FINAL Geotechnical Engineering Report ...

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RAHWAY ARCH PROPERTY

Carteret, New Jersey

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1.0 INTRODUCTION

In accordance with our proposal, Baker has completed the Subsurface Exploration and Geotechnical Evaluation for the proposed Rahway Arch project, located in Carteret, New Jersey (Figure A-1).

The purpose of this study was to determine general subsurface conditions at the project site and to evaluate those conditions with respect to geotechnical engineering considerations for the proposed construction. The specific scope of our services on this project consisted of the following.

- Drilling and Fieldwork, consisting of 31 auger borings and ten (10) cone penetrometer test with pore pressure measurements (CPTu) borings.
- Laboratory testing consisting of water content, Atterberg limits, and grain-size distribution, USCS textural classification, specific gravity, pH, organic content, permeability, consolidation analyses, unconsolidated-undrained triaxial tests, and consolidated-undrained (CIU) triaxial tests.
- A review and description of the field and laboratory test procedures conducted and their results;
- A review of area and site geologic conditions, including geological hazards at the site, such as soft soils, swelling soils, sensitive soils, liquefaction, etc.;
- A review of subsurface conditions encountered with available physical properties;
- Potential excavation difficulties;
- Results of slope stability and settlement analyses;
- Recommendations for constructing the embankment/cap;
- Recommendations for a geotechnical monitoring program;
- Recommendations for shallow foundations (Net allowable bearing pressure and applied safety factor, recommended bearing depth, resistance to sliding, resistance to uplift, estimated settlement and modulus of subgrade reaction);
- Recommendations for deep foundations, if necessary;
- Subsurface drainage and potential difficulties with groundwater;
- Seismic site classification and recommendations;
- Site preparation, subgrade preparation, and construction and testing compacted fills;
- Other geotechnical concerns that may affect the planned construction; and
- A review and comment on the final remedial plan design for consistency with the geotechnical recommendations.

2.0 SITE AND PROJECT DESCRIPTION

In this section, details of the areas explored are described based on information available at the time of this report. A conceptual design site plan, indicating the location of the buildings, site boundaries, and associated parking; a topographic survey drawing; and past geotechnical and environmental reports were provided for this report by Soil Safe, Inc. (Soil Safe).

2.1. SITE DESCRIPTION

The Rahway Arch site is located on the banks of the Rahway River in the Borough of Carteret and was used from the 1930s through the 1970s for disposal of a mixture of alum sludge and yellow prussiate of soda (YPS) sludge from the American Cyanamide Warner Plant in Linden, New Jersey. The overall 124.7 acre site contains six impoundments, encompassing approximately 85 acres, located on the Rahway River. The impoundments were constructed above existing grade with wooden and earthen dikes. They contain approximately 2,000,000 tons of the cyanide containing alum-YPS sludge. The thickness of the sludge ranges from 5 to 20 feet.

The majority of the site is lightly vegetated with cattails and similar vegetation, with a relatively flat topography. The site is bounded to the northwest, north, northeast, and east by the Rahway River. To the west is marshland and to the south and southeast are tank farms. Site elevations vary between +13 ft above mean sea level (amsl) on the north portion of the property to sea level along the wetlands bordering the site.

2.2. PROJECT DESCRIPTION

The owner has entered into an agreement with Soil Safe to be the reclamation contractor and construct a cap over the impoundments. Soil Safe will be constructing a Class B soil recycling facility on Impoundment 2 to manufacture the engineered fill required for the cap. Impoundment 2 will be capped at the end of the project; after all other impoundments have been capped. The thickness of the soil cap will be determined, in part, from the study contemplated herein. In addition, the Soil Safe process will require the use of large temporary soil stockpiles for both pre-process and post-process soil material. For the purpose of this investigation, Baker will assume soil placement thicknesses in the range of five (5) to thirty (30) feet for the cap and possibly an additional twenty-five (25) feet for the soil stockpiles. Based upon historic data, the subsurface profile consists of surface fill, alum-YPS sludge, peat, organic silts and

clays, and alluvial sand and glacial deposits (clay, silt, sand, and gravel) overlying red-brown siltstone and shale.

In order to construct this cap, the shear strength and compressibility of the underlying materials must be determined. This includes the time-dependent stress behavior of the underlying materials in order to formulate a time sequenced soil placement plan to safely construct the soil cap. Specific objectives include:

- characterizing the subsurface conditions in the impoundments, berms and the adjacent wetlands outside the berms;
- determining the stability of the berms for the existing conditions and placement of an engineered fill cap over the impoundments;
- evaluating the geotechnical conditions in the proposed areas for the Class B facility, the scale and the steel bridge that allows access of the site;
- evaluating stability of the impoundments to support the engineered fill cap;
- performing slope stability analyses to ensure that adequate factors of safety can be maintained in the final cap design;
- estimating the settlement that will occur in the impoundments;
- determination of the effective vertical overburden pressure by area and related time rate of consolidation allowable to safely place the soil cap and temporary stockpiles;
- develop construction options for handling excessive settlement and slope stability issues; and
- develop a geotechnical monitoring program to be implemented during construction (along with contingency options for excessive settlement and slope stability issues).

3.0 GEOLOGIC SETTING

3.1. SITE GEOLOGY

Based upon the Surficial Geology Map of the Perth Amboy and Arthur Kill Quadrangles (Stanford, 1999) and the Geologic Map of New Jersey (Drake, etal, 1996), the proposed development will be sited primarily over a relatively thin layer of surficial unconsolidated deposits and bedrock below that. Surficial unconsolidated materials in the Perth Amboy and Arthur Kill quadrangles consist of glacial, stream, wetland, and weathered bedrock sediment. The glacial sediment is not found at the Rahway site. The stream sediment, as much as 40 feet thick, includes sand, gravel, and silt deposited in floodplains, stream terraces, and former river plains. The wetland sediment includes peat and organic silt and clay deposited in freshwater swamps and saltwater marshes and estuaries. It is as much as 100 feet thick. The weathered bedrock consists of silty clay and shale fragments formed by chemical and mechanical decomposition of shale bedrock of Triassic and Jurassic Age. It is generally less than 10 feet thick. In the area of the Rahway Arch property, the primary surficial unconsolidated deposits are pre-glacial weathered bedrock and postglacial artificial fill and estuarine and salt-marsh deposits. The underlying bedrock is comprised of Passaic and Lockatong Formation sedimentary rock. Specific details of the units found at the site are included below:

Artificial Fill overlying Estuarine and Salt-Marsh Deposits (af/Qm). Artificial fill is made up of excavated sand, silt, clay, gravel, rock, and till, and man-made materials (bricks, cinders, ash, slag, glass, construction materials and minor amounts of trash). Color is variable, but generally gray to black. The unit is as much as 50 feet thick, but is generally less than 20 feet thick. At the Rahway site, the artificial fill is primarily YPS-alum sludge.

Estuarine and Salt-Marsh Deposits (Qm). Brown to dark gray, peat and organic clay and silt, with minor sand and shells. Locally, at the base of this unit, alluvial sand and gravel, deposited before marine inundation, may be present. The thickness of the unit may be as thick as 100 feet.

Weathered Shale (Qsw). Poorly-sorted, nonstratified to weakly stratified, reddish-brown to yellowish-red silty clay to clayey silt with some to many angular to subangular chips of red (and minor gray) shale. Derived from mechanical and chemical decomposition of shale of the Passaic Formation of Triassic and Jurassic Age. The unit is generally less than 10 feet thick.

Passaic Formation (JTrp). This Lower Jurassic and Upper Triassic Age formation, previously known as the Brunswick Formation, is comprised of predominantly red beds consisting of argillaceous siltstone; silty mudstone; argillaceous, very fine grained sandstone; and shale; mostly red-brown to brown-purple

and gray-red. The red beds occur typically in 10 to 23 feet thick, cyclic playa-lake-mudflat sequences and fining-upward fluvial sequences. Lamination is commonly indistinct due to borrowing, dessication, and paleosol formation. Where layering is preserved, most bedforms are wavy parallel lamination and trough and climbing-ripple cross lamination. Calcite- or dolomite-filled vugs and flattened cavities, mostly 0.02 to 0.08 inch across, occur mostly in the lower half. Sand-filled burrows, 0.08 to 0.2 inch in diameter, are prevalent in the upper two-thirds of the unit. Dessication cracks, intraformational breccias, and curled silt laminae are abundant in the lower half. Lake cycles, mostly 7 to 16 feet thick, have a basal, greenish-gray, argillaceous siltstone; a medial, dark-gray to black, pyritic, carbonaceous, fossiliferous, and, in places, calcerous lake-bottom fissile mudstone or siltstone; and an upper thick-bedded, gray to reddish and purplish-gray argillaceous siltstone with dessication cracks, intraformational breccias, burrows, and mineralized vugs. The thickness of the formation is about 11,500 feet.

Lockatong Formation (Trl). This Upper Triassic formation is comprised of predominantly cyclic lacustrine sequences of silty, dolomitic or analcime-bearing argillite; laminated mudstone; silty to calcareous, argillaceous very fine-grained sandstone and pyritic siltstone; and minor silty limestone, mostly light- to dark-gray, greenish gray, and black. Grayish-red, grayish-purple, and dark brown-red sequences occur in some places, especially in the upper half. Two types of cycles are recognized: freshwater-lake (detrital) and alkaline-lake (chemical) cycles. Freshwater-lake cycles average 17 feet thick and consist of basal, transgressive, fluvial to lake-margin deposits that are argillaceous, very fine-grained sandstone to coarse siltstone with indistinct lamination, planar or cross lamination, or are disrupted by convolute bedding, dessication cracks, root casts, soil-ped casts, and tubes. Medial lake-bottom deposits are laminated siltstones, silty mudstones, or silty limestones that are dark gray to black with calcite laminae and grains and lenses, or streaks of pyrite; fossils are common, including fish scales and articulated fish, conchostracens, plants, spores, and pollen. Upper regressive lake margin, playa lake, and mudflat deposits are light- to dark-gray silty mudstone to argillitic siltstone or very fine-grained sandstone, mostly thick-bedded to massive, with dessication cracks, intraformational breccias, faint wavy laminations, burrows, euhedral pyrite grains, and dolomite or calcite specks. Alkaline-lake cycles are similar to freshwater-lake cycles, but are thinner, averaging 10 feet, have fewer fossils (mainly conchostracens), and commonly have red beds, extensive dessication features, and abundant analcime and dolomite specks in the upper parts of cycles. The thickness of the formation near Byram is about 3,500 feet. The formation thins to the southeast and northeast, with the thickness less than 2,300 feet near Princeton.

The Passaic Formation underlies the majority of the site, whereas the Lockatong Formation underlies Impound 1 and possibly portions of Impound 2. There do not appear to be any major faults close to the site, although any structural features of the basement rock underlying the site are hidden by the overlying unconsolidated deposits.

3.2. SITE HYDROGEOLOGY

The hydrogeology of the site is dominated primarily by the Rahway River and sea level tidal fluctuations, with shallow groundwater flow generally toward the river. Deeper groundwater within the underlying Passaic Formation bedrock flows seaward. The Passaic Formation is a major source of groundwater to the west of the site, with flow occurring primarily in fractured shale. Separating these two aquifers is a continuous layer of red-brown clay. The clay layer identified beneath the shallow unconsolidated material functions as a confining unit for the underlying Passaic Formation (Hydrosystems, 1989). As such, the clay layer will restrict the vertical flow of water between the shallow and bedrock aquifers. Within the impounds, a groundwater mound composed of freshwater roughly five to ten feet above the groundwater elevation of the surrounding areas has developed, creating a horizontal and vertical flow field within the impounds flowing radially outward to the adjacent surface waters of the Rahway River, Cross Creek, and Deep Creek. The natural groundwater in the area is generally brackish, therefore the impound groundwater is less dense and therefore floats above the brackish groundwater table (Hydrosystems, 1989).

Eight paired monitoring well clusters were installed at this site to monitor the shallow unconsolidated and bedrock aquifers. The shallow monitoring wells were screened from depths of 10 to 20 feet in the shallow fill material and tidal marsh deposits. The deep wells were screened in the upper weathered portion of the Passaic Formation at depths ranging from 40 to 60 feet below ground surface (bgs). The water table is encountered approximately 2 feet bgs in shallow monitoring wells. Water table mounding occurs in the shallow aquifer beneath the impoundments, where ground-water elevation was measured as approximately 10 feet above mean sea level (Hydrosystems, 1989).

The fine-grained Passaic Formation typically has low primary porosity. Where coarser-grained rock is present, it is tightly cemented and has a high clay mineral content. Ground water flow occurs primarily in bedding plane fractures or in secondary fractures (joint sets) formed by stresses related to faulting following the deposition and lithification of the beds (USGS, 1968). Regional flow in the Passaic Formation occurs vertically and laterally toward the northeast, with ultimate discharge to surface water bodies which, in the vicinity of the Carteret Impoundments, include the lower Rahway River, Arthur Kilt, and, eventually, the Atlantic Ocean (Blasland, etal., 1995). Disko (1982) completed permeability tests on subsurface samples. Using data presented in Disko (1982), Blasland, etal. (1995) estimated a mean coefficient of permeability (k) for the sludge fill and tidal marsh units. The mean k value derived from these data was 1.10 ft/day.

3.3. SITE SEISMIC HAZARDS

It is unknown whether a seismic hazard assessment has been performed for this site or for any sites nearby. Historical seismicity within the New York/New Jersey area indicates that over the past 300 years, there have been a number of significant seismological events. Earthquakes with a maximum modified Mercalli scale of VII (roughly between 5.5 and 6.0 on the Richter scale) occurred in the New York City area in 1737, 1783, and 1884 (Dombroski, 2005). A number of smaller events have also occurred in the area over the last 300 years. The time spans between events indicate a 100 year return period. Based upon review of a geology map of New Jersey, there are no known faults on or near the site. However, there are many faults in New Jersey including the Ramapo Fault, separating the Piedmont and Highlands Physiographic Provinces, to the northeast of the site.

Utilizing current data developed from earthquake measurements in the region, the peak horizontal ground acceleration with a 7% probability of exceedance in any 75-year period ranges between 88 gals and 98 gals or 0.09g to 0.10g (AASHTO, 2008). The spectral acceleration at 0.2 second period with a 7% probability of exceedance in any 75-year period ranges between 157 gals and 177 gals or 0.16g to 0.18g and the spectral acceleration at 1.0 second period with a 7% probability of exceedance in any 75-year period ranges between 29 gals and 39 gals or 0.03g to 0.04g. Peak acceleration is the acceleration experienced by a particle on the ground. Spectral acceleration is approximately what is experienced by a building, as modeled by a particle on a mass-less vertical rod having the same natural period of vibration as the building.

Most methods for determining seismic soil response are based upon the assumption that upward propagation of horizontally polarized shear waves from the underlying rock formation governs the response of the soil deposit. Two independent design response spectra are typically developed, one to define the horizontal component of ground motion, and the second to define the vertical component. The vertical component of ground motion usually contains much higher frequency content than the horizontal component; therefore the spectral shape is different than that of the horizontal component. The peak ground acceleration (PGA) associated with the vertical component will also be different than the PGA of the horizontal component. Both values of PGA are dependent on the distance from the source.

The type of soil affects the response to dynamic loading. The most significant factors include grain size distribution, clay fraction, and degree of saturation. For sensitive cohesive soils, such as those that exist at the site, liquefaction and seismic response may be important. Embankment slope materials that are vulnerable to earthquake loadings include very steep, weak, fractured, and brittle rocks or unsaturated loess; loose saturated sand; sensitive cohesive soils with natural moisture exceeding the liquid limit; and dry cohesionless material on slopes at the angle of repose.

4.0 HISTORICAL DATA

4.1. PREVIOUS INVESTIGATIONS

There have been a number of geotechnical and environmental-related studies conducted at the Rahway Arch property. M. Disko Associates (Disko, 1981a) conducted the earliest study on the impounded sludge in June 1981, drilling twelve (12) borings inside the impounds (one at the edge and one at the center of each impound) to the bottom of the sludge layer. Twelve (12) in-situ density tests on the sludge were made using the Sand Cone Method (ASTM D1556). The resulting sludge densities ranged from 36.4 pcf to 81.9 pcf with an average in-situ density of 54.7 pcf. The moisture content was not tested. Falling head permeability tests were also run on remolded samples of sludge, with permeability ranging from $6.57(10)^{-6}$ cm/sec to $1.19(10)^{-4}$ cm/sec, averaging $5.33(10)^{-5}$. Field conditions within the impounds were also noted. Pond #1 was the only pond that was covered by vegetation. The sludge also showed signs of stratification and coloring within all of the impounds, being most pronounced within Impounds 2, 3, and 4.

In September 1981, Disko (1981b) again conducted a sludge investigation, drilling twelve (12) borings and conducting laboratory permeability tests. The intent was to evaluate permeability closer to the base of the sludge layer. The borings were again drilled at the edge and center of each impound to depths ranging from 10 feet at the edge of Impound 1 to 29 feet at the center of Impound 6. Sludge depths ranged from 5 feet at the edge of Impound 2 to 20 feet at the edge of Impound 5. The borings were terminated in the organic silt layer underlying a layer of peat. Falling head permeability tests were run on remolded samples of sludge 1 to 2 feet above the bottom of the sludge layer and on remolded samples of the underlying silt collected 3 to 13 feet below the sludge/soil interface. Permeability values of the bottom of the sludge ranged from $5.90(10)^{-6}$ cm/sec to $8.00(10)^{-5}$ cm/sec, averaging $2.46(10)^{-5}$ cm/sec. The permeability values of the silt layer ranged from $2.20(10)^{-7}$ cm/sec to $6.34(10)^{-6}$ cm/sec, averaging $2.46(10)^{-6}$ cm/sec.

A third investigation was conducted by Disko (1982) in January 1982 to evaluate the condition and soil material of the earth berms surrounding the impounds and to evaluate what type of material they were constructed upon. The borings were drilled through the berms and underlying silt material and to the underlying rock formation (for three of the borings). Eleven (11) borings were drilled at the site, B-1 to B-10 and B-6A. Three (3) borings were drilled to the top of rock at depths ranging from 29 feet to 38.5 feet. Sludge was found below the earth berms in eight (8) of the eleven (11) borings. The berm was found to be lying directly on peat in three (3) borings. Falling head permeability tests were also run on remolded samples of sludge, berm material, peat, organic silt, sand and gravel, and shale fragments. The

permeability of the berm material ranged from $3.00(10)^{-2}$ cm/sec to $5.00(10)^{-6}$ cm/sec. The permeability of the materials were similar to past test results.

In 1997, Blasland, Bouck, and Lee (BBL, 1997) conducted a geotechnical exploration at the site, performing SPT drilling, Shelby tube sampling, field vane shear testing, and laboratory analysis. Seven (7) soil borings (SB1 to SB4, SB6 to SB8) were drilled within the Impounds 2, 3, 4, and 5 to collect Shelby tube samples and to determine the depth of the sludge. A total of 56 vane shear tests were also performed within all of the sludge impoundments conducted using a Geonor H-60 at 13 locations and at depth of 1, 2, 5 and 9 feet below the ground surface. At locations further into the impounds, the tested undrained shear strength ranged from 115 psf to 940 psf with an average strength of 482 psf. At test locations near the berms, the undrained shear strength varied from 668 psf to 1337 psf with an average of 981 psf. The results from locations in Impound 6 have the lowest undrained shear strength. Remolded vane shear tests were also performed with results ranging from 0 to 574 psf, averaging 47.6 psf.

The "undisturbed" Shelby tube sludge samples were tested in a geotechnical laboratory. A total of 13 samples from Borings SB1 to SB4 and SB6 to SB8 were tested for index properties, moist and dry density, specific gravity, shear strength testing, and consolidation testing. The sludge samples were characterized as elastic silts and silts with moisture contents ranging from 69.3% to 128.9% with an average of 93.8%. The tested moist density ranged from 60.3 to 102.7 pcf with an average moisture density of 92.5 pcf. Specific gravity values ranged from 2.89 to 3.27 with an average value of 3.11. The initial void ratio ranged from 2.295 to 3.948 with an average of 3.073.

A total of seven (7) undisturbed sludge samples were laboratory tested for unconsolidated undrained (UU) shear strength in 1997 by BBL (1997). The applied confining pressure in the triaxial chamber for the UU testing is approximately equivalent to the total overburden pressure at the sample depth. The tested undrained shear strength ranged from 215 to 1085 psf depending on the sample location. Three (3) undisturbed sludge samples were tested using the direct shear test method under drained conditions in 1997 by BBL. The samples were tested under 1, 3 and 10 ksf vertical pressures. The tested peak drained shear strength was 35º internal friction angle and 300 psf cohesion. If the cohesion is neglected, the equivalent internal friction angle under each vertical loading varies from 36º to 48º. Four (4) consolidation tests were also performed on undisturbed samples of the on-site sludge. Compression and recompression indices ranged from 0.767 to 1.152, averaging 0.965 and 0.02 to 0.022, averaging 0.021, respectively. Estimated preconsolidation stresses ranged from 0.9 to 3.1 tons per square foot (tsf) with the highest stress reported from a sample collected within two (2) feet of ground surface, indicating that drying of the material over time has potentially created an overconsolidated material.

In 2006, Edwards and Kelcey (2006) conducted a geotechnical investigation for the Tremley Point

Connector Road, Interchange 12 Improvements Project, for the New Jersey Turnpike Authority (NJTA). The exploration program consisted of drilling and sampling 32 SPT soil borings, installing two (2) observation wells, and performing laboratory testing on select soil and rock samples. The investigation covered wetland areas and three alternate alignments adjacent to the Rahway Property (then owned by Cytec) as well as a portion of the Rahway Property within Impound 3. All borings were drilled to the top of bedrock, which was encountered between 20 and 50 feet below ground surface. Eight (8) unconfined compression tests and ten (10) consolidation tests were performed on undisturbed samples of organic clayey silt to peat with varying amounts of sand. Undrained shear strength values ranged from 60 psf to 290 psf, averaging 181 psf. Compression and recompression indices ranged from 0.062 to 5.127, averaging 1.285 and 0.006 to 0.959, averaging 0.159, respectively. Estimated preconsolidation stresses ranged from 0.2 to 4.7 tons per square foot (tsf).

5.0 FIELD AND LABORATORY WORK

5.1. FIELD EXPLORATION

The field exploration consisted of drilling thirty-one (31) standard penetration test (SPT) borings and ten (10) CPTu borings. Warren George, Inc. (Warren George) completed the borings using a swamp buggy-mounted drill rig and a truck-mounted drill rig from July 10th to August 3rd, 2012 using flush joint casing with mud rotary drilling (casing advancer system) methods to drill the borings. "Tiger" mud and powdered sodium-bentonite were circulated within the hole to remove cuttings. Rock coring was not conducted. All CPT borings were performed from the swamp buggy using a drill rig to advance the CPT rods and probe. Baker personnel logged the borings.

The boring locations were staked by Eaststar Environmental (Eaststar) personnel. Final surveyed locations and elevations at the as-drilled boring locations were provided by Kernan Consulting Engineers (Kernan). Current and historical boring locations are shown in Figure A-2, located in Appendix A. All SPT and CPT borings were drilled and sampled to the depths shown in Table 5-1.

Table 5-1. Boring Locations and Depths

Boring	Depth (ft)	Location	Boring	Depth (ft)	Location
BD-01R	41.5	Impound 4 Berm	IS-02	27.0	Impound 2
BD-02	32.0	Impound 3 Berm	W-01	41.0	Wetland adjacent to Impound 4
BD-03	47.0	Impound 4 Berm	W-02	26.5	Wetland adjacent to Impound 4
BD-04R	39.0	Impound 2 Berm	W-03	30.0	Wetland adjacent to Impound 3
BD-05	37.0	Impound 1 Berm	W-04	32.0	Wetland adjacent to Impound 1
BS-01	32.0	Impound 6 Berm	W-05	42.0	Wetland adjacent to Impound 5
BS-02	32.0	Impound 3 Berm	W-07R	27.0	Wetland adjacent to Impound 2
BS-03	26.0	Impound 4 Berm	W-08	32.0	Wetland adjacent to Impound 3
BS-04	27.0	Impound 4 Berm	CP-01	28.9	Impound 4
BS-05	27.0	Impound 1 Berm	CP-02	29.5	Impound 4
BS-06	24.0	Impound 1 Berm	CP-03	19.8	Wetland adjacent to Impound 2
BS-07R	27.0	Impound 2 Berm	CP-04	26.6	Impound 6
BS-08	25.0	Impound 3 Berm	CP-05	39.5	Impound 5
BS-09	26.0	Access Bridge	CP-06A	26.9	Impound 2
ID-01	49.0	Impound 4	CP-08	24.1	Impound 6

Table 5-1. Boring Locations and Depths					
Boring	**Depth (ft)**	**Location**	**Boring**	**Depth (ft)**	**Location**
ID-02	47.0	Impound 5	CP-08A	20.8	Impound 6
ID-03R	34.5	Impound 6	CP-09D	18.9	Impound 3
ID-04	36.0	Impound 3	CP-10	21.0	Wetland adjacent to Impound 6
ID-05	47.0	Impound 2	CP-11A	21.2	Impound 2
ID-06	37.0	Impound 1	CP-12	20.8	Impound 1
IS-01	27.0	Impound 2/5			

5.1.1. Standard Penetration Testing

The field exploration consisted of SPT soil samples obtained at a continuous 2-feet interval for the top 10-feet of drilling, and at 5-feet intervals below 10-feet, except for within the impounds, where continuous sampling was conducted through the entire depth of the sludge. In general, the SPT consisted of advancing a sampling spoon (2-inch outside diameter) 2-feet by driving it with a 140-pound hammer falling 30-inches. Typically, an 18 inch spoon is driven, however, a 24-inch sampling spoon was used for this project. The values reported on the boring logs are the blows required to advance four successive increments. The first 6-inch increment is considered as seating. The sum of the number of blows for the second and third increments is the "N" value. The fourth value is not used, but is recorded on the logs. The soils were classified in general accordance with the Unified Soil Classification System.

5.1.2. Cone Penetrometer Testing with Pore Pressure Measurements

The CPTu boring program took place on July 10th, 12th, 13th and 16th, 2012. A total of eighteen (18) soundings were completed at eleven (11) different sounding locations. The CPT program was performed to evaluate in situ geotechnical criteria relative to the soils. In addition to the CPT soundings, shear wave velocity tests were performed at eight (8) of the locations with testing at five-foot depth intervals and dissipation tests were performed at nine (9) locations at various depths. The cone penetrometer tests were carried out using an integrated electronic piezocone. The piezocone used was a compression model cone penetrometer with a 15 cm^2 tip and a 225 cm^2 friction sleeve. The cone is designed with an equal end area friction sleeve and a tip end area ratio of 0.80. The piezocone dimensions and the operating procedure were in accordance with ASTM standard D-5778-07.

Pore pressure filter elements, made of porous plastic, were saturated under a vacuum using silicone fluid as the saturating medium. The pore pressure element was six millimeters thick and was located

immediately behind the tip (the u_2 location) for all soundings. The cone was advanced using a skid drill rig, mounted on a Kori rig operated by Warren George. The following data were recorded onto magnetic media every five centimeters (approximately every two inches) as the cone was advanced into the ground: Tip Resistance (qc), Sleeve Friction (fs), and Dynamic Pore Pressure (u).

During seismic testing, the seismic signals were recorded using a geophone mounted in the cone and an up-hole digital oscilloscope. A sledge hammer, struck against a steel wedge was used as the seismic source. While stopped, pore water pressures were automatically recorded at five-second intervals and the readings stored in a dissipation file for estimation of C_h, the coefficient of consolidation that can in turn be used to calculate K_h, the horizontal hydraulic conductivity.

5.2. LABORATORY ANALYSES

The laboratory testing consisted of performing classification and index testing; including natural moisture content, grain-size distribution, Atterberg limits, and hydrometer analysis; specific gravity; pH; organic content; consolidation analyses; unconsolidated-undrained triaxial tests; and consolidated-undrained (CIU) triaxial tests as shown in Table 5-2 below.

Table 5-2. Laboratory Testing

Laboratory Analysis	ASTM Standard	Purpose
Natural Moisture Content	D2216	Determine soil moisture content
Atterberg Limits	D4318	Determine soil plasticity
Sieve Analysis	D422	Determine soil grain size distribution
Hydrometer Analysis	D422	Determine clay and silt fraction
Specific Gravity	D854	Determine specific gravity
pH	D4972	Determine acidity
Organic Content	D2974	Determine organic content
Permeability	D5084	Determine soil permeability
Consolidation	D2435	Determine soil compressibility
unconsolidated-undrained (UU) triaxial	D2850	Determine undrained shear strength
consolidated-undrained (CIU) triaxial	D4767	Determine drained shear strength

5.2.1. Classification Testing

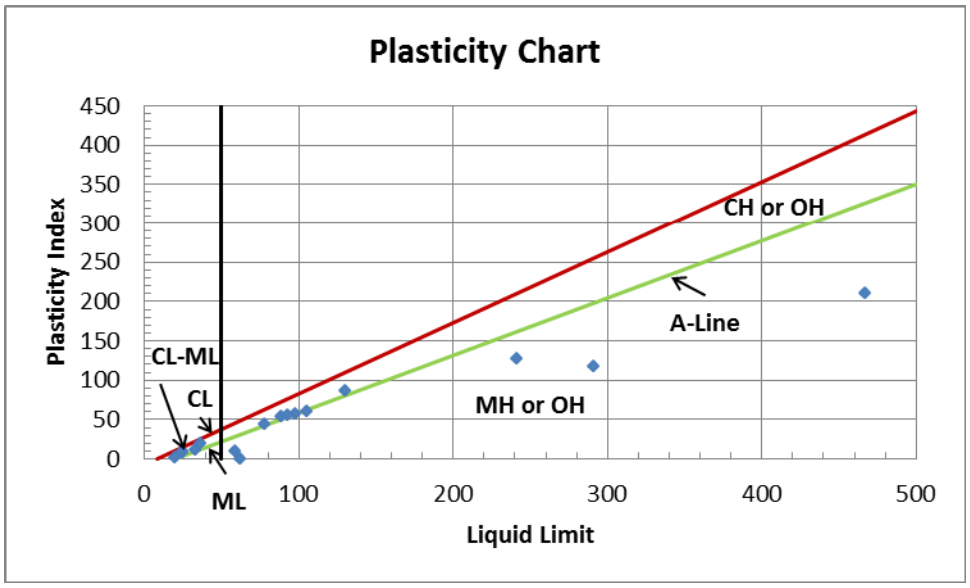
Results of classification testing are summarized in Table 5-3. Natural Moisture Content results are shown on Test Boring Logs in Appendix B and grain-size distribution graphs, specific gravity, pH, organic content, consolidation, UU triaxial, CIU triaxial test results in Appendix C.

Table 5-3. Laboratory Classification Results

Sample	Depth (ft)	Description	LL%	PL%	NMC	% Clay/Fines	USCS
BD-01R/T-1	24.0-26.0	Elastic SILT with Sand (Peat)	291	173	72.9	16.5/79.1	MH
BD-03/T-1	23.0-25.0	Sandy Elastic SILT (Peat)	105	45	65.1	18.3/66.5	MH
BD-03/S-12	25.0-27.0	Sandy Fat CLAY (Peat)	89	35	73.8	13.8/56.6	CH
BD-04R/T-1	21.0-23.0	Fat CLAY (Peat)	98	41	75.0	17.9/93.2	CH
BD-05/S-5	14.0-16.0	Fat CLAY with Sand (Peat)	78	34	70.9	16.2/82.3	CH
BS-01/S-9	16.0-18.0	Sandy Lean CLAY	25	17	20.4	17.4/64.6	CL
BS-02/T-1	7.0-9.0	Sandy Elastic SILT (Peat)	467	256	375.7	21.5/62.0	MH
BS-03/T-1	8.0-10.0	Elastic SILT (Sludge)	-	-	87.3-124.3	18.0/93.0	MH
BS-04/T-1	23.0-25.0	Fat CLAY (Peat)	93	38	71.9	21.2/87.3	SM
BS-04/S-12	25.0-27.0	Silty SAND	-	-	45.0	-/32.0	SM
BS-06/U-1	2.0-4.0	Elastic SILT (Sludge)	-	-	73.6-84.9	21.0/96.0	MH
BS-08/T-1	15.0-17.0	SILT with Sand	20	18	20.1	7.0/71.1	ML
BS-08/S-10	21.0-23.0	SILT with Sand	-	-	16.0	-/80.0	ML
BS-09/T-1	12.0-14.0	Silty SAND (Peat)	241	113	58.6	7.7/43.1	SM
ID-01/S-3	4.0-6.0	Elastic SILT (Sludge)	59	49	134.3	5.0/96.6	MH
ID-03R/T-1	0.0-2.0	Elastic SILT (Sludge)	-	-	114.5-170.1	26.0/86.7	MH
ID-06/S-2	2.0-4.0	Elastic SILT (Sludge)	62	61	109.2	-/-	MH
ID-06/U-2	14.0-16.0	Fat CLAY (Peat)	130	43	120.9	-/-	CH
IS-02/U-1	19.0-21.0	Sandy Lean CLAY (Peat)	33	22	99.3	-/-	CL
W-05/T-1	15.0-17.0	Sandy Lean CLAY (Peat)	25	15	26.1	-/-	CL
W-08/U-1	14.0-16.0	Lean CLAY (Peat)	36	16	30.4	-/-	CL
COMPOSITE	-	Elastic SILT	NP	64	94.3-115.8	-/-	MH

USCS: Unified Soil Classification System **PL:** Plastic Limit **LL:** Liquid Limit **NMC:** Natural Moisture Content

In general, the liquid and plastic limits of the on-site organic peat material are very high, which is characteristic of these materials. The sludge material generally has lower liquid and plastic limits. There are some peat soils that have lower limits, which may indicate some mixing of the peat and overlying sludge material. The accompanying figure below presents classification results on a plasticity chart.



5.2.2. Permeability Testing

One sample was tested to determine the coefficient of permeability of the sludge using the falling head constant volume method within a triaxial cell. The test was performed on a composite sludge sample taken from several Shelby tubes to determine the flow characteristics of the sludge in a remolded condition. Numerous attempts were made to collect Shelby tube samples within the sludge, however many were unsuccessful due to the low shear strength of the sludge. Many of the Shelby tube samples collected tended to be within the upper portions of the sludge, which tended to be drier and stronger and not necessarily representative of the entire sludge profile. The sample was remolded to a specified density and molding water contents (similar to the undisturbed samples collected), consolidated to 700 psf and then tested to estimate permeability. The pre-test moisture content and dry density were 71.89% and 103.0 pcf, respectively. Table 5-4 presents the results of the permeability testing.

Table 5-4. Permeability Testing Result

Sample	Depth (ft)	Description	Consolidation Pressure (psf)	Permeability (cm/sec)
COMP	-	Elastic SILT (Sludge)	700	$6.43(10)^{-6}$

Note: composite compacted from BS-03/T-1, BS-06/U-1, and ID-03R/T-1

The remolded permeability of the sludge is in the lower range of permeability values measured by previous investigators. The data sheets are presented within Appendix C.

5.2.3. Shear Strength Testing

Shear strength testing was conducted on a total of eleven (11) undisturbed Shelby tube samples and two (2) composited, remolded samples; nine (9) unconsolidated-undrained (UU) compression tests and four (4) consolidated isotropically undrained compression (CIUC) tests. UU testing was conducted on undisturbed soils from borings BD-01R/T-1 (24.0'-26.0'), BD-04R/T-1 (21.0'-23.0'), BS-02/T-1 (7.0'-9.0'), BS-04/T-1 (23.0'-25.0'), BS-08/T-1 (15.0'-17.0'), IS-02/U-1 (19.0-21.0'), W-05/T-1 (15.0'-17.0'), and W-08/U-1 (14.0-16.0'. UU testing was also conducted on a composited, remolded sample of sludge. The CIUC tests were conducted on undisturbed soil from borings BD-03/T-1 (23.0'-25.0'), BS-09/T-1 (12.0'-14.0'), and BS-03R/T-1 (8.0'-10.0') and a composited, remolded sample of sludge. Appendix E contains photographs of these samples before, during, and after testing.

UU compression tests are performed within a triaxial cell with the drainage lines closed. A minimal cell pressure is applied followed by axial loading, therefore, only a small amount of consolidation is allowed to occur. Measured soil parameters depend heavily upon degree of saturation. The confining pressure is atmospheric (or zero gauge pressure). CIUC compression tests involve the initial consolidation of the sample under some designated confining cell pressure with the drainage lines open. Under isotropic conditions, the confining cell pressure is equal in all directions. After consolidation is complete, the drainage lines are closed and the sample is compressed.

UU and CIUC samples contained in shelby tubes were extruded, trimmed and set-up at the specified confining pressures of 2,000 psf for BD-01R/T-1 (24.0'-26.0'), 2,500 psf for BD-04R/T-1 (21.0'-23.0'), 900 psf for BS-02/T-1 (7.0'-9.0'), 2,800 psf for BS-04/T-1 (23.0'-25.0'), 1,700 psf for BS-08/T-1 (15.0'-17.0'), 2,300 psf for IS-02/U-1 (19.0-21.0'), 1,600 psf for W-05/T-1 (15.0'-17.0'), and 1,700 psf for W-08/U-1 (14.0-16.0'. The confining pressures were chosen to simulate the existing loading conditions of the samples when they were collected. The confining pressure for the composited, remolded sludge was 1,000 psf. The CIUC samples were also contained within Shelby tubes and were extruded, trimmed and set-up within triaxial cells for testing. The samples were back-pressured up to 100 psi to improve the degree of saturation. They were then consolidated to specified effective consolidation pressures of 500, 2,000 and 5,000 psf for BD-03/T-1 (23.0'-25.0') and BS-09/T-1 (12.0'-14.0'), and 200, 2,000 and 5,000 psf for BS-03R/T-1 (8.0'-10.0') and then sheared under undrained conditions. The effective consolidation pressures for the composited, remolded sludge sample were also 200, 2,000 and 5,000 psf. Table 5-5 presents the results.

Table 5-5. Triaxial Compression Test Results					
Boring/ Sample	**Depth (ft)**	**Description**	**Undrained Shear Strength**	**Effective Stress Parameters**	
			S_u (psf)	**ϕ'-angle**	**c' (psf)**
BD-01R/T-1	24.0-26.0	Elastic SILT with Sand (MH)	665	-	-
BD-03/T-1	23.0-25.0	Sandy Elastic SILT (MH)	-	27.4	450
BD-04R/T-1	21.0-23.0	Fat CLAY (CH)	390	-	-
BS-02/T-1	7.0-9.0	Sandy Elastic SILT (MH)	360	-	-
BS-03/T-1	8.0-10.0	Elastic SILT (MH)	-	63.4	0
BS-04/T-1	23.0-25.0	Fat CLAY (CH)	550	-	-
BS-08/T-1	15.0-17.0	SILT with Sand (MH)	305	-	-
BS-09/T-1	12.0-14.0	Silty SAND (SM)	-	33.6	550
IS-02/U-1	19.0-21.0	Sandy Lean CLAY (CL)	155	-	-
W-05/T-1	15.0-17.0	Sandy Lean CLAY (CL)	175	-	-
W-08/U-1	14.0-16.0	Lean CLAY (CL)	305	-	-
Composite	-	Elastic SILT (MH)	30	44.0	0
S_u: Undrained Shear Strength; **ϕ, ϕ':** Angle of Internal Friction (total and effective); **c, c':** cohesion (total and effective)					

After testing of the samples, the failure planes were analyzed and photographed (see Appendix E). In overconsolidated clays, the clays tend to expand or dilate when sheared, creating negative pore pressures, while normally consolidated clays contract when sheared, creating positive pore pressures as pore water is squeezed out. As shown on the CIUC data sheets within appendix B, excess pore pressures are generally positive for samples BD-03 and BS-09. For sludge sample BS-03, the excess pore pressures are initially positive but become slightly negative as strain continues. Since this sample was collected relatively close to ground surface, this may indicated that the sludge has dried out to a degree, therefore appearing to be slightly overconsolidated.

While in the field, the Baker field engineer conducted pocket penetrometer testing of the SPT samples. The pocket penetrometer is a hand-held device with a calibrated spring. The device is pushed into the sample until the clay is penetrated a certain distance. The resulting value of unconfined compressive strength is approximately equal to twice the undrained shear strength, as illustrated below in Table 5-6.

Table 5-6. Pocket Penetrometer Results

Boring	Depth (ft)	Description	Unconfined Compressive Strength (tsf)	Undrained Shear Strength (psf)
BD-01R	32	Clayey SAND	1.25	1.250
	42	Clayey SAND	4.0	4,000
BD-03	19	Sandy Elastic SILT (peat)	0	0
	21	Sandy Elastic SILT (peat)	0	0
BD-04R	0	Clayey SILT (fill)	4.5	4,500
	2	Elastic SILT (sludge)	1	1,000
	23	Fat CLAY (peat)	0	0
BD-05	9	Fat CLAY with Sand (peat)	0	0
	12	Fat CLAY with Sand (peat)	0	0
	36	Silty SAND	0.5	500
BS-01	10	Sandy Lean CLAY	0.5	500
	12	Sandy Lean CLAY	0.5	500
	14	Sandy Lean CLAY	1.0	1,000
	16	Sandy Lean CLAY	2.0	2,000
	18	Sandy Lean CLAY	1.0	1,000
	23	Sandy Lean CLAY	0.25	250
	24	Sandy Lean CLAY	1.0	1,000
	25	Sandy Lean CLAY	1.5	1,500
BS-02	4	Elastic SILT (sludge)	0	0
BS-05	16	Silty SAND	<0.01	<10
BS-06	10	Fat CLAY (peat)	0	0
	16	Fat CLAY (peat)	0	0
	18	Fat CLAY (peat)	<0.05	<50
BS-08	6	Organic CLAY (peat)	0.25	250
	8	Organic CLAY (peat)	0	0
	10	Organic CLAY (peat)	0	0
	12	Organic CLAY (peat)	0	0
	13	SILT with Sand	0	0
ID-01	10	Elastic SILT (sludge)	<0.1	<100
	12	Elastic SILT (sludge)	<0.1	<100
	18	Fat CLAY (peat)	<0.1	<100
	24	Fat CLAY (peat)	<0.1	<100
ID-01	35	Clayey SILT	1.0	1,000
ID-02	14	Elastic SILT (sludge)	0	0
	16	Sandy Silty CLAY (peat)	0	0
	18	Sandy Silty CLAY (peat)	0	0

Table 5-6. Pocket Penetrometer Results

Boring	Depth (ft)	Description	Unconfined Compressive Strength (tsf)	Undrained Shear Strength (psf)
	23	Sandy Silty CLAY (peat)	0	0
	25	Sandy Silty CLAY (peat)	0	0
ID-06	16	Fat CLAY (peat)	0	0
	18	Fat CLAY (peat)	0.15	150
	19.3	Silty SAND	2.5	2,500
IS-01	12	Lean CLAY (peat)	0	0
	17	Lean CLAY (peat)	0	0
	21	Lean CLAY (peat)	0	0
	23	Lean CLAY (peat)	0	0
IS-02	14	Sandy Lean CLAY (peat)	0	0
	16	Sandy Lean CLAY (peat)	0	0
W-01	8	Fat CLAY (peat)	0	0
	14	Fat CLAY (peat)	0	0
	27	Silty GRAVEL with Sand	2.0	2,000
W-03	6	Fat CLAY (peat)	0	0
	8	Fat CLAY (peat)	0	0
	10	Fat CLAY (peat)	0	0
	17.8	Silty GRAVEL	2	2,000
W-04	8	Elastic SILT (peat)	0	0
	16	Elastic SILT (peat)	0	0
W-05	4	Sandy Lean CLAY (peat)	0	0
	6	Sandy Lean CLAY (peat)	0	0
	8	Sandy Lean CLAY (peat)	0	0
	10	Sandy Lean CLAY (peat)	0	0
	12	Sandy Lean CLAY (peat)	0	0
W-07R	15	Sandy SILT	1.25	1,250
	20	Sandy SILT	1.5	1,500
W-08	8	Lean CLAY (peat)	0	0
	10	Lean CLAY (peat)	0	0
	16	SILT	2.0	2,000

5.2.4. Consolidation Testing

Eight (8) one-dimensional consolidation tests were performed on undisturbed Shelby tube samples from borings BD-04R/T-1 (21.0’-23.0’), BS-02/T-1 (7.0’-9.0’), BS-03/T-1 (8.0’-10.0’), BS-06/U-1 (2.0’-4.0’), BS-09/T-1 (12.0’-14.0’), ID-03R/T-1 (0.0-2.0’), ID-06/U-2 (14.0’-16.0’), and IS-02/U-1 (19.0’-21.0’).

One (1) consolidation test was performed on a composted, remolded sample of sludge. Consolidation tests are performed on saturated samples placed within a confining metal fixed-ring or floating ring apparatus. As load is applied to the sample, water flows from the sample and the sample volume subsequently reduces. The samples were extruded, trimmed and set-up within Antius® consolidometers and were then loaded up to 1, 2, 4, or 6 tons per square foot (tsf)) before initial unloading and then reloaded up to 2, 8, 12, or 16 tsf to better define the virgin slope and pre-consolidation characteristics. Table 5-7 presents the results.

Table 5-7. Consolidation Test Results

Boring/ Sample	Depth (ft)	Description	C_c	C_r	e_o	P_c (psf)	P_o (psf)	C_v (ft^2/day) @ 2 tsf	OCR
BD-04R/T-1	21.0-23.0	Fat CLAY	0.83	0.13	2.000	1,440	1,450	0.07	1.0
BS-02/T-1	7.0-9.0	Sandy Elastic SILT	5.64	0.64	8.150	920	380	0.01	2.4
BS-03/T-1	8.0-10.0	Elastic SILT (Sludge)	1.29	0.03	3.866	4,800	538	4.93	8.9
BS-06/U-1	2.0-4.0	Elastic SILT (Sludge)	0.77	0.03	2.790	6,400	336	1.37	19.1
BS-09/T-1	12.0-14.0	Silty SAND	0.48	0.06	1.279	1,660	870	2.07	1.9
ID-03R/T-1	0.0-2.0	Elastic SILT (Sludge)	1.10	0.05	4.289	800	104	0.61	7.7
ID-06/U-2	14.0-16.0	Fat CLAY	0.79	0.13	2.466	980	600	0.11	1.6
IS-02/U-1	19.0-21.0	Sandy Lean CLAY	0.41	0.04	0.904	2,160	1,060	0.02	2.0
Composite	-	SILT (Sludge)	0.60	0.06	3.704	-	-	3.00	-

C_c: Compression Index **C_r:** Recompression Index **C_s:** Swell Index **P_c:** Preconsolidation Pressure
P_o: Current Overburden Pressure **C_v:** Coefficient of Consolidation **OCR:** Overconsolidation Ratio

5.2.5. Miscellaneous Testing

Specific Gravity (ASTM D854). Nine (9) samples were analyzed to determine specific gravity, including BD-03R/T-1 (24.0'-26.0'), BD-03/T-1 (23.0'-25.0'), BS-02/T-1 (7.0'-9.0'), BS-03/T-1 (8.0'-10.0'), BS-06/U-1 (2.0'-4.0'), BS-09/T-1 (12.0'-14.0'), ID-03R/T-1 (0.0-2.0'), ID-06/U-2 (14.0'-16.0'), and IS-02/U-1 (19.0'-21.0'). Specific gravity is useful in determining the void ratio of a soil and to determine the density of a soil. The results are tabulated below in Table 5-8.

Table 5-8. Specific Gravity Testing Results

Boring/Sample	Depth (m)	Description	Specific Gravity
BD-01R/T-1	24.0-26.0	Elastic SILT with Sand	2.36

Table 5-8. Specific Gravity Testing Results			
Boring/Sample	**Depth (m)**	**Description**	**Specific Gravity**
BD-03/T-1	23.0-25.0	Sandy Elastic SILT	2.53
BS-02/T-1	7.0-9.0	Sandy Elastic SILT	2.14
BS-03/T-1	8.0-10.0	Elastic SILT (Sludge)	3.17
BS-06/U-1	2.0-4.0	Elastic SILT (Sludge)	3.10
BS-09/T-1	12.0-14.0	Silty SAND (SM)	2.52
ID-03R/T-1	0.0-2.0	Elastic SILT (Sludge)	2.76
ID-06/U-2	14.0-16.0	Fat CLAY (CH)	2.58
IS-02/U-1	19.0-21.0	Sandy Lean CLAY (CL)	2.63

The specific gravity of the sludges on site varies between 2.76 and 3.17, substantially higher than typically encountered soils.

Organic Content (ASTM D2974). Four (4) samples were analyzed to determine organic content, including BD-01R/T-1 (24.0'-26.0'), BD-05/S-5 (14.0'-16.0'), BS-02/T-1 (7.0'-9.0'), and BS-09/T-1 (12.0'-14.0'). The purpose of this testing was to determine the potential for secondary long-term creep settlement due to compression of organic materials. The results were fairly low as shown in Table 5-9.

Table 5-9. Organic Content Testing Results			
Boring/Sample	**Depth (m)**	**Description**	**Organic Content (%)**
BD-01R/T-1	24.0-26.0	Elastic SILT with Sand (MH)	14.8
BD-05/S-5	14.0-16.0	Fat CLAY with Sand (CH)	5.7
BS-02/T-1	7.0-9.0	Sandy Elastic SILT (MH)	19.3
BS-09/T-1	12.0-14.0	Silty SAND (SM)	2.9

Based upon the organic content of these samples, BD-01R/T-1 and BS-02/T-1 would not necessarily be classified as peat, but do have moderately high organic contents. The other two samples are not organic soils.

pH (ASTM D4972). Four (4) samples were analyzed to determine pH, including BD-01R/T-1 (24.0'-

26.0'), BD-05/S-5 (14.0'-16.0'), BS-02/T-1 (7.0'-9.0'), and BS-09/T-1 (12.0'-14.0'). The purpose of this testing was to determine whether these samples are organic materials. The results are illustrated in Table 5-10.

Table 5-10. pH Testing Results

Boring/Sample	Depth (m)	Description	pH
BD-01R/T-1	24.0-26.0	Elastic SILT with Sand (MH)	6.9
BD-05/S-5	14.0-16.0	Fat CLAY with Sand (CH)	6.6
BS-02/T-1	7.0-9.0	Sandy Elastic SILT (MH)	6.7
BS-09/T-1	12.0-14.0	Silty SAND (SM)	6.5

Based upon the pH of these samples, they do not appear to be peat.

6.0 SUBSURFACE CONDITIONS

6.1. SUBSURFACE CONDITIONS

The soil profiles and the test boring logs in Appendix B, depict details related to the subsurface conditions encountered in the various borings. The stratification lines shown on the soil profiles and the test boring logs represent approximate transitions between material types. In situ, strata changes could occur gradually or at slightly different levels. Also, the borings depict conditions at particular locations and at the particular times indicated. Some conditions, particularly groundwater conditions between borings could vary from the conditions encountered at the particular boring locations. The borings encountered the following seven (7) distinct strata.

Stratum I: FILL (Existing Berm): This stratum was encountered at ground surface to a depths ranging from 0.5 feet to 14.9 feet below ground surface within all berm borings, except BS-03 and BS-06 where sludge was encountered at ground surface and BD-05 where peat was encountered at ground surface. Fill was also encountered at ground surface in several impoundment borings including ID-02, ID-04, ID-05, IS-01, and IS-02. The stratum generally consisted of black to brown to gray, loose to very dense, Silty SAND (SM) with Gravel and red-brown, Clayey GRAVEL (GC) to stiff to very stiff, yellow to light gray, Clayey SILT (ML) and red-brown, Sandy Lean CLAY (CL), with varying amounts of debris (bricks, rail ties, and similar debris). The SPT N-values ranged from 5 to 200 blows per foot (bpf), averaging 43 bpf.

Stratum II: FILL (Sludge): This stratum was encountered in all berm and impoundment borings and one wetland boring (W-08), except for BD-05, BS-01, BS-05, BS-08, and BS-09. It was found at ground surface or just below berm FILL soils to depths ranging from 2.3 feet to 19.8 feet. Soils within this layer can be generally classified as gray to dark gray, very loose to dense, Elastic SILT (MH) with varying amounts of peat and sand. The SPT-N values varied from 0 to 38 bpf, averaging 9 blows bpf, indicating a wide range of density for this layer. The sludge had liquid limits ranging from 59 to 62 percent, averaging 61 percent, and plasticity indices ranging from 1 to 10 percent, averaging 5 percent. The moisture content ranged from 73.6 to 269.9 percent, averaging 122 percent.

Stratum III: Peat: This stratum was encountered in all borings, except BS-01, BS-03, and BS-07R, generally below Stratum I and/or II to depths ranging from 8.7 feet to 29.9 feet below ground surface. In wetland borings, it was encountered at ground surface. Soils within this layer can be generally classified as gray, very loose to very dense, Elastic SILT (MH) with varying amounts of Sand and brown,

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very loose, Silty SAND (SM) to gray to dark gray, very soft to very stiff, Organic Fat CLAY (CH-OH); very soft to stiff, Organic Lean CLAY (CL) with varying amounts of Sand, and very soft to soft, Sandy Silty CLAY (CL-ML), with varying amounts of plant fiber. The SPT-N values varied from 0 to over 35 bpf, averaging 3 bpf. The higher blow counts were generally found near interfaces with harder soils. The soil was highly plastic with liquid limits ranging from 25.0 to 467.0 percent, averaging 141 percent and plasticity indices ranging from 15 to 256 percent, averaging 69 percent. The moisture content ranged from 26.1 to 375.7 percent, averaging 101 percent.

Stratum IV: Soft Organic Clay/Silt: This stratum was encountered in all borings, except BS-01 and BS-07R, generally below Stratum III and above Stratum IV or V. Soils within this layer can be generally classified as very loose to very dense, Elastic SILT (MH) with varying amounts of Sand to gray to dark gray, very soft to very stiff, Organic Fat CLAY (CH-OH); very soft to stiff and Organic Lean CLAY (CL) with varying amounts of Sand. The SPT-N values varied from 0 to over 7 bpf, averaging 5 bpf.

Stratum V: Stiff Clay/Silt: This stratum was encountered in borings BD-02, BS-01, BS-02, BS-03, BS-07R, BS-08, ID-03R, ID-05, ID-06, and W-05 generally below Stratum III or IV. Soils within this layer can be generally classified as brown to gray, medium dense to very dense Clayey SILT (ML) to medium stiff to very stiff Silty CLAY (CL), Fat CLAY (CH) and Lean CLAY (CL) with varying amounts of Sand. The SPT-N values varied from 4 to over 60 bpf, averaging 24 bpf.

Stratum VI: Alluvial Soil: This stratum was encountered in all borings except BD-01R, BD-02, BS-02, BS-03, BS-07R, BS-08, ID-01, ID-04, W-03, and W-08 generally below Stratum III or IV. Soils within this layer can be generally classified as grey to brown, loose to very dense, Silty GRAVEL (SM) with Sand; Poorly-Graded GRAVEL (GP) with Sand; Clayey SAND (SC); Silty SAND (SM); and Sandy SILT (ML). The SPT-N values varied from 0 to over 200 bpf, averaging 55 bpf.

Stratum VII: Residual Soil: This stratum was encountered in borings BD-01R, BD-02, ID-04, ID-06, W-01, W-02, W-03, W-07R, and W-08 generally below Stratum V or VI to the boring termination depth. Soils within this layer can be generally classified as red-brown, medium dense to very dense, Clayey SAND (SC) and Clayey SILT (ML) to very stiff to hard, Sandy Lean CLAY (CL); commonly with Shale fragments. The SPT-N values varied from 10 to over 200 bpf, averaging 59 bpf.

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6.2. GROUNDWATER

Groundwater was encountered in all most borings from ground surface to as deep as 6 feet below ground surface, averaging 3.5 feet, during the field exploration. Within the berms, groundwater depths ranged from 1 foot to 6 feet below ground surface, averaging 3.8 feet below ground surface. Within the impoundments, groundwater depths ranged from 0 foot to 6 feet below ground surface, averaging 3.2 feet below ground surface. Groundwater within the wetlands was approximately at ground surface. A more accurate determination of the hydrostatic water table would require the installation of monitoring wells or piezometers. It should be noted that the actual level of the hydrostatic water table and the amount and level of perched water should be anticipated to fluctuate throughout the year, depending upon variations in precipitation, surface run-off, infiltration, site topography, and drainage.

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7.0 EVALUATIONS AND RECOMMENDATIONS

7.1. RECOMMENDED SOFT SOIL PARAMETERS FOR DESIGN

7.1.1. Geotechnical Properties of Alum Sludge

Index Properties

Based upon available data on the alum sludge, the in-situ density is between 36.4 pcf to 81.9 pcf, with an average of 54.7 pcf. Laboratory test moist density ranged from 60.3 to 102.7 pcf with an average moisture density of 92.5 pcf. The moisture content ranged from 69.3% to 130.8% with an average of 93.8%. Currently, Baker tested 6 Shelby Tube samples from borings BR-3R, BS-06 and ID-03R for moist and dry density values (Table 7-1). The tested moist density values are between 83.6 and 96.4 pcf with an average of 91.9 pcf. It is noted that the moisture density in both 1997 and the current investigation is significantly greater than the in-situ sand cone test results performed in 1981.

A total of 8 specific gravity values were obtained from the 1997 and current investigations, ranging from 2.76 to 3.27 with an average value of 3.07. The specific gravity of typical natural soil ranges from 2.50 to 2.80 (US Department of the Interior, Bureau of Reclamation, 1998). The grain size distribution curves are summarized in Figure 7-1. The grain size of the alum sludge is predominantly silt size. As can be seen from Table 7-1, about half of the samples were found to be non-plastic (primarily from the 1997 investigation). The remaining samples were classified as "elastic silt". The calculated void ratio ranged from 2.361 to 4.292 with an average of 3.221. The void ratio as well as the moisture content indicates that the alum sludge falls within the typical soft soil classification. Comparing with the moisture density measured from 1981 and 1997, it appears that the moisture density of the on-site sludge has slightly increased due to long time exposure.

Table 7-1. Index Properties of Alum Sludge

Boring No.	Sample No	Sample Depth (ft)	Moisture Content (%)	Liquid Limit	Plastic Limit	Sieve Minus No. 200 (%)	Hydro. % Minus 2 µm (%)	Moist Density (pcf)	Dry Density (pcf)	Specific Gravity
BS-03R	T-1A	8.35	90.9	59	49			96.4	50.5	
BS-03R	T-1B	8.9	108.1					91.7	44.0	
BS-03R	T-1C	9.45	106.7					94.2	45.6	
BS-03R	T-1D	10.0	123.9			93.0	18	91.3	40.8	3.173
BS-06	U-1C	3.55	84.9	NP	64	96.0	21	94.4	51.1	3.100
ID-03R	T-1C	1.25	157.1			86.7	26	83.6	32.5	2.756
SB-1	B	2.9	112.4	78	59			86.7	40.8	
SB-1	C	7.6	105.4	NP	NP	94.4	4	92.3	44.9	3.141

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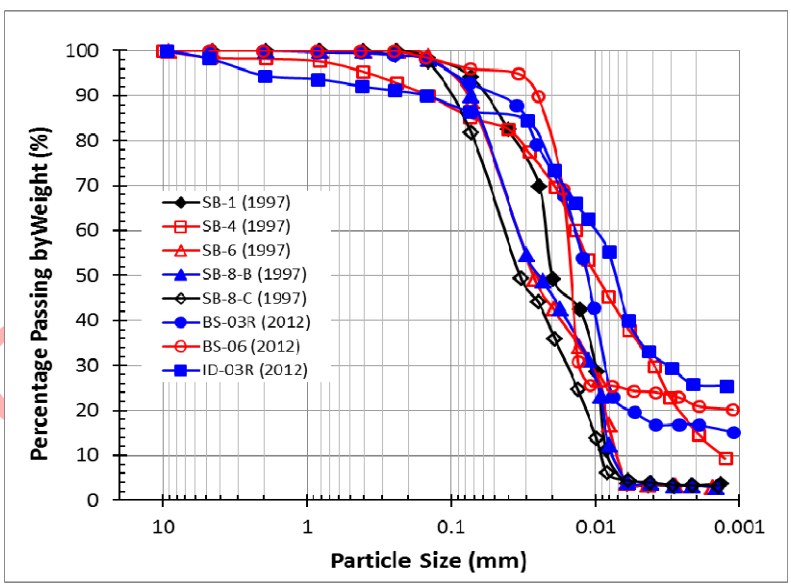
Table 7-1. Index Properties of Alum Sludge

Boring No.	Sample No	Sample Depth (ft)	Moisture Content (%)	Liquid Limit	Plastic Limit	Sieve Minus No. 200 (%)	Hydro. % Minus 2 µm (%)	Moist Density (pcf)	Dry Density (pcf)	Specific Gravity
SB-1	A	6.45	98					91.9	46.4	
SB-2	C	2.6	85.5					95.6	51.5	
SB-3	C	3.6	130.8	NP	NP			88.3	38.3	
SB-4	B	4.95	128.9	67	55	85.2	15	95.7	41.8	2.969
SB-6	B	2.95	90.7	NP	NP	89	4	93.3	48.9	2.890
SB-6	C	11.6	75.5	NP	NP			60.3	34.4	
SB-7	B	2.5	90.5					96.5	50.7	
SB-8	C	6.95	87.9					99	52.7	
SB-8	C	7.25	87.7	NP	NP	81.9	4	96.7	51.5	3.267
SB-8	C	7.7	69.3					102.7	60.7	
SB-8	B	10.5	71.7					97.9	57.0	
SB-8	B	11	79.5	NP	NP	90	4	98.6	54.9	3.271

The index properties of the on-site alum sludge are comparable with the properties of alum sludge from water treatment processes (Wu et. al., 2007; O'Kelly, 2008). Wu et al (2007) reported a case history of constructing a highway embankment over approximately 20 feet of alum sludge from a water treatment operation. The water treatment process involved the use of alum as a coagulant and lime and soda ash for softening. The index properties of the sludge were liquid limit = 125-135%, plastic limits = 40-43% and water content between 200% and 300%. O'Kelly (2008) also studied the geotechnical properties of different alum sludges from water treatment processes. The sludges had the following index properties: Liquid limit: 490%, plastic limit: 240%, specific gravity: 1.86, moisture density: 65 pcf and dry density: 9 pcf, void ratio: 12.2.

