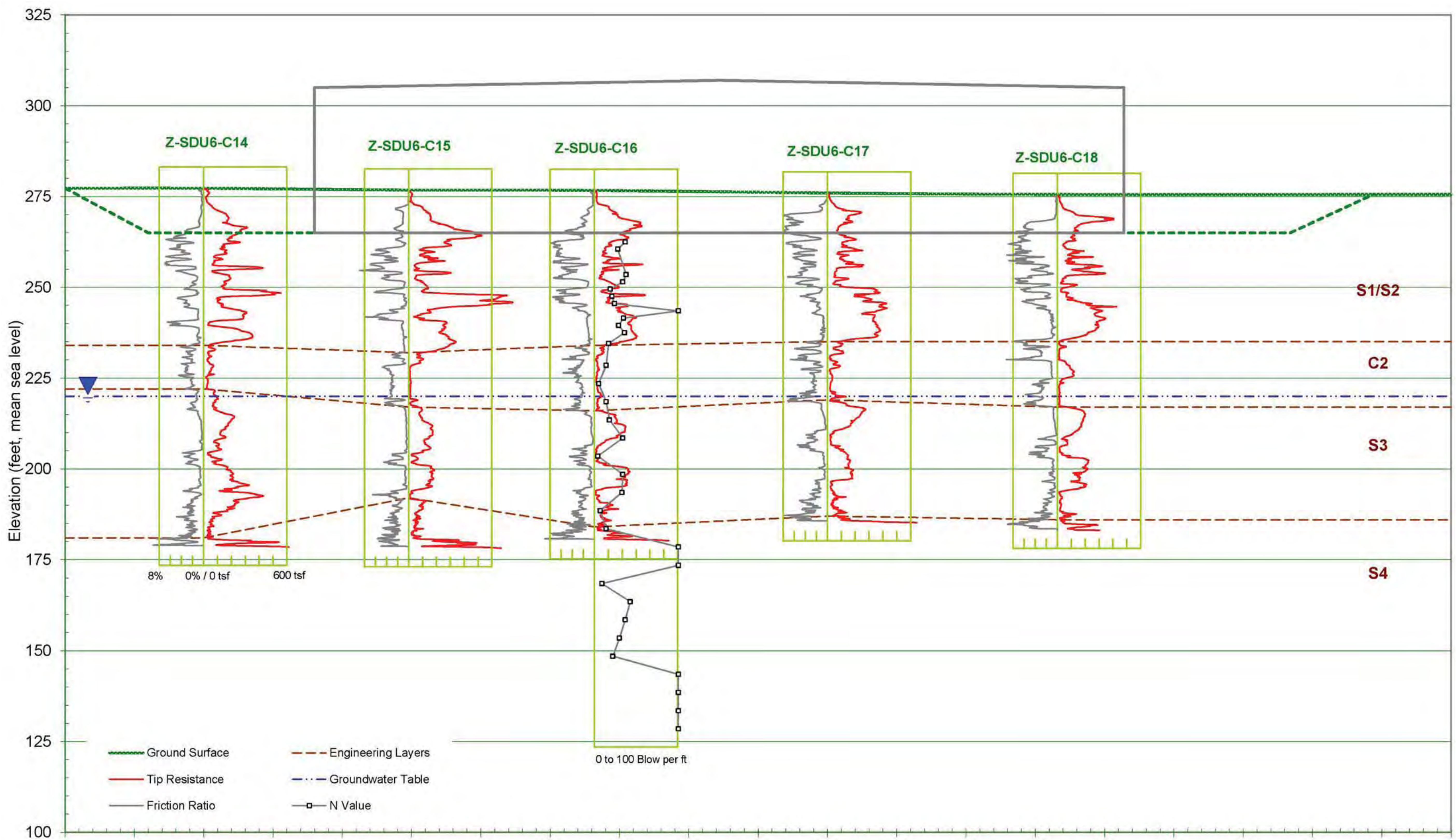



**Figure 6: Cross Section BB**

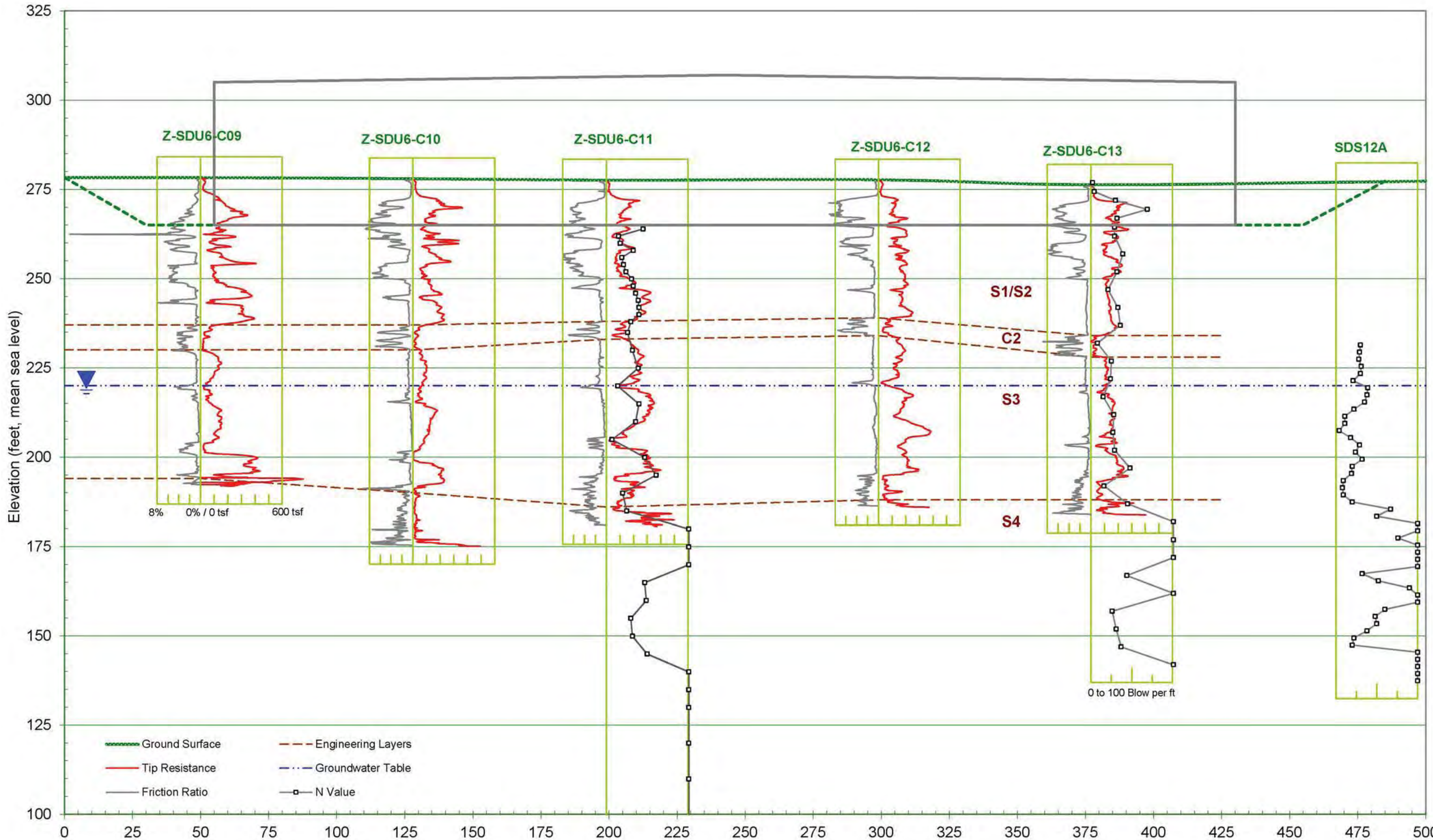



**Figure 7: Cross Section CC**

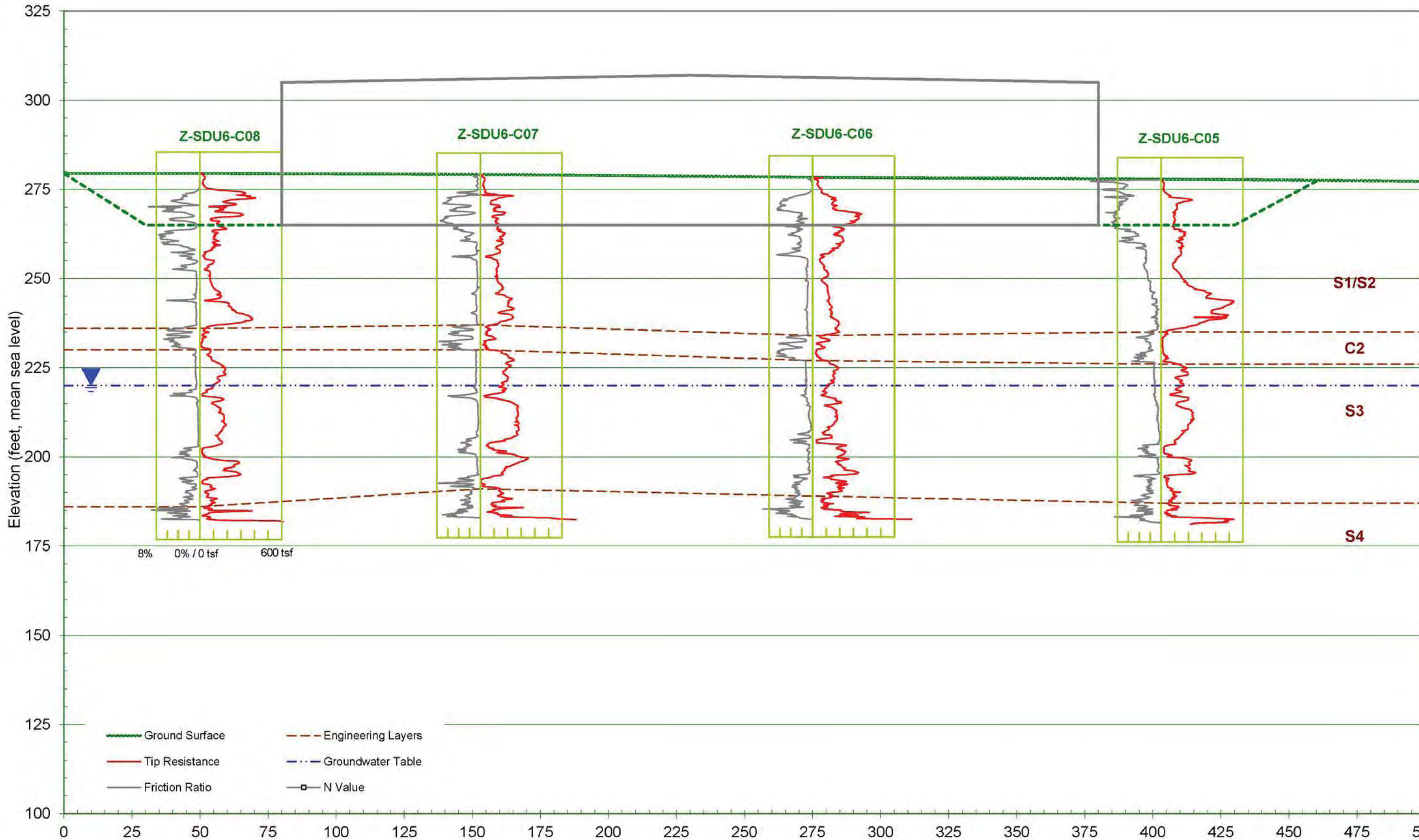


**Figure 8: Cross Section DD**

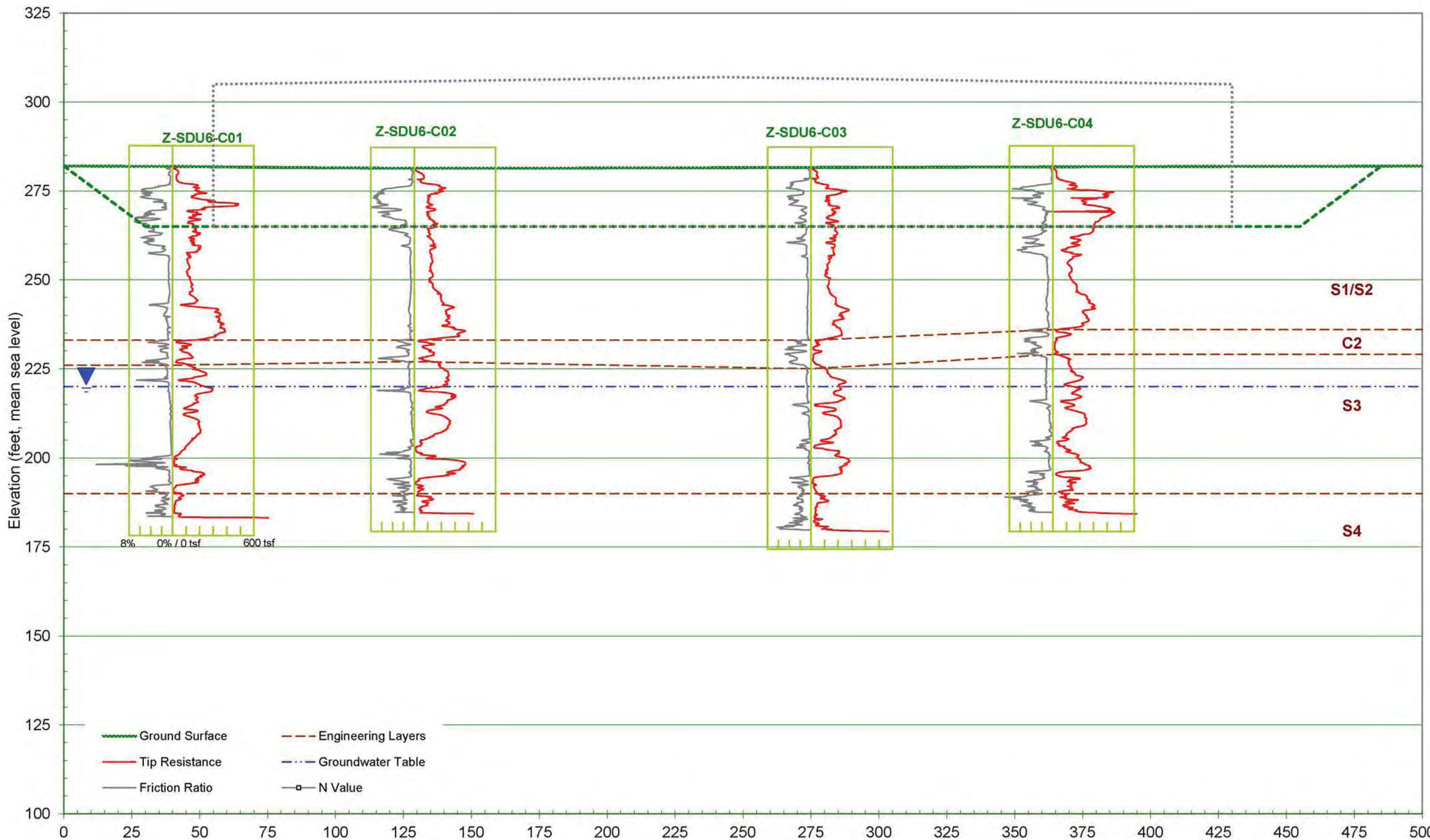



**Figure 9: Cross Section EE**

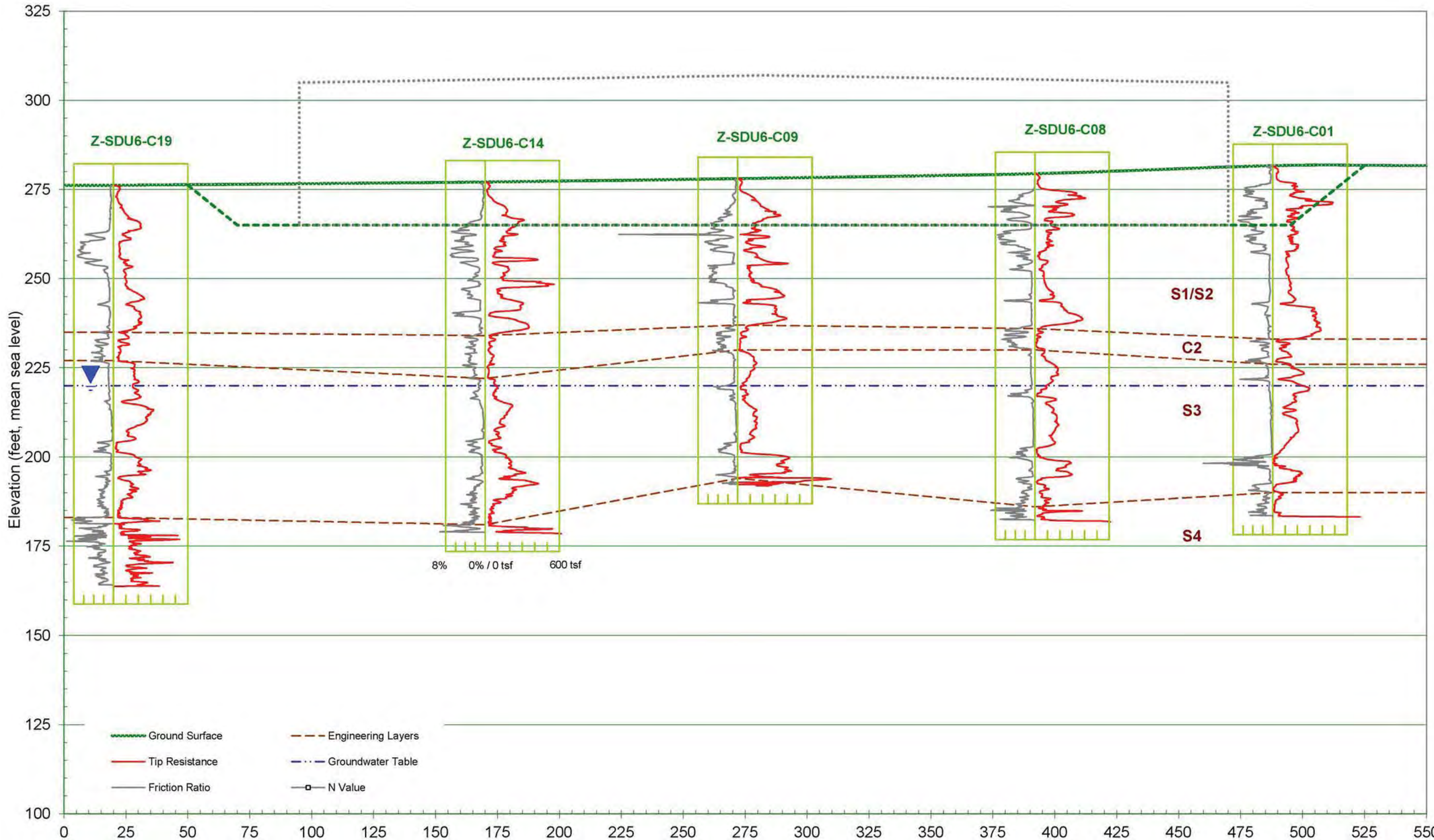



**Figure 10: Cross Section FF**

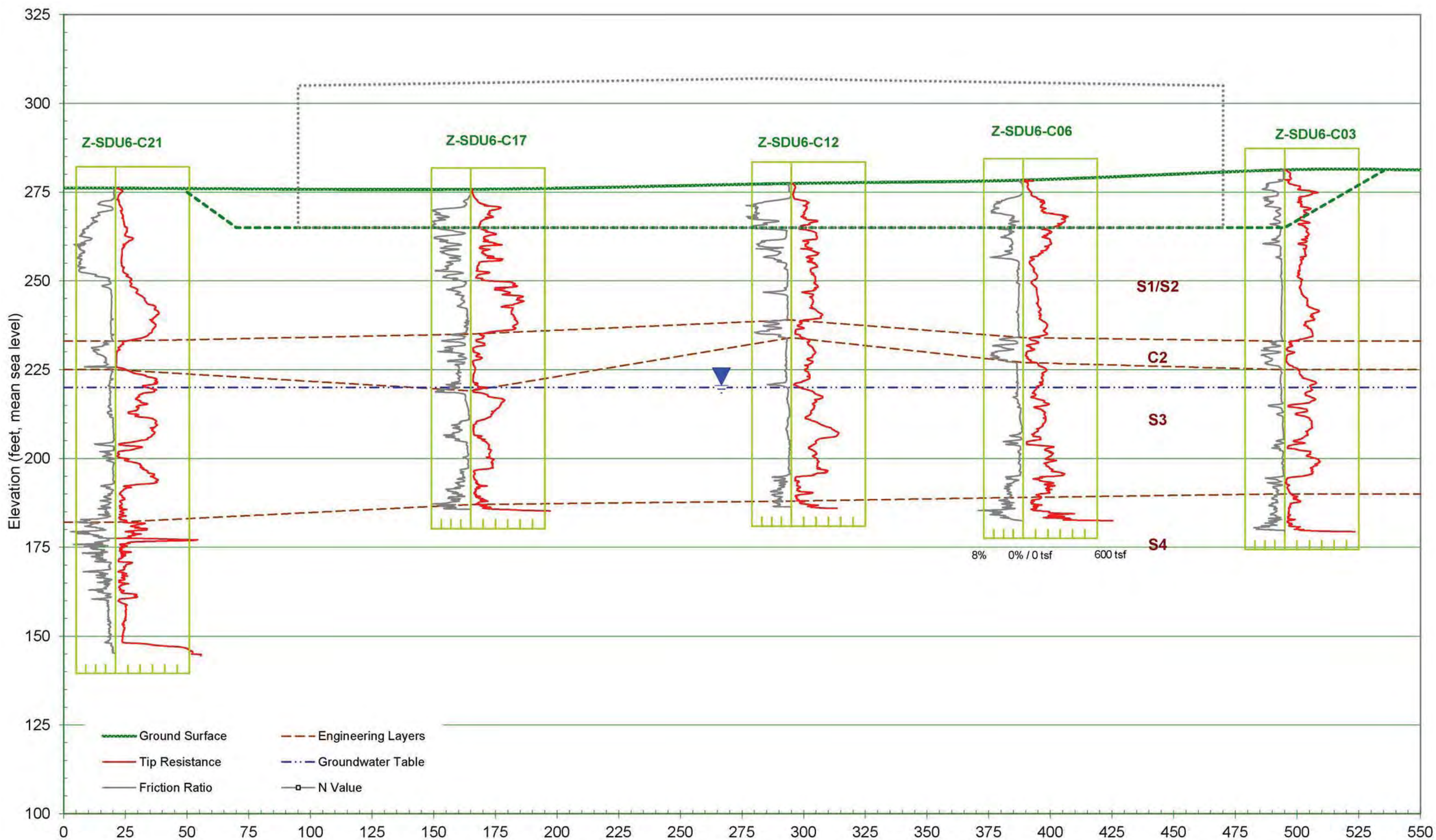



Figure 11: Cross Section GG

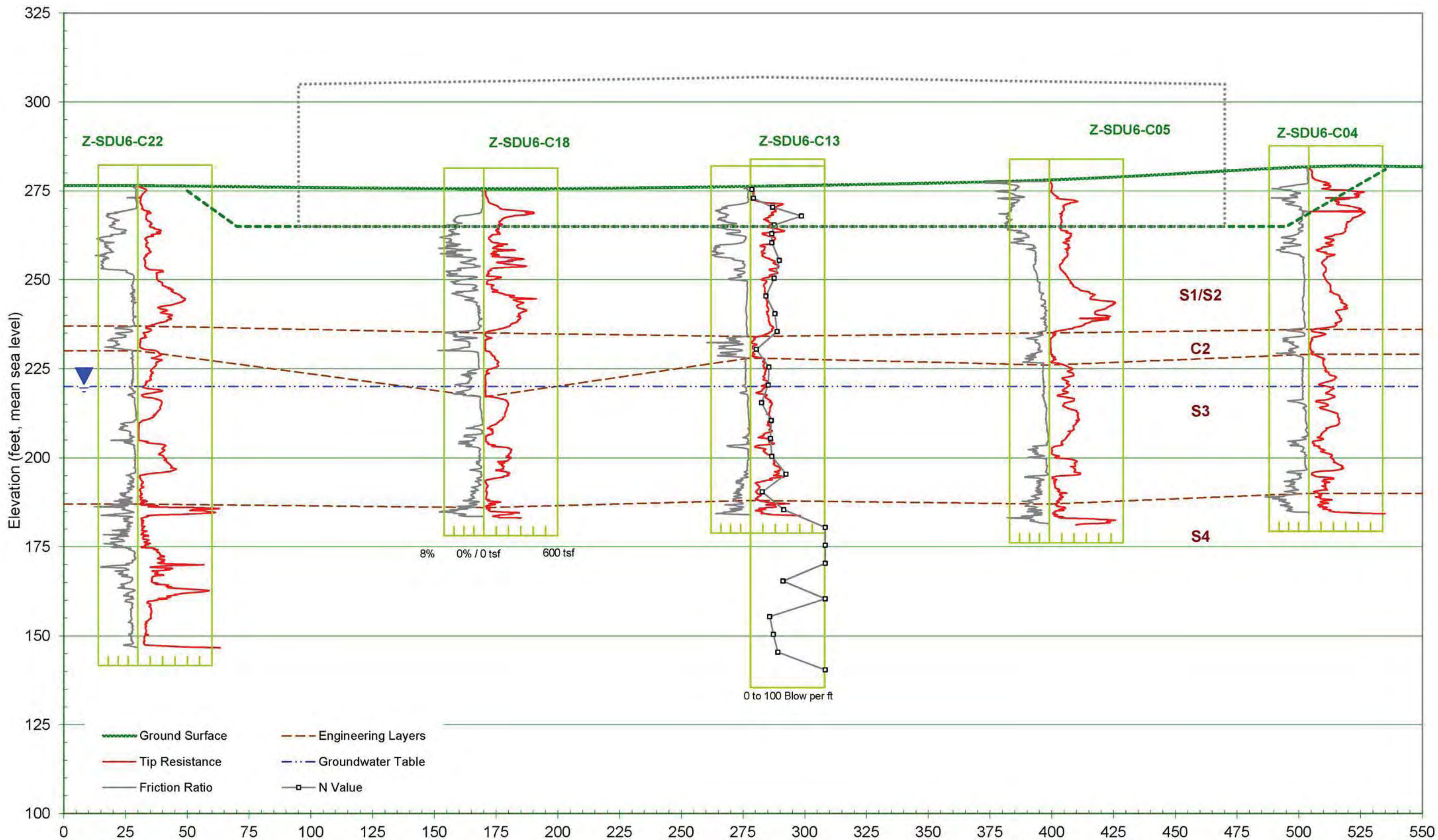



Figure 12: Cross Section HH

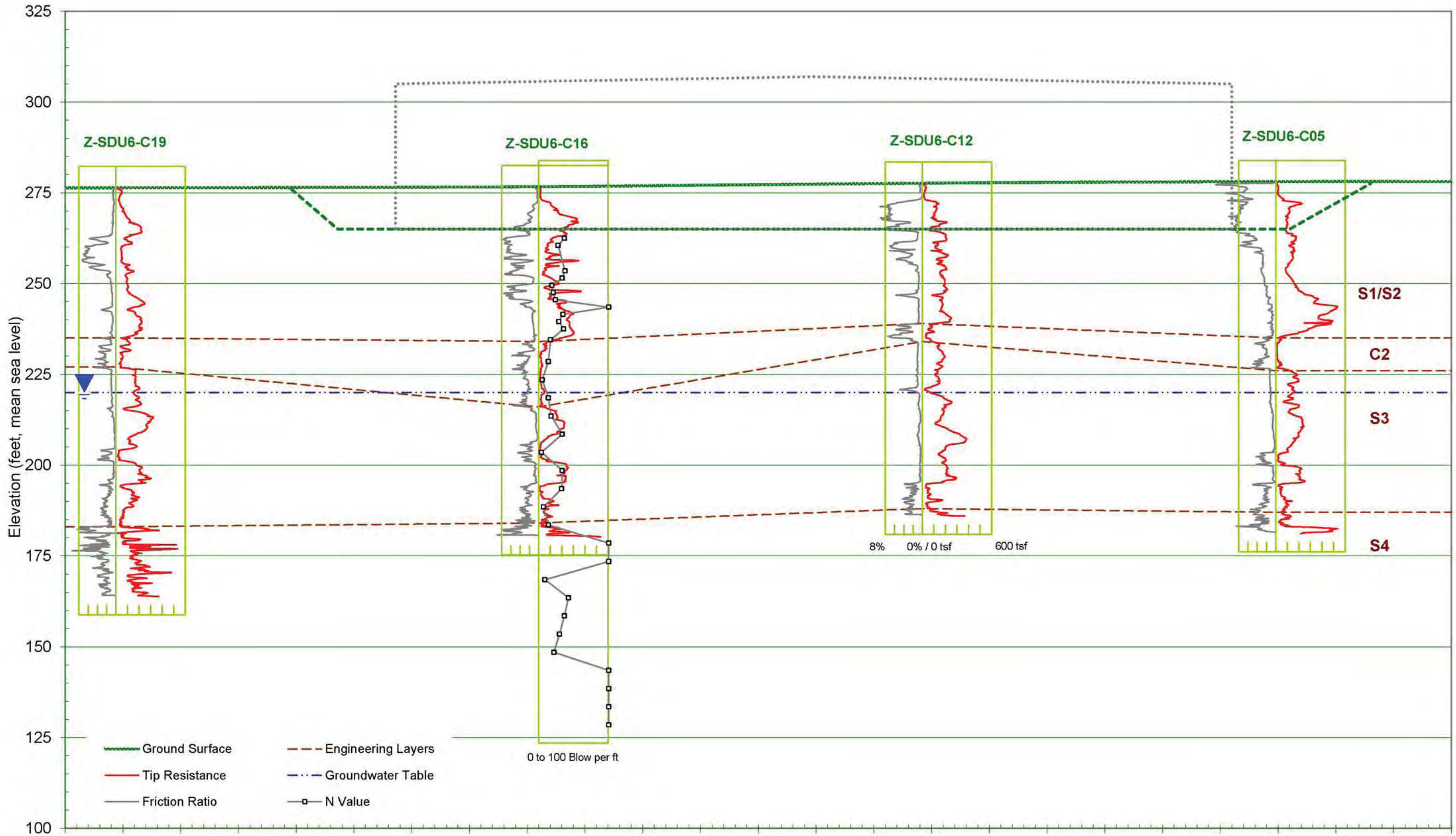



Figure 13: Cross Section II

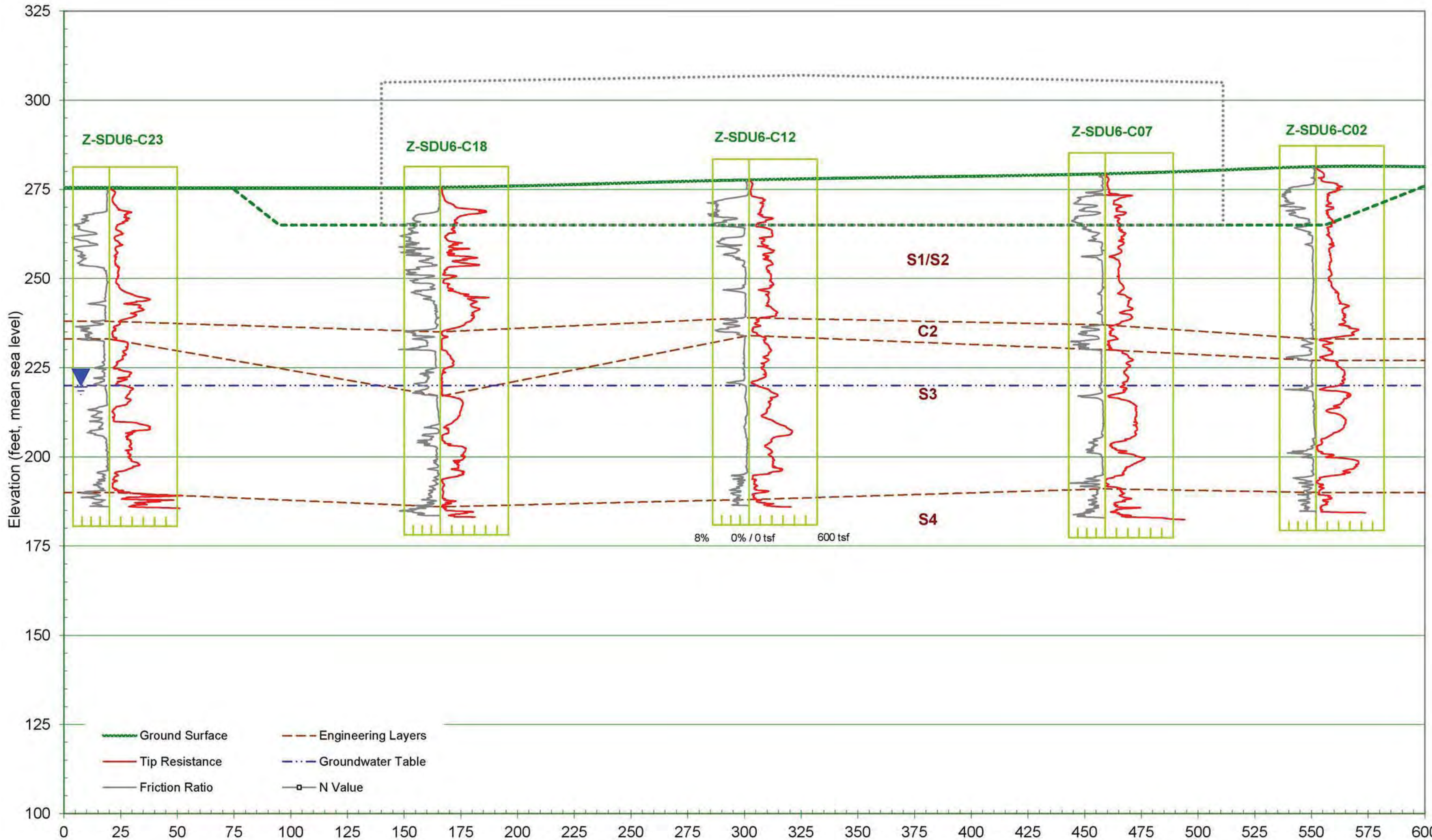



Figure 14: Cross Section JJ

## Attachment 1 - CPT Data Curves (engineering strata indicated)

LANKELMA
GEOTECHNICAL & ENVIRONMENTAL
SITE INVESTIGATION

**Lankelma, Inc.**
841 Main Street.
New Ellenton, SC 29809
T: (713) 481 6832
F: (713) 758 0135

Project No.: R11S002
Revision No.: 0
Task Order No.: 10
January 16, 2011

Mr. Bill Joyce/ Mr. Rucker Williams
Savannah River Nuclear Solutions
Building 730-4B, Room 3064
Aiken, SC 29809

Re: Saltstone Disposal Unit 6

Dear Mr. Joyce and Mr. Williams:

Lankelma, Inc. (Lankelma) presents this final report of Piezo Cone Penetration Test (PCPT) and Seismic Cone Penetration test logs for the tests performed as part of Saltstone Disposal Unit 6 CPT Investigation Project. This report contains all the data collected related to this task and supersedes all previously provided information. The testing was performed under SRNS Strategic Agreement SAQ003, Subcontract No. 0000002744, Statement of Work No.: SAQ003-4644, Revision 0. A total of 23 CPT soundings were performed as part of this task between October 31, 2011 through November 9, 2011 as presented in the attached table. The sounding depths ranged from about 97 to 132 ft.

This report contains the collected data at the sounding locations presented in the attached table. The data presented on the attached sheets was obtained and presented by qualified Lankelma personnel in accordance with the requirements of SRNS Subcontract. The information contained in this report shall supersede all previously provided information for this sub-task and shall be considered as final and correct.

Please feel free to call us if you have any questions regarding the enclosed information.

Sincerely,
**Lankelma, Inc.**

Umesh K. Bachu
President

Attachments: CPT Summary Table
CPT Data including S-Wave data
Pore Pressure Dissipation Graphs

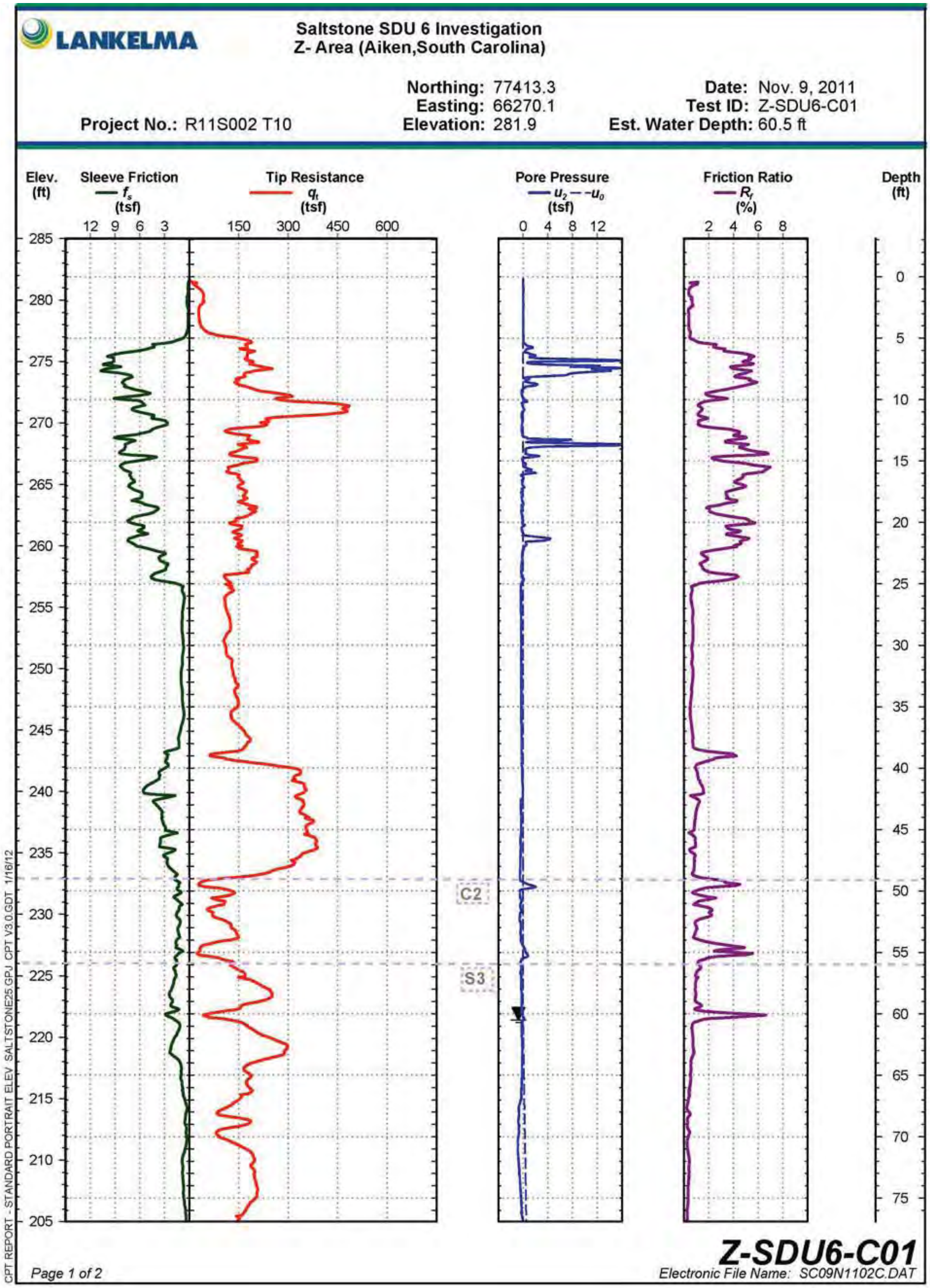
Project No.: R11S002
Revision No. 0
Task Order No.: 10 (SDU6)

LANKELMA

| CPT No. | File Name. | Type | Test Date | Depth, ft | Northing | Easting | Elevation |
|---|---|---|---|---|---|---|---|
| Z-SDU6-C01 | SC09N1102C | CPT | 11/9/2011 | 98.7 | 77413.3 | 66270.1 | 281.9 |
| Z-SDU6-C02 | SC09N1101C | SCPT | 11/9/2011 | 97.1 | 77448.1 | 66350.4 | 281.4 |
| Z-SDU6-C03 | SC08N1101C | CPT | 11/8/2011 | 102.3 | 77478.3 | 66494.3 | 281.6 |
| Z-SDU6-C04 | SC07N1102C | CPT | 11/7/2011 | 97.5 | 77503.3 | 66578.8 | 281.8 |
| Z-SDU6-C05 | SC07N1101C | SCPT | 11/7/2011 | 97.0 | 77624.5 | 66594.9 | 278.1 |
| Z-SDU6-C06 | SC04N1103C | CPT | 11/4/2011 | 97.0 | 77587.6 | 66472.8 | 278.6 |
| Z-SDU6-C07 | SC08N1102C | CPT | 11/8/2011 | 97.0 | 77546.9 | 66357.1 | 279.4 |
| Z-SDU6-C08 | SC08N1103C | CPT | 11/8/2011 | 97.9 | 77511.4 | 66258.9 | 279.7 |
| Z-SDU6-C09 | SC03N1102C | CPT | 11/3/2011 | 86.4 | 77621.8 | 66210.4 | 278.3 |
| Z-SDU6-C10 | SC03N1103C | CPT | 11/3/2011 | 102.9 | 77644.2 | 66285.6 | 278 |
| Z-SDU6-C11 | SC03N1104C | CPT | 11/3/2011 | 97.0 | 77663.3 | 66354.1 | 277.6 |
| Z-SDU6-C12 | SC04N1102C | SCPT | 11/4/2011 | 91.8 | 77682.6 | 66452.6 | 277.7 |
| Z-SDU6-C13 | SC04N1101C | CPT | 11/4/2011 | 92.5 | 77722.6 | 66523.4 | 276.3 |
| Z-SDU6-C14 | SC02N1101C | CPT | 11/2/2011 | 98.8 | 77720.6 | 66180.9 | 277.3 |
| Z-SDU6-C15 | SC02N1102C | CPT | 11/2/2011 | 98.6 | 77748.2 | 66249.8 | 276.8 |
| Z-SDU6-C16 | SC02N1103C | SCPT | 11/2/2011 | 96.5 | 77772.2 | 66312.2 | 276.7 |
| Z-SDU6-C17 | SC02N1104C | CPT | 11/2/2011 | 90.8 | 77796.3 | 66393.3 | 276 |
| Z-SDU6-C18 | SC03N1101C | SCPT | 11/3/2011 | 92.5 | 77819.4 | 66471.7 | 275.6 |
| Z-SDU6-C19 | SC31O1101C | SCPT | 10/31/2011 | 112.6 | 77869.3 | 66155.6 | 276.4 |
| Z-SDU6-C20 | SC31O1102C | CPT | 10/31/2011 | 127.8 | 77895 | 66236.9 | 276 |
| Z-SDU6-C21 | SC01N1101C | CPT | 11/1/2011 | 131.8 | 77920.9 | 66321.6 | 276.3 |
| Z-SDU6-C22 | SC01N1102C | CPT | 11/1/2011 | 131.5 | 77947.5 | 66415.1 | 276.5 |
| Z-SDU6-C23 | SC01N1103C | CPT | 11/1/2011 | 90.0 | 77967.7 | 66482.5 | 275.5 |

**Notes:**

1. Soil Behavior Type interpretation is based on 1990 Robertson and Companella method using friction ratio.
2. Soil Behavior type and the tip and sleeve resistance is not plotted when the push rate is outside ASTM standards, less than 1 cm/sec or greater than 3 cm/sec. Typically, this occurs in hard soils.
3. Negative sleeve friction is typical when the cone passes from hard layers to immediately soft layers.
4. Negative tip stresses are not typically observed in CPT logs. The cones are temperature compensated. However, small shifts in base lines can result in computed values being negative. The magnitude is very low and could be the due to impact of temperature or baseline shifts.
5. Dissipation tests were performed at most locations. Several of the tests reached hydrostatic pressures during the test period.
6. Compression wave data was unusable and not presented. Possible interference and inconsistent triggering resulted in unreliable data for interpretation.
7. Shear wave signals that were not usable were removed from the analyses.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Saltstone SDU 6 Investigation
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Northing: 77413.3
Easting: 66270.1
Elevation: 281.9
Date: Nov. 9, 2011
Test ID: Z-SDU6-C01
Est. Water Depth: 60.5 ft
Project No.: R11S002 T10
Elev. (ft)
Sleeve Friction
fs (tsf)
Tip Resistance
qt (tsf)
Pore Pressure
u2 - -u0 (tsf)
Friction Ratio
Rf (%)
Depth (ft)
C2
S3
CPT REPORT - STANDARD PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12
Page 1 of 2
Z-SDU6-C01
Electronic File Name: SC09N1102C.DAT

LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

**Project No.:** R11S002 T10
**Northing:** 77413.3
**Easting:** 66270.1
**Elevation:** 281.9
**Date:** Nov. 9, 2011
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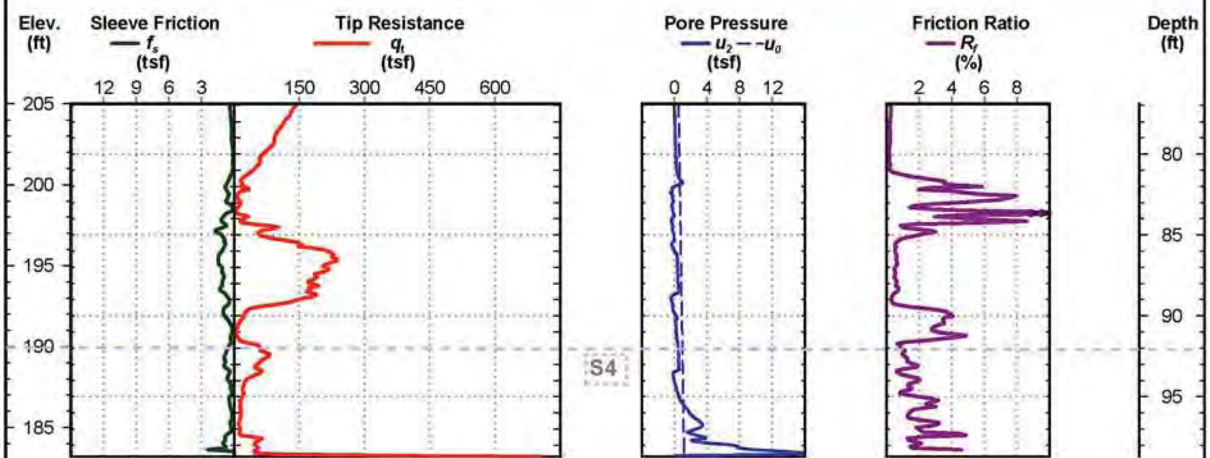
**Est. Water Depth:** 60.5 ft




CPT REPORT - STANDARD PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

Page 2 of 2

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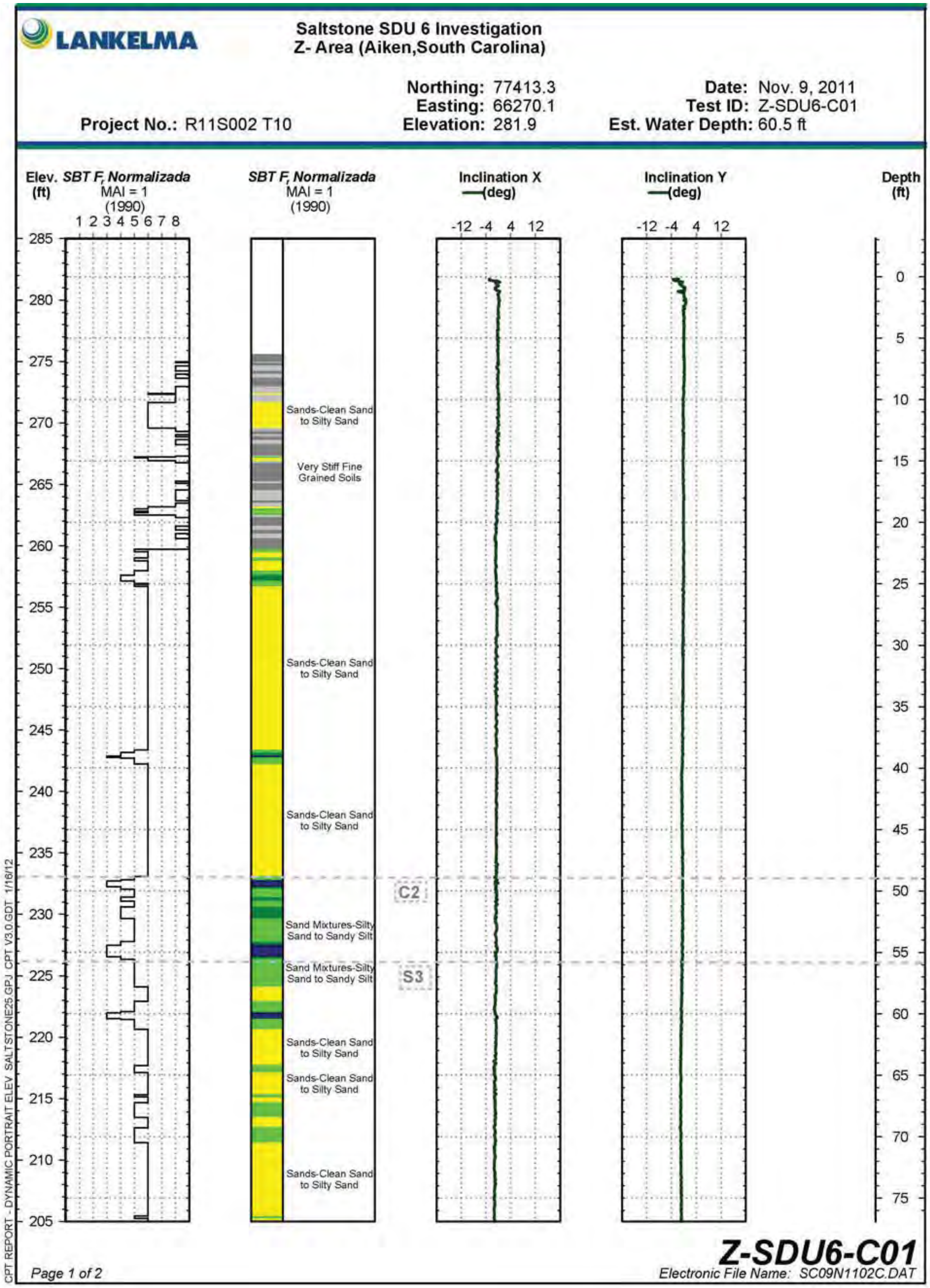

LANKELMA
Saltstone SDU 6 Investigation
Z- Area (Aiken,South Carolina)
Project No.: R11S002 T10
Northing: 77413.3
Easting: 66270.1
Elevation: 281.9
Date: Nov. 9, 2011
Test ID: Z-SDU6-C01
Est. Water Depth: 60.5 ft
Elev. (ft)
SBT F, Normalizada MAI = 1 (1990)
Inclination X (deg)
Inclination Y (deg)
Depth (ft)
Sands-Clean Sand to Silty Sand
Very Stiff Fine Grained Soils
Sand Mixtures-Silty Sand to Sandy Silt
C2
S3
CPT REPORT - DYNAMIC PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12
Page 1 of 2
Z-SDU6-C01
Electronic File Name: SC09N1102C.DAT

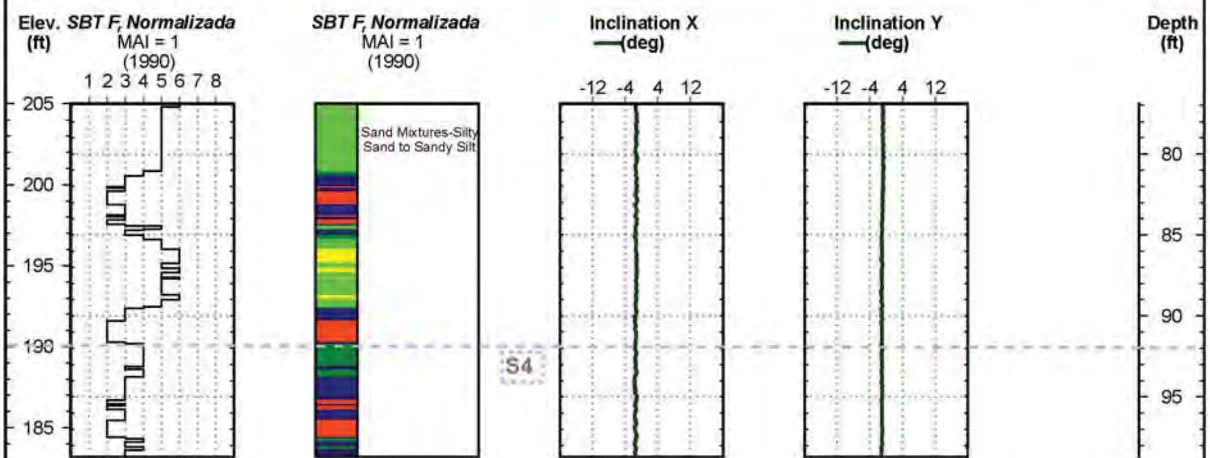
**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

LANKELMA

**Project No.:** R11S002 T10

**Northing:** 77413.3
**Easting:** 66270.1
**Elevation:** 281.9

**Date:** Nov. 9, 2011
**Test ID:** Z-SDU6-C01
**Est. Water Depth:** 60.5 ft




CPT REPORT - DYNAMIC PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

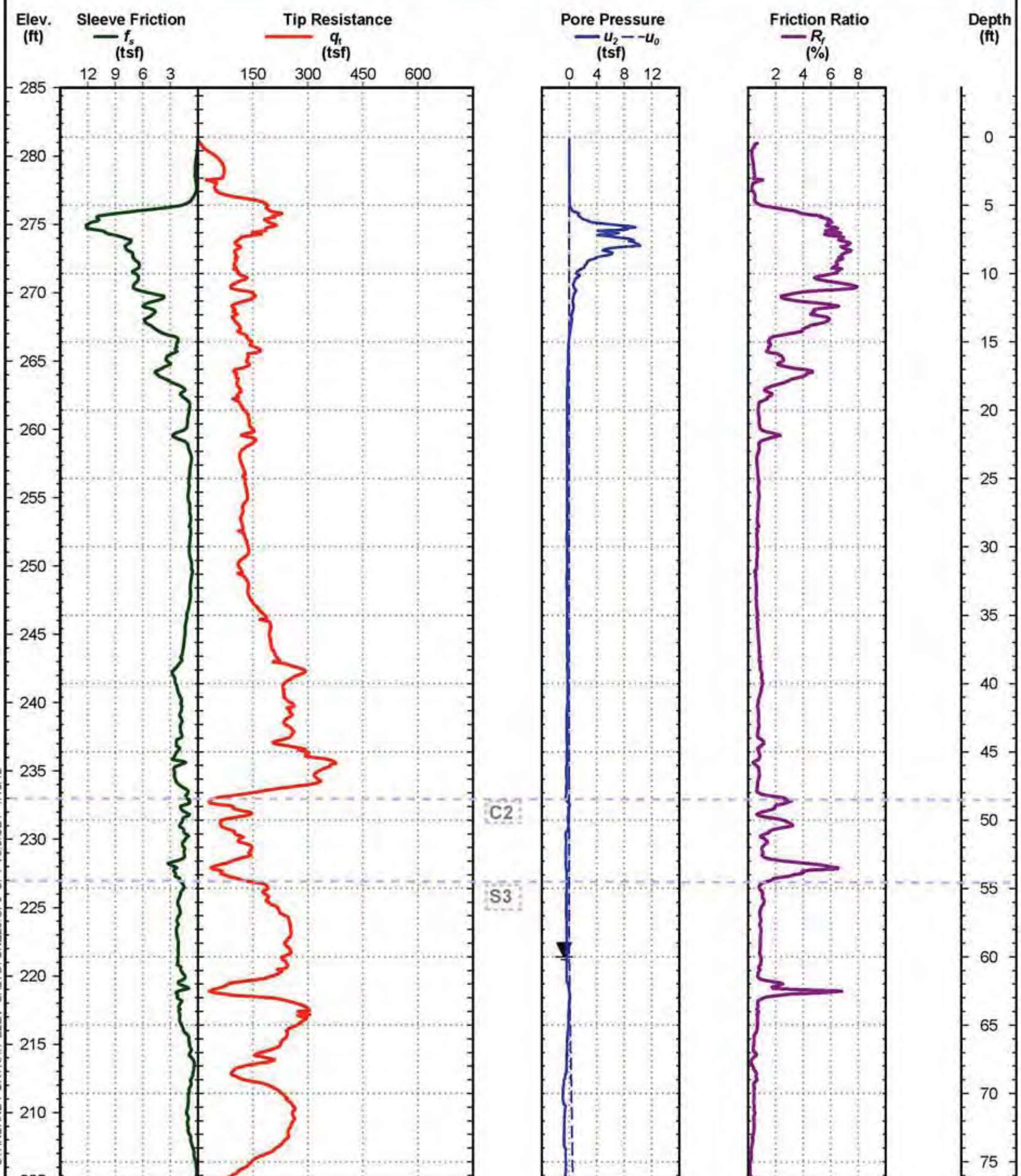
Page 2 of 2

**Z-SDU6-C01**
Electronic File Name: SC09N1102C.DAT

LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

**Project No.:** R11S002 T10
**Northing:** 77448.1
**Easting:** 66350.4
**Elevation:** 281.4
**Date:** Nov. 9, 2011
**Test ID:** Z-SDU6-C02
**Est. Water Depth:** 60 ft




CPT REPORT - STANDARD PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

Page 1 of 2

**Z-SDU6-C02**

Electronic File Name: SC09N1101C.DAT

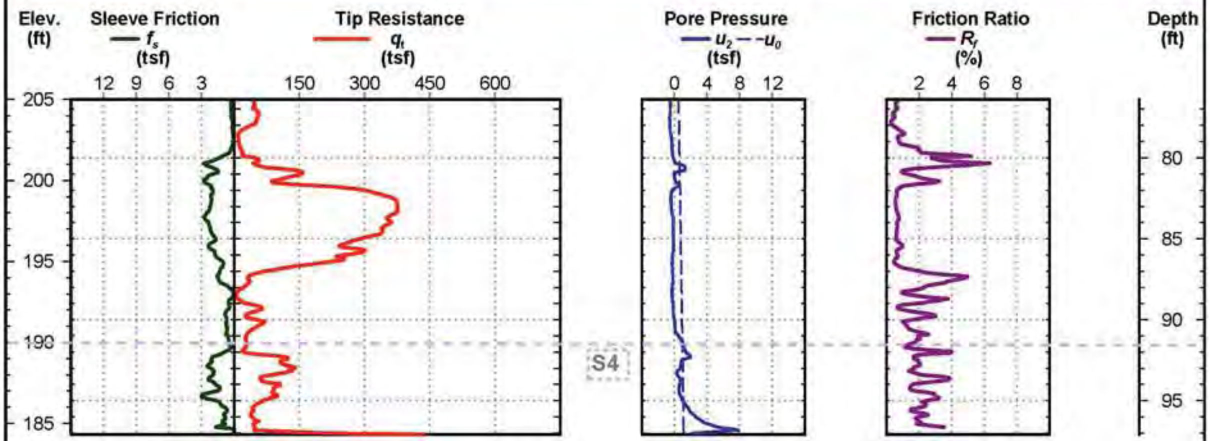
LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

**Project No.:** R11S002 T10

**Northing:** 77448.1
**Easting:** 66350.4
**Elevation:** 281.4

**Date:** Nov. 9, 2011
**Test ID:** Z-SDU6-C02
**Est. Water Depth:** 60 ft




CPT REPORT - STANDARD PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

Page 2 of 2

**Z-SDU6-C02**
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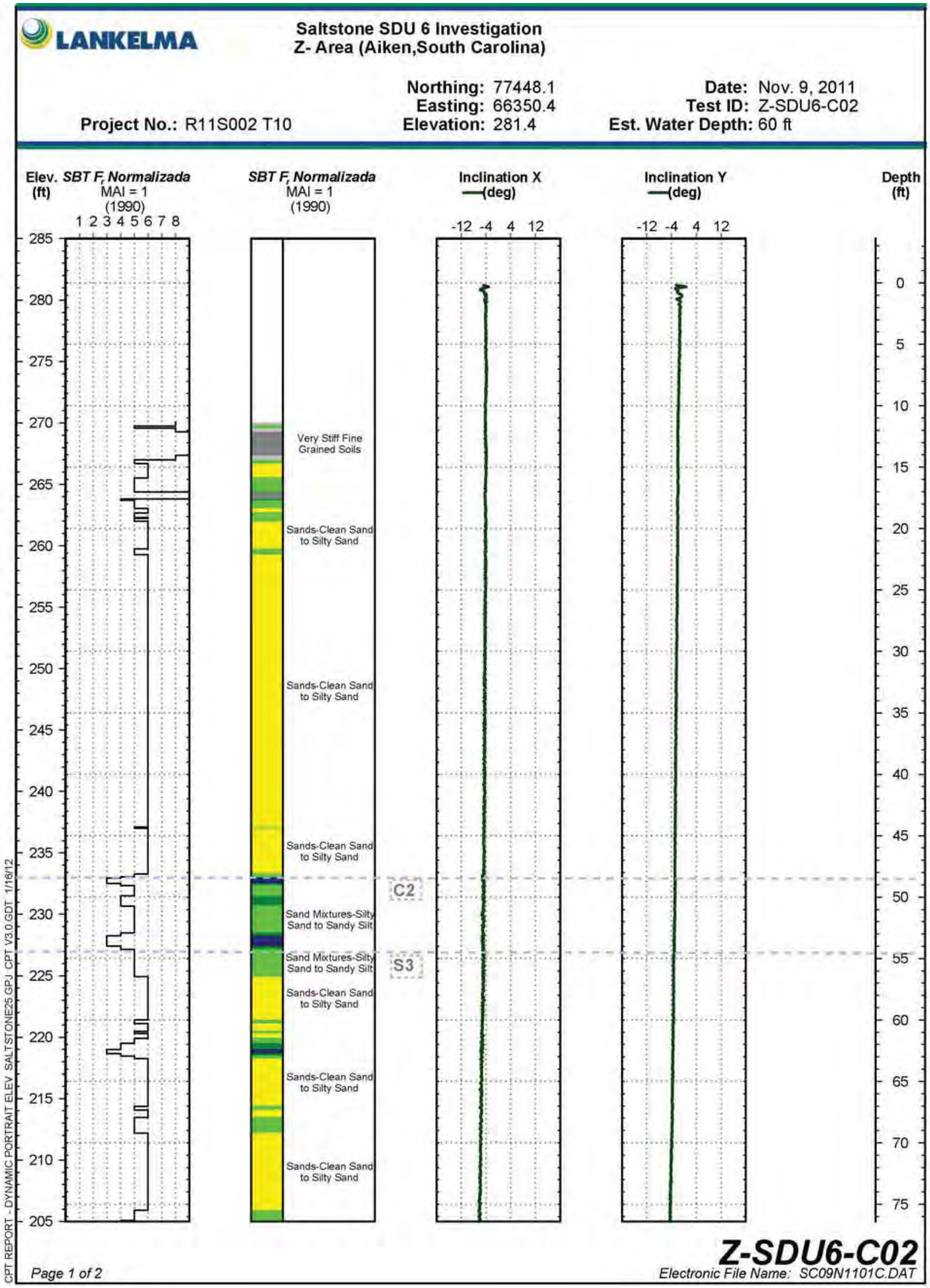
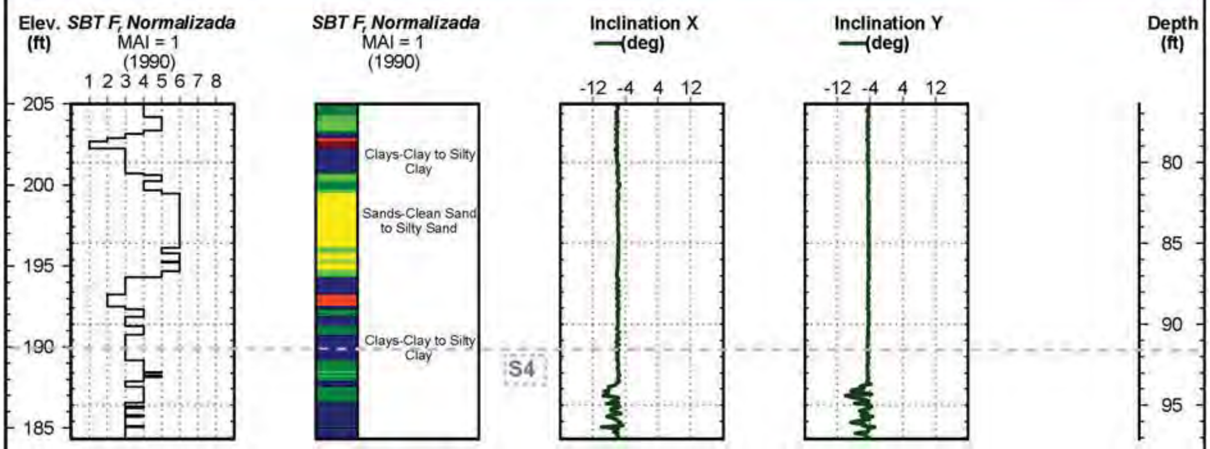

LANKELMA
Saltstone SDU 6 Investigation
Z- Area (Aiken,South Carolina)
Project No.: R11S002 T10
Northing: 77448.1
Easting: 66350.4
Elevation: 281.4
Date: Nov. 9, 2011
Test ID: Z-SDU6-C02
Est. Water Depth: 60 ft
Elev. (ft)
SBT F, Normalizada MAI = 1 (1990)
Inclination X (deg)
Inclination Y (deg)
Depth (ft)
Very Stiff Fine Grained Soils
Sands-Clean Sand to Silty Sand
Sand Mixtures-Silty Sand to Sandy Silt
C2
S3
CPT REPORT - DYNAMIC PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12
Page 1 of 2
Z-SDU6-C02
Electronic File Name: SC09N1101C.DAT

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

**Project No.:** R11S002 T10

**Northing:** 77448.1
**Easting:** 66350.4
**Elevation:** 281.4

**Date:** Nov. 9, 2011
**Test ID:** Z-SDU6-C02
**Est. Water Depth:** 60 ft




CPT REPORT - DYNAMIC PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

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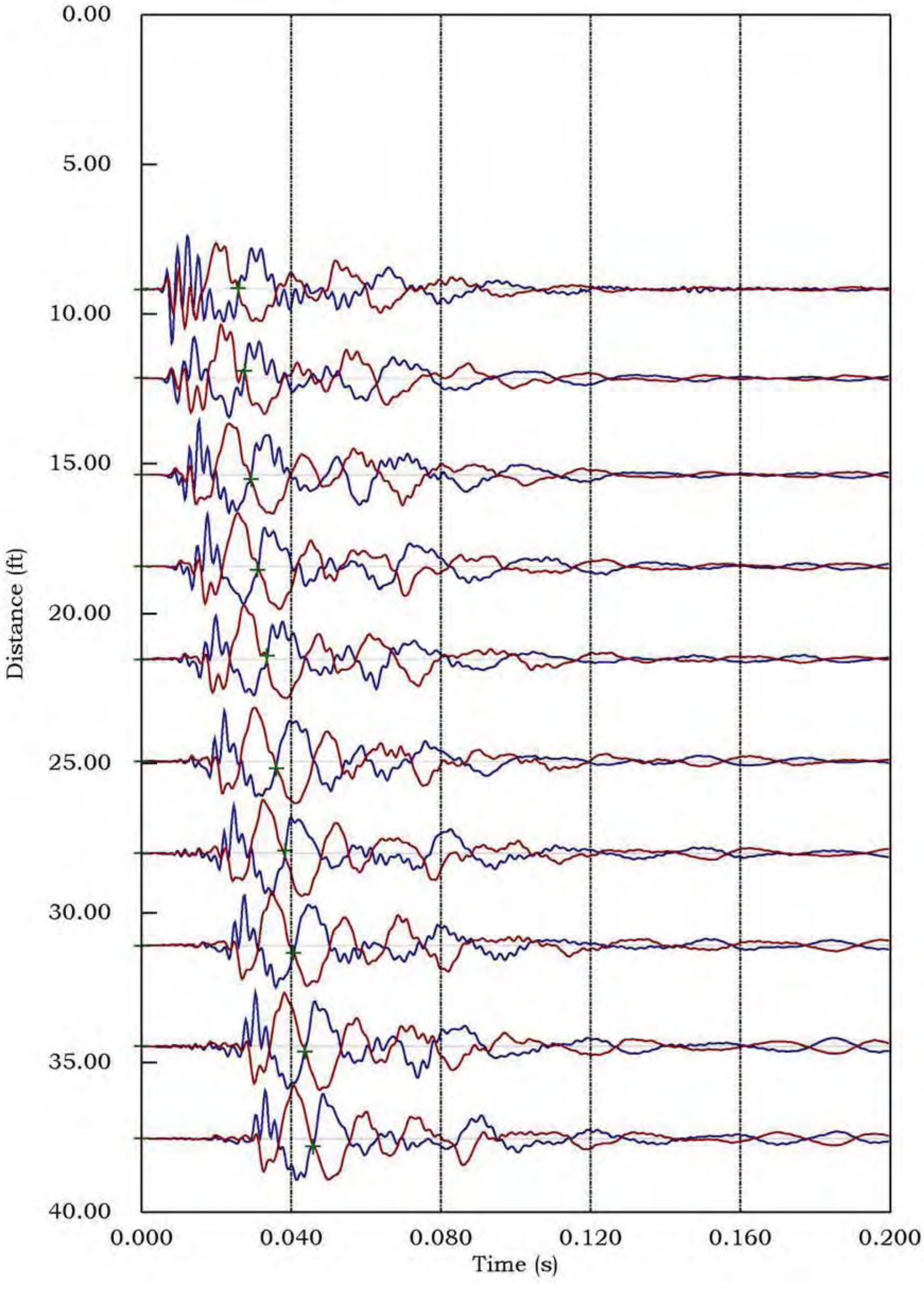
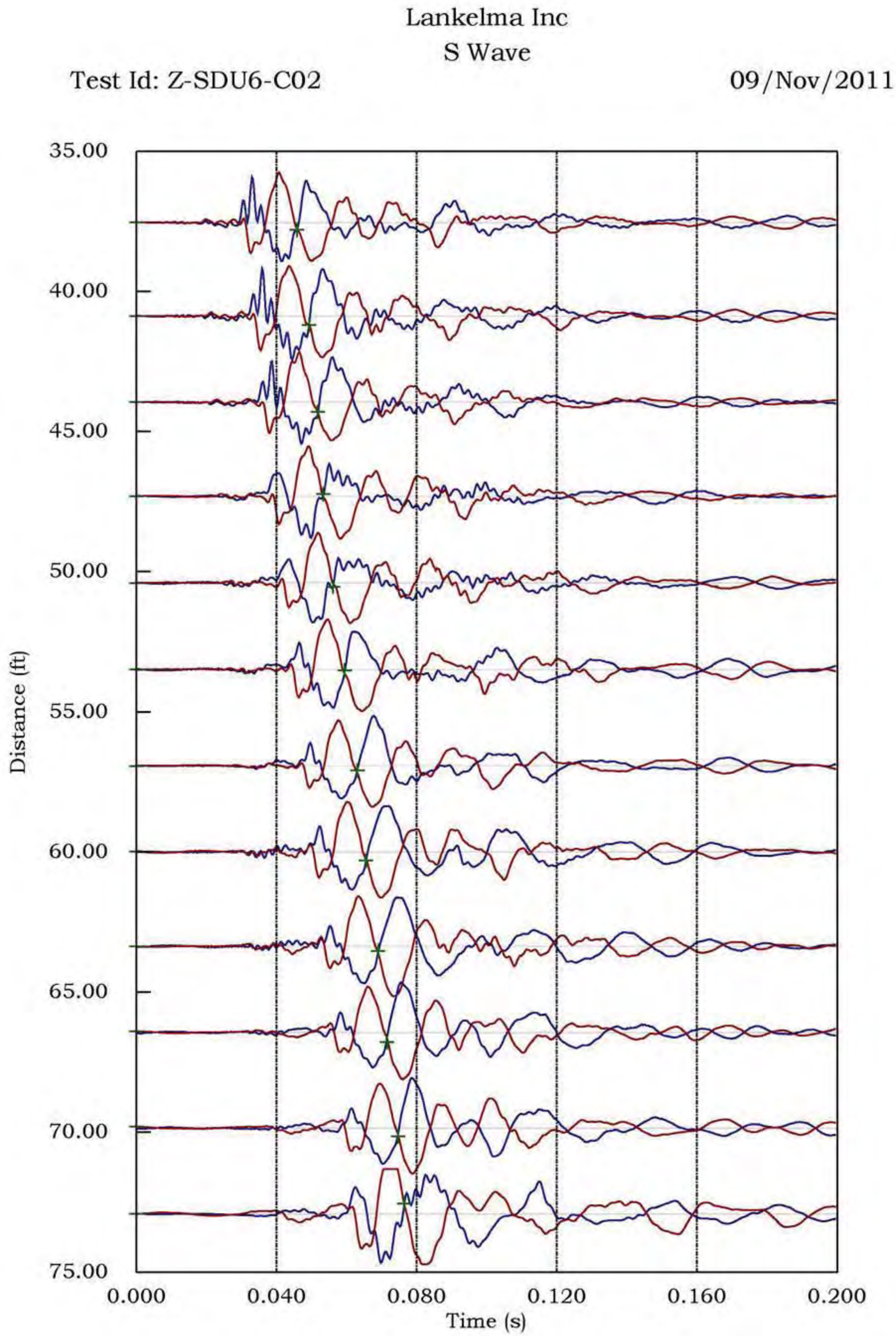
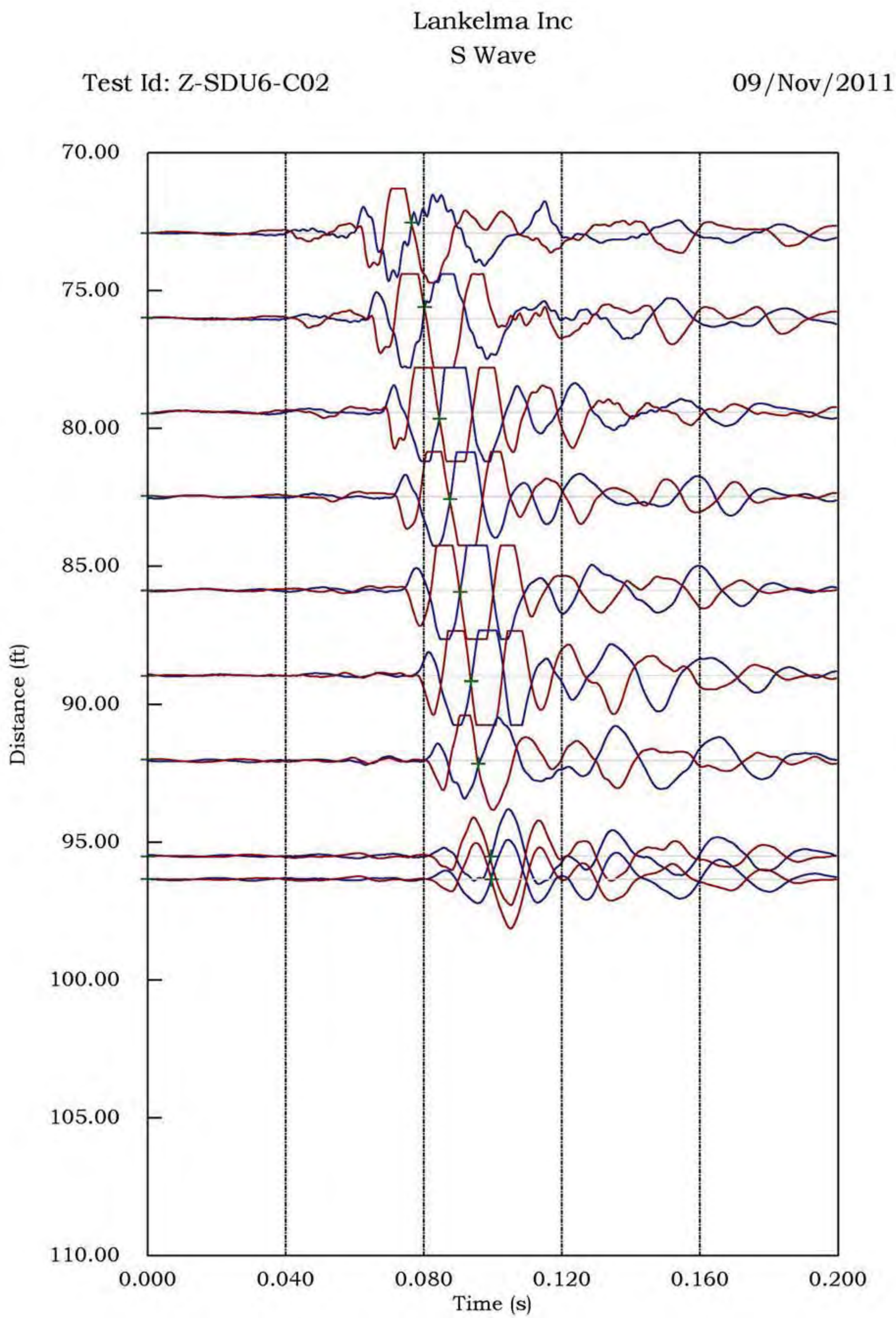
**Z-SDU6-C02**
*Electronic File Name: SC09N1101C.DAT*

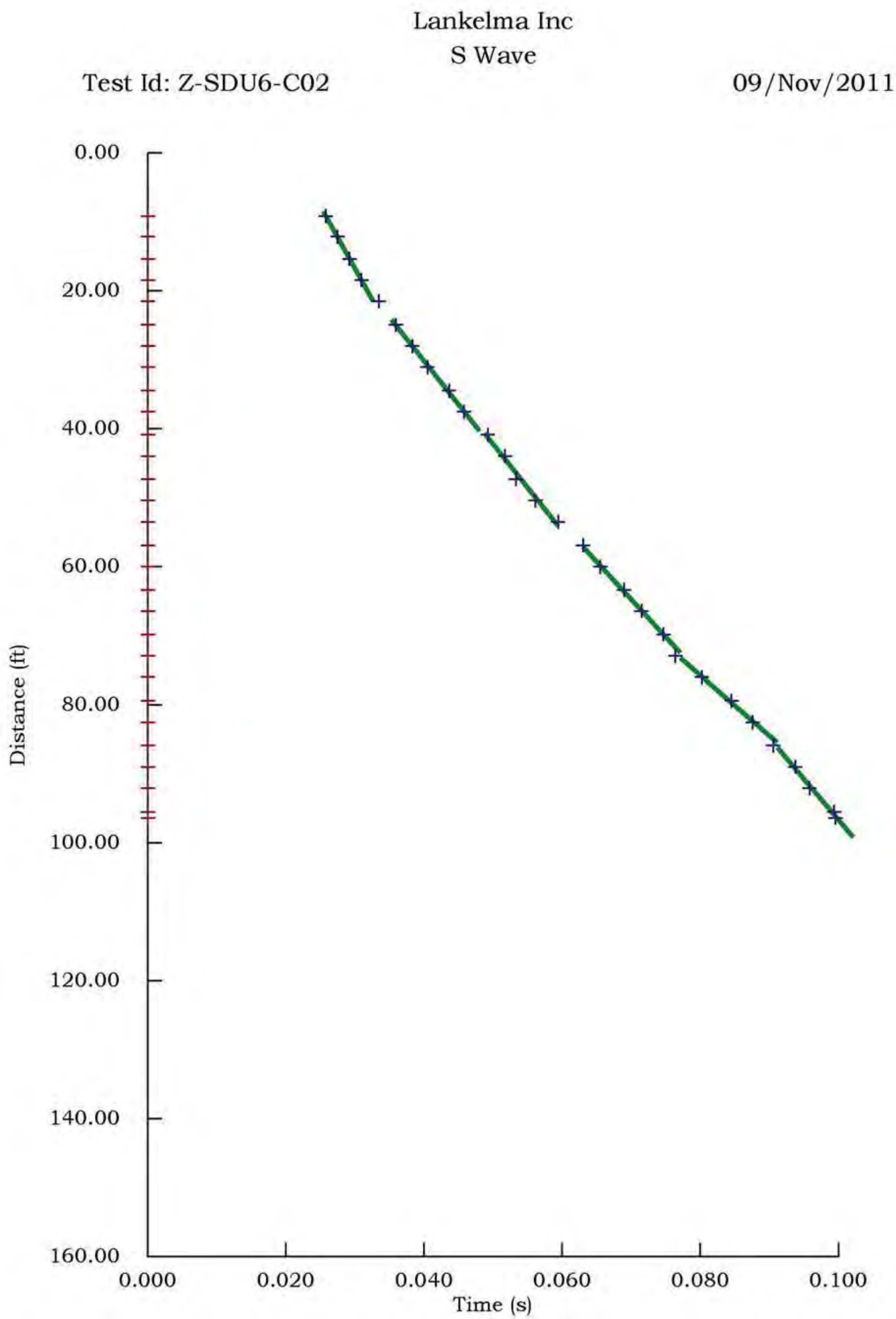
Lankelma Inc
S Wave

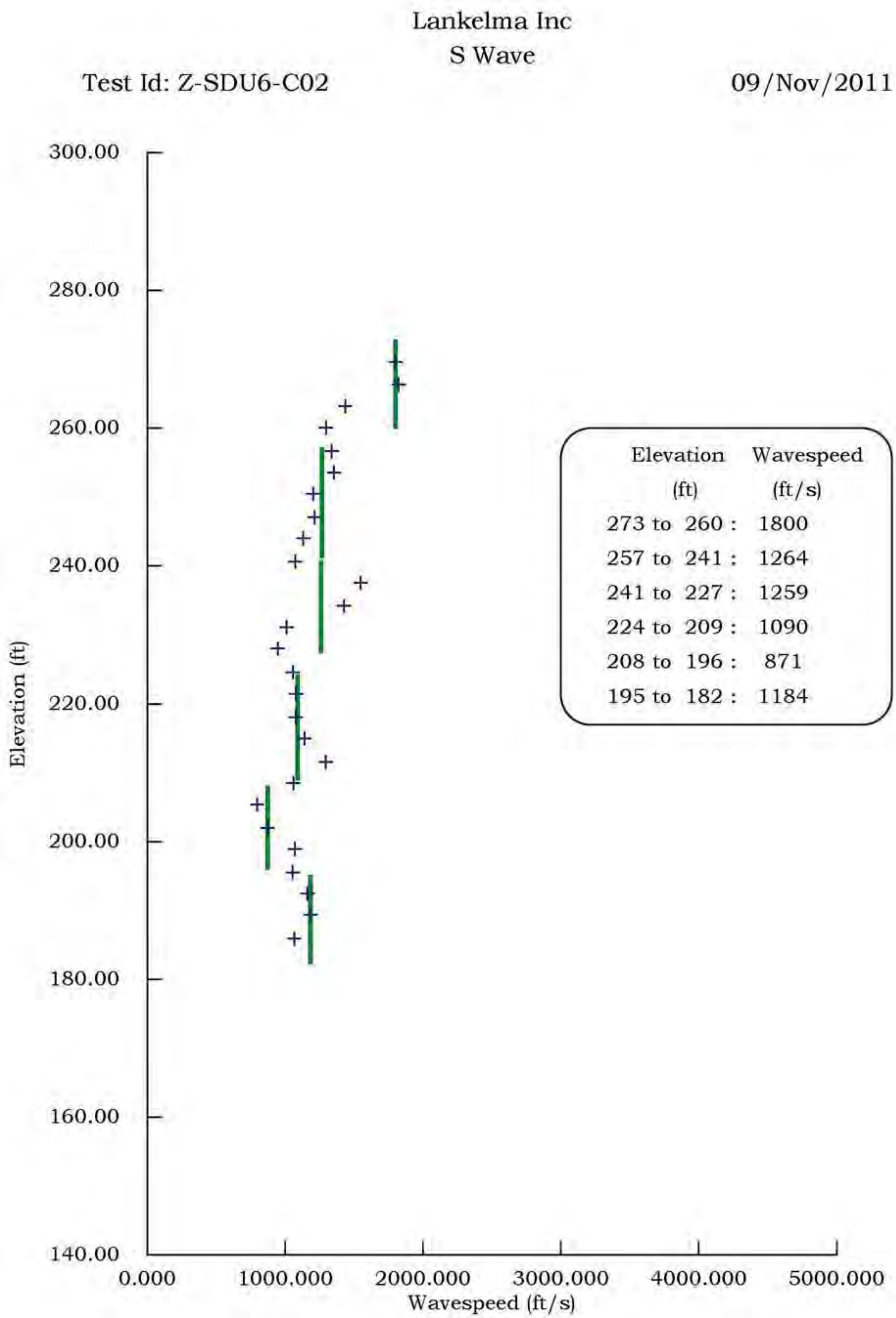
Test Id: Z-SDU6-C02 09/Nov/2011




Lankelma Inc
S Wave
Test Id: Z-SDU6-C02
09/Nov/2011
35.00
40.00
45.00
50.00
55.00
60.00
65.00
70.00
75.00
Distance (ft)
0.000
0.040
0.080
0.120
0.160
0.200
Time (s)


Lankelma Inc
S Wave
Test Id: Z-SDU6-C02
09/Nov/2011
Distance (ft)
70.00
75.00
80.00
85.00
90.00
95.00
100.00
105.00
110.00
0.000
0.040
0.080
0.120
0.160
0.200
Time (s)


Lankelma Inc
S Wave
Test Id: Z-SDU6-C02
09/Nov/2011
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
160.00
Distance (ft)
0.000
0.020
0.040
0.060
0.080
0.100
Time (s)


Lankelma Inc
S Wave
Test Id: Z-SDU6-C02
09/Nov/2011
Elevation (ft)
300.00
280.00
260.00
240.00
220.00
200.00
180.00
160.00
140.00
0.000
1000.000
2000.000
3000.000
4000.000
5000.000
Wavespeed (ft/s)
Elevation (ft) Wavespeed (ft/s)
273 to 260 : 1800
257 to 241 : 1264
241 to 227 : 1259
224 to 209 : 1090
208 to 196 : 871
195 to 182 : 1184

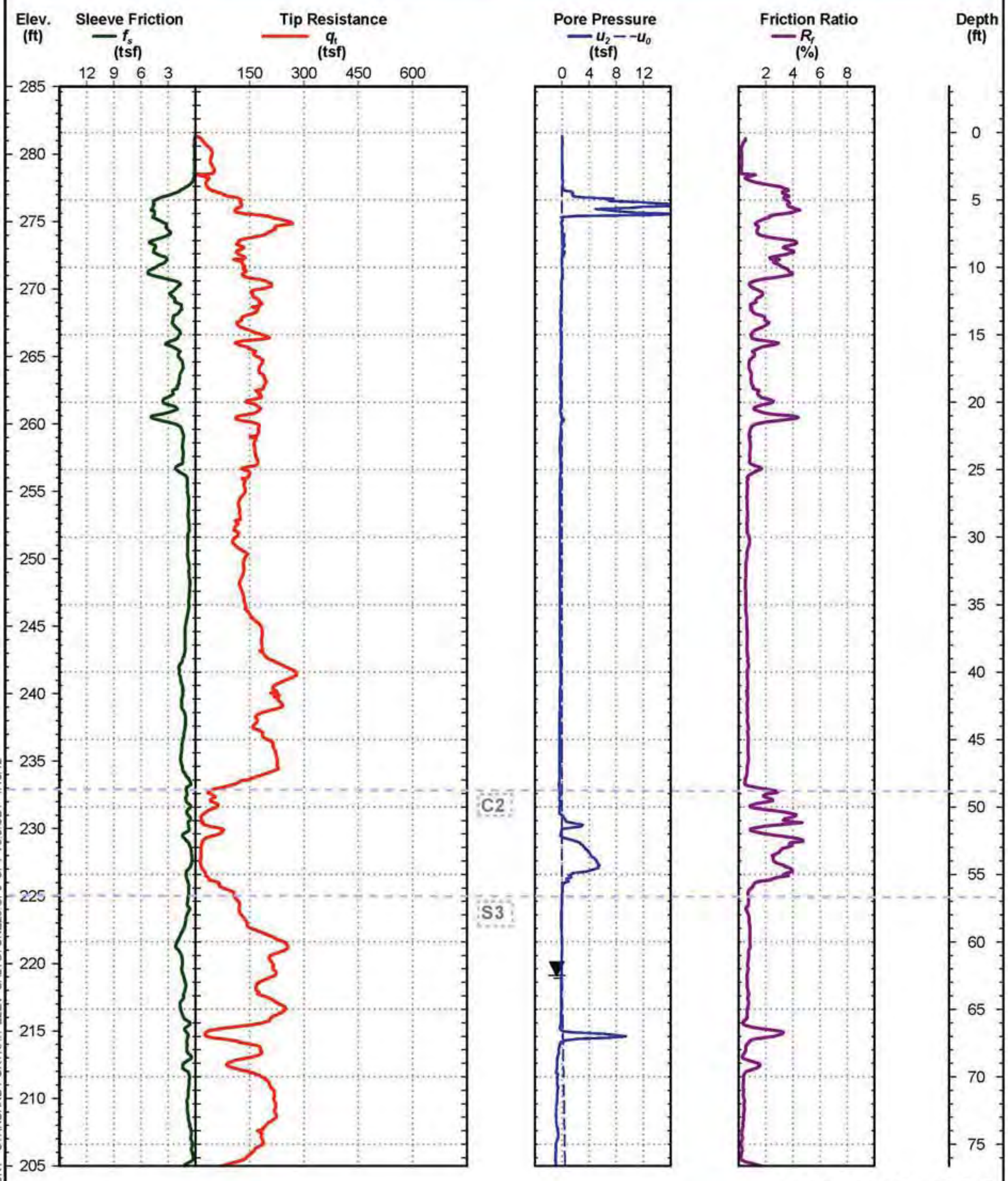
LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

**Northing:** 77478.3
**Easting:** 66494.3
**Elevation:** 281.6

**Date:** Nov. 8, 2011
**Test ID:** Z-SDU6-C03
**Est. Water Depth:** 62.5 ft

**Project No.:** R11S002 T10




CPT REPORT - STANDARD PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

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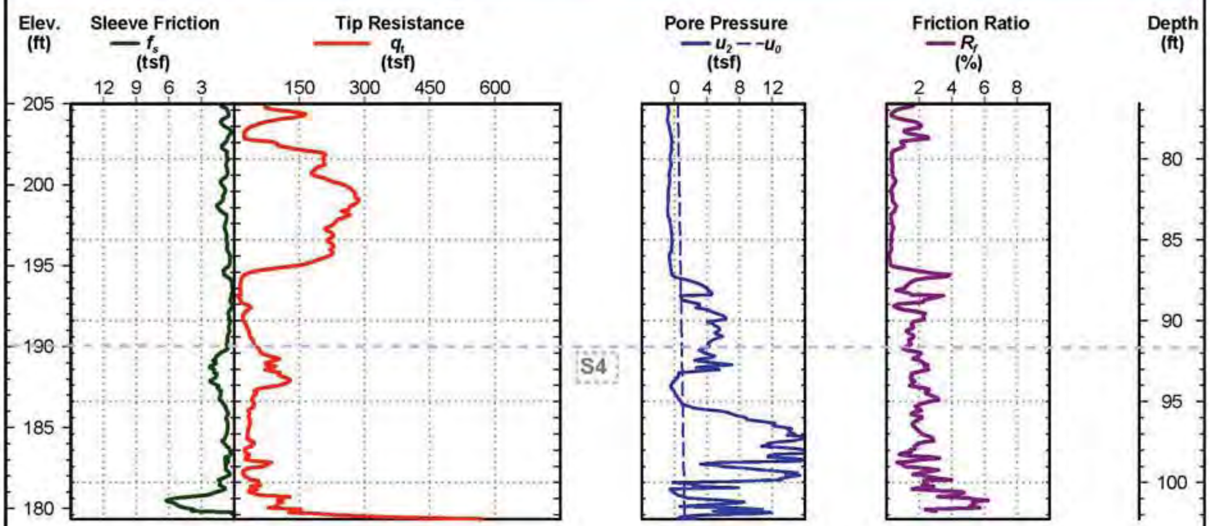
**Z-SDU6-C03**

*Electronic File Name: SC08N1101C.DAT*

LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

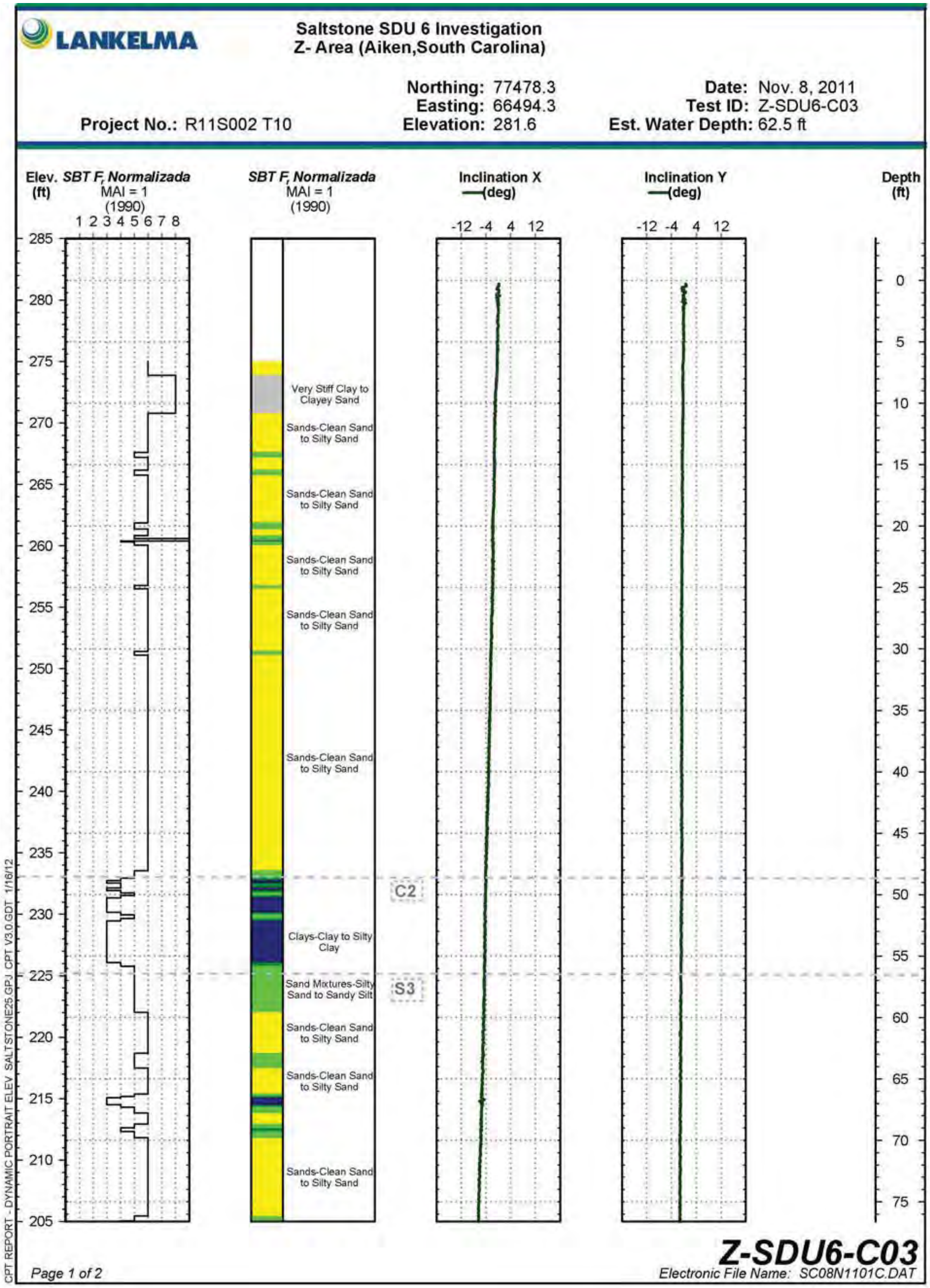
**Project No.:** R11S002 T10
**Northing:** 77478.3
**Easting:** 66494.3
**Elevation:** 281.6
**Date:** Nov. 8, 2011
**Test ID:** Z-SDU6-C03
**Est. Water Depth:** 62.5 ft




CPT REPORT - STANDARD PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

Page 2 of 2

**Z-SDU6-C03**
*Electronic File Name: SC08N1101C.DAT*


LANKELMA
Saltstone SDU 6 Investigation
Z- Area (Aiken,South Carolina)
Project No.: R11S002 T10
Northing: 77478.3
Easting: 66494.3
Elevation: 281.6
Date: Nov. 8, 2011
Test ID: Z-SDU6-C03
Est. Water Depth: 62.5 ft
Elev. (ft)
SBT F, Normalizada MAI = 1 (1990)
Inclination X (deg)
Inclination Y (deg)
Depth (ft)
Very Stiff Clay to Clayey Sand
Sands-Clean Sand to Silty Sand
Clays-Clay to Silty Clay
Sand Mixtures-Silty Sand to Sandy Silt
C2
S3
CPT REPORT - DYNAMIC PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12
Page 1 of 2
Z-SDU6-C03
Electronic File Name: SC08N1101C.DAT

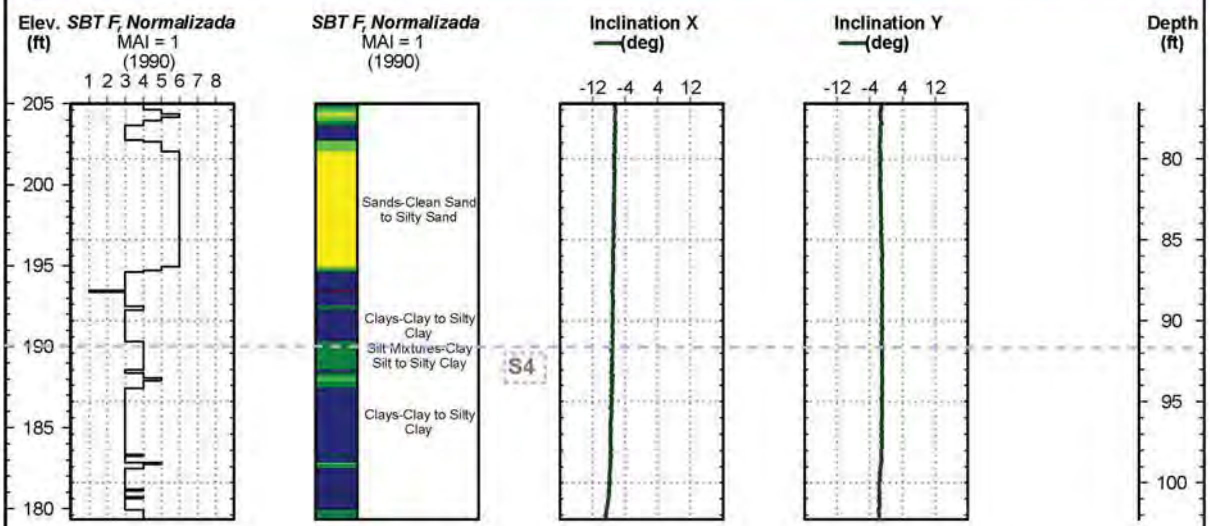
LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

**Project No.:** R11S002 T10

**Northing:** 77478.3
**Easting:** 66494.3
**Elevation:** 281.6

**Date:** Nov. 8, 2011
**Test ID:** Z-SDU6-C03
**Est. Water Depth:** 62.5 ft




CPT REPORT - DYNAMIC PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

*Page 2 of 2*

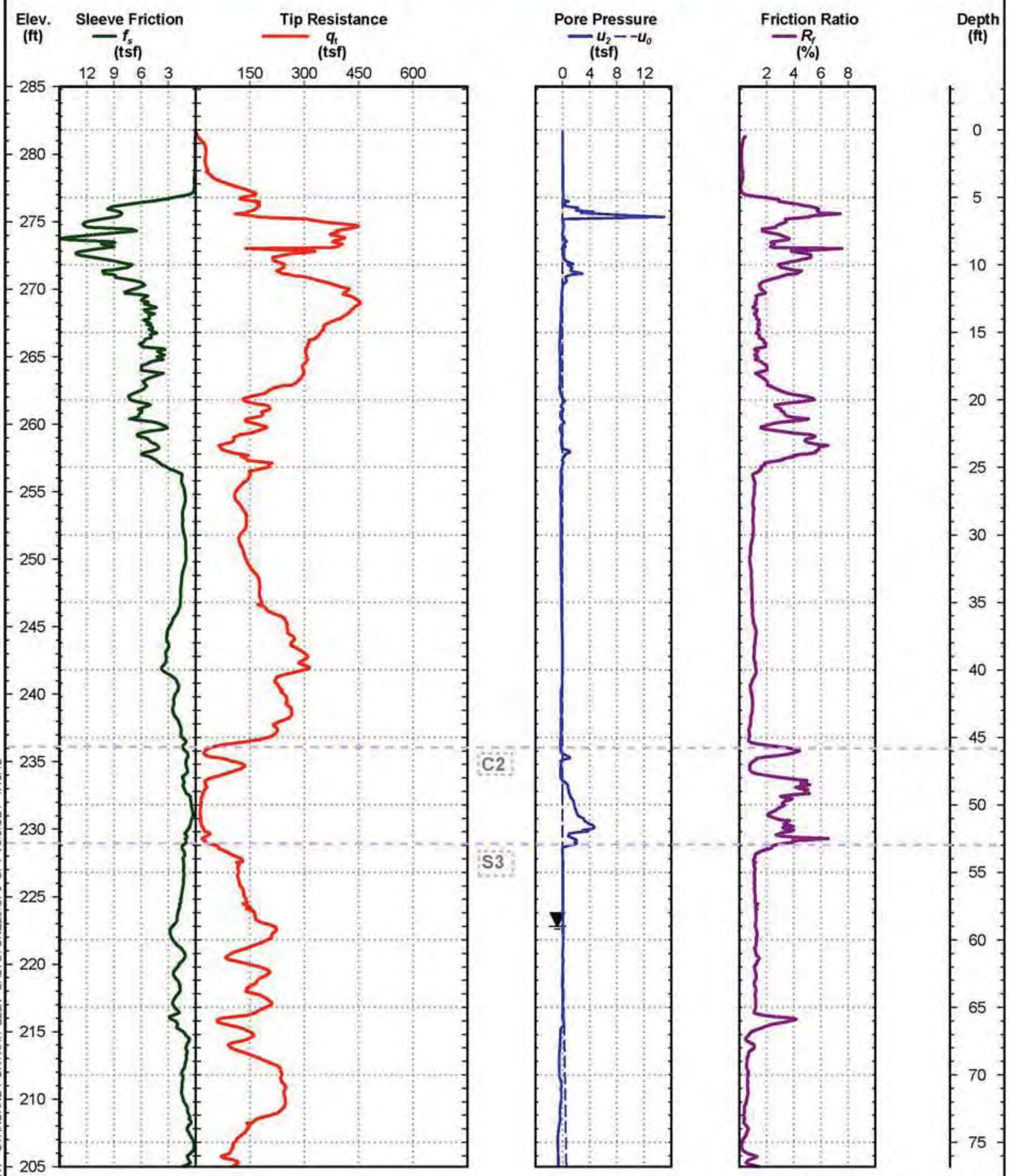
**Z-SDU6-C03**
*Electronic File Name: SC08N1101C.DAT*

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

**Northing:** 77503.3
**Easting:** 66578.8
**Elevation:** 281.8

**Date:** Nov. 7, 2011
**Test ID:** Z-SDU6-C04
**Est. Water Depth:** 59 ft

**Project No.:** R11S002 T10




CPT REPORT - STANDARD PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

**Z-SDU6-C04**

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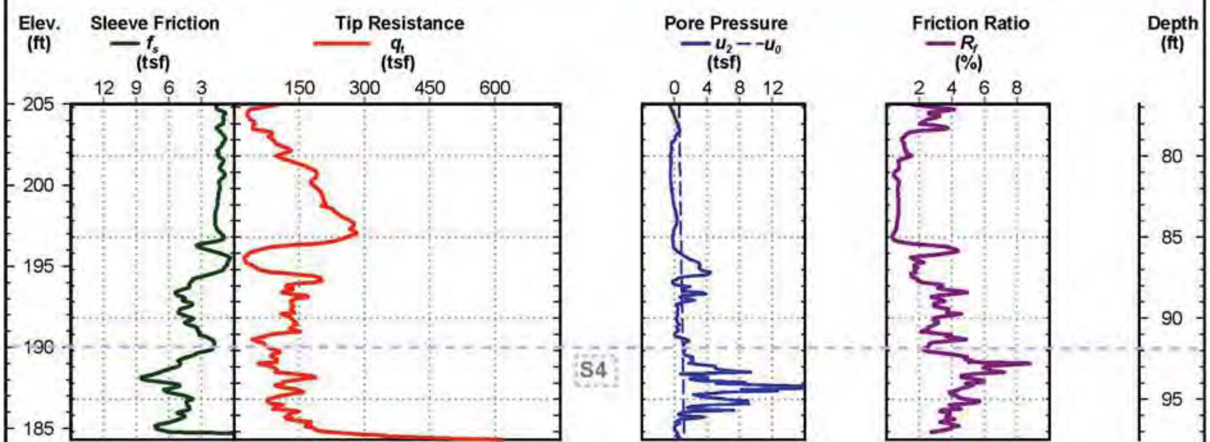
Electronic File Name: SC07N1102C.DAT

LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

**Project No.:** R11S002 T10
**Northing:** 77503.3
**Easting:** 66578.8
**Elevation:** 281.8
**Date:** Nov. 7, 2011
**Test ID:** Z-SDU6-C04
**Est. Water Depth:** 59 ft




CPT REPORT - STANDARD PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

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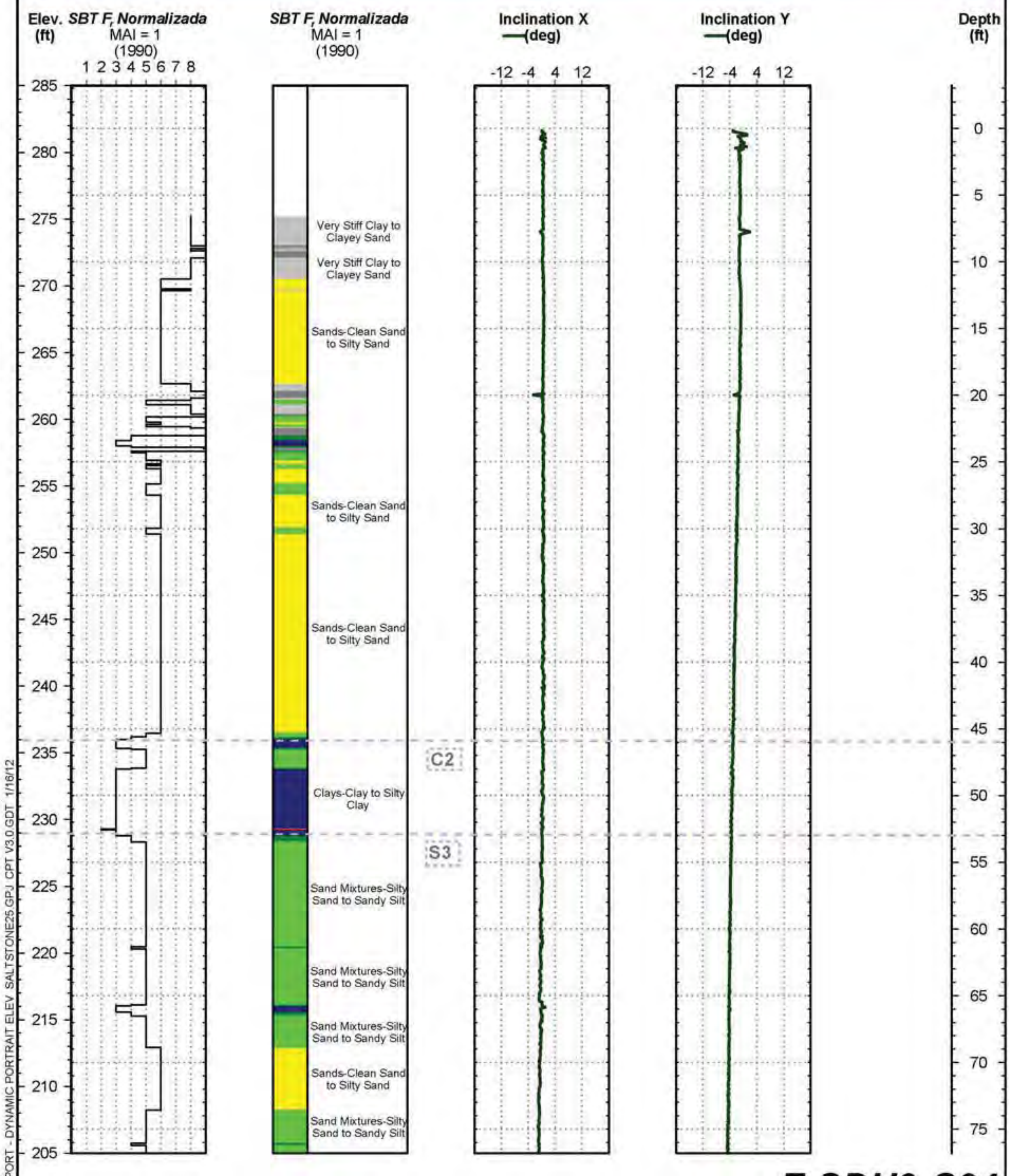
**Z-SDU6-C04**
*Electronic File Name: SC07N1102C.DAT*

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

LANKELMA

**Project No.:** R11S002 T10
**Northing:** 77503.3
**Easting:** 66578.8
**Elevation:** 281.8
**Date:** Nov. 7, 2011
**Test ID:** Z-SDU6-C04
**Est. Water Depth:** 59 ft

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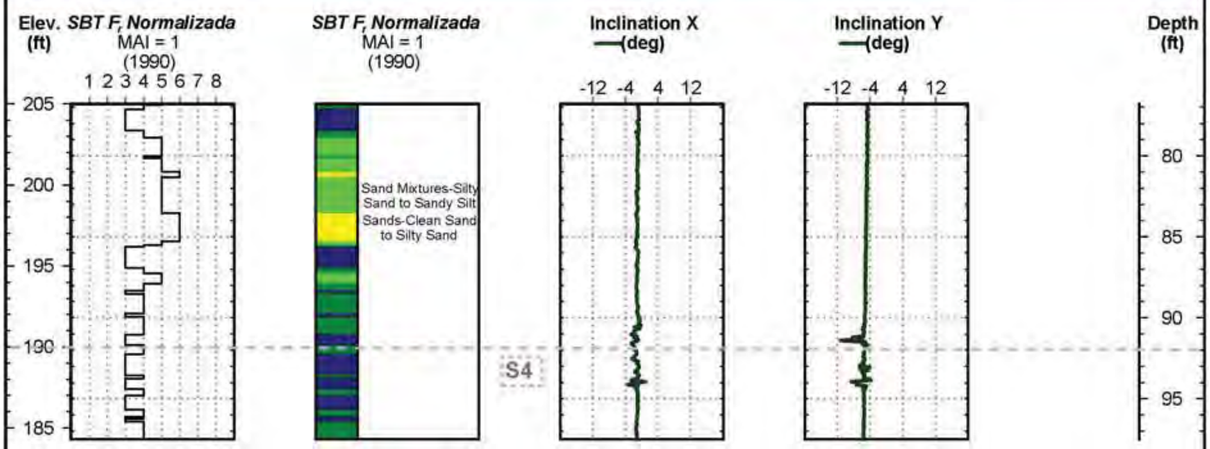
**Z-SDU6-C04**

*Electronic File Name: SC07N1102C.DAT*

LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

**Project No.:** R11S002 T10
**Northing:** 77503.3
**Easting:** 66578.8
**Elevation:** 281.8
**Date:** Nov. 7, 2011
**Test ID:** Z-SDU6-C04
**Est. Water Depth:** 59 ft




CPT REPORT - DYNAMIC PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

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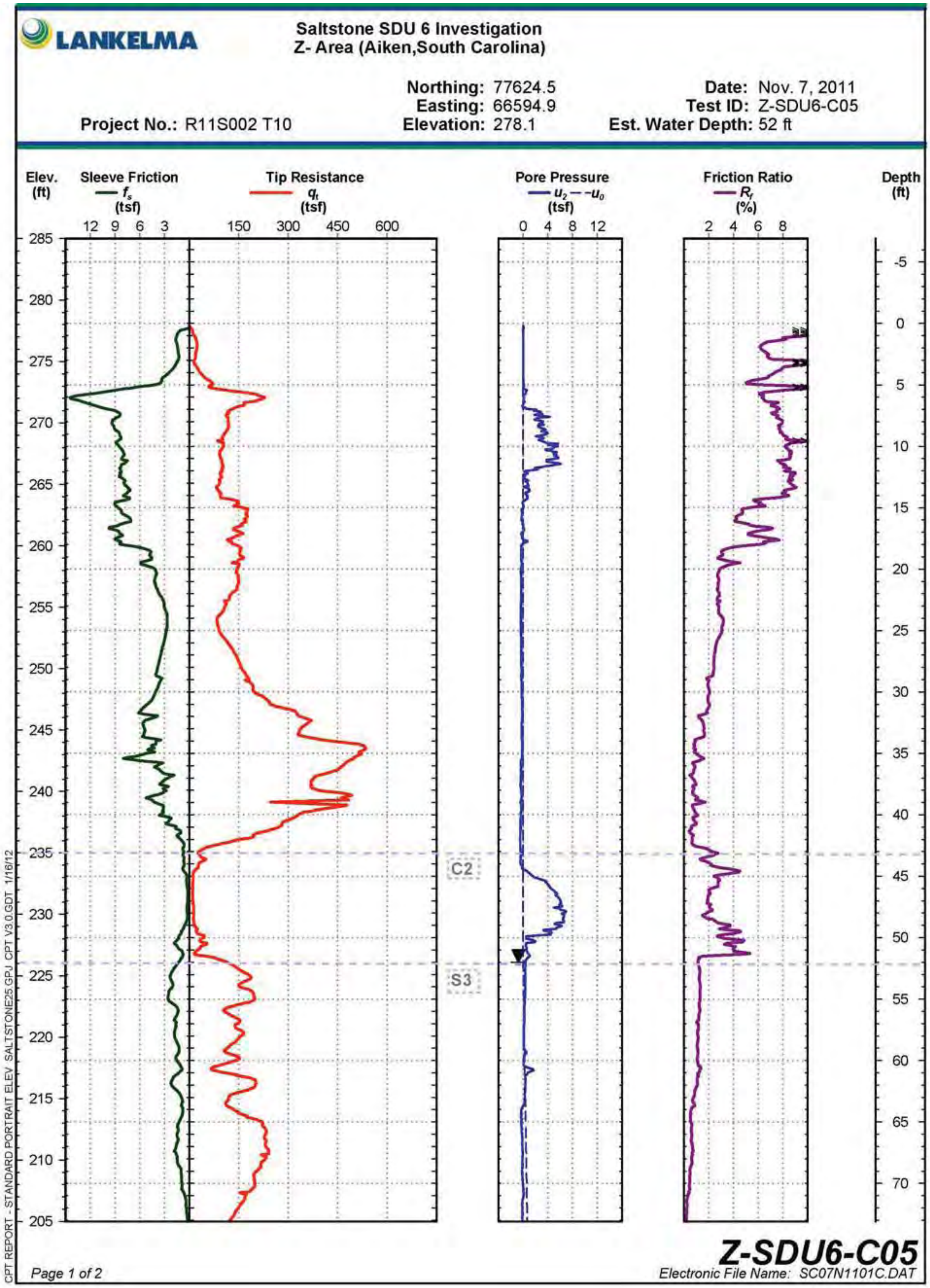
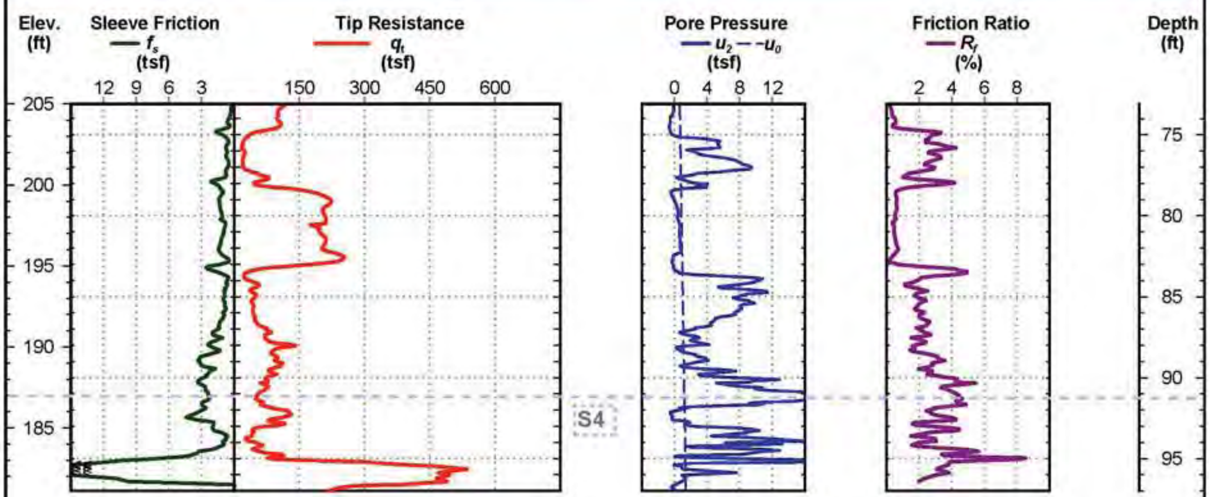
**Z-SDU6-C04**
Electronic File Name: SC07N1102C.DAT


LANKELMA
Saltstone SDU 6 Investigation
Z- Area (Aiken,South Carolina)
Northing: 77624.5
Easting: 66594.9
Elevation: 278.1
Date: Nov. 7, 2011
Test ID: Z-SDU6-C05
Est. Water Depth: 52 ft
Project No.: R11S002 T10
Elev. (ft)
Sleeve Friction
(tsf)
Tip Resistance
(tsf)
Pore Pressure
(tsf)
Friction Ratio
(%)
Depth (ft)
C2
S3
Z-SDU6-C05
Page 1 of 2
Electronic File Name: SC07N1101C.DAT
CPT REPORT - STANDARD PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

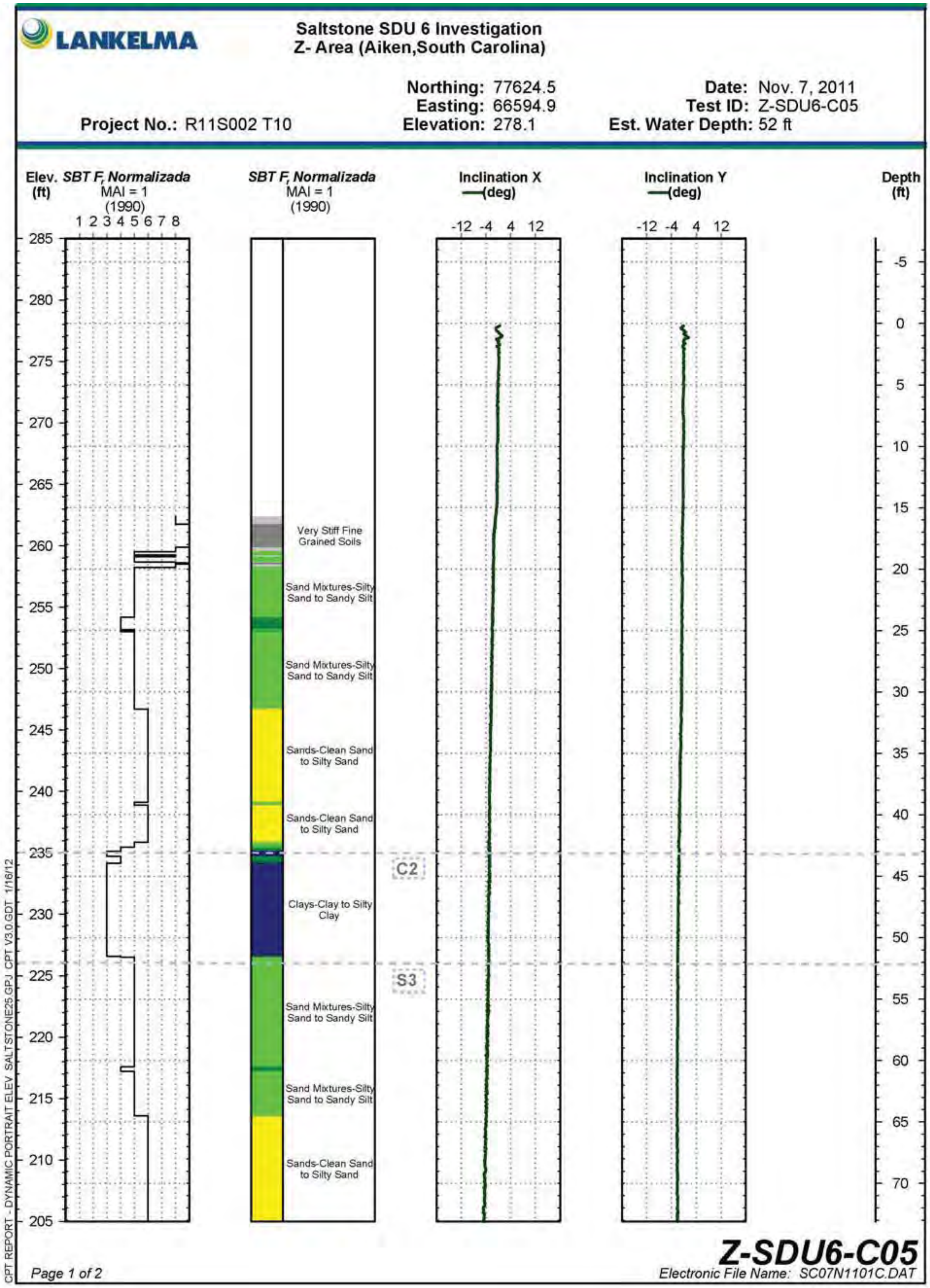
**Project No.:** R11S002 T10
**Northing:** 77624.5
**Easting:** 66594.9
**Elevation:** 278.1
**Date:** Nov. 7, 2011
**Test ID:** Z-SDU6-C05
**Est. Water Depth:** 52 ft

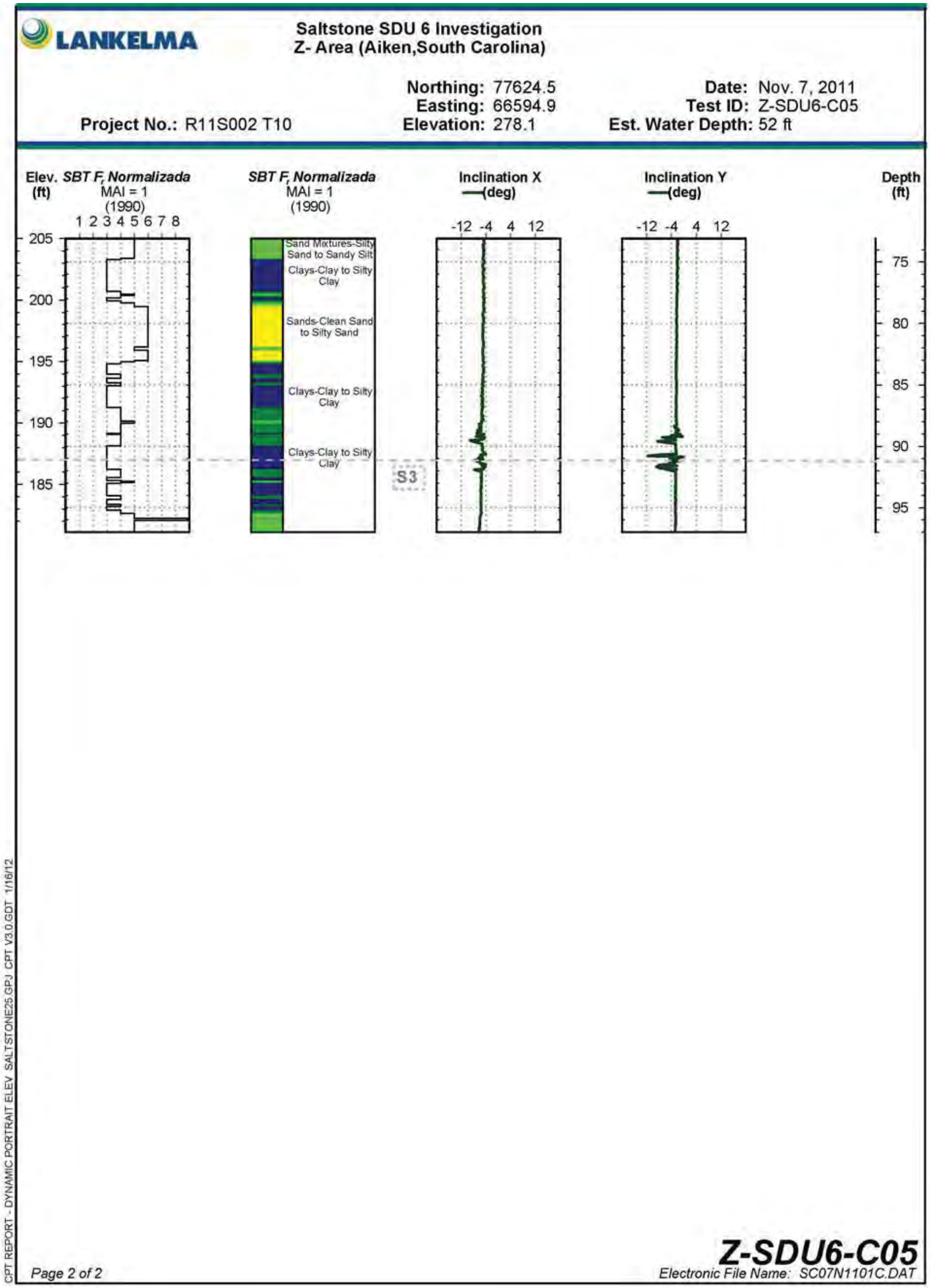



CPT REPORT - STANDARD PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

Page 2 of 2

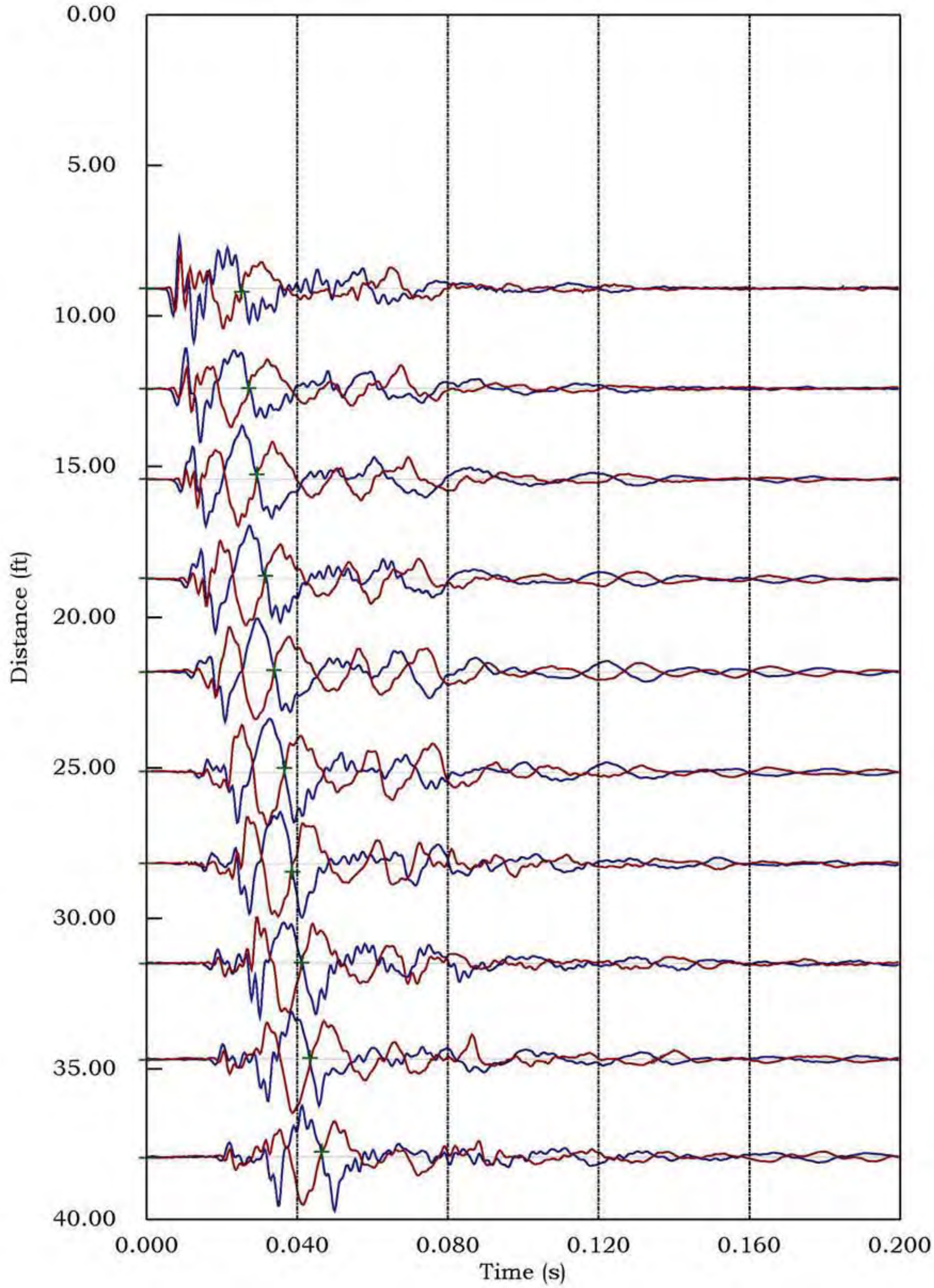
**Z-SDU6-C05**
Electronic File Name: SC07N1101C.DAT


LANKELMA
Saltstone SDU 6 Investigation
Z- Area (Aiken,South Carolina)
Project No.: R11S002 T10
Northing: 77624.5
Easting: 66594.9
Elevation: 278.1
Date: Nov. 7, 2011
Test ID: Z-SDU6-C05
Est. Water Depth: 52 ft
Elev. (ft)
SBT F, Normalizada
MAI = 1
(1990)
Inclination X
(deg)
Inclination Y
(deg)
Depth (ft)
Very Stiff Fine Grained Soils
Sand Mixtures-Silty Sand to Sandy Silt
Sands-Clean Sand to Silty Sand
Clays-Clay to Silty Clay
C2
S3
CPT REPORT - DYNAMIC PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12
Page 1 of 2
Z-SDU6-C05
Electronic File Name: SC07N1101C.DAT


LANKELMA
Saltstone SDU 6 Investigation
Z- Area (Aiken,South Carolina)
Northing: 77624.5
Easting: 66594.9
Elevation: 278.1
Date: Nov. 7, 2011
Test ID: Z-SDU6-C05
Est. Water Depth: 52 ft
Project No.: R11S002 T10
Elev. (ft)
SBT F, Normalizada MAI = 1 (1990)
Sand Mixtures-Silty Sand to Sandy Silt
Clays-Clay to Silty Clay
Sands-Clean Sand to Silty Sand
Clays-Clay to Silty Clay
Clays-Clay to Silty Clay
Inclination X (deg)
Inclination Y (deg)
S3
Depth (ft)
CPT REPORT - DYNAMIC PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12
Page 2 of 2
Z-SDU6-C05
Electronic File Name: SC07N1101C.DAT

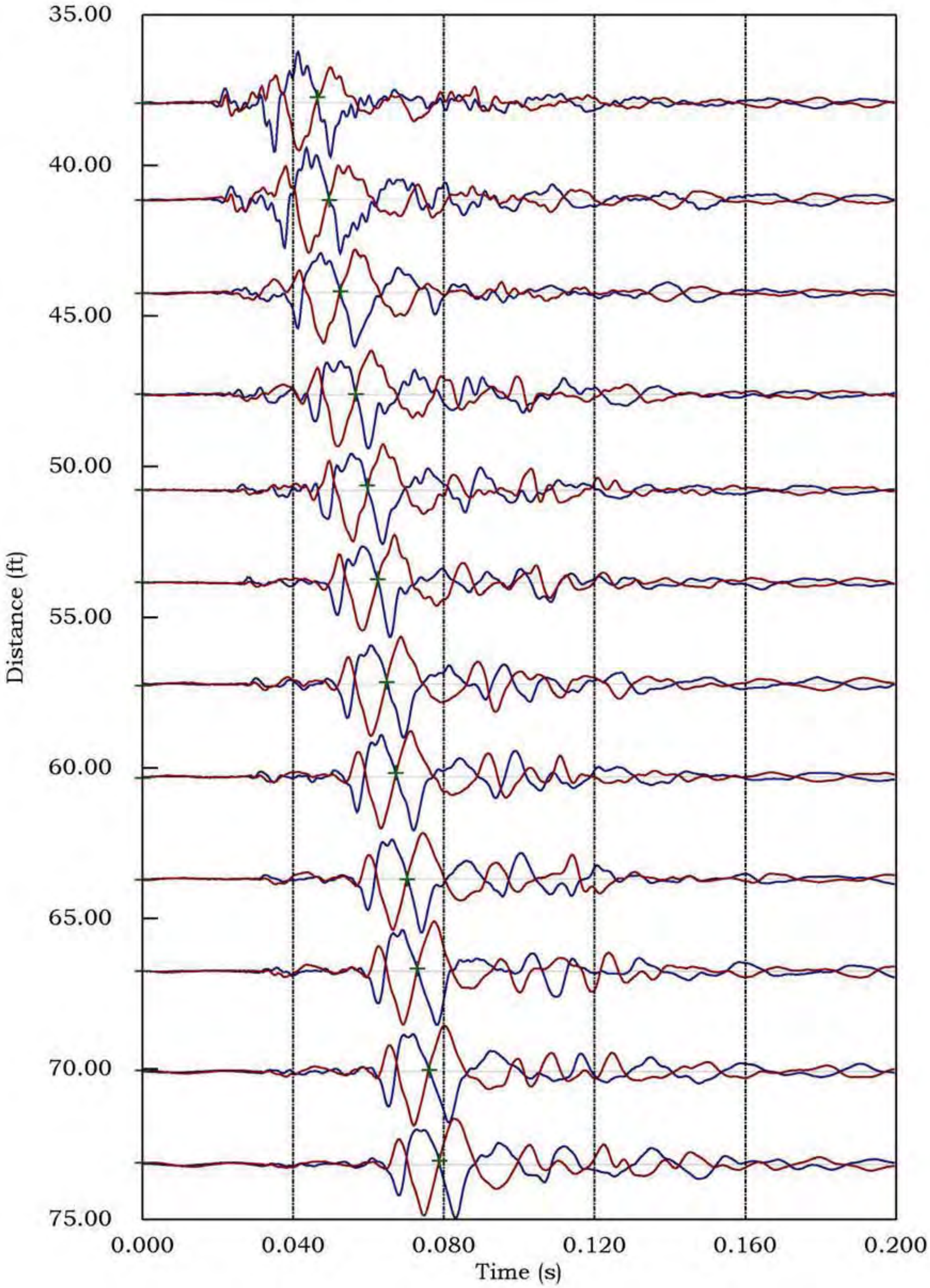
Lankelma
S Wave

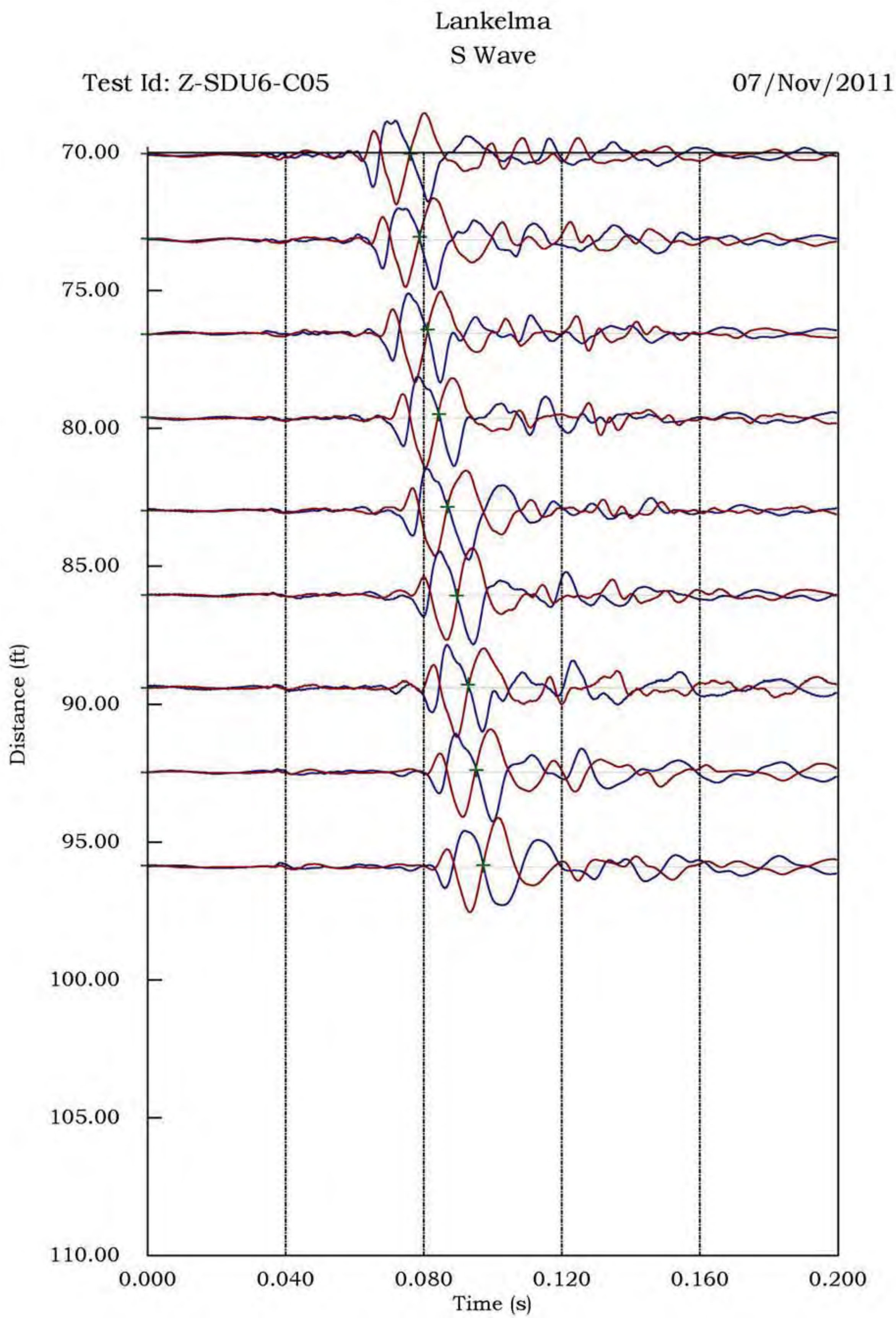
Test Id: Z-SDU6-C05 07/Nov/2011

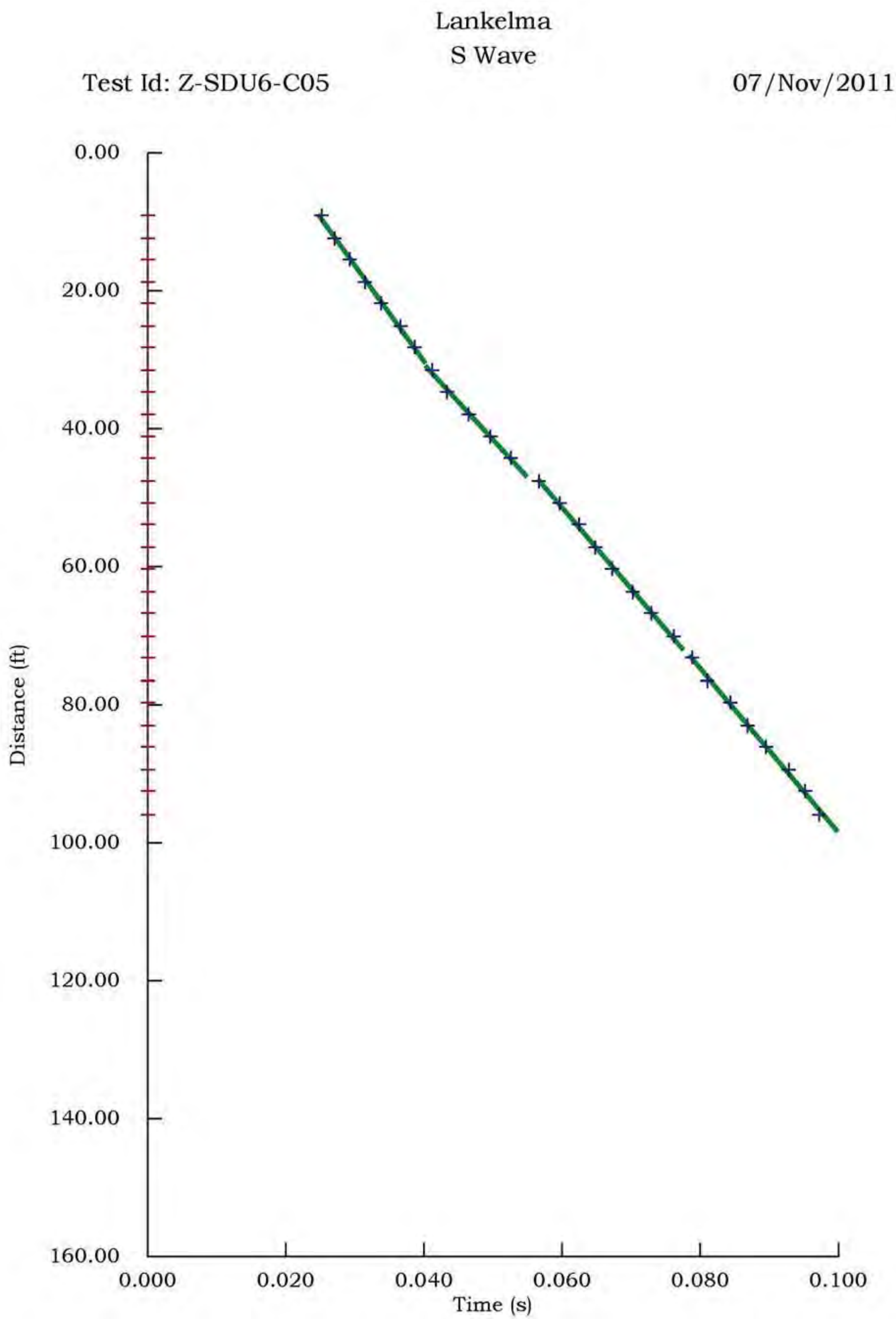


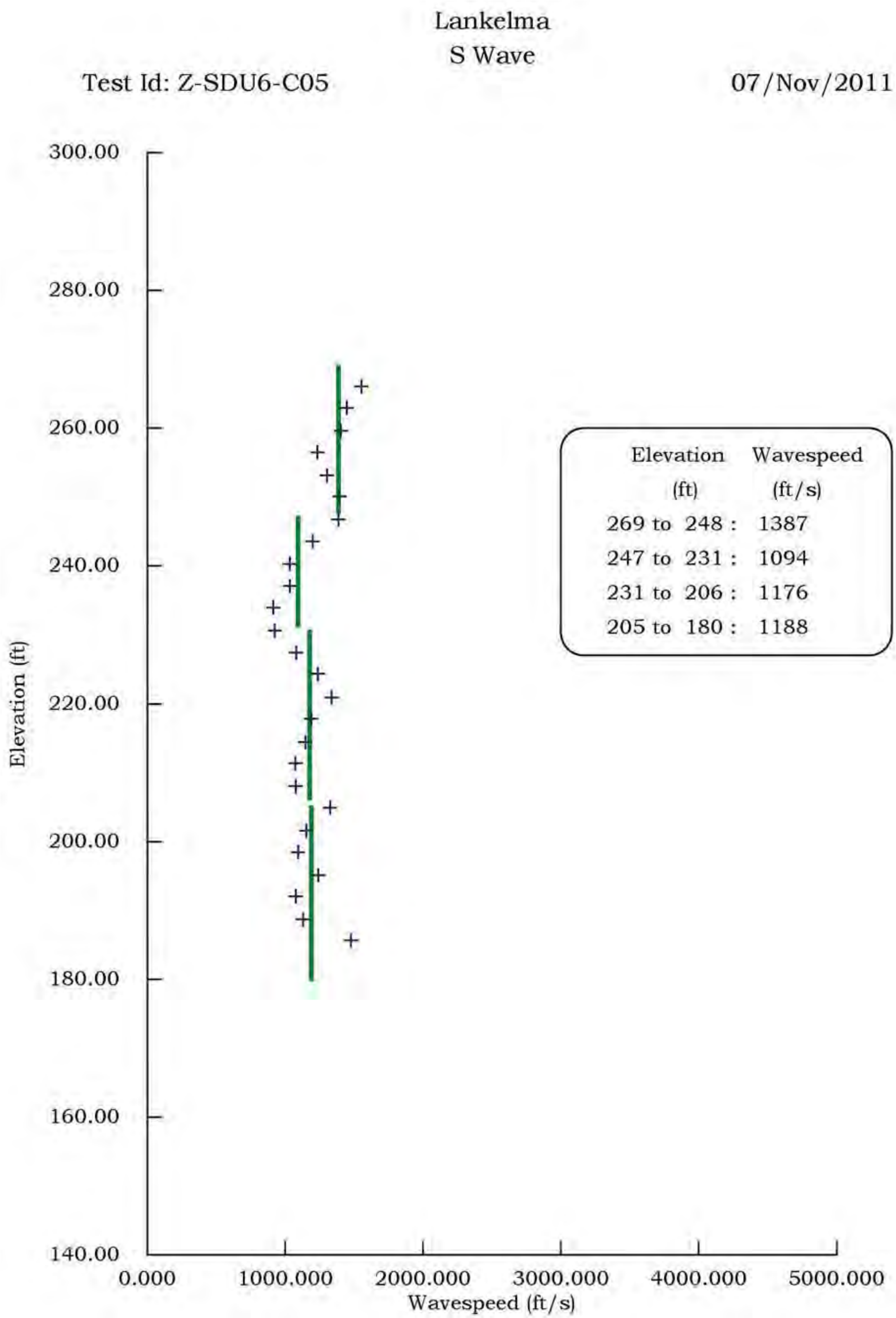
Lankelma
S Wave

Test Id: Z-SDU6-C05 07/Nov/2011




Lankelma
S Wave
Test Id: Z-SDU6-C05
07/Nov/2011
70.00
75.00
80.00
85.00
90.00
95.00
100.00
105.00
110.00
Distance (ft)
0.000
0.040
0.080
0.120
0.160
0.200
Time (s)


Lankelma
S Wave
Test Id: Z-SDU6-C05
07/Nov/2011
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
160.00
Distance (ft)
0.000
0.020
0.040
0.060
0.080
0.100
Time (s)


Lankelma
S Wave
Test Id: Z-SDU6-C05
07/Nov/2011
Elevation (ft)
300.00
280.00
260.00
240.00
220.00
200.00
180.00
160.00
140.00
0.000
1000.000
2000.000
3000.000
4000.000
5000.000
Wavespeed (ft/s)
Elevation (ft)
Wavespeed (ft/s)
269 to 248 : 1387
247 to 231 : 1094
231 to 206 : 1176
205 to 180 : 1188

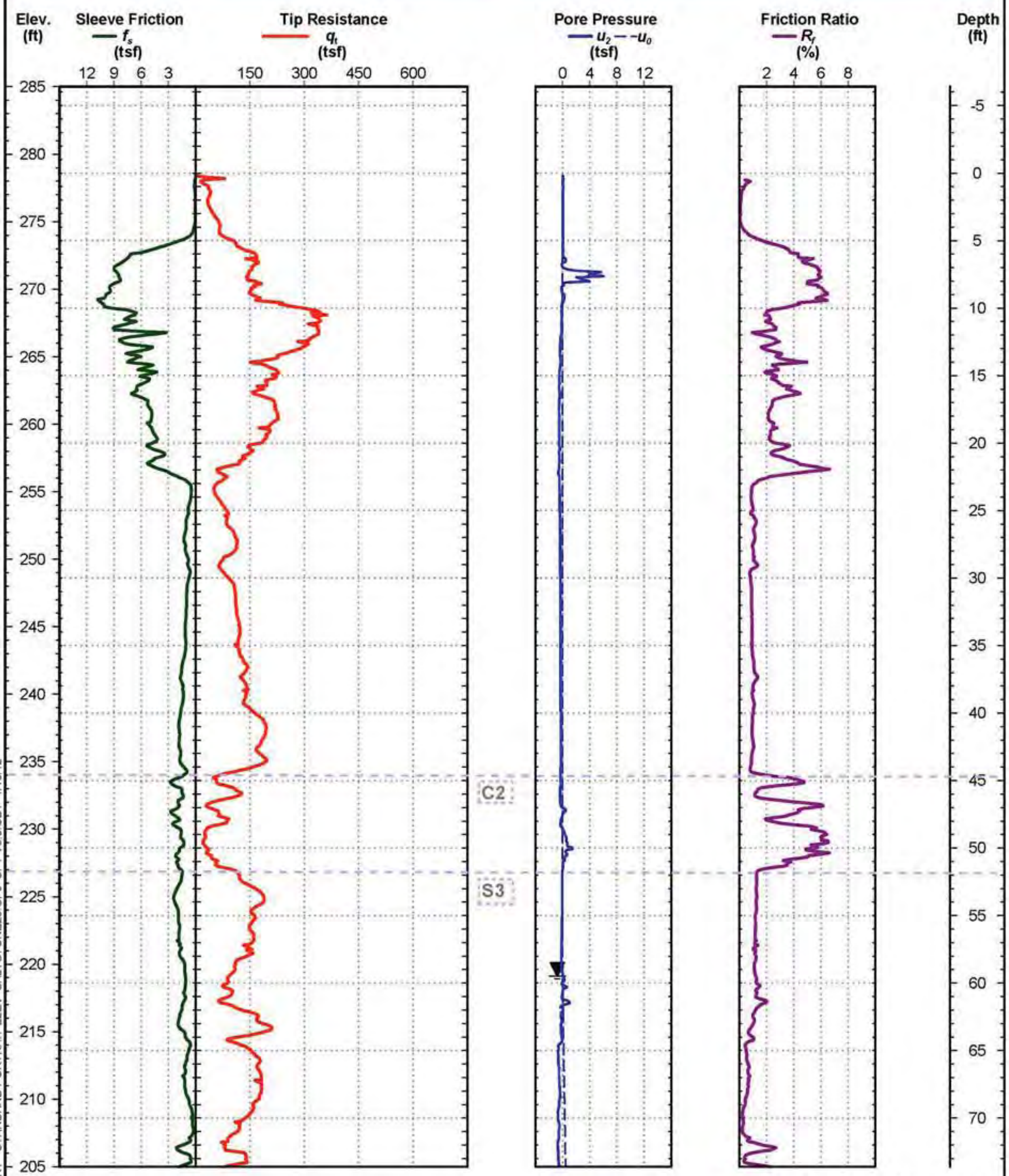
**LANKELMA**

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

**Northing:** 77587.6
**Easting:** 66472.8
**Elevation:** 278.6

**Date:** Nov. 4, 2011
**Test ID:** Z-SDU6-C06
**Est. Water Depth:** 59.5 ft

**Project No.:** R11S002 T10




CPT REPORT - STANDARD PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

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**Z-SDU6-C06**

Electronic File Name: SC04N1103C.DAT

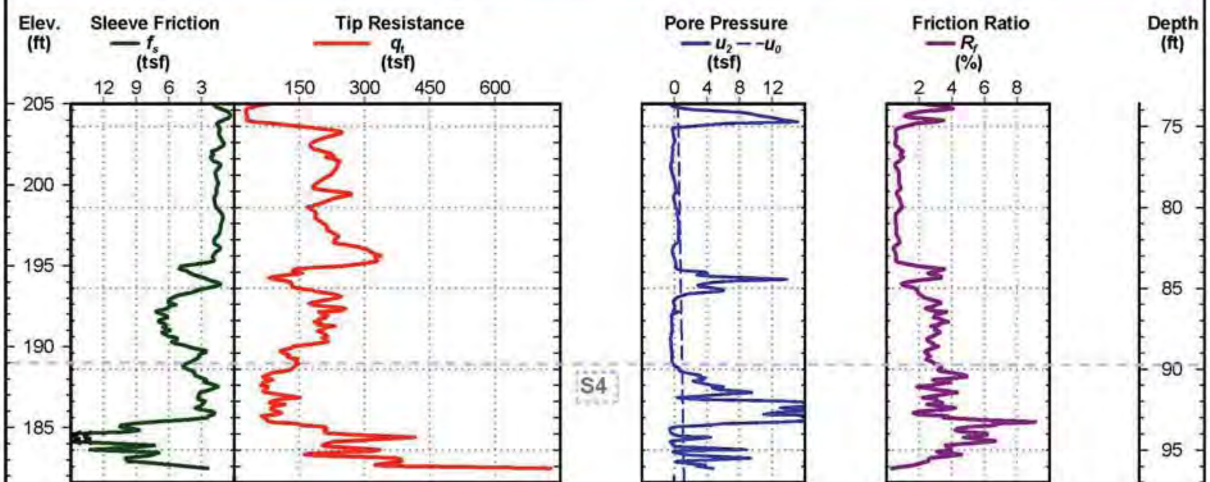
LANKELMA

Saltstone SDU 6 Investigation
Z- Area (Aiken,South Carolina)

Project No.: R11S002 T10

Northing: 77587.6
Easting: 66472.8
Elevation: 278.6

Date: Nov. 4, 2011
Test ID: Z-SDU6-C06
Est. Water Depth: 59.5 ft




CPT REPORT - STANDARD PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

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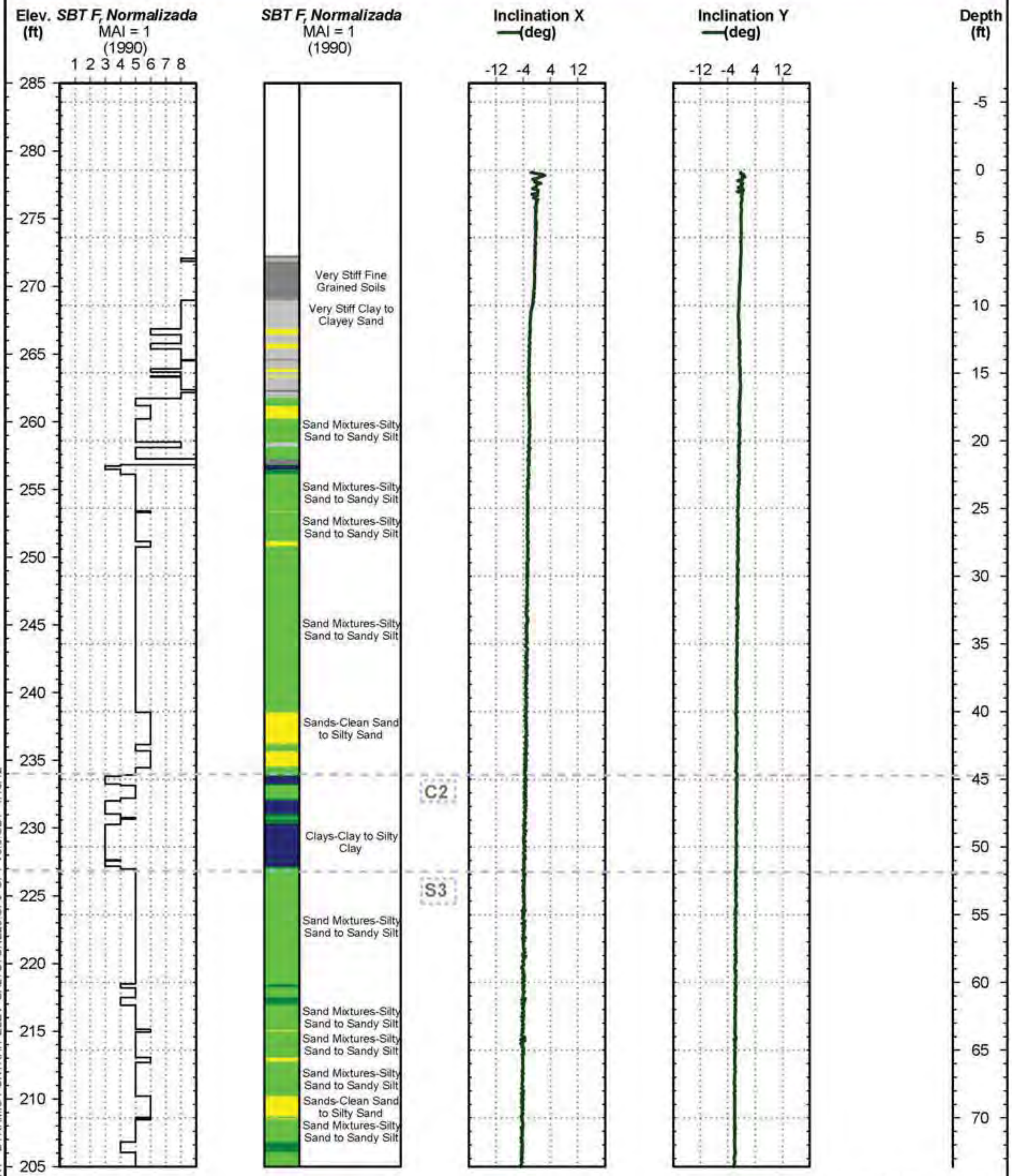
Z-SDU6-C06
Electronic File Name: SC04N1103C.DAT

LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

**Project No.:** R11S002 T10
**Northing:** 77587.6
**Easting:** 66472.8
**Elevation:** 278.6
**Date:** Nov. 4, 2011
**Test ID:** Z-SDU6-C06
**Est. Water Depth:** 59.5 ft




CPT REPORT - DYNAMIC PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

Page 1 of 2

**Z-SDU6-C06**
Electronic File Name: SC04N1103C.DAT

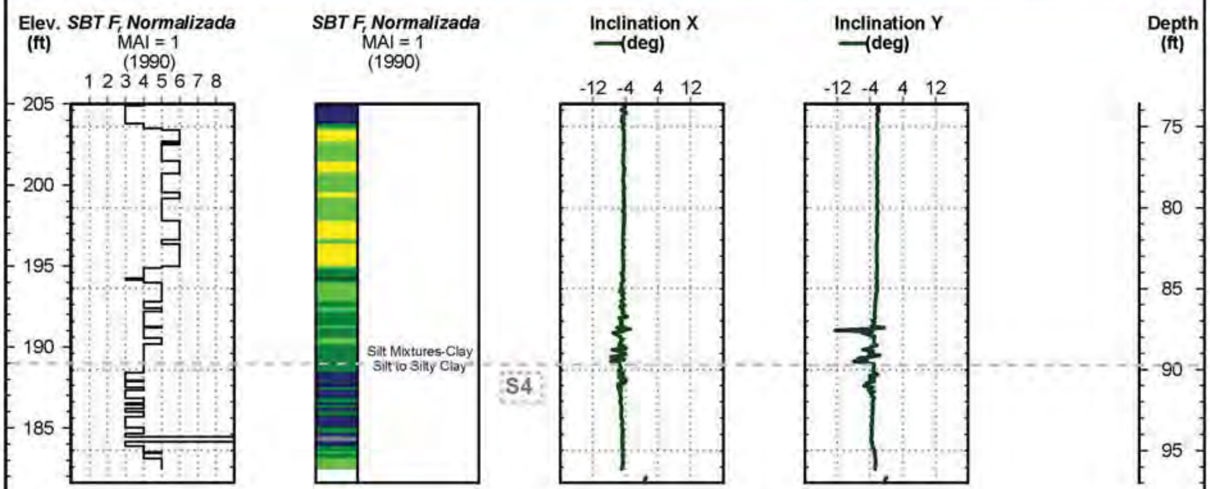
LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

**Project No.:** R11S002 T10

**Northing:** 77587.6
**Easting:** 66472.8
**Elevation:** 278.6

**Date:** Nov. 4, 2011
**Test ID:** Z-SDU6-C06
**Est. Water Depth:** 59.5 ft




CPT REPORT - DYNAMIC PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

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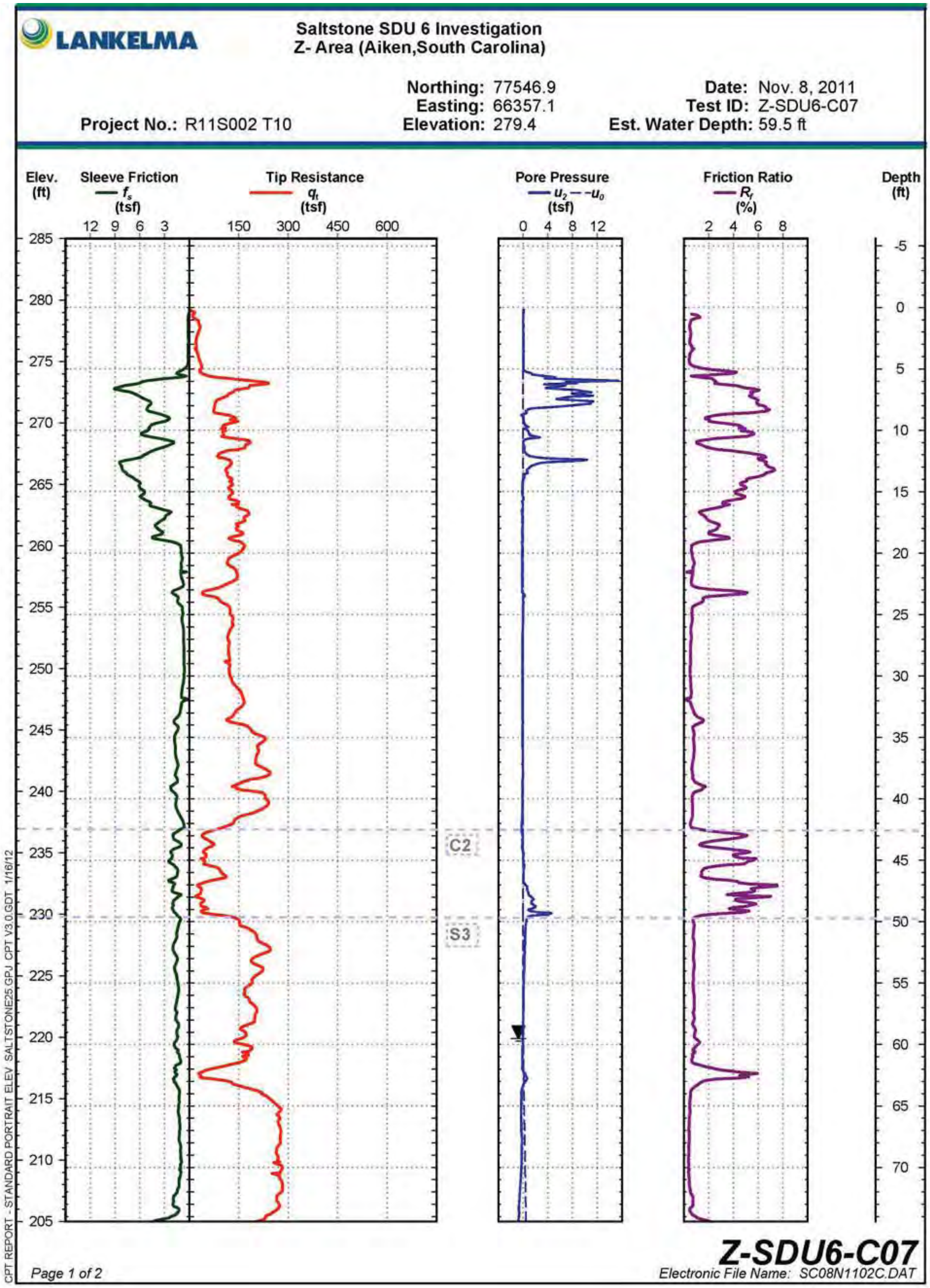
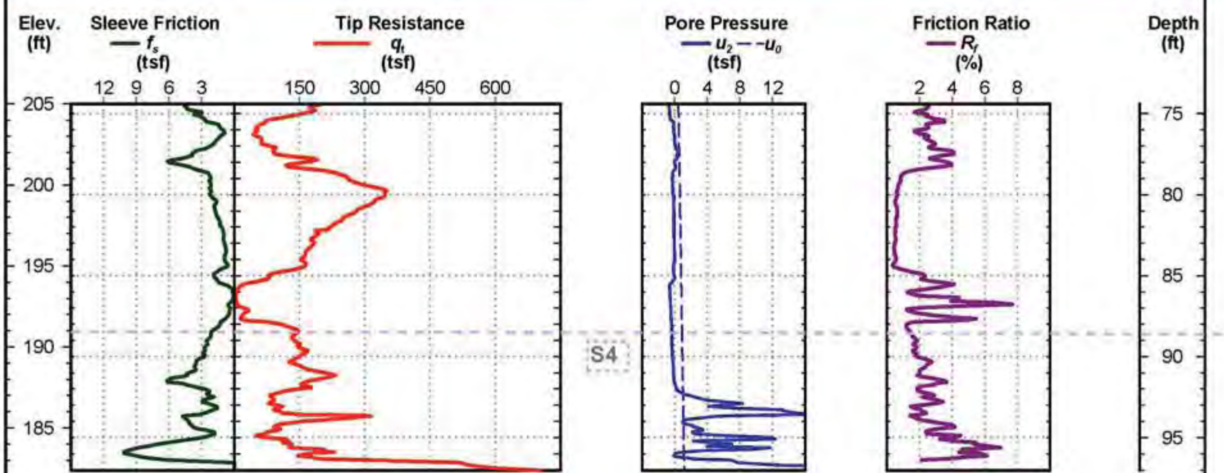
**Z-SDU6-C06**
Electronic File Name: SC04N1103C.DAT


LANKELMA
Saltstone SDU 6 Investigation
Z- Area (Aiken,South Carolina)
Project No.: R11S002 T10
Northing: 77546.9
Easting: 66357.1
Elevation: 279.4
Date: Nov. 8, 2011
Test ID: Z-SDU6-C07
Est. Water Depth: 59.5 ft
Elev. (ft)
Sleeve Friction
fs (tsf)
Tip Resistance
qt (tsf)
Pore Pressure
u2 - -u0 (tsf)
Friction Ratio
Rf (%)
Depth (ft)
C2
S3
CPT REPORT - STANDARD PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12
Page 1 of 2
Z-SDU6-C07
Electronic File Name: SC08N1102C.DAT

LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

**Project No.:** R11S002 T10
**Northing:** 77546.9
**Easting:** 66357.1
**Elevation:** 279.4
**Date:** Nov. 8, 2011
**Test ID:** Z-SDU6-C07
**Est. Water Depth:** 59.5 ft




CPT REPORT - STANDARD PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

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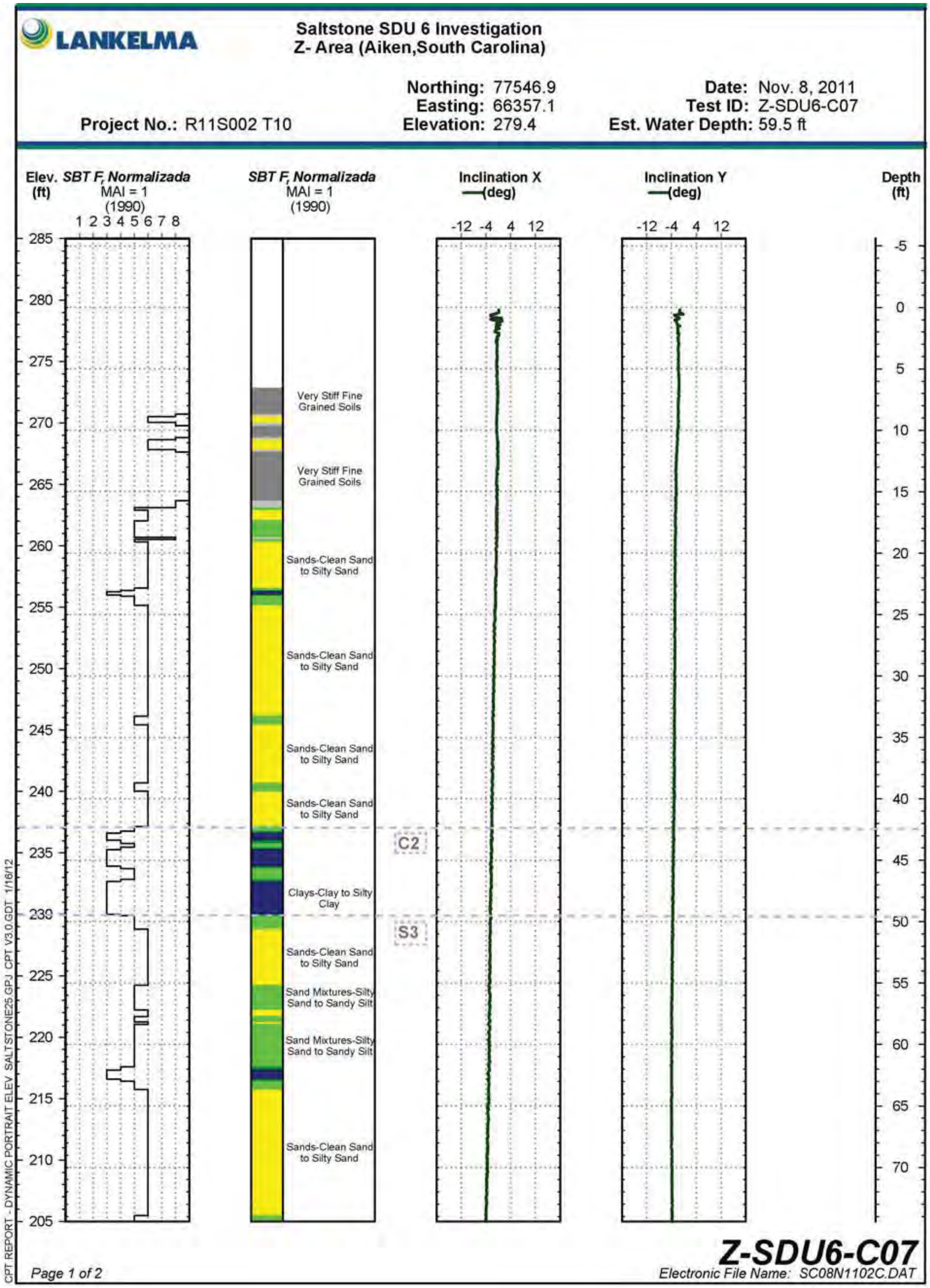
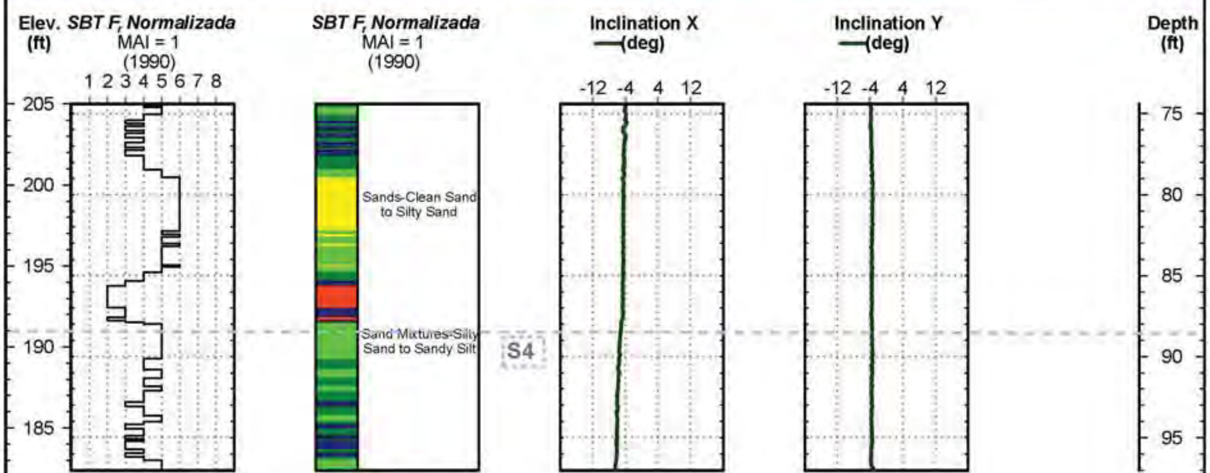
**Z-SDU6-C07**
Electronic File Name: SC08N1102C.DAT


LANKELMA
Saltstone SDU 6 Investigation
Z- Area (Aiken,South Carolina)
Project No.: R11S002 T10
Northing: 77546.9
Easting: 66357.1
Elevation: 279.4
Date: Nov. 8, 2011
Test ID: Z-SDU6-C07
Est. Water Depth: 59.5 ft
Elev. (ft)
SBT F, Normalizada MAI = 1 (1990)
1 2 3 4 5 6 7 8
SBT F, Normalizada MAI = 1 (1990)
Inclination X (deg)
-12 -4 4 12
Inclination Y (deg)
-12 -4 4 12
Depth (ft)
Very Stiff Fine Grained Soils
Very Stiff Fine Grained Soils
Sands-Clean Sand to Silty Sand
Sands-Clean Sand to Silty Sand
Sands-Clean Sand to Silty Sand
Sands-Clean Sand to Silty Sand
C2
Clays-Clay to Silty Clay
S3
Sands-Clean Sand to Silty Sand
Sand Mixtures-Silty Sand to Sandy Silt
Sand Mixtures-Silty Sand to Sandy Silt
Sands-Clean Sand to Silty Sand
CPT REPORT - DYNAMIC PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12
Page 1 of 2
Z-SDU6-C07
Electronic File Name: SC08N1102C.DAT

LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

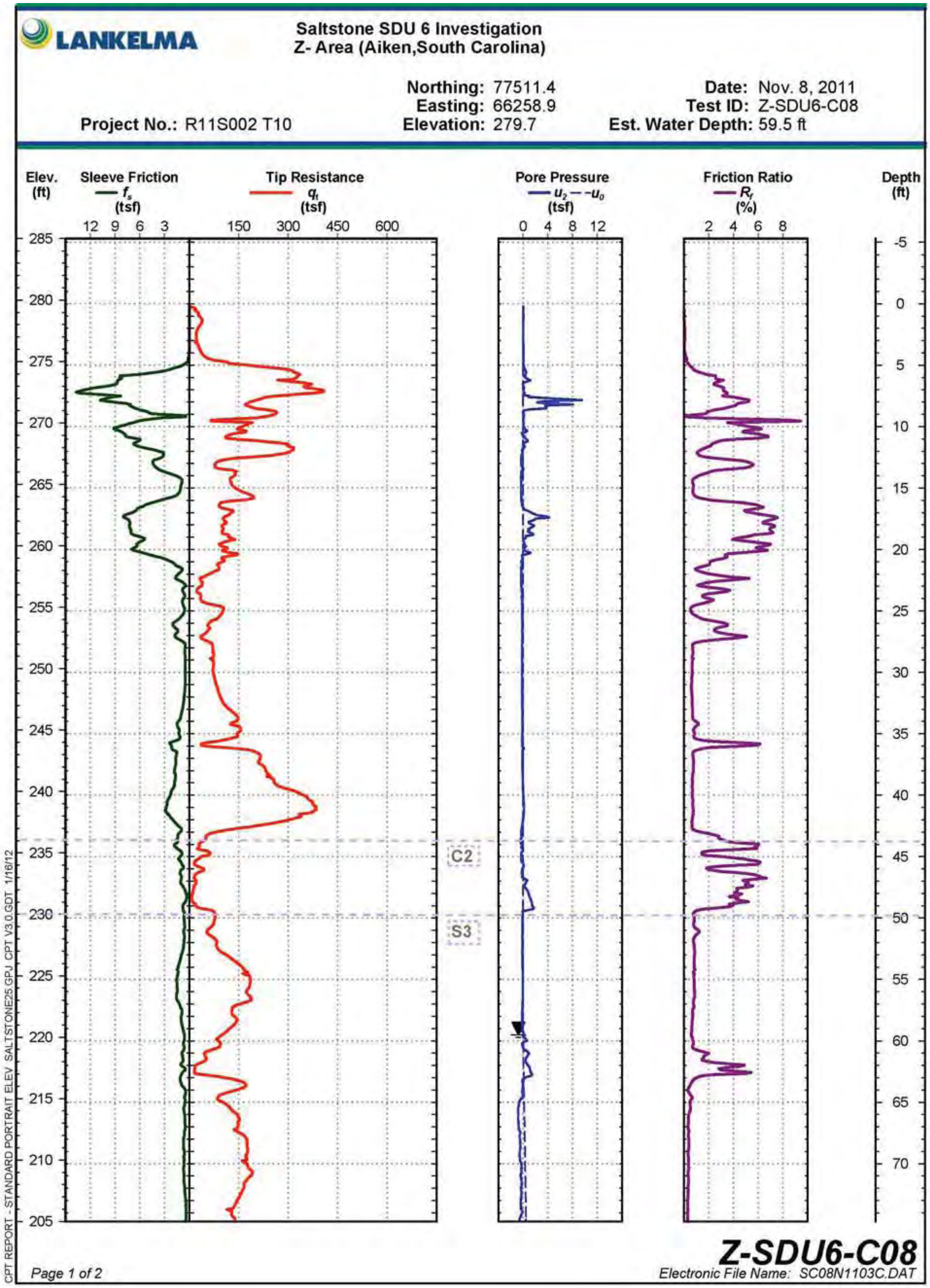
**Project No.:** R11S002 T10
**Northing:** 77546.9
**Easting:** 66357.1
**Elevation:** 279.4
**Date:** Nov. 8, 2011
**Test ID:** Z-SDU6-C07
**Est. Water Depth:** 59.5 ft




CPT REPORT - DYNAMIC PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

Page 2 of 2

**Z-SDU6-C07**
Electronic File Name: SC08N1102C.DAT

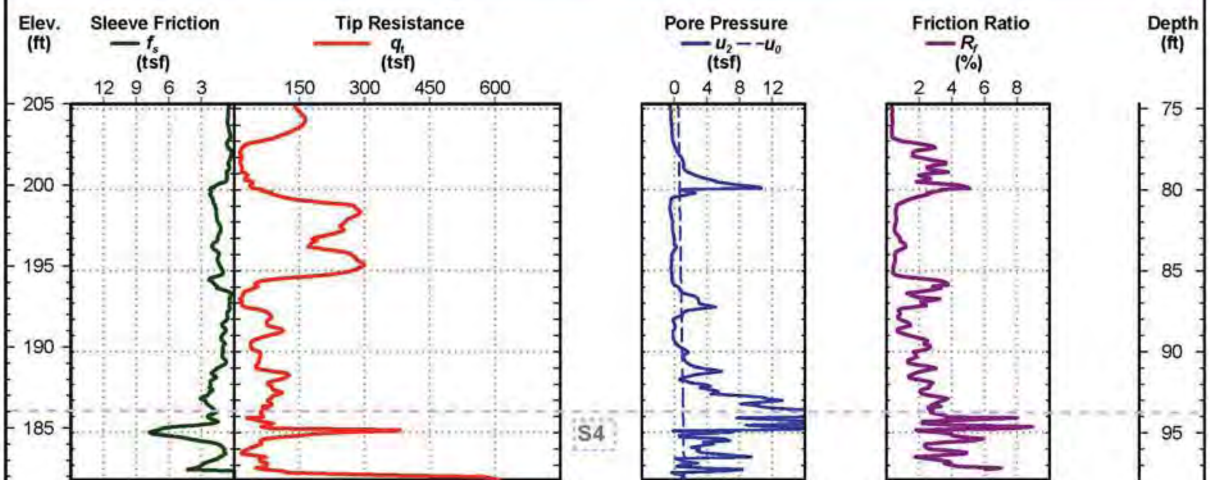

LANKELMA
Saltstone SDU 6 Investigation
Z- Area (Aiken,South Carolina)
Northing: 77511.4
Easting: 66258.9
Elevation: 279.7
Date: Nov. 8, 2011
Test ID: Z-SDU6-C08
Est. Water Depth: 59.5 ft
Project No.: R11S002 T10
Elev. (ft)
Sleeve Friction fs (tsf)
Tip Resistance qt (tsf)
Pore Pressure u2 u0 (tsf)
Friction Ratio Rf (%)
Depth (ft)
C2
S3
CPT REPORT - STANDARD PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12
Page 1 of 2
Z-SDU6-C08
Electronic File Name: SC08N1103C.DAT

Saltstone SDU 6 Investigation
Z- Area (Aiken,South Carolina)

Project No.: R11S002 T10

Northing: 77511.4
Easting: 66258.9
Elevation: 279.7

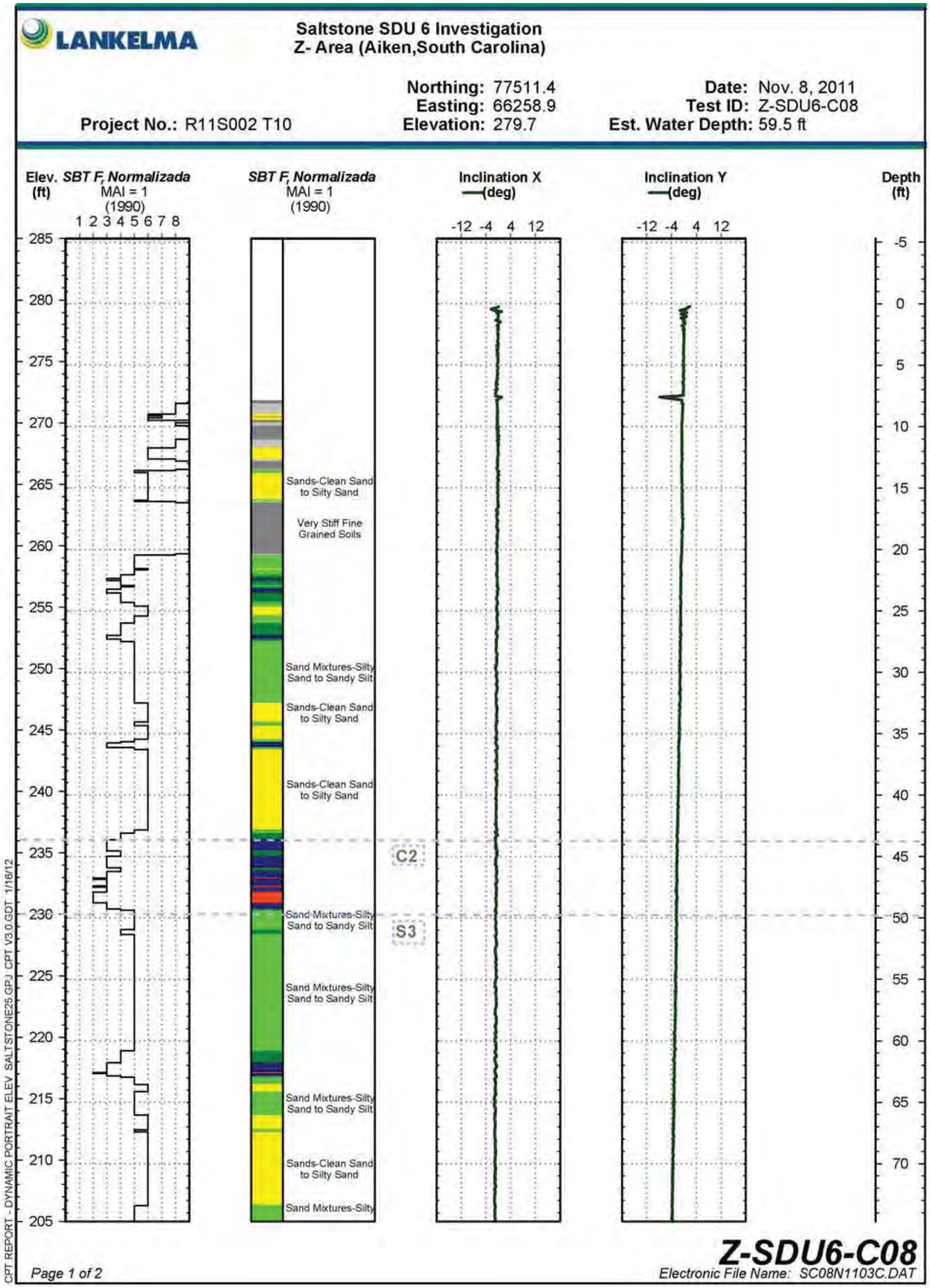
Date: Nov. 8, 2011
Test ID: Z-SDU6-C08
Est. Water Depth: 59.5 ft




CPT REPORT - STANDARD PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

Page 2 of 2

**Z-SDU6-C08**
Electronic File Name: SC08N1103C.DAT


LANKELMA
Saltstone SDU 6 Investigation
Z- Area (Aiken,South Carolina)
Project No.: R11S002 T10
Northing: 77511.4
Easting: 66258.9
Elevation: 279.7
Date: Nov. 8, 2011
Test ID: Z-SDU6-C08
Est. Water Depth: 59.5 ft
Elev. (ft)
SBT F, Normalizada
MAI = 1
(1990)
Inclination X (deg)
Inclination Y (deg)
Depth (ft)
Sands-Clean Sand to Silty Sand
Very Stiff Fine Grained Soils
Sand Mixtures-Silty Sand to Sandy Silt
C2
S3
Z-SDU6-C08
Page 1 of 2
Electronic File Name: SC08N1103C.DAT
CPT REPORT - DYNAMIC PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

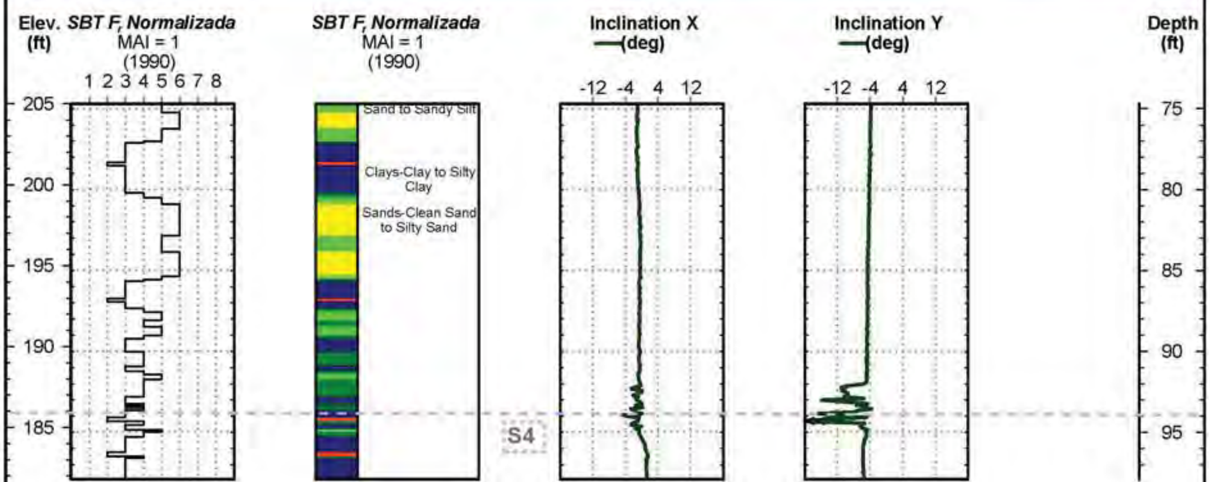
LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

**Project No.:** R11S002 T10

**Northing:** 77511.4
**Easting:** 66258.9
**Elevation:** 279.7

**Date:** Nov. 8, 2011
**Test ID:** Z-SDU6-C08
**Est. Water Depth:** 59.5 ft




CPT REPORT - DYNAMIC PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

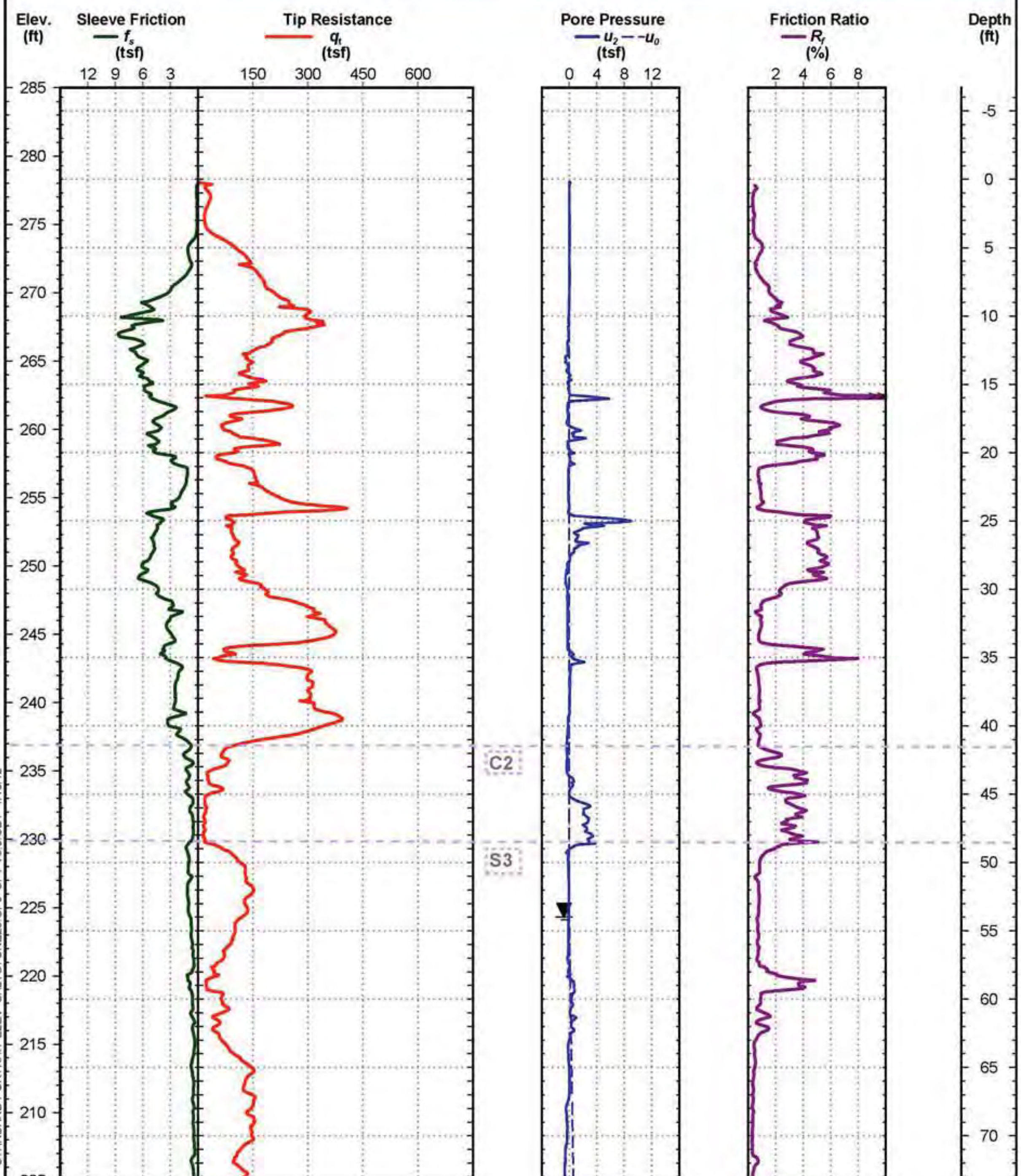
*Page 2 of 2*

**Z-SDU6-C08**
*Electronic File Name: SC08N1103C.DAT*

LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

**Project No.:** R11S002 T10
**Northing:** 77621.8
**Easting:** 66210.4
**Elevation:** 278.3
**Date:** Nov. 3, 2011
**Test ID:** Z-SDU6-C09
**Est. Water Depth:** 54 ft




CPT REPORT - STANDARD PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

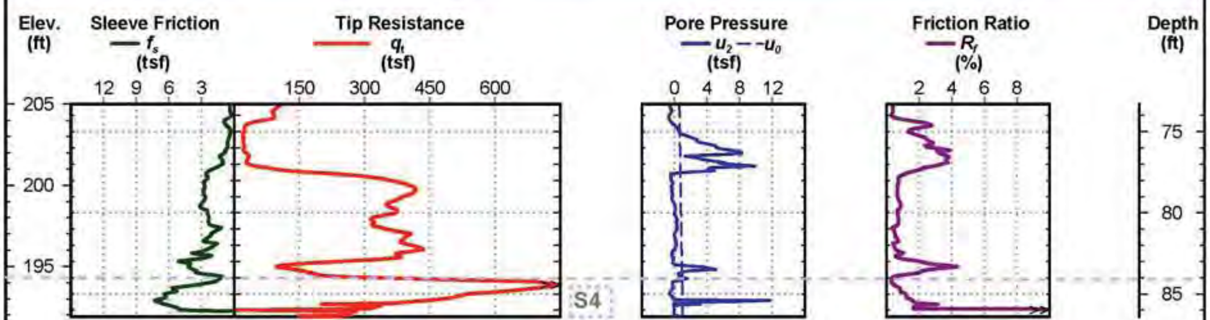
Page 1 of 2

**Z-SDU6-C09**
Electronic File Name: SC03N1102C.DAT

LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

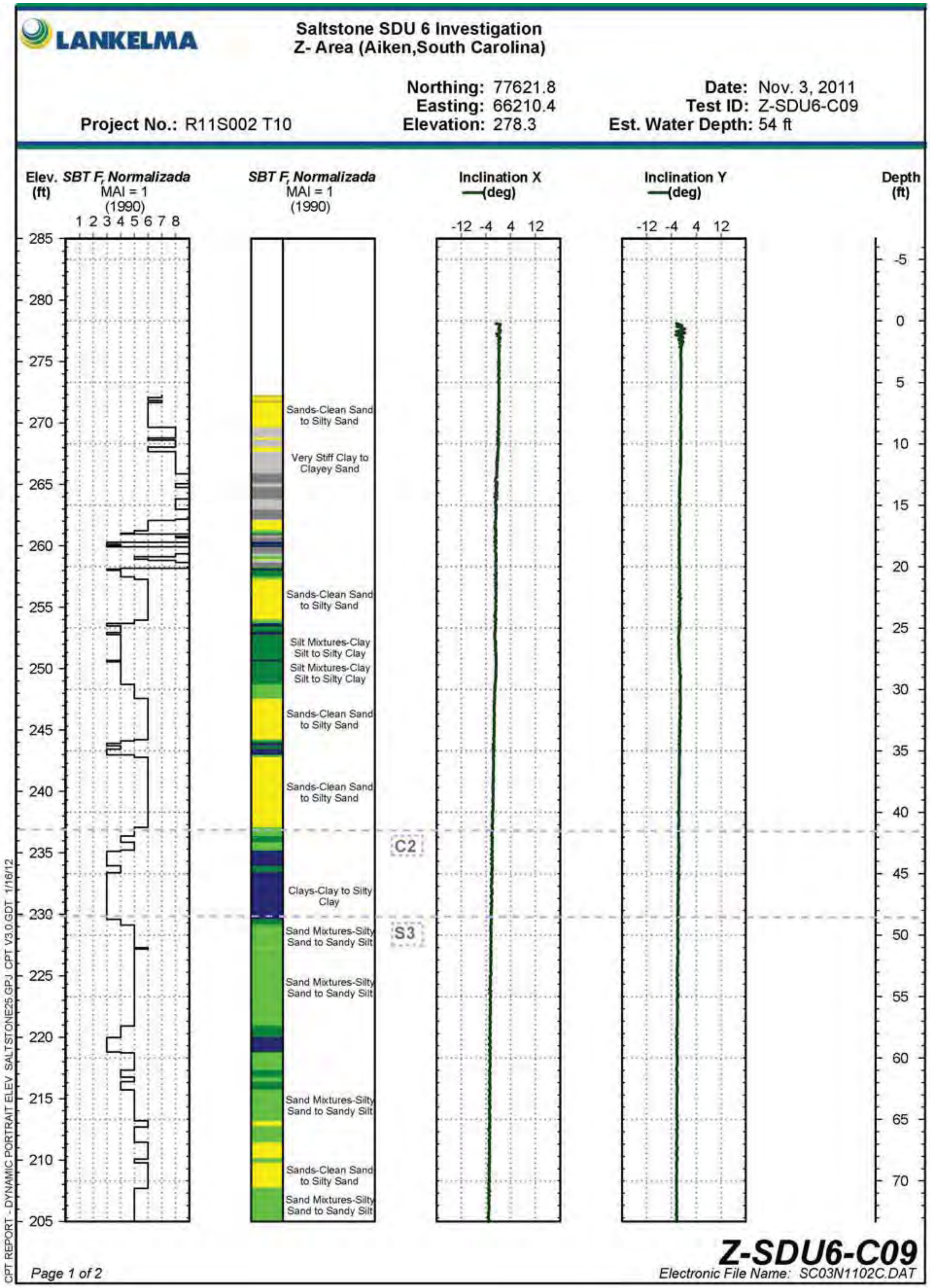
**Project No.:** R11S002 T10
**Northing:** 77621.8
**Easting:** 66210.4
**Elevation:** 278.3
**Date:** Nov. 3, 2011
**Test ID:** Z-SDU6-C09
**Est. Water Depth:** 54 ft




CPT REPORT - STANDARD PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

Page 2 of 2

**Z-SDU6-C09**
Electronic File Name: SC03N1102C.DAT


LANKELMA
Saltstone SDU 6 Investigation
Z- Area (Aiken,South Carolina)
Project No.: R11S002 T10
Northing: 77621.8
Easting: 66210.4
Elevation: 278.3
Date: Nov. 3, 2011
Test ID: Z-SDU6-C09
Est. Water Depth: 54 ft
Elev. (ft)
SBT F, Normalizada MAI = 1 (1990)
Inclination X (deg)
Inclination Y (deg)
Depth (ft)
Sands-Clean Sand to Silty Sand
Very Stiff Clay to Clayey Sand
Silt Mixtures-Clay Silt to Silty Clay
Clays-Clay to Silty Clay
Sand Mixtures-Silty Sand to Sandy Silt
C2
S3
CPT REPORT - DYNAMIC PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12
Page 1 of 2
Z-SDU6-C09
Electronic File Name: SC03N1102C.DAT

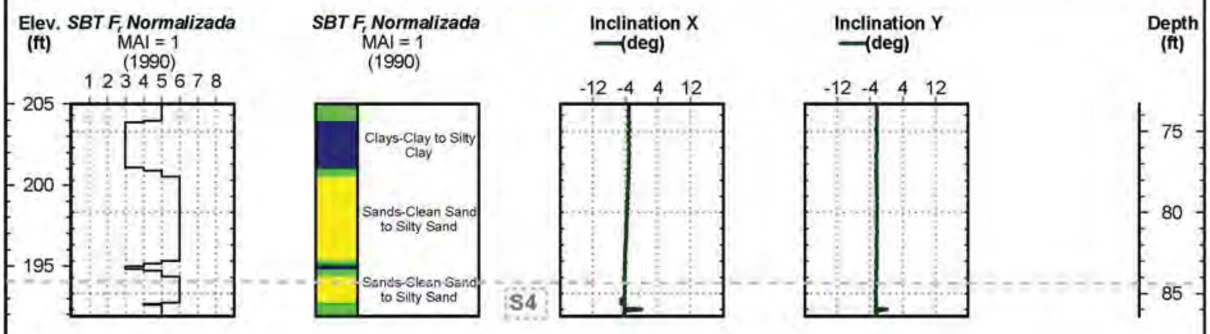
LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

**Project No.:** R11S002 T10

**Northing:** 77621.8
**Easting:** 66210.4
**Elevation:** 278.3

**Date:** Nov. 3, 2011
**Test ID:** Z-SDU6-C09
**Est. Water Depth:** 54 ft




CPT REPORT - DYNAMIC PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

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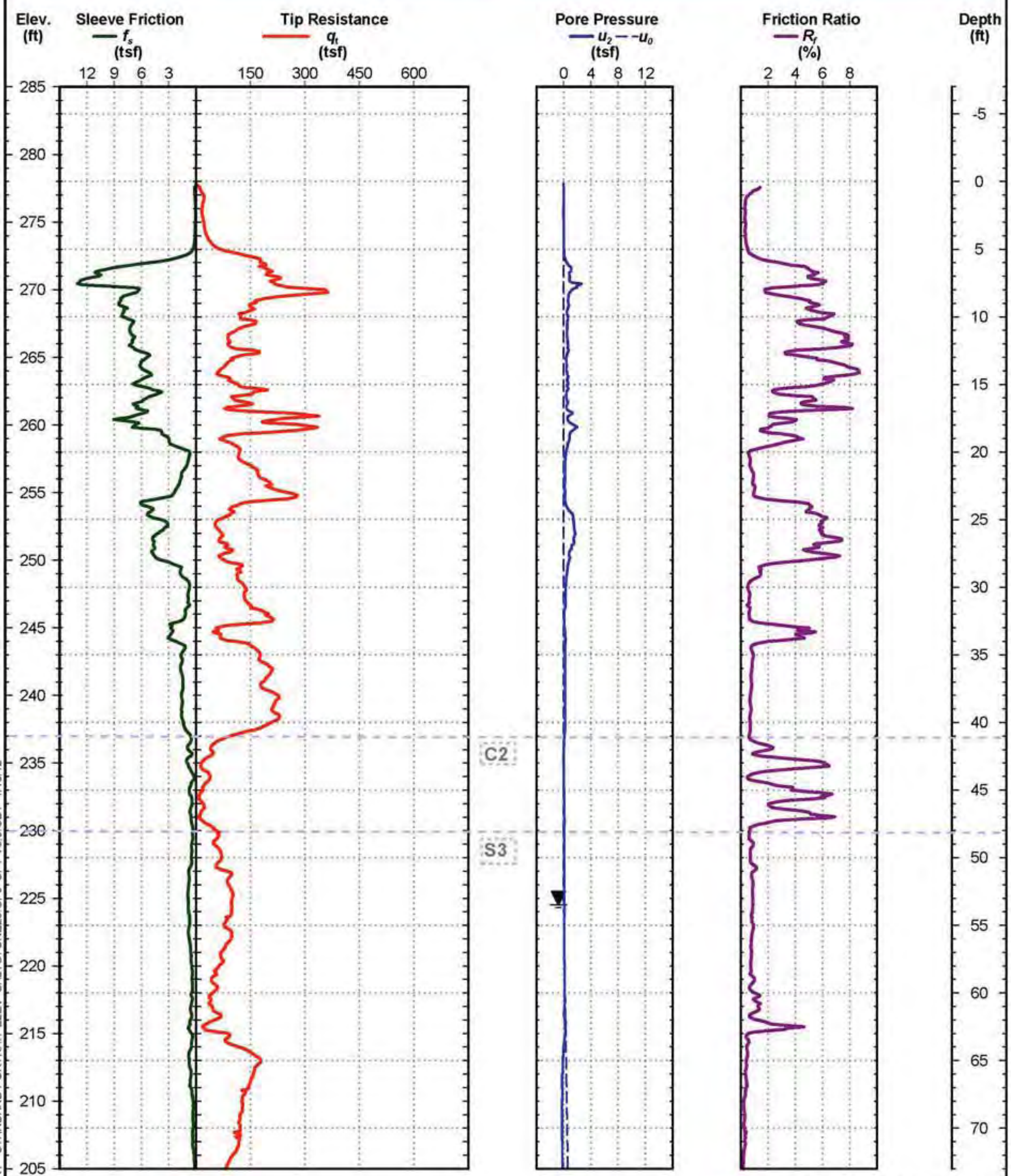
**Z-SDU6-C09**
*Electronic File Name: SC03N1102C.DAT*

LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

**Project No.:** R11S002 T10
**Northing:** 77644.2
**Easting:** 66285.6
**Elevation:** 278.0
**Date:** Nov. 3, 2011
**Test ID:** Z-SDU6-C10
**Est. Water Depth:** 53.5 ft




CPT REPORT - STANDARD PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

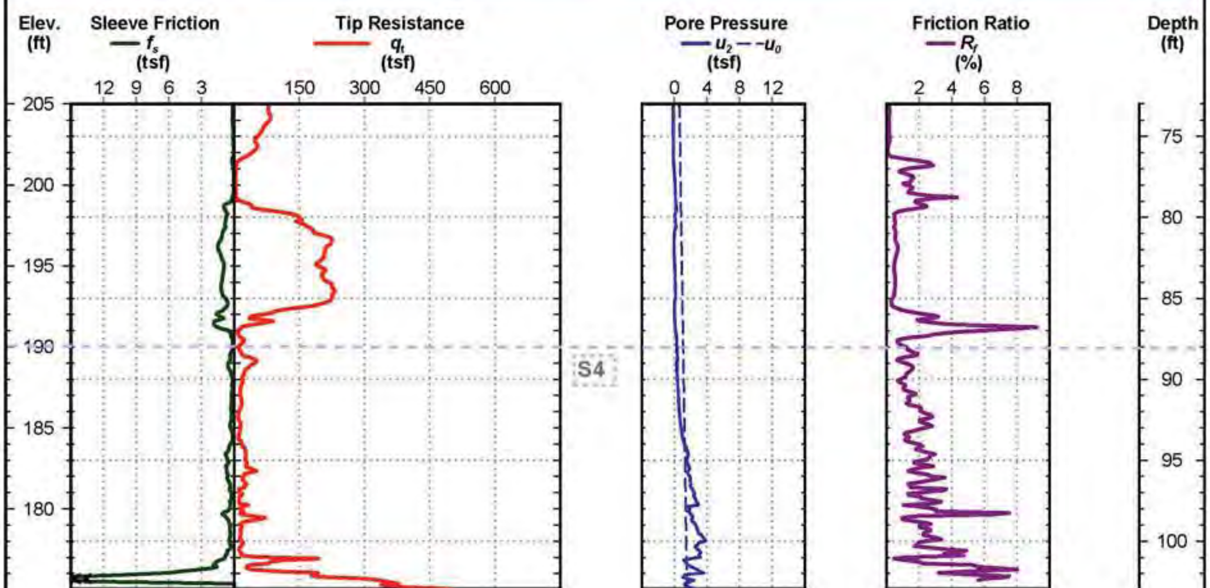
Page 1 of 2

**Z-SDU6-C10**
Electronic File Name: SC03N1103C.DAT

LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

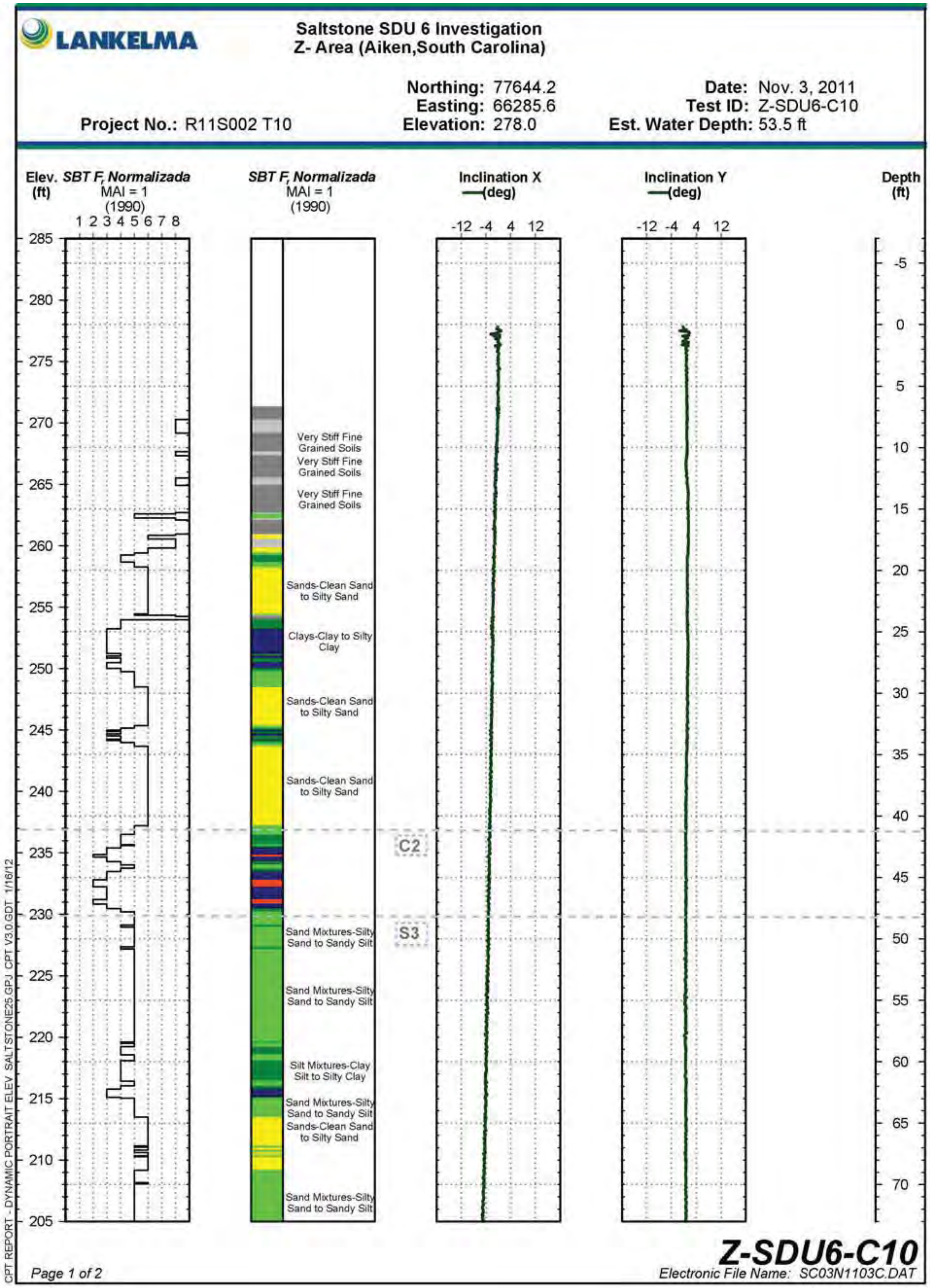
**Project No.:** R11S002 T10
**Northing:** 77644.2
**Easting:** 66285.6
**Elevation:** 278.0
**Date:** Nov. 3, 2011
**Test ID:** Z-SDU6-C10
**Est. Water Depth:** 53.5 ft




CPT REPORT - STANDARD PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

Page 2 of 2

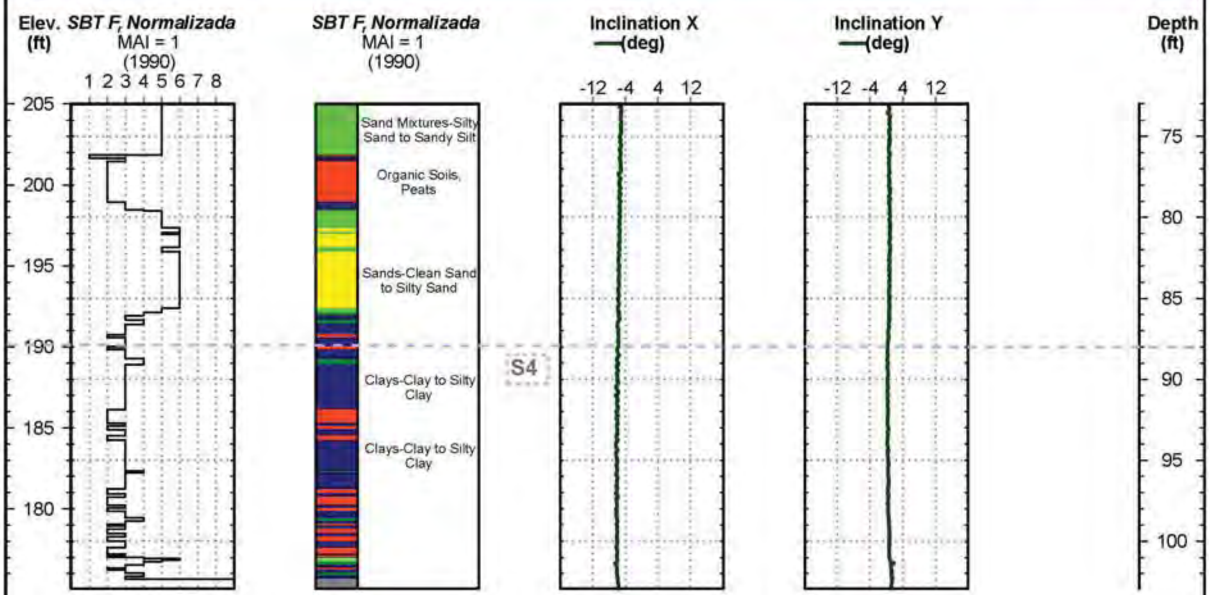
**Z-SDU6-C10**
Electronic File Name: SC03N1103C.DAT


LANKELMA
Saltstone SDU 6 Investigation
Z- Area (Aiken,South Carolina)
Northing: 77644.2
Easting: 66285.6
Elevation: 278.0
Date: Nov. 3, 2011
Test ID: Z-SDU6-C10
Est. Water Depth: 53.5 ft
Project No.: R11S002 T10
Elev. (ft)
SBT F, Normalizada
MAI = 1
(1990)
1 2 3 4 5 6 7 8
SBT F, Normalizada
MAI = 1
(1990)
Inclination X
(deg)
-12 -4 4 12
Inclination Y
(deg)
-12 -4 4 12
Depth (ft)
285
280
275
270
265
260
255
250
245
240
235
230
225
220
215
210
205
-5
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Very Stiff Fine Grained Soils
Very Stiff Fine Grained Soils
Very Stiff Fine Grained Soils
Sands-Clean Sand to Silty Sand
Clays-Clay to Silty Clay
Sands-Clean Sand to Silty Sand
Sands-Clean Sand to Silty Sand
C2
S3
Sand Mixtures-Silty Sand to Sandy Silt
Sand Mixtures-Silty Sand to Sandy Silt
Silt Mixtures-Clay Silt to Silty Clay
Sand Mixtures-Silty Sand to Sandy Silt
Sands-Clean Sand to Silty Sand
Sand Mixtures-Silty Sand to Sandy Silt
CPT REPORT - DYNAMIC PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12
Page 1 of 2
Z-SDU6-C10
Electronic File Name: SC03N1103C.DAT

LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

**Project No.:** R11S002 T10
**Northing:** 77644.2
**Easting:** 66285.6
**Elevation:** 278.0
**Date:** Nov. 3, 2011
**Test ID:** Z-SDU6-C10
**Est. Water Depth:** 53.5 ft




CPT REPORT - DYNAMIC PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

Page 2 of 2

**Z-SDU6-C10**
Electronic File Name: SC03N1103C.DAT

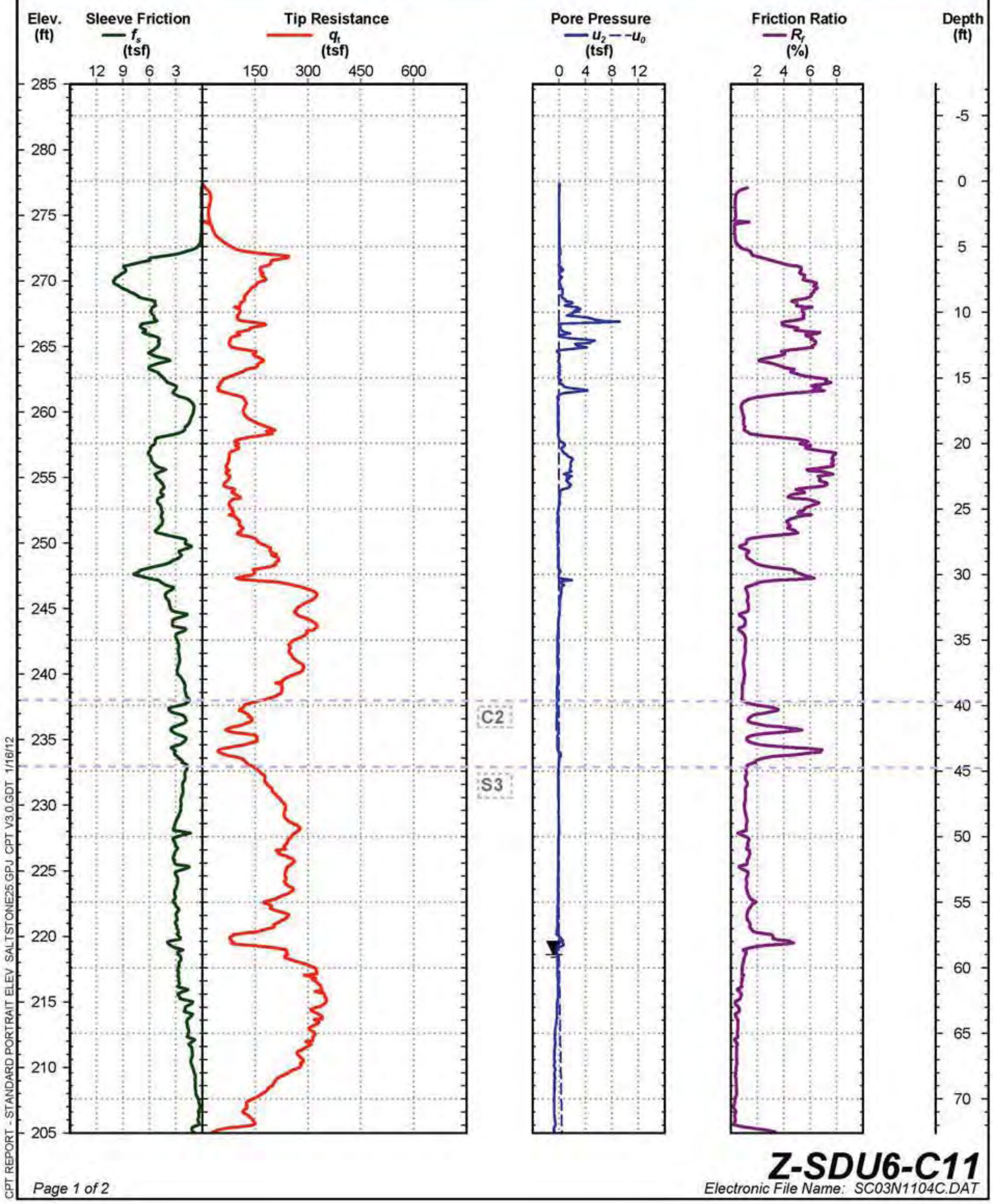
LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

**Northing:** 77663.3
**Easting:** 66354.1
**Elevation:** 277.6

**Date:** Nov. 3, 2011
**Test ID:** Z-SDU6-C11
**Est. Water Depth:** 59 ft

**Project No.:** R11S002 T10

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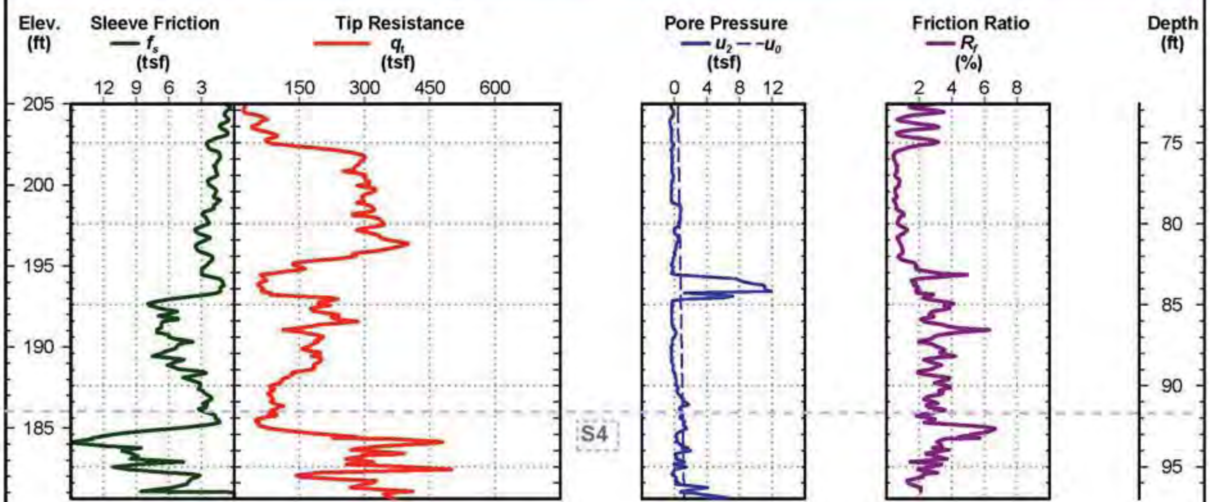
**Z-SDU6-C11**
*Electronic File Name: SC03N1104C.DAT*

LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

**Project No.:** R11S002 T10
**Northing:** 77663.3
**Easting:** 66354.1
**Elevation:** 277.6
**Date:** Nov. 3, 2011
**Test ID:** Z-SDU6-C11
**Est. Water Depth:** 59 ft




CPT REPORT - STANDARD PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

Page 2 of 2

**Z-SDU6-C11**
Electronic File Name: SC03N1104C.DAT

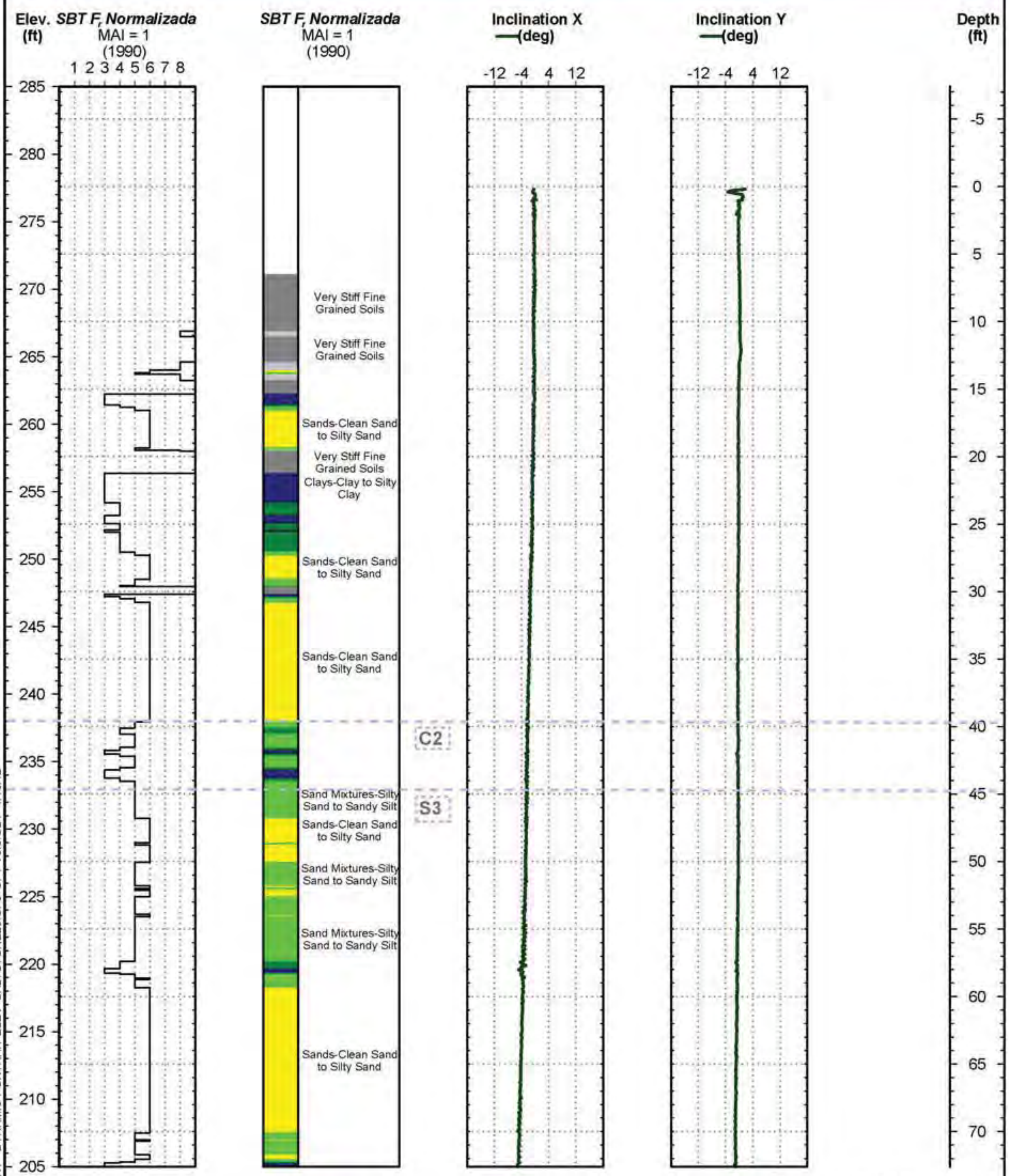
LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

**Northing:** 77663.3
**Easting:** 66354.1
**Elevation:** 277.6

**Date:** Nov. 3, 2011
**Test ID:** Z-SDU6-C11
**Est. Water Depth:** 59 ft

**Project No.:** R11S002 T10




CPT REPORT - DYNAMIC PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

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**Z-SDU6-C11**

Electronic File Name: SC03N1104C.DAT

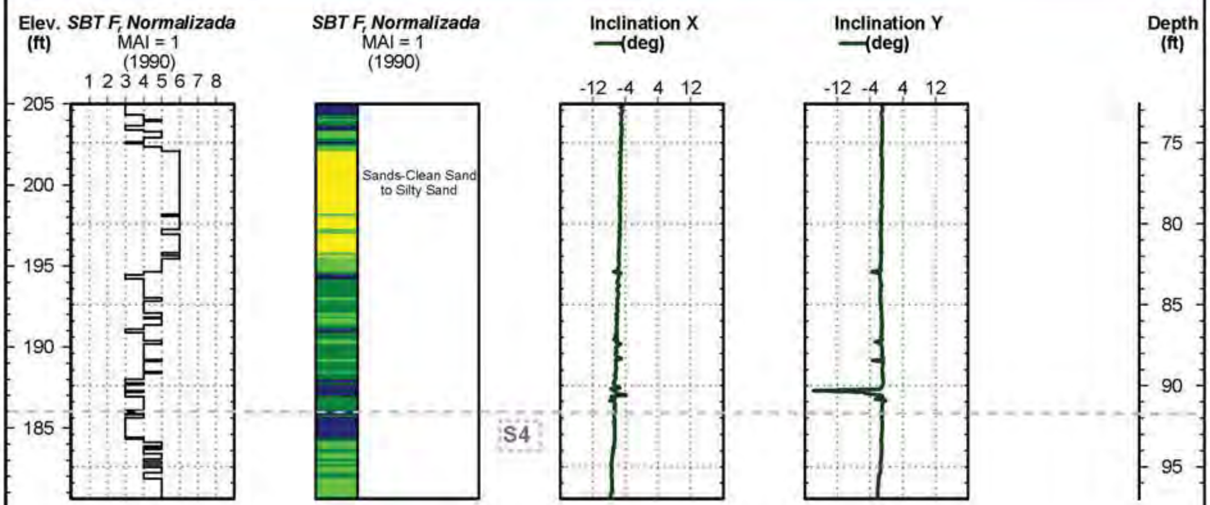
LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

**Project No.:** R11S002 T10

**Northing:** 77663.3
**Easting:** 66354.1
**Elevation:** 277.6

**Date:** Nov. 3, 2011
**Test ID:** Z-SDU6-C11
**Est. Water Depth:** 59 ft




CPT REPORT - DYNAMIC PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

*Page 2 of 2*

**Z-SDU6-C11**
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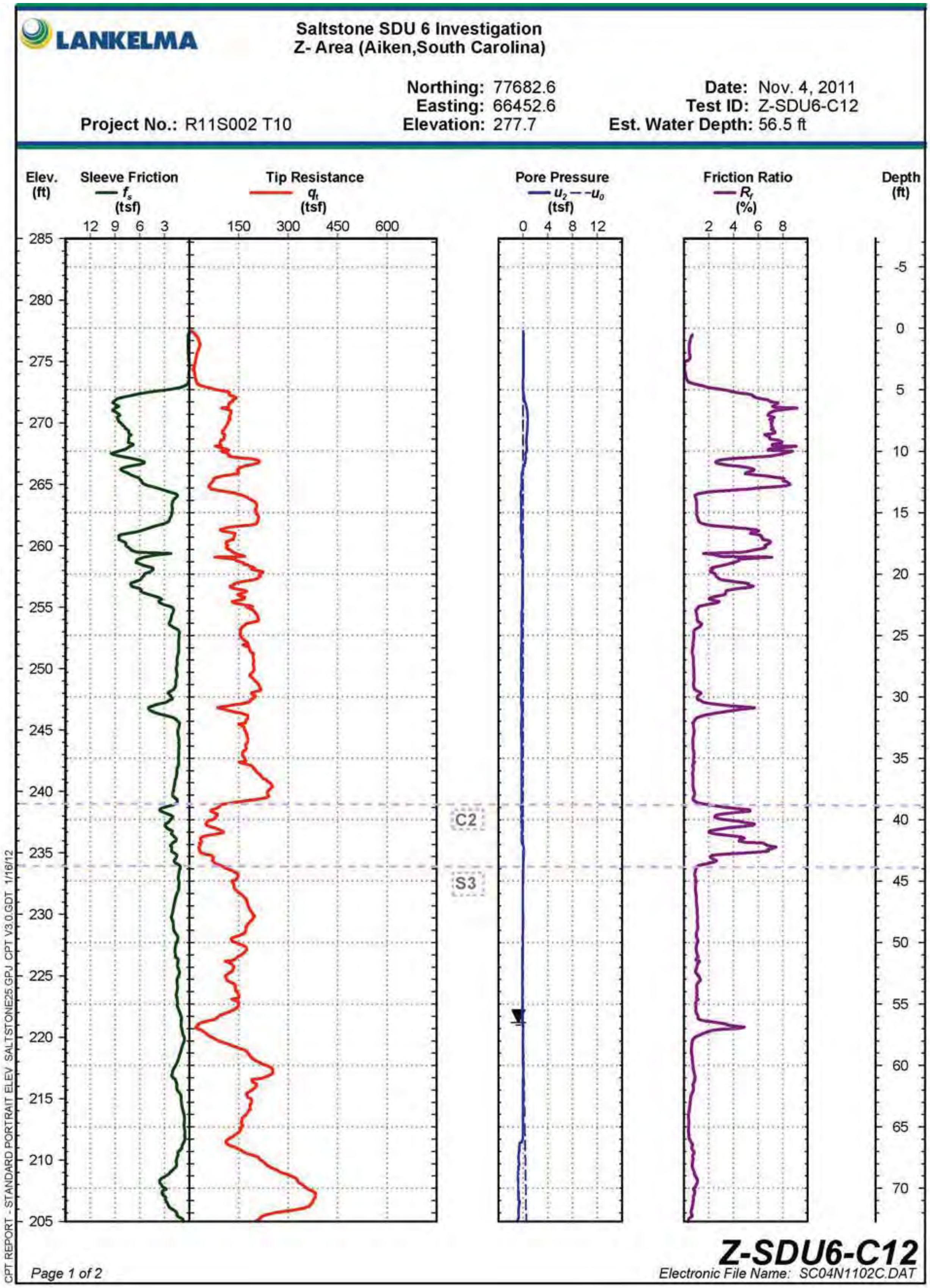

LANKELMA
Saltstone SDU 6 Investigation
Z- Area (Aiken,South Carolina)
Project No.: R11S002 T10
Northing: 77682.6
Easting: 66452.6
Elevation: 277.7
Date: Nov. 4, 2011
Test ID: Z-SDU6-C12
Est. Water Depth: 56.5 ft
Elev. (ft)
Sleeve Friction $f_s$ (tsf)
12 9 6 3
Tip Resistance $q_t$ (tsf)
150 300 450 600
Pore Pressure $u_2$ $u_0$ (tsf)
0 4 8 12
Friction Ratio $R_f$ (%)
2 4 6 8
Depth (ft)
285 280 275 270 265 260 255 250 245 240 235 230 225 220 215 210 205
-5 0 5 10 15 20 25 30 35 40 45 50 55 60 65 70
C2
S3
CPT REPORT - STANDARD PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12
Page 1 of 2
Z-SDU6-C12
Electronic File Name: SC04N1102C.DAT

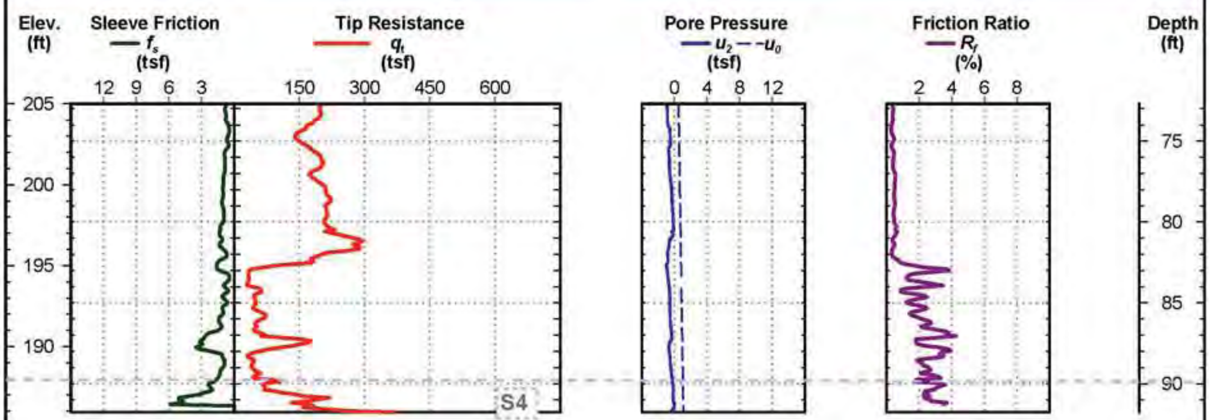
LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

**Project No.:** R11S002 T10

**Northing:** 77682.6
**Easting:** 66452.6
**Elevation:** 277.7

**Date:** Nov. 4, 2011
**Test ID:** Z-SDU6-C12
**Est. Water Depth:** 56.5 ft








**Z-SDU6-C12**
Electronic File Name: SC04N1102C.DAT

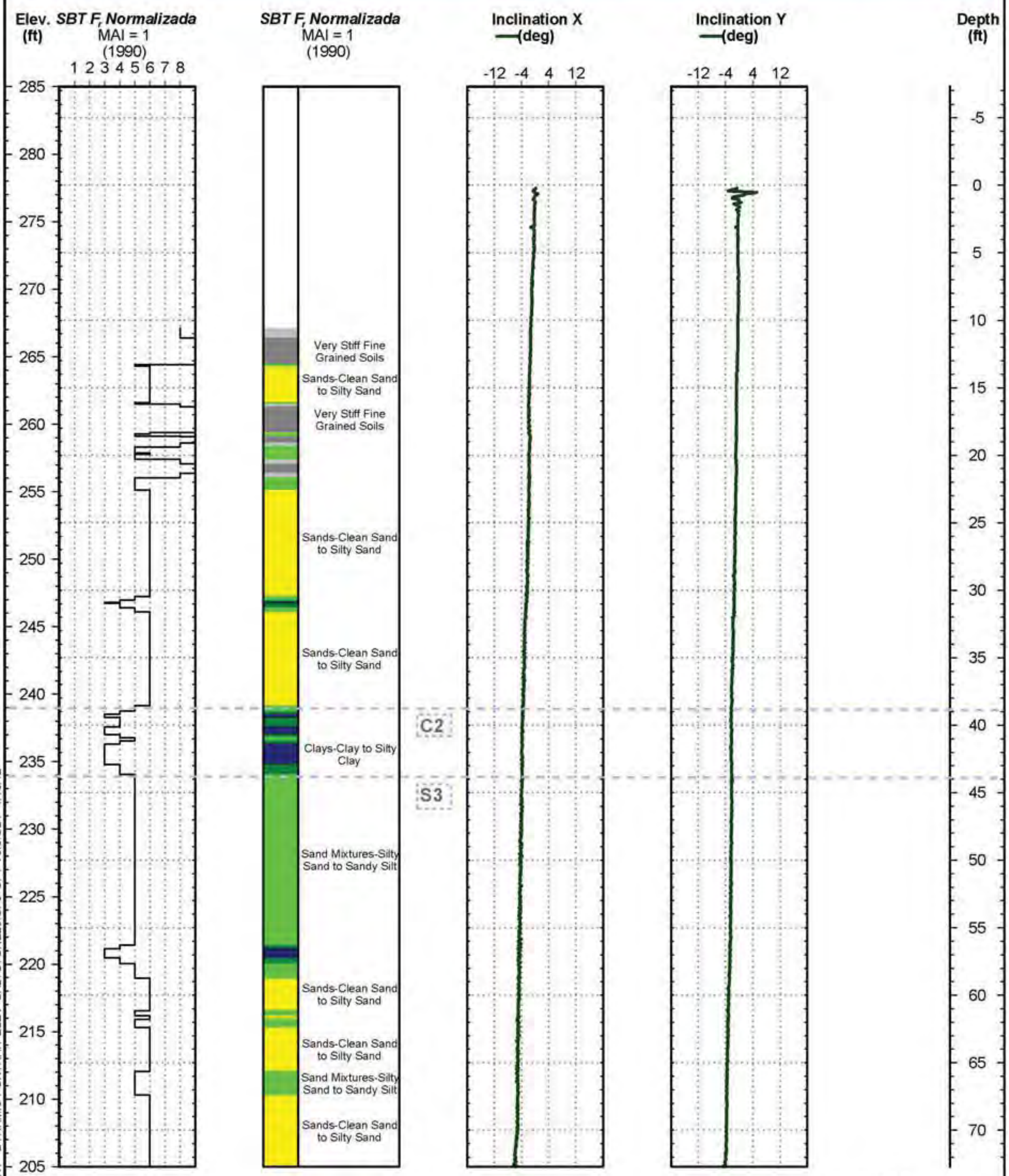
LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

**Project No.:** R11S002 T10

**Northing:** 77682.6
**Easting:** 66452.6
**Elevation:** 277.7

**Date:** Nov. 4, 2011
**Test ID:** Z-SDU6-C12
**Est. Water Depth:** 56.5 ft




CPT REPORT - DYNAMIC PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

**Z-SDU6-C12**

Page 1 of 2

*Electronic File Name: SC04N1102C.DAT*

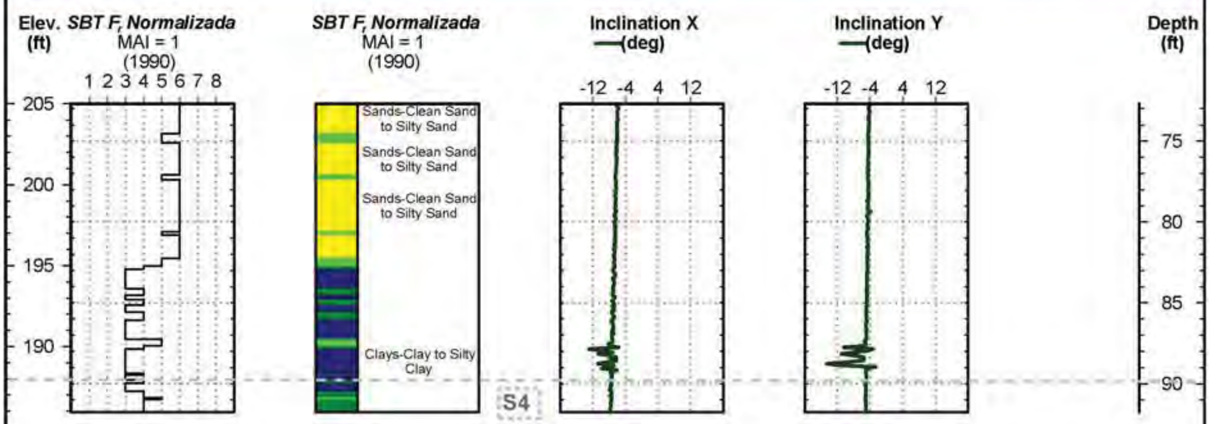
**LANKELMA**

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

**Northing:** 77682.6
**Easting:** 66452.6
**Elevation:** 277.7

**Date:** Nov. 4, 2011
**Test ID:** Z-SDU6-C12
**Est. Water Depth:** 56.5 ft

**Project No.:** R11S002 T10

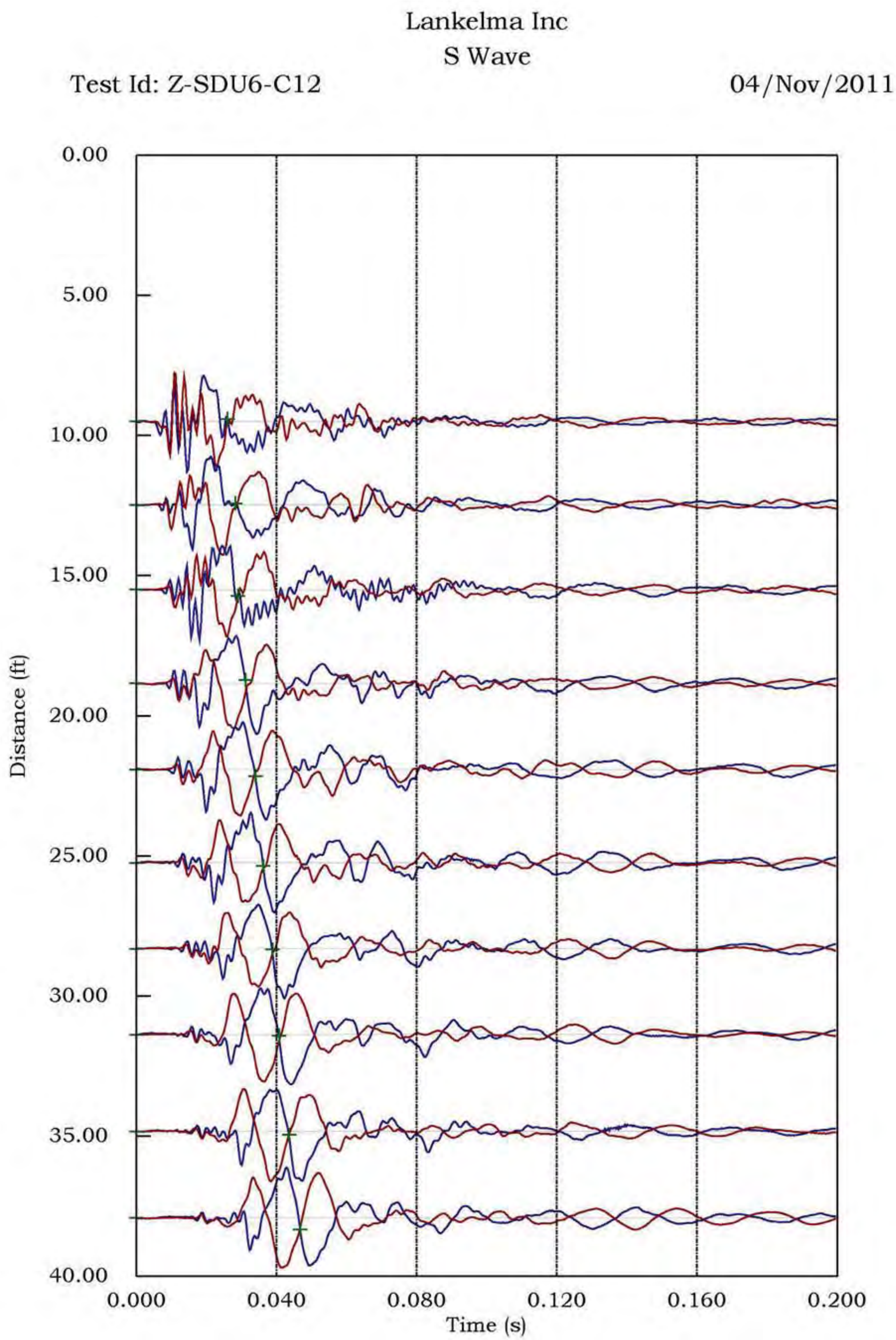



CPT REPORT - DYNAMIC PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

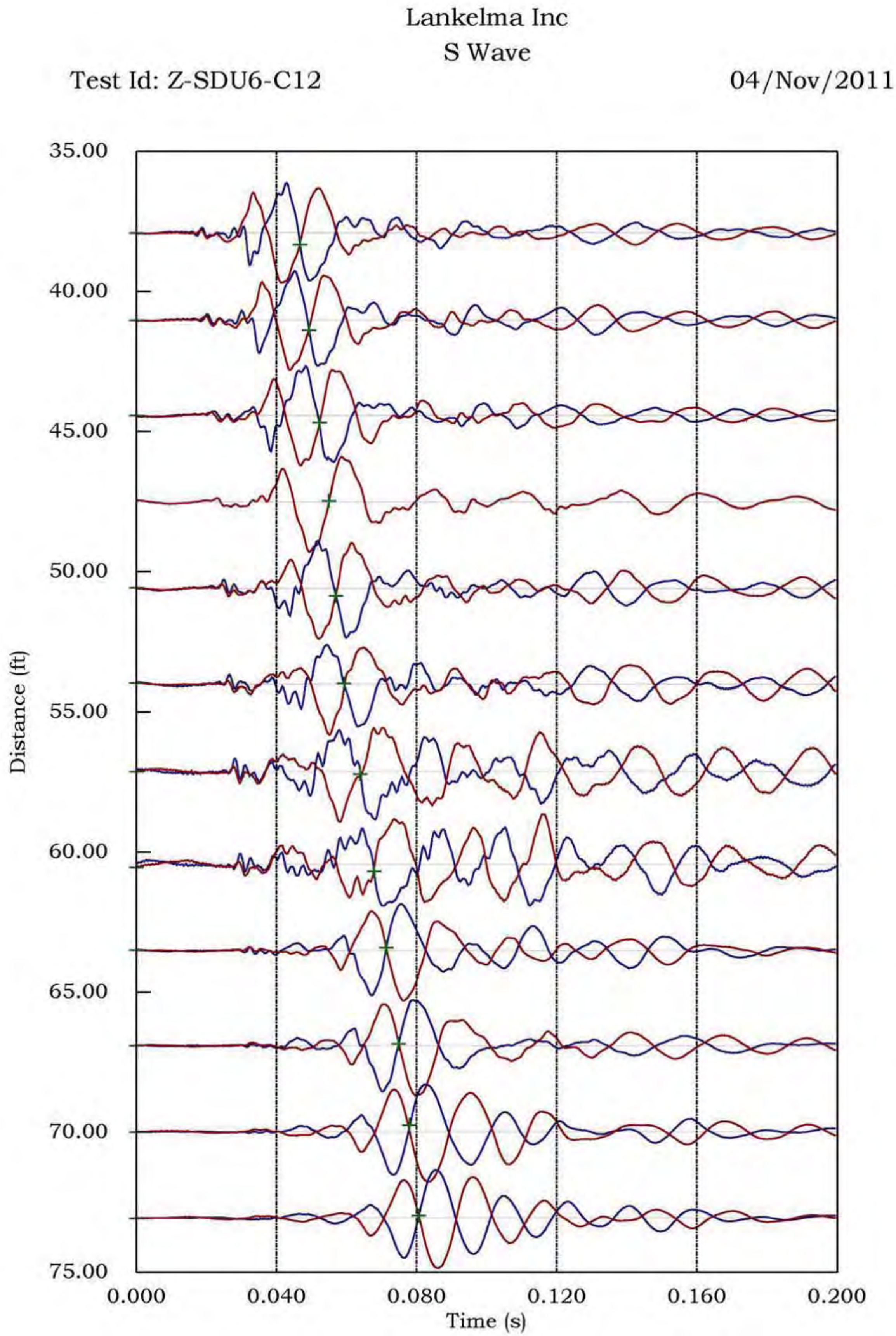
*Page 2 of 2*

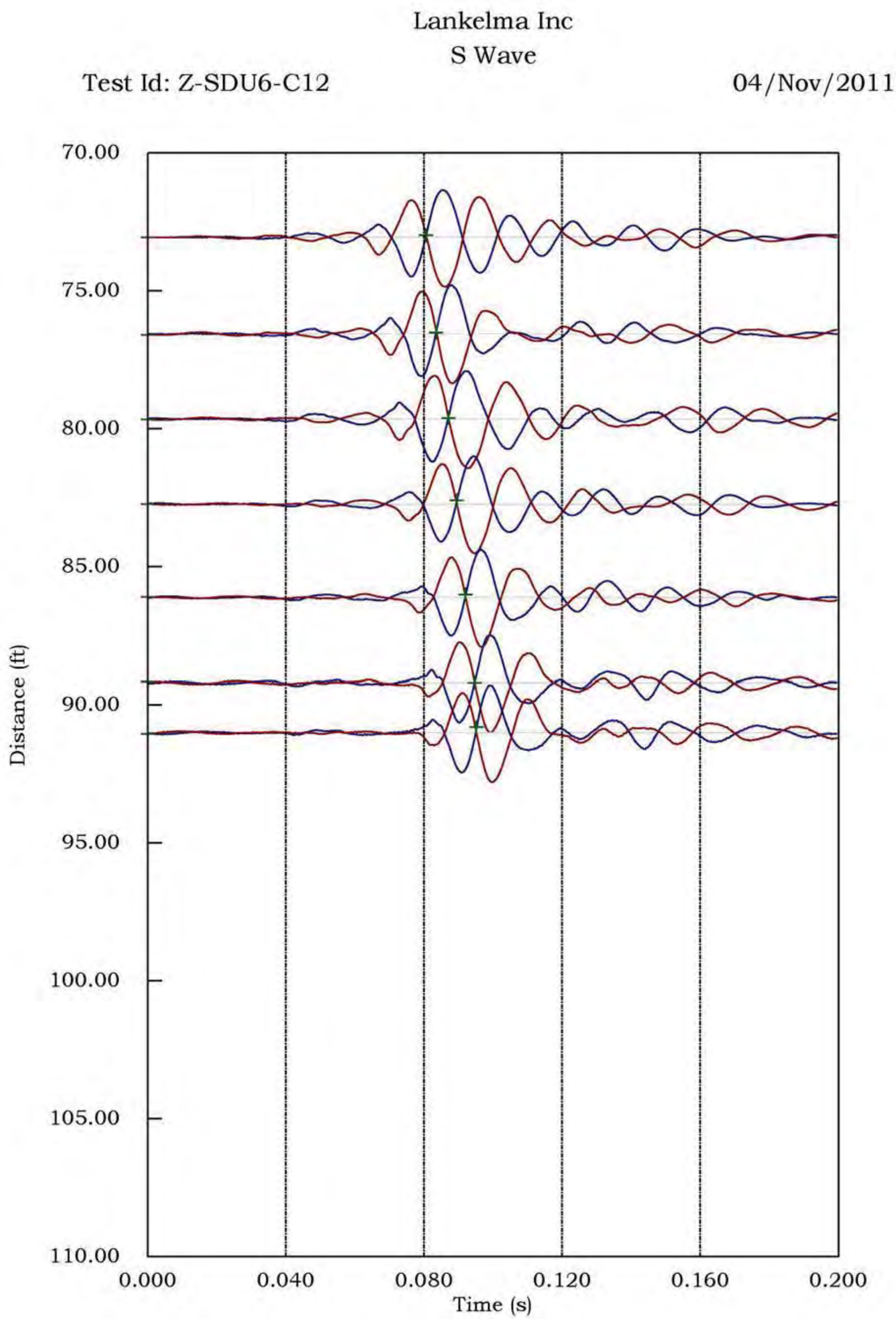
**Z-SDU6-C12**

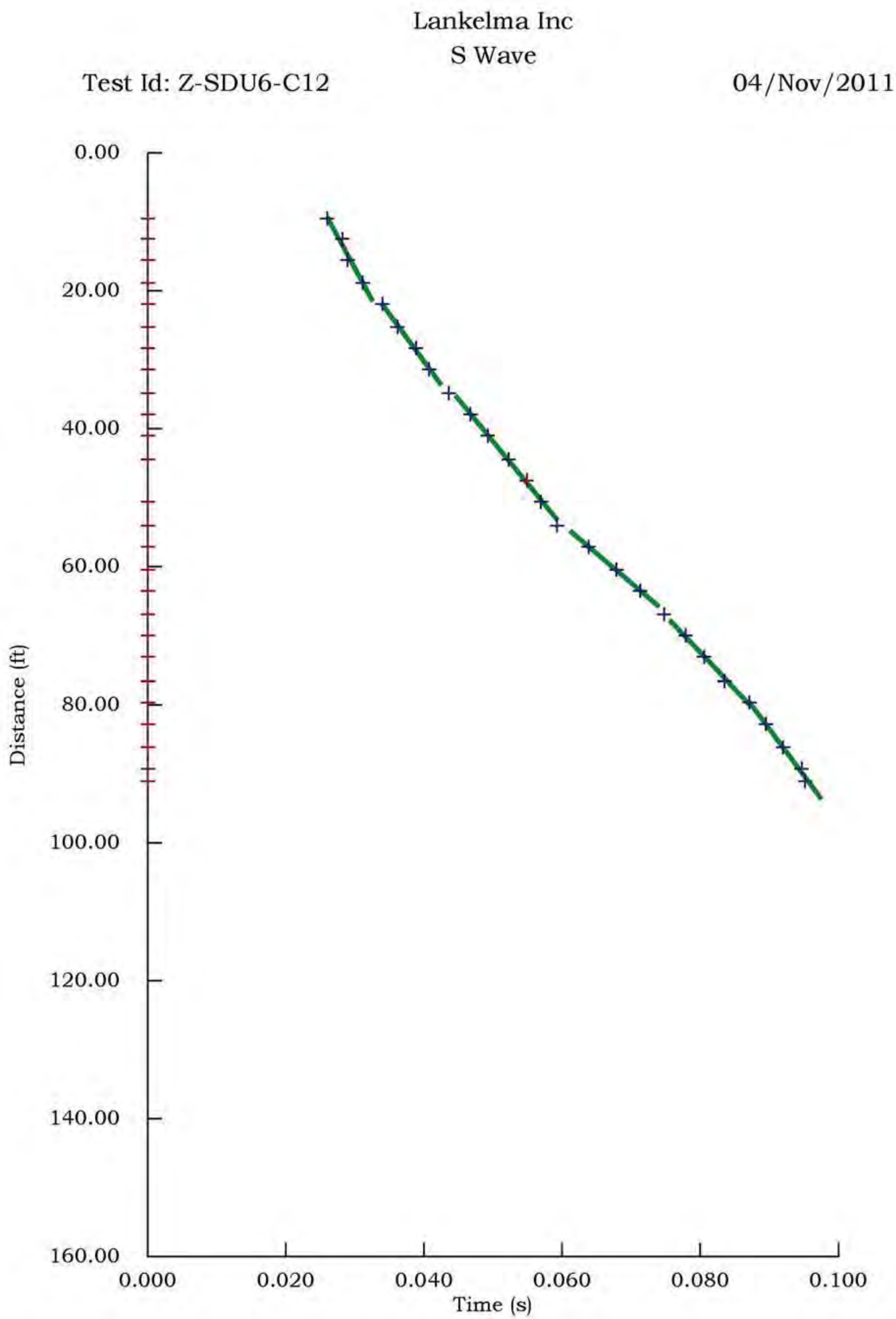
*Electronic File Name: SC04N1102C.DAT*

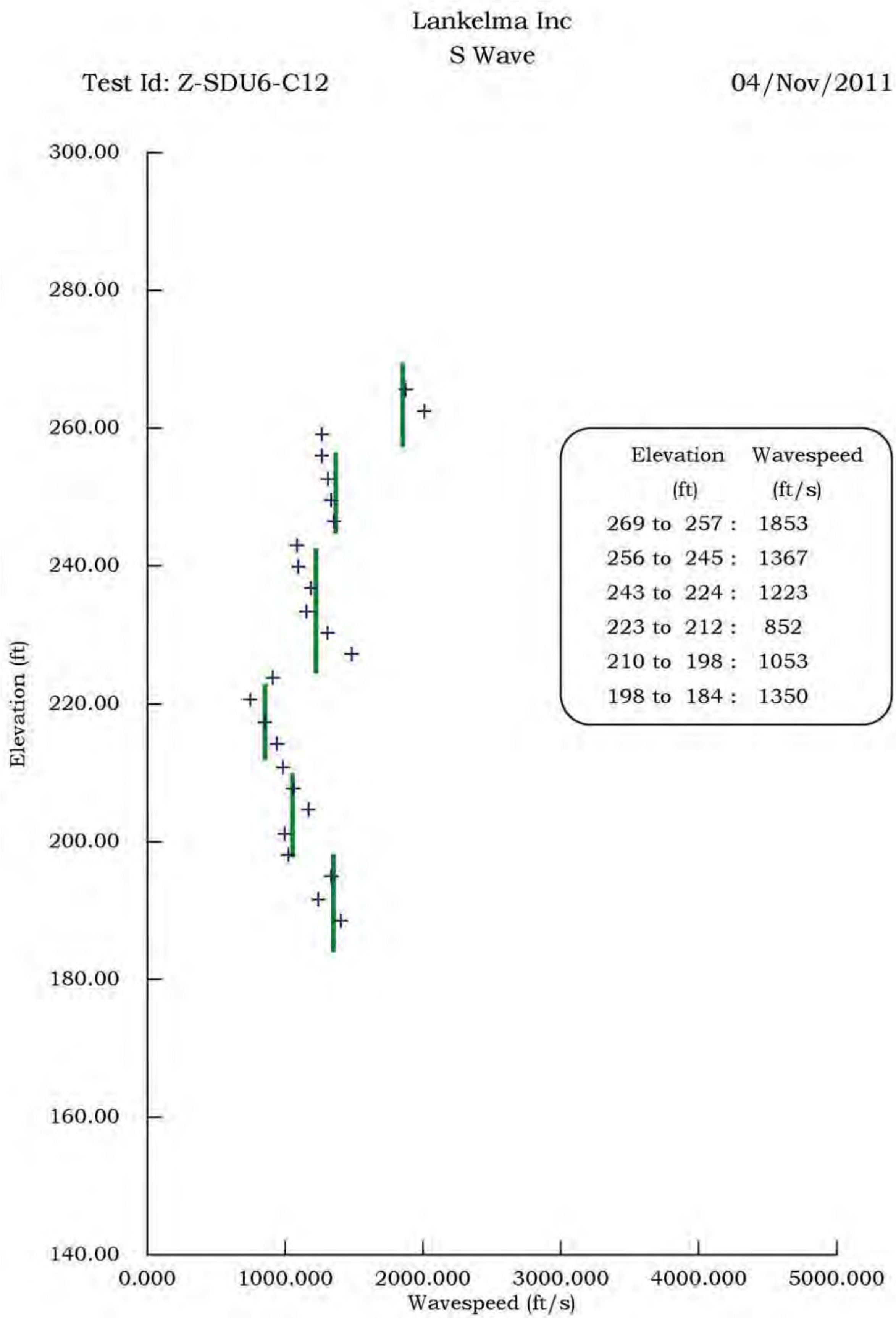


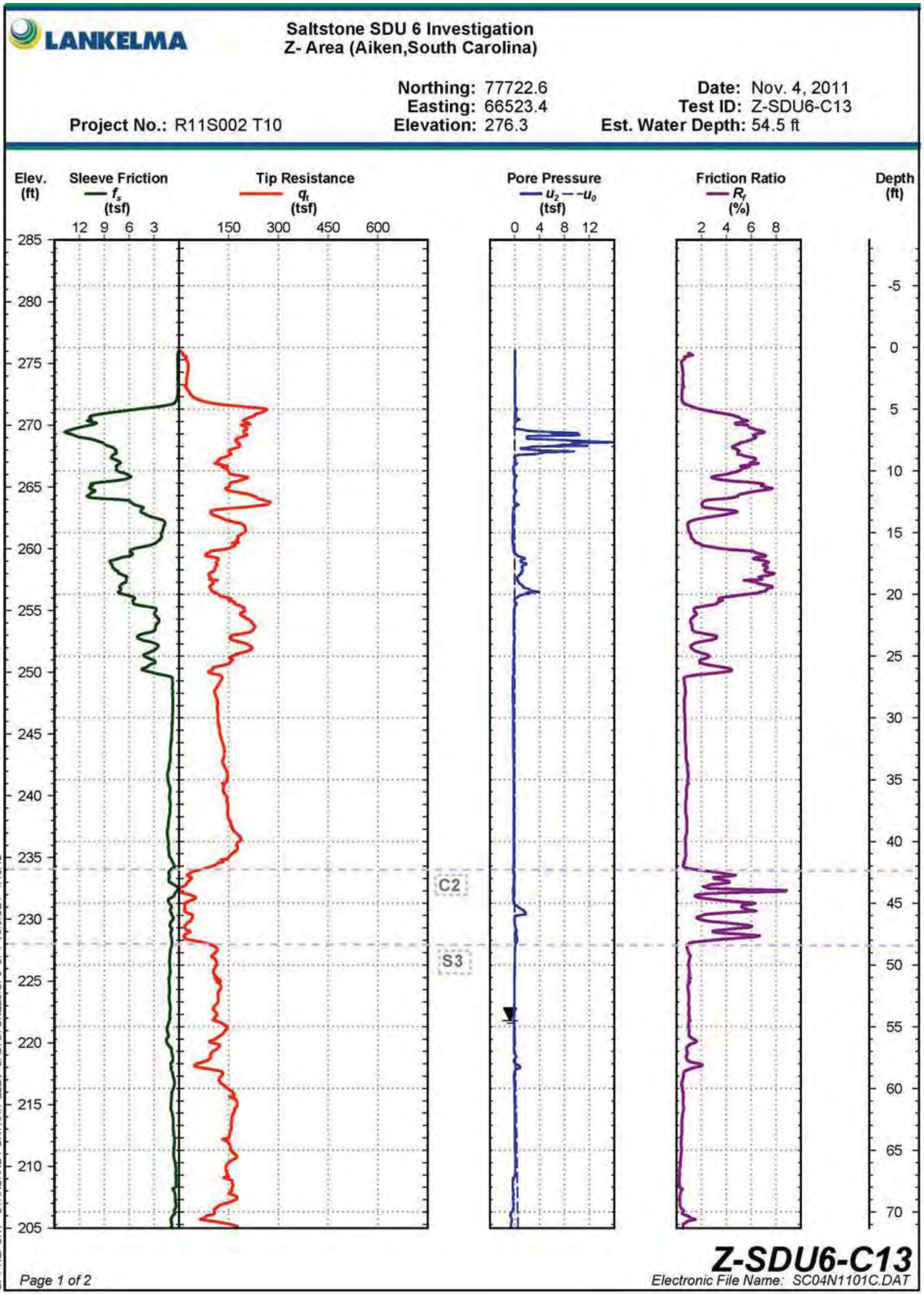
Lankelma Inc
S Wave
Test Id: Z-SDU6-C12
04/Nov/2011
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
Distance (ft)
0.000
0.040
0.080
0.120
0.160
0.200
Time (s)


Lankelma Inc
S Wave
Test Id: Z-SDU6-C12
04/Nov/2011
35.00
40.00
45.00
50.00
55.00
60.00
65.00
70.00
75.00
Distance (ft)
0.000
0.040
0.080
0.120
0.160
0.200
Time (s)


Lankelma Inc
S Wave
Test Id: Z-SDU6-C12
04/Nov/2011
70.00
75.00
80.00
85.00
90.00
95.00
100.00
105.00
110.00
Distance (ft)
0.000
0.040
0.080
0.120
0.160
0.200
Time (s)


Lankelma Inc
S Wave
Test Id: Z-SDU6-C12
04/Nov/2011
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
160.00
Distance (ft)
0.000
0.020
0.040
0.060
0.080
0.100
Time (s)


Lankelma Inc
S Wave
Test Id: Z-SDU6-C12
04/Nov/2011
300.00
280.00
260.00
240.00
220.00
200.00
180.00
160.00
140.00
Elevation (ft)
0.000
1000.000
2000.000
3000.000
4000.000
5000.000
Wavespeed (ft/s)
Elevation (ft)
Wavespeed (ft/s)
269 to 257 : 1853
256 to 245 : 1367
243 to 224 : 1223
223 to 212 : 852
210 to 198 : 1053
198 to 184 : 1350


LANKELMA
Saltstone SDU 6 Investigation
Z- Area (Aiken,South Carolina)
Northing: 77722.6
Easting: 66523.4
Elevation: 276.3
Date: Nov. 4, 2011
Test ID: Z-SDU6-C13
Est. Water Depth: 54.5 ft
Project No.: R11S002 T10
Elev. (ft)
Sleeve Friction $f_s$ (tsf)
Tip Resistance $q_t$ (tsf)
Pore Pressure $u_2$ $u_0$ (tsf)
Friction Ratio $R_f$ (%)
Depth (ft)
C2
S3
CPT REPORT - STANDARD PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12
Page 1 of 2
Z-SDU6-C13
Electronic File Name: SC04N1101C.DAT

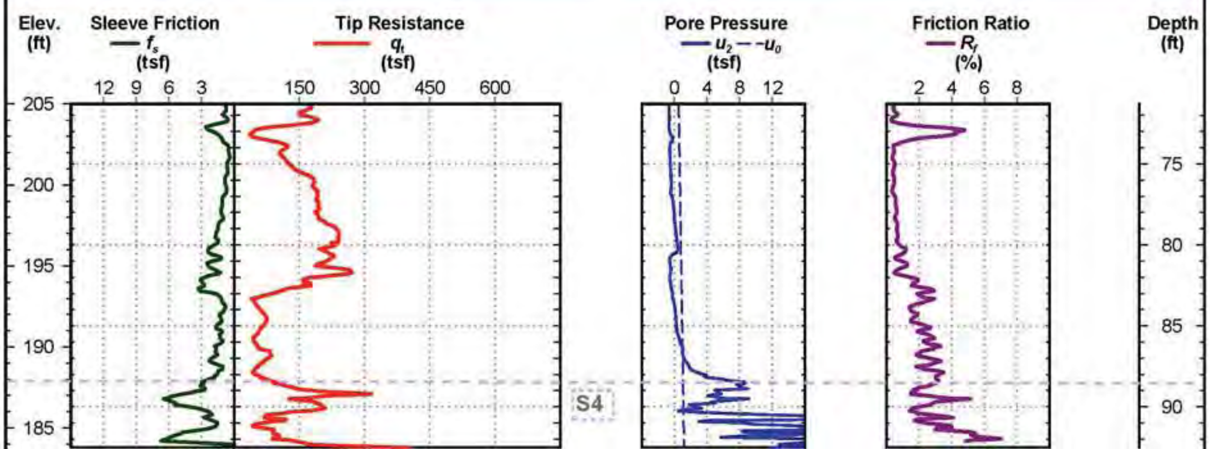
LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

**Project No.:** R11S002 T10

**Northing:** 77722.6
**Easting:** 66523.4
**Elevation:** 276.3

**Date:** Nov. 4, 2011
**Test ID:** Z-SDU6-C13
**Est. Water Depth:** 54.5 ft




CPT REPORT - STANDARD PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

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**Z-SDU6-C13**
Electronic File Name: SC04N1101C.DAT

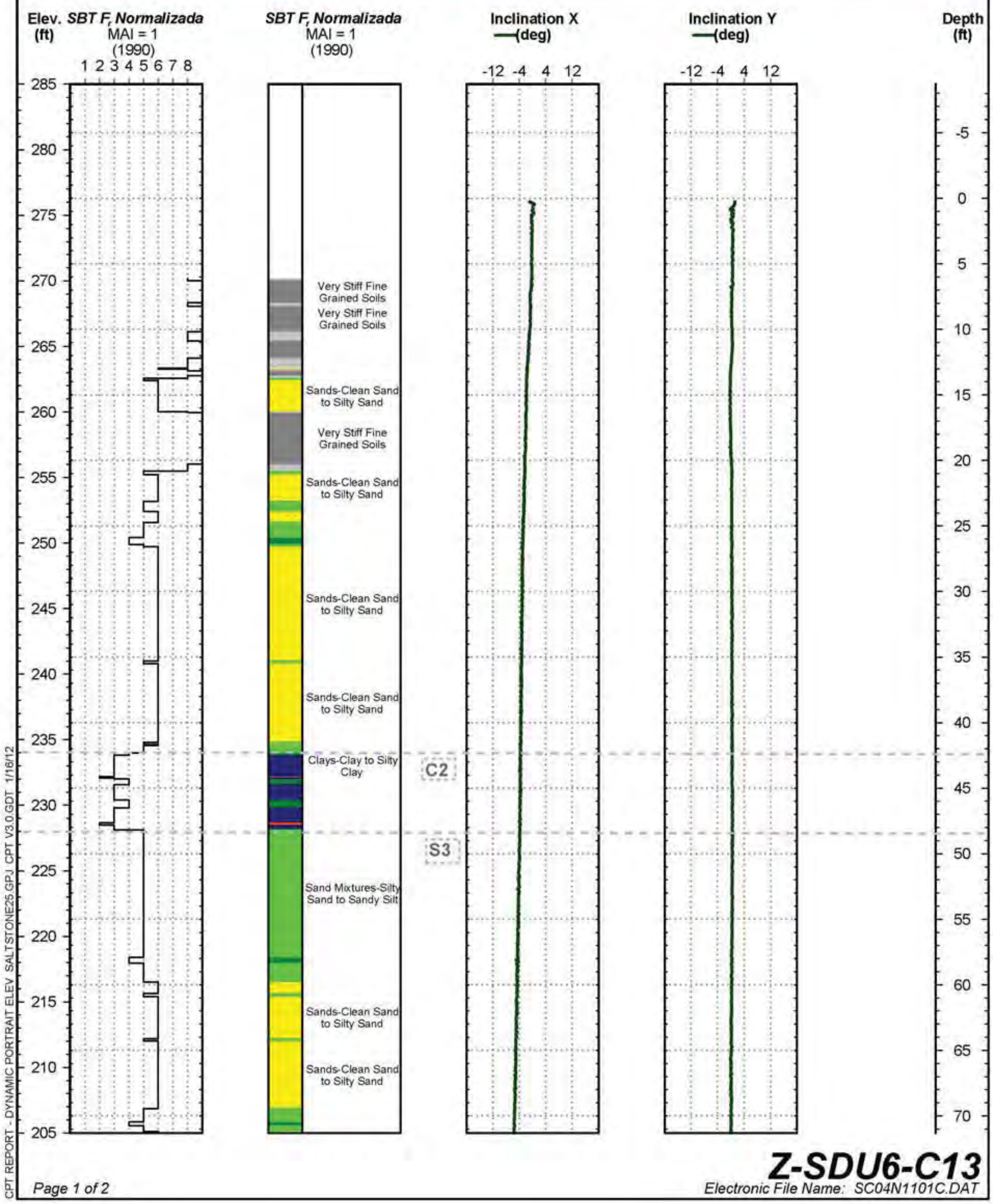
**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

LANKELMA

**Northing:** 77722.6
**Easting:** 66523.4
**Elevation:** 276.3

**Date:** Nov. 4, 2011
**Test ID:** Z-SDU6-C13
**Est. Water Depth:** 54.5 ft

**Project No.:** R11S002 T10

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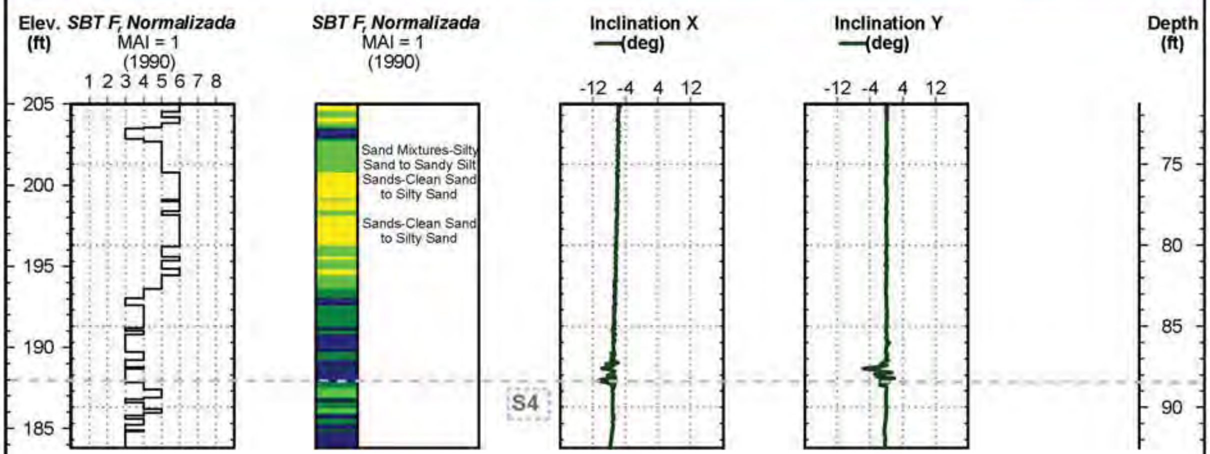
**Z-SDU6-C13**

Electronic File Name: SC04N1101C.DAT

**LANKELMA**

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

**Project No.:** R11S002 T10
**Northing:** 77722.6
**Easting:** 66523.4
**Elevation:** 276.3
**Date:** Nov. 4, 2011
**Test ID:** Z-SDU6-C13
**Est. Water Depth:** 54.5 ft





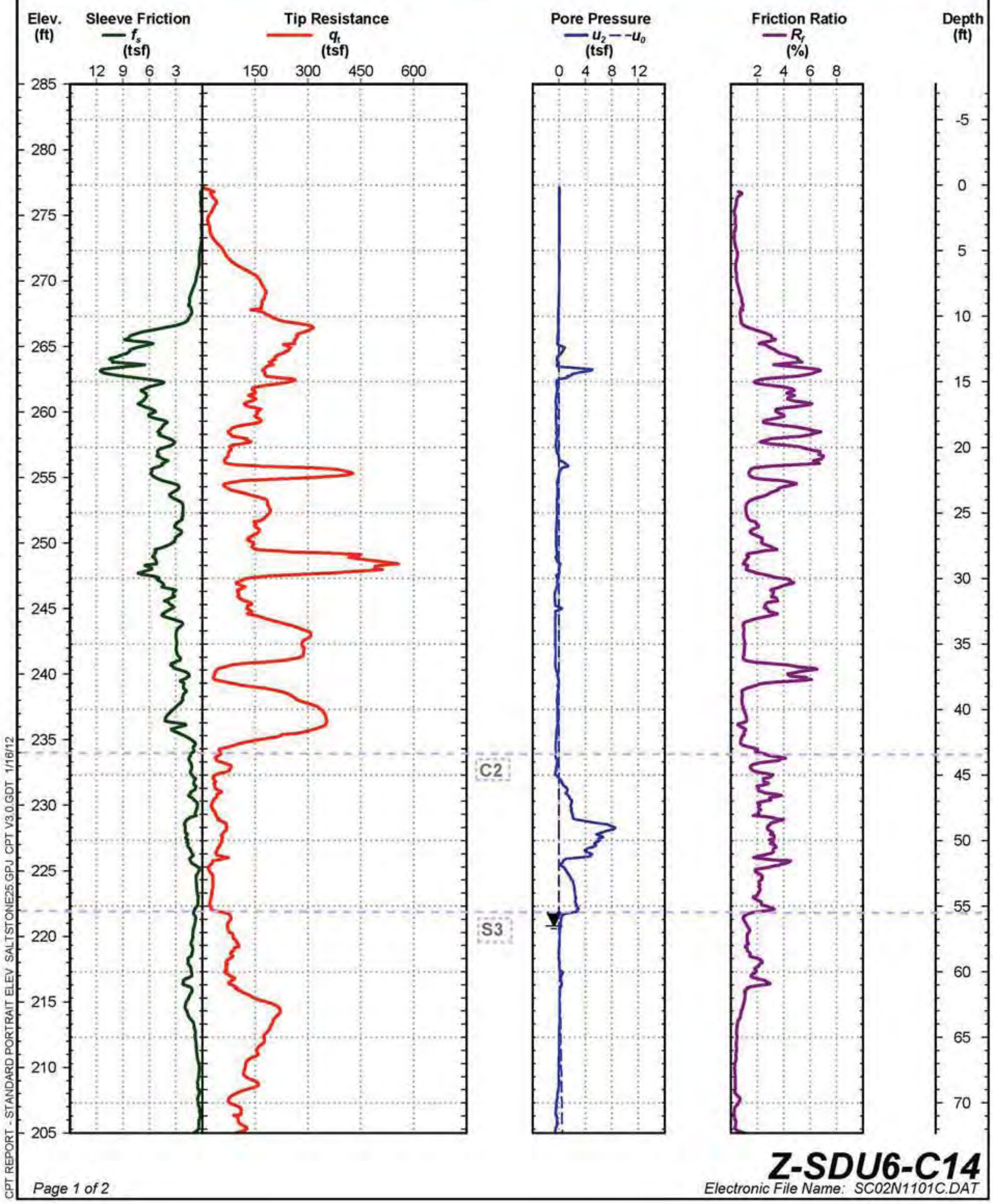

**Z-SDU6-C13**
Electronic File Name: SC04N1101C.DAT

CPT REPORT - DYNAMIC PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

LANKELMA

Saltstone SDU 6 Investigation
Z- Area (Aiken,South Carolina)

Project No.: R11S002 T10
Northing: 77720.6
Easting: 66180.9
Elevation: 277.3
Date: Nov. 2, 2011
Test ID: Z-SDU6-C14
Est. Water Depth: 56.5 ft

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**Z-SDU6-C14**

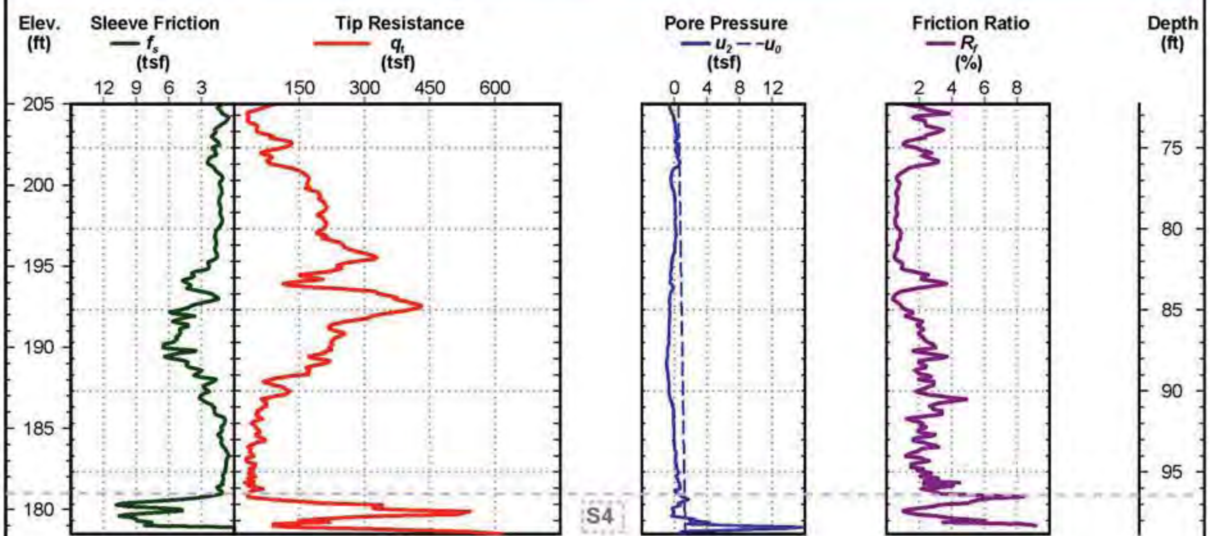
Electronic File Name: SC02N1101C.DAT

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

**Project No.:** R11S002 T10

**Northing:** 77720.6
**Easting:** 66180.9
**Elevation:** 277.3

**Date:** Nov. 2, 2011
**Test ID:** Z-SDU6-C14
**Est. Water Depth:** 56.5 ft




CPT REPORT - STANDARD PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

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**Z-SDU6-C14**
Electronic File Name: SC02N1101C.DAT

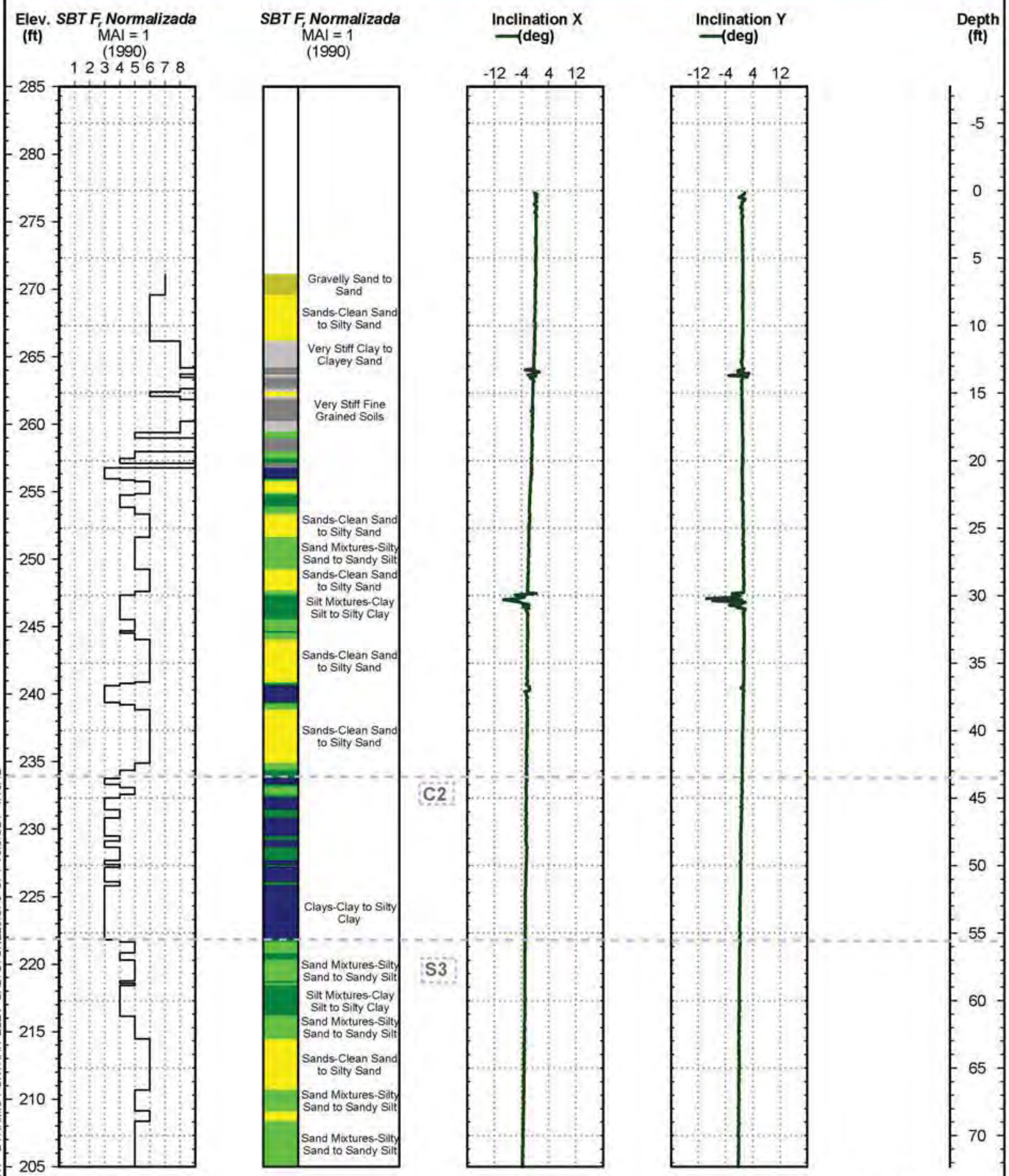
LANKELMA

Saltstone SDU 6 Investigation
Z- Area (Aiken,South Carolina)

Project No.: R11S002 T10

Northing: 77720.6
Easting: 66180.9
Elevation: 277.3

Date: Nov. 2, 2011
Test ID: Z-SDU6-C14
Est. Water Depth: 56.5 ft




CPT REPORT - DYNAMIC PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

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**Z-SDU6-C14**

Electronic File Name: SC02N1101C.DAT

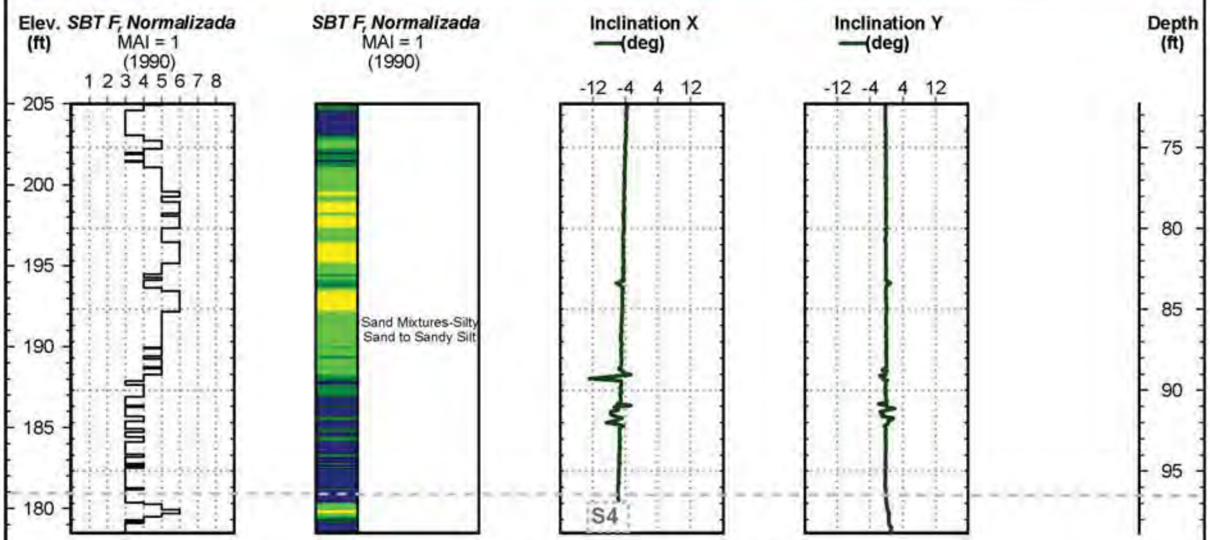
LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

**Project No.:** R11S002 T10

**Northing:** 77720.6
**Easting:** 66180.9
**Elevation:** 277.3

**Date:** Nov. 2, 2011
**Test ID:** Z-SDU6-C14
**Est. Water Depth:** 56.5 ft




CPT REPORT - DYNAMIC PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

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**Z-SDU6-C14**
Electronic File Name: SC02N1101C.DAT

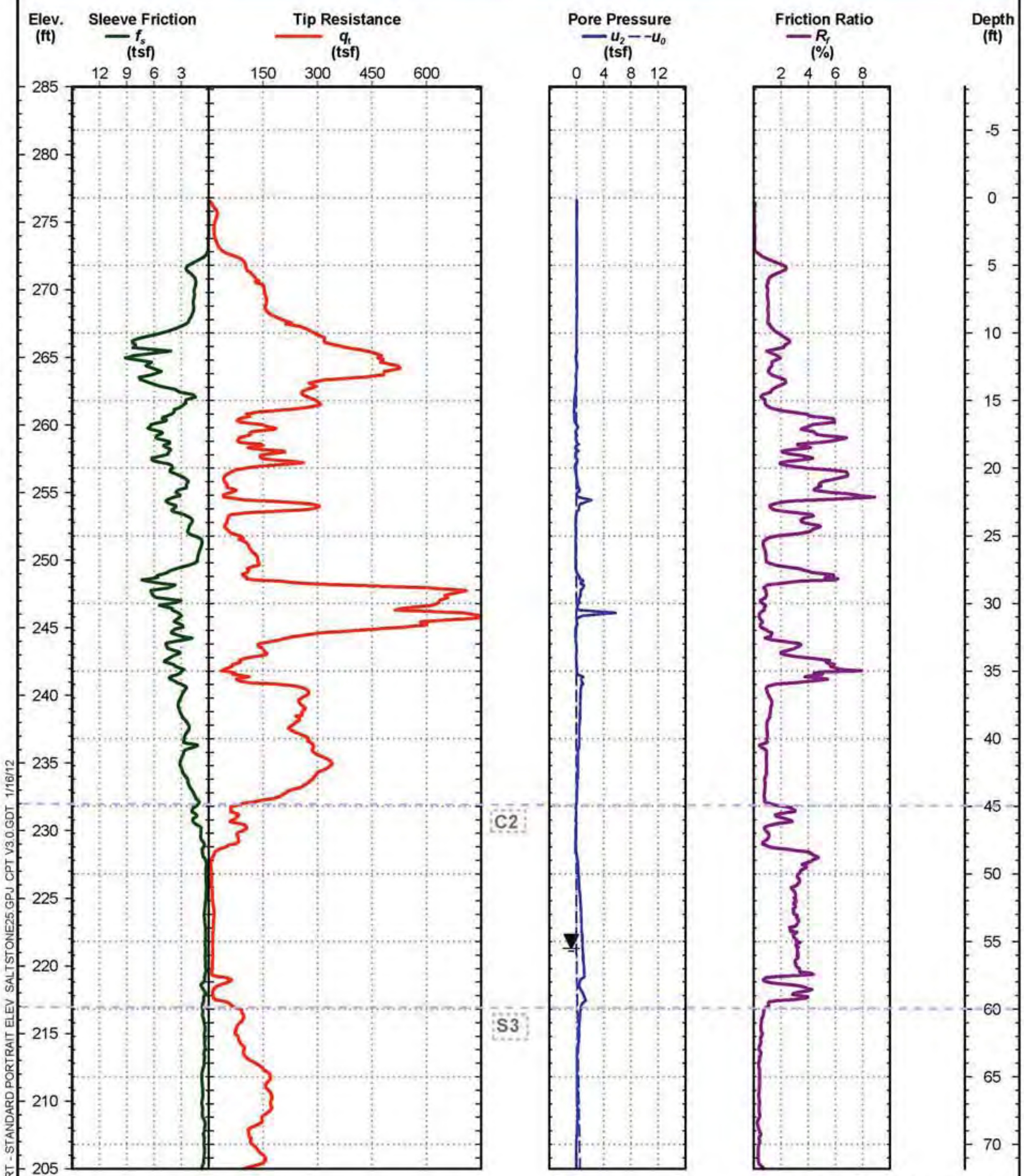
LANKELMA

Saltstone SDU 6 Investigation
Z- Area (Aiken,South Carolina)

Project No.: R11S002 T10

Northing: 77748.2
Easting: 66249.8
Elevation: 276.8

Date: Nov. 2, 2011
Test ID: Z-SDU6-C15
Est. Water Depth: 55.5 ft

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Z-SDU6-C15

Electronic File Name: SC02N1102C.DAT

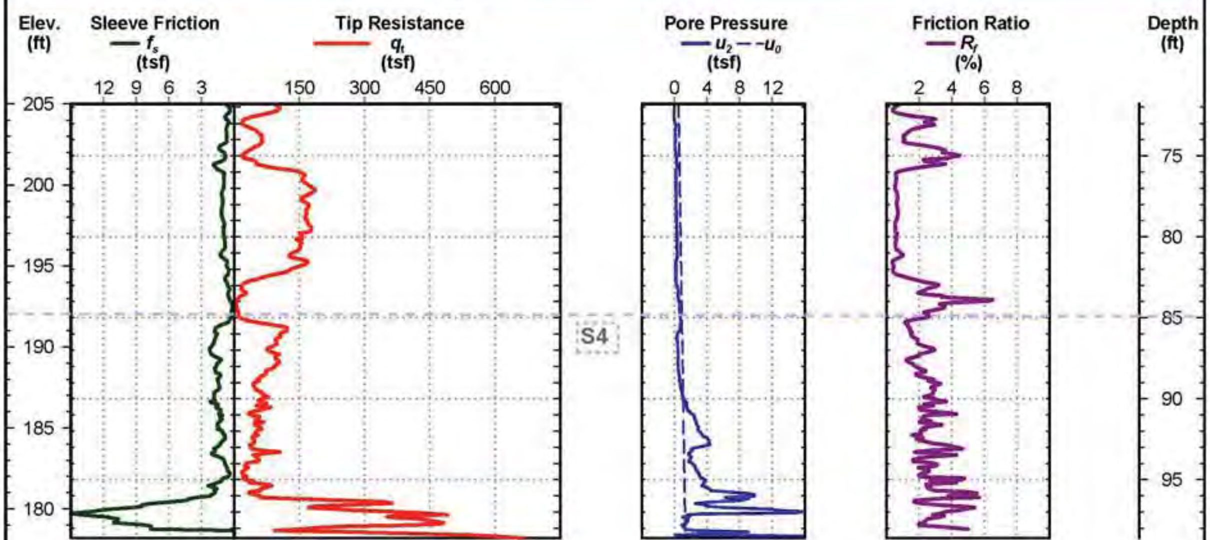
LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

**Project No.:** R11S002 T10

**Northing:** 77748.2
**Easting:** 66249.8
**Elevation:** 276.8

**Date:** Nov. 2, 2011
**Test ID:** Z-SDU6-C15
**Est. Water Depth:** 55.5 ft




CPT REPORT - STANDARD PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

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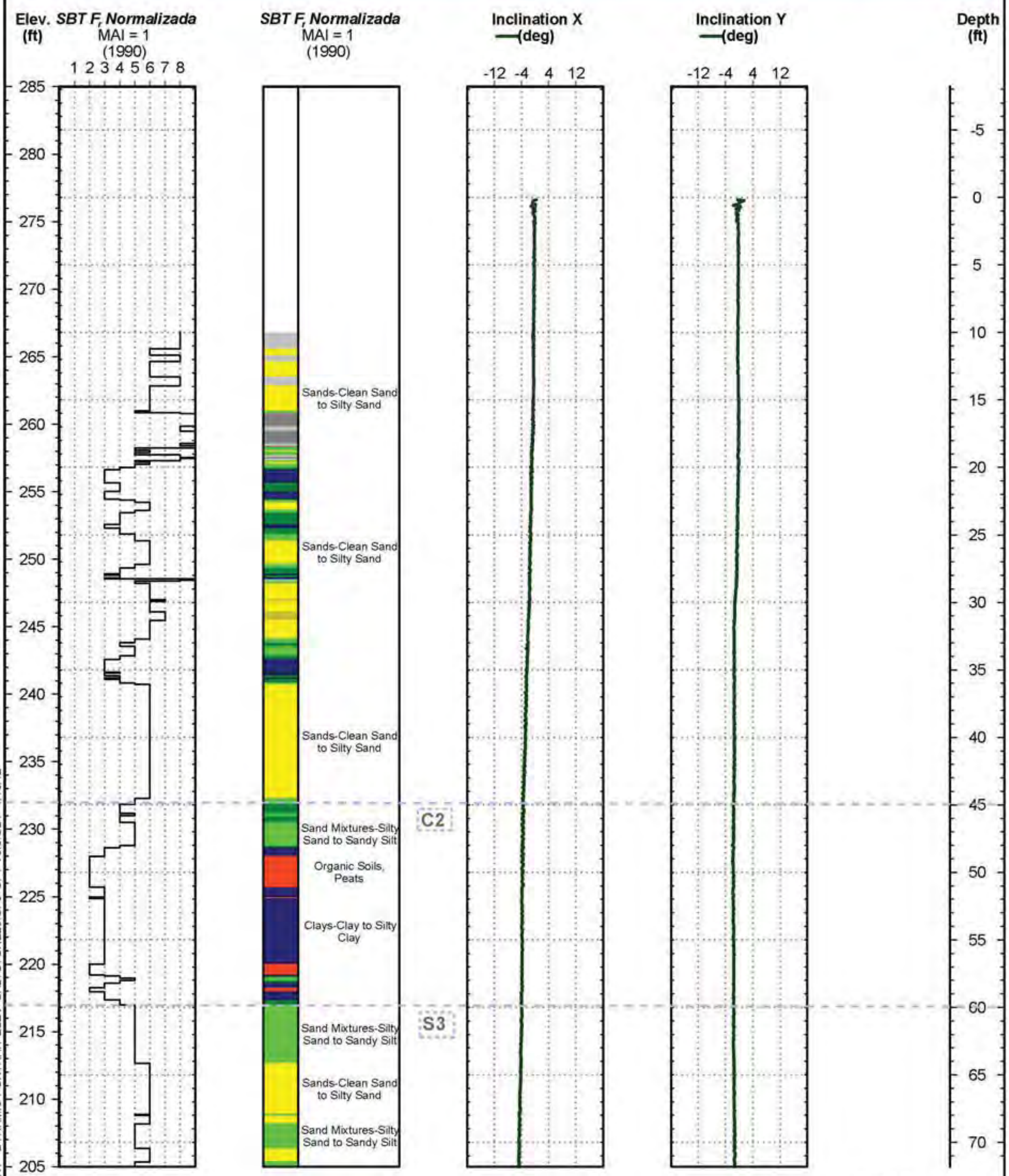
**Z-SDU6-C15**
*Electronic File Name: SC02N1102C.DAT*

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

**Project No.:** R11S002 T10
**Northing:** 77748.2
**Easting:** 66249.8
**Elevation:** 276.8
**Date:** Nov. 2, 2011
**Test ID:** Z-SDU6-C15
**Est. Water Depth:** 55.5 ft




CPT REPORT - DYNAMIC PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

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**Z-SDU6-C15**
*Electronic File Name: SC02N1102C.DAT*

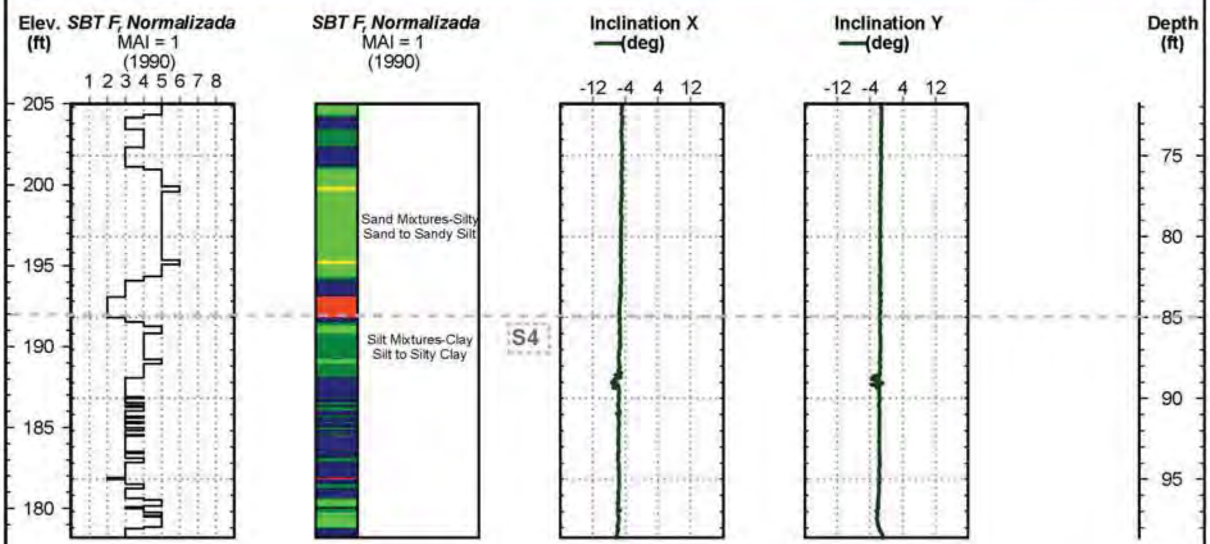
LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

**Project No.:** R11S002 T10

**Northing:** 77748.2
**Easting:** 66249.8
**Elevation:** 276.8

**Date:** Nov. 2, 2011
**Test ID:** Z-SDU6-C15
**Est. Water Depth:** 55.5 ft




CPT REPORT - DYNAMIC PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

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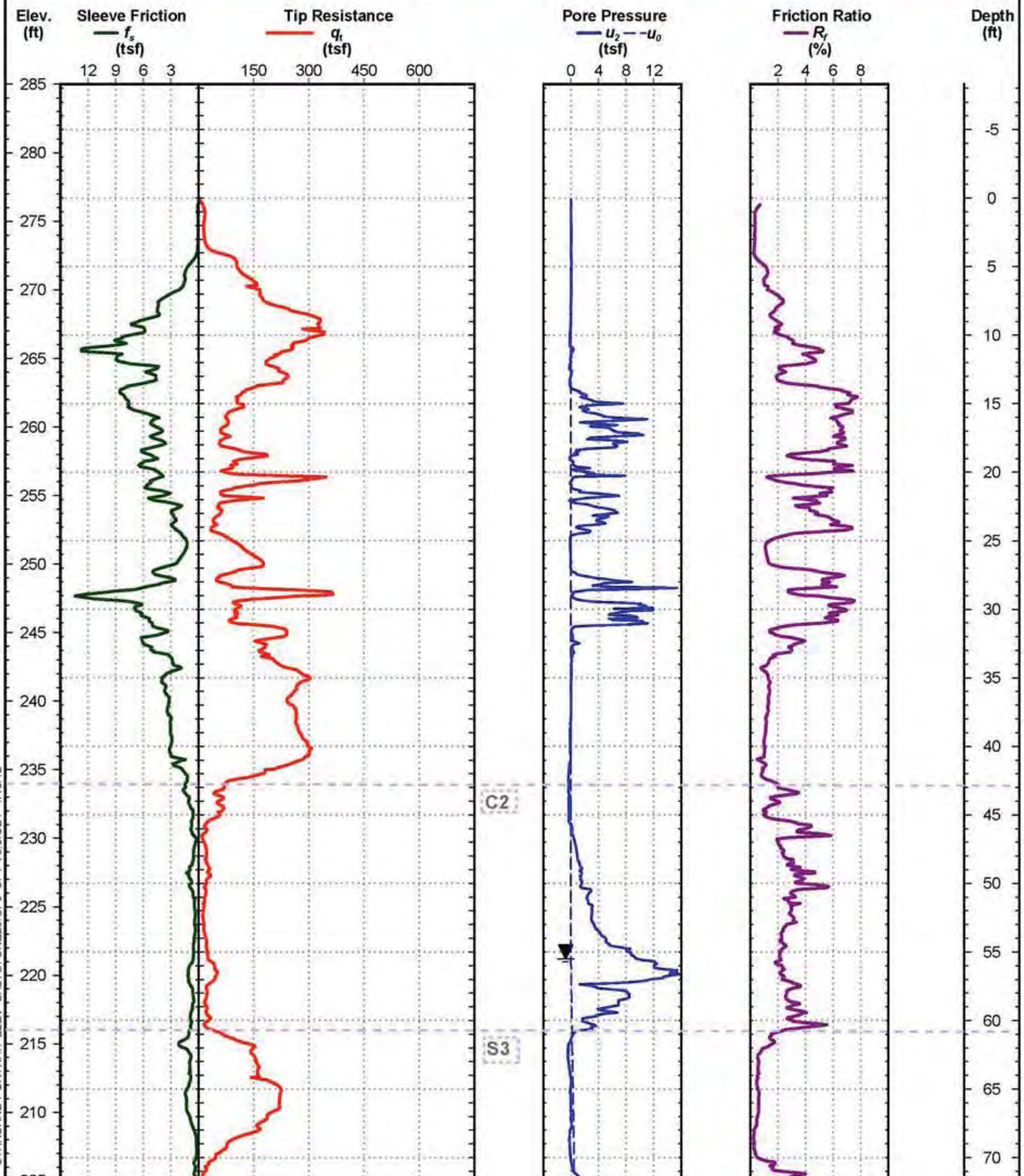
**Z-SDU6-C15**
*Electronic File Name: SC02N1102C.DAT*

LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

**Project No.:** R11S002 T10
**Northing:** 77772.2
**Easting:** 66312.2
**Elevation:** 276.7
**Date:** Nov. 2, 2011
**Test ID:** Z-SDU6-C16
**Est. Water Depth:** 55.5 ft




CPT REPORT - STANDARD PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

**Z-SDU6-C16**

*Electronic File Name: SC02N1103C.DAT*

*Page 1 of 2*

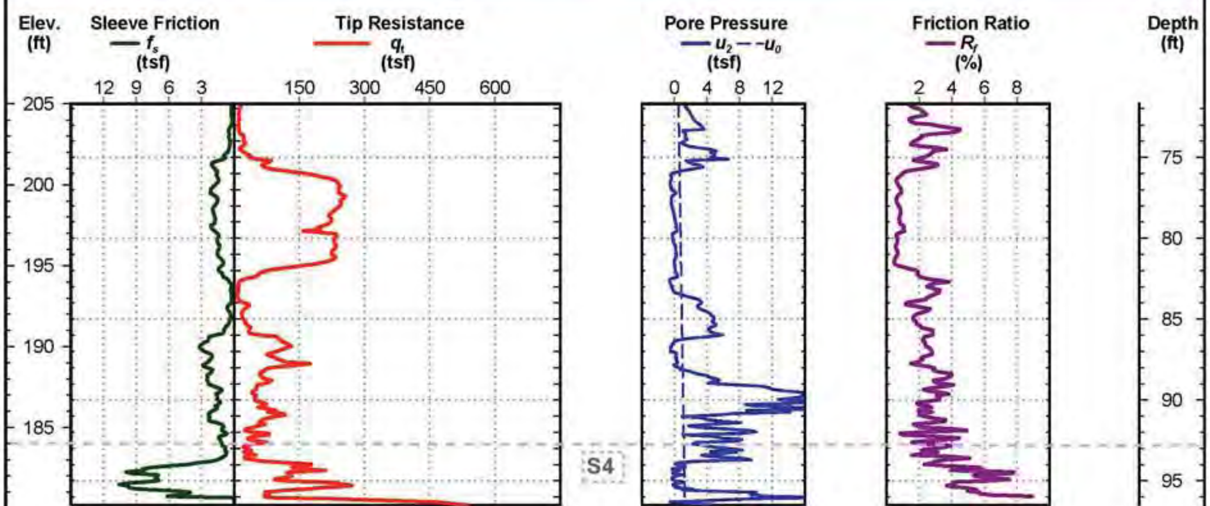
LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

**Northing:** 77772.2
**Easting:** 66312.2
**Elevation:** 276.7

**Date:** Nov. 2, 2011
**Test ID:** Z-SDU6-C16
**Est. Water Depth:** 55.5 ft

**Project No.:** R11S002 T10




CPT REPORT - STANDARD PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

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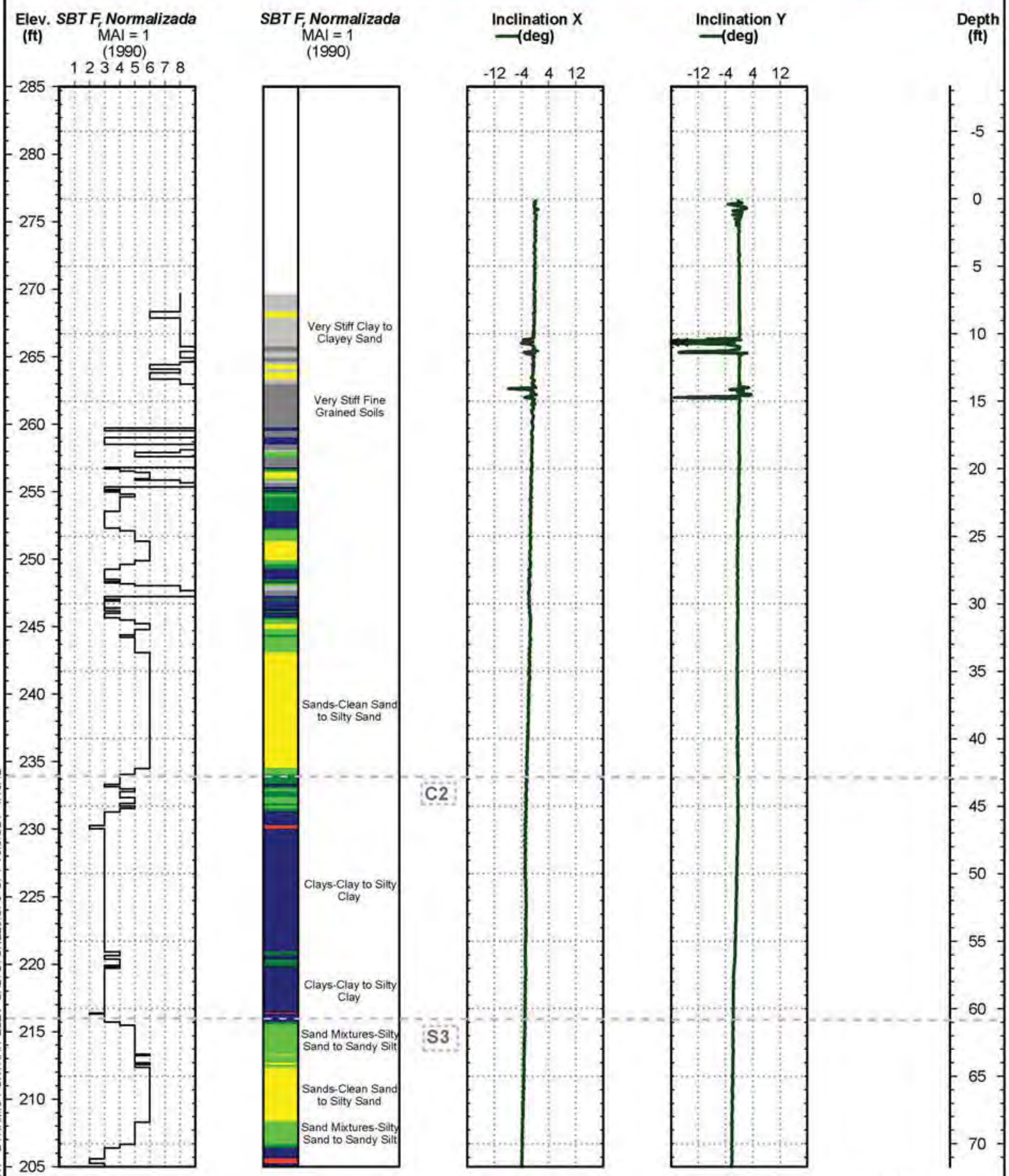
**Z-SDU6-C16**
*Electronic File Name: SC02N1103C.DAT*

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

**Project No.:** R11S002 T10

**Northing:** 77772.2
**Easting:** 66312.2
**Elevation:** 276.7

**Date:** Nov. 2, 2011
**Test ID:** Z-SDU6-C16
**Est. Water Depth:** 55.5 ft




CPT REPORT - DYNAMIC PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

**Z-SDU6-C16**

Electronic File Name: SC02N1103C.DAT

Page 1 of 2

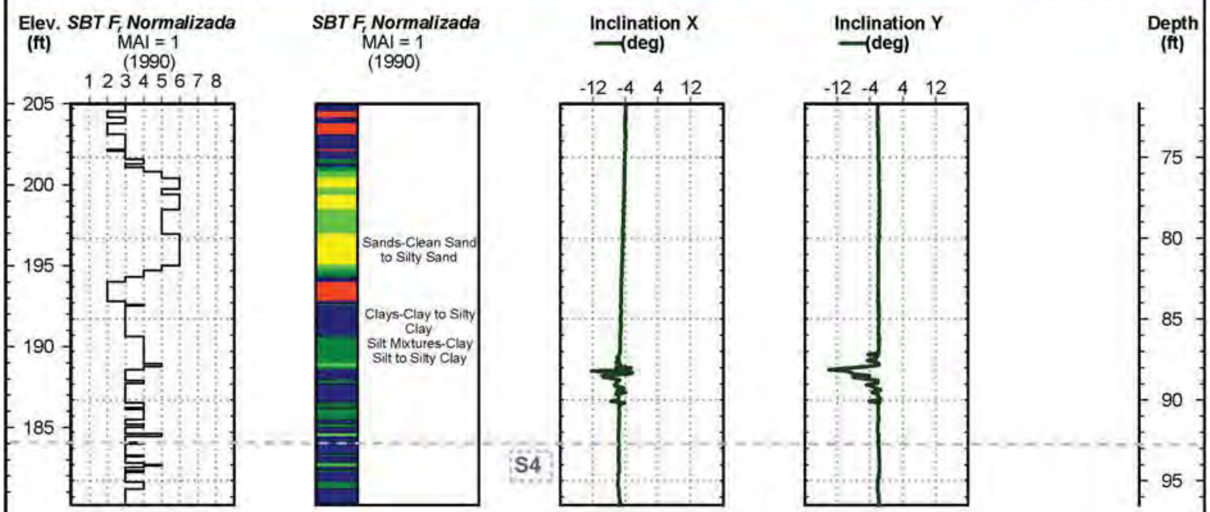
LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

**Project No.:** R11S002 T10

**Northing:** 77772.2
**Easting:** 66312.2
**Elevation:** 276.7

**Date:** Nov. 2, 2011
**Test ID:** Z-SDU6-C16
**Est. Water Depth:** 55.5 ft





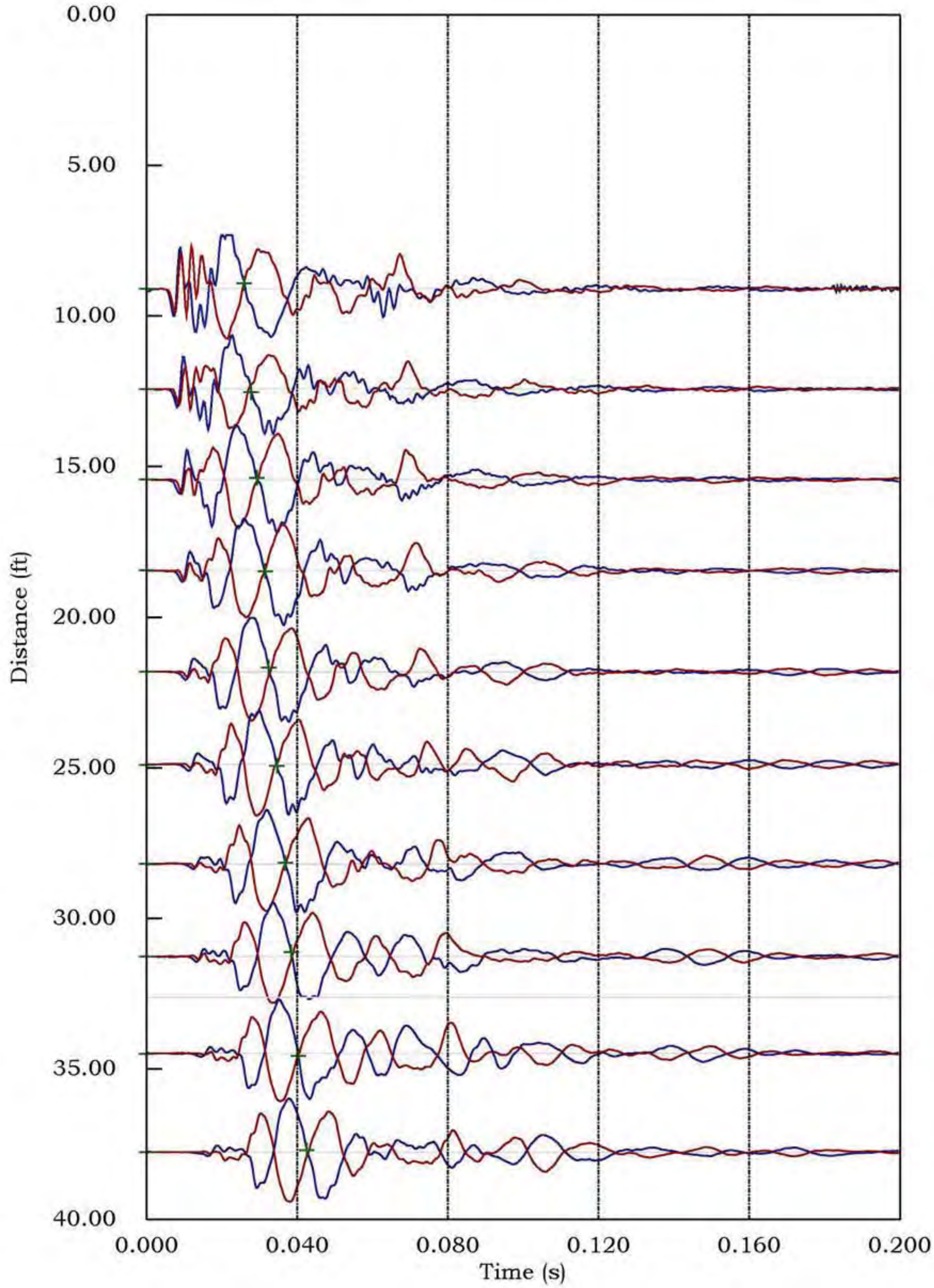

*Page 2 of 2*

**Z-SDU6-C16**
*Electronic File Name: SC02N1103C.DAT*

Lankelma Inc

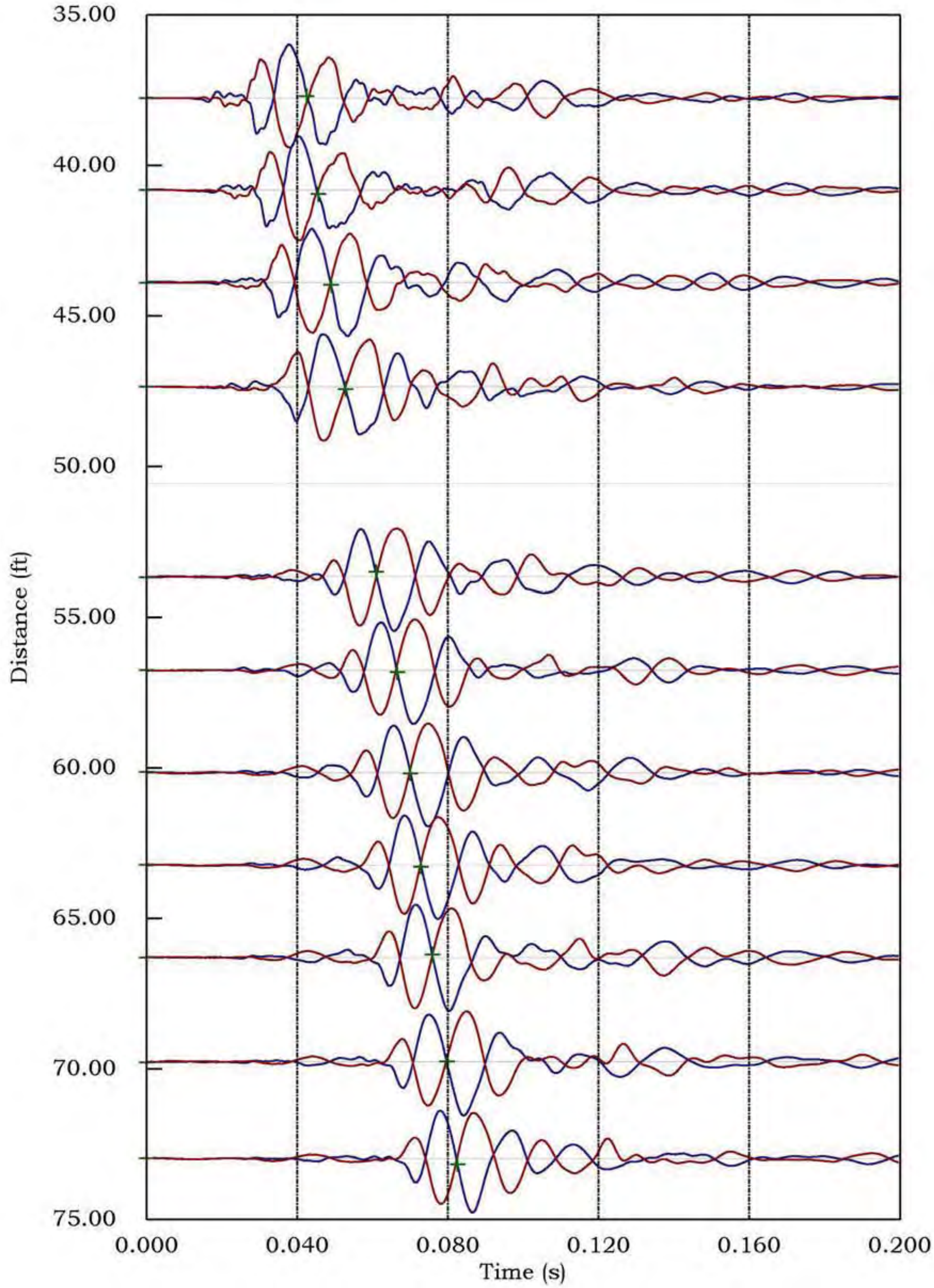
S Wave

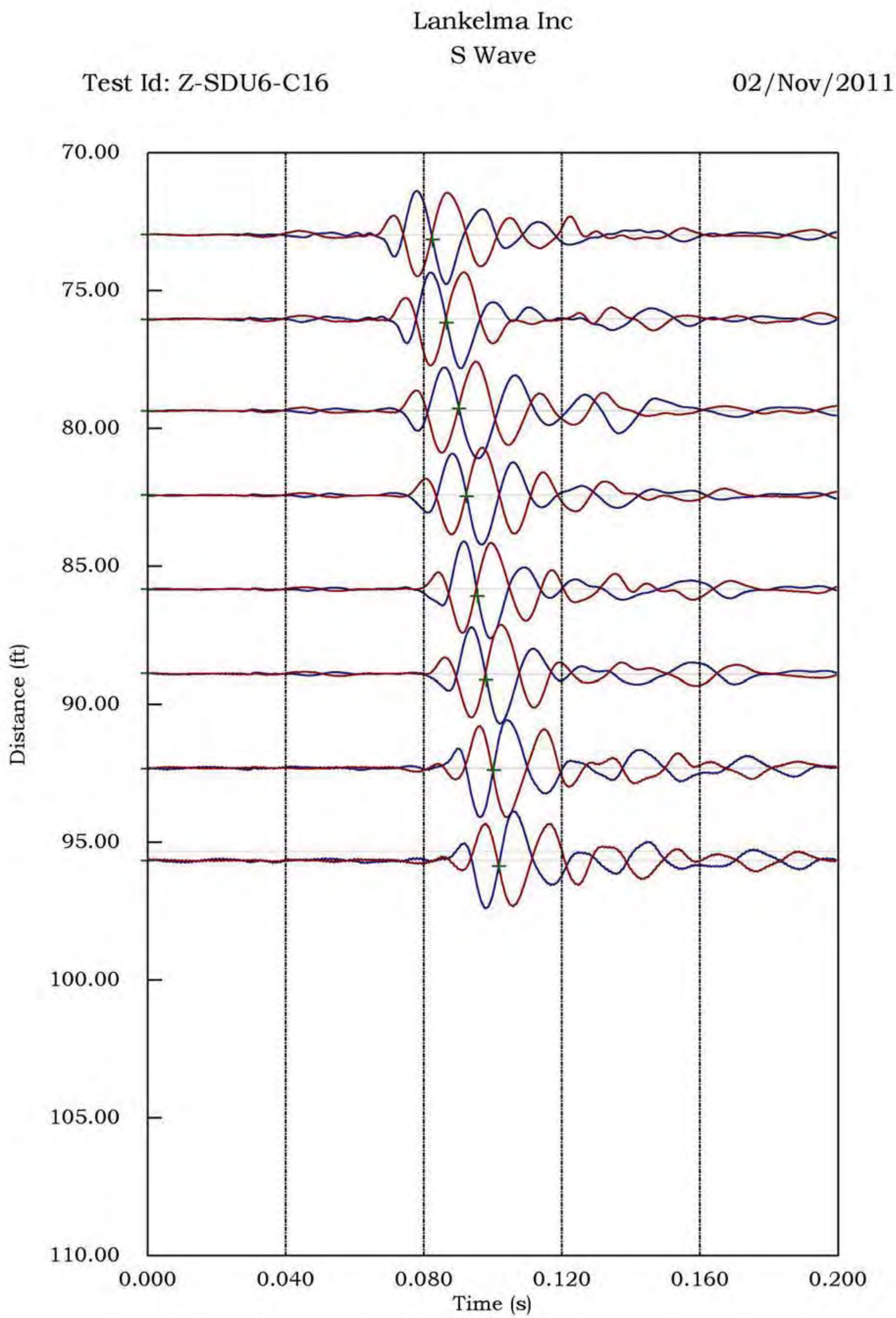
Test Id: Z-SDU6-C16 02/Nov/2011

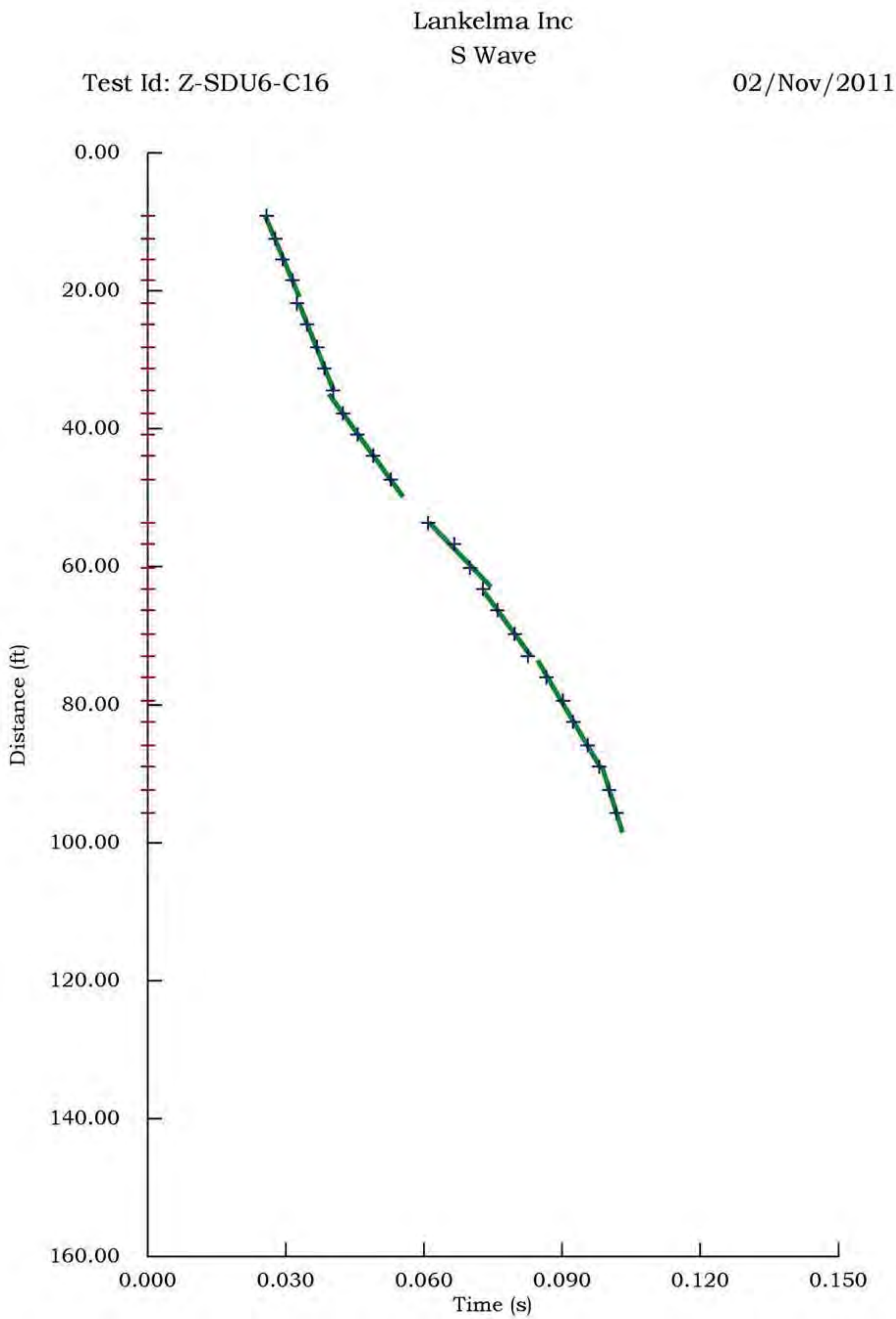


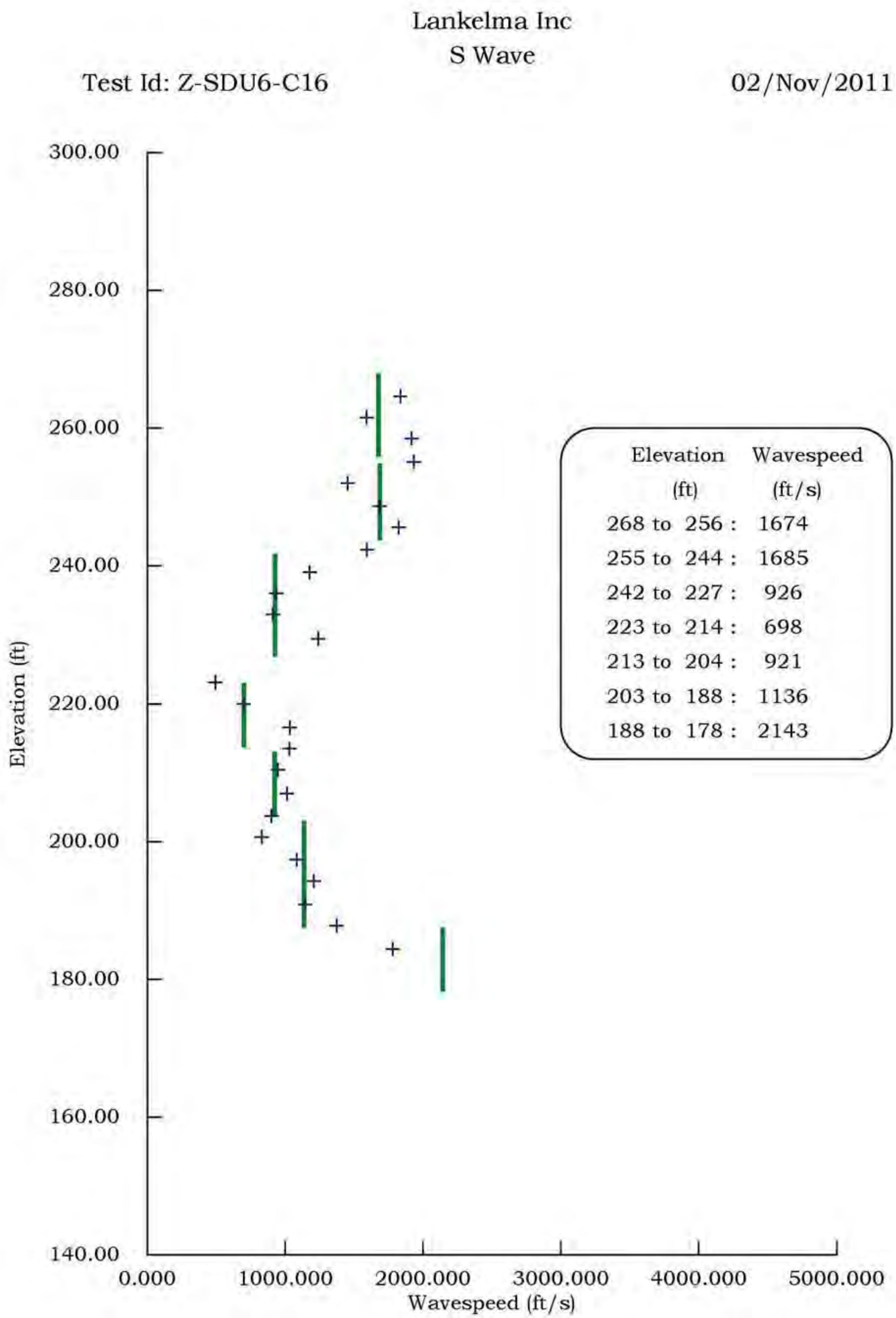
Lankelma Inc
S Wave

Test Id: Z-SDU6-C16 02/Nov/2011




Lankelma Inc
S Wave
Test Id: Z-SDU6-C16
02/Nov/2011
70.00
75.00
80.00
85.00
90.00
95.00
100.00
105.00
110.00
Distance (ft)
0.000
0.040
0.080
0.120
0.160
0.200
Time (s)


Lankelma Inc
S Wave
Test Id: Z-SDU6-C16
02/Nov/2011
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
160.00
Distance (ft)
0.000
0.030
0.060
0.090
0.120
0.150
Time (s)


Lankelma Inc
S Wave
Test Id: Z-SDU6-C16
02/Nov/2011
300.00
280.00
260.00
240.00
220.00
200.00
180.00
160.00
140.00
Elevation (ft)
0.000
1000.000
2000.000
3000.000
4000.000
5000.000
Wavespeed (ft/s)
Elevation (ft) Wavespeed (ft/s)
268 to 256 : 1674
255 to 244 : 1685
242 to 227 : 926
223 to 214 : 698
213 to 204 : 921
203 to 188 : 1136
188 to 178 : 2143

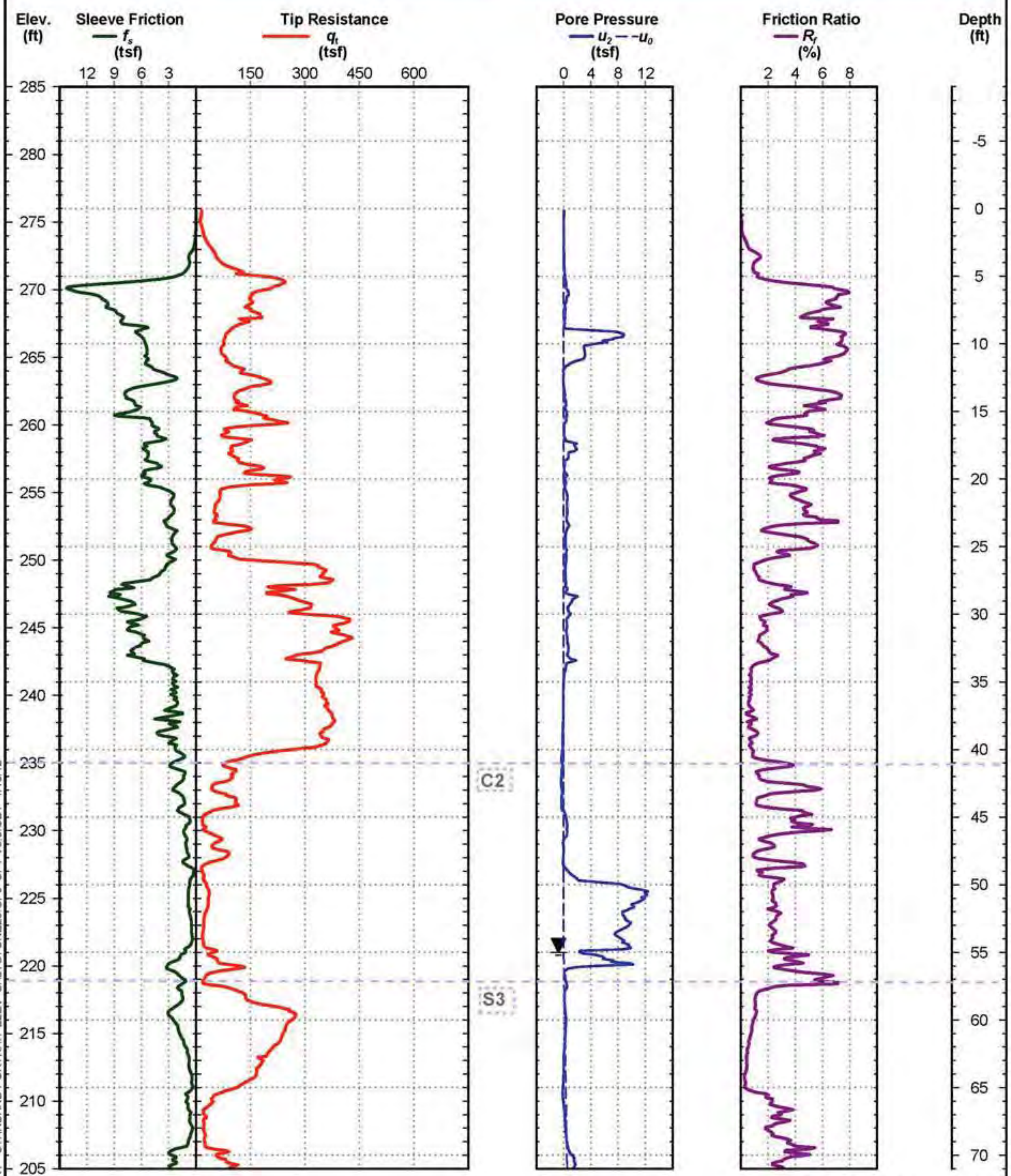
LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

**Northing:** 77796.3
**Easting:** 66393.3
**Elevation:** 276.0

**Date:** Nov. 2, 2011
**Test ID:** Z-SDU6-C17
**Est. Water Depth:** 55 ft

**Project No.:** R11S002 T10




CPT REPORT - STANDARD PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

**Z-SDU6-C17**

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Electronic File Name: SC02N1104C.DAT

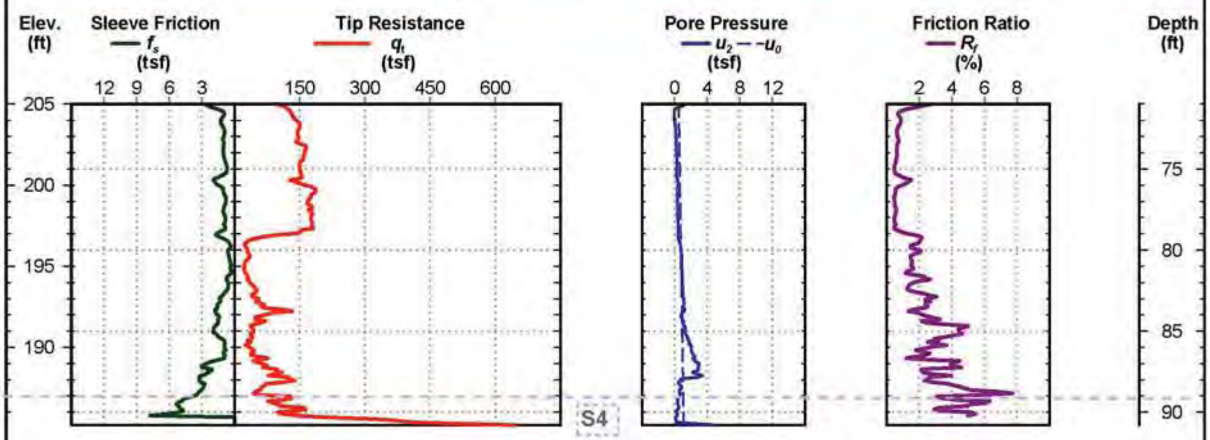
LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