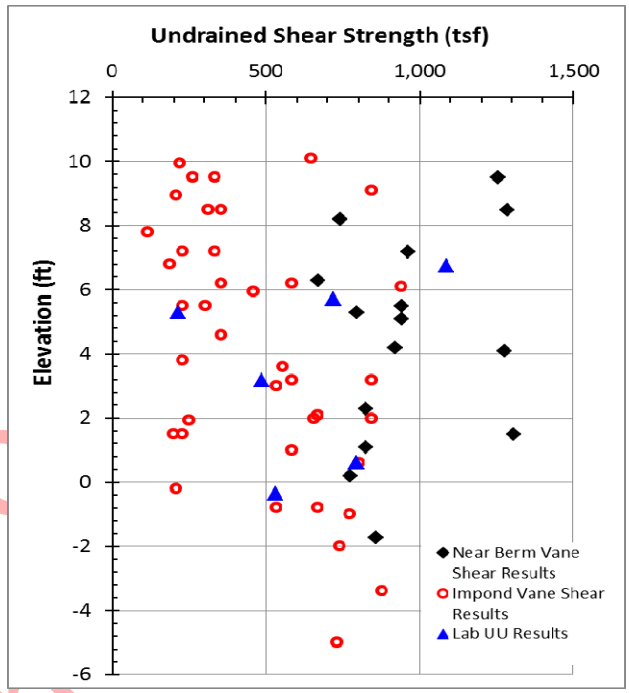
Figure 7-1 Grain Size Distribution of On-Site Alum Sludge



Undrained Shear Strength

When saturated soft cohesive soil is covered with overburden soils, the pore pressure within the soil will increase and the strength will decrease (in the short term). Before dissipation of the excess pore pressure, the stability problem should be evaluated by using the undrained shear strength of the soft soils (in this case, the alum sludge). The laboratory UU test results and vane shear test results (BBL, 1997) are summarized in Figure 7-2. From the field vane shear tests performed at different locations and the laboratory UU test results, it is clear that the undrained shear strength results from locations further into the ponds are generally lower than those near the berms. In addition, the results from locations within Impound 6 have the lowest undrained shear strength.

Figure 7-2. Tested Undrained Shear Strength of the On-Site Alum Sludge



The undrained shear strength can be estimated from the tip resistance from Cone Penetrometer Testing with Pore Pressure Measurement (CPTu) by using the following empirical relationship:

$$S_u = \frac{Q_c - \sigma_{v0}}{N_k}$$

where

Q_c = cone tip resistance;
σ_{v0} = total vertical overburden pressure;
N_k = empirical cone factor.

For soft soil, N_k ranges from 8 to 15 with an average of 12.5 (Lunne et al., 1997). Due to the variation of the N_k factor, the undrained shear strength obtained from the CPTu should be calibrated with laboratory or in-situ test results.

A total of twelve (12) CPTu borings were conducted during the current investigation phase. Eight (8) CPTu borings were performed within the sludge impoundments. If an N_k factor of 15 is used in the analysis, the undrained shear strength values from the CPTu borings within Impoundment 6 (CPT-08 & CPT-08A) are similar to those from vane shear test results from the same pond (Figure 7-3). Based on this

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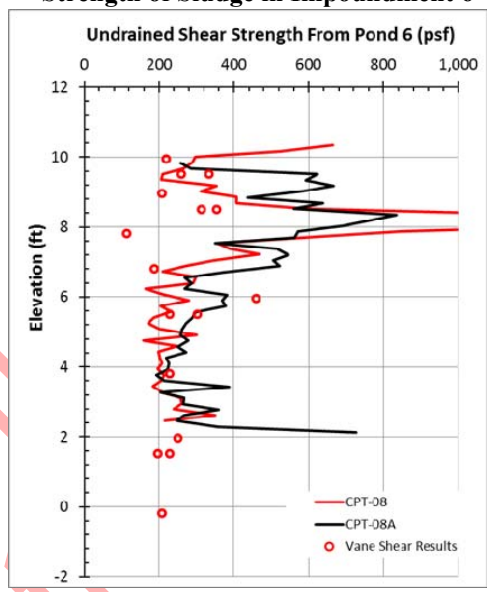
observation, it was decided that an N_k factor of 15 should be utilized to determine the undrained shear strength of the sludge.

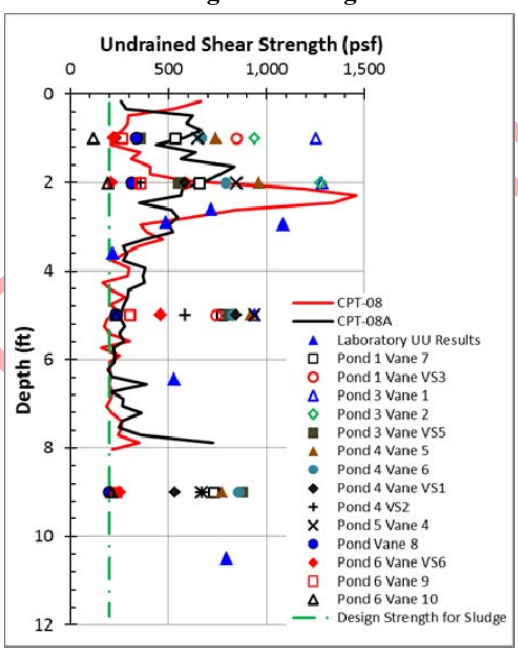
Figure 7-3 Tested Undrained Shear Strength of Sludge in Impoundment 6



O'Kelly (2005) indicated that the shear strength of the alum sludge increases with a decrease in moisture content. It is also noted that the strength of the on-site sludge varies significantly due to the desiccation (loss of moisture content), inundation, and compression by the overburden soils. The variation of shear strength was observed in the field investigation. Higher SPT N values were encountered in the sludge layers underneath the soil berms (i.e., Boring BD-01R) or above groundwater elevations (i.e., BS-03).

Figure 7-4 summarizes the undrained shear strength values from laboratory UU tests, field vane shear tests, and field CPTU tests. The undrained strength values are very scattered but a value of 200 psf represents the lowest tested undrained shear strength value of sludge. Therefore, a minimum design undrained shear strength of 200 psf is recommended for the stability analysis in this project.

Figure 7-4. Design Undrained Shear Strength for Sludge



Drained Effective Shear Strength

The long-term stability of the site under the proposed fill loads should be calculated utilizing drained (effective) strength parameters. Undisturbed sludge samples were collected and tested using the direct shear test under drained conditions in 1997 (BBL, 1997). The tested peak strength was 300 psf cohesion and 35º internal friction angle. If the cohesion is neglected, the equivalent internal friction angle under each vertical loading varies from 36º to 48º.

During the current investigation, both undisturbed as well as remolded sludge samples were tested for effective strength parameters by using the Consolidated Undrained Triaxial Shear Test with Pore Water Pore Water Pressure Measurement (CIU) method. The resulting effective shear strength parameters for the undisturbed samples were zero cohesion and an internal friction angle of 63º.

The test results for the remolded samples with the same density and moisture content as the undisturbed samples indicated an internal friction angle of 44º with zero cohesion. These tests demonstrate an unconventionally high internal friction angle.

Baker further performed an extensive literature review to detemine if these high effective strength values were reasonable. Wu et al. (2007) determined that the alum sludge at an Ohio embankment construction site had a range of internal friction angles from 38º to 41º, depending on the triaxial test method. The sample tested had an initial moisture content of 250%. O'Kelly (2008) reported a CIU test results of 39º on a sludge sample with 250% of initial moisture content. In the current study, the moisture content of the sludge samples are around 100%. It is reasonable that the strength of the on-site sludge has a higher strength. For design purposes, an internal friction angle of 36º was conservatively used in the analysis due to the small amount of sludge samples tested.

Compressibility

A total of seven (7) consolidation test results on the on-site sludge are available; three (3) tested at the current stage and four (4) samples tested in 1997. Curves showing the volumetric strain vs. consolidation pressure are presented in Figure 7-5 and the test results are summarized in Table 7-2. Only six (6) tests are shown in Table 7-2 since the results from Boring SB-8 (1997) were unreasonable and were discarded. From Table 7-2 and Figure 7-6, it can be seen that the compressibility of the different sludge samples is

Table 7-2. Summary of Consolidation Tests on Sludge

Sample	Depth (ft)	Water Content (%)	Effective Overburden Pressure (tsf)	Initial Void Ratio	Compression Index, C_c	Recompression Index, C_r	P'c (tsf)	OCR
BS-03R/T-1D	10	123.9	0.269	3.875	1.287	0.029	2.4	8.9
BS-06/U-1C	3.55	84.9	0.168	2.790	0.731	0.030	3.2	19.1
ID-03R/T-1C	1.25	157.1	0.052	4.289	0.968	0.053	0.4	7.7
SB-1	7.6	105.4	0.207	3.362	1.152	0.022	2.7	13.0
SB-4	4.95	128.9	0.151	3.948	0.975	0.020	0.9	5.9
SB-6	2.95	90.7	0.138	2.686	0.767	0.022	3.1	22.5
Average		115.2	NA	3.492	0.980	0.029	2.12	12.9
Standard Deviation		27.0	N/A	0.656	0.215	0.012	1.18	6.7

similar to each other in terms of the compression index as well as the recompression index. However, the "pre-consolidation pressure" is significantly different. Generally, higher pre-consolidation pressure value is associated with lower moisture content of the sample. It is worth noting that the term "pre-consolidation pressure" here is not necessarily associated with the past overburden pressure in classical soil mechanics. Besides the overburden soil pressure, the desiccation or chemical reactions within the

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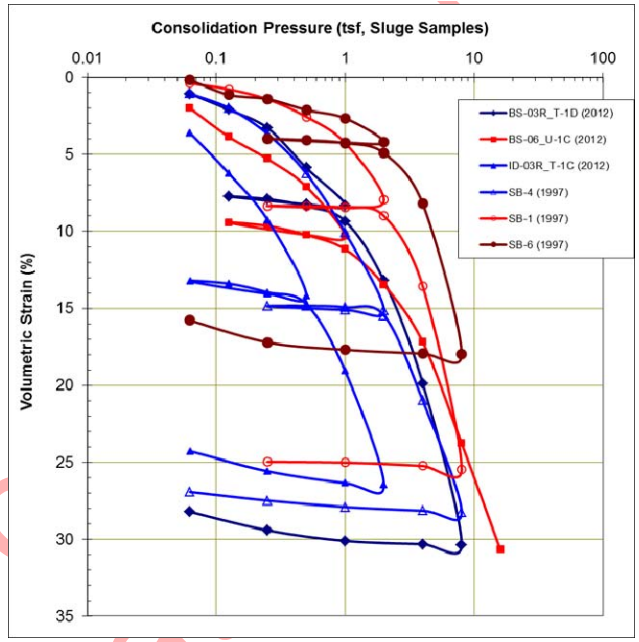
sludge will likely increase the tested "pre-consolidation pressure".

At Ohio embankment over sludge site (Wu et al., 2007), the tested pre-consolidation pressure of 0.3 tsf for sludge with 250% moisture content seems to be independent with the depth. At current site, a minimum pre-consolidation pressure of 0.4 tsf is assumed for the settlement analysis.

Figure 7-5. Summary of Consolidation Test Results on Sludge



Settlement Rate

The settlement rate of the soft sludge is related to the rate of consolidation. The rate of consolidation in the vertical direction is evaluated through laboratory consolidation tests. The rate of consolidation in the horizontal consolidation can be evaluated using CPTu dissipation test result. The laboratory tested coefficients of consolidation values in the vertical direction are summarized in Table 7-3. The average coefficient of consolidation is several square feet per day and the value does not decrease with an increase in consolidation pressure. The test results are very similar to the value of average laboratory tested coefficient of consolidation of 3.72 ft^2/day determined by Wu et al. (2007). The coefficient of consolidation of a typical soft cohesive soil is 0.05 square feet per day.

Table 7-3. Summary of Laboratory Tested Coefficient of Consolidation

Boring/Sample I.D.	Effective Overburden Pressure (tsf)	Coefficient of Consolidation (ft^2/day) at Consolidation Pressure (tsf)							
		0.0625	0.125	0.25	0.5	1	2	4	8
BS-03R/T-1D	0.269	6.85	6.43	6.16	6.00	5.37	5.06	4.65	3.80
BS-06/U-1C	0.168	7.18	6.41	5.53	5.67	1.18	1.77	0.83	0.18
ID-03R/T-1C	0.052	0.24	0.22	0.13	0.27	0.59	0.72		
SB-1	0.207		10.65	19.27	7.42	6.69	9.65	7.17	6.89
SB-4	0.151	1.85	4.79	3.32	2.16	2.17	2.65	3.25	3.36
SB-6	0.138	6.12	4.56	4.49	5.93	0.81	17.47	16.54	7.47

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Table 7-3. Summary of Laboratory Tested Coefficient of Consolidation									
Boring/Sample I.D.	Effective Overburden Pressure (tsf)	Coefficient of Consolidation (ft^2/day) at Consolidation Pressure (tsf)							
		0.0625	0.125	0.25	0.5	1	2	4	8
Average		3.72	4.74	5.59	3.99	2.54	5.62	6.07	4.95

The coefficient of consolidation in the horizontal direction, C_h, can be obtained through the use of CPTu dissipation test results and the following equation (Houlsby and Teh, 1988):

$$C_h = \frac{T_{50}^{*} R^2 \sqrt{I_r}}{t_{50}}$$

where:

T^*_{50} = modified dimensionless time factor for 50% of pore pressure dissipation, as recommended by Houlsby and Teh (1988), T^*_{50} = 0.245 for pore pressure filter at the U_2 location.

R = Radius of the CPTu probe (1.83 cm or 0.72 inch).

I_r = Soil rigidity index. A rigidity index of 100 was used for the sludge.

t_{50} = Time duration at 50% dissipation of excess pore pressures.

Robertson *et al.* (1992) reviewed dissipation data from CPTU tests to predict the coefficient of consolidation using Houlsby and Teh's (1988) solutions with reference values from laboratory tests and field observations. The review showed that the Teh and Houlsby solution provided reasonable estimates of C_h. Results were evaluated for pore pressure data from different filter locations and the least scatter was obtained with the pore pressure element location immediately above the cone *(u_2)*. The coefficients of consolidation in the horizontal direction estimated from the CPTU dissipation test results are summarized in Table 7-4.

Table 7-4. Summary of CPTu Dissipation Results					
Boring	Dissipation Depth (ft)	Effective Overburden Pressure (tsf)	t_{50} (min)	t_{50} (second)	c_h (ft^2/day), Houslby and Teh (1988)
CPT-04	11.3	0.410	0.89	53.3	22.36
CPT-05	10.8	0.375	0.75	45.2	28.48
CPT-08	10.5	0.375	0.16	9.6	113.32
CPT-09	7.05	0.268	0.24	14.2	87.35
CPT-12	7.05	0.268	1.17	70.4	17.96

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Table 7-4. Summary of CPTu Dissipation Results					
Boring	**Dissipation Depth (ft)**	**Effective Overburden Pressure (tsf)**	**t_{50} (min)**	**t_{50} (second)**	**c_h (ft^2/day), Houslby and Teh (1988)**
				Average Value:	**53.89**

The average in-situ CPTu dissipation tested coefficient of consolidation in the horizontal direction is approximately one magnitude higher than the laboratory tested value. This result is consistent with CPTu dissipation results in other stratified soils. A coefficient of consolidation in the vertical direction of 4 square feet per day was used in estimating the settlement rate of the on-site sludge.

Tested Permeability of the Alum Sludge

The permeability of the impound sludge has historically been extensively evaluated. In June 1981 (M. Disko Associates), the remolded sludge samples from all six impoundments were laboratory tested for permeability (Table 7-5). M. Disko Associates (September 1981) also tested the permeability of sludge samples at depths 2 ft above the underlying soil. The average coefficient of permeability is $4.4(10)^{-5}$ cm/sec for remolded soils and $3.67(10)^{-5}$ cm/sec for in-situ sludge. It was concluded that the permeability of the sludge is little different between remolded and undisturbed samples.

Table 7-5. Laboratory Tested Permeability Results on Sludge (June & Sept., 1981)			
Sample	**Unit Weight (pcf)**	**Permeability (cm/sec, Remolded Sample, Jun.)**	**Permeability (cm/sec, Undisturbed Sample, Sept.)**
Impound 1 (Edge)	59.09	1.19E-04	1.49E-05
Impound 1 (Center)	51.51	6.57E-06	3.65E-05
Impound 2 (Edge)	36.42	5.61E-05	1.67E-05
Impound 2 (Center)	46.75	6.05E-05	1.05E-05
Impound 3 (Edge)	81.88	4.02E-05	2.58E-05
Impound 3 (Center)	81.32	2.63E-05	5.90E-06
Impound 4 (Edge)	51.96	1.03E-04	8.07E-06
Impound 4 (Center)	48.92	5.73E-05	3.06E-06
Impound 5 (Edge)	39.7	8.06E-06	8.00E-05
Impound 5 (Center)	50.6	2.28E-05	3.09E-05
Impound 6 (Edge)	66.47	1.34E-05	9.15E-05
Impound 6 (Center)	42.31	1.62E-05	2.67E-05

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The permeability can also be indirectly evaluated from the consolidation test results (Table 7-6). The samples below were from the 1997 and current (2012) investigations. The permeability values range from $7.94(10)^{-6}$ cm/sec to $5.70(10)^{-7}$ cm/sec. The calculated permeability generally reduces with an increase in consolidation pressure.

Table 7-6. Permeability of Sludge From Laboratory Consolidation Tests

Boring/Sample I.D.	Coefficient of Permeability (cm/sec) at Consolidation Pressure (tsf)							
	0.0625	0.125	0.25	0.5	1	2	4	8
BS-03R/T-1D	5.16E-06	9.74E-06	5.33E-06	3.39E-06	2.77E-06	8.32E-07	1.20E-06	8.32E-07
BS-06/U-1C	1.23E-05	1.85E-05	7.29E-06	3.56E-06	5.36E-07	1.53E-07	1.46E-07	2.68E-08
ID-03R/T-1C	1.40E-06	7.64E-07	3.38E-07	4.97E-07	4.25E-07	4.64E-07		
SB-1	7.96E-06	8.81E-06	7.68E-06	2.46E-06	1.92E-06	2.44E-06	6.45E-07	1.51E-07
SB-4	2.54E-06	7.15E-06	3.78E-06	2.11E-06	1.63E-06	1.35E-06	5.86E-07	5.49E-07
SB-6	1.24E-06	2.67E-06	2.78E-06	1.04E-06	1.18E-07	8.15E-07	1.12E-06	1.29E-06
Average	5.10E-06	7.94E-06	4.53E-06	2.18E-06	1.23E-06	1.01E-06	7.39E-07	5.70E-07

In the current investigation, one composited, remolded sludge sample was laboratory tested using using the constant head permeability method, resulting in a permeability value of $6.43(10)^{-6}$ cm/sec, which is very similar to in-situ test results and laboratory test results on undisturbed samples.

7.1.2. Organic Clays/Silts and Peat

Based on the subsurface investigations, the soil underlying the sludge (and earthen berms) consists of a peat layer and a soft organic clay/silt layer followed by a stiff clay or alluvial layer before hard residual soil is encountered. The peat layer however is commonly intermingled with the underlying soft clay/silt so that a clear interface between the two often cannot be defined. Beneath the berms and impounds, the two layers are roughly 10 to 11 feet thick, while within the wetlands, the two layers are closer to 16 feet thick. The lower thickness of the peat and clay/silt layer on the Rahway Arch property may be due to settlement caused by the overlying sludge and berm materials.

According to Leroueil and Rowe (2001), peat is defined as a soil material with ash content less than 20% or organic content greater than 80%. Typically, this material also has very high moisture contents, low

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dry density, very low shear strength, and very high compressibility (Samson and Rochelle; 1972, Rowe et al, 1984; Duncan et al, 1989; Schober et al, 1993; Volk et al, 1994; Rowe and Mylleville, 1996; Mesri et al, 1997, Leroueil and Rowe, 2001). Samson and Rochelle (1972) reported a case history involving the use of surcharge loading at a highway project in Canada where construction of an embankment over peat deposits was conducted. The original thickness of the peat material varied from 11 to 19 feet with an average organic content of 91%, void ratio of 14 and moisture content of 890%. Under an approximate embankment and surcharge height of 10 feet, the observed total settlement during the two year construction period was 5 to 11 ft.

Rowe et al (1984) reported that a roadway embankment 19.5 ft high was constructed over a highly compressible peat deposit using geotextile reinforcement. The thickness of the peat in this deposit varied between 15.8 ft and 18.7 ft. The average moisture content of peat was 445% and 785% at the two investigated Sections (A and B). The average unit density was 66.2 pcf with an organic content of 50%. The average in situ vane shear strength was 355 psf with a "remolded shear strength" of 135 psf. The observed maximum settlement was 15.4 ft.

Volk et al (1994) reported on the construction of an embankment over peat/organic soil in the coastal plain of New Jersey. The peat/organic soil thickness varied between 20 to 23 ft; the moisture content ranged from 97% to 240%; liquid limits were between 90% and 200%, and plasticity indices ranged from 30% to 80%. The measured total unit weight ranged from 70 to 90 pcf. The laboratory tested unconsolidated undrained shear strength was 100 psf for the root mat at the top and varied from 30 psf to 200 psf in the organic soil layer. The design embankment height varied from 9 feet to 15 feet high. The final embankment elevation was achieved through a staged construction process with four embankment loading stages in order to maintain the stability of the embankment. The observed vertical settlement was approximately 6 feet with 2 feet of lateral deflection.

The organic content of the soft clays/silts and peat at this site were generally less than 20%, therefore they don't meet this definition, however, they have other properties in common with peat, such as high liquid limits and plasticity indices, elevated moisture content. As indicated from the above summary, the index and mechanical properties of the soil samples are very important to the design and construction of the embankment.

<u>Index Properties</u>

The index properties of the organic clays/silts and peat at the site are summarized in Table 7-7. As can be seen from this table, the organic content ranged from 24% to 39%. According to Leroueil and Rowe (2001), peat is a soil with an organic content greater than 80%, therefore the soft soil at the site might not

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be classified as a "peat". And according to the Unified Soil Classification System (USCS), the soft soils at the embankment site can be classified as Elastic Silt with Sand (MH) or Silt with Sand (ML).

The void ratio of the soil was determined using the one-dimensional consolidation test. This value ranged from 5.758 to 11.385, indicating that the soil might be very compressible. The unit weight varied from 63.2 pcf to 73.9 pcf. Considering the potential moisture lost during sample extraction and transportation, an average unit weight of 70 pcf is recommended for the analysis. Comparing the unit weight of the soils at the project site with recent case histories of highway embankment construction over organic soil within the coastal plain of New Jersey (Volk et al, 1994), it is clear that the unit weight at the current project site is even smaller.

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Table 7-7. Index Properties of Organic Clays/Silts and Peat

Boring No.	Sample No	Sample Depth (ft)	Moisture Content (%)	Liquid Limit	Plastic Limit	Sieve Minus No. 200 (%)	Hydro. % Minus 2 µm (%)	Moist Density (pcf)	Dry Density (pcf)	Specific Gravity
BD-01R	T-1	25.0	72.9	291	173	79.0	16.0	100.6	58.2	2.36
BD-03	T-1	24.0	65.1-80.9	105	45	66.0	18.0	90.2	51.4	2.53
BD-03	S-12	26.0	73.8	89	35	57.0	14.0			
BD-04R	T-1	22.0	75.0-81.9	98	41	93.0	18.0	93.1	51.2	
BD-05	S--5	15.0	70.9	78	34	82.0	16.0			
BS-02	T-1	8.0	375.7-384.1	467	256	62	21	78.3	13.6	2.14
BS-04	T-1	24.0	71.9-110.5	93	58	87	21	96.0	45.6	
BS-09	T-1	13.0	58.6-170.9	241	113	43	8		24.3-92.6	2.52
ID-06	U-2	15.0	96.4-120.9	130	43	94	32	91.3	46.5	2.58
IS-02	U-1	20.0	37.5-223.1	33	22	69	14		22.7-86.2	2.63
W-05	T-1	16.0	26.1-27.0	25	15	53	15	123.6	97.3	
W-08	U-1	15.0	30.4	36	16	87	33	119.8	91.9	
A-5-3	TS-1	5.0	63.6-93.6	52	40	98.3	17	89.2-98.6	46.1-59.5	
A-5-4	TS-1	3.0	64.1-77.1	38	32	98.4	3	94.3-97.5	55.5-56.1	
A-7-1	A	11.0	18.4-454.1	258	105	63.6	21	80.2-107.4	31.5-67.7	
A-7-3	B	9.0	47.3-145.9	106	37	86.2	32	86.7-91.7	37.8-45.8	
CR-10	B	9.0	21.6-22.4	28	20	88.6	10	117.5-127.9	105.2	
CR-24	D	7.0	89.8-557.8	398	144	80.2	27	65.6-74.0	10.0-11.5	
CR-36	ST-1	6.0	92.2-142.4	122	42	98.4	38	83.2-97.9	34.3-51.0	
CR-41	C	8.0	50.3-91.6	59	41	96.4	13	91.4-97.7	47.7-56.1	
CR-66	TS-2	7.0	15.3-22.0	24	16	64.6	10	126.2-132.5	108.6	
CR-74	TS-1	9.0	51.4-60.8	44	39	89.6	11	99.0-102.4	63.0-67.7	

Undrained Shear Strength

For geotechnical analyses, the undrained shear strength, S_u, of the underlying peat and clay/silt soils was evaluated using several methods and data sources, including derivation of field CPT derived strengths

using an N_k factor of 15, using shear strengths derived from laboratory unconsolidated-undrained (UU) triaxial tests, and using the SHANSEP (Stress History and Normalized Soil Engineering Parameter) method. SHANSEP is an empirical method used to estimate the undrained shear strength of cohesive soils (Ladd et. al, 1993). It is a common approach recommended in the FHWA Soil and Rock Properties manual (FHWA-IF-02-034). The equation is given as: $S_u=0.23\sigma'_v OCR^{0.8}$.

The soil strengths were evaluated for different locations, namely impound soils, soils underneath or close to the existing berms, and wetland soils. Results are presented in Figure 7-6 to 7-8. Two major findings are presented herein:

- The organic peat and clay/silt soils within the impounds and underneath the berms have higher strengths than those at the wetland areas. CPT curves for soils underneath the berms are more scattered at the top perhaps due to mixing of the overlying berm materials with the native clays.
- The results from the laboratory UU tests, field CPT data interpretation, and the SHANSEP method correlate fairly well with each other.

From these results, the initial S_u (prior to loading by the proposed cap) was determined to be 240 psf for impound peat and organic clays, 260 psf for soils underneath the existing berms, and 190 psf for wetland soft clays. Upon consolidation, the soil strengths are expected to increase. Depending on specific

Figure 7-6. CPTs Near Berms – Initial Undrained Shear Strength (psf)

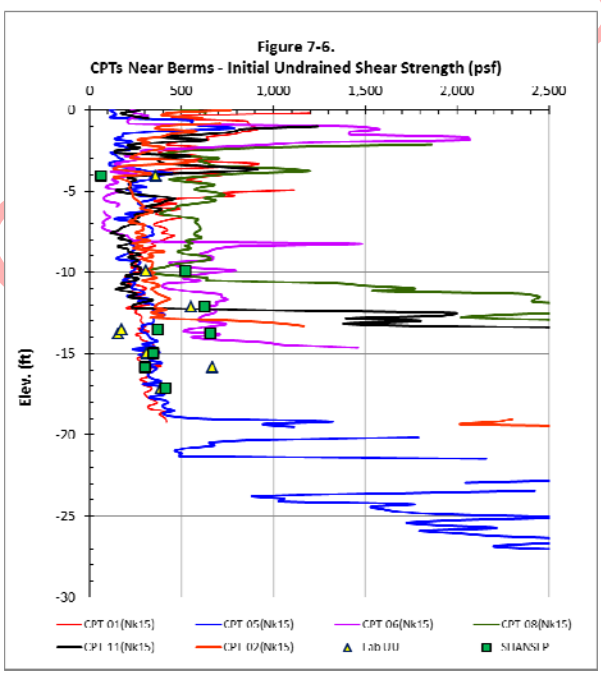
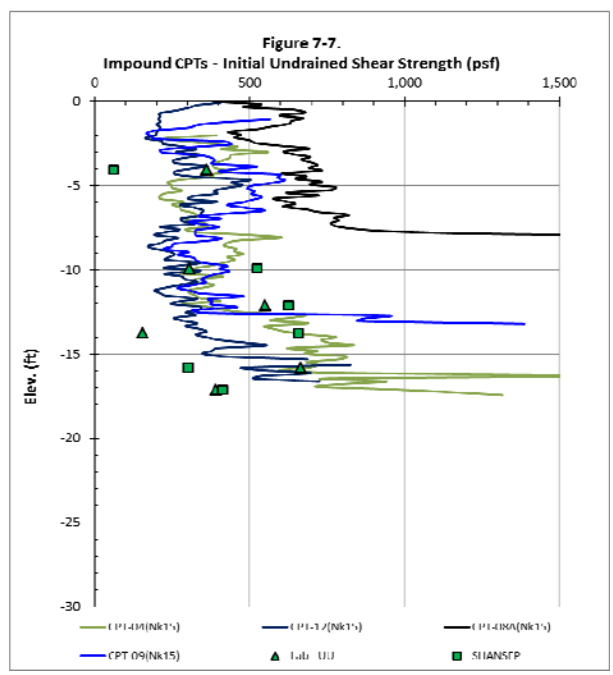
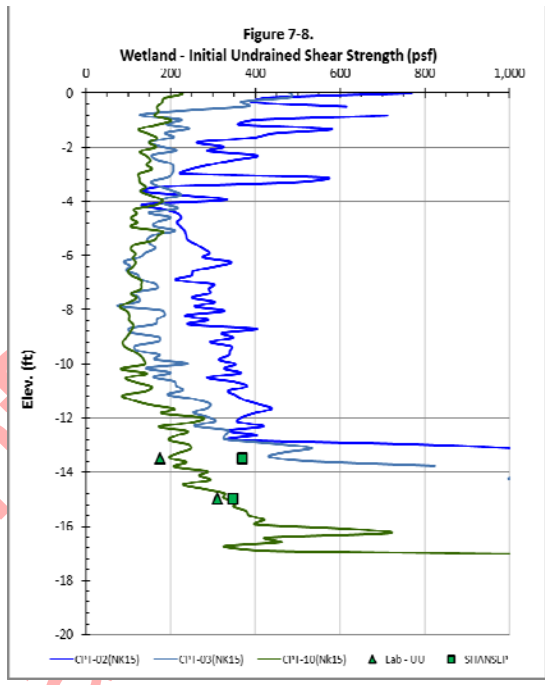


Figure 7-7. Impound CPTs – Initial Undrained Shear Strength (psf)



locations, a shear strength value (S_u) of 400 psf to 450 psf (and 220 psf for wetland soils) was used for geotechnical analyses for subsequent construction stages. These values were determined from using the upper bound of the CPT curves. Overall, these estimated soil shear strengths are conservative.

Figure 7-8. Wetland CPTs– Initial Undrained Shear Strength (psf)



Compressibility

A total of fifteen (15) consolidation test results on the on-site sludge are available; five (5) tested during the current investigation and ten (10) samples tested in 2006. Test results are summarized in Table 7-8. In order to reasonably estimate the settlement amount, one of the key parameters is the soil pre-consolidation pressure, P_c, as it is used to determine whether the in-situ soil is normally consolidated or over-consolidated.

The laboratory consolidation tests included an estimation of P_c using the Cassagrande method, typically involving a search for the sharpest curvature (a turning

Table 7-8. Summary of Consolidation Tests on Peat and Clay/Silts

Sample	Depth (ft)	Water Content (%)	Effective Overburden Pressure (psf)	Initial Void Ratio	Compression Index, C_c	Recompression Index, C_r	P'c (psf)	OCR
BD-04R/T-1	22.0	75.0	1,450	2.000	0.83	0.13	1,440	1.0
BS-02/T-1	8.0	375.7	380	8.150	5.64	0.64	920	2.4
BS-09/T-1	13.0	58.6	870	1.279	0.48	0.06	1,660	1.9
ID-06/U-2	15.0	120.9	600	2.466	0.79	0.13	980	1.6
IS-02/U-1	20.0	99.3	1,060	0.904	0.41	0.04	2,160	2.0
A-5-3/TS-1	5.0	93.6	188	2.643	0.743	0.026	2,000	10.6
A-5-4/TS-1	3.0	75.8	113	2.106	0.547	0.037	4,200	37.2
A-7-1/B	11.0	154.2	414	3.650	1.841	0.237	600	1.5
A-7-3/B	9.0	129.4	338	3.620	1.705	0.162	600	1.8
CR-10/B	9.0	21.6	338	0.591	0.062	0.006	9,400	27.8
CR-24/D	7.0	557.8	263	10.147	5.127	0.959	400	1.5
CR-36/ST-1	6.0	142.4	226	3.802	1.623	0.120	400	1.8
CR-41/C	8.0	91.6	301	2.405	0.678	0.027	2,400	8.0
CR-66/TS-2	7.0	22.0	263	0.604	0.008	0.101	6,400	24.3
CR-74/TS-1	9.0	60.8	338	1.578	0.428	0.008	9,000	26.6
Average		138.6	476	3.063	1.394	0.179	2837	10.0
Standard Deviation		143.0	371	2.706	1.713	0.267	3039	12.4

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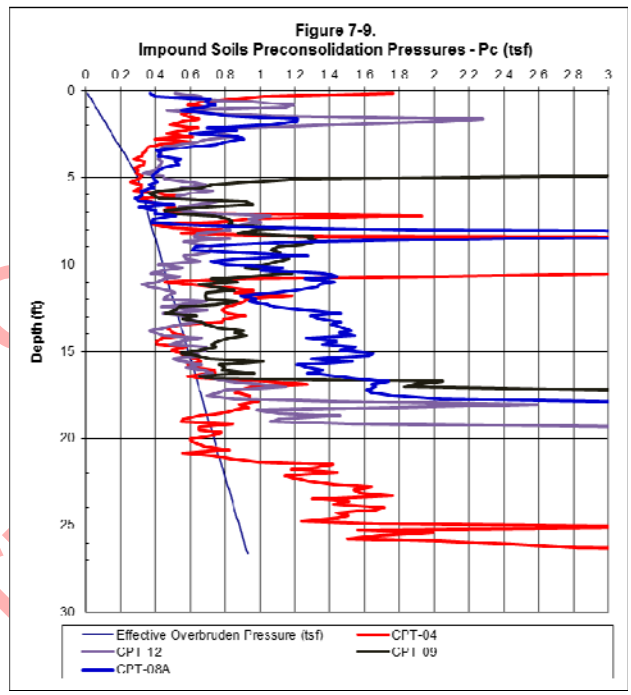
point) of the consolidation e-log(p) curve. However, the judgment of the curvature is highly arbitrary and empirical. Current laboratory test results generally indicate higher than expected P_c. Due to the highly sensitive and soft nature of the in-situ soils and thus the high tendency of sample disturbance during transportations, these estimated pre-consolidated pressures may not be reliable.

Both Paul Mayne (2007) and Dermers (2002) provided an alternative approach to estimate P_c based on in-situ CPT data. The formula is given as $P_c = (1/3.4) \times (q_t - \sigma'_v)$ or similarly, $0.33P_c \times (q_t - \sigma'_v)$, where q_t is the cone tip resistance and σ'_v is the effective overburden stress of the soil. These approaches involve the use of in-situ data so that the sample disturbance issue can be avoided. For the current settlement analyses, the P_c was determined using these approaches. Results are provided in Figure 7-9. The preconsolidation pressure for peat and the soft organic clay/silts was estimated to be 0.6 tsf and 0.65 tsf, respectively. As can be seen from Figure 7-9, the soils close to ground surface have higher values of preconsolidation pressure possibly due to drying.

Figure 7-9. Impound Soils Preconsolidation Pressures – Pc (tsf)



7.1.3. Stiff Clay, Alluvial Soils, and Residual Soils

As stated earlier, these soils consist of relatively dense sands and gravels (Stratum VI and some Stratum VII soils) and stiff to very stiff clays and silts (Stratum V and some Stratum VI soils). There is no available shear strength or consolidation testing data available for these soils, primarily due to the difficulty in obtaining undisturbed samples in dense cohesionless soils and very stiff cohesive soils. Stratum V (stiff clay/silt) soils within this layer can be generally classified as Clayey SILT (CL) to Silty CLAY (CL), Fat CLAY (CH) and Lean CLAY (CL) with varying amounts of Sand. The SPT-N values varied from 4 to over 60 bpf, averaging 24 bpf, with the bulk of the N-values lying between 10 and 40. Stratum VI soils (alluvial soils) can be generally classified as Silty GRAVEL (SM) with Sand; Poorly-Graded GRAVEL (GP) with Sand; Clayey SAND (SC); Silty SAND (SM); and Sandy SILT (ML). The SPT-N values varied from 0 to over 200 bpf, averaging 55 bpf, with the bulk of the N-values lying between 15 and 50. Stratum VII soils (residual soils) can be generally classified as Clayey SAND (SC) and Clayey SILT (ML) to Sandy Lean CLAY (CL). The SPT-N values varied from 10 to over 200 bpf, averaging 59 bpf, with the bulk of the N-values lying between 25 and 65.

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7.2. GEOTECHNICAL ANALYSIS

The design and construction of an embankment over very soft organic soil/peat materials has been widely discussed and case histories have been reported (Weber, 1969; Samson and Rochelle, 1972; Lefebvre et al., 1984; Rowe et al., 1984; Bonaparte and Christopher, 1987; Duncan et al., 1989; Schober et al., 1993, Volk et al., 1994; Holtz et al., 1998; Christopher et al., 2000; Kerr et al., 2001; Leroueil and Rowe, 2001; and Hinchberg and Rowe, 2003). Different design procedures have been developed to address the very low shear strength and very high compressibility of the organic soil/peat material (Holtz et al., 1998; Christopher et al., 2000; and Leroueil and Rowe, 2001).

The Federal Highway Administration (FHWA) provided a guideline for the design and construction of an embankment over soft soils (FHWA HI-95-038). Most findings from aforementioned studies are incorporated in the manual. For the current remediation project, this guideline is followed step by step to perform analyses and design of the fill cap.

7.2.1. Define Fill Cap Dimensions and Loading Conditions

As shown in the cross sections provided by Eaststar, the cap is to be constructed to a maximum elevation of EL ±36 with side slopes being no steeper than 8H:1V. The only exception is for impound 6, which has a lower elevation compared to the other impounds (EL ±26). It should also be noted that toes of the proposed fill caps are always retained by berms. Berms will be proposed if there is no existing one to retain the cap. According to the proposed cross sections, the top of retaining berms are at E.L. 10 with a minimum width of 20 ft. For geotechnical analyses, an 11-ft wide berm is conservatively used based on the measured minimum width of existing berms surrounding the site. Generally, the existing soil berms have a slope of greater than 3H:1V towards the lower wetlands at E.L. 2.

Within the project limits, one section representing an unfavorable subsurface condition was selected for various analysis purposes. The section was cut approximately from the southwest edge of Impound No. 6 where boring BS-01 was located, to the east edge of Impound No. 2. The proposed cap fill along the section spans approximately 1,100 ft. This section was accurately modeled for settlement studies. In the final global stability models, however, the fill cap width was cut in half to 700 ft to simplify the analysis.

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7.2.2. Establish Soil Profile and Determine Engineering Properties of Foundation Soil

In all analytical models, the impound surface was considered to be at elevation EL 10, which is level with the top of the existing berm. The in-situ soils were characterized, in descending order, as a 13 feet thick sludge layer, 5 feet of peat meadow mat, 7 feet of organic clay/silt, and a 2 feet thick stiff clay layer. Lying underneath these compressible soils is the dense to very dense alluvial and residual soil which extends to elevation EL -40, approximately the top of the shale bedrock. The residual soil stratum is hard enough to be considered incompressible. Detailed discussions regarding the strengths and compressibility of the each soil layer are provided in the previous sections.

It should be noted that the field investigation indicated that the actual impound sludge layer has a maximum thickness of roughly 20 feet. However, a portion of the sludge has SPT-N values greater than 15, indicating a very stiff material. This portion was excluded in the sludge analyses. The modeled sludge layer in the analysis represents the soft part of the actual material. A thickness of 13 feet is reasonably conservative.

7.2.3. Obtain Engineering Properties of Fill Materials

The cap material used by Soil Safe for previous projects has a wide grain size range. It has been classified as silty gravel (GM), silty sand (SM) and clayey sand with silt (SC-SM) under the USCS classification system or as A-2-4 under the AASHTO classification system. The bulk density of the material varies from 102 pcf to 127 pcf with natural moisture contents in the range of 7%-10%. Upon compaction at the optimum water content, the maximum dry density of the material can be 127.7 pcf. According to the Remedial Action Workplan, the same cap material will be used for the current project. Permeability of the cap fills is no greater than 2×10^{-6} cm/sec. In the analyses, this material was conservatively modeled as granular sand with a moisture density of 120 pcf and an internal friction angle of 33˚, although the actual material is believed to have some cohesion due to its low permeability.

7.2.4. Suggested Minimum Factors of Safety

The following factors of safety are typically recommended:

- Overall Bearing Capacity: 1.5
- Global (Rotational) Shear Stability at the End of Construction: 1.2*
- Internal Shear Stability, Long Term: 1.5
- Lateral Spreading (Sliding): 1.5

*: FHWA suggests an F.S of 1.3 for the global stability of embankments in the short term, utilizing rotational critical

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failure circle methods.

For this project, considering the highly sensitive and soft nature of the in-situ soils, a random failure plan search method was used instead. The random method searches the most critical curve along the weakest zone within soil layers and such a curve does not necessarily need to be circular in shape. Therefore, this method should yield more realistic results. Past experience on other projects related to highway embankments on soft soils indicate that the F.S. using the random search method is 0.3 to 0.6 lower than those derived from the conventional circle methods. Since this method typically yields more conservative results, it was decided to use a F.S of 1.2 for short term stability. The F.S. for long term global stability analysis, however, was maintained as 1.5, regardless of the analysis methods used.

7.2.5. Check Bearing Capacity

Due to the large width of the proposed cap fill (> 600 ft), the bearing capacity of the foundation soil estimated from conventional methods is not a concern. However, both Holtz et al (1998) and Leroueil & Rowe (2001) point out that classical analyses are not appropriate if the thickness of the underlying soft deposit is small compared to the width of the embankment. In this case, high lateral stresses in the confined soft stratum beneath the embankment could lead to a lateral squeeze type failure. Failures due to lateral squeeze can be evaluated based on FHWA's Soils and foundation Workshop Manual (FHWA-NHI-00-045, 2000). The threshold condition for lateral squeeze is given as:

$$\gamma_{fill} H < 3S_u$$

where γ_{fill} is the unit weight of the fill, H is the height of the embankment, s_u is the undrained shear strength of the foundation soil.

Assuming that the initial S_u of the sludge deposit is 200 psf and the initial fill density is 120 pcf, the maximum height of the cap is calculated as 5 feet, indicating that staged construction is required for cap installation. Each lift shall not be greater than 5 feet. After the completion of the first lift, the undrained shear strength of the sludge shall increase upon its consolidation. Since the consolidation coefficient (C_v) of the sludge is high, the waiting period between each construction stage is not expected to be long.

According to the Workshop, the equation for Safety Factor against Lateral Squeeze is given as:

$$FS = \left[\frac{2S_u}{\gamma \cdot D_s \cdot \tan\theta}\right] + \left[\frac{4.14S_u}{\gamma \cdot H}\right] \quad \text{(Silvestri, 1983)}$$

where:

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θ = angle of slope ($\tan(\theta)$ = 1V : 8H = 0.125)
γ = unit weight of the fill (120 pcf)
D_S = depth of soft soil beneath the toe of the end slope or side slope of the fill (13-ft sludge + 5-ft peat + 7-ft organic clay + 2-ft stiff clay = 27 ft total)
H = height of the fill (first lift = 5 ft)
S_u = undrained shear strength of soft soil beneath the fill (200 psf)

Solving this equation using these parameter values, an F.S. of 2.0 can be achieved. Overall, based on the bearing capacity evaluation, the cap should be installed in stages with a maximum of 5 feet fill for each lift. A waiting period is required for each construction stage.

In a review of 40 embankment case histories (Humphrey and Holtz, 1986; Humphery, 1987), the risk of embankment failure due to bearing, even with high strength geotextile reinforcement, increases significantly (4 out of 9 cases) when the height is more than 6 to 7 feet. Wu (2005) reported using 10 feet high embankments for each construction stage with a total of 3 stages. However, the embankment was constructed using 3 layers of high strength geotextile. Considering that the current project will not apply high strength geotextile for cap reinforcement (indicated to be adequate from the stability analysis), a maximum lift height of 5 feet is reasonable.

7.2.6. Short-Term and Long-Term Global Stability

The stability of the fill cap was evaluated based on limit equilibrium theory. The random search method from the commercial software, STEDWIN (Version 2.4), was used to find the critical plane and calculate its factor of safety. The cap was assumed to be initially supported by a layer of drainage blanket lying above the sludge deposit. A full height fill cap model (36 feet) was initially analyzed as if the cap was built without staged construction. If the result from such a model can satisfy the minimum F.S of 1.2 and 1.5 for short term and long term, respectively, the stability of the actual staged cap construction would not be a concern. This height included additional amount of fills to compensate for the anticipated settlement in order to reach a final design elevation of EL ±36.

The drainage blanket is necessary for areas where the impound sludge is exposed at the ground surface, facilitating and speeding the consolidation process and strengthening the sludge. It also can serve as a protective crust for further cap installation as well as a platform for construction activities. Detailed discussions are provided in the settlement evaluation section. Soil parameters for stability analyses are summarized in the following tables:

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Table 7-9. Initial Soil Strength (proposed for initial construction of the 3-ft drainage blanket–short term)

Soil Layer	Soils underneath/close to existing berms				Impound Soils				Soils at wetlands (Outside)			
	γ_m (pcf)	φ (˚)	C (psf)	S_u (psf)	γ_m (pcf)	φ (˚)	C (psf)	S_u (psf)	γ_m (pcf)	φ (˚)	C (psf)	S_u (psf)
Drainage Layer (3 ft)	-	-	-	-	120	34	0	0	-	-	-	-
Existing Berm	125	34	100	0	-	-	-	-	-	-	-	-
Sludge (13 ft)	92	0	-	220	92	0	-	200	-	-	-	-
Peat (5 ft)	82	0	-	260	82	0	-	240	80	0	-	190
Soft Organic Clay (7 ft)	95	0	-	260	95		-	240	85	-	-	190
Stiff Clay (2 ft)	120	0	-	600	120	0	-	600	110	0	-	400
Residual Soil	125	35	500	-	125	35	500	-	125	35	500	-

Note: γ_m: soil density; φ: soil internal friction angle; C: cohesion; Su: undrained shear strength

Table 7-10. Soil Strength (end of full height cap construction & before completion of consolidation–short term)

Soil Layer	Soils underneath/close to existing berms				Impound Soils				Soils at wetlands (Outside)			
	γ_m (pcf)	φ (˚)	C (psf)	S_u (psf)	γ_m (pcf)	φ (˚)	C (psf)	S_u (psf)	γ_m (pcf)	φ (˚)	C (psf)	S_u (psf)
Cap Fill (Max. 32 ft)	-	-	-	-	125	33	0	0	-	-	-	-
Existing Berm	125	34	100	0	-	-	-	-	-	-	-	-
Sludge (13 ft)	115	36	0	-	115	36	0	-	-	-	-	-
Peat (5 ft)	85	0	-	450	85	0	0	400	80	0	0	220
Soft Organic Clay (7 ft)	105	0	-	450	105	0	-	400	80	0	-	220
Stiff Clay (2 ft)	123	0	-	800	123	0	-	800	112	0	0	600
Residual Soil	125	35	500	-	125	35	500	-	125	35	500	-

Table 7-11. Final Soil Strength (full Cap fill after consolidation – long term)

Soil Layer	Soils underneath/close to existing berms				Impound Soils				Soils at wetlands (Outside)			
	γ_m (pcf)	φ (˚)	C (psf)	S_u (psf)	γ_m (pcf)	φ (˚)	C (psf)	S_u (psf)	γ_m (pcf)	φ (˚)	C (psf)	S_u (psf)
Cap Fill (Max. 32 ft)	-	-	-	-	120	33	0	0	-	-	-	-
Existing Berm	125	34	100	0	-	-	-	-	-	-	-	-
Sludge (13 ft)	100	0	-	250	100	0	-	220	-	-	-	-
Peat (5 ft)	82	0	-	450	82	0	-	400	80	0	0	220
Soft Organic Clay (7 ft)	105		-	450	105		-	400	95	0	-	220
Stiff Clay (2 ft)	120	0	-	800	120	0	-	800	110	0	0	600
Residual Soil	125	35	500	-	125	35	500	-	125	35	500	-

The soil strengths at the initial stage were estimated from the in-situ CPT data calibrated with both current

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and existing field and laboratory test data. For peat and organic clay/silt soils, the amount of strength increase at the end stage of construction was estimated by using the SHANSEP method, which estimates shear strength using $S_u=0.23\sigma'_v OCR^{0.8}$. Upon consolidation, the undrained shear strength of the peat/clay soil shall increase proportionally to the effective overburden pressures induced by continuous cap installation. In the model, using an undrained shear strength of 400 psf for impound peat and organic clay at the end stage of construction is conservative. For the wetland area, however, the shear strength is not expected to increase significantly because no considerable consolidation is anticipated for soils within that area. Results of the stability analyses are presented in the following table.

Table 7-12. Stability Analysis Results

Construction Stage	Construction Height (ft)	Factor of Safety
Initial Drainage Blanket (Short Term)	3	1.21
End of Fill Cap Construction (Before Consolidation - Short Term	32	1.20
End of Fill Cap Construction (Completion of Consolidation - Long Term)	32	1.50

With reasonably conservative soil parameters assigned, analyses results indicate that a minimum factor of safety (F.S.) for both short term and long term stabilities can be achieved. It is anticipated that the actual staged construction would have higher F.S. than the modeled case.

The sliding and overturning potential of the existing berm was also evaluated. For the sliding check, a failure plane was defined directly underneath the berm in the global stability model. For overturning evaluations, the search for failure circles was limited to within 30 feet of the berm toe. Results indicated that the critical plane would have an F.S of 2.25 for sliding and 1.43 for overturning in the short term, both of which are greater than the required minimum values. It should be emphasized that the analyses are based on the assumption that all berms retaining the fill cap are topped at elevation EL 10. Also, additional searches were conducted along the proposed cap slope. Results suggest that the most critical failure curve would not develop on the proposed slope. An 8H:1V slope ratio is therefore reasonable.

Overall, extensive global stability analyses indicate that the proposed cap would be stable in both the short and long term without high strength geotextile reinforcement. The most critical circle is more likely to occur near the edge of the proposed cap top where the slope starts. Therefore, it is recommended that no heavy construction live load (other than lightweight dozers) shall be applied within 50 feet of the cap edge during construction. Small temporary stockpiles should also be placed at least 50 feet from the cap edge with a lightweight dozer spreading the material from that point forward. Compaction of the first lift should only be performed by the tracking of the lightweight dozer.

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7.2.7. Check Lateral Spreading (Sliding) of the Proposed Cap

According to the FHWA manual, lateral spreading for an un-reinforced embankment is evaluated via the following equation:

$$FS = \left[\frac{b \cdot \tan \phi'_{sg}}{K_a H} \right]$$

where b is the width of the proposed slope (assuming 5 ft lift and 8H:1V slope ratio, b = 40 ft), ϕ'_{sg} is friction angle between the cap material and the foundation soil (cap will be firstly constructed on a crust, $\phi'_{sg} = 30^\circ$, therefore, tan ($\phi'_{sg} = 0.58$), H is the fill height (5 ft for each lift), and K_a is the coefficient of lateral pressure (assuming an internal friction angle of 33° for the fill, $K_a = \tan^2(45^\circ - 33/2^\circ) = 0.283$). Following the equation and inputting all the known values, the calculated F.S. is greater than 16. Overall, due to the proposed gentle slope, lateral spreading of the proposed cap is not likely.

7.2.8. Settlement Evaluation

Due to the high compressibility of the site soils, the majority of the settlement is expected to be caused by the consolidation upon loading. The amount of consolidation can be estimated based on the conventional Terzaghi's one dimensional theory. Settlement parameters were obtained from current and existing laboratory tests and are summarized in the table below. The FHWA funded computer program Fossa (Version 2.0) was used to calculate soil settlement. The software is the improved and commercial version of FHWA recommended software, EMBANK. It can solve two or three dimensional embankment settlement problems with complicated boundary conditions.

Table 7-13. Primary Consolidation Parameters for Cohesive Soils

Compressive Soil Layers	γ_m (pcf)	WC (%)	Initial Void Ratio, e_0	Compression Index, Cc	Compression Ratio, CR	Recompression Index, Cr	Recompression Ratio, RR	RR/ CR	p_c (tsf)
Soft Sludge (13 ft)	92	91.3	2.42	1.155	0.273	0.028	0.007	0.046	0.4
Peat (5 ft)	82	228	4.73	2.750	0.485	0.386	0.07	0.13	0.6
Soft Organic Clay (7 ft)	105	228	4.73	2.750	0.485	0.386	0.07	0.13	0.65
Stiff Clay (2 ft)	120	61	1.62	0.788	0.277	0.086	0.030	0.082	1.6

P_c: Preconsolidation Pressure
*: Depending on the significance of the fibrous organic content

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Table 7-14. Settlement Rate									
Soil Layer	Coefficient of Consolidation (ft^2/day) at Consolidation Pressure (tsf)								Used for analyses
	0.0625	0.125	0.25	0.5	1	2	4	8	
Soft Sludge (13 ft)	5.95	5.53	7.10	5.46	3.84	5.67	6.90	3.70	4
Peat (5 ft)	1.63	1.03	1.04	1.17	1.19	1.46	1.34	1.28	1.0-1.2
Soft Organic Clay (7 ft)	0.32	0.08	0.05	0.02	0.02	0.02	0.03	0.16	0.02-0.04*
Stiff Clay (2 ft)	0.13	0.05	0.04	0.02	0.02	0.02	0.03	0.02	0.026

*: Depends on the significance of the fibrous organic content.

Two consolidation models were developed for analyses. The first model was established to simulate the soil consolidation in exposed sludge areas upon the initial installation of a 3-ft thick drainage layer. The other model was created to evaluate the settlement due to the construction of a full height fill cap (32 ft). An 1,100-ft wide cap was used in the model. The model considered the drainage blanket as a "new ground" after its settlement. This mean that the deformed soil layers from the initial drainage stage were inputted into the latter construction model. New void ratios and soil densities as a result of the initial consolidation were also used in the fill cap model. Results are presented in the following table:

Table 7-15. Primary Consolidation Results						
Construction Stage	Construction Height (ft)	Total Primary Consolidation (ft)	Time to Reach 90% of The Sludge Consolidation (days)	Time to Reach 90% of The Peat Consolidation (days)	Time to Reach 75% Organic Clay Consolidation (days)	Time to Reach 90% of Total Primary Consolidation (days)
Initial Drainage Blanket (3 ft)	3	1.0-1.3	38	20	110	-
Full Height Fill Cap (32 ft)	32	5.5	36	20	111	515~1010*

It should be noted that the selected section for analyses represented the most unfavorable condition at the project site. Under such a condition, the sludge is directly exposed at the ground surface without natural soil covers. Moreover, a conservatively large width of the cap was used in the analyses and only the maximum settlement value, typically occurring in at the center of the embankment, was reported. Additionally, the model did not consider the staged cap construction effects and waiting period among each stage. Therefore, the estimated result is potentially conservative.

Results indicated that a waiting period of 38 days is required after the construction of the drainage blanket. When the fill cap is to be constructed, the waiting period between each construction stage is three and a half months. After the finish of fill cap construction, it would take 1.5 to 3 years to complete 90%

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of the total consolidation. Due to the highly variable subsurface conditions of the project site, the actual completion of settlement and its rate should be monitored through a field instrumentation program.

7.2.9. Immediate and Secondary Settlement

In theory, the total settlement of a cohesive organic soil layer also includes an immediate settlement due to the elasticity of the soil and a secondary settlement due to gradual decay of the organic matter within the soil matrix. The immediate settlement can be estimated using Hoek's Law based on known loading conditions and the Young's Modulus (E) of the material. Young's modulus can be further converted from the CPT derived shear moduli by using the equation: E=G/2(1+v), where v is the Poisson's Ratio of the material. The immediate settlement for the drainage stage and cap construction stage is estimated as 1 inch and 5 inches, respectively. Considering the rapidity of immediate settlement and the much lower magnitude compared to consolidation settlement, immediate settlement was not taken into account for this project.

The secondary settlement can be calculated using the AASHTO recommended formula expressed as:

$$S'' = C_{\alpha} H \log \frac{t}{t_p}$$

However, for this project, the secondary settlement was not analyzed since the major focus of the project is the stability of the proposed cap. Settlement is not a significant concern. Moreover, as compared to the primary settlement, the secondary consolidation is always minor. Past experiences on similar embankments over peat/soft clay soil indicate that secondary consolidation is typically 0.5-2" and lasts as long as 30 years if there is no preloading applied.

7.3. EXISTING BRIDGE FOUNDATION EVALUATION

The existing bridge foundation was analyzed to determine the long-term stability (bearing capacity, overturning, and sliding) of the structure. Assuming an internal angle of friction of 30 degrees based upon the SPT N-values from boring BS-09, the bridge foundation appears to be stable. Supporting calculations are contained within Appendix D.

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7.4. SEISMIC CONSIDERATIONS

Liquefaction is a phenomenon related to saturated, loose and cohesionless soil deposits that are subjected to repeated shaking during an earthquake event. The liquefaction potential for a given cohesionless soil deposit is a function of various factors, including its relative density, earthquake intensity (ground acceleration), duration and the effective number of cycles of shaking (earthquake magnitude). Relatively loose, clean to moderately silty sands at shallow depths below the groundwater table are most susceptible to total or partial liquefaction.

Soil liquefaction resistance can be evaluated with different in-situ test methods. A standard procedure termed the "simplified procedure," which is largely empirical, has been evolved for evaluating the liquefaction resistance of soils. This procedure was recommended by the National Center of Earthquake Engineering (NCEER) workshop (Youd et al., 2001). The liquefaction potential of this project was evaluated using SPT blow counts and CPT normalized cone resistance and friction values. The SPT evaluation methods were based on the NCEER "simplified procedure" (Youd et al., 2001) and more up to date materials (Andrus and Stokoe, 2000; Robertson and Wride, 1998; Youd, 1998). The CPT analysis methods were based on procedures contained within Idriss and Boulanger (2008). Based on the current field testing information and laboratory test results, the underlying sludge, clays and sand and gravel soils overlying rock at the site are not likely to have a significant liquefaction potential under an earthquake with a magnitude of M~5.

Baker also evaluated slope stability during a seismic event utilizing the pseudo-static method. This method involves the inclusion of horizontal and vertical static seismic forces that are used to simulate the potential inertial forces due to ground accelerations in an earthquake. These forces are assumed to be proportional to the weight of the potential sliding mass multiplied by a seismic coefficient. Typically, the vertical forces are ignored in these analyses. The horizontal earthquake coefficient was estimated by using ½ of the peak horizontal ground acceleration (PGA) or 0.045g. The resulting factor of safety was found to exceed 1.0, the minimum recommended factor of safety for seismic events. Supporting calculations are contained within Appendix D.

7.5. INSTRUMENTATION

It is highly recommended that instrumentation be installed prior to construction and monitored during filling operations. Recommended instrumentation includes settlement plates, vibrating wire piezometers, and inclinometers. The recommended locations are shown in Figure A-13 and in the tables below.

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Settlement Plates:

Settlement plates should be installed after 2 ft to 3 ft of the drainage blanket has been placed at the site at the following locations shown in Table 7-16:

Table 7-16. Settlement Plate Locations

Settlement Plate Number	Northing	Easting
SP-1	570685.39	642105.83
SP-2	570681.69	642532.11
SP -3	570133.86	642776.74
SP -4	570145.24	643236.96
SP -5	570706.47	643159.61
SP -6	571229.91	643780.89
SP -7	571714.86	644186.74
SP -8	571335.68	644248.12
SP -9	571619.51	643685.98
SP -10	571112.82	643345.78
SP -11	571243.06	642566.99
SP -12	571953.06	642164.95
SP -13	571830.79	641874.42

Vibrating Wire Piezometer

The vibrating wire piezometers should be installed at the following locations shown in Table 7-17.

Table 7-17. Vibrating Wire Piezometer Locations

Piezometer Number	Northing	Easting	Probe Elevation (ft)
VW-1	570688.20	642075.59	-12, -20
VW-2	570676.04	642502.77	-12, -20
VW-3	570150.81	642730.35	-12, -20
VW-4	570084.62	643228.39	-12, -20
VW-5	570734.91	643146.35	-12, -20
VW-6	571241.27	643752.38	-12, -20
VW-7	571689.62	644223.79	-12, -20
VW-8	571314.74	644279.51	-12, -20
VW-9	571595.21	643651.00	-12, -20
VW-10	571127.50	643319.90	-12, -20

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VW-11	571245.56	642603.63	-12, -20
VW-12	571930.74	642187.58	-12, -20
VW-13	571850.29	641850.75	-12, -20

Slope Inclinometer

The slope inclinometers should be installed at the following locations shown in Table 7-18.

Table 7-18. Slope Inclinometer Locations

Inclinometer Number	Northing	Easting	Bottom Elevation of Probe (ft)
IN-1	570305.94	642055.82	-40
IN-2	569795.94	642770.90	-40
IN-3	570114.93	643235.70	-40
IN-4	570657.78	643607.96	-40
IN-5	571018.34	644186.03	-40
IN-6	571336.17	644790.87	-40
IN-7	571726.89	644241.95	-40
IN-8	571721.79	643483.05	-40
IN-9	571419.25	642671.14	-40
IN-12	571974.44	642141.70	-40

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8.0 GEOTECHNICAL RECOMMENDATIONS

Both the settlement and the stability analysis indicate that the proposed grading plan can be safely achieved as long as construction is performed in stages with waiting periods between stages. It is further understood that the completion of the fill will take approximately 5 years; therefore this should not be an issue. Based on the current available data, 90% consolidation of the cohesive soil underneath the sludge will take two to three years after the placement of fill. For a sludge layer 13 feet thick, the estimated time required to reach 90% of consolidation is approximately 48 days.

The following construction sequence is recommended:

1. Prepare the Subgrade

   - Only cut trees and stumps flush with ground surface.
   - Do not remove or disturb root mat or meadow mat.
   - Leave small vegetative cover, such as grass and reeds, in place. The vegetation will help to carry the construction equipment load during the site preparation and placing the first several feet of the fill.

   Prior to receiving materials without permeability requirements, a minimum of three (3) feet of "fair drainage material" shall be placed on top of the current impoundments. The "fair drainage material" is defined as soil materials with laboratory tested permeability greater than 5.0E-05 cm/s. The laboratory permeability test procedures should conform to ASTM D2434 or ASTM D5856. The sample for the permeability test should have a minimum of 90% maximum dry density as determined by ASTM D698 (Standard Compaction Effort). The following procedure should be followed:

   a. End-dump the fill materials into the impoundment from the adjacent access road. The first lift of the fill should consist of "fair drainage material".

      - Use appropriate trucks and equipment compatible with constructability design.
      - End-dump on the previously placed fill;
      - Limit height of dumped piles, e.g., to less than four (4) ft above the adjacent sludge or five (5) feet above the previous fill, to avoid a local bearing failure. Spread piles immediately to avoid local depressions.
      - Use lightweight dozers and/or front-end loaders to spread the fill.

   b. Traffic on the first lift should be limited.

- Construction vehicles should be limited in size and weight to limit initial lift rutting to 3 inches. If rut depths exceed 3 inches, decrease the construction vehicle size and/or weight.

c. The first lift should be compacted only by tracking in place with low-ground-pressure bulldozers or end-loaders.

d. Once the cap is at least 2 ft above the original ground, subsequent lifts can be compacted with a smooth drum vibratory roller or other suitable compactor. If localized liquefied conditions occur, the vibrator should be turned off and the weight of the drum alone should be used for compaction.

e. Generally, the above procedure applies to Impoundments 1, 4, 5 and 6. Minor adjustment of the thickness of the first lift and the construction sequence might be required during construction.

2. After the "fair drainage material" (first lift) is placed, the geotechnical instrumentation needs to be installed including settlement plates, vibrating wire piezometers and slope inclinometers. Special Provisions for instrumentation will be developed during final design when a draft fill plan is available. The following are the brief summary:

   a. The settlement plates should be placed at the top of the first lift. The objective of the settlement plate installation is to control the construction sequence.
   b. For the piezometers located near the river, filters shall be installed in both organic cohesive soil as well as the sludge. At other locations, the piezometer filters are only required to be installed within the sludge. The objective of installing piezometers is to monitor the dissipation of excess pore pressures generated during construction. The shear strength of the soil will increase after dissipation.
   c. The slope inclinometers should be installed along the edge of the proposed fill to ensure that slope stability is maintained.
   d. Additional geotechnical in-situ tests such as CPTu and field vane shear testing will be required during construction.

3. End of Stage One construction. The starting time for the next stage of construction will be based on the instrumentation monitoring results. Generally, the criterion for the next construction stage is when

the soft material reaches a minimum of 90% of primary consolidation. The estimated waiting period is approximately 38 days.

4. At areas near the river (Impoundments 4 and 6), the fill placement might also be controlled by dissipation of excess pore pressure within the in-situ cohesive soils underlying the sludge. A longer waiting period time might be required. For construction activities in these areas, more frequent instrumentation monitoring will be required to ensure the rate of fill placement is slow enough to allow the dissipation of excess pore pressure.

5. Place the embankment and surcharge fills for each construction stage. The thickness of each construction should not exceed 5 ft. The fill material needs to be roller compacted.

6. To facilitate the dissipation of the excess pore water pressure in the in-situ cohesive soil underlying the sludge, place all fill material in a pattern with relatively the same elevation.

7. Due to the relatively high shear strength of surface material at Impoundments 2 and 3, fill material should be no more than ten feet in height above the adjacent ground. At all other areas, piles should be no more than six (6) feet in height. If higher stockpile heights are desired, it is recommended that the stockpiles be placed in a staged manner, thereby allowing the underlying soils to consolidate. Once the stockpile has been reached the desired height, further staged placement should not be required. The consolidation of the underlying materials should also be monitored with field shear strength testing completed prior to building the stockpiles to greater heights.

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10.0 BASIS OF RECOMMENDATIONS

This report has been prepared to aid in the evaluation for the proposed construction described in this report. Adequate recommendations have been provided to serve as a basis for design and preparation of plans and specifications. The opinions, conclusions, and recommendations contained in this report are based upon our professional judgment and generally accepted principles of geotechnical engineering. Inherent to these are the assumptions that the earthwork and foundation construction should be monitored and tested by an engineering technician acting under the guidance of a licensed geotechnical engineer.

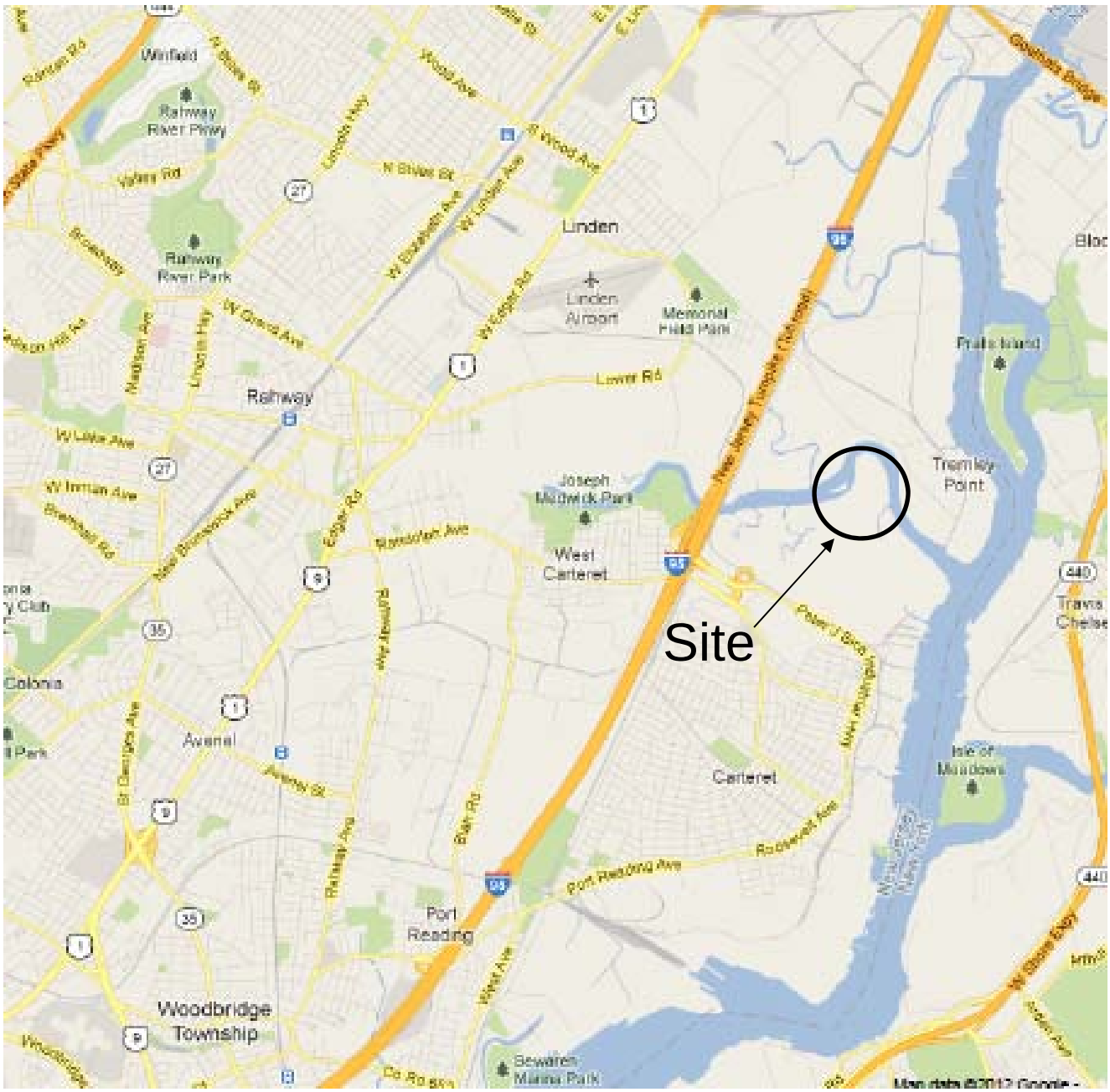
These analyses and recommendations are, of necessity, based on the information available at the time of the actual writing of the report and on the site conditions, surface and subsurface, that existed at the time the exploratory borings were drilled. Further assumption has been made that the limited exploratory borings, in relation both to lateral extent of the site and to depth, are representative of conditions across the site.

The nature and extent of variations between borings may not become evident until construction. If variations from the anticipated conditions are encountered, it may be necessary to revise the recommendations in this report. We cannot accept the responsibility for designs based on recommendations in this report unless we are engaged to make site visits during construction to: a) check that the subsurface conditions exposed during construction are in general conformance with our design assumptions and b) ascertain that, in general, the work is being performed in compliance with the contract documents.

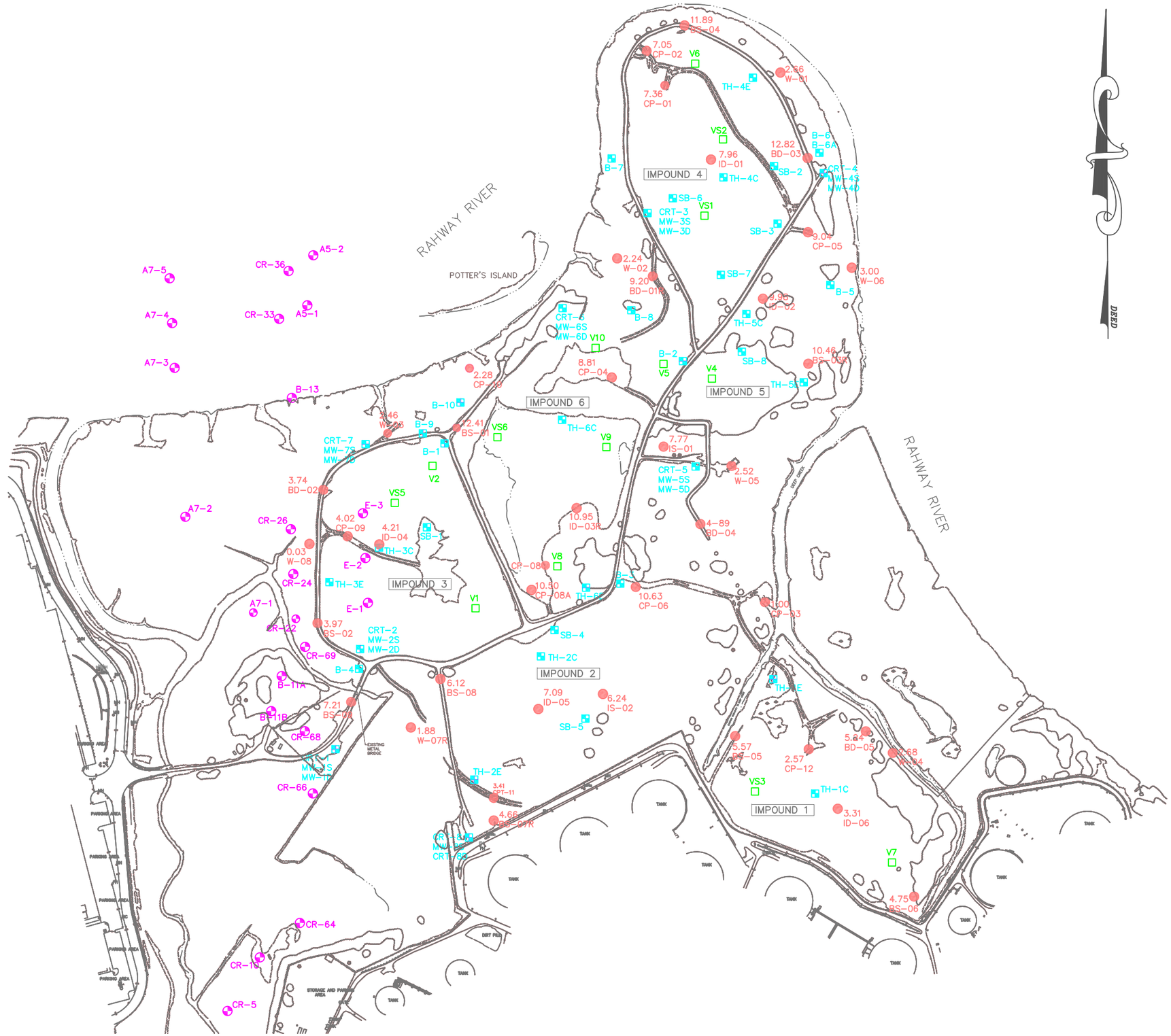
Our professional services have been performed in accordance with generally accepted engineering principles and practices; no other warranty, expressed or implied, is made. Baker assumes no responsibility for interpretations made by others on the work performed by Baker.

We recommend that this report be made available in its entirety to contractors for informational purposes only. The boring logs and laboratory test data contained in this report represent an integral part of this report and incorrect interpretation of the data may occur if the attachments are separated from the text.

APPENDIX A



Baker	Project Title **Rahway Property**	Project No. **128911**
	Sheet Title **Site Vicinity Map**	Drawing Sheet No. **A-1**
	Scale: NTS / Date: October 2012	



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LEGEND

A5-2	NJTA Borings
B-2	Historical Borings
3.00 W-06	2012 Borings
V5	Historical Vane Shear Test Borings

Figure A-2
BORING LOCATION PLAN

Graphical Scale

400 200 0 400

1 inch = 400 feet

Baker
MICHAEL BAKER JR., INC.
1304 Concourse Drive, Suite 200
Linthicum, MD 21090-1014
Phone: (410) 689-3400

DATE	REVISIONS

RAHWAY ARCH SITE
GEOTECHNICAL AND REMEDIAL INVESTIGATION
BORING LOCATION PLAN

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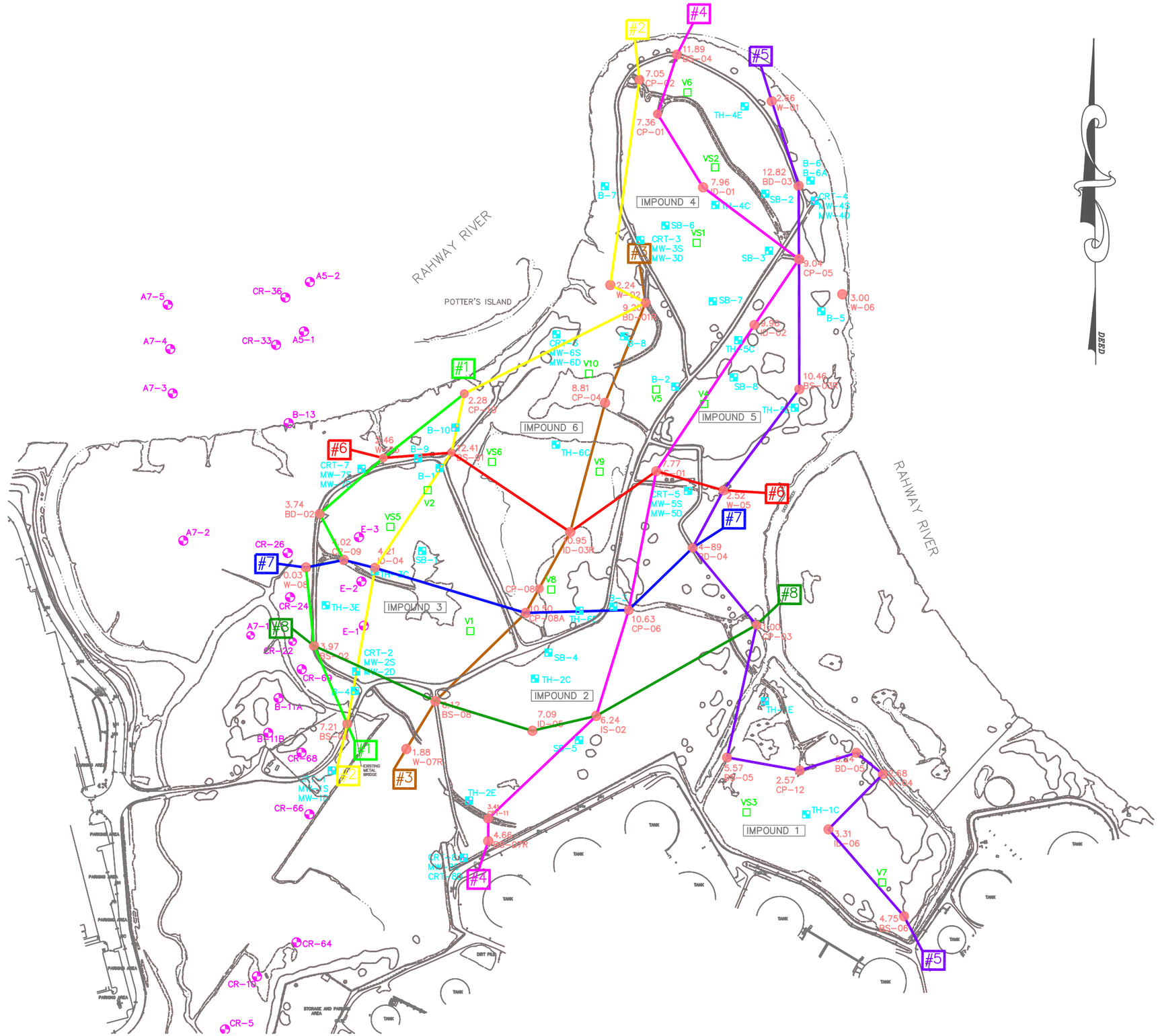
CONTRACT NO. _____

File Name: Boring Location Plan.dwg

Drawn by: DM
Checked by: TM
Sheet ID:
Sheet OF XXX



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LEGEND

A5-2	NJTA Borings
B-2	Historical Borings
3.00 W-06	2012 Borings
V5	Historical Vane Shear Test Borings

Figure A-3
SOIL PROFILE PLAN

Graphical Scale

400 200 0 400

1 inch = 400 feet

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DATE	REVISIONS

RAHWAY ARCH SITE
GEOTECHNICAL AND REMEDIAL INVESTIGATION
SOIL PROFILE PLAN

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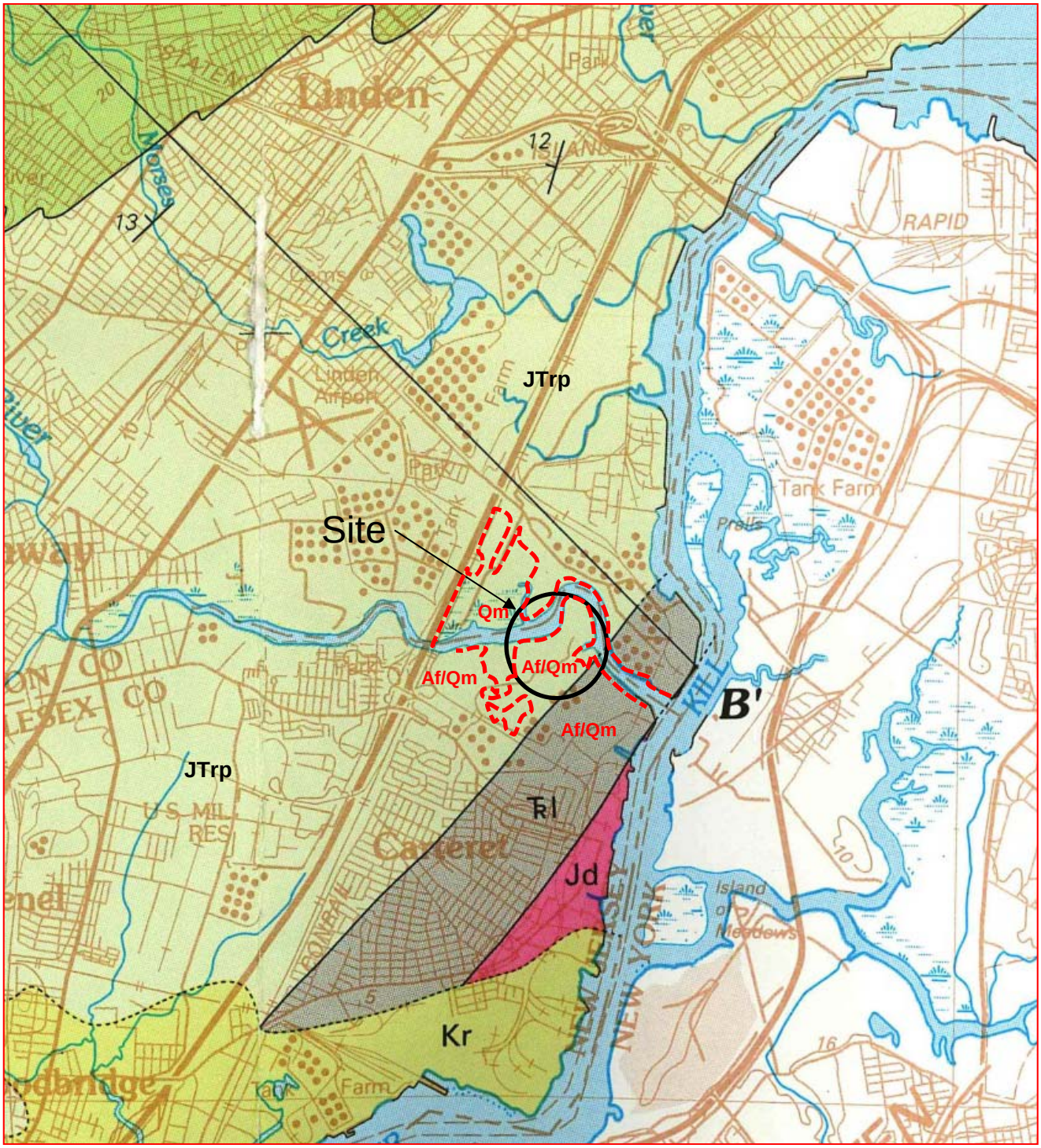
CONTRACT NO. _____

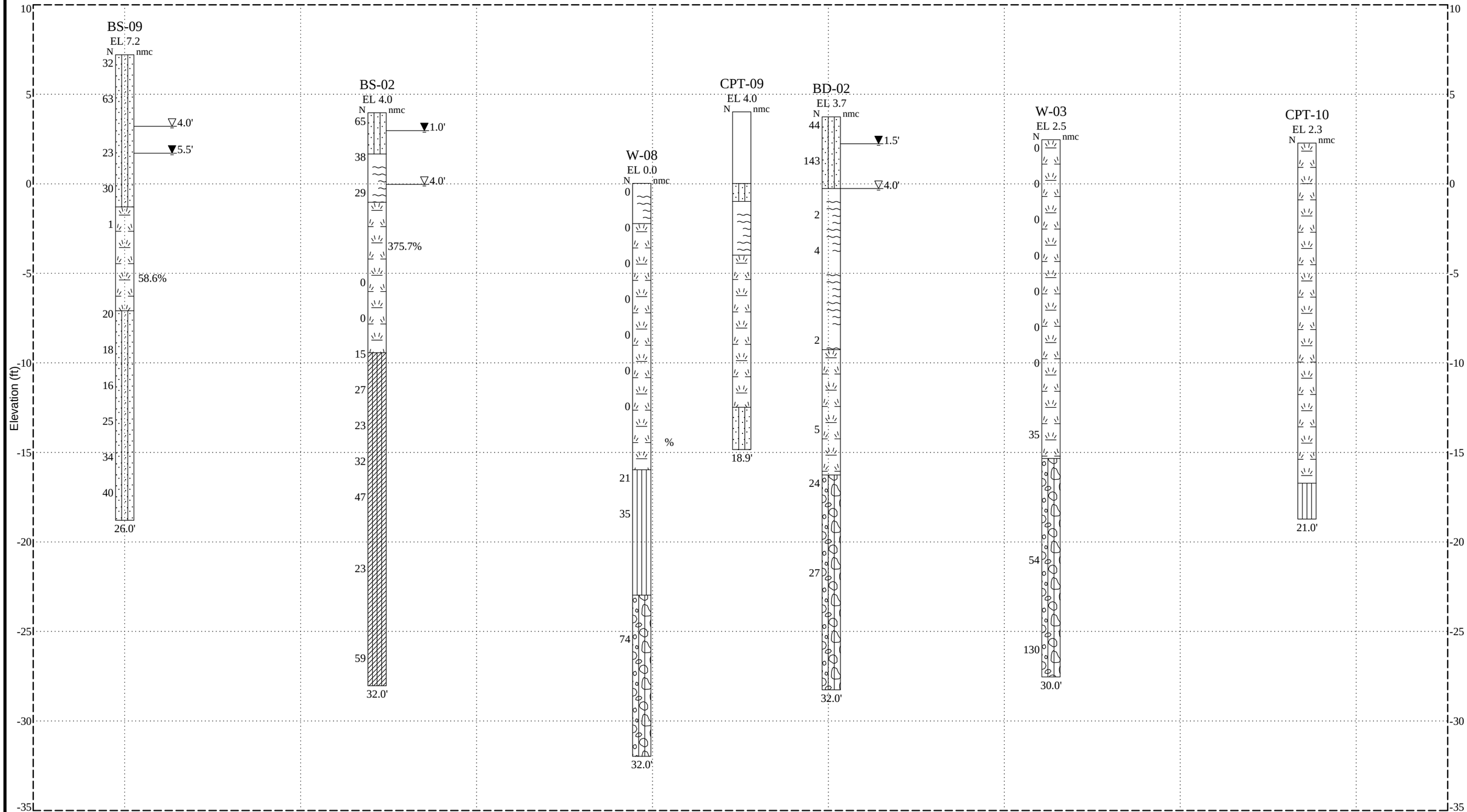
File Name: Boring Plan with Cross Sections.dwg

Drawn by: DM
Checked by: TM
Sheet ID:
Sheet OF XXX



Surficial geology in red (ref.: Stanford, 1999. "Surficial Geology of the Perth Amboy and Arthur Kill Quadrangles, MiddleSex and Union Counties, New Jersey." NJ Open File Map 28, scale 1:24,000.)
Bedrock Geology in black (ref.: Drake etal., 1996. "Bedrock Geologic Map of Northern New Jersey." United states Geological Survey Miscellaneous Investigation Series Map I-2450-A, scale 1:100,000.)

Baker	Project Title **Rahway Property**	Project No. **128911**
	Sheet Title **Site Geology Map**	Drawing Sheet No. **A-4**
	Scale: NTS / Date: October 2012	

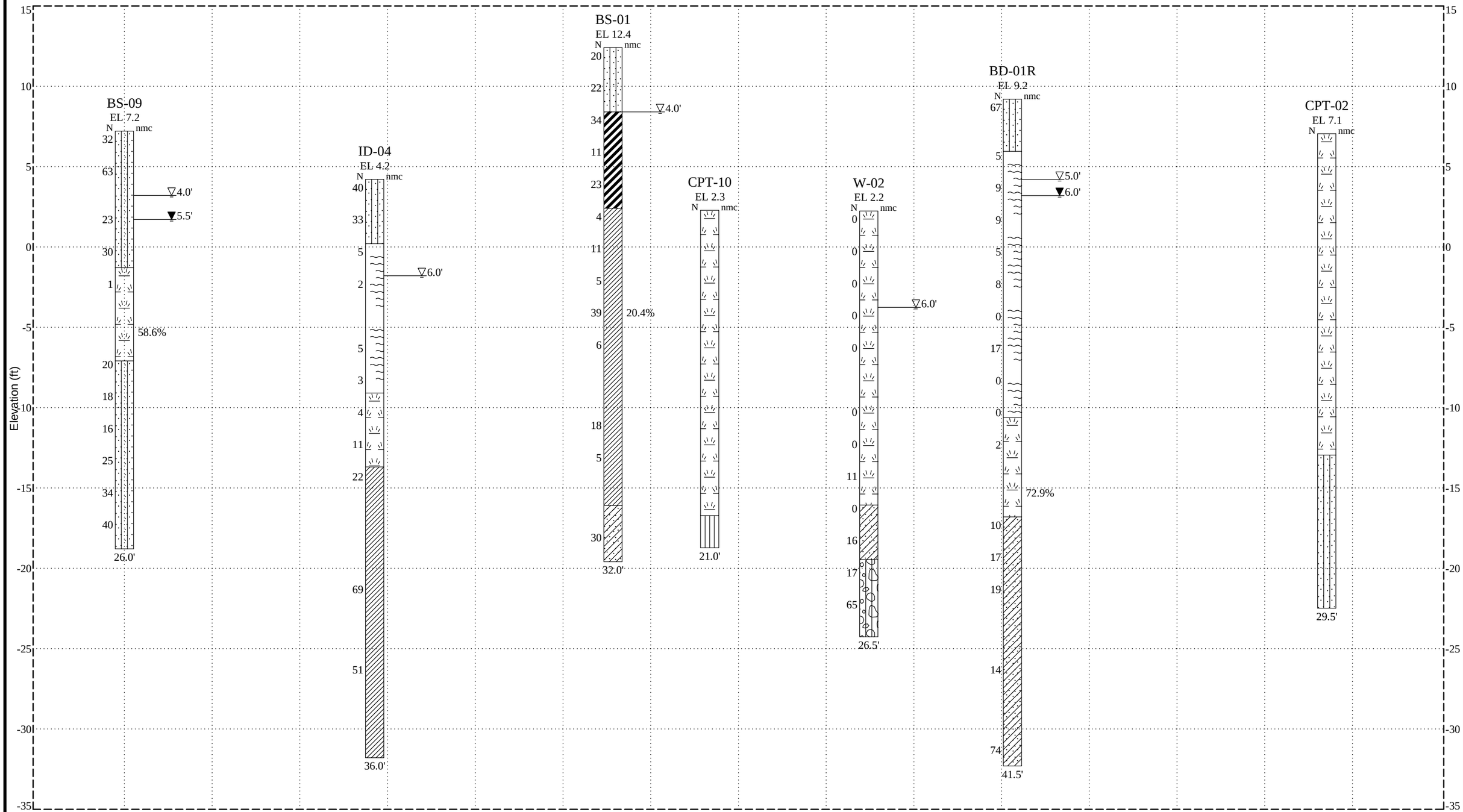


LITHOLOGY GRAPHICS

Silty Sand | Sludge | Peat | Silty Gravel | Low Plasticity Silty Clay | Silt

Title: Rahway Arch Geotech Inv. Soil Profile			Figure No. #1
Drawn: ACO	Approved: MZY	Date: 10/11/12	Job No. 128911

MBAKER (LINTHICUM) 11 X 17 RAHWAY ARCH SITE.GPJ 10/11/12



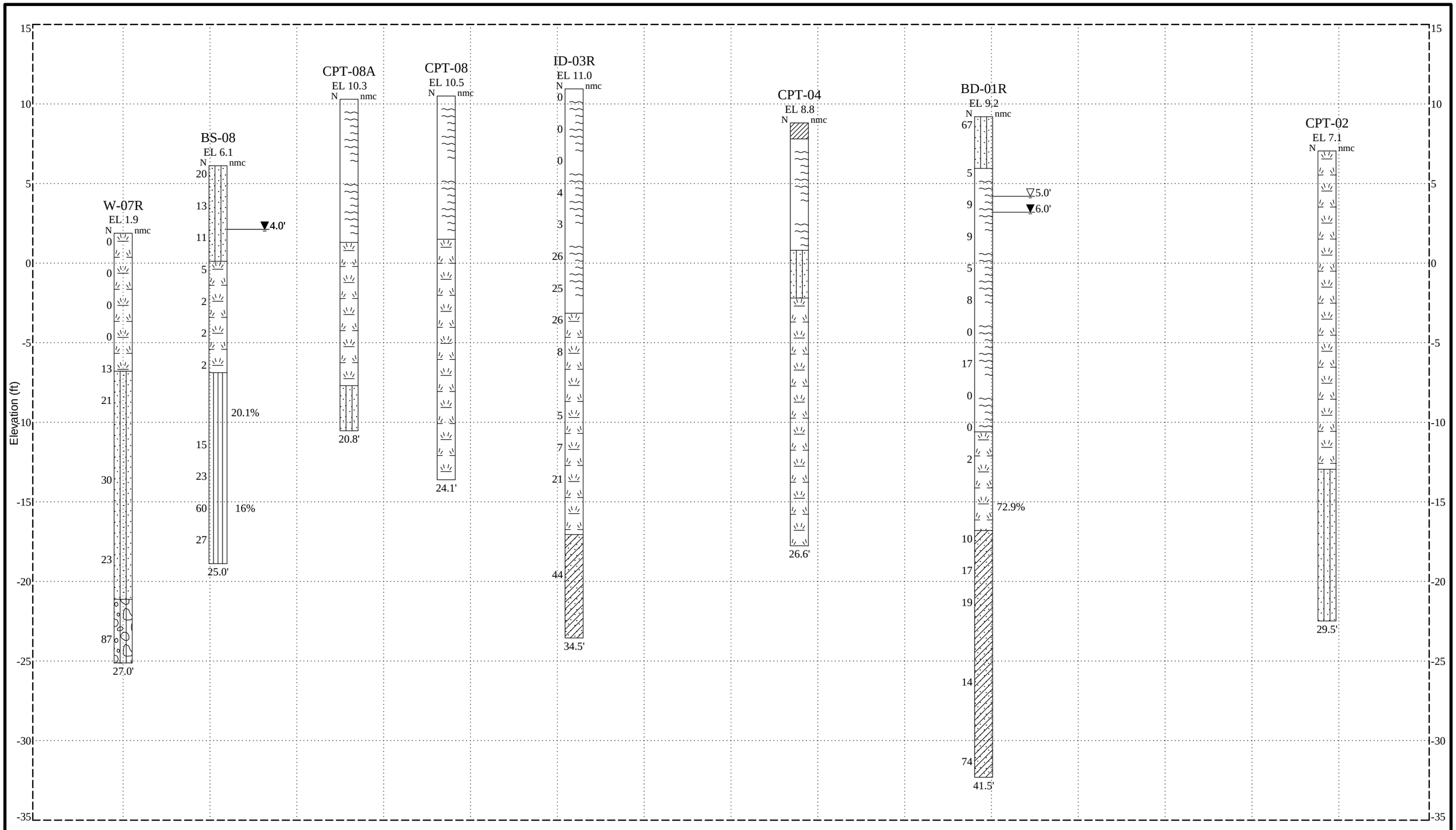
LITHOLOGY GRAPHICS

Silty Sand | Sludge | Peat | Clayey Sand | High Plasticity Clay | Low Plasticity Clay

Silt | Silty Gravel

Title: Rahway Arch Geotech Inv. Soil Profile			Figure No. #2
Drawn: ACO	Approved: MZY	Date: 10/11/12	Job No. 128911

MBAKER (LINTHICUM) 11 X 17 RAHWAY ARCH SITE.GPJ 10/11/12

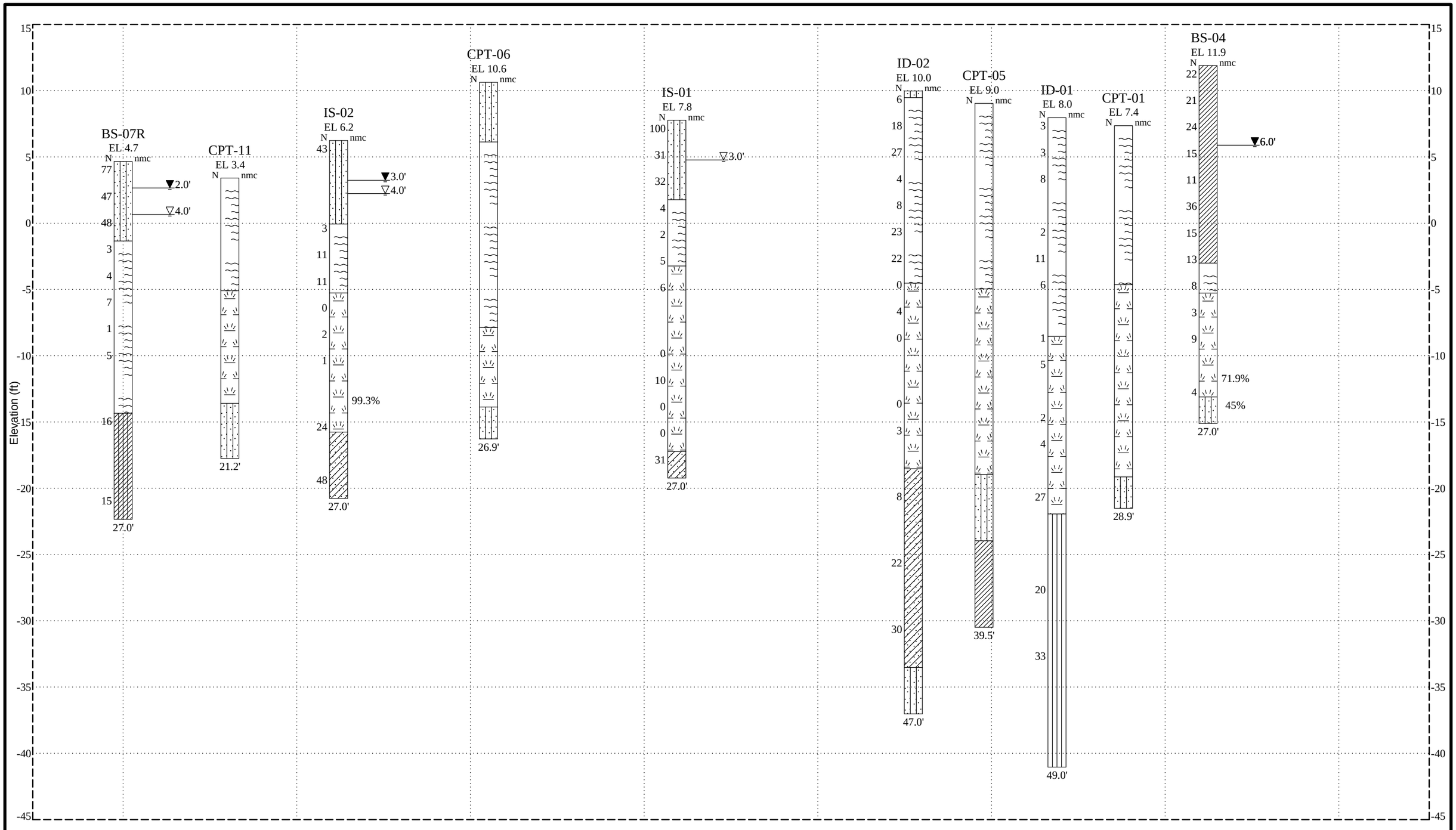


LITHOLOGY GRAPHICS

- Silty Sand
- Sludge
- Peat
- Clayey Sand
- Silt
- Low Plasticity Clay
- Silty Gravel

Title: Rahway Arch Geotech Inv. Soil Profile			Figure No. #3
Drawn: ACO	Approved: MZY	Date: 10/11/12	Job No. 128911

MBAKER (LINTHICUM) 11 X 17 RAHWAY ARCH SITE.GPJ 10/11/12

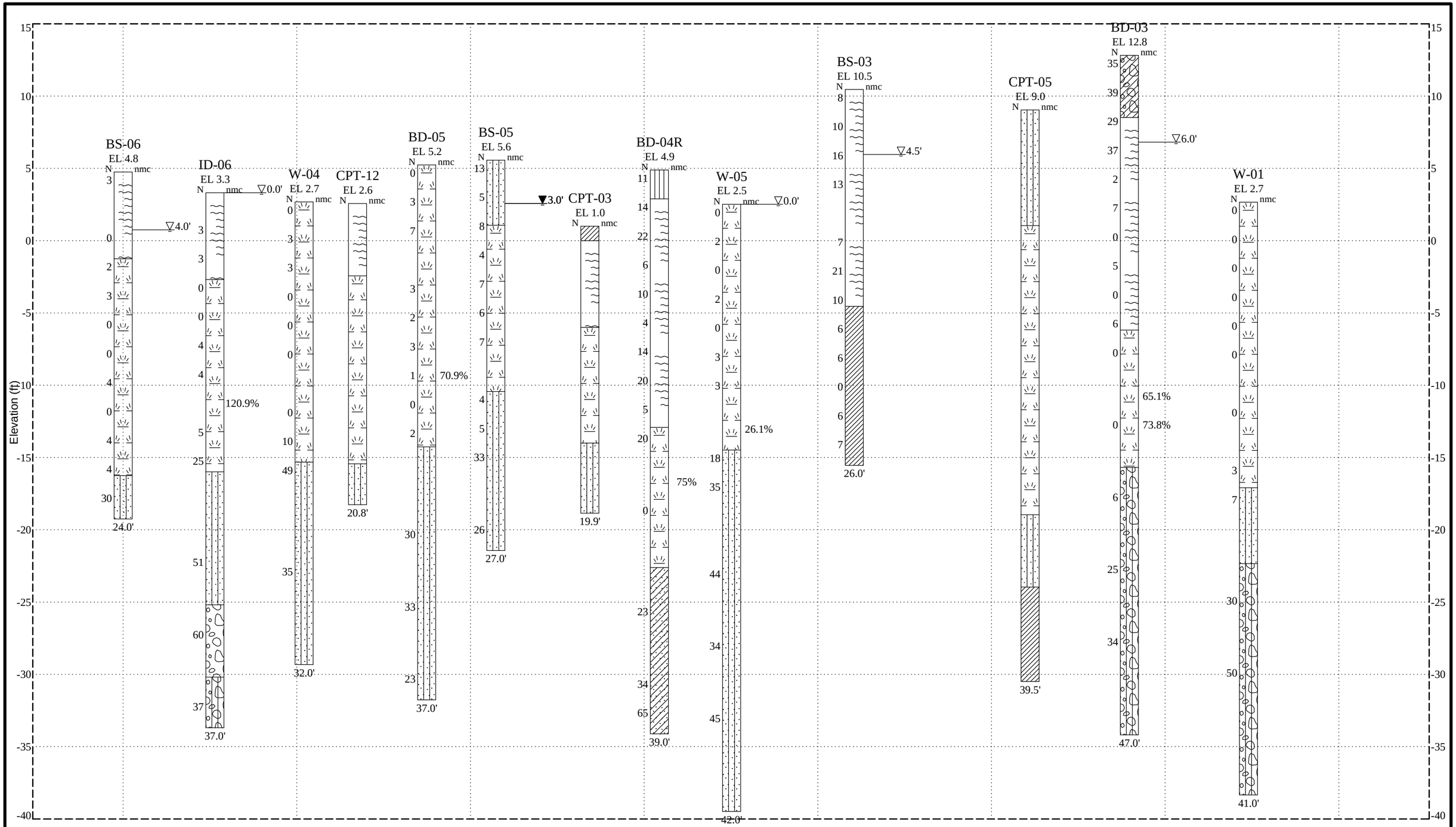


LITHOLOGY GRAPHICS

- Low Plasticity Clay
- Sludge
- Peat
- Silty Sand
- Low Plasticity Silty Clay
- Silt
- Clayey Sand

Title: Rahway Arch Geotech Inv. Soil Profile			Figure No. #4
Drawn: ACO	Approved: MZY	Date: 10/11/12	Job No. 128911

MBAKER (LINTHICUM) 11 X 17 RAHWAY ARCH SITE.GPJ 10/11/12

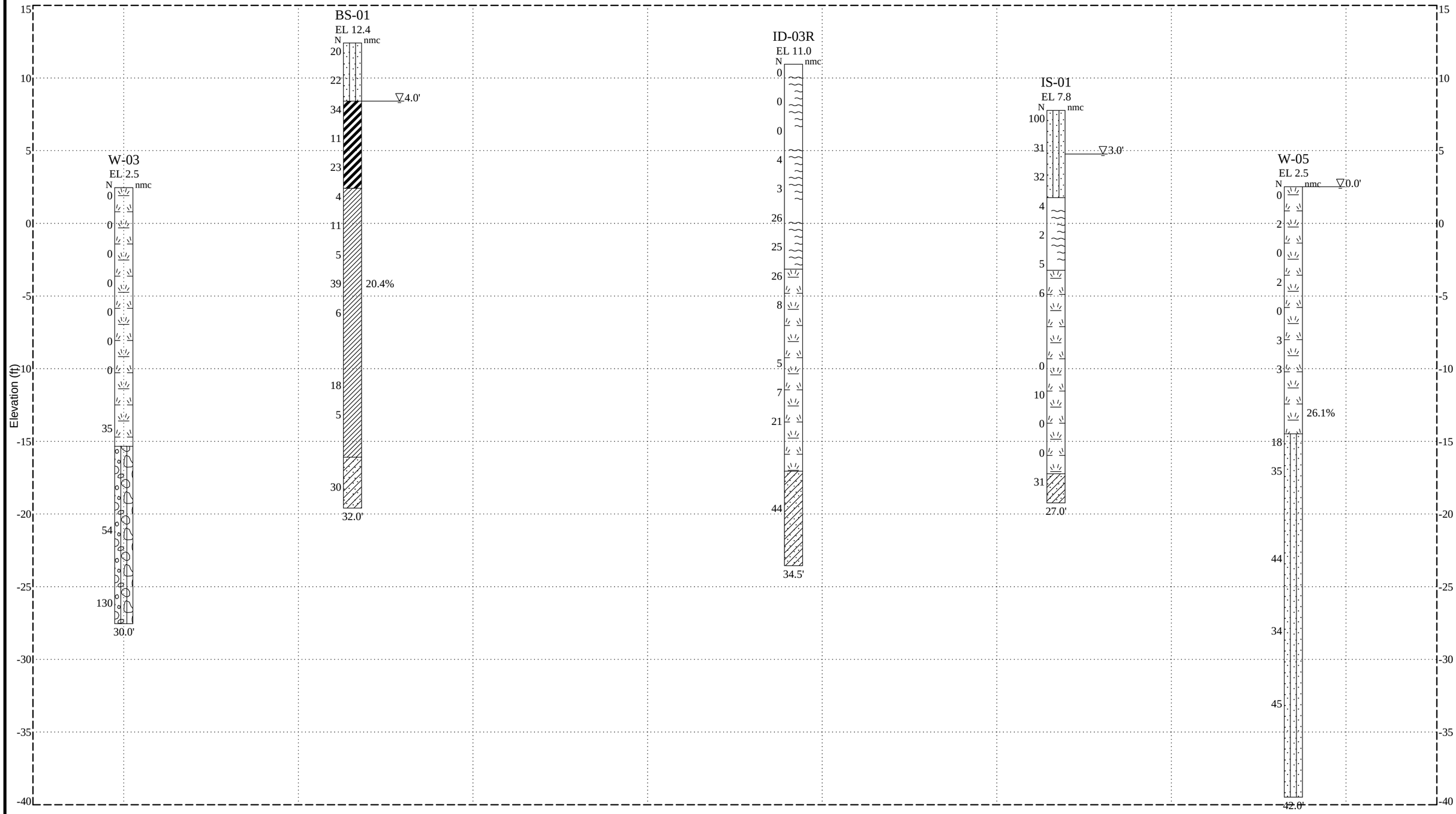


LITHOLOGY GRAPHICS

- Clayey Gravel
- Sludge
- Peat
- Silty Gravel
- Silt
- Clayey Sand
- Silty Sand
- Low Plasticity Clay
- Poorly-graded Gravel

Title: Rahway Arch Geotech Inv. Soil Profile			Figure No. #5
Drawn: ACO	Approved: MZY	Date: 10/11/12	Job No. 128911

MBAKER (LINTHICUM) 11 X 17 RAHWAY ARCH SITE.GPJ 10/11/12

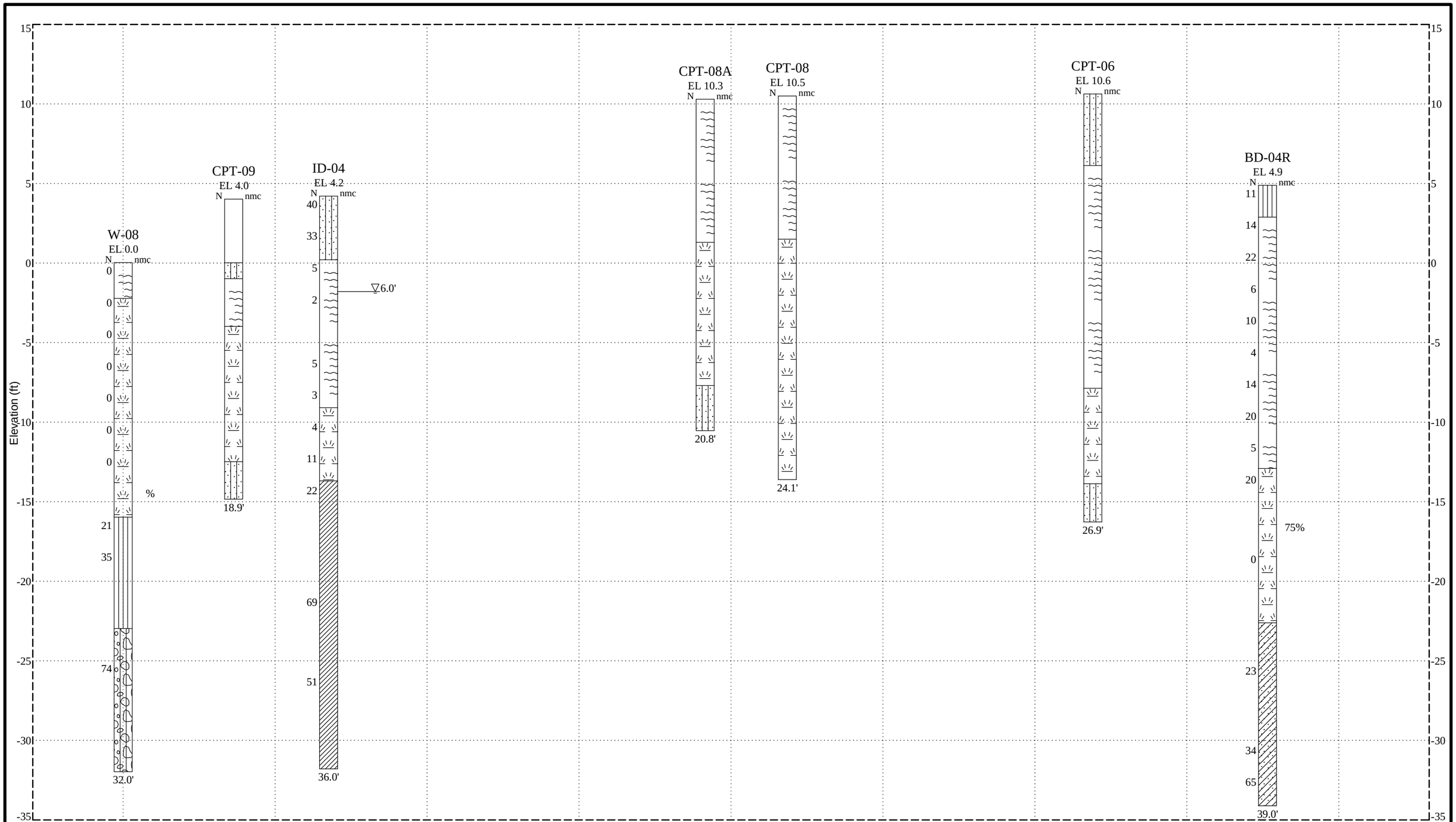


LITHOLOGY GRAPHICS

Silty Sand | High Plasticity Clay | Low Plasticity Clay | Clayey Sand | Sludge | Peat | Silty Gravel

Title: Rahway Arch Geotech Inv. Soil Profile			Figure No. #6
Drawn: ACO	Approved: MZY	Date: 10/11/12	Job No. 128911

MBAKER (LINTHICUM) 11 X 17 RAHWAY ARCH SITE.GPJ 10/11/12

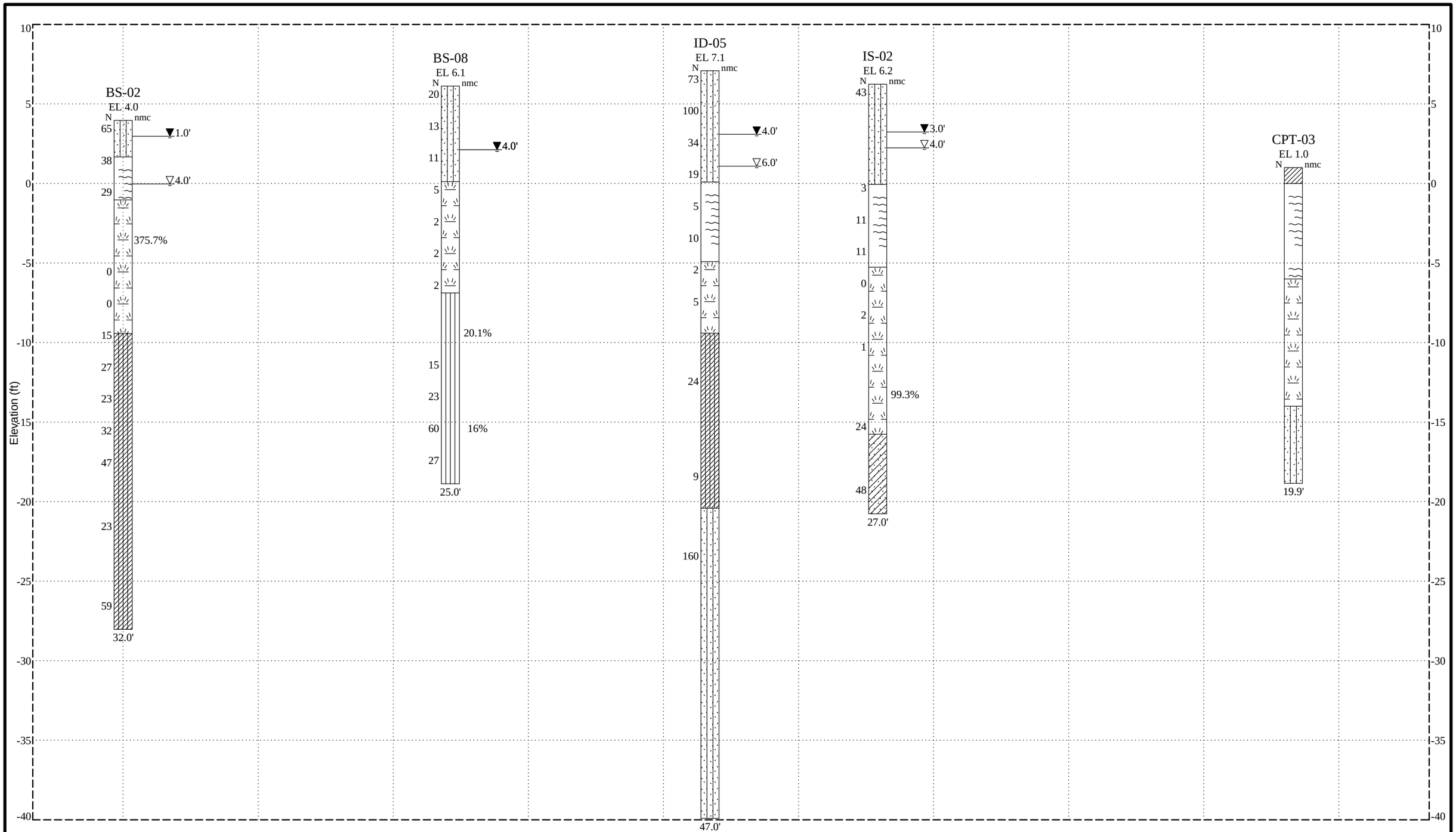


LITHOLOGY GRAPHICS

Silt | Sludge | Peat | Clayey Sand | Silty Sand | Low Plasticity Clay | Silty Gravel

Title: Rahway Arch Geotech Inv. Soil Profile			Figure No. #7
Drawn: ACO	Approved: MZY	Date: 10/11/12	Job No. 128911

MBAKER (LINTHICUM) 11 X 17 RAHWAY ARCH SITE.GPJ 10/11/12

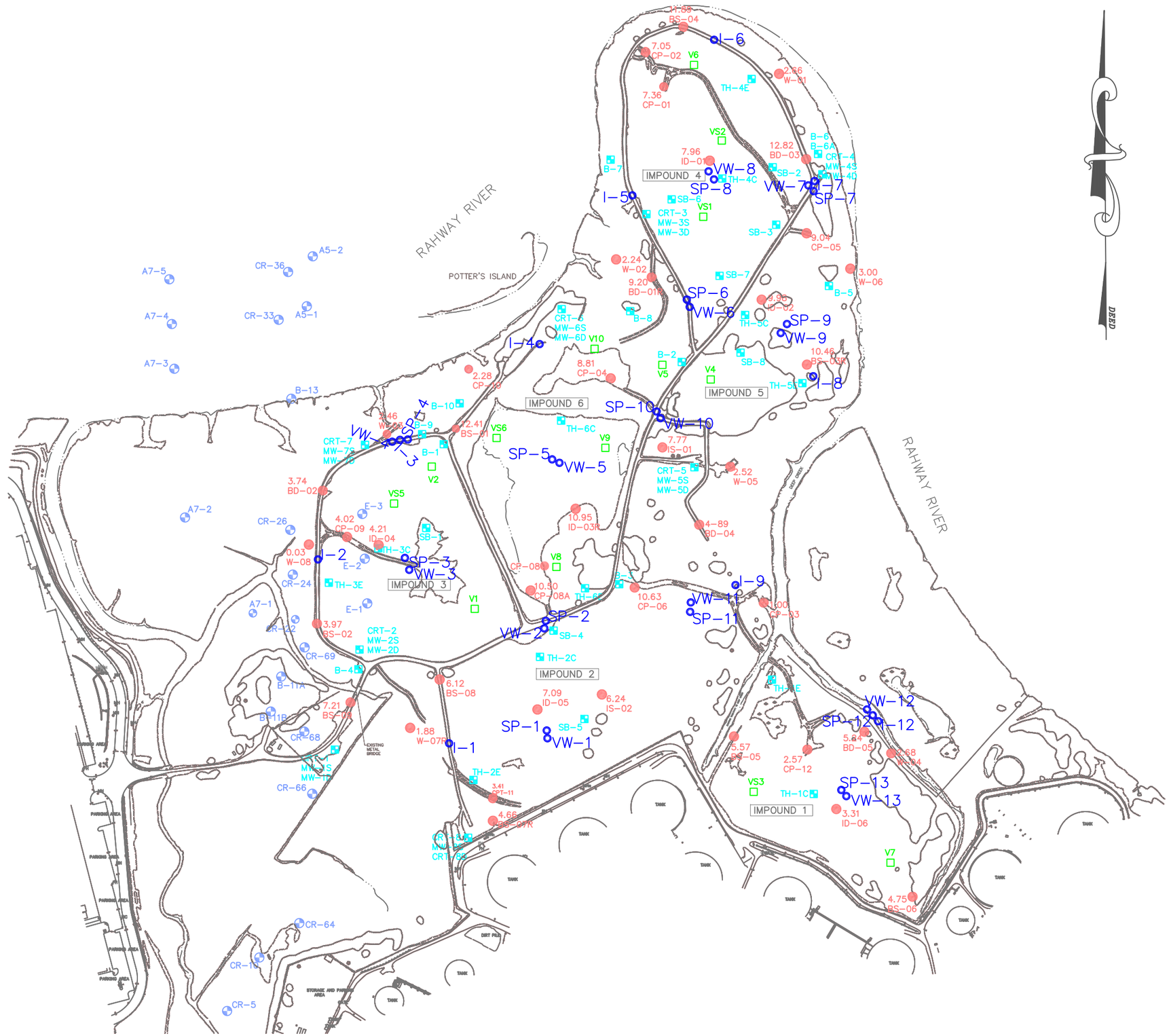


LITHOLOGY GRAPHICS

- Silty Sand
- Sludge
- Peat
- Low Plasticity Silty Clay
- Silt
- Low Plasticity Clay
- Clayey Sand

Title: Rahway Arch Geotech Inv. Soil Profile			Figure No. #8
Drawn: ACO	Approved: MZY	Date: 10/11/12	Job No. 128911