**Project No.:** R11S002 T10

**Northing:** 77796.3
**Easting:** 66393.3
**Elevation:** 276.0

**Date:** Nov. 2, 2011
**Test ID:** Z-SDU6-C17
**Est. Water Depth:** 55 ft




CPT REPORT - STANDARD PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

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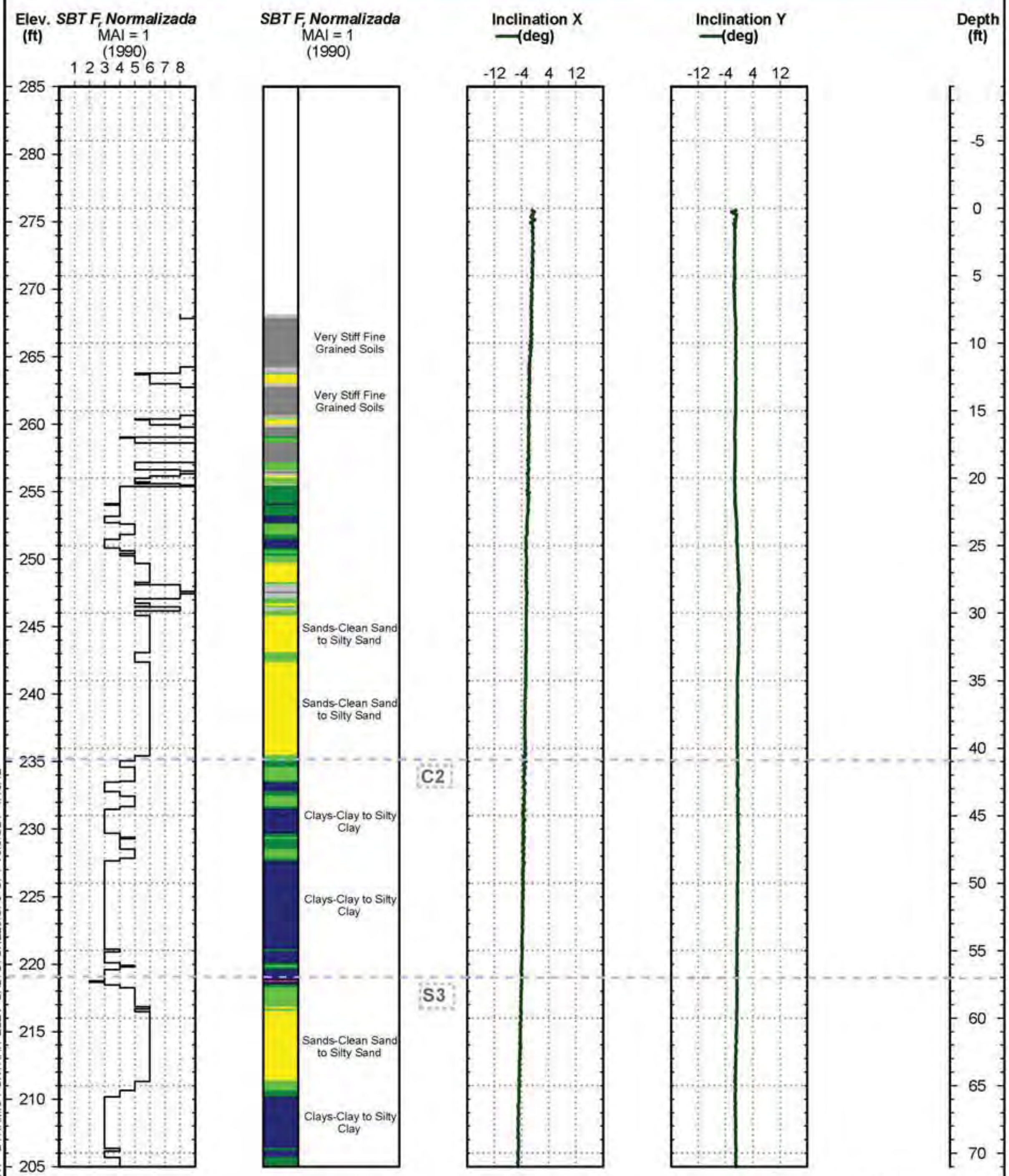
**Z-SDU6-C17**

Electronic File Name: SC02N1104C.DAT

LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

**Project No.:** R11S002 T10
**Northing:** 77796.3
**Easting:** 66393.3
**Elevation:** 276.0
**Date:** Nov. 2, 2011
**Test ID:** Z-SDU6-C17
**Est. Water Depth:** 55 ft




CPT REPORT - DYNAMIC PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

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**Z-SDU6-C17**
*Electronic File Name: SC02N1104C.DAT*

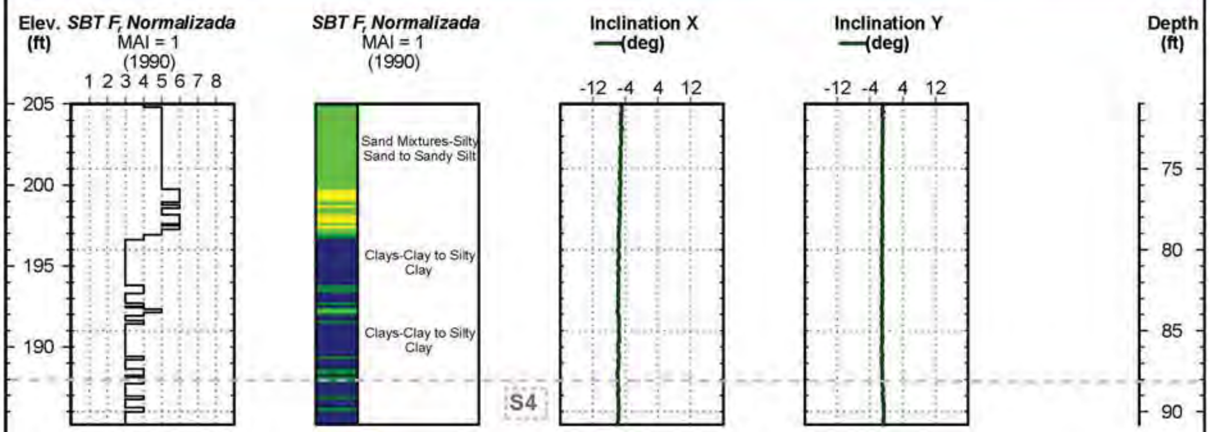
LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

**Project No.:** R11S002 T10

**Northing:** 77796.3
**Easting:** 66393.3
**Elevation:** 276.0

**Date:** Nov. 2, 2011
**Test ID:** Z-SDU6-C17
**Est. Water Depth:** 55 ft




CPT REPORT - DYNAMIC PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

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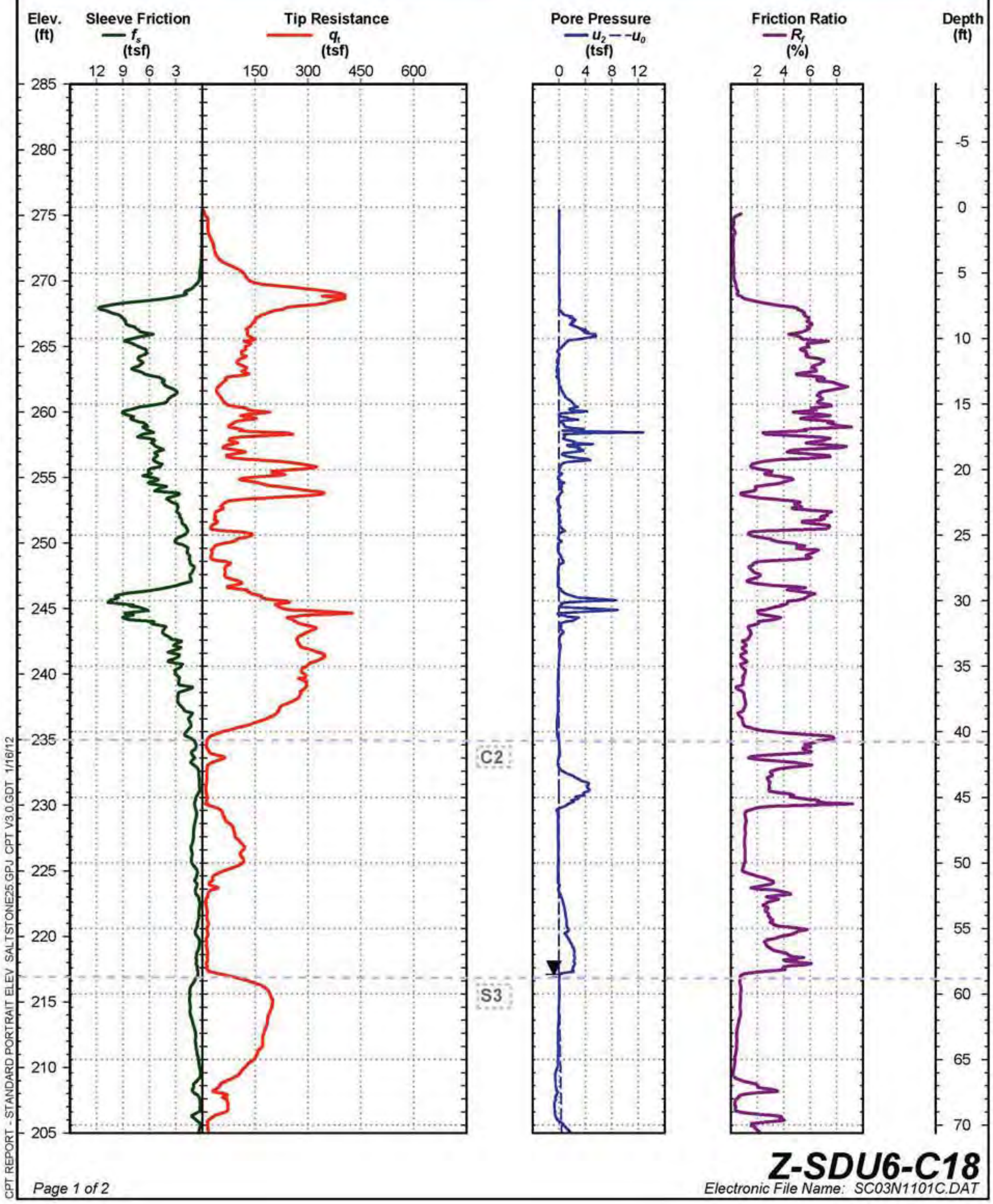
**Z-SDU6-C17**
Electronic File Name: SC02N1104C.DAT

LANKELMA

Saltstone SDU 6 Investigation
Z- Area (Aiken,South Carolina)

Project No.: R11S002 T10
Northing: 77819.4
Easting: 66471.7
Elevation: 275.6
Date: Nov. 3, 2011
Test ID: Z-SDU6-C18
Est. Water Depth: 58.5 ft

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**Z-SDU6-C18**

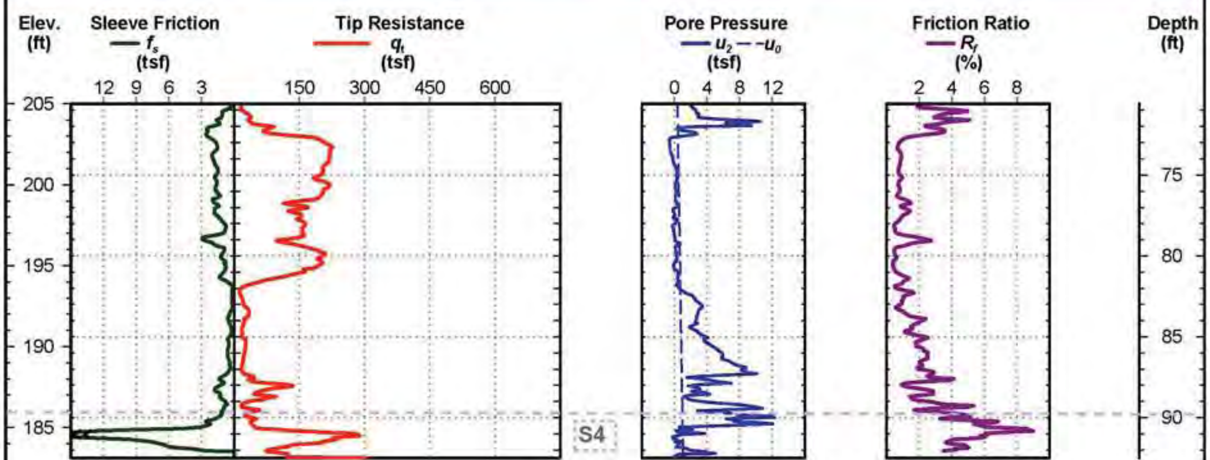
Electronic File Name: SC03N1101C.DAT

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

**Project No.:** R11S002 T10

**Northing:** 77819.4
**Easting:** 66471.7
**Elevation:** 275.6

**Date:** Nov. 3, 2011
**Test ID:** Z-SDU6-C18
**Est. Water Depth:** 58.5 ft




CPT REPORT - STANDARD PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

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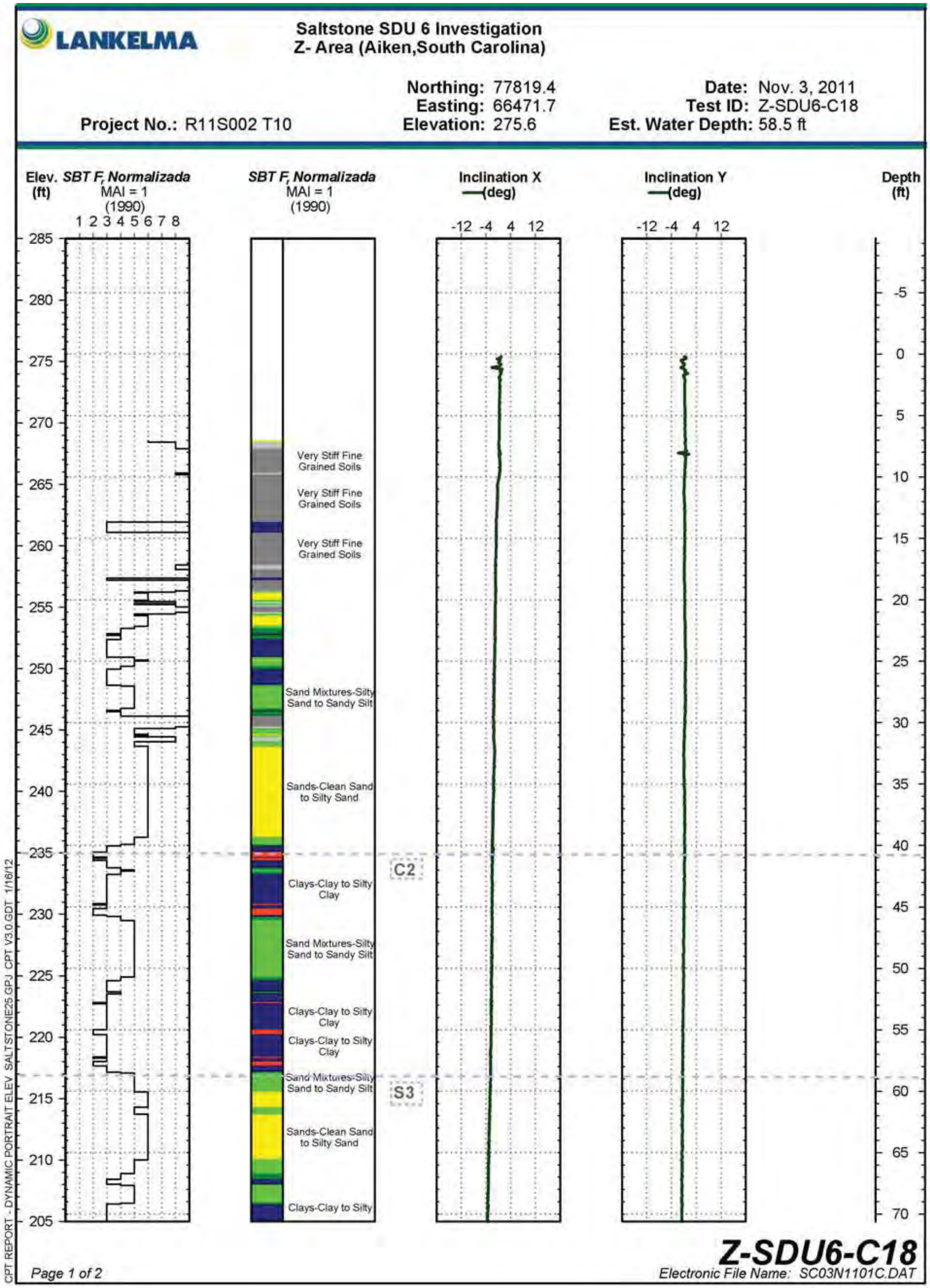
**Z-SDU6-C18**
Electronic File Name: SC03N1101C.DAT


LANKELMA
Saltstone SDU 6 Investigation
Z- Area (Aiken,South Carolina)
Project No.: R11S002 T10
Northing: 77819.4
Easting: 66471.7
Elevation: 275.6
Date: Nov. 3, 2011
Test ID: Z-SDU6-C18
Est. Water Depth: 58.5 ft
Elev. (ft)
SBT F, Normalizada MAI = 1 (1990)
1 2 3 4 5 6 7 8
SBT F, Normalizada MAI = 1 (1990)
Inclination X (deg)
-12 -4 4 12
Inclination Y (deg)
-12 -4 4 12
Depth (ft)
Very Stiff Fine Grained Soils
Very Stiff Fine Grained Soils
Very Stiff Fine Grained Soils
Sand Mixtures-Silty Sand to Sandy Silt
Sands-Clean Sand to Silty Sand
Clays-Clay to Silty Clay
Sand Mixtures-Silty Sand to Sandy Silt
Clays-Clay to Silty Clay
Clays-Clay to Silty Clay
Sand Mixtures-Silty Sand to Sandy Silt
Sands-Clean Sand to Silty Sand
Clays-Clay to Silty
C2
S3
CPT REPORT - DYNAMIC PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12
Page 1 of 2
Z-SDU6-C18
Electronic File Name: SC03N1101C.DAT

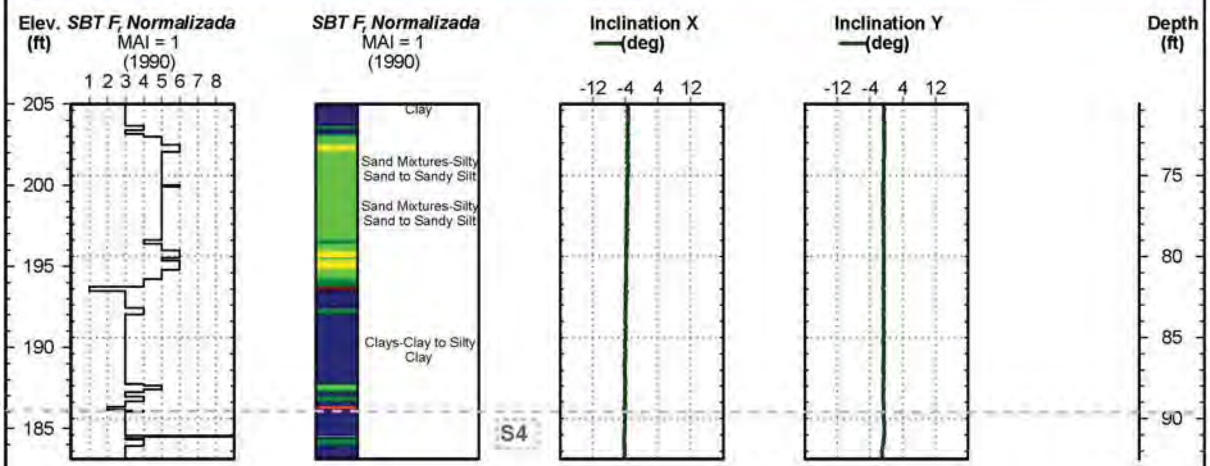
LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

**Northing:** 77819.4
**Easting:** 66471.7
**Elevation:** 275.6

**Date:** Nov. 3, 2011
**Test ID:** Z-SDU6-C18
**Est. Water Depth:** 58.5 ft

**Project No.:** R11S002 T10




CPT REPORT - DYNAMIC PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

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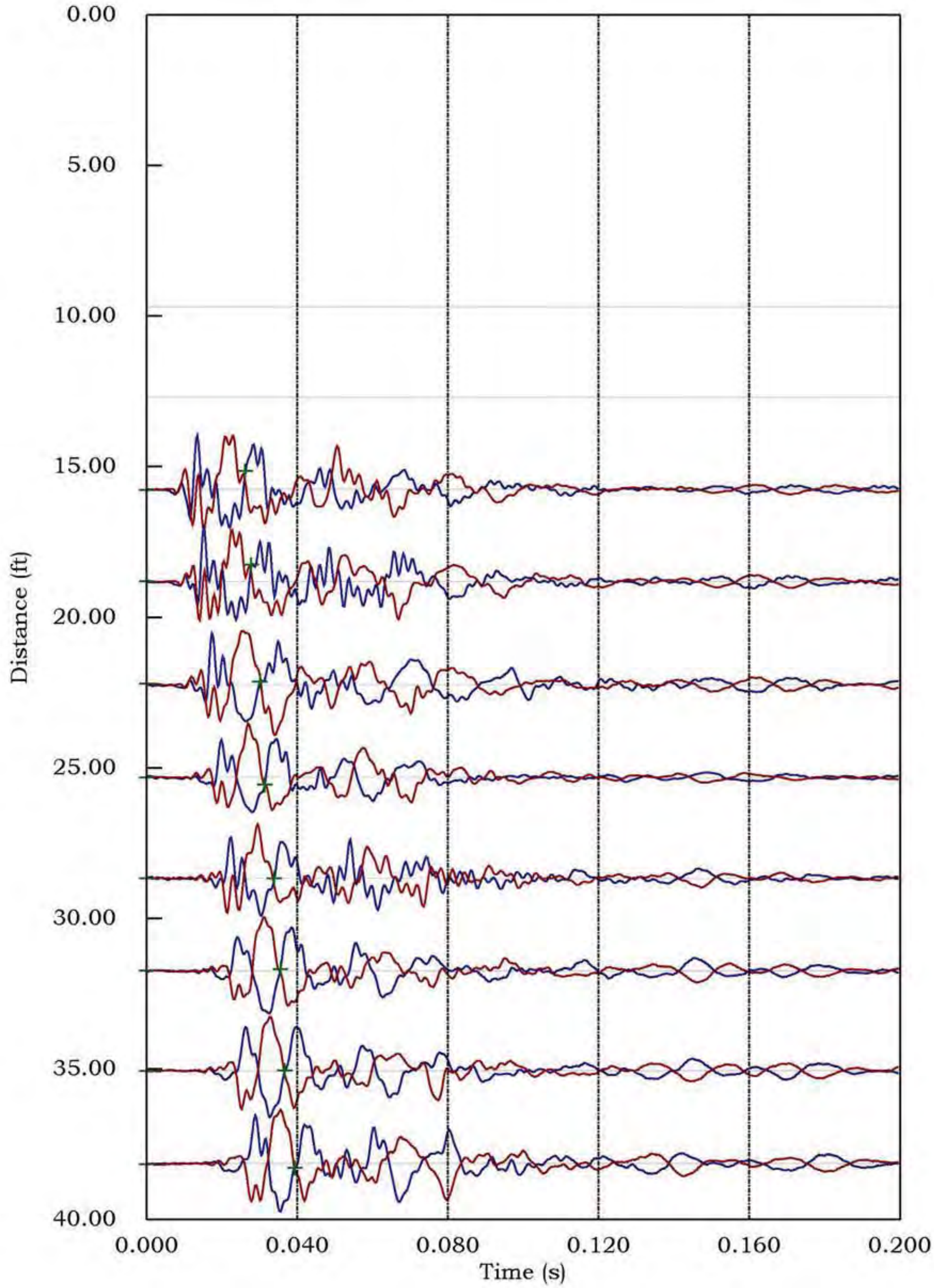
**Z-SDU6-C18**

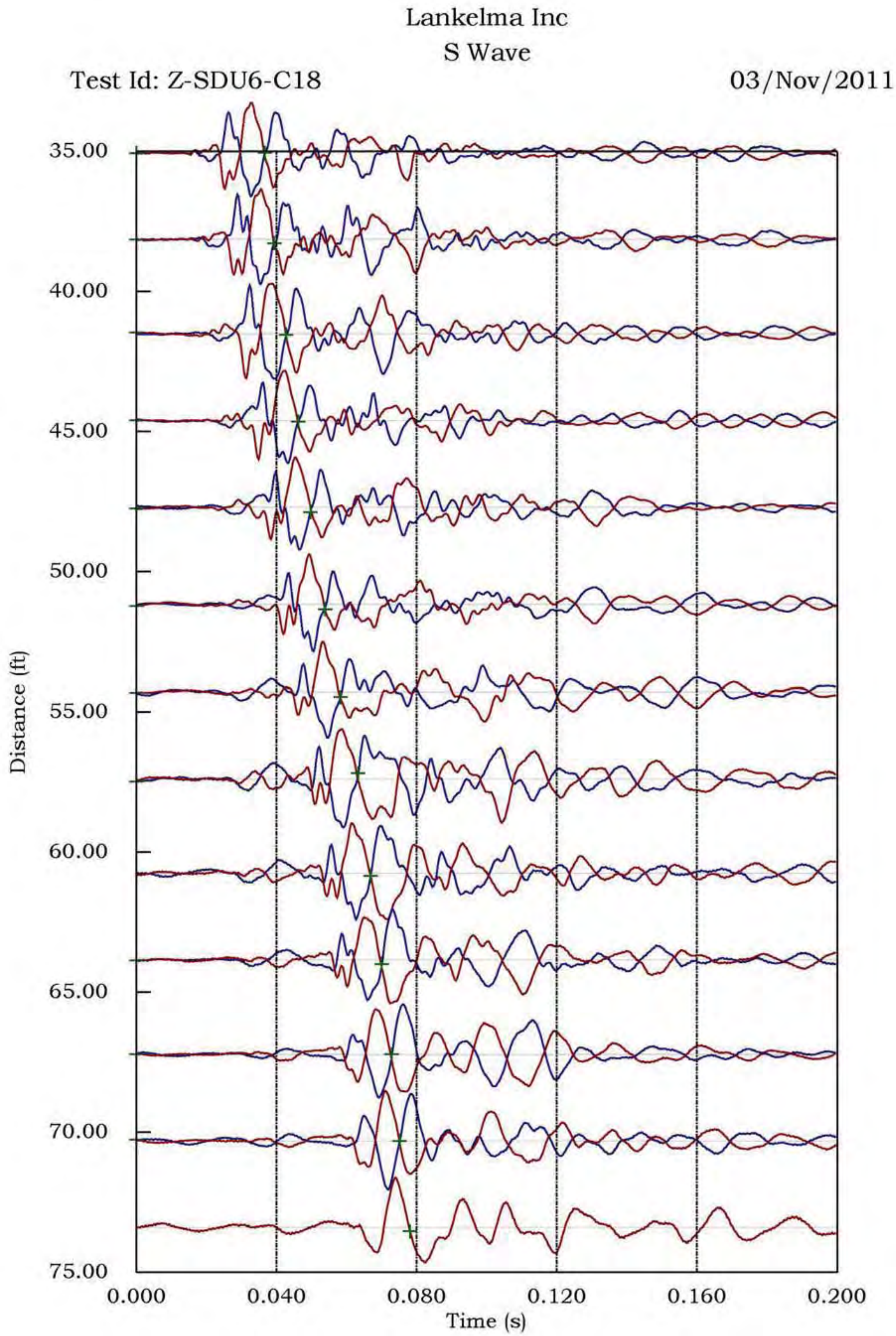
*Electronic File Name: SC03N1101C.DAT*

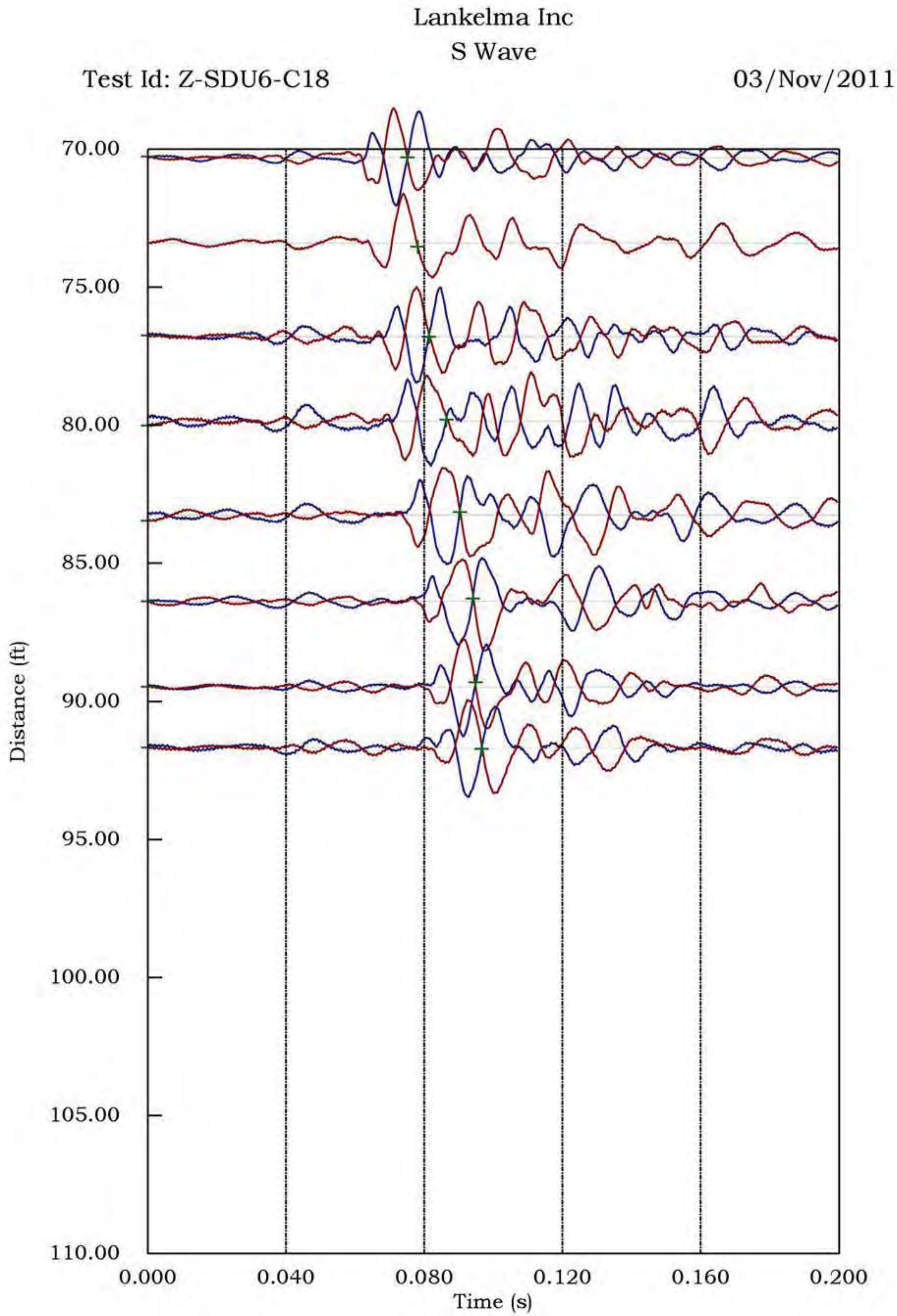
Lankelma Inc

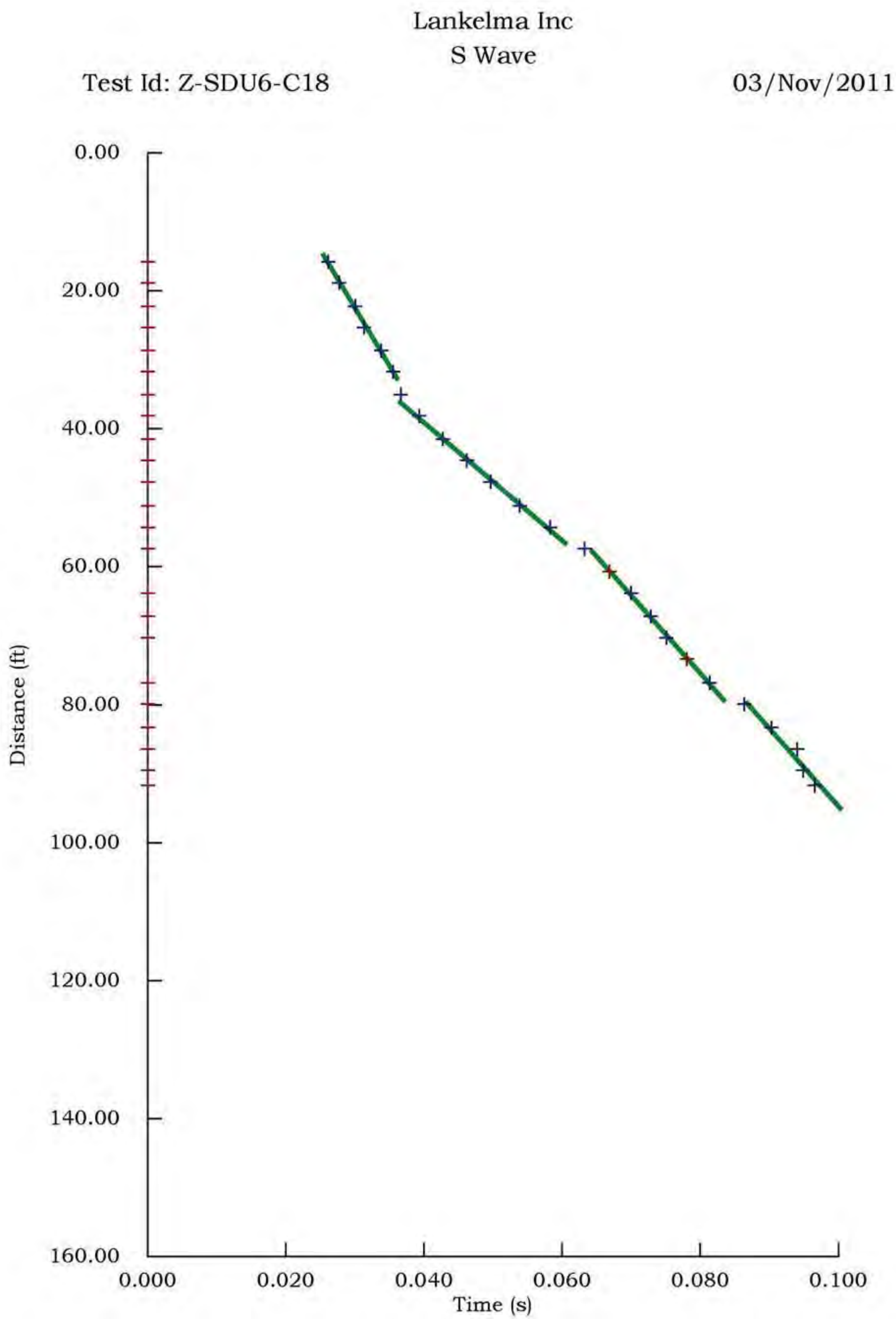
S Wave

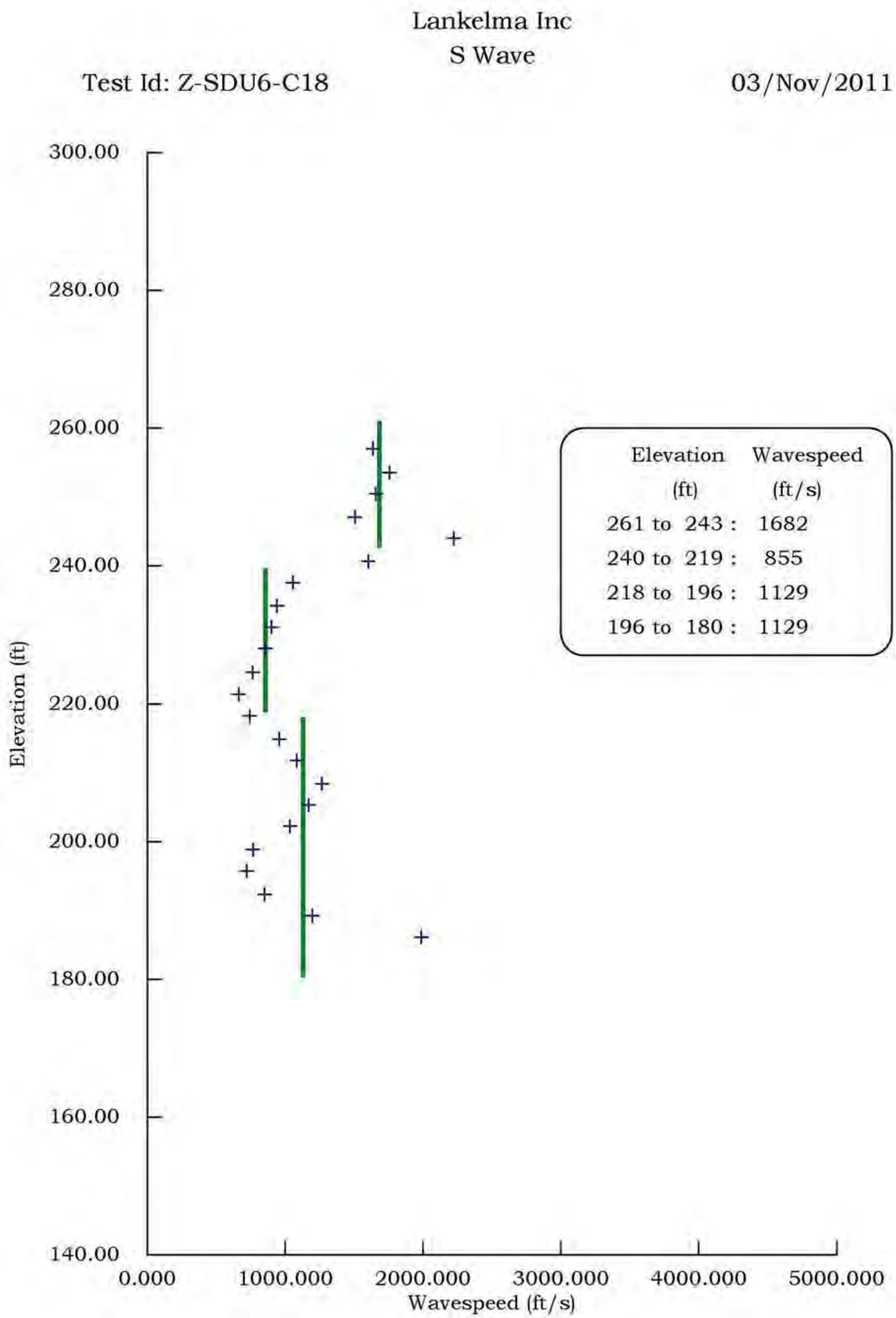
Test Id: Z-SDU6-C18 03/Nov/2011




Lankelma Inc
S Wave
Test Id: Z-SDU6-C18
03/Nov/2011
35.00
40.00
45.00
50.00
55.00
60.00
65.00
70.00
75.00
Distance (ft)
0.000
0.040
0.080
0.120
0.160
0.200
Time (s)


Lankelma Inc
S Wave
Test Id: Z-SDU6-C18
03/Nov/2011
70.00
75.00
80.00
85.00
90.00
95.00
100.00
105.00
110.00
Distance (ft)
0.000
0.040
0.080
0.120
0.160
0.200
Time (s)

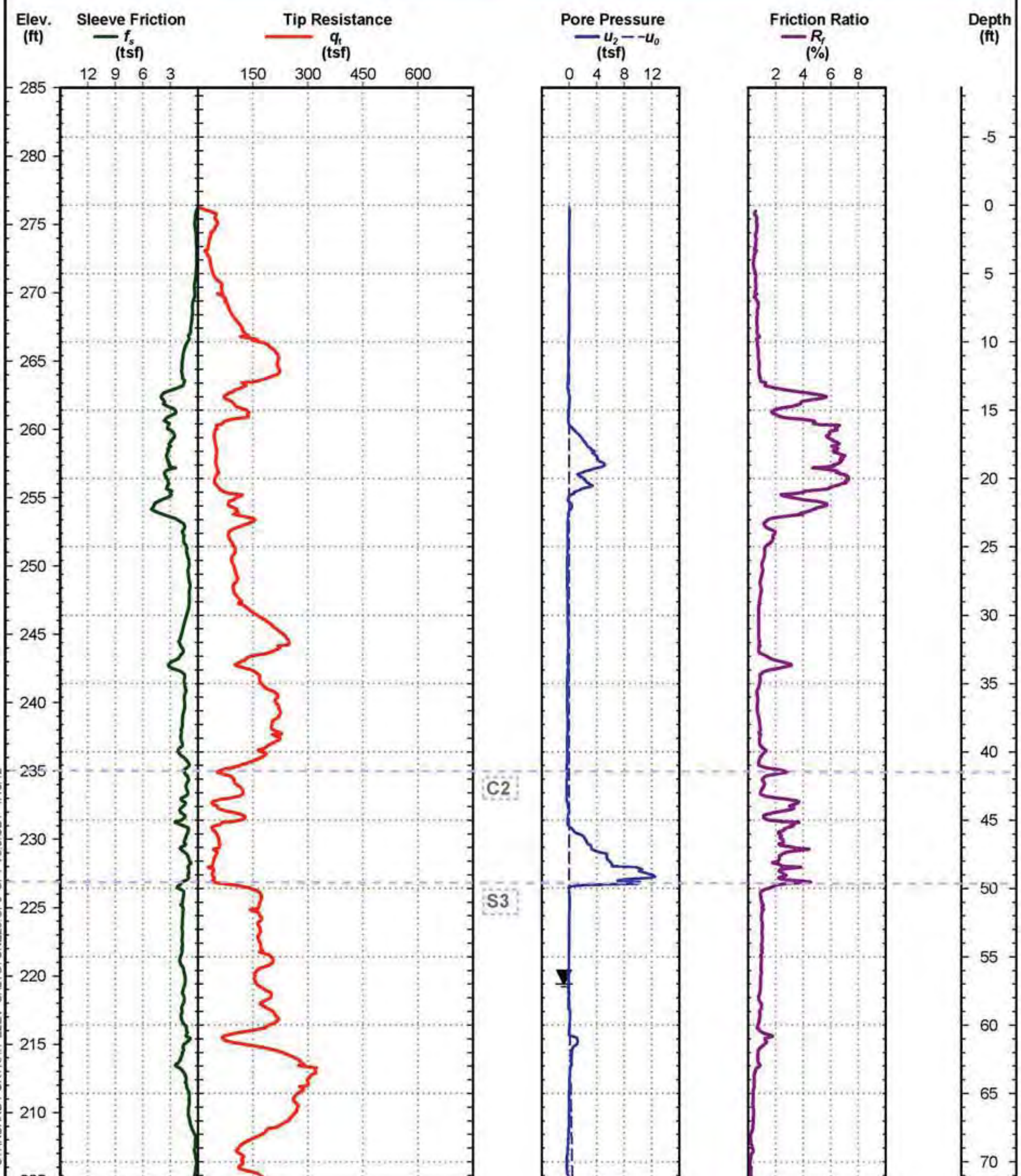

Lankelma Inc
S Wave
Test Id: Z-SDU6-C18
03/Nov/2011
Distance (ft)
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
160.00
0.000
0.020
0.040
0.060
0.080
0.100
Time (s)


Lankelma Inc
S Wave
Test Id: Z-SDU6-C18
03/Nov/2011
300.00
280.00
260.00
240.00
220.00
200.00
180.00
160.00
140.00
Elevation (ft)
0.000
1000.000
2000.000
3000.000
4000.000
5000.000
Wavespeed (ft/s)
Elevation (ft) Wavespeed (ft/s)
261 to 243 : 1682
240 to 219 : 855
218 to 196 : 1129
196 to 180 : 1129

LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

**Project No.:** R11S002 T10
**Northing:** 77869.3
**Easting:** 66155.6
**Elevation:** 276.4
**Date:** Oct. 31, 2011
**Test ID:** Z-SDU6-C19
**Est. Water Depth:** 57 ft




**Z-SDU6-C19**

CPT REPORT - STANDARD PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

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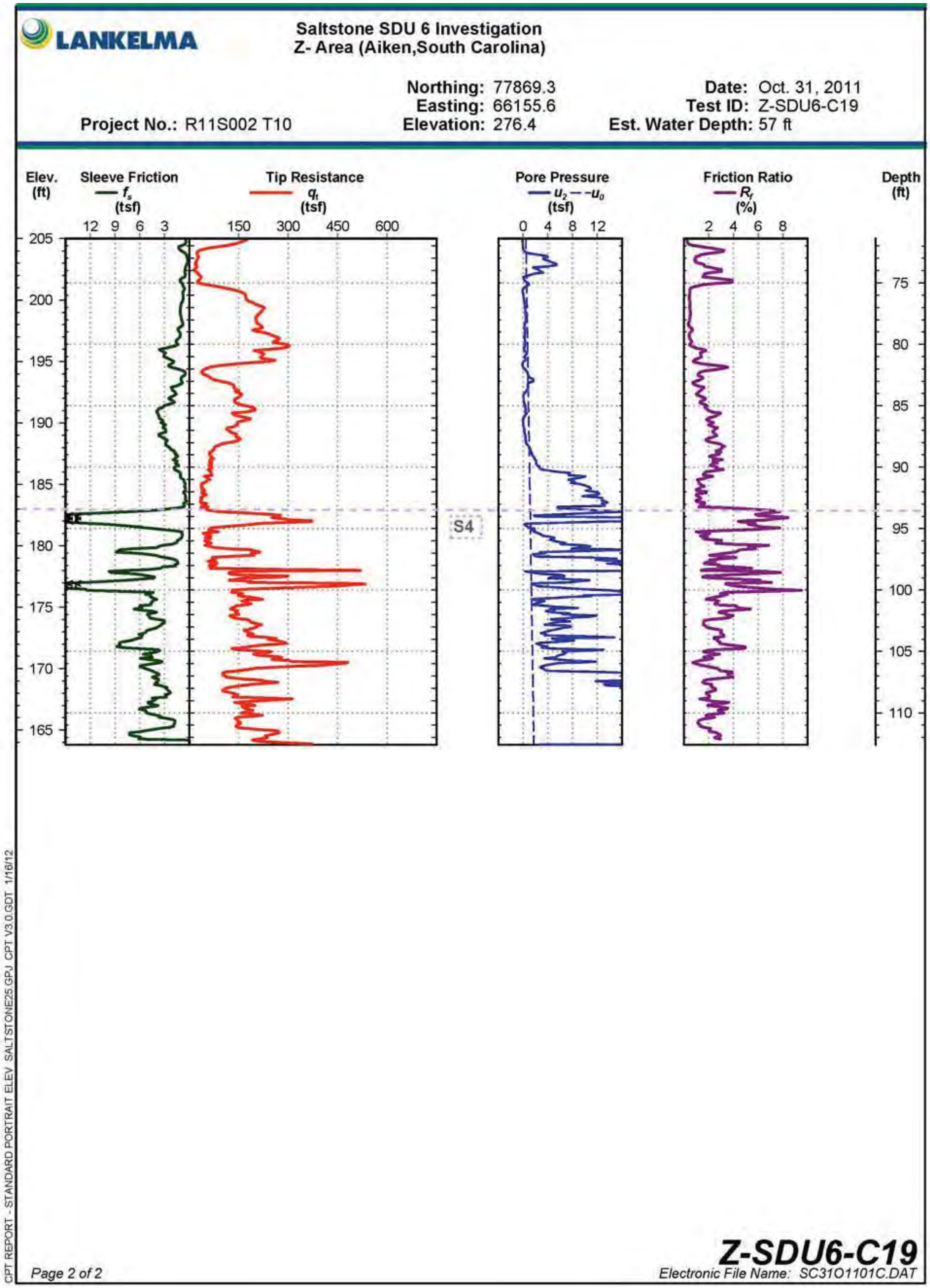
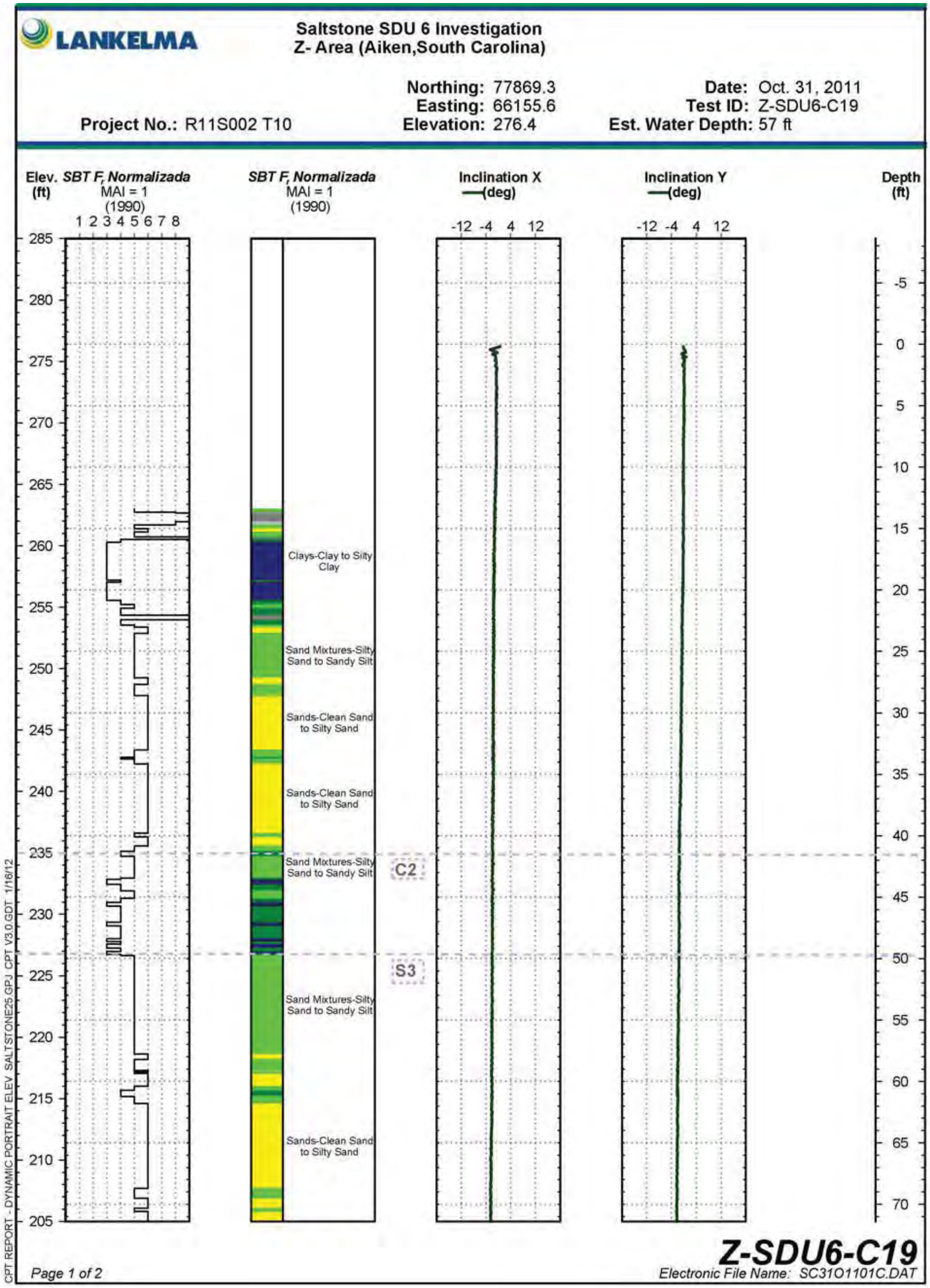
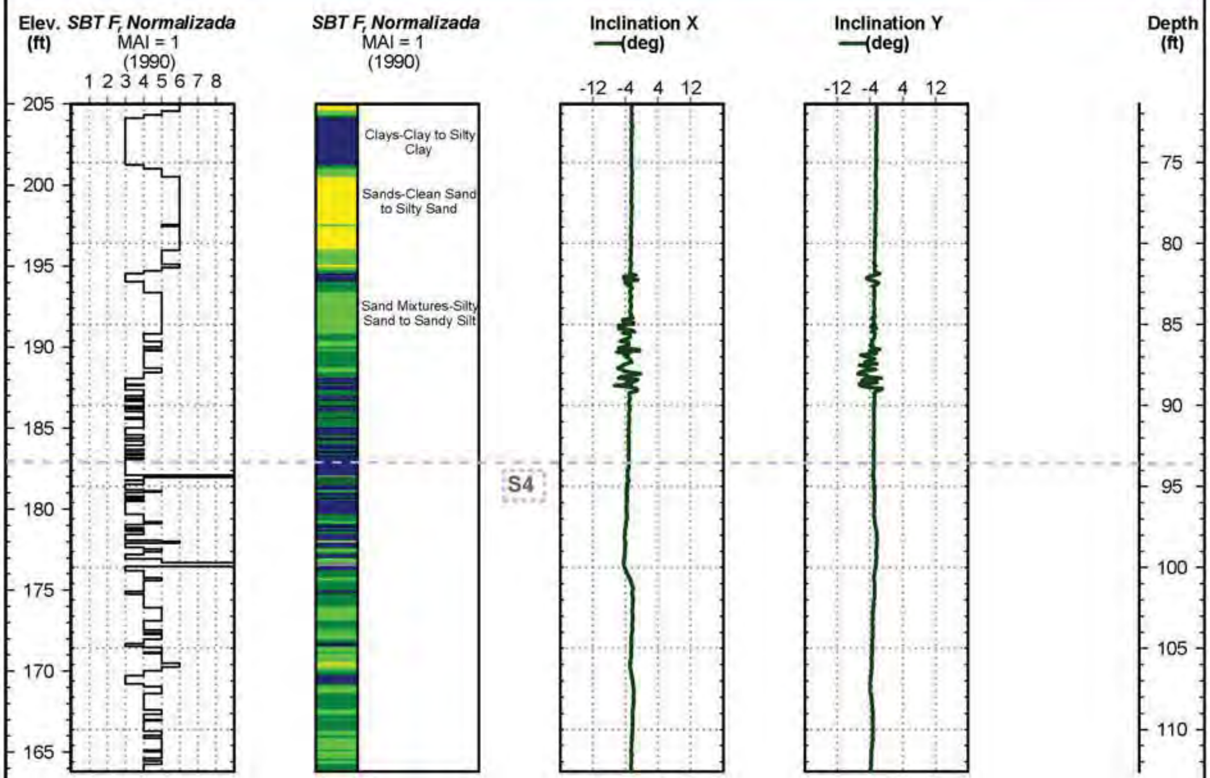
Electronic File Name: SC31O1101C.DAT


LANKELMA
Saltstone SDU 6 Investigation
Z- Area (Aiken,South Carolina)
Northing: 77869.3
Easting: 66155.6
Elevation: 276.4
Date: Oct. 31, 2011
Test ID: Z-SDU6-C19
Est. Water Depth: 57 ft
Project No.: R11S002 T10
Elev. (ft)
Sleeve Friction
fs (tsf)
Tip Resistance
qt (tsf)
Pore Pressure
u2 - -u0 (tsf)
Friction Ratio
Rf (%)
Depth (ft)
S4
CPT REPORT - STANDARD PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12
Page 2 of 2
Z-SDU6-C19
Electronic File Name: SC31O1101C.DAT


LANKELMA
Saltstone SDU 6 Investigation
Z- Area (Aiken,South Carolina)
Northing: 77869.3
Easting: 66155.6
Elevation: 276.4
Date: Oct. 31, 2011
Test ID: Z-SDU6-C19
Est. Water Depth: 57 ft
Project No.: R11S002 T10
Elev. (ft)
SBT F, Normalizada MAI = 1 (1990)
Inclination X (deg)
Inclination Y (deg)
Depth (ft)
Clays-Clay to Silty Clay
Sand Mixtures-Silty Sand to Sandy Silt
Sands-Clean Sand to Silty Sand
C2
S3
CPT REPORT - DYNAMIC PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12
Page 1 of 2
Z-SDU6-C19
Electronic File Name: SC31O1101C.DAT

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

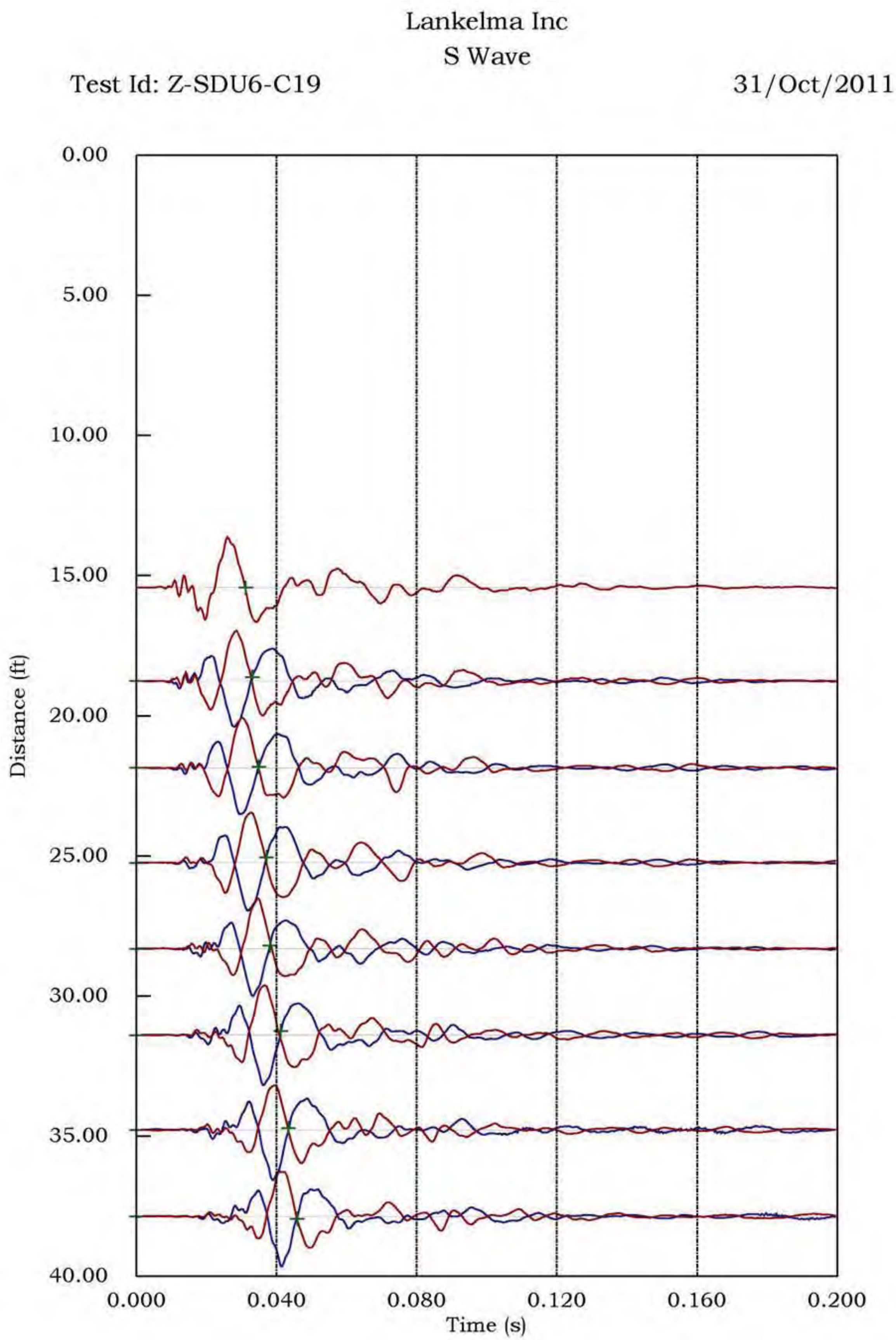
**Project No.:** R11S002 T10
**Northing:** 77869.3
**Easting:** 66155.6
**Elevation:** 276.4
**Date:** Oct. 31, 2011
**Test ID:** Z-SDU6-C19
**Est. Water Depth:** 57 ft




CPT REPORT - DYNAMIC PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

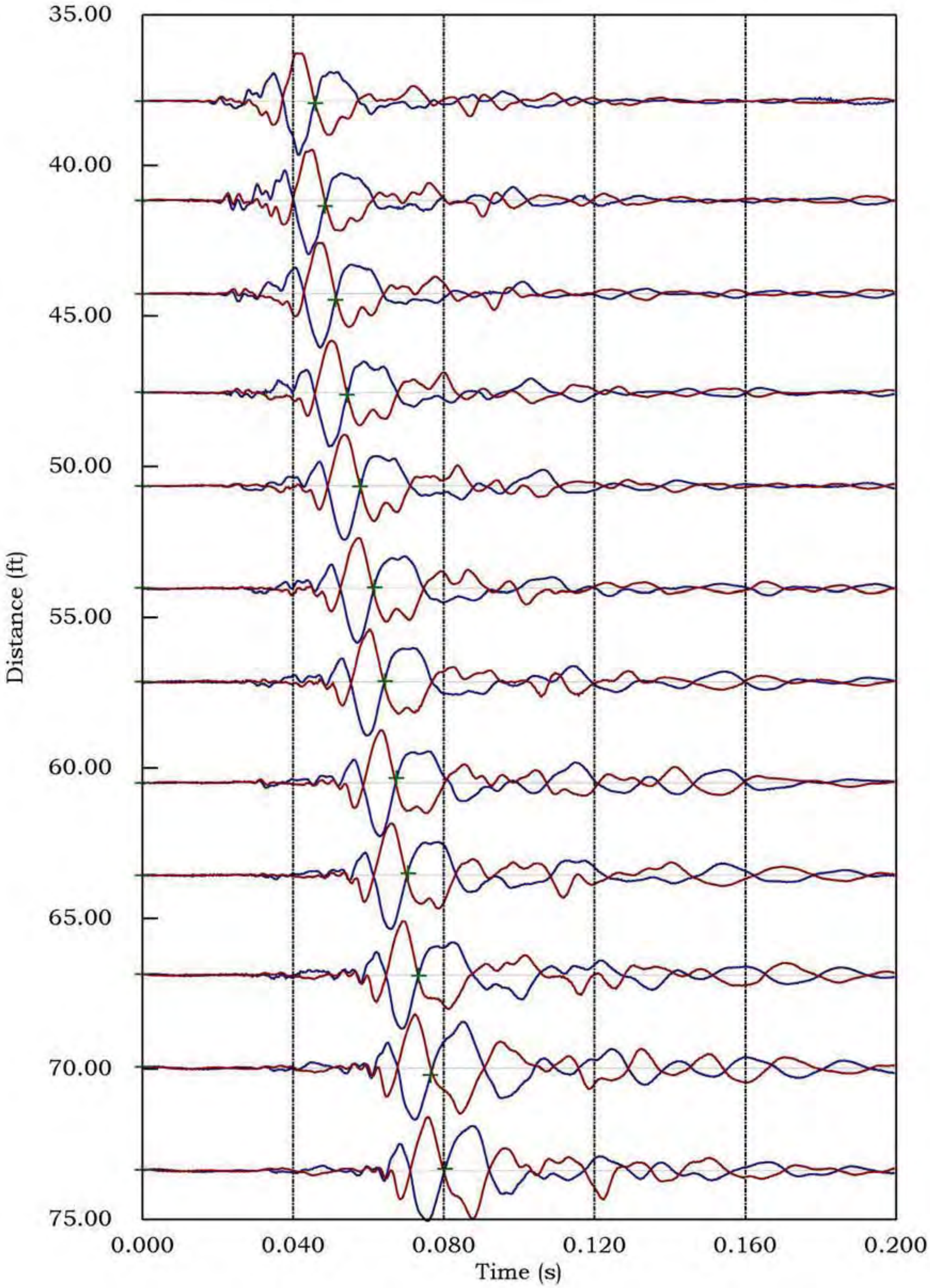
*Page 2 of 2*

**Z-SDU6-C19**
*Electronic File Name: SC31O1101C.DAT*

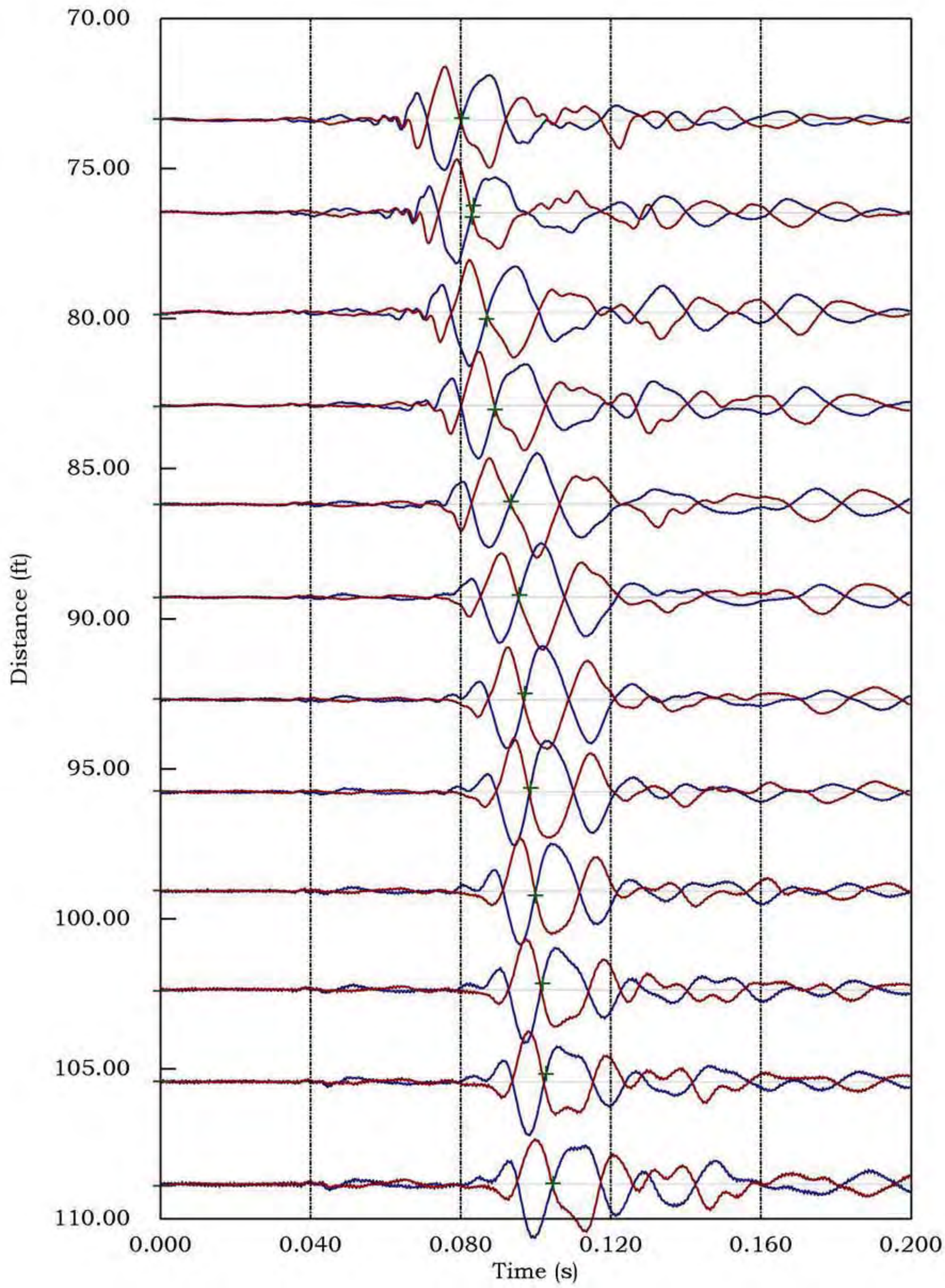

Lankelma Inc
S Wave
Test Id: Z-SDU6-C19
31/Oct/2011
Distance (ft)
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
0.000
0.040
0.080
0.120
0.160
0.200
Time (s)

Lankelma Inc
S Wave

Test Id: Z-SDU6-C19 31/Oct/2011

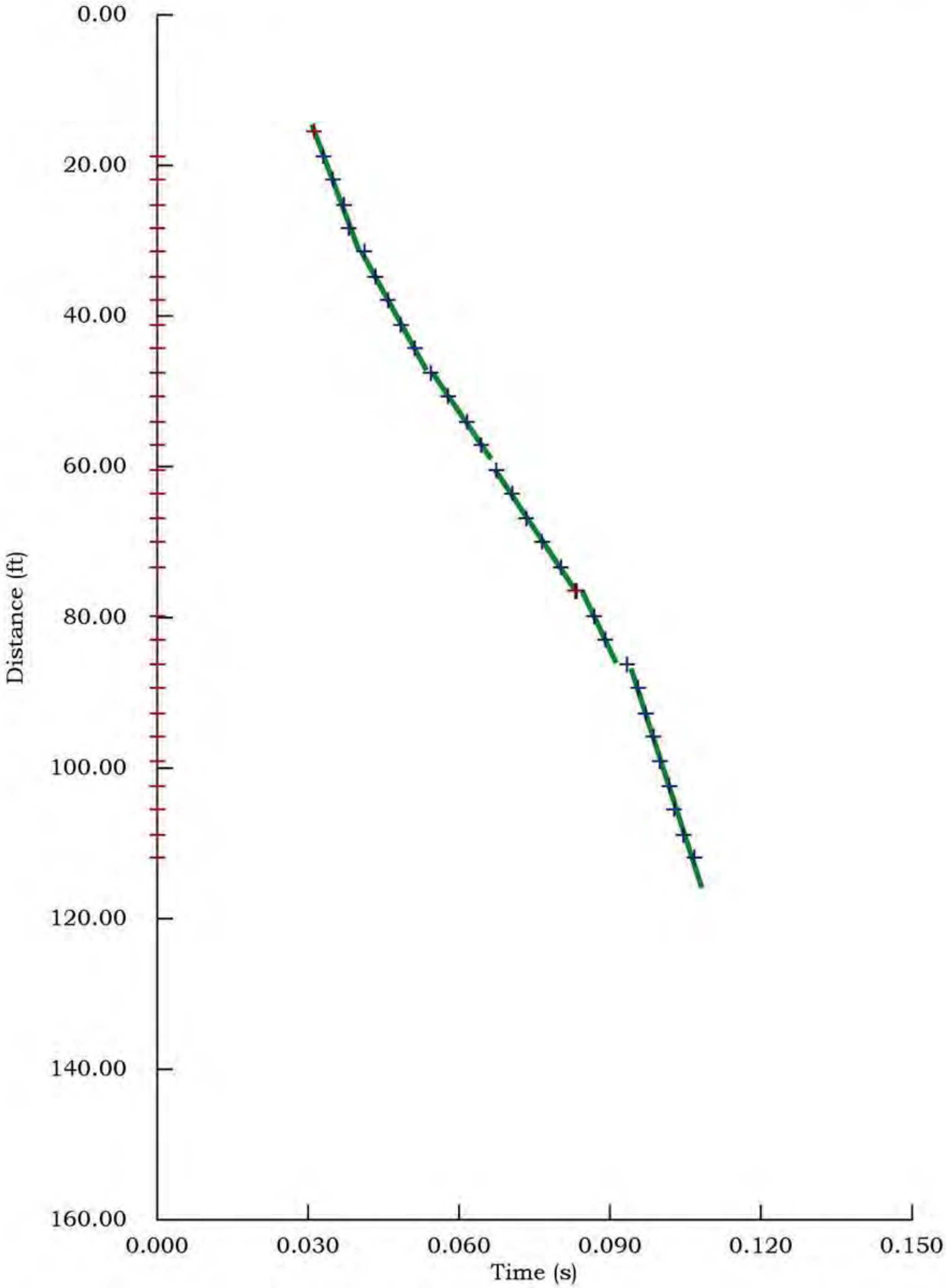


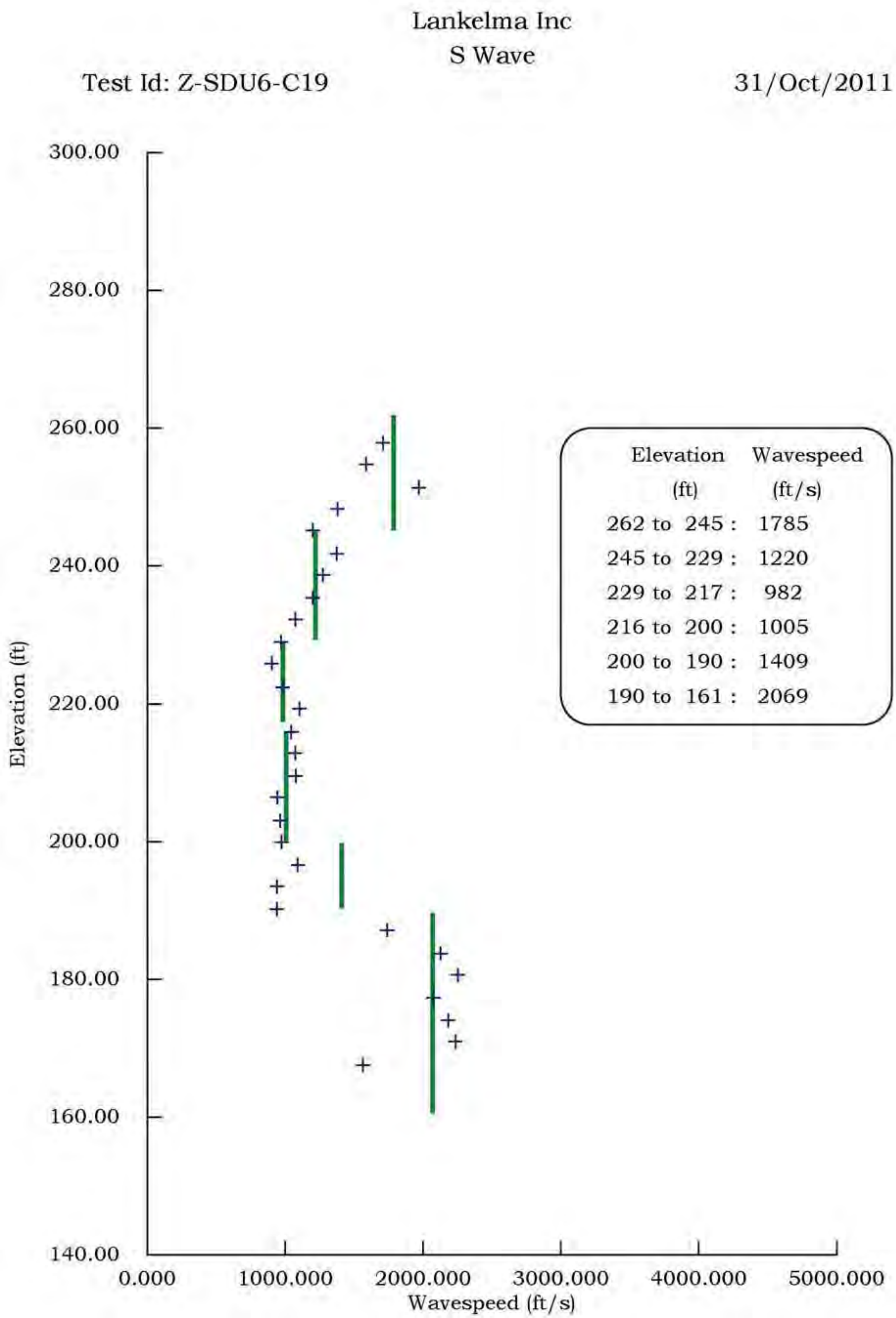
Lankelma Inc
S Wave
Test Id: Z-SDU6-C19 31/Oct/2011



Lankelma Inc
S Wave

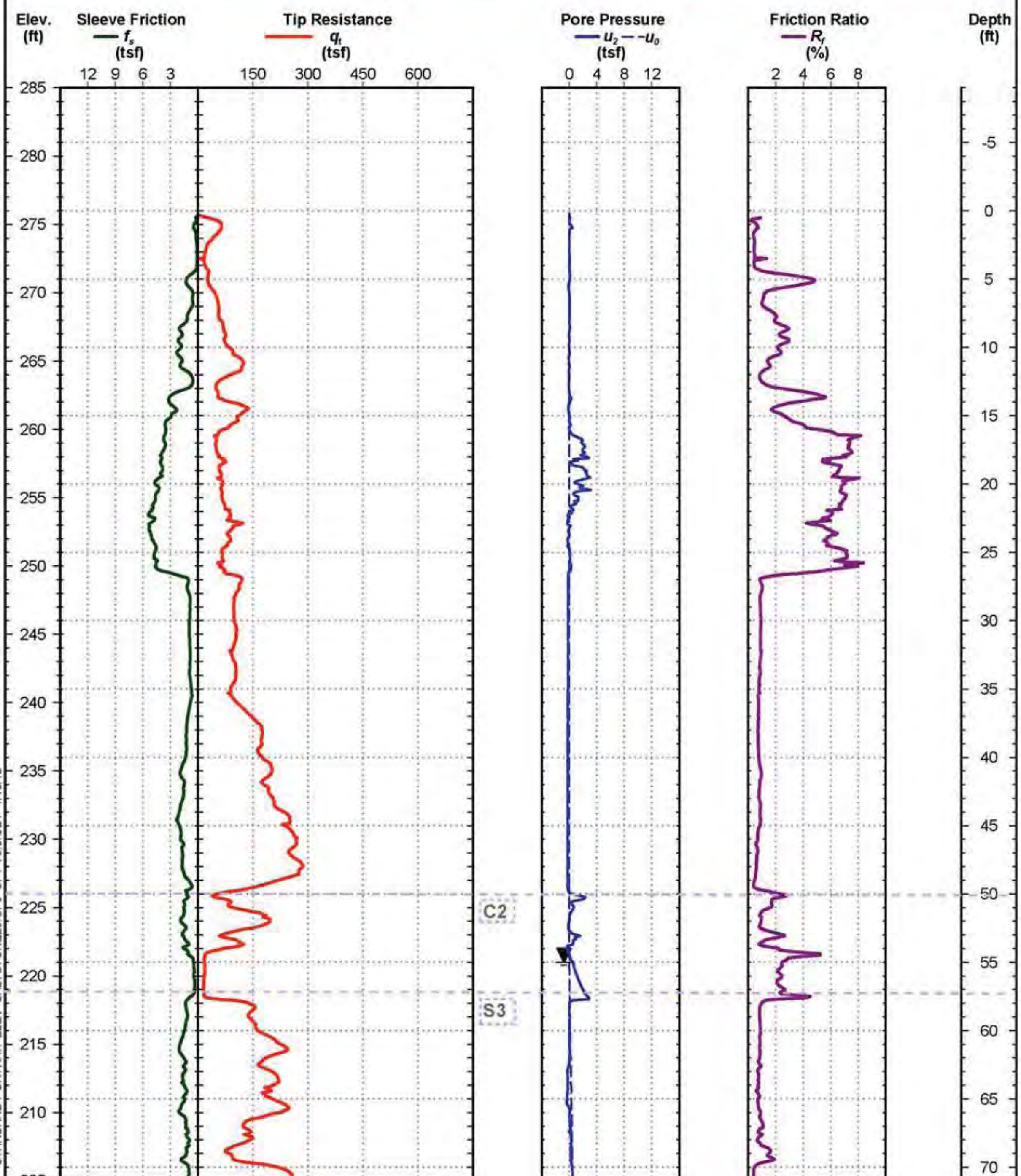
Test Id: Z-SDU6-C19 31/Oct/2011




Lankelma Inc
S Wave
Test Id: Z-SDU6-C19
31/Oct/2011
300.00
280.00
260.00
240.00
220.00
200.00
180.00
160.00
140.00
Elevation (ft)
0.000
1000.000
2000.000
3000.000
4000.000
5000.000
Wavespeed (ft/s)
Elevation (ft) Wavespeed (ft/s)
262 to 245 : 1785
245 to 229 : 1220
229 to 217 : 982
216 to 200 : 1005
200 to 190 : 1409
190 to 161 : 2069

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

**Project No.:** R11S002 T10
**Northing:** 77895.0
**Easting:** 66236.9
**Elevation:** 276.0
**Date:** Oct. 31, 2011
**Test ID:** Z-SDU6-C20
**Est. Water Depth:** 55 ft




CPT REPORT - STANDARD PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

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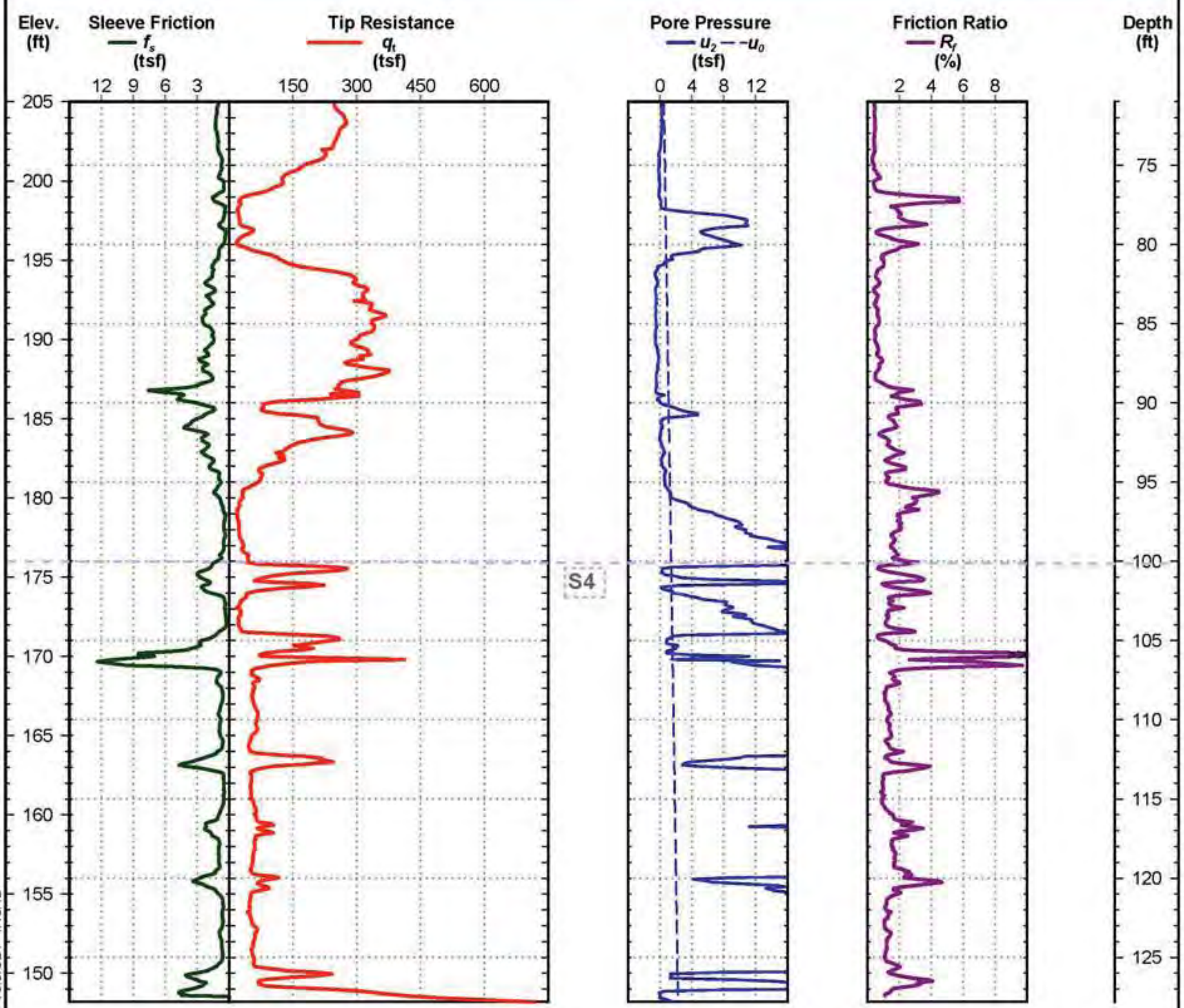
**Z-SDU6-C20**
Electronic File Name: SC31O1102C.DAT

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

**Project No.:** R11S002 T10

**Northing:** 77895.0
**Easting:** 66236.9
**Elevation:** 276.0

**Date:** Oct. 31, 2011
**Test ID:** Z-SDU6-C20
**Est. Water Depth:** 55 ft




CPT REPORT - STANDARD PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

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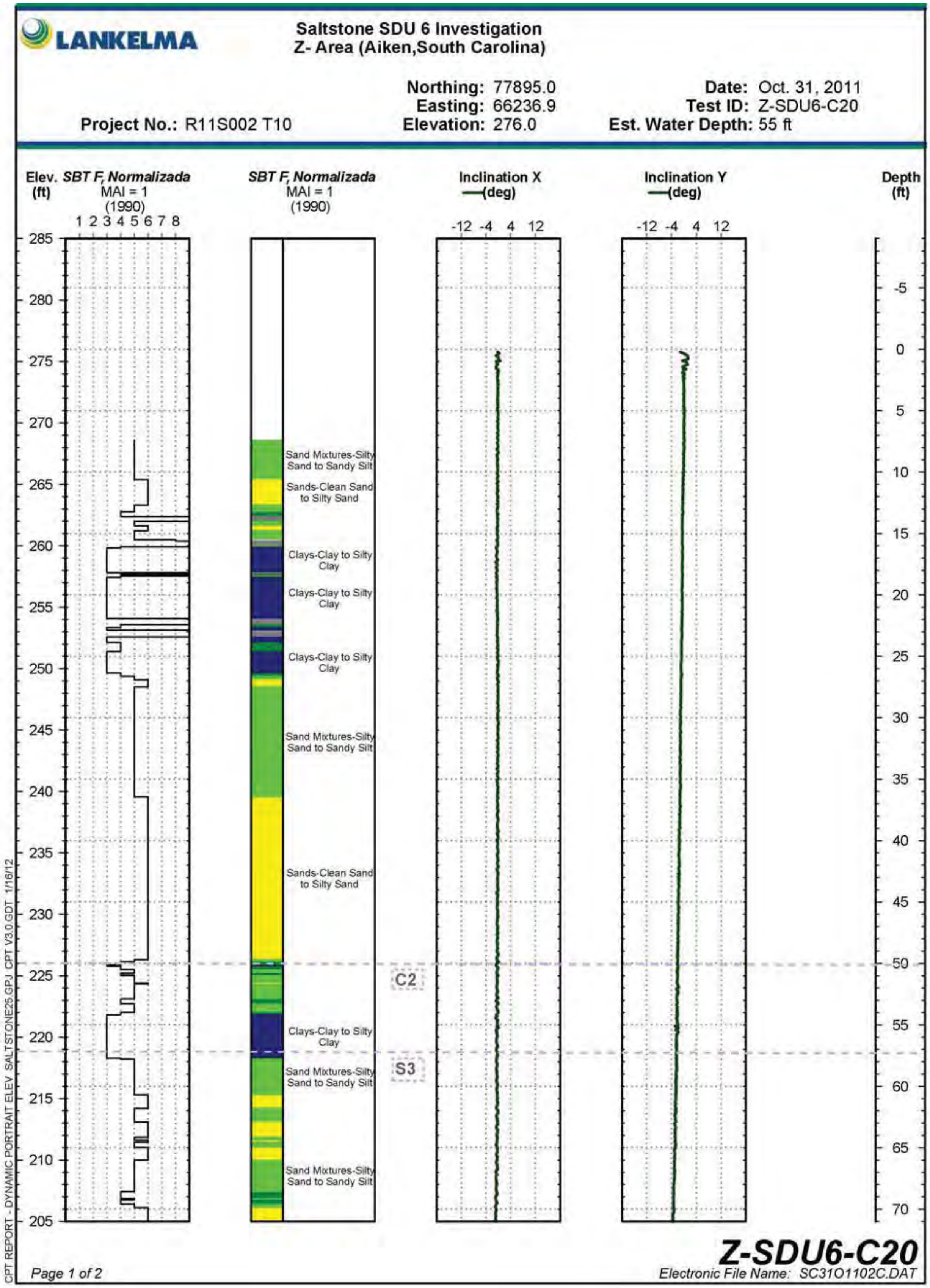
**Z-SDU6-C20**

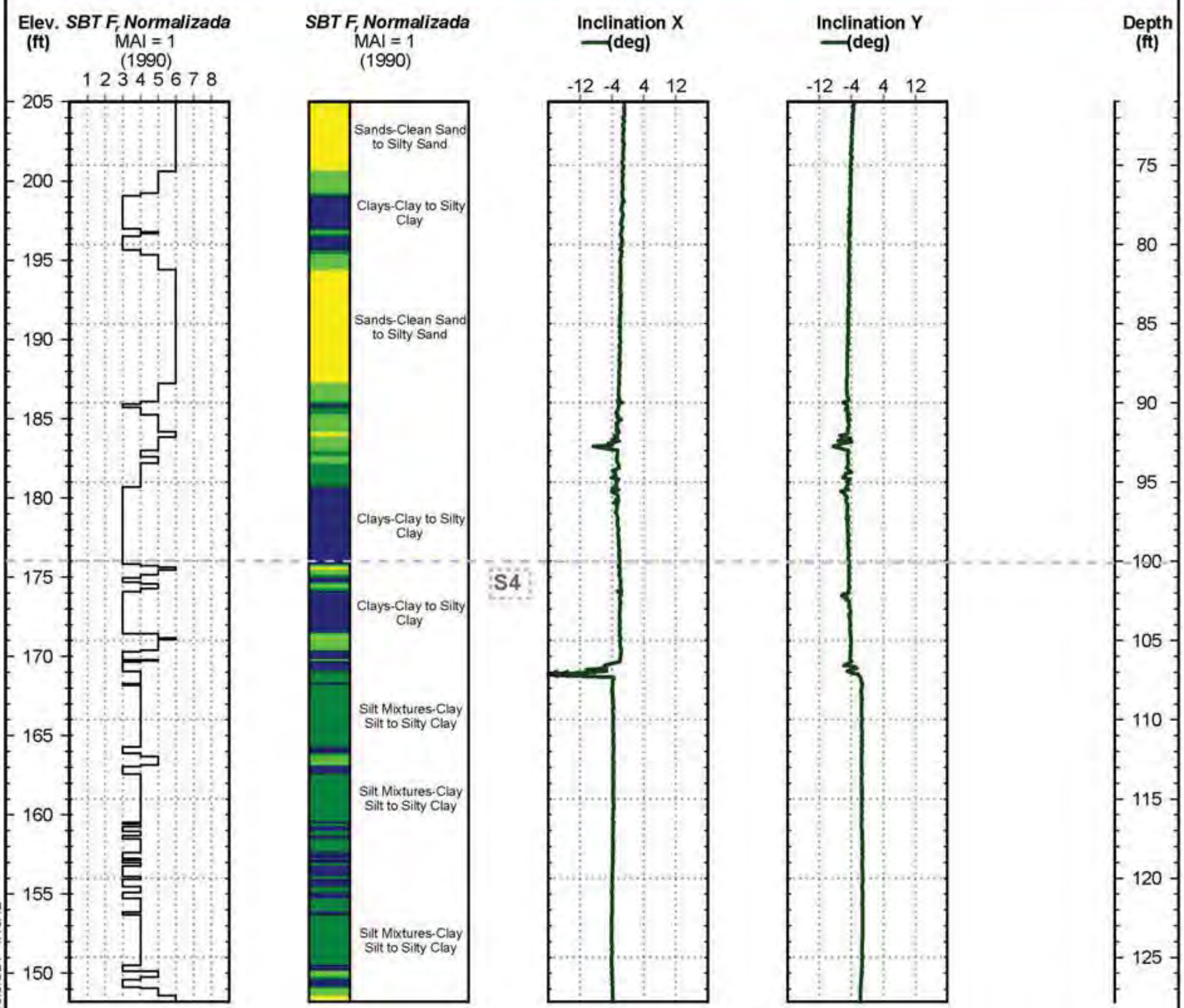
Electronic File Name: SC31O1102C.DAT


LANKELMA
Saltstone SDU 6 Investigation
Z- Area (Aiken,South Carolina)
Project No.: R11S002 T10
Northing: 77895.0
Easting: 66236.9
Elevation: 276.0
Date: Oct. 31, 2011
Test ID: Z-SDU6-C20
Est. Water Depth: 55 ft
Elev. (ft)
SBT F, Normalizada MAI = 1 (1990)
Inclination X (deg)
Inclination Y (deg)
Depth (ft)
Sand Mixtures-Silty Sand to Sandy Silt
Sands-Clean Sand to Silty Sand
Clays-Clay to Silty Clay
C2
S3
CPT REPORT - DYNAMIC PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12
Page 1 of 2
Z-SDU6-C20
Electronic File Name: SC31O1102C.DAT

LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

| | | |
|---|---|---|
| **Project No.:** R11S002 T10 | **Northing:** 77895.0<br>**Easting:** 66236.9<br>**Elevation:** 276.0 | **Date:** Oct. 31, 2011<br>**Test ID:** Z-SDU6-C20<br>**Est. Water Depth:** 55 ft |




CPT REPORT - DYNAMIC PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

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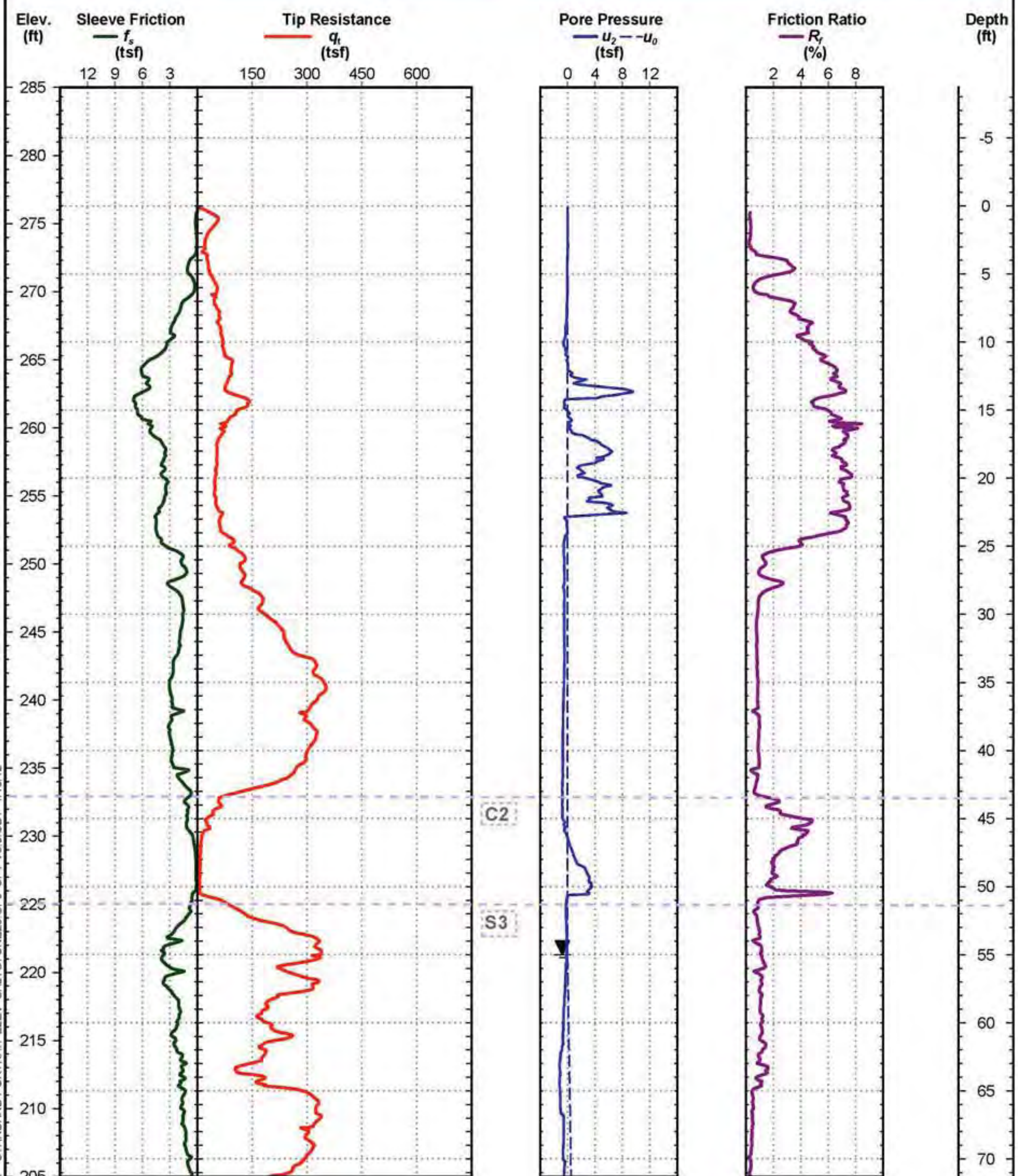
**Z-SDU6-C20**

*Electronic File Name: SC31O1102C.DAT*

**LANKELMA**

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

**Project No.:** R11S002 T10
**Northing:** 77920.9
**Easting:** 66321.6
**Elevation:** 276.3
**Date:** Nov. 1, 2011
**Test ID:** Z-SDU6-C21
**Est. Water Depth:** 55 ft




CPT REPORT - STANDARD PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

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**Z-SDU6-C21**

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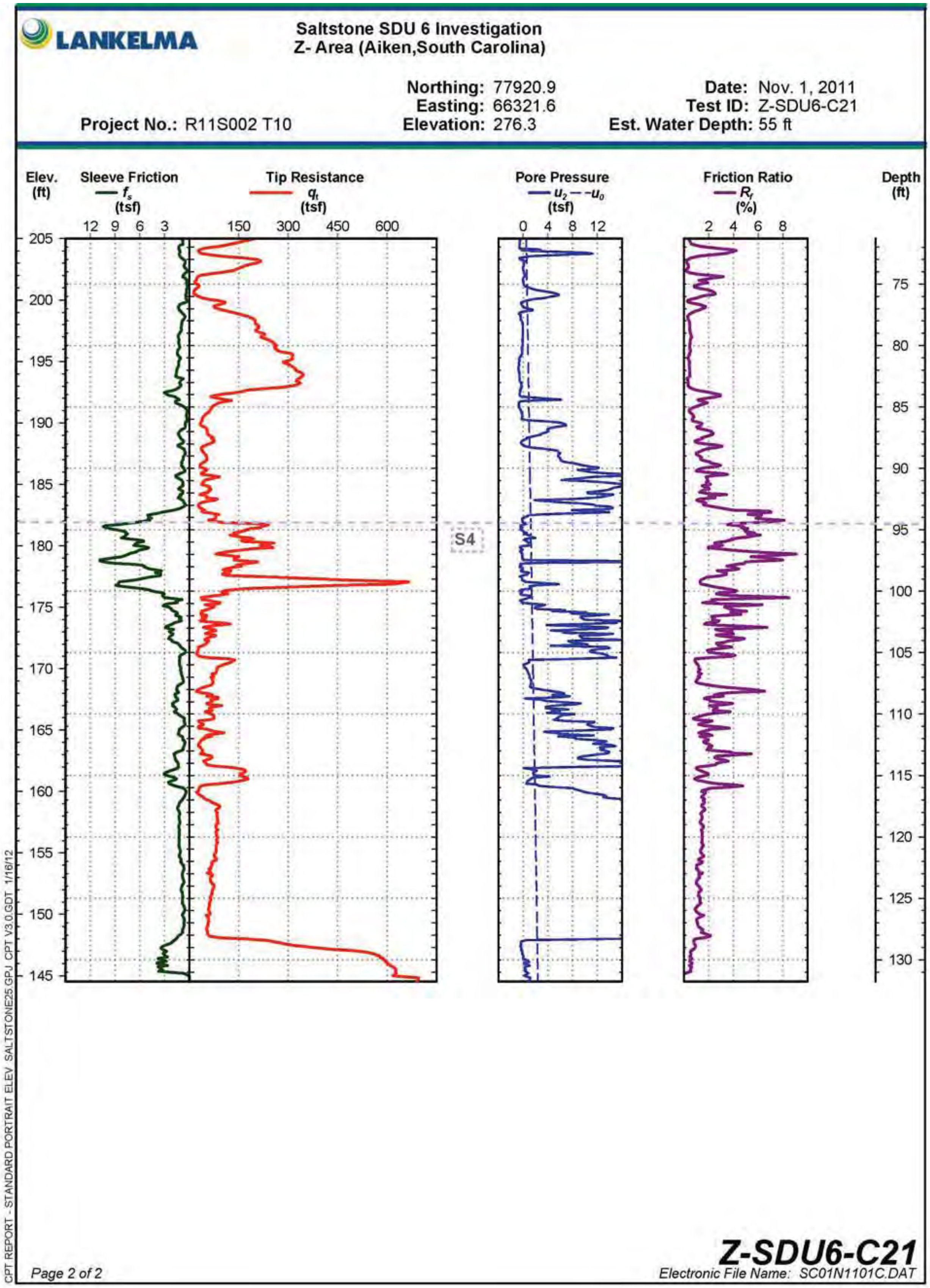
LANKELMA
Saltstone SDU 6 Investigation
Z- Area (Aiken,South Carolina)
Northing: 77920.9
Easting: 66321.6
Elevation: 276.3
Date: Nov. 1, 2011
Test ID: Z-SDU6-C21
Est. Water Depth: 55 ft
Project No.: R11S002 T10
Elev. (ft)
Sleeve Friction
$f_s$ (tsf)
Tip Resistance
$q_t$ (tsf)
Pore Pressure
$u_2$ — $u_0$ (tsf)
Friction Ratio
$R_f$ (%)
Depth (ft)
S4
CPT REPORT - STANDARD PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12
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Z-SDU6-C21
Electronic File Name: SC01N1101C.DAT

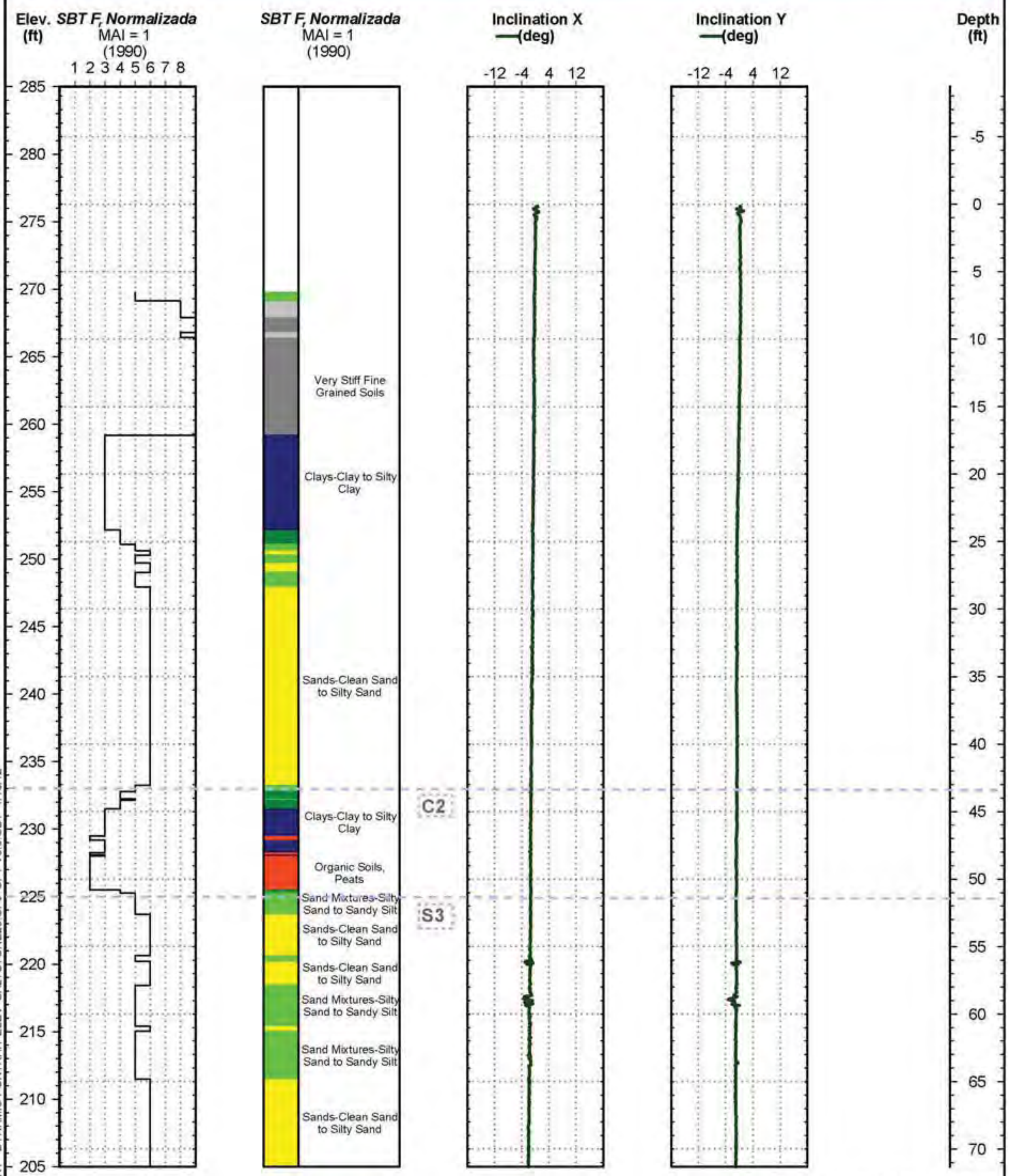
LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

**Project No.:** R11S002 T10

**Northing:** 77920.9
**Easting:** 66321.6
**Elevation:** 276.3

**Date:** Nov. 1, 2011
**Test ID:** Z-SDU6-C21
**Est. Water Depth:** 55 ft



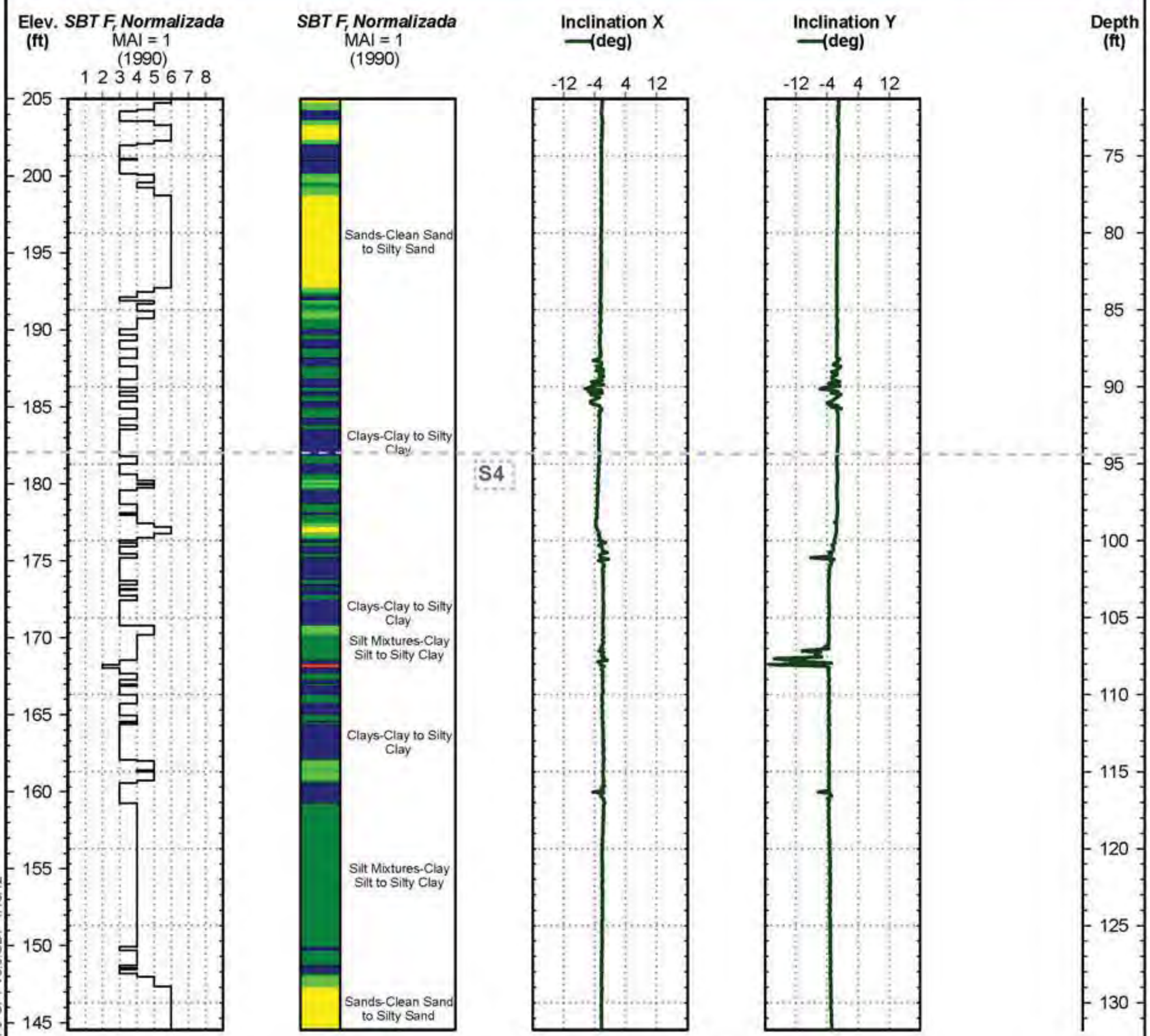

CPT REPORT - DYNAMIC PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

Page 1 of 2

**Z-SDU6-C21**
Electronic File Name: SC01N1101C.DAT

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

**Project No.:** R11S002 T10
**Northing:** 77920.9
**Easting:** 66321.6
**Elevation:** 276.3
**Date:** Nov. 1, 2011
**Test ID:** Z-SDU6-C21
**Est. Water Depth:** 55 ft




CPT REPORT - DYNAMIC PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

Page 2 of 2

**Z-SDU6-C21**

Electronic File Name: SC01N1101C.DAT

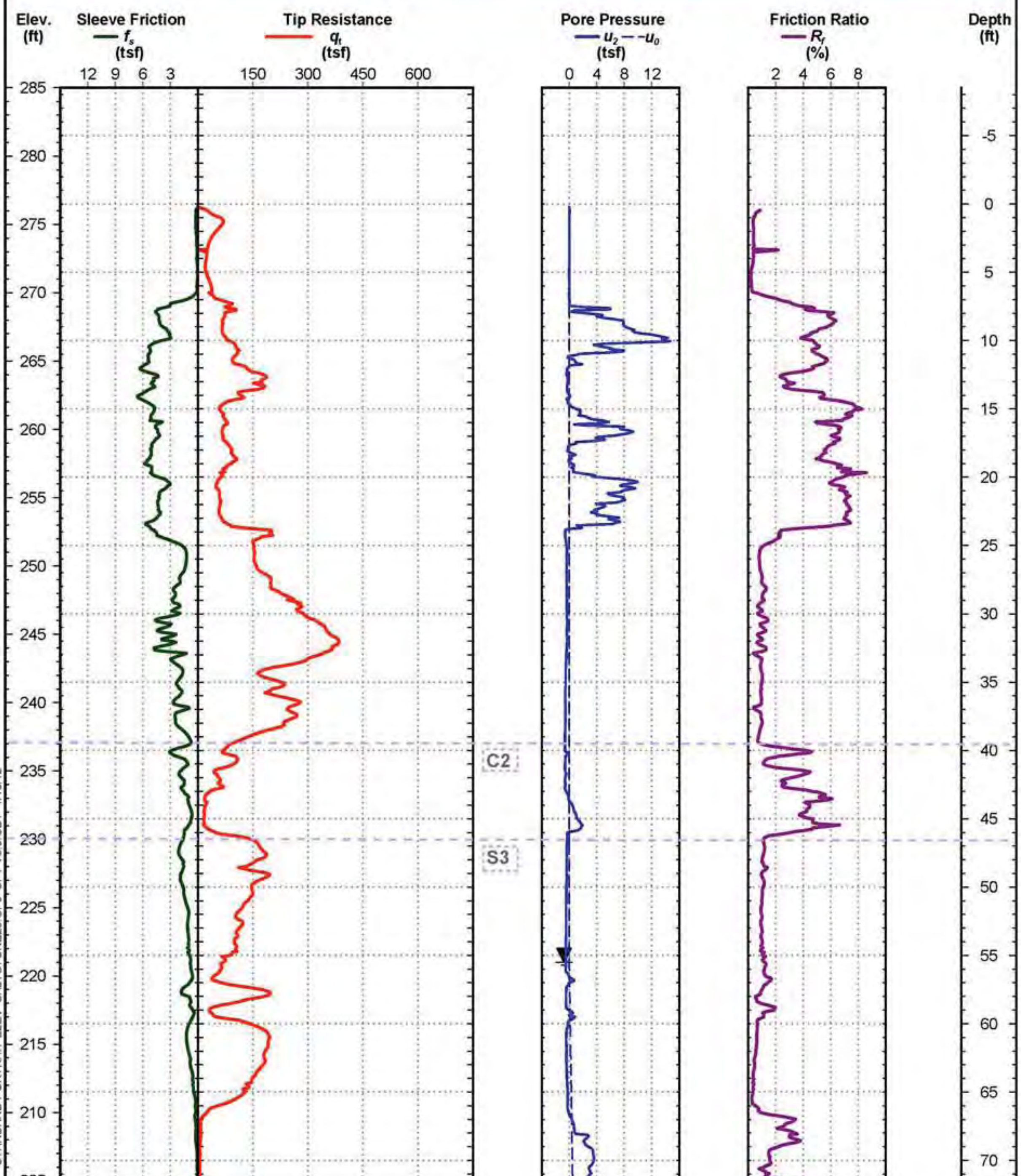
**LANKELMA**

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

**Northing:** 77947.5
**Easting:** 66415.1
**Elevation:** 276.5

**Date:** Nov. 1, 2011
**Test ID:** Z-SDU6-C22
**Est. Water Depth:** 55.5 ft

**Project No.:** R11S002 T10




CPT REPORT - STANDARD PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

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**Z-SDU6-C22**

Electronic File Name: SC01N1102C.DAT

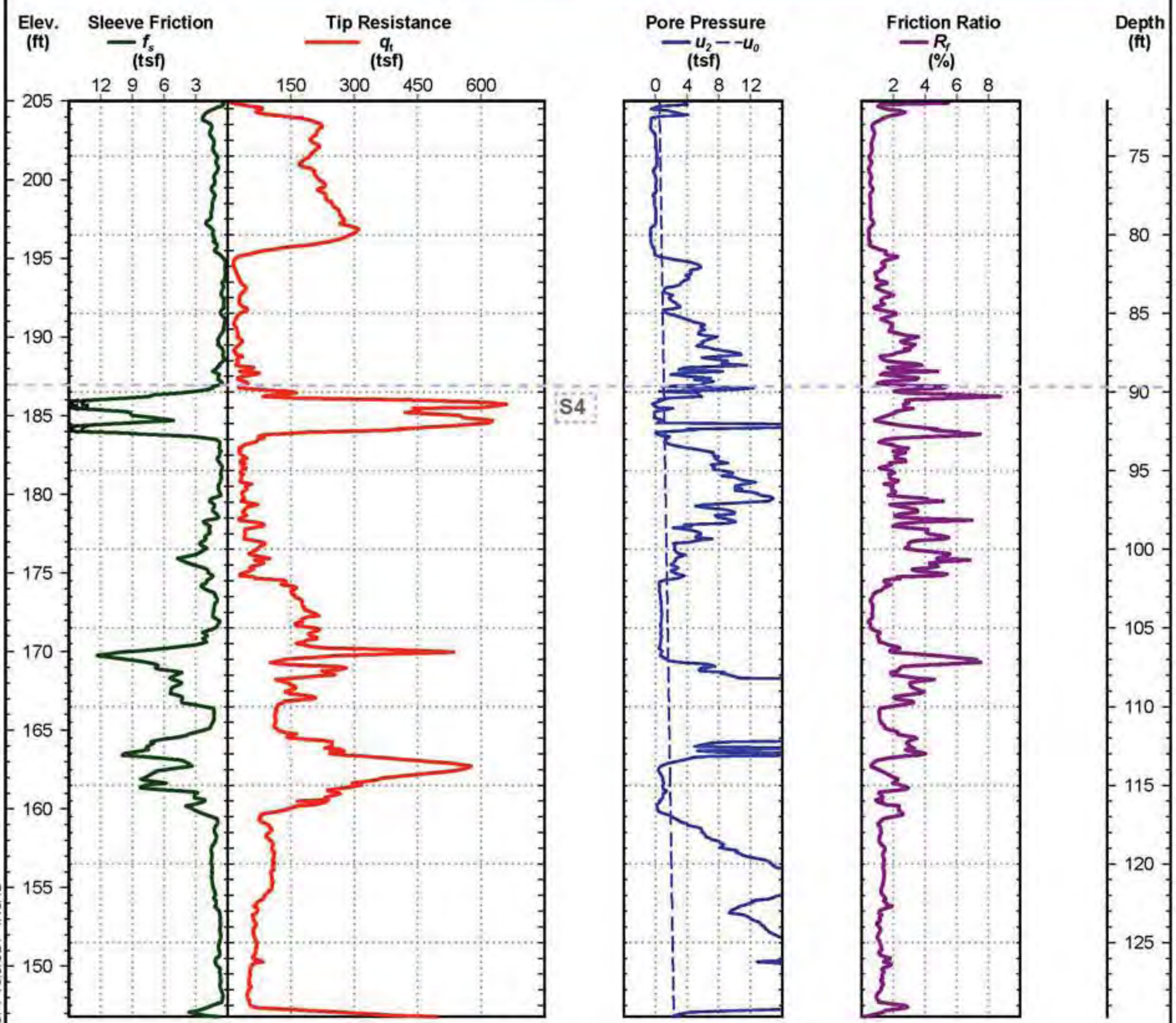
LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

**Project No.:** R11S002 T10

**Northing:** 77947.5
**Easting:** 66415.1
**Elevation:** 276.5

**Date:** Nov. 1, 2011
**Test ID:** Z-SDU6-C22
**Est. Water Depth:** 55.5 ft




CPT REPORT - STANDARD PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

Page 2 of 2

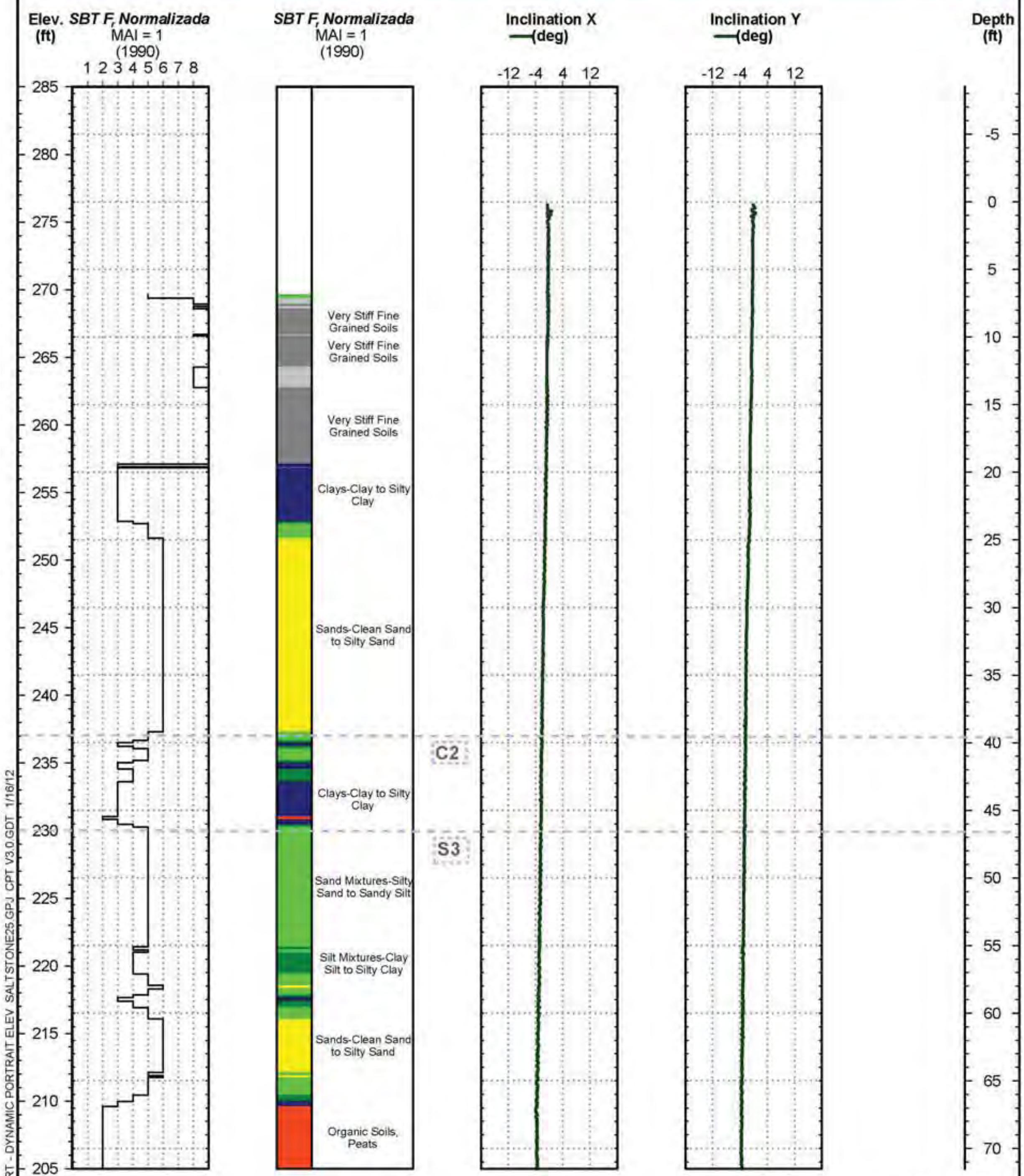
**Z-SDU6-C22**

*Electronic File Name: SC01N1102C.DAT*

LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

**Northing:** 77947.5
**Easting:** 66415.1
**Elevation:** 276.5
**Project No.:** R11S002 T10
**Date:** Nov. 1, 2011
**Test ID:** Z-SDU6-C22
**Est. Water Depth:** 55.5 ft




**Z-SDU6-C22**

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Electronic File Name: SC01N1102C.DAT

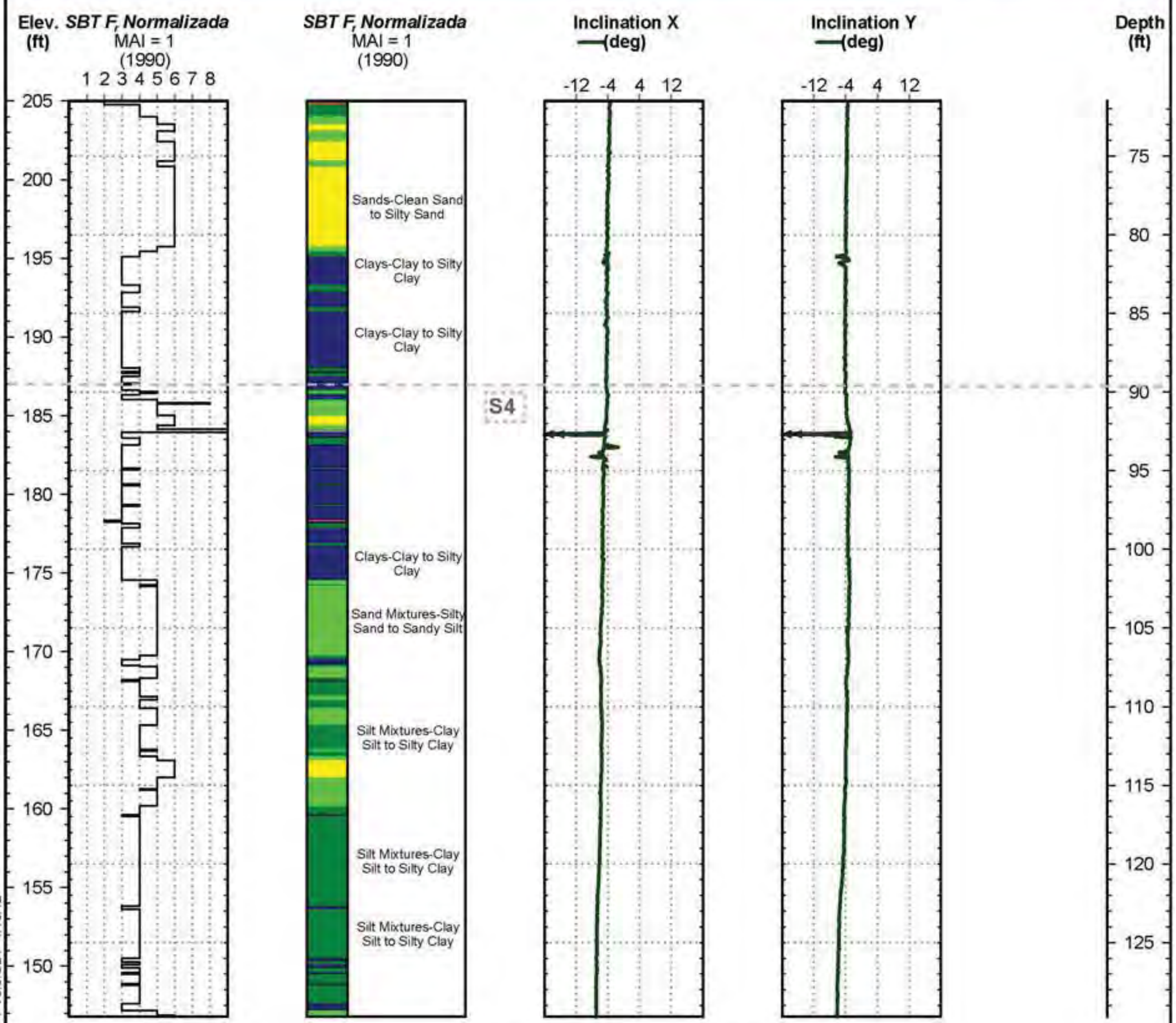
LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

**Northing:** 77947.5
**Easting:** 66415.1
**Elevation:** 276.5

**Date:** Nov. 1, 2011
**Test ID:** Z-SDU6-C22
**Est. Water Depth:** 55.5 ft

**Project No.:** R11S002 T10




CPT REPORT - DYNAMIC PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

*Page 2 of 2*

**Z-SDU6-C22**
*Electronic File Name: SC01N1102C.DAT*

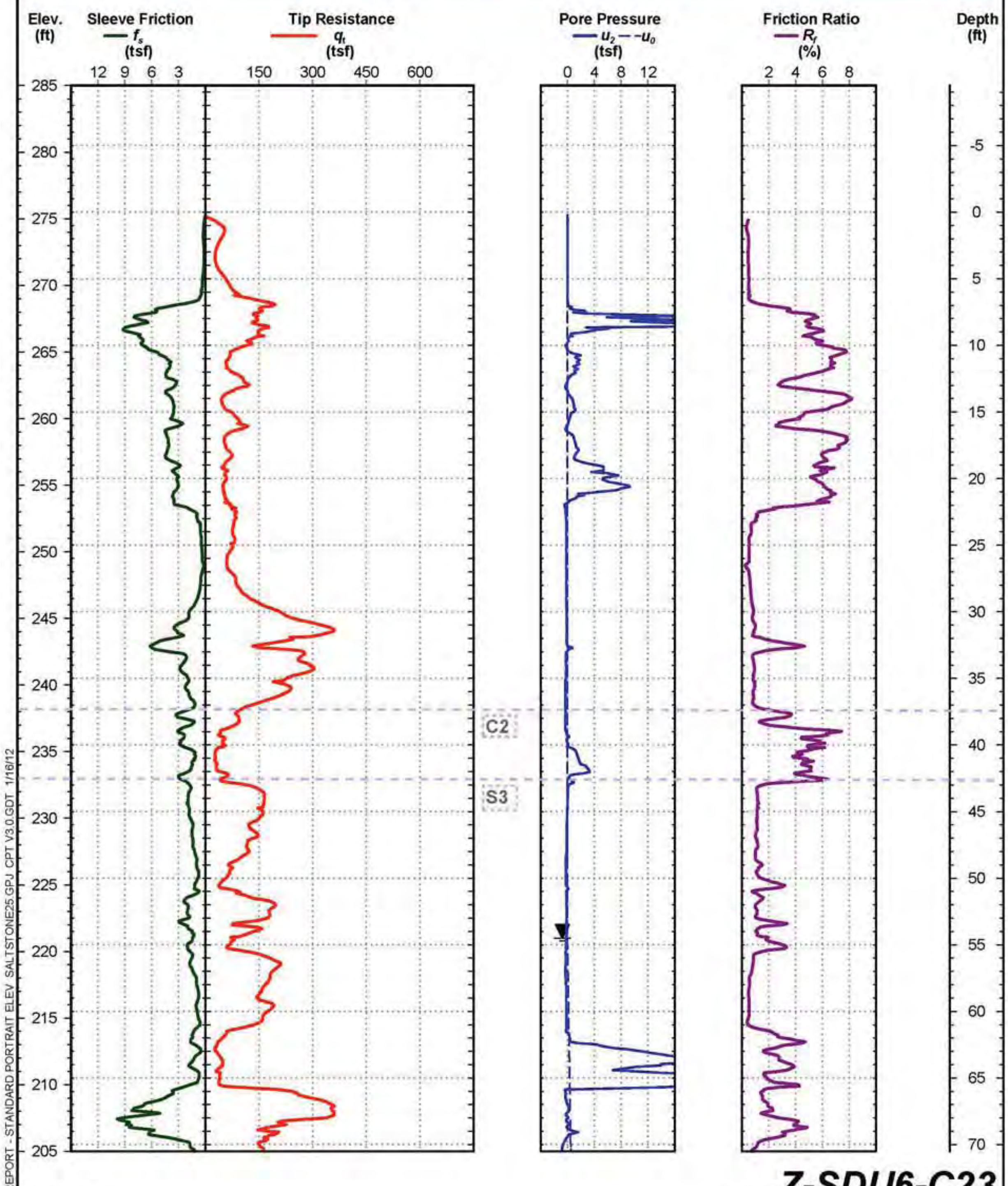
LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

**Project No.:** R11S002 T10

**Northing:** 77967.7
**Easting:** 66482.5
**Elevation:** 275.5

**Date:** Nov. 1, 2011
**Test ID:** Z-SDU6-C23
**Est. Water Depth:** 54.5 ft




Page 1 of 2

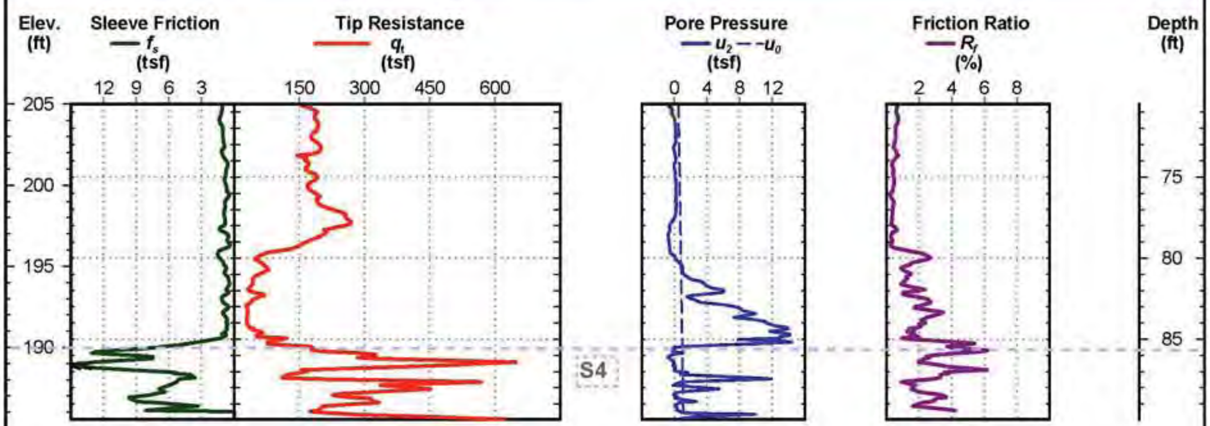
**Z-SDU6-C23**

*Electronic File Name: SC01N1103C.DAT*

LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

**Project No.:** R11S002 T10
**Northing:** 77967.7
**Easting:** 66482.5
**Elevation:** 275.5
**Date:** Nov. 1, 2011
**Test ID:** Z-SDU6-C23
**Est. Water Depth:** 54.5 ft




CPT REPORT - STANDARD PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

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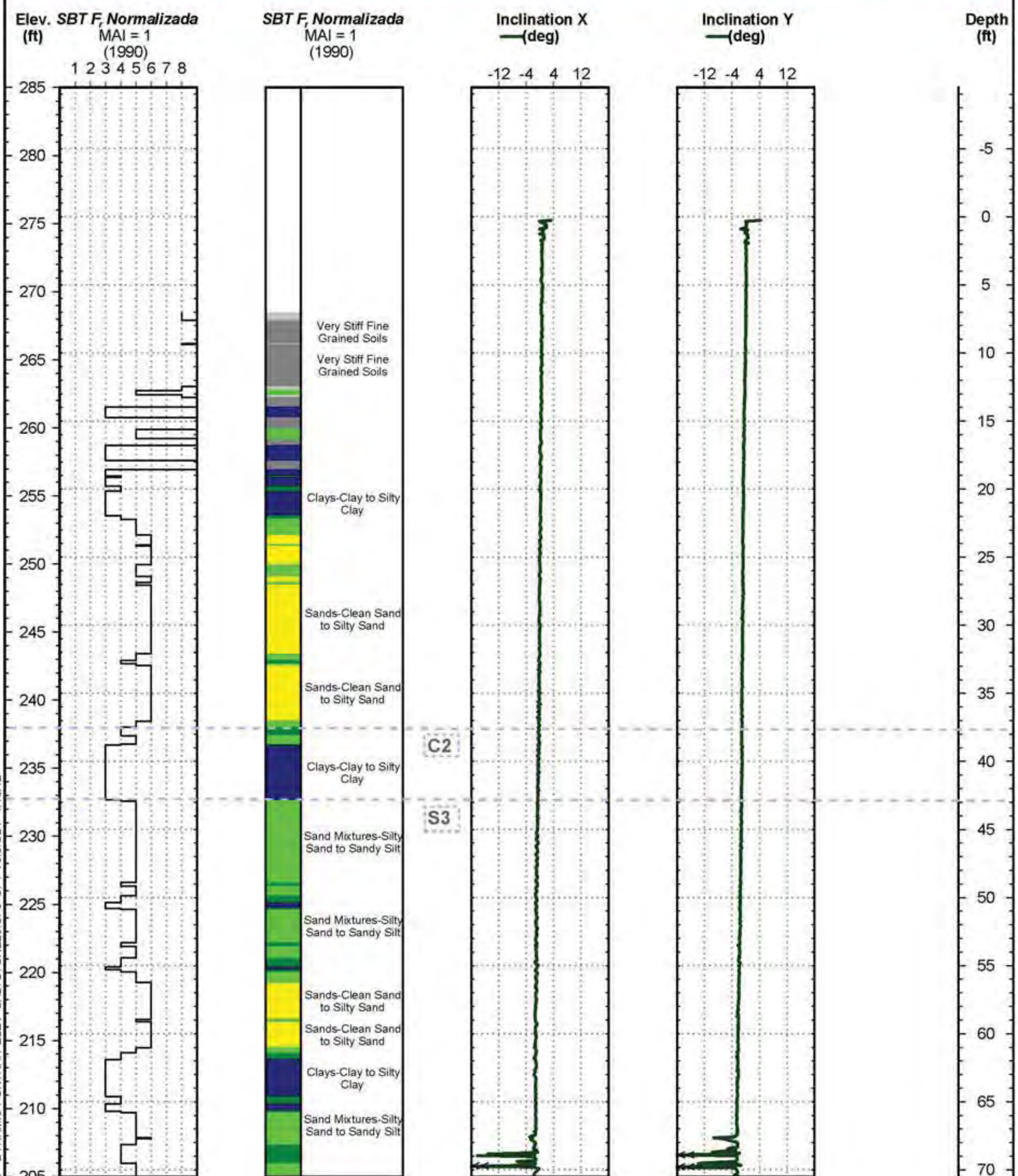
**Z-SDU6-C23**
Electronic File Name: SC01N1103C.DAT

LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

**Project No.:** R11S002 T10
**Northing:** 77967.7
**Easting:** 66482.5
**Elevation:** 275.5
**Date:** Nov. 1, 2011
**Test ID:** Z-SDU6-C23
**Est. Water Depth:** 54.5 ft




CPT REPORT - DYNAMIC PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

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**Z-SDU6-C23**

*Electronic File Name: SC01N1103C.DAT*

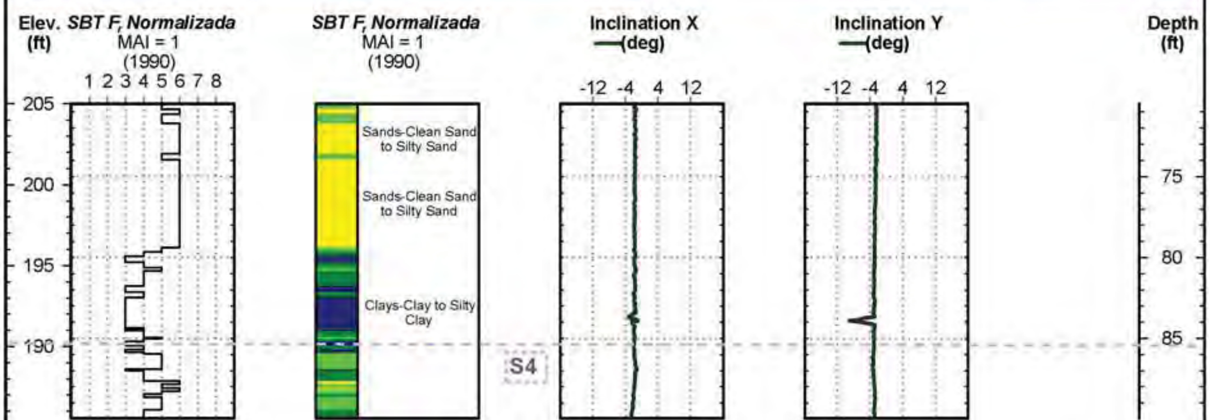
LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**

**Northing:** 77967.7
**Easting:** 66482.5
**Elevation:** 275.5

**Date:** Nov. 1, 2011
**Test ID:** Z-SDU6-C23
**Est. Water Depth:** 54.5 ft

**Project No.:** R11S002 T10




CPT REPORT - DYNAMIC PORTRAIT ELEV SALTSTONE25.GPJ CPT V3.0.GDT 1/16/12

*Page 2 of 2*

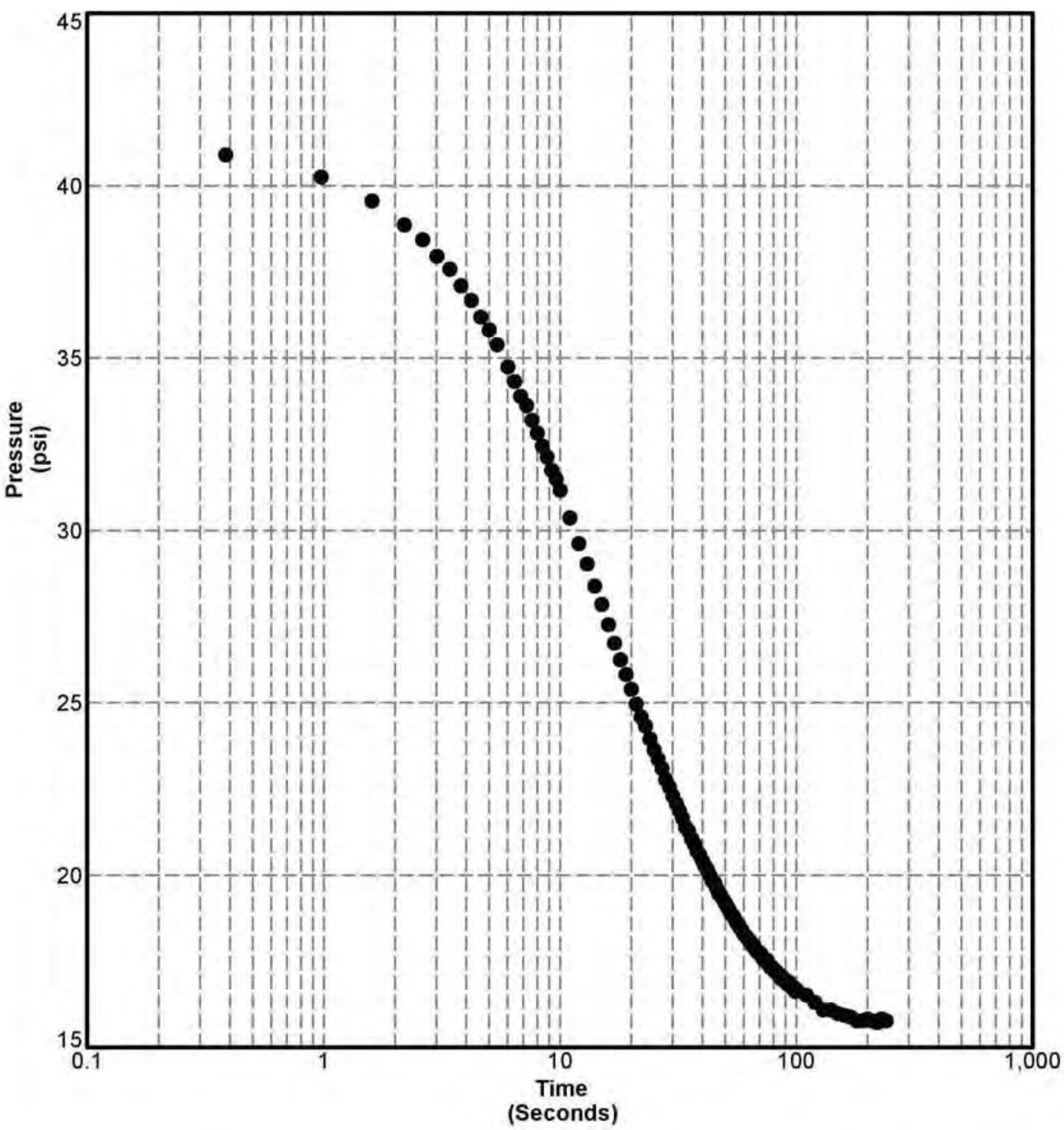
**Z-SDU6-C23**
*Electronic File Name: SC01N1103C.DAT*

LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**
Project No. :R11S002 T10

# Pore Pressure Dissipation:

**Date:** Nov. 9, 2011
**Estimated Water Depth:** 60.5 ft
**Rig/Operator:** JAH | NS
**Northing:** 77413.3
**Easting:** 66270.1
**Elevation:** 281.9
**Total Depth:** 98.7 ft
**Termination Criteria:**
**Test Depth:** 97.0 ft

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**Z-SDU6-C01**

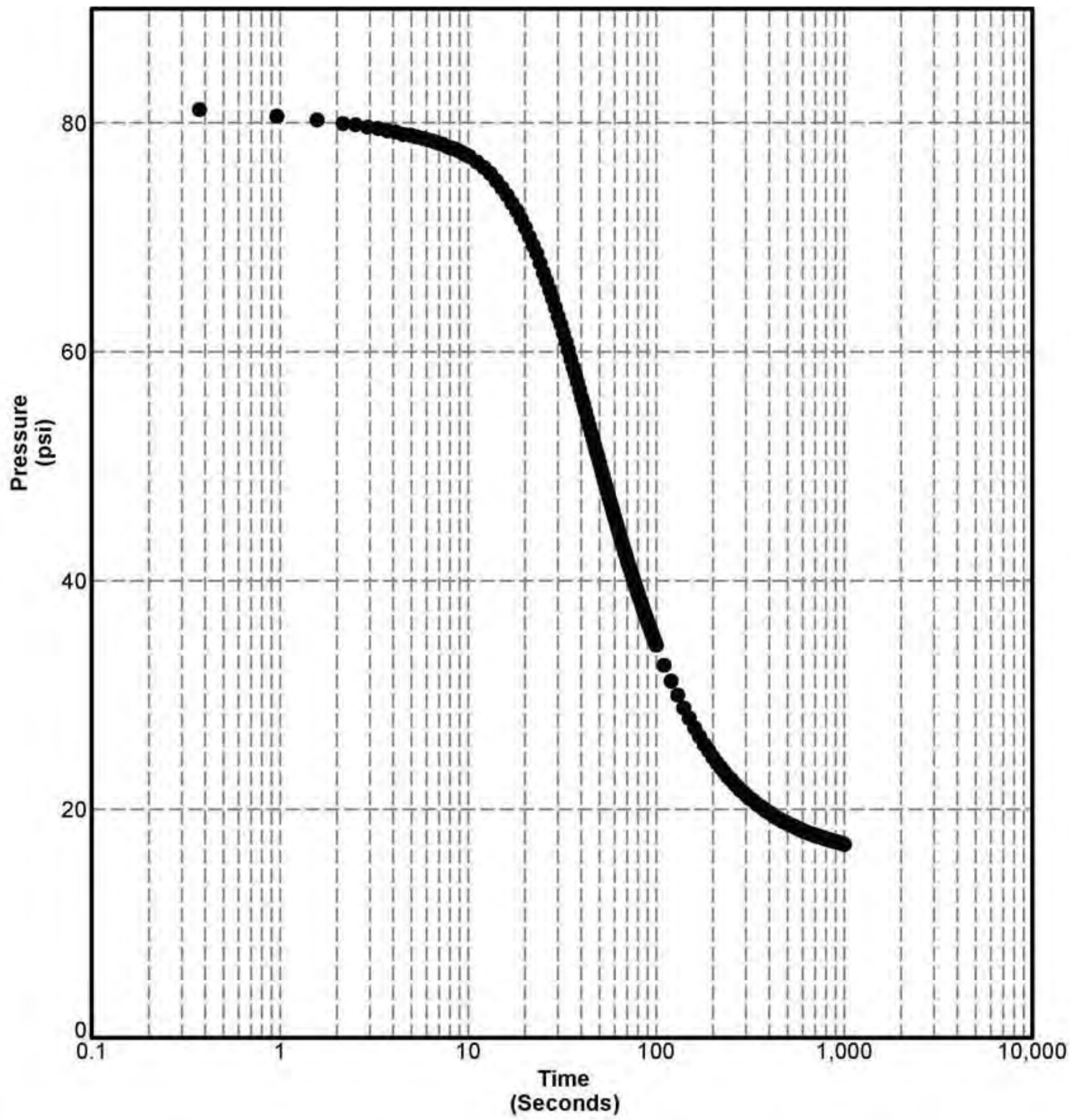
Electronic File Name: sc09n1102d.97

LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**
Project No. :R11S002 T10

# Pore Pressure Dissipation:

**Date:** Nov. 9, 2011
**Estimated Water Depth:** 60 ft
**Rig/Operator:** JAH | NS
**Northing:** 77448.1
**Easting:** 66350.4
**Elevation:** 281.4
**Total Depth:** 97.1 ft
**Termination Criteria:**
**Test Depth:** 96.8 ft




**Z-SDU6-C02**

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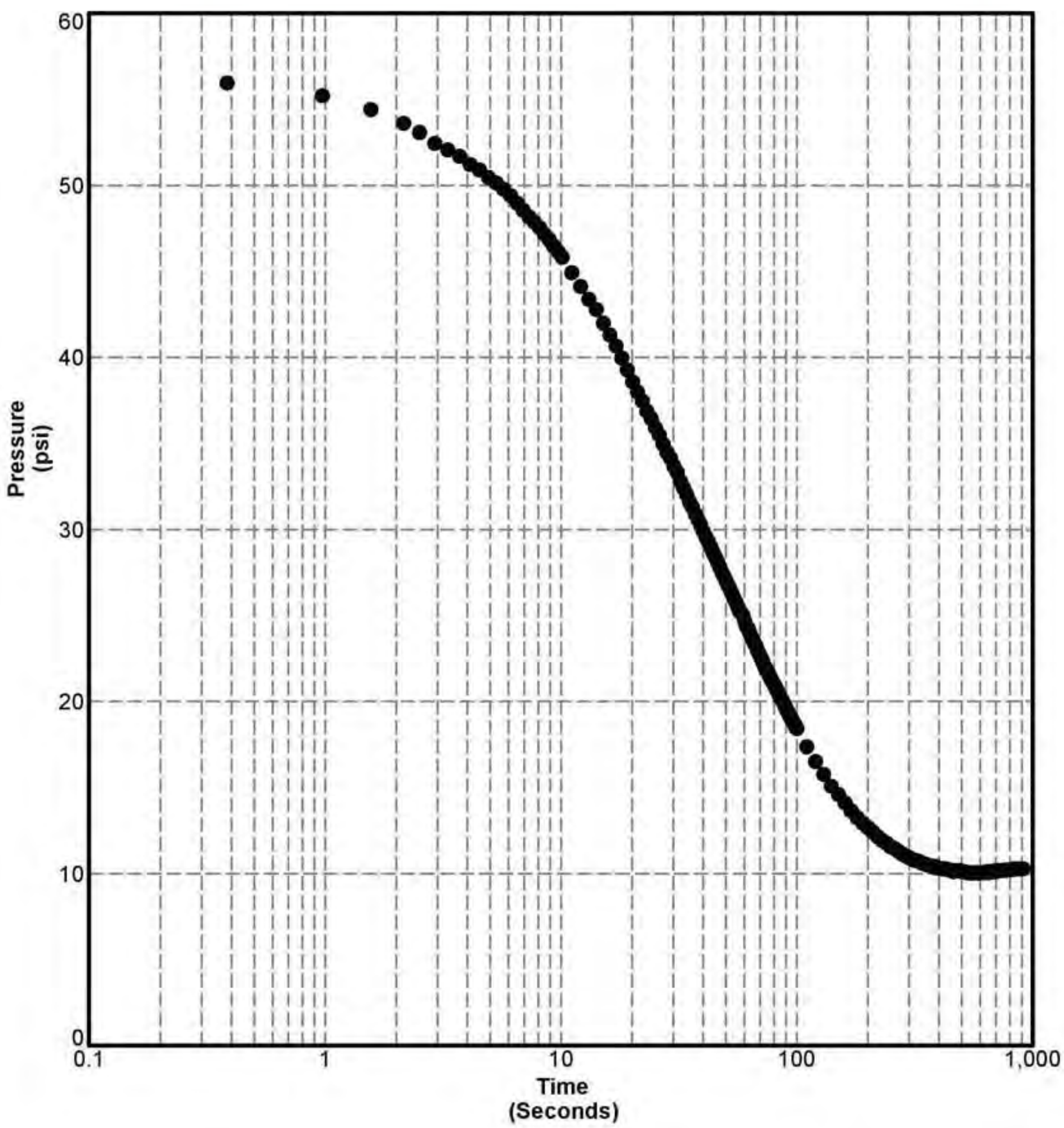
Electronic File Name: sc09n1101d.97

LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**
Project No. :R11S002 T10

# Pore Pressure Dissipation:

**Date:** Nov. 8, 2011
**Estimated Water Depth:** 62.5 ft
**Rig/Operator:** JAH | NS
**Northing:** 77478.3
**Easting:** 66494.3
**Elevation:** 281.6
**Total Depth:** 102.3 ft
**Termination Criteria:**
**Test Depth:** 88.5 ft




**Z-SDU6-C03**

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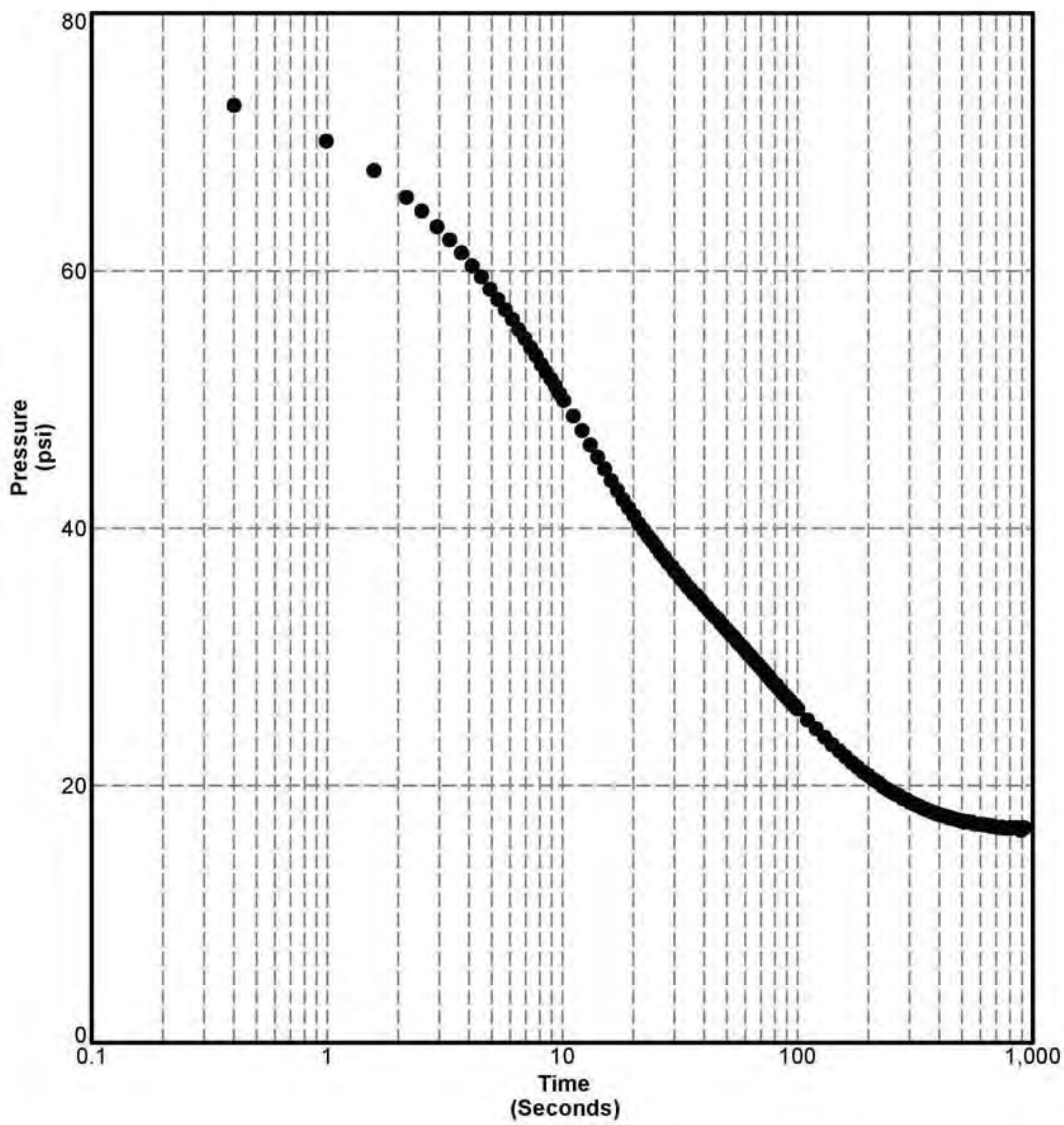
*Electronic File Name: sc08n1101d.88*

LANKELMA

Saltstone SDU 6 Investigation
Z- Area (Aiken,South Carolina)
Project No. :R11S002 T10

# Pore Pressure Dissipation:

| | | | | | |
|---|---|---|---|---|---|
| Date: | Nov. 8, 2011 | Northing: | 77478.3 | Total Depth: | 102.3 ft |
| Estimated Water Depth: | 62.5 ft | Easting: | 66494.3 | Termination Criteria: | |
| Rig/Operator: | JAH \| NS | Elevation: | 281.6 | Test Depth: | 101.3 ft |




Z-SDU6-C03

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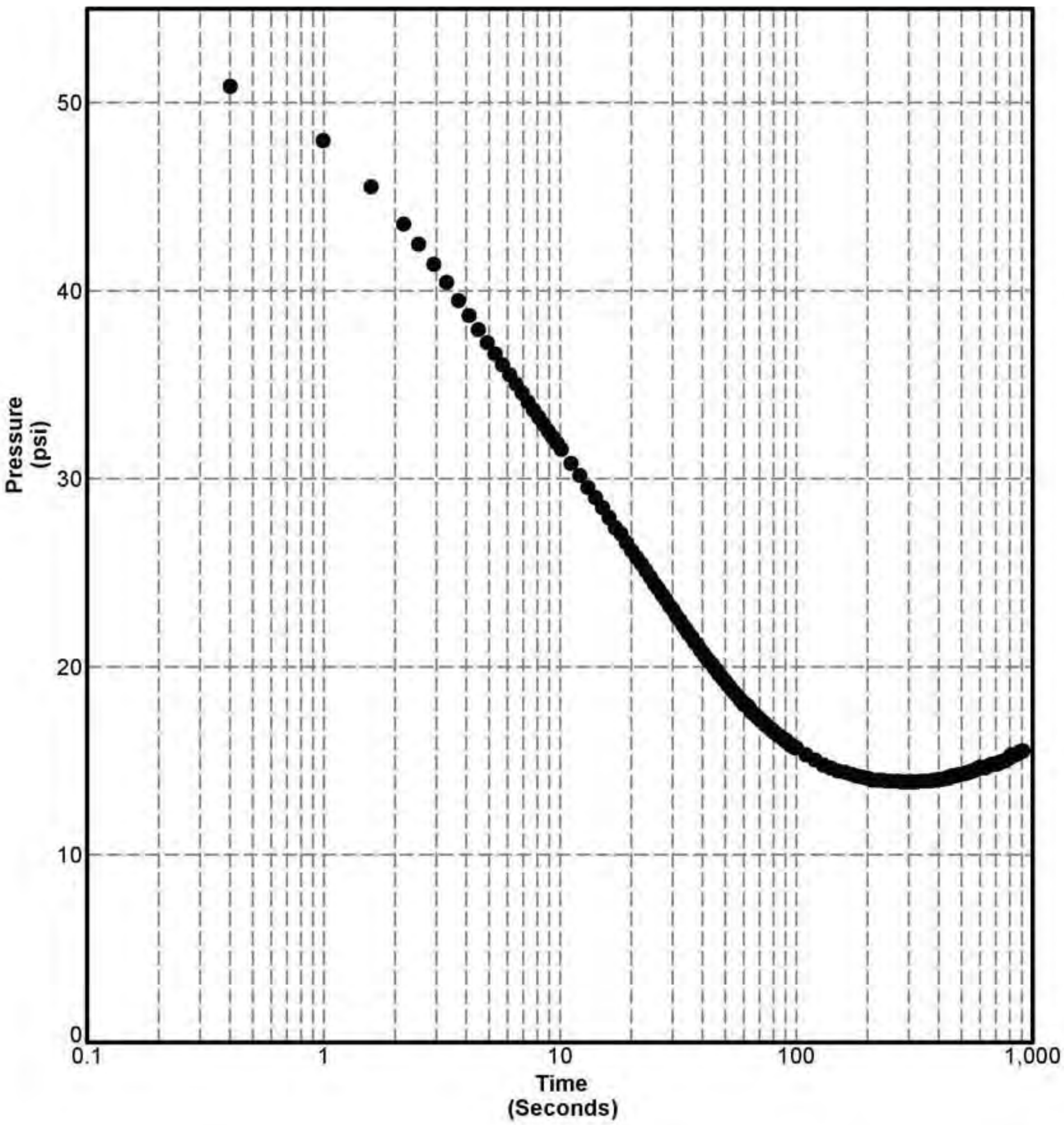
Electronic File Name: sc08n1101d.101

LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**
Project No. :R11S002 T10

# Pore Pressure Dissipation:

**Date:** Nov. 7, 2011
**Estimated Water Depth:** 59 ft
**Rig/Operator:** JAH | NS
**Northing:** 77503.3
**Easting:** 66578.8
**Elevation:** 281.8
**Total Depth:** 97.5 ft
**Termination Criteria:**
**Test Depth:** 93.4 ft

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**Z-SDU6-C04**

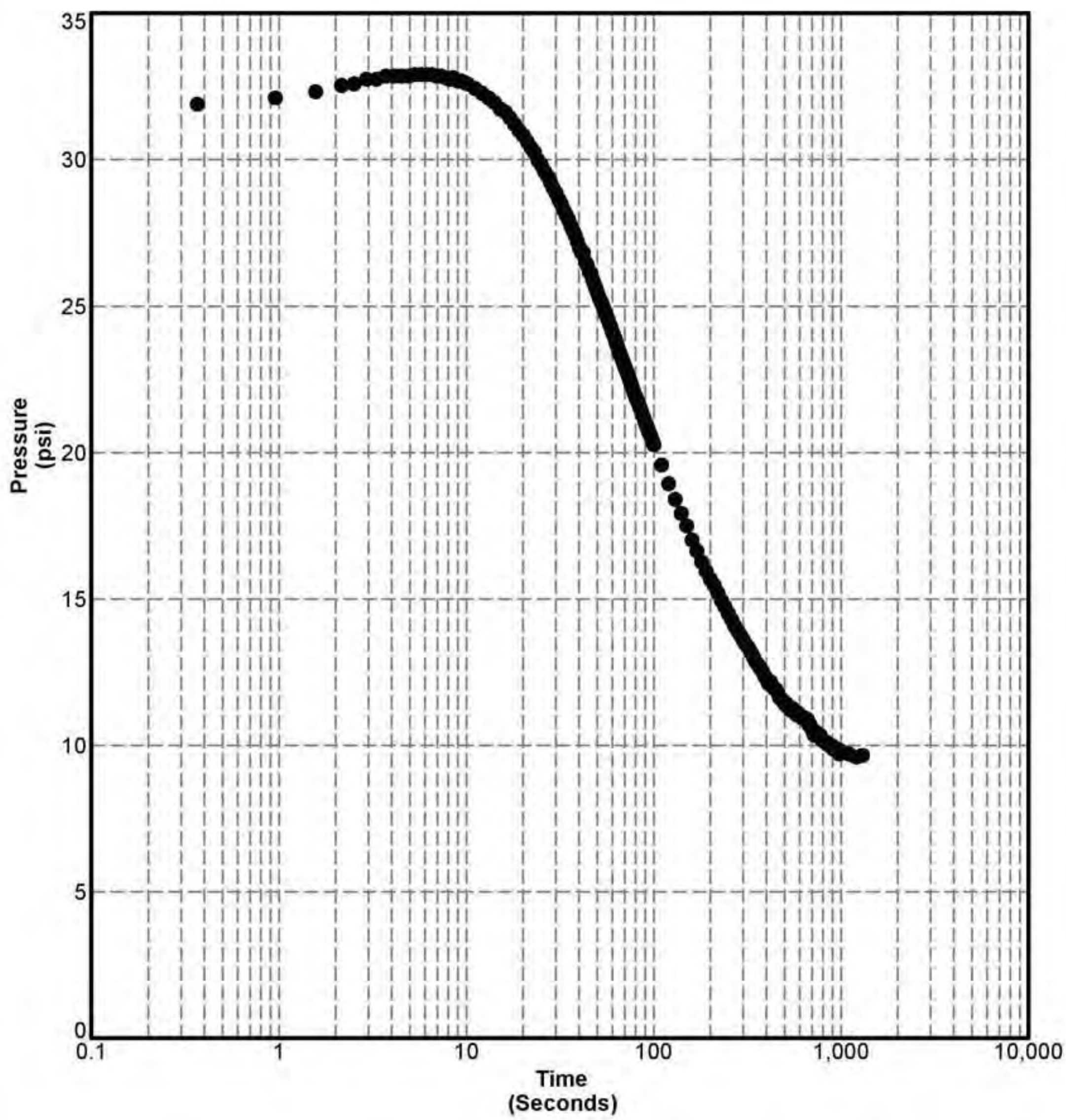
*Electronic File Name: sc07n1102d.93*

LANKELMA

Saltstone SDU 6 Investigation
Z- Area (Aiken,South Carolina)
Project No. :R11S002 T10

# Pore Pressure Dissipation:

**Date:** Nov. 7, 2011
**Estimated Water Depth:** 52 ft
**Rig/Operator:** JAH | NS
**Northing:** 77624.5
**Easting:** 66594.9
**Elevation:** 278.1
**Total Depth:** 97.0 ft
**Termination Criteria:**
**Test Depth:** 50.4 ft

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**Z-SDU6-C05**

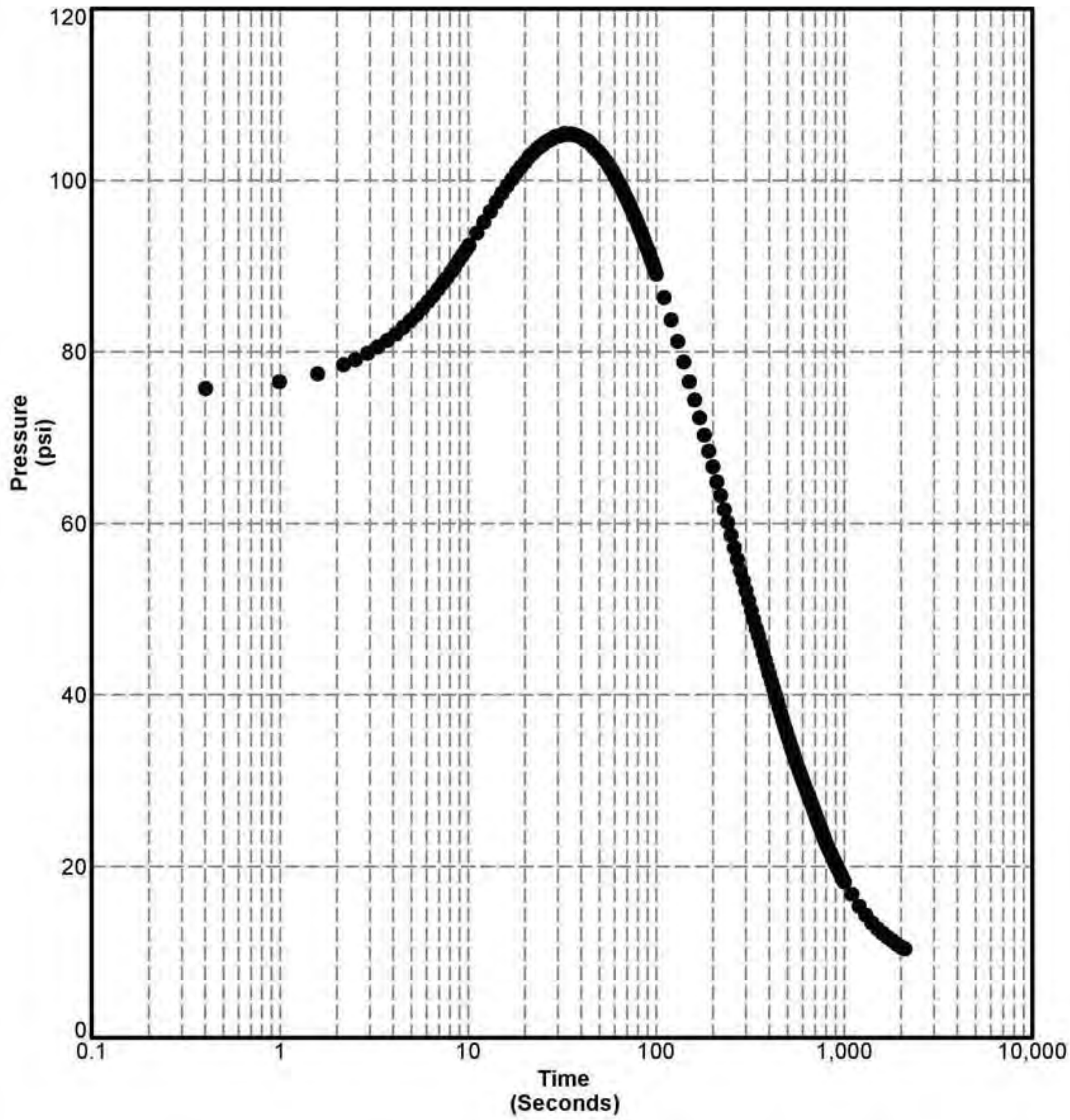
*Electronic File Name: sc07n1101d.50*

LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**
Project No. :R11S002 T10

# Pore Pressure Dissipation:

**Date:** Nov. 7, 2011
**Estimated Water Depth:** 52 ft
**Rig/Operator:** JAH | NS
**Northing:** 77624.5
**Easting:** 66594.9
**Elevation:** 278.1
**Total Depth:** 97.0 ft
**Termination Criteria:**
**Test Depth:** 75.8 ft

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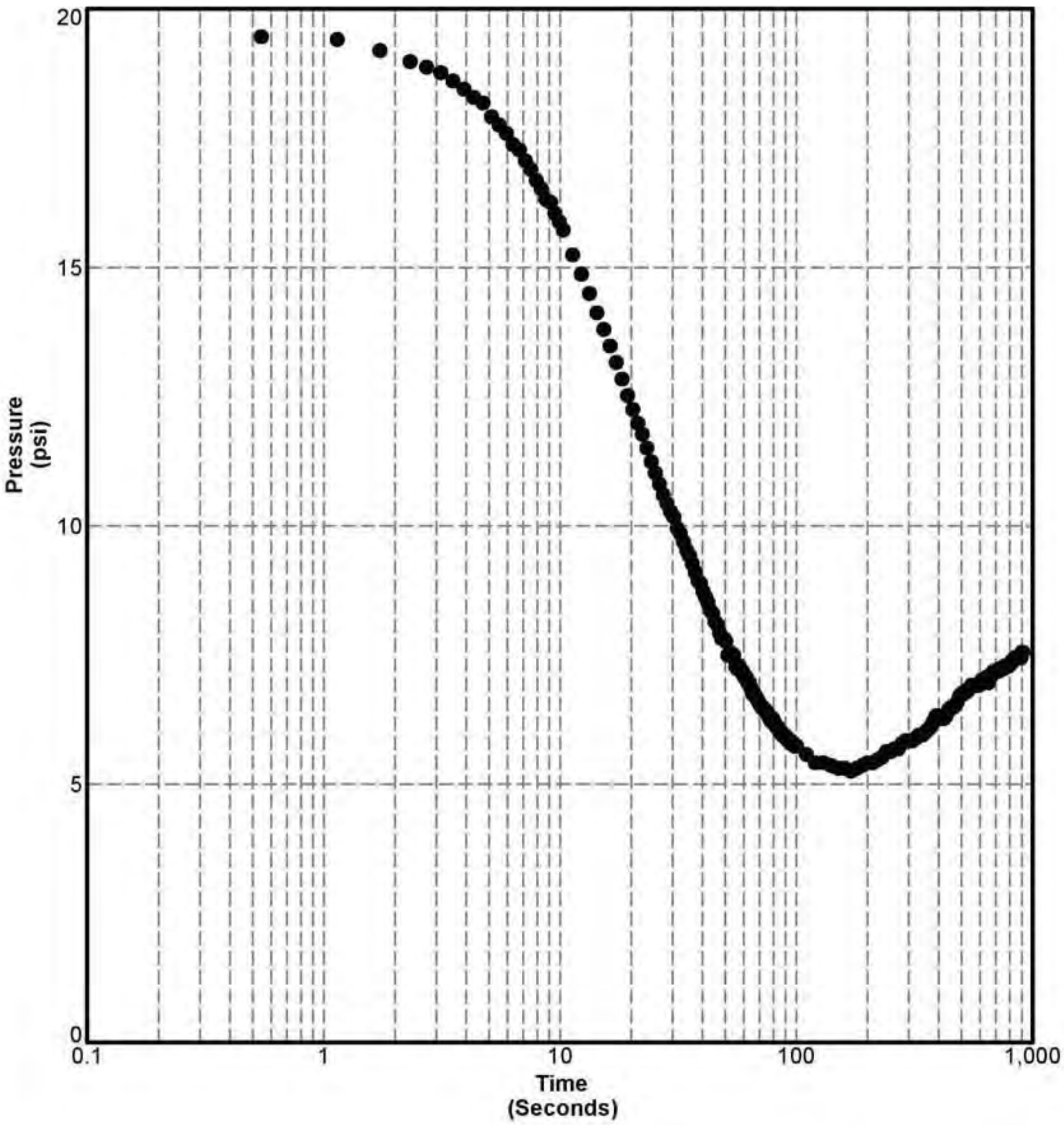
**Z-SDU6-C05**

*Electronic File Name: sc07n1101d.76*

Saltstone SDU 6 Investigation
Z- Area (Aiken,South Carolina)
Project No. :R11S002 T10

# Pore Pressure Dissipation:

| | | | | | |
|---|---|---|---|---|---|
| **Date:** | Nov. 4, 2011 | **Northing:** | 77587.6 | **Total Depth:** | 97.0 ft |
| **Estimated Water Depth:** | 59.5 ft | **Easting:** | 66472.8 | **Termination Criteria:** | |
| **Rig/Operator:** | JAH \| NS | **Elevation:** | 278.6 | **Test Depth:** | 74.9 ft |




**Z-SDU6-C06**

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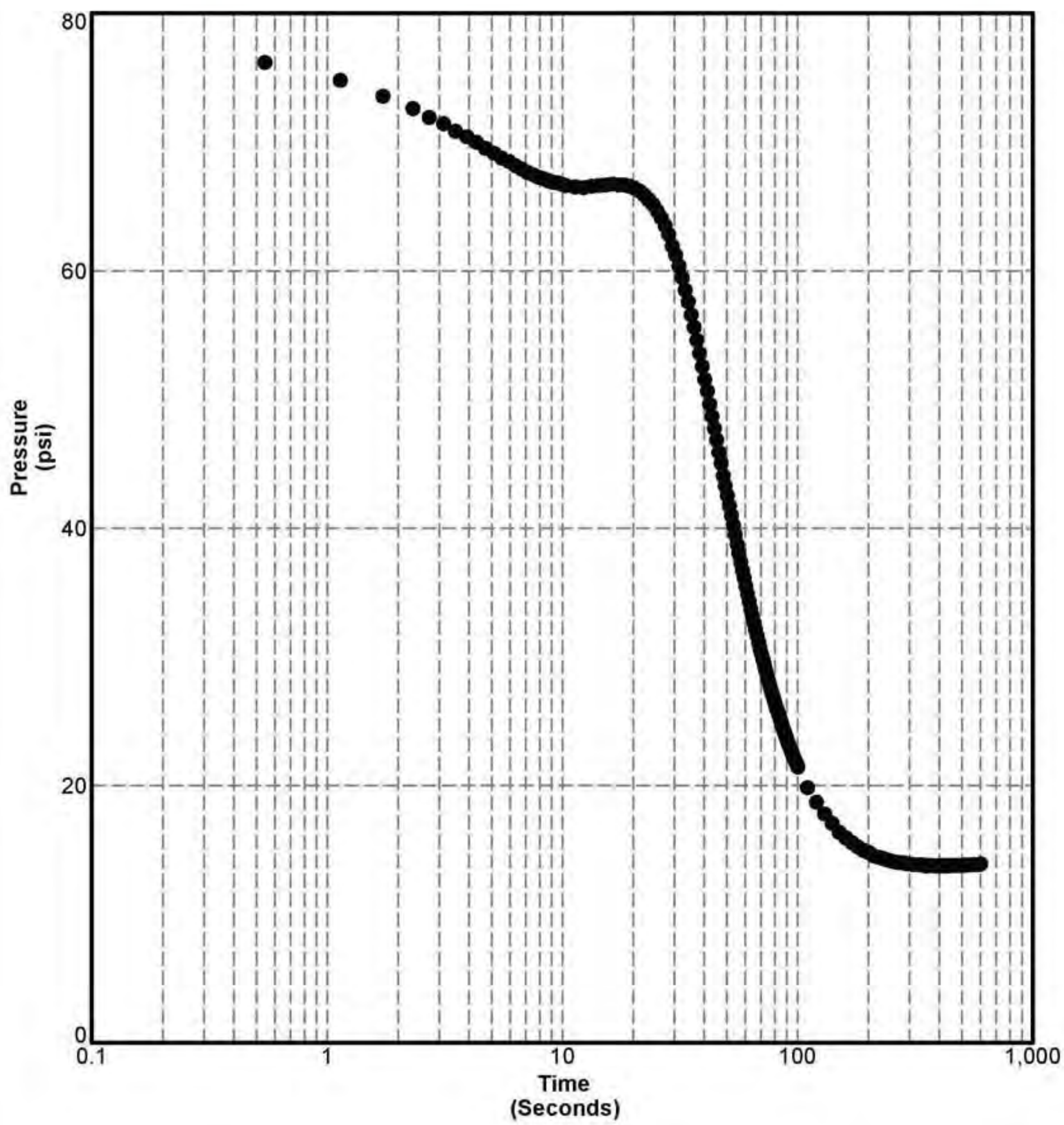
Electronic File Name: sc04n1103d.75

LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**
Project No. :R11S002 T10

# Pore Pressure Dissipation:

**Date:** Nov. 4, 2011
**Estimated Water Depth:** 59.5 ft
**Rig/Operator:** JAH | NS
**Northing:** 77587.6
**Easting:** 66472.8
**Elevation:** 278.6
**Total Depth:** 97.0 ft
**Termination Criteria:**
**Test Depth:** 91.5 ft

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**Z-SDU6-C06**

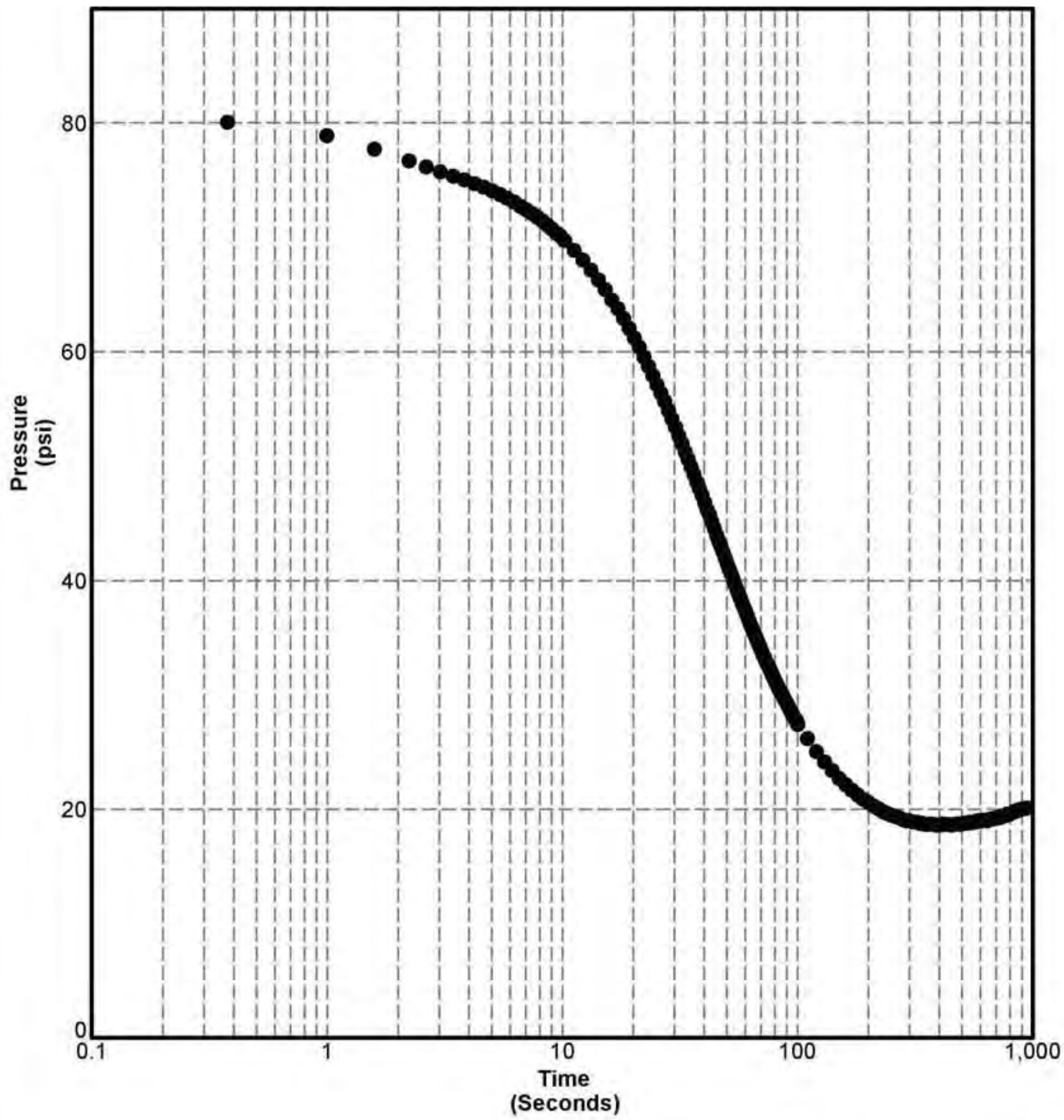
*Electronic File Name: sc04n1103d.92*

LANKELMA

Saltstone SDU 6 Investigation
Z- Area (Aiken,South Carolina)
Project No. :R11S002 T10

# Pore Pressure Dissipation:

**Date:** Nov. 8, 2011
**Estimated Water Depth:** 59.5 ft
**Rig/Operator:** JAH | NS
**Northing:** 77546.9
**Easting:** 66357.1
**Elevation:** 279.4
**Total Depth:** 97.0 ft
**Termination Criteria:**
**Test Depth:** 92.8 ft

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**Z-SDU6-C07**

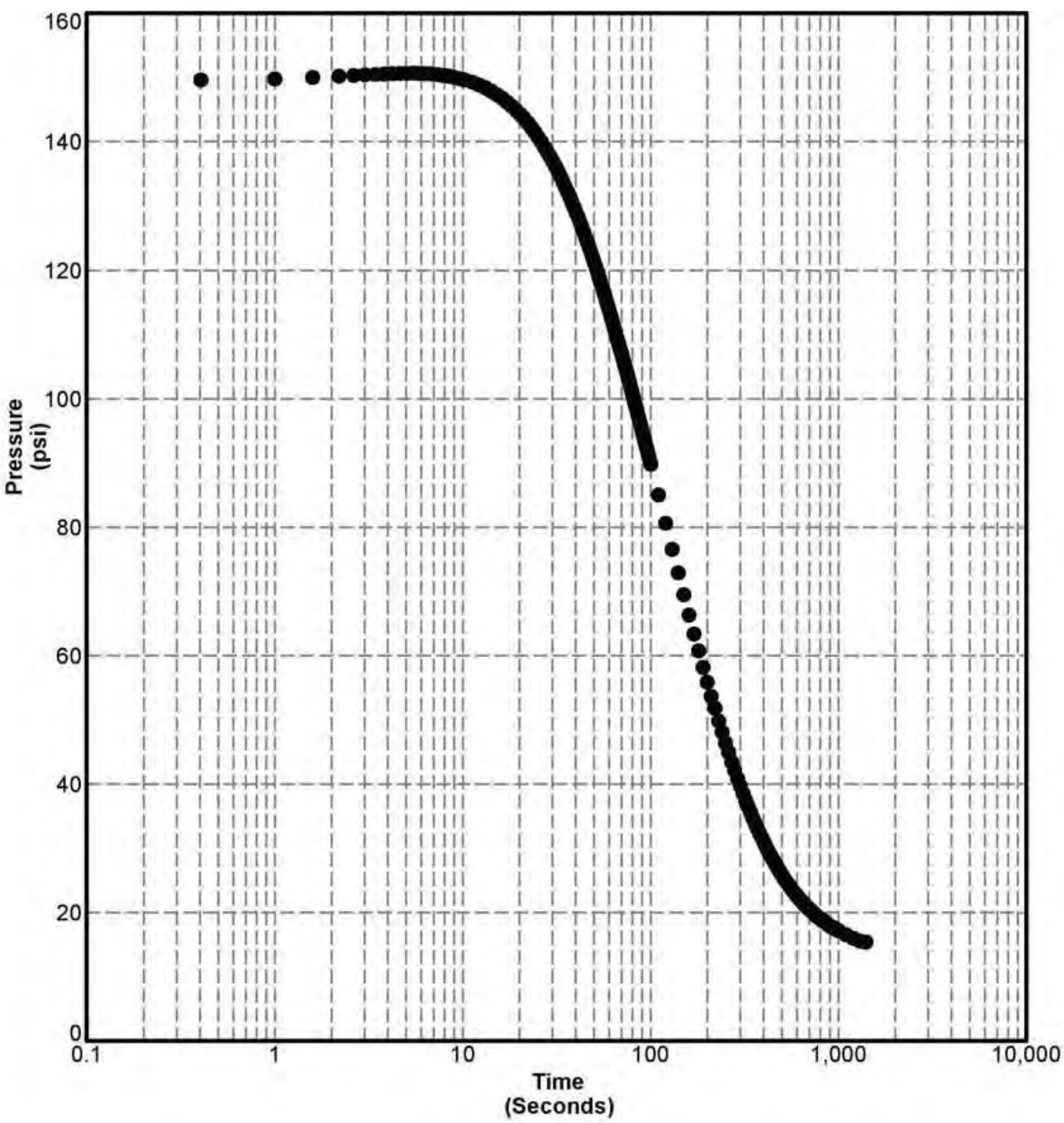
Electronic File Name: sc08n1102d.93

LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**
Project No. :R11S002 T10

# Pore Pressure Dissipation:

**Date:** Nov. 8, 2011
**Estimated Water Depth:** 59.5 ft
**Rig/Operator:** JAH | NS
**Northing:** 77511.4
**Easting:** 66258.9
**Elevation:** 279.7
**Total Depth:** 97.9 ft
**Termination Criteria:**
**Test Depth:** 79.9 ft

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**Z-SDU6-C08**

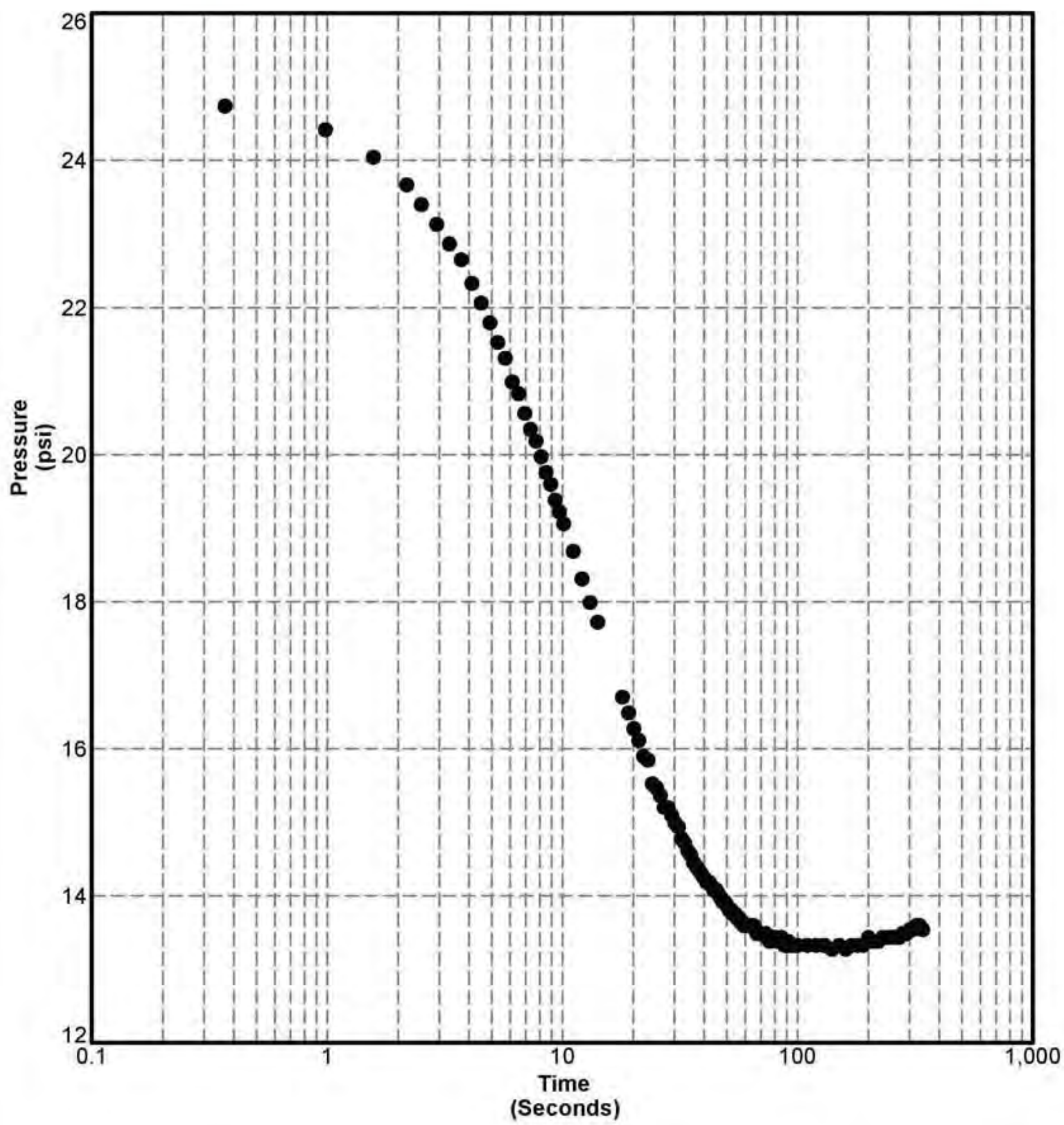
*Electronic File Name: sc08n1103d.80*

LANKELMA

Saltstone SDU 6 Investigation
Z- Area (Aiken,South Carolina)
Project No. :R11S002 T10

# Pore Pressure Dissipation:

**Date:** Nov. 8, 2011
**Estimated Water Depth:** 59.5 ft
**Rig/Operator:** JAH | NS
**Northing:** 77511.4
**Easting:** 66258.9
**Elevation:** 279.7
**Total Depth:** 97.9 ft
**Termination Criteria:**
**Test Depth:** 90.2 ft

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**Z-SDU6-C08**

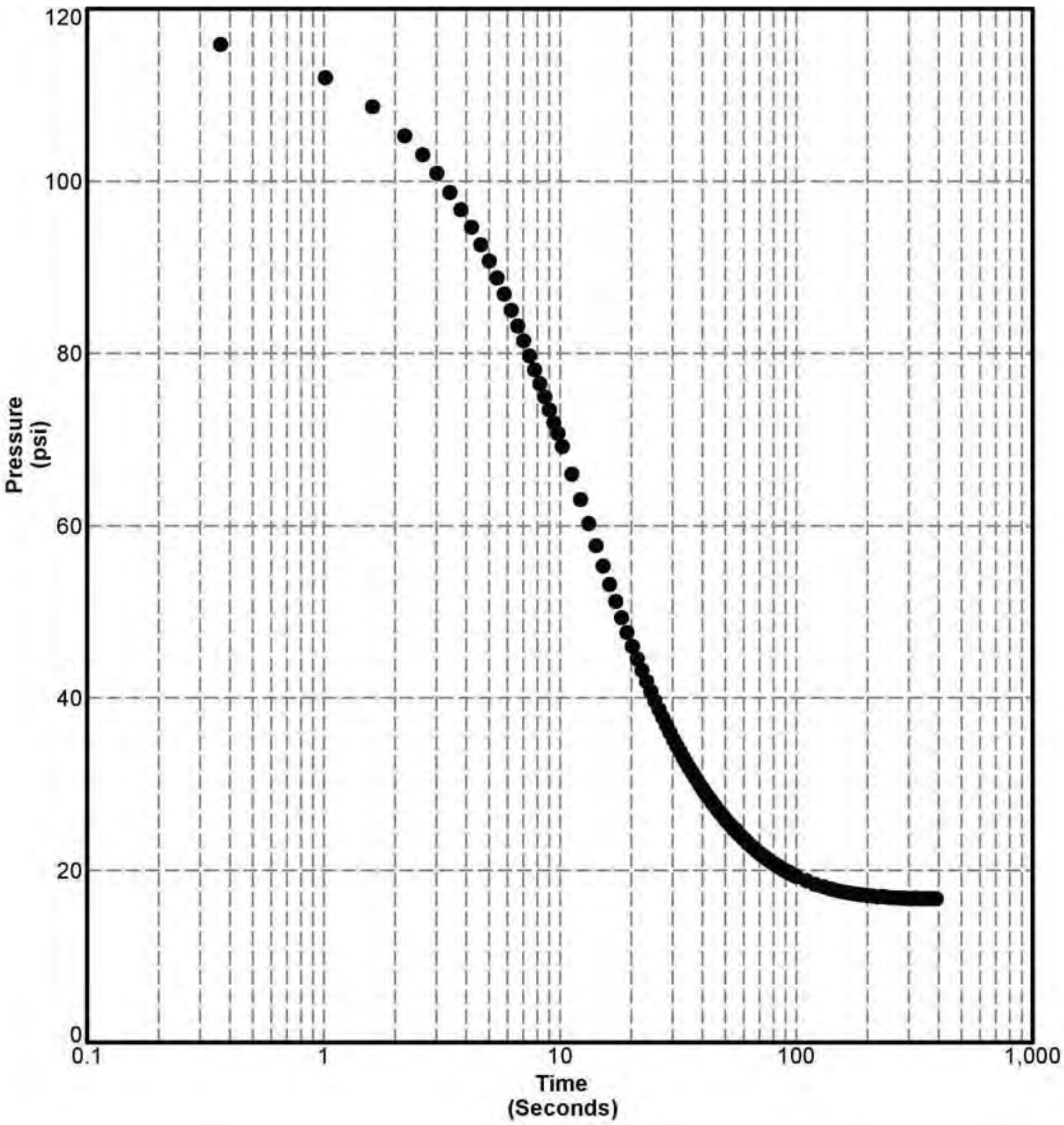
Electronic File Name: sc08n1103d.90

LANKELMA

Saltstone SDU 6 Investigation
Z- Area (Aiken,South Carolina)
Project No. :R11S002 T10

# Pore Pressure Dissipation:

**Date:** Nov. 8, 2011
**Estimated Water Depth:** 59.5 ft
**Rig/Operator:** JAH | NS
**Northing:** 77511.4
**Easting:** 66258.9
**Elevation:** 279.7
**Total Depth:** 97.9 ft
**Termination Criteria:**
**Test Depth:** 94.1 ft

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**Z-SDU6-C08**

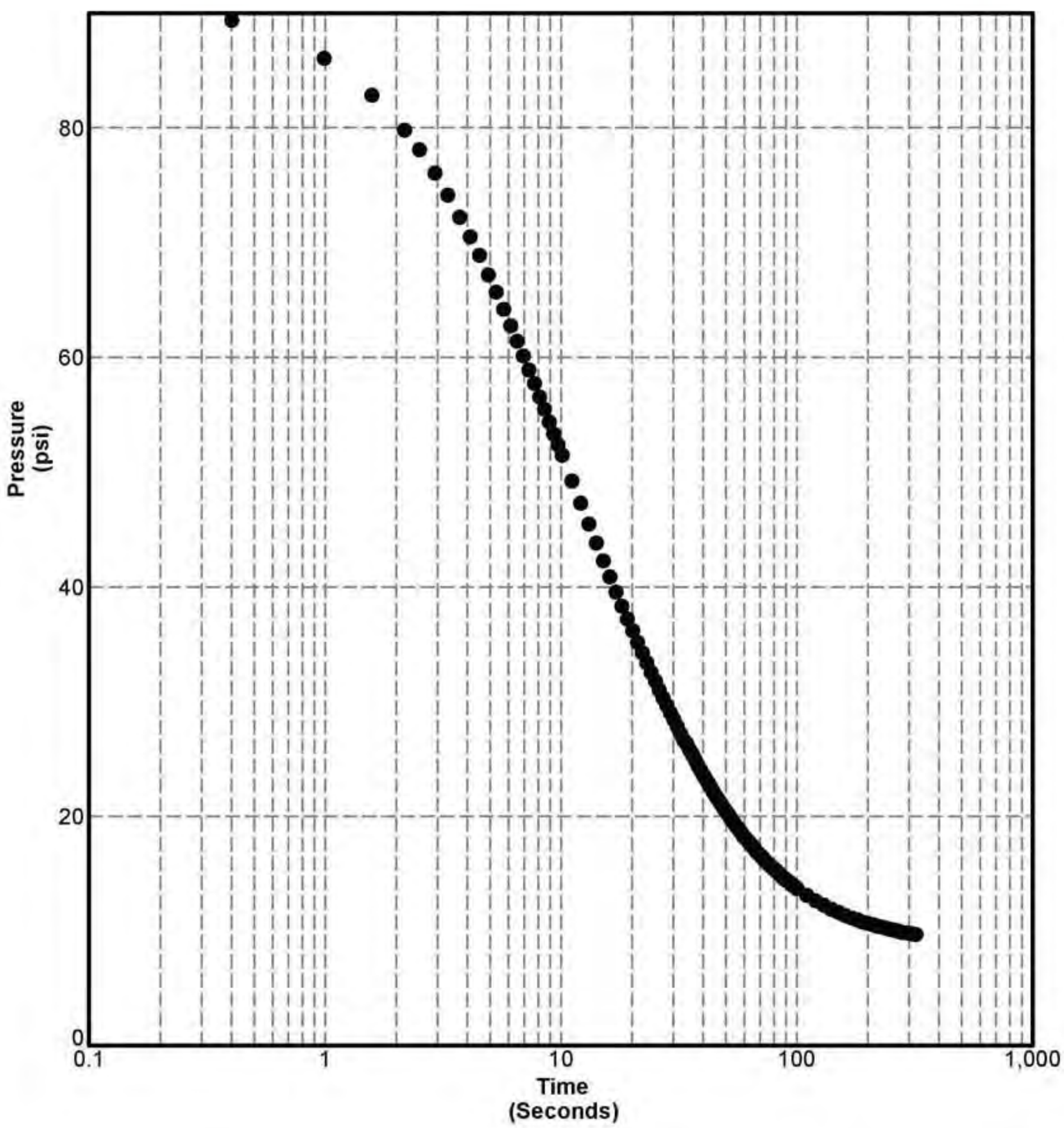
Electronic File Name: sc08n1103d.94

LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**
Project No. :R11S002 T10

# Pore Pressure Dissipation:

**Date:** Nov. 3, 2011
**Estimated Water Depth:** 54 ft
**Rig/Operator:** JAH | NS
**Northing:** 77621.8
**Easting:** 66210.4
**Elevation:** 278.3
**Total Depth:** 86.4 ft
**Termination Criteria:**
**Test Depth:** 76.4 ft




**Z-SDU6-C09**

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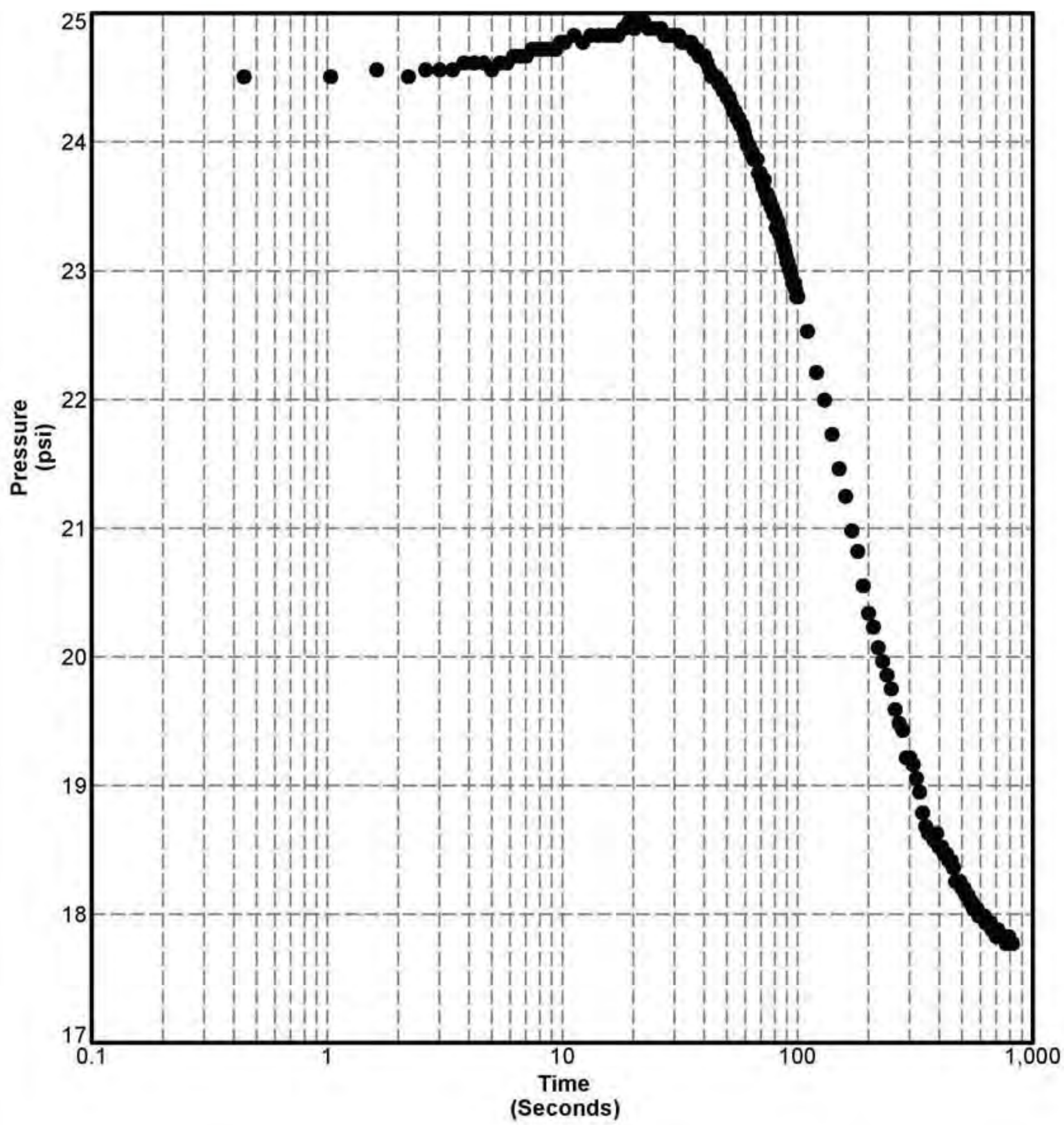
Electronic File Name: sc03n1102d.76

LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**
Project No. :R11S002 T10

# Pore Pressure Dissipation:

**Date:** Nov. 3, 2011
**Estimated Water Depth:** 53.5 ft
**Rig/Operator:** JAH | NS
**Northing:** 77644.2
**Easting:** 66285.6
**Elevation:** 278.0
**Total Depth:** 102.9 ft
**Termination Criteria:**
**Test Depth:** 94.7 ft




**Z-SDU6-C10**

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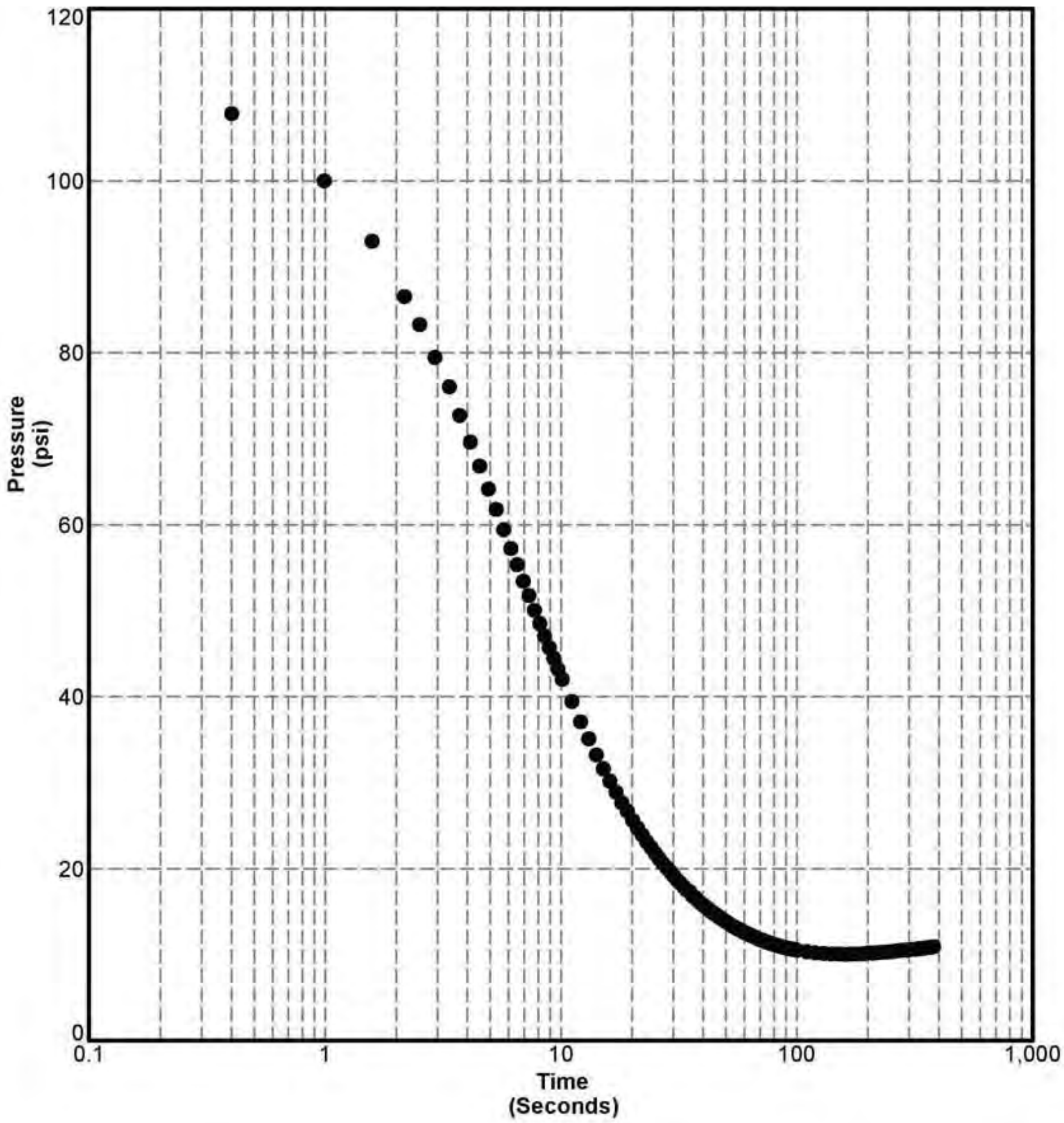
Electronic File Name: sc03n1103d.95

LANKELMA

Saltstone SDU 6 Investigation
Z- Area (Aiken,South Carolina)
Project No. :R11S002 T10

# Pore Pressure Dissipation:

**Date:** Nov. 3, 2011
**Estimated Water Depth:** 59 ft
**Rig/Operator:** JAH | NS
**Northing:** 77663.3
**Easting:** 66354.1
**Elevation:** 277.6
**Total Depth:** 97.0 ft
**Termination Criteria:**
**Test Depth:** 84.2 ft




**Z-SDU6-C11**

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*Electronic File Name: sc03n1104d.84*

LANKELMA

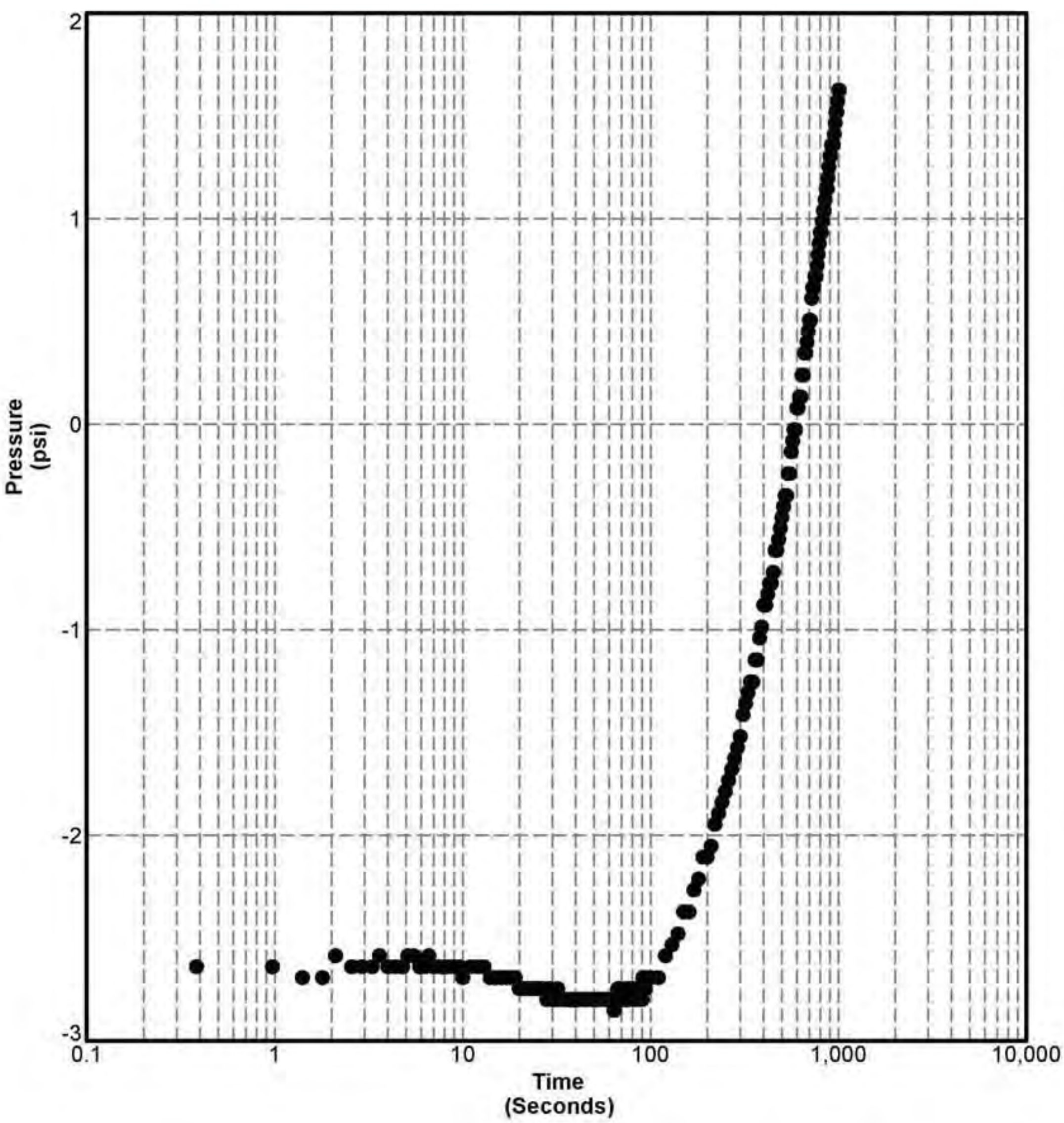
Saltstone SDU 6 Investigation
Z- Area (Aiken,South Carolina)
Project No. :R11S002 T10

# Pore Pressure Dissipation:

**Date:** Nov. 4, 2011
**Estimated Water Depth:** 56.5 ft
**Rig/Operator:** JAH | NS

**Northing:** 77682.6
**Easting:** 66452.6
**Elevation:** 277.7

**Total Depth:** 91.8 ft
**Termination Criteria:**
**Test Depth:** 91.9 ft




Z-SDU6-C12

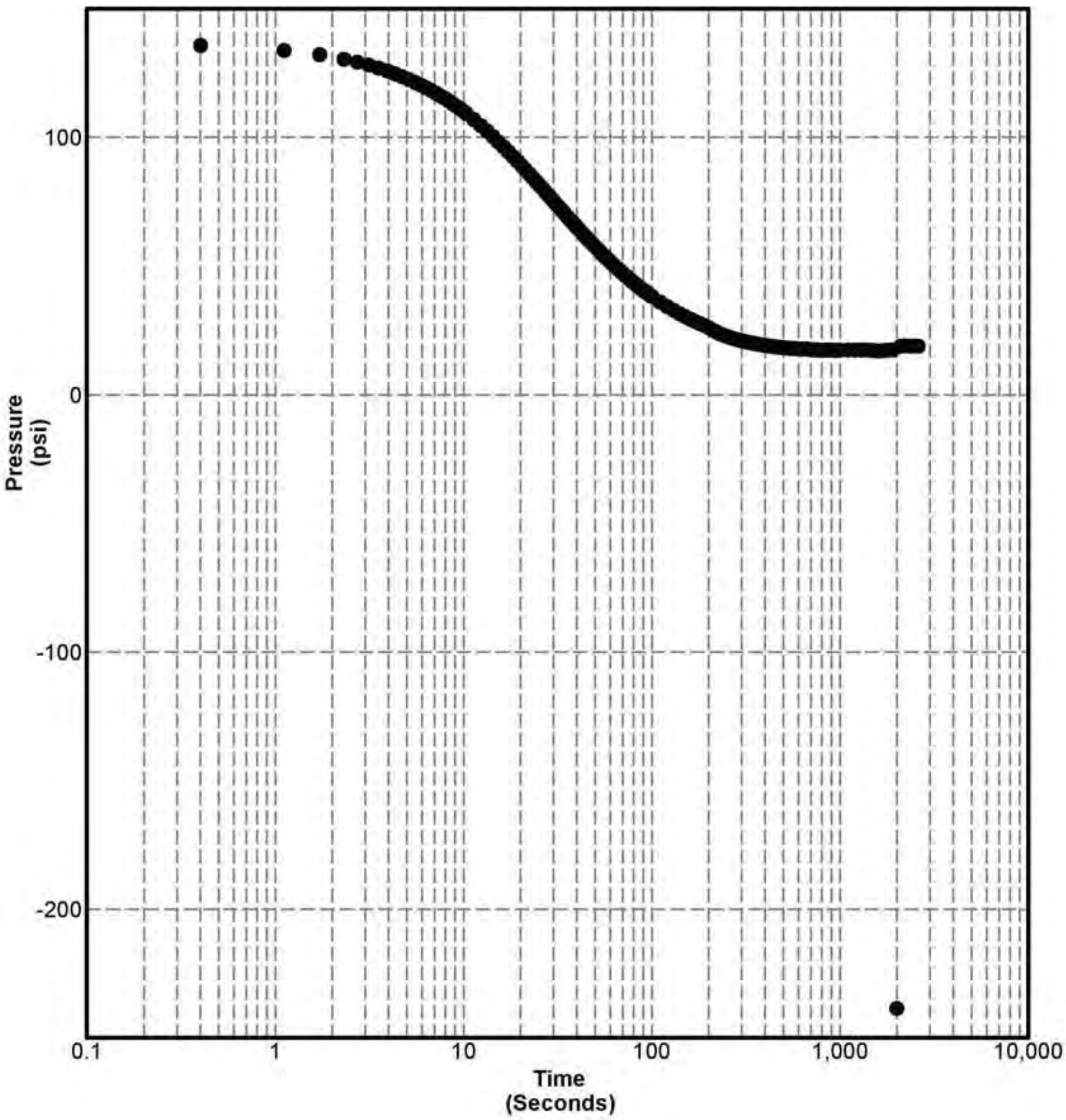
Electronic File Name: sc04n1102d.92

LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**
Project No. :R11S002 T10

# Pore Pressure Dissipation:

| | | | | | |
|---|---|---|---|---|---|
| **Date:** | Nov. 4, 2011 | **Northing:** | 77722.6 | **Total Depth:** | 92.5 ft |
| **Estimated Water Depth:** | 54.5 ft | **Easting:** | 66523.4 | **Termination Criteria:** | |
| **Rig/Operator:** | JAH \| NS | **Elevation:** | 276.3 | **Test Depth:** | 92.5 ft |




**Z-SDU6-C13**

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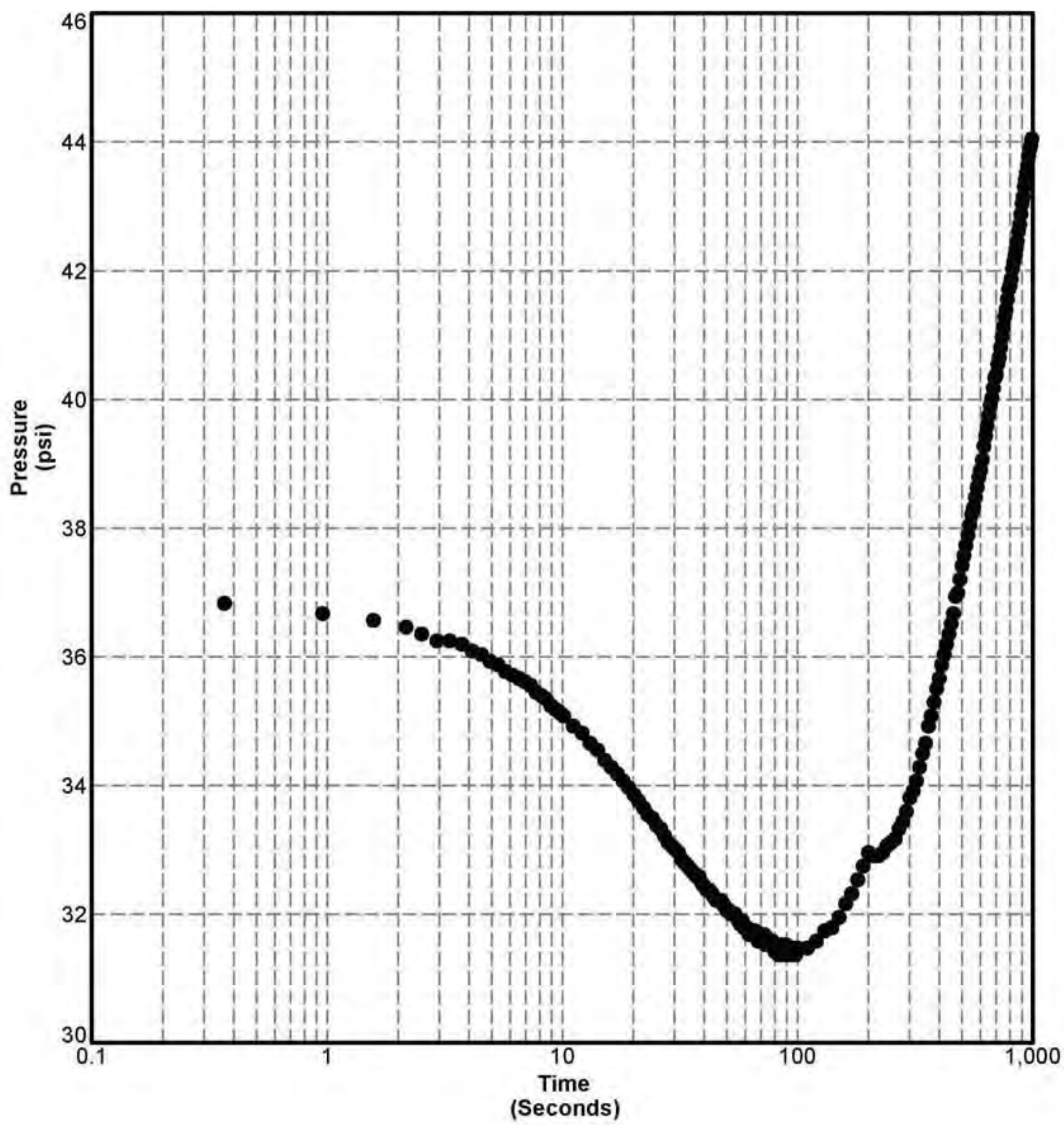
*Electronic File Name: sc04n1101d.92*

LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**
Project No. :R11S002 T10

# Pore Pressure Dissipation:

| | | | | | |
|---|---|---|---|---|---|
| **Date:** | Nov. 2, 2011 | **Northing:** | 77720.6 | **Total Depth:** | 98.8 ft |
| **Estimated Water Depth:** | 56.5 ft | **Easting:** | 66180.9 | **Termination Criteria:** | |
| **Rig/Operator:** | JAH \| NS | **Elevation:** | 277.3 | **Test Depth:** | 48.4 ft |




**Z-SDU6-C14**

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Electronic File Name: sc02n1101d.48

LANKELMA

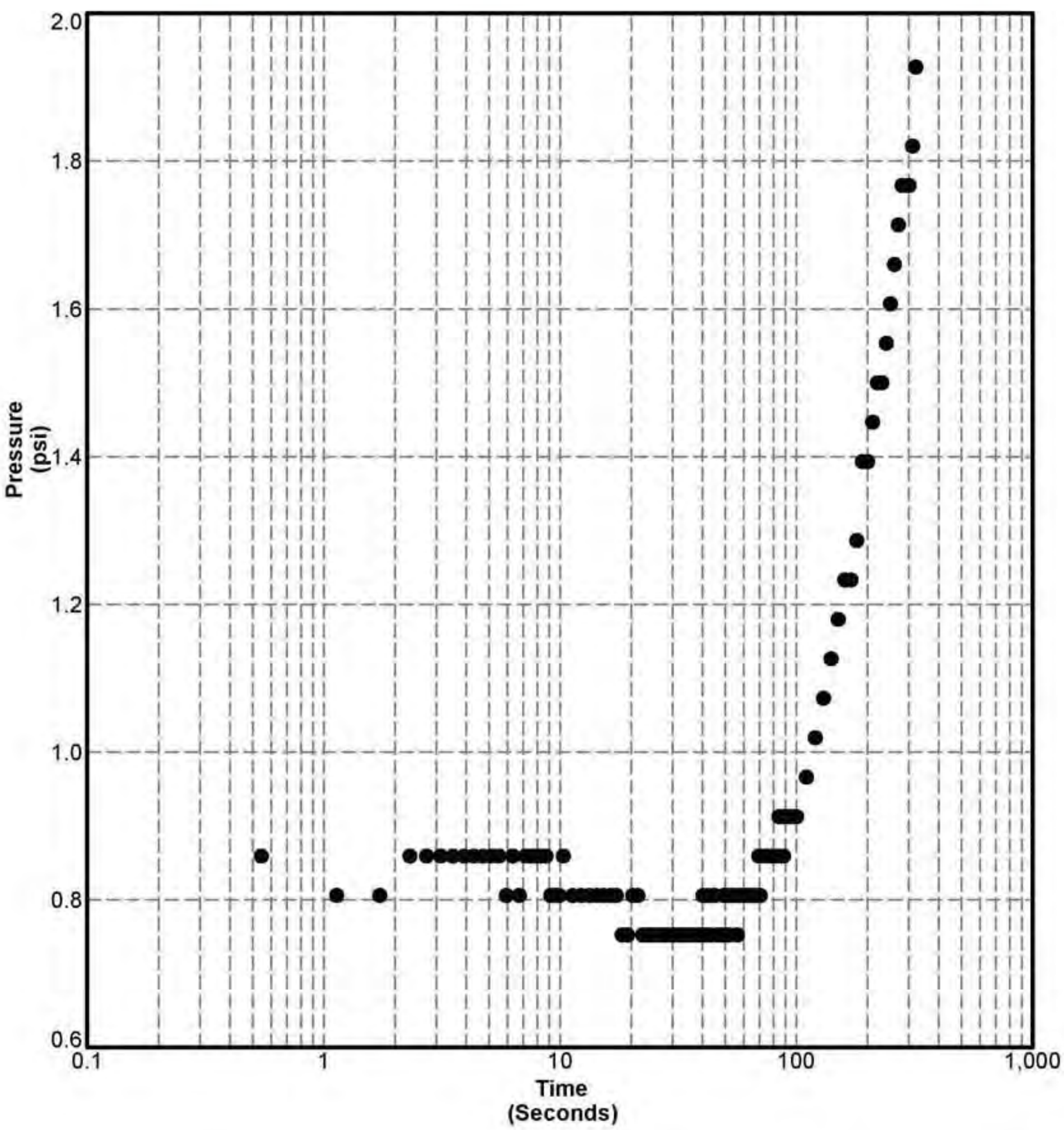
Saltstone SDU 6 Investigation
Z- Area (Aiken,South Carolina)
Project No. :R11S002 T10

# Pore Pressure Dissipation:

**Date:** Nov. 2, 2011
**Estimated Water Depth:** 55.5 ft
**Rig/Operator:** JAH | NS

**Northing:** 77748.2
**Easting:** 66249.8
**Elevation:** 276.8

**Total Depth:** 98.6 ft
**Termination Criteria:**
**Test Depth:** 48.8 ft

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Electronic File Name: sc02n1102d.49

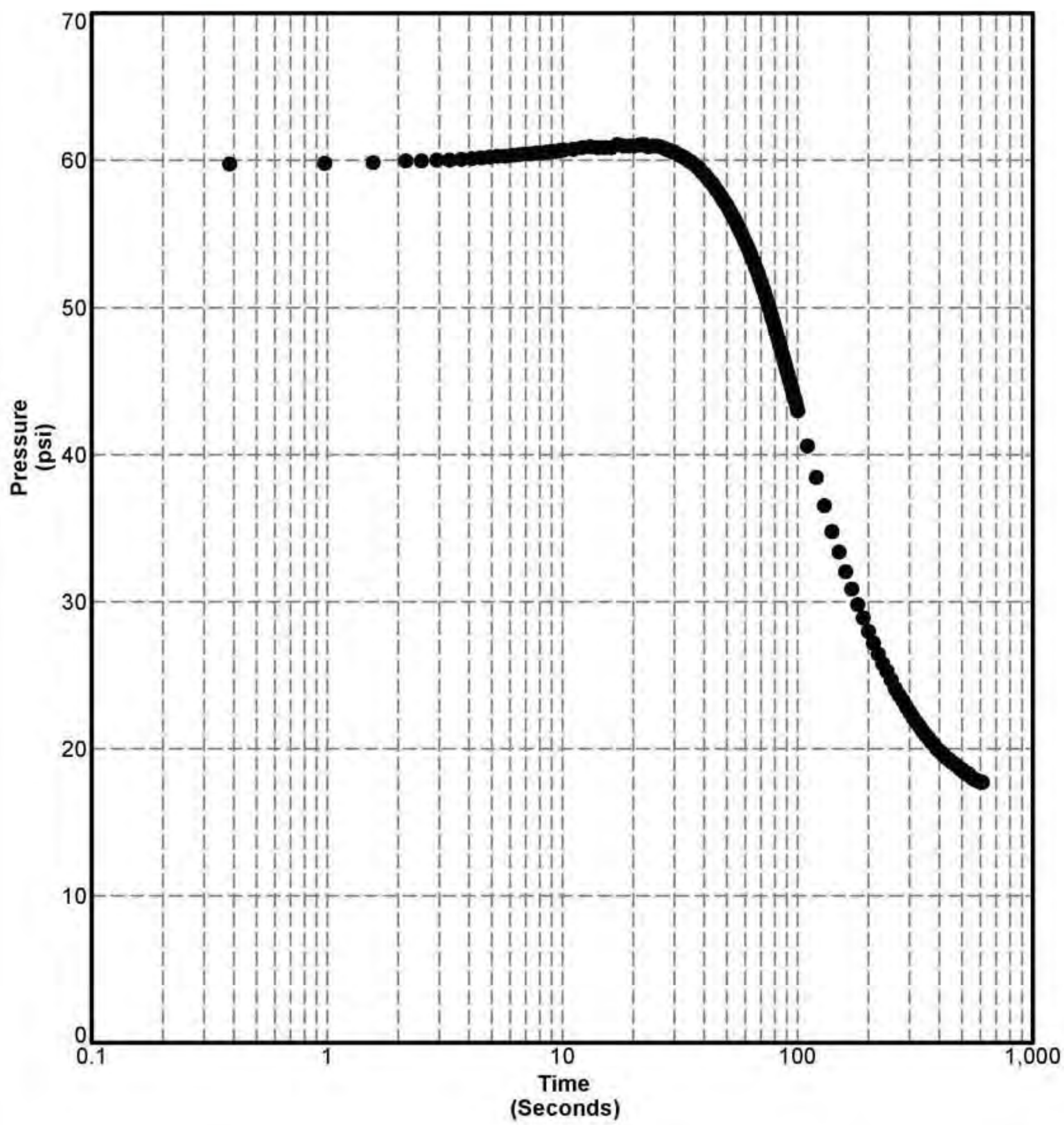
**Z-SDU6-C15**

LANKELMA

Saltstone SDU 6 Investigation
Z- Area (Aiken,South Carolina)
Project No. :R11S002 T10

# Pore Pressure Dissipation:

| | | | | | |
|---|---|---|---|---|---|
| Date: | Nov. 2, 2011 | Northing: | 77748.2 | Total Depth: | 98.6 ft |
| Estimated Water Depth: | 55.5 ft | Easting: | 66249.8 | Termination Criteria: | |
| Rig/Operator: | JAH \| NS | Elevation: | 276.8 | Test Depth: | 92.8 ft |




Z-SDU6-C15

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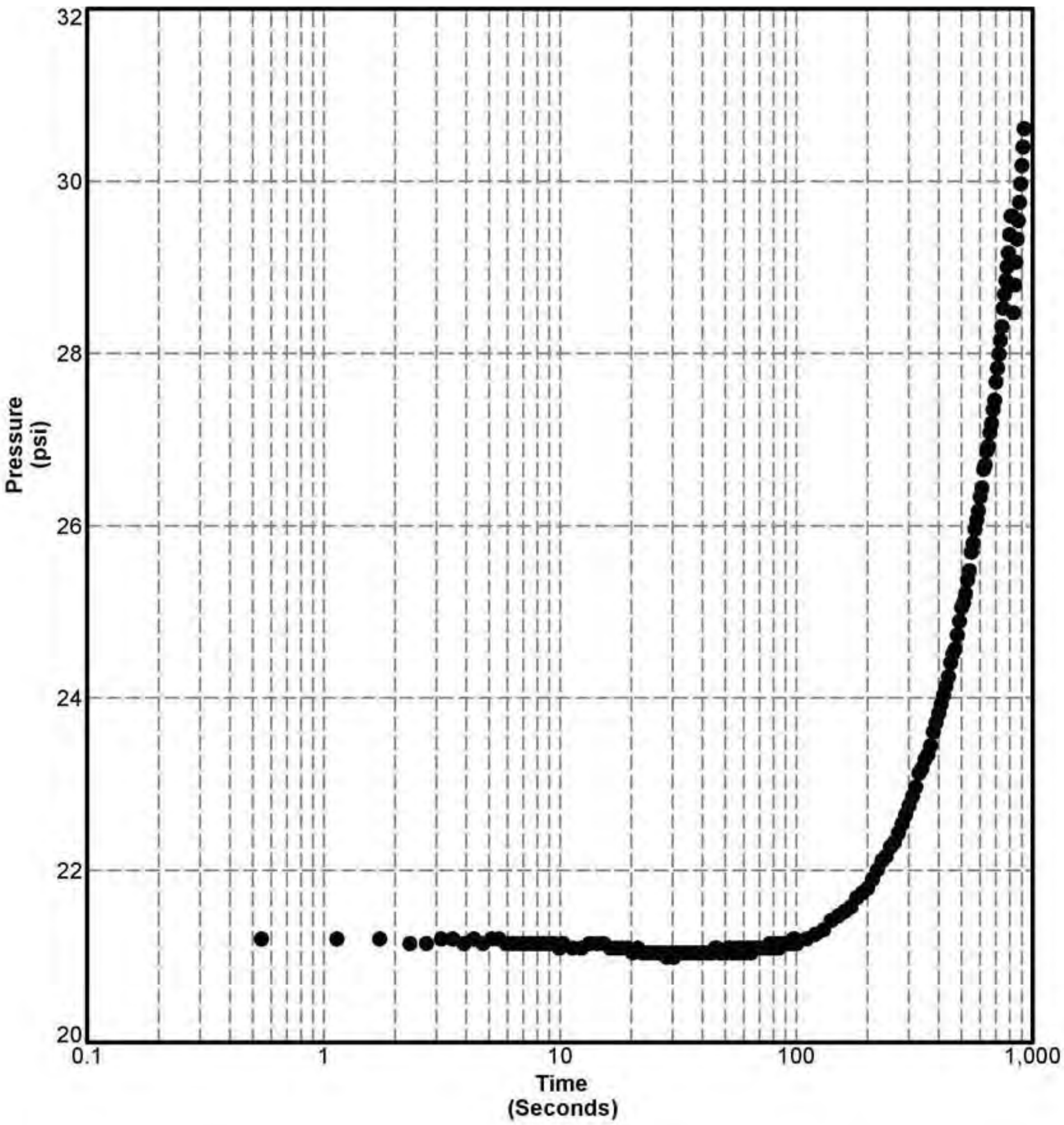
Electronic File Name: sc02n1102d.93

LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**
Project No. :R11S002 T10

# Pore Pressure Dissipation:

**Date:** Nov. 2, 2011
**Estimated Water Depth:** 55.5 ft
**Rig/Operator:** JAH | NS
**Northing:** 77772.2
**Easting:** 66312.2
**Elevation:** 276.7
**Total Depth:** 96.5 ft
**Termination Criteria:**
**Test Depth:** 50.3 ft

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**Z-SDU6-C16**

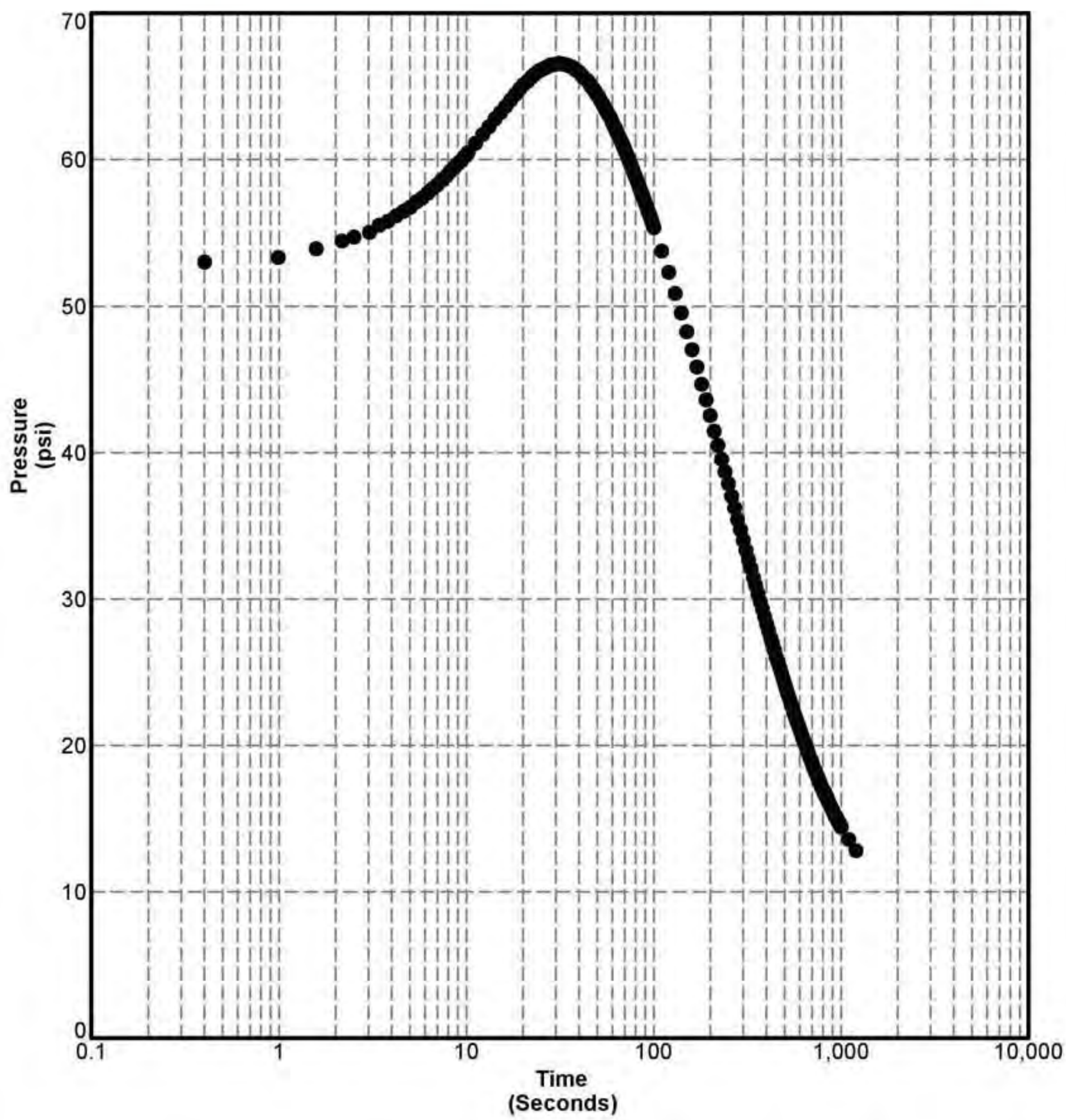
*Electronic File Name: sc02n1103d.50*

LANKELMA

Saltstone SDU 6 Investigation
Z- Area (Aiken,South Carolina)
Project No. :R11S002 T10

# Pore Pressure Dissipation:

**Date:** Nov. 2, 2011
**Estimated Water Depth:** 55.5 ft
**Rig/Operator:** JAH | NS
**Northing:** 77772.2
**Easting:** 66312.2
**Elevation:** 276.7
**Total Depth:** 96.5 ft
**Termination Criteria:**
**Test Depth:** 73.3 ft




**Z-SDU6-C16**

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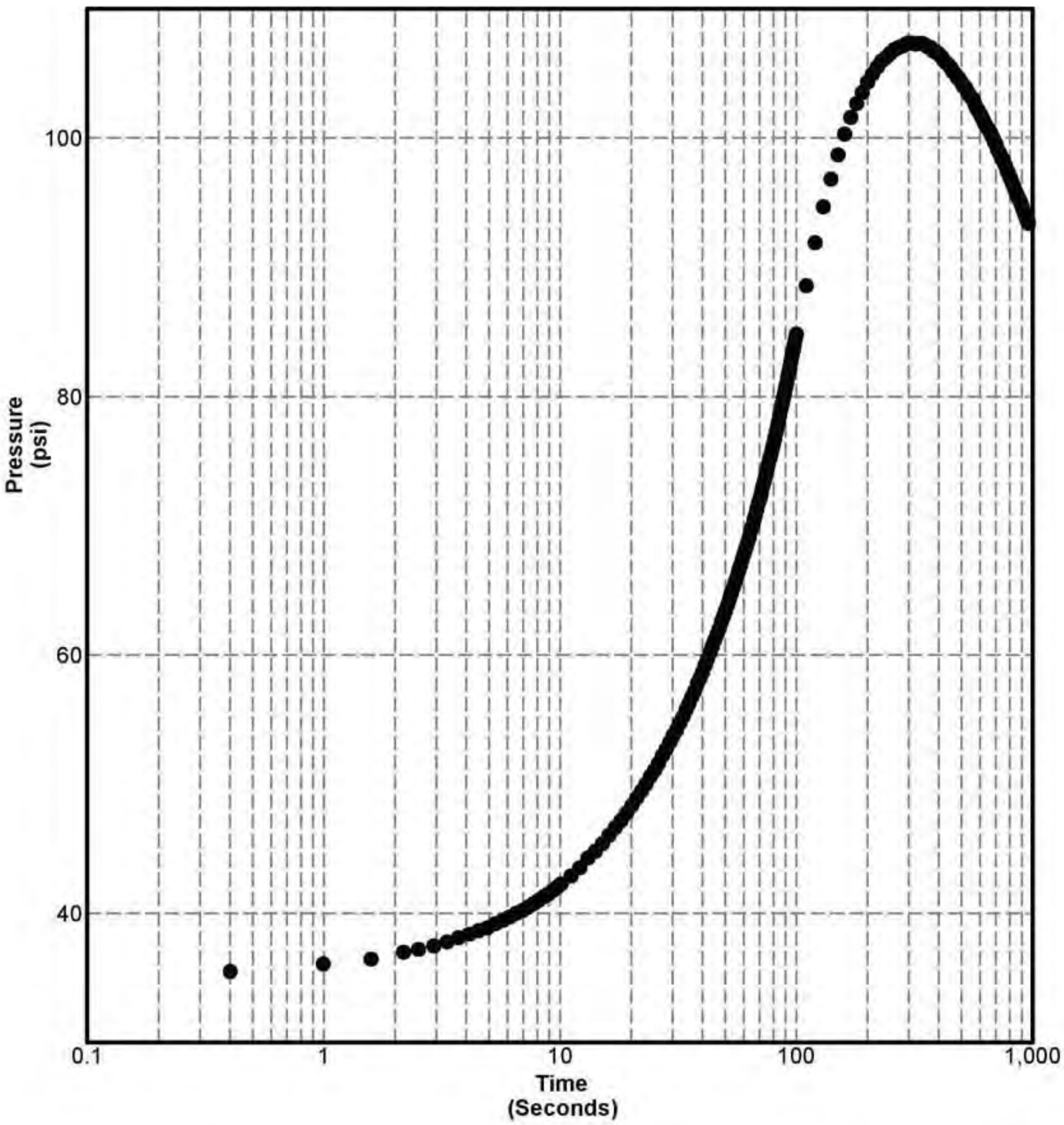
*Electronic File Name: sc02n1103d.73*

LANKELMA

Saltstone SDU 6 Investigation
Z- Area (Aiken,South Carolina)
Project No. :R11S002 T10

# Pore Pressure Dissipation:

| | | | | | |
|---|---|---|---|---|---|
| Date: | Nov. 2, 2011 | Northing: | 77796.3 | Total Depth: | 90.8 ft |
| Estimated Water Depth: | 55 ft | Easting: | 66393.3 | Termination Criteria: | |
| Rig/Operator: | JAH \| NS | Elevation: | 276.0 | Test Depth: | 49.7 ft |




Z-SDU6-C17

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Electronic File Name: sc02n1104d.50

LANKELMA

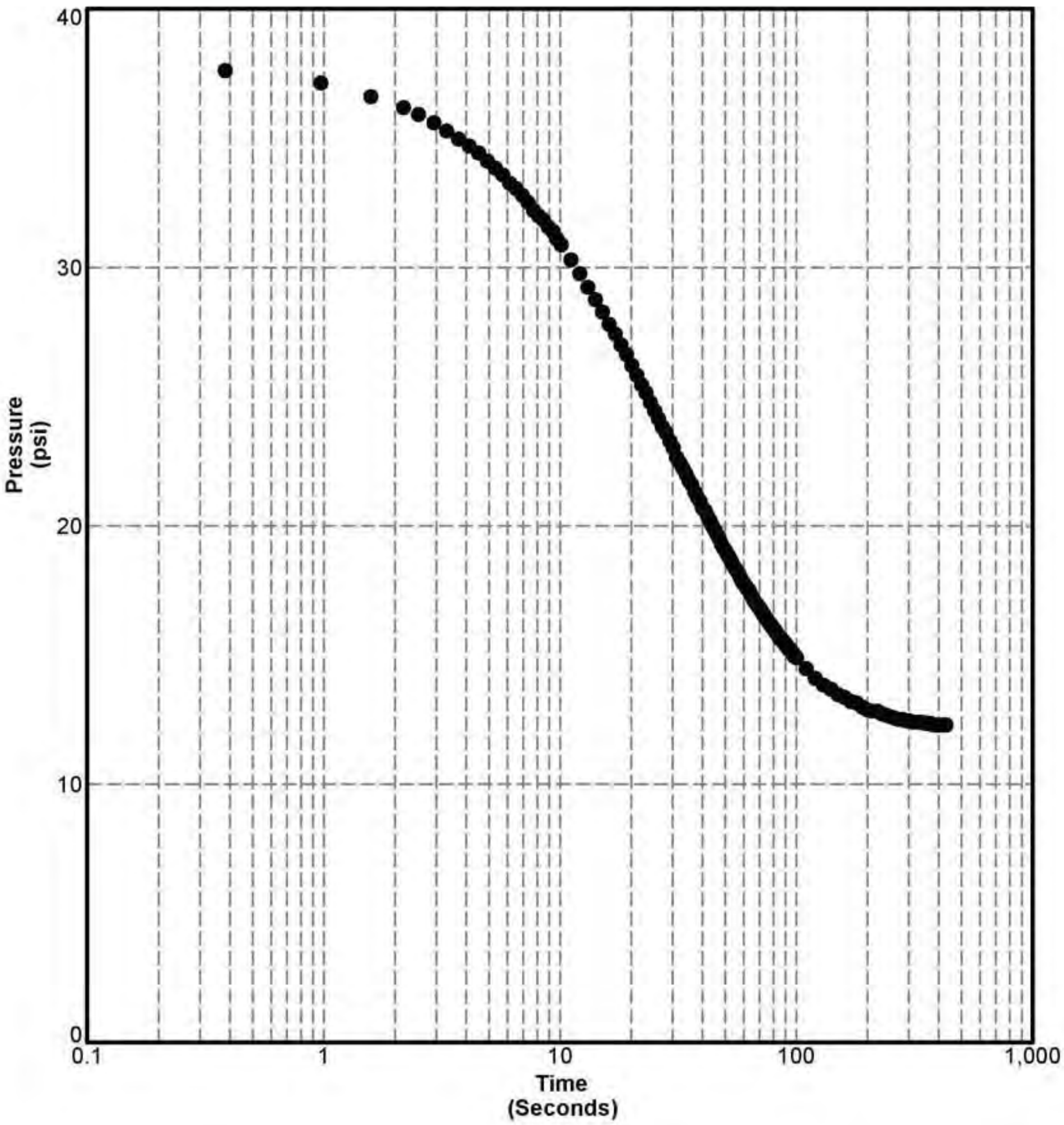
Saltstone SDU 6 Investigation
Z- Area (Aiken,South Carolina)
Project No. :R11S002 T10

**Pore Pressure Dissipation:**

**Date:** Nov. 3, 2011
**Estimated Water Depth:** 58.5 ft
**Rig/Operator:** JAH | NS

**Northing:** 77819.4
**Easting:** 66471.7
**Elevation:** 275.6

**Total Depth:** 92.5 ft
**Termination Criteria:**
**Test Depth:** 87.3 ft

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Electronic File Name: sc03n1101d.87

**Z-SDU6-C18**

LANKELMA

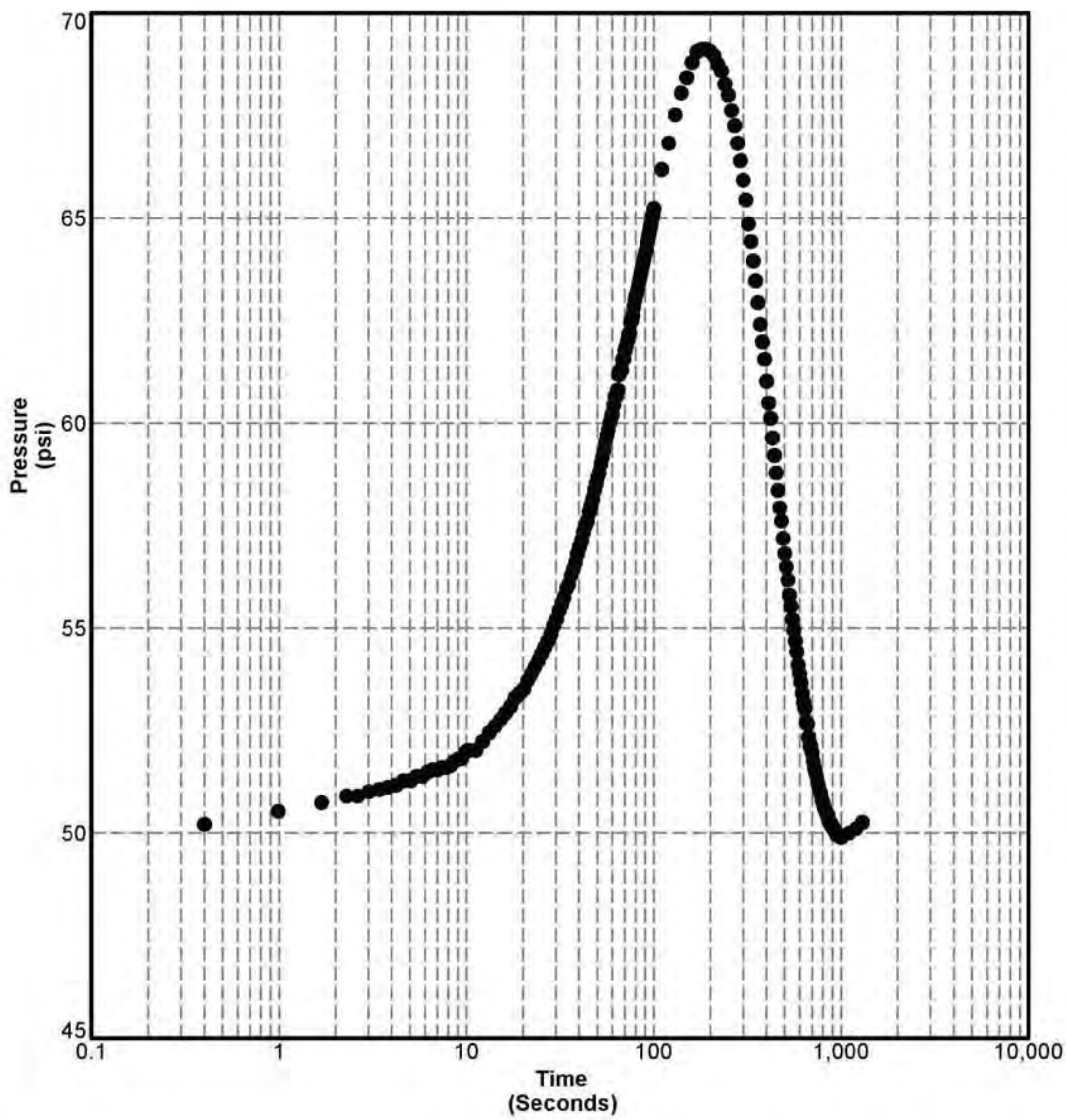
Saltstone SDU 6 Investigation
Z- Area (Aiken,South Carolina)
Project No. :R11S002 T10

# Pore Pressure Dissipation:

Date: Oct. 31, 2011
Estimated Water Depth: 57 ft
Rig/Operator: JAH | NS

Northing: 77869.3
Easting: 66155.6
Elevation: 276.4

Total Depth: 112.6 ft
Termination Criteria:
Test Depth: 47.1 ft




Z-SDU6-C19

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Electronic File Name: sc31o1101d.47

LANKELMA

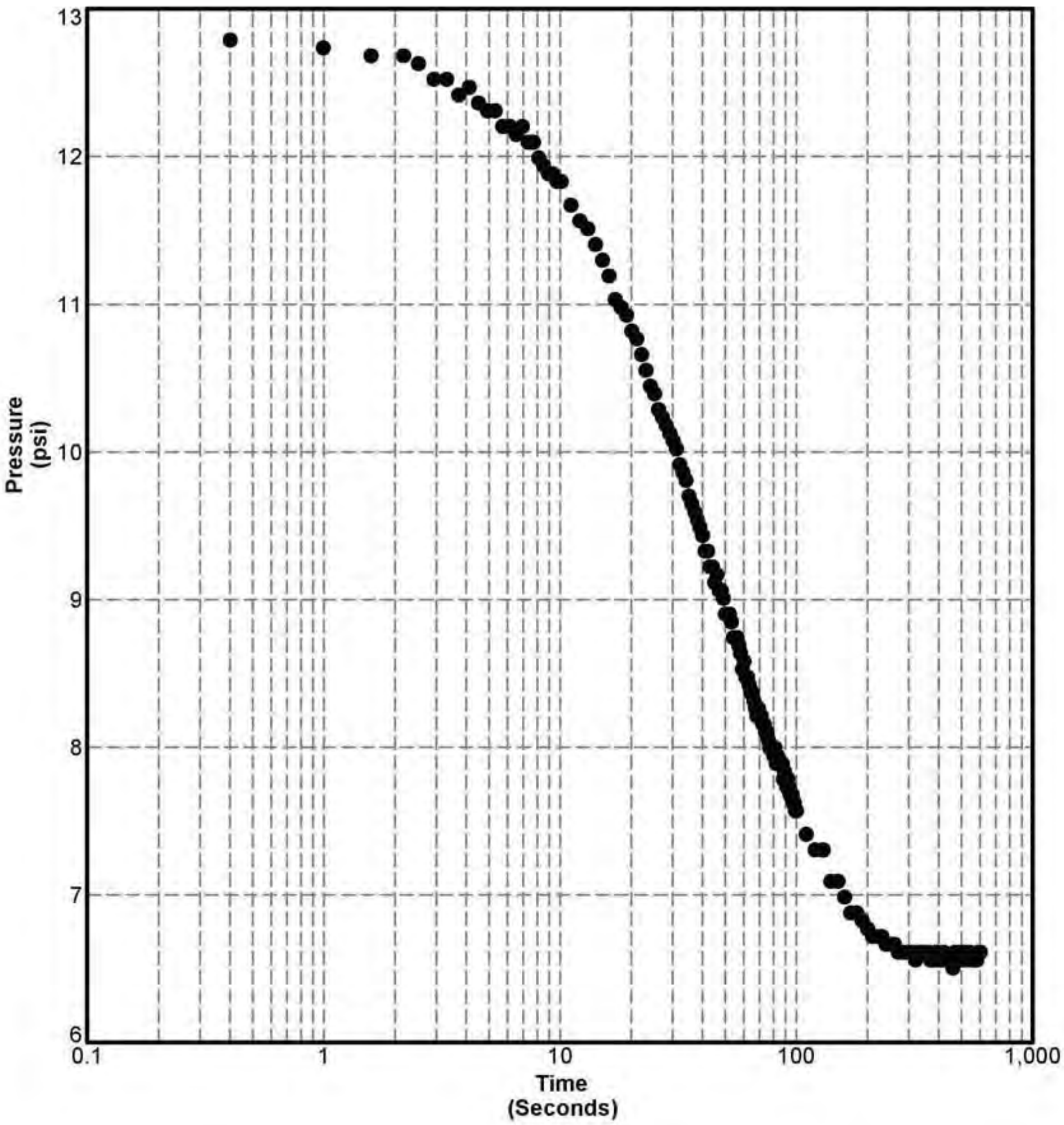
Saltstone SDU 6 Investigation
Z- Area (Aiken,South Carolina)
Project No. :R11S002 T10

# Pore Pressure Dissipation:

Date: Oct. 31, 2011
Estimated Water Depth: 57 ft
Rig/Operator: JAH | NS

Northing: 77869.3
Easting: 66155.6
Elevation: 276.4

Total Depth: 112.6 ft
Termination Criteria:
Test Depth: 75.2 ft




Z-SDU6-C19

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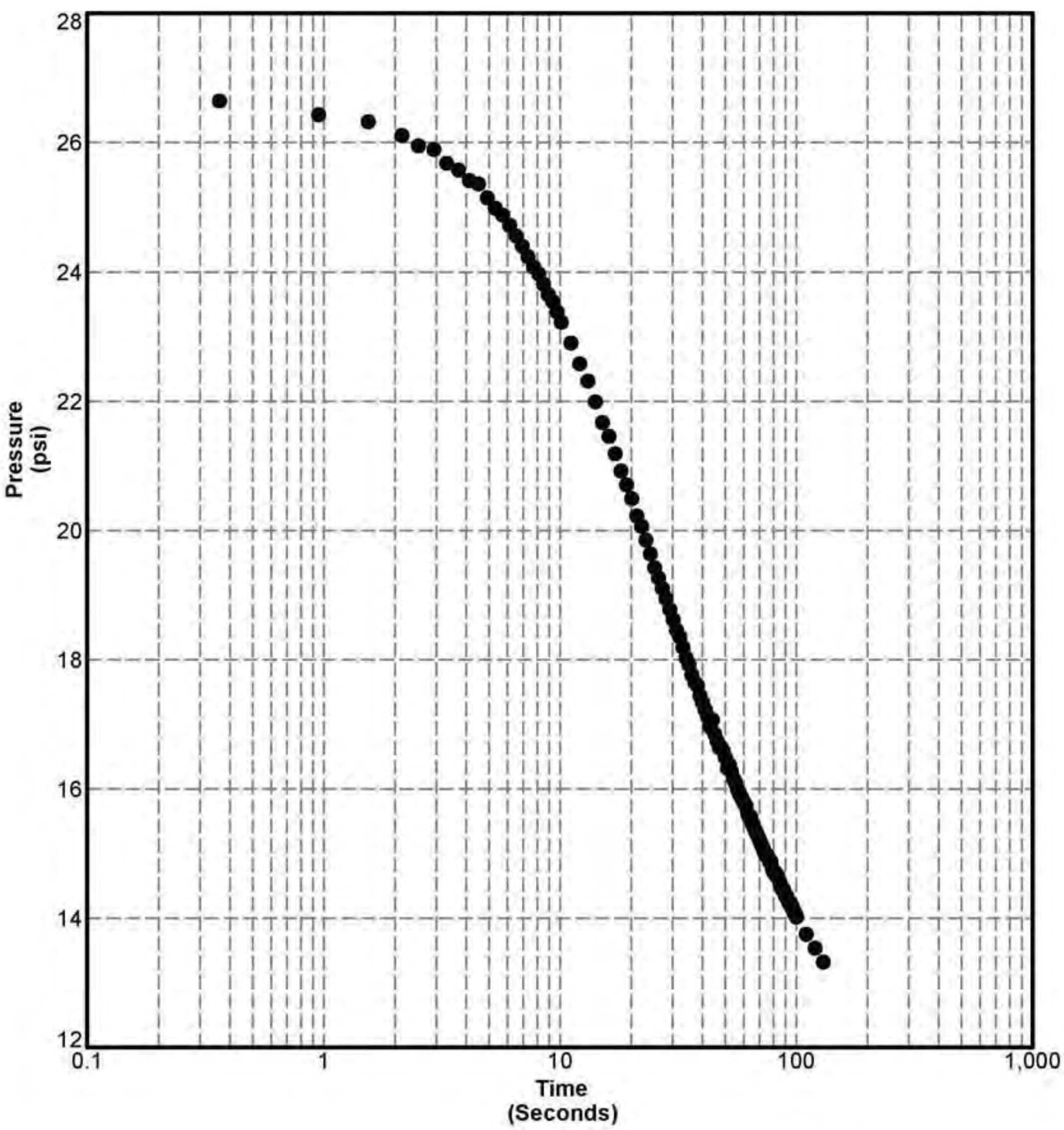
Electronic File Name: sc31o1101d.75

LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**
Project No. :R11S002 T10

# Pore Pressure Dissipation:

**Date:** Oct. 31, 2011
**Estimated Water Depth:** 55 ft
**Rig/Operator:** JAH | NS
**Northing:** 77895.0
**Easting:** 66236.9
**Elevation:** 276.0
**Total Depth:** 127.8 ft
**Termination Criteria:**
**Test Depth:** 53.1 ft




**Z-SDU6-C20**

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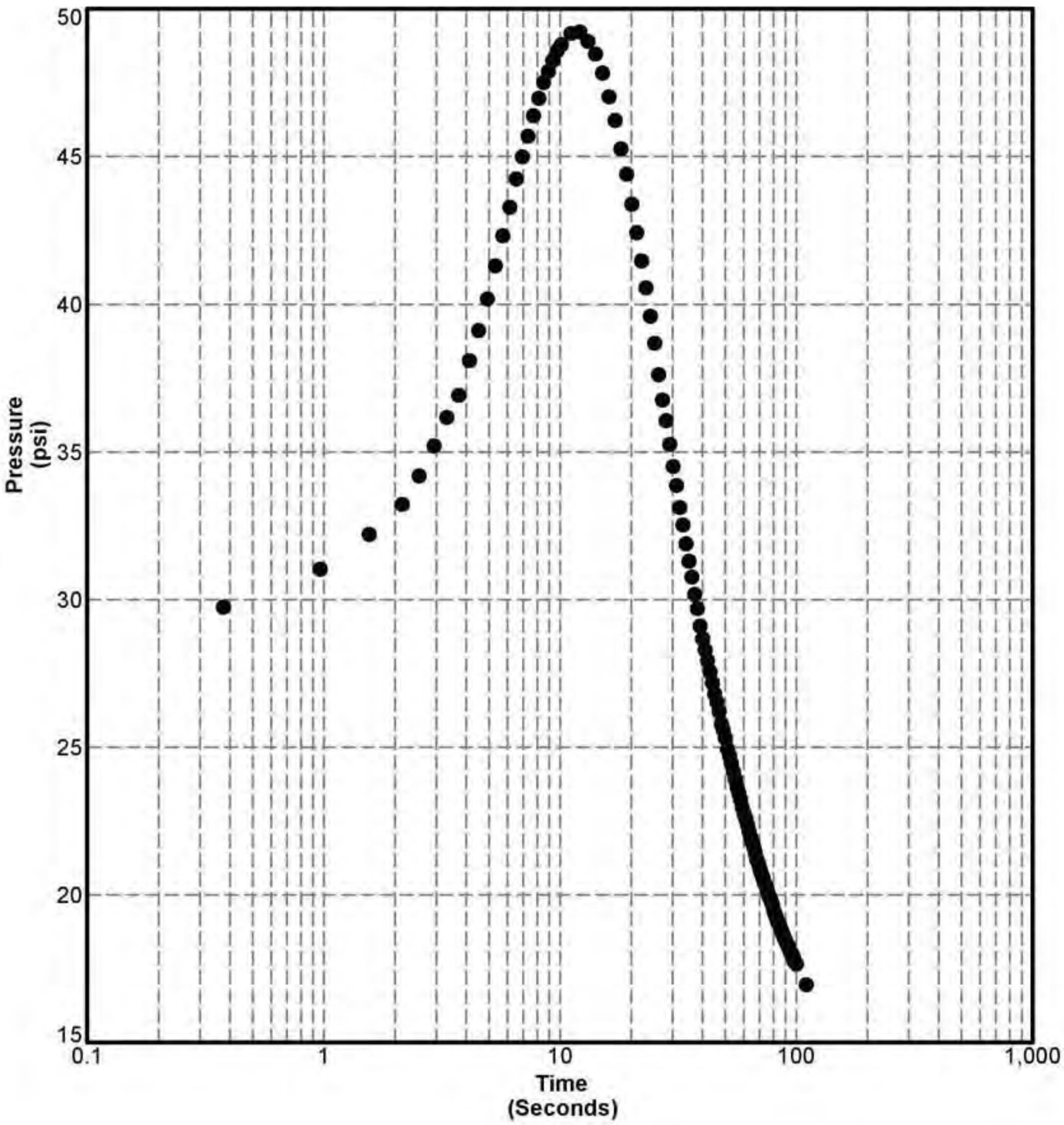
*Electronic File Name: sc31o1102d.53*

LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**
Project No. :R11S002 T10

# Pore Pressure Dissipation:

| | | | | | |
|---|---|---|---|---|---|
| **Date:** | Oct. 31, 2011 | **Northing:** | 77895.0 | **Total Depth:** | 127.8 ft |
| **Estimated Water Depth:** | 55 ft | **Easting:** | 66236.9 | **Termination Criteria:** | |
| **Rig/Operator:** | JAH \| NS | **Elevation:** | 276.0 | **Test Depth:** | 95.8 ft |

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**Z-SDU6-C20**

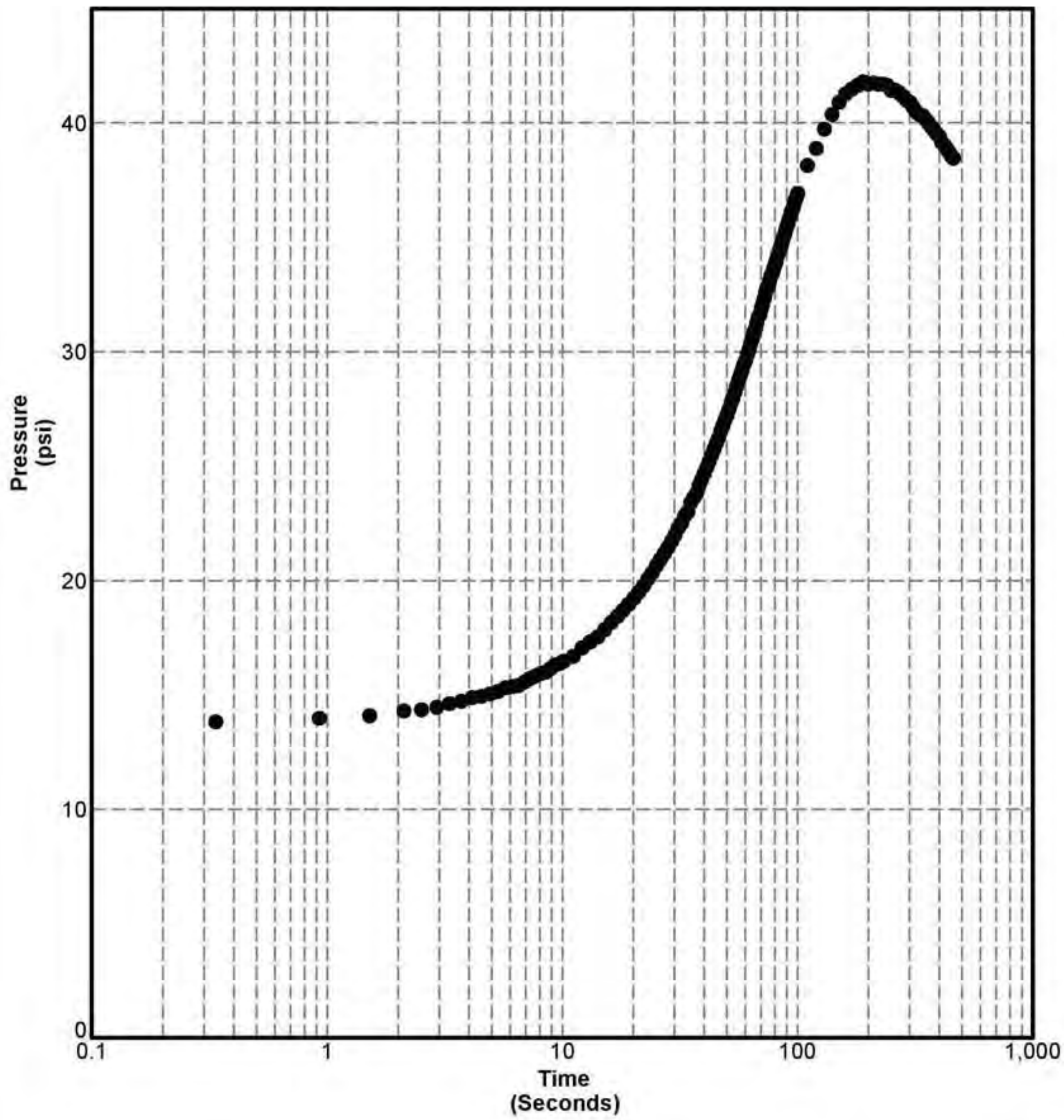
Electronic File Name: sc31o1102d.96

LANKELMA

Saltstone SDU 6 Investigation
Z- Area (Aiken,South Carolina)
Project No. :R11S002 T10

# Pore Pressure Dissipation:

**Date:** Nov. 1, 2011
**Estimated Water Depth:** 55.5 ft
**Rig/Operator:** JAH | NS
**Northing:** 77947.5
**Easting:** 66415.1
**Elevation:** 276.5
**Total Depth:** 131.5 ft
**Termination Criteria:**
**Test Depth:** 68.1 ft




Z-SDU6-C22

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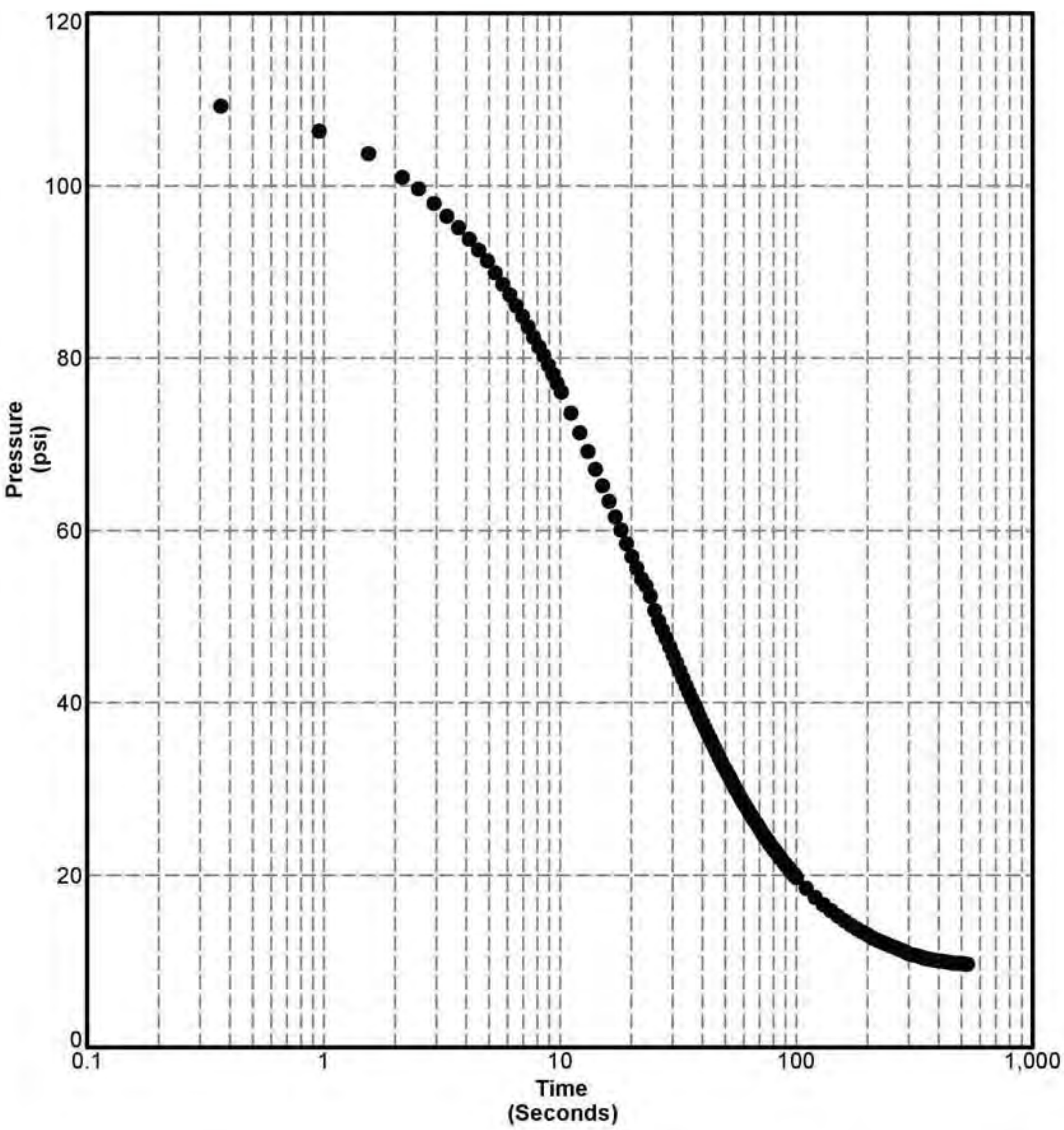
Electronic File Name: sc01n1102d.68

LANKELMA

Saltstone SDU 6 Investigation
Z- Area (Aiken,South Carolina)
Project No. :R11S002 T10

# Pore Pressure Dissipation:

**Date:** Nov. 1, 2011
**Estimated Water Depth:** 55.5 ft
**Rig/Operator:** JAH | NS
**Northing:** 77947.5
**Easting:** 66415.1
**Elevation:** 276.5
**Total Depth:** 131.5 ft
**Termination Criteria:**
**Test Depth:** 88.3 ft

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**Z-SDU6-C22**

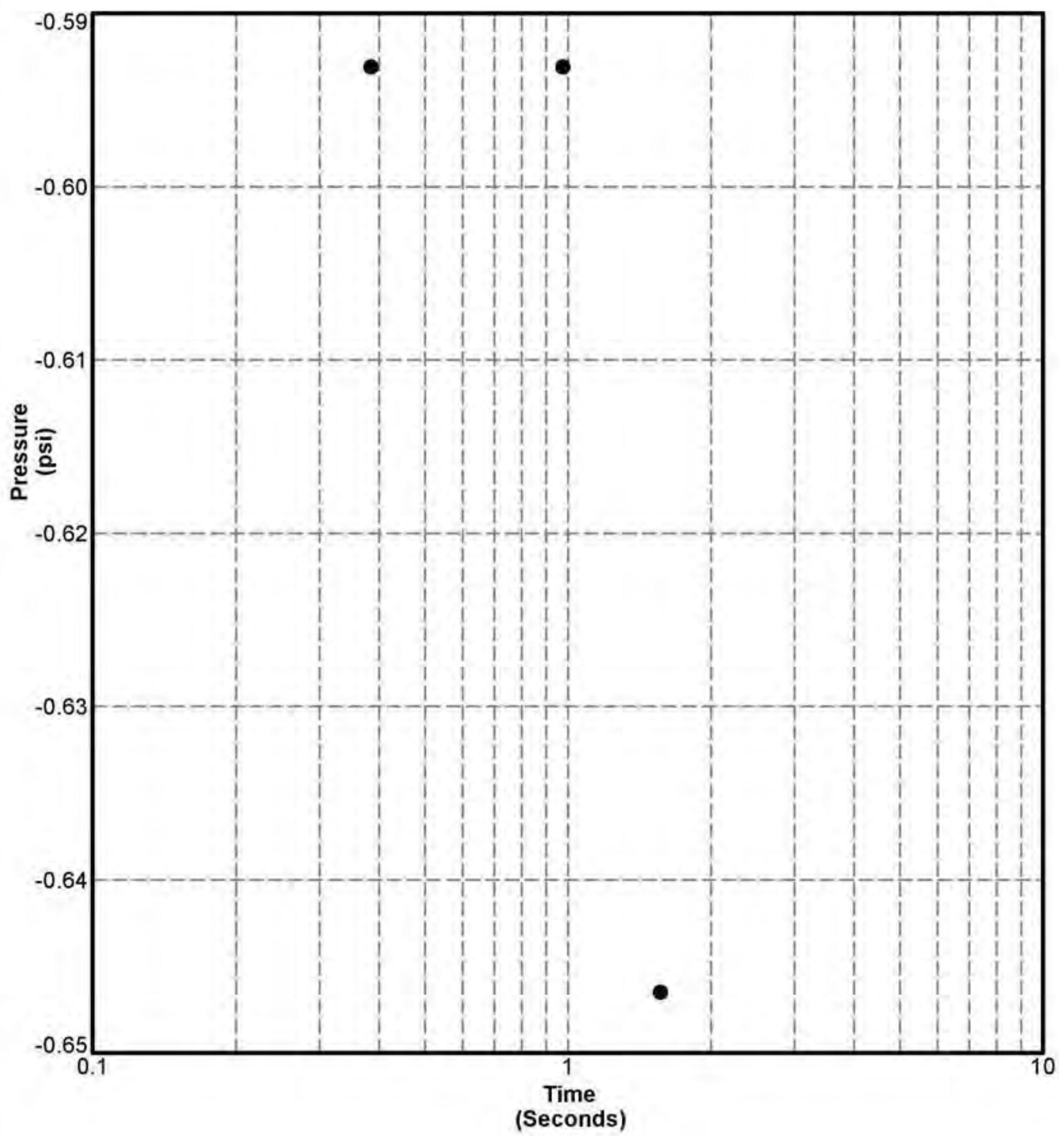
Electronic File Name: sc01n1102d.88

LANKELMA

Saltstone SDU 6 Investigation
Z- Area (Aiken,South Carolina)
Project No. :R11S002 T10

# Pore Pressure Dissipation:

**Date:** Nov. 1, 2011
**Estimated Water Depth:** 54.5 ft
**Rig/Operator:** JAH | NS
**Northing:** 77967.7
**Easting:** 66482.5
**Elevation:** 275.5
**Total Depth:** 90.0 ft
**Termination Criteria:**
**Test Depth:** 60.8 ft

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**Z-SDU6-C23**

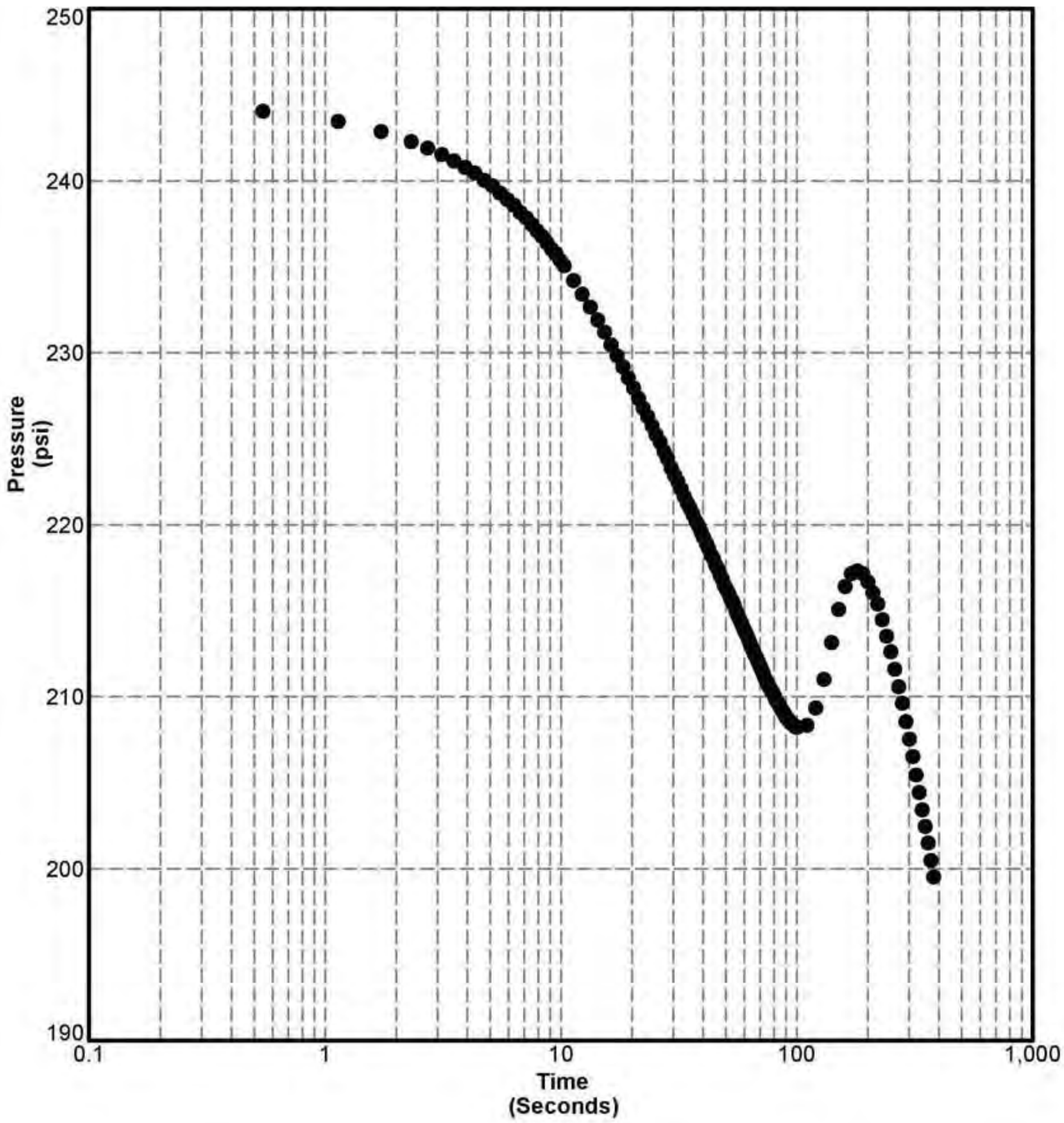
*Electronic File Name: sc01n1103d.61*

LANKELMA

**Saltstone SDU 6 Investigation**
**Z- Area (Aiken,South Carolina)**
Project No. :R11S002 T10

# Pore Pressure Dissipation:

**Date:** Nov. 1, 2011
**Estimated Water Depth:** 54.5 ft
**Rig/Operator:** JAH | NS
**Northing:** 77967.7
**Easting:** 66482.5
**Elevation:** 275.5
**Total Depth:** 90.0 ft
**Termination Criteria:**
**Test Depth:** 63.4 ft




**Z-SDU6-C23**

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*Electronic File Name: sc01n1103d.63*

**Attachment 2: Boring Logs (engineering strata indicated)**

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Savannah River Site
Aiken, SC 29208

Savannah River NUCLEAR SOLUTIONS

## BORING NUMBER Z-SDU6-B01

PAGE 1 OF 4

CLIENT Savannah River Remediation
PROJECT NAME Saltstone Disposal Unit 6
PROJECT NUMBER
PROJECT LOCATION Z-Area
DATE STARTED 12/20/11 COMPLETED 12/23/11
GROUND ELEVATION 276.6 ft HOLE SIZE 6 inches
DRILLING CONTRACTOR SAEDACCO
COORDINATES: NORTH 77771.3 EAST 66309.1
DRILLING METHOD Mud rotary
LOGGED BY M. Hasek CHECKED BY [signature]
NOTES UD

| Depth (ft) | Sample Type Number | Sample Interval | In. Recovered / In. Driven | Blow Counts (N value) | Graphic Log | Material Description | Blow Count (blows/ft) 20 40 60 80 | Elevation (ft) |
|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | Mud rotary drill. | | 275 |
| 5 | | | | | | | | 270 |
| 10 | | | | | | | | 265 |
| | ST-01 | | 9/17 | | | | | |
| 15 | | | | | | Mud rotary drill. | | |
| | ST-02 | | 18/19 | | | | | |
| | | | | | | Mud rotary drill. | | 260 |
| 20 | | | | | | | | 255 |
| | FP-01 | | 24/24 | | | | | |
| 25 | | | | | | Mud rotary drill. | | 250 |
| 30 | | | | | | | | 245 |
| 35 | | | | | | | | |

GEOTECH_BLOW COUNT - GINT STD US.GDT - 02/16/12 10:17 - C:\PROGRAM FILES\GINT\PROJECTS\SDU_6.GPJ

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Savannah River NUCLEAR SOLUTIONS

Savannah River Nuclear Solutions, Inc.
Savannah River Site
Aiken, SC 29208

# BORING NUMBER Z-SDU6-B01



**CLIENT** Savannah River Remediation **PROJECT NAME** Saltstone Disposal Unit 6

**PROJECT NUMBER** **PROJECT LOCATION** Z-Area

| Depth (ft) | Sample Type Number | Sample Interval | In. Recovered / In. Driven | Blow Counts (N value) | Graphic Log | Material Description | Blow Count (blows/ft) 20 40 60 80 | Elevation (ft) |
|---|---|---|---|---|---|---|---|---|
| 35 | ST-03 | | 26/16 | | | | | |
| | | | | | | Mud rotary drill. | | 240 |
| 40 | | | | | | | | |
| | | | | | | | | 235 |
| 45 | | | | | | | | |
| | | | | | | | | 230 |
| 50 | ST-04 | | 27.5/24 | | | | | |
| | | | | | | Mud rotary drill. | | |
| | ST-05 | | 27/24 | | | | | 225 |
| | | | | | | Mud rotary drill. | | |
| 55 | | | | | | | | |
| | | | | | | | | 220 |
| 60 | ST-06 | | 27/24 | | | | | |
| | | | | | | Mud rotary drill. | | |
| | | | | | | | | 215 |
| 65 | | | | | | | | |
| | | | | | | | | 210 |
| 70 | | | | | | | | |
| | ST-07 | | 9/24 | | | | | 205 |
| | | | | | | Mud rotary drill. | | |
| 75 | ST-08 | | 14/24 | | | | | |

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GEOTECH_BLOW COUNT - GINT STD US.GDT - 02/16/12 10:24 - C:\PROGRAM FILES\GINT\PROJECTS\SDU_6.GPJ

Savannah River NUCLEAR SOLUTIONS

Savannah River Nuclear Solutions, Inc.
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Aiken, SC 29208

# BORING NUMBER Z-SDU6-B01



CLIENT Savannah River Remediation
PROJECT NAME Saltstone Disposal Unit 6
PROJECT NUMBER
PROJECT LOCATION Z-Area

| Depth (ft) | Sample Type Number | Sample Interval | In. Recovered / In. Driven | Blow Counts (N value) | Graphic Log | Material Description | Blow Count (blows/ft) 20 40 60 80 | Elevation (ft) |
|---|---|---|---|---|---|---|---|---|
| 75 | | | | | | Mud rotary drill. | | 200 |
| 80 | | | | | | | | 195 |
| | FP-02 | | 24/24 | | | | | |
| 85 | | | | | | Mud rotary drill. | | 190 |
| 90 | | | | | | | | 185 |
| | ST-09 | | 0/7 | | | Mud rotary drill. | | |
| 95 | | | | | | | | 180 |
| 100 | | | | | | | | 175 |
| 105 | | | | | | | | 170 |
| 110 | | | | | | | | 165 |
| 115 | | | | | | | | |

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GEOTECH_BLOW COUNT - GINT STD US.GDT - 02/16/12 10:24 - C:\PROGRAM FILES\GINT\PROJECTS\SDU_6.GPJ

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Savannah River Site
Aiken, SC 29208

# BORING NUMBER Z-SDU6-B01

PAGE 4 OF 4

**CLIENT** Savannah River Remediation
**PROJECT NAME** Saltstone Disposal Unit 6
**PROJECT NUMBER**
**PROJECT LOCATION** Z-Area

| Depth (ft) | Sample Type Number | Sample Interval | In. Recovered / In. Driven | Blow Counts (N value) | Graphic Log | Material Description | Blow Count (blows/ft) 20 40 60 80 | Elevation (ft) |
|---|---|---|---|---|---|---|---|---|
| 115 | ST-10 | | 8.5/8 | | | | | |
| | | | | | | Mud rotary drill. | | 160 |
| 120 | | | | | | | | 155 |
| 125 | ST-11 | | 20/18 | | | | | 150 |
| | | | | | | Mud rotary drill. | | |
| | | | | | | Bottom of borehole at 128.0 feet. | | 145 |
| | | | | | | | | 140 |
| | | | | | | | | 135 |
| | | | | | | | | 130 |
| | | | | | | | | 125 |

GEOTECH_BLOW COUNT - GINT STD US.GDT - 02/16/12 10:24 - C:\PROGRAM FILES\GINT\PROJECTS\SDU_6.GPJ

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# BORING NUMBER Z-SDU6-B02A



CLIENT Savannah River Remediation
PROJECT NAME Saltstone Disposal Unit 6
PROJECT NUMBER
PROJECT LOCATION Z-Area
DATE STARTED 12/27/11 COMPLETED 12/29/11
GROUND ELEVATION 278 ft HOLE SIZE 6 inches
DRILLING CONTRACTOR SAEDACCO
COORDINATES:NORTH 77625.3 EAST 66594.8
DRILLING METHOD Mud rotary
LOGGED BY M. Hasek CHECKED BY [signature]
NOTES UD

| Depth (ft) | Sample Type Number | Sample Interval | In. Recovered / In. Driven | Blow Counts (N value) | Graphic Log | Material Description | Blow Count (blows/ft) 20 40 60 80 | Elevation (ft) |
|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | Mud rotary drill. | | |
| 5 | | | | | | | | 275 |
| 10 | ST-01 | | 4/4 | | | Mud rotary drill. | | 270 |
| | ST-02 | | 6/6 | | | Mud rotary drill. | | |
| 15 | | | | | | | | 265 |
| | ST-03 | | 3/4 | | | Mud rotary drill. | | |
| | ST-04 | | 2.5/3 | | | Mud rotary drill. | | 260 |
| 20 | | | | | | | | |
| | ST-05 | | 4/7.5 | | | Mud rotary drill. | | 255 |
| 25 | | | | | | | | |
| 30 | | | | | | | | 250 |
| 35 | | | | | | | | 245 |

GEOTECH_BLOW COUNT - GINT STD US.GDT - 02/16/12 10:17 - C:\PROGRAM FILES\GINT\PROJECTS\SDU_6.GPJ

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# BORING NUMBER Z-SDU6-B02A

PAGE 2 OF 2

**CLIENT** Savannah River Remediation **PROJECT NAME** Saltstone Disposal Unit 6
**PROJECT NUMBER** **PROJECT LOCATION** Z-Area

| Depth (ft) | Sample Type Number | Sample Interval | In. Recovered / In. Driven | Blow Counts (N value) | Graphic Log | Material Description | Blow Count (blows/ft) 20 40 60 80 | Elevation (ft) |
|---|---|---|---|---|---|---|---|---|
| 35 | | | | | | Mud rotary drill. *(continued)* | | |
| | | | | | | | | 240 |
| 40 | | | | | | | | |
| | | | | | | | | 235 |
| 45 | FP-01 | | 23/24 | | | | | |
| | | | | | | Mud rotary drill. | | |
| | FP-02 | | 24/24 | | | | | 230 |
| 50 | | | | | | Mud rotary drill. | | |
| | | | | | | | | 225 |
| 55 | | | | | | | | |
| | ST-06 | | 4/6 | | | | | 220 |
| | | | | | | Mud rotary drill. | | |
| 60 | | | | | | | | |
| | | | | | | | | 215 |
| 65 | | | | | | | | |
| | | | | | | | | 210 |
| 70 | | | | | | | | |
| | | | | | | | | 205 |
| 75 | | | | | | | | |

Bottom of borehole at 75.0 feet.

GEOTECH_BLOW COUNT - GINT STD US.GDT - 02/16/12 10:24 - C:\PROGRAM FILES\GINT\PROJECTS\SDU_6.GPJ

Savannah River NUCLEAR SOLUTIONS

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Aiken, SC 29208

# BORING NUMBER Z-SDU6-B02B

PAGE 1 OF 4

CLIENT Savannah River Remediation
PROJECT NAME Saltstone Disposal Unit 6
PROJECT NUMBER
PROJECT LOCATION Z-Area
DATE STARTED 12/29/11 COMPLETED 01/05/12
GROUND ELEVATION 278.1 ft HOLE SIZE 6 inches
DRILLING CONTRACTOR SAEDACCO
COORDINATES: NORTH 77629.2 EAST 66588.9
DRILLING METHOD Mud rotary
LOGGED BY M. Hasek CHECKED BY [signature]
NOTES UD

| Depth (ft) | Sample Type Number | Sample Interval | In. Recovered / In. Driven | Blow Counts (N value) | Graphic Log | Material Description | Blow Count (blows/ft) 20 40 60 80 | Elevation (ft) |
|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | Mud rotary drill. | | |
| 5 | | | | | | | | 275 |
| 10 | | | | | | | | 270 |
| 15 | | | | | | | | 265 |
| 20 | | | | | | | | 260 |
| 25 | | | | | | | | 255 |
| 30 | | | | | | | | 250 |
| 35 | | | | | | | | 245 |

GEOTECH_BLOW COUNT - GINT STD US.GDT - 02/16/12 10:18 - C:\PROGRAM FILES\GINT\PROJECTS\SDU_6.GPJ

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Savannah River NUCLEAR SOLUTIONS

Savannah River Nuclear Solutions, Inc.
Savannah River Site
Aiken, SC 29208

# BORING NUMBER Z-SDU6-B02B



**CLIENT** Savannah River Remediation
**PROJECT NAME** Saltstone Disposal Unit 6
**PROJECT NUMBER**
**PROJECT LOCATION** Z-Area

| Depth (ft) | Sample Type Number | Sample Interval | In. Recovered / In. Driven | Blow Counts (N value) | Graphic Log | Material Description | Blow Count (blows/ft) 20 40 60 80 | Elevation (ft) |
|---|---|---|---|---|---|---|---|---|
| 35 | | | | | | Mud rotary drill. | | |
| | | | | | | | | 240 |
| 40 | | | | | | | | |
| | | | | | | | | 235 |
| 45 | | | | | | C2 | | |
| | | | | | | | | 230 |
| 50 | | | | | | | | |
| | | | | | | S3 | | |
| | | | | | | | | 225 |
| 55 | | | | | | | | |
| | | | | | | | | 220 |
| 60 | | | | | | | | |
| | | | | | | | | 215 |
| 65 | | | | | | | | |
| | | | | | | | | 210 |
| 70 | | | | | | | | |
| | | | | | | | | 205 |
| 75 | | | | | | | | |

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GEOTECH_BLOW COUNT - GINT STD US.GDT - 02/16/12 10:24 - C:\PROGRAM FILES\GINT\PROJECTS\SDU_6.GPJ

Savannah River NUCLEAR SOLUTIONS

Savannah River Nuclear Solutions, Inc.
Savannah River Site
Aiken, SC 29208

# BORING NUMBER Z-SDU6-B02B

PAGE 3 OF 4

CLIENT Savannah River Remediation

PROJECT NUMBER

PROJECT NAME Saltstone Disposal Unit 6

PROJECT LOCATION Z-Area

| Depth (ft) | Sample Type Number | Sample Interval | In. Recovered / In. Driven | Blow Counts (N value) | Graphic Log | Material Description | Blow Count (blows/ft) 20 40 60 80 | Elevation (ft) |
|---|---|---|---|---|---|---|---|---|
| 75 | FP-01 | | 24/24 | | | | | |
| | | | | | | Mud rotary drill. | | 200 |
| 80 | | | | | | | | |
| | | | | | | | | 195 |
| 85 | FP-02 | | 4/24 | | | | | |
| | | | | | | Mud rotary drill. S4 | | 190 |
| 90 | | | | | | | | |
| | | | | | | | | 185 |
| 95 | | | | | | | | |
| | | | | | | | | 180 |
| 100 | | | | | | | | |
| | | | | | | | | 175 |
| 105 | | | | | | | | |
| | | | | | | | | 170 |
| 110 | | | | | | | | |
| | | | | | | | | 165 |
| 115 | | | | | | | | |

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GEOTECH_BLOW COUNT - GINT STD US.GDT - 02/16/12 10:24 - C:\PROGRAM FILES\GINT\PROJECTS\SDU_6.GPJ

Savannah River NUCLEAR SOLUTIONS

Savannah River Nuclear Solutions, Inc.
Savannah River Site
Aiken, SC 29208

# BORING NUMBER Z-SDU6-B02B



**CLIENT** Savannah River Remediation **PROJECT NAME** Saltstone Disposal Unit 6

**PROJECT NUMBER** **PROJECT LOCATION** Z-Area

| Depth (ft) | Sample Type Number | Sample Interval | In. Recovered / In. Driven | Blow Counts (N value) | Graphic Log | Material Description | Blow Count (blows/ft) 20 40 60 80 | Elevation (ft) |
|---|---|---|---|---|---|---|---|---|
| 115 | | | | | | Mud rotary drill. *(continued)* | | |
| 120 | | | | | | | | 160 |
| 125 | | | | | | | | 155 |
| 130 | | | | | | | | 150 |
| | | | | | | Bottom of borehole at 131.0 feet. | | 145 |
| | | | | | | | | 140 |
| | | | | | | | | 135 |
| | | | | | | | | 130 |
| | | | | | | | | 125 |

GEOTECH_BLOW COUNT - GINT STD US.GDT - 02/16/12 10:24 - C:\PROGRAM FILES\GINT\PROJECTS\SDU_6.GPJ

Savannah River Nuclear Solutions, Inc.
Savannah River Site
Aiken, SC 29208

# BORING NUMBER Z-SDU6-B03



CLIENT Savannah River Remediation
PROJECT NAME Saltstone Disposal Unit 6
PROJECT NUMBER
PROJECT LOCATION Z-Area
DATE STARTED 01/05/12 COMPLETED 01/11/12
GROUND ELEVATION 276.5 ft HOLE SIZE 4 inches
DRILLING CONTRACTOR SAEDACCO
COORDINATES: NORTH 77769.6 EAST 66304.5
DRILLING METHOD Mud rotary
LOGGED BY M. Hasek CHECKED BY [signature]
NOTES SPT

| Depth (ft) | Sample Type Number | Sample Interval | In. Recovered / In. Driven | Blow Counts (N value) | Graphic Log | Material Description | Blow Count (blows/ft) 20 40 60 80 | Elevation (ft) |
|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | Mud rotary drill. | | 275 |
| 5 | | | | | | | | 270 |
| 10 | | | | | | | | 265 |
| | SS-01 | X | 14/24 | | | Red silty Sand (SM), sand fine to medium, subangular to subround, low plasticity, moist, dense, with few brownish yellow mottles. | | |
| 15 | SS-02 | X | 18/24 | 10-17-20-23 (37) | | Red silty Sand (SM), sand fine to medium, subangular to subround, low plasticity, moist, medium dense. | | |
| | SS-03 | X | 19/24 | 9-12-16-23 (28) | | Red sandy Silt (ML), sand portion fine to medium and subangular to subround, med. plasticity, moist, medium dense. | | 260 |
| 20 | | | | | | Mud rotary drill. | | 255 |
| | SS-04 | X | 20/24 | 10-19-19-24 (38) | | Yellowish red clayey Silt (MH) (upper 7 in), high plasticity, trace sand (fine to medium, subangular), moist, dense; Yellowish red silty Sand (SM) (lower 13 in), fine to medium, subangular, low plasticity, moist, dense. | | |
| 25 | SS-05 | X | 21/24 | 10-18-16-19 (34) | | Red clayey Silt (MH) (upper 3 in), high plasticity, moist; Red sandy Silt (ML) (lower 18 in), sand fine and subangular, low plasticity, moist, hard, brownish yellow mottle bottom 1 in. | | 250 |
| | SS-06 | X | 21.5/24 | 9-7-12-17 (19) | | Red sandy Silt (ML) (upper 8 in), sand fine to medium and subangular, moist, very stiff; Reddish yellow clayey Silt (MH) (lower 13 in), high plasticity, moist, very stiff. | | |
| 30 | SS-07 | X | 18/24 | 5-8-13-17 (21) | | Reddish yellow silty Sand (SM) (upper 14 in), sand subangular and fine with trace medium, subangular, low plasticity, moist, very stiff; Red sandy Silt (SM) (lower 4 in), very low plasticity, moist. | | 245 |
| | SS-08 | X | 19/24 | 12-12-12-12 (24) | | Reddish yellow silty Sand (SM), sand subangular and fine, very low plasticity, moist, medium dense. | | |
| 35 | SS-09 | X | 18/18 | 10-18-50 (68) | | Reddish yellow silty Sand (SM) (upper 5 in), fine to medium, subangular, low plasticity, moist; Red sandy Clay (CL) (upper mid 3 in), high plasticity, moist; white fat Clay (CH) (lower mid 7 in), high plasticity, | | |

(Continued Next Page)

GEOTECH_BLOW COUNT - GINT STD US GDT - 02/16/12 10:15 - C:\PROGRAM FILES\GINT\PROJECTS\SDU_6.GPJ

Savannah River NUCLEAR SOLUTIONS

Savannah River Nuclear Solutions, Inc.
Savannah River Site
Aiken, SC 29208

# BORING NUMBER Z-SDU6-B03

PAGE 2 OF 5

**CLIENT** Savannah River Remediation **PROJECT NAME** Saltstone Disposal Unit 6

**PROJECT NUMBER** **PROJECT LOCATION** Z-Area

| Depth (ft) | Sample Type Number | Sample Interval | In. Recovered / In. Driven | Blow Counts (N value) | Graphic Log | Material Description | Blow Count (blows/ft) 20 40 60 80 | Elevation (ft) |
|---|---|---|---|---|---|---|---|---|
| 35 | SS-10 | X | 19/24 | 10-15-20-27 (35) | | Clay (CH) (lower 4 in), little fine to medium sand and subangular, high plasticity, moist. | | 240 |
| | SS-11 | X | 20/24 | 10-13-16-16 (29) | | Reddish yellow silty Sand (SM) (upper 2 in), fine to medium, subangular, low plasticity, moist; white sandy Clay (CL/CH) (upper mid 2 in), sand fine to medium and subangular, high plasticity, moist; Red with white alternating layers silty Sand (SM) (lower 15 in), fine to medium, subangular, low plasticity, moist, dense. | | |
| 40 | SS-12 | X | 20/24 | 11-15-21-27 (36) | | Red and yellowish red poorly graded Sand (SP) (lower 17.5 in), fine with trace medium, subangular, nonplastic, moist, medium dense; white Clay (CL/CH) (upper 2.5 in), little sand (fine, subangular), high plasticity; moist. | | 235 |
| | | | | | | Red silty Sand (SM), fine, subangular, nonplastic grading to reddish yellow silty sand with lower silt content with depth; moist, dense. | | |
| | SS-13 | X | 13/24 | 7-7-10-11 (17) | | Mud rotary drill. | | |
| 45 | | | | | | Reddish yellow silty Sand (SM) (upper 3 in), sand fine and subangular, low plasticity, moist, medium dense; Red silty Sand (SM) (lower 10 in), sand fine and subangular, medium plasticity, moist, medium dense. | | C2 |
| | | | | | | Mud rotary drill. | | 230 |
| 50 | SS-14 | X | 24/24 | 5-6-8-12 (14) | | Yellow fat Clay (CH), high plasticity, moist, few very fine sand, stiff. | | |
| | | | | | | Mud rotary drill. | | 225 |
| 55 | SS-15 | X | 24/24 | 2-2-3-6 (5) | | Light greenish gray interlayered fat Clay (CH) (high plasticity, moist, no sand) with clayey Sand (SC) grading to sandier clay with depth (CL) (lower 10 in), sand fine to medium and subangular to subround, moist, medium soft. | | |
| | | | | | | Mud rotary drill. | | 220 |
| 60 | SS-16 | X | 24/24 | 5-7-7-8 (14) | | Light greenish gray fat Clay (CH), high plasticity, moist; grading to light greenish gray clayey Sand (SC) below 12 inches, fine to medium, subangular, moist, stiff. | | S3 |
| | | | | | | Mud rotary drill. | | 215 |
| 65 | SS-17 | X | 17/24 | 5-7-11-11 (18) | | Light yellowish brown poorly graded Sand (SP), fine (mostly) to medium, subangular, non-plastic, wet, few black inclusions throughout up to 5 mm, medium dense. | | |
| | | | | | | Mud rotary drill. | | 210 |
| 70 | SS-18 | X | 19/24 | 15-15-19-23 (34) | | Yellowish red poorly graded Sand (SP) grading to reddish yellow with depth, fine (mostly) to medium, subangular, non-plastic, trace silt, wet, dense. | | |
| | | | | | | Mud rotary drill. | | 205 |
| 75 | SS-19 | X | 24/24 | 2-2-2-3 (4) | | Yellowish brown poorly graded Sand (SP) (upper 13 in), fine to medium, subangular to subrounded, nonplastic, wet, very loose, few pale yellow zones to 25 mm; grading to red clayey Sand (SC) (lower 11 in), sand fine to | | |

(Continued Next Page)

GEOTECH_BLOW COUNT - GINT STD US.GDT - 02/16/12 10:24 - C:\PROGRAM FILES\GINT\PROJECTS\SDU_6.GPJ

Savannah River NUCLEAR SOLUTIONS

Savannah River Nuclear Solutions, Inc.
Savannah River Site
Aiken, SC 29208

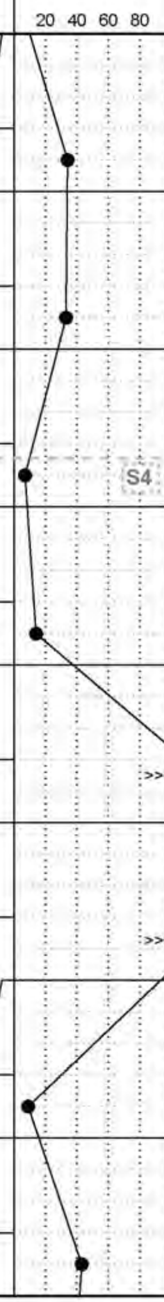
# BORING NUMBER Z-SDU6-B03

PAGE 3 OF 5

**CLIENT** Savannah River Remediation **PROJECT NAME** Saltstone Disposal Unit 6
**PROJECT NUMBER** **PROJECT LOCATION** Z-Area

| Depth (ft) | Sample Type Number | Sample Interval | In. Recovered / In. Driven | Blow Counts (N value) | Graphic Log | Material Description | Elevation (ft) |
|---|---|---|---|---|---|---|---|
| 75 | | | | | | medium and subangular to subround, low plasticity, wet, very loose. | |
| | | | | | | Mud rotary drill. | 200 |
| 80 | SS-20 | X | 18/24 | 3-13-21-32 (34) | | Yellow poorly graded Sand (SP), fine, trace medium sand, little silt, nonplastic, wet, dense; few black zones (6 mm to 12 mm) throughout upper 11 in, hard zone 9 to 10.5 in from bottom. | |
| | | | | | | Mud rotary drill. | 195 |
| 85 | SS-21 | X | 16/24 | 15-16-17-13 (33) | | Strong brown well-graded Sand (SW), fine to medium, subangular to subround, trace fines, nonplastic, wet, dense, lower 13 in pale yellow with few black areas up to 8 mm. | |
| | | | | | | Mud rotary drill. | 190 |
| 90 | SS-22 | X | 24/24 | 3-3-4-6 (7) | | Pale yellow Silt (MH), medium to high plasticity, trace clay, wet, medium soft. | |
| | | | | | | Mud rotary drill. | 185 |
| 95 | SS-23 | X | 24/24 | 9-7-7-7 (14) | | Pale yellow clayey Silt (ML/MH), little sand, fine to coarse, angular to subangular; few gravel, angular to subangular up to 25 mm, hard; wet, weak HCl, medium plasticity, stiff. | |
| | | | | | | Mud rotary drill. | 180 |
| 100 | SS-24 | X | 11/11.5 | 23-104/6" | | Pale yellow clayey Silt (MH), little sand, fine to coarse, angular to subangular; few white gravel, angular to subangular up to 35 mm, hard (silica cementation ?); wet, weak HCl, medium plasticity, very dense. | |
| | | | | | | Mud rotary drill. | 175 |
| 105 | SS-25 | X | 17/17 | 21-47-50/5" | | Pale yellow well-graded Sand (SW) (upper 5 in), fine to medium, clean, nonplastic, wet. Pale yellow Silt (ML) (lower 14 in) with trace white gravel, gravel subangular, weak HCl, hard, few sand; rock in tip of spoon, angular, hard, cemented silt/very fine sand. | |
| | | | | | | Mud rotary drill. | 170 |
| 110 | SS-26 | X | 17/24 | 6-5-4-9 (9) | | Pale yellow to very pale brown silty Sand (SM), sand fine, low plasticity, wet, loose; one inch rock layers at 7 and 12 inches from bottom. | |
| | | | | | | Mud rotary drill. | 165 |
| 115 | SS-27 | X | 24/24 | 11-19-24-46 (43) | | Greenish gray silty Sand (SM), fine; white shell fragments, fine to medium, 25% of soil, moderate HCl; very low plasticity, moist, dense. | |

Blow Count (blows/ft)

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GEOTECH_BLOW COUNT - GINT STD US.GDT - 02/16/12 10:24 - C:\PROGRAM FILES\GINT\PROJECTS\SDU_6.GPJ

Savannah River NUCLEAR SOLUTIONS

Savannah River Nuclear Solutions, Inc.
Savannah River Site
Aiken, SC 29208

# BORING NUMBER Z-SDU6-B03



**CLIENT** Savannah River Remediation **PROJECT NAME** Saltstone Disposal Unit 6

**PROJECT NUMBER** **PROJECT LOCATION** Z-Area

| Depth (ft) | Sample Type Number | Sample Interval | In. Recovered / In. Driven | Blow Counts (N value) | Graphic Log | Material Description | Elevation (ft) |
|---|---|---|---|---|---|---|---|
| 115 | | | | | | Mud rotary drill. | 160 |
| 120 | SS-28 | X | 24/24 | 17-18-19-26 (37) | | Greenish gray silty Sand (SM), fine; white shell fragments, 90% of soil at top grading to 5% at bottom, weak HCl; very low plasticity, moist, dense; grades to dark greenish gray towards bottom. | |
| | | | | | | Mud rotary drill. | 155 |
| 125 | SS-29 | X | 24/24 | 10-13-17-40 (30) | | Dark greenish gray fat Clay (CH), high plasticity, trace fine sand, moist, very stiff. | |
| | | | | | | Mud rotary drill. | 150 |
| 130 | SS-30 | X | 24/24 | 9-10-12-18 (22) | | Greenish black silty fine Sand (SM) grading to dark greenish gray fat Clay with depth; upper sand angular to subangular, low plasticity, moist, medium dense/very stiff, grading to high plasticity with trace fine sand with depth, moist, trace mica throughout. | |
| | | | | | | Mud rotary drill. | 145 |
| 135 | SS-31 | X | 8/8 | 63-50/2" | | Greenish black well graded Sand (SW) with areas of greenish gray Sand (SW), trace silt, well-graded, sand fine to medium and angular to subangular, wet, very dense; fat Clay (CH) (upper 1 in) with dark greenish gray Gravel piece, 30 mm, subangular. | |
| | | | | | | Mud rotary drill. | 140 |
| | SS-32 | | 0/2 | 50/2" | | No recovery. Very dense. | |
| 140 | | | | | | Mud rotary drill. | 135 |
| | SS-33 | | 0/2.5 | 50/3" | | Dark greenish gray, poorly graded fine Sand, trace silt, angular to subangular, nonplastic, wet (sample from shoe), very dense. | |
| 145 | | | | | | Mud rotary drill. | 130 |
| 150 | SS-34 | X | 10/10 | 54-50/4" | | Gray poorly graded Sand (SP) (lower 4 in), fine, angular to subangular, nonplastic, wet, very dense; Very dark gray fat Clay (CH) (mid 4 in), high plasticity, wet, hard, trace fine sand; upper 2 in waste soil. | |
| 155 | | | | | | Mud rotary drill. | 125 |

Blow Count (blows/ft)


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Savannah River NUCLEAR SOLUTIONS
Savannah River Nuclear Solutions, Inc.
Savannah River Site
Aiken, SC 29208

# BORING NUMBER Z-SDU6-B03



**CLIENT** Savannah River Remediation **PROJECT NAME** Saltstone Disposal Unit 6
**PROJECT NUMBER** **PROJECT LOCATION** Z-Area

| Depth (ft) | Sample Type Number | Sample Interval | In. Recovered / In. Driven | Blow Counts (N value) | Graphic Log | Material Description | Blow Count (blows/ft) 20 40 60 80 | Elevation (ft) |
|---|---|---|---|---|---|---|---|---|
| 155 | | | | | | Mud rotary drill. *(continued)* | | 120 |
| | | | | | | Bottom of borehole at 157.0 feet. | | 115 110 105 100 95 90 85 |

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# BORING NUMBER Z-SDU6-B04

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CLIENT Savannah River Remediation
PROJECT NAME Saltstone Disposal Unit 6
PROJECT NUMBER
PROJECT LOCATION Z-Area
DATE STARTED 01/11/12 COMPLETED 01/26/12
GROUND ELEVATION 277.9 ft HOLE SIZE 4 inches
DRILLING CONTRACTOR SAEDACCO
COORDINATES: NORTH 77663.9 EAST 66351.1
DRILLING METHOD Mud rotary
LOGGED BY M. Hasek CHECKED BY [signature]
NOTES SPT

| Depth (ft) | Sample Type Number | Sample Interval | In. Recovered / In. Driven | Blow Counts (N value) | Graphic Log | Material Description | Blow Count (blows/ft) 20 40 60 80 | Elevation (ft) |
|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | Mud rotary drill. | | |
| | | | | | | | | 275 |
| 5 | | | | | | | | |
| | | | | | | | | 270 |
| 10 | | | | | | | | |
| | | | | | | | | 265 |
| 15 | SS-01 | X | 18/24 | 17-22-23-20 (45) | | Red silty well graded Sand (SW-SM), mostly fine sand, little medium sand, subangular, well graded, moist, dense. | | |
| | SS-02 | X | 15/24 | 7-8-7-9 (15) | | Red sandy Silt (ML), trace clay, fine sand subangular, low plasticity; upper 4 in trace subround medium sand, moist, medium dense. | | 260 |
| 20 | SS-03 | X | 13/24 | 6-6-11-18 (17) | | Red silty Sand (SM), upper 2 in medium sand, subround, nonplastic, moist; lower 11 in silty poorly graded Sand (SP-SM), fine sand, angular to subangular, nonplastic, moist, medium dense. | | |
| | SS-04 | X | 20/24 | 15-15-18-24 (33) | | Red clayey, sandy Silt (MH) (lower 18 in), little sand, little clay, sand fine to medium and subangular, medium plasticity, moist, hard, upper 2 in preferentially sorted during SPT. | | |
| | SS-05 | X | 18/24 | 8-9-10-15 (19) | | Red clayey Silt (MH), few sand fine to medium and subangular to subround, medium plasticity, moist, very stiff, few yellow mottles, yellow layer from 12 to 15 in above bottom. | | 255 |
| 25 | SS-06 | X | 19/24 | 8-10-11-15 (21) | | Red sandy Silt (ML), few clay, some sand fine to medium and subangular to subround, medium plasticity, moist, very stiff, few yellow mottles. | | |
| | SS-07 | X | 18/24 | 8-11-13-17 (24) | | Red silty poorly graded Sand (SP-SM), trace clay, medium sand, poorly graded, subangular to subround, low plasticity, few yellow mottles, moist, medium dense. | | 250 |
| 30 | SS-08 | X | 16/24 | 7-15-16-18 (31) | | Red silty Sand (SM), some silt, trace clay, fine to medium sand subangular to subround, low plasticity, few yellow mottles, moist, dense. | | |
| | SS-09 | X | 18/24 | 12-15-18-31 (33) | | Red silty Sand (SM), some silt, trace clay, fine to medium sand subangular to subround, low plasticity, few yellow mottles, moist, dense. | | |
| | SS-10 | X | 14/24 | 11-17-19-27 (36) | | Red silty Sand (SM) grading to yellowish red poorly graded Sand (SP) with depth, sand fine and angular to subangular, trace fines, nonplastic, moist, dense. | | 245 |
| 35 | | X | 15/24 | 14-17-22-30 | | | | |

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Aiken, SC 29208

# BORING NUMBER Z-SDU6-B04



**CLIENT** Savannah River Remediation **PROJECT NAME** Saltstone Disposal Unit 6

**PROJECT NUMBER** **PROJECT LOCATION** Z-Area

| Depth (ft) | Sample Type Number | Sample Interval | In. Recovered / In. Driven | Blow Counts (N value) | Material Description | Elevation (ft) |
|---|---|---|---|---|---|---|
| 35 | SS-11 | X | 15/24 | (39) | Reddish yellow poorly graded Sand (SP), medium sand, subangular to subround, trace fine sand, trace silt, nonplastic, moist, dense. *(continued)* | |
| | SS-12 | X | 12/24 | 13-19-21-26 (40) | Reddish yellow well graded Sand (SW), medium sand, subangular to subround, little fine sand, trace silt, nonplastic, moist, dense. | 240 |
| 40 | SS-13 | X | 10/24 | 6-17-23-31 (40) | Reddish yellow well graded Sand (SW), medium sand, subangular to subround, little fine sand, trace silt, nonplastic, moist, dense. | |
| | SS-14 | X | 15/24 | 16-12-18-24 (30) | Reddish yellow well graded Sand (SW), medium sand, subangular to subround, little fine sand, trace silt, nonplastic, moist, medium dense; Dark red at 0 to 3 in from bottom and 5 to 5.5 in from bottom. | |
| | | | | | Mud rotary drill. (C2) | 235 |
| 45 | SS-15 | X | 15/24 | 9-13-13-15 (26) | Reddish yellow sandy Clay (CL), fine sand, subangular to subround, trace silt, low plasticity, moist, very stiff; upper 2 in and lower 3 in yellow fat Clay (CH), few fine sand. | |
| | | | | | Mud rotary drill. (S3) | 230 |
| 50 | SS-16 | X | 12/24 | 11-14-18-26 (32) | Brownish yellow clayey poorly graded Sand (SP-SC), fine sand, angular to subangular, little clay, low plasticity, moist, dense; sandy clay peds throughout up to 8 mm. | |
| | | | | | Mud rotary drill. | 225 |
| 55 | SS-17 | X | 13/24 | 13-17-22-30 (39) | Brownish yellow poorly graded Sand (SP), fine sand, subangular, trace clay, nonplastic, moist, dense; sandy clay peds throughout up to 10 mm. | |
| | | | | | Mud rotary drill. | 220 |
| 60 | SS-18 | X | 18/24 | 9-7-7-20 (14) | Yellow clayey poorly graded Sand (SP-SC), fine sand, angular to subangular, low plasticity, grading to sandy Clay with depth (CL), medium plasticity, moist, medium dense/stiff. | |
| | | | | | Mud rotary drill. | 215 |
| 65 | SS-19 | X | 14/24 | 14-17-23-31 (40) | Brownish yellow poorly graded Sand (SP), fine to medium sand, angular to subangular, trace clay, nonplastic, moist, dense. | |
| | | | | | Mud rotary drill. | 210 |
| 70 | SS-20 | X | 12/24 | 12-16-20-26 (36) | Brownish yellow silty poorly graded Sand (SP-SM), fine (mostly) to medium sand, subangular, very low plasticity, wet, dense; lower 2.5 in dark yellowish brown, mostly fine sand, subangular. | |
| | | | | | Mud rotary drill. | 205 |
| 75 | SS-21 | X | 24/24 | 5-2-5-3 (7) | Dark brownish gray silty poorly graded Sand (SP-SM) (upper 4 in), sand fine to medium, subangular, nonplastic, wet; Dark gray fat Clay (CH) (13 to 16 in from bottom), trace fine sand, high plasticity, wet; Brownish yellow sandy | |

Blow Count (blows/ft): 20 40 60 80

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Savannah River NUCLEAR SOLUTIONS

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Savannah River Site
Aiken, SC 29208

# BORING NUMBER Z-SDU6-B04

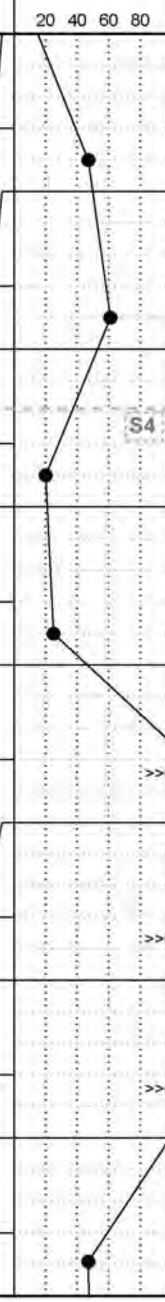


**CLIENT** Savannah River Remediation **PROJECT NAME** Saltstone Disposal Unit 6

**PROJECT NUMBER** **PROJECT LOCATION** Z-Area

| Depth (ft) | Sample Type Number | Sample Interval | In. Recovered / In. Driven | Blow Counts (N value) | Graphic Log | Material Description | Elevation (ft) |
|---|---|---|---|---|---|---|---|
| 75 | | | | | | Clay (CL) (lower 13 in), few fine sand, angular to subangular, high plasticity, wet, loose/medium soft. | |
| | | | | | | Mud rotary drill. | 200 |
| 80 | SS-22 | X | 18/24 | 12-20-27-44 (47) | | Brownish yellow poorly graded Sand (SP) (upper 3 in), medium, angular, nonplastic, wet; Pale yellow to brownish yellow poorly graded Sand (SP) (middle 12 in), fine to medium sand, angular to subangular, nonplastic, wet, dense; Weak red poorly graded Sand (SP) (lower 3 in), fine to medium, angular to subangular, nonplastic, wet. | |
| | | | | | | Mud rotary drill. | 195 |
| 85 | SS-23 | X | 13/24 | 18-28-33-30 (61) | | Brownish yellow to pale yellow poorly graded Sand (SP), fine (mostly) to medium, subangular to subround, nonplastic, wet, very dense. | |
| | | | | | | Mud rotary drill. | |
| | | | | | | S4 | 190 |
| 90 | SS-24 | X | 24/24 | 8-8-12-17 (20) | | Pale yellow clayey Silt (ML/MH), few clay, moderatetly plastic, wet, very stiff, weak HCl Rx; trace white gravel, subangular, very hard, up to 25 mm. | |
| | | | | | | Mud rotary drill. | 185 |
| 95 | SS-25 | X | 24/24 | 11-13-12-26 (25) | | Pale brown clayey Silt (ML/MH), few sand, moderatetly plastic, wet, very stiff, weak HCl Rx; fractured rock and few gravel, very hard, angular to subangular, very hard, up to 25 mm. | |
| | | | | | | Mud rotary drill. | 180 |
| 100 | SS-26 | X | 10/10 | 22-50/4" | | Pale yellow clayey Silt (MH), medium plasticity, very weak HCl Rx, moist, hard; white rock layer from 5 to 6.5 in from bottom, very hard arenaceous carbonate, strong HCl Rx; few white gravel, subangular to subround, very hard. | |
| | | | | | | Mud rotary drill. | 175 |
| 105 | SS-27 | X | 21/16 | 9-22-50/4" | | Pale yellow clayey Silt (MH), medium to high plasticity, weak to strong HCl Rx, moist, hard; tip packed with hard, weathered rock (2 in). | |
| | | | | | | Mud rotary drill. | 170 |
| 110 | SS-28 | X | 10/10 | 29-50/4" | | Greenish gray clayey Silt (ML/MH), medium to high plasticity, strong HCl Rx, moist, hard; Greenish gray rock 1 in thick from 4 to 5 in from bottom, fractured, hard, weak HCl Rx. | |
| | | | | | | Mud rotary drill. | 165 |
| 115 | SS-29 | X | 24/22 | 12-19-28-50/4" (47) | | Greenish gray clayey Sand (SC), mostly sand-sized white and dark brown shell fragments (fragments up to 5 mm), little clay, medium plasticity, medium to strong HCl Rx, moist, dense. | |

Blow Count (blows/ft)

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Savannah River NUCLEAR SOLUTIONS

Savannah River Nuclear Solutions, Inc.
Savannah River Site
Aiken, SC 29208

# BORING NUMBER Z-SDU6-B04



**CLIENT** Savannah River Remediation
**PROJECT NAME** Saltstone Disposal Unit 6
**PROJECT NUMBER**
**PROJECT LOCATION** Z-Area

| Depth (ft) | Sample Type Number | Sample Interval | In. Recovered / In. Driven | Blow Counts (N value) | Graphic Log | Material Description | Elevation (ft) |
|---|---|---|---|---|---|---|---|
| 115 | | | | | | Mud rotary drill. | 160 |
| 120 | SS-30 | | 24/24 | 14-21-28-50 (49) | | Greenish gray clayey Sand (SC), mostly sand-sized white and dark brown shell fragments (fragments up to 5 mm), little clay, medium plasticity, medium to strong HCl Rx, moist, dense; light greenish gray upper 11 in. | |
| | | | | | | Mud rotary drill. | 155 |
| 125 | SS-31 | | 24/24 | 8-10-20-48 (30) | | Greenish black sandy Clay (CL) (upper 12 in), trace silt; some sand, mostly fine and angular, few medium subangular; silty laminations < 3 mm thick from 11 to 15 in from bottom, high plasticity, moist, very stiff; Dark greenish gray sandy Clay (CH) (lower 12 in), high plasticity, moist, very stiff. | |
| | | | | | | Mud rotary drill. | 150 |
| 130 | SS-32 | | 24/24 | 8-14-18-23 (32) | | Greenish black sandy Clay (CL) (upper 12 in); some fine angular sand, few subangular to subround medium sand, medium plasticity, moist, hard. | |
| | | | | | | Mud rotary drill. | 145 |
| 135 | SS-33 | | 11/11 | 21-50/5" | | Dark greenish gray sandy Clay (CL/CH) (upper 2 in), high plasticity, wet; Dark greenish gray well graded Sand (SW) (lower 9.5 in), mostly subangular fine sand, few subround medium sand, trace clay, nonplastic, wet, very dense. | |
| | | | | | | Mud rotary drill. | 140 |
| 140 | SS-34 | | 2/4 | 50/4" | | Greenish gray well graded Sand (SW), trace clay, fine sand, angular to subangular, nonplastic, wet, very dense. | |
| | | | | | | Mud rotary drill. | 135 |
| 145 | SS-35 | | 0/2 | 50/2" | | Dark greenish gray poorly graded Sand (SP), mostly subangular fine sand, few subangular to subround medium sand, trace silt, nonplastic, wet, very dense. | |
| | | | | | | Mud rotary drill. | 130 |
| 150 | SS-36 | | 0/2 | 50/2" | | Dark gray poorly graded Sand (SP), fine sand, subangular, nonplastic, wet, very dense. | |
| 155 | | | | | | Mud rotary drill. | 125 |


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Savannah River Nuclear Solutions, Inc.
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# BORING NUMBER Z-SDU6-B04



**CLIENT** Savannah River Remediation **PROJECT NAME** Saltstone Disposal Unit 6
**PROJECT NUMBER** **PROJECT LOCATION** Z-Area

| Depth (ft) | Sample Type Number | Sample Interval | In. Recovered / In. Driven | Blow Counts (N value) | Graphic Log | Material Description | Blow Count (blows/ft) 20 40 60 80 | Elevation (ft) |
|---|---|---|---|---|---|---|---|---|
| 155 | | | | | | Mud rotary drill. *(continued)* | | |
| | SS-37 | | 3/4 | 50/4" | | Greenish black well graded Sand (SW), fine to medium sand, subangular, trace silt, nonplastic, wet, very dense. | >> | 120 |
| 160 | | | | | | Mud rotary drill. | | 115 |
| 165 | | | | | | | | |
| | SS-38 | | 0/3 | 50/3" | | Grayish brown poorly graded Sand (SP), fine sand, angular to subangular, trace medium sand, trace silt, nonplastic, wet, very dense. | >> | 110 |
| 170 | | | | | | Mud rotary drill. | | 105 |
| 175 | | | | | | | | |
| | SS-39 | | 2/4 | 50/4" | | Black well graded silty Sand (SW-SM), fine to medium sand, subangular to subround; little silt, trace clay, nonplastic, wet, very dense. | >> | 100 |
| 180 | | | | | | Mud rotary drill. | | 95 |
| 185 | | | | | | | | 90 |
| | SS-40 | | 8/11 | 50-50/5" | | Gray poorly graded Sand (SP), fine to medium, angular to subangular, nonplastic, wet, black inclusions (lignite?) up to 30% of sample, very dense. | >> | |
| 190 | | | | | | Mud rotary drill. | | 85 |
| 195 | | | | | | | | |

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Savannah River Site
Aiken, SC 29208

# BORING NUMBER Z-SDU6-B04



**CLIENT** Savannah River Remediation
**PROJECT NAME** Saltstone Disposal Unit 6
**PROJECT NUMBER**
**PROJECT LOCATION** Z-Area

| Depth (ft) | Sample Type Number | Sample Interval | In. Recovered / In. Driven | Blow Counts (N value) | Graphic Log | Material Description | Blow Count (blows/ft) 20 40 60 80 | Elevation (ft) |
|---|---|---|---|---|---|---|---|---|
| 195 | | | | | | Mud rotary drill. *(continued)* | | |
| | SS-41 | | 0/2 | 50/2" | | Dark grayish brown poorly graded Sand (SP), medium, subangular, nonplastic, wet, very dense. | >> | 80 |
| 200 | | | | | | Mud rotary drill. | | 75 |
| 205 | | | | | | | | 70 |
| | SS-42 | | 11/18 | 47-27-50 (77) | | Greenish gray poorly graded Sand (SP), medium sand, subangular; little fine sand, angular to subangular; nonplastic, wet, very dense. | | |
| 210 | | | | | | Mud rotary drill. | | 65 |
| 215 | | | | | | | | 60 |
| | SS-43 | | 6/10 | 32-50/4" | | Dark greenish gray poorly graded Sand (SP), medium, subangular; little fine sand, subangular; nonplastic, wet, very dense, slightly sulfurous; lower 1 in cohesive, medium sand. | >> | |
| 220 | | | | | | Mud rotary drill. | | 55 |
| 225 | | | | | | | | 50 |
| | SS-44 | | 16/22 | 29-26-46-50/4" (72) | | Dark gray poorly graded Sand (SP), medium sand, subangular; trace fine sand, nonplastic, wet, very dense; dark gray clayey poorly graded Sand (SP-SC), 7.5 to 10 in from bottom, medium sand, subangular, little clay, trace fine sand, low plasticity. | | |
| 230 | | | | | | Mud rotary drill. | | 45 |
| 235 | | | | | | | | |

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Savannah River Nuclear Solutions, Inc.
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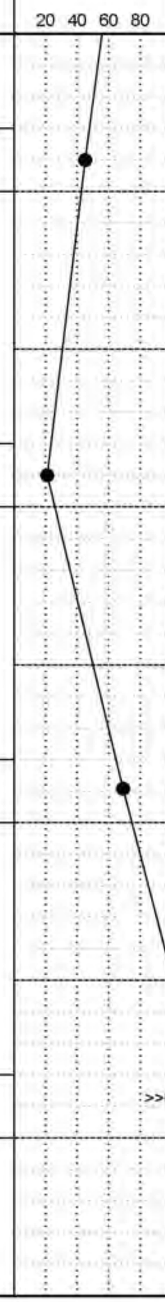
Aiken, SC 29208

# BORING NUMBER Z-SDU6-B04



**CLIENT** Savannah River Remediation
**PROJECT NAME** Saltstone Disposal Unit 6
**PROJECT NUMBER**
**PROJECT LOCATION** Z-Area

| Depth (ft) | Sample Type Number | Sample Interval | In. Recovered / In. Driven | Blow Counts (N value) | Graphic Log | Material Description | Elevation (ft) |
|---|---|---|---|---|---|---|---|
| 235 | | | | | | Mud rotary drill. *(continued)* | |
| | SS-45 | X | 0/24 | 12-18-27-50 (45) | | Dark gray sandy Silt (ML), very fine sand, low plasticity, wet, hard. | 40 |
| 240 | | | | | | Mud rotary drill. | 35 |
| 245 | | | | | | | 30 |
| | SS-46 | X | 24/24 | 7-8-13-21 (21) | | Grayish green clayey Sand (SC), fine to predominantly medium sand, subangular, low plasticity, moist, medium dense, slightly sulfurous. | |
| 250 | | | | | | Mud rotary drill. | 25 |
| 255 | | | | | | | 20 |
| | SS-47 | X | 16/22 | 21-32-37 (69) | | Dark gray poorly graded Sand (SP), sand predominatly fine to medium, subangular, trace silt, trace clay, nonplastic, wet, very dense. | |
| 260 | | | | | | Mud rotary drill. | 15 |
| 265 | | | | | | | 10 |
| | SS-48 | X | 15/17 | 25-38-50/5" | | Gray silty poorly graded Sand (SP-SM), predominantly fine to medium sand, angular to subangular, little mica, few silt, trace clay, nonplastic, wet, very dense, moderately sulfurous. | |
| 270 | | | | | | Mud rotary drill. | 5 |
| 275 | | | | | | | |

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Aiken, SC 29208

# BORING NUMBER Z-SDU6-B04

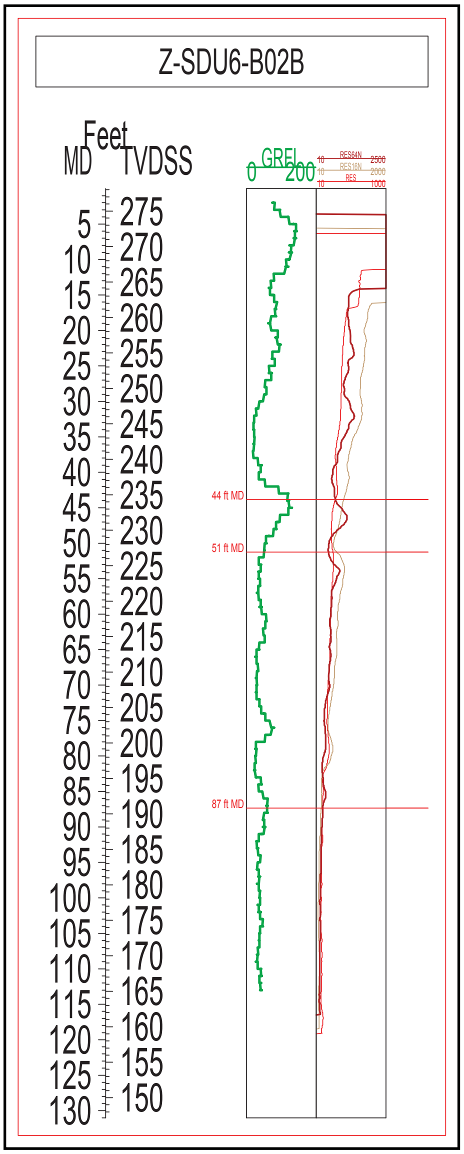


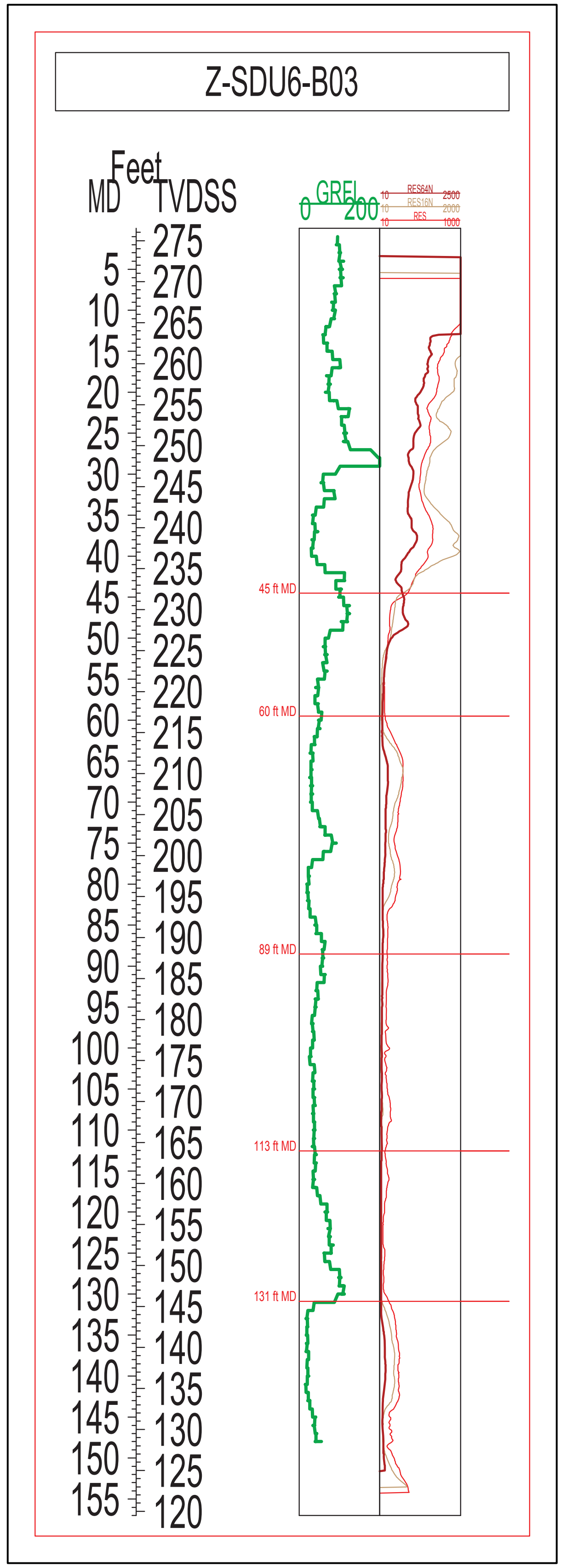
**CLIENT** Savannah River Remediation **PROJECT NAME** Saltstone Disposal Unit 6
**PROJECT NUMBER** **PROJECT LOCATION** Z-Area

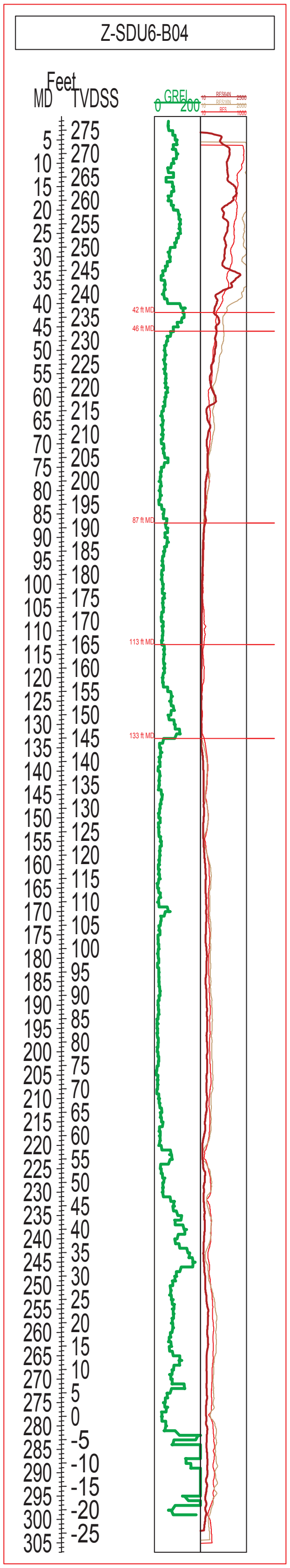
| Depth (ft) | Sample Type Number | Sample Interval | In. Recovered / In. Driven | Blow Counts (N value) | Graphic Log | Material Description | Blow Count (blows/ft) 20 40 60 80 | Elevation (ft) |
|---|---|---|---|---|---|---|---|---|
| 275 | | | | | | Mud rotary drill. *(continued)* | | |
| | SS-49 | | 10/18 | 33-55-50 (105) | | Gray poorly graded Sand (SP), fine to predomantly medium, subangular to subround, trace mica, nonplastic, wet, very dense, slightly sulfurous. | >> | 0 |
| 280 | | | | | | Mud rotary drill. | | -5 |
| 285 | | | | | | | | |
| | SS-50 | | 7/10 | 44-50/4" | | Light gray poorly graded Sand (SP), medium sand, subangular, trace fine sand, trace kaolin, few mica, wet, very dense. | >> | -10 |
| 290 | | | | | | Mud rotary drill. | | -15 |
| 295 | | | | | | | | |
| | SS-51 | | 4/5 | 50/5" | | Light gray poorly graded Sand (SP), medium, subangular, trace mica, nonplastic, wet, very dense. | >> | -20 |
| 300 | | | | | | Mud rotary drill. | | -25 |
| 305 | | | | | | | | |
| | | | | | | Bottom of borehole at 307.0 feet. | | -30 |
| | | | | | | | | -35 |

GEOTECH_BLOW COUNT - GINT STD US.GDT - 02/16/12 10:24 - C:\PROGRAM FILES\GINT\PROJECTS\SDU_6.GPJ

**Attachment 3: Geophysical Logging Curves**




Z-SDU6-B04
Feet
MD TVDSS
GREI
0 200
42 ft MD
46 ft MD
87 ft MD
113 ft MD
133 ft MD

**Appendix B – Test Data / Soil Properties**

K-CLC-Z-00023, Rev. 0

March 2012

Soil Design Parameters from Field and Laboratory Testing for Saltstone Disposal Unit 6

(58 pages)

OSR 45-24 (Rev 1-20-2009)

# Calculation Cover Sheet

| | | |
|---|---|---|
| **Project/Task**<br>**Saltstone Disposal Unit 6** | **Calculation No.**<br>**K-CLC-Z-00023** | **Project /Task No.**<br>**SDU6** |
| **Title**<br>**Soil Design Parameters from Field and laboratory Testing for Saltstone Disposal Unit 6** | **Functional Classification**<br>**PS** | **Sheet 1 of 57** |
| | **Discipline**<br>**Geotechnical** | |
| **Calc Level**<br>☒ Type 1 ☐ Type 2 | **Type 1 Calc Status**<br>☐ Preliminary ☒ Confirmed | |
| **Computer Program No.**<br>Excel 2010 ☐ N/A | **Version / Release No.**<br>N/A | |
| **Purpose and Objective**<br>The reduction and evaluation of field and laboratory data and the development of soil engineering design parameters are performed for the determination of soil engineering properties at the Saltstone Disposal Unit 6 site. | **DC/RO**<br>UNCLASSIFIED<br>DOES NOT CONTAIN UNCLASSIFIED CONTROLLED NUCLEAR INFORMATION<br>ADC & Reviewing Official: [signature] (Name)<br>Date: 3/20/12 | |

**Summary of Conclusion**

The recommended soil design parameters are given in Section 6.

**Revisions**

| Rev. # | Revision Description |
|---|---|
| 0 | Original |
| | |

**Sign Off**

| Rev. # | Originator (Print) Sign / Date | Verification / Checking Method | Verifier/Checker (Print) Sign/Date | Manager (Print) Sign / Date |
|---|---|---|---|---|
| 0 | Michael J. Hasek<br>[signature] 03/19/2012 | ☐ Design Check (GS/PS Only)<br>☒ Document Review<br>☐ Qualification Testing<br>☐ Alternate Calculation<br>☐ Operational Testing | Rucker J. Williams<br>[signature] 3-19-12 | Nick Kennedy<br>[signature] 3-20-12 |
| | | ☐ Design Check (GS/PS Only)<br>☒ Document Review<br>☐ Qualification Testing<br>☐ Alternate Calculation<br>☐ Operational Testing | | |

| | | |
|---|---|---|
| **Additional Reviewer (Print)**<br>N/A | **Signature** | **Date** |
| **Design Authority (Print)**<br>N/A | **Signature** | **Date** |
| **Release to Outside Agency (Print)**<br>N/A | **Signature** | **Date** |
| **Security Classification of the Calculation**<br>Unclassified | | |

**Table of Contents**

## 1. Introduction

The purpose of this calculation is to provide soil design properties for the 375-ft diameter foundation of the Saltstone Disposal Unit No. 6 vault located in Z-area (Figure 1). Geotechnical test data were obtained from field exploration and testing and laboratory testing. Field tests that were performed included cone penetration tests (CPT), seismic cone penetration tests (SCPT), and standard penetration tests (SPT) (Figure 2). Soil samples were recovered for laboratory testing using a fixed piston tube sampler and a split spoon sampler. The laboratory tests included consolidated undrained triaxial compression, consolidation, moisture content, Atterberg limits, unit weight, and grain size distribution. The data from the test results were reduced, correlated, and summarized and the soil design properties are presented for the design of the tank foundation.

## 2. Input Data

Input data was obtained from the results of field exploration and testing and laboratory testing. The data obtained from the CPT included cone tip stress ($q_c$), corrected cone tip stress ($q_t$), excess pore pressure ($u_2$), sleeve stress ($f_s$) and the SCPT provided an additional test - shear wave and compressive wave velocities in the soil. The estimated unit weight based on the soil behavior type (SBT) index was also derived from the CPT data. Blow counts were obtained from the SPT, which simultaneously retrieved split spoon soil samples for descriptions and laboratory index tests.

Index tests included Atterberg limits, grain size distribution, and moisture content. Undisturbed samples were retrieved from boreholes using both a fixed-piston sampler and a Shelby thin-walled tube sampler. Soils were extracted from the tubes and tested in triaxial compression in the laboratory to determine the total cohesion and total friction angle and the effective cohesion and effective friction angle (c and $\phi$ and $c'$ and $\phi'$, respectively) and the total and dry unit weight ($\gamma_t$ and $\gamma_d$, respectively) and the natural moisture content ($w_n$). Consolidation tests were performed to obtain the initial void ratio ($e_o$), compression index ($C_c$), the recompression index (treated as synonymous with swelling index) ($C_r$), and the preconsolidation stress ($\sigma'_p$) for use in settlement analysis.

## 3. Assumptions

The following aspects are assumed for the design calculation:

1. The blow count (N) as generated in the field maintains an energy efficiency of 60% and is equal to $N_{60}$, and
2. The swelling index ($C_s$) used in older reports is approximately defined as the recompression index ($C_r$).

## 4. Methods and Calculations

### 4.1 Cone Penetration Test

The locations and penetration depths of the Cone Penetration Tests (CPT) are given in Table 1. The CPT yields data that is used to calculate numerous values, such as uncorrected tip stress ($q_c$), corrected tip stress ($q_t$), sleeve stress ($f_s$), pore pressure ($u_2$), and friction ratio ($F_R$). For the purpose of determining soil properties, the corrected and normalized tip stress ($q_{t1}$) is expressed as follows:

$$q_{t1} = C_Q \cdot q_t$$

$$C_Q = (p_a/\sigma'_{vo})^{0.5} \qquad \text{(Liao and Whitman, 1986)}$$

$p_a$ = reference pressure in same units as $\sigma'_{vo}$

(100 kPa ≈ 1 atm ≈ 1 ton/ft$^2$ = 2000 lb/ft$^2$)

$\sigma'_{vo}$ = effective vertical stress

All of the CPT data is found in the report by Lankelma, Inc. (2012). The values are compared to the unit weights of the triaxial and consolidation specimens.

### 4.2 Standard Penetration Test

The locations and penetration depths of the Standard Penetration Tests (SPT) are given in Table 2. Soil samples obtained during the tests are listed in Tables 3 and 4. The method of measurement for the SPT, referred to as the blow count, is performed by summing the two middle (6-inch) drive intervals during the SPT test. It requires normalization to 1 ton/ft$^2$ to account for the variation in vertical overburden stress. It is determined as:

$$N_1 = C_N \cdot N$$

N = measured blow count

$C_N$ = normalization coefficient

$$C_N = (p_a/\sigma'_{vo})^{0.5} \qquad \text{(Liao and Whitman, 1986)}$$

$p_a$ = reference pressure in same units as $\sigma'_{vo}$

(100 kPa ≈ 1 atm ≈ 1 ton/ft$^2$ = 2000 lb/ft$^2$)

$\sigma'_{vo}$ = effective vertical stress

It was assumed that no energy correction is necessary for the blow count because the SPT hammer operates at an energy ratio above 60%. Therefore:

$$N = N_{60}$$

and $$N_{1,60} = N_1$$

### 4.3 Shear Strength Properties

Undisturbed soil samples were used for determining the shear strength properties of the soils. The samples were retrieved from the boreholes and depths as listed in Table 5. Isotropically-consolidated triaxial compression tests were performed in the laboratory. The shear strength data was compared to the effective friction angle that was calculated using relationships that have been established between the effective friction angle and the CPT and the SPT. Estimates of the effective friction angle ($\phi'$) for granular, cohesionless soil can be obtained by the following relationships based on the normalized, corrected tip stress ($q_{t1}$) of the CPT as follows:

$$\phi' = 17.6 + 11.0\cdot\log(q_{t1})$$ (Kulhawy and Mayne, 1990)

Friction angle relationships that are based on the SPT blow count include:

$$\phi' = 27.1 + 0.3\cdot N_{1,60} - 0.00054\cdot(N_{1,60})^2$$ (Peck, Hanson, and Thornburn, 1974)

$$\phi' = \tan^{-1}\cdot[N_{60}/(12.2 + 20.3\cdot(\sigma'_o/p_a)]^{0.34}$$ (Schmertmann, 1975)

$$\phi' = (20\cdot N_{1,60})^{0.5} + 20$$ (Hatanaka and Uchida, 1996)

The variables are defined as: $N_{60}$ = energy-corrected blow count

$N_{1,60}$ = normalized, energy-corrected blow count

$\sigma'_o$ = effective vertical stress

$p_a$ = reference pressure in same units as $\sigma'_o$

(100 kPa ≈ 1 atm ≈ 1 ton/ft$^2$ = 2000 lb/ft$^2$)

Total and effective cohesion and friction angle were obtained from isotropically consolidated undrained triaxial tests with pore pressure measurements per ASTM D 4767.

### 4.4 Consolidation Test

Consolidation tests were performed on undisturbed tube samples. The pre-consolidation pressure ($\sigma'_p$) was determined using the Casagrande method (ASTM D 2435). Other properties included the initial void ratio ($e_o$), over-consolidation ratio (OCR), compression index ($C_c$), re-compression index ($C_r$), and $C_c/C_r$.

### 4.5 Unit Weight and Moisture Content

The total and dry unit weights (based on the subcontractor's procedure TP-4) (AMEC, 2012) and the moisture content (ASTM D 2216) were determined from the triaxial compression specimens, the hydraulic conductivity specimen, and the consolidation specimens. The disturbed soils obtained from the split spoon sampler (Tables 3 and 4) were used to determine only moisture content. Moisture content from the split spoon samples is not considered to be accurate because the soils of lesser cohesion become very disturbed during the dynamic driving process and there is a redistribution of moisture within the soil. In addition, the total unit weight was estimated using the CPT data based on the soil behavior type (SBT) classification as discussed in Lunne et al. (2001).

### 4.6 Atterberg Limits

Atterberg limit tests (liquid limit and plastic limit) were performed in accordance with ASTM D 4318.

### 4.7 Grain Size Distribution

The grain size proportions and distribution of the disturbed soil from the split spoon sampler were determined according to ASTM D 422. Both the sieve and hydrometer tests were performed.

### 4.8 Hydraulic Conductivity

One hydraulic conductivity test was performed per the test standard ASTM D 5084.

### 4.9 Soil Layer Definitions

Soil layers were defined as contained in Calculation No. K-CLC-Z00022 and are presented in Table 6.

## 5. Results

### 5.1 Shear Strength Properties

The shear strength properties derived from the CPT, SPT, and isotropically-consolidated triaxial compression tests (AMEC, 2012) yielded values of total cohesion and total friction angle and effective cohesion and effective friction angle. The effective friction angle was calculated using four different methods in addition to the triaxial test results. As shown in Figure 3 (Boreholes B01 and B03 and CPT C16), the effective friction angles from the triaxial tests are in good agreement with the Kulhawy and Mayne (1990) method using the CPT. The Kulhawy and Mayne method is also in best agreement with the SPT-based method by Hatanaka and Uchida (1996). Based on the agreement of these, the effective friction angle estimated by Hatanaka and Uchida is assumed to hold true for soils below the final depth of the CPT. Likewise, Figure 4 (Borehole B04 and CPT C11) shows good agreement between the Kulhawy and Mayne method and the Hatanaka and Uchida method.

Figure 5 (Z-SDU6-C05) shows one effective friction angle value from a triaxial test plotted relative to the effective friction angle curve using the method of Kulhawy and Mayne. As with the previous, this shows good agreement.

The effective friction angle envelope shown in Figure 6 was developed from the CPT-based friction angle determination. This provides an upper bound effective friction angle from the ground surface to an elevation of about 144 ft, MSL (depth of about 137 ft). The friction angles range from 21 to 36 degrees. Effective friction angles below 137 ft can be estimated from the Hatanaka and Uchida relationship as shown in Figure 4. Very high friction angles occur and a limit is placed on these. Subsequently, the upper bound envelope is shown in Figure 4 with a maximum effective friction angle of 40 degrees.

The results of the triaxial tests are given in Table 7 for specimens tested at different depths. Additional strength data was obtained from adjacent projects in Z-Area, including Vaults 2, 3, and 5 and is included in Tables 8 and 9. Section 6 contains a summary of the strength data and the recommendations for design parameters and Figures 4 and 6 contain the effective friction angles.

### 5.2 Unit Weight and Moisture Content

The total unit weight determined from the soil specimens compares favorably with the total unit weights determined from the CPT SBT classification (Robertson). This is shown in Figures 7 and 8. The unit weight and moisture content for the test specimens are given in Table 10 in addition to data obtained from the undeveloped 6/7 area. More unit weight and moisture content data was available from testing at Vault 2 (WSRC, 2006) and Vaults 3 and 5 (SRNS, 2010) as shown in Tables 11 and 12, respectively. The ranges of total unit weight are given in Section 6 with the recommended values for design parameters.

### 5.3 Grain Size Distribution

The grain size distribution of the soils is given in Tables 13 and 14. Table 13 presents the proportions according to sieve size, whereas Table 14 presents the soil proportions by the grain categories – gravel, sand, silt, clay, and the percentage finer than the #200 sieve. Gravel content ranges from 0 to 28%, sand content ranges from 2 to 94%, and the less than #200 sieve (fines) ranges from 6 to 98%. Not all analyses differentiated between the silt and clay fractions. The D50 for the soils ranged from 0.002 to 0.520 mm. The grain size data is not used in the design for the tank foundation.

### 5.4 Atterberg Limits

The Atterberg limits were determined for some of the SDU 6 soils and are given in Table 15 with the USCS classification. The Atterberg limits were useful for determining the soil type.

### 5.5 Consolidation Properties

Consolidation properties were obtained from five sources for comparison with the consolidation properties of the soil from SDU 6 and SDU 6/7 that are given in Table 16. The additional consolidation properties were from the Z-area sites of Vault 1 (Table 17), SDU Vault 2 (Table 18), SDU Vaults 3 and 5 (Table 19), a previous investigation for SDU 6 that was designated SDU6/7 (Table 16), and the Defense Waste Processing Facility in S-Area (Table 20). The ranges of $e_o$, $C_c$, and $C_r$ and $C_s$ are given in Section 6.

### 5.6 Hydraulic Conductivity

The hydraulic conductivity of one sample from Z-SDU6-B02, FPT02 from 47 to 49 ft yielded a hydraulic conductivity of 8.5 x $10^{-8}$ cm/sec.

### 5.7 Groundwater Elevation

The groundwater depth was estimated at about 60 ft below the ground surface. This is based on work performed at the SDU67 site near the SDU6 site. Inclusive of a seasonal watertable fluctuation, the watertable elevation ranges from about 215 to 221 ft MSL. Observation wells installed in February 2012 north of Vault 2 indicated a water elevation of 215 ft, MSL (undocumented source).

## 6. Conclusions and Recommendations

Based on the results from field and laboratory testing, the following conclusions and recommendations are made with respect to soil design parameters for the foundation of the SDU 6 storage tank:

1. The effective friction angle varies with depth as shown in Figures 4 and 6.

2. The ranges of total cohesion, total friction angle, effective cohesion, total unit weight, and consolidation properties are included in the following table with the recommended design value in parentheses.

| Layer | $\gamma_t$ (lb/ft$^3$) | $e_o$ | $\sigma'_p$ (lb/ft$^2$) | $C_c$ | $C_r$ and $C_s$ | $\phi$ (deg) | c (lb/ft$^2$) | c′ (lb/ft$^2$) |
|---|---|---|---|---|---|---|---|---|
| S1/S2 | 110 - 130 (123) | 0.57 - 0.65 (0.63) | 6000 – 14600 (10200) | 0.04 - 0.10 (0.06) | 0.005 - 0.009 (0.007) | 8 - 36 (32) | 250 - 2808 (725) | 50 - 440 (275) |
| C2 | 93 - 122 (106) | 1.25 - 1.99 (1.35) | 3700 – 16800 (4500) | 0.37 - 1.23 (0.58) | 0.05 - 0.14 (0.10) | 9 - 15 (11) | 640 - 1230 (950) | 0 - 376 (175) |
| S3 | 107 - 124 (116) | 0.57 - 1.62 (0.76) | (3400 – 26000 (6600) | 0.030 - 0.80 (0.23) | 0.008 - 0.083 (0.03) | --- | --- | --- |
| S4 | 114 - 122 (119) | 0.92, 0.92 (0.92) | 23200, 31800 (27500) | 0.196, 0.361 (0.28) | 0.016, 0.023 (0.02) | 11 (11) | 1526 (500) | 566 (175) |

3. The watertable is approximately 60 ft below the ground surface.

**7. References**

AMEC Environment and Infrastructure. Saltstone Disposal Unit 6 Test Report. Subcontract No. AC54317N, Delivery Order No. 28, February 2012.

ASTM D 422-63 (Reapproved 2007). Standard Test Method for Particle-Size Analysis of Soils. American Society for Testing and Materials.

ASTM D 2216-10. Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass. American Society for Testing and Materials.

ASTM D 2435-11. Standard Test Methods for One-Dimensional Consolidation Properties of Soils Using Incremental Loading. American Society for Testing and Materials.

ASTM D 4318-10. Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils. American Society for Testing and Materials.

ASTM D 4767-11. Standard Test Method for Consolidated Undrained Triaxial Compression Test for Cohesive Soils. American Society for Testing and Materials.

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Kulhawy, F.H. and Mayne, P.W. 1990. Manual on Estimating Soil Properties for Foundation Design. Electric Power Research Institute, Palo Alto, California,

Lankelma, Inc. Subcontract No. R11S002. Cone Penetration Testing for Saltstone Disposal Unit 6. January 2012.

Liao, S.S.C. and Whitman, R.V. 1986. Overburden Correction Factors for SPT in Sand. Journal of Geotechnical Engineering, Vol. 112, No. 3, 373-377.

Lunne, T., Robertson, P.K., and Powell, J.J.M. 2001. Cone Penetration Testing in Geotechnical Practice. Spon Press, 312 pp.

Mayne, P.W. 2009. Engineering Design Using the Cone Penetration Test: Geotechnical Applications Guide. Produced by ConeTec, 165 pp.

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SRNS. Savannah River Nuclear Solutions, Inc. 2010. Geotechnical Investigation Report, Saltstone Disposal Cells No. 3 and 5. Report No. K-ESR-Z-00002, Rev. 1, March 2010.

Schmertmann, J.H. 1975. Measurement of *In Situ* Shear Strength. Proceedings of the Specialty Conference on *In Situ* Measurements of Soil Properties, Vol. 2, 57-138.

WSRC. Washington Savannah River Co. 2006. Saltstone Vault No. 2 Geotechnical Investigation Report. Report No. K-ESR-Z-00001, Rev. 0, April 2006.

Table 1. Locations of Seismic Cone Penetration Tests Performed at SDU 6.

| SCPT No. | SRS Northing (feet) | SRS Easting (feet) | Ground Elevation (feet, MSL) | Total Depth (feet) |
|---|---|---|---|---|
| Z-SDU6-C01 | 77413.3 | 66270.1 | 281.9 | 98.72 |
| Z-SDU6-C02 | 77448.1 | 66350.4 | 281.4 | 97.09 |
| Z-SDU6-C03 | 77478.3 | 66494.3 | 281.6 | 102.27 |
| Z-SDU6-C04 | 77503.3 | 66578.8 | 281.8 | 97.51 |
| Z-SDU6-C05 | 77624.5 | 66594.9 | 278.1 | 97.00 |
| Z-SDU6-C06 | 77587.6 | 66472.8 | 278.6 | 97.00 |
| Z-SDU6-C07 | 77546.9 | 66357.1 | 279.4 | 97.04 |
| Z-SDU6-C08 | 77511.4 | 66258.9 | 279.7 | 97.92 |
| Z-SDU6-C09 | 77621.8 | 66210.4 | 278.3 | 86.42 |
| Z-SDU6-C10 | 77644.2 | 66285.6 | 278.0 | 102.93 |
| Z-SDU6-C11 | 77663.3 | 66354.1 | 277.6 | 96.98 |
| Z-SDU6-C12 | 77682.6 | 66452.6 | 277.7 | 91.77 |
| Z-SDU6-C13 | 77722.6 | 66523.4 | 276.3 | 92.52 |
| Z-SDU6-C14 | 77720.6 | 66180.9 | 277.3 | 98.84 |
| Z-SDU6-C15 | 77748.2 | 66249.8 | 276.8 | 98.62 |
| Z-SDU6-C16 | 77772.2 | 66312.2 | 276.7 | 96.50 |
| Z-SDU6-C17 | 77796.3 | 66393.3 | 276.0 | 90.80 |
| Z-SDU6-C18 | 77819.4 | 66471.7 | 275.6 | 92.50 |
| Z-SDU6-C19 | 77869.3 | 66155.6 | 276.4 | 112.60 |
| Z-SDU6-C20 | 77895.0 | 66236.9 | 276.0 | 127.81 |
| Z-SDU6-C21 | 77920.9 | 66321.6 | 276.3 | 131.77 |
| Z-SDU6-C22 | 77947.5 | 66415.1 | 276.5 | 129.72 |
| Z-SDU6-C23 | 77967.7 | 66482.5 | 275.5 | 89.95 |

Table 2. Locations of Standard Penetration Tests (SPT) and Undisturbed Sampling Boreholes (UD) at SDU 6.

| Borehole No. | Borehole Type | SRS Northing (ft) | SRS Easting (ft) | Ground Elevation (ft, MSL) | Total Depth (ft) |
|---|---|---|---|---|---|
| Z-SDU6-B01 | UD | 77771.3 | 66309.1 | 276.6 | 127.6 |
| Z-SDU6-B02A | UD | 77625.3 | 66594.8 | 278.0 | 75.0 |
| Z-SDU6-B02B | UD | 77629.2 | 66588.9 | 278.1 | 131.0 |
| Z-SDU6-B03 | SPT | 77769.6 | 66304.5 | 276.5 | 158.0 |
| Z-SDU6-B04 | SPT | 77663.9 | 66351.1 | 277.9 | 307.5 |

Table 3. Disturbed Soil Samples from Standard Penetration Test Split Spoon Sampler at SDU 6 Borehole Z-SDU6-**B03**.

| Borehole No. | Sample No. | Sampling Depth (ft) | | Elev. (ft, MSL) | |
|---|---|---|---|---|---|
| | | from | to | from | to |
| Z-SDU6-B03 | SS01 | 12.0 | 14.0 | 264.5 | 262.5 |
| Z-SDU6-B03 | SS02 | 14.0 | 16.0 | 262.5 | 260.5 |
| Z-SDU6-B03 | SS03 | 16.0 | 18.0 | 260.5 | 258.5 |
| Z-SDU6-B03 | SS04 | 23.0 | 25.0 | 253.5 | 251.5 |
| Z-SDU6-B03 | SS05 | 25.0 | 27.0 | 251.5 | 249.5 |
| Z-SDU6-B03 | SS06 | 27.0 | 29.0 | 249.5 | 247.5 |
| Z-SDU6-B03 | SS07 | 29.0 | 31.0 | 247.5 | 245.5 |
| Z-SDU6-B03 | SS08 | 31.0 | 33.0 | 245.5 | 243.5 |
| Z-SDU6-B03 | SS09 | 33.0 | 35.0 | 243.5 | 241.5 |
| Z-SDU6-B03 | SS10 | 35.0 | 37.0 | 241.5 | 239.5 |
| Z-SDU6-B03 | SS11 | 37.0 | 39.0 | 239.5 | 237.5 |
| Z-SDU6-B03 | SS12 | 39.0 | 41.0 | 237.5 | 235.5 |
| Z-SDU6-B03 | SS13 | 42.0 | 44.0 | 234.5 | 232.5 |
| Z-SDU6-B03 | SS14 | 48.0 | 50.0 | 228.5 | 226.5 |
| Z-SDU6-B03 | SS15 | 53.0 | 55.0 | 223.5 | 221.5 |
| Z-SDU6-B03 | SS16 | 58.0 | 60.0 | 218.5 | 216.5 |
| Z-SDU6-B03 | SS17 | 63.0 | 65.0 | 213.5 | 211.5 |
| Z-SDU6-B03 | SS18 | 68.0 | 70.0 | 208.5 | 206.5 |
| Z-SDU6-B03 | SS19 | 73.0 | 75.0 | 203.5 | 201.5 |
| Z-SDU6-B03 | SS20 | 78.0 | 80.0 | 198.5 | 196.5 |
| Z-SDU6-B03 | SS21 | 83.0 | 85.0 | 193.5 | 191.5 |
| Z-SDU6-B03 | SS22 | 88.0 | 90.0 | 188.5 | 186.5 |
| Z-SDU6-B03 | SS23 | 93.0 | 95.0 | 183.5 | 181.5 |
| Z-SDU6-B03 | SS24 | 98.0 | 100.0 | 178.5 | 176.5 |
| Z-SDU6-B03 | SS25 | 103.0 | 105.0 | 173.5 | 171.5 |
| Z-SDU6-B03 | SS26 | 108.0 | 110.0 | 168.5 | 166.5 |
| Z-SDU6-B03 | SS27 | 113.0 | 115.0 | 163.5 | 161.5 |
| Z-SDU6-B03 | SS28 | 118.0 | 120.0 | 158.5 | 156.5 |
| Z-SDU6-B03 | SS29 | 123.0 | 125.0 | 153.5 | 151.5 |
| Z-SDU6-B03 | SS30 | 128.0 | 130.0 | 148.5 | 146.5 |
| Z-SDU6-B03 | SS31 | 133.0 | 135.0 | 143.5 | 141.5 |
| Z-SDU6-B03 | SS33 | 143.0 | 145.0 | 133.5 | 131.5 |
| Z-SDU6-B03 | SS34 | 148.0 | 150.0 | 128.5 | 126.5 |

Table 4. Disturbed Soil Samples from Standard Penetration Test Split Spoon Sampler at SDU 6 Borehole Z-SDU6-**B04**.

| Borehole No. | Sample No. | Sampling Depth (ft) | | Elev. (ft, MSL) | |
|---|---|---|---|---|---|
| | | from | to | from | to |
| Z-SDU6-B04 | SS01 | 14.0 | 16.0 | 263.9 | 261.9 |
| Z-SDU6-B04 | SS02 | 16.0 | 18.0 | 261.9 | 259.9 |
| Z-SDU6-B04 | SS03 | 18.0 | 20.0 | 259.9 | 257.9 |
| Z-SDU6-B04 | SS04 | 20.0 | 22.0 | 257.9 | 255.9 |
| Z-SDU6-B04 | SS05 | 22.0 | 24.0 | 255.9 | 253.9 |
| Z-SDU6-B04 | SS06 | 24.0 | 26.0 | 253.9 | 251.9 |
| Z-SDU6-B04 | SS07 | 26.0 | 28.0 | 251.9 | 249.9 |
| Z-SDU6-B04 | SS08 | 28.0 | 30.0 | 249.9 | 247.9 |
| Z-SDU6-B04 | SS09 | 30.0 | 32.0 | 247.9 | 245.9 |
| Z-SDU6-B04 | SS10 | 32.0 | 34.0 | 245.9 | 243.9 |
| Z-SDU6-B04 | SS11 | 34.0 | 36.0 | 243.9 | 241.9 |
| Z-SDU6-B04 | SS12 | 36.0 | 38.0 | 241.9 | 239.9 |
| Z-SDU6-B04 | SS13 | 38.0 | 40.0 | 239.9 | 237.9 |
| Z-SDU6-B04 | SS14 | 40.0 | 42.0 | 237.9 | 235.9 |
| Z-SDU6-B04 | SS15 | 43.0 | 45.0 | 234.9 | 232.9 |
| Z-SDU6-B04 | SS16 | 48.0 | 50.0 | 229.9 | 227.9 |
| Z-SDU6-B04 | SS17 | 53.0 | 55.0 | 224.9 | 222.9 |
| Z-SDU6-B04 | SS18 | 58.0 | 60.0 | 219.9 | 217.9 |
| Z-SDU6-B04 | SS19 | 63.0 | 65.0 | 214.9 | 212.9 |
| Z-SDU6-B04 | SS20 | 68.0 | 70.0 | 209.9 | 207.9 |
| Z-SDU6-B04 | SS21 | 73.0 | 75.0 | 204.9 | 202.9 |
| Z-SDU6-B04 | SS22 | 78.0 | 80.0 | 199.9 | 197.9 |
| Z-SDU6-B04 | SS23 | 83.0 | 85.0 | 194.9 | 192.9 |
| Z-SDU6-B04 | SS24 | 88.0 | 90.0 | 189.9 | 187.9 |
| Z-SDU6-B04 | SS25 | 93.0 | 95.0 | 184.9 | 182.9 |
| Z-SDU6-B04 | SS26 | 98.0 | 100.0 | 179.9 | 177.9 |
| Z-SDU6-B04 | SS27 | 103.0 | 105.0 | 174.9 | 172.9 |
| Z-SDU6-B04 | SS28 | 108.0 | 110.0 | 169.9 | 167.9 |
| Z-SDU6-B04 | SS29 | 113.0 | 115.0 | 164.9 | 162.9 |
| Z-SDU6-B04 | SS30 | 118.0 | 120.0 | 159.9 | 157.9 |
| Z-SDU6-B04 | SS31 | 123.0 | 125.0 | 154.9 | 152.9 |
| Z-SDU6-B04 | SS32 | 128.0 | 130.0 | 149.9 | 147.9 |
| Z-SDU6-B04 | SS33 | 133.0 | 135.0 | 144.9 | 142.9 |
| Z-SDU6-B04 | SS34 | 138.0 | 140.0 | 139.9 | 137.9 |

Table 5. Undisturbed Soil Samples at SDU 6.

| Borehole No. | Sample No. | Planned Sampling Depth (ft) | | Actual Sampling Depth (ft) | | Soil Recovery (%) | Actual Sampling Elev. (ft, MSL) | |
|---|---|---|---|---|---|---|---|---|
| | | from | to | from | to | | from | to |
| Z-SDU6-B01 | ST01 | 13.0 | 15.0 | 13.0 | 14.4 | 53 | 263.6 | 262.2 |
| Z-SDU6-B01 | ST02 | 15.0 | 17.0 | 15.0 | 16.6 | 95 | 261.6 | 259.6 |
| Z-SDU6-B01 | FPT01 | 22.0 | 24.0 | 22.0 | 24.0 | 100 | 254.6 | 252.6 |
| Z-SDU6-B01 | ST03 | 35.0 | 37.0 | 35.0 | 36.3 | 100 | 241.6 | 240.3 |
| Z-SDU6-B01 | ST04 | 48.25 | 50.25 | 48.25 | 50.25 | 100 | 228.6 | 226.6 |
| Z-SDU6-B01 | ST05 | 51.1 | 53.1 | 51.1 | 53.1 | 100 | 225.5 | 223.5 |
| Z-SDU6-B01 | ST06 | 58.0 | 60.0 | 58.0 | 60.0 | 100 | 218.6 | 216.6 |
| Z-SDU6-B01 | ST07 | 71.0 | 73.0 | 71.0 | 73.0 | 38 | 205.6 | 203.6 |
| Z-SDU6-B01 | ST08 | 73.2 | 75.2 | 73.2 | 75.2 | 58 | 203.4 | 201.4 |
| Z-SDU6-B01 | FPT02 | 82.0 | 84.0 | 82.0 | 84.0 | 100 | 194.6 | 192.6 |
| Z-SDU6-B01 | ST09 | 92.0 | 94.0 | 92.0 | 92.6 | 0 | 184.6 | 184.0 |
| -SDU6-B01 | ST10 | 115.1 | 117.1 | 115.1 | 115.8 | 100 | 161.5 | 160.8 |
| Z-SDU6-B01 | ST11 | 126.1 | 127.6 | 126.1 | 127.6 | 100 | 150.5 | 149.0 |
| Z-SDU6-B02A | ST01 | 9.7 | 10.7 | 9.7 | 10.0 | 100 | 268.3 | 268.0 |
| Z-SDU6-B02A | ST02 | 10.5 | 12.5 | 10.5 | 11.0 | 100 | 267.5 | 267.0 |
| Z-SDU6-B02A | ST03 | 16.0 | 18.0 | 16.0 | 16.3 | 75 | 262.0 | 261.7 |
| Z-SDU6-B02A | ST04 | 16.5 | 18.5 | 16.5 | 16.8 | 83 | 261.5 | 261.2 |
| Z-SDU6-B02A | ST05 | 23.0 | 25.0 | 23.0 | 23.6 | 53 | 255.0 | 254.4 |
| Z-SDU6-B02A | FPT01 | 44.0 | 46.0 | 44.0 | 46.0 | 96 | 234.0 | 232.0 |
| Z-SDU6-B02A | FPT02 | 47.0 | 49.0 | 47.0 | 49.0 | 100 | 231.0 | 229.0 |
| Z-SDU6-B02A | ST06 | 58.0 | 60.0 | 58.0 | 58.5 | 67 | 220.0 | 219.5 |
| Z-SDU6-B02B | FP01 | 75.0 | 77.0 | 75.0 | 77.0 | 100 | 203.1 | 201.1 |
| Z-SDU6-B02B | FP02 | 85.0 | 87.0 | 85.0 | 85.3 | 17 | 193.1 | 192.8 |

Table 6. Elevations and Thicknesses of Major Soil Layers at SDU 6.

| | | Top Elev. (ft) | | | | | Thickness (ft) | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| BH/CPT | Surface Elev. (ft) | C2 | S3 | S4 | GC | Congaree | C2 | S3 | S4 | GC |
| Z-SDU6-B02B | 278.1 | 234 | 227 | 191 | --- | --- | 7 | 36 | --- | --- |
| Z-SDU6-B03 | 276.5 | 232 | 217 | 188 | 164 | 146 | 15 | 29 | 24 | 18 |
| Z-SDU6-B04 | 277.9 | 236 | 232 | 191 | 165 | 145 | 4 | 41 | 26 | 20 |
| Z-SDU6-C01 | 281.9 | 233 | 226 | 190 | --- | --- | 7 | 36 | --- | --- |
| Z-SDU6-C02 | 281.4 | 233 | 227 | 190 | --- | --- | 6 | 37 | --- | --- |
| Z-SDU6-C03 | 281.6 | 233 | 225 | 190 | --- | --- | 8 | 35 | --- | --- |
| Z-SDU6-C04 | 281.8 | 236 | 229 | 190 | --- | --- | 7 | 39 | --- | --- |
| Z-SDU6-C05 | 278.1 | 235 | 226 | 187 | --- | --- | 9 | 39 | --- | --- |
| Z-SDU6-C06 | 278.6 | 234 | 227 | 189 | --- | --- | 7 | 38 | --- | --- |
| Z-SDU6-C07 | 279.4 | 237 | 230 | 191 | --- | --- | 7 | 39 | --- | --- |
| Z-SDU6-C08 | 279.7 | 236 | 230 | 186 | --- | --- | 6 | 44 | --- | --- |
| Z-SDU6-C09 | 278.3 | 237 | 230 | 194 | --- | --- | 7 | 36 | --- | --- |
| Z-SDU6-C10 | 278.0 | 237 | 230 | 190 | --- | --- | 7 | 40 | --- | --- |
| Z-SDU6-C11 | 277.6 | 238 | 233 | 186 | --- | --- | 5 | 47 | --- | --- |
| Z-SDU6-C12 | 277.7 | 239 | 234 | 188 | --- | --- | 5 | 46 | --- | --- |
| Z-SDU6-C13 | 276.3 | 234 | 228 | 188 | --- | --- | 6 | 40 | --- | --- |
| Z-SDU6-C14 | 277.3 | 234 | 222 | 181 | --- | --- | 12 | 41 | --- | --- |
| Z-SDU6-C15 | 276.8 | 232 | 217 | 192 | --- | --- | 15 | 25 | --- | --- |
| Z-SDU6-C16 | 276.7 | 234 | 216 | 184 | --- | --- | 18 | 32 | --- | --- |
| Z-SDU6-C17 | 276.0 | 235 | 219 | 187 | --- | --- | 16 | 32 | --- | --- |
| Z-SDU6-C18 | 275.6 | 235 | 217 | 186 | --- | --- | 18 | 31 | --- | --- |
| Z-SDU6-C19 | 276.4 | 235 | 227 | 183 | --- | --- | 8 | 44 | --- | --- |
| Z-SDU6-C20 | 276.0 | 226 | 219 | 176 | --- | --- | 7 | 43 | --- | --- |
| Z-SDU6-C21 | 276.3 | 233 | 225 | 182 | --- | --- | 8 | 43 | --- | --- |
| Z-SDU6-C22 | 276.5 | 237 | 230 | 187 | --- | --- | 7 | 43 | --- | --- |
| Z-SDU6-C23 | 275.5 | 238 | 233 | 190 | --- | --- | 5 | 43 | --- | --- |

Table 7. Results of Isotropically-Consolidated Undrained Triaxial Test with Pore Pressure Measurement at SDU 6.

| Borehole/Sample No. | Depth Range (ft) | Layer | $\phi$ (deg) | c ($lb/ft^2$) | $\phi'$ (deg) | c′ ($lb/ft^2$) |
|---|---|---|---|---|---|---|
| Z-SDU6-B01/FP01 | 22.0 to 24.0 | S1/S2 | 32 | 1180 | 36 | 440 |
| Z-SDU6-B01/ST05 | 51.1 to 53.1 | C2 | 15 | 640 | 32 | 0 |
| Z-SDU6-B02/FP01 | 44.0 to 46.0 | C2 | 11 | 1230 | 31 | 180 |

Table 8. Results of Isotropically-Consolidated Undrained Triaxial Test with Pore Pressure Measurement at Vault 2 (Washington Savannah River Co. 2006).

| Borehole No. | Layer | $\phi$ (deg) | c ($lb/ft^2$) | $\phi'$ (deg) | c′ ($lb/ft^2$) |
|---|---|---|---|---|---|
| Z-V2-B2U-ST1 | S1/2 | deleted | 300 | 33 | 250 |
| Z-V2-B2U-ST2 | S1/2 | 35 | 1700 | 30 | 380 |
| Z-V2-B2U-ST3 | S1/2 | 36 | 250 | 33 | 50 |
| Z-V2-B2U-ST4 | S1/2 | 26 | 250 | 32 | 260 |
| Z-V2-B1U-PS1 | S4 | 11 | 1526 | 26 | 566 |

Table 9. Results of Isotropically-Consolidated Undrained Triaxial Test with Pore Pressure Measurement at Vaults 3 and 5 (Savannah River Nuclear Solutions, 2010).

| Borehole No. | Layer | $\phi$ (deg) | c ($lb/ft^2$) | $\phi'$ (deg) | c′ ($lb/ft^2$) |
|---|---|---|---|---|---|
| Z-V3V5-B1-ST1 | S1/2 | 31 | 2606 | 33 | 137 |
| Z-V3V5-B1-ST3 | S1/2 | 8 | 2808 | 29 | 299 |
| Z-V3V5-B4-ST1 | S1/2 | 10 | 2462 | 34 | 322 |
| Z-V3V5-B4-ST3 | S1/2 | --- | --- | 33 | 357 |
| Z-V3V5-B4-ST4 | C2 | 9 | 1041 | 25 | 376 |

Table 10. Unit Weights and Moisture Contents at SDU 6 and SDU 6/7.

| Borehole No. | Layer | $\gamma_t$ (lb/ft$^3$) | $w_n$ (%) | $\gamma_d$ (lb/ft$^3$) |
|---|---|---|---|---|
| Z-SDU6-B01/FP01 | S1/S2 | 116 | 32.9 | 87 |
| Z-SDU6-B01/FP01 | S1/S2 | 116 | 33.8 | 86 |
| Z-SDU6-B01/FP01 | S1/S2 | 127 | 21.4 | 105 |
| Z-SDU6-B01/ST05 | C2 | 105 | 56.9 | 67 |
| Z-SDU6-B01/ST05 | C2 | 95 | 82.8 | 52 |
| Z-SDU6-B01/ST05 | C2 | 112 | 36.4 | 82 |
| Z-SDU6-B02/FPT01 | C2 | 122 | 21.8 | 100 |
| Z-SDU6-B02/FPT01 | C2 | 121 | 21.7 | 99 |
| Z-SDU6-B02/FPT01 | C2 | 119 | 26.5 | 94 |
| Z-SDU6-B02/FPT02 | C2 | 117 | 30.0 | 90 |
| Z-SDU6-B01/ST06 | C2 | 112 | 37.3 | 81 |
| Z-SDU6-B01/ST06 | C2 | 95 | 67.6 | 56 |
| Z-SD67-B01/ST04 | C2 | 108 | 45.2 | 74 |
| Z-SD67-B06/ST05 | C2 | 106 | 41.9 | 75 |

Table 11. Unit Weights and Moisture Contents at Vault 2 (Washington Savannah River Co. 2006).

| Borehole No. | Layer | $\gamma_t$ (lb/ft$^3$) | $w_n$ (%) | $\gamma_d$ (lb/ft$^3$) |
|---|---|---|---|---|
| Z-V2-B1U-ST1 | S1/2 | 120 | 13.6 | 106 |
| Z-V2-B1U-ST2 | S1/2 | 117 | 17.2 | 100 |
| Z-V2-B1U-ST2 | S1/2 | 118 | 16.7 | 102 |
| Z-V2-B1U-ST3 | S1/2 | 124 | 17.0 | 106 |
| Z-V2-B1U-ST4 | S1/2 | 119 | 15.4 | 103 |
| Z-V2-B1U-ST4 | S1/2 | 120 | 17.7 | 102 |
| Z-V2-B2U-ST1 | S1/2 | 126 | 20.2 | 104 |
| Z-V2-B2U-ST1 | S1/2 | 127 | 19.8 | 106 |
| Z-V2-B2U-ST1 | S1/2 | 130 | 16.1 | 112 |
| Z-V2-B2U-ST2 | S1/2 | 129 | 15.7 | 111 |
| Z-V2-B2U-ST2 | S1/2 | 132 | 14.1 | 116 |
| Z-V2-B2U-ST3 | S1/2 | 126 | 16.4 | 108 |
| Z-V2-B2U-ST3 | S1/2 | 124 | 14.6 | 108 |
| Z-V2-B2U-ST3 | S1/2 | 126 | 14.6 | 110 |
| Z-V2-B2U-ST4 | S1/2 | 117 | 17.8 | 99 |
| Z-V2-B2U-ST4 | S1/2 | 121 | 19.3 | 102 |
| Z-V2-B2U-ST4 | S1/2 | 120 | 19.8 | 100 |
| Z-V2-B3U-ST1 | S1/2 | 127 | 14.9 | 111 |

| Borehole No. | Layer | $\gamma_t$ (lb/ft$^3$) | $w_n$ (%) | $\gamma_d$ (lb/ft$^3$) |
|---|---|---|---|---|
| Z-V2-B3U-ST3 | S1/2 | 116 | 11.6 | 104 |
| Z-V2-B1U-ST5 | C2 | 101 | 45.3 | 70 |
| Z-V2-B1U-ST5 | C2 | 103 | 48.7 | 69 |
| Z-V2-B1U-ST7 | S3 | 124 | 17.7 | 105 |
| Z-V2-B1U-PS1 | S4 | 122 | 32.4 | 93 |
| Z-V2-B1U-PS1 | S4 | 118 | 34.9 | 88 |
| Z-V2-B1U-PS1 | S4 | 117 | 35.5 | 87 |
| Z-V2-B1U-PS1 | S4 | 122 | 25.7 | 97 |
| Z-V2-B1U-PS3 | S4 | 114 | 32.6 | 86 |

Table 12. Unit Weights and Moisture Contents at Vaults 3 and 5 (Savannah River Nuclear Solutions, 2010).

| Borehole-Sample No. | Layer | $\gamma_t$ (lb/ft$^3$) | $w_n$ (%) | $\gamma_d$ (lb/ft$^3$) |
|---|---|---|---|---|
| Z-V3V5-B1-ST2 | S1/2 | 110.0 | 14.0 | 96.6 |
| Z-V3V5-B4-ST2 | S1/2 | 120.8 | 13.9 | 106.1 |
| Z-V3V5-B1-ST1 | S1/2 | 117.2 | 11.7 | 104.9 |
| Z-V3V5-B1-ST1 | S1/2 | 117.2 | 14.2 | 102.6 |
| Z-V3V5-B1-ST1 | S1/2 | 119.6 | 12.4 | 106.4 |
| Z-V3V5-B4-ST1 | S1/2 | 129.1 | 19.1 | 108.4 |
| Z-V3V5-B4-ST1 | S1/2 | 130.1 | 19.1 | 109.2 |
| Z-V3V5-B4-ST1 | S1/2 | 128.7 | 19.8 | 107.4 |
| Z-V3V5-B4-ST2 | S1/2 | 123.2 | 15.8 | 106.4 |
| Z-V3V5-B4-ST5 | C2 | 93.6 | 69.1 | 55.4 |
| Z-V3V5-B1-ST5 | C2 | 122.0 | 17.9 | 103.5 |
| Z-V3V5-B4-ST4 | C2 | 103.8 | 50.3 | 69.1 |
| Z-V3V5-B4-ST5 | C2 | 92.8 | 64.3 | 56.5 |
| Z-V3V5-B4-ST6 | S3 | 118.6 | 29.8 | 91.4 |
| Z-V3V5-B1-ST4 | S3 | 106.9 | 13.3 | 94.4 |
| Z-V3V5-B4-ST6 | S3 | 115.3 | 33.2 | 86.5 |

Table 13. Summary of Grain Size Distribution.

| Boring No. | Sample No. | GRAVEL (%) | SAND (%) | SILT (%) | CLAY (%) | #200 (%) | $D_{50}$ (mm) | USCS |
|---|---|---|---|---|---|---|---|---|
| Z-SDU6-B01 | ST02 | 0.6 | 62.4 | | | 37.0 | 0.209 | SC |
| Z-SDU6-B01 | FPT01 | 0.0 | 15.2 | | | 84.8 | | |
| Z-SDU6-B01 | ST03 | 0.0 | 90.0 | | | 10.0 | 0.327 | |
| Z-SDU6-B01 | ST04 | 0.0 | 55.5 | 8.9 | 35.6 | 44.5 | 0.108 | SC |
| Z-SDU6-B01 | ST05 | 2.3 | 32.8 | 13.9 | 51.0 | 64.9 | 0.002 | |
| Z-SDU6-B01 | ST06 | 0.0 | 63.9 | 9.2 | 26.9 | 36.1 | 0.335 | SC |
| Z-SDU6-B01 | ST08 | 0.0 | 89.1 | | | 10.9 | 0.172 | |
| Z-SDU6-B01 | FPT02 | 0.0 | 91.4 | | | 8.6 | 0.305 | |
| Z-SDU6-B01 | ST11 | 0.0 | 74.0 | | | 26.0 | 0.246 | |
| Z-SDU6-B02A | FPT01 | 0.0 | 75.1 | | | 24.9 | 0.278 | |
| Z-SDU6-B02A | FPT02 | 0.0 | 59.8 | 9.2 | 31.0 | 40.2 | 0.131 | |
| Z-SDU6-B02A | ST02 | 0.0 | 54.8 | 10.0 | 35.2 | 45.2 | 0.115 | SC |
| Z-SDU6-B02B | FPT03 | 0.0 | 69.8 | | | 30.2 | 0.234 | |
| Z-SDU6-B03 | SS01 | 0.0 | 66.6 | | | 33.4 | 0.225 | |
| Z-SDU6-B03 | SS02 | 0.5 | 72.6 | | | 26.9 | 0.351 | |
| Z-SDU6-B03 | SS03 | 2.2 | 49.8 | 9.6 | 38.4 | 48.0 | 0.105 | SC |
| Z-SDU6-B03 | SS04 | 0.0 | 58.0 | | | 42.0 | 0.245 | |
| Z-SDU6-B03 | SS05 | 0.0 | 58.7 | | | 41.3 | 0.146 | |
| Z-SDU6-B03 | SS06 | 0.0 | 16.5 | | | 83.5 | | CH |
| Z-SDU6-B03 | SS07 | 0.0 | 76.7 | | | 23.3 | 0.243 | |
| Z-SDU6-B03 | SS08 | 2.7 | 72.5 | | | 24.8 | 0.248 | |
| Z-SDU6-B03 | SS09 | 10.0 | 53.6 | | | 36.4 | 0.223 | |
| Z-SDU6-B03 | SS10 | 0.0 | 78.6 | | | 21.4 | 0.373 | |
| Z-SDU6-B03 | SS11 | 0.0 | 76.1 | | | 23.9 | 0.255 | |
| Z-SDU6-B03 | SS12 | 0.0 | 84.3 | | | 15.7 | 0.280 | |
| Z-SDU6-B03 | SS13 | 0.0 | 76.5 | | | 23.5 | 0.243 | |
| Z-SDU6-B03 | SS14 | 0.0 | 56.9 | 8.0 | 35.1 | 43.1 | 0.147 | SC |
| Z-SDU6-B03 | SS15 | 0.0 | 39.6 | | | 60.4 | | |
| Z-SDU6-B03 | SS16 | 0.0 | 63.3 | 14.7 | 22.0 | 36.7 | 0.297 | SC |
| Z-SDU6-B03 | SS17 | 0.0 | 92.4 | | | 7.6 | 0.366 | |
| Z-SDU6-B03 | SS18 | 0.0 | 93.1 | | | 6.9 | 0.314 | |
| Z-SDU6-B03 | SS19 | 0.0 | 84.0 | | | 16.0 | 0.186 | |
| Z-SDU6-B03 | SS20 | 0.0 | 92.7 | | | 7.3 | 0.294 | |
| Z-SDU6-B03 | SS21 | 0.0 | 90.3 | | | 9.7 | 0.391 | |
| Z-SDU6-B03 | SS22 | 0.0 | 63.9 | | | 36.1 | 0.091 | |
| Z-SDU6-B03 | SS23 | 0.5 | 48.4 | | | 51.1 | | |
| Z-SDU6-B03 | SS24 | 23.6 | 26.2 | | | 50.2 | | |
| Z-SDU6-B03 | SS25 | 6.2 | 43.8 | 34.0 | 16.0 | 50.0 | 0.075 | ML |
| Z-SDU6-B03 | SS26 | 6.3 | 75.7 | 12.9 | 5.1 | 18.0 | 0.122 | |
| Z-SDU6-B03 | SS27 | 1.0 | 40.8 | | | 58.2 | | |
| Z-SDU6-B03 | SS28 | 0.0 | 61.3 | | | 38.7 | 0.103 | |
| Z-SDU6-B03 | SS29 | 0.0 | 3.7 | | | 96.3 | | MH |

| Boring No. | Sample No. | GRAVEL (%) | SAND (%) | SILT (%) | CLAY (%) | #200 (%) | $D_{50}$ (mm) | USCS |
|---|---|---|---|---|---|---|---|---|
| Z-SDU6-B03 | SS30 | 0.0 | 53.0 | | | 47.0 | 0.098 | |
| Z-SDU6-B03 | SS31 | 0.0 | 91.4 | | | 8.6 | 0.352 | |
| Z-SDU6-B03 | SS33 | 0.0 | 89.7 | | | 10.3 | 0.254 | |
| Z-SDU6-B03 | SS34 | 0.0 | 87.8 | | | 12.2 | 0.153 | |
| Z-SDU6-B04 | SS01 | 0.3 | 80.3 | | | 19.4 | 0.520 | |
| Z-SDU6-B04 | SS02 | 0.2 | 83.1 | | | 16.7 | 0.222 | |
| Z-SDU6-B04 | SS03 | 0.8 | 85.8 | | | 13.4 | 0.228 | |
| Z-SDU6-B04 | SS04 | 0.0 | 52.8 | | | 47.2 | 0.137 | |
| Z-SDU6-B04 | SS05 | 0.0 | 56.4 | | | 43.6 | 0.156 | |
| Z-SDU6-B04 | SS06 | 0.0 | 77.2 | | | 22.8 | 0.342 | |
| Z-SDU6-B04 | SS07 | 0.0 | 75.5 | | | 24.5 | 0.338 | |
| Z-SDU6-B04 | SS08 | 0.0 | 81.2 | | | 18.8 | 0.361 | SC |
| Z-SDU6-B04 | SS09 | 0.5 | 80.1 | | | 19.4 | 0.297 | |
| Z-SDU6-B04 | SS10 | 0.0 | 87.7 | | | 12.3 | 0.293 | |
| Z-SDU6-B04 | SS11 | 0.0 | 92.1 | | | 7.9 | 0.482 | |
| Z-SDU6-B04 | SS12 | 0.0 | 88.6 | | | 11.4 | 0.455 | |
| Z-SDU6-B04 | SS13 | 0.3 | 87.3 | | | 12.4 | 0.474 | |
| Z-SDU6-B04 | SS14 | 0.0 | 83.0 | | | 17.0 | 0.396 | |
| Z-SDU6-B04 | SS15 | 0.0 | 68.0 | | | 32.0 | 0.166 | |
| Z-SDU6-B04 | SS16 | 0.0 | 86.1 | | | 13.9 | 0.286 | |
| Z-SDU6-B04 | SS17 | 0.0 | 84.2 | 7.0 | 8.8 | 15.8 | 0.264 | |
| Z-SDU6-B04 | SS18 | 0.0 | 76.5 | | | 23.5 | 0.277 | |
| Z-SDU6-B04 | SS19 | 0.0 | 91.2 | 4.5 | 4.3 | 8.8 | 0.352 | SP-SM |
| Z-SDU6-B04 | SS20 | 0.0 | 92.2 | | | 7.8 | 0.351 | |
| Z-SDU6-B04 | SS21 | 0.0 | 85.4 | | | 14.6 | 0.219 | |
| Z-SDU6-B04 | SS22 | 0.0 | 93.6 | | | 6.4 | 0.413 | |
| Z-SDU6-B04 | SS23 | 0.0 | 90.0 | | | 10.0 | 0.295 | |
| Z-SDU6-B04 | SS24 | 0.0 | 65.6 | | | 34.4 | 0.092 | |
| Z-SDU6-B04 | SS25 | 4.9 | 44.7 | | | 50.4 | | |
| Z-SDU6-B04 | SS26 | 27.9 | 19.3 | 37.9 | 14.9 | 52.8 | 0.067 | ML |
| Z-SDU6-B04 | SS27 | 4.2 | 21.0 | | | 74.8 | | |
| Z-SDU6-B04 | SS28 | 19.4 | 44.3 | 22.7 | 13.6 | 36.3 | 0.120 | SC |
| Z-SDU6-B04 | SS29 | 0.5 | 55.2 | | | 44.3 | 0.107 | |
| Z-SDU6-B04 | SS30 | 0.5 | 66.8 | | | 32.7 | 0.139 | |
| Z-SDU6-B04 | SS31 | 0.0 | 1.8 | | | 98.2 | | MH |
| Z-SDU6-B04 | SS32 | 0.0 | 68.6 | | | 31.4 | 0.198 | |
| Z-SDU6-B04 | SS33 | 0.0 | 91.0 | | | 9.0 | 0.252 | |
| Z-SDU6-B04 | SS34 | 0.0 | 90.3 | | | 9.7 | 0.238 | |

Table 14. Grain Size Distribution.

| Boring No. | Sample No. | Percentage Less than Sieve Size | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 5/8 in | 3/8 in | 1/4 in | #4 | #10 | #20 | #40 | #60 | #100 | #140 | 0.005 (mm) |
| Z-SDU6-B01 | ST02 | 100 | 100 | 99.7 | 99.4 | 97.3 | 90.2 | 71.3 | 54.4 | 43.8 | 39.5 | |
| Z-SDU6-B01 | FPT01 | 100 | 100 | 100 | 100 | 100 | 99.5 | 97.5 | 95.0 | 91.4 | 88.0 | |
| Z-SDU6-B01 | ST03 | 100 | 100 | 100 | 100 | 100 | 99.3 | 76.0 | 24.8 | 11.2 | 10.3 | |
| Z-SDU6-B01 | ST04 | 100 | 100 | 100 | 100 | 99.8 | 98.0 | 92.5 | 75.5 | 61.9 | 49.5 | 35.6 |
| Z-SDU6-B01 | ST05 | 100 | 100 | 98.5 | 97.7 | 97.2 | 95.2 | 85.8 | 78.5 | 74.7 | 69.1 | 51.0 |
| Z-SDU6-B01 | ST06 | 100 | 100 | 100 | 100 | 99.9 | 92.9 | 59.5 | 42.8 | 39.5 | 37.6 | 26.9 |
| Z-SDU6-B01 | ST08 | 100 | 100 | 100 | 100 | 99.9 | 98.7 | 93.8 | 81.0 | 38.1 | 16.8 | |
| Z-SDU6-B01 | FPT02 | 100 | 100 | 100 | 100 | 98.7 | 87.0 | 68.2 | 38.3 | 16.5 | 10.4 | |
| Z-SDU6-B01 | ST11 | 100 | 100 | 100 | 100 | 99.7 | 92.8 | 76.0 | 50.8 | 34.2 | 29.1 | |
| Z-SDU6-B02A | FPT01 | 100 | 100 | 100 | 100 | 97.6 | 85.4 | 68.3 | 45.4 | 29.0 | 26.0 | |
| Z-SDU6-B02A | FPT02 | 100 | 100 | 100 | 100 | 100 | 99.1 | 90.1 | 75.9 | 55.8 | 43.1 | 31.0 |
| Z-SDU6-B02A | ST02 | 100 | 100 | 100 | 100 | 99.9 | 97.1 | 84.9 | 70.6 | 55.8 | 48.7 | 35.2 |
| Z-SDU6-B02B | FPT03 | 100 | 100 | 100 | 100 | 98.6 | 94.9 | 82.2 | 53.5 | 33.3 | 30.7 | |
| Z-SDU6-B03 | SS01 | 100 | 100 | 100 | 100 | 98.3 | 88.4 | 66.8 | 52.3 | 42.3 | 37.0 | |
| Z-SDU6-B03 | SS02 | 100 | 100 | 99.8 | 99.5 | 98.7 | 90.4 | 57.8 | 40.1 | 32.1 | 28.9 | |
| Z-SDU6-B03 | SS03 | 100 | 100 | 98.6 | 97.8 | 97.0 | 89.0 | 70.6 | 59.9 | 53.2 | 50.1 | 38.4 |
| Z-SDU6-B03 | SS04 | 100 | 100 | 100 | 100 | 99.7 | 89.4 | 61.8 | 50.2 | 45.8 | 43.6 | |
| Z-SDU6-B03 | SS05 | 100 | 100 | 100 | 100 | 100 | 96.6 | 81.7 | 65.3 | 50.6 | 45.1 | |
| Z-SDU6-B03 | SS06 | 100 | 100 | 100 | 100 | 100 | 99.7 | 97.9 | 95.7 | 91.8 | 87.6 | |
| Z-SDU6-B03 | SS07 | 100 | 100 | 100 | 100 | 98.7 | 87.5 | 60.7 | 50.8 | 33.8 | 26.8 | |
| Z-SDU6-B03 | SS08 | 100 | 100 | 98.3 | 97.3 | 93.6 | 81.5 | 64.5 | 50.3 | 35.0 | 28.4 | |
| Z-SDU6-B03 | SS09 | 100 | 96.7 | 92.6 | 90.0 | 83.0 | 74.1 | 61.7 | 52.0 | 43.3 | 38.7 | |
| Z-SDU6-B03 | SS10 | 100 | 100 | 100 | 100 | 99.6 | 86.2 | 55.6 | 36.2 | 25.7 | 22.4 | |
| Z-SDU6-B03 | SS11 | 100 | 100 | 100 | 100 | 99.7 | 92.6 | 74.7 | 49.0 | 30.0 | 25.5 | |
| Z-SDU6-B03 | SS12 | 100 | 100 | 100 | 100 | 99.9 | 98.6 | 84.5 | 41.0 | 19.2 | 16.6 | |
| Z-SDU6-B03 | SS13 | 100 | 100 | 100 | 100 | 99.7 | 94.4 | 74.8 | 51.4 | 30.6 | 25.1 | |
| Z-SDU6-B03 | SS14 | 100 | 100 | 100 | 100 | 99.7 | 96.4 | 85.9 | 58.3 | 50.2 | 45.3 | 35.1 |
| Z-SDU6-B03 | SS15 | 100 | 100 | 100 | 100 | 100 | 96.7 | 79.3 | 72.0 | 69.4 | 64.4 | |
| Z-SDU6-B03 | SS16 | 100 | 100 | 100 | 100 | 100 | 95.4 | 64.0 | 45.8 | 41.8 | 39.0 | 22.0 |
| Z-SDU6-B03 | SS17 | 100 | 100 | 100 | 100 | 99.4 | 90.0 | 57.1 | 32.4 | 11.5 | 8.2 | |
| Z-SDU6-B03 | SS18 | 100 | 100 | 100 | 100 | 99.5 | 91.5 | 66.2 | 36.4 | 10.5 | 7.7 | |
| Z-SDU6-B03 | SS19 | 100 | 100 | 100 | 100 | 99.5 | 96.4 | 85.0 | 67.9 | 36.2 | 20.5 | |
| Z-SDU6-B03 | SS20 | 100 | 100 | 100 | 100 | 99.0 | 87.8 | 66.3 | 41.4 | 15.0 | 9.0 | |
| Z-SDU6-B03 | SS21 | 100 | 100 | 100 | 100 | 98.8 | 84.0 | 54.0 | 30.7 | 15.7 | 11.4 | |
| Z-SDU6-B03 | SS22 | 100 | 100 | 100 | 100 | 99.7 | 95.7 | 91.1 | 89.4 | 83.5 | 61.5 | |
| Z-SDU6-B03 | SS23 | 100 | 100 | 99.7 | 99.5 | 99.0 | 98.4 | 97.4 | 96.0 | 91.5 | 72.7 | |
| Z-SDU6-B03 | SS24 | 96.1 | 82.1 | 77.1 | 76.4 | 71.4 | 68.8 | 67.4 | 66.0 | 62.0 | 55.7 | |
| Z-SDU6-B03 | SS25 | 100 | 100 | 96.6 | 93.8 | 84.3 | 78.7 | 75.8 | 71.4 | 64.8 | 57.5 | 16.0 |
| Z-SDU6-B03 | SS26 | 100 | 95.1 | 94.1 | 93.7 | 93.6 | 93.3 | 93.0 | 91.6 | 74.3 | 33.6 | 5.1 |
| Z-SDU6-B03 | SS27 | 100 | 99.0 | 99.0 | 99.0 | 98.4 | 96.0 | 91.0 | 82.4 | 69.3 | 62.3 | |
| Z-SDU6-B03 | SS28 | 100 | 100 | 100 | 100 | 98.5 | 93.6 | 86.7 | 77.8 | 65.1 | 51.0 | |

| Boring No. | Sample No. | Percentage Less than Sieve Size | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 5/8 in | 3/8 in | 1/4 in | #4 | #10 | #20 | #40 | #60 | #100 | #140 | 0.005 (mm) |
| Z-SDU6-B03 | SS29 | 100 | 100 | 100 | 100 | 100 | 99.8 | 99.4 | 98.7 | 98.0 | 97.2 | |
| Z-SDU6-B03 | SS30 | 100 | 100 | 100 | 100 | 99.6 | 98.2 | 93.1 | 81.2 | 60.6 | 51.4 | |
| Z-SDU6-B03 | SS31 | 100 | 100 | 100 | 100 | 99.3 | 92.3 | 59.6 | 33.9 | 14.6 | 9.7 | |
| Z-SDU6-B03 | SS33 | 100 | 100 | 100 | 100 | 100 | 99.7 | 95.0 | 48.6 | 16.9 | 12.0 | |
| Z-SDU6-B03 | SS34 | 100 | 100 | 100 | 100 | 100 | 99.2 | 93.6 | 75.8 | 48.2 | 18.0 | |
| Z-SDU6-B04 | SS01 | 100 | 100 | 99.9 | 99.7 | 97.5 | 79.8 | 39.8 | 29.6 | 23.7 | 20.8 | |
| Z-SDU6-B04 | SS02 | 100 | 100 | 99.9 | 99.8 | 99.1 | 91.6 | 72.9 | 55.4 | 32.0 | 22.4 | |
| Z-SDU6-B04 | SS03 | 100 | 100 | 99.5 | 99.2 | 98.3 | 90.0 | 72.0 | 54.4 | 29.7 | 19.5 | |
| Z-SDU6-B04 | SS04 | 100 | 100 | 100 | 100 | 99.9 | 94.8 | 84.8 | 72.5 | 51.9 | 48.1 | |
| Z-SDU6-B04 | SS05 | 100 | 100 | 100 | 100 | 99.8 | 94.0 | 83.5 | 71.9 | 48.7 | 44.4 | |
| Z-SDU6-B04 | SS06 | 100 | 100 | 100 | 100 | 99.5 | 83.0 | 55.8 | 43.1 | 29.8 | 23.7 | |
| Z-SDU6-B04 | SS07 | 100 | 100 | 100 | 100 | 99.7 | 85.9 | 58.1 | 41.1 | 29.8 | 25.5 | |
| Z-SDU6-B04 | SS08 | 100 | 100 | 100 | 100 | 99.8 | 88.2 | 57.6 | 35.4 | 23.4 | 19.9 | |
| Z-SDU6-B04 | SS09 | 100 | 100 | 99.7 | 99.5 | 97.6 | 88.3 | 71.9 | 39.7 | 22.9 | 20.3 | |
| Z-SDU6-B04 | SS10 | 100 | 100 | 100 | 100 | 99.6 | 95.0 | 79.2 | 37.8 | 17.3 | 13.8 | |
| Z-SDU6-B04 | SS11 | 100 | 100 | 100 | 100 | 99.8 | 88.4 | 41.7 | 19.7 | 11.8 | 9.0 | |
| Z-SDU6-B04 | SS12 | 100 | 100 | 100 | 100 | 98.6 | 80.8 | 46.9 | 29.7 | 17.6 | 13.4 | |
| Z-SDU6-B04 | SS13 | 100 | 100 | 99.8 | 99.7 | 97.6 | 85.5 | 43.7 | 24.3 | 17.3 | 14.0 | |
| Z-SDU6-B04 | SS14 | 100 | 100 | 100 | 100 | 97.7 | 71.2 | 52.0 | 36.2 | 23.1 | 18.9 | |
| Z-SDU6-B04 | SS15 | 100 | 100 | 100 | 100 | 99.9 | 98.8 | 91.3 | 62.6 | 47.2 | 36.1 | |
| Z-SDU6-B04 | SS16 | 100 | 100 | 100 | 100 | 100 | 99.1 | 87.3 | 38.4 | 20.2 | 15.8 | |
| Z-SDU6-B04 | SS17 | 100 | 100 | 100 | 100 | 99.9 | 99.8 | 95.8 | 45.1 | 21.3 | 17.5 | 8.8 |
| Z-SDU6-B04 | SS18 | 100 | 100 | 100 | 100 | 99.8 | 92.5 | 74.5 | 44.9 | 30.2 | 25.0 | |
| Z-SDU6-B04 | SS19 | 100 | 100 | 100 | 100 | 99.4 | 91.5 | 60.0 | 33.0 | 14.7 | 10.4 | 4.3 |
| Z-SDU6-B04 | SS20 | 100 | 100 | 100 | 100 | 98.7 | 85.8 | 59.3 | 33.0 | 13.5 | 9.3 | |
| Z-SDU6-B04 | SS21 | 100 | 100 | 100 | 100 | 99.8 | 98.6 | 93.9 | 62.5 | 19.6 | 15.7 | |
| Z-SDU6-B04 | SS22 | 100 | 100 | 100 | 100 | 98.6 | 81.7 | 51.4 | 26.7 | 11.3 | 7.8 | |
| Z-SDU6-B04 | SS23 | 100 | 100 | 100 | 100 | 99.3 | 89.3 | 66.2 | 42.0 | 19.3 | 12.5 | |
| Z-SDU6-B04 | SS24 | 100 | 100 | 100 | 100 | 100 | 99.9 | 99.7 | 99.3 | 95.2 | 63.2 | |
| Z-SDU6-B04 | SS25 | 100 | 96.5 | 95.7 | 95.1 | 93.5 | 92.8 | 92.1 | 90.3 | 84.8 | 69.7 | |
| Z-SDU6-B04 | SS26 | 90.3 | 73.9 | 72.8 | 72.1 | 70.1 | 69.1 | 68.3 | 67.2 | 64.7 | 59.0 | 14.9 |
| Z-SDU6-B04 | SS27 | 100 | 100 | 97.5 | 95.8 | 91.2 | 88.7 | 87.1 | 86.2 | 84.0 | 80.4 | |
| Z-SDU6-B04 | SS28 | 90.6 | 83.1 | 81.4 | 80.6 | 80.0 | 79.1 | 77.8 | 75.0 | 62.1 | 44.2 | 13.6 |
| Z-SDU6-B04 | SS29 | 100 | 100 | 99.7 | 99.5 | 94.3 | 85.6 | 76.7 | 67.2 | 56.2 | 49.8 | |
| Z-SDU6-B04 | SS30 | 100 | 100 | 99.7 | 99.5 | 91.9 | 80.1 | 70.8 | 63.1 | 52.8 | 40.0 | |
| Z-SDU6-B04 | SS31 | 100 | 100 | 100 | 100 | 99.9 | 99.8 | 99.7 | 99.5 | 99.2 | 98.8 | |
| Z-SDU6-B04 | SS32 | 100 | 100 | 100 | 100 | 99.4 | 95.5 | 84.3 | 61.6 | 39.3 | 34.0 | |
| Z-SDU6-B04 | SS33 | 100 | 100 | 100 | 100 | 95.7 | 83.5 | 66.8 | 49.5 | 18.6 | 10.8 | |
| Z-SDU6-B04 | SS34 | 100 | 100 | 100 | 100 | 99.8 | 97.4 | 83.0 | 53.8 | 18.9 | 11.8 | |

Table 15. Atterberg Limits and USCS at SDU 6.

| Borehole No. | Layer | LL (%) | PL (%) | PI (%) | USCS |
|---|---|---|---|---|---|
| Z-SDU6-B01 | S1/S2 | 53 | 24 | 29 | SC |
| Z-SDU6-B02A | S1/S2 | 49 | 24 | 25 | SC |
| Z-SDU6-B03 | S1/S2 | 58 | 26 | 32 | SC |
| Z-SDU6-B03 | S1/S2 | 73 | 34 | 39 | CH |
| Z-SDU6-B04 | S1/S2 | 45 | 21 | 24 | SC |
| Z-SDU6-B01 | C2 | 104 | 30 | 74 | SC |
| Z-SDU6-B03 | C2 | 99 | 38 | 61 | SC |
| Z-SDU6-B03 | S4 | 92 | 33 | 59 | SC |
| Z-SDU6-B03 | S4 | 43 | 39 | 4 | ML |
| Z-SDU6-B03 | S4 | 104 | 56 | 48 | MH |
| Z-SDU6-B01 | S4 | 114 | 44 | 70 | SC |
| Z-SDU6-B04 | S4 | 43 | 33 | 10 | ML |
| Z-SDU6-B04 | S4 | 32 | 22 | 10 | SC |
| Z-SDU6-B04 | S4 | 110 | 51 | 59 | MH |

Table 16. Results of Consolidation Tests at SDU 6 and SDU 6/7.

| Borehole No. | Depth Range (ft) | Layer | $\sigma'_{vo}$ (lb/ft$^2$) | $\sigma'_p$ (lb/ft$^2$) | $e_o$ | OCR | $C_c$ | $C_r$ | $C_c/C_r$ |
|---|---|---|---|---|---|---|---|---|---|
| Z-SDU6-B01 | 48.0 to 50.0 | C2 | 5635 | 4500 | 1.27 | 0.80 | 0.37 | 0.10 | 3.7 |
| Z-SD67-B01 | 49.0 to 51.0 | C2 | 5750 | 4100 | 1.99 | 0.71 | 0.74 | 0.13 | 5.5 |
| Z-SD67-B02 | 51.0 to 53.0 | C2 | 5980 | 3700 | 1.25 | 0.62 | 0.42 | 0.07 | 10.6 |
| Z-SDU6-B01 | 58.0 to 60.0 | S3 | 6785 | 3600 | 1.06 | 0.53 | 0.25 | 0.04 | 6.2 |

Table 17. Results of Consolidation Tests at the Z-Area Saltstone Disposal Site (Vault 1) (Mueser Rutledge, 1986).

| Borehole No. | Layer | $\sigma'_{vo}$ (lb/ft$^2$) | $\sigma'_p$ (lb/ft$^2$) | $e_o$ | OCR | $C_c$ | $C_r$ | $C_c/C_r$ |
|---|---|---|---|---|---|---|---|---|
| Z-219U | C2 | 9200 | 10600 | 1.017 | 1.15 | 0.429 | 0.063 | 6.8 |
| Z-224U | C2 | 7200 | 15000 | 1.213 | 2.08 | 0.476 | 0.032 | 15 |
| Z-225U | C2 | 7600 | 13200 | 1.675 | 1.74 | 1.118 | 0.214 | 5.2 |
| Z-211U | S3a | 9600 | 5400 | 1.616 | 0.56 | 0.800 | 0.060 | 13 |

Table 18. Results of Consolidation Tests at Vault 2 (Washington Savannah River Co., 2006).

| Borehole No. | Layer | $\sigma K_{vo}$ (lb/ft$^2$) | $\sigma K_{p}$ (lb/ft$^2$) | $e_o$ | OCR | $C_c$ | $C_r$ | $C_c/C_r$ |
|---|---|---|---|---|---|---|---|---|
| Z-V2-B1U-ST2 | S1/2 | 3600 | 7300 | 0.653 | 2.0 | 0.071 | 0.007 | 9.7 |
| Z-V2-B1U-ST2a | S1/2 | 3600 | 3000 | 0.622 | 0.8 | 0.056 | 0.009 | 6.6 |
| Z-V2-B1U-ST4 | S1/2 | 5500 | 7200 | 0.609 | 1.3 | 0.101 | 0.008 | 12.7 |
| Z-V2-B1U-ST4a | S1/2 | 5500 | 4500 | 0.628 | 0.8 | 0.069 | 0.008 | 8.5 |
| Z-V2-B1U-ST5 | C2 | 7600 | 8400 | 1.378 | 1.1 | 0.781 | 0.102 | 7.6 |
| Z-V2-B1U-ST5a | C2 | 7600 | 7800 | 1.391 | 1.0 | 0.725 | 0.083 | 8.7 |
| Z-V2-B1U-ST7 | S3 | 10600 | 7200 | 0.571 | 0.7 | 0.071 | 0.012 | 5.8 |
| Z-V2-B1U-PS1 | S4 | 12600 | 11600 | 0.92 | 0.9 | 0.196 | 0.023 | 8.4 |
| Z-V2-B1U-PS3 | S4 | 14800 | 15900 | 0.921 | 1.1 | 0.361 | 0.016 | 23.3 |

Table 19. Results of Consolidation Tests at Vaults 3 and 5 (Savannah River Nuclear Solutions, 2010).

| Borehole/Sample No. | Layer | $\sigma K_{vo}$ (lb/ft$^2$) | $\sigma K_{p}$ (lb/ft$^2$) | $e_o$ | OCR | $C_c$ | $C_r$ | $C_c/C_r$ |
|---|---|---|---|---|---|---|---|---|
| Z-V3V5-B4-ST2 | S1/2 | 3800 | 7000 | 0.57 | 1.8 | 0.036 | 0.0050 | 7.3 |
| Z-V3V5-B4-ST4 | C2 | 6100 | 6100 | 1.44 | 1.0 | 0.48 | 0.075 | 6.4 |
| Z-V3V5-B4-ST5 | C2 | 6200 | 4300 | 1.98 | 0.7 | 0.51 | 0.136 | 3.8 |
| Z-V3V5-B1-ST4 | S3 | 6000 | 3400 | 0.60 | 0.6 | 0.051 | 0.0083 | 6.1 |
| Z-V3V5-B1-ST5 | S3 | 6300 | 8000 | 0.75 | 1.3 | 0.030 | 0.0083 | 3.6 |
| Z-V3V5-B4-ST6 | S3 | 7800 | 5000 | 0.81 | 0.6 | 0.725 | 0.083 | 8.7 |

Table 20. Results of Consolidation Tests at the S-Area DWPF (Mueser Rutledge, 1984).

| Borehole No. | Layer | $\sigma K_{vo}$ (lb/ft$^2$) | $\sigma K_{p}$ (lb/ft$^2$) | $e_o$ | OCR | $C_c$ | $C_r$ | $C_c/C_r$ |
|---|---|---|---|---|---|---|---|---|
| 47 | C2 | 7800 | 9000 | --- | 1.15 | 0.86 | 0.09 | 9.6 |
| 6A | C2 | 7000 | 12400 | --- | 1.77 | 0.73 | 0.07 | 10 |
| 90 | C2 | 6400 | 13600 | --- | 2.12 | 1.23 | 0.05 | 25 |
| 7 | C2 | 8400 | 13200 | --- | 1.57 | 0.98 | 0.12 | 8.2 |
| 6 | S3a | 10800 | 26000 | --- | 2.41 | 0.26 | 0.02 | 13 |

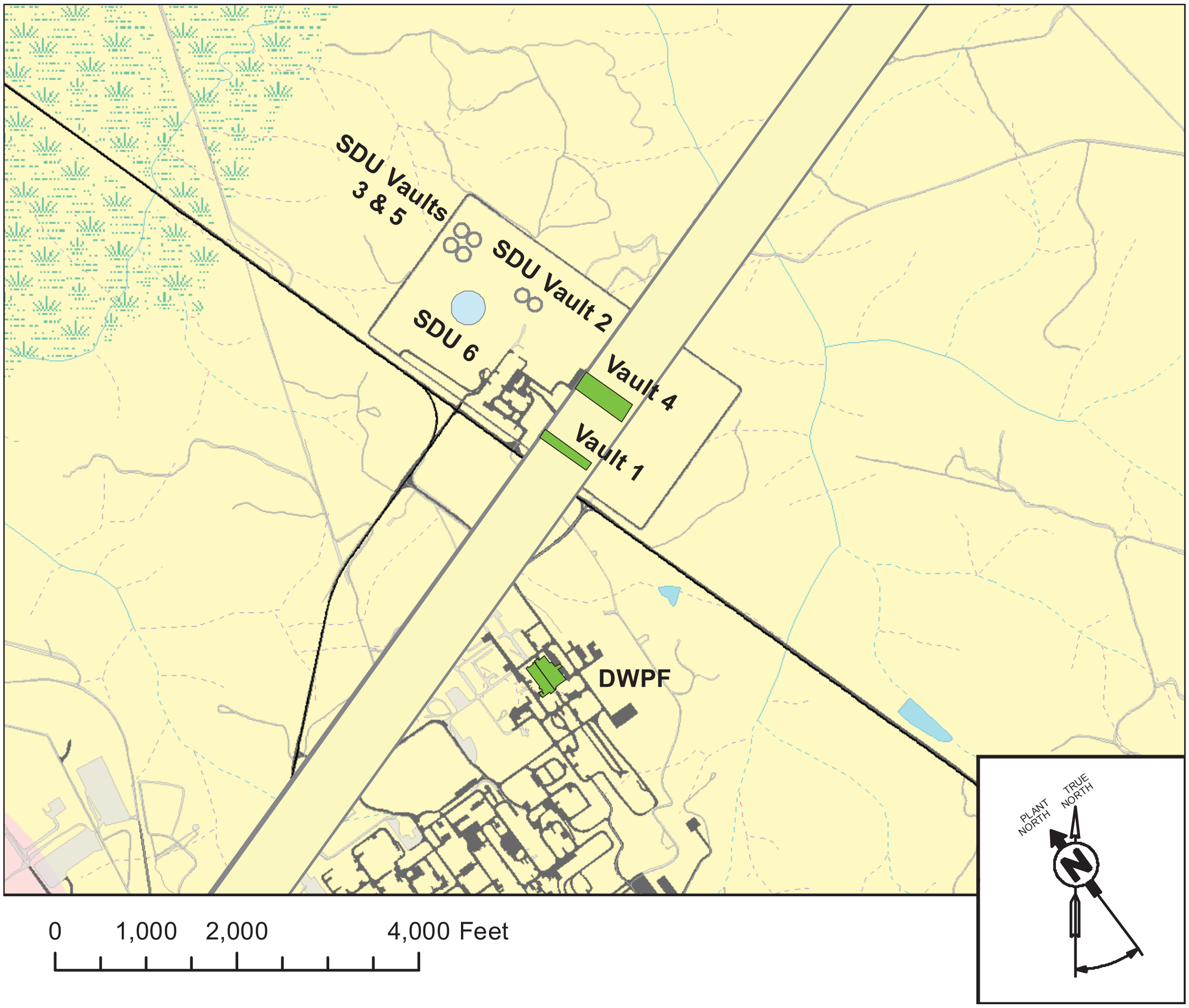


Figure 1. Z-Area Vault Sites.

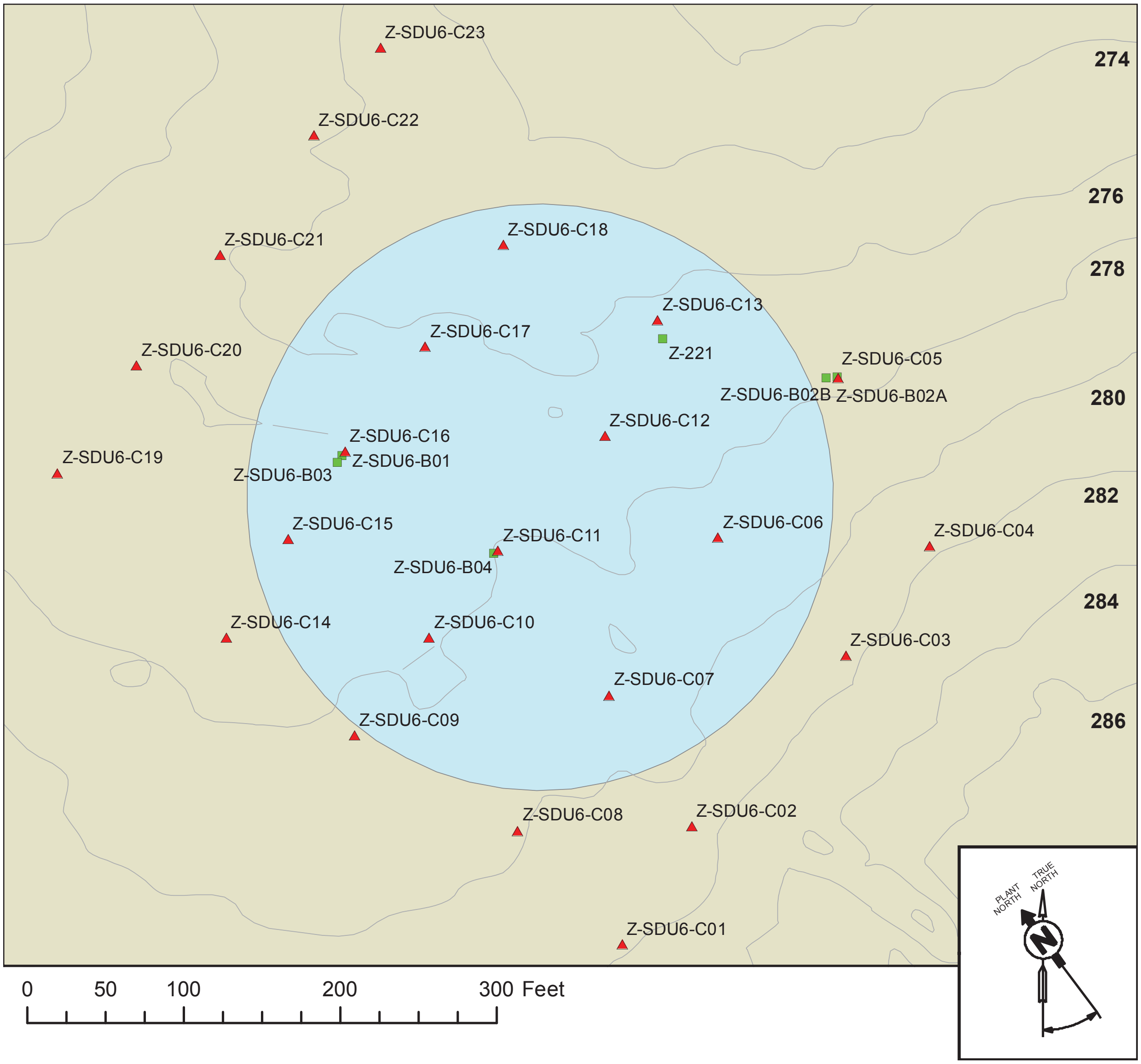


Figure 2. SDU 6 Exploration and Testing Locations.

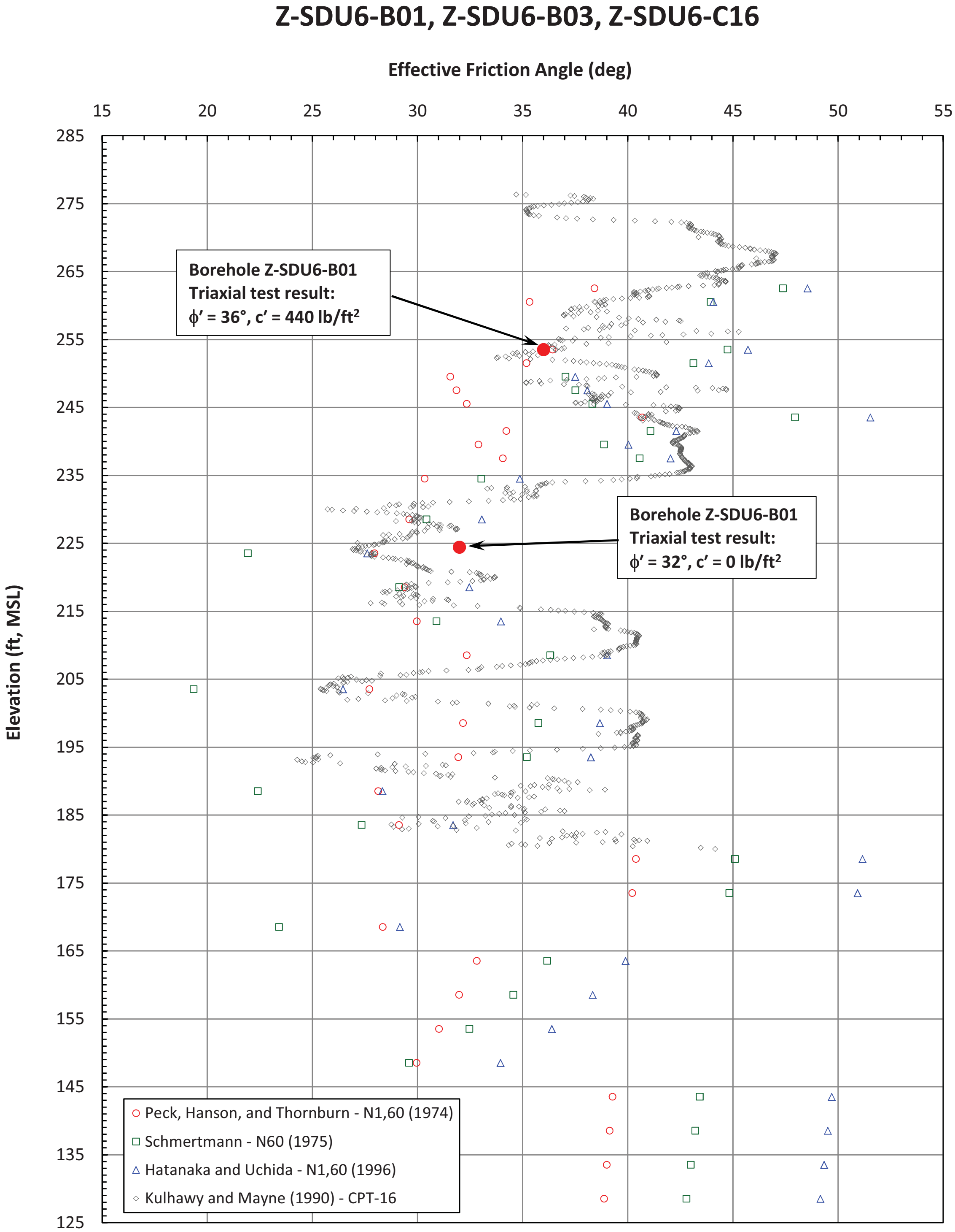


Figure 3. Relationship Between Effective Friction Angle Calculated Using Methods Based on Standard Penetration Blow Count and Cone Tip Penetration Resistance and Compared to Effective Friction Angle from Triaxial Tests.

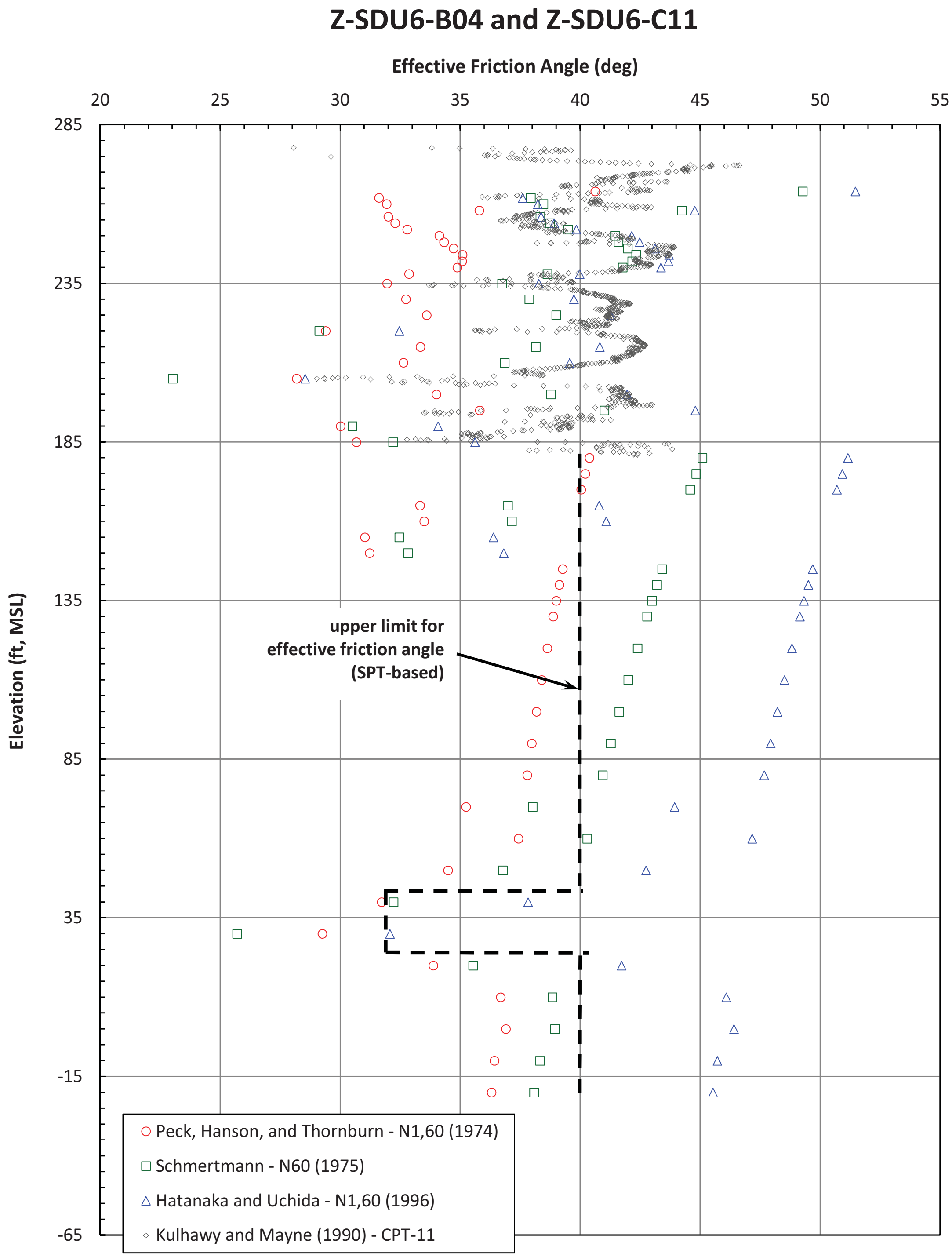


Figure 4. Effective Friction Angle Correlated to $N_{1,60}$ and Cone Penetration Tip Resistance ($q_{t1}$) for Deep Standard Penetration Test Borehole Showing Effective Friction Angle Envelope.

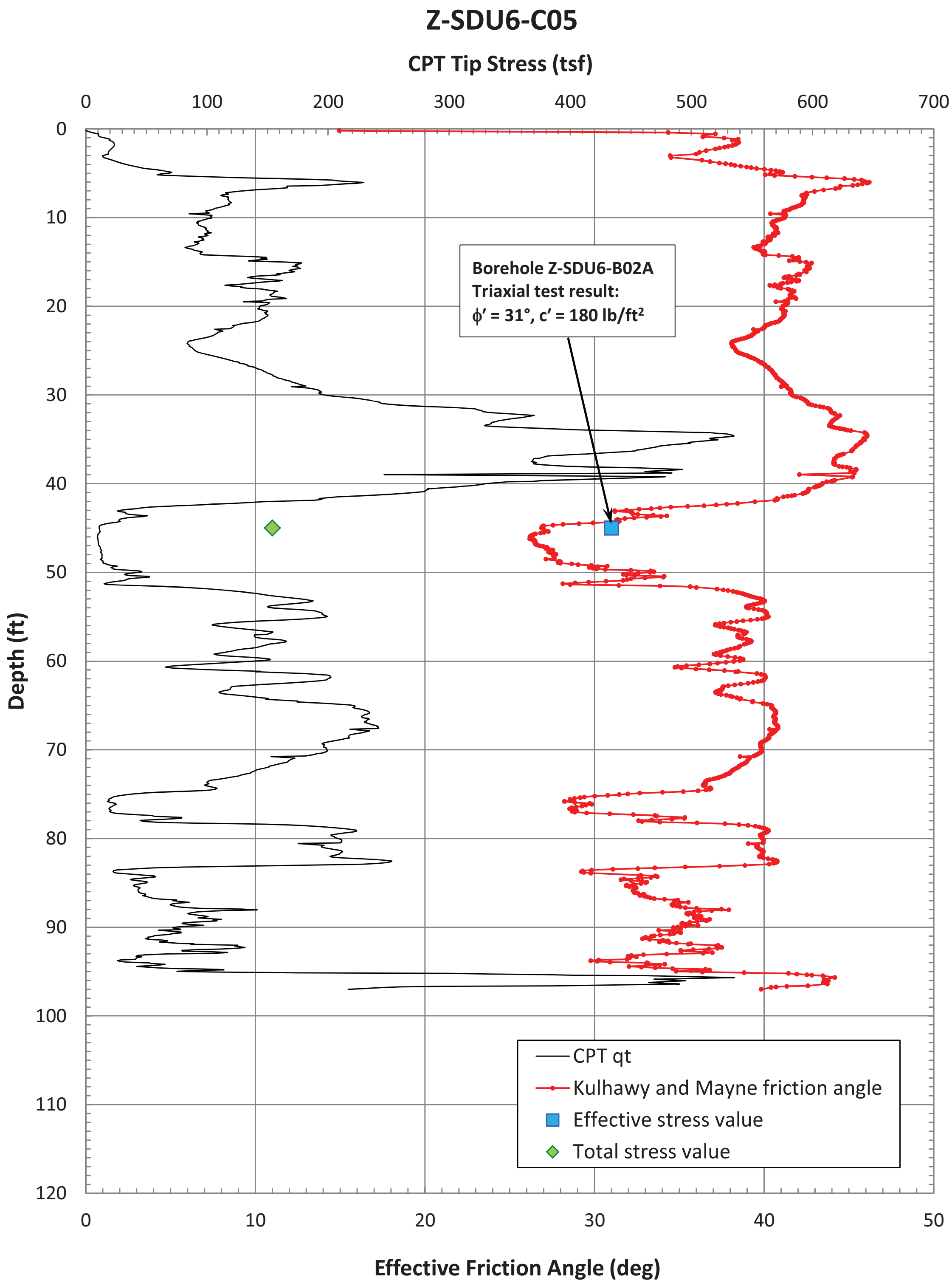


Figure 5. Relationship Between Effective Friction Angle Calculated Using Method of Kulhawy and Mayne (1990) as Compared to Effective Friction Angle from Triaxial Test.

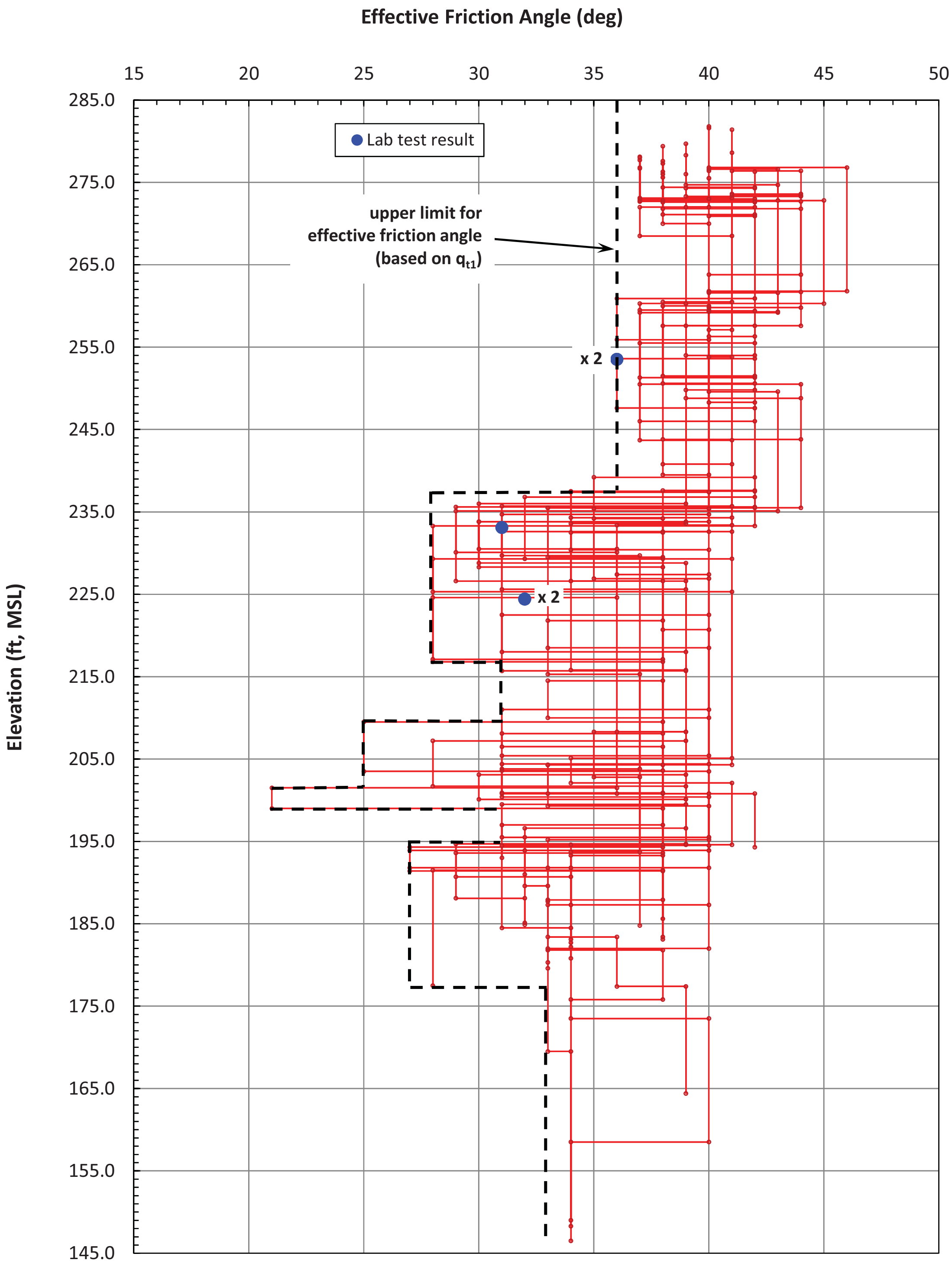


Figure 6. Effective Friction Angle Envelope Formed from Twenty-three CPTs Based on Method of Kulhawy and Mayne (1990) using $q_{t1}$.

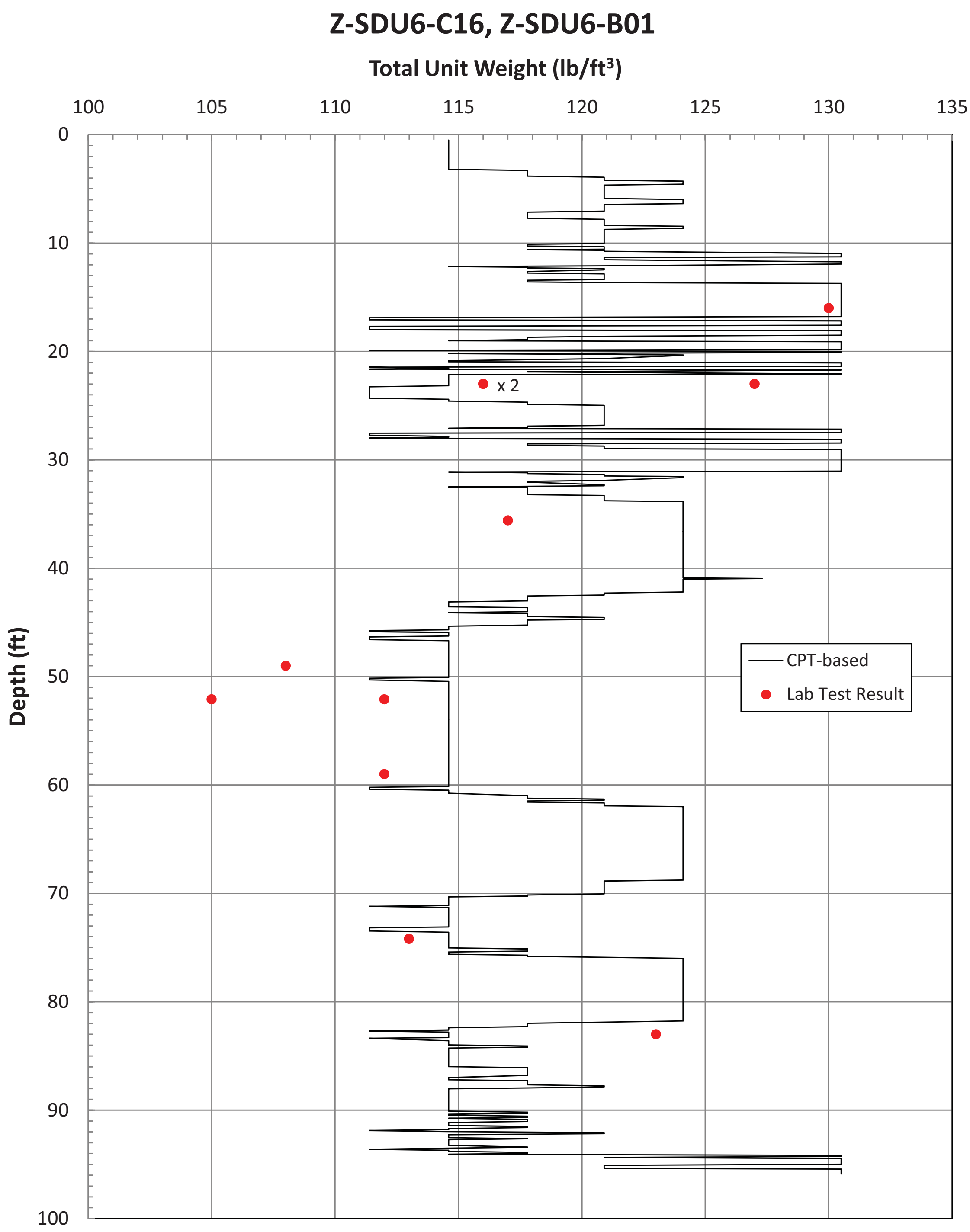


Figure 7. Total Unit Weight from Laboratory Test Results of Samples from Borehole Z-SDU6-B01 Compared to CPT-based Total Unit Weight Determined from CPT Z-SDU6-C16.

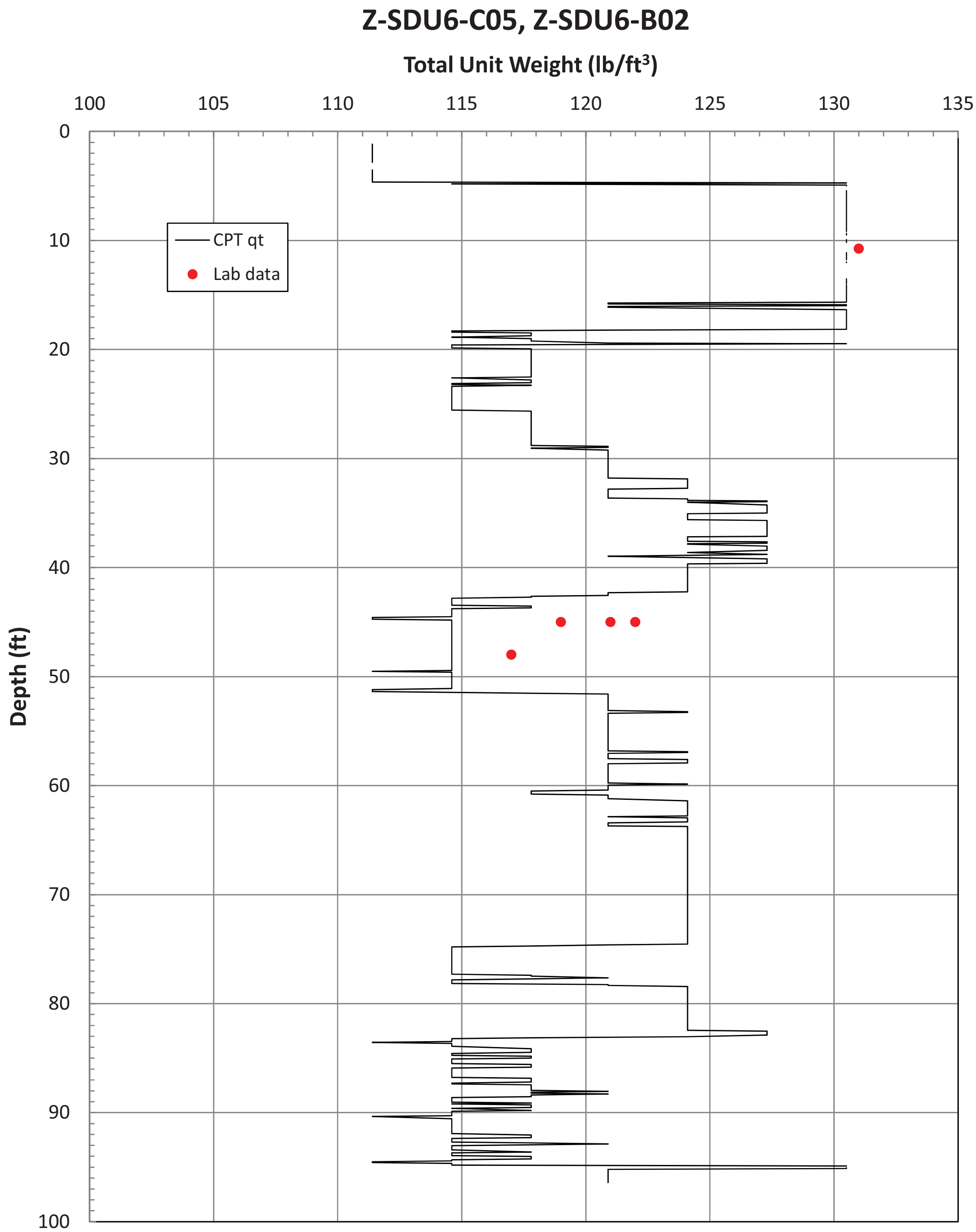


Figure 8. Total Unit Weight from Laboratory Test Results of Samples from Borehole Z-SDU6-B02 Compared to CPT-based Total Unit Weight Determined from CPT Z-SDU6-C05.

# Appendix A: Boring Logs

(23 pages)

Savannah River Nuclear Solutions, Inc.
Savannah River Site
Aiken, SC 29208

Savannah River NUCLEAR SOLUTIONS™

# BORING NUMBER Z-SDU6-B01



CLIENT Savannah River Remediation
PROJECT NAME Saltstone Disposal Unit 6
PROJECT NUMBER
PROJECT LOCATION Z-Area
DATE STARTED 12/20/11 COMPLETED 12/23/11
GROUND ELEVATION 276.6 ft HOLE SIZE 6 inches
DRILLING CONTRACTOR SAEDACCO
COORDINATES:NORTH 77771.3 EAST 66309.1
DRILLING METHOD Mud rotary
LOGGED BY M. Hasek CHECKED BY [signature]
NOTES UD

| Depth (ft) | Sample Type Number | Sample Interval | In. Recovered / In. Driven | Blow Counts (N value) | Graphic Log | Material Description | Blow Count (blows/ft) 20 40 60 80 | Elevation (ft) |
|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | Mud rotary drill. | | |
| 5 | | | | | | | | 275 |
| 10 | | | | | | | | 270 |
| | | | | | | | | 265 |
| | ST-01 | | 9/17 | | | | | |
| 15 | | | | | | Mud rotary drill. | | |
| | ST-02 | | 18/19 | | | | | |
| | | | | | | Mud rotary drill. | | 260 |
| 20 | | | | | | | | 255 |
| | FP-01 | | 24/24 | | | | | |
| 25 | | | | | | Mud rotary drill. | | 250 |
| 30 | | | | | | | | 245 |
| 35 | | | | | | | | |

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GEOTECH_BLOW COUNT - GINT STD US.GDT - 02/16/12 10:17 - C:\PROGRAM FILES\GINT\PROJECTS\SDU_6.GPJ

**CLIENT** Savannah River Remediation

**PROJECT NAME** Saltstone Disposal Unit 6

**PROJECT NUMBER**

**PROJECT LOCATION** Z-Area

| Depth (ft) | Sample Type Number | Sample Interval | In. Recovered / In. Driven | Blow Counts (N value) | Graphic Log | Material Description | Blow Count (blows/ft) 20 40 60 80 | Elevation (ft) |
|---|---|---|---|---|---|---|---|---|
| 35 | ST-03 | | 26/16 | | | | | |
| | | | | | | Mud rotary drill. | | 240 |
| 40 | | | | | | | | |
| | | | | | | | | 235 |
| 45 | | | | | | | | |
| | | | | | | | | 230 |
| | ST-04 | | 27.5/24 | | | | | |
| 50 | | | | | | Mud rotary drill. | | |
| | ST-05 | | 27/24 | | | | | 225 |
| | | | | | | Mud rotary drill. | | |
| 55 | | | | | | | | |
| | | | | | | | | 220 |
| | ST-06 | | 27/24 | | | | | |
| 60 | | | | | | Mud rotary drill. | | |
| | | | | | | | | 215 |
| 65 | | | | | | | | |
| | | | | | | | | 210 |
| 70 | | | | | | | | |
| | ST-07 | | 9/24 | | | | | 205 |
| | ST-08 | | 14/24 | | | Mud rotary drill. | | |
| 75 | | | | | | | | |

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GEOTECH_BLOW COUNT - GINT STD US.GDT - 02/16/12 10:24 - C:\PROGRAM FILES\GINT\PROJECTS\SDU_6.GPJ

**CLIENT** Savannah River Remediation
**PROJECT NAME** Saltstone Disposal Unit 6
**PROJECT NUMBER**
**PROJECT LOCATION** Z-Area

| Depth (ft) | Sample Type Number | Sample Interval | In. Recovered / In. Driven | Blow Counts (N value) | Graphic Log | Material Description | Blow Count (blows/ft) 20 40 60 80 | Elevation (ft) |
|---|---|---|---|---|---|---|---|---|
| 75 | | | | | | Mud rotary drill. | | |
| 80 | | | | | | | | 200 / 195 |
| 83 | FP-02 | | 24/24 | | | | | |
| 85 | | | | | | Mud rotary drill. | | 190 |
| 90 | | | | | | | | 185 |
| 92 | ST-09 | | 0/7 | | | | | |
| 92.6 | | | | | | Mud rotary drill. | | |
| 95 | | | | | | | | 180 |
| 100 | | | | | | | | 175 |
| 105 | | | | | | | | 170 |
| 110 | | | | | | | | 165 |
| 115 | | | | | | | | |

GEOTECH_BLOW COUNT - GINT STD US.GDT - 02/16/12 10:24 - C:\PROGRAM FILES\GINT\PROJECTS\SDU_6.GPJ

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Savannah River Nuclear Solutions, Inc.
Savannah River Site
Aiken, SC 29208

# BORING NUMBER Z-SDU6-B01



**CLIENT** Savannah River Remediation **PROJECT NAME** Saltstone Disposal Unit 6

**PROJECT NUMBER** **PROJECT LOCATION** Z-Area

| Depth (ft) | Sample Type Number | Sample Interval | In. Recovered / In. Driven | Blow Counts (N value) | Graphic Log | Material Description | Blow Count (blows/ft) 20 40 60 80 | Elevation (ft) |
|---|---|---|---|---|---|---|---|---|
| 115 | ST-10 | | 8.5/8 | | | | | |
| | | | | | | Mud rotary drill. | | 160 |
| 120 | | | | | | | | 155 |
| 125 | | | | | | | | |
| | ST-11 | | 20/18 | | | | | 150 |
| | | | | | | Mud rotary drill. | | |
| | | | | | | Bottom of borehole at 128.0 feet. | | 145 |
| | | | | | | | | 140 |
| | | | | | | | | 135 |
| | | | | | | | | 130 |
| | | | | | | | | 125 |

GEOTECH_BLOW COUNT - GINT STD US.GDT - 02/16/12 10:24 - C:\PROGRAM FILES\GINT\PROJECTS\SDU_6.GPJ

# BORING NUMBER Z-SDU6-B02A



Savannah River NUCLEAR SOLUTIONS
Savannah River Nuclear Solutions, Inc.
Savannah River Site
Aiken, SC 29208

CLIENT Savannah River Remediation
PROJECT NAME Saltstone Disposal Unit 6
PROJECT NUMBER
PROJECT LOCATION Z-Area
DATE STARTED 12/27/11 COMPLETED 12/29/11
GROUND ELEVATION 278 ft HOLE SIZE 6 inches
DRILLING CONTRACTOR SAEDACCO
COORDINATES: NORTH 77625.3 EAST 66594.8
DRILLING METHOD Mud rotary
LOGGED BY M. Hasek CHECKED BY [signature]
NOTES UD

| Depth (ft) | Sample Type Number | Sample Interval | In. Recovered / In. Driven | Blow Counts (N value) | Graphic Log | Material Description | Blow Count (blows/ft) 20 40 60 80 | Elevation (ft) |
|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | Mud rotary drill. | | |
| 5 | | | | | | | | 275 |
| 10 | ST-01 | | 4/4 | | | | | 270 |
| | ST-02 | | 6/6 | | | Mud rotary drill. | | |
| | | | | | | Mud rotary drill. | | |
| 15 | | | | | | | | 265 |
| | ST-03 | | 3/4 | | | Mud rotary drill. | | |
| | ST-04 | | 2.5/3 | | | Mud rotary drill. | | 260 |
| 20 | | | | | | | | |
| | ST-05 | | 4/7.5 | | | Mud rotary drill. | | 255 |
| 25 | | | | | | | | |
| 30 | | | | | | | | 250 |
| 35 | | | | | | | | 245 |

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**CLIENT** Savannah River Remediation
**PROJECT NAME** Saltstone Disposal Unit 6
**PROJECT NUMBER**
**PROJECT LOCATION** Z-Area

| Depth (ft) | Sample Type Number | Sample Interval | In. Recovered / In. Driven | Blow Counts (N value) | Graphic Log | Material Description | Blow Count (blows/ft) 20 40 60 80 | Elevation (ft) |
|---|---|---|---|---|---|---|---|---|
| 35 | | | | | | Mud rotary drill. *(continued)* | | |
| | | | | | | | | 240 |
| 40 | | | | | | | | |
| | | | | | | | | 235 |
| 45 | FP-01 | | 23/24 | | | | | |
| | | | | | | Mud rotary drill. | | |
| | FP-02 | | 24/24 | | | | | 230 |
| 50 | | | | | | Mud rotary drill. | | |
| | | | | | | | | 225 |
| 55 | | | | | | | | |
| | ST-06 | | 4/6 | | | | | 220 |
| | | | | | | Mud rotary drill. | | |
| 60 | | | | | | | | |
| | | | | | | | | 215 |
| 65 | | | | | | | | |
| | | | | | | | | 210 |
| 70 | | | | | | | | |
| | | | | | | | | 205 |
| 75 | | | | | | | | |

Bottom of borehole at 75.0 feet.

GEOTECH_BLOW COUNT - GINT STD US.GDT - 02/16/12 10:24 - C:\PROGRAM FILES\GINT\PROJECTS\SDU_6.GPJ

# BORING NUMBER Z-SDU6-B02B



Savannah River Nuclear Solutions
Savannah River Nuclear Solutions, Inc.
Savannah River Site
Aiken, SC 29208

| | |
|---|---|
| CLIENT Savannah River Remediation | PROJECT NAME Saltstone Disposal Unit 6 |
| PROJECT NUMBER | PROJECT LOCATION Z-Area |
| DATE STARTED 12/29/11 COMPLETED 01/05/12 | GROUND ELEVATION 278.1 ft HOLE SIZE 6 inches |
| DRILLING CONTRACTOR SAEDACCO | COORDINATES:NORTH 77629.2 EAST 66588.9 |
| DRILLING METHOD Mud rotary | |
| LOGGED BY M. Hasek CHECKED BY [signature] | |
| NOTES UD | |

| Depth (ft) | Sample Type Number | Sample Interval | In. Recovered / In. Driven | Blow Counts (N value) | Graphic Log | Material Description | Blow Count (blows/ft) 20 40 60 80 | Elevation (ft) |
|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | Mud rotary drill. | | |
| 5 | | | | | | | | 275 |
| 10 | | | | | | | | 270 |
| 15 | | | | | | | | 265 |
| 20 | | | | | | | | 260 |
| 25 | | | | | | | | 255 |
| 30 | | | | | | | | 250 |
| 35 | | | | | | | | 245 |

GEOTECH_BLOW COUNT - GINT STD US.GDT - 02/16/12 10:18 - C:\PROGRAM FILES\GINT\PROJECTS\SDU_6.GPJ

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**CLIENT** Savannah River Remediation

**PROJECT NAME** Saltstone Disposal Unit 6

**PROJECT NUMBER**

**PROJECT LOCATION** Z-Area

| Depth (ft) | Sample Type Number | Sample Interval | In. Recovered / In. Driven | Blow Counts (N value) | Graphic Log | Material Description | Blow Count (blows/ft) 20 40 60 80 | Elevation (ft) |
|---|---|---|---|---|---|---|---|---|
| 35 | | | | | | Mud rotary drill. | | |
| 40 | | | | | | | | 240 |
| 45 | | | | | | | | 235 |
| 50 | | | | | | | | 230 |
| 55 | | | | | | | | 225 |
| 60 | | | | | | | | 220 |
| 65 | | | | | | | | 215 |
| 70 | | | | | | | | 210 |
| 75 | | | | | | | | 205 |

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**CLIENT** Savannah River Remediation
**PROJECT NAME** Saltstone Disposal Unit 6
**PROJECT NUMBER**
**PROJECT LOCATION** Z-Area

| Depth (ft) | Sample Type Number | Sample Interval | In. Recovered / In. Driven | Blow Counts (N value) | Graphic Log | Material Description | Blow Count (blows/ft) 20 40 60 80 | Elevation (ft) |
|---|---|---|---|---|---|---|---|---|
| 75 | FP-01 | | 24/24 | | | | | |
| | | | | | | Mud rotary drill. | | 200 |
| 80 | | | | | | | | |
| | | | | | | | | 195 |
| 85 | FP-02 | | 4/24 | | | | | |
| | | | | | | Mud rotary drill. | | 190 |
| 90 | | | | | | | | |
| | | | | | | | | 185 |
| 95 | | | | | | | | |
| | | | | | | | | 180 |
| 100 | | | | | | | | |
| | | | | | | | | 175 |
| 105 | | | | | | | | |
| | | | | | | | | 170 |
| 110 | | | | | | | | |
| | | | | | | | | 165 |
| 115 | | | | | | | | |

GEOTECH_BLOW COUNT - GINT STD US.GDT - 02/16/12 10:24 - C:\PROGRAM FILES\GINT\PROJECTS\SDU_6.GPJ

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**CLIENT** Savannah River Remediation

**PROJECT NAME** Saltstone Disposal Unit 6

**PROJECT NUMBER**

**PROJECT LOCATION** Z-Area

| Depth (ft) | Sample Type Number | Sample Interval | In. Recovered / In. Driven | Blow Counts (N value) | Graphic Log | Material Description | Blow Count (blows/ft) 20 40 60 80 | Elevation (ft) |
|---|---|---|---|---|---|---|---|---|
| 115 | | | | | | Mud rotary drill. *(continued)* | | |
| 120 | | | | | | | | 160 |
| 125 | | | | | | | | 155 |
| 130 | | | | | | | | 150 |
| | | | | | | Bottom of borehole at 131.0 feet. | | 145 |
| | | | | | | | | 140 |
| | | | | | | | | 135 |
| | | | | | | | | 130 |
| | | | | | | | | 125 |

Savannah River NUCLEAR SOLUTIONS

Savannah River Nuclear Solutions, Inc.
Savannah River Site
Aiken, SC 29208

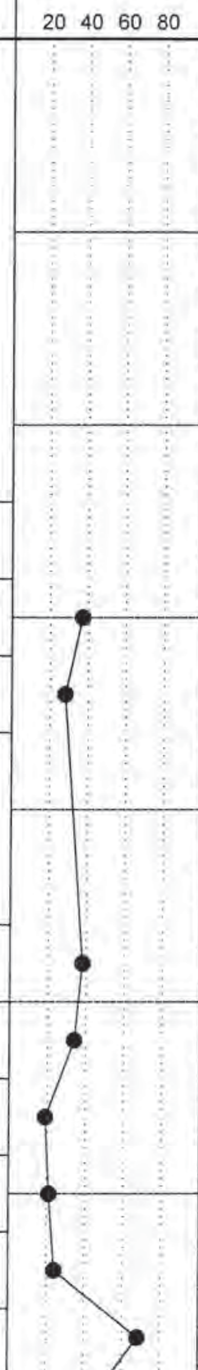
# BORING NUMBER Z-SDU6-B03



**CLIENT** Savannah River Remediation
**PROJECT NAME** Saltstone Disposal Unit 6
**PROJECT NUMBER**
**PROJECT LOCATION** Z-Area
**DATE STARTED** 01/05/12 **COMPLETED** 01/11/12
**GROUND ELEVATION** 276.5 ft **HOLE SIZE** 4 inches
**DRILLING CONTRACTOR** SAEDACCO
**COORDINATES:NORTH** 77769.6 **EAST** 66304.5
**DRILLING METHOD** Mud rotary
**LOGGED BY** M. Hasek **CHECKED BY** [signature]
**NOTES** SPT

| Depth (ft) | Sample Type Number | Sample Interval | In. Recovered / In. Driven | Blow Counts (N value) | Graphic Log | Material Description | Elevation (ft) |
|---|---|---|---|---|---|---|---|
| 0 | | | | | | Mud rotary drill. | |
| | | | | | | | 275 |
| 5 | | | | | | | |
| | | | | | | | 270 |
| 10 | | | | | | | |
| | | | | | | | 265 |
| | SS-01 | X | 14/24 | | | Red silty Sand (SM), sand fine to medium, subangular to subround, low plasticity, moist, dense, with few brownish yellow mottles. | |
| 15 | SS-02 | X | 18/24 | 10-17-20-23 (37) | | Red silty Sand (SM), sand fine to medium, subangular to subround, low plasticity, moist, medium dense. | |
| | SS-03 | X | 19/24 | 9-12-16-23 (28) | | Red sandy Silt (ML), sand portion fine to medium and subangular to subround, med. plasticity, moist, medium dense. | 260 |
| 20 | | | | | | Mud rotary drill. | |
| | | | | | | | 255 |
| 25 | SS-04 | X | 20/24 | 10-19-19-24 (38) | | Yellowish red clayey Silt (MH) (upper 7 in), high plasticity, trace sand (fine to medium, subangular), moist, dense; Yellowish red silty Sand (SM) (lower 13 in), fine to medium, subangular, low plasticity, moist, dense. | |
| | SS-05 | X | 21/24 | 10-18-16-19 (34) | | Red clayey Silt (MH) (upper 3 in), high plasticity, moist; Red sandy Silt (ML) (lower 18 in), sand fine and subangular, low plasticity, moist, hard, brownish yellow mottle bottom 1 in. | 250 |
| | SS-06 | X | 21.5/24 | 9-7-12-17 (19) | | Red sandy Silt (ML) (upper 8 in), sand fine to medium and subangular, moist, very stiff; Reddish yellow clayey Silt (MH) (lower 13 in), high plasticity, moist, very stiff. | |
| 30 | SS-07 | X | 18/24 | 5-8-13-17 (21) | | Reddish yellow silty Sand (SM) (upper 14 in), sand subangular and fine with trace medium, subangular, low plasticity, moist, very stiff; Red sandy Silt (SM) (lower 4 in), very low plasticity, moist. | |
| | SS-08 | X | 19/24 | 12-12-12-12 (24) | | Reddish yellow silty Sand (SM), sand subangular and fine, very low plasticity, moist, medium dense. | 245 |
| 35 | SS-09 | X | 18/18 | 10-18-50 (68) | | Reddish yellow silty Sand (SM) (upper 5 in), fine to medium, subangular, low plasticity, moist; Red sandy Clay (CL) (upper mid 3 in), high plasticity, moist; white fat Clay (CH) (lower mid 7 in), high plasticity, | |

Blow Count (blows/ft)

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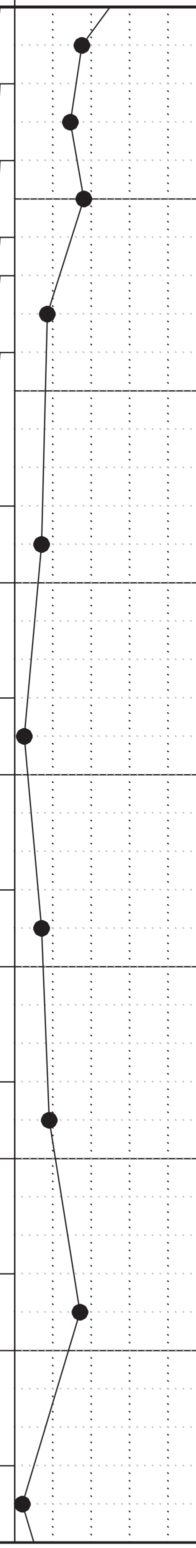
GEOTECH_BLOW COUNT - GINT STD US.GDT - 02/16/12 10:15 - C:\PROGRAM FILES\GINT\PROJECTS\SDU_6.GPJ

**CLIENT** Savannah River Remediation **PROJECT NAME** Saltstone Disposal Unit 6

**PROJECT NUMBER** **PROJECT LOCATION** Z-Area

| Depth (ft) | Sample Type Number | Sample Interval | In. Recovered / In. Driven | Blow Counts (N value) | Graphic Log | Material Description | Elevation (ft) |
|---|---|---|---|---|---|---|---|
| 35 | SS-10 | X | 19/24 | 10-15-20-27 (35) | | Clay (CH) (lower 4 in), little fine to medium sand and subangular, high plasticity, moist. | 240 |
| | SS-11 | X | 20/24 | 10-13-16-16 (29) | | Reddish yellow silty Sand (SM) (upper 2 in), fine to medium, subangular, low plasticity, moist; white sandy Clay (CL/CH) (upper mid 2 in), sand fine to medium and subangular, high plasticity, moist; Red with white alternating layers silty Sand (SM) (lower 15 in), fine to medium, subangular, low plasticity, moist, dense. | |
| 40 | SS-12 | X | 20/24 | 11-15-21-27 (36) | | Red and yellowish red poorly graded Sand (SP) (lower 17.5 in), fine with trace medium, subangular, nonplastic, moist, medium dense; white Clay (CL/CH) (upper 2.5 in), little sand (fine, subangular), high plasticity; moist. | |
| | | | | | | Red silty Sand (SM), fine, subangular, nonplastic grading to reddish yellow silty sand with lower silt content with depth; moist, dense. | 235 |
| | | | | | | Mud rotary drill. | |
| | SS-13 | X | 13/24 | 7-7-10-11 (17) | | Reddish yellow silty Sand (SM) (upper 3 in), sand fine and subangular, low plasticity, moist, medium dense; Red silty Sand (SM) (lower 10 in), sand fine and subangular, medium plasticity, moist, medium dense. | |
| 45 | | | | | | Mud rotary drill. | 230 |
| 50 | SS-14 | X | 24/24 | 5-6-8-12 (14) | | Yellow fat Clay (CH), high plasticity, moist, few very fine sand, stiff. | |
| | | | | | | Mud rotary drill. | 225 |
| 55 | SS-15 | X | 24/24 | 2-2-3-6 (5) | | Light greenish gray interlayered fat Clay (CH) (high plasticity, moist, no sand) with clayey Sand (SC) grading to sandier clay with depth (CL) (lower 10 in), sand fine to medium and subangular to subround, moist, medium soft. | |
| | | | | | | Mud rotary drill. | 220 |
| 60 | SS-16 | X | 24/24 | 5-7-7-8 (14) | | Light greenish gray fat Clay (CH), high plasticity, moist; grading to light greenish gray clayey Sand (SC) below 12 inches, fine to medium, subangular, moist, stiff. | |
| | | | | | | Mud rotary drill. | 215 |
| 65 | SS-17 | X | 17/24 | 5-7-11-11 (18) | | Light yellowish brown poorly graded Sand (SP), fine (mostly) to medium, subangular, non-plastic, wet, few black inclusions throughout up to 5 mm, medium dense. | |
| | | | | | | Mud rotary drill. | 210 |
| 70 | SS-18 | X | 19/24 | 15-15-19-23 (34) | | Yellowish red poorly graded Sand (SP) grading to reddish yellow with depth, fine (mostly) to medium, subangular, non-plastic, trace silt, wet, dense. | |
| | | | | | | Mud rotary drill. | 205 |
| 75 | SS-19 | X | 24/24 | 2-2-2-3 (4) | | Yellowish brown poorly graded Sand (SP) (upper 13 in), fine to medium, subangular to subrounded, nonplastic, wet, very loose, few pale yellow zones to 25 mm; grading to red clayey Sand (SC) (lower 11 in), sand fine to | |

Blow Count (blows/ft)

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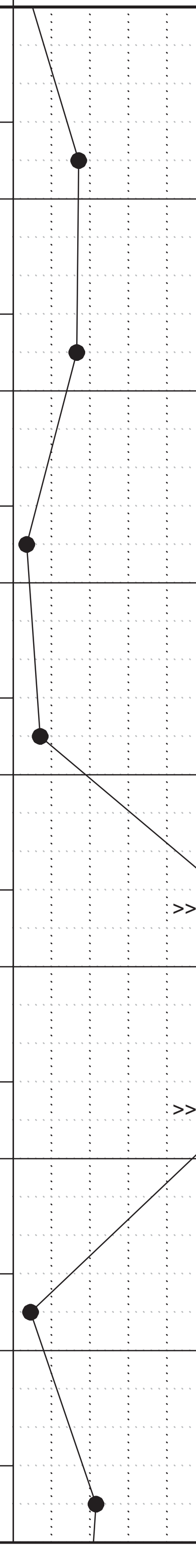
GEOTECH_BLOW COUNT - GINT STD US.GDT - 02/16/12 10:24 - C:\PROGRAM FILES\GINT\PROJECTS\SDU_6.GPJ

**CLIENT** Savannah River Remediation **PROJECT NAME** Saltstone Disposal Unit 6

**PROJECT NUMBER** **PROJECT LOCATION** Z-Area

| Depth (ft) | Sample Type Number | Sample Interval | In. Recovered / In. Driven | Blow Counts (N value) | Graphic Log | Material Description | Blow Count (blows/ft) 20 40 60 80 | Elevation (ft) |
|---|---|---|---|---|---|---|---|---|
| 75 | | | | | | medium and subangular to subround, low plasticity, wet, very loose. | | |
| | | | | | | Mud rotary drill. | | 200 |
| 80 | SS-20 | | 18/24 | 3-13-21-32 (34) | | Yellow poorly graded Sand (SP), fine, trace medium sand, little silt, nonplastic, wet, dense; few black zones (6 mm to 12 mm) throughout upper 11 in, hard zone 9 to 10.5 in from bottom. | | |
| | | | | | | Mud rotary drill. | | 195 |
| 85 | SS-21 | | 16/24 | 15-16-17-13 (33) | | Strong brown well-graded Sand (SW), fine to medium, subangular to subround, trace fines, nonplastic, wet, dense, lower 13 in pale yellow with few black areas up to 8 mm. | | |
| | | | | | | Mud rotary drill. | | 190 |
| 90 | SS-22 | | 24/24 | 3-3-4-6 (7) | | Pale yellow Silt (MH), medium to high plasticity, trace clay, wet, medium soft. | | |
| | | | | | | Mud rotary drill. | | 185 |
| 95 | SS-23 | | 24/24 | 9-7-7-7 (14) | | Pale yellow clayey Silt (ML/MH), little sand, fine to coarse, angular to subangular; few gravel, angular to subangular up to 25 mm, hard; wet, weak HCl, medium plasticity, stiff. | | |
| | | | | | | Mud rotary drill. | | 180 |
| 100 | SS-24 | | 11/11.5 | 23-104/6" | | Pale yellow clayey Silt (MH), little sand, fine to coarse, angular to subangular; few white gravel, angular to subangular up to 35 mm, hard (silica cementation ?); wet, weak HCl, medium plasticity, very dense. | >> | |
| | | | | | | Mud rotary drill. | | 175 |
| 105 | SS-25 | | 17/17 | 21-47-50/5" | | Pale yellow well-graded Sand (SW) (upper 5 in), fine to medium, clean, nonplastic, wet. Pale yellow Silt (ML) (lower 14 in) with trace white gravel, gravel subangular, weak HCl, hard, few sand; rock in tip of spoon, angular, hard, cemented silt/very fine sand. | >> | |
| | | | | | | Mud rotary drill. | | 170 |
| 110 | SS-26 | | 17/24 | 6-5-4-9 (9) | | Pale yellow to very pale brown silty Sand (SM), sand fine, low plasticity, wet, loose; one inch rock layers at 7 and 12 inches from bottom. | | |
| | | | | | | Mud rotary drill. | | 165 |
| 115 | SS-27 | | 24/24 | 11-19-24-46 (43) | | Greenish gray silty Sand (SM), fine; white shell fragments, fine to medium, 25% of soil, moderate HCl; very low plasticity, moist, dense. | | |



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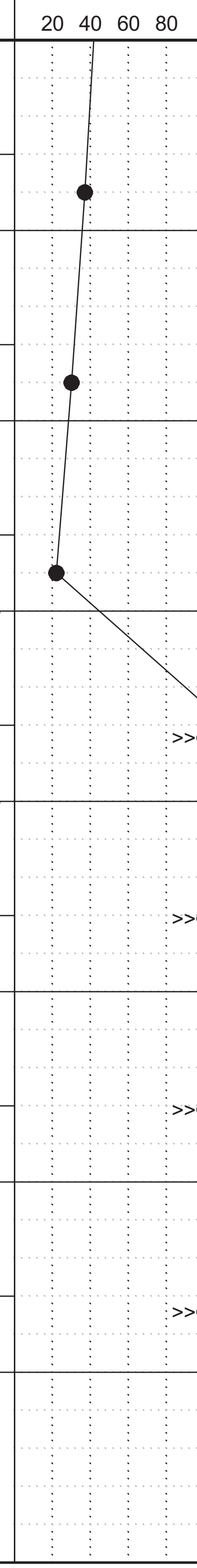
**CLIENT** Savannah River Remediation **PROJECT NAME** Saltstone Disposal Unit 6

**PROJECT NUMBER** **PROJECT LOCATION** Z-Area

| Depth (ft) | Sample Type Number | Sample Interval | In. Recovered / In. Driven | Blow Counts (N value) | Graphic Log | Material Description | Elevation (ft) |
|---|---|---|---|---|---|---|---|
| 115 | | | | | | Mud rotary drill. | 160 |
| 120 | SS-28 | | 24/24 | 17-18-19-26 (37) | | Greenish gray silty Sand (SM), fine; white shell fragments, 90% of soil at top grading to 5% at bottom, weak HCl; very low plasticity, moist, dense; grades to dark greenish gray towards bottom. | |
| | | | | | | Mud rotary drill. | 155 |
| 125 | SS-29 | | 24/24 | 10-13-17-40 (30) | | Dark greenish gray fat Clay (CH), high plasticity, trace fine sand, moist, very stiff. | |
| | | | | | | Mud rotary drill. | 150 |
| 130 | SS-30 | | 24/24 | 9-10-12-18 (22) | | Greenish black silty fine Sand (SM) grading to dark greenish gray fat Clay with depth; upper sand angular to subangular, low plasticity, moist, medium dense/very stiff, grading to high plasticity with trace fine sand with depth, moist, trace mica throughout. | |
| | | | | | | Mud rotary drill. | 145 |
| 135 | SS-31 | | 8/8 | 63-50/2" | | Greenish black well graded Sand (SW) with areas of greenish gray Sand (SW), trace silt, well-graded, sand fine to medium and angular to subangular, wet, very dense; fat Clay (CH) (upper 1 in) with dark greenish gray Gravel piece, 30 mm, subangular. | |
| | | | | | | Mud rotary drill. | 140 |
| 140 | SS-32 | | 0/2 | 50/2" | | No recovery. Very dense. | |
| | | | | | | Mud rotary drill. | 135 |
| 145 | SS-33 | | 0/2.5 | 50/3" | | Dark greenish gray, poorly graded fine Sand, trace silt, angular to subangular, nonplastic, wet (sample from shoe), very dense. | |
| | | | | | | Mud rotary drill. | 130 |
| 150 | SS-34 | | 10/10 | 54-50/4" | | Gray poorly graded Sand (SP) (lower 4 in), fine, angular to subangular, nonplastic, wet, very dense; Very dark gray fat Clay (CH) (mid 4 in), high plasticity, wet, hard, trace fine sand; upper 2 in waste soil. | |
| 155 | | | | | | Mud rotary drill. | 125 |

Blow Count (blows/ft)

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GEOTECH_BLOW COUNT - GINT STD US.GDT - 02/16/12 10:24 - C:\PROGRAM FILES\GINT\PROJECTS\SDU_6.GPJ

**CLIENT** Savannah River Remediation

**PROJECT NAME** Saltstone Disposal Unit 6

**PROJECT NUMBER**

**PROJECT LOCATION** Z-Area

| Depth (ft) | Sample Type Number | Sample Interval | In. Recovered / In. Driven | Blow Counts (N value) | Graphic Log | Material Description | Blow Count (blows/ft) 20 40 60 80 | Elevation (ft) |
|---|---|---|---|---|---|---|---|---|
| 155 | | | | | | Mud rotary drill. *(continued)* | | 120 |
| | | | | | | Bottom of borehole at 157.0 feet. | | 115<br>110<br>105<br>100<br>95<br>90<br>85 |

# BORING NUMBER Z-SDU6-B04



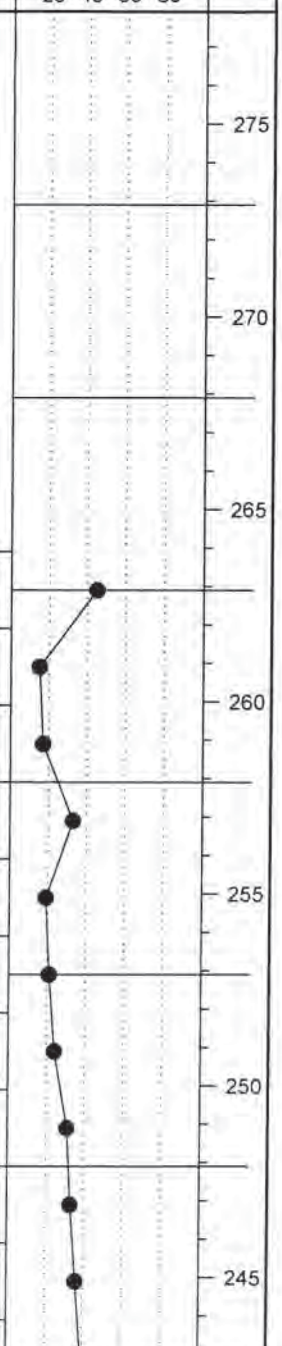
Savannah River NUCLEAR SOLUTIONS

Savannah River Nuclear Solutions, Inc.
Savannah River Site
Aiken, SC 29208

CLIENT Savannah River Remediation
PROJECT NAME Saltstone Disposal Unit 6
PROJECT NUMBER
PROJECT LOCATION Z-Area
DATE STARTED 01/11/12 COMPLETED 01/26/12
GROUND ELEVATION 277.9 ft HOLE SIZE 4 inches
DRILLING CONTRACTOR SAEDACCO
COORDINATES: NORTH 77663.9 EAST 66351.1
DRILLING METHOD Mud rotary
LOGGED BY M. Hasek CHECKED BY [signature]
NOTES SPT

| Depth (ft) | Sample Type Number | Sample Interval | In. Recovered / In. Driven | Blow Counts (N value) | Graphic Log | Material Description |
|---|---|---|---|---|---|---|
| 0 | | | | | | Mud rotary drill. |
| 15 | SS-01 | X | 18/24 | 17-22-23-20 (45) | | Red silty well graded Sand (SW-SM), mostly fine sand, little medium sand, subangular, well graded, moist, dense. |
| | SS-02 | X | 15/24 | 7-8-7-9 (15) | | Red sandy Silt (ML), trace clay, fine sand subangular, low plasticity; upper 4 in trace subround medium sand, moist, medium dense. |
| | SS-03 | X | 13/24 | 6-6-11-18 (17) | | Red silty Sand (SM), upper 2 in medium sand, subround, nonplastic, moist; lower 11 in silty poorly graded Sand (SP-SM), fine sand, angular to subangular, nonplastic, moist, medium dense. |
| 20 | SS-04 | X | 20/24 | 15-15-18-24 (33) | | Red clayey, sandy Silt (MH) (lower 18 in), little sand, little clay, sand fine to medium and subangular, medium plasticity, moist, hard, upper 2 in preferentially sorted during SPT. |
| | SS-05 | X | 18/24 | 8-9-10-15 (19) | | Red clayey Silt (MH), few sand fine to medium and subangular to subround, medium plasticity, moist, very stiff, few yellow mottles, yellow layer from 12 to 15 in above bottom. |
| 25 | SS-06 | X | 19/24 | 8-10-11-15 (21) | | Red sandy Silt (ML), few clay, some sand fine to medium and subangular to subround, medium plasticity, moist, very stiff, few yellow mottles. |
| | SS-07 | X | 18/24 | 8-11-13-17 (24) | | Red silty poorly graded Sand (SP-SM), trace clay, medium sand, poorly graded, subangular to subround, low plasticity, few yellow mottles, moist, medium dense. |
| | SS-08 | X | 16/24 | 7-15-16-18 (31) | | Red silty Sand (SM), some silt, trace clay, fine to medium sand subangular to subround, low plasticity, few yellow mottles, moist, dense. |
| 30 | SS-09 | X | 18/24 | 12-15-18-31 (33) | | Red silty Sand (SM), some silt, trace clay, fine to medium sand subangular to subround, low plasticity, few yellow mottles, moist, dense. |
| | SS-10 | X | 14/24 | 11-17-19-27 (36) | | Red silty Sand (SM) grading to yellowish red poorly graded Sand (SP) with depth, sand fine and angular to subangular, trace fines, nonplastic, moist, dense. |
| 35 | | X | 15/24 | 14-17-22-30 | | |

Blow Count (blows/ft) / Elevation (ft)



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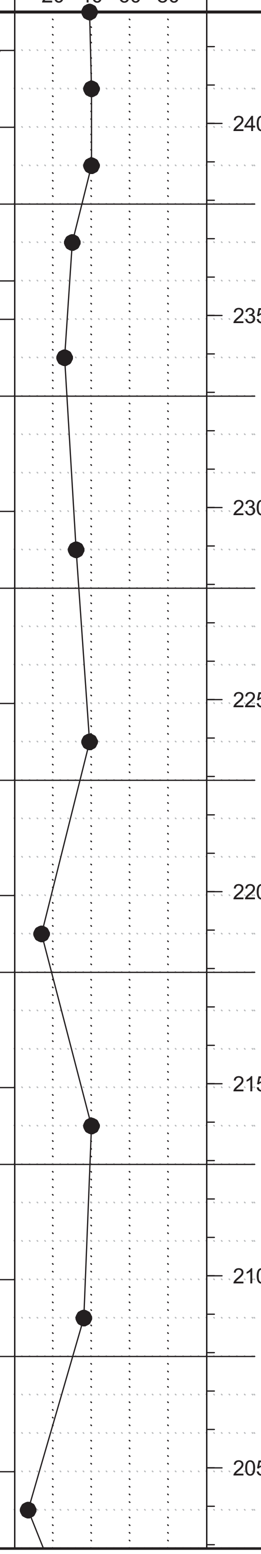
GEOTECH_BLOW COUNT - GINT STD US GDT - 02/15/12 08:37 - C:\PROGRAM FILES\GINT\PROJECTS\SDU_6.GPJ

**CLIENT** Savannah River Remediation **PROJECT NAME** Saltstone Disposal Unit 6

**PROJECT NUMBER** **PROJECT LOCATION** Z-Area

| Depth (ft) | Sample Type Number | Sample Interval | In. Recovered / In. Driven | Blow Counts (N value) | Graphic Log | Material Description |
|---|---|---|---|---|---|---|
| 35 | SS-11 | X | 15/24 | (39) | | Reddish yellow poorly graded Sand (SP), medium sand, subangular to subround, trace fine sand, trace silt, nonplastic, moist, dense. *(continued)* |
| | SS-12 | X | 12/24 | 13-19-21-26 (40) | | Reddish yellow well graded Sand (SW), medium sand, subangular to subround, little fine sand, trace silt, nonplastic, moist, dense. |
| 40 | SS-13 | X | 10/24 | 6-17-23-31 (40) | | Reddish yellow well graded Sand (SW), medium sand, subangular to subround, little fine sand, trace silt, nonplastic, moist, dense. |
| | SS-14 | X | 15/24 | 16-12-18-24 (30) | | Reddish yellow well graded Sand (SW), medium sand, subangular to subround, little fine sand, trace silt, nonplastic, moist, medium dense; Dark red at 0 to 3 in from bottom and 5 to 5.5 in from bottom. |
| | | | | | | Mud rotary drill. |
| 45 | SS-15 | X | 15/24 | 9-13-13-15 (26) | | Reddish yellow sandy Clay (CL), fine sand, subangular to subround, trace silt, low plasticity, moist, very stiff; upper 2 in and lower 3 in yellow fat Clay (CH), few fine sand. |
| | | | | | | Mud rotary drill. |
| 50 | SS-16 | X | 12/24 | 11-14-18-26 (32) | | Brownish yellow clayey poorly graded Sand (SP-SC), fine sand, angular to subangular, little clay, low plasticity, moist, dense; sandy clay peds throughout up to 8 mm. |
| | | | | | | Mud rotary drill. |
| 55 | SS-17 | X | 13/24 | 13-17-22-30 (39) | | Brownish yellow poorly graded Sand (SP), fine sand, subangular, trace clay, nonplastic, moist, dense; sandy clay peds throughout up to 10 mm. |
| | | | | | | Mud rotary drill. |
| 60 | SS-18 | X | 18/24 | 9-7-7-20 (14) | | Yellow clayey poorly graded Sand (SP-SC), fine sand, angular to subangular, low plasticity, grading to sandy Clay with depth (CL), medium plasticity, moist, medium dense/stiff. |
| | | | | | | Mud rotary drill. |
| 65 | SS-19 | X | 14/24 | 14-17-23-31 (40) | | Brownish yellow poorly graded Sand (SP), fine to medium sand, angular to subangular, trace clay, nonplastic, moist, dense. |
| | | | | | | Mud rotary drill. |
| 70 | SS-20 | X | 12/24 | 12-16-20-26 (36) | | Brownish yellow silty poorly graded Sand (SP-SM), fine (mostly) to medium sand, subangular, very low plasticity, wet, dense; lower 2.5 in dark yellowish brown, mostly fine sand, subangular. |
| | | | | | | Mud rotary drill. |
| 75 | SS-21 | X | 24/24 | 5-2-5-3 (7) | | Dark brownish gray silty poorly graded Sand (SP-SM) (upper 4 in), sand fine to medium, subangular, nonplastic, wet; Dark gray fat Clay (CH) (13 to 16 in from bottom), trace fine sand, high plasticity, wet; Brownish yellow sandy |

Blow Count (blows/ft)

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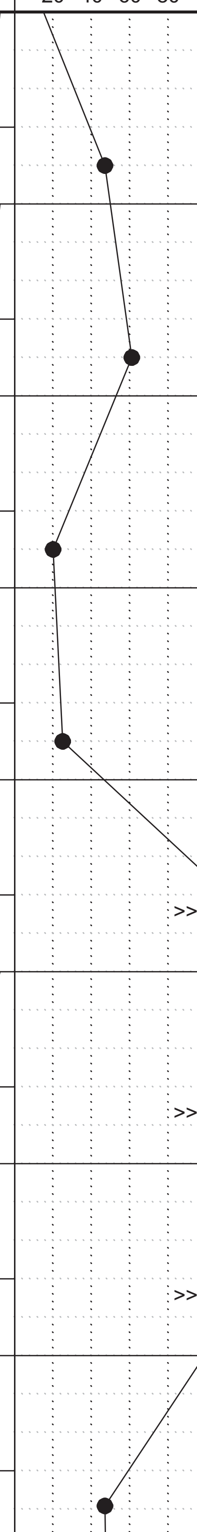
GEOTECH_BLOW COUNT - GINT STD US.GDT - 02/16/12 10:24 - C:\PROGRAM FILES\GINT\PROJECTS\SDU_6.GPJ

**CLIENT** Savannah River Remediation **PROJECT NAME** Saltstone Disposal Unit 6

**PROJECT NUMBER** **PROJECT LOCATION** Z-Area

| Depth (ft) | Sample Type Number | Sample Interval | In. Recovered / In. Driven | Blow Counts (N value) | Graphic Log | Material Description | Elevation (ft) |
|---|---|---|---|---|---|---|---|
| 75 | | | | | | Clay (CL) (lower 13 in), few fine sand, angular to subangular, high plasticity, wet, loose/medium soft. | |
| | | | | | | Mud rotary drill. | 200 |
| 80 | SS-22 | X | 18/24 | 12-20-27-44 (47) | | Brownish yellow poorly graded Sand (SP) (upper 3 in), medium, angular, nonplastic, wet; Pale yellow to brownish yellow poorly graded Sand (SP) (middle 12 in), fine to medium sand, angular to subangular, nonplastic, wet, dense; Weak red poorly graded Sand (SP) (lower 3 in), fine to medium, angular to subangular, nonplastic, wet. | |
| | | | | | | Mud rotary drill. | 195 |
| 85 | SS-23 | X | 13/24 | 18-28-33-30 (61) | | Brownish yellow to pale yellow poorly graded Sand (SP), fine (mostly) to medium, subangular to subround, nonplastic, wet, very dense. | |
| | | | | | | Mud rotary drill. | 190 |
| 90 | SS-24 | X | 24/24 | 8-8-12-17 (20) | | Pale yellow clayey Silt (ML/MH), few clay, moderatetly plastic, wet, very stiff, weak HCl Rx; trace white gravel, subangular, very hard, up to 25 mm. | |
| | | | | | | Mud rotary drill. | 185 |
| 95 | SS-25 | X | 24/24 | 11-13-12-26 (25) | | Pale brown clayey Silt (ML/MH), few sand, moderatetly plastic, wet, very stiff, weak HCl Rx; fractured rock and few gravel, very hard, angular to subangular, very hard, up to 25 mm. | |
| | | | | | | Mud rotary drill. | 180 |
| 100 | SS-26 | X | 10/10 | 22-50/4" | | Pale yellow clayey Silt (MH), medium plasticity, very weak HCl Rx, moist, hard; white rock layer from 5 to 6.5 in from bottom, very hard arenaceous carbonate, strong HCl Rx; few white gravel, subangular to subround, very hard. | |
| | | | | | | Mud rotary drill. | 175 |
| 105 | SS-27 | X | 21/16 | 9-22-50/4" | | Pale yellow clayey Silt (MH), medium to high plasticity, weak to strong HCl Rx, moist, hard; tip packed with hard, weathered rock (2 in). | |
| | | | | | | Mud rotary drill. | 170 |
| 110 | SS-28 | X | 10/10 | 29-50/4" | | Greenish gray clayey Silt (ML/MH), medium to high plasticity, strong HCl Rx, moist, hard; Greenish gray rock 1 in thick from 4 to 5 in from bottom, fractured, hard, weak HCl Rx. | |
| | | | | | | Mud rotary drill. | 165 |
| 115 | SS-29 | X | 24/22 | 12-19-28-50/4" (47) | | Greenish gray clayey Sand (SC), mostly sand-sized white and dark brown shell fragments (fragments up to 5 mm), little clay, medium plasticity, medium to strong HCl Rx, moist, dense. | |

Blow Count (blows/ft)

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GEOTECH_BLOW COUNT - GINT STD US.GDT - 02/16/12 10:24 - C:\PROGRAM FILES\GINT\PROJECTS\SDU_6.GPJ

**CLIENT** Savannah River Remediation
**PROJECT NAME** Saltstone Disposal Unit 6
**PROJECT NUMBER**
**PROJECT LOCATION** Z-Area

| Depth (ft) | Sample Type Number | In. Recovered / In. Driven | Blow Counts (N value) | Material Description | Elevation (ft) |
|---|---|---|---|---|---|
| 115–118 | | | | Mud rotary drill. | 160 |
| 118–120 | SS-30 | 24/24 | 14-21-28-50 (49) | Greenish gray clayey Sand (SC), mostly sand-sized white and dark brown shell fragments (fragments up to 5 mm), little clay, medium plasticity, medium to strong HCl Rx, moist, dense; light greenish gray upper 11 in. | |
| 120–123 | | | | Mud rotary drill. | 155 |
| 123–125 | SS-31 | 24/24 | 8-10-20-48 (30) | Greenish black sandy Clay (CL) (upper 12 in), trace silt; some sand, mostly fine and angular, few medium subangular; silty laminations < 3 mm thick from 11 to 15 in from bottom, high plasticity, moist, very stiff; Dark greenish gray sandy Clay (CH) (lower 12 in), high plasticity, moist, very stiff. | |
| 125–128 | | | | Mud rotary drill. | 150 |
| 128–130 | SS-32 | 24/24 | 8-14-18-23 (32) | Greenish black sandy Clay (CL) (upper 12 in); some fine angular sand, few subangular to subround medium sand, medium plasticity, moist, hard. | |
| 130–133 | | | | Mud rotary drill. | 145 |
| 133–135 | SS-33 | 11/11 | 21-50/5" | Dark greenish gray sandy Clay (CL/CH) (upper 2 in), high plasticity, wet; Dark greenish gray well graded Sand (SW) (lower 9.5 in), mostly subangular fine sand, few subround medium sand, trace clay, nonplastic, wet, very dense. | |
| 135–138 | | | | Mud rotary drill. | 140 |
| 138–140 | SS-34 | 2/4 | 50/4" | Greenish gray well graded Sand (SW), trace clay, fine sand, angular to subangular, nonplastic, wet, very dense. | |
| 140–143 | | | | Mud rotary drill. | 135 |
| 143–145 | SS-35 | 0/2 | 50/2" | Dark greenish gray poorly graded Sand (SP), mostly subangular fine sand, few subangular to subround medium sand, trace silt, nonplastic, wet, very dense. | |
| 145–148 | | | | Mud rotary drill. | 130 |
| 148–150 | SS-36 | 0/2 | 50/2" | Dark gray poorly graded Sand (SP), fine sand, subangular, nonplastic, wet, very dense. | |
| 150–155 | | | | Mud rotary drill. | 125 |

Blow Count (blows/ft): 20 40 60 80


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GEOTECH_BLOW COUNT - GINT STD US.GDT - 02/16/12 10:24 - C:\PROGRAM FILES\GINT\PROJECTS\SDU_6.GPJ

# BORING NUMBER Z-SDU6-B04



Savannah River Nuclear Solutions, Inc.
Savannah River Site
Aiken, SC 29208

**CLIENT** Savannah River Remediation
**PROJECT NAME** Saltstone Disposal Unit 6
**PROJECT NUMBER**
**PROJECT LOCATION** Z-Area

| Depth (ft) | Sample Type Number | Sample Interval | In. Recovered / In. Driven | Blow Counts (N value) | Graphic Log | Material Description | Blow Count (blows/ft) 20 40 60 80 | Elevation (ft) |
|---|---|---|---|---|---|---|---|---|
| 155 | | | | | | Mud rotary drill. *(continued)* | | |
| | SS-37 | | 3/4 | 50/4" | | Greenish black well graded Sand (SW), fine to medium sand, subangular, trace silt, nonplastic, wet, very dense. | >> | 120 |
| 160 | | | | | | Mud rotary drill. | | 115 |
| 165 | | | | | | | | |
| | SS-38 | | 0/3 | 50/3" | | Grayish brown poorly graded Sand (SP), fine sand, angular to subangular, trace medium sand, trace silt, nonplastic, wet, very dense. | >> | 110 |
| 170 | | | | | | Mud rotary drill. | | 105 |
| 175 | | | | | | | | |
| | SS-39 | | 2/4 | 50/4" | | Black well graded silty Sand (SW-SM), fine to medium sand, subangular to subround; little silt, trace clay, nonplastic, wet, very dense. | >> | 100 |
| 180 | | | | | | Mud rotary drill. | | 95 |
| 185 | | | | | | | | 90 |
| | SS-40 | | 8/11 | 50-50/5" | | Gray poorly graded Sand (SP), fine to medium, angular to subangular, nonplastic, wet, black inclusions (lignite?) up to 30% of sample, very dense. | >> | |
| 190 | | | | | | Mud rotary drill. | | 85 |
| 195 | | | | | | | | |

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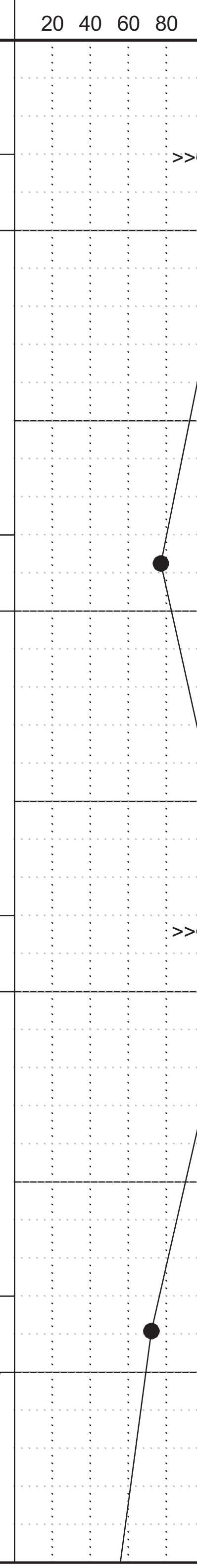
GEOTECH_BLOW COUNT - GINT STD US.GDT - 02/16/12 10:24 - C:\PROGRAM FILES\GINT\PROJECTS\SDU_6.GPJ

**CLIENT** Savannah River Remediation **PROJECT NAME** Saltstone Disposal Unit 6

**PROJECT NUMBER** **PROJECT LOCATION** Z-Area

| Depth (ft) | Sample Type Number | Sample Interval | In. Recovered / In. Driven | Blow Counts (N value) | Graphic Log | Material Description | Elevation (ft) |
|---|---|---|---|---|---|---|---|
| 195 | | | | | | Mud rotary drill. *(continued)* | |
| | SS-41 | | 0/2 | 50/2" | | Dark grayish brown poorly graded Sand (SP), medium, subangular, nonplastic, wet, very dense. | 80 |
| 200 | | | | | | Mud rotary drill. | |
| 205 | | | | | | | 75 |
| | SS-42 | | 11/18 | 47-27-50 (77) | | Greenish gray poorly graded Sand (SP), medium sand, subangular; little fine sand, angular to subangular; nonplastic, wet, very dense. | 70 |
| 210 | | | | | | Mud rotary drill. | |
| 215 | | | | | | | 65 |
| | SS-43 | | 6/10 | 32-50/4" | | Dark greenish gray poorly graded Sand (SP), medium, subangular; little fine sand, subangular; nonplastic, wet, very dense, slightly sulfurous; lower 1 in cohesive, medium sand. | 60 |
| 220 | | | | | | Mud rotary drill. | |
| 225 | | | | | | | 55 |
| | SS-44 | | 16/22 | 29-26-46-50/4" (72) | | Dark gray poorly graded Sand (SP), medium sand, subangular; trace fine sand, nonplastic, wet, very dense; dark gray clayey poorly graded Sand (SP-SC), 7.5 to 10 in from bottom, medium sand, subangular, little clay, trace fine sand, low plasticity. | 50 |
| 230 | | | | | | Mud rotary drill. | 45 |
| 235 | | | | | | | |

Blow Count (blows/ft)

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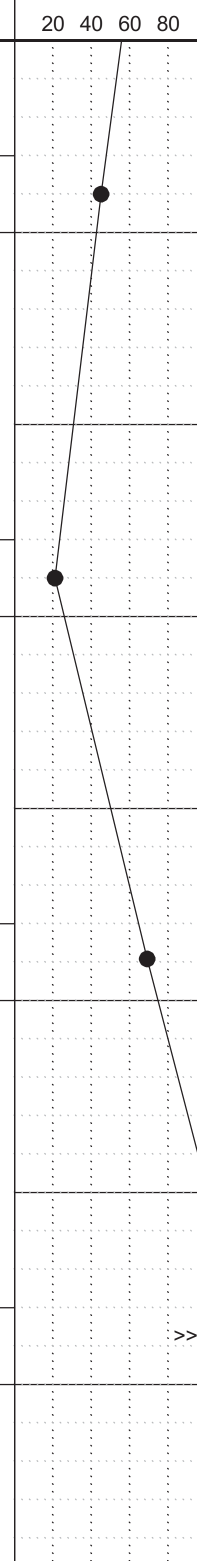
**CLIENT** Savannah River Remediation **PROJECT NAME** Saltstone Disposal Unit 6

**PROJECT NUMBER** **PROJECT LOCATION** Z-Area

| Depth (ft) | Sample Type Number | Sample Interval | In. Recovered / In. Driven | Blow Counts (N value) | Graphic Log | Material Description | Elevation (ft) |
|---|---|---|---|---|---|---|---|
| 235 | | | | | | Mud rotary drill. *(continued)* | 40 |
| 240 | SS-45 | X | 0/24 | 12-18-27-50 (45) | | Dark gray sandy Silt (ML), very fine sand, low plasticity, wet, hard. | |
| 245 | | | | | | Mud rotary drill. | 35 |
| 250 | SS-46 | X | 24/24 | 7-8-13-21 (21) | | Grayish green clayey Sand (SC), fine to predominantly medium sand, subangular, low plasticity, moist, medium dense, slightly sulfurous. | 30 |
| 255 | | | | | | Mud rotary drill. | 25 |
| 260 | SS-47 | X | 16/22 | 21-32-37 (69) | | Dark gray poorly graded Sand (SP), sand predominatly fine to medium, subangular, trace silt, trace clay, nonplastic, wet, very dense. | 20 |
| 265 | | | | | | Mud rotary drill. | 15 |
| 270 | SS-48 | X | 15/17 | 25-38-50/5" | | Gray silty poorly graded Sand (SP-SM), predominantly fine to medium sand, angular to subangular, little mica, few silt, trace clay, nonplastic, wet, very dense, moderately sulfurous. | 10 |
| 275 | | | | | | Mud rotary drill. | 5 |

Blow Count (blows/ft)

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CLIENT Savannah River Remediation
PROJECT NAME Saltstone Disposal Unit 6
PROJECT NUMBER
PROJECT LOCATION Z-Area

| Depth (ft) | Sample Type Number | Sample Interval | In. Recovered / In. Driven | Blow Counts (N value) | Graphic Log | Material Description | Blow Count (blows/ft) 20 40 60 80 | Elevation (ft) |
|---|---|---|---|---|---|---|---|---|
| 275 | | | | | | Mud rotary drill. *(continued)* | | |
| | SS-49 | | 10/18 | 33-55-50 (105) | | Gray poorly graded Sand (SP), fine to predomantly medium, subangular to subround, trace mica, nonplastic, wet, very dense, slightly sulfurous. | >> | 0 |
| 280 | | | | | | Mud rotary drill. | | -5 |
| 285 | | | | | | | | |
| | SS-50 | | 7/10 | 44-50/4" | | Light gray poorly graded Sand (SP), medium sand, subangular, trace fine sand, trace kaolin, few mica, wet, very dense. | >> | -10 |
| 290 | | | | | | Mud rotary drill. | | -15 |
| 295 | | | | | | | | |
| | SS-51 | | 4/5 | 50/5" | | Light gray poorly graded Sand (SP), medium, subangular, trace mica, nonplastic, wet, very dense. | >> | -20 |
| 300 | | | | | | Mud rotary drill. | | -25 |
| 305 | | | | | | | | |
| | | | | | | Bottom of borehole at 307.0 feet. | | -30 |
| | | | | | | | | -35 |

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**Appendix C – Bearing Capacity and Static Settlements**

K-CLC-Z-00024, Rev. 0

March 2012

Bearing Capacity and Static Settlement Calculations for Saltstone Disposal Unit 6

(140 pages)

OSR 45-24 (Rev 1-20-2009)

# CALCULATION COVER SHEET

| Project/Task | Calculation No. | Project /Task No. |
|---|---|---|
| **Saltstone Disposal Unit 6** | **K-CLC-Z-00024** | **SDU6** |

| | | |
|---|---|---|
| **Title**<br>**Bearing Capacity and Static Settlement Calculations for Saltstone Disposal Unit 6** | **Functional Classification**<br>**PS** | **Sheet 1 of 139** |
| | **Discipline**<br>**Geotechnical** | |
| **Calc Level**<br>☒ Type 1 ☐ Type 2 | **Type 1 Calc Status**<br>☐ Preliminary ☒ Confirmed | |
| **Computer Program No.**<br>☒ N/A | **Version / Release No.**<br>N/A | |
| **Purpose and Objective**<br>The purpose of this calculation is to provide bearing capacity and static settlement analysis for the Saltstone Disposal Unit 6 project. | **DC/RO**<br>UNCLASSIFIED<br>DOES NOT CONTAIN UNCLASSIFIED CONTROLLED NUCLEAR INFORMATION<br>ADC & Reviewing Official [signature] (Name)<br>Date: 3/20/12 | |

**Summary of Conclusion**

See the Conclusions Section.

**Revisions**

| Rev. # | Revision Description |
|---|---|
| 0 | Original |
| | |

**Sign Off**

| Rev. # | Originator (Print) Sign / Date | Verification / Checking Method | Verifier/Checker (Print) Sign/Date | Manager (Print) Sign / Date |
|---|---|---|---|---|
| 0 | Rucker J. Williams<br>[signature] 3-20-12 | ☐ Design Check (GS/PS Only)<br>☒ Document Review<br>☐ Qualification Testing<br>☐ Alternate Calculation<br>☐ Operational Testing | Michael J. Hasek<br>[signature] 03/20/12 | Nick Kennedy<br>[signature] 3-20-12 |
| | | ☐ Design Check (GS/PS Only)<br>☒ Document Review<br>☐ Qualification Testing<br>☐ Alternate Calculation<br>☐ Operational Testing | | |

| Additional Reviewer (Print) | Signature | Date |
|---|---|---|
| N/A | | |
| **Design Authority (Print)** | **Signature** | **Date** |
| N/A | | |
| **Release to Outside Agency (Print)** | **Signature** | **Date** |
| N/A | | |

**Security Classification of the Calculation**

Unclassified

# TABLE OF CONTENTS

## 1. Introduction

The purpose of this calculation is to provide the bearing capacity and the static settlement for the Saltstone Disposal Unit 6 facility. See Figure 1 for the general location of Saltstone Disposal Unit 6. This calculation was performed to support the permitting and engineering design of Saltstone Disposal Unit 6.

## 2. Input

### 2.1 **Facility Configuration**

Saltstone Disposal Unit 6 consists of a single post-tensioned concrete tank with an average inside diameter of 375 feet.

The following are used for Saltstone Disposal Unit 6:

- Bottom of Mud Mat Elevation: 265 ft, msl
- Excavation Dimensions: 400 ft by 450 ft
- Tank foundation outside diameter: 382 ft
- Tank height: 43 ft
- Weight of fluid Saltstone: 110 psf

The tank floor will be a 1-foot reinforced concrete slab. The slab will be thickened to approximately 2 feet at the perimeter beneath the tank wall. The base dimension of the thickened slab will be 7 feet. The tank roof will be supported by 208 circular columns supported on square pedestals supported by the floor slab.

### 2.2 **Stratigraphy**

The ground surface elevation at the project site ranges from 275 ft to 282 ft, msl, based on CPT surface elevations and SRS topographic maps. Groundwater elevation at the site ranges from 215 to 220 ft, msl (Ref. WSRC 2003). A value of 220 ft, msl was used in this calculation.

Five (5) geotechnical borings, three (3) undisturbed borings and two (2) Standard Penetration Test (SPT) borings, were performed for the Saltstone Disposal Unit 6, see Figure 2. Boring Z-SDU6-B02A was abandoned at a depth of 75 feet; boring Z-SDU6-B02B was performed adjacent to the abandoned boring. Stratigraphic interpretations for the three borings were based primarily on the geophysical logs. Twenty-three (23) CPTs and SCPTs were pushed for Saltstone Disposal Unit 6 (see Figure 2). Stratigraphic interpretations of the borings, CPTs, and SCPTs are summarized below (Ref. SRS 2012a).

| ID | CPT Type | SRS Northing | SRS Easting | Elevation ft, msl | Elevation Top Pick (ft, msl) | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | C2 Layer | S3 Layer | S4 Layer | Congaree |
| Z-SDU6-C01 | CPT | 77413.3 | 66270.1 | 281.9 | 233 | 226 | 190 | |
| Z-SDU6-C02 | SCPT | 77448.1 | 66350.4 | 281.4 | 233 | 227 | 190 | |
| Z-SDU6-C03 | CPT | 77478.3 | 66494.3 | 281.6 | 233 | 225 | 190 | |

| ID | CPT Type | SRS Northing | SRS Easting | Elevation ft, msl | Elevation Top Pick (ft, msl) C2 Layer | S3 Layer | S4 Layer | Congaree |
|---|---|---|---|---|---|---|---|---|
| Z-SDU6-C04 | CPT | 77503.3 | 66578.8 | 281.8 | 236 | 229 | 190 | |
| Z-SDU6-C05 | SCPT | 77624.5 | 66594.9 | 278.1 | 235 | 226 | 187 | |
| Z-SDU6-C06 | CPT | 77587.6 | 66472.8 | 278.6 | 234 | 227 | 189 | |
| Z-SDU6-C07 | CPT | 77546.9 | 66357.1 | 279.4 | 237 | 230 | 191 | |
| Z-SDU6-C08 | CPT | 77511.4 | 66258.9 | 279.7 | 236 | 230 | 186 | |
| Z-SDU6-C09 | CPT | 77621.8 | 66210.4 | 278.3 | 237 | 230 | 194 | |
| Z-SDU6-C10 | CPT | 77644.2 | 66285.6 | 278.0 | 237 | 230 | 190 | |
| Z-SDU6-C11 | CPT | 77663.3 | 66354.1 | 277.6 | 238 | 233 | 186 | |
| Z-SDU6-C12 | SCPT | 77682.6 | 66452.6 | 277.7 | 239 | 234 | 188 | |
| Z-SDU6-C13 | CPT | 77722.6 | 66523.4 | 276.3 | 234 | 228 | 188 | |
| Z-SDU6-C14 | CPT | 77720.6 | 66180.9 | 277.3 | 234 | 222 | 181 | |
| Z-SDU6-C15 | CPT | 77748.2 | 66249.8 | 276.8 | 232 | 217 | 192 | |
| Z-SDU6-C16 | SCPT | 77772.2 | 66312.2 | 276.7 | 234 | 216 | 184 | |
| Z-SDU6-C17 | CPT | 77796.3 | 66393.3 | 276.0 | 235 | 219 | 187 | |
| Z-SDU6-C18 | SCPT | 77819.4 | 66471.7 | 275.6 | 235 | 217 | 186 | |
| Z-SDU6-C19 | SCPT | 77869.3 | 66155.6 | 276.4 | 235 | 227 | 183 | |
| Z-SDU6-C20 | CPT | 77895.0 | 66236.9 | 276.0 | 226 | 219 | 176 | |
| Z-SDU6-C21 | CPT | 77920.9 | 66321.6 | 276.3 | 233 | 225 | 182 | |
| Z-SDU6-C22 | CPT | 77947.5 | 66415.1 | 276.5 | 237 | 230 | 187 | |
| Z-SDU6-C23 | CPT | 77967.7 | 66482.5 | 275.5 | 238 | 233 | 190 | |
| Z-SDU6-B01 | | 77771.3 | 66309.1 | 276.6 | | | | |
| Z-SDU6-B02A | | 77625.3 | 66594.8 | 278.0 | | | | |
| Z-SDU6-B02B | | 77629.2 | 66588.9 | 278.1 | 234 | 227 | 191 | |
| Z-SDU6-B03 | | 77769.6 | 66304.5 | 276.5 | 232 | 217 | 188 | 146 |
| Z-SDU6-B04 | | 77663.9 | 66351.1 | 277.9 | 236 | 232 | 191 | 145 |

## 2.3 **Soil Properties**

Total unit weights for soils beneath Saltstone Disposal Unit 6 range from 93 to 130 pcf. Recommended values for in situ soils range from 106 to 123 pcf. A value of 120 pcf will used in this calculation for ease of computations. Shear stress parameters for effective stress conditions and consolidation properties are summarized in the table below. The effective shear strength parameters vary with depth. The recommended effective cohesion values range from 175 psf to 275 psf. Effective friction values ranged from 26° to 40° based on correlations between the effective friction angle and the CPT and the SPT (Ref. SRS 2012b). A conservative effective cohesion value of 100 psf was chosen for analysis. An effective cohesion of 32° was chosen for design.

| Unit Weight | |
|---|---|
| *In situ* Soils | 120 pcf |
| **Effective Shear Strength (All layers except Fill)** | |
| Effective Friction Angle | 32° |
| Effective Cohesion | 100 psf |

**Consolidation Parameters by Layer**

| | S1/2 | C2 | S3 | S4 |
|---|---|---|---|---|
| Compression Index, $C_c$ | 0.06 | 0.58 | 0.23 | 0.28 |
| Recompression Index, $C_r$ | 0.007 | 0.10 | 0.03 | 0.02 |
| Initial Void Ration, $e_0$ | 0.63 | 1.35 | 0.76 | 0.92 |

## 3. Computations and Results

The following sections provide the bearing capacity and static settlement calculations for the foundation systems.

### 3.1 **Bearing Capacity**

This section provides the bearing capacity parameters including ultimate bearing capacity, allowable static bearing capacity, design bearing capacity, allowable dynamic bearing capacity, and the strength reduction factor. The bearing capacity of the 382-foot diameter tank was analyzed as a square foundation of equivalent area, or a 339-foot by 339-foot square. Bearing capacity results are summarized in Table 1 and bearing capacity parameters are summarized in Table 2.

#### *3.1.1 Ultimate Bearing Capacity*

For $\phi > 0°$, the ultimate bearing capacity $q_u$ is computed using the equations originating with Terzaghi and later modified by others. For $\phi = 0°$, a modification of Skempton's bearing capacity equation for undrained cohesive soils was used. Correction factors suggested by Hanse, Vesic, and Meyerhof were used for this calculation (Ref. Bowles 1988, COE 1990).

$$q_u = cN_cS_cD_cI_cG_cB_c + q_qN_qS_qD_qI_qG_qB_q + \frac{\gamma_z B}{2} N_\gamma S_\gamma D_\gamma I_\gamma G_\gamma B_\gamma r_\gamma \quad \text{(Terzaghi)}$$

$$q_u = 5.14c(1 + S_c + D_c - I_c - B_c - G_c) + q_q \quad \text{(Skempton)}$$

where c = cohesion,

$q_q$ = overburden or surcharge pressure at the foundation base,

$\gamma_z$ = effective unit weight of soil below the foundation base,

B = foundation width,

$r_\gamma$ = foundation width reduction factor.

$N_c$, $N_q$, and $N_\gamma$ are bearing capacity factors; $S_c$, $S_q$, and $S_\gamma$ are foundation shape factors; $D_c$, $D_q$, and $D_\gamma$ are depth factors; $I_c$, $I_q$, and $I_\gamma$ are load inclination factors; $B_c$, $B_q$, and $B_\gamma$ are foundation base inclination factors; and $G_c$, $G_q$, and $G_\gamma$ are ground inclination factors.

The bearing capacity factors $N_c$, $N_q$, and $N_\gamma$ suggested by Hansen are:

$$N_c = \cot\phi\left(N_q - 1\right)$$

$$N_q = e^{\pi \tan\phi} \tan^2\left(45° + \frac{\phi}{2}\right)$$

$$N_\gamma = 1.5\left(N_q - 1\right)\tan\phi$$

The bearing capacity factors $N_c$, $N_q$, and $N_\gamma$ suggested by Vesic are:

$$N_c = \cot\phi\left(N_q - 1\right)$$

$$N_q = e^{\pi \tan\phi} \tan^2\left(45° + \frac{\phi}{2}\right)$$

$$N_\gamma = 2\left(N_q + 1\right)\tan\phi$$

The bearing capacity factors $N_c$, $N_q$, and $N_\gamma$ suggested by Meyerhof are:

$$N_c = \cot\phi\left(N_q - 1\right)$$

$$N_q = e^{\pi \tan\phi} \tan^2\left(45° + \frac{\phi}{2}\right)$$

$$N_\gamma = \left(N_q - 1\right)\tan 1.4\phi$$

The shape factors $S_c$, $S_q$, and $S_\gamma$ suggested by Hansen are:

$S_c = 1.0$ For $L/B \geq 10$, any $\phi$

$S_c = 0.2\frac{B}{L}$ For $\phi = 0°$, $L/B < 10$

$S_c = 1 + \frac{B}{L}\frac{N_q}{N_c}$ For $\phi > 0°$, $L/B < 10$

$S_q = 1 + \frac{B}{L}\tan\phi$ For any $\phi$

$S_\gamma = 1$ For $\phi = 0°$

$S_\gamma = 1 - 0.4\frac{B}{L}$ For $\phi > 0°$

The shape factors $S_c$, $S_q$, and $S_\gamma$ suggested by Vesic are:

$S_c = 1.0$ For $L/B \geq 10$, any $\phi$

$S_c = 0.2\frac{B}{L}$ For $\phi = 0°$, $L/B < 10$

$S_c = 1 + \frac{B}{L}\frac{N_q}{N_c}$ For $\phi > 0°$, $L/B < 10$

$S_q = 1 + \frac{B}{L}\tan\phi$ For any $\phi$

$S_\gamma = 1$ For $\phi = 0°$

$S_\gamma = 1 - 0.4\frac{B}{L}$ For $\phi > 0°$

The shape factors $S_c$, $S_q$, and $S_\gamma$ suggested by Meyerhof are:

$$S_c = 1 + 0.2\tan^2\left(45° + \frac{\phi}{2}\right)\frac{B}{L} \qquad \text{Any } \phi$$

$$S_q = S_\gamma = 1 + 0.1\tan^2\left(45° + \frac{\phi}{2}\right)\frac{B}{L} \qquad \text{For } \phi > 10°$$

$$S_q = S_\gamma = 1 \qquad \text{For } \phi = 0°$$

The depth factors $D_c$, $D_q$, and $D_\gamma$ for D < B given by Hansen are:

$$D_c = 0.4k \qquad \text{For } \phi = 0°$$

$$D_c = 1 + 0.4k \qquad \text{For } \phi > 0°$$

$$D_q = 1 + 2\tan\phi(1 - \sin\phi)^2 k$$

$$D_\gamma = 1$$

$$k = \frac{D}{B} \text{ for } \frac{D}{B} \le 1 \text{ or } \tan^{-1}\left(\frac{D}{B}\right) \text{ for } \frac{D}{B} > 1 \text{ (in radians)}$$

The depth factors $D_c$, $D_q$, and $D_\gamma$ for D < B given by Vesic are:

$$D_c = 1 + 0.4k$$

$$D_q = 1 + 2\tan\phi(1 - \sin\phi)^2 k$$

$$D_\gamma = 1$$

$$k = \frac{D}{B} \text{ for } \frac{D}{B} \le 1 \text{ or } \tan^{-1}\left(\frac{D}{B}\right) \text{ for } \frac{D}{B} > 1 \text{ (in radians)}$$

The depth factors $D_c$, $D_q$, and $D_\gamma$ for D < B given by Meyerhof are:

$$D_c = 1 + 0.2\frac{B}{L}\sqrt{\tan^2\left(45° + \frac{\phi}{2}\right)} \qquad \text{Any } \phi$$

$$D_q = D_\gamma = 1 + 0.1\frac{B}{L}\sqrt{\tan^2\left(45° + \frac{\phi}{2}\right)} \qquad \text{For } \phi > 10°$$

$$D_q = D_\gamma = 1 \qquad \text{For } \phi = 0°$$

For this calculation, level ground surface and uniform loading were used; i.e. ground inclination ($G_c$, $G_q$, and $G_\gamma$), load inclination ($I_c$, $I_q$, and $I_\gamma$), and base inclination ($B_c$, $B_q$, and $B_\gamma$) factors are 1.0 for $\phi > 0°$ (Ref. Bowles 1998).

Since the distance to the groundwater table is less than the width of the foundation, the effective unit weight of the soil beneath the foundation is determined by the following equation (Ref. Fang 1991):

$$\gamma_z = (\gamma_{bf} - \gamma_w) + \frac{D_w - D}{B}\gamma_w$$

where $\gamma_{bf}$ = unit weight of soil below the foundation,

$\gamma_w$ = unit weight of water,

$D_w$ = Depth to water,

D = embedment depth of foundation,

B = foundation width,

For foundation widths less than 6 feet, the $r_\gamma$ is 1.0. For foundation widths greater than or equal to 6 feet, the following reduction factor is applied to the calculated ultimate bearing capacity (Ref. Bowles 1998):

$$r_\gamma = 1 - \frac{\log(B/6)}{4}$$

### *3.1.2 Allowable Static Bearing Capacity*

The allowable bearing capacity is calculated by applying a factor of safety to the ultimate bearing capacity. The factor of safety used in this calculation is 3.0 (Ref. SRS 2006).

$$q_a = \frac{q_u}{FS}$$

### *3.1.3 Allowable Dynamic Bearing Capacity*

The dynamic bearing capacity is determined by increasing the allowable static bearing capacity by a factor of one-third (Ref. SRS 2006).

$$q_{dyn} = 1\tfrac{1}{3} q_a$$

### *3.1.4 Design Bearing Capacity*

The design bearing capacity $q_\Phi$, used for Load and Resistance Factor Design (LRFD), was computed with the same equations as the ultimate bearing capacity. Strength reduction factors were applied to the soil strength parameters of effective cohesion and effective friction angle. A cohesion reduction factor ($f_c$) of 0.5 was applied to the effective cohesion and a friction reduction factor ($f_\phi$) of 0.8 was applied to the tangent of the effective friction angle as shown in the following equations (Ref. Fang 1991):

$$c_{red} = f_c c$$

$$\phi_{red} = \tan^{-1}\left(f_\phi \tan\phi\right)$$

$$q_\Phi = c_{red} N_c S_c D_c I_c G_c B_c + q_q N_q S_q D_q I_q G_q B_q + \frac{\gamma_z B}{2} N_\gamma S_\gamma D_\gamma I_\gamma G_\gamma B_\gamma r_\gamma \quad \text{(Terzaghi)}$$

$$q_\Phi = 5.14c(1 + S_c + D_c - I_c - B_c - G_c) + q_q \quad \text{(Skempton)}$$

The bearing capacity factors, shape factors, and depth factors are calculated using the reduced cohesion and reduced friction angle to determine the design bearing capacity.

### *3.1.5 Strength Reduction Factor*

The strength reduction factor, Φ, is based on the ultimate bearing capacity and the design bearing capacity (Ref. SRS 2006). The strength reduction factor is given by the equation:

$$\Phi = {q_\Phi}/{q_u}$$

## 3.2 **Static Settlement**

The following sections discuss the static loadings and the computation of settlement. Settlements were computed using various methodologies.

### *3.2.1 Static Loading*

The current surface elevations range from 275 to 282 ft, msl. During excavation, 10 to 17 feet of soil will be removed to reach elevation 265 ft, msl. This is a decrease in overburden pressures of 1,200 to 2,040 psf at the bottom of the excavation.

At the end of construction, the floor slab will have a bearing pressure of approximately 600 psf (see Appendix A for derivation) assuming a uniform distribution. During leak testing of the structure, the floor slab will have a bearing pressure of approximately 3,300 psf, including the weight of the structure. At the end of tank operations when the tank is filled with Saltstone (41 ft x 110 pcf), the floor slab will have a bearing pressure of approximately 5,100 psf including the weight of the tank. The remaining 3 feet of tank space will later be filled with a grout cap in preparation for closure operations, adding approximately 400 psf to the tank bearing pressure.

During closure operations, a soil cover, approximately 20 feet thick, may be placed over the tank. It is anticipated that the thickness of the closure cap over SDU6 will be uniform. This additional soil cover will result in an additional overburden of approximately 2,500 psf assuming 125 pcf of compacted fill materials.

| | Vertical Pressure at Elevation 265 ft, msl | | | | | | |
|---|---|---|---|---|---|---|---|
| | Existing | End of Excavation | End of Construction | Tank Half Full | End of Operations | Pre Closure | Post Closure |
| Minimum | 1,200 psf | 0 psf | 600 psf | 2,800 psf | 5,100 psf | 5,500 psf | 8,000 psf |
| Maximum | 2,040 psf | 0 psf | 600 psf | 2,800 psf | 5,100 psf | 5,500 psf | 8,000 psf |

### *3.2.2 Settlement Estimate by Subgrade Modulus*

Subgrade moduli of other large structures at SRS range from 6 to 23 pci (Section 3.3) for similar soil conditions.

The loading cases presented in Section 3.2.1 and a subgrade modulus range of 6 to 23 pci are considered to estimate potential settlements. The results are:

| | **Minimum Settlement (inches)** | **Maximum Settlement (inches)** | **Average Settlement (inches)** |
|---|---|---|---|
| Heave | -0.4 | -2.4 | -1.2 |
| Tank Half Full | 0.9 | 3.2 | 2.0 |
| End of Operations | 1.5 | 5.9 | 3.7 |
| Pre Closure | 1.7 | 6.4 | 4.0 |
| Post Closure | 2.4 | 9.3 | 5.8 |

### *3.2.3 One-Dimensional Consolidation Theory*

Settlement of the soil column was computed using one dimensional consolidation theory.

For normally consolidated soils:

$$S = \frac{C_c H}{1+e_o}\log\left(\frac{\sigma_o^{'} + \Delta\sigma^{'}}{\sigma_o^{'}}\right)$$

For over-consolidated soils

where $\sigma_o^{'} + \Delta\sigma^{'} < \sigma_p^{'}$

$$S = \frac{C_r H}{1+e_o}\log\left(\frac{\sigma_o^{'} + \Delta\sigma^{'}}{\sigma_o^{'}}\right)$$

where $\sigma_o^{'} + \Delta\sigma^{'} > \sigma_p^{'}$

$$S = \frac{C_r H}{1+e_o}\log\left(\frac{\sigma_p^{'}}{\sigma_o^{'}}\right) + \frac{C_c H}{1+e_o}\log\left(\frac{\sigma_o^{'} + \Delta\sigma^{'}}{\sigma_p^{'}}\right)$$

where

- H = thickness of cohesive layer
- $C_c$ = virgin compression index
- $C_r$ = recompression index
- $\sigma'_o$ = initial effective overburden pressure
- $\sigma'_p$ = preconsolidation pressure
- $\Delta\sigma'$ = change in effective pressure
- $e_o$ = initial void ratio

Early settlement estimates for DWPF in S Area, which has an average load of similar to that of the fully loaded SDU6, ranged from 13 to 16 inches. Further analysis resulted in settlement predictions of 3 to 5 inches. The reduction in predicted settlement was based upon recompression of the soil column rather than virgin compression. The approach was validated by back-calculating settlements of similarly loaded existing H-Area structures. The DWPF engineers adopted a conservative approach in that half of the C2 layer would experience recompression and half would experience virgin compression (Ref. SRS 1984). To date DWPF has settled less than 3.5 inches (Ref. SRS 2011). Early 1980's analysis of the Z-Area vaults utilized soil consolidation properties from neighboring S Area based on similar index test results. However specific properties were developed for the C2 layer (Ref. SRS 1986).

The properties used in the calculation, listed in Section 2.3, consider both S-Area and Z-Area soil properties. All layers, except the C2 layer, are assumed to experience only recompression resulting from the loads imparted by Saltstone Disposal Unit 6 at the end of operations (5,100 psf). As with DWPF, half of the C2 layer was assumed to experience recompression and half experience virgin compression.

The C2 average thickness is approximately 8 feet across the site. Beneath the northwestern

portion of the tank, the C2 layer is approximately 12 to 18 feet thick, but thins back to a thickness of 5 to 8 feet at the northwestern perimeter of the excavation. The depth to the C2 layer from the bottom of the excavation ranges from 27 feet to 39 feet, and averages 30 feet.

Consolidation settlements were computed at each CPT location, based on the CPT-specific stratigraphic picks. Two cases were performed, one where the C2 layer virgin compression occurred in the top half of the layer, and one where the virgin compression occurred in the bottom half of the layer. The results of these two cases were averaged to predict consolidation settlements. Only CPTs beneath the tank and adjacent to the tank (Z-SDU-C05 through Z-SDU6-C18) were used for statistical purposes as summarized in the table below.

| | **Minimum Settlement (inches)** | **Maximum Settlement (inches)** | **Average Settlement (inches)** |
|---|---|---|---|
| Heave After Excavation | -1.2 | -1.5 | -1.4 |
| End of Construction | 0.5 | 0.6 | 0.5 |
| Tank Half Full | 2.6 | 4.3 | 3.2 |
| End of Operations | 4.7 | 8.0 | 5.8 |
| Post Closure | 10.8 | 16.9 | 13.5 |

Experience in H and S Areas also indicates that the rate of secondary compression for the SRS is small, on the order of ¼-inch over 30 years, for structural loading ranging from 3 to 6 ksf (Ref. SRS 2007b).

### *3.2.4 Empirical Settlement Analysis*

The following sections will discuss empirical methods used to determine the settlement of the soil column using cohesionless soil settlement analyses.

3.2.4.1. *Burland and Burbidge*

The Burland and Burbidge method estimates the immediate settlement, $S_0$, based on SPT data. The soil is assumed to be consolidated to the overburden pressure prior to excavation (Ref. PICE 1985; COE 1990).

$$S_0 = f_s \times f_1 \times q' \times B^{0.7} \times I_c \quad \text{for a normally consolidated sand}$$

$$S_0 = f_s \times f_1 \times \left(q' - \tfrac{2}{3}\sigma'_{vo}\right) \times B^{0.7} \times I_c \quad \text{for } q' > \sigma'_{vo} \qquad \text{(Equations 1, 2, 3)}$$

$$S_0 = f_s \times f_1 \times q' \times B^{0.7} \times \frac{I_c}{3} \quad \text{for } q' < \sigma'_{vo}$$

where $f_s$ = shape factor, $f_s = \left(\frac{1.25 \times L/B}{(L/B) + 0.25}\right)^2$

$f_1$ = layer correction factor, $H/Z_1 \left(2 - H/Z_1\right)$

$q'$ = average effective bearing pressure

$\sigma'_{vo}$ = effective overburden

B = foundation width
H = thickness of the layer
$Z_1$ = depth of influence of loaded area
= $1.35B^{0.75}$ for constant or increasing $N_{ave}$ with depth
= 2B for decreasing $N_{ave}$ with depth
$N_{ave}$ = average SPT blow count over depth of influence
$I_c$ =compressibility influence factor, $0.23/N_{ave}^{1.4}$

Blow counts were not corrected to $N_{60}$ values for use in this calculation because it is assumed that the N value is equal to $N_{60}$. For each boring the average N value within the depth of influence was determined. Refusals and blow counts in excess of 50 were treated as a value of 50 for the purposes of averaging. See Figures 3 through 5 for N value averages. No corrections were made for gravelly or silty soils.

Settlement can be further estimated by changing $I_c$ to achieve upper and lower bound estimates of settlement. The lower and upper bounds are defined below (Ref. COE 1990).

Lower bound settlement is computed using $I_{cmin} = 0.08/N_{ave}^{1.3}$
Upper bound settlement is computed using $I_{cmax} = 1.34/N_{ave}^{1.67}$

Settlement after time *t,* at least 3 years following construction, may be estimated by:

$S_t = f_t\, S_0$ (Equation 4)

where $f_t = 1 + R_3 + R_t \log (t/3)$

$R_3$ and $R_t$ are the time–dependent settlement ratios, for $t$ = 30 years

$R_3$ = 0.3 for static loads or 0.7 for fluctuating loads
$R_t$ = 0.2 for static loads or 0.8 for fluctuating loads

Assuming static loads,

$f_t = 1 + 0.3 + 0.2 \log (30/3) = 1.5$

Therefore, total settlement at $t$ = 30 years is:

$S_t = 1.5\, S_0$

The depth of influence for the tank is approximately 120 feet using the Burland and Burbidge method. The immediate settlements were calculated for each of the 3 borings within the footprint of the structure. The settlements were calculated for loads at the end of operations (5,100 psf), at the completion of closure operations (8,000 psf) and at 30 years after closure.

The lower bound, upper bound, and average settlements were computed using $I_{cmin}$, $I_{cmax}$, and $I_c$ as described earlier. The settlement values summarized below are the average of the three boring-specific settlements. The calculated average settlements at the midpoint of operations ranged from 1.1 to 1.4 inches and from 2.6 to 3.2 inches at the end of operations.

| | Lower Bound Settlement (inches) | Upper Bound Settlement (inches) | Average Settlement (inches) |
|---|---|---|---|
| Heave | -0.1 | -0.4 | -0.2 |
| End of Construction | 0.1 | 0.3 | 0.1 |
| Tank Half Full | 0.6 | 2.8 | 1.2 |
| End of Operations | 1.4 | 6.4 | 2.8 |
| Post Closure | 2.3 | 10.8 | 4.8 |
| 30 Years Post Closure | 3.5 | 16.3 | 7.1 |

3.2.4.2. *Schmertmann Method*

The Schmertmann method estimates the immediate settlement $S_0$ based on CPT data (Ref. COE 1990):

$$S_0 = C_1 \times C_t \times \Delta P \times \sum_{i=1}^{n} \frac{\Delta z_i}{E_{si}} \times I_{zi} \qquad \text{(Equation 5)}$$

where $C_1$ = strain relief from embedment correction factor, $C_1 = [1 - (0.5\ \sigma'_{vo} / \Delta p)] \geq 0.5$,

$C_t$ = correction for time-dependent increase in settlement and $C_t = 1 + 0.2 \log (t/0.1)$

$t$ = in years,

for $t$ = 30 years, $C_t = 1 + 0.2 \log (30/0.1) = 1.5$

$\Delta p$ = net applied footing pressure

$\Delta z_i$ = depth increment $i$,

$\sigma'_{vo}$ = effective overburden at base of foundation

$I_{zp}$ = peak influence factor

$$= 0.5 + 0.1 \left( \frac{\Delta P}{\sigma'_{Izp}} \right)^{0.5}$$

$I_{zi}$ = influence factor of soil layer $i$

$E_{si}$ = elastic modulus of soil layer $i$

= 2.5 $q_c$ for L/B = 1

= 3.5 $q_c$ for L/B ≥ 10

where $q_c$ is the average tip stress of soil layer $i$ in tsf. For this evaluation, thickness of each soil layer (depth increment) is 1 foot. The depth was determined relative to the foundation elevation of 265 ft, msl. The influence factor of a soil layer can be calculated based on the geometry of the foundation as follows (Ref. Coduto 1994):

For square and circular foundations (L/B = 1)

$$I_{zs} = 0.1 + \left(\frac{z_i}{B}\right)\left(2I_{zp} - 0.2\right) \quad \text{For } z_i = 0 \text{ to } B/2$$

$$I_{zs} = 0.667 + I_{zp}\left(2 - \frac{z_i}{B}\right) \quad \text{For } z_i = B/2 \text{ to } B$$

(Equations 6, 7)

For continuous foundations (L/B ≥ 10)

$$I_{zc} = 0.2 + \left(\frac{z_i}{B}\right)\left(I_{zp} - 0.2\right) \quad \text{For } z_i = 0 \text{ to B}$$

$$I_{zc} = 0.333 + I_{zp}\left(4 - \frac{z_i}{B}\right) \quad \text{For } z_i = \text{B to 4B}$$

(Equations 8, 9)

For rectangular foundations (1 < L/B < 10)

$$I_{zr} = I_{zs} + 0.111\left(I_{zc} - I_{zs}\right)\left(\tfrac{L}{B} - 1\right) \quad \text{(Equation 10)}$$

Previous analyses performed for the Vitrification Building, 221-S, found that the estimated Schmertmann settlements were more than double the measured settlements, likely due to the methodology underestimating the elastic modulus for the cohesionless soils present at SRS. Realistic results may be obtained by dividing the Schmertmann result by a conservative adjustment factor of 2 (Ref. SRS 2007b).

The Congaree Formation is located approximately 120 feet below the bottom of the excavation. During the investigation for Saltstone Disposal Unit 6, CPTs refused before reaching the Congaree; however CPTs Z-SDU6-C20, Z-SDU6-C21, and Z-SDU6-C22 appear to have refused refused on the top of the Congaree Formation with tip stresses of approximately 500 tsf. SPT blow counts in the Congaree Formation and below refused (50 blows over 6 inch or less interval) excepting an N value of 45 and 21 at a depth of 240 and 250 feet in Z-SDU6-B04. Because of the high CPT tip stress and the SPT refusals, the Congaree is considered a rigid base and the Schmertmann settlement analysis was only performed for layers above the Congaree.

The Schmertmann settlement analysis was performed for all 23 CPTs and SCPTs. Average tip stresses were computed on 1-foot intervals relative to the depth below the bottom of the foundation (i.e. 265 ft, msl). CPTs which terminated above the Congaree Formation were supplemented with the average tip stress values from the remaining CPTs for the corresponding 1-foot intervals.

The following table presents the settlement values using the Schmertmann method. Lower and upper bound settlements are the minimum and maximum CPT specific settlements, respectively. Only CPTs beneath the tank and adjacent to the tank (Z-SDU-C05 through Z-SDU6-C18) were used for statistical purposes as summarized in the table below. As applied, the Schmertmann methodology does not compute settlement for values less than the existing overburden stress; therefore no estimates of heave or settlement at the end of construction are presented in the table below.

| | **Minimum Settlement (inches)** | **Maximum Settlement (inches)** | **Average Settlement (inches)** |
|---|---|---|---|
| Tank Half Full | 0.2 | 0.5 | 0.3 |
| End of Operations | 0.7 | 2.1 | 1.2 |
| Post Closure | 1.5 | 4.4 | 2.5 |
| 30 Years Post Closure | 2.2 | 6.6 | 3.7 |

### 3.3 **Subgrade Modulus**

The subgrade modulus is a foundation-specific value and is not a specific soil property. The subgrade modulus correlates foundation pressure and settlement by

$$k_s = \frac{p}{\Delta}$$

where $p$ = foundation contact pressure (pounds per square inch, psi)

$\Delta$ = foundation settlement (inches)

The subscript $s$ refers to the foundation size. For example, $k_1$ refers to the subgrade modulus for a 1-foot square foundation. When no subscript is used, the value refers to the subgrade modulus for the entire foundation.

The subgrade modulus depends on the size and shape of the loaded area. This calculation will estimate the subgrade modulus for Saltstone Disposal Unit 6 based on SPT/CPT correlations and historical data.

#### *3.3.1 Historical Data*

Heave data from the excavation of Vault 2 (approximately 250 ft by 400 ft; 7.3 to 19 feet deep, ), indicates movement ranging from ¼ inch to 1 inch. Based on this data, the subgrade modulus for a large excavation could range from 26 to 43 kcf (15 to 25 pci).

Based on values for other large facilities around the SRS, including the In Tank Precipitation (ITP) tanks, DWPF, and the Remote Handling Building (RHB) subgrade modulus (k) values range from approximately 10 to 40 kcf (6 to 23 pci). Converting these values to $k_1$ results in values of 40 to 160 kcf (23 to 93 pci) (Ref. SRS 2007a).

The settlement values predicted using subgrade modulus (Section 3.2.2) are in good agreement with the other methods of settlement prediction. Given the potential for differential settlement of the tank as discussed in Section 3.2.5, the range of subgrade moduli should be considered in foundation analysis.

#### *3.3.2 CPT and SPT Correlations*

Subgrade modulus at the project site was estimated based on CPT uncorrected tip stress ($q_c$, kPa) and friction ratio ($R_f$, %). For all CPTs the average uncorrected tip stress is approximately 140 tsf and the average friction ratio is approximately 2.3%. CPT depths range from 86 to 131 feet. Figure 18 correlates the empirical formula $q_c/100R_f$ (kPa/%) to modulus of subgrade reaction, $k_1$. The subgrade modulus, $k_1$, based on the average CPT data is 240 pci.

| | Average Tip Stress $q_c$ (tsf) | Average Tip Stress $q_c$ (kPa) | Average Friction Ratio $R_f$ (%) | $q_c/100R_f$ (kPa/%) |
|---|---|---|---|---|
| Average | 140 | 13406 | 2.3 | 58 |
| | | | $k_1$ | 240 pci |

Average SPT blow counts ($N_{55}$) and uncorrected CPT tip stresses were also used to estimate the subgrade modulus. Measured blow counts were converted to energy-corrected blow counts, $N_{55}$,

which correspond to 55% of input energy using the following equation (Ref. Bowles):

$N'_{rb} = N \times E_r / E_{rb}$ (Eq. 1)

where N = measured blow count,

$N'_{rb}$ = energy corrected blow count

$E_r$ = actual energy ratio = 60

$E_{rb}$ = standard energy ratio = 55

Thus,

$N_{55} = 1.09 * N.$

Figure 28 correlates the empirical formula $q_c/100N_{55}$ (kPa) to modulus of subgrade reaction, $k_1$. Figure 28 indicates that a small change in $q_c/100N_{55}$ results in a large change in subgrade modulus. Therefore, the minimum $q_c/100N_{55}$ value was used to give a conservative estimate of the subgrade modulus. The modulus of subgrade reaction, $k_1$, based on CPT and SPT data is 400 pci.

| | Average Tip Stress $q_c$ (tsf) | Average Tip Stress $q_c$ (kPa) | Average Blow Count N | Average Blow Count $N_{55}$ | $q_c/100N_{55}$ (kPa) |
|---|---|---|---|---|---|
| Average | 140 | 13406 | 32 | 35 | 3.8 |
| | | | | $k_1$ | 225 pci |

Based on the above computations, the range of $k_1$ is approximately 225 to 240 pci. To find the subgrade modulus for a 30-inch plate as required by the ACI code (Ref. ACI 1997), the following equation is used:

$k_s = [(B + 1)/(2B)]^2 * k_1$

where B is the width of the load (30 inches or 2.5 feet in this case). Therefore,

$k_{2.5} = 0.49\ k_1$

Using the ACI Code for design, the range of subgrade modulus, $k_{2.5}$ (i.e., subgrade modulus for a 30 inch plate) is between about 110 to 120 pci. This applies to point loads or loads on smaller areas.

Using the equation for $k_s$

As $B \rightarrow \infty, k_s \rightarrow \frac{1}{4} k_1$

Therefore, for large foundations the subgrade modulus ranges from 55 to 60 pci, based on emperical analysis. These values are greater than the values back-calculated from other large structures at SRS (6 to 23 pci).

### 3.4 **Lateral Earth Pressure**

The effective friction angle ($\phi'$) of the compacted fill is assumed to be between 30° and 35°, depending on the material source and the level of compaction. The lateral earth pressure coefficients are computed using the following:

Active earth pressure $k_a = \tan^2\left(45 - \phi/2\right)$

Passive earth pressure $k_p = \tan^2\left(45 + \phi/2\right)$

At-rest earth pressure $k_0 = 1 - \sin\phi$ For $\phi \leq 30°$

$k_0 = 0.5$ For $\phi > 30°$

Consideration was given to compaction-induced lateral earth pressures. The method recommended by Duncan et. al (Ref. Duncan 1991, Duncan 1993) determines $\sigma'_h$ graphically based on depth, compaction effort, and the method of compaction. The site specific $\sigma'_h$ is calculated by applying correction factors to $\sigma'_h$ based on lift thickness (t), distance of from the wall (x), friction angle ($\phi$), and roller width (w). Higher $\phi$ values result in increased compaction induced lateral earth pressures when utilizing the method recommended by Duncan et. al, therefore $\phi$ = 35° was analyzed. For the purposes of this analysis, it is assumed that soil will be compacted in 6-inch lifts with a 600 lb/in, 7-foot roller within half a foot of the tank wall.

## 4. Results

### 4.1 Bearing capacity

Bearing capacity results are summarized in Table 1 and bearing capacity parameters are summarized in Table 2. Allowable bearing capacity values ranged from 30,900 psf to 88,600 psf. The Hansen parameters resulted in the most conservative values of bearing capacity and are thus recommended for design. The allowable bearing capacity is 30,900 psf.

### 4.2 Settlement

A summary of the settlement analyses is found in Table 3. Table 4 summarizes the average values of the various methods. All heave movements are expected to occur during excavation and will have ceased prior to the beginning of construction. The average heave within the excavation is expected to be approximately 1 inch.

Figures 6 and 7 show the plan view of cross sections used in this calculation. Figures 8 through 17 present predicted settlements along these cross sections for Saltstone Disposal Unit 6 at the end of operations based on CPT-specific predicted settlements. The estimated load at the end of operations is 5,100 psf. Settlements outside the footprint of the tank, estimated using a 5,100 psf load, are also shown on the cross sections. The predicted settlements shown are based on the Schmertmann approach and from consolidation computations. The Schertmann approach estimates a lower total settlement value than the one-dimensional consolidation approach; however the two approaches show general agreement in relative predicted movements.

Average settlements predicted via the different methodologies range from 2.8 inches to 5.5 inches at the end of operations. Maximum predicted settlements are located along cross section BB with the greatest differential settlement sections running perpendicular to this section and cross section CC. Considering the location-specific differential settlements by different methodologies, the maximum differential settlements occur between sections BB and CC. The

average differential settlement between these sections is 2.9 inches, with a maximum predicted differential settlement is 3.2 inches. The distance between cross section BB and CC is approximately 110 feet (Figure 6).

| Cross Section | | Differential Settlement | | |
|---|---|---|---|---|
| BB | CC | Consolidation | Schmertmann | Burland and Burbidge |
| Z-SDU6-C15 | Z-SDU6-C10 | 2.8 | 0.0 | --- |
| Z-SDU6-C16 | Z-SDU6-C11 | 2.8 | 1.1 | --- |
| Z-SDU6-C17 | Z-SDU6-C12 | 2.6 | 0.7 | --- |
| Z-SDU6-C18 | Z-SDU6-C13 | 3.2 | 0.9 | --- |
| Z-SDU6-B03 | Z-SDU6-B04 | --- | --- | 0.6 |

Average settlements via the different methodologies for the tank at half of operational capacity (2,800 psf) range from 0.3 to 3.0 inches. Settlement profiles for the tank at half capacity are presented in Appendix B. The maximum differential settlement at the midpoint of operations is approximately 1.5 inches.

Settlements were predicted with up to 4 inches of deviation between methodologies. In order to verify the estimated settlements, it is recommended that heave and settlement monitoring points be installed and surveyed during and after construction of Saltstone Disposal Unit 6. Settlement data will provide important information, which can be used to verify and calibrate settlement analysis methods and may result in more accurate settlement estimations in the future.

### 4.3 Subgrade modulus

Subgrade modulus values are summarized in Table 5. The use of empirical formulas to estimate the modulus of subgrade reaction predicted higher values for $k_s$ (55 to 60 pci) compared to values back-calculated from existing SRS structures (6 to 23 pci). The use of the back-calculated values is recommended for design purposes.

### 4.4 Lateral earth pressures

Considering effective friction angles ranging from 30° to 35° depending on source and degree of compaction, the coefficient of at-rest earth pressure is 0.5. The active earth pressure ranges from 0.27 to 0.33 depending upon the source material and degree of compaction. The passive earth pressure ranges from 3.00 to 3.69 depending on the source material and degree of compaction.

The induced pressures below 16 feet were considered to extend linearly to intersect the $K_0$ line, below which $K_0$ conditions control; see Figure 19. The compaction induced lateral earth pressures are summarized in the Table 6.

## 5. Conclusions

Bearing Capacity – Appendix C

- Ultimate Bearing Capacity 92,000 psf
- Design Bearing Capacity 38,800 psf
- Strength Reduction Factor 0.42
- Allowable Bearing Capacity – Static 30,900 psf
- Allowable Bearing Capacity – Dynamic 41,200 psf

Settlement – Appendix D

Recommended settlement values are the arithmetic average of the average settlements for each of the methods employed.

- Average heave after excavation is approximately 1 inch.
- Average total settlement after operations are complete is approximately 4 inches.
    - Maximum settlement along cross section BB is approximately 6 inches.
- Average settlement after the closure cap is complete is approximately 7 inches.
- Average settlement 30 years after the closure cap is complete is approximately 8 inches.
- Differential settlement at the midpoint of operations is 1.5 inches across 110 feet.
- The maximum expected differential settlement at the end of operations is 3.2 inches across 110 feet.

Subgrade Modulus – Appendix E

- The recommended $k_1$ value is 100 pci, based on historical and theoretical values.
- A reduced $k_1$ value of 25 pci is recommended for use where higher settlements are predicted along the northern portion of the tank.

Lateral Earth Pressure

- Active earth pressure, $k_a$ = 0.27 to 0.33
- Passive earth pressure, $k_p$ = 3.00 to 3.69
- At-rest earth pressure, $k_0$ = 0.5
- Compaction-induced lateral earth pressures are summarized in Table 6

## 6. References


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13. SRS 2007b K-ESR-S-00006, Rev. 2, Glass Waste Storage Building #2 Geotechnical Baseline and Evaluation Report, December 2007.
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15. SRS 2012a, K-CLC-Z-00022, Rev. 0, Stratigraphy for Saltstone Disposal Unit 6
16. SRS 2012b, K-CLC-Z-00023, Rev. 0, Geotechnical Properties for Saltstone Disposal Unit 6.
17. WSRC-2003-00250, Rev. 0, An Updated Regional Water Table of the Savannah River Site and Related Coverages, December 2003.

# Tables

**Table 1: Calculated Bearing Capacities**

| | Ultimate Bearing Capacity (psf) | Allowable Static Bearing Capacity (psf) | Design Bearing Capacity (psf) | Allowable Dynamic Bearing Capacity (psf) | Φ (psf) |
|---|---|---|---|---|---|
| Hansen | 92,000 | 30,900 | 38,800 | 41,200 | 0.42 |
| Vesic | 128,000 | 42,600 | 57,100 | 56,900 | 0.45 |
| Meyerhof | 266,000 | 88,600 | 95,800 | 118,200 | 0.36 |

**Table 2: Summary of Bearing Capacity Factors**

| | **N** | | | **S** | | | **D** | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | $N_c$ | $N_q$ | $N_\gamma$ | $S_c$ | $S_q$ | $S_\gamma$ | $D_c$ | $D_q$ | $D_\gamma$ | $r_\gamma$ |
| Hansen | 35.49 | 23.18 | 20.79 | 1.65 | 1.62 | 0.60 | 1.00 | 1.00 | 1.00 | 0.562 |
| Vesic | 35.49 | 23.18 | 30.21 | 1.65 | 1.62 | 0.60 | 1.00 | 1.00 | 1.00 | 0.562 |
| Meyerhof | 35.49 | 23.18 | 22.02 | 4.25 | 1.33 | 1.33 | 2.80 | 1.18 | 1.18 | 0.562 |

**Table 3: Summary of Settlement Statistics**

| | **Settlement (inches)** | | | |
|---|---|---|---|---|
| | **Subgrade Modulus** | **Consolidation** | **Burland and Burbidge** | **Schmertmann** |
| Heave | | | | |
| Average | -1.2 | -1.3 | -0.2 | --- |
| Minimum | -0.4 | -1.1 | -0.1 | --- |
| Maximum | -2.4 | -1.4 | -0.4 | --- |
| Tank Half Full | | | | |
| Average | 2.0 | 3.0 | 1.2 | 0.3 |
| Minimum | 0.9 | 2.4 | 1.1 | 0.2 |
| Maximum | 3.2 | 4.1 | 1.4 | 0.5 |
| End of Operations | | | | |
| Average | 3.7 | 5.8 | 2.8 | 1.2 |
| Minimum | 1.5 | 4.7 | 2.6 | 0.7 |
| Maximum | 5.9 | 8.0 | 3.2 | 2.1 |
| Post Closure | | | | |
| Average | 5.8 | 13.5 | 4.8 | 2.5 |
| Minimum | 2.4 | 10.8 | 2.3 | 1.5 |
| Maximum | 9.3 | 16.9 | 10.8 | 4.4 |

**Table 4: Summary of Average Static Settlements**

| | **Minimum Settlement (inches)** | **Maximum Settlement (inches)** | **Recommended Settlement (inches)** |
|---|---|---|---|
| Heave | -0.2 | -1.3 | -1 |
| Tank Half Full | 0.3 | 3.0 | 2 |
| Operations Complete | 1.2 | 5.5 | 4 |
| Closure Cap Complete | 2.5 | 13.5 | 7 |

**Table 5: Summary of Subgrade Modulus**

| | **$k_1$ (pci)** | **$k_s$ (pci)** |
|---|---|---|
| Historical SRS Data | 23 to 93 | 6 to 23 |
| CPT Correlation | 240 | 60 |
| CPT-SPT Correlation | 225 | 55 |

**Table 6: Compaction-Induced Lateral Earth Pressure**

| Depth (feet) | $\sigma_{H\ Design}$ (psf) |
|---|---|
| 0 | 0 |
| 2 | 600 |
| 4 | 790 |
| 8 | 980 |
| 16 | 1,200 |
| 22 | 1,375 |
| 43 | 2,688 |

$K_0$ controls at 22 feet and below

**Figures**

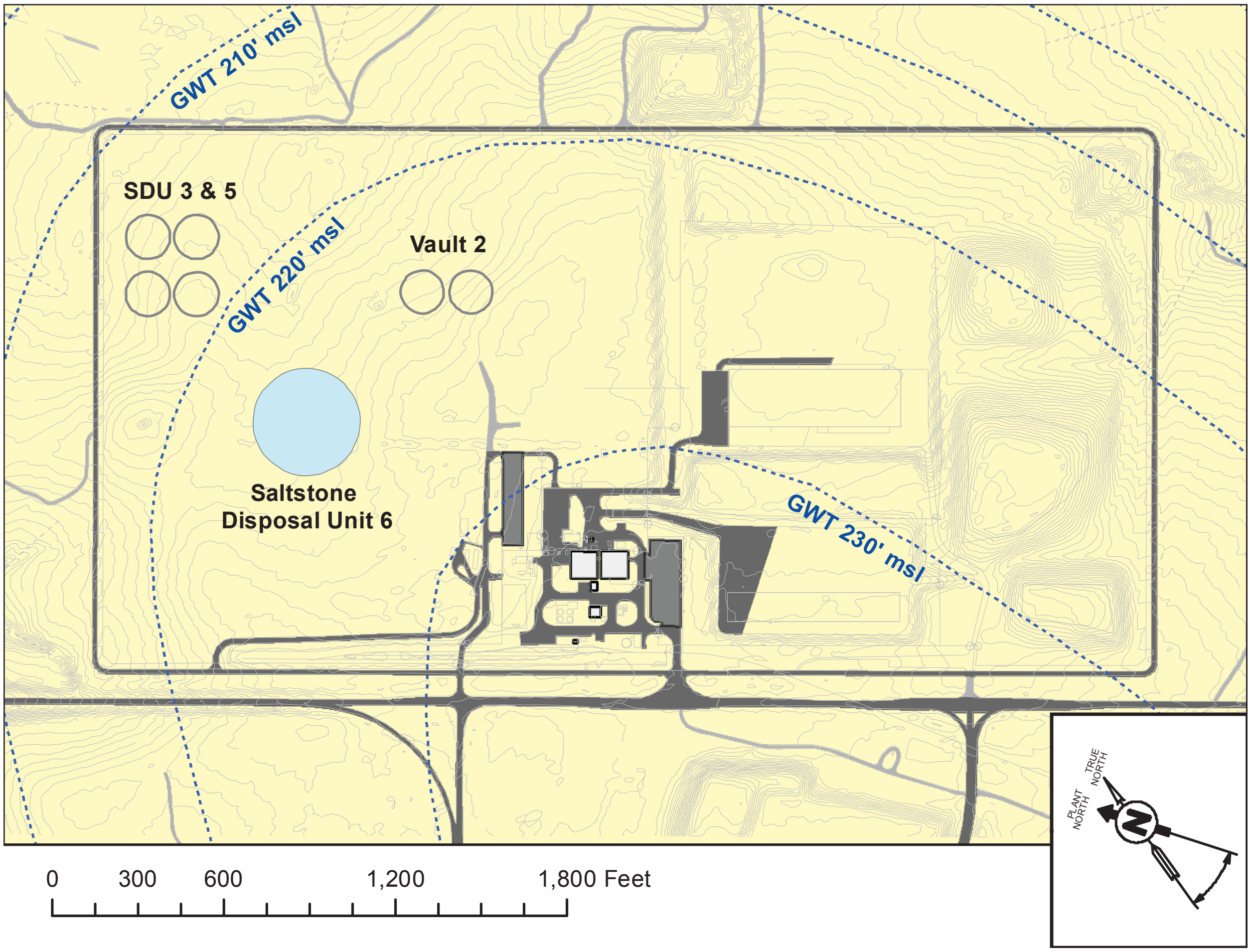



**Figure 1: Location of Saltstone Disposal Unit 6**

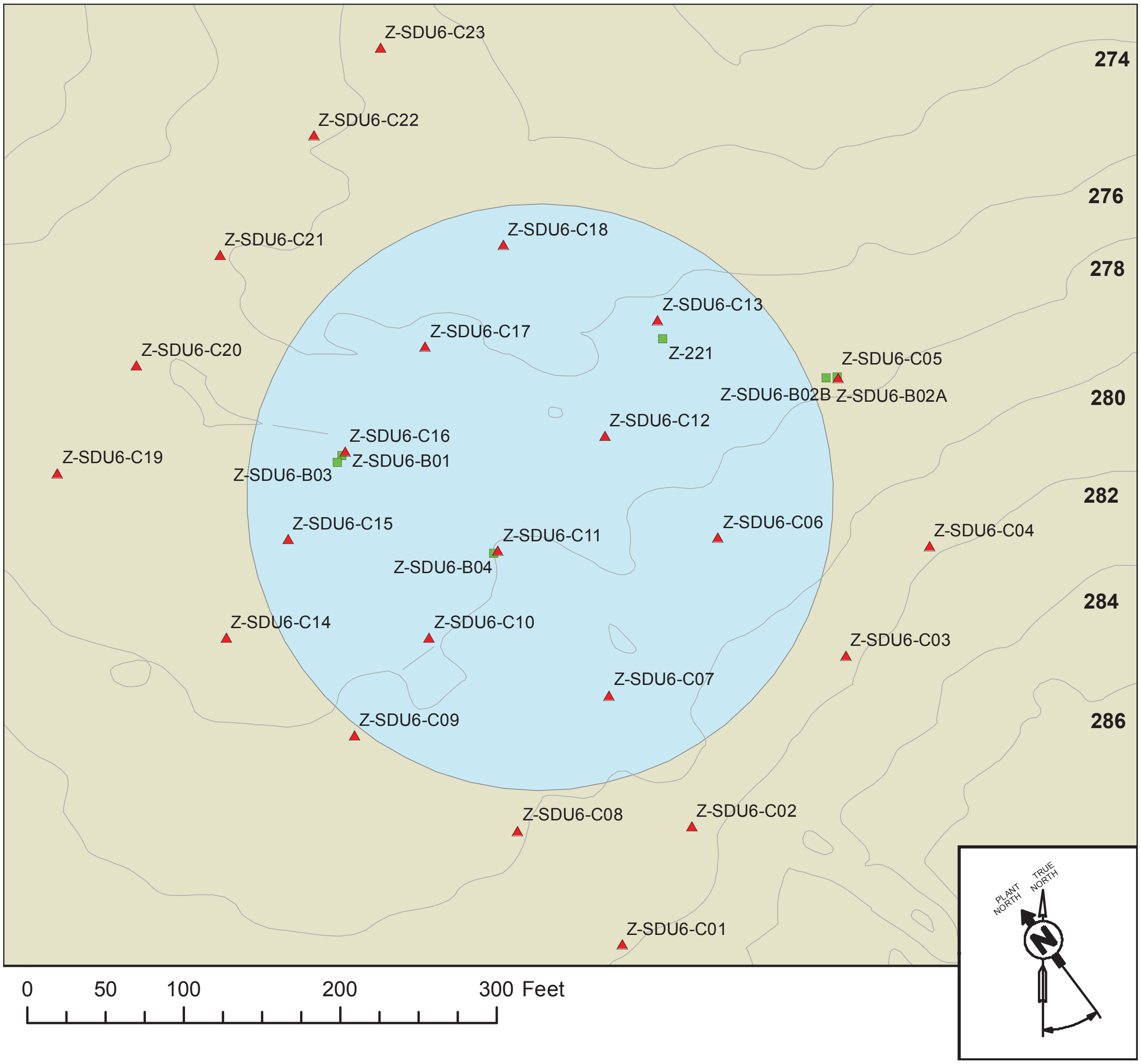



**Figure 2: Saltstone Disposal Unit 6 Geotechnical Exploration Locations with Topography**

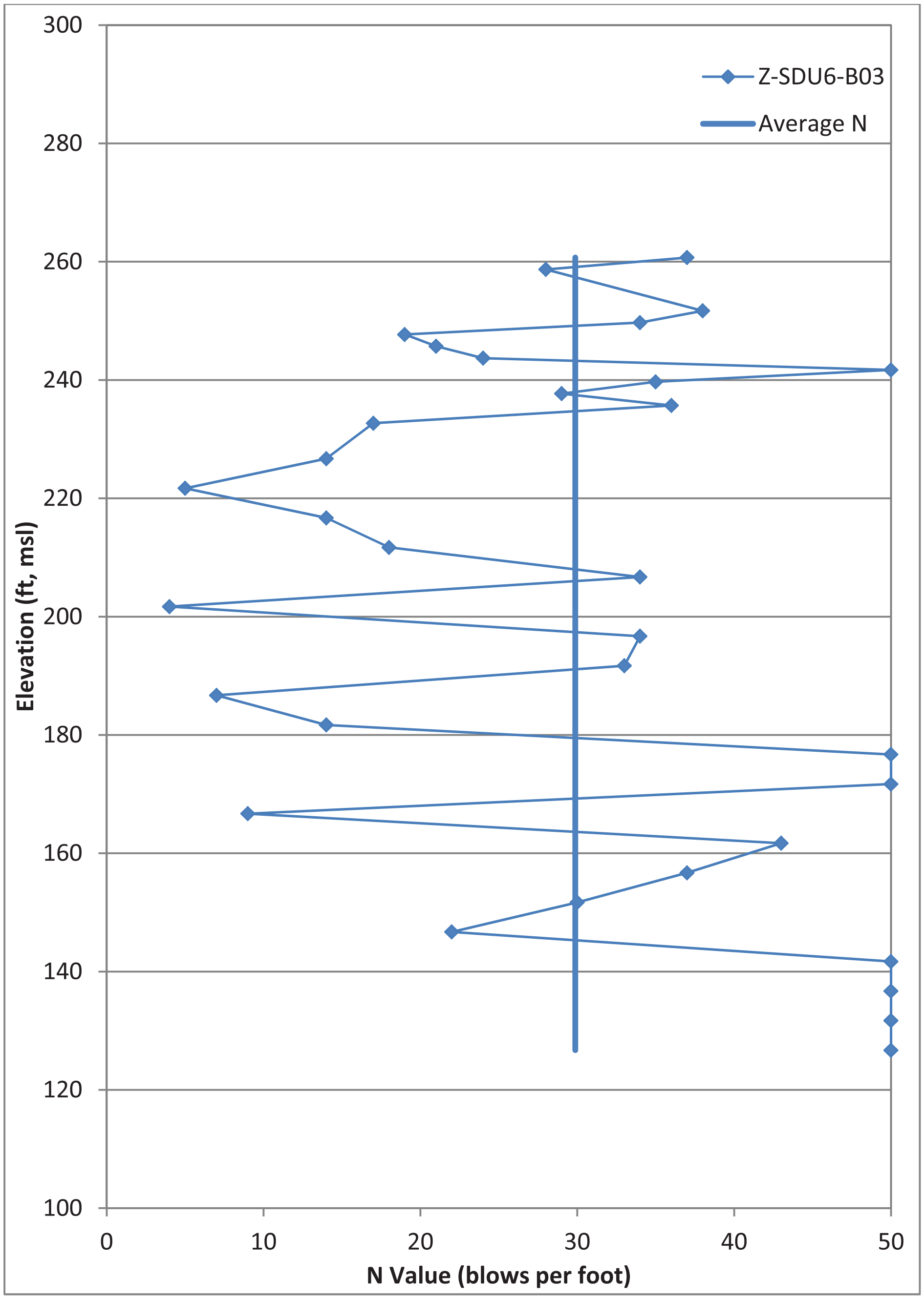



**Figure 3: Average N Value within the Depth of Influence for Boring Z-SDU6-B03**

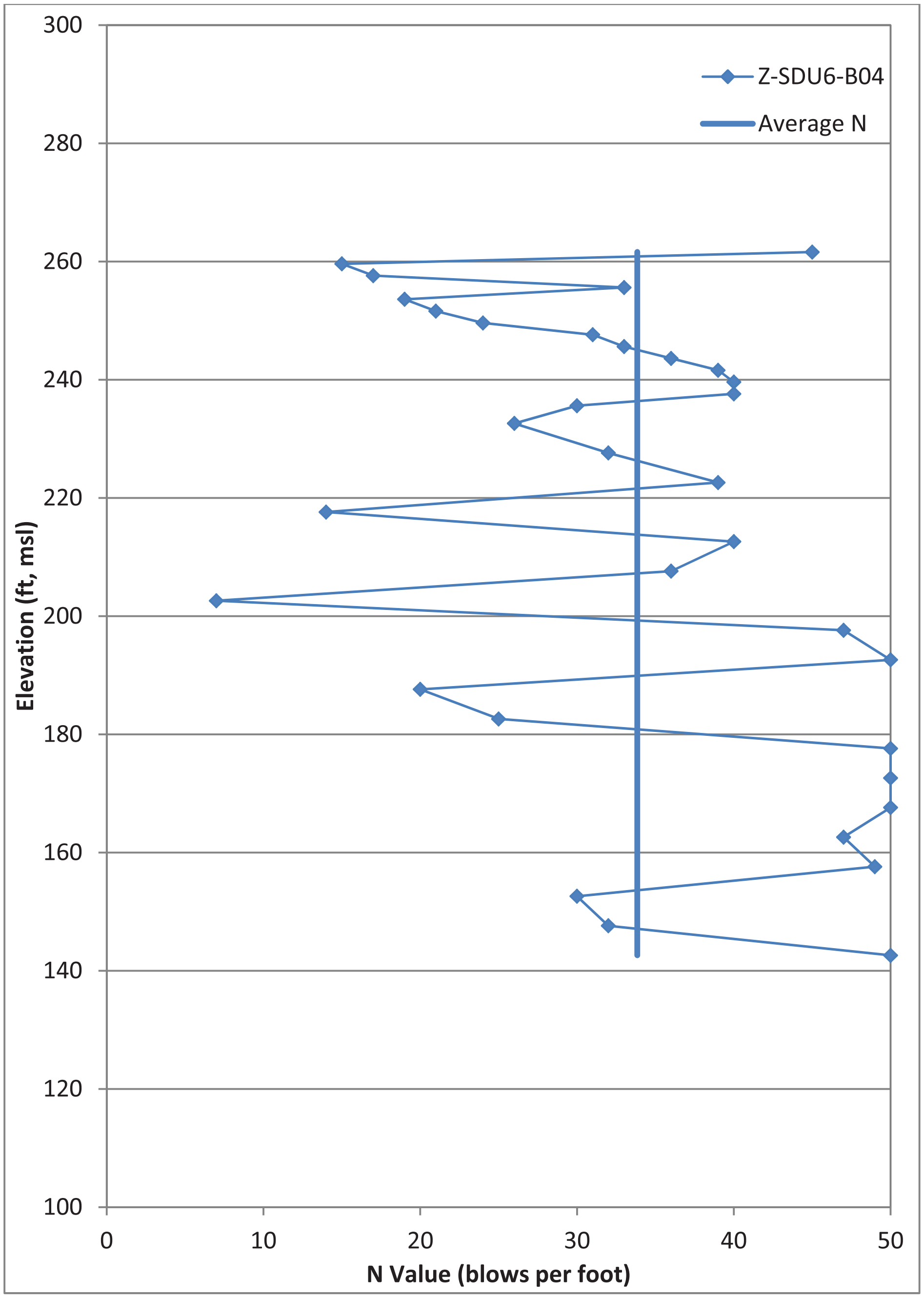



**Figure 4: Average N Value within the Depth of Influence for Boring Z-SDU6-B04**

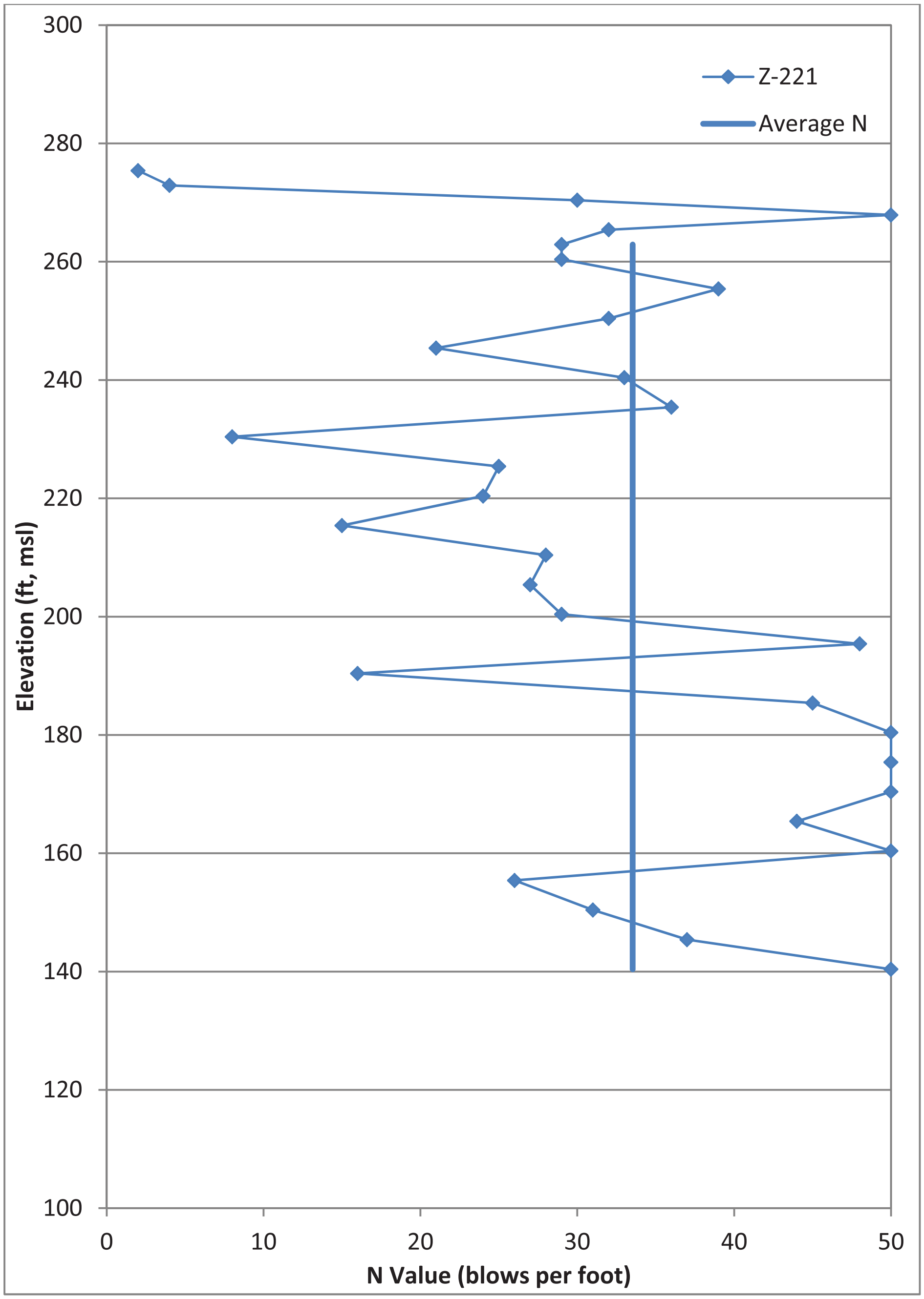



**Figure 5: Average N Value within the Depth of Influence for Boring Z-221**

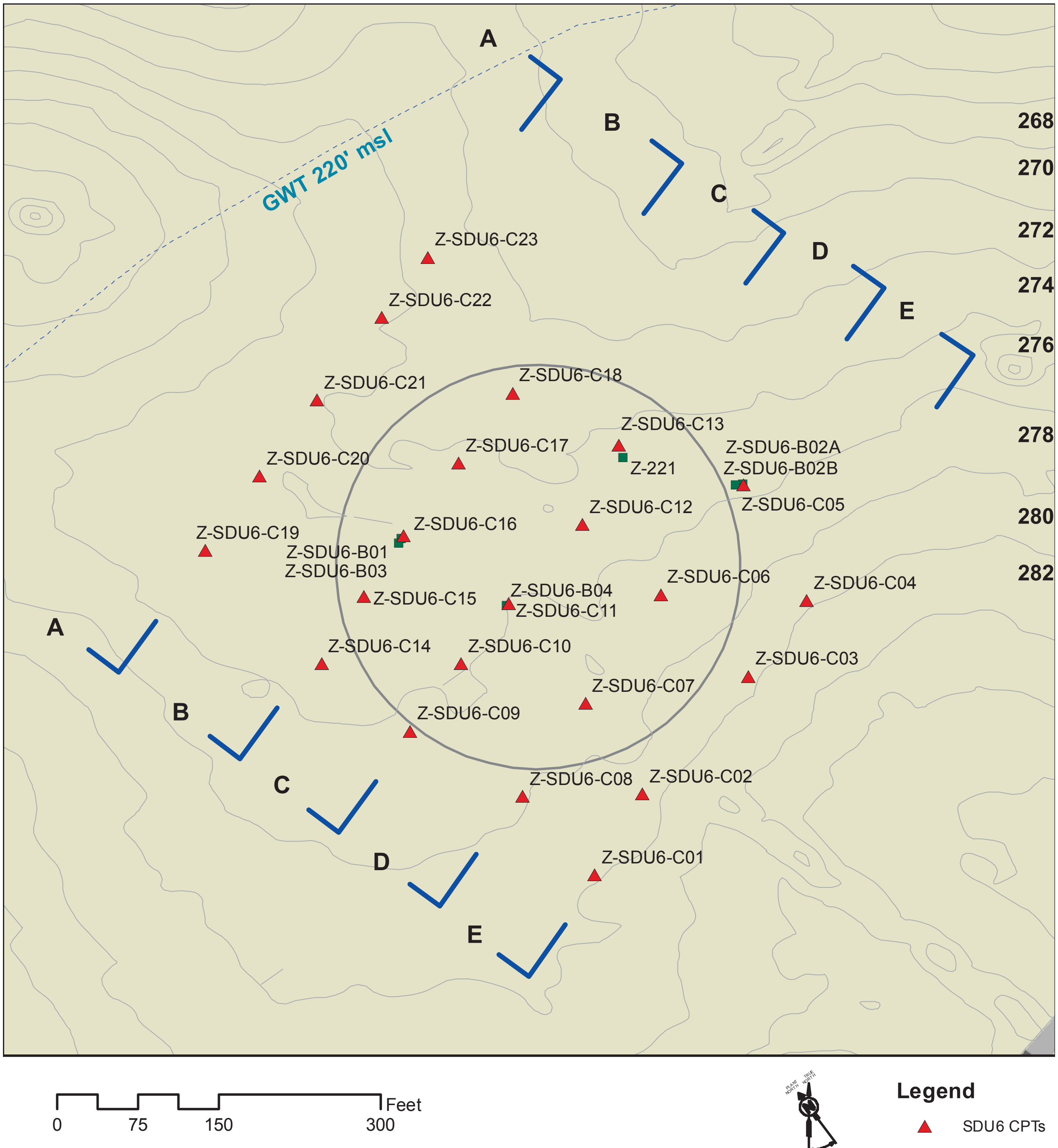



**Figure 6: Cross Sections A through E**

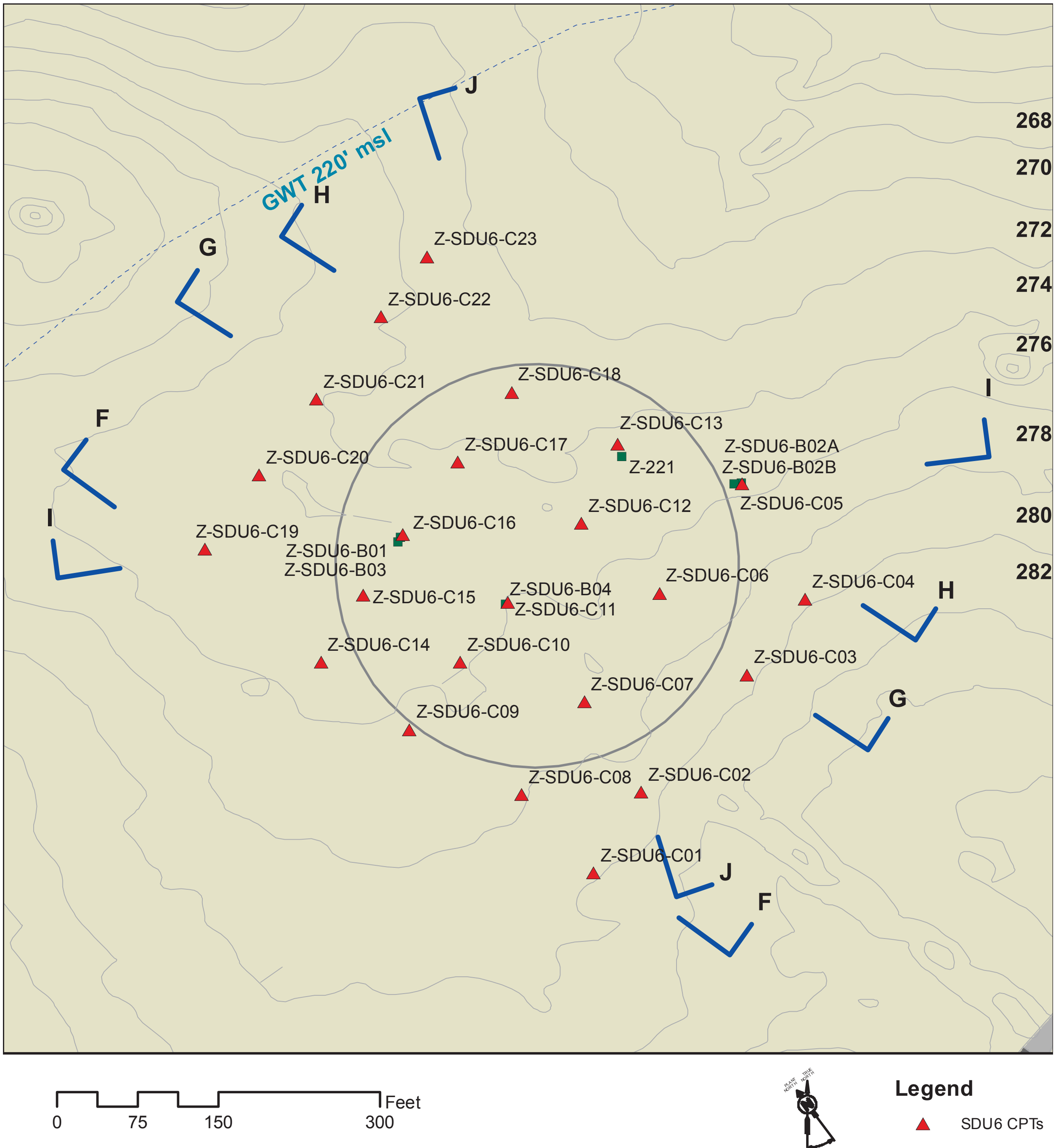



**Figure 7: Cross Sections F through J**

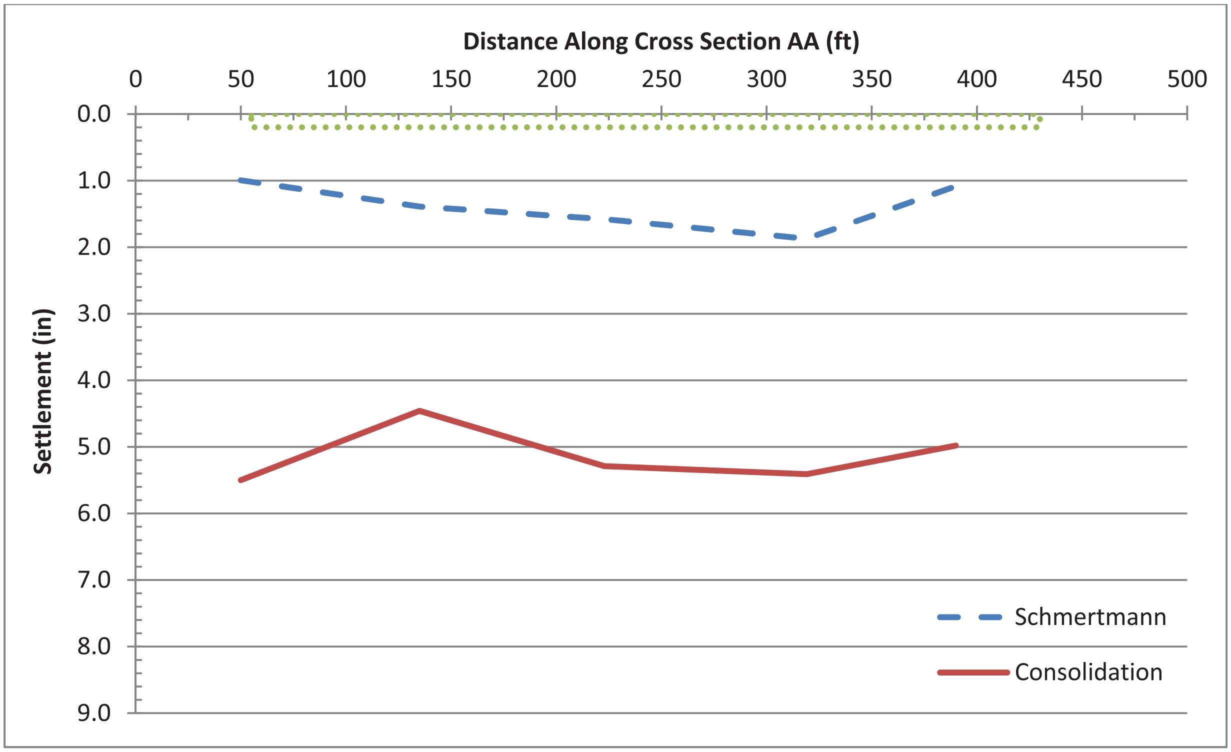



**Figure 8: Predicted Settlement Cross Section for SDU 6 at the End of Operations**

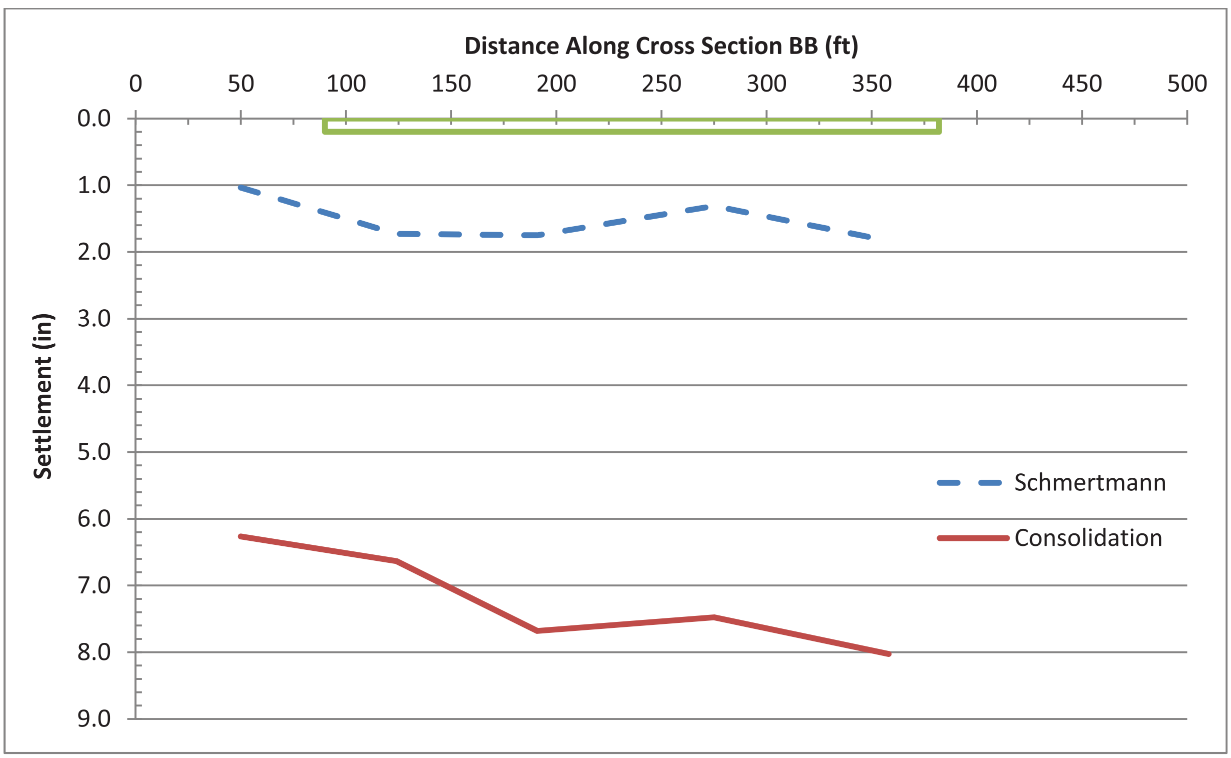



**Figure 9: Predicted Settlement Cross Section for SDU 6 at the End of Operations**

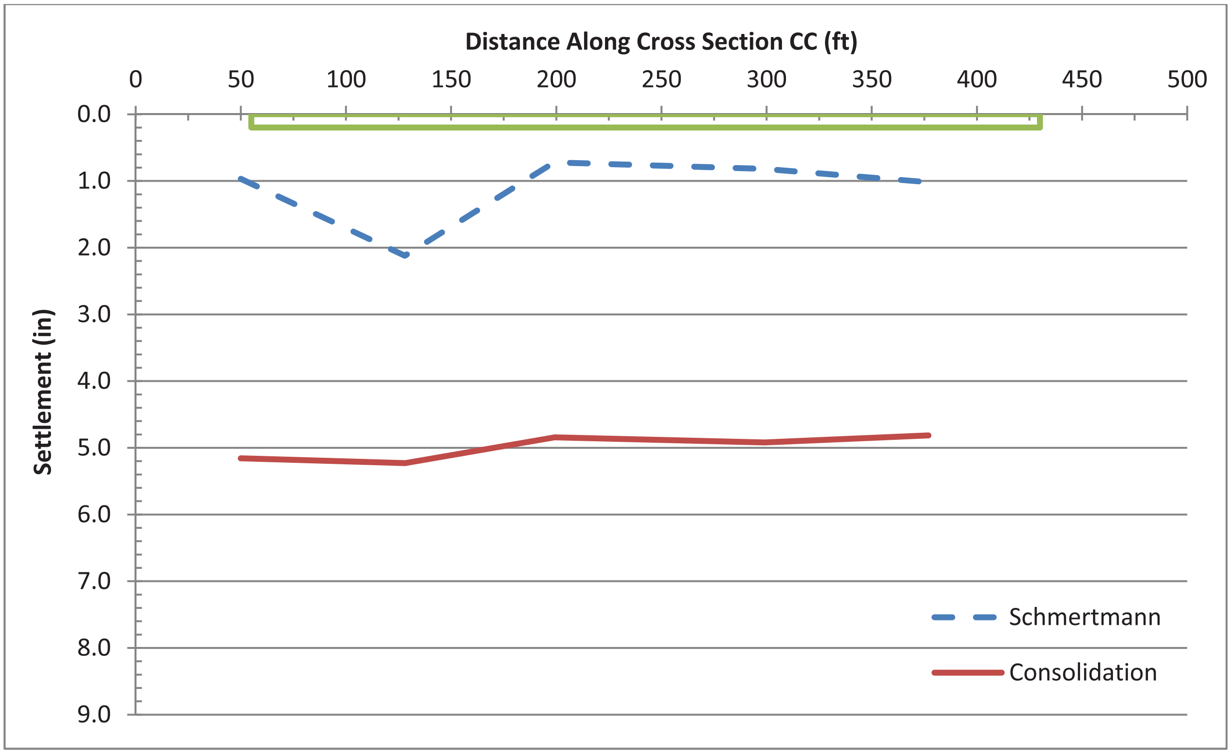



**Figure 10: Predicted Settlement Cross Section for SDU 6 at the End of Operations**

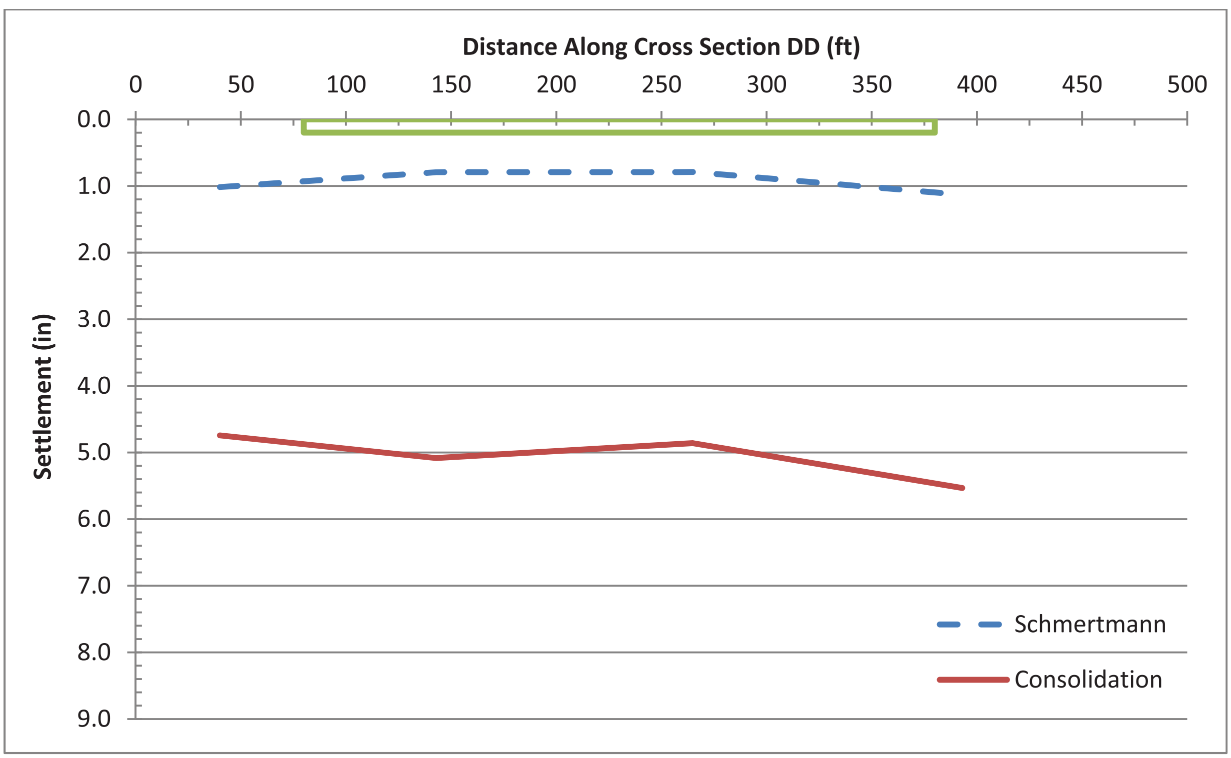



**Figure 11: Predicted Settlement Cross Section for SDU 6 at the End of Operations**

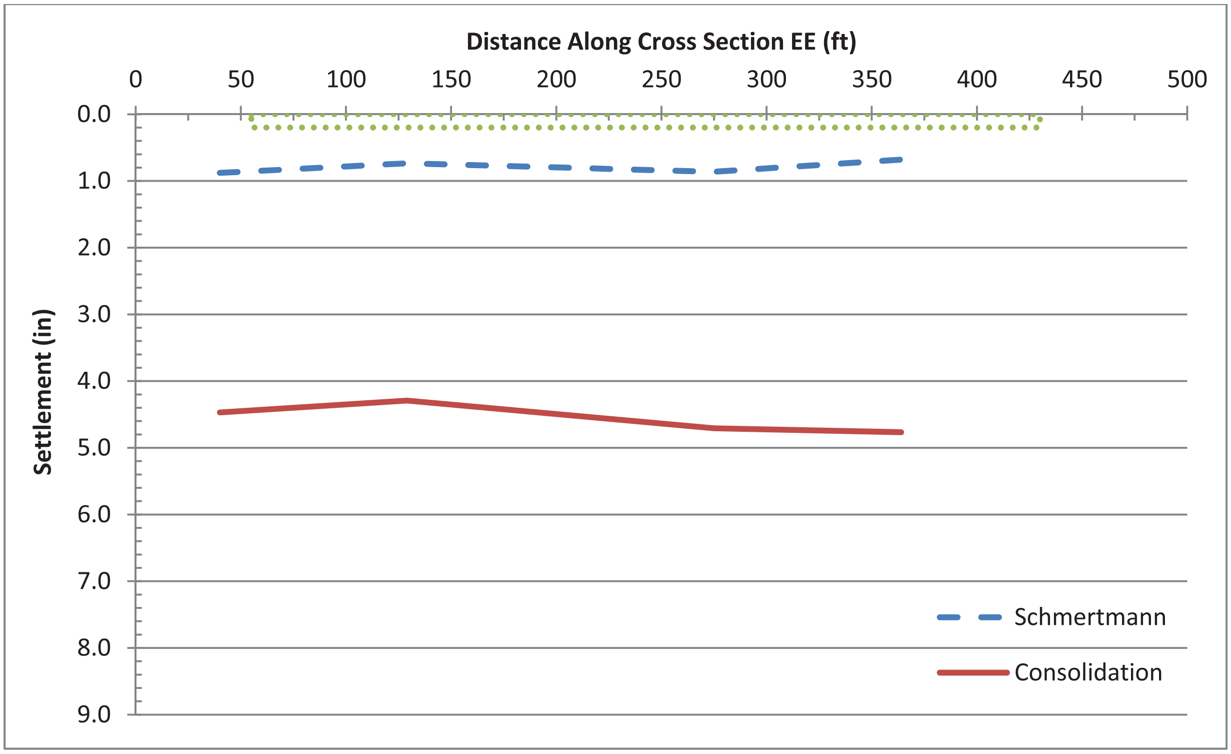



**Figure 12: Predicted Settlement Cross Section for SDU 6 at the End of Operations**

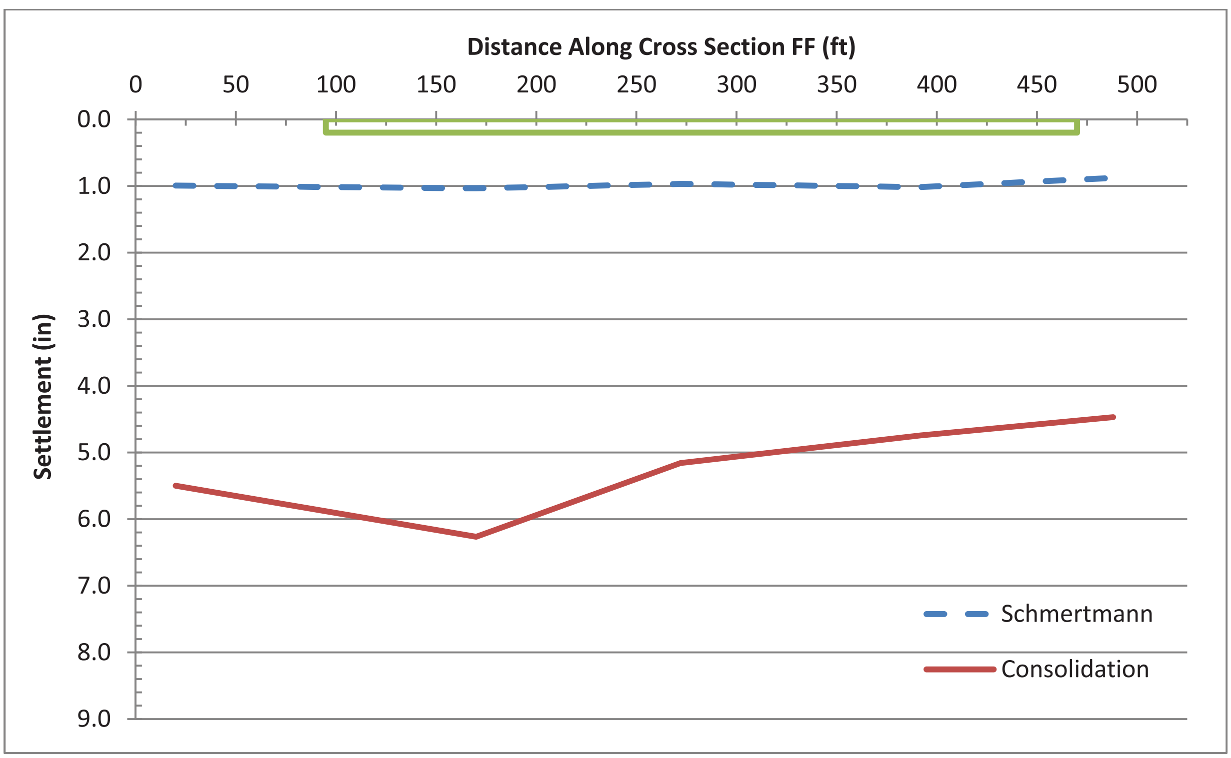



**Figure 13: Predicted Settlement Cross Section for SDU 6 at the End of Operations**

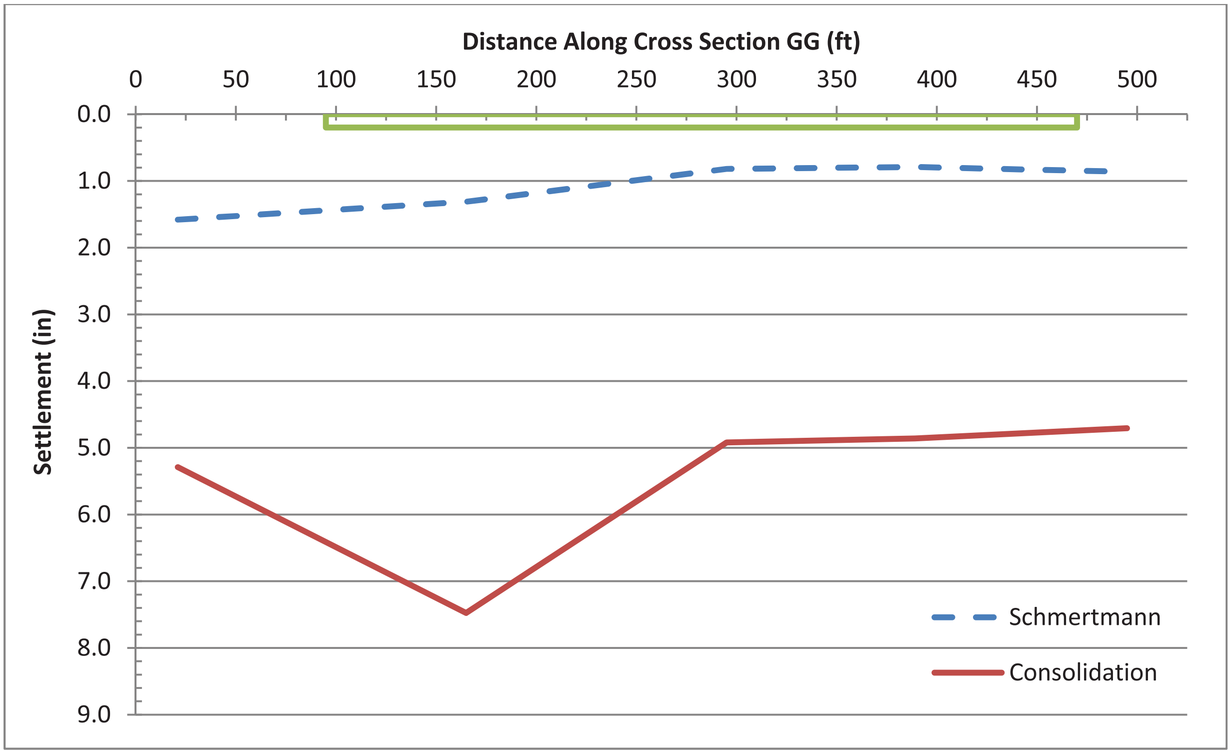



**Figure 14: Predicted Settlement Cross Section for SDU 6 at the End of Operations**

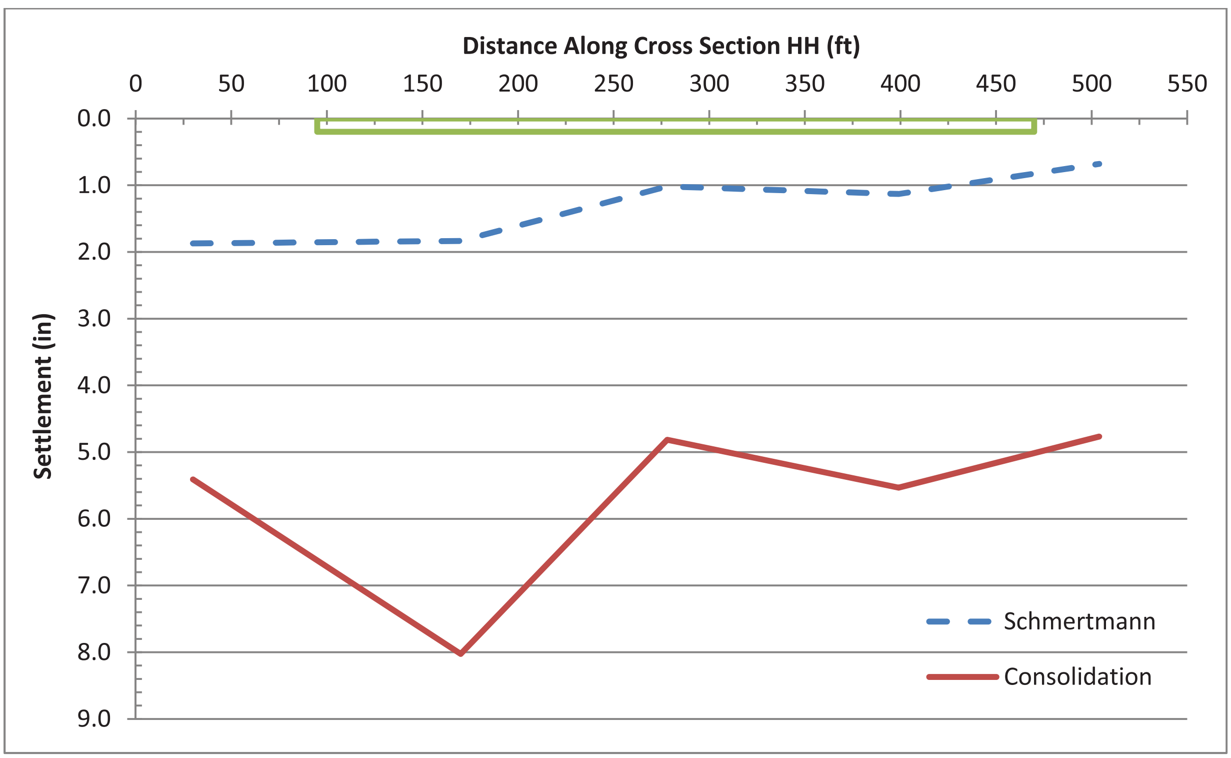



**Figure 15: Predicted Settlement Cross Section for SDU 6 at the End of Operations**

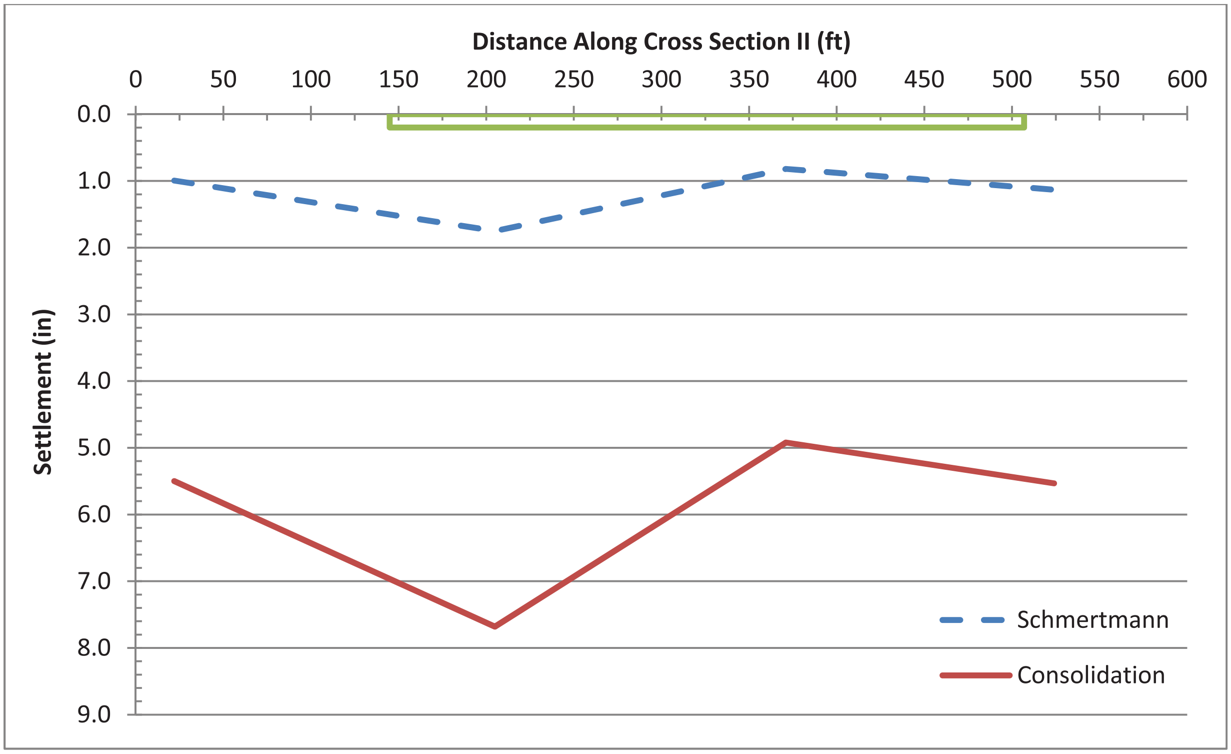



**Figure 16: Predicted Settlement Cross Section for SDU 6 at the End of Operations**

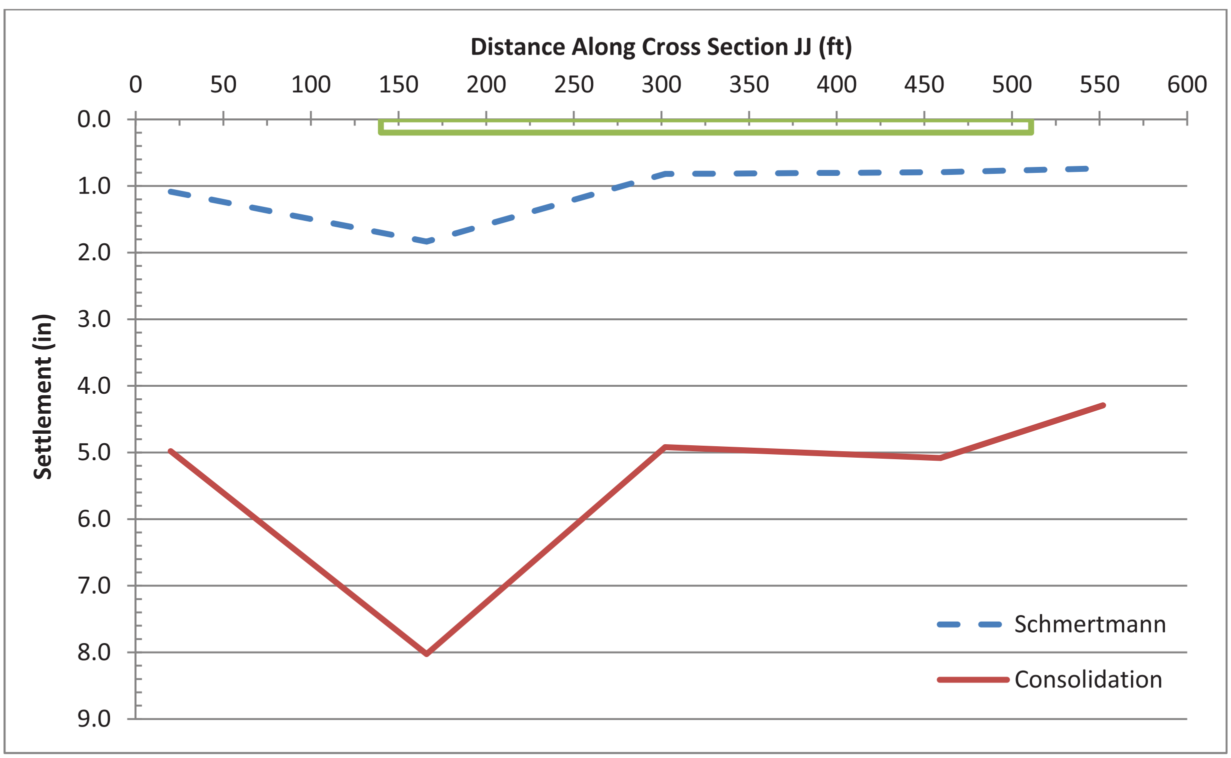



**Figure 17: Predicted Settlement Cross Section for SDU 6 at the End of Operations**

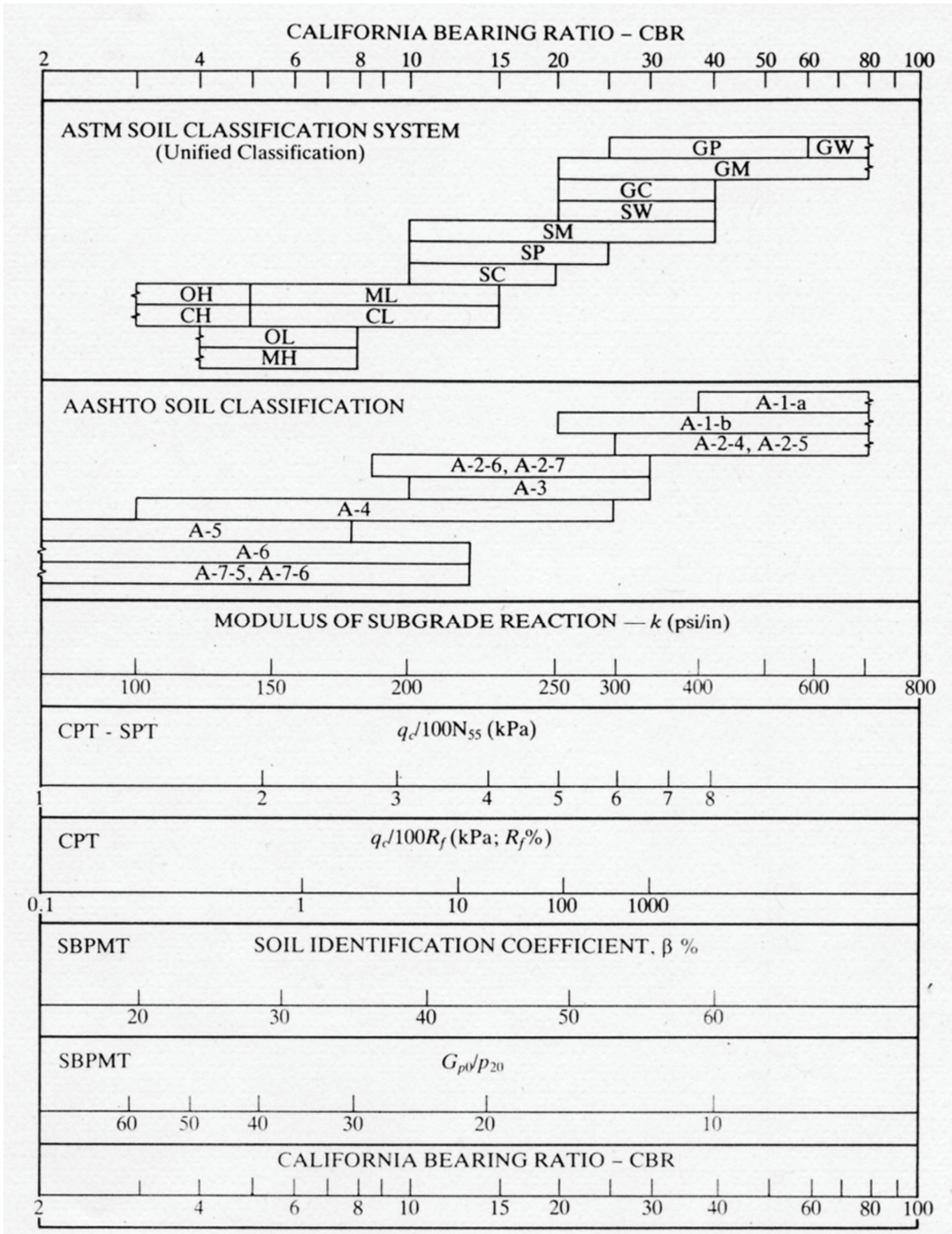



**Figure 18: Correlation between CPT and SPT Data and Subgrade Modulus**

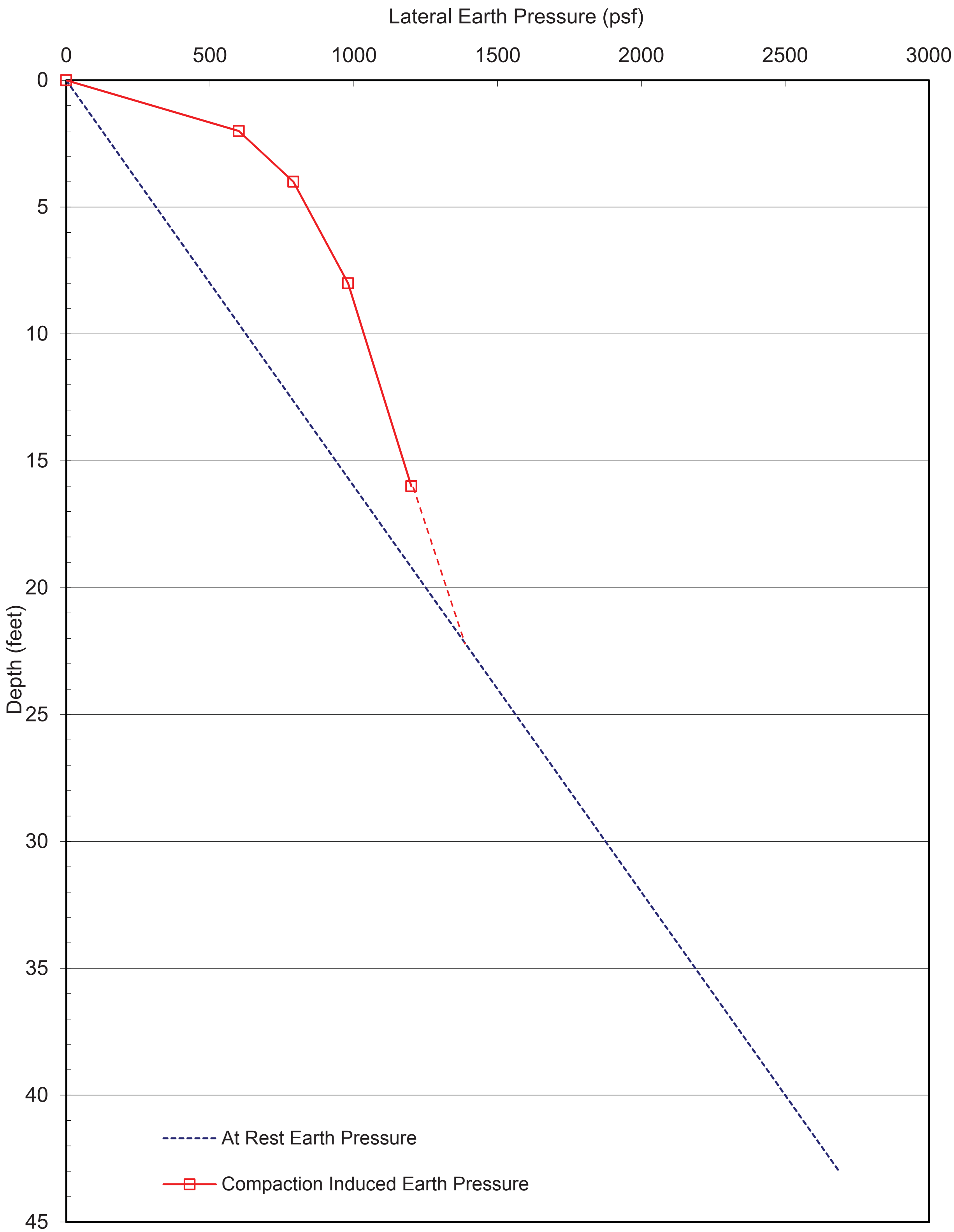



**Figure 19: Compaction-Induced Lateral Earth Pressures**

**Appendix A – Estimated Empty Tank Load**

**Fw: Estimated Bearing Pressures**
Matthew Maryak to: Rucker Williams 02/17/2012 02:05 PM

Here you go. Better late than never. Oh by the way, you can never use that line on me!!!!!!!!

Matthew Maryak, PE
803-208-8642
Pager 803-725-7243, #12768
Cell 706-832-4396
----- Forwarded by Matthew Maryak/SRR/Srs on 02/17/2012 02:04 PM -----

| | |
|---|---|
| From: | <Michele.McHenry@CH2M.com> |
| To: | <matthew.maryak@srs.gov> |
| Cc: | <sergio.mazul@srs.gov>, <Sue.Frey@CH2M.com> |
| Date: | 02/17/2012 12:07 PM |
| Subject: | Estimated Bearing Pressures |

Estimated bearing pressures for the 50% tank arrangement are as follows:

Column footing – tank empty: 3.7 ksf – 208 5'x5' footings
- tank full: 7.9 ksf
Wall footing – tank empty: 3.9 ksf 382 π · 7' wall foundation
- tank full: 6.7 ksf

Give me a little margin so any roof loads in addition to the 30 psf live load considered in the above don't put me over. Above numbers are gross bearing pressures before backfill at worst spot along the wall. We can adjust as needed based on geotechnical recommendations.

Michele

*End of Construction Loads*

$3.7 \text{ ksf} \cdot 208 \cdot 5' \cdot 5' = 19240 \text{ kips}$

$382' \pi \cdot 7' \cdot 3.9 \text{ ksf} = 32762 \text{ kips}$

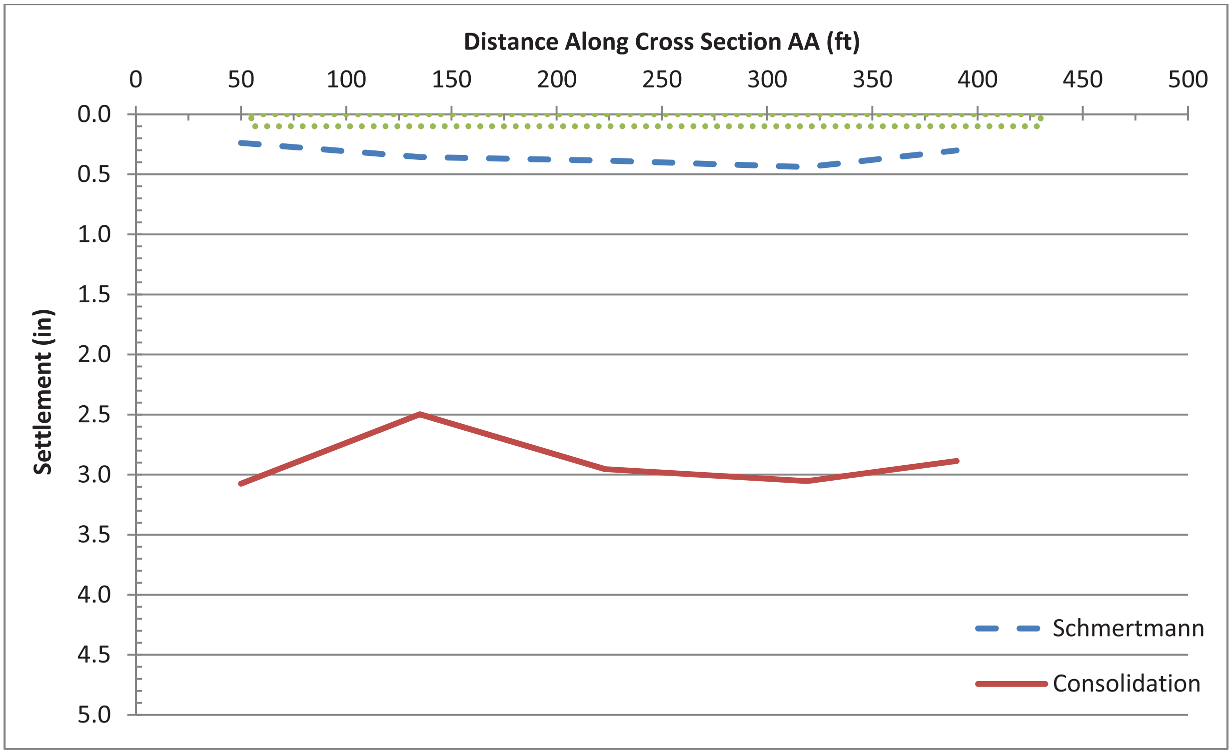
$A = \frac{(382')^2 \pi}{4} = 114608 \text{ ft}^2$

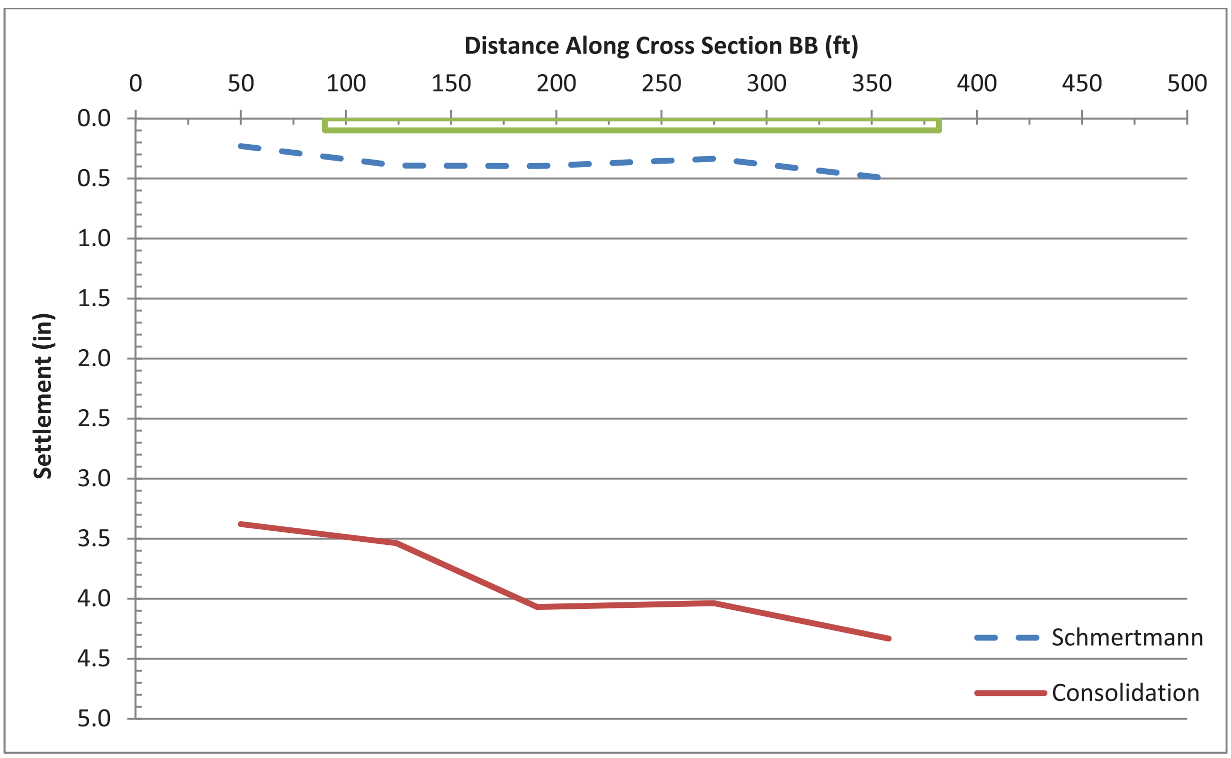
$\frac{19240 + 32762 \text{ kips}}{114608 \text{ ft}^2} \approx 0.45 \text{ ksf} = 450 \text{ psf}$

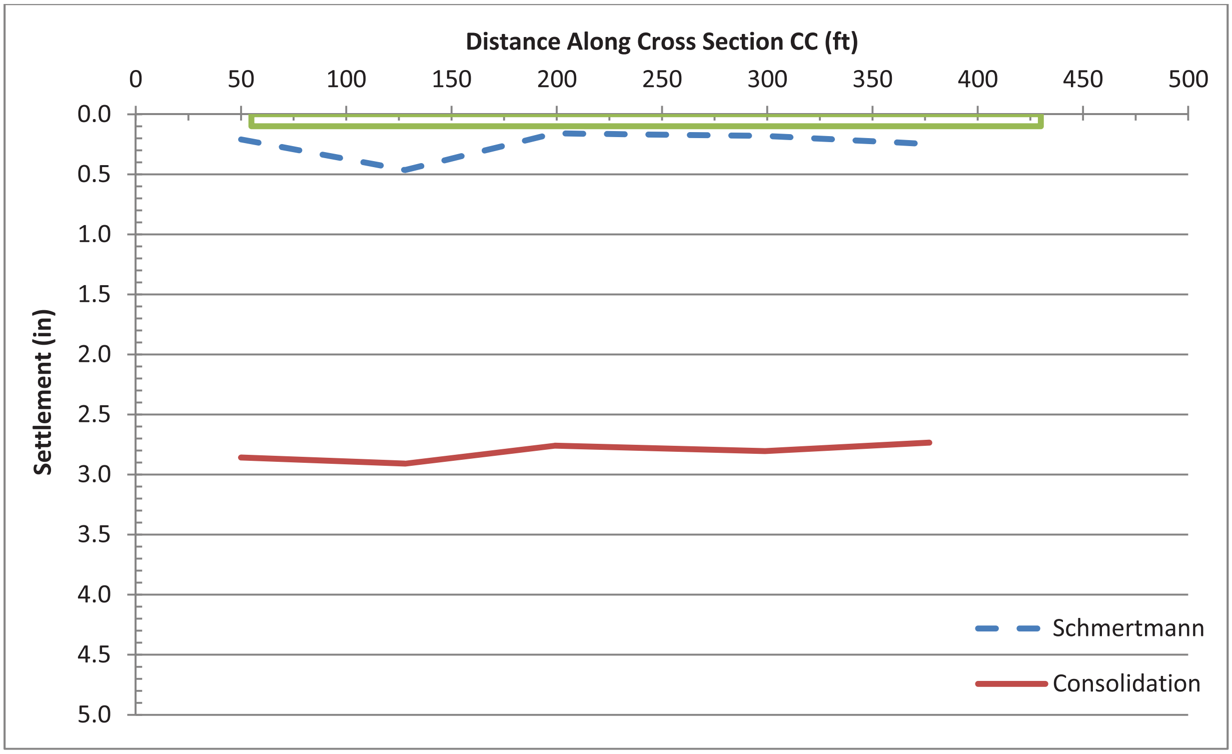
plus 1ft floor slab, concrete ≈ 150 psf

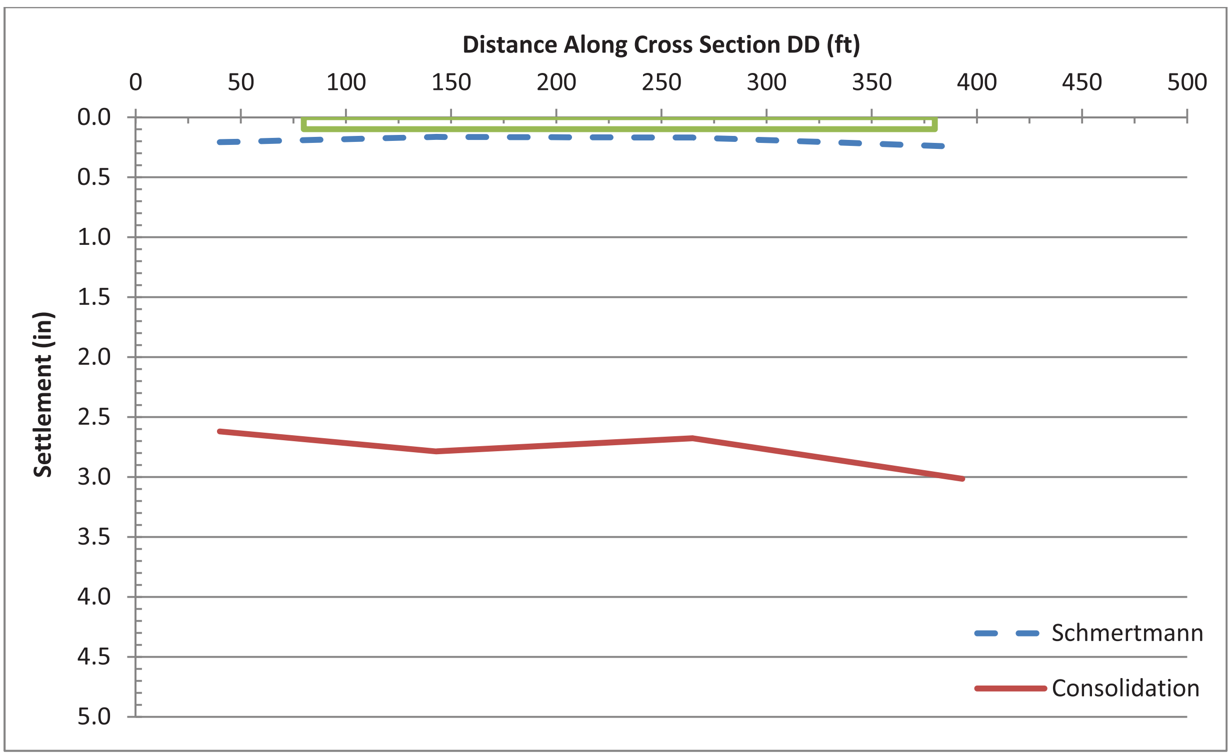
≈ 600 psf @ End of Construction

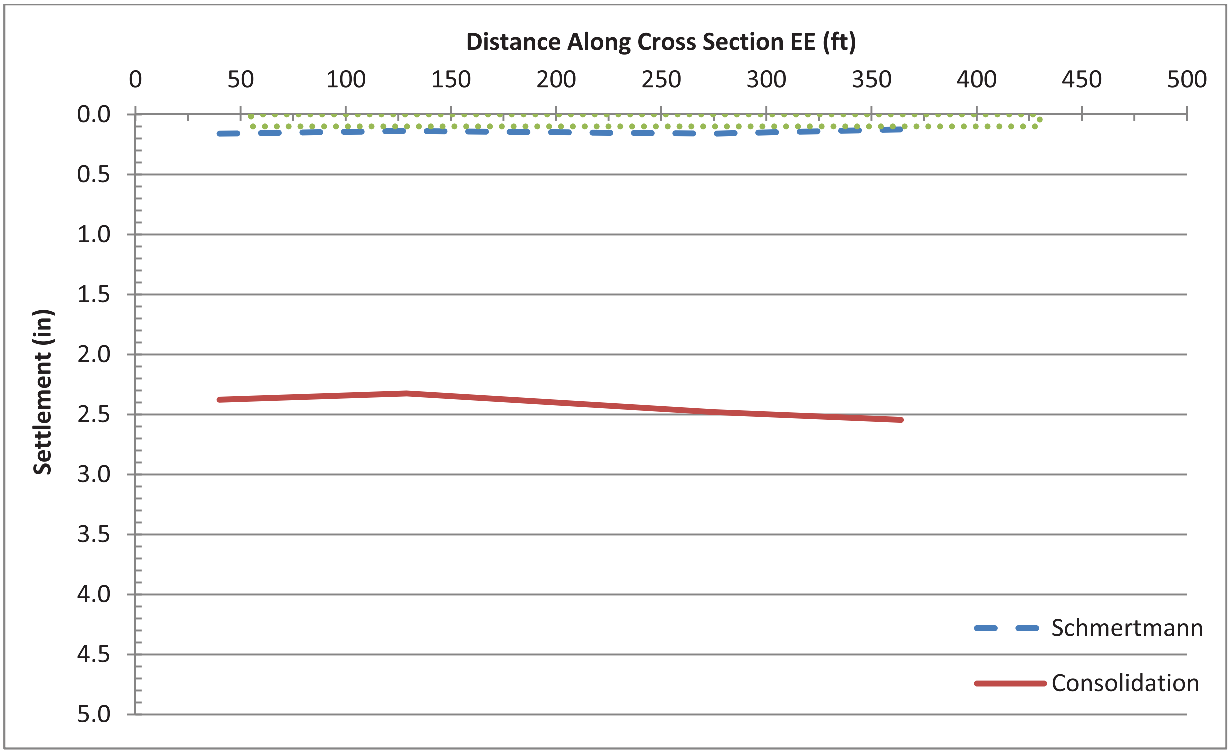
# Appendix B – Settlement Cross Sections – Tank Half Full

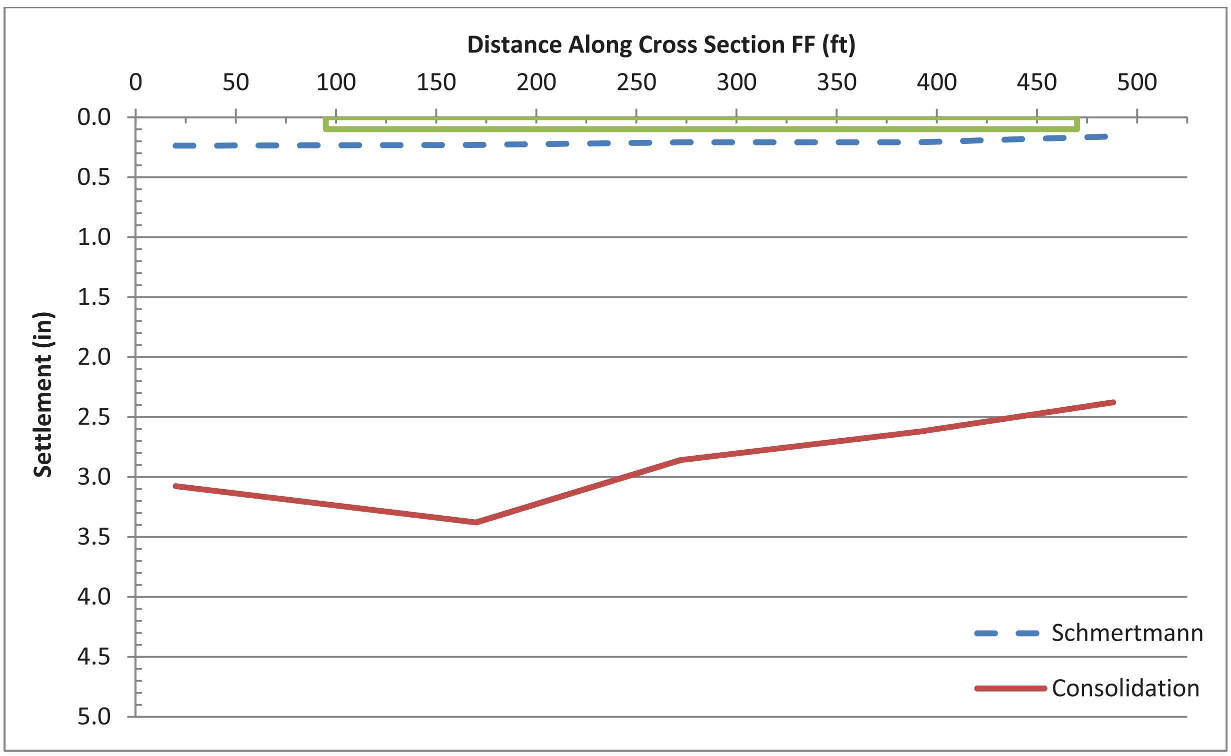

Distance Along Cross Section AA (ft)
0
50
100
150
200
250
300
350
400
450
500
Settlement (in)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Schmertmann
Consolidation

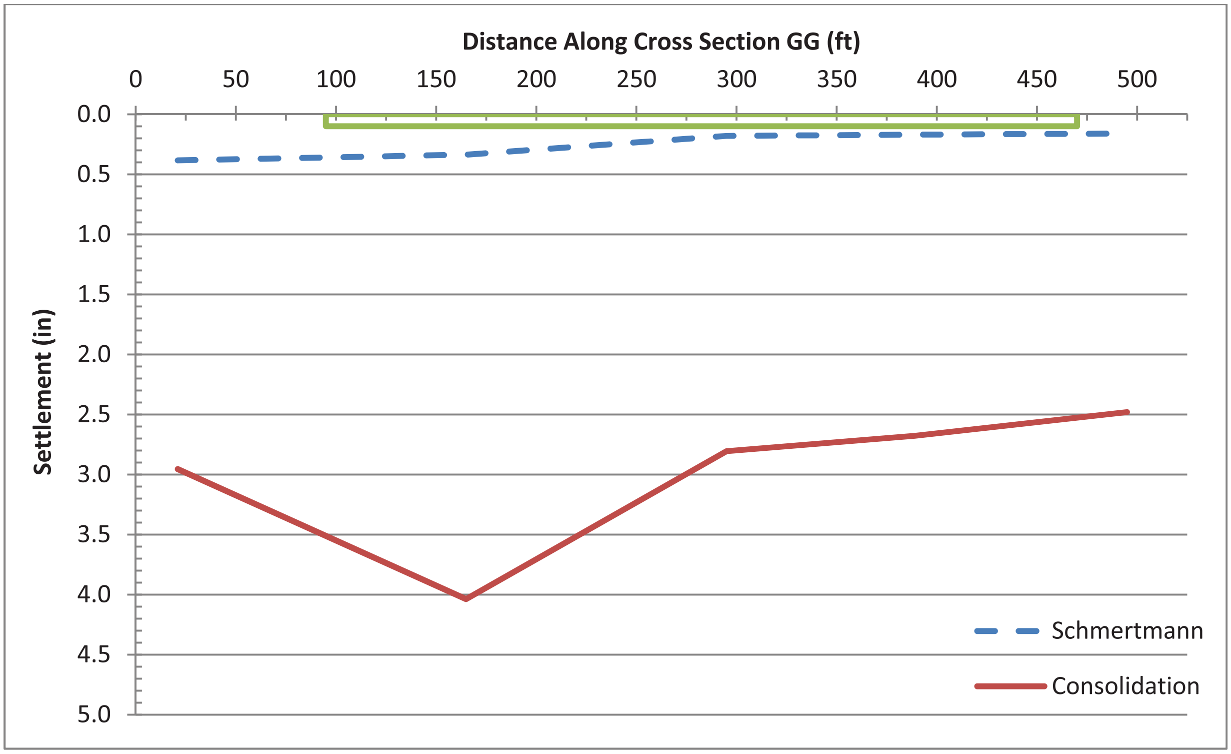

Distance Along Cross Section BB (ft)
0
50
100
150
200
250
300
350
400
450
500
Settlement (in)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Schmertmann
Consolidation

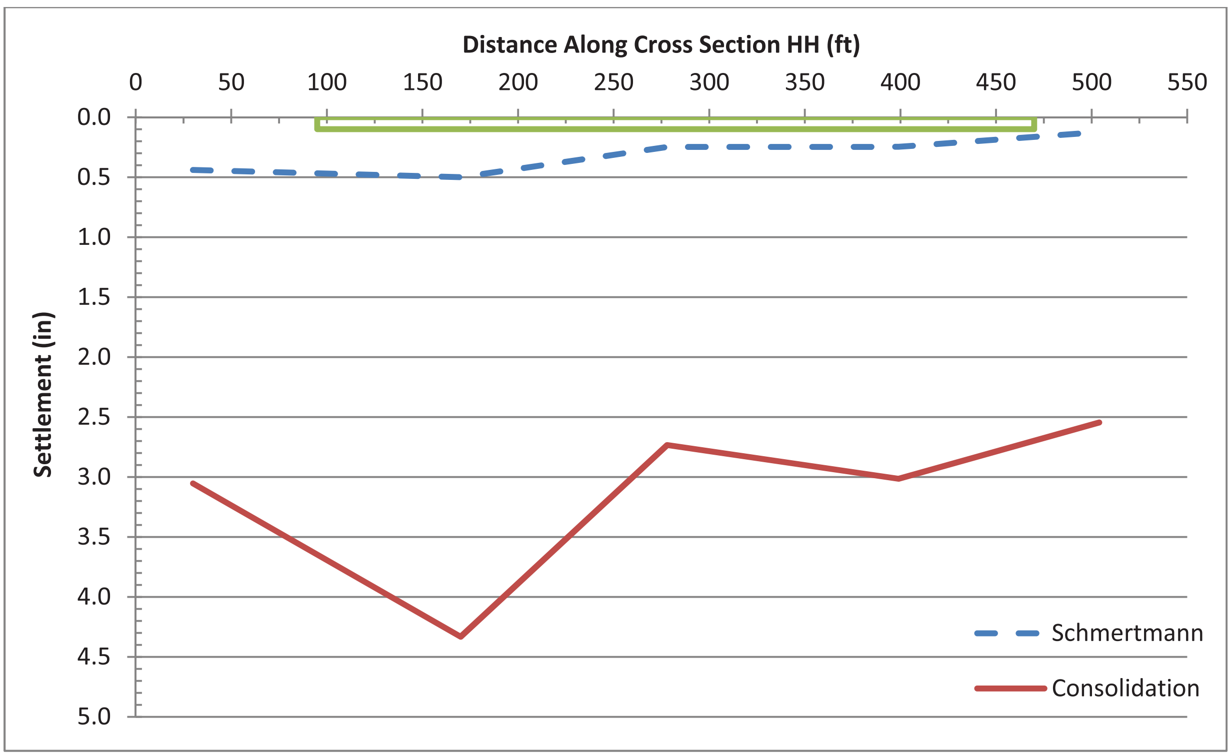

Distance Along Cross Section CC (ft)
0
50
100
150
200
250
300
350
400
450
500
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Settlement (in)
Schmertmann
Consolidation

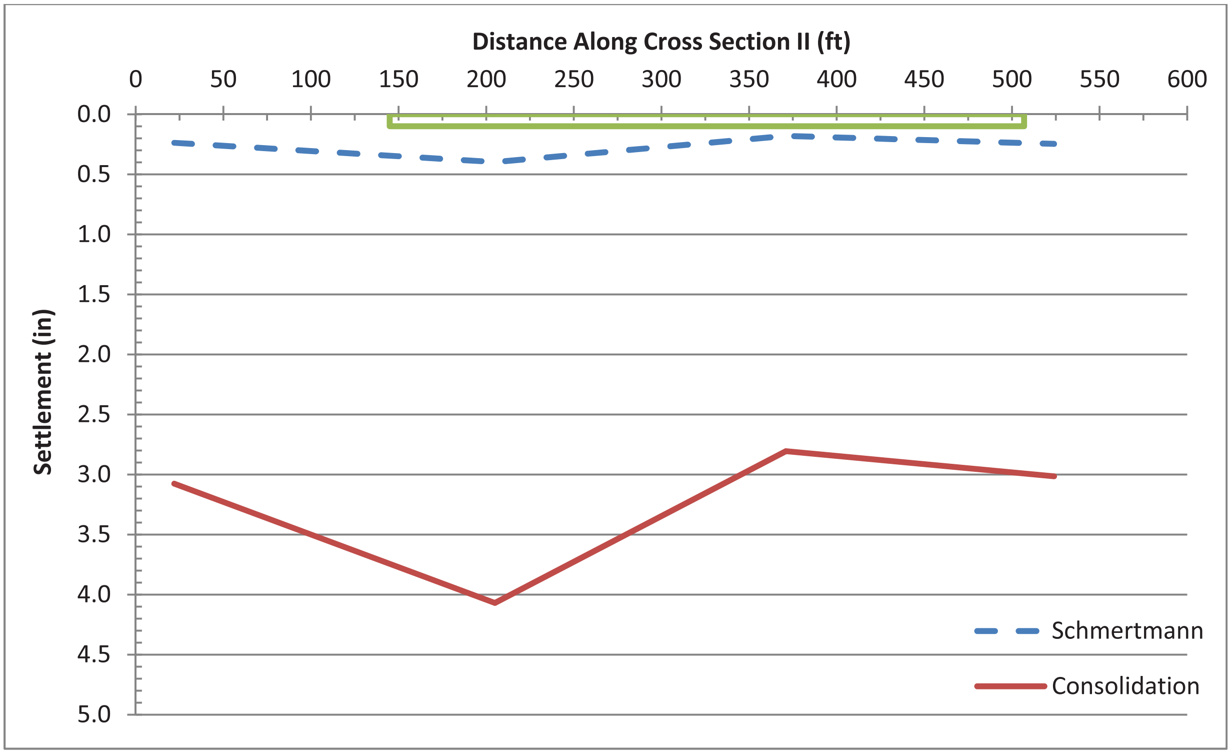

Distance Along Cross Section DD (ft)
0
50
100
150
200
250
300
350
400
450
500
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Settlement (in)
Schmertmann
Consolidation

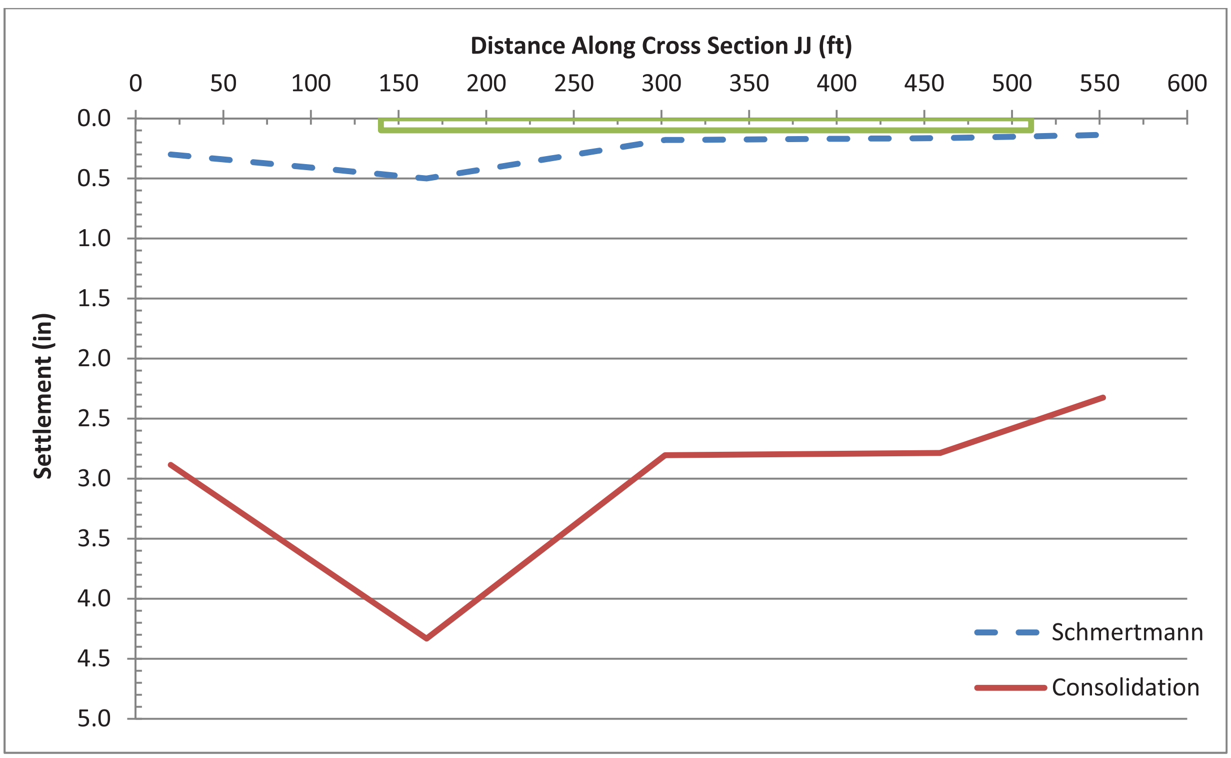

Distance Along Cross Section EE (ft)
0
50
100
150
200
250
300
350
400
450
500
Settlement (in)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Schmertmann
Consolidation


Distance Along Cross Section FF (ft)
0
50
100
150
200
250
300
350
400
450
500
Settlement (in)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Schmertmann
Consolidation


Distance Along Cross Section GG (ft)
0
50
100
150
200
250
300
350
400
450
500
Settlement (in)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Schmertmann
Consolidation


Distance Along Cross Section HH (ft)
0
50
100
150
200
250
300
350
400
450
500
550
Settlement (in)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Schmertmann
Consolidation


Distance Along Cross Section II (ft)
0
50
100
150
200
250
300
350
400
450
500
550
600
Settlement (in)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Schmertmann
Consolidation


Distance Along Cross Section JJ (ft)
0
50
100
150
200
250
300
350
400
450
500
550
600
Settlement (in)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Schmertmann
Consolidation

# Appendix C – Bearing Capacity Calculation Worksheets

Excerpts from Fang



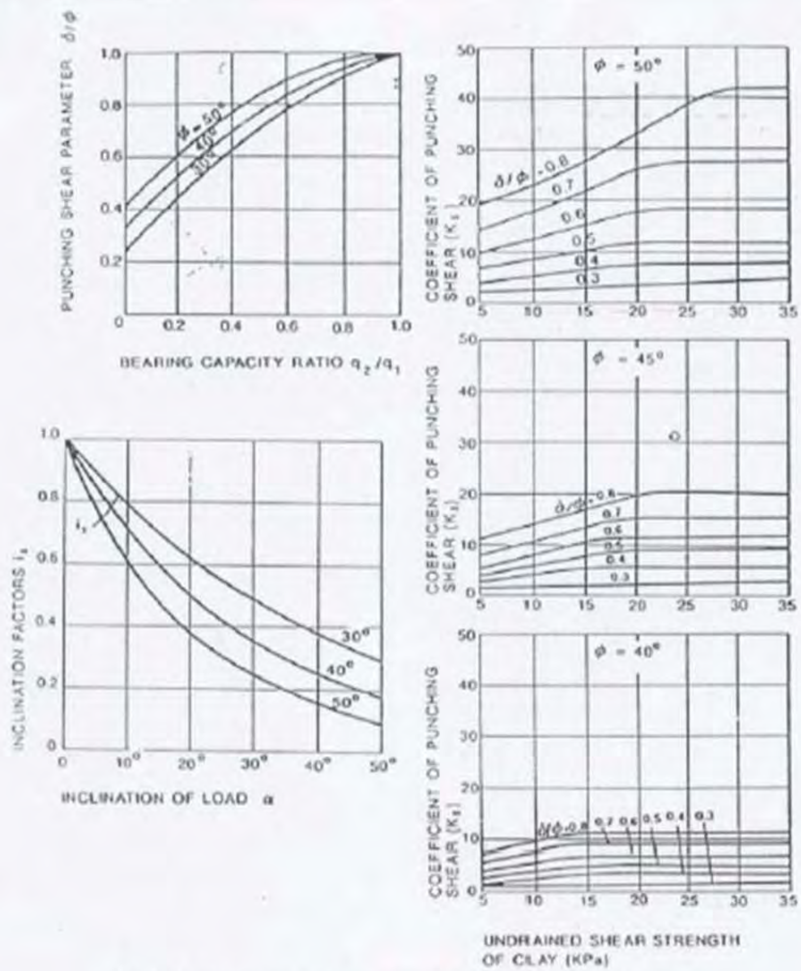



**Fig. 4.17** Graphical aids for Meyerhof and Hanna solution to layered foundation.

## 4.9 INFLUENCE OF GROUNDWATER TABLE

The position of the groundwater table may have a significant effect on the bearing capacity of shallow foundations. Generally the submergence of soils will cause loss of the apparent cohesion due to capillary stresses or weak cementation bonds. At the same time the effective unit weight of submerged soils will be reduced to about one-half the weight of the same soils above water. Thus, through submergence, all three terms involved in the bearing capacity equation are reduced. For this reason, it is essential that the bearing capacity analysis be made assuming the highest possible groundwater level at the particular level for the expected lifetime of the structure. The assessment of this level must be made taking into consideration the probability of temporary high levels that could be expected in some locations during heavy rainstorms or floods, although they may not appear in the official records.

If the highest groundwater level is within the depth $z_w < B$ below the foundation level (Fig. 4.18) the effective weight $\gamma$ of the soil below the foundation base should be taken as

$$\gamma = \gamma' + \frac{z_w}{B}(\gamma_m - \gamma') \qquad (4.28)$$

where $\gamma'$ is the submerged unit weight and $\gamma_m$ is the moist unit weight of soil, corresponding to the minimum moisture content of the soil above the water table (Meyerhof, 1953). If the water

**TABLE 4.8 VALUES OF MINIMUM PARTIAL FACTORS[a]**

| *Category* | *Item* | *Load Factor* | *Resistance Factor* |
|---|---|---|---|
| Loads | Dead loads | ($f_d$) 1.25 (0.85) | |
| | Live loads, wind or earthquake | ($f_l$) 1.5 | |
| | Water pressures | ($f_u$) 1.25 (0.85) | |
| Shear strength | Cohesion ($c$) (stability; earth pressures) | | ($f_c$) 0.65 |
| | Cohesion ($c$) (foundations) | | ($f_c$) 0.5 |
| | Friction ($\tan \phi$) | | ($f_\phi$) 0.8 |

Note: Load factors given in parentheses apply to dead loads and water pressures when their effects are beneficial, as for dead loads resisting instability by sliding, overturning or uplift.

[a] Meyerhof (1984).

factors) given in Table 4.8. The higher values in Table 4.7 are applied to the normal loads and service conditions, while the lower values are applied to the maximum loads and worst environmental conditions.

The basic philosophy using total factors of safety is that the foundation should be capable of resisting a load $F_s$ times greater than the design load. The load and resistance factor design (LRFD) method applies separate or partial factors to the loads and soil resistance. The load factors are provided mainly for variability and pattern of loading, which differ for dead loads, live loads, environmental loads, and water pressures. The resistance factors consider the variability and uncertainty of assessment of soil resistance, which differ for the cohesive and friction components. Thus, the factored shear strength of soil at the ultimate limit state may be expressed as

$$\tau = f_c c + \sigma_n f_\phi \tan \phi \qquad (4.33)$$

for the Coulomb criterion. The factors $f_c$ and $f_\phi$ are the resistance factors for the cohesive and friction components, respectively. It is evident from Equation 4.33 that the total factor of safety obtained will depend on the relative contributions of the cohesive and friction components.

Whitman (1984) has recently reviewed the application of the related topic of risk analysis to geotechnical engineering.

## 4.13 EXAMPLE PROBLEMS

### EXAMPLE 4.1

A rectangular footing (Fig. 4.21) 28 ft wide and 84 ft long is to be placed at a depth of 10 ft in a deep stratum of soft, saturated clay (bulk unit weight 105 lb/ft³). The water table is at 8 ft below ground surface. Find the ultimate bearing capacity under the following two conditions:

a. assuming that the rate of application of dead and live loads is fast in comparison with the rate of dissipation of excess pore-water pressures caused by loads, so that undrained conditions prevail at failure;

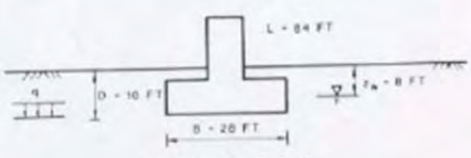



Fig. 4.21 Footing geometry.

b. assuming, as the other extreme, that the rate of loading is slow enough that no excess pore-water pressures are introduced in the foundation soil.

The strength parameters of the soil, obtained from unconsolidated, undrained tests are $c_u = 0.22$ ton/ft², $\phi_u = 0$. Consolidated, drained tests give $c_d = 0.04$ ton/ft², $\phi_d = 23°$.

CONDITION (a)

Submerged unit weight of soil: $\gamma' = 105 - 62 = 43$ lb/ft³.
Overburden stress: $q = [(8)(105) + (2)(43)]/(2000) = 0.463$ ton/ft².
Bearing capacity factors (Table 4.1): $N_c = 5.14$; $N_q = 1$; $N_\gamma = 0$.
Shape factors (Table 4.4, Brinch Hansen):

$$s_c = 1 + \frac{B}{L}\frac{N_q}{N_c} = 1 + (1/3)(0.19) = 1.065$$

$$s_q = 1.00$$

Ultimate bearing pressure (Eq. 4.24):

$$q_0 = cN_c s_c + qN_q s_q$$

$$q_0 = (0.22)(5.14)(1.065) + (0.463)(1)(1.00)$$

$$= 1.21 + 0.46 = 1.67 \text{ ton/ft}^2$$

CONDITION (b)

Bearing capacity factors: $N_c = 18.05$; $N_q = 8.66$; $N_\gamma = 9.70$.
Shape factors:

$$s_c = 1 + \frac{B}{L}\frac{N_q}{N_c} = 1 + (1/3)(0.48) = 1.16$$

$$s_q = 1 + \frac{B}{L}\tan\phi = 1 + (1/3)(0.42) = 1.14$$

$$s_\gamma = 1 - 0.4\frac{B}{L} = 1 - (0.4)(1/3) = 0.87$$

Ultimate bearing pressure:

$$q_0 = cN_c s_c + qN_q s_q + \frac{\gamma B}{2}N_\gamma s_\gamma$$

$$q_0 = (0.04)(18.05)(1.16) + (0.463)(8.66)(1.14) + (1/2)(43)(28)(9.7)(0.87)/(2000)$$

$$= 0.72 + 4.57 + 2.54 = 7.83 \text{ ton/ft}^2$$

Excerpts from Bowles



ing reduction factor (revised from the previous edition) as follows:

$$r_\gamma = 1 - 0.25 \log\left(\frac{B}{\kappa}\right) \qquad B \geqq 6 \text{ ft or } 2 \text{ m}$$

where $\kappa = 6.0$ for fps and 2.0 for SI

This gives:

| $B = 2$ | 2.5 | 3 | 3.5 | 4 | 5 | 10 | 20 | 100 m |
|---|---|---|---|---|---|---|---|---|
| $r_\gamma = 1.0$ | 0.97 | 0.95 | 0.93 | 0.92 | 0.90 | 0.82 | 0.75 | 0.57 |

One can use this reduction factor with any of the bearing capacity methods to give

$$0.5\gamma B N_\gamma s_\gamma d_\gamma r_\gamma$$

This equation is particularly applicable for large bases at small $D/B$ ratios where the $BN_\gamma$ term is predominating.

General observations about the bearing-capacity equations may be made as follows:

1. The cohesion term predominates in cohesive soil.
2. The depth term ($\bar{q}N_q$) predominates in cohesionless soils. Only a small $D$ increases $q_{ult}$ substantially.
3. The base width term $0.5\gamma BN_\gamma$ provides some increase in bearing capacity for both cohesive and cohensionless soils. In cases where $B < 3$ to 4 m this term could be neglected with little error.
4. No one would place a footing on the ground surface of a cohesionless soil mass.
5. It is highly unlikely that one would place a footing on a cohesionless soil with a $D_r$ (Table 3-4) less than 0.5. If the soil is loose, it would be compacted in some manner to a higher density prior to placing footings in it.
6. Where the soil beneath the footing is not homogeneous or is stratified, some judgment must be applied to determining the bearing capacity. In the case of stratification, later sections will consider several cases.
7. When a base must be designed for a particular load, except for the Terzaghi method, one must use an iterative procedure since the shape, depth, and inclination factors depend on $B$. A computer program such as B-31 is most useful for this type problem. It should be set to increment the base by 0.075 m or 0.25 ft (3 in) steps as this is a common multiple of base dimensions.
8. Inspection of Table 4-1 indicates that the Terzaghi equation is much easier to use than the other methods (see also Example 4-1) so that it has great appeal for many practitioners—particularly for bases with only vertical loads and $D/B \leq$ Its form is also widely used for deep foundations but with adjusted $N$ factor
9. Vesić (1973) recommends that depth factors $d_i$ not be used for shallo foundations ($D/B \leq 1$) because of uncertainties in quality of the overburde

**TABLE 4-1 Bearing-capacity equations by the several authors indicated**

Terzaghi (see Table 4-2 for typical values and for $K_{p\gamma}$ values)

$$q_{ult} = cN_c s_c + \bar{q}N_q + 0.5\gamma B N_\gamma s_\gamma \qquad N_q = \frac{a^2}{2\cos^2(45 + \phi/2)}$$

$$a = e^{(0.75\pi - \phi/2)\tan\phi}$$

$$N_c = (N_q - 1)\cot\phi$$

$$N_\gamma = \frac{\tan\phi}{2}\left(\frac{K_{p\gamma}}{\cos^2\phi} - 1\right)$$

| For: | strip | round | square |
|---|---|---|---|
| $s_c =$ | 1.0 | 1.3 | 1.3 |
| $s_\gamma =$ | 1.0 | 0.6 | 0.8 |

Meyerhof (see Table 4-3 for shape, depth, and inclination factors)

Vertical load: $q_{ult} = cN_c s_c d_c + \bar{q}N_q s_q d_q + 0.5\gamma B N_\gamma s_\gamma d_\gamma$

Inclined load: $q_{ult} = cN_c d_c i_c + \bar{q}N_q d_q i_q + 0.5\gamma B N_\gamma d_\gamma i_\gamma$

$$N_q = e^{\pi\tan\phi}\tan^2\left(45 + \frac{\phi}{2}\right)$$

$$N_c = (N_q - 1)\cot\phi$$

$$N_\gamma = (N_q - 1)\tan(1.4\phi)$$

Hansen (see Table 4-5 for shape, depth, and other factors)

General: $q_{ult} = cN_c s_c d_c i_c g_c b_c + \bar{q}N_q s_q d_q i_q g_q b_q + 0.5\gamma B N_\gamma s_\gamma d_\gamma i_\gamma g_\gamma b_\gamma$

when $\phi = 0$

use $q_{ult}\ 5.14 s_u(1 + s_c' + d_c' - i_c' - b_c' - g_c') + \bar{q}$

$N_q$ = same as Meyerhof above

$N_c$ = same as Meyerhof above

$N_\gamma = 1.5(N_q - 1)\tan\phi$

Vesić (see Table 4-5 for shape, depth, and other factors)

Use Hansen's equations above

$N_q$ = same as Meyerhof above

$N_c$ = same as Meyerhof above

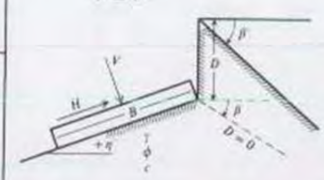
$N_\gamma = 2(N_q + 1)\tan\phi$

He also proposed using inclination factors to reduce the bearing capacit[y] when the load resultant was inclined from the vertical by the angle $\theta$.

Up to about $D = B$ of Fig. 4-3$a$ Meyerhof's $q_{ult}$ is not greatly different fro[m] the Terzaghi value. The difference is more pronounced at larger $D/B$ ratios.