MBAKER (LINTHICUM) 11 X 17 RAHWAY ARCH SITE.GPJ 10/11/12



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LEGEND

A5-2	NJTA Borings
B-2	Historical Borings
3.00 W-06	2012 Borings
V5	Historical Vane Shear Test Borings
SP-1	Settlement Plate
VW-1	Vibrating Wire
I-1	Inclinometer

Figure A-13
INSTRUMENTATION PLAN

Graphical Scale

400 200 0 400

1 inch = 400 feet

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RAHWAY ARCH SITE
GEOTECHNICAL AND REMEDIAL INVESTIGATION
INSTRUMENTATION PLAN

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File Name: INSTRUMENTATION Plan.dwg

Drawn by: DM
Checked by: TM
Sheet ID:
Sheet OF XXX

BORING LOGS AND SUBSURFACE PROFILES

APPENDIX B

TEST BORING LOG

BORING BD-01R

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 1 of 2
NORTHING: 643867.99
EASTING: 571093.53
ELEVATION: 9.2
START DATE: 7/17/2012
END DATE: 7/17/2012
DRILLER: Buck/W.G
LOGGED BY: D. Morar

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
7/17/2012		5			SIZE, ID	4 1/4"	1 3/8"	
7/18/2012		6			HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
S-1	0.0	6"	7 17 50/5"							Black Silty Sand (sm), with (topsoil, red brick, rail tie and other debris), moist, very dense (Fill).	Safety hammer was used
								EL 6.0 3.3			
S-2	3.0	18"	2 3 2 3							Dark gray Sludge (classified as Elastic Silt (mh)), wet, very loose to m. dense (Fill).	
							5				
S-3	5.0	24"	3 2 7 7								
S-4	7.0	24"	3 5 4 5								
S-5	9.0	22"	1 3 2 4								Started mud rotary drilling @ 9 ft
							10				
S-6	11.0	NR	3 4 4 4								
S-7	13.0	23"	0 0 0 0								
							15				
S-8	15.0	6"	0 8 9 6								
S-9	17.0	20"	0 0 0 0								
S-10	19.0	22"	0 0 0 0					EL -10.6 19.8			
							20			Gray ELASTIC SILT with SAND (MH, fibrous Peat), wet, very loose.	
S-11	21.0	20"	0 1 1 1								

BLOWS/FT.	DENSITY	BLOWS/FT.	CONSISTENCY
0-4	VERY LOOSE	0-2	VERY SOFT
5-10	LOOSE	3-4	SOFT
11-30	MEDIUM DENSE	5-8	MEDIUM STIFF
31-50	DENSE	9-15	STIFF
OVER 50	VERY DENSE	16-30	VERY STIFF
		OVER 30	HARD

SAMPLE IDENTIFICATION
- S - SPLIT SPOON
- T - THIN WALL TUBE
- SS - 3in. SPLIT SPOON
- R - DIAMOND CORE
- W - WASH SAMPLE
- U - UNDISTURBED

SAMPLE PROPORTIONS	
DESCRIPTIVE TERM	PERCENT
TRACE	1 TO 10
LITTLE	11 TO 20
SOME	21 TO 35
AND	35 TO 50

BORING BD-01R

TEST BORING LOG

BORING BD-01R

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 2 of 2
NORTHING: 643867.99
EASTING: 571093.53
ELEVATION: 9.2
START DATE: 7/17/2012
END DATE: 7/17/2012
DRILLER: Buck/W.G
LOGGED BY: D. Morar

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
7/17/2012		5			SIZE, ID	4 1/4"	1 3/8"	
7/18/2012		6			HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
T-1	24.0	24"		72.9%	291	118	25				
								EL -16.8 / 26.0		Dark Grey Silty Sand (sm), wet, loose to m. dense.	
S-12	26.0	24"	4 4 6 6								
S-13	28.0	12"	12 8 9 16								
S-14	30.0	12"	6 10 9 11				30	EL -21.6 / 30.8		Red Sandy Lean Clay (sc) with Gravel, wet, stiff to hard.	pp = 1.25 tsf
S-15	35.0	1"	10 8 6 9				35				
S-16	40.0	12"	20 24 50/5"				40	EL -32.3 / 41.5			pp = 4.00 tsf
										Bottom of Boring @ 41.5 ft.	
							45				

BLOWS/FT.	DENSITY	BLOWS/FT.	CONSISTENCY
0-4	VERY LOOSE	0-2	VERY SOFT
5-10	LOOSE	3-4	SOFT
11-30	MEDIUM DENSE	5-8	MEDIUM STIFF
31-50	DENSE	9-15	STIFF
OVER 50	VERY DENSE	16-30	VERY STIFF
		OVER 30	HARD

SAMPLE IDENTIFICATION
- S - SPLIT SPOON
- T - THIN WALL TUBE
- SS - 3in. SPLIT SPOON
- R - DIAMOND CORE
- W - WASH SAMPLE
- U - UNDISTURBED

SAMPLE PROPORTIONS	
DESCRIPTIVE TERM	PERCENT
TRACE	1 TO 10
LITTLE	11 TO 20
SOME	21 TO 35
AND	35 TO 50

BORING BD-01R

TEST BORING LOG

BORING BD-02

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 1 of 2
NORTHING: 643038.72
EASTING: 569814.75
ELEVATION: 3.74
START DATE: 7/11/2012
END DATE: 7/11/2012
DRILLER: J. Wilson/W.G
LOGGED BY: B. Imamoglu

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
7/11/2012		4			SIZE, ID	4 1/4"	1 3/8"	
7/12/2012		1.5			HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
S-1	0.0	12"	15 19 25 28							Brown Silty Sand with Gravel (sm), moist, dense to very dense (Fill).	
S-2	2.0	6"	10 76 67 50					EL -0.3 / 4.0			
							5			Dark gray Sludge (classified as Elastic Silt (mh)), wet, very loose (Fill).	
S-3	5.0	24"	1 1 1 1								
S-4	7.0	12"	1 2 2 1								
							10				
T-1	10.0	NR									
S-5	12.0	NR	1 1 1 1					EL -9.3 / 13.0		Brown Elastic Silt (mh, fibrous Peat), wet, very soft to loose.	
							15				
T-2	15.0	NR									
S-6	17.0	24"	3 2 3 2								Sand encountered @ bottom of S-6
							20	EL -16.3 / 20.0		Gray to brown Sandy Gravel with Sand (gp), wet, medium dense.	
S-7	20.0	10"	10 18 6 6								

BLOWS/FT.	DENSITY	BLOWS/FT.	CONSISTENCY
0-4	VERY LOOSE	0-2	VERY SOFT
5-10	LOOSE	3-4	SOFT
11-30	MEDIUM DENSE	5-8	MEDIUM STIFF
31-50	DENSE	9-15	STIFF
OVER 50	VERY DENSE	16-30	VERY STIFF
		OVER 30	HARD

SAMPLE IDENTIFICATION
- S - SPLIT SPOON
- T - THIN WALL TUBE
- SS - 3in. SPLIT SPOON
- R - DIAMOND CORE
- W - WASH SAMPLE
- U - UNDISTURBED

SAMPLE PROPORTIONS	
DESCRIPTIVE TERM	PERCENT
TRACE	1 TO 10
LITTLE	11 TO 20
SOME	21 TO 35
AND	35 TO 50

BORING BD-02

TEST BORING LOG

BORING BD-02

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 2 of 2
NORTHING: 643038.72
EASTING: 569814.75
ELEVATION: 3.74
START DATE: 7/11/2012
END DATE: 7/11/2012
DRILLER: J. Wilson/W.G
LOGGED BY: B. Imamoglu

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
7/11/2012		4			SIZE, ID	4 1/4"	1 3/8"	
7/12/2012		1.5			HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
S-8	25.0	12"	3 11 16 19				25	EL -21.8 25.5		Brown Clayey Silt (ml) with Sand and Gravel, wet, m. dense.	
								EL -24.8 28.5		Brown-red Sandy Gravel (gp) with shale fragments, wet, very dense.	
S-9	30.0	3"	50/3"				30	EL -28.3 32.0		Bottom of Boring @ 32 ft.	
							35				
							40				
							45				

BLOWS/FT.	DENSITY
0-4	VERY LOOSE
5-10	LOOSE
11-30	MEDIUM DENSE
31-50	DENSE
OVER 50	VERY DENSE

BLOWS/FT.	CONSISTENCY
0-2	VERY SOFT
3-4	SOFT
5-8	MEDIUM STIFF
9-15	STIFF
16-30	VERY STIFF
OVER 30	HARD

SAMPLE IDENTIFICATION
- S - SPLIT SPOON
- T - THIN WALL TUBE
- SS - 3in. SPLIT SPOON
- R - DIAMOND CORE
- W - WASH SAMPLE
- U - UNDISTURBED

SAMPLE PROPORTIONS	
DESCRIPTIVE TERM	PERCENT
TRACE	1 TO 10
LITTLE	11 TO 20
SOME	21 TO 35
AND	35 TO 50

BORING BD-02

TEST BORING LOG

BORING BD-03

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 1 of 3
NORTHING: 644326.83
EASTING: 571694.34
ELEVATION: 12.82
START DATE: 7/17/2012
END DATE: 7/18/2012
DRILLER: Buck/W.G
LOGGED BY: D. Morar

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
7/17/2012		6			SIZE, ID	4 1/4"	1 3/8"	
					HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
S-1	0.0	12"	14 18 17 13							Red Lean Clay (cl) with Gravel and Sand, moist, dense (Fill).	
S-2	2.0	12"	14 16 23 23								
								EL 8.5 / 4.3			
S-3	4.0	14"	19 13 16 26				5			Gray Sludge (Classified as Elastic Silt (mh)), wet, very loose to dense (Fill).	
S-4	6.0	22"	15 18 19 28								
S-5	8.0	12"	1 1 1 1								Started mud drilling @8 ft
S-6	10.0	12"	3 4 3 2				10				
S-7	12.0	24"	0 0 0 0								
S-8	14.0	24"	0 3 2 2				15				
S-9	16.0	10"	0 0 0 0								
S-10	18.0	24"	0 3 3 4					EL -6.2 / 19.0		Gray SANDY ELASTIC SILT (MH, with fibrous Peat), wet, very loose to loose.	pp = 0 tsf
S-11	20.0	10"	0 0 0 0				20				pp = 0 tsf

BLOWS/FT.	DENSITY
0-4	VERY LOOSE
5-10	LOOSE
11-30	MEDIUM DENSE
31-50	DENSE
OVER 50	VERY DENSE

BLOWS/FT.	CONSISTENCY
0-2	VERY SOFT
3-4	SOFT
5-8	MEDIUM STIFF
9-15	STIFF
16-30	VERY STIFF
OVER 30	HARD

SAMPLE IDENTIFICATION
- S - SPLIT SPOON
- T - THIN WALL TUBE
- SS - 3in. SPLIT SPOON
- R - DIAMOND CORE
- W - WASH SAMPLE
- U - UNDISTURBED

SAMPLE PROPORTIONS	
DESCRIPTIVE TERM	PERCENT
TRACE	1 TO 10
LITTLE	11 TO 20
SOME	21 TO 35
AND	35 TO 50

BORING BD-03

TEST BORING LOG

BORING BD-03

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 2 of 3
NORTHING: 644326.83
EASTING: 571694.34
ELEVATION: 12.82
START DATE: 7/17/2012
END DATE: 7/18/2012
DRILLER: Buck/W.G
LOGGED BY: D. Morar

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
7/17/2012		6			SIZE, ID	4 1/4"	1 3/8"	
					HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
T-1	23.0			65.1%	105	60					Some Gravel encountered @ sample S-8
S-12	25.0	24"	0 0 0 0	73.8%	89	54	25				
								EL -15.7 28.5		Gray Silty Sand (sm), wet, loose.	
S-13	30.0	24"	2 4 2 2				30				Sand encountered @ S-13
								EL -20.7 33.5		Gray Sandy Gravel (gw), wet, medium to very dense.	
S-14	35.0	10"	11 10 15 8				35				
S-15	40.0	4"	19 18 16 23				40				
S-16	45.0	5"	50/5"				45			Sandstone fragments	

BLOWS/FT.	DENSITY
0-4	VERY LOOSE
5-10	LOOSE
11-30	MEDIUM DENSE
31-50	DENSE
OVER 50	VERY DENSE

BLOWS/FT.	CONSISTENCY
0-2	VERY SOFT
3-4	SOFT
5-8	MEDIUM STIFF
9-15	STIFF
16-30	VERY STIFF
OVER 30	HARD

SAMPLE IDENTIFICATION
- S - SPLIT SPOON
- T - THIN WALL TUBE
- SS - 3in. SPLIT SPOON
- R - DIAMOND CORE
- W - WASH SAMPLE
- U - UNDISTURBED

SAMPLE PROPORTIONS	
DESCRIPTIVE TERM	PERCENT
TRACE	1 TO 10
LITTLE	11 TO 20
SOME	21 TO 35
AND	35 TO 50

BORING BD-03

TEST BORING LOG

BORING BD-03

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 3 of 3
NORTHING: 644326.83
EASTING: 571694.34
ELEVATION: 12.82
START DATE: 7/17/2012
END DATE: 7/18/2012
DRILLER: Buck/W.G
LOGGED BY: D. Morar

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
7/17/2012		6			SIZE, ID	4 1/4"	1 3/8"	
					HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
								EL -34.2 / 47.0			Drilling refusal
										Bottom of Boring @ 47 ft.	
							50				
							55				
							60				
							65				

BLOWS/FT.	DENSITY	BLOWS/FT.	CONSISTENCY	SAMPLE IDENTIFICATION
0-4	VERY LOOSE	0-2	VERY SOFT	- S - SPLIT SPOON
5-10	LOOSE	3-4	SOFT	- T - THIN WALL TUBE
11-30	MEDIUM DENSE	5-8	MEDIUM STIFF	- SS - 3in. SPLIT SPOON
31-50	DENSE	9-15	STIFF	- R - DIAMOND CORE
OVER 50	VERY DENSE	16-30	VERY STIFF	- W - WASH SAMPLE
		OVER 30	HARD	- U - UNDISTURBED

SAMPLE PROPORTIONS	
DESCRIPTIVE TERM	PERCENT
TRACE	1 TO 10
LITTLE	11 TO 20
SOME	21 TO 35
AND	35 TO 50

BORING BD-03

TEST BORING LOG

BORING BD-04R

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 1 of 2
NORTHING: 642905.67
EASTING: 571278.33
ELEVATION: 4.89
START DATE: 7/18/2012
END DATE: 7/18/2012
DRILLER: Buck/W.G
LOGGED BY: D. Morar

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
					SIZE, ID	4 1/4"	1 3/8"	
					HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
S-1	0.0	14"	5 5 6 6					EL 2.9		Yellow to light gray Clayey Silt (ml), moist, stiff (Fill).	pp = 4.5 tsf
S-2	2.0	13"	3 3 11 12					2.0		Grey to black SLUDGE (classified as Elastic Silt (mh)), moist to wet, loose to medium dense (Fill).	pp = 1 tsf
S-3	4.0	16"	8 12 10 12				5				
S-4	6.0	24"	0 0 6 6								Started mud rotary drilling @ 6 ft
S-5	8.0	18"	2 4 6 7					EL -5.1			Encountered some Gravel @ S-5
S-6	10.0	8"	0 2 2 3				10	10.0		Red Lean Clay (cl) with Gravel, wet, soft (Fill).	Lean Clay with Gravel (cl) encountered @ S-6, S-7
S-7	12.0	20"	5 5 9 7					EL -7.9			
S-8	14.0	24"	4 7 13 21					12.8		Black SLUDGE (classified as Elastic Silt (mh)), moist to wet, medium dense (Fill).	
							15	EL -10.1			
								15.0		Red Lean Clay (cl) with Gravel, wet, very soft (Fill).	
								EL -11.1			
S-9	16.0	24"	2 2 3 3					16.0		Black SLUDGE (classified as Elastic Silt (mh)), moist to wet, loose (Fill).	Lean Clay with Gravel (cl) encountered @ S-9
								EL -12.6			
S-10	18.0	24"	7 10 10 10					17.5		Gray FAT CLAY (CH, with fibrous Peat and Gravel), wet, very soft to very stiff.	
							20				
T-1	21.0			75%	98	57					

BLOWS/FT.	DENSITY	BLOWS/FT.	CONSISTENCY
0-4	VERY LOOSE	0-2	VERY SOFT
5-10	LOOSE	3-4	SOFT
11-30	MEDIUM DENSE	5-8	MEDIUM STIFF
31-50	DENSE	9-15	STIFF
OVER 50	VERY DENSE	16-30	VERY STIFF
		OVER 30	HARD

SAMPLE IDENTIFICATION
- S - SPLIT SPOON
- T - THIN WALL TUBE
- SS - 3in. SPLIT SPOON
- R - DIAMOND CORE
- W - WASH SAMPLE
- U - UNDISTURBED

SAMPLE PROPORTIONS	
DESCRIPTIVE TERM	PERCENT
TRACE	1 TO 10
LITTLE	11 TO 20
SOME	21 TO 35
AND	35 TO 50

BORING BD-04R

TEST BORING LOG

BORING BD-04R

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 2 of 2
NORTHING: 642905.67
EASTING: 571278.33
ELEVATION: 4.89
START DATE: 7/18/2012
END DATE: 7/18/2012
DRILLER: Buck/W.G
LOGGED BY: D. Morar

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
					SIZE, ID	4 1/4"	1 3/8"	
					HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
S-11	23.0	24"	0 0 0 0				25				pp = 0 tsf
								EL -22.6 27.5		Red Clayey Sand (sc), wet, medium dense to dense.	
S-12	30.0	24"	0 10 13 12				30				
S-13	35.0	2"	15 18 16 16				35	EL -32.1 37.0			
S-14	37.0	10"	26 25 40 50/4"					EL -34.1 39.0		Red Lean Clay (cl) with Gravel, wet, hard.	
							40			Bottom of Boring @ 39 ft.	Drilling refusal
							45				

BLOWS/FT.	DENSITY	BLOWS/FT.	CONSISTENCY	SAMPLE IDENTIFICATION	SAMPLE PROPORTIONS: DESCRIPTIVE TERM	PERCENT
0-4	VERY LOOSE	0-2	VERY SOFT	- S - SPLIT SPOON	TRACE	1 TO 10
5-10	LOOSE	3-4	SOFT	- T - THIN WALL TUBE	LITTLE	11 TO 20
11-30	MEDIUM DENSE	5-8	MEDIUM STIFF	- SS - 3in. SPLIT SPOON	SOME	21 TO 35
31-50	DENSE	9-15	STIFF	- R - DIAMOND CORE	AND	35 TO 50
OVER 50	VERY DENSE	16-30	VERY STIFF	- W - WASH SAMPLE		
		OVER 30	HARD	- U - UNDISTURBED		

BORING BD-04R

TEST BORING LOG

BORING BD-05

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 1 of 2
NORTHING: 642100.92
EASTING: 571920.59
ELEVATION: 5.24
START DATE: 7/26/2012
END DATE: 7/26/2012
DRILLER: C. Moreira/W.G
LOGGED BY: G. Shen

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
					SIZE, ID	4 1/4"	1 3/8"	
					HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
S-1	0.0	4"	1 0 0 0							Grey Silt (ml) with some black Peat and Sludge, moist, very loose (Fill).	
S-2	2.0	18"	2 1 2 3					EL 2.7 / 2.5		Gray FAT CLAY with SAND (CH, fibrous Peat), moist, very soft to soft.	
S-3	4.0	18"	3 4 3 3				5				Sludge encountered @ S-3
U-1	6.0	NR									
S-5	8.0	24"	0 1 2 1								Organic odor encountered @ S-5 pp = 0 tsf
S-6	10.0	16"	0 1 1 1				10				
S-7	12.0	24"	1 1 2 2								pp = 0 tsf
S-8	14.0	24"	0 1 0 0	70.9%	78	44	15				
S-9	16.0	24"	0 0 0 0								
S-10	18.0	24"	9 1 1 8					EL -14.3 / 19.5			Medium Sand encountered @ S-10
							20			Gray Silty Fine Sand (sm), wet, medium dense to dense.	

BLOWS/FT.	DENSITY
0-4	VERY LOOSE
5-10	LOOSE
11-30	MEDIUM DENSE
31-50	DENSE
OVER 50	VERY DENSE

BLOWS/FT.	CONSISTENCY
0-2	VERY SOFT
3-4	SOFT
5-8	MEDIUM STIFF
9-15	STIFF
16-30	VERY STIFF
OVER 30	HARD

SAMPLE IDENTIFICATION
- S - SPLIT SPOON
- T - THIN WALL TUBE
- SS - 3in. SPLIT SPOON
- R - DIAMOND CORE
- W - WASH SAMPLE
- U - UNDISTURBED

SAMPLE PROPORTIONS	
DESCRIPTIVE TERM	PERCENT
TRACE	1 TO 10
LITTLE	11 TO 20
SOME	21 TO 35
AND	35 TO 50

BORING BD-05

TEST BORING LOG

BORING BD-05

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 2 of 2
NORTHING: 642100.92
EASTING: 571920.59
ELEVATION: 5.24
START DATE: 7/26/2012
END DATE: 7/26/2012
DRILLER: C. Moreira/W.G
LOGGED BY: G. Shen

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
					SIZE, ID	4 1/4"	1 3/8"	
					HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
S-11	25.0	20"	10 14 16 21				25				
S-12	30.0	18"	8 16 17 17				30				Gravels encountered @ S-12
S-13	35.0	24"	11 13 10 8				35	EL -31.6			pp = 0.5 to 1.0 tsf
								EL -31.8 37.0		Red-br Grav. Silt (ml), wet, m. dense.	Shale fragments
							40			Bottom of Boring @ 37 ft.	
							45				

BLOWS/FT.	DENSITY
0-4	VERY LOOSE
5-10	LOOSE
11-30	MEDIUM DENSE
31-50	DENSE
OVER 50	VERY DENSE

BLOWS/FT.	CONSISTENCY
0-2	VERY SOFT
3-4	SOFT
5-8	MEDIUM STIFF
9-15	STIFF
16-30	VERY STIFF
OVER 30	HARD

SAMPLE IDENTIFICATION
- S - SPLIT SPOON
- T - THIN WALL TUBE
- SS - 3in. SPLIT SPOON
- R - DIAMOND CORE
- W - WASH SAMPLE
- U - UNDISTURBED

SAMPLE PROPORTIONS	
DESCRIPTIVE TERM	PERCENT
TRACE	1 TO 10
LITTLE	11 TO 20
SOME	21 TO 35
AND	35 TO 50

BORING BD-05

TEST BORING LOG

BORING BS-01

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 1 of 2
NORTHING: 643279.44
EASTING: 570331.75
ELEVATION: 12.41
START DATE: 7/13/2012
END DATE: 7/13/2012
DRILLER: Buck/W.G
LOGGED BY: B. Imamoglu

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
7/13/2012		4			SIZE, ID	4 1/4"	1 3/8"	
					HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
S-1	0.0	6"	5 12 8 4							Brown Gravelly Silty Sand (sm), moist, medium dense (Fill).	
S-2	2.0	10"	5 7 15 16								
							▽	EL 8.4 / 4.0			
S-3	4.0	12"	13 14 20 25				5			Brown Fat Clay with Sand (ch), moist, stiff to very stiff (Fill).	
S-4	6.0	12"	2 5 6 7								
S-5	8.0	12"	7 11 12 11								
							10	EL 2.4 / 10.0			
S-6	10.0	10"	2 2 2 3							Brown SANDY LEAN CLAY (CL), wet, medium to very stiff.	pp = 0.5 tsf
S-7	12.0	16"	2 4 7 8								pp = 0.5 tsf
S-8	14.0	16"	2 3 3 3				15				pp = 1.0 tsf
S-9	16.0	20"	15 26 13 14	20.4%	25	8					Encountered Gravel @ S-9 pp = 2.0 tsf
S-10	18.0	20'	0 2 4 3				20				pp = 1.0 tsf
T-1	21.0										

BLOWS/FT.	DENSITY	BLOWS/FT.	CONSISTENCY	SAMPLE IDENTIFICATION
0-4	VERY LOOSE	0-2	VERY SOFT	- S - SPLIT SPOON
5-10	LOOSE	3-4	SOFT	- T - THIN WALL TUBE
11-30	MEDIUM DENSE	5-8	MEDIUM STIFF	- SS - 3in. SPLIT SPOON
31-50	DENSE	9-15	STIFF	- R - DIAMOND CORE
OVER 50	VERY DENSE	16-30	VERY STIFF	- W - WASH SAMPLE
		OVER 30	HARD	- U - UNDISTURBED

SAMPLE PROPORTIONS	
DESCRIPTIVE TERM	PERCENT
TRACE	1 TO 10
LITTLE	11 TO 20
SOME	21 TO 35
AND	35 TO 50

BORING BS-01

TEST BORING LOG

BORING BS-01

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 2 of 2
NORTHING: 643279.44
EASTING: 570331.75
ELEVATION: 12.41
START DATE: 7/13/2012
END DATE: 7/13/2012
DRILLER: Buck/W.G
LOGGED BY: B. Imamoglu

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
7/13/2012		4			SIZE, ID	4 1/4"	1 3/8"	
					HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
S-11	23.0	24"	6 5 13 11								pp = 0.25 tsf pp = 1.0 tsf
S-12	25.0	20"	0 3 2 3				25				Encountered Peat @ S-12 pp = 1.5 tsf
								EL -16.1 28.5		Gray Clayey Sand with Gravel (sc), wet, dense.	
S-13	30.0	10"	10 12 18 15				30				
								EL -19.6 32.0		Bottom of Boring @ 32 ft.	
							35				
							40				
							45				

BLOWS/FT.	DENSITY
0-4	VERY LOOSE
5-10	LOOSE
11-30	MEDIUM DENSE
31-50	DENSE
OVER 50	VERY DENSE

BLOWS/FT.	CONSISTENCY
0-2	VERY SOFT
3-4	SOFT
5-8	MEDIUM STIFF
9-15	STIFF
16-30	VERY STIFF
OVER 30	HARD

SAMPLE IDENTIFICATION
- S - SPLIT SPOON
- T - THIN WALL TUBE
- SS - 3in. SPLIT SPOON
- R - DIAMOND CORE
- W - WASH SAMPLE
- U - UNDISTURBED

SAMPLE PROPORTIONS	
DESCRIPTIVE TERM	PERCENT
TRACE	1 TO 10
LITTLE	11 TO 20
SOME	21 TO 35
AND	35 TO 50

BORING BS-01

TEST BORING LOG

BORING BS-02

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 1 of 2
NORTHING: 642521
EASTING: 569792.09
ELEVATION: 3.97
START DATE: 7/11/2012
END DATE: 7/11/2012
DRILLER: Buck/W.G
LOGGED BY: B. Imamoglu

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
7/11/2012		4			SIZE, ID	4 1/4"	1 3/8"	
7/12/2012		1			HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
S-1	0.0	10"	17 32 33 50/4"							Brown Silty Sand (sm), moist to wet, very dense (Fill).	
								EL 1.7 2.3			
S-2	2.0	12"	8 13 25 19							Dark gray Sludge (classified as Elastic Silt (mh)), wet, dense (Fill).	
S-3	4.0	24"	11 15 14 13					EL -1.0 5.0			pp = 0 tsf
							5			Dark gray SANDY ELASTIC SILT (MH, fibrous Peat), wet, very loose to medium dense, organic ordor.	
T-1	7.0			375.7%	467	211					
S-4	9.0	24"	0 0 0 0				10				
S-5	11.0	24"	0 0 0 0								
								EL -9.4 13.4			
S-6	13.0	10"	7 8 7 10							Brown Clayey Silt (cl-ml), wet, medium dense to very dense.	
S-7	15.0	24"	10 12 15 14				15				Organic Clay encountered @ S-7
S-8	17.0	16"	2 10 13 14								
S-9	19.0	16"	15 16 16 25				20				
S-10	21.0	16"	15 20 27 26								

BLOWS/FT.	DENSITY	BLOWS/FT.	CONSISTENCY
0-4	VERY LOOSE	0-2	VERY SOFT
5-10	LOOSE	3-4	SOFT
11-30	MEDIUM DENSE	5-8	MEDIUM STIFF
31-50	DENSE	9-15	STIFF
OVER 50	VERY DENSE	16-30	VERY STIFF
		OVER 30	HARD

SAMPLE IDENTIFICATION
- S - SPLIT SPOON
- T - THIN WALL TUBE
- SS - 3in. SPLIT SPOON
- R - DIAMOND CORE
- W - WASH SAMPLE
- U - UNDISTURBED

SAMPLE PROPORTIONS	
DESCRIPTIVE TERM	PERCENT
TRACE	1 TO 10
LITTLE	11 TO 20
SOME	21 TO 35
AND	35 TO 50

BORING BS-02

TEST BORING LOG

BORING BS-02

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 2 of 2
NORTHING: 642521
EASTING: 569792.09
ELEVATION: 3.97
START DATE: 7/11/2012
END DATE: 7/11/2012
DRILLER: Buck/W.G
LOGGED BY: B. Imamoglu

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
7/11/2012		4			SIZE, ID	4 1/4"	1 3/8"	
7/12/2012		1			HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
S-11	25.0	24"	6 12 11 15				25				
S-12	30.0	24"	5 9 50 24				30	EL -28.0 32.0		Bottom of Boring @ 32 ft.	
							35				
							40				
							45				

BLOWS/FT.	DENSITY
0-4	VERY LOOSE
5-10	LOOSE
11-30	MEDIUM DENSE
31-50	DENSE
OVER 50	VERY DENSE

BLOWS/FT.	CONSISTENCY
0-2	VERY SOFT
3-4	SOFT
5-8	MEDIUM STIFF
9-15	STIFF
16-30	VERY STIFF
OVER 30	HARD

SAMPLE IDENTIFICATION
- S - SPLIT SPOON
- T - THIN WALL TUBE
- SS - 3in. SPLIT SPOON
- R - DIAMOND CORE
- W - WASH SAMPLE
- U - UNDISTURBED

SAMPLE PROPORTIONS	
DESCRIPTIVE TERM	PERCENT
TRACE	1 TO 10
LITTLE	11 TO 20
SOME	21 TO 35
AND	35 TO 50

BORING BS-02

TEST BORING LOG

BORING BS-03

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 1 of 2
NORTHING: 643528.08
EASTING: 571697.05
ELEVATION: 10.46
START DATE: 7/31/2012
END DATE: 7/31/2012
DRILLER: C. Moreira/W.G
LOGGED BY: D. Morar

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
7/31/2012		4.5			SIZE, ID	4 1/4"	1 3/8"	
					HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
S-1	0.0	4"	3 3 5 6							Dark Gray Sludge (classified as Elastic Silt (mh)), moist to wet, loose to medium dense (Fill).	Safety Hammer is used
S-2	2.0	1"	4 4 6 11								
S-3	4.0	19"	5 8 8 7				5				
S-4	6.0	24"	5 6 7 6								
T-1	8.0	24"									
S-5	10.0	24"	3 3 4 10				10				
S-6	12.0	24"	2 7 12 9								Peat encountered @ S-6 and S-7
S-7	14.0	24"	4 5 5 6				15	EL -4.5 / 15.0		Dark gray Lean Clay (cl), wet, very soft to medium stiff.	
S-8	16.0	24"	3 4 2 7								
S-9	18.0	24"	3 3 3 3				20				
S-10	20.0	24"	0 0 0 0								
S-11	22.0	24"	1 4								

BLOWS/FT.	DENSITY
0-4	VERY LOOSE
5-10	LOOSE
11-30	MEDIUM DENSE
31-50	DENSE
OVER 50	VERY DENSE

BLOWS/FT.	CONSISTENCY
0-2	VERY SOFT
3-4	SOFT
5-8	MEDIUM STIFF
9-15	STIFF
16-30	VERY STIFF
OVER 30	HARD

SAMPLE IDENTIFICATION
- S - SPLIT SPOON
- T - THIN WALL TUBE
- SS - 3in. SPLIT SPOON
- R - DIAMOND CORE
- W - WASH SAMPLE
- U - UNDISTURBED

SAMPLE PROPORTIONS	
DESCRIPTIVE TERM	PERCENT
TRACE	1 TO 10
LITTLE	11 TO 20
SOME	21 TO 35
AND	35 TO 50

BORING BS-03

TEST BORING LOG

BORING BS-03

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 2 of 2
NORTHING: 643528.08
EASTING: 571697.05
ELEVATION: 10.46
START DATE: 7/31/2012
END DATE: 7/31/2012
DRILLER: C. Moreira/W.G
LOGGED BY: D. Morar

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
7/31/2012		4.5			SIZE, ID	4 1/4"	1 3/8"	
					HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
S-12	24.0	24"	2 2 3 3 4 4				25	EL -15.5 / 26.0			
										Bottom of Boring @ 26 ft.	
							30				
							35				
							40				
							45				

BLOWS/FT.	DENSITY
0-4	VERY LOOSE
5-10	LOOSE
11-30	MEDIUM DENSE
31-50	DENSE
OVER 50	VERY DENSE

BLOWS/FT.	CONSISTENCY
0-2	VERY SOFT
3-4	SOFT
5-8	MEDIUM STIFF
9-15	STIFF
16-30	VERY STIFF
OVER 30	HARD

SAMPLE IDENTIFICATION
- S - SPLIT SPOON
- T - THIN WALL TUBE
- SS - 3in. SPLIT SPOON
- R - DIAMOND CORE
- W - WASH SAMPLE
- U - UNDISTURBED

SAMPLE PROPORTIONS	
DESCRIPTIVE TERM	PERCENT
TRACE	1 TO 10
LITTLE	11 TO 20
SOME	21 TO 35
AND	35 TO 50

BORING BS-03

TEST BORING LOG

BORING BS-04

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 1 of 2
NORTHING: 644841.43
EASTING: 571216.77
ELEVATION: 11.89
START DATE: 7/17/2012
END DATE: 7/17/2012
DRILLER: Buck/W.G
LOGGED BY: D. Morar

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
7/17/2012		6			SIZE, ID	4 1/4"	1 3/8"	
7/18/2012		6			HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
S-1	0.0	12"	13 14 8 7							Red-brown Sandy Lean Clay (cl) with concrete debris, moist, stiff to hard (Fill).	
S-2	2.0	6"	3 7 14 21								
S-3	4.0	6"	6 12 12 9				5				Gravel encountered @ S-3
S-4	6.0	4"	8 6 9 10								
S-5	8.0	NR	4 4 7 6								
S-6	10.0	2"	15 22 14 13				10				Color changed to reddish brown with tan and gray
S-7	12.0	2"	12 7 8 7								
S-8	14.0	12"	3 6 7 5				15	EL -3.0 / 14.9			
										Dark grey Sludge (classified as Elastic Silt (mh)), wet, loose (Fill).	
S-9	16.0	24"	7 4 4 4					EL -5.3 / 17.2			
										Dark Gray FAT CLAY (CH, fibrous Peat), wet, soft to stiff.	
S-10	18.0	23"	0 0 3 3				20				
S-11	20.0	24"	4 5 4 5								
T-1	22.0										

BLOWS/FT.	DENSITY	BLOWS/FT.	CONSISTENCY
0-4	VERY LOOSE	0-2	VERY SOFT
5-10	LOOSE	3-4	SOFT
11-30	MEDIUM DENSE	5-8	MEDIUM STIFF
31-50	DENSE	9-15	STIFF
OVER 50	VERY DENSE	16-30	VERY STIFF
		OVER 30	HARD

SAMPLE IDENTIFICATION
- S - SPLIT SPOON
- T - THIN WALL TUBE
- SS - 3in. SPLIT SPOON
- R - DIAMOND CORE
- W - WASH SAMPLE
- U - UNDISTURBED

SAMPLE PROPORTIONS	
DESCRIPTIVE TERM	PERCENT
TRACE	1 TO 10
LITTLE	11 TO 20
SOME	21 TO 35
AND	35 TO 50

BORING BS-04

TEST BORING LOG

BORING BS-04

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 2 of 2
NORTHING: 644841.43
EASTING: 571216.77
ELEVATION: 11.89
START DATE: 7/17/2012
END DATE: 7/17/2012
DRILLER: Buck/W.G
LOGGED BY: D. Morar

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
7/17/2012		6			SIZE, ID	4 1/4"	1 3/8"	
7/18/2012		6			HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
				71.9%	93	55					
S-12	24.0	24"	1 2 2 5	45%			25	EL -13.1 / 25.0		Brown Silty Sand (sm), wet, very loose.	
								EL -15.1 / 27.0		Bottom of Boring @ 27 ft.	
							30				
							35				
							40				
							45				

BLOWS/FT.	DENSITY	BLOWS/FT.	CONSISTENCY
0-4	VERY LOOSE	0-2	VERY SOFT
5-10	LOOSE	3-4	SOFT
11-30	MEDIUM DENSE	5-8	MEDIUM STIFF
31-50	DENSE	9-15	STIFF
OVER 50	VERY DENSE	16-30	VERY STIFF
		OVER 30	HARD

SAMPLE IDENTIFICATION
- S - SPLIT SPOON
- T - THIN WALL TUBE
- SS - 3in. SPLIT SPOON
- R - DIAMOND CORE
- W - WASH SAMPLE
- U - UNDISTURBED

SAMPLE PROPORTIONS	
DESCRIPTIVE TERM	PERCENT
TRACE	1 TO 10
LITTLE	11 TO 20
SOME	21 TO 35
AND	35 TO 50

BORING BS-04

TEST BORING LOG

BORING BS-05

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 1 of 2
NORTHING: 642082.5
EASTING: 571413.38
ELEVATION: 5.57
START DATE: 7/24/2012
END DATE: 7/24/2012
DRILLER: Buck/W.G
LOGGED BY: D. Morar

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
7/24/2012		3			SIZE, ID	4 1/4"	1 3/8"	
7/25/2012		3			HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
S-1	0.0	7"	12 7 6 14						Brown Gravely Silty Sand (sm), loose to medium dense (Fill).	
S-2	2.0	3"	4 3 2 3							
S-3	4.0	16"	2 4 4 3				5	EL 1.1 / 4.5	Dark brown to brown Sandy Elastic Silt (mh, fibrous Peat), wet, very loose to loose, organic ordor.	
S-4	6.0	18"	2 2 2 3							
S-5	8.0	24"	3 4 3 4							Yellow color encountered @ S-5
S-6	10.0	NR	3 4 2 4				10			
S-7	12.0	20"	3 4 3 5							Fat Clay encountered @ S-7
U-1	14.0						15			
S-8	16.0	12"	2 3 1 2					EL -10.4 / 16.0	Grey Organic Silt (oh), wet, very soft, some Peat, organic odor	pp = <0.1 tsf
S-9	18.0	24"	2 3 2 3							
S-10	20.0	18"	8 16 17 16				20	EL -14.4 / 20.0	Gray Silty Sand (sm), wet, medium dense to dense, organic ordor.	

BLOWS/FT.	DENSITY	BLOWS/FT.	CONSISTENCY
0-4	VERY LOOSE	0-2	VERY SOFT
5-10	LOOSE	3-4	SOFT
11-30	MEDIUM DENSE	5-8	MEDIUM STIFF
31-50	DENSE	9-15	STIFF
OVER 50	VERY DENSE	16-30	VERY STIFF
		OVER 30	HARD

SAMPLE IDENTIFICATION
- S - SPLIT SPOON
- T - THIN WALL TUBE
- SS - 3in. SPLIT SPOON
- R - DIAMOND CORE
- W - WASH SAMPLE
- U - UNDISTURBED

SAMPLE PROPORTIONS	
DESCRIPTIVE TERM	PERCENT
TRACE	1 TO 10
LITTLE	11 TO 20
SOME	21 TO 35
AND	35 TO 50

BORING BS-05

TEST BORING LOG

BORING BS-05

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 2 of 2
NORTHING: 642082.5
EASTING: 571413.38
ELEVATION: 5.57
START DATE: 7/24/2012
END DATE: 7/24/2012
DRILLER: Buck/W.G
LOGGED BY: D. Morar

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
7/24/2012		3			SIZE, ID	4 1/4"	1 3/8"	
7/25/2012		3			HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
S-11	25.0	16"	8 14 12 8				25				
								EL -21.4 27.0		Bottom of Boring @ 27 ft.	
							30				
							35				
							40				
							45				

BLOWS/FT.	DENSITY
0-4	VERY LOOSE
5-10	LOOSE
11-30	MEDIUM DENSE
31-50	DENSE
OVER 50	VERY DENSE

BLOWS/FT.	CONSISTENCY
0-2	VERY SOFT
3-4	SOFT
5-8	MEDIUM STIFF
9-15	STIFF
16-30	VERY STIFF
OVER 30	HARD

SAMPLE IDENTIFICATION
- S - SPLIT SPOON
- T - THIN WALL TUBE
- SS - 3in. SPLIT SPOON
- R - DIAMOND CORE
- W - WASH SAMPLE
- U - UNDISTURBED

SAMPLE PROPORTIONS	
DESCRIPTIVE TERM	PERCENT
TRACE	1 TO 10
LITTLE	11 TO 20
SOME	21 TO 35
AND	35 TO 50

BORING BS-05

TEST BORING LOG

BORING BS-06

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 1 of 2
NORTHING: 641459.47
EASTING: 572107.79
ELEVATION: 4.75
START DATE: 7/27/2012
END DATE: 7/27/2012
DRILLER: C. Moreira/W.G
LOGGED BY: G. Shen

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
7/27/2012		4			SIZE, ID	4 1/4"	1 3/8"	
					HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
S-1	0.0	24"	2 2 1 2							Dark gray Sludge (classified as Elastic Silt (mh)), moist to wet, very loose (Fill).	
U-1	2.0	17"									
S-3	4.0	2"	0 0 0 0				5	EL -1.3 / 6.0			
S-4	6.0	24"	2 1 1 1							Gray Organic Fat Clay (oh, fibrous Peat), wet, very soft to soft.	
S-5	8.0	NR	2 1 2 3								
S-6	10.0	1"	0 0 0 0				10				pp = 0
S-7	12.0	NR	0 0 0 0								
S-8	14.0	16"	2 2 2 3				15				
S-9	16.0	16"	0 0 0 0								pp = 0
S-10	18.0	24"	0 2 2 3				20				pp < 0.05 tsf
S-11	20.0	24"	0 0 4 11					EL -16.3 / 21.0		Dark gray Silty Fine Sand (sm), wet, medium dense.	
S-12	22.0	24"	13 13								

BLOWS/FT.	DENSITY
0-4	VERY LOOSE
5-10	LOOSE
11-30	MEDIUM DENSE
31-50	DENSE
OVER 50	VERY DENSE

BLOWS/FT.	CONSISTENCY
0-2	VERY SOFT
3-4	SOFT
5-8	MEDIUM STIFF
9-15	STIFF
16-30	VERY STIFF
OVER 30	HARD

SAMPLE IDENTIFICATION
- S - SPLIT SPOON
- T - THIN WALL TUBE
- SS - 3in. SPLIT SPOON
- R - DIAMOND CORE
- W - WASH SAMPLE
- U - UNDISTURBED

SAMPLE PROPORTIONS	
DESCRIPTIVE TERM	PERCENT
TRACE	1 TO 10
LITTLE	11 TO 20
SOME	21 TO 35
AND	35 TO 50

BORING BS-06

TEST BORING LOG

BORING BS-06

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 2 of 2
NORTHING: 641459.47
EASTING: 572107.79
ELEVATION: 4.75
START DATE: 7/27/2012
END DATE: 7/27/2012
DRILLER: C. Moreira/W.G
LOGGED BY: G. Shen

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
7/27/2012		4			SIZE, ID	4 1/4"	1 3/8"	
					HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
X			17 18					EL -19.3 24.0			
							25			Bottom of Boring @ 24 ft.	
							30				
							35				
							40				
							45				

BLOWS/FT.	DENSITY
0-4	VERY LOOSE
5-10	LOOSE
11-30	MEDIUM DENSE
31-50	DENSE
OVER 50	VERY DENSE

BLOWS/FT.	CONSISTENCY
0-2	VERY SOFT
3-4	SOFT
5-8	MEDIUM STIFF
9-15	STIFF
16-30	VERY STIFF
OVER 30	HARD

SAMPLE IDENTIFICATION
- S - SPLIT SPOON
- T - THIN WALL TUBE
- SS - 3in. SPLIT SPOON
- R - DIAMOND CORE
- W - WASH SAMPLE
- U - UNDISTURBED

SAMPLE PROPORTIONS	
DESCRIPTIVE TERM	PERCENT
TRACE	1 TO 10
LITTLE	11 TO 20
SOME	21 TO 35
AND	35 TO 50

BORING BS-06

TEST BORING LOG

BORING BS-07R

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 1 of 2
NORTHING: 641754.64
EASTING: 570476.25
ELEVATION: 4.66
START DATE: 7/16/2012
END DATE: 7/16/2012
DRILLER: Buck/W.G
LOGGED BY: B. Imamoglu

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
7/16/2012		4			SIZE, ID	4 1/4"	1 3/8"	
7/17/2012		2			HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
S-1	0.0	18"	24 27 50 24							Gray Silty Sand with Gravel (sm), moist to wet, very dense (Fill).	
S-2	2.0	16"	10 15 32 46								
S-3	4.0	4"	10 23 25 28				5	EL -1.3			
S-4	6.0	NR	1 2 1 1					6.0		Dark gray to gray Sludge (classified as Elastic Silt (mh)), wet, very loose (Fill).	
S-5	8.0	12"	2 2 2 2					EL -3.8 8.5		Black Organic Fat Clay (oh, fibrous Peat), wet, soft to medium stiff, organic ordor.	
S-6	10.0	20"	2 3 4 4				10	EL -7.3			
S-7	12.0	6"	0 1 0 1					12.0		Black to gray Sludge (classified as Elastic Silt (mh)), some Peat, wet, very loose to loose (Fill).	
S-8	14.0	12"	1 2 3 2				15				
T-1	17.0							EL -14.3			
S-9	19.0	20"	6 6 10 14				20	19.0		Brown Clayey Silt with Sand (cl-ml), wet, very stiff.	

BLOWS/FT.	DENSITY
0-4	VERY LOOSE
5-10	LOOSE
11-30	MEDIUM DENSE
31-50	DENSE
OVER 50	VERY DENSE

BLOWS/FT.	CONSISTENCY
0-2	VERY SOFT
3-4	SOFT
5-8	MEDIUM STIFF
9-15	STIFF
16-30	VERY STIFF
OVER 30	HARD

SAMPLE IDENTIFICATION
- S - SPLIT SPOON
- T - THIN WALL TUBE
- SS - 3in. SPLIT SPOON
- R - DIAMOND CORE
- W - WASH SAMPLE
- U - UNDISTURBED

SAMPLE PROPORTIONS	
DESCRIPTIVE TERM	PERCENT
TRACE	1 TO 10
LITTLE	11 TO 20
SOME	21 TO 35
AND	35 TO 50

BORING BS-07R

TEST BORING LOG

BORING BS-07R

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 2 of 2
NORTHING: 641754.64
EASTING: 570476.25
ELEVATION: 4.66
START DATE: 7/16/2012
END DATE: 7/16/2012
DRILLER: Buck/W.G
LOGGED BY: B. Imamoglu

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
7/16/2012		4			SIZE, ID	4 1/4"	1 3/8"	
7/17/2012		2			HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
S-10	25.0	12"	10 6 9 25				25				Gravel encountered @ S-10
								EL -22.3 27.0		Bottom of Boring @ 27 ft.	
							30				
							35				
							40				
							45				

BLOWS/FT.	DENSITY
0-4	VERY LOOSE
5-10	LOOSE
11-30	MEDIUM DENSE
31-50	DENSE
OVER 50	VERY DENSE

BLOWS/FT.	CONSISTENCY
0-2	VERY SOFT
3-4	SOFT
5-8	MEDIUM STIFF
9-15	STIFF
16-30	VERY STIFF
OVER 30	HARD

SAMPLE IDENTIFICATION
- S - SPLIT SPOON
- T - THIN WALL TUBE
- SS - 3in. SPLIT SPOON
- R - DIAMOND CORE
- W - WASH SAMPLE
- U - UNDISTURBED

SAMPLE PROPORTIONS	
DESCRIPTIVE TERM	PERCENT
TRACE	1 TO 10
LITTLE	11 TO 20
SOME	21 TO 35
AND	35 TO 50

BORING BS-07R

TEST BORING LOG

BORING BS-08

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 1 of 2
NORTHING: 642304.09
EASTING: 570268.9
ELEVATION: 6.12
START DATE: 7/10/2012
END DATE: 7/10/2012
DRILLER: J. Harris/W.G
LOGGED BY: B. Imamoglu

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
7/10/2012		4			SIZE, ID	4 1/4"	1 3/8"	
7/11/2012		4			HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
S-1	0.0	4"	10 8 12 8							Brown Silty Sand with Gravel (sm), moist, medium dense (Fill).	
S-2	2.0	4"	8 4 9 11								
S-3	4.0	4"	2 3 8 5				5	EL 0.1			
S-4	6.0	24"	2 2 3 2					6.0 / EL -1.9		Dark grey Silty Clay (cl-ml), wet, soft (Fill).	pp = 0.25 tsf
S-5	8.0	24"	1 1 1 1					8.0		Dark Organic Clay (oh, fibrous Peat), wet, very soft.	pp = 0 tsf
S-6	10.0	24"	1 1 1 1				10				pp = 0 tsf
S-7	12.0	24"	1 1 1 1					EL -6.9			pp = 0 tsf
								13.0		Dark grey ORGANIC SILT (OL), wet, very loose, organic odor.	pp = 0 tsf
T-1	15.0			20.1%	20	2	15				
								EL -10.9 / 17.0		Brown Silty Sand (sm), some Gravel, wet, medium dense to dense	
S-8	17.0	24"	9 8 7 8								
S-9	19.0	24"	8 9 14 20				20				
S-10	21.0	24"	10 25 35 25	16%							

BLOWS/FT.	DENSITY	BLOWS/FT.	CONSISTENCY
0-4	VERY LOOSE	0-2	VERY SOFT
5-10	LOOSE	3-4	SOFT
11-30	MEDIUM DENSE	5-8	MEDIUM STIFF
31-50	DENSE	9-15	STIFF
OVER 50	VERY DENSE	16-30	VERY STIFF
		OVER 30	HARD

SAMPLE IDENTIFICATION
- S - SPLIT SPOON
- T - THIN WALL TUBE
- SS - 3in. SPLIT SPOON
- R - DIAMOND CORE
- W - WASH SAMPLE
- U - UNDISTURBED

SAMPLE PROPORTIONS	
DESCRIPTIVE TERM	PERCENT
TRACE	1 TO 10
LITTLE	11 TO 20
SOME	21 TO 35
AND	35 TO 50

BORING BS-08

TEST BORING LOG

BORING BS-08

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 2 of 2
NORTHING: 642304.09
EASTING: 570268.9
ELEVATION: 6.12
START DATE: 7/10/2012
END DATE: 7/10/2012
DRILLER: J. Harris/W.G
LOGGED BY: B. Imamoglu

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
7/10/2012		4			SIZE, ID	4 1/4"	1 3/8"	
7/11/2012		4			HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
S-11	23.0	24"	10 13 14 20								
							25	EL -18.9 25.0			
										Bottom of Boring @ 25 ft.	
							30				
							35				
							40				
							45				

BLOWS/FT.	DENSITY
0-4	VERY LOOSE
5-10	LOOSE
11-30	MEDIUM DENSE
31-50	DENSE
OVER 50	VERY DENSE

BLOWS/FT.	CONSISTENCY
0-2	VERY SOFT
3-4	SOFT
5-8	MEDIUM STIFF
9-15	STIFF
16-30	VERY STIFF
OVER 30	HARD

SAMPLE IDENTIFICATION
- S - SPLIT SPOON
- T - THIN WALL TUBE
- SS - 3in. SPLIT SPOON
- R - DIAMOND CORE
- W - WASH SAMPLE
- U - UNDISTURBED

SAMPLE PROPORTIONS	
DESCRIPTIVE TERM	PERCENT
TRACE	1 TO 10
LITTLE	11 TO 20
SOME	21 TO 35
AND	35 TO 50

BORING BS-08

TEST BORING LOG

BORING BS-09

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 1 of 2
NORTHING: 642214.79
EASTING: 569922.78
ELEVATION: 7.21
START DATE: 7/10/2012
END DATE: 7/10/2012
DRILLER: J. Harris/W.G
LOGGED BY: B. Imamoglu

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
7/10/2012		4			SIZE, ID	4 1/4"	1 3/8"	
7/11/2012		5.5			HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
S-1	0.0	4"	16 15 17 15							Brown to gray Silty Sand with Gravel (sm), moist to wet, medium dense to very dense (Fill).	Donut Hammer is used
S-2	2.0	5"	17 18 45 50/3"								
							5				
S-3	5.0	16"	14 16 7 5								Started mud rotary drilling @ 6 ft.
S-4	7.0	16"	6 14 16 12					EL -1.3 / 8.5			
S-5	9.0	NR	0 1 0 0				10			Brown SILTY SAND (SM, fibrous Peat), wet, very loose.	
T-1	12.0			58.6%	241	128					
S-6	14.0	20"	2 9 11 10				15	EL -7.1 / 14.3		Grey to brown SILTY SAND (SM), wet, medium dense to dense.	
S-7	16.0	20"	8 9 9 23								
S-8	18.0	24"	7 8 8 8				20				
S-9	20.0	24"	4 11 14 17								
S-10	22.0	24"	13 15								

BLOWS/FT.	DENSITY	BLOWS/FT.	CONSISTENCY	SAMPLE IDENTIFICATION	SAMPLE PROPORTIONS	
0-4	VERY LOOSE	0-2	VERY SOFT	- S - SPLIT SPOON	DESCRIPTIVE TERM	PERCENT
5-10	LOOSE	3-4	SOFT	- T - THIN WALL TUBE	TRACE	1 TO 10
11-30	MEDIUM DENSE	5-8	MEDIUM STIFF	- SS - 3in. SPLIT SPOON	LITTLE	11 TO 20
31-50	DENSE	9-15	STIFF	- R - DIAMOND CORE	SOME	21 TO 35
OVER 50	VERY DENSE	16-30	VERY STIFF	- W - WASH SAMPLE	AND	35 TO 50
		OVER 30	HARD	- U - UNDISTURBED		

BORING BS-09

TEST BORING LOG

BORING BS-09

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 2 of 2
NORTHING: 642214.79
EASTING: 569922.78
ELEVATION: 7.21
START DATE: 7/10/2012
END DATE: 7/10/2012
DRILLER: J. Harris/W.G
LOGGED BY: B. Imamoglu

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
7/10/2012		4			SIZE, ID	4 1/4"	1 3/8"	
7/11/2012		5.5			HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
S-11	24.0	24"	19 15 13 15 25 29				25	EL -18.8 26.0			
										Bottom of Boring @ 26 ft.	
							30				
							35				
							40				
							45				

BLOWS/FT.	DENSITY
0-4	VERY LOOSE
5-10	LOOSE
11-30	MEDIUM DENSE
31-50	DENSE
OVER 50	VERY DENSE

BLOWS/FT.	CONSISTENCY
0-2	VERY SOFT
3-4	SOFT
5-8	MEDIUM STIFF
9-15	STIFF
16-30	VERY STIFF
OVER 30	HARD

SAMPLE IDENTIFICATION
- S - SPLIT SPOON
- T - THIN WALL TUBE
- SS - 3in. SPLIT SPOON
- R - DIAMOND CORE
- W - WASH SAMPLE
- U - UNDISTURBED

SAMPLE PROPORTIONS	
DESCRIPTIVE TERM	PERCENT
TRACE	1 TO 10
LITTLE	11 TO 20
SOME	21 TO 35
AND	35 TO 50

BORING BS-09

TEST BORING LOG

BORING ID-01

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 1 of 3
NORTHING: 644320.93
EASTING: 571319.24
ELEVATION: 7.96
START DATE: 7/23/2012
END DATE: 7/23/2012
DRILLER: C. Moreira/W.G
LOGGED BY: G. Shen

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
					SIZE, ID	4 1/4"	1 3/8"	
					HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
S-1	0.0	7"	2 1 2 3							Gray Sludge (classified as Elastic Silt (mh)), wet, very loose to medium dense (Fill).	Safety Hammer is used
S-2	2.0	16"	2 1 2 4								
S-3	4.0	24"	3 5 3 3	134.3%	59	10	5				
U-1	6.0										
S-4	8.0	24"	0 0 2 4								
S-5	10.0	24"	2 1 10 7				10				pp < 0.1 tsf
S-6	12.0	20"	2 2 4 7								pp < 0.1 tsf
U-2	14.0						15				
S-7	16.0	24"	0 0 1 1					EL -8.5 / 16.5		Brown to dark gray Organic Fat Clay (ch, fibrous Peat), wet, very soft to soft, organic odor.	
S-8	18.0	24"	2 3 2 2				20				pp < 0.1 tsf
U-3	20.0	24"									
S-9	22.0	24"	1 1								

BLOWS/FT.	DENSITY
0-4	VERY LOOSE
5-10	LOOSE
11-30	MEDIUM DENSE
31-50	DENSE
OVER 50	VERY DENSE

BLOWS/FT.	CONSISTENCY
0-2	VERY SOFT
3-4	SOFT
5-8	MEDIUM STIFF
9-15	STIFF
16-30	VERY STIFF
OVER 30	HARD

SAMPLE IDENTIFICATION
- S - SPLIT SPOON
- T - THIN WALL TUBE
- SS - 3in. SPLIT SPOON
- R - DIAMOND CORE
- W - WASH SAMPLE
- U - UNDISTURBED

SAMPLE PROPORTIONS	
DESCRIPTIVE TERM	PERCENT
TRACE	1 TO 10
LITTLE	11 TO 20
SOME	21 TO 35
AND	35 TO 50

BORING ID-01

TEST BORING LOG

BORING ID-01

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 2 of 3
NORTHING: 644320.93
EASTING: 571319.24
ELEVATION: 7.96
START DATE: 7/23/2012
END DATE: 7/23/2012
DRILLER: C. Moreira/W.G
LOGGED BY: G. Shen

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
					SIZE, ID	4 1/4"	1 3/8"	
					HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
			1 2								
S-10	24.0	24"	2 2 2 3				25				pp < 0.1 tsf
U-4	26.0	15"									Fine Sand encountered @ U-4 and S-11
								EL -20.0 28.0		Dark grey Silty Sand, wet, organic odor.	
S-11	28.0	18"	6 15 12 15					EL -21.9 29.9			
							30			Reddish brown Clayey Silt (ml), wet, very stiff to hard.	
S-12	35.0	24"	5 9 11 16				35				Gravel encountered @ S-12 pp = 1.0 tsf
S-13	40.0	24"	26 16 17 19				40				Fine Sand encountered @ S-13
							45				

BLOWS/FT.	DENSITY	BLOWS/FT.	CONSISTENCY	SAMPLE IDENTIFICATION	SAMPLE PROPORTIONS: DESCRIPTIVE TERM	PERCENT
0-4	VERY LOOSE	0-2	VERY SOFT	- S - SPLIT SPOON	TRACE	1 TO 10
5-10	LOOSE	3-4	SOFT	- T - THIN WALL TUBE	LITTLE	11 TO 20
11-30	MEDIUM DENSE	5-8	MEDIUM STIFF	- SS - 3in. SPLIT SPOON	SOME	21 TO 35
31-50	DENSE	9-15	STIFF	- R - DIAMOND CORE	AND	35 TO 50
OVER 50	VERY DENSE	16-30	VERY STIFF	- W - WASH SAMPLE		
		OVER 30	HARD	- U - UNDISTURBED		

BORING ID-01

TEST BORING LOG

BORING ID-01

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 3 of 3
NORTHING: 644320.93
EASTING: 571319.24
ELEVATION: 7.96
START DATE: 7/23/2012
END DATE: 7/23/2012
DRILLER: C. Moreira/W.G
LOGGED BY: G. Shen

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
					SIZE, ID	4 1/4"	1 3/8"	
					HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
											Hard drilling from 46 to 49 ft.
								EL -41.0 / 49.0			
							50			Bottom of Boring @ 49 ft.	
							55				
							60				
							65				

BLOWS/FT.	DENSITY
0-4	VERY LOOSE
5-10	LOOSE
11-30	MEDIUM DENSE
31-50	DENSE
OVER 50	VERY DENSE

BLOWS/FT.	CONSISTENCY
0-2	VERY SOFT
3-4	SOFT
5-8	MEDIUM STIFF
9-15	STIFF
16-30	VERY STIFF
OVER 30	HARD

SAMPLE IDENTIFICATION
- S - SPLIT SPOON
- T - THIN WALL TUBE
- SS - 3in. SPLIT SPOON
- R - DIAMOND CORE
- W - WASH SAMPLE
- U - UNDISTURBED

SAMPLE PROPORTIONS	
DESCRIPTIVE TERM	PERCENT
TRACE	1 TO 10
LITTLE	11 TO 20
SOME	21 TO 35
AND	35 TO 50

BORING ID-01

TEST BORING LOG

BORING ID-02

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 1 of 3
NORTHING: 643780.57
EASTING: 571521
ELEVATION: 9.98
START DATE: 7/15/2012
END DATE: 7/15/2012
DRILLER: C. Moreira/W.G
LOGGED BY: B. Imamoglu

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
					SIZE, ID	4 1/4"	1 3/8"	
					HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
S-1	0.0	12"	2 3 3 3							Brown Silty Sand (sm), moist, loose (Fill).	Safety Hammer is used
S-2	2.0	24"	5 10 8 20							Gray Sludge (classified as Elastic Silt (mh)), moist to wet, very loose to medium dense (Fill).	
S-3	4.0	24"	19 15 12 12				5				
S-4	6.0	24"	3 1 3 4								
S-5	8.0	24"	2 3 5 9								
S-6	10.0	24"	3 8 15 19				10				
S-7	12.0	24"	4 8 14 13								
S-8	14.0	24"	0 0 0 0				15	EL -4.5 / 14.5		Gray Sandy Silty Clay (cl-ml, fibrous Peat), wet, very soft to soft.	pp = 0 tsf
S-9	16.0	24"	1 2 2 3								pp = 0 tsf
S-10	18.0	12"	0 0 0 0				20				pp = 0 tsf
T-1	21.0	24"									