**TABLE 4-5**

**Shape, depth, inclination, ground and base factors for use in either the Hansen (1970) or Vesić (1973) bearing-capacity equations of Table 4-1. Factors apply to either method unless subscripted with (H) or (V). Use primed factors when $\phi = 0$**

| Shape factors | Depth factors | Inclination factors | Ground factors (base on slope) |
|---|---|---|---|
| $s'_c = 0.2 \cdot \frac{B}{L}$ | $d'_c = 0.4k$ | $i'_{c(H)} = 0.5 - 0.5\sqrt{1 - \frac{H}{A_f c_a}}$ = 0 | $g'_c = \frac{\beta^\circ}{147^\circ}$ = 0 |
| $s_c = 1 + \frac{N_q}{N_c} \cdot \frac{B}{L}$ | $d_c = 1 + 0.4k$ | $i_{c(V)} = 1 - \frac{mH}{A_f c_a N_c}$ | for Vesić use $N_\gamma = -2 \sin \beta$ for $\phi = 0$ |
| $s_c = 1$ for strip | | $i_c = i_q - \frac{1 - i_q}{N_q - 1}$ (Hansen and Vesić) | $g_c = 1 - \frac{\beta^\circ}{147^\circ}$ 0 |
| $s_q = 1 + \frac{B}{L} \tan \phi$ | $d_q = 1 + 2 \tan \phi (1 - \sin \phi) k$ | $i_{q(H)} = \left(1 - \frac{0.5H}{V + A_f c_a \cot \phi}\right)^5$ | $g_{q(H)} = g_{\gamma(H)} = (1 - 0.5 \tan \beta)^5$ |
| $s_\gamma = 1 - 0.4 \cdot \frac{B}{L}$ | $d_\gamma = 1.00$ for all $\phi$ | $i_{q(V)} = \left(1 - \frac{H}{V + A_f c_a \cot \phi}\right)^m$ | $g_{q(V)} = g_{\gamma(V)} = (1 - \tan \beta)^2$ |
| $s'_c = 0$ for strip ($B/L \approx 0$) | $k = \frac{D}{B}$ for $\frac{D}{B} \le 1$ | | **Base factors (tilted base)** |
| | $k = \tan^{-1} \frac{D}{B}$ for $\frac{D}{B} > 1$ (rad) | | $b'_c = \frac{\eta^\circ}{147^\circ}$ |
| | | | $b_c = 1 - \frac{\eta^\circ}{147^\circ}$ |
| Where $A_f$ = effective footing area $B' \times L'$ (see Fig. 4-4)<br>$c_a$ = adhesion to base = cohesion or a reduced value<br>$D$ = depth of footing in ground (used with $B$ and not $B'$)<br>$e_B, e_L$ = eccentricity of load with respect to center of footing area<br>$H$ = horizontal component of footing load with $H \le V \tan \delta + c_a A_f$<br>$V$ = total vertical load on footing<br>$\beta$ = slope of ground away from base with downward = (+)<br>$\delta$ = friction angle between base and soil—usually $\delta = \phi$ for concrete on soil<br>$\eta$ = tilt angle of base from horizontal with (+) upward as usual case | | $i_{\gamma(H)} = \left(1 - \frac{0.7H}{V + A_f c_a \cot \phi}\right)^5$ ($\eta = 0$)<br>$i_{\gamma(H)} = \left(1 - \frac{(0.7 - \eta^\circ/450)H}{V + A_f c_a \cot \phi}\right)^5$ ($\eta > 0$)<br>$i_{\gamma(V)} = \left(1 - \frac{H}{V + A_f c_a \cot \phi}\right)^{m+1}$ | $b_{q(H)} = \exp(-2\eta \tan \phi)$<br>$b_{\gamma(H)} = \exp(-2.7\eta \tan \phi)$<br>$b_{q(V)} = b_{\gamma(V)} = (1 - \eta \tan \phi)^2$<br>*Notes:* $\beta + \eta \le 90^\circ$<br>$\beta \le \phi$ |
| *General:* 1. Do not use $s_i$ in combination with $i_i$.<br>2. Can use $s_i$ in combination with $d_i$, $g_i$, and $b_i$.<br>3. For $L/B \le 2$ use $\phi_{tr}$<br>For $L/B > 2$ use $\phi_{ps} = 1.5\phi_{tr} - 17$<br>For $\phi \le 34^\circ$ use $\phi_{ps} = \phi_{tr}$ | | $m = m_B = \frac{2 + B/L}{1 + B/L}$ $H$ parallel to $B$<br>$m = m_L = \frac{2 + L/B}{1 + L/B}$ $H$ parallel to $L$<br>*Note:* $i_q, i_\gamma > 0$ |  |

| **Input Parameters** | | | **Foundation** | Tank - Hansen | |
|---|---|---|---|---|---|
| Effective Friction Angle (deg) | $\phi$ : | 32 | Footing Width (ft) | B : | 339 |
| Cohesion (psf) | c : | 100 | Footing Length (ft) | L : | 339 |
| Total Unit Weight of Soil Above Foundation (pcf) | $\gamma_{af}$ : | 120 | Footing Depth (ft) | D : | 2 |
| | | | Depth to Groundwater (ft) | $D_w$ : | 45 |
| Total Unit Weight of Soil Below Foundation (pcf) | $\gamma_{bf}$ : | 120 | Unit Weight of Water (pcf) | $\gamma_w$ : | 62.4 |
| Factor of Safety | FS : | 3 | Cohesion Reduction Factor | $f_c$ : | 0.5 |
| | | | Friction Angle Reduction Factor | $f_\phi$ : | 0.8 |

**Effective Unit Weight of Soil Above the Foundation ($\gamma_D$)**

For $D < D_w$ $\quad \gamma_D = \gamma_{af}$

For $D > D_w$ $\quad \gamma_D = \gamma_{af} - \frac{D - D_w}{D}\gamma_w$

$\gamma_D$ = 120 pcf

$q_q = \gamma_D * D$

Overburden at base of foundation: $q_q$ = 240 psf

**Effective Unit Weight of Soil Below the Foundation ($\gamma_z$)**

For $D_w < D$ $\quad \gamma_z = \gamma_{bf} - \gamma_w$

For $D_w > D + B$ $\quad \gamma_z = \gamma_{bf}$

For $D_w < D + B$ $\quad \gamma_z = (\gamma_{bf} - \gamma_w) + \frac{D_w - D}{B}\gamma_w$

$\gamma_z$ = 65.5 pcf

**Ultimate Bearing Capacity ($q_u$)**

$$q_u = cN_cS_cD_cG_c + q_qN_qS_qD_qG_q + \frac{\gamma_z B}{2}N_\gamma S_\gamma D_\gamma G_\gamma r_\gamma$$

$q_u$ = 92766 psf

Ultimate Bearing Capacity : 92,000 psf

**Allowable Static Bearing Capacity ($q_a$)**

$$q_a = \frac{cN_cS_cD_cG_c + q_qN_qS_qD_qG_q + \frac{\gamma_z B}{2}N_\gamma S_\gamma D_\gamma G_\gamma r_\gamma}{FS}$$

$q_a$ = 30922 psf

Allowable Static Bearing Capacity: 30,900 psf

**Allowable Dynamic Bearing Capacity**

$$q_{dyn} = 1\tfrac{1}{3}\, q_a$$

$q_{dyn}$ = 41229 psf

Allowable Dynamic Bearing Capacity : 41,200 psf

**Foundation** Tank - Hansen

**Bearing Capacity Factors**

$$N_c = \cot\phi(N_q - 1)$$ $N_c$ = 35.49

$$N_q = e^{\pi \tan\phi} \tan^2\left(45° + \frac{\phi}{2}\right)$$ $N_q$ = 23.18

$$N_\gamma = 1.5(N_q - 1)\tan\phi$$ $N_\gamma$ = 20.79

**Shape Factors**

$$S_c = 0.2\frac{B}{L} \quad \text{For } \phi = 0°$$

$$S_c = 1 + \frac{B}{L}\frac{N_q}{N_c} \quad \text{For } \phi > 0°$$

$$S_q = 1 + \frac{B}{L}\tan\phi$$

$$S_\gamma = 1 \quad \text{For } \phi = 0°$$

$$S_\gamma = 1 - 0.4\frac{B}{L} \quad \text{For } \phi > 0°$$

$S_c$ = 1.65

$S_q$ = 1.62

$S_\gamma$ = 0.60

**Depth Factors**

$$D_c = 0.4k \quad \text{For } \phi = 0°$$

$$D_c = 1 + 0.4k \quad \text{For } \phi > 0°$$ $D_c$ = 1.00

$$D_q = 1 + 2\tan\phi(1 - \sin\phi)^2 k$$ $D_q$ = 1.00

$$D_\gamma = 1$$ $D_\gamma$ = 1.00

$$k = \frac{D}{B} \text{ for } \frac{D}{B} \le 1 \text{ or } \tan^{-1}\left(\frac{D}{B}\right) \text{ for } \frac{D}{B} > 1 \text{ (in radians)}$$ k = 0.006

**Inclination Factors**

$G_c$ = 1.0

$G_q$ = 1.0

$G_\gamma$ = 1.0

**Foundation Width Correction**

For foundation widths less than 6 feet, $r_\gamma = 1$ $r_\gamma$ = 0.562

For foundation widths greater than 6 feet:

$$r_\gamma = 1 - \frac{\log(B/6)}{4}$$

**Reduced Soil Strength Parameters**

$$c_{red} = f_c c$$

$$\phi_{red} = \tan^{-1}(f_\phi \tan\phi)$$

$\phi_{red}$ = 26.6

$c_{red}$ = 50 psf

| | | | |
|---|---|---|---|
| $N_c$ = | 23.18 | $S_c$ = | 1.543 |
| $N_q$ = | 12.59 | $S_q$ = | 1.500 |
| $N_\gamma$ = | 8.69 | $S_\gamma$ = | 0.600 |
| $D_c$ = | 1.00 | $G_c$ = | 1.00 |
| $D_q$ = | 1.00 | $G_q$ = | 1.00 |
| $D_\gamma$ = | 1.00 | $G_\gamma$ = | 1.00 |
| | | $r_\gamma$ = | 0.562 |

**Design Bearing Capacity ($q_\Phi$)**

$$q_\Phi = cN_cS_cD_cG_c + q_qN_qS_qD_qG_q + \frac{\gamma_z B}{2}N_\gamma S_\gamma D_\gamma G_\gamma r_\gamma$$ $q_\Phi$ = 38866 psf

Design Bearing Capacity: 38,800 psf

| Input Parameters | | | Foundation | Tank - Vesic | |
|---|---|---|---|---|---|
| Effective Friction Angle (deg) | $\phi$ : | 32 | Footing Width (ft) | B : | 339 |
| Cohesion (psf) | c : | 100 | Footing Length (ft) | L : | 339 |
| Total Unit Weight of Soil Above Foundation (pcf) | $\gamma_{af}$ : | 120 | Footing Depth (ft) | D : | 2 |
| | | | Depth to Groundwater (ft) | $D_w$ : | 45 |
| Total Unit Weight of Soil Below Foundation (pcf) | $\gamma_{bf}$ : | 120 | Unit Weight of Water (pcf) | $\gamma_w$ : | 62.4 |
| Factor of Safety | FS : | 3 | Cohesion Reduction Factor | $f_c$ : | 0.5 |
| | | | Friction Angle Reduction Factor | $f_\phi$ : | 0.8 |

**Effective Unit Weight of Soil Above the Foundation ($\gamma_D$)**

For $D < D_w$ $\quad \gamma_D = \gamma_{af}$

For $D > D_w$ $\quad \gamma_D = \gamma_{af} - \frac{D - D_w}{D}\gamma_w$

$\gamma_D$ = 120 pcf

$q_q = \gamma_D * D$

Overburden at base of foundation: $q_q$ = 240 psf

**Effective Unit Weight of Soil Below the Foundation ($\gamma_z$)**

For $D_w < D$ $\quad \gamma_z = \gamma_{bf} - \gamma_w$

For $D_w > D + B$ $\quad \gamma_z = \gamma_{bf}$

For $D_w < D + B$ $\quad \gamma_z = (\gamma_{bf} - \gamma_w) + \frac{D_w - D}{B}\gamma_w$

$\gamma_z$ = 65.5 pcf

**Ultimate Bearing Capacity ($q_u$)**

$$q_u = cN_cS_cD_cG_c + q_qN_qS_qD_qG_q + \frac{\gamma_z B}{2}N_\gamma S_\gamma D_\gamma G_\gamma r_\gamma$$

$q_u$ = 128069 psf

Ultimate Bearing Capacity : 128,000 psf

**Allowable Static Bearing Capacity ($q_a$)**

$$q_a = \frac{cN_cS_cD_cG_c + q_qN_qS_qD_qG_q + \frac{\gamma_z B}{2}N_\gamma S_\gamma D_\gamma G_\gamma r_\gamma}{FS}$$

$q_a$ = 42690 psf

Allowable Static Bearing Capacity: 42,600 psf

**Allowable Dynamic Bearing Capacity**

$$q_{dyn} = 1\tfrac{1}{3}\, q_a$$

$q_{dyn}$ = 56920 psf

Allowable Dynamic Bearing Capacity : 56,900 psf

**Foundation** Tank - Vesic

**Bearing Capacity Factors**

$$N_c = \cot\phi(N_q - 1)$$

$N_c$ = 35.49

$$N_q = e^{\pi \tan\phi} \tan^2\left(45° + \frac{\phi}{2}\right)$$

$N_q$ = 23.18

$$N_\gamma = 2(N_q + 1)\tan\phi$$

$N_\gamma$ = 30.21

**Shape Factors**

$S_c = 0.2\frac{B}{L}$ For $\phi = 0°$

$S_c = 1 + \frac{B}{L}\frac{N_q}{N_c}$ For $\phi > 0°$

$S_q = 1 + \frac{B}{L}\tan\phi$

$S_\gamma = 1$ For $\phi = 0°$

$S_\gamma = 1 - 0.4\frac{B}{L}$ For $\phi > 0°$

$S_c$ = 1.65

$S_q$ = 1.62

$S_\gamma$ = 0.60

**Depth Factors**

$$D_c = 1 + 0.4k$$

$$D_q = 1 + 2\tan\phi(1 - \sin\phi)^2 k$$

$$D_\gamma = 1$$

$$k = \frac{D}{B} \text{ for } \frac{D}{B} \le 1 \text{ or } \tan^{-1}\left(\frac{D}{B}\right) \text{ for } \frac{D}{B} > 1 \text{ (in radians)}$$

$D_c$ = 1.00

$D_q$ = 1.00

$D_\gamma$ = 1.00

k = 0.006

**Inclination Factors**

$G_c$ = 1.0

$G_q$ = 1.0

$G_\gamma$ = 1.0

**Foundation Width Correction**

For foundation widths less than 6 feet, $r_\gamma$ = 1

For foundation widths greater than 6 feet:

$$r_\gamma = 1 - \frac{\log(B/6)}{4}$$

$r_\gamma$ = 0.562

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**Reduced Soil Strength Parameters**

$$c_{red} = f_c c$$

$$\phi_{red} = \tan^{-1}(f_\phi \tan\phi)$$

$\phi_{red}$ = 26.6

$c_{red}$ = 50 psf

| | |
|---|---|
| $N_c$ = 23.18 | $S_c$ = 1.543 |
| $N_q$ = 12.59 | $S_q$ = 1.500 |
| $N_\gamma$ = 13.58 | $S_\gamma$ = 0.600 |
| $D_c$ = 1.00 | $G_c$ = 1.00 |
| $D_q$ = 1.00 | $G_q$ = 1.00 |
| $D_\gamma$ = 1.00 | $G_\gamma$ = 1.00 |
| | $r_\gamma$ = 0.562 |

**Design Bearing Capacity ($q_\Phi$)**

$$q_\Phi = cN_cS_cD_cG_c + q_qN_qS_qD_qG_q + \frac{\gamma_z B}{2}N_\gamma S_\gamma D_\gamma G_\gamma r_\gamma$$

$q_\Phi$ = 57199 psf

Design Bearing Capacity: 57,100 psf

| **Input Parameters** | | | **Foundation** | Tank - Meyerhof | |
|---|---|---|---|---|---|
| Effective Friction Angle (deg) | $\phi$ : | 32 | Footing Width (ft) | B : | 339 |
| Cohesion (psf) | c : | 100 | Footing Length (ft) | L : | 339 |
| Total Unit Weight of Soil Above Foundation (pcf) | $\gamma_{af}$ : | 120 | Footing Depth (ft) | D : | 2 |
| | | | Depth to Groundwater (ft) | $D_w$ : | 45 |
| Total Unit Weight of Soil Below Foundation (pcf) | $\gamma_{bf}$ : | 120 | Unit Weight of Water (pcf) | $\gamma_w$ : | 62.4 |
| Factor of Safety | FS : | 3 | Cohesion Reduction Factor | $f_c$ : | 0.5 |
| | | | Friction Angle Reduction Factor | $f_\phi$ : | 0.8 |

**Effective Unit Weight of Soil Above the Foundation ($\gamma_D$)**

For $D < D_w$ $\quad \gamma_D = \gamma_{af}$

For $D > D_w$ $\quad \gamma_D = \gamma_{af} - \frac{D - D_w}{D}\gamma_w$

$\gamma_D$ = 120 pcf

$q_q = \gamma_D * D$

Overburden at base of foundation: $q_q$ = 240 psf

**Effective Unit Weight of Soil Below the Foundation ($\gamma_z$)**

For $D_w < D$ $\quad \gamma_z = \gamma_{bf} - \gamma_w$

For $D_w > D + B$ $\quad \gamma_z = \gamma_{bf}$

For $D_w < D + B$ $\quad \gamma_z = (\gamma_{bf} - \gamma_w) + \frac{D_w - D}{B}\gamma_w$

$\gamma_z$ = 65.5 pcf

**Ultimate Bearing Capacity ($q_u$)**

$$q_u = cN_cS_cD_cG_c + q_qN_qS_qD_qG_q + \frac{\gamma_z B}{2}N_\gamma S_\gamma D_\gamma G_\gamma r_\gamma$$

$q_u$ = 266074 psf

Ultimate Bearing Capacity : 266,000 psf

**Allowable Static Bearing Capacity ($q_a$)**

$$q_a = \frac{cN_cS_cD_cG_c + q_qN_qS_qD_qG_q + \frac{\gamma_z B}{2}N_\gamma S_\gamma D_\gamma G_\gamma r_\gamma}{FS}$$

$q_a$ = 88691 psf

Allowable Static Bearing Capacity: 88,600 psf

**Allowable Dynamic Bearing Capacity**

$$q_{dyn} = 1\tfrac{1}{3}\, q_a$$

$q_{dyn}$ = 118255 psf

Allowable Dynamic Bearing Capacity : 118,200 psf

**Foundation** Tank - Meyerhof

**Bearing Capacity Factors**

$$N_c = \cot\phi\left(N_q - 1\right)$$ $N_c = 35.49$

$$N_q = e^{\pi \tan\phi} \tan^2\left(45° + \frac{\phi}{2}\right)$$ $N_q = 23.18$

$$N_\gamma = \left(N_q - 1\right)\tan 1.4\phi$$ $N_\gamma = 22.02$

**Shape Factors**

$$S_c = 1 + 0.2\tan^2\left(45° + \frac{\phi}{2}\right)\frac{B}{L}$$ Any $\phi$ $S_c = 4.25$

$$S_q = S_\gamma = 1 + 0.1\tan^2\left(45° + \frac{\phi}{2}\right)\frac{B}{L}$$ For $\phi > 10°$ $S_q = 1.33$

$$S_q = S_\gamma = 1$$ For $\phi = 0°$ $S_\gamma = 1.33$

**Depth Factors**

$$D_c = 1 + 0.2\frac{B}{L}\sqrt{\tan^2\left(45° + \frac{\phi}{2}\right)}$$ Any $\phi$ $D_c = 2.80$

$$D_q = D_\gamma = 1 + 0.1\frac{B}{L}\sqrt{\tan^2\left(45° + \frac{\phi}{2}\right)}$$ For $\phi > 10°$ $D_q = 1.18$

$D_\gamma = 1.18$

$$D_q = D_\gamma = 1$$ For $\phi = 0°$

**Inclination Factors**

$G_c = 1.0$
$G_q = 1.0$
$G_\gamma = 1.0$

**Foundation Width Correction**

For foundation widths less than 6 feet, $r_\gamma = 1$ $r_\gamma =$ 0.562

For foundation widths greater than 6 feet:

$$r_\gamma = 1 - \frac{\log(B/6)}{4}$$

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**Reduced Soil Strength Parameters**

$$c_{red} = f_c c$$

$$\phi_{red} = \tan^{-1}\left(f_\phi \tan\phi\right)$$

$\phi_{red} =$ 26.6

$c_{red} =$ 50 psf

| | |
|---|---|
| $N_c = 23.18$ | $S_c = 3.618$ |
| $N_q = 12.59$ | $S_q = 1.262$ |
| $N_\gamma = 8.79$ | $S_\gamma = 1.262$ |
| $D_c = 2.62$ | $G_c = 1.00$ |
| $D_q = 1.16$ | $G_q = 1.00$ |
| $D_\gamma = 1.16$ | $G_\gamma = 1.00$ |
| | $r_\gamma =$ 0.562 |

**Design Bearing Capacity ($q_\Phi$)**

$$q_\Phi = cN_cS_cD_cG_c + q_qN_qS_qD_qG_q + \frac{\gamma_z B}{2}N_\gamma S_\gamma D_\gamma G_\gamma r_\gamma$$ $q_\Phi =$ 95822 psf

Design Bearing Capacity: 95,800 psf

**Appendix D – Settlement Calculation Worksheets**

SCHMERTMANN

| | | | | |
|---|---|---|---|---|
| Footing width | B = | | 382.0 | ft |
| Footing length | L = | | 382.0 | ft |
| Ground elevation | | | 281.9 | ft |
| Foundation elevation | | | 265.0 | ft |
| Ground Water elevation | | | 220.0 | ft |
| Excavated or embedded depth | D = | | 16.9 | ft |
| Depth to Groundwater | | | 61.9 | ft |
| Unit weight | $\gamma$ = | | 120.0 | pcf |
| Gross Footing Load | | | 5.10 | ksf |
| Net applied footing pressure | $\Delta p$ = | | **3.072** | ksf |
| | L/B = | | 1.00 | - |

**Z-SDU6-C01**

Immediate Settlement (in.) ($S_0$ / 2)

| | Load | $S_0$ = |
|---|---|---|
| End of Operations | 5.10 | 0.9 |
| Tank Half Full | 2.80 | 0.2 |
| Pre Closure | 5.50 | 1.1 |
| Post Closure | 8.00 | 2.2 |

30 Year Settlement (in.) ($S_{30}$ / 2)

| Load | $S_0$ = |
|---|---|
| 5.10 | 1.3 |
| 8.00 | 3.2 |

**Computation**

| | | | | |
|---|---|---|---|---|
| Settlement | $\rho_i$ = | $C_1 C_t \Delta p \Sigma(\Delta z_i I_{zi}/E_{si})$ | 0.147 | ft |
| | $\rho_i$ = | $C_t = 1$ | **1.759** | **in** |
| | S(t) = | | 0.219 | ft |
| | S(t) = | | **2.630** | **in** |
| Correction for strain relief | $C_1$ = | $1 - 0.5(\sigma'_D/q')$ | 0.670 | - |
| Effective vertical overburden pressure at D | $\sigma'_{vo}$ = | $\gamma$ D | 2.028 | ksf |
| Correction for time dependent increase | $C_t$ = | 1 + 0.2 log( t / 0.1 ) | 1.50 | - |
| | t = | | 30.00 | years |
| Elastic modulus of soil layer i | $E_{si}$ = | 2.5 $q_c$ | see Column H | if L/B = 1 |
| | $E_{si}$ = | 3.5 $q_c$ | see Column H | If L/B $\geq$ 10 |
| Depth increment i | $\Delta z_i$ | | see Column D | |
| Influence factor of soil layer i | $I_{zi}$ | Figure 3-4 | see Column G | |
| Peak depth influence factor | $I_{zp}$ = | $0.5 + 0.1 (\Delta p/\sigma'_{Izp})^{1/2}$ | 0.544 | - |
| | $z_p$ = | 0.5B + D | 207.90 | ft If L/B = 1 |
| | $z_p$ = | B + D | 398.90 | ft If L/B $\geq$ 10 |
| | $z_p$ = | | 207.90 | ft for L/B=1.00 |
| Effective overburden pressure at depth Izp | $\sigma'_{Izp}$ = | | 15.84 | ksf |
| Elastic Modulus | $E_{si}$ = | | 2.50 | $q_c$ If L/B = 1 |
| | $E_{si}$ = | | 3.50 | $q_c$ If L/B $\geq$ 10 |
| | $E_{si}$ = | | 2.50 | $q_c$ for L/B=1.00 |

Depths Below Are Relative to the Bottom of Foundation

| A | B | C | D | E | F | G | H | I | J | K |
|---|---|---|---|---|---|---|---|---|---|---|
| Layer No. | Layer top depth (ft) | Layer bottom depth (ft) | Layer thickness $\Delta z_i$ (ft) | Mid-layer depth $z_{ave}$ (ft) | Average tip stress $q_c$ (tsf) | $I_{zi}$ | Elastic modulus $E_{si}$ (ksf) | $\Delta z_i I_{zi}/E_{si}$ | $\Delta z_i I_{zi}/E_{si}$ | Notes |
| 1 | 0.0 | 1.0 | 1.0 | 0.5 | 174.3 | 0.101 | 871.3 | 0.00012 | 0.00012 | |
| 2 | 1.0 | 2.0 | 1.0 | 1.5 | 169.6 | 0.103 | 848.1 | 0.00012 | 0.00012 | |
| 3 | 2.0 | 3.0 | 1.0 | 2.5 | 143.1 | 0.106 | 715.7 | 0.00015 | 0.00015 | |
| 4 | 3.0 | 4.0 | 1.0 | 3.5 | 151.6 | 0.108 | 758.0 | 0.00014 | 0.00014 | |
| 5 | 4.0 | 5.0 | 1.0 | 4.5 | 190.3 | 0.110 | 951.7 | 0.00012 | 0.00012 | |
| 6 | 5.0 | 6.0 | 1.0 | 5.5 | 192.6 | 0.113 | 962.8 | 0.00012 | 0.00012 | |
| 7 | 6.0 | 7.0 | 1.0 | 6.5 | 132.3 | 0.115 | 661.7 | 0.00017 | 0.00017 | |
| 8 | 7.0 | 8.0 | 1.0 | 7.5 | 123.8 | 0.117 | 619.2 | 0.00019 | 0.00019 | |
| 9 | 8.0 | 9.0 | 1.0 | 8.5 | 109.0 | 0.120 | 545.2 | 0.00022 | 0.00022 | |
| 10 | 9.0 | 10.0 | 1.0 | 9.5 | 117.4 | 0.122 | 586.8 | 0.00021 | 0.00021 | |
| 11 | 10.0 | 11.0 | 1.0 | 10.5 | 124.4 | 0.124 | 621.8 | 0.00020 | 0.00020 | |
| 12 | 11.0 | 12.0 | 1.0 | 11.5 | 109.3 | 0.127 | 546.6 | 0.00023 | 0.00023 | |
| 13 | 12.0 | 13.0 | 1.0 | 12.5 | 111.7 | 0.129 | 558.5 | 0.00023 | 0.00023 | |
| 14 | 13.0 | 14.0 | 1.0 | 13.5 | 127.6 | 0.131 | 638.2 | 0.00021 | 0.00021 | |
| 15 | 14.0 | 15.0 | 1.0 | 14.5 | 134.9 | 0.134 | 674.4 | 0.00020 | 0.00020 | |
| 16 | 15.0 | 16.0 | 1.0 | 15.5 | 142.0 | 0.136 | 709.8 | 0.00019 | 0.00019 | |
| 17 | 16.0 | 17.0 | 1.0 | 16.5 | 145.4 | 0.138 | 727.2 | 0.00019 | 0.00019 | |
| 18 | 17.0 | 18.0 | 1.0 | 17.5 | 131.5 | 0.141 | 657.6 | 0.00021 | 0.00021 | |
| 19 | 18.0 | 19.0 | 1.0 | 18.5 | 144.5 | 0.143 | 722.4 | 0.00020 | 0.00020 | |
| 20 | 19.0 | 20.0 | 1.0 | 19.5 | 176.0 | 0.145 | 879.9 | 0.00017 | 0.00017 | |
| 21 | 20.0 | 21.0 | 1.0 | 20.5 | 147.9 | 0.148 | 739.6 | 0.00020 | 0.00020 | |
| 22 | 21.0 | 22.0 | 1.0 | 21.5 | 155.2 | 0.150 | 775.8 | 0.00019 | 0.00019 | |
| 23 | 22.0 | 23.0 | 1.0 | 22.5 | 326.7 | 0.152 | 1633.7 | 0.00009 | 0.00009 | |
| 24 | 23.0 | 24.0 | 1.0 | 23.5 | 343.7 | 0.155 | 1718.4 | 0.00009 | 0.00009 | |
| 25 | 24.0 | 25.0 | 1.0 | 24.5 | 337.1 | 0.157 | 1685.5 | 0.00009 | 0.00009 | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 26 | 25.0 | 26.0 | 1.0 | 25.5 | 342.7 | 0.159 | 1713.7 | 0.00009 | 0.00009 |
| 27 | 26.0 | 27.0 | 1.0 | 26.5 | 362.2 | 0.162 | 1811.0 | 0.00009 | 0.00009 |
| 28 | 27.0 | 28.0 | 1.0 | 27.5 | 365.1 | 0.164 | 1825.4 | 0.00009 | 0.00009 |
| 29 | 28.0 | 29.0 | 1.0 | 28.5 | 382.3 | 0.166 | 1911.5 | 0.00009 | 0.00009 |
| 30 | 29.0 | 30.0 | 1.0 | 29.5 | 327.5 | 0.169 | 1637.7 | 0.00010 | 0.00010 |
| 31 | 30.0 | 31.0 | 1.0 | 30.5 | 240.2 | 0.171 | 1200.8 | 0.00014 | 0.00014 |
| 32 | 31.0 | 32.0 | 1.0 | 31.5 | 57.6 | 0.173 | 288.1 | 0.00060 | 0.00060 |
| 33 | 32.0 | 33.0 | 1.0 | 32.5 | 111.0 | 0.176 | 554.8 | 0.00032 | 0.00032 |
| 34 | 33.0 | 34.0 | 1.0 | 33.5 | 71.6 | 0.178 | 357.9 | 0.00050 | 0.00050 |
| 35 | 34.0 | 35.0 | 1.0 | 34.5 | 101.4 | 0.180 | 506.9 | 0.00036 | 0.00036 |
| 36 | 35.0 | 36.0 | 1.0 | 35.5 | 140.5 | 0.183 | 702.5 | 0.00026 | 0.00026 |
| 37 | 36.0 | 37.0 | 1.0 | 36.5 | 55.6 | 0.185 | 277.9 | 0.00067 | 0.00067 |
| 38 | 37.0 | 38.0 | 1.0 | 37.5 | 75.6 | 0.187 | 378.2 | 0.00049 | 0.00049 |
| 39 | 38.0 | 39.0 | 1.0 | 38.5 | 147.9 | 0.190 | 739.7 | 0.00026 | 0.00026 |
| 40 | 39.0 | 40.0 | 1.0 | 39.5 | 199.3 | 0.192 | 996.3 | 0.00019 | 0.00019 |
| 41 | 40.0 | 41.0 | 1.0 | 40.5 | 244.8 | 0.194 | 1224.0 | 0.00016 | 0.00016 |
| 42 | 41.0 | 42.0 | 1.0 | 41.5 | 157.9 | 0.196 | 789.5 | 0.00025 | 0.00025 |
| 43 | 42.0 | 43.0 | 1.0 | 42.5 | 104.5 | 0.199 | 522.7 | 0.00038 | 0.00038 |
| 44 | 43.0 | 44.0 | 1.0 | 43.5 | 202.5 | 0.201 | 1012.5 | 0.00020 | 0.00020 |
| 45 | 44.0 | 45.0 | 1.0 | 44.5 | 281.3 | 0.203 | 1406.7 | 0.00014 | 0.00014 |
| 46 | 45.0 | 46.0 | 1.0 | 45.5 | 263.0 | 0.206 | 1315.0 | 0.00016 | 0.00016 |
| 47 | 46.0 | 47.0 | 1.0 | 46.5 | 175.2 | 0.208 | 876.0 | 0.00024 | 0.00024 |
| 48 | 47.0 | 48.0 | 1.0 | 47.5 | 179.1 | 0.210 | 895.5 | 0.00023 | 0.00023 |
| 49 | 48.0 | 49.0 | 1.0 | 48.5 | 176.7 | 0.213 | 883.5 | 0.00024 | 0.00024 |
| 50 | 49.0 | 50.0 | 1.0 | 49.5 | 124.5 | 0.215 | 622.5 | 0.00035 | 0.00035 |
| 51 | 50.0 | 51.0 | 1.0 | 50.5 | 132.3 | 0.217 | 661.4 | 0.00033 | 0.00033 |
| 52 | 51.0 | 52.0 | 1.0 | 51.5 | 119.8 | 0.220 | 598.9 | 0.00037 | 0.00037 |
| 53 | 52.0 | 53.0 | 1.0 | 52.5 | 126.6 | 0.222 | 632.9 | 0.00035 | 0.00035 |
| 54 | 53.0 | 54.0 | 1.0 | 53.5 | 187.9 | 0.224 | 939.5 | 0.00024 | 0.00024 |
| 55 | 54.0 | 55.0 | 1.0 | 54.5 | 193.3 | 0.227 | 966.4 | 0.00023 | 0.00023 |
| 56 | 55.0 | 56.0 | 1.0 | 55.5 | 199.8 | 0.229 | 998.9 | 0.00023 | 0.00023 |
| 57 | 56.0 | 57.0 | 1.0 | 56.5 | 205.7 | 0.231 | 1028.6 | 0.00022 | 0.00022 |
| 58 | 57.0 | 58.0 | 1.0 | 57.5 | 185.9 | 0.234 | 929.3 | 0.00025 | 0.00025 |
| 59 | 58.0 | 59.0 | 1.0 | 58.5 | 157.4 | 0.236 | 787.2 | 0.00030 | 0.00030 |
| 60 | 59.0 | 60.0 | 1.0 | 59.5 | 132.6 | 0.238 | 663.2 | 0.00036 | 0.00036 |
| 61 | 60.0 | 61.0 | 1.0 | 60.5 | 105.7 | 0.241 | 528.4 | 0.00046 | 0.00046 |
| 62 | 61.0 | 62.0 | 1.0 | 61.5 | 87.5 | 0.243 | 437.7 | 0.00056 | 0.00056 |
| 63 | 62.0 | 63.0 | 1.0 | 62.5 | 59.0 | 0.245 | 295.0 | 0.00083 | 0.00083 |
| 64 | 63.0 | 64.0 | 1.0 | 63.5 | 27.3 | 0.248 | 136.3 | 0.00182 | 0.00182 |
| 65 | 64.0 | 65.0 | 1.0 | 64.5 | 15.8 | 0.250 | 78.8 | 0.00317 | 0.00317 |
| 66 | 65.0 | 66.0 | 1.0 | 65.5 | 12.1 | 0.252 | 60.4 | 0.00418 | 0.00418 |
| 67 | 66.0 | 67.0 | 1.0 | 66.5 | 51.1 | 0.255 | 255.7 | 0.00100 | 0.00100 |
| 68 | 67.0 | 68.0 | 1.0 | 67.5 | 117.3 | 0.257 | 586.4 | 0.00044 | 0.00044 |
| 69 | 68.0 | 69.0 | 1.0 | 68.5 | 224.7 | 0.259 | 1123.4 | 0.00023 | 0.00023 |
| 70 | 69.0 | 70.0 | 1.0 | 69.5 | 195.2 | 0.262 | 975.9 | 0.00027 | 0.00027 |
| 71 | 70.0 | 71.0 | 1.0 | 70.5 | 178.8 | 0.264 | 894.0 | 0.00030 | 0.00030 |
| 72 | 71.0 | 72.0 | 1.0 | 71.5 | 73.9 | 0.266 | 369.7 | 0.00072 | 0.00072 |
| 73 | 72.0 | 73.0 | 1.0 | 72.5 | 13.8 | 0.269 | 68.8 | 0.00390 | 0.00390 |
| 74 | 73.0 | 74.0 | 1.0 | 73.5 | 17.2 | 0.271 | 86.2 | 0.00314 | 0.00314 |
| 75 | 74.0 | 75.0 | 1.0 | 74.5 | 68.1 | 0.273 | 340.3 | 0.00080 | 0.00080 |
| 76 | 75.0 | 76.0 | 1.0 | 75.5 | 51.3 | 0.276 | 256.5 | 0.00107 | 0.00107 |
| 77 | 76.0 | 77.0 | 1.0 | 76.5 | 22.4 | 0.278 | 112.1 | 0.00248 | 0.00248 |
| 78 | 77.0 | 78.0 | 1.0 | 77.5 | 16.0 | 0.280 | 80.0 | 0.00350 | 0.00350 |
| 79 | 78.0 | 79.0 | 1.0 | 78.5 | 13.4 | 0.282 | 66.8 | 0.00423 | 0.00423 |
| 80 | 79.0 | 80.0 | 1.0 | 79.5 | 35.3 | 0.285 | 176.5 | 0.00161 | 0.00161 |
| 81 | 80.0 | 81.0 | 1.0 | 80.5 | 163.8 | 0.287 | 818.8 | 0.00035 | 0.00035 |
| 82 | 81.0 | 82.0 | 1.0 | 81.5 | 181.6 | 0.289 | 907.9 | 0.00032 | 0.00032 |
| 83 | 82.0 | 83.0 | 1.0 | 82.5 | 163.1 | 0.292 | 815.3 | 0.00036 | 0.00036 |
| 84 | 83.0 | 84.0 | 1.0 | 83.5 | 131.7 | 0.294 | 658.5 | 0.00045 | 0.00045 |
| 85 | 84.0 | 85.0 | 1.0 | 84.5 | 171.8 | 0.296 | 859.0 | 0.00035 | 0.00035 |
| 86 | 85.0 | 86.0 | 1.0 | 85.5 | 139.6 | 0.299 | 698.1 | 0.00043 | 0.00043 |
| 87 | 86.0 | 87.0 | 1.0 | 86.5 | 107.2 | 0.301 | 536.2 | 0.00056 | 0.00056 |
| 88 | 87.0 | 88.0 | 1.0 | 87.5 | 142.6 | 0.303 | 713.2 | 0.00043 | 0.00043 |
| 89 | 88.0 | 89.0 | 1.0 | 88.5 | 159.0 | 0.306 | 795.1 | 0.00038 | 0.00038 |
| 90 | 89.0 | 90.0 | 1.0 | 89.5 | 101.7 | 0.308 | 508.4 | 0.00061 | 0.00061 |
| 91 | 90.0 | 91.0 | 1.0 | 90.5 | 113.9 | 0.310 | 569.7 | 0.00054 | 0.00054 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 92 | 91.0 | 92.0 | 1.0 | 91.5 | 128.0 | 0.313 | 639.8 | 0.00049 | 0.00049 | |
| 93 | 92.0 | 93.0 | 1.0 | 92.5 | 132.8 | 0.315 | 663.8 | 0.00047 | 0.00047 | |
| 94 | 93.0 | 94.0 | 1.0 | 93.5 | 201.8 | 0.317 | 1009.1 | 0.00031 | 0.00031 | |
| 95 | 94.0 | 95.0 | 1.0 | 94.5 | 142.9 | 0.320 | 714.4 | 0.00045 | 0.00045 | |
| 96 | 95.0 | 96.0 | 1.0 | 95.5 | 118.3 | 0.322 | 591.6 | 0.00054 | 0.00054 | |
| 97 | 96.0 | 97.0 | 1.0 | 96.5 | 115.9 | 0.324 | 579.7 | 0.00056 | 0.00056 | |
| 98 | 97.0 | 98.0 | 1.0 | 97.5 | 111.7 | 0.327 | 558.5 | 0.00058 | 0.00058 | |
| 99 | 98.0 | 99.0 | 1.0 | 98.5 | 93.3 | 0.329 | 466.7 | 0.00070 | 0.00070 | |
| 100 | 99.0 | 100.0 | 1.0 | 99.5 | 131.0 | 0.331 | 655.2 | 0.00051 | 0.00051 | |
| 101 | 100.0 | 101.0 | 1.0 | 100.5 | 199.1 | 0.334 | 995.3 | 0.00034 | 0.00034 | |
| 102 | 101.0 | 102.0 | 1.0 | 101.5 | 210.6 | 0.336 | 1053.0 | 0.00032 | 0.00032 | |
| 103 | 102.0 | 103.0 | 1.0 | 102.5 | 167.6 | 0.338 | 837.8 | 0.00040 | 0.00040 | |
| 104 | 103.0 | 104.0 | 1.0 | 103.5 | 117.9 | 0.341 | 589.5 | 0.00058 | 0.00058 | |
| 105 | 104.0 | 105.0 | 1.0 | 104.5 | 71.2 | 0.343 | 356.1 | 0.00096 | 0.00096 | |
| 106 | 105.0 | 106.0 | 1.0 | 105.5 | 84.2 | 0.345 | 421.0 | 0.00082 | 0.00082 | |
| 107 | 106.0 | 107.0 | 1.0 | 106.5 | 82.8 | 0.348 | 414.1 | 0.00084 | 0.00084 | |
| 108 | 107.0 | 108.0 | 1.0 | 107.5 | 85.5 | 0.350 | 427.5 | 0.00082 | 0.00082 | |
| 109 | 108.0 | 109.0 | 1.0 | 108.5 | 87.7 | 0.352 | 438.7 | 0.00080 | 0.00080 | |
| 110 | 109.0 | 110.0 | 1.0 | 109.5 | 71.5 | 0.355 | 357.6 | 0.00099 | 0.00099 | |
| 111 | 110.0 | 111.0 | 1.0 | 110.5 | 60.5 | 0.357 | 302.6 | 0.00118 | 0.00118 | |
| 112 | 111.0 | 112.0 | 1.0 | 111.5 | 64.9 | 0.359 | 324.4 | 0.00111 | 0.00111 | |
| 113 | 112.0 | 113.0 | 1.0 | 112.5 | 62.6 | 0.362 | 313.2 | 0.00115 | 0.00115 | |
| 114 | 113.0 | 114.0 | 1.0 | 113.5 | 70.2 | 0.364 | 351.0 | 0.00104 | 0.00104 | |
| 115 | 114.0 | 115.0 | 1.0 | 114.5 | 80.1 | 0.366 | 400.6 | 0.00091 | 0.00091 | |
| 116 | 115.0 | 116.0 | 1.0 | 115.5 | 191.7 | 0.369 | 958.5 | 0.00038 | 0.00038 | |
| 117 | 116.0 | 117.0 | 1.0 | 116.5 | 204.5 | 0.371 | 1022.4 | 0.00036 | 0.00036 | |
| 118 | 117.0 | 118.0 | 1.0 | 117.5 | 508.1 | 0.373 | 2540.5 | 0.00015 | 0.00015 | |
| 119 | 118.0 | 119.0 | 1.0 | 118.5 | 621.5 | 0.375 | 3107.7 | 0.00012 | 0.00012 | |
| 120 | 119.0 | 120.0 | 1.0 | 119.5 | 668.1 | 0.378 | 3340.6 | 0.00011 | 0.00011 | |
| Σ = | | | | | | | | | 0.07121 | |

$I_{zr}$ (1 < L/B < 10): $I_{zr} = I_{zs} + 0.111 (I_{zc} - I_{zs}) (L/B - 1)$

$I_{zs}$ (L/B = 1):

For $z_{ave}$ = 0 to B/2: $I_{zs} = 0.1 + (z_{ave}/B)(2I_{zp} - 0.2)$

For $z_{ave}$ = B/2 to 2B: $I_{zs} = 0.667\, I_{zp} (2 - z_{ave}/B)$

$I_{zc}$ ($L/B \geq 10$):

For $z_{ave}$ = 0 to B: $I_{zc} = 0.2 + (z_{ave}/B)(I_{zp} - 0.2)$

For $z_{ave}$ = B to 4B: $I_{zc} = 0.333\, I_{zp} (4 - z_{ave}/B)$ ( Coduto p.228. )

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Footing width | B = | | 382.0 | ft | Z-SDU6-C02 | | | |
| Footing length | L = | | 382.0 | ft | | | Immediate | |
| Ground elevation | | | 281.4 | ft | | | Settlement (in.) | |
| Foundation elevation | | | 265.0 | ft | | | ($S_0$ / 2) | |
| Ground Water elevation | | | 220.0 | ft | | Load | | $S_0$ = |
| Excavated or embedded depth | D = | | 16.4 | ft | End of Operations | 5.10 | | 0.7 |
| Depth to Groundwater | | | 61.4 | ft | Tank Half Full | 2.80 | | 0.1 |
| Unit weight | $\gamma$ = | | 120.0 | pcf | Pre Closure | 5.50 | | 0.9 |
| Gross Footing Load | | | 5.10 | ksf | Post Closure | 8.00 | | 1.8 |
| Net applied footing pressure | $\Delta p$ = | | **3.132** | ksf | | | | |
| | L/B = | | 1.00 | - | | | | |
| | | | | | | | 30 Year | |
| **Computation** | | | | | | | Settlement (in.) | |
| Settlement | $\rho_i$ = | $C_1 C_t \Delta p \Sigma(\Delta z_i I_{zi}/E_{si})$ | 0.123 | ft | | | ($S_{30}$ / 2) | |
| | $\rho_i$ = | $C_t$ = 1 | **1.471** | **in** | | Load | | $S_0$ = |
| | S(t) = | | 0.183 | ft | | 5.10 | | 1.1 |
| | S(t) = | | **2.200** | **in** | | 8.00 | | 2.6 |
| Correction for strain relief | $C_1$ = | 1 - 0.5($\sigma'_D$/q') | 0.686 | - | | | | |
| Effective vertical overburden pressure at D | $\sigma'_{vo}$ = | $\gamma$ D | 1.968 | ksf | | | | |
| Correction for time dependent increase | $C_t$ = | 1 + 0.2 log( t / 0.1 ) | 1.50 | - | | | | |
| | t = | | 30.00 | years | | | | |
| Elastic modulus of soil layer i | $E_{si}$ = | 2.5 $q_c$ | see | Column H | if L/B = 1 | | | |
| | $E_{si}$ = | 3.5 $q_c$ | see | Column H | If L/B $\geq$ 10 | | | |
| Depth increment i | $\Delta z_i$ | | see | Column D | | | | |
| Influence factor of soil layer i | $I_{zi}$ | Figure 3-4 | see | Column G | | | | |
| Peak depth influence factor | $I_{zp}$ = | 0.5 + 0.1 ($\Delta p/\sigma'_{Izp}$)$^{1/2}$ | 0.545 | - | | | | |
| | $z_p$ = | 0.5B + D | 207.40 | ft | If L/B = 1 | | | |
| | $z_p$ = | B + D | 398.40 | ft | If L/B $\geq$ 10 | | | |
| | $z_p$ = | | 207.40 | ft | for L/B=1.00 | | | |
| Effective overburden pressure at depth Izp | $\sigma'_{Izp}$ = | | 15.78 | ksf | | | | |
| Elastic Modulus | $E_{si}$ = | | 2.50 | $q_c$ | If L/B = 1 | | | |
| | $E_{si}$ = | | 3.50 | $q_c$ | If L/B $\geq$ 10 | | | |
| | $E_{si}$ = | | 2.50 | $q_c$ | for L/B=1.00 | | | |

Computations made relative to the bottom of foundation

| A | B | C | D | E | F | G | H | I | J | K |
|---|---|---|---|---|---|---|---|---|---|---|
| Layer No. | Layer top depth (ft) | Layer bottom depth (ft) | Layer thickness $\Delta z_i$ (ft) | Mid-layer depth $z_{ave}$ (ft) | Average tip stress $q_c$ (tsf) | $I_{zi}$ | Elastic modulus $E_{si}$ (ksf) | $\Delta z_i I_{zi}/E_{si}$ | $\Delta z_i I_{zi}/E_{si}$ | Notes |
| 1 | 0.0 | 1.0 | 1.0 | 0.5 | 107.6 | 0.101 | 537.9 | 0.00019 | 0.00019 | |
| 2 | 1.0 | 2.0 | 1.0 | 1.5 | 111.0 | 0.103 | 555.1 | 0.00019 | 0.00019 | |
| 3 | 2.0 | 3.0 | 1.0 | 2.5 | 123.8 | 0.106 | 619.2 | 0.00017 | 0.00017 | |
| 4 | 3.0 | 4.0 | 1.0 | 3.5 | 141.2 | 0.108 | 706.0 | 0.00015 | 0.00015 | |
| 5 | 4.0 | 5.0 | 1.0 | 4.5 | 143.9 | 0.110 | 719.7 | 0.00015 | 0.00015 | |
| 6 | 5.0 | 6.0 | 1.0 | 5.5 | 123.5 | 0.113 | 617.4 | 0.00018 | 0.00018 | |
| 7 | 6.0 | 7.0 | 1.0 | 6.5 | 119.0 | 0.115 | 594.9 | 0.00019 | 0.00019 | |
| 8 | 7.0 | 8.0 | 1.0 | 7.5 | 127.6 | 0.117 | 638.1 | 0.00018 | 0.00018 | |
| 9 | 8.0 | 9.0 | 1.0 | 8.5 | 133.0 | 0.120 | 664.8 | 0.00018 | 0.00018 | |
| 10 | 9.0 | 10.0 | 1.0 | 9.5 | 126.8 | 0.122 | 633.8 | 0.00019 | 0.00019 | |
| 11 | 10.0 | 11.0 | 1.0 | 10.5 | 119.3 | 0.124 | 596.5 | 0.00021 | 0.00021 | |
| 12 | 11.0 | 12.0 | 1.0 | 11.5 | 123.6 | 0.127 | 618.2 | 0.00021 | 0.00021 | |
| 13 | 12.0 | 13.0 | 1.0 | 12.5 | 135.7 | 0.129 | 678.4 | 0.00019 | 0.00019 | |
| 14 | 13.0 | 14.0 | 1.0 | 13.5 | 122.7 | 0.131 | 613.4 | 0.00021 | 0.00021 | |
| 15 | 14.0 | 15.0 | 1.0 | 14.5 | 120.4 | 0.134 | 601.9 | 0.00022 | 0.00022 | |
| 16 | 15.0 | 16.0 | 1.0 | 15.5 | 136.8 | 0.136 | 683.8 | 0.00020 | 0.00020 | |
| 17 | 16.0 | 17.0 | 1.0 | 16.5 | 147.0 | 0.138 | 734.8 | 0.00019 | 0.00019 | |
| 18 | 17.0 | 18.0 | 1.0 | 17.5 | 176.0 | 0.141 | 880.2 | 0.00016 | 0.00016 | |
| 19 | 18.0 | 19.0 | 1.0 | 18.5 | 196.9 | 0.143 | 984.7 | 0.00015 | 0.00015 | |
| 20 | 19.0 | 20.0 | 1.0 | 19.5 | 197.8 | 0.145 | 988.9 | 0.00015 | 0.00015 | |
| 21 | 20.0 | 21.0 | 1.0 | 20.5 | 211.8 | 0.148 | 1058.9 | 0.00014 | 0.00014 | |
| 22 | 21.0 | 22.0 | 1.0 | 21.5 | 268.0 | 0.150 | 1339.9 | 0.00011 | 0.00011 | |
| 23 | 22.0 | 23.0 | 1.0 | 22.5 | 242.5 | 0.152 | 1212.5 | 0.00013 | 0.00013 | |
| 24 | 23.0 | 24.0 | 1.0 | 23.5 | 237.4 | 0.155 | 1186.9 | 0.00013 | 0.00013 | |
| 25 | 24.0 | 25.0 | 1.0 | 24.5 | 253.8 | 0.157 | 1269.1 | 0.00012 | 0.00012 | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 26 | 25.0 | 26.0 | 1.0 | 25.5 | 243.3 | 0.159 | 1216.6 | 0.00013 | 0.00013 |
| 27 | 26.0 | 27.0 | 1.0 | 26.5 | 241.4 | 0.162 | 1206.9 | 0.00013 | 0.00013 |
| 28 | 27.0 | 28.0 | 1.0 | 27.5 | 279.8 | 0.164 | 1398.9 | 0.00012 | 0.00012 |
| 29 | 28.0 | 29.0 | 1.0 | 28.5 | 356.0 | 0.166 | 1779.8 | 0.00009 | 0.00009 |
| 30 | 29.0 | 30.0 | 1.0 | 29.5 | 322.7 | 0.169 | 1613.6 | 0.00010 | 0.00010 |
| 31 | 30.0 | 31.0 | 1.0 | 30.5 | 177.0 | 0.171 | 885.2 | 0.00019 | 0.00019 |
| 32 | 31.0 | 32.0 | 1.0 | 31.5 | 74.3 | 0.173 | 371.7 | 0.00047 | 0.00047 |
| 33 | 32.0 | 33.0 | 1.0 | 32.5 | 91.4 | 0.176 | 457.1 | 0.00038 | 0.00038 |
| 34 | 33.0 | 34.0 | 1.0 | 33.5 | 96.6 | 0.178 | 483.1 | 0.00037 | 0.00037 |
| 35 | 34.0 | 35.0 | 1.0 | 34.5 | 134.8 | 0.180 | 673.9 | 0.00027 | 0.00027 |
| 36 | 35.0 | 36.0 | 1.0 | 35.5 | 103.1 | 0.183 | 515.4 | 0.00035 | 0.00035 |
| 37 | 36.0 | 37.0 | 1.0 | 36.5 | 69.1 | 0.185 | 345.4 | 0.00054 | 0.00054 |
| 38 | 37.0 | 38.0 | 1.0 | 37.5 | 176.6 | 0.187 | 883.2 | 0.00021 | 0.00021 |
| 39 | 38.0 | 39.0 | 1.0 | 38.5 | 195.4 | 0.190 | 976.9 | 0.00019 | 0.00019 |
| 40 | 39.0 | 40.0 | 1.0 | 39.5 | 232.9 | 0.192 | 1164.4 | 0.00016 | 0.00016 |
| 41 | 40.0 | 41.0 | 1.0 | 40.5 | 252.6 | 0.194 | 1262.8 | 0.00015 | 0.00015 |
| 42 | 41.0 | 42.0 | 1.0 | 41.5 | 244.4 | 0.197 | 1222.1 | 0.00016 | 0.00016 |
| 43 | 42.0 | 43.0 | 1.0 | 42.5 | 242.5 | 0.199 | 1212.3 | 0.00016 | 0.00016 |
| 44 | 43.0 | 44.0 | 1.0 | 43.5 | 229.8 | 0.201 | 1149.2 | 0.00018 | 0.00018 |
| 45 | 44.0 | 45.0 | 1.0 | 44.5 | 115.0 | 0.204 | 575.0 | 0.00035 | 0.00035 |
| 46 | 45.0 | 46.0 | 1.0 | 45.5 | 139.9 | 0.206 | 699.6 | 0.00029 | 0.00029 |
| 47 | 46.0 | 47.0 | 1.0 | 46.5 | 289.1 | 0.208 | 1445.6 | 0.00014 | 0.00014 |
| 48 | 47.0 | 48.0 | 1.0 | 47.5 | 271.6 | 0.211 | 1358.0 | 0.00016 | 0.00016 |
| 49 | 48.0 | 49.0 | 1.0 | 48.5 | 236.9 | 0.213 | 1184.5 | 0.00018 | 0.00018 |
| 50 | 49.0 | 50.0 | 1.0 | 49.5 | 190.8 | 0.215 | 954.0 | 0.00023 | 0.00023 |
| 51 | 50.0 | 51.0 | 1.0 | 50.5 | 146.0 | 0.218 | 730.1 | 0.00030 | 0.00030 |
| 52 | 51.0 | 52.0 | 1.0 | 51.5 | 122.7 | 0.220 | 613.7 | 0.00036 | 0.00036 |
| 53 | 52.0 | 53.0 | 1.0 | 52.5 | 221.3 | 0.222 | 1106.7 | 0.00020 | 0.00020 |
| 54 | 53.0 | 54.0 | 1.0 | 53.5 | 257.7 | 0.225 | 1288.5 | 0.00017 | 0.00017 |
| 55 | 54.0 | 55.0 | 1.0 | 54.5 | 258.8 | 0.227 | 1293.8 | 0.00018 | 0.00018 |
| 56 | 55.0 | 56.0 | 1.0 | 55.5 | 246.8 | 0.229 | 1234.1 | 0.00019 | 0.00019 |
| 57 | 56.0 | 57.0 | 1.0 | 56.5 | 218.3 | 0.232 | 1091.6 | 0.00021 | 0.00021 |
| 58 | 57.0 | 58.0 | 1.0 | 57.5 | 153.9 | 0.234 | 769.7 | 0.00030 | 0.00030 |
| 59 | 58.0 | 59.0 | 1.0 | 58.5 | 99.4 | 0.236 | 497.0 | 0.00048 | 0.00048 |
| 60 | 59.0 | 60.0 | 1.0 | 59.5 | 49.5 | 0.238 | 247.6 | 0.00096 | 0.00096 |
| 61 | 60.0 | 61.0 | 1.0 | 60.5 | 40.5 | 0.241 | 202.5 | 0.00119 | 0.00119 |
| 62 | 61.0 | 62.0 | 1.0 | 61.5 | 10.8 | 0.243 | 53.9 | 0.00451 | 0.00451 |
| 63 | 62.0 | 63.0 | 1.0 | 62.5 | 32.5 | 0.245 | 162.3 | 0.00151 | 0.00151 |
| 64 | 63.0 | 64.0 | 1.0 | 63.5 | 119.2 | 0.248 | 596.2 | 0.00042 | 0.00042 |
| 65 | 64.0 | 65.0 | 1.0 | 64.5 | 240.6 | 0.250 | 1202.9 | 0.00021 | 0.00021 |
| 66 | 65.0 | 66.0 | 1.0 | 65.5 | 373.2 | 0.252 | 1866.2 | 0.00014 | 0.00014 |
| 67 | 66.0 | 67.0 | 1.0 | 66.5 | 352.2 | 0.255 | 1761.1 | 0.00014 | 0.00014 |
| 68 | 67.0 | 68.0 | 1.0 | 67.5 | 303.5 | 0.257 | 1517.7 | 0.00017 | 0.00017 |
| 69 | 68.0 | 69.0 | 1.0 | 68.5 | 264.6 | 0.259 | 1323.0 | 0.00020 | 0.00020 |
| 70 | 69.0 | 70.0 | 1.0 | 69.5 | 106.1 | 0.262 | 530.4 | 0.00049 | 0.00049 |
| 71 | 70.0 | 71.0 | 1.0 | 70.5 | 23.3 | 0.264 | 116.5 | 0.00227 | 0.00227 |
| 72 | 71.0 | 72.0 | 1.0 | 71.5 | 28.5 | 0.266 | 142.5 | 0.00187 | 0.00187 |
| 73 | 72.0 | 73.0 | 1.0 | 72.5 | 46.8 | 0.269 | 233.8 | 0.00115 | 0.00115 |
| 74 | 73.0 | 74.0 | 1.0 | 73.5 | 33.3 | 0.271 | 166.3 | 0.00163 | 0.00163 |
| 75 | 74.0 | 75.0 | 1.0 | 74.5 | 43.6 | 0.273 | 217.8 | 0.00126 | 0.00126 |
| 76 | 75.0 | 76.0 | 1.0 | 75.5 | 118.6 | 0.276 | 593.1 | 0.00046 | 0.00046 |
| 77 | 76.0 | 77.0 | 1.0 | 76.5 | 80.9 | 0.278 | 404.3 | 0.00069 | 0.00069 |
| 78 | 77.0 | 78.0 | 1.0 | 77.5 | 75.5 | 0.280 | 377.7 | 0.00074 | 0.00074 |
| 79 | 78.0 | 79.0 | 1.0 | 78.5 | 43.8 | 0.283 | 218.9 | 0.00129 | 0.00129 |
| 80 | 79.0 | 80.0 | 1.0 | 79.5 | 138.3 | 0.285 | 691.3 | 0.00041 | 0.00041 |
| 81 | 80.0 | 81.0 | 1.0 | 80.5 | 117.1 | 0.287 | 585.5 | 0.00049 | 0.00049 |
| 82 | 81.0 | 82.0 | 1.0 | 81.5 | 181.6 | 0.290 | 907.9 | 0.00032 | 0.00032 |
| 83 | 82.0 | 83.0 | 1.0 | 82.5 | 163.1 | 0.292 | 815.3 | 0.00036 | 0.00036 |
| 84 | 83.0 | 84.0 | 1.0 | 83.5 | 131.7 | 0.294 | 658.5 | 0.00045 | 0.00045 |
| 85 | 84.0 | 85.0 | 1.0 | 84.5 | 171.8 | 0.297 | 859.0 | 0.00035 | 0.00035 |
| 86 | 85.0 | 86.0 | 1.0 | 85.5 | 139.6 | 0.299 | 698.1 | 0.00043 | 0.00043 |
| 87 | 86.0 | 87.0 | 1.0 | 86.5 | 107.2 | 0.301 | 536.2 | 0.00056 | 0.00056 |
| 88 | 87.0 | 88.0 | 1.0 | 87.5 | 142.6 | 0.304 | 713.2 | 0.00043 | 0.00043 |
| 89 | 88.0 | 89.0 | 1.0 | 88.5 | 159.0 | 0.306 | 795.1 | 0.00038 | 0.00038 |
| 90 | 89.0 | 90.0 | 1.0 | 89.5 | 101.7 | 0.308 | 508.4 | 0.00061 | 0.00061 |
| 91 | 90.0 | 91.0 | 1.0 | 90.5 | 113.9 | 0.311 | 569.7 | 0.00055 | 0.00055 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 92 | 91.0 | 92.0 | 1.0 | 91.5 | 128.0 | 0.313 | 639.8 | 0.00049 | 0.00049 | |
| 93 | 92.0 | 93.0 | 1.0 | 92.5 | 132.8 | 0.315 | 663.8 | 0.00047 | 0.00047 | |
| 94 | 93.0 | 94.0 | 1.0 | 93.5 | 201.8 | 0.318 | 1009.1 | 0.00031 | 0.00031 | |
| 95 | 94.0 | 95.0 | 1.0 | 94.5 | 142.9 | 0.320 | 714.4 | 0.00045 | 0.00045 | |
| 96 | 95.0 | 96.0 | 1.0 | 95.5 | 118.3 | 0.322 | 591.6 | 0.00054 | 0.00054 | |
| 97 | 96.0 | 97.0 | 1.0 | 96.5 | 115.9 | 0.325 | 579.7 | 0.00056 | 0.00056 | |
| 98 | 97.0 | 98.0 | 1.0 | 97.5 | 111.7 | 0.327 | 558.5 | 0.00059 | 0.00059 | |
| 99 | 98.0 | 99.0 | 1.0 | 98.5 | 93.3 | 0.329 | 466.7 | 0.00071 | 0.00071 | |
| 100 | 99.0 | 100.0 | 1.0 | 99.5 | 131.0 | 0.332 | 655.2 | 0.00051 | 0.00051 | |
| 101 | 100.0 | 101.0 | 1.0 | 100.5 | 199.1 | 0.334 | 995.3 | 0.00034 | 0.00034 | |
| 102 | 101.0 | 102.0 | 1.0 | 101.5 | 210.6 | 0.336 | 1053.0 | 0.00032 | 0.00032 | |
| 103 | 102.0 | 103.0 | 1.0 | 102.5 | 167.6 | 0.339 | 837.8 | 0.00040 | 0.00040 | |
| 104 | 103.0 | 104.0 | 1.0 | 103.5 | 117.9 | 0.341 | 589.5 | 0.00058 | 0.00058 | |
| 105 | 104.0 | 105.0 | 1.0 | 104.5 | 71.2 | 0.343 | 356.1 | 0.00096 | 0.00096 | |
| 106 | 105.0 | 106.0 | 1.0 | 105.5 | 84.2 | 0.346 | 421.0 | 0.00082 | 0.00082 | |
| 107 | 106.0 | 107.0 | 1.0 | 106.5 | 82.8 | 0.348 | 414.1 | 0.00084 | 0.00084 | |
| 108 | 107.0 | 108.0 | 1.0 | 107.5 | 85.5 | 0.350 | 427.5 | 0.00082 | 0.00082 | |
| 109 | 108.0 | 109.0 | 1.0 | 108.5 | 87.7 | 0.353 | 438.7 | 0.00080 | 0.00080 | |
| 110 | 109.0 | 110.0 | 1.0 | 109.5 | 71.5 | 0.355 | 357.6 | 0.00099 | 0.00099 | |
| 111 | 110.0 | 111.0 | 1.0 | 110.5 | 60.5 | 0.357 | 302.6 | 0.00118 | 0.00118 | |
| 112 | 111.0 | 112.0 | 1.0 | 111.5 | 64.9 | 0.360 | 324.4 | 0.00111 | 0.00111 | |
| 113 | 112.0 | 113.0 | 1.0 | 112.5 | 62.6 | 0.362 | 313.2 | 0.00116 | 0.00116 | |
| 114 | 113.0 | 114.0 | 1.0 | 113.5 | 70.2 | 0.364 | 351.0 | 0.00104 | 0.00104 | |
| 115 | 114.0 | 115.0 | 1.0 | 114.5 | 80.1 | 0.366 | 400.6 | 0.00091 | 0.00091 | |
| 116 | 115.0 | 116.0 | 1.0 | 115.5 | 191.7 | 0.369 | 958.5 | 0.00038 | 0.00038 | |
| 117 | 116.0 | 117.0 | 1.0 | 116.5 | 204.5 | 0.371 | 1022.4 | 0.00036 | 0.00036 | |
| 118 | 117.0 | 118.0 | 1.0 | 117.5 | 508.1 | 0.373 | 2540.5 | 0.00015 | 0.00015 | |
| 119 | 118.0 | 119.0 | 1.0 | 118.5 | 621.5 | 0.376 | 3107.7 | 0.00012 | 0.00012 | |
| 120 | 119.0 | 120.0 | 1.0 | 119.5 | 668.1 | 0.378 | 3340.6 | 0.00011 | 0.00011 | |
| Σ = | | | | | | | | | 0.05706 | |

*$I_{zr}$ (1 < L/B < 10):* $I_{zr} = I_{zs} + 0.111\,(I_{zc} - I_{zs})\,(L/B - 1)$

*$I_{zs}$ (L/B = 1):*

*For $z_{ave}$ = 0 to B/2:* $I_{zs} = 0.1 + (z_{ave}/B)(2I_{zp} - 0.2)$

*For $z_{ave}$ = B/2 to 2B:* $I_{zs} = 0.667\, I_{zp}\,(2 - z_{ave}/B)$

*$I_{zc}$ (L/B $\geq$ 10):*

*For $z_{ave}$ = 0 to B:* $I_{zc} = 0.2 + (z_{ave}/B)(I_{zp} - 0.2)$

*For $z_{ave}$ = B to 4B:* $I_{zc} = 0.333\, I_{zp}\,(4 - z_{ave}/B)$ ( Coduto p.228. )

| | | | | |
|---|---|---|---|---|
| Footing width | B = | | 382.0 | ft |
| Footing length | L = | | 382.0 | ft |
| Ground elevation | | | 281.6 | ft |
| Foundation elevation | | | 265.0 | ft |
| Ground Water elevation | | | 220.0 | ft |
| Excavated or embedded depth | D = | | 16.6 | ft |
| Depth to Groundwater | | | 61.6 | ft |
| Unit weight | $\gamma$ = | | 120.0 | pcf |
| Gross Footing Load | | | 5.10 | ksf |
| Net applied footing pressure | $\Delta p$ = | | **3.108** | ksf |
| | L/B = | | 1.00 | - |

**Z-SDU6-C03**

| | Immediate Settlement (in.) ($S_0$ / 2) | |
|---|---|---|
| | Load | $S_0$ = |
| End of Operations | 5.10 | 0.9 |
| Tank Half Full | 2.80 | 0.2 |
| Pre Closure | 5.50 | 1.0 |
| Post Closure | 8.00 | 2.1 |

| 30 Year Settlement (in.) ($S_{30}$ / 2) | |
|---|---|
| Load | $S_0$ = |
| 5.10 | 1.3 |
| 8.00 | 3.1 |

**Computation**

| | | | | |
|---|---|---|---|---|
| Settlement | $\rho_i$ = | $C_1\ C_t\ \Delta p\ \Sigma(\Delta z_i\ I_{zi}/E_{si})$ | 0.144 | ft |
| | $\rho_i$ = | $C_t$ = 1 | **1.725** | **in** |
| | S(t) = | | 0.215 | ft |
| | S(t) = | | **2.580** | **in** |
| Correction for strain relief | $C_1$ = | 1 - 0.5($\sigma'_D$/q') | 0.680 | - |
| Effective vertical overburden pressure at D | $\sigma'_{vo}$ = | $\gamma$ D | 1.992 | ksf |
| Correction for time dependent increase | $C_t$ = | 1 + 0.2 log( t / 0.1 ) | 1.50 | - |
| | t = | | 30.00 | years |
| Elastic modulus of soil layer i | $E_{si}$ = | 2.5 $q_c$ | see Column H | if L/B = 1 |
| | $E_{si}$ = | 3.5 $q_c$ | see Column H | If L/B $\geq$ 10 |
| Depth increment i | $\Delta z_i$ | | see Column D | |
| Influence factor of soil layer i | $I_{zi}$ | Figure 3-4 | see Column G | |
| Peak depth influence factor | $I_{zp}$ = | 0.5 + 0.1 ($\Delta p/\sigma'_{Izp}$)$^{1/2}$ | 0.544 | - |
| | $z_p$ = | 0.5B + D | 207.60 ft | If L/B = 1 |
| | $z_p$ = | B + D | 398.60 ft | If L/B $\geq$ 10 |
| | $z_p$ = | | 207.60 ft | for L/B=1.00 |
| Effective overburden pressure at depth Izp | $\sigma'_{Izp}$ = | | 15.80 ksf | |
| Elastic Modulus | $E_{si}$ = | | 2.50 $q_c$ | If L/B = 1 |
| | $E_{si}$ = | | 3.50 $q_c$ | If L/B $\geq$ 10 |
| | $E_{si}$ = | | 2.50 $q_c$ | for L/B=1.00 |

Computations made relative to the bottom of foundation

| A | B | C | D | E | F | G | H | I | J | K |
|---|---|---|---|---|---|---|---|---|---|---|
| Layer No. | Layer top depth (ft) | Layer bottom depth (ft) | Layer thickness $\Delta z_i$ (ft) | Mid-layer depth $z_{ave}$ (ft) | Average tip stress $q_c$ (tsf) | $I_{zi}$ | Elastic modulus $E_{si}$ (ksf) | $\Delta z_i\ I_{zi}/E_{si}$ | $\Delta z_i\ I_{zi}/E_{si}$ | Notes |
| 1 | 0.0 | 1.0 | 1.0 | 0.5 | 186.5 | 0.101 | 932.5 | 0.00011 | 0.00011 | |
| 2 | 1.0 | 2.0 | 1.0 | 1.5 | 182.9 | 0.103 | 914.7 | 0.00011 | 0.00011 | |
| 3 | 2.0 | 3.0 | 1.0 | 2.5 | 165.2 | 0.106 | 826.1 | 0.00013 | 0.00013 | |
| 4 | 3.0 | 4.0 | 1.0 | 3.5 | 140.0 | 0.108 | 700.1 | 0.00015 | 0.00015 | |
| 5 | 4.0 | 5.0 | 1.0 | 4.5 | 172.0 | 0.110 | 859.9 | 0.00013 | 0.00013 | |
| 6 | 5.0 | 6.0 | 1.0 | 5.5 | 164.0 | 0.113 | 819.8 | 0.00014 | 0.00014 | |
| 7 | 6.0 | 7.0 | 1.0 | 6.5 | 168.6 | 0.115 | 842.9 | 0.00014 | 0.00014 | |
| 8 | 7.0 | 8.0 | 1.0 | 7.5 | 146.4 | 0.117 | 732.2 | 0.00016 | 0.00016 | |
| 9 | 8.0 | 9.0 | 1.0 | 8.5 | 136.2 | 0.120 | 681.1 | 0.00018 | 0.00018 | |
| 10 | 9.0 | 10.0 | 1.0 | 9.5 | 125.9 | 0.122 | 629.4 | 0.00019 | 0.00019 | |
| 11 | 10.0 | 11.0 | 1.0 | 10.5 | 121.8 | 0.124 | 608.9 | 0.00020 | 0.00020 | |
| 12 | 11.0 | 12.0 | 1.0 | 11.5 | 113.9 | 0.127 | 569.6 | 0.00022 | 0.00022 | |
| 13 | 12.0 | 13.0 | 1.0 | 12.5 | 110.0 | 0.129 | 550.1 | 0.00023 | 0.00023 | |
| 14 | 13.0 | 14.0 | 1.0 | 13.5 | 130.4 | 0.131 | 652.0 | 0.00020 | 0.00020 | |
| 15 | 14.0 | 15.0 | 1.0 | 14.5 | 133.4 | 0.134 | 667.0 | 0.00020 | 0.00020 | |
| 16 | 15.0 | 16.0 | 1.0 | 15.5 | 126.5 | 0.136 | 632.3 | 0.00022 | 0.00022 | |
| 17 | 16.0 | 17.0 | 1.0 | 16.5 | 129.3 | 0.138 | 646.3 | 0.00021 | 0.00021 | |
| 18 | 17.0 | 18.0 | 1.0 | 17.5 | 138.1 | 0.141 | 690.3 | 0.00020 | 0.00020 | |
| 19 | 18.0 | 19.0 | 1.0 | 18.5 | 162.6 | 0.143 | 813.1 | 0.00018 | 0.00018 | |
| 20 | 19.0 | 20.0 | 1.0 | 19.5 | 183.8 | 0.145 | 918.9 | 0.00016 | 0.00016 | |
| 21 | 20.0 | 21.0 | 1.0 | 20.5 | 183.4 | 0.148 | 917.1 | 0.00016 | 0.00016 | |
| 22 | 21.0 | 22.0 | 1.0 | 21.5 | 212.7 | 0.150 | 1063.5 | 0.00014 | 0.00014 | |
| 23 | 22.0 | 23.0 | 1.0 | 22.5 | 267.9 | 0.152 | 1339.3 | 0.00011 | 0.00011 | |
| 24 | 23.0 | 24.0 | 1.0 | 23.5 | 223.6 | 0.155 | 1117.8 | 0.00014 | 0.00014 | |
| 25 | 24.0 | 25.0 | 1.0 | 24.5 | 233.1 | 0.157 | 1165.7 | 0.00013 | 0.00013 | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 26 | 25.0 | 26.0 | 1.0 | 25.5 | 186.5 | 0.159 | 932.3 | 0.00017 | 0.00017 |
| 27 | 26.0 | 27.0 | 1.0 | 26.5 | 170.2 | 0.162 | 851.2 | 0.00019 | 0.00019 |
| 28 | 27.0 | 28.0 | 1.0 | 27.5 | 203.2 | 0.164 | 1015.9 | 0.00016 | 0.00016 |
| 29 | 28.0 | 29.0 | 1.0 | 28.5 | 222.7 | 0.166 | 1113.5 | 0.00015 | 0.00015 |
| 30 | 29.0 | 30.0 | 1.0 | 29.5 | 217.9 | 0.169 | 1089.6 | 0.00015 | 0.00015 |
| 31 | 30.0 | 31.0 | 1.0 | 30.5 | 128.2 | 0.171 | 641.0 | 0.00027 | 0.00027 |
| 32 | 31.0 | 32.0 | 1.0 | 31.5 | 44.8 | 0.173 | 224.2 | 0.00077 | 0.00077 |
| 33 | 32.0 | 33.0 | 1.0 | 32.5 | 44.8 | 0.176 | 223.9 | 0.00078 | 0.00078 |
| 34 | 33.0 | 34.0 | 1.0 | 33.5 | 21.3 | 0.178 | 106.6 | 0.00167 | 0.00167 |
| 35 | 34.0 | 35.0 | 1.0 | 34.5 | 51.1 | 0.180 | 255.7 | 0.00070 | 0.00070 |
| 36 | 35.0 | 36.0 | 1.0 | 35.5 | 16.2 | 0.183 | 80.8 | 0.00226 | 0.00226 |
| 37 | 36.0 | 37.0 | 1.0 | 36.5 | 15.0 | 0.185 | 75.0 | 0.00247 | 0.00247 |
| 38 | 37.0 | 38.0 | 1.0 | 37.5 | 34.7 | 0.187 | 173.5 | 0.00108 | 0.00108 |
| 39 | 38.0 | 39.0 | 1.0 | 38.5 | 85.1 | 0.190 | 425.3 | 0.00045 | 0.00045 |
| 40 | 39.0 | 40.0 | 1.0 | 39.5 | 117.6 | 0.192 | 588.1 | 0.00033 | 0.00033 |
| 41 | 40.0 | 41.0 | 1.0 | 40.5 | 132.0 | 0.194 | 659.9 | 0.00029 | 0.00029 |
| 42 | 41.0 | 42.0 | 1.0 | 41.5 | 169.5 | 0.197 | 847.4 | 0.00023 | 0.00023 |
| 43 | 42.0 | 43.0 | 1.0 | 42.5 | 242.7 | 0.199 | 1213.6 | 0.00016 | 0.00016 |
| 44 | 43.0 | 44.0 | 1.0 | 43.5 | 213.7 | 0.201 | 1068.6 | 0.00019 | 0.00019 |
| 45 | 44.0 | 45.0 | 1.0 | 44.5 | 217.5 | 0.204 | 1087.6 | 0.00019 | 0.00019 |
| 46 | 45.0 | 46.0 | 1.0 | 45.5 | 178.6 | 0.206 | 892.8 | 0.00023 | 0.00023 |
| 47 | 46.0 | 47.0 | 1.0 | 46.5 | 199.0 | 0.208 | 995.0 | 0.00021 | 0.00021 |
| 48 | 47.0 | 48.0 | 1.0 | 47.5 | 236.7 | 0.211 | 1183.3 | 0.00018 | 0.00018 |
| 49 | 48.0 | 49.0 | 1.0 | 48.5 | 151.4 | 0.213 | 756.9 | 0.00028 | 0.00028 |
| 50 | 49.0 | 50.0 | 1.0 | 49.5 | 61.5 | 0.215 | 307.5 | 0.00070 | 0.00070 |
| 51 | 50.0 | 51.0 | 1.0 | 50.5 | 174.2 | 0.217 | 871.1 | 0.00025 | 0.00025 |
| 52 | 51.0 | 52.0 | 1.0 | 51.5 | 107.7 | 0.220 | 538.3 | 0.00041 | 0.00041 |
| 53 | 52.0 | 53.0 | 1.0 | 52.5 | 185.8 | 0.222 | 929.1 | 0.00024 | 0.00024 |
| 54 | 53.0 | 54.0 | 1.0 | 53.5 | 216.0 | 0.224 | 1079.9 | 0.00021 | 0.00021 |
| 55 | 54.0 | 55.0 | 1.0 | 54.5 | 219.8 | 0.227 | 1098.8 | 0.00021 | 0.00021 |
| 56 | 55.0 | 56.0 | 1.0 | 55.5 | 214.2 | 0.229 | 1070.9 | 0.00021 | 0.00021 |
| 57 | 56.0 | 57.0 | 1.0 | 56.5 | 183.8 | 0.231 | 919.2 | 0.00025 | 0.00025 |
| 58 | 57.0 | 58.0 | 1.0 | 57.5 | 175.4 | 0.234 | 876.8 | 0.00027 | 0.00027 |
| 59 | 58.0 | 59.0 | 1.0 | 58.5 | 125.0 | 0.236 | 624.9 | 0.00038 | 0.00038 |
| 60 | 59.0 | 60.0 | 1.0 | 59.5 | 112.6 | 0.238 | 563.1 | 0.00042 | 0.00042 |
| 61 | 60.0 | 61.0 | 1.0 | 60.5 | 42.5 | 0.241 | 212.6 | 0.00113 | 0.00113 |
| 62 | 61.0 | 62.0 | 1.0 | 61.5 | 94.1 | 0.243 | 470.7 | 0.00052 | 0.00052 |
| 63 | 62.0 | 63.0 | 1.0 | 62.5 | 203.2 | 0.245 | 1015.9 | 0.00024 | 0.00024 |
| 64 | 63.0 | 64.0 | 1.0 | 63.5 | 204.9 | 0.248 | 1024.7 | 0.00024 | 0.00024 |
| 65 | 64.0 | 65.0 | 1.0 | 64.5 | 275.0 | 0.250 | 1374.8 | 0.00018 | 0.00018 |
| 66 | 65.0 | 66.0 | 1.0 | 65.5 | 267.1 | 0.252 | 1335.5 | 0.00019 | 0.00019 |
| 67 | 66.0 | 67.0 | 1.0 | 66.5 | 224.0 | 0.255 | 1120.1 | 0.00023 | 0.00023 |
| 68 | 67.0 | 68.0 | 1.0 | 67.5 | 223.5 | 0.257 | 1117.5 | 0.00023 | 0.00023 |
| 69 | 68.0 | 69.0 | 1.0 | 68.5 | 201.4 | 0.259 | 1007.1 | 0.00026 | 0.00026 |
| 70 | 69.0 | 70.0 | 1.0 | 69.5 | 39.6 | 0.262 | 197.9 | 0.00132 | 0.00132 |
| 71 | 70.0 | 71.0 | 1.0 | 70.5 | 13.8 | 0.264 | 69.2 | 0.00382 | 0.00382 |
| 72 | 71.0 | 72.0 | 1.0 | 71.5 | 26.4 | 0.266 | 131.9 | 0.00202 | 0.00202 |
| 73 | 72.0 | 73.0 | 1.0 | 72.5 | 24.9 | 0.269 | 124.7 | 0.00215 | 0.00215 |
| 74 | 73.0 | 74.0 | 1.0 | 73.5 | 40.3 | 0.271 | 201.6 | 0.00134 | 0.00134 |
| 75 | 74.0 | 75.0 | 1.0 | 74.5 | 74.0 | 0.273 | 370.2 | 0.00074 | 0.00074 |
| 76 | 75.0 | 76.0 | 1.0 | 75.5 | 92.9 | 0.276 | 464.4 | 0.00059 | 0.00059 |
| 77 | 76.0 | 77.0 | 1.0 | 76.5 | 85.6 | 0.278 | 427.8 | 0.00065 | 0.00065 |
| 78 | 77.0 | 78.0 | 1.0 | 77.5 | 42.2 | 0.280 | 210.8 | 0.00133 | 0.00133 |
| 79 | 78.0 | 79.0 | 1.0 | 78.5 | 34.8 | 0.283 | 174.0 | 0.00162 | 0.00162 |
| 80 | 79.0 | 80.0 | 1.0 | 79.5 | 34.4 | 0.285 | 171.9 | 0.00166 | 0.00166 |
| 81 | 80.0 | 81.0 | 1.0 | 80.5 | 30.6 | 0.287 | 152.8 | 0.00188 | 0.00188 |
| 82 | 81.0 | 82.0 | 1.0 | 81.5 | 43.2 | 0.290 | 215.9 | 0.00134 | 0.00134 |
| 83 | 82.0 | 83.0 | 1.0 | 82.5 | 45.8 | 0.292 | 228.8 | 0.00128 | 0.00128 |
| 84 | 83.0 | 84.0 | 1.0 | 83.5 | 89.9 | 0.294 | 449.3 | 0.00065 | 0.00065 |
| 85 | 84.0 | 85.0 | 1.0 | 84.5 | 273.8 | 0.297 | 1369.1 | 0.00022 | 0.00022 |
| 86 | 85.0 | 86.0 | 1.0 | 85.5 | 139.6 | 0.299 | 698.1 | 0.00043 | 0.00043 |
| 87 | 86.0 | 87.0 | 1.0 | 86.5 | 107.2 | 0.301 | 536.2 | 0.00056 | 0.00056 |
| 88 | 87.0 | 88.0 | 1.0 | 87.5 | 142.6 | 0.304 | 713.2 | 0.00043 | 0.00043 |
| 89 | 88.0 | 89.0 | 1.0 | 88.5 | 159.0 | 0.306 | 795.1 | 0.00038 | 0.00038 |
| 90 | 89.0 | 90.0 | 1.0 | 89.5 | 101.7 | 0.308 | 508.4 | 0.00061 | 0.00061 |
| 91 | 90.0 | 91.0 | 1.0 | 90.5 | 113.9 | 0.311 | 569.7 | 0.00055 | 0.00055 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 92 | 91.0 | 92.0 | 1.0 | 91.5 | 128.0 | 0.313 | 639.8 | 0.00049 | 0.00049 | |
| 93 | 92.0 | 93.0 | 1.0 | 92.5 | 132.8 | 0.315 | 663.8 | 0.00047 | 0.00047 | |
| 94 | 93.0 | 94.0 | 1.0 | 93.5 | 201.8 | 0.318 | 1009.1 | 0.00031 | 0.00031 | |
| 95 | 94.0 | 95.0 | 1.0 | 94.5 | 142.9 | 0.320 | 714.4 | 0.00045 | 0.00045 | |
| 96 | 95.0 | 96.0 | 1.0 | 95.5 | 118.3 | 0.322 | 591.6 | 0.00054 | 0.00054 | |
| 97 | 96.0 | 97.0 | 1.0 | 96.5 | 115.9 | 0.325 | 579.7 | 0.00056 | 0.00056 | |
| 98 | 97.0 | 98.0 | 1.0 | 97.5 | 111.7 | 0.327 | 558.5 | 0.00059 | 0.00059 | |
| 99 | 98.0 | 99.0 | 1.0 | 98.5 | 93.3 | 0.329 | 466.7 | 0.00071 | 0.00071 | |
| 100 | 99.0 | 100.0 | 1.0 | 99.5 | 131.0 | 0.331 | 655.2 | 0.00051 | 0.00051 | |
| 101 | 100.0 | 101.0 | 1.0 | 100.5 | 199.1 | 0.334 | 995.3 | 0.00034 | 0.00034 | |
| 102 | 101.0 | 102.0 | 1.0 | 101.5 | 210.6 | 0.336 | 1053.0 | 0.00032 | 0.00032 | |
| 103 | 102.0 | 103.0 | 1.0 | 102.5 | 167.6 | 0.338 | 837.8 | 0.00040 | 0.00040 | |
| 104 | 103.0 | 104.0 | 1.0 | 103.5 | 117.9 | 0.341 | 589.5 | 0.00058 | 0.00058 | |
| 105 | 104.0 | 105.0 | 1.0 | 104.5 | 71.2 | 0.343 | 356.1 | 0.00096 | 0.00096 | |
| 106 | 105.0 | 106.0 | 1.0 | 105.5 | 84.2 | 0.345 | 421.0 | 0.00082 | 0.00082 | |
| 107 | 106.0 | 107.0 | 1.0 | 106.5 | 82.8 | 0.348 | 414.1 | 0.00084 | 0.00084 | |
| 108 | 107.0 | 108.0 | 1.0 | 107.5 | 85.5 | 0.350 | 427.5 | 0.00082 | 0.00082 | |
| 109 | 108.0 | 109.0 | 1.0 | 108.5 | 87.7 | 0.352 | 438.7 | 0.00080 | 0.00080 | |
| 110 | 109.0 | 110.0 | 1.0 | 109.5 | 71.5 | 0.355 | 357.6 | 0.00099 | 0.00099 | |
| 111 | 110.0 | 111.0 | 1.0 | 110.5 | 60.5 | 0.357 | 302.6 | 0.00118 | 0.00118 | |
| 112 | 111.0 | 112.0 | 1.0 | 111.5 | 64.9 | 0.359 | 324.4 | 0.00111 | 0.00111 | |
| 113 | 112.0 | 113.0 | 1.0 | 112.5 | 62.6 | 0.362 | 313.2 | 0.00115 | 0.00115 | |
| 114 | 113.0 | 114.0 | 1.0 | 113.5 | 70.2 | 0.364 | 351.0 | 0.00104 | 0.00104 | |
| 115 | 114.0 | 115.0 | 1.0 | 114.5 | 80.1 | 0.366 | 400.6 | 0.00091 | 0.00091 | |
| 116 | 115.0 | 116.0 | 1.0 | 115.5 | 191.7 | 0.369 | 958.5 | 0.00038 | 0.00038 | |
| 117 | 116.0 | 117.0 | 1.0 | 116.5 | 204.5 | 0.371 | 1022.4 | 0.00036 | 0.00036 | |
| 118 | 117.0 | 118.0 | 1.0 | 117.5 | 508.1 | 0.373 | 2540.5 | 0.00015 | 0.00015 | |
| 119 | 118.0 | 119.0 | 1.0 | 118.5 | 621.5 | 0.376 | 3107.7 | 0.00012 | 0.00012 | |
| 120 | 119.0 | 120.0 | 1.0 | 119.5 | 668.1 | 0.378 | 3340.6 | 0.00011 | 0.00011 | |
| $\Sigma$ = | | | | | | | | | 0.06808 | |

| | |
|---|---|
| $I_{zr}$ $(1 < L/B < 10)$: | $I_{zr} = I_{zs} + 0.111\,(I_{zc} - I_{zs})\,(L/B - 1)$ |
| $I_{zs}$ $(L/B = 1)$: | |
| For $z_{ave} = 0$ to $B/2$: | $I_{zs} = 0.1 + (z_{ave}/B)(2I_{zp} - 0.2)$ |
| For $z_{ave} = B/2$ to $2B$: | $I_{zs} = 0.667\, I_{zp}\,(2 - z_{ave}/B)$ |
| $I_{zc}$ $(L/B \geq 10)$: | |
| For $z_{ave} = 0$ to $B$: | $I_{zc} = 0.2 + (z_{ave}/B)(I_{zp} - 0.2)$ |
| For $z_{ave} = B$ to $4B$: | $I_{zc} = 0.333\, I_{zp}\,(4 - z_{ave}/B)$ ( Coduto p.228. ) |

**Z-SDU6-C04**

| | | | | |
|---|---|---|---|---|
| Footing width | B = | | 382.0 | ft |
| Footing length | L = | | 382.0 | ft |
| Ground elevation | | | 281.8 | ft |
| Foundation elevation | | | 265.0 | ft |
| Ground Water elevation | | | 220.0 | ft |
| Excavated or embedded depth | D = | | 16.8 | ft |
| Depth to Groundwater | | | 61.8 | ft |
| Unit weight | $\gamma$ = | | 120.0 | pcf |
| Gross Footing Load | | | 5.10 | ksf |
| Net applied footing pressure | $\Delta p$ = | | **3.084** | ksf |
| | L/B = | | 1.00 | - |

Immediate Settlement (in.) ($S_0$ / 2)

| | Load | $S_0$ = |
|---|---|---|
| End of Operations | 5.10 | 0.7 |
| Tank Half Full | 2.80 | 0.1 |
| Pre Closure | 5.50 | 0.8 |
| Post Closure | 8.00 | 1.7 |

30 Year Settlement (in.) ($S_{30}$ / 2)

| Load | $S_0$ = |
|---|---|
| 5.10 | 1.0 |
| 8.00 | 2.5 |

**Computation**

| | | | | | |
|---|---|---|---|---|---|
| Settlement | $\rho_i$ = | $C_1 C_t \Delta p \Sigma(\Delta z_i I_{zi}/E_{si})$ | 0.114 | ft | |
| | $\rho_i$ = | $C_t = 1$ | **1.363** | **in** | |
| | S(t) = | | 0.170 | ft | |
| | S(t) = | | **2.038** | **in** | |
| Correction for strain relief | $C_1$ = | $1 - 0.5(\sigma'_D/q')$ | 0.673 | - | |
| Effective vertical overburden pressure at D | $\sigma'_{vo}$ = | $\gamma$ D | 2.016 | ksf | |
| Correction for time dependent increase | $C_t$ = | $1 + 0.2 \log(t / 0.1)$ | 1.50 | - | |
| | t = | | 30.00 | years | |
| Elastic modulus of soil layer i | $E_{si}$ = | 2.5 $q_c$ | see Column H | | if L/B = 1 |
| | $E_{si}$ = | 3.5 $q_c$ | see Column H | | If L/B $\geq$ 10 |
| Depth increment i | $\Delta z_i$ | | see Column D | | |
| Influence factor of soil layer i | $I_{zi}$ | Figure 3-4 | see Column G | | |
| Peak depth influence factor | $I_{zp}$ = | $0.5 + 0.1 (\Delta p/\sigma'_{Izp})^{1/2}$ | 0.544 | - | |
| | $z_p$ = | 0.5B + D | 207.80 | ft | If L/B = 1 |
| | $z_p$ = | B + D | 398.80 | ft | If L/B $\geq$ 10 |
| | $z_p$ = | | 207.80 | ft | for L/B=1.00 |
| Effective overburden pressure at depth Izp | $\sigma'_{Izp}$ = | | 15.83 | ksf | |
| Elastic Modulus | $E_{si}$ = | | 2.50 | $q_c$ | If L/B = 1 |
| | $E_{si}$ = | | 3.50 | $q_c$ | If L/B $\geq$ 10 |
| | $E_{si}$ = | | 2.50 | $q_c$ | for L/B=1.00 |

Computations made relative to the bottom of foundation

| A | B | C | D | E | F | G | H | I | J | K |
|---|---|---|---|---|---|---|---|---|---|---|
| Layer No. | Layer top depth (ft) | Layer bottom depth (ft) | Layer thickness $\Delta z_i$ (ft) | Mid-layer depth $z_{ave}$ (ft) | Average tip stress $q_c$ (tsf) | $I_{zi}$ | Elastic modulus $E_{si}$ (ksf) | $\Delta z_i I_{zi}/E_{si}$ | $\Delta z_i I_{zi}/E_{si}$ | Notes |
| 1 | 0.0 | 1.0 | 1.0 | 0.5 | 291.7 | 0.101 | 1458.5 | 0.00007 | 0.00007 | |
| 2 | 1.0 | 2.0 | 1.0 | 1.5 | 206.5 | 0.103 | 1032.4 | 0.00010 | 0.00010 | |
| 3 | 2.0 | 3.0 | 1.0 | 2.5 | 162.3 | 0.106 | 811.4 | 0.00013 | 0.00013 | |
| 4 | 3.0 | 4.0 | 1.0 | 3.5 | 166.7 | 0.108 | 833.5 | 0.00013 | 0.00013 | |
| 5 | 4.0 | 5.0 | 1.0 | 4.5 | 161.1 | 0.110 | 805.5 | 0.00014 | 0.00014 | |
| 6 | 5.0 | 6.0 | 1.0 | 5.5 | 86.1 | 0.113 | 430.5 | 0.00026 | 0.00026 | |
| 7 | 6.0 | 7.0 | 1.0 | 6.5 | 144.5 | 0.115 | 722.3 | 0.00016 | 0.00016 | |
| 8 | 7.0 | 8.0 | 1.0 | 7.5 | 172.2 | 0.117 | 861.1 | 0.00014 | 0.00014 | |
| 9 | 8.0 | 9.0 | 1.0 | 8.5 | 128.5 | 0.120 | 642.5 | 0.00019 | 0.00019 | |
| 10 | 9.0 | 10.0 | 1.0 | 9.5 | 111.9 | 0.122 | 559.7 | 0.00022 | 0.00022 | |
| 11 | 10.0 | 11.0 | 1.0 | 10.5 | 133.5 | 0.124 | 667.5 | 0.00019 | 0.00019 | |
| 12 | 11.0 | 12.0 | 1.0 | 11.5 | 137.9 | 0.127 | 689.3 | 0.00018 | 0.00018 | |
| 13 | 12.0 | 13.0 | 1.0 | 12.5 | 121.6 | 0.129 | 608.1 | 0.00021 | 0.00021 | |
| 14 | 13.0 | 14.0 | 1.0 | 13.5 | 132.3 | 0.131 | 661.5 | 0.00020 | 0.00020 | |
| 15 | 14.0 | 15.0 | 1.0 | 14.5 | 151.4 | 0.134 | 757.1 | 0.00018 | 0.00018 | |
| 16 | 15.0 | 16.0 | 1.0 | 15.5 | 173.2 | 0.136 | 866.1 | 0.00016 | 0.00016 | |
| 17 | 16.0 | 17.0 | 1.0 | 16.5 | 177.0 | 0.138 | 885.0 | 0.00016 | 0.00016 | |
| 18 | 17.0 | 18.0 | 1.0 | 17.5 | 190.3 | 0.141 | 951.7 | 0.00015 | 0.00015 | |
| 19 | 18.0 | 19.0 | 1.0 | 18.5 | 242.8 | 0.143 | 1213.9 | 0.00012 | 0.00012 | |
| 20 | 19.0 | 20.0 | 1.0 | 19.5 | 261.2 | 0.145 | 1306.2 | 0.00011 | 0.00011 | |
| 21 | 20.0 | 21.0 | 1.0 | 20.5 | 278.3 | 0.148 | 1391.7 | 0.00011 | 0.00011 | |
| 22 | 21.0 | 22.0 | 1.0 | 21.5 | 300.2 | 0.150 | 1501.0 | 0.00010 | 0.00010 | |
| 23 | 22.0 | 23.0 | 1.0 | 22.5 | 262.1 | 0.152 | 1310.6 | 0.00012 | 0.00012 | |
| 24 | 23.0 | 24.0 | 1.0 | 23.5 | 227.8 | 0.155 | 1139.0 | 0.00014 | 0.00014 | |
| 25 | 24.0 | 25.0 | 1.0 | 24.5 | 251.8 | 0.157 | 1258.8 | 0.00012 | 0.00012 | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 26 | 25.0 | 26.0 | 1.0 | 25.5 | 258.8 | 0.159 | 1294.0 | 0.00012 | 0.00012 |
| 27 | 26.0 | 27.0 | 1.0 | 26.5 | 222.6 | 0.162 | 1112.8 | 0.00015 | 0.00015 |
| 28 | 27.0 | 28.0 | 1.0 | 27.5 | 132.6 | 0.164 | 662.8 | 0.00025 | 0.00025 |
| 29 | 28.0 | 29.0 | 1.0 | 28.5 | 45.6 | 0.166 | 227.9 | 0.00073 | 0.00073 |
| 30 | 29.0 | 30.0 | 1.0 | 29.5 | 115.9 | 0.169 | 579.5 | 0.00029 | 0.00029 |
| 31 | 30.0 | 31.0 | 1.0 | 30.5 | 32.2 | 0.171 | 161.2 | 0.00106 | 0.00106 |
| 32 | 31.0 | 32.0 | 1.0 | 31.5 | 19.0 | 0.173 | 95.1 | 0.00182 | 0.00182 |
| 33 | 32.0 | 33.0 | 1.0 | 32.5 | 13.9 | 0.176 | 69.6 | 0.00252 | 0.00252 |
| 34 | 33.0 | 34.0 | 1.0 | 33.5 | 16.9 | 0.178 | 84.5 | 0.00211 | 0.00211 |
| 35 | 34.0 | 35.0 | 1.0 | 34.5 | 27.6 | 0.180 | 138.2 | 0.00130 | 0.00130 |
| 36 | 35.0 | 36.0 | 1.0 | 35.5 | 71.6 | 0.183 | 358.0 | 0.00051 | 0.00051 |
| 37 | 36.0 | 37.0 | 1.0 | 36.5 | 120.0 | 0.185 | 600.1 | 0.00031 | 0.00031 |
| 38 | 37.0 | 38.0 | 1.0 | 37.5 | 117.9 | 0.187 | 589.7 | 0.00032 | 0.00032 |
| 39 | 38.0 | 39.0 | 1.0 | 38.5 | 128.9 | 0.190 | 644.7 | 0.00029 | 0.00029 |
| 40 | 39.0 | 40.0 | 1.0 | 39.5 | 141.1 | 0.192 | 705.5 | 0.00027 | 0.00027 |
| 41 | 40.0 | 41.0 | 1.0 | 40.5 | 167.6 | 0.194 | 838.2 | 0.00023 | 0.00023 |
| 42 | 41.0 | 42.0 | 1.0 | 41.5 | 214.9 | 0.197 | 1074.4 | 0.00018 | 0.00018 |
| 43 | 42.0 | 43.0 | 1.0 | 42.5 | 171.9 | 0.199 | 859.7 | 0.00023 | 0.00023 |
| 44 | 43.0 | 44.0 | 1.0 | 43.5 | 100.9 | 0.201 | 504.6 | 0.00040 | 0.00040 |
| 45 | 44.0 | 45.0 | 1.0 | 44.5 | 187.4 | 0.203 | 937.1 | 0.00022 | 0.00022 |
| 46 | 45.0 | 46.0 | 1.0 | 45.5 | 158.9 | 0.206 | 794.6 | 0.00026 | 0.00026 |
| 47 | 46.0 | 47.0 | 1.0 | 46.5 | 190.5 | 0.208 | 952.5 | 0.00022 | 0.00022 |
| 48 | 47.0 | 48.0 | 1.0 | 47.5 | 163.6 | 0.210 | 817.8 | 0.00026 | 0.00026 |
| 49 | 48.0 | 49.0 | 1.0 | 48.5 | 93.8 | 0.213 | 468.9 | 0.00045 | 0.00045 |
| 50 | 49.0 | 50.0 | 1.0 | 49.5 | 134.6 | 0.215 | 672.8 | 0.00032 | 0.00032 |
| 51 | 50.0 | 51.0 | 1.0 | 50.5 | 131.5 | 0.217 | 657.7 | 0.00033 | 0.00033 |
| 52 | 51.0 | 52.0 | 1.0 | 51.5 | 217.0 | 0.220 | 1085.0 | 0.00020 | 0.00020 |
| 53 | 52.0 | 53.0 | 1.0 | 52.5 | 238.2 | 0.222 | 1190.9 | 0.00019 | 0.00019 |
| 54 | 53.0 | 54.0 | 1.0 | 53.5 | 246.0 | 0.224 | 1230.0 | 0.00018 | 0.00018 |
| 55 | 54.0 | 55.0 | 1.0 | 54.5 | 242.2 | 0.227 | 1210.9 | 0.00019 | 0.00019 |
| 56 | 55.0 | 56.0 | 1.0 | 55.5 | 175.5 | 0.229 | 877.6 | 0.00026 | 0.00026 |
| 57 | 56.0 | 57.0 | 1.0 | 56.5 | 132.1 | 0.231 | 660.4 | 0.00035 | 0.00035 |
| 58 | 57.0 | 58.0 | 1.0 | 57.5 | 102.6 | 0.234 | 513.0 | 0.00046 | 0.00046 |
| 59 | 58.0 | 59.0 | 1.0 | 58.5 | 95.7 | 0.236 | 478.7 | 0.00049 | 0.00049 |
| 60 | 59.0 | 60.0 | 1.0 | 59.5 | 40.2 | 0.238 | 201.0 | 0.00119 | 0.00119 |
| 61 | 60.0 | 61.0 | 1.0 | 60.5 | 59.5 | 0.241 | 297.7 | 0.00081 | 0.00081 |
| 62 | 61.0 | 62.0 | 1.0 | 61.5 | 105.8 | 0.243 | 529.2 | 0.00046 | 0.00046 |
| 63 | 62.0 | 63.0 | 1.0 | 62.5 | 132.9 | 0.245 | 664.6 | 0.00037 | 0.00037 |
| 64 | 63.0 | 64.0 | 1.0 | 63.5 | 183.8 | 0.248 | 919.0 | 0.00027 | 0.00027 |
| 65 | 64.0 | 65.0 | 1.0 | 64.5 | 197.9 | 0.250 | 989.3 | 0.00025 | 0.00025 |
| 66 | 65.0 | 66.0 | 1.0 | 65.5 | 225.8 | 0.252 | 1129.2 | 0.00022 | 0.00022 |
| 67 | 66.0 | 67.0 | 1.0 | 66.5 | 271.9 | 0.255 | 1359.3 | 0.00019 | 0.00019 |
| 68 | 67.0 | 68.0 | 1.0 | 67.5 | 185.7 | 0.257 | 928.3 | 0.00028 | 0.00028 |
| 69 | 68.0 | 69.0 | 1.0 | 68.5 | 32.9 | 0.259 | 164.7 | 0.00157 | 0.00157 |
| 70 | 69.0 | 70.0 | 1.0 | 69.5 | 129.9 | 0.262 | 649.4 | 0.00040 | 0.00040 |
| 71 | 70.0 | 71.0 | 1.0 | 70.5 | 134.8 | 0.264 | 673.9 | 0.00039 | 0.00039 |
| 72 | 71.0 | 72.0 | 1.0 | 71.5 | 131.2 | 0.266 | 655.9 | 0.00041 | 0.00041 |
| 73 | 72.0 | 73.0 | 1.0 | 72.5 | 136.2 | 0.269 | 681.2 | 0.00039 | 0.00039 |
| 74 | 73.0 | 74.0 | 1.0 | 73.5 | 76.0 | 0.271 | 380.2 | 0.00071 | 0.00071 |
| 75 | 74.0 | 75.0 | 1.0 | 74.5 | 91.1 | 0.273 | 455.4 | 0.00060 | 0.00060 |
| 76 | 75.0 | 76.0 | 1.0 | 75.5 | 124.8 | 0.276 | 624.2 | 0.00044 | 0.00044 |
| 77 | 76.0 | 77.0 | 1.0 | 76.5 | 124.7 | 0.278 | 623.7 | 0.00045 | 0.00045 |
| 78 | 77.0 | 78.0 | 1.0 | 77.5 | 98.3 | 0.280 | 491.5 | 0.00057 | 0.00057 |
| 79 | 78.0 | 79.0 | 1.0 | 78.5 | 146.3 | 0.283 | 731.6 | 0.00039 | 0.00039 |
| 80 | 79.0 | 80.0 | 1.0 | 79.5 | 316.7 | 0.285 | 1583.3 | 0.00018 | 0.00018 |
| 81 | 80.0 | 81.0 | 1.0 | 80.5 | 117.1 | 0.287 | 585.5 | 0.00049 | 0.00049 |
| 82 | 81.0 | 82.0 | 1.0 | 81.5 | 181.6 | 0.290 | 907.9 | 0.00032 | 0.00032 |
| 83 | 82.0 | 83.0 | 1.0 | 82.5 | 163.1 | 0.292 | 815.3 | 0.00036 | 0.00036 |
| 84 | 83.0 | 84.0 | 1.0 | 83.5 | 131.7 | 0.294 | 658.5 | 0.00045 | 0.00045 |
| 85 | 84.0 | 85.0 | 1.0 | 84.5 | 171.8 | 0.296 | 859.0 | 0.00035 | 0.00035 |
| 86 | 85.0 | 86.0 | 1.0 | 85.5 | 139.6 | 0.299 | 698.1 | 0.00043 | 0.00043 |
| 87 | 86.0 | 87.0 | 1.0 | 86.5 | 107.2 | 0.301 | 536.2 | 0.00056 | 0.00056 |
| 88 | 87.0 | 88.0 | 1.0 | 87.5 | 142.6 | 0.303 | 713.2 | 0.00043 | 0.00043 |
| 89 | 88.0 | 89.0 | 1.0 | 88.5 | 159.0 | 0.306 | 795.1 | 0.00038 | 0.00038 |
| 90 | 89.0 | 90.0 | 1.0 | 89.5 | 101.7 | 0.308 | 508.4 | 0.00061 | 0.00061 |
| 91 | 90.0 | 91.0 | 1.0 | 90.5 | 113.9 | 0.310 | 569.7 | 0.00054 | 0.00054 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 92 | 91.0 | 92.0 | 1.0 | 91.5 | 128.0 | 0.313 | 639.8 | 0.00049 | 0.00049 | |
| 93 | 92.0 | 93.0 | 1.0 | 92.5 | 132.8 | 0.315 | 663.8 | 0.00047 | 0.00047 | |
| 94 | 93.0 | 94.0 | 1.0 | 93.5 | 201.8 | 0.317 | 1009.1 | 0.00031 | 0.00031 | |
| 95 | 94.0 | 95.0 | 1.0 | 94.5 | 142.9 | 0.320 | 714.4 | 0.00045 | 0.00045 | |
| 96 | 95.0 | 96.0 | 1.0 | 95.5 | 118.3 | 0.322 | 591.6 | 0.00054 | 0.00054 | |
| 97 | 96.0 | 97.0 | 1.0 | 96.5 | 115.9 | 0.324 | 579.7 | 0.00056 | 0.00056 | |
| 98 | 97.0 | 98.0 | 1.0 | 97.5 | 111.7 | 0.327 | 558.5 | 0.00058 | 0.00058 | |
| 99 | 98.0 | 99.0 | 1.0 | 98.5 | 93.3 | 0.329 | 466.7 | 0.00071 | 0.00071 | |
| 100 | 99.0 | 100.0 | 1.0 | 99.5 | 131.0 | 0.331 | 655.2 | 0.00051 | 0.00051 | |
| 101 | 100.0 | 101.0 | 1.0 | 100.5 | 199.1 | 0.334 | 995.3 | 0.00034 | 0.00034 | |
| 102 | 101.0 | 102.0 | 1.0 | 101.5 | 210.6 | 0.336 | 1053.0 | 0.00032 | 0.00032 | |
| 103 | 102.0 | 103.0 | 1.0 | 102.5 | 167.6 | 0.338 | 837.8 | 0.00040 | 0.00040 | |
| 104 | 103.0 | 104.0 | 1.0 | 103.5 | 117.9 | 0.341 | 589.5 | 0.00058 | 0.00058 | |
| 105 | 104.0 | 105.0 | 1.0 | 104.5 | 71.2 | 0.343 | 356.1 | 0.00096 | 0.00096 | |
| 106 | 105.0 | 106.0 | 1.0 | 105.5 | 84.2 | 0.345 | 421.0 | 0.00082 | 0.00082 | |
| 107 | 106.0 | 107.0 | 1.0 | 106.5 | 82.8 | 0.348 | 414.1 | 0.00084 | 0.00084 | |
| 108 | 107.0 | 108.0 | 1.0 | 107.5 | 85.5 | 0.350 | 427.5 | 0.00082 | 0.00082 | |
| 109 | 108.0 | 109.0 | 1.0 | 108.5 | 87.7 | 0.352 | 438.7 | 0.00080 | 0.00080 | |
| 110 | 109.0 | 110.0 | 1.0 | 109.5 | 71.5 | 0.355 | 357.6 | 0.00099 | 0.00099 | |
| 111 | 110.0 | 111.0 | 1.0 | 110.5 | 60.5 | 0.357 | 302.6 | 0.00118 | 0.00118 | |
| 112 | 111.0 | 112.0 | 1.0 | 111.5 | 64.9 | 0.359 | 324.4 | 0.00111 | 0.00111 | |
| 113 | 112.0 | 113.0 | 1.0 | 112.5 | 62.6 | 0.362 | 313.2 | 0.00115 | 0.00115 | |
| 114 | 113.0 | 114.0 | 1.0 | 113.5 | 70.2 | 0.364 | 351.0 | 0.00104 | 0.00104 | |
| 115 | 114.0 | 115.0 | 1.0 | 114.5 | 80.1 | 0.366 | 400.6 | 0.00091 | 0.00091 | |
| 116 | 115.0 | 116.0 | 1.0 | 115.5 | 191.7 | 0.369 | 958.5 | 0.00038 | 0.00038 | |
| 117 | 116.0 | 117.0 | 1.0 | 116.5 | 204.5 | 0.371 | 1022.4 | 0.00036 | 0.00036 | |
| 118 | 117.0 | 118.0 | 1.0 | 117.5 | 508.1 | 0.373 | 2540.5 | 0.00015 | 0.00015 | |
| 119 | 118.0 | 119.0 | 1.0 | 118.5 | 621.5 | 0.376 | 3107.7 | 0.00012 | 0.00012 | |
| 120 | 119.0 | 120.0 | 1.0 | 119.5 | 668.1 | 0.378 | 3340.6 | 0.00011 | 0.00011 | |
| $\Sigma$ = | | | | | | | | | 0.05470 | |

| | |
|---|---|
| $I_{zr}$ (1 < L/B < 10): | $I_{zr} = I_{zs} + 0.111\,(I_{zc} - I_{zs})\,(L/B - 1)$ |
| $I_{zs}$ (L/B = 1): | |
| For $z_{ave}$ = 0 to B/2: | $I_{zs} = 0.1 + (z_{ave}/B)(2I_{zp} - 0.2)$ |
| For $z_{ave}$ = B/2 to 2B: | $I_{zs} = 0.667\,I_{zp}\,(2 - z_{ave}/B)$ |
| $I_{zc}$ ($L/B \geq 10$): | |
| For $z_{ave}$ = 0 to B: | $I_{zc} = 0.2 + (z_{ave}/B)(I_{zp} - 0.2)$ |
| For $z_{ave}$ = B to 4B: | $I_{zc} = 0.333\,I_{zp}\,(4 - z_{ave}/B)$ ( Coduto p.228. ) |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Footing width | B = | | 382.0 | ft | **Z-SDU6-C05** | | |
| Footing length | L = | | 382.0 | ft | | Immediate | |
| Ground elevation | | | 278.1 | ft | | Settlement (in.) | |
| Foundation elevation | | | 265.0 | ft | | ($S_0$ / 2) | |
| Ground Water elevation | | | 220.0 | ft | | Load | $S_0$ = |
| Excavated or embedded depth | D = | | 13.1 | ft | End of Operations | 5.10 | 1.1 |
| Depth to Groundwater | | | 58.1 | ft | Tank Half Full | 2.80 | 0.2 |
| Unit weight | $\gamma$ = | | 120.0 | pcf | Pre Closure | 5.50 | 1.3 |
| Gross Footing Load | | | 5.10 | ksf | Post Closure | 8.00 | 2.4 |
| Net applied footing pressure | $\Delta p$ = | | **3.528** | ksf | | | |
| | L/B = | | 1.00 | - | | | |
| | | | | | | 30 Year | |
| **Computation** | | | | | | Settlement (in.) | |
| Settlement | $\rho_i$ = | $C_1 C_t \Delta p \Sigma(\Delta z_i I_{zi}/E_{si})$ | 0.188 | ft | | ($S_{30}$ / 2) | |
| | $\rho_i$ = | $C_t$ = 1 | **2.261** | **in** | | Load | $S_0$ = |
| | S(t) = | | 0.282 | ft | | 5.10 | 1.7 |
| | S(t) = | | **3.381** | **in** | | 8.00 | 3.6 |
| Correction for strain relief | $C_1$ = | 1 - 0.5($\sigma'_D$/q') | 0.777 | - | | | |
| Effective vertical overburden pressure at D | $\sigma'_{vo}$ = | $\gamma$ D | 1.572 | ksf | | | |
| Correction for time dependent increase | $C_t$ = | 1 + 0.2 log( t / 0.1 ) | 1.50 | - | | | |
| | t = | | 30.00 | years | | | |
| Elastic modulus of soil layer i | $E_{si}$ = | 2.5 $q_c$ | see | Column H | if L/B = 1 | | |
| | $E_{si}$ = | 3.5 $q_c$ | see | Column H | If L/B $\geq$ 10 | | |
| Depth increment i | $\Delta z_i$ | | see | Column D | | | |
| Influence factor of soil layer i | $I_{zi}$ | Figure 3-4 | see | Column G | | | |
| Peak depth influence factor | $I_{zp}$ = | 0.5 + 0.1 ($\Delta p/\sigma'_{Izp}$)$^{1/2}$ | 0.548 | - | | | |
| | $z_p$ = | 0.5B + D | 204.10 | ft | If L/B = 1 | | |
| | $z_p$ = | B + D | 395.10 | ft | If L/B $\geq$ 10 | | |
| | $z_p$ = | | 204.10 | ft | for L/B=1.00 | | |
| Effective overburden pressure at depth Izp | $\sigma'_{Izp}$ = | | 15.38 | ksf | | | |
| Elastic Modulus | $E_{si}$ = | | 2.50 | $q_c$ | If L/B = 1 | | |
| | $E_{si}$ = | | 3.50 | $q_c$ | If L/B $\geq$ 10 | | |
| | $E_{si}$ = | | 2.50 | $q_c$ | for L/B=1.00 | | |

Computations made relative to the bottom of foundation

| A | B | C | D | E | F | G | H | I | J | K |
|---|---|---|---|---|---|---|---|---|---|---|
| Layer No. | Layer top depth (ft) | Layer bottom depth (ft) | Layer thickness $\Delta z_i$ (ft) | Mid-layer depth $z_{ave}$ (ft) | Average tip stress $q_c$ (tsf) | $I_{zi}$ | Elastic modulus $E_{si}$ (ksf) | $\Delta z_i I_{zi}/E_{si}$ | $\Delta z_i I_{zi}/E_{si}$ | Notes |
| 1 | 0.0 | 1.0 | 1.0 | 0.5 | 134.8 | 0.101 | 674.1 | 0.00015 | 0.00015 | |
| 2 | 1.0 | 2.0 | 1.0 | 1.5 | 173.6 | 0.104 | 868.2 | 0.00012 | 0.00012 | |
| 3 | 2.0 | 3.0 | 1.0 | 2.5 | 151.0 | 0.106 | 755.0 | 0.00014 | 0.00014 | |
| 4 | 3.0 | 4.0 | 1.0 | 3.5 | 133.8 | 0.108 | 668.8 | 0.00016 | 0.00016 | |
| 5 | 4.0 | 5.0 | 1.0 | 4.5 | 154.7 | 0.111 | 773.5 | 0.00014 | 0.00014 | |
| 6 | 5.0 | 6.0 | 1.0 | 5.5 | 148.0 | 0.113 | 739.8 | 0.00015 | 0.00015 | |
| 7 | 6.0 | 7.0 | 1.0 | 6.5 | 147.2 | 0.115 | 735.8 | 0.00016 | 0.00016 | |
| 8 | 7.0 | 8.0 | 1.0 | 7.5 | 141.3 | 0.118 | 706.5 | 0.00017 | 0.00017 | |
| 9 | 8.0 | 9.0 | 1.0 | 8.5 | 115.9 | 0.120 | 579.6 | 0.00021 | 0.00021 | |
| 10 | 9.0 | 10.0 | 1.0 | 9.5 | 95.8 | 0.122 | 478.8 | 0.00026 | 0.00026 | |
| 11 | 10.0 | 11.0 | 1.0 | 10.5 | 87.0 | 0.125 | 434.9 | 0.00029 | 0.00029 | |
| 12 | 11.0 | 12.0 | 1.0 | 11.5 | 104.0 | 0.127 | 520.1 | 0.00024 | 0.00024 | |
| 13 | 12.0 | 13.0 | 1.0 | 12.5 | 131.7 | 0.129 | 658.6 | 0.00020 | 0.00020 | |
| 14 | 13.0 | 14.0 | 1.0 | 13.5 | 151.5 | 0.132 | 757.3 | 0.00017 | 0.00017 | |
| 15 | 14.0 | 15.0 | 1.0 | 14.5 | 171.0 | 0.134 | 855.1 | 0.00016 | 0.00016 | |
| 16 | 15.0 | 16.0 | 1.0 | 15.5 | 192.4 | 0.136 | 962.1 | 0.00014 | 0.00014 | |
| 17 | 16.0 | 17.0 | 1.0 | 16.5 | 230.9 | 0.139 | 1154.4 | 0.00012 | 0.00012 | |
| 18 | 17.0 | 18.0 | 1.0 | 17.5 | 312.4 | 0.141 | 1561.9 | 0.00009 | 0.00009 | |
| 19 | 18.0 | 19.0 | 1.0 | 18.5 | 349.1 | 0.143 | 1745.4 | 0.00008 | 0.00008 | |
| 20 | 19.0 | 20.0 | 1.0 | 19.5 | 364.1 | 0.146 | 1820.5 | 0.00008 | 0.00008 | |
| 21 | 20.0 | 21.0 | 1.0 | 20.5 | 524.2 | 0.148 | 2620.8 | 0.00006 | 0.00006 | |
| 22 | 21.0 | 22.0 | 1.0 | 21.5 | 488.9 | 0.150 | 2444.7 | 0.00006 | 0.00006 | |
| 23 | 22.0 | 23.0 | 1.0 | 22.5 | 425.7 | 0.153 | 2128.6 | 0.00007 | 0.00007 | |
| 24 | 23.0 | 24.0 | 1.0 | 23.5 | 378.0 | 0.155 | 1890.0 | 0.00008 | 0.00008 | |
| 25 | 24.0 | 25.0 | 1.0 | 24.5 | 438.3 | 0.157 | 2191.4 | 0.00007 | 0.00007 | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 26 | 25.0 | 26.0 | 1.0 | 25.5 | 379.7 | 0.160 | 1898.3 | 0.00008 | 0.00008 |
| 27 | 26.0 | 27.0 | 1.0 | 26.5 | 288.3 | 0.162 | 1441.3 | 0.00011 | 0.00011 |
| 28 | 27.0 | 28.0 | 1.0 | 27.5 | 201.6 | 0.164 | 1008.1 | 0.00016 | 0.00016 |
| 29 | 28.0 | 29.0 | 1.0 | 28.5 | 63.0 | 0.167 | 315.0 | 0.00053 | 0.00053 |
| 30 | 29.0 | 30.0 | 1.0 | 29.5 | 36.0 | 0.169 | 180.2 | 0.00094 | 0.00094 |
| 31 | 30.0 | 31.0 | 1.0 | 30.5 | 17.6 | 0.172 | 88.2 | 0.00194 | 0.00194 |
| 32 | 31.0 | 32.0 | 1.0 | 31.5 | 10.5 | 0.174 | 52.5 | 0.00331 | 0.00331 |
| 33 | 32.0 | 33.0 | 1.0 | 32.5 | 10.4 | 0.176 | 51.8 | 0.00340 | 0.00340 |
| 34 | 33.0 | 34.0 | 1.0 | 33.5 | 12.6 | 0.179 | 63.2 | 0.00282 | 0.00282 |
| 35 | 34.0 | 35.0 | 1.0 | 34.5 | 13.9 | 0.181 | 69.7 | 0.00260 | 0.00260 |
| 36 | 35.0 | 36.0 | 1.0 | 35.5 | 29.7 | 0.183 | 148.6 | 0.00123 | 0.00123 |
| 37 | 36.0 | 37.0 | 1.0 | 36.5 | 35.7 | 0.186 | 178.7 | 0.00104 | 0.00104 |
| 38 | 37.0 | 38.0 | 1.0 | 37.5 | 61.6 | 0.188 | 307.9 | 0.00061 | 0.00061 |
| 39 | 38.0 | 39.0 | 1.0 | 38.5 | 152.7 | 0.190 | 763.4 | 0.00025 | 0.00025 |
| 40 | 39.0 | 40.0 | 1.0 | 39.5 | 168.3 | 0.193 | 841.3 | 0.00023 | 0.00023 |
| 41 | 40.0 | 41.0 | 1.0 | 40.5 | 189.2 | 0.195 | 945.9 | 0.00021 | 0.00021 |
| 42 | 41.0 | 42.0 | 1.0 | 41.5 | 136.4 | 0.197 | 682.2 | 0.00029 | 0.00029 |
| 43 | 42.0 | 43.0 | 1.0 | 42.5 | 140.2 | 0.200 | 700.8 | 0.00028 | 0.00028 |
| 44 | 43.0 | 44.0 | 1.0 | 43.5 | 154.2 | 0.202 | 771.0 | 0.00026 | 0.00026 |
| 45 | 44.0 | 45.0 | 1.0 | 44.5 | 130.1 | 0.204 | 650.6 | 0.00031 | 0.00031 |
| 46 | 45.0 | 46.0 | 1.0 | 45.5 | 130.4 | 0.207 | 651.9 | 0.00032 | 0.00032 |
| 47 | 46.0 | 47.0 | 1.0 | 46.5 | 92.2 | 0.209 | 460.9 | 0.00045 | 0.00045 |
| 48 | 47.0 | 48.0 | 1.0 | 47.5 | 186.2 | 0.211 | 931.1 | 0.00023 | 0.00023 |
| 49 | 48.0 | 49.0 | 1.0 | 48.5 | 153.7 | 0.214 | 768.3 | 0.00028 | 0.00028 |
| 50 | 49.0 | 50.0 | 1.0 | 49.5 | 119.2 | 0.216 | 595.9 | 0.00036 | 0.00036 |
| 51 | 50.0 | 51.0 | 1.0 | 50.5 | 182.2 | 0.218 | 911.2 | 0.00024 | 0.00024 |
| 52 | 51.0 | 52.0 | 1.0 | 51.5 | 228.8 | 0.221 | 1143.9 | 0.00019 | 0.00019 |
| 53 | 52.0 | 53.0 | 1.0 | 52.5 | 231.1 | 0.223 | 1155.5 | 0.00019 | 0.00019 |
| 54 | 53.0 | 54.0 | 1.0 | 53.5 | 235.3 | 0.225 | 1176.7 | 0.00019 | 0.00019 |
| 55 | 54.0 | 55.0 | 1.0 | 54.5 | 214.5 | 0.228 | 1072.3 | 0.00021 | 0.00021 |
| 56 | 55.0 | 56.0 | 1.0 | 55.5 | 197.2 | 0.230 | 986.2 | 0.00023 | 0.00023 |
| 57 | 56.0 | 57.0 | 1.0 | 56.5 | 184.8 | 0.232 | 924.2 | 0.00025 | 0.00025 |
| 58 | 57.0 | 58.0 | 1.0 | 57.5 | 158.6 | 0.235 | 792.9 | 0.00030 | 0.00030 |
| 59 | 58.0 | 59.0 | 1.0 | 58.5 | 134.9 | 0.237 | 674.3 | 0.00035 | 0.00035 |
| 60 | 59.0 | 60.0 | 1.0 | 59.5 | 104.5 | 0.240 | 522.7 | 0.00046 | 0.00046 |
| 61 | 60.0 | 61.0 | 1.0 | 60.5 | 77.3 | 0.242 | 386.3 | 0.00063 | 0.00063 |
| 62 | 61.0 | 62.0 | 1.0 | 61.5 | 21.9 | 0.244 | 109.3 | 0.00223 | 0.00223 |
| 63 | 62.0 | 63.0 | 1.0 | 62.5 | 21.0 | 0.247 | 105.2 | 0.00234 | 0.00234 |
| 64 | 63.0 | 64.0 | 1.0 | 63.5 | 52.5 | 0.249 | 262.7 | 0.00095 | 0.00095 |
| 65 | 64.0 | 65.0 | 1.0 | 64.5 | 169.4 | 0.251 | 847.2 | 0.00030 | 0.00030 |
| 66 | 65.0 | 66.0 | 1.0 | 65.5 | 210.1 | 0.254 | 1050.6 | 0.00024 | 0.00024 |
| 67 | 66.0 | 67.0 | 1.0 | 66.5 | 201.3 | 0.256 | 1006.5 | 0.00025 | 0.00025 |
| 68 | 67.0 | 68.0 | 1.0 | 67.5 | 206.9 | 0.258 | 1034.7 | 0.00025 | 0.00025 |
| 69 | 68.0 | 69.0 | 1.0 | 68.5 | 231.6 | 0.261 | 1157.8 | 0.00023 | 0.00023 |
| 70 | 69.0 | 70.0 | 1.0 | 69.5 | 45.9 | 0.263 | 229.6 | 0.00115 | 0.00115 |
| 71 | 70.0 | 71.0 | 1.0 | 70.5 | 47.8 | 0.265 | 239.0 | 0.00111 | 0.00111 |
| 72 | 71.0 | 72.0 | 1.0 | 71.5 | 42.8 | 0.268 | 213.9 | 0.00125 | 0.00125 |
| 73 | 72.0 | 73.0 | 1.0 | 72.5 | 55.7 | 0.270 | 278.3 | 0.00097 | 0.00097 |
| 74 | 73.0 | 74.0 | 1.0 | 73.5 | 88.5 | 0.272 | 442.3 | 0.00062 | 0.00062 |
| 75 | 74.0 | 75.0 | 1.0 | 74.5 | 95.3 | 0.275 | 476.7 | 0.00058 | 0.00058 |
| 76 | 75.0 | 76.0 | 1.0 | 75.5 | 90.6 | 0.277 | 453.2 | 0.00061 | 0.00061 |
| 77 | 76.0 | 77.0 | 1.0 | 76.5 | 69.0 | 0.279 | 345.1 | 0.00081 | 0.00081 |
| 78 | 77.0 | 78.0 | 1.0 | 77.5 | 69.9 | 0.282 | 349.5 | 0.00081 | 0.00081 |
| 79 | 78.0 | 79.0 | 1.0 | 78.5 | 105.4 | 0.284 | 527.1 | 0.00054 | 0.00054 |
| 80 | 79.0 | 80.0 | 1.0 | 79.5 | 40.6 | 0.286 | 202.8 | 0.00141 | 0.00141 |
| 81 | 80.0 | 81.0 | 1.0 | 80.5 | 74.4 | 0.289 | 371.9 | 0.00078 | 0.00078 |
| 82 | 81.0 | 82.0 | 1.0 | 81.5 | 395.3 | 0.291 | 1976.3 | 0.00015 | 0.00015 |
| 83 | 82.0 | 83.0 | 1.0 | 82.5 | 337.1 | 0.293 | 1685.7 | 0.00017 | 0.00017 |
| 84 | 83.0 | 84.0 | 1.0 | 83.5 | 131.7 | 0.296 | 658.5 | 0.00045 | 0.00045 |
| 85 | 84.0 | 85.0 | 1.0 | 84.5 | 171.8 | 0.298 | 859.0 | 0.00035 | 0.00035 |
| 86 | 85.0 | 86.0 | 1.0 | 85.5 | 139.6 | 0.300 | 698.1 | 0.00043 | 0.00043 |
| 87 | 86.0 | 87.0 | 1.0 | 86.5 | 107.2 | 0.303 | 536.2 | 0.00056 | 0.00056 |
| 88 | 87.0 | 88.0 | 1.0 | 87.5 | 142.6 | 0.305 | 713.2 | 0.00043 | 0.00043 |
| 89 | 88.0 | 89.0 | 1.0 | 88.5 | 159.0 | 0.308 | 795.1 | 0.00039 | 0.00039 |
| 90 | 89.0 | 90.0 | 1.0 | 89.5 | 101.7 | 0.310 | 508.4 | 0.00061 | 0.00061 |
| 91 | 90.0 | 91.0 | 1.0 | 90.5 | 113.9 | 0.312 | 569.7 | 0.00055 | 0.00055 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 92 | 91.0 | 92.0 | 1.0 | 91.5 | 128.0 | 0.315 | 639.8 | 0.00049 | 0.00049 | |
| 93 | 92.0 | 93.0 | 1.0 | 92.5 | 132.8 | 0.317 | 663.8 | 0.00048 | 0.00048 | |
| 94 | 93.0 | 94.0 | 1.0 | 93.5 | 201.8 | 0.319 | 1009.1 | 0.00032 | 0.00032 | |
| 95 | 94.0 | 95.0 | 1.0 | 94.5 | 142.9 | 0.322 | 714.4 | 0.00045 | 0.00045 | |
| 96 | 95.0 | 96.0 | 1.0 | 95.5 | 118.3 | 0.324 | 591.6 | 0.00055 | 0.00055 | |
| 97 | 96.0 | 97.0 | 1.0 | 96.5 | 115.9 | 0.326 | 579.7 | 0.00056 | 0.00056 | |
| 98 | 97.0 | 98.0 | 1.0 | 97.5 | 111.7 | 0.329 | 558.5 | 0.00059 | 0.00059 | |
| 99 | 98.0 | 99.0 | 1.0 | 98.5 | 93.3 | 0.331 | 466.7 | 0.00071 | 0.00071 | |
| 100 | 99.0 | 100.0 | 1.0 | 99.5 | 131.0 | 0.333 | 655.2 | 0.00051 | 0.00051 | |
| 101 | 100.0 | 101.0 | 1.0 | 100.5 | 199.1 | 0.336 | 995.3 | 0.00034 | 0.00034 | |
| 102 | 101.0 | 102.0 | 1.0 | 101.5 | 210.6 | 0.338 | 1053.0 | 0.00032 | 0.00032 | |
| 103 | 102.0 | 103.0 | 1.0 | 102.5 | 167.6 | 0.340 | 837.8 | 0.00041 | 0.00041 | |
| 104 | 103.0 | 104.0 | 1.0 | 103.5 | 117.9 | 0.343 | 589.5 | 0.00058 | 0.00058 | |
| 105 | 104.0 | 105.0 | 1.0 | 104.5 | 71.2 | 0.345 | 356.1 | 0.00097 | 0.00097 | |
| 106 | 105.0 | 106.0 | 1.0 | 105.5 | 84.2 | 0.347 | 421.0 | 0.00083 | 0.00083 | |
| 107 | 106.0 | 107.0 | 1.0 | 106.5 | 82.8 | 0.350 | 414.1 | 0.00084 | 0.00084 | |
| 108 | 107.0 | 108.0 | 1.0 | 107.5 | 85.5 | 0.352 | 427.5 | 0.00082 | 0.00082 | |
| 109 | 108.0 | 109.0 | 1.0 | 108.5 | 87.7 | 0.354 | 438.7 | 0.00081 | 0.00081 | |
| 110 | 109.0 | 110.0 | 1.0 | 109.5 | 71.5 | 0.357 | 357.6 | 0.00100 | 0.00100 | |
| 111 | 110.0 | 111.0 | 1.0 | 110.5 | 60.5 | 0.359 | 302.6 | 0.00119 | 0.00119 | |
| 112 | 111.0 | 112.0 | 1.0 | 111.5 | 64.9 | 0.361 | 324.4 | 0.00111 | 0.00111 | |
| 113 | 112.0 | 113.0 | 1.0 | 112.5 | 62.6 | 0.364 | 313.2 | 0.00116 | 0.00116 | |
| 114 | 113.0 | 114.0 | 1.0 | 113.5 | 70.2 | 0.366 | 351.0 | 0.00104 | 0.00104 | |
| 115 | 114.0 | 115.0 | 1.0 | 114.5 | 80.1 | 0.369 | 400.6 | 0.00092 | 0.00092 | |
| 116 | 115.0 | 116.0 | 1.0 | 115.5 | 191.7 | 0.371 | 958.5 | 0.00039 | 0.00039 | |
| 117 | 116.0 | 117.0 | 1.0 | 116.5 | 204.5 | 0.373 | 1022.4 | 0.00037 | 0.00037 | |
| 118 | 117.0 | 118.0 | 1.0 | 117.5 | 508.1 | 0.376 | 2540.5 | 0.00015 | 0.00015 | |
| 119 | 118.0 | 119.0 | 1.0 | 118.5 | 621.5 | 0.378 | 3107.7 | 0.00012 | 0.00012 | |
| 120 | 119.0 | 120.0 | 1.0 | 119.5 | 668.1 | 0.380 | 3340.6 | 0.00011 | 0.00011 | |
| $\Sigma$ = | | | | | | | | | 0.06871 | |

| | |
|---|---|
| $I_{zr}$ $(1 < L/B < 10)$: | $I_{zr} = I_{zs} + 0.111\,(I_{zc} - I_{zs})\,(L/B - 1)$ |
| $I_{zs}$ $(L/B = 1)$: | |
| For $z_{ave}$ = 0 to B/2: | $I_{zs} = 0.1 + (z_{ave}/B)(2I_{zp} - 0.2)$ |
| For $z_{ave}$ = B/2 to 2B: | $I_{zs} = 0.667\,I_{zp}\,(2 - z_{ave}/B)$ |
| $I_{zc}$ $(L/B \geq 10)$: | |
| For $z_{ave}$ = 0 to B: | $I_{zc} = 0.2 + (z_{ave}/B)(I_{zp} - 0.2)$ |
| For $z_{ave}$ = B to 4B: | $I_{zc} = 0.333\,I_{zp}\,(4 - z_{ave}/B)$ ( Coduto p.228. ) |

| | | | | | |
|---|---|---|---|---|---|
| Footing width | B = | | 382.0 | ft | **Z-SDU6-C06** |
| Footing length | L = | | 382.0 | ft | |
| Ground elevation | | | 278.6 | ft | |
| Foundation elevation | | | 265.0 | ft | |
| Ground Water elevation | | | 220.0 | ft | |
| Excavated or embedded depth | D = | | 13.6 | ft | |
| Depth to Groundwater | | | 58.6 | ft | |
| Unit weight | $\gamma$ = | | 120.0 | pcf | |
| Gross Footing Load | | | 5.10 | ksf | |
| Net applied footing pressure | $\Delta p$ = | | **3.468** | ksf | |
| | L/B = | | 1.00 | - | |

Immediate Settlement (in.) ($S_0$ / 2)

| | Load | $S_0$ = |
|---|---|---|
| End of Operations | 5.10 | 0.8 |
| Tank Half Full | 2.80 | 0.2 |
| Pre Closure | 5.50 | 0.9 |
| Post Closure | 8.00 | 1.7 |

**Computation**

| | | | | | |
|---|---|---|---|---|---|
| Settlement | $\rho_i$ = | $C_1 C_t \Delta p \Sigma(\Delta z_i I_{zi}/E_{si})$ | 0.132 | ft | |
| | $\rho_i$ = | $C_t$ = 1 | **1.581** | **in** | |
| | S(t) = | | 0.197 | ft | |
| | S(t) = | | **2.365** | **in** | |
| Correction for strain relief | $C_1$ = | $1 - 0.5(\sigma'_D/q')$ | 0.765 | - | |
| Effective vertical overburden pressure at D | $\sigma'_{vo}$ = | $\gamma$ D | 1.632 | ksf | |
| Correction for time dependent increase | $C_t$ = | 1 + 0.2 log( t / 0.1 ) | 1.50 | - | |
| | t = | | 30.00 | years | |
| Elastic modulus of soil layer i | $E_{si}$ = | 2.5 $q_c$ | see | Column H | if L/B = 1 |
| | $E_{si}$ = | 3.5 $q_c$ | see | Column H | If L/B $\geq$ 10 |
| Depth increment i | $\Delta z_i$ | | see | Column D | |
| Influence factor of soil layer i | $I_{zi}$ | Figure 3-4 | see | Column G | |
| Peak depth influence factor | $I_{zp}$ = | $0.5 + 0.1 (\Delta p/\sigma'_{Izp})^{1/2}$ | 0.547 | - | |
| | $z_p$ = | 0.5B + D | 204.60 | ft | If L/B = 1 |
| | $z_p$ = | B + D | 395.60 | ft | If L/B $\geq$ 10 |
| | $z_p$ = | | 204.60 | ft | for L/B=1.00 |
| Effective overburden pressure at depth Izp | $\sigma'_{Izp}$ = | | 15.44 | ksf | |
| Elastic Modulus | $E_{si}$ = | | 2.50 | $q_c$ | If L/B = 1 |
| | $E_{si}$ = | | 3.50 | $q_c$ | If L/B $\geq$ 10 |
| | $E_{si}$ = | | 2.50 | $q_c$ | for L/B=1.00 |

30 Year Settlement (in.) ($S_{30}$ / 2)

| Load | $S_0$ = |
|---|---|
| 5.10 | 1.2 |
| 8.00 | 2.5 |

Computations made relative to the bottom of foundation

| A | B | C | D | E | F | G | H | I | J | K |
|---|---|---|---|---|---|---|---|---|---|---|
| Layer No. | Layer top depth (ft) | Layer bottom depth (ft) | Layer thickness $\Delta z_i$ (ft) | Mid-layer depth $z_{ave}$ (ft) | Average tip stress $q_c$ (tsf) | $I_{zi}$ | Elastic modulus $E_{si}$ (ksf) | $\Delta z_i I_{zi}/E_{si}$ | $\Delta z_i I_{zi}/E_{si}$ | Notes |
| 1 | 0.0 | 1.0 | 1.0 | 0.5 | 216.7 | 0.101 | 1083.4 | 0.00009 | 0.00009 | |
| 2 | 1.0 | 2.0 | 1.0 | 1.5 | 175.1 | 0.104 | 875.5 | 0.00012 | 0.00012 | |
| 3 | 2.0 | 3.0 | 1.0 | 2.5 | 216.3 | 0.106 | 1081.5 | 0.00010 | 0.00010 | |
| 4 | 3.0 | 4.0 | 1.0 | 3.5 | 222.2 | 0.108 | 1110.8 | 0.00010 | 0.00010 | |
| 5 | 4.0 | 5.0 | 1.0 | 4.5 | 198.3 | 0.111 | 991.3 | 0.00011 | 0.00011 | |
| 6 | 5.0 | 6.0 | 1.0 | 5.5 | 167.5 | 0.113 | 837.7 | 0.00013 | 0.00013 | |
| 7 | 6.0 | 7.0 | 1.0 | 6.5 | 131.7 | 0.115 | 658.6 | 0.00017 | 0.00017 | |
| 8 | 7.0 | 8.0 | 1.0 | 7.5 | 75.0 | 0.118 | 374.9 | 0.00031 | 0.00031 | |
| 9 | 8.0 | 9.0 | 1.0 | 8.5 | 59.6 | 0.120 | 297.9 | 0.00040 | 0.00040 | |
| 10 | 9.0 | 10.0 | 1.0 | 9.5 | 61.7 | 0.122 | 308.4 | 0.00040 | 0.00040 | |
| 11 | 10.0 | 11.0 | 1.0 | 10.5 | 84.2 | 0.125 | 420.9 | 0.00030 | 0.00030 | |
| 12 | 11.0 | 12.0 | 1.0 | 11.5 | 91.6 | 0.127 | 457.8 | 0.00028 | 0.00028 | |
| 13 | 12.0 | 13.0 | 1.0 | 12.5 | 111.5 | 0.129 | 557.6 | 0.00023 | 0.00023 | |
| 14 | 13.0 | 14.0 | 1.0 | 13.5 | 103.0 | 0.132 | 514.9 | 0.00026 | 0.00026 | |
| 15 | 14.0 | 15.0 | 1.0 | 14.5 | 69.7 | 0.134 | 348.3 | 0.00038 | 0.00038 | |
| 16 | 15.0 | 16.0 | 1.0 | 15.5 | 92.9 | 0.136 | 464.7 | 0.00029 | 0.00029 | |
| 17 | 16.0 | 17.0 | 1.0 | 16.5 | 108.9 | 0.139 | 544.5 | 0.00025 | 0.00025 | |
| 18 | 17.0 | 18.0 | 1.0 | 17.5 | 112.0 | 0.141 | 559.9 | 0.00025 | 0.00025 | |
| 19 | 18.0 | 19.0 | 1.0 | 18.5 | 117.5 | 0.143 | 587.3 | 0.00024 | 0.00024 | |
| 20 | 19.0 | 20.0 | 1.0 | 19.5 | 121.0 | 0.146 | 604.9 | 0.00024 | 0.00024 | |
| 21 | 20.0 | 21.0 | 1.0 | 20.5 | 117.9 | 0.148 | 589.3 | 0.00025 | 0.00025 | |
| 22 | 21.0 | 22.0 | 1.0 | 21.5 | 132.1 | 0.150 | 660.7 | 0.00023 | 0.00023 | |
| 23 | 22.0 | 23.0 | 1.0 | 22.5 | 133.5 | 0.153 | 667.6 | 0.00023 | 0.00023 | |
| 24 | 23.0 | 24.0 | 1.0 | 23.5 | 138.6 | 0.155 | 693.2 | 0.00022 | 0.00022 | |
| 25 | 24.0 | 25.0 | 1.0 | 24.5 | 137.1 | 0.157 | 685.4 | 0.00023 | 0.00023 | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 26 | 25.0 | 26.0 | 1.0 | 25.5 | 168.5 | 0.160 | 842.4 | 0.00019 | 0.00019 | |
| 27 | 26.0 | 27.0 | 1.0 | 26.5 | 193.0 | 0.162 | 965.2 | 0.00017 | 0.00017 | |
| 28 | 27.0 | 28.0 | 1.0 | 27.5 | 181.8 | 0.164 | 908.8 | 0.00018 | 0.00018 | |
| 29 | 28.0 | 29.0 | 1.0 | 28.5 | 181.0 | 0.167 | 905.2 | 0.00018 | 0.00018 | |
| 30 | 29.0 | 30.0 | 1.0 | 29.5 | 142.0 | 0.169 | 710.2 | 0.00024 | 0.00024 | |
| 31 | 30.0 | 31.0 | 1.0 | 30.5 | 67.9 | 0.171 | 339.5 | 0.00050 | 0.00050 | |
| 32 | 31.0 | 32.0 | 1.0 | 31.5 | 99.4 | 0.174 | 497.2 | 0.00035 | 0.00035 | |
| 33 | 32.0 | 33.0 | 1.0 | 32.5 | 48.4 | 0.176 | 241.9 | 0.00073 | 0.00073 | |
| 34 | 33.0 | 34.0 | 1.0 | 33.5 | 65.0 | 0.178 | 325.0 | 0.00055 | 0.00055 | |
| 35 | 34.0 | 35.0 | 1.0 | 34.5 | 25.3 | 0.181 | 126.7 | 0.00143 | 0.00143 | |
| 36 | 35.0 | 36.0 | 1.0 | 35.5 | 31.4 | 0.183 | 157.1 | 0.00117 | 0.00117 | |
| 37 | 36.0 | 37.0 | 1.0 | 36.5 | 58.8 | 0.185 | 294.2 | 0.00063 | 0.00063 | |
| 38 | 37.0 | 38.0 | 1.0 | 37.5 | 119.7 | 0.188 | 598.7 | 0.00031 | 0.00031 | |
| 39 | 38.0 | 39.0 | 1.0 | 38.5 | 167.7 | 0.190 | 838.3 | 0.00023 | 0.00023 | |
| 40 | 39.0 | 40.0 | 1.0 | 39.5 | 179.1 | 0.193 | 895.6 | 0.00021 | 0.00021 | |
| 41 | 40.0 | 41.0 | 1.0 | 40.5 | 158.0 | 0.195 | 789.9 | 0.00025 | 0.00025 | |
| 42 | 41.0 | 42.0 | 1.0 | 41.5 | 153.9 | 0.197 | 769.4 | 0.00026 | 0.00026 | |
| 43 | 42.0 | 43.0 | 1.0 | 42.5 | 151.6 | 0.200 | 758.2 | 0.00026 | 0.00026 | |
| 44 | 43.0 | 44.0 | 1.0 | 43.5 | 129.8 | 0.202 | 649.2 | 0.00031 | 0.00031 | |
| 45 | 44.0 | 45.0 | 1.0 | 44.5 | 103.3 | 0.204 | 516.7 | 0.00040 | 0.00040 | |
| 46 | 45.0 | 46.0 | 1.0 | 45.5 | 87.6 | 0.207 | 438.2 | 0.00047 | 0.00047 | |
| 47 | 46.0 | 47.0 | 1.0 | 46.5 | 81.9 | 0.209 | 409.5 | 0.00051 | 0.00051 | |
| 48 | 47.0 | 48.0 | 1.0 | 47.5 | 140.8 | 0.211 | 703.9 | 0.00030 | 0.00030 | |
| 49 | 48.0 | 49.0 | 1.0 | 48.5 | 190.3 | 0.214 | 951.4 | 0.00022 | 0.00022 | |
| 50 | 49.0 | 50.0 | 1.0 | 49.5 | 121.7 | 0.216 | 608.4 | 0.00035 | 0.00035 | |
| 51 | 50.0 | 51.0 | 1.0 | 50.5 | 155.7 | 0.218 | 778.3 | 0.00028 | 0.00028 | |
| 52 | 51.0 | 52.0 | 1.0 | 51.5 | 174.5 | 0.221 | 872.6 | 0.00025 | 0.00025 | |
| 53 | 52.0 | 53.0 | 1.0 | 52.5 | 179.5 | 0.223 | 897.7 | 0.00025 | 0.00025 | |
| 54 | 53.0 | 54.0 | 1.0 | 53.5 | 179.2 | 0.225 | 895.9 | 0.00025 | 0.00025 | |
| 55 | 54.0 | 55.0 | 1.0 | 54.5 | 160.3 | 0.228 | 801.5 | 0.00028 | 0.00028 | |
| 56 | 55.0 | 56.0 | 1.0 | 55.5 | 132.2 | 0.230 | 660.9 | 0.00035 | 0.00035 | |
| 57 | 56.0 | 57.0 | 1.0 | 56.5 | 107.3 | 0.232 | 536.4 | 0.00043 | 0.00043 | |
| 58 | 57.0 | 58.0 | 1.0 | 57.5 | 89.3 | 0.235 | 446.3 | 0.00053 | 0.00053 | |
| 59 | 58.0 | 59.0 | 1.0 | 58.5 | 137.9 | 0.237 | 689.6 | 0.00034 | 0.00034 | |
| 60 | 59.0 | 60.0 | 1.0 | 59.5 | 37.2 | 0.239 | 186.0 | 0.00129 | 0.00129 | |
| 61 | 60.0 | 61.0 | 1.0 | 60.5 | 161.0 | 0.242 | 805.0 | 0.00030 | 0.00030 | |
| 62 | 61.0 | 62.0 | 1.0 | 61.5 | 190.9 | 0.244 | 954.4 | 0.00026 | 0.00026 | |
| 63 | 62.0 | 63.0 | 1.0 | 62.5 | 231.0 | 0.246 | 1155.0 | 0.00021 | 0.00021 | |
| 64 | 63.0 | 64.0 | 1.0 | 63.5 | 213.3 | 0.249 | 1066.4 | 0.00023 | 0.00023 | |
| 65 | 64.0 | 65.0 | 1.0 | 64.5 | 224.2 | 0.251 | 1121.0 | 0.00022 | 0.00022 | |
| 66 | 65.0 | 66.0 | 1.0 | 65.5 | 189.6 | 0.253 | 948.2 | 0.00027 | 0.00027 | |
| 67 | 66.0 | 67.0 | 1.0 | 66.5 | 205.1 | 0.256 | 1025.5 | 0.00025 | 0.00025 | |
| 68 | 67.0 | 68.0 | 1.0 | 67.5 | 247.3 | 0.258 | 1236.6 | 0.00021 | 0.00021 | |
| 69 | 68.0 | 69.0 | 1.0 | 68.5 | 321.7 | 0.260 | 1608.3 | 0.00016 | 0.00016 | |
| 70 | 69.0 | 70.0 | 1.0 | 69.5 | 139.5 | 0.263 | 697.3 | 0.00038 | 0.00038 | |
| 71 | 70.0 | 71.0 | 1.0 | 70.5 | 177.3 | 0.265 | 886.6 | 0.00030 | 0.00030 | |
| 72 | 71.0 | 72.0 | 1.0 | 71.5 | 214.5 | 0.267 | 1072.4 | 0.00025 | 0.00025 | |
| 73 | 72.0 | 73.0 | 1.0 | 72.5 | 204.0 | 0.270 | 1020.1 | 0.00026 | 0.00026 | |
| 74 | 73.0 | 74.0 | 1.0 | 73.5 | 193.7 | 0.272 | 968.3 | 0.00028 | 0.00028 | |
| 75 | 74.0 | 75.0 | 1.0 | 74.5 | 125.3 | 0.275 | 626.7 | 0.00044 | 0.00044 | |
| 76 | 75.0 | 76.0 | 1.0 | 75.5 | 106.2 | 0.277 | 530.9 | 0.00052 | 0.00052 | |
| 77 | 76.0 | 77.0 | 1.0 | 76.5 | 72.8 | 0.279 | 364.0 | 0.00077 | 0.00077 | |
| 78 | 77.0 | 78.0 | 1.0 | 77.5 | 100.9 | 0.282 | 504.6 | 0.00056 | 0.00056 | |
| 79 | 78.0 | 79.0 | 1.0 | 78.5 | 111.6 | 0.284 | 557.8 | 0.00051 | 0.00051 | |
| 80 | 79.0 | 80.0 | 1.0 | 79.5 | 263.2 | 0.286 | 1316.2 | 0.00022 | 0.00022 | |
| 81 | 80.0 | 81.0 | 1.0 | 80.5 | 248.1 | 0.289 | 1240.6 | 0.00023 | 0.00023 | |
| 82 | 81.0 | 82.0 | 1.0 | 81.5 | 431.3 | 0.291 | 2156.3 | 0.00013 | 0.00013 | |
| 83 | 82.0 | 83.0 | 1.0 | 82.5 | 163.1 | 0.293 | 815.3 | 0.00036 | 0.00036 | |
| 84 | 83.0 | 84.0 | 1.0 | 83.5 | 131.7 | 0.296 | 658.5 | 0.00045 | 0.00045 | |
| 85 | 84.0 | 85.0 | 1.0 | 84.5 | 171.8 | 0.298 | 859.0 | 0.00035 | 0.00035 | |
| 86 | 85.0 | 86.0 | 1.0 | 85.5 | 139.6 | 0.300 | 698.1 | 0.00043 | 0.00043 | |
| 87 | 86.0 | 87.0 | 1.0 | 86.5 | 107.2 | 0.303 | 536.2 | 0.00056 | 0.00056 | |
| 88 | 87.0 | 88.0 | 1.0 | 87.5 | 142.6 | 0.305 | 713.2 | 0.00043 | 0.00043 | |
| 89 | 88.0 | 89.0 | 1.0 | 88.5 | 159.0 | 0.307 | 795.1 | 0.00039 | 0.00039 | |
| 90 | 89.0 | 90.0 | 1.0 | 89.5 | 101.7 | 0.310 | 508.4 | 0.00061 | 0.00061 | |
| 91 | 90.0 | 91.0 | 1.0 | 90.5 | 113.9 | 0.312 | 569.7 | 0.00055 | 0.00055 | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 92 | 91.0 | 92.0 | 1.0 | 91.5 | 128.0 | 0.314 | 639.8 | 0.00049 | 0.00049 | |
| 93 | 92.0 | 93.0 | 1.0 | 92.5 | 132.8 | 0.317 | 663.8 | 0.00048 | 0.00048 | |
| 94 | 93.0 | 94.0 | 1.0 | 93.5 | 201.8 | 0.319 | 1009.1 | 0.00032 | 0.00032 | |
| 95 | 94.0 | 95.0 | 1.0 | 94.5 | 142.9 | 0.321 | 714.4 | 0.00045 | 0.00045 | |
| 96 | 95.0 | 96.0 | 1.0 | 95.5 | 118.3 | 0.324 | 591.6 | 0.00055 | 0.00055 | |
| 97 | 96.0 | 97.0 | 1.0 | 96.5 | 115.9 | 0.326 | 579.7 | 0.00056 | 0.00056 | |
| 98 | 97.0 | 98.0 | 1.0 | 97.5 | 111.7 | 0.328 | 558.5 | 0.00059 | 0.00059 | |
| 99 | 98.0 | 99.0 | 1.0 | 98.5 | 93.3 | 0.331 | 466.7 | 0.00071 | 0.00071 | |
| 100 | 99.0 | 100.0 | 1.0 | 99.5 | 131.0 | 0.333 | 655.2 | 0.00051 | 0.00051 | |
| 101 | 100.0 | 101.0 | 1.0 | 100.5 | 199.1 | 0.335 | 995.3 | 0.00034 | 0.00034 | |
| 102 | 101.0 | 102.0 | 1.0 | 101.5 | 210.6 | 0.338 | 1053.0 | 0.00032 | 0.00032 | |
| 103 | 102.0 | 103.0 | 1.0 | 102.5 | 167.6 | 0.340 | 837.8 | 0.00041 | 0.00041 | |
| 104 | 103.0 | 104.0 | 1.0 | 103.5 | 117.9 | 0.342 | 589.5 | 0.00058 | 0.00058 | |
| 105 | 104.0 | 105.0 | 1.0 | 104.5 | 71.2 | 0.345 | 356.1 | 0.00097 | 0.00097 | |
| 106 | 105.0 | 106.0 | 1.0 | 105.5 | 84.2 | 0.347 | 421.0 | 0.00082 | 0.00082 | |
| 107 | 106.0 | 107.0 | 1.0 | 106.5 | 82.8 | 0.349 | 414.1 | 0.00084 | 0.00084 | |
| 108 | 107.0 | 108.0 | 1.0 | 107.5 | 85.5 | 0.352 | 427.5 | 0.00082 | 0.00082 | |
| 109 | 108.0 | 109.0 | 1.0 | 108.5 | 87.7 | 0.354 | 438.7 | 0.00081 | 0.00081 | |
| 110 | 109.0 | 110.0 | 1.0 | 109.5 | 71.5 | 0.356 | 357.6 | 0.00100 | 0.00100 | |
| 111 | 110.0 | 111.0 | 1.0 | 110.5 | 60.5 | 0.359 | 302.6 | 0.00119 | 0.00119 | |
| 112 | 111.0 | 112.0 | 1.0 | 111.5 | 64.9 | 0.361 | 324.4 | 0.00111 | 0.00111 | |
| 113 | 112.0 | 113.0 | 1.0 | 112.5 | 62.6 | 0.364 | 313.2 | 0.00116 | 0.00116 | |
| 114 | 113.0 | 114.0 | 1.0 | 113.5 | 70.2 | 0.366 | 351.0 | 0.00104 | 0.00104 | |
| 115 | 114.0 | 115.0 | 1.0 | 114.5 | 80.1 | 0.368 | 400.6 | 0.00092 | 0.00092 | |
| 116 | 115.0 | 116.0 | 1.0 | 115.5 | 191.7 | 0.371 | 958.5 | 0.00039 | 0.00039 | |
| 117 | 116.0 | 117.0 | 1.0 | 116.5 | 204.5 | 0.373 | 1022.4 | 0.00036 | 0.00036 | |
| 118 | 117.0 | 118.0 | 1.0 | 117.5 | 508.1 | 0.375 | 2540.5 | 0.00015 | 0.00015 | |
| 119 | 118.0 | 119.0 | 1.0 | 118.5 | 621.5 | 0.378 | 3107.7 | 0.00012 | 0.00012 | |
| 120 | 119.0 | 120.0 | 1.0 | 119.5 | 668.1 | 0.380 | 3340.6 | 0.00011 | 0.00011 | |
| $\Sigma$ = | | | | | | | | | 0.04969 | |

$I_{zr}$ (1 < L/B < 10): $I_{zr} = I_{zs} + 0.111\,(I_{zc} - I_{zs})\,(L/B - 1)$

$I_{zs}$ (L/B = 1):

For $z_{ave}$ = 0 to B/2: $I_{zs} = 0.1 + (z_{ave}/B)(2I_{zp} - 0.2)$

For $z_{ave}$ = B/2 to 2B: $I_{zs} = 0.667\, I_{zp}\,(2 - z_{ave}/B)$

$I_{zc}$ (L/B $\geq$ 10):

For $z_{ave}$ = 0 to B: $I_{zc} = 0.2 + (z_{ave}/B)(I_{zp} - 0.2)$

For $z_{ave}$ = B to 4B: $I_{zc} = 0.333\, I_{zp}\,(4 - z_{ave}/B)$ ( Coduto p.228. )

| | | | | | |
|---|---|---|---|---|---|
| Footing width | B = | | 382.0 | ft | **Z-SDU6-C07** |
| Footing length | L = | | 382.0 | ft | |
| Ground elevation | | | 279.4 | ft | |
| Foundation elevation | | | 265.0 | ft | |
| Ground Water elevation | | | 220.0 | ft | |
| Excavated or embedded depth | D = | | 14.4 | ft | |
| Depth to Groundwater | | | 59.4 | ft | |
| Unit weight | $\gamma$ = | | 120.0 | pcf | |
| Gross Footing Load | | | 5.10 | ksf | |
| Net applied footing pressure | $\Delta p$ = | | **3.372** | ksf | |
| | L/B = | | 1.00 | - | |

Immediate Settlement (in.) ($S_0$ / 2)

| | Load | $S_0$ = |
|---|---|---|
| End of Operations | 5.10 | 0.8 |
| Tank Half Full | 2.80 | 0.2 |
| Pre Closure | 5.50 | 0.9 |
| Post Closure | 8.00 | 1.7 |

30 Year Settlement (in.) ($S_{30}$ / 2)

| Load | $S_0$ = |
|---|---|
| 5.10 | 1.2 |
| 8.00 | 2.6 |

**Computation**

| | | | | | |
|---|---|---|---|---|---|
| Settlement | $\rho_i$ = | $C_1 C_t \Delta p \, \Sigma(\Delta z_i I_{zi}/E_{si})$ | 0.132 | ft | |
| | $\rho_i$ = | $C_t$ = 1 | **1.586** | **in** | |
| | S(t) = | | 0.198 | ft | |
| | S(t) = | | **2.372** | **in** | |
| Correction for strain relief | $C_1$ = | $1 - 0.5(\sigma'_D/q')$ | 0.744 | - | |
| Effective vertical overburden pressure at D | $\sigma'_{vo}$ = | $\gamma$ D | 1.728 | ksf | |
| Correction for time dependent increase | $C_t$ = | 1 + 0.2 log( t / 0.1 ) | 1.50 | - | |
| | t = | | 30.00 | years | |
| Elastic modulus of soil layer i | $E_{si}$ = | 2.5 $q_c$ | see | Column H | if L/B = 1 |
| | $E_{si}$ = | 3.5 $q_c$ | see | Column H | If L/B $\geq$ 10 |
| Depth increment i | $\Delta z_i$ | | see | Column D | |
| Influence factor of soil layer i | $I_{zi}$ | Figure 3-4 | see | Column G | |
| Peak depth influence factor | $I_{zp}$ = | $0.5 + 0.1 (\Delta p/\sigma'_{Izp})^{1/2}$ | 0.547 | - | |
| | $z_p$ = | 0.5B + D | 205.40 | ft | If L/B = 1 |
| | $z_p$ = | B + D | 396.40 | ft | If L/B $\geq$ 10 |
| | $z_p$ = | | 205.40 | ft | for L/B=1.00 |
| Effective overburden pressure at depth Izp | $\sigma'_{Izp}$ = | | 15.54 | ksf | |
| Elastic Modulus | $E_{si}$ = | | 2.50 | $q_c$ | If L/B = 1 |
| | $E_{si}$ = | | 3.50 | $q_c$ | If L/B $\geq$ 10 |
| | $E_{si}$ = | | 2.50 | $q_c$ | for L/B=1.00 |

Computations made relative to the bottom of foundation

| A | B | C | D | E | F | G | H | I | J | K |
|---|---|---|---|---|---|---|---|---|---|---|
| Layer No. | Layer top depth (ft) | Layer bottom depth (ft) | Layer thickness $\Delta z_i$ (ft) | Mid-layer depth $z_{ave}$ (ft) | Average tip stress $q_c$ (tsf) | $I_{zi}$ | Elastic modulus $E_{si}$ (ksf) | $\Delta z_i I_{zi}/E_{si}$ | $\Delta z_i I_{zi}/E_{si}$ | Notes |
| 1 | 0.0 | 1.0 | 1.0 | 0.5 | 140.7 | 0.101 | 703.4 | 0.00014 | 0.00014 | |
| 2 | 1.0 | 2.0 | 1.0 | 1.5 | 173.2 | 0.104 | 866.2 | 0.00012 | 0.00012 | |
| 3 | 2.0 | 3.0 | 1.0 | 2.5 | 149.8 | 0.106 | 748.8 | 0.00014 | 0.00014 | |
| 4 | 3.0 | 4.0 | 1.0 | 3.5 | 144.9 | 0.108 | 724.7 | 0.00015 | 0.00015 | |
| 5 | 4.0 | 5.0 | 1.0 | 4.5 | 150.2 | 0.111 | 750.9 | 0.00015 | 0.00015 | |
| 6 | 5.0 | 6.0 | 1.0 | 5.5 | 123.5 | 0.113 | 617.6 | 0.00018 | 0.00018 | |
| 7 | 6.0 | 7.0 | 1.0 | 6.5 | 142.2 | 0.115 | 711.1 | 0.00016 | 0.00016 | |
| 8 | 7.0 | 8.0 | 1.0 | 7.5 | 80.1 | 0.118 | 400.6 | 0.00029 | 0.00029 | |
| 9 | 8.0 | 9.0 | 1.0 | 8.5 | 90.7 | 0.120 | 453.7 | 0.00026 | 0.00026 | |
| 10 | 9.0 | 10.0 | 1.0 | 9.5 | 126.6 | 0.122 | 633.1 | 0.00019 | 0.00019 | |
| 11 | 10.0 | 11.0 | 1.0 | 10.5 | 128.2 | 0.125 | 641.1 | 0.00019 | 0.00019 | |
| 12 | 11.0 | 12.0 | 1.0 | 11.5 | 118.9 | 0.127 | 594.4 | 0.00021 | 0.00021 | |
| 13 | 12.0 | 13.0 | 1.0 | 12.5 | 119.6 | 0.129 | 597.9 | 0.00022 | 0.00022 | |
| 14 | 13.0 | 14.0 | 1.0 | 13.5 | 120.9 | 0.132 | 604.5 | 0.00022 | 0.00022 | |
| 15 | 14.0 | 15.0 | 1.0 | 14.5 | 123.5 | 0.134 | 617.3 | 0.00022 | 0.00022 | |
| 16 | 15.0 | 16.0 | 1.0 | 15.5 | 143.0 | 0.136 | 715.2 | 0.00019 | 0.00019 | |
| 17 | 16.0 | 17.0 | 1.0 | 16.5 | 163.0 | 0.139 | 815.2 | 0.00017 | 0.00017 | |
| 18 | 17.0 | 18.0 | 1.0 | 17.5 | 142.4 | 0.141 | 712.2 | 0.00020 | 0.00020 | |
| 19 | 18.0 | 19.0 | 1.0 | 18.5 | 150.9 | 0.143 | 754.4 | 0.00019 | 0.00019 | |
| 20 | 19.0 | 20.0 | 1.0 | 19.5 | 213.4 | 0.146 | 1067.2 | 0.00014 | 0.00014 | |
| 21 | 20.0 | 21.0 | 1.0 | 20.5 | 209.4 | 0.148 | 1047.1 | 0.00014 | 0.00014 | |
| 22 | 21.0 | 22.0 | 1.0 | 21.5 | 203.9 | 0.150 | 1019.7 | 0.00015 | 0.00015 | |
| 23 | 22.0 | 23.0 | 1.0 | 22.5 | 233.6 | 0.153 | 1167.9 | 0.00013 | 0.00013 | |
| 24 | 23.0 | 24.0 | 1.0 | 23.5 | 155.7 | 0.155 | 778.3 | 0.00020 | 0.00020 | |
| 25 | 24.0 | 25.0 | 1.0 | 24.5 | 231.6 | 0.157 | 1158.1 | 0.00014 | 0.00014 | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 26 | 25.0 | 26.0 | 1.0 | 25.5 | 210.9 | 0.160 | 1054.7 | 0.00015 | 0.00015 |
| 27 | 26.0 | 27.0 | 1.0 | 26.5 | 125.9 | 0.162 | 629.5 | 0.00026 | 0.00026 |
| 28 | 27.0 | 28.0 | 1.0 | 27.5 | 54.6 | 0.164 | 272.9 | 0.00060 | 0.00060 |
| 29 | 28.0 | 29.0 | 1.0 | 28.5 | 59.7 | 0.167 | 298.7 | 0.00056 | 0.00056 |
| 30 | 29.0 | 30.0 | 1.0 | 29.5 | 47.1 | 0.169 | 235.3 | 0.00072 | 0.00072 |
| 31 | 30.0 | 31.0 | 1.0 | 30.5 | 95.2 | 0.171 | 476.0 | 0.00036 | 0.00036 |
| 32 | 31.0 | 32.0 | 1.0 | 31.5 | 51.9 | 0.174 | 259.4 | 0.00067 | 0.00067 |
| 33 | 32.0 | 33.0 | 1.0 | 32.5 | 34.1 | 0.176 | 170.4 | 0.00103 | 0.00103 |
| 34 | 33.0 | 34.0 | 1.0 | 33.5 | 41.9 | 0.178 | 209.4 | 0.00085 | 0.00085 |
| 35 | 34.0 | 35.0 | 1.0 | 34.5 | 138.3 | 0.181 | 691.4 | 0.00026 | 0.00026 |
| 36 | 35.0 | 36.0 | 1.0 | 35.5 | 195.6 | 0.183 | 978.2 | 0.00019 | 0.00019 |
| 37 | 36.0 | 37.0 | 1.0 | 36.5 | 232.8 | 0.185 | 1163.8 | 0.00016 | 0.00016 |
| 38 | 37.0 | 38.0 | 1.0 | 37.5 | 203.2 | 0.188 | 1015.8 | 0.00018 | 0.00018 |
| 39 | 38.0 | 39.0 | 1.0 | 38.5 | 213.6 | 0.190 | 1067.8 | 0.00018 | 0.00018 |
| 40 | 39.0 | 40.0 | 1.0 | 39.5 | 186.3 | 0.192 | 931.7 | 0.00021 | 0.00021 |
| 41 | 40.0 | 41.0 | 1.0 | 40.5 | 171.7 | 0.195 | 858.3 | 0.00023 | 0.00023 |
| 42 | 41.0 | 42.0 | 1.0 | 41.5 | 197.8 | 0.197 | 989.0 | 0.00020 | 0.00020 |
| 43 | 42.0 | 43.0 | 1.0 | 42.5 | 196.0 | 0.199 | 980.1 | 0.00020 | 0.00020 |
| 44 | 43.0 | 44.0 | 1.0 | 43.5 | 166.0 | 0.202 | 830.0 | 0.00024 | 0.00024 |
| 45 | 44.0 | 45.0 | 1.0 | 44.5 | 163.0 | 0.204 | 814.9 | 0.00025 | 0.00025 |
| 46 | 45.0 | 46.0 | 1.0 | 45.5 | 172.7 | 0.206 | 863.3 | 0.00024 | 0.00024 |
| 47 | 46.0 | 47.0 | 1.0 | 46.5 | 85.3 | 0.209 | 426.4 | 0.00049 | 0.00049 |
| 48 | 47.0 | 48.0 | 1.0 | 47.5 | 90.1 | 0.211 | 450.7 | 0.00047 | 0.00047 |
| 49 | 48.0 | 49.0 | 1.0 | 48.5 | 210.6 | 0.213 | 1053.0 | 0.00020 | 0.00020 |
| 50 | 49.0 | 50.0 | 1.0 | 49.5 | 265.0 | 0.216 | 1325.1 | 0.00016 | 0.00016 |
| 51 | 50.0 | 51.0 | 1.0 | 50.5 | 271.0 | 0.218 | 1355.2 | 0.00016 | 0.00016 |
| 52 | 51.0 | 52.0 | 1.0 | 51.5 | 275.5 | 0.220 | 1377.7 | 0.00016 | 0.00016 |
| 53 | 52.0 | 53.0 | 1.0 | 52.5 | 273.9 | 0.223 | 1369.7 | 0.00016 | 0.00016 |
| 54 | 53.0 | 54.0 | 1.0 | 53.5 | 266.4 | 0.225 | 1332.0 | 0.00017 | 0.00017 |
| 55 | 54.0 | 55.0 | 1.0 | 54.5 | 275.7 | 0.227 | 1378.6 | 0.00016 | 0.00016 |
| 56 | 55.0 | 56.0 | 1.0 | 55.5 | 274.9 | 0.230 | 1374.5 | 0.00017 | 0.00017 |
| 57 | 56.0 | 57.0 | 1.0 | 56.5 | 277.2 | 0.232 | 1386.0 | 0.00017 | 0.00017 |
| 58 | 57.0 | 58.0 | 1.0 | 57.5 | 269.3 | 0.234 | 1346.3 | 0.00017 | 0.00017 |
| 59 | 58.0 | 59.0 | 1.0 | 58.5 | 238.8 | 0.237 | 1194.1 | 0.00020 | 0.00020 |
| 60 | 59.0 | 60.0 | 1.0 | 59.5 | 157.4 | 0.239 | 787.0 | 0.00030 | 0.00030 |
| 61 | 60.0 | 61.0 | 1.0 | 60.5 | 56.5 | 0.241 | 282.4 | 0.00086 | 0.00086 |
| 62 | 61.0 | 62.0 | 1.0 | 61.5 | 77.4 | 0.244 | 387.2 | 0.00063 | 0.00063 |
| 63 | 62.0 | 63.0 | 1.0 | 62.5 | 140.0 | 0.246 | 700.1 | 0.00035 | 0.00035 |
| 64 | 63.0 | 64.0 | 1.0 | 63.5 | 251.3 | 0.248 | 1256.4 | 0.00020 | 0.00020 |
| 65 | 64.0 | 65.0 | 1.0 | 64.5 | 333.5 | 0.251 | 1667.5 | 0.00015 | 0.00015 |
| 66 | 65.0 | 66.0 | 1.0 | 65.5 | 290.0 | 0.253 | 1449.9 | 0.00017 | 0.00017 |
| 67 | 66.0 | 67.0 | 1.0 | 66.5 | 229.6 | 0.255 | 1147.9 | 0.00022 | 0.00022 |
| 68 | 67.0 | 68.0 | 1.0 | 67.5 | 182.1 | 0.258 | 910.7 | 0.00028 | 0.00028 |
| 69 | 68.0 | 69.0 | 1.0 | 68.5 | 161.5 | 0.260 | 807.4 | 0.00032 | 0.00032 |
| 70 | 69.0 | 70.0 | 1.0 | 69.5 | 102.3 | 0.263 | 511.3 | 0.00051 | 0.00051 |
| 71 | 70.0 | 71.0 | 1.0 | 70.5 | 12.4 | 0.265 | 61.8 | 0.00429 | 0.00429 |
| 72 | 71.0 | 72.0 | 1.0 | 71.5 | 17.8 | 0.267 | 89.1 | 0.00300 | 0.00300 |
| 73 | 72.0 | 73.0 | 1.0 | 72.5 | 76.4 | 0.270 | 382.0 | 0.00071 | 0.00071 |
| 74 | 73.0 | 74.0 | 1.0 | 73.5 | 141.5 | 0.272 | 707.5 | 0.00038 | 0.00038 |
| 75 | 74.0 | 75.0 | 1.0 | 74.5 | 149.6 | 0.274 | 748.0 | 0.00037 | 0.00037 |
| 76 | 75.0 | 76.0 | 1.0 | 75.5 | 185.2 | 0.277 | 925.9 | 0.00030 | 0.00030 |
| 77 | 76.0 | 77.0 | 1.0 | 76.5 | 141.1 | 0.279 | 705.7 | 0.00040 | 0.00040 |
| 78 | 77.0 | 78.0 | 1.0 | 77.5 | 92.9 | 0.281 | 464.6 | 0.00061 | 0.00061 |
| 79 | 78.0 | 79.0 | 1.0 | 78.5 | 166.9 | 0.284 | 834.6 | 0.00034 | 0.00034 |
| 80 | 79.0 | 80.0 | 1.0 | 79.5 | 91.8 | 0.286 | 459.1 | 0.00062 | 0.00062 |
| 81 | 80.0 | 81.0 | 1.0 | 80.5 | 184.4 | 0.288 | 921.8 | 0.00031 | 0.00031 |
| 82 | 81.0 | 82.0 | 1.0 | 81.5 | 589.3 | 0.291 | 2946.5 | 0.00010 | 0.00010 |
| 83 | 82.0 | 83.0 | 1.0 | 82.5 | 163.1 | 0.293 | 815.3 | 0.00036 | 0.00036 |
| 84 | 83.0 | 84.0 | 1.0 | 83.5 | 131.7 | 0.295 | 658.5 | 0.00045 | 0.00045 |
| 85 | 84.0 | 85.0 | 1.0 | 84.5 | 171.8 | 0.298 | 859.0 | 0.00035 | 0.00035 |
| 86 | 85.0 | 86.0 | 1.0 | 85.5 | 139.6 | 0.300 | 698.1 | 0.00043 | 0.00043 |
| 87 | 86.0 | 87.0 | 1.0 | 86.5 | 107.2 | 0.302 | 536.2 | 0.00056 | 0.00056 |
| 88 | 87.0 | 88.0 | 1.0 | 87.5 | 142.6 | 0.305 | 713.2 | 0.00043 | 0.00043 |
| 89 | 88.0 | 89.0 | 1.0 | 88.5 | 159.0 | 0.307 | 795.1 | 0.00039 | 0.00039 |
| 90 | 89.0 | 90.0 | 1.0 | 89.5 | 101.7 | 0.309 | 508.4 | 0.00061 | 0.00061 |
| 91 | 90.0 | 91.0 | 1.0 | 90.5 | 113.9 | 0.312 | 569.7 | 0.00055 | 0.00055 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 92 | 91.0 | 92.0 | 1.0 | 91.5 | 128.0 | 0.314 | 639.8 | 0.00049 | 0.00049 | |
| 93 | 92.0 | 93.0 | 1.0 | 92.5 | 132.8 | 0.316 | 663.8 | 0.00048 | 0.00048 | |
| 94 | 93.0 | 94.0 | 1.0 | 93.5 | 201.8 | 0.319 | 1009.1 | 0.00032 | 0.00032 | |
| 95 | 94.0 | 95.0 | 1.0 | 94.5 | 142.9 | 0.321 | 714.4 | 0.00045 | 0.00045 | |
| 96 | 95.0 | 96.0 | 1.0 | 95.5 | 118.3 | 0.323 | 591.6 | 0.00055 | 0.00055 | |
| 97 | 96.0 | 97.0 | 1.0 | 96.5 | 115.9 | 0.326 | 579.7 | 0.00056 | 0.00056 | |
| 98 | 97.0 | 98.0 | 1.0 | 97.5 | 111.7 | 0.328 | 558.5 | 0.00059 | 0.00059 | |
| 99 | 98.0 | 99.0 | 1.0 | 98.5 | 93.3 | 0.330 | 466.7 | 0.00071 | 0.00071 | |
| 100 | 99.0 | 100.0 | 1.0 | 99.5 | 131.0 | 0.333 | 655.2 | 0.00051 | 0.00051 | |
| 101 | 100.0 | 101.0 | 1.0 | 100.5 | 199.1 | 0.335 | 995.3 | 0.00034 | 0.00034 | |
| 102 | 101.0 | 102.0 | 1.0 | 101.5 | 210.6 | 0.337 | 1053.0 | 0.00032 | 0.00032 | |
| 103 | 102.0 | 103.0 | 1.0 | 102.5 | 167.6 | 0.340 | 837.8 | 0.00041 | 0.00041 | |
| 104 | 103.0 | 104.0 | 1.0 | 103.5 | 117.9 | 0.342 | 589.5 | 0.00058 | 0.00058 | |
| 105 | 104.0 | 105.0 | 1.0 | 104.5 | 71.2 | 0.344 | 356.1 | 0.00097 | 0.00097 | |
| 106 | 105.0 | 106.0 | 1.0 | 105.5 | 84.2 | 0.347 | 421.0 | 0.00082 | 0.00082 | |
| 107 | 106.0 | 107.0 | 1.0 | 106.5 | 82.8 | 0.349 | 414.1 | 0.00084 | 0.00084 | |
| 108 | 107.0 | 108.0 | 1.0 | 107.5 | 85.5 | 0.351 | 427.5 | 0.00082 | 0.00082 | |
| 109 | 108.0 | 109.0 | 1.0 | 108.5 | 87.7 | 0.354 | 438.7 | 0.00081 | 0.00081 | |
| 110 | 109.0 | 110.0 | 1.0 | 109.5 | 71.5 | 0.356 | 357.6 | 0.00100 | 0.00100 | |
| 111 | 110.0 | 111.0 | 1.0 | 110.5 | 60.5 | 0.358 | 302.6 | 0.00118 | 0.00118 | |
| 112 | 111.0 | 112.0 | 1.0 | 111.5 | 64.9 | 0.361 | 324.4 | 0.00111 | 0.00111 | |
| 113 | 112.0 | 113.0 | 1.0 | 112.5 | 62.6 | 0.363 | 313.2 | 0.00116 | 0.00116 | |
| 114 | 113.0 | 114.0 | 1.0 | 113.5 | 70.2 | 0.365 | 351.0 | 0.00104 | 0.00104 | |
| 115 | 114.0 | 115.0 | 1.0 | 114.5 | 80.1 | 0.368 | 400.6 | 0.00092 | 0.00092 | |
| 116 | 115.0 | 116.0 | 1.0 | 115.5 | 191.7 | 0.370 | 958.5 | 0.00039 | 0.00039 | |
| 117 | 116.0 | 117.0 | 1.0 | 116.5 | 204.5 | 0.372 | 1022.4 | 0.00036 | 0.00036 | |
| 118 | 117.0 | 118.0 | 1.0 | 117.5 | 508.1 | 0.375 | 2540.5 | 0.00015 | 0.00015 | |
| 119 | 118.0 | 119.0 | 1.0 | 118.5 | 621.5 | 0.377 | 3107.7 | 0.00012 | 0.00012 | |
| 120 | 119.0 | 120.0 | 1.0 | 119.5 | 668.1 | 0.379 | 3340.6 | 0.00011 | 0.00011 | |
| $\Sigma$ = | | | | | | | | | 0.05271 | |

| | |
|---|---|
| $I_{zr}$ $(1 < L/B < 10)$: | $I_{zr} = I_{zs} + 0.111\,(I_{zc} - I_{zs})\,(L/B - 1)$ |
| $I_{zs}$ $(L/B = 1)$: | |
| For $z_{ave} = 0$ to $B/2$: | $I_{zs} = 0.1 + (z_{ave}/B)(2I_{zp} - 0.2)$ |
| For $z_{ave} = B/2$ to $2B$: | $I_{zs} = 0.667\,I_{zp}\,(2 - z_{ave}/B)$ |
| $I_{zc}$ $(L/B \geq 10)$: | |
| For $z_{ave} = 0$ to $B$: | $I_{zc} = 0.2 + (z_{ave}/B)(I_{zp} - 0.2)$ |
| For $z_{ave} = B$ to $4B$: | $I_{zc} = 0.333\,I_{zp}\,(4 - z_{ave}/B)$ ( Coduto p.228. ) |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Footing width | B = | | 382.0 | ft | **Z-SDU6-C08** | | | |
| Footing length | L = | | 382.0 | ft | | Immediate | | |
| Ground elevation | | | 279.7 | ft | | Settlement (in.) | | |
| Foundation elevation | | | 265.0 | ft | | $(S_0 / 2)$ | | |
| Ground Water elevation | | | 220.0 | ft | | Load | $S_0$ = | |
| Excavated or embedded depth | D = | | 14.7 | ft | End of Operations | 5.10 | 1.0 | |
| Depth to Groundwater | | | 59.7 | ft | Tank Half Full | 2.80 | 0.2 | |
| Unit weight | $\gamma$ = | | 120.0 | pcf | Pre Closure | 5.50 | 1.2 | |
| Gross Footing Load | | | 5.10 | ksf | Post Closure | 8.00 | 2.3 | |
| Net applied footing pressure | $\Delta p$ = | | **3.336** | ksf | | | | |
| | L/B = | | 1.00 | - | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | 30 Year | |
| **Computation** | | | | | | Settlement (in.) | |
| Settlement | $\rho_i$ = | $C_1 C_t \Delta p \Sigma(\Delta z_i I_{zi}/E_{si})$ | 0.169 | ft | | $(S_{30} / 2)$ | |
| | $\rho_i$ = | $C_t$ = 1 | **2.034** | **in** | | Load | $S_0$ = |
| | S(t) = | | 0.253 | ft | | 5.10 | 1.5 |
| | S(t) = | | **3.041** | **in** | | 8.00 | 3.4 |
| Correction for strain relief | $C_1$ = | $1 - 0.5(\sigma'_D/q')$ | 0.736 | - | | | |
| Effective vertical overburden pressure at D | $\sigma'_{vo}$ = | $\gamma$ D | 1.764 | ksf | | | |
| Correction for time dependent increase | $C_t$ = | 1 + 0.2 log( t / 0.1 ) | 1.50 | - | | | |
| | t = | | 30.00 | years | | | |
| Elastic modulus of soil layer i | $E_{si}$ = | 2.5 $q_c$ | see | Column H | if L/B = 1 | | |
| | $E_{si}$ = | 3.5 $q_c$ | see | Column H | If L/B $\geq$ 10 | | |
| Depth increment i | $\Delta z_i$ | | see | Column D | | | |
| Influence factor of soil layer i | $I_{zi}$ | Figure 3-4 | see | Column G | | | |
| Peak depth influence factor | $I_{zp}$ = | $0.5 + 0.1 (\Delta p/\sigma'_{Izp})^{1/2}$ | 0.546 | - | | | |
| | $z_p$ = | 0.5B + D | 205.70 | ft | If L/B = 1 | | |
| | $z_p$ = | B + D | 396.70 | ft | If L/B $\geq$ 10 | | |
| | $z_p$ = | | 205.70 | ft | for L/B=1.00 | | |
| Effective overburden pressure at depth Izp | $\sigma'_{Izp}$ = | | 15.57 | ksf | | | |
| Elastic Modulus | $E_{si}$ = | | 2.50 | $q_c$ | If L/B = 1 | | |
| | $E_{si}$ = | | 3.50 | $q_c$ | If L/B $\geq$ 10 | | |
| | $E_{si}$ = | | 2.50 | $q_c$ | for L/B=1.00 | | |

Computations made relative to the bottom of foundation

| A | B | C | D | E | F | G | H | I | J | K |
|---|---|---|---|---|---|---|---|---|---|---|
| Layer No. | Layer top depth (ft) | Layer bottom depth (ft) | Layer thickness $\Delta z_i$ (ft) | Mid-layer depth $z_{ave}$ (ft) | Average tip stress $q_c$ (tsf) | $I_{zi}$ | Elastic modulus $E_{si}$ (ksf) | $\Delta z_i I_{zi}/E_{si}$ | $\Delta z_i I_{zi}/E_{si}$ | Notes |
| 1 | 0.0 | 1.0 | 1.0 | 0.5 | 126.3 | 0.101 | 631.7 | 0.00016 | 0.00016 | |
| 2 | 1.0 | 2.0 | 1.0 | 1.5 | 116.6 | 0.104 | 583.0 | 0.00018 | 0.00018 | |
| 3 | 2.0 | 3.0 | 1.0 | 2.5 | 103.2 | 0.106 | 516.0 | 0.00021 | 0.00021 | |
| 4 | 3.0 | 4.0 | 1.0 | 3.5 | 113.5 | 0.108 | 567.3 | 0.00019 | 0.00019 | |
| 5 | 4.0 | 5.0 | 1.0 | 4.5 | 116.7 | 0.111 | 583.6 | 0.00019 | 0.00019 | |
| 6 | 5.0 | 6.0 | 1.0 | 5.5 | 93.7 | 0.113 | 468.7 | 0.00024 | 0.00024 | |
| 7 | 6.0 | 7.0 | 1.0 | 6.5 | 51.8 | 0.115 | 259.1 | 0.00044 | 0.00044 | |
| 8 | 7.0 | 8.0 | 1.0 | 7.5 | 29.8 | 0.118 | 149.2 | 0.00079 | 0.00079 | |
| 9 | 8.0 | 9.0 | 1.0 | 8.5 | 48.3 | 0.120 | 241.5 | 0.00050 | 0.00050 | |
| 10 | 9.0 | 10.0 | 1.0 | 9.5 | 97.5 | 0.122 | 487.7 | 0.00025 | 0.00025 | |
| 11 | 10.0 | 11.0 | 1.0 | 10.5 | 61.2 | 0.125 | 306.0 | 0.00041 | 0.00041 | |
| 12 | 11.0 | 12.0 | 1.0 | 11.5 | 48.6 | 0.127 | 242.8 | 0.00052 | 0.00052 | |
| 13 | 12.0 | 13.0 | 1.0 | 12.5 | 72.1 | 0.129 | 360.4 | 0.00036 | 0.00036 | |
| 14 | 13.0 | 14.0 | 1.0 | 13.5 | 72.1 | 0.132 | 360.7 | 0.00036 | 0.00036 | |
| 15 | 14.0 | 15.0 | 1.0 | 14.5 | 74.7 | 0.134 | 373.5 | 0.00036 | 0.00036 | |
| 16 | 15.0 | 16.0 | 1.0 | 15.5 | 84.2 | 0.136 | 420.9 | 0.00032 | 0.00032 | |
| 17 | 16.0 | 17.0 | 1.0 | 16.5 | 98.0 | 0.139 | 489.9 | 0.00028 | 0.00028 | |
| 18 | 17.0 | 18.0 | 1.0 | 17.5 | 130.3 | 0.141 | 651.6 | 0.00022 | 0.00022 | |
| 19 | 18.0 | 19.0 | 1.0 | 18.5 | 143.8 | 0.143 | 719.2 | 0.00020 | 0.00020 | |
| 20 | 19.0 | 20.0 | 1.0 | 19.5 | 131.2 | 0.146 | 655.8 | 0.00022 | 0.00022 | |
| 21 | 20.0 | 21.0 | 1.0 | 20.5 | 126.8 | 0.148 | 634.1 | 0.00023 | 0.00023 | |
| 22 | 21.0 | 22.0 | 1.0 | 21.5 | 215.4 | 0.150 | 1076.8 | 0.00014 | 0.00014 | |
| 23 | 22.0 | 23.0 | 1.0 | 22.5 | 236.6 | 0.153 | 1183.1 | 0.00013 | 0.00013 | |
| 24 | 23.0 | 24.0 | 1.0 | 23.5 | 277.0 | 0.155 | 1385.1 | 0.00011 | 0.00011 | |
| 25 | 24.0 | 25.0 | 1.0 | 24.5 | 356.9 | 0.157 | 1784.7 | 0.00009 | 0.00009 | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 26 | 25.0 | 26.0 | 1.0 | 25.5 | 375.0 | 0.160 | 1875.1 | 0.00009 | 0.00009 |
| 27 | 26.0 | 27.0 | 1.0 | 26.5 | 261.9 | 0.162 | 1309.6 | 0.00012 | 0.00012 |
| 28 | 27.0 | 28.0 | 1.0 | 27.5 | 74.9 | 0.164 | 374.3 | 0.00044 | 0.00044 |
| 29 | 28.0 | 29.0 | 1.0 | 28.5 | 36.5 | 0.167 | 182.5 | 0.00091 | 0.00091 |
| 30 | 29.0 | 30.0 | 1.0 | 29.5 | 33.4 | 0.169 | 166.9 | 0.00101 | 0.00101 |
| 31 | 30.0 | 31.0 | 1.0 | 30.5 | 28.3 | 0.171 | 141.6 | 0.00121 | 0.00121 |
| 32 | 31.0 | 32.0 | 1.0 | 31.5 | 17.0 | 0.174 | 85.0 | 0.00204 | 0.00204 |
| 33 | 32.0 | 33.0 | 1.0 | 32.5 | 8.9 | 0.176 | 44.6 | 0.00395 | 0.00395 |
| 34 | 33.0 | 34.0 | 1.0 | 33.5 | 44.4 | 0.178 | 221.8 | 0.00080 | 0.00080 |
| 35 | 34.0 | 35.0 | 1.0 | 34.5 | 76.3 | 0.181 | 381.5 | 0.00047 | 0.00047 |
| 36 | 35.0 | 36.0 | 1.0 | 35.5 | 60.4 | 0.183 | 301.9 | 0.00061 | 0.00061 |
| 37 | 36.0 | 37.0 | 1.0 | 36.5 | 83.5 | 0.185 | 417.7 | 0.00044 | 0.00044 |
| 38 | 37.0 | 38.0 | 1.0 | 37.5 | 121.6 | 0.188 | 607.9 | 0.00031 | 0.00031 |
| 39 | 38.0 | 39.0 | 1.0 | 38.5 | 164.5 | 0.190 | 822.6 | 0.00023 | 0.00023 |
| 40 | 39.0 | 40.0 | 1.0 | 39.5 | 183.9 | 0.192 | 919.6 | 0.00021 | 0.00021 |
| 41 | 40.0 | 41.0 | 1.0 | 40.5 | 180.5 | 0.195 | 902.5 | 0.00022 | 0.00022 |
| 42 | 41.0 | 42.0 | 1.0 | 41.5 | 145.6 | 0.197 | 728.1 | 0.00027 | 0.00027 |
| 43 | 42.0 | 43.0 | 1.0 | 42.5 | 139.3 | 0.199 | 696.6 | 0.00029 | 0.00029 |
| 44 | 43.0 | 44.0 | 1.0 | 43.5 | 113.5 | 0.202 | 567.6 | 0.00036 | 0.00036 |
| 45 | 44.0 | 45.0 | 1.0 | 44.5 | 88.9 | 0.204 | 444.4 | 0.00046 | 0.00046 |
| 46 | 45.0 | 46.0 | 1.0 | 45.5 | 52.2 | 0.206 | 260.8 | 0.00079 | 0.00079 |
| 47 | 46.0 | 47.0 | 1.0 | 46.5 | 20.4 | 0.209 | 101.8 | 0.00205 | 0.00205 |
| 48 | 47.0 | 48.0 | 1.0 | 47.5 | 130.8 | 0.211 | 654.0 | 0.00032 | 0.00032 |
| 49 | 48.0 | 49.0 | 1.0 | 48.5 | 122.6 | 0.213 | 613.2 | 0.00035 | 0.00035 |
| 50 | 49.0 | 50.0 | 1.0 | 49.5 | 110.7 | 0.216 | 553.4 | 0.00039 | 0.00039 |
| 51 | 50.0 | 51.0 | 1.0 | 50.5 | 146.4 | 0.218 | 732.2 | 0.00030 | 0.00030 |
| 52 | 51.0 | 52.0 | 1.0 | 51.5 | 149.7 | 0.220 | 748.7 | 0.00029 | 0.00029 |
| 53 | 52.0 | 53.0 | 1.0 | 52.5 | 174.1 | 0.223 | 870.3 | 0.00026 | 0.00026 |
| 54 | 53.0 | 54.0 | 1.0 | 53.5 | 175.0 | 0.225 | 874.8 | 0.00026 | 0.00026 |
| 55 | 54.0 | 55.0 | 1.0 | 54.5 | 178.5 | 0.227 | 892.3 | 0.00025 | 0.00025 |
| 56 | 55.0 | 56.0 | 1.0 | 55.5 | 177.3 | 0.230 | 886.4 | 0.00026 | 0.00026 |
| 57 | 56.0 | 57.0 | 1.0 | 56.5 | 160.4 | 0.232 | 801.8 | 0.00029 | 0.00029 |
| 58 | 57.0 | 58.0 | 1.0 | 57.5 | 141.0 | 0.234 | 704.8 | 0.00033 | 0.00033 |
| 59 | 58.0 | 59.0 | 1.0 | 58.5 | 131.5 | 0.237 | 657.5 | 0.00036 | 0.00036 |
| 60 | 59.0 | 60.0 | 1.0 | 59.5 | 151.7 | 0.239 | 758.7 | 0.00032 | 0.00032 |
| 61 | 60.0 | 61.0 | 1.0 | 60.5 | 140.0 | 0.241 | 700.1 | 0.00034 | 0.00034 |
| 62 | 61.0 | 62.0 | 1.0 | 61.5 | 34.4 | 0.244 | 172.2 | 0.00142 | 0.00142 |
| 63 | 62.0 | 63.0 | 1.0 | 62.5 | 15.7 | 0.246 | 78.4 | 0.00314 | 0.00314 |
| 64 | 63.0 | 64.0 | 1.0 | 63.5 | 27.7 | 0.248 | 138.3 | 0.00180 | 0.00180 |
| 65 | 64.0 | 65.0 | 1.0 | 64.5 | 85.1 | 0.251 | 425.7 | 0.00059 | 0.00059 |
| 66 | 65.0 | 66.0 | 1.0 | 65.5 | 271.5 | 0.253 | 1357.7 | 0.00019 | 0.00019 |
| 67 | 66.0 | 67.0 | 1.0 | 66.5 | 252.1 | 0.255 | 1260.7 | 0.00020 | 0.00020 |
| 68 | 67.0 | 68.0 | 1.0 | 67.5 | 191.1 | 0.258 | 955.3 | 0.00027 | 0.00027 |
| 69 | 68.0 | 69.0 | 1.0 | 68.5 | 274.1 | 0.260 | 1370.3 | 0.00019 | 0.00019 |
| 70 | 69.0 | 70.0 | 1.0 | 69.5 | 203.3 | 0.262 | 1016.5 | 0.00026 | 0.00026 |
| 71 | 70.0 | 71.0 | 1.0 | 70.5 | 35.2 | 0.265 | 176.1 | 0.00150 | 0.00150 |
| 72 | 71.0 | 72.0 | 1.0 | 71.5 | 39.6 | 0.267 | 198.2 | 0.00135 | 0.00135 |
| 73 | 72.0 | 73.0 | 1.0 | 72.5 | 86.6 | 0.269 | 432.9 | 0.00062 | 0.00062 |
| 74 | 73.0 | 74.0 | 1.0 | 73.5 | 61.2 | 0.272 | 306.0 | 0.00089 | 0.00089 |
| 75 | 74.0 | 75.0 | 1.0 | 74.5 | 53.9 | 0.274 | 269.6 | 0.00102 | 0.00102 |
| 76 | 75.0 | 76.0 | 1.0 | 75.5 | 84.6 | 0.276 | 423.2 | 0.00065 | 0.00065 |
| 77 | 76.0 | 77.0 | 1.0 | 76.5 | 92.4 | 0.279 | 462.2 | 0.00060 | 0.00060 |
| 78 | 77.0 | 78.0 | 1.0 | 77.5 | 78.6 | 0.281 | 393.1 | 0.00072 | 0.00072 |
| 79 | 78.0 | 79.0 | 1.0 | 78.5 | 65.1 | 0.283 | 325.5 | 0.00087 | 0.00087 |
| 80 | 79.0 | 80.0 | 1.0 | 79.5 | 172.7 | 0.286 | 863.6 | 0.00033 | 0.00033 |
| 81 | 80.0 | 81.0 | 1.0 | 80.5 | 42.4 | 0.288 | 211.9 | 0.00136 | 0.00136 |
| 82 | 81.0 | 82.0 | 1.0 | 81.5 | 123.0 | 0.290 | 615.2 | 0.00047 | 0.00047 |
| 83 | 82.0 | 83.0 | 1.0 | 82.5 | 590.7 | 0.293 | 2953.4 | 0.00010 | 0.00010 |
| 84 | 83.0 | 84.0 | 1.0 | 83.5 | 131.7 | 0.295 | 658.5 | 0.00045 | 0.00045 |
| 85 | 84.0 | 85.0 | 1.0 | 84.5 | 171.8 | 0.297 | 859.0 | 0.00035 | 0.00035 |
| 86 | 85.0 | 86.0 | 1.0 | 85.5 | 139.6 | 0.300 | 698.1 | 0.00043 | 0.00043 |
| 87 | 86.0 | 87.0 | 1.0 | 86.5 | 107.2 | 0.302 | 536.2 | 0.00056 | 0.00056 |
| 88 | 87.0 | 88.0 | 1.0 | 87.5 | 142.6 | 0.304 | 713.2 | 0.00043 | 0.00043 |
| 89 | 88.0 | 89.0 | 1.0 | 88.5 | 159.0 | 0.307 | 795.1 | 0.00039 | 0.00039 |
| 90 | 89.0 | 90.0 | 1.0 | 89.5 | 101.7 | 0.309 | 508.4 | 0.00061 | 0.00061 |
| 91 | 90.0 | 91.0 | 1.0 | 90.5 | 113.9 | 0.311 | 569.7 | 0.00055 | 0.00055 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 92 | 91.0 | 92.0 | 1.0 | 91.5 | 128.0 | 0.314 | 639.8 | 0.00049 | 0.00049 | |
| 93 | 92.0 | 93.0 | 1.0 | 92.5 | 132.8 | 0.316 | 663.8 | 0.00048 | 0.00048 | |
| 94 | 93.0 | 94.0 | 1.0 | 93.5 | 201.8 | 0.318 | 1009.1 | 0.00032 | 0.00032 | |
| 95 | 94.0 | 95.0 | 1.0 | 94.5 | 142.9 | 0.321 | 714.4 | 0.00045 | 0.00045 | |
| 96 | 95.0 | 96.0 | 1.0 | 95.5 | 118.3 | 0.323 | 591.6 | 0.00055 | 0.00055 | |
| 97 | 96.0 | 97.0 | 1.0 | 96.5 | 115.9 | 0.325 | 579.7 | 0.00056 | 0.00056 | |
| 98 | 97.0 | 98.0 | 1.0 | 97.5 | 111.7 | 0.328 | 558.5 | 0.00059 | 0.00059 | |
| 99 | 98.0 | 99.0 | 1.0 | 98.5 | 93.3 | 0.330 | 466.7 | 0.00071 | 0.00071 | |
| 100 | 99.0 | 100.0 | 1.0 | 99.5 | 131.0 | 0.332 | 655.2 | 0.00051 | 0.00051 | |
| 101 | 100.0 | 101.0 | 1.0 | 100.5 | 199.1 | 0.335 | 995.3 | 0.00034 | 0.00034 | |
| 102 | 101.0 | 102.0 | 1.0 | 101.5 | 210.6 | 0.337 | 1053.0 | 0.00032 | 0.00032 | |
| 103 | 102.0 | 103.0 | 1.0 | 102.5 | 167.6 | 0.339 | 837.8 | 0.00041 | 0.00041 | |
| 104 | 103.0 | 104.0 | 1.0 | 103.5 | 117.9 | 0.342 | 589.5 | 0.00058 | 0.00058 | |
| 105 | 104.0 | 105.0 | 1.0 | 104.5 | 71.2 | 0.344 | 356.1 | 0.00097 | 0.00097 | |
| 106 | 105.0 | 106.0 | 1.0 | 105.5 | 84.2 | 0.347 | 421.0 | 0.00082 | 0.00082 | |
| 107 | 106.0 | 107.0 | 1.0 | 106.5 | 82.8 | 0.349 | 414.1 | 0.00084 | 0.00084 | |
| 108 | 107.0 | 108.0 | 1.0 | 107.5 | 85.5 | 0.351 | 427.5 | 0.00082 | 0.00082 | |
| 109 | 108.0 | 109.0 | 1.0 | 108.5 | 87.7 | 0.354 | 438.7 | 0.00081 | 0.00081 | |
| 110 | 109.0 | 110.0 | 1.0 | 109.5 | 71.5 | 0.356 | 357.6 | 0.00100 | 0.00100 | |
| 111 | 110.0 | 111.0 | 1.0 | 110.5 | 60.5 | 0.358 | 302.6 | 0.00118 | 0.00118 | |
| 112 | 111.0 | 112.0 | 1.0 | 111.5 | 64.9 | 0.361 | 324.4 | 0.00111 | 0.00111 | |
| 113 | 112.0 | 113.0 | 1.0 | 112.5 | 62.6 | 0.363 | 313.2 | 0.00116 | 0.00116 | |
| 114 | 113.0 | 114.0 | 1.0 | 113.5 | 70.2 | 0.365 | 351.0 | 0.00104 | 0.00104 | |
| 115 | 114.0 | 115.0 | 1.0 | 114.5 | 80.1 | 0.368 | 400.6 | 0.00092 | 0.00092 | |
| 116 | 115.0 | 116.0 | 1.0 | 115.5 | 191.7 | 0.370 | 958.5 | 0.00039 | 0.00039 | |
| 117 | 116.0 | 117.0 | 1.0 | 116.5 | 204.5 | 0.372 | 1022.4 | 0.00036 | 0.00036 | |
| 118 | 117.0 | 118.0 | 1.0 | 117.5 | 508.1 | 0.375 | 2540.5 | 0.00015 | 0.00015 | |
| 119 | 118.0 | 119.0 | 1.0 | 118.5 | 621.5 | 0.377 | 3107.7 | 0.00012 | 0.00012 | |
| 120 | 119.0 | 120.0 | 1.0 | 119.5 | 668.1 | 0.379 | 3340.6 | 0.00011 | 0.00011 | |
| $\Sigma$ = | | | | | | | | | 0.06905 | |

*$I_{zr}$ (1 < L/B < 10):* $I_{zr} = I_{zs} + 0.111\,(I_{zc} - I_{zs})\,(L/B - 1)$

*$I_{zs}$ (L/B = 1):*

*For $z_{ave}$ = 0 to B/2:* $I_{zs} = 0.1 + (z_{ave}/B)(2I_{zp} - 0.2)$

*For $z_{ave}$ = B/2 to 2B:* $I_{zs} = 0.667\, I_{zp}\,(2 - z_{ave}/B)$

*$I_{zc}$ (L/B $\geq$ 10):*

*For $z_{ave}$ = 0 to B:* $I_{zc} = 0.2 + (z_{ave}/B)(I_{zp} - 0.2)$

*For $z_{ave}$ = B to 4B:* $I_{zc} = 0.333\, I_{zp}\,(4 - z_{ave}/B)$ ( Coduto p.228. )

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Footing width | B = | | 382.0 | ft | **Z-SDU6-C09** | | |
| Footing length | L = | | 382.0 | ft | | Immediate | |
| Ground elevation | | | 278.3 | ft | | Settlement (in.) | |
| Foundation elevation | | | 265.0 | ft | | ($S_0$ / 2) | |
| Ground Water elevation | | | 220.0 | ft | | Load | $S_0$ = |
| Excavated or embedded depth | D = | | 13.3 | ft | End of Operations | 5.10 | 1.0 |
| Depth to Groundwater | | | 58.3 | ft | Tank Half Full | 2.80 | 0.2 |
| Unit weight | $\gamma$ = | | 120.0 | pcf | Pre Closure | 5.50 | 1.1 |
| Gross Footing Load | | | 5.10 | ksf | Post Closure | 8.00 | 2.1 |
| Net applied footing pressure | $\Delta p$ = | | **3.504** | ksf | | | |
| | L/B = | | 1.00 | - | | | |
| | | | | | | 30 Year | |
| **Computation** | | | | | | Settlement (in.) | |
| Settlement | $\rho_i$ = | $C_1 C_t \Delta p \Sigma(\Delta z_i I_{zi}/E_{si})$ | 0.161 | ft | | ($S_{30}$ / 2) | |
| | $\rho_i$ = | $C_t$ = 1 | **1.938** | **in** | | Load | $S_0$ = |
| | S(t) = | | 0.241 | ft | | 5.10 | 1.4 |
| | S(t) = | | **2.898** | **in** | | 8.00 | 3.1 |
| Correction for strain relief | $C_1$ = | 1 - 0.5($\sigma'_D$/q') | 0.772 | - | | | |
| Effective vertical overburden pressure at D | $\sigma'_{vo}$ = | $\gamma$ D | 1.596 | ksf | | | |
| Correction for time dependent increase | $C_t$ = | 1 + 0.2 log( t / 0.1 ) | 1.50 | - | | | |
| | t = | | 30.00 | years | | | |
| Elastic modulus of soil layer i | $E_{si}$ = | 2.5 $q_c$ | see | Column H | if L/B = 1 | | |
| | $E_{si}$ = | 3.5 $q_c$ | see | Column H | If L/B $\geq$ 10 | | |
| Depth increment i | $\Delta z_i$ | | see | Column D | | | |
| Influence factor of soil layer i | $I_{zi}$ | Figure 3-4 | see | Column G | | | |
| Peak depth influence factor | $I_{zp}$ = | 0.5 + 0.1 ($\Delta p/\sigma'_{Izp}$)$^{1/2}$ | 0.548 | - | | | |
| | $z_p$ = | 0.5B + D | 204.30 | ft | If L/B = 1 | | |
| | $z_p$ = | B + D | 395.30 | ft | If L/B $\geq$ 10 | | |
| | $z_p$ = | | 204.30 | ft | for L/B=1.00 | | |
| Effective overburden pressure at depth Izp | $\sigma'_{Izp}$ = | | 15.41 | ksf | | | |
| Elastic Modulus | $E_{si}$ = | | 2.50 | $q_c$ | If L/B = 1 | | |
| | $E_{si}$ = | | 3.50 | $q_c$ | If L/B $\geq$ 10 | | |
| | $E_{si}$ = | | 2.50 | $q_c$ | for L/B=1.00 | | |

Computations made relative to the bottom of foundation

| A | B | C | D | E | F | G | H | I | J | K |
|---|---|---|---|---|---|---|---|---|---|---|
| Layer No. | Layer top depth (ft) | Layer bottom depth (ft) | Layer thickness $\Delta z_i$ (ft) | Mid-layer depth $z_{ave}$ (ft) | Average tip stress $q_c$ (tsf) | $I_{zi}$ | Elastic modulus $E_{si}$ (ksf) | $\Delta z_i I_{zi}/E_{si}$ | $\Delta z_i I_{zi}/E_{si}$ | Notes |
| 1 | 0.0 | 1.0 | 1.0 | 0.5 | 152.0 | 0.101 | 759.9 | 0.00013 | 0.00013 | |
| 2 | 1.0 | 2.0 | 1.0 | 1.5 | 104.7 | 0.104 | 523.7 | 0.00020 | 0.00020 | |
| 3 | 2.0 | 3.0 | 1.0 | 2.5 | 197.6 | 0.106 | 988.0 | 0.00011 | 0.00011 | |
| 4 | 3.0 | 4.0 | 1.0 | 3.5 | 83.9 | 0.108 | 419.5 | 0.00026 | 0.00026 | |
| 5 | 4.0 | 5.0 | 1.0 | 4.5 | 116.6 | 0.111 | 582.9 | 0.00019 | 0.00019 | |
| 6 | 5.0 | 6.0 | 1.0 | 5.5 | 117.5 | 0.113 | 587.5 | 0.00019 | 0.00019 | |
| 7 | 6.0 | 7.0 | 1.0 | 6.5 | 95.6 | 0.115 | 478.1 | 0.00024 | 0.00024 | |
| 8 | 7.0 | 8.0 | 1.0 | 7.5 | 155.4 | 0.118 | 776.8 | 0.00015 | 0.00015 | |
| 9 | 8.0 | 9.0 | 1.0 | 8.5 | 191.9 | 0.120 | 959.5 | 0.00012 | 0.00012 | |
| 10 | 9.0 | 10.0 | 1.0 | 9.5 | 306.5 | 0.122 | 1532.5 | 0.00008 | 0.00008 | |
| 11 | 10.0 | 11.0 | 1.0 | 10.5 | 115.1 | 0.125 | 575.7 | 0.00022 | 0.00022 | |
| 12 | 11.0 | 12.0 | 1.0 | 11.5 | 92.7 | 0.127 | 463.5 | 0.00027 | 0.00027 | |
| 13 | 12.0 | 13.0 | 1.0 | 12.5 | 101.8 | 0.129 | 508.8 | 0.00025 | 0.00025 | |
| 14 | 13.0 | 14.0 | 1.0 | 13.5 | 99.6 | 0.132 | 497.9 | 0.00026 | 0.00026 | |
| 15 | 14.0 | 15.0 | 1.0 | 14.5 | 120.0 | 0.134 | 599.8 | 0.00022 | 0.00022 | |
| 16 | 15.0 | 16.0 | 1.0 | 15.5 | 165.8 | 0.136 | 829.0 | 0.00016 | 0.00016 | |
| 17 | 16.0 | 17.0 | 1.0 | 16.5 | 241.6 | 0.139 | 1208.0 | 0.00011 | 0.00011 | |
| 18 | 17.0 | 18.0 | 1.0 | 17.5 | 319.6 | 0.141 | 1597.8 | 0.00009 | 0.00009 | |
| 19 | 18.0 | 19.0 | 1.0 | 18.5 | 362.9 | 0.143 | 1814.6 | 0.00008 | 0.00008 | |
| 20 | 19.0 | 20.0 | 1.0 | 19.5 | 281.1 | 0.146 | 1405.4 | 0.00010 | 0.00010 | |
| 21 | 20.0 | 21.0 | 1.0 | 20.5 | 71.2 | 0.148 | 355.9 | 0.00042 | 0.00042 | |
| 22 | 21.0 | 22.0 | 1.0 | 21.5 | 260.4 | 0.150 | 1301.9 | 0.00012 | 0.00012 | |
| 23 | 22.0 | 23.0 | 1.0 | 22.5 | 306.3 | 0.153 | 1531.7 | 0.00010 | 0.00010 | |
| 24 | 23.0 | 24.0 | 1.0 | 23.5 | 302.4 | 0.155 | 1511.8 | 0.00010 | 0.00010 | |
| 25 | 24.0 | 25.0 | 1.0 | 24.5 | 334.5 | 0.157 | 1672.3 | 0.00009 | 0.00009 | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 26 | 25.0 | 26.0 | 1.0 | 25.5 | 356.7 | 0.160 | 1783.5 | 0.00009 | 0.00009 | |
| 27 | 26.0 | 27.0 | 1.0 | 26.5 | 215.0 | 0.162 | 1075.0 | 0.00015 | 0.00015 | |
| 28 | 27.0 | 28.0 | 1.0 | 27.5 | 78.9 | 0.164 | 394.5 | 0.00042 | 0.00042 | |
| 29 | 28.0 | 29.0 | 1.0 | 28.5 | 69.1 | 0.167 | 345.6 | 0.00048 | 0.00048 | |
| 30 | 29.0 | 30.0 | 1.0 | 29.5 | 28.0 | 0.169 | 140.1 | 0.00121 | 0.00121 | |
| 31 | 30.0 | 31.0 | 1.0 | 30.5 | 41.9 | 0.171 | 209.5 | 0.00082 | 0.00082 | |
| 32 | 31.0 | 32.0 | 1.0 | 31.5 | 20.7 | 0.174 | 103.6 | 0.00168 | 0.00168 | |
| 33 | 32.0 | 33.0 | 1.0 | 32.5 | 17.9 | 0.176 | 89.6 | 0.00197 | 0.00197 | |
| 34 | 33.0 | 34.0 | 1.0 | 33.5 | 16.5 | 0.179 | 82.6 | 0.00216 | 0.00216 | |
| 35 | 34.0 | 35.0 | 1.0 | 34.5 | 51.1 | 0.181 | 255.6 | 0.00071 | 0.00071 | |
| 36 | 35.0 | 36.0 | 1.0 | 35.5 | 109.3 | 0.183 | 546.7 | 0.00034 | 0.00034 | |
| 37 | 36.0 | 37.0 | 1.0 | 36.5 | 129.7 | 0.186 | 648.5 | 0.00029 | 0.00029 | |
| 38 | 37.0 | 38.0 | 1.0 | 37.5 | 145.0 | 0.188 | 725.2 | 0.00026 | 0.00026 | |
| 39 | 38.0 | 39.0 | 1.0 | 38.5 | 131.7 | 0.190 | 658.6 | 0.00029 | 0.00029 | |
| 40 | 39.0 | 40.0 | 1.0 | 39.5 | 126.4 | 0.193 | 632.2 | 0.00030 | 0.00030 | |
| 41 | 40.0 | 41.0 | 1.0 | 40.5 | 101.2 | 0.195 | 506.0 | 0.00039 | 0.00039 | |
| 42 | 41.0 | 42.0 | 1.0 | 41.5 | 89.5 | 0.197 | 447.7 | 0.00044 | 0.00044 | |
| 43 | 42.0 | 43.0 | 1.0 | 42.5 | 69.1 | 0.200 | 345.3 | 0.00058 | 0.00058 | |
| 44 | 43.0 | 44.0 | 1.0 | 43.5 | 46.4 | 0.202 | 232.1 | 0.00087 | 0.00087 | |
| 45 | 44.0 | 45.0 | 1.0 | 44.5 | 27.2 | 0.204 | 136.1 | 0.00150 | 0.00150 | |
| 46 | 45.0 | 46.0 | 1.0 | 45.5 | 58.9 | 0.207 | 294.5 | 0.00070 | 0.00070 | |
| 47 | 46.0 | 47.0 | 1.0 | 46.5 | 66.8 | 0.209 | 333.9 | 0.00063 | 0.00063 | |
| 48 | 47.0 | 48.0 | 1.0 | 47.5 | 50.0 | 0.211 | 250.0 | 0.00085 | 0.00085 | |
| 49 | 48.0 | 49.0 | 1.0 | 48.5 | 59.8 | 0.214 | 299.2 | 0.00071 | 0.00071 | |
| 50 | 49.0 | 50.0 | 1.0 | 49.5 | 91.5 | 0.216 | 457.4 | 0.00047 | 0.00047 | |
| 51 | 50.0 | 51.0 | 1.0 | 50.5 | 135.2 | 0.218 | 675.9 | 0.00032 | 0.00032 | |
| 52 | 51.0 | 52.0 | 1.0 | 51.5 | 135.8 | 0.221 | 678.8 | 0.00033 | 0.00033 | |
| 53 | 52.0 | 53.0 | 1.0 | 52.5 | 135.4 | 0.223 | 676.8 | 0.00033 | 0.00033 | |
| 54 | 53.0 | 54.0 | 1.0 | 53.5 | 146.7 | 0.225 | 733.3 | 0.00031 | 0.00031 | |
| 55 | 54.0 | 55.0 | 1.0 | 54.5 | 147.7 | 0.228 | 738.4 | 0.00031 | 0.00031 | |
| 56 | 55.0 | 56.0 | 1.0 | 55.5 | 147.3 | 0.230 | 736.5 | 0.00031 | 0.00031 | |
| 57 | 56.0 | 57.0 | 1.0 | 56.5 | 121.1 | 0.232 | 605.5 | 0.00038 | 0.00038 | |
| 58 | 57.0 | 58.0 | 1.0 | 57.5 | 102.9 | 0.235 | 514.5 | 0.00046 | 0.00046 | |
| 59 | 58.0 | 59.0 | 1.0 | 58.5 | 124.8 | 0.237 | 623.9 | 0.00038 | 0.00038 | |
| 60 | 59.0 | 60.0 | 1.0 | 59.5 | 93.4 | 0.239 | 467.0 | 0.00051 | 0.00051 | |
| 61 | 60.0 | 61.0 | 1.0 | 60.5 | 29.2 | 0.242 | 145.8 | 0.00166 | 0.00166 | |
| 62 | 61.0 | 62.0 | 1.0 | 61.5 | 22.1 | 0.244 | 110.6 | 0.00221 | 0.00221 | |
| 63 | 62.0 | 63.0 | 1.0 | 62.5 | 37.5 | 0.246 | 187.7 | 0.00131 | 0.00131 | |
| 64 | 63.0 | 64.0 | 1.0 | 63.5 | 273.7 | 0.249 | 1368.7 | 0.00018 | 0.00018 | |
| 65 | 64.0 | 65.0 | 1.0 | 64.5 | 398.4 | 0.251 | 1992.2 | 0.00013 | 0.00013 | |
| 66 | 65.0 | 66.0 | 1.0 | 65.5 | 360.2 | 0.254 | 1800.9 | 0.00014 | 0.00014 | |
| 67 | 66.0 | 67.0 | 1.0 | 66.5 | 336.8 | 0.256 | 1684.2 | 0.00015 | 0.00015 | |
| 68 | 67.0 | 68.0 | 1.0 | 67.5 | 399.3 | 0.258 | 1996.6 | 0.00013 | 0.00013 | |
| 69 | 68.0 | 69.0 | 1.0 | 68.5 | 312.5 | 0.261 | 1562.3 | 0.00017 | 0.00017 | |
| 70 | 69.0 | 70.0 | 1.0 | 69.5 | 247.5 | 0.263 | 1237.6 | 0.00021 | 0.00021 | |
| 71 | 70.0 | 71.0 | 1.0 | 70.5 | 609.0 | 0.265 | 3044.9 | 0.00009 | 0.00009 | |
| 72 | 71.0 | 72.0 | 1.0 | 71.5 | 301.3 | 0.268 | 1506.6 | 0.00018 | 0.00018 | |
| 73 | 72.0 | 73.0 | 1.0 | 72.5 | 198.2 | 0.270 | 991.2 | 0.00027 | 0.00027 | |
| 74 | 73.0 | 74.0 | 1.0 | 73.5 | 97.2 | 0.272 | 486.1 | 0.00056 | 0.00056 | |
| 75 | 74.0 | 75.0 | 1.0 | 74.5 | 105.7 | 0.275 | 528.7 | 0.00052 | 0.00052 | |
| 76 | 75.0 | 76.0 | 1.0 | 75.5 | 105.0 | 0.277 | 524.9 | 0.00053 | 0.00053 | |
| 77 | 76.0 | 77.0 | 1.0 | 76.5 | 100.8 | 0.279 | 504.2 | 0.00055 | 0.00055 | |
| 78 | 77.0 | 78.0 | 1.0 | 77.5 | 96.8 | 0.282 | 484.1 | 0.00058 | 0.00058 | |
| 79 | 78.0 | 79.0 | 1.0 | 78.5 | 129.6 | 0.284 | 647.9 | 0.00044 | 0.00044 | |
| 80 | 79.0 | 80.0 | 1.0 | 79.5 | 142.8 | 0.286 | 713.9 | 0.00040 | 0.00040 | |
| 81 | 80.0 | 81.0 | 1.0 | 80.5 | 117.1 | 0.289 | 585.5 | 0.00049 | 0.00049 | |
| 82 | 81.0 | 82.0 | 1.0 | 81.5 | 181.6 | 0.291 | 907.9 | 0.00032 | 0.00032 | |
| 83 | 82.0 | 83.0 | 1.0 | 82.5 | 163.1 | 0.293 | 815.3 | 0.00036 | 0.00036 | |
| 84 | 83.0 | 84.0 | 1.0 | 83.5 | 131.7 | 0.296 | 658.5 | 0.00045 | 0.00045 | |
| 85 | 84.0 | 85.0 | 1.0 | 84.5 | 171.8 | 0.298 | 859.0 | 0.00035 | 0.00035 | |
| 86 | 85.0 | 86.0 | 1.0 | 85.5 | 139.6 | 0.300 | 698.1 | 0.00043 | 0.00043 | |
| 87 | 86.0 | 87.0 | 1.0 | 86.5 | 107.2 | 0.303 | 536.2 | 0.00056 | 0.00056 | |
| 88 | 87.0 | 88.0 | 1.0 | 87.5 | 142.6 | 0.305 | 713.2 | 0.00043 | 0.00043 | |
| 89 | 88.0 | 89.0 | 1.0 | 88.5 | 159.0 | 0.307 | 795.1 | 0.00039 | 0.00039 | |
| 90 | 89.0 | 90.0 | 1.0 | 89.5 | 101.7 | 0.310 | 508.4 | 0.00061 | 0.00061 | |
| 91 | 90.0 | 91.0 | 1.0 | 90.5 | 113.9 | 0.312 | 569.7 | 0.00055 | 0.00055 | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 92 | 91.0 | 92.0 | 1.0 | 91.5 | 128.0 | 0.314 | 639.8 | 0.00049 | 0.00049 | |
| 93 | 92.0 | 93.0 | 1.0 | 92.5 | 132.8 | 0.317 | 663.8 | 0.00048 | 0.00048 | |
| 94 | 93.0 | 94.0 | 1.0 | 93.5 | 201.8 | 0.319 | 1009.1 | 0.00032 | 0.00032 | |
| 95 | 94.0 | 95.0 | 1.0 | 94.5 | 142.9 | 0.322 | 714.4 | 0.00045 | 0.00045 | |
| 96 | 95.0 | 96.0 | 1.0 | 95.5 | 118.3 | 0.324 | 591.6 | 0.00055 | 0.00055 | |
| 97 | 96.0 | 97.0 | 1.0 | 96.5 | 115.9 | 0.326 | 579.7 | 0.00056 | 0.00056 | |
| 98 | 97.0 | 98.0 | 1.0 | 97.5 | 111.7 | 0.329 | 558.5 | 0.00059 | 0.00059 | |
| 99 | 98.0 | 99.0 | 1.0 | 98.5 | 93.3 | 0.331 | 466.7 | 0.00071 | 0.00071 | |
| 100 | 99.0 | 100.0 | 1.0 | 99.5 | 131.0 | 0.333 | 655.2 | 0.00051 | 0.00051 | |
| 101 | 100.0 | 101.0 | 1.0 | 100.5 | 199.1 | 0.336 | 995.3 | 0.00034 | 0.00034 | |
| 102 | 101.0 | 102.0 | 1.0 | 101.5 | 210.6 | 0.338 | 1053.0 | 0.00032 | 0.00032 | |
| 103 | 102.0 | 103.0 | 1.0 | 102.5 | 167.6 | 0.340 | 837.8 | 0.00041 | 0.00041 | |
| 104 | 103.0 | 104.0 | 1.0 | 103.5 | 117.9 | 0.343 | 589.5 | 0.00058 | 0.00058 | |
| 105 | 104.0 | 105.0 | 1.0 | 104.5 | 71.2 | 0.345 | 356.1 | 0.00097 | 0.00097 | |
| 106 | 105.0 | 106.0 | 1.0 | 105.5 | 84.2 | 0.347 | 421.0 | 0.00082 | 0.00082 | |
| 107 | 106.0 | 107.0 | 1.0 | 106.5 | 82.8 | 0.350 | 414.1 | 0.00084 | 0.00084 | |
| 108 | 107.0 | 108.0 | 1.0 | 107.5 | 85.5 | 0.352 | 427.5 | 0.00082 | 0.00082 | |
| 109 | 108.0 | 109.0 | 1.0 | 108.5 | 87.7 | 0.354 | 438.7 | 0.00081 | 0.00081 | |
| 110 | 109.0 | 110.0 | 1.0 | 109.5 | 71.5 | 0.357 | 357.6 | 0.00100 | 0.00100 | |
| 111 | 110.0 | 111.0 | 1.0 | 110.5 | 60.5 | 0.359 | 302.6 | 0.00119 | 0.00119 | |
| 112 | 111.0 | 112.0 | 1.0 | 111.5 | 64.9 | 0.361 | 324.4 | 0.00111 | 0.00111 | |
| 113 | 112.0 | 113.0 | 1.0 | 112.5 | 62.6 | 0.364 | 313.2 | 0.00116 | 0.00116 | |
| 114 | 113.0 | 114.0 | 1.0 | 113.5 | 70.2 | 0.366 | 351.0 | 0.00104 | 0.00104 | |
| 115 | 114.0 | 115.0 | 1.0 | 114.5 | 80.1 | 0.368 | 400.6 | 0.00092 | 0.00092 | |
| 116 | 115.0 | 116.0 | 1.0 | 115.5 | 191.7 | 0.371 | 958.5 | 0.00039 | 0.00039 | |
| 117 | 116.0 | 117.0 | 1.0 | 116.5 | 204.5 | 0.373 | 1022.4 | 0.00036 | 0.00036 | |
| 118 | 117.0 | 118.0 | 1.0 | 117.5 | 508.1 | 0.375 | 2540.5 | 0.00015 | 0.00015 | |
| 119 | 118.0 | 119.0 | 1.0 | 118.5 | 621.5 | 0.378 | 3107.7 | 0.00012 | 0.00012 | |
| 120 | 119.0 | 120.0 | 1.0 | 119.5 | 668.1 | 0.380 | 3340.6 | 0.00011 | 0.00011 | |
| Σ = | | | | | | | | | 0.05968 | |

$I_{zr}$ (1 < L/B < 10): $I_{zr} = I_{zs} + 0.111\,(I_{zc} - I_{zs})\,(L/B - 1)$

$I_{zs}$ (L/B = 1):

For $z_{ave}$ = 0 to B/2: $I_{zs} = 0.1 + (z_{ave}/B)(2I_{zp} - 0.2)$

For $z_{ave}$ = B/2 to 2B: $I_{zs} = 0.667\,I_{zp}\,(2 - z_{ave}/B)$

$I_{zc}$ ($L/B \geq 10$):

For $z_{ave}$ = 0 to B: $I_{zc} = 0.2 + (z_{ave}/B)(I_{zp} - 0.2)$

For $z_{ave}$ = B to 4B: $I_{zc} = 0.333\,I_{zp}\,(4 - z_{ave}/B)$ ( Coduto p.228. )

| | | | | | | |
|---|---|---|---|---|---|---|
| Footing width | B = | 382.0 | ft | Z-SDU6-C10 | | |
| Footing length | L = | 382.0 | ft | | Immediate Settlement (in.) ($S_0$ / 2) | |
| Ground elevation | | 278.0 | ft | | | |
| Foundation elevation | | 265.0 | ft | | | |
| Ground Water elevation | | 220.0 | ft | | Load | $S_0$ = |
| Excavated or embedded depth | D = | 13.0 | ft | End of Operations | 5.10 | 2.1 |
| Depth to Groundwater | | 58.0 | ft | Tank Half Full | 2.80 | 0.5 |
| Unit weight | $\gamma$ = | 120.0 | pcf | Pre Closure | 5.50 | 2.4 |
| Gross Footing Load | | 5.10 | ksf | Post Closure | 8.00 | 4.4 |
| Net applied footing pressure | $\Delta p$ = | **3.540** | ksf | | | |
| | L/B = | 1.00 | - | | | |

30 Year Settlement (in.) ($S_{30}$ / 2)

| Load | $S_0$ = |
|---|---|
| 5.10 | 3.2 |
| 8.00 | 6.6 |

**Computation**

| | | | | | |
|---|---|---|---|---|---|
| Settlement | $\rho_i$ = | $C_1 C_t \Delta p\, \Sigma(\Delta z_i I_{zi}/E_{si})$ | 0.353 | ft | |
| | $\rho_i$ = | $C_t$ = 1 | **4.240** | **in** | |
| | S(t) = | | 0.528 | ft | |
| | S(t) = | | **6.341** | **in** | |
| Correction for strain relief | $C_1$ = | $1 - 0.5(\sigma'_D/q')$ | 0.780 | - | |
| Effective vertical overburden pressure at D | $\sigma'_{vo}$ = | $\gamma$ D | 1.560 | ksf | |
| Correction for time dependent increase | $C_t$ = | 1 + 0.2 log( t / 0.1 ) | 1.50 | - | |
| | t = | | 30.00 | years | |
| Elastic modulus of soil layer i | $E_{si}$ = | 2.5 $q_c$ | see | Column H | if L/B = 1 |
| | $E_{si}$ = | 3.5 $q_c$ | see | Column H | If L/B $\geq$ 10 |
| Depth increment i | $\Delta z_i$ | | see | Column D | |
| Influence factor of soil layer i | $I_{zi}$ | Figure 3-4 | see | Column G | |
| Peak depth influence factor | $I_{zp}$ = | $0.5 + 0.1 (\Delta p/\sigma'_{Izp})^{1/2}$ | 0.548 | - | |
| | $z_p$ = | 0.5B + D | 204.00 | ft | If L/B = 1 |
| | $z_p$ = | B + D | 395.00 | ft | If L/B $\geq$ 10 |
| | $z_p$ = | | 204.00 | ft | for L/B=1.00 |
| Effective overburden pressure at depth Izp | $\sigma'_{Izp}$ = | | 15.37 | ksf | |
| Elastic Modulus | $E_{si}$ = | | 2.50 | $q_c$ | If L/B = 1 |
| | $E_{si}$ = | | 3.50 | $q_c$ | If L/B $\geq$ 10 |
| | $E_{si}$ = | | 2.50 | $q_c$ | for L/B=1.00 |

Computations made relative to the bottom of foundation

| A | B | C | D | E | F | G | H | I | J | K |
|---|---|---|---|---|---|---|---|---|---|---|
| Layer No. | Layer top depth (ft) | Layer bottom depth (ft) | Layer thickness $\Delta z_i$ (ft) | Mid-layer depth $z_{ave}$ (ft) | Average tip stress $q_c$ (tsf) | $I_{zi}$ | Elastic modulus $E_{si}$ (ksf) | $\Delta z_i I_{zi}/E_{si}$ | $\Delta z_i I_{zi}/E_{si}$ | Notes |
| 1 | 0.0 | 1.0 | 1.0 | 0.5 | 82.6 | 0.101 | 413.1 | 0.00024 | 0.00024 | |
| 2 | 1.0 | 2.0 | 1.0 | 1.5 | 146.0 | 0.104 | 730.0 | 0.00014 | 0.00014 | |
| 3 | 2.0 | 3.0 | 1.0 | 2.5 | 118.2 | 0.106 | 591.0 | 0.00018 | 0.00018 | |
| 4 | 3.0 | 4.0 | 1.0 | 3.5 | 239.0 | 0.108 | 1194.9 | 0.00009 | 0.00009 | |
| 5 | 4.0 | 5.0 | 1.0 | 4.5 | 201.3 | 0.111 | 1006.4 | 0.00011 | 0.00011 | |
| 6 | 5.0 | 6.0 | 1.0 | 5.5 | 103.1 | 0.113 | 515.3 | 0.00022 | 0.00022 | |
| 7 | 6.0 | 7.0 | 1.0 | 6.5 | 124.9 | 0.115 | 624.3 | 0.00018 | 0.00018 | |
| 8 | 7.0 | 8.0 | 1.0 | 7.5 | 169.3 | 0.118 | 846.7 | 0.00014 | 0.00014 | |
| 9 | 8.0 | 9.0 | 1.0 | 8.5 | 209.6 | 0.120 | 1047.8 | 0.00011 | 0.00011 | |
| 10 | 9.0 | 10.0 | 1.0 | 9.5 | 214.4 | 0.122 | 1071.8 | 0.00011 | 0.00011 | |
| 11 | 10.0 | 11.0 | 1.0 | 10.5 | 92.3 | 0.125 | 461.3 | 0.00027 | 0.00027 | |
| 12 | 11.0 | 12.0 | 1.0 | 11.5 | 58.6 | 0.127 | 293.0 | 0.00043 | 0.00043 | |
| 13 | 12.0 | 13.0 | 1.0 | 12.5 | 73.2 | 0.129 | 365.9 | 0.00035 | 0.00035 | |
| 14 | 13.0 | 14.0 | 1.0 | 13.5 | 80.5 | 0.132 | 402.3 | 0.00033 | 0.00033 | |
| 15 | 14.0 | 15.0 | 1.0 | 14.5 | 112.6 | 0.134 | 563.0 | 0.00024 | 0.00024 | |
| 16 | 15.0 | 16.0 | 1.0 | 15.5 | 121.7 | 0.136 | 608.3 | 0.00022 | 0.00022 | |
| 17 | 16.0 | 17.0 | 1.0 | 16.5 | 134.9 | 0.139 | 674.4 | 0.00021 | 0.00021 | |
| 18 | 17.0 | 18.0 | 1.0 | 17.5 | 163.9 | 0.141 | 819.3 | 0.00017 | 0.00017 | |
| 19 | 18.0 | 19.0 | 1.0 | 18.5 | 163.8 | 0.143 | 819.0 | 0.00018 | 0.00018 | |
| 20 | 19.0 | 20.0 | 1.0 | 19.5 | 64.2 | 0.146 | 320.9 | 0.00045 | 0.00045 | |
| 21 | 20.0 | 21.0 | 1.0 | 20.5 | 156.4 | 0.148 | 781.8 | 0.00019 | 0.00019 | |
| 22 | 21.0 | 22.0 | 1.0 | 21.5 | 188.0 | 0.150 | 939.9 | 0.00016 | 0.00016 | |
| 23 | 22.0 | 23.0 | 1.0 | 22.5 | 199.8 | 0.153 | 998.8 | 0.00015 | 0.00015 | |
| 24 | 23.0 | 24.0 | 1.0 | 23.5 | 193.5 | 0.155 | 967.6 | 0.00016 | 0.00016 | |
| 25 | 24.0 | 25.0 | 1.0 | 24.5 | 219.7 | 0.157 | 1098.5 | 0.00014 | 0.00014 | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 26 | 25.0 | 26.0 | 1.0 | 25.5 | 219.9 | 0.160 | 1099.4 | 0.00015 | 0.00015 |
| 27 | 26.0 | 27.0 | 1.0 | 26.5 | 158.3 | 0.162 | 791.4 | 0.00020 | 0.00020 |
| 28 | 27.0 | 28.0 | 1.0 | 27.5 | 59.0 | 0.165 | 295.1 | 0.00056 | 0.00056 |
| 29 | 28.0 | 29.0 | 1.0 | 28.5 | 34.3 | 0.167 | 171.6 | 0.00097 | 0.00097 |
| 30 | 29.0 | 30.0 | 1.0 | 29.5 | 24.2 | 0.169 | 121.2 | 0.00140 | 0.00140 |
| 31 | 30.0 | 31.0 | 1.0 | 30.5 | 29.2 | 0.172 | 146.0 | 0.00117 | 0.00117 |
| 32 | 31.0 | 32.0 | 1.0 | 31.5 | 12.6 | 0.174 | 62.9 | 0.00276 | 0.00276 |
| 33 | 32.0 | 33.0 | 1.0 | 32.5 | 16.4 | 0.176 | 82.1 | 0.00215 | 0.00215 |
| 34 | 33.0 | 34.0 | 1.0 | 33.5 | 29.8 | 0.179 | 149.2 | 0.00120 | 0.00120 |
| 35 | 34.0 | 35.0 | 1.0 | 34.5 | 56.2 | 0.181 | 280.8 | 0.00064 | 0.00064 |
| 36 | 35.0 | 36.0 | 1.0 | 35.5 | 64.8 | 0.183 | 323.8 | 0.00057 | 0.00057 |
| 37 | 36.0 | 37.0 | 1.0 | 36.5 | 63.1 | 0.186 | 315.3 | 0.00059 | 0.00059 |
| 38 | 37.0 | 38.0 | 1.0 | 37.5 | 91.4 | 0.188 | 457.0 | 0.00041 | 0.00041 |
| 39 | 38.0 | 39.0 | 1.0 | 38.5 | 97.6 | 0.190 | 488.0 | 0.00039 | 0.00039 |
| 40 | 39.0 | 40.0 | 1.0 | 39.5 | 98.2 | 0.193 | 490.8 | 0.00039 | 0.00039 |
| 41 | 40.0 | 41.0 | 1.0 | 40.5 | 87.4 | 0.195 | 437.2 | 0.00045 | 0.00045 |
| 42 | 41.0 | 42.0 | 1.0 | 41.5 | 93.0 | 0.197 | 465.0 | 0.00042 | 0.00042 |
| 43 | 42.0 | 43.0 | 1.0 | 42.5 | 81.9 | 0.200 | 409.6 | 0.00049 | 0.00049 |
| 44 | 43.0 | 44.0 | 1.0 | 43.5 | 69.9 | 0.202 | 349.3 | 0.00058 | 0.00058 |
| 45 | 44.0 | 45.0 | 1.0 | 44.5 | 53.4 | 0.204 | 267.1 | 0.00077 | 0.00077 |
| 46 | 45.0 | 46.0 | 1.0 | 45.5 | 51.4 | 0.207 | 256.9 | 0.00080 | 0.00080 |
| 47 | 46.0 | 47.0 | 1.0 | 46.5 | 39.6 | 0.209 | 198.0 | 0.00106 | 0.00106 |
| 48 | 47.0 | 48.0 | 1.0 | 47.5 | 58.8 | 0.211 | 294.0 | 0.00072 | 0.00072 |
| 49 | 48.0 | 49.0 | 1.0 | 48.5 | 37.3 | 0.214 | 186.4 | 0.00115 | 0.00115 |
| 50 | 49.0 | 50.0 | 1.0 | 49.5 | 90.5 | 0.216 | 452.5 | 0.00048 | 0.00048 |
| 51 | 50.0 | 51.0 | 1.0 | 50.5 | 155.9 | 0.218 | 779.4 | 0.00028 | 0.00028 |
| 52 | 51.0 | 52.0 | 1.0 | 51.5 | 166.6 | 0.221 | 832.8 | 0.00027 | 0.00027 |
| 53 | 52.0 | 53.0 | 1.0 | 52.5 | 150.8 | 0.223 | 754.2 | 0.00030 | 0.00030 |
| 54 | 53.0 | 54.0 | 1.0 | 53.5 | 132.7 | 0.225 | 663.5 | 0.00034 | 0.00034 |
| 55 | 54.0 | 55.0 | 1.0 | 54.5 | 127.1 | 0.228 | 635.6 | 0.00036 | 0.00036 |
| 56 | 55.0 | 56.0 | 1.0 | 55.5 | 120.5 | 0.230 | 602.4 | 0.00038 | 0.00038 |
| 57 | 56.0 | 57.0 | 1.0 | 56.5 | 117.9 | 0.233 | 589.7 | 0.00039 | 0.00039 |
| 58 | 57.0 | 58.0 | 1.0 | 57.5 | 112.1 | 0.235 | 560.7 | 0.00042 | 0.00042 |
| 59 | 58.0 | 59.0 | 1.0 | 58.5 | 89.7 | 0.237 | 448.7 | 0.00053 | 0.00053 |
| 60 | 59.0 | 60.0 | 1.0 | 59.5 | 80.3 | 0.240 | 401.6 | 0.00060 | 0.00060 |
| 61 | 60.0 | 61.0 | 1.0 | 60.5 | 67.8 | 0.242 | 339.2 | 0.00071 | 0.00071 |
| 62 | 61.0 | 62.0 | 1.0 | 61.5 | 49.7 | 0.244 | 248.4 | 0.00098 | 0.00098 |
| 63 | 62.0 | 63.0 | 1.0 | 62.5 | 16.3 | 0.247 | 81.5 | 0.00303 | 0.00303 |
| 64 | 63.0 | 64.0 | 1.0 | 63.5 | 3.4 | 0.249 | 16.8 | 0.01482 | 0.01482 |
| 65 | 64.0 | 65.0 | 1.0 | 64.5 | 4.6 | 0.251 | 22.9 | 0.01096 | 0.01096 |
| 66 | 65.0 | 66.0 | 1.0 | 65.5 | 71.7 | 0.254 | 358.4 | 0.00071 | 0.00071 |
| 67 | 66.0 | 67.0 | 1.0 | 66.5 | 166.8 | 0.256 | 833.8 | 0.00031 | 0.00031 |
| 68 | 67.0 | 68.0 | 1.0 | 67.5 | 215.1 | 0.258 | 1075.3 | 0.00024 | 0.00024 |
| 69 | 68.0 | 69.0 | 1.0 | 68.5 | 202.0 | 0.261 | 1009.8 | 0.00026 | 0.00026 |
| 70 | 69.0 | 70.0 | 1.0 | 69.5 | 204.7 | 0.263 | 1023.7 | 0.00026 | 0.00026 |
| 71 | 70.0 | 71.0 | 1.0 | 70.5 | 226.3 | 0.265 | 1131.4 | 0.00023 | 0.00023 |
| 72 | 71.0 | 72.0 | 1.0 | 71.5 | 161.2 | 0.268 | 805.8 | 0.00033 | 0.00033 |
| 73 | 72.0 | 73.0 | 1.0 | 72.5 | 40.6 | 0.270 | 202.8 | 0.00133 | 0.00133 |
| 74 | 73.0 | 74.0 | 1.0 | 73.5 | 14.6 | 0.272 | 72.9 | 0.00374 | 0.00374 |
| 75 | 74.0 | 75.0 | 1.0 | 74.5 | 27.2 | 0.275 | 135.8 | 0.00202 | 0.00202 |
| 76 | 75.0 | 76.0 | 1.0 | 75.5 | 29.9 | 0.277 | 149.3 | 0.00186 | 0.00186 |
| 77 | 76.0 | 77.0 | 1.0 | 76.5 | 16.0 | 0.279 | 79.9 | 0.00350 | 0.00350 |
| 78 | 77.0 | 78.0 | 1.0 | 77.5 | 15.7 | 0.282 | 78.4 | 0.00360 | 0.00360 |
| 79 | 78.0 | 79.0 | 1.0 | 78.5 | 11.7 | 0.284 | 58.5 | 0.00486 | 0.00486 |
| 80 | 79.0 | 80.0 | 1.0 | 79.5 | 12.8 | 0.286 | 64.0 | 0.00448 | 0.00448 |
| 81 | 80.0 | 81.0 | 1.0 | 80.5 | 24.4 | 0.289 | 121.9 | 0.00237 | 0.00237 |
| 82 | 81.0 | 82.0 | 1.0 | 81.5 | 32.1 | 0.291 | 160.3 | 0.00182 | 0.00182 |
| 83 | 82.0 | 83.0 | 1.0 | 82.5 | 18.5 | 0.294 | 92.7 | 0.00316 | 0.00316 |
| 84 | 83.0 | 84.0 | 1.0 | 83.5 | 15.8 | 0.296 | 78.8 | 0.00375 | 0.00375 |
| 85 | 84.0 | 85.0 | 1.0 | 84.5 | 31.0 | 0.298 | 155.1 | 0.00192 | 0.00192 |
| 86 | 85.0 | 86.0 | 1.0 | 85.5 | 14.9 | 0.301 | 74.4 | 0.00404 | 0.00404 |
| 87 | 86.0 | 87.0 | 1.0 | 86.5 | 19.7 | 0.303 | 98.6 | 0.00307 | 0.00307 |
| 88 | 87.0 | 88.0 | 1.0 | 87.5 | 89.6 | 0.305 | 448.0 | 0.00068 | 0.00068 |
| 89 | 88.0 | 89.0 | 1.0 | 88.5 | 316.0 | 0.308 | 1580.0 | 0.00019 | 0.00019 |
| 90 | 89.0 | 90.0 | 1.0 | 89.5 | 101.7 | 0.310 | 508.4 | 0.00061 | 0.00061 |
| 91 | 90.0 | 91.0 | 1.0 | 90.5 | 113.9 | 0.312 | 569.7 | 0.00055 | 0.00055 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 92 | 91.0 | 92.0 | 1.0 | 91.5 | 128.0 | 0.315 | 639.8 | 0.00049 | 0.00049 | |
| 93 | 92.0 | 93.0 | 1.0 | 92.5 | 132.8 | 0.317 | 663.8 | 0.00048 | 0.00048 | |
| 94 | 93.0 | 94.0 | 1.0 | 93.5 | 201.8 | 0.319 | 1009.1 | 0.00032 | 0.00032 | |
| 95 | 94.0 | 95.0 | 1.0 | 94.5 | 142.9 | 0.322 | 714.4 | 0.00045 | 0.00045 | |
| 96 | 95.0 | 96.0 | 1.0 | 95.5 | 118.3 | 0.324 | 591.6 | 0.00055 | 0.00055 | |
| 97 | 96.0 | 97.0 | 1.0 | 96.5 | 115.9 | 0.326 | 579.7 | 0.00056 | 0.00056 | |
| 98 | 97.0 | 98.0 | 1.0 | 97.5 | 111.7 | 0.329 | 558.5 | 0.00059 | 0.00059 | |
| 99 | 98.0 | 99.0 | 1.0 | 98.5 | 93.3 | 0.331 | 466.7 | 0.00071 | 0.00071 | |
| 100 | 99.0 | 100.0 | 1.0 | 99.5 | 131.0 | 0.333 | 655.2 | 0.00051 | 0.00051 | |
| 101 | 100.0 | 101.0 | 1.0 | 100.5 | 199.1 | 0.336 | 995.3 | 0.00034 | 0.00034 | |
| 102 | 101.0 | 102.0 | 1.0 | 101.5 | 210.6 | 0.338 | 1053.0 | 0.00032 | 0.00032 | |
| 103 | 102.0 | 103.0 | 1.0 | 102.5 | 167.6 | 0.340 | 837.8 | 0.00041 | 0.00041 | |
| 104 | 103.0 | 104.0 | 1.0 | 103.5 | 117.9 | 0.343 | 589.5 | 0.00058 | 0.00058 | |
| 105 | 104.0 | 105.0 | 1.0 | 104.5 | 71.2 | 0.345 | 356.1 | 0.00097 | 0.00097 | |
| 106 | 105.0 | 106.0 | 1.0 | 105.5 | 84.2 | 0.347 | 421.0 | 0.00083 | 0.00083 | |
| 107 | 106.0 | 107.0 | 1.0 | 106.5 | 82.8 | 0.350 | 414.1 | 0.00084 | 0.00084 | |
| 108 | 107.0 | 108.0 | 1.0 | 107.5 | 85.5 | 0.352 | 427.5 | 0.00082 | 0.00082 | |
| 109 | 108.0 | 109.0 | 1.0 | 108.5 | 87.7 | 0.354 | 438.7 | 0.00081 | 0.00081 | |
| 110 | 109.0 | 110.0 | 1.0 | 109.5 | 71.5 | 0.357 | 357.6 | 0.00100 | 0.00100 | |
| 111 | 110.0 | 111.0 | 1.0 | 110.5 | 60.5 | 0.359 | 302.6 | 0.00119 | 0.00119 | |
| 112 | 111.0 | 112.0 | 1.0 | 111.5 | 64.9 | 0.362 | 324.4 | 0.00111 | 0.00111 | |
| 113 | 112.0 | 113.0 | 1.0 | 112.5 | 62.6 | 0.364 | 313.2 | 0.00116 | 0.00116 | |
| 114 | 113.0 | 114.0 | 1.0 | 113.5 | 70.2 | 0.366 | 351.0 | 0.00104 | 0.00104 | |
| 115 | 114.0 | 115.0 | 1.0 | 114.5 | 80.1 | 0.369 | 400.6 | 0.00092 | 0.00092 | |
| 116 | 115.0 | 116.0 | 1.0 | 115.5 | 191.7 | 0.371 | 958.5 | 0.00039 | 0.00039 | |
| 117 | 116.0 | 117.0 | 1.0 | 116.5 | 204.5 | 0.373 | 1022.4 | 0.00037 | 0.00037 | |
| 118 | 117.0 | 118.0 | 1.0 | 117.5 | 508.1 | 0.376 | 2540.5 | 0.00015 | 0.00015 | |
| 119 | 118.0 | 119.0 | 1.0 | 118.5 | 621.5 | 0.378 | 3107.7 | 0.00012 | 0.00012 | |
| 120 | 119.0 | 120.0 | 1.0 | 119.5 | 668.1 | 0.380 | 3340.6 | 0.00011 | 0.00011 | |
| $\Sigma$ = | | | | | | | | | 0.12803 | |

$I_{zr}$ (1 < L/B < 10): $I_{zr} = I_{zs} + 0.111\,(I_{zc} - I_{zs})\,(L/B - 1)$

$I_{zs}$ (L/B = 1):

For $z_{ave}$ = 0 to B/2: $I_{zs} = 0.1 + (z_{ave}/B)(2I_{zp} - 0.2)$

For $z_{ave}$ = B/2 to 2B: $I_{zs} = 0.667\, I_{zp}\,(2 - z_{ave}/B)$

$I_{zc}$ ($L/B \geq 10$):

For $z_{ave}$ = 0 to B: $I_{zc} = 0.2 + (z_{ave}/B)(I_{zp} - 0.2)$

For $z_{ave}$ = B to 4B: $I_{zc} = 0.333\, I_{zp}\,(4 - z_{ave}/B)$ ( Coduto p.228. )

| | | | | |
|---|---|---|---|---|
| Footing width | B = | 382.0 | ft | **Z-SDU6-C11** |
| Footing length | L = | 382.0 | ft | |
| Ground elevation | | 277.6 | ft | |
| Foundation elevation | | 265.0 | ft | |
| Ground Water elevation | | 220.0 | ft | |
| Excavated or embedded depth | D = | 12.6 | ft | |
| Depth to Groundwater | | 57.6 | ft | |
| Unit weight | $\gamma$ = | 120.0 | pcf | |
| Gross Footing Load | | 5.10 | ksf | |
| Net applied footing pressure | $\Delta p$ = | **3.588** | ksf | |
| | L/B = | 1.00 | - | |

Immediate Settlement (in.) ($S_0$ / 2)

| | Load | $S_0$ = |
|---|---|---|
| End of Operations | 5.10 | 0.7 |
| Tank Half Full | 2.80 | 0.2 |
| Pre Closure | 5.50 | 0.8 |
| Post Closure | 8.00 | 1.5 |

30 Year Settlement (in.) ($S_{30}$ / 2)

| Load | $S_0$ = |
|---|---|
| 5.10 | 1.1 |
| 8.00 | 2.2 |

**Computation**

| | | | | | |
|---|---|---|---|---|---|
| Settlement | $\rho_i$ = | $C_1 C_t \Delta p \Sigma(\Delta z_i I_{zi}/E_{si})$ | 0.120 | ft | |
| | $\rho_i$ = | $C_t$ = 1 | **1.442** | **in** | |
| | S(t) = | | 0.180 | ft | |
| | S(t) = | | **2.156** | **in** | |
| Correction for strain relief | $C_1$ = | 1 - 0.5($\sigma'_D$/q') | 0.789 | - | |
| Effective vertical overburden pressure at D | $\sigma'_{vo}$ = | $\gamma$ D | 1.512 | ksf | |
| Correction for time dependent increase | $C_t$ = | 1 + 0.2 log( t / 0.1 ) | 1.50 | - | |
| | t = | | 30.00 | years | |
| Elastic modulus of soil layer i | $E_{si}$ = | 2.5 $q_c$ | see | Column H | if L/B = 1 |
| | $E_{si}$ = | 3.5 $q_c$ | see | Column H | If L/B $\geq$ 10 |
| Depth increment i | $\Delta z_i$ | | see | Column D | |
| Influence factor of soil layer i | $I_{zi}$ | Figure 3-4 | see | Column G | |
| Peak depth influence factor | $I_{zp}$ = | 0.5 + 0.1 ($\Delta p/\sigma'_{Izp}$)$^{1/2}$ | 0.548 | - | |
| | $z_p$ = | 0.5B + D | 203.60 | ft | If L/B = 1 |
| | $z_p$ = | B + D | 394.60 | ft | If L/B $\geq$ 10 |
| | $z_p$ = | | 203.60 | ft | for L/B=1.00 |
| Effective overburden pressure at depth Izp | $\sigma'_{Izp}$ = | | 15.32 | ksf | |
| Elastic Modulus | $E_{si}$ = | | 2.50 | $q_c$ | If L/B = 1 |
| | $E_{si}$ = | | 3.50 | $q_c$ | If L/B $\geq$ 10 |
| | $E_{si}$ = | | 2.50 | $q_c$ | for L/B=1.00 |

Computations made relative to the bottom of foundation

| A | B | C | D | E | F | G | H | I | J | K |
|---|---|---|---|---|---|---|---|---|---|---|
| Layer No. | Layer top depth (ft) | Layer bottom depth (ft) | Layer thickness $\Delta z_i$ (ft) | Mid-layer depth $z_{ave}$ (ft) | Average tip stress $q_c$ (tsf) | $I_{zi}$ | Elastic modulus $E_{si}$ (ksf) | $\Delta z_i I_{zi}/E_{si}$ | $\Delta z_i I_{zi}/E_{si}$ | Notes |
| 1 | 0.0 | 1.0 | 1.0 | 0.5 | 147.9 | 0.101 | 739.6 | 0.00014 | 0.00014 | |
| 2 | 1.0 | 2.0 | 1.0 | 1.5 | 69.5 | 0.104 | 347.5 | 0.00030 | 0.00030 | |
| 3 | 2.0 | 3.0 | 1.0 | 2.5 | 77.6 | 0.106 | 388.1 | 0.00027 | 0.00027 | |
| 4 | 3.0 | 4.0 | 1.0 | 3.5 | 120.8 | 0.108 | 604.0 | 0.00018 | 0.00018 | |
| 5 | 4.0 | 5.0 | 1.0 | 4.5 | 134.9 | 0.111 | 674.4 | 0.00016 | 0.00016 | |
| 6 | 5.0 | 6.0 | 1.0 | 5.5 | 175.3 | 0.113 | 876.6 | 0.00013 | 0.00013 | |
| 7 | 6.0 | 7.0 | 1.0 | 6.5 | 97.5 | 0.115 | 487.5 | 0.00024 | 0.00024 | |
| 8 | 7.0 | 8.0 | 1.0 | 7.5 | 75.5 | 0.118 | 377.5 | 0.00031 | 0.00031 | |
| 9 | 8.0 | 9.0 | 1.0 | 8.5 | 71.7 | 0.120 | 358.3 | 0.00033 | 0.00033 | |
| 10 | 9.0 | 10.0 | 1.0 | 9.5 | 72.8 | 0.122 | 364.0 | 0.00034 | 0.00034 | |
| 11 | 10.0 | 11.0 | 1.0 | 10.5 | 90.9 | 0.125 | 454.7 | 0.00027 | 0.00027 | |
| 12 | 11.0 | 12.0 | 1.0 | 11.5 | 83.4 | 0.127 | 416.8 | 0.00030 | 0.00030 | |
| 13 | 12.0 | 13.0 | 1.0 | 12.5 | 106.3 | 0.129 | 531.5 | 0.00024 | 0.00024 | |
| 14 | 13.0 | 14.0 | 1.0 | 13.5 | 130.6 | 0.132 | 652.8 | 0.00020 | 0.00020 | |
| 15 | 14.0 | 15.0 | 1.0 | 14.5 | 190.6 | 0.134 | 952.9 | 0.00014 | 0.00014 | |
| 16 | 15.0 | 16.0 | 1.0 | 15.5 | 200.8 | 0.136 | 1003.9 | 0.00014 | 0.00014 | |
| 17 | 16.0 | 17.0 | 1.0 | 16.5 | 142.5 | 0.139 | 712.6 | 0.00019 | 0.00019 | |
| 18 | 17.0 | 18.0 | 1.0 | 17.5 | 302.1 | 0.141 | 1510.6 | 0.00009 | 0.00009 | |
| 19 | 18.0 | 19.0 | 1.0 | 18.5 | 295.2 | 0.143 | 1476.2 | 0.00010 | 0.00010 | |
| 20 | 19.0 | 20.0 | 1.0 | 19.5 | 277.3 | 0.146 | 1386.7 | 0.00011 | 0.00011 | |
| 21 | 20.0 | 21.0 | 1.0 | 20.5 | 314.9 | 0.148 | 1574.3 | 0.00009 | 0.00009 | |
| 22 | 21.0 | 22.0 | 1.0 | 21.5 | 264.2 | 0.150 | 1320.9 | 0.00011 | 0.00011 | |
| 23 | 22.0 | 23.0 | 1.0 | 22.5 | 253.8 | 0.153 | 1268.8 | 0.00012 | 0.00012 | |
| 24 | 23.0 | 24.0 | 1.0 | 23.5 | 281.1 | 0.155 | 1405.7 | 0.00011 | 0.00011 | |
| 25 | 24.0 | 25.0 | 1.0 | 24.5 | 232.9 | 0.158 | 1164.3 | 0.00014 | 0.00014 | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 26 | 25.0 | 26.0 | 1.0 | 25.5 | 211.0 | 0.160 | 1055.0 | 0.00015 | 0.00015 |
| 27 | 26.0 | 27.0 | 1.0 | 26.5 | 123.0 | 0.162 | 615.0 | 0.00026 | 0.00026 |
| 28 | 27.0 | 28.0 | 1.0 | 27.5 | 132.2 | 0.165 | 660.8 | 0.00025 | 0.00025 |
| 29 | 28.0 | 29.0 | 1.0 | 28.5 | 113.3 | 0.167 | 566.7 | 0.00029 | 0.00029 |
| 30 | 29.0 | 30.0 | 1.0 | 29.5 | 99.7 | 0.169 | 498.5 | 0.00034 | 0.00034 |
| 31 | 30.0 | 31.0 | 1.0 | 30.5 | 104.5 | 0.172 | 522.3 | 0.00033 | 0.00033 |
| 32 | 31.0 | 32.0 | 1.0 | 31.5 | 167.1 | 0.174 | 835.4 | 0.00021 | 0.00021 |
| 33 | 32.0 | 33.0 | 1.0 | 32.5 | 187.9 | 0.176 | 939.7 | 0.00019 | 0.00019 |
| 34 | 33.0 | 34.0 | 1.0 | 33.5 | 218.2 | 0.179 | 1090.9 | 0.00016 | 0.00016 |
| 35 | 34.0 | 35.0 | 1.0 | 34.5 | 234.3 | 0.181 | 1171.5 | 0.00015 | 0.00015 |
| 36 | 35.0 | 36.0 | 1.0 | 35.5 | 261.6 | 0.183 | 1307.9 | 0.00014 | 0.00014 |
| 37 | 36.0 | 37.0 | 1.0 | 36.5 | 250.4 | 0.186 | 1251.8 | 0.00015 | 0.00015 |
| 38 | 37.0 | 38.0 | 1.0 | 37.5 | 229.7 | 0.188 | 1148.7 | 0.00016 | 0.00016 |
| 39 | 38.0 | 39.0 | 1.0 | 38.5 | 251.7 | 0.190 | 1258.7 | 0.00015 | 0.00015 |
| 40 | 39.0 | 40.0 | 1.0 | 39.5 | 235.9 | 0.193 | 1179.6 | 0.00016 | 0.00016 |
| 41 | 40.0 | 41.0 | 1.0 | 40.5 | 245.5 | 0.195 | 1227.3 | 0.00016 | 0.00016 |
| 42 | 41.0 | 42.0 | 1.0 | 41.5 | 194.4 | 0.197 | 972.0 | 0.00020 | 0.00020 |
| 43 | 42.0 | 43.0 | 1.0 | 42.5 | 230.8 | 0.200 | 1154.0 | 0.00017 | 0.00017 |
| 44 | 43.0 | 44.0 | 1.0 | 43.5 | 170.8 | 0.202 | 853.8 | 0.00024 | 0.00024 |
| 45 | 44.0 | 45.0 | 1.0 | 44.5 | 123.7 | 0.204 | 618.3 | 0.00033 | 0.00033 |
| 46 | 45.0 | 46.0 | 1.0 | 45.5 | 246.6 | 0.207 | 1232.9 | 0.00017 | 0.00017 |
| 47 | 46.0 | 47.0 | 1.0 | 46.5 | 312.6 | 0.209 | 1563.0 | 0.00013 | 0.00013 |
| 48 | 47.0 | 48.0 | 1.0 | 47.5 | 329.5 | 0.212 | 1647.5 | 0.00013 | 0.00013 |
| 49 | 48.0 | 49.0 | 1.0 | 48.5 | 345.2 | 0.214 | 1725.8 | 0.00012 | 0.00012 |
| 50 | 49.0 | 50.0 | 1.0 | 49.5 | 325.8 | 0.216 | 1629.1 | 0.00013 | 0.00013 |
| 51 | 50.0 | 51.0 | 1.0 | 50.5 | 326.2 | 0.219 | 1631.1 | 0.00013 | 0.00013 |
| 52 | 51.0 | 52.0 | 1.0 | 51.5 | 313.3 | 0.221 | 1566.7 | 0.00014 | 0.00014 |
| 53 | 52.0 | 53.0 | 1.0 | 52.5 | 288.4 | 0.223 | 1442.1 | 0.00015 | 0.00015 |
| 54 | 53.0 | 54.0 | 1.0 | 53.5 | 279.4 | 0.226 | 1397.1 | 0.00016 | 0.00016 |
| 55 | 54.0 | 55.0 | 1.0 | 54.5 | 239.7 | 0.228 | 1198.4 | 0.00019 | 0.00019 |
| 56 | 55.0 | 56.0 | 1.0 | 55.5 | 192.4 | 0.230 | 962.0 | 0.00024 | 0.00024 |
| 57 | 56.0 | 57.0 | 1.0 | 56.5 | 144.6 | 0.233 | 723.1 | 0.00032 | 0.00032 |
| 58 | 57.0 | 58.0 | 1.0 | 57.5 | 126.3 | 0.235 | 631.5 | 0.00037 | 0.00037 |
| 59 | 58.0 | 59.0 | 1.0 | 58.5 | 104.4 | 0.237 | 522.0 | 0.00045 | 0.00045 |
| 60 | 59.0 | 60.0 | 1.0 | 59.5 | 36.7 | 0.240 | 183.5 | 0.00131 | 0.00131 |
| 61 | 60.0 | 61.0 | 1.0 | 60.5 | 65.1 | 0.242 | 325.3 | 0.00074 | 0.00074 |
| 62 | 61.0 | 62.0 | 1.0 | 61.5 | 145.0 | 0.244 | 725.1 | 0.00034 | 0.00034 |
| 63 | 62.0 | 63.0 | 1.0 | 62.5 | 289.2 | 0.247 | 1445.8 | 0.00017 | 0.00017 |
| 64 | 63.0 | 64.0 | 1.0 | 63.5 | 297.1 | 0.249 | 1485.4 | 0.00017 | 0.00017 |
| 65 | 64.0 | 65.0 | 1.0 | 64.5 | 304.9 | 0.251 | 1524.3 | 0.00016 | 0.00016 |
| 66 | 65.0 | 66.0 | 1.0 | 65.5 | 302.1 | 0.254 | 1510.6 | 0.00017 | 0.00017 |
| 67 | 66.0 | 67.0 | 1.0 | 66.5 | 320.5 | 0.256 | 1602.6 | 0.00016 | 0.00016 |
| 68 | 67.0 | 68.0 | 1.0 | 67.5 | 356.1 | 0.258 | 1780.4 | 0.00015 | 0.00015 |
| 69 | 68.0 | 69.0 | 1.0 | 68.5 | 242.5 | 0.261 | 1212.7 | 0.00022 | 0.00022 |
| 70 | 69.0 | 70.0 | 1.0 | 69.5 | 108.3 | 0.263 | 541.4 | 0.00049 | 0.00049 |
| 71 | 70.0 | 71.0 | 1.0 | 70.5 | 89.5 | 0.266 | 447.7 | 0.00059 | 0.00059 |
| 72 | 71.0 | 72.0 | 1.0 | 71.5 | 204.4 | 0.268 | 1021.9 | 0.00026 | 0.00026 |
| 73 | 72.0 | 73.0 | 1.0 | 72.5 | 206.0 | 0.270 | 1030.1 | 0.00026 | 0.00026 |
| 74 | 73.0 | 74.0 | 1.0 | 73.5 | 187.8 | 0.273 | 939.0 | 0.00029 | 0.00029 |
| 75 | 74.0 | 75.0 | 1.0 | 74.5 | 186.4 | 0.275 | 931.8 | 0.00030 | 0.00030 |
| 76 | 75.0 | 76.0 | 1.0 | 75.5 | 154.4 | 0.277 | 771.9 | 0.00036 | 0.00036 |
| 77 | 76.0 | 77.0 | 1.0 | 76.5 | 87.6 | 0.280 | 438.0 | 0.00064 | 0.00064 |
| 78 | 77.0 | 78.0 | 1.0 | 77.5 | 93.1 | 0.282 | 465.7 | 0.00061 | 0.00061 |
| 79 | 78.0 | 79.0 | 1.0 | 78.5 | 70.5 | 0.284 | 352.3 | 0.00081 | 0.00081 |
| 80 | 79.0 | 80.0 | 1.0 | 79.5 | 282.6 | 0.287 | 1413.0 | 0.00020 | 0.00020 |
| 81 | 80.0 | 81.0 | 1.0 | 80.5 | 310.8 | 0.289 | 1553.9 | 0.00019 | 0.00019 |
| 82 | 81.0 | 82.0 | 1.0 | 81.5 | 284.7 | 0.291 | 1423.3 | 0.00020 | 0.00020 |
| 83 | 82.0 | 83.0 | 1.0 | 82.5 | 291.2 | 0.294 | 1455.9 | 0.00020 | 0.00020 |
| 84 | 83.0 | 84.0 | 1.0 | 83.5 | 358.3 | 0.296 | 1791.6 | 0.00017 | 0.00017 |
| 85 | 84.0 | 85.0 | 1.0 | 84.5 | 171.8 | 0.298 | 859.0 | 0.00035 | 0.00035 |
| 86 | 85.0 | 86.0 | 1.0 | 85.5 | 139.6 | 0.301 | 698.1 | 0.00043 | 0.00043 |
| 87 | 86.0 | 87.0 | 1.0 | 86.5 | 107.2 | 0.303 | 536.2 | 0.00057 | 0.00057 |
| 88 | 87.0 | 88.0 | 1.0 | 87.5 | 142.6 | 0.305 | 713.2 | 0.00043 | 0.00043 |
| 89 | 88.0 | 89.0 | 1.0 | 88.5 | 159.0 | 0.308 | 795.1 | 0.00039 | 0.00039 |
| 90 | 89.0 | 90.0 | 1.0 | 89.5 | 101.7 | 0.310 | 508.4 | 0.00061 | 0.00061 |
| 91 | 90.0 | 91.0 | 1.0 | 90.5 | 113.9 | 0.312 | 569.7 | 0.00055 | 0.00055 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 92 | 91.0 | 92.0 | 1.0 | 91.5 | 128.0 | 0.315 | 639.8 | 0.00049 | 0.00049 | |
| 93 | 92.0 | 93.0 | 1.0 | 92.5 | 132.8 | 0.317 | 663.8 | 0.00048 | 0.00048 | |
| 94 | 93.0 | 94.0 | 1.0 | 93.5 | 201.8 | 0.320 | 1009.1 | 0.00032 | 0.00032 | |
| 95 | 94.0 | 95.0 | 1.0 | 94.5 | 142.9 | 0.322 | 714.4 | 0.00045 | 0.00045 | |
| 96 | 95.0 | 96.0 | 1.0 | 95.5 | 118.3 | 0.324 | 591.6 | 0.00055 | 0.00055 | |
| 97 | 96.0 | 97.0 | 1.0 | 96.5 | 115.9 | 0.327 | 579.7 | 0.00056 | 0.00056 | |
| 98 | 97.0 | 98.0 | 1.0 | 97.5 | 111.7 | 0.329 | 558.5 | 0.00059 | 0.00059 | |
| 99 | 98.0 | 99.0 | 1.0 | 98.5 | 93.3 | 0.331 | 466.7 | 0.00071 | 0.00071 | |
| 100 | 99.0 | 100.0 | 1.0 | 99.5 | 131.0 | 0.334 | 655.2 | 0.00051 | 0.00051 | |
| 101 | 100.0 | 101.0 | 1.0 | 100.5 | 199.1 | 0.336 | 995.3 | 0.00034 | 0.00034 | |
| 102 | 101.0 | 102.0 | 1.0 | 101.5 | 210.6 | 0.338 | 1053.0 | 0.00032 | 0.00032 | |
| 103 | 102.0 | 103.0 | 1.0 | 102.5 | 167.6 | 0.341 | 837.8 | 0.00041 | 0.00041 | |
| 104 | 103.0 | 104.0 | 1.0 | 103.5 | 117.9 | 0.343 | 589.5 | 0.00058 | 0.00058 | |
| 105 | 104.0 | 105.0 | 1.0 | 104.5 | 71.2 | 0.345 | 356.1 | 0.00097 | 0.00097 | |
| 106 | 105.0 | 106.0 | 1.0 | 105.5 | 84.2 | 0.348 | 421.0 | 0.00083 | 0.00083 | |
| 107 | 106.0 | 107.0 | 1.0 | 106.5 | 82.8 | 0.350 | 414.1 | 0.00085 | 0.00085 | |
| 108 | 107.0 | 108.0 | 1.0 | 107.5 | 85.5 | 0.352 | 427.5 | 0.00082 | 0.00082 | |
| 109 | 108.0 | 109.0 | 1.0 | 108.5 | 87.7 | 0.355 | 438.7 | 0.00081 | 0.00081 | |
| 110 | 109.0 | 110.0 | 1.0 | 109.5 | 71.5 | 0.357 | 357.6 | 0.00100 | 0.00100 | |
| 111 | 110.0 | 111.0 | 1.0 | 110.5 | 60.5 | 0.359 | 302.6 | 0.00119 | 0.00119 | |
| 112 | 111.0 | 112.0 | 1.0 | 111.5 | 64.9 | 0.362 | 324.4 | 0.00112 | 0.00112 | |
| 113 | 112.0 | 113.0 | 1.0 | 112.5 | 62.6 | 0.364 | 313.2 | 0.00116 | 0.00116 | |
| 114 | 113.0 | 114.0 | 1.0 | 113.5 | 70.2 | 0.366 | 351.0 | 0.00104 | 0.00104 | |
| 115 | 114.0 | 115.0 | 1.0 | 114.5 | 80.1 | 0.369 | 400.6 | 0.00092 | 0.00092 | |
| 116 | 115.0 | 116.0 | 1.0 | 115.5 | 191.7 | 0.371 | 958.5 | 0.00039 | 0.00039 | |
| 117 | 116.0 | 117.0 | 1.0 | 116.5 | 204.5 | 0.373 | 1022.4 | 0.00037 | 0.00037 | |
| 118 | 117.0 | 118.0 | 1.0 | 117.5 | 508.1 | 0.376 | 2540.5 | 0.00015 | 0.00015 | |
| 119 | 118.0 | 119.0 | 1.0 | 118.5 | 621.5 | 0.378 | 3107.7 | 0.00012 | 0.00012 | |
| 120 | 119.0 | 120.0 | 1.0 | 119.5 | 668.1 | 0.381 | 3340.6 | 0.00011 | 0.00011 | |
| $\Sigma$ = | | | | | | | | | 0.04243 | |

| | |
|---|---|
| $I_{zr}$ (1 < L/B < 10): | $I_{zr} = I_{zs} + 0.111 (I_{zc} - I_{zs}) (L/B - 1)$ |
| $I_{zs}$ (L/B = 1): | |
| For $z_{ave}$ = 0 to B/2: | $I_{zs} = 0.1 + (z_{ave}/B)(2I_{zp} - 0.2)$ |
| For $z_{ave}$ = B/2 to 2B: | $I_{zs} = 0.667 I_{zp} (2 - z_{ave}/B)$ |
| $I_{zc}$ ($L/B \geq 10$): | |
| For $z_{ave}$ = 0 to B: | $I_{zc} = 0.2 + (z_{ave}/B)(I_{zp} - 0.2)$ |
| For $z_{ave}$ = B to 4B: | $I_{zc} = 0.333 I_{zp} (4 - z_{ave}/B)$ ( Coduto p.228. ) |

| | | | | | | |
|---|---|---|---|---|---|---|
| Footing width | B = | 382.0 | ft | **Z-SDU6-C12** | | |
| Footing length | L = | 382.0 | ft | | Immediate Settlement (in.) ($S_0$ / 2) | |
| Ground elevation | | 277.7 | ft | | | |
| Foundation elevation | | 265.0 | ft | | | |
| Ground Water elevation | | 220.0 | ft | | Load | $S_0$ = |
| Excavated or embedded depth | D = | 12.7 | ft | End of Operations | 5.10 | 0.8 |
| Depth to Groundwater | | 57.7 | ft | Tank Half Full | 2.80 | 0.2 |
| Unit weight | $\gamma$ = | 120.0 | pcf | Pre Closure | 5.50 | 0.9 |
| Gross Footing Load | | 5.10 | ksf | Post Closure | 8.00 | 1.7 |
| Net applied footing pressure | $\Delta p$ = | **3.576** | ksf | | | |
| | L/B = | 1.00 | - | | | |

**Computation**

| | | | | | | |
|---|---|---|---|---|---|---|
| Settlement | $\rho_i$ = | $C_1 C_t \Delta p \Sigma(\Delta z_i I_{zi}/E_{si})$ | 0.137 ft | | 30 Year Settlement (in.) ($S_{30}$ / 2) | |
| | $\rho_i$ = | $C_t$ = 1 | **1.638 in** | | Load | $S_0$ = |
| | S(t) = | | 0.204 ft | | 5.10 | 1.2 |
| | S(t) = | | **2.450 in** | | 8.00 | 2.5 |
| Correction for strain relief | $C_1$ = | $1 - 0.5(\sigma'_D/q')$ | 0.787 - | | | |
| Effective vertical overburden pressure at D | $\sigma'_{vo}$ = | $\gamma$ D | 1.524 ksf | | | |
| Correction for time dependent increase | $C_t$ = | 1 + 0.2 log( t / 0.1 ) | 1.50 - | | | |
| | t = | | 30.00 years | | | |
| Elastic modulus of soil layer i | $E_{si}$ = | 2.5 $q_c$ | see Column H | if L/B = 1 | | |
| | $E_{si}$ = | 3.5 $q_c$ | see Column H | If L/B $\geq$ 10 | | |
| Depth increment i | $\Delta z_i$ | | see Column D | | | |
| Influence factor of soil layer i | $I_{zi}$ | Figure 3-4 | see Column G | | | |
| Peak depth influence factor | $I_{zp}$ = | $0.5 + 0.1 (\Delta p/\sigma'_{Izp})^{1/2}$ | 0.548 - | | | |
| | $z_p$ = | 0.5B + D | 203.70 ft | If L/B = 1 | | |
| | $z_p$ = | B + D | 394.70 ft | If L/B $\geq$ 10 | | |
| | $z_p$ = | | 203.70 ft | for L/B=1.00 | | |
| Effective overburden pressure at depth Izp | $\sigma'_{Izp}$ = | | 15.33 ksf | | | |
| Elastic Modulus | $E_{si}$ = | | 2.50 $q_c$ | If L/B = 1 | | |
| | $E_{si}$ = | | 3.50 $q_c$ | If L/B $\geq$ 10 | | |
| | $E_{si}$ = | | 2.50 $q_c$ | for L/B=1.00 | | |

Computations made relative to the bottom of foundation

| A | B | C | D | E | F | G | H | I | J | K |
|---|---|---|---|---|---|---|---|---|---|---|
| Layer No. | Layer top depth (ft) | Layer bottom depth (ft) | Layer thickness $\Delta z_i$ (ft) | Mid-layer depth $z_{ave}$ (ft) | Average tip stress $q_c$ (tsf) | $I_{zi}$ | Elastic modulus $E_{si}$ (ksf) | $\Delta z_i I_{zi}/E_{si}$ | $\Delta z_i I_{zi}/E_{si}$ | Notes |
| 1 | 0.0 | 1.0 | 1.0 | 0.5 | 196.4 | 0.101 | 982.0 | 0.00010 | 0.00010 | |
| 2 | 1.0 | 2.0 | 1.0 | 1.5 | 205.9 | 0.104 | 1029.7 | 0.00010 | 0.00010 | |
| 3 | 2.0 | 3.0 | 1.0 | 2.5 | 147.8 | 0.106 | 739.0 | 0.00014 | 0.00014 | |
| 4 | 3.0 | 4.0 | 1.0 | 3.5 | 125.3 | 0.108 | 626.5 | 0.00017 | 0.00017 | |
| 5 | 4.0 | 5.0 | 1.0 | 4.5 | 129.2 | 0.111 | 645.8 | 0.00017 | 0.00017 | |
| 6 | 5.0 | 6.0 | 1.0 | 5.5 | 170.9 | 0.113 | 854.4 | 0.00013 | 0.00013 | |
| 7 | 6.0 | 7.0 | 1.0 | 6.5 | 203.6 | 0.115 | 1017.9 | 0.00011 | 0.00011 | |
| 8 | 7.0 | 8.0 | 1.0 | 7.5 | 145.9 | 0.118 | 729.3 | 0.00016 | 0.00016 | |
| 9 | 8.0 | 9.0 | 1.0 | 8.5 | 158.8 | 0.120 | 794.2 | 0.00015 | 0.00015 | |
| 10 | 9.0 | 10.0 | 1.0 | 9.5 | 199.8 | 0.122 | 999.2 | 0.00012 | 0.00012 | |
| 11 | 10.0 | 11.0 | 1.0 | 10.5 | 173.5 | 0.125 | 867.4 | 0.00014 | 0.00014 | |
| 12 | 11.0 | 12.0 | 1.0 | 11.5 | 162.1 | 0.127 | 810.3 | 0.00016 | 0.00016 | |
| 13 | 12.0 | 13.0 | 1.0 | 12.5 | 184.3 | 0.129 | 921.7 | 0.00014 | 0.00014 | |
| 14 | 13.0 | 14.0 | 1.0 | 13.5 | 194.7 | 0.132 | 973.5 | 0.00014 | 0.00014 | |
| 15 | 14.0 | 15.0 | 1.0 | 14.5 | 191.4 | 0.134 | 956.8 | 0.00014 | 0.00014 | |
| 16 | 15.0 | 16.0 | 1.0 | 15.5 | 207.3 | 0.136 | 1036.4 | 0.00013 | 0.00013 | |
| 17 | 16.0 | 17.0 | 1.0 | 16.5 | 182.8 | 0.139 | 914.1 | 0.00015 | 0.00015 | |
| 18 | 17.0 | 18.0 | 1.0 | 17.5 | 132.4 | 0.141 | 662.2 | 0.00021 | 0.00021 | |
| 19 | 18.0 | 19.0 | 1.0 | 18.5 | 168.7 | 0.143 | 843.4 | 0.00017 | 0.00017 | |
| 20 | 19.0 | 20.0 | 1.0 | 19.5 | 174.4 | 0.146 | 872.1 | 0.00017 | 0.00017 | |
| 21 | 20.0 | 21.0 | 1.0 | 20.5 | 168.5 | 0.148 | 842.7 | 0.00018 | 0.00018 | |
| 22 | 21.0 | 22.0 | 1.0 | 21.5 | 170.8 | 0.150 | 853.9 | 0.00018 | 0.00018 | |
| 23 | 22.0 | 23.0 | 1.0 | 22.5 | 210.5 | 0.153 | 1052.5 | 0.00015 | 0.00015 | |
| 24 | 23.0 | 24.0 | 1.0 | 23.5 | 244.0 | 0.155 | 1219.9 | 0.00013 | 0.00013 | |
| 25 | 24.0 | 25.0 | 1.0 | 24.5 | 204.9 | 0.158 | 1024.4 | 0.00015 | 0.00015 | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 26 | 25.0 | 26.0 | 1.0 | 25.5 | 80.9 | 0.160 | 404.7 | 0.00039 | 0.00039 |
| 27 | 26.0 | 27.0 | 1.0 | 26.5 | 64.5 | 0.162 | 322.3 | 0.00050 | 0.00050 |
| 28 | 27.0 | 28.0 | 1.0 | 27.5 | 68.0 | 0.165 | 340.2 | 0.00048 | 0.00048 |
| 29 | 28.0 | 29.0 | 1.0 | 28.5 | 32.9 | 0.167 | 164.3 | 0.00102 | 0.00102 |
| 30 | 29.0 | 30.0 | 1.0 | 29.5 | 70.8 | 0.169 | 354.1 | 0.00048 | 0.00048 |
| 31 | 30.0 | 31.0 | 1.0 | 30.5 | 127.9 | 0.172 | 639.3 | 0.00027 | 0.00027 |
| 32 | 31.0 | 32.0 | 1.0 | 31.5 | 138.3 | 0.174 | 691.3 | 0.00025 | 0.00025 |
| 33 | 32.0 | 33.0 | 1.0 | 32.5 | 161.2 | 0.176 | 805.8 | 0.00022 | 0.00022 |
| 34 | 33.0 | 34.0 | 1.0 | 33.5 | 183.1 | 0.179 | 915.6 | 0.00020 | 0.00020 |
| 35 | 34.0 | 35.0 | 1.0 | 34.5 | 188.9 | 0.181 | 944.7 | 0.00019 | 0.00019 |
| 36 | 35.0 | 36.0 | 1.0 | 35.5 | 161.0 | 0.183 | 805.0 | 0.00023 | 0.00023 |
| 37 | 36.0 | 37.0 | 1.0 | 36.5 | 153.4 | 0.186 | 767.2 | 0.00024 | 0.00024 |
| 38 | 37.0 | 38.0 | 1.0 | 37.5 | 148.0 | 0.188 | 740.1 | 0.00025 | 0.00025 |
| 39 | 38.0 | 39.0 | 1.0 | 38.5 | 128.2 | 0.190 | 641.2 | 0.00030 | 0.00030 |
| 40 | 39.0 | 40.0 | 1.0 | 39.5 | 123.8 | 0.193 | 619.0 | 0.00031 | 0.00031 |
| 41 | 40.0 | 41.0 | 1.0 | 40.5 | 144.4 | 0.195 | 722.0 | 0.00027 | 0.00027 |
| 42 | 41.0 | 42.0 | 1.0 | 41.5 | 140.0 | 0.197 | 700.2 | 0.00028 | 0.00028 |
| 43 | 42.0 | 43.0 | 1.0 | 42.5 | 73.0 | 0.200 | 365.1 | 0.00055 | 0.00055 |
| 44 | 43.0 | 44.0 | 1.0 | 43.5 | 40.4 | 0.202 | 202.2 | 0.00100 | 0.00100 |
| 45 | 44.0 | 45.0 | 1.0 | 44.5 | 114.2 | 0.204 | 571.2 | 0.00036 | 0.00036 |
| 46 | 45.0 | 46.0 | 1.0 | 45.5 | 184.3 | 0.207 | 921.3 | 0.00022 | 0.00022 |
| 47 | 46.0 | 47.0 | 1.0 | 46.5 | 239.2 | 0.209 | 1196.0 | 0.00017 | 0.00017 |
| 48 | 47.0 | 48.0 | 1.0 | 47.5 | 218.0 | 0.211 | 1090.2 | 0.00019 | 0.00019 |
| 49 | 48.0 | 49.0 | 1.0 | 48.5 | 184.8 | 0.214 | 924.1 | 0.00023 | 0.00023 |
| 50 | 49.0 | 50.0 | 1.0 | 49.5 | 185.7 | 0.216 | 928.6 | 0.00023 | 0.00023 |
| 51 | 50.0 | 51.0 | 1.0 | 50.5 | 167.5 | 0.219 | 837.7 | 0.00026 | 0.00026 |
| 52 | 51.0 | 52.0 | 1.0 | 51.5 | 153.9 | 0.221 | 769.6 | 0.00029 | 0.00029 |
| 53 | 52.0 | 53.0 | 1.0 | 52.5 | 121.8 | 0.223 | 608.9 | 0.00037 | 0.00037 |
| 54 | 53.0 | 54.0 | 1.0 | 53.5 | 173.8 | 0.226 | 868.9 | 0.00026 | 0.00026 |
| 55 | 54.0 | 55.0 | 1.0 | 54.5 | 245.5 | 0.228 | 1227.5 | 0.00019 | 0.00019 |
| 56 | 55.0 | 56.0 | 1.0 | 55.5 | 316.0 | 0.230 | 1580.0 | 0.00015 | 0.00015 |
| 57 | 56.0 | 57.0 | 1.0 | 56.5 | 365.1 | 0.233 | 1825.3 | 0.00013 | 0.00013 |
| 58 | 57.0 | 58.0 | 1.0 | 57.5 | 369.8 | 0.235 | 1849.0 | 0.00013 | 0.00013 |
| 59 | 58.0 | 59.0 | 1.0 | 58.5 | 250.3 | 0.237 | 1251.5 | 0.00019 | 0.00019 |
| 60 | 59.0 | 60.0 | 1.0 | 59.5 | 197.9 | 0.240 | 989.6 | 0.00024 | 0.00024 |
| 61 | 60.0 | 61.0 | 1.0 | 60.5 | 163.8 | 0.242 | 818.9 | 0.00030 | 0.00030 |
| 62 | 61.0 | 62.0 | 1.0 | 61.5 | 159.6 | 0.244 | 798.0 | 0.00031 | 0.00031 |
| 63 | 62.0 | 63.0 | 1.0 | 62.5 | 198.9 | 0.247 | 994.3 | 0.00025 | 0.00025 |
| 64 | 63.0 | 64.0 | 1.0 | 63.5 | 182.5 | 0.249 | 912.5 | 0.00027 | 0.00027 |
| 65 | 64.0 | 65.0 | 1.0 | 64.5 | 213.0 | 0.251 | 1065.0 | 0.00024 | 0.00024 |
| 66 | 65.0 | 66.0 | 1.0 | 65.5 | 213.8 | 0.254 | 1069.1 | 0.00024 | 0.00024 |
| 67 | 66.0 | 67.0 | 1.0 | 66.5 | 214.0 | 0.256 | 1070.0 | 0.00024 | 0.00024 |
| 68 | 67.0 | 68.0 | 1.0 | 67.5 | 277.9 | 0.258 | 1389.4 | 0.00019 | 0.00019 |
| 69 | 68.0 | 69.0 | 1.0 | 68.5 | 194.1 | 0.261 | 970.6 | 0.00027 | 0.00027 |
| 70 | 69.0 | 70.0 | 1.0 | 69.5 | 42.4 | 0.263 | 211.9 | 0.00124 | 0.00124 |
| 71 | 70.0 | 71.0 | 1.0 | 70.5 | 52.8 | 0.265 | 264.0 | 0.00101 | 0.00101 |
| 72 | 71.0 | 72.0 | 1.0 | 71.5 | 50.7 | 0.268 | 253.4 | 0.00106 | 0.00106 |
| 73 | 72.0 | 73.0 | 1.0 | 72.5 | 57.5 | 0.270 | 287.6 | 0.00094 | 0.00094 |
| 74 | 73.0 | 74.0 | 1.0 | 73.5 | 114.7 | 0.273 | 573.3 | 0.00048 | 0.00048 |
| 75 | 74.0 | 75.0 | 1.0 | 74.5 | 53.8 | 0.275 | 268.9 | 0.00102 | 0.00102 |
| 76 | 75.0 | 76.0 | 1.0 | 75.5 | 46.4 | 0.277 | 231.8 | 0.00120 | 0.00120 |
| 77 | 76.0 | 77.0 | 1.0 | 76.5 | 92.3 | 0.280 | 461.5 | 0.00061 | 0.00061 |
| 78 | 77.0 | 78.0 | 1.0 | 77.5 | 183.4 | 0.282 | 917.0 | 0.00031 | 0.00031 |
| 79 | 78.0 | 79.0 | 1.0 | 78.5 | 368.7 | 0.284 | 1843.7 | 0.00015 | 0.00015 |
| 80 | 79.0 | 80.0 | 1.0 | 79.5 | 142.8 | 0.287 | 713.9 | 0.00040 | 0.00040 |
| 81 | 80.0 | 81.0 | 1.0 | 80.5 | 117.1 | 0.289 | 585.5 | 0.00049 | 0.00049 |
| 82 | 81.0 | 82.0 | 1.0 | 81.5 | 181.6 | 0.291 | 907.9 | 0.00032 | 0.00032 |
| 83 | 82.0 | 83.0 | 1.0 | 82.5 | 163.1 | 0.294 | 815.3 | 0.00036 | 0.00036 |
| 84 | 83.0 | 84.0 | 1.0 | 83.5 | 131.7 | 0.296 | 658.5 | 0.00045 | 0.00045 |
| 85 | 84.0 | 85.0 | 1.0 | 84.5 | 171.8 | 0.298 | 859.0 | 0.00035 | 0.00035 |
| 86 | 85.0 | 86.0 | 1.0 | 85.5 | 139.6 | 0.301 | 698.1 | 0.00043 | 0.00043 |
| 87 | 86.0 | 87.0 | 1.0 | 86.5 | 107.2 | 0.303 | 536.2 | 0.00057 | 0.00057 |
| 88 | 87.0 | 88.0 | 1.0 | 87.5 | 142.6 | 0.305 | 713.2 | 0.00043 | 0.00043 |
| 89 | 88.0 | 89.0 | 1.0 | 88.5 | 159.0 | 0.308 | 795.1 | 0.00039 | 0.00039 |
| 90 | 89.0 | 90.0 | 1.0 | 89.5 | 101.7 | 0.310 | 508.4 | 0.00061 | 0.00061 |
| 91 | 90.0 | 91.0 | 1.0 | 90.5 | 113.9 | 0.312 | 569.7 | 0.00055 | 0.00055 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 92 | 91.0 | 92.0 | 1.0 | 91.5 | 128.0 | 0.315 | 639.8 | 0.00049 | 0.00049 | |
| 93 | 92.0 | 93.0 | 1.0 | 92.5 | 132.8 | 0.317 | 663.8 | 0.00048 | 0.00048 | |
| 94 | 93.0 | 94.0 | 1.0 | 93.5 | 201.8 | 0.319 | 1009.1 | 0.00032 | 0.00032 | |
| 95 | 94.0 | 95.0 | 1.0 | 94.5 | 142.9 | 0.322 | 714.4 | 0.00045 | 0.00045 | |
| 96 | 95.0 | 96.0 | 1.0 | 95.5 | 118.3 | 0.324 | 591.6 | 0.00055 | 0.00055 | |
| 97 | 96.0 | 97.0 | 1.0 | 96.5 | 115.9 | 0.326 | 579.7 | 0.00056 | 0.00056 | |
| 98 | 97.0 | 98.0 | 1.0 | 97.5 | 111.7 | 0.329 | 558.5 | 0.00059 | 0.00059 | |
| 99 | 98.0 | 99.0 | 1.0 | 98.5 | 93.3 | 0.331 | 466.7 | 0.00071 | 0.00071 | |
| 100 | 99.0 | 100.0 | 1.0 | 99.5 | 131.0 | 0.334 | 655.2 | 0.00051 | 0.00051 | |
| 101 | 100.0 | 101.0 | 1.0 | 100.5 | 199.1 | 0.336 | 995.3 | 0.00034 | 0.00034 | |
| 102 | 101.0 | 102.0 | 1.0 | 101.5 | 210.6 | 0.338 | 1053.0 | 0.00032 | 0.00032 | |
| 103 | 102.0 | 103.0 | 1.0 | 102.5 | 167.6 | 0.341 | 837.8 | 0.00041 | 0.00041 | |
| 104 | 103.0 | 104.0 | 1.0 | 103.5 | 117.9 | 0.343 | 589.5 | 0.00058 | 0.00058 | |
| 105 | 104.0 | 105.0 | 1.0 | 104.5 | 71.2 | 0.345 | 356.1 | 0.00097 | 0.00097 | |
| 106 | 105.0 | 106.0 | 1.0 | 105.5 | 84.2 | 0.348 | 421.0 | 0.00083 | 0.00083 | |
| 107 | 106.0 | 107.0 | 1.0 | 106.5 | 82.8 | 0.350 | 414.1 | 0.00085 | 0.00085 | |
| 108 | 107.0 | 108.0 | 1.0 | 107.5 | 85.5 | 0.352 | 427.5 | 0.00082 | 0.00082 | |
| 109 | 108.0 | 109.0 | 1.0 | 108.5 | 87.7 | 0.355 | 438.7 | 0.00081 | 0.00081 | |
| 110 | 109.0 | 110.0 | 1.0 | 109.5 | 71.5 | 0.357 | 357.6 | 0.00100 | 0.00100 | |
| 111 | 110.0 | 111.0 | 1.0 | 110.5 | 60.5 | 0.359 | 302.6 | 0.00119 | 0.00119 | |
| 112 | 111.0 | 112.0 | 1.0 | 111.5 | 64.9 | 0.362 | 324.4 | 0.00112 | 0.00112 | |
| 113 | 112.0 | 113.0 | 1.0 | 112.5 | 62.6 | 0.364 | 313.2 | 0.00116 | 0.00116 | |
| 114 | 113.0 | 114.0 | 1.0 | 113.5 | 70.2 | 0.366 | 351.0 | 0.00104 | 0.00104 | |
| 115 | 114.0 | 115.0 | 1.0 | 114.5 | 80.1 | 0.369 | 400.6 | 0.00092 | 0.00092 | |
| 116 | 115.0 | 116.0 | 1.0 | 115.5 | 191.7 | 0.371 | 958.5 | 0.00039 | 0.00039 | |
| 117 | 116.0 | 117.0 | 1.0 | 116.5 | 204.5 | 0.373 | 1022.4 | 0.00037 | 0.00037 | |
| 118 | 117.0 | 118.0 | 1.0 | 117.5 | 508.1 | 0.376 | 2540.5 | 0.00015 | 0.00015 | |
| 119 | 118.0 | 119.0 | 1.0 | 118.5 | 621.5 | 0.378 | 3107.7 | 0.00012 | 0.00012 | |
| 120 | 119.0 | 120.0 | 1.0 | 119.5 | 668.1 | 0.380 | 3340.6 | 0.00011 | 0.00011 | |
| $\Sigma$ = | | | | | | | | | 0.04851 | |

| | |
|---|---|
| $I_{zr}$ *(1 < L/B < 10):* | $I_{zr} = I_{zs} + 0.111\,(I_{zc} - I_{zs})\,(L/B - 1)$ |
| $I_{zs}$ *(L/B = 1):* | |
| *For* $z_{ave}$ *= 0 to B/2:* | $I_{zs} = 0.1 + (z_{ave}/B)(2I_{zp} - 0.2)$ |
| *For* $z_{ave}$ *= B/2 to 2B:* | $I_{zs} = 0.667\, I_{zp}\,(2 - z_{ave}/B)$ |
| $I_{zc}$ *(L/B* $\geq$ *10):* | |
| *For* $z_{ave}$ *= 0 to B:* | $I_{zc} = 0.2 + (z_{ave}/B)(I_{zp} - 0.2)$ |
| *For* $z_{ave}$ *= B to 4B:* | $I_{zc} = 0.333\, I_{zp}\,(4 - z_{ave}/B)$ ( Coduto p.228. ) |

| | | | | | |
|---|---|---|---|---|---|
| Footing width | B = | | 382.0 | ft | **Z-SDU6-C13** |
| Footing length | L = | | 382.0 | ft | |
| Ground elevation | | | 276.3 | ft | |
| Foundation elevation | | | 265.0 | ft | |
| Ground Water elevation | | | 220.0 | ft | |
| Excavated or embedded depth | D = | | 11.3 | ft | |
| Depth to Groundwater | | | 56.3 | ft | |
| Unit weight | $\gamma$ = | | 120.0 | pcf | |
| Gross Footing Load | | | 5.10 | ksf | |
| Net applied footing pressure | $\Delta p$ = | | **3.744** | ksf | |
| | L/B = | | 1.00 | - | |

Immediate Settlement (in.) ($S_0$ / 2)

| | Load | $S_0$ = |
|---|---|---|
| End of Operations | 5.10 | 1.0 |
| Tank Half Full | 2.80 | 0.2 |
| Pre Closure | 5.50 | 1.2 |
| Post Closure | 8.00 | 2.0 |

30 Year Settlement (in.) ($S_{30}$ / 2)

| Load | $S_0$ = |
|---|---|
| 5.10 | 1.5 |
| 8.00 | 3.0 |

**Computation**

| | | | | | |
|---|---|---|---|---|---|
| Settlement | $\rho_i$ = | $C_1 C_t \Delta p \Sigma(\Delta z_i I_{zi}/E_{si})$ | 0.170 | ft | |
| | $\rho_i$ = | $C_t$ = 1 | **2.037** | **in** | |
| | S(t) = | | 0.254 | ft | |
| | S(t) = | | **3.046** | **in** | |
| Correction for strain relief | $C_1$ = | $1 - 0.5(\sigma'_D/q')$ | 0.819 | - | |
| Effective vertical overburden pressure at D | $\sigma'_{vo}$ = | $\gamma$ D | 1.356 | ksf | |
| Correction for time dependent increase | $C_t$ = | 1 + 0.2 log( t / 0.1 ) | 1.50 | - | |
| | t = | | 30.00 | years | |
| Elastic modulus of soil layer i | $E_{si}$ = | 2.5 $q_c$ | see | Column H | if L/B = 1 |
| | $E_{si}$ = | 3.5 $q_c$ | see | Column H | If L/B $\geq$ 10 |
| Depth increment i | $\Delta z_i$ | | see | Column D | |
| Influence factor of soil layer i | $I_{zi}$ | Figure 3-4 | see | Column G | |
| Peak depth influence factor | $I_{zp}$ = | $0.5 + 0.1 (\Delta p/\sigma'_{Izp})^{1/2}$ | 0.550 | - | |
| | $z_p$ = | 0.5B + D | 202.30 | ft | If L/B = 1 |
| | $z_p$ = | B + D | 393.30 | ft | If L/B $\geq$ 10 |
| | $z_p$ = | | 202.30 | ft | for L/B=1.00 |
| Effective overburden pressure at depth Izp | $\sigma'_{Izp}$ = | | 15.17 | ksf | |
| Elastic Modulus | $E_{si}$ = | | 2.50 | $q_c$ | If L/B = 1 |
| | $E_{si}$ = | | 3.50 | $q_c$ | If L/B $\geq$ 10 |
| | $E_{si}$ = | | 2.50 | $q_c$ | for L/B=1.00 |

Computations made relative to the bottom of foundation

| A | B | C | D | E | F | G | H | I | J | K |
|---|---|---|---|---|---|---|---|---|---|---|
| Layer<br>No. | Layer top depth (ft) | Layer bottom depth (ft) | Layer thickness $\Delta z_i$ (ft) | Mid-layer depth $z_{ave}$ (ft) | Average tip stress $q_c$ (tsf) | $I_{zi}$ | Elastic modulus $E_{si}$ (ksf) | $\Delta z_i I_{zi}/E_{si}$ | $\Delta z_i I_{zi}/E_{si}$ | Notes |
| 1 | 0.0 | 1.0 | 1.0 | 0.5 | 206.3 | 0.101 | 1031.3 | 0.00010 | 0.00010 | |
| 2 | 1.0 | 2.0 | 1.0 | 1.5 | 128.5 | 0.104 | 642.7 | 0.00016 | 0.00016 | |
| 3 | 2.0 | 3.0 | 1.0 | 2.5 | 195.6 | 0.106 | 977.8 | 0.00011 | 0.00011 | |
| 4 | 3.0 | 4.0 | 1.0 | 3.5 | 172.6 | 0.108 | 863.2 | 0.00013 | 0.00013 | |
| 5 | 4.0 | 5.0 | 1.0 | 4.5 | 102.3 | 0.111 | 511.4 | 0.00022 | 0.00022 | |
| 6 | 5.0 | 6.0 | 1.0 | 5.5 | 109.6 | 0.113 | 548.1 | 0.00021 | 0.00021 | |
| 7 | 6.0 | 7.0 | 1.0 | 6.5 | 97.4 | 0.115 | 487.1 | 0.00024 | 0.00024 | |
| 8 | 7.0 | 8.0 | 1.0 | 7.5 | 110.9 | 0.118 | 554.6 | 0.00021 | 0.00021 | |
| 9 | 8.0 | 9.0 | 1.0 | 8.5 | 175.5 | 0.120 | 877.5 | 0.00014 | 0.00014 | |
| 10 | 9.0 | 10.0 | 1.0 | 9.5 | 199.8 | 0.122 | 998.9 | 0.00012 | 0.00012 | |
| 11 | 10.0 | 11.0 | 1.0 | 10.5 | 216.5 | 0.125 | 1082.6 | 0.00012 | 0.00012 | |
| 12 | 11.0 | 12.0 | 1.0 | 11.5 | 181.8 | 0.127 | 908.9 | 0.00014 | 0.00014 | |
| 13 | 12.0 | 13.0 | 1.0 | 12.5 | 183.5 | 0.129 | 917.7 | 0.00014 | 0.00014 | |
| 14 | 13.0 | 14.0 | 1.0 | 13.5 | 117.9 | 0.132 | 589.6 | 0.00022 | 0.00022 | |
| 15 | 14.0 | 15.0 | 1.0 | 14.5 | 121.1 | 0.134 | 605.3 | 0.00022 | 0.00022 | |
| 16 | 15.0 | 16.0 | 1.0 | 15.5 | 111.6 | 0.136 | 558.0 | 0.00024 | 0.00024 | |
| 17 | 16.0 | 17.0 | 1.0 | 16.5 | 115.6 | 0.139 | 577.8 | 0.00024 | 0.00024 | |
| 18 | 17.0 | 18.0 | 1.0 | 17.5 | 117.5 | 0.141 | 587.4 | 0.00024 | 0.00024 | |
| 19 | 18.0 | 19.0 | 1.0 | 18.5 | 121.1 | 0.144 | 605.7 | 0.00024 | 0.00024 | |
| 20 | 19.0 | 20.0 | 1.0 | 19.5 | 129.0 | 0.146 | 645.2 | 0.00023 | 0.00023 | |
| 21 | 20.0 | 21.0 | 1.0 | 20.5 | 136.4 | 0.148 | 682.1 | 0.00022 | 0.00022 | |
| 22 | 21.0 | 22.0 | 1.0 | 21.5 | 136.2 | 0.151 | 681.0 | 0.00022 | 0.00022 | |
| 23 | 22.0 | 23.0 | 1.0 | 22.5 | 144.6 | 0.153 | 722.8 | 0.00021 | 0.00021 | |
| 24 | 23.0 | 24.0 | 1.0 | 23.5 | 136.0 | 0.155 | 679.9 | 0.00023 | 0.00023 | |
| 25 | 24.0 | 25.0 | 1.0 | 24.5 | 146.1 | 0.158 | 730.6 | 0.00022 | 0.00022 | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 26 | 25.0 | 26.0 | 1.0 | 25.5 | 147.9 | 0.160 | 739.5 | 0.00022 | 0.00022 |
| 27 | 26.0 | 27.0 | 1.0 | 26.5 | 160.3 | 0.162 | 801.5 | 0.00020 | 0.00020 |
| 28 | 27.0 | 28.0 | 1.0 | 27.5 | 180.5 | 0.165 | 902.5 | 0.00018 | 0.00018 |
| 29 | 28.0 | 29.0 | 1.0 | 28.5 | 166.5 | 0.167 | 832.5 | 0.00020 | 0.00020 |
| 30 | 29.0 | 30.0 | 1.0 | 29.5 | 113.5 | 0.169 | 567.4 | 0.00030 | 0.00030 |
| 31 | 30.0 | 31.0 | 1.0 | 30.5 | 36.1 | 0.172 | 180.4 | 0.00095 | 0.00095 |
| 32 | 31.0 | 32.0 | 1.0 | 31.5 | 13.1 | 0.174 | 65.7 | 0.00265 | 0.00265 |
| 33 | 32.0 | 33.0 | 1.0 | 32.5 | 33.1 | 0.177 | 165.4 | 0.00107 | 0.00107 |
| 34 | 33.0 | 34.0 | 1.0 | 33.5 | 28.8 | 0.179 | 144.0 | 0.00124 | 0.00124 |
| 35 | 34.0 | 35.0 | 1.0 | 34.5 | 24.4 | 0.181 | 122.0 | 0.00149 | 0.00149 |
| 36 | 35.0 | 36.0 | 1.0 | 35.5 | 34.0 | 0.184 | 170.1 | 0.00108 | 0.00108 |
| 37 | 36.0 | 37.0 | 1.0 | 36.5 | 107.3 | 0.186 | 536.3 | 0.00035 | 0.00035 |
| 38 | 37.0 | 38.0 | 1.0 | 37.5 | 110.1 | 0.188 | 550.7 | 0.00034 | 0.00034 |
| 39 | 38.0 | 39.0 | 1.0 | 38.5 | 108.7 | 0.191 | 543.7 | 0.00035 | 0.00035 |
| 40 | 39.0 | 40.0 | 1.0 | 39.5 | 122.9 | 0.193 | 614.4 | 0.00031 | 0.00031 |
| 41 | 40.0 | 41.0 | 1.0 | 40.5 | 116.9 | 0.195 | 584.6 | 0.00033 | 0.00033 |
| 42 | 41.0 | 42.0 | 1.0 | 41.5 | 108.7 | 0.198 | 543.4 | 0.00036 | 0.00036 |
| 43 | 42.0 | 43.0 | 1.0 | 42.5 | 129.1 | 0.200 | 645.5 | 0.00031 | 0.00031 |
| 44 | 43.0 | 44.0 | 1.0 | 43.5 | 117.5 | 0.202 | 587.6 | 0.00034 | 0.00034 |
| 45 | 44.0 | 45.0 | 1.0 | 44.5 | 109.7 | 0.205 | 548.7 | 0.00037 | 0.00037 |
| 46 | 45.0 | 46.0 | 1.0 | 45.5 | 71.7 | 0.207 | 358.3 | 0.00058 | 0.00058 |
| 47 | 46.0 | 47.0 | 1.0 | 46.5 | 119.0 | 0.209 | 595.0 | 0.00035 | 0.00035 |
| 48 | 47.0 | 48.0 | 1.0 | 47.5 | 138.6 | 0.212 | 692.9 | 0.00031 | 0.00031 |
| 49 | 48.0 | 49.0 | 1.0 | 48.5 | 166.8 | 0.214 | 833.8 | 0.00026 | 0.00026 |
| 50 | 49.0 | 50.0 | 1.0 | 49.5 | 167.5 | 0.217 | 837.4 | 0.00026 | 0.00026 |
| 51 | 50.0 | 51.0 | 1.0 | 50.5 | 158.6 | 0.219 | 792.8 | 0.00028 | 0.00028 |
| 52 | 51.0 | 52.0 | 1.0 | 51.5 | 150.8 | 0.221 | 754.0 | 0.00029 | 0.00029 |
| 53 | 52.0 | 53.0 | 1.0 | 52.5 | 155.9 | 0.224 | 779.5 | 0.00029 | 0.00029 |
| 54 | 53.0 | 54.0 | 1.0 | 53.5 | 159.7 | 0.226 | 798.6 | 0.00028 | 0.00028 |
| 55 | 54.0 | 55.0 | 1.0 | 54.5 | 143.1 | 0.228 | 715.5 | 0.00032 | 0.00032 |
| 56 | 55.0 | 56.0 | 1.0 | 55.5 | 160.9 | 0.231 | 804.5 | 0.00029 | 0.00029 |
| 57 | 56.0 | 57.0 | 1.0 | 56.5 | 162.0 | 0.233 | 809.9 | 0.00029 | 0.00029 |
| 58 | 57.0 | 58.0 | 1.0 | 57.5 | 112.1 | 0.235 | 560.4 | 0.00042 | 0.00042 |
| 59 | 58.0 | 59.0 | 1.0 | 58.5 | 122.0 | 0.238 | 610.1 | 0.00039 | 0.00039 |
| 60 | 59.0 | 60.0 | 1.0 | 59.5 | 170.2 | 0.240 | 850.8 | 0.00028 | 0.00028 |
| 61 | 60.0 | 61.0 | 1.0 | 60.5 | 90.4 | 0.242 | 451.9 | 0.00054 | 0.00054 |
| 62 | 61.0 | 62.0 | 1.0 | 61.5 | 95.8 | 0.245 | 479.2 | 0.00051 | 0.00051 |
| 63 | 62.0 | 63.0 | 1.0 | 62.5 | 120.1 | 0.247 | 600.5 | 0.00041 | 0.00041 |
| 64 | 63.0 | 64.0 | 1.0 | 63.5 | 169.1 | 0.250 | 845.4 | 0.00030 | 0.00030 |
| 65 | 64.0 | 65.0 | 1.0 | 64.5 | 188.3 | 0.252 | 941.7 | 0.00027 | 0.00027 |
| 66 | 65.0 | 66.0 | 1.0 | 65.5 | 192.8 | 0.254 | 963.8 | 0.00026 | 0.00026 |
| 67 | 66.0 | 67.0 | 1.0 | 66.5 | 219.0 | 0.257 | 1094.8 | 0.00023 | 0.00023 |
| 68 | 67.0 | 68.0 | 1.0 | 67.5 | 231.0 | 0.259 | 1155.2 | 0.00022 | 0.00022 |
| 69 | 68.0 | 69.0 | 1.0 | 68.5 | 213.0 | 0.261 | 1065.1 | 0.00025 | 0.00025 |
| 70 | 69.0 | 70.0 | 1.0 | 69.5 | 218.5 | 0.264 | 1092.6 | 0.00024 | 0.00024 |
| 71 | 70.0 | 71.0 | 1.0 | 70.5 | 115.2 | 0.266 | 575.9 | 0.00046 | 0.00046 |
| 72 | 71.0 | 72.0 | 1.0 | 71.5 | 55.9 | 0.268 | 279.6 | 0.00096 | 0.00096 |
| 73 | 72.0 | 73.0 | 1.0 | 72.5 | 69.2 | 0.271 | 345.9 | 0.00078 | 0.00078 |
| 74 | 73.0 | 74.0 | 1.0 | 73.5 | 49.6 | 0.273 | 248.2 | 0.00110 | 0.00110 |
| 75 | 74.0 | 75.0 | 1.0 | 74.5 | 74.3 | 0.275 | 371.6 | 0.00074 | 0.00074 |
| 76 | 75.0 | 76.0 | 1.0 | 75.5 | 54.1 | 0.278 | 270.6 | 0.00103 | 0.00103 |
| 77 | 76.0 | 77.0 | 1.0 | 76.5 | 156.4 | 0.280 | 782.0 | 0.00036 | 0.00036 |
| 78 | 77.0 | 78.0 | 1.0 | 77.5 | 185.0 | 0.282 | 925.1 | 0.00031 | 0.00031 |
| 79 | 78.0 | 79.0 | 1.0 | 78.5 | 81.5 | 0.285 | 407.7 | 0.00070 | 0.00070 |
| 80 | 79.0 | 80.0 | 1.0 | 79.5 | 98.5 | 0.287 | 492.3 | 0.00058 | 0.00058 |
| 81 | 80.0 | 81.0 | 1.0 | 80.5 | 292.5 | 0.290 | 1462.3 | 0.00020 | 0.00020 |
| 82 | 81.0 | 82.0 | 1.0 | 81.5 | 181.6 | 0.292 | 907.9 | 0.00032 | 0.00032 |
| 83 | 82.0 | 83.0 | 1.0 | 82.5 | 163.1 | 0.294 | 815.3 | 0.00036 | 0.00036 |
| 84 | 83.0 | 84.0 | 1.0 | 83.5 | 131.7 | 0.297 | 658.5 | 0.00045 | 0.00045 |
| 85 | 84.0 | 85.0 | 1.0 | 84.5 | 171.8 | 0.299 | 859.0 | 0.00035 | 0.00035 |
| 86 | 85.0 | 86.0 | 1.0 | 85.5 | 139.6 | 0.301 | 698.1 | 0.00043 | 0.00043 |
| 87 | 86.0 | 87.0 | 1.0 | 86.5 | 107.2 | 0.304 | 536.2 | 0.00057 | 0.00057 |
| 88 | 87.0 | 88.0 | 1.0 | 87.5 | 142.6 | 0.306 | 713.2 | 0.00043 | 0.00043 |
| 89 | 88.0 | 89.0 | 1.0 | 88.5 | 159.0 | 0.308 | 795.1 | 0.00039 | 0.00039 |
| 90 | 89.0 | 90.0 | 1.0 | 89.5 | 101.7 | 0.311 | 508.4 | 0.00061 | 0.00061 |
| 91 | 90.0 | 91.0 | 1.0 | 90.5 | 113.9 | 0.313 | 569.7 | 0.00055 | 0.00055 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 92 | 91.0 | 92.0 | 1.0 | 91.5 | 128.0 | 0.315 | 639.8 | 0.00049 | 0.00049 | |
| 93 | 92.0 | 93.0 | 1.0 | 92.5 | 132.8 | 0.318 | 663.8 | 0.00048 | 0.00048 | |
| 94 | 93.0 | 94.0 | 1.0 | 93.5 | 201.8 | 0.320 | 1009.1 | 0.00032 | 0.00032 | |
| 95 | 94.0 | 95.0 | 1.0 | 94.5 | 142.9 | 0.322 | 714.4 | 0.00045 | 0.00045 | |
| 96 | 95.0 | 96.0 | 1.0 | 95.5 | 118.3 | 0.325 | 591.6 | 0.00055 | 0.00055 | |
| 97 | 96.0 | 97.0 | 1.0 | 96.5 | 115.9 | 0.327 | 579.7 | 0.00056 | 0.00056 | |
| 98 | 97.0 | 98.0 | 1.0 | 97.5 | 111.7 | 0.330 | 558.5 | 0.00059 | 0.00059 | |
| 99 | 98.0 | 99.0 | 1.0 | 98.5 | 93.3 | 0.332 | 466.7 | 0.00071 | 0.00071 | |
| 100 | 99.0 | 100.0 | 1.0 | 99.5 | 131.0 | 0.334 | 655.2 | 0.00051 | 0.00051 | |
| 101 | 100.0 | 101.0 | 1.0 | 100.5 | 199.1 | 0.337 | 995.3 | 0.00034 | 0.00034 | |
| 102 | 101.0 | 102.0 | 1.0 | 101.5 | 210.6 | 0.339 | 1053.0 | 0.00032 | 0.00032 | |
| 103 | 102.0 | 103.0 | 1.0 | 102.5 | 167.6 | 0.341 | 837.8 | 0.00041 | 0.00041 | |
| 104 | 103.0 | 104.0 | 1.0 | 103.5 | 117.9 | 0.344 | 589.5 | 0.00058 | 0.00058 | |
| 105 | 104.0 | 105.0 | 1.0 | 104.5 | 71.2 | 0.346 | 356.1 | 0.00097 | 0.00097 | |
| 106 | 105.0 | 106.0 | 1.0 | 105.5 | 84.2 | 0.348 | 421.0 | 0.00083 | 0.00083 | |
| 107 | 106.0 | 107.0 | 1.0 | 106.5 | 82.8 | 0.351 | 414.1 | 0.00085 | 0.00085 | |
| 108 | 107.0 | 108.0 | 1.0 | 107.5 | 85.5 | 0.353 | 427.5 | 0.00083 | 0.00083 | |
| 109 | 108.0 | 109.0 | 1.0 | 108.5 | 87.7 | 0.355 | 438.7 | 0.00081 | 0.00081 | |
| 110 | 109.0 | 110.0 | 1.0 | 109.5 | 71.5 | 0.358 | 357.6 | 0.00100 | 0.00100 | |
| 111 | 110.0 | 111.0 | 1.0 | 110.5 | 60.5 | 0.360 | 302.6 | 0.00119 | 0.00119 | |
| 112 | 111.0 | 112.0 | 1.0 | 111.5 | 64.9 | 0.363 | 324.4 | 0.00112 | 0.00112 | |
| 113 | 112.0 | 113.0 | 1.0 | 112.5 | 62.6 | 0.365 | 313.2 | 0.00116 | 0.00116 | |
| 114 | 113.0 | 114.0 | 1.0 | 113.5 | 70.2 | 0.367 | 351.0 | 0.00105 | 0.00105 | |
| 115 | 114.0 | 115.0 | 1.0 | 114.5 | 80.1 | 0.370 | 400.6 | 0.00092 | 0.00092 | |
| 116 | 115.0 | 116.0 | 1.0 | 115.5 | 191.7 | 0.372 | 958.5 | 0.00039 | 0.00039 | |
| 117 | 116.0 | 117.0 | 1.0 | 116.5 | 204.5 | 0.374 | 1022.4 | 0.00037 | 0.00037 | |
| 118 | 117.0 | 118.0 | 1.0 | 117.5 | 508.1 | 0.377 | 2540.5 | 0.00015 | 0.00015 | |
| 119 | 118.0 | 119.0 | 1.0 | 118.5 | 621.5 | 0.379 | 3107.7 | 0.00012 | 0.00012 | |
| 120 | 119.0 | 120.0 | 1.0 | 119.5 | 668.1 | 0.381 | 3340.6 | 0.00011 | 0.00011 | |
| $\Sigma$ = | | | | | | | | | 0.05536 | |

| | |
|---|---|
| $I_{zr}$ *(1 < L/B < 10):* | $I_{zr} = I_{zs} + 0.111 (I_{zc} - I_{zs}) (L/B - 1)$ |
| $I_{zs}$ *(L/B = 1):* | |
| *For* $z_{ave}$ *= 0 to B/2:* | $I_{zs} = 0.1 + (z_{ave}/B)(2I_{zp} - 0.2)$ |
| *For* $z_{ave}$ *= B/2 to 2B:* | $I_{zs} = 0.667 I_{zp} (2 - z_{ave}/B)$ |
| $I_{zc}$ *(L/B* $\geq$ *10):* | |
| *For* $z_{ave}$ *= 0 to B:* | $I_{zc} = 0.2 + (z_{ave}/B)(I_{zp} - 0.2)$ |
| *For* $z_{ave}$ *= B to 4B:* | $I_{zc} = 0.333 I_{zp} (4 - z_{ave}/B)$ ( Coduto p.228. ) |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Footing width | B = | | 382.0 | ft | **Z-SDU6-C14** | | |
| Footing length | L = | | 382.0 | ft | | Immediate Settlement (in.) ($S_0$ / 2) | |
| Ground elevation | | | 277.3 | ft | | | |
| Foundation elevation | | | 265.0 | ft | | | |
| Ground Water elevation | | | 220.0 | ft | | Load | $S_0$ = |
| Excavated or embedded depth | D = | | 12.3 | ft | End of Operations | 5.10 | 1.0 |
| Depth to Groundwater | | | 57.3 | ft | Tank Half Full | 2.80 | 0.2 |
| Unit weight | $\gamma$ = | | 120.0 | pcf | Pre Closure | 5.50 | 1.2 |
| Gross Footing Load | | | 5.10 | ksf | Post Closure | 8.00 | 2.1 |
| Net applied footing pressure | $\Delta p$ = | | **3.624** | ksf | | | |
| | L/B = | | 1.00 | - | | | |

**Computation**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | 30 Year Settlement (in.) ($S_{30}$ / 2) | |
| Settlement | $\rho_i$ = | $C_1 C_t \Delta p \Sigma(\Delta z_i I_{zi}/E_{si})$ | 0.173 | ft | | Load | $S_0$ = |
| | $\rho_i$ = | $C_t$ = 1 | **2.073** | **in** | | 5.10 | 1.5 |
| | S(t) = | | 0.258 | ft | | 8.00 | 3.2 |
| | S(t) = | | **3.100** | **in** | | | |
| Correction for strain relief | $C_1$ = | $1 - 0.5(\sigma'_D/q')$ | 0.796 | - | | | |
| Effective vertical overburden pressure at D | $\sigma'_{vo}$ = | $\gamma$ D | 1.476 | ksf | | | |
| Correction for time dependent increase | $C_t$ = | 1 + 0.2 log( t / 0.1 ) | 1.50 | - | | | |
| | t = | | 30.00 | years | | | |
| Elastic modulus of soil layer i | $E_{si}$ = | 2.5 $q_c$ | see | Column H | if L/B = 1 | | |
| | $E_{si}$ = | 3.5 $q_c$ | see | Column H | If L/B $\geq$ 10 | | |
| Depth increment i | $\Delta z_i$ | | see | Column D | | | |
| Influence factor of soil layer i | $I_{zi}$ | Figure 3-4 | see | Column G | | | |
| Peak depth influence factor | $I_{zp}$ = | $0.5 + 0.1 (\Delta p/\sigma'_{Izp})^{1/2}$ | 0.549 | - | | | |
| | $z_p$ = | 0.5B + D | 203.30 | ft | If L/B = 1 | | |
| | $z_p$ = | B + D | 394.30 | ft | If L/B $\geq$ 10 | | |
| | $z_p$ = | | 203.30 | ft | for L/B=1.00 | | |
| Effective overburden pressure at depth Izp | $\sigma'_{Izp}$ = | | 15.29 | ksf | | | |
| Elastic Modulus | $E_{si}$ = | | 2.50 | $q_c$ | If L/B = 1 | | |
| | $E_{si}$ = | | 3.50 | $q_c$ | If L/B $\geq$ 10 | | |
| | $E_{si}$ = | | 2.50 | $q_c$ | for L/B=1.00 | | |

Computations made relative to the bottom of foundation

| A | B | C | D | E | F | G | H | I | J | K |
|---|---|---|---|---|---|---|---|---|---|---|
| Layer No. | Layer top depth (ft) | Layer bottom depth (ft) | Layer thickness $\Delta z_i$ (ft) | Mid-layer depth $z_{ave}$ (ft) | Average tip stress $q_c$ (tsf) | $I_{zi}$ | Elastic modulus $E_{si}$ (ksf) | $\Delta z_i I_{zi}/E_{si}$ | $\Delta z_i I_{zi}/E_{si}$ | Notes |
| 1 | 0.0 | 1.0 | 1.0 | 0.5 | 189.0 | 0.101 | 945.2 | 0.00011 | 0.00011 | |
| 2 | 1.0 | 2.0 | 1.0 | 1.5 | 218.7 | 0.104 | 1093.6 | 0.00009 | 0.00009 | |
| 3 | 2.0 | 3.0 | 1.0 | 2.5 | 146.1 | 0.106 | 730.7 | 0.00014 | 0.00014 | |
| 4 | 3.0 | 4.0 | 1.0 | 3.5 | 142.6 | 0.108 | 713.1 | 0.00015 | 0.00015 | |
| 5 | 4.0 | 5.0 | 1.0 | 4.5 | 157.0 | 0.111 | 784.9 | 0.00014 | 0.00014 | |
| 6 | 5.0 | 6.0 | 1.0 | 5.5 | 85.7 | 0.113 | 428.7 | 0.00026 | 0.00026 | |
| 7 | 6.0 | 7.0 | 1.0 | 6.5 | 103.7 | 0.115 | 518.5 | 0.00022 | 0.00022 | |
| 8 | 7.0 | 8.0 | 1.0 | 7.5 | 69.7 | 0.118 | 348.4 | 0.00034 | 0.00034 | |
| 9 | 8.0 | 9.0 | 1.0 | 8.5 | 344.0 | 0.120 | 1720.1 | 0.00007 | 0.00007 | |
| 10 | 9.0 | 10.0 | 1.0 | 9.5 | 111.7 | 0.122 | 558.3 | 0.00022 | 0.00022 | |
| 11 | 10.0 | 11.0 | 1.0 | 10.5 | 153.3 | 0.125 | 766.6 | 0.00016 | 0.00016 | |
| 12 | 11.0 | 12.0 | 1.0 | 11.5 | 188.7 | 0.127 | 943.5 | 0.00013 | 0.00013 | |
| 13 | 12.0 | 13.0 | 1.0 | 12.5 | 159.1 | 0.129 | 795.4 | 0.00016 | 0.00016 | |
| 14 | 13.0 | 14.0 | 1.0 | 13.5 | 143.8 | 0.132 | 719.2 | 0.00018 | 0.00018 | |
| 15 | 14.0 | 15.0 | 1.0 | 14.5 | 247.6 | 0.134 | 1238.1 | 0.00011 | 0.00011 | |
| 16 | 15.0 | 16.0 | 1.0 | 15.5 | 484.7 | 0.136 | 2423.3 | 0.00006 | 0.00006 | |
| 17 | 16.0 | 17.0 | 1.0 | 16.5 | 226.7 | 0.139 | 1133.4 | 0.00012 | 0.00012 | |
| 18 | 17.0 | 18.0 | 1.0 | 17.5 | 105.8 | 0.141 | 529.0 | 0.00027 | 0.00027 | |
| 19 | 18.0 | 19.0 | 1.0 | 18.5 | 122.1 | 0.143 | 610.3 | 0.00024 | 0.00024 | |
| 20 | 19.0 | 20.0 | 1.0 | 19.5 | 161.3 | 0.146 | 806.5 | 0.00018 | 0.00018 | |
| 21 | 20.0 | 21.0 | 1.0 | 20.5 | 271.4 | 0.148 | 1357.0 | 0.00011 | 0.00011 | |
| 22 | 21.0 | 22.0 | 1.0 | 21.5 | 291.9 | 0.151 | 1459.7 | 0.00010 | 0.00010 | |
| 23 | 22.0 | 23.0 | 1.0 | 22.5 | 277.3 | 0.153 | 1386.6 | 0.00011 | 0.00011 | |
| 24 | 23.0 | 24.0 | 1.0 | 23.5 | 78.7 | 0.155 | 393.6 | 0.00039 | 0.00039 | |
| 25 | 24.0 | 25.0 | 1.0 | 24.5 | 57.3 | 0.158 | 286.4 | 0.00055 | 0.00055 | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 26 | 25.0 | 26.0 | 1.0 | 25.5 | 233.1 | 0.160 | 1165.3 | 0.00014 | 0.00014 | |
| 27 | 26.0 | 27.0 | 1.0 | 26.5 | 322.3 | 0.162 | 1611.7 | 0.00010 | 0.00010 | |
| 28 | 27.0 | 28.0 | 1.0 | 27.5 | 350.5 | 0.165 | 1752.7 | 0.00009 | 0.00009 | |
| 29 | 28.0 | 29.0 | 1.0 | 28.5 | 254.6 | 0.167 | 1273.2 | 0.00013 | 0.00013 | |
| 30 | 29.0 | 30.0 | 1.0 | 29.5 | 87.0 | 0.169 | 434.9 | 0.00039 | 0.00039 | |
| 31 | 30.0 | 31.0 | 1.0 | 30.5 | 52.6 | 0.172 | 263.2 | 0.00065 | 0.00065 | |
| 32 | 31.0 | 32.0 | 1.0 | 31.5 | 59.8 | 0.174 | 299.2 | 0.00058 | 0.00058 | |
| 33 | 32.0 | 33.0 | 1.0 | 32.5 | 40.0 | 0.176 | 200.0 | 0.00088 | 0.00088 | |
| 34 | 33.0 | 34.0 | 1.0 | 33.5 | 35.5 | 0.179 | 177.5 | 0.00101 | 0.00101 | |
| 35 | 34.0 | 35.0 | 1.0 | 34.5 | 34.6 | 0.181 | 172.8 | 0.00105 | 0.00105 | |
| 36 | 35.0 | 36.0 | 1.0 | 35.5 | 62.1 | 0.183 | 310.5 | 0.00059 | 0.00059 | |
| 37 | 36.0 | 37.0 | 1.0 | 36.5 | 55.3 | 0.186 | 276.3 | 0.00067 | 0.00067 | |
| 38 | 37.0 | 38.0 | 1.0 | 37.5 | 46.9 | 0.188 | 234.4 | 0.00080 | 0.00080 | |
| 39 | 38.0 | 39.0 | 1.0 | 38.5 | 27.1 | 0.190 | 135.3 | 0.00141 | 0.00141 | |
| 40 | 39.0 | 40.0 | 1.0 | 39.5 | 28.4 | 0.193 | 142.1 | 0.00136 | 0.00136 | |
| 41 | 40.0 | 41.0 | 1.0 | 40.5 | 28.1 | 0.195 | 140.4 | 0.00139 | 0.00139 | |
| 42 | 41.0 | 42.0 | 1.0 | 41.5 | 23.4 | 0.197 | 117.1 | 0.00169 | 0.00169 | |
| 43 | 42.0 | 43.0 | 1.0 | 42.5 | 69.3 | 0.200 | 346.5 | 0.00058 | 0.00058 | |
| 44 | 43.0 | 44.0 | 1.0 | 43.5 | 76.9 | 0.202 | 384.3 | 0.00053 | 0.00053 | |
| 45 | 44.0 | 45.0 | 1.0 | 44.5 | 96.4 | 0.205 | 481.9 | 0.00042 | 0.00042 | |
| 46 | 45.0 | 46.0 | 1.0 | 45.5 | 79.4 | 0.207 | 397.0 | 0.00052 | 0.00052 | |
| 47 | 46.0 | 47.0 | 1.0 | 46.5 | 69.0 | 0.209 | 345.0 | 0.00061 | 0.00061 | |
| 48 | 47.0 | 48.0 | 1.0 | 47.5 | 86.4 | 0.212 | 432.2 | 0.00049 | 0.00049 | |
| 49 | 48.0 | 49.0 | 1.0 | 48.5 | 141.6 | 0.214 | 708.0 | 0.00030 | 0.00030 | |
| 50 | 49.0 | 50.0 | 1.0 | 49.5 | 213.1 | 0.216 | 1065.7 | 0.00020 | 0.00020 | |
| 51 | 50.0 | 51.0 | 1.0 | 50.5 | 202.0 | 0.219 | 1010.0 | 0.00022 | 0.00022 | |
| 52 | 51.0 | 52.0 | 1.0 | 51.5 | 180.1 | 0.221 | 900.3 | 0.00025 | 0.00025 | |
| 53 | 52.0 | 53.0 | 1.0 | 52.5 | 162.1 | 0.223 | 810.5 | 0.00028 | 0.00028 | |
| 54 | 53.0 | 54.0 | 1.0 | 53.5 | 133.9 | 0.226 | 669.3 | 0.00034 | 0.00034 | |
| 55 | 54.0 | 55.0 | 1.0 | 54.5 | 124.6 | 0.228 | 622.9 | 0.00037 | 0.00037 | |
| 56 | 55.0 | 56.0 | 1.0 | 55.5 | 136.6 | 0.230 | 683.2 | 0.00034 | 0.00034 | |
| 57 | 56.0 | 57.0 | 1.0 | 56.5 | 81.6 | 0.233 | 408.0 | 0.00057 | 0.00057 | |
| 58 | 57.0 | 58.0 | 1.0 | 57.5 | 105.7 | 0.235 | 528.3 | 0.00045 | 0.00045 | |
| 59 | 58.0 | 59.0 | 1.0 | 58.5 | 114.0 | 0.237 | 570.0 | 0.00042 | 0.00042 | |
| 60 | 59.0 | 60.0 | 1.0 | 59.5 | 50.5 | 0.240 | 252.7 | 0.00095 | 0.00095 | |
| 61 | 60.0 | 61.0 | 1.0 | 60.5 | 50.0 | 0.242 | 250.0 | 0.00097 | 0.00097 | |
| 62 | 61.0 | 62.0 | 1.0 | 61.5 | 107.0 | 0.244 | 535.0 | 0.00046 | 0.00046 | |
| 63 | 62.0 | 63.0 | 1.0 | 62.5 | 85.7 | 0.247 | 428.5 | 0.00058 | 0.00058 | |
| 64 | 63.0 | 64.0 | 1.0 | 63.5 | 162.4 | 0.249 | 812.2 | 0.00031 | 0.00031 | |
| 65 | 64.0 | 65.0 | 1.0 | 64.5 | 189.2 | 0.252 | 945.8 | 0.00027 | 0.00027 | |
| 66 | 65.0 | 66.0 | 1.0 | 65.5 | 205.4 | 0.254 | 1027.0 | 0.00025 | 0.00025 | |
| 67 | 66.0 | 67.0 | 1.0 | 66.5 | 204.2 | 0.256 | 1021.0 | 0.00025 | 0.00025 | |
| 68 | 67.0 | 68.0 | 1.0 | 67.5 | 235.2 | 0.259 | 1176.0 | 0.00022 | 0.00022 | |
| 69 | 68.0 | 69.0 | 1.0 | 68.5 | 290.1 | 0.261 | 1450.5 | 0.00018 | 0.00018 | |
| 70 | 69.0 | 70.0 | 1.0 | 69.5 | 192.8 | 0.263 | 964.2 | 0.00027 | 0.00027 | |
| 71 | 70.0 | 71.0 | 1.0 | 70.5 | 259.6 | 0.266 | 1298.1 | 0.00020 | 0.00020 | |
| 72 | 71.0 | 72.0 | 1.0 | 71.5 | 394.4 | 0.268 | 1971.9 | 0.00014 | 0.00014 | |
| 73 | 72.0 | 73.0 | 1.0 | 72.5 | 261.4 | 0.270 | 1307.1 | 0.00021 | 0.00021 | |
| 74 | 73.0 | 74.0 | 1.0 | 73.5 | 235.2 | 0.273 | 1176.0 | 0.00023 | 0.00023 | |
| 75 | 74.0 | 75.0 | 1.0 | 74.5 | 207.9 | 0.275 | 1039.6 | 0.00026 | 0.00026 | |
| 76 | 75.0 | 76.0 | 1.0 | 75.5 | 157.6 | 0.277 | 788.0 | 0.00035 | 0.00035 | |
| 77 | 76.0 | 77.0 | 1.0 | 76.5 | 103.2 | 0.280 | 515.8 | 0.00054 | 0.00054 | |
| 78 | 77.0 | 78.0 | 1.0 | 77.5 | 70.8 | 0.282 | 354.1 | 0.00080 | 0.00080 | |
| 79 | 78.0 | 79.0 | 1.0 | 78.5 | 51.6 | 0.284 | 257.9 | 0.00110 | 0.00110 | |
| 80 | 79.0 | 80.0 | 1.0 | 79.5 | 57.0 | 0.287 | 285.0 | 0.00101 | 0.00101 | |
| 81 | 80.0 | 81.0 | 1.0 | 80.5 | 36.2 | 0.289 | 180.9 | 0.00160 | 0.00160 | |
| 82 | 81.0 | 82.0 | 1.0 | 81.5 | 40.8 | 0.291 | 204.1 | 0.00143 | 0.00143 | |
| 83 | 82.0 | 83.0 | 1.0 | 82.5 | 41.0 | 0.294 | 205.1 | 0.00143 | 0.00143 | |
| 84 | 83.0 | 84.0 | 1.0 | 83.5 | 161.1 | 0.296 | 805.3 | 0.00037 | 0.00037 | |
| 85 | 84.0 | 85.0 | 1.0 | 84.5 | 310.7 | 0.299 | 1553.7 | 0.00019 | 0.00019 | |
| 86 | 85.0 | 86.0 | 1.0 | 85.5 | 324.8 | 0.301 | 1623.9 | 0.00019 | 0.00019 | |
| 87 | 86.0 | 87.0 | 1.0 | 86.5 | 107.2 | 0.303 | 536.2 | 0.00057 | 0.00057 | |
| 88 | 87.0 | 88.0 | 1.0 | 87.5 | 142.6 | 0.306 | 713.2 | 0.00043 | 0.00043 | |
| 89 | 88.0 | 89.0 | 1.0 | 88.5 | 159.0 | 0.308 | 795.1 | 0.00039 | 0.00039 | |
| 90 | 89.0 | 90.0 | 1.0 | 89.5 | 101.7 | 0.310 | 508.4 | 0.00061 | 0.00061 | |
| 91 | 90.0 | 91.0 | 1.0 | 90.5 | 113.9 | 0.313 | 569.7 | 0.00055 | 0.00055 | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 92 | 91.0 | 92.0 | 1.0 | 91.5 | 128.0 | 0.315 | 639.8 | 0.00049 | 0.00049 | |
| 93 | 92.0 | 93.0 | 1.0 | 92.5 | 132.8 | 0.317 | 663.8 | 0.00048 | 0.00048 | |
| 94 | 93.0 | 94.0 | 1.0 | 93.5 | 201.8 | 0.320 | 1009.1 | 0.00032 | 0.00032 | |
| 95 | 94.0 | 95.0 | 1.0 | 94.5 | 142.9 | 0.322 | 714.4 | 0.00045 | 0.00045 | |
| 96 | 95.0 | 96.0 | 1.0 | 95.5 | 118.3 | 0.324 | 591.6 | 0.00055 | 0.00055 | |
| 97 | 96.0 | 97.0 | 1.0 | 96.5 | 115.9 | 0.327 | 579.7 | 0.00056 | 0.00056 | |
| 98 | 97.0 | 98.0 | 1.0 | 97.5 | 111.7 | 0.329 | 558.5 | 0.00059 | 0.00059 | |
| 99 | 98.0 | 99.0 | 1.0 | 98.5 | 93.3 | 0.331 | 466.7 | 0.00071 | 0.00071 | |
| 100 | 99.0 | 100.0 | 1.0 | 99.5 | 131.0 | 0.334 | 655.2 | 0.00051 | 0.00051 | |
| 101 | 100.0 | 101.0 | 1.0 | 100.5 | 199.1 | 0.336 | 995.3 | 0.00034 | 0.00034 | |
| 102 | 101.0 | 102.0 | 1.0 | 101.5 | 210.6 | 0.338 | 1053.0 | 0.00032 | 0.00032 | |
| 103 | 102.0 | 103.0 | 1.0 | 102.5 | 167.6 | 0.341 | 837.8 | 0.00041 | 0.00041 | |
| 104 | 103.0 | 104.0 | 1.0 | 103.5 | 117.9 | 0.343 | 589.5 | 0.00058 | 0.00058 | |
| 105 | 104.0 | 105.0 | 1.0 | 104.5 | 71.2 | 0.345 | 356.1 | 0.00097 | 0.00097 | |
| 106 | 105.0 | 106.0 | 1.0 | 105.5 | 84.2 | 0.348 | 421.0 | 0.00083 | 0.00083 | |
| 107 | 106.0 | 107.0 | 1.0 | 106.5 | 82.8 | 0.350 | 414.1 | 0.00085 | 0.00085 | |
| 108 | 107.0 | 108.0 | 1.0 | 107.5 | 85.5 | 0.353 | 427.5 | 0.00082 | 0.00082 | |
| 109 | 108.0 | 109.0 | 1.0 | 108.5 | 87.7 | 0.355 | 438.7 | 0.00081 | 0.00081 | |
| 110 | 109.0 | 110.0 | 1.0 | 109.5 | 71.5 | 0.357 | 357.6 | 0.00100 | 0.00100 | |
| 111 | 110.0 | 111.0 | 1.0 | 110.5 | 60.5 | 0.360 | 302.6 | 0.00119 | 0.00119 | |
| 112 | 111.0 | 112.0 | 1.0 | 111.5 | 64.9 | 0.362 | 324.4 | 0.00112 | 0.00112 | |
| 113 | 112.0 | 113.0 | 1.0 | 112.5 | 62.6 | 0.364 | 313.2 | 0.00116 | 0.00116 | |
| 114 | 113.0 | 114.0 | 1.0 | 113.5 | 70.2 | 0.367 | 351.0 | 0.00104 | 0.00104 | |
| 115 | 114.0 | 115.0 | 1.0 | 114.5 | 80.1 | 0.369 | 400.6 | 0.00092 | 0.00092 | |
| 116 | 115.0 | 116.0 | 1.0 | 115.5 | 191.7 | 0.371 | 958.5 | 0.00039 | 0.00039 | |
| 117 | 116.0 | 117.0 | 1.0 | 116.5 | 204.5 | 0.374 | 1022.4 | 0.00037 | 0.00037 | |
| 118 | 117.0 | 118.0 | 1.0 | 117.5 | 508.1 | 0.376 | 2540.5 | 0.00015 | 0.00015 | |
| 119 | 118.0 | 119.0 | 1.0 | 118.5 | 621.5 | 0.378 | 3107.7 | 0.00012 | 0.00012 | |
| 120 | 119.0 | 120.0 | 1.0 | 119.5 | 668.1 | 0.381 | 3340.6 | 0.00011 | 0.00011 | |
| $\Sigma$ = | | | | | | | | | 0.05985 | |

*$I_{zr}$ (1 < L/B < 10):* $I_{zr} = I_{zs} + 0.111\,(I_{zc} - I_{zs})\,(L/B - 1)$

*$I_{zs}$ (L/B = 1):*

*For $z_{ave}$ = 0 to B/2:* $I_{zs} = 0.1 + (z_{ave}/B)(2I_{zp} - 0.2)$

*For $z_{ave}$ = B/2 to 2B:* $I_{zs} = 0.667\,I_{zp}\,(2 - z_{ave}/B)$

*$I_{zc}$ (L/B $\geq$ 10):*

*For $z_{ave}$ = 0 to B:* $I_{zc} = 0.2 + (z_{ave}/B)(I_{zp} - 0.2)$

*For $z_{ave}$ = B to 4B:* $I_{zc} = 0.333\,I_{zp}\,(4 - z_{ave}/B)$ ( Coduto p.228. )

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Footing width | B = | | 382.0 | ft | Z-SDU6-C15 | | | | |
| Footing length | L = | | 382.0 | ft | | | Immediate | | |
| Ground elevation | | | 276.8 | ft | | | Settlement (in.) | | |
| Foundation elevation | | | 265.0 | ft | | | $(S_0 / 2)$ | | |
| Ground Water elevation | | | 220.0 | ft | | | Load | $S_0$ = | |
| Excavated or embedded depth | D = | | 11.8 | ft | End of Operations | | 5.10 | 1.7 | |
| Depth to Groundwater | | | 56.8 | ft | Tank Half Full | | 2.80 | 0.4 | |
| Unit weight | $\gamma$ = | | 120.0 | pcf | Pre Closure | | 5.50 | 2.0 | |
| Gross Footing Load | | | 5.10 | ksf | Post Closure | | 8.00 | 3.5 | |
| Net applied footing pressure | $\Delta p$ = | | **3.684** | ksf | | | | | |
| | L/B = | | 1.00 | - | | | | | |
| | | | | | | | 30 Year | | |
| **Computation** | | | | | | | Settlement (in.) | | |
| Settlement | $\rho_i$ = | $C_1 C_t \Delta p \Sigma(\Delta z_i I_{zi}/E_{si})$ | 0.288 | ft | | | $(S_{30} / 2)$ | | |
| | $\rho_i$ = | $C_t$ = 1 | **3.460** | **in** | | | Load | $S_0$ = | |
| | S(t) = | | 0.431 | ft | | | 5.10 | 2.6 | |
| | S(t) = | | **5.174** | **in** | | | 8.00 | 5.2 | |
| Correction for strain relief | $C_1$ = | 1 - 0.5($\sigma'_D$/q') | 0.808 | - | | | | | |
| Effective vertical overburden pressure at D | $\sigma'_{vo}$ = | $\gamma$ D | 1.416 | ksf | | | | | |
| Correction for time dependent increase | $C_t$ = | 1 + 0.2 log( t / 0.1 ) | 1.50 | - | | | | | |
| | t = | | 30.00 | years | | | | | |
| Elastic modulus of soil layer i | $E_{si}$ = | 2.5 $q_c$ | see | Column H | if L/B = 1 | | | | |
| | $E_{si}$ = | 3.5 $q_c$ | see | Column H | If L/B $\geq$ 10 | | | | |
| Depth increment i | $\Delta z_i$ | | see | Column D | | | | | |
| Influence factor of soil layer i | $I_{zi}$ | Figure 3-4 | see | Column G | | | | | |
| Peak depth influence factor | $I_{zp}$ = | $0.5 + 0.1 (\Delta p/\sigma'_{Izp})^{1/2}$ | 0.549 | - | | | | | |
| | $z_p$ = | 0.5B + D | 202.80 | ft | If L/B = 1 | | | | |
| | $z_p$ = | B + D | 393.80 | ft | If L/B $\geq$ 10 | | | | |
| | $z_p$ = | | 202.80 | ft | for L/B=1.00 | | | | |
| Effective overburden pressure at depth Izp | $\sigma'_{Izp}$ = | | 15.23 | ksf | | | | | |
| Elastic Modulus | $E_{si}$ = | | 2.50 | $q_c$ | If L/B = 1 | | | | |
| | $E_{si}$ = | | 3.50 | $q_c$ | If L/B $\geq$ 10 | | | | |
| | $E_{si}$ = | | 2.50 | $q_c$ | for L/B=1.00 | | | | |

Computations made relative to the bottom of foundation

| A | B | C | D | E | F | G | H | I | J | K |
|---|---|---|---|---|---|---|---|---|---|---|
| Layer<br>No. | Layer top depth (ft) | Layer bottom depth (ft) | Layer thickness $\Delta z_i$ (ft) | Mid-layer depth $z_{ave}$ (ft) | Average tip stress $q_c$ (tsf) | $I_{zi}$ | Elastic modulus $E_{si}$ (ksf) | $\Delta z_i I_{zi}/E_{si}$ | $\Delta z_i I_{zi}/E_{si}$ | Notes |
| 1 | 0.0 | 1.0 | 1.0 | 0.5 | 384.4 | 0.101 | 1922.0 | 0.00005 | 0.00005 | |
| 2 | 1.0 | 2.0 | 1.0 | 1.5 | 271.0 | 0.104 | 1354.9 | 0.00008 | 0.00008 | |
| 3 | 2.0 | 3.0 | 1.0 | 2.5 | 273.1 | 0.106 | 1365.6 | 0.00008 | 0.00008 | |
| 4 | 3.0 | 4.0 | 1.0 | 3.5 | 108.6 | 0.108 | 543.1 | 0.00020 | 0.00020 | |
| 5 | 4.0 | 5.0 | 1.0 | 4.5 | 133.6 | 0.111 | 668.2 | 0.00017 | 0.00017 | |
| 6 | 5.0 | 6.0 | 1.0 | 5.5 | 121.6 | 0.113 | 608.2 | 0.00019 | 0.00019 | |
| 7 | 6.0 | 7.0 | 1.0 | 6.5 | 192.0 | 0.115 | 960.1 | 0.00012 | 0.00012 | |
| 8 | 7.0 | 8.0 | 1.0 | 7.5 | 72.2 | 0.118 | 361.0 | 0.00033 | 0.00033 | |
| 9 | 8.0 | 9.0 | 1.0 | 8.5 | 54.9 | 0.120 | 274.5 | 0.00044 | 0.00044 | |
| 10 | 9.0 | 10.0 | 1.0 | 9.5 | 161.4 | 0.122 | 807.2 | 0.00015 | 0.00015 | |
| 11 | 10.0 | 11.0 | 1.0 | 10.5 | 151.8 | 0.125 | 759.0 | 0.00016 | 0.00016 | |
| 12 | 11.0 | 12.0 | 1.0 | 11.5 | 50.1 | 0.127 | 250.6 | 0.00051 | 0.00051 | |
| 13 | 12.0 | 13.0 | 1.0 | 12.5 | 92.9 | 0.129 | 464.3 | 0.00028 | 0.00028 | |
| 14 | 13.0 | 14.0 | 1.0 | 13.5 | 125.2 | 0.132 | 625.9 | 0.00021 | 0.00021 | |
| 15 | 14.0 | 15.0 | 1.0 | 14.5 | 121.9 | 0.134 | 609.3 | 0.00022 | 0.00022 | |
| 16 | 15.0 | 16.0 | 1.0 | 15.5 | 179.9 | 0.136 | 899.5 | 0.00015 | 0.00015 | |
| 17 | 16.0 | 17.0 | 1.0 | 16.5 | 650.7 | 0.139 | 3253.5 | 0.00004 | 0.00004 | |
| 18 | 17.0 | 18.0 | 1.0 | 17.5 | 586.1 | 0.141 | 2930.3 | 0.00005 | 0.00005 | |
| 19 | 18.0 | 19.0 | 1.0 | 18.5 | 635.8 | 0.144 | 3178.8 | 0.00005 | 0.00005 | |
| 20 | 19.0 | 20.0 | 1.0 | 19.5 | 273.3 | 0.146 | 1366.5 | 0.00011 | 0.00011 | |
| 21 | 20.0 | 21.0 | 1.0 | 20.5 | 148.8 | 0.148 | 744.0 | 0.00020 | 0.00020 | |
| 22 | 21.0 | 22.0 | 1.0 | 21.5 | 95.9 | 0.151 | 479.5 | 0.00031 | 0.00031 | |
| 23 | 22.0 | 23.0 | 1.0 | 22.5 | 73.1 | 0.153 | 365.7 | 0.00042 | 0.00042 | |
| 24 | 23.0 | 24.0 | 1.0 | 23.5 | 241.7 | 0.155 | 1208.7 | 0.00013 | 0.00013 | |
| 25 | 24.0 | 25.0 | 1.0 | 24.5 | 256.2 | 0.158 | 1280.8 | 0.00012 | 0.00012 | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 26 | 25.0 | 26.0 | 1.0 | 25.5 | 253.4 | 0.160 | 1266.8 | 0.00013 | 0.00013 | |
| 27 | 26.0 | 27.0 | 1.0 | 26.5 | 236.5 | 0.162 | 1182.5 | 0.00014 | 0.00014 | |
| 28 | 27.0 | 28.0 | 1.0 | 27.5 | 278.6 | 0.165 | 1392.9 | 0.00012 | 0.00012 | |
| 29 | 28.0 | 29.0 | 1.0 | 28.5 | 304.2 | 0.167 | 1521.1 | 0.00011 | 0.00011 | |
| 30 | 29.0 | 30.0 | 1.0 | 29.5 | 315.4 | 0.169 | 1577.1 | 0.00011 | 0.00011 | |
| 31 | 30.0 | 31.0 | 1.0 | 30.5 | 270.1 | 0.172 | 1350.5 | 0.00013 | 0.00013 | |
| 32 | 31.0 | 32.0 | 1.0 | 31.5 | 176.0 | 0.174 | 880.2 | 0.00020 | 0.00020 | |
| 33 | 32.0 | 33.0 | 1.0 | 32.5 | 69.2 | 0.176 | 346.2 | 0.00051 | 0.00051 | |
| 34 | 33.0 | 34.0 | 1.0 | 33.5 | 84.7 | 0.179 | 423.6 | 0.00042 | 0.00042 | |
| 35 | 34.0 | 35.0 | 1.0 | 34.5 | 81.2 | 0.181 | 405.9 | 0.00045 | 0.00045 | |
| 36 | 35.0 | 36.0 | 1.0 | 35.5 | 26.7 | 0.183 | 133.6 | 0.00137 | 0.00137 | |
| 37 | 36.0 | 37.0 | 1.0 | 36.5 | 7.4 | 0.186 | 37.0 | 0.00503 | 0.00503 | |
| 38 | 37.0 | 38.0 | 1.0 | 37.5 | 8.4 | 0.188 | 42.0 | 0.00448 | 0.00448 | |
| 39 | 38.0 | 39.0 | 1.0 | 38.5 | 9.5 | 0.191 | 47.3 | 0.00403 | 0.00403 | |
| 40 | 39.0 | 40.0 | 1.0 | 39.5 | 12.6 | 0.193 | 62.8 | 0.00307 | 0.00307 | |
| 41 | 40.0 | 41.0 | 1.0 | 40.5 | 14.0 | 0.195 | 69.8 | 0.00280 | 0.00280 | |
| 42 | 41.0 | 42.0 | 1.0 | 41.5 | 12.3 | 0.198 | 61.5 | 0.00321 | 0.00321 | |
| 43 | 42.0 | 43.0 | 1.0 | 42.5 | 11.3 | 0.200 | 56.5 | 0.00354 | 0.00354 | |
| 44 | 43.0 | 44.0 | 1.0 | 43.5 | 11.1 | 0.202 | 55.4 | 0.00365 | 0.00365 | |
| 45 | 44.0 | 45.0 | 1.0 | 44.5 | 18.6 | 0.205 | 93.2 | 0.00219 | 0.00219 | |
| 46 | 45.0 | 46.0 | 1.0 | 45.5 | 31.5 | 0.207 | 157.5 | 0.00131 | 0.00131 | |
| 47 | 46.0 | 47.0 | 1.0 | 46.5 | 30.8 | 0.209 | 154.2 | 0.00136 | 0.00136 | |
| 48 | 47.0 | 48.0 | 1.0 | 47.5 | 89.9 | 0.212 | 449.3 | 0.00047 | 0.00047 | |
| 49 | 48.0 | 49.0 | 1.0 | 48.5 | 78.7 | 0.214 | 393.3 | 0.00054 | 0.00054 | |
| 50 | 49.0 | 50.0 | 1.0 | 49.5 | 84.9 | 0.216 | 424.7 | 0.00051 | 0.00051 | |
| 51 | 50.0 | 51.0 | 1.0 | 50.5 | 100.4 | 0.219 | 502.1 | 0.00044 | 0.00044 | |
| 52 | 51.0 | 52.0 | 1.0 | 51.5 | 145.5 | 0.221 | 727.7 | 0.00030 | 0.00030 | |
| 53 | 52.0 | 53.0 | 1.0 | 52.5 | 164.5 | 0.223 | 822.3 | 0.00027 | 0.00027 | |
| 54 | 53.0 | 54.0 | 1.0 | 53.5 | 169.6 | 0.226 | 848.1 | 0.00027 | 0.00027 | |
| 55 | 54.0 | 55.0 | 1.0 | 54.5 | 168.3 | 0.228 | 841.4 | 0.00027 | 0.00027 | |
| 56 | 55.0 | 56.0 | 1.0 | 55.5 | 139.6 | 0.231 | 698.2 | 0.00033 | 0.00033 | |
| 57 | 56.0 | 57.0 | 1.0 | 56.5 | 112.5 | 0.233 | 562.3 | 0.00041 | 0.00041 | |
| 58 | 57.0 | 58.0 | 1.0 | 57.5 | 130.3 | 0.235 | 651.7 | 0.00036 | 0.00036 | |
| 59 | 58.0 | 59.0 | 1.0 | 58.5 | 140.4 | 0.238 | 701.9 | 0.00034 | 0.00034 | |
| 60 | 59.0 | 60.0 | 1.0 | 59.5 | 75.8 | 0.240 | 378.8 | 0.00063 | 0.00063 | |
| 61 | 60.0 | 61.0 | 1.0 | 60.5 | 35.7 | 0.242 | 178.5 | 0.00136 | 0.00136 | |
| 62 | 61.0 | 62.0 | 1.0 | 61.5 | 53.5 | 0.245 | 267.6 | 0.00091 | 0.00091 | |
| 63 | 62.0 | 63.0 | 1.0 | 62.5 | 44.3 | 0.247 | 221.7 | 0.00111 | 0.00111 | |
| 64 | 63.0 | 64.0 | 1.0 | 63.5 | 154.0 | 0.249 | 769.8 | 0.00032 | 0.00032 | |
| 65 | 64.0 | 65.0 | 1.0 | 64.5 | 171.4 | 0.252 | 857.2 | 0.00029 | 0.00029 | |
| 66 | 65.0 | 66.0 | 1.0 | 65.5 | 166.6 | 0.254 | 833.0 | 0.00030 | 0.00030 | |
| 67 | 66.0 | 67.0 | 1.0 | 66.5 | 169.8 | 0.256 | 849.2 | 0.00030 | 0.00030 | |
| 68 | 67.0 | 68.0 | 1.0 | 67.5 | 152.4 | 0.259 | 762.1 | 0.00034 | 0.00034 | |
| 69 | 68.0 | 69.0 | 1.0 | 68.5 | 147.1 | 0.261 | 735.3 | 0.00036 | 0.00036 | |
| 70 | 69.0 | 70.0 | 1.0 | 69.5 | 100.0 | 0.263 | 500.0 | 0.00053 | 0.00053 | |
| 71 | 70.0 | 71.0 | 1.0 | 70.5 | 20.0 | 0.266 | 100.2 | 0.00265 | 0.00265 | |
| 72 | 71.0 | 72.0 | 1.0 | 71.5 | 7.1 | 0.268 | 35.6 | 0.00753 | 0.00753 | |
| 73 | 72.0 | 73.0 | 1.0 | 72.5 | 59.7 | 0.271 | 298.5 | 0.00091 | 0.00091 | |
| 74 | 73.0 | 74.0 | 1.0 | 73.5 | 103.7 | 0.273 | 518.7 | 0.00053 | 0.00053 | |
| 75 | 74.0 | 75.0 | 1.0 | 74.5 | 92.0 | 0.275 | 460.1 | 0.00060 | 0.00060 | |
| 76 | 75.0 | 76.0 | 1.0 | 75.5 | 78.3 | 0.278 | 391.4 | 0.00071 | 0.00071 | |
| 77 | 76.0 | 77.0 | 1.0 | 76.5 | 52.2 | 0.280 | 261.1 | 0.00107 | 0.00107 | |
| 78 | 77.0 | 78.0 | 1.0 | 77.5 | 64.6 | 0.282 | 322.8 | 0.00087 | 0.00087 | |
| 79 | 78.0 | 79.0 | 1.0 | 78.5 | 50.0 | 0.285 | 250.2 | 0.00114 | 0.00114 | |
| 80 | 79.0 | 80.0 | 1.0 | 79.5 | 50.0 | 0.287 | 250.2 | 0.00115 | 0.00115 | |
| 81 | 80.0 | 81.0 | 1.0 | 80.5 | 58.6 | 0.289 | 293.0 | 0.00099 | 0.00099 | |
| 82 | 81.0 | 82.0 | 1.0 | 81.5 | 27.8 | 0.292 | 139.1 | 0.00210 | 0.00210 | |
| 83 | 82.0 | 83.0 | 1.0 | 82.5 | 49.9 | 0.294 | 249.5 | 0.00118 | 0.00118 | |
| 84 | 83.0 | 84.0 | 1.0 | 83.5 | 174.5 | 0.296 | 872.6 | 0.00034 | 0.00034 | |
| 85 | 84.0 | 85.0 | 1.0 | 84.5 | 394.9 | 0.299 | 1974.7 | 0.00015 | 0.00015 | |
| 86 | 85.0 | 86.0 | 1.0 | 85.5 | 324.2 | 0.301 | 1621.0 | 0.00019 | 0.00019 | |
| 87 | 86.0 | 87.0 | 1.0 | 86.5 | 107.2 | 0.303 | 536.2 | 0.00057 | 0.00057 | |
| 88 | 87.0 | 88.0 | 1.0 | 87.5 | 142.6 | 0.306 | 713.2 | 0.00043 | 0.00043 | |
| 89 | 88.0 | 89.0 | 1.0 | 88.5 | 159.0 | 0.308 | 795.1 | 0.00039 | 0.00039 | |
| 90 | 89.0 | 90.0 | 1.0 | 89.5 | 101.7 | 0.310 | 508.4 | 0.00061 | 0.00061 | |
| 91 | 90.0 | 91.0 | 1.0 | 90.5 | 113.9 | 0.313 | 569.7 | 0.00055 | 0.00055 | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 92 | 91.0 | 92.0 | 1.0 | 91.5 | 128.0 | 0.315 | 639.8 | 0.00049 | 0.00049 | |
| 93 | 92.0 | 93.0 | 1.0 | 92.5 | 132.8 | 0.318 | 663.8 | 0.00048 | 0.00048 | |
| 94 | 93.0 | 94.0 | 1.0 | 93.5 | 201.8 | 0.320 | 1009.1 | 0.00032 | 0.00032 | |
| 95 | 94.0 | 95.0 | 1.0 | 94.5 | 142.9 | 0.322 | 714.4 | 0.00045 | 0.00045 | |
| 96 | 95.0 | 96.0 | 1.0 | 95.5 | 118.3 | 0.325 | 591.6 | 0.00055 | 0.00055 | |
| 97 | 96.0 | 97.0 | 1.0 | 96.5 | 115.9 | 0.327 | 579.7 | 0.00056 | 0.00056 | |
| 98 | 97.0 | 98.0 | 1.0 | 97.5 | 111.7 | 0.329 | 558.5 | 0.00059 | 0.00059 | |
| 99 | 98.0 | 99.0 | 1.0 | 98.5 | 93.3 | 0.332 | 466.7 | 0.00071 | 0.00071 | |
| 100 | 99.0 | 100.0 | 1.0 | 99.5 | 131.0 | 0.334 | 655.2 | 0.00051 | 0.00051 | |
| 101 | 100.0 | 101.0 | 1.0 | 100.5 | 199.1 | 0.336 | 995.3 | 0.00034 | 0.00034 | |
| 102 | 101.0 | 102.0 | 1.0 | 101.5 | 210.6 | 0.339 | 1053.0 | 0.00032 | 0.00032 | |
| 103 | 102.0 | 103.0 | 1.0 | 102.5 | 167.6 | 0.341 | 837.8 | 0.00041 | 0.00041 | |
| 104 | 103.0 | 104.0 | 1.0 | 103.5 | 117.9 | 0.343 | 589.5 | 0.00058 | 0.00058 | |
| 105 | 104.0 | 105.0 | 1.0 | 104.5 | 71.2 | 0.346 | 356.1 | 0.00097 | 0.00097 | |
| 106 | 105.0 | 106.0 | 1.0 | 105.5 | 84.2 | 0.348 | 421.0 | 0.00083 | 0.00083 | |
| 107 | 106.0 | 107.0 | 1.0 | 106.5 | 82.8 | 0.350 | 414.1 | 0.00085 | 0.00085 | |
| 108 | 107.0 | 108.0 | 1.0 | 107.5 | 85.5 | 0.353 | 427.5 | 0.00083 | 0.00083 | |
| 109 | 108.0 | 109.0 | 1.0 | 108.5 | 87.7 | 0.355 | 438.7 | 0.00081 | 0.00081 | |
| 110 | 109.0 | 110.0 | 1.0 | 109.5 | 71.5 | 0.358 | 357.6 | 0.00100 | 0.00100 | |
| 111 | 110.0 | 111.0 | 1.0 | 110.5 | 60.5 | 0.360 | 302.6 | 0.00119 | 0.00119 | |
| 112 | 111.0 | 112.0 | 1.0 | 111.5 | 64.9 | 0.362 | 324.4 | 0.00112 | 0.00112 | |
| 113 | 112.0 | 113.0 | 1.0 | 112.5 | 62.6 | 0.365 | 313.2 | 0.00116 | 0.00116 | |
| 114 | 113.0 | 114.0 | 1.0 | 113.5 | 70.2 | 0.367 | 351.0 | 0.00105 | 0.00105 | |
| 115 | 114.0 | 115.0 | 1.0 | 114.5 | 80.1 | 0.369 | 400.6 | 0.00092 | 0.00092 | |
| 116 | 115.0 | 116.0 | 1.0 | 115.5 | 191.7 | 0.372 | 958.5 | 0.00039 | 0.00039 | |
| 117 | 116.0 | 117.0 | 1.0 | 116.5 | 204.5 | 0.374 | 1022.4 | 0.00037 | 0.00037 | |
| 118 | 117.0 | 118.0 | 1.0 | 117.5 | 508.1 | 0.376 | 2540.5 | 0.00015 | 0.00015 | |
| 119 | 118.0 | 119.0 | 1.0 | 118.5 | 621.5 | 0.379 | 3107.7 | 0.00012 | 0.00012 | |
| 120 | 119.0 | 120.0 | 1.0 | 119.5 | 668.1 | 0.381 | 3340.6 | 0.00011 | 0.00011 | |
| $\Sigma$ = | | | | | | | | | 0.09688 | |

$I_{zr}$ $(1 < L/B < 10)$: $I_{zr} = I_{zs} + 0.111\,(I_{zc} - I_{zs})\,(L/B - 1)$

$I_{zs}$ $(L/B = 1)$:

For $z_{ave} = 0$ to $B/2$: $I_{zs} = 0.1 + (z_{ave}/B)(2I_{zp} - 0.2)$

For $z_{ave} = B/2$ to $2B$: $I_{zs} = 0.667\, I_{zp}\,(2 - z_{ave}/B)$

$I_{zc}$ $(L/B \geq 10)$:

For $z_{ave} = 0$ to $B$: $I_{zc} = 0.2 + (z_{ave}/B)(I_{zp} - 0.2)$

For $z_{ave} = B$ to $4B$: $I_{zc} = 0.333\, I_{zp}\,(4 - z_{ave}/B)$ ( Coduto p.228. )

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Footing width | B = | | 382.0 | ft | **Z-SDU6-C16** | | | |
| Footing length | L = | | 382.0 | ft | | Immediate | | |
| Ground elevation | | | 276.7 | ft | | Settlement (in.) | | |
| Foundation elevation | | | 265.0 | ft | | $(S_0 / 2)$ | | |
| Ground Water elevation | | | 220.0 | ft | | Load | $S_0$ = | |
| Excavated or embedded depth | D = | | 11.7 | ft | End of Operations | 5.10 | 1.8 | |
| Depth to Groundwater | | | 56.7 | ft | Tank Half Full | 2.80 | 0.4 | |
| Unit weight | $\gamma$ = | | 120.0 | pcf | Pre Closure | 5.50 | 2.0 | |
| Gross Footing Load | | | 5.10 | ksf | Post Closure | 8.00 | 3.5 | |
| Net applied footing pressure | $\Delta p$ = | | **3.696** | ksf | | | | |
| | L/B = | | 1.00 | - | | | | |

**Computation**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | 30 Year Settlement (in.) $(S_{30} / 2)$ | | |
| Settlement | $\rho_i$ = | $C_1 C_t \Delta p \Sigma(\Delta z_i I_{zi}/E_{si})$ | 0.292 | ft | Load | $S_0$ = |
| | $\rho_i$ = | $C_t$ = 1 | **3.501** | **in** | 5.10 | 2.6 |
| | S(t) = | | 0.436 | ft | 8.00 | 5.3 |
| | S(t) = | | **5.236** | **in** | | |
| Correction for strain relief | $C_1$ = | $1 - 0.5(\sigma'_D/q')$ | 0.810 | - | | |
| Effective vertical overburden pressure at D | $\sigma'_{vo}$ = | $\gamma$ D | 1.404 | ksf | | |
| Correction for time dependent increase | $C_t$ = | 1 + 0.2 log( t / 0.1 ) | 1.50 | - | | |
| | t = | | 30.00 | years | | |
| Elastic modulus of soil layer i | $E_{si}$ = | 2.5 $q_c$ | see Column H | if L/B = 1 | | |
| | $E_{si}$ = | 3.5 $q_c$ | see Column H | If L/B $\geq$ 10 | | |
| Depth increment i | $\Delta z_i$ | | see Column D | | | |
| Influence factor of soil layer i | $I_{zi}$ | Figure 3-4 | see Column G | | | |
| Peak depth influence factor | $I_{zp}$ = | $0.5 + 0.1 (\Delta p/\sigma'_{Izp})^{1/2}$ | 0.549 | - | | |
| | $z_p$ = | 0.5B + D | 202.70 | ft | If L/B = 1 | |
| | $z_p$ = | B + D | 393.70 | ft | If L/B $\geq$ 10 | |
| | $z_p$ = | | 202.70 | ft | for L/B=1.00 | |
| Effective overburden pressure at depth Izp | $\sigma'_{Izp}$ = | | 15.21 | ksf | | |
| Elastic Modulus | $E_{si}$ = | | 2.50 | $q_c$ | If L/B = 1 | |
| | $E_{si}$ = | | 3.50 | $q_c$ | If L/B $\geq$ 10 | |
| | $E_{si}$ = | | 2.50 | $q_c$ | for L/B=1.00 | |

Computations made relative to the bottom of foundation

| A | B | C | D | E | F | G | H | I | J | K |
|---|---|---|---|---|---|---|---|---|---|---|
| Layer No. | Layer top depth (ft) | Layer bottom depth (ft) | Layer thickness $\Delta z_i$ (ft) | Mid-layer depth $z_{ave}$ (ft) | Average tip stress $q_c$ (tsf) | $I_{zi}$ | Elastic modulus $E_{si}$ (ksf) | $\Delta z_i I_{zi}/E_{si}$ | $\Delta z_i I_{zi}/E_{si}$ | Notes |
| 1 | 0.0 | 1.0 | 1.0 | 0.5 | 225.8 | 0.101 | 1129.0 | 0.00009 | 0.00009 | |
| 2 | 1.0 | 2.0 | 1.0 | 1.5 | 125.4 | 0.104 | 627.2 | 0.00017 | 0.00017 | |
| 3 | 2.0 | 3.0 | 1.0 | 2.5 | 106.9 | 0.106 | 534.5 | 0.00020 | 0.00020 | |
| 4 | 3.0 | 4.0 | 1.0 | 3.5 | 76.8 | 0.108 | 383.9 | 0.00028 | 0.00028 | |
| 5 | 4.0 | 5.0 | 1.0 | 4.5 | 67.8 | 0.111 | 339.1 | 0.00033 | 0.00033 | |
| 6 | 5.0 | 6.0 | 1.0 | 5.5 | 88.2 | 0.113 | 441.0 | 0.00026 | 0.00026 | |
| 7 | 6.0 | 7.0 | 1.0 | 6.5 | 128.2 | 0.115 | 641.1 | 0.00018 | 0.00018 | |
| 8 | 7.0 | 8.0 | 1.0 | 7.5 | 166.3 | 0.118 | 831.5 | 0.00014 | 0.00014 | |
| 9 | 8.0 | 9.0 | 1.0 | 8.5 | 107.3 | 0.120 | 536.3 | 0.00022 | 0.00022 | |
| 10 | 9.0 | 10.0 | 1.0 | 9.5 | 77.6 | 0.122 | 388.2 | 0.00032 | 0.00032 | |
| 11 | 10.0 | 11.0 | 1.0 | 10.5 | 51.4 | 0.125 | 257.1 | 0.00049 | 0.00049 | |
| 12 | 11.0 | 12.0 | 1.0 | 11.5 | 48.5 | 0.127 | 242.4 | 0.00052 | 0.00052 | |
| 13 | 12.0 | 13.0 | 1.0 | 12.5 | 104.2 | 0.129 | 521.2 | 0.00025 | 0.00025 | |
| 14 | 13.0 | 14.0 | 1.0 | 13.5 | 160.4 | 0.132 | 802.2 | 0.00016 | 0.00016 | |
| 15 | 14.0 | 15.0 | 1.0 | 14.5 | 115.4 | 0.134 | 576.9 | 0.00023 | 0.00023 | |
| 16 | 15.0 | 16.0 | 1.0 | 15.5 | 121.3 | 0.136 | 606.7 | 0.00022 | 0.00022 | |
| 17 | 16.0 | 17.0 | 1.0 | 16.5 | 212.0 | 0.139 | 1060.0 | 0.00013 | 0.00013 | |
| 18 | 17.0 | 18.0 | 1.0 | 17.5 | 103.4 | 0.141 | 516.9 | 0.00027 | 0.00027 | |
| 19 | 18.0 | 19.0 | 1.0 | 18.5 | 176.2 | 0.144 | 880.9 | 0.00016 | 0.00016 | |
| 20 | 19.0 | 20.0 | 1.0 | 19.5 | 192.4 | 0.146 | 962.0 | 0.00015 | 0.00015 | |
| 21 | 20.0 | 21.0 | 1.0 | 20.5 | 182.3 | 0.148 | 911.6 | 0.00016 | 0.00016 | |
| 22 | 21.0 | 22.0 | 1.0 | 21.5 | 238.3 | 0.151 | 1191.4 | 0.00013 | 0.00013 | |
| 23 | 22.0 | 23.0 | 1.0 | 22.5 | 285.3 | 0.153 | 1426.7 | 0.00011 | 0.00011 | |
| 24 | 23.0 | 24.0 | 1.0 | 23.5 | 253.3 | 0.155 | 1266.6 | 0.00012 | 0.00012 | |
| 25 | 24.0 | 25.0 | 1.0 | 24.5 | 258.7 | 0.158 | 1293.5 | 0.00012 | 0.00012 | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 26 | 25.0 | 26.0 | 1.0 | 25.5 | 266.1 | 0.160 | 1330.3 | 0.00012 | 0.00012 |
| 27 | 26.0 | 27.0 | 1.0 | 26.5 | 281.5 | 0.162 | 1407.3 | 0.00012 | 0.00012 |
| 28 | 27.0 | 28.0 | 1.0 | 27.5 | 300.1 | 0.165 | 1500.7 | 0.00011 | 0.00011 |
| 29 | 28.0 | 29.0 | 1.0 | 28.5 | 261.0 | 0.167 | 1305.2 | 0.00013 | 0.00013 |
| 30 | 29.0 | 30.0 | 1.0 | 29.5 | 130.8 | 0.169 | 654.0 | 0.00026 | 0.00026 |
| 31 | 30.0 | 31.0 | 1.0 | 30.5 | 60.0 | 0.172 | 300.2 | 0.00057 | 0.00057 |
| 32 | 31.0 | 32.0 | 1.0 | 31.5 | 62.2 | 0.174 | 310.8 | 0.00056 | 0.00056 |
| 33 | 32.0 | 33.0 | 1.0 | 32.5 | 41.4 | 0.176 | 207.0 | 0.00085 | 0.00085 |
| 34 | 33.0 | 34.0 | 1.0 | 33.5 | 16.1 | 0.179 | 80.4 | 0.00222 | 0.00222 |
| 35 | 34.0 | 35.0 | 1.0 | 34.5 | 18.2 | 0.181 | 90.8 | 0.00200 | 0.00200 |
| 36 | 35.0 | 36.0 | 1.0 | 35.5 | 21.9 | 0.184 | 109.3 | 0.00168 | 0.00168 |
| 37 | 36.0 | 37.0 | 1.0 | 36.5 | 28.7 | 0.186 | 143.3 | 0.00130 | 0.00130 |
| 38 | 37.0 | 38.0 | 1.0 | 37.5 | 20.1 | 0.188 | 100.3 | 0.00188 | 0.00188 |
| 39 | 38.0 | 39.0 | 1.0 | 38.5 | 16.1 | 0.191 | 80.6 | 0.00236 | 0.00236 |
| 40 | 39.0 | 40.0 | 1.0 | 39.5 | 12.8 | 0.193 | 64.2 | 0.00300 | 0.00300 |
| 41 | 40.0 | 41.0 | 1.0 | 40.5 | 14.8 | 0.195 | 74.0 | 0.00264 | 0.00264 |
| 42 | 41.0 | 42.0 | 1.0 | 41.5 | 20.6 | 0.198 | 102.8 | 0.00192 | 0.00192 |
| 43 | 42.0 | 43.0 | 1.0 | 42.5 | 25.6 | 0.200 | 128.0 | 0.00156 | 0.00156 |
| 44 | 43.0 | 44.0 | 1.0 | 43.5 | 45.7 | 0.202 | 228.6 | 0.00089 | 0.00089 |
| 45 | 44.0 | 45.0 | 1.0 | 44.5 | 35.2 | 0.205 | 175.9 | 0.00116 | 0.00116 |
| 46 | 45.0 | 46.0 | 1.0 | 45.5 | 21.3 | 0.207 | 106.6 | 0.00194 | 0.00194 |
| 47 | 46.0 | 47.0 | 1.0 | 46.5 | 21.9 | 0.209 | 109.5 | 0.00191 | 0.00191 |
| 48 | 47.0 | 48.0 | 1.0 | 47.5 | 24.7 | 0.212 | 123.4 | 0.00172 | 0.00172 |
| 49 | 48.0 | 49.0 | 1.0 | 48.5 | 89.8 | 0.214 | 448.8 | 0.00048 | 0.00048 |
| 50 | 49.0 | 50.0 | 1.0 | 49.5 | 147.5 | 0.216 | 737.4 | 0.00029 | 0.00029 |
| 51 | 50.0 | 51.0 | 1.0 | 50.5 | 159.8 | 0.219 | 799.0 | 0.00027 | 0.00027 |
| 52 | 51.0 | 52.0 | 1.0 | 51.5 | 177.9 | 0.221 | 889.6 | 0.00025 | 0.00025 |
| 53 | 52.0 | 53.0 | 1.0 | 52.5 | 222.3 | 0.223 | 1111.4 | 0.00020 | 0.00020 |
| 54 | 53.0 | 54.0 | 1.0 | 53.5 | 216.8 | 0.226 | 1084.1 | 0.00021 | 0.00021 |
| 55 | 54.0 | 55.0 | 1.0 | 54.5 | 178.7 | 0.228 | 893.6 | 0.00026 | 0.00026 |
| 56 | 55.0 | 56.0 | 1.0 | 55.5 | 137.2 | 0.231 | 686.2 | 0.00034 | 0.00034 |
| 57 | 56.0 | 57.0 | 1.0 | 56.5 | 73.0 | 0.233 | 364.9 | 0.00064 | 0.00064 |
| 58 | 57.0 | 58.0 | 1.0 | 57.5 | 34.0 | 0.235 | 170.0 | 0.00138 | 0.00138 |
| 59 | 58.0 | 59.0 | 1.0 | 58.5 | 15.3 | 0.238 | 76.3 | 0.00311 | 0.00311 |
| 60 | 59.0 | 60.0 | 1.0 | 59.5 | 12.2 | 0.240 | 60.8 | 0.00395 | 0.00395 |
| 61 | 60.0 | 61.0 | 1.0 | 60.5 | 12.1 | 0.242 | 60.5 | 0.00401 | 0.00401 |
| 62 | 61.0 | 62.0 | 1.0 | 61.5 | 19.8 | 0.245 | 99.2 | 0.00247 | 0.00247 |
| 63 | 62.0 | 63.0 | 1.0 | 62.5 | 56.9 | 0.247 | 284.5 | 0.00087 | 0.00087 |
| 64 | 63.0 | 64.0 | 1.0 | 63.5 | 192.4 | 0.249 | 961.8 | 0.00026 | 0.00026 |
| 65 | 64.0 | 65.0 | 1.0 | 64.5 | 246.6 | 0.252 | 1233.0 | 0.00020 | 0.00020 |
| 66 | 65.0 | 66.0 | 1.0 | 65.5 | 232.4 | 0.254 | 1161.9 | 0.00022 | 0.00022 |
| 67 | 66.0 | 67.0 | 1.0 | 66.5 | 205.9 | 0.256 | 1029.5 | 0.00025 | 0.00025 |
| 68 | 67.0 | 68.0 | 1.0 | 67.5 | 232.6 | 0.259 | 1163.0 | 0.00022 | 0.00022 |
| 69 | 68.0 | 69.0 | 1.0 | 68.5 | 216.4 | 0.261 | 1082.2 | 0.00024 | 0.00024 |
| 70 | 69.0 | 70.0 | 1.0 | 69.5 | 66.4 | 0.263 | 331.9 | 0.00079 | 0.00079 |
| 71 | 70.0 | 71.0 | 1.0 | 70.5 | 9.5 | 0.266 | 47.6 | 0.00559 | 0.00559 |
| 72 | 71.0 | 72.0 | 1.0 | 71.5 | 21.0 | 0.268 | 104.9 | 0.00256 | 0.00256 |
| 73 | 72.0 | 73.0 | 1.0 | 72.5 | 26.3 | 0.271 | 131.4 | 0.00206 | 0.00206 |
| 74 | 73.0 | 74.0 | 1.0 | 73.5 | 82.5 | 0.273 | 412.3 | 0.00066 | 0.00066 |
| 75 | 74.0 | 75.0 | 1.0 | 74.5 | 98.5 | 0.275 | 492.7 | 0.00056 | 0.00056 |
| 76 | 75.0 | 76.0 | 1.0 | 75.5 | 87.8 | 0.278 | 438.8 | 0.00063 | 0.00063 |
| 77 | 76.0 | 77.0 | 1.0 | 76.5 | 57.9 | 0.280 | 289.3 | 0.00097 | 0.00097 |
| 78 | 77.0 | 78.0 | 1.0 | 77.5 | 64.2 | 0.282 | 321.0 | 0.00088 | 0.00088 |
| 79 | 78.0 | 79.0 | 1.0 | 78.5 | 75.9 | 0.285 | 379.6 | 0.00075 | 0.00075 |
| 80 | 79.0 | 80.0 | 1.0 | 79.5 | 48.7 | 0.287 | 243.7 | 0.00118 | 0.00118 |
| 81 | 80.0 | 81.0 | 1.0 | 80.5 | 31.7 | 0.289 | 158.6 | 0.00182 | 0.00182 |
| 82 | 81.0 | 82.0 | 1.0 | 81.5 | 130.7 | 0.292 | 653.7 | 0.00045 | 0.00045 |
| 83 | 82.0 | 83.0 | 1.0 | 82.5 | 173.6 | 0.294 | 867.8 | 0.00034 | 0.00034 |
| 84 | 83.0 | 84.0 | 1.0 | 83.5 | 202.8 | 0.296 | 1014.2 | 0.00029 | 0.00029 |
| 85 | 84.0 | 85.0 | 1.0 | 84.5 | 171.8 | 0.299 | 859.0 | 0.00035 | 0.00035 |
| 86 | 85.0 | 86.0 | 1.0 | 85.5 | 139.6 | 0.301 | 698.1 | 0.00043 | 0.00043 |
| 87 | 86.0 | 87.0 | 1.0 | 86.5 | 107.2 | 0.303 | 536.2 | 0.00057 | 0.00057 |
| 88 | 87.0 | 88.0 | 1.0 | 87.5 | 142.6 | 0.306 | 713.2 | 0.00043 | 0.00043 |
| 89 | 88.0 | 89.0 | 1.0 | 88.5 | 159.0 | 0.308 | 795.1 | 0.00039 | 0.00039 |
| 90 | 89.0 | 90.0 | 1.0 | 89.5 | 101.7 | 0.311 | 508.4 | 0.00061 | 0.00061 |
| 91 | 90.0 | 91.0 | 1.0 | 90.5 | 113.9 | 0.313 | 569.7 | 0.00055 | 0.00055 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 92 | 91.0 | 92.0 | 1.0 | 91.5 | 128.0 | 0.315 | 639.8 | 0.00049 | 0.00049 | |
| 93 | 92.0 | 93.0 | 1.0 | 92.5 | 132.8 | 0.318 | 663.8 | 0.00048 | 0.00048 | |
| 94 | 93.0 | 94.0 | 1.0 | 93.5 | 201.8 | 0.320 | 1009.1 | 0.00032 | 0.00032 | |
| 95 | 94.0 | 95.0 | 1.0 | 94.5 | 142.9 | 0.322 | 714.4 | 0.00045 | 0.00045 | |
| 96 | 95.0 | 96.0 | 1.0 | 95.5 | 118.3 | 0.325 | 591.6 | 0.00055 | 0.00055 | |
| 97 | 96.0 | 97.0 | 1.0 | 96.5 | 115.9 | 0.327 | 579.7 | 0.00056 | 0.00056 | |
| 98 | 97.0 | 98.0 | 1.0 | 97.5 | 111.7 | 0.329 | 558.5 | 0.00059 | 0.00059 | |
| 99 | 98.0 | 99.0 | 1.0 | 98.5 | 93.3 | 0.332 | 466.7 | 0.00071 | 0.00071 | |
| 100 | 99.0 | 100.0 | 1.0 | 99.5 | 131.0 | 0.334 | 655.2 | 0.00051 | 0.00051 | |
| 101 | 100.0 | 101.0 | 1.0 | 100.5 | 199.1 | 0.336 | 995.3 | 0.00034 | 0.00034 | |
| 102 | 101.0 | 102.0 | 1.0 | 101.5 | 210.6 | 0.339 | 1053.0 | 0.00032 | 0.00032 | |
| 103 | 102.0 | 103.0 | 1.0 | 102.5 | 167.6 | 0.341 | 837.8 | 0.00041 | 0.00041 | |
| 104 | 103.0 | 104.0 | 1.0 | 103.5 | 117.9 | 0.343 | 589.5 | 0.00058 | 0.00058 | |
| 105 | 104.0 | 105.0 | 1.0 | 104.5 | 71.2 | 0.346 | 356.1 | 0.00097 | 0.00097 | |
| 106 | 105.0 | 106.0 | 1.0 | 105.5 | 84.2 | 0.348 | 421.0 | 0.00083 | 0.00083 | |
| 107 | 106.0 | 107.0 | 1.0 | 106.5 | 82.8 | 0.351 | 414.1 | 0.00085 | 0.00085 | |
| 108 | 107.0 | 108.0 | 1.0 | 107.5 | 85.5 | 0.353 | 427.5 | 0.00083 | 0.00083 | |
| 109 | 108.0 | 109.0 | 1.0 | 108.5 | 87.7 | 0.355 | 438.7 | 0.00081 | 0.00081 | |
| 110 | 109.0 | 110.0 | 1.0 | 109.5 | 71.5 | 0.358 | 357.6 | 0.00100 | 0.00100 | |
| 111 | 110.0 | 111.0 | 1.0 | 110.5 | 60.5 | 0.360 | 302.6 | 0.00119 | 0.00119 | |
| 112 | 111.0 | 112.0 | 1.0 | 111.5 | 64.9 | 0.362 | 324.4 | 0.00112 | 0.00112 | |
| 113 | 112.0 | 113.0 | 1.0 | 112.5 | 62.6 | 0.365 | 313.2 | 0.00116 | 0.00116 | |
| 114 | 113.0 | 114.0 | 1.0 | 113.5 | 70.2 | 0.367 | 351.0 | 0.00105 | 0.00105 | |
| 115 | 114.0 | 115.0 | 1.0 | 114.5 | 80.1 | 0.369 | 400.6 | 0.00092 | 0.00092 | |
| 116 | 115.0 | 116.0 | 1.0 | 115.5 | 191.7 | 0.372 | 958.5 | 0.00039 | 0.00039 | |
| 117 | 116.0 | 117.0 | 1.0 | 116.5 | 204.5 | 0.374 | 1022.4 | 0.00037 | 0.00037 | |
| 118 | 117.0 | 118.0 | 1.0 | 117.5 | 508.1 | 0.376 | 2540.5 | 0.00015 | 0.00015 | |
| 119 | 118.0 | 119.0 | 1.0 | 118.5 | 621.5 | 0.379 | 3107.7 | 0.00012 | 0.00012 | |
| 120 | 119.0 | 120.0 | 1.0 | 119.5 | 668.1 | 0.381 | 3340.6 | 0.00011 | 0.00011 | |
| $\Sigma$ = | | | | | | | | | 0.09745 | |

$I_{zr}$ $(1 < L/B < 10)$: $I_{zr} = I_{zs} + 0.111\,(I_{zc} - I_{zs})\,(L/B - 1)$

$I_{zs}$ $(L/B = 1)$:

For $z_{ave} = 0$ to $B/2$: $I_{zs} = 0.1 + (z_{ave}/B)(2I_{zp} - 0.2)$

For $z_{ave} = B/2$ to $2B$: $I_{zs} = 0.667\, I_{zp}\,(2 - z_{ave}/B)$

$I_{zc}$ $(L/B \geq 10)$:

For $z_{ave} = 0$ to $B$: $I_{zc} = 0.2 + (z_{ave}/B)(I_{zp} - 0.2)$

For $z_{ave} = B$ to $4B$: $I_{zc} = 0.333\, I_{zp}\,(4 - z_{ave}/B)$ ( Coduto p.228. )

| | | | | | |
|---|---|---|---|---|---|
| Footing width | B = | | 382.0 | ft | **Z-SDU6-C17** |
| Footing length | L = | | 382.0 | ft | |
| Ground elevation | | | 276.0 | ft | |
| Foundation elevation | | | 265.0 | ft | |
| Ground Water elevation | | | 220.0 | ft | |
| Excavated or embedded depth | D = | | 11.0 | ft | |
| Depth to Groundwater | | | 56.0 | ft | |
| Unit weight | $\gamma$ = | | 120.0 | pcf | |
| Gross Footing Load | | | 5.10 | ksf | |
| Net applied footing pressure | $\Delta p$ = | | **3.780** | ksf | |
| | L/B = | | 1.00 | - | |

Immediate Settlement (in.) ($S_0$ / 2)

| | Load | $S_0$ = |
|---|---|---|
| End of Operations | 5.10 | 1.3 |
| Tank Half Full | 2.80 | 0.3 |
| Pre Closure | 5.50 | 1.5 |
| Post Closure | 8.00 | 2.6 |

30 Year Settlement (in.) ($S_{30}$ / 2)

| Load | $S_0$ = |
|---|---|
| 5.10 | 2.0 |
| 8.00 | 3.9 |

**Computation**

| | | | | | |
|---|---|---|---|---|---|
| Settlement | $\rho_i$ = | $C_1 C_t \Delta p \Sigma(\Delta z_i I_{zi}/E_{si})$ | 0.219 | ft | |
| | $\rho_i$ = | $C_t$ = 1 | **2.622** | **in** | |
| | S(t) = | | 0.327 | ft | |
| | S(t) = | | **3.921** | **in** | |
| Correction for strain relief | $C_1$ = | 1 - 0.5($\sigma'_D$/q') | 0.825 | - | |
| Effective vertical overburden pressure at D | $\sigma'_{vo}$ = | $\gamma$ D | 1.320 | ksf | |
| Correction for time dependent increase | $C_t$ = | 1 + 0.2 log( t / 0.1 ) | 1.50 | - | |
| | t = | | 30.00 | years | |
| Elastic modulus of soil layer i | $E_{si}$ = | 2.5 $q_c$ | see | Column H | if L/B = 1 |
| | $E_{si}$ = | 3.5 $q_c$ | see | Column H | If L/B $\geq$ 10 |
| Depth increment i | $\Delta z_i$ | | see | Column D | |
| Influence factor of soil layer i | $I_{zi}$ | Figure 3-4 | see | Column G | |
| Peak depth influence factor | $I_{zp}$ = | 0.5 + 0.1 ($\Delta p/\sigma'_{Izp}$)$^{1/2}$ | 0.550 | - | |
| | $z_p$ = | 0.5B + D | 202.00 | ft | If L/B = 1 |
| | $z_p$ = | B + D | 393.00 | ft | If L/B $\geq$ 10 |
| | $z_p$ = | | 202.00 | ft | for L/B=1.00 |
| Effective overburden pressure at depth Izp | $\sigma'_{Izp}$ = | | 15.13 | ksf | |
| Elastic Modulus | $E_{si}$ = | | 2.50 | $q_c$ | If L/B = 1 |
| | $E_{si}$ = | | 3.50 | $q_c$ | If L/B $\geq$ 10 |
| | $E_{si}$ = | | 2.50 | $q_c$ | for L/B=1.00 |

Computations made relative to the bottom of foundation

| A | B | C | D | E | F | G | H | I | J | K |
|---|---|---|---|---|---|---|---|---|---|---|
| Layer No. | Layer top depth (ft) | Layer bottom depth (ft) | Layer thickness $\Delta z_i$ (ft) | Mid-layer depth $z_{ave}$ (ft) | Average tip stress $q_c$ (tsf) | $I_{zi}$ | Elastic modulus $E_{si}$ (ksf) | $\Delta z_i I_{zi}/E_{si}$ | $\Delta z_i I_{zi}/E_{si}$ | Notes |
| 1 | 0.0 | 1.0 | 1.0 | 0.5 | 171.4 | 0.101 | 857.2 | 0.00012 | 0.00012 | |
| 2 | 1.0 | 2.0 | 1.0 | 1.5 | 126.6 | 0.104 | 632.8 | 0.00016 | 0.00016 | |
| 3 | 2.0 | 3.0 | 1.0 | 2.5 | 116.1 | 0.106 | 580.6 | 0.00018 | 0.00018 | |
| 4 | 3.0 | 4.0 | 1.0 | 3.5 | 195.6 | 0.108 | 977.9 | 0.00011 | 0.00011 | |
| 5 | 4.0 | 5.0 | 1.0 | 4.5 | 93.1 | 0.111 | 465.3 | 0.00024 | 0.00024 | |
| 6 | 5.0 | 6.0 | 1.0 | 5.5 | 118.1 | 0.113 | 590.6 | 0.00019 | 0.00019 | |
| 7 | 6.0 | 7.0 | 1.0 | 6.5 | 112.7 | 0.115 | 563.6 | 0.00020 | 0.00020 | |
| 8 | 7.0 | 8.0 | 1.0 | 7.5 | 184.6 | 0.118 | 922.9 | 0.00013 | 0.00013 | |
| 9 | 8.0 | 9.0 | 1.0 | 8.5 | 156.9 | 0.120 | 784.3 | 0.00015 | 0.00015 | |
| 10 | 9.0 | 10.0 | 1.0 | 9.5 | 61.8 | 0.122 | 309.1 | 0.00040 | 0.00040 | |
| 11 | 10.0 | 11.0 | 1.0 | 10.5 | 53.4 | 0.125 | 267.2 | 0.00047 | 0.00047 | |
| 12 | 11.0 | 12.0 | 1.0 | 11.5 | 106.3 | 0.127 | 531.3 | 0.00024 | 0.00024 | |
| 13 | 12.0 | 13.0 | 1.0 | 12.5 | 52.9 | 0.129 | 264.4 | 0.00049 | 0.00049 | |
| 14 | 13.0 | 14.0 | 1.0 | 13.5 | 87.1 | 0.132 | 435.5 | 0.00030 | 0.00030 | |
| 15 | 14.0 | 15.0 | 1.0 | 14.5 | 345.3 | 0.134 | 1726.6 | 0.00008 | 0.00008 | |
| 16 | 15.0 | 16.0 | 1.0 | 15.5 | 326.7 | 0.137 | 1633.6 | 0.00008 | 0.00008 | |
| 17 | 16.0 | 17.0 | 1.0 | 16.5 | 239.1 | 0.139 | 1195.3 | 0.00012 | 0.00012 | |
| 18 | 17.0 | 18.0 | 1.0 | 17.5 | 292.6 | 0.141 | 1463.2 | 0.00010 | 0.00010 | |
| 19 | 18.0 | 19.0 | 1.0 | 18.5 | 400.2 | 0.144 | 2001.2 | 0.00007 | 0.00007 | |
| 20 | 19.0 | 20.0 | 1.0 | 19.5 | 396.1 | 0.146 | 1980.4 | 0.00007 | 0.00007 | |
| 21 | 20.0 | 21.0 | 1.0 | 20.5 | 355.1 | 0.148 | 1775.7 | 0.00008 | 0.00008 | |
| 22 | 21.0 | 22.0 | 1.0 | 21.5 | 310.2 | 0.151 | 1551.0 | 0.00010 | 0.00010 | |
| 23 | 22.0 | 23.0 | 1.0 | 22.5 | 332.8 | 0.153 | 1664.2 | 0.00009 | 0.00009 | |
| 24 | 23.0 | 24.0 | 1.0 | 23.5 | 341.2 | 0.155 | 1705.9 | 0.00009 | 0.00009 | |
| 25 | 24.0 | 25.0 | 1.0 | 24.5 | 357.2 | 0.158 | 1785.9 | 0.00009 | 0.00009 | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 26 | 25.0 | 26.0 | 1.0 | 25.5 | 375.1 | 0.160 | 1875.5 | 0.00009 | 0.00009 | |
| 27 | 26.0 | 27.0 | 1.0 | 26.5 | 356.2 | 0.162 | 1780.8 | 0.00009 | 0.00009 | |
| 28 | 27.0 | 28.0 | 1.0 | 27.5 | 350.6 | 0.165 | 1752.9 | 0.00009 | 0.00009 | |
| 29 | 28.0 | 29.0 | 1.0 | 28.5 | 159.2 | 0.167 | 796.0 | 0.00021 | 0.00021 | |
| 30 | 29.0 | 30.0 | 1.0 | 29.5 | 94.3 | 0.170 | 471.5 | 0.00036 | 0.00036 | |
| 31 | 30.0 | 31.0 | 1.0 | 30.5 | 67.5 | 0.172 | 337.4 | 0.00051 | 0.00051 | |
| 32 | 31.0 | 32.0 | 1.0 | 31.5 | 88.1 | 0.174 | 440.4 | 0.00040 | 0.00040 | |
| 33 | 32.0 | 33.0 | 1.0 | 32.5 | 60.1 | 0.177 | 300.3 | 0.00059 | 0.00059 | |
| 34 | 33.0 | 34.0 | 1.0 | 33.5 | 19.8 | 0.179 | 99.0 | 0.00181 | 0.00181 | |
| 35 | 34.0 | 35.0 | 1.0 | 34.5 | 49.5 | 0.181 | 247.6 | 0.00073 | 0.00073 | |
| 36 | 35.0 | 36.0 | 1.0 | 35.5 | 69.2 | 0.184 | 346.1 | 0.00053 | 0.00053 | |
| 37 | 36.0 | 37.0 | 1.0 | 36.5 | 34.2 | 0.186 | 171.0 | 0.00109 | 0.00109 | |
| 38 | 37.0 | 38.0 | 1.0 | 37.5 | 21.1 | 0.188 | 105.4 | 0.00179 | 0.00179 | |
| 39 | 38.0 | 39.0 | 1.0 | 38.5 | 34.2 | 0.191 | 170.9 | 0.00112 | 0.00112 | |
| 40 | 39.0 | 40.0 | 1.0 | 39.5 | 32.9 | 0.193 | 164.3 | 0.00118 | 0.00118 | |
| 41 | 40.0 | 41.0 | 1.0 | 40.5 | 22.8 | 0.195 | 114.0 | 0.00171 | 0.00171 | |
| 42 | 41.0 | 42.0 | 1.0 | 41.5 | 19.1 | 0.198 | 95.6 | 0.00207 | 0.00207 | |
| 43 | 42.0 | 43.0 | 1.0 | 42.5 | 30.3 | 0.200 | 151.6 | 0.00132 | 0.00132 | |
| 44 | 43.0 | 44.0 | 1.0 | 43.5 | 55.2 | 0.202 | 275.9 | 0.00073 | 0.00073 | |
| 45 | 44.0 | 45.0 | 1.0 | 44.5 | 64.7 | 0.205 | 323.7 | 0.00063 | 0.00063 | |
| 46 | 45.0 | 46.0 | 1.0 | 45.5 | 64.0 | 0.207 | 319.9 | 0.00065 | 0.00065 | |
| 47 | 46.0 | 47.0 | 1.0 | 46.5 | 151.9 | 0.210 | 759.7 | 0.00028 | 0.00028 | |
| 48 | 47.0 | 48.0 | 1.0 | 47.5 | 260.5 | 0.212 | 1302.5 | 0.00016 | 0.00016 | |
| 49 | 48.0 | 49.0 | 1.0 | 48.5 | 249.3 | 0.214 | 1246.5 | 0.00017 | 0.00017 | |
| 50 | 49.0 | 50.0 | 1.0 | 49.5 | 229.3 | 0.217 | 1146.7 | 0.00019 | 0.00019 | |
| 51 | 50.0 | 51.0 | 1.0 | 50.5 | 196.9 | 0.219 | 984.4 | 0.00022 | 0.00022 | |
| 52 | 51.0 | 52.0 | 1.0 | 51.5 | 173.1 | 0.221 | 865.6 | 0.00026 | 0.00026 | |
| 53 | 52.0 | 53.0 | 1.0 | 52.5 | 141.2 | 0.224 | 706.2 | 0.00032 | 0.00032 | |
| 54 | 53.0 | 54.0 | 1.0 | 53.5 | 65.6 | 0.226 | 327.8 | 0.00069 | 0.00069 | |
| 55 | 54.0 | 55.0 | 1.0 | 54.5 | 30.5 | 0.228 | 152.5 | 0.00150 | 0.00150 | |
| 56 | 55.0 | 56.0 | 1.0 | 55.5 | 23.2 | 0.231 | 115.9 | 0.00199 | 0.00199 | |
| 57 | 56.0 | 57.0 | 1.0 | 56.5 | 22.9 | 0.233 | 114.6 | 0.00203 | 0.00203 | |
| 58 | 57.0 | 58.0 | 1.0 | 57.5 | 49.9 | 0.235 | 249.7 | 0.00094 | 0.00094 | |
| 59 | 58.0 | 59.0 | 1.0 | 58.5 | 83.9 | 0.238 | 419.3 | 0.00057 | 0.00057 | |
| 60 | 59.0 | 60.0 | 1.0 | 59.5 | 125.4 | 0.240 | 627.0 | 0.00038 | 0.00038 | |
| 61 | 60.0 | 61.0 | 1.0 | 60.5 | 146.9 | 0.243 | 734.6 | 0.00033 | 0.00033 | |
| 62 | 61.0 | 62.0 | 1.0 | 61.5 | 154.5 | 0.245 | 772.7 | 0.00032 | 0.00032 | |
| 63 | 62.0 | 63.0 | 1.0 | 62.5 | 154.4 | 0.247 | 772.1 | 0.00032 | 0.00032 | |
| 64 | 63.0 | 64.0 | 1.0 | 63.5 | 149.4 | 0.250 | 747.0 | 0.00033 | 0.00033 | |
| 65 | 64.0 | 65.0 | 1.0 | 64.5 | 178.4 | 0.252 | 891.9 | 0.00028 | 0.00028 | |
| 66 | 65.0 | 66.0 | 1.0 | 65.5 | 174.4 | 0.254 | 872.0 | 0.00029 | 0.00029 | |
| 67 | 66.0 | 67.0 | 1.0 | 66.5 | 173.0 | 0.257 | 865.2 | 0.00030 | 0.00030 | |
| 68 | 67.0 | 68.0 | 1.0 | 67.5 | 42.6 | 0.259 | 213.2 | 0.00122 | 0.00122 | |
| 69 | 68.0 | 69.0 | 1.0 | 68.5 | 29.1 | 0.261 | 145.6 | 0.00180 | 0.00180 | |
| 70 | 69.0 | 70.0 | 1.0 | 69.5 | 27.2 | 0.264 | 136.1 | 0.00194 | 0.00194 | |
| 71 | 70.0 | 71.0 | 1.0 | 70.5 | 45.3 | 0.266 | 226.5 | 0.00117 | 0.00117 | |
| 72 | 71.0 | 72.0 | 1.0 | 71.5 | 77.3 | 0.268 | 386.3 | 0.00069 | 0.00069 | |
| 73 | 72.0 | 73.0 | 1.0 | 72.5 | 50.1 | 0.271 | 250.3 | 0.00108 | 0.00108 | |
| 74 | 73.0 | 74.0 | 1.0 | 73.5 | 35.4 | 0.273 | 177.2 | 0.00154 | 0.00154 | |
| 75 | 74.0 | 75.0 | 1.0 | 74.5 | 48.7 | 0.276 | 243.5 | 0.00113 | 0.00113 | |
| 76 | 75.0 | 76.0 | 1.0 | 75.5 | 92.9 | 0.278 | 464.5 | 0.00060 | 0.00060 | |
| 77 | 76.0 | 77.0 | 1.0 | 76.5 | 74.5 | 0.280 | 372.5 | 0.00075 | 0.00075 | |
| 78 | 77.0 | 78.0 | 1.0 | 77.5 | 121.1 | 0.283 | 605.7 | 0.00047 | 0.00047 | |
| 79 | 78.0 | 79.0 | 1.0 | 78.5 | 295.3 | 0.285 | 1476.7 | 0.00019 | 0.00019 | |
| 80 | 79.0 | 80.0 | 1.0 | 79.5 | 142.8 | 0.287 | 713.9 | 0.00040 | 0.00040 | |
| 81 | 80.0 | 81.0 | 1.0 | 80.5 | 117.1 | 0.290 | 585.5 | 0.00049 | 0.00049 | |
| 82 | 81.0 | 82.0 | 1.0 | 81.5 | 181.6 | 0.292 | 907.9 | 0.00032 | 0.00032 | |
| 83 | 82.0 | 83.0 | 1.0 | 82.5 | 163.1 | 0.294 | 815.3 | 0.00036 | 0.00036 | |
| 84 | 83.0 | 84.0 | 1.0 | 83.5 | 131.7 | 0.297 | 658.5 | 0.00045 | 0.00045 | |
| 85 | 84.0 | 85.0 | 1.0 | 84.5 | 171.8 | 0.299 | 859.0 | 0.00035 | 0.00035 | |
| 86 | 85.0 | 86.0 | 1.0 | 85.5 | 139.6 | 0.301 | 698.1 | 0.00043 | 0.00043 | |
| 87 | 86.0 | 87.0 | 1.0 | 86.5 | 107.2 | 0.304 | 536.2 | 0.00057 | 0.00057 | |
| 88 | 87.0 | 88.0 | 1.0 | 87.5 | 142.6 | 0.306 | 713.2 | 0.00043 | 0.00043 | |
| 89 | 88.0 | 89.0 | 1.0 | 88.5 | 159.0 | 0.309 | 795.1 | 0.00039 | 0.00039 | |
| 90 | 89.0 | 90.0 | 1.0 | 89.5 | 101.7 | 0.311 | 508.4 | 0.00061 | 0.00061 | |
| 91 | 90.0 | 91.0 | 1.0 | 90.5 | 113.9 | 0.313 | 569.7 | 0.00055 | 0.00055 | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 92 | 91.0 | 92.0 | 1.0 | 91.5 | 128.0 | 0.316 | 639.8 | 0.00049 | 0.00049 | |
| 93 | 92.0 | 93.0 | 1.0 | 92.5 | 132.8 | 0.318 | 663.8 | 0.00048 | 0.00048 | |
| 94 | 93.0 | 94.0 | 1.0 | 93.5 | 201.8 | 0.320 | 1009.1 | 0.00032 | 0.00032 | |
| 95 | 94.0 | 95.0 | 1.0 | 94.5 | 142.9 | 0.323 | 714.4 | 0.00045 | 0.00045 | |
| 96 | 95.0 | 96.0 | 1.0 | 95.5 | 118.3 | 0.325 | 591.6 | 0.00055 | 0.00055 | |
| 97 | 96.0 | 97.0 | 1.0 | 96.5 | 115.9 | 0.327 | 579.7 | 0.00056 | 0.00056 | |
| 98 | 97.0 | 98.0 | 1.0 | 97.5 | 111.7 | 0.330 | 558.5 | 0.00059 | 0.00059 | |
| 99 | 98.0 | 99.0 | 1.0 | 98.5 | 93.3 | 0.332 | 466.7 | 0.00071 | 0.00071 | |
| 100 | 99.0 | 100.0 | 1.0 | 99.5 | 131.0 | 0.334 | 655.2 | 0.00051 | 0.00051 | |
| 101 | 100.0 | 101.0 | 1.0 | 100.5 | 199.1 | 0.337 | 995.3 | 0.00034 | 0.00034 | |
| 102 | 101.0 | 102.0 | 1.0 | 101.5 | 210.6 | 0.339 | 1053.0 | 0.00032 | 0.00032 | |
| 103 | 102.0 | 103.0 | 1.0 | 102.5 | 167.6 | 0.341 | 837.8 | 0.00041 | 0.00041 | |
| 104 | 103.0 | 104.0 | 1.0 | 103.5 | 117.9 | 0.344 | 589.5 | 0.00058 | 0.00058 | |
| 105 | 104.0 | 105.0 | 1.0 | 104.5 | 71.2 | 0.346 | 356.1 | 0.00097 | 0.00097 | |
| 106 | 105.0 | 106.0 | 1.0 | 105.5 | 84.2 | 0.349 | 421.0 | 0.00083 | 0.00083 | |
| 107 | 106.0 | 107.0 | 1.0 | 106.5 | 82.8 | 0.351 | 414.1 | 0.00085 | 0.00085 | |
| 108 | 107.0 | 108.0 | 1.0 | 107.5 | 85.5 | 0.353 | 427.5 | 0.00083 | 0.00083 | |
| 109 | 108.0 | 109.0 | 1.0 | 108.5 | 87.7 | 0.356 | 438.7 | 0.00081 | 0.00081 | |
| 110 | 109.0 | 110.0 | 1.0 | 109.5 | 71.5 | 0.358 | 357.6 | 0.00100 | 0.00100 | |
| 111 | 110.0 | 111.0 | 1.0 | 110.5 | 60.5 | 0.360 | 302.6 | 0.00119 | 0.00119 | |
| 112 | 111.0 | 112.0 | 1.0 | 111.5 | 64.9 | 0.363 | 324.4 | 0.00112 | 0.00112 | |
| 113 | 112.0 | 113.0 | 1.0 | 112.5 | 62.6 | 0.365 | 313.2 | 0.00117 | 0.00117 | |
| 114 | 113.0 | 114.0 | 1.0 | 113.5 | 70.2 | 0.367 | 351.0 | 0.00105 | 0.00105 | |
| 115 | 114.0 | 115.0 | 1.0 | 114.5 | 80.1 | 0.370 | 400.6 | 0.00092 | 0.00092 | |
| 116 | 115.0 | 116.0 | 1.0 | 115.5 | 191.7 | 0.372 | 958.5 | 0.00039 | 0.00039 | |
| 117 | 116.0 | 117.0 | 1.0 | 116.5 | 204.5 | 0.374 | 1022.4 | 0.00037 | 0.00037 | |
| 118 | 117.0 | 118.0 | 1.0 | 117.5 | 508.1 | 0.377 | 2540.5 | 0.00015 | 0.00015 | |
| 119 | 118.0 | 119.0 | 1.0 | 118.5 | 621.5 | 0.379 | 3107.7 | 0.00012 | 0.00012 | |
| 120 | 119.0 | 120.0 | 1.0 | 119.5 | 668.1 | 0.382 | 3340.6 | 0.00011 | 0.00011 | |
| $\Sigma$ = | | | | | | | | | 0.07004 | |

| | | |
|---|---|---|
| $I_{zr}$ (1 < L/B < 10): | $I_{zr} = I_{zs} + 0.111\,(I_{zc} - I_{zs})\,(L/B - 1)$ | |
| $I_{zs}$ (L/B = 1): | | |
| For $z_{ave}$ = 0 to B/2: | $I_{zs} = 0.1 + (z_{ave}/B)(2I_{zp} - 0.2)$ | |
| For $z_{ave}$ = B/2 to 2B: | $I_{zs} = 0.667\,I_{zp}\,(2 - z_{ave}/B)$ | |
| $I_{zc}$ (L/B $\geq$ 10): | | |
| For $z_{ave}$ = 0 to B: | $I_{zc} = 0.2 + (z_{ave}/B)(I_{zp} - 0.2)$ | |
| For $z_{ave}$ = B to 4B: | $I_{zc} = 0.333\,I_{zp}\,(4 - z_{ave}/B)$ | ( Coduto p.228. ) |

| | | | | |
|---|---|---|---|---|
| Footing width | B = | 382.0 | ft | **Z-SDU6-C18** |
| Footing length | L = | 382.0 | ft | |
| Ground elevation | | 275.6 | ft | |
| Foundation elevation | | 265.0 | ft | |
| Ground Water elevation | | 220.0 | ft | |
| Excavated or embedded depth | D = | 10.6 | ft | |
| Depth to Groundwater | | 55.6 | ft | |
| Unit weight | $\gamma$ = | 120.0 | pcf | |
| Gross Footing Load | | 5.10 | ksf | |
| Net applied footing pressure | $\Delta p$ = | **3.828** | ksf | |
| | L/B = | 1.00 | - | |

Immediate Settlement (in.) ($S_0$ / 2)

| | Load | $S_0$ = |
|---|---|---|
| End of Operations | 5.10 | 1.8 |
| Tank Half Full | 2.80 | 0.5 |
| Pre Closure | 5.50 | 2.1 |
| Post Closure | 8.00 | 3.6 |

30 Year Settlement (in.) ($S_{30}$ / 2)

| Load | $S_0$ = |
|---|---|
| 5.10 | 2.7 |
| 8.00 | 5.3 |

**Computation**

| | | | | | |
|---|---|---|---|---|---|
| Settlement | $\rho_i$ = | $C_1 C_t \Delta p \Sigma(\Delta z_i I_{zi}/E_{si})$ | 0.306 | ft | |
| | $\rho_i$ = | $C_t$ = 1 | **3.670** | **in** | |
| | S(t) = | | 0.457 | ft | |
| | S(t) = | | **5.489** | **in** | |
| Correction for strain relief | $C_1$ = | 1 - 0.5($\sigma'_D$/q') | 0.834 | - | |
| Effective vertical overburden pressure at D | $\sigma'_{vo}$ = | $\gamma$ D | 1.272 | ksf | |
| Correction for time dependent increase | $C_t$ = | 1 + 0.2 log( t / 0.1 ) | 1.50 | - | |
| | t = | | 30.00 | years | |
| Elastic modulus of soil layer i | $E_{si}$ = | 2.5 $q_c$ | see | Column H | if L/B = 1 |
| | $E_{si}$ = | 3.5 $q_c$ | see | Column H | If L/B $\geq$ 10 |
| Depth increment i | $\Delta z_i$ | | see | Column D | |
| Influence factor of soil layer i | $I_{zi}$ | Figure 3-4 | see | Column G | |
| Peak depth influence factor | $I_{zp}$ = | 0.5 + 0.1 ($\Delta p/\sigma'_{Izp}$)$^{1/2}$ | 0.550 | - | |
| | $z_p$ = | 0.5B + D | 201.60 | ft | If L/B = 1 |
| | $z_p$ = | B + D | 392.60 | ft | If L/B $\geq$ 10 |
| | $z_p$ = | | 201.60 | ft | for L/B=1.00 |
| Effective overburden pressure at depth Izp | $\sigma'_{Izp}$ = | | 15.08 | ksf | |
| Elastic Modulus | $E_{si}$ = | | 2.50 | $q_c$ | If L/B = 1 |
| | $E_{si}$ = | | 3.50 | $q_c$ | If L/B $\geq$ 10 |
| | $E_{si}$ = | | 2.50 | $q_c$ | for L/B=1.00 |

Computations made relative to the bottom of foundation

| A | B | C | D | E | F | G | H | I | J | K |
|---|---|---|---|---|---|---|---|---|---|---|
| Layer No. | Layer top depth (ft) | Layer bottom depth (ft) | Layer thickness $\Delta z_i$ (ft) | Mid-layer depth $z_{ave}$ (ft) | Average tip stress $q_c$ (tsf) | $I_{zi}$ | Elastic modulus $E_{si}$ (ksf) | $\Delta z_i I_{zi}/E_{si}$ | $\Delta z_i I_{zi}/E_{si}$ | Notes |
| 1 | 0.0 | 1.0 | 1.0 | 0.5 | 112.1 | 0.101 | 560.6 | 0.00018 | 0.00018 | |
| 2 | 1.0 | 2.0 | 1.0 | 1.5 | 80.8 | 0.104 | 403.8 | 0.00026 | 0.00026 | |
| 3 | 2.0 | 3.0 | 1.0 | 2.5 | 45.2 | 0.106 | 226.2 | 0.00047 | 0.00047 | |
| 4 | 3.0 | 4.0 | 1.0 | 3.5 | 91.7 | 0.108 | 458.7 | 0.00024 | 0.00024 | |
| 5 | 4.0 | 5.0 | 1.0 | 4.5 | 129.0 | 0.111 | 645.2 | 0.00017 | 0.00017 | |
| 6 | 5.0 | 6.0 | 1.0 | 5.5 | 136.9 | 0.113 | 684.7 | 0.00017 | 0.00017 | |
| 7 | 6.0 | 7.0 | 1.0 | 6.5 | 81.1 | 0.115 | 405.4 | 0.00028 | 0.00028 | |
| 8 | 7.0 | 8.0 | 1.0 | 7.5 | 150.8 | 0.118 | 754.1 | 0.00016 | 0.00016 | |
| 9 | 8.0 | 9.0 | 1.0 | 8.5 | 238.9 | 0.120 | 1194.5 | 0.00010 | 0.00010 | |
| 10 | 9.0 | 10.0 | 1.0 | 9.5 | 171.3 | 0.122 | 856.3 | 0.00014 | 0.00014 | |
| 11 | 10.0 | 11.0 | 1.0 | 10.5 | 226.5 | 0.125 | 1132.7 | 0.00011 | 0.00011 | |
| 12 | 11.0 | 12.0 | 1.0 | 11.5 | 48.3 | 0.127 | 241.4 | 0.00053 | 0.00053 | |
| 13 | 12.0 | 13.0 | 1.0 | 12.5 | 33.0 | 0.129 | 164.9 | 0.00079 | 0.00079 | |
| 14 | 13.0 | 14.0 | 1.0 | 13.5 | 109.4 | 0.132 | 547.2 | 0.00024 | 0.00024 | |
| 15 | 14.0 | 15.0 | 1.0 | 14.5 | 33.1 | 0.134 | 165.5 | 0.00081 | 0.00081 | |
| 16 | 15.0 | 16.0 | 1.0 | 15.5 | 54.8 | 0.137 | 273.9 | 0.00050 | 0.00050 | |
| 17 | 16.0 | 17.0 | 1.0 | 16.5 | 74.4 | 0.139 | 371.8 | 0.00037 | 0.00037 | |
| 18 | 17.0 | 18.0 | 1.0 | 17.5 | 103.8 | 0.141 | 519.2 | 0.00027 | 0.00027 | |
| 19 | 18.0 | 19.0 | 1.0 | 18.5 | 209.4 | 0.144 | 1047.1 | 0.00014 | 0.00014 | |
| 20 | 19.0 | 20.0 | 1.0 | 19.5 | 293.4 | 0.146 | 1466.8 | 0.00010 | 0.00010 | |
| 21 | 20.0 | 21.0 | 1.0 | 20.5 | 296.5 | 0.148 | 1482.5 | 0.00010 | 0.00010 | |
| 22 | 21.0 | 22.0 | 1.0 | 21.5 | 272.9 | 0.151 | 1364.5 | 0.00011 | 0.00011 | |
| 23 | 22.0 | 23.0 | 1.0 | 22.5 | 330.2 | 0.153 | 1650.9 | 0.00009 | 0.00009 | |
| 24 | 23.0 | 24.0 | 1.0 | 23.5 | 293.8 | 0.155 | 1469.1 | 0.00011 | 0.00011 | |
| 25 | 24.0 | 25.0 | 1.0 | 24.5 | 292.7 | 0.158 | 1463.6 | 0.00011 | 0.00011 | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 26 | 25.0 | 26.0 | 1.0 | 25.5 | 278.0 | 0.160 | 1389.8 | 0.00012 | 0.00012 | |
| 27 | 26.0 | 27.0 | 1.0 | 26.5 | 228.3 | 0.162 | 1141.7 | 0.00014 | 0.00014 | |
| 28 | 27.0 | 28.0 | 1.0 | 27.5 | 167.7 | 0.165 | 838.3 | 0.00020 | 0.00020 | |
| 29 | 28.0 | 29.0 | 1.0 | 28.5 | 53.7 | 0.167 | 268.4 | 0.00062 | 0.00062 | |
| 30 | 29.0 | 30.0 | 1.0 | 29.5 | 14.0 | 0.170 | 70.2 | 0.00241 | 0.00241 | |
| 31 | 30.0 | 31.0 | 1.0 | 30.5 | 40.0 | 0.172 | 199.8 | 0.00086 | 0.00086 | |
| 32 | 31.0 | 32.0 | 1.0 | 31.5 | 13.1 | 0.174 | 65.6 | 0.00266 | 0.00266 | |
| 33 | 32.0 | 33.0 | 1.0 | 32.5 | 11.1 | 0.177 | 55.6 | 0.00318 | 0.00318 | |
| 34 | 33.0 | 34.0 | 1.0 | 33.5 | 12.3 | 0.179 | 61.5 | 0.00291 | 0.00291 | |
| 35 | 34.0 | 35.0 | 1.0 | 34.5 | 51.5 | 0.181 | 257.5 | 0.00070 | 0.00070 | |
| 36 | 35.0 | 36.0 | 1.0 | 35.5 | 78.0 | 0.184 | 390.1 | 0.00047 | 0.00047 | |
| 37 | 36.0 | 37.0 | 1.0 | 36.5 | 99.2 | 0.186 | 496.2 | 0.00038 | 0.00038 | |
| 38 | 37.0 | 38.0 | 1.0 | 37.5 | 113.1 | 0.188 | 565.7 | 0.00033 | 0.00033 | |
| 39 | 38.0 | 39.0 | 1.0 | 38.5 | 103.3 | 0.191 | 516.6 | 0.00037 | 0.00037 | |
| 40 | 39.0 | 40.0 | 1.0 | 39.5 | 34.4 | 0.193 | 172.2 | 0.00112 | 0.00112 | |
| 41 | 40.0 | 41.0 | 1.0 | 40.5 | 24.0 | 0.195 | 119.8 | 0.00163 | 0.00163 | |
| 42 | 41.0 | 42.0 | 1.0 | 41.5 | 11.3 | 0.198 | 56.3 | 0.00351 | 0.00351 | |
| 43 | 42.0 | 43.0 | 1.0 | 42.5 | 14.0 | 0.200 | 70.2 | 0.00285 | 0.00285 | |
| 44 | 43.0 | 44.0 | 1.0 | 43.5 | 15.2 | 0.203 | 75.8 | 0.00267 | 0.00267 | |
| 45 | 44.0 | 45.0 | 1.0 | 44.5 | 12.4 | 0.205 | 61.8 | 0.00331 | 0.00331 | |
| 46 | 45.0 | 46.0 | 1.0 | 45.5 | 14.5 | 0.207 | 72.7 | 0.00285 | 0.00285 | |
| 47 | 46.0 | 47.0 | 1.0 | 46.5 | 21.9 | 0.210 | 109.5 | 0.00191 | 0.00191 | |
| 48 | 47.0 | 48.0 | 1.0 | 47.5 | 137.2 | 0.212 | 686.0 | 0.00031 | 0.00031 | |
| 49 | 48.0 | 49.0 | 1.0 | 48.5 | 193.4 | 0.214 | 966.9 | 0.00022 | 0.00022 | |
| 50 | 49.0 | 50.0 | 1.0 | 49.5 | 195.5 | 0.217 | 977.7 | 0.00022 | 0.00022 | |
| 51 | 50.0 | 51.0 | 1.0 | 50.5 | 184.4 | 0.219 | 921.9 | 0.00024 | 0.00024 | |
| 52 | 51.0 | 52.0 | 1.0 | 51.5 | 174.2 | 0.221 | 871.0 | 0.00025 | 0.00025 | |
| 53 | 52.0 | 53.0 | 1.0 | 52.5 | 164.7 | 0.224 | 823.5 | 0.00027 | 0.00027 | |
| 54 | 53.0 | 54.0 | 1.0 | 53.5 | 137.8 | 0.226 | 688.9 | 0.00033 | 0.00033 | |
| 55 | 54.0 | 55.0 | 1.0 | 54.5 | 101.1 | 0.229 | 505.3 | 0.00045 | 0.00045 | |
| 56 | 55.0 | 56.0 | 1.0 | 55.5 | 48.3 | 0.231 | 241.7 | 0.00096 | 0.00096 | |
| 57 | 56.0 | 57.0 | 1.0 | 56.5 | 69.7 | 0.233 | 348.5 | 0.00067 | 0.00067 | |
| 58 | 57.0 | 58.0 | 1.0 | 57.5 | 51.0 | 0.236 | 254.9 | 0.00092 | 0.00092 | |
| 59 | 58.0 | 59.0 | 1.0 | 58.5 | 15.8 | 0.238 | 79.1 | 0.00301 | 0.00301 | |
| 60 | 59.0 | 60.0 | 1.0 | 59.5 | 23.6 | 0.240 | 118.2 | 0.00203 | 0.00203 | |
| 61 | 60.0 | 61.0 | 1.0 | 60.5 | 67.4 | 0.243 | 337.1 | 0.00072 | 0.00072 | |
| 62 | 61.0 | 62.0 | 1.0 | 61.5 | 206.8 | 0.245 | 1033.8 | 0.00024 | 0.00024 | |
| 63 | 62.0 | 63.0 | 1.0 | 62.5 | 216.6 | 0.247 | 1083.0 | 0.00023 | 0.00023 | |
| 64 | 63.0 | 64.0 | 1.0 | 63.5 | 200.0 | 0.250 | 1000.1 | 0.00025 | 0.00025 | |
| 65 | 64.0 | 65.0 | 1.0 | 64.5 | 204.8 | 0.252 | 1024.2 | 0.00025 | 0.00025 | |
| 66 | 65.0 | 66.0 | 1.0 | 65.5 | 143.5 | 0.254 | 717.4 | 0.00035 | 0.00035 | |
| 67 | 66.0 | 67.0 | 1.0 | 66.5 | 157.2 | 0.257 | 785.8 | 0.00033 | 0.00033 | |
| 68 | 67.0 | 68.0 | 1.0 | 67.5 | 142.0 | 0.259 | 710.1 | 0.00036 | 0.00036 | |
| 69 | 68.0 | 69.0 | 1.0 | 68.5 | 199.5 | 0.262 | 997.5 | 0.00026 | 0.00026 | |
| 70 | 69.0 | 70.0 | 1.0 | 69.5 | 137.5 | 0.264 | 687.6 | 0.00038 | 0.00038 | |
| 71 | 70.0 | 71.0 | 1.0 | 70.5 | 22.6 | 0.266 | 113.1 | 0.00235 | 0.00235 | |
| 72 | 71.0 | 72.0 | 1.0 | 71.5 | 25.8 | 0.269 | 129.0 | 0.00208 | 0.00208 | |
| 73 | 72.0 | 73.0 | 1.0 | 72.5 | 24.2 | 0.271 | 121.1 | 0.00224 | 0.00224 | |
| 74 | 73.0 | 74.0 | 1.0 | 73.5 | 22.5 | 0.273 | 112.4 | 0.00243 | 0.00243 | |
| 75 | 74.0 | 75.0 | 1.0 | 74.5 | 23.0 | 0.276 | 115.1 | 0.00239 | 0.00239 | |
| 76 | 75.0 | 76.0 | 1.0 | 75.5 | 23.4 | 0.278 | 116.9 | 0.00238 | 0.00238 | |
| 77 | 76.0 | 77.0 | 1.0 | 76.5 | 73.1 | 0.280 | 365.5 | 0.00077 | 0.00077 | |
| 78 | 77.0 | 78.0 | 1.0 | 77.5 | 45.9 | 0.283 | 229.5 | 0.00123 | 0.00123 | |
| 79 | 78.0 | 79.0 | 1.0 | 78.5 | 37.2 | 0.285 | 186.1 | 0.00153 | 0.00153 | |
| 80 | 79.0 | 80.0 | 1.0 | 79.5 | 206.4 | 0.287 | 1032.1 | 0.00028 | 0.00028 | |
| 81 | 80.0 | 81.0 | 1.0 | 80.5 | 125.8 | 0.290 | 629.0 | 0.00046 | 0.00046 | |
| 82 | 81.0 | 82.0 | 1.0 | 81.5 | 181.6 | 0.292 | 907.9 | 0.00032 | 0.00032 | |
| 83 | 82.0 | 83.0 | 1.0 | 82.5 | 163.1 | 0.295 | 815.3 | 0.00036 | 0.00036 | |
| 84 | 83.0 | 84.0 | 1.0 | 83.5 | 131.7 | 0.297 | 658.5 | 0.00045 | 0.00045 | |
| 85 | 84.0 | 85.0 | 1.0 | 84.5 | 171.8 | 0.299 | 859.0 | 0.00035 | 0.00035 | |
| 86 | 85.0 | 86.0 | 1.0 | 85.5 | 139.6 | 0.302 | 698.1 | 0.00043 | 0.00043 | |
| 87 | 86.0 | 87.0 | 1.0 | 86.5 | 107.2 | 0.304 | 536.2 | 0.00057 | 0.00057 | |
| 88 | 87.0 | 88.0 | 1.0 | 87.5 | 142.6 | 0.306 | 713.2 | 0.00043 | 0.00043 | |
| 89 | 88.0 | 89.0 | 1.0 | 88.5 | 159.0 | 0.309 | 795.1 | 0.00039 | 0.00039 | |
| 90 | 89.0 | 90.0 | 1.0 | 89.5 | 101.7 | 0.311 | 508.4 | 0.00061 | 0.00061 | |
| 91 | 90.0 | 91.0 | 1.0 | 90.5 | 113.9 | 0.313 | 569.7 | 0.00055 | 0.00055 | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 92 | 91.0 | 92.0 | 1.0 | 91.5 | 128.0 | 0.316 | 639.8 | 0.00049 | 0.00049 | |
| 93 | 92.0 | 93.0 | 1.0 | 92.5 | 132.8 | 0.318 | 663.8 | 0.00048 | 0.00048 | |
| 94 | 93.0 | 94.0 | 1.0 | 93.5 | 201.8 | 0.320 | 1009.1 | 0.00032 | 0.00032 | |
| 95 | 94.0 | 95.0 | 1.0 | 94.5 | 142.9 | 0.323 | 714.4 | 0.00045 | 0.00045 | |
| 96 | 95.0 | 96.0 | 1.0 | 95.5 | 118.3 | 0.325 | 591.6 | 0.00055 | 0.00055 | |
| 97 | 96.0 | 97.0 | 1.0 | 96.5 | 115.9 | 0.328 | 579.7 | 0.00056 | 0.00056 | |
| 98 | 97.0 | 98.0 | 1.0 | 97.5 | 111.7 | 0.330 | 558.5 | 0.00059 | 0.00059 | |
| 99 | 98.0 | 99.0 | 1.0 | 98.5 | 93.3 | 0.332 | 466.7 | 0.00071 | 0.00071 | |
| 100 | 99.0 | 100.0 | 1.0 | 99.5 | 131.0 | 0.335 | 655.2 | 0.00051 | 0.00051 | |
| 101 | 100.0 | 101.0 | 1.0 | 100.5 | 199.1 | 0.337 | 995.3 | 0.00034 | 0.00034 | |
| 102 | 101.0 | 102.0 | 1.0 | 101.5 | 210.6 | 0.339 | 1053.0 | 0.00032 | 0.00032 | |
| 103 | 102.0 | 103.0 | 1.0 | 102.5 | 167.6 | 0.342 | 837.8 | 0.00041 | 0.00041 | |
| 104 | 103.0 | 104.0 | 1.0 | 103.5 | 117.9 | 0.344 | 589.5 | 0.00058 | 0.00058 | |
| 105 | 104.0 | 105.0 | 1.0 | 104.5 | 71.2 | 0.346 | 356.1 | 0.00097 | 0.00097 | |
| 106 | 105.0 | 106.0 | 1.0 | 105.5 | 84.2 | 0.349 | 421.0 | 0.00083 | 0.00083 | |
| 107 | 106.0 | 107.0 | 1.0 | 106.5 | 82.8 | 0.351 | 414.1 | 0.00085 | 0.00085 | |
| 108 | 107.0 | 108.0 | 1.0 | 107.5 | 85.5 | 0.353 | 427.5 | 0.00083 | 0.00083 | |
| 109 | 108.0 | 109.0 | 1.0 | 108.5 | 87.7 | 0.356 | 438.7 | 0.00081 | 0.00081 | |
| 110 | 109.0 | 110.0 | 1.0 | 109.5 | 71.5 | 0.358 | 357.6 | 0.00100 | 0.00100 | |
| 111 | 110.0 | 111.0 | 1.0 | 110.5 | 60.5 | 0.361 | 302.6 | 0.00119 | 0.00119 | |
| 112 | 111.0 | 112.0 | 1.0 | 111.5 | 64.9 | 0.363 | 324.4 | 0.00112 | 0.00112 | |
| 113 | 112.0 | 113.0 | 1.0 | 112.5 | 62.6 | 0.365 | 313.2 | 0.00117 | 0.00117 | |
| 114 | 113.0 | 114.0 | 1.0 | 113.5 | 70.2 | 0.368 | 351.0 | 0.00105 | 0.00105 | |
| 115 | 114.0 | 115.0 | 1.0 | 114.5 | 80.1 | 0.370 | 400.6 | 0.00092 | 0.00092 | |
| 116 | 115.0 | 116.0 | 1.0 | 115.5 | 191.7 | 0.372 | 958.5 | 0.00039 | 0.00039 | |
| 117 | 116.0 | 117.0 | 1.0 | 116.5 | 204.5 | 0.375 | 1022.4 | 0.00037 | 0.00037 | |
| 118 | 117.0 | 118.0 | 1.0 | 117.5 | 508.1 | 0.377 | 2540.5 | 0.00015 | 0.00015 | |
| 119 | 118.0 | 119.0 | 1.0 | 118.5 | 621.5 | 0.379 | 3107.7 | 0.00012 | 0.00012 | |
| 120 | 119.0 | 120.0 | 1.0 | 119.5 | 668.1 | 0.382 | 3340.6 | 0.00011 | 0.00011 | |
| $\sum$ = | | | | | | | | | 0.09582 | |

| | |
|---|---|
| $I_{zr}$ (1 < L/B < 10): | $I_{zr} = I_{zs} + 0.111 (I_{zc} - I_{zs}) (L/B - 1)$ |
| $I_{zs}$ (L/B = 1): | |
| For $z_{ave}$ = 0 to B/2: | $I_{zs} = 0.1 + (z_{ave}/B)(2I_{zp} - 0.2)$ |
| For $z_{ave}$ = B/2 to 2B: | $I_{zs} = 0.667 I_{zp} (2 - z_{ave}/B)$ |
| $I_{zc}$ ($L/B \geq 10$): | |
| For $z_{ave}$ = 0 to B: | $I_{zc} = 0.2 + (z_{ave}/B)(I_{zp} - 0.2)$ |
| For $z_{ave}$ = B to 4B: | $I_{zc} = 0.333 I_{zp} (4 - z_{ave}/B)$ ( Coduto p.228. ) |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Footing width | B = | | 382.0 | ft | **Z-SDU6-C19** | | | |
| Footing length | L = | | 382.0 | ft | | | Immediate | |
| Ground elevation | | | 276.4 | ft | | | Settlement (in.) | |
| Foundation elevation | | | 265.0 | ft | | | ($S_0$ / 2) | |
| Ground Water elevation | | | 220.0 | ft | | | Load | $S_0$ = |
| Excavated or embedded depth | D = | | 11.4 | ft | End of Operations | | 5.10 | 1.0 |
| Depth to Groundwater | | | 56.4 | ft | Tank Half Full | | 2.80 | 0.2 |
| Unit weight | $\gamma$ = | | 120.0 | pcf | Pre Closure | | 5.50 | 1.1 |
| Gross Footing Load | | | 5.10 | ksf | Post Closure | | 8.00 | 2.0 |
| Net applied footing pressure | $\Delta p$ = | | **3.732** | ksf | | | | |
| | L/B = | | 1.00 | - | | | | |
| | | | | | | | 30 Year | |
| **Computation** | | | | | | | Settlement (in.) | |
| Settlement | $\rho_i$ = | $C_1 C_t \Delta p \Sigma(\Delta z_i I_{zi}/E_{si})$ | 0.166 | ft | | | ($S_{30}$ / 2) | |
| | $\rho_i$ = | $C_t$ = 1 | **1.991** | **in** | | | Load | $S_0$ = |
| | S(t) = | | 0.248 | ft | | | 5.10 | 1.5 |
| | S(t) = | | **2.978** | **in** | | | 8.00 | 3.0 |
| Correction for strain relief | $C_1$ = | $1 - 0.5(\sigma'_D/q')$ | 0.817 | - | | | | |
| Effective vertical overburden pressure at D | $\sigma'_{vo}$ = | $\gamma$ D | 1.368 | ksf | | | | |
| Correction for time dependent increase | $C_t$ = | 1 + 0.2 log( t / 0.1 ) | 1.50 | - | | | | |
| | t = | | 30.00 | years | | | | |
| Elastic modulus of soil layer i | $E_{si}$ = | 2.5 $q_c$ | see | Column H | if L/B = 1 | | | |
| | $E_{si}$ = | 3.5 $q_c$ | see | Column H | If L/B $\geq$ 10 | | | |
| Depth increment i | $\Delta z_i$ | | see | Column D | | | | |
| Influence factor of soil layer i | $I_{zi}$ | Figure 3-4 | see | Column G | | | | |
| Peak depth influence factor | $I_{zp}$ = | $0.5 + 0.1 (\Delta p/\sigma'_{Izp})^{1/2}$ | 0.550 | - | | | | |
| | $z_p$ = | 0.5B + D | 202.40 | ft | If L/B = 1 | | | |
| | $z_p$ = | B + D | 393.40 | ft | If L/B $\geq$ 10 | | | |
| | $z_p$ = | | 202.40 | ft | for L/B=1.00 | | | |
| Effective overburden pressure at depth Izp | $\sigma'_{Izp}$ = | | 15.18 | ksf | | | | |
| Elastic Modulus | $E_{si}$ = | | 2.50 | $q_c$ | If L/B = 1 | | | |
| | $E_{si}$ = | | 3.50 | $q_c$ | If L/B $\geq$ 10 | | | |
| | $E_{si}$ = | | 2.50 | $q_c$ | for L/B=1.00 | | | |

Computations made relative to the bottom of foundation

| A | B | C | D | E | F | G | H | I | J | K |
|---|---|---|---|---|---|---|---|---|---|---|
| Layer No. | Layer top depth (ft) | Layer bottom depth (ft) | Layer thickness $\Delta z_i$ (ft) | Mid-layer depth $z_{ave}$ (ft) | Average tip stress $q_c$ (tsf) | $I_{zi}$ | Elastic modulus $E_{si}$ (ksf) | $\Delta z_i I_{zi}/E_{si}$ | $\Delta z_i I_{zi}/E_{si}$ | Notes |
| 1 | 0.0 | 1.0 | 1.0 | 0.5 | 160.6 | 0.101 | 803.1 | 0.00013 | 0.00013 | |
| 2 | 1.0 | 2.0 | 1.0 | 1.5 | 86.2 | 0.104 | 431.0 | 0.00024 | 0.00024 | |
| 3 | 2.0 | 3.0 | 1.0 | 2.5 | 119.2 | 0.106 | 596.0 | 0.00018 | 0.00018 | |
| 4 | 3.0 | 4.0 | 1.0 | 3.5 | 80.5 | 0.108 | 402.6 | 0.00027 | 0.00027 | |
| 5 | 4.0 | 5.0 | 1.0 | 4.5 | 45.8 | 0.111 | 228.9 | 0.00048 | 0.00048 | |
| 6 | 5.0 | 6.0 | 1.0 | 5.5 | 49.9 | 0.113 | 249.3 | 0.00045 | 0.00045 | |
| 7 | 6.0 | 7.0 | 1.0 | 6.5 | 49.8 | 0.115 | 248.9 | 0.00046 | 0.00046 | |
| 8 | 7.0 | 8.0 | 1.0 | 7.5 | 49.7 | 0.118 | 248.5 | 0.00047 | 0.00047 | |
| 9 | 8.0 | 9.0 | 1.0 | 8.5 | 75.5 | 0.120 | 377.7 | 0.00032 | 0.00032 | |
| 10 | 9.0 | 10.0 | 1.0 | 9.5 | 93.5 | 0.122 | 467.5 | 0.00026 | 0.00026 | |
| 11 | 10.0 | 11.0 | 1.0 | 10.5 | 132.0 | 0.125 | 660.2 | 0.00019 | 0.00019 | |
| 12 | 11.0 | 12.0 | 1.0 | 11.5 | 93.7 | 0.127 | 468.7 | 0.00027 | 0.00027 | |
| 13 | 12.0 | 13.0 | 1.0 | 12.5 | 95.9 | 0.129 | 479.4 | 0.00027 | 0.00027 | |
| 14 | 13.0 | 14.0 | 1.0 | 13.5 | 95.4 | 0.132 | 477.2 | 0.00028 | 0.00028 | |
| 15 | 14.0 | 15.0 | 1.0 | 14.5 | 103.0 | 0.134 | 514.9 | 0.00026 | 0.00026 | |
| 16 | 15.0 | 16.0 | 1.0 | 15.5 | 99.4 | 0.136 | 497.1 | 0.00027 | 0.00027 | |
| 17 | 16.0 | 17.0 | 1.0 | 16.5 | 112.1 | 0.139 | 560.5 | 0.00025 | 0.00025 | |
| 18 | 17.0 | 18.0 | 1.0 | 17.5 | 157.0 | 0.141 | 784.9 | 0.00018 | 0.00018 | |
| 19 | 18.0 | 19.0 | 1.0 | 18.5 | 207.8 | 0.144 | 1039.0 | 0.00014 | 0.00014 | |
| 20 | 19.0 | 20.0 | 1.0 | 19.5 | 239.4 | 0.146 | 1197.1 | 0.00012 | 0.00012 | |
| 21 | 20.0 | 21.0 | 1.0 | 20.5 | 165.3 | 0.148 | 826.3 | 0.00018 | 0.00018 | |
| 22 | 21.0 | 22.0 | 1.0 | 21.5 | 130.5 | 0.151 | 652.4 | 0.00023 | 0.00023 | |
| 23 | 22.0 | 23.0 | 1.0 | 22.5 | 173.5 | 0.153 | 867.4 | 0.00018 | 0.00018 | |
| 24 | 23.0 | 24.0 | 1.0 | 23.5 | 210.2 | 0.155 | 1051.2 | 0.00015 | 0.00015 | |
| 25 | 24.0 | 25.0 | 1.0 | 24.5 | 221.0 | 0.158 | 1104.9 | 0.00014 | 0.00014 | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 26 | 25.0 | 26.0 | 1.0 | 25.5 | 205.2 | 0.160 | 1026.1 | 0.00016 | 0.00016 | |
| 27 | 26.0 | 27.0 | 1.0 | 26.5 | 216.2 | 0.162 | 1080.8 | 0.00015 | 0.00015 | |
| 28 | 27.0 | 28.0 | 1.0 | 27.5 | 181.5 | 0.165 | 907.5 | 0.00018 | 0.00018 | |
| 29 | 28.0 | 29.0 | 1.0 | 28.5 | 122.5 | 0.167 | 612.6 | 0.00027 | 0.00027 | |
| 30 | 29.0 | 30.0 | 1.0 | 29.5 | 82.6 | 0.169 | 413.1 | 0.00041 | 0.00041 | |
| 31 | 30.0 | 31.0 | 1.0 | 30.5 | 115.5 | 0.172 | 577.3 | 0.00030 | 0.00030 | |
| 32 | 31.0 | 32.0 | 1.0 | 31.5 | 56.5 | 0.174 | 282.4 | 0.00062 | 0.00062 | |
| 33 | 32.0 | 33.0 | 1.0 | 32.5 | 104.4 | 0.177 | 522.2 | 0.00034 | 0.00034 | |
| 34 | 33.0 | 34.0 | 1.0 | 33.5 | 47.9 | 0.179 | 239.3 | 0.00075 | 0.00075 | |
| 35 | 34.0 | 35.0 | 1.0 | 34.5 | 55.7 | 0.181 | 278.4 | 0.00065 | 0.00065 | |
| 36 | 35.0 | 36.0 | 1.0 | 35.5 | 44.1 | 0.184 | 220.6 | 0.00083 | 0.00083 | |
| 37 | 36.0 | 37.0 | 1.0 | 36.5 | 40.9 | 0.186 | 204.6 | 0.00091 | 0.00091 | |
| 38 | 37.0 | 38.0 | 1.0 | 37.5 | 114.2 | 0.188 | 571.2 | 0.00033 | 0.00033 | |
| 39 | 38.0 | 39.0 | 1.0 | 38.5 | 169.8 | 0.191 | 848.9 | 0.00022 | 0.00022 | |
| 40 | 39.0 | 40.0 | 1.0 | 39.5 | 166.3 | 0.193 | 831.4 | 0.00023 | 0.00023 | |
| 41 | 40.0 | 41.0 | 1.0 | 40.5 | 167.6 | 0.195 | 838.2 | 0.00023 | 0.00023 | |
| 42 | 41.0 | 42.0 | 1.0 | 41.5 | 167.9 | 0.198 | 839.7 | 0.00024 | 0.00024 | |
| 43 | 42.0 | 43.0 | 1.0 | 42.5 | 189.9 | 0.200 | 949.6 | 0.00021 | 0.00021 | |
| 44 | 43.0 | 44.0 | 1.0 | 43.5 | 172.2 | 0.202 | 861.2 | 0.00024 | 0.00024 | |
| 45 | 44.0 | 45.0 | 1.0 | 44.5 | 161.5 | 0.205 | 807.5 | 0.00025 | 0.00025 | |
| 46 | 45.0 | 46.0 | 1.0 | 45.5 | 190.5 | 0.207 | 952.7 | 0.00022 | 0.00022 | |
| 47 | 46.0 | 47.0 | 1.0 | 46.5 | 195.6 | 0.209 | 978.2 | 0.00021 | 0.00021 | |
| 48 | 47.0 | 48.0 | 1.0 | 47.5 | 206.0 | 0.212 | 1030.1 | 0.00021 | 0.00021 | |
| 49 | 48.0 | 49.0 | 1.0 | 48.5 | 93.6 | 0.214 | 468.0 | 0.00046 | 0.00046 | |
| 50 | 49.0 | 50.0 | 1.0 | 49.5 | 225.0 | 0.217 | 1124.8 | 0.00019 | 0.00019 | |
| 51 | 50.0 | 51.0 | 1.0 | 50.5 | 294.4 | 0.219 | 1471.8 | 0.00015 | 0.00015 | |
| 52 | 51.0 | 52.0 | 1.0 | 51.5 | 305.3 | 0.221 | 1526.5 | 0.00014 | 0.00014 | |
| 53 | 52.0 | 53.0 | 1.0 | 52.5 | 276.6 | 0.224 | 1382.8 | 0.00016 | 0.00016 | |
| 54 | 53.0 | 54.0 | 1.0 | 53.5 | 268.0 | 0.226 | 1339.9 | 0.00017 | 0.00017 | |
| 55 | 54.0 | 55.0 | 1.0 | 54.5 | 246.4 | 0.228 | 1231.8 | 0.00019 | 0.00019 | |
| 56 | 55.0 | 56.0 | 1.0 | 55.5 | 177.5 | 0.231 | 887.5 | 0.00026 | 0.00026 | |
| 57 | 56.0 | 57.0 | 1.0 | 56.5 | 116.9 | 0.233 | 584.6 | 0.00040 | 0.00040 | |
| 58 | 57.0 | 58.0 | 1.0 | 57.5 | 120.2 | 0.235 | 601.1 | 0.00039 | 0.00039 | |
| 59 | 58.0 | 59.0 | 1.0 | 58.5 | 154.1 | 0.238 | 770.7 | 0.00031 | 0.00031 | |
| 60 | 59.0 | 60.0 | 1.0 | 59.5 | 112.6 | 0.240 | 562.8 | 0.00043 | 0.00043 | |
| 61 | 60.0 | 61.0 | 1.0 | 60.5 | 24.2 | 0.242 | 121.0 | 0.00200 | 0.00200 | |
| 62 | 61.0 | 62.0 | 1.0 | 61.5 | 21.7 | 0.245 | 108.6 | 0.00225 | 0.00225 | |
| 63 | 62.0 | 63.0 | 1.0 | 62.5 | 41.5 | 0.247 | 207.4 | 0.00119 | 0.00119 | |
| 64 | 63.0 | 64.0 | 1.0 | 63.5 | 159.8 | 0.249 | 798.8 | 0.00031 | 0.00031 | |
| 65 | 64.0 | 65.0 | 1.0 | 64.5 | 208.3 | 0.252 | 1041.3 | 0.00024 | 0.00024 | |
| 66 | 65.0 | 66.0 | 1.0 | 65.5 | 204.5 | 0.254 | 1022.7 | 0.00025 | 0.00025 | |
| 67 | 66.0 | 67.0 | 1.0 | 66.5 | 223.5 | 0.257 | 1117.6 | 0.00023 | 0.00023 | |
| 68 | 67.0 | 68.0 | 1.0 | 67.5 | 278.4 | 0.259 | 1392.0 | 0.00019 | 0.00019 | |
| 69 | 68.0 | 69.0 | 1.0 | 68.5 | 229.0 | 0.261 | 1145.1 | 0.00023 | 0.00023 | |
| 70 | 69.0 | 70.0 | 1.0 | 69.5 | 82.8 | 0.264 | 414.1 | 0.00064 | 0.00064 | |
| 71 | 70.0 | 71.0 | 1.0 | 70.5 | 83.6 | 0.266 | 418.0 | 0.00064 | 0.00064 | |
| 72 | 71.0 | 72.0 | 1.0 | 71.5 | 146.0 | 0.268 | 730.2 | 0.00037 | 0.00037 | |
| 73 | 72.0 | 73.0 | 1.0 | 72.5 | 163.0 | 0.271 | 815.1 | 0.00033 | 0.00033 | |
| 74 | 73.0 | 74.0 | 1.0 | 73.5 | 162.2 | 0.273 | 810.8 | 0.00034 | 0.00034 | |
| 75 | 74.0 | 75.0 | 1.0 | 74.5 | 133.0 | 0.275 | 665.2 | 0.00041 | 0.00041 | |
| 76 | 75.0 | 76.0 | 1.0 | 75.5 | 125.7 | 0.278 | 628.7 | 0.00044 | 0.00044 | |
| 77 | 76.0 | 77.0 | 1.0 | 76.5 | 68.3 | 0.280 | 341.7 | 0.00082 | 0.00082 | |
| 78 | 77.0 | 78.0 | 1.0 | 77.5 | 64.0 | 0.282 | 320.1 | 0.00088 | 0.00088 | |
| 79 | 78.0 | 79.0 | 1.0 | 78.5 | 55.3 | 0.285 | 276.6 | 0.00103 | 0.00103 | |
| 80 | 79.0 | 80.0 | 1.0 | 79.5 | 41.6 | 0.287 | 208.0 | 0.00138 | 0.00138 | |
| 81 | 80.0 | 81.0 | 1.0 | 80.5 | 39.2 | 0.289 | 196.1 | 0.00148 | 0.00148 | |
| 82 | 81.0 | 82.0 | 1.0 | 81.5 | 234.3 | 0.292 | 1171.5 | 0.00025 | 0.00025 | |
| 83 | 82.0 | 83.0 | 1.0 | 82.5 | 125.2 | 0.294 | 625.9 | 0.00047 | 0.00047 | |
| 84 | 83.0 | 84.0 | 1.0 | 83.5 | 55.3 | 0.297 | 276.3 | 0.00107 | 0.00107 | |
| 85 | 84.0 | 85.0 | 1.0 | 84.5 | 141.5 | 0.299 | 707.6 | 0.00042 | 0.00042 | |
| 86 | 85.0 | 86.0 | 1.0 | 85.5 | 92.1 | 0.301 | 460.3 | 0.00065 | 0.00065 | |
| 87 | 86.0 | 87.0 | 1.0 | 86.5 | 208.3 | 0.304 | 1041.4 | 0.00029 | 0.00029 | |
| 88 | 87.0 | 88.0 | 1.0 | 87.5 | 272.1 | 0.306 | 1360.7 | 0.00022 | 0.00022 | |
| 89 | 88.0 | 89.0 | 1.0 | 88.5 | 174.8 | 0.308 | 873.9 | 0.00035 | 0.00035 | |
| 90 | 89.0 | 90.0 | 1.0 | 89.5 | 139.4 | 0.311 | 696.9 | 0.00045 | 0.00045 | |
| 91 | 90.0 | 91.0 | 1.0 | 90.5 | 193.1 | 0.313 | 965.6 | 0.00032 | 0.00032 | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 92 | 91.0 | 92.0 | 1.0 | 91.5 | 236.9 | 0.315 | 1184.3 | 0.00027 | 0.00027 | |
| 93 | 92.0 | 93.0 | 1.0 | 92.5 | 197.3 | 0.318 | 986.4 | 0.00032 | 0.00032 | |
| 94 | 93.0 | 94.0 | 1.0 | 93.5 | 314.8 | 0.320 | 1573.9 | 0.00020 | 0.00020 | |
| 95 | 94.0 | 95.0 | 1.0 | 94.5 | 131.8 | 0.322 | 659.1 | 0.00049 | 0.00049 | |
| 96 | 95.0 | 96.0 | 1.0 | 95.5 | 156.2 | 0.325 | 780.9 | 0.00042 | 0.00042 | |
| 97 | 96.0 | 97.0 | 1.0 | 96.5 | 177.0 | 0.327 | 885.1 | 0.00037 | 0.00037 | |
| 98 | 97.0 | 98.0 | 1.0 | 97.5 | 181.5 | 0.330 | 907.5 | 0.00036 | 0.00036 | |
| 99 | 98.0 | 99.0 | 1.0 | 98.5 | 154.4 | 0.332 | 772.0 | 0.00043 | 0.00043 | |
| 100 | 99.0 | 100.0 | 1.0 | 99.5 | 238.9 | 0.334 | 1194.4 | 0.00028 | 0.00028 | |
| 101 | 100.0 | 101.0 | 1.0 | 100.5 | 319.4 | 0.337 | 1597.0 | 0.00021 | 0.00021 | |
| 102 | 101.0 | 102.0 | 1.0 | 101.5 | 210.6 | 0.339 | 1053.0 | 0.00032 | 0.00032 | |
| 103 | 102.0 | 103.0 | 1.0 | 102.5 | 167.6 | 0.341 | 837.8 | 0.00041 | 0.00041 | |
| 104 | 103.0 | 104.0 | 1.0 | 103.5 | 117.9 | 0.344 | 589.5 | 0.00058 | 0.00058 | |
| 105 | 104.0 | 105.0 | 1.0 | 104.5 | 71.2 | 0.346 | 356.1 | 0.00097 | 0.00097 | |
| 106 | 105.0 | 106.0 | 1.0 | 105.5 | 84.2 | 0.348 | 421.0 | 0.00083 | 0.00083 | |
| 107 | 106.0 | 107.0 | 1.0 | 106.5 | 82.8 | 0.351 | 414.1 | 0.00085 | 0.00085 | |
| 108 | 107.0 | 108.0 | 1.0 | 107.5 | 85.5 | 0.353 | 427.5 | 0.00083 | 0.00083 | |
| 109 | 108.0 | 109.0 | 1.0 | 108.5 | 87.7 | 0.355 | 438.7 | 0.00081 | 0.00081 | |
| 110 | 109.0 | 110.0 | 1.0 | 109.5 | 71.5 | 0.358 | 357.6 | 0.00100 | 0.00100 | |
| 111 | 110.0 | 111.0 | 1.0 | 110.5 | 60.5 | 0.360 | 302.6 | 0.00119 | 0.00119 | |
| 112 | 111.0 | 112.0 | 1.0 | 111.5 | 64.9 | 0.362 | 324.4 | 0.00112 | 0.00112 | |
| 113 | 112.0 | 113.0 | 1.0 | 112.5 | 62.6 | 0.365 | 313.2 | 0.00116 | 0.00116 | |
| 114 | 113.0 | 114.0 | 1.0 | 113.5 | 70.2 | 0.367 | 351.0 | 0.00105 | 0.00105 | |
| 115 | 114.0 | 115.0 | 1.0 | 114.5 | 80.1 | 0.370 | 400.6 | 0.00092 | 0.00092 | |
| 116 | 115.0 | 116.0 | 1.0 | 115.5 | 191.7 | 0.372 | 958.5 | 0.00039 | 0.00039 | |
| 117 | 116.0 | 117.0 | 1.0 | 116.5 | 204.5 | 0.374 | 1022.4 | 0.00037 | 0.00037 | |
| 118 | 117.0 | 118.0 | 1.0 | 117.5 | 508.1 | 0.377 | 2540.5 | 0.00015 | 0.00015 | |
| 119 | 118.0 | 119.0 | 1.0 | 118.5 | 621.5 | 0.379 | 3107.7 | 0.00012 | 0.00012 | |
| 120 | 119.0 | 120.0 | 1.0 | 119.5 | 668.1 | 0.381 | 3340.6 | 0.00011 | 0.00011 | |
| Σ = | | | | | | | | | 0.05445 | |

$I_{zr}$ *(1 < L/B < 10):* $I_{zr} = I_{zs} + 0.111\,(I_{zc} - I_{zs})\,(L/B - 1)$

$I_{zs}$ *(L/B = 1):*

*For* $z_{ave} = 0$ *to B/2:* $I_{zs} = 0.1 + (z_{ave}/B)(2I_{zp} - 0.2)$

*For* $z_{ave} = B/2$ *to 2B:* $I_{zs} = 0.667\,I_{zp}\,(2 - z_{ave}/B)$

$I_{zc}$ *(L/B ≥ 10):*

*For* $z_{ave} = 0$ *to B:* $I_{zc} = 0.2 + (z_{ave}/B)(I_{zp} - 0.2)$

*For* $z_{ave} = B$ *to 4B:* $I_{zc} = 0.333\,I_{zp}\,(4 - z_{ave}/B)$ ( Coduto p.228. )

| | | | | | | |
|---|---|---|---|---|---|---|
| Footing width | B = | 382.0 | ft | **Z-SDU6-C20** | | |
| Footing length | L = | 382.0 | ft | | Immediate Settlement (in.) $(S_0 / 2)$ | |
| Ground elevation | | 276.0 | ft | | | |
| Foundation elevation | | 265.0 | ft | | | |
| Ground Water elevation | | 220.0 | ft | | Load | $S_0$ = |
| Excavated or embedded depth | D = | 11.0 | ft | End of Operations | 5.10 | 1.4 |
| Depth to Groundwater | | 56.0 | ft | Tank Half Full | 2.80 | 0.4 |
| Unit weight | $\gamma$ = | 120.0 | pcf | Pre Closure | 5.50 | 1.6 |
| Gross Footing Load | | 5.10 | ksf | Post Closure | 8.00 | 2.7 |
| Net applied footing pressure | $\Delta p$ = | **3.780** | ksf | | | |
| | L/B = | 1.00 | - | | | |

**Computation**

| | | | | | | |
|---|---|---|---|---|---|---|
| Settlement | $\rho_i$ = | $C_1 C_t \Delta p \Sigma(\Delta z_i I_{zi}/E_{si})$ | 0.232 ft | | 30 Year Settlement (in.) $(S_{30} / 2)$ | |
| | $\rho_i$ = | $C_t = 1$ | **2.779 in** | | Load | $S_0$ = |
| | S(t) = | | 0.346 ft | | 5.10 | 2.1 |
| | S(t) = | | **4.156 in** | | 8.00 | 4.1 |
| Correction for strain relief | $C_1$ = | $1 - 0.5(\sigma'_D/q')$ | 0.825 - | | | |
| Effective vertical overburden pressure at D | $\sigma'_{vo}$ = | $\gamma$ D | 1.320 ksf | | | |
| Correction for time dependent increase | $C_t$ = | 1 + 0.2 log( t / 0.1 ) | 1.50 - | | | |
| | t = | | 30.00 years | | | |
| Elastic modulus of soil layer i | $E_{si}$ = | 2.5 $q_c$ | see Column H | if L/B = 1 | | |
| | $E_{si}$ = | 3.5 $q_c$ | see Column H | If L/B $\geq$ 10 | | |
| Depth increment i | $\Delta z_i$ | | see Column D | | | |
| Influence factor of soil layer i | $I_{zi}$ | Figure 3-4 | see Column G | | | |
| Peak depth influence factor | $I_{zp}$ = | $0.5 + 0.1 (\Delta p/\sigma'_{Izp})^{1/2}$ | 0.550 - | | | |
| | $z_p$ = | 0.5B + D | 202.00 ft | If L/B = 1 | | |
| | $z_p$ = | B + D | 393.00 ft | If L/B $\geq$ 10 | | |
| | $z_p$ = | | 202.00 ft | for L/B=1.00 | | |
| Effective overburden pressure at depth Izp | $\sigma'_{Izp}$ = | | 15.13 ksf | | | |
| Elastic Modulus | $E_{si}$ = | | 2.50 $q_c$ | If L/B = 1 | | |
| | $E_{si}$ = | | 3.50 $q_c$ | If L/B $\geq$ 10 | | |
| | $E_{si}$ = | | 2.50 $q_c$ | for L/B=1.00 | | |

Computations made relative to the bottom of foundation

| A | B | C | D | E | F | G | H | I | J | K |
|---|---|---|---|---|---|---|---|---|---|---|
| Layer No. | Layer top depth (ft) | Layer bottom depth (ft) | Layer thickness $\Delta z_i$ (ft) | Mid-layer depth $z_{ave}$ (ft) | Average tip stress $q_c$ (tsf) | $I_{zi}$ | Elastic modulus $E_{si}$ (ksf) | $\Delta z_i I_{zi}/E_{si}$ | $\Delta z_i I_{zi}/E_{si}$ | Notes |
| 1 | 0.0 | 1.0 | 1.0 | 0.5 | 61.4 | 0.101 | 306.9 | 0.00033 | 0.00033 | |
| 2 | 1.0 | 2.0 | 1.0 | 1.5 | 58.3 | 0.104 | 291.3 | 0.00036 | 0.00036 | |
| 3 | 2.0 | 3.0 | 1.0 | 2.5 | 120.8 | 0.106 | 603.9 | 0.00018 | 0.00018 | |
| 4 | 3.0 | 4.0 | 1.0 | 3.5 | 96.6 | 0.108 | 482.9 | 0.00022 | 0.00022 | |
| 5 | 4.0 | 5.0 | 1.0 | 4.5 | 52.6 | 0.111 | 263.0 | 0.00042 | 0.00042 | |
| 6 | 5.0 | 6.0 | 1.0 | 5.5 | 51.2 | 0.113 | 256.1 | 0.00044 | 0.00044 | |
| 7 | 6.0 | 7.0 | 1.0 | 6.5 | 63.7 | 0.115 | 318.5 | 0.00036 | 0.00036 | |
| 8 | 7.0 | 8.0 | 1.0 | 7.5 | 62.8 | 0.118 | 314.2 | 0.00037 | 0.00037 | |
| 9 | 8.0 | 9.0 | 1.0 | 8.5 | 64.9 | 0.120 | 324.3 | 0.00037 | 0.00037 | |
| 10 | 9.0 | 10.0 | 1.0 | 9.5 | 72.8 | 0.122 | 364.1 | 0.00034 | 0.00034 | |
| 11 | 10.0 | 11.0 | 1.0 | 10.5 | 93.0 | 0.125 | 465.0 | 0.00027 | 0.00027 | |
| 12 | 11.0 | 12.0 | 1.0 | 11.5 | 88.3 | 0.127 | 441.3 | 0.00029 | 0.00029 | |
| 13 | 12.0 | 13.0 | 1.0 | 12.5 | 76.9 | 0.129 | 384.5 | 0.00034 | 0.00034 | |
| 14 | 13.0 | 14.0 | 1.0 | 13.5 | 65.7 | 0.132 | 328.6 | 0.00040 | 0.00040 | |
| 15 | 14.0 | 15.0 | 1.0 | 14.5 | 87.4 | 0.134 | 437.2 | 0.00031 | 0.00031 | |
| 16 | 15.0 | 16.0 | 1.0 | 15.5 | 113.3 | 0.137 | 566.6 | 0.00024 | 0.00024 | |
| 17 | 16.0 | 17.0 | 1.0 | 16.5 | 99.5 | 0.139 | 497.3 | 0.00028 | 0.00028 | |
| 18 | 17.0 | 18.0 | 1.0 | 17.5 | 98.3 | 0.141 | 491.4 | 0.00029 | 0.00029 | |
| 19 | 18.0 | 19.0 | 1.0 | 18.5 | 103.1 | 0.144 | 515.4 | 0.00028 | 0.00028 | |
| 20 | 19.0 | 20.0 | 1.0 | 19.5 | 101.4 | 0.146 | 506.9 | 0.00029 | 0.00029 | |
| 21 | 20.0 | 21.0 | 1.0 | 20.5 | 93.8 | 0.148 | 468.9 | 0.00032 | 0.00032 | |
| 22 | 21.0 | 22.0 | 1.0 | 21.5 | 103.0 | 0.151 | 514.9 | 0.00029 | 0.00029 | |
| 23 | 22.0 | 23.0 | 1.0 | 22.5 | 98.0 | 0.153 | 489.8 | 0.00031 | 0.00031 | |
| 24 | 23.0 | 24.0 | 1.0 | 23.5 | 93.8 | 0.155 | 468.9 | 0.00033 | 0.00033 | |
| 25 | 24.0 | 25.0 | 1.0 | 24.5 | 126.0 | 0.158 | 630.0 | 0.00025 | 0.00025 | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 26 | 25.0 | 26.0 | 1.0 | 25.5 | 162.9 | 0.160 | 814.6 | 0.00020 | 0.00020 | |
| 27 | 26.0 | 27.0 | 1.0 | 26.5 | 174.5 | 0.162 | 872.6 | 0.00019 | 0.00019 | |
| 28 | 27.0 | 28.0 | 1.0 | 27.5 | 168.0 | 0.165 | 839.8 | 0.00020 | 0.00020 | |
| 29 | 28.0 | 29.0 | 1.0 | 28.5 | 193.3 | 0.167 | 966.6 | 0.00017 | 0.00017 | |
| 30 | 29.0 | 30.0 | 1.0 | 29.5 | 188.3 | 0.170 | 941.3 | 0.00018 | 0.00018 | |
| 31 | 30.0 | 31.0 | 1.0 | 30.5 | 194.3 | 0.172 | 971.7 | 0.00018 | 0.00018 | |
| 32 | 31.0 | 32.0 | 1.0 | 31.5 | 212.3 | 0.174 | 1061.4 | 0.00016 | 0.00016 | |
| 33 | 32.0 | 33.0 | 1.0 | 32.5 | 245.7 | 0.177 | 1228.7 | 0.00014 | 0.00014 | |
| 34 | 33.0 | 34.0 | 1.0 | 33.5 | 259.8 | 0.179 | 1299.2 | 0.00014 | 0.00014 | |
| 35 | 34.0 | 35.0 | 1.0 | 34.5 | 260.3 | 0.181 | 1301.3 | 0.00014 | 0.00014 | |
| 36 | 35.0 | 36.0 | 1.0 | 35.5 | 268.9 | 0.184 | 1344.3 | 0.00014 | 0.00014 | |
| 37 | 36.0 | 37.0 | 1.0 | 36.5 | 263.4 | 0.186 | 1316.9 | 0.00014 | 0.00014 | |
| 38 | 37.0 | 38.0 | 1.0 | 37.5 | 146.1 | 0.188 | 730.3 | 0.00026 | 0.00026 | |
| 39 | 38.0 | 39.0 | 1.0 | 38.5 | 72.4 | 0.191 | 362.0 | 0.00053 | 0.00053 | |
| 40 | 39.0 | 40.0 | 1.0 | 39.5 | 162.6 | 0.193 | 813.1 | 0.00024 | 0.00024 | |
| 41 | 40.0 | 41.0 | 1.0 | 40.5 | 136.9 | 0.195 | 684.7 | 0.00029 | 0.00029 | |
| 42 | 41.0 | 42.0 | 1.0 | 41.5 | 96.5 | 0.198 | 482.6 | 0.00041 | 0.00041 | |
| 43 | 42.0 | 43.0 | 1.0 | 42.5 | 27.1 | 0.200 | 135.4 | 0.00148 | 0.00148 | |
| 44 | 43.0 | 44.0 | 1.0 | 43.5 | 18.4 | 0.202 | 91.9 | 0.00220 | 0.00220 | |
| 45 | 44.0 | 45.0 | 1.0 | 44.5 | 15.8 | 0.205 | 79.2 | 0.00259 | 0.00259 | |
| 46 | 45.0 | 46.0 | 1.0 | 45.5 | 51.9 | 0.207 | 259.6 | 0.00080 | 0.00080 | |
| 47 | 46.0 | 47.0 | 1.0 | 46.5 | 145.9 | 0.210 | 729.5 | 0.00029 | 0.00029 | |
| 48 | 47.0 | 48.0 | 1.0 | 47.5 | 153.7 | 0.212 | 768.3 | 0.00028 | 0.00028 | |
| 49 | 48.0 | 49.0 | 1.0 | 48.5 | 197.6 | 0.214 | 987.8 | 0.00022 | 0.00022 | |
| 50 | 49.0 | 50.0 | 1.0 | 49.5 | 221.2 | 0.217 | 1106.1 | 0.00020 | 0.00020 | |
| 51 | 50.0 | 51.0 | 1.0 | 50.5 | 178.5 | 0.219 | 892.5 | 0.00025 | 0.00025 | |
| 52 | 51.0 | 52.0 | 1.0 | 51.5 | 214.9 | 0.221 | 1074.7 | 0.00021 | 0.00021 | |
| 53 | 52.0 | 53.0 | 1.0 | 52.5 | 191.3 | 0.224 | 956.4 | 0.00023 | 0.00023 | |
| 54 | 53.0 | 54.0 | 1.0 | 53.5 | 232.8 | 0.226 | 1164.0 | 0.00019 | 0.00019 | |
| 55 | 54.0 | 55.0 | 1.0 | 54.5 | 153.6 | 0.228 | 768.0 | 0.00030 | 0.00030 | |
| 56 | 55.0 | 56.0 | 1.0 | 55.5 | 138.1 | 0.231 | 690.6 | 0.00033 | 0.00033 | |
| 57 | 56.0 | 57.0 | 1.0 | 56.5 | 101.0 | 0.233 | 504.9 | 0.00046 | 0.00046 | |
| 58 | 57.0 | 58.0 | 1.0 | 57.5 | 129.0 | 0.235 | 644.8 | 0.00037 | 0.00037 | |
| 59 | 58.0 | 59.0 | 1.0 | 58.5 | 246.8 | 0.238 | 1234.1 | 0.00019 | 0.00019 | |
| 60 | 59.0 | 60.0 | 1.0 | 59.5 | 257.5 | 0.240 | 1287.5 | 0.00019 | 0.00019 | |
| 61 | 60.0 | 61.0 | 1.0 | 60.5 | 267.6 | 0.243 | 1337.8 | 0.00018 | 0.00018 | |
| 62 | 61.0 | 62.0 | 1.0 | 61.5 | 248.7 | 0.245 | 1243.6 | 0.00020 | 0.00020 | |
| 63 | 62.0 | 63.0 | 1.0 | 62.5 | 212.9 | 0.247 | 1064.7 | 0.00023 | 0.00023 | |
| 64 | 63.0 | 64.0 | 1.0 | 63.5 | 146.0 | 0.250 | 730.2 | 0.00034 | 0.00034 | |
| 65 | 64.0 | 65.0 | 1.0 | 64.5 | 96.1 | 0.252 | 480.6 | 0.00052 | 0.00052 | |
| 66 | 65.0 | 66.0 | 1.0 | 65.5 | 24.2 | 0.254 | 120.8 | 0.00211 | 0.00211 | |
| 67 | 66.0 | 67.0 | 1.0 | 66.5 | 26.6 | 0.257 | 133.1 | 0.00193 | 0.00193 | |
| 68 | 67.0 | 68.0 | 1.0 | 67.5 | 35.6 | 0.259 | 178.0 | 0.00146 | 0.00146 | |
| 69 | 68.0 | 69.0 | 1.0 | 68.5 | 72.2 | 0.261 | 361.1 | 0.00072 | 0.00072 | |
| 70 | 69.0 | 70.0 | 1.0 | 69.5 | 199.1 | 0.264 | 995.4 | 0.00026 | 0.00026 | |
| 71 | 70.0 | 71.0 | 1.0 | 70.5 | 306.5 | 0.266 | 1532.7 | 0.00017 | 0.00017 | |
| 72 | 71.0 | 72.0 | 1.0 | 71.5 | 319.7 | 0.268 | 1598.3 | 0.00017 | 0.00017 | |
| 73 | 72.0 | 73.0 | 1.0 | 72.5 | 345.8 | 0.271 | 1729.1 | 0.00016 | 0.00016 | |
| 74 | 73.0 | 74.0 | 1.0 | 73.5 | 325.2 | 0.273 | 1625.8 | 0.00017 | 0.00017 | |
| 75 | 74.0 | 75.0 | 1.0 | 74.5 | 310.8 | 0.276 | 1554.0 | 0.00018 | 0.00018 | |
| 76 | 75.0 | 76.0 | 1.0 | 75.5 | 304.6 | 0.278 | 1523.1 | 0.00018 | 0.00018 | |
| 77 | 76.0 | 77.0 | 1.0 | 76.5 | 310.2 | 0.280 | 1550.8 | 0.00018 | 0.00018 | |
| 78 | 77.0 | 78.0 | 1.0 | 77.5 | 233.3 | 0.283 | 1166.7 | 0.00024 | 0.00024 | |
| 79 | 78.0 | 79.0 | 1.0 | 78.5 | 117.4 | 0.285 | 586.8 | 0.00049 | 0.00049 | |
| 80 | 79.0 | 80.0 | 1.0 | 79.5 | 243.9 | 0.287 | 1219.4 | 0.00024 | 0.00024 | |
| 81 | 80.0 | 81.0 | 1.0 | 80.5 | 185.5 | 0.290 | 927.7 | 0.00031 | 0.00031 | |
| 82 | 81.0 | 82.0 | 1.0 | 81.5 | 113.8 | 0.292 | 569.1 | 0.00051 | 0.00051 | |
| 83 | 82.0 | 83.0 | 1.0 | 82.5 | 74.1 | 0.294 | 370.3 | 0.00079 | 0.00079 | |
| 84 | 83.0 | 84.0 | 1.0 | 83.5 | 43.3 | 0.297 | 216.6 | 0.00137 | 0.00137 | |
| 85 | 84.0 | 85.0 | 1.0 | 84.5 | 23.5 | 0.299 | 117.5 | 0.00255 | 0.00255 | |
| 86 | 85.0 | 86.0 | 1.0 | 85.5 | 21.6 | 0.301 | 108.2 | 0.00279 | 0.00279 | |
| 87 | 86.0 | 87.0 | 1.0 | 86.5 | 26.6 | 0.304 | 133.0 | 0.00228 | 0.00228 | |
| 88 | 87.0 | 88.0 | 1.0 | 87.5 | 37.9 | 0.306 | 189.4 | 0.00162 | 0.00162 | |
| 89 | 88.0 | 89.0 | 1.0 | 88.5 | 167.3 | 0.309 | 836.4 | 0.00037 | 0.00037 | |
| 90 | 89.0 | 90.0 | 1.0 | 89.5 | 117.0 | 0.311 | 585.2 | 0.00053 | 0.00053 | |
| 91 | 90.0 | 91.0 | 1.0 | 90.5 | 31.3 | 0.313 | 156.5 | 0.00200 | 0.00200 | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 92 | 91.0 | 92.0 | 1.0 | 91.5 | 24.3 | 0.316 | 121.5 | 0.00260 | 0.00260 | |
| 93 | 92.0 | 93.0 | 1.0 | 92.5 | 116.9 | 0.318 | 584.5 | 0.00054 | 0.00054 | |
| 94 | 93.0 | 94.0 | 1.0 | 93.5 | 152.2 | 0.320 | 761.0 | 0.00042 | 0.00042 | |
| 95 | 94.0 | 95.0 | 1.0 | 94.5 | 148.2 | 0.323 | 741.0 | 0.00044 | 0.00044 | |
| 96 | 95.0 | 96.0 | 1.0 | 95.5 | 60.3 | 0.325 | 301.6 | 0.00108 | 0.00108 | |
| 97 | 96.0 | 97.0 | 1.0 | 96.5 | 56.1 | 0.327 | 280.3 | 0.00117 | 0.00117 | |
| 98 | 97.0 | 98.0 | 1.0 | 97.5 | 64.7 | 0.330 | 323.3 | 0.00102 | 0.00102 | |
| 99 | 98.0 | 99.0 | 1.0 | 98.5 | 63.4 | 0.332 | 317.2 | 0.00105 | 0.00105 | |
| 100 | 99.0 | 100.0 | 1.0 | 99.5 | 48.9 | 0.334 | 244.6 | 0.00137 | 0.00137 | |
| 101 | 100.0 | 101.0 | 1.0 | 100.5 | 151.4 | 0.337 | 756.9 | 0.00044 | 0.00044 | |
| 102 | 101.0 | 102.0 | 1.0 | 101.5 | 56.0 | 0.339 | 280.0 | 0.00121 | 0.00121 | |
| 103 | 102.0 | 103.0 | 1.0 | 102.5 | 51.2 | 0.341 | 255.9 | 0.00133 | 0.00133 | |
| 104 | 103.0 | 104.0 | 1.0 | 103.5 | 60.5 | 0.344 | 302.7 | 0.00114 | 0.00114 | |
| 105 | 104.0 | 105.0 | 1.0 | 104.5 | 76.1 | 0.346 | 380.4 | 0.00091 | 0.00091 | |
| 106 | 105.0 | 106.0 | 1.0 | 105.5 | 69.3 | 0.349 | 346.3 | 0.00101 | 0.00101 | |
| 107 | 106.0 | 107.0 | 1.0 | 106.5 | 57.2 | 0.351 | 286.0 | 0.00123 | 0.00123 | |
| 108 | 107.0 | 108.0 | 1.0 | 107.5 | 65.2 | 0.353 | 326.1 | 0.00108 | 0.00108 | |
| 109 | 108.0 | 109.0 | 1.0 | 108.5 | 75.9 | 0.356 | 379.6 | 0.00094 | 0.00094 | |
| 110 | 109.0 | 110.0 | 1.0 | 109.5 | 49.2 | 0.358 | 246.0 | 0.00146 | 0.00146 | |
| 111 | 110.0 | 111.0 | 1.0 | 110.5 | 51.3 | 0.360 | 256.6 | 0.00140 | 0.00140 | |
| 112 | 111.0 | 112.0 | 1.0 | 111.5 | 61.9 | 0.363 | 309.3 | 0.00117 | 0.00117 | |
| 113 | 112.0 | 113.0 | 1.0 | 112.5 | 55.0 | 0.365 | 274.9 | 0.00133 | 0.00133 | |
| 114 | 113.0 | 114.0 | 1.0 | 113.5 | 84.8 | 0.367 | 423.9 | 0.00087 | 0.00087 | |
| 115 | 114.0 | 115.0 | 1.0 | 114.5 | 130.1 | 0.370 | 650.5 | 0.00057 | 0.00057 | |
| 116 | 115.0 | 116.0 | 1.0 | 115.5 | 463.8 | 0.372 | 2318.9 | 0.00016 | 0.00016 | |
| 117 | 116.0 | 117.0 | 1.0 | 116.5 | 204.5 | 0.374 | 1022.4 | 0.00037 | 0.00037 | |
| 118 | 117.0 | 118.0 | 1.0 | 117.5 | 508.1 | 0.377 | 2540.5 | 0.00015 | 0.00015 | |
| 119 | 118.0 | 119.0 | 1.0 | 118.5 | 621.5 | 0.379 | 3107.7 | 0.00012 | 0.00012 | |
| 120 | 119.0 | 120.0 | 1.0 | 119.5 | 668.1 | 0.382 | 3340.6 | 0.00011 | 0.00011 | |
| $\Sigma$ = | | | | | | | | | 0.07423 | |

$I_{zr}$ $(1 < L/B < 10)$: $I_{zr} = I_{zs} + 0.111\,(I_{zc} - I_{zs})\,(L/B - 1)$

$I_{zs}$ $(L/B = 1)$:

For $z_{ave} = 0$ to $B/2$: $I_{zs} = 0.1 + (z_{ave}/B)(2I_{zp} - 0.2)$

For $z_{ave} = B/2$ to $2B$: $I_{zs} = 0.667\,I_{zp}\,(2 - z_{ave}/B)$

$I_{zc}$ $(L/B \geq 10)$:

For $z_{ave} = 0$ to $B$: $I_{zc} = 0.2 + (z_{ave}/B)(I_{zp} - 0.2)$

For $z_{ave} = B$ to $4B$: $I_{zc} = 0.333\,I_{zp}\,(4 - z_{ave}/B)$ ( Coduto p.228. )

| | | | | | |
|---|---|---|---|---|---|
| Footing width | B = | | 382.0 | ft | **Z-SDU6-C21** |
| Footing length | L = | | 382.0 | ft | |
| Ground elevation | | | 276.3 | ft | |
| Foundation elevation | | | 265.0 | ft | |
| Ground Water elevation | | | 220.0 | ft | |
| Excavated or embedded depth | D = | | 11.3 | ft | |
| Depth to Groundwater | | | 56.3 | ft | |
| Unit weight | $\gamma$ = | | 120.0 | pcf | |
| Gross Footing Load | | | 5.10 | ksf | |
| Net applied footing pressure | $\Delta p$ = | | **3.744** | ksf | |
| | L/B = | | 1.00 | - | |

Immediate Settlement (in.) ($S_0$ / 2)

| | Load | $S_0$ = |
|---|---|---|
| End of Operations | 5.10 | 1.6 |
| Tank Half Full | 2.80 | 0.4 |
| Pre Closure | 5.50 | 1.8 |
| Post Closure | 8.00 | 3.1 |

30 Year Settlement (in.) ($S_{30}$ / 2)

| Load | $S_0$ = |
|---|---|
| 5.10 | 2.4 |
| 8.00 | 4.7 |

**Computation**

| | | | | | |
|---|---|---|---|---|---|
| Settlement | $\rho_i$ = | $C_1 C_t \Delta p\, \Sigma(\Delta z_i I_{zi}/E_{si})$ | 0.263 | ft | |
| | $\rho_i$ = | $C_t$ = 1 | **3.159** | **in** | |
| | S(t) = | | 0.394 | ft | |
| | S(t) = | | **4.724** | **in** | |
| Correction for strain relief | $C_1$ = | $1 - 0.5(\sigma'_D/q')$ | 0.819 | - | |
| Effective vertical overburden pressure at D | $\sigma'_{vo}$ = | $\gamma$ D | 1.356 | ksf | |
| Correction for time dependent increase | $C_t$ = | 1 + 0.2 log( t / 0.1 ) | 1.50 | - | |
| | t = | | 30.00 | years | |
| Elastic modulus of soil layer i | $E_{si}$ = | 2.5 $q_c$ | see | Column H | if L/B = 1 |
| | $E_{si}$ = | 3.5 $q_c$ | see | Column H | If L/B $\geq$ 10 |
| Depth increment i | $\Delta z_i$ | | see | Column D | |
| Influence factor of soil layer i | $I_{zi}$ | Figure 3-4 | see | Column G | |
| Peak depth influence factor | $I_{zp}$ = | $0.5 + 0.1\,(\Delta p/\sigma'_{Izp})^{1/2}$ | 0.550 | - | |
| | $z_p$ = | 0.5B + D | 202.30 | ft | If L/B = 1 |
| | $z_p$ = | B + D | 393.30 | ft | If L/B $\geq$ 10 |
| | $z_p$ = | | 202.30 | ft | for L/B=1.00 |
| Effective overburden pressure at depth Izp | $\sigma'_{Izp}$ = | | 15.17 | ksf | |
| Elastic Modulus | $E_{si}$ = | | 2.50 | $q_c$ | If L/B = 1 |
| | $E_{si}$ = | | 3.50 | $q_c$ | If L/B $\geq$ 10 |
| | $E_{si}$ = | | 2.50 | $q_c$ | for L/B=1.00 |

Computations made relative to the bottom of foundation

| A | B | C | D | E | F | G | H | I | J | K |
|---|---|---|---|---|---|---|---|---|---|---|
| Layer No. | Layer top depth (ft) | Layer bottom depth (ft) | Layer thickness $\Delta z_i$ (ft) | Mid-layer depth $z_{ave}$ (ft) | Average tip stress $q_c$ (tsf) | $I_{zi}$ | Elastic modulus $E_{si}$ (ksf) | $\Delta z_i I_{zi}/E_{si}$ | $\Delta z_i I_{zi}/E_{si}$ | Notes |
| 1 | 0.0 | 1.0 | 1.0 | 0.5 | 85.2 | 0.101 | 426.2 | 0.00024 | 0.00024 | |
| 2 | 1.0 | 2.0 | 1.0 | 1.5 | 99.3 | 0.104 | 496.7 | 0.00021 | 0.00021 | |
| 3 | 2.0 | 3.0 | 1.0 | 2.5 | 125.9 | 0.106 | 629.7 | 0.00017 | 0.00017 | |
| 4 | 3.0 | 4.0 | 1.0 | 3.5 | 84.2 | 0.108 | 420.9 | 0.00026 | 0.00026 | |
| 5 | 4.0 | 5.0 | 1.0 | 4.5 | 64.0 | 0.111 | 320.1 | 0.00035 | 0.00035 | |
| 6 | 5.0 | 6.0 | 1.0 | 5.5 | 53.9 | 0.113 | 269.6 | 0.00042 | 0.00042 | |
| 7 | 6.0 | 7.0 | 1.0 | 6.5 | 53.2 | 0.115 | 266.1 | 0.00043 | 0.00043 | |
| 8 | 7.0 | 8.0 | 1.0 | 7.5 | 49.7 | 0.118 | 248.3 | 0.00047 | 0.00047 | |
| 9 | 8.0 | 9.0 | 1.0 | 8.5 | 47.6 | 0.120 | 237.8 | 0.00050 | 0.00050 | |
| 10 | 9.0 | 10.0 | 1.0 | 9.5 | 51.8 | 0.122 | 258.8 | 0.00047 | 0.00047 | |
| 11 | 10.0 | 11.0 | 1.0 | 10.5 | 62.1 | 0.125 | 310.5 | 0.00040 | 0.00040 | |
| 12 | 11.0 | 12.0 | 1.0 | 11.5 | 67.7 | 0.127 | 338.3 | 0.00038 | 0.00038 | |
| 13 | 12.0 | 13.0 | 1.0 | 12.5 | 97.0 | 0.129 | 485.1 | 0.00027 | 0.00027 | |
| 14 | 13.0 | 14.0 | 1.0 | 13.5 | 123.6 | 0.132 | 618.2 | 0.00021 | 0.00021 | |
| 15 | 14.0 | 15.0 | 1.0 | 14.5 | 123.5 | 0.134 | 617.4 | 0.00022 | 0.00022 | |
| 16 | 15.0 | 16.0 | 1.0 | 15.5 | 131.3 | 0.136 | 656.6 | 0.00021 | 0.00021 | |
| 17 | 16.0 | 17.0 | 1.0 | 16.5 | 173.5 | 0.139 | 867.6 | 0.00016 | 0.00016 | |
| 18 | 17.0 | 18.0 | 1.0 | 17.5 | 180.0 | 0.141 | 899.8 | 0.00016 | 0.00016 | |
| 19 | 18.0 | 19.0 | 1.0 | 18.5 | 219.8 | 0.144 | 1099.0 | 0.00013 | 0.00013 | |
| 20 | 19.0 | 20.0 | 1.0 | 19.5 | 240.6 | 0.146 | 1203.2 | 0.00012 | 0.00012 | |
| 21 | 20.0 | 21.0 | 1.0 | 20.5 | 274.5 | 0.148 | 1372.3 | 0.00011 | 0.00011 | |
| 22 | 21.0 | 22.0 | 1.0 | 21.5 | 321.9 | 0.151 | 1609.6 | 0.00009 | 0.00009 | |
| 23 | 22.0 | 23.0 | 1.0 | 22.5 | 338.5 | 0.153 | 1692.7 | 0.00009 | 0.00009 | |
| 24 | 23.0 | 24.0 | 1.0 | 23.5 | 339.1 | 0.155 | 1695.4 | 0.00009 | 0.00009 | |
| 25 | 24.0 | 25.0 | 1.0 | 24.5 | 309.3 | 0.158 | 1546.5 | 0.00010 | 0.00010 | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 26 | 25.0 | 26.0 | 1.0 | 25.5 | 303.3 | 0.160 | 1516.5 | 0.00011 | 0.00011 | |
| 27 | 26.0 | 27.0 | 1.0 | 26.5 | 324.0 | 0.162 | 1620.2 | 0.00010 | 0.00010 | |
| 28 | 27.0 | 28.0 | 1.0 | 27.5 | 306.3 | 0.165 | 1531.3 | 0.00011 | 0.00011 | |
| 29 | 28.0 | 29.0 | 1.0 | 28.5 | 289.3 | 0.167 | 1446.7 | 0.00012 | 0.00012 | |
| 30 | 29.0 | 30.0 | 1.0 | 29.5 | 258.9 | 0.169 | 1294.3 | 0.00013 | 0.00013 | |
| 31 | 30.0 | 31.0 | 1.0 | 30.5 | 149.6 | 0.172 | 748.0 | 0.00023 | 0.00023 | |
| 32 | 31.0 | 32.0 | 1.0 | 31.5 | 62.3 | 0.174 | 311.6 | 0.00056 | 0.00056 | |
| 33 | 32.0 | 33.0 | 1.0 | 32.5 | 34.9 | 0.177 | 174.5 | 0.00101 | 0.00101 | |
| 34 | 33.0 | 34.0 | 1.0 | 33.5 | 22.1 | 0.179 | 110.4 | 0.00162 | 0.00162 | |
| 35 | 34.0 | 35.0 | 1.0 | 34.5 | 10.0 | 0.181 | 49.9 | 0.00363 | 0.00363 | |
| 36 | 35.0 | 36.0 | 1.0 | 35.5 | 8.0 | 0.184 | 40.0 | 0.00458 | 0.00458 | |
| 37 | 36.0 | 37.0 | 1.0 | 36.5 | 7.1 | 0.186 | 35.3 | 0.00527 | 0.00527 | |
| 38 | 37.0 | 38.0 | 1.0 | 37.5 | 6.6 | 0.188 | 32.8 | 0.00573 | 0.00573 | |
| 39 | 38.0 | 39.0 | 1.0 | 38.5 | 45.4 | 0.191 | 226.9 | 0.00084 | 0.00084 | |
| 40 | 39.0 | 40.0 | 1.0 | 39.5 | 115.6 | 0.193 | 578.0 | 0.00033 | 0.00033 | |
| 41 | 40.0 | 41.0 | 1.0 | 40.5 | 216.2 | 0.195 | 1081.0 | 0.00018 | 0.00018 | |
| 42 | 41.0 | 42.0 | 1.0 | 41.5 | 313.5 | 0.198 | 1567.5 | 0.00013 | 0.00013 | |
| 43 | 42.0 | 43.0 | 1.0 | 42.5 | 331.6 | 0.200 | 1658.2 | 0.00012 | 0.00012 | |
| 44 | 43.0 | 44.0 | 1.0 | 43.5 | 254.1 | 0.202 | 1270.6 | 0.00016 | 0.00016 | |
| 45 | 44.0 | 45.0 | 1.0 | 44.5 | 304.9 | 0.205 | 1524.5 | 0.00013 | 0.00013 | |
| 46 | 45.0 | 46.0 | 1.0 | 45.5 | 272.2 | 0.207 | 1361.0 | 0.00015 | 0.00015 | |
| 47 | 46.0 | 47.0 | 1.0 | 46.5 | 187.1 | 0.209 | 935.7 | 0.00022 | 0.00022 | |
| 48 | 47.0 | 48.0 | 1.0 | 47.5 | 182.1 | 0.212 | 910.7 | 0.00023 | 0.00023 | |
| 49 | 48.0 | 49.0 | 1.0 | 48.5 | 230.8 | 0.214 | 1154.2 | 0.00019 | 0.00019 | |
| 50 | 49.0 | 50.0 | 1.0 | 49.5 | 182.7 | 0.217 | 913.3 | 0.00024 | 0.00024 | |
| 51 | 50.0 | 51.0 | 1.0 | 50.5 | 156.4 | 0.219 | 782.1 | 0.00028 | 0.00028 | |
| 52 | 51.0 | 52.0 | 1.0 | 51.5 | 145.3 | 0.221 | 726.6 | 0.00030 | 0.00030 | |
| 53 | 52.0 | 53.0 | 1.0 | 52.5 | 239.9 | 0.224 | 1199.3 | 0.00019 | 0.00019 | |
| 54 | 53.0 | 54.0 | 1.0 | 53.5 | 325.1 | 0.226 | 1625.3 | 0.00014 | 0.00014 | |
| 55 | 54.0 | 55.0 | 1.0 | 54.5 | 329.7 | 0.228 | 1648.7 | 0.00014 | 0.00014 | |
| 56 | 55.0 | 56.0 | 1.0 | 55.5 | 308.0 | 0.231 | 1540.2 | 0.00015 | 0.00015 | |
| 57 | 56.0 | 57.0 | 1.0 | 56.5 | 309.6 | 0.233 | 1547.8 | 0.00015 | 0.00015 | |
| 58 | 57.0 | 58.0 | 1.0 | 57.5 | 300.3 | 0.235 | 1501.6 | 0.00016 | 0.00016 | |
| 59 | 58.0 | 59.0 | 1.0 | 58.5 | 253.6 | 0.238 | 1268.1 | 0.00019 | 0.00019 | |
| 60 | 59.0 | 60.0 | 1.0 | 59.5 | 103.4 | 0.240 | 517.2 | 0.00046 | 0.00046 | |
| 61 | 60.0 | 61.0 | 1.0 | 60.5 | 123.2 | 0.242 | 615.8 | 0.00039 | 0.00039 | |
| 62 | 61.0 | 62.0 | 1.0 | 61.5 | 133.8 | 0.245 | 668.8 | 0.00037 | 0.00037 | |
| 63 | 62.0 | 63.0 | 1.0 | 62.5 | 24.6 | 0.247 | 123.0 | 0.00201 | 0.00201 | |
| 64 | 63.0 | 64.0 | 1.0 | 63.5 | 25.0 | 0.250 | 125.1 | 0.00199 | 0.00199 | |
| 65 | 64.0 | 65.0 | 1.0 | 64.5 | 93.5 | 0.252 | 467.6 | 0.00054 | 0.00054 | |
| 66 | 65.0 | 66.0 | 1.0 | 65.5 | 180.3 | 0.254 | 901.5 | 0.00028 | 0.00028 | |
| 67 | 66.0 | 67.0 | 1.0 | 66.5 | 213.1 | 0.257 | 1065.4 | 0.00024 | 0.00024 | |
| 68 | 67.0 | 68.0 | 1.0 | 67.5 | 249.6 | 0.259 | 1247.8 | 0.00021 | 0.00021 | |
| 69 | 68.0 | 69.0 | 1.0 | 68.5 | 294.5 | 0.261 | 1472.4 | 0.00018 | 0.00018 | |
| 70 | 69.0 | 70.0 | 1.0 | 69.5 | 314.9 | 0.264 | 1574.7 | 0.00017 | 0.00017 | |
| 71 | 70.0 | 71.0 | 1.0 | 70.5 | 333.9 | 0.266 | 1669.4 | 0.00016 | 0.00016 | |
| 72 | 71.0 | 72.0 | 1.0 | 71.5 | 169.9 | 0.268 | 849.6 | 0.00032 | 0.00032 | |
| 73 | 72.0 | 73.0 | 1.0 | 72.5 | 86.2 | 0.271 | 430.8 | 0.00063 | 0.00063 | |
| 74 | 73.0 | 74.0 | 1.0 | 73.5 | 46.4 | 0.273 | 232.2 | 0.00118 | 0.00118 | |
| 75 | 74.0 | 75.0 | 1.0 | 74.5 | 48.1 | 0.275 | 240.6 | 0.00114 | 0.00114 | |
| 76 | 75.0 | 76.0 | 1.0 | 75.5 | 60.8 | 0.278 | 304.1 | 0.00091 | 0.00091 | |
| 77 | 76.0 | 77.0 | 1.0 | 76.5 | 45.9 | 0.280 | 229.6 | 0.00122 | 0.00122 | |
| 78 | 77.0 | 78.0 | 1.0 | 77.5 | 43.4 | 0.282 | 217.1 | 0.00130 | 0.00130 | |
| 79 | 78.0 | 79.0 | 1.0 | 78.5 | 49.7 | 0.285 | 248.7 | 0.00115 | 0.00115 | |
| 80 | 79.0 | 80.0 | 1.0 | 79.5 | 52.5 | 0.287 | 262.6 | 0.00109 | 0.00109 | |
| 81 | 80.0 | 81.0 | 1.0 | 80.5 | 47.4 | 0.290 | 236.8 | 0.00122 | 0.00122 | |
| 82 | 81.0 | 82.0 | 1.0 | 81.5 | 62.5 | 0.292 | 312.3 | 0.00093 | 0.00093 | |
| 83 | 82.0 | 83.0 | 1.0 | 82.5 | 174.4 | 0.294 | 871.8 | 0.00034 | 0.00034 | |
| 84 | 83.0 | 84.0 | 1.0 | 83.5 | 176.7 | 0.297 | 883.3 | 0.00034 | 0.00034 | |
| 85 | 84.0 | 85.0 | 1.0 | 84.5 | 155.2 | 0.299 | 776.0 | 0.00039 | 0.00039 | |
| 86 | 85.0 | 86.0 | 1.0 | 85.5 | 152.1 | 0.301 | 760.4 | 0.00040 | 0.00040 | |
| 87 | 86.0 | 87.0 | 1.0 | 86.5 | 232.8 | 0.304 | 1163.9 | 0.00026 | 0.00026 | |
| 88 | 87.0 | 88.0 | 1.0 | 87.5 | 241.6 | 0.306 | 1207.8 | 0.00025 | 0.00025 | |
| 89 | 88.0 | 89.0 | 1.0 | 88.5 | 70.1 | 0.308 | 350.3 | 0.00088 | 0.00088 | |
| 90 | 89.0 | 90.0 | 1.0 | 89.5 | 46.9 | 0.311 | 234.5 | 0.00133 | 0.00133 | |
| 91 | 90.0 | 91.0 | 1.0 | 90.5 | 68.3 | 0.313 | 341.5 | 0.00092 | 0.00092 | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 92 | 91.0 | 92.0 | 1.0 | 91.5 | 59.0 | 0.315 | 295.0 | 0.00107 | 0.00107 | |
| 93 | 92.0 | 93.0 | 1.0 | 92.5 | 29.0 | 0.318 | 145.0 | 0.00219 | 0.00219 | |
| 94 | 93.0 | 94.0 | 1.0 | 93.5 | 98.9 | 0.320 | 494.6 | 0.00065 | 0.00065 | |
| 95 | 94.0 | 95.0 | 1.0 | 94.5 | 75.5 | 0.322 | 377.5 | 0.00085 | 0.00085 | |
| 96 | 95.0 | 96.0 | 1.0 | 95.5 | 47.9 | 0.325 | 239.6 | 0.00136 | 0.00136 | |
| 97 | 96.0 | 97.0 | 1.0 | 96.5 | 66.9 | 0.327 | 334.4 | 0.00098 | 0.00098 | |
| 98 | 97.0 | 98.0 | 1.0 | 97.5 | 67.7 | 0.330 | 338.6 | 0.00097 | 0.00097 | |
| 99 | 98.0 | 99.0 | 1.0 | 98.5 | 42.4 | 0.332 | 212.0 | 0.00157 | 0.00157 | |
| 100 | 99.0 | 100.0 | 1.0 | 99.5 | 60.1 | 0.334 | 300.6 | 0.00111 | 0.00111 | |
| 101 | 100.0 | 101.0 | 1.0 | 100.5 | 34.8 | 0.337 | 174.0 | 0.00193 | 0.00193 | |
| 102 | 101.0 | 102.0 | 1.0 | 101.5 | 57.6 | 0.339 | 288.0 | 0.00118 | 0.00118 | |
| 103 | 102.0 | 103.0 | 1.0 | 102.5 | 158.4 | 0.341 | 791.8 | 0.00043 | 0.00043 | |
| 104 | 103.0 | 104.0 | 1.0 | 103.5 | 75.8 | 0.344 | 379.0 | 0.00091 | 0.00091 | |
| 105 | 104.0 | 105.0 | 1.0 | 104.5 | 45.6 | 0.346 | 227.9 | 0.00152 | 0.00152 | |
| 106 | 105.0 | 106.0 | 1.0 | 105.5 | 85.1 | 0.348 | 425.7 | 0.00082 | 0.00082 | |
| 107 | 106.0 | 107.0 | 1.0 | 106.5 | 84.1 | 0.351 | 420.7 | 0.00083 | 0.00083 | |
| 108 | 107.0 | 108.0 | 1.0 | 107.5 | 83.5 | 0.353 | 417.6 | 0.00085 | 0.00085 | |
| 109 | 108.0 | 109.0 | 1.0 | 108.5 | 82.4 | 0.355 | 412.2 | 0.00086 | 0.00086 | |
| 110 | 109.0 | 110.0 | 1.0 | 109.5 | 75.7 | 0.358 | 378.3 | 0.00095 | 0.00095 | |
| 111 | 110.0 | 111.0 | 1.0 | 110.5 | 64.6 | 0.360 | 323.2 | 0.00111 | 0.00111 | |
| 112 | 111.0 | 112.0 | 1.0 | 111.5 | 69.5 | 0.363 | 347.7 | 0.00104 | 0.00104 | |
| 113 | 112.0 | 113.0 | 1.0 | 112.5 | 66.5 | 0.365 | 332.7 | 0.00110 | 0.00110 | |
| 114 | 113.0 | 114.0 | 1.0 | 113.5 | 60.3 | 0.367 | 301.4 | 0.00122 | 0.00122 | |
| 115 | 114.0 | 115.0 | 1.0 | 114.5 | 57.3 | 0.370 | 286.3 | 0.00129 | 0.00129 | |
| 116 | 115.0 | 116.0 | 1.0 | 115.5 | 60.9 | 0.372 | 304.5 | 0.00122 | 0.00122 | |
| 117 | 116.0 | 117.0 | 1.0 | 116.5 | 319.4 | 0.374 | 1597.1 | 0.00023 | 0.00023 | |
| 118 | 117.0 | 118.0 | 1.0 | 117.5 | 574.7 | 0.377 | 2873.7 | 0.00013 | 0.00013 | |
| 119 | 118.0 | 119.0 | 1.0 | 118.5 | 621.5 | 0.379 | 3107.7 | 0.00012 | 0.00012 | |
| 120 | 119.0 | 120.0 | 1.0 | 119.5 | 668.1 | 0.381 | 3340.6 | 0.00011 | 0.00011 | |
| $\Sigma$ = | | | | | | | | | 0.08587 | |

| | |
|---|---|
| $I_{zr}$ $(1 < L/B < 10)$: | $I_{zr} = I_{zs} + 0.111\,(I_{zc} - I_{zs})\,(L/B - 1)$ |
| $I_{zs}$ $(L/B = 1)$: | |
| For $z_{ave} = 0$ to $B/2$: | $I_{zs} = 0.1 + (z_{ave}/B)(2I_{zp} - 0.2)$ |
| For $z_{ave} = B/2$ to $2B$: | $I_{zs} = 0.667\,I_{zp}\,(2 - z_{ave}/B)$ |
| $I_{zc}$ $(L/B \geq 10)$: | |
| For $z_{ave} = 0$ to $B$: | $I_{zc} = 0.2 + (z_{ave}/B)(I_{zp} - 0.2)$ |
| For $z_{ave} = B$ to $4B$: | $I_{zc} = 0.333\,I_{zp}\,(4 - z_{ave}/B)$ ( Coduto p.228. ) |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Footing width | B = | | 382.0 | ft | Z-SDU6-C22 | | | |
| Footing length | L = | | 382.0 | ft | | Immediate | | |
| Ground elevation | | | 276.5 | ft | | Settlement (in.) | | |
| Foundation elevation | | | 265.0 | ft | | $(S_0 / 2)$ | | |
| Ground Water elevation | | | 220.0 | ft | | Load | $S_0$ = | |
| Excavated or embedded depth | D = | | 11.5 | ft | End of Operations | 5.10 | 1.9 | |
| Depth to Groundwater | | | 56.5 | ft | Tank Half Full | 2.80 | 0.4 | |
| Unit weight | $\gamma$ = | | 120.0 | pcf | Pre Closure | 5.50 | 2.1 | |
| Gross Footing Load | | | 5.10 | ksf | Post Closure | 8.00 | 3.7 | |
| Net applied footing pressure | $\Delta p$ = | | **3.720** | ksf | | | | |
| | L/B = | | 1.00 | - | | | | |
| | | | | | | 30 Year | | |
| **Computation** | | | | | | Settlement (in.) | | |
| Settlement | $\rho_i$ = | $C_1 C_t \Delta p \Sigma(\Delta z_i I_{zi}/E_{si})$ | 0.312 | ft | | $(S_{30} / 2)$ | | |
| | $\rho_i$ = | $C_t = 1$ | **3.746** | **in** | | Load | $S_0$ = | |
| | S(t) = | | 0.467 | ft | | 5.10 | 2.8 | |
| | S(t) = | | **5.602** | **in** | | 8.00 | 5.6 | |
| Correction for strain relief | $C_1$ = | $1 - 0.5(\sigma'_D/q')$ | 0.815 | - | | | | |
| Effective vertical overburden pressure at D | $\sigma'_{vo}$ = | $\gamma$ D | 1.380 | ksf | | | | |
| Correction for time dependent increase | $C_t$ = | 1 + 0.2 log( t / 0.1 ) | 1.50 | - | | | | |
| | t = | | 30.00 | years | | | | |
| Elastic modulus of soil layer i | $E_{si}$ = | 2.5 $q_c$ | see | Column H | if L/B = 1 | | | |
| | $E_{si}$ = | 3.5 $q_c$ | see | Column H | If L/B $\geq$ 10 | | | |
| Depth increment i | $\Delta z_i$ | | see | Column D | | | | |
| Influence factor of soil layer i | $I_{zi}$ | Figure 3-4 | see | Column G | | | | |
| Peak depth influence factor | $I_{zp}$ = | $0.5 + 0.1 (\Delta p/\sigma'_{Izp})^{1/2}$ | 0.549 | - | | | | |
| | $z_p$ = | 0.5B + D | 202.50 | ft | If L/B = 1 | | | |
| | $z_p$ = | B + D | 393.50 | ft | If L/B $\geq$ 10 | | | |
| | $z_p$ = | | 202.50 | ft | for L/B=1.00 | | | |
| Effective overburden pressure at depth Izp | $\sigma'_{Izp}$ = | | 15.19 | ksf | | | | |
| Elastic Modulus | $E_{si}$ = | | 2.50 | $q_c$ | If L/B = 1 | | | |
| | $E_{si}$ = | | 3.50 | $q_c$ | If L/B $\geq$ 10 | | | |
| | $E_{si}$ = | | 2.50 | $q_c$ | for L/B=1.00 | | | |

Computations made relative to the bottom of foundation

| A | B | C | D | E | F | G | H | I | J | K |
|---|---|---|---|---|---|---|---|---|---|---|
| Layer No. | Layer top depth (ft) | Layer bottom depth (ft) | Layer thickness $\Delta z_i$ (ft) | Mid-layer depth $z_{ave}$ (ft) | Average tip stress $q_c$ (tsf) | $I_{zi}$ | Elastic modulus $E_{si}$ (ksf) | $\Delta z_i I_{zi}/E_{si}$ | $\Delta z_i I_{zi}/E_{si}$ | Notes |
| 1 | 0.0 | 1.0 | 1.0 | 0.5 | 177.5 | 0.101 | 887.3 | 0.00011 | 0.00011 | |
| 2 | 1.0 | 2.0 | 1.0 | 1.5 | 118.7 | 0.104 | 593.5 | 0.00017 | 0.00017 | |
| 3 | 2.0 | 3.0 | 1.0 | 2.5 | 65.4 | 0.106 | 326.9 | 0.00032 | 0.00032 | |
| 4 | 3.0 | 4.0 | 1.0 | 3.5 | 73.1 | 0.108 | 365.3 | 0.00030 | 0.00030 | |
| 5 | 4.0 | 5.0 | 1.0 | 4.5 | 69.0 | 0.111 | 345.0 | 0.00032 | 0.00032 | |
| 6 | 5.0 | 6.0 | 1.0 | 5.5 | 89.7 | 0.113 | 448.3 | 0.00025 | 0.00025 | |
| 7 | 6.0 | 7.0 | 1.0 | 6.5 | 89.8 | 0.115 | 448.9 | 0.00026 | 0.00026 | |
| 8 | 7.0 | 8.0 | 1.0 | 7.5 | 60.2 | 0.118 | 301.1 | 0.00039 | 0.00039 | |
| 9 | 8.0 | 9.0 | 1.0 | 8.5 | 55.2 | 0.120 | 276.0 | 0.00043 | 0.00043 | |
| 10 | 9.0 | 10.0 | 1.0 | 9.5 | 59.7 | 0.122 | 298.6 | 0.00041 | 0.00041 | |
| 11 | 10.0 | 11.0 | 1.0 | 10.5 | 66.5 | 0.125 | 332.4 | 0.00038 | 0.00038 | |
| 12 | 11.0 | 12.0 | 1.0 | 11.5 | 165.2 | 0.127 | 825.9 | 0.00015 | 0.00015 | |
| 13 | 12.0 | 13.0 | 1.0 | 12.5 | 153.8 | 0.129 | 769.0 | 0.00017 | 0.00017 | |
| 14 | 13.0 | 14.0 | 1.0 | 13.5 | 154.3 | 0.132 | 771.6 | 0.00017 | 0.00017 | |
| 15 | 14.0 | 15.0 | 1.0 | 14.5 | 177.9 | 0.134 | 889.6 | 0.00015 | 0.00015 | |
| 16 | 15.0 | 16.0 | 1.0 | 15.5 | 205.7 | 0.136 | 1028.5 | 0.00013 | 0.00013 | |
| 17 | 16.0 | 17.0 | 1.0 | 16.5 | 256.3 | 0.139 | 1281.6 | 0.00011 | 0.00011 | |
| 18 | 17.0 | 18.0 | 1.0 | 17.5 | 290.7 | 0.141 | 1453.6 | 0.00010 | 0.00010 | |
| 19 | 18.0 | 19.0 | 1.0 | 18.5 | 343.6 | 0.144 | 1717.8 | 0.00008 | 0.00008 | |
| 20 | 19.0 | 20.0 | 1.0 | 19.5 | 374.9 | 0.146 | 1874.5 | 0.00008 | 0.00008 | |
| 21 | 20.0 | 21.0 | 1.0 | 20.5 | 329.4 | 0.148 | 1647.1 | 0.00009 | 0.00009 | |
| 22 | 21.0 | 22.0 | 1.0 | 21.5 | 206.7 | 0.151 | 1033.6 | 0.00015 | 0.00015 | |
| 23 | 22.0 | 23.0 | 1.0 | 22.5 | 212.7 | 0.153 | 1063.4 | 0.00014 | 0.00014 | |
| 24 | 23.0 | 24.0 | 1.0 | 23.5 | 231.4 | 0.155 | 1157.1 | 0.00013 | 0.00013 | |
| 25 | 24.0 | 25.0 | 1.0 | 24.5 | 261.0 | 0.158 | 1305.0 | 0.00012 | 0.00012 | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 26 | 25.0 | 26.0 | 1.0 | 25.5 | 233.3 | 0.160 | 1166.4 | 0.00014 | 0.00014 | |
| 27 | 26.0 | 27.0 | 1.0 | 26.5 | 136.3 | 0.162 | 681.6 | 0.00024 | 0.00024 | |
| 28 | 27.0 | 28.0 | 1.0 | 27.5 | 79.8 | 0.165 | 399.0 | 0.00041 | 0.00041 | |
| 29 | 28.0 | 29.0 | 1.0 | 28.5 | 88.1 | 0.167 | 440.5 | 0.00038 | 0.00038 | |
| 30 | 29.0 | 30.0 | 1.0 | 29.5 | 53.9 | 0.169 | 269.4 | 0.00063 | 0.00063 | |
| 31 | 30.0 | 31.0 | 1.0 | 30.5 | 40.7 | 0.172 | 203.6 | 0.00084 | 0.00084 | |
| 32 | 31.0 | 32.0 | 1.0 | 31.5 | 19.8 | 0.174 | 98.8 | 0.00176 | 0.00176 | |
| 33 | 32.0 | 33.0 | 1.0 | 32.5 | 16.7 | 0.176 | 83.4 | 0.00212 | 0.00212 | |
| 34 | 33.0 | 34.0 | 1.0 | 33.5 | 66.8 | 0.179 | 333.8 | 0.00054 | 0.00054 | |
| 35 | 34.0 | 35.0 | 1.0 | 34.5 | 166.4 | 0.181 | 831.9 | 0.00022 | 0.00022 | |
| 36 | 35.0 | 36.0 | 1.0 | 35.5 | 166.5 | 0.184 | 832.5 | 0.00022 | 0.00022 | |
| 37 | 36.0 | 37.0 | 1.0 | 36.5 | 167.9 | 0.186 | 839.3 | 0.00022 | 0.00022 | |
| 38 | 37.0 | 38.0 | 1.0 | 37.5 | 150.9 | 0.188 | 754.3 | 0.00025 | 0.00025 | |
| 39 | 38.0 | 39.0 | 1.0 | 38.5 | 135.6 | 0.191 | 678.1 | 0.00028 | 0.00028 | |
| 40 | 39.0 | 40.0 | 1.0 | 39.5 | 109.1 | 0.193 | 545.3 | 0.00035 | 0.00035 | |
| 41 | 40.0 | 41.0 | 1.0 | 40.5 | 114.1 | 0.195 | 570.5 | 0.00034 | 0.00034 | |
| 42 | 41.0 | 42.0 | 1.0 | 41.5 | 103.5 | 0.198 | 517.5 | 0.00038 | 0.00038 | |
| 43 | 42.0 | 43.0 | 1.0 | 42.5 | 88.5 | 0.200 | 442.7 | 0.00045 | 0.00045 | |
| 44 | 43.0 | 44.0 | 1.0 | 43.5 | 60.5 | 0.202 | 302.6 | 0.00067 | 0.00067 | |
| 45 | 44.0 | 45.0 | 1.0 | 44.5 | 81.1 | 0.205 | 405.7 | 0.00050 | 0.00050 | |
| 46 | 45.0 | 46.0 | 1.0 | 45.5 | 165.2 | 0.207 | 826.2 | 0.00025 | 0.00025 | |
| 47 | 46.0 | 47.0 | 1.0 | 46.5 | 44.9 | 0.209 | 224.4 | 0.00093 | 0.00093 | |
| 48 | 47.0 | 48.0 | 1.0 | 47.5 | 135.0 | 0.212 | 674.8 | 0.00031 | 0.00031 | |
| 49 | 48.0 | 49.0 | 1.0 | 48.5 | 191.6 | 0.214 | 958.2 | 0.00022 | 0.00022 | |
| 50 | 49.0 | 50.0 | 1.0 | 49.5 | 184.5 | 0.216 | 922.5 | 0.00023 | 0.00023 | |
| 51 | 50.0 | 51.0 | 1.0 | 50.5 | 175.2 | 0.219 | 875.8 | 0.00025 | 0.00025 | |
| 52 | 51.0 | 52.0 | 1.0 | 51.5 | 149.2 | 0.221 | 745.8 | 0.00030 | 0.00030 | |
| 53 | 52.0 | 53.0 | 1.0 | 52.5 | 123.5 | 0.224 | 617.3 | 0.00036 | 0.00036 | |
| 54 | 53.0 | 54.0 | 1.0 | 53.5 | 57.9 | 0.226 | 289.3 | 0.00078 | 0.00078 | |
| 55 | 54.0 | 55.0 | 1.0 | 54.5 | 12.0 | 0.228 | 59.9 | 0.00381 | 0.00381 | |
| 56 | 55.0 | 56.0 | 1.0 | 55.5 | 7.7 | 0.231 | 38.7 | 0.00597 | 0.00597 | |
| 57 | 56.0 | 57.0 | 1.0 | 56.5 | 6.3 | 0.233 | 31.4 | 0.00741 | 0.00741 | |
| 58 | 57.0 | 58.0 | 1.0 | 57.5 | 5.8 | 0.235 | 28.9 | 0.00814 | 0.00814 | |
| 59 | 58.0 | 59.0 | 1.0 | 58.5 | 5.5 | 0.238 | 27.5 | 0.00863 | 0.00863 | |
| 60 | 59.0 | 60.0 | 1.0 | 59.5 | 66.2 | 0.240 | 331.1 | 0.00072 | 0.00072 | |
| 61 | 60.0 | 61.0 | 1.0 | 60.5 | 207.2 | 0.242 | 1036.2 | 0.00023 | 0.00023 | |
| 62 | 61.0 | 62.0 | 1.0 | 61.5 | 206.4 | 0.245 | 1032.2 | 0.00024 | 0.00024 | |
| 63 | 62.0 | 63.0 | 1.0 | 62.5 | 190.7 | 0.247 | 953.6 | 0.00026 | 0.00026 | |
| 64 | 63.0 | 64.0 | 1.0 | 63.5 | 199.4 | 0.249 | 996.9 | 0.00025 | 0.00025 | |
| 65 | 64.0 | 65.0 | 1.0 | 64.5 | 224.3 | 0.252 | 1121.3 | 0.00022 | 0.00022 | |
| 66 | 65.0 | 66.0 | 1.0 | 65.5 | 247.2 | 0.254 | 1236.1 | 0.00021 | 0.00021 | |
| 67 | 66.0 | 67.0 | 1.0 | 66.5 | 272.4 | 0.256 | 1362.1 | 0.00019 | 0.00019 | |
| 68 | 67.0 | 68.0 | 1.0 | 67.5 | 286.4 | 0.259 | 1431.8 | 0.00018 | 0.00018 | |
| 69 | 68.0 | 69.0 | 1.0 | 68.5 | 104.9 | 0.261 | 524.6 | 0.00050 | 0.00050 | |
| 70 | 69.0 | 70.0 | 1.0 | 69.5 | 16.5 | 0.264 | 82.4 | 0.00320 | 0.00320 | |
| 71 | 70.0 | 71.0 | 1.0 | 70.5 | 32.3 | 0.266 | 161.6 | 0.00165 | 0.00165 | |
| 72 | 71.0 | 72.0 | 1.0 | 71.5 | 31.2 | 0.268 | 155.9 | 0.00172 | 0.00172 | |
| 73 | 72.0 | 73.0 | 1.0 | 72.5 | 31.1 | 0.271 | 155.4 | 0.00174 | 0.00174 | |
| 74 | 73.0 | 74.0 | 1.0 | 73.5 | 20.5 | 0.273 | 102.7 | 0.00266 | 0.00266 | |
| 75 | 74.0 | 75.0 | 1.0 | 74.5 | 25.5 | 0.275 | 127.5 | 0.00216 | 0.00216 | |
| 76 | 75.0 | 76.0 | 1.0 | 75.5 | 28.0 | 0.278 | 139.9 | 0.00199 | 0.00199 | |
| 77 | 76.0 | 77.0 | 1.0 | 76.5 | 44.2 | 0.280 | 221.2 | 0.00127 | 0.00127 | |
| 78 | 77.0 | 78.0 | 1.0 | 77.5 | 121.0 | 0.282 | 605.1 | 0.00047 | 0.00047 | |
| 79 | 78.0 | 79.0 | 1.0 | 78.5 | 541.1 | 0.285 | 2705.3 | 0.00011 | 0.00011 | |
| 80 | 79.0 | 80.0 | 1.0 | 79.5 | 525.8 | 0.287 | 2629.1 | 0.00011 | 0.00011 | |
| 81 | 80.0 | 81.0 | 1.0 | 80.5 | 95.0 | 0.289 | 474.8 | 0.00061 | 0.00061 | |
| 82 | 81.0 | 82.0 | 1.0 | 81.5 | 33.5 | 0.292 | 167.3 | 0.00174 | 0.00174 | |
| 83 | 82.0 | 83.0 | 1.0 | 82.5 | 35.3 | 0.294 | 176.7 | 0.00166 | 0.00166 | |
| 84 | 83.0 | 84.0 | 1.0 | 83.5 | 39.5 | 0.297 | 197.4 | 0.00150 | 0.00150 | |
| 85 | 84.0 | 85.0 | 1.0 | 84.5 | 43.7 | 0.299 | 218.7 | 0.00137 | 0.00137 | |
| 86 | 85.0 | 86.0 | 1.0 | 85.5 | 47.7 | 0.301 | 238.4 | 0.00126 | 0.00126 | |
| 87 | 86.0 | 87.0 | 1.0 | 86.5 | 48.8 | 0.304 | 244.0 | 0.00124 | 0.00124 | |
| 88 | 87.0 | 88.0 | 1.0 | 87.5 | 72.0 | 0.306 | 360.2 | 0.00085 | 0.00085 | |
| 89 | 88.0 | 89.0 | 1.0 | 88.5 | 67.0 | 0.308 | 334.9 | 0.00092 | 0.00092 | |
| 90 | 89.0 | 90.0 | 1.0 | 89.5 | 103.5 | 0.311 | 517.3 | 0.00060 | 0.00060 | |
| 91 | 90.0 | 91.0 | 1.0 | 90.5 | 163.0 | 0.313 | 815.1 | 0.00038 | 0.00038 | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 92 | 91.0 | 92.0 | 1.0 | 91.5 | 191.7 | 0.315 | 958.3 | 0.00033 | 0.00033 | |
| 93 | 92.0 | 93.0 | 1.0 | 92.5 | 187.9 | 0.318 | 939.4 | 0.00034 | 0.00034 | |
| 94 | 93.0 | 94.0 | 1.0 | 93.5 | 241.3 | 0.320 | 1206.7 | 0.00027 | 0.00027 | |
| 95 | 94.0 | 95.0 | 1.0 | 94.5 | 216.0 | 0.322 | 1079.8 | 0.00030 | 0.00030 | |
| 96 | 95.0 | 96.0 | 1.0 | 95.5 | 208.9 | 0.325 | 1044.3 | 0.00031 | 0.00031 | |
| 97 | 96.0 | 97.0 | 1.0 | 96.5 | 163.8 | 0.327 | 819.1 | 0.00040 | 0.00040 | |
| 98 | 97.0 | 98.0 | 1.0 | 97.5 | 132.9 | 0.329 | 664.6 | 0.00050 | 0.00050 | |
| 99 | 98.0 | 99.0 | 1.0 | 98.5 | 113.1 | 0.332 | 565.6 | 0.00059 | 0.00059 | |
| 100 | 99.0 | 100.0 | 1.0 | 99.5 | 176.2 | 0.334 | 881.1 | 0.00038 | 0.00038 | |
| 101 | 100.0 | 101.0 | 1.0 | 100.5 | 290.7 | 0.337 | 1453.4 | 0.00023 | 0.00023 | |
| 102 | 101.0 | 102.0 | 1.0 | 101.5 | 518.2 | 0.339 | 2590.9 | 0.00013 | 0.00013 | |
| 103 | 102.0 | 103.0 | 1.0 | 102.5 | 293.1 | 0.341 | 1465.6 | 0.00023 | 0.00023 | |
| 104 | 103.0 | 104.0 | 1.0 | 103.5 | 217.4 | 0.344 | 1087.0 | 0.00032 | 0.00032 | |
| 105 | 104.0 | 105.0 | 1.0 | 104.5 | 92.0 | 0.346 | 460.0 | 0.00075 | 0.00075 | |
| 106 | 105.0 | 106.0 | 1.0 | 105.5 | 98.2 | 0.348 | 490.9 | 0.00071 | 0.00071 | |
| 107 | 106.0 | 107.0 | 1.0 | 106.5 | 107.1 | 0.351 | 535.6 | 0.00065 | 0.00065 | |
| 108 | 107.0 | 108.0 | 1.0 | 107.5 | 107.7 | 0.353 | 538.7 | 0.00066 | 0.00066 | |
| 109 | 108.0 | 109.0 | 1.0 | 108.5 | 104.9 | 0.355 | 524.4 | 0.00068 | 0.00068 | |
| 110 | 109.0 | 110.0 | 1.0 | 109.5 | 89.7 | 0.358 | 448.6 | 0.00080 | 0.00080 | |
| 111 | 110.0 | 111.0 | 1.0 | 110.5 | 65.6 | 0.360 | 328.0 | 0.00110 | 0.00110 | |
| 112 | 111.0 | 112.0 | 1.0 | 111.5 | 63.2 | 0.362 | 316.1 | 0.00115 | 0.00115 | |
| 113 | 112.0 | 113.0 | 1.0 | 112.5 | 66.4 | 0.365 | 332.0 | 0.00110 | 0.00110 | |
| 114 | 113.0 | 114.0 | 1.0 | 113.5 | 65.5 | 0.367 | 327.6 | 0.00112 | 0.00112 | |
| 115 | 114.0 | 115.0 | 1.0 | 114.5 | 53.0 | 0.369 | 265.1 | 0.00139 | 0.00139 | |
| 116 | 115.0 | 116.0 | 1.0 | 115.5 | 50.4 | 0.372 | 252.0 | 0.00148 | 0.00148 | |
| 117 | 116.0 | 117.0 | 1.0 | 116.5 | 89.5 | 0.374 | 447.7 | 0.00084 | 0.00084 | |
| 118 | 117.0 | 118.0 | 1.0 | 117.5 | 441.5 | 0.377 | 2207.3 | 0.00017 | 0.00017 | |
| 119 | 118.0 | 119.0 | 1.0 | 118.5 | 621.5 | 0.379 | 3107.7 | 0.00012 | 0.00012 | |
| 120 | 119.0 | 120.0 | 1.0 | 119.5 | 668.1 | 0.381 | 3340.6 | 0.00011 | 0.00011 | |
| $\Sigma$ = | | | | | | | | | 0.10302 | |

$I_{zr}$ *(1 < L/B < 10):* $I_{zr} = I_{zs} + 0.111\,(I_{zc} - I_{zs})\,(L/B - 1)$

$I_{zs}$ *(L/B = 1):*

*For* $z_{ave}$ *= 0 to B/2:* $I_{zs} = 0.1 + (z_{ave}/B)(2I_{zp} - 0.2)$

*For* $z_{ave}$ *= B/2 to 2B:* $I_{zs} = 0.667\,I_{zp}\,(2 - z_{ave}/B)$

$I_{zc}$ *(L/B* $\geq$ *10):*

*For* $z_{ave}$ *= 0 to B:* $I_{zc} = 0.2 + (z_{ave}/B)(I_{zp} - 0.2)$

*For* $z_{ave}$ *= B to 4B:* $I_{zc} = 0.333\,I_{zp}\,(4 - z_{ave}/B)$ ( Coduto p.228. )

| | | | | |
|---|---|---|---|---|
| Footing width | B = | | 382.0 | ft |
| Footing length | L = | | 382.0 | ft |
| Ground elevation | | | 275.5 | ft |
| Foundation elevation | | | 265.0 | ft |
| Ground Water elevation | | | 220.0 | ft |
| Excavated or embedded depth | D = | | 10.5 | ft |
| Depth to Groundwater | | | 55.5 | ft |
| Unit weight | $\gamma$ = | | 120.0 | pcf |
| Gross Footing Load | | | 5.10 | ksf |
| Net applied footing pressure | $\Delta p$ = | | **3.840** | ksf |
| | L/B = | | 1.00 | - |

**Z-SDU6-C23**

Immediate Settlement (in.) ($S_0$ / 2)

| | Load | $S_0$ = |
|---|---|---|
| End of Operations | 5.10 | 1.1 |
| Tank Half Full | 2.80 | 0.3 |
| Pre Closure | 5.50 | 1.2 |
| Post Closure | 8.00 | 2.1 |

30 Year Settlement (in.) ($S_{30}$ / 2)

| Load | $S_0$ = |
|---|---|
| 5.10 | 1.6 |
| 8.00 | 3.2 |

**Computation**

| | | | | | |
|---|---|---|---|---|---|
| Settlement | $\rho_i$ = | $C_1\ C_t\ \Delta p\ \Sigma(\Delta z_i\ I_{zi}/E_{si})$ | 0.181 | ft | |
| | $\rho_i$ = | $C_t$ = 1 | **2.172** | **in** | |
| | S(t) = | | 0.271 | ft | |
| | S(t) = | | **3.247** | **in** | |
| Correction for strain relief | $C_1$ = | 1 - 0.5($\sigma'_D$/q') | 0.836 | - | |
| Effective vertical overburden pressure at D | $\sigma'_{vo}$ = | $\gamma$ D | 1.260 | ksf | |
| Correction for time dependent increase | $C_t$ = | 1 + 0.2 log( t / 0.1 ) | 1.50 | - | |
| | t = | | 30.00 | years | |
| Elastic modulus of soil layer i | $E_{si}$ = | 2.5 $q_c$ | see | Column H | if L/B = 1 |
| | $E_{si}$ = | 3.5 $q_c$ | see | Column H | If L/B $\geq$ 10 |
| Depth increment i | $\Delta z_i$ | | see | Column D | |
| Influence factor of soil layer i | $I_{zi}$ | Figure 3-4 | see | Column G | |
| Peak depth influence factor | $I_{zp}$ = | 0.5 + 0.1 ($\Delta p/\sigma'_{Izp}$)$^{1/2}$ | 0.550 | - | |
| | $z_p$ = | 0.5B + D | 201.50 | ft | If L/B = 1 |
| | $z_p$ = | B + D | 392.50 | ft | If L/B $\geq$ 10 |
| | $z_p$ = | | 201.50 | ft | for L/B=1.00 |
| Effective overburden pressure at depth Izp | $\sigma'_{Izp}$ = | | 15.07 | ksf | |
| Elastic Modulus | $E_{si}$ = | | 2.50 | $q_c$ | If L/B = 1 |
| | $E_{si}$ = | | 3.50 | $q_c$ | If L/B $\geq$ 10 |
| | $E_{si}$ = | | 2.50 | $q_c$ | for L/B=1.00 |

Computations made relative to the bottom of foundation

| A | B | C | D | E | F | G | H | I | J | K |
|---|---|---|---|---|---|---|---|---|---|---|
| Layer No. | Layer top depth (ft) | Layer bottom depth (ft) | Layer thickness $\Delta z_i$ (ft) | Mid-layer depth $z_{ave}$ (ft) | Average tip stress $q_c$ (tsf) | $I_{zi}$ | Elastic modulus $E_{si}$ (ksf) | $\Delta z_i\ I_{zi}/E_{si}$ | $\Delta z_i\ I_{zi}/E_{si}$ | Notes |
| 1 | 0.0 | 1.0 | 1.0 | 0.5 | 78.8 | 0.101 | 394.0 | 0.00026 | 0.00026 | |
| 2 | 1.0 | 2.0 | 1.0 | 1.5 | 100.0 | 0.104 | 500.0 | 0.00021 | 0.00021 | |
| 3 | 2.0 | 3.0 | 1.0 | 2.5 | 50.1 | 0.106 | 250.4 | 0.00042 | 0.00042 | |
| 4 | 3.0 | 4.0 | 1.0 | 3.5 | 68.2 | 0.108 | 341.1 | 0.00032 | 0.00032 | |
| 5 | 4.0 | 5.0 | 1.0 | 4.5 | 93.4 | 0.111 | 466.9 | 0.00024 | 0.00024 | |
| 6 | 5.0 | 6.0 | 1.0 | 5.5 | 56.2 | 0.113 | 281.2 | 0.00040 | 0.00040 | |
| 7 | 6.0 | 7.0 | 1.0 | 6.5 | 66.7 | 0.115 | 333.7 | 0.00035 | 0.00035 | |
| 8 | 7.0 | 8.0 | 1.0 | 7.5 | 56.7 | 0.118 | 283.3 | 0.00042 | 0.00042 | |
| 9 | 8.0 | 9.0 | 1.0 | 8.5 | 55.4 | 0.120 | 277.1 | 0.00043 | 0.00043 | |
| 10 | 9.0 | 10.0 | 1.0 | 9.5 | 51.9 | 0.122 | 259.7 | 0.00047 | 0.00047 | |
| 11 | 10.0 | 11.0 | 1.0 | 10.5 | 67.8 | 0.125 | 338.8 | 0.00037 | 0.00037 | |
| 12 | 11.0 | 12.0 | 1.0 | 11.5 | 82.9 | 0.127 | 414.3 | 0.00031 | 0.00031 | |
| 13 | 12.0 | 13.0 | 1.0 | 12.5 | 77.8 | 0.129 | 388.8 | 0.00033 | 0.00033 | |
| 14 | 13.0 | 14.0 | 1.0 | 13.5 | 77.0 | 0.132 | 384.8 | 0.00034 | 0.00034 | |
| 15 | 14.0 | 15.0 | 1.0 | 14.5 | 61.9 | 0.134 | 309.3 | 0.00043 | 0.00043 | |
| 16 | 15.0 | 16.0 | 1.0 | 15.5 | 71.9 | 0.137 | 359.4 | 0.00038 | 0.00038 | |
| 17 | 16.0 | 17.0 | 1.0 | 16.5 | 89.5 | 0.139 | 447.3 | 0.00031 | 0.00031 | |
| 18 | 17.0 | 18.0 | 1.0 | 17.5 | 128.4 | 0.141 | 641.9 | 0.00022 | 0.00022 | |
| 19 | 18.0 | 19.0 | 1.0 | 18.5 | 206.0 | 0.144 | 1030.0 | 0.00014 | 0.00014 | |
| 20 | 19.0 | 20.0 | 1.0 | 19.5 | 315.8 | 0.146 | 1579.1 | 0.00009 | 0.00009 | |
| 21 | 20.0 | 21.0 | 1.0 | 20.5 | 291.8 | 0.148 | 1459.2 | 0.00010 | 0.00010 | |
| 22 | 21.0 | 22.0 | 1.0 | 21.5 | 241.9 | 0.151 | 1209.3 | 0.00012 | 0.00012 | |
| 23 | 22.0 | 23.0 | 1.0 | 22.5 | 286.9 | 0.153 | 1434.4 | 0.00011 | 0.00011 | |
| 24 | 23.0 | 24.0 | 1.0 | 23.5 | 238.3 | 0.155 | 1191.5 | 0.00013 | 0.00013 | |
| 25 | 24.0 | 25.0 | 1.0 | 24.5 | 224.4 | 0.158 | 1122.1 | 0.00014 | 0.00014 | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 26 | 25.0 | 26.0 | 1.0 | 25.5 | 132.8 | 0.160 | 663.9 | 0.00024 | 0.00024 |
| 27 | 26.0 | 27.0 | 1.0 | 26.5 | 91.3 | 0.163 | 456.6 | 0.00036 | 0.00036 |
| 28 | 27.0 | 28.0 | 1.0 | 27.5 | 50.6 | 0.165 | 253.0 | 0.00065 | 0.00065 |
| 29 | 28.0 | 29.0 | 1.0 | 28.5 | 45.0 | 0.167 | 224.9 | 0.00074 | 0.00074 |
| 30 | 29.0 | 30.0 | 1.0 | 29.5 | 28.6 | 0.170 | 143.0 | 0.00119 | 0.00119 |
| 31 | 30.0 | 31.0 | 1.0 | 30.5 | 46.8 | 0.172 | 234.1 | 0.00073 | 0.00073 |
| 32 | 31.0 | 32.0 | 1.0 | 31.5 | 102.7 | 0.174 | 513.7 | 0.00034 | 0.00034 |
| 33 | 32.0 | 33.0 | 1.0 | 32.5 | 163.9 | 0.177 | 819.4 | 0.00022 | 0.00022 |
| 34 | 33.0 | 34.0 | 1.0 | 33.5 | 156.7 | 0.179 | 783.6 | 0.00023 | 0.00023 |
| 35 | 34.0 | 35.0 | 1.0 | 34.5 | 130.8 | 0.181 | 654.0 | 0.00028 | 0.00028 |
| 36 | 35.0 | 36.0 | 1.0 | 35.5 | 132.7 | 0.184 | 663.6 | 0.00028 | 0.00028 |
| 37 | 36.0 | 37.0 | 1.0 | 36.5 | 113.7 | 0.186 | 568.7 | 0.00033 | 0.00033 |
| 38 | 37.0 | 38.0 | 1.0 | 37.5 | 75.4 | 0.188 | 377.0 | 0.00050 | 0.00050 |
| 39 | 38.0 | 39.0 | 1.0 | 38.5 | 56.4 | 0.191 | 281.8 | 0.00068 | 0.00068 |
| 40 | 39.0 | 40.0 | 1.0 | 39.5 | 81.4 | 0.193 | 406.8 | 0.00047 | 0.00047 |
| 41 | 40.0 | 41.0 | 1.0 | 40.5 | 181.3 | 0.196 | 906.6 | 0.00022 | 0.00022 |
| 42 | 41.0 | 42.0 | 1.0 | 41.5 | 155.0 | 0.198 | 775.1 | 0.00026 | 0.00026 |
| 43 | 42.0 | 43.0 | 1.0 | 42.5 | 118.3 | 0.200 | 591.4 | 0.00034 | 0.00034 |
| 44 | 43.0 | 44.0 | 1.0 | 43.5 | 74.5 | 0.203 | 372.4 | 0.00054 | 0.00054 |
| 45 | 44.0 | 45.0 | 1.0 | 44.5 | 176.8 | 0.205 | 884.0 | 0.00023 | 0.00023 |
| 46 | 45.0 | 46.0 | 1.0 | 45.5 | 190.7 | 0.207 | 953.5 | 0.00022 | 0.00022 |
| 47 | 46.0 | 47.0 | 1.0 | 46.5 | 164.0 | 0.210 | 820.2 | 0.00026 | 0.00026 |
| 48 | 47.0 | 48.0 | 1.0 | 47.5 | 157.3 | 0.212 | 786.5 | 0.00027 | 0.00027 |
| 49 | 48.0 | 49.0 | 1.0 | 48.5 | 175.0 | 0.214 | 875.1 | 0.00024 | 0.00024 |
| 50 | 49.0 | 50.0 | 1.0 | 49.5 | 126.6 | 0.217 | 633.0 | 0.00034 | 0.00034 |
| 51 | 50.0 | 51.0 | 1.0 | 50.5 | 47.1 | 0.219 | 235.7 | 0.00093 | 0.00093 |
| 52 | 51.0 | 52.0 | 1.0 | 51.5 | 32.7 | 0.221 | 163.4 | 0.00136 | 0.00136 |
| 53 | 52.0 | 53.0 | 1.0 | 52.5 | 45.2 | 0.224 | 225.8 | 0.00099 | 0.00099 |
| 54 | 53.0 | 54.0 | 1.0 | 53.5 | 39.0 | 0.226 | 195.0 | 0.00116 | 0.00116 |
| 55 | 54.0 | 55.0 | 1.0 | 54.5 | 188.8 | 0.229 | 943.9 | 0.00024 | 0.00024 |
| 56 | 55.0 | 56.0 | 1.0 | 55.5 | 340.7 | 0.231 | 1703.3 | 0.00014 | 0.00014 |
| 57 | 56.0 | 57.0 | 1.0 | 56.5 | 296.0 | 0.233 | 1480.0 | 0.00016 | 0.00016 |
| 58 | 57.0 | 58.0 | 1.0 | 57.5 | 178.4 | 0.236 | 892.1 | 0.00026 | 0.00026 |
| 59 | 58.0 | 59.0 | 1.0 | 58.5 | 160.7 | 0.238 | 803.3 | 0.00030 | 0.00030 |
| 60 | 59.0 | 60.0 | 1.0 | 59.5 | 180.7 | 0.240 | 903.7 | 0.00027 | 0.00027 |
| 61 | 60.0 | 61.0 | 1.0 | 60.5 | 188.7 | 0.243 | 943.4 | 0.00026 | 0.00026 |
| 62 | 61.0 | 62.0 | 1.0 | 61.5 | 190.7 | 0.245 | 953.6 | 0.00026 | 0.00026 |
| 63 | 62.0 | 63.0 | 1.0 | 62.5 | 166.0 | 0.247 | 830.2 | 0.00030 | 0.00030 |
| 64 | 63.0 | 64.0 | 1.0 | 63.5 | 179.9 | 0.250 | 899.4 | 0.00028 | 0.00028 |
| 65 | 64.0 | 65.0 | 1.0 | 64.5 | 181.5 | 0.252 | 907.3 | 0.00028 | 0.00028 |
| 66 | 65.0 | 66.0 | 1.0 | 65.5 | 225.6 | 0.254 | 1128.0 | 0.00023 | 0.00023 |
| 67 | 66.0 | 67.0 | 1.0 | 66.5 | 242.9 | 0.257 | 1214.4 | 0.00021 | 0.00021 |
| 68 | 67.0 | 68.0 | 1.0 | 67.5 | 167.9 | 0.259 | 839.5 | 0.00031 | 0.00031 |
| 69 | 68.0 | 69.0 | 1.0 | 68.5 | 67.4 | 0.262 | 337.1 | 0.00078 | 0.00078 |
| 70 | 69.0 | 70.0 | 1.0 | 69.5 | 59.4 | 0.264 | 297.2 | 0.00089 | 0.00089 |
| 71 | 70.0 | 71.0 | 1.0 | 70.5 | 46.3 | 0.266 | 231.7 | 0.00115 | 0.00115 |
| 72 | 71.0 | 72.0 | 1.0 | 71.5 | 32.5 | 0.269 | 162.4 | 0.00165 | 0.00165 |
| 73 | 72.0 | 73.0 | 1.0 | 72.5 | 33.4 | 0.271 | 166.8 | 0.00163 | 0.00163 |
| 74 | 73.0 | 74.0 | 1.0 | 73.5 | 86.7 | 0.273 | 433.5 | 0.00063 | 0.00063 |
| 75 | 74.0 | 75.0 | 1.0 | 74.5 | 296.2 | 0.276 | 1480.8 | 0.00019 | 0.00019 |
| 76 | 75.0 | 76.0 | 1.0 | 75.5 | 211.6 | 0.278 | 1057.8 | 0.00026 | 0.00026 |
| 77 | 76.0 | 77.0 | 1.0 | 76.5 | 347.5 | 0.280 | 1737.6 | 0.00016 | 0.00016 |
| 78 | 77.0 | 78.0 | 1.0 | 77.5 | 250.3 | 0.283 | 1251.3 | 0.00023 | 0.00023 |
| 79 | 78.0 | 79.0 | 1.0 | 78.5 | 357.3 | 0.285 | 1786.5 | 0.00016 | 0.00016 |
| 80 | 79.0 | 80.0 | 1.0 | 79.5 | 142.8 | 0.288 | 713.9 | 0.00040 | 0.00040 |
| 81 | 80.0 | 81.0 | 1.0 | 80.5 | 117.1 | 0.290 | 585.5 | 0.00050 | 0.00050 |
| 82 | 81.0 | 82.0 | 1.0 | 81.5 | 181.6 | 0.292 | 907.9 | 0.00032 | 0.00032 |
| 83 | 82.0 | 83.0 | 1.0 | 82.5 | 163.1 | 0.295 | 815.3 | 0.00036 | 0.00036 |
| 84 | 83.0 | 84.0 | 1.0 | 83.5 | 131.7 | 0.297 | 658.5 | 0.00045 | 0.00045 |
| 85 | 84.0 | 85.0 | 1.0 | 84.5 | 171.8 | 0.299 | 859.0 | 0.00035 | 0.00035 |
| 86 | 85.0 | 86.0 | 1.0 | 85.5 | 139.6 | 0.302 | 698.1 | 0.00043 | 0.00043 |
| 87 | 86.0 | 87.0 | 1.0 | 86.5 | 107.2 | 0.304 | 536.2 | 0.00057 | 0.00057 |
| 88 | 87.0 | 88.0 | 1.0 | 87.5 | 142.6 | 0.306 | 713.2 | 0.00043 | 0.00043 |
| 89 | 88.0 | 89.0 | 1.0 | 88.5 | 159.0 | 0.309 | 795.1 | 0.00039 | 0.00039 |
| 90 | 89.0 | 90.0 | 1.0 | 89.5 | 101.7 | 0.311 | 508.4 | 0.00061 | 0.00061 |
| 91 | 90.0 | 91.0 | 1.0 | 90.5 | 113.9 | 0.313 | 569.7 | 0.00055 | 0.00055 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 92 | 91.0 | 92.0 | 1.0 | 91.5 | 128.0 | 0.316 | 639.8 | 0.00049 | 0.00049 | |
| 93 | 92.0 | 93.0 | 1.0 | 92.5 | 132.8 | 0.318 | 663.8 | 0.00048 | 0.00048 | |
| 94 | 93.0 | 94.0 | 1.0 | 93.5 | 201.8 | 0.321 | 1009.1 | 0.00032 | 0.00032 | |
| 95 | 94.0 | 95.0 | 1.0 | 94.5 | 142.9 | 0.323 | 714.4 | 0.00045 | 0.00045 | |
| 96 | 95.0 | 96.0 | 1.0 | 95.5 | 118.3 | 0.325 | 591.6 | 0.00055 | 0.00055 | |
| 97 | 96.0 | 97.0 | 1.0 | 96.5 | 115.9 | 0.328 | 579.7 | 0.00057 | 0.00057 | |
| 98 | 97.0 | 98.0 | 1.0 | 97.5 | 111.7 | 0.330 | 558.5 | 0.00059 | 0.00059 | |
| 99 | 98.0 | 99.0 | 1.0 | 98.5 | 93.3 | 0.332 | 466.7 | 0.00071 | 0.00071 | |
| 100 | 99.0 | 100.0 | 1.0 | 99.5 | 131.0 | 0.335 | 655.2 | 0.00051 | 0.00051 | |
| 101 | 100.0 | 101.0 | 1.0 | 100.5 | 199.1 | 0.337 | 995.3 | 0.00034 | 0.00034 | |
| 102 | 101.0 | 102.0 | 1.0 | 101.5 | 210.6 | 0.339 | 1053.0 | 0.00032 | 0.00032 | |
| 103 | 102.0 | 103.0 | 1.0 | 102.5 | 167.6 | 0.342 | 837.8 | 0.00041 | 0.00041 | |
| 104 | 103.0 | 104.0 | 1.0 | 103.5 | 117.9 | 0.344 | 589.5 | 0.00058 | 0.00058 | |
| 105 | 104.0 | 105.0 | 1.0 | 104.5 | 71.2 | 0.346 | 356.1 | 0.00097 | 0.00097 | |
| 106 | 105.0 | 106.0 | 1.0 | 105.5 | 84.2 | 0.349 | 421.0 | 0.00083 | 0.00083 | |
| 107 | 106.0 | 107.0 | 1.0 | 106.5 | 82.8 | 0.351 | 414.1 | 0.00085 | 0.00085 | |
| 108 | 107.0 | 108.0 | 1.0 | 107.5 | 85.5 | 0.354 | 427.5 | 0.00083 | 0.00083 | |
| 109 | 108.0 | 109.0 | 1.0 | 108.5 | 87.7 | 0.356 | 438.7 | 0.00081 | 0.00081 | |
| 110 | 109.0 | 110.0 | 1.0 | 109.5 | 71.5 | 0.358 | 357.6 | 0.00100 | 0.00100 | |
| 111 | 110.0 | 111.0 | 1.0 | 110.5 | 60.5 | 0.361 | 302.6 | 0.00119 | 0.00119 | |
| 112 | 111.0 | 112.0 | 1.0 | 111.5 | 64.9 | 0.363 | 324.4 | 0.00112 | 0.00112 | |
| 113 | 112.0 | 113.0 | 1.0 | 112.5 | 62.6 | 0.365 | 313.2 | 0.00117 | 0.00117 | |
| 114 | 113.0 | 114.0 | 1.0 | 113.5 | 70.2 | 0.368 | 351.0 | 0.00105 | 0.00105 | |
| 115 | 114.0 | 115.0 | 1.0 | 114.5 | 80.1 | 0.370 | 400.6 | 0.00092 | 0.00092 | |
| 116 | 115.0 | 116.0 | 1.0 | 115.5 | 191.7 | 0.372 | 958.5 | 0.00039 | 0.00039 | |
| 117 | 116.0 | 117.0 | 1.0 | 116.5 | 204.5 | 0.375 | 1022.4 | 0.00037 | 0.00037 | |
| 118 | 117.0 | 118.0 | 1.0 | 117.5 | 508.1 | 0.377 | 2540.5 | 0.00015 | 0.00015 | |
| 119 | 118.0 | 119.0 | 1.0 | 118.5 | 621.5 | 0.379 | 3107.7 | 0.00012 | 0.00012 | |
| 120 | 119.0 | 120.0 | 1.0 | 119.5 | 668.1 | 0.382 | 3340.6 | 0.00011 | 0.00011 | |
| $\Sigma$ = | | | | | | | | | 0.05638 | |

$I_{zr}$ $(1 < L/B < 10)$: $I_{zr} = I_{zs} + 0.111\,(I_{zc} - I_{zs})\,(L/B - 1)$

$I_{zs}$ $(L/B = 1)$:

For $z_{ave}$ = 0 to B/2: $I_{zs} = 0.1 + (z_{ave}/B)(2I_{zp} - 0.2)$

For $z_{ave}$ = B/2 to 2B: $I_{zs} = 0.667\,I_{zp}\,(2 - z_{ave}/B)$

$I_{zc}$ $(L/B \geq 10)$:

For $z_{ave}$ = 0 to B: $I_{zc} = 0.2 + (z_{ave}/B)(I_{zp} - 0.2)$

For $z_{ave}$ = B to 4B: $I_{zc} = 0.333\,I_{zp}\,(4 - z_{ave}/B)$ ( Coduto p.228. )

# BURLAND AND BURBIDGE METHOD

| | Depth of Excavation | initial height of the compressible layer | Unit weight | Blow Count | Width of Stress change | Length of Stress change | Depth of Foundation | Applied vertical Load | Depth of Influence | Shape Correction Factor | Layer Thickness Correction Factor | Average Effective Bearing Pressure | preconsolidation stress | Compressibility Influence Factor | Settlement | Settlement | Lower Bound Compressibility Influence Factor | Upper Bound Compressibility Influence Factor | Lower Bound Settlement | Upper Bound Settlement | 30-Year Settlement | 30-Year Settlement Lower | 30-Year Settlement Upper |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $D_e$ | $H_o$ | $\gamma$ | $N_{ave}$ | B | L | D | $\sigma$ | $z_I$ | $f_s$ | $f_i$ | q' | $\sigma'_{vo}$ | $I_c$ | $S_0$ | $S_0$ | $I_c$ | $I_c$ | $S_0$ | $S_0$ | $S_{30}$ | $S_{30}$ | $S_{30}$ |
| | feet | feet | pcf | - | feet | feet | feet | ksf | feet | - | - | tsf | tsf | | feet | in | tsf | tsf | in | in | in | in | in |
| Over Consolidated to Effective Vertical Stress Prior to Excavation | | | | | | | | | | | | | | | | | | | | | | | |
| Z-SDU6-B03 | | | | | | | | | | | | | | | | | | | | | | | |
| Heave | 11.50 | 120 | 120 | 30 | 382 | 382 | 1.0 | -0.69 | 116.6 | 1.000 | 1.00 | -0.35 | 0.690 | 0.0020 | -0.015 | -0.2 | 0.0010 | 0.0046 | -0.085 | -0.405 | -0.26 | -0.13 | -0.61 |
| End of Construction | 11.50 | 120 | 120 | 30 | 382 | 382 | 1.0 | 0.60 | 116.6 | 1.000 | 1.00 | 0.30 | 0.690 | 0.0020 | 0.013 | 0.2 | 0.0010 | 0.0046 | 0.074 | 0.352 | 0.23 | 0.11 | 0.53 |
| Tank Half Full | 11.50 | 120 | 120 | 30 | 382 | 382 | 1.0 | 2.80 | 116.6 | 1.000 | 1.00 | 1.40 | 0.690 | 0.0020 | 0.119 | 1.4 | 0.0010 | 0.0046 | 0.696 | 3.312 | 2.14 | 1.04 | 4.97 |
| End of Operations | 11.50 | 120 | 120 | 30 | 382 | 382 | 1.0 | 5.10 | 116.6 | 1.000 | 1.00 | 2.55 | 0.690 | 0.0020 | 0.264 | 3.2 | 0.0010 | 0.0046 | 1.547 | 7.363 | 4.75 | 2.32 | 11.05 |
| Post Closure | 11.50 | 120 | 120 | 30 | 382 | 382 | 1.0 | 8.00 | 116.6 | 1.000 | 1.00 | 4.00 | 0.690 | 0.0020 | 0.447 | 5.4 | 0.0010 | 0.0046 | 2.621 | 12.472 | 8.04 | 3.93 | 18.71 |
| Z-SDU6-B04 | | | | | | | | | | | | | | | | | | | | | | | |
| Heave | 12.90 | 120 | 120 | 34 | 382 | 382 | 1.0 | -0.77 | 116.6 | 1.000 | 1.00 | -0.39 | 0.774 | 0.0017 | -0.014 | -0.2 | 0.0008 | 0.0037 | -0.081 | -0.369 | -0.25 | -0.12 | -0.55 |
| End of Construction | 12.90 | 120 | 120 | 34 | 382 | 382 | 1.0 | 0.60 | 116.6 | 1.000 | 1.00 | 0.30 | 0.774 | 0.0017 | 0.011 | 0.1 | 0.0008 | 0.0037 | 0.063 | 0.286 | 0.19 | 0.09 | 0.43 |
| Tank Half Full | 12.90 | 120 | 120 | 34 | 382 | 382 | 1.0 | 2.80 | 116.6 | 1.000 | 1.00 | 1.40 | 0.774 | 0.0017 | 0.094 | 1.1 | 0.0008 | 0.0037 | 0.556 | 2.527 | 1.69 | 0.83 | 3.79 |
| End of Operations | 12.90 | 120 | 120 | 34 | 382 | 382 | 1.0 | 5.10 | 116.6 | 1.000 | 1.00 | 2.55 | 0.774 | 0.0017 | 0.216 | 2.6 | 0.0008 | 0.0037 | 1.280 | 5.814 | 3.88 | 1.92 | 8.72 |
| Post Closure | 12.90 | 120 | 120 | 34 | 382 | 382 | 1.0 | 8.00 | 116.6 | 1.000 | 1.00 | 4.00 | 0.774 | 0.0017 | 0.369 | 4.4 | 0.0008 | 0.0037 | 2.192 | 9.960 | 6.64 | 3.29 | 14.94 |
| Z-221 | | | | | | | | | | | | | | | | | | | | | | | |
| Heave | 11.90 | 120 | 120 | 34 | 382 | 382 | 1.0 | -0.71 | 116.6 | 1.000 | 1.00 | -0.36 | 0.714 | 0.0017 | -0.013 | -0.2 | 0.0008 | 0.0037 | -0.075 | -0.340 | -0.23 | -0.11 | -0.51 |
| End of Construction | 11.90 | 120 | 120 | 34 | 382 | 382 | 1.0 | 0.60 | 116.6 | 1.000 | 1.00 | 0.30 | 0.714 | 0.0017 | 0.011 | 0.1 | 0.0008 | 0.0037 | 0.063 | 0.286 | 0.19 | 0.09 | 0.43 |
| Tank Half Full | 11.90 | 120 | 120 | 34 | 382 | 382 | 1.0 | 2.80 | 116.6 | 1.000 | 1.00 | 1.40 | 0.714 | 0.0017 | 0.098 | 1.2 | 0.0008 | 0.0037 | 0.581 | 2.641 | 1.76 | 0.87 | 3.96 |
| End of Operations | 11.90 | 120 | 120 | 34 | 382 | 382 | 1.0 | 5.10 | 116.6 | 1.000 | 1.00 | 2.55 | 0.714 | 0.0017 | 0.220 | 2.6 | 0.0008 | 0.0037 | 1.305 | 5.929 | 3.96 | 1.96 | 8.89 |
| Post Closure | 11.90 | 120 | 120 | 34 | 382 | 382 | 1.0 | 8.00 | 116.6 | 1.000 | 1.00 | 4.00 | 0.714 | 0.0017 | 0.373 | 4.5 | 0.0008 | 0.0037 | 2.217 | 10.074 | 6.72 | 3.33 | 15.11 |
| Average Values | | | | | | | | | | | | | | | | | | | | | | | |
| Heave | | | | | | | | | | | | | | | | -0.2 | | | -0.1 | -0.4 | --- | --- | --- |
| End of Construction | | | | | | | | | | | | | | | | 0.1 | | | 0.1 | 0.3 | --- | --- | --- |
| Tank Half Full | | | | | | | | | | | | | | | | 1.2 | | | 0.6 | 2.8 | --- | --- | --- |
| End of Operations | | | | | | | | | | | | | | | | 2.8 | | | 1.4 | 6.4 | --- | --- | --- |
| Post Closure | | | | | | | | | | | | | | | | 4.8 | | | 2.3 | 10.8 | 7.1 | 3.5 | 16.3 |

## Consolidation

The consolidation calculation was performed using Excel 2010 using the VLOOKUP function and the Table feature. The VLOOKUP function was used to adjust the layer thickness (H) based on the CPT-specific values. The Table feature was used to determine the settlement for each CPT location for various loading conditions. The stratigraphy array which the VLOOKUP function utilizes and the Settlement vs Loading Condition table are included in this portion of the Appendix.

The upper half of the C2 layer is normally consolidated
The lower half of the C2 layer will only experience recompression

| | | | H | $e_o$ | $C_c$ | $C_r$ | OCR | B | L | $\sigma'_o$ | $\sigma'_p$ | F | $\Delta\sigma'$ | $\sigma'_f$ | Heave / Settlement Heave | $\sigma_f < \sigma_p$ | $\sigma_f > \sigma_p$ | $\Delta H$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | ft | --- | --- | --- | --- | ft | ft | psf | psf | --- | psf | psf | inches | inches | inches | inches | |
| Excavation | Excavate | 120 | 16.9 | | | | | 380 | 190 | | | | -2,028 | | | | | | |
| | S1/2 | 123 | 32 | 0.63 | 0.06 | 0.007 | 2.2 | | | 3,996 | 8,791 | 0.85 | -1,725 | 2,271 | -0.40 | 0.00 | 0.00 | -0.40 | |
| | C2 | 106 | 3.5 | 1.35 | 0.58 | 0.100 | 1.0 | | | 6,150 | 6,150 | 0.72 | -1,462 | 4,687 | -0.21 | 0.00 | 0.00 | -0.21 | |
| | C2 | 106 | 3.5 | 1.35 | 0.58 | 0.100 | 2.0 | | | 6,521 | 13,041 | 0.70 | -1,418 | 5,103 | -0.19 | 0.00 | 0.00 | -0.19 | |
| | S3 | 64 | 36 | 0.76 | 0.23 | 0.030 | 1.4 | | | 7,858 | 11,001 | 0.59 | -1,200 | 6,658 | -0.53 | 0.00 | 0.00 | -0.53 | |
| | S4 | 57 | 48.1 | 0.92 | 0.28 | 0.020 | 1.2 | | | 10,371 | 12,445 | 0.43 | -876 | 9,495 | -0.23 | 0.00 | 0.00 | -0.23 | |
| Operation | | | | | | | | | | | | | | | | | | Total Heave | -1.57 |
| | | | | | | | | 380 | 190 | | | | 5,100 | | | | | | |
| | S1/2 | 123 | 32 | 0.63 | 0.06 | 0.007 | 2.2 | | | 2,271 | 8,791 | 0.85 | 4,339 | 6,609 | 0.00 | 0.77 | 0.00 | 0.77 | |
| | C2 | 106 | 3.5 | 1.35 | 0.58 | 0.100 | 1.0 | | | 4,687 | 6,150 | 0.72 | 3,677 | 8,365 | 0.00 | 0.00 | 1.60 | 1.60 | |
| | C2 | 106 | 3.5 | 1.35 | 0.58 | 0.100 | 2.0 | | | 5,103 | 13,041 | 0.70 | 3,565 | 8,668 | 0.00 | 0.41 | 0.00 | 0.41 | |
| | S3 | 64 | 36 | 0.76 | 0.23 | 0.030 | 1.4 | | | 6,658 | 11,001 | 0.59 | 3,018 | 9,676 | 0.00 | 1.20 | 0.00 | 1.20 | |
| | S4 | 57 | 48.1 | 0.92 | 0.28 | 0.020 | 1.2 | | | 9,495 | 12,445 | 0.43 | 2,204 | 11,699 | 0.00 | 0.54 | 0.00 | 0.54 | |
| | | | | | | | | | | | | | | | | | | Total Settlement | 4.51 |

Note:
OCR values for layers S1/2, S3, and S4 where adjusted
such that only recompression settlements occurred.

| Stratigraphy | | Elevations | | | | Thickness | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Surface | Top C2 | Bot C2 | Bot S3 | Excavation | S1/2 | C2 | S3 |
| 1 | Z-SDU6-C01 | 281.9 | 233 | 226 | 190 | 16.9 | 32 | 7 | 36 |
| 2 | Z-SDU6-C02 | 281.4 | 233 | 227 | 190 | 16.4 | 32 | 6 | 37 |
| 3 | Z-SDU6-C03 | 281.6 | 233 | 225 | 190 | 16.6 | 32 | 8 | 35 |
| 4 | Z-SDU6-C04 | 281.8 | 236 | 229 | 190 | 16.8 | 29 | 7 | 39 |
| 5 | Z-SDU6-C05 | 278.1 | 235 | 226 | 187 | 13.1 | 30 | 9 | 39 |
| 6 | Z-SDU6-C06 | 278.6 | 234 | 227 | 189 | 13.6 | 31 | 7 | 38 |
| 7 | Z-SDU6-C07 | 279.4 | 237 | 230 | 191 | 14.4 | 28 | 7 | 39 |
| 8 | Z-SDU6-C08 | 279.7 | 236 | 230 | 186 | 14.7 | 29 | 6 | 44 |
| 9 | Z-SDU6-C09 | 278.3 | 237 | 230 | 194 | 13.3 | 28 | 7 | 36 |
| 10 | Z-SDU6-C10 | 278 | 237 | 230 | 190 | 13 | 28 | 7 | 40 |
| 11 | Z-SDU6-C11 | 277.6 | 238 | 233 | 186 | 12.6 | 27 | 5 | 47 |
| 12 | Z-SDU6-C12 | 277.7 | 239 | 234 | 188 | 12.7 | 26 | 5 | 46 |
| 13 | Z-SDU6-C13 | 276.3 | 234 | 228 | 188 | 11.3 | 31 | 6 | 40 |
| 14 | Z-SDU6-C14 | 277.3 | 234 | 222 | 181 | 12.3 | 31 | 12 | 41 |
| 15 | Z-SDU6-C15 | 276.8 | 232 | 217 | 192 | 11.8 | 33 | 15 | 25 |
| 16 | Z-SDU6-C16 | 276.7 | 234 | 216 | 184 | 11.7 | 31 | 18 | 32 |
| 17 | Z-SDU6-C17 | 276 | 235 | 219 | 187 | 11 | 30 | 16 | 32 |
| 18 | Z-SDU6-C18 | 275.6 | 235 | 217 | 186 | 10.6 | 30 | 18 | 31 |
| 19 | Z-SDU6-C19 | 276.4 | 235 | 227 | 183 | 11.4 | 30 | 8 | 44 |
| 20 | Z-SDU6-C20 | 276 | 226 | 219 | 176 | 11 | 39 | 7 | 43 |
| 21 | Z-SDU6-C21 | 276.3 | 233 | 225 | 182 | 11.3 | 32 | 8 | 43 |
| 22 | Z-SDU6-C22 | 276.5 | 237 | 230 | 187 | 11.5 | 28 | 7 | 43 |
| 23 | Z-SDU6-C23 | 275.5 | 238 | 233 | 190 | 10.5 | 27 | 5 | 43 |

| CPT | Tank Settlement (inches) as a Function of Load (psf) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| ID Z-SDU6-C# | End of Construction | | | Tank 1/2 Full | Hydro Test | | End of Operations | Pre Closure | Post Closure |
| 4.51 | **600** | **1000** | **2000** | **2800** | **3300** | **4000** | **5100** | **5500** | **8000** |
| 1 | 0.51 | 0.83 | 1.55 | 2.39 | 2.89 | 3.55 | 4.51 | 4.84 | 8.97 |
| 2 | 0.50 | 0.81 | 1.53 | 2.34 | 2.80 | 3.42 | 4.32 | 4.63 | 9.02 |
| 3 | 0.52 | 0.85 | 1.59 | 2.50 | 3.03 | 3.74 | 4.76 | 5.11 | 9.46 |
| 4 | 0.55 | 0.89 | 1.65 | 2.56 | 3.09 | 3.80 | 4.82 | 5.16 | 9.95 |
| 5 | 0.58 | 0.94 | 2.01 | 3.05 | 3.66 | 4.46 | 5.62 | 6.02 | 12.73 |
| 6 | 0.54 | 0.87 | 1.80 | 2.70 | 3.22 | 3.91 | 4.91 | 5.26 | 11.58 |
| 7 | 0.57 | 0.92 | 1.86 | 2.81 | 3.36 | 4.09 | 5.14 | 5.50 | 12.15 |
| 8 | 0.55 | 0.89 | 1.76 | 2.64 | 3.14 | 3.81 | 4.78 | 5.12 | 10.86 |
| 9 | 0.57 | 0.93 | 1.93 | 2.88 | 3.44 | 4.17 | 5.22 | 5.58 | 13.27 |
| 10 | 0.58 | 0.94 | 1.97 | 2.94 | 3.49 | 4.23 | 5.29 | 5.65 | 13.19 |
| 11 | 0.58 | 0.93 | 1.92 | 2.78 | 3.27 | 3.93 | 4.88 | 5.20 | 12.93 |
| 12 | 0.59 | 0.95 | 1.95 | 2.82 | 3.33 | 3.99 | 4.96 | 5.28 | 13.39 |
| 13 | 0.54 | 0.88 | 1.90 | 2.76 | 3.25 | 3.91 | 4.86 | 5.18 | 13.02 |
| 14 | 0.61 | 0.98 | 2.25 | 3.45 | 4.15 | 5.08 | 6.42 | 6.88 | 13.34 |
| 15 | 0.59 | 0.96 | 2.34 | 3.63 | 4.39 | 5.39 | 6.84 | 7.34 | 14.90 |
| 16 | 0.66 | 1.07 | 2.69 | 4.21 | 5.10 | 6.27 | 7.98 | 8.56 | 15.95 |
| 17 | 0.66 | 1.06 | 2.72 | 4.17 | 5.02 | 6.14 | 7.75 | 8.31 | 16.52 |
| 18 | 0.68 | 1.10 | 2.93 | 4.50 | 5.41 | 6.62 | 8.36 | 8.96 | 17.42 |
| 19 | 0.58 | 0.94 | 2.11 | 3.11 | 3.70 | 4.47 | 5.58 | 5.96 | 13.46 |
| 20 | 0.48 | 0.78 | 1.73 | 2.52 | 2.98 | 3.60 | 4.50 | 4.81 | 9.85 |
| 21 | 0.56 | 0.90 | 2.03 | 2.99 | 3.55 | 4.29 | 5.36 | 5.73 | 12.72 |
| 22 | 0.59 | 0.96 | 2.11 | 3.09 | 3.65 | 4.40 | 5.48 | 5.84 | 14.18 |
| 23 | 0.58 | 0.94 | 2.04 | 2.91 | 3.41 | 4.07 | 5.02 | 5.48 | 15.07 |

The lower half of the C2 layer is normally consolidated
The upper half of the C2 layer will only experience recompression

| | | | H | $e_o$ | $C_c$ | $C_r$ | OCR | B | L | $\sigma'_o$ | $\sigma'_p$ | F | $\Delta\sigma'$ | $\sigma'_f$ | Heave / Settlement<br>Heave | $\sigma_f < \sigma_p$ | $\sigma_f > \sigma_p$ | $\Delta H$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | ft | --- | --- | --- | --- | ft | ft | psf | psf | --- | psf | psf | inches | inches | inches | inches | |
| Excavation | Excavate | 120 | 16.9 | | | | | 380 | 190 | | | | -2,028 | | | | | | |
| | S1/2 | 123 | 32 | 0.63 | 0.06 | 0.007 | 2.2 | | | 3,996 | 8,791 | 0.85 | -1,725 | 2,271 | -0.40 | 0.00 | 0.00 | -0.40 | |
| | C2 | 106 | 3.5 | 1.35 | 0.58 | 0.100 | 2.0 | | | 6,150 | 12,299 | 0.72 | -1,462 | 4,687 | -0.21 | 0.00 | 0.00 | -0.21 | |
| | C2 | 106 | 3.5 | 1.35 | 0.58 | 0.100 | 1.0 | | | 6,521 | 6,521 | 0.70 | -1,418 | 5,103 | -0.19 | 0.00 | 0.00 | -0.19 | |
| | S3 | 64 | 36 | 0.76 | 0.23 | 0.030 | 1.4 | | | 7,858 | 11,001 | 0.59 | -1,200 | 6,658 | -0.53 | 0.00 | 0.00 | -0.53 | |
| | S4 | 57 | 48.1 | 0.92 | 0.28 | 0.020 | 1.2 | | | 10,371 | 12,445 | 0.43 | -876 | 9,495 | -0.23 | 0.00 | 0.00 | -0.23 | |
| Operation | | | | | | | | | | | | | | | | | | Total Heave | -1.57 |
| | | | | | | | | 380 | 190 | | | | 5,100 | | | | | | |
| | S1/2 | 123 | 32 | 0.63 | 0.06 | 0.007 | 2.2 | | | 2,271 | 8,791 | 0.85 | 4,339 | 6,609 | 0.00 | 0.77 | 0.00 | 0.77 | |
| | C2 | 106 | 3.5 | 1.35 | 0.58 | 0.100 | 2.0 | | | 4,687 | 12,299 | 0.72 | 3,677 | 8,365 | 0.00 | 0.45 | 0.00 | 0.45 | |
| | C2 | 106 | 3.5 | 1.35 | 0.58 | 0.100 | 1.0 | | | 5,103 | 6,521 | 0.70 | 3,565 | 8,668 | 0.00 | 0.00 | 1.47 | 1.47 | |
| | S3 | 64 | 36 | 0.76 | 0.23 | 0.030 | 1.4 | | | 6,658 | 11,001 | 0.59 | 3,018 | 9,676 | 0.00 | 1.20 | 0.00 | 1.20 | |
| | S4 | 57 | 48.1 | 0.92 | 0.28 | 0.020 | 1.2 | | | 9,495 | 12,445 | 0.43 | 2,204 | 11,699 | 0.00 | 0.54 | 0.00 | 0.54 | |
| | | | | | | | | | | | | | | | | | | Total Settlement | 4.43 |

Note:
OCR values for layers S1/2, S3, and S4 where adjusted
such that only recompression settlements occurred.

| Stratigraphy | | Elevations | | | | Thickness | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Surface | Top C2 | Bot C2 | Bot S3 | Excavation | S1/2 | C2 | S3 |
| 1 | Z-SDU6-C01 | 281.9 | 233 | 226 | 190 | 16.9 | 32 | 7 | 36 |
| 2 | Z-SDU6-C02 | 281.4 | 233 | 227 | 190 | 16.4 | 32 | 6 | 37 |
| 3 | Z-SDU6-C03 | 281.6 | 233 | 225 | 190 | 16.6 | 32 | 8 | 35 |
| 4 | Z-SDU6-C04 | 281.8 | 236 | 229 | 190 | 16.8 | 29 | 7 | 39 |
| 5 | Z-SDU6-C05 | 278.1 | 235 | 226 | 187 | 13.1 | 30 | 9 | 39 |
| 6 | Z-SDU6-C06 | 278.6 | 234 | 227 | 189 | 13.6 | 31 | 7 | 38 |
| 7 | Z-SDU6-C07 | 279.4 | 237 | 230 | 191 | 14.4 | 28 | 7 | 39 |
| 8 | Z-SDU6-C08 | 279.7 | 236 | 230 | 186 | 14.7 | 29 | 6 | 44 |
| 9 | Z-SDU6-C09 | 278.3 | 237 | 230 | 194 | 13.3 | 28 | 7 | 36 |
| 10 | Z-SDU6-C10 | 278 | 237 | 230 | 190 | 13 | 28 | 7 | 40 |
| 11 | Z-SDU6-C11 | 277.6 | 238 | 233 | 186 | 12.6 | 27 | 5 | 47 |
| 12 | Z-SDU6-C12 | 277.7 | 239 | 234 | 188 | 12.7 | 26 | 5 | 46 |
| 13 | Z-SDU6-C13 | 276.3 | 234 | 228 | 188 | 11.3 | 31 | 6 | 40 |
| 14 | Z-SDU6-C14 | 277.3 | 234 | 222 | 181 | 12.3 | 31 | 12 | 41 |
| 15 | Z-SDU6-C15 | 276.8 | 232 | 217 | 192 | 11.8 | 33 | 15 | 25 |
| 16 | Z-SDU6-C16 | 276.7 | 234 | 216 | 184 | 11.7 | 31 | 18 | 32 |
| 17 | Z-SDU6-C17 | 276 | 235 | 219 | 187 | 11 | 30 | 16 | 32 |
| 18 | Z-SDU6-C18 | 275.6 | 235 | 217 | 186 | 10.6 | 30 | 18 | 31 |
| 19 | Z-SDU6-C19 | 276.4 | 235 | 227 | 183 | 11.4 | 30 | 8 | 44 |
| 20 | Z-SDU6-C20 | 276 | 226 | 219 | 176 | 11 | 39 | 7 | 43 |
| 21 | Z-SDU6-C21 | 276.3 | 233 | 225 | 182 | 11.3 | 32 | 8 | 43 |
| 22 | Z-SDU6-C22 | 276.5 | 237 | 230 | 187 | 11.5 | 28 | 7 | 43 |
| 23 | Z-SDU6-C23 | 275.5 | 238 | 233 | 190 | 10.5 | 27 | 5 | 43 |

| CPT | Tank Settlement (inches) as a Function of Load (psf) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| ID<br>Z-SDU6-C# | End of Construction | | | Tank 1/2 Full | Hydro Test | | End of Operations | Pre Closure | Post Closure |
| 4.43 | **500** | **1000** | **2000** | **2800** | **3300** | **4000** | **5100** | **5500** | **8000** |
| 1 | 0.43 | 0.83 | 1.55 | 2.36 | 2.85 | 3.49 | 4.43 | 4.75 | 8.83 |
| 2 | 0.42 | 0.81 | 1.53 | 2.31 | 2.77 | 3.38 | 4.26 | 4.56 | 8.92 |
| 3 | 0.44 | 0.85 | 1.59 | 2.46 | 2.98 | 3.66 | 4.65 | 4.99 | 9.28 |
| 4 | 0.46 | 0.89 | 1.65 | 2.53 | 3.05 | 3.73 | 4.72 | 5.06 | 9.80 |
| 5 | 0.49 | 0.94 | 1.98 | 2.98 | 3.56 | 4.33 | 5.44 | 5.82 | 12.47 |
| 6 | 0.45 | 0.87 | 1.79 | 2.66 | 3.16 | 3.83 | 4.81 | 5.14 | 11.43 |
| 7 | 0.48 | 0.92 | 1.85 | 2.76 | 3.30 | 4.01 | 5.03 | 5.38 | 11.99 |
| 8 | 0.46 | 0.89 | 1.75 | 2.60 | 3.10 | 3.75 | 4.70 | 5.03 | 10.74 |
| 9 | 0.48 | 0.93 | 1.91 | 2.83 | 3.37 | 4.07 | 5.10 | 5.45 | 13.09 |
| 10 | 0.49 | 0.94 | 1.95 | 2.88 | 3.42 | 4.14 | 5.17 | 5.52 | 13.01 |
| 11 | 0.49 | 0.93 | 1.90 | 2.74 | 3.23 | 3.88 | 4.81 | 5.13 | 12.83 |
| 12 | 0.49 | 0.95 | 1.93 | 2.79 | 3.29 | 3.94 | 4.88 | 5.21 | 13.31 |
| 13 | 0.46 | 0.88 | 1.88 | 2.71 | 3.20 | 3.84 | 4.77 | 5.09 | 12.90 |
| 14 | 0.51 | 0.98 | 2.19 | 3.31 | 3.97 | 4.84 | 6.11 | 6.55 | 12.90 |
| 15 | 0.50 | 0.96 | 2.26 | 3.44 | 4.14 | 5.07 | 6.43 | 6.90 | 14.31 |
| 16 | 0.55 | 1.07 | 2.56 | 3.93 | 4.74 | 5.81 | 7.38 | 7.92 | 15.08 |
| 17 | 0.55 | 1.06 | 2.58 | 3.90 | 4.68 | 5.70 | 7.20 | 7.71 | 15.73 |
| 18 | 0.57 | 1.10 | 2.76 | 4.17 | 4.99 | 6.09 | 7.69 | 8.24 | 16.47 |
| 19 | 0.49 | 0.94 | 2.08 | 3.04 | 3.60 | 4.34 | 5.42 | 5.79 | 13.23 |
| 20 | 0.40 | 0.78 | 1.71 | 2.48 | 2.93 | 3.53 | 4.42 | 4.72 | 9.72 |
| 21 | 0.47 | 0.90 | 2.00 | 2.92 | 3.46 | 4.17 | 5.22 | 5.57 | 12.51 |
| 22 | 0.50 | 0.96 | 2.08 | 3.02 | 3.57 | 4.30 | 5.34 | 5.70 | 13.99 |
| 23 | 0.49 | 0.94 | 2.02 | 2.87 | 3.36 | 4.01 | 4.94 | 5.40 | 15.07 |

**Appendix E – Subgrade Modulus Worksheet**

**$k_1$ based on CPT Tests**

| ID | Average $q_c$ (tsf) | Average $q_c$ (kPa) | Average $F_r$ (%) | $q_u$ / $100F_r$ |
|---|---|---|---|---|
| Average | 140 | 13406 | 2.3 | 58 |
| ***Average*** | ***140*** | ***13406*** | ***2.3*** | ***58*** |

| SDU6 Soil Column | | |
|---|---|---|
| Thickness | 120 | ft |
| Unit Weight | 120.0 | pcf |
| $\sigma_o'$ | 7.200 | ksf |

Modulus of Subgrade Reaction, $k_1$ **240** pci Based on the average $q_u/100F_r$ of 58

**$k_1$ based on CPT and SPT Tests**

| $\eta_1 = E_r / E_{rb}$ | |
|---|---|
| $E_r$ | 60 |
| $E_{rb}$ | 55 |
| $\eta_1$ | 1.09 |

| ID | Average $q_c$ (tsf)* | Average $q_c$ (kPa) | Average N | $N_{55}$ | $q_u$/ $100N_{55}$ |
|---|---|---|---|---|---|
| Average | 140 | 13406 | 32 | 35 | 3.8 |
| ***Average*** | ***140*** | ***13406*** | ***32*** | ***35*** | ***3.8*** |

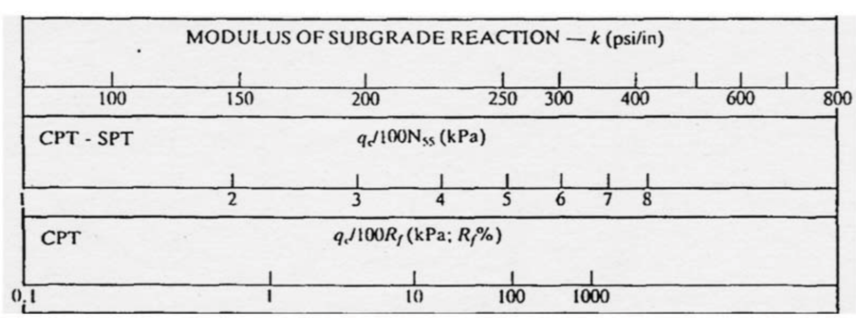
* Average $q_c$ values taken from above

Modulus of Subgrade Reaction, $k_1$ **225** pci Based on the average $q_u/100N_{55}$ of 3.8

**Modulus of Subgrade Reaction, $k_s$**

| | | |
|---|---|---|
| For footings on clay | $k_s = k_1 * B$ | (Bowles Eq. 9-3) |
| For footings on sand | $k_s = k_1 ((B+1) / (2B))^2$ | (Bowles Eq. 9-4) |
| For rectangular footings on sand (B x mB) | $k_s = k_1 ((m+0.5) / (1.5m))$ | (Bowles Eq. 9-5) |

| $k_s$ for ASTM D1196 30 in. plate | | |
|---|---|---|
| CPT | 117.6 | pci |
| CPT-SPT | 110.3 | pci |




Fang, Second Edition

# Appendix D – Liquefaction Analysis

K-CLC-Z-00025, Rev. 0

April 2012

Liquefaction Analysis for Saltstone Disposal Unit 6

(83 pages)

# CALCULATION COVER SHEET

| Project/Task | Calculation No. | Project /Task No. |
|---|---|---|
| Saltstone Disposal Unit 6 | K-CLC-Z-00025 | SDU6 |

**Title**
Liquefaction Analysis for Saltstone Disposal Unit 6

**Functional Classification**
PS

**Sheet 1 of 82** + 1 CD

**Discipline**
Geotechnical

**Calc Level** ☒ Type 1 ☐ Type 2

**Type 1 Calc Status** ☐ Preliminary ☒ Confirmed

**Computer Program No.** ☒ N/A

**Version / Release No.**
N/A

**Purpose and Objective**

The purpose of this calculation is to provide an evaluation of the liquefaction potential and an estimate of settlement resulting from liquefaction, partial liquefaction, and volumetric compression for the Saltstone Disposal Unit 6 project.

**DC/RO**

UNCLASSIFIED
DOES NOT CONTAIN
UNCLASSIFIED CONTROLLED
NUCLEAR INFORMATION
ADC & Reviewing Official [signature]
(Name)
Date: 4/24/12

**Summary of Conclusion**

See the Conclusions Section.

**Revisions**

| Rev. # | Revision Description |
|---|---|
| 0 | Original |
| | |

**Sign Off**

| Rev. # | Originator (Print) Sign / Date | Verification / Checking Method | Verifier/Checker (Print) Sign/Date | Manager (Print) Sign / Date |
|---|---|---|---|---|
| 0 | Rucker J. Williams<br>[signature] 4-17-12 | ☐ Design Check (GS/PS Only)<br>☒ Document Review<br>☐ Qualification Testing<br>☐ Alternate Calculation<br>☐ Operational Testing | Michael J. Hasek<br>[signature] 04/18/12 | Nick Kennedy<br>[signature] 4/18/12 |
| | | ☐ Design Check (GS/PS Only)<br>☒ Document Review<br>☐ Qualification Testing<br>☐ Alternate Calculation<br>☐ Operational Testing | | |

| Additional Reviewer (Print) | Signature | Date |
|---|---|---|
| N/A | | |

| Design Authority (Print) | Signature | Date |
|---|---|---|
| N/A | | |

| Release to Outside Agency (Print) | Signature | Date |
|---|---|---|
| N/A | | |

**Security Classification of the Calculation**
Unclassified

# Table of Contents

## 1. Introduction

The purpose of this calculation is to provide an evaluation of liquefaction potential and estimate settlements due to liquefaction, partial liquefaction, and volumetric compression. See Figure 1 for the location of Disposal Unit 6.

## 2. Input

### 2.1 Site Configuration and Soil Properties

The ground surface elevation at the project site ranges from 275 ft to 282 ft, msl, based on CPT surface elevations and SRS topographic maps. Groundwater elevation at the site ranges from 215 to 220 ft, msl (Ref. WSRC 2003).

Five (5) geotechnical borings, three (3) undisturbed sample borings and two (2) Standard Penetration Test (SPT) borings, were performed for the Saltstone Disposal Unit 6, see Figure 2. Boring Z-SDU6-B02A was abandoned at a depth of 75 feet; boring Z-SDU6-B02B was performed adjacent to the abandoned boring. Stratigraphic interpretations for the three borings were based primarily on the geophysical logs. Twenty-three (23) CPTs and SCPTs were pushed for Saltstone Disposal Unit 6 (see Figure 2). Stratigraphic interpretations of the borings, CPTs, and SCPTs are summarized below (Ref. SRS 2012a).

| | | | | | Elevation Top Pick (ft, msl) | | | |
|---|---|---|---|---|---|---|---|---|
| ID | Type | SRS Northing | SRS Easting | Elevation ft, msl | C2 Layer | S3 Layer | S4 Layer | Congaree |
| Z-SDU6-C01 | CPT | 77413.3 | 66270.1 | 281.9 | 233 | 226 | 190 | |
| Z-SDU6-C02 | SCPT | 77448.1 | 66350.4 | 281.4 | 233 | 227 | 190 | |
| Z-SDU6-C03 | CPT | 77478.3 | 66494.3 | 281.6 | 233 | 225 | 190 | |
| Z-SDU6-C04 | CPT | 77503.3 | 66578.8 | 281.8 | 236 | 229 | 190 | |
| Z-SDU6-C05 | SCPT | 77624.5 | 66594.9 | 278.1 | 235 | 226 | 187 | |
| Z-SDU6-C06 | CPT | 77587.6 | 66472.8 | 278.6 | 234 | 227 | 189 | |
| Z-SDU6-C07 | CPT | 77546.9 | 66357.1 | 279.4 | 237 | 230 | 191 | |
| Z-SDU6-C08 | CPT | 77511.4 | 66258.9 | 279.7 | 236 | 230 | 186 | |
| Z-SDU6-C09 | CPT | 77621.8 | 66210.4 | 278.3 | 237 | 230 | 194 | |
| Z-SDU6-C10 | CPT | 77644.2 | 66285.6 | 278.0 | 237 | 230 | 190 | |
| Z-SDU6-C11 | CPT | 77663.3 | 66354.1 | 277.6 | 238 | 233 | 186 | |
| Z-SDU6-C12 | SCPT | 77682.6 | 66452.6 | 277.7 | 239 | 234 | 188 | |
| Z-SDU6-C13 | CPT | 77722.6 | 66523.4 | 276.3 | 234 | 228 | 188 | |
| Z-SDU6-C14 | CPT | 77720.6 | 66180.9 | 277.3 | 234 | 222 | 181 | |
| Z-SDU6-C15 | CPT | 77748.2 | 66249.8 | 276.8 | 232 | 217 | 192 | |
| Z-SDU6-C16 | SCPT | 77772.2 | 66312.2 | 276.7 | 234 | 216 | 184 | |
| Z-SDU6-C17 | CPT | 77796.3 | 66393.3 | 276.0 | 235 | 219 | 187 | |
| Z-SDU6-C18 | SCPT | 77819.4 | 66471.7 | 275.6 | 235 | 217 | 186 | |
| Z-SDU6-C19 | SCPT | 77869.3 | 66155.6 | 276.4 | 235 | 227 | 183 | |
| Z-SDU6-C20 | CPT | 77895.0 | 66236.9 | 276.0 | 226 | 219 | 176 | |
| Z-SDU6-C21 | CPT | 77920.9 | 66321.6 | 276.3 | 233 | 225 | 182 | |
| Z-SDU6-C22 | CPT | 77947.5 | 66415.1 | 276.5 | 237 | 230 | 187 | |
| Z-SDU6-C23 | CPT | 77967.7 | 66482.5 | 275.5 | 238 | 233 | 190 | |

| ID | Type | SRS Northing | SRS Easting | Elevation ft, msl | Elevation Top Pick (ft, msl) C2 Layer | S3 Layer | S4 Layer | Congaree |
|---|---|---|---|---|---|---|---|---|
| Z-SDU6-B01 | UD | 77771.3 | 66309.1 | 276.6 | | | | |
| Z-SDU6-B02A | UD | 77625.3 | 66594.8 | 278.0 | | | | |
| Z-SDU6-B02B | UD | 77629.2 | 66588.9 | 278.1 | 234 | 227 | 191 | |
| Z-SDU6-B03 | SPT | 77769.6 | 66304.5 | 276.5 | 232 | 217 | 188 | 146 |
| Z-SDU6-B04 | SPT | 77663.9 | 66351.1 | 277.9 | 236 | 232 | 191 | 145 |

S1/S2 layer consists of the Upland Formation, Tobacco Road Formation, and the upper portion of the Dry Branch Formation. The C2 Layer is the Tan Clay Unit within the Dry Branch Formation. The S3 layer is the lower portion of the Dry Branch Formation, while the S4 layer is the Santee/Tinker Formation. For this calculation, the liquefaction analysis is performed for the saturated portions of the Tobacco Road and Dry Branch Formations (S1/S2, C2, and S3 layers).

Formations below the Santee Formation (S4) are assumed to have no dynamic settlement contributions as they are too dense (Ref. SRS 2008). SPT N values for soils below the S4 layer reaffirm this assumption. Dynamic settlement within the Santee Formation due to “soft zones” is covered in another calculation, K-CLC-Z-00026.

Total unit weights for soils beneath Saltstone Disposal Unit 6 range from 93 to 130 pcf. Recommended values for in situ soils range from 106 to 123 pcf. The average layer-specific total unit weight will be utilized in this calculation. The recommended total unit weights are summarized in the table below. Sieve analyses were performed on soil samples taken from geotechnical boreholes as part of the subsurface investigation (Ref. SRS 2012b). The locations of the boreholes are summarized in the table above (Ref. SRS 2012a). Table 1 summarizes the fines content of the soil samples.

| Layer | Total Unit Weight |
|---|---|
| S1/S2 | 123 pcf |
| C2 | 106 pcf |
| S3 | 116 pcf |
| S4 | 119 pcf |

## 2.2 **Design Basis Earthquake**

The design basis earthquake is a 2,500 year return event developed based on SRS Engineering Standard 1060 (Ref. SRS 2010). For Seismic Design Category (SDC) 1 and 2 structures the DBE is based on the methodology found in the IBC Sections 1613 and 1803 (Ref. IBC 2009). The peak ground acceleration (PGA) used in the calculation was 0.18g. The derivation of this value is found in Appendix B.

The USGS has performed a site-specific Probabilistic Seismic Hazard Analysis (PSHA) at the top of rock for the SRS (Ref. Frankel 1999). See Appendix C. The SRS PGA deaggregation for the 2,500 year return period is presented in Figure 2 and Table 2. The hazard deaggregation is used to establish weights for averaging earthquake results based on earthquake magnitude.

## 3. Computation

### 3.1 **Liquefaction Susceptibility**

In this calculation the liquefaction potential for the Saltstone Disposal Units 3 and 5 is evaluated using a modified version of the "Simplified Procedure for Evaluating Soil Liquefaction Potential" (Ref. Seed and Idriss 1971; NCEER, 1997; Youd et al. 2001). The simplified procedure calculates the liquefaction factor of safety as the ratio of Cyclic Resistance Ratio (CRR) to the Cyclic Stress Ratio (CSR) generated by the earthquake.

Factor of Safety = CRR / CSR

It should be noted that CRR was previously termed the CSR required to induce liquefaction, but has been changed to more clearly distinguish the term from the CSR induced by the earthquake (Ref. NCEER, 1997). The CRR (soil capacity) and CSR (earthquake demand) are defined below

$$CRR = \tau_{ave\text{-}liq} / \sigma'_{vo}$$

where:

$\tau_{ave\text{-}liq}$ = average shear stress required to induce liquefaction
$\sigma'_{vo}$ = effective vertical overburden stress

CSR is

$$CSR = \tau_{ave} / \sigma'_{vo} = 0.65 \times (a_{max} / g) \times (\sigma_{vo} / \sigma'_{vo}) \times r_d$$

where:

$\tau_{ave}$ = average shear stress induced by the earthquake
$\sigma'_{vo}$ = effective vertical overburden stress

#### *3.1.1 Earthquake Demand or Cyclic Stress Ratio (CSR)*

The "Simplified Procedure for Evaluating Soil Liquefaction Potential" uses peak ground acceleration (PGA) to estimate shear stress ($\tau_{ave}$) at ground surface and a stress reduction factor ($r_d$) to calculate $\tau_{ave}$ as a function of depth (Ref. Seed and Idriss, 1971; NCEER, 1997). The simplified method of CSR determination is given below.

$$CSR = \tau_{ave} / \sigma'_{vo} = 0.65 \times (a_{max} / g) \times (\sigma_{vo} / \sigma'_{vo}) \times r_d$$

where

$a_{max}$ = maximum horizontal acceleration at ground surface
$g$ = the gravitational acceleration
$\sigma_{vo}$ = total vertical stress
$\sigma'_{vo}$ = effective vertical stress
$r_d$ = stress reduction factor as a function of depth in meters
= $1.000 - 0.00765z$ for $z \leq 9.15$ m
= $1.174 - 0.0267z$ for $9.15 \text{ m} < z \leq 23$ m
= $0.744 - 0.0080z$ for $23 \text{ m} < z \leq 30$ m
= $0.500$ for $z > 30$ m

#### *3.1.2* **Soil Capacity or Cyclic Resistance Ratio (CRR)**

The original simplified procedure determines CRR using the normalized and corrected Standard

Penetration Test (SPT) $N_{160}$ values and a boundary curve delineating liquefaction. The CRR from the curve is further modified by several factors that have been developed over time. These factors correct for: aging, static driving shear stress, overburden pressure, fines content, and earthquake magnitude. For this calculation the curves based on CPTu tip stress ($q_{t1}$) are used to determine CRR. The $q_{t1}$ CRR curves were developed from testing of SRS soils in lieu of the standard SPT and CPTu liquefaction methods developed for Holocene and younger deposits (Ref. SRS 2007b). When applying the correction factors, the Factor of Safety is expressed as given below. Each of the correction factors used in this calculation for determining CRR is discussed in the following sections.

$$\text{Factor of Safety} = \frac{CRR_{7.5} \cdot K_{\sigma} \cdot K_{age} \cdot K_{\alpha} \cdot MSF}{CSR}$$

### *3.1.3* Age Correction Factor $K_{age}$

The $q_{t1}$ curves used for this calculation were developed specifically for SRS using data from investigations in H-Area after extensive field and laboratory testing programs (Ref. BSRI 1993; WSRC 1995; SRS 2007a). Because the SRS $q_{t1}$ CRR curves were developed from testing of the Tobacco Road and Dry Branch sediments, aging is incorporated into the curves. The curves may be directly applied to calculate liquefaction susceptibility without applying an age correction factor (i.e., $K_{age}$ = 1.0).

### *3.1.4* Static Driving Shear Stress Correction Factor, $K_{\alpha}$

Relationships proposed by Seed and Harder (1990) suggest that a static driving shear stress can increase or decrease the soil's resistance to liquefaction, depending on the magnitude of the driving stress and the relative density of the soil. A static driving shear stress correction factor ($K_{\alpha}$) has been proposed by Seed and Harder to correct CRR (Ref. Seed and Harder 1990). However, the proposed chart to estimate $K_{\alpha}$ is preliminary and this correction factor is a subject of current research (Ref. NCEER, 1997). For this calculation, no $K_{\alpha}$ correction was used (i.e., $K_{\alpha}$ = 1.0).

### *3.1.5* Static Effective Overburden Pressure Correction Factor, $K_{\sigma}$

Most of the case history data used to develop the standard liquefaction curves (Ref. Seed and Idriss 1982; NRC 1985) were taken from cases of level ground with relatively small initial effective overburden stresses ($\sigma'_o \leq 1$ tsf). However, at higher effective overburden stresses ($\sigma'_o > 1$ tsf), the liquefaction susceptibility of the soil will increase for a given CSR (Ref. Seed and Harder 1990). Thus, the CRR must be corrected for the influence of the static overburden stresses. This is done by multiplying CRR by the correction factor $K_{\sigma}$. The soils at SRS are much older than the case history data typically used for liquefaction studies. Therefore, testing of soils at SRS has been performed to determine appropriate $K_{\sigma}$ for SRS soils (Ref. WSRC 1995; BSRI 1993). Figure 3 shows the SRS $K_{\sigma}$ curve along with data used to develop the curve (Ref. SRS 1994a). The NCEER recommended $K_{\sigma}$ curves (Ref. Youd et al. 2001) are also shown on Figure 3 for comparison. The polynomial representing the SRS $K_{\sigma}$ curve shown in Figure 3 is given below.

$$K_\sigma = 1.009376 - 0.18326 \log(\sigma'_{vo}) - 0.08340 \log(\sigma'_{vo})^2$$

where:

$\sigma'_{vo}$ = Effective Vertical Overburden Pressure in tsf.

Note that the $K_\sigma$ used for this calculation is the site-specific relationship developed using data from investigations in H-Area (Ref. WSRC 1995; SRS 1994a and SRS 2007a) and not the standard $K_\sigma$ relationship proposed by NCEER (Ref. Youd et al. 2001). The SRS $K_\sigma$ is used but is less stringent than the $K_\sigma$ proposed by NCEER.

### *3.1.6* Earthquake Magnitude Scaling Factor, MSF

The CRR curves used for liquefaction analysis are only valid for M = 7.5 earthquakes. For earthquakes with differing magnitudes, the CRR values must be multiplied by a magnitude scaling factor (MSF).

The earthquake magnitudes from the PSHA and the appropriate MSF for each magnitude are given below. These MSFs represent the middle of the NCEER (1997) recommended values shown on Figure 4 and were used to fit an exponential curve.

| Earthquake Magnitude (Mw) | Magnitude Scaling Factor |
|---|---|
| 5.5 | 2.5 |
| 6.0 | 2.0 |
| 6.5 | 1.6 |
| 7.0 | 1.25 |
| 7.5 | 1.0 |
| 8.0 | 0.8 |
| 8.5 | 0.7 |

The MSF equation is given by

$$MSF = 27.3e^{-0.44 \times Mw}$$

where

$M_W$ = earthquake magnitude

The MSF equation is rounded to the nearest tenth (0.1) for use in calculations.

### *3.1.7 CRR from the SRS $q_{t1}$ versus CRR Curves*

The CRR curves utilized at SRS were reevaluated to incorporate the state of the art methods used in liquefaction analysis. The new CRR curves are presented in this calculation and are recommended for design.

3.1.7.1. *Current SRS CRR Curves*

Figure 5 presents the SRS $q_{t_1}$ versus CRR curves (Ref. SRS 2007b). Equations for these curves allow computer application of the SRS $q_{t_1}$ versus CRR curves. Laboratory testing and development of the curves are discussed in SRS (2007a) and by Lewis and Arango (Ref. SRS 2007b).

The SRS CRR relationship has adopted the shape of the Idriss and Boulanger CRR relationship. The SRS clean sand curve is the Idriss and Boulanger relationship multiplied by a factor of 1.3 to account for strength gain due to aging (Ref. SRS 2007b). The Idriss and Boulanger CRR clean

sand curve (i.e., fines content ≤ 5%) is given below (Ref. Idriss and Boulanger 2004).

$$CRR_{M=7.5,\sigma'_{vo}=1} = \exp\left[\left(\frac{(q_t)_1}{540}\right) + \left(\frac{(q_t)_1}{67}\right)^2 - \left(\frac{(q_t)_1}{80}\right)^3 + \left(\frac{(q_t)_1}{114}\right)^4 - 3\right]$$

This same curve is multiplied by increasing factors to account for aging and increased fines content. The multipliers for various fines contents are provided below (Ref. SRS 2007b).

| Fines Content (%) | SRS Multiplier for CRR Curve |
|---|---|
| K5 | 1.3 |
| 10 | 1.6 |
| 15 | 2.1 |
| 20 | 2.6 |
| 25 | 3.1 |
| ≥30 | 3.4 |

The CPTu tip stress ($q_t$) must be normalized ($q_{t_1}$) for overburden stress prior to applying the CRR curves. This is done using an overburden correction factor $C_Q$ shown below (Ref. Youd et al. 2001).

$q_{t_1} = C_Q \text{ x } q_t$

$C_Q = (P_a / \sigma'_{vo})^n$ with $C_Q \leq 1.7$

where

$C_Q$ = CPTu Overburden Normalization Factor

$P_a$ = Atmospheric pressure (1 atm, 1 tsf)

$\sigma'_{vo}$ = Effective vertical overburden pressure at time of testing

$P_a$ and $\sigma'_{vo}$ must be in the same units

n = exponent ranges between 0.5 for clean sand and 1.0 for clays

For this calculation the exponent n was assumed to vary linearly, based on percent fines, between 0.5 for clean sand (i.e., fines ≤ 5%) and 1.0 for clays (i.e., fines ≥ 50%). It is important to note that normalization of $q_t$ to $q_{t_1}$ is performed using effective vertical overburden pressure at the time of data collection.

### *3.1.8* Percent Fines

The liquefaction methodology used in this calculation requires percent fines to determine CRR. Percent fines is determined using an SRS site-specific CPTu method that was developed by correlating laboratory determined fines content from borings with nearby CPTu results (Ref. SRS 2001). The SRS method uses a classification index ($I_c$) to calculate percent fines. The SRS method is given below.

Percent Fines = $29.47(I_c)^{1.21} - 0.09$

$I_c = [(1.60\text{-}\log Q_t)^2 + (\log Fr + 0.41)^2]^{0.5}$

where:

$Q_t$ = normalized tip resistance $Q_t = (q_t - \sigma_{vo}) / \sigma'_{vo}$
Fr = stress normalized friction ratio $Fr = [(f_s/(q_t - \sigma_{vo}) \times 100]$
$q_t$ = CPTu tip stress corrected for unequal area effects
$f_s$ = CPTu sleeve friction
$\sigma_{vo}$ = total vertical stress (total unit weight of soil × depth)
$\sigma'_{vo}$ = effective vertical stress

Table 1 summarizes the fines content determined from samples taken during the subsurface investigations (Ref. SRS 2012b). The four borings at Saltstone Disposal Unit 6 were generally located within approximately 10 feet of a CPT/SCPT. Figures 6 through 8 compare the laboratory measured fines content to the CPT calculated fines content. The CPT results provide reasonable estimates of fines content.

## 3.2 **Dynamic Settlement above the Santee Formation**

Settlement due to liquefaction and partial liquefaction can be calculated using standard techniques from the geotechnical engineering literature or techniques based on site-specific testing. Due to the age and increased strength, it was necessary to sample and test SRS soils to quantify strain due to cyclic loading.

### ***3.2.1 Volumetric Strain Curves***

SRS-specific volumetric strain curves were developed during sampling and laboratory testing programs from H Area (Ref. SRS 1994b; SRS 2006b; BSRI 1993; WSRC, 1995). The SRS volumetric strain curves (Figure 9) give volumetric strain as a function of CPTu tip resistance and factor of safety. Because the SRS volumetric strain curves were developed from testing of the Tobacco Road and Dry Branch sediments, the curves incorporate strength due to aging. These soils were generally classified as SC or SM soils with liquid limits ranging from non-plastic (NP) to 80% (Ref. SRS 2007b). Similar soil conditions are found at the Saltstone Disposal Unit 6 site (Ref. SRS 2012b).

For conservatism, the SRS volumetric strain curves considered liquefaction triggered in all zones having a factor of safety less than or equal to 1.15 (Ref. BSRI 1993; WSRC 1995). Soils having factors of safety between 1.15 and 2.2 are considered to be partially liquefied. Soils with a factor of safety greater than 2.2 are considered to be non-liquefiable. No settlement is expected for factors of safety greater than 2.2.

The volumetric strain curves developed for SRS using H-Area data and used in this calculation are presented in Figure 9 (Ref. SRS, 2006b; WSRC 1995). The volumetric strain curves for various values of $q_{t_1}$ are a function of factor of safety. These curves have been fitted with the following regression equations, which were derived and presented in calculation C-CLC-H-00815 (Ref. SRS 2006b).

for $q_{t_1} = 160$, and $0.4 < FS < 1.15$

strain (%) = 0.65

for $q_{t_1} = 130$, and $0.4 < FS < 1.15$

strain (%) = $2.9883 + 10.354(FS)^4 - 30.258(FS)^3 + 30.7(FS)^2 - 13.064(FS)$

for $q_{t_1}$ = 100, and 0.4 < FS < 1.15

strain (%) = $2.0308 + 8.3929(FS)^4 - 21.111(FS)^3 + 16.12(FS)^2 - 4.5756(FS)$

for $q_{t_1}$ = 50, and 0.4 < FS < 0.65

strain (%) = $-41.6495 - 756.666(FS)^4 + 1505.222(FS)^3 - 1123.65(FS)^2 + 371.2387(FS)$

for $q_{t_1}$ = 50, and 0.65 < FS < 1.15

log strain (%) = $1.256225 - 0.21100(FS)^2 - 1.01242(FS)$

for $q_{t_1}$ = 30, and 0.4 < FS < 0.65

strain (%) = $-45.4815 - 830.0000(FS)^4 + 1651.074(FS)^3 - 1231.64(FS)^2 + 406.5062(FS)$

for $q_{t_1}$ = 30, and 0.65 < FS < 1.15

log strain (%) = $1.181442 - 0.47909(FS)^2 - 0.63184(FS)$

for $q_{t_1}$ = 20, and 0.4 < FS < 0.65

strain (%) = $-45.2315 - 830.0000(FS)^4 + 1651.074(FS)^3 - 1231.64(FS)^2 + 406.5062(FS)$

for $q_{t_1}$ = 20, and 0.65 < FS < 1.15

log strain (%) = $0.679601 - 1.17026(FS)^2 + 0.616392(FS)$

for $q_{t_1}$ = 10, and 0.4 < FS < 0.65

strain (%) = $-29.6577 - 560.0000(FS)^4 + 1114.074(FS)^3 - 836.066(FS)^2 + 278.6576(FS)$

for $q_{t_1}$ = 10, and 0.65 < FS < 1.15

log strain (%) = $0.454166 - 1.56185(FS)^2 + 1.272068(FS)$

for $q_{t_1}$ = 5, and 0.4 < FS < 0.65

strain (%) = $-29.7775 - 566.666(FS)^4 + 1127.333(FS)^3 - 845.883(FS)^2 + 281.8638(FS)$

for $q_{t_1}$ = 5, and 0.65 < FS < 1.15

log strain (%) = $0.367762 - 1.73636(FS)^2 + 1.555255(FS)$

for partial liquefaction 1.15 < FS < 1.6 and all $q_{t_1}$ values

log strain (%) = $1.256225 - 0.21100(FS)^2 - 1.01242(FS)$

for partial liquefaction 1.6 < FS < 2.2 and all $q_{t_1}$ values

strain (%) = $0.728794 + 0.100221(FS)^2 - 0.54090(FS)$

### *3.2.2* Liquefaction and Partial Liquefaction Settlement

For this calculation the volumetric strain curves were used for evaluation purposes. Dynamic settlement of unsaturated (i.e., above the water table) sands was ignored, because of their small contribution to the total dynamic settlement (Appendix D)

It was assumed that all liquefiable and partially liquefiable zones will settle and the resulting settlement will be cumulative at the surface. No consideration is given for dilation or bridging effects of interspersed or overlying, non-liquefied layers. This is a conservative assumption and actual settlements may be less, especially if the thickness of the non-liquefied layers is

substantial. Total cumulative settlement resulting from liquefaction and partial liquefaction is estimated for the profile by summing the liquefaction settlement or partial liquefaction settlement for each increment:

$$S_{Total} = \Sigma\, S_{Liq} + \Sigma\, S_{P\ Liq} + \Sigma\, S_{Dry} \qquad \text{(Eq. 32)}$$

where:

$S_{Total}$ = cumulative settlement,
$S_{Liq}$ = settlement of the increment due to liquefaction,
$S_{P\ Liq}$ = settlement of the increment due to partial liquefaction,
$S_{Dr}$ = dynamic settlement of dry sands

The value of $S_{Liq}$ and $S_{P\ Liq}$ are calculated from:

$$S_{Liq} = \text{(volumetric strain due to liquefaction) dz} \qquad \text{(Eq. 33)}$$

$$S_{P\ Liq} = \text{(volumetric strain due to partial liquefaction) dz} \qquad \text{(Eq. 34)}$$

where:

dz = thickness of the increment.

## 3.3 **Liquefaction Hazard Weighting**

Table 2 summarizes the PGA hazard for the 2,500 year earthquake (Ref. Frankel 1999). The weight for a given magnitude range is the sum of the weights for the various distances for the given magnitude Settlement due to liquefaction and partial liquefaction is calculated using different magnitudes. The magnitudes selected are the midpoints of the magnitude ranges given in Table 2 (i.e. 4.75, 5.25, 5.75, 6.25, 6.75, and 7.5). The results are then weighted according to the PGA hazard deaggregation.

$$Sw = \Sigma\, (S_{Mw\text{-}i} \times W_{Mw\text{-}i}) / \Sigma\, W_{Mw\text{-}i}$$

where:

$S_{Mw\text{-}i}$ = cumulative settlement for a given earthquake magnitude
$W_{Mw\text{-}i}$ = weight for a given earthquake magnitude

## 3.4 **Shear Wave Velocity Determination of CRR**

CRR values can be computed using shear wave velocity as follows (Ref. Andrus and Stokoe 2000): Note, these curves were generated based on uncemented, Holocene age soils.

$$CRR = 0.022\left(\frac{V_{S1}}{100}\right)^2 + 2.8\left(\frac{1}{V_{S1}^* - V_{S1}} - \frac{1}{V_{S1}^*}\right)$$

where

$V_{S1}$ = the shear wave velocity corrected for overburden stress
$V_{s1}^*$ = the limiting value of $V_{S1}$ for cyclic liquefaction occurrence

$V_{S1}$ is computed by

$$V_{S1} = V_S\left(\frac{P_a}{\sigma'_{vo}}\right)^{0.25}$$

where

$P_a$ = Atmospheric pressure (1 atm, 1 tsf)

$\sigma'_{vo}$ = effective vertical stress

$V_{S1}^*$ is computed by the following

$V_{S1}^*$ = 215 m/s for $FC \leq 5\%$

$V_{S1}^*$ = 215 – 0.5(FC – 5) m/s for $5\% < FC < 35\%$

$V_{S1}^*$ = 200 m/s for $FC \geq 35\%$

where

FC = fines content (%)

Figure 10 presents the $V_{S1}^*$ vs CRR curves.

The method incorporating site-specific CRR curves presented in Section 3.1.7 is considered more applicable than the CRR computed using shear wave velocity; however this was done for comparative purposes.

## 4. Results

Table 3 summarizes the liquefaction induced settlement using the SRS CRR curves. Individual CPT settlements (for a 7.5 magnitude earthquake) range from less than ¼ inch to 2¼ inches based on the new CRR curves. All settlements for the 7.5 magnitude earthquake are less than 1.0 inch except for CPTs Z-SDU6-C09 (1.0 inches) and Z-SDU6-C10 (2.2 inches). The increased liquefaction settlements in CPTs Z-SDU6-C10 is due to a 2-foot lens of cohesionless material located at elevation 200 ft msl which is susceptible to liquefaction under the DBE.

The weighted average using the USGS PGA hazard deaggregation for weighting is ¼-inch for the 2,500 year earthquake. The USGS weighted 2,500-year settlements range from 0.1 inch to 1.1 inch. The settlement is expected to occur rather uniformly and thus not contribute significantly to differential settlement. Similar results were computed for Saltstone Vault No. 2 (SRS 2006a) and for Saltstone Disposal Units No. 3 and 5 (SRS 2009).

Liquefaction settlements in the S4 formation result from partial liquefaction (1.15 <FS<2.2). CPTs Z-SDU6-C20, -C21, and -C22 appear to have completely penetrated the S4 formation (Ref. SRS 2012c). For the magnitude 7.5 earthquake the settlements in the S4 formation is approximately ¼ inch, all due to partial liquefaction. For lesser magnitude earthquakes the settlements in the S4 formation are negligible. Based on the deaggregation weight of the 7.5 magnitude earthquake, this would add approximately ⅛-inch to the 2,500-year weighted average for the remaining CPTs, all of which had partial penetration of the S4 layer, thus reducing the amount to be added to the total settlements. The partial liquefaction settlement in the S4 layer is expected to be uniform and thus not contribute to differential settlement.

Liquefaction potential based on the CRR determination using shear wave velocity indicates the soil is generally not susceptible to liquefaction. The average factors of safety are in excess of 3.0 for each of the SCPTs considered. The minimum factors of safety from the SCPTs range from 0.5 to more than 5.0. For the point which has a factor of safety less than one, the fines content is in excess of 40%, which tends to reduce the susceptibility to liquefaction. See the attached summary pages in Appendix E. Settlements were not calculated using factors of safety

determined through the use of shear wave velocities since the SRS volumetric strain curves are correlated to CPT tip stresses.

The maximum liquefaction induced settlements occur in CPTs Z-SDU6-C10 and Z-SDU6-C09, on cross section CC. See Figure 11 for SDU6 cross sections. The greatest differential settlement due to liquefaction would be expected to occur between these and adjacent locations. The distance between cross sections BB and CC, and CC and DD is approximately 110 feet each. The differential settlement is taken to be twice the standard deviation (Ref. SRS 2008) of the weighted 2,500 year settlements.

## 5. Conclusions

Excepting the lens of cohesionless material in Z-SDU6-C10, the Saltstone Disposal Unit 6 location has acceptable margin against liquefaction. The maximum settlement is expected to occur in the vicinity of Z-SDU6-C10, along cross section CC.

Including S4 partial liquefaction settlement, the average 2,500 year weighted settlement is less than ½-inch.

The maximum differential liquefaction-induced settlement is ½-inch.

## 6. References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**Tables**

**Table 1: Fines Content**

| Boring No. | Sample No. | Top Elevation (ft, msl) | Bottom Elevation (ft, msl) | Engineering Layer | Percent Fines |
|---|---|---|---|---|---|
| Z-SDU6-B01 | ST02 | 261.6 | 259.6 | S1/S2 | 37.0 |
| Z-SDU6-B01 | FPT01 | 254.6 | 252.6 | S1/S2 | 84.8 |
| Z-SDU6-B01 | ST03 | 241.6 | 240.3 | S1/S2 | 10.0 |
| Z-SDU6-B01 | ST04 | 228.6 | 226.6 | C2 | 44.5 |
| Z-SDU6-B01 | ST05 | 225.5 | 223.5 | C2 | 64.9 |
| Z-SDU6-B01 | ST06 | 218.6 | 216.6 | C2 | 36.1 |
| Z-SDU6-B01 | ST08 | 203.4 | 201.4 | S3 | 10.9 |
| Z-SDU6-B01 | FPT02 | 194.6 | 192.6 | S3 | 8.6 |
| Z-SDU6-B01 | ST11 | 150.5 | 149.0 | S4 | 26.0 |
| Z-SDU6-B02A | FPT01 | 234.0 | 232.0 | C2 | 24.9 |
| Z-SDU6-B02A | FPT02 | 231.0 | 229.0 | C2 | 40.2 |
| Z-SDU6-B02A | ST02 | 267.5 | 267.0 | S1/S2 | 45.2 |
| Z-SDU6-B02B | FP01 | 203.1 | 201.1 | S3 | 30.2 |
| Z-SDU6-B03 | SS01 | 264.5 | 262.5 | S1/S2 | 33.4 |
| Z-SDU6-B03 | SS02 | 262.5 | 260.5 | S1/S2 | 26.9 |
| Z-SDU6-B03 | SS03 | 260.5 | 258.5 | S1/S2 | 48.0 |
| Z-SDU6-B03 | SS04 | 253.5 | 251.5 | S1/S2 | 42.0 |
| Z-SDU6-B03 | SS05 | 251.5 | 249.5 | S1/S2 | 41.3 |
| Z-SDU6-B03 | SS06 | 249.5 | 247.5 | S1/S2 | 83.5 |
| Z-SDU6-B03 | SS07 | 247.5 | 245.5 | S1/S2 | 23.3 |
| Z-SDU6-B03 | SS08 | 245.5 | 243.5 | S1/S2 | 24.8 |
| Z-SDU6-B03 | SS09 | 243.5 | 241.5 | S1/S2 | 36.4 |
| Z-SDU6-B03 | SS10 | 241.5 | 239.5 | S1/S2 | 21.4 |
| Z-SDU6-B03 | SS11 | 239.5 | 237.5 | S1/S2 | 23.9 |
| Z-SDU6-B03 | SS12 | 237.5 | 235.5 | S1/S2 | 15.7 |
| Z-SDU6-B03 | SS13 | 234.5 | 232.5 | S1/S2 | 23.5 |
| Z-SDU6-B03 | SS14 | 228.5 | 226.5 | C2 | 43.1 |
| Z-SDU6-B03 | SS15 | 223.5 | 221.5 | C2 | 60.4 |
| Z-SDU6-B03 | SS16 | 218.5 | 216.5 | C2 | 36.7 |
| Z-SDU6-B03 | SS17 | 213.5 | 211.5 | S3 | 7.6 |
| Z-SDU6-B03 | SS18 | 208.5 | 206.5 | S3 | 6.9 |
| Z-SDU6-B03 | SS19 | 203.5 | 201.5 | S3 | 16.0 |
| Z-SDU6-B03 | SS20 | 198.5 | 196.5 | S3 | 7.3 |
| Z-SDU6-B03 | SS21 | 193.5 | 191.5 | S3 | 9.7 |
| Z-SDU6-B03 | SS22 | 188.5 | 186.5 | S4 | 36.1 |
| Z-SDU6-B03 | SS23 | 183.5 | 181.5 | S4 | 51.1 |
| Z-SDU6-B03 | SS24 | 178.5 | 176.5 | S4 | 50.2 |
| Z-SDU6-B03 | SS25 | 173.5 | 171.5 | S4 | 50.0 |
| Z-SDU6-B03 | SS26 | 168.5 | 166.5 | S4 | 18.0 |
| Z-SDU6-B03 | SS27 | 163.5 | 161.5 | S4 | 58.2 |
| Z-SDU6-B03 | SS28 | 158.5 | 156.5 | S4 | 38.7 |
| Z-SDU6-B03 | SS29 | 153.5 | 151.5 | S4 | 96.3 |
| Z-SDU6-B03 | SS30 | 148.5 | 146.5 | S4 | 47.0 |
| Z-SDU6-B03 | SS31 | 143.5 | 141.5 | S4 | 8.6 |
| Z-SDU6-B03 | SS33 | 133.5 | 131.5 | S4 | 10.3 |
| Z-SDU6-B03 | SS34 | 128.5 | 126.5 | S4 | 12.2 |
| Z-SDU6-B04 | SS01 | 263.9 | 261.9 | S1/S2 | 19.4 |

| Boring No. | Sample No. | Top Elevation (ft, msl) | Bottom Elevation (ft, msl) | Engineering Layer | Percent Fines |
|---|---|---|---|---|---|
| Z-SDU6-B04 | SS02 | 261.9 | 259.9 | S1/S2 | 16.7 |
| Z-SDU6-B04 | SS03 | 259.9 | 257.9 | S1/S2 | 13.4 |
| Z-SDU6-B04 | SS04 | 257.9 | 255.9 | S1/S2 | 47.2 |
| Z-SDU6-B04 | SS05 | 255.9 | 253.9 | S1/S2 | 43.6 |
| Z-SDU6-B04 | SS06 | 253.9 | 251.9 | S1/S2 | 22.8 |
| Z-SDU6-B04 | SS07 | 251.9 | 249.9 | S1/S2 | 24.5 |
| Z-SDU6-B04 | SS08 | 249.9 | 247.9 | S1/S2 | 18.8 |
| Z-SDU6-B04 | SS09 | 247.9 | 245.9 | S1/S2 | 19.4 |
| Z-SDU6-B04 | SS10 | 245.9 | 243.9 | S1/S2 | 12.3 |
| Z-SDU6-B04 | SS11 | 243.9 | 241.9 | S1/S2 | 7.9 |
| Z-SDU6-B04 | SS12 | 241.9 | 239.9 | S1/S2 | 11.4 |
| Z-SDU6-B04 | SS13 | 239.9 | 237.9 | S1/S2 | 12.4 |
| Z-SDU6-B04 | SS14 | 237.9 | 235.9 | S1/S2 | 17.0 |
| Z-SDU6-B04 | SS15 | 234.9 | 232.9 | C2 | 32.0 |
| Z-SDU6-B04 | SS16 | 229.9 | 227.9 | S3 | 13.9 |
| Z-SDU6-B04 | SS17 | 224.9 | 222.9 | S3 | 15.8 |
| Z-SDU6-B04 | SS18 | 219.9 | 217.9 | S3 | 23.5 |
| Z-SDU6-B04 | SS19 | 214.9 | 212.9 | S3 | 8.8 |
| Z-SDU6-B04 | SS20 | 209.9 | 207.9 | S3 | 7.8 |
| Z-SDU6-B04 | SS21 | 204.9 | 202.9 | S3 | 14.6 |
| Z-SDU6-B04 | SS22 | 199.9 | 197.9 | S3 | 6.4 |
| Z-SDU6-B04 | SS23 | 194.9 | 192.9 | S3 | 10.0 |
| Z-SDU6-B04 | SS24 | 189.9 | 187.9 | S4 | 34.4 |
| Z-SDU6-B04 | SS25 | 184.9 | 182.9 | S4 | 50.4 |
| Z-SDU6-B04 | SS26 | 179.9 | 177.9 | S4 | 52.8 |
| Z-SDU6-B04 | SS27 | 174.9 | 172.9 | S4 | 74.8 |
| Z-SDU6-B04 | SS28 | 169.9 | 167.9 | S4 | 36.3 |
| Z-SDU6-B04 | SS29 | 164.9 | 162.9 | S4 | 44.3 |
| Z-SDU6-B04 | SS30 | 159.9 | 157.9 | S4 | 32.7 |
| Z-SDU6-B04 | SS31 | 154.9 | 152.9 | S4 | 98.2 |
| Z-SDU6-B04 | SS32 | 149.9 | 147.9 | S4 | 31.4 |
| Z-SDU6-B04 | SS33 | 144.9 | 142.9 | S4 | 9.0 |
| Z-SDU6-B04 | SS34 | 139.9 | 137.9 | S4 | 9.7 |

**Table 2: USGS Rock Seismic Hazard: 100 Hz Oscillator Frequency, 2,500 Year Return Period, $S_a$ = 0.15 g**

| Distance | Mw = 4.5 to 5.0 | Mw = 5.0 to 5.5 | Mw = 5.5 to 6.0 | Mw = 6.0 to 6.5 | Mw = 6.5 to 7.0 | Mw = 7.0 to 8.0 |
|---|---|---|---|---|---|---|
| 7.5 km | 7.13 | 3.56 | 1.73 | 0.78 | 0.42 | 0.00 |
| 20 km | 4.93 | 3.64 | 2.35 | 1.28 | 0.78 | 0.00 |
| 37.5 km | 3.11 | 3.90 | 4.04 | 3.24 | 2.72 | 0.00 |
| 75 km | 0.33 | 0.93 | 2.05 | 3.24 | 0.00 | 16.45 |
| 150 km | 0.03 | 0.14 | 0.59 | 1.68 | 0.00 | 29.25 |
| 250 km | 0.00 | 0.00 | 0.00 | 0.04 | 0.00 | 1.63 |
| 550 km | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.08 |
| Mw Bin Sum = | 15.52 | 12.16 | 10.76 | 10.25 | 3.92 | 47.40 |

Note: Ŏ wt Frankel et al. attenuation model, ⅓ wt Toro et al. attenuation model and ⅓ wt AB95 attenuation model

**Table 3: Liquefaction Based on SRS CRR Curves**

| | Settlement (inches) | | | | | | |
|---|---|---|---|---|---|---|---|
| | $M_w$ = 4.75 | $M_w$ = 5.25 | $M_w$ = 5.75 | $M_w$ = 6.25 | $M_w$ = 6.75 | $M_w$ = 7.5 | 2,500 Yr Weighting |
| Z-SDU6-C01 | 0.00 | 0.00 | 0.00 | 0.03 | 0.11 | 0.68 | 0.33 |
| Z-SDU6-C02 | 0.00 | 0.00 | 0.00 | 0.01 | 0.04 | 0.30 | 0.14 |
| Z-SDU6-C03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.32 | 0.15 |
| Z-SDU6-C04 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.25 | 0.12 |
| Z-SDU6-C05 | 0.00 | 0.00 | 0.00 | 0.01 | 0.04 | 0.36 | 0.17 |
| Z-SDU6-C06 | 0.00 | 0.00 | 0.00 | 0.01 | 0.04 | 0.32 | 0.15 |
| Z-SDU6-C07 | 0.00 | 0.00 | 0.00 | 0.01 | 0.04 | 0.20 | 0.10 |
| Z-SDU6-C08 | 0.00 | 0.00 | 0.00 | 0.02 | 0.09 | 0.64 | 0.31 |
| Z-SDU6-C09 | 0.00 | 0.00 | 0.00 | 0.06 | 0.19 | 1.03 | 0.50 |
| Z-SDU6-C10 | 0.00 | 0.01 | 0.03 | 0.17 | 0.54 | 2.17 | 1.07 |
| Z-SDU6-C11 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.16 | 0.08 |
| Z-SDU6-C12 | 0.00 | 0.00 | 0.00 | 0.01 | 0.03 | 0.31 | 0.15 |
| Z-SDU6-C13 | 0.00 | 0.00 | 0.00 | 0.01 | 0.08 | 0.60 | 0.29 |
| Z-SDU6-C14 | 0.00 | 0.00 | 0.00 | 0.02 | 0.08 | 0.58 | 0.28 |
| Z-SDU6-C15 | 0.00 | 0.00 | 0.00 | 0.01 | 0.11 | 0.73 | 0.35 |
| Z-SDU6-C16 | 0.00 | 0.00 | 0.00 | 0.01 | 0.04 | 0.44 | 0.21 |
| Z-SDU6-C17 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.33 | 0.16 |
| Z-SDU6-C18 | 0.00 | 0.00 | 0.00 | 0.02 | 0.07 | 0.60 | 0.29 |
| Z-SDU6-C19 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.32 | 0.15 |
| Z-SDU6-C20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.04 | 0.62 | 0.29 |
| Z-SDU6-C21 | 0.00 | 0.00 | 0.00 | 0.01 | 0.07 | 0.68 | 0.33 |
| Z-SDU6-C22 | 0.00 | 0.00 | 0.00 | 0.01 | 0.10 | 0.89 | 0.43 |
| Z-SDU6-C23 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.26 | 0.12 |
| | | | | | | Average | 0.27 |
| | | | | | | Minimum | 0.08 |
| | | | | | | Maximum | 1.07 |
| | | | | | | Standard Deviation | 0.21 |

## Figures

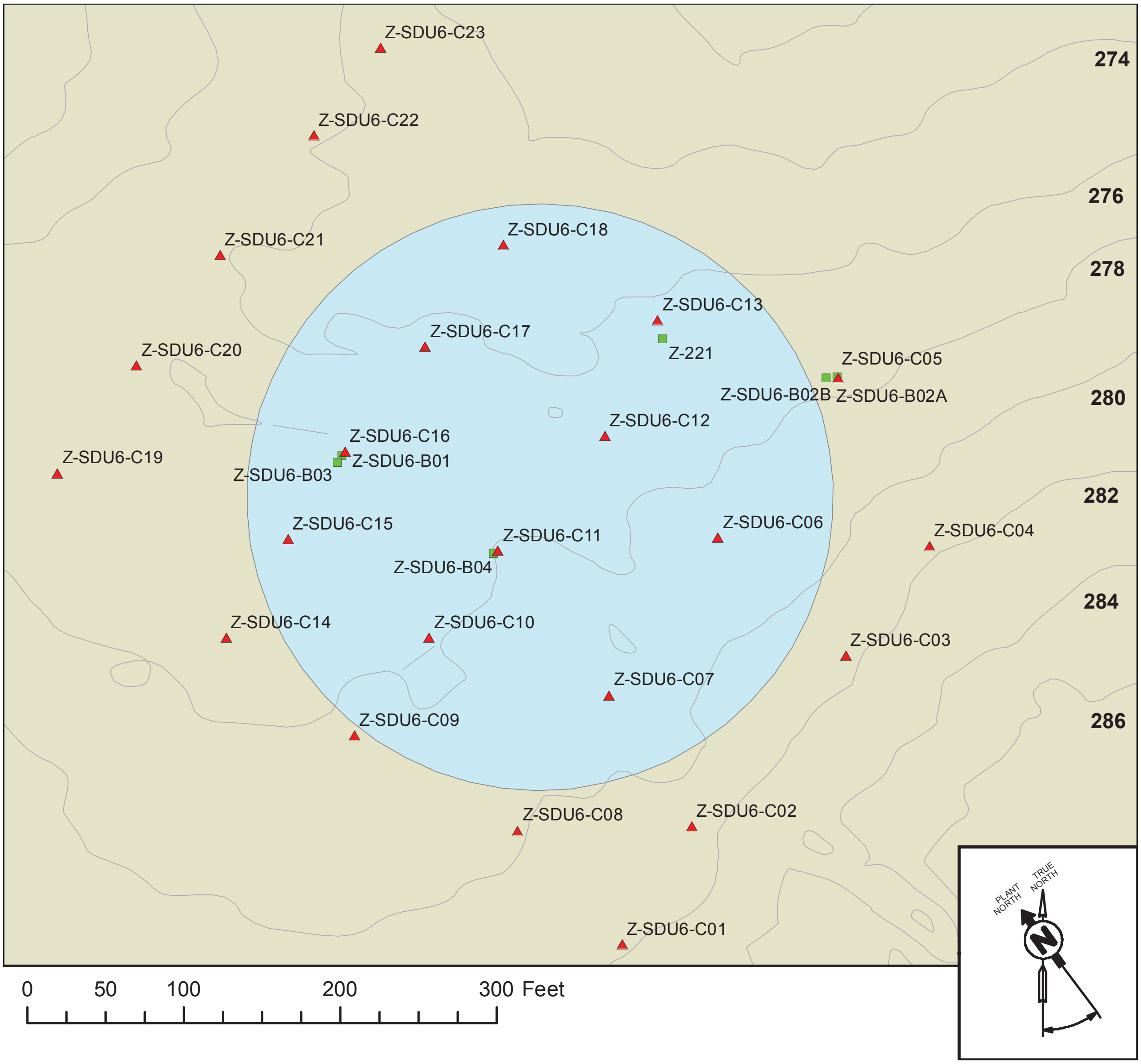



**Figure 1: Saltstone Disposal Unit 6 Project Site**

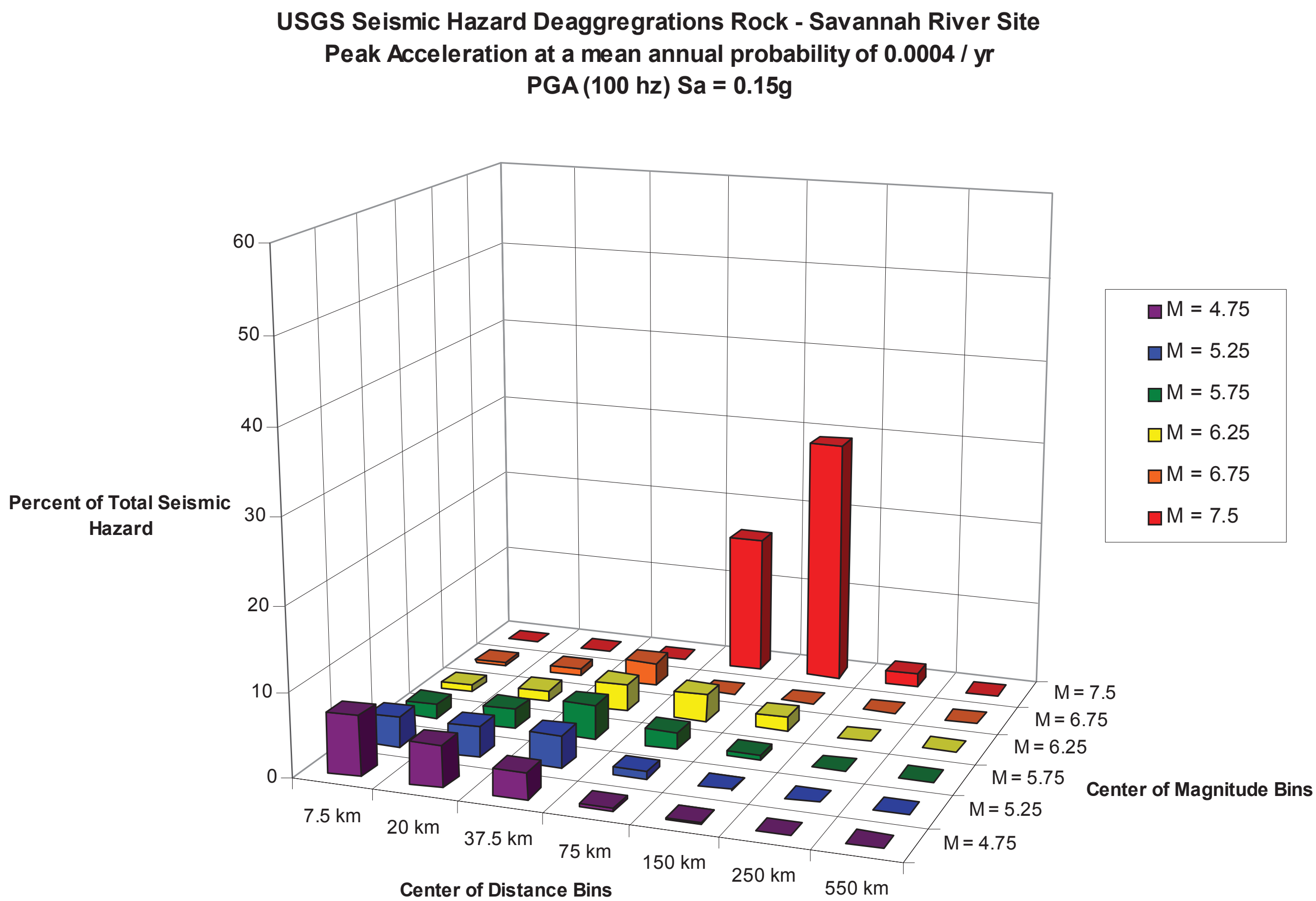



**Figure 2: USGS Rock Seismic Hazard Deaggregation: 100 Hz, 2,500 Year Return, $S_a$ = 0.15g**

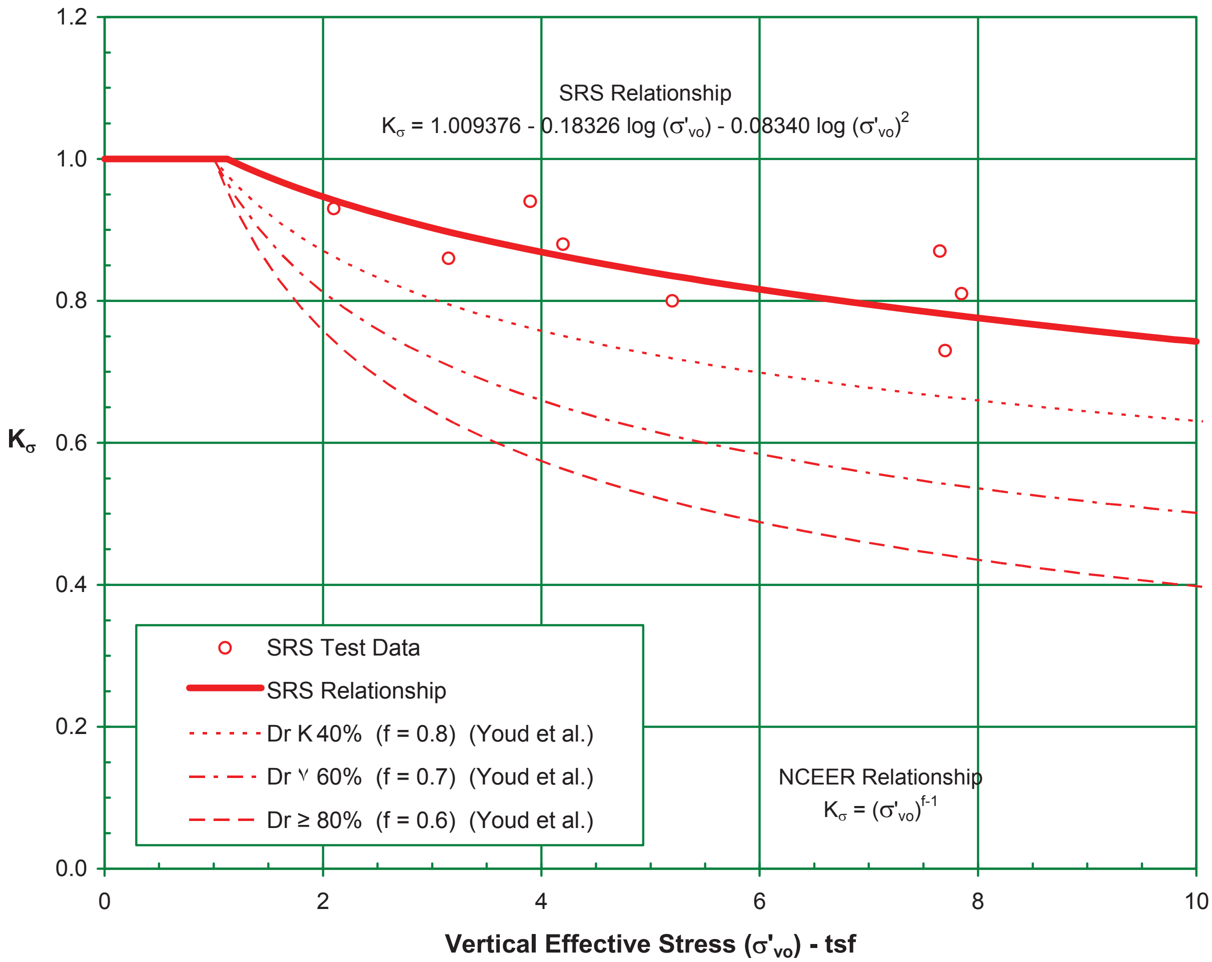



**Figure 3: Comparison of NCEER Kσ with SRS Kσ**

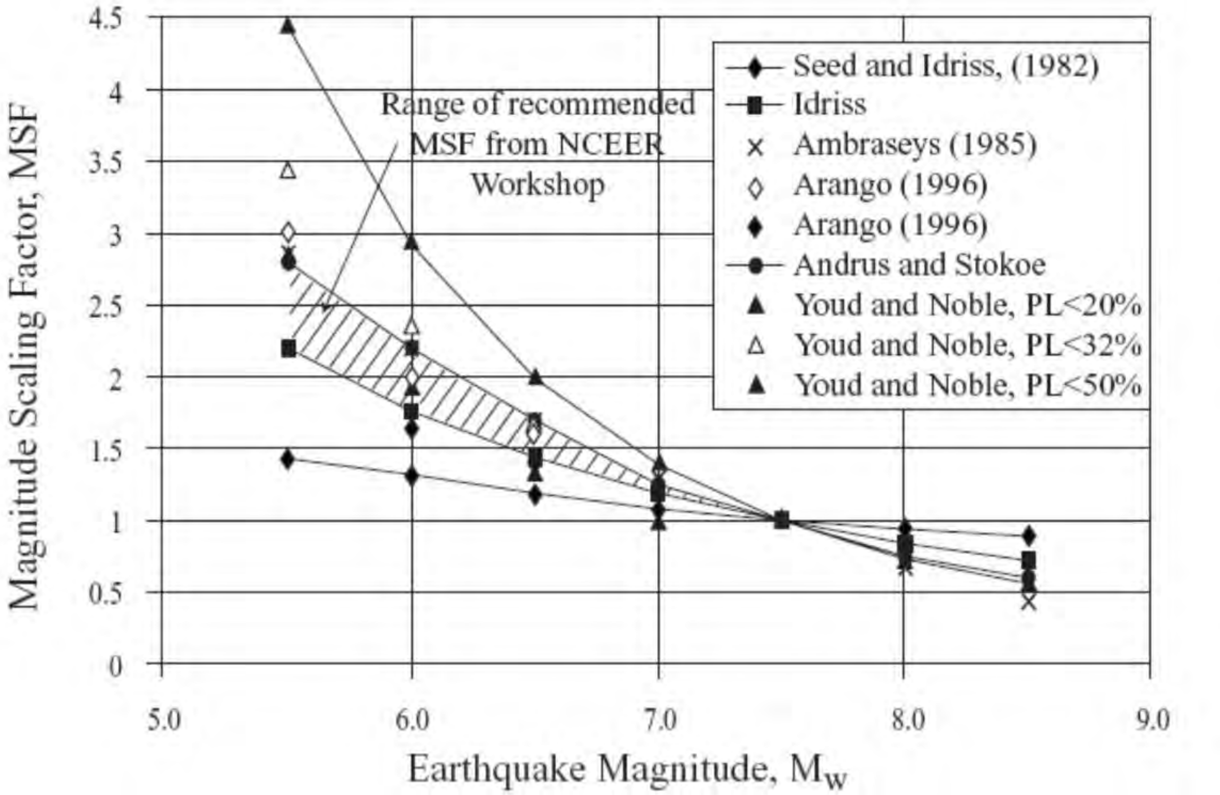



**Figure 4: Magnitude Scaling Factor Recommendations Presented by NCEER**

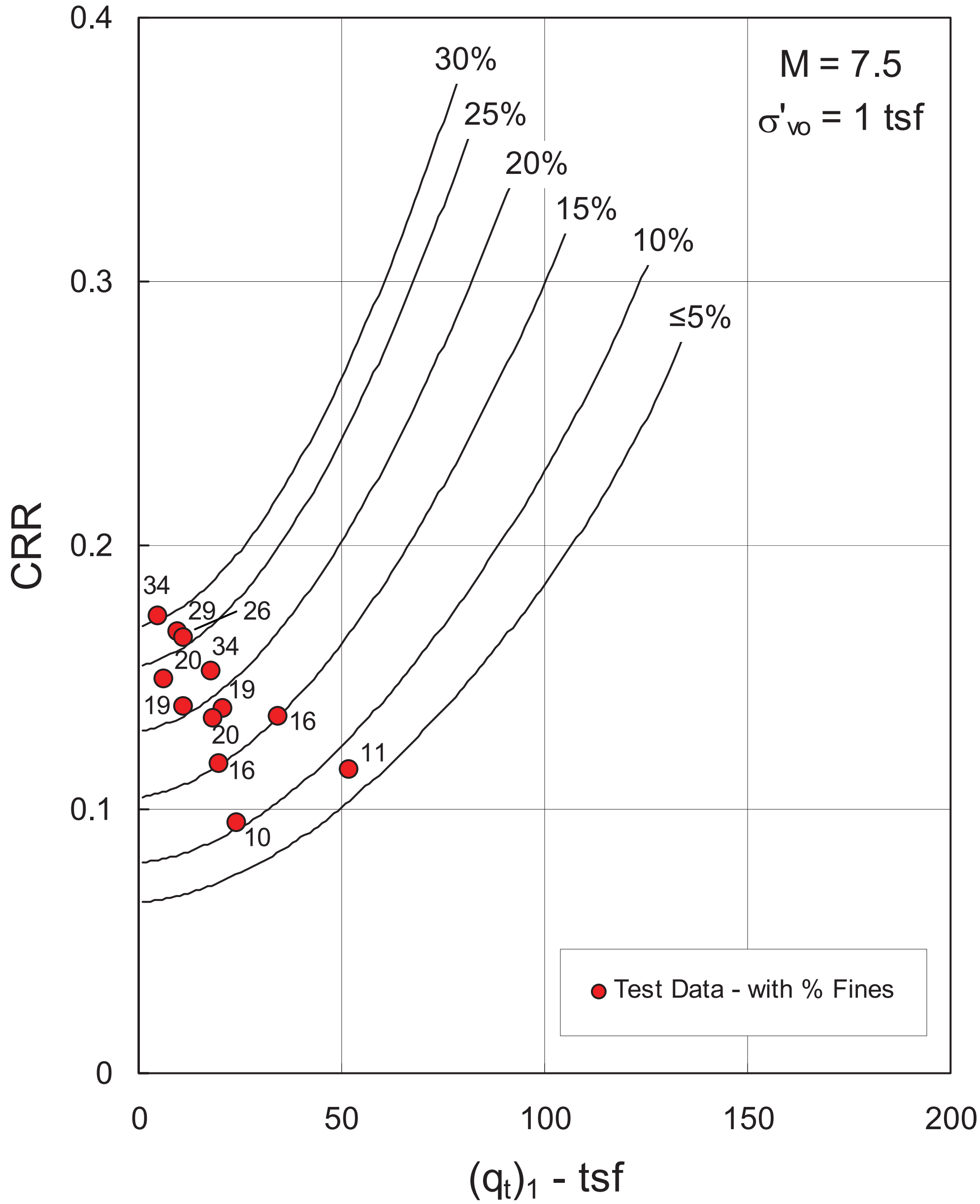



**Figure 5: New SRS Cyclic Resistance Ratio (CRR) Curves**

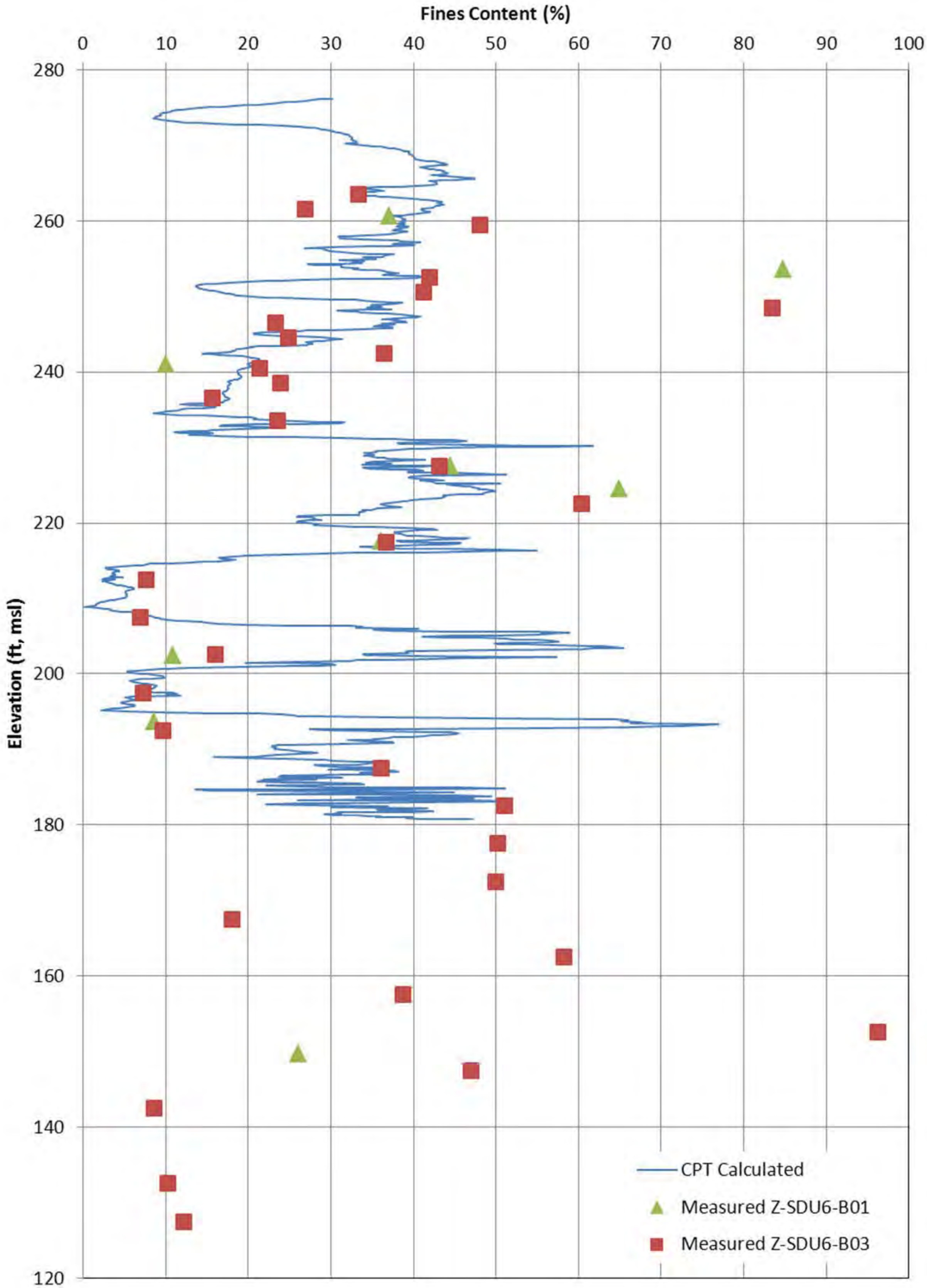



**Figure 6: Comparison of Fine Content from Z-SDU6-C16 and Z-SDU6-B01 and Z-SDU6-B03**

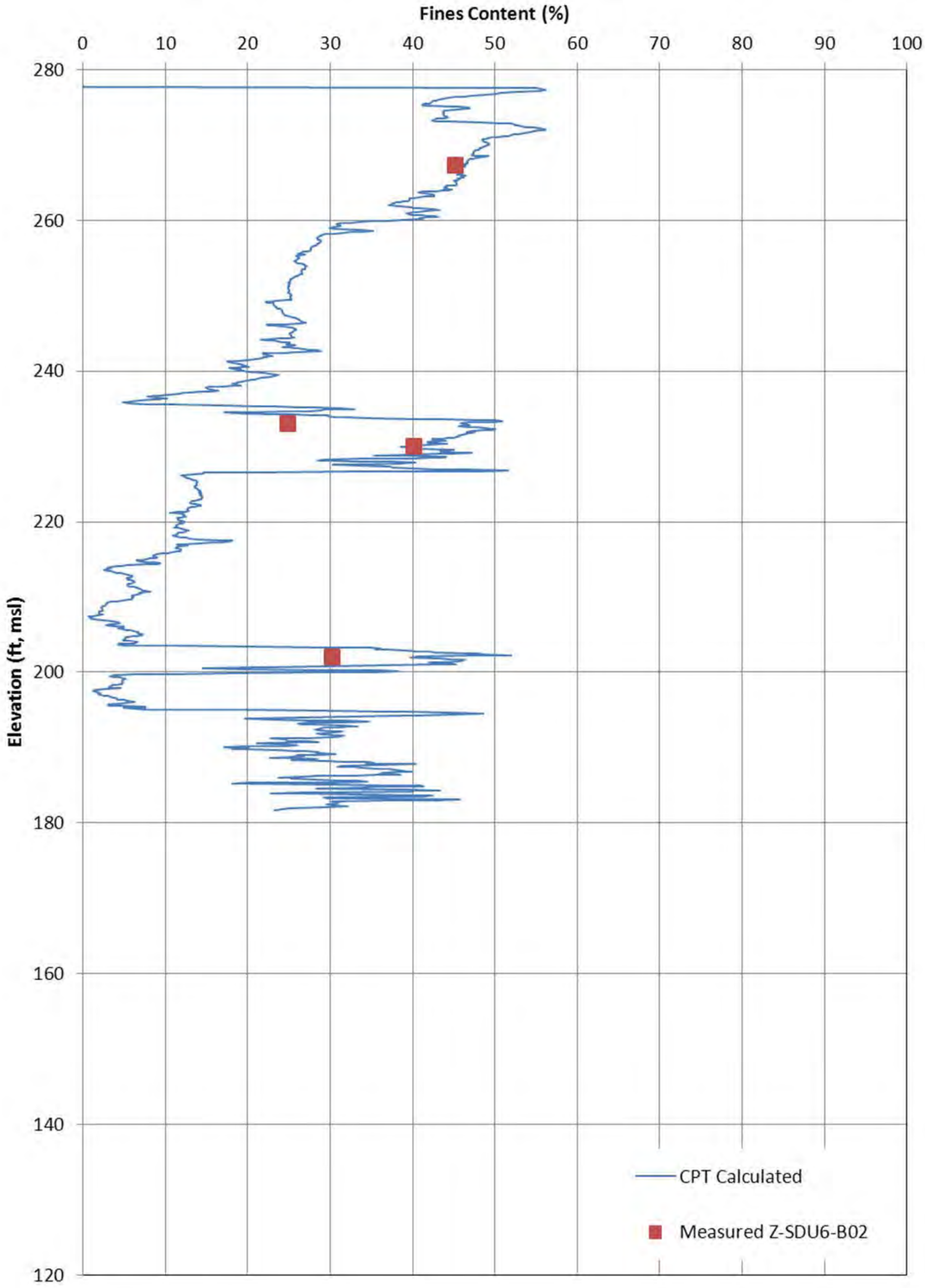



**Figure 7: Comparison of Fine Content from Z-SDU6-C05 and Z-SDU6-B02**

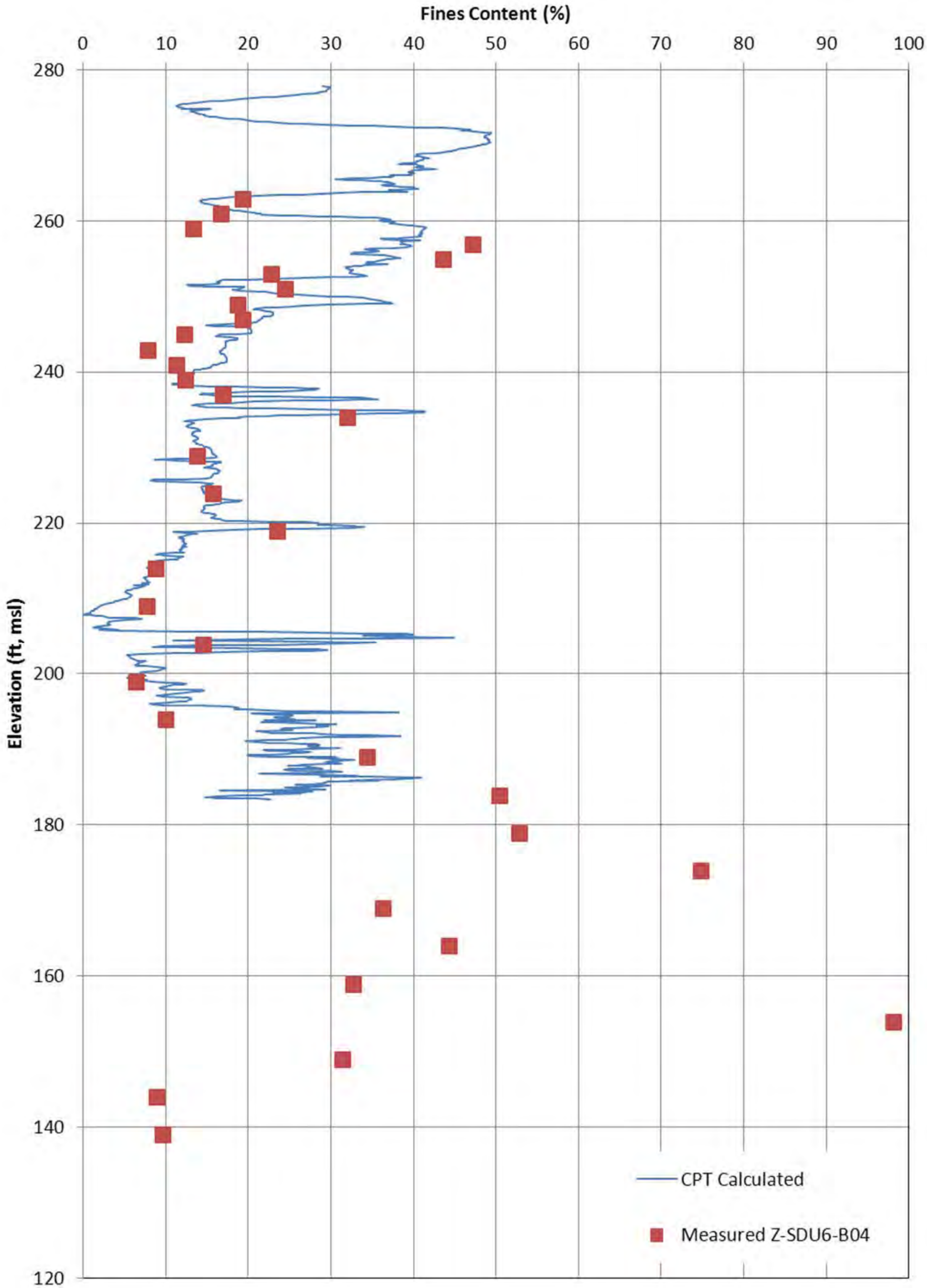



**Figure 8: Comparison of Fine Content from Z-SDU6-C11 and Z-SDU6-B04**

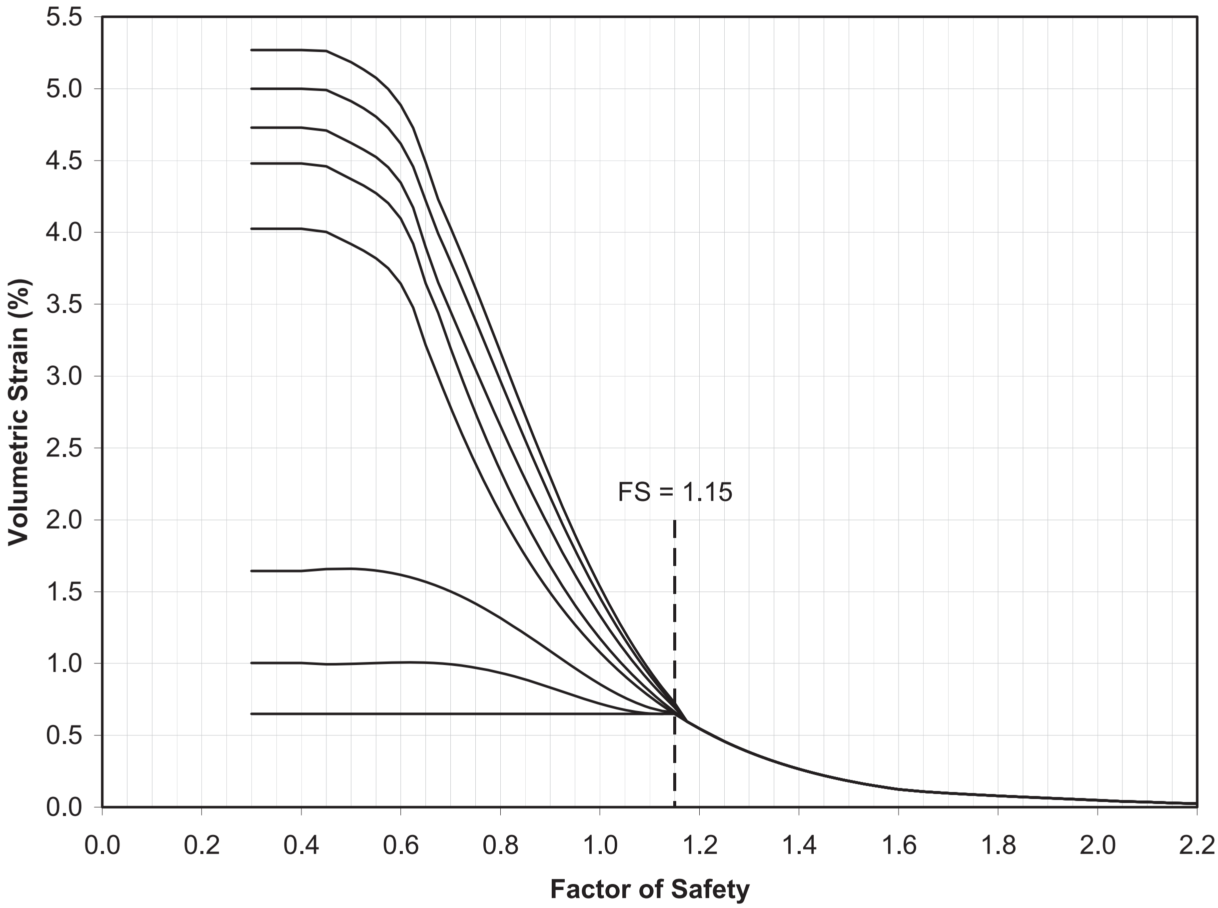



**Figure 9: SRS Volumetric Strain Curves for Liquefaction Analysis**

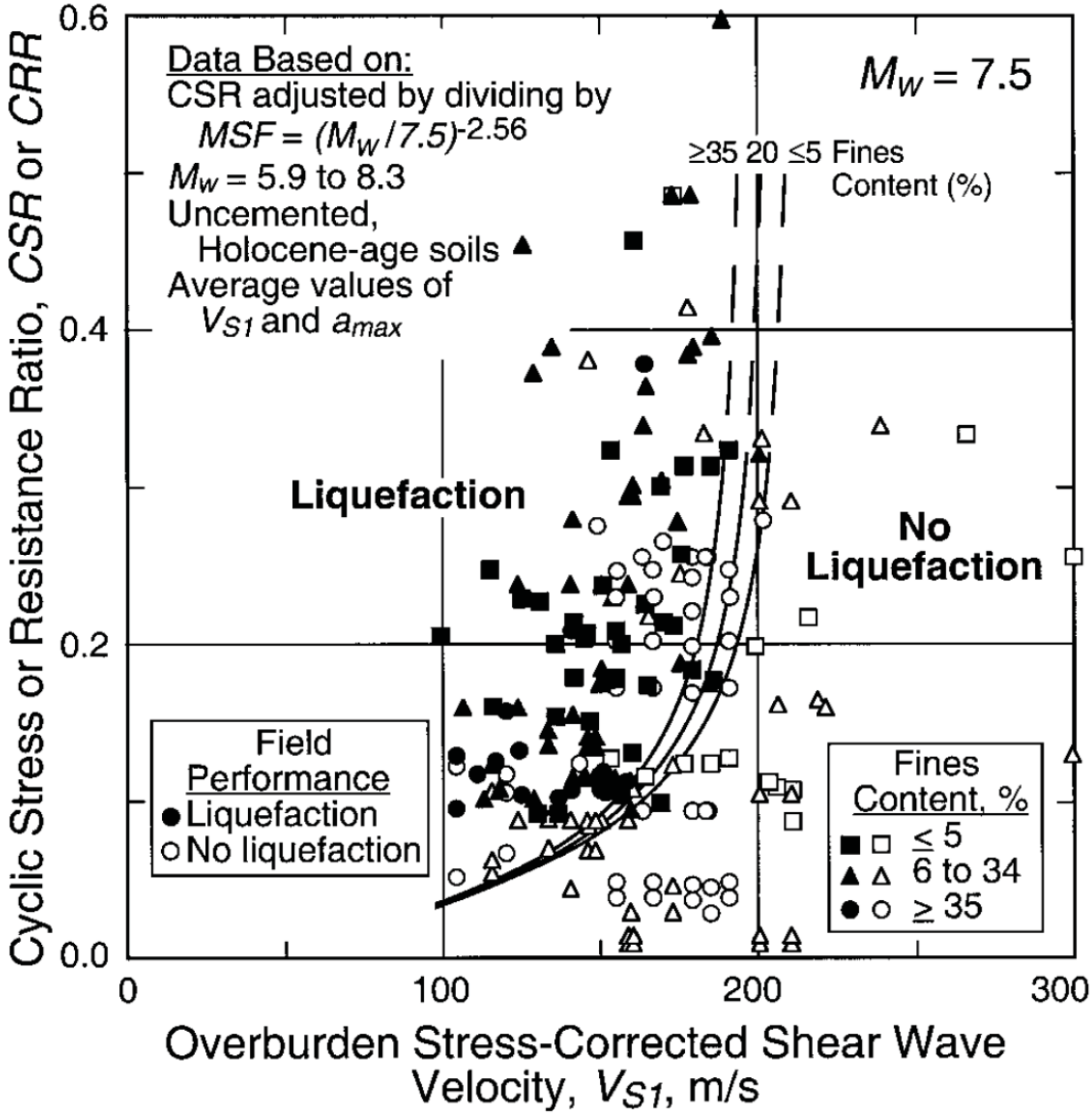



**Figure 10: Relationship between CRR and $V_{S1}$***

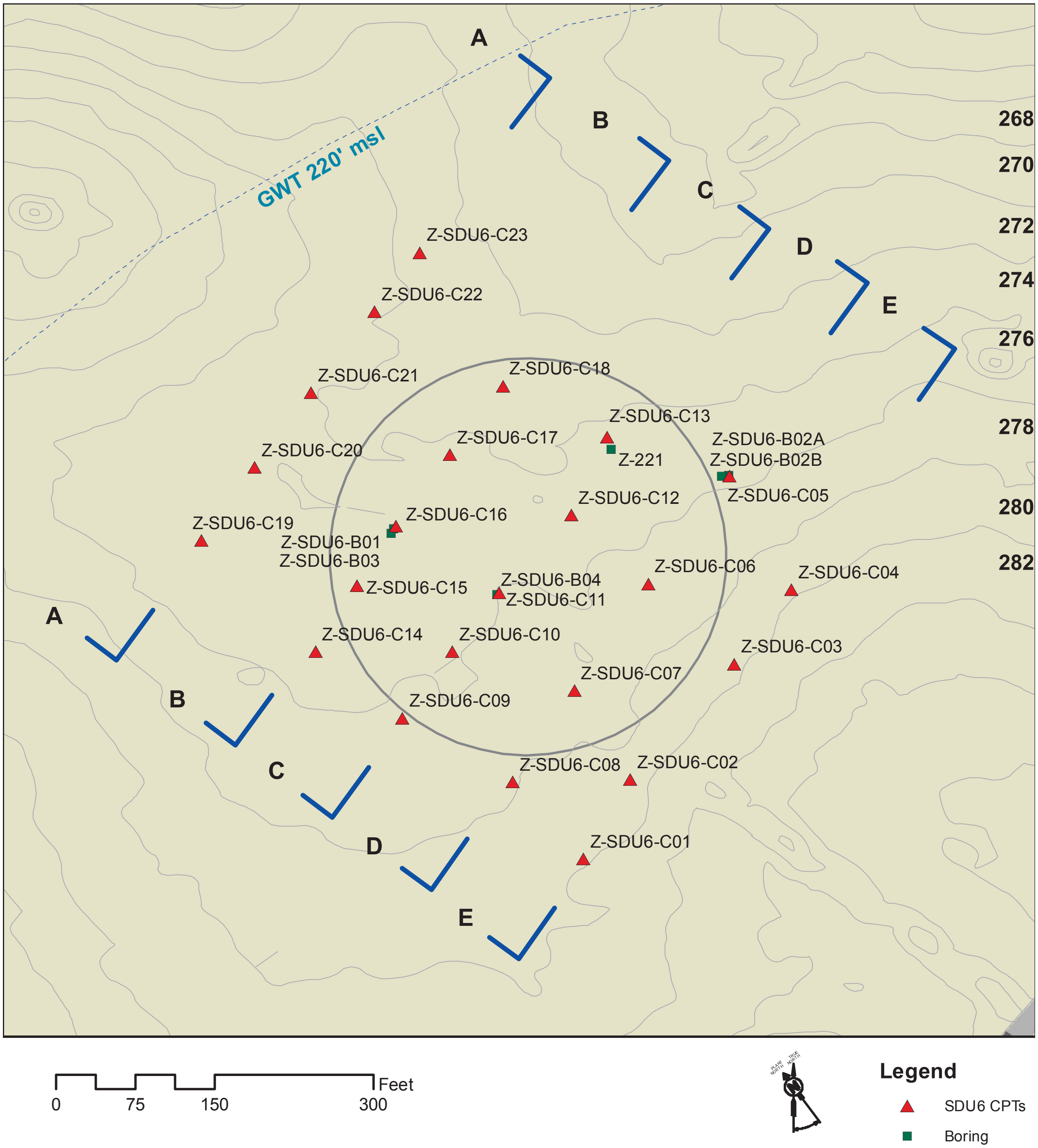
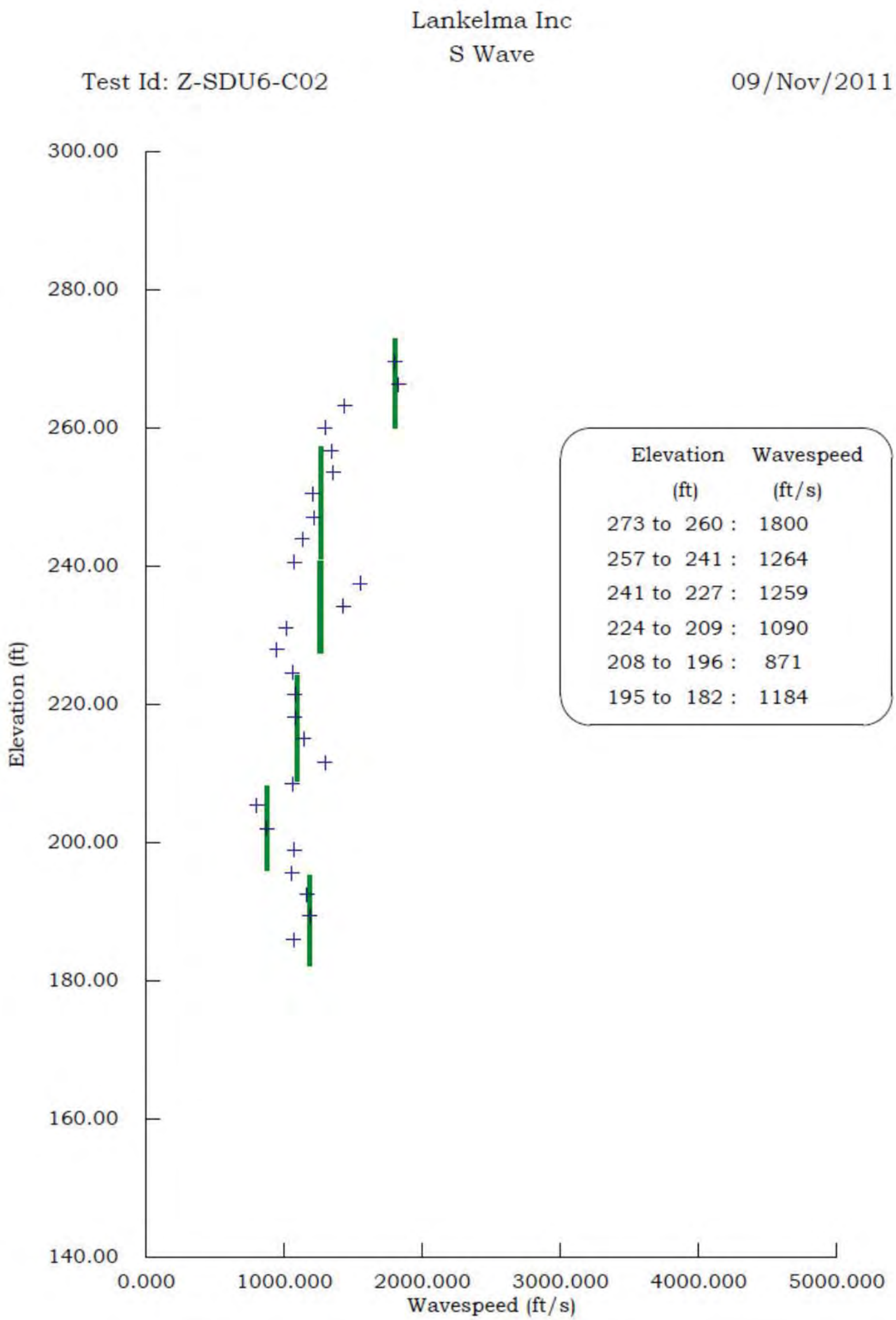
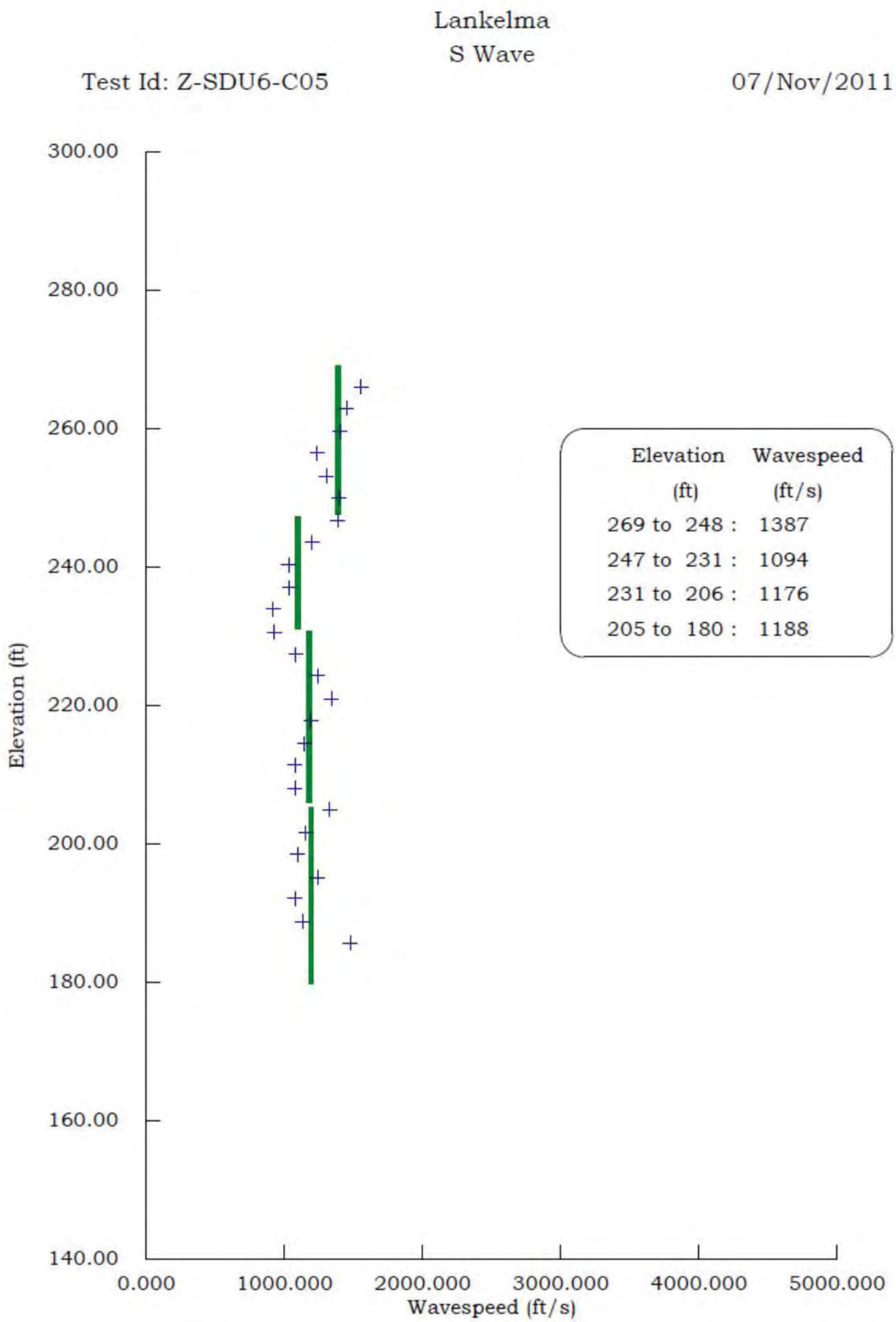
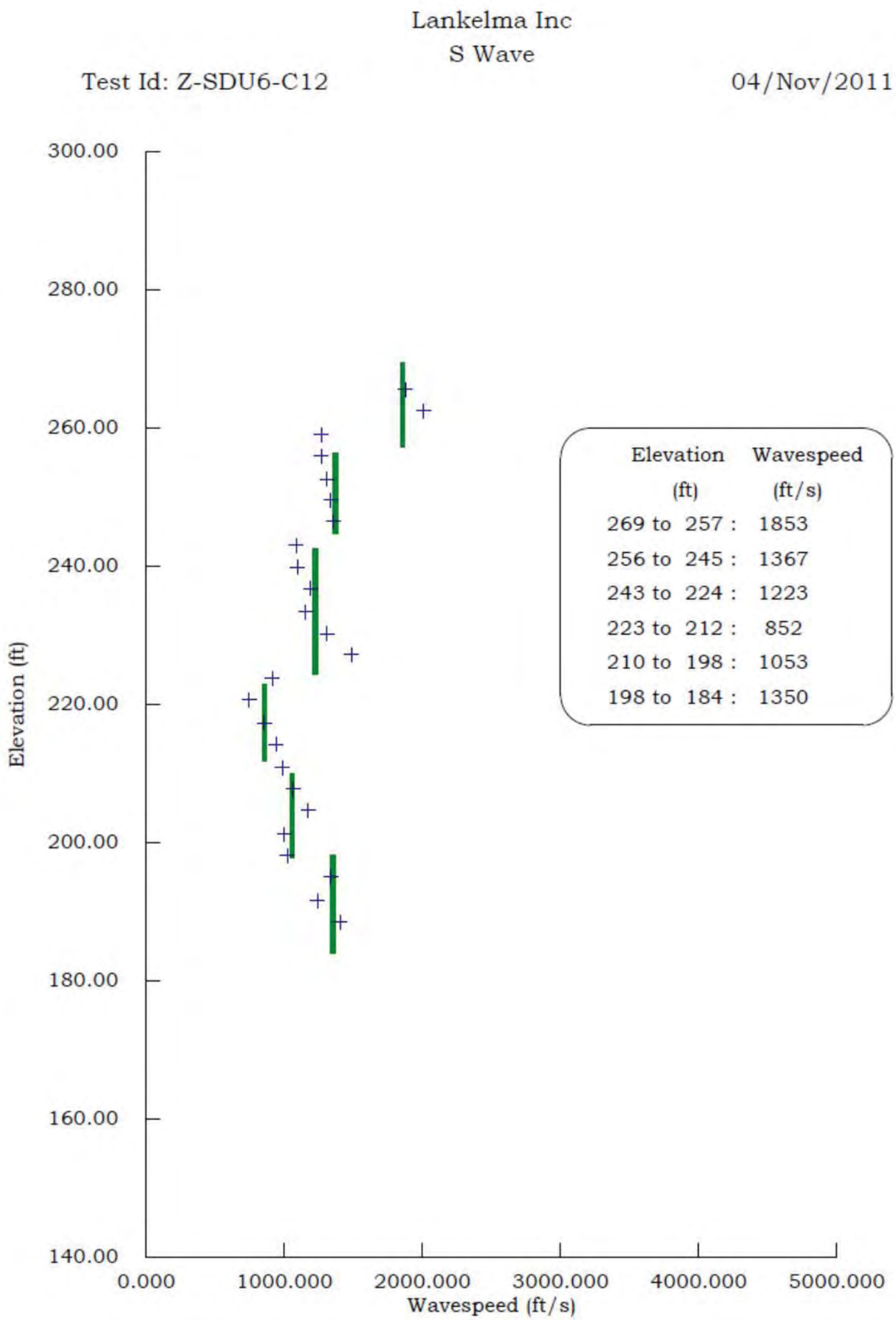



**Figure 11: Cross Sections for SDU6**

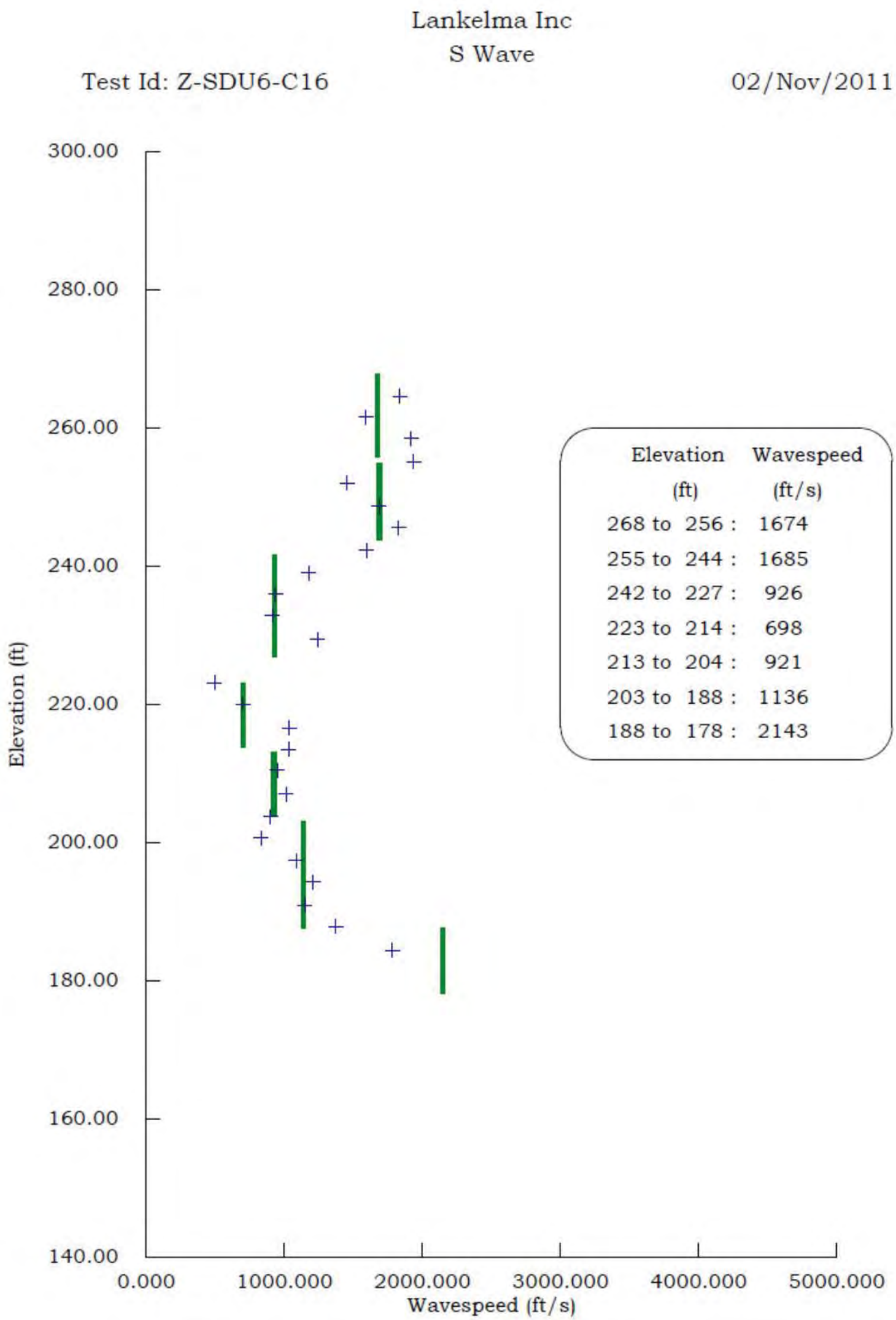
## Appendix A – Seismic Data

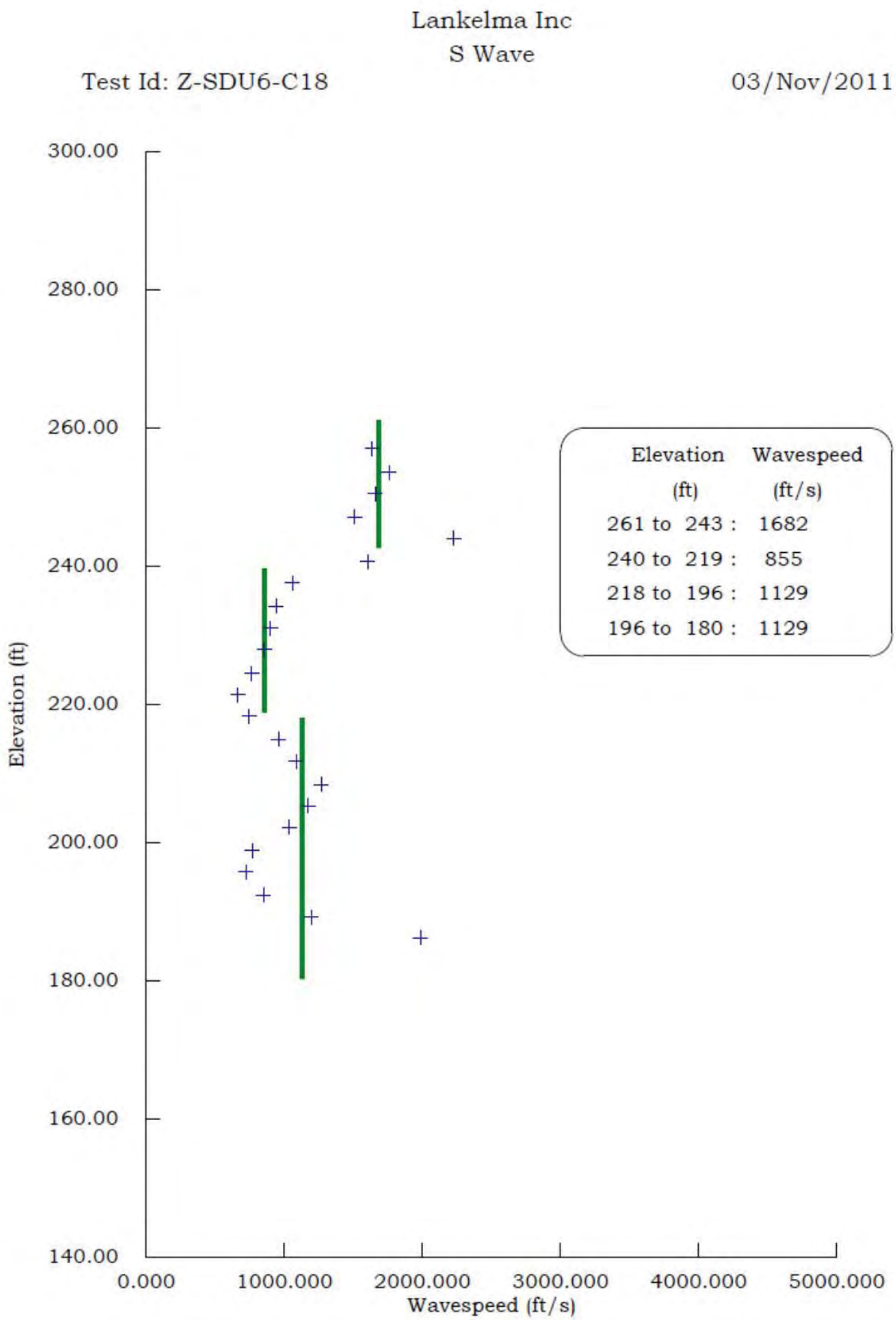

Lankelma Inc
S Wave
Test Id: Z-SDU6-C02
09/Nov/2011
300.00
280.00
260.00
240.00
220.00
200.00
180.00
160.00
140.00
Elevation (ft)
0.000
1000.000
2000.000
3000.000
4000.000
5000.000
Wavespeed (ft/s)
Elevation (ft) Wavespeed (ft/s)
273 to 260 : 1800
257 to 241 : 1264
241 to 227 : 1259
224 to 209 : 1090
208 to 196 : 871
195 to 182 : 1184

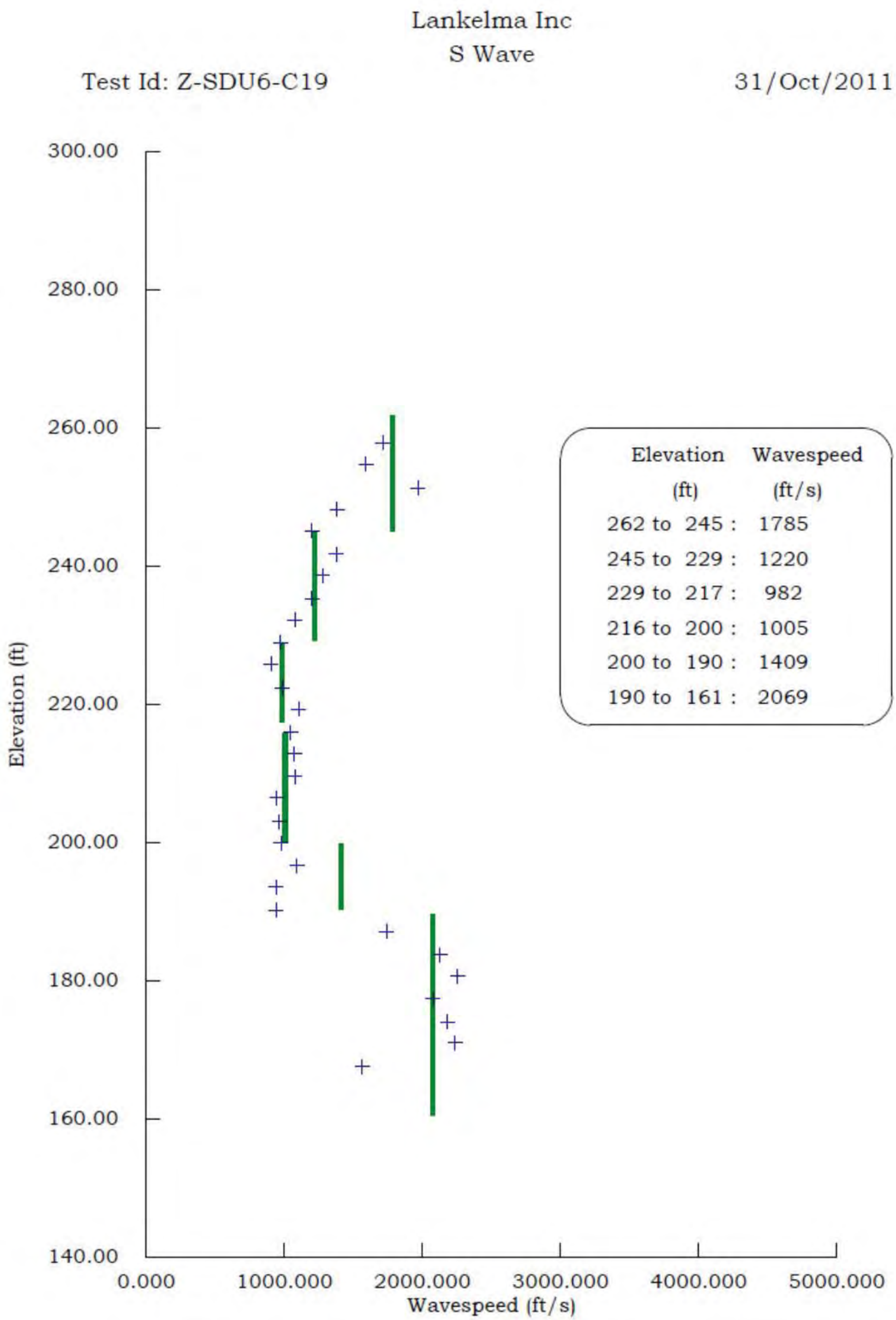

Lankelma
S Wave
Test Id: Z-SDU6-C05
07/Nov/2011
Elevation (ft)
Wavespeed (ft/s)
Elevation (ft) Wavespeed (ft/s)
269 to 248 : 1387
247 to 231 : 1094
231 to 206 : 1176
205 to 180 : 1188
300.00
280.00
260.00
240.00
220.00
200.00
180.00
160.00
140.00
0.000
1000.000
2000.000
3000.000
4000.000
5000.000




| Elevation (ft) | Wavespeed (ft/s) |
|---|---|
| 269 to 257 : | 1853 |
| 256 to 245 : | 1367 |
| 243 to 224 : | 1223 |
| 223 to 212 : | 852 |
| 210 to 198 : | 1053 |
| 198 to 184 : | 1350 |


Lankelma Inc
S Wave
Test Id: Z-SDU6-C16
02/Nov/2011
300.00
280.00
260.00
240.00
220.00
200.00
180.00
160.00
140.00
Elevation (ft)
0.000
1000.000
2000.000
3000.000
4000.000
5000.000
Wavespeed (ft/s)
Elevation (ft) Wavespeed (ft/s)
268 to 256 : 1674
255 to 244 : 1685
242 to 227 : 926
223 to 214 : 698
213 to 204 : 921
203 to 188 : 1136
188 to 178 : 2143


Lankelma Inc
S Wave
Test Id: Z-SDU6-C18
03/Nov/2011
Elevation (ft)
Wavespeed (ft/s)
Elevation (ft) Wavespeed (ft/s)
261 to 243 : 1682
240 to 219 : 855
218 to 196 : 1129
196 to 180 : 1129
300.00
280.00
260.00
240.00
220.00
200.00
180.00
160.00
140.00
0.000
1000.000
2000.000
3000.000
4000.000
5000.000



Lankelma Inc
S Wave
Test Id: Z-SDU6-C19
31/Oct/2011
Elevation (ft)
300.00
280.00
260.00
240.00
220.00
200.00
180.00
160.00
140.00
0.000
1000.000
2000.000
3000.000
4000.000
5000.000
Wavespeed (ft/s)
Elevation (ft) Wavespeed (ft/s)
262 to 245 : 1785
245 to 229 : 1220
229 to 217 : 982
216 to 200 : 1005
200 to 190 : 1409
190 to 161 : 2069

# Appendix B – Response Spectra

Per IBC 2009 Section 1803.5.12

**1803.5.12 Seismic Design Categories D through F.** For structures assigned to *Seismic Design Category* D, E or F in accordance with Section 1613, the geotechnical investigation required by Section 1803.5.11, shall also include:

1. The determination of lateral pressures on foundation walls and retaining walls due to earthquake motions.
2. The potential for liquefaction and soil strength loss evaluated for site peak ground accelerations, magnitudes and source characteristics consistent with the design earthquake ground motions. Peak ground acceleration shall be permitted to be determined based on a site-specific study taking into account soil amplification effects, as specified in Chapter 21 of ASCE 7, or, in the absence of such a study, peak ground accelerations shall be assumed equal to $S_{DS}/2.5$, where $S_{DS}$ is determined in accordance with Section 1613.5.4.