BLOWS/FT.	DENSITY	BLOWS/FT.	CONSISTENCY	SAMPLE IDENTIFICATION	SAMPLE PROPORTIONS: DESCRIPTIVE TERM	PERCENT
0-4	VERY LOOSE	0-2	VERY SOFT	- S - SPLIT SPOON	TRACE	1 TO 10
5-10	LOOSE	3-4	SOFT	- T - THIN WALL TUBE	LITTLE	11 TO 20
11-30	MEDIUM DENSE	5-8	MEDIUM STIFF	- SS - 3in. SPLIT SPOON	SOME	21 TO 35
31-50	DENSE	9-15	STIFF	- R - DIAMOND CORE	AND	35 TO 50
OVER 50	VERY DENSE	16-30	VERY STIFF	- W - WASH SAMPLE		
		OVER 30	HARD	- U - UNDISTURBED		

BORING ID-02

TEST BORING LOG

BORING ID-02

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 2 of 3
NORTHING: 643780.57
EASTING: 571521
ELEVATION: 9.98
START DATE: 7/15/2012
END DATE: 7/15/2012
DRILLER: C. Moreira/W.G
LOGGED BY: B. Imamoglu

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
					SIZE, ID	4 1/4"	1 3/8"	
					HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
S-11	23.0	24"	0 0 0 0								pp = 0 tsf
							25				
S-12	25.0	24"	0 1 2 3								pp = 0 tsf
								EL -18.5 / 28.5		Gray to brown Clayey Sand with Gravel (sc), wet, loose to medium dense.	
							30				
S-13	30.0	16"	6 4 4 6								
							35				
S-14	35.0	24"	12 10 12 13								
							40				
S-15	40.0	24"	10 12 18 25								
								EL -33.5 / 43.5		Green to gray Silty Sand (sm), wet, very dense.	
							45				
S-16	45.0	5"	50/5"								

BLOWS/FT.	DENSITY
0-4	VERY LOOSE
5-10	LOOSE
11-30	MEDIUM DENSE
31-50	DENSE
OVER 50	VERY DENSE

BLOWS/FT.	CONSISTENCY
0-2	VERY SOFT
3-4	SOFT
5-8	MEDIUM STIFF
9-15	STIFF
16-30	VERY STIFF
OVER 30	HARD

SAMPLE IDENTIFICATION
- S - SPLIT SPOON
- T - THIN WALL TUBE
- SS - 3in. SPLIT SPOON
- R - DIAMOND CORE
- W - WASH SAMPLE
- U - UNDISTURBED

SAMPLE PROPORTIONS	
DESCRIPTIVE TERM	PERCENT
TRACE	1 TO 10
LITTLE	11 TO 20
SOME	21 TO 35
AND	35 TO 50

BORING ID-02

TEST BORING LOG

BORING ID-02

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 3 of 3
NORTHING: 643780.57
EASTING: 571521
ELEVATION: 9.98
START DATE: 7/15/2012
END DATE: 7/15/2012
DRILLER: C. Moreira/W.G
LOGGED BY: B. Imamoglu

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
					SIZE, ID	4 1/4"	1 3/8"	
					HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
								EL -37.0 / 47.0			
										Bottom of Boring @ 47 ft.	
							50				
							55				
							60				
							65				

BLOWS/FT.	DENSITY
0-4	VERY LOOSE
5-10	LOOSE
11-30	MEDIUM DENSE
31-50	DENSE
OVER 50	VERY DENSE

BLOWS/FT.	CONSISTENCY
0-2	VERY SOFT
3-4	SOFT
5-8	MEDIUM STIFF
9-15	STIFF
16-30	VERY STIFF
OVER 30	HARD

SAMPLE IDENTIFICATION
- S - SPLIT SPOON
- T - THIN WALL TUBE
- SS - 3in. SPLIT SPOON
- R - DIAMOND CORE
- W - WASH SAMPLE
- U - UNDISTURBED

SAMPLE PROPORTIONS	
DESCRIPTIVE TERM	PERCENT
TRACE	1 TO 10
LITTLE	11 TO 20
SOME	21 TO 35
AND	35 TO 50

BORING ID-02

TEST BORING LOG

BORING ID-03R

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 1 of 2
NORTHING: 642967.64
EASTING: 570797.8
ELEVATION: 10.95
START DATE: 7/30/2012
END DATE: 7/30/2012
DRILLER: C. Moreira/W.G
LOGGED BY: D. Morar

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
					SIZE, ID	4 1/4"	1 3/8"	
					HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
T-1	0.0		0 0 0 0							Light to dark gray Sludge (classified as Elastic Silt (mh)), moist to wet, very loose to medium dense (Fill).	Safety Hammer is used
S-2	2.0	15"	0 0 0 0								
S-3	4.0	24"	0 0 0 0				5				
S-4	6.0	24"	0 2 2 9								2" fibrous peat encountered @ S-4
S-5	8.0	6"	2 2 1 0								
S-6	10.0	24"	4 10 16 11				10				
S-7	12.0	24"	5 8 17 21								
								EL -3.2 / 14.1			
S-8	14.0	18"	8 14 12 7				15			Dark gray Organic Fat Clay (oh, fibrous Peat), wet, medium stiff to very stiff.	Sludge encountered @ S-8
S-9	16.0	24"	5 4 4 4								
T-2	18.0										
S-11	20.0	22"	2 2 3 3				20				
S-12	22.0	24"	3 3								

BLOWS/FT.	DENSITY
0-4	VERY LOOSE
5-10	LOOSE
11-30	MEDIUM DENSE
31-50	DENSE
OVER 50	VERY DENSE

BLOWS/FT.	CONSISTENCY
0-2	VERY SOFT
3-4	SOFT
5-8	MEDIUM STIFF
9-15	STIFF
16-30	VERY STIFF
OVER 30	HARD

SAMPLE IDENTIFICATION
- S - SPLIT SPOON
- T - THIN WALL TUBE
- SS - 3in. SPLIT SPOON
- R - DIAMOND CORE
- W - WASH SAMPLE
- U - UNDISTURBED

SAMPLE PROPORTIONS	
DESCRIPTIVE TERM	PERCENT
TRACE	1 TO 10
LITTLE	11 TO 20
SOME	21 TO 35
AND	35 TO 50

BORING ID-03R

TEST BORING LOG

BORING ID-03R

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 2 of 2
NORTHING: 642967.64
EASTING: 570797.8
ELEVATION: 10.95
START DATE: 7/30/2012
END DATE: 7/30/2012
DRILLER: C. Moreira/W.G
LOGGED BY: D. Morar

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
					SIZE, ID	4 1/4"	1 3/8"	
					HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
			4 4					EL -12.9			
S-13	24.0	24"	6 7 14 19				25	23.8		Dark to light grey Lean Clay (cl) with some Sand and organic matter, wet, very stiff.	Sand encountered @ S-13
								EL -17.1			
								28.0		Red-brown Clayey Sand with Gravel (sc), wet, dense to very dense.	
S-14	30.0	10"	21 19 25 32				30				
							35	EL -24.2			Drill refusal
S-15	35.0	NR	50/1"					35.1		Bottom of Boring @ 34.5 ft.	
							40				
							45				

BLOWS/FT.	DENSITY
0-4	VERY LOOSE
5-10	LOOSE
11-30	MEDIUM DENSE
31-50	DENSE
OVER 50	VERY DENSE

BLOWS/FT.	CONSISTENCY
0-2	VERY SOFT
3-4	SOFT
5-8	MEDIUM STIFF
9-15	STIFF
16-30	VERY STIFF
OVER 30	HARD

SAMPLE IDENTIFICATION
- S - SPLIT SPOON
- T - THIN WALL TUBE
- SS - 3in. SPLIT SPOON
- R - DIAMOND CORE
- W - WASH SAMPLE
- U - UNDISTURBED

SAMPLE PROPORTIONS	
DESCRIPTIVE TERM	PERCENT
TRACE	1 TO 10
LITTLE	11 TO 20
SOME	21 TO 35
AND	35 TO 50

BORING ID-03R

TEST BORING LOG

BORING ID-04

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 1 of 2
NORTHING: 642826.52
EASTING: 570031.74
ELEVATION: 4.21
START DATE: 7/30/2012
END DATE: 7/30/2012
DRILLER: C. Moreira/W.G
LOGGED BY: D. Morar

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
7/30/2012		6			SIZE, ID	4 1/4"	1 3/8"	
					HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
S-1	0.0	6"	8 14 26 17							Brown Silty Sand with Gravel (sm), moist, dense.	Safety Hammer is used
S-2	2.0	6"	3 11 22 22								Sludge encountered @ S-2
								EL 0.2 / 4.0			
S-3	4.0	NR	3 3 2 1				5			Dark gray Sludge (classified as Elastic Silt (mh)), wet, very loose to loose (Fill).	
S-4	6.0	12"	1 1 1 1								
T-1	8.0	14"									
S-5	10.0	24"	2 2 3 2				10				
S-6	12.0	20"	2 2 1 1								
								EL -9.1 / 13.3			
S-7	14.0	24"	3 2 2 4				15			Dark gray Organic Fat Clay (oh, fibrous Peat), wet, soft to stiff.	
S-8	16.0	24"	3 4 7 14								Sand encountered @ S-8
								EL -13.7 / 17.9			
S-9	18.0	14"	9 10 12 13				20			Reddish brown Sandy Lean Clay with Gravel (cl), very stiff to hard.	

BLOWS/FT.	DENSITY
0-4	VERY LOOSE
5-10	LOOSE
11-30	MEDIUM DENSE
31-50	DENSE
OVER 50	VERY DENSE

BLOWS/FT.	CONSISTENCY
0-2	VERY SOFT
3-4	SOFT
5-8	MEDIUM STIFF
9-15	STIFF
16-30	VERY STIFF
OVER 30	HARD

SAMPLE IDENTIFICATION
- S - SPLIT SPOON
- T - THIN WALL TUBE
- SS - 3in. SPLIT SPOON
- R - DIAMOND CORE
- W - WASH SAMPLE
- U - UNDISTURBED

SAMPLE PROPORTIONS	
DESCRIPTIVE TERM	PERCENT
TRACE	1 TO 10
LITTLE	11 TO 20
SOME	21 TO 35
AND	35 TO 50

BORING ID-04

TEST BORING LOG

BORING ID-04

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 2 of 2
NORTHING: 642826.52
EASTING: 570031.74
ELEVATION: 4.21
START DATE: 7/30/2012
END DATE: 7/30/2012
DRILLER: C. Moreira/W.G
LOGGED BY: D. Morar

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
7/30/2012		6			SIZE, ID	4 1/4"	1 3/8"	
					HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
S-10	25.0	18"	13 25 44 37				25				
S-11	30.0	NR	11 25 26 25				30				
S-12	35.0	6"	48 50/5"				35	EL -31.8 36.0		Bottom of Boring @ 36 ft.	Drill refusal
							40				
							45				

BLOWS/FT.	DENSITY	BLOWS/FT.	CONSISTENCY
0-4	VERY LOOSE	0-2	VERY SOFT
5-10	LOOSE	3-4	SOFT
11-30	MEDIUM DENSE	5-8	MEDIUM STIFF
31-50	DENSE	9-15	STIFF
OVER 50	VERY DENSE	16-30	VERY STIFF
		OVER 30	HARD

SAMPLE IDENTIFICATION
- S - SPLIT SPOON
- T - THIN WALL TUBE
- SS - 3in. SPLIT SPOON
- R - DIAMOND CORE
- W - WASH SAMPLE
- U - UNDISTURBED

SAMPLE PROPORTIONS	
DESCRIPTIVE TERM	PERCENT
TRACE	1 TO 10
LITTLE	11 TO 20
SOME	21 TO 35
AND	35 TO 50

BORING ID-04

TEST BORING LOG

BORING ID-05

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 1 of 3
NORTHING: 642187.4
EASTING: 570649.34
ELEVATION: 7.09
START DATE: 7/13/2012
END DATE: 7/16/2012
DRILLER: Buck/W.G
LOGGED BY: B. Imamoglu

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
7/13/2012		6			SIZE, ID	4 1/4"	1 3/8"	
7/16/2012		4			HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
S-1	0.0	10"	8 23 50 50/3"							Brown to gray Silty Sand with Gravel (sm), moist to wet, medium dense to very dense (Fill).	Donut Hammer is used
S-2	2.0	NR	16 50/0"								
S-3	4.0	2"	18 12 22 13				5				
S-4	6.0	NR	2 10 9 8					EL 0.1 7.0		Dark gray to gray Sludge (classified as Elastic Silt (mh)), wet, loose (Fill).	
S-5	8.0	10"	2 2 3 4								
S-6	10.0	4"	6 5 5 7				10	EL -4.9 12.0			
S-7	12.0	24"	1 1 1 1							Dark gray Organic Fat Clay (oh, fibrous Peat), wet, very soft to medium stiff.	
S-8	14.0	6"	1 2 3 3				15	EL -9.4 16.5			
T-1	17.0									Gray to brown Silty Clay (cl-ml), wet, stiff to very stiff.	
S-9	19.0	24"	6 11 13 18				20				Gravel and Sand encountered @ S-9, S-10

BLOWS/FT.	DENSITY	BLOWS/FT.	CONSISTENCY
0-4	VERY LOOSE	0-2	VERY SOFT
5-10	LOOSE	3-4	SOFT
11-30	MEDIUM DENSE	5-8	MEDIUM STIFF
31-50	DENSE	9-15	STIFF
OVER 50	VERY DENSE	16-30	VERY STIFF
		OVER 30	HARD

SAMPLE IDENTIFICATION
- S - SPLIT SPOON
- T - THIN WALL TUBE
- SS - 3in. SPLIT SPOON
- R - DIAMOND CORE
- W - WASH SAMPLE
- U - UNDISTURBED

SAMPLE PROPORTIONS	
DESCRIPTIVE TERM	PERCENT
TRACE	1 TO 10
LITTLE	11 TO 20
SOME	21 TO 35
AND	35 TO 50

BORING ID-05

TEST BORING LOG

BORING ID-05

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 2 of 3
NORTHING: 642187.4
EASTING: 570649.34
ELEVATION: 7.09
START DATE: 7/13/2012
END DATE: 7/16/2012
DRILLER: Buck/W.G
LOGGED BY: B. Imamoglu

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
7/13/2012		6			SIZE, ID	4 1/4"	1 3/8"	
7/16/2012		4			HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
S-10	25.0	24"	4 5 7 11				25				
								EL -20.4 27.5		Brown Silty Sand with Gravel (sm), wet, very dense.	
S-11	30.0	6"	80/6"				30				
S-12	34.5	20"	73 78 75/3"				35				Less Gravel encountered @ S-12
S-13	40.0	2"	50/2"				40				
S-14	45.0	2"	50/2"				45				No Gravel @ S-14

BLOWS/FT.	DENSITY
0-4	VERY LOOSE
5-10	LOOSE
11-30	MEDIUM DENSE
31-50	DENSE
OVER 50	VERY DENSE

BLOWS/FT.	CONSISTENCY
0-2	VERY SOFT
3-4	SOFT
5-8	MEDIUM STIFF
9-15	STIFF
16-30	VERY STIFF
OVER 30	HARD

SAMPLE IDENTIFICATION
- S - SPLIT SPOON
- T - THIN WALL TUBE
- SS - 3in. SPLIT SPOON
- R - DIAMOND CORE
- W - WASH SAMPLE
- U - UNDISTURBED

SAMPLE PROPORTIONS	
DESCRIPTIVE TERM	PERCENT
TRACE	1 TO 10
LITTLE	11 TO 20
SOME	21 TO 35
AND	35 TO 50

BORING ID-05

TEST BORING LOG

BORING ID-05

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 3 of 3
NORTHING: 642187.4
EASTING: 570649.34
ELEVATION: 7.09
START DATE: 7/13/2012
END DATE: 7/16/2012
DRILLER: Buck/W.G
LOGGED BY: B. Imamoglu

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
7/13/2012		6			SIZE, ID	4 1/4"	1 3/8"	
7/16/2012		4			HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
								EL -39.9 / 47.0			
										Bottom of Boring @ 47 ft.	
							50				
							55				
							60				
							65				

BLOWS/FT.	DENSITY
0-4	VERY LOOSE
5-10	LOOSE
11-30	MEDIUM DENSE
31-50	DENSE
OVER 50	VERY DENSE

BLOWS/FT.	CONSISTENCY
0-2	VERY SOFT
3-4	SOFT
5-8	MEDIUM STIFF
9-15	STIFF
16-30	VERY STIFF
OVER 30	HARD

SAMPLE IDENTIFICATION
- S - SPLIT SPOON
- T - THIN WALL TUBE
- SS - 3in. SPLIT SPOON
- R - DIAMOND CORE
- W - WASH SAMPLE
- U - UNDISTURBED

SAMPLE PROPORTIONS	
DESCRIPTIVE TERM	PERCENT
TRACE	1 TO 10
LITTLE	11 TO 20
SOME	21 TO 35
AND	35 TO 50

BORING ID-05

TEST BORING LOG

BORING ID-06

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 1 of 2
NORTHING: 641800.44
EASTING: 571811.34
ELEVATION: 3.31
START DATE: 7/26/2012
END DATE: 7/26/2012
DRILLER: C. Moreira/W.G
LOGGED BY: G. Shen

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
7/26/2012		0			SIZE, ID	4 1/4"	1 3/8"	
					HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
U-1	0.0	7"							Gray Sludge (classified as Elastic Silt (mh)), wet, soft.	Safety Hammer is used
S-2	2.0	20"	1 2 1 2	109.2%	62	1				
S-3	4.0	24"	1 2 1 2				5	EL -2.7		
S-4	6.0	24"	0 0 0 0					6.0	Dark Grey Organic FAT CLAY (CH, fibrous Peat), wet, very soft to medium stiff.	
S-5	8.0	24"	0 0 0 0							
S-6	10.0	24"	1 2 2 4				10			
S-7	12.0	24"	1 2 2 2							
U-2	14.0	24"		120.9%	130	87	15			
S-8	16.0	24"	1 2 3 2					EL -14.7		pp = 0 tsf
S-9	18.0	24"	7 8 17 14					18.0	Dark grey Sandy Fat Clay (ch), wet, very stiff, slight odor.	pp = 0.15 tsf Sand encountered @ bottom of S-9 pp = 2.5 tsf
							20	EL -16.0 19.3	Brown Silty Sand (sm), wet, medium dense to very dense.	

BLOWS/FT.	DENSITY	BLOWS/FT.	CONSISTENCY
0-4	VERY LOOSE	0-2	VERY SOFT
5-10	LOOSE	3-4	SOFT
11-30	MEDIUM DENSE	5-8	MEDIUM STIFF
31-50	DENSE	9-15	STIFF
OVER 50	VERY DENSE	16-30	VERY STIFF
		OVER 30	HARD

SAMPLE IDENTIFICATION
- S - SPLIT SPOON
- T - THIN WALL TUBE
- SS - 3in. SPLIT SPOON
- R - DIAMOND CORE
- W - WASH SAMPLE
- U - UNDISTURBED

SAMPLE PROPORTIONS	
DESCRIPTIVE TERM	PERCENT
TRACE	1 TO 10
LITTLE	11 TO 20
SOME	21 TO 35
AND	35 TO 50

BORING ID-06

TEST BORING LOG

BORING ID-06

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 2 of 2
NORTHING: 641800.44
EASTING: 571811.34
ELEVATION: 3.31
START DATE: 7/26/2012
END DATE: 7/26/2012
DRILLER: C. Moreira/W.G
LOGGED BY: G. Shen

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
7/26/2012		0			SIZE, ID	4 1/4"	1 3/8"	
					HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
S-10	25.0	12"	21 25 26 18				25				Rounded Gravel encountered @ S-10
								EL -25.2 / 28.5		Yellow-brown Poorly Graded Gravel with Sand (gp), wet, very dense.	
S-11	30.0	2"	19 31 29 10				30				
								EL -30.2 / 33.5		Red-brown Silty Gravel with Sand (gm), wet, dense.	
S-12	35.0	3"	8 14 23 12				35				
								EL -33.7 / 37.0		Bottom of Boring @ 37 ft.	
							40				
							45				

BLOWS/FT.	DENSITY
0-4	VERY LOOSE
5-10	LOOSE
11-30	MEDIUM DENSE
31-50	DENSE
OVER 50	VERY DENSE

BLOWS/FT.	CONSISTENCY
0-2	VERY SOFT
3-4	SOFT
5-8	MEDIUM STIFF
9-15	STIFF
16-30	VERY STIFF
OVER 30	HARD

SAMPLE IDENTIFICATION
- S - SPLIT SPOON
- T - THIN WALL TUBE
- SS - 3in. SPLIT SPOON
- R - DIAMOND CORE
- W - WASH SAMPLE
- U - UNDISTURBED

SAMPLE PROPORTIONS	
DESCRIPTIVE TERM	PERCENT
TRACE	1 TO 10
LITTLE	11 TO 20
SOME	21 TO 35
AND	35 TO 50

BORING ID-06

TEST BORING LOG

BORING IS-01

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 1 of 2
NORTHING: 643206.36
EASTING: 571135.27
ELEVATION: 7.77
START DATE: 7/18/2012
END DATE: 7/19/2012
DRILLER: C. Moreira/W.G
LOGGED BY: B. Imamoglu

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
7/18/2012		3			SIZE, ID	4 1/4"	1 3/8"	
					HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
S-1	0.0	6"	9 50/5"							Brown Silty Sand with Gravel (sm), moist, dense to very dense (Fill).	Safety Hammer is used
S-2	2.0	6"	20 19 12 11								
S-3	4.0	20"	6 17 15 13				5				
								EL 1.8 6.0			
S-4	6.0	24"	3 2 2 2							Gray Sludge (classified as Elastic Silt (mh)), wet, very loose (Fill).	4" of Silty Clay encountered @ bottom of S-4
S-5	8.0	24"	2 1 1 1								
S-6	10.0	24"	1 2 3 2				10	EL -3.2 11.0			
										Dark gray Organic Lean Clay (oh, fibrous Peat), wet, very soft to stiff.	
S-7	12.0	24"	2 3 3 3								pp = 0 tsf
T-1	15.0						15				
S-8	17.0	24"	0 0 0 0								pp = 0 tsf
S-9	19.0	24"	5 5 5 5				20				
S-10	21.0	24"	0 0 0 0								pp = 0 tsf

BLOWS/FT.	DENSITY
0-4	VERY LOOSE
5-10	LOOSE
11-30	MEDIUM DENSE
31-50	DENSE
OVER 50	VERY DENSE

BLOWS/FT.	CONSISTENCY
0-2	VERY SOFT
3-4	SOFT
5-8	MEDIUM STIFF
9-15	STIFF
16-30	VERY STIFF
OVER 30	HARD

SAMPLE IDENTIFICATION
- S - SPLIT SPOON
- T - THIN WALL TUBE
- SS - 3in. SPLIT SPOON
- R - DIAMOND CORE
- W - WASH SAMPLE
- U - UNDISTURBED

SAMPLE PROPORTIONS	
DESCRIPTIVE TERM	PERCENT
TRACE	1 TO 10
LITTLE	11 TO 20
SOME	21 TO 35
AND	35 TO 50

BORING IS-01

TEST BORING LOG

BORING IS-01

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 2 of 2
NORTHING: 643206.36
EASTING: 571135.27
ELEVATION: 7.77
START DATE: 7/18/2012
END DATE: 7/19/2012
DRILLER: C. Moreira/W.G
LOGGED BY: B. Imamoglu

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
7/18/2012		3			SIZE, ID	4 1/4"	1 3/8"	
					HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
S-11	23.0	20"	0 0 0 1								pp = 0 tsf
							25	EL -17.2 25.0			
S-12	25.0	16"	21 21 10 16							Brown to gray Clayey Sand with Gravel (sc), wet, dense.	
								EL -19.2 27.0			
										Bottom of Boring @ 27 ft.	
							30				
							35				
							40				
							45				

BLOWS/FT.	DENSITY	BLOWS/FT.	CONSISTENCY	SAMPLE IDENTIFICATION	SAMPLE PROPORTIONS: DESCRIPTIVE TERM	PERCENT
0-4	VERY LOOSE	0-2	VERY SOFT	- S - SPLIT SPOON	TRACE	1 TO 10
5-10	LOOSE	3-4	SOFT	- T - THIN WALL TUBE	LITTLE	11 TO 20
11-30	MEDIUM DENSE	5-8	MEDIUM STIFF	- SS - 3in. SPLIT SPOON	SOME	21 TO 35
31-50	DENSE	9-15	STIFF	- R - DIAMOND CORE	AND	35 TO 50
OVER 50	VERY DENSE	16-30	VERY STIFF	- W - WASH SAMPLE		
		OVER 30	HARD	- U - UNDISTURBED		

BORING IS-01

TEST BORING LOG

BORING IS-02

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 1 of 2
NORTHING: 642245.9
EASTING: 570899.93
ELEVATION: 6.24
START DATE: 7/16/2012
END DATE: 7/16/2012
DRILLER: Buck/W.G
LOGGED BY: B. Imamoglu

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
7/16/2012		4			SIZE, ID	4 1/4"	1 3/8"	
7/17/2012		3			HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
S-1	0.0	10"	3 17 26 50/3"							Brown to gray Silty Sand with Gravel (sm), moist to wet, dense to very dense (Fill).	Donut Hammer is used
S-2	4.0	2"	50/5"				5				
								EL -0.1 6.3			
S-3	6.0	24"	1 2 1 3							Dark gray Sludge (classified as Elastic Silt (mh)), wet, very loose to medium dense (Fill).	Sludge encountered @ bottom of S-3
S-4	8.0	24"	4 5 6 10								
S-5	10.0	24"	3 5 6 5				10				
								EL -5.3 11.5			
S-6	12.0	24"	0 0 0 0							Dark Gray SANDY LEAN CLAY (CL, fibrous Peat), wet, very soft.	Sludge encountered @ S-6
S-7	14.0	24"	0 0 2 2				15				pp = 0 tsf
S-8	16.0	24"	0 0 1 2								pp = 0 tsf
T-1	19.0			99.3%	33	11	20				
S-9	21.0	24"	4 12 12 13					EL -15.8 22.0			Sand encountered @ first half of S-9
										Brown Clayey Sand with Gravel (sc),	

BLOWS/FT.	DENSITY
0-4	VERY LOOSE
5-10	LOOSE
11-30	MEDIUM DENSE
31-50	DENSE
OVER 50	VERY DENSE

BLOWS/FT.	CONSISTENCY
0-2	VERY SOFT
3-4	SOFT
5-8	MEDIUM STIFF
9-15	STIFF
16-30	VERY STIFF
OVER 30	HARD

SAMPLE IDENTIFICATION
- S - SPLIT SPOON
- T - THIN WALL TUBE
- SS - 3in. SPLIT SPOON
- R - DIAMOND CORE
- W - WASH SAMPLE
- U - UNDISTURBED

SAMPLE PROPORTIONS	
DESCRIPTIVE TERM	PERCENT
TRACE	1 TO 10
LITTLE	11 TO 20
SOME	21 TO 35
AND	35 TO 50

BORING IS-02

TEST BORING LOG

BORING IS-02

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 2 of 2
NORTHING: 642245.9
EASTING: 570899.93
ELEVATION: 6.24
START DATE: 7/16/2012
END DATE: 7/16/2012
DRILLER: Buck/W.G
LOGGED BY: B. Imamoglu

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
7/16/2012		4			SIZE, ID	4 1/4"	1 3/8"	
7/17/2012		3			HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
										wet, medium dense to dense.	
S-10	25.0	20"	7 8 40 37				25				
								EL -20.8 27.0			
										Bottom of Boring @ 27 ft.	
							30				
							35				
							40				
							45				

BLOWS/FT.	DENSITY	BLOWS/FT.	CONSISTENCY	SAMPLE IDENTIFICATION
0-4	VERY LOOSE	0-2	VERY SOFT	- S - SPLIT SPOON
5-10	LOOSE	3-4	SOFT	- T - THIN WALL TUBE
11-30	MEDIUM DENSE	5-8	MEDIUM STIFF	- SS - 3in. SPLIT SPOON
31-50	DENSE	9-15	STIFF	- R - DIAMOND CORE
OVER 50	VERY DENSE	16-30	VERY STIFF	- W - WASH SAMPLE
		OVER 30	HARD	- U - UNDISTURBED

SAMPLE PROPORTIONS	
DESCRIPTIVE TERM	PERCENT
TRACE	1 TO 10
LITTLE	11 TO 20
SOME	21 TO 35
AND	35 TO 50

BORING IS-02

TEST BORING LOG

BORING W-01

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 1 of 2
NORTHING: 644658.8
EASTING: 571589.02
ELEVATION: 2.66
START DATE: 8/3/2012
END DATE: 8/3/2012
DRILLER: C. Moreira/W.G
LOGGED BY: G. Shen

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
					SIZE, ID	4 1/4"	1 3/8"	
					HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
S-1	0.0	NR	0 0 0 0							Dark gray Organic Fat Clay (oh, fibrous Peat), wet, very soft to soft, organic ordor.	Safety Hammer is used
S-2	2.0	NR	0 0 0 0								
S-3	4.0	NR	0 0 0 0				5				
S-4	6.0	1"	0 0 0 0								
S-5	8.0	10"	0 0 0 0								pp = 0 tsf
S-6	10.0	24"	0 0 0 0				10				
U-1	12.0	NR									
S-7	14.0	24"	0 0 0 0				15				pp = 0 tsf
U-2	16.0	NR									
S-8	18.0	24"	0 0 3 3					EL -17.1			
S-9	20.0	24"	3 3 4 16				20	19.8		Dark gray Silty Sand (sm), wet, loose, slight organic ordor.	Sand encountered @ bottom of S-9

BLOWS/FT.	DENSITY	BLOWS/FT.	CONSISTENCY	SAMPLE IDENTIFICATION	SAMPLE PROPORTIONS: DESCRIPTIVE TERM	PERCENT
0-4	VERY LOOSE	0-2	VERY SOFT	- S - SPLIT SPOON	TRACE	1 TO 10
5-10	LOOSE	3-4	SOFT	- T - THIN WALL TUBE	LITTLE	11 TO 20
11-30	MEDIUM DENSE	5-8	MEDIUM STIFF	- SS - 3in. SPLIT SPOON	SOME	21 TO 35
31-50	DENSE	9-15	STIFF	- R - DIAMOND CORE	AND	35 TO 50
OVER 50	VERY DENSE	16-30	VERY STIFF	- W - WASH SAMPLE		
		OVER 30	HARD	- U - UNDISTURBED		

BORING W-01

TEST BORING LOG

BORING W-01

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 2 of 2
NORTHING: 644658.8
EASTING: 571589.02
ELEVATION: 2.66
START DATE: 8/3/2012
END DATE: 8/3/2012
DRILLER: C. Moreira/W.G
LOGGED BY: G. Shen

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
					SIZE, ID	4 1/4"	1 3/8"	
					HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							25	EL -22.3 / 25.0		Red-brown Silty Gravel with Sand (gm), wet, medium dense to dense.	
S-10	27.0	12"	14 13 17 20								pp = 2.0 to 2.5 tsf
							30				
S-11	32.0	12"	15 33 17 21								
							35				
							40	EL -38.3 / 41.0			Drill refusal
										Bottom of Boring @ 41 ft.	
							45				

BLOWS/FT.	DENSITY	BLOWS/FT.	CONSISTENCY
0-4	VERY LOOSE	0-2	VERY SOFT
5-10	LOOSE	3-4	SOFT
11-30	MEDIUM DENSE	5-8	MEDIUM STIFF
31-50	DENSE	9-15	STIFF
OVER 50	VERY DENSE	16-30	VERY STIFF
		OVER 30	HARD

SAMPLE IDENTIFICATION
- S - SPLIT SPOON
- T - THIN WALL TUBE
- SS - 3in. SPLIT SPOON
- R - DIAMOND CORE
- W - WASH SAMPLE
- U - UNDISTURBED

SAMPLE PROPORTIONS	
DESCRIPTIVE TERM	PERCENT
TRACE	1 TO 10
LITTLE	11 TO 20
SOME	21 TO 35
AND	35 TO 50

BORING W-01

TEST BORING LOG

BORING W-02

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 1 of 2
NORTHING: 643937.12
EASTING: 570955.32
ELEVATION: 2.24
START DATE: 7/31/2012
END DATE: 7/31/2012
DRILLER: C. Moreira/W.G
LOGGED BY: D. Morar

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
7/31/2012		6			SIZE, ID	4 1/4"	1 3/8"	
					HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
S-1	0.0	NR	0 0 0 0							Dark gray Organic Fat Clay (oh, fibrous Peat), wet, very soft to stiff.	Safety hammer is used
S-2	2.0	NR	0 0 0 0								
S-3	4.0	NR	0 0 0 0				5				
S-4	6.0	16"	0 0 0 0								
S-5	8.0	1"	0 0 0 0								4" of fibrous Peat encountered @ S-5
T-1	10.0	NR					10				
S-6	12.0	6"	0 0 0 0								
S-7	14.0	8"	0 0 0 0				15				
S-8	16.0	22"	6 5 6 4								
S-9	18.0	8"	0 0 0 0					EL -16.1 / 18.3		Light gray Clayey Sand (sc), wet, very loose to medium dense.	
S-10	20.0	20"	8 8 8 16				20	EL -19.5 / 21.7			
S-11	22.0	24"	20 8							Red-brown Silty Gravel with Sand (gm), wet, medium dense to very	

BLOWS/FT.	DENSITY
0-4	VERY LOOSE
5-10	LOOSE
11-30	MEDIUM DENSE
31-50	DENSE
OVER 50	VERY DENSE

BLOWS/FT.	CONSISTENCY
0-2	VERY SOFT
3-4	SOFT
5-8	MEDIUM STIFF
9-15	STIFF
16-30	VERY STIFF
OVER 30	HARD

SAMPLE IDENTIFICATION
- S - SPLIT SPOON
- T - THIN WALL TUBE
- SS - 3in. SPLIT SPOON
- R - DIAMOND CORE
- W - WASH SAMPLE
- U - UNDISTURBED

SAMPLE PROPORTIONS	
DESCRIPTIVE TERM	PERCENT
TRACE	1 TO 10
LITTLE	11 TO 20
SOME	21 TO 35
AND	35 TO 50

BORING W-02

TEST BORING LOG

BORING W-02

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 2 of 2
NORTHING: 643937.12
EASTING: 570955.32
ELEVATION: 2.24
START DATE: 7/31/2012
END DATE: 7/31/2012
DRILLER: C. Moreira/W.G
LOGGED BY: D. Morar

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
7/31/2012		6			SIZE, ID	4 1/4"	1 3/8"	
					HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
S-12	24.0	17"	9 17 8 13 50/5"				25			dense.	
								EL -24.3 26.5		Bottom of Boring @ 26.5 ft.	Drill refusal
							30				
							35				
							40				
							45				

BLOWS/FT.	DENSITY
0-4	VERY LOOSE
5-10	LOOSE
11-30	MEDIUM DENSE
31-50	DENSE
OVER 50	VERY DENSE

BLOWS/FT.	CONSISTENCY
0-2	VERY SOFT
3-4	SOFT
5-8	MEDIUM STIFF
9-15	STIFF
16-30	VERY STIFF
OVER 30	HARD

SAMPLE IDENTIFICATION
- S - SPLIT SPOON
- T - THIN WALL TUBE
- SS - 3in. SPLIT SPOON
- R - DIAMOND CORE
- W - WASH SAMPLE
- U - UNDISTURBED

SAMPLE PROPORTIONS	
DESCRIPTIVE TERM	PERCENT
TRACE	1 TO 10
LITTLE	11 TO 20
SOME	21 TO 35
AND	35 TO 50

BORING W-02

TEST BORING LOG

BORING W-03

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 1 of 2
NORTHING: 643258.26
EASTING: 570064.21
ELEVATION: 2.46
START DATE: 8/2/2012
END DATE: 8/2/2012
DRILLER: C. Moreira/W.G
LOGGED BY: G. Shen

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
					SIZE, ID	4 1/4"	1 3/8"	
					HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
S-1	0.0	NR	0 0 0 0							Dark gray Organic Fat Clay (oh, fibrous Peat), wet, very soft.	Safety Hammer is used
S-2	2.0	NR	0 0 0 0								
S-3	4.0	NR	0 0 0 0				5				
S-4	6.0	4"	0 0 0 0								pp = 0 tsf
S-5	8.0	16"	0 0 0 0								pp = 0 tsf
S-6	10.0	16"	0 0 0 0				10				pp = 0 tsf
S-7	12.0	24"	0 0 0 0								
U-1	14.0	NR					15				
S-8	16.0	24"	12 14 21 32					EL -14.7 / 17.2		Red-brown Silty Gravel (gm), wet, dense to very dense.	pp = 2 tsf
							20				

BLOWS/FT.	DENSITY
0-4	VERY LOOSE
5-10	LOOSE
11-30	MEDIUM DENSE
31-50	DENSE
OVER 50	VERY DENSE

BLOWS/FT.	CONSISTENCY
0-2	VERY SOFT
3-4	SOFT
5-8	MEDIUM STIFF
9-15	STIFF
16-30	VERY STIFF
OVER 30	HARD

SAMPLE IDENTIFICATION
- S - SPLIT SPOON
- T - THIN WALL TUBE
- SS - 3in. SPLIT SPOON
- R - DIAMOND CORE
- W - WASH SAMPLE
- U - UNDISTURBED

SAMPLE PROPORTIONS	
DESCRIPTIVE TERM	PERCENT
TRACE	1 TO 10
LITTLE	11 TO 20
SOME	21 TO 35
AND	35 TO 50

BORING W-03

TEST BORING LOG

BORING W-03

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 2 of 2
NORTHING: 643258.26
EASTING: 570064.21
ELEVATION: 2.46
START DATE: 8/2/2012
END DATE: 8/2/2012
DRILLER: C. Moreira/W.G
LOGGED BY: G. Shen

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
					SIZE, ID	4 1/4"	1 3/8"	
					HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
S-9	23.0	6"	18 26 28 18				25				
S-10	28.0	8"	60 50/4"								
							30	EL -27.5 30.0		Bottom of Boring @ 30 ft.	
							35				
							40				
							45				

BLOWS/FT.	DENSITY
0-4	VERY LOOSE
5-10	LOOSE
11-30	MEDIUM DENSE
31-50	DENSE
OVER 50	VERY DENSE

BLOWS/FT.	CONSISTENCY
0-2	VERY SOFT
3-4	SOFT
5-8	MEDIUM STIFF
9-15	STIFF
16-30	VERY STIFF
OVER 30	HARD

SAMPLE IDENTIFICATION
- S - SPLIT SPOON
- T - THIN WALL TUBE
- SS - 3in. SPLIT SPOON
- R - DIAMOND CORE
- W - WASH SAMPLE
- U - UNDISTURBED

SAMPLE PROPORTIONS	
DESCRIPTIVE TERM	PERCENT
TRACE	1 TO 10
LITTLE	11 TO 20
SOME	21 TO 35
AND	35 TO 50

BORING W-03

TEST BORING LOG

BORING W-04

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 1 of 2
NORTHING: 642017.49
EASTING: 572024.97
ELEVATION: 2.68
START DATE: 7/27/2012
END DATE: 7/27/2012
DRILLER: C. Moreira/W.G
LOGGED BY: G. Shen

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
					SIZE, ID	4 1/4"	1 3/8"	
					HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
S-1	0.0	2"	0 0 0 0							Dark gray Elastic Silt (mh, fibrous Peat), wet, very loose to loose, organic ordor.	Safety Hammer is used
S-2	2.0	2"	0 1 2 1								
S-3	4.0	10"	1 1 2 2				5				
S-4	6.0	4"	0 0 0 0								
S-5	8.0	24"	0 0 0 0								pp = 0 tsf
S-6	10.0	18"	0 0 0 0				10				
U-1	12.0	24"									
S-7	14.0	24"	0 0 0 0				15				
S-8	16.0	24"	3 2 8 9								pp = 0 tsf
								EL -15.3			
S-9	18.0	24"	14 17 32 34				20	18.0		Brown to gray Silty Sand with Gravel (gm, rounded), wet, dense to very dense.	

BLOWS/FT.	DENSITY
0-4	VERY LOOSE
5-10	LOOSE
11-30	MEDIUM DENSE
31-50	DENSE
OVER 50	VERY DENSE

BLOWS/FT.	CONSISTENCY
0-2	VERY SOFT
3-4	SOFT
5-8	MEDIUM STIFF
9-15	STIFF
16-30	VERY STIFF
OVER 30	HARD

SAMPLE IDENTIFICATION
- S - SPLIT SPOON
- T - THIN WALL TUBE
- SS - 3in. SPLIT SPOON
- R - DIAMOND CORE
- W - WASH SAMPLE
- U - UNDISTURBED

SAMPLE PROPORTIONS	
DESCRIPTIVE TERM	PERCENT
TRACE	1 TO 10
LITTLE	11 TO 20
SOME	21 TO 35
AND	35 TO 50

BORING W-04

TEST BORING LOG

BORING W-04

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 2 of 2
NORTHING: 642017.49
EASTING: 572024.97
ELEVATION: 2.68
START DATE: 7/27/2012
END DATE: 7/27/2012
DRILLER: C. Moreira/W.G
LOGGED BY: G. Shen

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
					SIZE, ID	4 1/4"	1 3/8"	
					HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
S-10	25.0	22"	6 16 19 16				25				
								EL -24.1 26.8		Red-brown Gravelly Silt (ml), wet, very dense.	
S-11	30.0	6"	35 50 50/3"				30				
								EL -29.3 32.0		Bottom of Boring @ 32 ft.	
							35				
							40				
							45				

BLOWS/FT.	DENSITY	BLOWS/FT.	CONSISTENCY	SAMPLE IDENTIFICATION
0-4	VERY LOOSE	0-2	VERY SOFT	- S - SPLIT SPOON
5-10	LOOSE	3-4	SOFT	- T - THIN WALL TUBE
11-30	MEDIUM DENSE	5-8	MEDIUM STIFF	- SS - 3in. SPLIT SPOON
31-50	DENSE	9-15	STIFF	- R - DIAMOND CORE
OVER 50	VERY DENSE	16-30	VERY STIFF	- W - WASH SAMPLE
		OVER 30	HARD	- U - UNDISTURBED

SAMPLE PROPORTIONS	
DESCRIPTIVE TERM	PERCENT
TRACE	1 TO 10
LITTLE	11 TO 20
SOME	21 TO 35
AND	35 TO 50

BORING W-04

TEST BORING LOG

BORING W-05

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 1 of 2
NORTHING: 643131.63
EASTING: 571399.36
ELEVATION: 2.52
START DATE: 7/17/2012
END DATE: 7/17/2012
DRILLER: C. Moreira/W.G
LOGGED BY: B. Imamoglu

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
7/17/2012		0			SIZE, ID	4 1/4"	1 3/8"	
					HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
S-1	0.0	2"	1 0 0 0							Brown to Gray SANDY LEAN CLAY (CL, fibrous Peat), wet, very soft to soft.	Safety hammer is used
S-2	2.0	4"	1 1 1 1								
S-3	4.0	18"	0 0 0 0				5				pp = 0 tsf
S-4	6.0	24"	1 1 1 1								pp = 0 tsf
S-5	8.0	16"	0 0 0 1								pp = 0 tsf
S-6	10.0	24"	1 1 2 1				10				pp = 0 tsf
S-7	12.0	24"	1 1 2 1								pp = 0 tsf
T-1	15.0			26.1%	25	10	15				
								EL -14.5 / 17.0			
S-8	17.0	12"	0 6 12 16							Gray Silty Sand with Gravel (sm), wet, medium dense to dense.	
S-9	19.0	24"	15 14 21 33				20				

BLOWS/FT.	DENSITY	BLOWS/FT.	CONSISTENCY	SAMPLE IDENTIFICATION	SAMPLE PROPORTIONS: DESCRIPTIVE TERM	PERCENT
0-4	VERY LOOSE	0-2	VERY SOFT	- S - SPLIT SPOON	TRACE	1 TO 10
5-10	LOOSE	3-4	SOFT	- T - THIN WALL TUBE	LITTLE	11 TO 20
11-30	MEDIUM DENSE	5-8	MEDIUM STIFF	- SS - 3in. SPLIT SPOON	SOME	21 TO 35
31-50	DENSE	9-15	STIFF	- R - DIAMOND CORE	AND	35 TO 50
OVER 50	VERY DENSE	16-30	VERY STIFF	- W - WASH SAMPLE		
		OVER 30	HARD	- U - UNDISTURBED		

BORING W-05

TEST BORING LOG

BORING W-05

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 2 of 2
NORTHING: 643131.63
EASTING: 571399.36
ELEVATION: 2.52
START DATE: 7/17/2012
END DATE: 7/17/2012
DRILLER: C. Moreira/W.G
LOGGED BY: B. Imamoglu

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
7/17/2012		0			SIZE, ID	4 1/4"	1 3/8"	
					HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
								EL -21.0 / 23.5		Brown to grey Sandy Gravel (gp), wet, dense.	
S-10	25.0	24"	14 29 15 28				25				
S-11	30.0	12"	20 15 19 19				30	EL -28.0 / 30.5		Brown to grey Clayey Silt (ml) with Sand and Gravel, wet, dense.	
S-12	35.0	12"	15 21 24 26				35				
								EL -36.5 / 39.0		Brown to grey Sandy Gravel (gp), wet, very dense.	
S-13	40.0	2"	50/2"				40	EL -39.5 / 42.0			Shale fragments encountered @ S-13
										Bottom of Boring @ 42 ft.	
							45				

BLOWS/FT.	DENSITY
0-4	VERY LOOSE
5-10	LOOSE
11-30	MEDIUM DENSE
31-50	DENSE
OVER 50	VERY DENSE

BLOWS/FT.	CONSISTENCY
0-2	VERY SOFT
3-4	SOFT
5-8	MEDIUM STIFF
9-15	STIFF
16-30	VERY STIFF
OVER 30	HARD

SAMPLE IDENTIFICATION
- S - SPLIT SPOON
- T - THIN WALL TUBE
- SS - 3in. SPLIT SPOON
- R - DIAMOND CORE
- W - WASH SAMPLE
- U - UNDISTURBED

SAMPLE PROPORTIONS	
DESCRIPTIVE TERM	PERCENT
TRACE	1 TO 10
LITTLE	11 TO 20
SOME	21 TO 35
AND	35 TO 50

BORING W-05

TEST BORING LOG

BORING W-07R

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 1 of 2
NORTHING: 642115.88
EASTING: 570154.55
ELEVATION: 1.88
START DATE: 8/2/2012
END DATE: 8/2/2012
DRILLER: C. Moreira/W.G
LOGGED BY: G. Shen

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
					SIZE, ID	4 1/4"	1 3/8"	
					HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
S-1	0.0	4"	0 0 0 0							Dark gray Organic Fat Clay (oh, fibrous Peat), wet, very soft.	Safety Hammer is used
S-2	2.0	4"	0 0 0 0								
S-3	4.0	6"	0 0 0 0				5				
S-4	6.0	12"	0 0 0 0								
S-5	8.0	20"	0 7 6 7					EL -6.8 / 8.7		Brown to red Sandy Silt (ml), wet, medium dense.	
S-6	10.0	13"	12 10 11 11				10				
S-7	15.0	13"	10 12 18 20				15				Shale fragment encountered @ S-7 pp = 0.75 to 1.25 tsf
S-8	20.0	12"	13 12 11 18				20	EL -21.1			Gravel encountered @ S-8 pp = 1.5 tsf

BLOWS/FT.	DENSITY
0-4	VERY LOOSE
5-10	LOOSE
11-30	MEDIUM DENSE
31-50	DENSE
OVER 50	VERY DENSE

BLOWS/FT.	CONSISTENCY
0-2	VERY SOFT
3-4	SOFT
5-8	MEDIUM STIFF
9-15	STIFF
16-30	VERY STIFF
OVER 30	HARD

SAMPLE IDENTIFICATION
- S - SPLIT SPOON
- T - THIN WALL TUBE
- SS - 3in. SPLIT SPOON
- R - DIAMOND CORE
- W - WASH SAMPLE
- U - UNDISTURBED

SAMPLE PROPORTIONS	
DESCRIPTIVE TERM	PERCENT
TRACE	1 TO 10
LITTLE	11 TO 20
SOME	21 TO 35
AND	35 TO 50

BORING W-07R

TEST BORING LOG

BORING W-07R

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 2 of 2
NORTHING: 642115.88
EASTING: 570154.55
ELEVATION: 1.88
START DATE: 8/2/2012
END DATE: 8/2/2012
DRILLER: C. Moreira/W.G
LOGGED BY: G. Shen

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
					SIZE, ID	4 1/4"	1 3/8"	
					HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
								23.0		Red-brown Silty Gravel (gm, weathered shale), wet, very dense.	
S-9	25.0	18"	32 37 50 50/3"				25	EL -25.1			
								27.0		Bottom of Boring @ 27 ft.	
							30				
							35				
							40				
							45				

BLOWS/FT.	DENSITY	BLOWS/FT.	CONSISTENCY	SAMPLE IDENTIFICATION	SAMPLE PROPORTIONS: DESCRIPTIVE TERM	PERCENT
0-4	VERY LOOSE	0-2	VERY SOFT	- S - SPLIT SPOON	TRACE	1 TO 10
5-10	LOOSE	3-4	SOFT	- T - THIN WALL TUBE	LITTLE	11 TO 20
11-30	MEDIUM DENSE	5-8	MEDIUM STIFF	- SS - 3in. SPLIT SPOON	SOME	21 TO 35
31-50	DENSE	9-15	STIFF	- R - DIAMOND CORE	AND	35 TO 50
OVER 50	VERY DENSE	16-30	VERY STIFF	- W - WASH SAMPLE		
		OVER 30	HARD	- U - UNDISTURBED		

BORING W-07R

TEST BORING LOG

BORING W-08

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

JOB NUMBER: 128911
SHEET NO. 1 of 2
NORTHING: 642828.5
EASTING: 569760.6
ELEVATION: .03
START DATE: 8/1/2012
END DATE: 8/1/2012
DRILLER: C. Moreira/W.G
LOGGED BY: G. Shen

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
					SIZE, ID	4 1/4"	1 3/8"	
					HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
S-1	0.0	3"	0 0 0 0							Dark gray Sludge (classified as Elastic Silt (mh)), wet, very loose (Fill).	Safety Hammer is used
								EL -2.2 / 2.3			
S-2	2.0	7"	0 0 0 0							Gray LEAN CLAY (CL, fibrous Peat), wet, very soft.	
S-3	4.0	NR	0 0 0 0				5				
S-4	6.0	8"	0 0 0 0								
S-5	8.0	20"	0 0 0 0								pp = 0 tsf
S-6	10.0	18"	0 0 0 0				10				pp = 0 tsf
S-7	12.0	18"	0 0 0 0								
U-1	14.0	24"			36	20	15				
								EL -16.0 / 16.0			
S-8	16.0	18"	5 11 10 10							Red-brown Silt (ml), moist, medium dense to dense.	pp = 2 tsf
S-9	18.0	18"	19 18 17 15				20				
								EL -23.0			

BLOWS/FT.	DENSITY	BLOWS/FT.	CONSISTENCY	SAMPLE IDENTIFICATION	SAMPLE PROPORTIONS: DESCRIPTIVE TERM	PERCENT
0-4	VERY LOOSE	0-2	VERY SOFT	- S - SPLIT SPOON	TRACE	1 TO 10
5-10	LOOSE	3-4	SOFT	- T - THIN WALL TUBE	LITTLE	11 TO 20
11-30	MEDIUM DENSE	5-8	MEDIUM STIFF	- SS - 3in. SPLIT SPOON	SOME	21 TO 35
31-50	DENSE	9-15	STIFF	- R - DIAMOND CORE	AND	35 TO 50
OVER 50	VERY DENSE	16-30	VERY STIFF	- W - WASH SAMPLE		
		OVER 30	HARD	- U - UNDISTURBED		

BORING W-08

TEST BORING LOG

BORING W-08

PROJECT : Rahway Arch Geotech Inv.
CLIENT : Soil Safe, Inc.
SITE: Rahway Arch Site

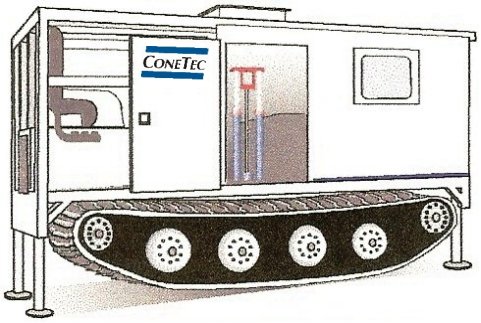
JOB NUMBER: 128911
SHEET NO. 2 of 2
NORTHING: 642828.5
EASTING: 569760.6
ELEVATION: .03
START DATE: 8/1/2012
END DATE: 8/1/2012
DRILLER: C. Moreira/W.G
LOGGED BY: G. Shen

GROUNDWATER DATA (feet)					EQUIPMENT	CASING	SAMPLER	CORE
Date	Time	Water	Inside Casing	Cave-In	TYPE	Mud rotary	SS	
					SIZE, ID	4 1/4"	1 3/8"	
					HAMMER WT.		140 lb	--------
					HAMMER FALL		30"	--------

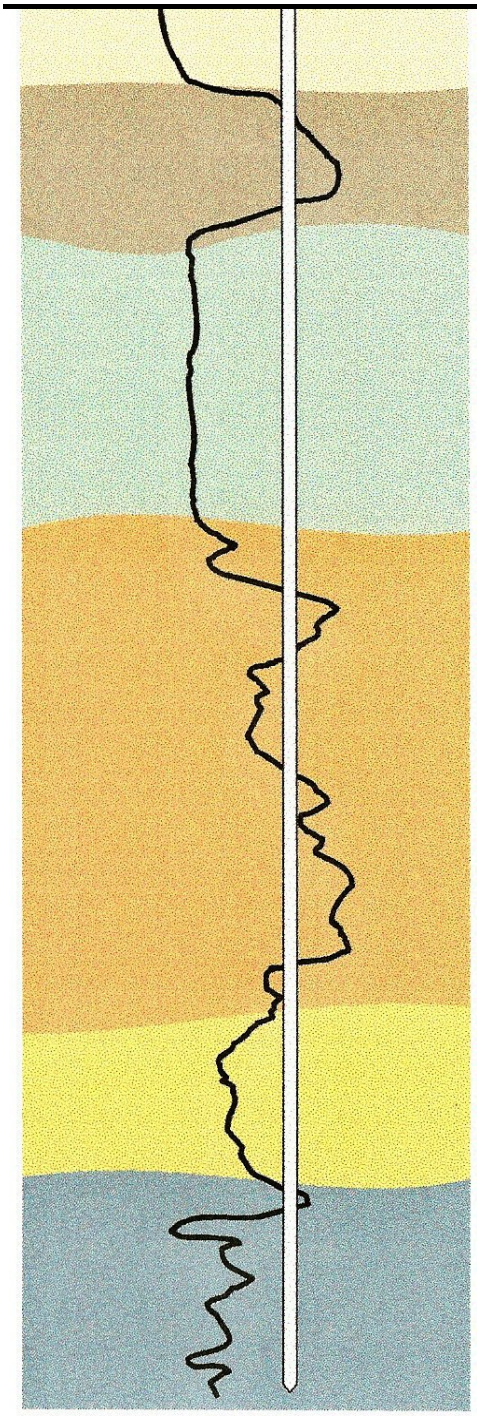
SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE RECOVERY	BLOWS / 6" (%RQD)	LABORATORY TEST RESULTS: NMC / Fract. Freq.	LIQUID LIMIT	PLASTICITY INDEX	DEPTH	ELEV. / DEPTH	GRAPHICS	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
								23.0		Red-brown Silty Gravel (gm, Shale fragments), wet, very dense.	
S-10	25.0	6"	10 24 50/3"				25				
							30				
								EL -32.0 32.0		Bottom of Boring @ 32 ft.	Drill refusal
							35				
							40				
							45				

BLOWS/FT.	DENSITY	BLOWS/FT.	CONSISTENCY	SAMPLE IDENTIFICATION	SAMPLE PROPORTIONS: DESCRIPTIVE TERM	PERCENT
0-4	VERY LOOSE	0-2	VERY SOFT	- S - SPLIT SPOON	TRACE	1 TO 10
5-10	LOOSE	3-4	SOFT	- T - THIN WALL TUBE	LITTLE	11 TO 20
11-30	MEDIUM DENSE	5-8	MEDIUM STIFF	- SS - 3in. SPLIT SPOON	SOME	21 TO 35
31-50	DENSE	9-15	STIFF	- R - DIAMOND CORE	AND	35 TO 50
OVER 50	VERY DENSE	16-30	VERY STIFF	- W - WASH SAMPLE		
		OVER 30	HARD	- U - UNDISTURBED		

BORING W-08



Geotechnical and Environmental In Situ Testing Contractors



ConeTec Field Report

Presentation of In Situ Test Results for:

Rahway Arch
Carteret, New Jersey

Presented to: Michael Baker Jr., Inc.

Date: July 25th, 2012

Presented by: ConeTec, Inc.
436 Commerce Lane
Unit C
West Berlin, NJ 08091
(856) 767-8600

PRESENTATION OF IN SITU TESTING PROGRAM RESULTS

Rahway Arch
Carteret, New Jersey

July 10th, 12th, 13th & 16th, 2012

Prepared for:

Michael Baker Jr., Inc.
Linthicum, Maryland

Prepared by:

ConeTec Inc.
West Berlin, NJ

July 25th, 2012

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TABLE 1 Summary of CPT Soundings

FIGURES

FIGURE 1 Typical Cone Penetrometer
FIGURE 2 Schematic of Shear Wave Testing Configuration
FIGURE 3 Typical Dissipation Tests

APPENDICES

APPENDIX A CPT Plots (shear wave, non-normalized and normalized)
APPENDIX B CPT Data Interpretation Summary
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1.0 INTRODUCTION

This report presents the results of a piezocone penetrometer testing (CPTU; also CPT) program carried out at the Rahway Arch Site located in Carteret, New Jersey. The work was performed under subcontract to Michael Baker Jr., Inc. of Linthicum, Maryland. The CPT program took place on July 10th, 12th, 13th & 16th, 2012.

A total of eighteen soundings were completed at eleven different sounding locations. The CPT program was performed to evaluate in situ geotechnical criteria relative to the soils.

In addition to the CPT soundings, shear wave velocity tests were performed at eight of the locations with testing at five foot depth intervals.

CPT sounding locations were selected and numbered under the direction and supervision of Baker personnel.

2.0 FIELD EQUIPMENT AND PROCEDURES

2.1 CONE PENETRATION TESTING

The cone penetrometer tests were carried out using an integrated electronic piezocone manufactured by ConeTec in Vancouver, Canada. The piezocone used was a compression model cone penetrometer with a 15 cm^2 tip and a 225 cm^2 friction sleeve. The cone is designed with an equal end area friction sleeve and a tip end area ratio of 0.80. The piezocone dimensions and the operating procedure were in accordance with ASTM standard D-5778-07. A diagram of the cone penetrometer used for this project is shown as Figure 1.

Pore pressure filter elements, made of porous plastic, were saturated under a vacuum using silicone fluid as the saturating medium. The pore pressure element was six millimeters thick and was located immediately behind the tip (the u_2 location) for all soundings.

The cone was advanced using a skid drill rig, mounted on a Kori rig operated by Warren George, Inc. The following data were recorded onto magnetic media every five centimeters (approximately every two inches) as the cone was advanced into the ground:

- Tip Resistance (q_c)
- Sleeve Friction (f_s)
- Dynamic Pore Pressure (u)

Before each sounding a complete set of analog baseline readings are taken with a multi-meter and compared with the digitized value on the computer screen. This provides a check on the analog to digital conversion board.

Evaluation of the analog baselines is key to consistent readings. The baseline data should be stable and should not wander excessively during the course of a sounding. Baseline data can be used to apply corrections to the cone data where necessary. For this project, the baseline shift from sounding to sounding was small, typically less than 0.1% of full scale, and no data corrections were applied.

During seismic testing, the seismic signals were recorded using a geophone mounted in the cone as shown in Figure 1 and an up-hole digital oscilloscope. A sledge hammer, struck against a steel wedge was used as the seismic source. A schematic of the shear wave testing configuration, used with our truck rigs, is shown in Figure 2.