SRS Calculation T-CLC-G-00312 Rev. 0 has previously calculated $S_{DS}$ for each area at the Savannah River Site per IBC 2009 Section 1613.5.4 / ASCE 7 Section 11.4.

For Z Area $S_{DS}$ was computed to be 0.428

**PGA = 0.428 / 2.5 = 0.1712**

Per ASCE 7 Section 11.8.3

**11.8.3 Additional Geotechnical Investigation Report Requirements for Seismic Design Categories D through F.** The geotechnical investigation report for a structure assigned to Seismic Design Category D, E, or F shall include:

1. The determination of lateral pressures on basement and retaining walls due to earthquake motions.
2. The potential for liquefaction and soil strength loss evaluated for site peak ground accelerations, magnitudes, and source characteristics consistent with the design earthquake ground motions. Peak ground acceleration is permitted to be determined based on a site-specific study taking into account soil amplification effects or, in the absence of such a study, peak ground accelerations shall be assumed equal to $S_S/2.5$.

SRS Calculation T-CLC-G-00312 Rev. 0 has previously calculated $S_{DS}$ for each area at the Savannah River Site per IBC 2009 Section 1613.5.4 / ASCE 7 Section 11.4.

For Z Area $S_S$ was computed to be 0.444

**PGA = 0.444 / 2.5 = 0.1776**

ASCE 7 Section 21 allows for a reduction of the maximum ground acceleration of up to 20%

where site-specific studies have been performed. The current $a_{max}$ at SRS is 0.160 for SDC-3 structures. This value is lower than the $a_{max}$ values determined above and thus a reduction is allowed by ASCE 7 to use the greater of 0.16 or 80% of the computed values above. However, the use of the values above would be considered conservative.

Use an $a_{max}$ value of ***0.18*** for liquefaction analysis

## Appendix C – PSHA Letter from A. Frankel

# United States Department of the Interior

U.S. GEOLOGICAL SURVEY

Arthur Frankel
U.S. Geological Survey
MS 966, Box 25046
Denver Federal Center
Denver, CO 80225
303-273-8556, fax 303-273-8600
afrankel@usgs.gov
Mar. 1, 1999

Richard Lee
1092 Sizemore Rd.
Aiken, SC 29803

Dear Rich,

Enclosed is a Zip disk with the de-aggregation tables for the Savannah River Site. See the Srs directory on the disk. I have also printed out the contents of the Readme.txt file on the disk. If you want this in some other format, let me know. If we have missed some particular rates of exceedance that you need, let me know. We'll be happy to answer any questions you have about these results.

Sincerely,

Arthur Frankel

**UNCLASSIFIED**
DOES NOT CONTAIN
UNCLASSIFIED CONTROLLED
NUCLEAR INFORMATION
ADC &
Reviewing
Official C.Q. Reeves, RO
(Name and Title)
Date: 7/24/01

Readme.txt

```
Notes on De-aggregations for Savannah River Site

The output files give relative contributions in percent (to 1 decimal
place), and include all rows with no data (no sources). There are 3 header
lines per file and 42 data (or dataless) lines per file.

The output files' names give a clue about the contents. The only
information about the attenuation model used is in the file name.

The file names start with psavrivab (for AB95 attenuation),
psavrivfr (for Frankel et al attenuation),
psavrivto (for Toro et al attenuation), and
psavrivtfa (for 1/3 wt Frankel, Toro and AB95 attenuation models combined).

The internal part of the name gives a clue about the return time, eg,
1Meg means 1,000,000 years, 33Me means 33,333,333 years, etc.
The final part (suffix) of name gives the PSA frequency (eg, 10hz) or is
pga for pga.(see below)


De-aggregations are calculated based on annual frequency of exceedance
for the case of three attenuation relations with equal weight. De-aggregations
at any given freq. of exceed. and ground motion frequency is based
on the same ground motion value.

Annual Rates of Exceedance and 4 letter code embedded in filename:
1e-2   100y
5e-3   200y
3e-3   333y
2e-3   500y
1e-3   1000
5e-4   2000
4e-4   2500
3e-4   3333
2e-4   5000
1e-4   10ky
5e-5   20ky
3e-5   33ky
2e-5   50ky
1e-5   100k
5e-6   200k
4e-6   250k
3e-6   333k
2e-6   500k
1e-6   1meg
5e-7   2meg
3e-7   3meg
2e-7   5meg
1e-7   10me
5e-7   20me
3e-7   33me
2e-7   50me
1e-8   100m

The second header line tells the approx. return time.
See table above for exact annual frequency of exceedance for that filename.
The middle of the second line shows the ground motion value
used in the de-aggrgeation. This value was derived from using the
mean hazard curve from the 3 attenuation relations.
The end of the second line shows the annual frequency of exceedance for
that attenuation relation for the given ground motion value.
When the de-aggregation is for the 3 atten reln. mean, this value
equals the annual freq. of exceedance.
```

Page 1

Steve Harmsen harmsen@usgs.gov
Art Frankel afrankel@usgs.gov

Filename: psavrivtfa.2500.pga

Return period: 2500yrs. 0.0 s. PSA (g)=0.146477 Computed annual rate=.40221E-03

| Dl | Dbar | Dh | Ml | Mbar | Mh | >2s | >1s | >mu | >-1s | >-2s | <=-2s | ROWTOT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | 9.0 | 15.0 | 4.5 | 4.80 | 5.0 | 0.3 | 1.6 | 3.4 | 1.7 | 0.1 | 0.0 | 7.12608 |
| 15.0 | 19.5 | 25.0 | 4.5 | 4.81 | 5.0 | 0.5 | 2.7 | 1.7 | 0.0 | 0.0 | 0.0 | 4.93071 |
| 25.0 | 32.7 | 50.0 | 4.5 | 4.83 | 5.0 | 1.7 | 1.4 | 0.0 | 0.0 | 0.0 | 0.0 | 3.10512 |
| 50.0 | 61.5 | 100.0 | 4.5 | 4.85 | 5.0 | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.32855 |
| 100.0 | 119.8 | 200.0 | 4.5 | 4.87 | 5.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.02554 |
| 200.0 | 211.7 | 300.0 | 4.5 | 4.90 | 5.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.00003 |
| 300.0 | 0.0 | 800.0 | 4.5 | 0.00 | 5.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.00000 |
| 0.0 | 9.2 | 15.0 | 5.0 | 5.23 | 5.5 | 0.1 | 0.6 | 1.6 | 1.1 | 0.1 | 0.0 | 3.55894 |
| 15.0 | 19.7 | 25.0 | 5.0 | 5.24 | 5.5 | 0.2 | 1.2 | 2.0 | 0.2 | 0.0 | 0.0 | 3.63554 |
| 25.0 | 33.9 | 50.0 | 5.0 | 5.26 | 5.5 | 1.0 | 2.4 | 0.5 | 0.0 | 0.0 | 0.0 | 3.89585 |
| 50.0 | 64.2 | 100.0 | 5.0 | 5.29 | 5.5 | 0.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.92566 |
| 100.0 | 121.9 | 200.0 | 5.0 | 5.32 | 5.5 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.14191 |
| 200.0 | 216.7 | 300.0 | 5.0 | 5.35 | 5.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.00044 |
| 300.0 | 315.2 | 800.0 | 5.0 | 5.41 | 5.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.00000 |
| 0.0 | 9.3 | 15.0 | 5.5 | 5.71 | 6.0 | 0.0 | 0.3 | 0.7 | 0.6 | 0.1 | 0.0 | 1.72815 |
| 15.0 | 19.9 | 25.0 | 5.5 | 5.72 | 6.0 | 0.1 | 0.5 | 1.2 | 0.5 | 0.0 | 0.0 | 2.35097 |
| 25.0 | 35.2 | 50.0 | 5.5 | 5.73 | 6.0 | 0.4 | 2.1 | 1.5 | 0.0 | 0.0 | 0.0 | 4.03774 |
| 50.0 | 67.2 | 100.0 | 5.5 | 5.76 | 6.0 | 1.3 | 0.7 | 0.0 | 0.0 | 0.0 | 0.0 | 2.04892 |
| 100.0 | 125.2 | 200.0 | 5.5 | 5.79 | 6.0 | 0.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.58848 |
| 200.0 | 219.7 | 300.0 | 5.5 | 5.82 | 6.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.00498 |
| 300.0 | 328.8 | 800.0 | 5.5 | 5.85 | 6.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.00012 |
| 0.0 | 9.3 | 15.0 | 6.0 | 6.22 | 6.5 | 0.0 | 0.1 | 0.3 | 0.3 | 0.1 | 0.0 | 0.77551 |
| 15.0 | 20.1 | 25.0 | 6.0 | 6.23 | 6.5 | 0.0 | 0.2 | 0.5 | 0.5 | 0.0 | 0.0 | 1.27647 |
| 25.0 | 36.3 | 50.0 | 6.0 | 6.24 | 6.5 | 0.2 | 1.0 | 1.8 | 0.3 | 0.0 | 0.0 | 3.23702 |
| 50.0 | 70.1 | 100.0 | 6.0 | 6.28 | 6.5 | 0.9 | 2.1 | 0.2 | 0.0 | 0.0 | 0.0 | 3.24201 |
| 100.0 | 129.1 | 200.0 | 6.0 | 6.30 | 6.5 | 1.3 | 0.4 | 0.0 | 0.0 | 0.0 | 0.0 | 1.67602 |
| 200.0 | 224.2 | 300.0 | 6.0 | 6.33 | 6.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.03644 |
| 300.0 | 334.7 | 800.0 | 6.0 | 6.36 | 6.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.00210 |
| 0.0 | 9.4 | 15.0 | 6.5 | 6.89 | 7.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | 0.41956 |
| 15.0 | 20.2 | 25.0 | 6.5 | 6.90 | 7.0 | 0.0 | 0.1 | 0.3 | 0.3 | 0.1 | 0.0 | 0.77539 |
| 25.0 | 37.2 | 50.0 | 6.5 | 6.92 | 7.0 | 0.1 | 0.5 | 1.3 | 0.7 | 0.0 | 0.0 | 2.72258 |
| 50.0 | 0.0 | 100.0 | 6.5 | 0.00 | 7.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.00000 |
| 100.0 | 0.0 | 200.0 | 6.5 | 0.00 | 7.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.00000 |
| 200.0 | 0.0 | 300.0 | 6.5 | 0.00 | 7.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.00000 |
| 300.0 | 0.0 | 800.0 | 6.5 | 0.00 | 7.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.00000 |
| 0.0 | 0.0 | 15.0 | 7.0 | 0.00 | 8.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.00000 |
| 15.0 | 0.0 | 25.0 | 7.0 | 0.00 | 8.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.00000 |
| 25.0 | 0.0 | 50.0 | 7.0 | 0.00 | 8.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.00000 |
| 50.0 | 79.9 | 100.0 | 7.0 | 7.19 | 8.0 | 1.3 | 7.5 | 7.4 | 0.2 | 0.0 | 0.0 | 16.44842 |
| 100.0 | 136.8 | 200.0 | 7.0 | 7.25 | 8.0 | 7.2 | 19.1 | 3.0 | 0.0 | 0.0 | 0.0 | 29.24517 |
| 200.0 | 217.8 | 300.0 | 7.0 | 7.26 | 8.0 | 1.3 | 0.4 | 0.0 | 0.0 | 0.0 | 0.0 | 1.63342 |
| 300.0 | 392.0 | 800.0 | 7.0 | 7.30 | 8.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.07649 |

# Appendix D– Dynamic Settlement of Dry Sands

| | |
|---|---|
| Average Surface Elevation | 277 ft msl |
| Bottom of Foundation | 265 ft msl |
| Groundwater Table | 225 ft msl |
| Average N value | 30 bpf |
| Average $(N_1)_{60}$ | 24 bpf |
| $a_{max}$ | 0.18g |

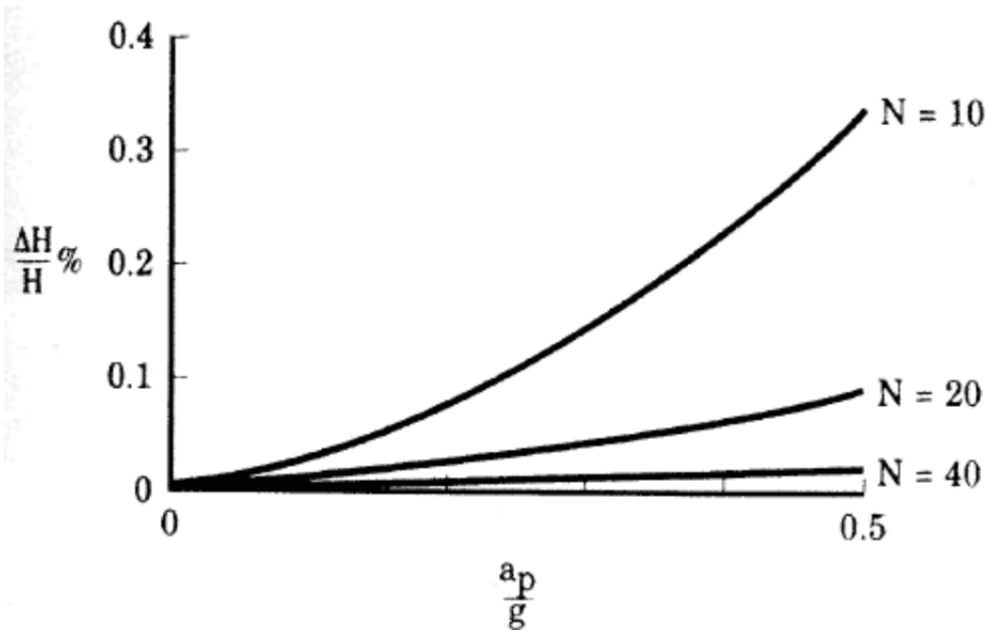
Using the simple chart below from Fundamentals of Earthquake Resistant Construction by Krinitzsky et. al, 1993:

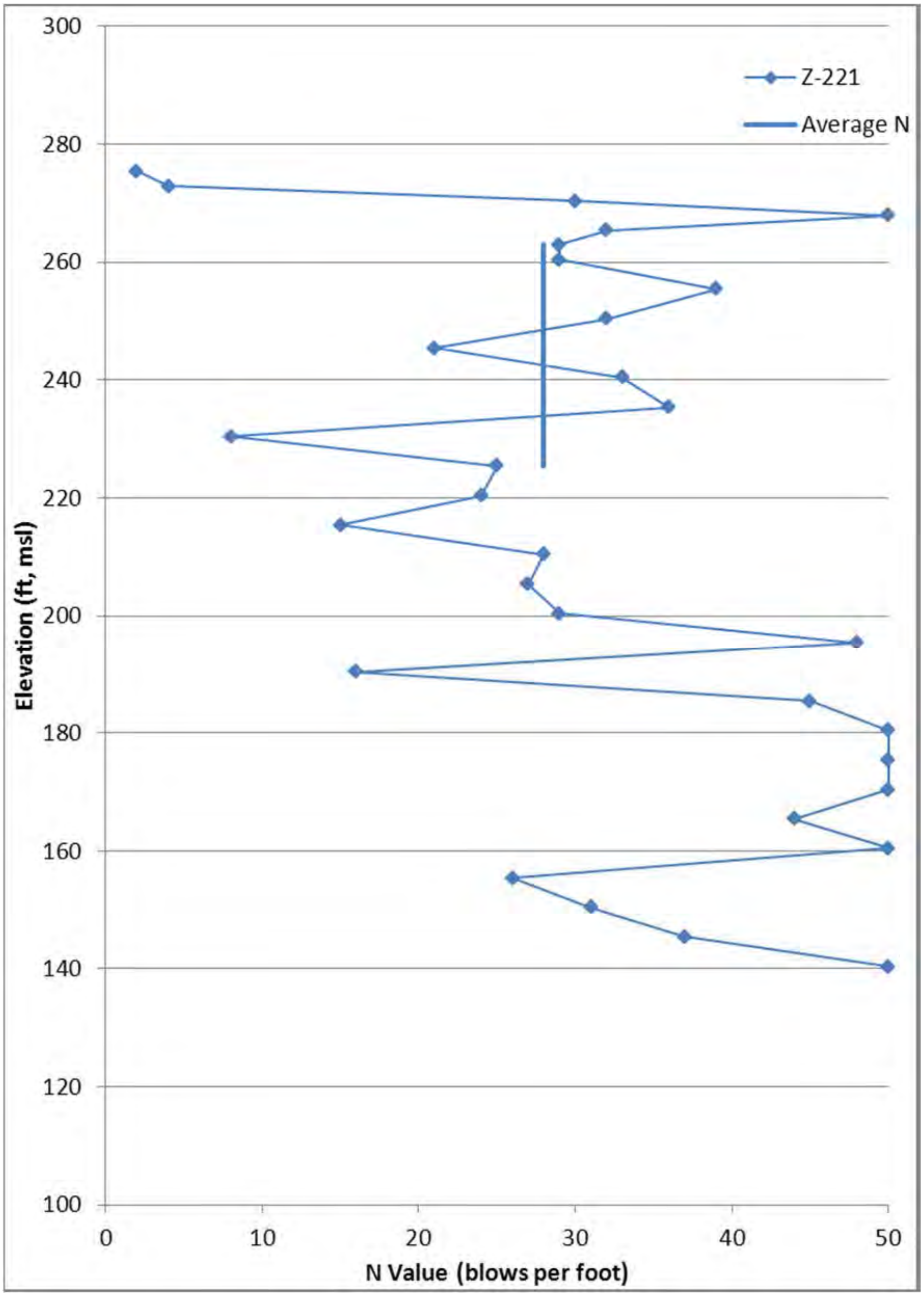
$\Delta H/H = 0.02\%$

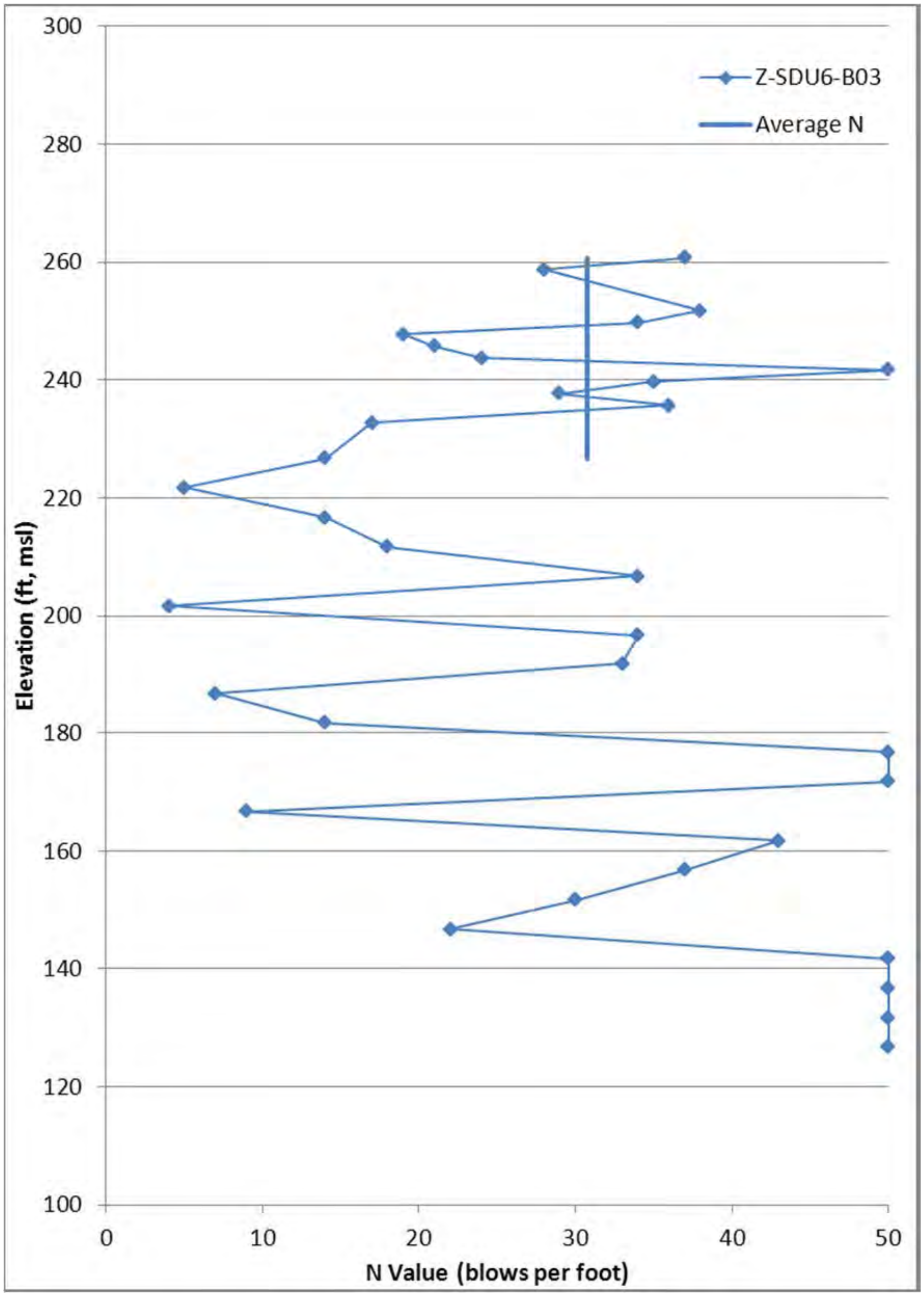
Therefore:

$$\Delta H = H \times 0.02\% = 40 \text{ ft} \times 0.0002 = 0.008 \text{ ft} = 0.096 \text{ inches}$$

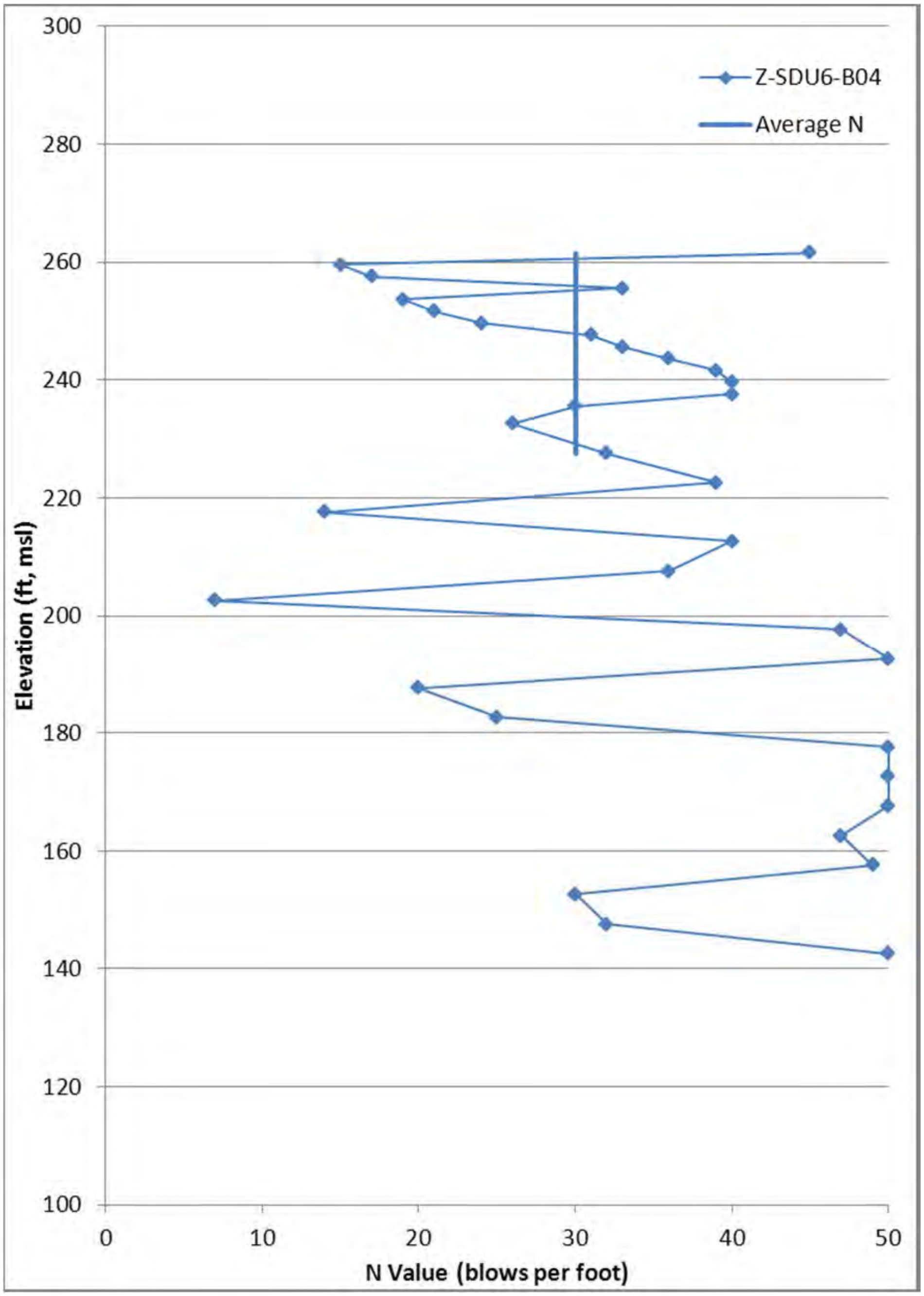
It is assumed that the methodology employed was originally developed for clean sands. The dry soils at SDU6 are not clean sands, fines content much greater than 5%. Thus the settlement of unsaturated soils at SDU6 may be neglected.




Z-221
Average N
Elevation (ft, msl)
300
280
260
240
220
200
180
160
140
120
100
0
10
20
30
40
50
N Value (blows per foot)



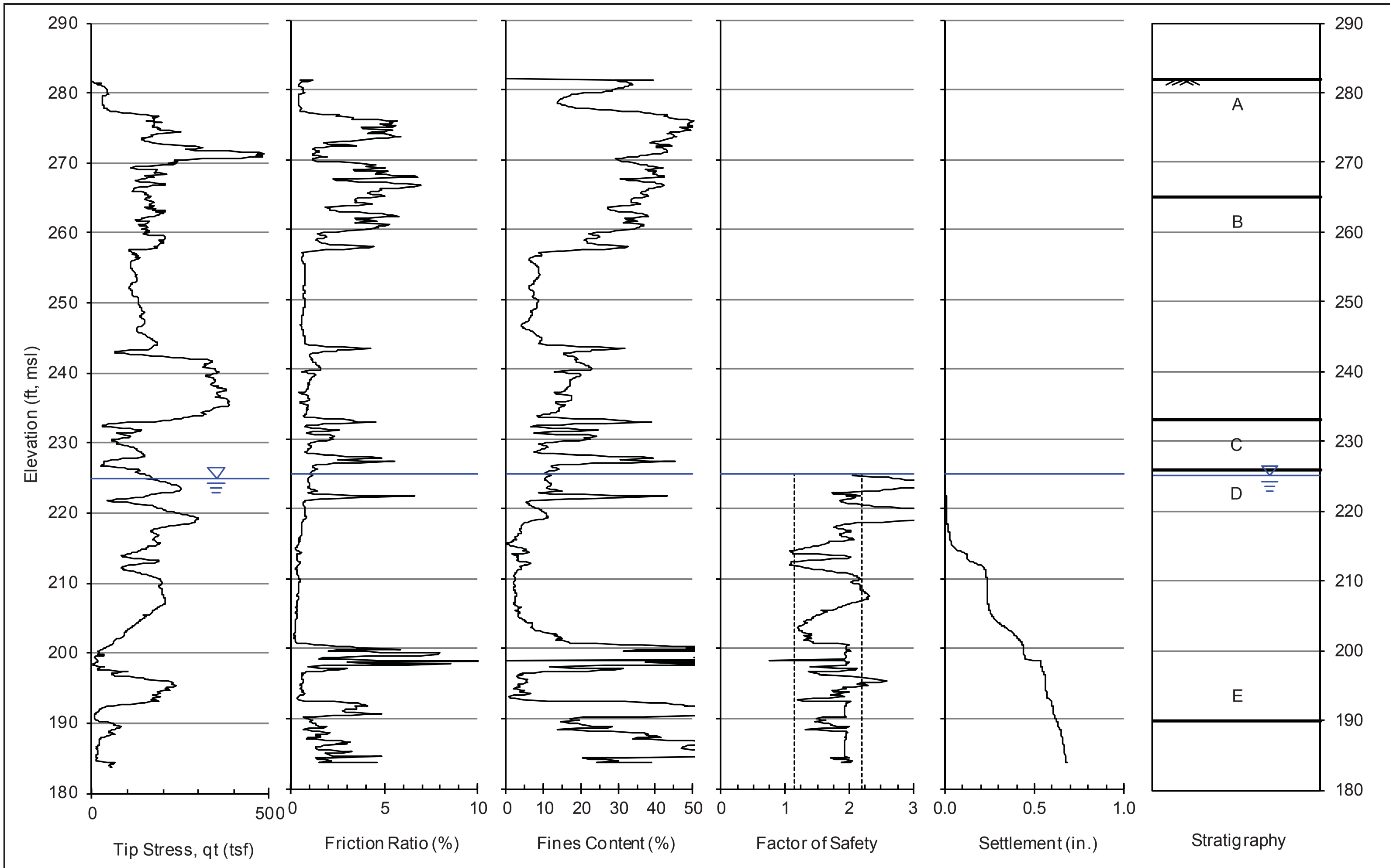
Z-SDU6-B03
Average N
300
280
260
240
220
200
180
160
140
120
100
Elevation (ft, msl)
0
10
20
30
40
50
N Value (blows per foot)


Z-SDU6-B04
Average N
Elevation (ft, msl)
N Value (blows per foot)
300
280
260
240
220
200
180
160
140
120
100
0
10
20
30
40
50

**Appendix E– Liquefaction Analysis Output**

Project: SDU 6
Cone ID: Z-SDU6-C01

**Design Basis Earthquake - Volumetric Strain**




Magnitude 7.50 Plot

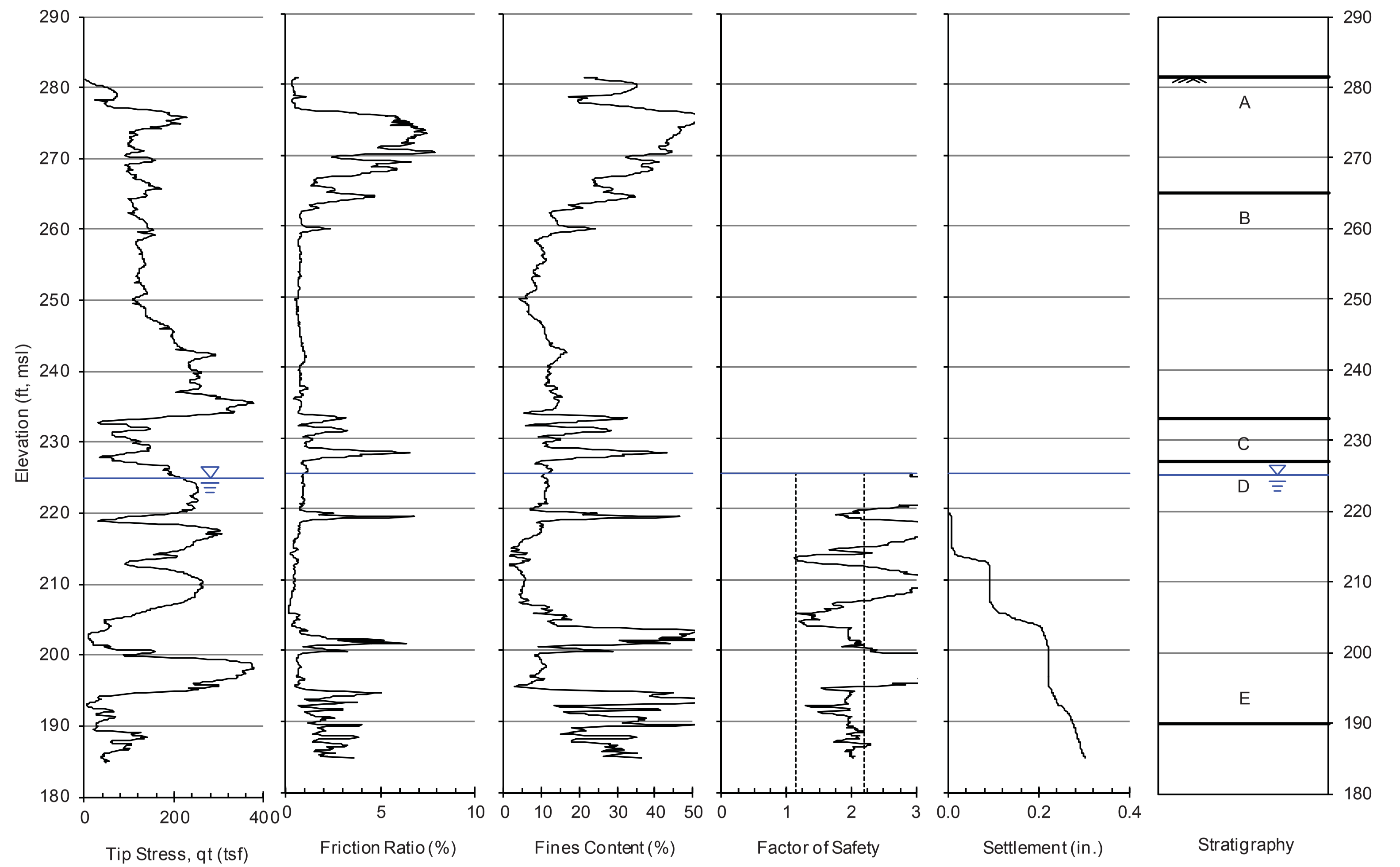
| **Magnitude** | **4.75** | **5.25** | **5.75** | **6.25** | **6.75** | **7.5** |
|---|---|---|---|---|---|---|
| Minimum Factor of Safety | 2.51 | 2.00 | 1.63 | 1.26 | 1.04 | 0.74 |
| Average Factor of Safety | 6.78 | 5.39 | 4.39 | 3.39 | 2.79 | 2.00 |
| Maximum Settlement | 0.00 in. | 0.00 in. | 0.00 in. | 0.03 in. | 0.11 in. | 0.68 in. |

| **2,500 Year Weighted Average Settlement** | 0.33 in. |
|---|---|

| Stratigraphy / Layer Description | | |
|---|---|---|
| A | S1/S2 | |
| B | Bottom of Excavation | |
| C | C2 | |
| D | S3 | |
| E | S4 | |

Project: SDU 6
Cone ID: Z-SDU6-C02

**_Design Basis Earthquake - Volumetric Strain_**




Magnitude 7.50 Plot

| **Magnitude** | **_4.75_** | **_5.25_** | **_5.75_** | **_6.25_** | **_6.75_** | **_7.5_** |
|---|---|---|---|---|---|---|
| Minimum Factor of Safety | 3.83 | 3.04 | 2.48 | 1.92 | 1.58 | 1.13 |
| Average Factor of Safety | 9.34 | 7.42 | 6.04 | 4.67 | 3.85 | 2.75 |
| Maximum Settlement | 0.00 in. | 0.00 in. | 0.00 in. | 0.01 in. | 0.04 in. | 0.30 in. |

| **2,500 Year Weighted Average Settlement** | 0.14 in. |
|---|---|

| Stratigraphy / Layer Description | | |
|---|---|---|
| A | S1/S2 | |
| B | Bottom of Excavation | |
| C | C2 | |
| D | S3 | |
| E | S4 | |

Project: SDU 6
Cone ID: Z-SDU6-C02

| | DBE | | | | | | Cha50 |
|---|---|---|---|---|---|---|---|
| Magnitudes | **4.75** | **5.25** | **5.75** | **6.25** | **6.75** | **7.5** | **7.3** |
| Liquefaction Settlements | 0.00 in. | 0.00 in. | 0.00 in. | 0.01 in. | 0.04 in. | 0.30 in. | 0.00 in. |

***Weighted DBE Settlements***

| SCPTu ID | 2,500 Year Average for all Magnitudes (100 Hz) |
|---|---|
| **Z-SDU6-C02** | 0.14 in. |

***Cha50 Settlement (Unweighted)***

| SCPTu ID | Cha50 Mw = 7.3 MSF = 1.1 |
|---|---|
| **Z-SDU6-C02** | 0.00 in. |

***PC3 Mw =7.5 CPT (tip stress) and Shear Wave Velocity Factor of Safety Comparison***

***CPT Approach***

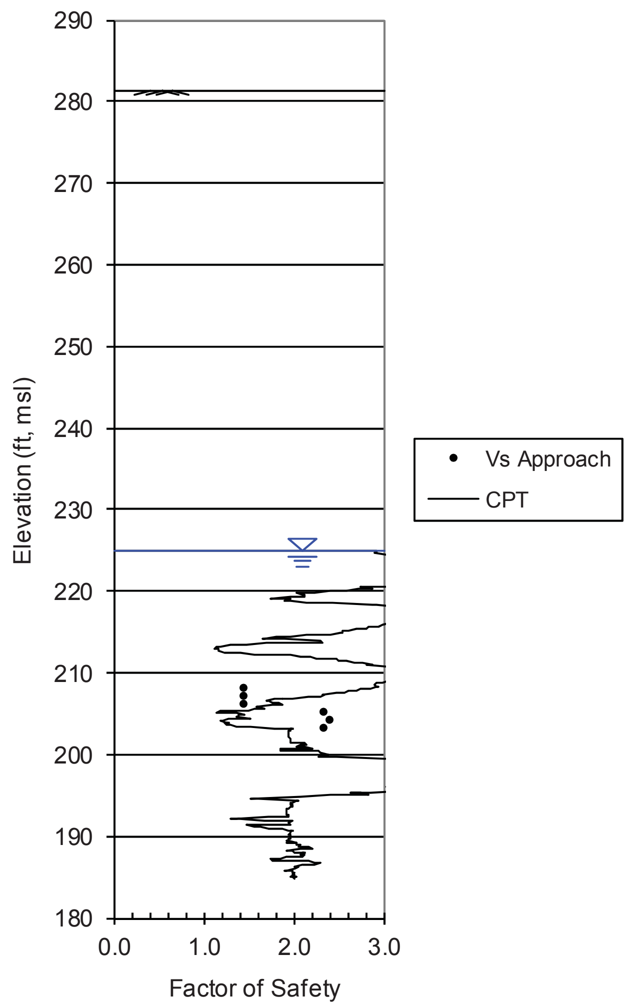
Min. Factor of Safety
1.13

Average Factor of Safety
2.75

***Vs Approach***

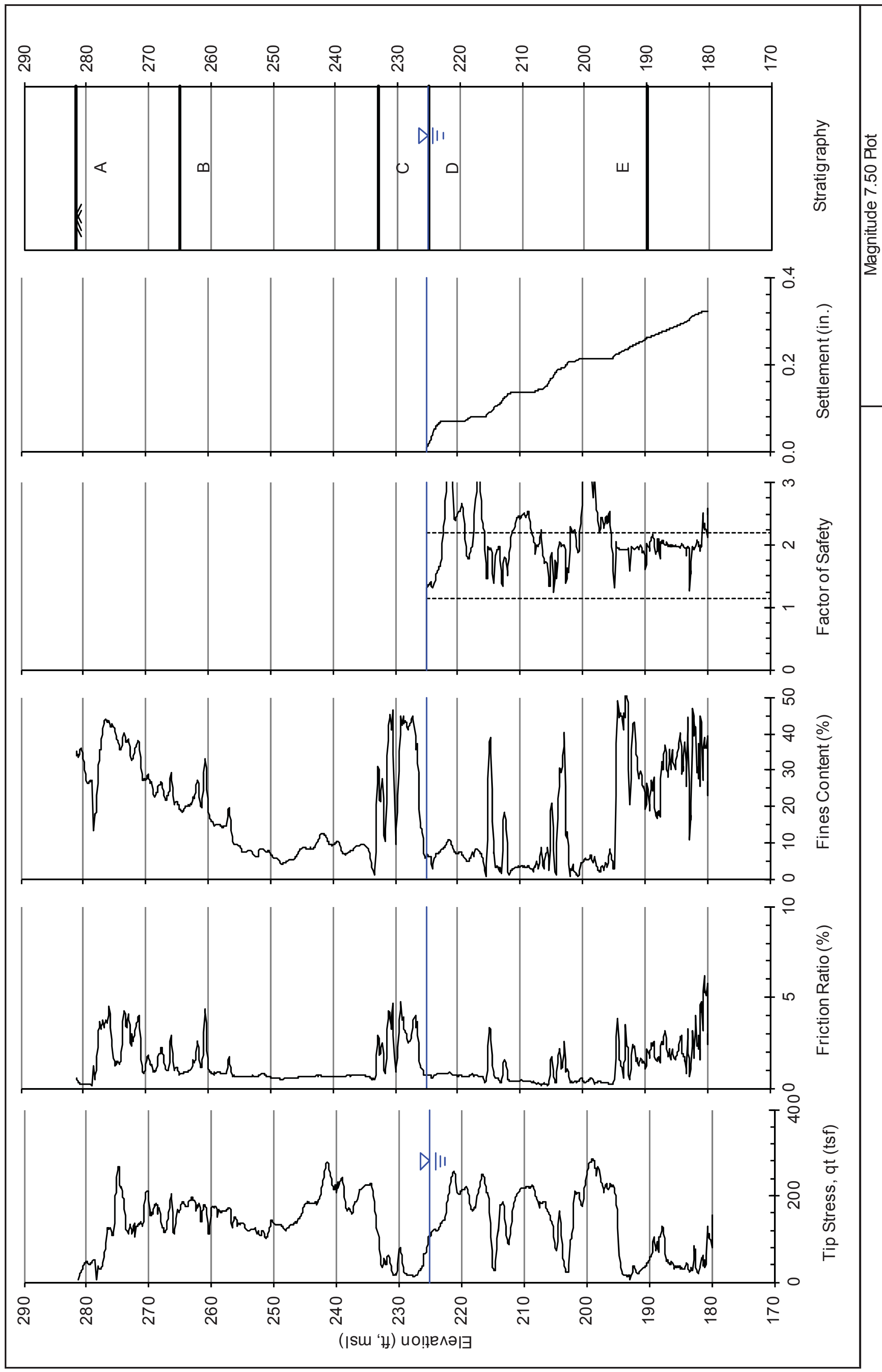
Min. Factor of Safety
1.43

Average Factor of Safety
4.87



Project: SDU 6
Cone ID: Z-SDU6-C03

**Design Basis Earthquake - Volumetric Strain**



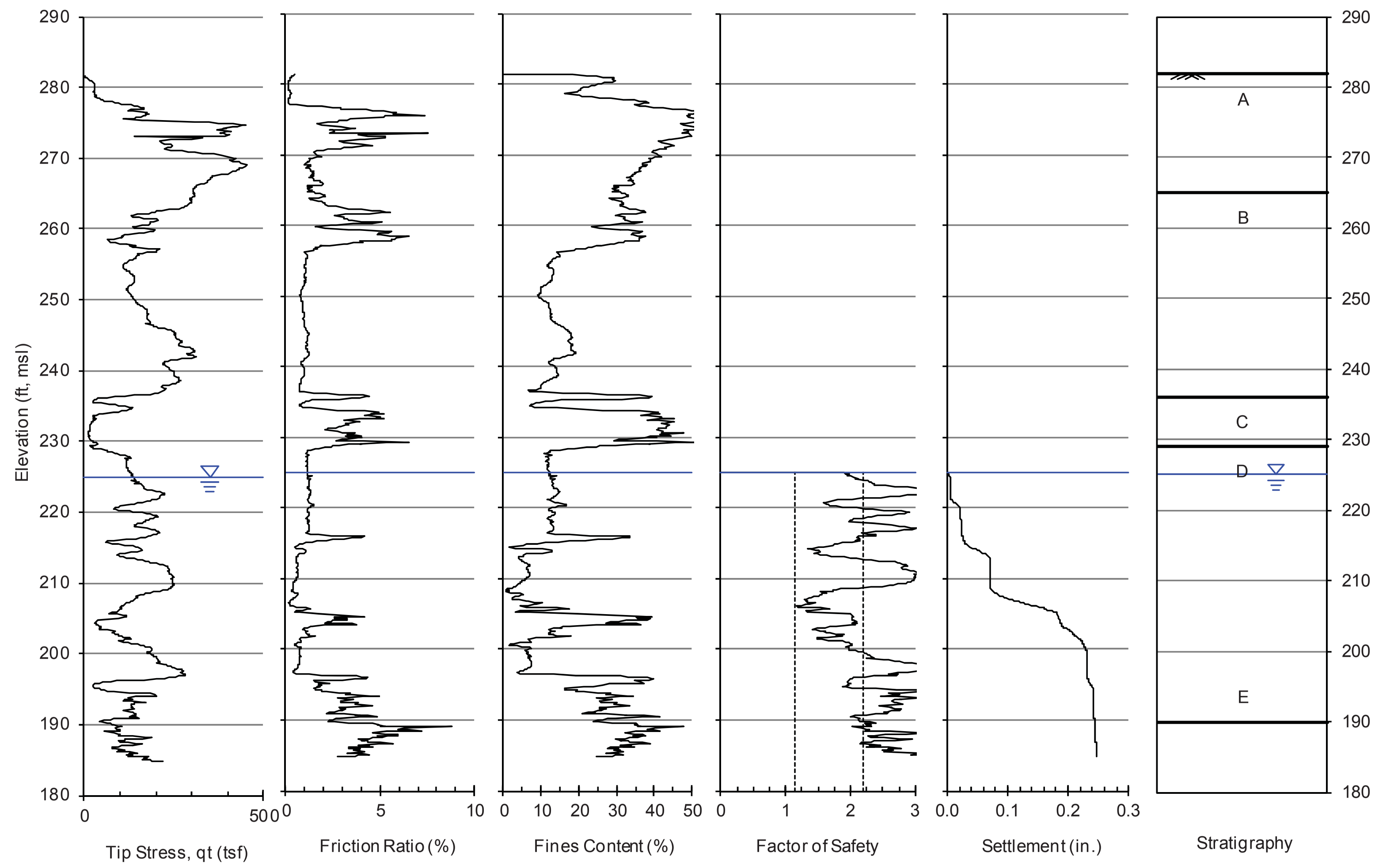

| Magnitude | 4.75 | 5.25 | 5.75 | 6.25 | 6.75 | 7.5 |
|---|---|---|---|---|---|---|
| Minimum Factor of Safety | 4.25 | 3.37 | 2.75 | 2.12 | 1.75 | 1.25 |
| Average Factor of Safety | 7.17 | 5.69 | 4.64 | 3.59 | 2.95 | 2.11 |
| Maximum Settlement | 0.00 in. | 0.00 in. | 0.00 in. | 0.00 in. | 0.03 in. | 0.32 in. |

| | |
|---|---|
| **2,500 Year Weighted Average Settlement** | 0.15 in. |

| | Stratigraphy / Layer Description |
|---|---|
| A | S1/S2 |
| B | Bottom of Excavation |
| C | C2 |
| D | S3 |
| E | S4 |

Project: SDU 6
Cone ID: Z-SDU6-C04

**Design Basis Earthquake - Volumetric Strain**




Magnitude 7.50 Plot

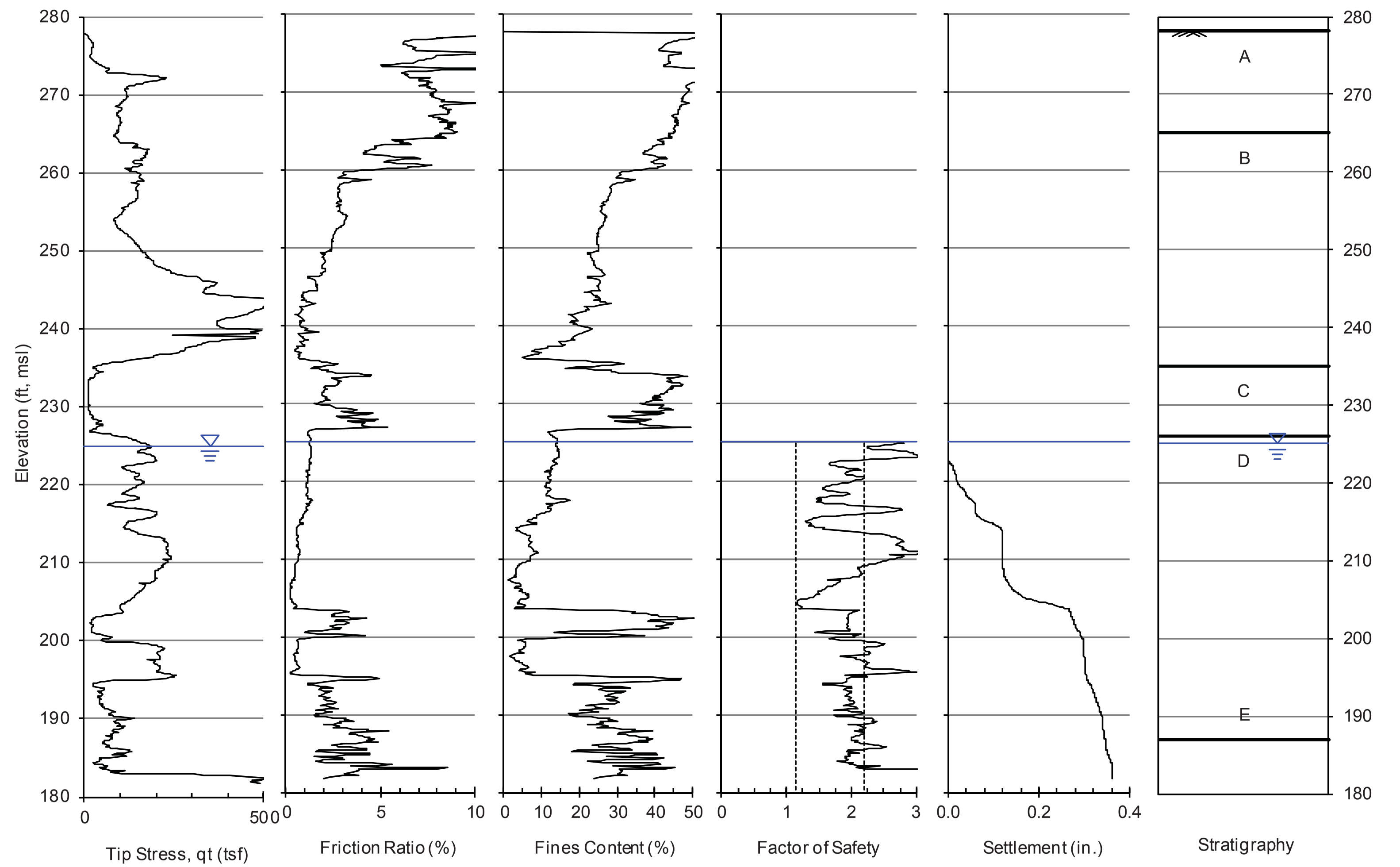
| **Magnitude** | ***4.75*** | ***5.25*** | ***5.75*** | ***6.25*** | ***6.75*** | ***7.5*** |
|---|---|---|---|---|---|---|
| Minimum Factor of Safety | 3.94 | 3.13 | 2.55 | 1.97 | 1.62 | 1.16 |
| Average Factor of Safety | 7.83 | 6.21 | 5.06 | 3.91 | 3.22 | 2.30 |
| Maximum Settlement | 0.00 in. | 0.00 in. | 0.00 in. | 0.00 in. | 0.03 in. | 0.25 in. |

| **2,500 Year Weighted Average Settlement** | 0.12 in. |
|---|---|

| Stratigraphy / Layer Description | | |
|---|---|---|
| A | S1/S2 | |
| B | Bottom of Excavation | |
| C | C2 | |
| D | S3 | |
| E | S4 | |

Project: SDU 6
Cone ID: Z-SDU6-C05

**Design Basis Earthquake - Volumetric Strain**




Magnitude 7.50 Plot

| Magnitude | **4.75** | **5.25** | **5.75** | **6.25** | **6.75** | **7.5** |
|---|---|---|---|---|---|---|
| Minimum Factor of Safety | 3.89 | 3.09 | 2.51 | 1.94 | 1.60 | 1.14 |
| Average Factor of Safety | 7.56 | 6.01 | 4.89 | 3.78 | 3.11 | 2.22 |
| Maximum Settlement | 0.00 in. | 0.00 in. | 0.00 in. | 0.01 in. | 0.04 in. | 0.36 in. |

| | |
|---|---|
| **2,500 Year Weighted Average Settlement** | 0.17 in. |

| Stratigraphy / Layer Description | | |
|---|---|---|
| A | S1/S2 | |
| B | Bottom of Excavation | |
| C | C2 | |
| D | S3 | |
| E | S4 | |

Project: SDU 6
Cone ID: Z-SDU6-C05

| | DBE | | | | | | Cha50 |
|---|---|---|---|---|---|---|---|
| Magnitudes | 4.75 | 5.25 | 5.75 | 6.25 | 6.75 | 7.5 | 7.3 |
| Liquefaction Settlements | 0.00 in. | 0.00 in. | 0.00 in. | 0.01 in. | 0.04 in. | 0.36 in. | 0.00 in. |

***Weighted DBE Settlements***

| SCPTu ID | 2,500 Year Average for all Magnitudes (100 Hz) |
|---|---|
| Z-SDU6-C05 | 0.17 in. |

***Cha50 Settlement (Unweighted)***

| SCPTu ID | Cha50 Mw = 7.3 MSF = 1.1 |
|---|---|
| Z-SDU6-C05 | 0.00 in. |

***PC3 Mw =7.5 CPT (tip stress) and Shear Wave Velocity Factor of Safety Comparison***

***CPT Approach***

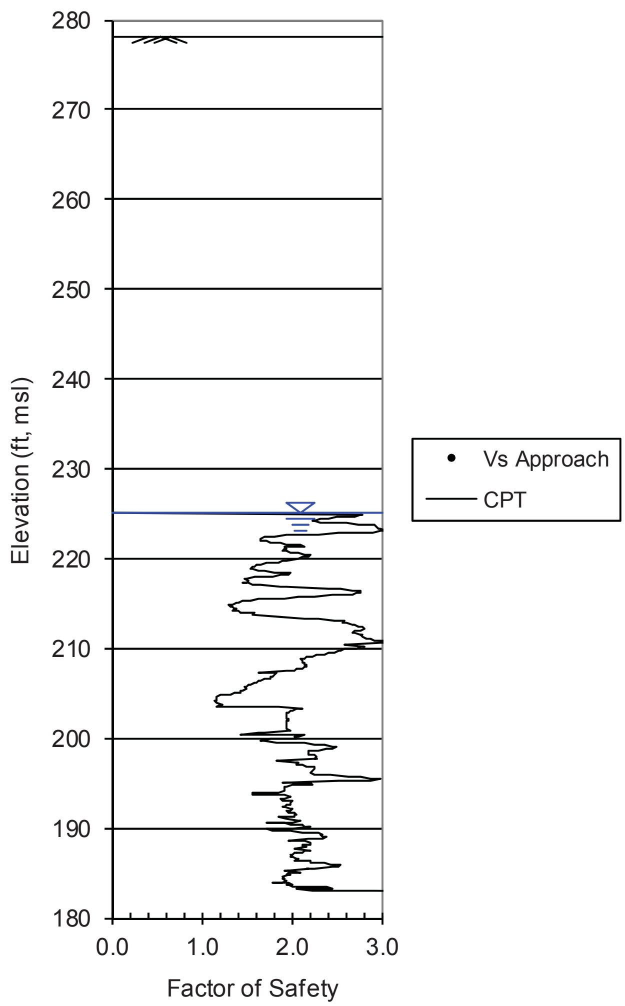
Min. Factor of Safety
1.14

Average Factor of Safety
2.22

***Vs Approach***

Min. Factor of Safety
5.16

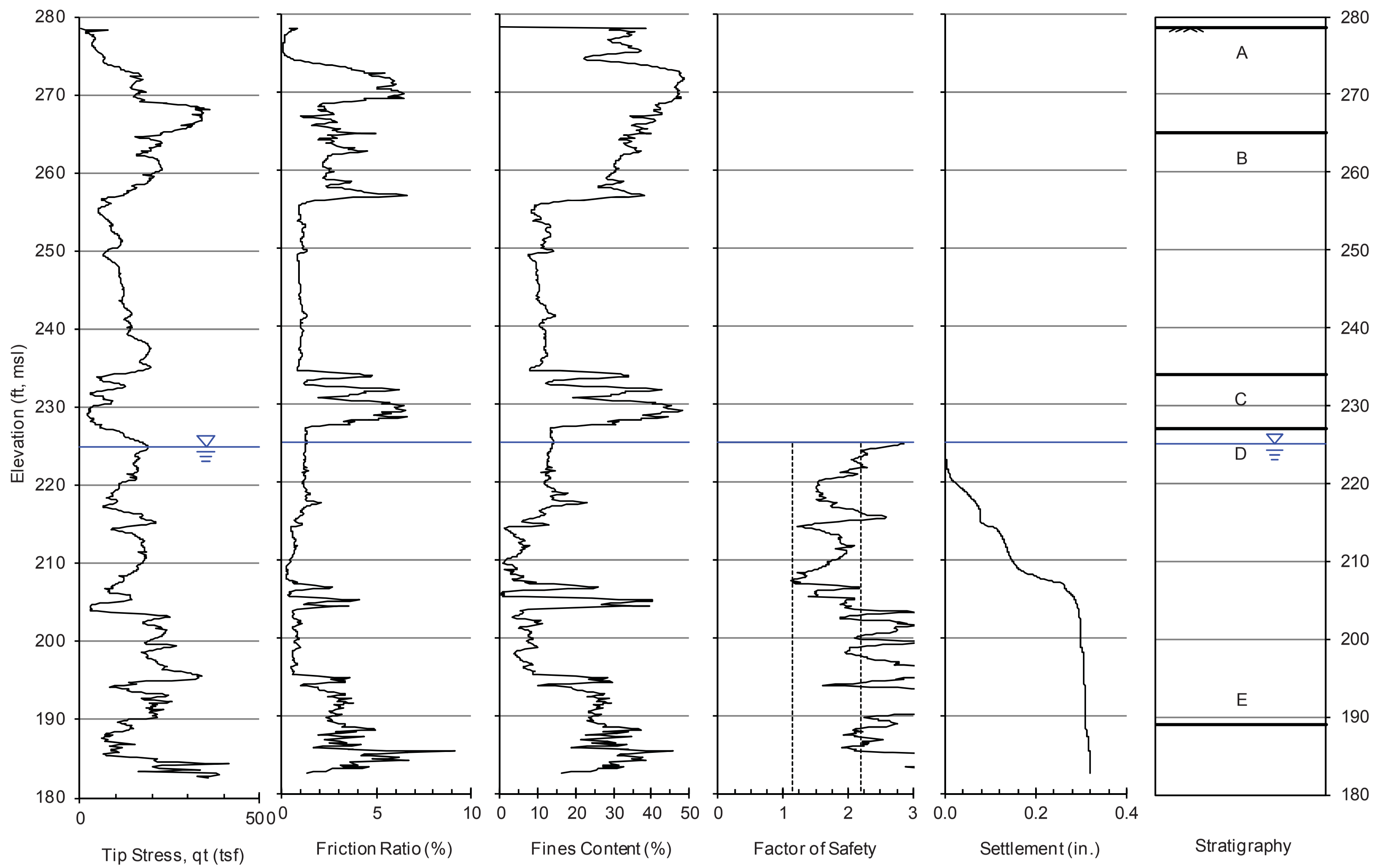
Average Factor of Safety
5.43



Project: SDU 6

Cone ID: Z-SDU6-C06

**_Design Basis Earthquake - Volumetric Strain_**




Magnitude 7.50 Plot

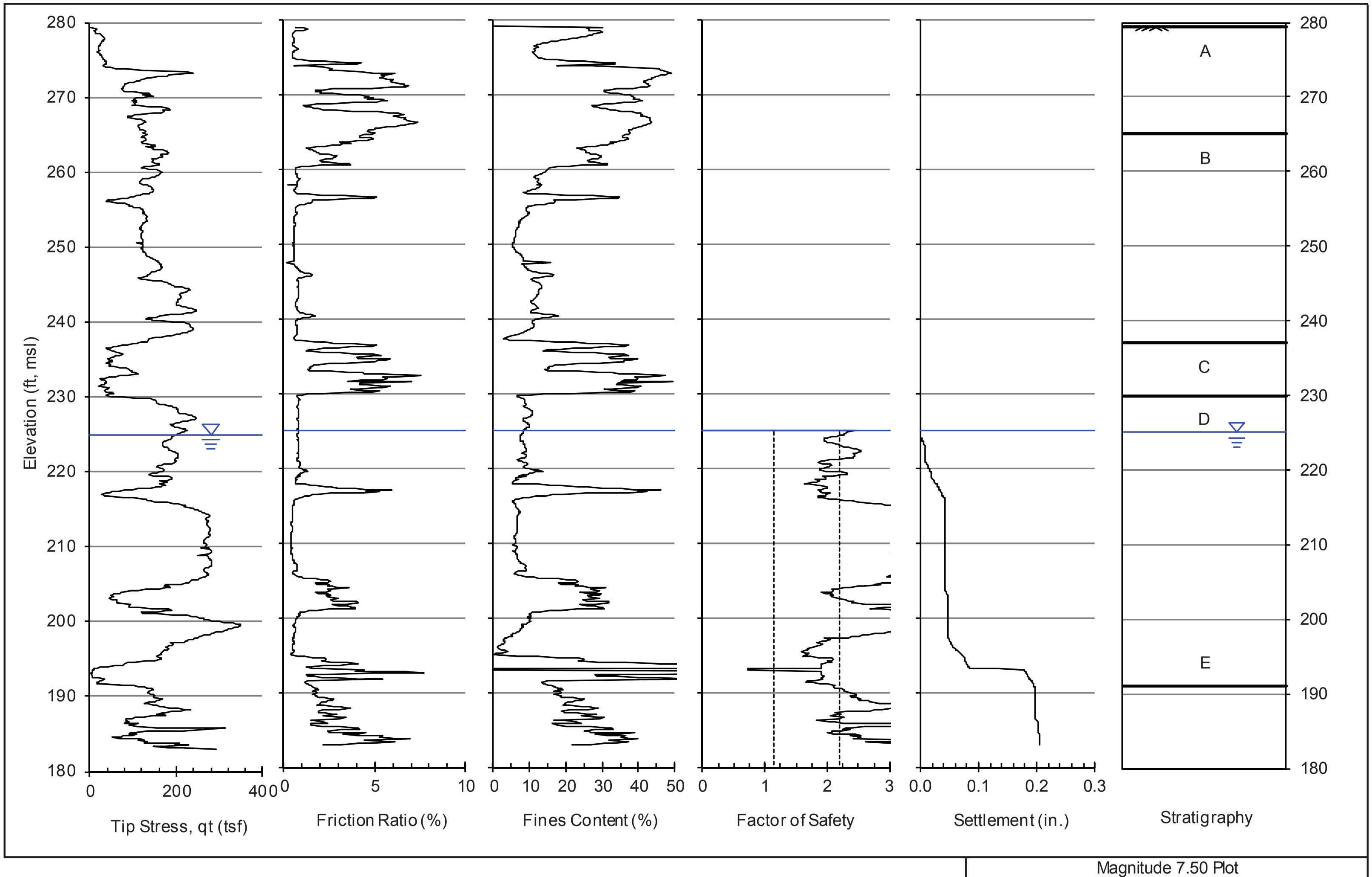
| **Magnitude** | ***4.75*** | ***5.25*** | ***5.75*** | ***6.25*** | ***6.75*** | ***7.5*** |
|---|---|---|---|---|---|---|
| Minimum Factor of Safety | 3.81 | 3.03 | 2.47 | 1.91 | 1.57 | 1.12 |
| Average Factor of Safety | 8.18 | 6.50 | 5.29 | 4.09 | 3.37 | 2.41 |
| Maximum Settlement | 0.00 in. | 0.00 in. | 0.00 in. | 0.01 in. | 0.04 in. | 0.32 in. |

| **2,500 Year Weighted Average Settlement** | 0.15 in. |
|---|---|

| Stratigraphy / Layer Description | | |
|---|---|---|
| A | S1/S2 | |
| B | Bottom of Excavation | |
| C | C2 | |
| D | S3 | |
| E | S4 | |

Project: SDU 6
Cone ID: Z-SDU6-C07

**_Design Basis Earthquake - Volumetric Strain_**



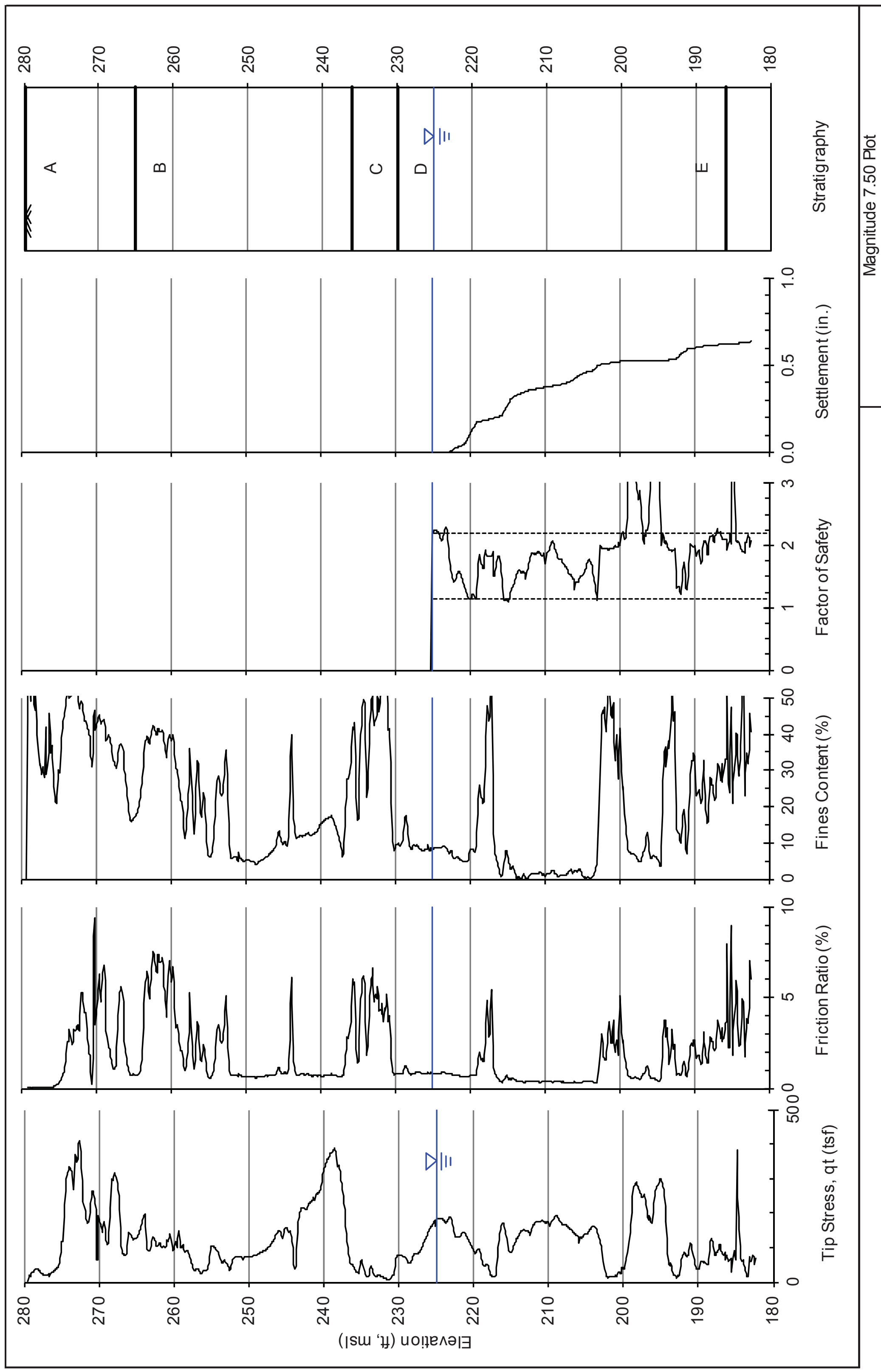

| Magnitude | 4.75 | 5.25 | 5.75 | 6.25 | 6.75 | 7.5 |
|---|---|---|---|---|---|---|
| Minimum Factor of Safety | 2.46 | 1.95 | 1.59 | 1.23 | 1.01 | 0.72 |
| Average Factor of Safety | 9.52 | 7.56 | 6.16 | 4.76 | 3.92 | 2.80 |
| Maximum Settlement | 0.00 in. | 0.00 in. | 0.00 in. | 0.01 in. | 0.04 in. | 0.20 in. |

| **2,500 Year Weighted Average Settlement** | 0.10 in. |
|---|---|

| Stratigraphy / Layer Description | | |
|---|---|---|
| A | S1/S2 | |
| B | Bottom of Excavation | |
| C | C2 | |
| D | S3 | |
| E | S4 | |

Project: SDU 6
Cone ID: Z-SDU6-C08

## *Design Basis Earthquake - Volumetric Strain*



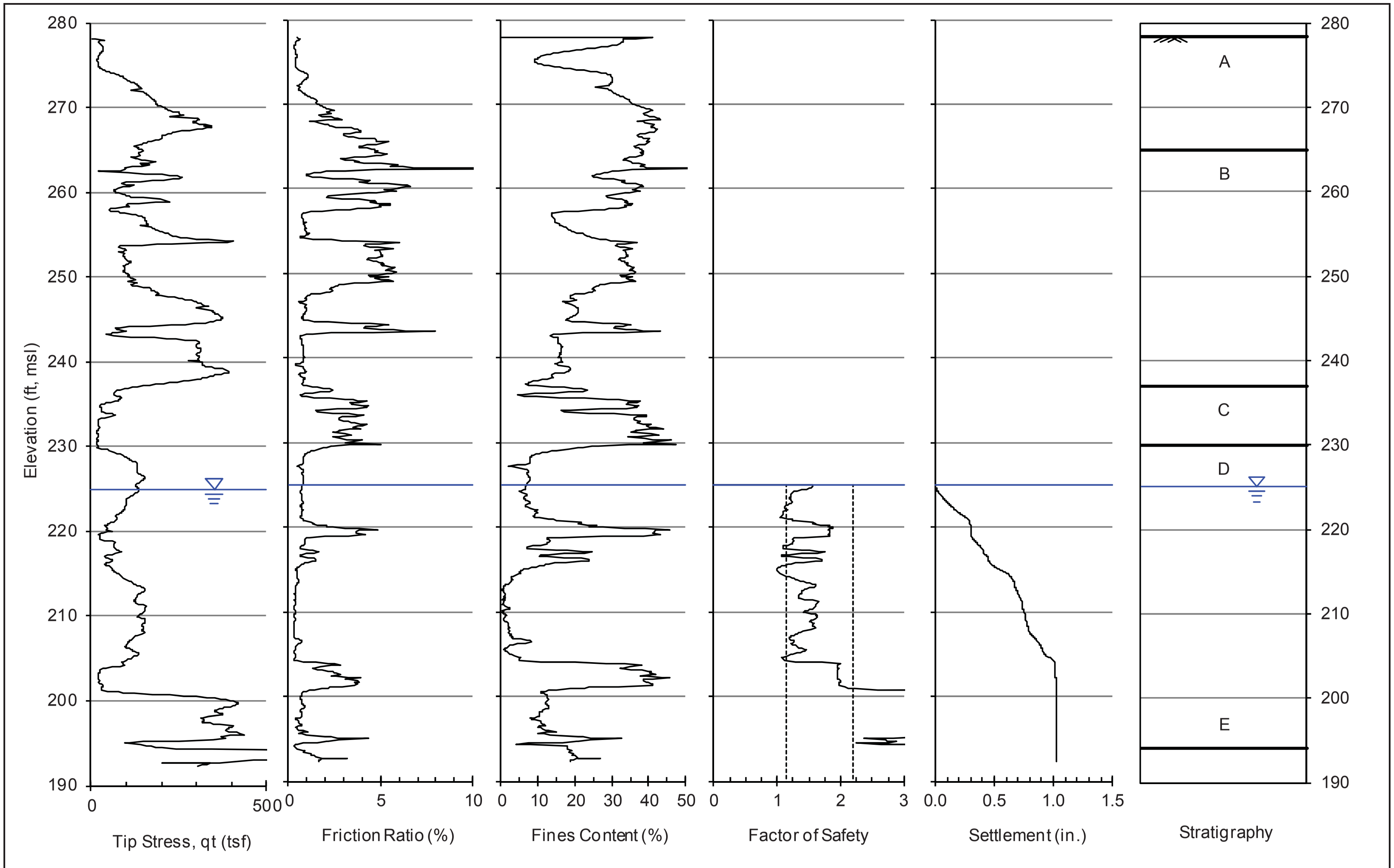

| **Magnitude** | **4.75** | **5.25** | **5.75** | **6.25** | **6.75** | **7.5** |
|---|---|---|---|---|---|---|
| Minimum Factor of Safety | 3.68 | 2.92 | 2.38 | 1.84 | 1.52 | 1.08 |
| Average Factor of Safety | 6.61 | 5.25 | 4.28 | 3.30 | 2.72 | 1.94 |
| Maximum Settlement | 0.00 in. | 0.00 in. | 0.00 in. | 0.02 in. | 0.09 in. | 0.64 in. |

| **2,500 Year Weighted Average Settlement** | 0.31 in. |
|---|---|

| Stratigraphy / Layer Description | |
|---|---|
| A | S1/S2 |
| B | Bottom of Excavation |
| C | C2 |
| D | S3 |
| E | S4 |

Project: SDU 6
Cone ID: Z-SDU6-C09

**_Design Basis Earthquake - Volumetric Strain_**




Magnitude 7.50 Plot

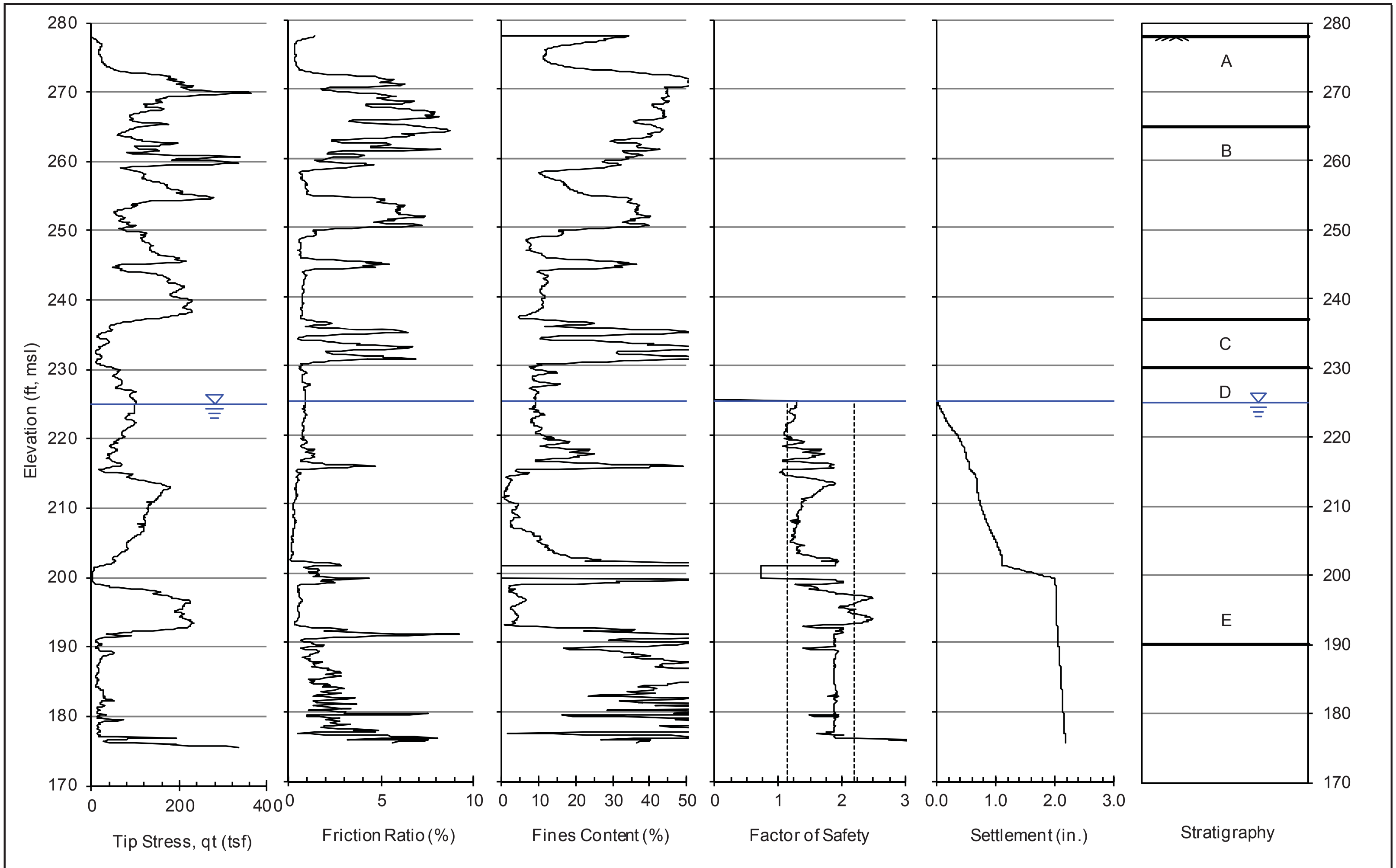
| **Magnitude** | ***4.75*** | ***5.25*** | ***5.75*** | ***6.25*** | ***6.75*** | ***7.5*** |
|---|---|---|---|---|---|---|
| Minimum Factor of Safety | 3.38 | 2.68 | 2.19 | 1.69 | 1.39 | 0.99 |
| Average Factor of Safety | 11.85 | 9.41 | 7.67 | 5.93 | 4.88 | 3.49 |
| Maximum Settlement | 0.00 in. | 0.00 in. | 0.00 in. | 0.06 in. | 0.19 in. | 1.03 in. |

| **2,500 Year Weighted Average Settlement** | 0.50 in. |
|---|---|

| Stratigraphy / Layer Description | | |
|---|---|---|
| A | S1/S2 | |
| B | Bottom of Excavation | |
| C | C2 | |
| D | S3 | |
| E | S4 | |

Project: SDU 6
Cone ID: Z-SDU6-C10

**_Design Basis Earthquake - Volumetric Strain_**




Magnitude 7.50 Plot

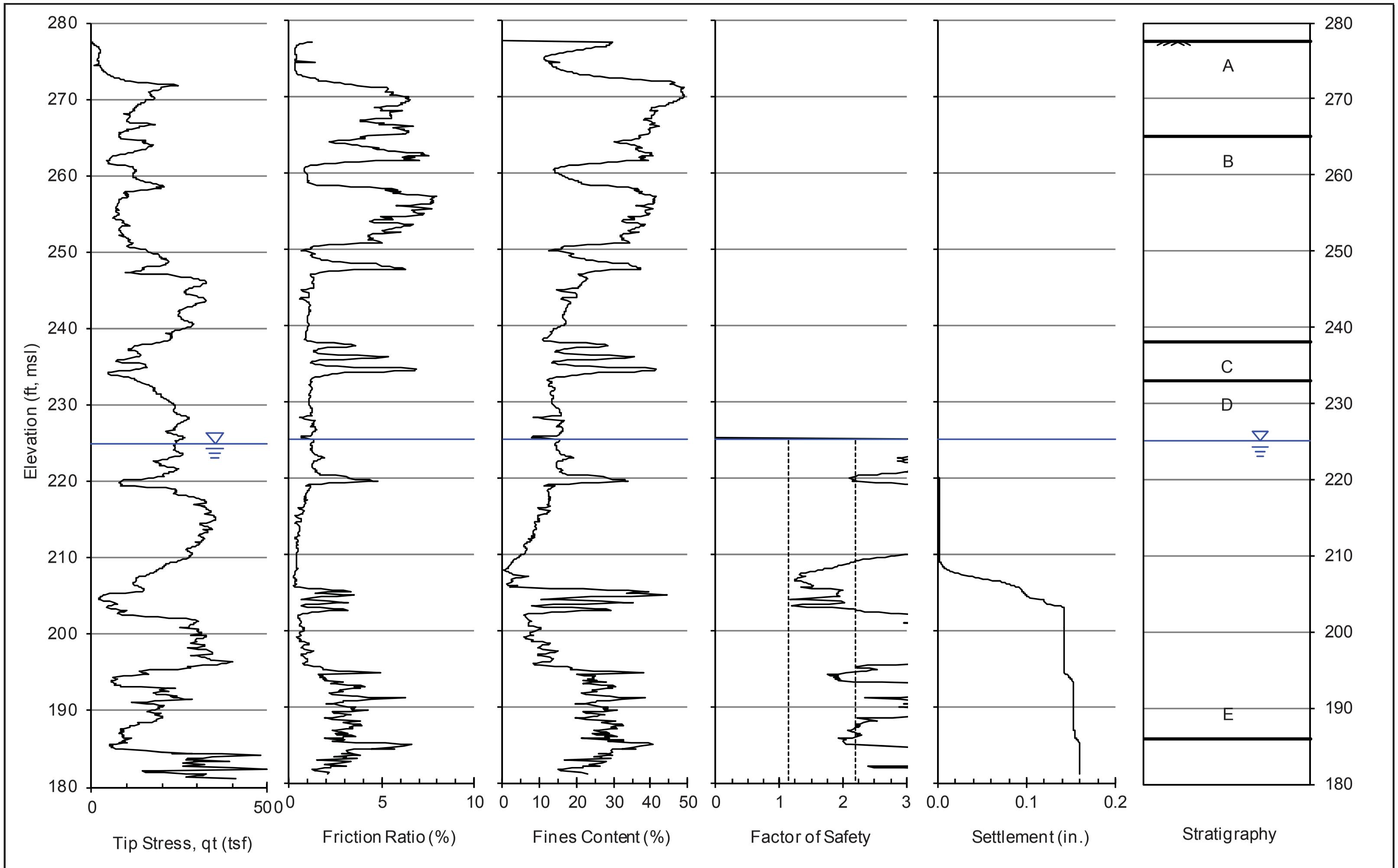
| **Magnitude** | ***4.75*** | ***5.25*** | ***5.75*** | ***6.25*** | ***6.75*** | ***7.5*** |
|---|---|---|---|---|---|---|
| Minimum Factor of Safety | 2.47 | 1.96 | 1.60 | 1.24 | 1.02 | 0.73 |
| Average Factor of Safety | 5.55 | 4.41 | 3.59 | 2.78 | 2.29 | 1.63 |
| Maximum Settlement | 0.00 in. | 0.01 in. | 0.03 in. | 0.17 in. | 0.54 in. | 2.17 in. |

| | |
|---|---|
| **2,500 Year Weighted Average Settlement** | 1.07 in. |

| Stratigraphy / Layer Description | | |
|---|---|---|
| A | S1/S2 | |
| B | Bottom of Excavation | |
| C | C2 | |
| D | S3 | |
| E | S4 | |

Project: SDU 6
Cone ID: Z-SDU6-C11

**Design Basis Earthquake - Volumetric Strain**




Magnitude 7.50 Plot

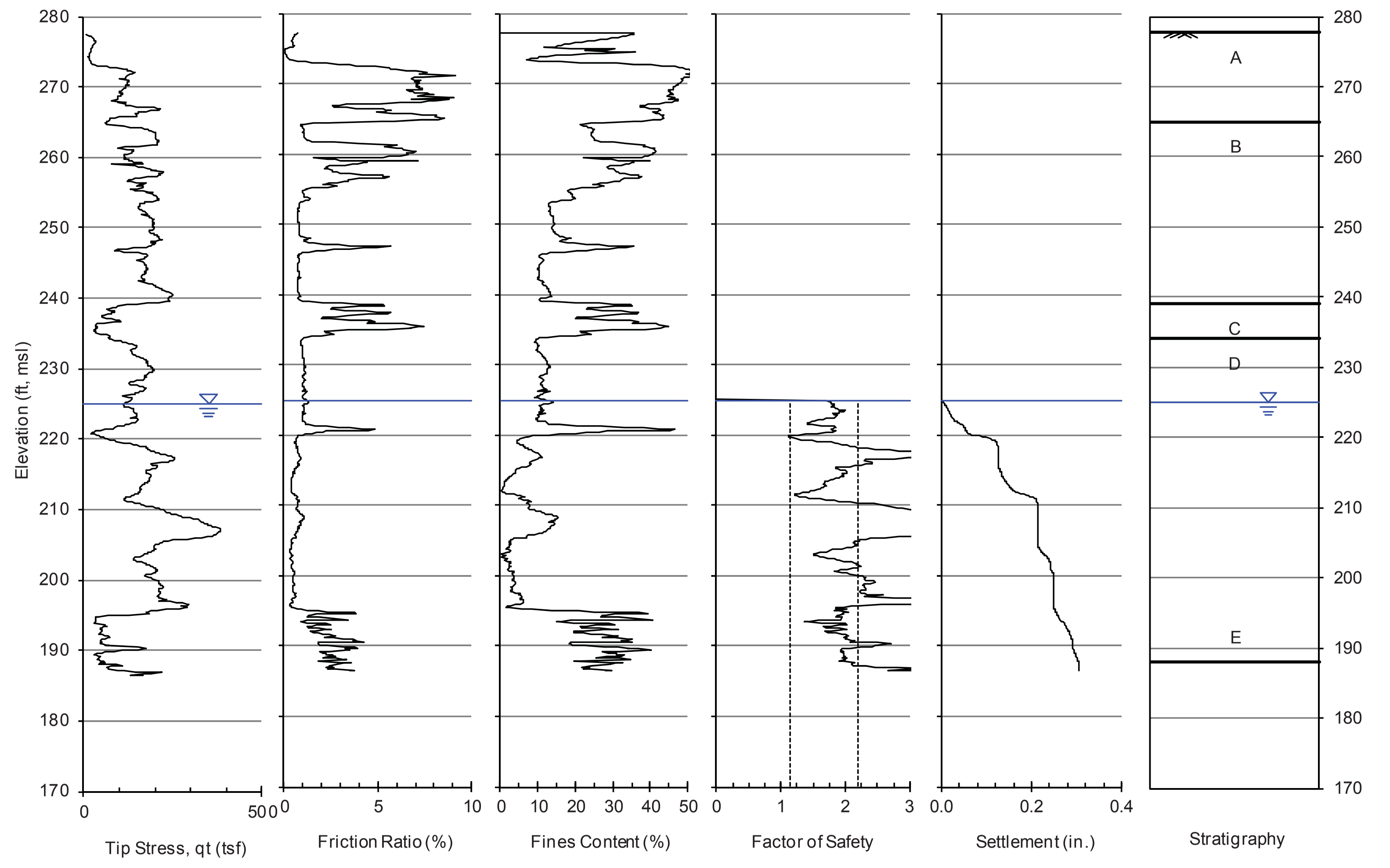
| Magnitude | ***4.75*** | ***5.25*** | ***5.75*** | ***6.25*** | ***6.75*** | ***7.5*** |
|---|---|---|---|---|---|---|
| Minimum Factor of Safety | 4.00 | 3.18 | 2.59 | 2.00 | 1.65 | 1.18 |
| Average Factor of Safety | 12.13 | 9.64 | 7.85 | 6.07 | 5.00 | 3.57 |
| Maximum Settlement | 0.00 in. | 0.00 in. | 0.00 in. | 0.00 in. | 0.02 in. | 0.16 in. |

| **2,500 Year Weighted Average Settlement** | 0.08 in. |
|---|---|

| Stratigraphy / Layer Description | | |
|---|---|---|
| A | S1/S2 | |
| B | Bottom of Excavation | |
| C | C2 | |
| D | S3 | |
| E | S4 | |

Project: SDU 6
Cone ID: Z-SDU6-C12

**Design Basis Earthquake - Volumetric Strain**




Magnitude 7.50 Plot

| **Magnitude** | **4.75** | **5.25** | **5.75** | **6.25** | **6.75** | **7.5** |
|---|---|---|---|---|---|---|
| Minimum Factor of Safety | 3.77 | 3.00 | 2.44 | 1.89 | 1.55 | 1.11 |
| Average Factor of Safety | 9.09 | 7.22 | 5.88 | 4.54 | 3.74 | 2.67 |
| Maximum Settlement | 0.00 in. | 0.00 in. | 0.00 in. | 0.01 in. | 0.03 in. | 0.31 in. |

| **2,500 Year Weighted Average Settlement** | 0.15 in. |
|---|---|

| Stratigraphy / Layer Description | | |
|---|---|---|
| A | S1/S2 | |
| B | Bottom of Excavation | |
| C | C2 | |
| D | S3 | |
| E | S4 | |

Project: SDU 6
Cone ID: Z-SDU6-C12

| | DBE | | | | | | Cha50 |
|---|---|---|---|---|---|---|---|
| Magnitudes | ***4.75*** | ***5.25*** | ***5.75*** | ***6.25*** | ***6.75*** | ***7.5*** | ***7.3*** |
| Liquefaction Settlements | 0.00 in. | 0.00 in. | 0.00 in. | 0.01 in. | 0.03 in. | 0.31 in. | 0.00 in. |

***Weighted DBE Settlements***

| SCPTu ID | 2,500 Year Average for all Magnitudes (100 Hz) |
|---|---|
| **Z-SDU6-C12** | 0.15 in. |

***Cha50 Settlement (Unweighted)***

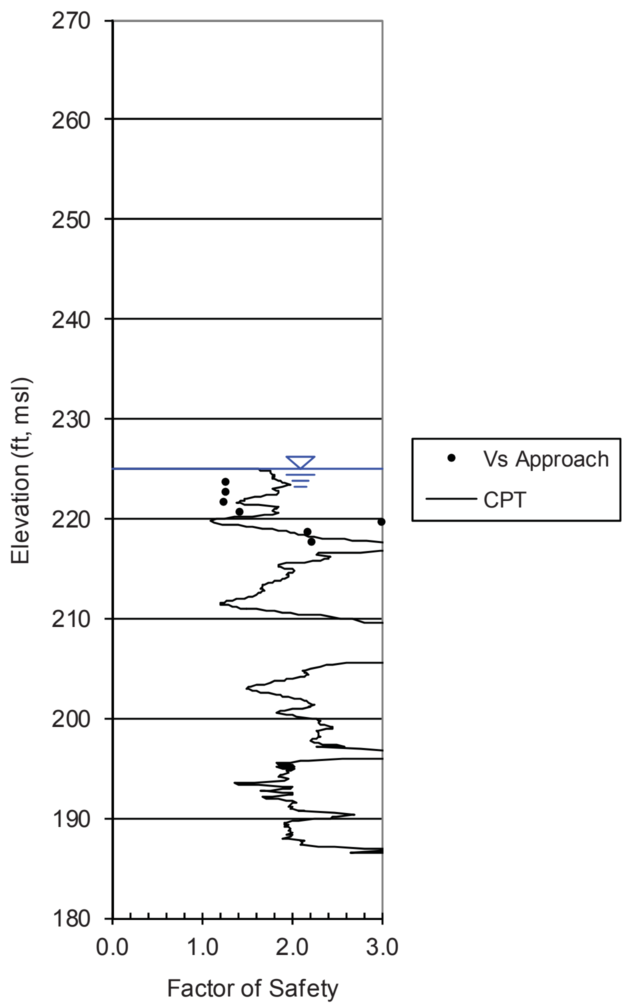
| SCPTu ID | Cha50 Mw = 7.3 MSF = 1.1 |
|---|---|
| **Z-SDU6-C12** | 0.00 in. |

***PC3 Mw =7.5 CPT (tip stress) and Shear Wave Velocity Factor of Safety Comparison***

***CPT Approach***

Min. Factor of Safety
1.11

Average Factor of Safety
2.67



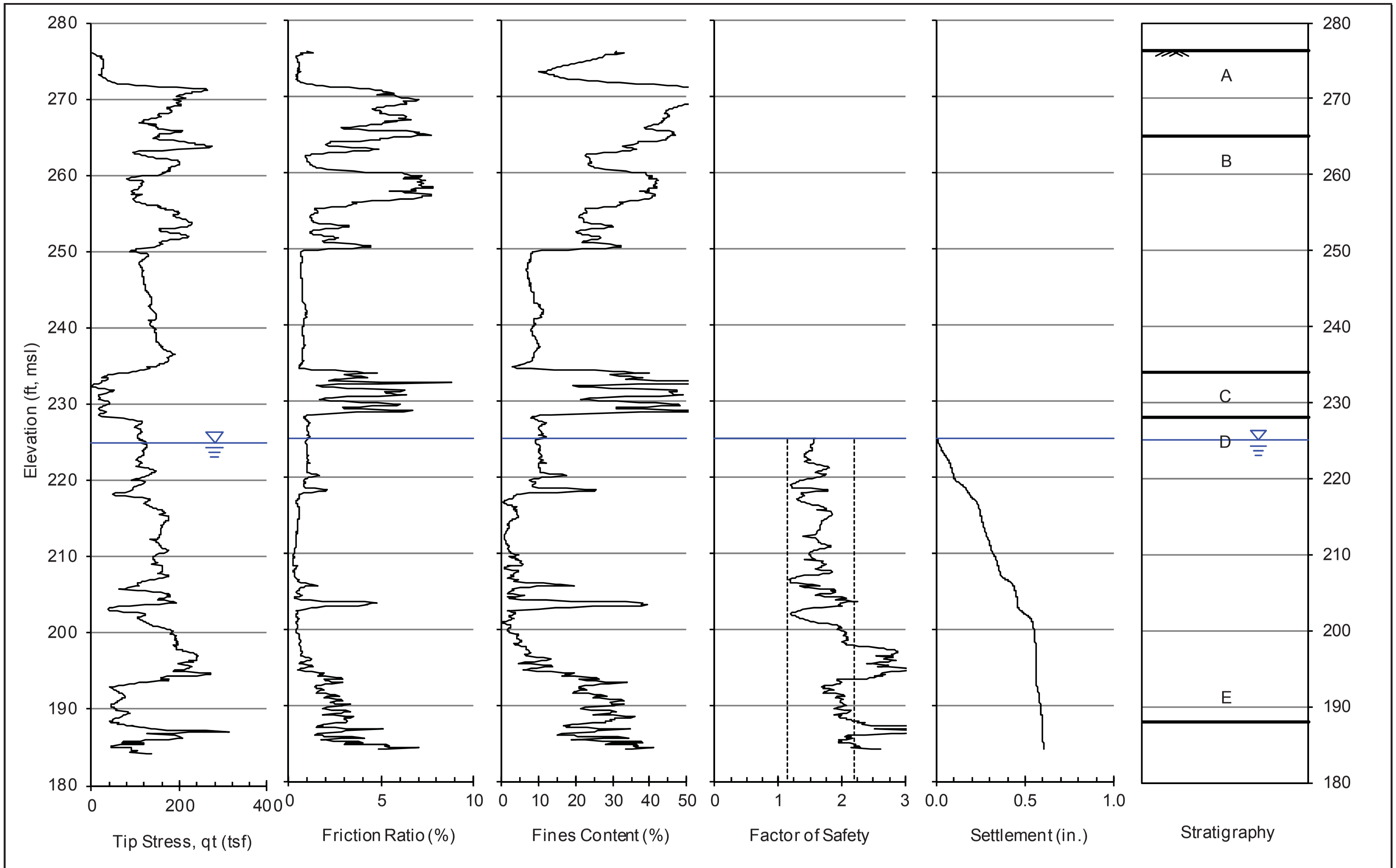

***Vs Approach***

Min. Factor of Safety
1.23

Average Factor of Safety
4.76

Project: SDU 6
Cone ID: Z-SDU6-C13

**Design Basis Earthquake - Volumetric Strain**




Magnitude 7.50 Plot

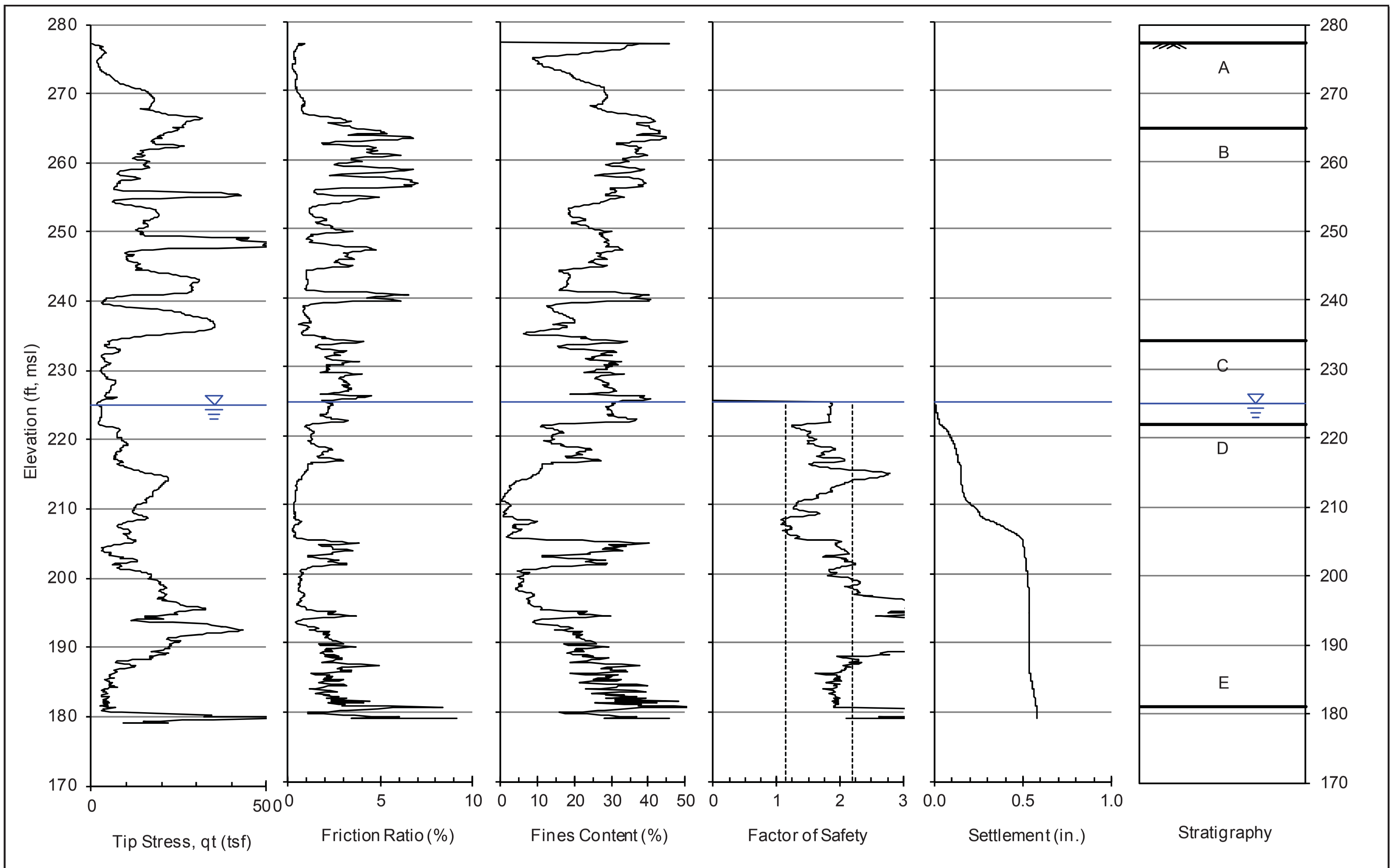
| **Magnitude** | ***4.75*** | ***5.25*** | ***5.75*** | ***6.25*** | ***6.75*** | ***7.5*** |
|---|---|---|---|---|---|---|
| Minimum Factor of Safety | 3.99 | 3.17 | 2.58 | 2.00 | 1.64 | 1.17 |
| Average Factor of Safety | 6.38 | 5.07 | 4.13 | 3.19 | 2.63 | 1.88 |
| Maximum Settlement | 0.00 in. | 0.00 in. | 0.00 in. | 0.01 in. | 0.08 in. | 0.60 in. |

| **2,500 Year Weighted Average Settlement** | 0.29 in. |
|---|---|

| Stratigraphy / Layer Description | | |
|---|---|---|
| A | S1/S2 | |
| B | Bottom of Excavation | |
| C | C2 | |
| D | S3 | |
| E | S4 | |

Project: SDU 6
Cone ID: Z-SDU6-C14

**Design Basis Earthquake - Volumetric Strain**




Magnitude 7.50 Plot

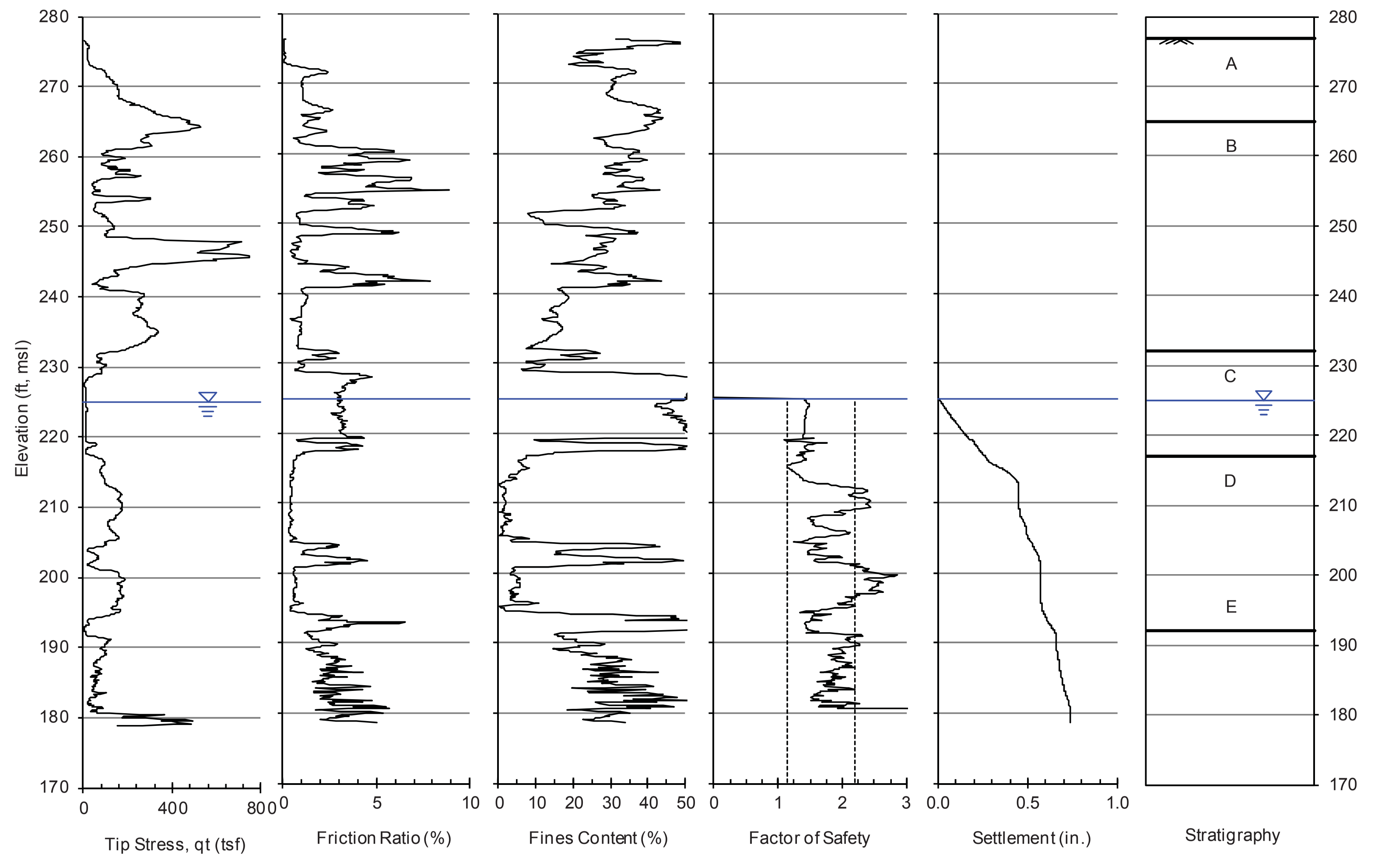
| Magnitude | 4.75 | 5.25 | 5.75 | 6.25 | 6.75 | 7.5 |
|---|---|---|---|---|---|---|
| Minimum Factor of Safety | 3.60 | 2.86 | 2.33 | 1.80 | 1.48 | 1.06 |
| Average Factor of Safety | 8.61 | 6.84 | 5.57 | 4.30 | 3.54 | 2.53 |
| Maximum Settlement | 0.00 in. | 0.00 in. | 0.00 in. | 0.02 in. | 0.08 in. | 0.58 in. |

| Stratigraphy / Layer Description | | |
|---|---|---|
| A | S1/S2 | |
| B | Bottom of Excavation | |
| C | C2 | |
| D | S3 | |
| E | S4 | |

| **2,500 Year Weighted Average Settlement** | 0.28 in. |
|---|---|

Project: SDU 6
Cone ID: Z-SDU6-C15

***Design Basis Earthquake - Volumetric Strain***




Magnitude 7.50 Plot

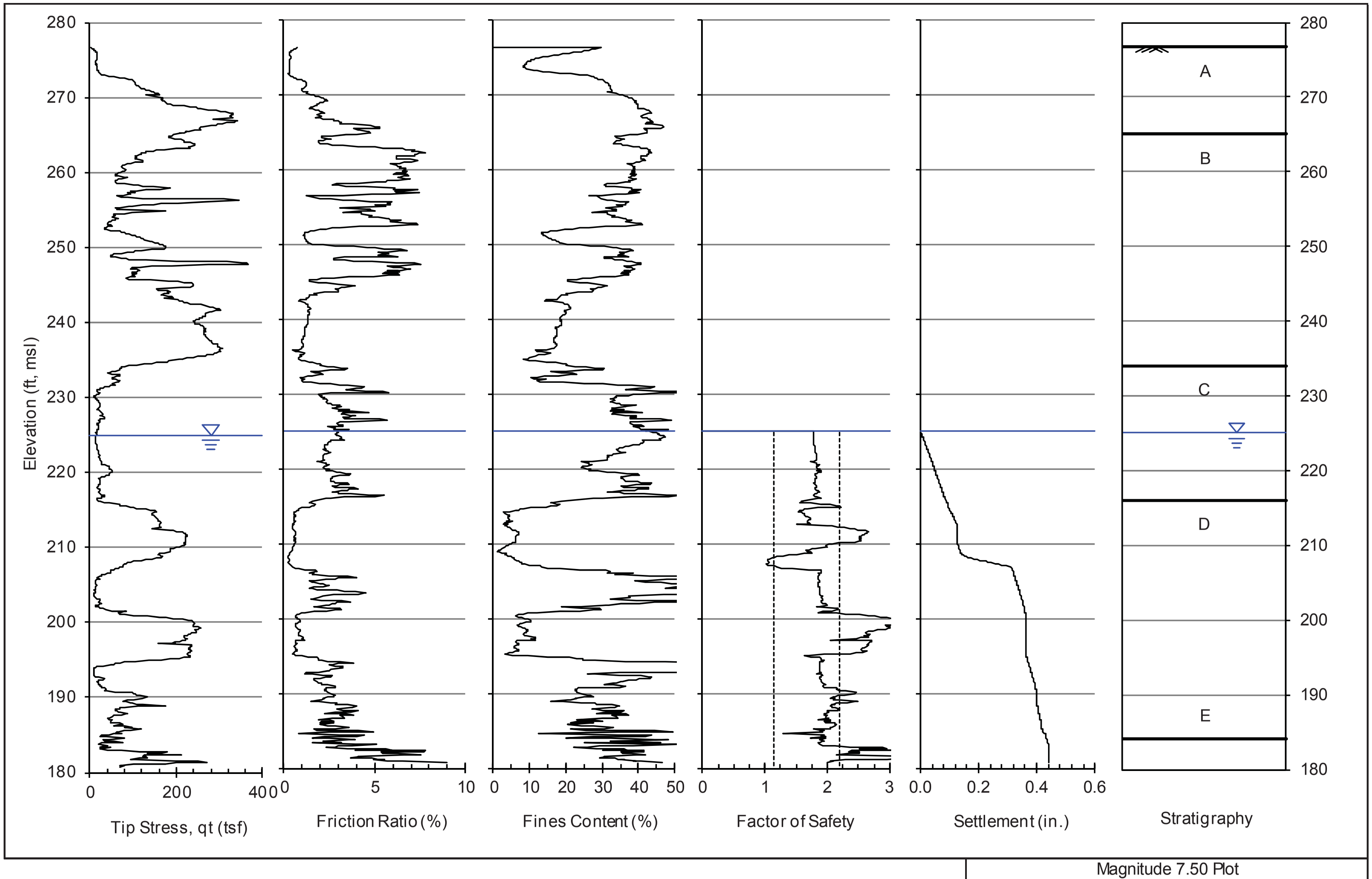
| **Magnitude** | ***4.75*** | ***5.25*** | ***5.75*** | ***6.25*** | ***6.75*** | ***7.5*** |
|---|---|---|---|---|---|---|
| Minimum Factor of Safety | 3.74 | 2.97 | 2.42 | 1.87 | 1.54 | 1.10 |
| Average Factor of Safety | 7.19 | 5.71 | 4.66 | 3.60 | 2.96 | 2.12 |
| Maximum Settlement | 0.00 in. | 0.00 in. | 0.00 in. | 0.01 in. | 0.11 in. | 0.73 in. |

| | |
|---|---|
| **2,500 Year Weighted Average Settlement** | 0.35 in. |

| Stratigraphy / Layer Description | | |
|---|---|---|
| A | S1/S2 | |
| B | Bottom of Excavation | |
| C | C2 | |
| D | S3 | |
| E | S4 | |

Project: SDU 6
Cone ID: Z-SDU6-C16

**Design Basis Earthquake - Volumetric Strain**




| **Magnitude** | ***4.75*** | ***5.25*** | ***5.75*** | ***6.25*** | ***6.75*** | ***7.5*** |
|---|---|---|---|---|---|---|
| Minimum Factor of Safety | 3.50 | 2.78 | 2.27 | 1.75 | 1.44 | 1.03 |
| Average Factor of Safety | 6.92 | 5.50 | 4.48 | 3.46 | 2.85 | 2.04 |
| Maximum Settlement | 0.00 in. | 0.00 in. | 0.00 in. | 0.01 in. | 0.04 in. | 0.44 in. |

| **2,500 Year Weighted Average Settlement** | 0.21 in. |
|---|---|

| Stratigraphy / Layer Description | | |
|---|---|---|
| A | S1/S2 | |
| B | Bottom of Excavation | |
| C | C2 | |
| D | S3 | |
| E | S4 | |

Project: SDU 6
Cone ID: Z-SDU6-C16

| | DBE | | | | | | Cha50 |
|---|---|---|---|---|---|---|---|
| Magnitudes | 4.75 | 5.25 | 5.75 | 6.25 | 6.75 | 7.5 | 7.3 |
| Liquefaction Settlements | 0.00 in. | 0.00 in. | 0.00 in. | 0.01 in. | 0.04 in. | 0.44 in. | 0.01 in. |

*Weighted DBE Settlements*

| SCPTu ID | 2,500 Year Average for all Magnitudes (100 Hz) |
|---|---|
| Z-SDU6-C16 | 0.21 in. |

*Cha50 Settlement (Unweighted)*

| SCPTu ID | Cha50 Mw = 7.3 MSF = 1.1 |
|---|---|
| Z-SDU6-C16 | 0.01 in. |

*PC3 Mw =7.5 CPT (tip stress) and Shear Wave Velocity Factor of Safety Comparison*

*CPT Approach*

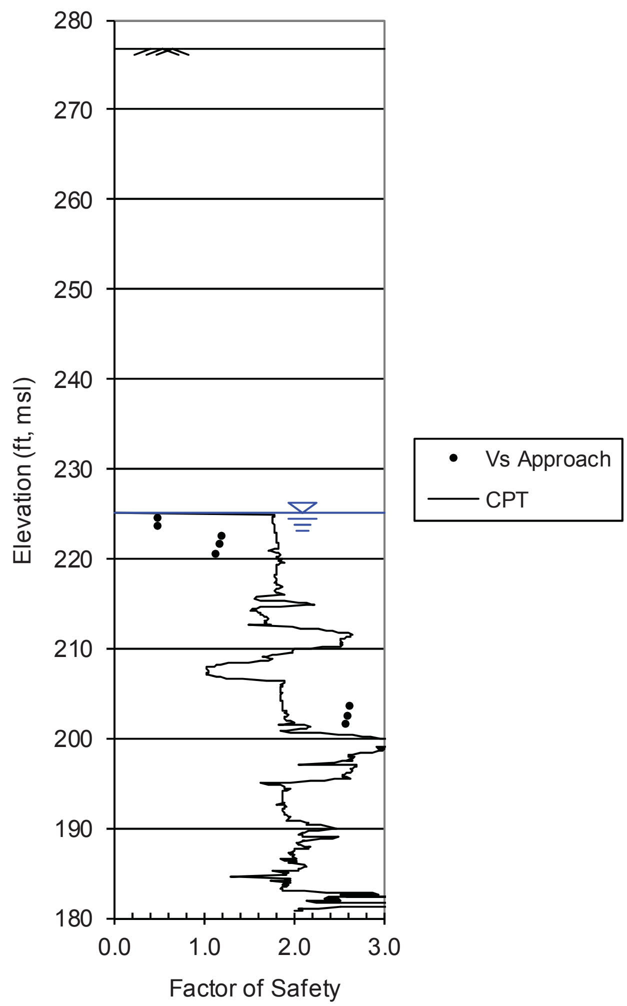
Min. Factor of Safety
1.03

Average Factor of Safety
2.04

*Vs Approach*

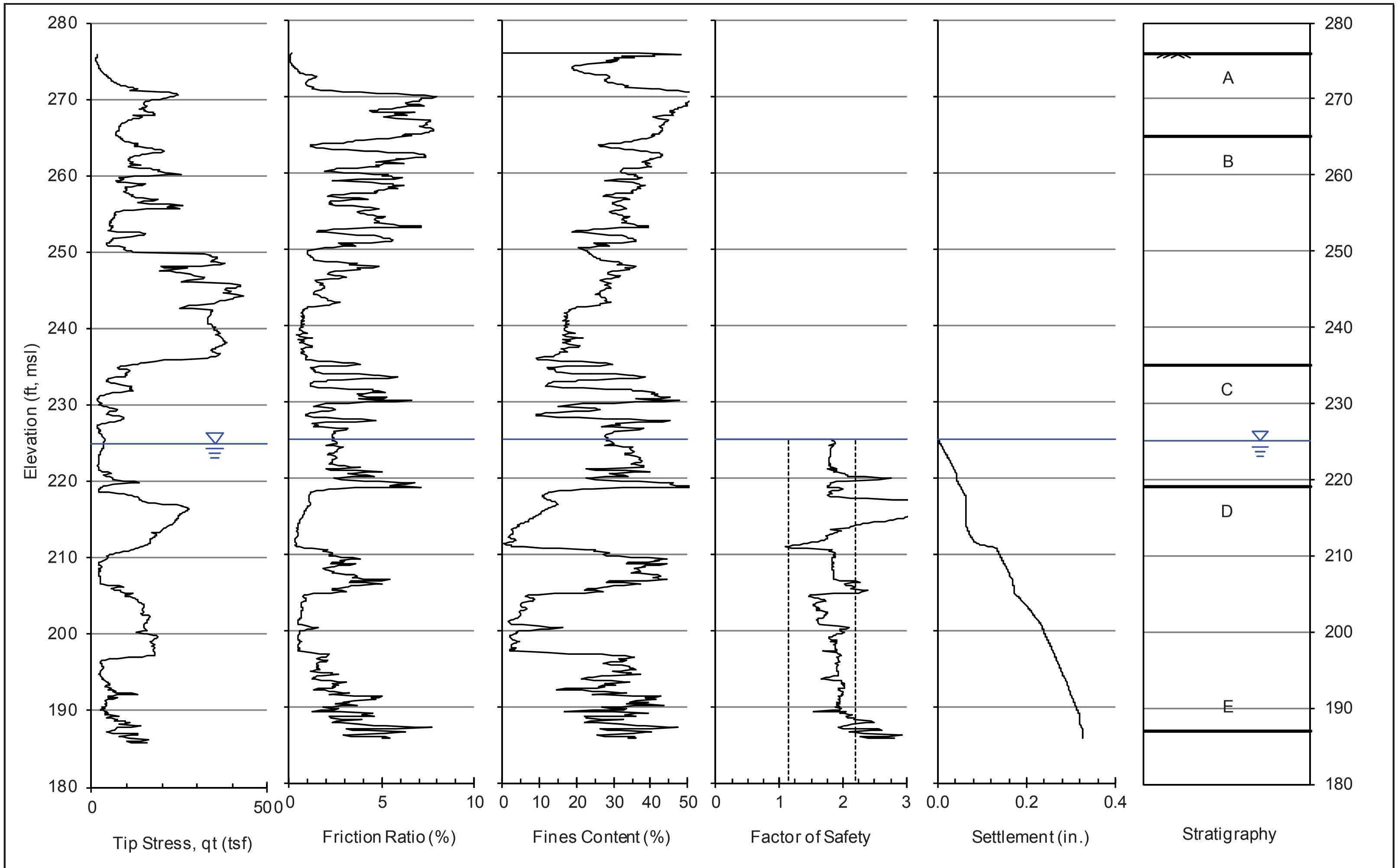
Min. Factor of Safety
0.48

Average Factor of Safety
4.59



Project: SDU 6
Cone ID: Z-SDU6-C17

**Design Basis Earthquake - Volumetric Strain**

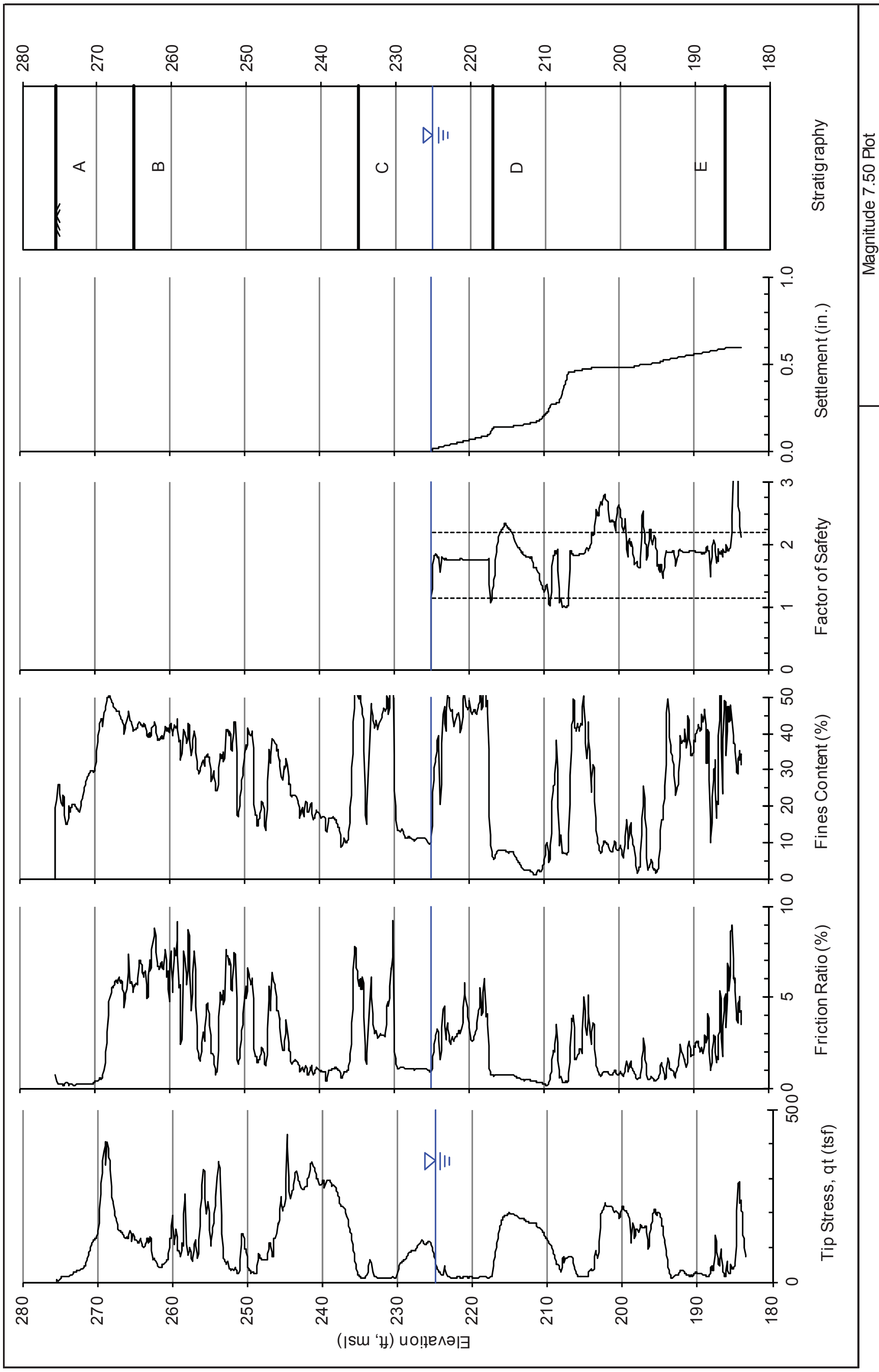



Magnitude 7.50 Plot

| Magnitude | 4.75 | 5.25 | 5.75 | 6.25 | 6.75 | 7.5 |
|---|---|---|---|---|---|---|
| Minimum Factor of Safety | 3.68 | 2.92 | 2.38 | 1.84 | 1.52 | 1.08 |
| Average Factor of Safety | 6.88 | 5.47 | 4.45 | 3.44 | 2.83 | 2.02 |
| Maximum Settlement | 0.00 in. | 0.00 in. | 0.00 in. | 0.00 in. | 0.01 in. | 0.33 in. |

| **2,500 Year Weighted Average Settlement** | 0.16 in. |
|---|---|

| Stratigraphy / Layer Description | | |
|---|---|---|
| A | S1/S2 | |
| B | Bottom of Excavation | |
| C | C2 | |
| D | S3 | |
| E | S4 | |




| Magnitude | 4.75 | 5.25 | 5.75 | 6.25 | 6.75 | 7.5 |
|---|---|---|---|---|---|---|
| Minimum Factor of Safety | 3.39 | 2.69 | 2.19 | 1.69 | 1.40 | 1.00 |
| Average Factor of Safety | 6.54 | 5.20 | 4.23 | 3.27 | 2.69 | 1.92 |
| Maximum Settlement | 0.00 in. | 0.00 in. | 0.00 in. | 0.02 in. | 0.07 in. | 0.60 in. |

| 2,500 Year Weighted Average Settlement | 0.29 in. |
|---|---|

| Stratigraphy / Layer Description | |
|---|---|
| A | S1/S2 |
| B | Bottom of Excavation |
| C | C2 |
| D | S3 |
| E | S4 |

Project: SDU 6
Cone ID: Z-SDU6-C18

| | DBE | | | | | | Cha50 |
|---|---|---|---|---|---|---|---|
| Magnitudes | 4.75 | 5.25 | 5.75 | 6.25 | 6.75 | 7.5 | 7.3 |
| Liquefaction Settlements | 0.00 in. | 0.00 in. | 0.00 in. | 0.02 in. | 0.07 in. | 0.60 in. | 0.02 in. |

***Weighted DBE Settlements***

| SCPTu ID | 2,500 Year Average for all Magnitudes (100 Hz) |
|---|---|
| Z-SDU6-C18 | 0.29 in. |

***Cha50 Settlement (Unweighted)***

| SCPTu ID | Cha50 Mw = 7.3 MSF = 1.1 |
|---|---|
| Z-SDU6-C18 | 0.02 in. |

***PC3 Mw =7.5 CPT (tip stress) and Shear Wave Velocity Factor of Safety Comparison***

***CPT Approach***

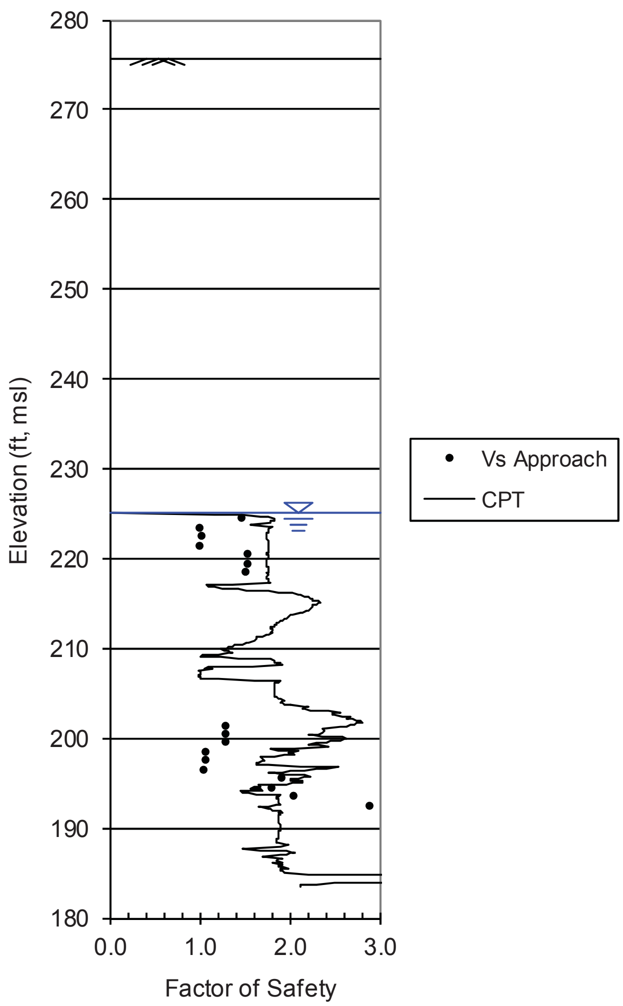
Min. Factor of Safety
1.00

Average Factor of Safety
1.92

***Vs Approach***

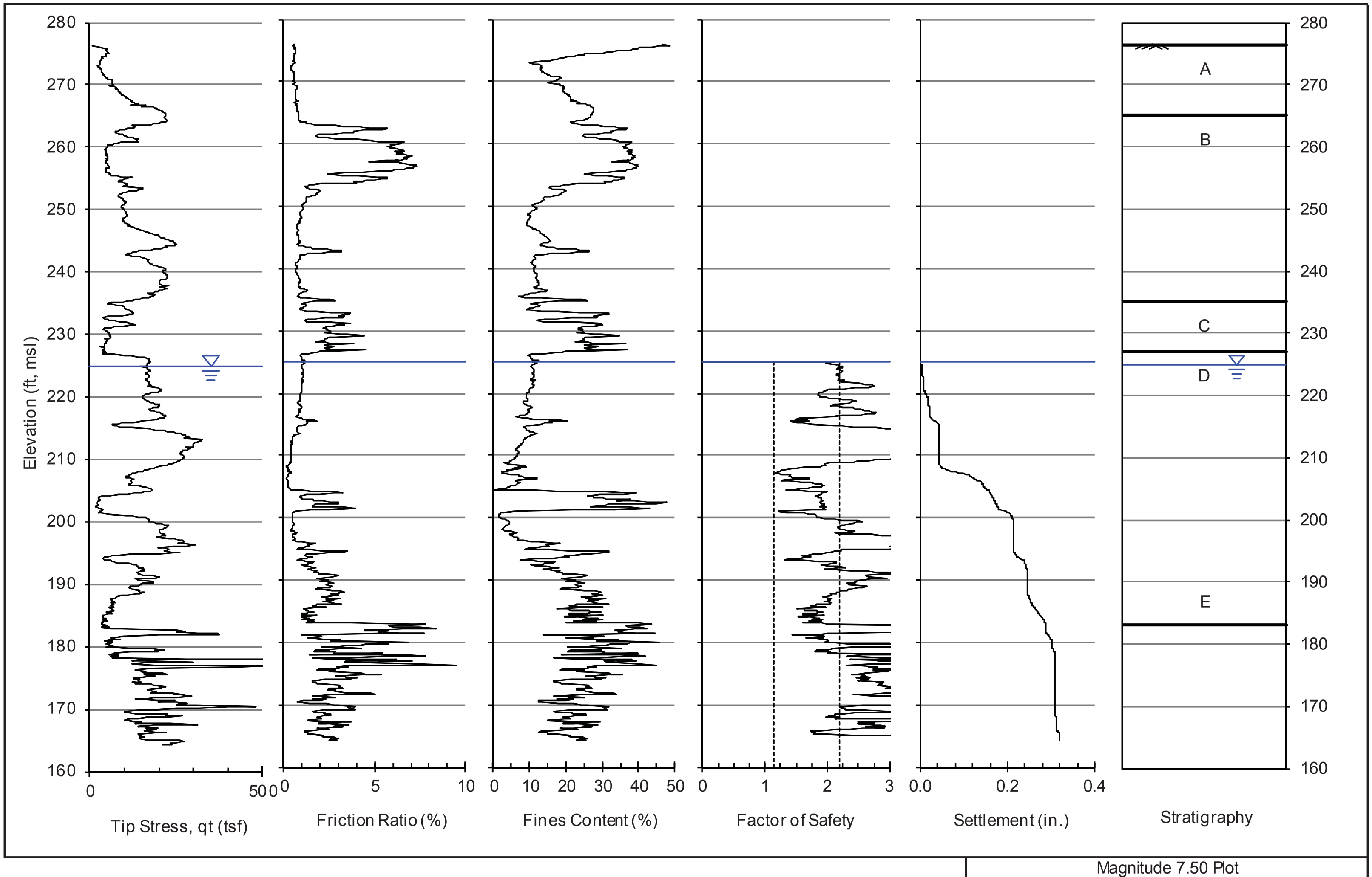
Min. Factor of Safety
0.99

Average Factor of Safety
3.61



Project: SDU 6
Cone ID: Z-SDU6-C19

**_Design Basis Earthquake - Volumetric Strain_**




| **Magnitude** | **_4.75_** | **_5.25_** | **_5.75_** | **_6.25_** | **_6.75_** | **_7.5_** |
|---|---|---|---|---|---|---|
| Minimum Factor of Safety | 3.96 | 3.14 | 2.56 | 1.98 | 1.63 | 1.16 |
| Average Factor of Safety | 8.91 | 7.08 | 5.77 | 4.46 | 3.67 | 2.62 |
| Maximum Settlement | 0.00 in. | 0.00 in. | 0.00 in. | 0.00 in. | 0.03 in. | 0.32 in. |

| **2,500 Year Weighted Average Settlement** | 0.15 in. |
|---|---|

| Stratigraphy / Layer Description | | |
|---|---|---|
| A | S1/S2 | |
| B | Bottom of Excavation | |
| C | C2 | |
| D | S3 | |
| E | S4 | |

Project: SDU 6
Cone ID: Z-SDU6-C19

| | DBE | | | | | | Cha50 |
|---|---|---|---|---|---|---|---|
| Magnitudes | 4.75 | 5.25 | 5.75 | 6.25 | 6.75 | 7.5 | 7.3 |
| Liquefaction Settlements | 0.00 in. | 0.00 in. | 0.00 in. | 0.00 in. | 0.03 in. | 0.32 in. | 0.00 in. |

*Weighted DBE Settlements*

| SCPTu ID | 2,500 Year Average for all Magnitudes (100 Hz) |
|---|---|
| Z-SDU6-C19 | 0.15 in. |

*Cha50 Settlement (Unweighted)*

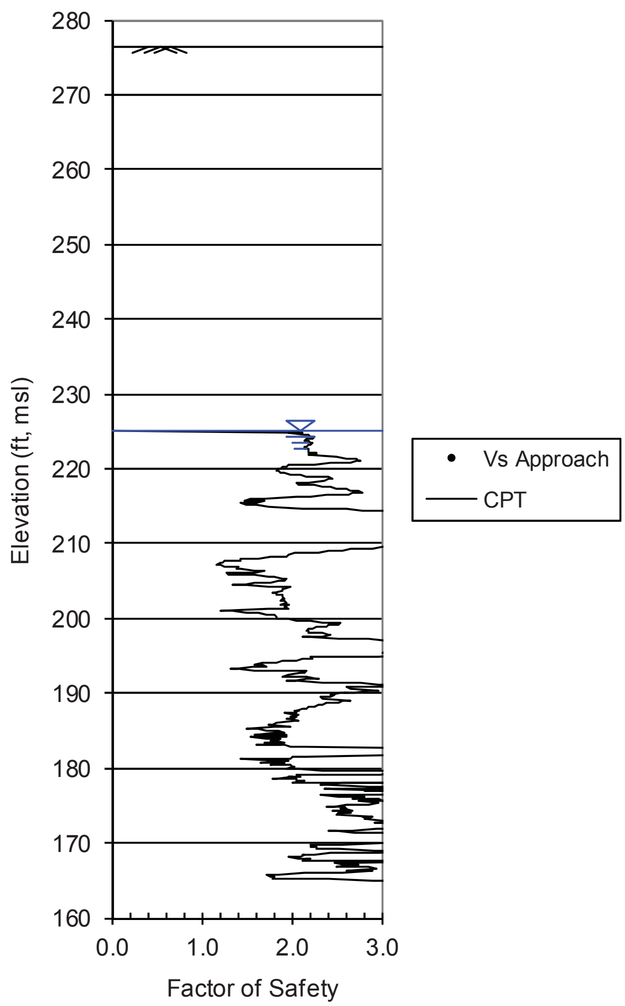
| SCPTu ID | Cha50 Mw = 7.3 MSF = 1.1 |
|---|---|
| Z-SDU6-C19 | 0.00 in. |

*PC3 Mw =7.5 CPT (tip stress) and Shear Wave Velocity Factor of Safety Comparison*

*CPT Approach*

Min. Factor of Safety
1.16

Average Factor of Safety
2.62



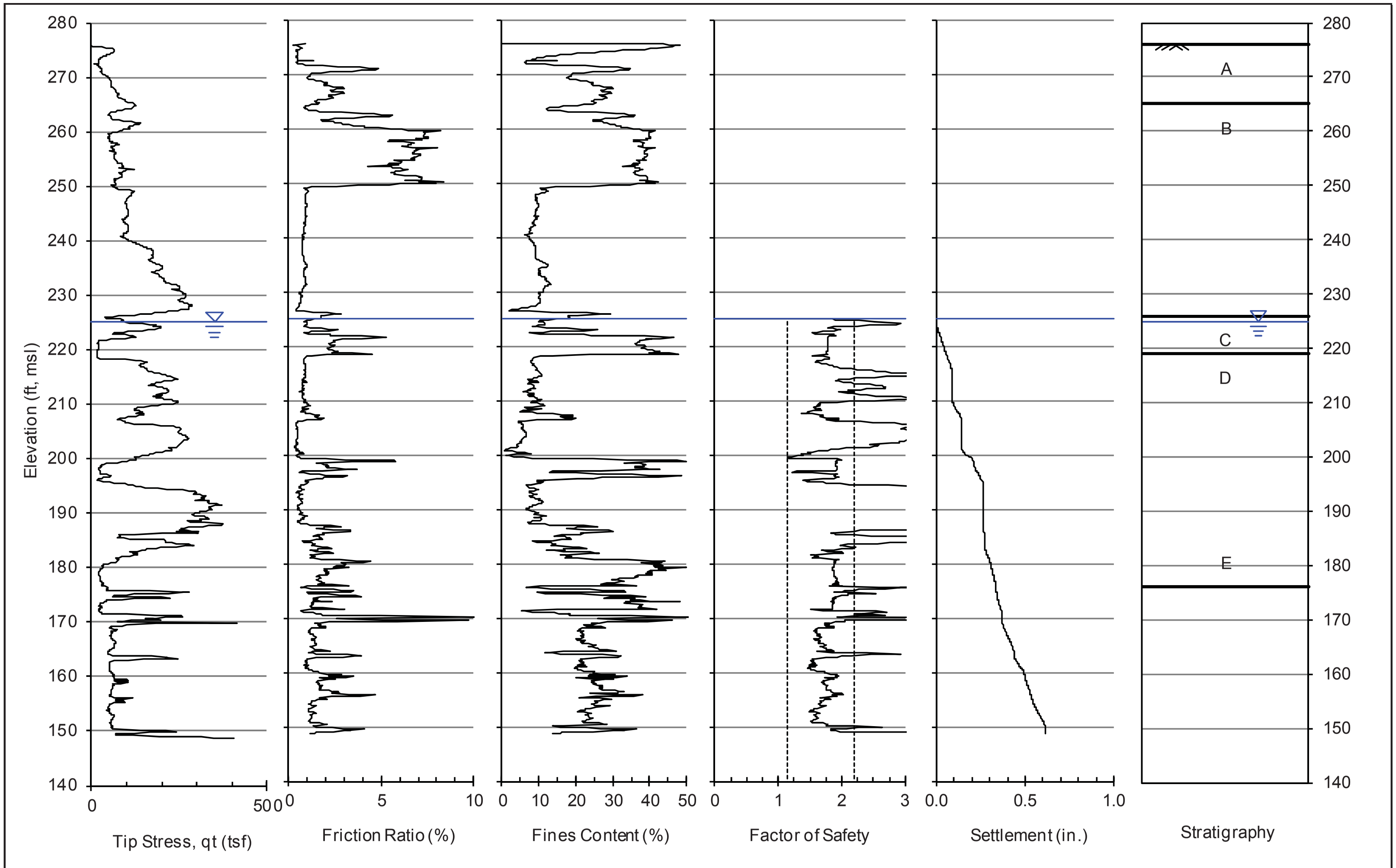

*Vs Approach*

Min. Factor of Safety
4.77

Average Factor of Safety
5.33

Project: SDU 6
Cone ID: Z-SDU6-C20

**Design Basis Earthquake - Volumetric Strain**




Magnitude 7.50 Plot

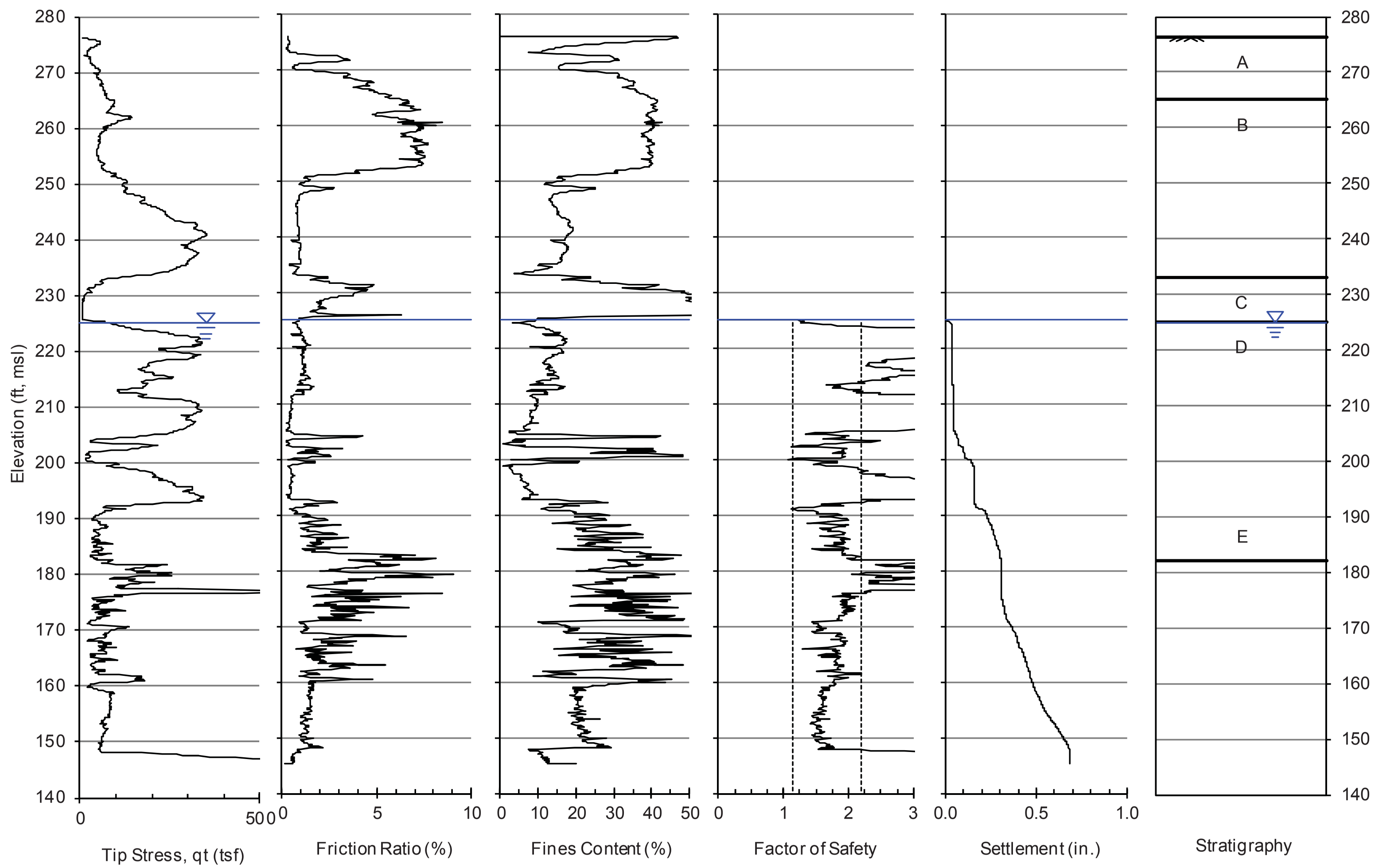
| Magnitude | *4.75* | *5.25* | *5.75* | *6.25* | *6.75* | *7.5* |
|---|---|---|---|---|---|---|
| Minimum Factor of Safety | 3.84 | 3.05 | 2.49 | 1.92 | 1.58 | 1.13 |
| Average Factor of Safety | 8.10 | 6.43 | 5.24 | 4.05 | 3.33 | 2.38 |
| Maximum Settlement | 0.00 in. | 0.00 in. | 0.00 in. | 0.00 in. | 0.04 in. | 0.62 in. |

| **2,500 Year Weighted Average Settlement** | 0.29 in. |
|---|---|

| Stratigraphy / Layer Description | | |
|---|---|---|
| A | S1/S2 | |
| B | Bottom of Excavation | |
| C | C2 | |
| D | S3 | |
| E | S4 | |

Project: SDU 6
Cone ID: Z-SDU6-C21

**Design Basis Earthquake - Volumetric Strain**




Magnitude 7.50 Plot

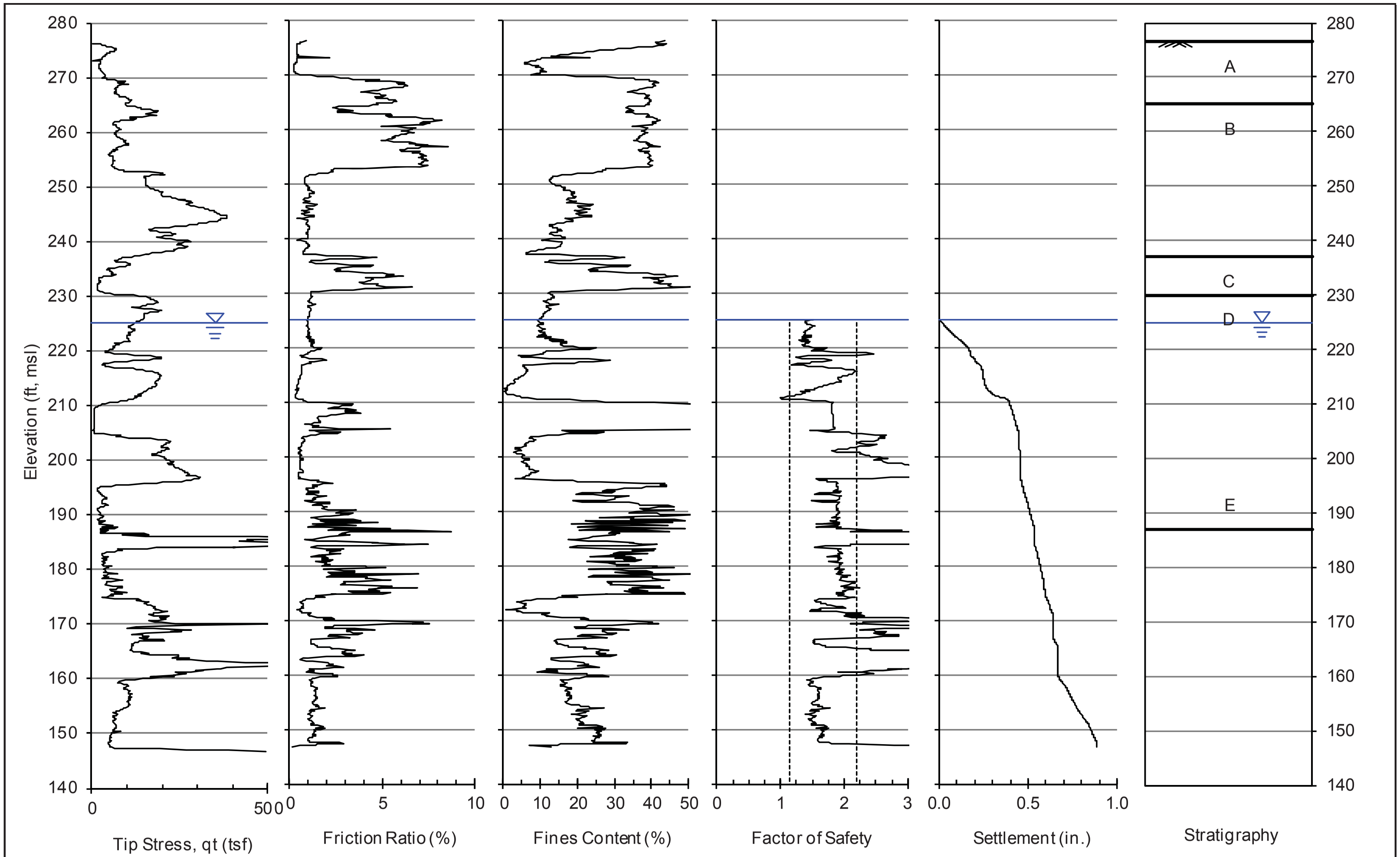
| **Magnitude** | ***4.75*** | ***5.25*** | ***5.75*** | ***6.25*** | ***6.75*** | ***7.5*** |
|---|---|---|---|---|---|---|
| Minimum Factor of Safety | 3.62 | 2.87 | 2.34 | 1.81 | 1.49 | 1.06 |
| Average Factor of Safety | 22.33 | 17.74 | 14.45 | 11.17 | 9.20 | 6.57 |
| Maximum Settlement | 0.00 in. | 0.00 in. | 0.00 in. | 0.01 in. | 0.07 in. | 0.68 in. |

| | |
|---|---|
| **2,500 Year Weighted Average Settlement** | 0.33 in. |

| Stratigraphy / Layer Description | |
|---|---|
| A | S1/S2 |
| B | Bottom of Excavation |
| C | C2 |
| D | S3 |
| E | S4 |

Project: SDU 6
Cone ID: Z-SDU6-C22

**Design Basis Earthquake - Volumetric Strain**




Magnitude 7.50 Plot

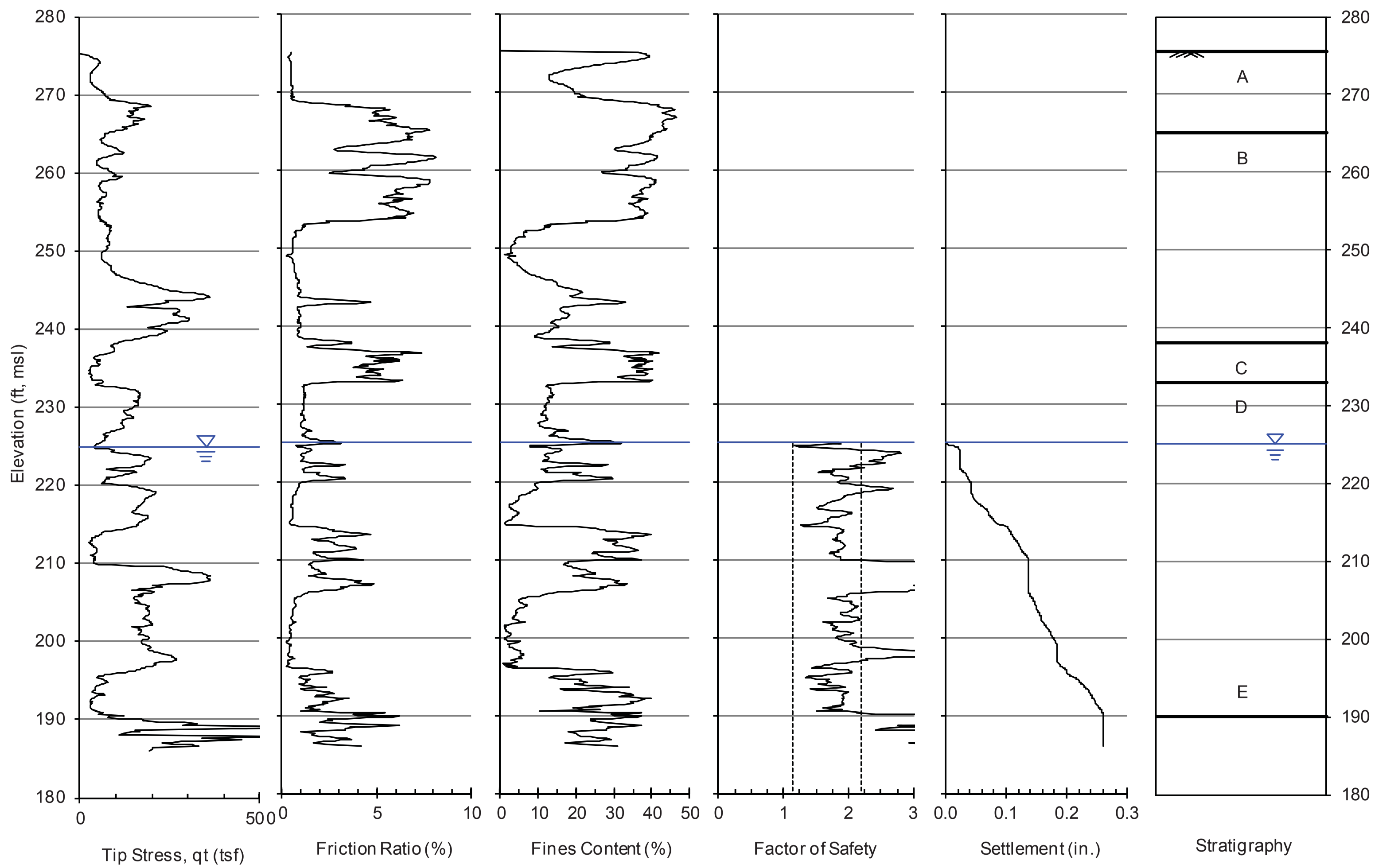
| **Magnitude** | **4.75** | **5.25** | **5.75** | **6.25** | **6.75** | **7.5** |
|---|---|---|---|---|---|---|
| Minimum Factor of Safety | 3.38 | 2.68 | 2.19 | 1.69 | 1.39 | 0.99 |
| Average Factor of Safety | 16.79 | 13.33 | 10.86 | 8.39 | 6.91 | 4.94 |
| Maximum Settlement | 0.00 in. | 0.00 in. | 0.00 in. | 0.01 in. | 0.10 in. | 0.89 in. |

| **2,500 Year Weighted Average Settlement** | 0.43 in. |
|---|---|

| Stratigraphy / Layer Description | | |
|---|---|---|
| A | S1/S2 | |
| B | Bottom of Excavation | |
| C | C2 | |
| D | S3 | |
| E | S4 | |

Project: SDU 6
Cone ID: Z-SDU6-C23

**_Design Basis Earthquake - Volumetric Strain_**




Magnitude 7.50 Plot

| Magnitude | 4.75 | 5.25 | 5.75 | 6.25 | 6.75 | 7.5 |
|---|---|---|---|---|---|---|
| Minimum Factor of Safety | 3.94 | 3.13 | 2.55 | 1.97 | 1.62 | 1.16 |
| Average Factor of Safety | 12.77 | 10.14 | 8.26 | 6.38 | 5.26 | 3.76 |
| Maximum Settlement | 0.00 in. | 0.00 in. | 0.00 in. | 0.00 in. | 0.01 in. | 0.26 in. |

| **2,500 Year Weighted Average Settlement** | 0.12 in. |
|---|---|

| Stratigraphy / Layer Description | | |
|---|---|---|
| A | S1/S2 | |
| B | Bottom of Excavation | |
| C | C2 | |
| D | S3 | |
| E | S4 | |

**Appendix E – Electronic Files**

| Folder: Liquefaction Analysis | | |
|---|---|---|
| SDU6C01.xlsm | SDU6C09.xlsm | SDU6C17.xlsm |
| SDU6C02.xlsm | SDU6C10.xlsm | SDU6C18.xlsm |
| SDU6C03.xlsm | SDU6C11.xlsm | SDU6C19.xlsm |
| SDU6C04.xlsm | SDU6C12.xlsm | SDU6C20.xlsm |
| SDU6C05.xlsm | SDU6C13.xlsm | SDU6C21.xlsm |
| SDU6C06.xlsm | SDU6C14.xlsm | SDU6C22.xlsm |
| SDU6C07.xlsm | SDU6C15.xlsm | SDU6C23.xlsm |
| SDU6C08.xlsm | SDU6C16.xlsm | Liquefaction Input.xlsx |

**Appendix E – Soft Zone Analysis**

K-CLC-Z-00026, Rev. 0

April 2012

Soft Zone Induced Settlements for Saltstone Disposal Unit 6

(16 pages)

# CALCULATION COVER SHEET

| Project/Task | Calculation No. | Project /Task No. |
|---|---|---|
| Saltstone Disposal Unit 6 | K-CLC-Z-00026 | SDU6 |
| **Title**<br>Soft Zone Induced Settlements for Saltstone Disposal Unit 6 | **Functional Classification**<br>PS<br>**Discipline**<br>Geotechnical | Sheet 1 of 15 |
| **Calc Level**<br>☒ Type 1 ☐ Type 2 | **Type 1 Calc Status**<br>☐ Preliminary ☒ Confirmed | |
| **Computer Program No.**<br>☒ N/A | **Version / Release No.**<br>N/A | |
| **Purpose and Objective**<br>The purpose of this calculation is to provide an estimate of the settlement resulting from the compression of soft zones for the Saltstone Disposal Unit 6 project. | **DC/RO**<br>UNCLASSIFIED<br>DOES NOT CONTAIN UNCLASSIFIED CONTROLLED NUCLEAR INFORMATION<br>ADC & Reviewing Official [signature]<br>(Name)<br>Date: 4/24/12 | |

**Summary of Conclusion**

See the Conclusions Section.

**Revisions**

| Rev. # | Revision Description |
|---|---|
| 0 | Original |
| | |

**Sign Off**

| Rev. # | Originator (Print) Sign / Date | Verification / Checking Method | Verifier/Checker (Print) Sign/Date | Manager (Print) Sign / Date |
|---|---|---|---|---|
| 0 | Rucker J. Williams<br>[signature] 4-18-12 | ☐ Design Check (GS/PS Only)<br>☒ Document Review<br>☐ Qualification Testing<br>☐ Alternate Calculation<br>☐ Operational Testing | Bruce Nothdurft<br>[signature] 4/18/12 | Nick Kennedy<br>[signature] 4/18/12 |
| | | ☐ Design Check (GS/PS Only)<br>☐ Document Review<br>☐ Qualification Testing<br>☐ Alternate Calculation<br>☐ Operational Testing | | |

| Additional Reviewer (Print) | Signature | Date |
|---|---|---|
| N/A | | |
| **Design Authority (Print)** | **Signature** | **Date** |
| N/A | | |
| **Release to Outside Agency (Print)** | **Signature** | **Date** |
| N/A | | |

**Security Classification of the Calculation**

Unclassified

# TABLE OF CONTENTS

## 1. Introduction

The purpose of this calculation is to provide an estimate of the settlement resulting from the compression of soft zones for Saltstone Disposal Unit 6.

## 2. Input

### 2.1 Soft Zone Input

Twenty-three (23) CPTs and SCPTs were pushed for the Saltstone Disposal Unit 6, see Figure 1. Stratigraphic interpretations of the CPT and SCPTs are summarized below (Ref. 1). These 23 CPTs and SCPTs were evaluated for the presence of soft zones.

| | | | | | Elevation Top Pick (ft, msl) | | | |
|---|---|---|---|---|---|---|---|---|
| **ID** | **CPT Type** | **SRS Northing** | **SRS Easting** | **Elevation ft, msl** | **C2 Layer** | **S3 Layer** | **S4 Layer** | **Congaree** |
| Z-SDU6-C01 | CPT | 77413.3 | 66270.1 | 281.9 | 233 | 226 | 190 | |
| Z-SDU6-C02 | SCPT | 77448.1 | 66350.4 | 281.4 | 233 | 227 | 190 | |
| Z-SDU6-C03 | CPT | 77478.3 | 66494.3 | 281.6 | 233 | 225 | 190 | |
| Z-SDU6-C04 | CPT | 77503.3 | 66578.8 | 281.8 | 236 | 229 | 190 | |
| Z-SDU6-C05 | SCPT | 77624.5 | 66594.9 | 278.1 | 235 | 226 | 187 | |
| Z-SDU6-C06 | CPT | 77587.6 | 66472.8 | 278.6 | 234 | 227 | 189 | |
| Z-SDU6-C07 | CPT | 77546.9 | 66357.1 | 279.4 | 237 | 230 | 191 | |
| Z-SDU6-C08 | CPT | 77511.4 | 66258.9 | 279.7 | 236 | 230 | 186 | |
| Z-SDU6-C09 | CPT | 77621.8 | 66210.4 | 278.3 | 237 | 230 | 194 | |
| Z-SDU6-C10 | CPT | 77644.2 | 66285.6 | 278.0 | 237 | 230 | 190 | |
| Z-SDU6-C11 | CPT | 77663.3 | 66354.1 | 277.6 | 238 | 233 | 186 | |
| Z-SDU6-C12 | SCPT | 77682.6 | 66452.6 | 277.7 | 239 | 234 | 188 | |
| Z-SDU6-C13 | CPT | 77722.6 | 66523.4 | 276.3 | 234 | 228 | 188 | |
| Z-SDU6-C14 | CPT | 77720.6 | 66180.9 | 277.3 | 234 | 222 | 181 | |
| Z-SDU6-C15 | CPT | 77748.2 | 66249.8 | 276.8 | 232 | 217 | 192 | |
| Z-SDU6-C16 | SCPT | 77772.2 | 66312.2 | 276.7 | 234 | 216 | 184 | |
| Z-SDU6-C17 | CPT | 77796.3 | 66393.3 | 276.0 | 235 | 219 | 187 | |
| Z-SDU6-C18 | SCPT | 77819.4 | 66471.7 | 275.6 | 235 | 217 | 186 | |
| Z-SDU6-C19 | SCPT | 77869.3 | 66155.6 | 276.4 | 235 | 227 | 183 | |
| Z-SDU6-C20 | CPT | 77895.0 | 66236.9 | 276.0 | 226 | 219 | 176 | |
| Z-SDU6-C21 | CPT | 77920.9 | 66321.6 | 276.3 | 233 | 225 | 182 | |
| Z-SDU6-C22 | CPT | 77947.5 | 66415.1 | 276.5 | 237 | 230 | 187 | |
| Z-SDU6-C23 | CPT | 77967.7 | 66482.5 | 275.5 | 238 | 233 | 190 | |

Five (5) borings were also performed for this investigation. Stratigraphic interpretations for the borings are listed in the table below. Borings Z-SDU6-B01 and Z-SDU6-B03 are adjacent to each other.

| ID | SRS Northing | SRS Easting | Elevation ft, msl | Elevation Top Pick (ft, msl) C2 Layer | S3 Layer | S4 Layer | Congaree |
|---|---|---|---|---|---|---|---|
| Z-SDU6-B01 | 77771.3 | 66309.1 | 276.6 | | | | |
| Z-SDU6-B02A | 77625.3 | 66594.8 | 278.0 | | | | |
| Z-SDU6-B02B | 77629.2 | 66588.9 | 278.1 | 234 | 227 | 191 | |
| Z-SDU6-B03 | 77769.6 | 66304.5 | 276.5 | 232 | 217 | 188 | 146 |
| Z-SDU6-B04 | 77663.9 | 66351.1 | 277.9 | 236 | 232 | 191 | 145 |

## 3. Computation

Soft zones are layers of underconsolidated soils within the Santee Formation (S4 layer) which are identified by a corrected tip stress value less than or equal to 15 tsf. Layers of soft zone soils (corrected tip stress less than or equal to 15 tsf) are considered to behave as a single soft zone if the interval of harder material (corrected tip stress greater than 15 tsf) between the soft zone soils is less than or equal to 2 feet in thickness. The thickness of the soft zone is the summation of the less than 15 tsf material. The top elevation of the soft zone is the top of the first layer of soil with a corrected tip stress less than 15 tsf within the Santee Formation Santee Formation (S4 layer).

If the interval of harder soil (corrected tip stress greater than 15 tsf) between soft zone soils is greater than 2 feet, the layers of soft zones soils are considered to behave as two separate soft zones (See Figure 3).

Soft zones may also be identified by N value less than or equal to 5 blows per foot (including weight of rod and weight of hammer events) within the Santee Formation (S4 layer). Loss of circulation is also an indication of the presence of soft zones.

### 3.1 Soft Zone Settlement

No soft zone samples were obtained during the geotechnical investigation for Saltstone Disposal Unit 6. The properties from Saltstone Vault 2, used for analysis in this calculation, are summarized below (Ref. 2).

| | |
|---|---|
| Compression Index, $C_c$ | 0.196 |
| Initial Void Ratio, $e_0$ | 0.72 |
| Overconsolidation Ratio, OCR | 0.9 |
| Compression Ratio, $C_c/(1+e_0)$ | 0.114 |

The bottom of the excavation will be 265 ft, msl at Saltstone Disposal Unit 6. The average top of the S4 layer (Santee Formation) at the site is 187 ft, msl. For conservatism, it will be assumed that the top of the soft zone is located at the top of the S4 layer.

The compression of the soft zone $s_S$ at depth is estimated assuming full overburden pressure:

$$s_S = H \{C_c/(1 + e_o)\} \log \{(P_o + \Delta P)/P_o\}$$

Where $s_S$ is the compression of the soft zone and H is the thickness of the soft zone. $C_c$ and $e_0$ were described in the previous section. When the arch above the soft zone is weakened, the $P_o + \Delta P$ term is equal to the overburden pressure and the $P_o$ term in the denominator is the soft zone preconsolidation pressure. In this instance the equation becomes:

$s_S = H \{C_c/(1 + e_o)\} \log (1/OCR)$

where OCR is the overconsolidation ratio of the soft zone.

**3.2 Methodology for Computing Surface Settlement**

A vertical slice of subsurface with unit thickness or perpendicular to the longitudinal direction of the soft zone was considered. Ground settlement, which is propagated from the subsurface deformation, was computed considering the surface settlement profile resembles the shape of an inverted normal distribution curve (Ref. 3). The surface settlement s(x) at any point x is:

$$s(x) = s(0)\ \mathrm{Exp.}\{-x^2/(2i^2)\} \quad \text{(Eq. 1)}$$

Where i is the distance from the center of the normal probability curve to the point of inflection:

$$i = W/(2\pi)^{1/2} \quad \text{(Eq. 2)}$$

and W is the half width of the normal probability curve and may be estimated as (Ref. 3):

$$W = z \tan \beta + W_{SZ}/2. \quad \text{(Eq. 3)}$$

where:

z is the soft zone depth and

$\beta$K is based on soil type

The volume lost at-depth due to compression of soft zone can be computed as:

$$V_L = s_S\ W_{SZ.} \quad \text{(Eq. 4)}$$

Where $s_S$ is the compression of the soft zone computed in the previous section and $W_{SZ}$ is the width of the soft zone.

As the soft zone collapses, the volume of the soil above the soft zone will be increased as a result of dilation and loosening as the soil stresses redistribute. For granular soils, appreciable volume changes can occur in the soil as a result of disturbances and displacement (Ref. 3).

The volume of the surface settlement is:

$$V_S = R_{S/L} V_L \quad \text{(Eq. 5)}$$

where $R_{S/L}$ is the ratio of the volume of the surface settlement to the volume lost at-depth due to compression of the soft zone. Substituting Equation (4) into Equation (5):

$$V_S = R_{S/L}\ s_S\ W_{SZ.} \quad \text{(Eq. 6)}$$

Surface settlement at the center of the normal probably curve is:

$$s(0) = V_S/W \quad \text{(Eq. 7)}$$

Substituting Equation (6) into Equation (7)

$$s(0) = R_{S/L}\ s_S\ W_{SZ}\ /W \quad \text{(Eq. 8)}$$

Substituting Equation (8) into Equation (1), settlement at any point x can then be expressed as

$$s(x) = R_{S/L}\ s_S\ W_{SZ}\ /W\ \mathrm{Exp}[-x^2/(2i^2)] \quad \text{(Eq. 9)}$$

Figure 3 illustrates the properties of a normal probability curve settlement trough.

**4. Results**

Soft zones were identified in 3 CPTs: Z-SDU6-C01, Z-SDU6-C10, and Z-SDU6-C15. The soft

zones in C01 and C15 are 1.25 feet and 1.38 feet thick, respectively. The CPT Z-SDU6-C10 contained 5.8 feet of soft zone material. This soft zone was used for settlement computations.

### 4.1 Surface Settlement due to the Compression of a Narrow Soft Zone

The assumption of normal probability is for underground disturbance over a short width. Assume the width of the soft zone is:

$W_{SZ} = 5$ feet

For the project site, at elevation of the foundation, 265 feet, MSL, the distance to the average depth of the soft zone is:

$z = 265 – 187 = 78$ feet

For SRS soil conditions $\beta$ falls between 33 and 50 degrees. For sands below groundwater level, $\beta$ is generally greater than 50 degrees. A smaller $\beta$ will provide conservative values of maximum slope and maximum change of slope (Ref. 3) at the project site, consider $\beta = 33$ degrees:

$W = z \tan \beta + W_{SZ}/2 = 78 \tan(33^o) + 5/2 = 53.154$ feet

$i = W/(2\pi)^{1/2} = 53.154 / (2\pi)^{1/2} = 21.205$ feet

The volume of the surface settlement is generally one third to two thirds less than the volume of lost ground (Ref. 1). In this calculation, $R_{S/L}$ is conservatively taken as 1.0, ie surface volume settlement is the same as the volume of lost ground at depth.

Using the soft zone properties from Vault 2, the compression of the soft zone is:

$s_S = H \{C_c/(1 + e_o)\} \log (1/OCR) = 5.8 \text{ x } 0.196/(1 + 0.72) \text{ x } \log (1/0.9) = 0.030$ feet

or $s_S = 0.3629$ inches.

Equation 8 becomes:

$s(0) = R_{S/L}\ s_S\ W_{SZ} /W = 1.0 \text{ x } 0.3629 \text{ x } 5/53.154 = 0.0341$ inches

Equation 1 becomes:

$s(x) = 0.0341 \text{ Exp } \{-x^2/(2 \text{ x } 21.205^2)\}$ inches

or $s(x) = 0.0341 \text{ Exp}(-x^2/899.304)$ inches

### 4.2 Surface Settlement

Wide soft zones maybe represented as a series of adjacent narrower soft zones. Surface settlements due to the wide soft zone are computed by superimposing the settlement troughs for each of the narrow soft zones. For this calculation, a series of 5 foot wide soft zones were utilized to represent soft zones ranging in width from 25 feet to 150 feet.

Maximum differential settlement is assumed to be equal to the total soft zone induced settlement. Maximum slope is the rate of change of settlement along the settlement trough, while curvature is the rate of change of the slope along the settlement trough.

Figure 4 presents the surface settlement profiles for each of the soft zone widths considered. Figures 5 – 7 illustrate the maximum surface settlement, maximum slope, and maximum curvature as functions of soft zone width. The values for these parameters are summarized in the

table below. The maximum curvature summarized in the maximum absolute value of the concave up and concave down curves. The ratio of the surface settlement to the compression of the soft zone at depth is also given in the table below.

| Soft Zone Width (ft) | Maximum Settlement (in) | Maximum Differential Settlement (in) | Maximum Slope (ft/ft) | Maximum Curvature (ft/ft per ft) | Ratio of Maximum Settlement ($S_0$) to Soft Zone Compression at Depth |
|---|---|---|---|---|---|
| 25 | -0.162 | 0.162 | 0.00036 | 0.00003 | 45% |
| 50 | -0.276 | 0.276 | 0.00053 | 0.00003 | 76% |
| 75 | -0.335 | 0.335 | 0.00057 | 0.00002 | 92% |
| 100 | -0.356 | 0.356 | 0.00057 | 0.00002 | 98% |
| 125 | -0.362 | 0.362 | 0.00057 | 0.00002 | 100% |
| 150 | -0.363 | 0.363 | 0.00057 | 0.00002 | 100% |
| Maximum | -0.363 | 0.584 | 0.00057 | 0.00003 | 100% |

## 5. Conclusions

Considering the maximum values presented in Section 4.2, the following values are recommended for design of soft zone induced settlements.

| Parameter | Recommended Value |
|---|---|
| Maximum soft zone settlement | ½ inch |
| Maximum soft zone differential settlement | ½ inch |
| Maximum Slope | 0.0006 ft/ft |
| Maximum Curvature | 0.00003 |

## 6. References


1. K-CLC-Z-00022, Rev. 0, Stratigraphy for Saltstone Disposal Unit 6 (SDU6), March 2012.
2. K-CLC-Z-00009, Rev. 0, Settlement due to Compression of Soft Zone, March 2006.
3. Cording, E.J., et al., "Displacements Around Tunnels in Soils," Report No. 76T-22, U.S. Department of Transportation, Washington D.C.

**Figures**

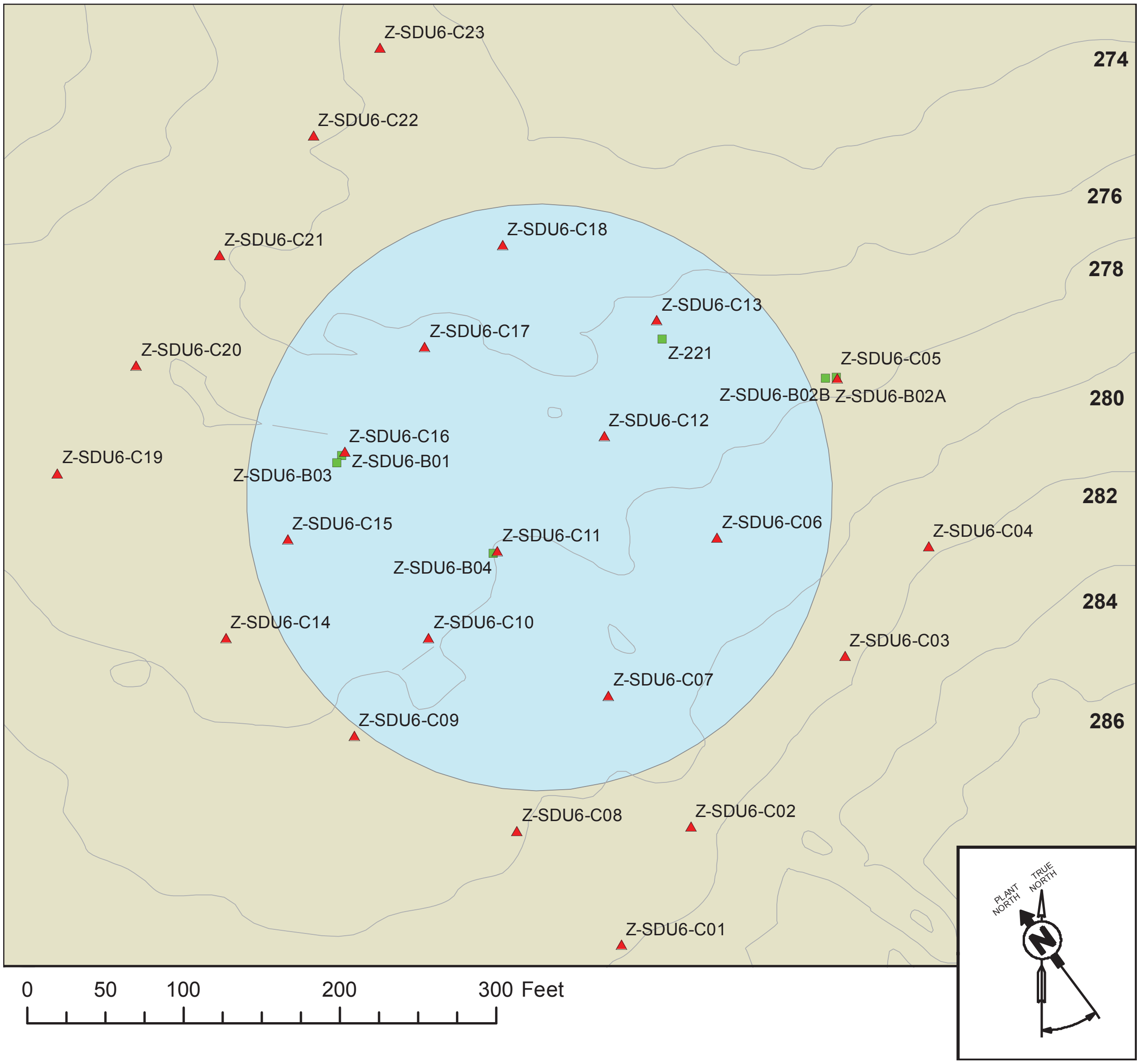



**Figure 1: Location of Geotechnical Investigations**

| Thickness | | Depth |
|---|---|---|
| 1.5 feet thick | $q_t$ = 15 tsf | 100.0 ft<br>101.5 ft |
| 0.5 feet thick | $q_t > 15$ tsf | |
| 1.0 feet thick | $q_t$ = 15 tsf | 102.0 ft<br>103.0 ft |

One Soft Zone
- 2.5 feet thick
  Top depth - 100 feet

| | | |
|---|---|---|
| 1.5 feet thick | $q_t$ = 15 tsf | 100.0 ft<br>101.5 ft |
| 2.5 feet thick | $q_t > 15$ tsf | |
| 1.0 feet thick | $q_t$ = 15 tsf | 104.0 ft<br>105.0 ft |

Two Soft Zones
- 1.5 feet thick
  Top depth - 100 feet
- 1.0 foot thick
  Top depth - 104 feet

**Figure 2: Graphical Depiction of Soft Zone Determination**

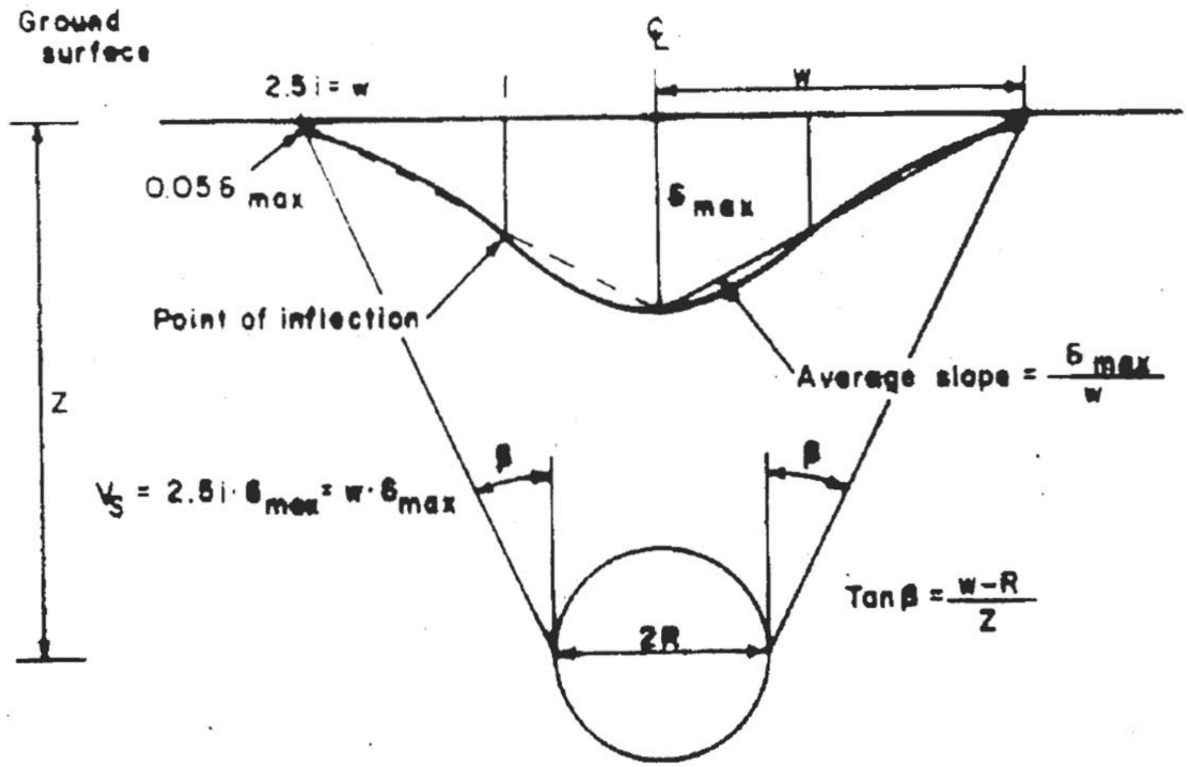



**Figure 3: Geometry of Surface Settlement Trough**

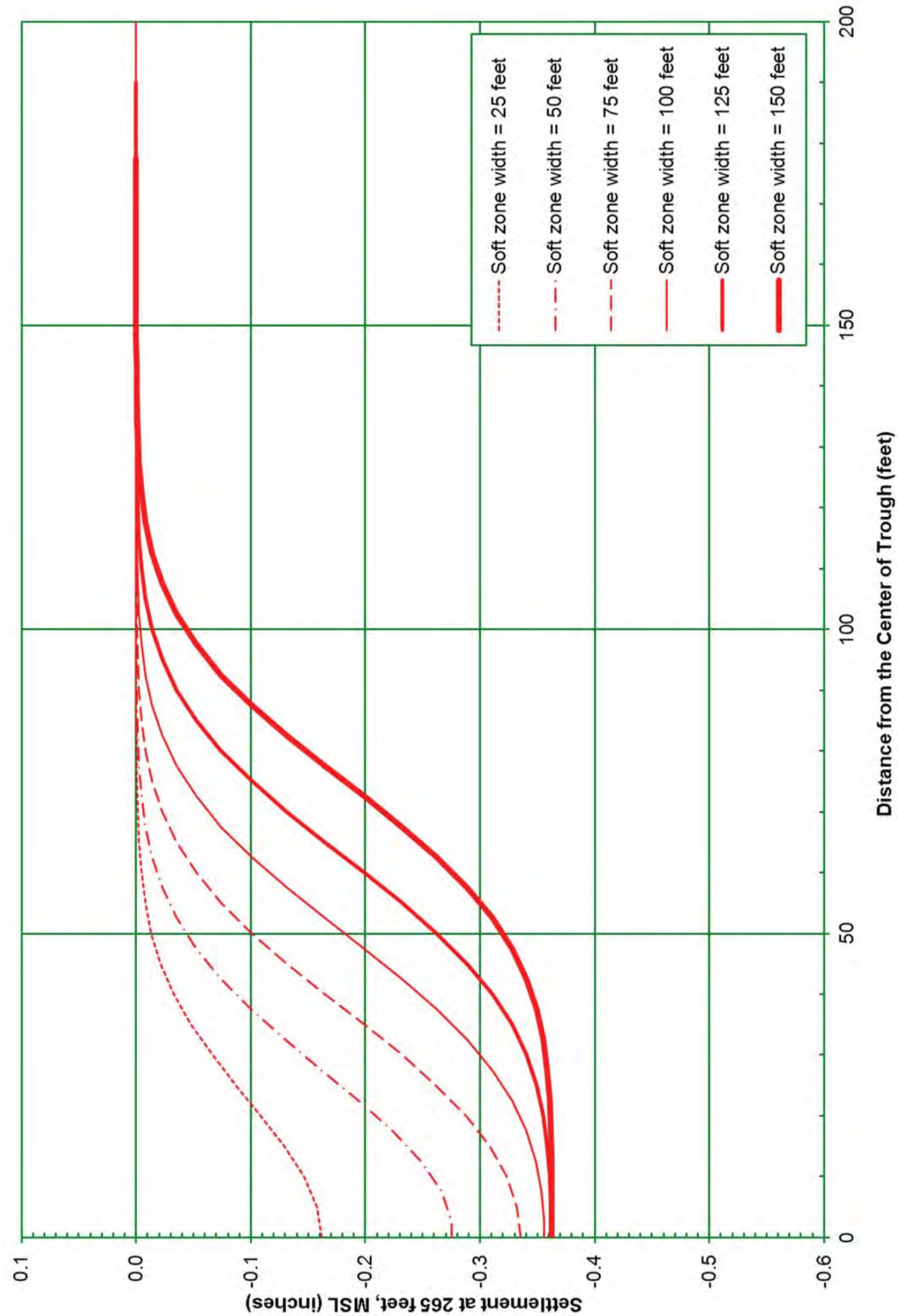



**Figure 4: Surface Settlement Profile for Soft Zones of Various Widths**

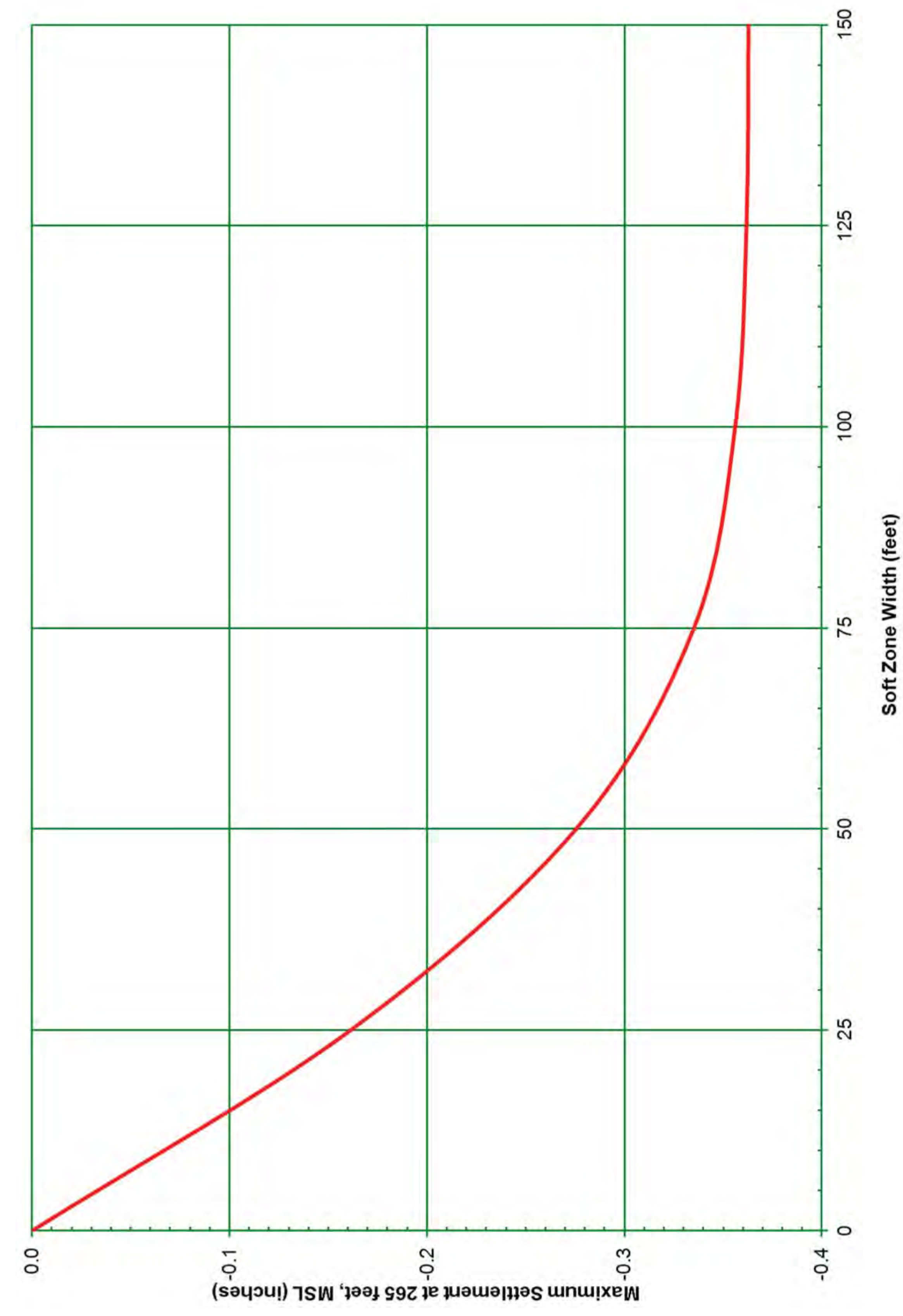



**Figure 5: Maximum Surface Settlement for Soft Zones of Various Widths**

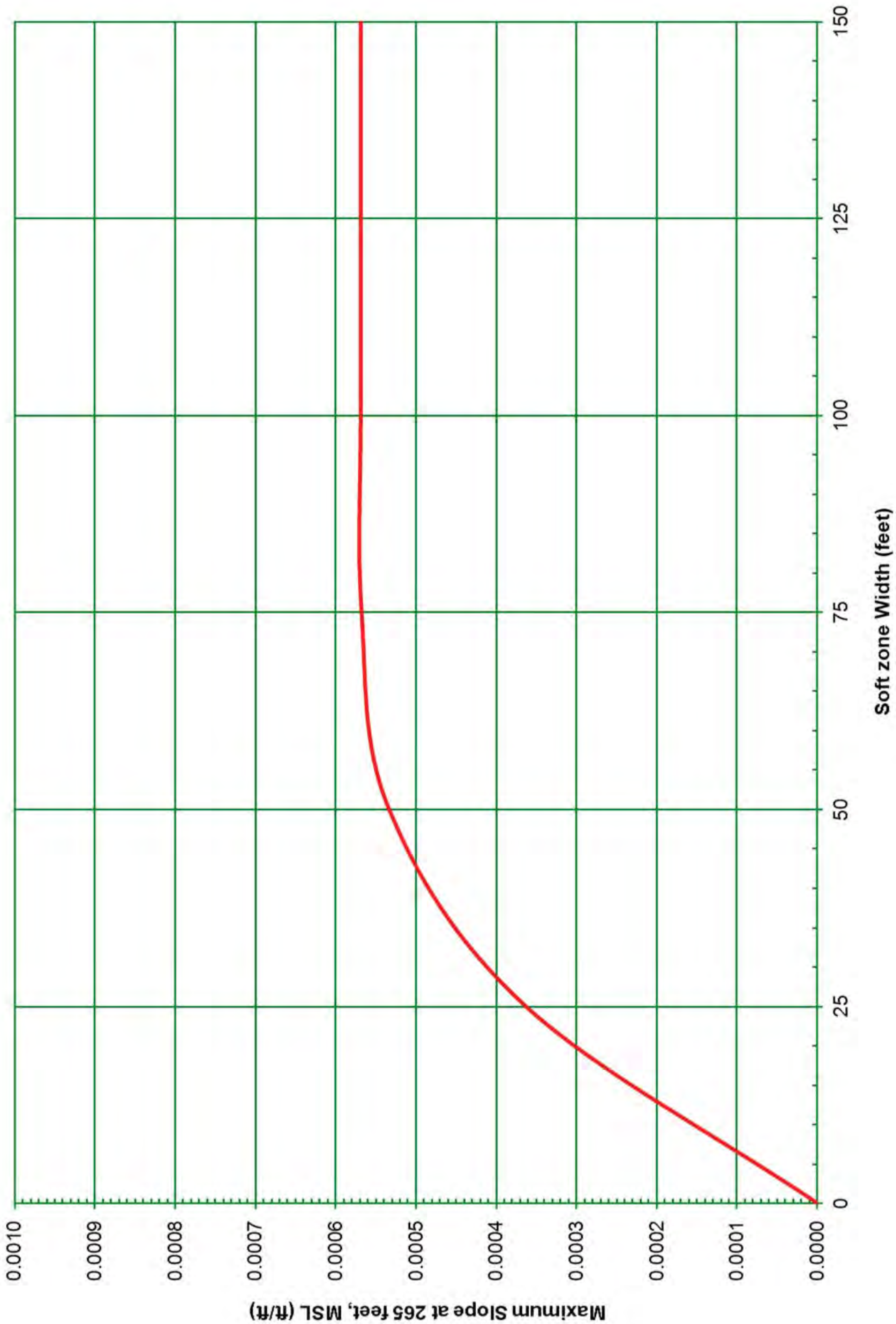



**Figure 6: Maximum Surface Slope for Soft Zones of Various Widths**

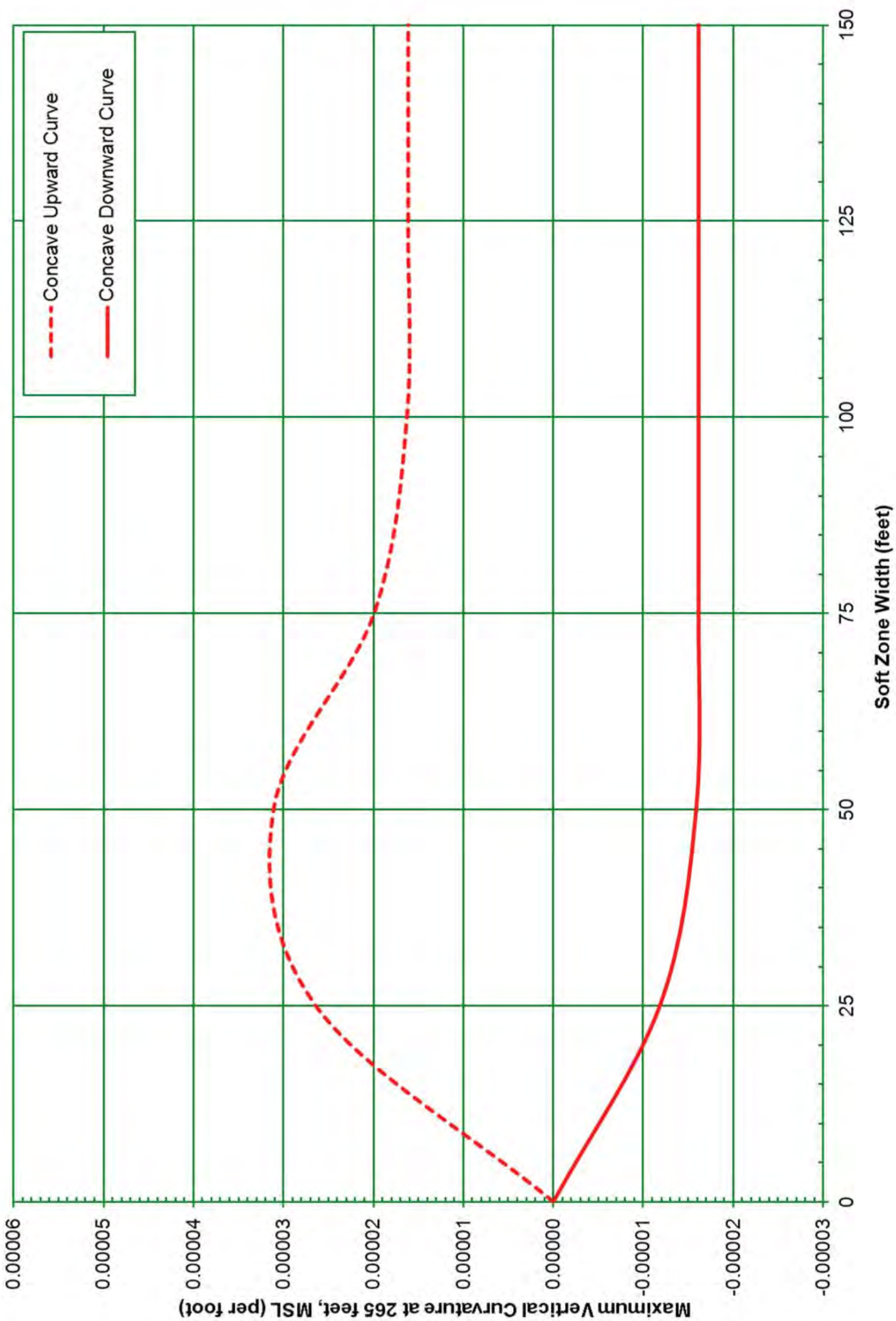



**Figure 7: Maximum Surface Settlement Curvature for Soft Zones of Various Widths**

**Appendix F – Slope Stability Analysis**

K-CLC-Z-00002, Rev. 1

September 2003

Slope Stability for the Saltstone Disposal Facility (U)

WRSC-TR-2003-00145, Rev. 0

March 2003

Additional Slope Stability Analyses for Saltstone Disposal Facility (U)

(72 pages)

# Calculation Cover Sheet

| Project<br>N.A. | Calculation No.<br>K-CLC-Z-00002 | Project Number<br>N.A. MDM 3/24/03 |
|---|---|---|
| Title<br>Slope Stability for the Saltstone Disposal Facility (U) | Functional Classification<br>GS<br>Discipline<br>Geotechnical | Sheet 1 of ~~47~~ 56<br>(one disk containing computer files) |

☐ Preliminary ☒ Confirmed

| Computer Program No.<br>☐ SLOPW/W | Version / Release No.<br>4.24 |
|---|---|

**Purpose and Objective**

The purpose of this calculation is to determine global slope stability safety factors for the soil cover over the Saltstone Disposal Facility for static and seismic loading cases.

**Summary of Conclusion**

See Summary and Conclusions Section on Sheet 7.

FOR REVISION 1 SEE SHEET 7 & 7A.

UNCLASSIFIED
DOES NOT CONTAIN
UNCLASSIFIED CONTROLLED
NUCLEAR INFORMATION
ADC & Reviewing Official: [signature]
(Name and Title)
Date: 3/24/03

**Revision**

| Rev. No. | Revision Description |
|---|---|
| 0 | Original |
| 1 | ADDITIONAL SLOPE STABILITY RUNS USING TOTAL STRESS SHEAR STRENGTHS AND HIGHER PEAK GROUND ACCELERATIONS. |
| | |

**Sign Off**

| Rev. No. | Originator (Print) Sign / Date | Verification / Checking Method | Verifier / Checker (Print) Sign / Date | Manager (Print) Sign / Date |
|---|---|---|---|---|
| 0 | Michael D. McHood<br>[signature] | Document Review | William T. Li<br>[signature] | Michael R. Lewis<br>[signature] 8/21/02 |
| 1 | MICHAEL D. MCHOOD<br>[signature] 3/24/03 | Document Review | William T. Li<br>[signature] | [signature] 4/3/03 |
| | | | | |

| Release to Outside Agency – Design Authority (Print) | Signature | Date |
|---|---|---|
| NA | NA | NA |

Security Classification of the Calculation

Unclassified

slope-calc.doc

ENGINEERING DOC. CONTROL – SRS
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# TABLE OF CONTENTS

# 1.0 PURPOSE

The purpose of this calculation is to determine global slope stability safety factors for the soil cover over the Saltstone Disposal Facility for static and seismic loading cases.

# 2.0 INPUT DATA

## 2.1 SLOPE / VAULT GEOMETRY AND DESIGN

This calculation is based on the following design information:

- Vault Dimensions and slope geometry were taken from SRS drawings C-CC-Z-0013 (SRS, 1998), W828992 (SRS, 1989), W780527 (SRS, 1986a), and W780529 (SRS, 1986b) (see Attachment 1).
- For this calculation the concrete vault and contents was modeled as a monolith with a conservatively assumed unit weight of 140 pcf.
- By specification the grout used to fill the Saltstone Vaults has a minimum compressive strength of 200 psi (WSRC, 1992). Actual compressive strength of the grout may be higher. For this calculation the conservative 200 psi value was used to model the disposal vault. No addition strength was attributed to the vault due to the reinforced concrete walls.

It is important to note that several conceptual designs have been considered for closure of the Saltstone Vaults. Both 4H:1V and 8H:1V slopes have been considered in conceptual designs for the final cover system. This calculation assumes the steeper 4H:1V slope. The post closure slope crest was set at 20 feet above the top of the vault. Other conceptual closure designs have much less fill placed over the top of the vault, reducing the slope height. The geometry of the vault and closure cover slope model is shown in Figure 1.

It is also important to note that some of the conceptual designs include geosynthetics and/or designed soil layers (i.e., low permeability capping soil or high permeability drainage layers). This calculation only considers global slope stability. Stability of the interface between geosynthetics and designed soil layers needs to be evaluated and designed for during final design of the cover system.

## 2.2 GROUNDWATER

The water table in the vicinity of Vault No. 4, based on Well ZBG-2, varies between 213 and 228 ft-msl (see Figure 2 and 3). However, the groundwater elevation used for the slope stability analysis is conservatively placed at 245 feet mean sea level. This conservative assumption is based on water levels observed in boreholes during drilling, (MRCE, 1986a) historical readings (Cook, 1983) and reports of perched water in Z-Area (MRCE, 1986b and Cook, 1986).

## 2.3 SEISMIC LOADING

Based on the USGS seismic hazard maps (Frankel et al., 1996, see Figure 4) and the International Building Code (ICC, 2000) a PGA of 0.21g would be selected for Z-Area. However, the International Building Code allows a reduction of up to 20% in cases where site specific studies have been performed. Extensive ground response modeling has been performed for the SRS (Lee et. al, 1997; Lee, 1998). Based on the results of ground response modeling at SRS the reduction is warranted and a PGA of 0.17g (i.e., 0.21 x 0.8) is applicable. This PGA is very conservative when compared with the PGA of 0.11g determined for Performance Category 1 structures at SRS (Lee, 1998), which is the performance category of the Saltstone Vaults.

For this calculation a horizontal seismic coefficient ($k_h$) of 0.17 and vertical seismic coefficients ($k_v$) of ±0.17 were used. Engineering practice allows seismic coefficients as low as ½ of the PGA and therefore these seismic coefficients are very conservative (Abramson et al., 1996). Combined horizontal and vertical loading cases were run with one component at 100 % and the second concurrent component at 40%, consistent with ASCE Standard 4-98 (ASCE, 1998). Seismic loading cases are summarized below.

- $k_h = 0.17$ and $k_v = 0$
- $k_h = 0$ and $k_v = \pm 0.17$ (+ is down and – is up)
- $k_h = 0.17$ and $k_v = \pm 0.07$ (+ is down and – is up)
- $k_h = 0.07$ and $k_v = \pm 0.17$ (+ is down and – is up)

## 2.4 SOILS AND VAULT STRENGTH

This calculation considers long-term stability of the soil slopes after closure of the saltstone vaults. Long-term soil shear strength properties are based on effective friction angle (ϕ'). Samples from borings ZB-2, ZB-8, Z-1, Z-2 and Z-4 (see Figure 3) were tested to determine ϕ'. Saturated CU and CIU triaxial shear tests yield ϕ' values between 28° and 34° (BSRI, 1992; Woodward-Clyde, 1985). Selection of the ϕ' values of 28° for the natural soil and 33° for the engineered fill is conservative and allows for some strength loss during seismic loading. Laboratory tests results are presented in Attachment 2. The following effective stress shear strengths were used for the slope stability calculations:

| | Effective Stress Properties | |
|---|---|---|
| Engineered Fill | ϕ' = 33° | c' = 20 psf |
| Natural Soil (above water table) | ϕ' = 28° | c' = 100 psf |
| Natural Soil (below water table) | ϕ' = 28° | c' = 0 psf |
| Vault Strength * | ϕ' = 0° | c' = 4,000 psf |

* For this calculation the concrete vault and grout were modeled as a soil having ϕ' = 0 and c' = 4,000 psf i.e., constant shear strength corresponding of compressive strength of 200 psi as defined by the American Concrete Institute (shear strength = $2\sqrt{fc'}$ where $fc'$ is compressive strength [ACI, 2002]), which is about a third of the shear strength as defined by Mohr-Coulomb failure criteria (shear strength = ½qu where qu is unconfined compression strength).

Engineered fill will be placed around and over the Saltstone vaults. The final design for the Saltstone Disposal Facility has not been performed and engineered fill will not be placed until some future date. The engineered fill must meet the requirements of existing site standards (WSRC, 2001) and be compacted to a minimum density of 95% of maximum dry density, determined in accordance with ASTM D-1557. The shear strength for the engineered fill is based on experience with SRS fill soils and engineering judgement. A soil unit weight of 120 pcf was assumed for this calculation.

For conservatism, a tension crack was assumed for all models (both static and seismic cases). The tension crack is two feet deep along the top of the slope up to the crest, tapering to zero feet at the toe of the slope. The tension crack was filled with water as may occur after rain.

## 3.0 CALCULATIONS

Slope stability calculations were completed using SLOPE/W version 4.24 software (GEO-SLOPE, 1998). SLOPE/W is commercially available software similar to PC STABL and other slope stability analysis software. Safety factors were calculated using Ordinary, Bishop's, Janbu's, and Spencer's Methods. Results reported in this calculation are from Spencer's method, which considers both moment and force equilibrium. Static and seismic slope stability calculations were completed for a closure concept having a 4H:1V slopes extending to the base of the vault. Several seismic loading cases were run having different vertical and horizontal loading. The results for both static and seismic cases are summarized in Table 1. Computer files are contained on the accompanying compact disk.

The models run allowed slip surfaces to pass through the disposal vault. Failure through the vault was never the critical case (i.e., didn't have the lowest factor of safety). At the request of the South Carolina Department of Health and Environmental Control, (SCDHEC) an additional stability case was run where slip surfaces were forced through the disposal vault to determine factor of safety against a combined vault and slope failure. Factor of safety for "vault failure" case is also summarized in Table 1.

As advised by the consultant, Dr. Marcuson, additional runs were performed where total stress shear strength was used. Total stress shear strength is lower than the effective stress accounting for pore pressure and strength loss due to loading and provides additional conservatism. For the additional runs the natural soil above the water table was given a conservative friction angle of 23° with cohesion of 650 psf. The natural soil below the water table was modeled two ways 1) with a friction angle of 8° and cohesion of 900 psf and 2) with a friction angle of zero and cohesion of 1,600 psf. Attachment 2 discusses the shear strength tests. In addition, the vault strength is the same as the engineered fill, assuming a failure through the engineered fill along the edge of the vault. For the total stress runs the seismic coefficients are $k_h = 0.17$ and $k_v = -0.07$ (i.e., the lowest factor of safety case using effective stress shear strength). Factor of safety for the "total stress" cases are summarized in Table 1.

**Table 1. Summary of Slope Stability Safety Factors Computed Using Slope/W and Effective Stress Shear Strengths**

| | Horizontal Seismic Coefficient ($k_h$) | Vertical Seismic Coefficient ($k_v$) | Factor of Safety | Minimum Acceptable Factor of Safety |
|---|---|---|---|---|
| Case 1 static | 0 | 0 | 2.6 | 1.2 to 1.5 |
| Case 2 | 0.17 | 0 | 1.5 | 1.0 to 1.2 |
| Case 3 | 0 | 0.17 | 2.6 | 1.0 to 1.2 |
| Case 4 | 0 | -0.17 | 2.7 | 1.0 to 1.2 |
| Case 5 | 0.17 | 0.07 | 1.6 | 1.0 to 1.2 |
| Case 6 | 0.17 | -0.07 | 1.5 | 1.0 to 1.2 |
| Case 7 | 0.07 | 0.17 | 2.1 | 1.0 to 1.2 |
| Case 8 | 0.07 | -0.17 | 2.0 | 1.0 to 1.2 |
| Case 9 vault failure | 0.17 | -0.07 | 1.8 | 1.0 to 1.2 |
| Case 10 total stress | 0.17 | -0.07 | 1.2 | 1.0 to 1.2 |
| Case 11 total stress | 0.17 | -0.07 | 1.2 | 1.0 to 1.2 |

Note: For Cases 1 through 8 effective stress shear strength was used, see Section 2.4.
For Case 9 the failure surface was forced through the vault with $k_h$ and $k_v$ same as Case 6 (i.e., lowest factor of safety case).
For Case 10 and 11 total stress shear strength was used. Natural soil above the water table was given a friction angle of 23° with cohesion of 650 psf. Natural soil below the water table was two ways 1) with a friction angle of 8° with cohesion of 900 psf (Case 10) and 2) with a friction angle of zero with cohesion of 1,600 psf (Case11). See Attachment 2 for shear strength tests.

## 3.1 ACCEPTABLE SAFETY FACTORS

### 3.1.1 STATIC

Generally, the recommended safety factor for static slope stability is around 1.5. However, safety factors as low as 1.2 have been recommended. The range of acceptable safety factors is due to many reasons including the consequence of failure, the extent of the subsurface characterization, whether or not site specific strength testing was performed, and the natural variability of the soils.

### 3.1.2 SEISMIC

For seismic slope stability, generally accepted safety factors range from 1.0 to 1.2 (USACE, 1970; Abramson et al., 1996; Huang, 1983). As with static slope stability, the range of acceptable safety factors is due to many reasons including the consequence of failure, the extent of the subsurface characterization, whether or not site specific strength testing was performed, and the natural variability of the soils.

## 4.0 RESULTS

A summary of the safety factors computed using SLOPE/W for static and seismic loading cases is contained in Table 1. Figures 5 through 15 contain the plots of the individual SLOPE/W stability runs. In all cases the static and seismic safety factors are much greater than required. Additional details of the analysis can be obtained from computer files listed in Attachment 3 and copied on the accompanying disk.

Figures 16 through 18 show variations of the case 6 seismic loading with a limited number of radius focal points and larger radii. These runs were performed to show other failure surfaces and their factor of safety. These failure surfaces extend down through the natural soil and past the toe of the slope. Factors of safety are greater for these deeper failure surfaces.

## 5.0 SUMMARY AND CONCLUSIONS

A slope of 4 horizontal to 1 vertical provides factors of safety above the range of acceptable factors of safety (see Table 1). However, for long term stability the following recommendations should be implemented.

- Engineered fill must meet the requirements of existing site standards (WSRC, 2001) and be compacted to a minimum density of 95% of maximum dry density, determined in accordance with ASTM D-1557, to achieve acceptable shear strength.
- Drainage ditches shall be provided so water is conveyed away from the disposal vaults.
- Erosion control on the slopes is required

It is also important to note that final design for cover system has not been performed. Final design may include geosynthetics and/or designed soil layers (i.e., low permeability capping soil or high permeability drainage layers). This calculation only considers global slope stability. Stability of the interface between geosynthetics and designed soil layers needs to be evaluated during final design of the cover system. However, for the range of slopes being considered (4H:1V and 8H:1V), incorporation of geosynthetics and/or designed soil layers is not expected to be an issue.

## 6.0 PURPOSE AND RESULTS FOR REVISION 1

At the request of SCDHEC additional slope stability analysis was performed for a horizontal PGA of 0.20g and 0.21g. Horizontal seismic coefficients ($K_h$) of 0.20 and 0.21 were used (i.e., the full PGA). No vertical seismic coefficients ($K_v$) were used for the additional work.

At the request of SCDHEC, the soil model was extended to include the soil beyond the vault allowing a failure beneath and past the vault structure. For the additional work the "total stress" cases (i.e., case 10 and 11 from the Revision 0 work) were re-evaluated because they result in the lowest Factor of Safety. The "total stress" or "undrained"

condition is conservative and assumes significant generation of pore pressure and associated strength loss during seismic loading. Figures 19 and 20 show the case 10 and case 11 soil models used for the previous work. Figures 21 and 22 show the extended models used for the additional work. Note that for the extended soil models (Figures 21 and 22) soil strengths are aligned with the soil stratum as opposed to assigning all soil beneath the water table one strength. Also note that the soil strength for deeper soils has been increased representing average strength as opposed to conservative lower bound strength. Strength test data are presented in Attachment 2. Sheet 42 shows strength data for the C2 stratum and the reinterpreted strength used for the C2 stratum. The strength of the engineered fill for both the effective stress cases and the total stress cases is $\phi = 33°$ & c = 20 psf. This strength is conservative and allows for some strength loss during seismic loading. By design the engineered fill will need to meet this strength requirement.

Results of the additional analyses are presented in Table 2. Figures 23 through 26 contain the plots of the additional slope stability runs. In all cases the static and seismic safety factors are acceptable. Additional details of the analysis can be obtained from computer files listed in Attachment 3 and copied on the accompanying disk.

**Table 2. Additional Slope Stability Safety Factors Computed Using Slope/W and Total Stress Shear Strengths**

| | Soil Strength Condition | Soil Strength [1] | Vault Strength [2] | Horizontal Seismic Coefficient ($k_h$) | Vertical Seismic Coefficient ($k_v$) | Factor of Safety |
|---|---|---|---|---|---|---|
| Case 10 a | total stress | Figure 21 | $\phi = 33°$ & c = 20 psf | 0.20 | 0 | 1.3 |
| Case 10 b | total stress | Figure 21 | $\phi = 33°$ & c = 20 psf | 0.21 | 0 | 1.3 |
| Case 11 a | total stress | Figure 22 | $\phi = 0°$ & c = 4000 psf | 0.20 | 0 | 1.2 |
| Case 11 b | total stress | Figure 22 | $\phi = 0°$ & c = 4000 psf | 0.21 | 0 | 1.2 |

1 Shear strengths of the soil layers are shown on the referenced Figure.

2 Shear strength of the vault was modeled both as a weak grout ($\phi = 0°$ & c = 4000 psf) and as engineered fill ($\phi = 33°$ & c = 20 psf). Results reported here are those that produced the lowest factor of safety.

## 6.0 REFERENCES

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# FIGURES

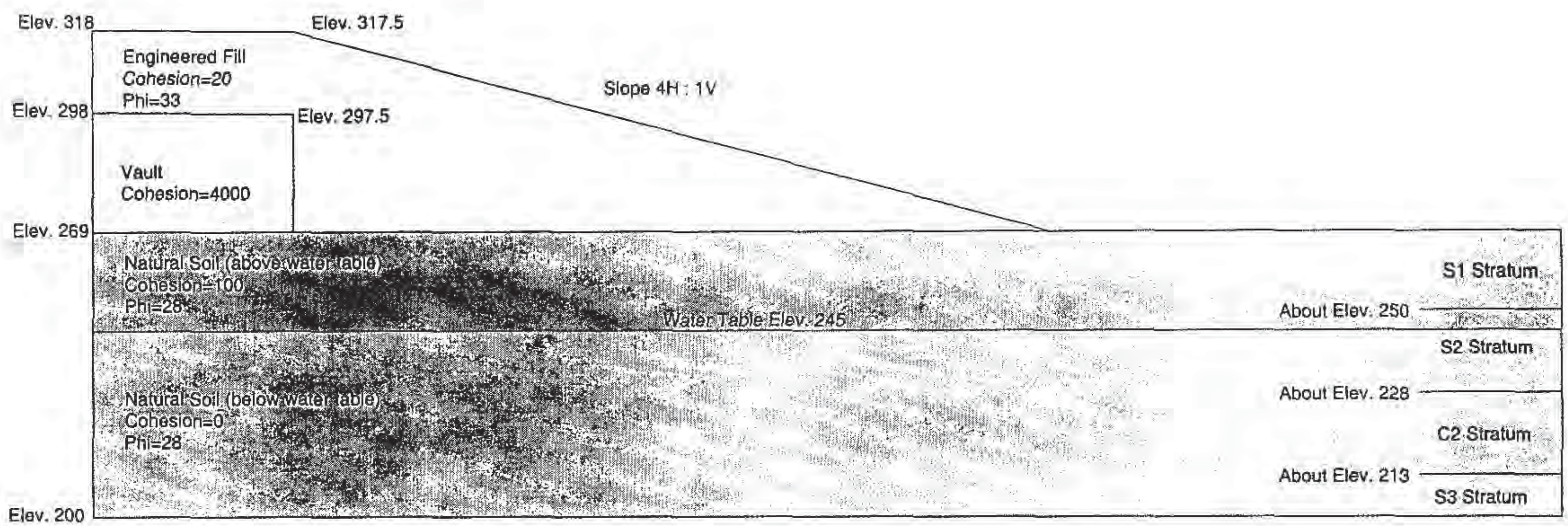


**Figure 1. Vault and Closure Cover Slope Geometry Used to Calculate Slope Stability**

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| Calculation No.<br>K-CLC-Z-00002 |
| Sheet No.<br>12 |
| Rev.<br>0 |

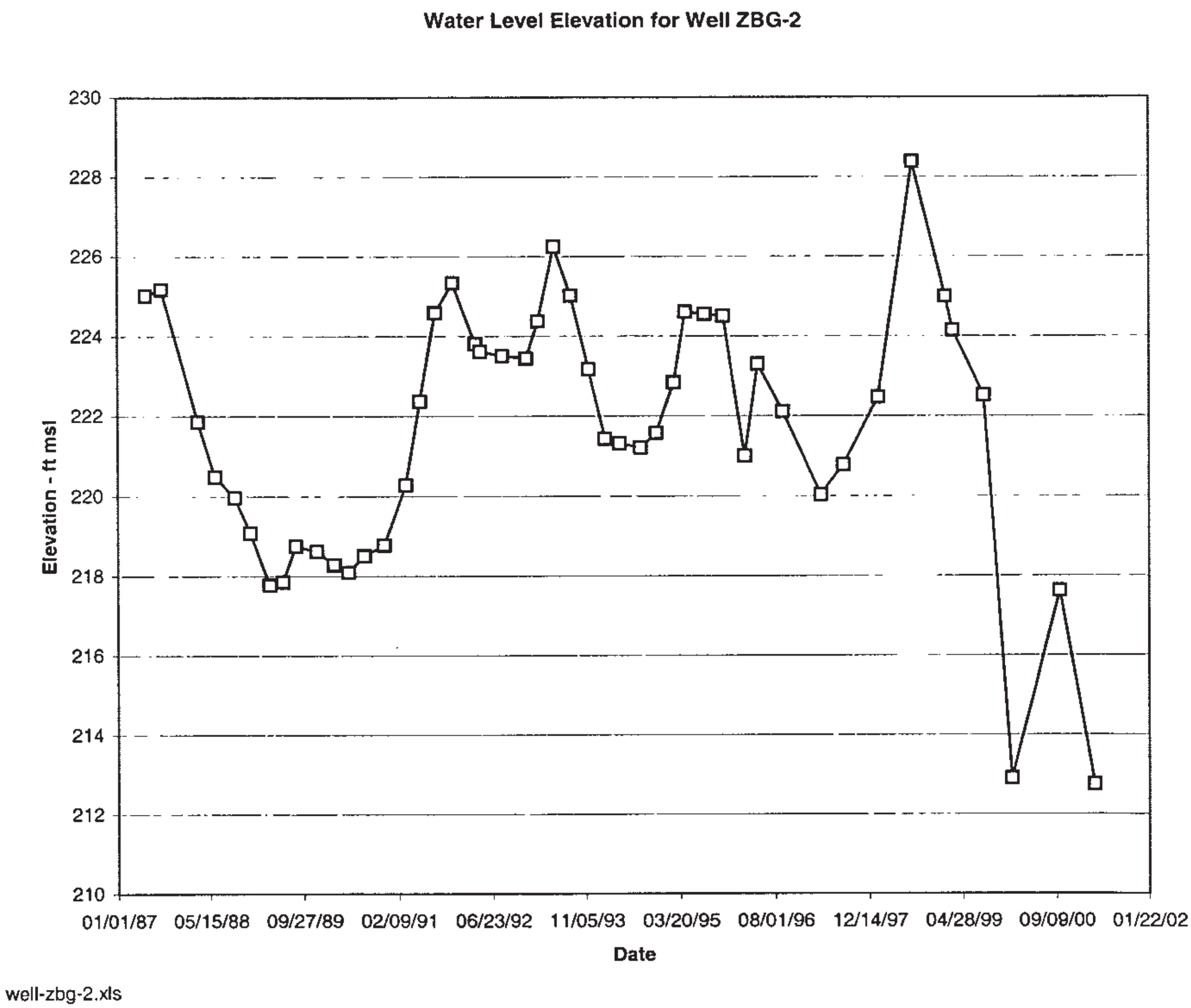


**Figure 2 - Water Table Elevation Measured in Well ZBG-2**
(SRS Groundwater Information Management System)

| Calculation No. K-CLC-Z-00002 |
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| Sheet No. 13 |
| Rev. 0 |

# Z-Area Vault No. 4

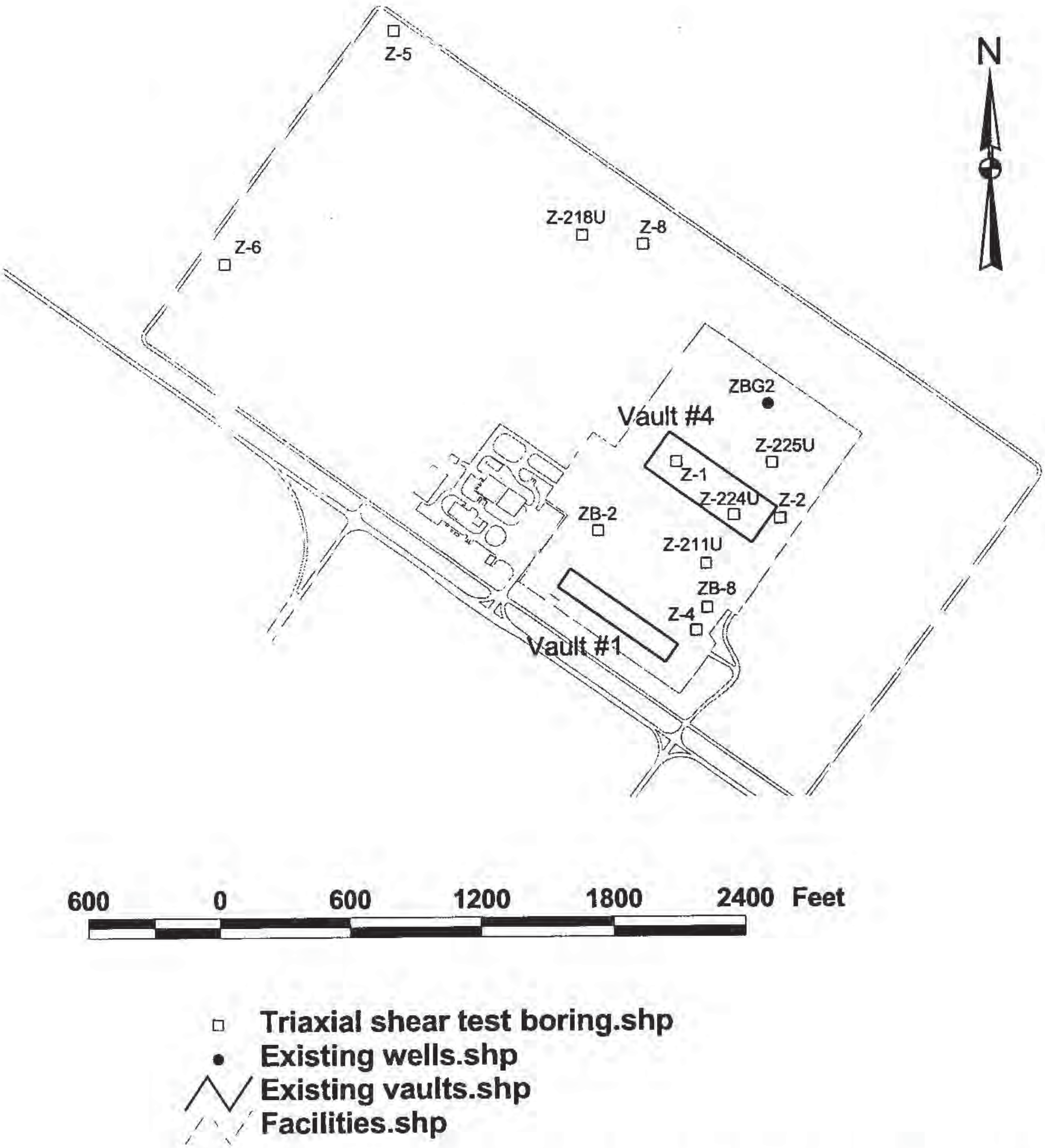


Figure 3 - Location of Vault No. 4, Triaxial Shear Test Borings and Well ZBG-2

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| Sheet No. 14 |
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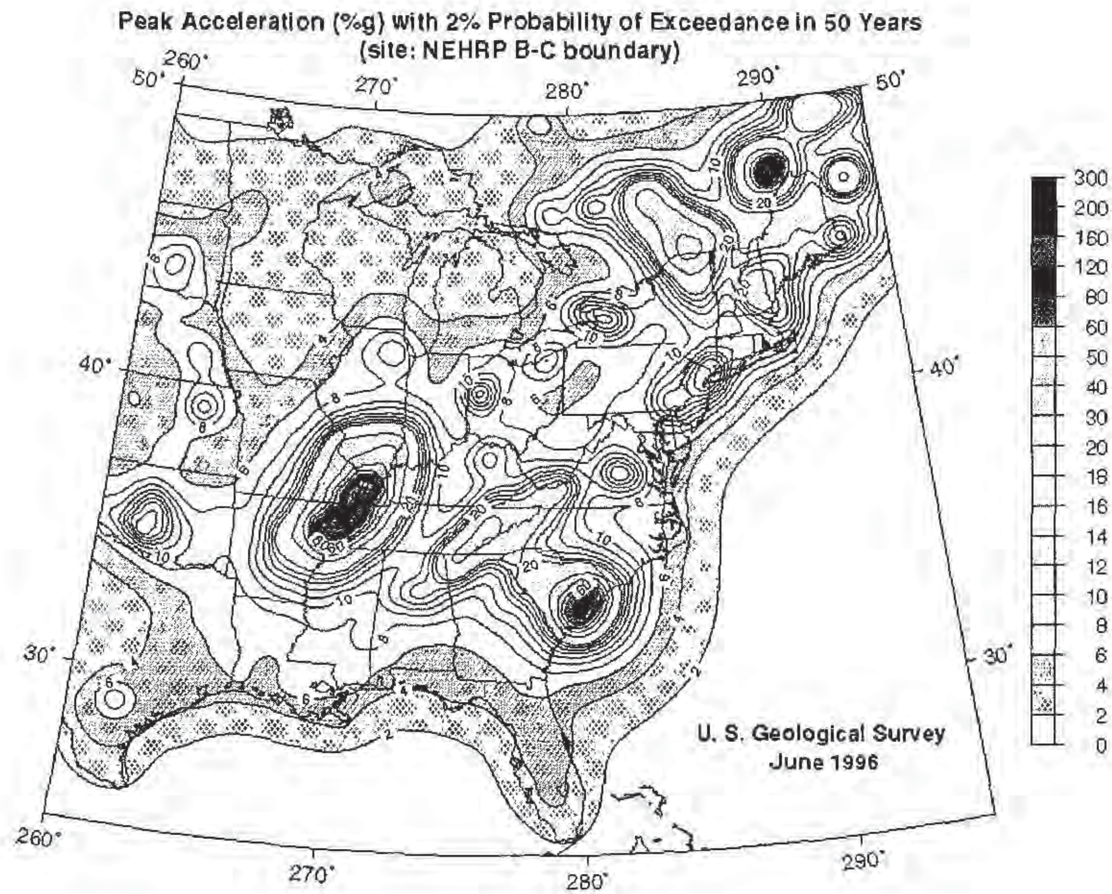


**Figure 4 - USGS Hazard Map for Peak Ground Acceleration**
**2% Probability of Exccedance in 50 Years**
(Frankel et al., 1996)

| Calculation No. K-CLC-Z-00002 |
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| Sheet No. 15 |
| Rev. 0 |

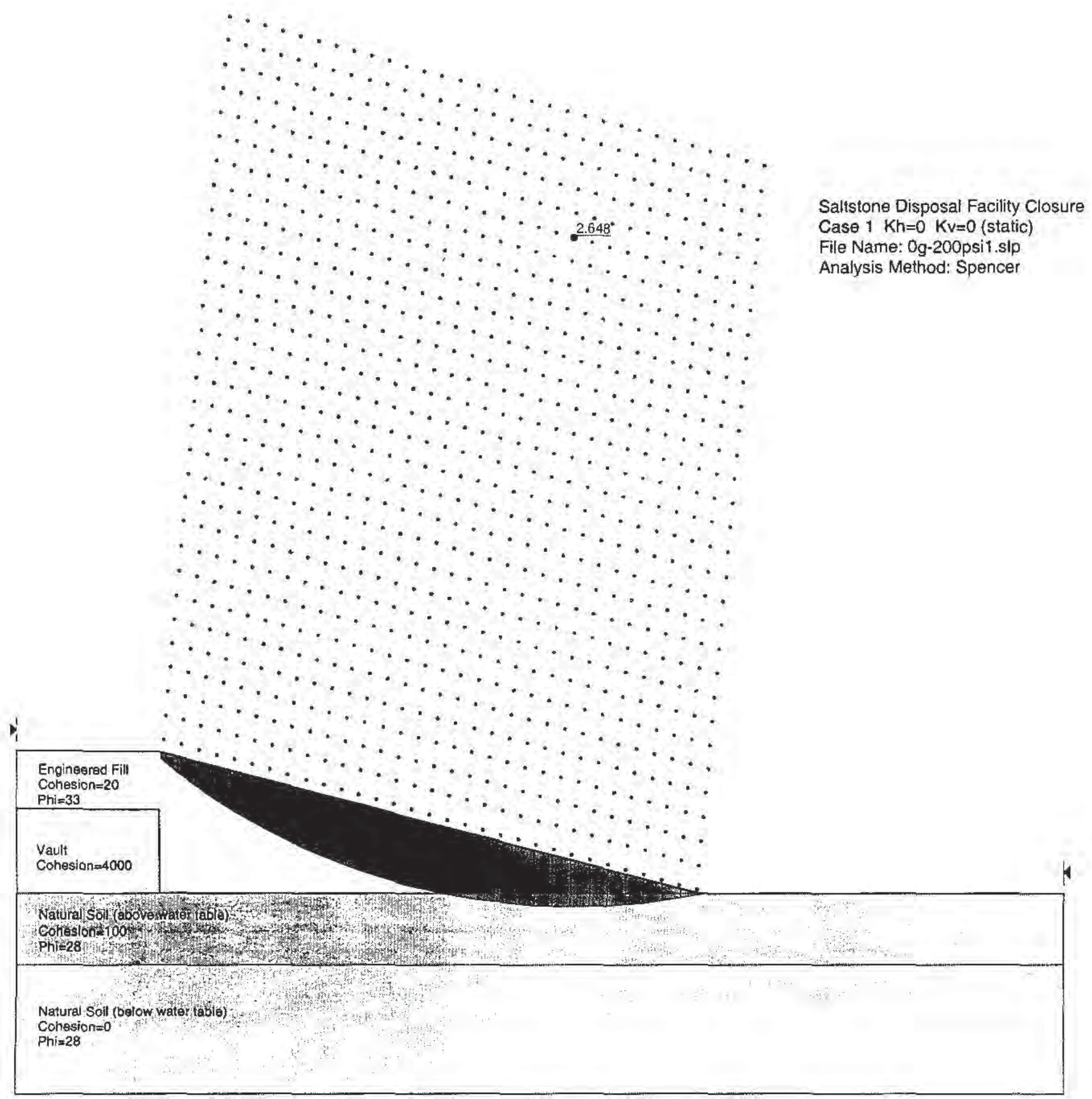


**Figure 5. Safety Factor Calculated Using Slope/W for Case 1 (Static Case $k_h$=0 and $k_v$=0)**

| Calculation No. K-CLC-Z-00002 | Sheet No. 16 | Rev. 0 |
|---|---|---|

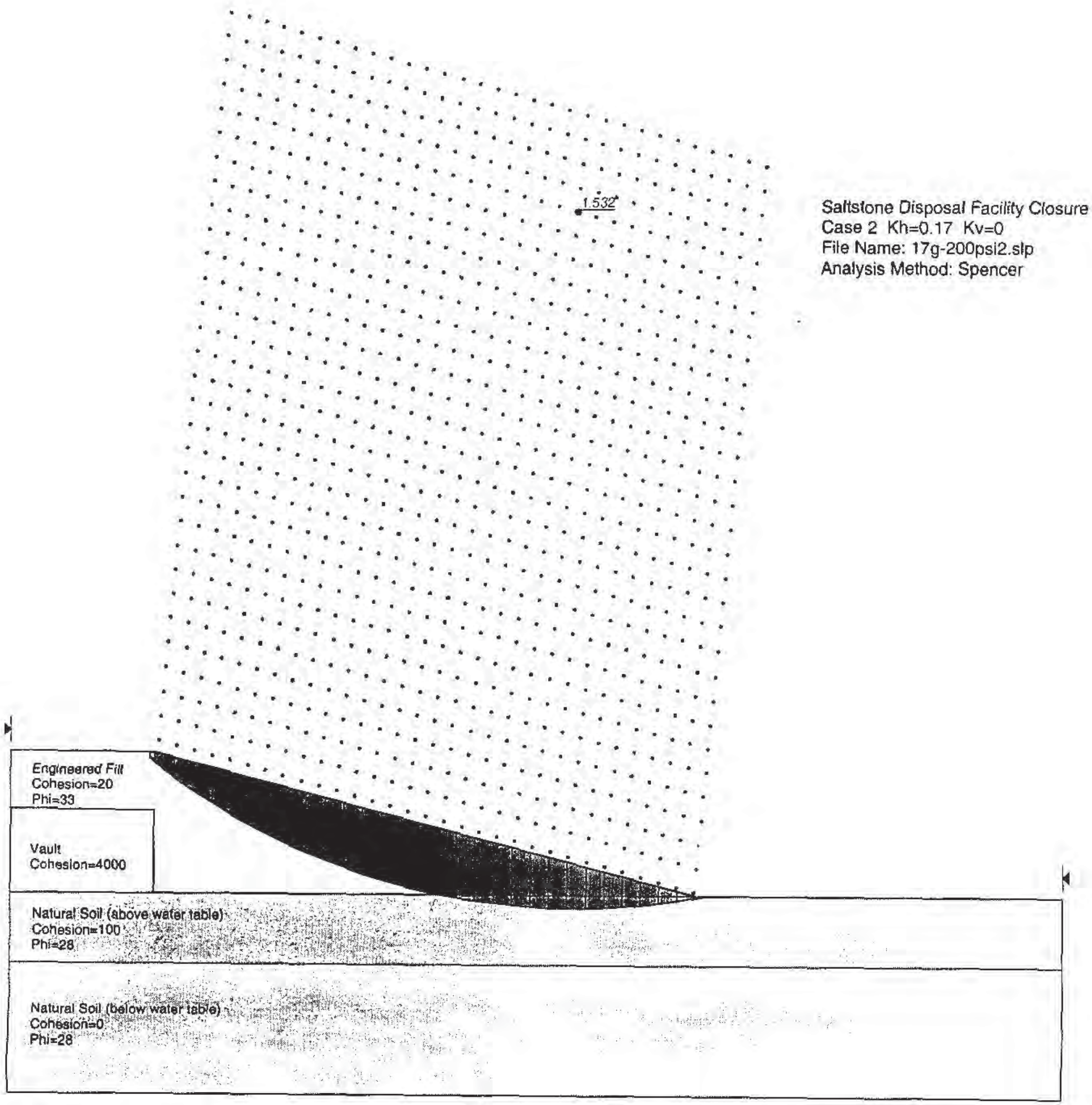


**Figure 6. Safety Factor Calculated Using Slope/W for Case 2 ($k_h$=0.17 and $k_v$=0)**

| Calculation No. K-CLC-Z-00002 |
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| Rev. 0 |

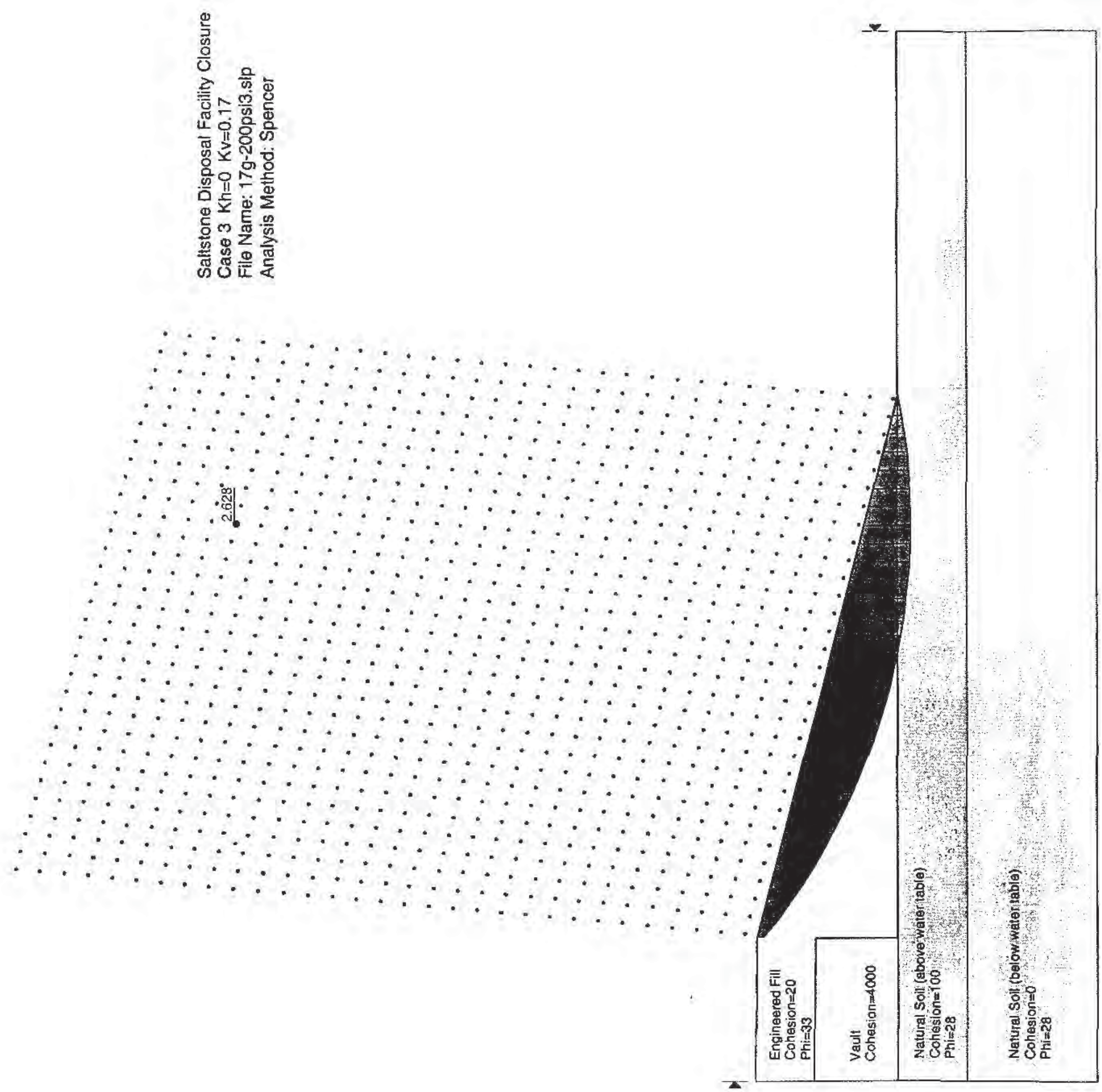


**Figure 7. Safety Factor Calculated Using Slope/W for Case 3 ($k_h$=0 and $k_v$=0.17)**

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| Rev. 0 |

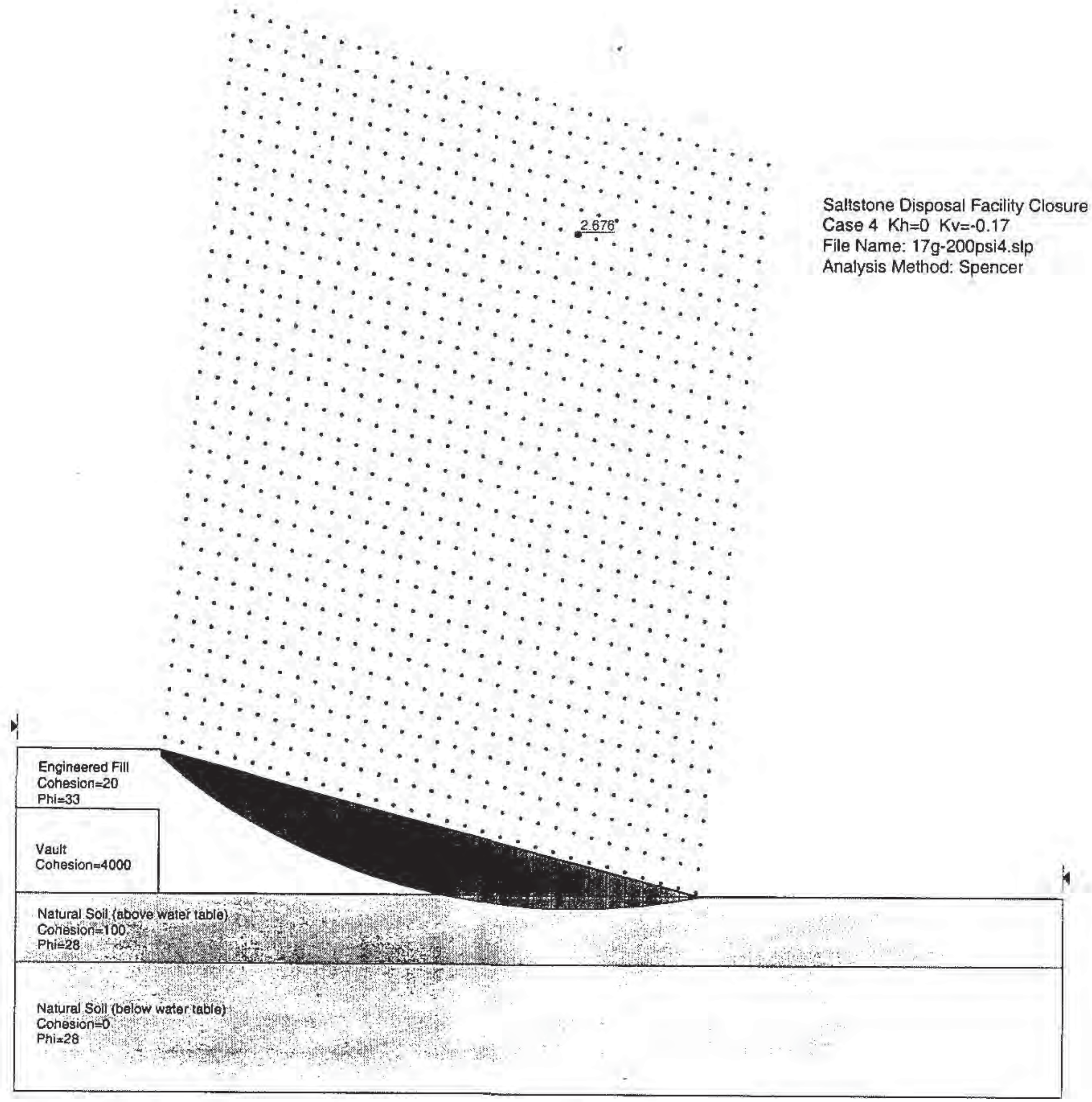


Figure 8. Safety Factor Calculated Using Slope/W for Case 4 ($k_h$=0 and $k_v$=-0.17)

| | |
|---|---|
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| **Sheet No.**<br>**19** | |
| **Rev.**<br>**0** | |

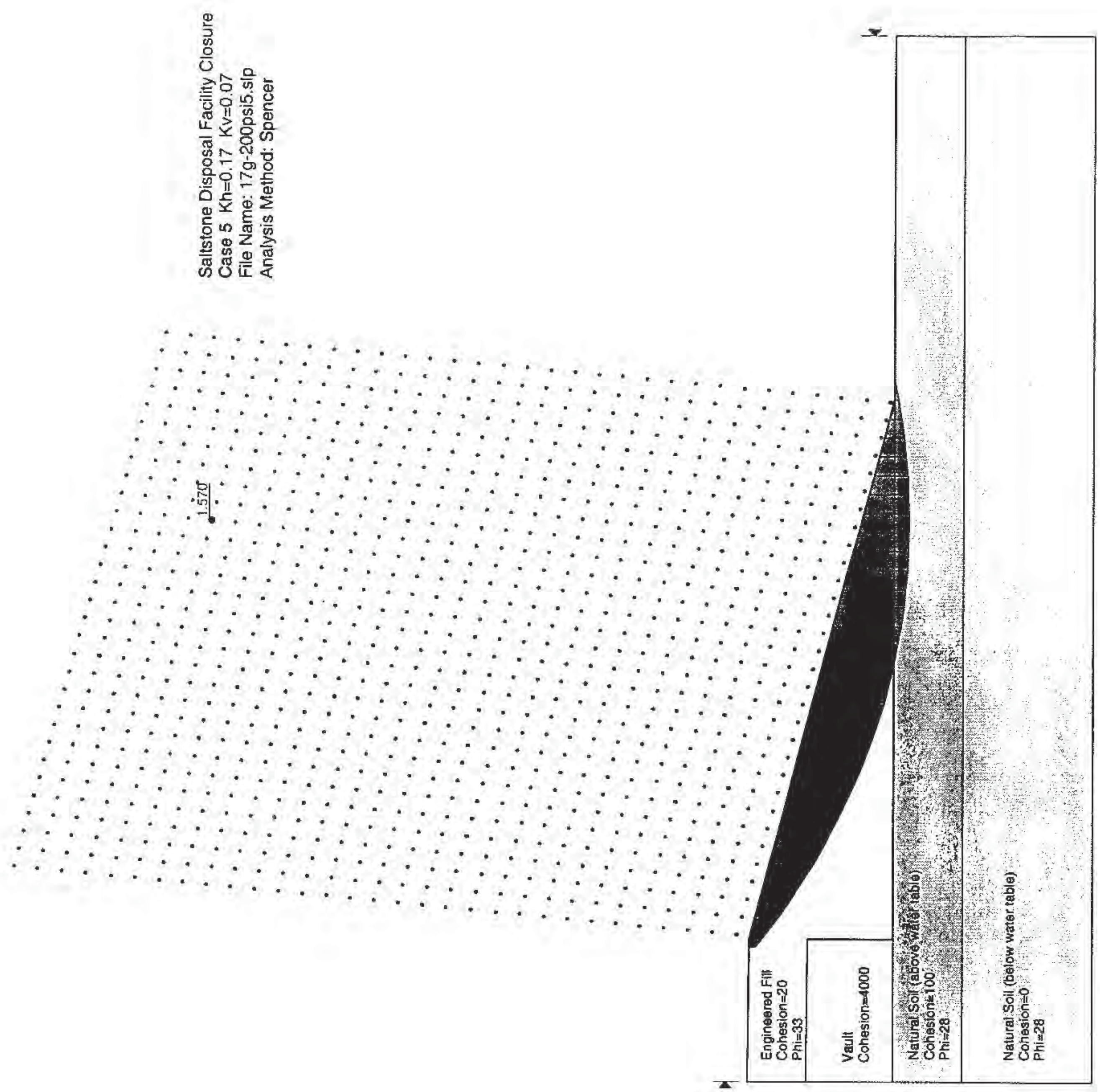


**Figure 9. Safety Factor Calculated Using Slope/W for Case 5 ($k_h$=0.17 and $k_v$=0.07)**

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| Sheet No. 20 |
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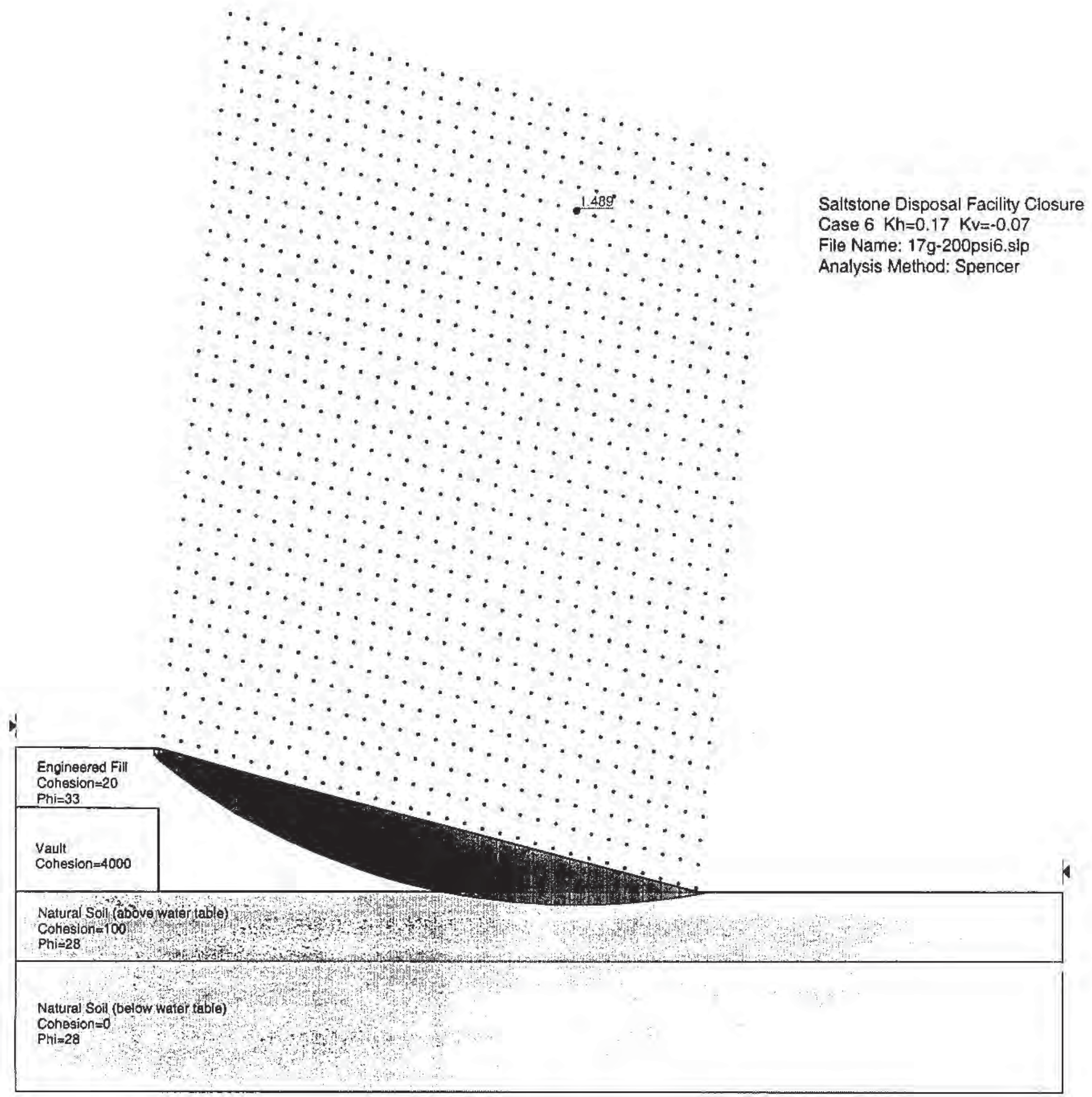


**Figure 10. Safety Factor Calculated Using Slope/W for Case 6 ($k_h$=0.17 and $k_v$=-0.07)**

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| Sheet No. 21 |
| Rev. 0 |

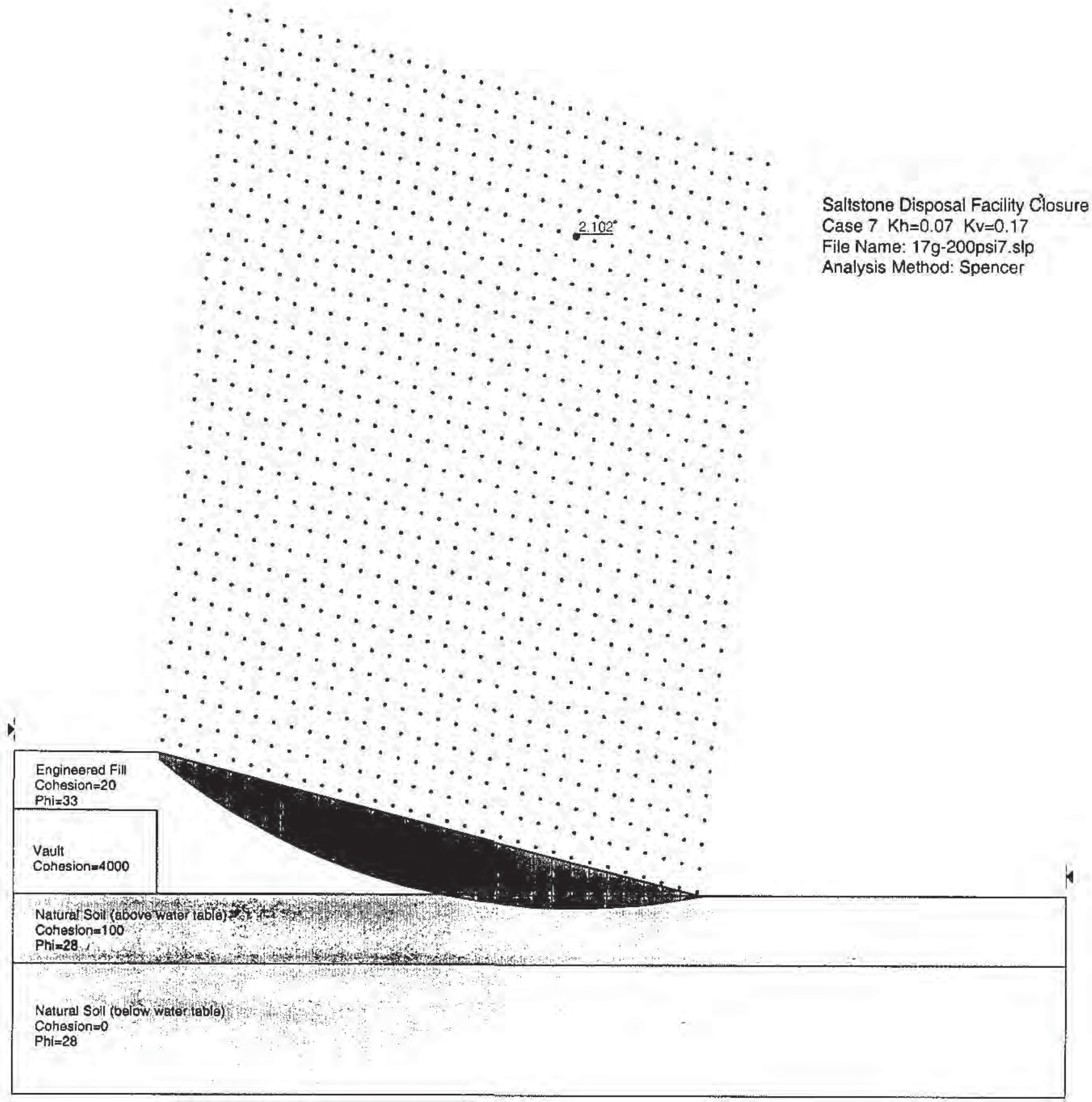



Figure 11. Safety Factor Calculated Using Slope/W for Case 7 ($k_h$=0.07 and $k_v$=0.17)

| Calculation No. K-CLC-Z-00002 | Sheet No. 22 | Rev. 0 |
|---|---|---|

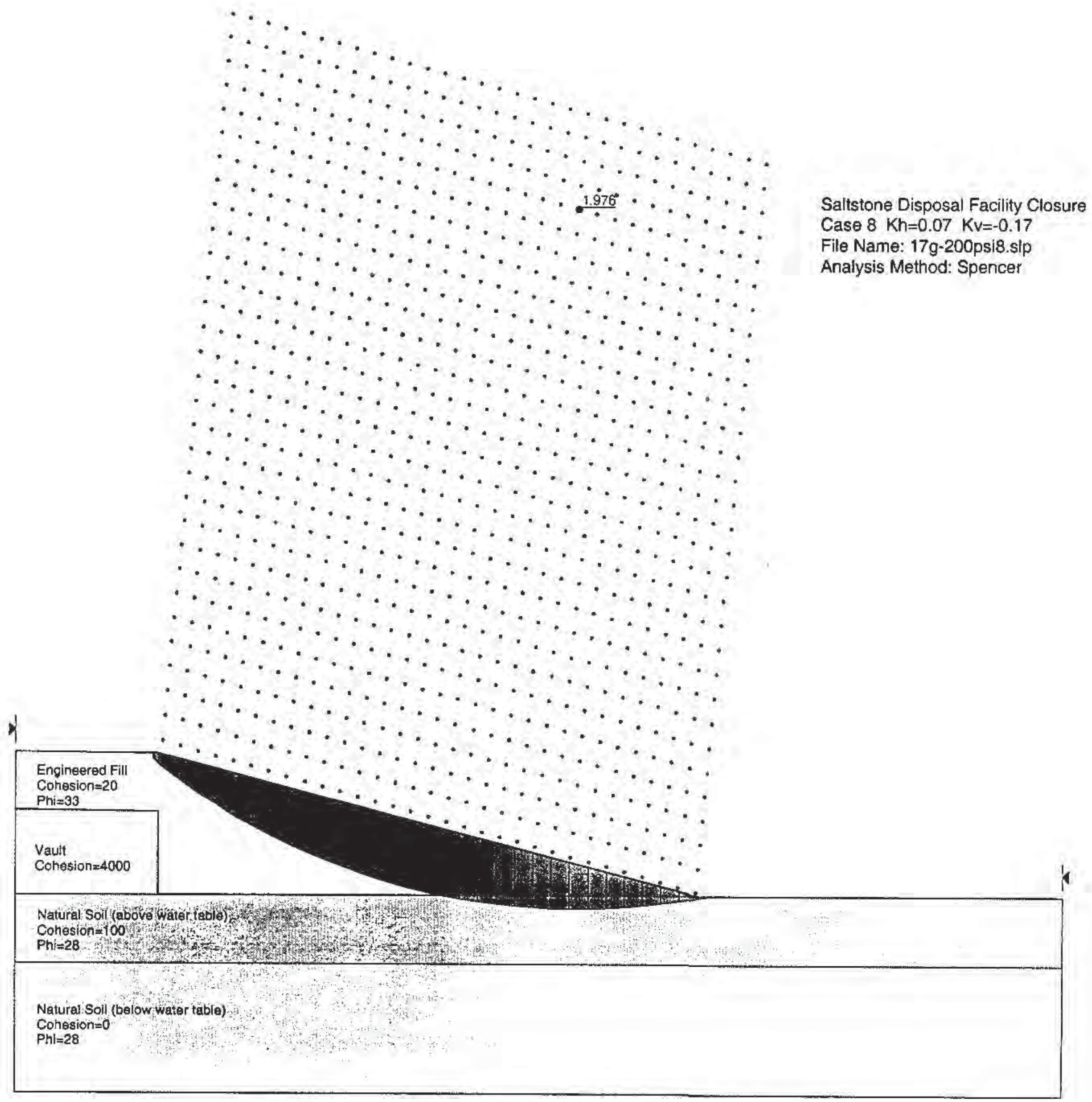



**Figure 12. Safety Factor Calculated Using Slope/W for Case 8 ($k_h$=0.07 and $k_v$=-0.17)**

| | |
|---|---|
| Calculation No. K-CLC-Z-00002 | Sheet No. 23 |
| Rev. 0 | |

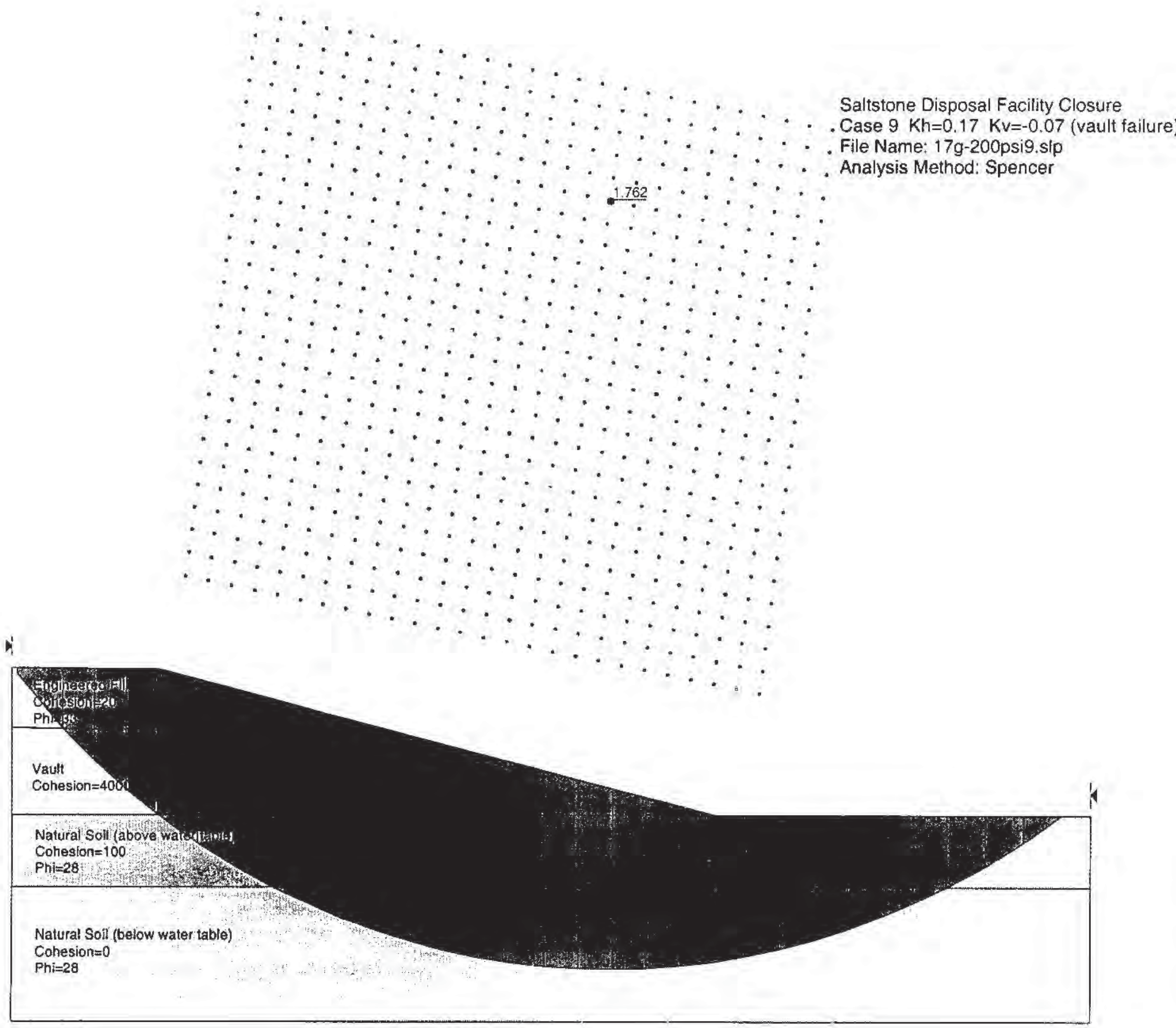



**Figure 13. Safety Factor Calculated Using Slope/W for Case 9 (Vault Failure – corner $k_h$=0.17 and $k_v$=-0.07)**

| Calculation No. K-CLC-Z-00002 | Sheet No. 24 | Rev. 0 |
|---|---|---|

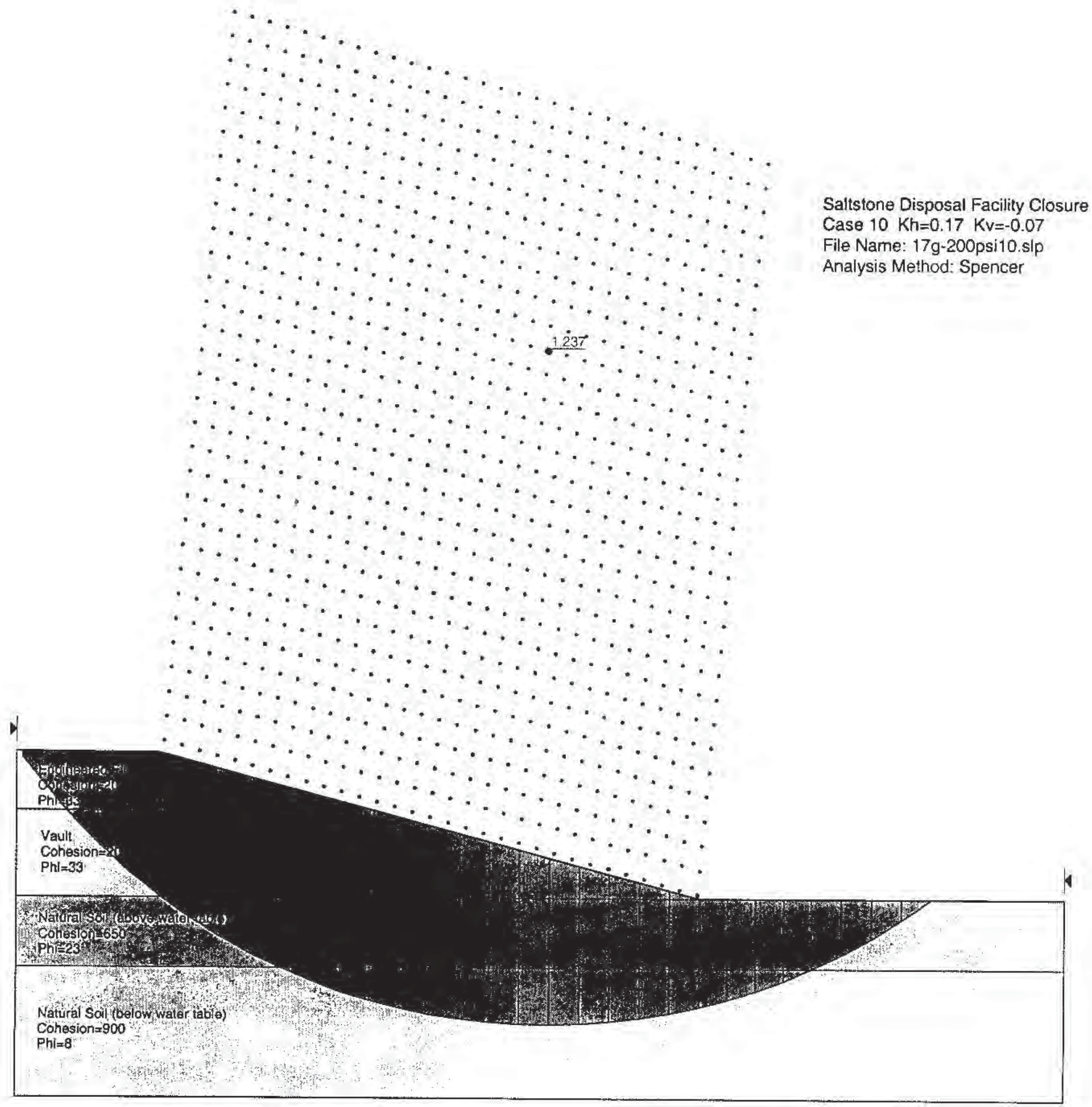



**Figure 14. Safety Factor Calculated Using Slope/W for Case 10 (total stress $k_h$=0.17 and $k_v$=-0.07)**

| Calculation No. K-CLC-Z-00002 | Sheet No. 25 | Rev. 0 |
|---|---|---|

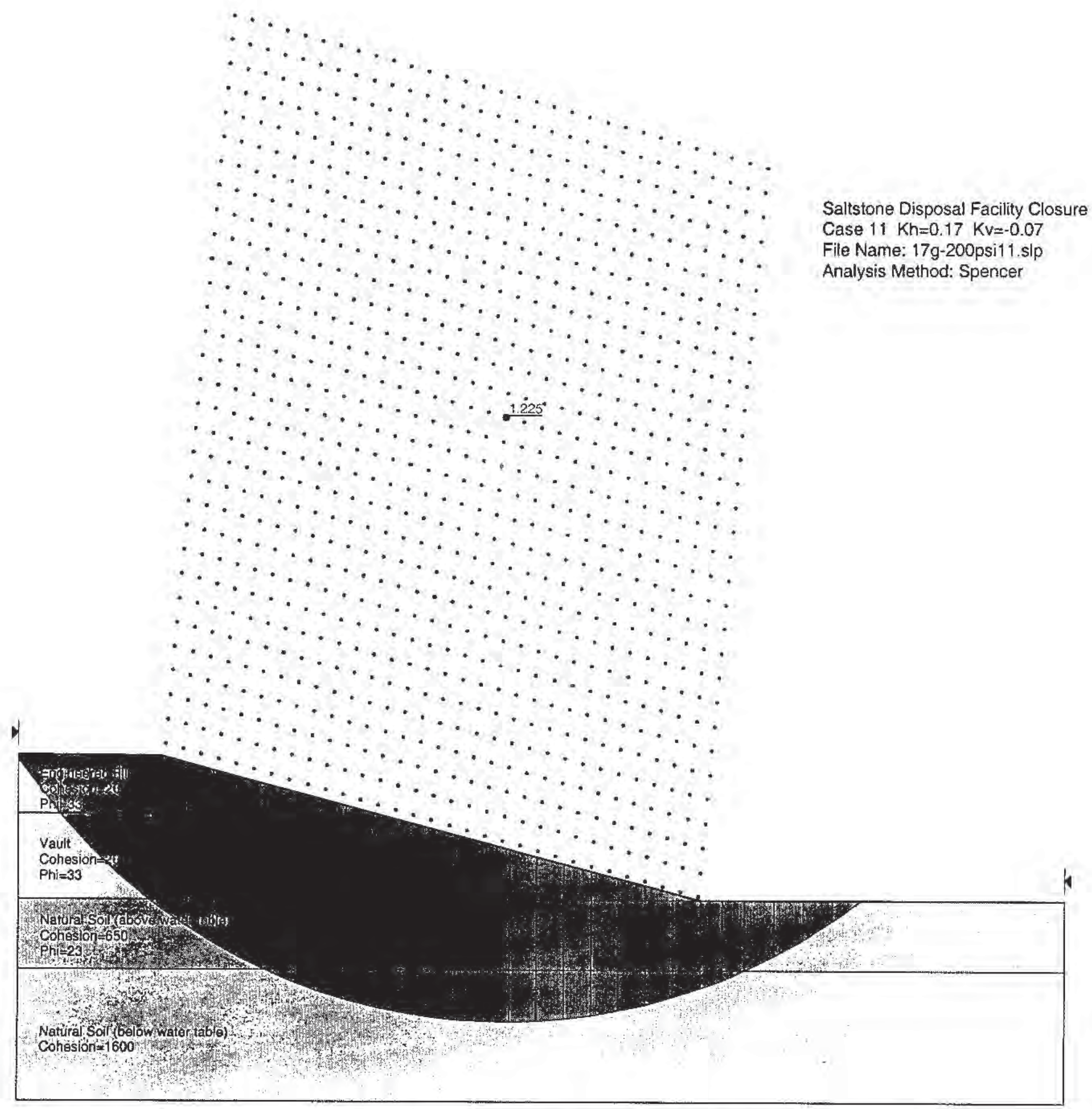



**Figure 15. Safety Factor Calculated Using Slope/W for Case 11 (total stress $k_h$=0.17 and $k_v$=-0.07)**

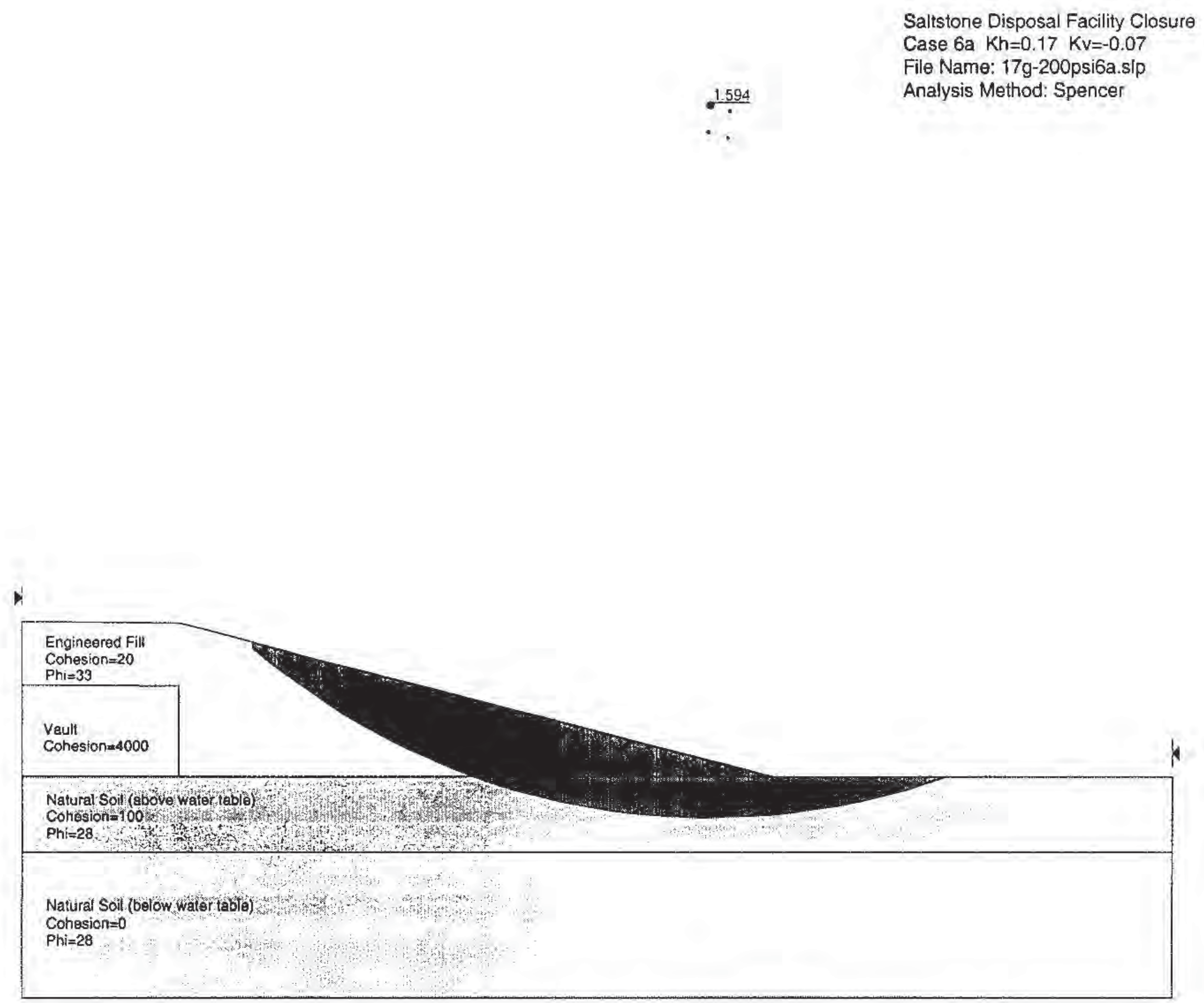



**Figure 16. Safety Factor Calculated Using Slope/W for Case 6a ($k_h$=0.17 and $k_v$=-0.07)**
(limited number of radius focal points and larger radii)

| Calculation No. K-CLC-Z-00002 | Sheet No. 27 | Rev. 0 |
|---|---|---|

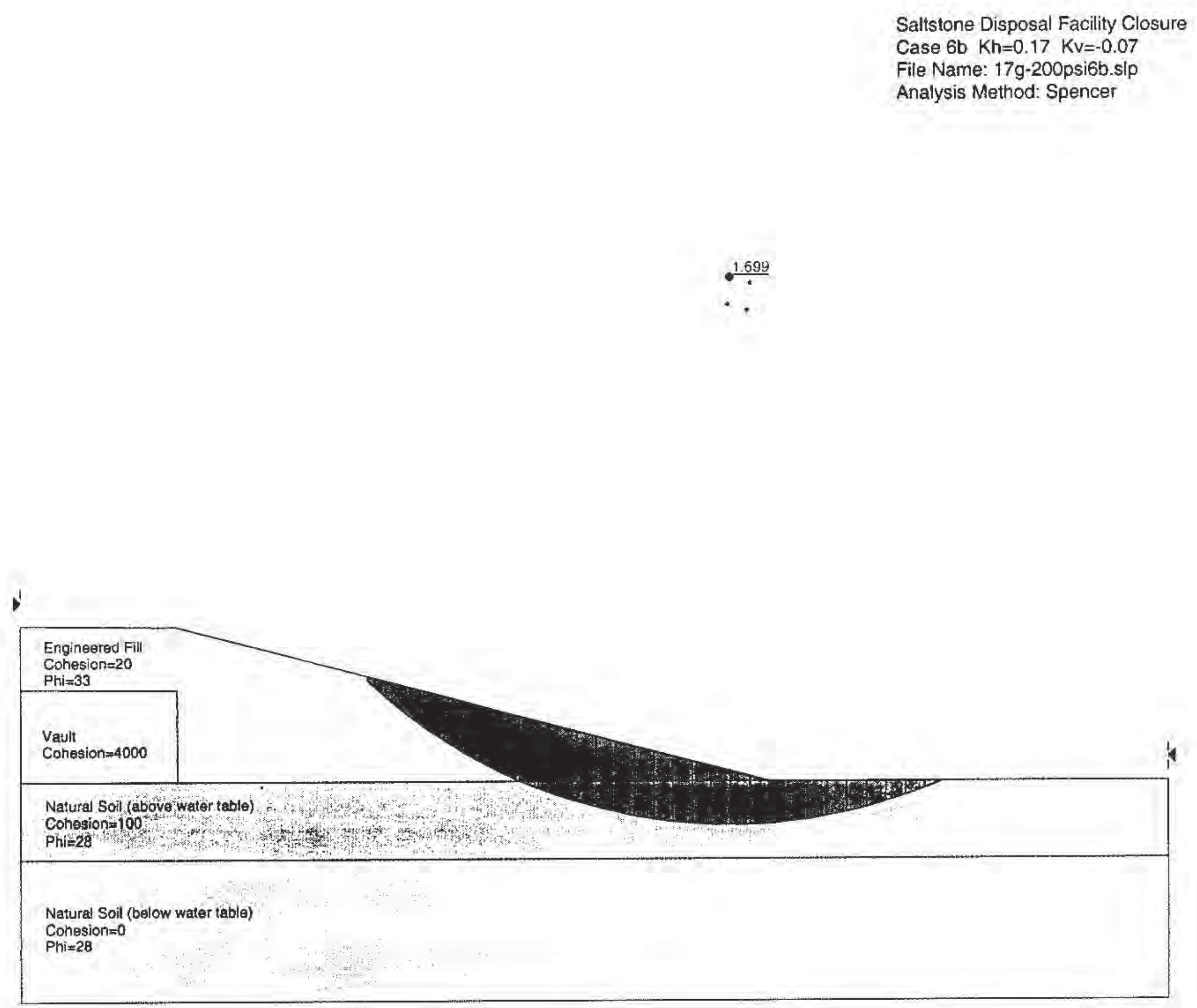



**Figure 17. Safety Factor Calculated Using Slope/W for Case 6b ($k_h$=0.17 and $k_v$=-0.07)**
(limited number of radius focal points and larger radii)

| | |
|---|---|
| Calculation No. K-CLC-Z-00002 | |
| Sheet No. 28 | |
| Rev. 0 | |

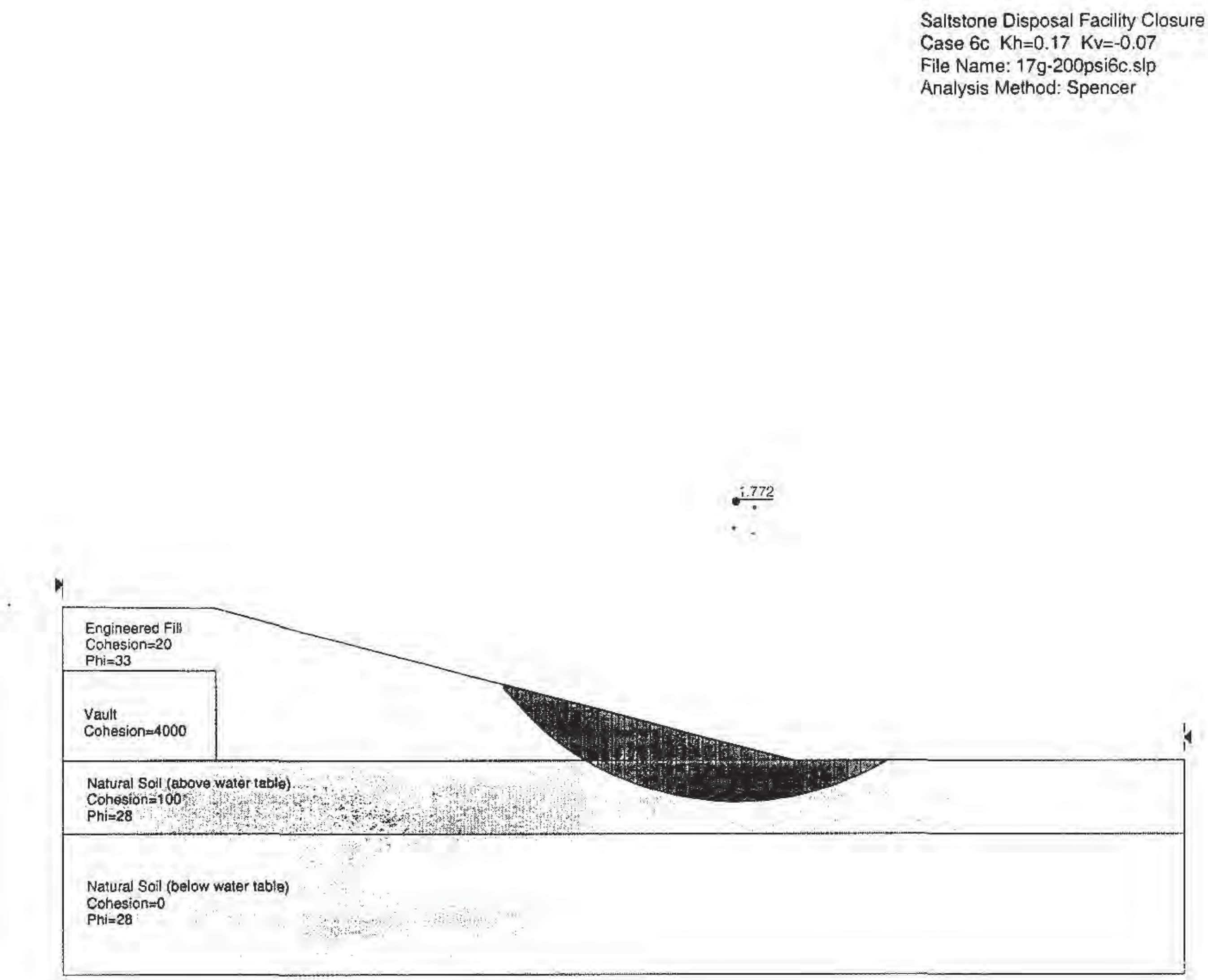



**Figure 18. Safety Factor Calculated Using Slope/W for Case 6c ($k_h$=0.17 and $k_v$=-0.07)**
(limited number of radius focal points and larger radii)

| Calculation No. K-CLC-Z-00002 | Sheet No. 28A | Rev. 1 |
|---|---|---|

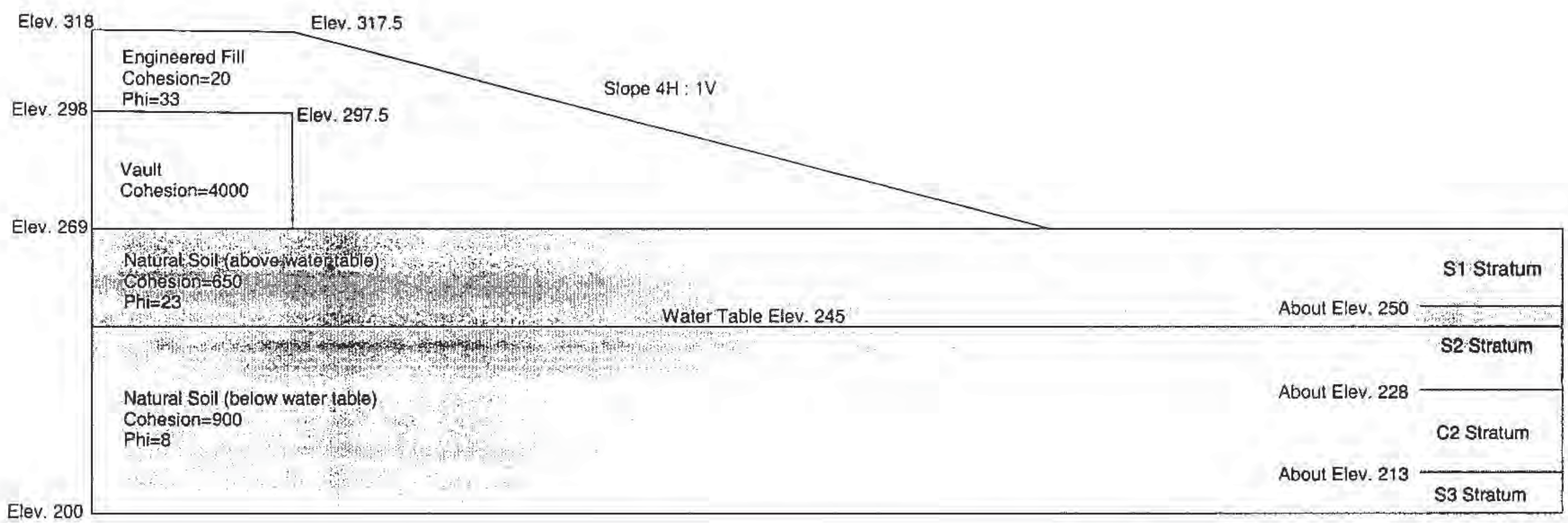



**Figure 19. Vault and Closure Cover Soil Model Used for Revision 0 Case 10**

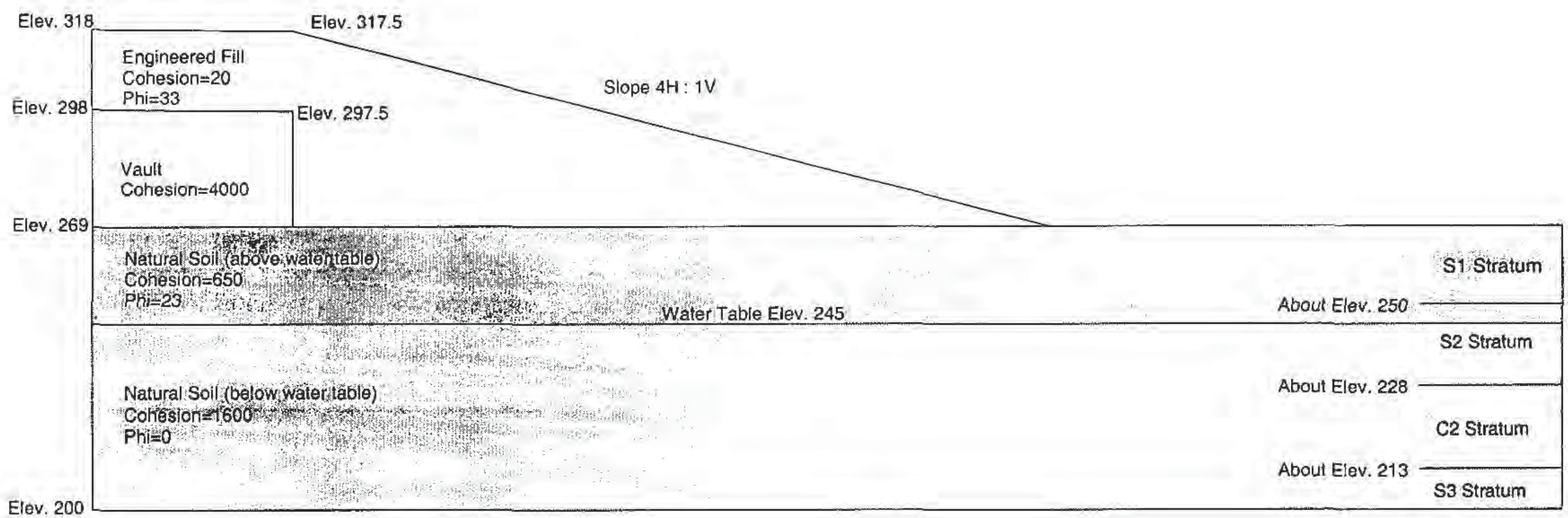



**Figure 20. Vault and Closure Cover Soil Model Used for Revision 0 Case 11**

| Calculation No. K-CLC-Z-00002 | Sheet No. 28C | Rev. 1 |
| --- | --- | --- |

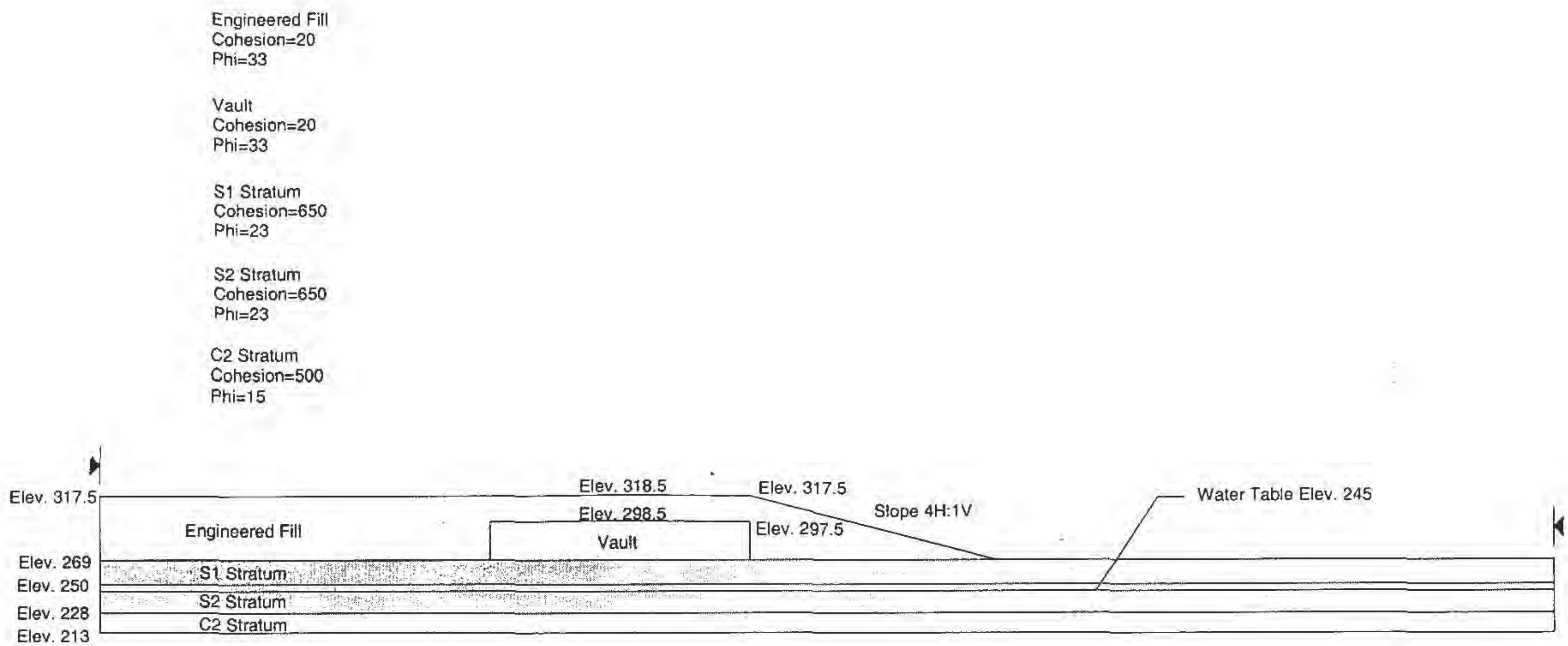



**Figure 21. Vault and Closure Cover Soil Model Used for Case 10 Extended (Revision 1)**

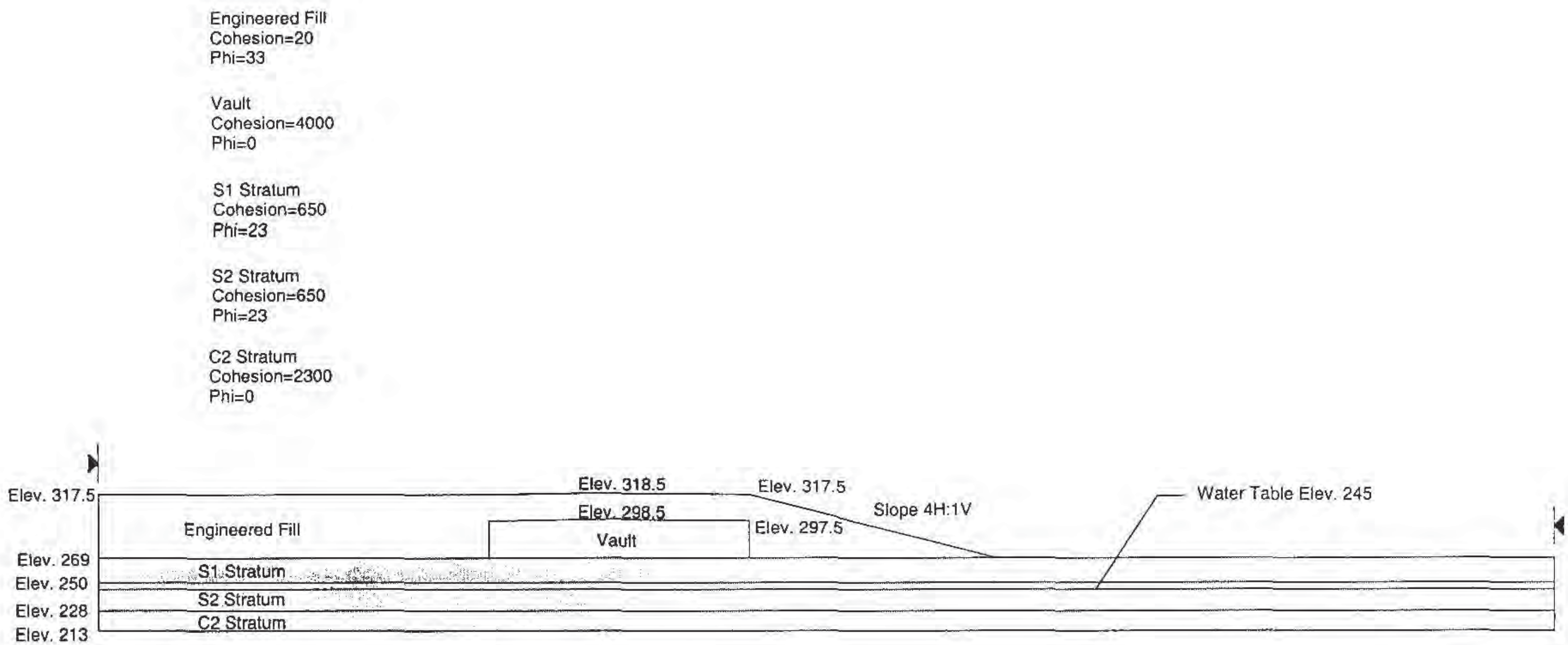



**Figure 22. Vault and Closure Cover Soil Model Used for Case 11 Extended (Revision 1)**

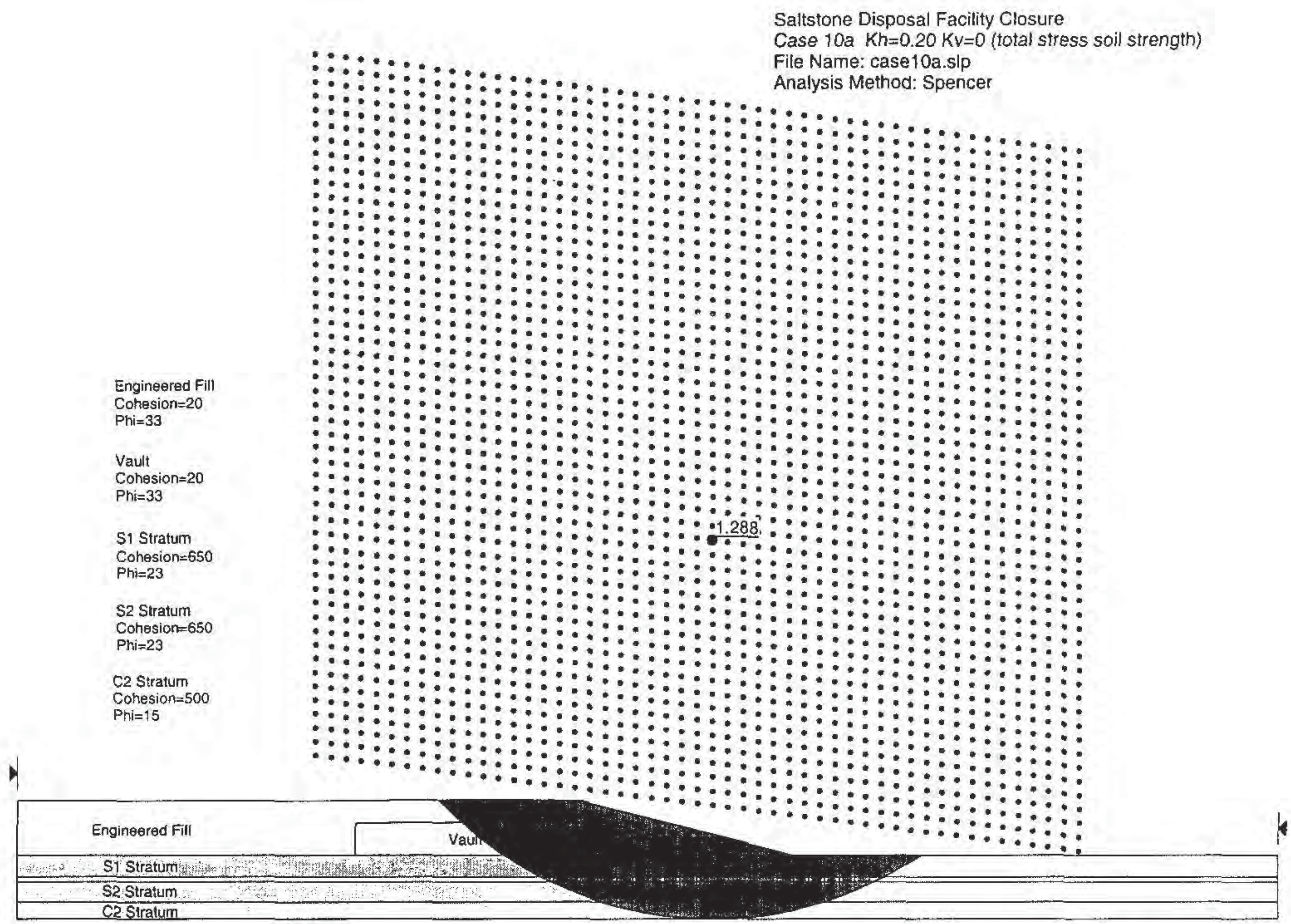



**Figure 23. Safety Factor Calculated Using Slope/W for Case 10a Extended (total stress $k_h$=0.20 and $k_v$=0)**

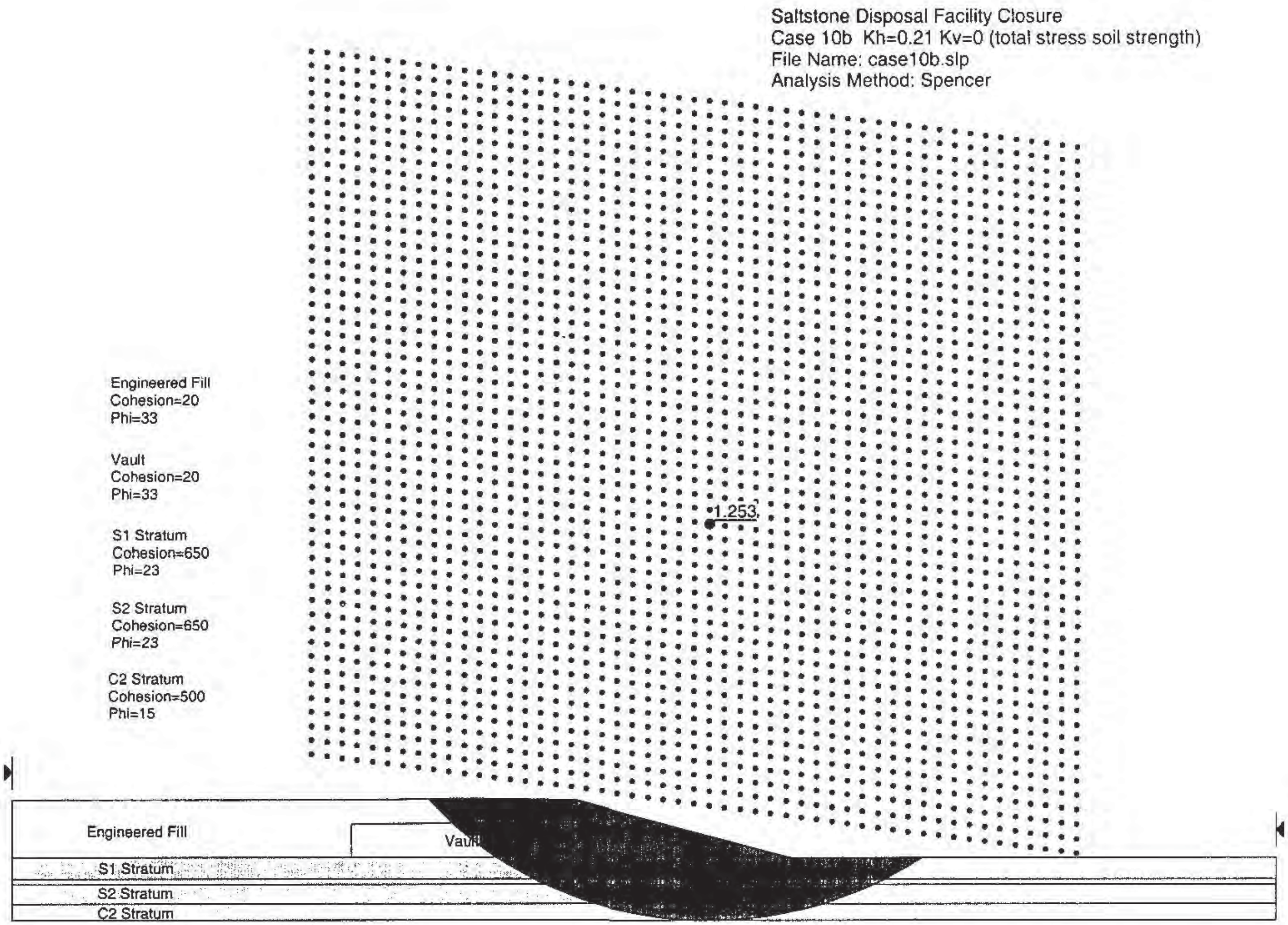



**Figure 24. Safety Factor Calculated Using Slope/W for Case 10b Extended (total stress $k_h$=0.21 and $k_v$=0)**

| Calculation No. K-CLC-Z-00002 | Sheet No. 28G | Rev. 1 |
|---|---|---|

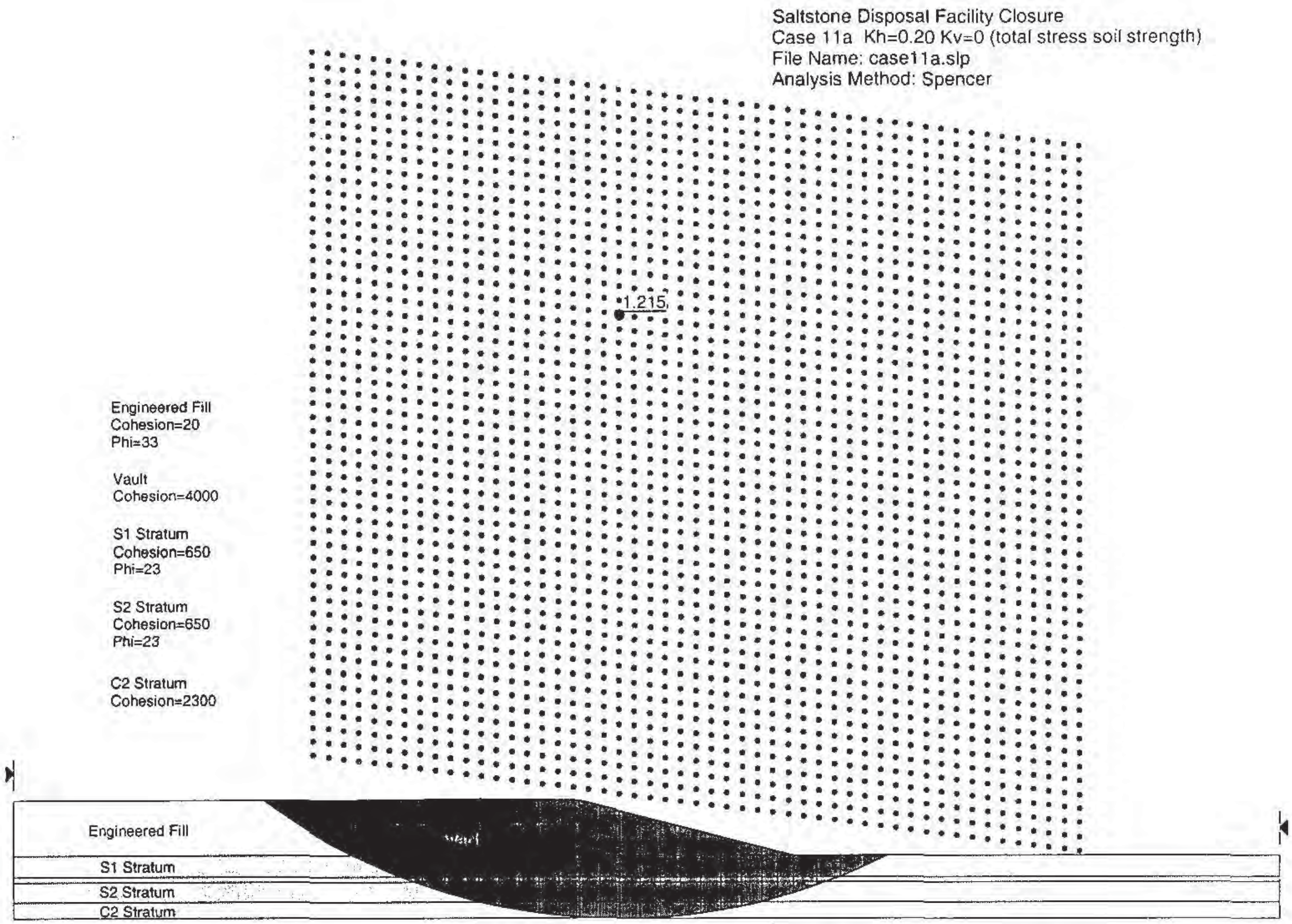



**Figure 25. Safety Factor Calculated Using Slope/W for Case 11a Extended (total stress $k_h$=0.20 and $k_v$=0)**

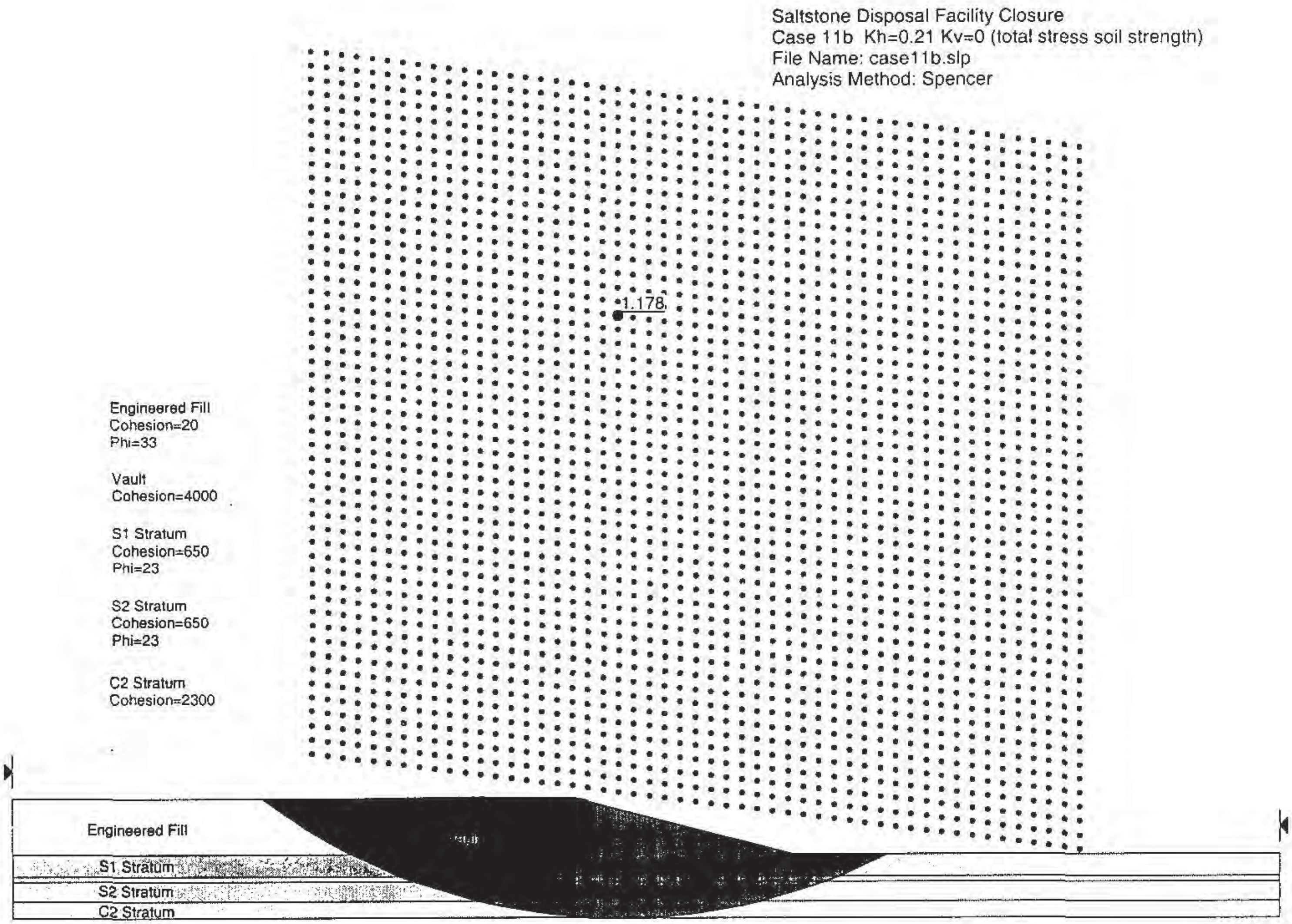
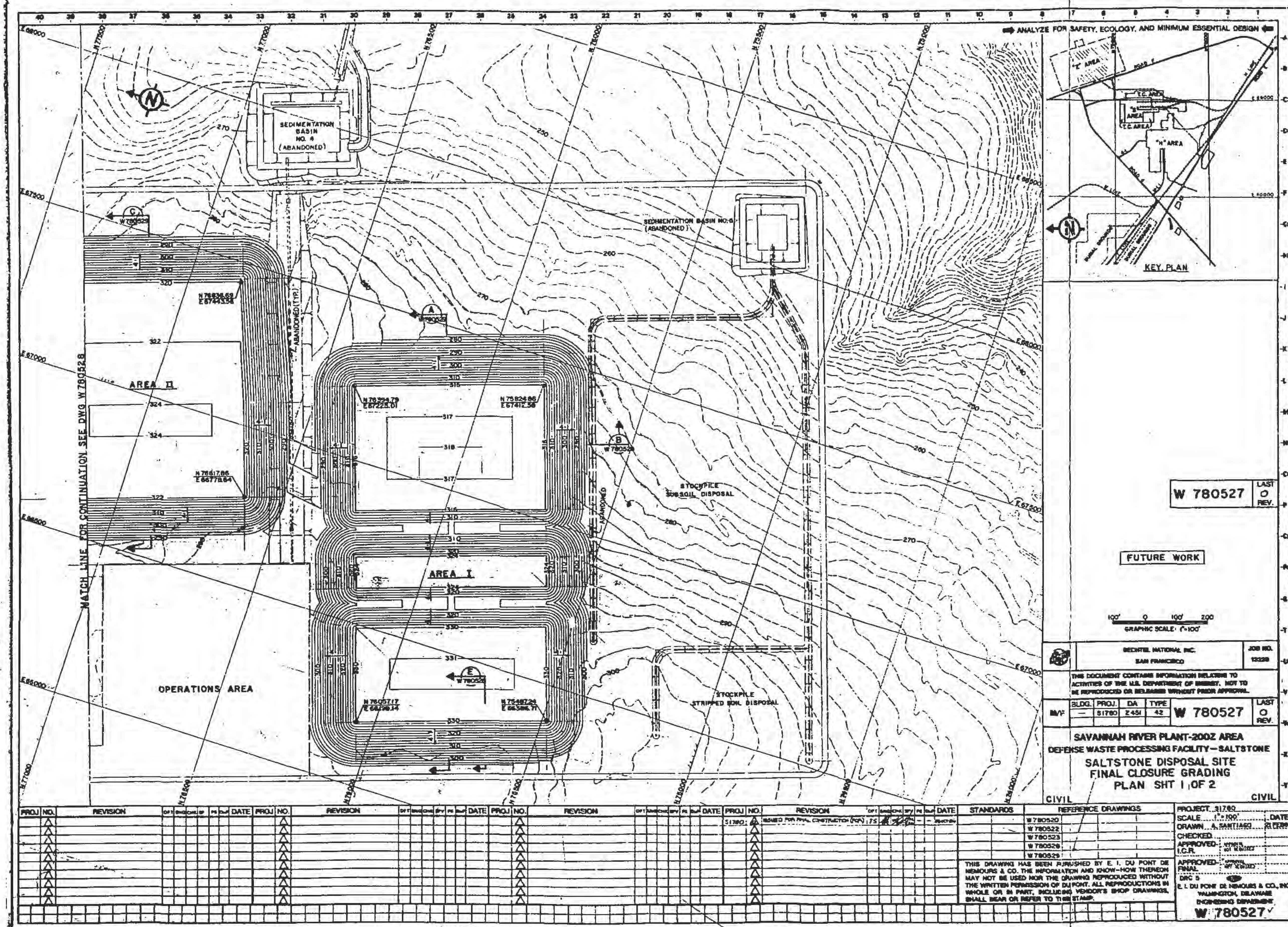


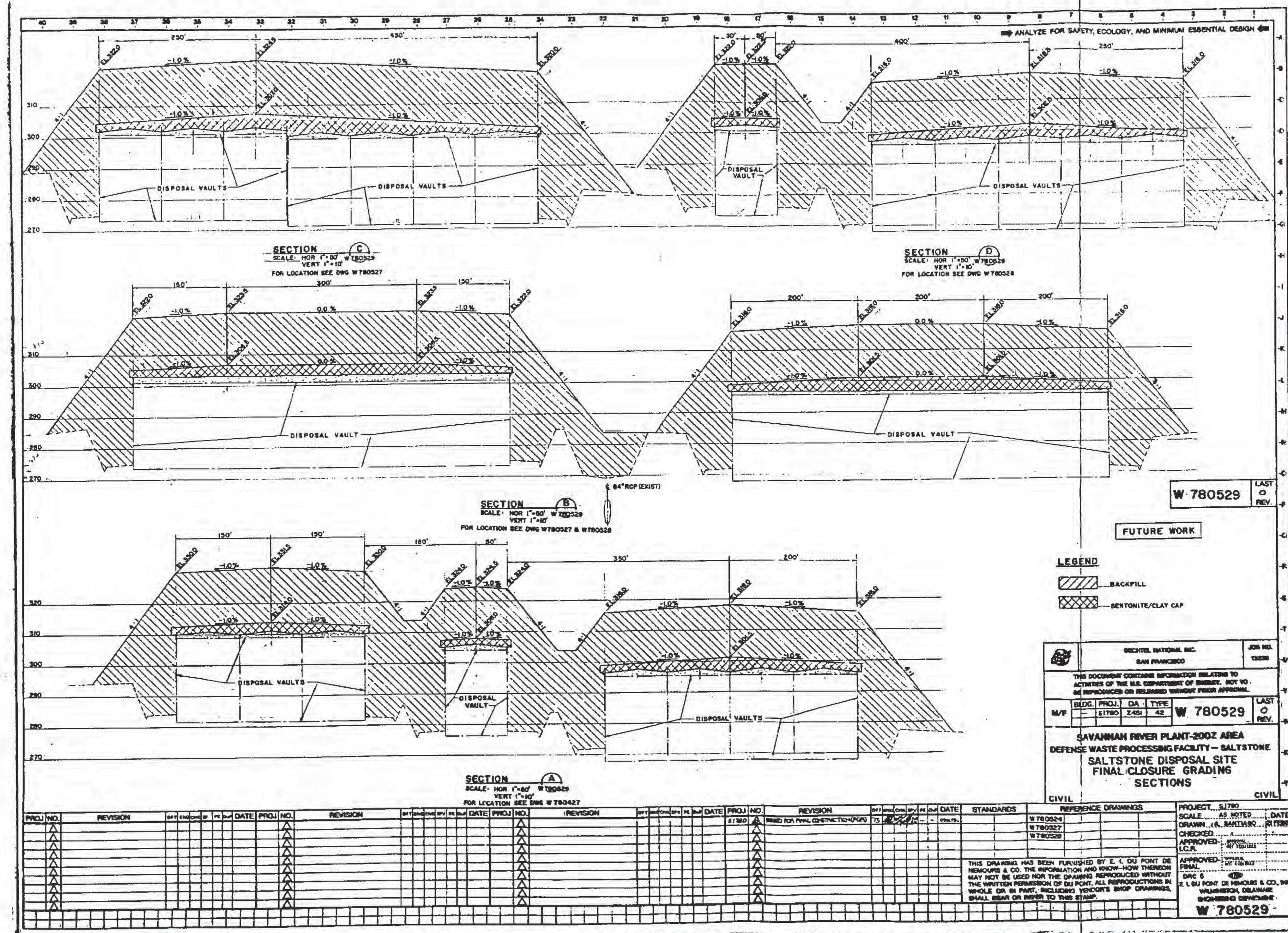

**Figure 26. Safety Factor Calculated Using Slope/W for Case 11b Extended (total stress $k_h$=0.21 and $k_v$=0)**

# ATTACHMENT 1: DRAWINGS

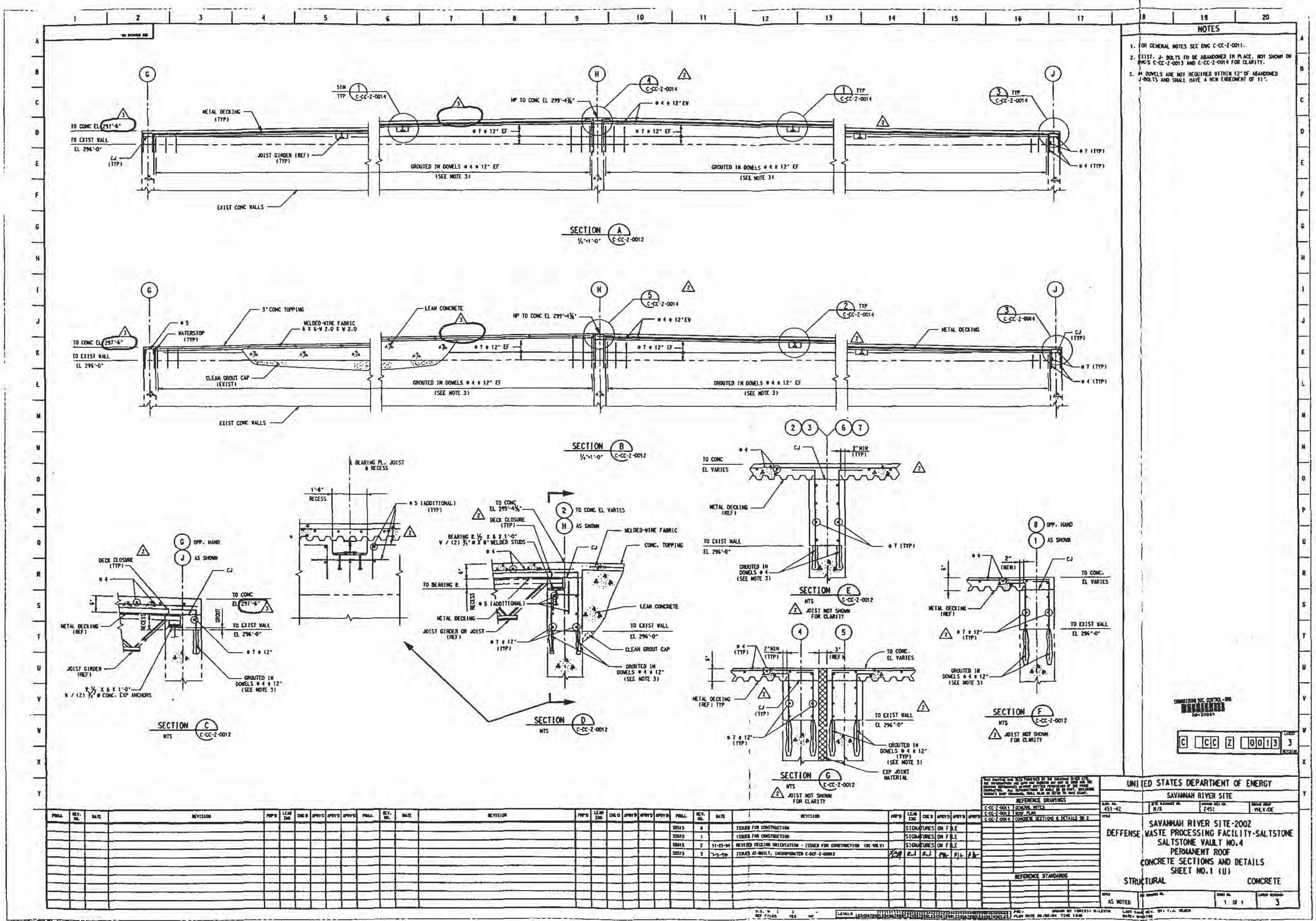
| | |
|---|---|
| Calculation No. | K-CLC-Z-00002 |
| Sheet No. | 30 |
| Rev. | 0 |



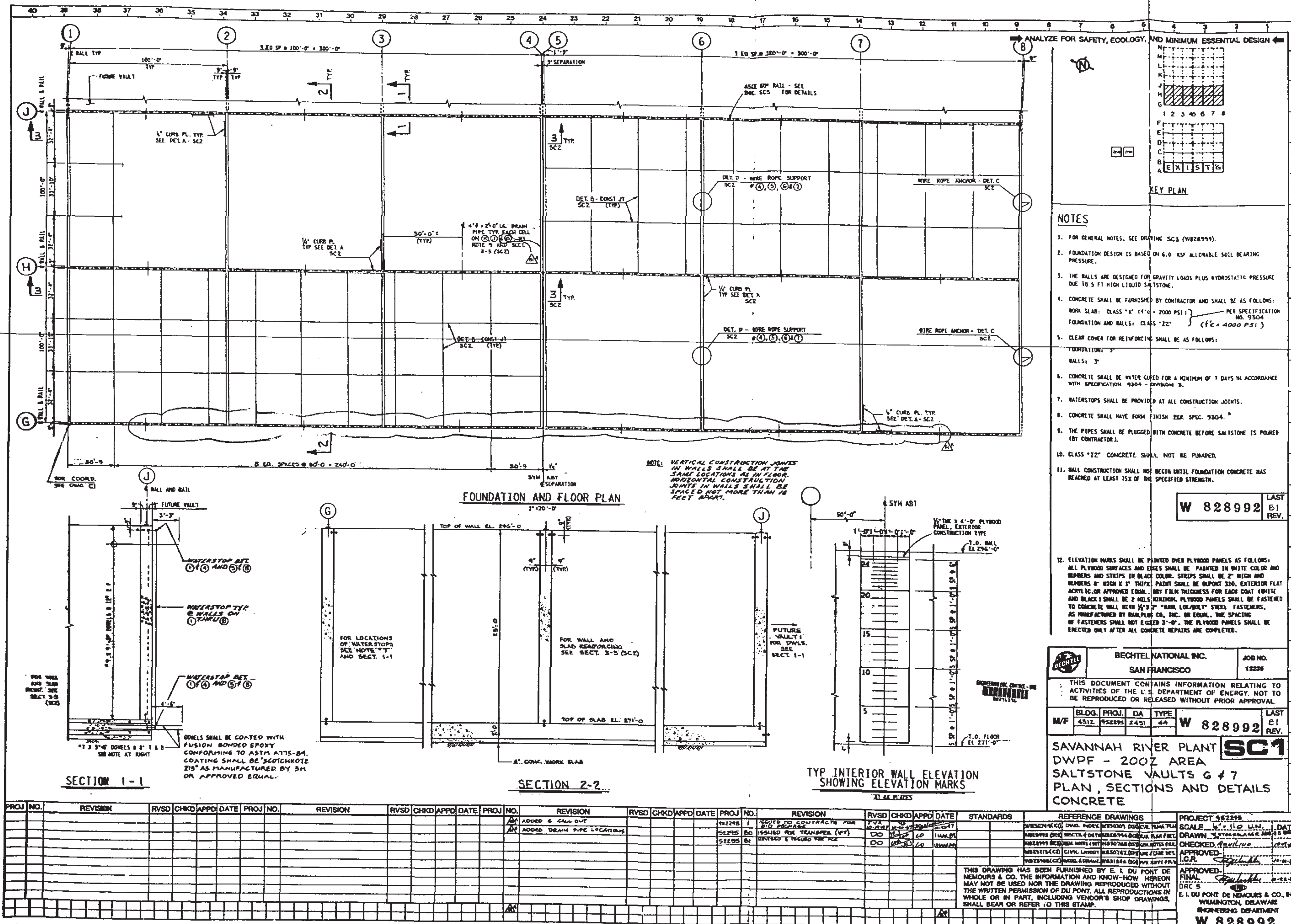
| Calculation No. K-CLC-Z-00002 |
| --- |
| Sheet No. 31 |
| Rev. 0 |



| | |
|---|---|
| Calculation No. | K-CLC-Z-00002 |
| Sheet No. | 32 |
| Rev. | 0 |



| Calculation No. K-CLC-Z-00002 |
|---|
| Sheet No. 33 |
| Rev. 0 |



## ATTACHMENT 2: SOIL SHEAR STRENGTH DATA

This attachment contains effective and total stress shear strength test results performed in the vicinity of the Saltstone Vaults. More detail regarding the testing can be obtained from *Investigations of Slope Stability Savannah River Plant Aiken, South Carolina*, by Woodward-Clyde Consultants (1985), *Stability of Trenches 200 Z Area Saltstone Landfill Savannah River Plant Aiken, South Carolina*, by Woodward-Clyde Consultants (1986), *Savannah River Site Z-Area Vault No. 2 Geotechnical Investigations Report (U)*, by Bechtel Savannah River, Inc. (1992), and *Saltstone Disposal Z-Area Savannah River Plant*, by Mueser Rutledge Consulting Engineers (1986).

Figure 1, on sheet 11 of this calculation, shows approximate elevations for the various soil strata beneath Vault No. 4. Detailed descriptions of the strata are provided in, *Saltstone Disposal Z-Area Savannah River Plant*, by Mueser Rutledge Consulting Engineers (1986). The majority of the strength tests are above the water table in the S1 stratum (see sheet 35). The S2 and S3 strata have very limited data. The S2 stratum is believed to behave like the S1 stratum when above the water table. Cone Penetrometer and Standard Penetration tests indicate that the S2 stratum is as strong or stronger than the S1 stratum. Assuming that the S2 stratum behaves as the S1 stratum is conservative. Five tests are available for the C2 stratum below the water table. The S3 stratum is interspersed and underlies the C2 stratum and is stronger than the C2 stratum. Assuming that the S3 stratum behaves as the C2 stratum is conservative. Boring ID, type of test, test moisture, and stratum for the triaxial shear tests are provided on sheet 35.

Effective stress results show sandy behavior with little cohesion for both saturated and unsaturated tests. Total stress results from unsaturated samples also tend to behave as sandy soils with little cohesion. However, total stress results from saturated samples exhibit strength due to cohesion and behave somewhat like clayey soils.

For "effective stress" cases the S1, S2, C2 and S3 soils above and below the water table were modeled as with a conservative friction angle 28° and cohesion of 100 psf above the water and no cohesion below the water table (see sheets 36 through 40 for supporting data).

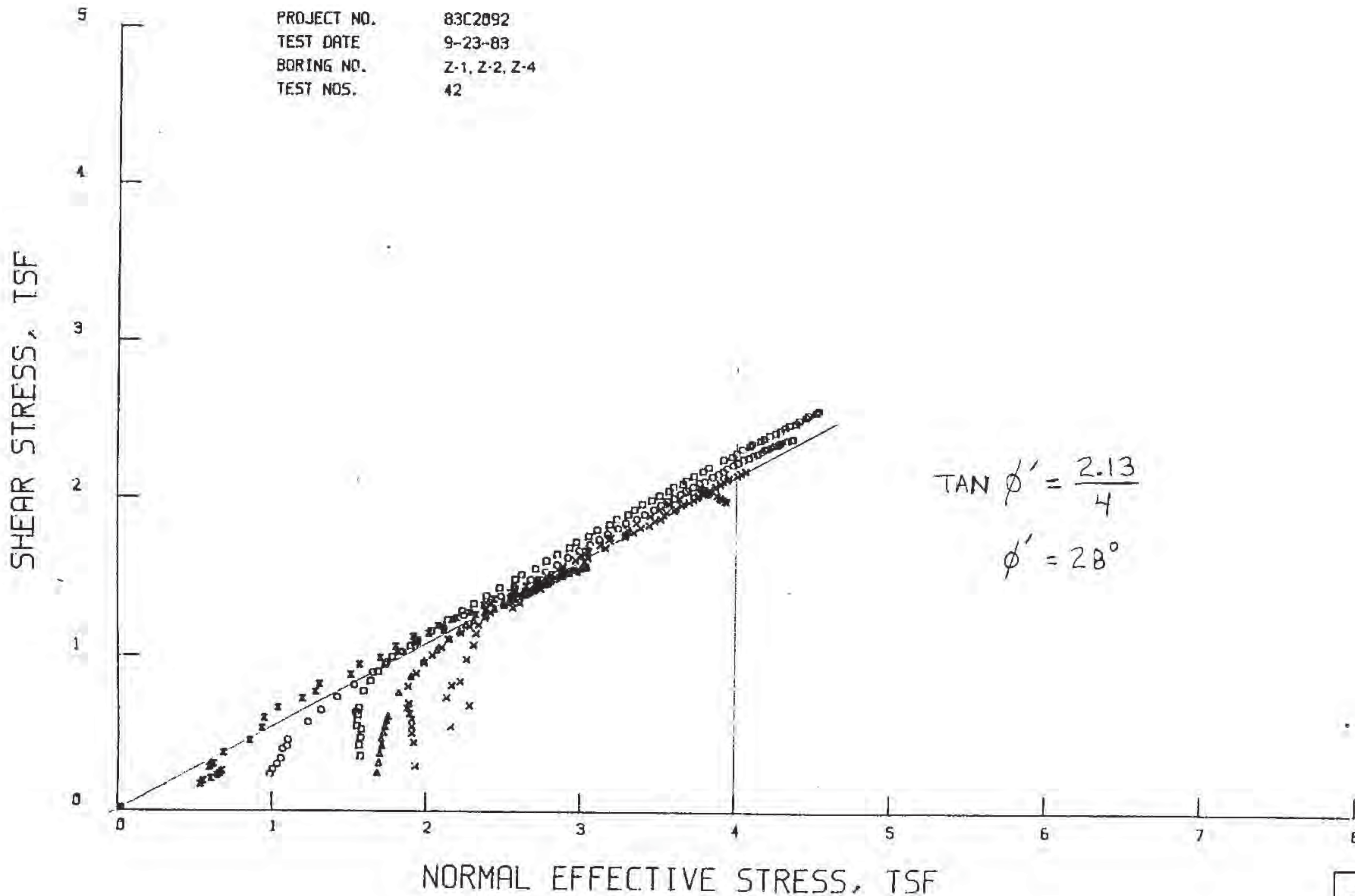
For the "total stress" cases the S1 and S2 soils above the water table were modeled with a conservative friction angle of 23° with cohesion of 650 psf as interpreted by Woodward-Clyde Consultants (1986) (see sheet 41 for plot of data). The S2, C2 and S3 soils below the water table were modeled two ways to insure the most conservative interpretation. The soils below the water table were modeled with 1) a friction angle of 8° and cohesion of 900 psf and 2) a friction angle of zero and cohesion of 1,600 psf (see sheet 42 for plot of saturated total stress data).

| Calculation No. K-CLC-Z-00002 |
|---|
| Sheet No. 35 |
| Rev. 0 |

| SGS File No. | Boring ID | SRS Northing | SRS Easting | Type of Test | Test Moisture | Stratum | Mid. Elev. (ft-msl) | Sheet No. |
|---|---|---|---|---|---|---|---|---|
| Z-SDF-9 | ZB-2 | 76156 | 66598 | CU | saturated | S1 | 261.0 | 37, 38, 42 |
| Z-SDF-9 | ZB-8 | 75575 | 66689 | CU | saturated | S1 | 270.8 | 39, 40, 42 |
| G-SRS-17 and Z-SDF-8 | Z-1 | 76200 | 66975 | CIU | natural | S1 | 270.9 | 41 |
| G-SRS-17 and Z-SDF-8 | Z-1 | 76200 | 66975 | CIU | saturated | S1 | 270.4 | 36 |
| G-SRS-17 and Z-SDF-8 | Z-1 | 76200 | 66975 | CIU | natural | S1 | 260.9 | 41 |
| G-SRS-17 and Z-SDF-8 | Z-1 | 76200 | 66975 | CIU | saturated | S1 | 260.4 | 36 |
| G-SRS-17 and Z-SDF-8 | Z-2 | 75710 | 67200 | CIU | saturated | S1 | 271.2 | 36 |
| G-SRS-17 and Z-SDF-8 | Z-2 | 75710 | 67200 | CIU | natural | S1 | 270.7 | 41 |
| G-SRS-17 and Z-SDF-8 | Z-2 | 75710 | 67200 | CIU | saturated | S1 | 256.7 | 36 |
| G-SRS-17 and Z-SDF-8 | Z-2 | 75710 | 67200 | CIU | natural | S1 | 256.2 | 41 |
| G-SRS-17 and Z-SDF-8 | Z-4 | 75520 | 66585 | CIU | natural | S1 | 273.3 | 41 |
| G-SRS-17 and Z-SDF-8 | Z-4 | 75520 | 66585 | CIU | saturated | S1 | 272.8 | 36 |
| G-SRS-17 and Z-SDF-8 | Z-4 | 75520 | 66585 | CIU | natural | S1 | 263.25 | 41 |
| G-SRS-17 and Z-SDF-8 | Z-4 | 75520 | 66585 | CIU | saturated | S1 | 262.8 | 36 |
| G-SRS-17 and Z-SDF-8 | Z-1 | 76200 | 66975 | UU | natural | S1 | 250.6 | 41 |
| G-SRS-17 and Z-SDF-8 | Z-1 | 76200 | 66975 | UU | natural | S2 | 240.9 | 41 |
| G-SRS-17 and Z-SDF-8 | Z-5 | 78560 | 67120 | UU | natural | S2 | 240.3 | 41 |
| G-SRS-17 and Z-SDF-8 | Z-6 | 78150 | 65850 | UU | natural | S1 | 260.1 | 41 |
| G-SRS-17 and Z-SDF-8 | Z-8 | 77100 | 67450 | UU | natural | S1 | 259.6 | 41 |
| Z-SDF-2 | Z-211U | 75741 | 66805 | CU | natural | S3 | 192 | 42, 43, 44 |
| Z-SDF-2 | Z-218U | 77297 | 67251 | CU | natural | C2 | 214.9 | 42, 43, 44 |
| Z-SDF-2 | Z-224U | 75847 | 67041 | CU | natural | C2 | 221.2 | 42, 43, 44 |
| Z-SDF-2 | Z-224U | 75847 | 67041 | CU | natural | C2 | 217.7 | 42, 43, 44 |
| Z-SDF-2 | Z-225U | 75939 | 67325 | CU | natural | C2 | 216 | 42, 43, 44 |
| Z-SDF-2 | Z-225U | 75939 | 67325 | CU | natural | C2 | 216 | 42, 43, 44 |

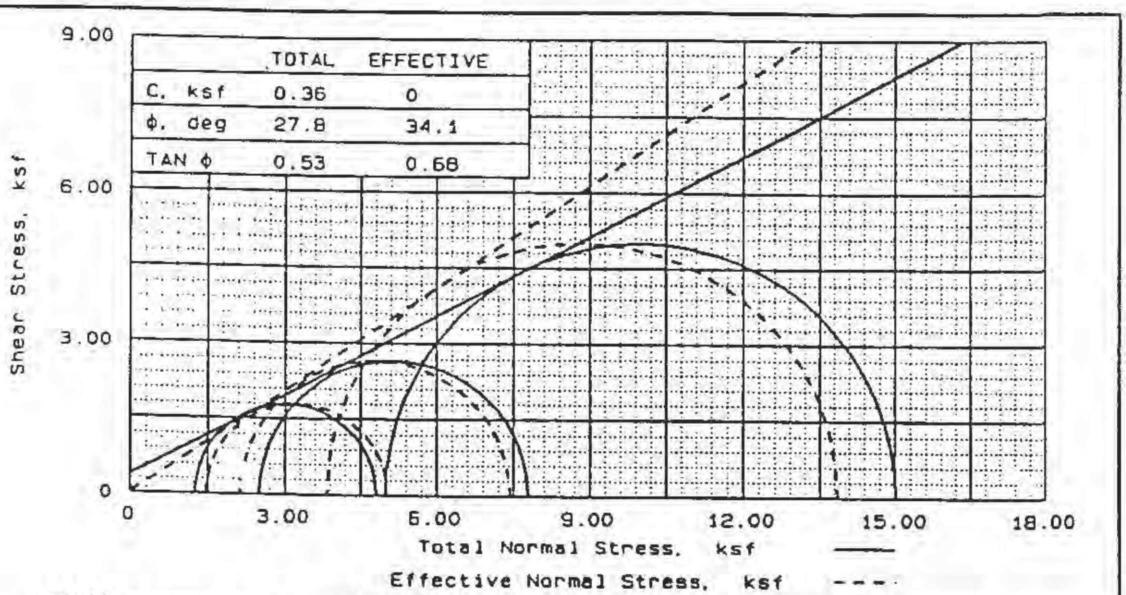
CU – Consolidated Undrained
CIU – Isotropically Consolidated Undrained
UU – Unconsolidated Undrained

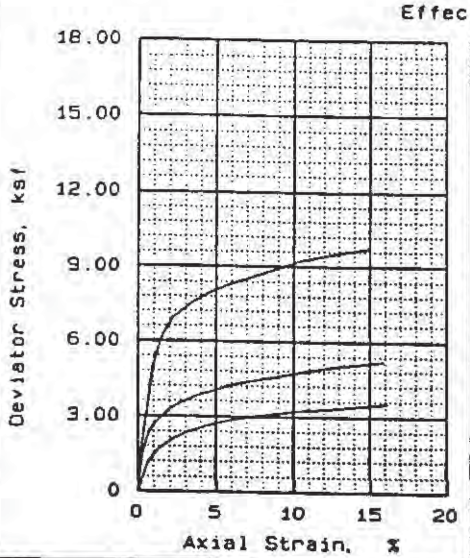
| Calculation No. K-CLC-Z-00002 |
|---|
| Sheet No. 36 |
| Rev. 0 |



| Calculation No. K-CLC-Z-00002 |
|---|
| Sheet No. 37 |
| Rev. 0 |

| | TOTAL | EFFECTIVE |
|---|---|---|
| C, ksf | 0.36 | 0 |
| $\phi$, deg | 27.8 | 34.1 |
| TAN $\phi$ | 0.53 | 0.68 |




| | SAMPLE NO. | 1 | 2 | 3 | |
|---|---|---|---|---|---|
| INITIAL | WATER CONTENT, % | 14.5 | 12.8 | 12.9 | 13.4 |
| | DRY DENSITY, pcf | 109.3 | 107.3 | 105.8 | ~ 107.467 |
| | SATURATION, % | 72.2 | 60.4 | 58.6 | 121.94 |
| | VOID RATIO | 0.543 | 0.571 | 0.593 | [illegible] |
| | DIAMETER, in | 2.87 | 2.87 | 2.86 | |
| | HEIGHT, in | 5.60 | 5.60 | 5.60 | |
| AT TEST | WATER CONTENT, % | 17.4 | 19.8 | 21.2 | |
| | DRY DENSITY, pcf | 114.7 | 109.8 | 107.2 | |
| | SATURATION, % | 100.0 | 100.0 | 100.0 | |
| | VOID RATIO | 0.470 | 0.536 | 0.572 | |
| | DIAMETER, in | 2.81 | 2.84 | 2.85 | |
| | HEIGHT, in | 5.54 | 5.56 | 5.58 | |
| | BACK PRESSURE, ksf | 2.75 | 2.68 | 2.00 | |
| | CELL PRESSURE, ksf | 7.75 | 5.18 | 3.25 | |
| | FAILURE STRESS, ksf | 10.01 | 5.30 | 3.56 | |
| | PORE PRESSURE, ksf | 3.90 | 3.04 | 1.79 | |
| | STRAIN RATE, %/min. | 0.100 | 0.100 | 0.100 | |
| | ULTIMATE STRESS, ksf | | | | |
| | PORE PRESSURE, ksf | | | | |
| | $\bar{\sigma}_1$ FAILURE, ksf | 13.86 | 7.44 | 5.02 | |
| | $\bar{\sigma}_3$ FAILURE, ksf | 3.85 | 2.14 | 1.47 | |

TYPE OF TEST:
CU with pore pressures
SAMPLE TYPE: UNDISTURBED
DESCRIPTION: RED BROWN & PURPLE CLAYEY SILTY MED. TO FN. SAND
LL= PL= PI=
SPECIFIC GRAVITY= 2.70
REMARKS: TESTED BY

REVIEWED BY

FIG. NO. 1

CLIENT: BECHTEL SAVANNAH RIVER, INC.

PROJECT: Z-AREA TASK ORDER 4

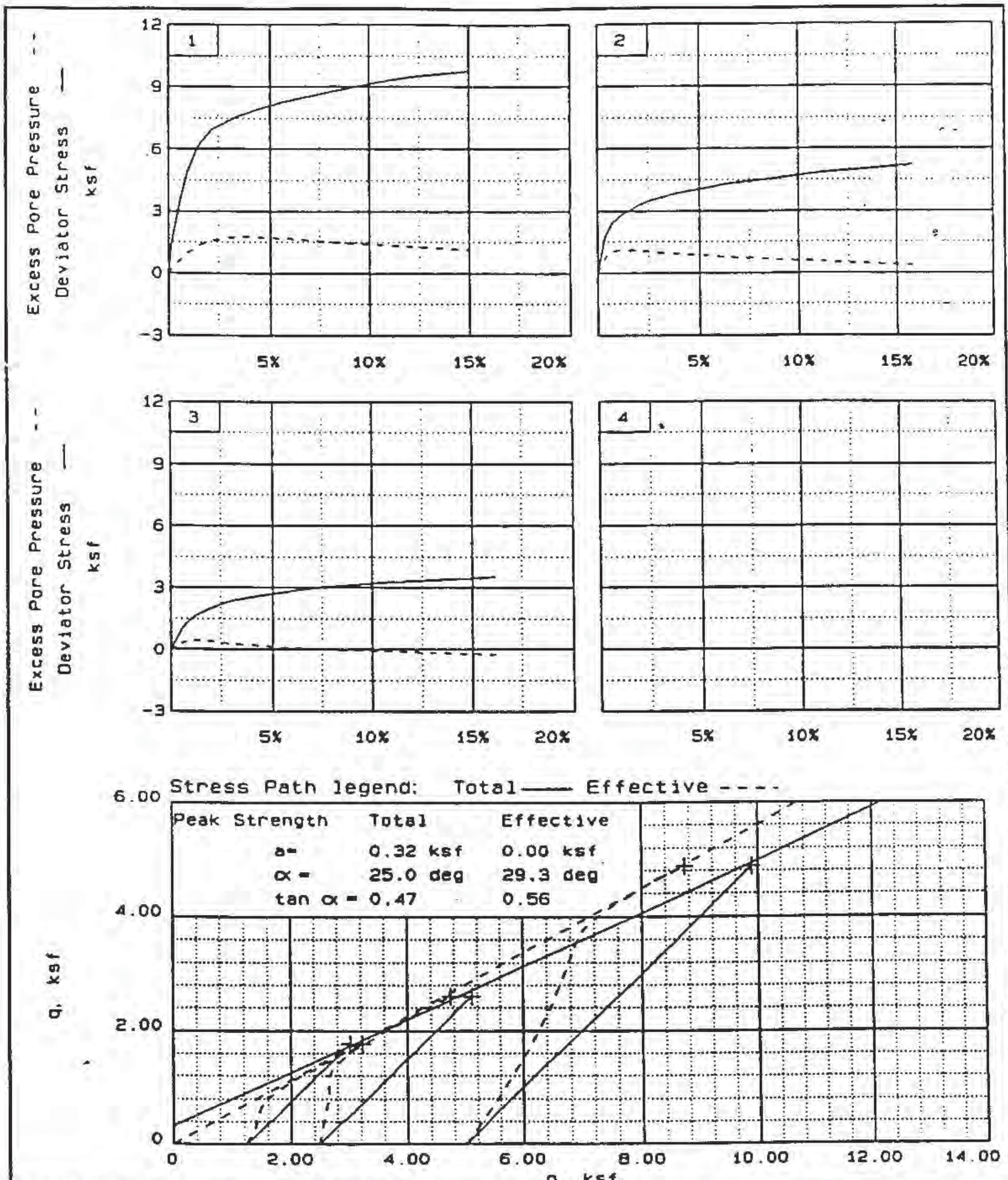
SAMPLE LOCATION: B-2 UD @ 20-22 FT.

PROJ. NO.: 1461010594 DATE: JUNE 12, 1992

TRIAXIAL COMPRESSION TEST

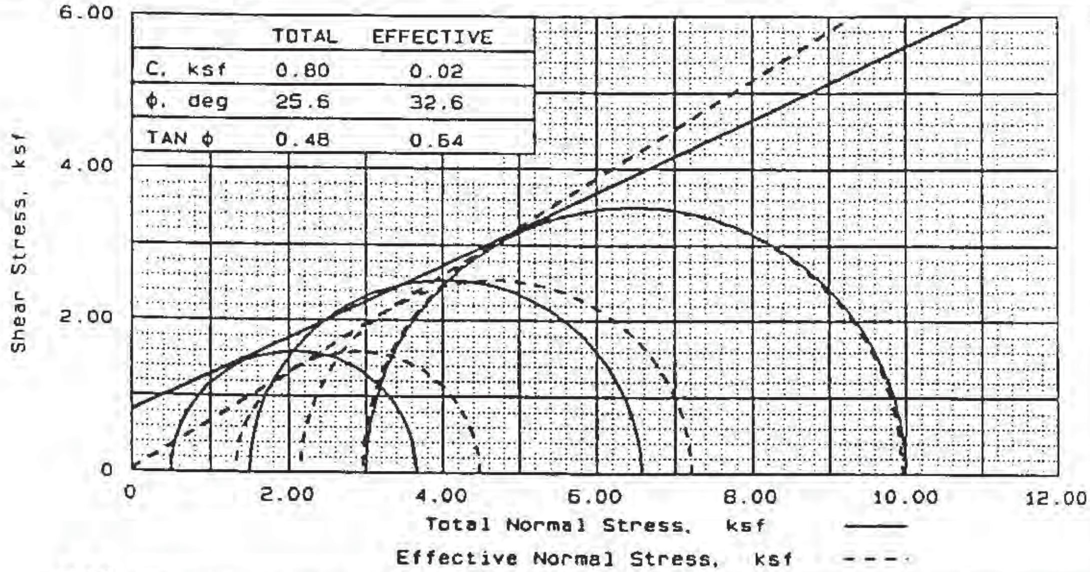
LAW ENGINEERING, INC.

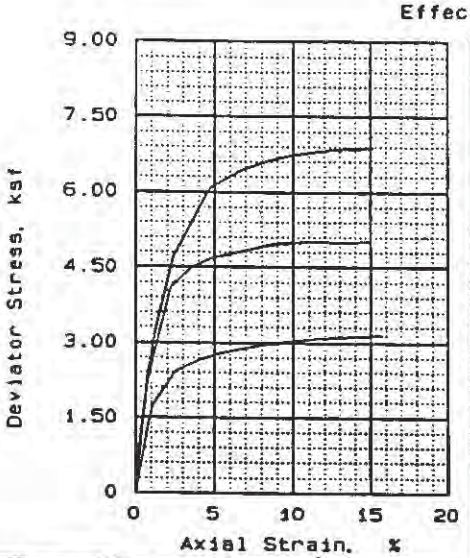
| Calculation No. K-CLC-Z-00002 |
| --- |
| Sheet No. 38 |
| Rev. 0 |




Client: BECHTEL SAVANNAH RIVER, INC.
Project: Z-AREA TASK ORDER 4
Location: B-2 UD @ 20-22 FT.
File: 61010594 Project No.: 1461010594 Page 2/2 Fig. No. 1

| | TOTAL | EFFECTIVE |
|---|---|---|
| C, ksf | 0.80 | 0.02 |
| φ, deg | 25.6 | 32.6 |
| TAN φ | 0.48 | 0.64 |




| SAMPLE NO. | | 1 | 2 | 3 |
|---|---|---|---|---|
| INITIAL | WATER CONTENT, % | 15.7 | 16.6 | 15.0 |
| | DRY DENSITY, pcf | 109.5 | 109.5 | 119.5 |
| | SATURATION, % | 78.5 | 83.2 | 98.9 |
| | VOID RATIO | 0.539 | 0.540 | 0.410 |
| | DIAMETER, in | 2.86 | 2.86 | 2.87 |
| | HEIGHT, in | 5.60 | 5.60 | 5.60 |
| AT TEST | WATER CONTENT, % | 19.5 | 19.2 | 13.8 |
| | DRY DENSITY, pcf | 110.4 | 110.9 | 122.8 |
| | SATURATION, % | 100.0 | 100.0 | 100.0 |
| | VOID RATIO | 0.527 | 0.519 | 0.373 |
| | DIAMETER, in | 2.85 | 2.85 | 2.84 |
| | HEIGHT, in | 5.59 | 5.58 | 5.56 |
| BACK PRESSURE, ksf | | 2.85 | 2.82 | 2.81 |
| CELL PRESSURE, ksf | | 3.35 | 4.32 | 5.81 |
| FAILURE STRESS, ksf | | 3.16 | 5.07 | 6.99 |
| PORE PRESSURE, ksf | | 2.03 | 2.17 | 2.85 |
| STRAIN RATE, %/min. | | 0.100 | 0.100 | 0.100 |
| ULTIMATE STRESS, ksf | | | | |
| PORE PRESSURE, ksf | | | | |
| $\bar{\sigma}_1$ FAILURE, ksf | | 4.48 | 7.22 | 9.94 |
| $\bar{\sigma}_3$ FAILURE, ksf | | 1.32 | 2.15 | 2.96 |

TYPE OF TEST:
CU with pore pressures
SAMPLE TYPE: UNDISTURBED
DESCRIPTION: PURPLE BROWN
CLAYEY SILTY MED. TO FN SAND
LL= PL= PI=
SPECIFIC GRAVITY= 2.70
REMARKS: TESTED BY

REVIEWED BY

FIG. NO. 2

CLIENT: BECHTEL SAVANNAH RIVER, INC.

PROJECT: Z-AREA TASK ORDER 4

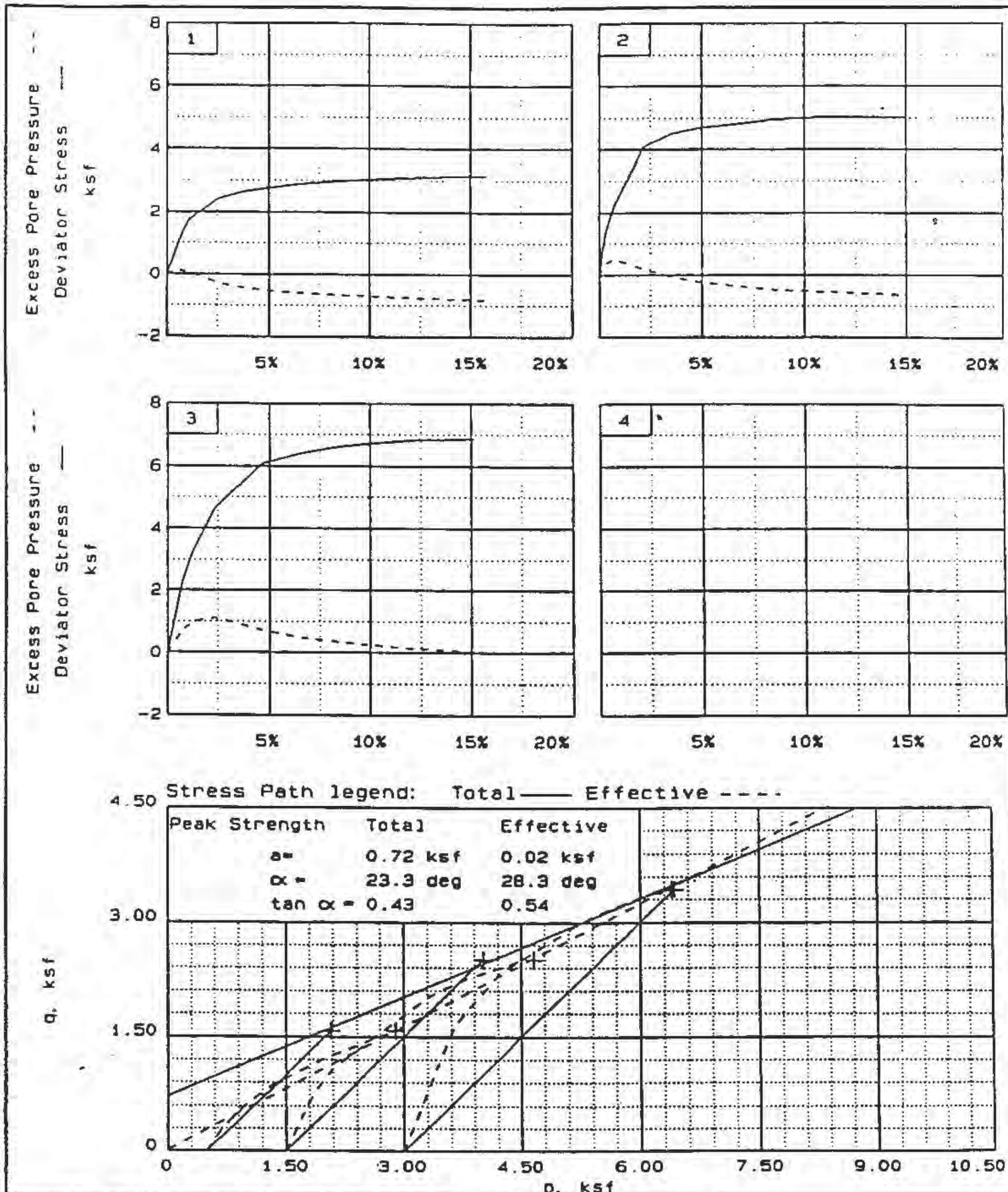
SAMPLE LOCATION: B-8 UD @ 10-12.5 FT.

PROJ. NO.: 1461010594 DATE: JUNE 12, 1992

TRIAXIAL COMPRESSION TEST

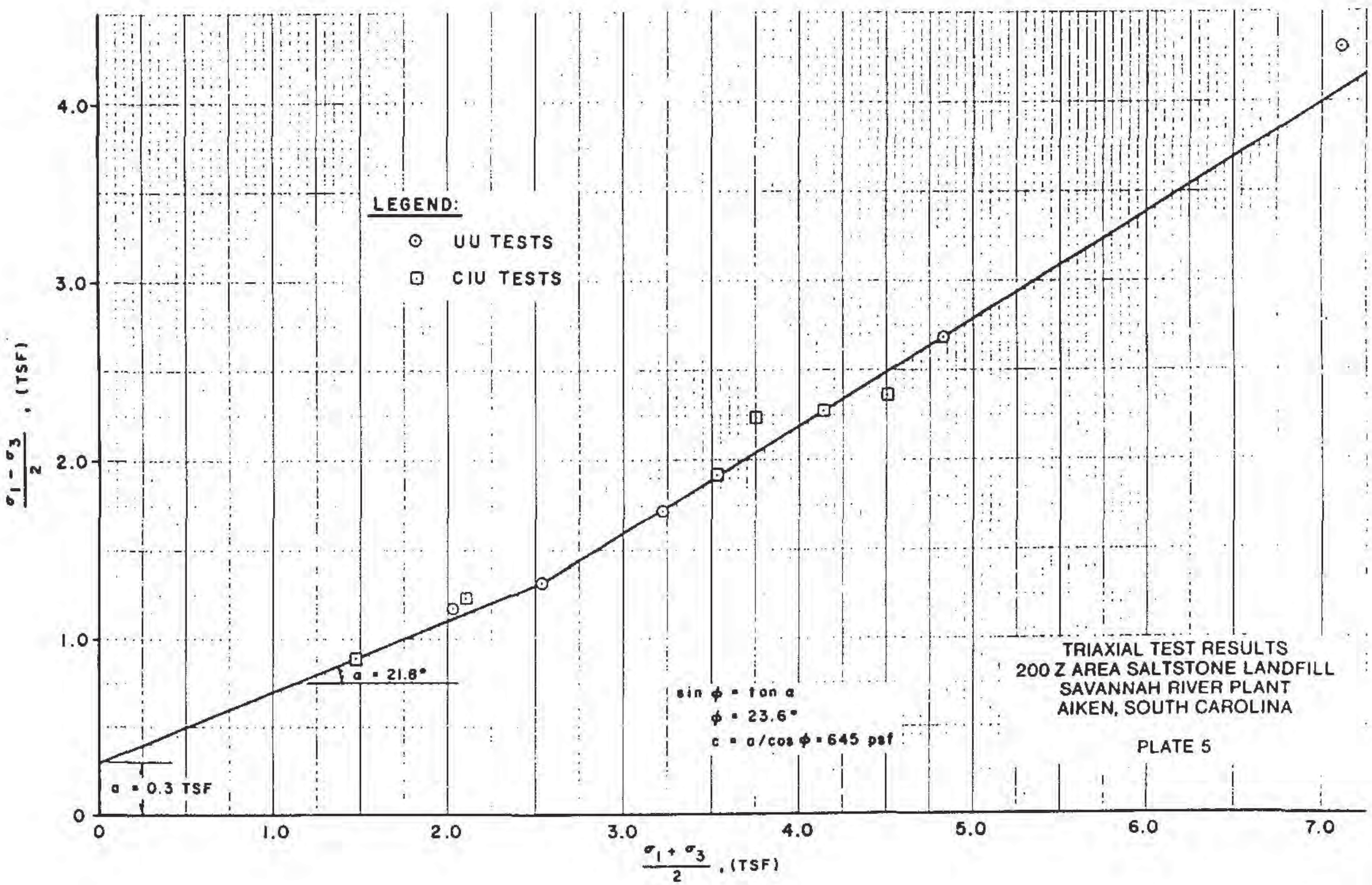
LAW ENGINEERING, INC.

| Calculation No. K-CLC-Z-00002 |
| --- |
| Sheet No. 40 |
| Rev. 0 |

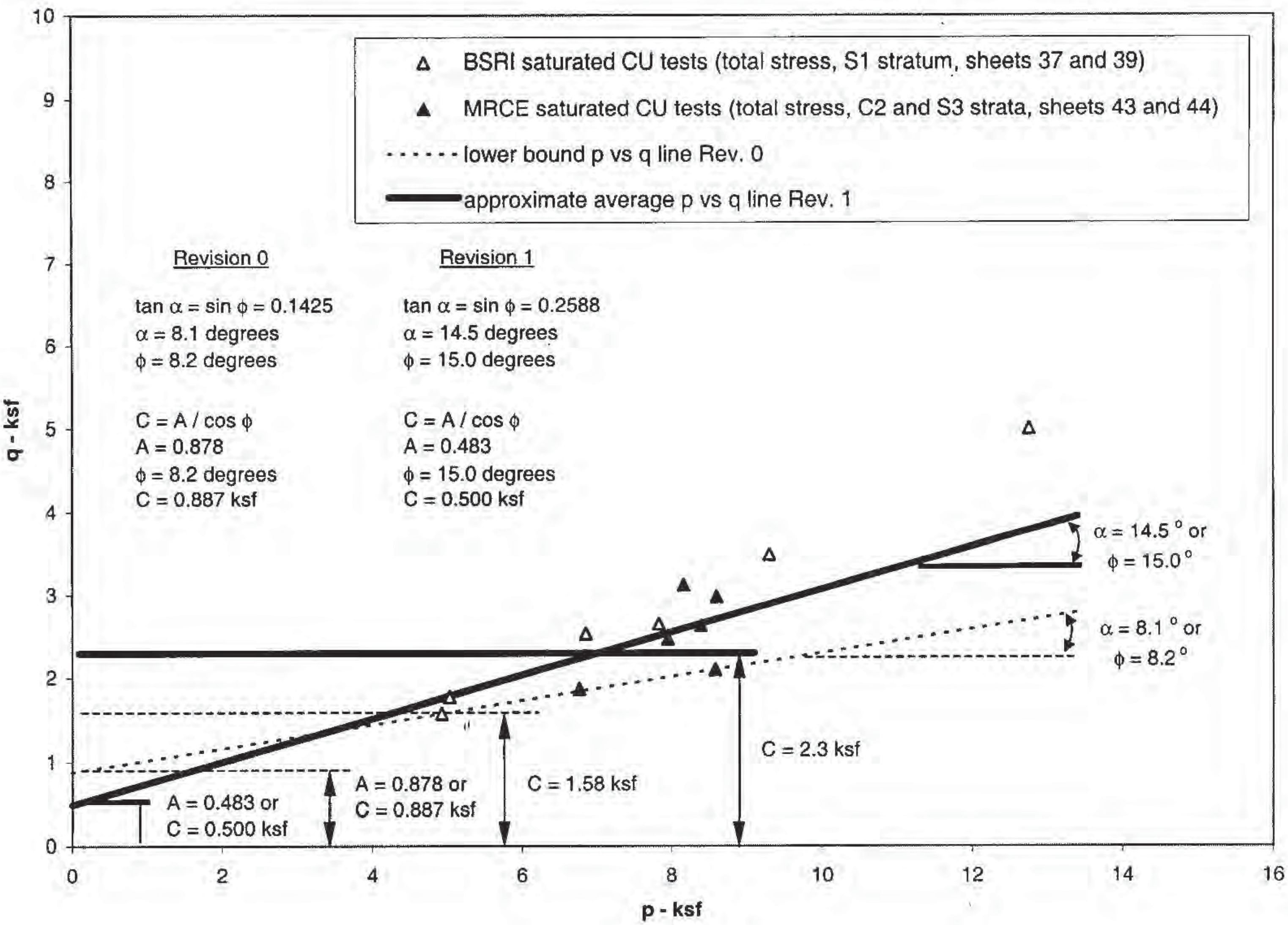



Client: BECHTEL SAVANNAH RIVER, INC.
Project: Z-AREA TASK ORDER 4
Location: B-8 UD @ 10-12.5 FT.
File: 1010594A Project No.: 1461010594 Page 2/2 Fig. No. 2

| Calculation No. K-CLC-Z-00002 |
|---|
| Sheet No. 41 |
| Rev. 0 |



## p vs q plot for Saturated Total Stress Tests



| Calculation No. K-CLC-Z-00002 |
|---|
| Sheet No. 43 |
| Rev. 0 |

# TABLE NO. 1
## SUMMARY OF LABORATORY TEST DATA

| SAMPLE IDENTIFICATION | | | | | CLASSIFICATION PROPERTIES | | | | | | | | PHYSICAL PROPERTIES | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | UNIFIED SOIL CLASSIFICATION SYSTEM | | | STRENGTH | | | | | | CONSOLIDATION | | | | | | |
| BORING NUMBER | SAMPLE NUMBER | ELEVATION, FT. | STRATUM DESIGNATION | SOIL TYPE | AVERAGE NATURAL WATER CONTENT, $w_n$, % | LIQUID LIMIT, $w_L$, % | PLASTICITY INDEX, $I_p$, % | NATURAL WATER CONTENT OF LIMIT SAMPLE, $w_n$, % | SPECIFIC GRAVITY OF SOLIDS, $G_s$ | GROUP SYMBOL | % SAND (<#4 >#200 SIEVE) | % FINES (<#200 SIEVE) | TYPE OF TEST | COMPRESSIVE STRENGTH $(\sigma_1-\sigma_3)$, TSF | CONFINING PRESSURE $\sigma_3$, TSF | STRAIN AT FAILURE, % | NATURAL WATER CONTENT, $w_n$, % | WATER CONTENT AT END OF TEST, $w_f$, % | NATURAL WATER CONTENT, $w_n$, % | INITIAL VOID RATIO, $e_0$ | EXISTING OVERBURDEN STRESS, $P_o$, TSF | ESTIMATED PRECONSOLIDATION STRESS, $P_c$, TSF | COMPRESSION INDEX, $C_c$ | SWELLING INDEX, $C_s$ | VOID RATIO AT START OF SWELL, $e_r$ |
| Z-201U | 18S | 220.3 | C2 | | 31 | 42 | 17 | 29 | | SC | 73 | 27 | | | | | | | | | | | | | |
| | | | | | | | | | | SC | 82 | 18 | | | | | | | | | | | | | |
| PZ-202U | 1UD | 263.8 | S1 | | 19 | 49 | 26 | 19 | | SC&CL | 69 | 31 | | | | | | | | | | | | | |
| | 2UD | 258.8 | S1 | | 16 | 44 | 21 | 17 | | SC | 68 | 32 | | | | | | | | | | | | | |
| | 3UD | 253.8 | S1 | | 16 | 42 | 15 | 16 | | SC | 82 | 18 | | | | | | | | | | | | | |
| PZ-210U | 1UD | 270.6 | S1 | | 17 | 45 | 24 | 18 | | SC | 72 | 28 | | | | | | | | | | | | | |
| | 2UD | 265.6 | S1 | | 17 | 35 | 12 | 17 | | SC | 77 | 23 | | | | | | | | | | | | | |
| | 3U | 258.6 | S1 | | 15 | 49 | 26 | 15 | | SC | 74 | 26 | | | | | | | | | | | | | |
| Z-211U | 25S | 192.0 | S3a | | 53 | 60 | 36 | 47 | 2.77 | SC | | | CU | 2.10 | 3.24 | 3.0 | 52.9 | 46.9 | 56.3 | 1.616 | 4.8 | 2.7 | 0.800 | 0.060 | 0.909 |
| PZ-216U | 1U | 275.0 | S1 | | 13 | 51 | 24 | 14 | | SC | 79 | 21 | | | | | | | | | | | | | |
| | 2U | 270.5 | S1 | | 21 | 31 | 7 | 21 | | SC | 68 | 32 | | | | | | | | | | | | | |
| | 3UD | 265.2 | S1 | | 17 | 38 | 14 | 17 | | SC | 55 | 45 | | | | | | | | | | | | | |
| Z-218U | 18U | 215.1 | C2 | | 69 | 136 | 35 | 108 | | MH | | 98 | CU | 2.63 | 2.88 | 3.1 | 68.5 | 67.6 | | | | | | | |
| | | | S3a | | 46 | | | | | SC | 68 | 32 | | | | | | | | | | | | | |
| Z-219U | 19U | 218.0 | C2 | | 30 | 62 | 43 | 28 | 2.75 | SC&CH | | | | | | | | | 34.3 | 1.017 | 4.6 | 5.3 | 0.429 | 0.063 | 0.516 |
| | | | | | 30 | | | | | SC | 67 | 33 | | | | | | | | | | | | | |
| | 22U | 211.5 | C2 | | 33 | 68 | 47 | 30 | | SC | 87 | 13 | | | | | | | | | | | | | |
| | 23S | 209.5 | S3a | | 28 | 66 | 44 | 28 | | SC | 88 | 12 | | | | | | | | | | | | | |
| Z-220U | 17U | 219.3 | S3b | | 27 | | | | | SP-SC | 91 | 9 | | | | | | | | | | | | | |
| | 18U | 217.8 | S3b | | 30 | | | | | SP-SC | 90 | 10 | | | | | | | | | | | | | |
| | | | | | | 127 | 98 | 104 | | CH | | | | | | | | | | | | | | | |

### SOIL DESCRIPTION

(S1) RED-BROWN AND GRAY CLAYEY FINE TO MEDIUM SAND; TO FINE TO MEDIUM SAND, SOME CLAY OCCASIONALLY INTERLAYERED WITH SANDY CLAY.

(C2) YELLOW-BROWN AND LIGHT GREEN CLAYEY FINE SAND:TO FINE TO MEDIUM SAND, SOME CLAY, INTERLAYERED WITH STIFF YELLOW-BROWN SILTY CLAY, TRACE LIGNITE, OCCASIONAL LAYERS OF LIGHT GRAY-GREEN CALCAREOUS FINE TO MEDIUM SAND, SOME CLAY, CLAY LAYERS, TRACE SHELLS.

(S3a) LIGHT BROWN TO GRAY FINE TO MEDIUM SAND, SOME CLAY, TRACE LIGNITE, OCCASIONAL SANDY CLAY LAYERS.

(S3b) LIGHT BROWN, AND YELLOW-BROWN FINE TO MEDIUM SAND, TRACE CLAY.

### NOTES

1. All tests summarized were performed in the soils laboratory of Mueser Rutledge Consulting Engineers.
2. The sample elevation is the average of the sampling interval.
3. GROUND SURFACE ELEVATIONS AT BORINGS ARE:

| Boring No. | Elevation Ft. | Boring No. | Elevation Ft. |
|---|---|---|---|
| Z-201U | 279.3 | Z-218U | 278.9 |
| PZ-202U | 278.3 | Z-219U | 290.5 |
| PZ-210U | 288.1 | Z-220U | 286.3 |
| Z-211U | 289.5 | Z-224U | 281.2 |
| PZ-216U | 294.5 | Z-225U | 277.0 |

4. "Average natural water content" is a weighted average of all material types recovered.
5. Compression tests performed were: CU - Consolidated Undrained Triaxial Compression.
6. Strength tests were performed on samples approximately 2.8 inches in diameter with a height-to-diameter ratio of 2.
7. Compression Index, $C_c$ = the slope of the virgin curve (straight line portion of the consolidation test e-log p plot).

$$e_2 = e_1 - C_c \times \log (P_2/P_1)$$

8. Swelling Index, $C_s$ = the slope of the rebound curve of the consolidation test...

$$e_2 = e_1 + C_s \times \log (P_1/P_2)$$

MUESER RUTLEDGE CONSULTING ENGINEERS

708 THIRD AVENUE, NEW YORK, N.Y. 10017

SALTSTONE DISPOSAL
SAVANNAH RIVER PLANT - Z AREA
E.I. DUPONT DE NEMOURS & CO., INC.

DATE: 7-14-86 FILE NO. 6329 SHEET 1 OF 2 TABLE NO. 1

# TABLE NO. 1

## SUMMARY OF LABORATORY TEST DATA

| SAMPLE IDENTIFICATION | | | | | CLASSIFICATION PROPERTIES | | | | | | | | PHYSICAL PROPERTIES | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | UNIFIED SOIL CLASSIFICATION SYSTEM | | | STRENGTH | | | | | | CONSOLIDATION | | | | | | |
| BORING NUMBER | SAMPLE NUMBER | ELEVATION, FT. | STRATUM DESIGNATION | SOIL TYPE | AVERAGE NATURAL WATER CONTENT, $w_n$, % | LIQUID LIMIT, $w_L$, % | PLASTICITY INDEX, $I_p$, % | NATURAL WATER CONTENT OF LIMIT SAMPLE, $w_n$, % | SPECIFIC GRAVITY OF SOLIDS, $G_s$ | GROUP SYMBOL | % SAND (< #4 > #200 SIEVE) | % FINES (< #200 SIEVE) | TYPE OF TEST | COMPRESSIVE STRENGTH $(\sigma_1 - \sigma_3)$, TSF | CONFINING PRESSURE $\sigma_3$, TSF | STRAIN AT FAILURE, % | NATURAL WATER CONTENT, $w_n$, % | WATER CONTENT AT END OF TEST, $w_f$, % | NATURAL WATER CONTENT, $w_n$, % | INITIAL VOID RATIO, $e_o$ | EXISTING OVERBURDEN STRESS, $P_o$, TSF | ESTIMATED PRECONSOLIDATION STRESS, $P_c$, TSF | COMPRESSION INDEX, $C_c$ | SWELLING INDEX, $C_s$ | VOID RATIO AT START OF SWELL, $e_r$ |
| Z-224U | 6U | 224.7 | C2 | | 22 | | | | | SC | 81 | 19 | | | | | | | | | | | | | |
| | | | | | 40 | 84 | 38 | 43 | 2.86 | SC | 62 | 38 | | | | | | | 36.7 | 1.213 | 3.6 | 7.5 | 0.476 | 0.032 | 0.678 |
| | 8U | 221.3 | C2 | | 58 | 114 | 84 | 58 | | CH | 34 | 66 | CU | 1.87 | 2.45 | 4.3 | 54.8 | 54.8 | | | | | | | |
| | 10U | 218.2 | C2 | | 80 | 134 | 83 | 63 | | CH | | 81 | CU | 3.12 | 2.52 | 2.6 | 78.8 | 77.9 | | | | | | | |
| | 13U | 213.2 | C2 | | | 62 | 36 | 35 | | CH | | 54 | | | | | | | | | | | | | |
| | | | | | 31 | | | | | *SC | 65 | 35 | | | | | | | | | | | | | |
| | 15U | 210.5 | C2 | | 31 | 104' | 83 | 31 | | SC | 86 | 14 | | | | | | | | | | | | | |
| Z-225U | 4U | 219.5 | S3a | | 31 | 56 | 36 | 29 | | SC | 74 | 26 | | | | | | | | | | | | | |
| | 6U | 216.0 | C2 | | 61 | 131 | 100 | 58 | 2.79 | CH | | 77 | CU | 2.47 | 2.74 | 2.9 | 62.3 | 62.6 | 58.9 | 1.675 | 3.8 | 6.6 | 1.118 | 0.214 | 0.700 |
| | 7U | 214.0 | C2 | | | 94 | 72 | 54 | | CH | | 59 | | | | | | | | | | | | | |
| | | | | | 49 | | | | | SC | 56 | 44 | CU | 2.98 | 2.81 | 4.1 | 43.9 | 43.8 | | | | | | | |

### SOIL DESCRIPTION

(S1) RED-BROWN AND GRAY CLAYEY FINE TO MEDIUM SAND; TO FINE TO MEDIUM SAND, SOME CLAY OCCASIONALLY INTERLAYERED WITH SANDY CLAY.

(C2) YELLOW-BROWN AND LIGHT GREEN CLAYEY FINE SAND;TO FINE TO MEDIUM SAND, SOME CLAY, INTERLAYERED WITH STIFF YELLOW-BROWN SILTY CLAY, TRACE LIGNITE, OCCASIONAL LAYERS OF LIGHT GRAY-GREEN CALCAREOUS FINE TO MEDIUM SAND, SOME CLAY, CLAY LAYERS, TRACE SHELLS.

(S3a) LIGHT BROWN TO GRAY FINE TO MEDIUM SAND, SOME CLAY, TRACE LIGNITE, OCCASIONAL SANDY CLAY LAYERS.

(S3b) LIGHT BROWN, AND YELLOW-BROWN FINE TO MEDIUM SAND, TRACE CLAY.

### NOTES

1. All tests summarized were performed in the soils laboratory of Mueser Rutledge Consulting Engineers.
2. The sample elevation is the average of the sampling interval.
3. GROUND SURFACE ELEVATIONS AT BORINGS ARE:

| Boring No. | Elevation Ft. | Boring No. | Elevation Ft. |
|---|---|---|---|
| Z-201U | 279.3 | Z-218U | 278.9 |
| PZ-202U | 278.3 | Z-219U | 290.5 |
| PZ-210U | 288.1 | Z-220U | 286.3 |
| Z-211U | 289.5 | Z-224U | 281.2 |
| PZ-216U | 294.5 | Z-225U | 277.0 |

4. "Average natural water content" is a weighted average of all material types recovered.
5. Compression tests performed were: CU - Consolidated Undrained Triaxial Compression.
6. Strength tests were performed on samples approximately 2.8 inches in diameter with a height-to-diameter ratio of 2.
7. Compression Index, $C_c$ = the slope of the virgin curve (straight line portion of the consolidation test e-log p plot).

$$e_2 = e_1 - C_c \times \log (P_2/P_1)$$

8. Swelling Index, $C_s$ = the slope of the rebound curve of the consolidation test...

$$e_2 = e_1 + C_s \times \log (P_1/P_2)$$

9. * - Sample showed a positive reaction with HCL.

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708 THIRD AVENUE, NEW YORK, N.Y. 10017

SALTSTONE DISPOSAL
SAVANNAH RIVER PLANT - Z AREA
E. I. DUPONT DE NEMOURS & CO., INC.

## ATTACHMENT 3: SLOPE/W FILES

The five types of files were created and used by SLOPE/W for this calculation.
The **SLP** file contains the data required for the factor of safety calculations (slope dimensions, soil layering, loads, etc.). The **SL2** file contains information relating to the graphical layout or presentation of the problem (e.g. page size and units, engineering units and scale, sketch lines and text). The **FAC** or factor of safety file contains the computed factors of safety for each slip surface. The **FRC** or slice forces file stores the slice forces for the critical slip surface. The **SL3** file contains the current graphical layout information for the contour drawing information.

The file names provide some information about the problem. The first part of the name indicates the seismic force, 17g indicate the peak ground acceleration of 0.17g and 0g indicates no seismic force or the static case (see Section 2.3 Seismic Loading for horizontal and vertical loading combinations). The 200psi indicates compressive strength of the vault grout (see Section 2.1 Slope /Vault Geometry and Design). The last number (1 through 11) is the seismic loading case (see Table 1). The files created for this calculation are listed on sheets 46 and 47. The attached CD contains a copy of the computer files.

## SLOPE/W File Listing

| Date | Time | File Size | File Name |
| --- | --- | --- | --- |
| 7/29/02 | 04:44p | 3,658,435 | 0g-200psi1.fac |
| 7/29/02 | 04:44p | 23,694 | 0g-200psi1.frc |
| 7/29/02 | 04:43p | 2,157 | 0g-200psi1.sl2 |
| 7/29/02 | 04:51p | 2,116 | 0g-200psi1.sl3 |
| 7/29/02 | 04:43p | 4,650 | 0g-200psi1.slp |
| 7/29/02 | 04:52p | 3,658,435 | 17g-200psi2.fac |
| 7/29/02 | 04:52p | 23,694 | 17g-200psi2.frc |
| 7/29/02 | 05:18p | 2,157 | 17g-200psi2.sl2 |
| 7/29/02 | 05:18p | 2,116 | 17g-200psi2.sl3 |
| 7/29/02 | 05:18p | 4,650 | 17g-200psi2.slp |
| 7/29/02 | 05:20p | 3,658,435 | 17g-200psi3.fac |
| 7/29/02 | 05:20p | 23,694 | 17g-200psi3.frc |
| 7/29/02 | 05:20p | 2,157 | 17g-200psi3.sl2 |
| 7/29/02 | 05:22p | 2,116 | 17g-200psi3.sl3 |
| 7/29/02 | 05:20p | 4,650 | 17g-200psi3.slp |
| 7/29/02 | 05:24p | 3,658,435 | 17g-200psi4.fac |
| 7/29/02 | 05:24p | 23,694 | 17g-200psi4.frc |
| 7/29/02 | 05:24p | 2,157 | 17g-200psi4.sl2 |
| 7/29/02 | 05:26p | 2,116 | 17g-200psi4.sl3 |
| 7/29/02 | 05:24p | 4,650 | 17g-200psi4.slp |
| 7/29/02 | 05:27p | 3,658,435 | 17g-200psi5.fac |
| 7/29/02 | 05:27p | 23,694 | 17g-200psi5.frc |
| 7/29/02 | 05:27p | 2,157 | 17g-200psi5.sl2 |
| 7/29/02 | 05:32p | 2,116 | 17g-200psi5.sl3 |
| 7/29/02 | 05:27p | 4,650 | 17g-200psi5.slp |
| 7/29/02 | 05:33p | 3,658,435 | 17g-200psi6.fac |
| 7/29/02 | 05:33p | 23,694 | 17g-200psi6.frc |
| 7/29/02 | 05:33p | 2,157 | 17g-200psi6.sl2 |
| 7/29/02 | 05:35p | 2,116 | 17g-200psi6.sl3 |
| 7/29/02 | 05:33p | 4,650 | 17g-200psi6.slp |
| 7/30/02 | 01:12p | 16,164 | 17g-200psi6a.fac |
| 7/30/02 | 01:12p | 23,694 | 17g-200psi6a.frc |
| 7/30/02 | 01:12p | 2,157 | 17g-200psi6a.sl2 |
| 7/30/02 | 01:13p | 2,116 | 17g-200psi6a.sl3 |
| 7/30/02 | 01:12p | 4,650 | 17g-200psi6a.slp |
| 7/30/02 | 01:16p | 16,164 | 17g-200psi6b.fac |
| 7/30/02 | 01:16p | 22,995 | 17g-200psi6b.frc |
| 7/30/02 | 01:15p | 2,157 | 17g-200psi6b.sl2 |
| 7/30/02 | 11:57a | 2,116 | 17g-200psi6b.sl3 |
| 7/30/02 | 01:15p | 4,650 | 17g-200psi6b.slp |
| 7/30/02 | 01:19p | 16,164 | 17g-200psi6c.fac |
| 7/30/02 | 01:19p | 22,296 | 17g-200psi6c.frc |
| 7/30/02 | 01:19p | 2,157 | 17g-200psi6c.sl2 |
| 7/30/02 | 01:20p | 2,116 | 17g-200psi6c.sl3 |
| 7/30/02 | 01:19p | 4,650 | 17g-200psi6c.slp |

| Date | Time | File Size | File Name |
| --- | --- | --- | --- |
| 7/29/02 | 05:36p | 3,658,435 | 17g-200psi7.fac |
| 7/29/02 | 05:36p | 23,694 | 17g-200psi7.frc |
| 7/29/02 | 05:36p | 2,157 | 17g-200psi7.sl2 |
| 7/29/02 | 05:48p | 2,116 | 17g-200psi7.sl3 |
| 7/29/02 | 05:36p | 4,650 | 17g-200psi7.slp |
| 7/29/02 | 05:50p | 3,658,435 | 17g-200psi8.fac |
| 7/29/02 | 05:50p | 23,694 | 17g-200psi8.frc |
| 7/29/02 | 05:50p | 2,157 | 17g-200psi8.sl2 |
| 7/29/02 | 05:52p | 2,116 | 17g-200psi8.sl3 |
| 7/29/02 | 05:50p | 4,650 | 17g-200psi8.slp |
| 7/30/02 | 08:51a | 478,827 | 17g-200psi9.fac |
| 7/30/02 | 08:51a | 23,694 | 17g-200psi9.frc |
| 7/30/02 | 08:50a | 2,157 | 17g-200psi9.sl2 |
| 7/30/02 | 08:56a | 2,116 | 17g-200psi9.sl3 |
| 7/30/02 | 08:50a | 4,684 | 17g-200psi9.slp |
| 8/6/02 | 04:34p | 3,658,435 | 17g-200psi10.fac |
| 8/6/02 | 04:34p | 23,694 | 17g-200psi10.frc |
| 8/6/02 | 04:34p | 2,157 | 17g-200psi10.sl2 |
| 8/6/02 | 04:36p | 2,116 | 17g-200psi10.sl3 |
| 8/6/02 | 04:34p | 4,650 | 17g-200psi10.slp |
| 8/6/02 | 04:38p | 3,658,435 | 17g-200psi11.fac |
| 8/6/02 | 04:38p | 23,694 | 17g-200psi11.frc |
| 8/6/02 | 04:38p | 2,157 | 17g-200psi11.sl2 |
| 8/6/02 | 04:39p | 2,116 | 17g-200psi11.sl3 |
| 8/6/02 | 04:38p | 4,650 | 17g-200psi11.slp |

## Additional SLOPE/W File Listing for Revision 1

| Date | Time | File Size | File Name |
| --- | --- | --- | --- |
| 3/21/2003 | 01:53p | 7,459,075 | case10a.fac |
| 3/21/2003 | 01:53p | 22,995 | case10a.frc |
| 3/21/2003 | 01:55p | 3,071 | case10a.sl2 |
| 3/21/2003 | 01:55p | 3,030 | case10a.sl3 |
| 3/21/2003 | 01:55p | 5,380 | case10a.slp |
| 3/21/2003 | 01:56p | 7,459,075 | case10b.fac |
| 3/21/2003 | 01:56p | 22,995 | case10b.frc |
| 3/21/2003 | 01:58p | 3,071 | case10b.sl2 |
| 3/21/2003 | 01:58p | 3,030 | case10b.sl3 |
| 3/21/2003 | 01:58p | 5,380 | case10b.slp |
| 3/21/2003 | 01:33p | 7,459,075 | case11a.fac |
| 3/21/2003 | 01:33p | 23,694 | case11a.frc |
| 3/21/2003 | 01:35p | 3,071 | case11a.sl2 |
| 3/21/2003 | 01:34p | 3,030 | case11a.sl3 |
| 3/21/2003 | 01:35p | 5,380 | case11a.slp |
| 3/21/2003 | 01:29p | 7,459,075 | case11b.fac |
| 3/21/2003 | 01:29p | 23,694 | case11b.frc |
| 3/21/2003 | 01:31p | 3,071 | case11b.sl2 |
| 3/21/2003 | 01:31p | 3,030 | case11b.sl3 |
| 3/21/2003 | 01:31p | 5,380 | case11b.slp |

WSRC-TR-2003-00145
Revision 0

KEY WORDS:
Z Area
Cover System
Soils

# ADDITIONAL SLOPE STABILITY ANALYSES FOR SALTSTONE DISPOSAL FACILITY (U)

**March 31, 2003**

**Westinghouse Savannah River Company**
**Savannah River Technology Center**
**Savannah River Site**
**Aiken, SC 29808**

**Prepared for the U.S. Department of Energy under Contract No. DE-AC09-96SR18500**

**DISCLAIMER**

**This report was prepared by Westinghouse Savannah River Company, LLC (WSRC) for the United States Department of Energy under Contract No. DE-AC09-96SR18500 and is an account of work performed under that contract. Reference herein to any specific commercial product, process, or service by trademark, name, manufacturer, or otherwise does not necessarily constitute or imply endorsement, recommendation, or favoring of same by WSRC or by the United States Government or any agency thereof.**

**Printed in the United States of America**
**Prepared for**
**U. S. Department of Energy**
**and**
**Westinghouse Savannah River Company, LLC**
**Aiken, South Carolina**

## Seismic Contour Map

The SCDHEC requested a map showing the seismic contours from Algermissen et al., (1982) along with the Savannah River Site (SRS) and the location of the Saltstone Vaults (Z-Area). To make this map the Algermissen et al. seismic contours were digitized and superimposed on a map showing the SRS and Z-Area. Plates 1 and 2 show the resulting map at different scales. As shown on the Plates, the 0.20g peak ground acceleration (PGA) contour runs directly through Z-Area (see Plates 1 and 2). Thus, based on recommendations from SCDHEC to utilize the Algermissen et al. map, the PGA for Z-Area should be 0.20g rather than 0.21g. However, the analysis given below addresses both PGA values.

## Additional Slope Stability Analysis

At the request of SCDHEC additional slope stability analysis was performed using the computer program STABL for Windows, version 2.0. The runs are similar to those run previously and submitted to the State, but with some refinements to the soil model and some modifications made at the request of SCDHEC. Many of the details of these additional analyses are the same as the previous work (e.g. vault and slope geometry, water table, etc.) and therefore are not repeated in this short report. Additional details not provided here may be found in Section 3 of the original report "Saltstone Landfill Design Equivalency Demonstration," (SRS, 2002a).

The computer program STABL and the previously used program (SLOPE/W) both simulate the effects of seismic loads due to an earthquake with pseudo-static body forces. Both programs have common analysis methods. Spencer's method, which considers both moment and force equilibrium, was used for work submitted previously and the analysis reported herein. However, the two programs use different methods for input of trial failure surfaces.

At the request of SCDHEC, analysis was performed for a horizontal PGA of 0.21g. Additional analysis was performed for PGA of 0.20g, based on the Algermissen et al. map discussed above. Horizontal seismic coefficients ($K_h$) of 0.20 and 0.21 were used (i.e., the full PGA). No vertical seismic coefficients ($K_v$) were used for the additional work.

At the request of SCDHEC, the soil model was extended to include the soil beyond the vault allowing a failure beneath and past the vault structure. For the additional work the "total stress" cases (i.e., case 10 and 11 from the original work) were re-evaluated because they result in the lowest Factor of Safety. The "total stress" or "undrained" condition is conservative and assumes significant generation of pore pressure and associated strength loss during seismic loading.

Figures 1a and 1b show the case 10 and case 11 soil models used for the previous work. Figures 2a and 2b show the extended models used for the additional work. Note that for the extended soil models (Figures 2a and 2b) soil strengths are aligned with the soil stratum as opposed to assigning all soil beneath the water table one strength. Also note that the soil strength for deeper soils has been increased representing average strength as opposed to conservative lower bound strength (Recall, SCDHEC had indicated that our strength values were very conservative and had suggested an increase). Strength test data are presented in Attachment 2 of the previous work (SRS, 2002b).

Results of the additional analyses are presented in Table 1. Comparable Factors of Safety are obtained when the analysis is repeated using SLOPE/W (SRS, 2003). Figures 3 through 6 contain the plots of the additional slope stability runs using STABL. In all cases the static and seismic safety factors are acceptable. Additional details of the analysis can be obtained from computer files listed in Table 2 and copied on the accompanying disk.

**Table 1 - Slope Stability Factor of Safety**
**Computed Using STABL for Windows and Total Stress Shear Strengths**

| | Soil Strength Condition | Soil Strength 1 | Vault Strength 2 | Horizontal Seismic Coefficient ($k_h$) | Vertical Seismic Coefficient ($k_v$) | Factor of Safety |
|---|---|---|---|---|---|---|
| Case 10 extended | total stress | Figure 2a | $\phi = 33°$ & c = 20 psf | 0.20 | 0 | 1.3 |
| Case 10 extended | total stress | Figure 2a | $\phi = 33°$ & c = 20 psf | 0.21 | 0 | 1.3 |
| Case 11 extended | total stress | Figure 2b | $\phi = 0°$ & c = 4000 psf | 0.20 | 0 | 1.2 |
| Case 11 extended | total stress | Figure 2b | $\phi = 0°$ & c = 4000 psf | 0.21 | 0 | 1.2 |

1 Shear strengths of the soil layers are shown on the referenced Figure.

2 Shear strength of the vault was modeled both as a weak grout ($\phi = 0°$ & c = 4000 psf) and as engineered fill ($\phi = 33°$ & c = 20 psf). Results reported here are those that produced the lowest factor of safety.

**Table 2 – Listing of Files for Slope Stability Analysis Using STABL for Windows**

| Date | Time | File Size | File Name |
|---|---|---|---|
| 3/18/2003 | 09:49a | 1,619 | CASE10a.in |
| 3/18/2003 | 09:49a | 35,206 | case10a.out |
| 3/18/2003 | 09:51a | 1,619 | CASE10b.in |
| 3/18/2003 | 09:52a | 35,593 | case10b.out |
| 3/18/2003 | 09:55a | 1,619 | CASE11a.in |
| 3/18/2003 | 09:59a | 39,342 | case11a.out |
| 3/18/2003 | 09:59a | 1,619 | CASE11b.in |
| 3/18/2003 | 10:01a | 39,342 | case11b.out |

Two types of files were created and used by STABL for Windows. Input files have an ".in" extension and output files have an ".out" extension.

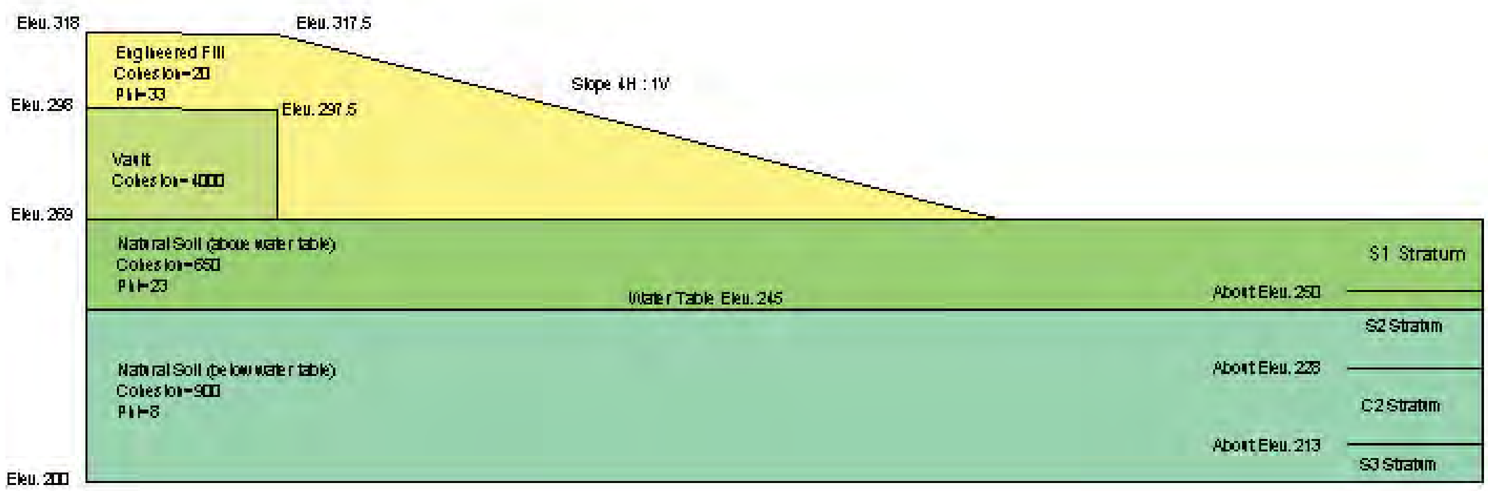



**Figure 1a - Vault and Closure Cover Soil Model Used for Original Case 10 (SRS, 2002b)**

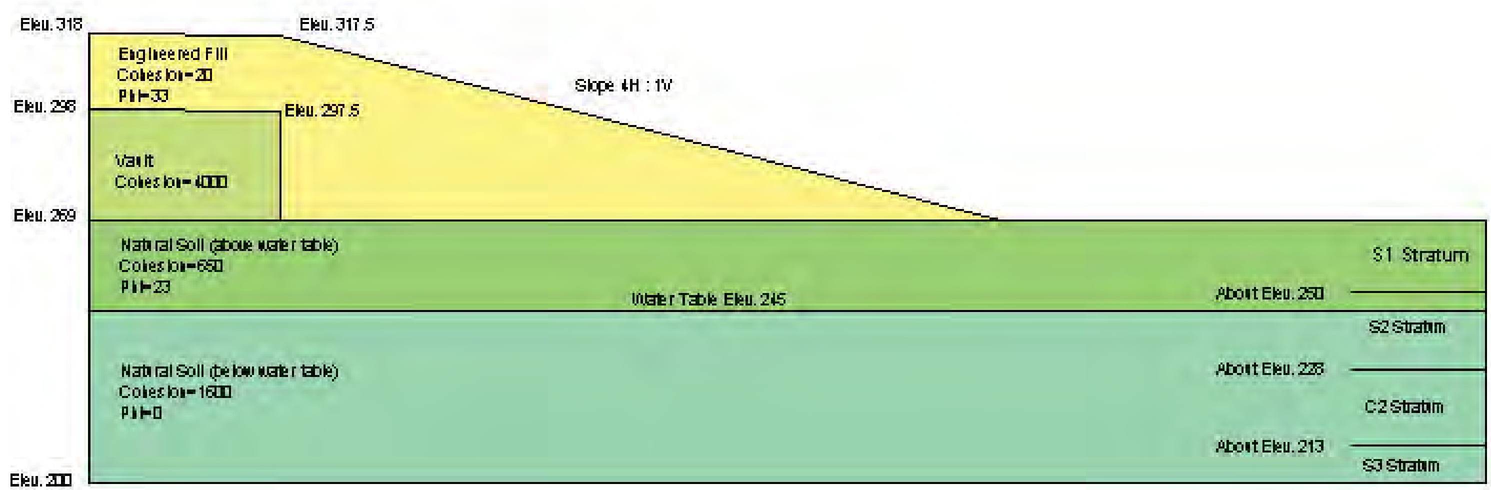



**Figure 1b - Vault and Closure Cover Soil Model Used for Original Case 11 (SRS, 2002b)**

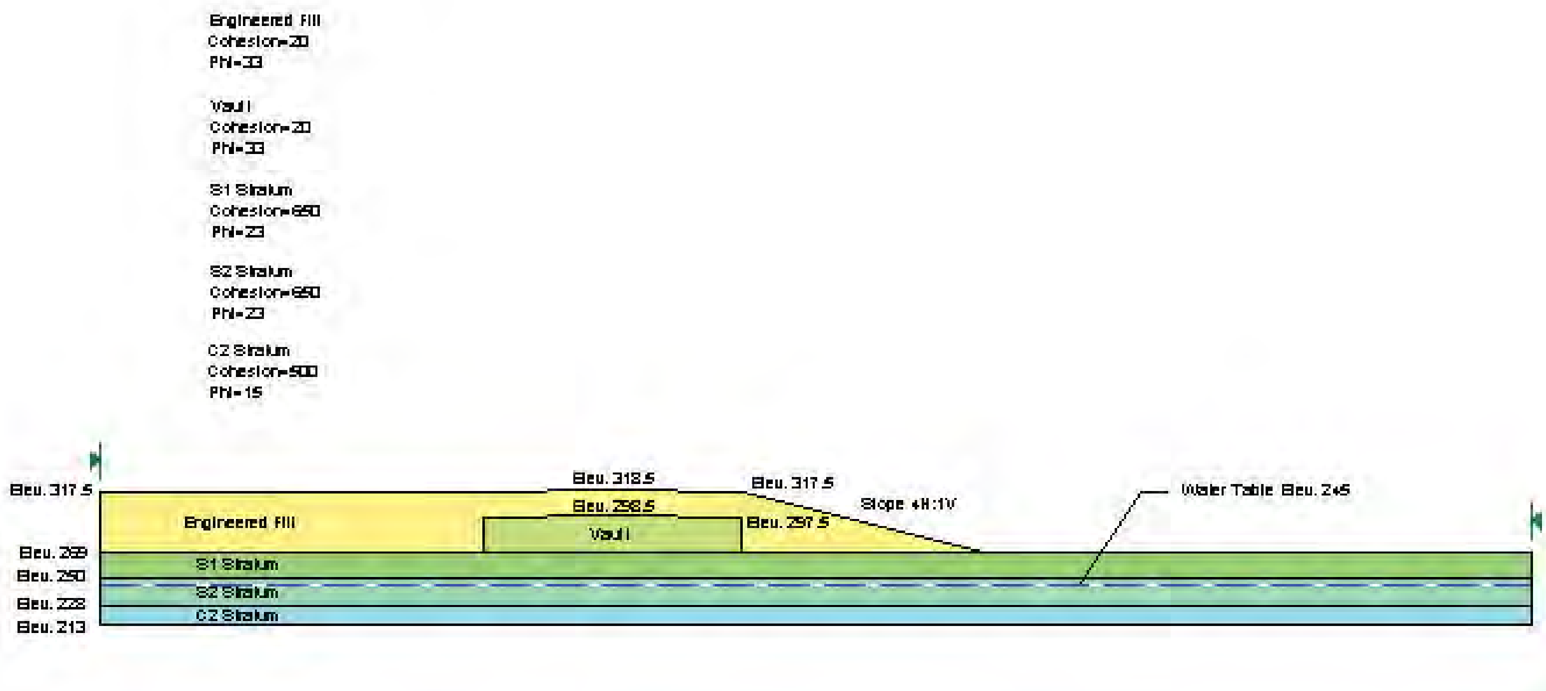



**Figure 2a - Vault and Closure Cover Soil Model Used for Case 10 Extended (SRS, 2003)**

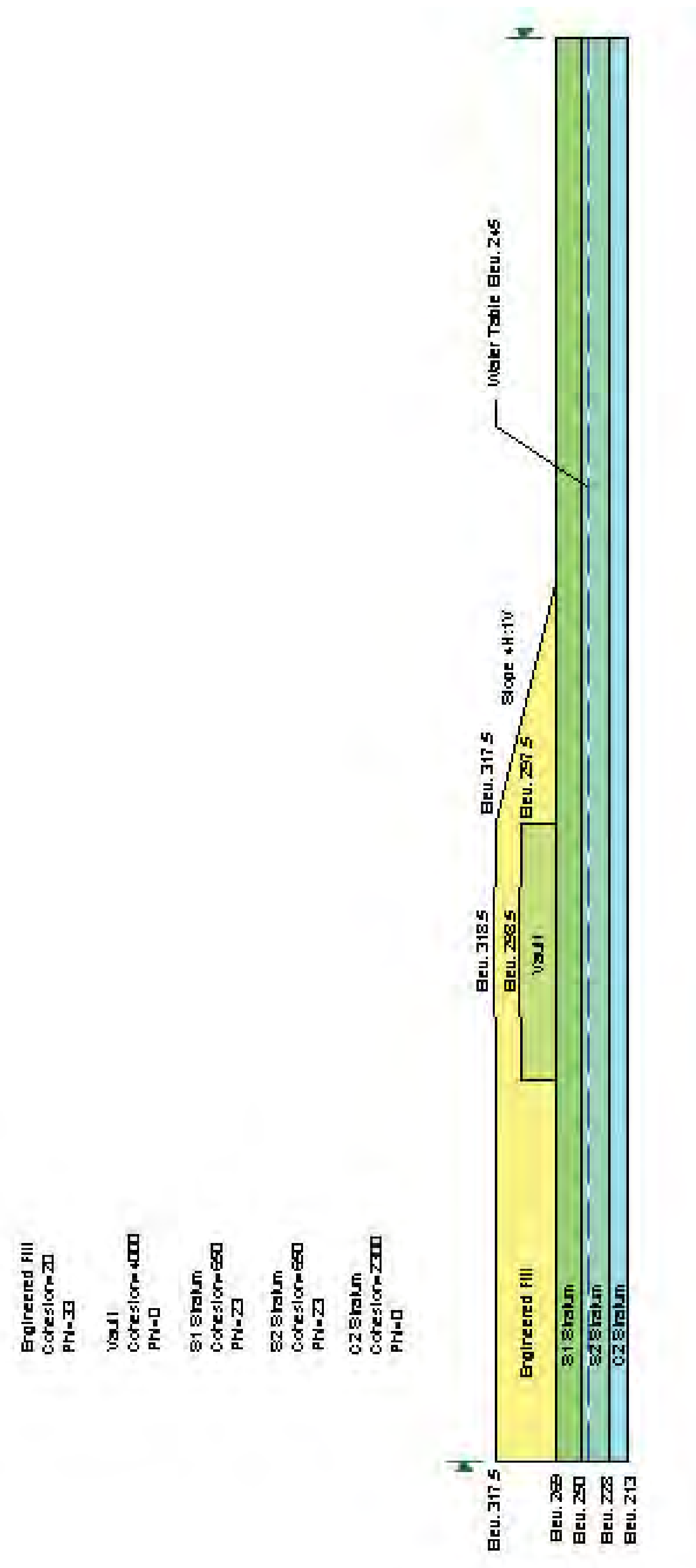



**Figure 2b - Vault and Closure Cover Soil Model Used for Case 11 Extended (SRS, 2003)**

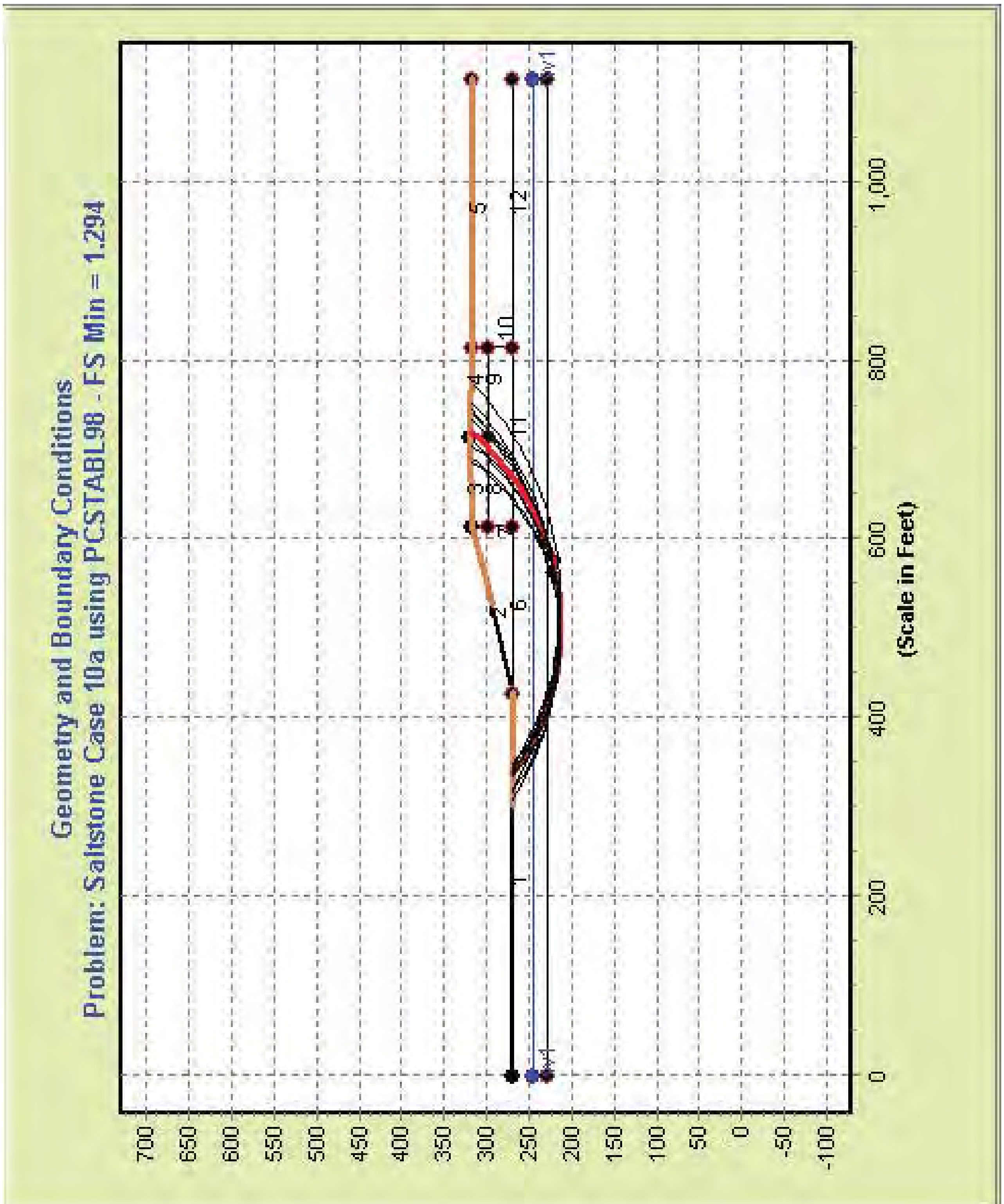



**Figure 3 – Factor of Safety and Failure Surfaces Calculated Using STABL for Case 10 $k_h$=0.20 and $k_v$=0**

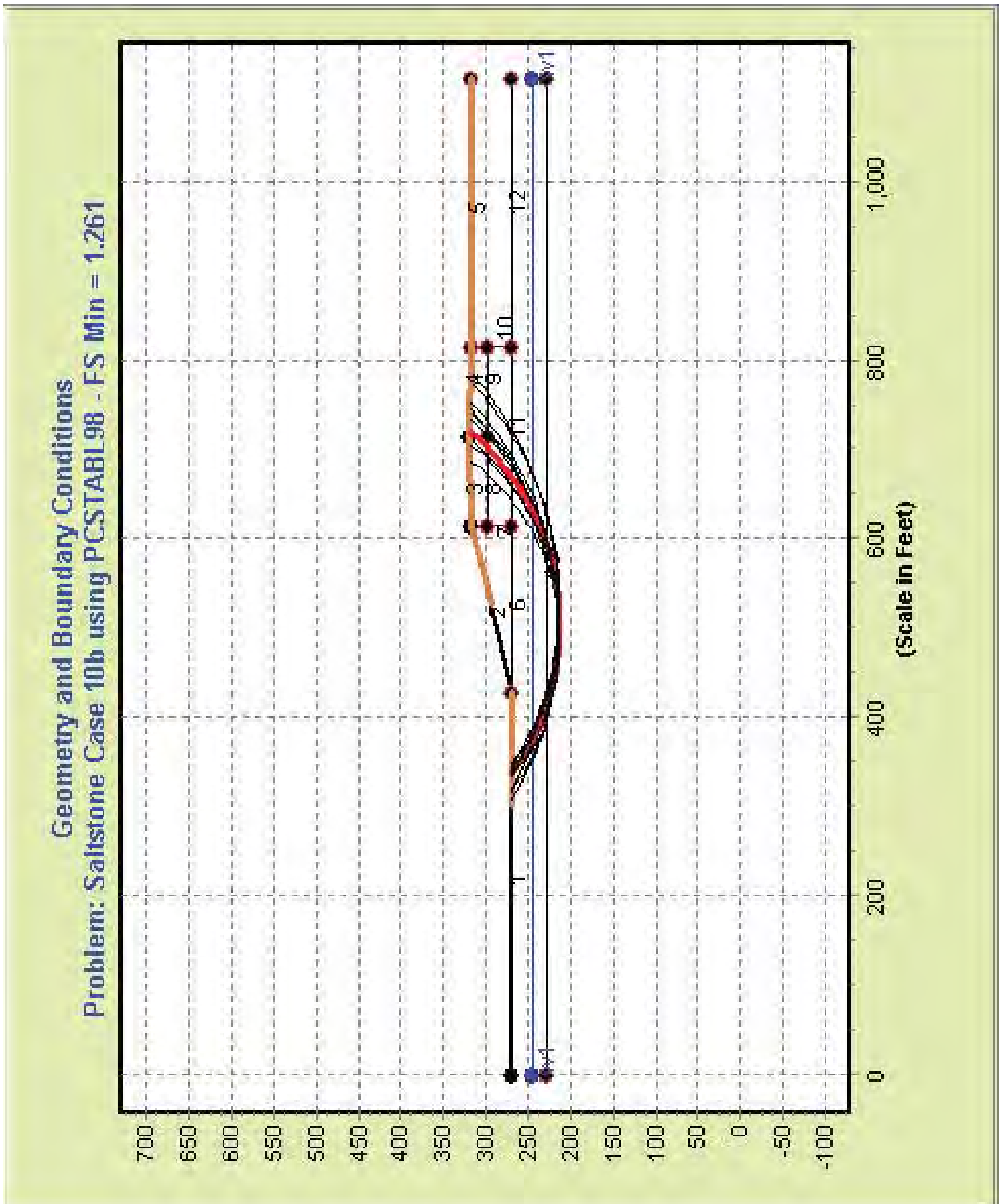



**Figure 4 – Factor of Safety and Failure Surfaces Calculated Using STABL for Case 10 $k_h$=0.21 and $k_v$=0**

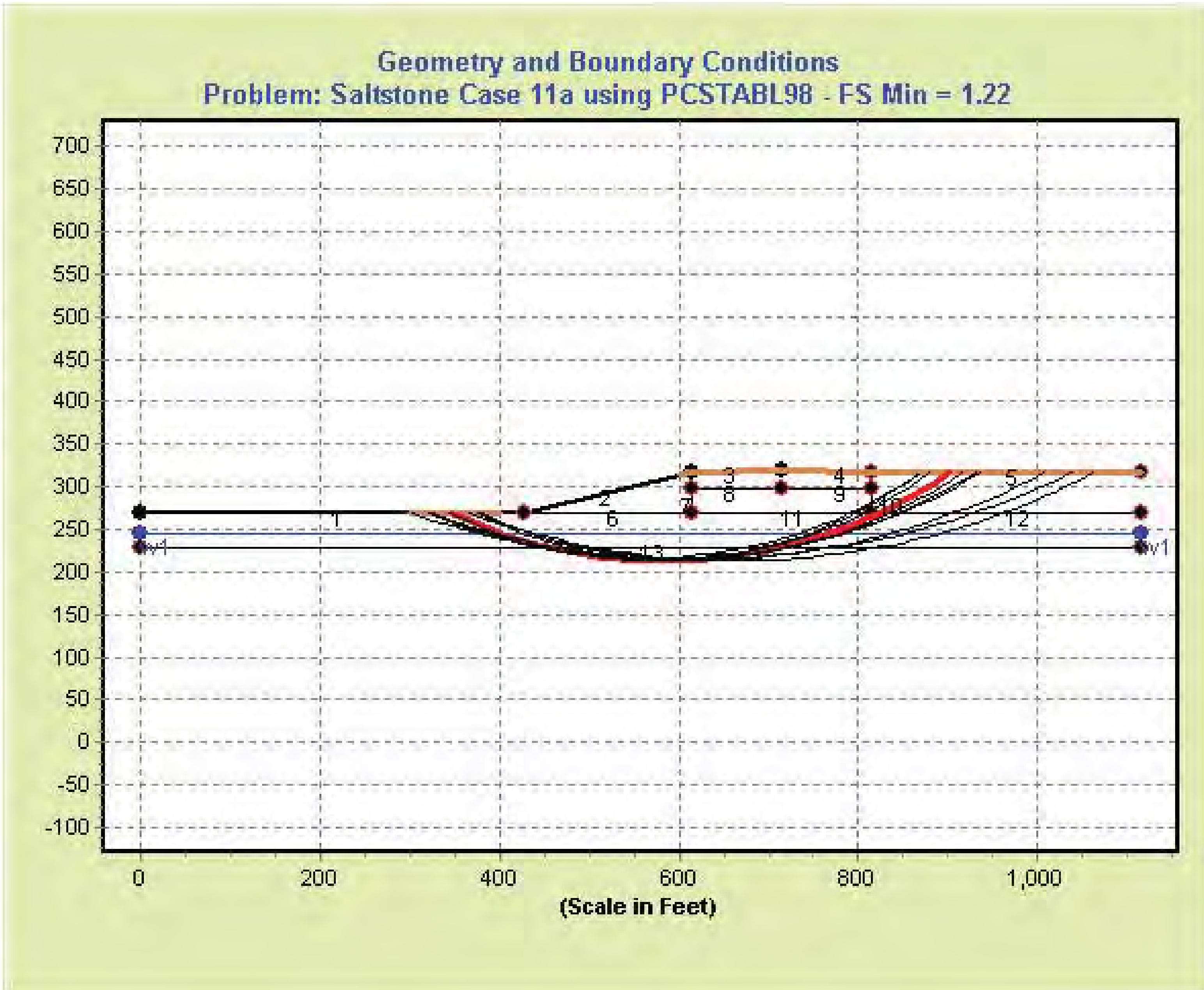



**Figure 5 – Factor of Safety and Failure Surfaces Calculated Using STABL for Case 11 $k_h$=0.20 and $k_v$=0**

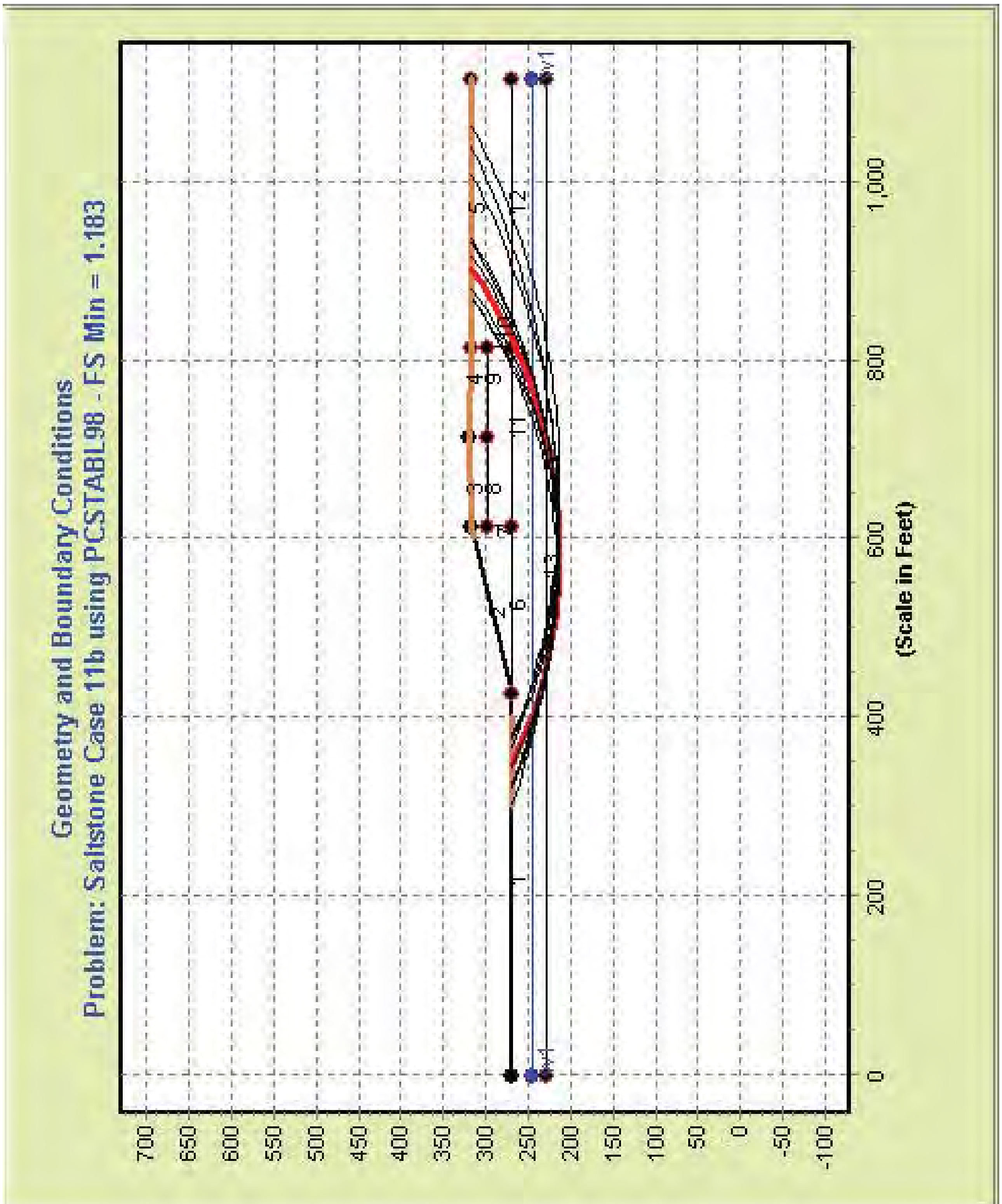



**Figure 6 – Factor of Safety and Failure Surfaces Calculated Using STABL for Case 11 $k_h$=0.21 and $k_v$=0**

## References:

Algermissen, S. T., Perkins, D. M., Thenhaus, P. C., Hanson, S. L., Bender, B. L., 1982. *Probabilistic Estimates of Maximum Acceleration and Velocity in Rock in the Contiguous United States*, U. S. Geologic Survey, Open File Report 82-1033.

SRS, 2002a. *Saltstone Landfill Design Equivalency Demonstration (U)*, Report No. WSRC-TR-2002-00236, Revision 0, August 30, 2002.

SRS, 2002b. *Slope Stability for the Saltstone Disposal Facility (U)*, Calculation No. K-CLC-Z-00002, Revision 0, August 21, 2002.

SRS, 2003. *Slope Stability for Saltstone Disposal Facility (U)*, Calculation No. K-CLC-Z-00002, Revision 1, March 31, 2003.

**Reference :**

Seismic Contours derived from
"MAP C - HORIZONTAL ACCELERATION
( 90 PERCENT PROABILITY OF NOT BEING EXCEEDED IN 250 YEARS )"
Algermissen, S.T. ,Perkins, D.M. ,Thenhaus, P.C. ,Hanson, S.L. ,Bender, B.L. , 1982
"Probabilistic Estimates of Maximum Acceleration and
Velocity in Rock in the Contiguous United States,
U.S. Geological Survey, Open File Report 83-1033.

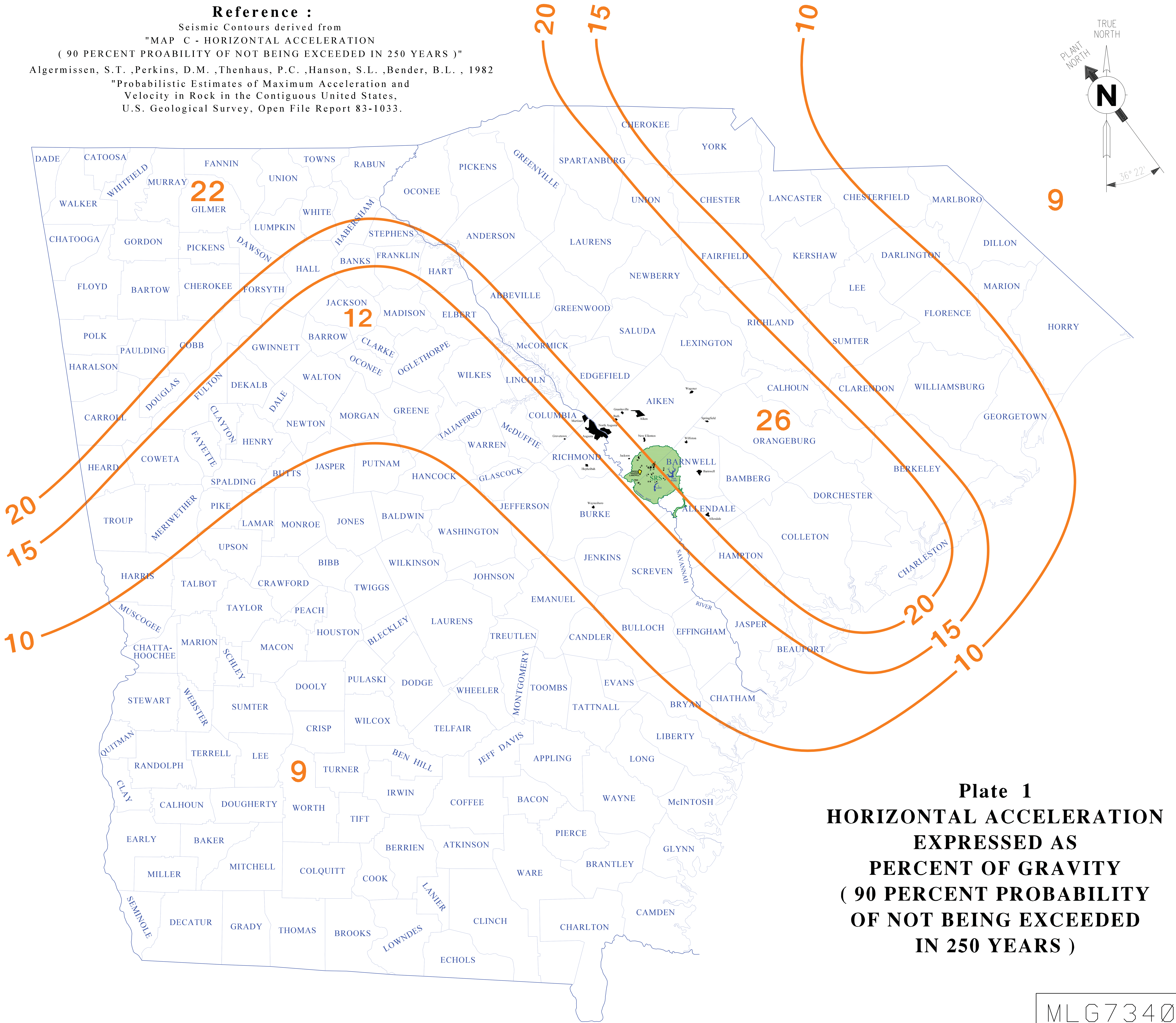
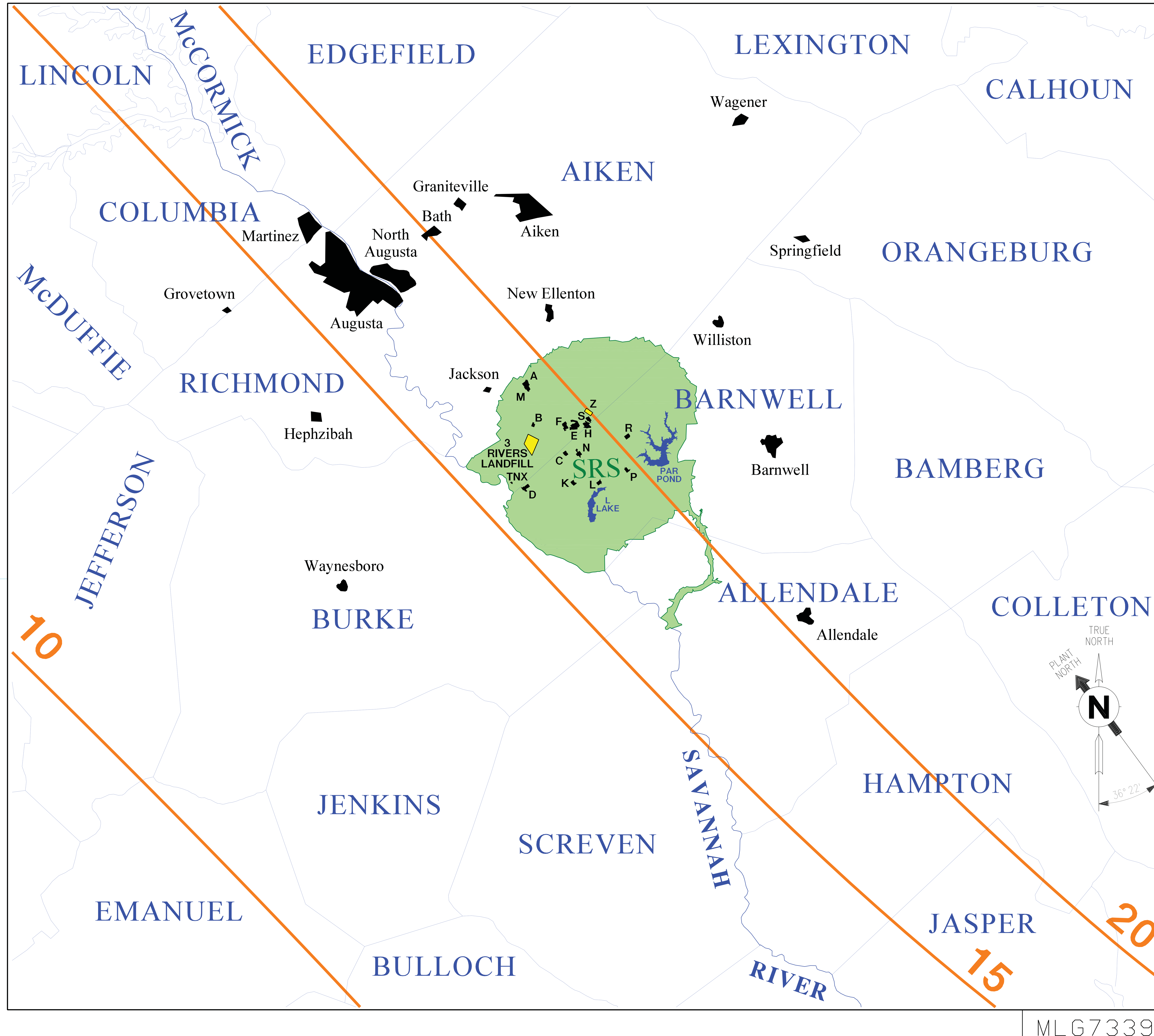



**Plate 1**
**HORIZONTAL ACCELERATION**
**EXPRESSED AS**
**PERCENT OF GRAVITY**
**( 90 PERCENT PROBABILITY**
**OF NOT BEING EXCEEDED**
**IN 250 YEARS )**

MLG734Ø




**Reference :**
Seismic Contours derived from
"MAP C - HORIZONTAL ACCELERATION
( 90 PERCENT PROBABILITY OF NOT BEING EXCEEDED IN 250 YEARS )"
Algermissen, S.T. ,Perkins, D.M. ,Thenhaus, P.C. ,Hanson, S.L. ,Bender, B.L. , 1982
"Probabilistic Estimates of Maximum Acceleration and Velocity in Rock in the Contiguous United States,
U.S. Geological Survey, Open File Report 83-1033.

**Plate 2**
**HORIZONTAL ACCELERATION EXPRESSED AS PERCENT GRAVITY ( 90 PERCENT PROBABILITY OF NOT BEING EXCEEDED IN 250 YEARS )**

**Appendix G – Laboratory Data**

AMEC Environment and Infastructure

February 2012

Saltstone Disposal Unit 6 Test Report

(218 pages)

February 9, 2012

Savannah River Nuclear Solutions
Bldg. 730-1B Room 2117
Aiken, SC 29808

Attention: Mr. Bill Joyce, STR

Subject: **Test Report – Saltstone Disposal Unit 6**
**Subcontract No. AC54317N, Delivery Order No. 28**
**Specification K-SPC-G-00013, Rev. 13**
**AMEC Project No. 6155-08-0031**

Dear Mr. Joyce:

AMEC Environment & Infrastructure (AMEC) has completed the assigned testing services for Delivery Order No. 28, Subcontract No. AC54317N. The test results are included in Attachment 1. An equipment list used in this Delivery Order is included in Attachment 2. The tests performed in this Delivery Order are listed below along with applicable ASTM or other procedures:

| | |
|---|---|
| Atterberg Limits | ASTM D4318 |
| Consolidation | ASTM D2435 |
| Unit Weight and Moisture Content | TP-4 |
| CU Triaxial Shear | ASTM D4767 |
| Sieve Analysis | ASTM D422 |
| Hydrometer & Sieve Analysis | ASTM D422 |
| Natural Moisture Content | ASTM D2216 |
| Permeability | ASTM D5084 |
| Tube Logging | TP06 |

These tests were performed in accordance with the above referenced contract order and AMEC's Quality Assurance Manual (QAM) Revision 1.

We appreciate the opportunity of serving your geotechnical laboratory testing needs. If you have questions, please contact us.

Sincerely,

AMEC

Jianren Wang
Principal

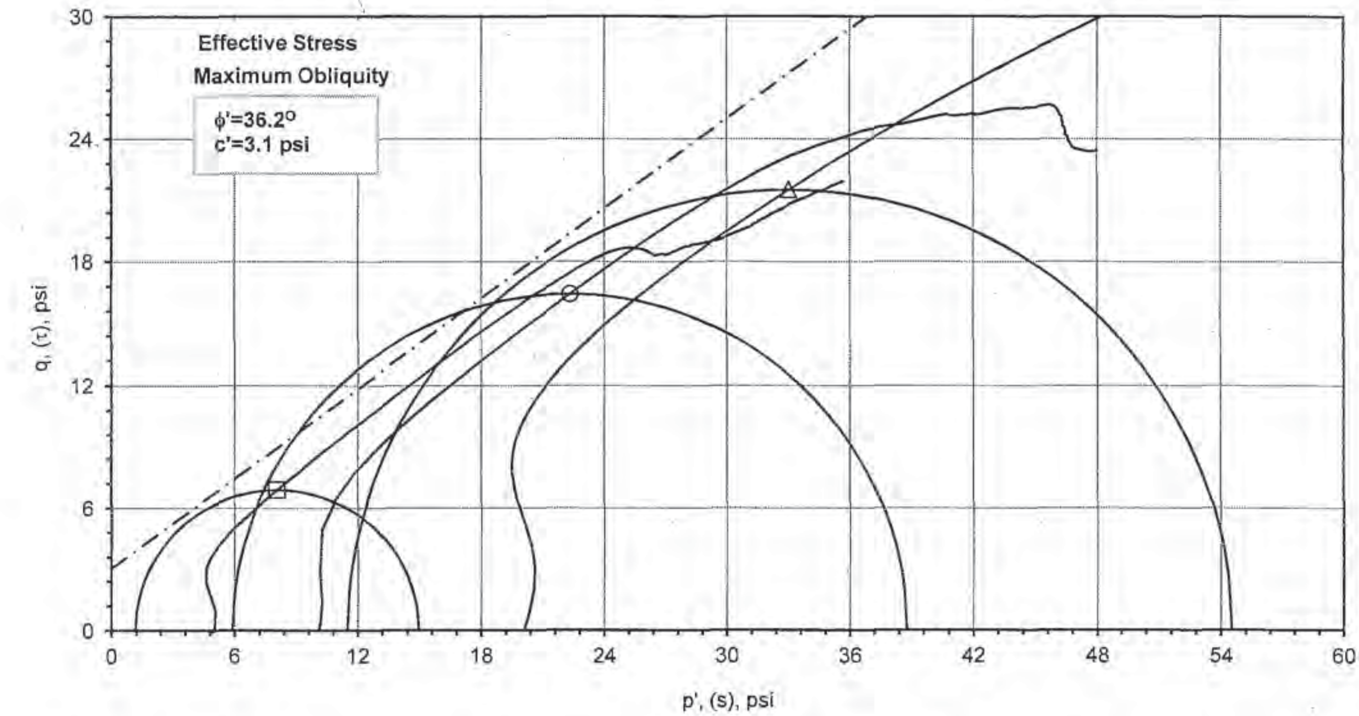
John Lynch
Principal

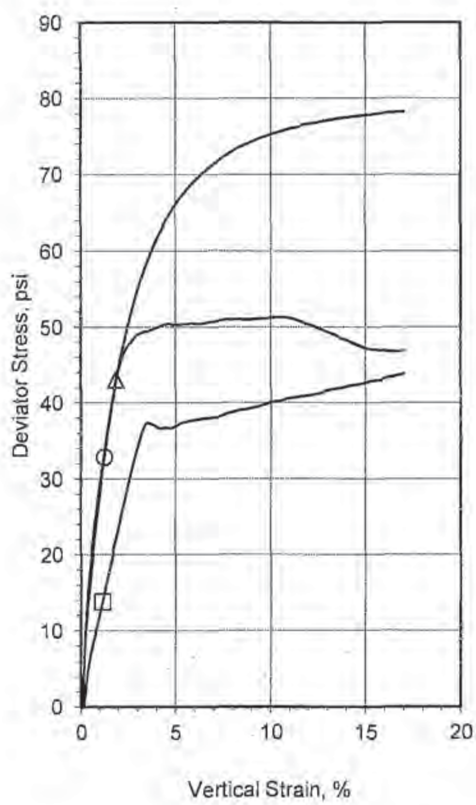
Cc: SRNS
Vendor Documents
Building 704-IN/Room 137
Aiken, SC 29808

**AMEC Environment & Infrastructure**
396 Plasters Avenue, NE • Atlanta, GA 30324 • Phone: 404-873-4761 • Fax: 404-817-0221
AMEC.com

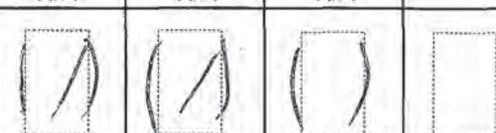
# ATTACHMENT 1

# Consolidated Undrained Triaxial Shear Test Report




| Symbols | | □ | ○ | △ | ◇ |
|---|---|---|---|---|---|
| Boring No. | | Z-SDU6-B01 | Z-SDU6-B01 | Z-SDU6-B01 | |
| Sample No. | | FP01 | FP01 | FP01 | |
| Test No. | | 11247.1 | 11247.2 | 11247.3 | |
| Depth | | 22-24 ft | 22-24 ft | 22-24 ft | |
| Initial | Diameter, in | 2.878 | 2.885 | 2.868 | |
| | Height, in | 5.974 | 5.968 | 5.971 | |
| | Water Content, % | 32.9 | 33.8 | 21.4 | |
| | Dry Density, pcf | 87.0 | 86.5 | 104.7 | |
| | Degree of Saturation, % | 94.9 | 96.4 | 94.8 | |
| | Void Ratio | 0.94 | 0.95 | 0.61 | |
| Before Shear | Water Content, % | 34.6 | 35.2 | 22.3 | |
| | Dry Density, pcf | 87.1 | 86.4 | 105.2 | |
| | Degree of Saturation, % | 100.0 | 100.0 | 100.0 | |
| | Void Ratio | 0.93 | 0.95 | 0.60 | |
| | Back Pressure, psi | 130.0 | 130.0 | 120.0 | |
| | B Value | 0.97 | 1.00 | 1.00 | |
| Effective Confining Pressure, psi | | 4.9 | 10.1 | 20.1 | |
| Shear Strength, psi | | 6.9 | 16.4 | 21.5 | |
| Strain at Failure, % | | 1.1 | 1.2 | 1.9 | |
| Strain Rate, %/min | | 0.05 | 0.05 | 0.05 | |
| Estimated Gs | | 2.7 | 2.7 | 2.7 | |
| Liquid Limit | | N/A | N/A | N/A | |
| Plastic Limit | | N/A | N/A | N/A | |

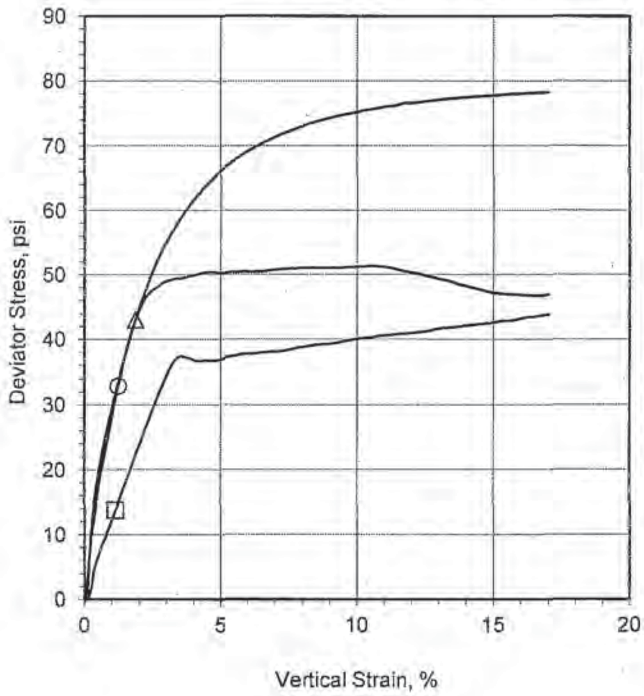


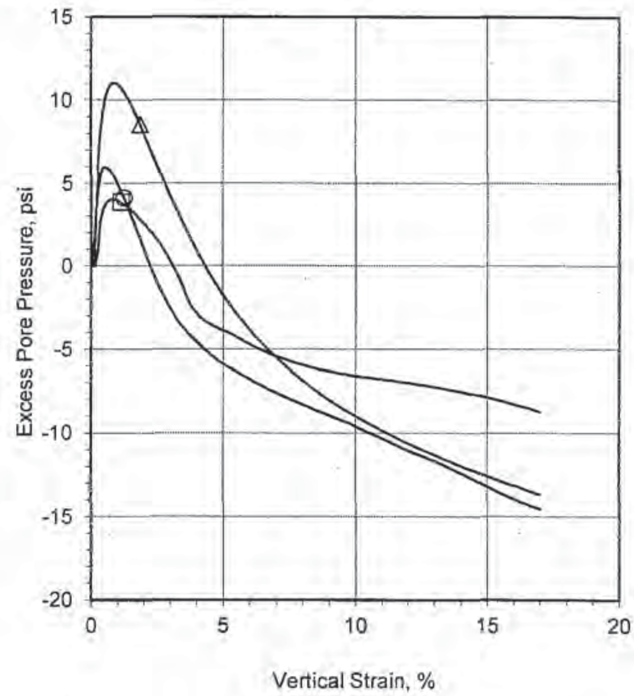
amec

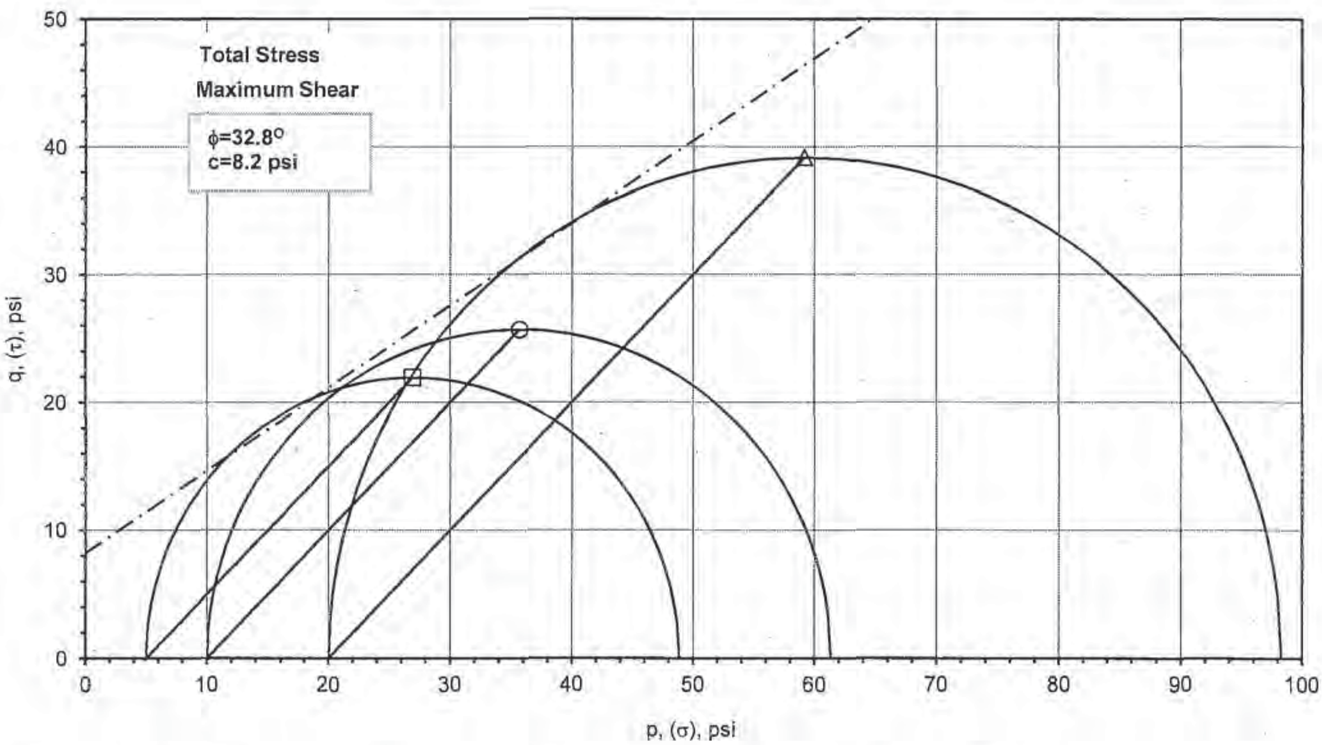
| | |
|---|---|
| Project: | Saltstone Disposal Unit 6 |
| Project No.: | 6155-08-0031.28 |
| Location: | Z-SDU6-B01 |
| Sample Type: | Undisturbed |
| Description: | Reddish Brown Sandy Silt |
| Remarks: | |

**Test Procedure: ASTM D4767-04**

# Consolidated Undrained Triaxial Shear Test Report




| Symbol | Boring No. | Sample No. | Test No. | Depth | Tested By | Test Date | Reviewed By | Reviewe Date |
|---|---|---|---|---|---|---|---|---|
| □ | Z-SDU6-B01 | FP01 | 11247.1 | 22-24 ft | JW | 12/29/2011 | JEL | 2/13/2012 |
| ○ | Z-SDU6-B01 | FP01 | 11247.2 | 22-24 ft | JW | 12/29/2011 | JEL | 2/13/2012 |
| △ | Z-SDU6-B01 | FP01 | 11247.3 | 22-24 ft | JW | 12/29/2011 | JEL | 2/13/2012 |
| ◇ | | | | | | | | |

| | | |
|---|---|---|
| Project: | Saltstone Disposal Unit 6 | Location: |
| Project No.: | 6155-08-0031.28 | Sample Type: Undisturbed |
| Description: | Reddish Brown Sandy Silt | |
| Remarks: | | |

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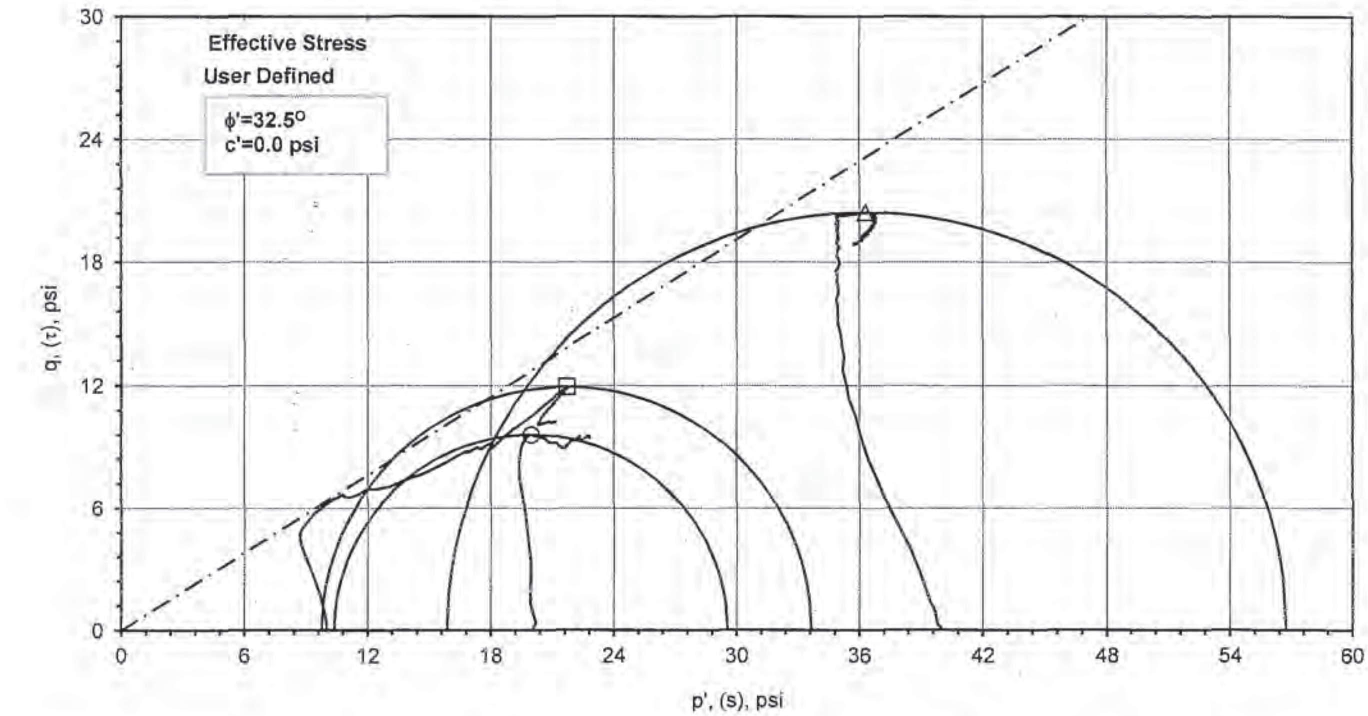
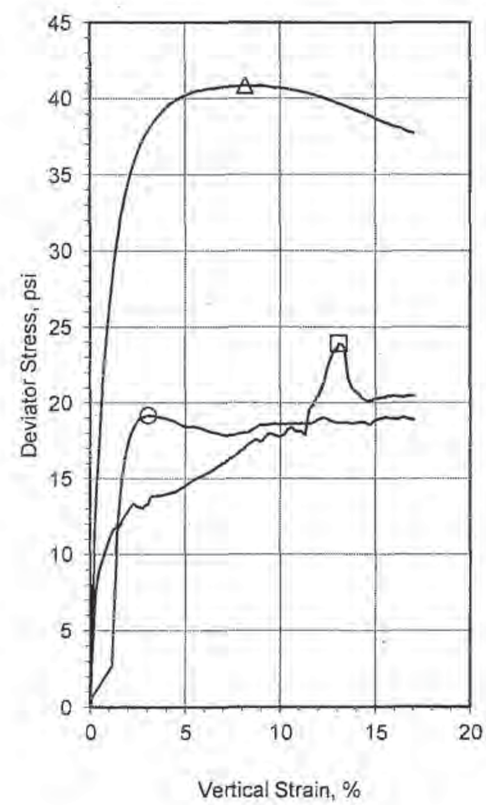
# Consolidated Undrained Triaxial Shear Test Report

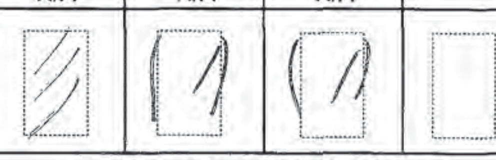



| Symbols | | □ | ○ | △ | ◇ |
|---|---|---|---|---|---|
| Boring No. | | Z-SDU6-B01 | Z-SDU6-B01 | Z-SDU6-B01 | |
| Sample No. | | ST05 | ST05 | ST05 | |
| Test No. | | 11250.1 | 11250.2 | 11251.3 | |
| Depth | | 51.1-53.1 ft | 51.1-53.1 ft | 51.1-53.1 ft | |
| Initial | Diameter, in | 2.869 | 2.871 | 2.881 | |
| | Height, in | 5.974 | 5.971 | 5.974 | |
| | Water Content, % | 56.9 | 82.8 | 36.4 | |
| | Dry Density, pcf | 66.7 | 51.9 | 81.8 | |
| | Degree of Saturation, % | 100.6 | 99.6 | 92.7 | |
| | Void Ratio | 1.53 | 2.24 | 1.06 | |
| Before Shear | Water Content, % | 58.4 | 65.6 | 36.0 | |
| | Dry Density, pcf | 65.4 | 60.8 | 85.4 | |
| | Degree of Saturation, % | 100.0 | 100.0 | 100.0 | |
| | Void Ratio | 1.58 | 1.77 | 0.97 | |
| | Back Pressure, psi | 130.0 | 120.0 | 100.0 | |
| | B Value | 0.99 | 1.00 | 0.99 | |
| Effective Confining Pressure, psi | | 10.0 | 20.0 | 39.9 | |
| Shear Strength, psi | | 11.9 | 9.6 | 20.4 | |
| Strain at Failure, % | | 13.1 | 3.0 | 8.1 | |
| Strain Rate, %/min | | 0.05 | 0.05 | 0.05 | |
| Estimated Gs | | 2.7 | 2.7 | 2.7 | |
| Liquid Limit | | N/A | N/A | N/A | |
| Plastic Limit | | N/A | N/A | N/A | |

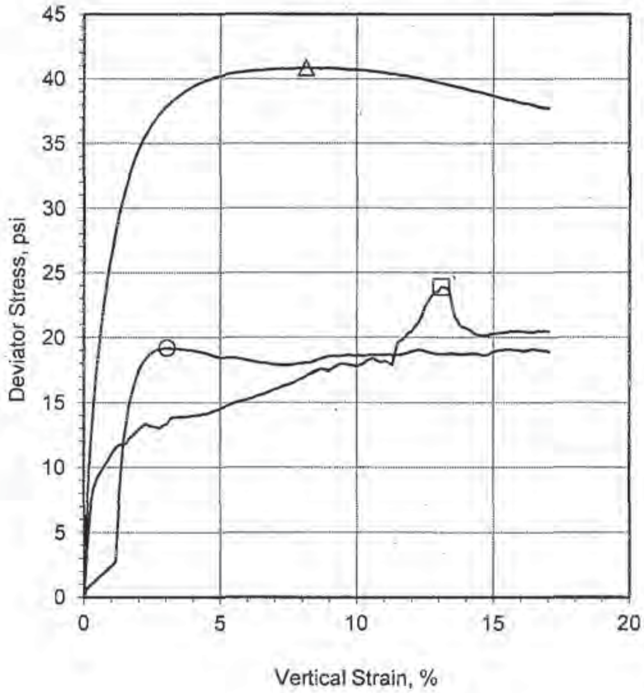
amec

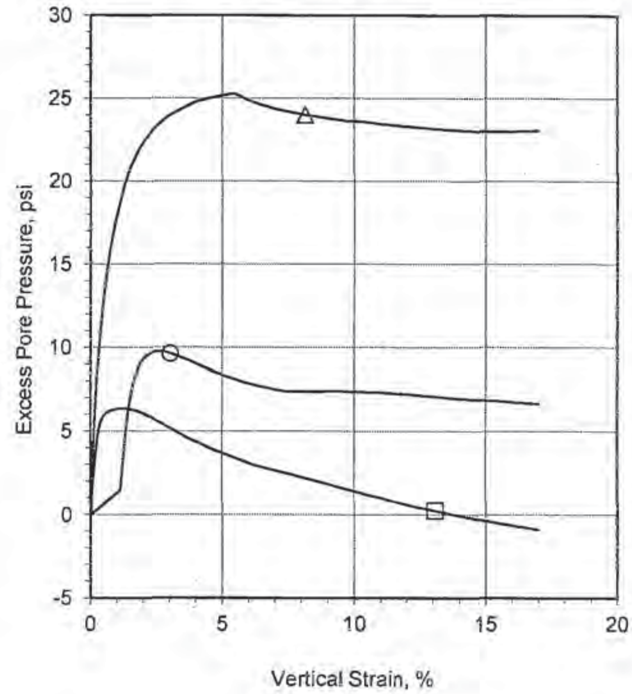
| | |
|---|---|
| Project: | Saltstone Disposal Unit 6 |
| Project No.: | 6155-08-0031.28 |
| Location: | TP-2 |
| Sample Type: | Undisturbed |
| Description: | Light Gray Sandy Clay |
| Remarks: | |

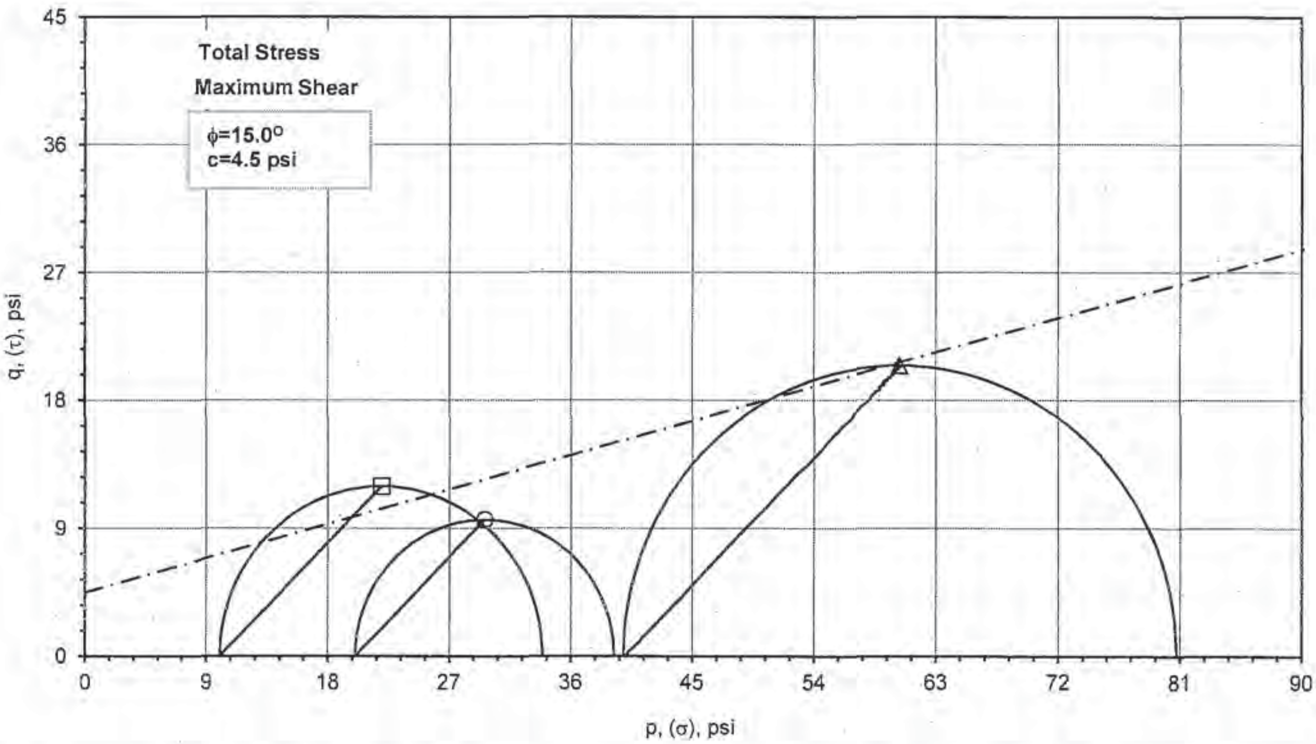


**Test Procedure: ASTM D4767-04**

# Consolidated Undrained Triaxial Shear Test Report



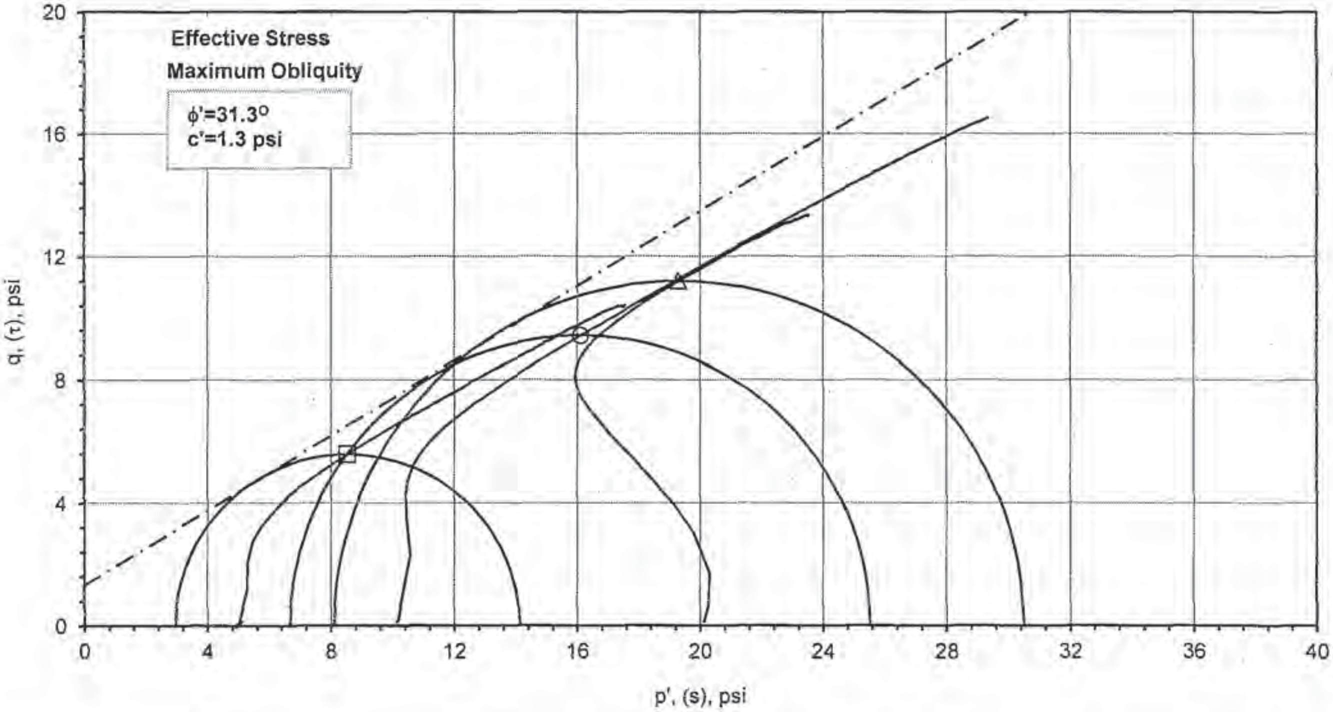



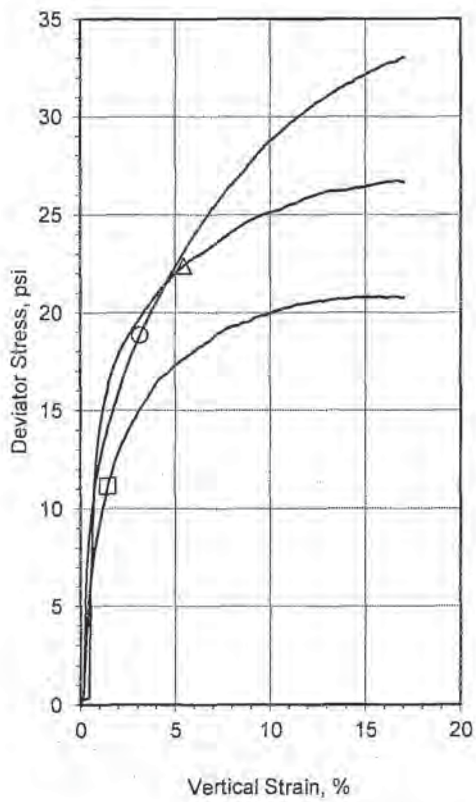

| Symbol | Boring No. | Sample No. | Test No. | Depth | Tested By | Test Date | Reviewed By | Reviewe Date |
|---|---|---|---|---|---|---|---|---|
| □ | Z-SDU6-B01 | ST05 | 11250.1 | 51.1-53.1 ft | JW | 12/29/2011 | JEL | 2/13/2012 |
| ○ | Z-SDU6-B01 | ST05 | 11250.2 | 51.1-53.1 ft | JW | 12/29/2011 | JEL | 2/13/2012 |
| △ | Z-SDU6-B01 | ST05 | 11251.3 | 51.1-53.1 ft | JW | 12/29/2011 | JEL | 2/13/2012 |
| ◇ | | | | | | | | |

| | | |
|---|---|---|
| Project: | Saltstone Disposal Unit 6 | Location: |
| Project No.: | 6155-08-0031.28 | Sample Type: Undisturbed |
| Description: | Light Gray Sandy Clay | |
| Remarks: | | |

amec

# Consolidated Undrained Triaxial Shear Test Report

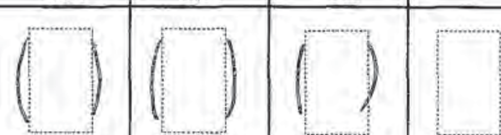



| Symbols | | □ | ○ | △ | ◇ |
|---|---|---|---|---|---|
| Boring No. | | Z-SDU6-B02 | Z-SDU6-B02 | Z-SDU6-B02 | |
| Sample No. | | FPT01 | FPT01 | FPT01 | |
| Test No. | | 11256.1 | 11256.2 | 11256.3 | |
| Depth | | 44-46 ft | 44-46 ft | 44-46 ft | |
| Initial | Diameter, in | 2.869 | 2.877 | 2.874 | |
| | Height, in | 5.962 | 5.967 | 5.556 | |
| | Water Content, % | 21.8 | 21.7 | 26.5 | |
| | Dry Density, pcf | 100.3 | 99.3 | 94.2 | |
| | Degree of Saturation, % | 89.2 | 86.4 | 93.1 | |
| | Void Ratio | 0.65 | 0.67 | 0.75 | |
| Before Shear | Water Content, % | 23.9 | 24.1 | 27.7 | |
| | Dry Density, pcf | 101.3 | 100.9 | 95.4 | |
| | Degree of Saturation, % | 100.0 | 100.0 | 100.0 | |
| | Void Ratio | 0.63 | 0.64 | 0.73 | |
| | Back Pressure, psi | 130.0 | 130.0 | 120.0 | |
| | B Value | 0.99 | 1.00 | 0.99 | |
| Effective Confining Pressure, psi | | 4.9 | 10.1 | 20.1 | |
| Shear Strength, psi | | 5.6 | 9.4 | 11.2 | |
| Strain at Failure, % | | 1.4 | 3.1 | 5.4 | |
| Strain Rate, %/min | | 0.05 | 0.05 | 0.05 | |
| Estimated Gs | | 2.65 | 2.65 | 2.65 | |
| Liquid Limit | | N/A | N/A | N/A | |
| Plastic Limit | | N/A | N/A | N/A | |

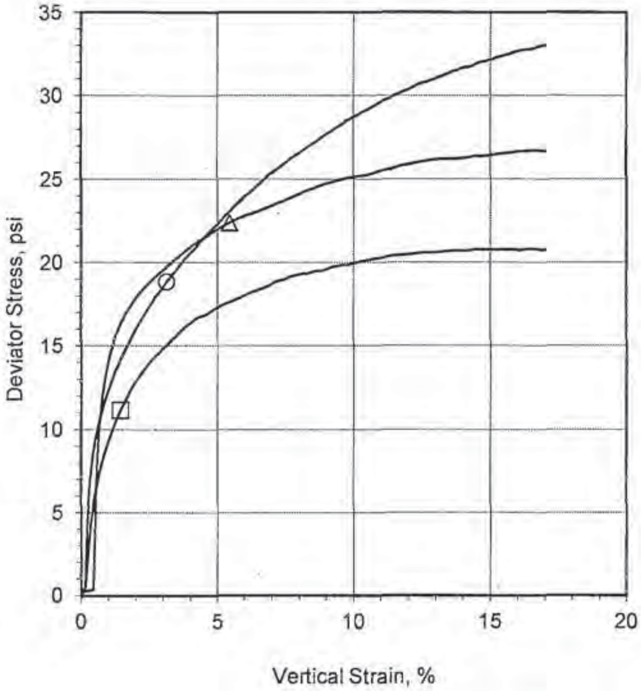
amec

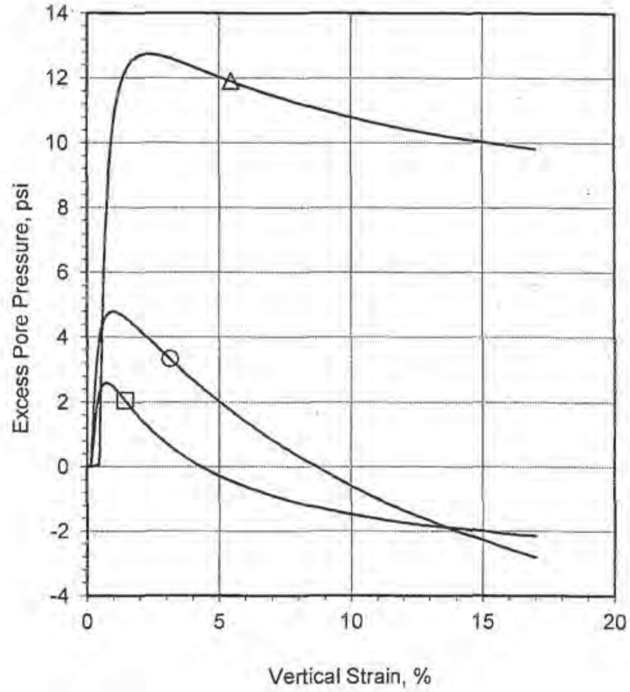
| | |
|---|---|
| Project: | Saltstone Disposal Unit 6 |
| Project No.: | 6155-08-0031.28 |
| Location: | TP-2 |
| Sample Type: | Undisturbed |
| Description: | Brown Clayey Sand |
| Remarks: | |

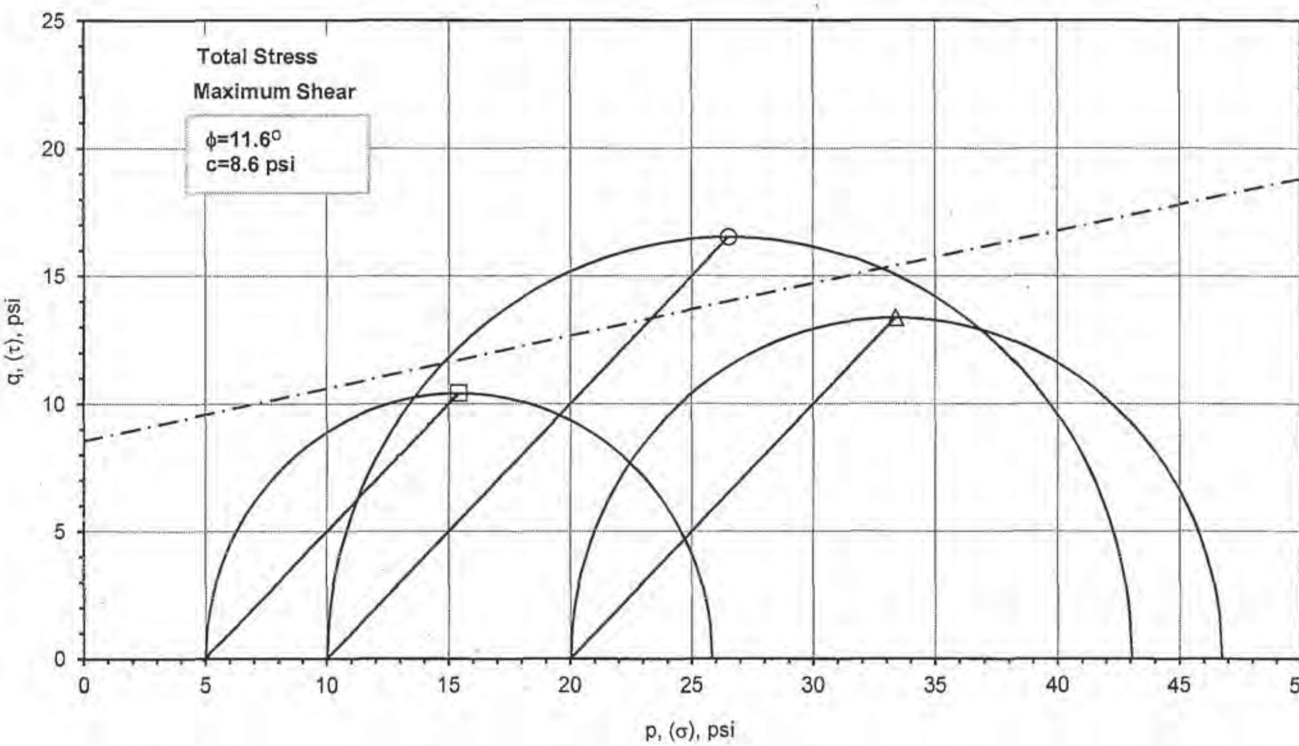


Test Procedure: ASTM D4767-04

# Consolidated Undrained Triaxial Shear Test Report



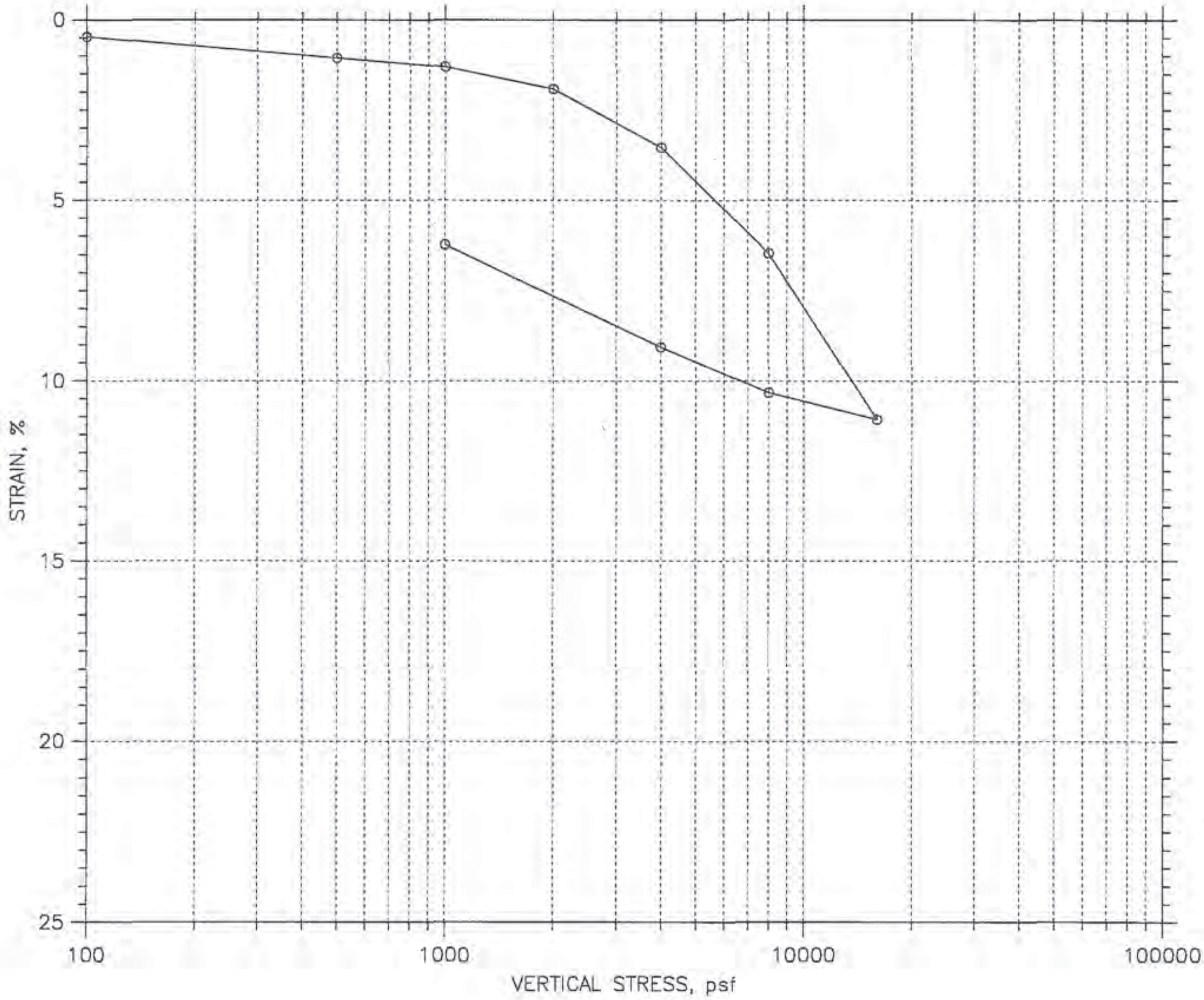




| Symbol | Boring No. | Sample No. | Test No. | Depth | Tested By | Test Date | Reviewed By | Reviewe Date |
|---|---|---|---|---|---|---|---|---|
| □ | Z-SDU6-B02 | FPT01 | 11256.1 | 44-46 ft | JW | 1/5/2012 | JEL | 2/13/2012 |
| ○ | Z-SDU6-B02 | FPT01 | 11256.2 | 44-46 ft | JW | 1/5/2012 | JEL | 2/13/2012 |
| △ | Z-SDU6-B02 | FPT01 | 11256.3 | 44-46 ft | JW | 1/5/2012 | JEL | 2/13/2012 |
| ◇ | | | | | | | | |

| | | |
|---|---|---|
| amec | Project: Saltstone Disposal Unit 6 | Location: |
| | Project No.: 6155-08-0031.28 | Sample Type: Undisturbed |
| | Description: Brown Clayey Sand | |
| | Remarks: | |

# CONSOLIDATION TEST DATA

SUMMARY REPORT

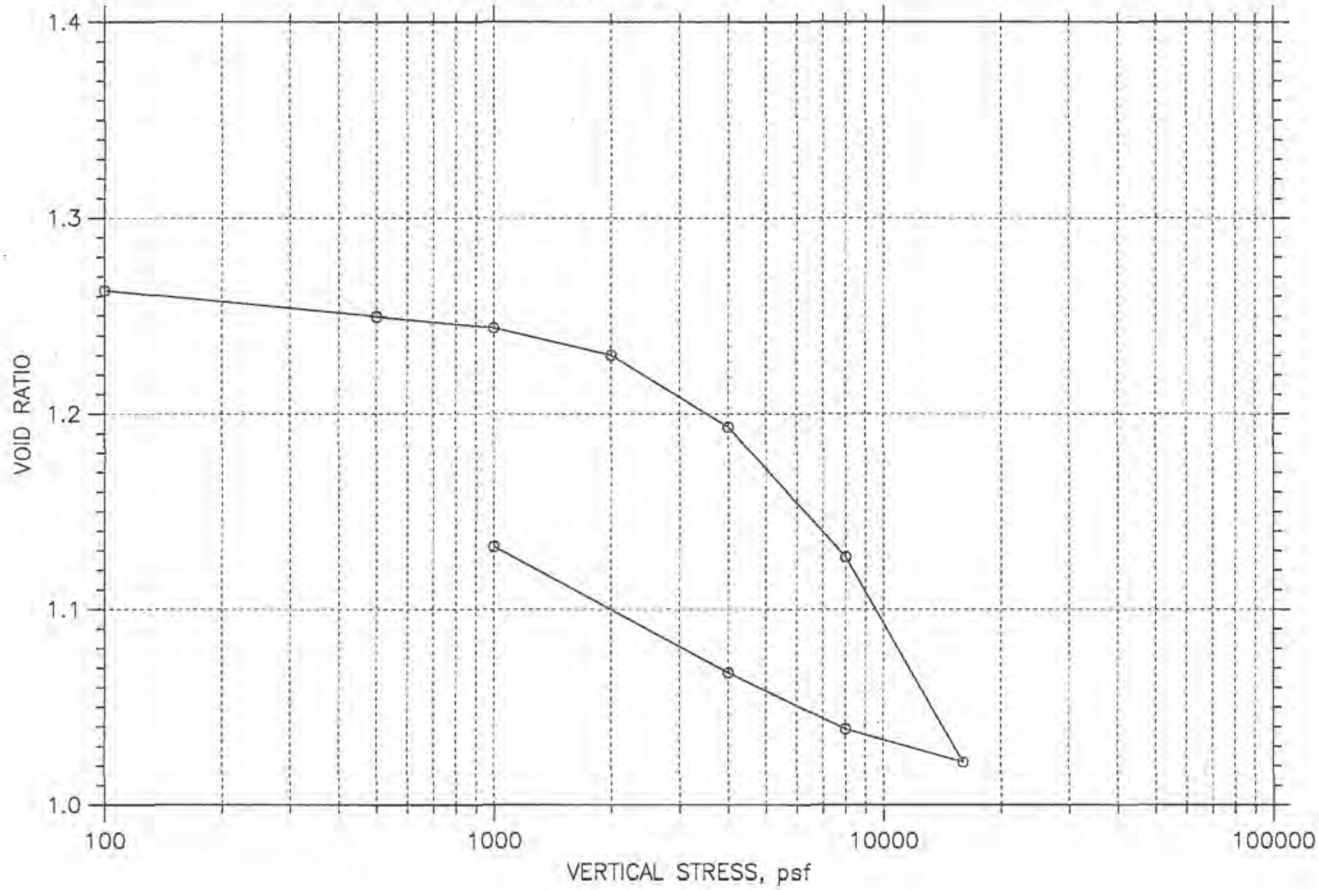


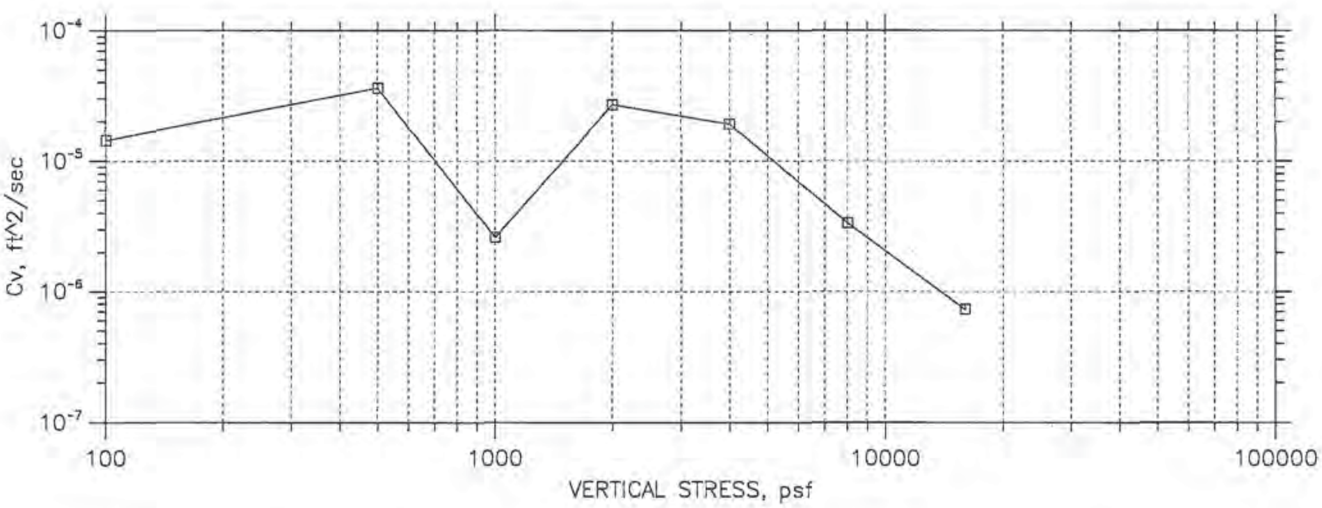

| | | | | | Before Test | After Test |
|---|---|---|---|---|---|---|
| Overburden Pressure: 0 psf | | | | Water Content, % | 45.24 | 45.01 |
| Preconsolidation Pressure: 0 psf | | | | Dry Unit Weight, pcf | 74.13 | 79.06 |
| Compression Index: 0 | | | | Saturation, % | 95.91 | 107.34 |
| Diameter: 2.499 in | | Height: 1.008 in | | Void Ratio | 1.27 | 1.13 |
| LL: 104 | PL: 30 | PI: 74 | GS: 2.70 | | | |

| | | | |
|---|---|---|---|
| amec | Project: Saltstone Disposal Unit 6 | Location: Z-SDU6-B01 | Project No.: 6155080031 |
| | Boring No.: Z-SDU6-B01 | Tested By: JW | Checked By: JEJ |
| | Sample No.: ST04 | Test Date: 12/28/11 | Depth: 48-50 ft |
| | Test No.: 11249 | Sample Type: UD | Elevation: N/A |
| | Description: Light Brown Clayey Sand (SC) | | |
| | Remarks: ASTM D2435-04 | | |

## CONSOLIDATION TEST DATA

SUMMARY REPORT

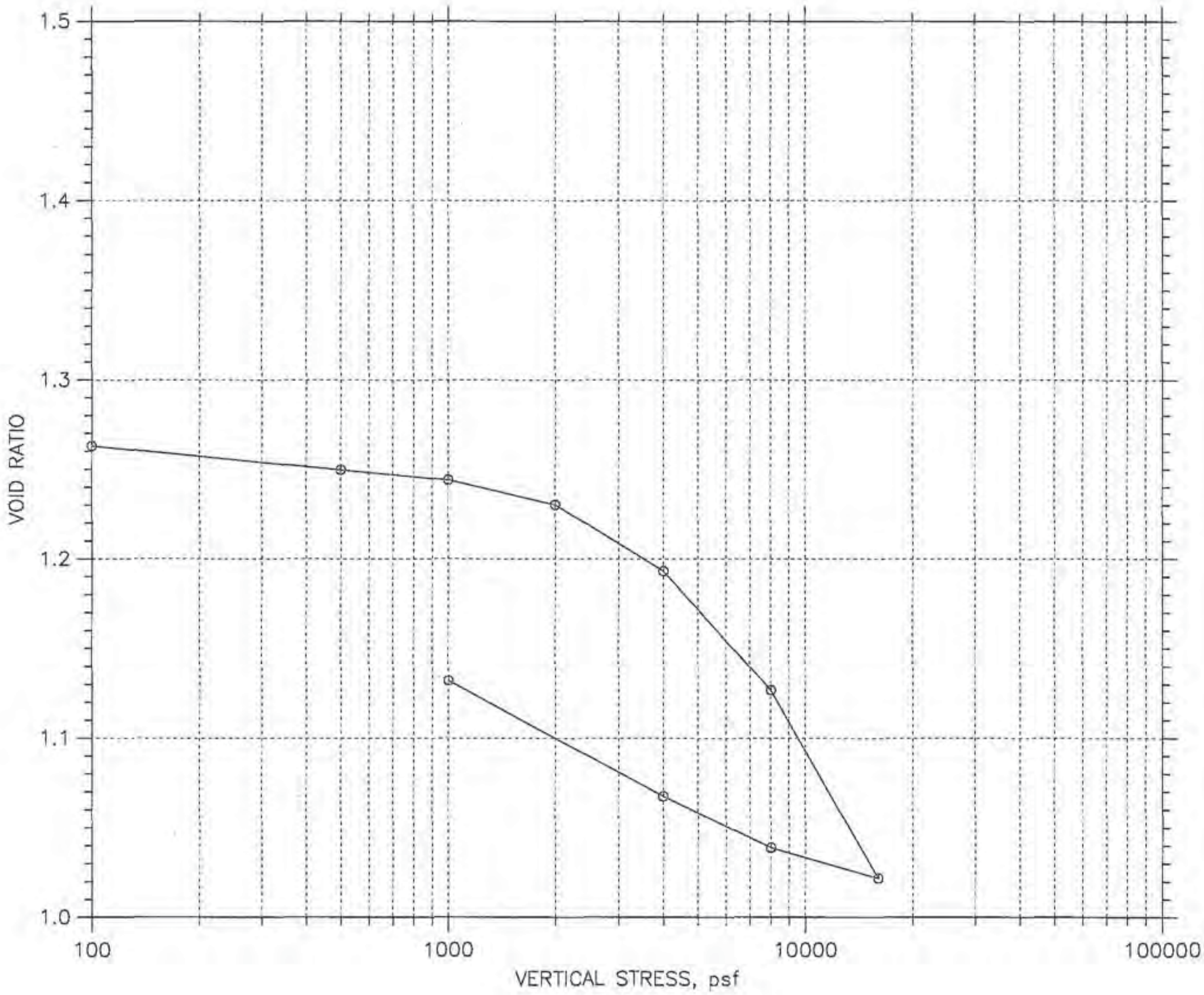



| amec | | | |
|---|---|---|---|
| | Project: Saltstone Disposal Unit 6 | Location: Z-SDU6-B01 | Project No.: 6155080031 |
| | Boring No.: Z-SDU6-B01 | Tested By: JW | Checked By: JEJ |
| | Sample No.: ST04 | Test Date: 12/28/11 | Depth: 48-50 ft |
| | Test No.: 11249 | Sample Type: UD | Elevation: N/A |
| | Description: Light Brown Clayey Sand (SC) | | |
| | Remarks: ASTM D2435-04 | | |

# CONSOLIDATION TEST DATA

SUMMARY REPORT




| | | | | | Before Test | After Test |
|---|---|---|---|---|---|---|
| Overburden Pressure: 0 psf | | | | Water Content, % | 45.24 | 45.01 |
| Preconsolidation Pressure: 0 psf | | | | Dry Unit Weight, pcf | 74.13 | 79.06 |
| Compression Index: 0 | | | | Saturation, % | 95.91 | 107.34 |
| Diameter: 2.499 in | | Height: 1.008 in | | Void Ratio | 1.27 | 1.13 |
| LL: 104 | PL: 30 | PI: 74 | GS: 2.70 | | | |

| amec | | | |
|---|---|---|---|
| | Project: Saltstone Disposal Unit 6 | Location: Z-SDU6-B01 | Project No.: 6155080031 |
| | Boring No.: Z-SDU6-B01 | Tested By: JW | Checked By: JEJ |
| | Sample No.: ST04 | Test Date: 12/28/11 | Depth: 48-50 ft |
| | Test No.: 11249 | Sample Type: UD | Elevation: N/A |
| | Description: Light Brown Clayey Sand (SC) | | |
| | Remarks: ASTM D2435-04 | | |

CONSOLIDATION TEST DATA

Project: Saltstone Disposal Unit 6
Boring No.: Z-SDU6-B01
Sample No.: ST04
Test No.: 11249

Location: Z-SDU6-B01
Tested By: JW
Test Date: 12/28/11
Sample Type: UD

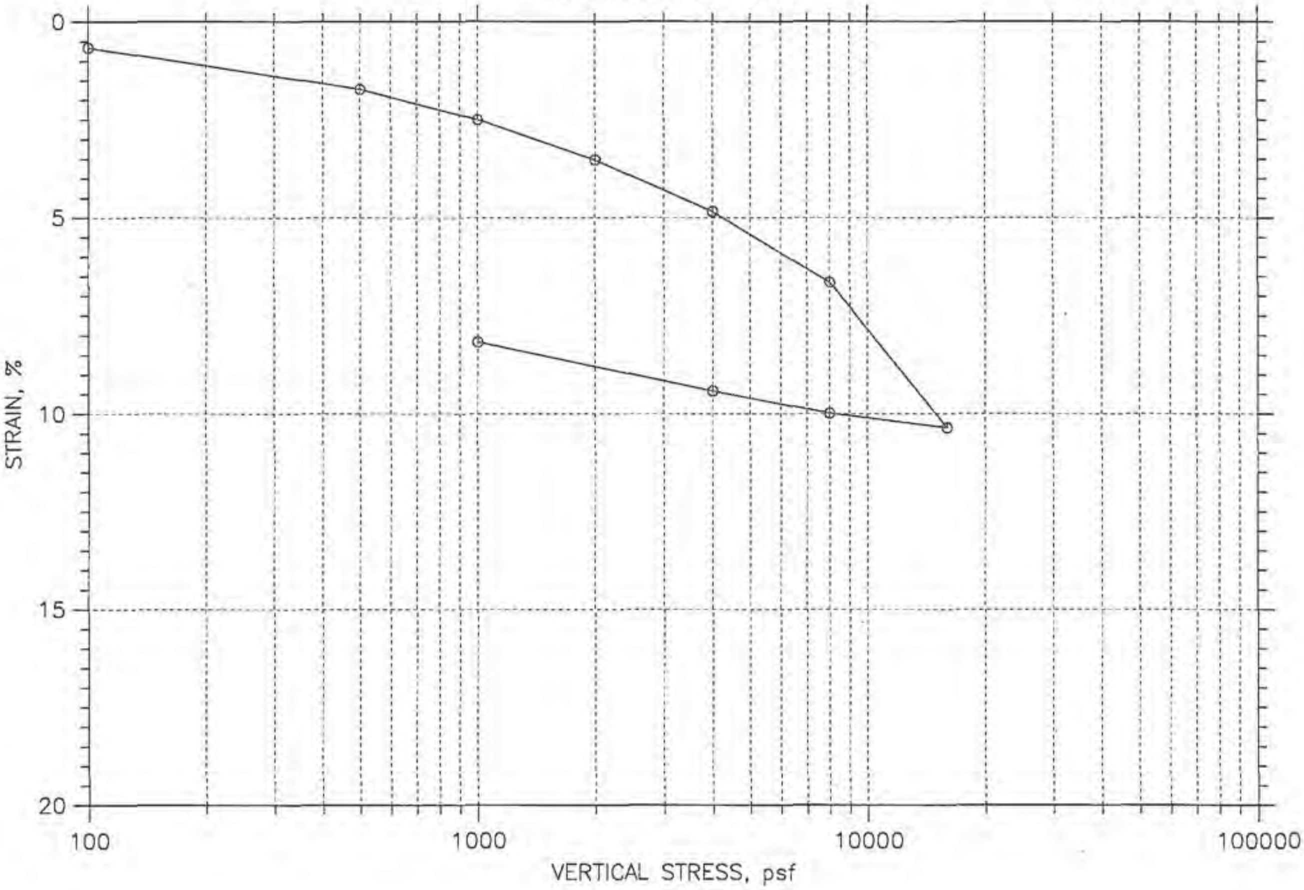
Project No.: 6155080031
Checked By:
Depth: 48-50 ft
Elevation: N/A

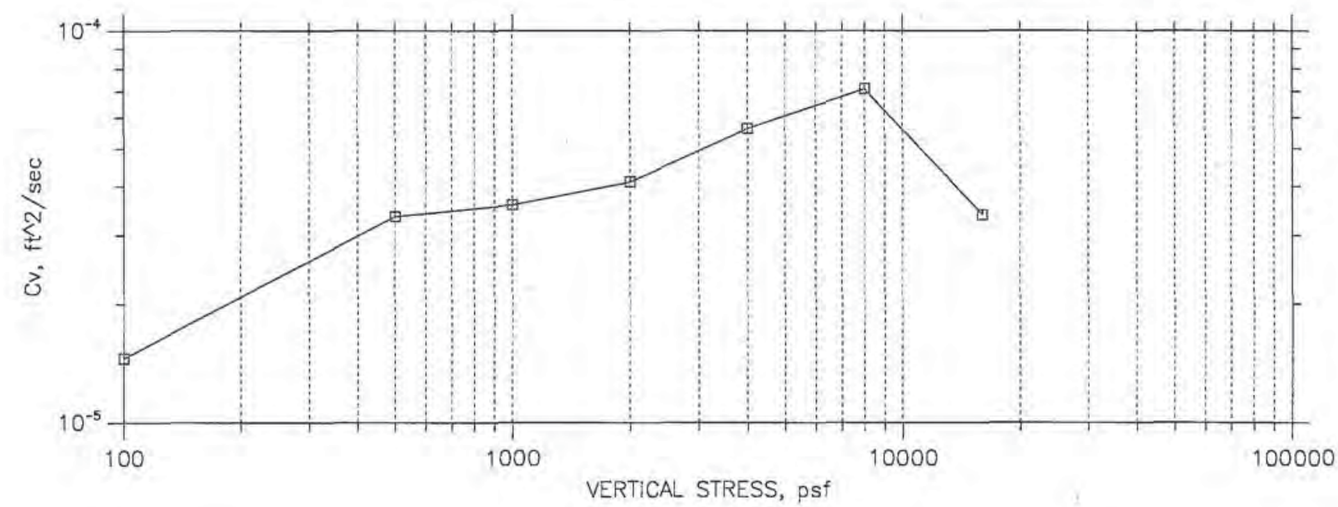
Soil Description: Light Brown Clayey Sand (SC)
Remarks: ASTM D2435-04

| | Applied Stress psf | Final Displacement in | Void Ratio | Strain at End % | T50 Fitting Sq.Rt. min | T50 Fitting Log min | Coefficient of Consolidation Sq.Rt. ft^2/sec | Coefficient of Consolidation Log ft^2/sec | Coefficient of Consolidation Ave. ft^2/sec |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 100 | 0.004732 | 1.263 | 0.47 | 0.4 | 0.0 | 1.44e-005 | 0.00e+000 | 1.44e-005 |
| 2 | 500 | 0.01066 | 1.250 | 1.06 | 0.2 | 0.0 | 3.61e-005 | 0.00e+000 | 3.61e-005 |
| 3 | 1e+003 | 0.01309 | 1.244 | 1.30 | 4.2 | 0.1 | 1.35e-006 | 3.86e-005 | 2.60e-006 |
| 4 | 2e+003 | 0.01929 | 1.230 | 1.91 | 0.3 | 0.1 | 1.82e-005 | 5.17e-005 | 2.70e-005 |
| 5 | 4e+003 | 0.03568 | 1.193 | 3.54 | 0.5 | 0.1 | 1.17e-005 | 5.23e-005 | 1.91e-005 |
| 6 | 8e+003 | 0.06513 | 1.127 | 6.46 | 1.7 | 1.4 | 3.00e-006 | 3.79e-006 | 3.35e-006 |
| 7 | 1.6e+004 | 0.1116 | 1.022 | 11.07 | 6.6 | 0.0 | 7.29e-007 | 0.00e+000 | 7.29e-007 |
| 8 | 8e+003 | 0.1041 | 1.039 | 10.33 | 0.8 | 0.3 | 5.86e-006 | 1.72e-005 | 8.74e-006 |
| 9 | 4e+003 | 0.09139 | 1.068 | 9.07 | 5.6 | 0.0 | 8.52e-007 | 0.00e+000 | 8.52e-007 |
| 10 | 1e+003 | 0.06276 | 1.132 | 6.23 | 20.4 | 0.0 | 2.42e-007 | 0.00e+000 | 2.42e-007 |

# CONSOLIDATION TEST DATA

SUMMARY REPORT

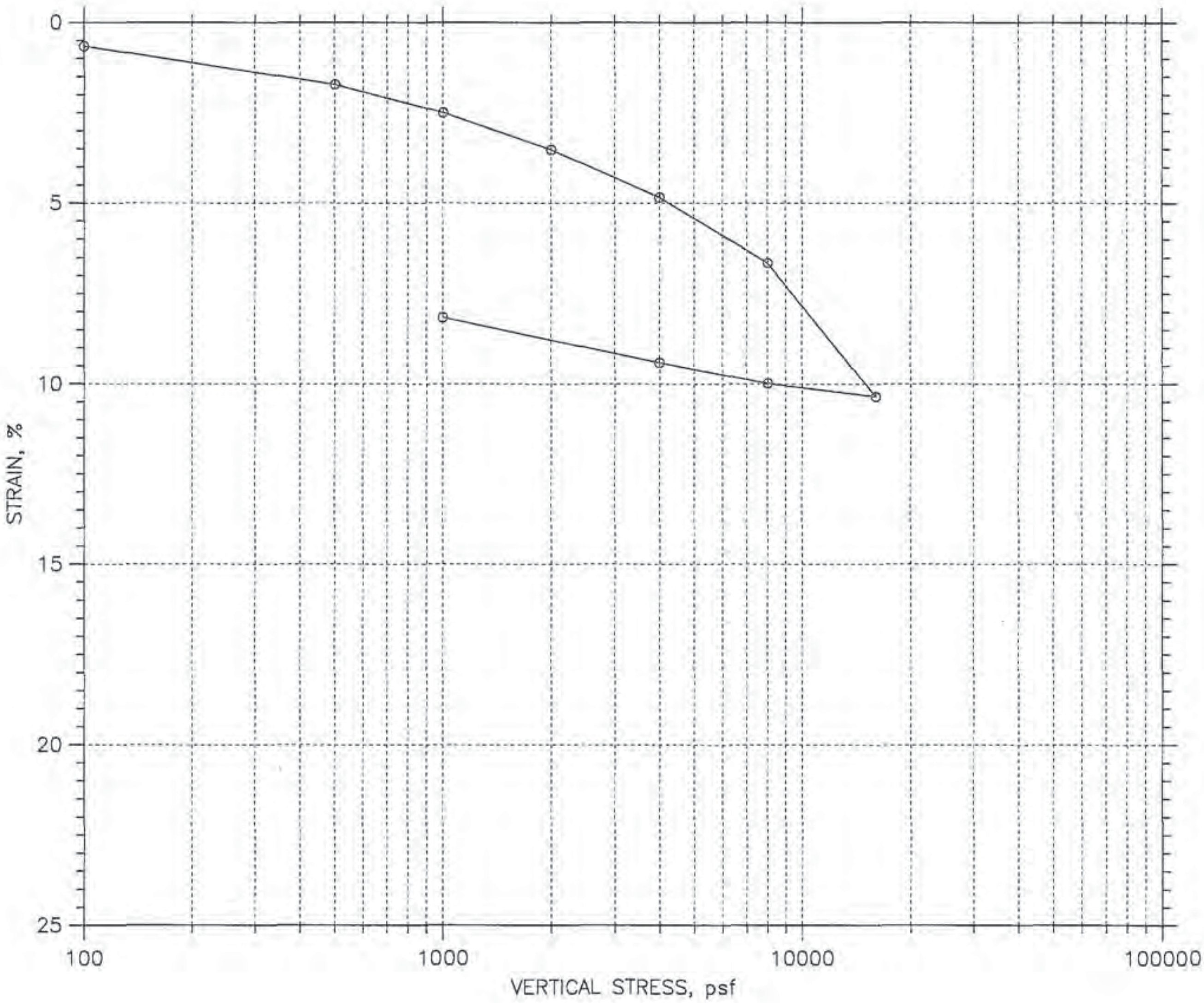



| | | | |
|---|---|---|---|
| amec | Project: Saltstone Disposal Unit 6 | Location: Z-SDU6-B01 | Project No.: 6155080031 |
| | Boring No.: Z-SDU6-B01 | Tested By: JW | Checked By: JEJ |
| | Sample No.: ST06 | Test Date: 12/28/11 | Depth: 58-60 ft |
| | Test No.: 11251 | Sample Type: UD | Elevation: N/A |
| | Description: Light Gray Clayey Sand (SC) | | |
| | Remarks: ASTM D2435-04 | | |

# CONSOLIDATION TEST DATA

SUMMARY REPORT

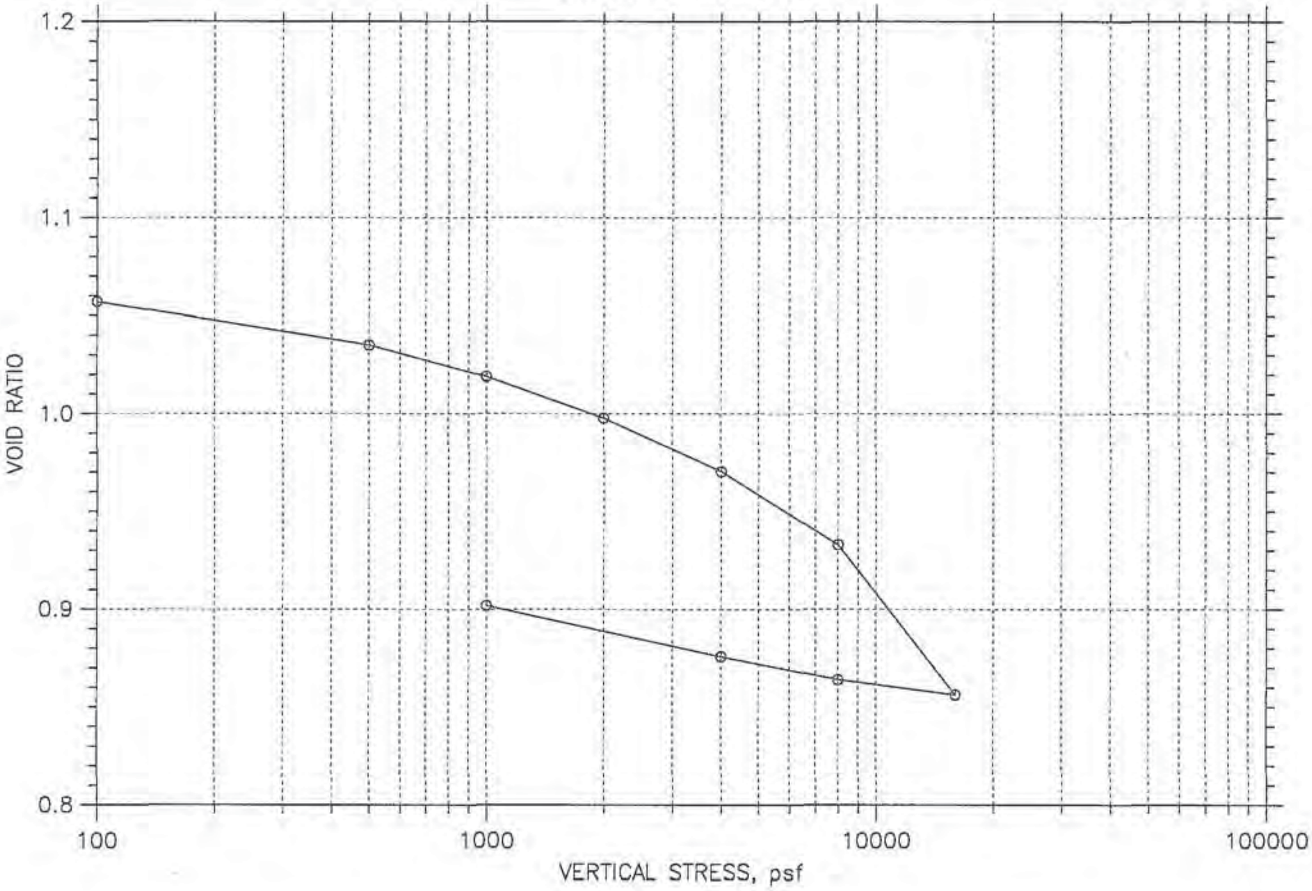


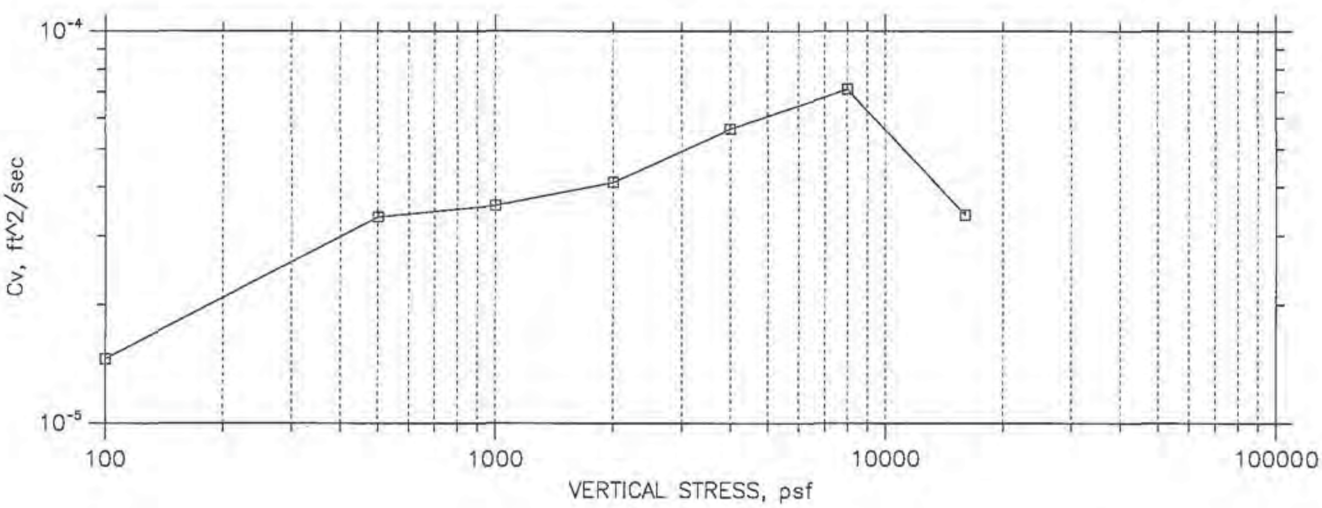

| | | | | | Before Test | After Test |
|---|---|---|---|---|---|---|
| Overburden Pressure: 0 psf | | | | Water Content, % | 37.32 | 35.97 |
| Preconsolidation Pressure: 0 psf | | | | Dry Unit Weight, pcf | 81.4 | 88.63 |
| Compression Index: 0 | | | | Saturation, % | 94.11 | 107.69 |
| Diameter: 2.499 in | | Height: 1.002 in | | Void Ratio | 1.07 | 0.90 |
| LL: 114 | PL: 44 | PI: 70 | GS: 2.70 | | | |

| | | | |
|---|---|---|---|
| amec | Project: Saltstone Disposal Unit 6 | Location: Z-SDU6-B01 | Project No.: 6155080031 |
| | Boring No.: Z-SDU6-B01 | Tested By: JW | Checked By: JEJ |
| | Sample No.: ST06 | Test Date: 12/28/11 | Depth: 58-60 ft |
| | Test No.: 11251 | Sample Type: UD | Elevation: N/A |
| | Description: Light Gray Clayey Sand (SC) | | |
| | Remarks: ASTM D2435-04 | | |

# CONSOLIDATION TEST DATA

SUMMARY REPORT

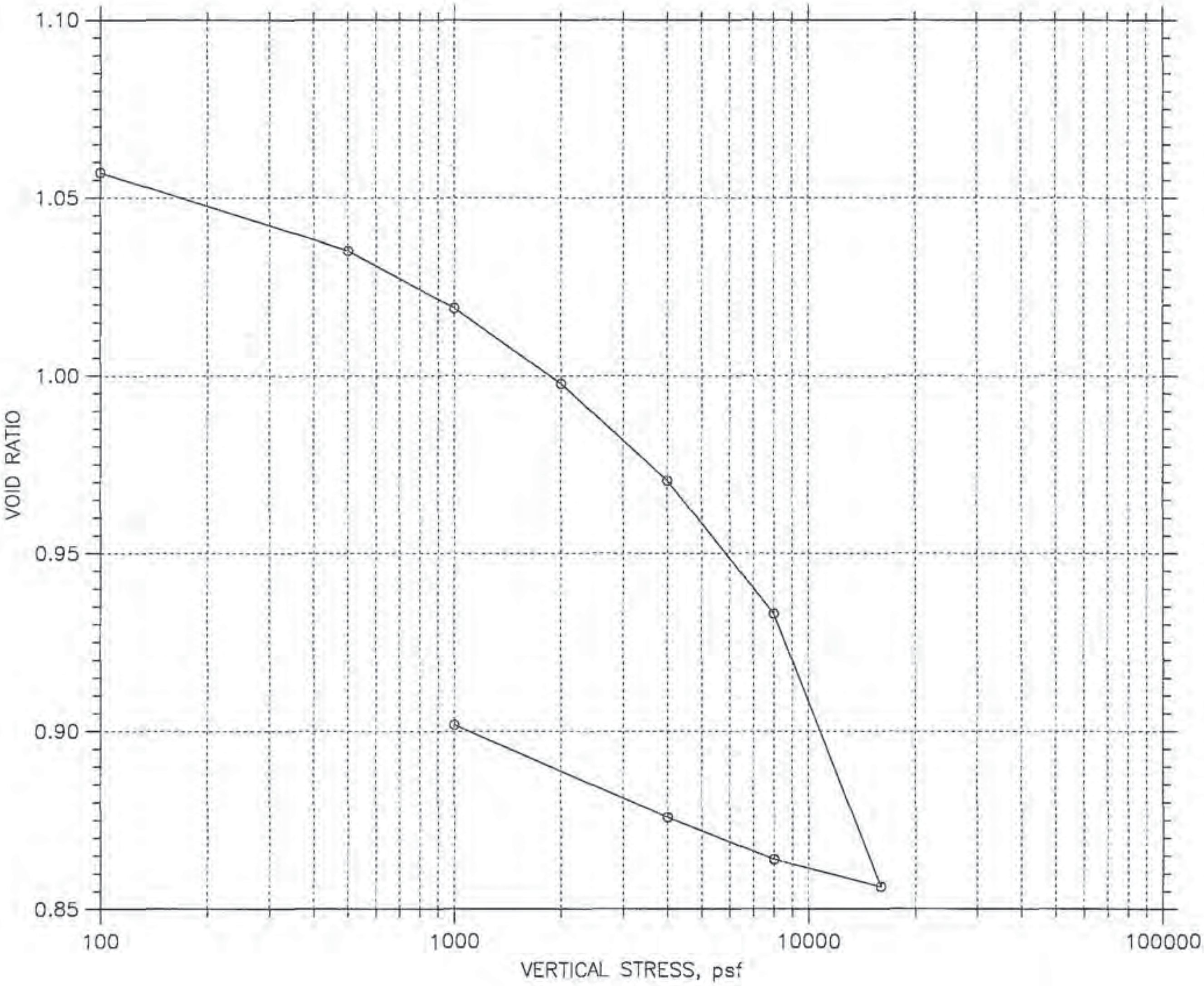



| | | | |
|---|---|---|---|
| amec | Project: Saltstone Disposal Unit 6 | Location: Z-SDU6-B01 | Project No.: 6155080031 |
| | Boring No.: Z-SDU6-B01 | Tested By: JW | Checked By: JEJ |
| | Sample No.: ST06 | Test Date: 12/28/11 | Depth: 58-60 ft |
| | Test No.: 11251 | Sample Type: UD | Elevation: N/A |
| | Description: Light Gray Clayey Sand (SC) | | |
| | Remarks: ASTM D2435-04 | | |

# CONSOLIDATION TEST DATA

SUMMARY REPORT




| | | | | | Before Test | After Test |
|---|---|---|---|---|---|---|
| Overburden Pressure: 0 psf | | | | Water Content, % | 37.32 | 35.97 |
| Preconsolidation Pressure: 0 psf | | | | Dry Unit Weight, pcf | 81.4 | 88.63 |
| Compression Index: 0 | | | | Saturation, % | 94.11 | 107.69 |
| Diameter: 2.499 in | | Height: 1.002 in | | Void Ratio | 1.07 | 0.90 |
| LL: 114 | PL: 44 | PI: 70 | GS: 2.70 | | | |

| | | | |
|---|---|---|---|
| amec | Project: Saltstone Disposal Unit 6 | Location: Z-SDU6-B01 | Project No.: 6155080031 |
| | Boring No.: Z-SDU6-B01 | Tested By: JW | Checked By: JCJ |
| | Sample No.: ST06 | Test Date: 12/28/11 | Depth: 58-60 ft |
| | Test No.: 11251 | Sample Type: UD | Elevation: N/A |
| | Description: Light Gray Clayey Sand (SC) | | |
| | Remarks: ASTM D2435-04 | | |

CONSOLIDATION TEST DATA

Project: Saltstone Disposal Unit 6
Boring No.: Z-SDU6-B01
Sample No.: ST06
Test No.: 11251

Location: Z-SDU6-B01
Tested By: JW
Test Date: 12/28/11
Sample Type: UD

Project No.: 6155080031
Checked By:
Depth: 58-60 ft
Elevation: N/A

Soil Description: Light Gray Clayey Sand (SC)
Remarks: ASTM D2435-04

| | Applied Stress psf | Final Displacement in | Void Ratio | Strain at End % | T50 Fitting Sq.Rt. min | T50 Fitting Log min | Coefficient of Consolidation Sq.Rt. ft^2/sec | Coefficient of Consolidation Log ft^2/sec | Coefficient of Consolidation Ave. ft^2/sec |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 100 | 0.006589 | 1.057 | 0.66 | 0.4 | 0.0 | 1.45e-005 | 0.00e+000 | 1.45e-005 |
| 2 | 500 | 0.0172 | 1.035 | 1.72 | 0.2 | 0.0 | 3.35e-005 | 0.00e+000 | 3.35e-005 |
| 3 | 1e+003 | 0.02502 | 1.019 | 2.50 | 0.2 | 0.2 | 3.61e-005 | 3.57e-005 | 3.59e-005 |
| 4 | 2e+003 | 0.03531 | 0.998 | 3.52 | 0.1 | 0.1 | 3.84e-005 | 4.43e-005 | 4.11e-005 |
| 5 | 4e+003 | 0.04853 | 0.970 | 4.84 | 0.1 | 0.1 | 5.84e-005 | 5.43e-005 | 5.62e-005 |
| 6 | 8e+003 | 0.06663 | 0.933 | 6.65 | 0.1 | 0.1 | 6.71e-005 | 7.55e-005 | 7.11e-005 |
| 7 | 1.6e+004 | 0.1038 | 0.856 | 10.36 | 0.2 | 0.1 | 2.47e-005 | 5.38e-005 | 3.39e-005 |
| 8 | 8e+003 | 0.1 | 0.864 | 9.98 | 0.1 | 0.0 | 8.76e-005 | 0.00e+000 | 8.76e-005 |
| 9 | 4e+003 | 0.09434 | 0.876 | 9.42 | 0.1 | 0.0 | 8.81e-005 | 0.00e+000 | 8.81e-005 |
| 10 | 1e+003 | 0.08176 | 0.902 | 8.16 | 0.2 | 0.1 | 2.62e-005 | 5.60e-005 | 3.57e-005 |

# HYDRAULIC CONDUCTIVITY

| | | | |
|---|---|---|---|
| Project No. | *6155-08-0031.28* | Tested By | *JW* |
| Project Name | *Saltstone Disposal Unit 6* | Test Date | *1/5/2012* |
| Boring No. | *Z-SDU6-B02* | Reviewed By | *JEL* JEL |
| Sample No. | *FPT02* | Review Date | *1/12/2012* |
| Sample Depth | *47-49 ft* | Lab No. | *11257* |
| Sample Description | *Light Brown Clayey Sand* | | |

*ASTM D5084-03 - (Method C Falling Head RisingTail)*

| | |
|---|---|
| Sample Type: | *UD* |
| Sample Orientation: | *Vertical* |
| Initial Water Content, %: | *30.0* |
| Wet Unit Weight, pcf: | *117.2* |
| Dry Unit Weight, pcf: | *90.2* |
| Compaction, %: | *N/A* |
| **Hydraulic Conductivity, cm/sec. @20 °C** | ***8.5E-08*** |

Remarks: ______________________________

**PERMEABILITY TEST**
**(ASTM D5084 - 03) (Method C, Increasing Tailwater Level)**

Project Number 6155-08-0031.28 — Tested By JW
Project Name Saltstone Disposal Unit 6 — Test Date 01/05/12
Boring No. Z-SDU6-B02 — Reviewed By JEL *JEL*
Sample No. FPT02 — Review Date 01/12/12
Sample Depth 47-49 ft — Lab No. 11257
Sample Description Light Brown Clayey Sand

| Initial Sample Data | | | | Final Sample Data | |
|---|---|---|---|---|---|
| Length, in | | Diameter, in | | Pan No. | T-19 |
| Location 1 | 4.944 | Location 1 | 2.866 | Wet Soil+Pan, g | 1025.46 |
| Location 2 | 4.919 | Location 2 | 2.867 | Dry Soil + Pan, g | 804.99 |
| Location3 | 4.945 | Location 3 | 2.870 | Pan Weight, g | 50.39 |
| Average | 4.936 | Average | 2.868 | Moisture Content, % | 29.2 |
| Volume, $in^3$ | 31.88 | Wet Soil + Tare, g | 980.65 | Dry Unit Weight, pcf | 94.0 |
| SG Assumed | 2.7 | Tare Weight, g | 0.00 | Saturation, % | 99.5 |
| Soil Sample Wt., g | 980.65 | Dry Soil + Tare, g | 754.60 | Diameter, in. | N/A |
| Dry UW, pcf | 90.2 | Moisture Content, % | 30.0 | Length, in. | N/A |
| Saturation, % | 93.2 | | | Volume, $in^3$ | N/A |

Consolidation

| | |
|---|---|
| Chamber Pressure, psi | 74.0 |
| Back Pressure, psi | 34.0 |
| Confining Pressure, psi | 40 |
| Initial Burette Reading | 35.2 |
| Finial Burette Reading | 14.2 |
| Volume Change, cc | 21.0 |
| Permeant used | Water |

| Time (sec) | $H_a$ (cm) | $H_1$ (cm) | $H_b$ (cm) | $H_2$ (cm) | Temp (°C) | Initial Hydraulic Gradient | Final Hydraulic Gradient | k cm/sec | k cm/sec at 20 °C |
|---|---|---|---|---|---|---|---|---|---|
| 12640 | 10.2 | 100.6 | 12.3 | 98.7 | 20.5 | 7.2 | 6.9 | 8.62E-08 | 8.52E-08 |
| 15650 | 10.2 | 100.6 | 12.6 | 98.0 | 20.6 | 7.2 | 6.8 | 8.75E-08 | 8.63E-08 |
| 19950 | 10.2 | 100.6 | 13.1 | 97.1 | 20.6 | 7.2 | 6.7 | 8.86E-08 | 8.73E-08 |
| 23280 | 10.2 | 100.6 | 13.4 | 96.5 | 20.7 | 7.2 | 6.6 | 8.71E-08 | 8.56E-08 |
| 27300 | 10.2 | 100.6 | 13.9 | 96.0 | 20.7 | 7.2 | 6.5 | 8.49E-08 | 8.35E-08 |
| 87164 | 10.2 | 100.6 | 17.8 | 83.5 | 21.0 | 7.2 | 5.2 | 8.81E-08 | 8.60E-08 |
| 6540 | 12.2 | 101.6 | 13.2 | 100.6 | 21.2 | 7.1 | 7.0 | 8.33E-08 | 8.09E-08 |

| No. of Trials | Sample Type | Max. Density (pcf) | Compaction % | Sample Orientation |
|---|---|---|---|---|
| 7 | UD | N/A | N/A | Vertical |

**Avg. k at 20 °C 8.50E-08 cm/sec**

a = area of burette in $cm^2$ — Ha = initial inlet head in cm — $H_b$ = final inlet head in cm — a = 0.16 $cm^2$
L = length of sample in cm — $H_1$ = initial outlet head in cm — $H_2$ = final outlet head in cm — A = 41.67 $cm^2$
A = area of sample in $cm^2$ — t = time in seconds — L = 12.54 cm

Remarks:

## TP-4 UNIT WEIGHT OF SAMPLE

| | | | |
|---|---|---|---|
| Project No.: | 6155-08-0031.28 | Boring No.: | Z-SDU6-B01 |
| Project Name: | Saltstone Disposal Unit 6 | Sample No.: | ST02 |
| Lab No. | 11246 | Depth: | 15-17 ft |
| Tested By: | EH | Reviewed By: | JW |
| Date: | 01/03/12 | Date: | 01/12/12 |

| **Total Sample Height, *inches*** | | **Inside Diameter of Cut Tube, *inches*** | | **Moisture Content** | | |
|---|---|---|---|---|---|---|
| 1 | 6.715 | | | Tare No. | R-6 | |
| 2 | 6.721 | Top | 2.865 | Tare Weight | 16.74 | *grams* |
| 3 | 6.703 | Bottom | 2.863 | Wet Weight + Tare | 109.21 | *grams* |
| Average | 6.713 | Average | 2.864 | Dry Weight + Tare | 98.57 | *grams* |
| | | | | Moisture Content | 13.0 | % |

| | | |
|---|---|---|
| Total Weight of Soil + Tube Section | 2007.26 | *grams* |
| Weight of Clean, Dry Tube Section | 537.68 | *grams* |
| Wet Weight of Soil | 3.24 | *lbs* |
| Volume of Sample | 0.025 | *ft*$^3$ |

### RESULT SUMMARY

| | | |
|---|---|---|
| **Moisture Content** | **13.0** | % |
| **Wet Density** | **129.5** | *pcf* |
| **Dry Density** | **114.6** | *pcf* |

Remarks:

amec

# TP-4 UNIT WEIGHT OF SAMPLE

| | | | |
|---|---|---|---|
| Project No.: | 6155-08-0031.28 | Boring No.: | Z-SDU6-B01 |
| Project Name: | Saltstone Disposal Unit 6 | Sample No.: | ST03 |
| Lab No. | 11248 | Depth: | 35-36.3 ft |
| Tested By: | EH | Reviewed By: | JW |
| Date: | 01/03/12 | Date: | 01/12/12 |

| Total Sample Height, *inches* | | Inside Diameter of Cut Tube, *inches* | | Moisture Content | | |
|---|---|---|---|---|---|---|
| 1 | 5.912 | | | Tare No. | R-23 | |
| 2 | 5.974 | Top | 2.877 | Tare Weight | 16.73 | *grams* |
| 3 | 5.969 | Bottom | 2.853 | Wet Weight + Tare | 138.78 | *grams* |
| Average | 5.952 | Average | 2.865 | Dry Weight + Tare | 125.70 | *grams* |
| | | | | Moisture Content | 12.0 | % |

| | | |
|---|---|---|
| Total Weight of Soil + Tube Section | 1712.31 | *grams* |
| Weight of Clean, Dry Tube Section | 531.21 | *grams* |
| Wet Weight of Soil | 2.604 | *lbs* |
| Volume of Sample | 0.0222 | $ft^3$ |

## RESULT SUMMARY

| | | |
|---|---|---|
| **Moisture Content** | **12.0** | % |
| **Wet Density** | **117.3** | *pcf* |
| **Dry Density** | **104.7** | *pcf* |

Remarks:

## TP-4 UNIT WEIGHT OF SAMPLE

| | | | |
|---|---|---|---|
| Project No.: | 6155-08-0031.28 | Boring No.: | Z-SDU6-B01 |
| Project Name: | Saltstone Disposal Unit 6 | Sample No.: | ST08 |
| Lab No. | 11252 | Depth: | 73.2-75.2 ft |
| Tested By: | EH | Reviewed By: | JW |
| Date: | 01/03/12 | Date: | 01/12/12 |

| **Total Sample Height, *inches*** | | **Inside Diameter of Cut Tube, *inches*** | | **Moisture Content** | | |
|---|---|---|---|---|---|---|
| 1 | 5.333 | | | Tare No. | R-63 | |
| 2 | 5.286 | Top | 2.868 | Tare Weight | 16.02 | *grams* |
| 3 | 5.311 | Bottom | 2.870 | Wet Weight + Tare | 148.79 | *grams* |
| Average | 5.310 | Average | 2.869 | Dry Weight + Tare | 115.82 | *grams* |
| | | | | Moisture Content | 33.0 | % |

| | | |
|---|---|---|
| Total Weight of Soil + Tube Section | 1456.70 | *grams* |
| Weight of Clean, Dry Tube Section | 440.30 | *grams* |
| Wet Weight of Soil | 2.241 | *lbs* |
| Volume of Sample | 0.0199 | $ft^3$ |

### RESULT SUMMARY

| | | |
|---|---|---|
| **Moisture Content** | **33.0** | % |
| **Wet Density** | **112.8** | *pcf* |
| **Dry Density** | **84.8** | *pcf* |

Remarks:

# TP-4 UNIT WEIGHT OF SAMPLE

| | | | |
|---|---|---|---|
| Project No.: | 6155-08-0031.28 | Boring No.: | Z-SDU6-B01 |
| Project Name: | Saltstone Disposal Unit 6 | Sample No.: | FP02 |
| Lab No. | 11253 | Depth: | 82-84 ft |
| Tested By: | EH | Reviewed By: | JW |
| Date: | 01/03/12 | Date: | 01/12/12 |

| **Total Sample Height, *inches*** | | **Inside Diameter of Cut Tube, *inches*** | | **Moisture Content** | | |
|---|---|---|---|---|---|---|
| 1 | 6.505 | | | Tare No. | V-52 | |
| 2 | 6.549 | Top | 2.874 | Tare Weight | 16.80 | *grams* |
| 3 | 6.565 | Bottom | 2.852 | Wet Weight + Tare | 136.03 | *grams* |
| Average | 6.540 | Average | 2.863 | Dry Weight + Tare | 114.93 | *grams* |
| | | | | Moisture Content | 21.5 | % |

| | | |
|---|---|---|
| Total Weight of Soil + Tube Section | 1900.43 | *grams* |
| Weight of Clean, Dry Tube Section | 539.84 | *grams* |
| Wet Weight of Soil | 2.9995 | *lbs* |
| Volume of Sample | 0.02436 | $ft^3$ |

## RESULT SUMMARY

| | | |
|---|---|---|
| **Moisture Content** | **21.5** | % |
| **Wet Density** | **123.1** | *pcf* |
| **Dry Density** | **101.3** | *pcf* |

Remarks:

# TP-4 UNIT WEIGHT OF SAMPLE

| | | | |
|---|---|---|---|
| Project No.: | 6155-08-0031.28 | Boring No.: | Z-SDU6-B02 |
| Project Name: | Saltstone Disposal Unit 6 | Sample No.: | ST02 |
| Lab No. | 11258 | Depth: | 10.5-11.0 ft |
| Tested By: | JW | Reviewed By: | EH |
| Date: | 01/05/12 | Date: | 01/12/12 |

| **Total Sample Height, *inches*** | | **Inside Diameter of Cut Tube, *inches*** | | **Moisture Content** | | |
|---|---|---|---|---|---|---|
| 1 | 5.189 | | | Tare No. | C-28 | |
| 2 | 5.288 | Top | 2.856 | Tare Weight | 15.71 | *grams* |
| 3 | 5.263 | Bottom | 2.871 | Wet Weight + Tare | 230.64 | *grams* |
| Average | 5.247 | Average | 2.864 | Dry Weight + Tare | 199.20 | *grams* |
| | | | | Moisture Content | 17.1 | % |

| | | |
|---|---|---|
| Total Weight of Soil + Tube Section | 1617.08 | *grams* |
| Weight of Clean, Dry Tube Section | 455.72 | *grams* |
| Wet Weight of Soil | 2.5603 | *lbs* |
| Volume of Sample | 0.01955 | $ft^3$ |

## RESULT SUMMARY

| | | |
|---|---|---|
| **Moisture Content** | **17.1** | % |
| **Wet Density** | **130.9** | *pcf* |
| **Dry Density** | **111.8** | *pcf* |

Remarks:

amec

# TP-4 UNIT WEIGHT OF SAMPLE

| | | | |
|---|---|---|---|
| Project No.: | 6155-08-0031.28 | Boring No.: | Z-SDU6-B01 |
| Project Name: | Saltstone Disposal Unit 6 | Sample No.: | ST11 |
| Lab No. | 11255 | Depth: | 126.1-127.6 ft |
| Tested By: | JW | Reviewed By: | EH |
| Date: | 01/05/12 | Date: | 01/12/12 |

| Total Sample Height, *inches* | | Inside Diameter of Cut Tube, *inches* | | Moisture Content | | |
|---|---|---|---|---|---|---|
| 1 | 5.755 | | | Tare No. | R-6 | |
| 2 | 5.695 | Top | 2.831 | Tare Weight | 16.70 | *grams* |
| 3 | 5.783 | Bottom | 2.854 | Wet Weight + Tare | 199.89 | *grams* |
| Average | 5.744 | Average | 2.843 | Dry Weight + Tare | 166.62 | *grams* |
| | | | | Moisture Content | 22.2 | % |

| | | |
|---|---|---|
| Total Weight of Soil + Tube Section | 1713.87 | *grams* |
| Weight of Clean, Dry Tube Section | 459.87 | *grams* |
| Wet Weight of Soil | 2.7646 | *lbs* |
| Volume of Sample | 0.02110 | $ft^3$ |

## RESULT SUMMARY

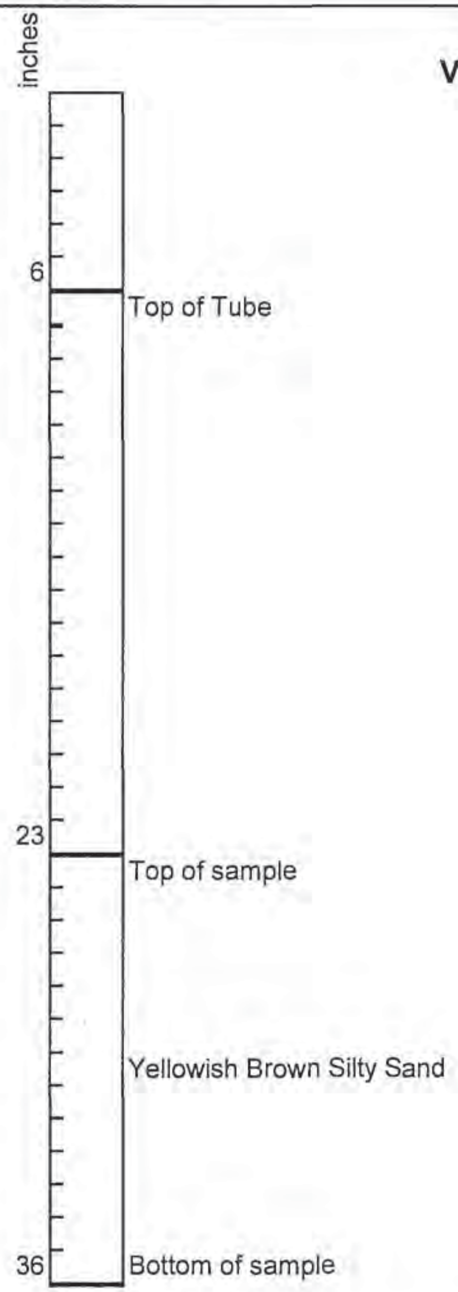
| | | |
|---|---|---|
| **Moisture Content** | **22.2** | % |
| **Wet Density** | **131.1** | *pcf* |
| **Dry Density** | **107.3** | *pcf* |

Remarks:

# UNDISTURBED SAMPLE LOG
## TECHNICAL PROCEDURE TP-06

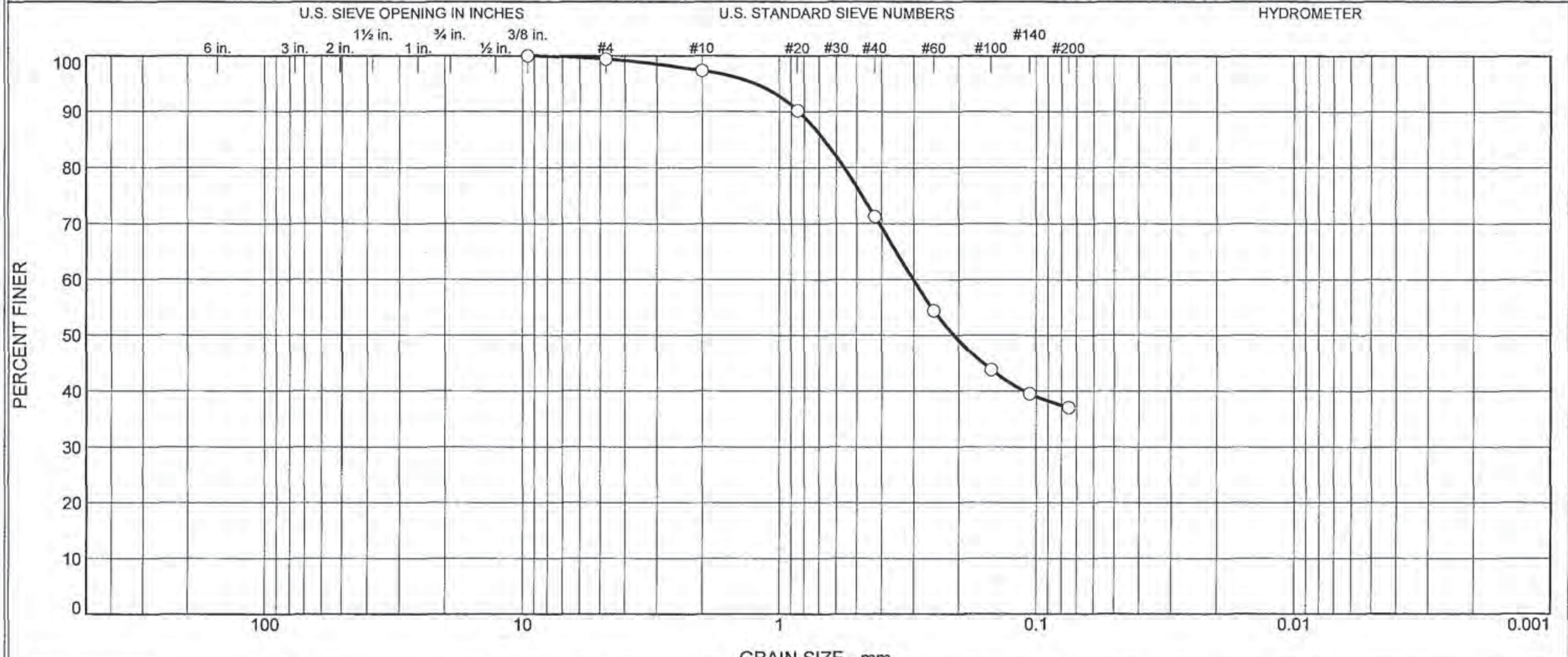
Project Name: Saltstone Disposal Unit 6 Date: 1/3/2012
Project No: 6155-08-0031.28 Lab No. 11252 Checked By: JW
Boring No: Z-SDU6-B01 Sample No: ST08 Depth: 73.2-75.2 ft
Method of Sample Extrusion: Vertical By: EH

### VISUAL DESCRIPTION




Remarks:

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.6 | 2.1 | 26.0 | 34.3 | 37.0 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B01 | ST02 | 15-17 ft | N/A | SC | Red Clayey Sand | 13.0 | 53 | 24 |

Client SRNS

Project Saltstone Disposal Unit 6

Project No. 6155-08-0031.28 Figure

amec

○ 11246

**Tested By:** EH **Checked By:** JW

# GRAIN SIZE DISTRIBUTION TEST DATA

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B01
**Depth:** 15-17 ft **Sample Number:** ST02
**Material Description:** Red Clayey Sand
**Date:** N/A **Natural Moisture:** 13.0
**Liquid Limit:** 53 **Plastic Limit:** 24 **USCS Class.:** SC
**Testing Remarks:** 11246
**Tested by:** EH **Checked by:** JW

## Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 90.26 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | 0.00 | 100.0 |
| | | | #4 | 0.56 | 99.4 |
| | | | #10 | 2.40 | 97.3 |
| | | | #20 | 8.89 | 90.2 |
| | | | #40 | 25.93 | 71.3 |
| | | | #60 | 41.16 | 54.4 |
| | | | #100 | 50.72 | 43.8 |
| | | | #140 | 54.59 | 39.5 |
| | | | #200 | 56.82 | 37.0 |

## Fractional Components

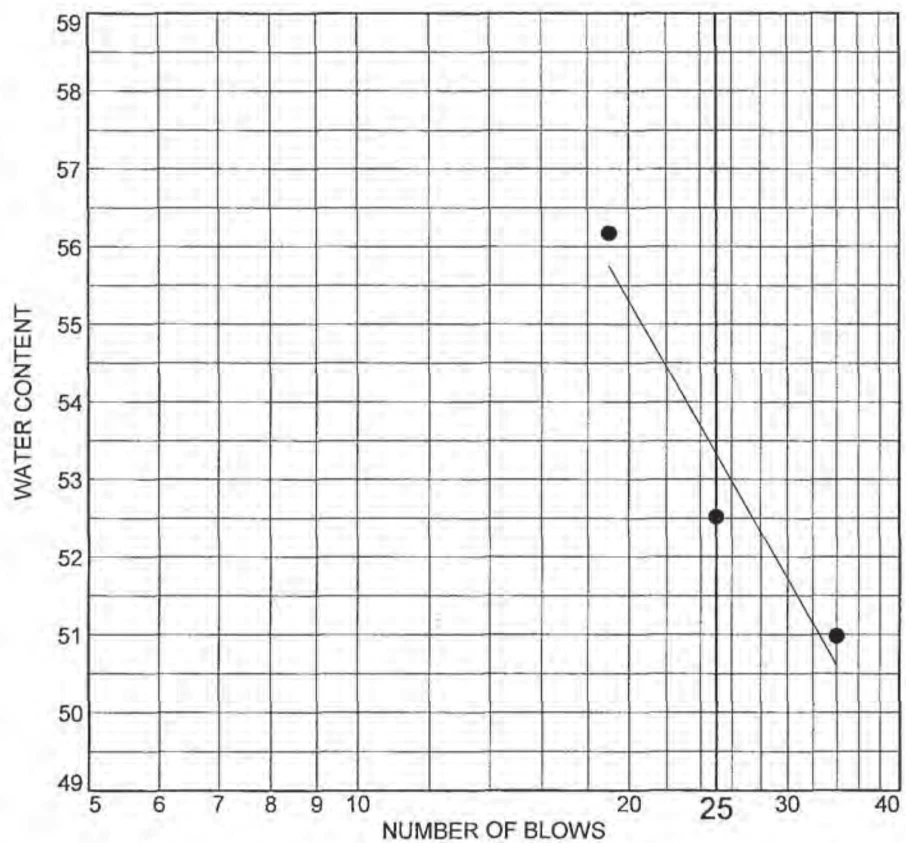
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.6 | 0.6 | 2.1 | 26.0 | 34.3 | 62.4 | | | 37.0 |

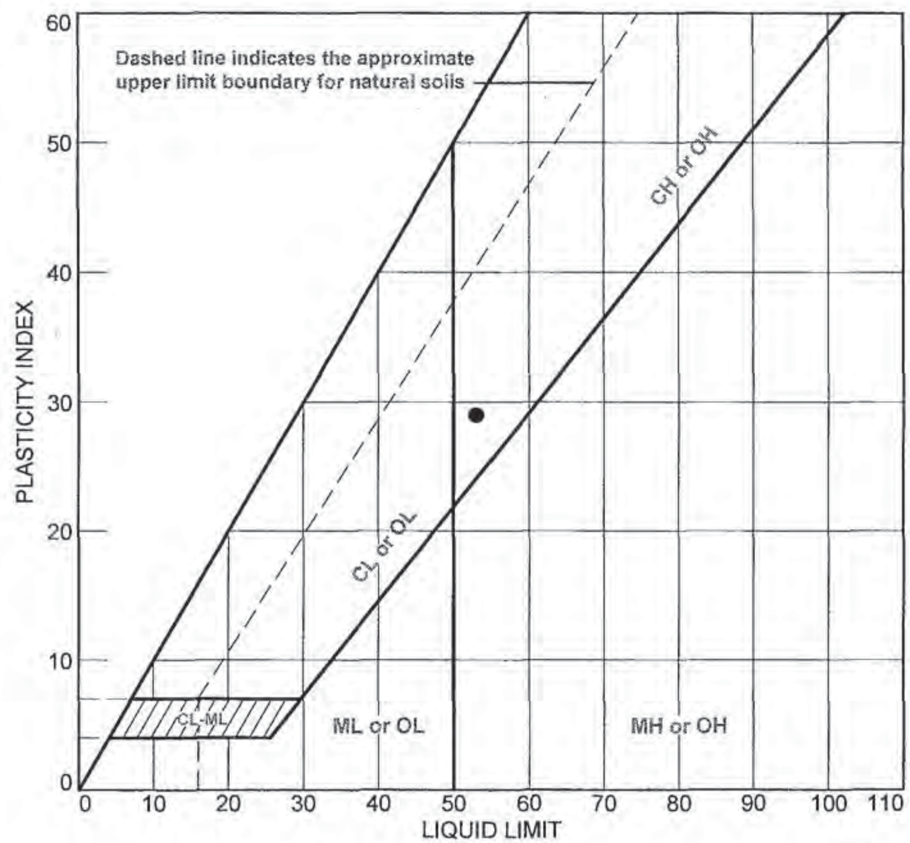
| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | | | | 0.2092 | 0.3020 | 0.5610 | 0.6730 | 0.8431 | 1.2409 |

| Fineness Modulus |
|---|
| 1.23 |

AMEC

# LIQUID AND PLASTIC LIMITS TEST REPORT (ASTM D4318-05)



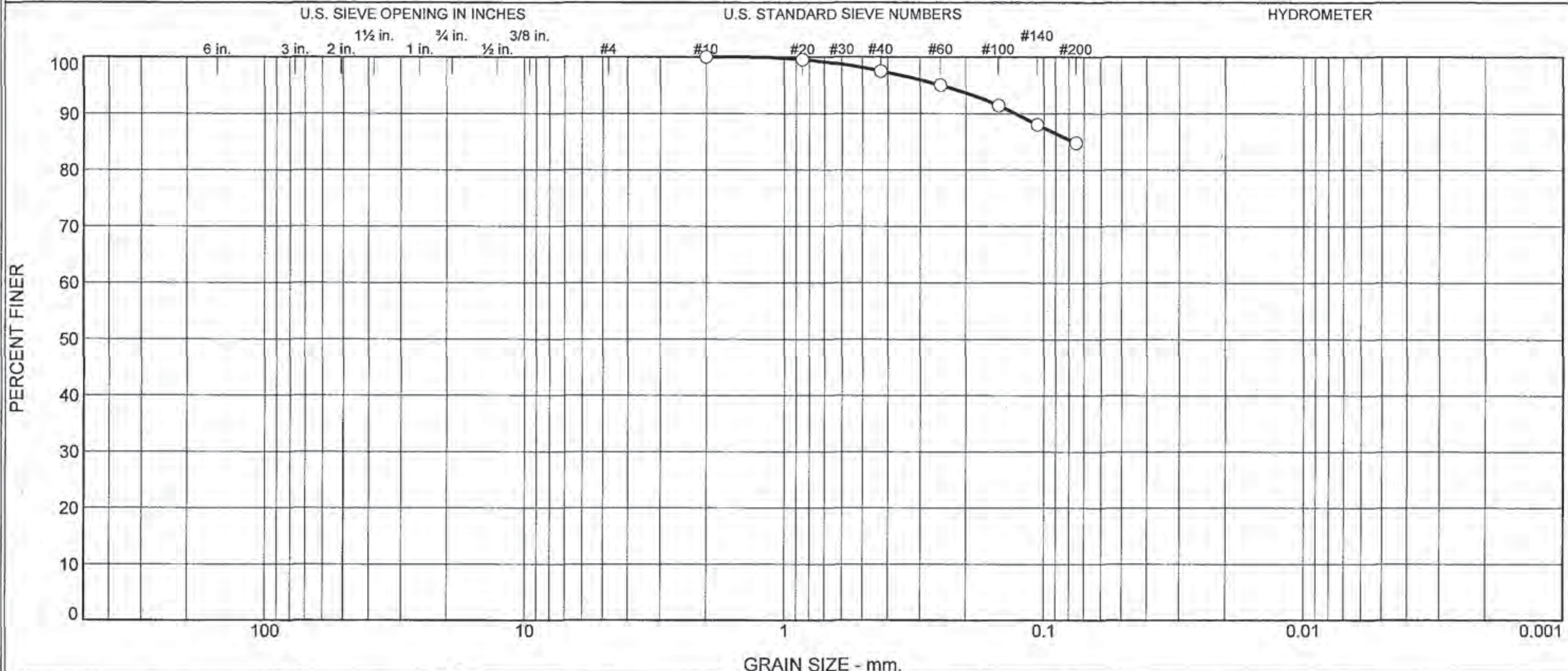

| | SOURCE | SAMPLE # | DEPTH/ELEV. | DATE SAMPLED | USCS | MATERIAL DESCRIPTION | NM % | LL | PI |
|---|---|---|---|---|---|---|---|---|---|
| ● | Z-SDU6-B01 | ST02 | 15-17 ft | N/A | SC | Red Clayey Sand | 13.0 | 53 | 29 |

Client SRNS
Project Saltstone Disposal Unit 6
Project No. 6155-08-0031.28 Figure

● 11246

**Tested By:** EH **Checked By:** JW

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.0 | 2.5 | 12.7 | 84.8 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B01 | FP01 | 22-24 ft | N/A | | Reddish Brown Sandy Silt | 29.9 | | |

Client SRNS

Project Saltstone Disposal Unit 6

Project No. 6155-08-0031.28 Figure

amec

○ 11247

**Tested By:** EH **Checked By:** JW

# GRAIN SIZE DISTRIBUTION TEST DATA

1/12/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B01
**Depth:** 22-24 ft
**Sample Number:** FP01
**Material Description:** Reddish Brown Sandy Silt
**Date:** N/A
**Natural Moisture:** 29.9
**Testing Remarks:** 11247
**Tested by:** EH
**Checked by:** JW

## Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 80.19 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | | |
| | | | #4 | | |
| | | | #10 | 0.00 | 100.0 |
| | | | #20 | 0.40 | 99.5 |
| | | | #40 | 2.02 | 97.5 |
| | | | #60 | 4.03 | 95.0 |
| | | | #100 | 6.89 | 91.4 |
| | | | #140 | 9.60 | 88.0 |
| | | | #200 | 12.17 | 84.8 |

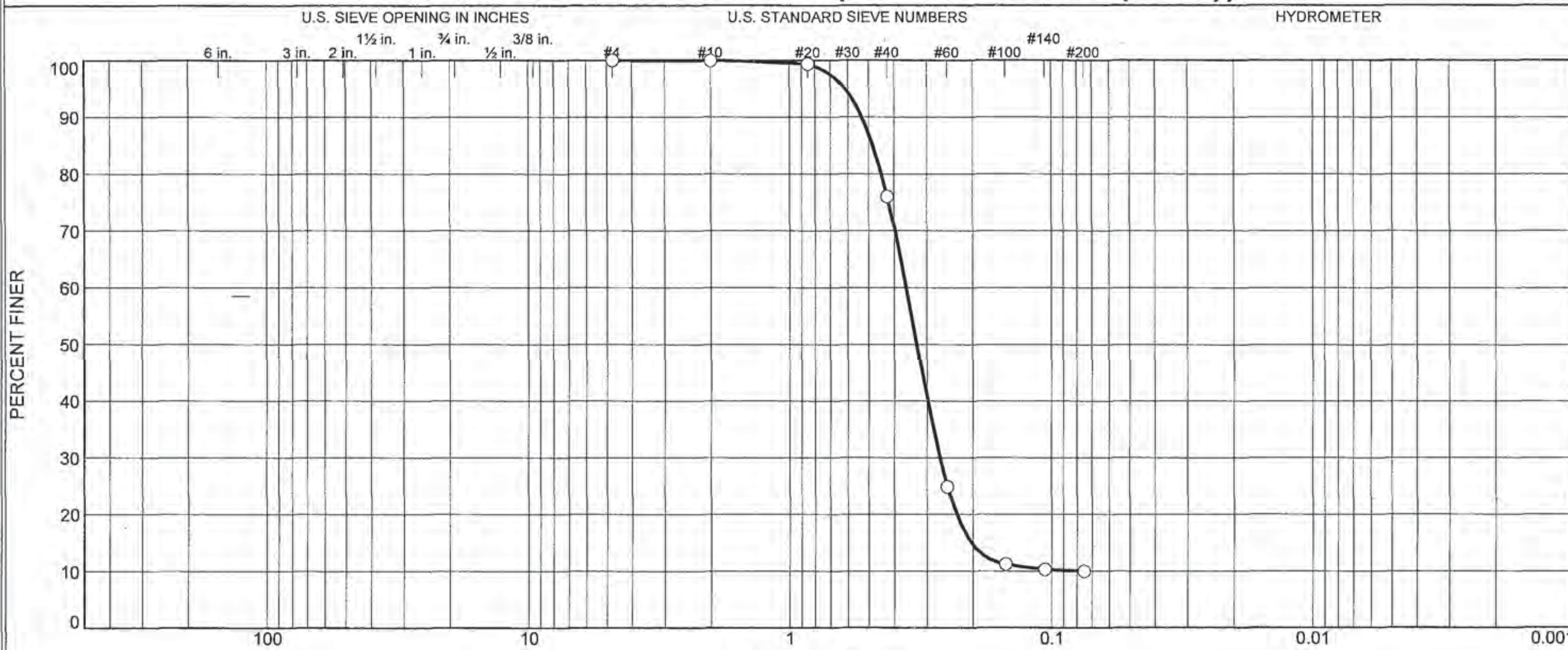
## Fractional Components

| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.5 | 12.7 | 15.2 | | | 84.8 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 0.0765 | 0.1292 | 0.2512 |

| Fineness Modulus |
|---|
| 0.14 |

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.0 | 24.0 | 66.0 | 10.0 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B01 | ST03 | 35-36.3 ft | N/A | | Yellowish Brown Poorly Graded Sand with Silt | 12.0 | | |

Client SRNS
Project Saltstone Disposal Unit 6
Project No. 6155-08-0031.28 Figure

○ 11248

**Tested By:** EH **Checked By:** JW

# GRAIN SIZE DISTRIBUTION TEST DATA

1/12/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B01
**Depth:** 35-36.3 ft **Sample Number:** ST03
**Material Description:** Yellowish Brown Poorly Graded Sand with Silt
**Date:** N/A **Natural Moisture:** 12.0
**Testing Remarks:** 11248
**Tested by:** EH **Checked by:** JW

## Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 108.97 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | | |
| | | | #4 | 0.00 | 100.0 |
| | | | #10 | 0.05 | 100.0 |
| | | | #20 | 0.74 | 99.3 |
| | | | #40 | 26.20 | 76.0 |
| | | | #60 | 81.90 | 24.8 |
| | | | #100 | 96.76 | 11.2 |
| | | | #140 | 97.77 | 10.3 |
| | | | #200 | 98.11 | 10.0 |

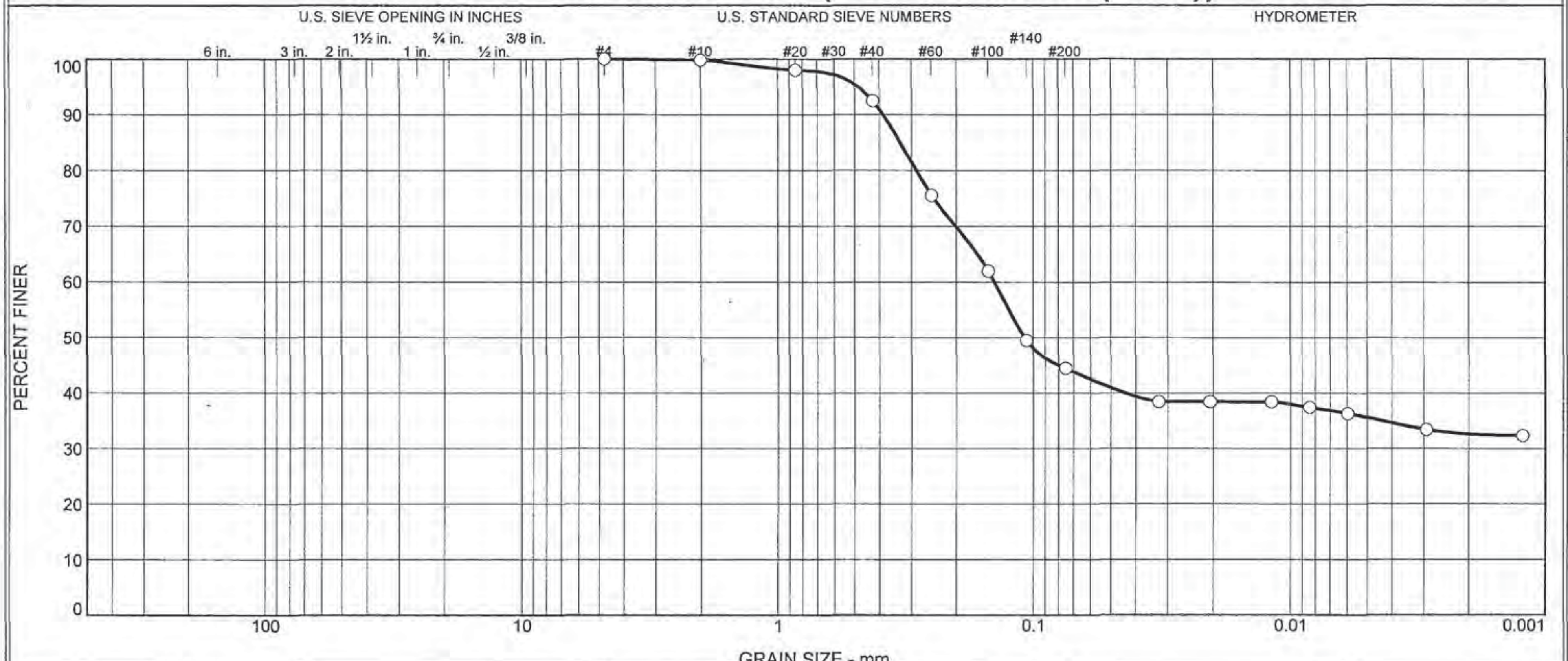
## Fractional Components

| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 24.0 | 66.0 | 90.0 | | | 10.0 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| 0.0794 | 0.2032 | 0.2308 | 0.2672 | 0.3273 | 0.3597 | 0.4478 | 0.4832 | 0.5329 | 0.6168 |

| Fineness Modulus | $C_u$ | $C_c$ |
|---|---|---|
| 1.54 | 4.53 | 2.50 |

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.2 | 7.3 | 48.0 | 8.9 | 35.6 |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B01 | ST04 | 48-50. ft | N/A | SC | Light Brown Clayey Sand | 35.7 | 104 | 30 |

Client SRNS
Project Saltstone Disposal Unit 6
Project No. 6155-08-0031.28 Figure

○ 11249

**Tested By:** EH **Checked By:** JW

# GRAIN SIZE DISTRIBUTION TEST DATA

1/12/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B01
**Depth:** 48-50. ft **Sample Number:** ST04
**Material Description:** Light Brown Clayey Sand
**Date:** N/A **Natural Moisture:** 35.7
**Liquid Limit:** 104 **Plastic Limit:** 30 **USCS Class.:** SC
**Testing Remarks:** 11249
**Tested by:** EH **Checked by:** JW

## Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 45.39 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | | |
| | | | #4 | 0.00 | 100.0 |
| | | | #10 | 0.09 | 99.8 |
| | | | #20 | 0.92 | 98.0 |
| | | | #40 | 3.42 | 92.5 |
| | | | #60 | 11.11 | 75.5 |
| | | | #100 | 17.28 | 61.9 |
| | | | #140 | 22.93 | 49.5 |
| | | | #200 | 25.19 | 44.5 |

## Hydrometer Test Data

Hydrometer test uses material passing #200
Percent passing #200 based upon complete sample = 44.5
Weight of hydrometer sample =20.2
Table of composite correction values:

| Temp., deg. C: | 17.6 | 19.1 | 20.9 | 21.8 | 23.9 |
|---|---|---|---|---|---|
| Comp. corr.: | -7.0 | -6.5 | -6.2 | -6.0 | -5.5 |

Meniscus correction only = 0.0
Specific gravity of solids = 2.7
Hydrometer type = 152H
Hydrometer effective depth equation: L = 16.294964 - 0.164 x Rm

| Elapsed Time (min.) | Temp. (deg. C.) | Actual Reading | Corrected Reading | K | Rm | Eff. Depth | Diameter (mm.) | Percent Finer |
|---|---|---|---|---|---|---|---|---|
| 2.00 | 22.4 | 23.5 | 17.6 | 0.0131 | 23.5 | 12.4 | 0.0326 | 38.4 |
| 5.00 | 22.4 | 23.5 | 17.6 | 0.0131 | 23.5 | 12.4 | 0.0206 | 38.4 |
| 15.00 | 22.4 | 23.5 | 17.6 | 0.0131 | 23.5 | 12.4 | 0.0119 | 38.4 |
| 30.00 | 22.5 | 23.0 | 17.2 | 0.0130 | 23.0 | 12.5 | 0.0084 | 37.4 |
| 60.00 | 22.5 | 22.5 | 16.7 | 0.0130 | 22.5 | 12.6 | 0.0060 | 36.3 |
| 250.00 | 23.2 | 21.0 | 15.3 | 0.0129 | 21.0 | 12.9 | 0.0029 | 33.4 |
| 1440.00 | 23.2 | 20.5 | 14.8 | 0.0129 | 20.5 | 12.9 | 0.0012 | 32.3 |

AMEC

## Fractional Components

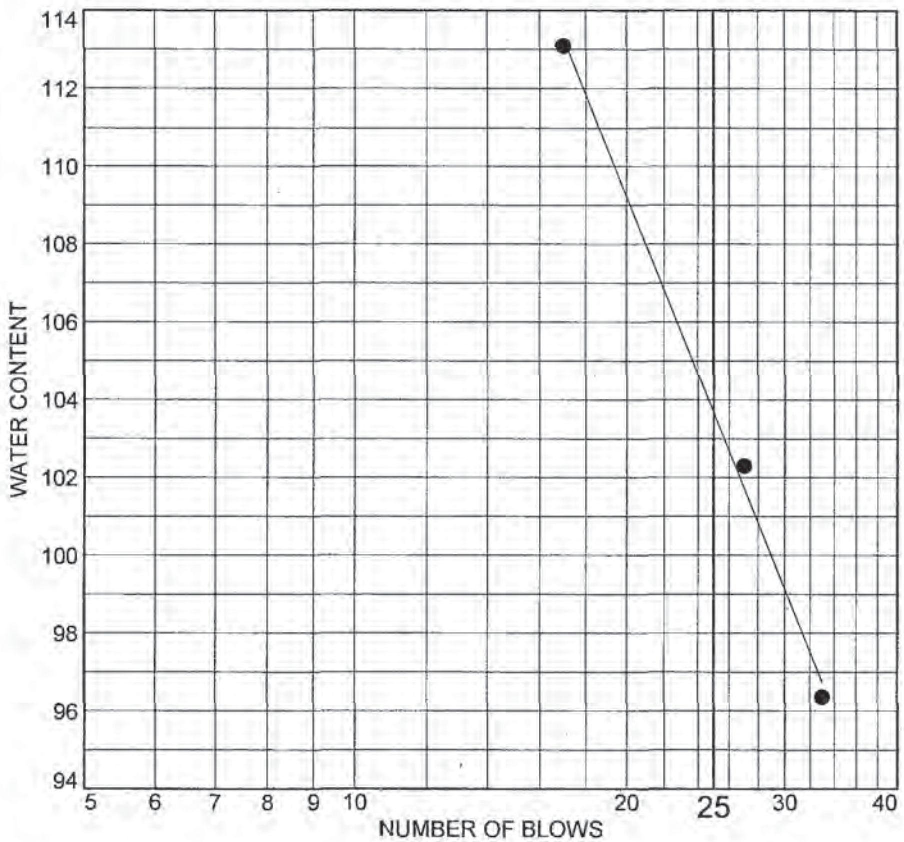
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 7.3 | 48.0 | 55.5 | 8.9 | 35.6 | 44.5 |

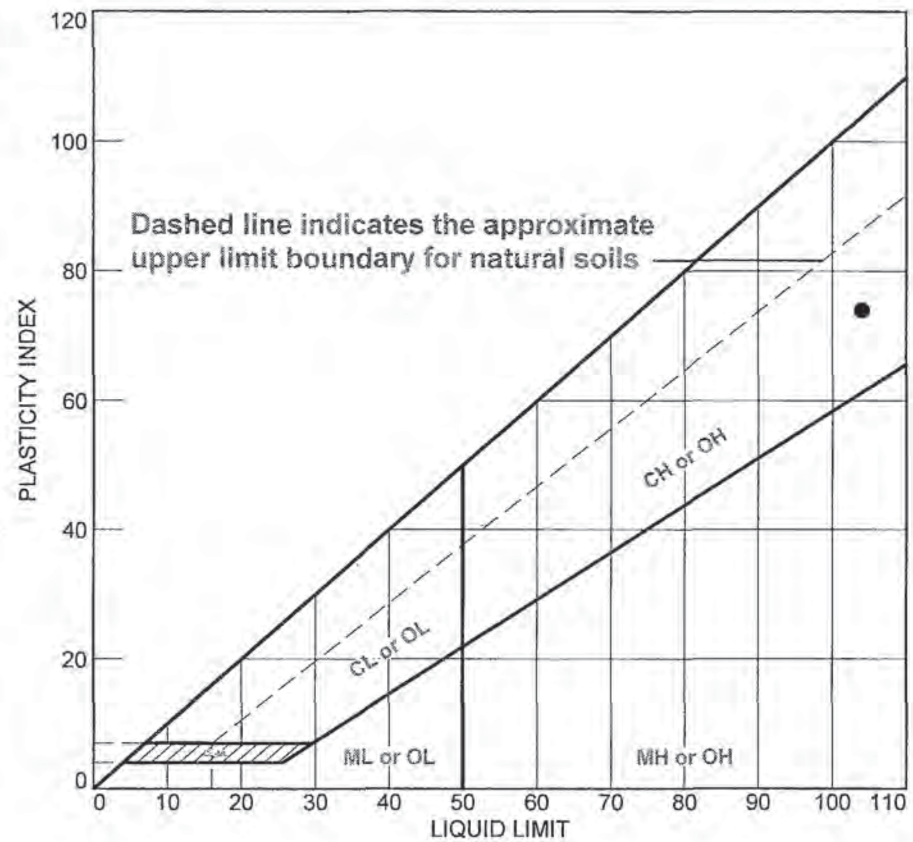
| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | | | | 0.1080 | 0.1421 | 0.2874 | 0.3321 | 0.3876 | 0.4843 |

| Fineness Modulus |
|---|
| 0.61 |

AMEC

# LIQUID AND PLASTIC LIMITS TEST REPORT (ASTM D4318-05)




| | SOURCE | SAMPLE # | DEPTH/ELEV. | DATE SAMPLED | USCS | MATERIAL DESCRIPTION | NM % | LL | PI |
|---|---|---|---|---|---|---|---|---|---|
| ● | Z-SDU6-B01 | ST04 | 48-50. ft | N/A | SC | Light Brown Clayey Sand | 35.7 | 104 | 74 |

Client SRNS

Project Saltstone Disposal Unit 6

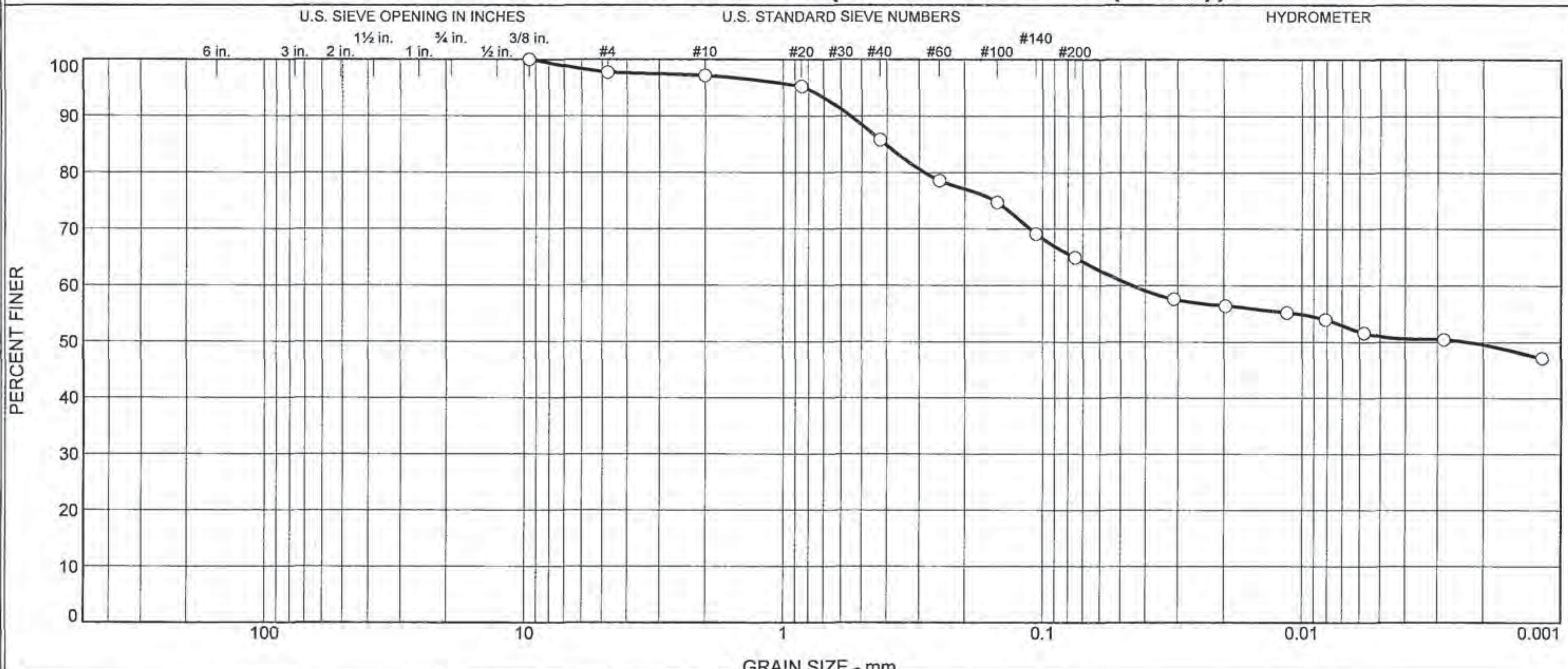
Project No. 6155-08-0031.28 Figure

amec

● 11249

**Tested By:** EH **Checked By:** JW

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 2.3 | 0.5 | 11.4 | 20.9 | 13.9 | 51.0 |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B01 | ST05 | 51.1-53.1 ft | N/A | | Light Gray Sandy Clay | 66.0 | | |

Client SRNS

Project Saltstone Disposal Unit 6

Project No. 6155-08-0031.28 Figure

amec

○ 11250

**Tested By:** EH **Checked By:** JW

## GRAIN SIZE DISTRIBUTION TEST DATA

1/12/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B01
**Depth:** 51.1-53.1 ft **Sample Number:** ST05
**Material Description:** Light Gray Sandy Clay
**Date:** N/A **Natural Moisture:** 66.0
**Testing Remarks:** 11250
**Tested by:** EH **Checked by:** JW

### Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 41.58 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | 0.00 | 100.0 |
| | | | #4 | 0.96 | 97.7 |
| | | | #10 | 1.18 | 97.2 |
| | | | #20 | 1.99 | 95.2 |
| | | | #40 | 5.90 | 85.8 |
| | | | #60 | 8.92 | 78.5 |
| | | | #100 | 10.54 | 74.7 |
| | | | #140 | 12.86 | 69.1 |
| | | | #200 | 14.61 | 64.9 |

### Hydrometer Test Data

**Hydrometer test uses material passing** #200
**Percent passing #200 based upon complete sample =** 64.9
**Weight of hydrometer sample =**26.97
**Table of composite correction values:**

| | | | | | |
|---|---|---|---|---|---|
| Temp., deg. C: | 17.6 | 19.1 | 20.9 | 21.8 | 23.9 |
| Comp. corr.: | -7.0 | -6.5 | -6.2 | -6.0 | -5.5 |

**Meniscus correction only =** 0.0
**Specific gravity of solids =** 2.7
**Hydrometer type =** 152H
**Hydrometer effective depth equation:** L = 16.294964 - 0.164 x Rm

| Elapsed Time (min.) | Temp. (deg. C.) | Actual Reading | Corrected Reading | K | Rm | Eff. Depth | Diameter (mm.) | Percent Finer |
|---|---|---|---|---|---|---|---|---|
| 2.00 | 22.6 | 30.0 | 24.2 | 0.0130 | 30.0 | 11.4 | 0.0311 | 57.5 |
| 5.00 | 22.6 | 29.5 | 23.7 | 0.0130 | 29.5 | 11.5 | 0.0197 | 56.3 |
| 15.00 | 22.6 | 29.0 | 23.2 | 0.0130 | 29.0 | 11.5 | 0.0114 | 55.2 |
| 30.00 | 22.6 | 28.5 | 22.7 | 0.0130 | 28.5 | 11.6 | 0.0081 | 54.0 |
| 60.00 | 22.6 | 27.5 | 21.7 | 0.0130 | 27.5 | 11.8 | 0.0058 | 51.6 |
| 250.00 | 22.6 | 27.0 | 21.2 | 0.0130 | 27.0 | 11.9 | 0.0028 | 50.4 |
| 1440.00 | 23.2 | 25.5 | 19.8 | 0.0129 | 25.5 | 12.1 | 0.0012 | 47.2 |

**AMEC**

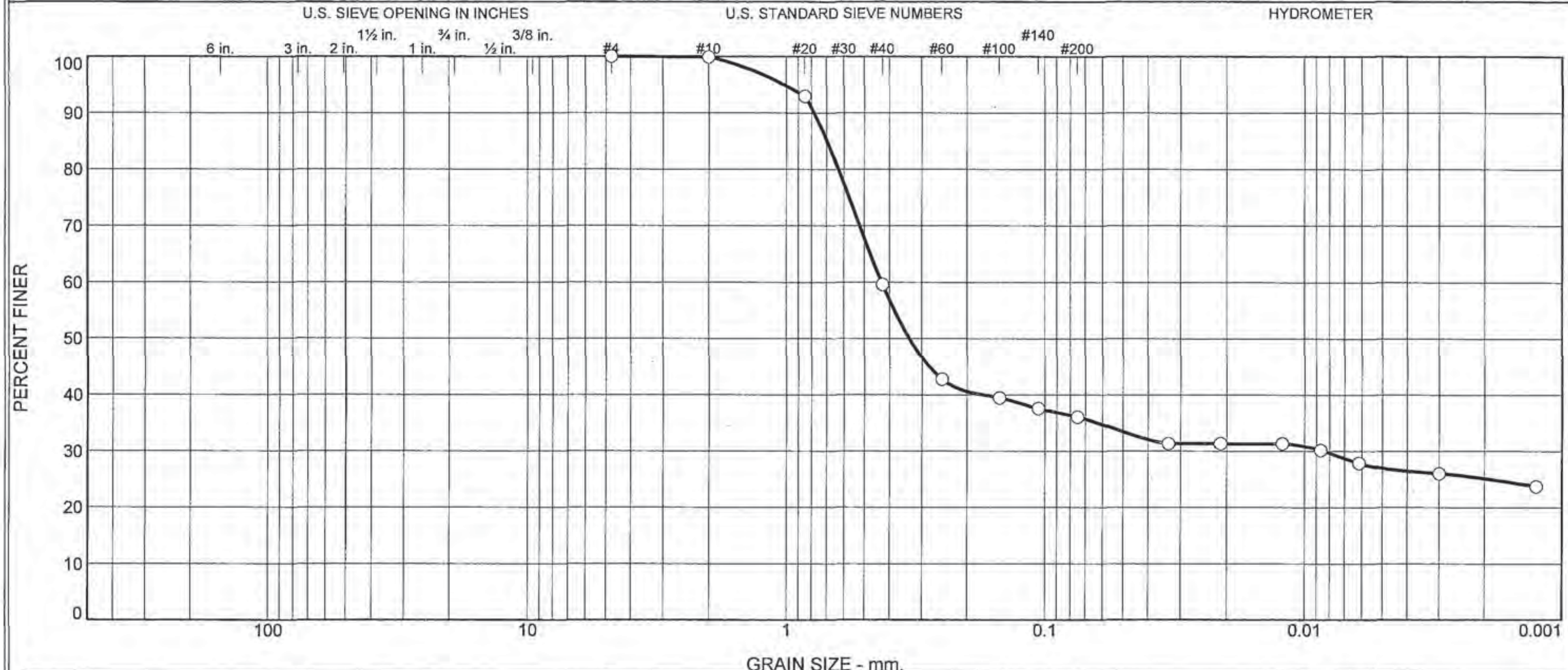
## Fractional Components

| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 2.3 | 2.3 | 0.5 | 11.4 | 20.9 | 32.8 | 13.9 | 51.0 | 64.9 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | | | | 0.0023 | 0.0453 | 0.2871 | 0.4042 | 0.5543 | 0.8293 |

| Fineness Modulus |
|---|
| 0.63 |

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.1 | 40.4 | 23.4 | 9.2 | 26.9 |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B01 | ST06 | 58-60 ft | N/A | SC | Light Gray Clayey Sand | 42.2 | 114 | 44 |

Client SRNS

Project Saltstone Disposal Unit 6

Project No. 6155-08-0031.28 Figure

○ 11251

**Tested By:** EH **Checked By:** JW

# GRAIN SIZE DISTRIBUTION TEST DATA

1/12/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B01
**Depth:** 58-60 ft **Sample Number:** ST06
**Material Description:** Light Gray Clayey Sand
**Date:** N/A **Natural Moisture:** 42.2
**Liquid Limit:** 114 **Plastic Limit:** 44 **USCS Class.:** SC
**Testing Remarks:** 11251
**Tested by:** EH **Checked by:** JW

## Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 43.11 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | | |
| | | | #4 | 0.00 | 100.0 |
| | | | #10 | 0.04 | 99.9 |
| | | | #20 | 3.05 | 92.9 |
| | | | #40 | 17.44 | 59.5 |
| | | | #60 | 24.67 | 42.8 |
| | | | #100 | 26.09 | 39.5 |
| | | | #140 | 26.91 | 37.6 |
| | | | #200 | 27.56 | 36.1 |

## Hydrometer Test Data

Hydrometer test uses material passing #200
Percent passing #200 based upon complete sample = 36.1
Weight of hydrometer sample =15.55
Table of composite correction values:

| Temp., deg. C: | 17.6 | 19.1 | 20.9 | 21.8 | 23.9 |
|---|---|---|---|---|---|
| Comp. corr.: | -7.0 | -6.5 | -6.2 | -6.0 | -5.5 |

Meniscus correction only = 0.0
Specific gravity of solids = 2.7
Hydrometer type = 152H
Hydrometer effective depth equation: L = 16.294964 - 0.164 x Rm

| Elapsed Time (min.) | Temp. (deg. C.) | Actual Reading | Corrected Reading | K | Rm | Eff. Depth | Diameter (mm.) | Percent Finer |
|---|---|---|---|---|---|---|---|---|
| 2.00 | 22.4 | 19.5 | 13.6 | 0.0131 | 19.5 | 13.1 | 0.0334 | 31.3 |
| 5.00 | 22.4 | 19.5 | 13.6 | 0.0131 | 19.5 | 13.1 | 0.0211 | 31.3 |
| 15.00 | 22.4 | 19.5 | 13.6 | 0.0131 | 19.5 | 13.1 | 0.0122 | 31.3 |
| 30.00 | 22.4 | 19.0 | 13.1 | 0.0131 | 19.0 | 13.2 | 0.0087 | 30.1 |
| 60.00 | 22.4 | 18.0 | 12.1 | 0.0131 | 18.0 | 13.3 | 0.0062 | 27.9 |
| 250.00 | 23.2 | 17.0 | 11.3 | 0.0129 | 17.0 | 13.5 | 0.0030 | 26.0 |
| 1440.00 | 23.2 | 16.0 | 10.3 | 0.0129 | 16.0 | 13.7 | 0.0013 | 23.7 |

AMEC

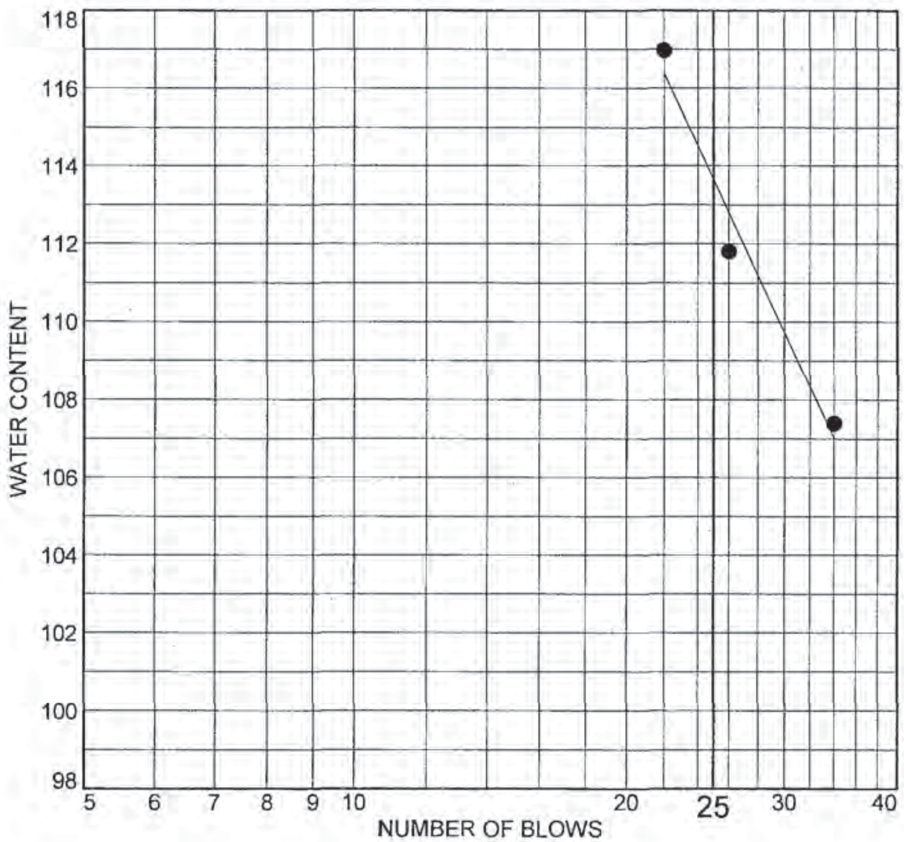
## Fractional Components

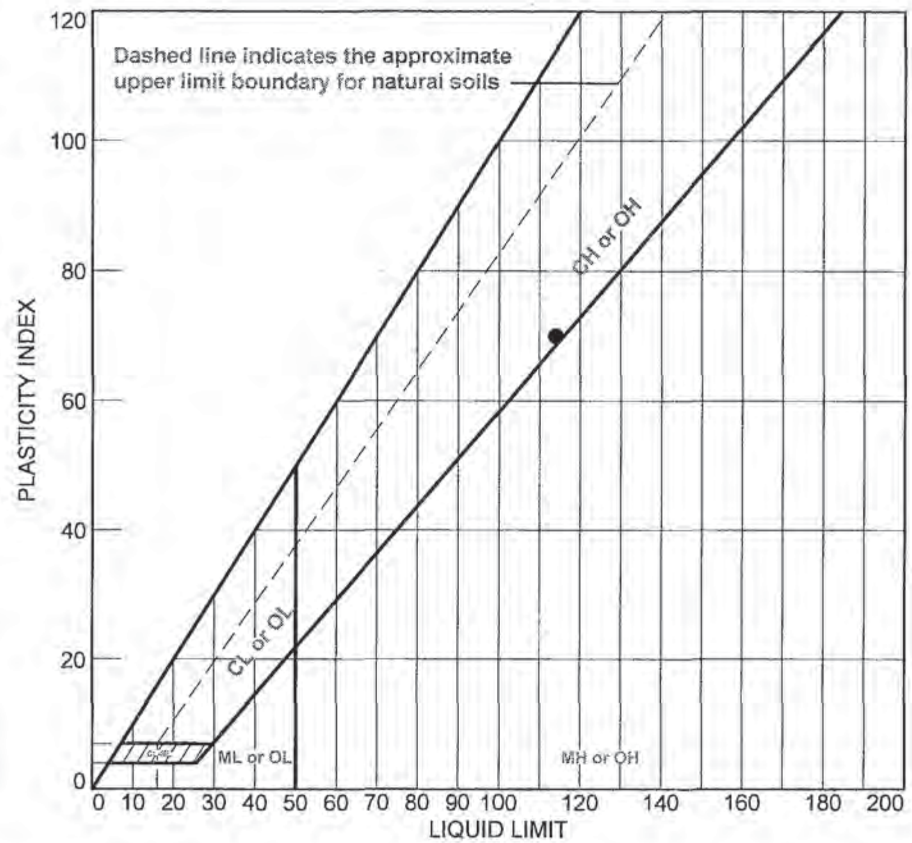
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 40.4 | 23.4 | 63.9 | 9.2 | 26.9 | 36.1 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | | | 0.0084 | 0.3349 | 0.4291 | 0.6320 | 0.6995 | 0.7846 | 1.0212 |

| Fineness Modulus |
|---|
| 1.40 |

# LIQUID AND PLASTIC LIMITS TEST REPORT (ASTM D4318-05)




| | SOURCE | SAMPLE # | DEPTH/ELEV. | DATE SAMPLED | USCS | MATERIAL DESCRIPTION | NM % | LL | PI |
|---|---|---|---|---|---|---|---|---|---|
| ● | Z-SDU6-B01 | ST06 | 58-60 ft | N/A | SC | Light Gray Clayey Sand | 42.2 | 114 | 70 |

Client SRNS

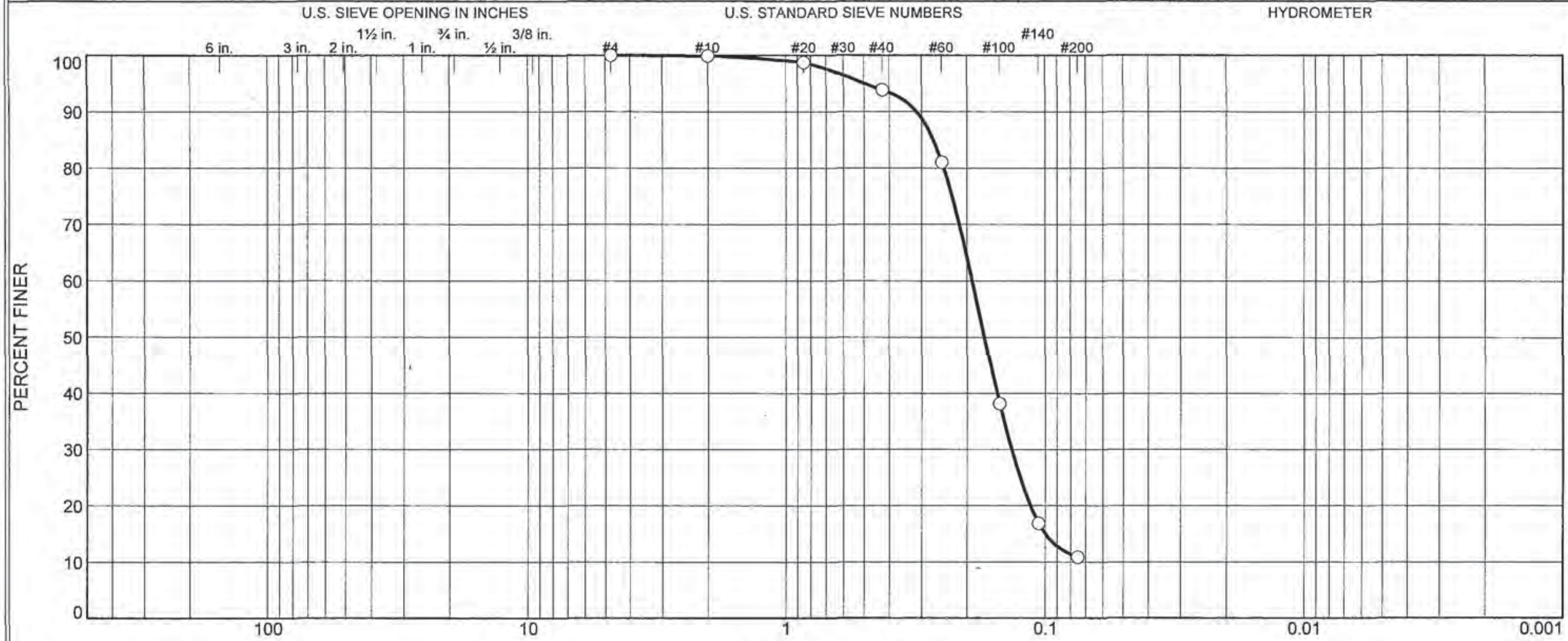
Project Saltstone Disposal Unit 6

Project No. 6155-08-0031.28 Figure

● 11251

**Tested By:** EH **Checked By:** JW

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.1 | 6.1 | 82.9 | 10.9 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B01 | ST08 | 73.2-75.2 ft | N/A | | Yellowish Brown Silty Sand | 33.0 | | |

Client SRNS
Project Saltstone Disposal Unit 6
Project No. 6155-08-0031.28 Figure

amec

○ 11252

**Tested By:** EH **Checked By:** JW

# GRAIN SIZE DISTRIBUTION TEST DATA

1/12/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B01
**Depth:** 73.2-75.2 ft
**Sample Number:** ST08
**Material Description:** Yellowish Brown Silty Sand
**Date:** N/A
**Natural Moisture:** 33.0
**Testing Remarks:** 11252
**Tested by:** EH
**Checked by:** JW

## Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 99.80 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | | |
| | | | #4 | 0.00 | 100.0 |
| | | | #10 | 0.11 | 99.9 |
| | | | #20 | 1.25 | 98.7 |
| | | | #40 | 6.18 | 93.8 |
| | | | #60 | 18.96 | 81.0 |
| | | | #100 | 61.73 | 38.1 |
| | | | #140 | 82.99 | 16.8 |
| | | | #200 | 88.97 | 10.9 |

## Fractional Components

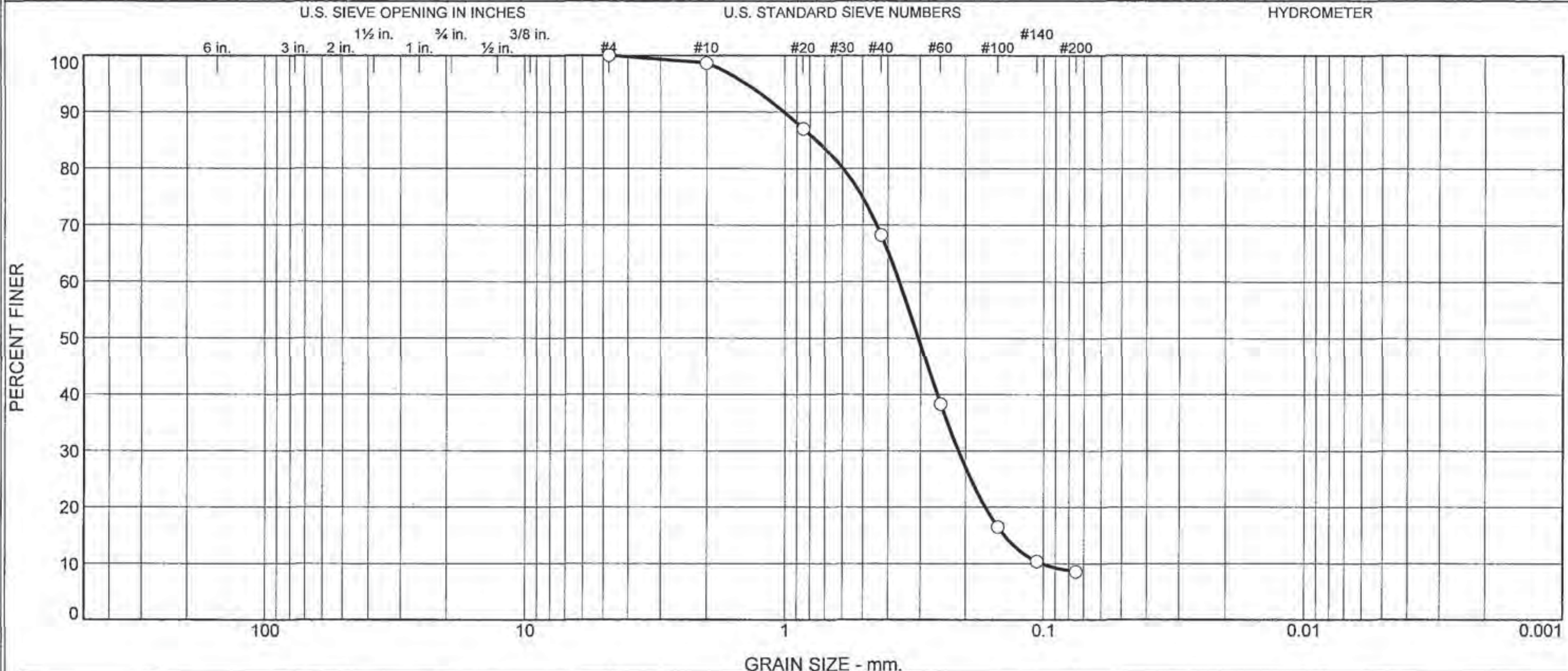
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 6.1 | 82.9 | 89.1 | | | 10.9 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | 0.1000 | 0.1142 | 0.1350 | 0.1716 | 0.1913 | 0.2459 | 0.2701 | 0.3138 | 0.4961 |

| Fineness Modulus |
|---|
| 0.77 |

AMEC

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 1.3 | 30.5 | 59.6 | 8.6 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B01 | FP02 | 82-84 ft | N/A | | Tan Poorly Graded Sand with Silt | 21.5 | | |

Client SRNS

Project Saltstone Disposal Unit 6

Project No. 6155-08-0031.28 Figure

amec

○ 11253

**Tested By:** EH **Checked By:** JW

## GRAIN SIZE DISTRIBUTION TEST DATA

1/12/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B01
**Depth:** 82-84 ft
**Sample Number:** FP02
**Material Description:** Tan Poorly Graded Sand with Silt
**Date:** N/A
**Natural Moisture:** 21.5
**Testing Remarks:** 11253
**Tested by:** EH
**Checked by:** JW

### Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 98.13 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | | |
| | | | #4 | 0.00 | 100.0 |
| | | | #10 | 1.32 | 98.7 |
| | | | #20 | 12.72 | 87.0 |
| | | | #40 | 31.19 | 68.2 |
| | | | #60 | 60.54 | 38.3 |
| | | | #100 | 81.98 | 16.5 |
| | | | #140 | 87.94 | 10.4 |
| | | | #200 | 89.72 | 8.6 |

### Fractional Components

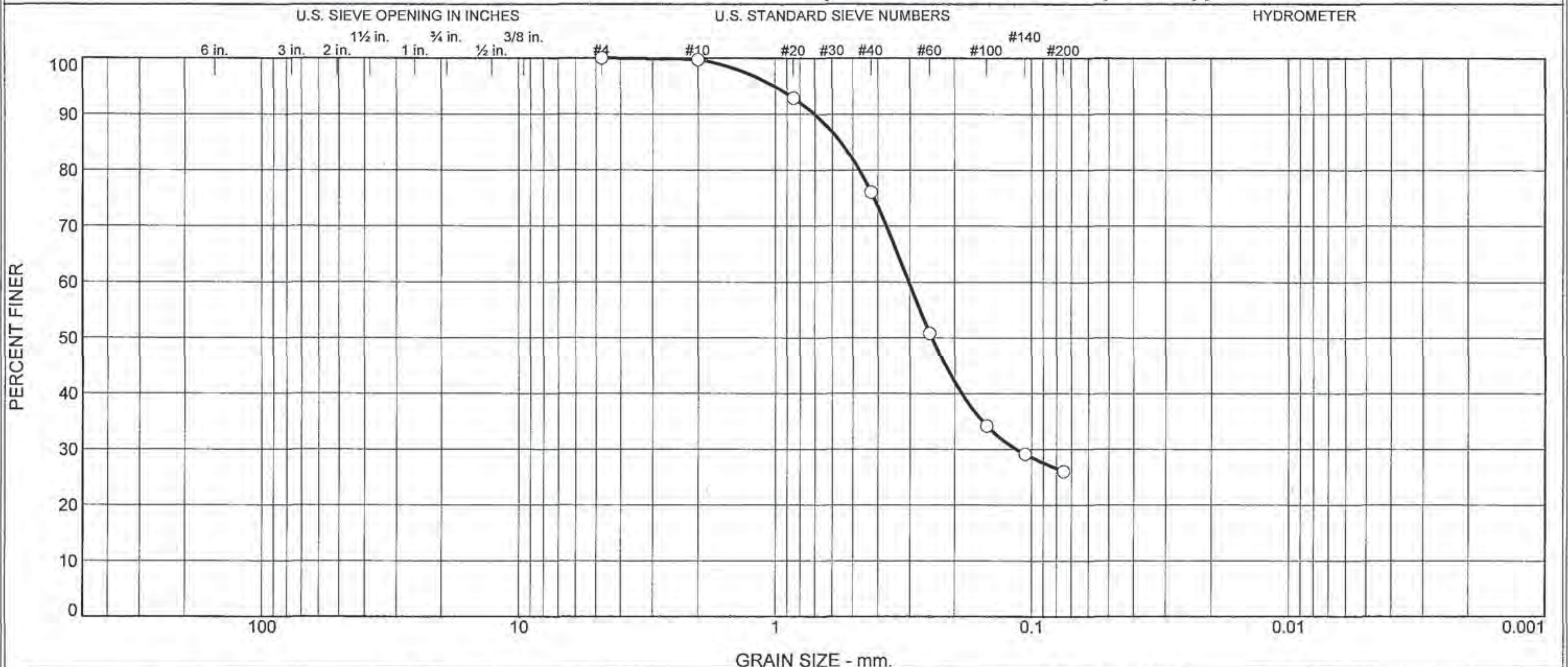
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.0 | 0.0 | 1.3 | 30.5 | 59.6 | 91.4 | | | 8.6 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| 0.1014 | 0.1417 | 0.1680 | 0.2133 | 0.3052 | 0.3622 | 0.5983 | 0.7574 | 1.0127 | 1.4126 |

| Fineness Modulus | $C_u$ | $C_c$ |
|---|---|---|
| 1.63 | 3.57 | 1.24 |

AMEC

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.3 | 23.7 | 50.0 | 26.0 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B01 | ST11 | 126.1-127.6 ft | N/A | | Dark Gray Silt Sand | 23.1 | | |

Client SRNS
Project Saltstone Disposal Unit 6
Project No. 6155-08-0031.28 Figure

○ 11255

**Tested By:** EH **Checked By:** JW

## GRAIN SIZE DISTRIBUTION TEST DATA

1/17/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B01
**Depth:** 126.1-127.6 ft
**Sample Number:** ST11
**Material Description:** Dark Gray Silt Sand
**Date:** N/A
**Natural Moisture:** 23.1
**Testing Remarks:** 11255
**Tested by:** EH
**Checked by:** JW

### Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 92.99 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | | |
| | | | #4 | 0.00 | 100.0 |
| | | | #10 | 0.27 | 99.7 |
| | | | #20 | 6.66 | 92.8 |
| | | | #40 | 22.29 | 76.0 |
| | | | #60 | 45.76 | 50.8 |
| | | | #100 | 61.23 | 34.2 |
| | | | #140 | 65.92 | 29.1 |
| | | | #200 | 68.82 | 26.0 |

### Fractional Components

| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 23.7 | 50.0 | 74.0 | | | 26.0 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | | | 0.1149 | 0.2456 | 0.3029 | 0.4727 | 0.5587 | 0.7062 | 1.0130 |

| Fineness Modulus |
|---|
| 1.23 |

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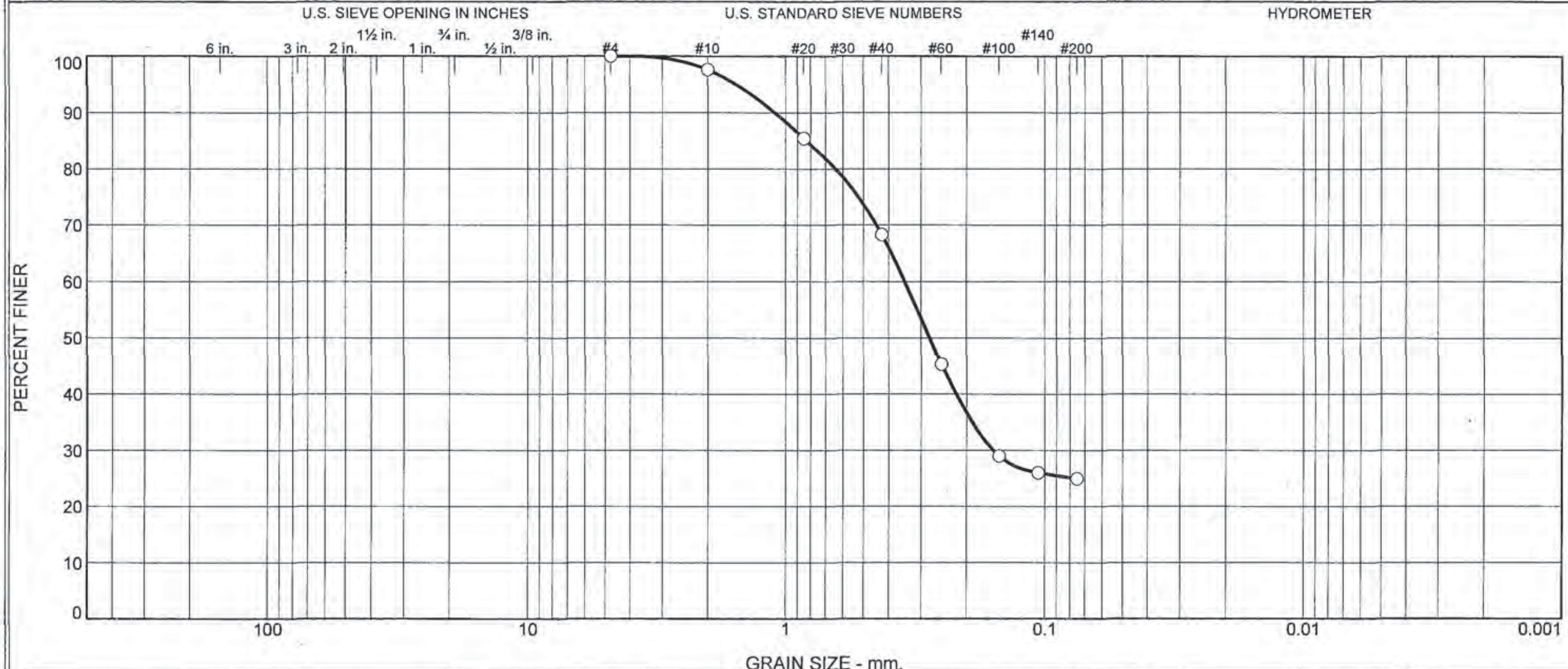
# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 2.4 | 29.3 | 43.4 | 24.9 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B02 | FPT01 | 44-46 ft | N/A | | Brown Clayey Sand | 26.4 | | |

Client SRNS

Project Saltstone Disposal Unit 6

Project No. 6155-08-0031.28 Figure

amec

○ 11256

**Tested By:** EH **Checked By:** JW

## GRAIN SIZE DISTRIBUTION TEST DATA

1/12/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B02
**Depth:** 44-46 ft
**Sample Number:** FPT01
**Material Description:** Brown Clayey Sand
**Date:** N/A
**Natural Moisture:** 26.4
**Testing Remarks:** 11256
**Tested by:** EH
**Checked by:** JW

### Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 85.73 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | | |
| | | | #4 | 0.00 | 100.0 |
| | | | #10 | 2.05 | 97.6 |
| | | | #20 | 12.49 | 85.4 |
| | | | #40 | 27.19 | 68.3 |
| | | | #60 | 46.85 | 45.4 |
| | | | #100 | 60.90 | 29.0 |
| | | | #140 | 63.46 | 26.0 |
| | | | #200 | 64.37 | 24.9 |

### Fractional Components

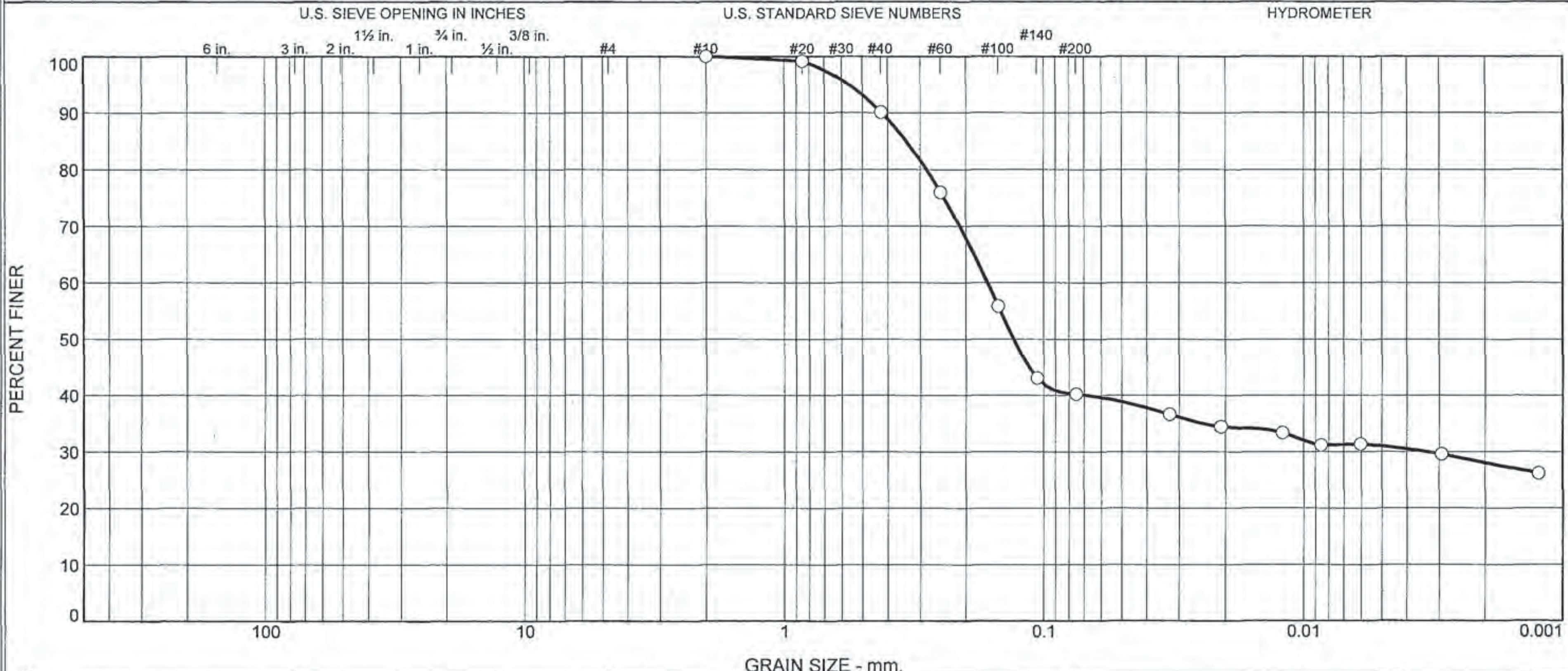
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.0 | 0.0 | 2.4 | 29.3 | 43.4 | 75.1 | | | 24.9 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | | | 0.1583 | 0.2778 | 0.3470 | 0.6430 | 0.8300 | 1.1063 | 1.5579 |

| Fineness Modulus |
|---|
| 1.49 |

AMEC

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.0 | 9.9 | 49.9 | 9.2 | 31.0 |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B02 | FPT02 | 47-49 ft | N/A | | Light Brown Clayey Sand | 33.4 | | |

Client SRNS

Project Saltstone Disposal Unit 6

Project No. 6155-08-0031.28 Figure

○ 11257

**Tested By:** EH **Checked By:** JW

## GRAIN SIZE DISTRIBUTION TEST DATA

1/17/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B02
**Depth:** 47-49 ft  **Sample Number:** FPT02
**Material Description:** Light Brown Clayey Sand
**Date:** N/A  **Natural Moisture:** 33.4
**Testing Remarks:** 11257
**Tested by:** EH  **Checked by:** JW

### Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 45.14 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | | |
| | | | #4 | | |
| | | | #10 | 0.00 | 100.0 |
| | | | #20 | 0.39 | 99.1 |
| | | | #40 | 4.46 | 90.1 |
| | | | #60 | 10.87 | 75.9 |
| | | | #100 | 19.96 | 55.8 |
| | | | #140 | 25.69 | 43.1 |
| | | | #200 | 27.00 | 40.2 |

### Hydrometer Test Data

Hydrometer test uses material passing #200
Percent passing #200 based upon complete sample = 40.2
Weight of hydrometer sample =18.14
Table of composite correction values:

| Temp., deg. C: | 17.6 | 19.1 | 20.9 | 21.8 | 23.9 |
|---|---|---|---|---|---|
| Comp. corr.: | -7.0 | -6.5 | -6.2 | -6.0 | -5.5 |

Meniscus correction only = 0.0
Specific gravity of solids = 2.7
Hydrometer type = 152H
Hydrometer effective depth equation: L = 16.294964 - 0.164 x Rm

| Elapsed Time (min.) | Temp. (deg. C.) | Actual Reading | Corrected Reading | K | Rm | Eff. Depth | Diameter (mm.) | Percent Finer |
|---|---|---|---|---|---|---|---|---|
| 2.00 | 22.7 | 22.5 | 16.7 | 0.0130 | 22.5 | 12.6 | 0.0327 | 36.6 |
| 5.00 | 22.7 | 21.5 | 15.7 | 0.0130 | 21.5 | 12.8 | 0.0208 | 34.4 |
| 15.00 | 22.7 | 21.0 | 15.2 | 0.0130 | 21.0 | 12.9 | 0.0120 | 33.3 |
| 30.00 | 22.7 | 20.0 | 14.2 | 0.0130 | 20.0 | 13.0 | 0.0086 | 31.1 |
| 60.00 | 23.1 | 20.0 | 14.3 | 0.0129 | 20.0 | 13.0 | 0.0060 | 31.3 |
| 250.00 | 24.0 | 19.0 | 13.5 | 0.0128 | 19.0 | 13.2 | 0.0029 | 29.6 |
| 1440.00 | 23.7 | 17.5 | 12.0 | 0.0129 | 17.5 | 13.4 | 0.0012 | 26.2 |

AMEC

## Fractional Components

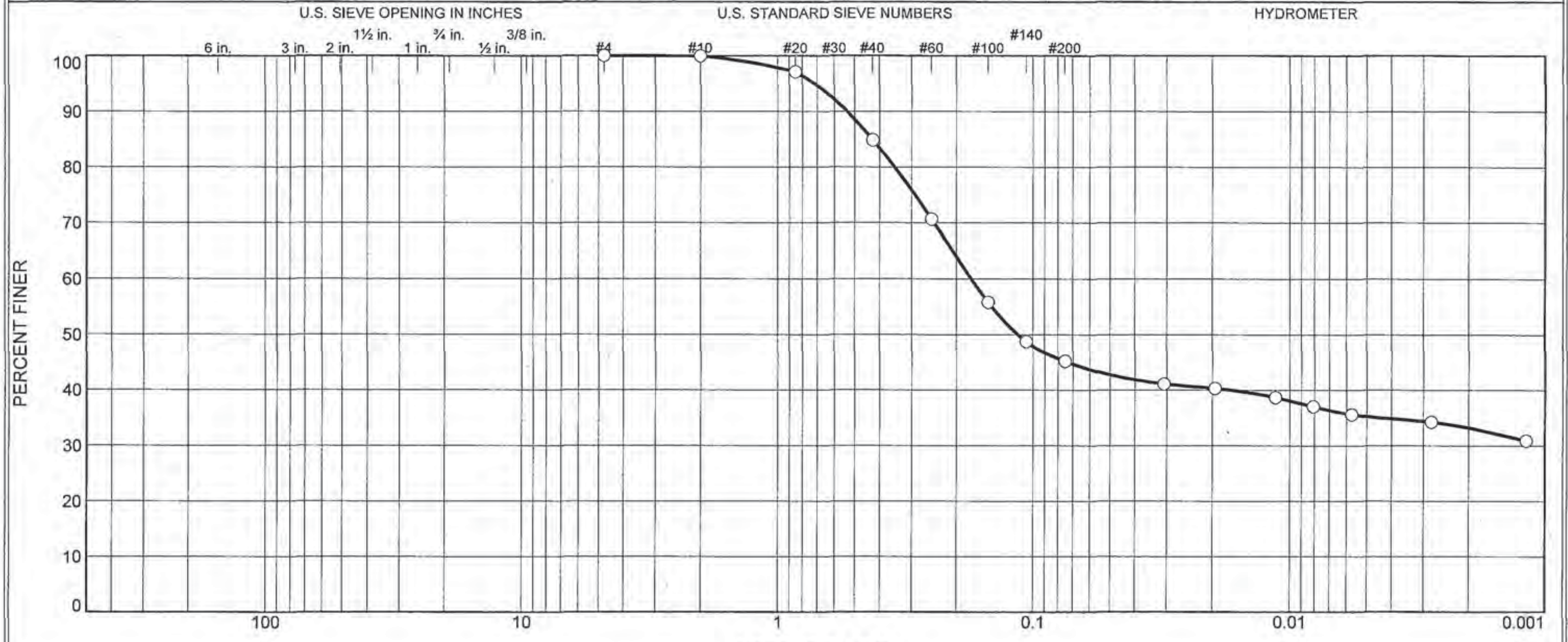
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 9.9 | 49.9 | 59.8 | 9.2 | 31.0 | 40.2 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | | | 0.0034 | 0.1308 | 0.1656 | 0.2839 | 0.3397 | 0.4225 | 0.5647 |

| Fineness Modulus |
|---|
| 0.67 |

AMEC

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.1 | 15.0 | 39.7 | 10.0 | 35.2 |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B02 | ST02 | 10.5-11 ft | N/A | SC | Yellowish Red Clayey Sand | 15.1 | 49 | 24 |

Client SRNS
Project Saltstone Disposal Unit 6
Project No. 6155-08-0031.28 Figure

○ 11258

**Tested By:** EH **Checked By:** JW

# GRAIN SIZE DISTRIBUTION TEST DATA

1/12/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B02
**Depth:** 10.5-11 ft **Sample Number:** ST02
**Material Description:** Yellowish Red Clayey Sand
**Date:** N/A **Natural Moisture:** 15.1
**Liquid Limit:** 49 **Plastic Limit:** 24 **USCS Class.:** SC
**Testing Remarks:** 11258
**Tested by:** EH **Checked by:** JW

## Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 60.66 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | | |
| | | | #4 | 0.00 | 100.0 |
| | | | #10 | 0.05 | 99.9 |
| | | | #20 | 1.77 | 97.1 |
| | | | #40 | 9.18 | 84.9 |
| | | | #60 | 17.84 | 70.6 |
| | | | #100 | 26.83 | 55.8 |
| | | | #140 | 31.10 | 48.7 |
| | | | #200 | 33.25 | 45.2 |

## Hydrometer Test Data

Hydrometer test uses material passing #200
Percent passing #200 based upon complete sample = 45.2
Weight of hydrometer sample =27.41
Table of composite correction values:

| | | | | | |
|---|---|---|---|---|---|
| Temp., deg. C: | 17.6 | 19.1 | 20.9 | 21.8 | 23.9 |
| Comp. corr.: | -7.0 | -6.5 | -6.2 | -6.0 | -5.5 |

Meniscus correction only = 0.0
Specific gravity of solids = 2.7
Hydrometer type = 152H
Hydrometer effective depth equation: L = 16.294964 - 0.164 x Rm

| Elapsed Time (min.) | Temp. (deg. C.) | Actual Reading | Corrected Reading | K | Rm | Eff. Depth | Diameter (mm.) | Percent Finer |
|---|---|---|---|---|---|---|---|---|
| 2.00 | 22.7 | 31.0 | 25.2 | 0.0130 | 31.0 | 11.2 | 0.0308 | 41.1 |
| 5.00 | 22.7 | 30.5 | 24.7 | 0.0130 | 30.5 | 11.3 | 0.0195 | 40.3 |
| 15.00 | 22.7 | 29.5 | 23.7 | 0.0130 | 29.5 | 11.5 | 0.0114 | 38.7 |
| 30.00 | 22.7 | 28.5 | 22.7 | 0.0130 | 28.5 | 11.6 | 0.0081 | 37.0 |
| 60.00 | 23.2 | 27.5 | 21.8 | 0.0129 | 27.5 | 11.8 | 0.0057 | 35.6 |
| 250.00 | 24.0 | 26.5 | 21.0 | 0.0128 | 26.5 | 11.9 | 0.0028 | 34.2 |
| 1440.00 | 23.7 | 24.5 | 19.0 | 0.0129 | 24.5 | 12.3 | 0.0012 | 30.9 |

AMEC

## Fractional Components

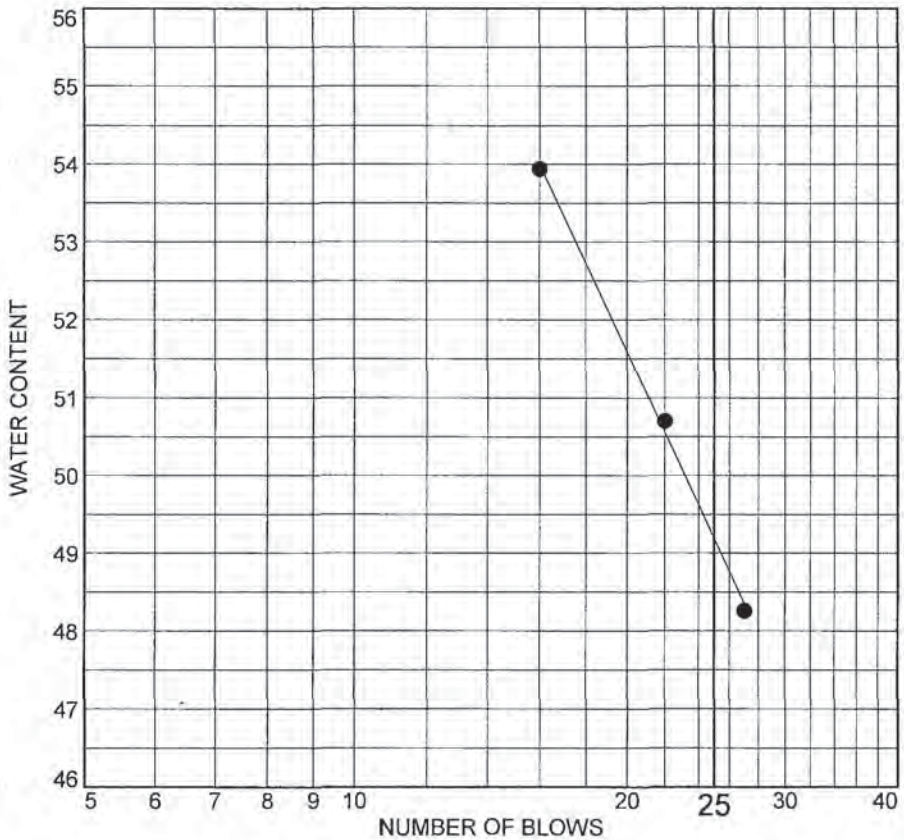
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 15.0 | 39.7 | 54.8 | 10.0 | 35.2 | 45.2 |

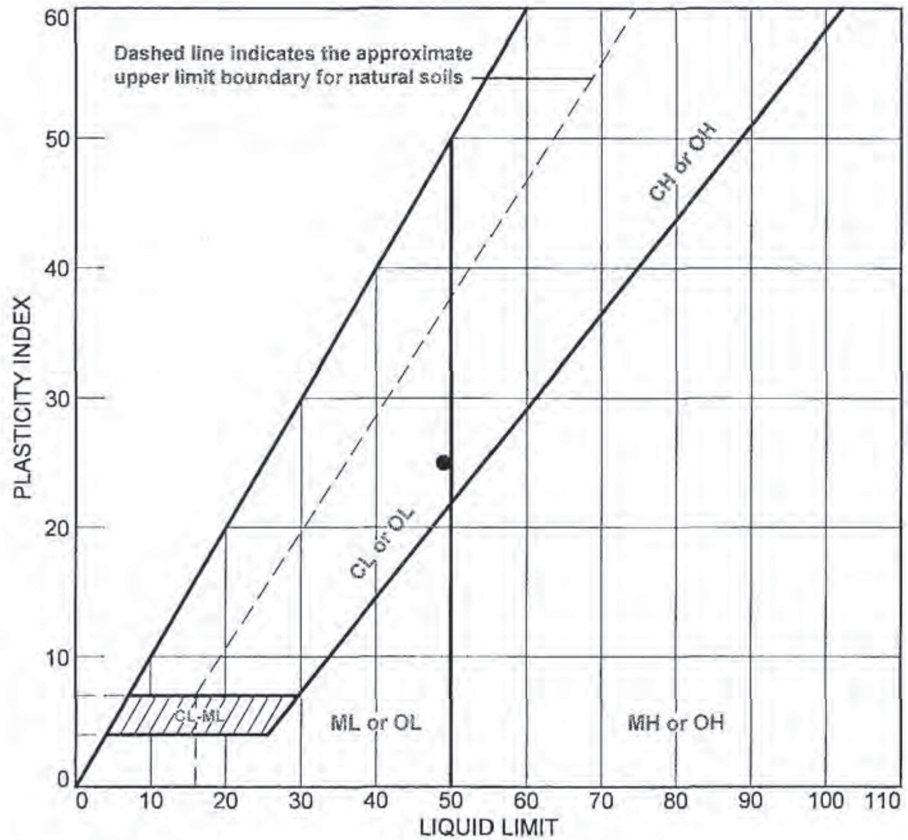
| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | | | | 0.1147 | 0.1754 | 0.3497 | 0.4274 | 0.5372 | 0.7179 |

| Fineness Modulus |
|---|
| 0.78 |

AMEC

# LIQUID AND PLASTIC LIMITS TEST REPORT (ASTM D4318-05)




| | SOURCE | SAMPLE # | DEPTH/ELEV. | DATE SAMPLED | USCS | MATERIAL DESCRIPTION | NM % | LL | PI |
|---|---|---|---|---|---|---|---|---|---|
| ● | Z-SDU6-B02 | ST02 | 10.5-11 ft | N/A | SC | Yellowish Red Clayey Sand | 15.1 | 49 | 25 |

Client SRNS

Project Saltstone Disposal Unit 6

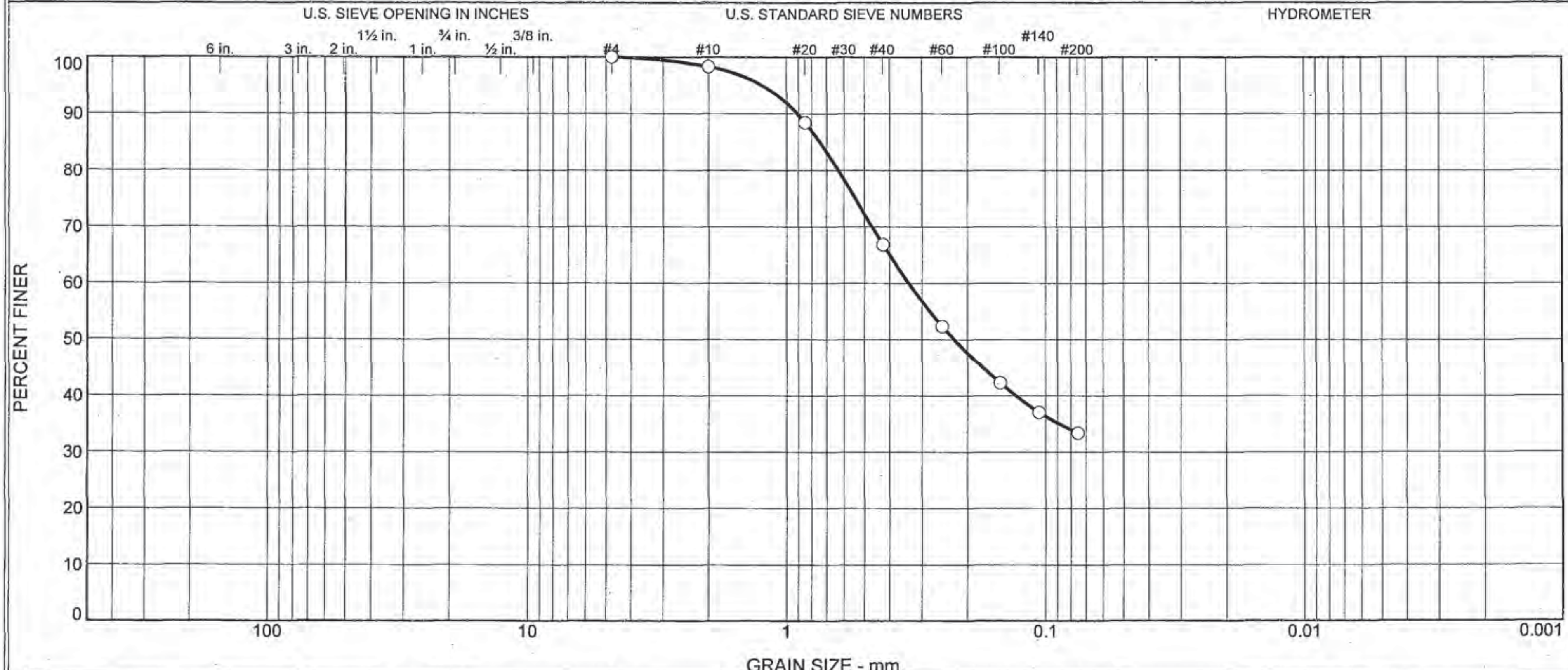
Project No. 6155-08-0031.28 Figure

amec

● 11258

**Tested By:** EH **Checked By:** JW

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 1.7 | 31.5 | 33.4 | 33.4 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B03 | SS01 | 12-14 ft | N/A | | Reddish Brown Silty Sand | 16.5 | | |

Client SRNS

Project Saltstone Disposal Unit 6

Project No. 6155-08-0031.28 Figure

○ 11307

**Tested By:** EH **Checked By:** JW

RCN: SRS200 Page 60 of 217

# GRAIN SIZE DISTRIBUTION TEST DATA

2/3/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B03
**Depth:** 12-14 ft
**Sample Number:** SS01
**Material Description:** Reddish Brown Silty Sand
**Date:** N/A
**Natural Moisture:** 16.5
**Testing Remarks:** 11307
**Tested by:** EH
**Checked by:** JW

## Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 92.44 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | | |
| | | | #4 | 0.00 | 100.0 |
| | | | #10 | 1.55 | 98.3 |
| | | | #20 | 10.69 | 88.4 |
| | | | #40 | 30.65 | 66.8 |
| | | | #60 | 44.06 | 52.3 |
| | | | #100 | 53.34 | 42.3 |
| | | | #140 | 58.21 | 37.0 |
| | | | #200 | 61.61 | 33.4 |

## Fractional Components

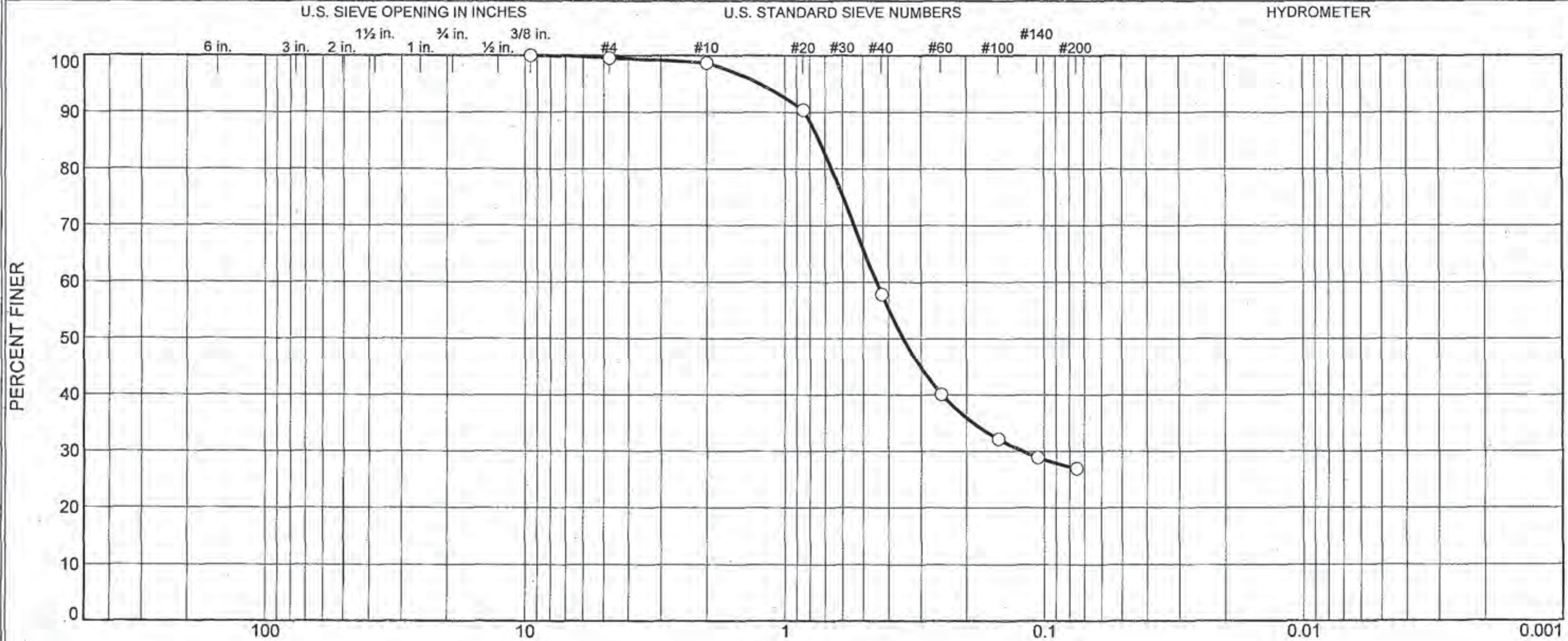
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.0 | 0.0 | 1.7 | 31.5 | 33.4 | 66.6 | | | 33.4 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | | | | 0.2250 | 0.3379 | 0.6329 | 0.7459 | 0.9110 | 1.2435 |

| Fineness Modulus |
|---|
| 1.29 |

AMEC

# Particale Size Distribution (ASTM D422-63 (2007))




| % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ 0.0 | 0.0 | 0.5 | 0.8 | 40.9 | 30.9 | 26.9 | |

| Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|
| ○ Z-SDU6-B03 | SS02 | 14-16 ft | N/A | | Reddish Brown Silty Sand | 16.0 | | |

Client SRNS

Project Saltstone Disposal Unit 6

Project No. 6155-08-0031.28 Figure

amec

○ 11308

**Tested By:** EH **Checked By:** JW

# GRAIN SIZE DISTRIBUTION TEST DATA

2/3/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B03
**Depth:** 14-16 ft
**Sample Number:** SS02
**Material Description:** Reddish Brown Silty Sand
**Date:** N/A
**Natural Moisture:** 16.0
**Testing Remarks:** 11308
**Tested by:** EH
**Checked by:** JW

## Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 100.79 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | 0.00 | 100.0 |
| | | | #4 | 0.47 | 99.5 |
| | | | #10 | 1.35 | 98.7 |
| | | | #20 | 9.69 | 90.4 |
| | | | #40 | 42.54 | 57.8 |
| | | | #60 | 60.36 | 40.1 |
| | | | #100 | 68.39 | 32.1 |
| | | | #140 | 71.69 | 28.9 |
| | | | #200 | 73.66 | 26.9 |

## Fractional Components

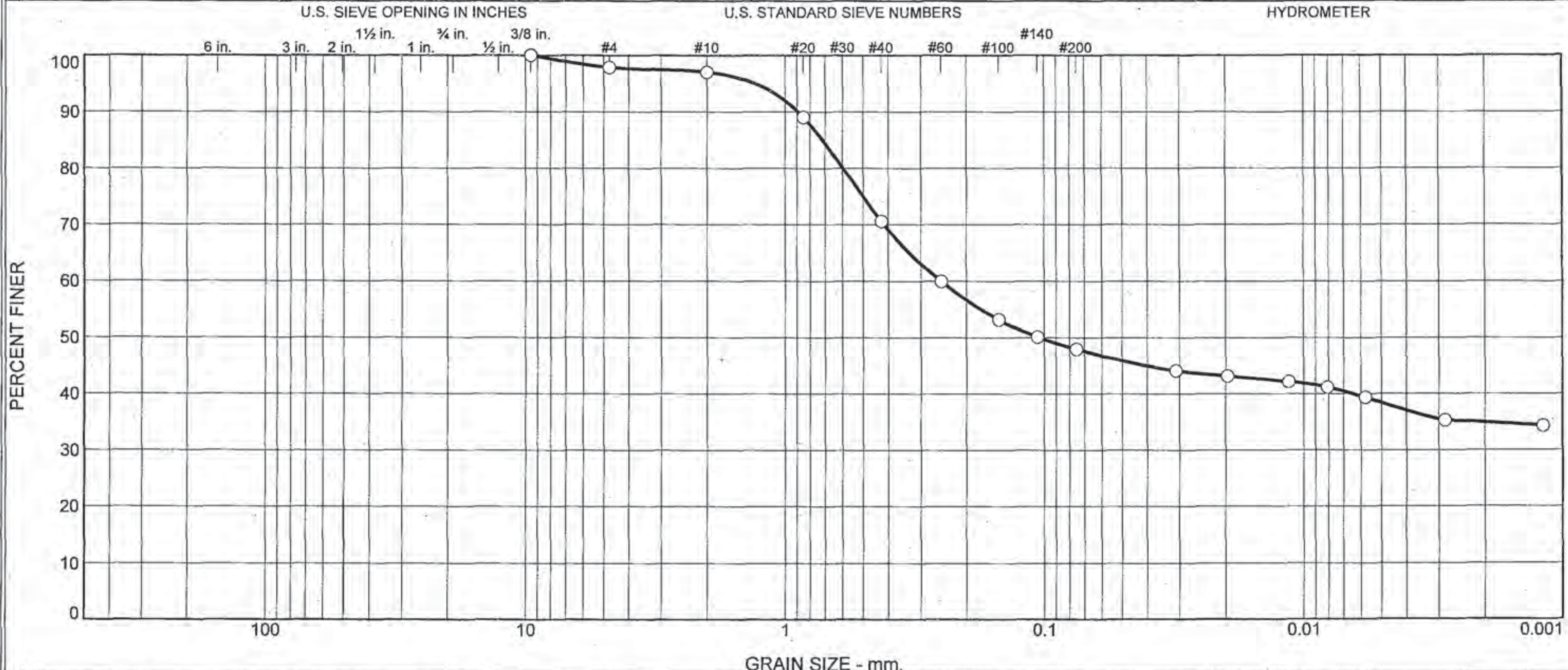
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.5 | 0.5 | 0.8 | 40.9 | 30.9 | 72.6 | | | 26.9 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | | | 0.1216 | 0.3510 | 0.4457 | 0.6625 | 0.7388 | 0.8403 | 1.2466 |

| Fineness Modulus |
|---|
| 1.55 |

AMEC

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 2.2 | 0.8 | 26.4 | 22.6 | 9.6 | 38.4 |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B03 | SS03 | 16-18 ft | N/A | SC | Reddish Brown Clayey Sand | 21.7 | 58 | 26 |

Client SRNS

Project Saltstone Disposal Unit 6

Project No. 6155-08-0031.28 Figure

amec

○ 11309

**Tested By:** EH **Checked By:** JW

## GRAIN SIZE DISTRIBUTION TEST DATA

2/3/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B03
**Depth:** 16-18 ft **Sample Number:** SS03
**Material Description:** Reddish Brown Clayey Sand
**Date:** N/A **Natural Moisture:** 21.7
**Liquid Limit:** 58 **Plastic Limit:** 26 **USCS Class.:** SC
**Testing Remarks:** 11309
**Tested by:** EH **Checked by:** JW

### Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 50.45 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | 0.00 | 100.0 |
| | | | #4 | 1.09 | 97.8 |
| | | | #10 | 1.51 | 97.0 |
| | | | #20 | 5.54 | 89.0 |
| | | | #40 | 14.85 | 70.6 |
| | | | #60 | 20.22 | 59.9 |
| | | | #100 | 23.62 | 53.2 |
| | | | #140 | 25.18 | 50.1 |
| | | | #200 | 26.25 | 48.0 |

### Hydrometer Test Data

Hydrometer test uses material passing #200
Percent passing #200 based upon complete sample = 48.0
Weight of hydrometer sample =24.2
Table of composite correction values:

| | | | | | |
|---|---|---|---|---|---|
| Temp., deg. C: | 17.6 | 19.1 | 20.9 | 21.8 | 23.9 |
| Comp. corr.: | -7.0 | -6.5 | -6.2 | -6.0 | -5.5 |

Meniscus correction only = 0.0
Specific gravity of solids = 2.7
Hydrometer type = 152H
Hydrometer effective depth equation: L = 16.294964 - 0.164 x Rm

| Elapsed Time (min.) | Temp. (deg. C.) | Actual Reading | Corrected Reading | K | Rm | Eff. Depth | Diameter (mm.) | Percent Finer |
|---|---|---|---|---|---|---|---|---|
| 2.00 | 23.9 | 28.0 | 22.5 | 0.0128 | 28.0 | 11.7 | 0.0310 | 44.1 |
| 5.00 | 23.9 | 27.5 | 22.0 | 0.0128 | 27.5 | 11.8 | 0.0197 | 43.1 |
| 15.00 | 23.9 | 27.0 | 21.5 | 0.0128 | 27.0 | 11.9 | 0.0114 | 42.1 |
| 30.00 | 23.9 | 26.5 | 21.0 | 0.0128 | 26.5 | 11.9 | 0.0081 | 41.2 |
| 60.00 | 23.9 | 25.6 | 20.1 | 0.0128 | 25.6 | 12.1 | 0.0058 | 39.3 |
| 250.00 | 24.3 | 23.5 | 18.0 | 0.0128 | 23.5 | 12.4 | 0.0028 | 35.3 |
| 1440.00 | 24.3 | 23.0 | 17.5 | 0.0128 | 23.0 | 12.5 | 0.0012 | 34.3 |

AMEC

## Fractional Components

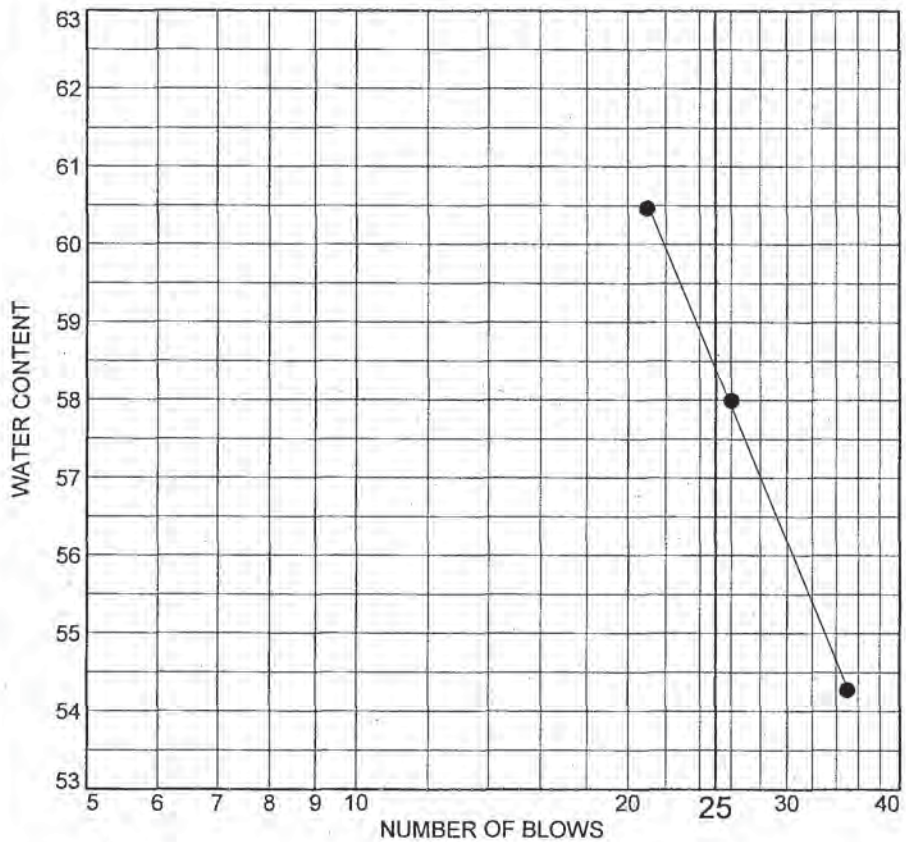
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 2.2 | 2.2 | 0.8 | 26.4 | 22.6 | 49.8 | 9.6 | 38.4 | 48.0 |

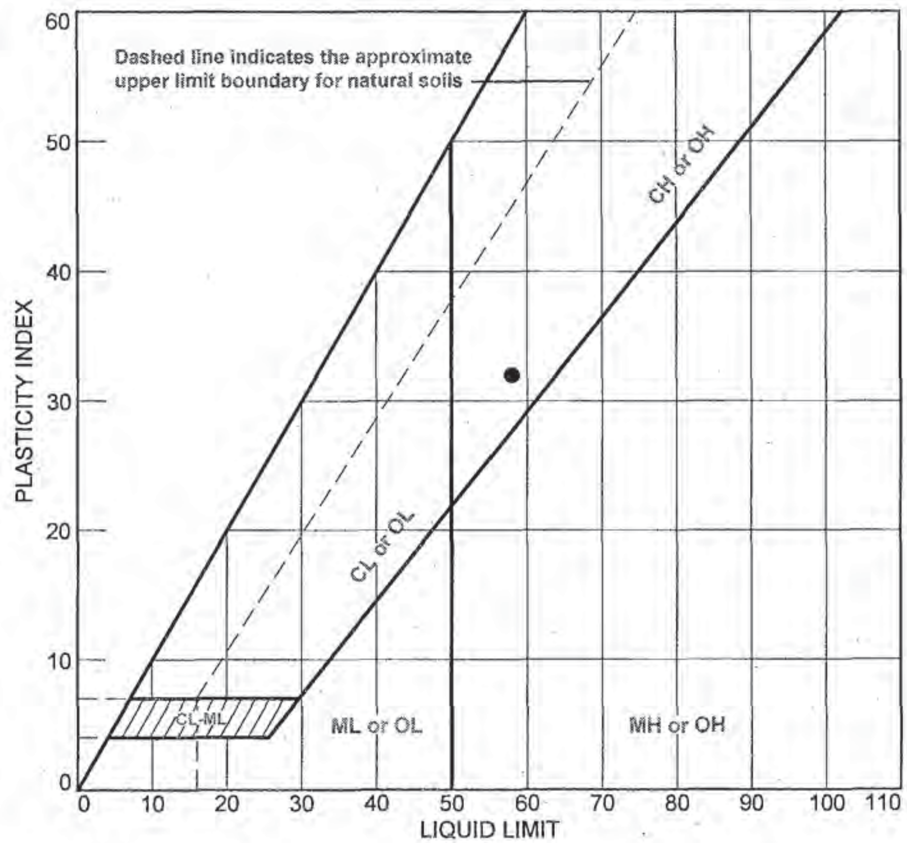
| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | | | | 0.1047 | 0.2512 | 0.5973 | 0.7169 | 0.8928 | 1.3005 |

| Fineness Modulus |
|---|
| 1.14 |

AMEC

# LIQUID AND PLASTIC LIMITS TEST REPORT (ASTM D4318-05)




| | SOURCE | SAMPLE # | DEPTH/ELEV. | DATE SAMPLED | USCS | MATERIAL DESCRIPTION | NM % | LL | PI |
|---|---|---|---|---|---|---|---|---|---|
| ● | Z-SDU6-B03 | SS03 | 16-18 ft | N/A | SC | Reddish Brown Clayey Sand | 21.7 | 58 | 32 |

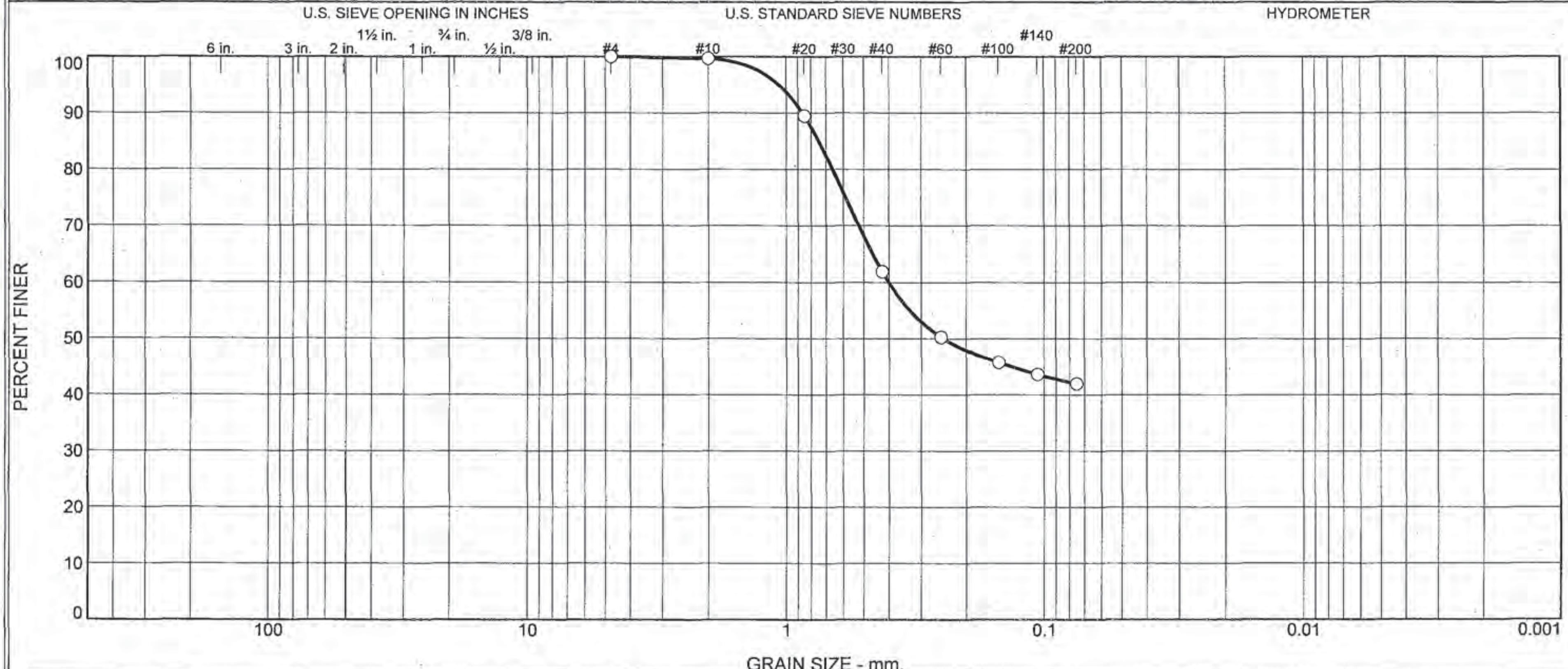
Client SRNS
Project Saltstone Disposal Unit 6
Project No. 6155-08-0031.28 Figure

amec

● 11309

**Tested By:** EH **Checked By:** JW

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.3 | 37.9 | 19.8 | 42.0 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B03 | SS04 | 23.-25 ft | N/A | | Reddish Brown Clayey Sand | 20.9 | | |

Client SRNS
Project Saltstone Disposal Unit 6
Project No. 6155-08-0031.28 Figure

○ 11310

**Tested By:** EH **Checked By:** JW

## GRAIN SIZE DISTRIBUTION TEST DATA

2/3/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B03
**Depth:** 23.-25 ft
**Sample Number:** SS04
**Material Description:** Reddish Brown Clayey Sand
**Date:** N/A
**Natural Moisture:** 20.9
**Testing Remarks:** 11310
**Tested by:** EH
**Checked by:** JW

### Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 87.37 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | | |
| | | | #4 | 0.00 | 100.0 |
| | | | #10 | 0.30 | 99.7 |
| | | | #20 | 9.24 | 89.4 |
| | | | #40 | 33.35 | 61.8 |
| | | | #60 | 43.48 | 50.2 |
| | | | #100 | 47.37 | 45.8 |
| | | | #140 | 49.24 | 43.6 |
| | | | #200 | 50.69 | 42.0 |

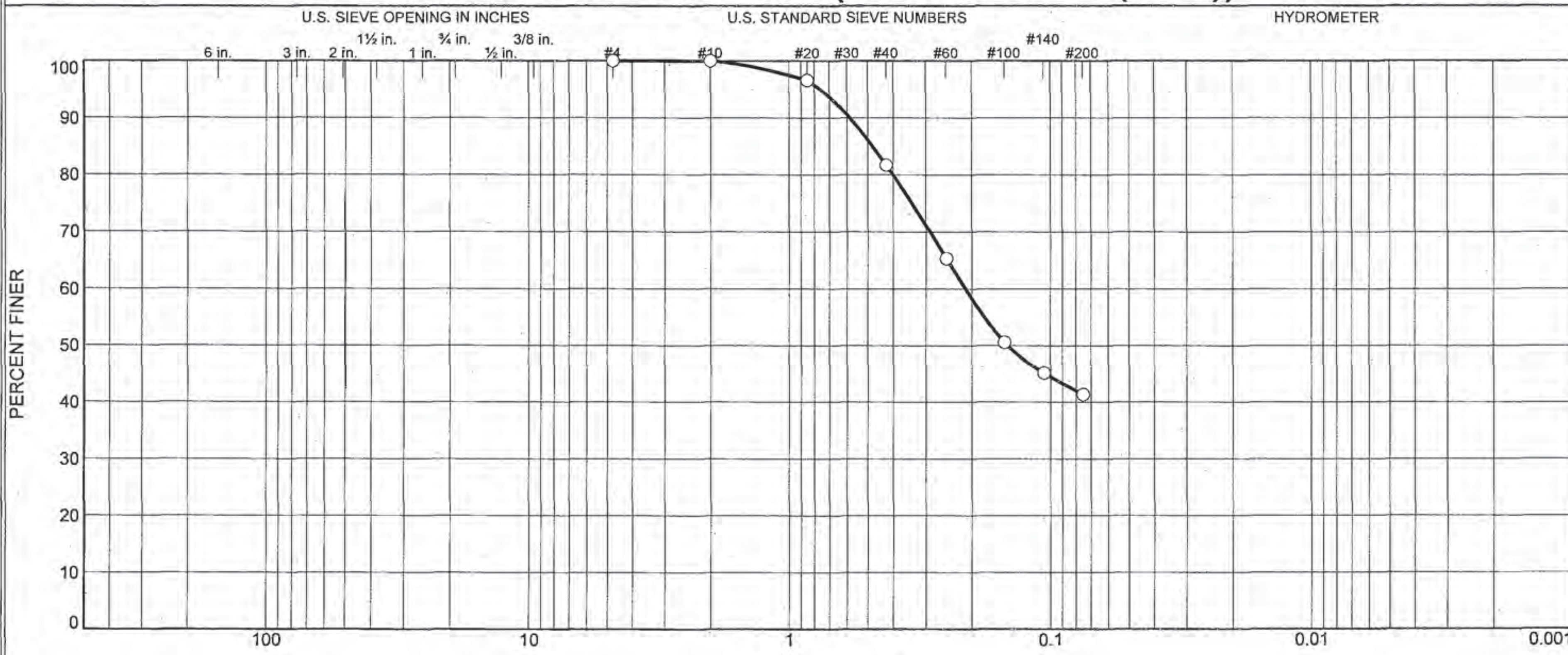
### Fractional Components

| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 37.9 | 19.8 | 58.0 | | | 42.0 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | | | | 0.2453 | 0.4017 | 0.6618 | 0.7490 | 0.8661 | 1.0685 |

| Fineness Modulus |
|---|
| 1.29 |

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.0 | 18.3 | 40.4 | 41.3 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B03 | SS05 | 25-27 ft | N/A | | Yellowish Brown Clayey Sand | 24.0 | | |

Client SRNS

Project Saltstone Disposal Unit 6

Project No. 6155-08-0031.28 Figure

○ 11311

**Tested By:** EH **Checked By:** JW

## GRAIN SIZE DISTRIBUTION TEST DATA

2/3/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B03
**Depth:** 25-27 ft
**Sample Number:** SS05
**Material Description:** Yellowish Brown Clayey Sand
**Date:** N/A
**Natural Moisture:** 24.0
**Testing Remarks:** 11311
**Tested by:** EH
**Checked by:** JW

### Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 81.79 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | | |
| | | | #4 | 0.00 | 100.0 |
| | | | #10 | 0.00 | 100.0 |
| | | | #20 | 2.80 | 96.6 |
| | | | #40 | 14.96 | 81.7 |
| | | | #60 | 28.40 | 65.3 |
| | | | #100 | 40.43 | 50.6 |
| | | | #140 | 44.88 | 45.1 |
| | | | #200 | 47.99 | 41.3 |

### Fractional Components

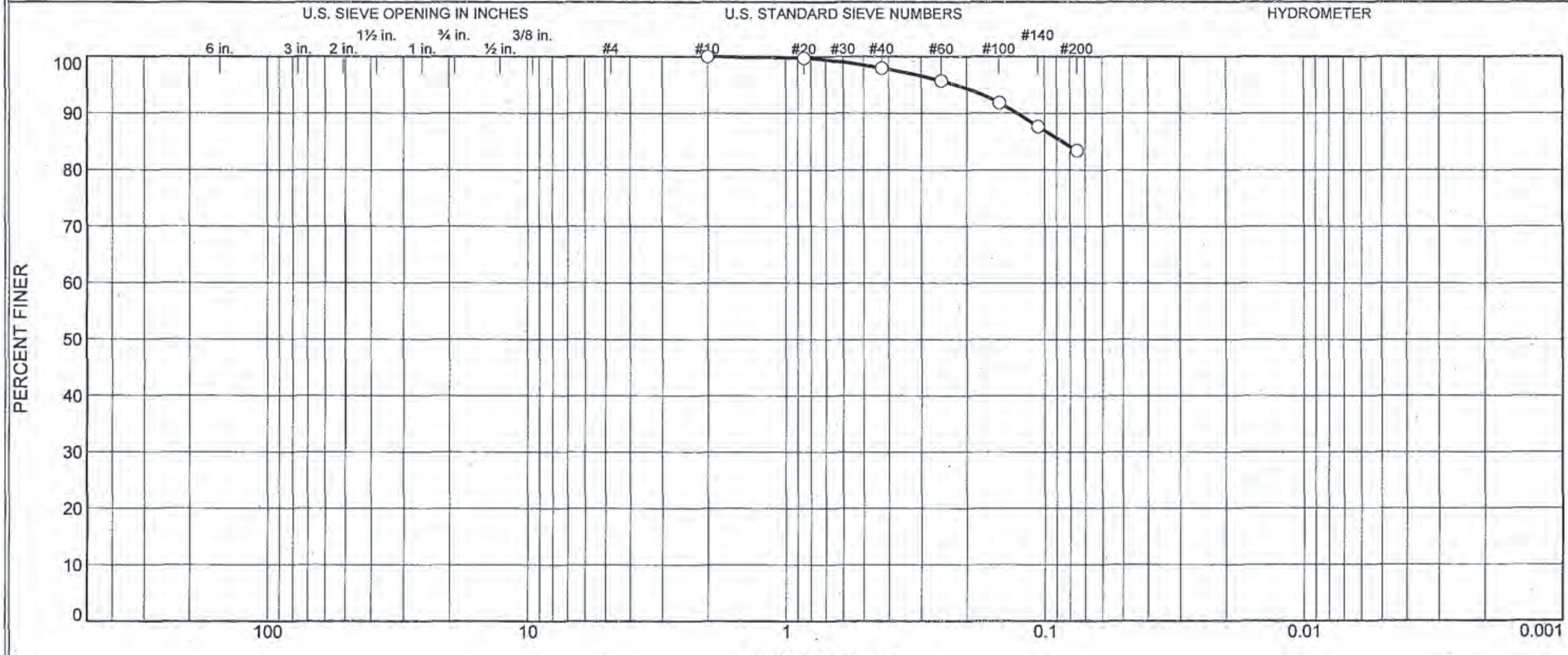
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 18.3 | 40.4 | 58.7 | | | 41.3 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | | | | 0.1459 | 0.2121 | 0.4005 | 0.4792 | 0.5877 | 0.7614 |

| Fineness Modulus |
|---|
| 0.90 |

AMEC

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.0 | 2.1 | 14.4 | 83.5 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B03 | SS06 | 27-29 ft | N/A | CH | Yellowish Brown Fat Clay with Sand | 31.1 | 73 | 34 |

Client SRNS
Project Saltstone Disposal Unit 6
Project No. 6155-08-0031.28 Figure

amec

○ 11312

**Tested By:** EH **Checked By:** JW

## GRAIN SIZE DISTRIBUTION TEST DATA

2/3/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B03
**Depth:** 27-29 ft **Sample Number:** SS06
**Material Description:** Yellowish Brown Fat Clay with Sand
**Date:** N/A **Natural Moisture:** 31.1
**Liquid Limit:** 73 **Plastic Limit:** 34 **USCS Class.:** CH
**Testing Remarks:** 11312
**Tested by:** EH **Checked by:** JW

### Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 63.33 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | | |
| | | | #4 | | |
| | | | #10 | 0.00 | 100.0 |
| | | | #20 | 0.18 | 99.7 |
| | | | #40 | 1.31 | 97.9 |
| | | | #60 | 2.73 | 95.7 |
| | | | #100 | 5.18 | 91.8 |
| | | | #140 | 7.84 | 87.6 |
| | | | #200 | 10.48 | 83.5 |

### Fractional Components

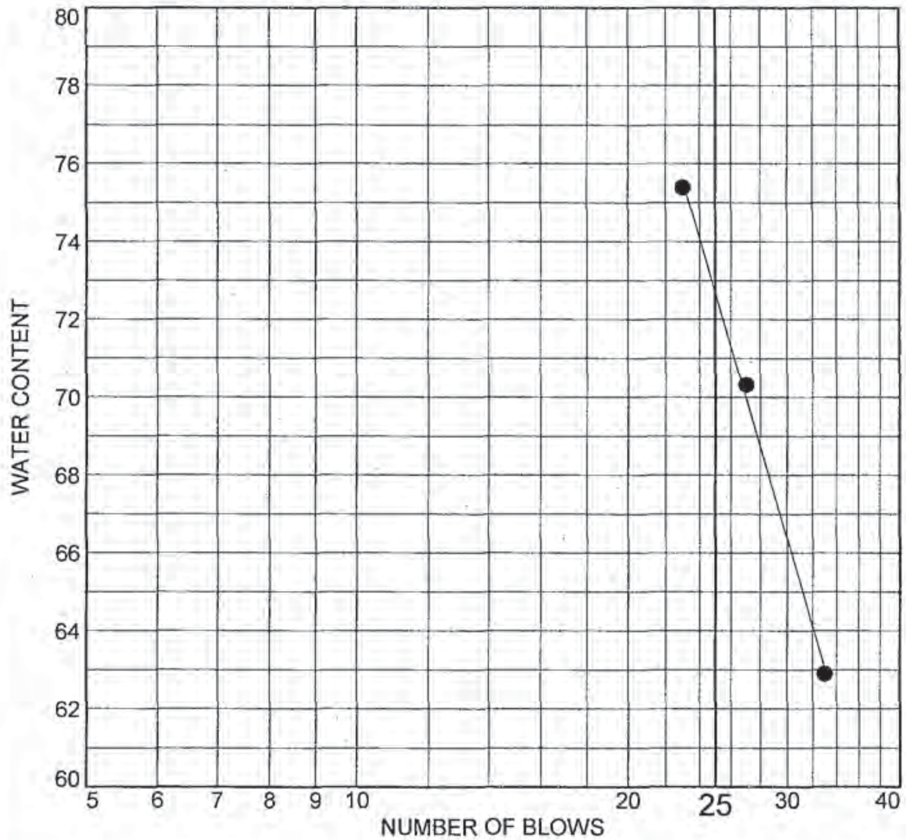
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.1 | 14.4 | 16.5 | | | 83.5 |

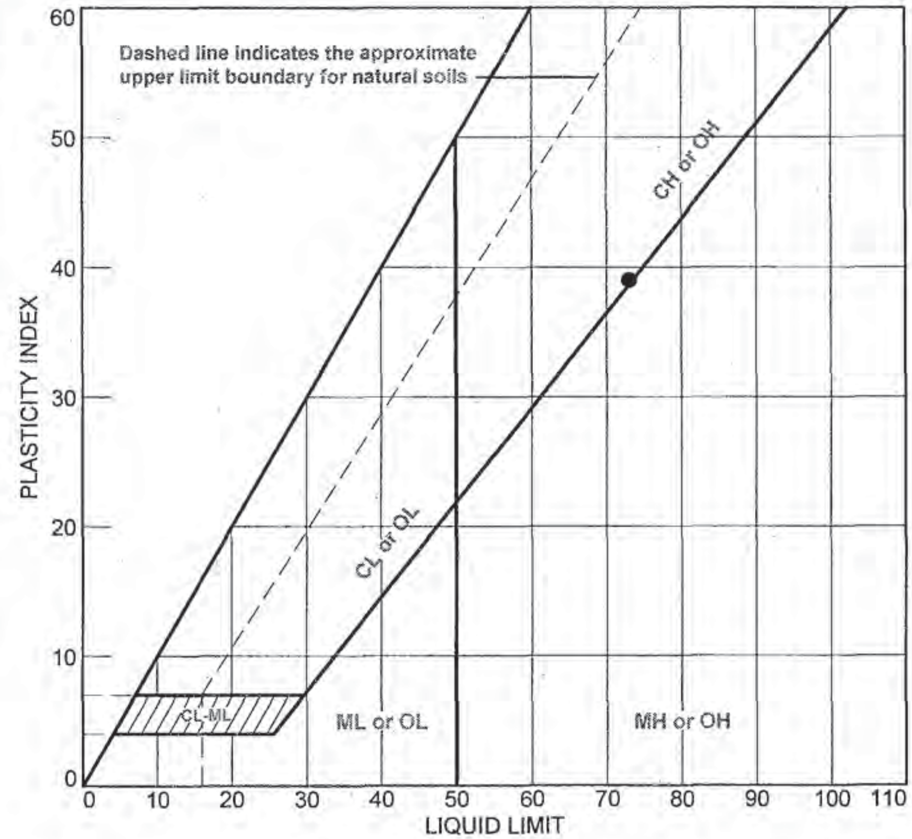
| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 0.0855 | 0.1281 | 0.2217 |

| Fineness Modulus |
|---|
| 0.13 |

AMEC

# LIQUID AND PLASTIC LIMITS TEST REPORT (ASTM D4318-05)




| | SOURCE | SAMPLE # | DEPTH/ELEV. | DATE SAMPLED | USCS | MATERIAL DESCRIPTION | NM % | LL | PI |
|---|---|---|---|---|---|---|---|---|---|
| ● | Z-SDU6-B03 | SS06 | 27-29 ft | N/A | CH | Yellowish Brown Fat Clay with Sand | 31.1 | 73 | 39 |

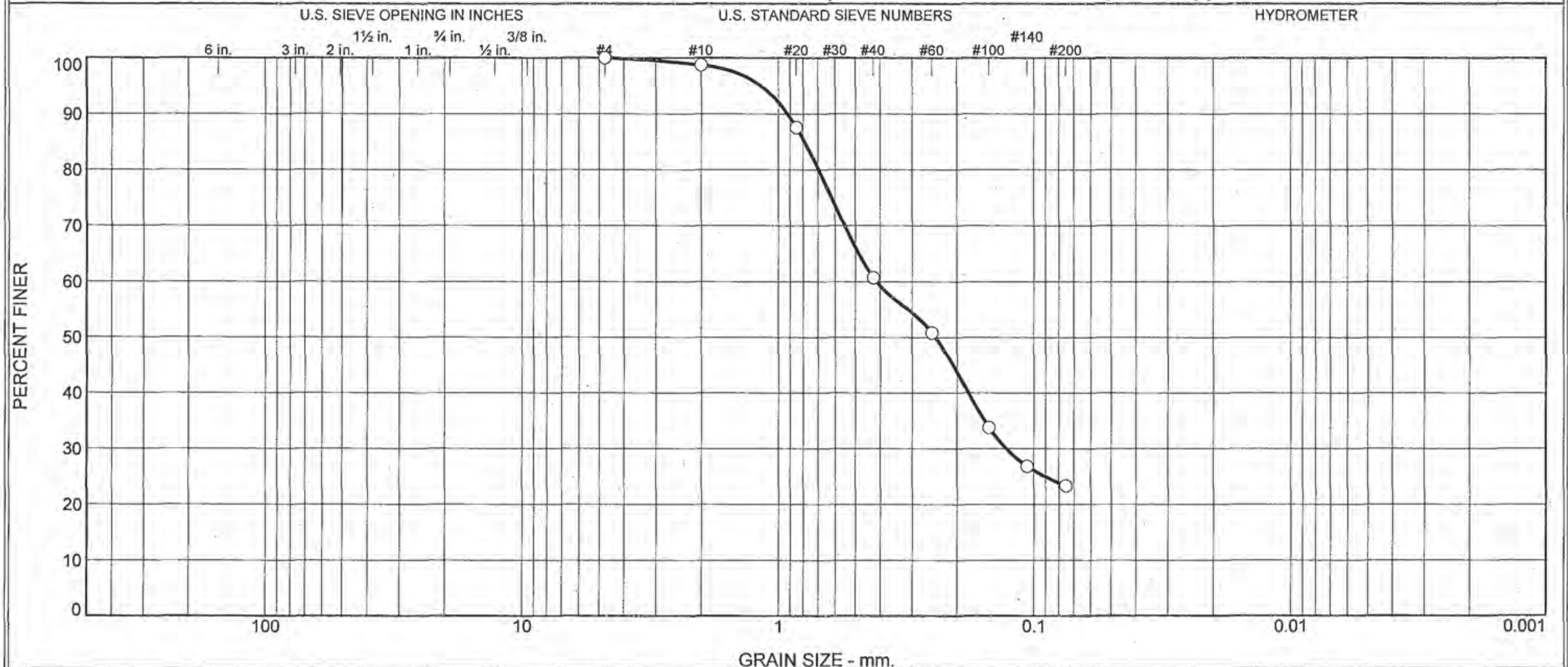
Client SRNS
Project Saltstone Disposal Unit 6
Project No. 6155-08-0031.28 Figure

amec

● 11312

**Tested By:** EH **Checked By:** JW

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 1.3 | 38.0 | 37.4 | 23.3 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B03 | SS07 | 29-31 ft | N/A | | Reddish Brown | 13.0 | | |

Client SRNS

Project Saltstone Disposal Unit 6

Project No. 6155-08-0031.28 Figure

amec

○ 11313

**Tested By:** EH **Checked By:** JW

## GRAIN SIZE DISTRIBUTION TEST DATA

2/3/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B03
**Depth:** 29-31 ft
**Sample Number:** SS07
**Material Description:** Reddish Brown
**Date:** N/A
**Natural Moisture:** 13.0
**Testing Remarks:** 11313
**Tested by:** EH
**Checked by:** JW

### Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 98.90 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | | |
| | | | #4 | 0.00 | 100.0 |
| | | | #10 | 1.28 | 98.7 |
| | | | #20 | 12.35 | 87.5 |
| | | | #40 | 38.87 | 60.7 |
| | | | #60 | 48.66 | 50.8 |
| | | | #100 | 65.52 | 33.8 |
| | | | #140 | 72.35 | 26.8 |
| | | | #200 | 75.84 | 23.3 |

### Fractional Components

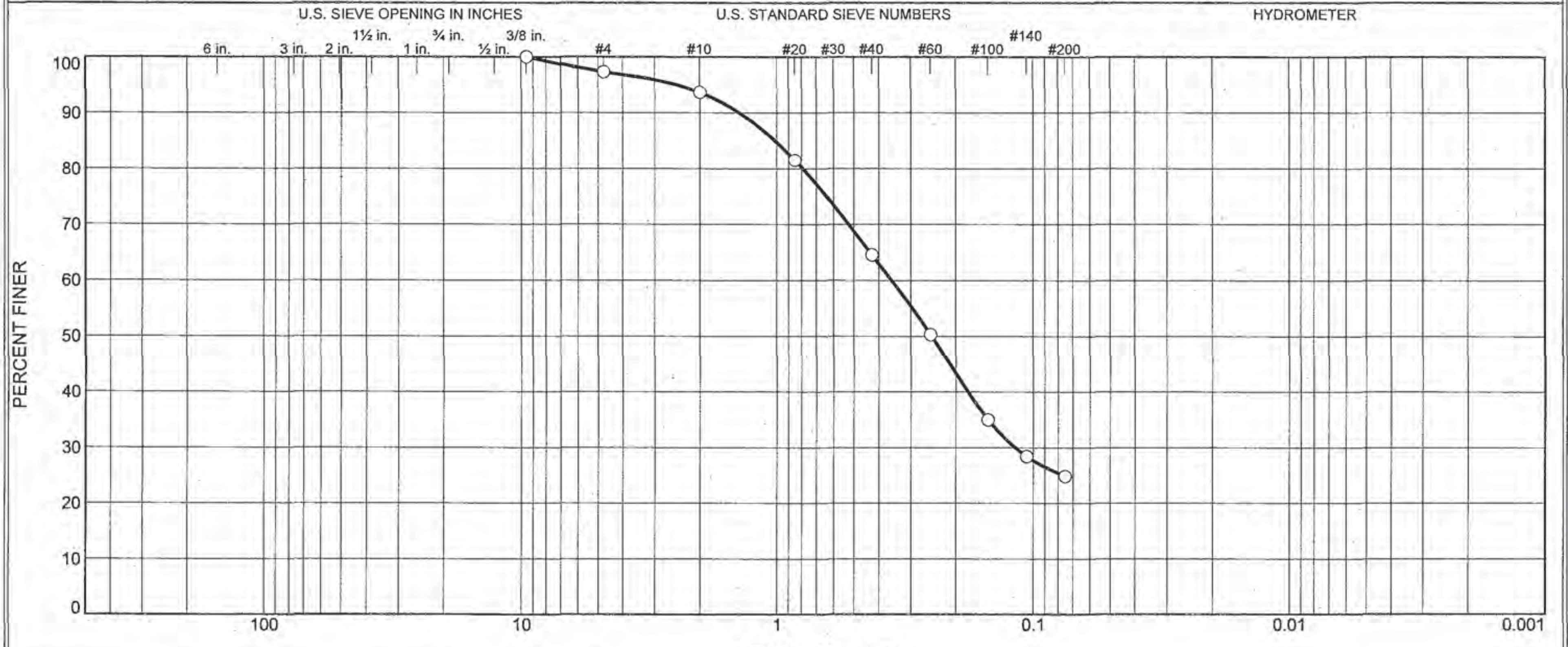
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.0 | 0.0 | 1.3 | 38.0 | 37.4 | 76.7 | | | 23.3 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | | | 0.1286 | 0.2426 | 0.4136 | 0.6981 | 0.7914 | 0.9230 | 1.1720 |

| Fineness Modulus |
|---|
| 1.44 |

AMEC

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 2.7 | 3.7 | 29.1 | 39.7 | 24.8 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B03 | SS08 | 31-33 ft | N/A | | Reddish and Yellowish Brown Silty Sand | 16.0 | | |

Client SRNS

Project Saltstone Disposal Unit 6

Project No. 6155-08-0031.28 Figure

amec

○ I1314

**Tested By:** EH **Checked By:** JW

# GRAIN SIZE DISTRIBUTION TEST DATA

2/3/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B03
**Depth:** 31-33 ft
**Sample Number:** SS08
**Material Description:** Reddish and Yellowish Brown Silty Sand
**Date:** N/A
**Natural Moisture:** 16.0
**Testing Remarks:** 11314
**Tested by:** EH
**Checked by:** JW

## Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 96.84 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | 0.00 | 100.0 |
| | | | #4 | 2.63 | 97.3 |
| | | | #10 | 6.16 | 93.6 |
| | | | #20 | 17.91 | 81.5 |
| | | | #40 | 34.38 | 64.5 |
| | | | #60 | 48.17 | 50.3 |
| | | | #100 | 62.94 | 35.0 |
| | | | #140 | 69.32 | 28.4 |
| | | | #200 | 72.79 | 24.8 |

## Fractional Components

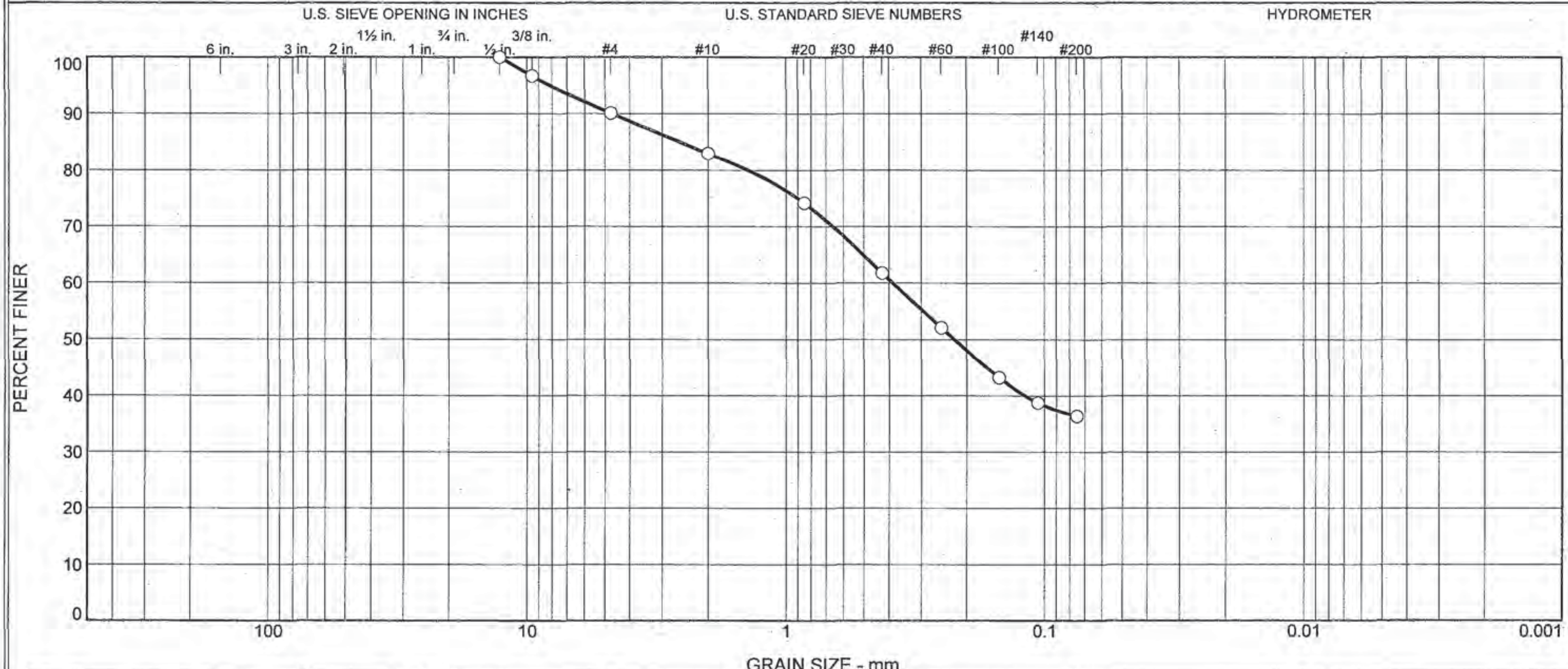
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 2.7 | 2.7 | 3.7 | 29.1 | 39.7 | 72.5 | | | 24.8 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | | | 0.1177 | 0.2479 | 0.3567 | 0.7927 | 1.0168 | 1.4055 | 2.4701 |

| Fineness Modulus |
|---|
| 1.57 |

AMEC

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 10.0 | 7.0 | 21.3 | 25.3 | 36.4 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B03 | SS09 | 33-35 ft | N/A | | Light Brown Clayey Sand with Gravel | 20.4 | | |

Client SRNS

Project Saltstone Disposal Unit 6

Project No. 6155-08-0031.28 Figure

amec

○ 11315

**Tested By:** EH **Checked By:** JW

# GRAIN SIZE DISTRIBUTION TEST DATA

2/3/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B03
**Depth:** 33-35 ft **Sample Number:** SS09
**Material Description:** Light Brown Clayey Sand with Gravel
**Date:** N/A **Natural Moisture:** 20.4
**Testing Remarks:** 11315
**Tested by:** EH **Checked by:** JW

## Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 92.53 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | 0.00 | 100.0 |
| | | | .375" | 3.09 | 96.7 |
| | | | #4 | 9.22 | 90.0 |
| | | | #10 | 15.76 | 83.0 |
| | | | #20 | 23.93 | 74.1 |
| | | | #40 | 35.43 | 61.7 |
| | | | #60 | 44.38 | 52.0 |
| | | | #100 | 52.50 | 43.3 |
| | | | #140 | 56.71 | 38.7 |
| | | | #200 | 58.89 | 36.4 |

## Fractional Components

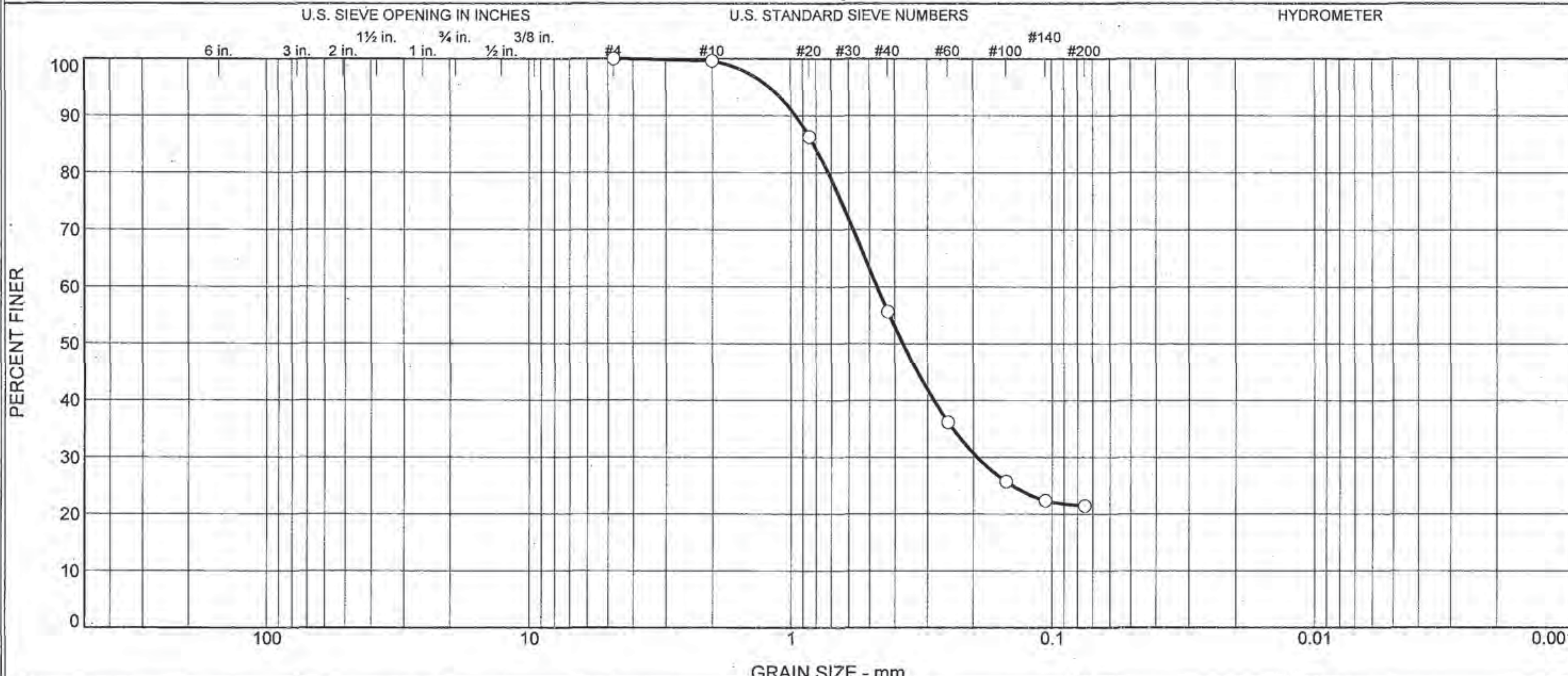
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 10.0 | 10.0 | 7.0 | 21.3 | 25.3 | 53.6 | | | 36.4 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | | | | 0.2231 | 0.3879 | 1.4076 | 2.5757 | 4.7302 | 8.1450 |

| Fineness Modulus |
|---|
| 1.84 |

AMEC

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.4 | 44.0 | 34.2 | 21.4 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B03 | SS10 | 35-37 ft | N/A | | Light Brown Claey Sand | 15.7 | | |

Client SRNS

Project Saltstone Disposal Unit 6

Project No. 6155-08-0031.28 Figure

amec

○ 11316

**Tested By:** EH **Checked By:** JW

# GRAIN SIZE DISTRIBUTION TEST DATA

2/3/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B03
**Depth:** 35-37 ft
**Sample Number:** SS10
**Material Description:** Light Brown Claey Sand
**Date:** N/A
**Natural Moisture:** 15.7
**Testing Remarks:** 11316
**Tested by:** EH
**Checked by:** JW

## Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 105.36 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | | |
| | | | #4 | 0.00 | 100.0 |
| | | | #10 | 0.40 | 99.6 |
| | | | #20 | 14.53 | 86.2 |
| | | | #40 | 46.78 | 55.6 |
| | | | #60 | 67.26 | 36.2 |
| | | | #100 | 78.29 | 25.7 |
| | | | #140 | 81.80 | 22.4 |
| | | | #200 | 82.80 | 21.4 |