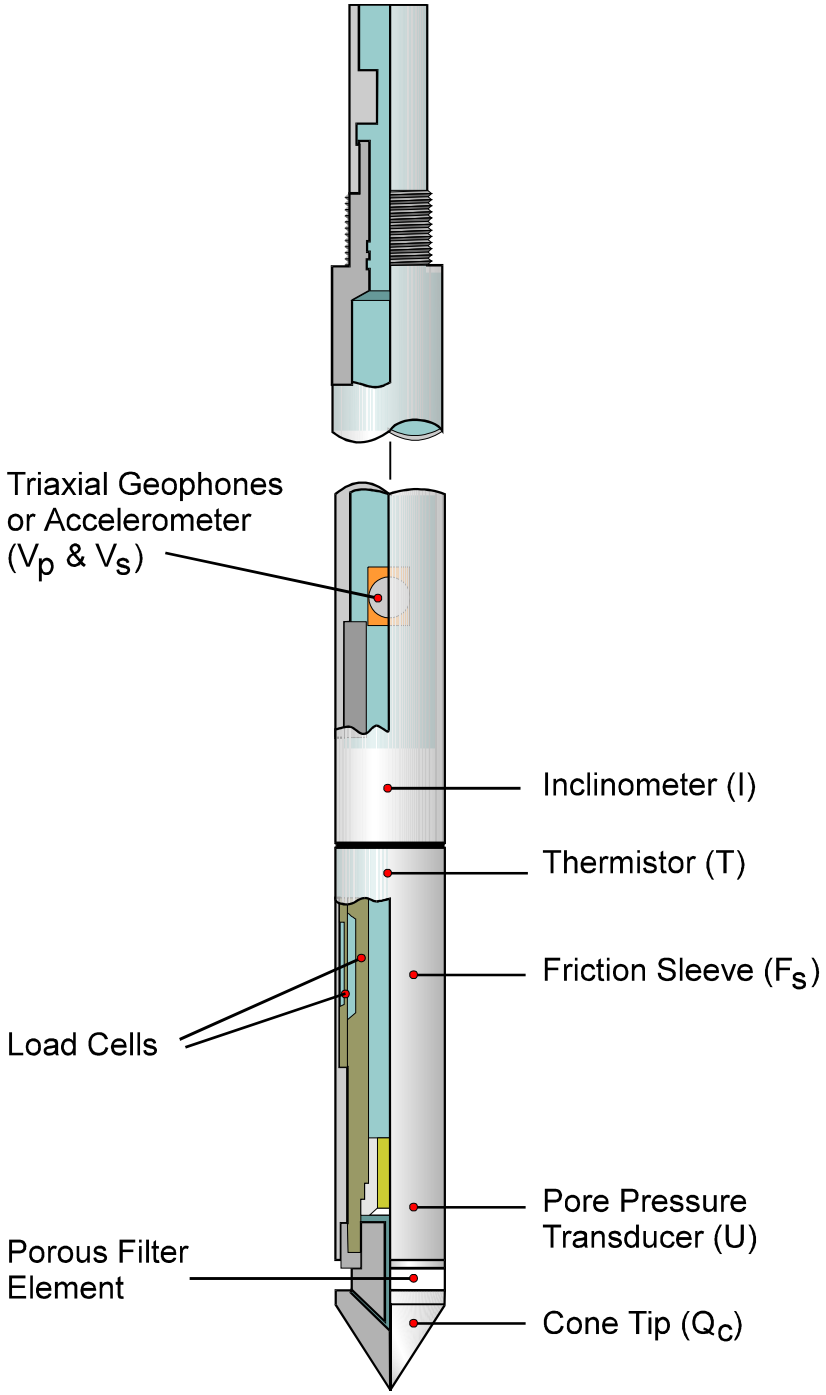


FIGURE 1 - TYPICAL CONE PENETROMETER

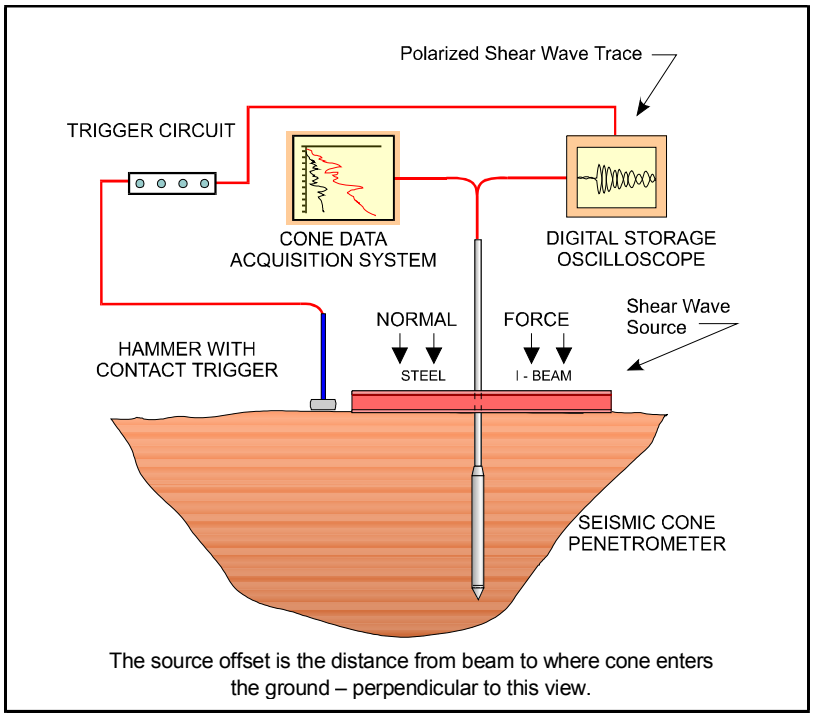


FIGURE 2 - SCHEMATIC OF SHEAR WAVE TESTING CONFIGURATION

2.2 PORE PRESSURE DISSIPATION TESTS

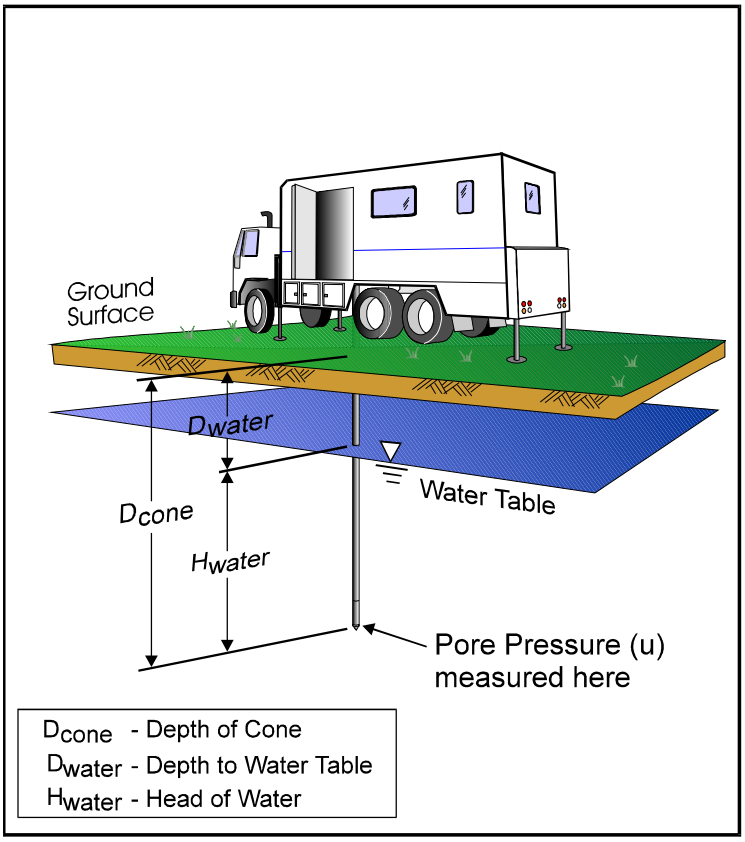
When cone penetration is stopped, the piezocone essentially becomes a piezometer. While stopped, pore water pressures are automatically recorded at five-second intervals and the readings are stored in a dissipation file (.ppd). Dissipation data can then be plotted onto a graph displaying a dissipation curve consisting of pore water pressure (u) verses time (t). The shapes of dissipation curves are very useful in evaluating soil type, drainage characteristics and in situ static water level.

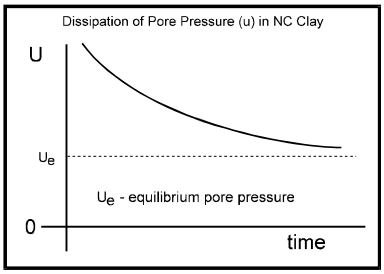
A flat curve that stabilizes quickly (i.e. less than 30 seconds) is typical of a free draining soil, generally sand. In this case, the final measured pore water represents the hydrostatic pressure in situ.

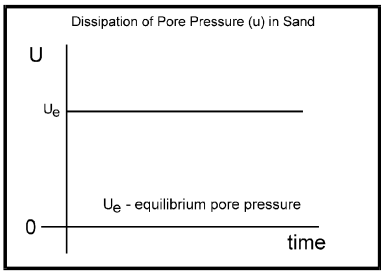
Soils that generate excess dynamic pore water pressure during penetration will dissipate this excess pressure when penetration stops. The shape of the dissipation curve and the time of dissipation can be used to estimate C_h, the coefficient of consolidation that can in turn be used to calculate K_h, the horizontal hydraulic conductivity.

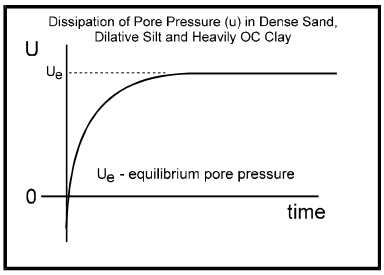
Figure 3 shows some idealized shapes of various pore water pressure dissipation curves. The reader is referred Robertson et. al., 1992 to reference dissipation test data analytical techniques.

Estimation of Ground Water Table from CPT Dissipation Tests









Water Table Calculation

$$D_{water} = D_{cone} - H_{water}$$

where $H_{water} = U_e$ (depth units)

Useful Conversion Factors:

1psi = 0.704m = 2.31 feet (water)
1tsf = 0.958 bar = 13.9 psi
1m = 3.28 feet

FIGURE 3 - TYPICAL DISSIPATION TESTS

3.0 CONE PENETRATION TEST DATA AND INTERPRETATION

3.1 ANALYSIS OF PIEZOCONE DATA - GENERAL

A total of eighteen CPT soundings, involving approximately 310.69 feet of testing, were completed at eleven locations.

The interpretation of cone data is based on the relationship between cone bearing, qc, sleeve friction, fs, and penetration pore water pressure, u. The friction ratio, Rf , (sleeve friction divided by cone bearing) is a calculated parameter which is used to infer soil behavior type. Generally, saturated cohesive soils have low tip resistance, high friction ratios and generate large excess pore water pressures. Cohesionless soils have higher tip resistances, lower friction ratios and do not generate significant excess pore water pressure.

The interpretation of soils encountered on this project was carried out using correlations developed by Robertson et al., 1992. It should be noted that it is not always possible to clearly identify a soil type based on q_c, f_s and u. Occasionally soils will fall within different soil categories on the classification charts. In these situations, experience and judgment and an assessment of the pore pressure dissipation data should be used to infer the soil behavior type. Computer tabulations of the interpreted soil types along with certain other geotechnical parameters for each sounding are presented in Appendix B.

Each of the parameters measured in the sounding are discussed briefly below. A detailed explanation of CPT testing and interpretation of the results can be found in Robertson, 1989.

TIP RESISTANCE (q_c): The resistance to penetration, measured at the cone tip, provides an accurate profile of subsurface strata. The recorded tip resistance is a composite of the penetration resistance of the soils located five to ten cone diameters (7 to 14 inches) in front of and behind the tip. The actual resistance "sensed" by the tip depends on the soil properties and on the relative stiffness of the layers encountered. Tip resistance is often corrected for pore pressure effects when testing in soft saturated cohesive soils.

For this project the correction was made and the tip resistance shown, q_t is the corrected tip resistance.

The correction used is: $q_t = q_c + (1-a)u$

Where:
- q_t = corrected tip resistance
- q_c = measured tip resistance
- a = net area ratio for cone (0.80 for this project)
- u = dynamic pore water pressure measured behind tip

SLEEVE FRICTION (f_s) The resistance recorded on the friction sleeve, is a measure of the remolded strength of the soil. Values of sleeve friction in very soft soils (such as peat) may fluctuate due to the measured force being small relative to the capacity of the measuring load cell.

FRICTION RATIO (R_f) The ratio of sleeve friction to tip resistance expressed as a percentage, is an indicator of soil type. Cohesive soils generally have friction ratios that are greater than two, while sands and non-plastic silts have friction ratios that are lower than two.

PORE PRESSURE (u) Dynamic pore water pressure is measured during penetration. Dynamic pore water pressure data can be found in the .cor and ifi.xls files. Static pore water pressure is measured when cone penetration is stopped. Static pore water pressure data can be found in the .ppd and -ppd.xls files. The measured dynamic pore water pressure changes with the location of the porous filter and negative readings are possible when the filter is located behind the tip.

It is important to note that the CPT classifies soil by physical behavior, not by grain size; therefore, the CPT classification should be verified against samples obtained from a conventional drilling program. While the CPT soil classification may not always be accurate in terms of the actual label it applies to a particular soil, it is very accurate in grouping soils with similar mechanical properties.

Table 1 presents a summary of CPT soundings, including sounding depths and pore pressure dissipation test results (when appropriate).

3.2 CONE PLOTS

The data from each sounding was plotted using the computer program SCREENzW. The plots are included in Appendix A. SCREENzW was developed by ConeTec Inc. and it incorporates soil behavior type (SBT) classification as part of the plot. The soil classification is based on the classification chart reproduced in Appendix B.

3.3 PORE PRESSURE DISSIPATION TEST RESULTS

When conducting CPT investigations, pore water pressure dissipations are automatically recorded during pauses in penetration. The pore water pressure dissipation data is recorded at five second intervals. Dynamic and static pore pressure measurements, for each CPT, are included in the electronic data package. Numerous pore water dissipation tests were completed during this project. Those plots can be found in Appendix D.

3.4 SHEAR WAVE VELOCITY MEASUREMENTS

Shear wave velocity measurements were conducted during eight of the CPT soundings. Shear wave velocity measurements were recorded at five foot depth intervals. The shear wave velocity data can be found in Appendix C.

3.5 CPT DATA PROCESSING

The electronic data files were processed using the program SCREENzW. SCREENzW is a program developed by ConeTec to calculate common engineering parameters from CPT data. The data files (.xls) can be found in the electronic data package. The calculations used are summarized in the table found in Appendix B. Each calculation is derived according to the referenced article.

For this project, the piezometric surface was determined from the dissipation data and the dynamic pore water pressure responses recorded during the CPT. The exact depth used can be found in the headers of the IFI.xls files.

3.6 ELECTRONIC DATA PACKAGE

Along with the report, all of the project data can be downloaded from ConeTec's "ConeTec Data Services" (CDS) website (www.conetecdataservices.com) using a secure, project-specific user name and password. These electronic files contain all important project information including tabular data (.xls and ASCII formats), GPS coordinates of approximate sounding locations, dynamic and static pore water pressure and some basic interpretation files in Microsoft™ Excel format (.xls). Information regarding the digital file formats of the electronic files is included in Appendix E.

5.0 REFERENCES

Robertson, P.K., 1989, “Soil Classification using the Cone Penetration Test”, Canadian Geotechnical Journal, vol. 27, pages 151-158.

Robertson, P.K., Sully, J., Woeller, D.G., Lunne, T., Powell, J.M., and Gillespie, D.J., 1992, “Estimating Coefficient of Consolidation from Piezocone Tests”, Canadian Geotechnical Journal, vol. 29, pages 539-550.

Appendix A

TABLE 1 - SUMMARY OF CPT SOUNDINGS

Job No.: 12-741
Location: Rahway Arch - Carteret, New Jersey
Client: Michael Baker Jr.
Date: July 10, 12, 13 & 16, 2012

Date	CPTU Sounding	Filename	Total Depth (ft)	Shear Wave Velocity Tests	Northing UTM Zone 18 (m)	Easting UTM Zone 18 (m)
7/12/2012	CPT-01	741CP01.COR	28.87	6	4494960.099	566384.254
7/13/2012	CPT-02	741CP02.COR	29.53	4	4495002.412	566357.083
7/13/2012	CPT-03	741CP03.COR	19.85		4494350.587	566502.512
7/10/2012	CPT-04	741CP04.COR	26.57	5	4494609.823	566318.272
7/10/2012	CPT-05	741CP05.COR	39.53	8	4494785.778	566546.575
7/12/2012	CPT-06	741CP06.COR	1.31		4494389.830	566338.565
7/12/2012	CPT-06A	741CP06A.COR	26.90		4494362.192	566351.504
7/10/2012	CPT-08	741CP08.COR	24.11	5	4494351.925	566237.360
7/10/2012	CPT-08A	741CP08A.COR	20.83		4494361.037	566221.765
7/12/2012	CPT-09	741CP09.COR	1.80		4494425.712	566004.003
7/12/2012	CPT-09A	741CP09A.COR	1.15		4494425.675	565999.772
7/12/2012	CPT-09B	741CP09B.COR	1.31		4494422.012	566004.036
7/12/2012	CPT-09C	741CP09C.COR	2.13		4494412.962	566026.681
7/13/2012	CPT-09D	741CP09D.COR	18.87	4	4494423.887	566006.840
7/13/2012	CPT-10	741CP10.COR	21.00		4494621.281	566150.348
7/12/2012	CPT-11	741CP11.COR	4.92		4494109.305	566209.899
7/12/2012	CPT-11A	741CP11A.COR	21.16	4	4494116.517	566188.679
7/16/2012	CPT-12	741CP12.COR	20.83	4	4494164.223	566559.179
Totals:		18	310.69	40		

Note: Coordinates are in UTM-NAD83 (meters) Zone 18.

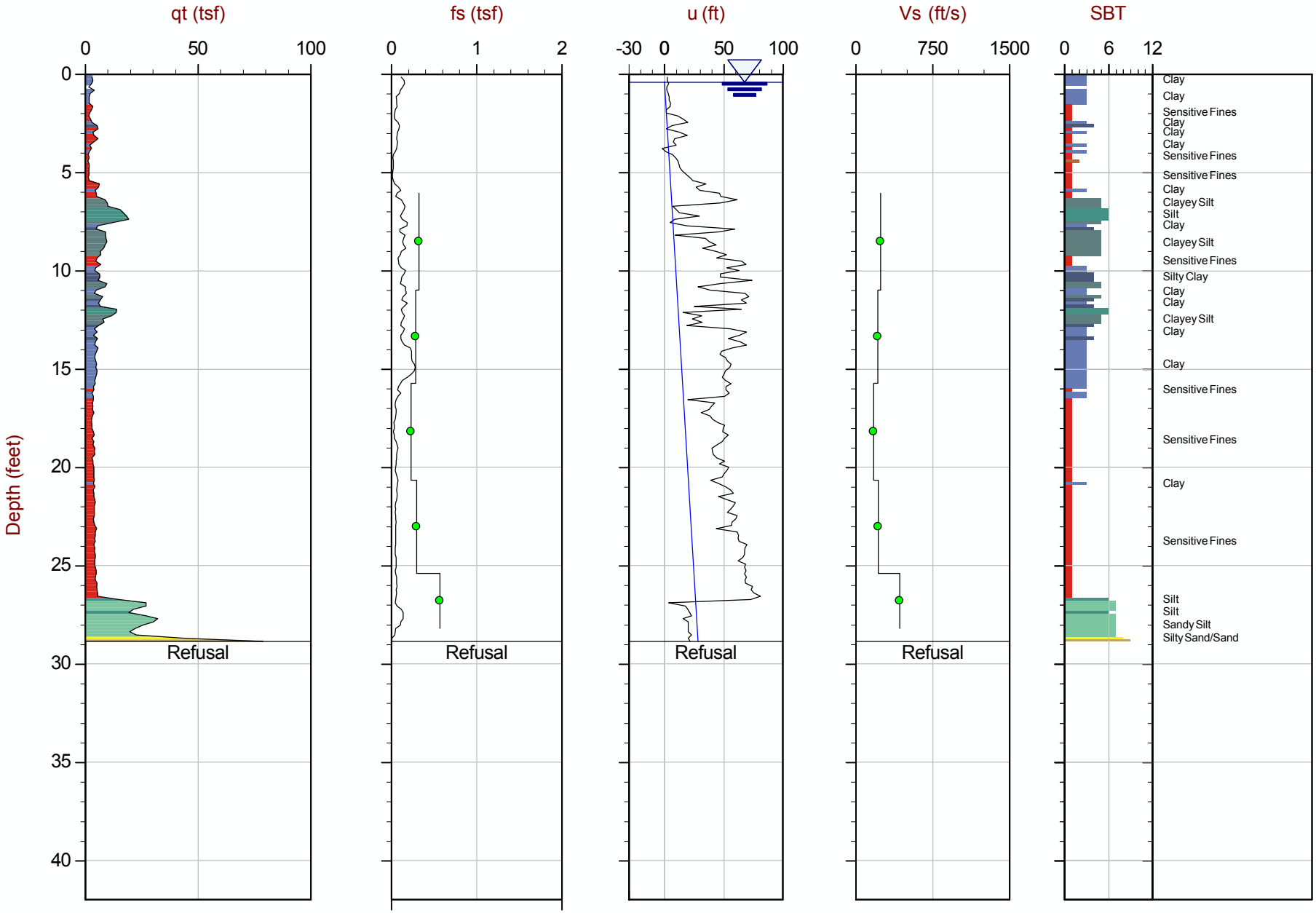
Shear Wave Velocity CPT Plots

CONETEC

Michael Baker Jr.

Job No: 12-741
Date: 07:12:12 07:18
Site: Rahway Arch

Sounding: CPT-01
Cone: 302:T1500F15U500



Max Depth: 8.800 m / 28.87 ft
Depth Inc: 0.050 m / 0.164 ft

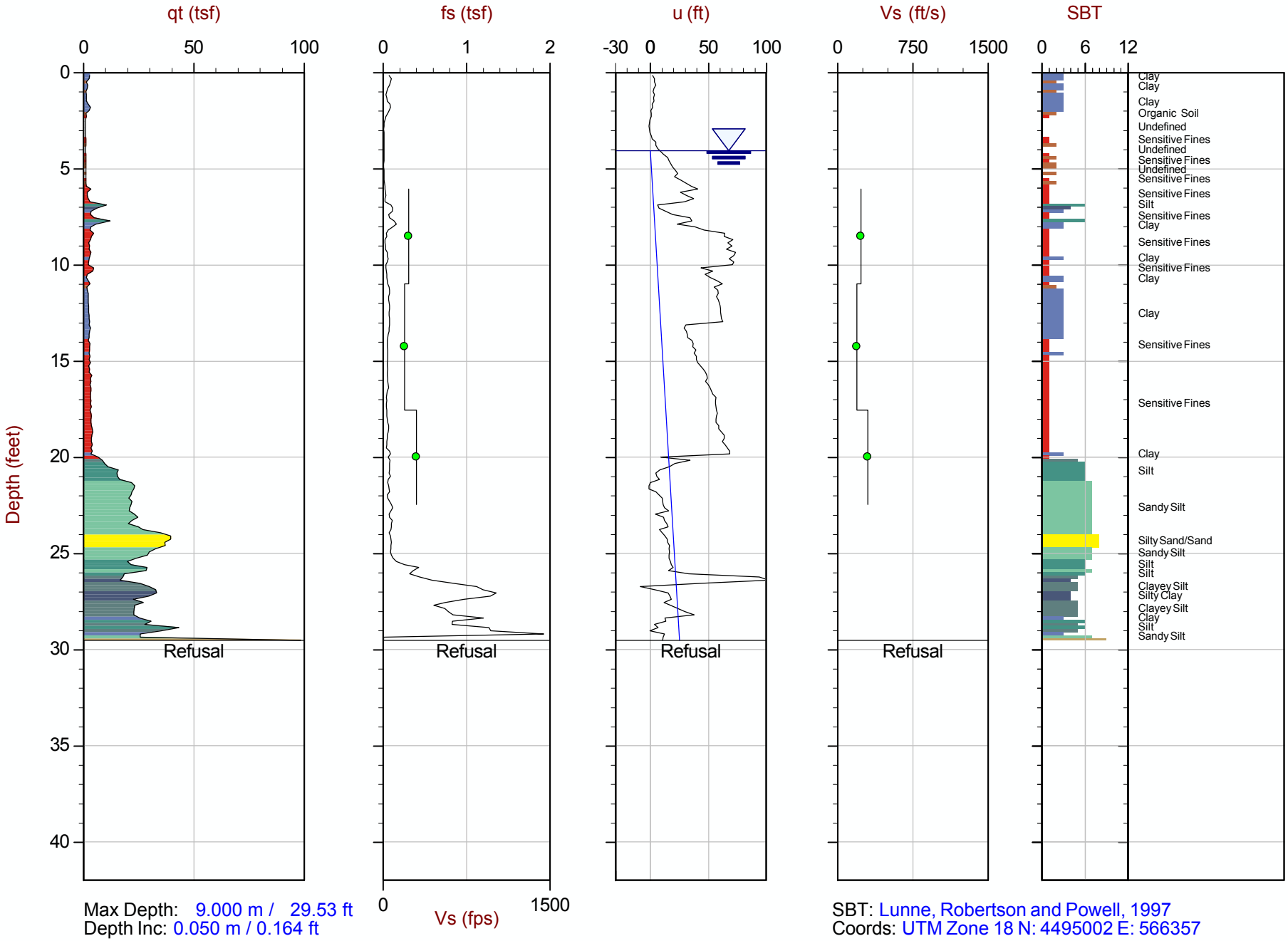
SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 18 N: 4494960 E: 566384

CONETEC

Michael Baker Jr.

Job No: 12-741
Date: 07:13:12 10:57
Site: Rahway Arch

Sounding: CPT-02
Cone: 302:T1500F15U500



Max Depth: 9.000 m / 29.53 ft
Depth Inc: 0.050 m / 0.164 ft

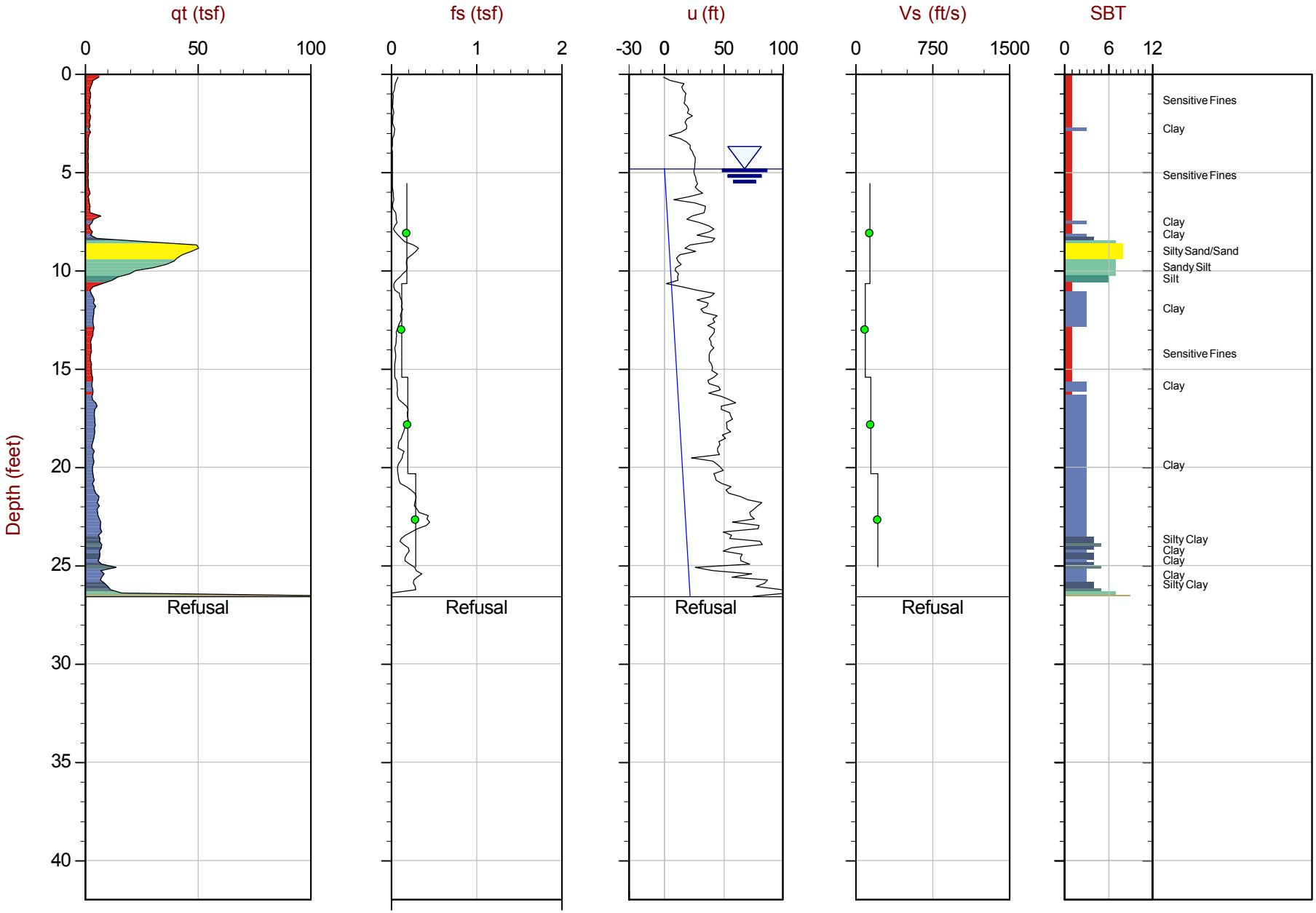
SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 18 N: 4495002 E: 566357

CONETEC

Michael Baker Jr.

Job No: 12-741
Date: 07:10:12 12:07
Site: Rahway Arch

Sounding: CPT-04
Cone: 302:T1500F15U500



Max Depth: 8.100 m / 26.57 ft
Depth Inc: 0.050 m / 0.164 ft

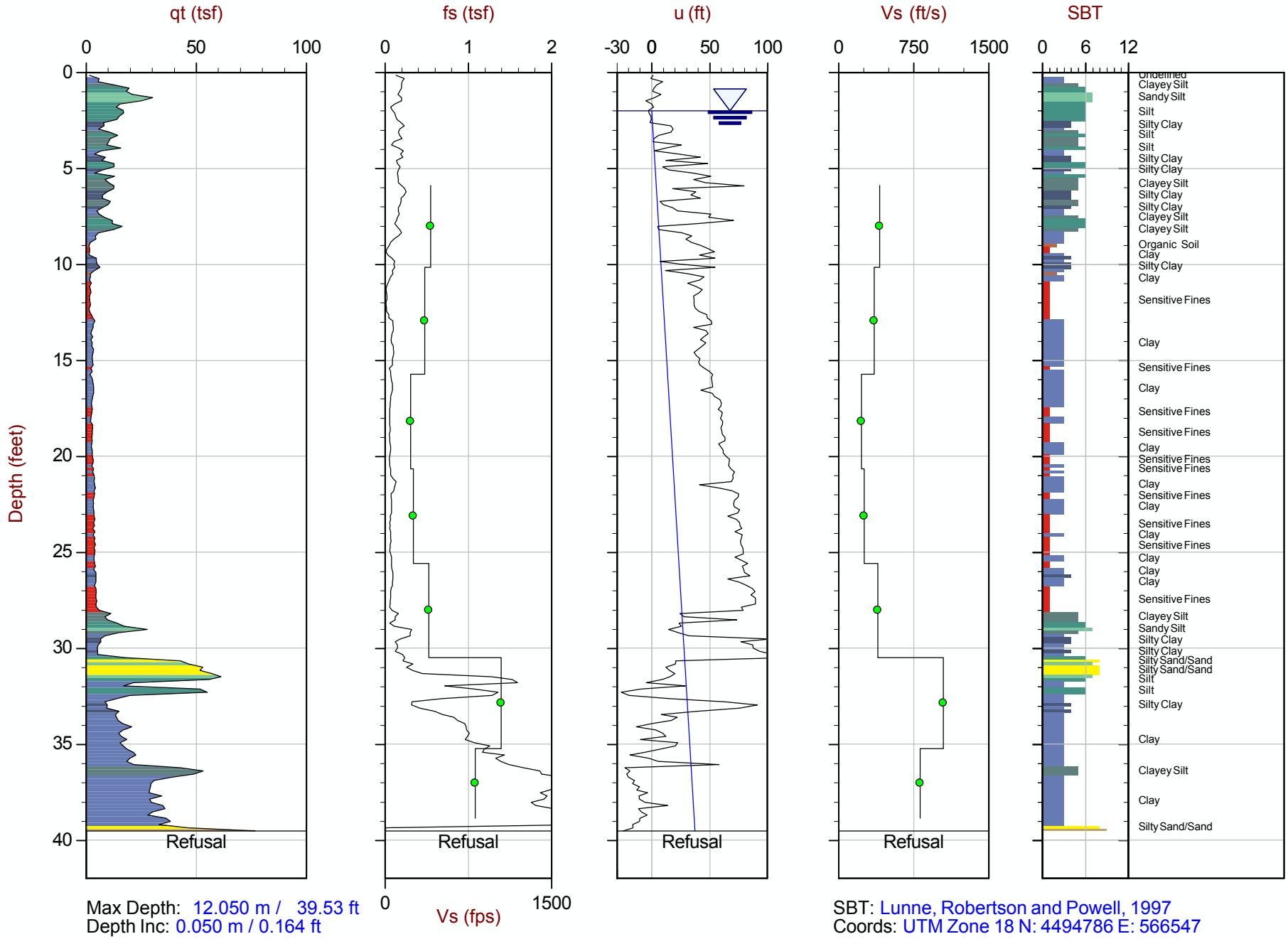
SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 18 N: 4494610 E: 566318

CONETEC

Michael Baker Jr.

Job No: 12-741
Date: 07:10:12 13:34
Site: Rahway Arch

Sounding: CPT-05
Cone: 302:T1500F15U500



Max Depth: 12.050 m / 39.53 ft
Depth Inc: 0.050 m / 0.164 ft

0 Vs (fps) 1500

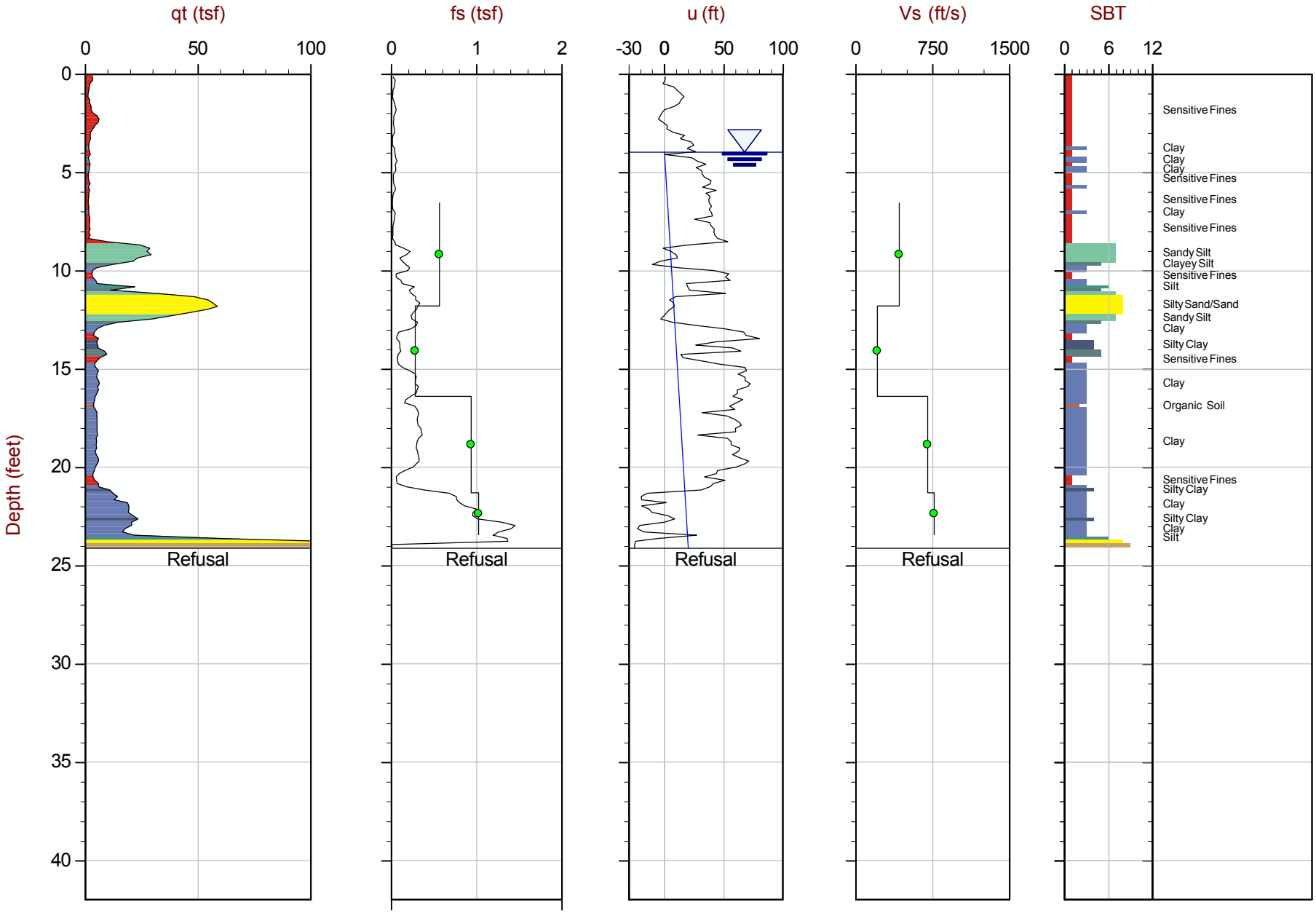
SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 18 N: 4494786 E: 566547

CONETEC

Michael Baker Jr.

Job No: 12-741
Date: 07:10:12 09:49
Site: Rahway Arch

Sounding: CPT-08
Cone: 302:T1500F15U500



Max Depth: 7.350 m / 24.11 ft
Depth Inc: 0.050 m / 0.164 ft

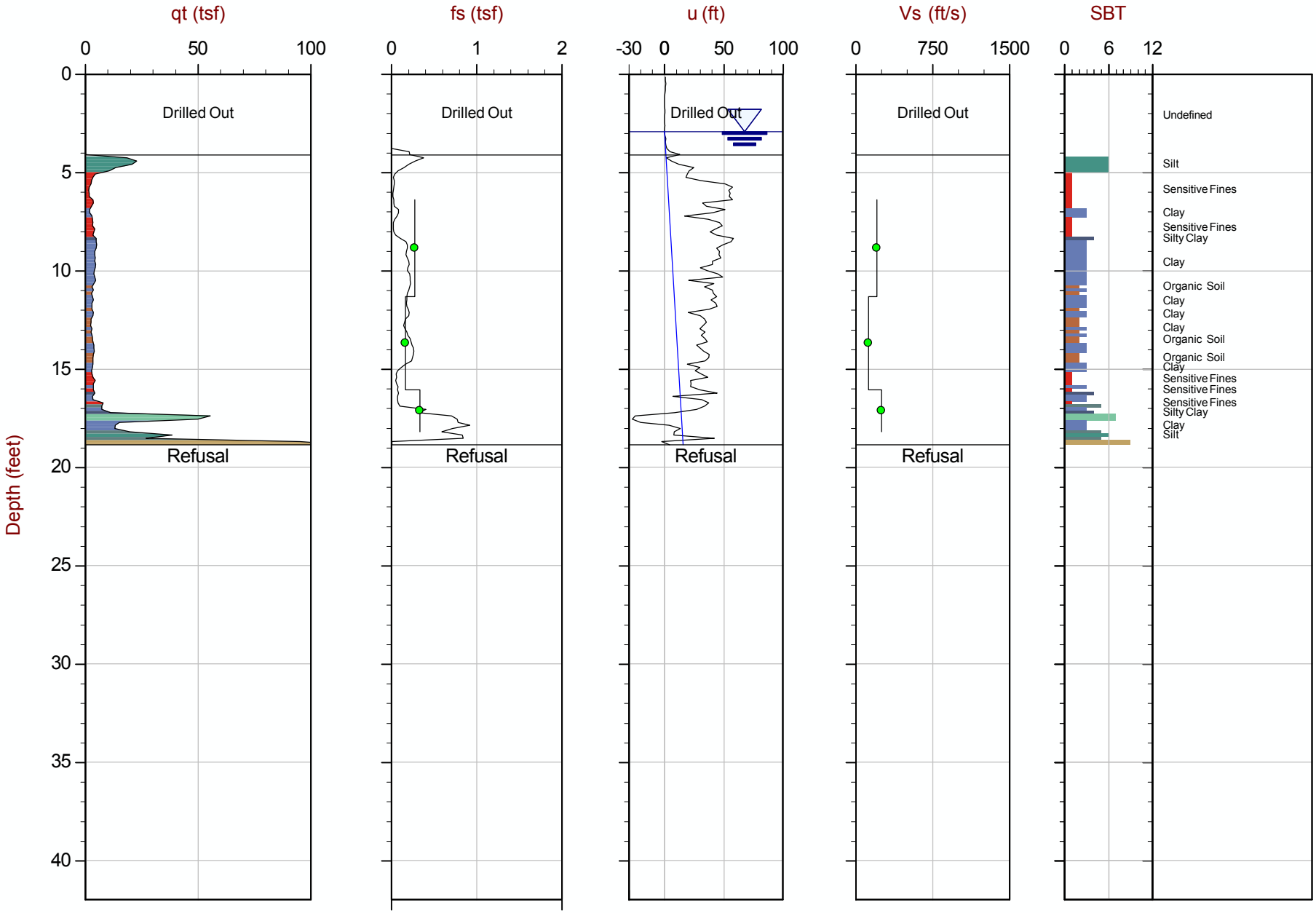
SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 18 N: 4494352 E: 566237

CONETEC

Michael Baker Jr.

Job No: 12-741
Date: 07:13:12 08:40
Site: Rahway Arch

Sounding: CPT-09D
Cone: 302:T1500F15U500



Max Depth: 5.750 m / 18.86 ft
Depth Inc: 0.050 m / 0.164 ft

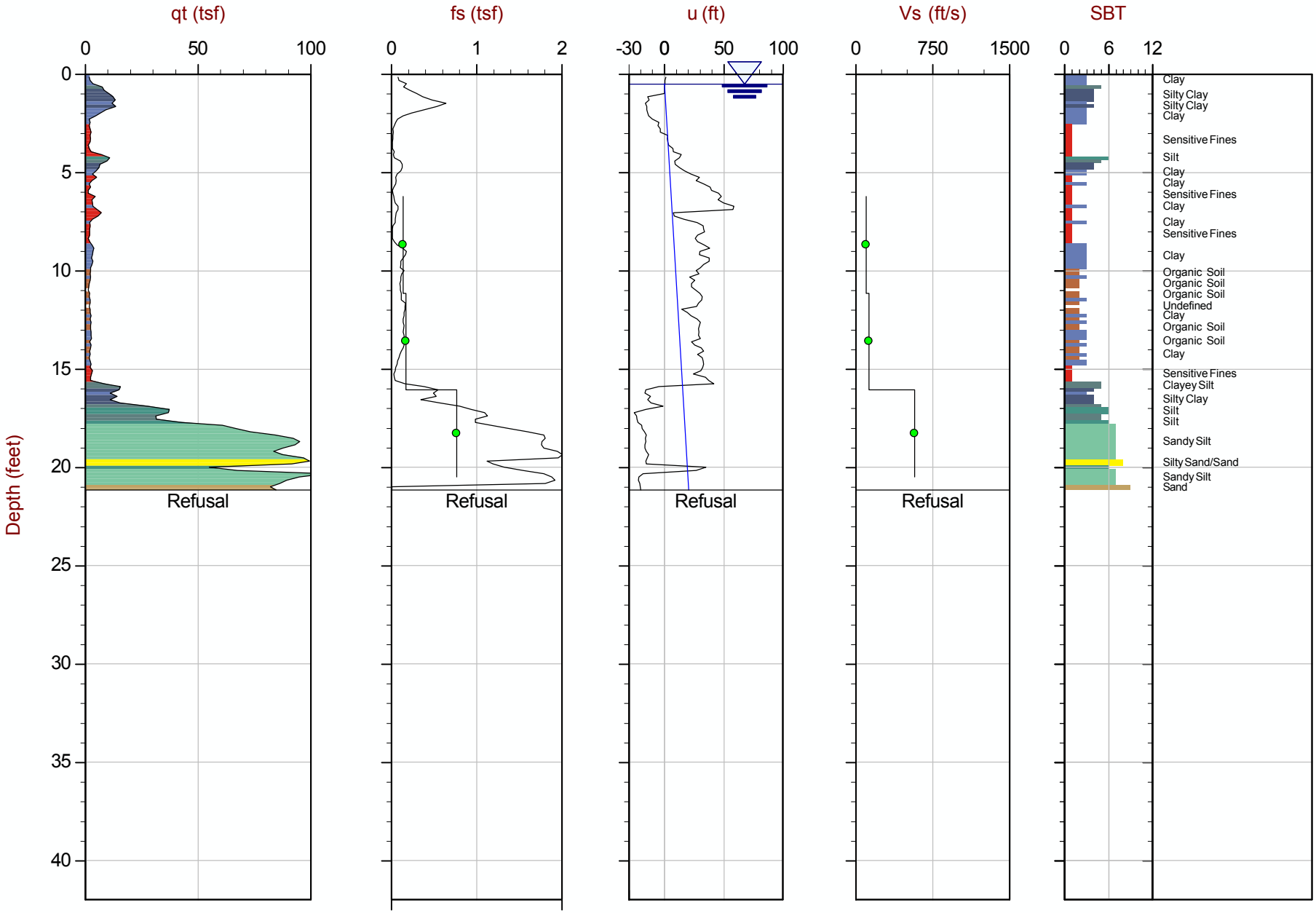
SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 18 N: 4494424 E: 566007

CONETEC

Michael Baker Jr.

Job No: 12-741
Date: 07:12:12 12:10
Site: Rahway Arch

Sounding: CPT-11A
Cone: 302:T1500F15U500



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Depth Inc: 0.050 m / 0.164 ft

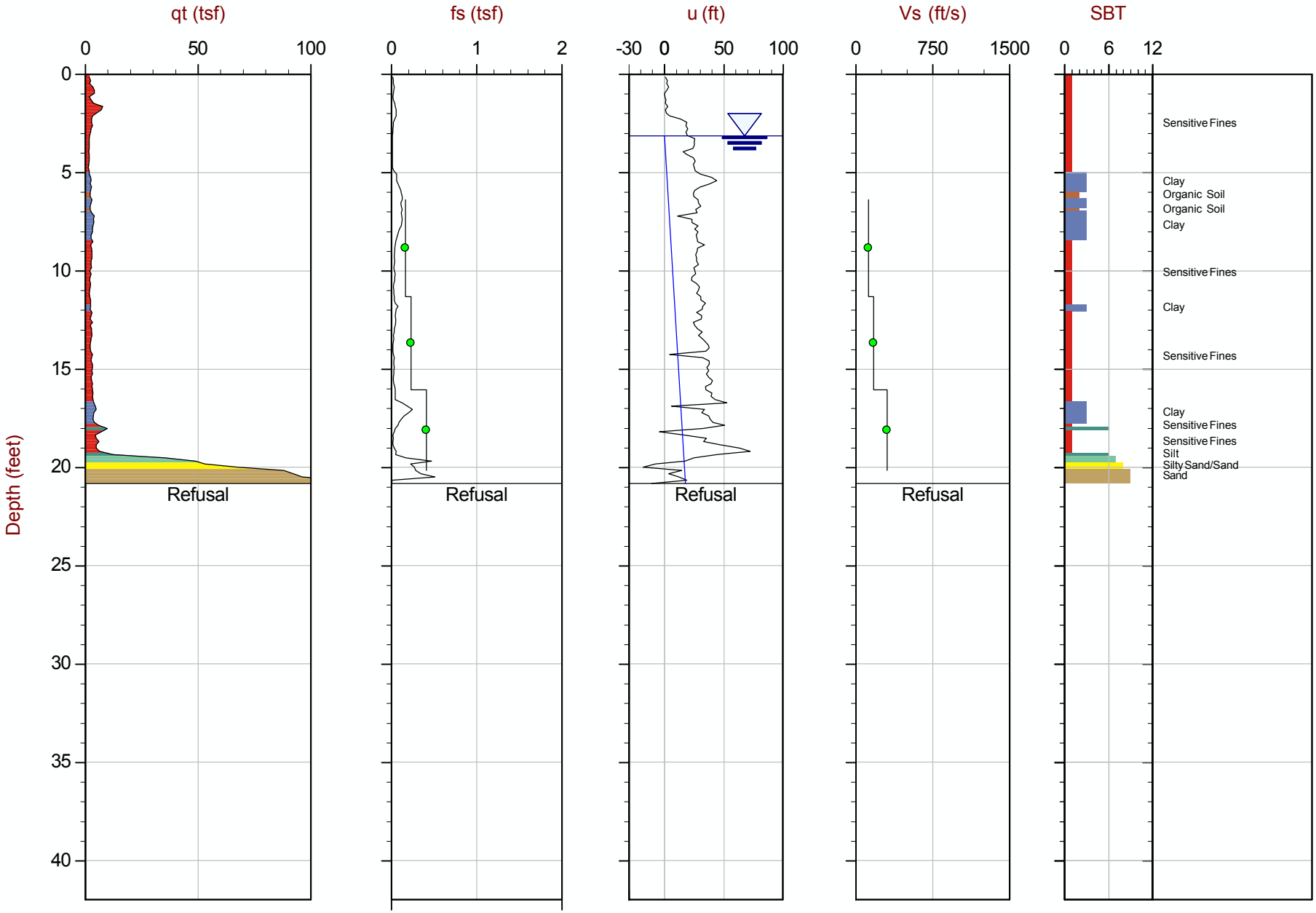
SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 18 N: 4494117 E: 566189

CONETEC

Michael Baker Jr.

Job No: 12-741
Date: 07:16:12 06:56
Site: Rahway Arch

Sounding: CPT-12
Cone: 302:T1500F15U500



Max Depth: 6.350 m / 20.83 ft
Depth Inc: 0.050 m / 0.164 ft

SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 18 N: 4494164 E: 566559

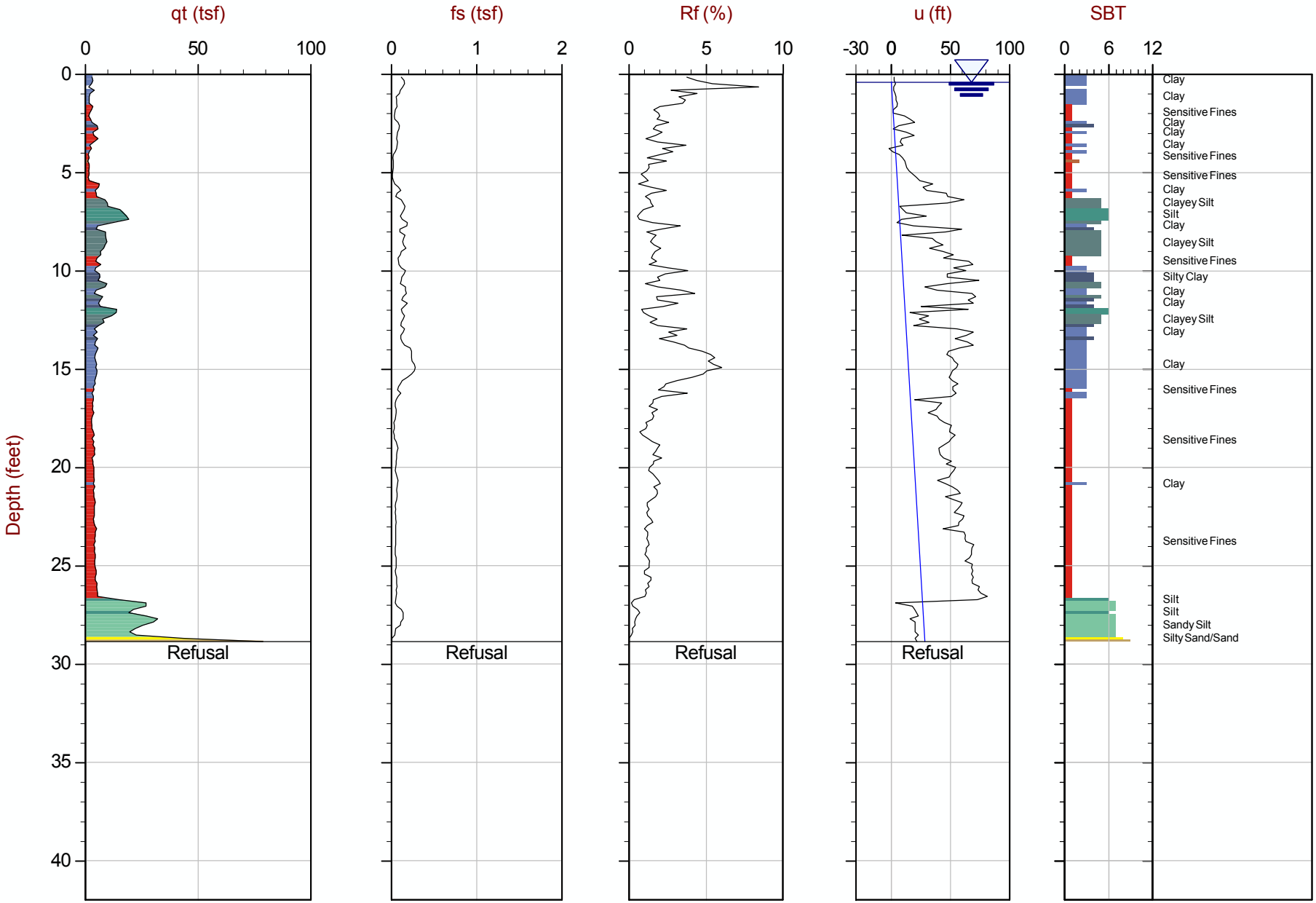
Non-Normalized CPT Plots

CONETEC

Michael Baker Jr.

Job No: 12-741
Date: 07:12:12 07:18
Site: Rahway Arch

Sounding: CPT-01
Cone: 302:T1500F15U500



Max Depth: 8.800 m / 28.87 ft
Depth Inc: 0.050 m / 0.164 ft

File: 741CP01.COR

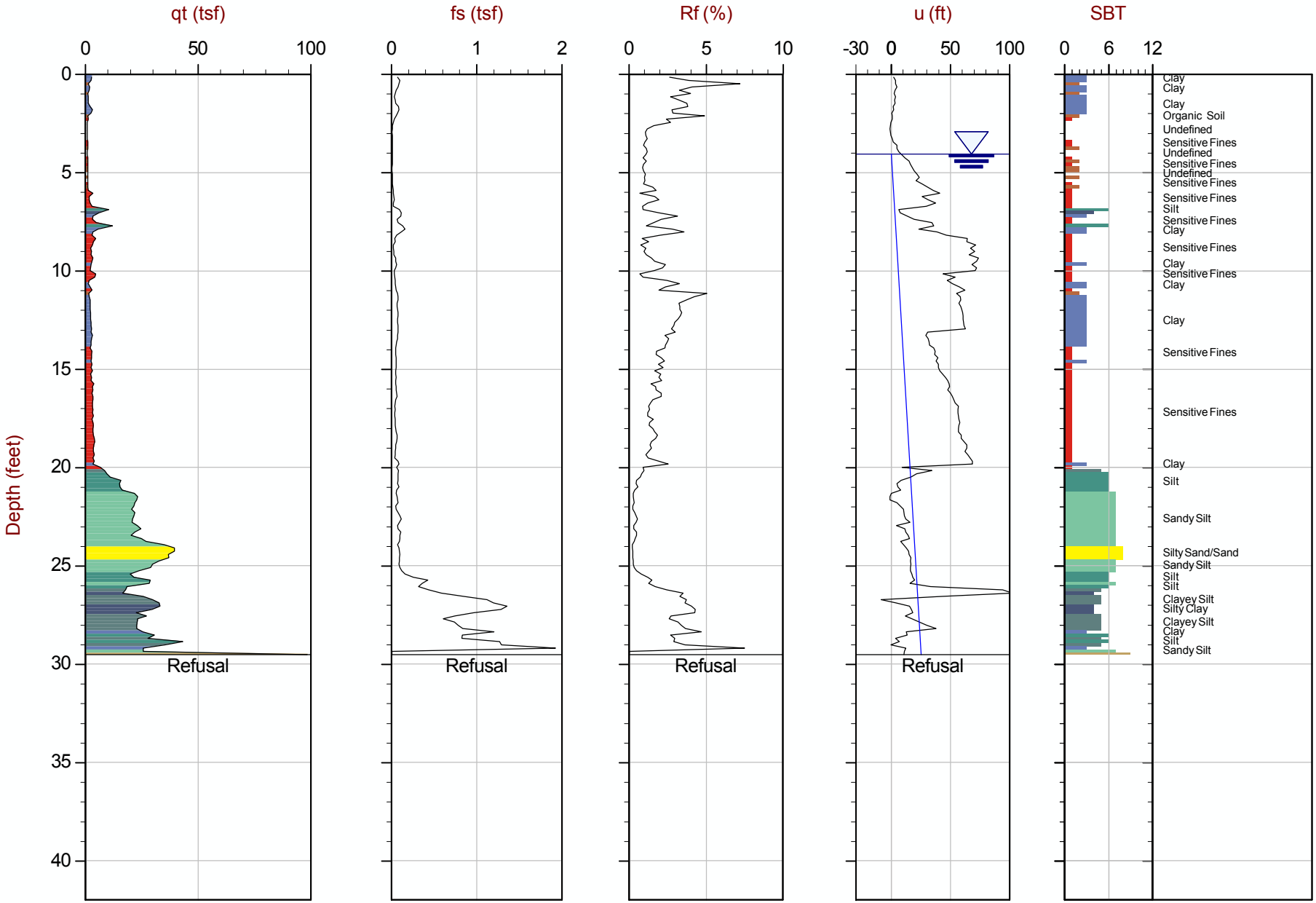
SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 18 N: 4494960 E: 566384

CONETEC

Michael Baker Jr.

Job No: 12-741
Date: 07:13:12 10:57
Site: Rahway Arch

Sounding: CPT-02
Cone: 302:T1500F15U500



Max Depth: 9.000 m / 29.53 ft
Depth Inc: 0.050 m / 0.164 ft

File: 741CP02.COR

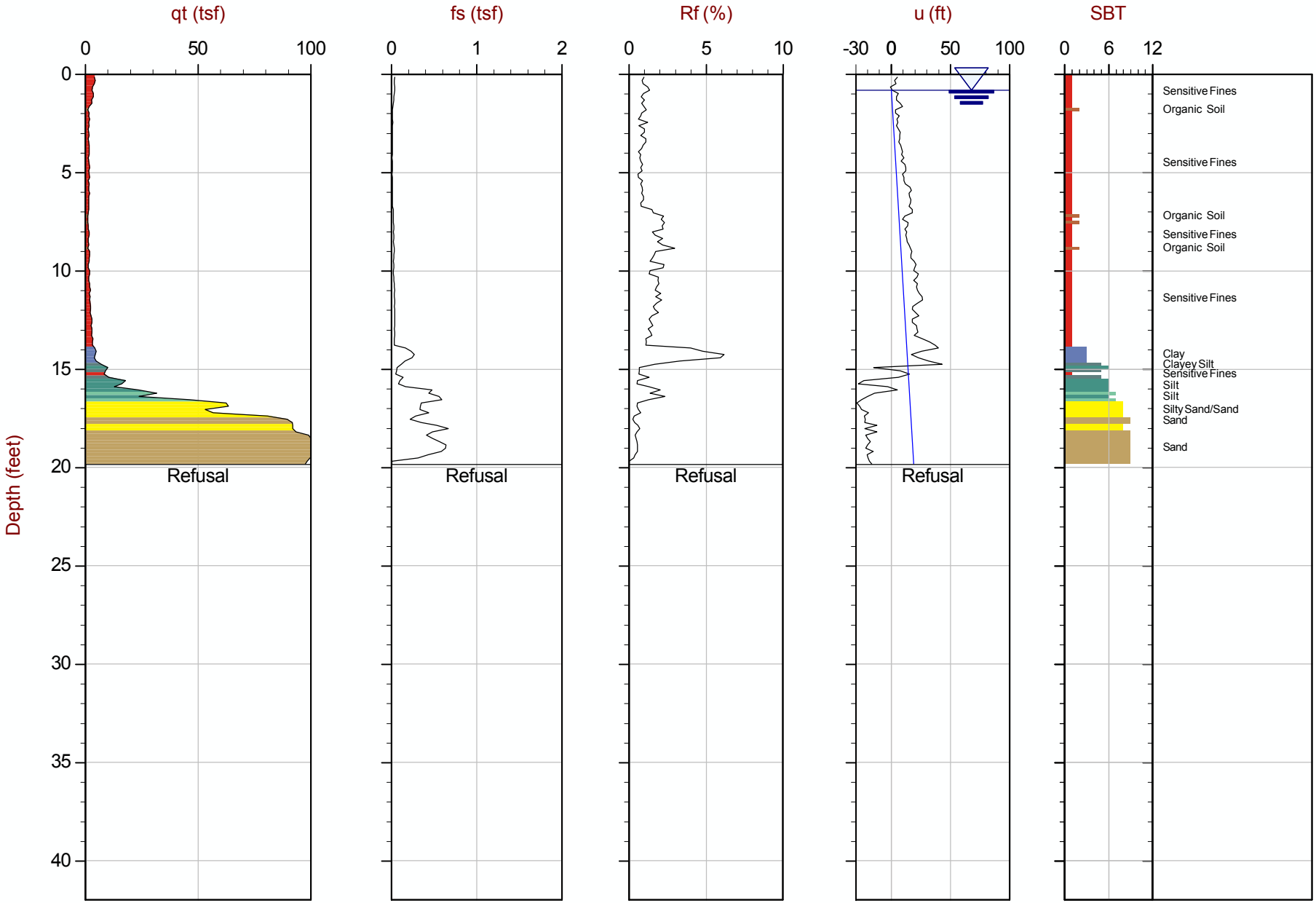
SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 18 N: 4495002 E: 566357

CONETEC

Michael Baker Jr.

Job No: 12-741
Date: 07:13:12 13:02
Site: Rahway Arch

Sounding: CPT-03
Cone: 302:T1500F15U500



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Depth Inc: 0.050 m / 0.164 ft

File: 741CP03.COR

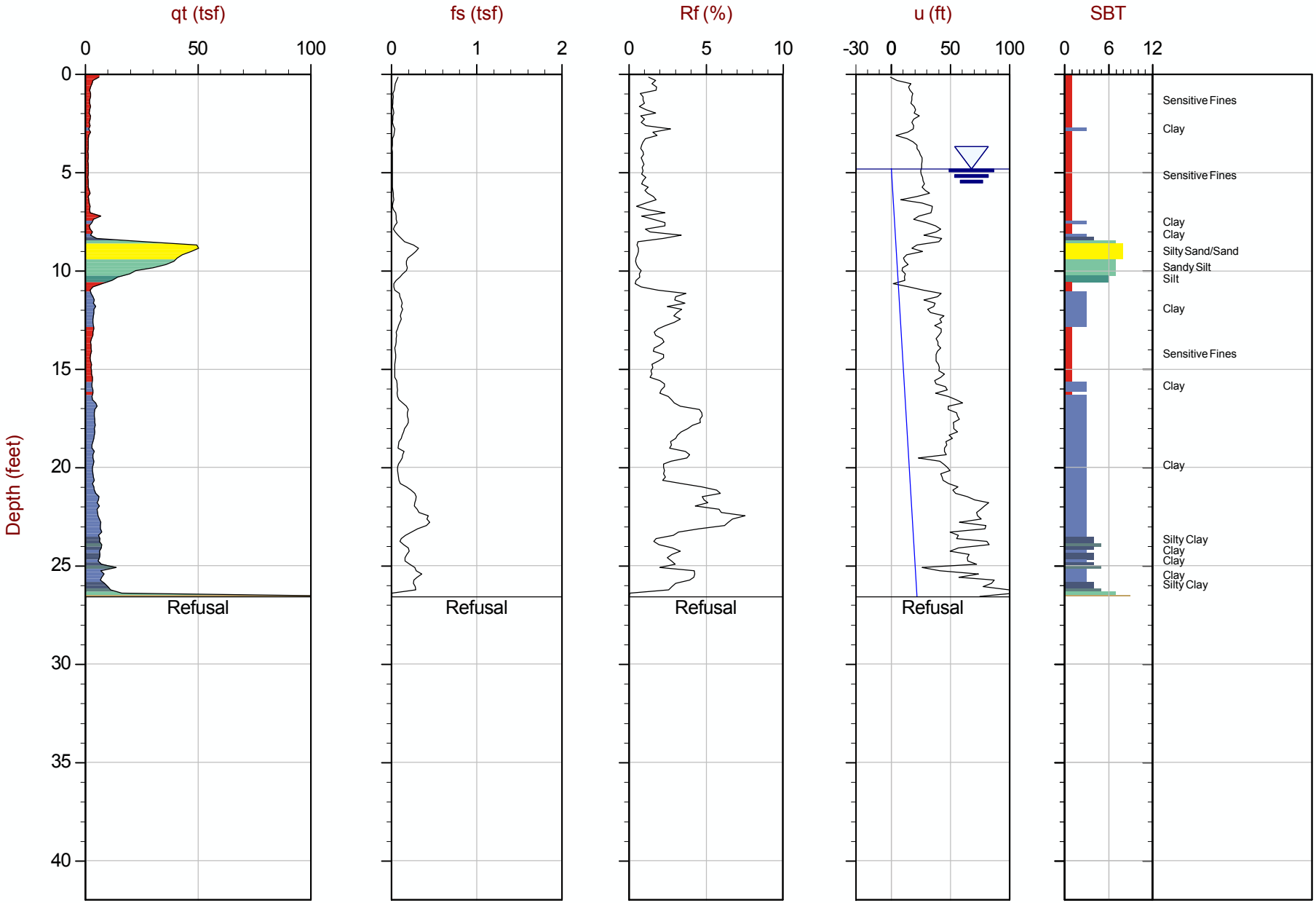
SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 18 N: 4494351 E: 566503

CONETEC

Michael Baker Jr.

Job No: 12-741
Date: 07:10:12 12:07
Site: Rahway Arch

Sounding: CPT-04
Cone: 302:T1500F15U500



Max Depth: 8.100 m / 26.57 ft
Depth Inc: 0.050 m / 0.164 ft

File: 741CP04.COR

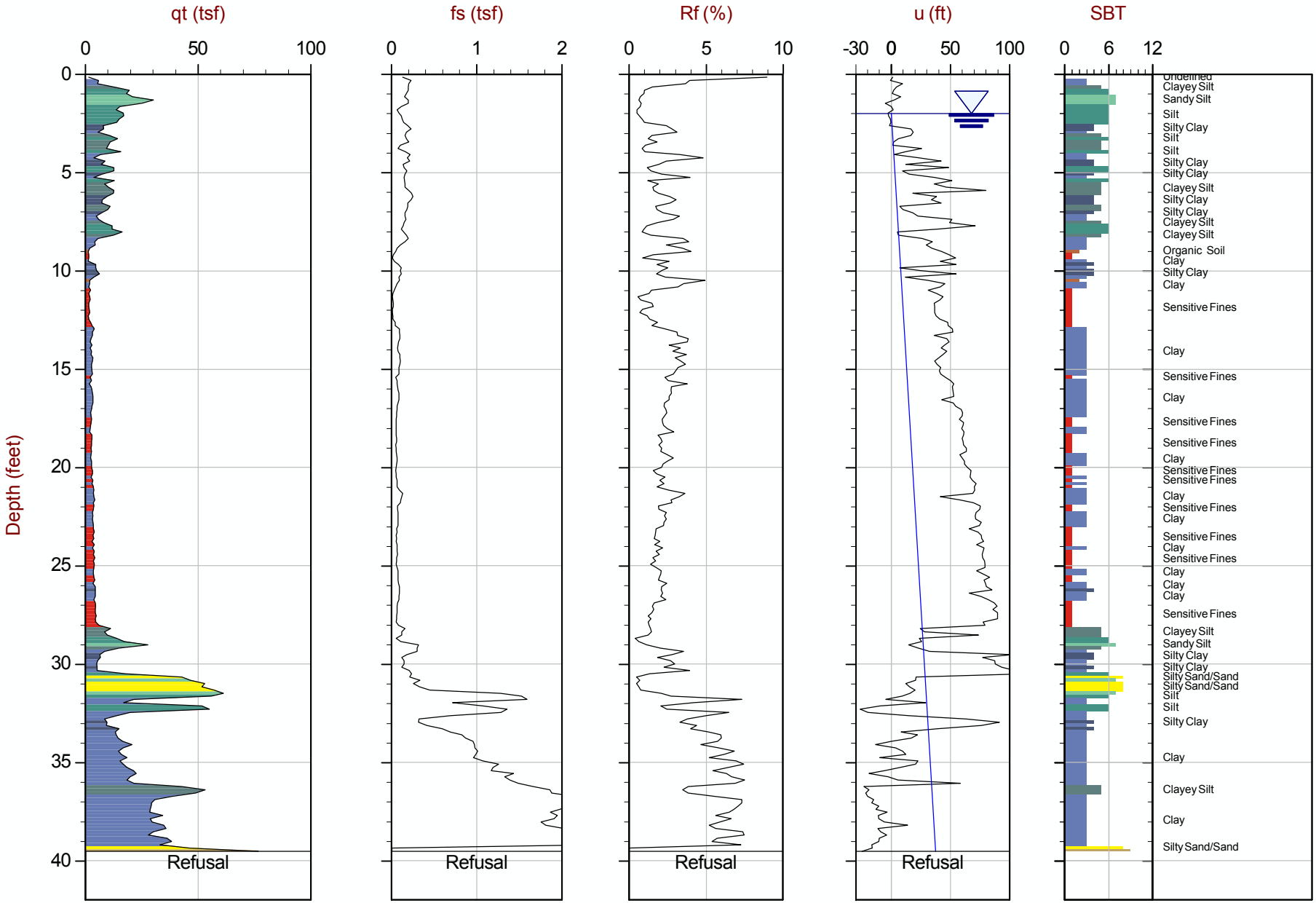
SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 18 N: 4494610 E: 566318

CONETEC

Michael Baker Jr.

Job No: 12-741
Date: 07:10:12 13:34
Site: Rahway Arch

Sounding: CPT-05
Cone: 302:T1500F15U500



Max Depth: 12.050 m / 39.53 ft
Depth Inc: 0.050 m / 0.164 ft

File: 741CP05.COR

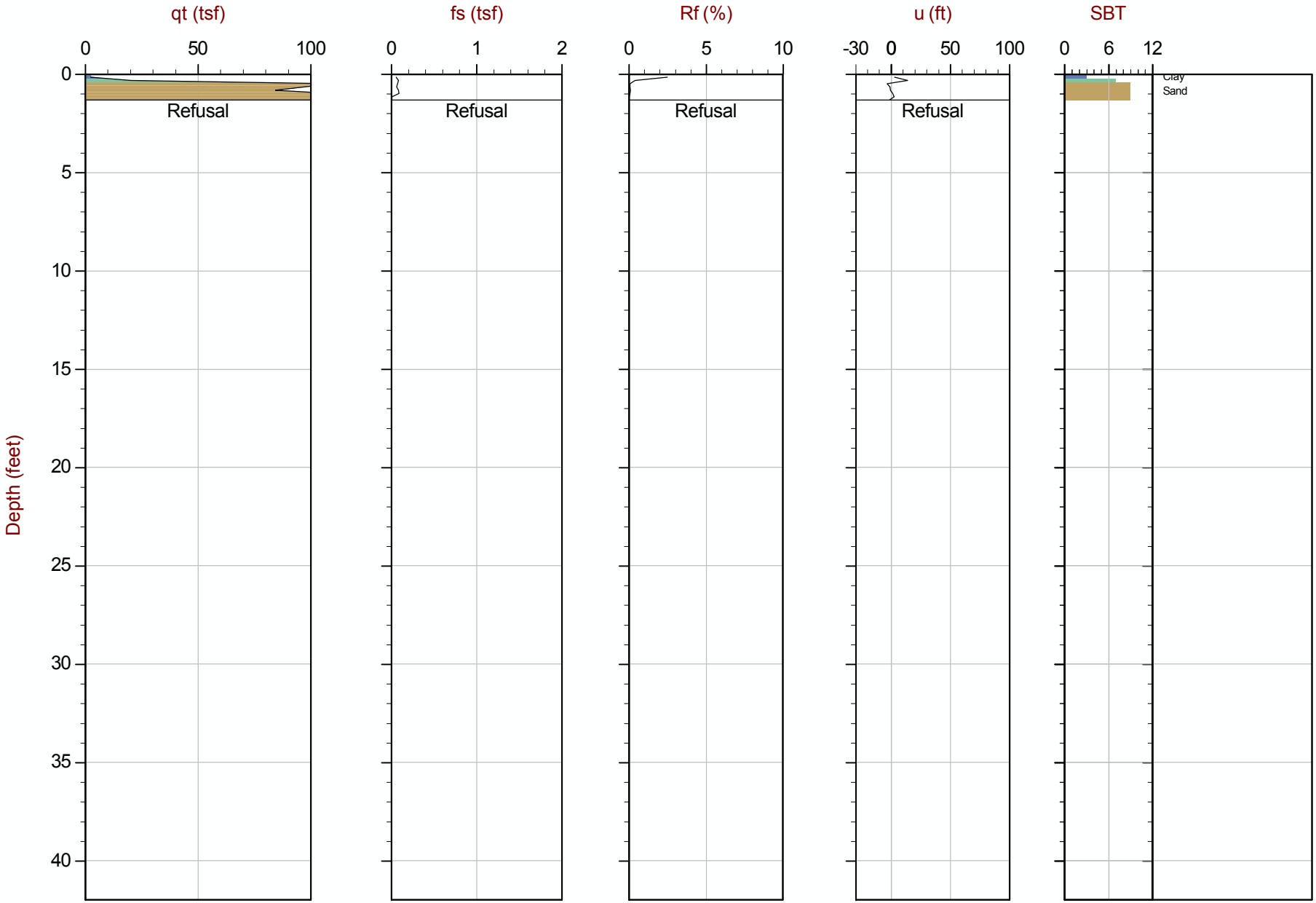
SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 18 N: 4494786 E: 566547

CONETEC

Michael Baker Jr.

Job No: 12-741
Date: 07:12:12 13:35
Site: Rahway Arch

Sounding: CPT-06
Cone: 302:T1500F15U500



Max Depth: 0.400 m / 1.31 ft
Depth Inc: 0.050 m / 0.164 ft

File: 741CP06.COR

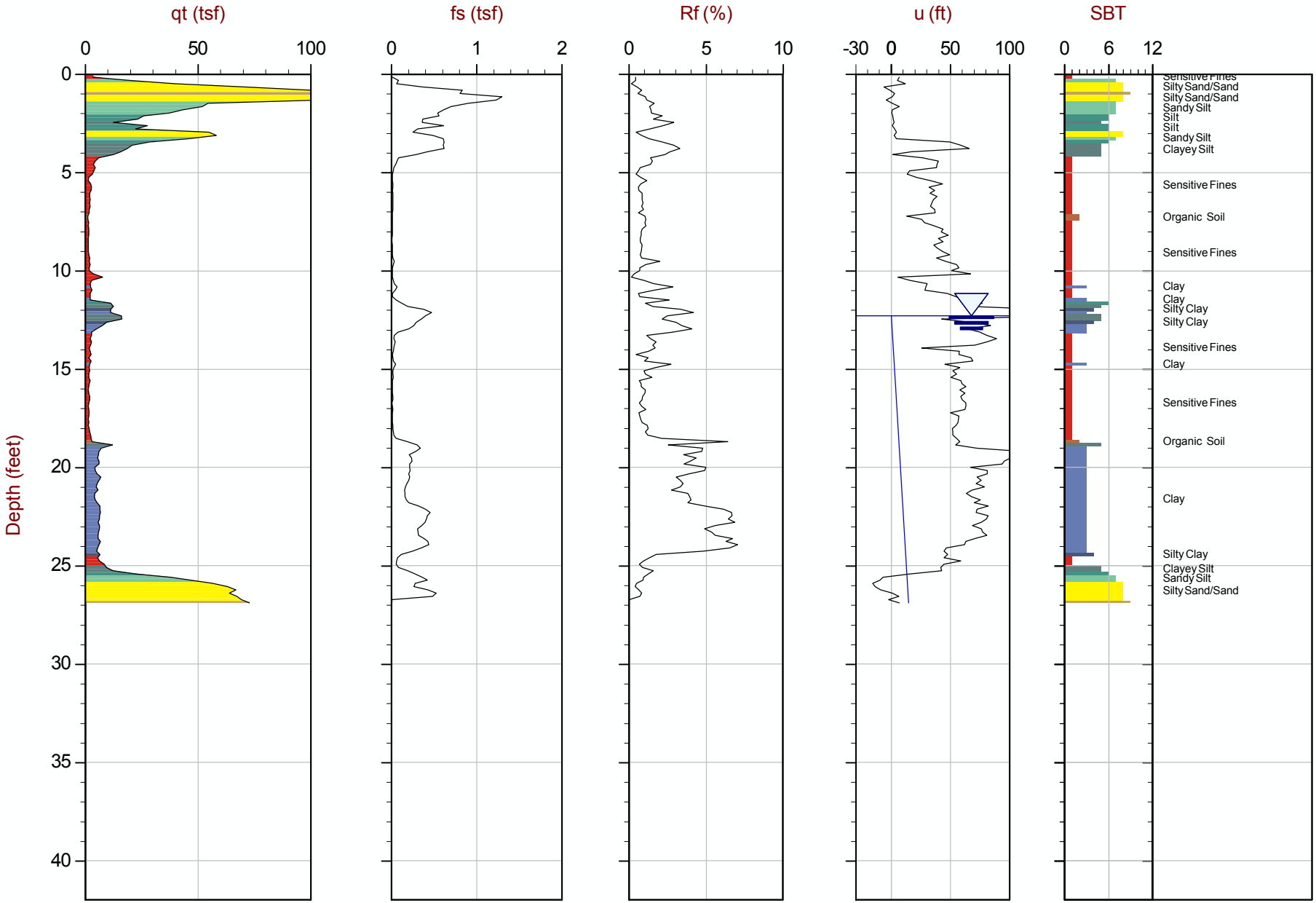
SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 18 N: 4494390 E: 566339

CONETEC

Michael Baker Jr.

Job No: 12-741
Date: 07:12:12 13:47
Site: Rahway Arch

Sounding: CPT-06A
Cone: 302:T1500F15U500



Max Depth: 8.200 m / 26.90 ft
Depth Inc: 0.050 m / 0.164 ft

File: 741CP06A.COR

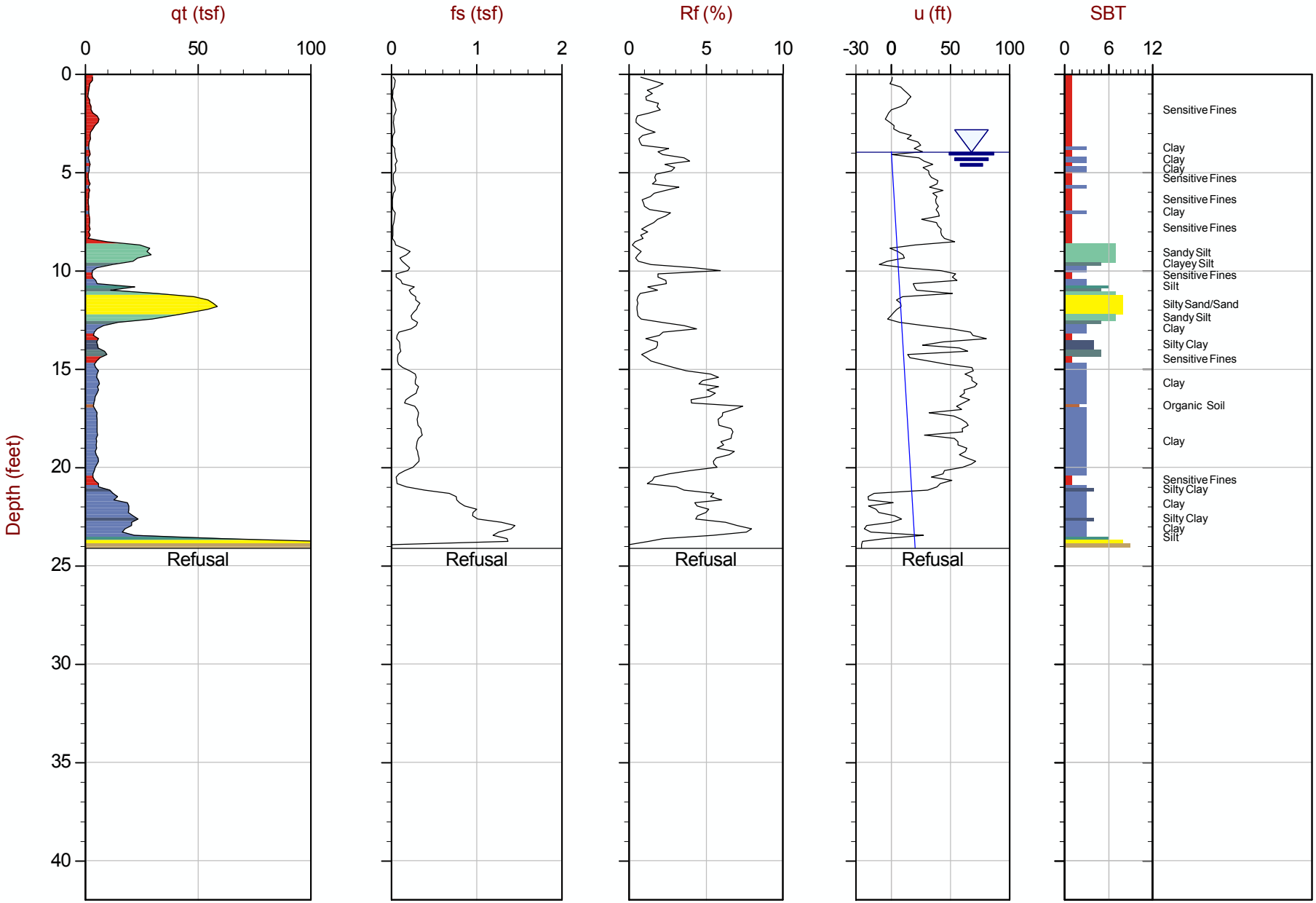
SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 18 N: 4494362 E: 566352

CONETEC

Michael Baker Jr.

Job No: 12-741
Date: 07:10:12 09:49
Site: Rahway Arch

Sounding: CPT-08
Cone: 302:T1500F15U500



Max Depth: 7.350 m / 24.11 ft
Depth Inc: 0.050 m / 0.164 ft

File: 741CP08.COR

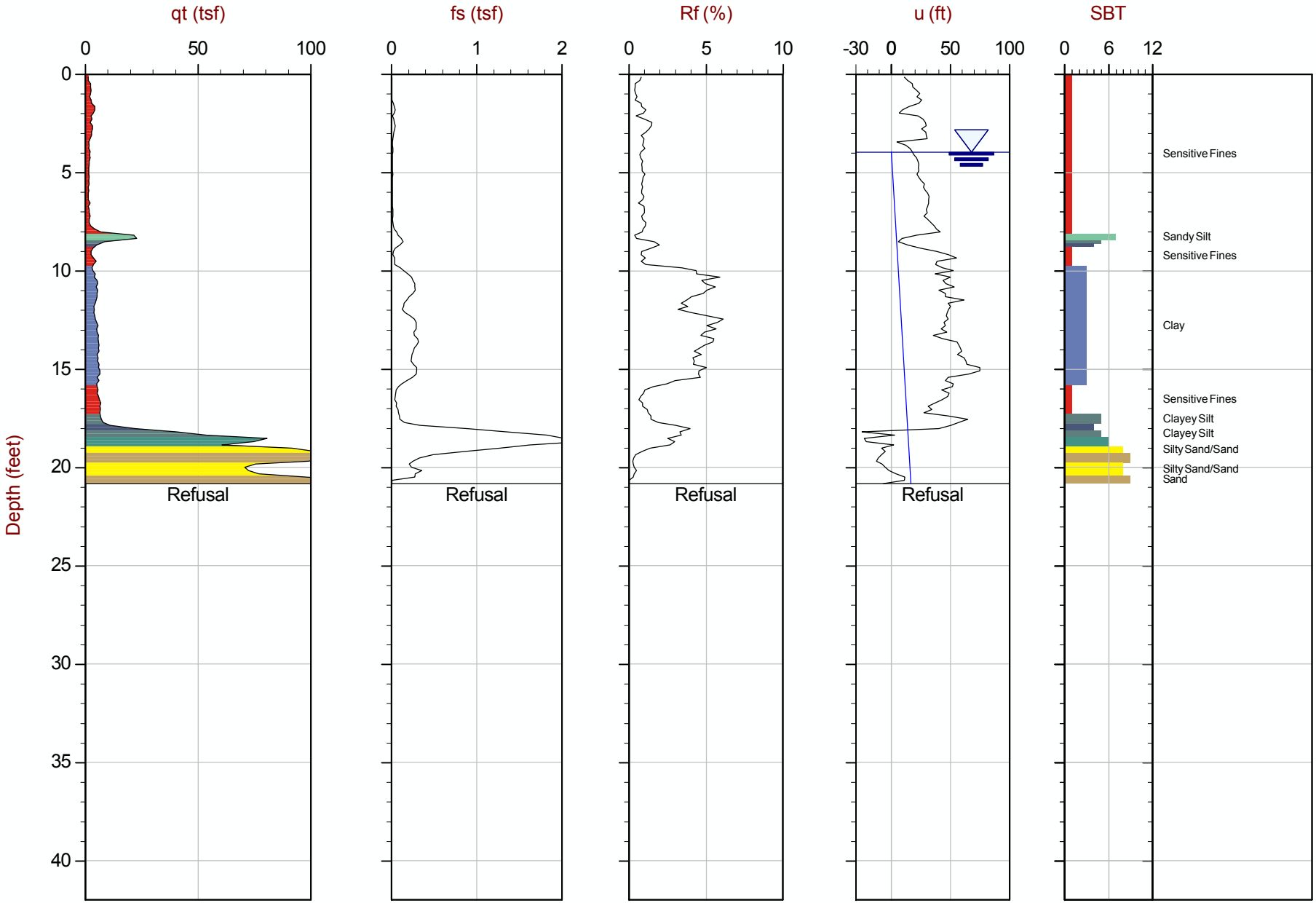
SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 18 N: 4494352 E: 566237

CONETEC

Michael Baker Jr.

Job No: 12-741
Date: 07:10:12 11:01
Site: Rahway Arch

Sounding: CPT-08A
Cone: 302:T1500F15U500



Max Depth: 6.350 m / 20.83 ft
Depth Inc: 0.050 m / 0.164 ft

File: 741CP08A.COR

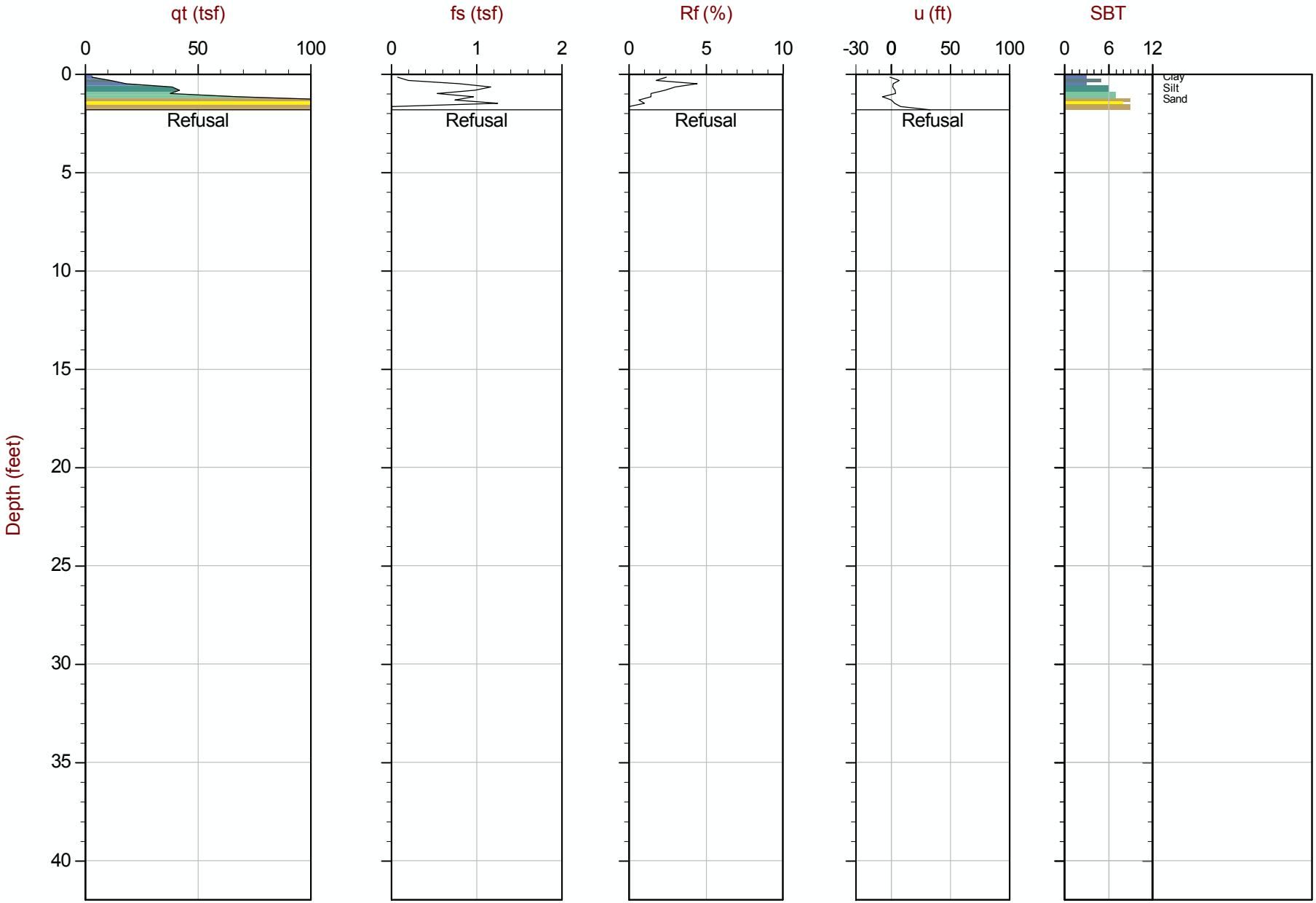
SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 18 N: 4494361 E: 566222

CONETEC

Michael Baker Jr.

Job No: 12-741
Date: 07:12:12 10:18
Site: Rahway Arch

Sounding: CPT-09
Cone: 302:T1500F15U500



Max Depth: 0.550 m / 1.80 ft
Depth Inc: 0.050 m / 0.164 ft

File: 741CP09.COR

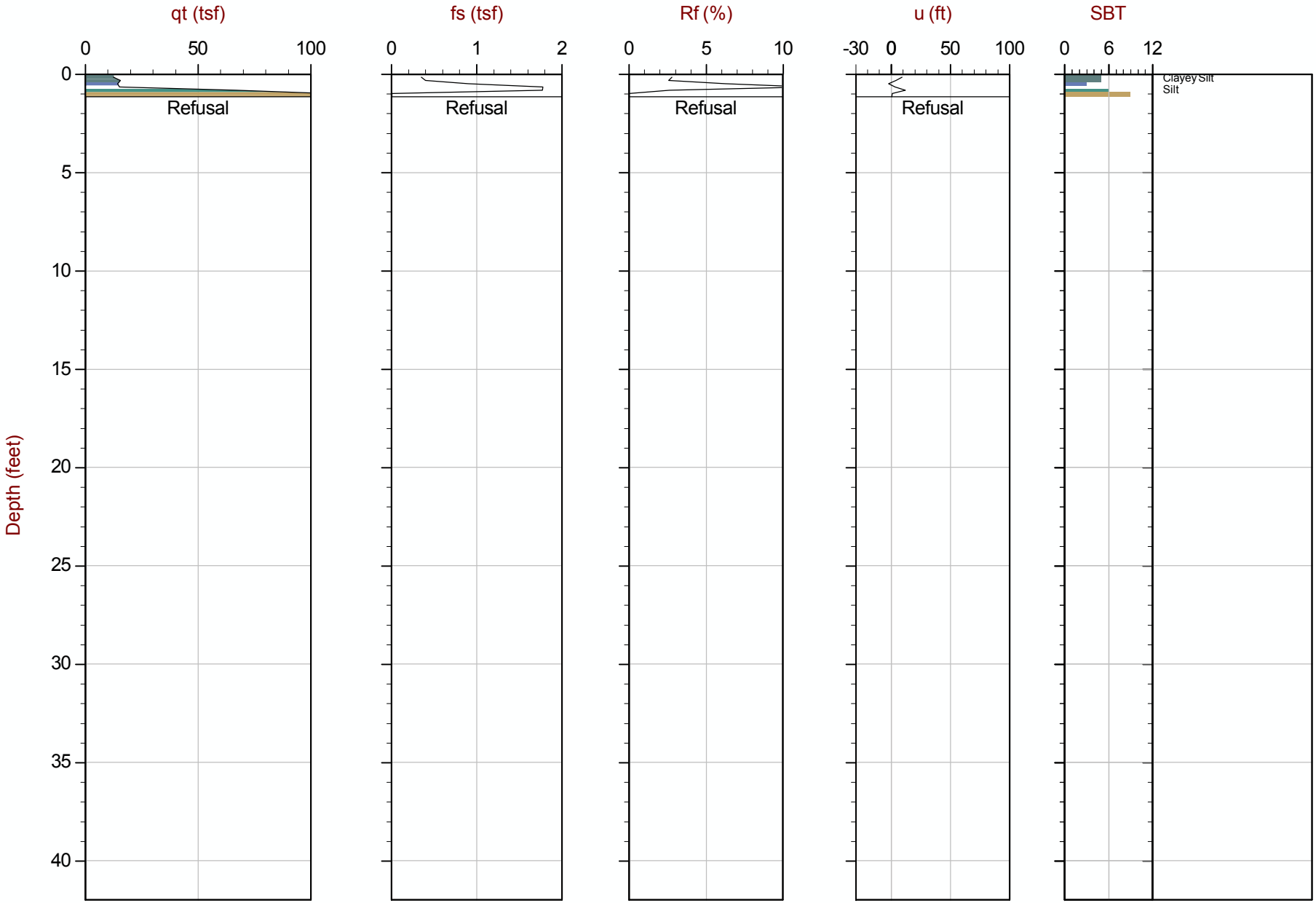
SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 18 N: 4494426 E: 566004

CONETEC

Michael Baker Jr.

Job No: 12-741
Date: 07:12:12 10:32
Site: Rahway Arch

Sounding: CPT-09A
Cone: 302:T1500F15U500



Max Depth: 0.350 m / 1.15 ft
Depth Inc: 0.050 m / 0.164 ft

File: 741CP09A.COR

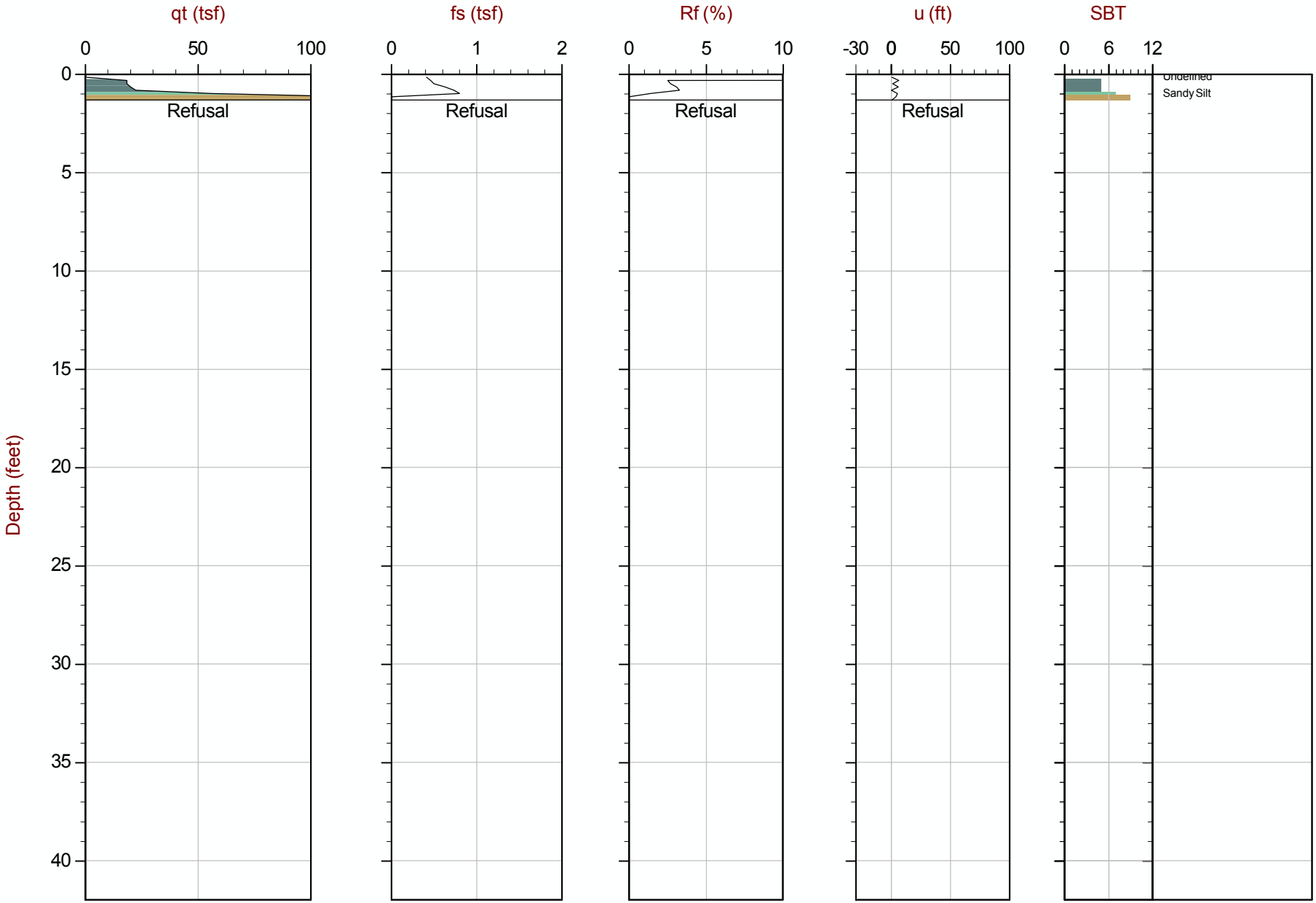
SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 18 N: 4494426 E: 566000

CONETEC

Michael Baker Jr.

Job No: 12-741
Date: 07:12:12 10:40
Site: Rahway Arch

Sounding: CPT-09B
Cone: 302:T1500F15U500



Max Depth: 0.400 m / 1.31 ft
Depth Inc: 0.050 m / 0.164 ft

File: 741CP09B.COR

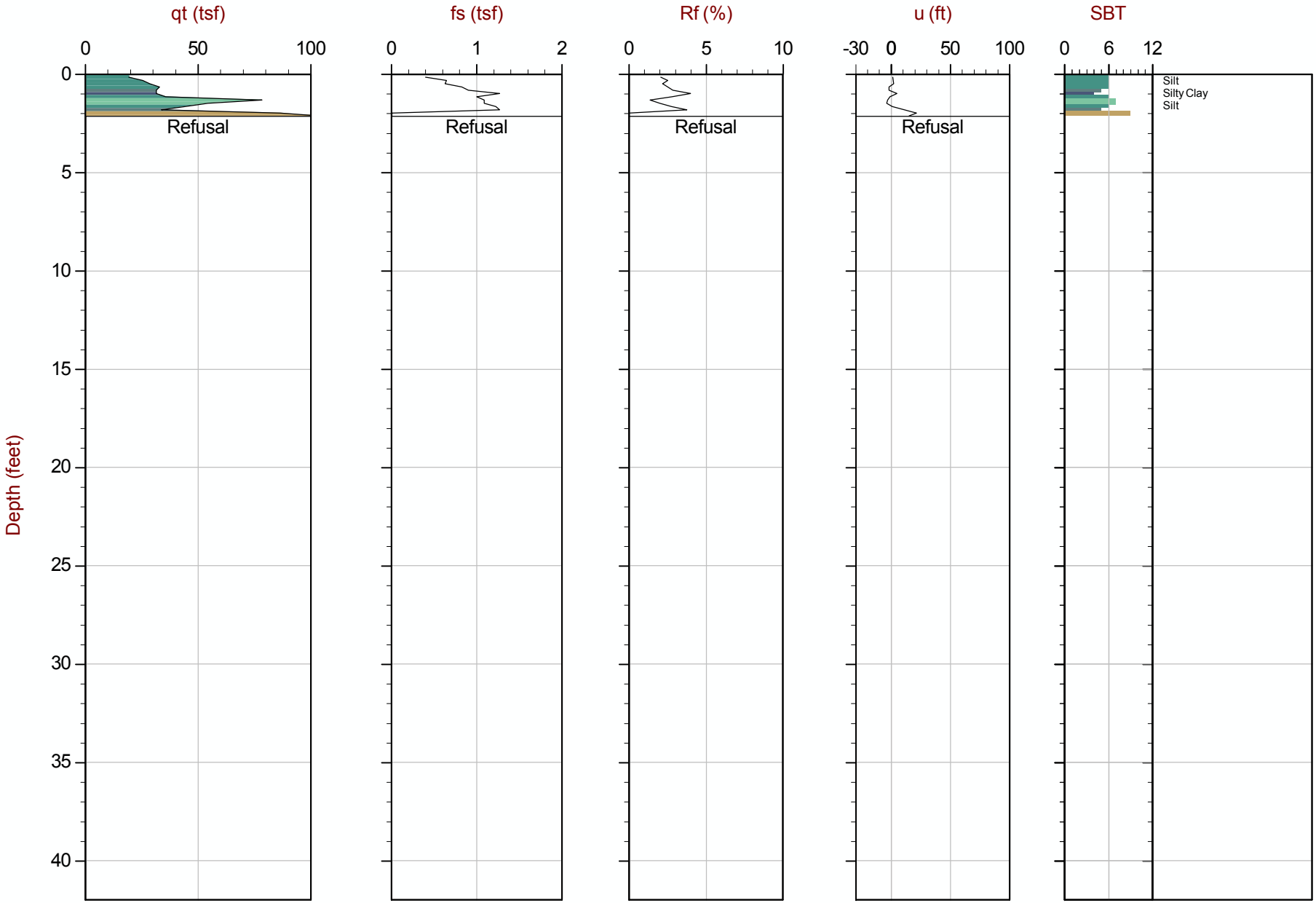
SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 18 N: 4494422 E: 566004

CONETEC

Michael Baker Jr.

Job No: 12-741
Date: 07:12:12 11:00
Site: Rahway Arch

Sounding: CPT-09C
Cone: 302:T1500F15U500



Max Depth: 0.650 m / 2.13 ft
Depth Inc: 0.050 m / 0.164 ft

File: 741CP09C.COR

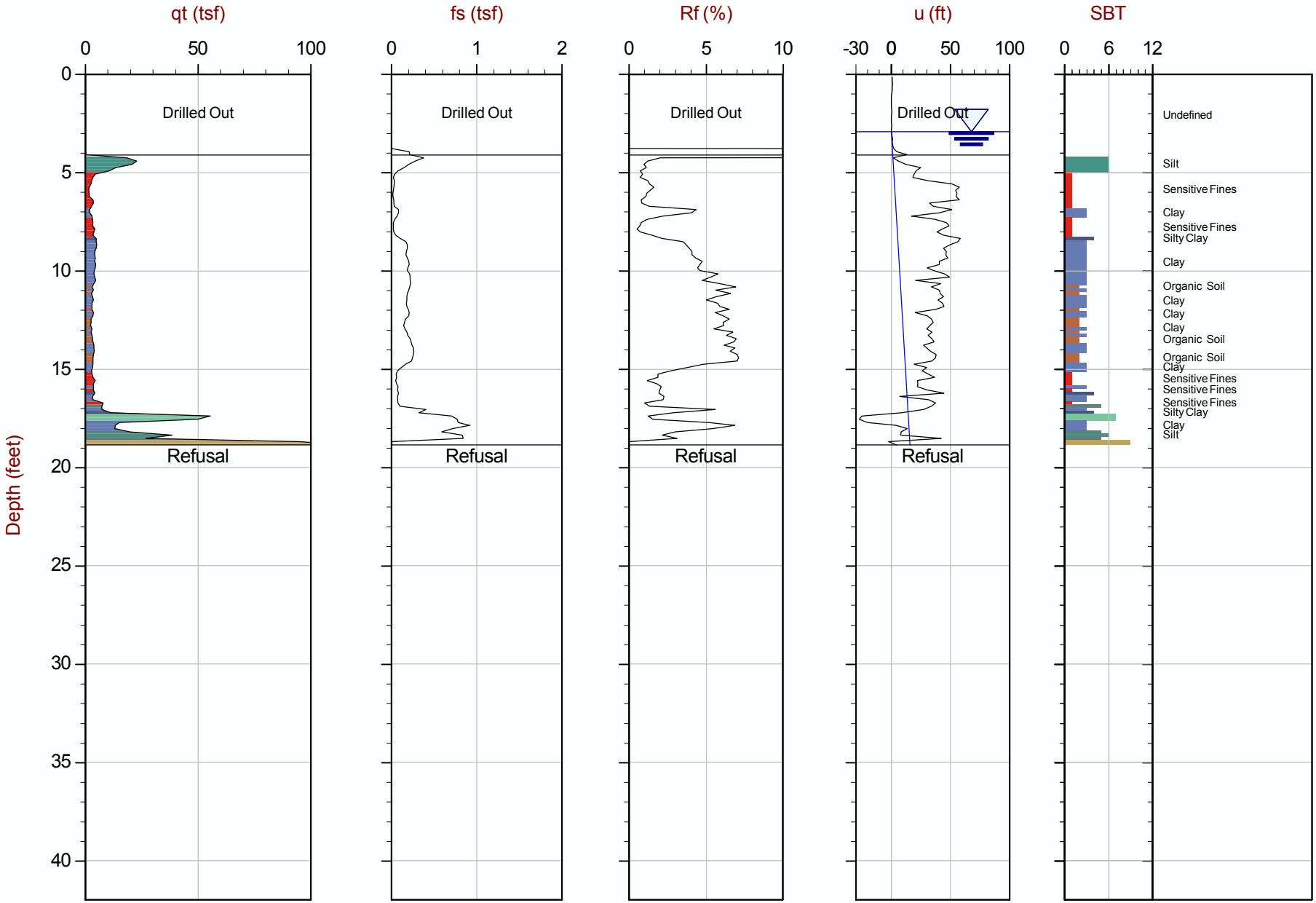
SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 18 N: 4494413 E: 566027

CONETEC

Michael Baker Jr.

Job No: 12-741
Date: 07:13:12 08:40
Site: Rahway Arch

Sounding: CPT-09D
Cone: 302:T1500F15U500



Max Depth: 5.750 m / 18.86 ft
Depth Inc: 0.050 m / 0.164 ft

File: 741CP09D.COR

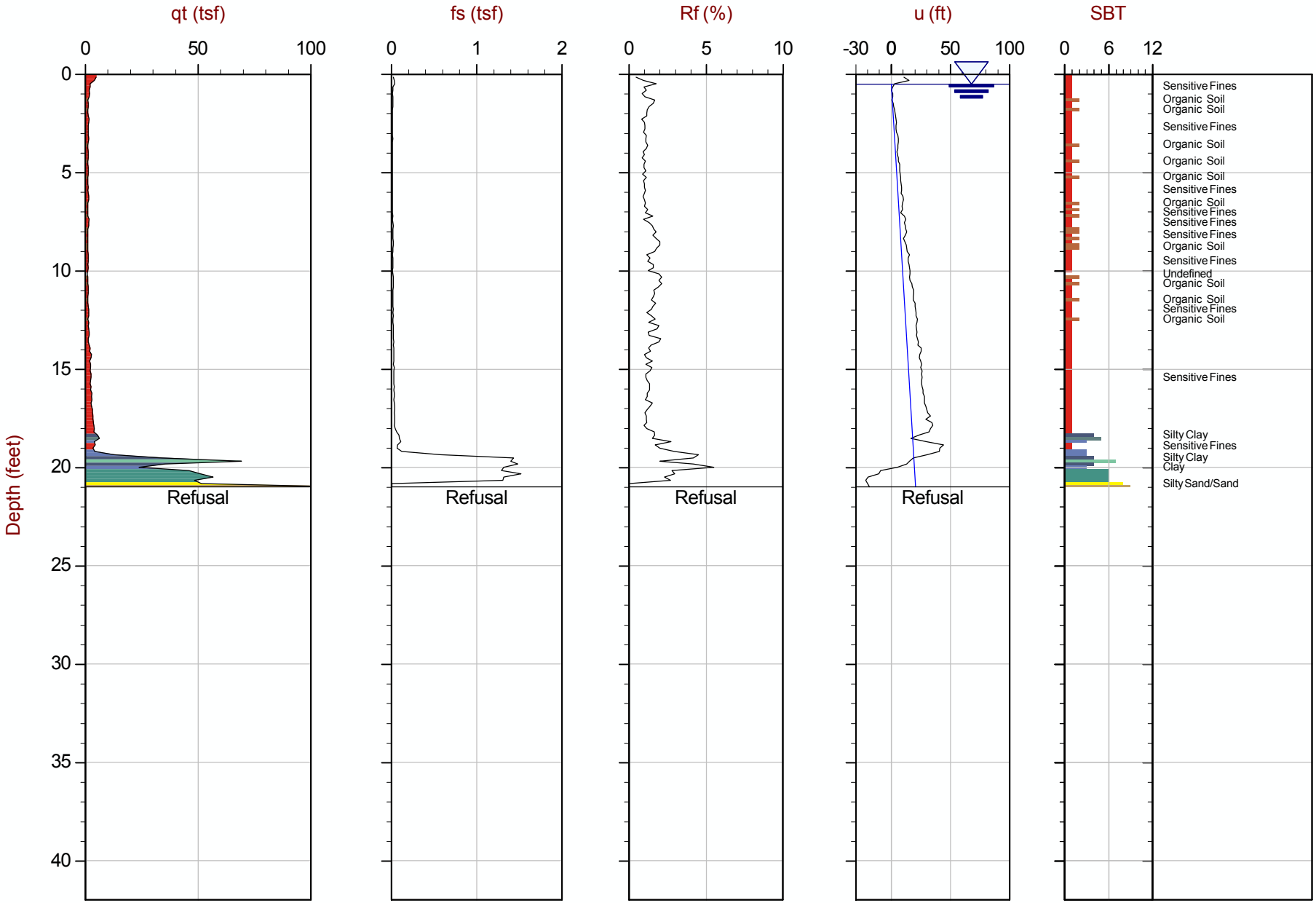
SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 18 N: 4494424 E: 566007

CONETEC

Michael Baker Jr.

Job No: 12-741
Date: 07:13:12 09:38
Site: Rahway Arch

Sounding: CPT-10
Cone: 302:T1500F15U500



Max Depth: 6.400 m / 21.00 ft
Depth Inc: 0.050 m / 0.164 ft

File: 741CP10.COR

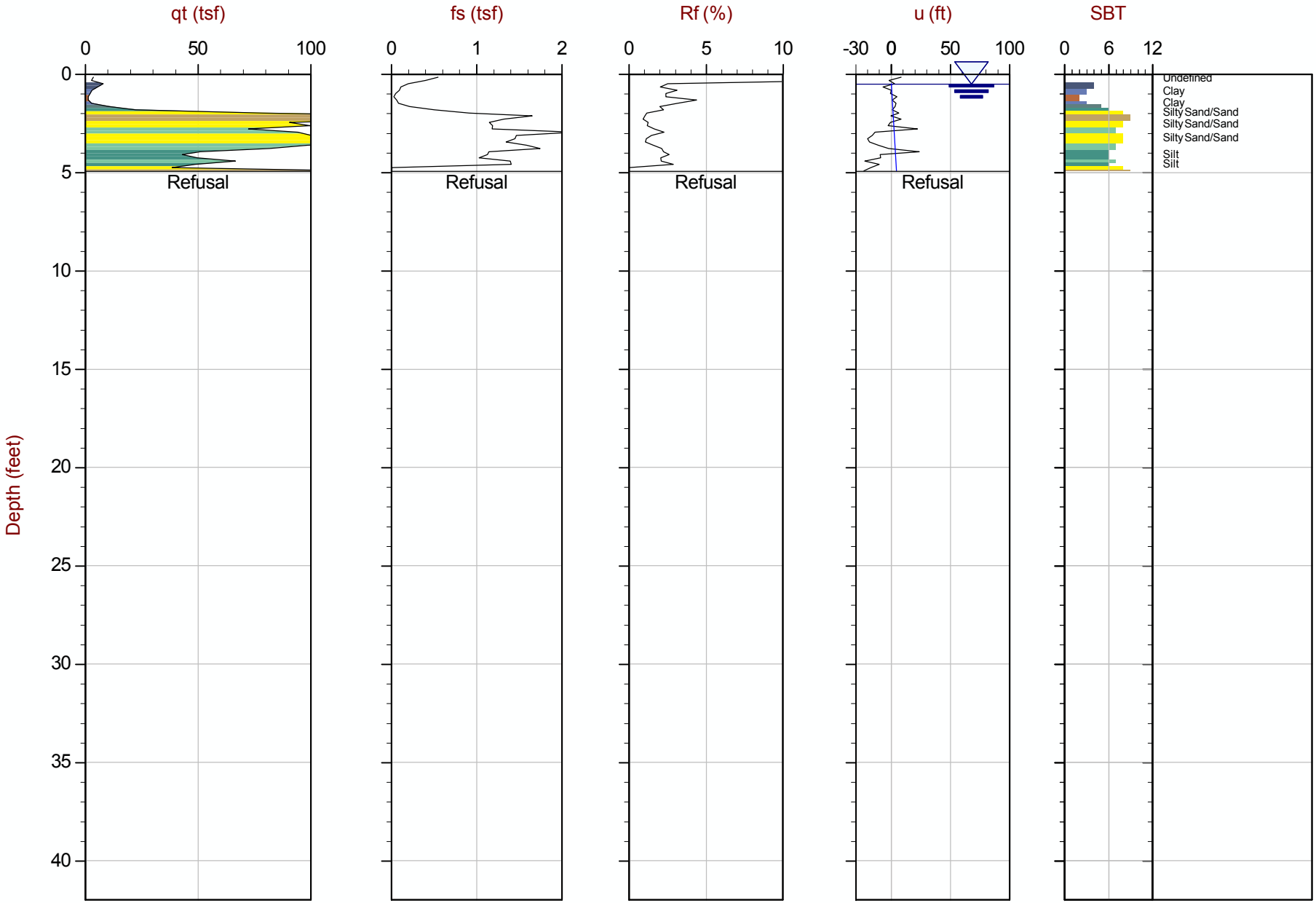
SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 18 N: 4494621 E: 566150

CONETEC

Michael Baker Jr.

Job No: 12-741
Date: 07:12:12 11:49
Site: Rahway Arch

Sounding: CPT-11
Cone: 302:T1500F15U500



Max Depth: 1.500 m / 4.92 ft
Depth Inc: 0.050 m / 0.164 ft

File: 741CP11.COR

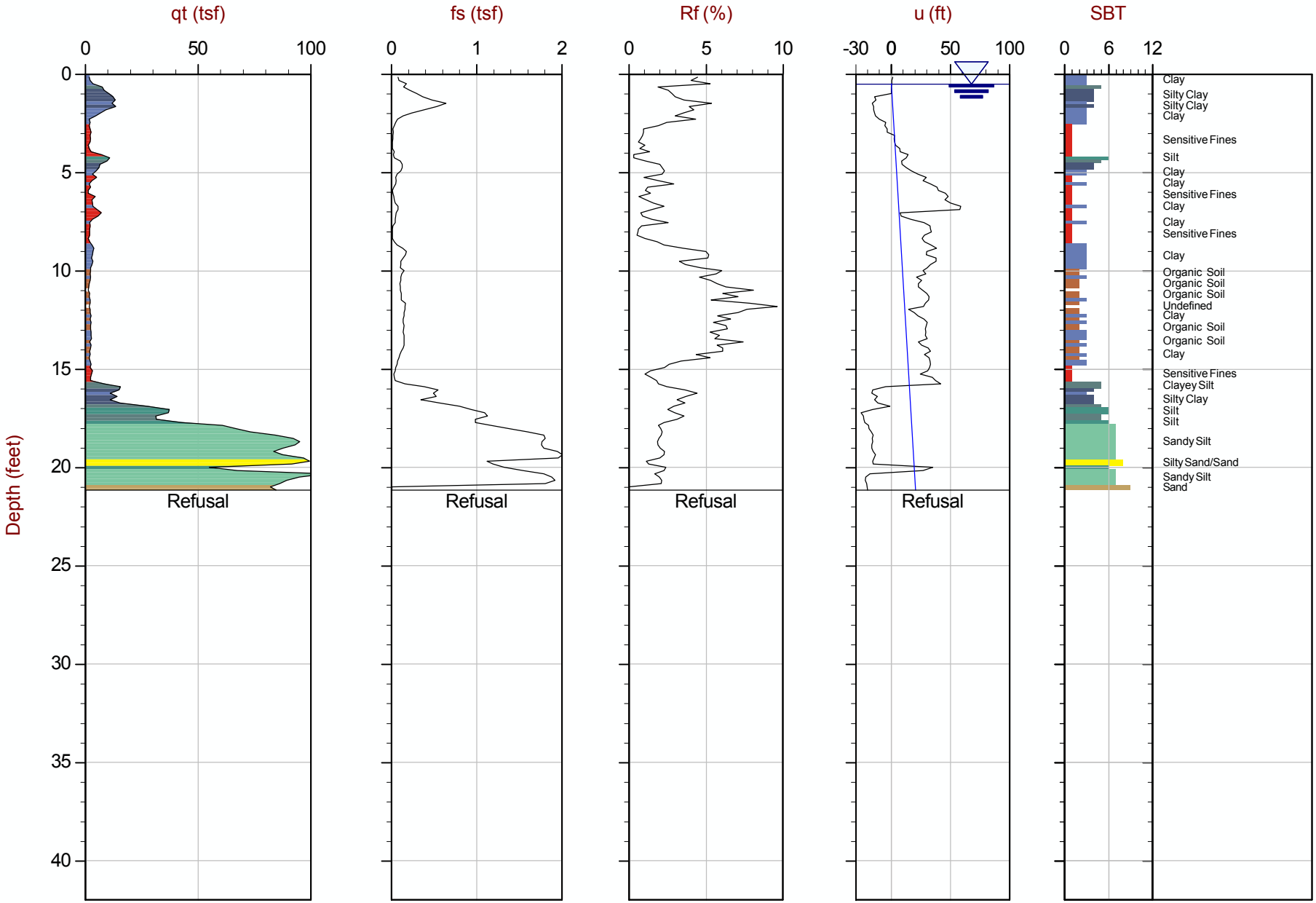
SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 18 N: 4494109 E: 566210

CONETEC

Michael Baker Jr.

Job No: 12-741
Date: 07:12:12 12:10
Site: Rahway Arch

Sounding: CPT-11A
Cone: 302:T1500F15U500



Max Depth: 6.450 m / 21.16 ft
Depth Inc: 0.050 m / 0.164 ft

File: 741CP11A.COR

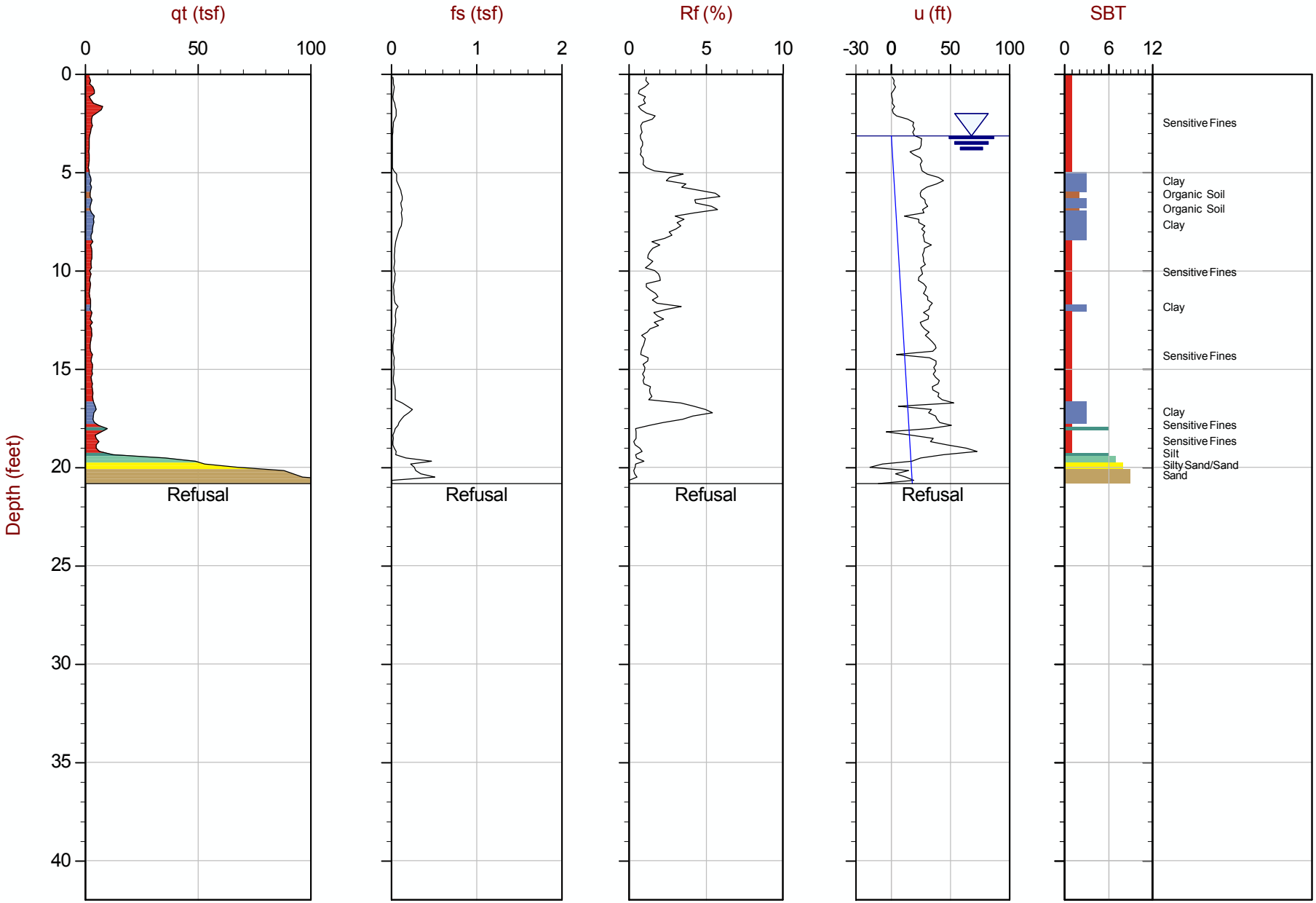
SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 18 N: 4494117 E: 566189

CONETEC

Michael Baker Jr.