## Fractional Components

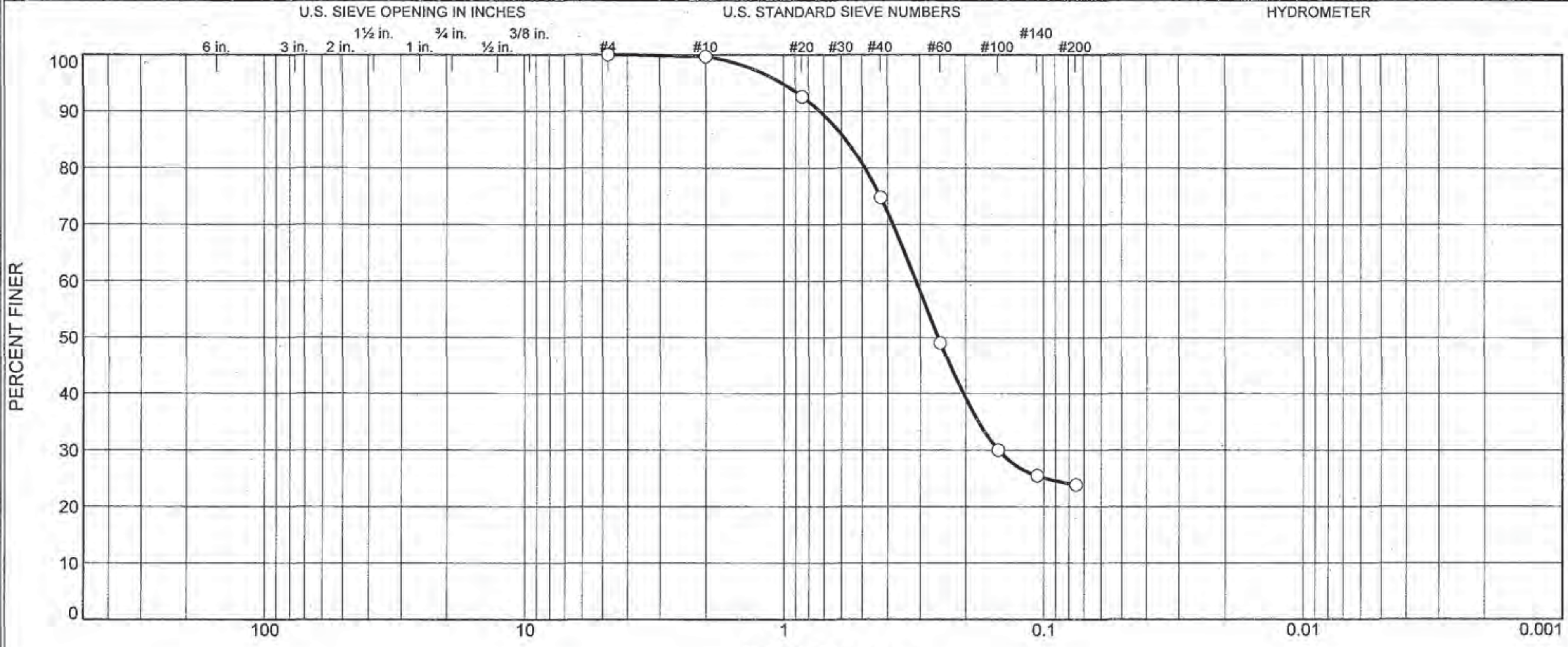
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.4 | 44.0 | 34.2 | 78.6 | | | 21.4 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | | | 0.1937 | 0.3727 | 0.4680 | 0.7222 | 0.8211 | 0.9626 | 1.2119 |

| Fineness Modulus |
|---|
| 1.66 |

AMEC

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.3 | 25.0 | 50.8 | 23.9 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B03 | SS11 | 37-39 ft | N/A | | Light Brown Clayey Sand | 17.6 | | |

Client SRNS
Project Saltstone Disposal Unit 6
Project No. 6155-08-0031.28 Figure

amec

○ 11317

**Tested By:** EH **Checked By:** JW

## GRAIN SIZE DISTRIBUTION TEST DATA

2/3/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B03
**Depth:** 37-39 ft
**Sample Number:** SS11
**Material Description:** Light Brown Clayey Sand
**Date:** N/A
**Natural Moisture:** 17.6
**Testing Remarks:** 11317
**Tested by:** EH
**Checked by:** JW

### Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 86.95 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | | |
| | | | #4 | 0.00 | 100.0 |
| | | | #10 | 0.29 | 99.7 |
| | | | #20 | 6.44 | 92.6 |
| | | | #40 | 21.96 | 74.7 |
| | | | #60 | 44.33 | 49.0 |
| | | | #100 | 60.88 | 30.0 |
| | | | #140 | 64.82 | 25.5 |
| | | | #200 | 66.21 | 23.9 |

### Fractional Components

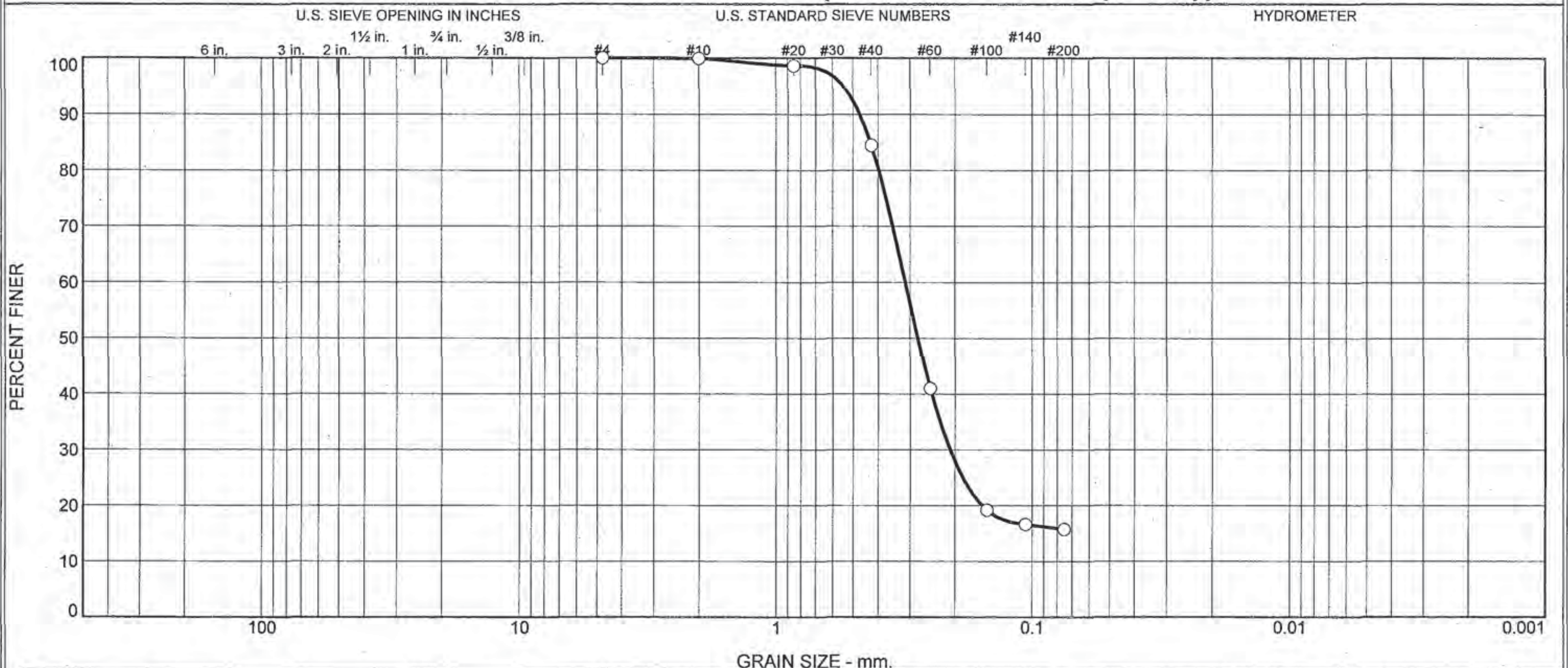
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 25.0 | 50.8 | 76.1 | | | 23.9 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | | | 0.1501 | 0.2551 | 0.3111 | 0.4895 | 0.5793 | 0.7268 | 1.0193 |

| Fineness Modulus |
|---|
| 1.30 |

AMEC

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.1 | 15.4 | 68.8 | 15.7 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B03 | SS12 | 39-41 ft | N/A | | Yellowish Brown Silty Sand | 16.6 | | |

Client SRNS
Project Saltstone Disposal Unit 6
Project No. 6155-08-0031.28 Figure

amec

○ 11318

**Tested By:** EH **Checked By:** JW

# GRAIN SIZE DISTRIBUTION TEST DATA

2/3/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B03
**Depth:** 39-41 ft
**Sample Number:** SS12
**Material Description:** Yellowish Brown Silty Sand
**Date:** N/A
**Natural Moisture:** 16.6
**Testing Remarks:** 11318
**Tested by:** EH
**Checked by:** JW

## Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 114.46 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | | |
| | | | #4 | 0.00 | 100.0 |
| | | | #10 | 0.13 | 99.9 |
| | | | #20 | 1.60 | 98.6 |
| | | | #40 | 17.76 | 84.5 |
| | | | #60 | 67.52 | 41.0 |
| | | | #100 | 92.52 | 19.2 |
| | | | #140 | 95.45 | 16.6 |
| | | | #200 | 96.44 | 15.7 |

## Fractional Components

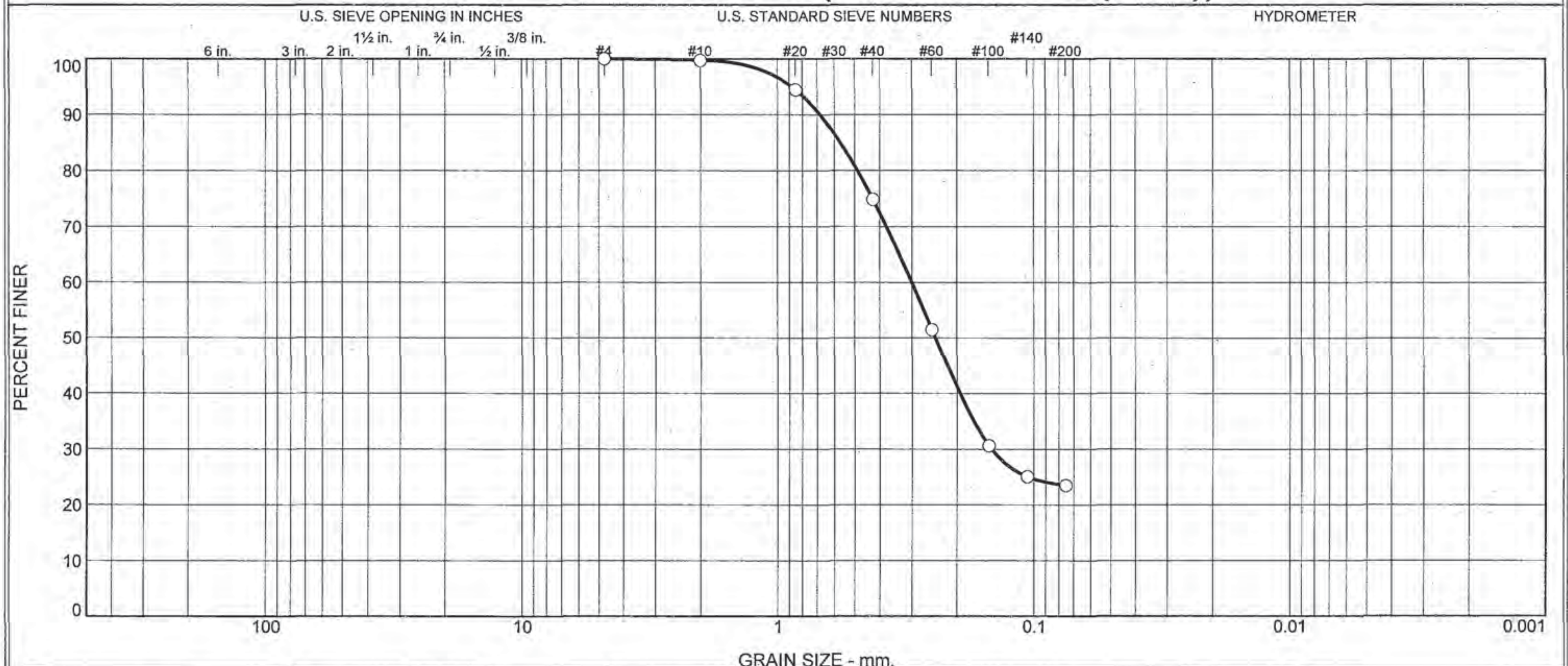
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 15.4 | 68.8 | 84.3 | | | 15.7 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | | 0.1568 | 0.2091 | 0.2797 | 0.3134 | 0.3977 | 0.4286 | 0.4717 | 0.5464 |

| Fineness Modulus |
|---|
| 1.29 |

AMEC

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.3 | 24.9 | 51.3 | 23.5 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B03 | SS13 | 42-44 ft | N/A | | Purple Silty Sand | 21.3 | | |

Client SRNS
Project Saltstone Disposal Unit 6
Project No. 6155-08-0031.28 Figure

amec

○ 11319

**Tested By:** EH **Checked By:** JW

## GRAIN SIZE DISTRIBUTION TEST DATA

2/3/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B03
**Depth:** 42-44 ft
**Sample Number:** SS13
**Material Description:** Purple Silty Sand
**Date:** N/A
**Natural Moisture:** 21.3
**Testing Remarks:** 11319
**Tested by:** EH
**Checked by:** JW

### Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 115.87 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | | |
| | | | #4 | 0.00 | 100.0 |
| | | | #10 | 0.33 | 99.7 |
| | | | #20 | 6.46 | 94.4 |
| | | | #40 | 29.19 | 74.8 |
| | | | #60 | 56.27 | 51.4 |
| | | | #100 | 80.40 | 30.6 |
| | | | #140 | 86.84 | 25.1 |
| | | | #200 | 88.66 | 23.5 |

### Fractional Components

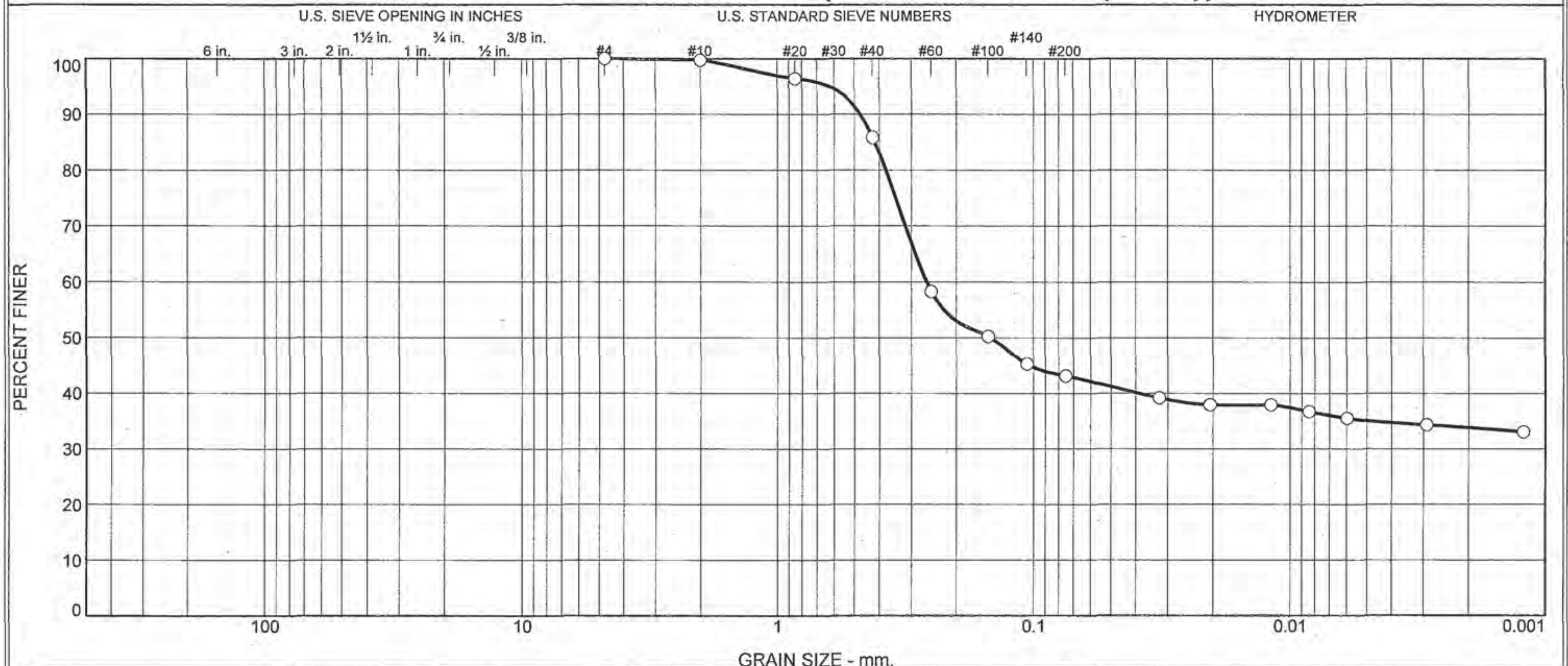
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 24.9 | 51.3 | 76.5 | | | 23.5 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | | | 0.1465 | 0.2425 | 0.3005 | 0.4892 | 0.5705 | 0.6853 | 0.8810 |

| Fineness Modulus |
|---|
| 1.25 |

AMEC

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.3 | 13.8 | 42.8 | 8.0 | 35.1 |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B03 | SS14 | 48-50 ft | N/A | SC | Tan Clayey Sand | 34.6 | 99 | 38 |

Client SRNS

Project Saltstone Disposal Unit 6

Project No. 6155-08-0031.28 Figure

○ 11320

**Tested By:** EH **Checked By:** JW

# GRAIN SIZE DISTRIBUTION TEST DATA

2/3/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B03
**Depth:** 48-50 ft **Sample Number:** SS14
**Material Description:** Tan Clayey Sand
**Date:** N/A **Natural Moisture:** 34.6
**Liquid Limit:** 99 **Plastic Limit:** 38 **USCS Class.:** SC
**Testing Remarks:** 11320
**Tested by:** EH **Checked by:** JW

## Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 40.40 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | | |
| | | | #4 | 0.00 | 100.0 |
| | | | #10 | 0.11 | 99.7 |
| | | | #20 | 1.45 | 96.4 |
| | | | #40 | 5.71 | 85.9 |
| | | | #60 | 16.86 | 58.3 |
| | | | #100 | 20.11 | 50.2 |
| | | | #140 | 22.10 | 45.3 |
| | | | #200 | 22.97 | 43.1 |

## Hydrometer Test Data

Hydrometer test uses material passing #200
Percent passing #200 based upon complete sample = 43.1
Weight of hydrometer sample =17.43
Table of composite correction values:

| Temp., deg. C: | 17.6 | 19.1 | 20.9 | 21.8 | 23.9 |
|---|---|---|---|---|---|
| Comp. corr.: | -7.0 | -6.5 | -6.2 | -6.0 | -5.5 |

Meniscus correction only = 0.0
Specific gravity of solids = 2.7
Hydrometer type = 152H
Hydrometer effective depth equation: L = 16.294964 - 0.164 x Rm

| Elapsed Time (min.) | Temp. (deg. C.) | Actual Reading | Corrected Reading | K | Rm | Eff. Depth | Diameter (mm.) | Percent Finer |
|---|---|---|---|---|---|---|---|---|
| 2.00 | 23.9 | 21.5 | 16.0 | 0.0128 | 21.5 | 12.8 | 0.0324 | 39.2 |
| 5.00 | 23.9 | 21.0 | 15.5 | 0.0128 | 21.0 | 12.9 | 0.0206 | 37.9 |
| 15.00 | 23.9 | 21.0 | 15.5 | 0.0128 | 21.0 | 12.9 | 0.0119 | 37.9 |
| 30.00 | 23.9 | 20.5 | 15.0 | 0.0128 | 20.5 | 12.9 | 0.0084 | 36.7 |
| 60.00 | 23.9 | 20.0 | 14.5 | 0.0128 | 20.0 | 13.0 | 0.0060 | 35.5 |
| 250.00 | 24.3 | 19.5 | 14.0 | 0.0128 | 19.5 | 13.1 | 0.0029 | 34.3 |
| 1440.00 | 24.3 | 19.0 | 13.5 | 0.0128 | 19.0 | 13.2 | 0.0012 | 33.0 |

AMEC

## Fractional Components

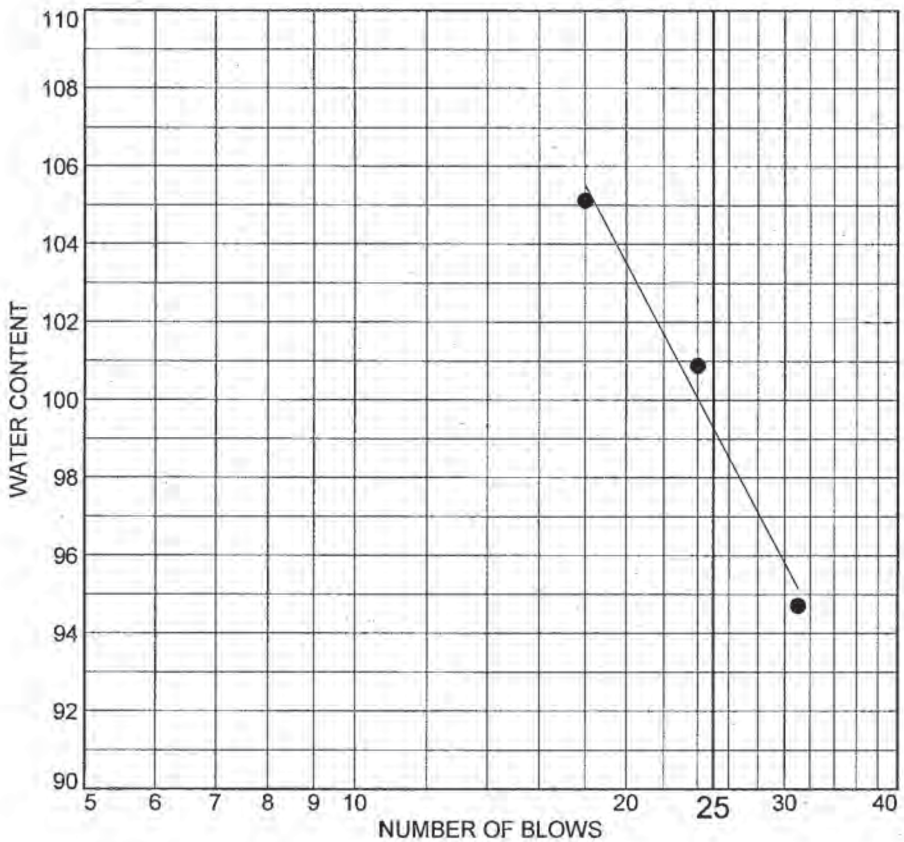
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 13.8 | 42.8 | 56.9 | 8.0 | 35.1 | 43.1 |

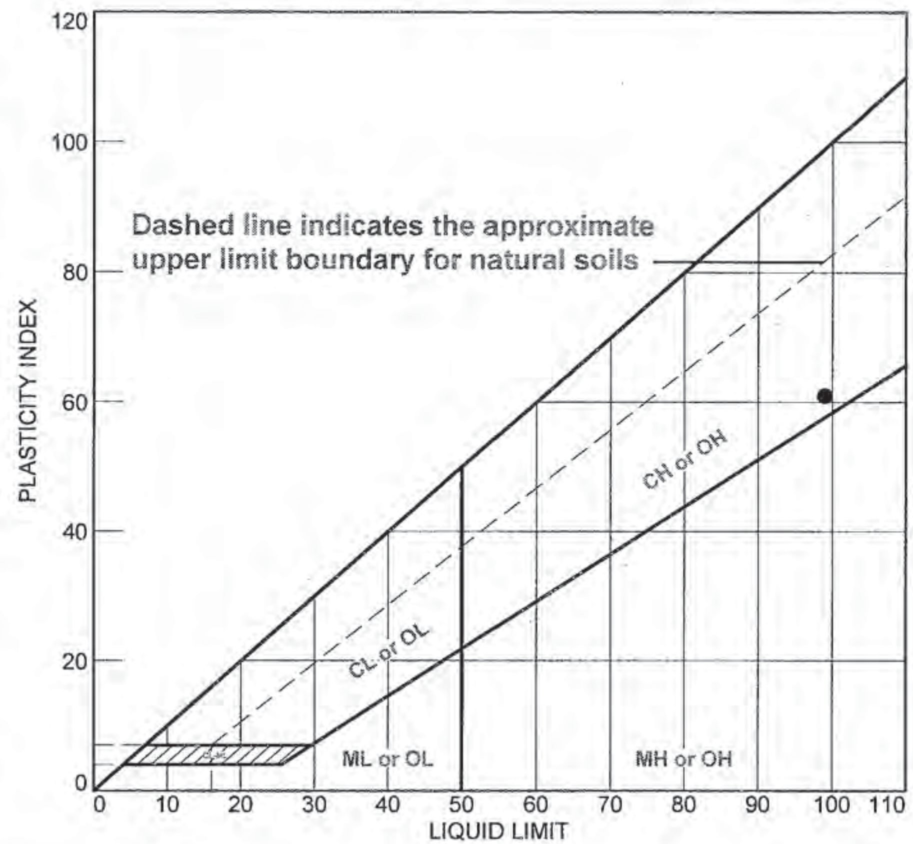
| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | | | | 0.1472 | 0.2611 | 0.3773 | 0.4168 | 0.4761 | 0.6225 |

| Fineness Modulus |
|---|
| 0.91 |

AMEC

# LIQUID AND PLASTIC LIMITS TEST REPORT (ASTM D4318-05)




| | SOURCE | SAMPLE # | DEPTH/ELEV. | DATE SAMPLED | USCS | MATERIAL DESCRIPTION | NM % | LL | PI |
|---|---|---|---|---|---|---|---|---|---|
| ● | Z-SDU6-B03 | SS14 | 48-50 ft | N/A | SC | Tan Clayey Sand | 34.6 | 99 | 61 |

Client SRNS

Project Saltstone Disposal Unit 6

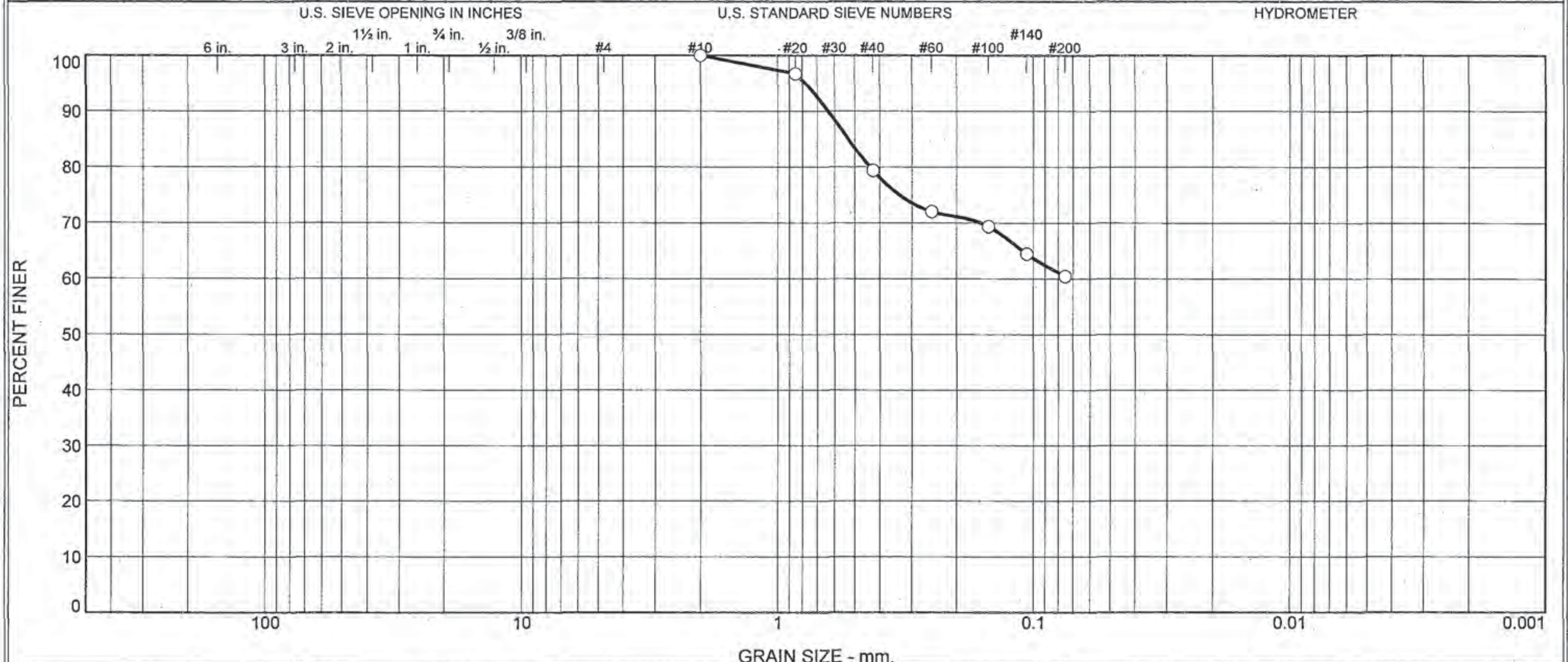
Project No. 6155-08-0031.28 Figure

amec

● 11320

**Tested By:** EH **Checked By:** JW

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.0 | 20.7 | 18.9 | 60.4 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B03 | SS15 | 53-55 ft | N/A | | Tan Sandy Clay | 65.3 | | |

Client SRNS

Project Saltstone Disposal Unit 6

Project No. 6155-08-0031.28 Figure

amec

○ 11321

**Tested By:** EH **Checked By:** JW

## GRAIN SIZE DISTRIBUTION TEST DATA

2/3/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B03
**Depth:** 53-55 ft  **Sample Number:** SS15
**Material Description:** Tan Sandy Clay
**Date:** N/A  **Natural Moisture:** 65.3
**Testing Remarks:** 11321
**Tested by:** EH  **Checked by:** JW

### Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 65.98 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | | |
| | | | #4 | | |
| | | | #10 | 0.00 | 100.0 |
| | | | #20 | 2.19 | 96.7 |
| | | | #40 | 13.63 | 79.3 |
| | | | #60 | 18.47 | 72.0 |
| | | | #100 | 20.22 | 69.4 |
| | | | #140 | 23.48 | 64.4 |
| | | | #200 | 26.13 | 60.4 |

### Fractional Components

| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 20.7 | 18.9 | 39.6 | | | 60.4 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 0.4374 | 0.5310 | 0.6372 | 0.7807 |

| Fineness Modulus |
|---|
| 0.71 |

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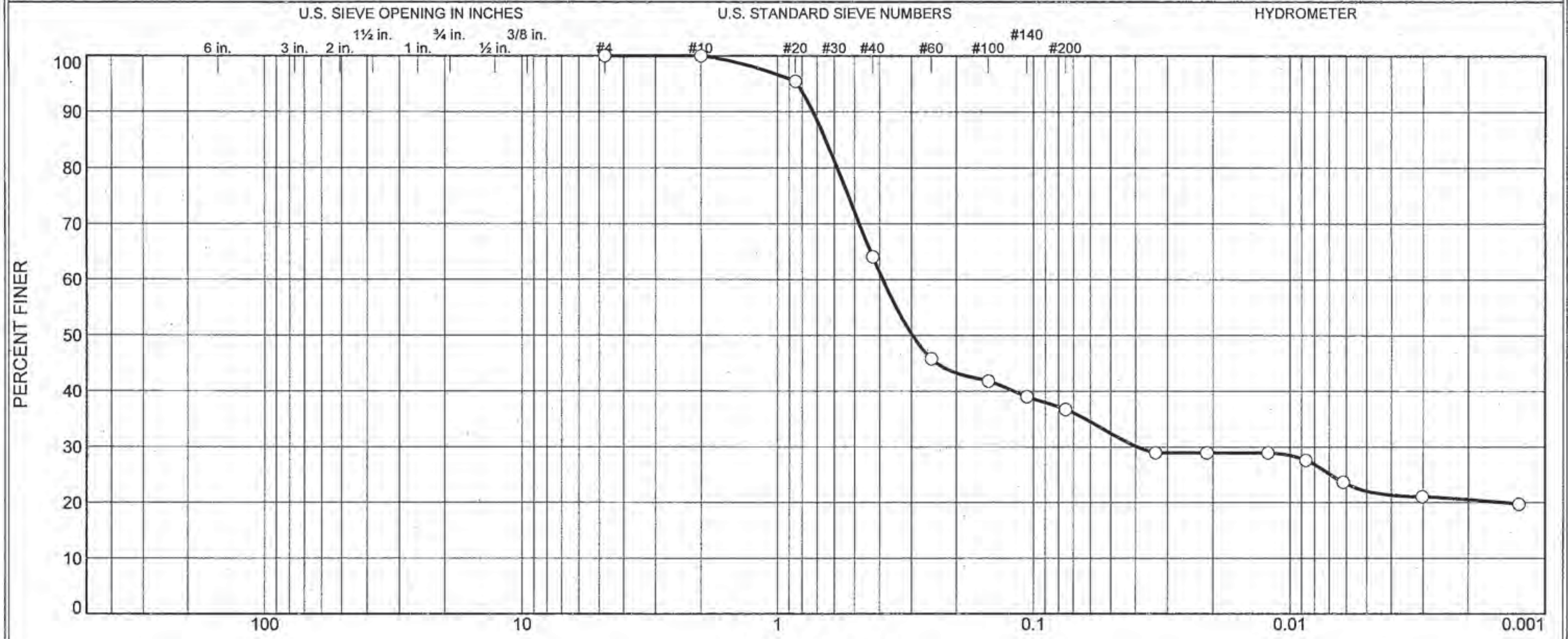
# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.0 | 36.0 | 27.3 | 14.7 | 22.0 |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B03 | SS16 | 58-60 ft | N/A | SC | Tan Clayey Sand | 42.0 | 92 | 33 |

Client SRNS
Project Saltstone Disposal Unit 6
Project No. 6155-08-0031.28 Figure

○ 11322

**Tested By:** EH **Checked By:** JW

# GRAIN SIZE DISTRIBUTION TEST DATA

2/3/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B03
**Depth:** 58-60 ft **Sample Number:** SS16
**Material Description:** Tan Clayey Sand
**Date:** N/A **Natural Moisture:** 42.0
**Liquid Limit:** 92 **Plastic Limit:** 33 **USCS Class.:** SC
**Testing Remarks:** 11322
**Tested by:** EH **Checked by:** JW

## Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 37.63 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | | |
| | | | #4 | 0.00 | 100.0 |
| | | | #10 | 0.00 | 100.0 |
| | | | #20 | 1.73 | 95.4 |
| | | | #40 | 13.54 | 64.0 |
| | | | #60 | 20.39 | 45.8 |
| | | | #100 | 21.90 | 41.8 |
| | | | #140 | 22.95 | 39.0 |
| | | | #200 | 23.81 | 36.7 |

## Hydrometer Test Data

Hydrometer test uses material passing #200
Percent passing #200 based upon complete sample = 36.7
Weight of hydrometer sample =13.82
Table of composite correction values:

| Temp., deg. C: | 17.6 | 19.1 | 20.9 | 21.8 | 23.9 |
|---|---|---|---|---|---|
| Comp. corr.: | -7.0 | -6.5 | -6.2 | -6.0 | -5.5 |

Meniscus correction only = 0.0
Specific gravity of solids = 2.7
Hydrometer type = 152H
Hydrometer effective depth equation: L = 16.294964 - 0.164 x Rm

| Elapsed Time (min.) | Temp. (deg. C.) | Actual Reading | Corrected Reading | K | Rm | Eff. Depth | Diameter (mm.) | Percent Finer |
|---|---|---|---|---|---|---|---|---|
| 2.00 | 23.9 | 16.5 | 11.0 | 0.0128 | 16.5 | 13.6 | 0.0334 | 28.9 |
| 5.00 | 23.9 | 16.5 | 11.0 | 0.0128 | 16.5 | 13.6 | 0.0211 | 28.9 |
| 15.00 | 23.9 | 16.5 | 11.0 | 0.0128 | 16.5 | 13.6 | 0.0122 | 28.9 |
| 30.00 | 23.9 | 16.0 | 10.5 | 0.0128 | 16.0 | 13.7 | 0.0087 | 27.6 |
| 60.00 | 23.9 | 14.5 | 9.0 | 0.0128 | 14.5 | 13.9 | 0.0062 | 23.7 |
| 250.00 | 24.3 | 13.5 | 8.0 | 0.0128 | 13.5 | 14.1 | 0.0030 | 21.0 |
| 1440.00 | 24.3 | 13.0 | 7.5 | 0.0128 | 13.0 | 14.2 | 0.0013 | 19.7 |

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## Fractional Components

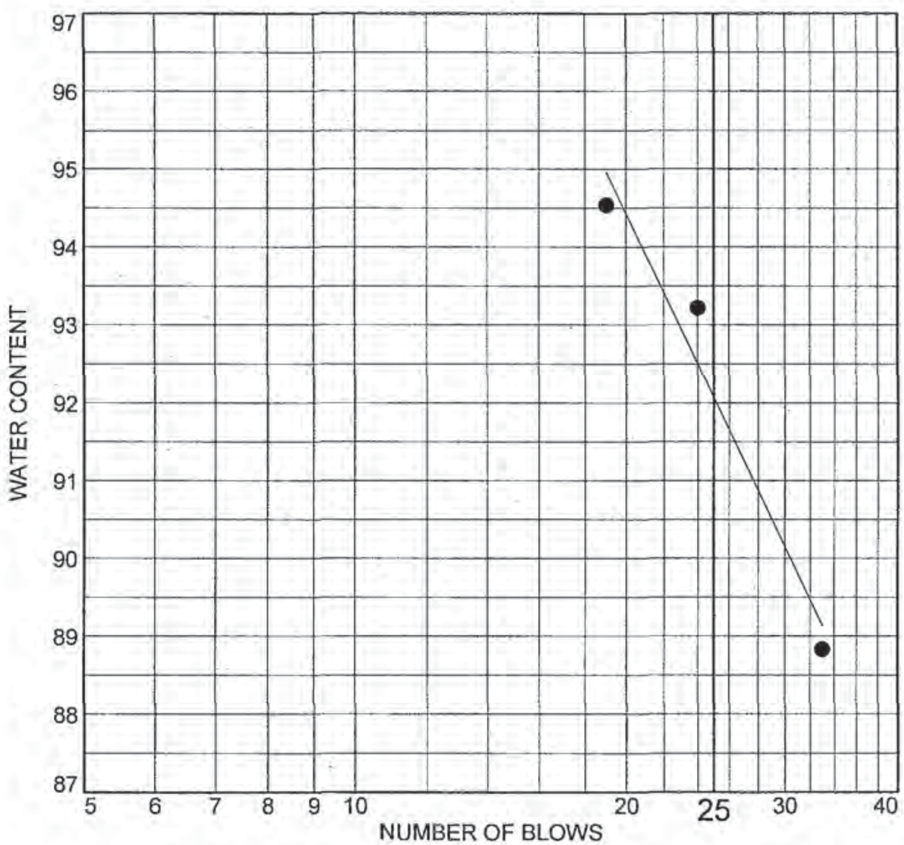
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 36.0 | 27.3 | 63.3 | 14.7 | 22.0 | 36.7 |

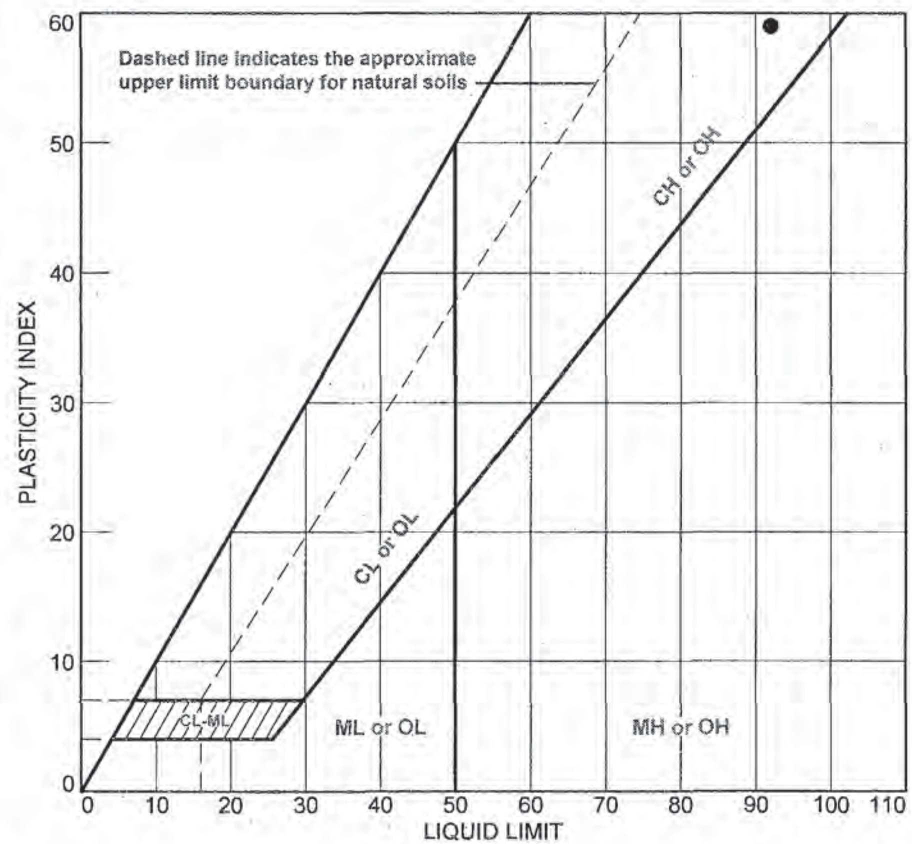
| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | | 0.0015 | 0.0395 | 0.2973 | 0.3891 | 0.5854 | 0.6496 | 0.7286 | 0.8385 |

| Fineness Modulus |
|---|
| 1.29 |

AMEC

# LIQUID AND PLASTIC LIMITS TEST REPORT (ASTM D4318-05)




| | SOURCE | SAMPLE # | DEPTH/ELEV. | DATE SAMPLED | USCS | MATERIAL DESCRIPTION | NM % | LL | PI |
|---|---|---|---|---|---|---|---|---|---|
| ● | Z-SDU6-B03 | SS16 | 58-60 ft | N/A | SC | Tan Clayey Sand | 42.0 | 92 | 59 |

Client SRNS

Project Saltstone Disposal Unit 6

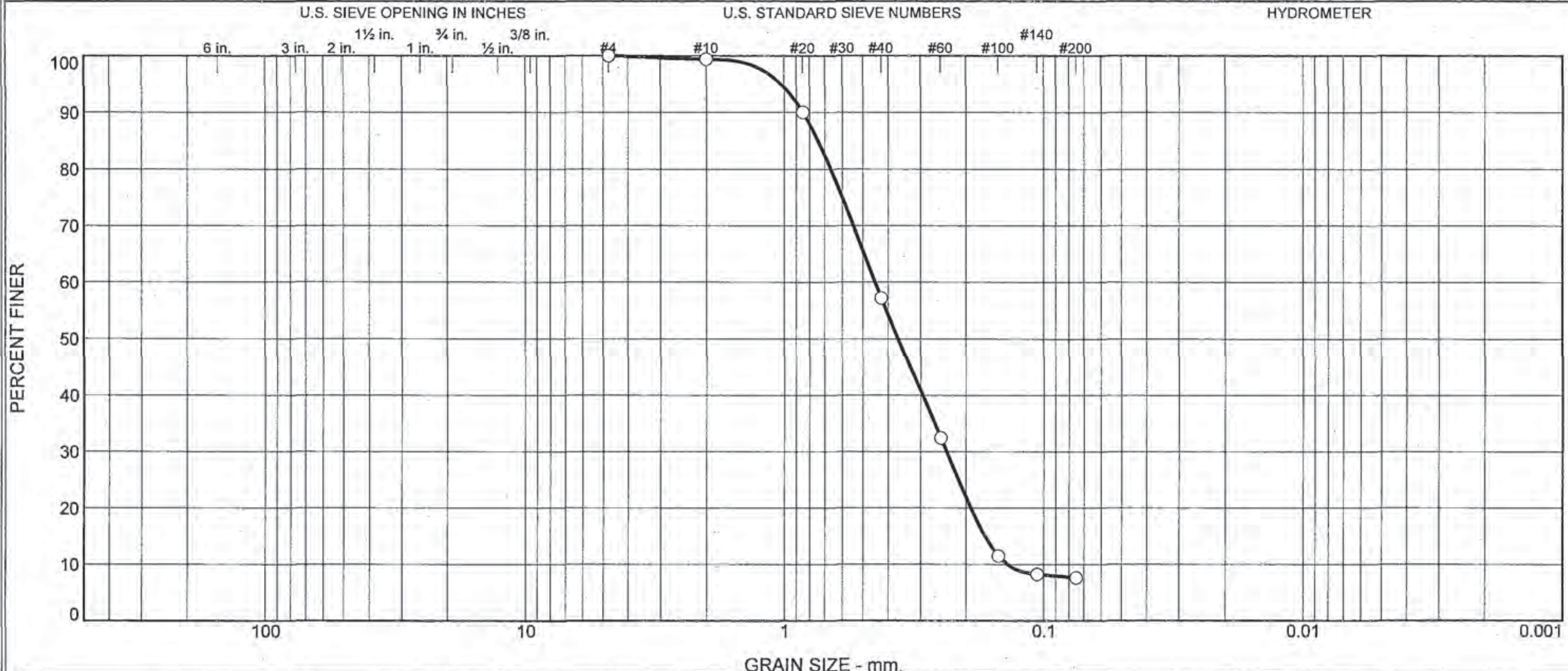
Project No. 6155-08-0031.28 | Figure

amec

● 11322

**Tested By:** EH **Checked By:** JW

# Particale Size Distribution (ASTM D422-63 (2007))




| % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ 0.0 | 0.0 | 0.0 | 0.6 | 42.3 | 49.5 | 7.6 | |

| Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|
| ○ Z-SDU6-B03 | SS17 | 63-65 ft | N/A | | Brown Poorly Graded Sand with Silt | 21.6 | | |

Client SRNS
Project Saltstone Disposal Unit 6
Project No. 6155-08-0031.28
Figure

amec

○ 11323

**Tested By:** EH **Checked By:** JW

## GRAIN SIZE DISTRIBUTION TEST DATA

2/3/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B03
**Depth:** 63-65 ft
**Sample Number:** SS17
**Material Description:** Brown Poorly Graded Sand with Silt
**Date:** N/A
**Natural Moisture:** 21.6
**Testing Remarks:** 11323
**Tested by:** EH
**Checked by:** JW

### Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 104.36 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | | |
| | | | #4 | 0.00 | 100.0 |
| | | | #10 | 0.66 | 99.4 |
| | | | #20 | 10.43 | 90.0 |
| | | | #40 | 44.74 | 57.1 |
| | | | #60 | 70.52 | 32.4 |
| | | | #100 | 92.40 | 11.5 |
| | | | #140 | 95.76 | 8.2 |
| | | | #200 | 96.41 | 7.6 |

### Fractional Components

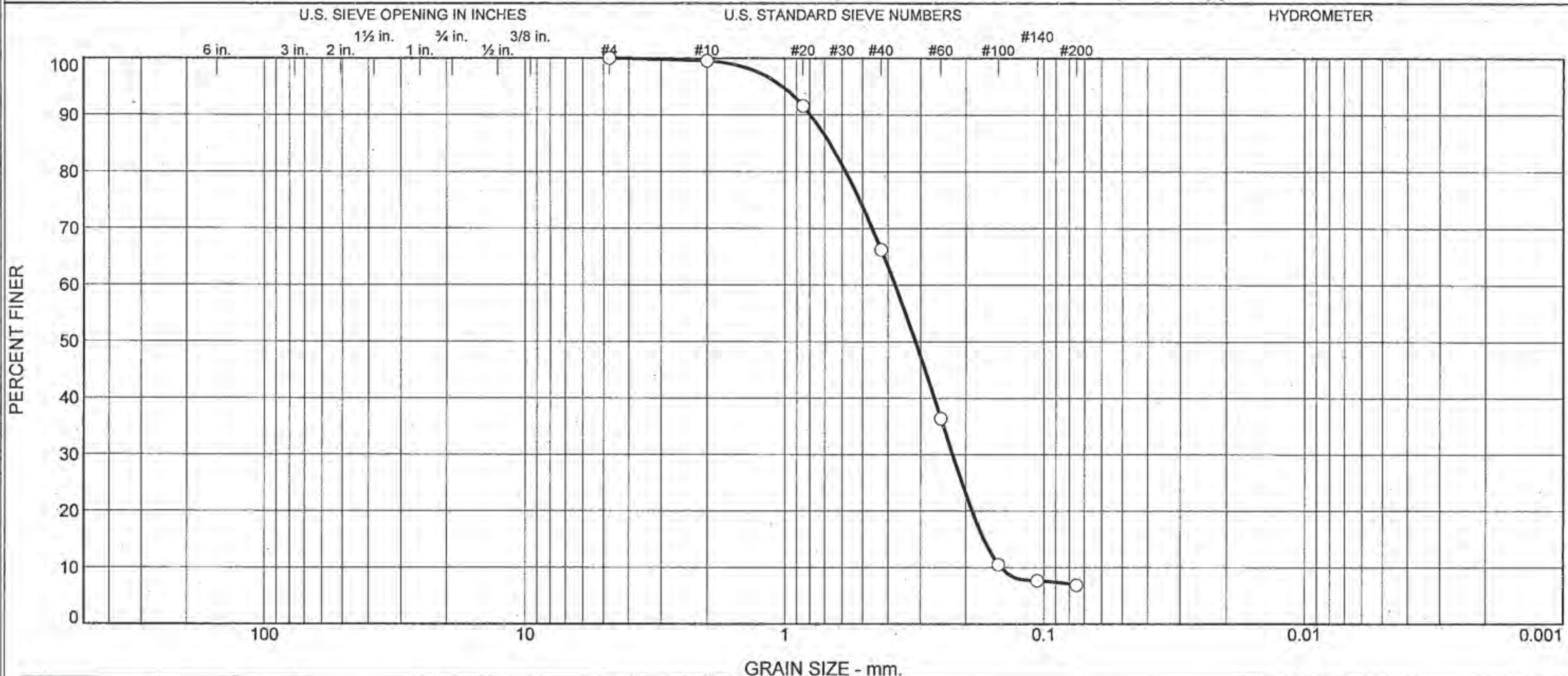
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.6 | 42.3 | 49.5 | 92.4 | | | 7.6 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| 0.1387 | 0.1693 | 0.1920 | 0.2377 | 0.3664 | 0.4498 | 0.6651 | 0.7439 | 0.8499 | 1.0305 |

| Fineness Modulus | $C_u$ | $C_c$ |
|---|---|---|
| 1.76 | 3.24 | 0.91 |

AMEC

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.5 | 33.3 | 59.3 | 6.9 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B03 | SS18 | 68-70 ft | N/A | | Yellowish Brown Poorly Graded Sand with Silt | 20.1 | | |

Client SRNS
Project Saltstone Disposal Unit 6
Project No. 6155-08-0031.28 Figure

amec

○ 11324

**Tested By:** EH **Checked By:** JW

RCN: SRS200 Page 101 of 217

## GRAIN SIZE DISTRIBUTION TEST DATA

2/3/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B03
**Depth:** 68-70 ft **Sample Number:** SS18
**Material Description:** Yellowish Brown Poorly Graded Sand with Silt
**Date:** N/A **Natural Moisture:** 20.1
**Testing Remarks:** 11324
**Tested by:** EH **Checked by:** JW

### Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 89.00 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | | |
| | | | #4 | 0.00 | 100.0 |
| | | | #10 | 0.43 | 99.5 |
| | | | #20 | 7.54 | 91.5 |
| | | | #40 | 30.09 | 66.2 |
| | | | #60 | 56.62 | 36.4 |
| | | | #100 | 79.64 | 10.5 |
| | | | #140 | 82.17 | 7.7 |
| | | | #200 | 82.87 | 6.9 |

### Fractional Components

| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.5 | 33.3 | 59.3 | 93.1 | | | 6.9 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| 0.1468 | 0.1708 | 0.1896 | 0.2254 | 0.3142 | 0.3765 | 0.5826 | 0.6712 | 0.7975 | 1.0230 |

| Fineness Modulus | $C_u$ | $C_c$ |
|---|---|---|
| 1.65 | 2.57 | 0.92 |

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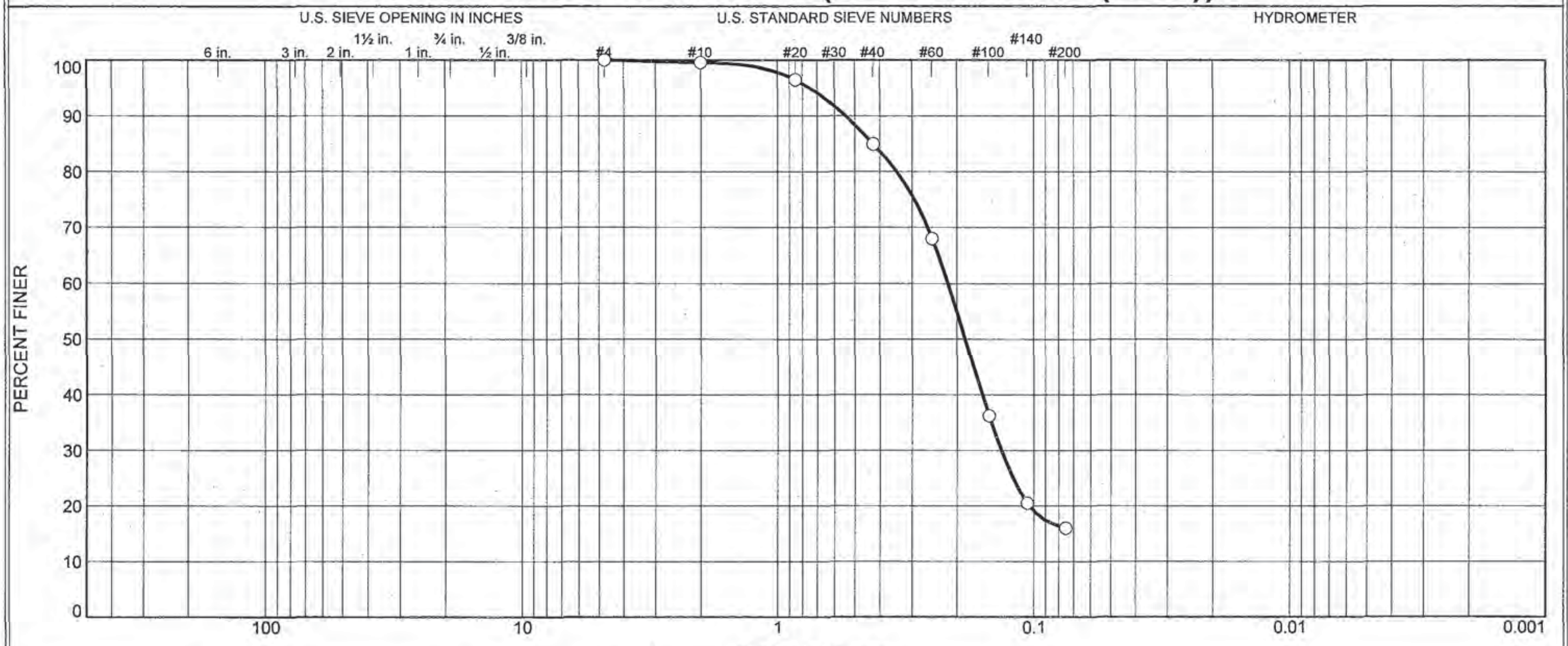
# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.5 | 14.5 | 69.0 | 16.0 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B03 | SS19 | 73-75 ft | N/A | | Brown Clayeye Sand | 30.0 | | |

Client SRNS

Project Saltstone Disposal Unit 6

Project No. 6155-08-0031.28 Figure

○ 11325

amec

**Tested By:** EH **Checked By:** JW

# GRAIN SIZE DISTRIBUTION TEST DATA

2/3/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B03
**Depth:** 73-75 ft
**Sample Number:** SS19
**Material Description:** Brown Clayeye Sand
**Date:** N/A
**Natural Moisture:** 30.0
**Testing Remarks:** 11325
**Tested by:** EH
**Checked by:** JW

## Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 85.01 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | | |
| | | | #4 | 0.00 | 100.0 |
| | | | #10 | 0.41 | 99.5 |
| | | | #20 | 3.04 | 96.4 |
| | | | #40 | 12.76 | 85.0 |
| | | | #60 | 27.25 | 67.9 |
| | | | #100 | 54.25 | 36.2 |
| | | | #140 | 67.61 | 20.5 |
| | | | #200 | 71.43 | 16.0 |

## Fractional Components

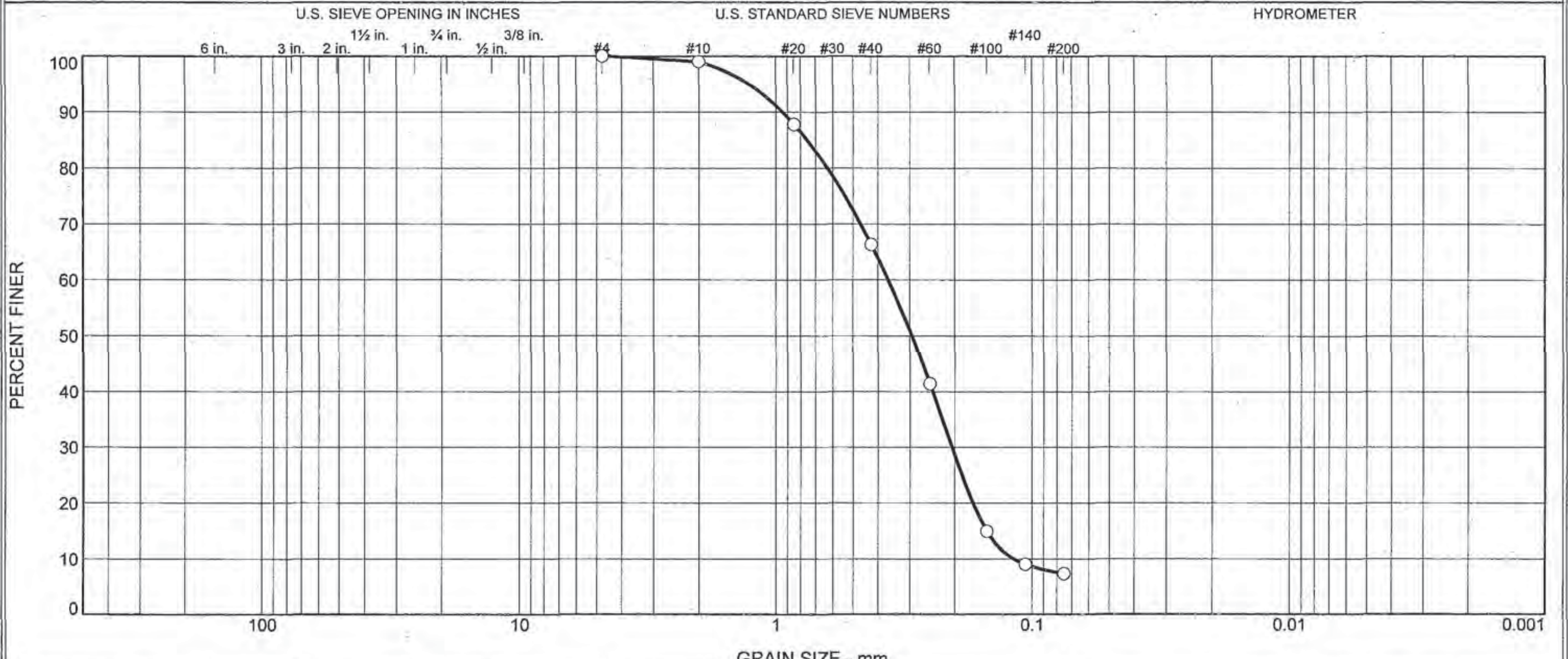
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.5 | 14.5 | 69.0 | 84.0 | | | 16.0 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | | 0.1041 | 0.1343 | 0.1860 | 0.2173 | 0.3446 | 0.4252 | 0.5458 | 0.7504 |

| Fineness Modulus |
|---|
| 0.98 |

AMEC

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 1.0 | 32.7 | 59.0 | 7.3 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B03 | SS20 | 78-80 ft | N/A | | Yellowish Brown Poorly Graded Sand with Silt | 20.4 | | |

Client SRNS
Project Saltstone Disposal Unit 6
Project No. 6155-08-0031.28 Figure

amec

○ 11326

**Tested By:** EH **Checked By:** JW

# GRAIN SIZE DISTRIBUTION TEST DATA

2/3/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B03
**Depth:** 78-80 ft **Sample Number:** SS20
**Material Description:** Yellowish Brown Poorly Graded Sand with Silt
**Date:** N/A **Natural Moisture:** 20.4
**Testing Remarks:** 11326
**Tested by:** EH **Checked by:** JW

## Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 98.05 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | | |
| | | | #4 | 0.00 | 100.0 |
| | | | #10 | 0.99 | 99.0 |
| | | | #20 | 11.93 | 87.8 |
| | | | #40 | 33.04 | 66.3 |
| | | | #60 | 57.46 | 41.4 |
| | | | #100 | 83.39 | 15.0 |
| | | | #140 | 89.21 | 9.0 |
| | | | #200 | 90.88 | 7.3 |

## Fractional Components

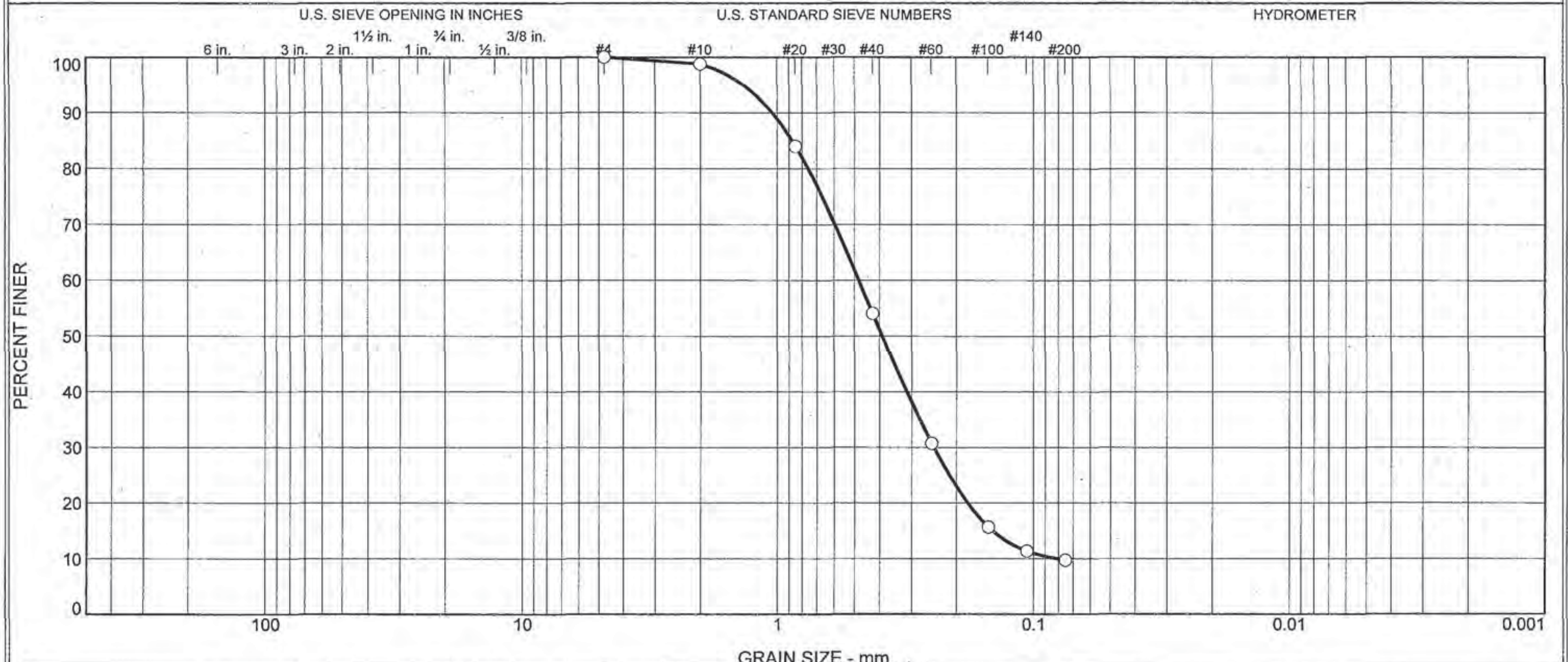
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 32.7 | 59.0 | 92.7 | | | 7.3 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| 0.1182 | 0.1502 | 0.1700 | 0.2052 | 0.2941 | 0.3648 | 0.6306 | 0.7552 | 0.9418 | 1.2790 |

| Fineness Modulus | $C_u$ | $C_c$ |
|---|---|---|
| 1.63 | 3.09 | 0.98 |

AMEC

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 1.2 | 44.8 | 44.3 | 9.7 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B03 | SS21 | 83-85 ft | N/A | | Tan Poorly Graded Sand with Silt | 20.4 | | |

Client SRNS

Project Saltstone Disposal Unit 6

Project No. 6155-08-0031.28 Figure

○ 11327

**Tested By:** EH **Checked By:** JW

# GRAIN SIZE DISTRIBUTION TEST DATA

2/3/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B03
**Depth:** 83-85 ft
**Sample Number:** SS21
**Material Description:** Tan Poorly Graded Sand with Silt
**Date:** N/A
**Natural Moisture:** 20.4
**Testing Remarks:** 11327
**Tested by:** EH
**Checked by:** JW

## Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 102.66 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | | |
| | | | #4 | 0.00 | 100.0 |
| | | | #10 | 1.25 | 98.8 |
| | | | #20 | 16.40 | 84.0 |
| | | | #40 | 47.23 | 54.0 |
| | | | #60 | 71.16 | 30.7 |
| | | | #100 | 86.59 | 15.7 |
| | | | #140 | 91.00 | 11.4 |
| | | | #200 | 92.69 | 9.7 |

## Fractional Components

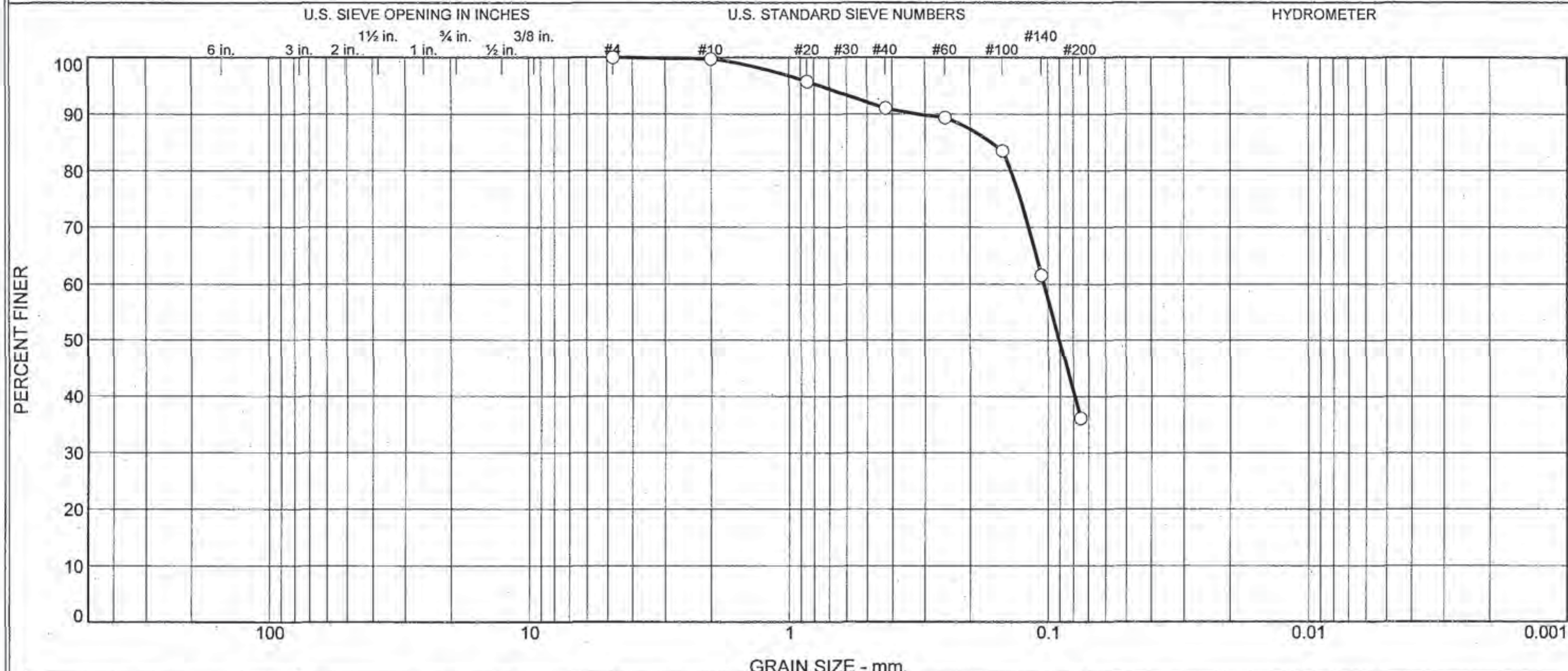
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.0 | 0.0 | 1.2 | 44.8 | 44.3 | 90.3 | | | 9.7 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| 0.0813 | 0.1447 | 0.1809 | 0.2455 | 0.3905 | 0.4821 | 0.7590 | 0.8760 | 1.0498 | 1.3646 |

| Fineness Modulus | $C_u$ | $C_c$ |
|---|---|---|
| 1.85 | 5.93 | 1.54 |

AMEC

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| O | 0.0 | 0.0 | 0.0 | 0.3 | 8.6 | 55.0 | 36.1 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| O | Z-SDU6-B03 | SS22 | 88-90 ft | N/A | | Tan Silty Sand | 35.3 | | |

Client SRNS
Project Saltstone Disposal Unit 6
Project No. 6155-08-0031.28 Figure

amec

O 11328

**Tested By:** EH **Checked By:** JW

## GRAIN SIZE DISTRIBUTION TEST DATA

2/3/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B03
**Depth:** 88-90 ft
**Sample Number:** SS22
**Material Description:** Tan Silty Sand
**Date:** N/A
**Natural Moisture:** 35.3
**Testing Remarks:** 11328
**Tested by:** EH
**Checked by:** JW

### Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 79.70 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | | |
| | | | #4 | 0.00 | 100.0 |
| | | | #10 | 0.23 | 99.7 |
| | | | #20 | 3.40 | 95.7 |
| | | | #40 | 7.13 | 91.1 |
| | | | #60 | 8.47 | 89.4 |
| | | | #100 | 13.15 | 83.5 |
| | | | #140 | 30.68 | 61.5 |
| | | | #200 | 50.93 | 36.1 |

### Fractional Components

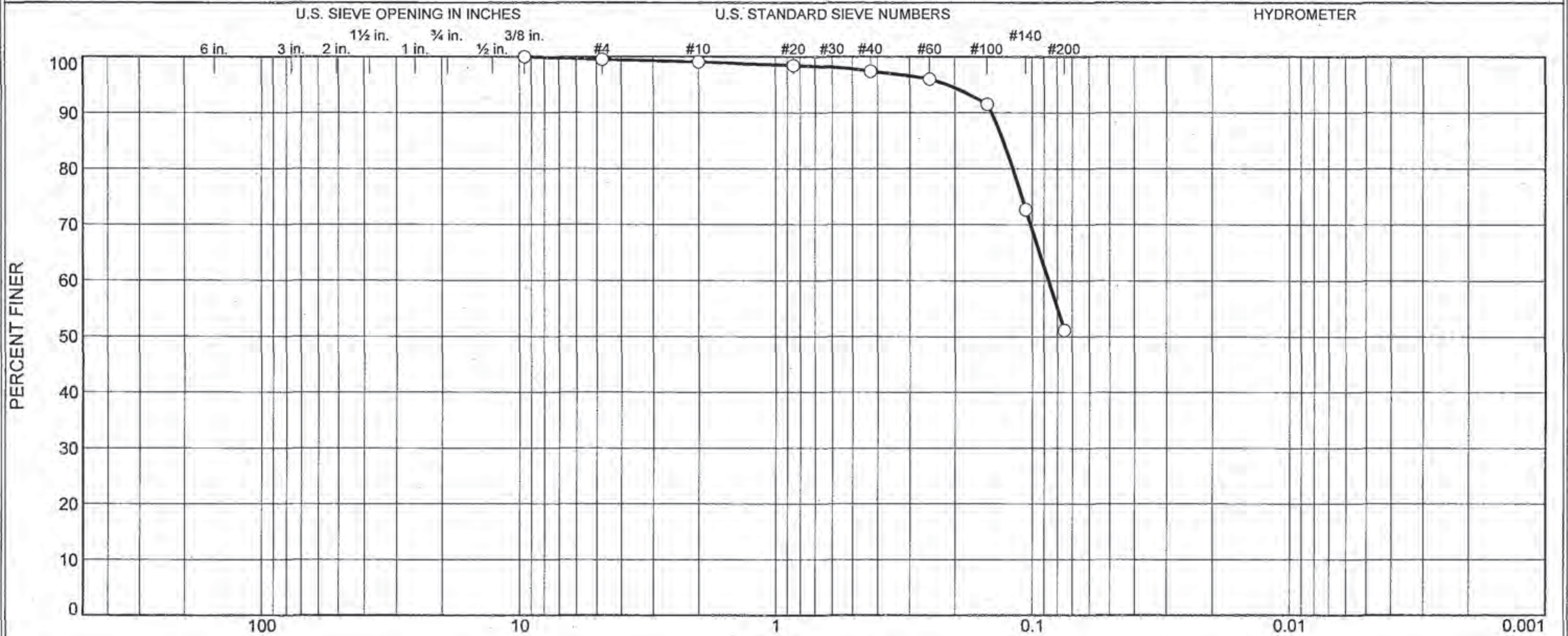
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 8.6 | 55.0 | 63.9 | | | 36.1 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | | | | 0.0907 | 0.1039 | 0.1395 | 0.1660 | 0.3252 | 0.7622 |

| Fineness Modulus |
|---|
| 0.36 |

AMEC

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.5 | 0.5 | 1.6 | 46.3 | 51.1 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B03 | SS23 | 93-95 ft | N/A | | Tan Sandy Silt | 43.3 | | |

Client SRNS

Project Saltstone Disposal Unit 6

Project No. 6155-08-0031.28 Figure

amec

○ 11329

**Tested By:** EH **Checked By:** JW

## GRAIN SIZE DISTRIBUTION TEST DATA

2/3/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B03
**Depth:** 93-95 ft
**Sample Number:** SS23
**Material Description:** Tan Sandy Silt
**Date:** N/A
**Natural Moisture:** 43.3
**Testing Remarks:** 11329
**Tested by:** EH
**Checked by:** JW

### Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 84.20 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | 0.00 | 100.0 |
| | | | #4 | 0.45 | 99.5 |
| | | | #10 | 0.81 | 99.0 |
| | | | #20 | 1.36 | 98.4 |
| | | | #40 | 2.23 | 97.4 |
| | | | #60 | 3.37 | 96.0 |
| | | | #100 | 7.16 | 91.5 |
| | | | #140 | 23.01 | 72.7 |
| | | | #200 | 41.14 | 51.1 |

### Fractional Components

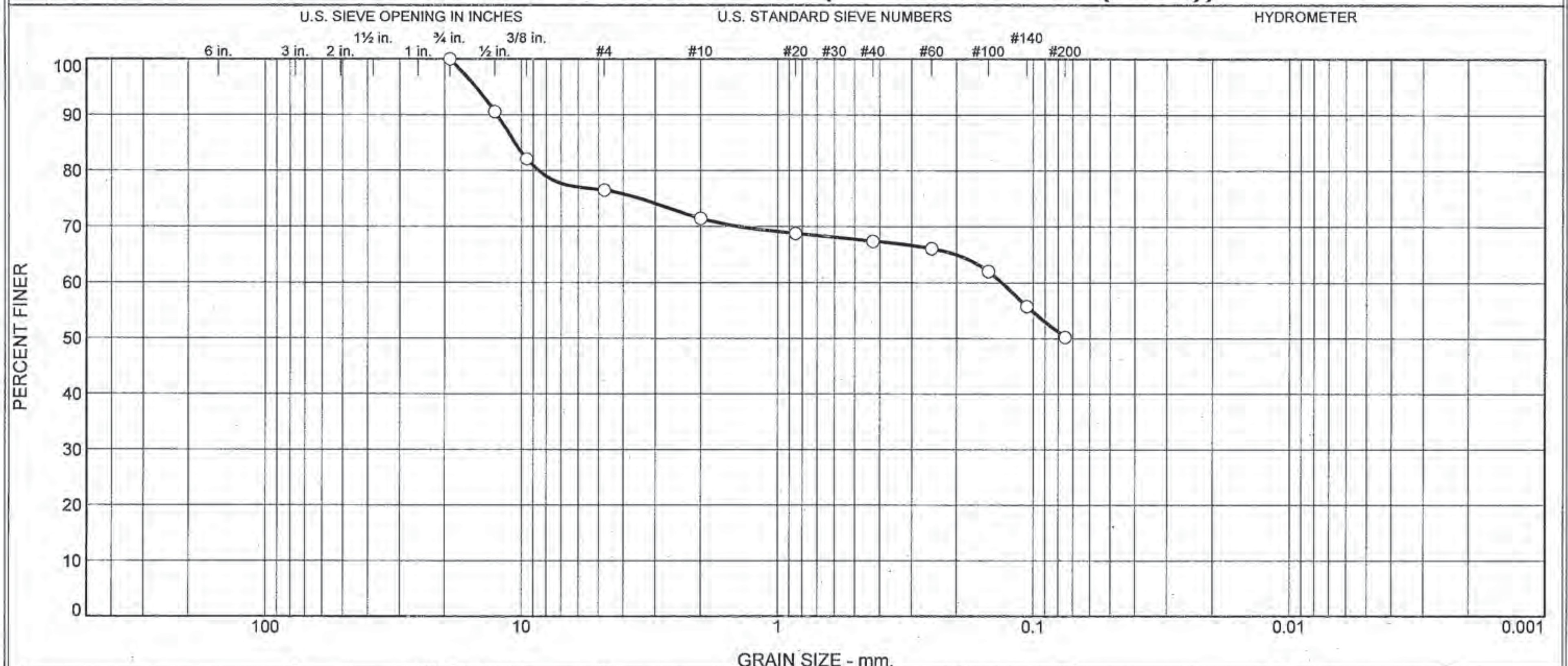
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.5 | 0.5 | 0.5 | 1.6 | 46.3 | 48.4 | | | 51.1 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | 0.0865 | 0.1192 | 0.1300 | 0.1443 | 0.2151 |

| Fineness Modulus |
|---|
| 0.17 |

AMEC

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 23.6 | 5.0 | 4.0 | 17.2 | 50.2 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B03 | SS24 | 98-100 ft | N/A | | Tan Sandy Silt with Gravel | 44.2 | | |

Client SRNS
Project Saltstone Disposal Unit 6
Project No. 6155-08-0031.28 Figure

amec

○ 11330

**Tested By:** EH **Checked By:** JW

# GRAIN SIZE DISTRIBUTION TEST DATA

2/3/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B03
**Depth:** 98-100 ft
**Sample Number:** SS24
**Material Description:** Tan Sandy Silt with Gravel
**Date:** N/A
**Natural Moisture:** 44.2
**Testing Remarks:** 11330
**Tested by:** EH
**Checked by:** JW

## Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 69.50 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | 0.00 | 100.0 |
| | | | .5" | 6.59 | 90.5 |
| | | | .375" | 12.46 | 82.1 |
| | | | #4 | 16.39 | 76.4 |
| | | | #10 | 19.86 | 71.4 |
| | | | #20 | 21.71 | 68.8 |
| | | | #40 | 22.68 | 67.4 |
| | | | #60 | 23.60 | 66.0 |
| | | | #100 | 26.42 | 62.0 |
| | | | #140 | 30.76 | 55.7 |
| | | | #200 | 34.61 | 50.2 |

## Fractional Components

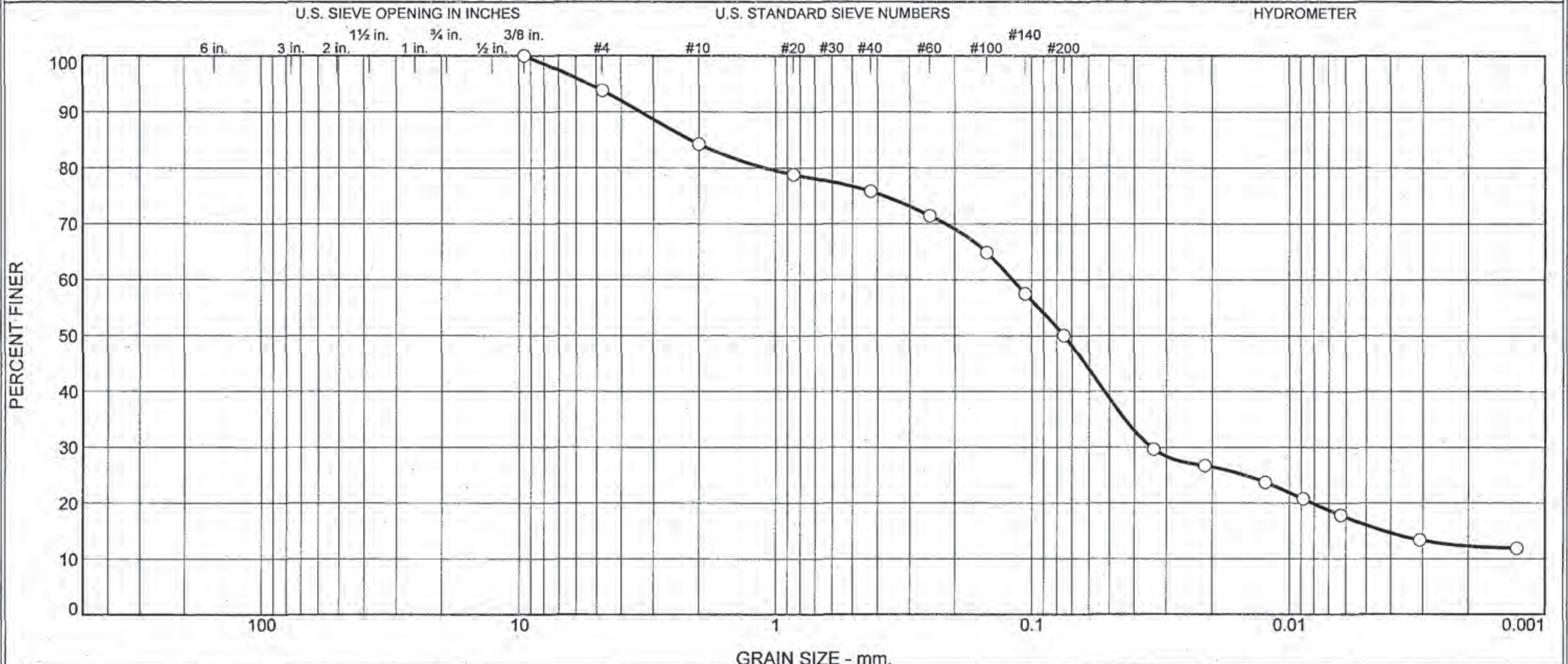
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 23.6 | 23.6 | 5.0 | 4.0 | 17.2 | 26.2 | | | 50.2 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | 0.1331 | 8.6062 | 10.6013 | 12.4779 | 15.0968 |

| Fineness Modulus |
|---|
| 2.03 |

AMEC

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 6.2 | 9.5 | 8.5 | 25.8 | 34.0 | 16.0 |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B03 | SS25 | 103-105 ft | N/A | ML | Tan Sandy Silt | 46.6 | 43 | 39 |

Client SRNS

Project Saltstone Disposal Unit 6

Project No. 6155-08-0031.28 Figure

amec

○ 11331

**Tested By:** EH **Checked By:** JW

# GRAIN SIZE DISTRIBUTION TEST DATA

2/3/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B03
**Depth:** 103-105 ft
**Sample Number:** SS25
**Material Description:** Tan Sandy Silt
**Date:** N/A
**Natural Moisture:** 46.6
**Liquid Limit:** 43
**Plastic Limit:** 39
**USCS Class.:** ML
**Testing Remarks:** 11331
**Tested by:** EH
**Checked by:** JW

## Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 33.36 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | 0.00 | 100.0 |
| | | | #4 | 2.08 | 93.8 |
| | | | #10 | 5.24 | 84.3 |
| | | | #20 | 7.09 | 78.7 |
| | | | #40 | 8.08 | 75.8 |
| | | | #60 | 9.54 | 71.4 |
| | | | #100 | 11.73 | 64.8 |
| | | | #140 | 14.19 | 57.5 |
| | | | #200 | 16.68 | 50.0 |

## Hydrometer Test Data

Hydrometer test uses material passing #200
Percent passing #200 based upon complete sample = 50.0
Weight of hydrometer sample =16.68
Table of composite correction values:

| | | | | | |
|---|---|---|---|---|---|
| Temp., deg. C: | 17.6 | 19.1 | 20.9 | 21.8 | 23.9 |
| Comp. corr.: | -7.0 | -6.5 | -6.2 | -6.0 | -5.5 |

Meniscus correction only = 0.0
Specific gravity of solids = 2.7
Hydrometer type = 152H
Hydrometer effective depth equation: L = 16.294964 - 0.164 x Rm

| Elapsed Time (min.) | Temp. (deg. C.) | Actual Reading | Corrected Reading | K | Rm | Eff. Depth | Diameter (mm.) | Percent Finer |
|---|---|---|---|---|---|---|---|---|
| 2.00 | 23.9 | 15.5 | 10.0 | 0.0128 | 15.5 | 13.8 | 0.0336 | 29.6 |
| 5.00 | 23.9 | 14.5 | 9.0 | 0.0128 | 14.5 | 13.9 | 0.0214 | 26.7 |
| 15.00 | 23.9 | 13.5 | 8.0 | 0.0128 | 13.5 | 14.1 | 0.0124 | 23.7 |
| 30.00 | 23.9 | 12.5 | 7.0 | 0.0128 | 12.5 | 14.2 | 0.0088 | 20.8 |
| 60.00 | 23.9 | 11.5 | 6.0 | 0.0128 | 11.5 | 14.4 | 0.0063 | 17.8 |
| 250.00 | 24.3 | 10.0 | 4.5 | 0.0128 | 10.0 | 14.7 | 0.0031 | 13.3 |
| 1440.00 | 24.3 | 9.5 | 4.0 | 0.0128 | 9.5 | 14.7 | 0.0013 | 11.9 |

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## Fractional Components

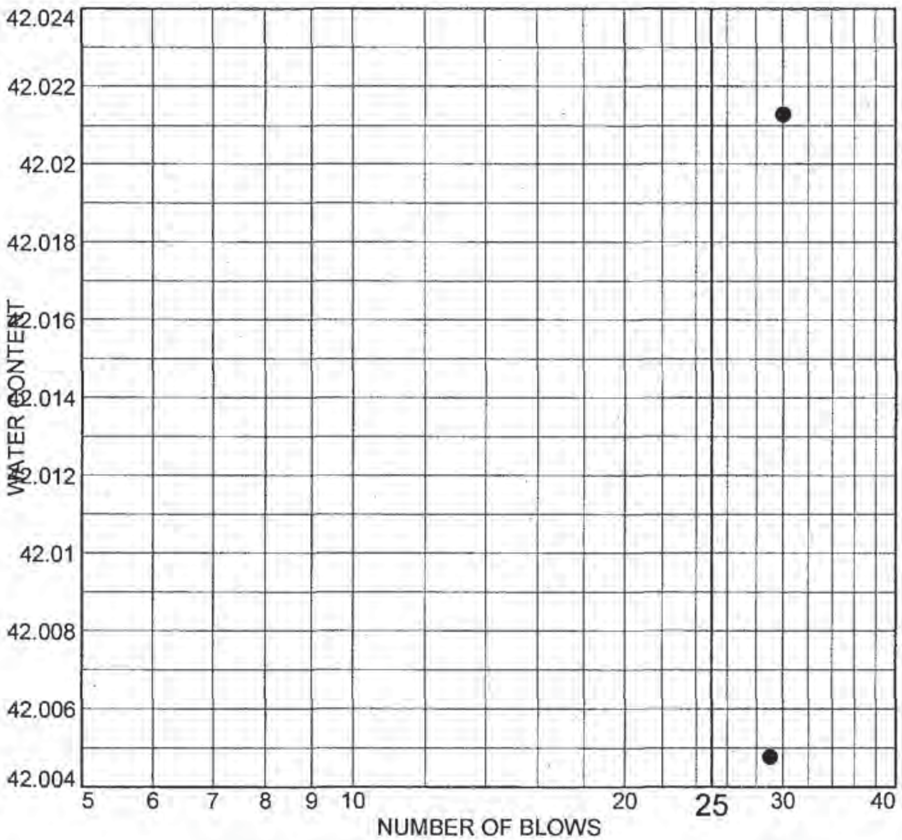
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 6.2 | 6.2 | 9.5 | 8.5 | 25.8 | 43.8 | 34.0 | 16.0 | 50.0 |

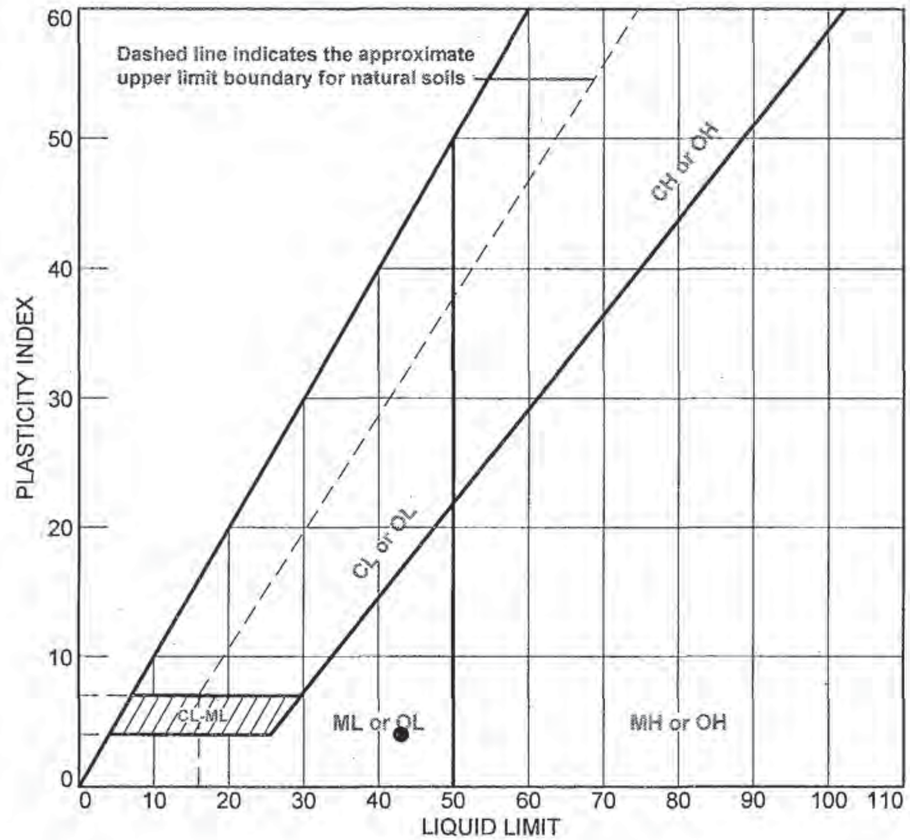
| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | 0.0043 | 0.0081 | 0.0344 | 0.0750 | 0.1190 | 1.1093 | 2.1508 | 3.3834 | 5.3727 |

| Fineness Modulus |
|---|
| 1.25 |

AMEC

# LIQUID AND PLASTIC LIMITS TEST REPORT (ASTM D4318-05)




| | SOURCE | SAMPLE # | DEPTH/ELEV. | DATE SAMPLED | USCS | MATERIAL DESCRIPTION | NM % | LL | PI |
|---|---|---|---|---|---|---|---|---|---|
| ● | Z-SDU6-B03 | SS25 | 103-105 ft | N/A | ML | Tan Sandy Silt | 46.6 | 43 | 4 |

Client SRNS

Project Saltstone Disposal Unit 6

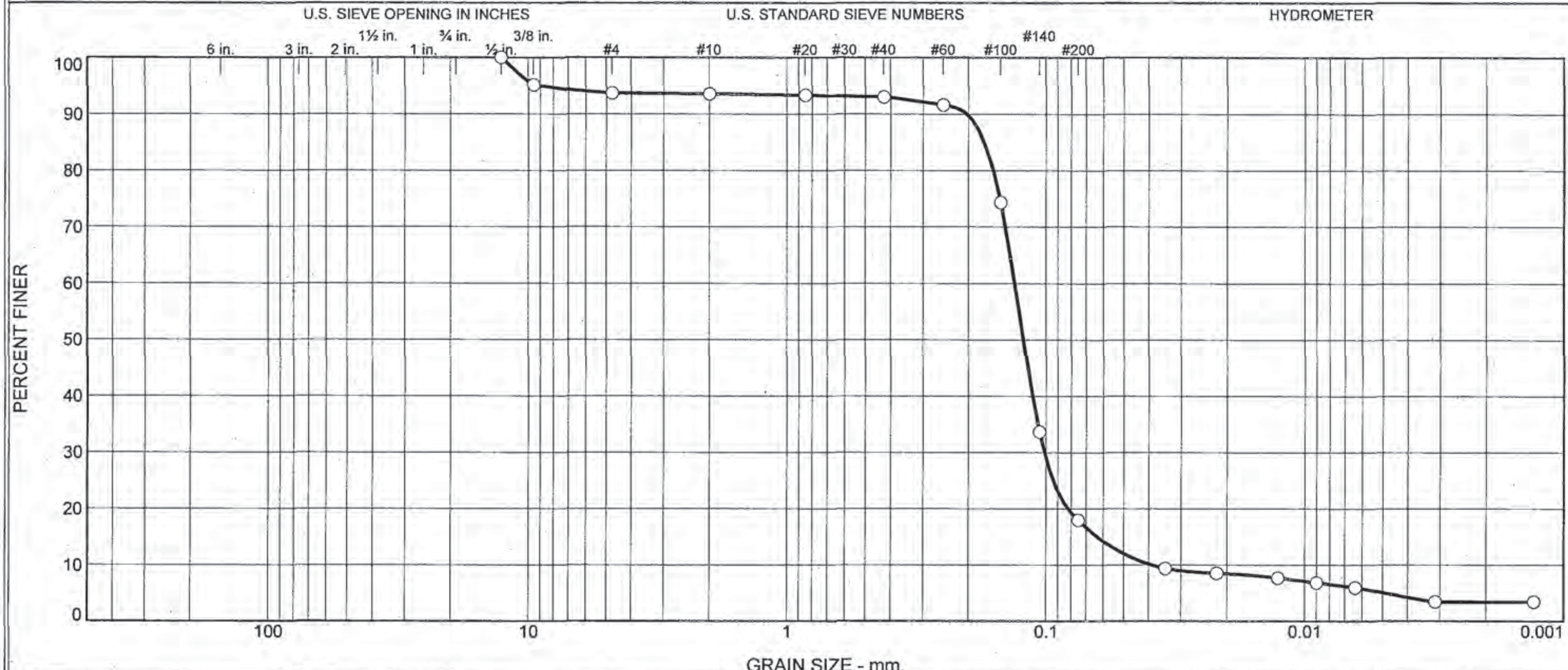
Project No. 6155-08-0031.28 | Figure

amec

● 11331

**Tested By:** EH **Checked By:** JW

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 6.3 | 0.1 | 0.6 | 75.0 | 12.9 | 5.1 |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B03 | SS26 | 108-110 ft | N/A | | Brown Silty Sand | 27.2 | | |

Client SRNS

Project Saltstone Disposal Unit 6

Project No. 6155-08-0031.28 Figure

amec

○ 11332

**Tested By:** EH **Checked By:** JW

## GRAIN SIZE DISTRIBUTION TEST DATA

2/3/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B03
**Depth:** 108-110 ft
**Sample Number:** SS26
**Material Description:** Brown Silty Sand
**Date:** N/A
**Natural Moisture:** 27.2
**Testing Remarks:** 11332
**Tested by:** EH
**Checked by:** JW

### Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 58.15 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | 0.00 | 100.0 |
| | | | .375" | 2.84 | 95.1 |
| | | | #4 | 3.67 | 93.7 |
| | | | #10 | 3.74 | 93.6 |
| | | | #20 | 3.89 | 93.3 |
| | | | #40 | 4.07 | 93.0 |
| | | | #60 | 4.89 | 91.6 |
| | | | #100 | 14.96 | 74.3 |
| | | | #140 | 38.60 | 33.6 |
| | | | #200 | 47.71 | 18.0 |

### Hydrometer Test Data

Hydrometer test uses material passing #200
Percent passing #200 based upon complete sample = 18.0
Weight of hydrometer sample =10.44
Table of composite correction values:

| | | | | | |
|---|---|---|---|---|---|
| Temp., deg. C: | 17.6 | 19.1 | 20.9 | 21.8 | 23.9 |
| Comp. corr.: | -7.0 | -6.5 | -6.2 | -6.0 | -5.5 |

Meniscus correction only = 0.0
Specific gravity of solids = 2.7
Hydrometer type = 152H
Hydrometer effective depth equation: L = 16.294964 - 0.164 x Rm

| Elapsed Time (min.) | Temp. (deg. C.) | Actual Reading | Corrected Reading | K | Rm | Eff. Depth | Diameter (mm.) | Percent Finer |
|---|---|---|---|---|---|---|---|---|
| 2.00 | 23.9 | 11.0 | 5.5 | 0.0128 | 11.0 | 14.5 | 0.0345 | 9.4 |
| 5.00 | 23.9 | 10.5 | 5.0 | 0.0128 | 10.5 | 14.6 | 0.0219 | 8.5 |
| 15.00 | 23.9 | 10.0 | 4.5 | 0.0128 | 10.0 | 14.7 | 0.0127 | 7.7 |
| 30.00 | 23.9 | 9.5 | 4.0 | 0.0128 | 9.5 | 14.7 | 0.0090 | 6.8 |
| 60.00 | 23.9 | 9.0 | 3.5 | 0.0128 | 9.0 | 14.8 | 0.0064 | 6.0 |
| 250.00 | 24.3 | 7.5 | 2.0 | 0.0128 | 7.5 | 15.1 | 0.0031 | 3.4 |
| 1440.00 | 24.3 | 7.5 | 2.0 | 0.0128 | 7.5 | 15.1 | 0.0013 | 3.4 |

AMEC

## Fractional Components

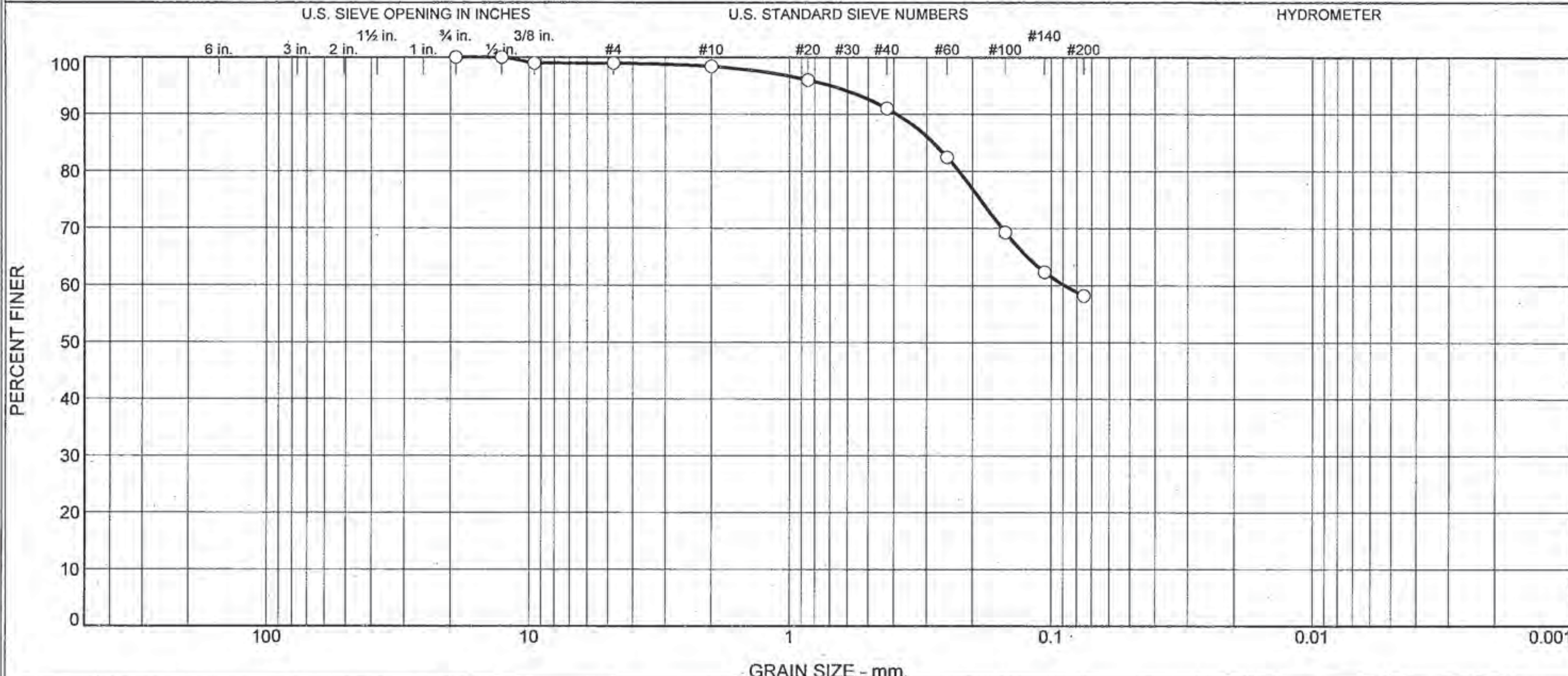
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 6.3 | 6.3 | 0.1 | 0.6 | 75.0 | 75.7 | 12.9 | 5.1 | 18.0 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| 0.0393 | 0.0633 | 0.0823 | 0.1015 | 0.1224 | 0.1324 | 0.1604 | 0.1741 | 0.2032 | 9.1454 |

| Fineness Modulus | $C_u$ | $C_c$ |
|---|---|---|
| 0.65 | 3.37 | 1.98 |

AMEC

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 1.0 | 0.6 | 7.4 | 32.8 | 58.2 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B03 | SS27 | 113-115 ft | N/A | | Gray Sandy Silt | 39.4 | | |

Client SRNS

Project Saltstone Disposal Unit 6

Project No. 6155-08-0031.28 Figure

○ 11333

**Tested By:** EH **Checked By:** JW

# GRAIN SIZE DISTRIBUTION TEST DATA

2/3/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B03
**Depth:** 113-115 ft
**Sample Number:** SS27
**Material Description:** Gray Sandy Silt
**Date:** N/A
**Natural Moisture:** 39.4
**Testing Remarks:** 11333
**Tested by:** EH
**Checked by:** JW

## Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 75.12 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | 0.00 | 100.0 |
| | | | .5" | 0.00 | 100.0 |
| | | | 0.375" | 0.78 | 99.0 |
| | | | #4 | 0.78 | 99.0 |
| | | | #10 | 1.20 | 98.4 |
| | | | #20 | 3.01 | 96.0 |
| | | | #40 | 6.77 | 91.0 |
| | | | #60 | 13.19 | 82.4 |
| | | | #100 | 23.08 | 69.3 |
| | | | #140 | 28.31 | 62.3 |
| | | | #200 | 31.42 | 58.2 |

## Fractional Components

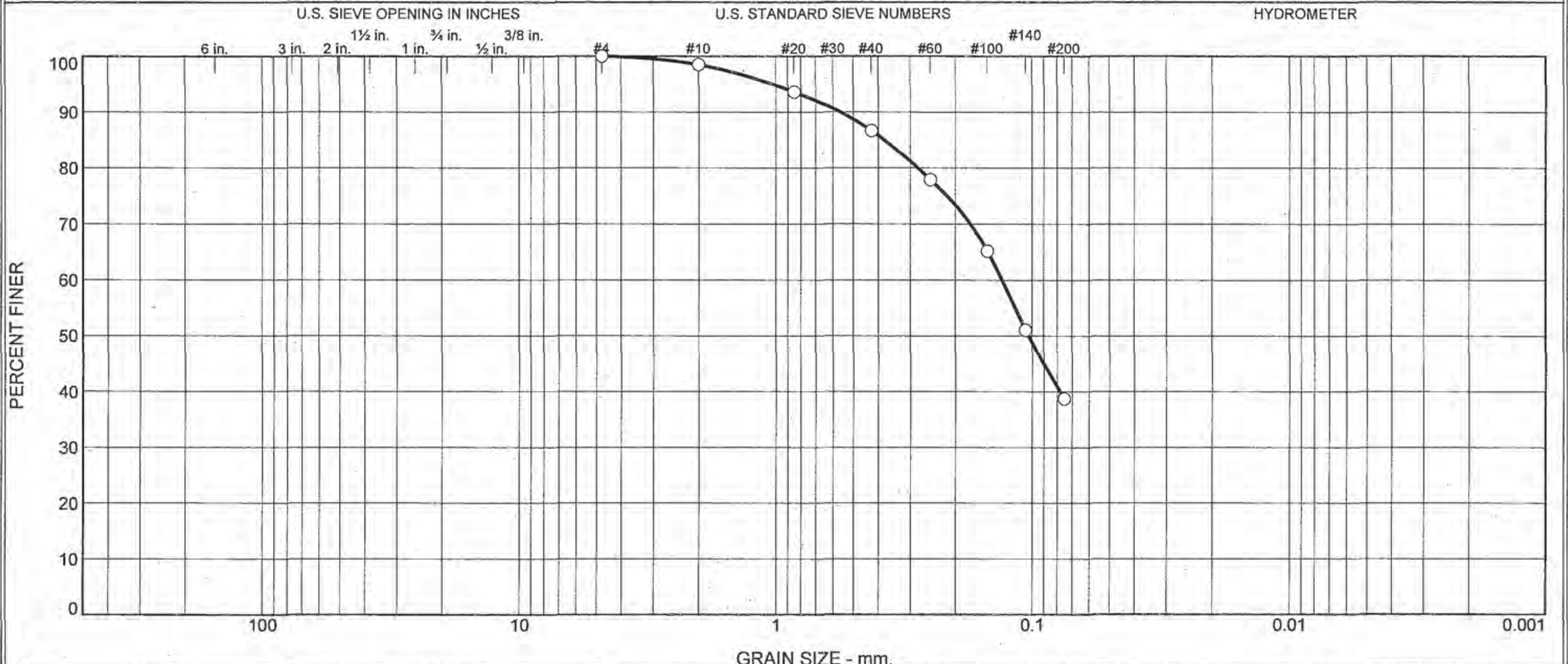
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 1.0 | 1.0 | 0.6 | 7.4 | 32.8 | 40.8 | | | 58.2 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | 0.0890 | 0.2258 | 0.2826 | 0.3904 | 0.6979 |

| Fineness Modulus |
|---|
| 0.57 |

AMEC

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 1.5 | 11.8 | 48.0 | 38.7 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B03 | SS28 | 118-120 ft | N/A | | Gray Silty Sand | 32.5 | | |

Client SRNS
Project Saltstone Disposal Unit 6
Project No. 6155-08-0031.28 Figure

○ 11334

**Tested By:** EH **Checked By:** JW

# GRAIN SIZE DISTRIBUTION TEST DATA

2/3/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B03
**Depth:** 118-120 ft
**Sample Number:** SS28
**Material Description:** Gray Silty Sand
**Date:** N/A
**Natural Moisture:** 32.5
**Testing Remarks:** 11334
**Tested by:** EH
**Checked by:** JW

## Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 76.09 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | | |
| | | | #4 | 0.00 | 100.0 |
| | | | #10 | 1.16 | 98.5 |
| | | | #20 | 4.86 | 93.6 |
| | | | #40 | 10.15 | 86.7 |
| | | | #60 | 16.87 | 77.8 |
| | | | #100 | 26.52 | 65.1 |
| | | | #140 | 37.27 | 51.0 |
| | | | #200 | 46.62 | 38.7 |

## Fractional Components

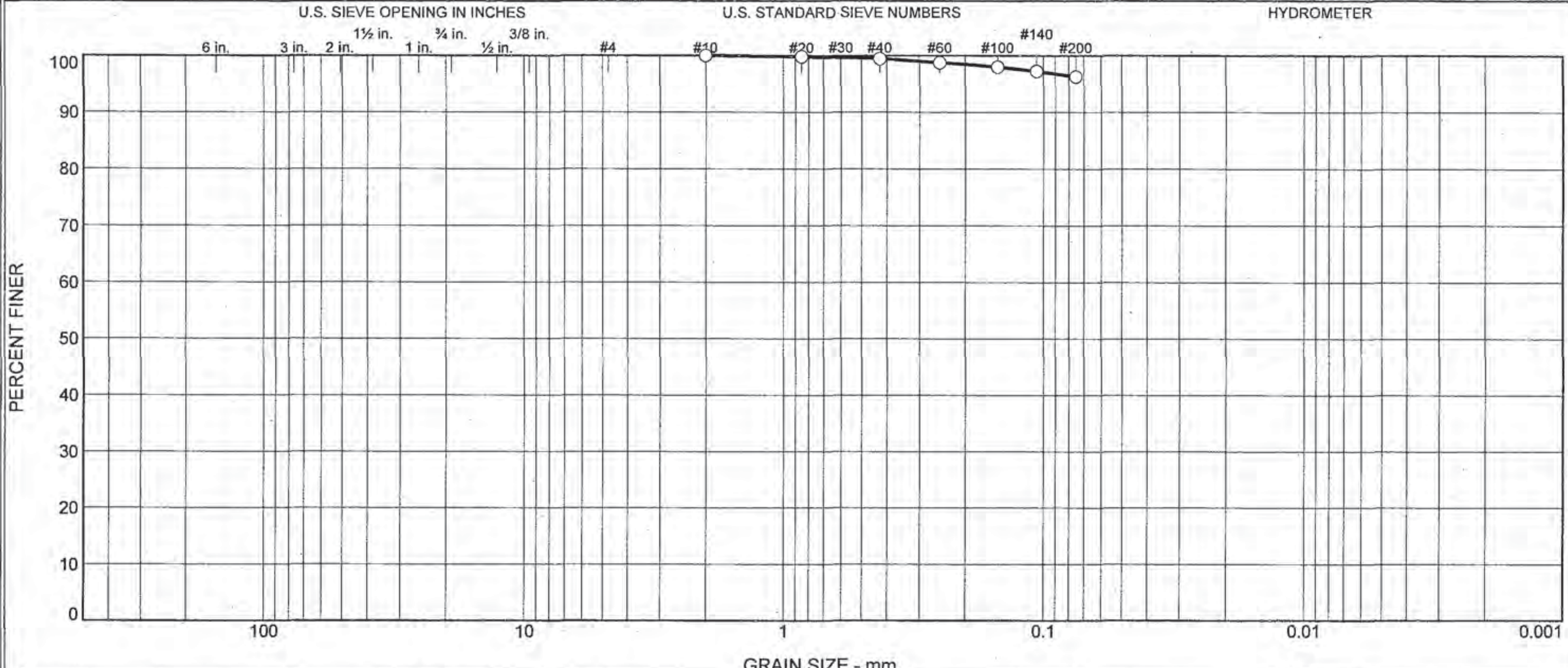
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.0 | 0.0 | 1.5 | 11.8 | 48.0 | 61.3 | | | 38.7 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | | | | 0.1033 | 0.1314 | 0.2813 | 0.3790 | 0.5622 | 1.0307 |

| Fineness Modulus |
|---|
| 0.68 |

AMEC

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.0 | 0.6 | 3.1 | 96.3 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B03 | SS29 | 123-125 ft | N/A | MH | Gray Elastic Silt | 52.6 | 104 | 56 |

Client SRNS
Project Saltstone Disposal Unit 6
Project No. 6155-08-0031.28 Figure

amec

○ 11335

**Tested By:** EH **Checked By:** JW

# GRAIN SIZE DISTRIBUTION TEST DATA

2/9/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B03
**Depth:** 123-125 ft
**Sample Number:** SS29
**Material Description:** Gray Elastic Silt
**Date:** N/A
**Natural Moisture:** 52.6
**Liquid Limit:** 104
**Plastic Limit:** 56
**USCS Class.:** MH
**Testing Remarks:** 11335
**Tested by:** EH
**Checked by:** JW

## Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 71.70 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | | |
| | | | #4 | | |
| | | | #10 | 0.00 | 100.0 |
| | | | #20 | 0.16 | 99.8 |
| | | | #40 | 0.42 | 99.4 |
| | | | #60 | 0.90 | 98.7 |
| | | | #100 | 1.46 | 98.0 |
| | | | #140 | 1.99 | 97.2 |
| | | | #200 | 2.68 | 96.3 |

## Fractional Components

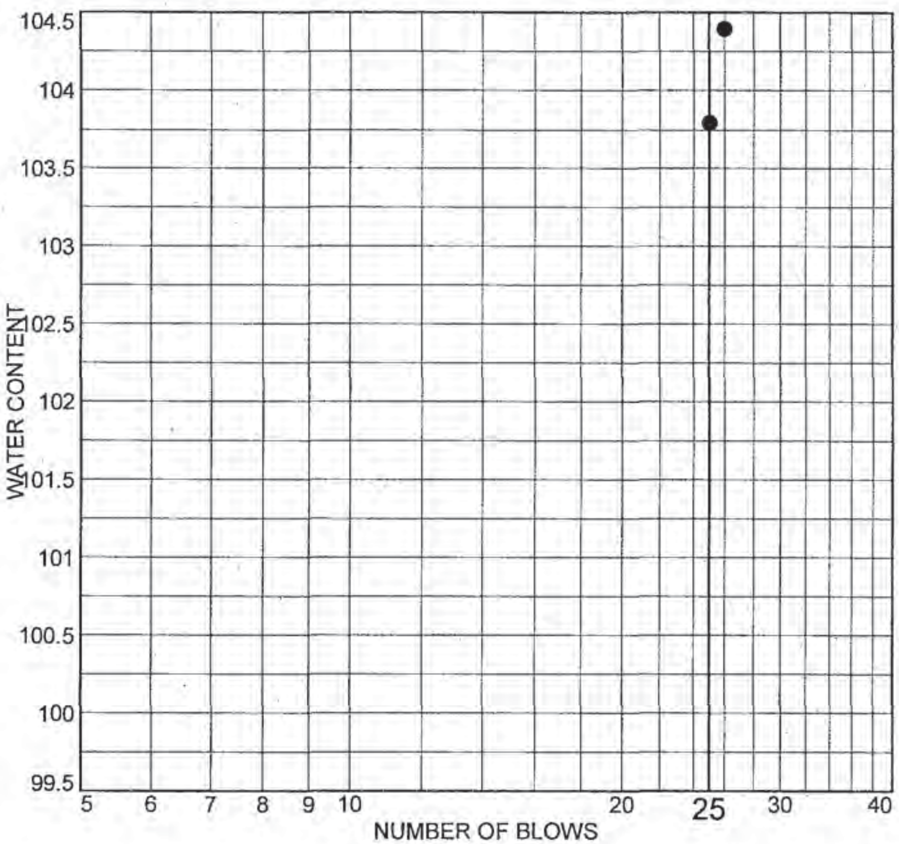
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.6 | 3.1 | 3.7 | | | 96.3 |

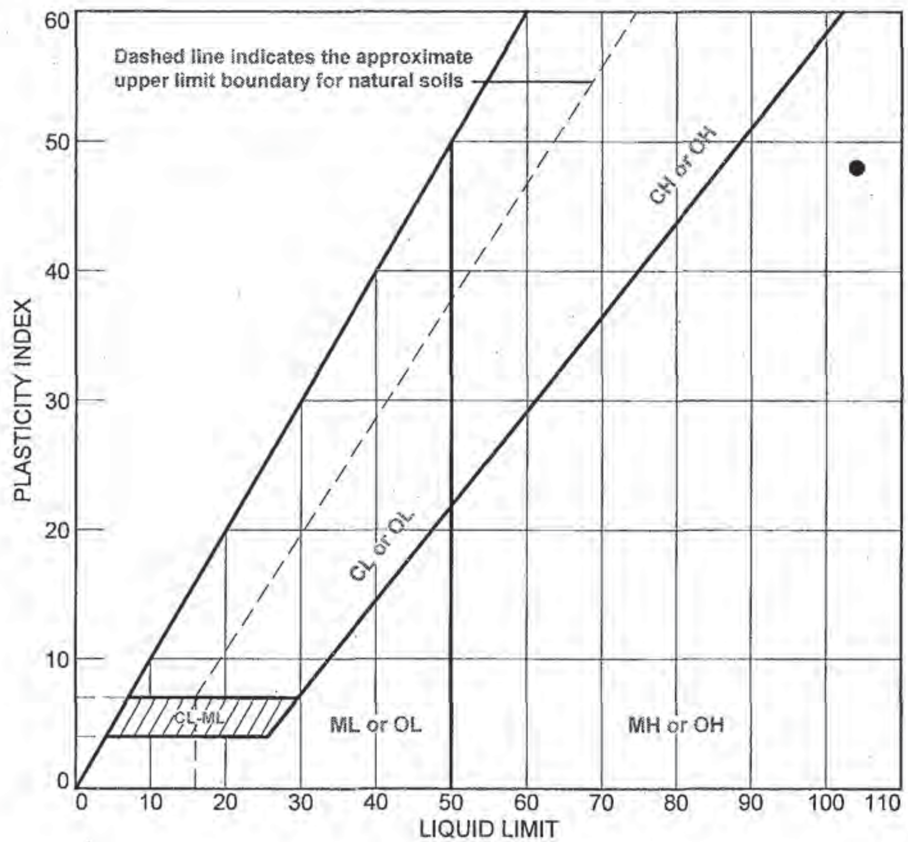
| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |

| Fineness Modulus |
|---|
| 0.04 |

AMEC

# LIQUID AND PLASTIC LIMITS TEST REPORT (ASTM D4318-05)




| | SOURCE | SAMPLE # | DEPTH/ELEV. | DATE SAMPLED | USCS | MATERIAL DESCRIPTION | NM % | LL | PI |
|---|---|---|---|---|---|---|---|---|---|
| ● | Z-SDU6-B03 | SS29 | 123-125 ft | N/A | MH | Gray Elastic Silt | 52.6 | 104 | 48 |

Client SRNS

Project Saltstone Disposal Unit 6

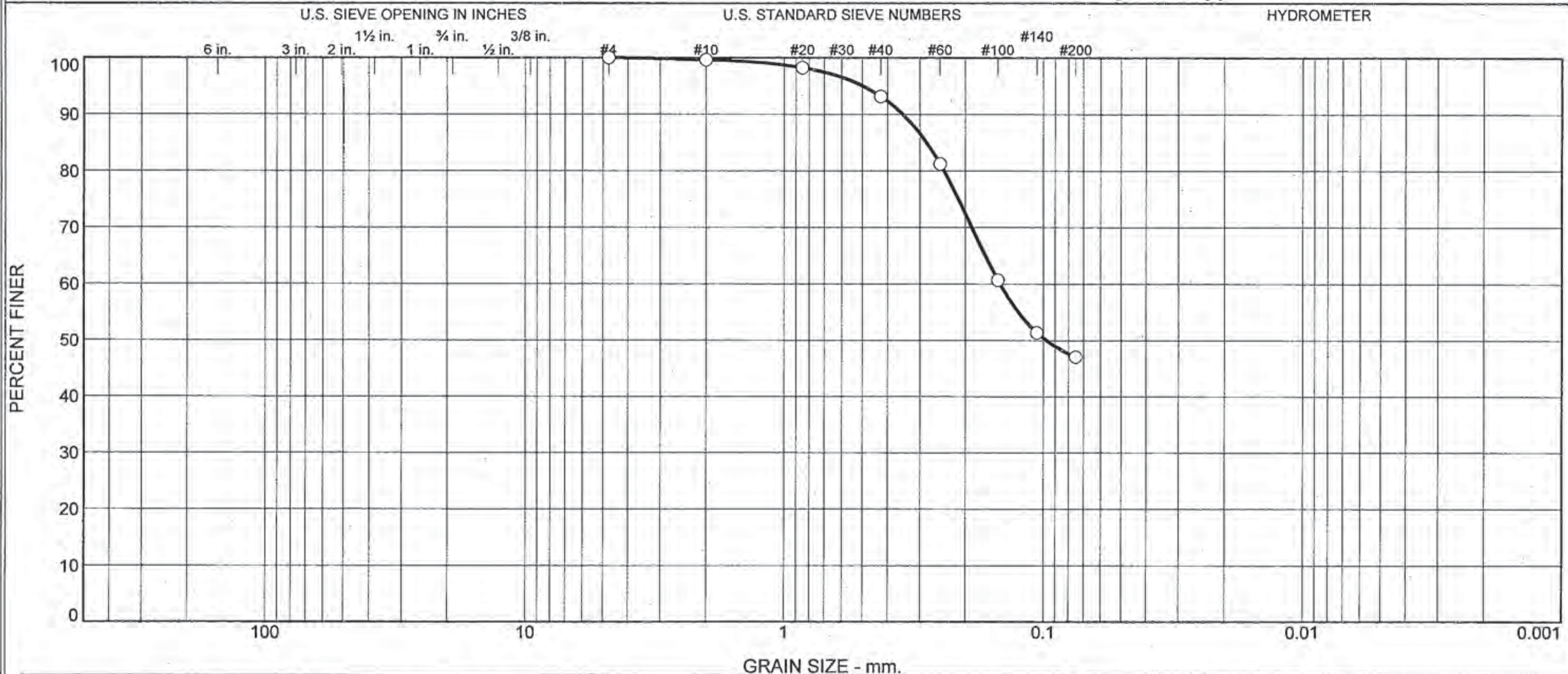
Project No. 6155-08-0031.28 Figure

amec

● 11335

**Tested By:** EH **Checked By:** JW

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.4 | 6.5 | 46.1 | 47.0 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B03 | SS30 | 128-130 ft | N/A | | DArk Gray Silty Sand | 26.9 | | |

Client SRNS

Project Saltstone Disposal Unit 6

Project No. 6155-08-0031.28 Figure

○ 11336

**Tested By:** EH **Checked By:** JW

## GRAIN SIZE DISTRIBUTION TEST DATA

2/3/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B03
**Depth:** 128-130 ft
**Sample Number:** SS30
**Material Description:** DArk Gray Silty Sand
**Date:** N/A
**Natural Moisture:** 26.9
**Testing Remarks:** 11336
**Tested by:** EH
**Checked by:** JW

### Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 82.54 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | | |
| | | | #4 | 0.00 | 100.0 |
| | | | #10 | 0.33 | 99.6 |
| | | | #20 | 1.48 | 98.2 |
| | | | #40 | 5.66 | 93.1 |
| | | | #60 | 15.53 | 81.2 |
| | | | #100 | 32.49 | 60.6 |
| | | | #140 | 40.15 | 51.4 |
| | | | #200 | 43.71 | 47.0 |

### Fractional Components

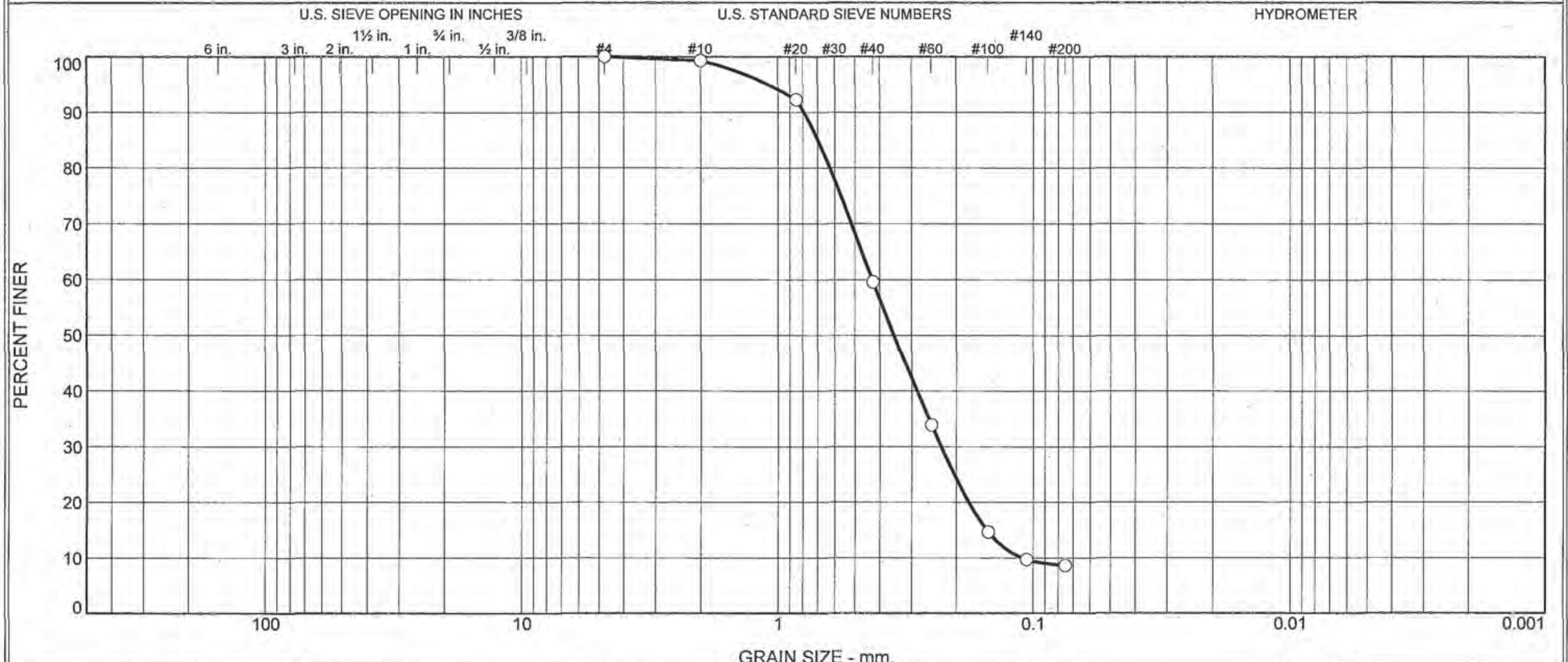
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.4 | 6.5 | 46.1 | 53.0 | | | 47.0 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | | | | 0.0975 | 0.1473 | 0.2419 | 0.2821 | 0.3491 | 0.4992 |

| Fineness Modulus |
|---|
| 0.57 |

AMEC

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.7 | 39.7 | 51.0 | 8.6 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B03 | SS31 | 133-135 ft | N/A | | Gray Poorly Graded Sand with Silt | 18.9 | | |

Client SRNS

Project Saltstone Disposal Unit 6

Project No. 6155-08-0031.28 Figure

○ 11337

**Tested By:** EH **Checked By:** JW

RCN: SRS200 Page 131 of 217

## GRAIN SIZE DISTRIBUTION TEST DATA

2/3/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B03
**Depth:** 133-135 ft
**Sample Number:** SS31
**Material Description:** Gray Poorly Graded Sand with Silt
**Date:** N/A
**Natural Moisture:** 18.9
**Testing Remarks:** 11337
**Tested by:** EH
**Checked by:** JW

### Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 88.51 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | | |
| | | | #4 | 0.00 | 100.0 |
| | | | #10 | 0.65 | 99.3 |
| | | | #20 | 6.83 | 92.3 |
| | | | #40 | 35.80 | 59.6 |
| | | | #60 | 58.54 | 33.9 |
| | | | #100 | 75.58 | 14.6 |
| | | | #140 | 79.94 | 9.7 |
| | | | #200 | 80.89 | 8.6 |

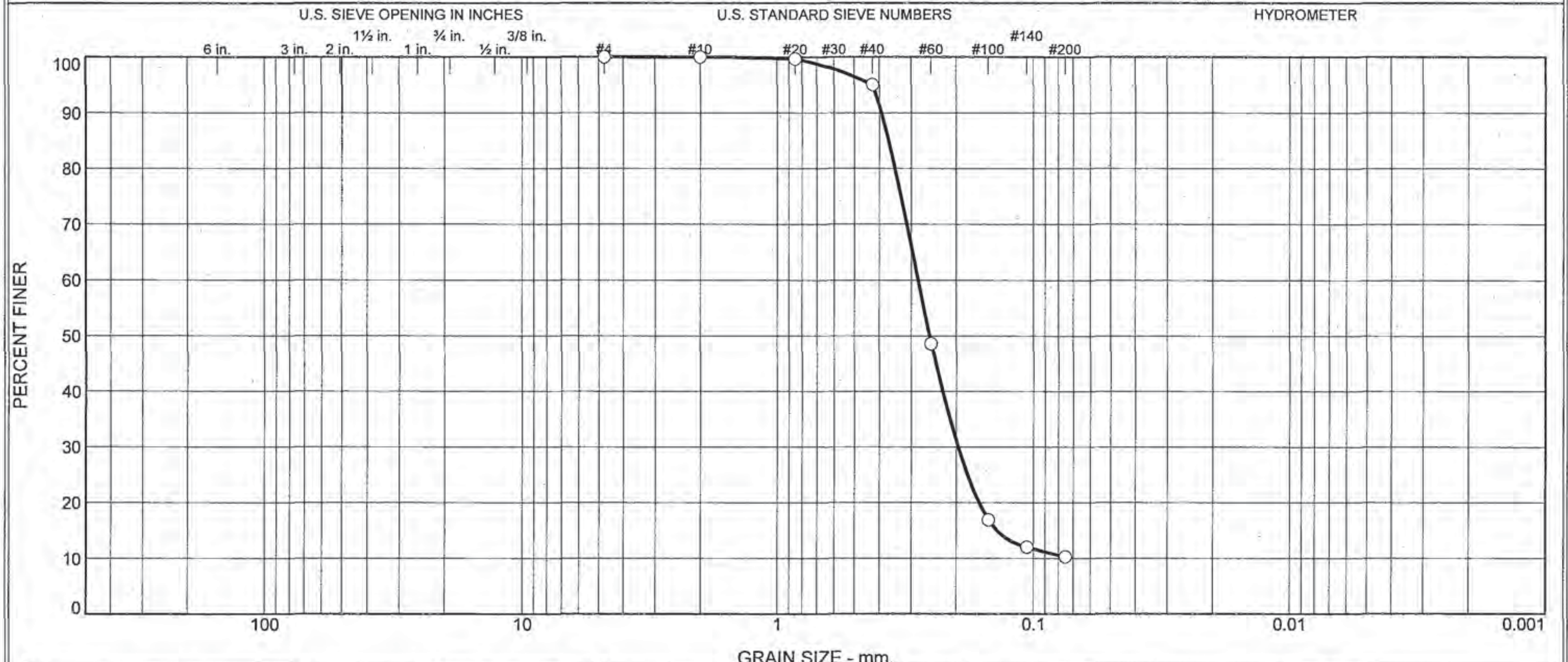
### Fractional Components

| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.7 | 39.7 | 51.0 | 91.4 | | | 8.6 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| 0.1108 | 0.1524 | 0.1792 | 0.2294 | 0.3521 | 0.4286 | 0.6282 | 0.6999 | 0.7934 | 1.0952 |

| Fineness Modulus | $C_u$ | $C_c$ |
|---|---|---|
| 1.70 | 3.87 | 1.11 |

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.0 | 5.0 | 84.7 | 10.3 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B03 | SS33 | 143-145 ft | N/A | | Gray Poorly Graded Sand with Silt | 22.2 | | |

Client SRNS

Project Saltstone Disposal Unit 6

Project No. 6155-08-0031.28 Figure

amec

○ 11338

**Tested By:** EH **Checked By:** JW

# GRAIN SIZE DISTRIBUTION TEST DATA

2/3/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B03
**Depth:** 143-145 ft
**Sample Number:** SS33
**Material Description:** Gray Poorly Graded Sand with Silt
**Date:** N/A
**Natural Moisture:** 22.2
**Testing Remarks:** 11338
**Tested by:** EH
**Checked by:** JW

## Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 84.26 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | | |
| | | | #4 | 0.00 | 100.0 |
| | | | #10 | 0.00 | 100.0 |
| | | | #20 | 0.28 | 99.7 |
| | | | #40 | 4.18 | 95.0 |
| | | | #60 | 43.30 | 48.6 |
| | | | #100 | 70.01 | 16.9 |
| | | | #140 | 74.14 | 12.0 |
| | | | #200 | 75.62 | 10.3 |

## Fractional Components

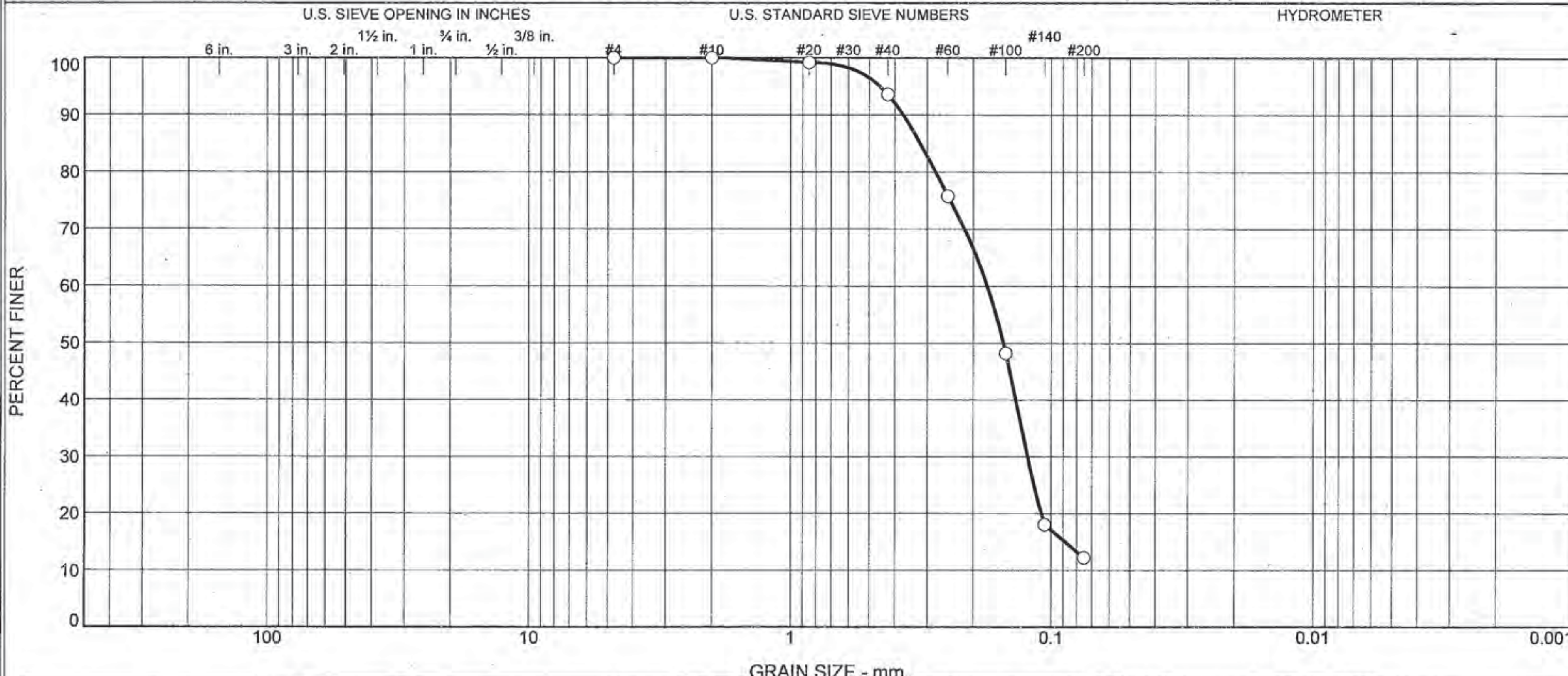
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 5.0 | 84.7 | 89.7 | | | 10.3 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | 0.1392 | 0.1634 | 0.1970 | 0.2538 | 0.2819 | 0.3472 | 0.3680 | 0.3927 | 0.4247 |

| Fineness Modulus |
|---|
| 1.19 |

AMEC

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.0 | 6.4 | 81.4 | 12.2 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B03 | SS34 | 148-150 ft | N/A | | Gray Silty Sand | 21.4 | | |

Client SRNS

Project Saltstone Disposal Unit 6

Project No. 6155-08-0031.28 Figure

○ 11339

**Tested By:** EH **Checked By:** JW

## GRAIN SIZE DISTRIBUTION TEST DATA

2/3/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B03
**Depth:** 148-150 ft
**Sample Number:** SS34
**Material Description:** Gray Silty Sand
**Date:** N/A
**Natural Moisture:** 21.4
**Testing Remarks:** 11339
**Tested by:** EH
**Checked by:** JW

### Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 102.01 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | | |
| | | | #4 | 0.00 | 100.0 |
| | | | #10 | 0.00 | 100.0 |
| | | | #20 | 0.82 | 99.2 |
| | | | #40 | 6.53 | 93.6 |
| | | | #60 | 24.73 | 75.8 |
| | | | #100 | 52.80 | 48.2 |
| | | | #140 | 83.63 | 18.0 |
| | | | #200 | 89.59 | 12.2 |

### Fractional Components

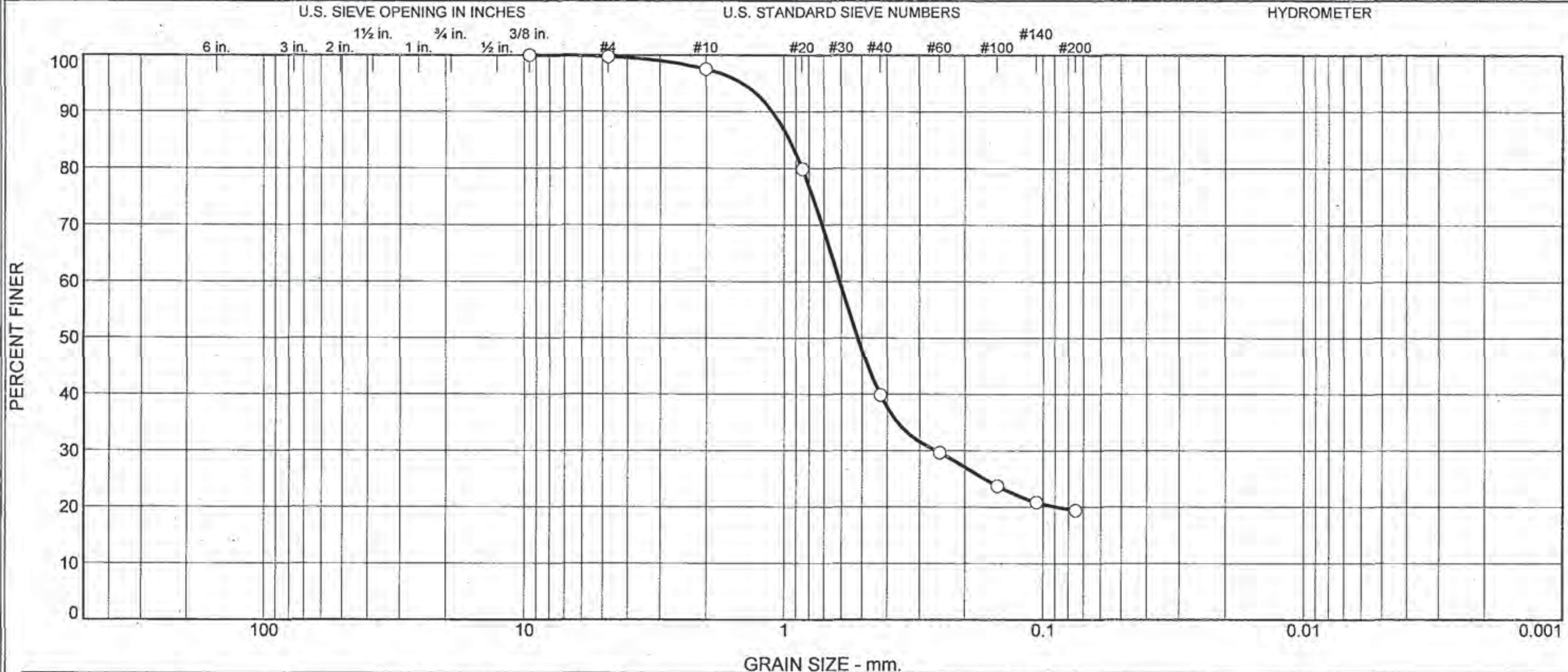
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 6.4 | 81.4 | 87.8 | | | 12.2 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | 0.0887 | 0.1094 | 0.1236 | 0.1532 | 0.1767 | 0.2791 | 0.3193 | 0.3713 | 0.4549 |

| Fineness Modulus |
|---|
| 0.71 |

AMEC

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.3 | 2.2 | 57.7 | 20.4 | 19.4 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B04 | SS01 | 14-16 ft | N/A | | Reddish Brown Silty Sand | 15.3 | | |

Client SRNS
Project Saltstone Disposal Unit 6
Project No. 6155-08-0031.28 Figure

amec

○ 11340

**Tested By:** EH **Checked By:** JW

## GRAIN SIZE DISTRIBUTION TEST DATA

2/6/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B04
**Depth:** 14-16 ft
**Sample Number:** SS01
**Material Description:** Reddish Brown Silty Sand
**Date:** N/A
**Natural Moisture:** 15.3
**Testing Remarks:** 11340
**Tested by:** EH
**Checked by:** JW

### Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 92.19 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | 0.00 | 100.0 |
| | | | #4 | 0.26 | 99.7 |
| | | | #10 | 2.29 | 97.5 |
| | | | #20 | 18.60 | 79.8 |
| | | | #40 | 55.47 | 39.8 |
| | | | #60 | 64.87 | 29.6 |
| | | | #100 | 70.32 | 23.7 |
| | | | #140 | 72.99 | 20.8 |
| | | | #200 | 74.34 | 19.4 |

### Fractional Components

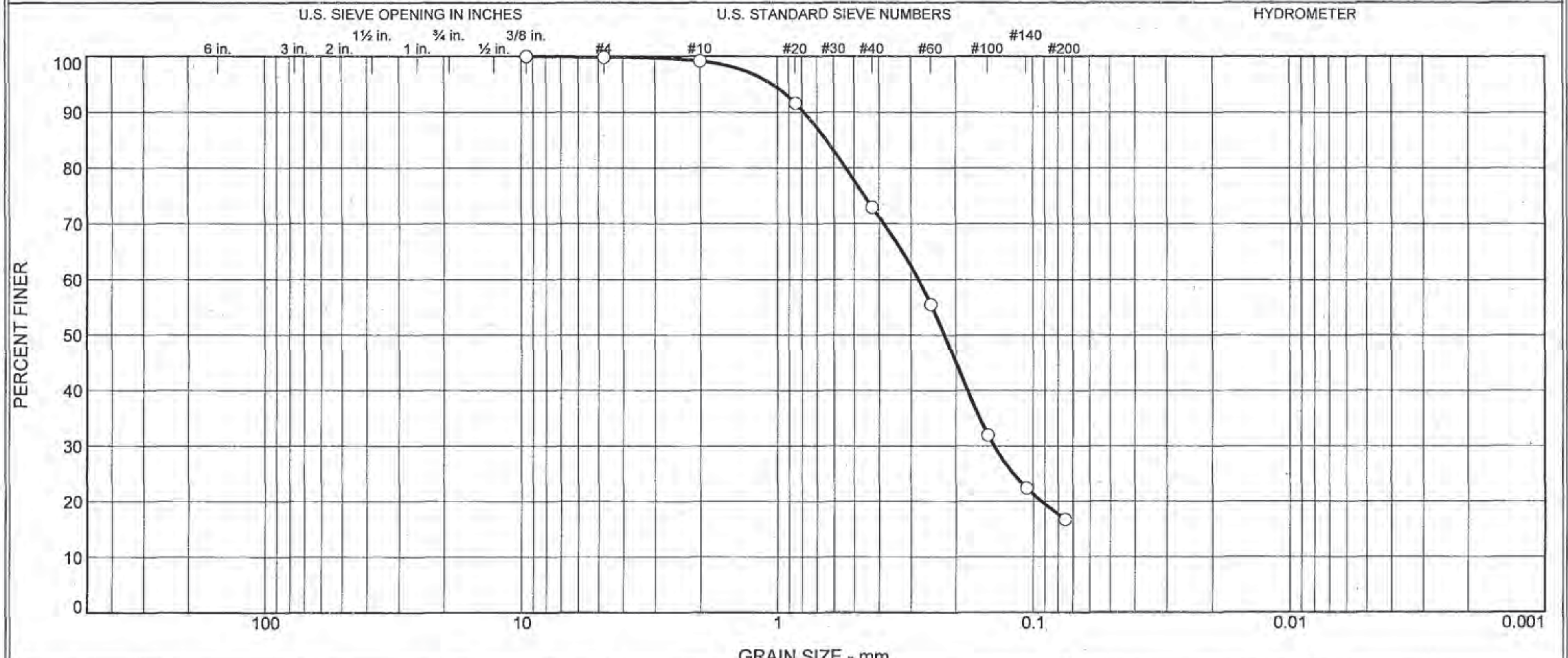
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.3 | 0.3 | 2.2 | 57.7 | 20.4 | 80.3 | | | 19.4 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | | 0.0895 | 0.2591 | 0.5197 | 0.6103 | 0.8530 | 0.9560 | 1.1143 | 1.4464 |

| Fineness Modulus |
|---|
| 1.96 |

AMEC

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.2 | 0.7 | 26.2 | 56.2 | 16.7 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B04 | SS02 | 16-18 ft | N/A | | Reddish Brown Silty Sand | 16.1 | | |

Client SRNS

Project Saltstone Disposal Unit 6

Project No. 6155-08-0031.28 Figure

amec

○ 11341

**Tested By:** EH **Checked By:** JW

# GRAIN SIZE DISTRIBUTION TEST DATA

2/6/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B04
**Depth:** 16-18 ft
**Sample Number:** SS02
**Material Description:** Reddish Brown Silty Sand
**Date:** N/A
**Natural Moisture:** 16.1
**Testing Remarks:** 11341
**Tested by:** EH
**Checked by:** JW

## Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 100.35 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | 0.00 | 100.0 |
| | | | #4 | 0.19 | 99.8 |
| | | | #10 | 0.88 | 99.1 |
| | | | #20 | 8.46 | 91.6 |
| | | | #40 | 27.20 | 72.9 |
| | | | #60 | 44.71 | 55.4 |
| | | | #100 | 68.28 | 32.0 |
| | | | #140 | 77.87 | 22.4 |
| | | | #200 | 83.58 | 16.7 |

## Fractional Components

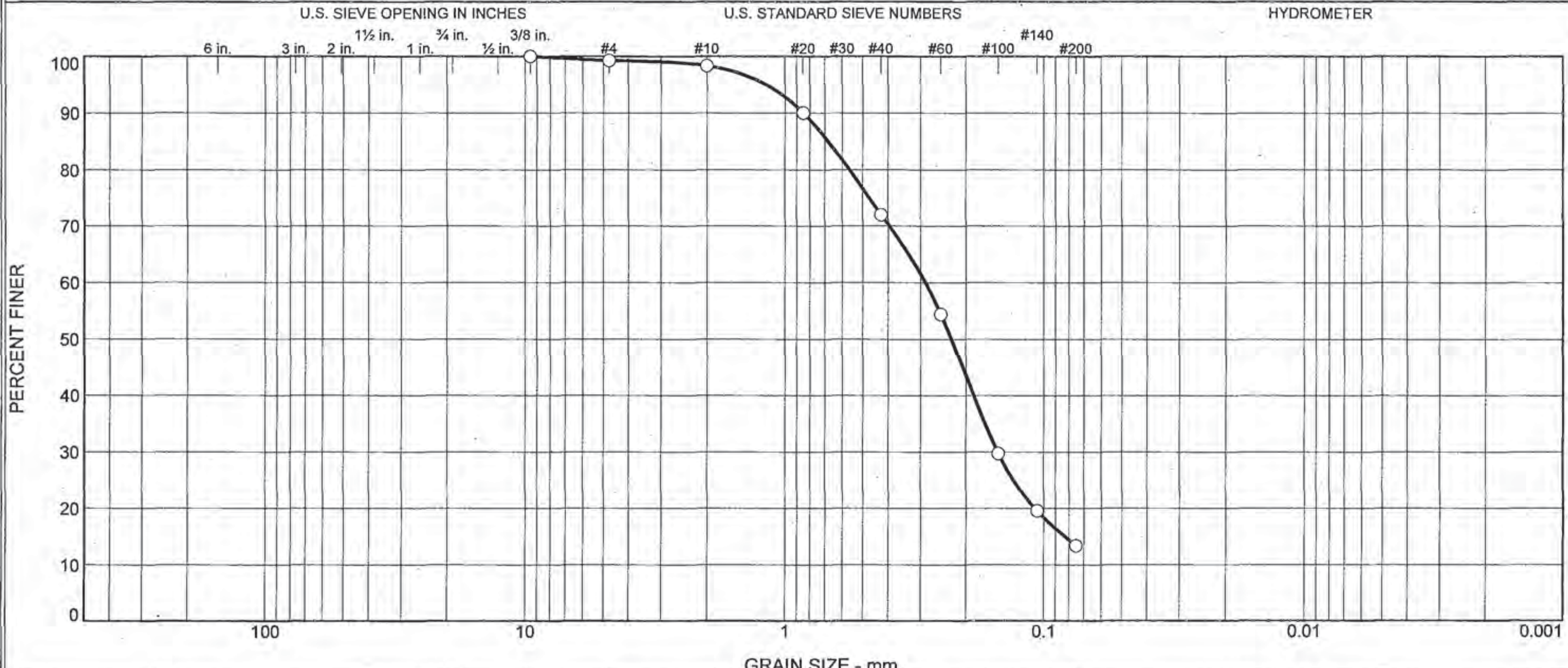
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.2 | 0.2 | 0.7 | 26.2 | 56.2 | 83.1 | | | 16.7 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | | 0.0928 | 0.1421 | 0.2217 | 0.2806 | 0.5406 | 0.6449 | 0.7887 | 1.0504 |

| Fineness Modulus |
|---|
| 1.27 |

AMEC

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.8 | 0.9 | 26.3 | 58.6 | 13.4 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B04 | SS03 | 18-20 ft | N/A | | Yellowish Brown Silty Sand | 12.2 | | |

Client SRNS
Project Saltstone Disposal Unit 6
Project No. 6155-08-0031.28 Figure

amec

○ 11342

**Tested By:** EH **Checked By:** JW

# GRAIN SIZE DISTRIBUTION TEST DATA

2/6/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B04
**Depth:** 18-20 ft
**Sample Number:** SS03
**Material Description:** Yellowish Brown Silty Sand
**Date:** N/A
**Natural Moisture:** 12.2
**Testing Remarks:** 11342
**Tested by:** EH
**Checked by:** JW

## Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 95.14 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | 0.00 | 100.0 |
| | | | #4 | 0.72 | 99.2 |
| | | | #10 | 1.60 | 98.3 |
| | | | #20 | 9.50 | 90.0 |
| | | | #40 | 26.66 | 72.0 |
| | | | #60 | 43.39 | 54.4 |
| | | | #100 | 66.86 | 29.7 |
| | | | #140 | 76.55 | 19.5 |
| | | | #200 | 82.42 | 13.4 |

## Fractional Components

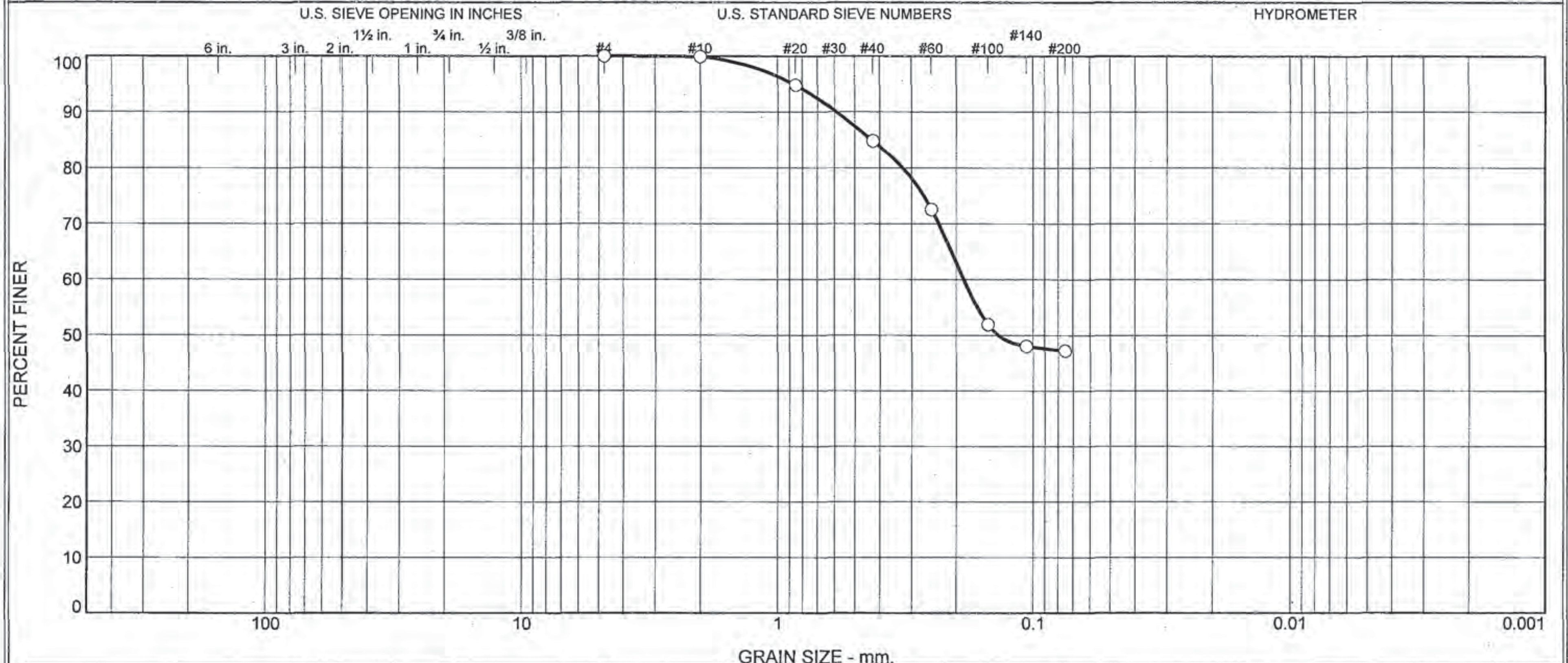
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.8 | 0.8 | 0.9 | 26.3 | 58.6 | 85.8 | | | 13.4 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | 0.0829 | 0.1083 | 0.1510 | 0.2276 | 0.2876 | 0.5637 | 0.6804 | 0.8494 | 1.1862 |

| Fineness Modulus |
|---|
| 1.34 |

AMEC

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.1 | 15.1 | 37.6 | 47.2 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B04 | SS04 | 20-22 ft | N/A | | Reddish Brown Clayey Sand | 22.6 | | |

Client SRNS

Project Saltstone Disposal Unit 6

Project No. 6155-08-0031.28 Figure

amec

○ 11343

**Tested By:** EH **Checked By:** JW

# GRAIN SIZE DISTRIBUTION TEST DATA

2/6/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B04
**Depth:** 20-22 ft
**Sample Number:** SS04
**Material Description:** Reddish Brown Clayey Sand
**Date:** N/A
**Natural Moisture:** 22.6
**Testing Remarks:** 11343
**Tested by:** EH
**Checked by:** JW

## Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 87.80 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | | |
| | | | #4 | 0.00 | 100.0 |
| | | | #10 | 0.09 | 99.9 |
| | | | #20 | 4.60 | 94.8 |
| | | | #40 | 13.37 | 84.8 |
| | | | #60 | 24.12 | 72.5 |
| | | | #100 | 42.24 | 51.9 |
| | | | #140 | 45.60 | 48.1 |
| | | | #200 | 46.37 | 47.2 |

## Fractional Components

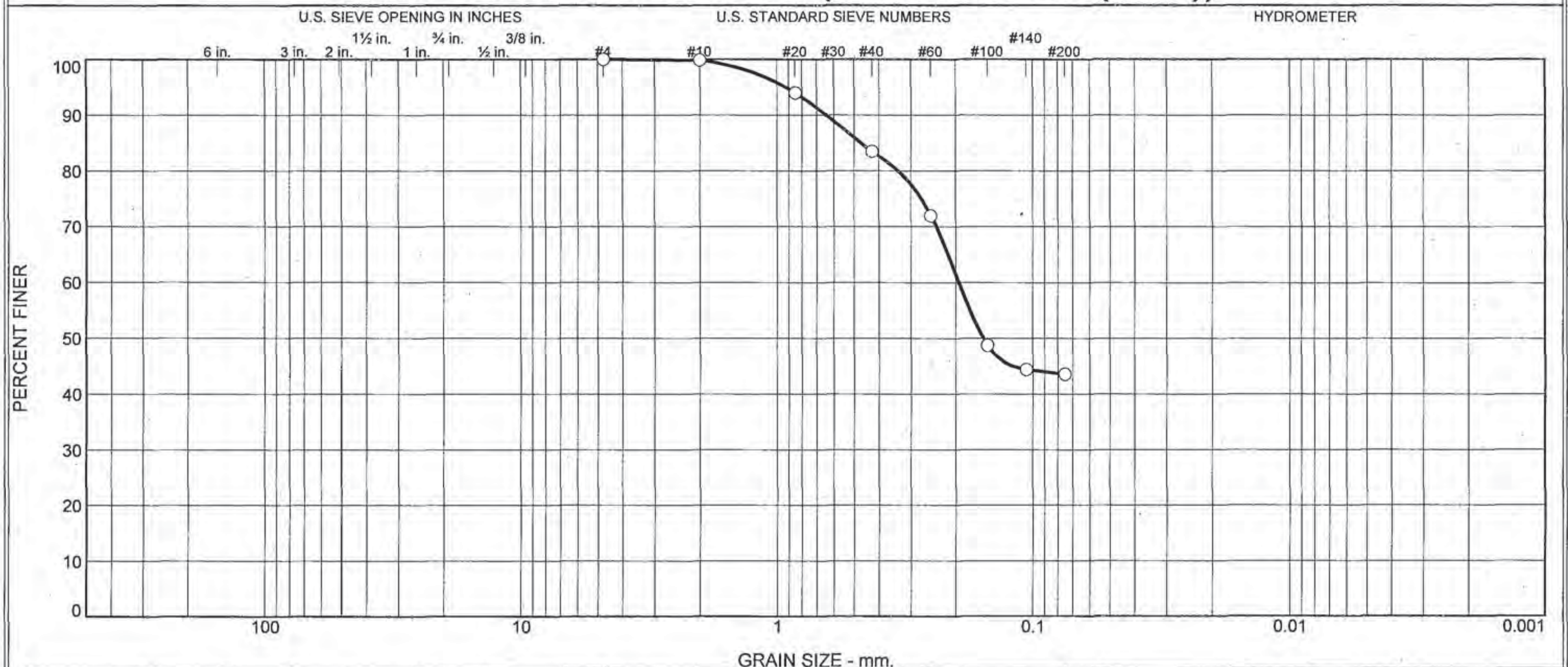
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 15.1 | 37.6 | 52.8 | | | 47.2 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | | | | 0.1368 | 0.1873 | 0.3250 | 0.4311 | 0.5934 | 0.8688 |

| Fineness Modulus |
|---|
| 0.82 |

AMEC

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.2 | 16.3 | 39.9 | 43.6 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B04 | SS05 | 22-24 ft | N/A | | Reddish Brown Clayey Sand | 23.7 | | |

Client SRNS

Project Saltstone Disposal Unit 6

Project No. 6155-08-0031.28 Figure

amec

○ 11344

**Tested By:** EH **Checked By:** JW

RCN: SRS200 Page 145 of 217

## GRAIN SIZE DISTRIBUTION TEST DATA

2/6/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B04
**Depth:** 22-24 ft
**Sample Number:** SS05
**Material Description:** Reddish Brown Clayey Sand
**Date:** N/A
**Natural Moisture:** 23.7
**Testing Remarks:** 11344
**Tested by:** EH
**Checked by:** JW

### Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 84.89 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | | |
| | | | #4 | 0.00 | 100.0 |
| | | | #10 | 0.15 | 99.8 |
| | | | #20 | 5.12 | 94.0 |
| | | | #40 | 14.01 | 83.5 |
| | | | #60 | 23.83 | 71.9 |
| | | | #100 | 43.53 | 48.7 |
| | | | #140 | 47.18 | 44.4 |
| | | | #200 | 47.90 | 43.6 |

### Fractional Components

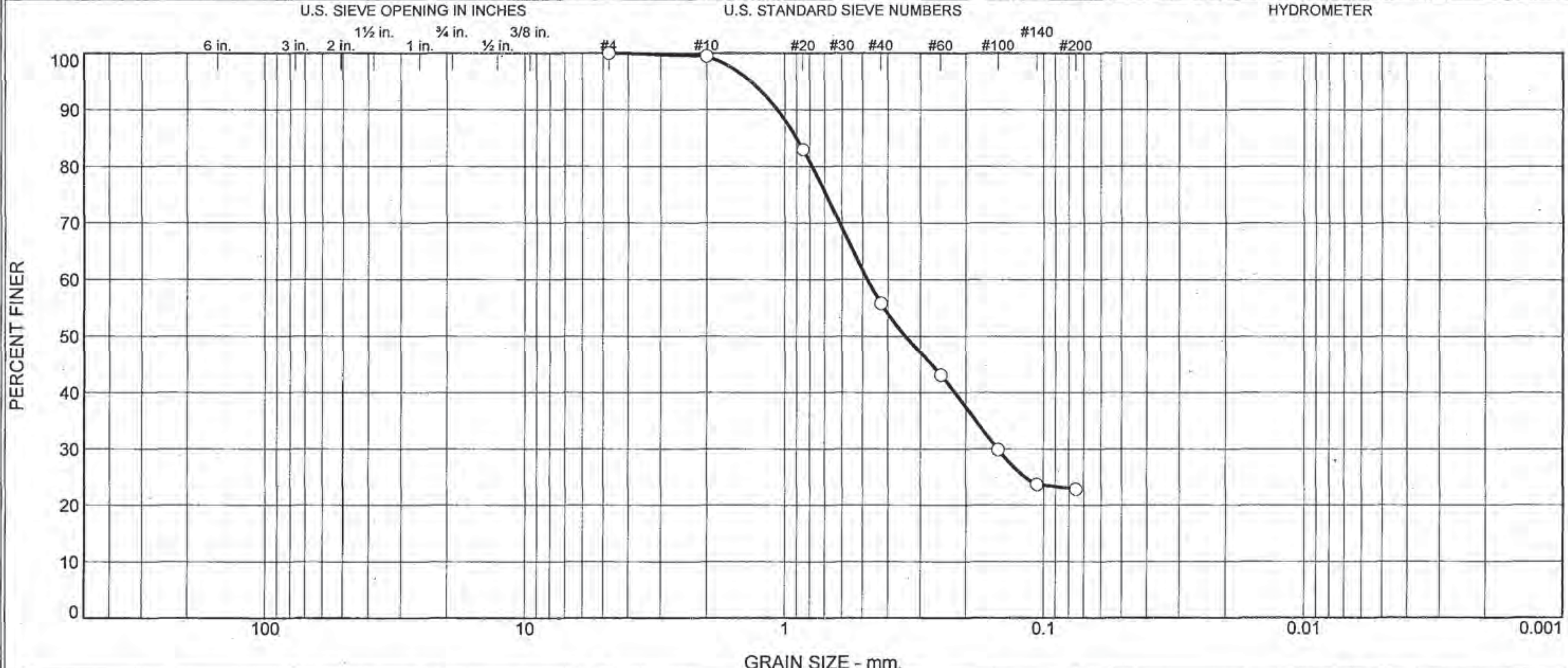
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 16.3 | 39.9 | 56.4 | | | 43.6 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | | | | 0.1560 | 0.1949 | 0.3369 | 0.4702 | 0.6450 | 0.9269 |

| Fineness Modulus |
|---|
| 0.88 |

AMEC

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.5 | 43.7 | 33.0 | 22.8 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B04 | SS06 | 24-26 ft | N/A | | Reddish Brown Clayey Sand | 15.8 | | |

Client SRNS

Project Saltstone Disposal Unit 6

Project No. 6155-08-0031.28 Figure

amec

○ 11345

**Tested By:** EH **Checked By:** JW

# GRAIN SIZE DISTRIBUTION TEST DATA

2/6/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B04
**Depth:** 24-26 ft
**Sample Number:** SS06
**Material Description:** Reddish Brown Clayey Sand
**Date:** N/A
**Natural Moisture:** 15.8
**Testing Remarks:** 11345
**Tested by:** EH
**Checked by:** JW

## Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 94.73 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | | |
| | | | #4 | 0.00 | 100.0 |
| | | | #10 | 0.49 | 99.5 |
| | | | #20 | 16.13 | 83.0 |
| | | | #40 | 41.90 | 55.8 |
| | | | #60 | 53.88 | 43.1 |
| | | | #100 | 66.46 | 29.8 |
| | | | #140 | 72.30 | 23.7 |
| | | | #200 | 73.10 | 22.8 |

## Fractional Components

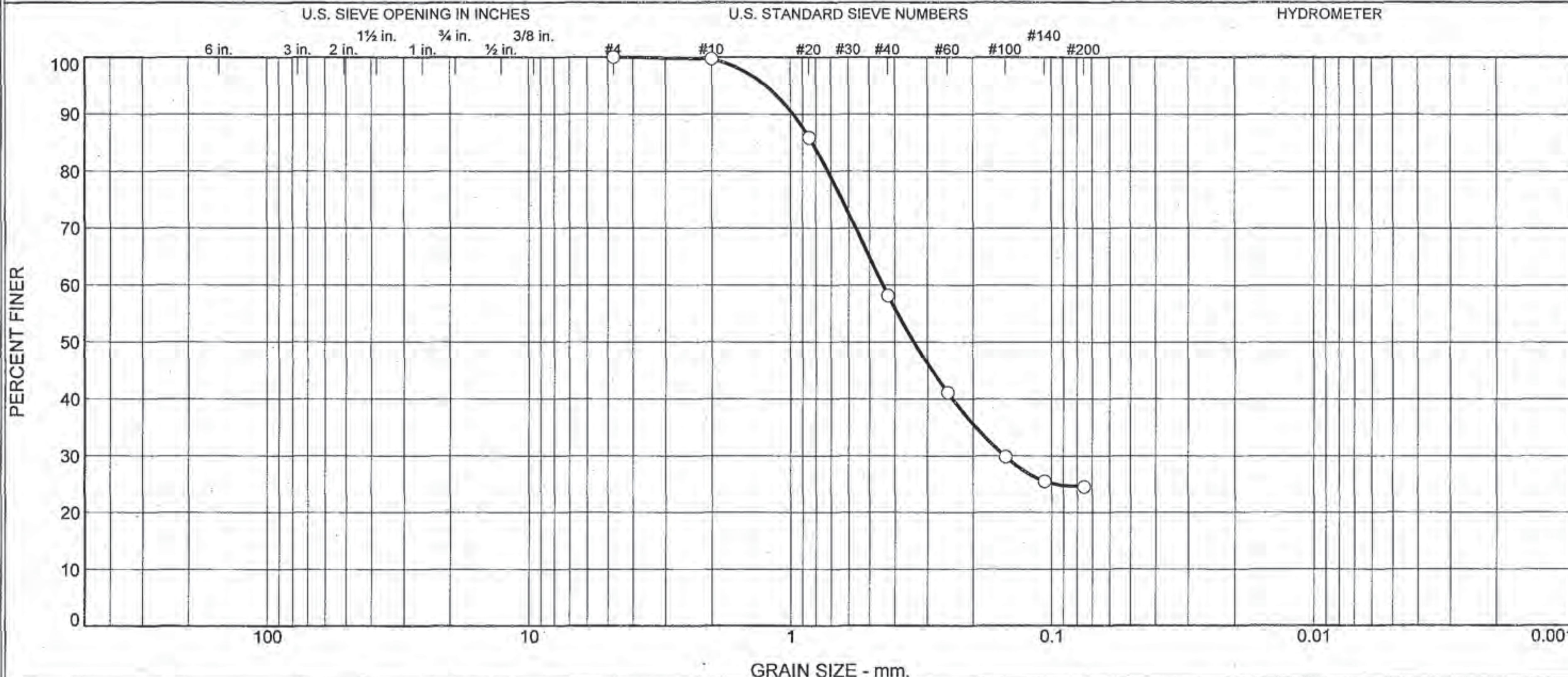
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.5 | 43.7 | 33.0 | 77.2 | | | 22.8 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | | | 0.1510 | 0.3420 | 0.4804 | 0.7843 | 0.9023 | 1.0722 | 1.3578 |

| Fineness Modulus |
|---|
| 1.62 |

AMEC

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.3 | 41.6 | 33.6 | 24.5 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B04 | SS07 | 26-28 ft | N/A | | Red Clayey Sand | 16.4 | | |

Client SRNS

Project Saltstone Disposal Unit 6

Project No. 6155-08-0031.28 Figure

amec

○ 11346

**Tested By:** EH **Checked By:** JW

# GRAIN SIZE DISTRIBUTION TEST DATA

2/6/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B04
**Depth:** 26-28 ft
**Sample Number:** SS07
**Material Description:** Red Clayey Sand
**Date:** N/A
**Natural Moisture:** 16.4
**Testing Remarks:** 11346
**Tested by:** EH
**Checked by:** JW

## Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 105.14 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | | |
| | | | #4 | 0.00 | 100.0 |
| | | | #10 | 0.33 | 99.7 |
| | | | #20 | 14.86 | 85.9 |
| | | | #40 | 44.02 | 58.1 |
| | | | #60 | 61.95 | 41.1 |
| | | | #100 | 73.82 | 29.8 |
| | | | #140 | 78.34 | 25.5 |
| | | | #200 | 79.37 | 24.5 |

## Fractional Components

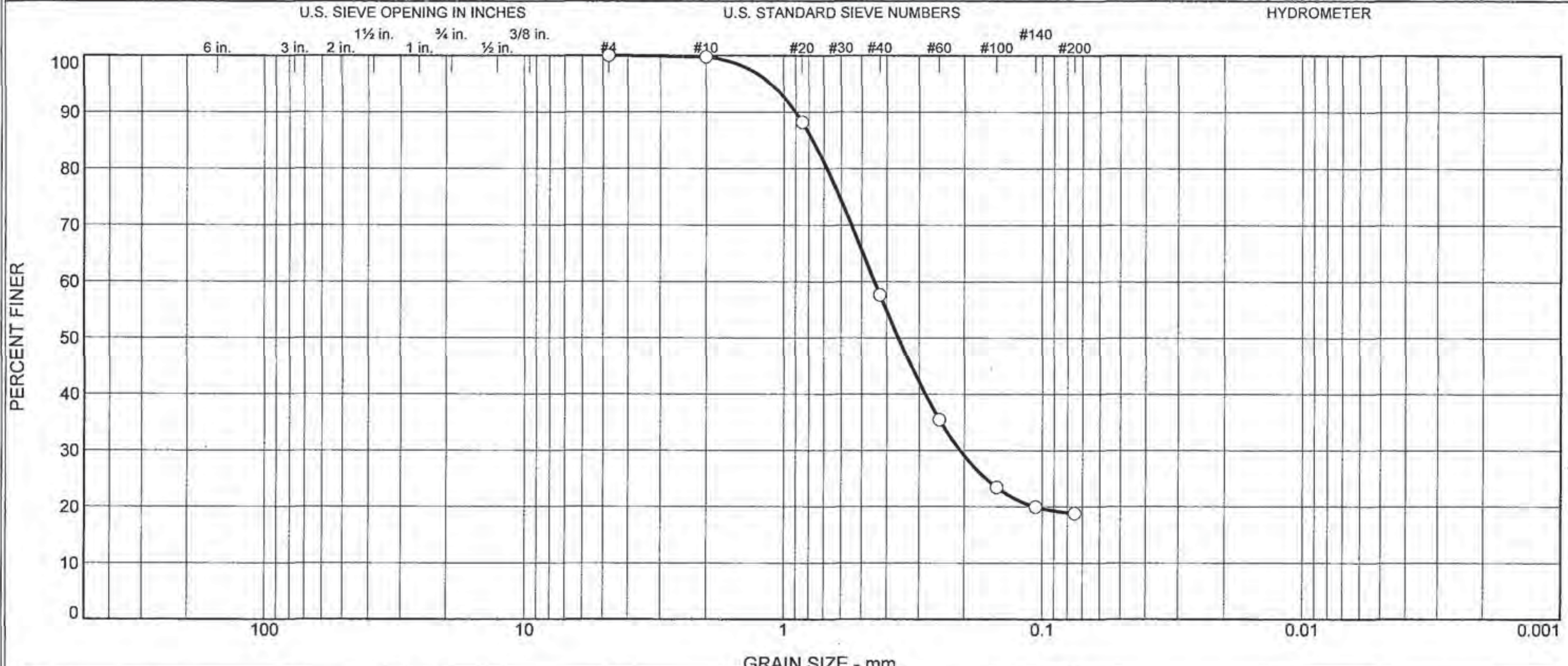
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 41.6 | 33.6 | 75.5 | | | 24.5 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | | | 0.1519 | 0.3383 | 0.4456 | 0.7212 | 0.8279 | 0.9809 | 1.2465 |

| Fineness Modulus |
|---|
| 1.58 |

AMEC

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.2 | 42.2 | 38.8 | 18.8 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B04 | SS08 | 28-30 ft | N/A | SC | Red Clayey Sand | 14.9 | 45 | 21 |

Client SRNS

Project Saltstone Disposal Unit 6

Project No. 6155-08-0031.28 Figure

amec

○ 11347

**Tested By:** EH **Checked By:** JW

# GRAIN SIZE DISTRIBUTION TEST DATA

2/7/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B04
**Depth:** 28-30 ft
**Sample Number:** SS08
**Material Description:** Red Clayey Sand
**Date:** N/A
**Natural Moisture:** 14.9
**Liquid Limit:** 45
**Plastic Limit:** 21
**USCS Class.:** SC
**Testing Remarks:** 11347
**Tested by:** EH
**Checked by:** JW

## Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 68.04 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | | |
| | | | #4 | 0.00 | 100.0 |
| | | | #10 | 0.16 | 99.8 |
| | | | #20 | 8.04 | 88.2 |
| | | | #40 | 28.85 | 57.6 |
| | | | #60 | 43.93 | 35.4 |
| | | | #100 | 52.11 | 23.4 |
| | | | #140 | 54.49 | 19.9 |
| | | | #200 | 55.26 | 18.8 |

## Fractional Components

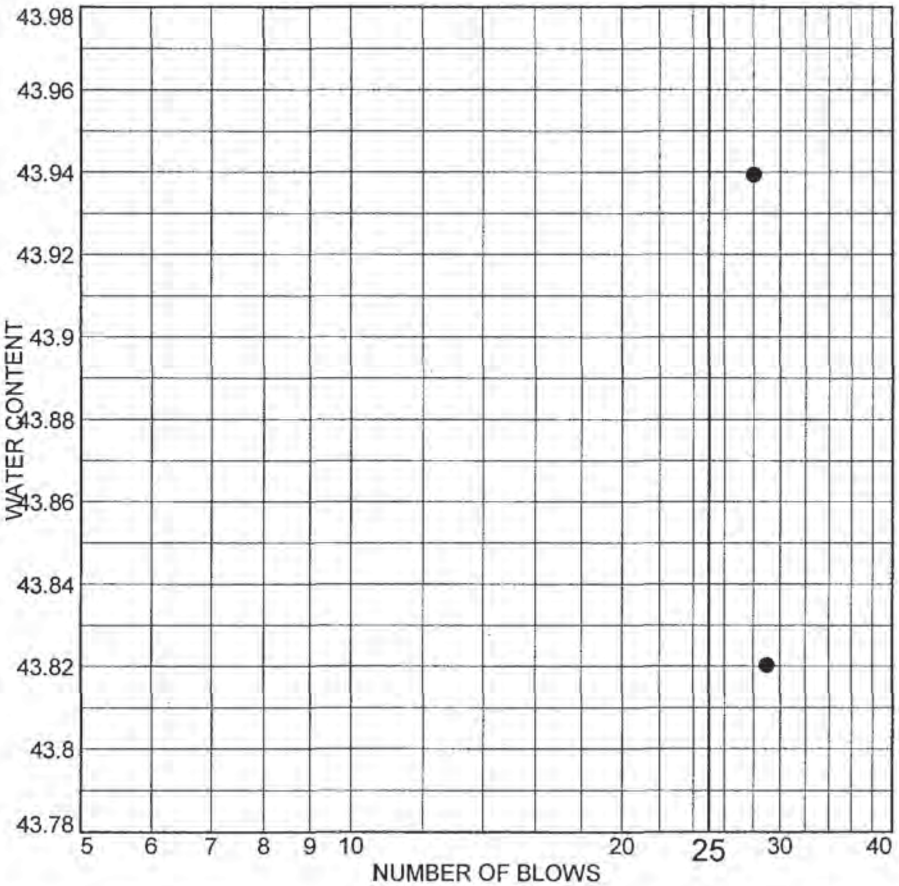
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 42.2 | 38.8 | 81.2 | | | 18.8 |

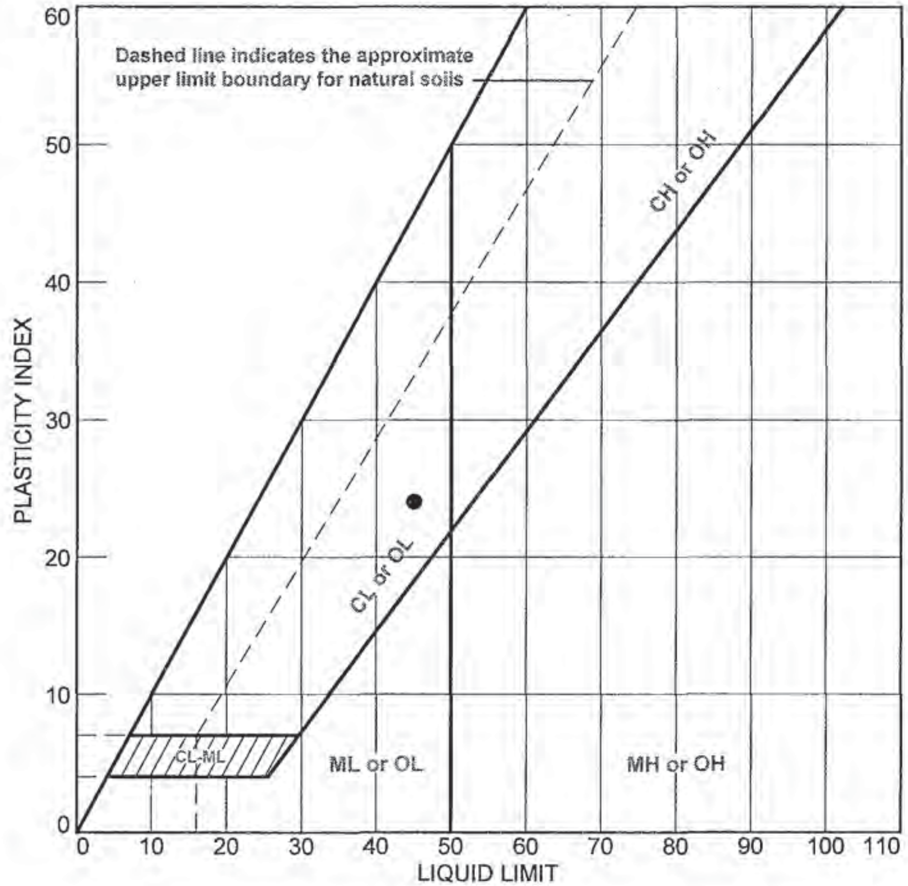
| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | | 0.1075 | 0.2079 | 0.3610 | 0.4467 | 0.6835 | 0.7750 | 0.9030 | 1.1270 |

| Fineness Modulus |
|---|
| 1.65 |

AMEC

# LIQUID AND PLASTIC LIMITS TEST REPORT (ASTM D4318-05)




| | SOURCE | SAMPLE # | DEPTH/ELEV. | DATE SAMPLED | USCS | MATERIAL DESCRIPTION | NM % | LL | PI |
|---|---|---|---|---|---|---|---|---|---|
| ● | Z-SDU6-B04 | SS08 | 28-30 ft | N/A | SC | Red Clayey Sand | 14.9 | 45 | 24 |

Client SRNS

Project Saltstone Disposal Unit 6

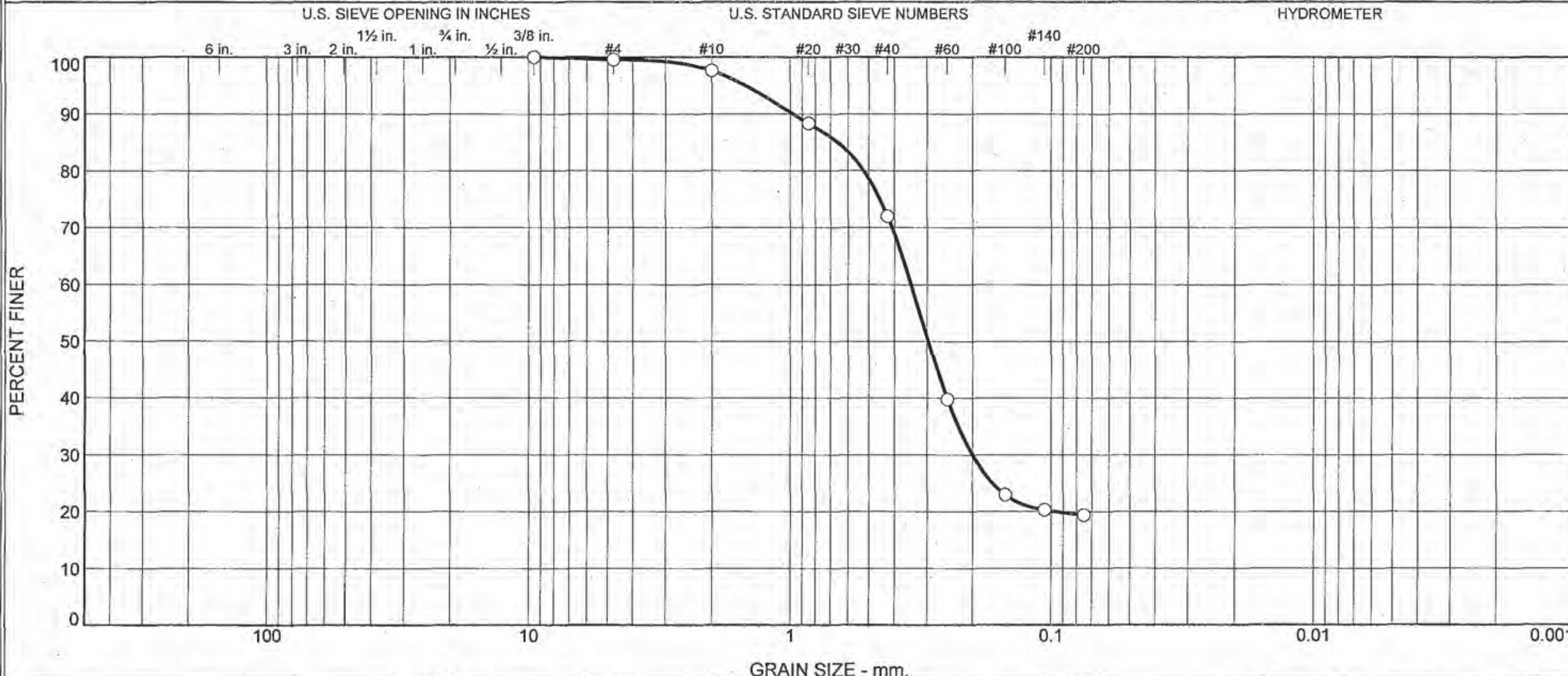
Project No. 6155-08-0031.28

Figure

amec

RCN: SRS200 Page 153 of 217

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.5 | 1.9 | 25.7 | 52.5 | 19.4 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B04 | SS09 | 30-32 ft | N/A | | Reddish Brown Silty Sand | 16.0 | | |

Client SRNS

Project Saltstone Disposal Unit 6

Project No. 6155-08-0031.28 Figure

amec

○ 11348

**Tested By:** EH **Checked By:** JW

## GRAIN SIZE DISTRIBUTION TEST DATA

2/6/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B04
**Depth:** 30-32 ft
**Sample Number:** SS09
**Material Description:** Reddish Brown Silty Sand
**Date:** N/A
**Natural Moisture:** 16.0
**Testing Remarks:** 11348
**Tested by:** EH
**Checked by:** JW

### Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 105.28 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | 0.00 | 100.0 |
| | | | #4 | 0.51 | 99.5 |
| | | | #10 | 2.53 | 97.6 |
| | | | #20 | 12.31 | 88.3 |
| | | | #40 | 29.54 | 71.9 |
| | | | #60 | 63.44 | 39.7 |
| | | | #100 | 81.13 | 22.9 |
| | | | #140 | 83.92 | 20.3 |
| | | | #200 | 84.88 | 19.4 |

### Fractional Components

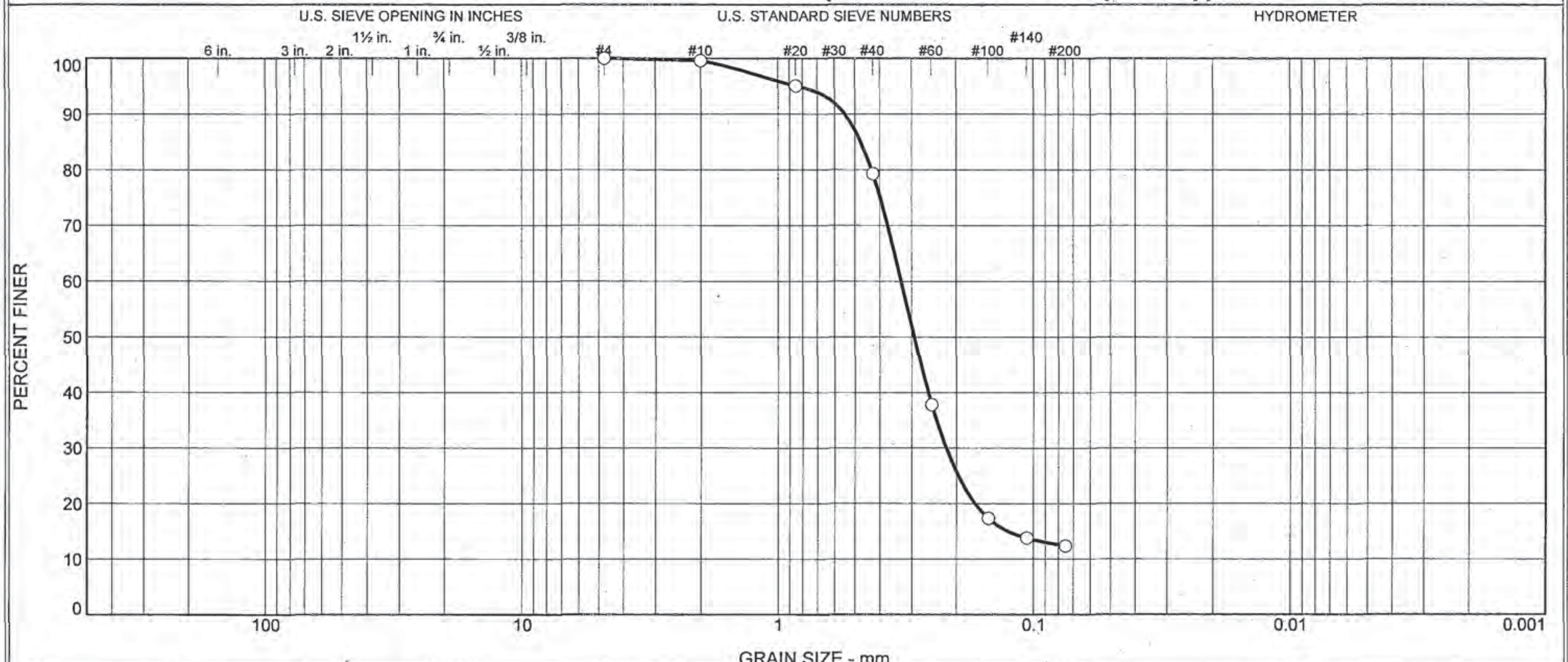
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.5 | 0.5 | 1.9 | 25.7 | 52.5 | 80.1 | | | 19.4 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | | 0.0967 | 0.2005 | 0.2965 | 0.3458 | 0.5239 | 0.6586 | 0.9782 | 1.4935 |

| Fineness Modulus |
|---|
| 1.53 |

AMEC

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.4 | 20.4 | 66.9 | 12.3 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B04 | SS10 | 32-34 ft | N/A | | Yellowish Brown Silty Sand | 6.3 | | |

Client SRNS

Project Saltstone Disposal Unit 6

Project No. 6155-08-0031.28 Figure

amec

○ 11349

**Tested By:** EH **Checked By:** JW

## GRAIN SIZE DISTRIBUTION TEST DATA

2/6/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B04
**Depth:** 32-34 ft
**Sample Number:** SS10
**Material Description:** Yellowish Brown Silty Sand
**Date:** N/A
**Natural Moisture:** 6.3
**Testing Remarks:** 11349
**Tested by:** EH
**Checked by:** JW

### Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 99.29 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | | |
| | | | #4 | 0.00 | 100.0 |
| | | | #10 | 0.43 | 99.6 |
| | | | #20 | 4.92 | 95.0 |
| | | | #40 | 20.62 | 79.2 |
| | | | #60 | 61.73 | 37.8 |
| | | | #100 | 82.12 | 17.3 |
| | | | #140 | 85.61 | 13.8 |
| | | | #200 | 87.06 | 12.3 |

### Fractional Components

| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.4 | 20.4 | 66.9 | 87.7 | | | 12.3 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | 0.1262 | 0.1695 | 0.2195 | 0.2928 | 0.3296 | 0.4305 | 0.4750 | 0.5493 | 0.8423 |

| Fineness Modulus |
|---|
| 1.42 |

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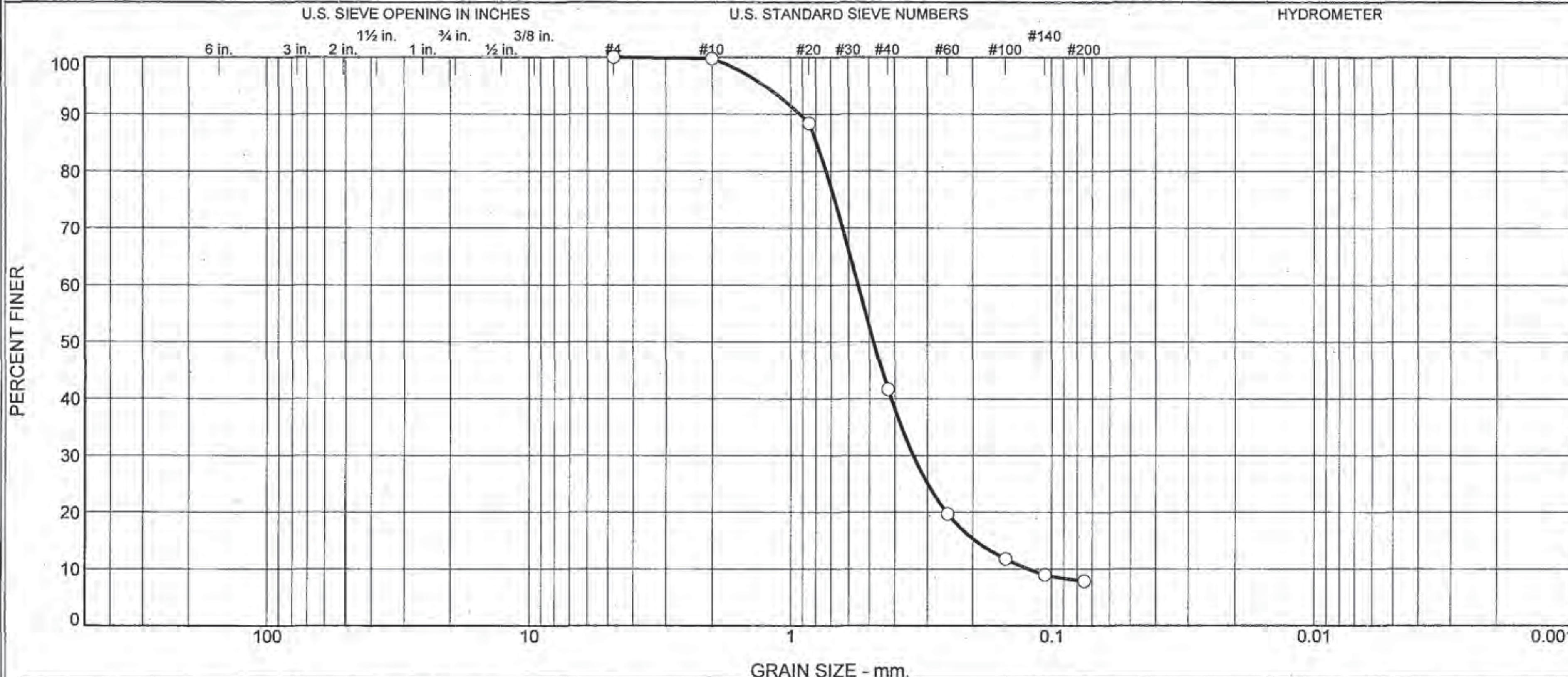
# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.2 | 58.1 | 33.8 | 7.9 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B04 | SS11 | 34-36 ft | N/A | | Yellowish Brown Poorly Graded Sand with Silt | 10.0 | | |

Client SRNS

Project Saltstone Disposal Unit 6

Project No. 6155-08-0031.28 Figure

amec

○ 11350

**Tested By:** EH **Checked By:** JW

## GRAIN SIZE DISTRIBUTION TEST DATA

2/6/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B04
**Depth:** 34-36 ft **Sample Number:** SS11
**Material Description:** Yellowish Brown Poorly Graded Sand with Silt
**Date:** N/A **Natural Moisture:** 10.0
**Testing Remarks:** 11350
**Tested by:** EH **Checked by:** JW

### Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 91.02 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | | |
| | | | #4 | 0.00 | 100.0 |
| | | | #10 | 0.22 | 99.8 |
| | | | #20 | 10.60 | 88.4 |
| | | | #40 | 53.09 | 41.7 |
| | | | #60 | 73.09 | 19.7 |
| | | | #100 | 80.30 | 11.8 |
| | | | #140 | 82.86 | 9.0 |
| | | | #200 | 83.86 | 7.9 |

### Fractional Components

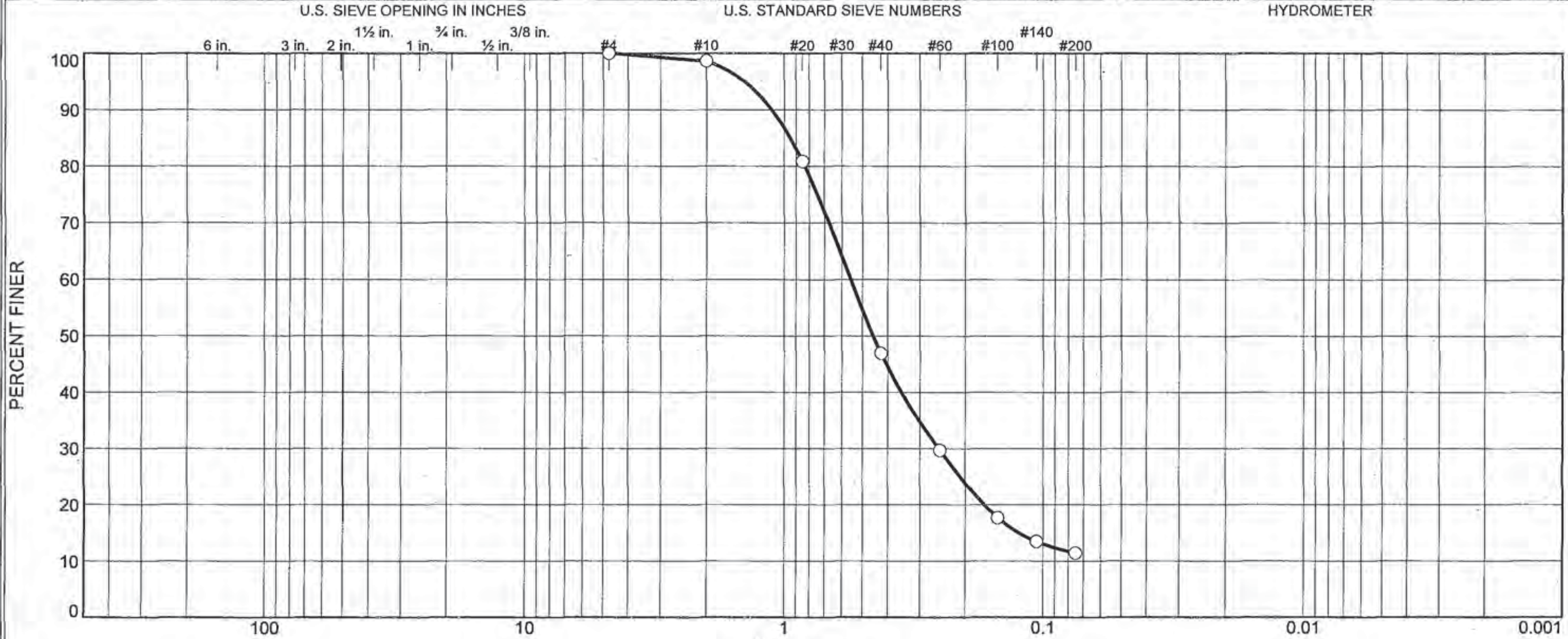
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 58.1 | 33.8 | 92.1 | | | 7.9 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| 0.1235 | 0.1962 | 0.2530 | 0.3399 | 0.4819 | 0.5530 | 0.7332 | 0.7970 | 0.9262 | 1.2619 |

| Fineness Modulus | $C_u$ | $C_c$ |
|---|---|---|
| 2.03 | 4.48 | 1.69 |

AMEC

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 1.4 | 51.7 | 35.5 | 11.4 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B04 | SS12 | 36-38 ft | N/A | | Yellowish Brown Poorly Graded Sand with Silt | 7.0 | | |

Client SRNS
Project Saltstone Disposal Unit 6
Project No. 6155-08-0031.28 Figure

○ 11351

**Tested By:** EH **Checked By:** JW

# GRAIN SIZE DISTRIBUTION TEST DATA

2/6/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B04
**Depth:** 36-38 ft **Sample Number:** SS12
**Material Description:** Yellowish Brown Poorly Graded Sand with Silt
**Date:** N/A **Natural Moisture:** 7.0
**Testing Remarks:** 11351
**Tested by:** EH **Checked by:** JW

## Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 101.39 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | | |
| | | | #4 | 0.00 | 100.0 |
| | | | #10 | 1.39 | 98.6 |
| | | | #20 | 19.46 | 80.8 |
| | | | #40 | 53.80 | 46.9 |
| | | | #60 | 71.30 | 29.7 |
| | | | #100 | 83.50 | 17.6 |
| | | | #140 | 87.77 | 13.4 |
| | | | #200 | 89.82 | 11.4 |

## Fractional Components

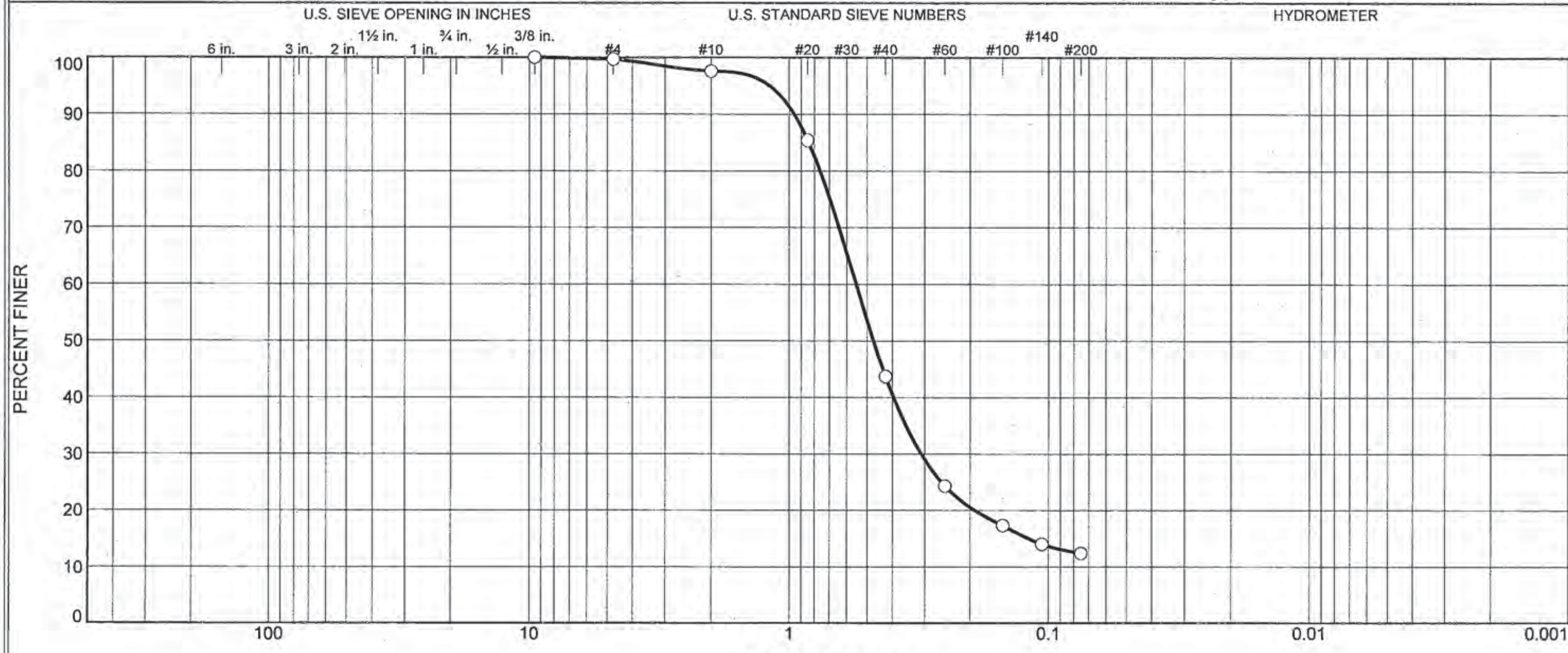
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.0 | 0.0 | 1.4 | 51.7 | 35.5 | 88.6 | | | 11.4 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | 0.1247 | 0.1695 | 0.2530 | 0.4552 | 0.5565 | 0.8337 | 0.9498 | 1.1214 | 1.4298 |

| Fineness Modulus |
|---|
| 1.94 |

AMEC

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.3 | 2.1 | 53.9 | 31.3 | 12.4 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B04 | SS13 | 38-40 ft | N/A | | Yellow Silty Sand | 4.9 | | |

Client SRNS
Project Saltstone Disposal Unit 6
Project No. 6155-08-0031.28 Figure

amec

○ 11352

**Tested By:** EH **Checked By:** JW

# GRAIN SIZE DISTRIBUTION TEST DATA

2/6/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B04
**Depth:** 38-40 ft
**Sample Number:** SS13
**Material Description:** Yellow Silty Sand
**Date:** N/A
**Natural Moisture:** 4.9
**Testing Remarks:** 11352
**Tested by:** EH
**Checked by:** JW

## Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 98.27 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | 0.00 | 100.0 |
| | | | #4 | 0.33 | 99.7 |
| | | | #10 | 2.39 | 97.6 |
| | | | #20 | 14.29 | 85.5 |
| | | | #40 | 55.33 | 43.7 |
| | | | #60 | 74.39 | 24.3 |
| | | | #100 | 81.27 | 17.3 |
| | | | #140 | 84.50 | 14.0 |
| | | | #200 | 86.10 | 12.4 |

## Fractional Components

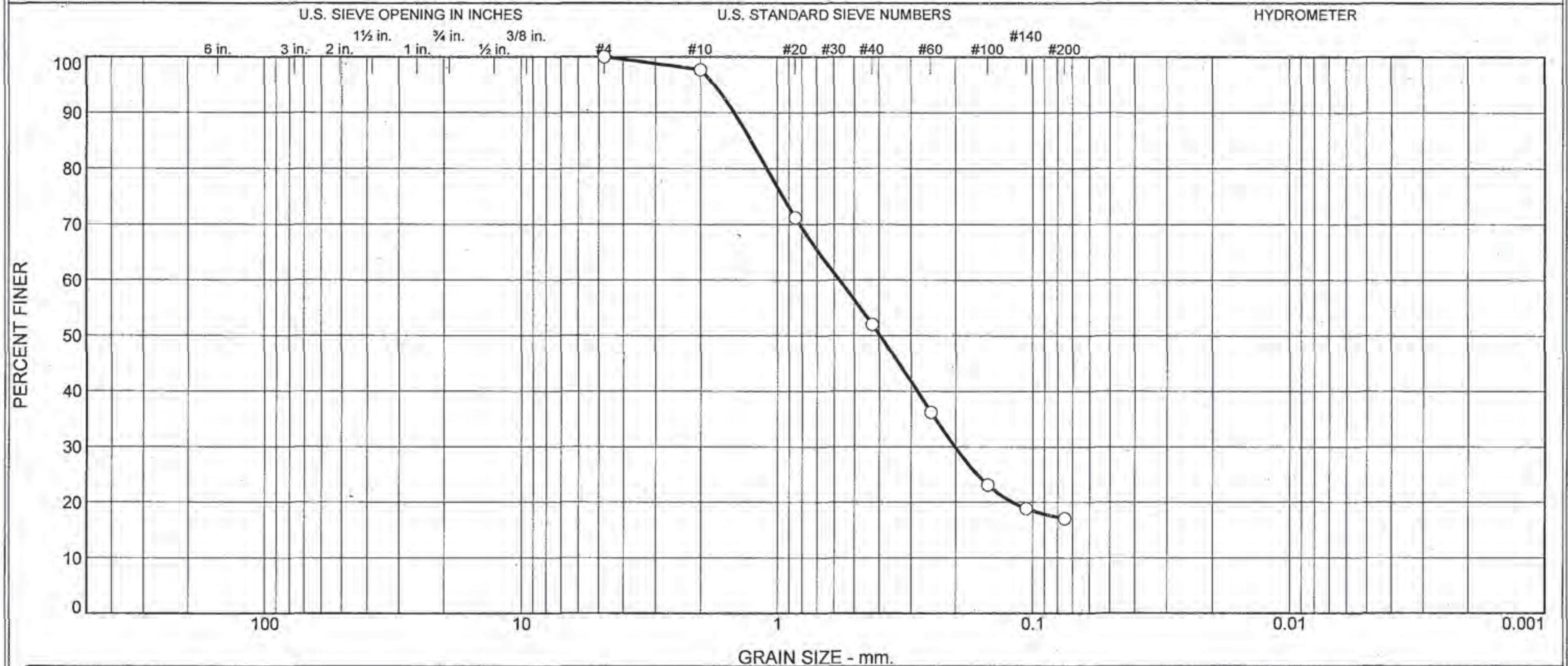
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.3 | 0.3 | 2.1 | 53.9 | 31.3 | 87.3 | | | 12.4 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | 0.1194 | 0.1922 | 0.3093 | 0.4735 | 0.5531 | 0.7614 | 0.8413 | 0.9581 | 1.1903 |

| Fineness Modulus |
|---|
| 1.96 |

AMEC

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 2.3 | 45.7 | 35.0 | 17.0 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B04 | SS14 | 40-42 ft | N/A | | Brown Silty Sand | 9.5 | | |

Client SRNS

Project Saltstone Disposal Unit 6

Project No. 6155-08-0031.28 Figure

○ 11353

**Tested By:** EH **Checked By:** JW

## GRAIN SIZE DISTRIBUTION TEST DATA

2/6/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B04
**Depth:** 40-42 ft
**Sample Number:** SS14
**Material Description:** Brown Silty Sand
**Date:** N/A
**Natural Moisture:** 9.5
**Testing Remarks:** 11353
**Tested by:** EH
**Checked by:** JW

### Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 95.00 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | | |
| | | | #4 | 0.00 | 100.0 |
| | | | #10 | 2.22 | 97.7 |
| | | | #20 | 27.40 | 71.2 |
| | | | #40 | 45.58 | 52.0 |
| | | | #60 | 60.60 | 36.2 |
| | | | #100 | 73.07 | 23.1 |
| | | | #140 | 77.08 | 18.9 |
| | | | #200 | 78.82 | 17.0 |

### Fractional Components

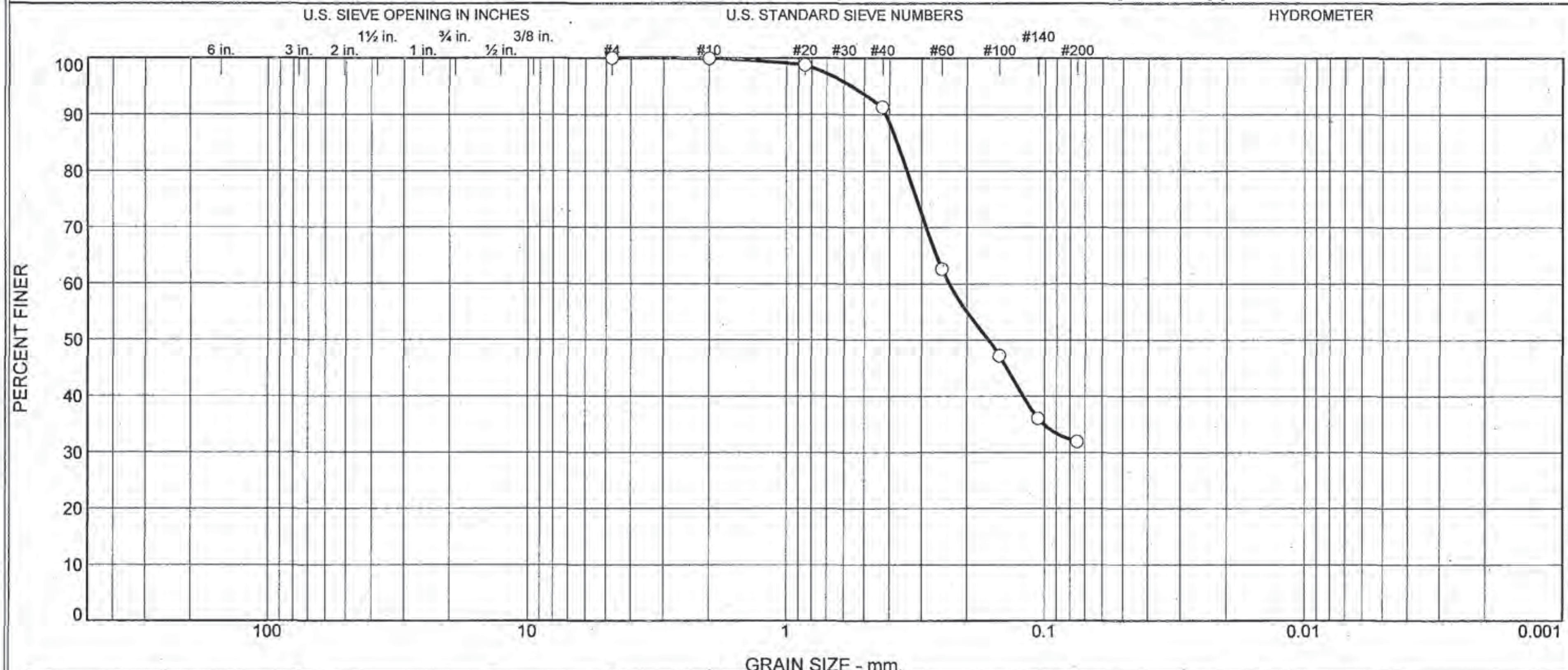
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.0 | 0.0 | 2.3 | 45.7 | 35.0 | 83.0 | | | 17.0 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | | 0.1204 | 0.2019 | 0.3957 | 0.5733 | 1.1027 | 1.2731 | 1.4826 | 1.7705 |

| Fineness Modulus |
|---|
| 1.93 |

AMEC

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.1 | 8.6 | 59.3 | 32.0 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B04 | SS15 | 43-45 ft | N/A | | Yellowish Brown Clayey Sand | 20.2 | | |

Client SRNS
Project Saltstone Disposal Unit 6
Project No. 6155-08-0031.28 Figure

amec

○ 11354

**Tested By:** EH **Checked By:** JW

# GRAIN SIZE DISTRIBUTION TEST DATA

2/6/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B04
**Depth:** 43-45 ft
**Sample Number:** SS15
**Material Description:** Yellowish Brown Clayey Sand
**Date:** N/A
**Natural Moisture:** 20.2
**Testing Remarks:** 11354
**Tested by:** EH
**Checked by:** JW

## Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 85.05 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | | |
| | | | #4 | 0.00 | 100.0 |
| | | | #10 | 0.05 | 99.9 |
| | | | #20 | 1.05 | 98.8 |
| | | | #40 | 7.40 | 91.3 |
| | | | #60 | 31.80 | 62.6 |
| | | | #100 | 44.91 | 47.2 |
| | | | #140 | 54.37 | 36.1 |
| | | | #200 | 57.86 | 32.0 |

## Fractional Components

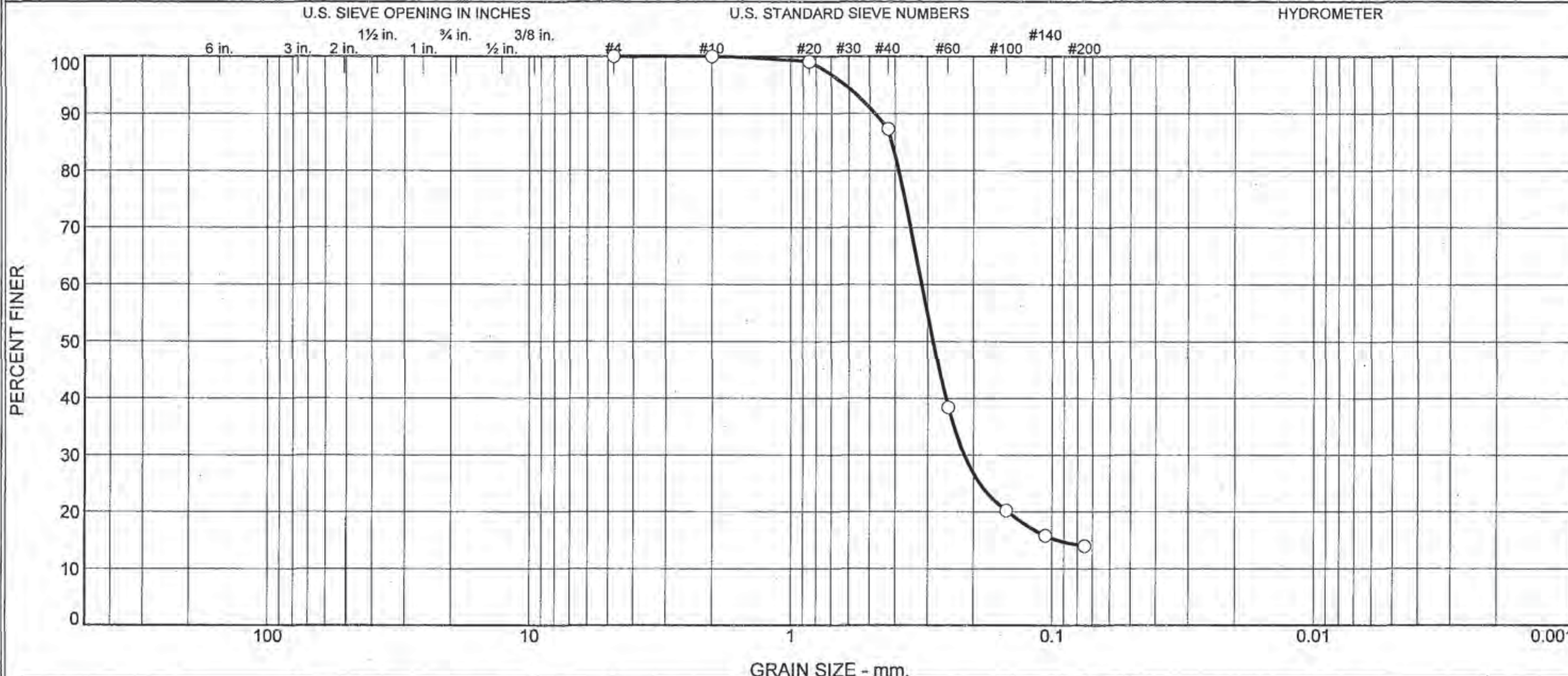
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 8.6 | 59.3 | 68.0 | | | 32.0 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | | | | 0.1657 | 0.2348 | 0.3414 | 0.3728 | 0.4122 | 0.5615 |

| Fineness Modulus |
|---|
| 0.85 |

AMEC

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.0 | 12.7 | 73.4 | 13.9 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B04 | SS16 | 48-50 ft | N/A | | Brown Silty Sand | 14.1 | | |

Client SRNS

Project Saltstone Disposal Unit 6

Project No. 6155-08-0031.28 Figure

amec

○ 11355

**Tested By:** EH **Checked By:** JW

# GRAIN SIZE DISTRIBUTION TEST DATA

2/6/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B04
**Depth:** 48-50 ft
**Sample Number:** SS16
**Material Description:** Brown Silty Sand
**Date:** N/A
**Natural Moisture:** 14.1
**Testing Remarks:** 11355
**Tested by:** EH
**Checked by:** JW

## Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 91.70 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | | |
| | | | #4 | 0.00 | 100.0 |
| | | | #10 | 0.02 | 100.0 |
| | | | #20 | 0.85 | 99.1 |
| | | | #40 | 11.64 | 87.3 |
| | | | #60 | 56.49 | 38.4 |
| | | | #100 | 73.17 | 20.2 |
| | | | #140 | 77.25 | 15.8 |
| | | | #200 | 78.92 | 13.9 |

## Fractional Components

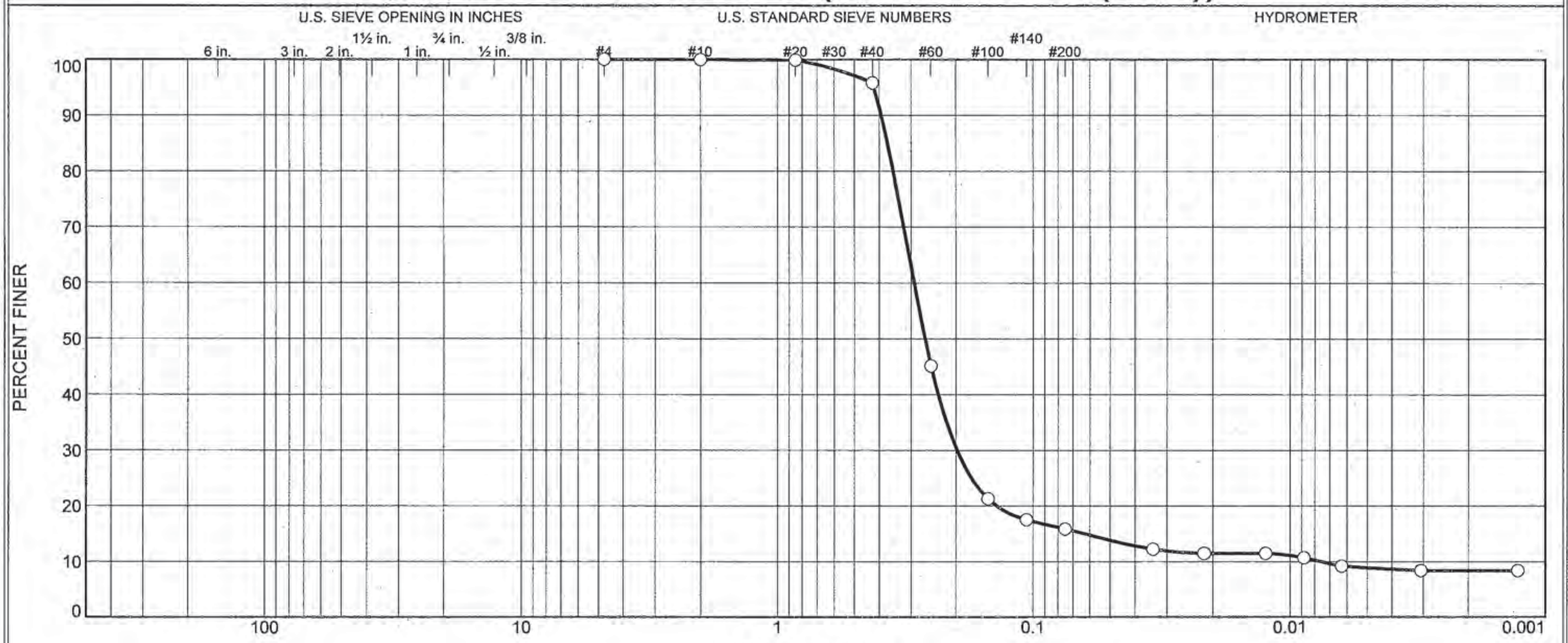
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 12.7 | 73.4 | 86.1 | | | 13.9 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | 0.0957 | 0.1480 | 0.2173 | 0.2859 | 0.3161 | 0.3876 | 0.4118 | 0.4781 | 0.6222 |

| Fineness Modulus |
|---|
| 1.31 |

AMEC

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.1 | 4.1 | 80.0 | 7.0 | 8.8 |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B04 | SS17 | 53-55 ft | N/A | | Yellowish Brown Silty Sand | 16.5 | | |

Client SRNS
Project Saltstone Disposal Unit 6
Project No. 6155-08-0031.28 Figure

amec

○ 11356

**Tested By:** EH **Checked By:** JW

## GRAIN SIZE DISTRIBUTION TEST DATA

2/6/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B04
**Depth:** 53-55 ft  **Sample Number:** SS17
**Material Description:** Yellowish Brown Silty Sand
**Date:** N/A  **Natural Moisture:** 16.5
**Testing Remarks:** 11356
**Tested by:** EH  **Checked by:** JW

### Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 64.93 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | | |
| | | | #4 | 0.00 | 100.0 |
| | | | #10 | 0.04 | 99.9 |
| | | | #20 | 0.10 | 99.8 |
| | | | #40 | 2.73 | 95.8 |
| | | | #60 | 35.62 | 45.1 |
| | | | #100 | 51.11 | 21.3 |
| | | | #140 | 53.56 | 17.5 |
| | | | #200 | 54.65 | 15.8 |

### Hydrometer Test Data

Hydrometer test uses material passing #200
Percent passing #200 based upon complete sample = 15.8
Weight of hydrometer sample =10.28
Table of composite correction values:

| Temp., deg. C: | 17.6 | 19.1 | 20.9 | 21.8 | 23.9 |
|---|---|---|---|---|---|
| Comp. corr.: | -7.0 | -6.5 | -6.2 | -6.0 | -5.5 |

Meniscus correction only = 0.0
Specific gravity of solids = 2.7
Hydrometer type = 152H
Hydrometer effective depth equation: L = 16.294964 - 0.164 x Rm

| Elapsed Time (min.) | Temp. (deg. C.) | Actual Reading | Corrected Reading | K | Rm | Eff. Depth | Diameter (mm.) | Percent Finer |
|---|---|---|---|---|---|---|---|---|
| 2.00 | 23.9 | 13.5 | 8.0 | 0.0128 | 13.5 | 14.1 | 0.0340 | 12.2 |
| 5.00 | 23.9 | 13.0 | 7.5 | 0.0128 | 13.0 | 14.2 | 0.0216 | 11.4 |
| 15.00 | 23.9 | 13.0 | 7.5 | 0.0128 | 13.0 | 14.2 | 0.0125 | 11.4 |
| 30.00 | 23.9 | 12.5 | 7.0 | 0.0128 | 12.5 | 14.2 | 0.0088 | 10.7 |
| 60.00 | 23.9 | 11.5 | 6.0 | 0.0128 | 11.5 | 14.4 | 0.0063 | 9.1 |
| 250.00 | 24.3 | 11.0 | 5.5 | 0.0128 | 11.0 | 14.5 | 0.0031 | 8.4 |
| 1440.00 | 24.3 | 11.0 | 5.5 | 0.0128 | 11.0 | 14.5 | 0.0013 | 8.4 |

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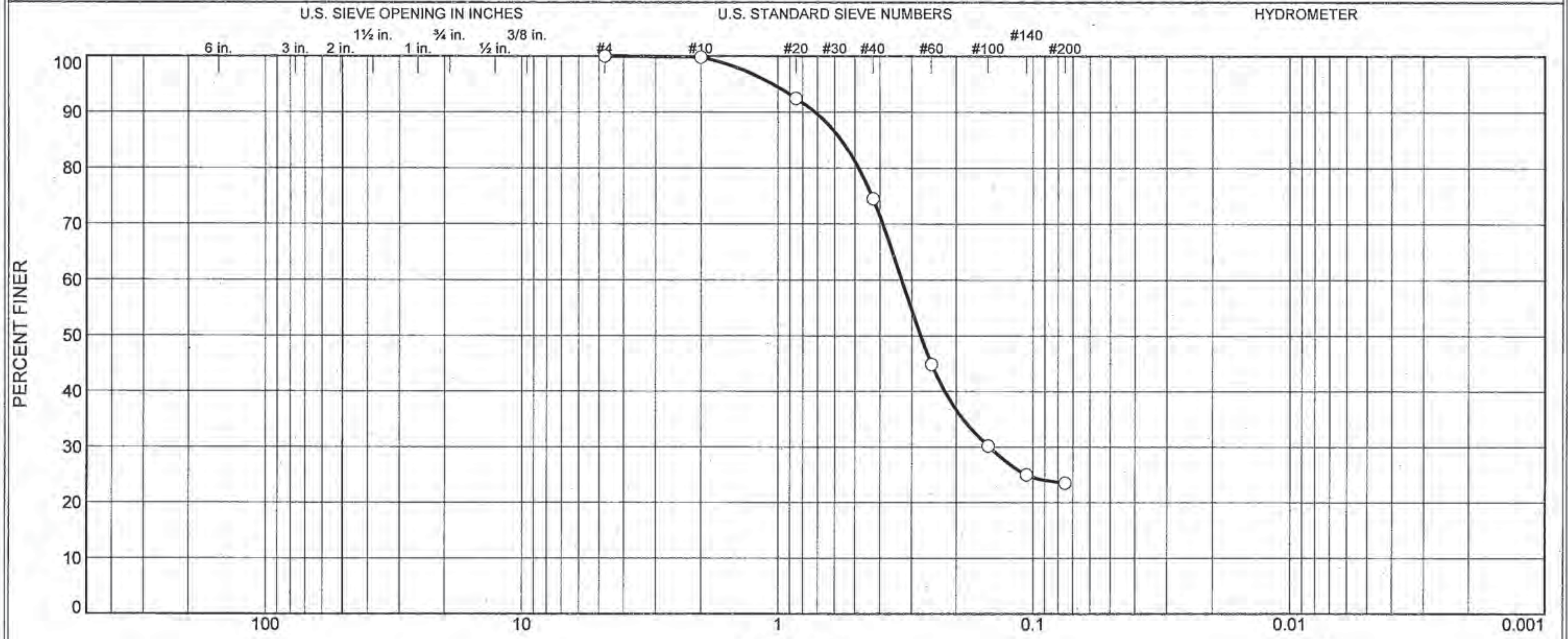
## Fractional Components

| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 4.1 | 80.0 | 84.2 | 7.0 | 8.8 | 15.8 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| 0.0076 | 0.0632 | 0.1389 | 0.1981 | 0.2638 | 0.2914 | 0.3525 | 0.3712 | 0.3928 | 0.4199 |

| Fineness Modulus | $C_u$ | $C_c$ |
|---|---|---|
| 1.18 | 38.27 | 17.68 |

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.2 | 25.3 | 51.0 | 23.5 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B04 | SS18 | 58-60 ft | N/A | | Brown Clayey Sand | 21.7 | | |

Client SRNS
Project Saltstone Disposal Unit 6
Project No. 6155-08-0031.28 Figure

amec

○ 11357

**Tested By:** EH **Checked By:** JW

## GRAIN SIZE DISTRIBUTION TEST DATA

2/6/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B04
**Depth:** 58-60 ft **Sample Number:** SS18
**Material Description:** Brown Clayey Sand
**Date:** N/A **Natural Moisture:** 21.7
**Testing Remarks:** 11357
**Tested by:** EH **Checked by:** JW

### Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 90.88 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | | |
| | | | #4 | 0.00 | 100.0 |
| | | | #10 | 0.19 | 99.8 |
| | | | #20 | 6.86 | 92.5 |
| | | | #40 | 23.21 | 74.5 |
| | | | #60 | 50.10 | 44.9 |
| | | | #100 | 63.46 | 30.2 |
| | | | #140 | 68.14 | 25.0 |
| | | | #200 | 69.50 | 23.5 |

### Fractional Components

| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 25.3 | 51.0 | 76.5 | | | 23.5 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | | | 0.1486 | 0.2765 | 0.3284 | 0.4840 | 0.5662 | 0.7177 | 1.0503 |

| Fineness Modulus |
|---|
| 1.33 |

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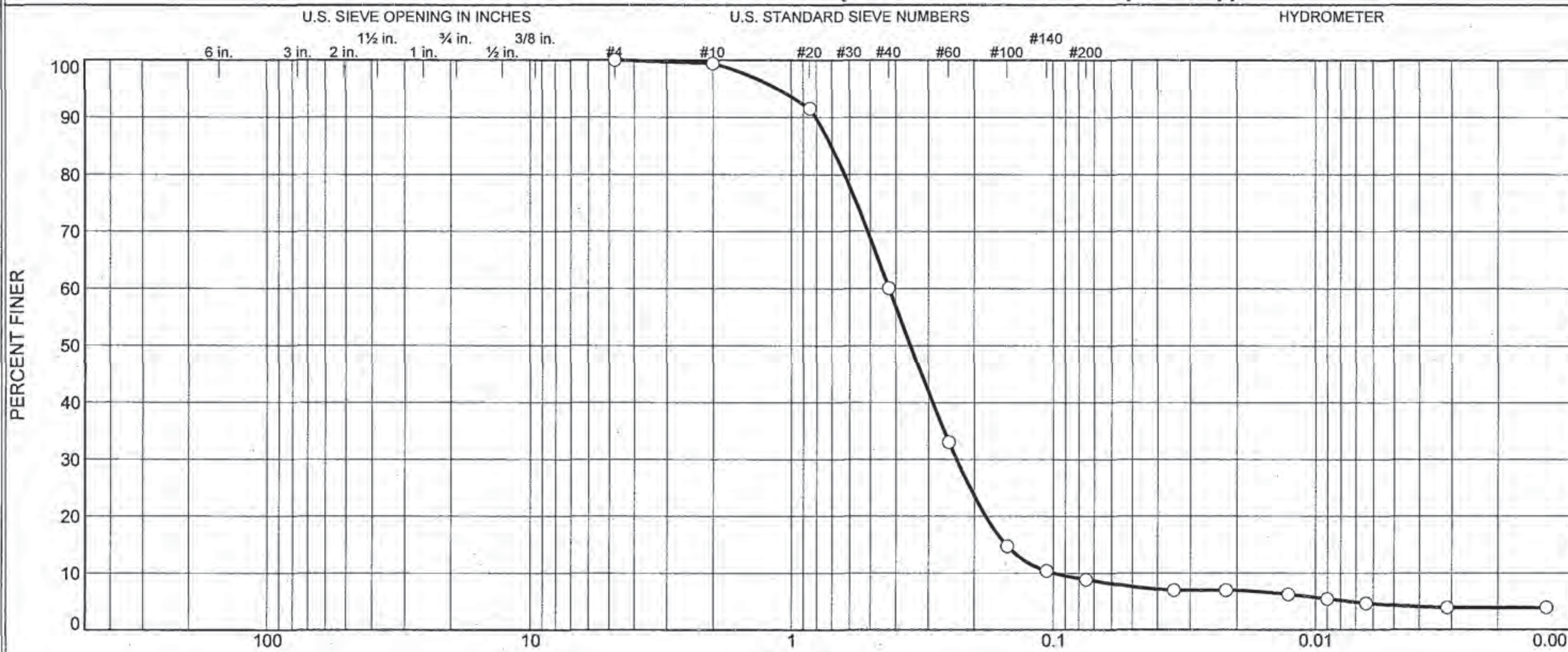
# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.6 | 39.4 | 51.2 | 4.5 | 4.3 |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B04 | SS19 | 63-65 ft | N/A | SP-SM | Yellowish Brown Poorly Graded Sand with Silt | 18.8 | NV | NP |

Client SRNS

Project Saltstone Disposal Unit 6

Project No. 6155-08-0031.28 Figure

amec

○ 11358

**Tested By:** EH **Checked By:** JW

## GRAIN SIZE DISTRIBUTION TEST DATA

2/6/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B04
**Depth:** 63-65 ft **Sample Number:** SS19
**Material Description:** Yellowish Brown Poorly Graded Sand with Silt
**Date:** N/A **Natural Moisture:** 18.8
**Liquid Limit:** NV **Plastic Limit:** NP **USCS Class.:** SP-SM
**Testing Remarks:** 11358
**Tested by:** EH **Checked by:** JW

### Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 63.83 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | | |
| | | | #4 | 0.00 | 100.0 |
| | | | #10 | 0.39 | 99.4 |
| | | | #20 | 5.43 | 91.5 |
| | | | #40 | 25.51 | 60.0 |
| | | | #60 | 42.76 | 33.0 |
| | | | #100 | 54.44 | 14.7 |
| | | | #140 | 57.21 | 10.4 |
| | | | #200 | 58.20 | 8.8 |

### Hydrometer Test Data

Hydrometer test uses material passing #200
Percent passing #200 based upon complete sample = 8.8
Weight of hydrometer sample =5.63
Table of composite correction values:

| Temp., deg. C: | 17.6 | 19.1 | 20.9 | 21.8 | 23.9 |
|---|---|---|---|---|---|
| Comp. corr.: | -7.0 | -6.5 | -6.2 | -6.0 | -5.5 |

Meniscus correction only = 0.0
Specific gravity of solids = 2.7
Hydrometer type = 152H
Hydrometer effective depth equation: L = 16.294964 - 0.164 x Rm

| Elapsed Time (min.) | Temp. (deg. C.) | Actual Reading | Corrected Reading | K | Rm | Eff. Depth | Diameter (mm.) | Percent Finer |
|---|---|---|---|---|---|---|---|---|
| 2.00 | 23.9 | 10.0 | 4.5 | 0.0128 | 10.0 | 14.7 | 0.0347 | 7.0 |
| 5.00 | 23.9 | 10.0 | 4.5 | 0.0128 | 10.0 | 14.7 | 0.0219 | 7.0 |
| 15.00 | 23.9 | 9.5 | 4.0 | 0.0128 | 9.5 | 14.7 | 0.0127 | 6.2 |
| 30.00 | 23.9 | 9.0 | 3.5 | 0.0128 | 9.0 | 14.8 | 0.0090 | 5.4 |
| 60.00 | 23.9 | 8.5 | 3.0 | 0.0128 | 8.5 | 14.9 | 0.0064 | 4.6 |
| 250.00 | 24.3 | 8.0 | 2.5 | 0.0128 | 8.0 | 15.0 | 0.0031 | 3.9 |
| 1440.00 | 24.3 | 8.0 | 2.5 | 0.0128 | 8.0 | 15.0 | 0.0013 | 3.9 |

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## Fractional Components

| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.6 | 39.4 | 51.2 | 91.2 | 4.5 | 4.3 | 8.8 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| 0.0996 | 0.1520 | 0.1814 | 0.2339 | 0.3517 | 0.4247 | 0.6291 | 0.7063 | 0.8097 | 1.1379 |

| Fineness Modulus | $C_u$ | $C_c$ |
|---|---|---|
| 1.71 | 4.26 | 1.29 |

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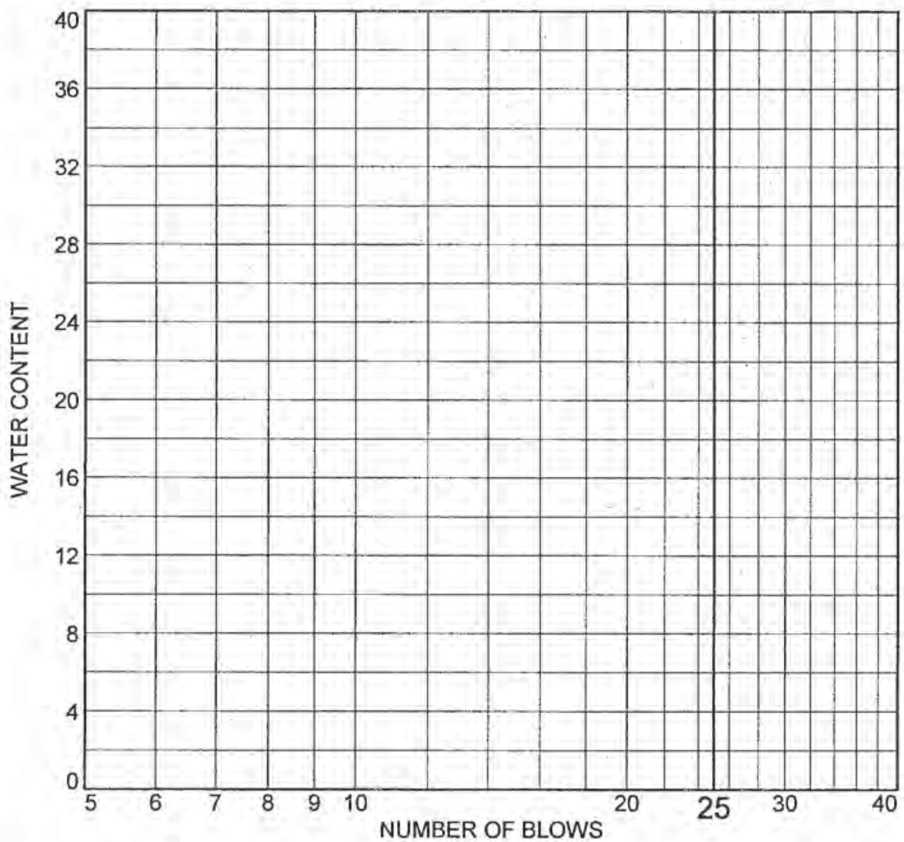
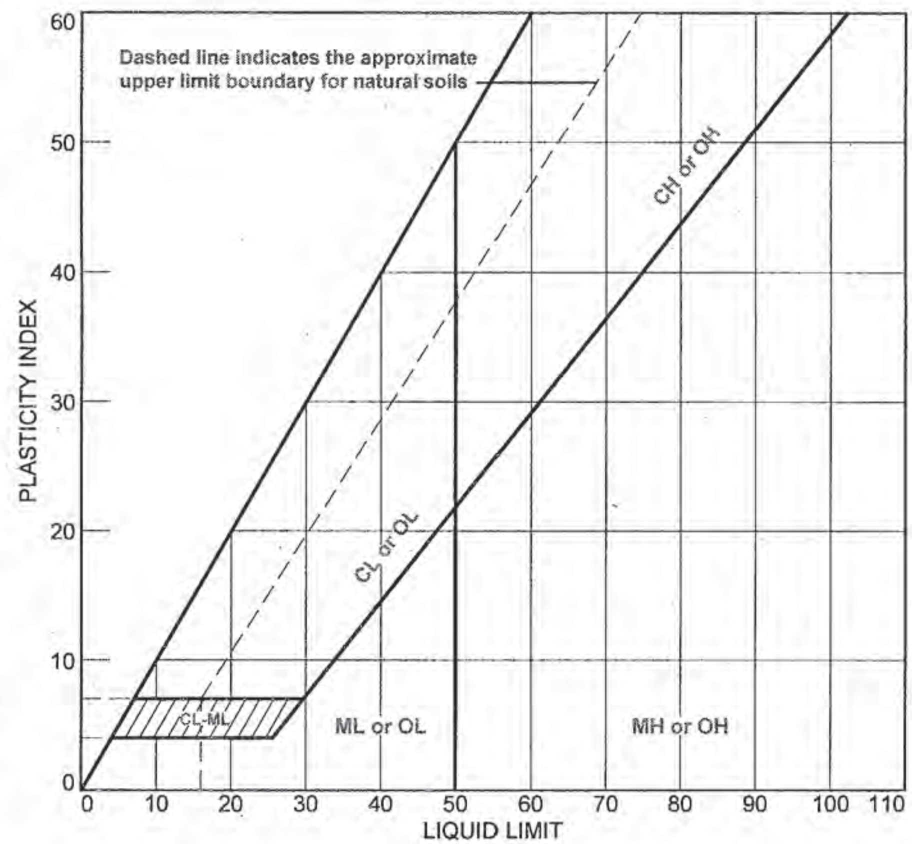
# LIQUID AND PLASTIC LIMITS TEST REPORT (ASTM D4318-05)




| | SOURCE | SAMPLE # | DEPTH/ELEV. | DATE SAMPLED | USCS | MATERIAL DESCRIPTION | NM % | LL | PI |
|---|---|---|---|---|---|---|---|---|---|
| ● | Z-SDU6-B04 | SS19 | 63-65 ft | N/A | SP-SM | Yellowish Brown Poorly Graded Sand with Silt | 18.8 | NV | NP |

Client SRNS

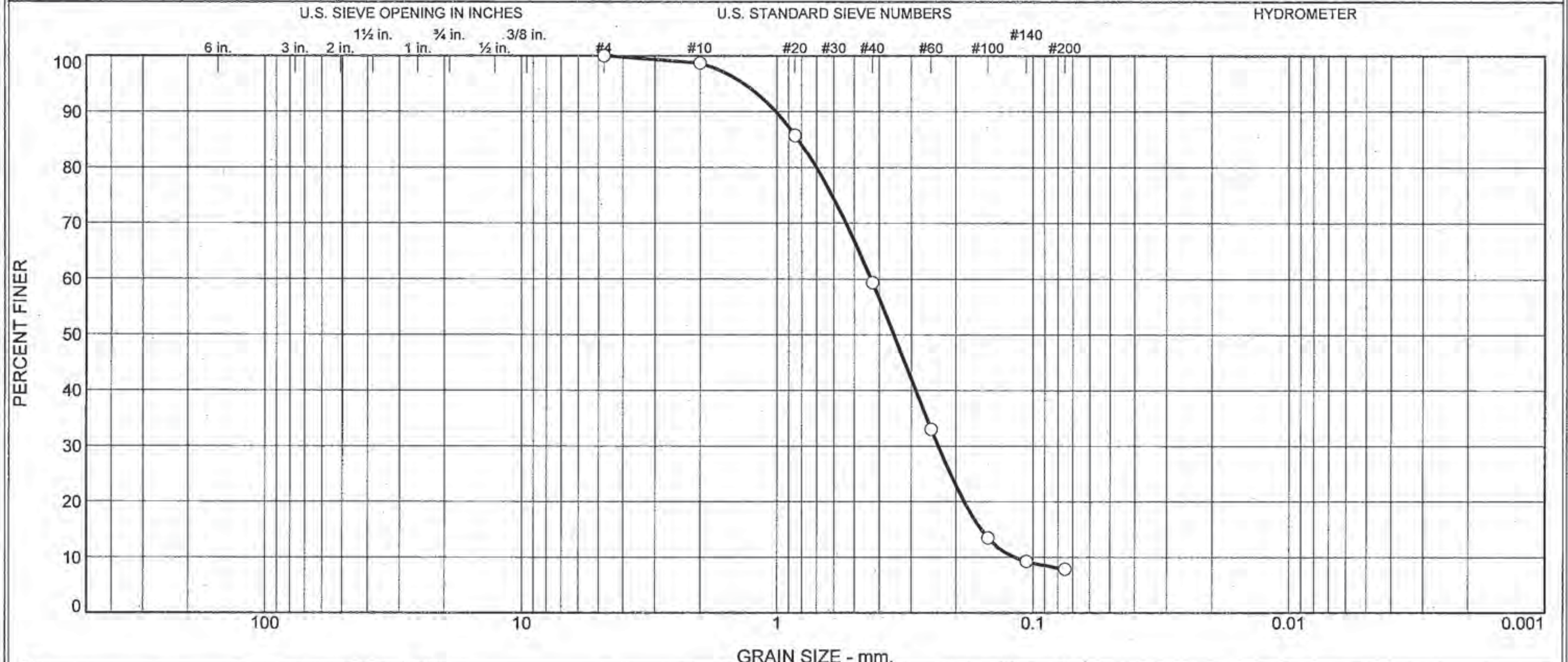
Project Saltstone Disposal Unit 6

Project No. 6155-08-0031.28 Figure

● 11358

**Tested By:** EH **Checked By:** JW

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 1.3 | 39.4 | 51.5 | 7.8 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B04 | SS20 | 68-70 ft | N/A | | Brown Poorly Graded Sand with Silt | 17.4 | | |

Client SRNS
Project Saltstone Disposal Unit 6
Project No. 6155-08-0031.28 Figure

amec

○ 11359

**Tested By:** EH **Checked By:** JW

# GRAIN SIZE DISTRIBUTION TEST DATA

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B04
**Depth:** 68-70 ft
**Sample Number:** SS20
**Material Description:** Brown Poorly Graded Sand with Silt
**Date:** N/A
**Natural Moisture:** 17.4
**Testing Remarks:** 11359
**Tested by:** EH
**Checked by:** JW

## Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 97.53 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | | |
| | | | #4 | 0.00 | 100.0 |
| | | | #10 | 1.30 | 98.7 |
| | | | #20 | 13.87 | 85.8 |
| | | | #40 | 39.66 | 59.3 |
| | | | #60 | 65.34 | 33.0 |
| | | | #100 | 84.38 | 13.5 |
| | | | #140 | 88.49 | 9.3 |
| | | | #200 | 89.89 | 7.8 |

## Fractional Components

| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.0 | 0.0 | 1.3 | 39.4 | 51.5 | 92.2 | | | 7.8 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| 0.1179 | 0.1594 | 0.1858 | 0.2347 | 0.3512 | 0.4310 | 0.7038 | 0.8266 | 1.0107 | 1.3486 |

| Fineness Modulus | $C_u$ | $C_c$ |
|---|---|---|
| 1.78 | 3.65 | 1.08 |

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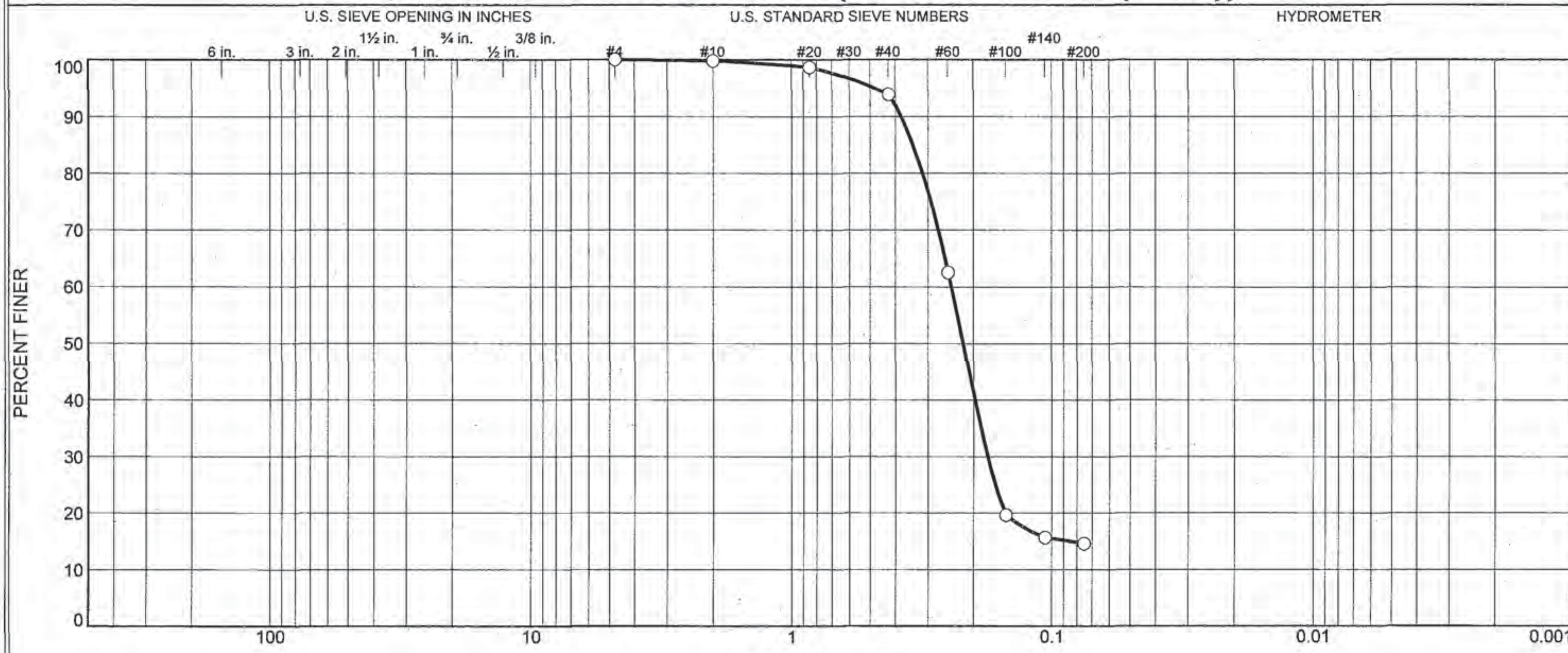
# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.2 | 5.9 | 79.3 | 14.6 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B04 | SS21 | 73-75 ft | N/A | | Brown Silty Sand | 29.8 | | |

Client SRNS
Project Saltstone Disposal Unit 6
Project No. 6155-08-0031.28 Figure

amec

○ 11360

**Tested By:** EH **Checked By:** JW

## GRAIN SIZE DISTRIBUTION TEST DATA

2/6/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B04
**Depth:** 73-75 ft **Sample Number:** SS21
**Material Description:** Brown Silty Sand
**Date:** N/A **Natural Moisture:** 29.8
**Testing Remarks:** 11360
**Tested by:** EH **Checked by:** JW

### Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 80.81 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | | |
| | | | #4 | 0.00 | 100.0 |
| | | | #10 | 0.20 | 99.8 |
| | | | #20 | 1.12 | 98.6 |
| | | | #40 | 4.93 | 93.9 |
| | | | #60 | 30.30 | 62.5 |
| | | | #100 | 64.99 | 19.6 |
| | | | #140 | 68.16 | 15.7 |
| | | | #200 | 69.03 | 14.6 |

### Fractional Components

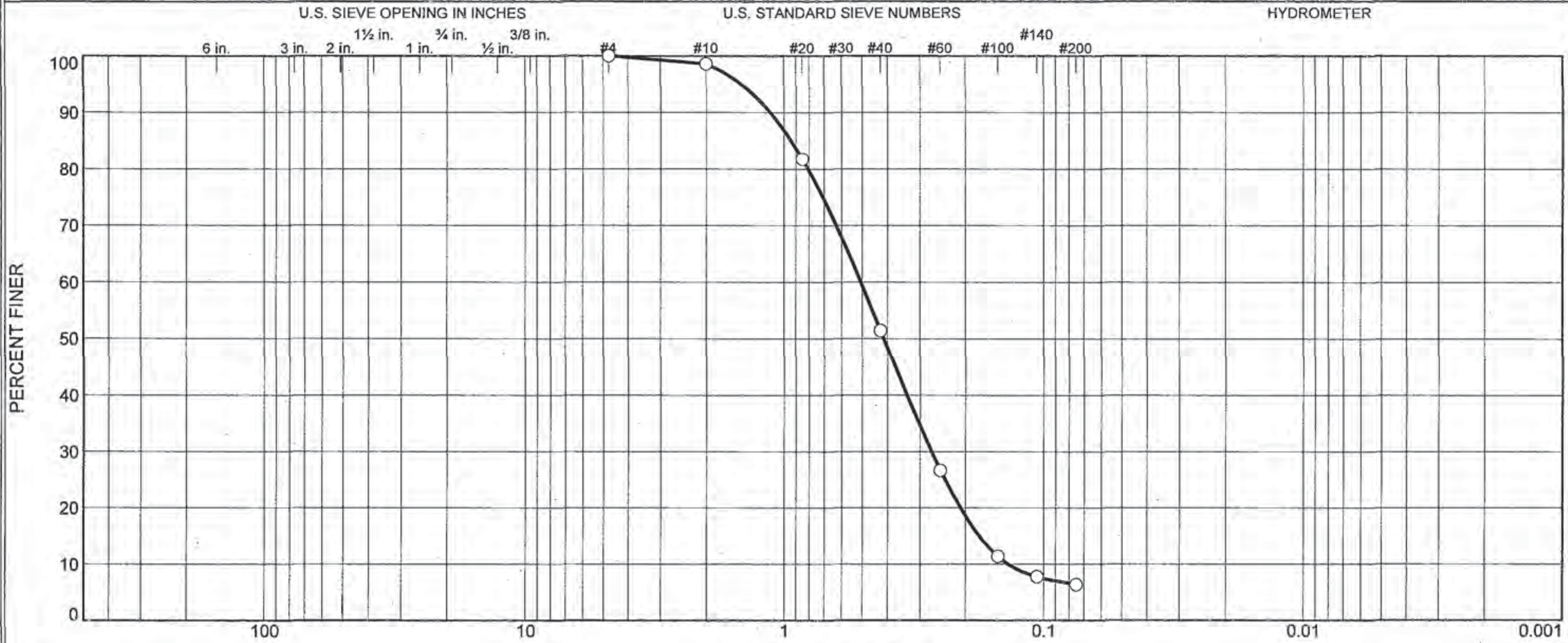
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 5.9 | 79.3 | 85.4 | | | 14.6 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | 0.0859 | 0.1514 | 0.1765 | 0.2191 | 0.2432 | 0.3147 | 0.3429 | 0.3811 | 0.4816 |

| Fineness Modulus |
|---|
| 1.08 |

AMEC

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 1.4 | 47.2 | 45.0 | 6.4 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B04 | SS22 | 78-80 ft | N/A | | Tan Poorly Graded Sand with Silt | 18.1 | | |

Client SRNS

Project Saltstone Disposal Unit 6

Project No. 6155-08-0031.28 Figure

amec

○ 11361

**Tested By:** EH **Checked By:** JW

# GRAIN SIZE DISTRIBUTION TEST DATA

2/6/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B04
**Depth:** 78-80 ft
**Sample Number:** SS22
**Material Description:** Tan Poorly Graded Sand with Silt
**Date:** N/A
**Natural Moisture:** 18.1
**Testing Remarks:** 11361
**Tested by:** EH
**Checked by:** JW

## Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 87.14 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | | |
| | | | #4 | 0.00 | 100.0 |
| | | | #10 | 1.24 | 98.6 |
| | | | #20 | 15.92 | 81.7 |
| | | | #40 | 42.35 | 51.4 |
| | | | #60 | 63.91 | 26.7 |
| | | | #100 | 77.27 | 11.3 |
| | | | #140 | 80.38 | 7.8 |
| | | | #200 | 81.59 | 6.4 |

## Fractional Components

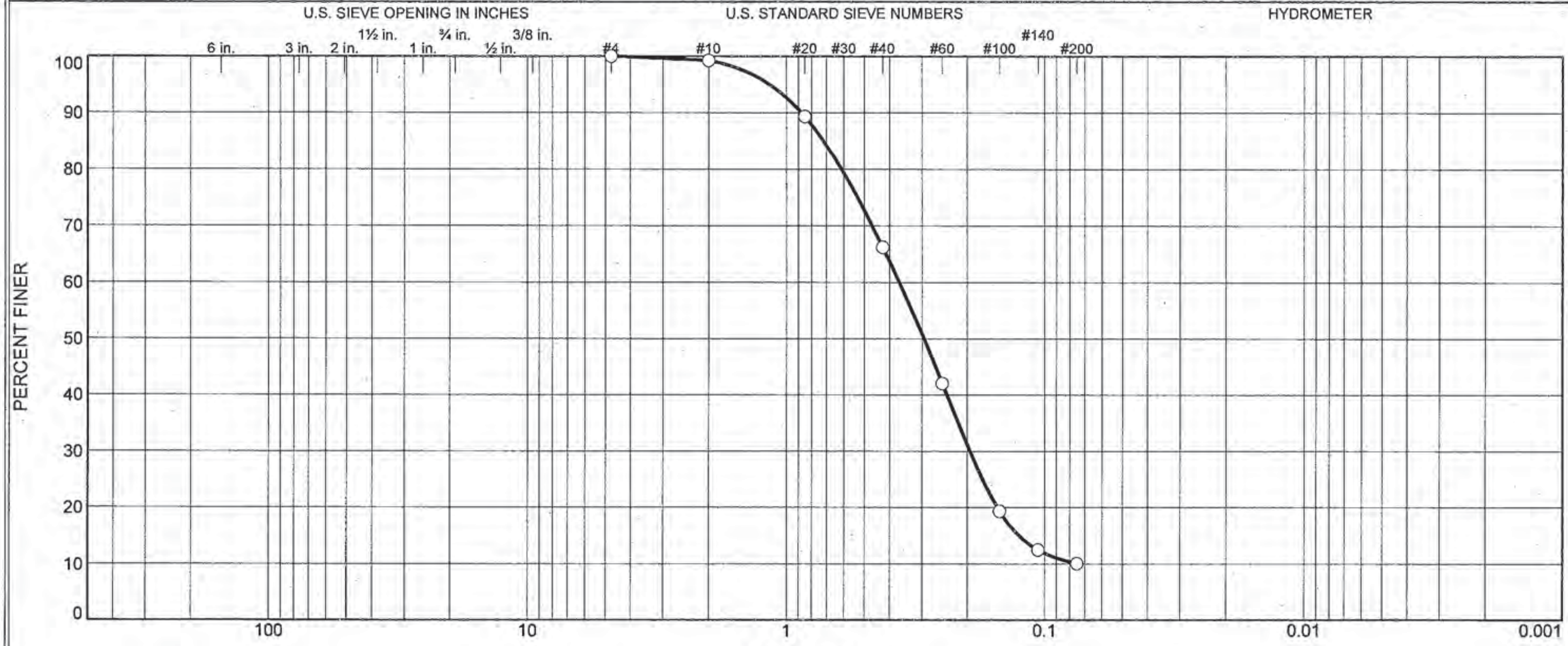
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.0 | 0.0 | 1.4 | 47.2 | 45.0 | 93.6 | | | 6.4 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| 0.1375 | 0.1773 | 0.2092 | 0.2707 | 0.4131 | 0.5073 | 0.8091 | 0.9410 | 1.1339 | 1.4668 |

| Fineness Modulus | $C_u$ | $C_c$ |
|---|---|---|
| 1.97 | 3.69 | 1.05 |

AMEC

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.7 | 33.1 | 56.2 | 10.0 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B04 | SS23 | 83-85 ft | N/A | | Tan Poorly Graded Sand with Silt | 19.3 | | |

Client SRNS
Project Saltstone Disposal Unit 6
Project No. 6155-08-0031.28 Figure

amec

○ 11362

**Tested By:** EH **Checked By:** JW

# GRAIN SIZE DISTRIBUTION TEST DATA

2/6/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B04
**Depth:** 83-85 ft
**Sample Number:** SS23
**Material Description:** Tan Poorly Graded Sand with Silt
**Date:** N/A
**Natural Moisture:** 19.3
**Testing Remarks:** 11362
**Tested by:** EH
**Checked by:** JW

## Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 97.39 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | | |
| | | | #4 | 0.00 | 100.0 |
| | | | #10 | 0.73 | 99.3 |
| | | | #20 | 10.43 | 89.3 |
| | | | #40 | 32.93 | 66.2 |
| | | | #60 | 56.44 | 42.0 |
| | | | #100 | 78.56 | 19.3 |
| | | | #140 | 85.26 | 12.5 |
| | | | #200 | 87.61 | 10.0 |

## Fractional Components

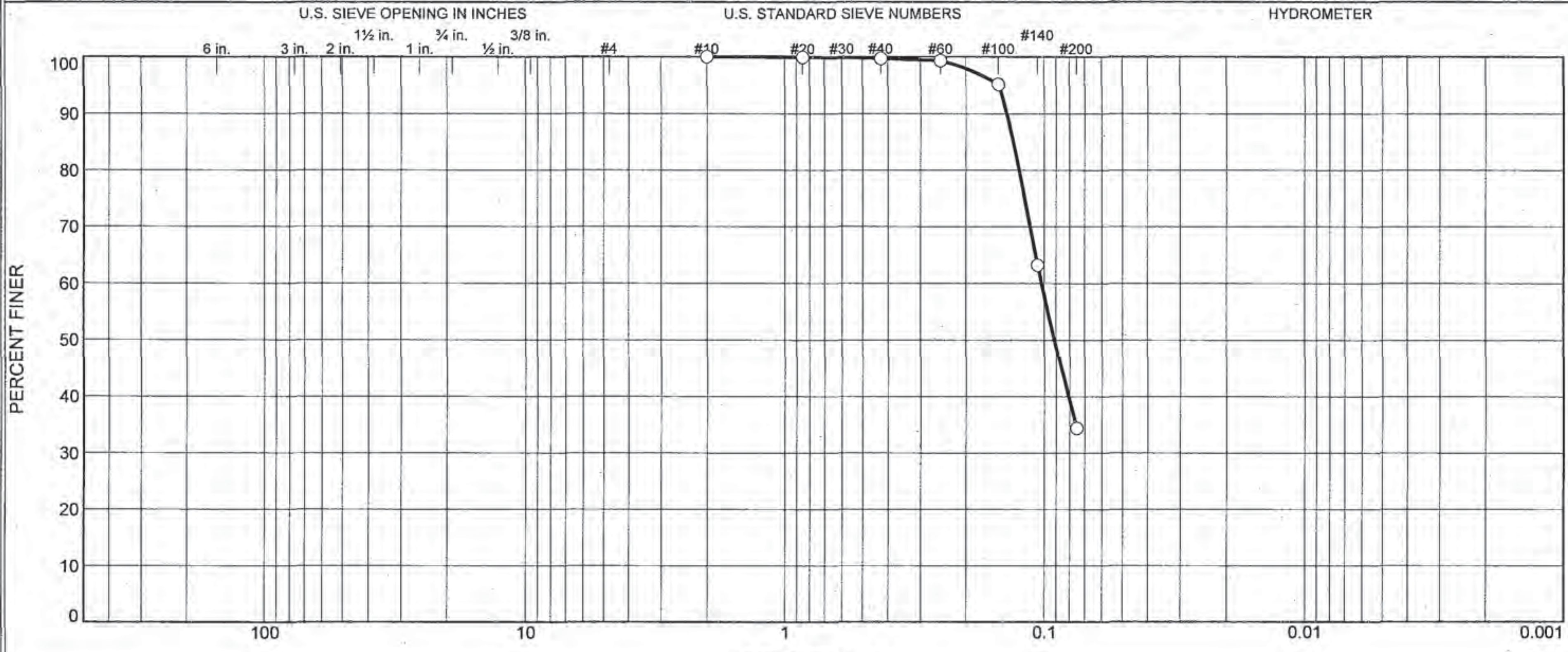
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.7 | 33.1 | 56.2 | 90.0 | | | 10.0 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | 0.1260 | 0.1531 | 0.1955 | 0.2949 | 0.3675 | 0.6135 | 0.7206 | 0.8771 | 1.1658 |

| Fineness Modulus |
|---|
| 1.56 |

AMEC

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 65.3 | 34.4 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B04 | SS24 | 88-90 ft | N/A | | Tan Silty Sand | 29.4 | | |

Client SRNS

Project Saltstone Disposal Unit 6

Project No. 6155-08-0031.28 Figure

amec

○ 11363

**Tested By:** EH **Checked By:** JW

## GRAIN SIZE DISTRIBUTION TEST DATA

2/6/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B04
**Depth:** 88-90 ft
**Sample Number:** SS24
**Material Description:** Tan Silty Sand
**Date:** N/A
**Natural Moisture:** 29.4
**Testing Remarks:** 11363
**Tested by:** EH
**Checked by:** JW

### Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 80.12 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | | |
| | | | #4 | | |
| | | | #10 | 0.00 | 100.0 |
| | | | #20 | 0.09 | 99.9 |
| | | | #40 | 0.27 | 99.7 |
| | | | #60 | 0.58 | 99.3 |
| | | | #100 | 3.88 | 95.2 |
| | | | #140 | 29.47 | 63.2 |
| | | | #200 | 52.58 | 34.4 |

### Fractional Components

| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 65.3 | 65.6 | | | 34.4 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | | | | 0.0915 | 0.1025 | 0.1251 | 0.1317 | 0.1395 | 0.1496 |

| Fineness Modulus |
|---|
| 0.06 |

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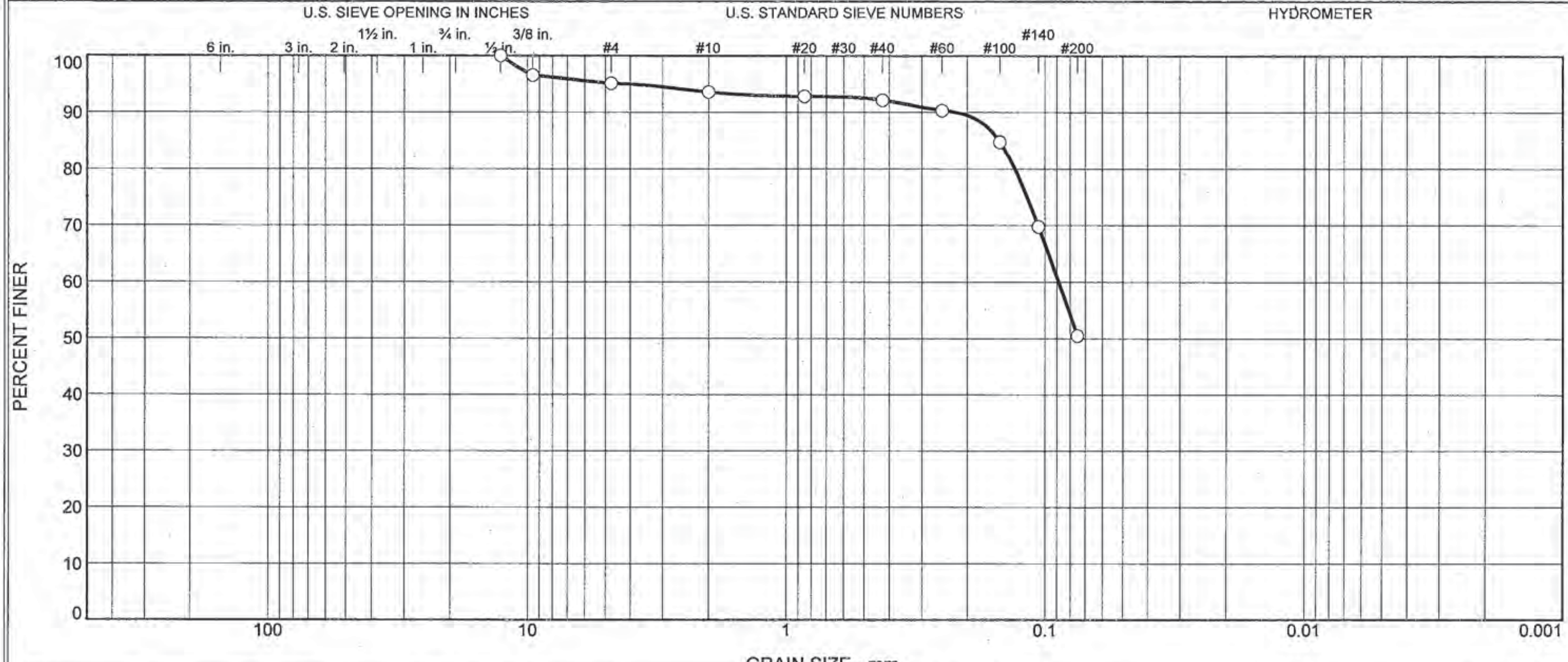
# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 4.9 | 1.6 | 1.4 | 41.7 | 50.4 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B04 | SS25 | 93-95 ft | N/A | | Tan Sandy Silt | 50.7 | | |

Client SRNS
Project Saltstone Disposal Unit 6
Project No. 6155-08-0031.28 Figure

amec

○ 11364

**Tested By:** EH **Checked By:** JW

## GRAIN SIZE DISTRIBUTION TEST DATA

2/6/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B04
**Depth:** 93-95 ft  **Sample Number:** SS25
**Material Description:** Tan Sandy Silt
**Date:** N/A  **Natural Moisture:** 50.7
**Testing Remarks:** 11364
**Tested by:** EH  **Checked by:** JW

### Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 73.66 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | 0.00 | 100.0 |
| | | | .375" | 2.55 | 96.5 |
| | | | #4 | 3.63 | 95.1 |
| | | | #10 | 4.76 | 93.5 |
| | | | #20 | 5.31 | 92.8 |
| | | | #40 | 5.81 | 92.1 |
| | | | #60 | 7.14 | 90.3 |
| | | | #100 | 11.20 | 84.8 |
| | | | #140 | 22.30 | 69.7 |
| | | | #200 | 36.50 | 50.4 |

### Fractional Components

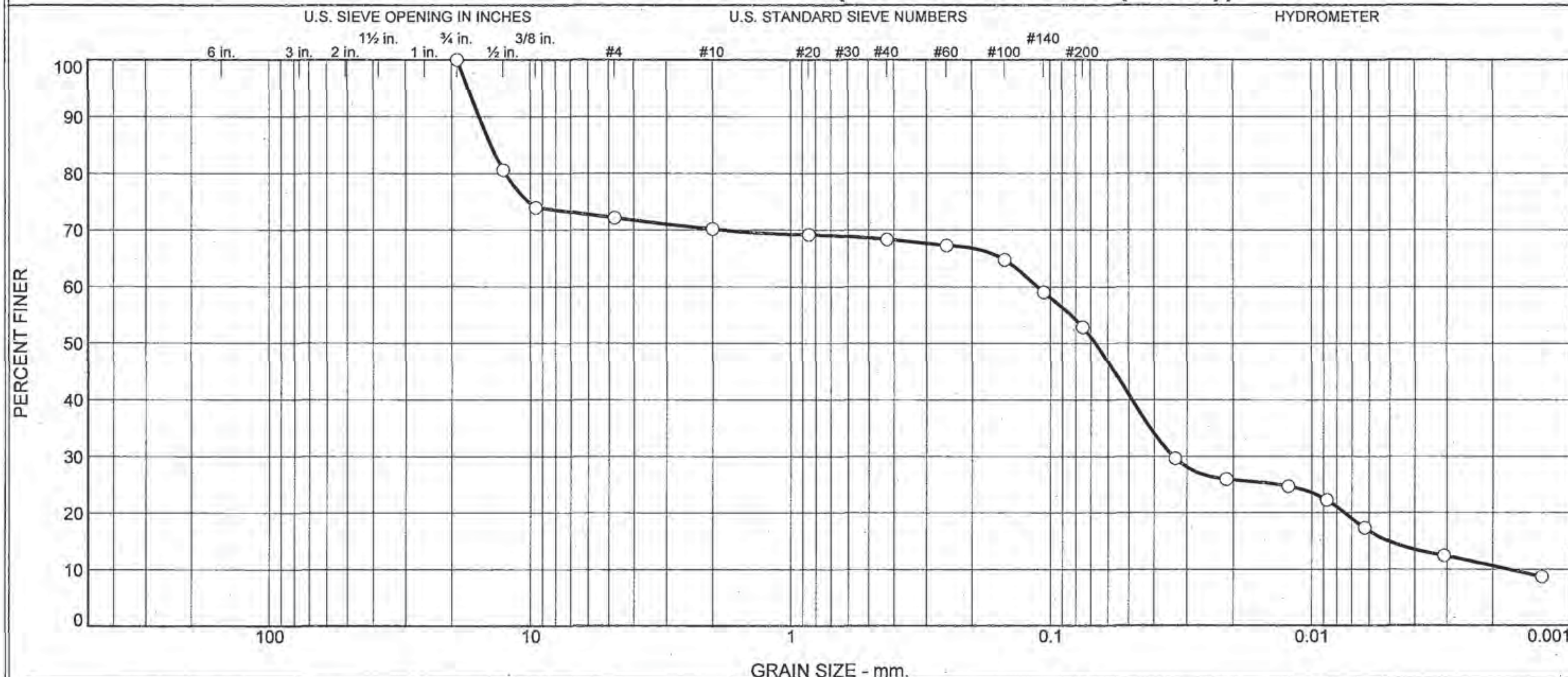
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 4.9 | 4.9 | 1.6 | 1.4 | 41.7 | 44.7 | | | 50.4 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | 0.0887 | 0.1312 | 0.1511 | 0.2234 | 4.1483 |

| Fineness Modulus |
|---|
| 0.53 |

AMEC

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 27.9 | 2.0 | 1.8 | 15.5 | 37.9 | 14.9 |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B04 | SS26 | 98-100 ft | N/A | ML | Tan Gravelly Silt with Sand | 42.0 | 43 | 33 |

Client SRNS

Project Saltstone Disposal Unit 6

Project No. 6155-08-0031.28 Figure

○ 11365

**Tested By:** EH **Checked By:** JW

# GRAIN SIZE DISTRIBUTION TEST DATA

2/6/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B04
**Depth:** 98-100 ft **Sample Number:** SS26
**Material Description:** Tan Gravelly Silt with Sand
**Date:** N/A **Natural Moisture:** 42.0
**Liquid Limit:** 43 **Plastic Limit:** 33 **USCS Class.:** ML
**Testing Remarks:** 11365
**Tested by:** EH **Checked by:** JW

## Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 40.03 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | 0.00 | 100.0 |
| | | | .5" | 7.79 | 80.5 |
| | | | .375" | 10.45 | 73.9 |
| | | | #4 | 11.16 | 72.1 |
| | | | #10 | 11.95 | 70.1 |
| | | | #20 | 12.37 | 69.1 |
| | | | #40 | 12.69 | 68.3 |
| | | | #60 | 13.12 | 67.2 |
| | | | #100 | 14.14 | 64.7 |
| | | | #140 | 16.42 | 59.0 |
| | | | #200 | 18.88 | 52.8 |

## Hydrometer Test Data

Hydrometer test uses material passing #200
Percent passing #200 based upon complete sample = 52.8
Weight of hydrometer sample =21.15
Table of composite correction values:

| | | | | | |
|---|---|---|---|---|---|
| Temp., deg. C: | 17.6 | 19.1 | 20.9 | 21.8 | 23.9 |
| Comp. corr.: | -7.0 | -6.5 | -6.2 | -6.0 | -5.5 |

Meniscus correction only = 0.0
Specific gravity of solids = 2.7
Hydrometer type = 152H
Hydrometer effective depth equation: L = 16.294964 - 0.164 x Rm

| Elapsed Time (min.) | Temp. (deg. C.) | Actual Reading | Corrected Reading | K | Rm | Eff. Depth | Diameter (mm.) | Percent Finer |
|---|---|---|---|---|---|---|---|---|
| 2.00 | 23.9 | 17.5 | 12.0 | 0.0128 | 17.5 | 13.4 | 0.0332 | 29.6 |
| 5.00 | 23.9 | 16.0 | 10.5 | 0.0128 | 16.0 | 13.7 | 0.0212 | 25.9 |
| 15.00 | 23.9 | 15.5 | 10.0 | 0.0128 | 15.5 | 13.8 | 0.0123 | 24.7 |
| 30.00 | 23.9 | 14.5 | 9.0 | 0.0128 | 14.5 | 13.9 | 0.0087 | 22.2 |
| 60.00 | 23.9 | 12.5 | 7.0 | 0.0128 | 12.5 | 14.2 | 0.0062 | 17.3 |
| 250.00 | 24.3 | 10.5 | 5.0 | 0.0128 | 10.5 | 14.6 | 0.0031 | 12.4 |
| 1440.00 | 24.3 | 9.0 | 3.5 | 0.0128 | 9.0 | 14.8 | 0.0013 | 8.6 |

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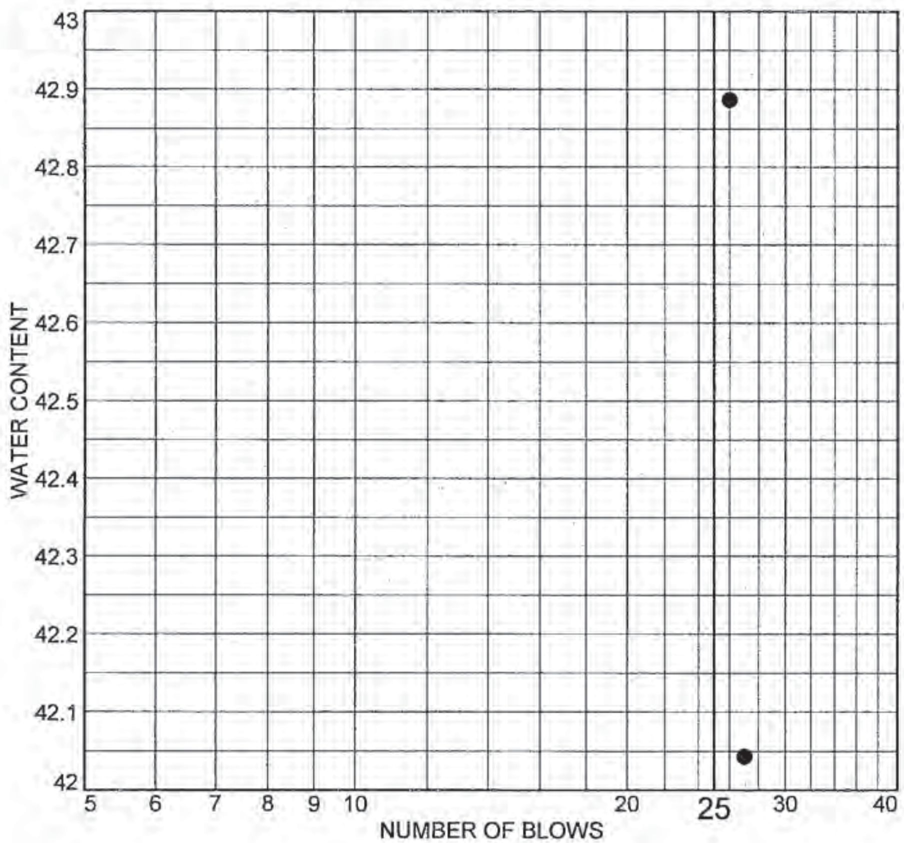
## Fractional Components

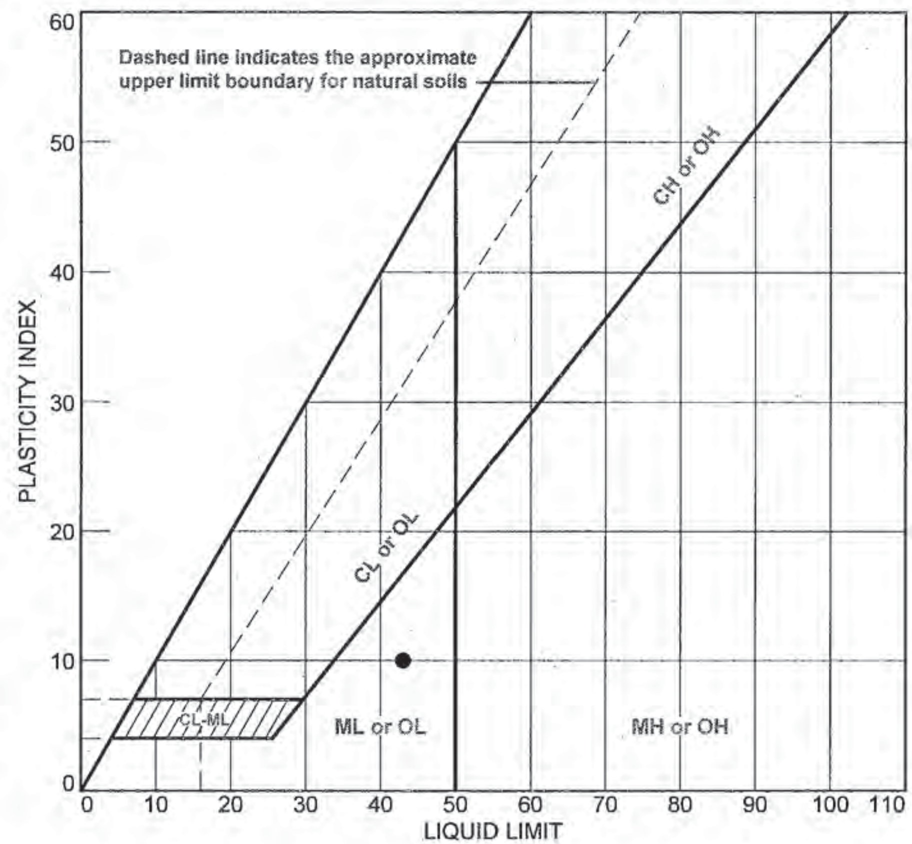
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 27.9 | 27.9 | 2.0 | 1.8 | 15.5 | 19.3 | 37.9 | 14.9 | 52.8 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| 0.0018 | 0.0051 | 0.0075 | 0.0338 | 0.0671 | 0.1124 | 12.5010 | 14.2046 | 15.7813 | 17.3711 |

| Fineness Modulus | $C_u$ | $C_c$ |
|---|---|---|
| 2.13 | 64.03 | 5.80 |

# LIQUID AND PLASTIC LIMITS TEST REPORT (ASTM D4318-05)




| | SOURCE | SAMPLE # | DEPTH/ELEV. | DATE SAMPLED | USCS | MATERIAL DESCRIPTION | NM % | LL | PI |
|---|---|---|---|---|---|---|---|---|---|
| ● | Z-SDU6-B04 | SS26 | 98-100 ft | N/A | ML | Tan Gravelly Silt with Sand | 42.0 | 43 | 10 |

Client SRNS

Project Saltstone Disposal Unit 6

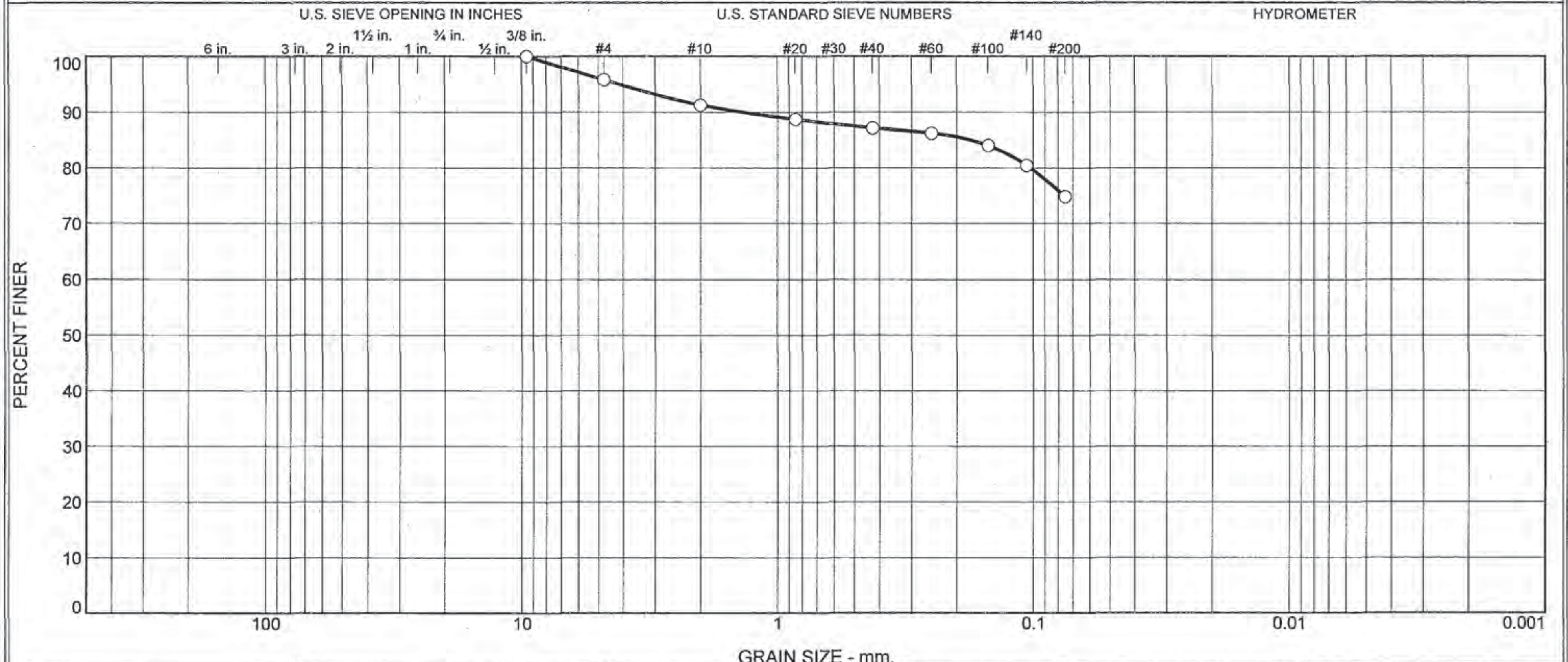
Project No. 6155-08-0031.28 Figure

amec

● 11365

**Tested By:** EH **Checked By:** JW

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 4.2 | 4.6 | 4.1 | 12.3 | 74.8 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B04 | SS27 | 103-105 ft | N/A | | Tan Sandy Silt | 49.6 | | |

Client SRNS
Project Saltstone Disposal Unit 6
Project No. 6155-08-0031.28 Figure

○ 11366

**Tested By:** EH **Checked By:** JW

# GRAIN SIZE DISTRIBUTION TEST DATA

2/6/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B04
**Depth:** 103-105 ft
**Sample Number:** SS27
**Material Description:** Tan Sandy Silt
**Date:** N/A
**Natural Moisture:** 49.6
**Testing Remarks:** 11366
**Tested by:** EH
**Checked by:** JW

## Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 68.95 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | 0.00 | 100.0 |
| | | | #4 | 2.91 | 95.8 |
| | | | #10 | 6.04 | 91.2 |
| | | | #20 | 7.80 | 88.7 |
| | | | #40 | 8.87 | 87.1 |
| | | | #60 | 9.52 | 86.2 |
| | | | #100 | 11.01 | 84.0 |
| | | | #140 | 13.51 | 80.4 |
| | | | #200 | 17.37 | 74.8 |

## Fractional Components

| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 4.2 | 4.2 | 4.6 | 4.1 | 12.3 | 21.0 | | | 74.8 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 0.1030 | 0.1756 | 1.4010 | 4.1623 |

| Fineness Modulus |
|---|
| 0.64 |

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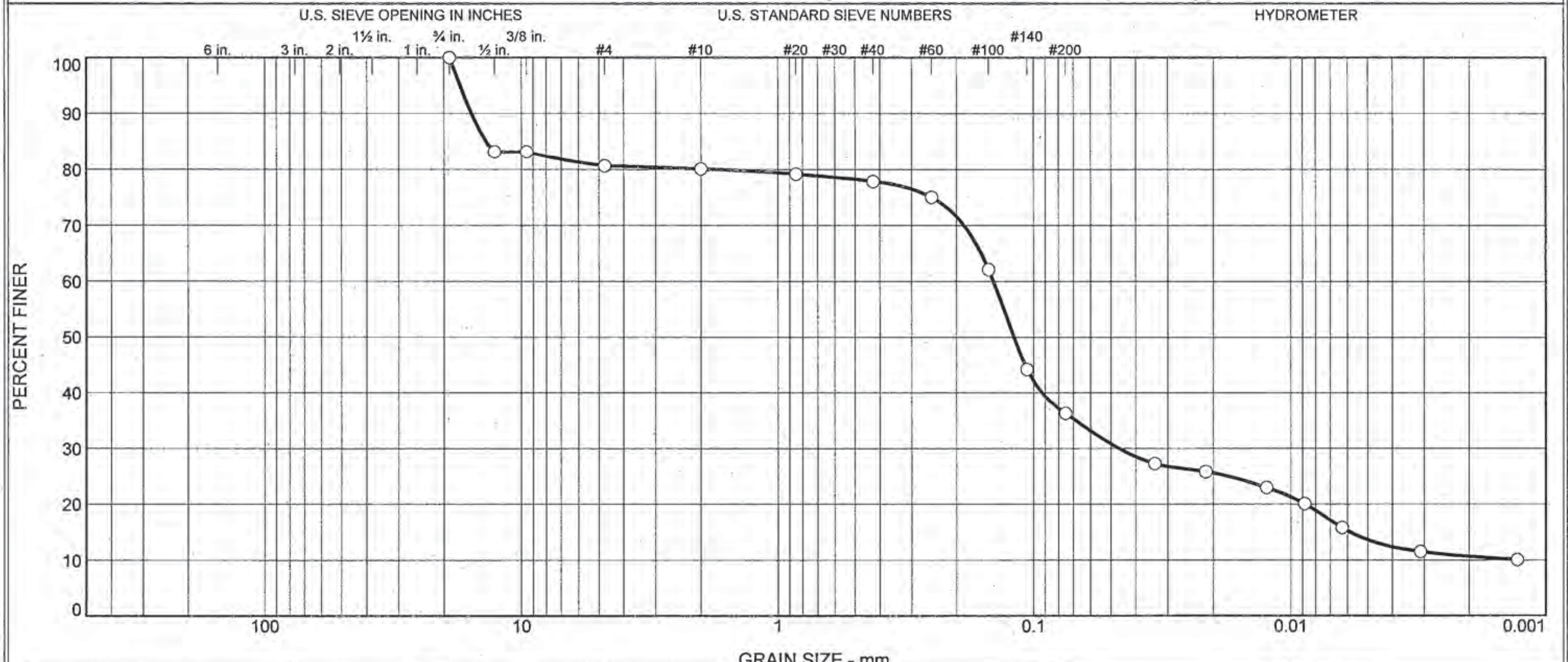
# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| O | 0.0 | 0.0 | 19.4 | 0.6 | 2.2 | 41.5 | 22.7 | 13.6 |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| O | Z-SDU6-B04 | SS28 | 108-110 ft | N/A | SC | Gray Clayey Sand with Gravel | 27.2 | 32 | 22 |

Client SRNS

Project Saltstone Disposal Unit 6

Project No. 6155-08-0031.28 Figure

amec

O 11367

**Tested By:** EH **Checked By:** JW

## GRAIN SIZE DISTRIBUTION TEST DATA

2/6/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B04
**Depth:** 108-110 ft **Sample Number:** SS28
**Material Description:** Gray Clayey Sand with Gravel
**Date:** N/A **Natural Moisture:** 27.2
**Liquid Limit:** 32 **Plastic Limit:** 22 **USCS Class.:** SC
**Testing Remarks:** 11367
**Tested by:** EH **Checked by:** JW

### Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 34.48 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | 0.00 | 100.0 |
| | | | .5" | 5.81 | 83.1 |
| | | | .375" | 5.81 | 83.1 |
| | | | #4 | 6.69 | 80.6 |
| | | | #10 | 6.89 | 80.0 |
| | | | #20 | 7.21 | 79.1 |
| | | | #40 | 7.65 | 77.8 |
| | | | #60 | 8.63 | 75.0 |
| | | | #100 | 13.08 | 62.1 |
| | | | #140 | 19.23 | 44.2 |
| | | | #200 | 21.97 | 36.3 |

### Hydrometer Test Data

**Hydrometer test uses material passing** #200
**Percent passing #200 based upon complete sample =** 36.3
**Weight of hydrometer sample =**12.51
**Table of composite correction values:**

| Temp., deg. C: | 17.6 | 19.1 | 20.9 | 21.8 | 23.9 |
|---|---|---|---|---|---|
| Comp. corr.: | -7.0 | -6.5 | -6.2 | -6.0 | -5.5 |

**Meniscus correction only =** 0.0
**Specific gravity of solids =** 2.7
**Hydrometer type =** 152H
**Hydrometer effective depth equation: L =** 16.294964 - 0.164 **x Rm**

| Elapsed Time (min.) | Temp. (deg. C.) | Actual Reading | Corrected Reading | K | Rm | Eff. Depth | Diameter (mm.) | Percent Finer |
|---|---|---|---|---|---|---|---|---|
| 2.00 | 23.9 | 15.0 | 9.5 | 0.0128 | 15.0 | 13.8 | 0.0337 | 27.2 |
| 5.00 | 23.9 | 14.5 | 9.0 | 0.0128 | 14.5 | 13.9 | 0.0214 | 25.8 |
| 15.00 | 23.9 | 13.5 | 8.0 | 0.0128 | 13.5 | 14.1 | 0.0124 | 22.9 |
| 30.00 | 23.9 | 12.5 | 7.0 | 0.0128 | 12.5 | 14.2 | 0.0088 | 20.1 |
| 60.00 | 23.9 | 11.0 | 5.5 | 0.0128 | 11.0 | 14.5 | 0.0063 | 15.8 |
| 250.00 | 24.3 | 9.5 | 4.0 | 0.0128 | 9.5 | 14.7 | 0.0031 | 11.5 |
| 1440.00 | 24.3 | 9.0 | 3.5 | 0.0128 | 9.0 | 14.8 | 0.0013 | 10.0 |

AMEC

## Fractional Components

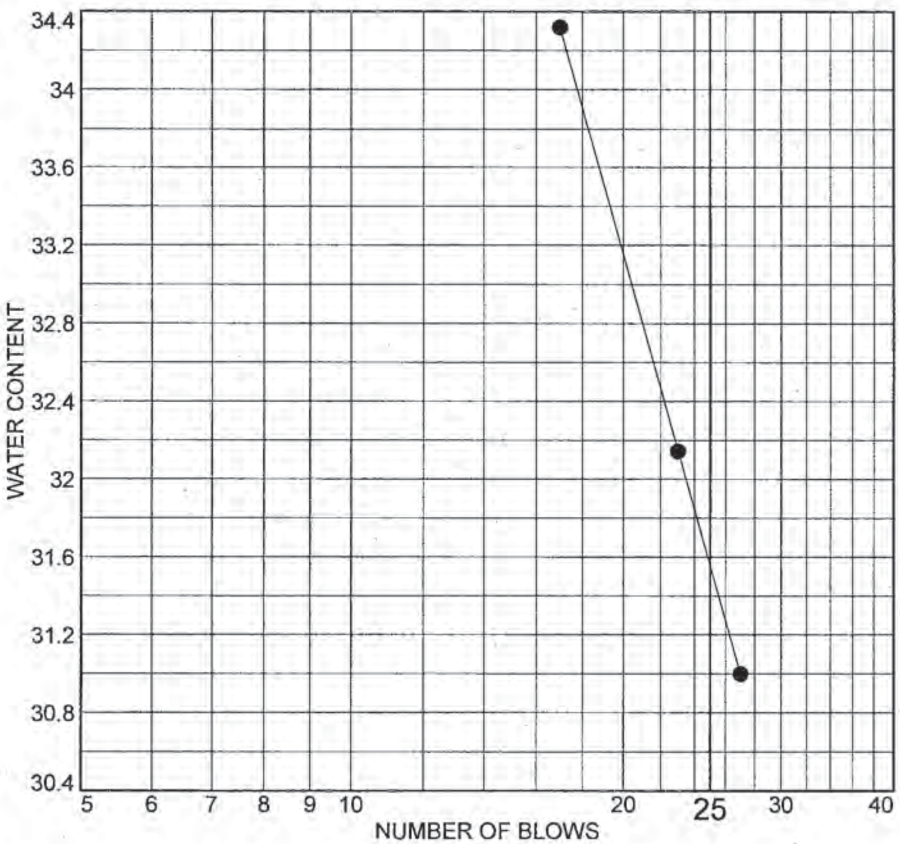
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 19.4 | 19.4 | 0.6 | 2.2 | 41.5 | 44.3 | 22.7 | 13.6 | 36.3 |

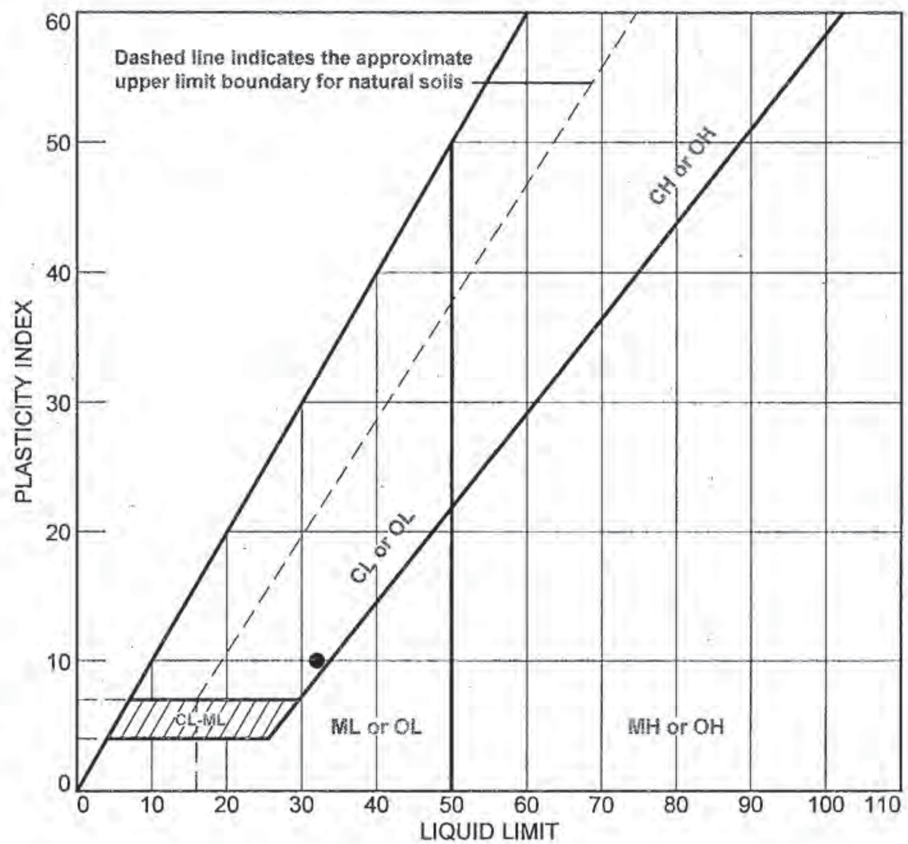
| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | 0.0059 | 0.0088 | 0.0465 | 0.1196 | 0.1438 | 1.9494 | 13.7604 | 15.6820 | 17.3554 |

| Fineness Modulus |
|---|
| 1.60 |

AMEC

# LIQUID AND PLASTIC LIMITS TEST REPORT (ASTM D4318-05)




| | SOURCE | SAMPLE # | DEPTH/ELEV. | DATE SAMPLED | USCS | MATERIAL DESCRIPTION | NM % | LL | PI |
|---|---|---|---|---|---|---|---|---|---|
| ● | Z-SDU6-B04 | SS28 | 108-110 ft | N/A | SC | Gray Clayey Sand with Gravel | 27.2 | 32 | 10 |

Client SRNS

Project Saltstone Disposal Unit 6

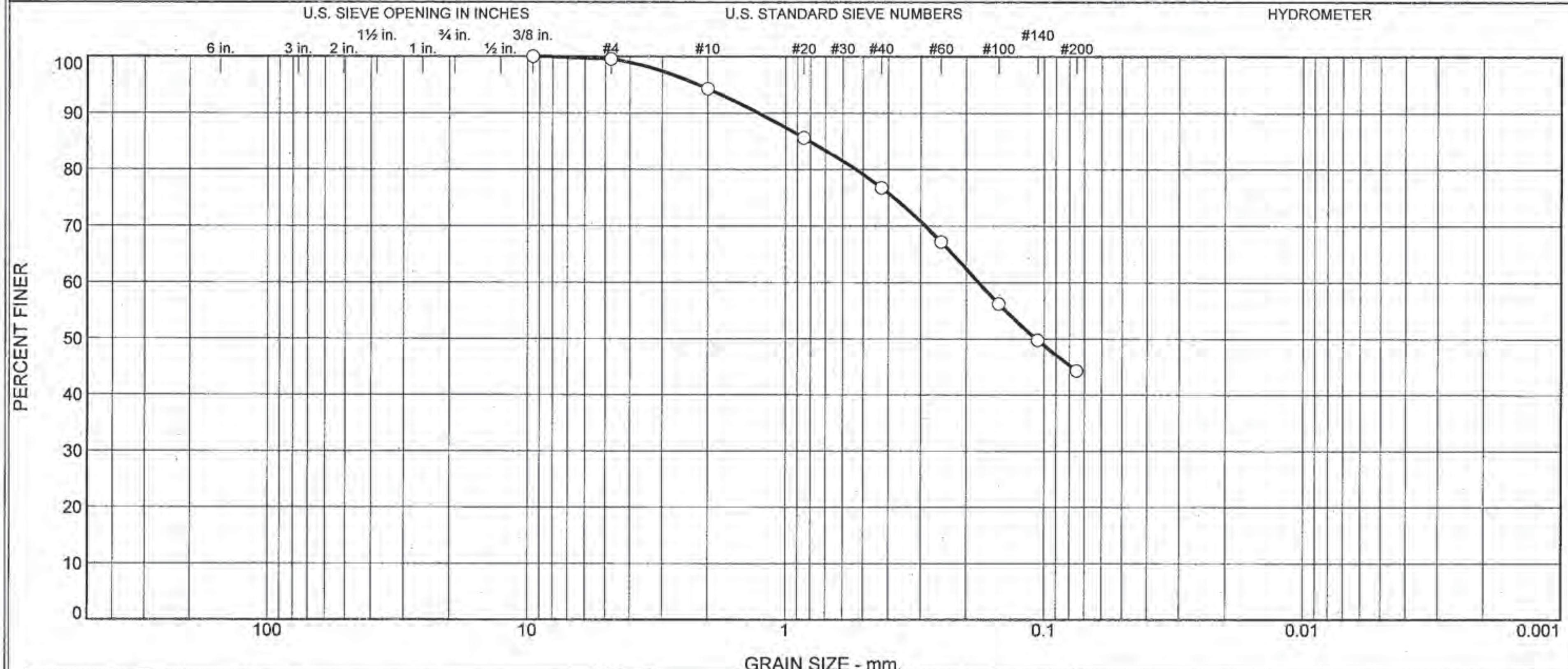
Project No. 6155-08-0031.28 Figure

amec

● 11367

**Tested By:** EH **Checked By:** JW

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.5 | 5.2 | 17.6 | 32.4 | 44.3 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B04 | SS29 | 113-115 ft | N/A | | Gray Silty Sand | 30.7 | | |

Client SRNS
Project Saltstone Disposal Unit 6
Project No. 6155-08-0031.28
Figure

amec

○ 11368

**Tested By:** EH **Checked By:** JW

# GRAIN SIZE DISTRIBUTION TEST DATA

2/6/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B04
**Depth:** 113-115 ft
**Sample Number:** SS29
**Material Description:** Gray Silty Sand
**Date:** N/A
**Natural Moisture:** 30.7
**Testing Remarks:** 11368
**Tested by:** EH
**Checked by:** JW

## Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 91.08 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | 0.00 | 100.0 |
| | | | #4 | 0.42 | 99.5 |
| | | | #10 | 5.19 | 94.3 |
| | | | #20 | 13.11 | 85.6 |
| | | | #40 | 21.22 | 76.7 |
| | | | #60 | 29.90 | 67.2 |
| | | | #100 | 39.90 | 56.2 |
| | | | #140 | 45.74 | 49.8 |
| | | | #200 | 50.72 | 44.3 |

## Fractional Components

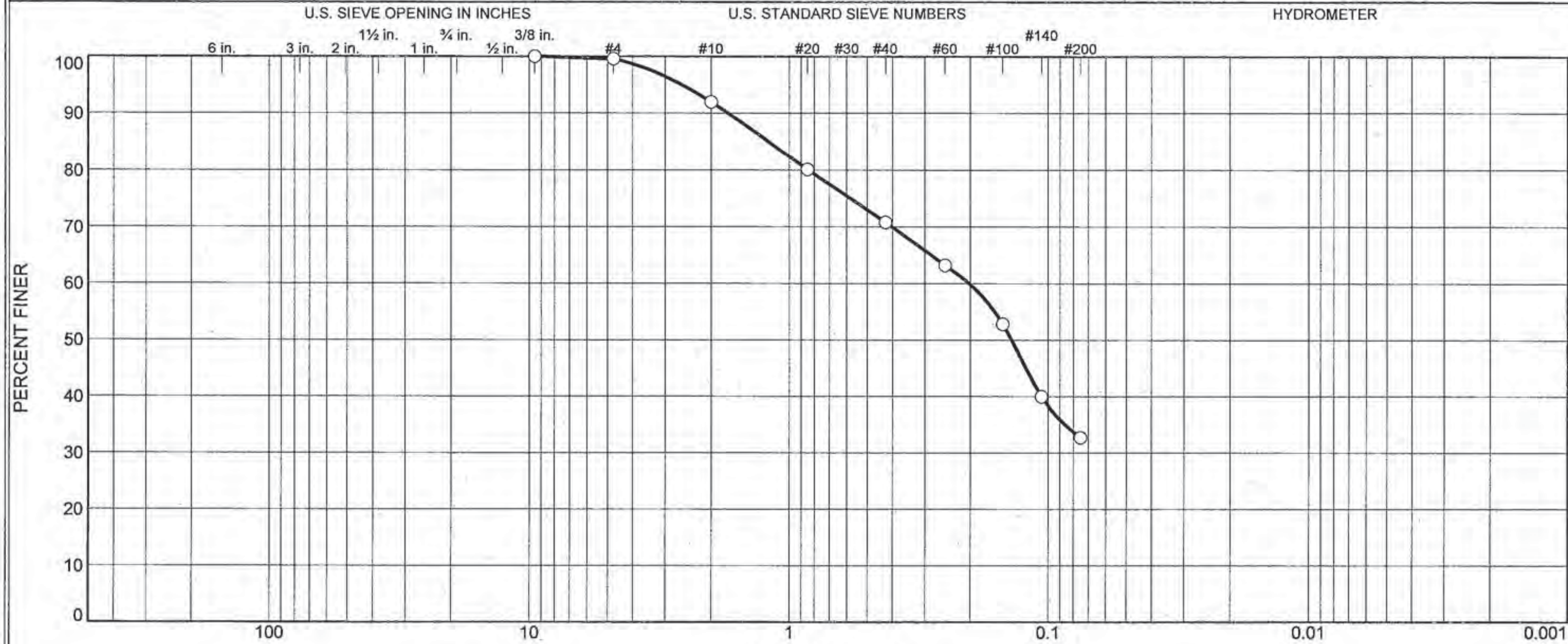
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.5 | 0.5 | 5.2 | 17.6 | 32.4 | 55.2 | | | 44.3 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | | | | 0.1074 | 0.1795 | 0.5354 | 0.8058 | 1.2740 | 2.1721 |

| Fineness Modulus |
|---|
| 1.07 |

AMEC

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.5 | 7.6 | 21.1 | 38.1 | 32.7 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B04 | SS30 | 118-120 ft | N/A | | Gray Silty Sand | 24.1 | | |

Client SRNS

Project Saltstone Disposal Unit 6

Project No. 6155-08-0031.28 Figure

amec

○ 11369

**Tested By:** EH **Checked By:** JW

RCN: SRS200 Page 203 of 217

## GRAIN SIZE DISTRIBUTION TEST DATA

2/6/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B04
**Depth:** 118-120 ft **Sample Number:** SS30
**Material Description:** Gray Silty Sand
**Date:** N/A **Natural Moisture:** 24.1
**Testing Remarks:** 11369
**Tested by:** EH **Checked by:** JW

### Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 98.92 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | 0.00 | 100.0 |
| | | | #4 | 0.45 | 99.5 |
| | | | #10 | 7.99 | 91.9 |
| | | | #20 | 19.70 | 80.1 |
| | | | #40 | 28.92 | 70.8 |
| | | | #60 | 36.46 | 63.1 |
| | | | #100 | 46.69 | 52.8 |
| | | | #140 | 59.36 | 40.0 |
| | | | #200 | 66.59 | 32.7 |

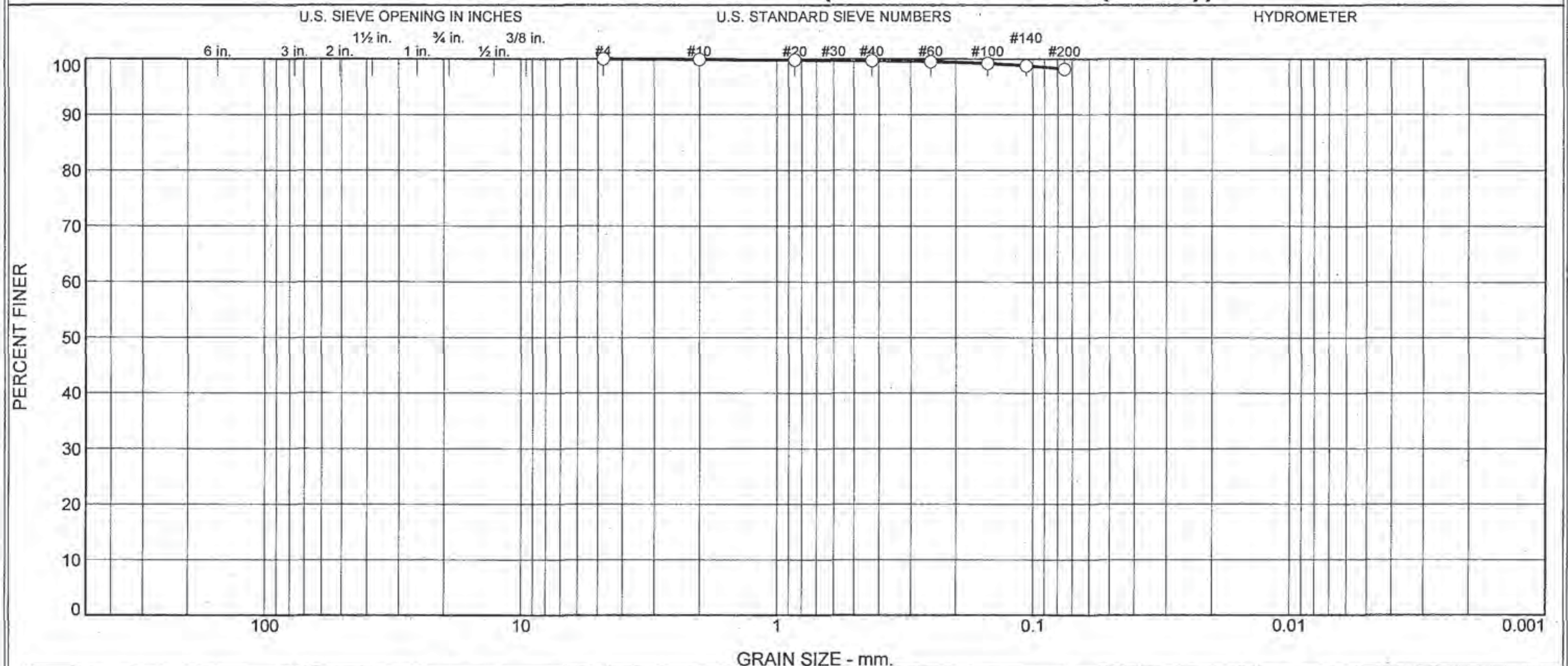
### Fractional Components

| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.5 | 0.5 | 7.6 | 21.1 | 38.1 | 66.8 | | | 32.7 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | | | | 0.1387 | 0.2028 | 0.8448 | 1.2041 | 1.7247 | 2.6034 |

| Fineness Modulus |
|---|
| 1.28 |

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 1.5 | 98.2 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B04 | SS31 | 123-125 ft | N/A | MH | Gray Elastic Silt | 50.1 | 110 | 51 |

Client SRNS
Project Saltstone Disposal Unit 6
Project No. 6155-08-0031.28 Figure

○ 11370

**Tested By:** EH **Checked By:** JW

# GRAIN SIZE DISTRIBUTION TEST DATA

2/9/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B04
**Depth:** 123-125 ft **Sample Number:** SS31
**Material Description:** Gray Elastic Silt
**Date:** N/A **Natural Moisture:** 50.1
**Liquid Limit:** 110 **Plastic Limit:** 51 **USCS Class.:** MH
**Testing Remarks:** 11370
**Tested by:** EH **Checked by:** JW

## Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 68.83 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | | |
| | | | #4 | 0.00 | 100.0 |
| | | | #10 | 0.07 | 99.9 |
| | | | #20 | 0.15 | 99.8 |
| | | | #40 | 0.24 | 99.7 |
| | | | #60 | 0.35 | 99.5 |
| | | | #100 | 0.57 | 99.2 |
| | | | #140 | 0.84 | 98.8 |
| | | | #200 | 1.25 | 98.2 |

## Fractional Components

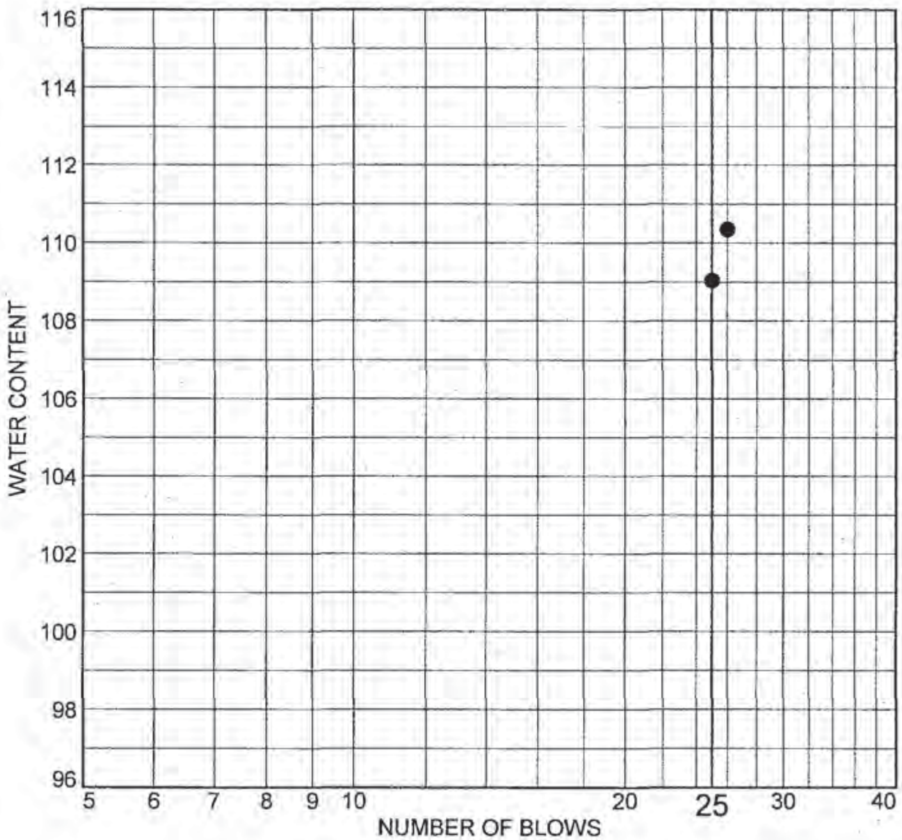
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 1.5 | 1.8 | | | 98.2 |

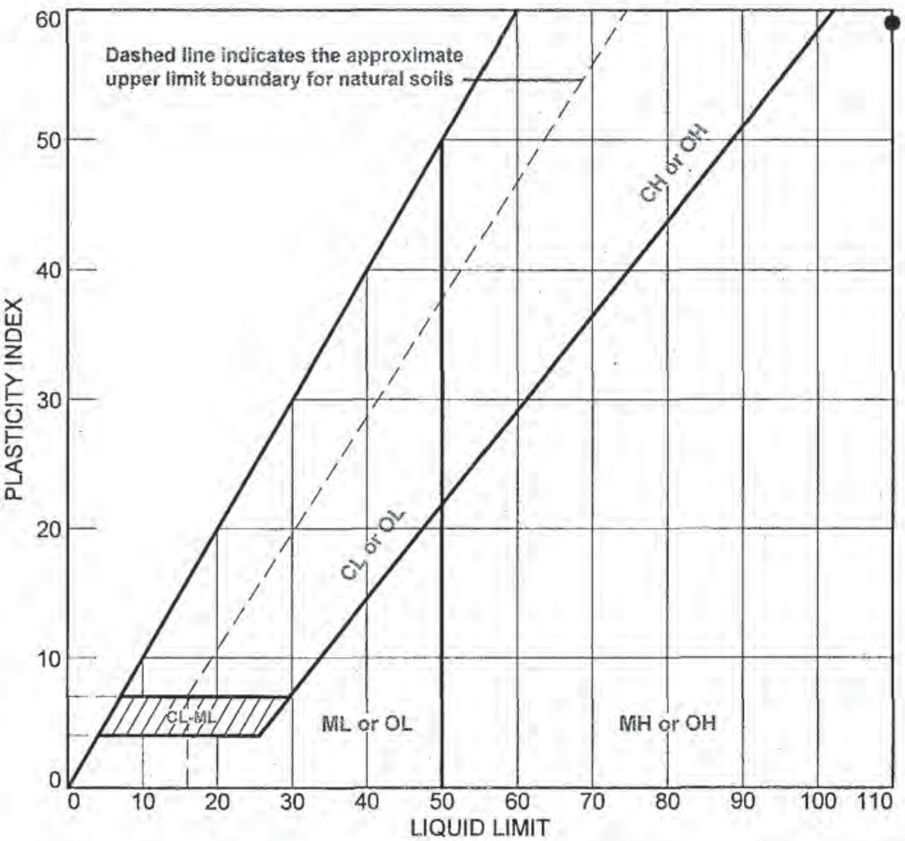
| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |

| Fineness Modulus |
|---|
| 0.02 |

AMEC

# LIQUID AND PLASTIC LIMITS TEST REPORT (ASTM D4318-05)




| | SOURCE | SAMPLE # | DEPTH/ELEV. | DATE SAMPLED | USCS | MATERIAL DESCRIPTION | NM % | LL | PI |
|---|---|---|---|---|---|---|---|---|---|
| ● | Z-SDU6-B04 | SS31 | 123-125 ft | N/A | MH | Gray Elastic Silt | 50.1 | 110 | 59 |

Client SRNS

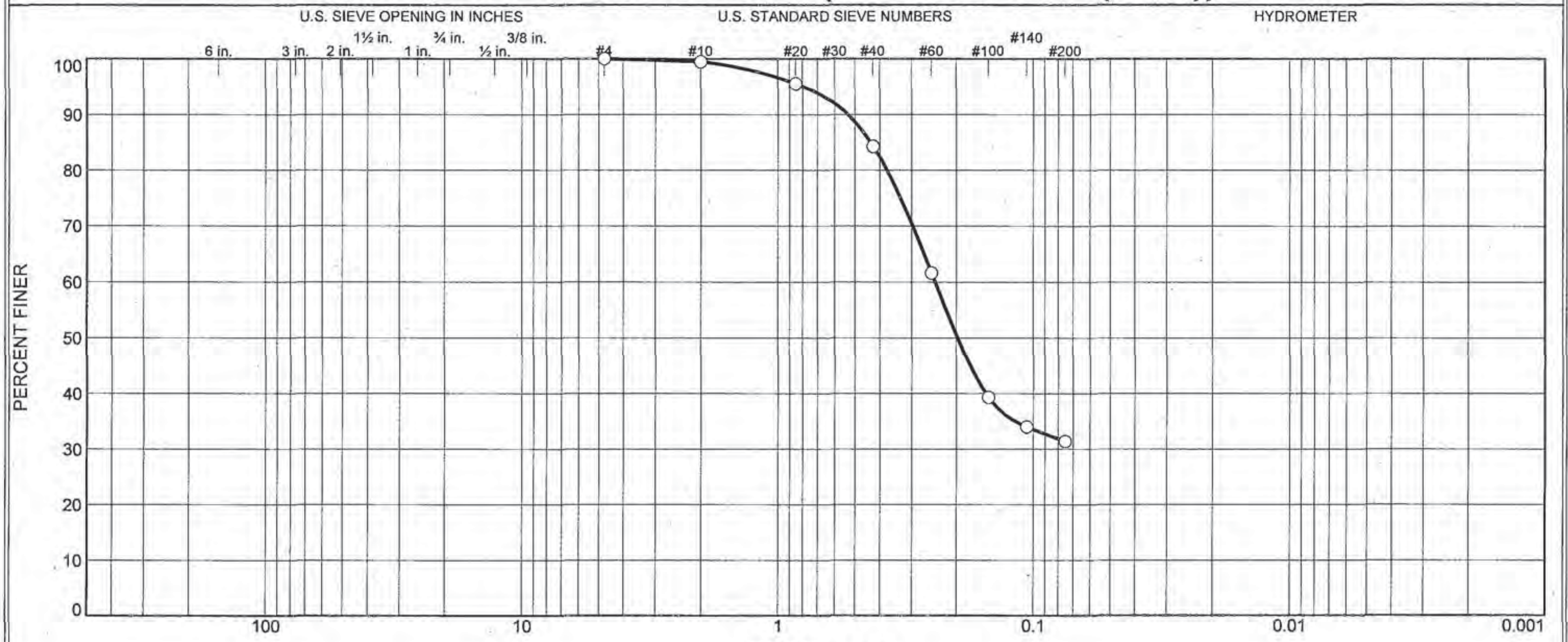
Project Saltstone Disposal Unit 6

Project No. 6155-08-0031.28 Figure

● 11370

Tested By: EH Checked By: JW

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.6 | 15.1 | 52.9 | 31.4 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B04 | SS32 | 128-130 ft | N/A | | Dark Gray Silty Sand | 20.3 | | |

Client SRNS

Project Saltstone Disposal Unit 6

Project No. 6155-08-0031.28 Figure

amec

○ 11371

**Tested By:** EH **Checked By:** JW

# GRAIN SIZE DISTRIBUTION TEST DATA

2/6/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B04
**Depth:** 128-130 ft
**Sample Number:** SS32
**Material Description:** Dark Gray Silty Sand
**Date:** N/A
**Natural Moisture:** 20.3
**Testing Remarks:** 11371
**Tested by:** EH
**Checked by:** JW

## Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 102.15 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | | |
| | | | #4 | 0.00 | 100.0 |
| | | | #10 | 0.58 | 99.4 |
| | | | #20 | 4.59 | 95.5 |
| | | | #40 | 16.00 | 84.3 |
| | | | #60 | 39.27 | 61.6 |
| | | | #100 | 61.98 | 39.3 |
| | | | #140 | 67.41 | 34.0 |
| | | | #200 | 70.11 | 31.4 |

## Fractional Components

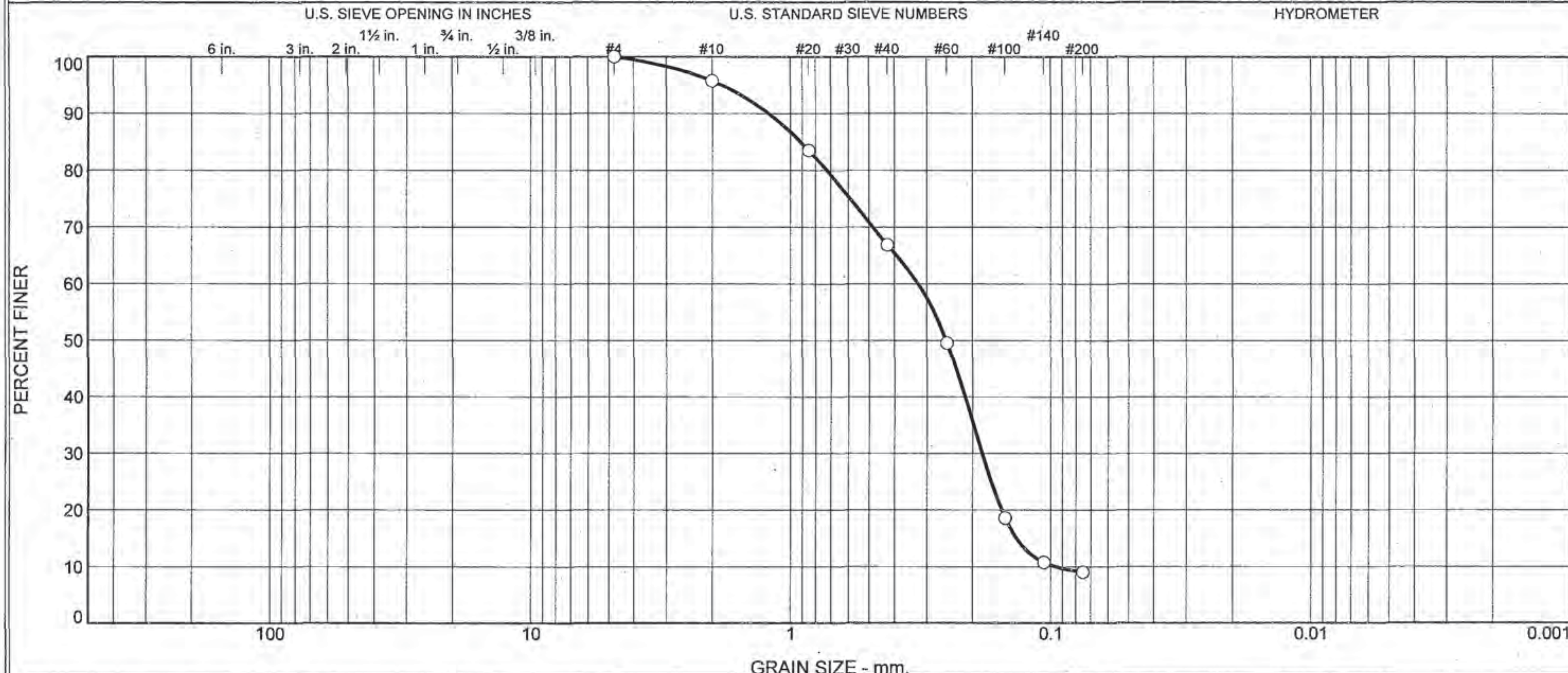
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.6 | 15.1 | 52.9 | 68.6 | | | 31.4 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | | | | 0.1980 | 0.2424 | 0.3751 | 0.4344 | 0.5340 | 0.7956 |

| Fineness Modulus |
|---|
| 1.01 |

AMEC

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 4.3 | 28.9 | 57.8 | 9.0 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B04 | SS33 | 133-135 ft | N/A | | Gray Poorly Graded Sand with Silt | 19.0 | | |

Client SRNS

Project Saltstone Disposal Unit 6

Project No. 6155-08-0031.28 Figure

amec

○ 11372

**Tested By:** EH **Checked By:** JW

## GRAIN SIZE DISTRIBUTION TEST DATA

2/6/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B04
**Depth:** 133-135 ft **Sample Number:** SS33
**Material Description:** Gray Poorly Graded Sand with Silt
**Date:** N/A **Natural Moisture:** 19.0
**Testing Remarks:** 11372
**Tested by:** EH **Checked by:** JW

### Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 105.84 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | | |
| | | | #4 | 0.00 | 100.0 |
| | | | #10 | 4.51 | 95.7 |
| | | | #20 | 17.45 | 83.5 |
| | | | #40 | 35.09 | 66.8 |
| | | | #60 | 53.41 | 49.5 |
| | | | #100 | 86.19 | 18.6 |
| | | | #140 | 94.46 | 10.8 |
| | | | #200 | 96.31 | 9.0 |

### Fractional Components

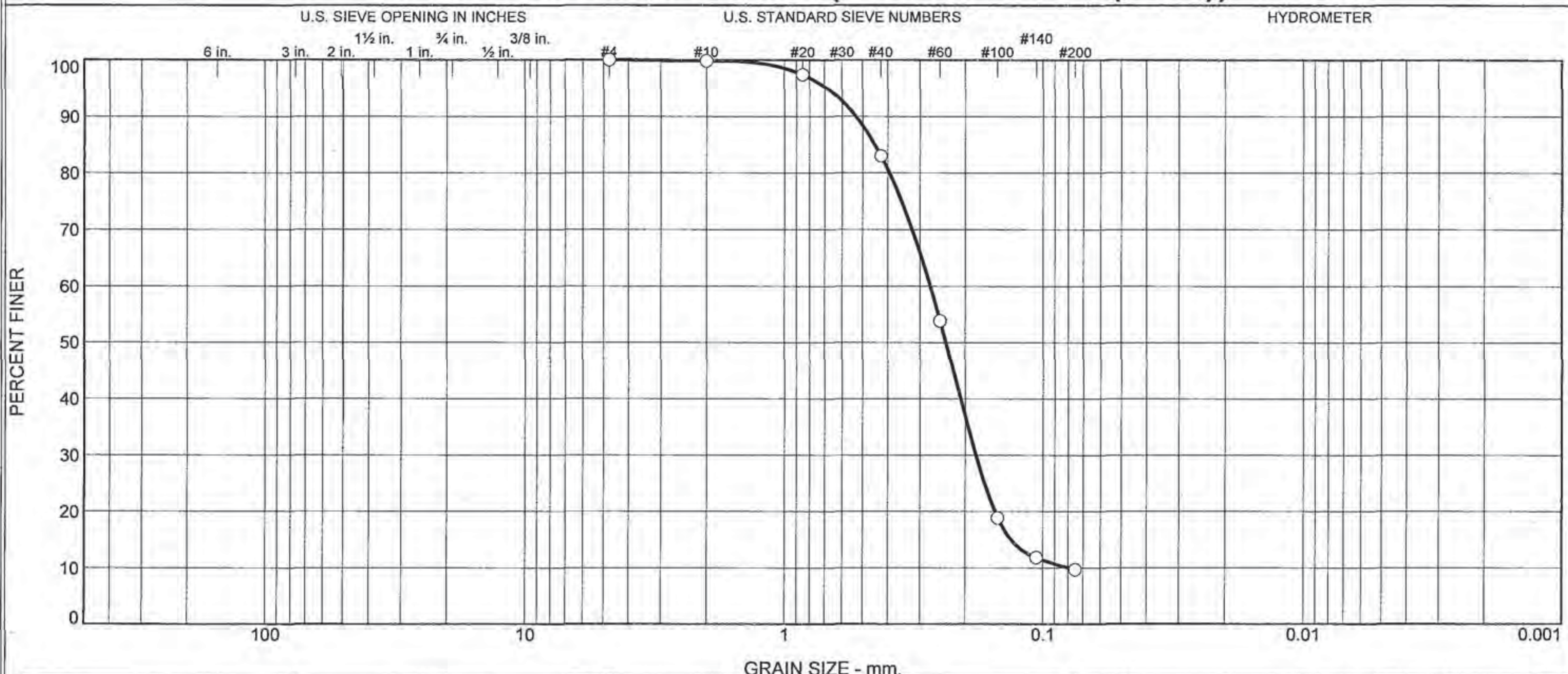
| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.0 | 0.0 | 4.3 | 28.9 | 57.8 | 91.0 | | | 9.0 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| 0.0959 | 0.1358 | 0.1548 | 0.1839 | 0.2522 | 0.3241 | 0.7265 | 0.9140 | 1.2179 | 1.8396 |

| Fineness Modulus | $C_u$ | $C_c$ |
|---|---|---|
| 1.62 | 3.38 | 1.09 |

AMEC

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 0.2 | 16.8 | 73.3 | 9.7 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B04 | SS34 | 138-140 ft | N/A | | Gray Poorly Graded Sand with Silt | 19.5 | | |

Client SRNS

Project Saltstone Disposal Unit 6

Project No. 6155-08-0031.28 Figure

amec

○ 11373

**Tested By:** EH **Checked By:** JW

# GRAIN SIZE DISTRIBUTION TEST DATA

2/6/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B04
**Depth:** 138-140 ft
**Sample Number:** SS34
**Material Description:** Gray Poorly Graded Sand with Silt
**Date:** N/A
**Natural Moisture:** 19.5
**Testing Remarks:** 11373
**Tested by:** EH
**Checked by:** JW

## Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 65.95 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | | |
| | | | #4 | 0.00 | 100.0 |
| | | | #10 | 0.12 | 99.8 |
| | | | #20 | 1.74 | 97.4 |
| | | | #40 | 11.21 | 83.0 |
| | | | #60 | 30.46 | 53.8 |
| | | | #100 | 53.51 | 18.9 |
| | | | #140 | 58.17 | 11.8 |
| | | | #200 | 59.57 | 9.7 |

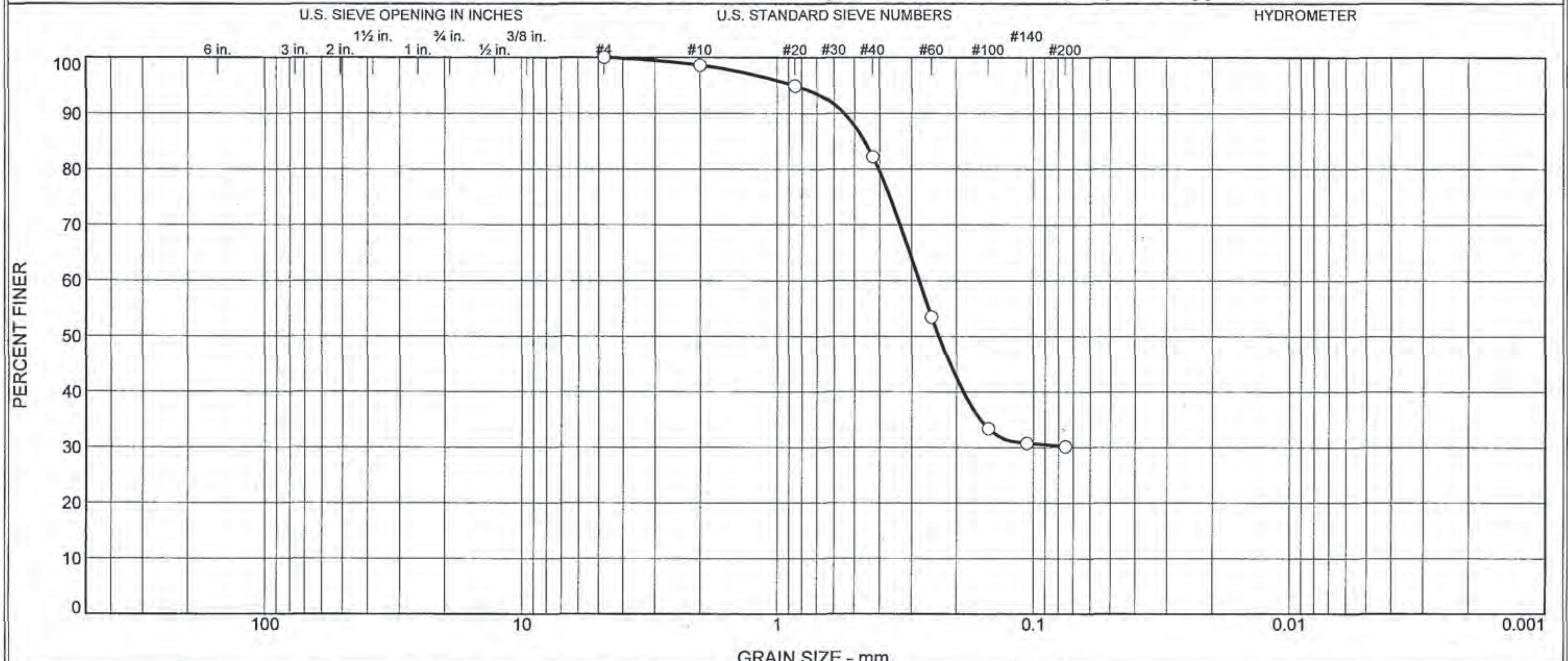
## Fractional Components

| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 16.8 | 73.3 | 90.3 | | | 9.7 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| 0.0798 | 0.1334 | 0.1538 | 0.1821 | 0.2375 | 0.2732 | 0.3944 | 0.4492 | 0.5321 | 0.6890 |

| Fineness Modulus | $C_u$ | $C_c$ |
|---|---|---|
| 1.23 | 3.43 | 1.52 |

# Particale Size Distribution (ASTM D422-63 (2007))




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 0.0 | 1.4 | 16.4 | 52.0 | 30.2 | |

| | Source | Sample # | Depth/Elev. | Date Sampled | USCS | Material Description | NM % | LL | PL |
|---|---|---|---|---|---|---|---|---|---|
| ○ | Z-SDU6-B02B | PFT03 | 75-77 ft | N/A | | Brown Clayey Sand | 32.2 | | |

Client SRNS
Project Saltstone Disposal Unit 6
Project No. 6155-08-0031.28 Figure

amec

○ 11374

**Tested By:** EH **Checked By:** JW

# GRAIN SIZE DISTRIBUTION TEST DATA

2/7/2012

**Client:** SRNS
**Project:** Saltstone Disposal Unit 6
**Project Number:** 6155-08-0031.28
**Location:** Z-SDU6-B02B
**Depth:** 75-77 ft
**Sample Number:** PFT03
**Material Description:** Brown Clayey Sand
**Date:** N/A
**Natural Moisture:** 32.2
**Testing Remarks:** 11374
**Tested by:** EH
**Checked by:** JW

## Sieve Test Data

| Dry Sample and Tare (grams) | Tare (grams) | Cumulative Pan Tare Weight (grams) | Sieve Opening Size | Cumulative Weight Retained (grams) | Percent Finer |
|---|---|---|---|---|---|
| 76.66 | 0.00 | 0.00 | 3.0" | | |
| | | | 2.5" | | |
| | | | 2.0" | | |
| | | | 1.5" | | |
| | | | 1.0" | | |
| | | | .75" | | |
| | | | .5" | | |
| | | | .375" | | |
| | | | #4 | 0.00 | 100.0 |
| | | | #10 | 1.08 | 98.6 |
| | | | #20 | 3.90 | 94.9 |
| | | | #40 | 13.62 | 82.2 |
| | | | #60 | 35.67 | 53.5 |
| | | | #100 | 51.10 | 33.3 |
| | | | #140 | 53.09 | 30.7 |
| | | | #200 | 53.54 | 30.2 |

## Fractional Components

| Cobbles | Gravel | | | Sand | | | | Fines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Total | Coarse | Medium | Fine | Total | Silt | Clay | Total |
| 0.0 | 0.0 | 0.0 | 0.0 | 1.4 | 16.4 | 52.0 | 69.8 | | | 30.2 |

| $D_{10}$ | $D_{15}$ | $D_{20}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $D_{80}$ | $D_{85}$ | $D_{90}$ | $D_{95}$ |
|---|---|---|---|---|---|---|---|---|---|
| | | | | 0.2343 | 0.2803 | 0.4037 | 0.4575 | 0.5502 | 0.8623 |

| Fineness Modulus |
|---|
| 1.15 |

AMEC

# ATTACHMENT 2

# Equipment List
## SRNS Delivery Order No. 28
## Subcontract No. AC54317N

| Equipment Name | Laboratory ID |
|---|---|
| Oven | 144 |
| Balance | 416/418 |
| Thermometer | 2866 |
| Caliper | 2424 |
| Triaxial Systems | 2581/2582/2583/2547/2546/2545 |
| Triaxial Systems | 2575/2577 |
| Pressure Transducers | 2536/2909 |
| Sieve Shake | 3175 |
| Sieves | 1150/568/1990/1187/1181 |
| Sieves | 2743/1917/2559 |
| Hydrometer | 2151 |
| Liquid Limit Device | 1188 |
| Grooving Tool | 3173 |