Job No: 12-741
Date: 07:16:12 06:56
Site: Rahway Arch

Sounding: CPT-12
Cone: 302:T1500F15U500



Max Depth: 6.350 m / 20.83 ft
Depth Inc: 0.050 m / 0.164 ft

File: 741CP12.COR

SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 18 N: 4494164 E: 566559

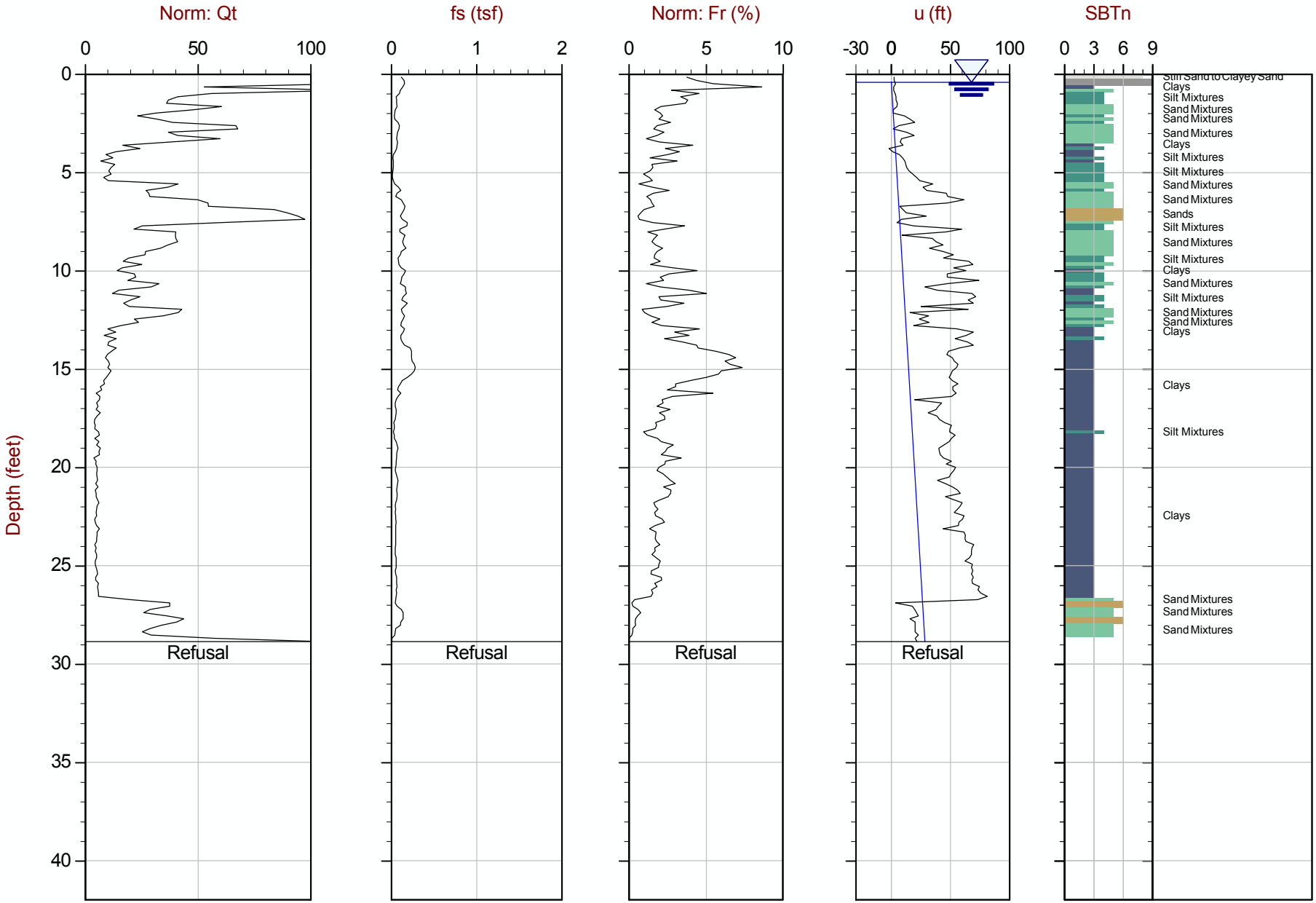
Normalized CPT Plots

CONETEC

Michael Baker Jr.

Job No: 12-741
Date: 07:12:12 07:18
Site: Rahway Arch

Sounding: CPT-01
Cone: 302:T1500F15U500



Max Depth: 8.800 m / 28.87 ft
Depth Inc: 0.050 m / 0.164 ft

File: 741CP01.COR

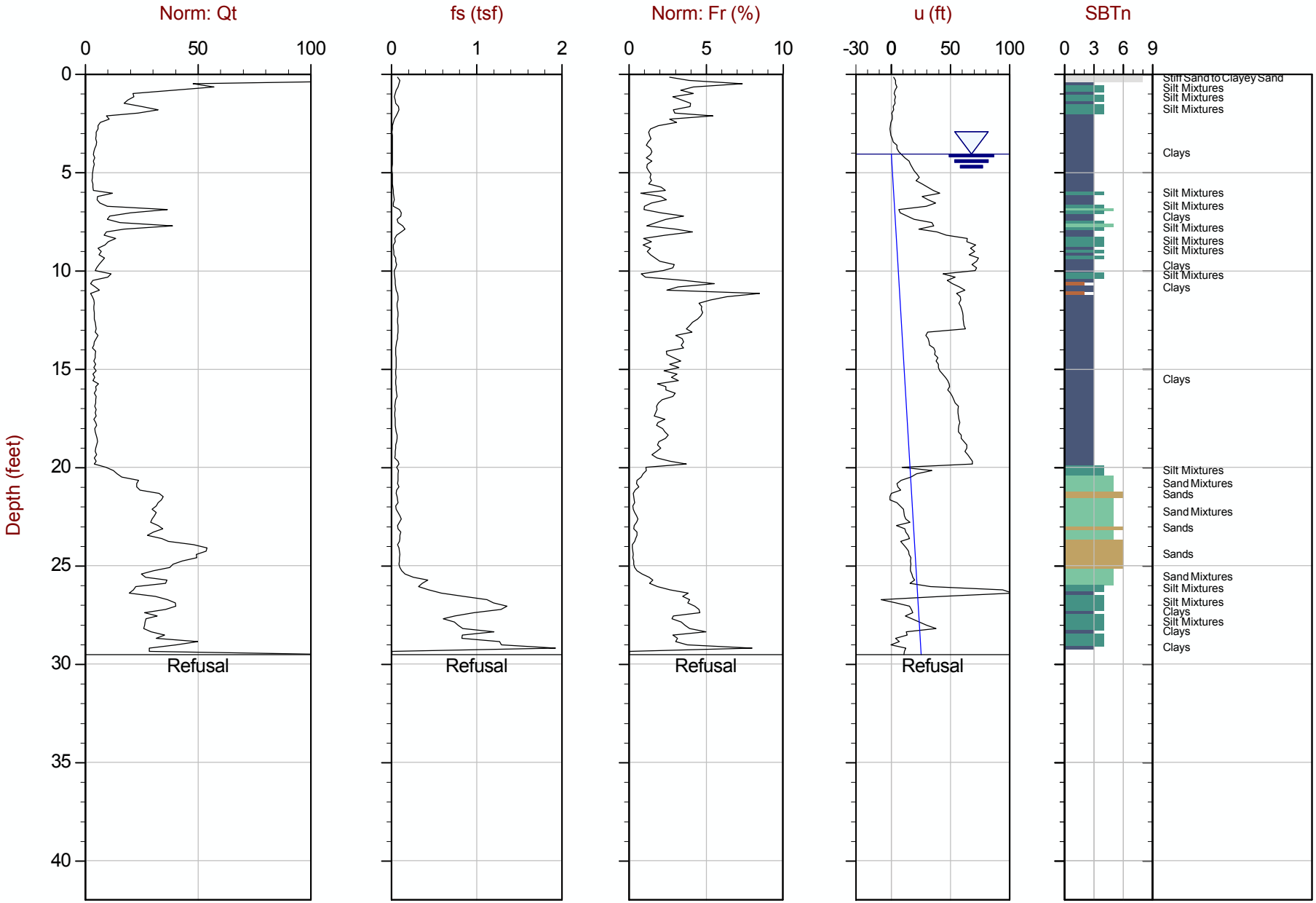
SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 18 N: 4494960 E: 566384

CONETEC

Michael Baker Jr.

Job No: 12-741
Date: 07:13:12 10:57
Site: Rahway Arch

Sounding: CPT-02
Cone: 302:T1500F15U500



Max Depth: 9.000 m / 29.53 ft
Depth Inc: 0.050 m / 0.164 ft

File: 741CP02.COR

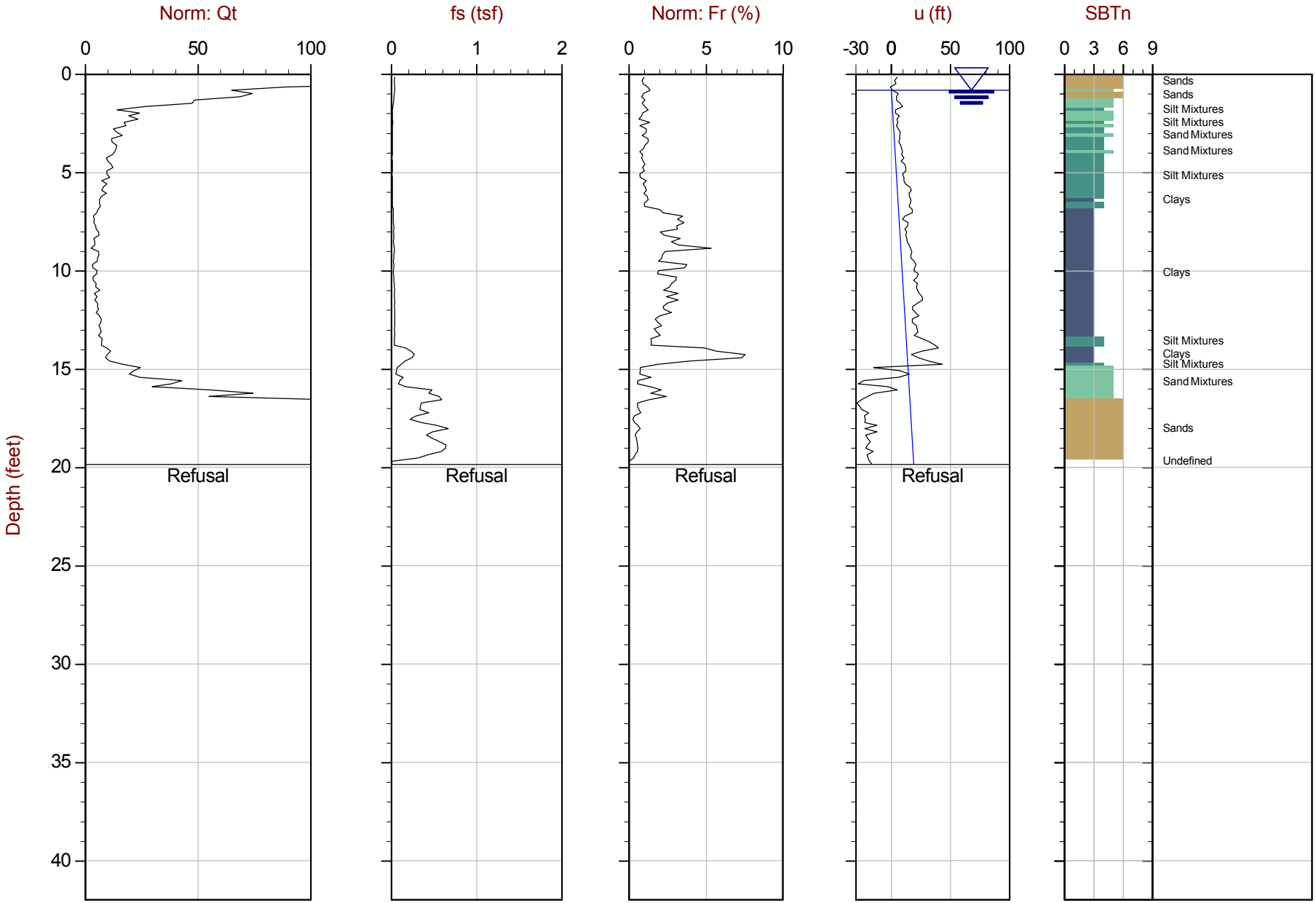
SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 18 N: 4495002 E: 566357

CONETEC

Michael Baker Jr.

Job No: 12-741
Date: 07:13:12 13:02
Site: Rahway Arch

Sounding: CPT-03
Cone: 302:T1500F15U500



Max Depth: 6.050 m / 19.85 ft
Depth Inc: 0.050 m / 0.164 ft

File: 741CP03.COR

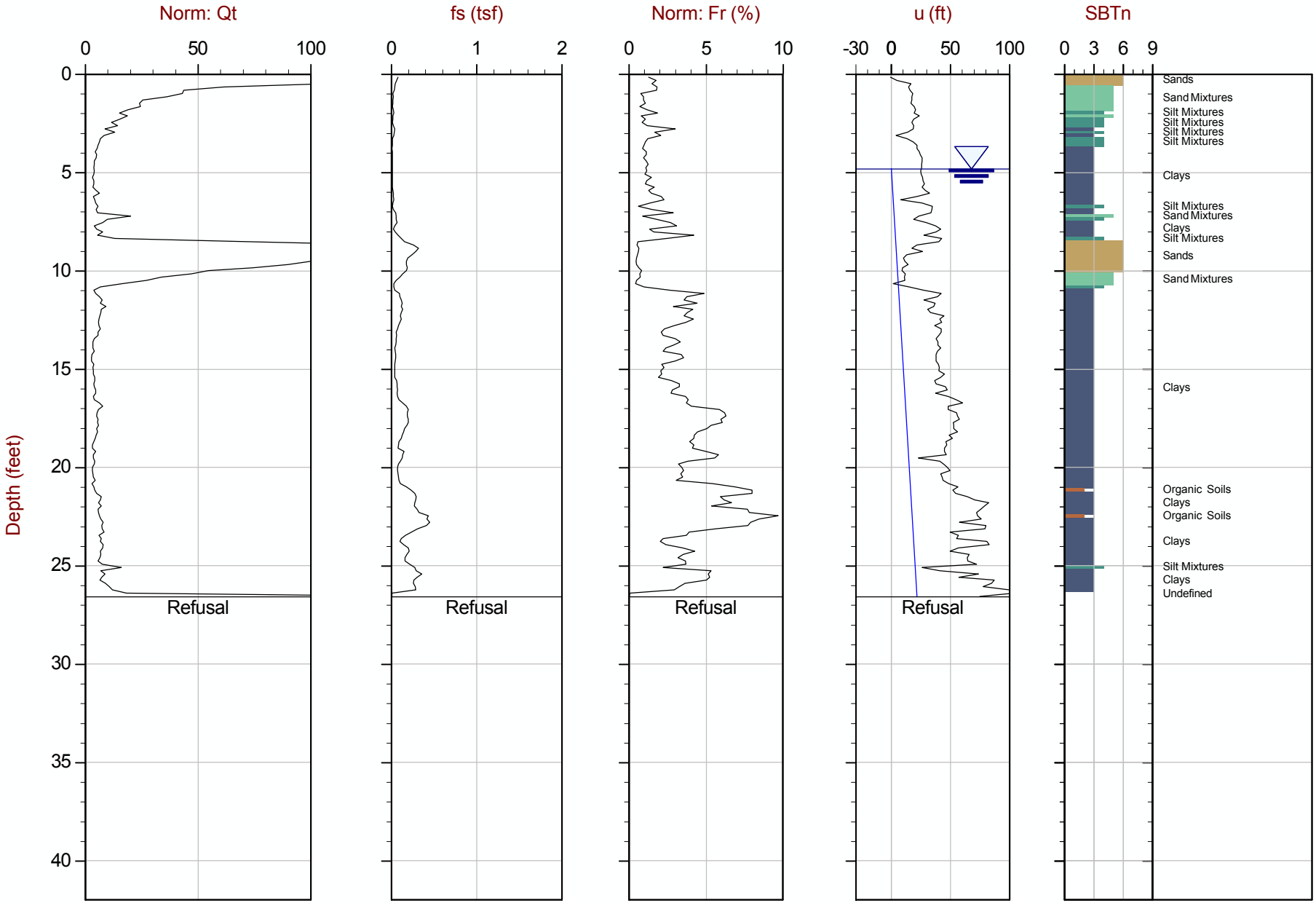
SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 18 N: 4494351 E: 566503

CONETEC

Michael Baker Jr.

Job No: 12-741
Date: 07:10:12 12:07
Site: Rahway Arch

Sounding: CPT-04
Cone: 302:T1500F15U500



Max Depth: 8.100 m / 26.57 ft
Depth Inc: 0.050 m / 0.164 ft

File: 741CP04.COR

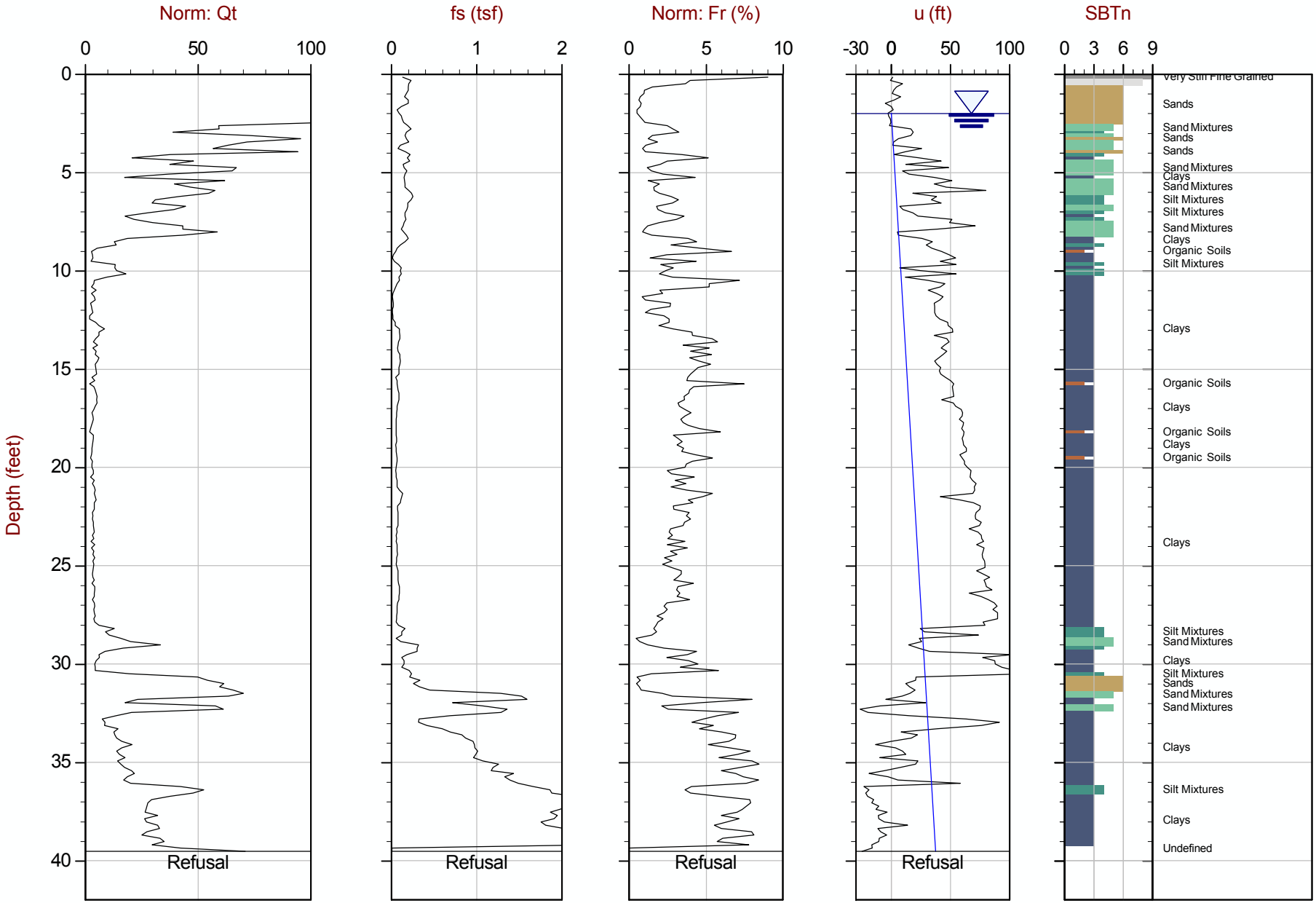
SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 18 N: 4494610 E: 566318

CONETEC

Michael Baker Jr.

Job No: 12-741
Date: 07:10:12 13:34
Site: Rahway Arch

Sounding: CPT-05
Cone: 302:T1500F15U500



Max Depth: 12.050 m / 39.53 ft
Depth Inc: 0.050 m / 0.164 ft

File: 741CP05.COR

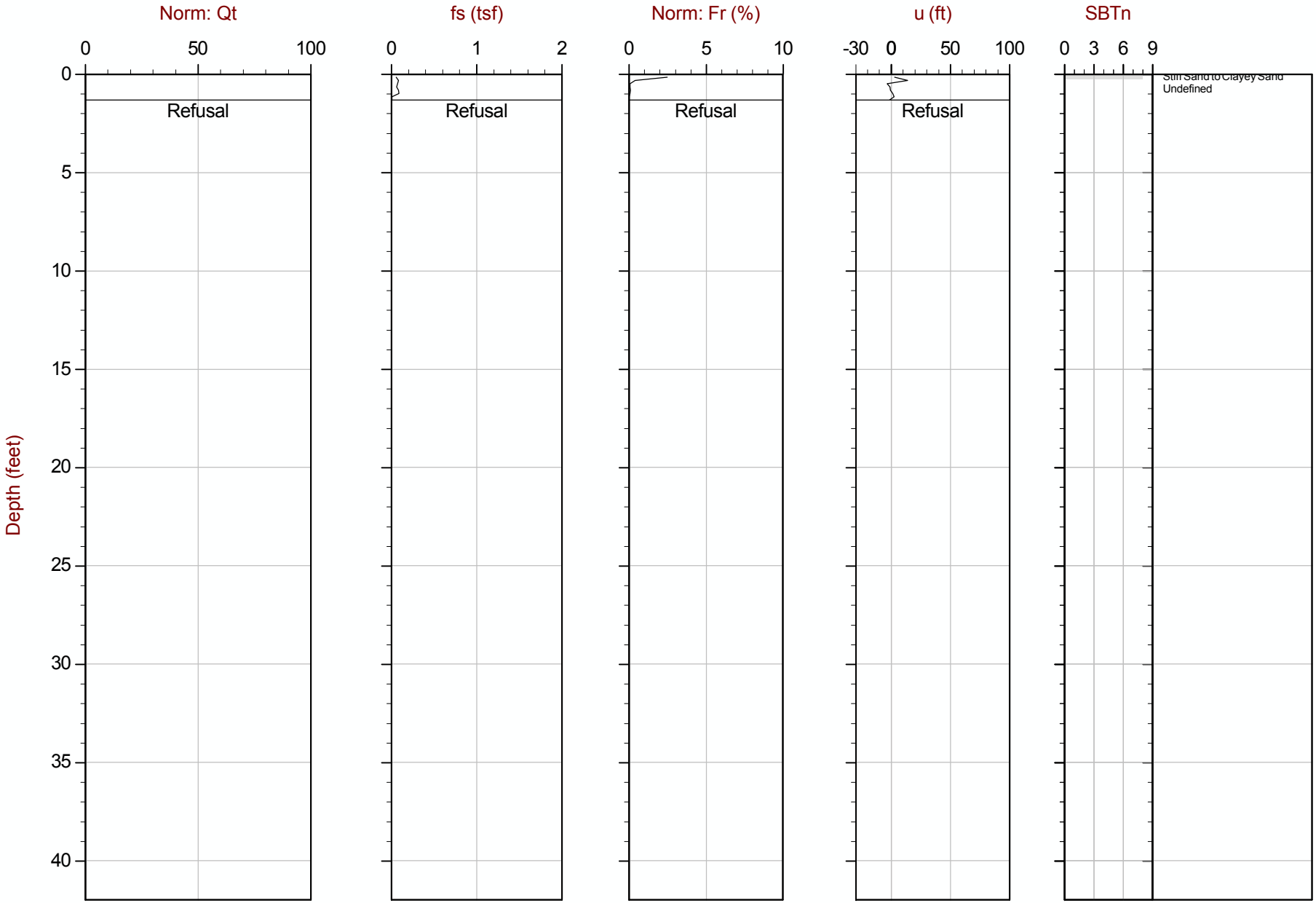
SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 18 N: 4494786 E: 566547

CONETEC

Michael Baker Jr.

Job No: 12-741
Date: 07:12:12 13:35
Site: Rahway Arch

Sounding: CPT-06
Cone: 302:T1500F15U500



Max Depth: 0.400 m / 1.31 ft
Depth Inc: 0.050 m / 0.164 ft

File: 741CP06.COR

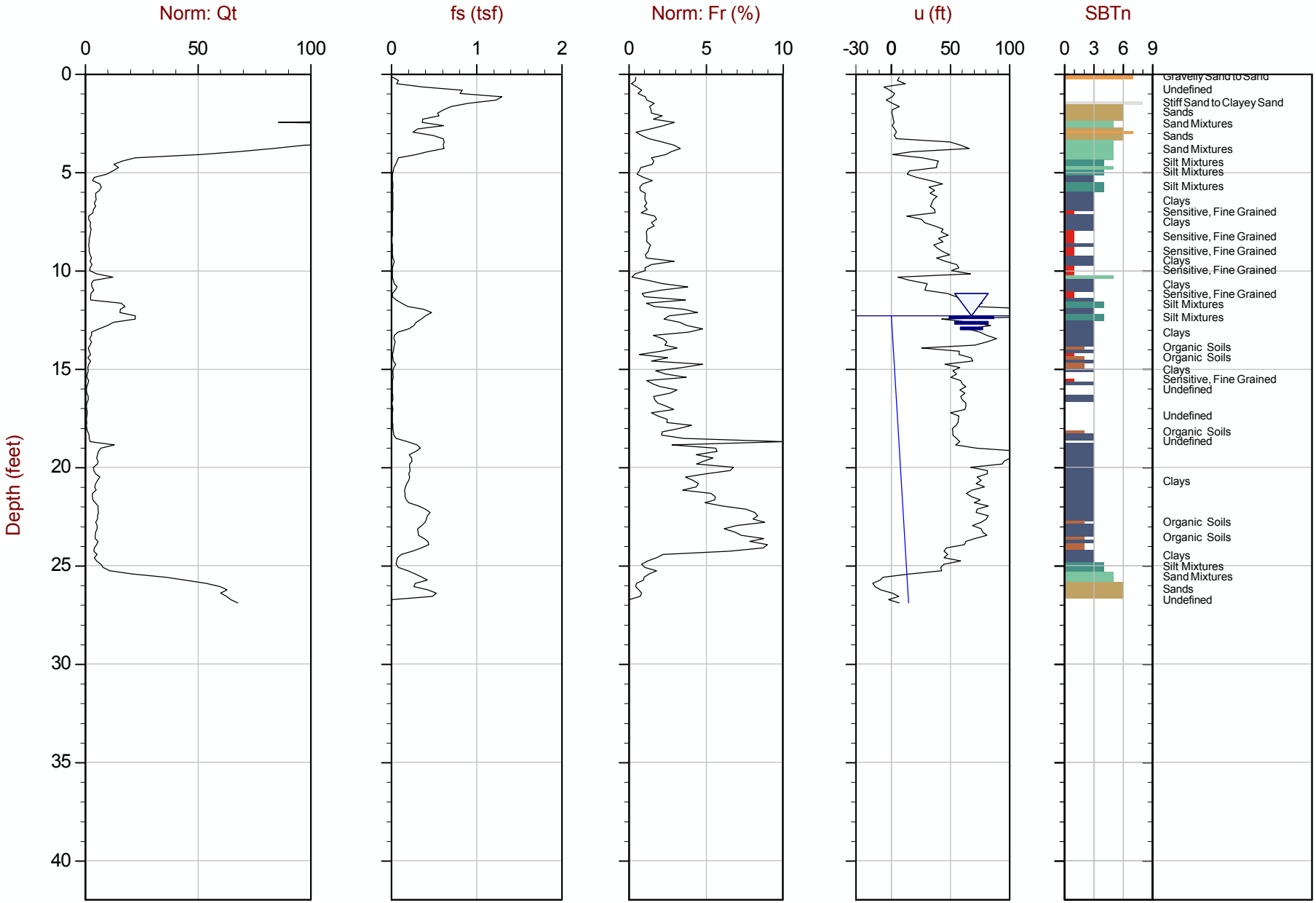
SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 18 N: 4494390 E: 566339

CONETEC

Michael Baker Jr.

Job No: 12-741
Date: 07:12:12 13:47
Site: Rahway Arch

Sounding: CPT-06A
Cone: 302:T1500F15U500



Max Depth: 8.200 m / 26.90 ft
Depth Inc: 0.050 m / 0.164 ft

File: 741CP06A.COR

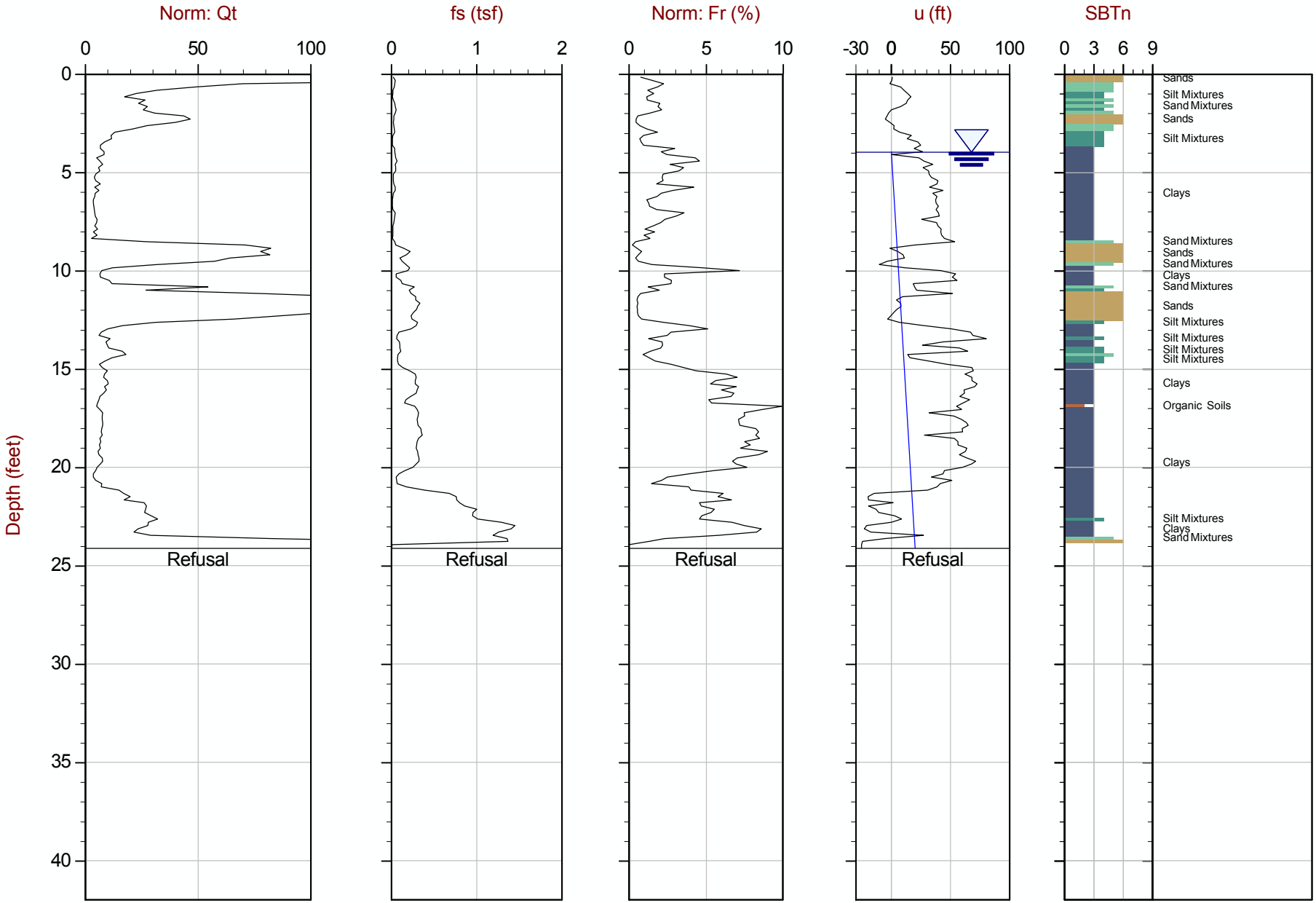
SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 18 N: 4494362 E: 566352

CONETEC

Michael Baker Jr.

Job No: 12-741
Date: 07:10:12 09:49
Site: Rahway Arch

Sounding: CPT-08
Cone: 302:T1500F15U500



Max Depth: 7.350 m / 24.11 ft
Depth Inc: 0.050 m / 0.164 ft

File: 741CP08.COR

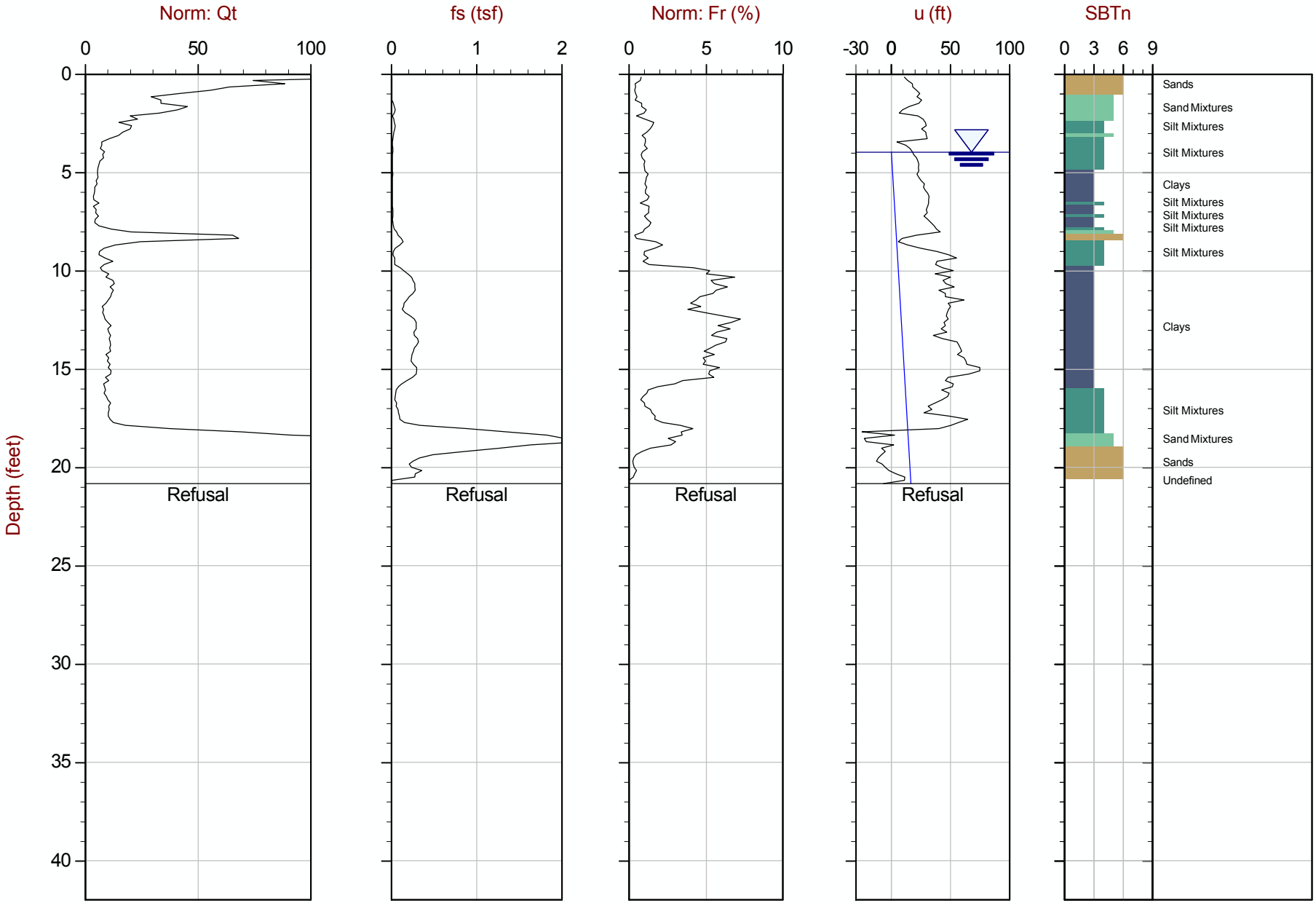
SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 18 N: 4494352 E: 566237

CONETEC

Michael Baker Jr.

Job No: 12-741
Date: 07:10:12 11:01
Site: Rahway Arch

Sounding: CPT-08A
Cone: 302:T1500F15U500



Max Depth: 6.350 m / 20.83 ft
Depth Inc: 0.050 m / 0.164 ft

File: 741CP08A.COR

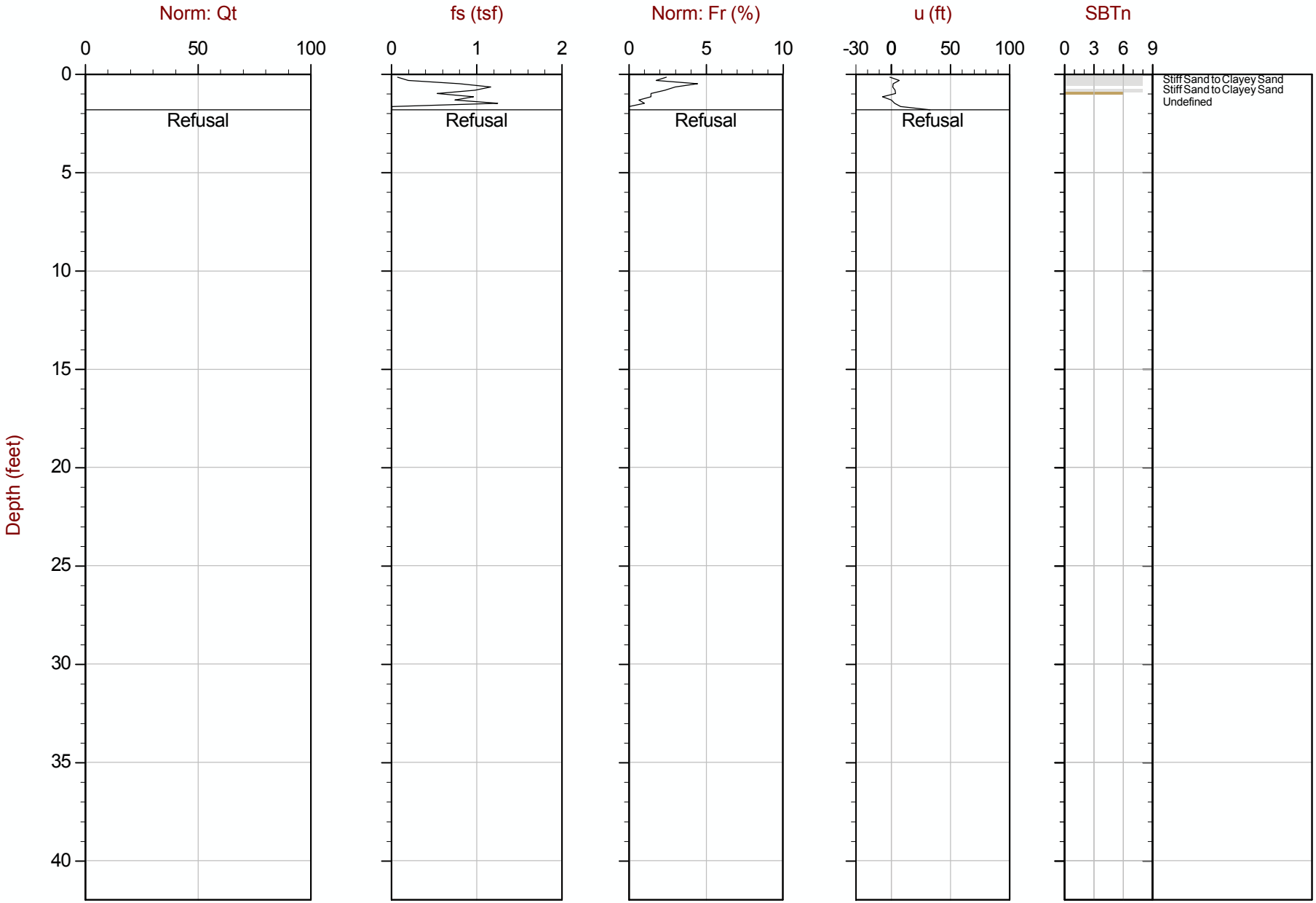
SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 18 N: 4494361 E: 566222

CONETEC

Michael Baker Jr.

Job No: 12-741
Date: 07:12:12 10:18
Site: Rahway Arch

Sounding: CPT-09
Cone: 302:T1500F15U500



Max Depth: 0.550 m / 1.80 ft
Depth Inc: 0.050 m / 0.164 ft

File: 741CP09.COR

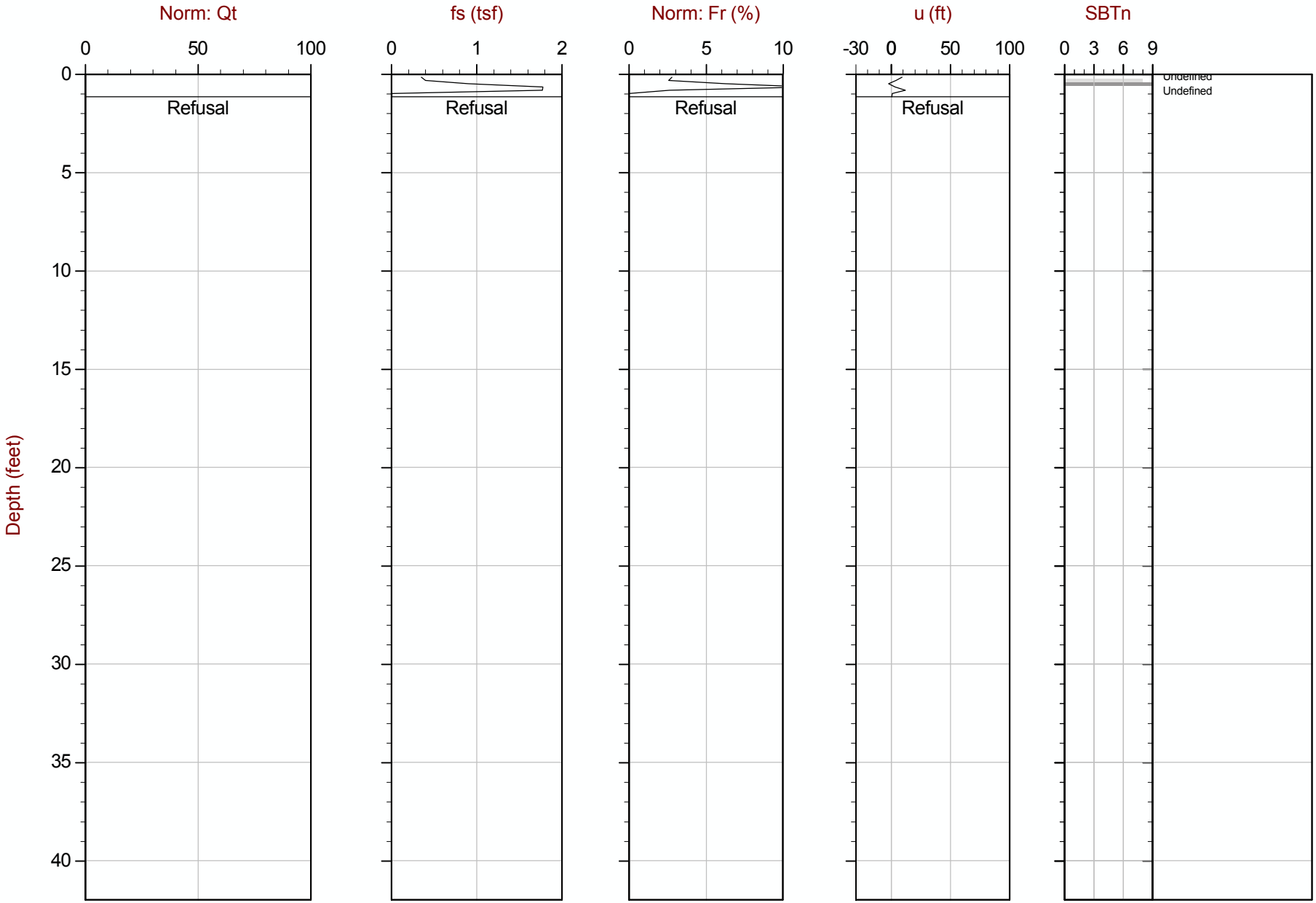
SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 18 N: 4494426 E: 566004

CONETEC

Michael Baker Jr.

Job No: 12-741
Date: 07:12:12 10:32
Site: Rahway Arch

Sounding: CPT-09A
Cone: 302:T1500F15U500



Max Depth: 0.350 m / 1.15 ft
Depth Inc: 0.050 m / 0.164 ft

File: 741CP09A.COR

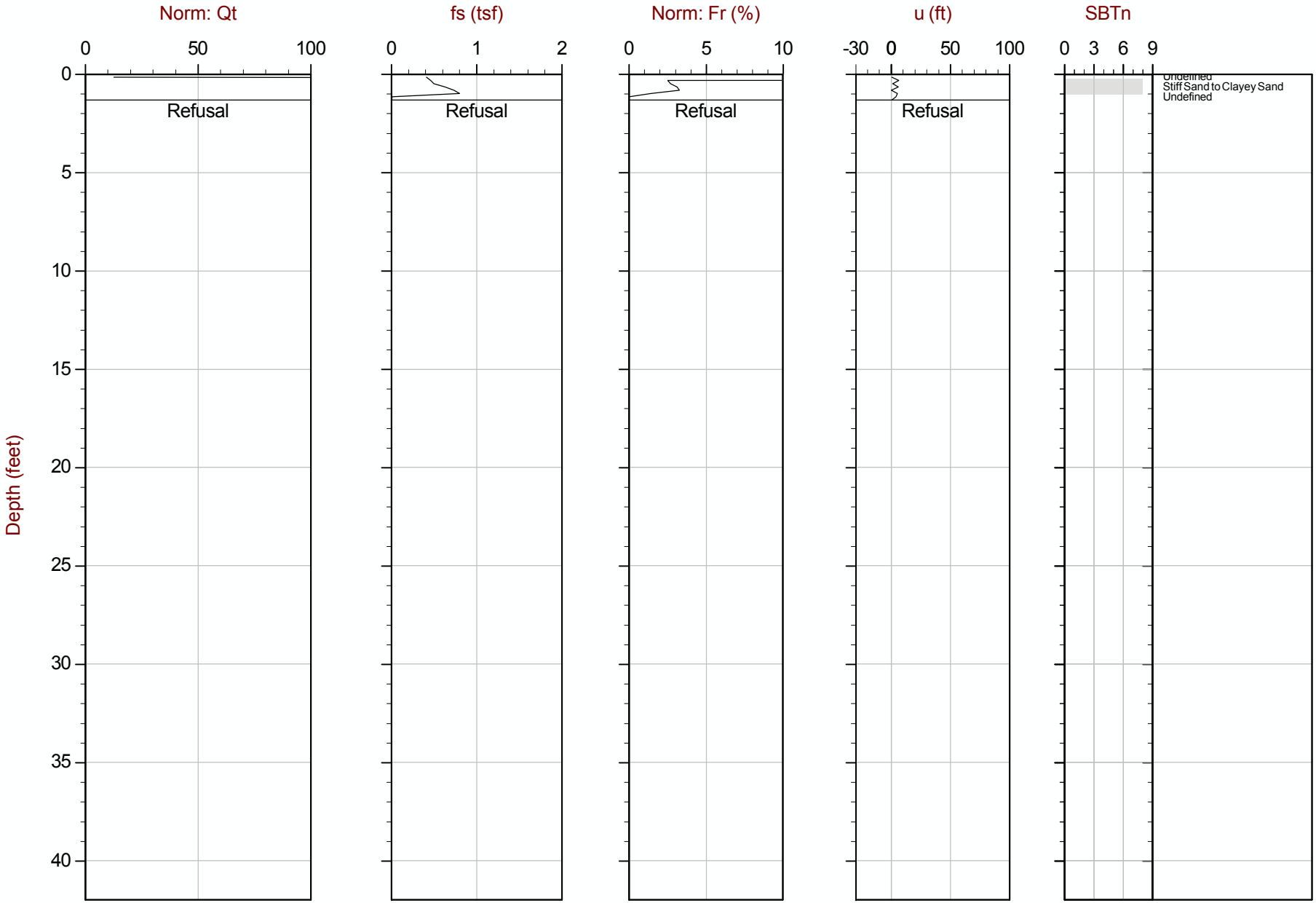
SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 18 N: 4494426 E: 566000

CONETEC

Michael Baker Jr.

Job No: 12-741
Date: 07:12:12 10:40
Site: Rahway Arch

Sounding: CPT-09B
Cone: 302:T1500F15U500



Max Depth: 0.400 m / 1.31 ft
Depth Inc: 0.050 m / 0.164 ft

File: 741CP09B.COR

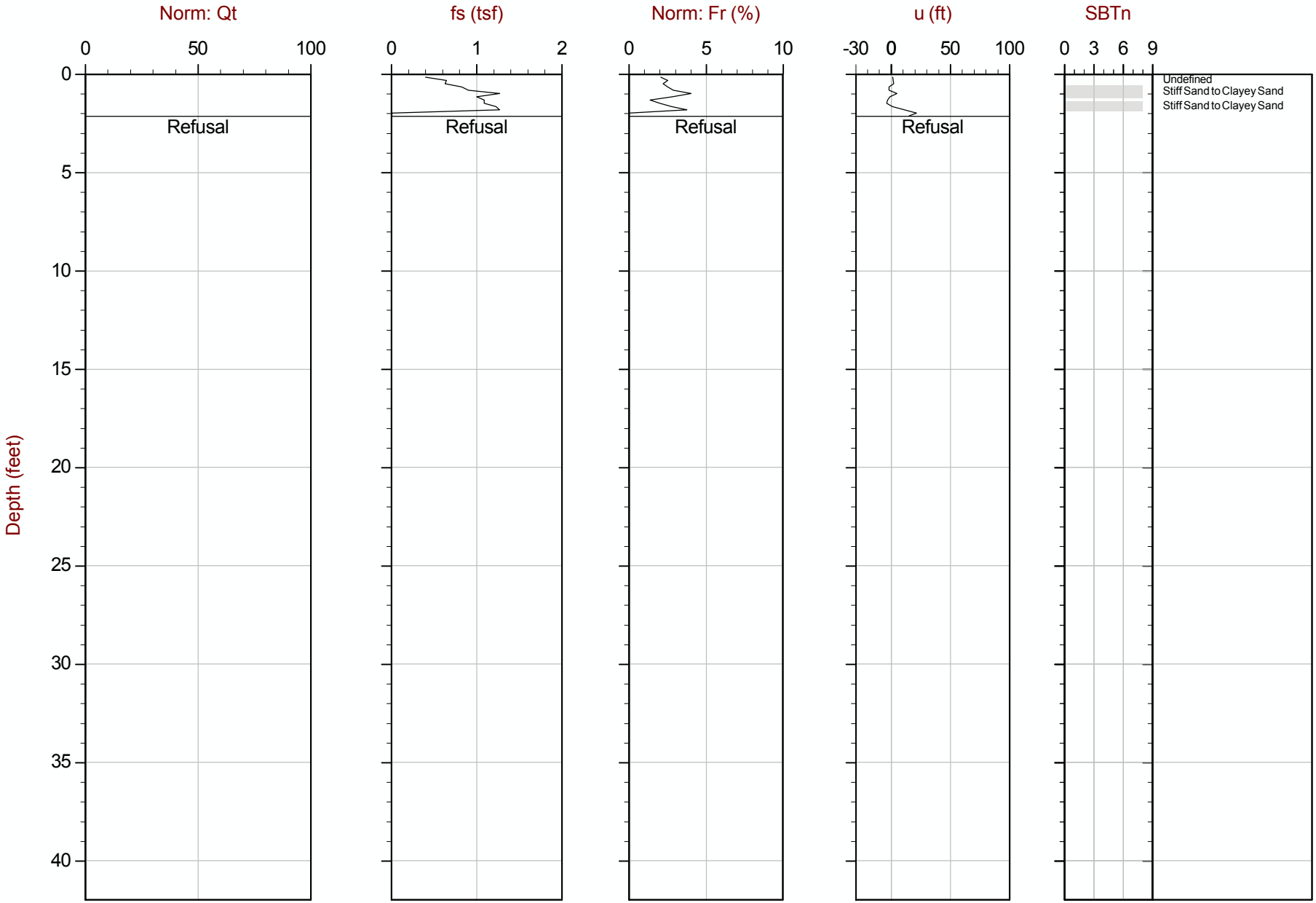
SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 18 N: 4494422 E: 566004

CONETEC

Michael Baker Jr.

Job No: 12-741
Date: 07:12:12 11:00
Site: Rahway Arch

Sounding: CPT-09C
Cone: 302:T1500F15U500



Max Depth: 0.650 m / 2.13 ft
Depth Inc: 0.050 m / 0.164 ft

File: 741CP09C.COR

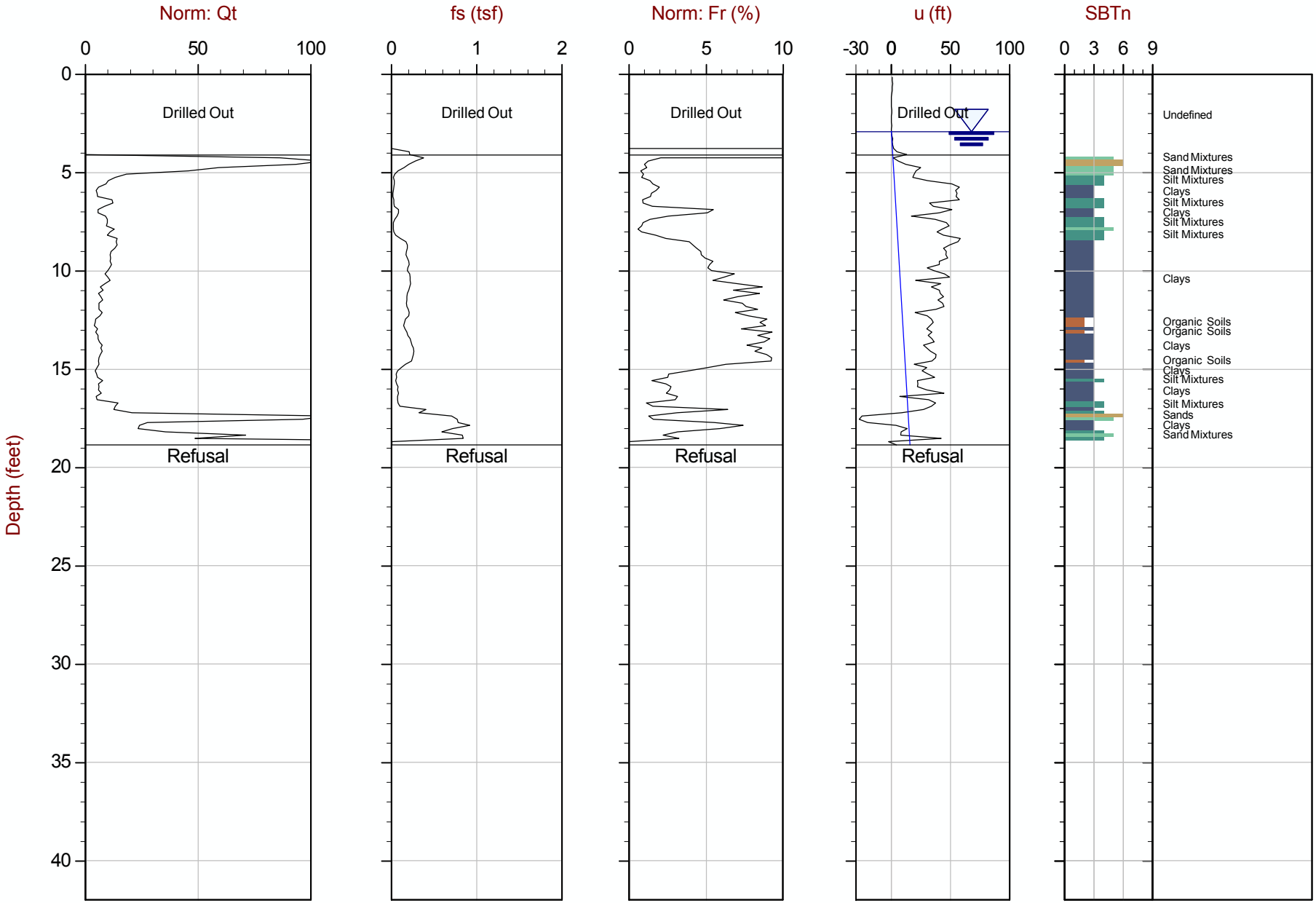
SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 18 N: 4494413 E: 566027

CONETEC

Michael Baker Jr.

Job No: 12-741
Date: 07:13:12 08:40
Site: Rahway Arch

Sounding: CPT-09D
Cone: 302:T1500F15U500



Max Depth: 5.750 m / 18.86 ft
Depth Inc: 0.050 m / 0.164 ft

File: 741CP09D.COR

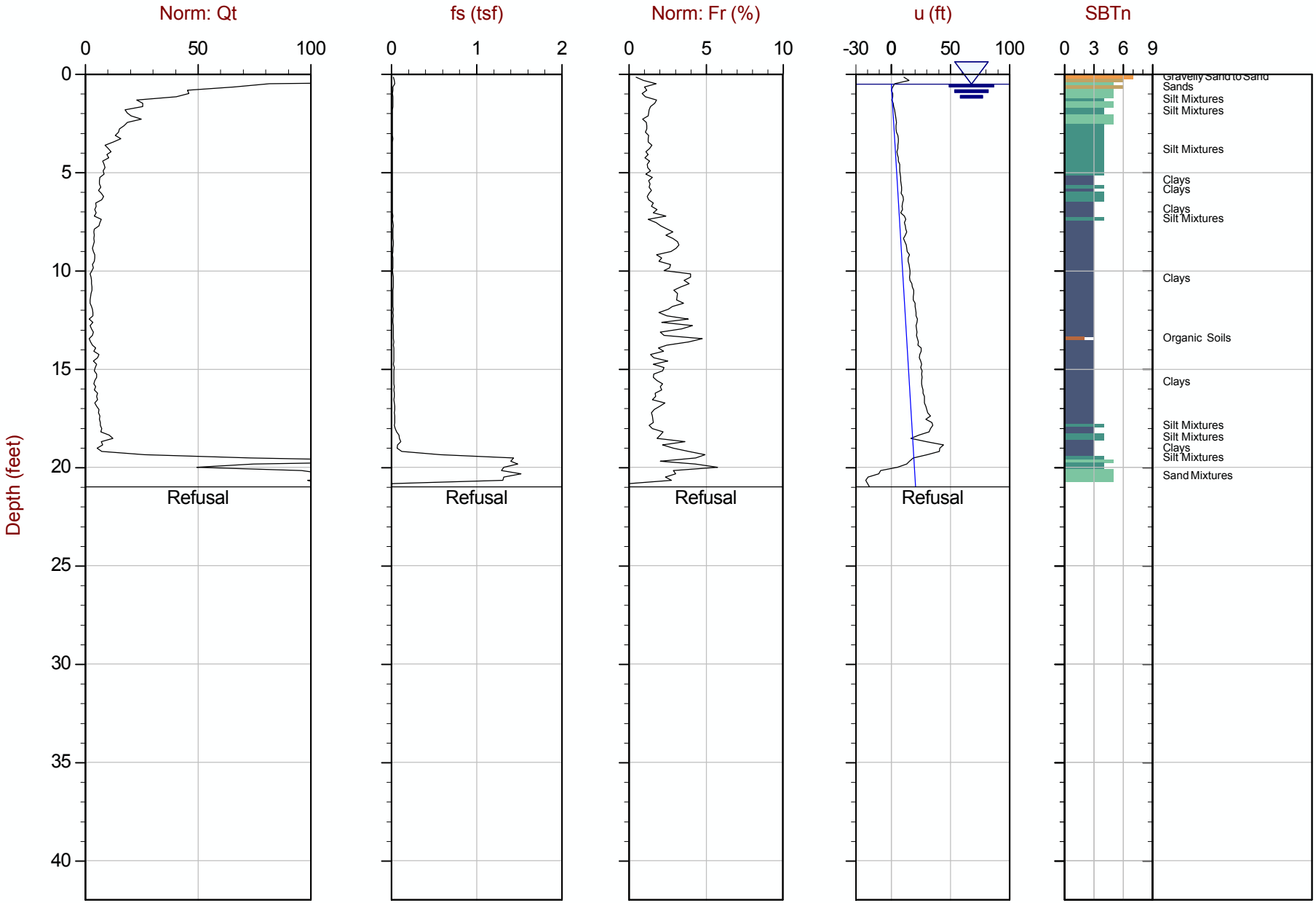
SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 18 N: 4494424 E: 566007

CONETEC

Michael Baker Jr.

Job No: 12-741
Date: 07:13:12 09:38
Site: Rahway Arch

Sounding: CPT-10
Cone: 302:T1500F15U500



Max Depth: 6.400 m / 21.00 ft
Depth Inc: 0.050 m / 0.164 ft

File: 741CP10.COR

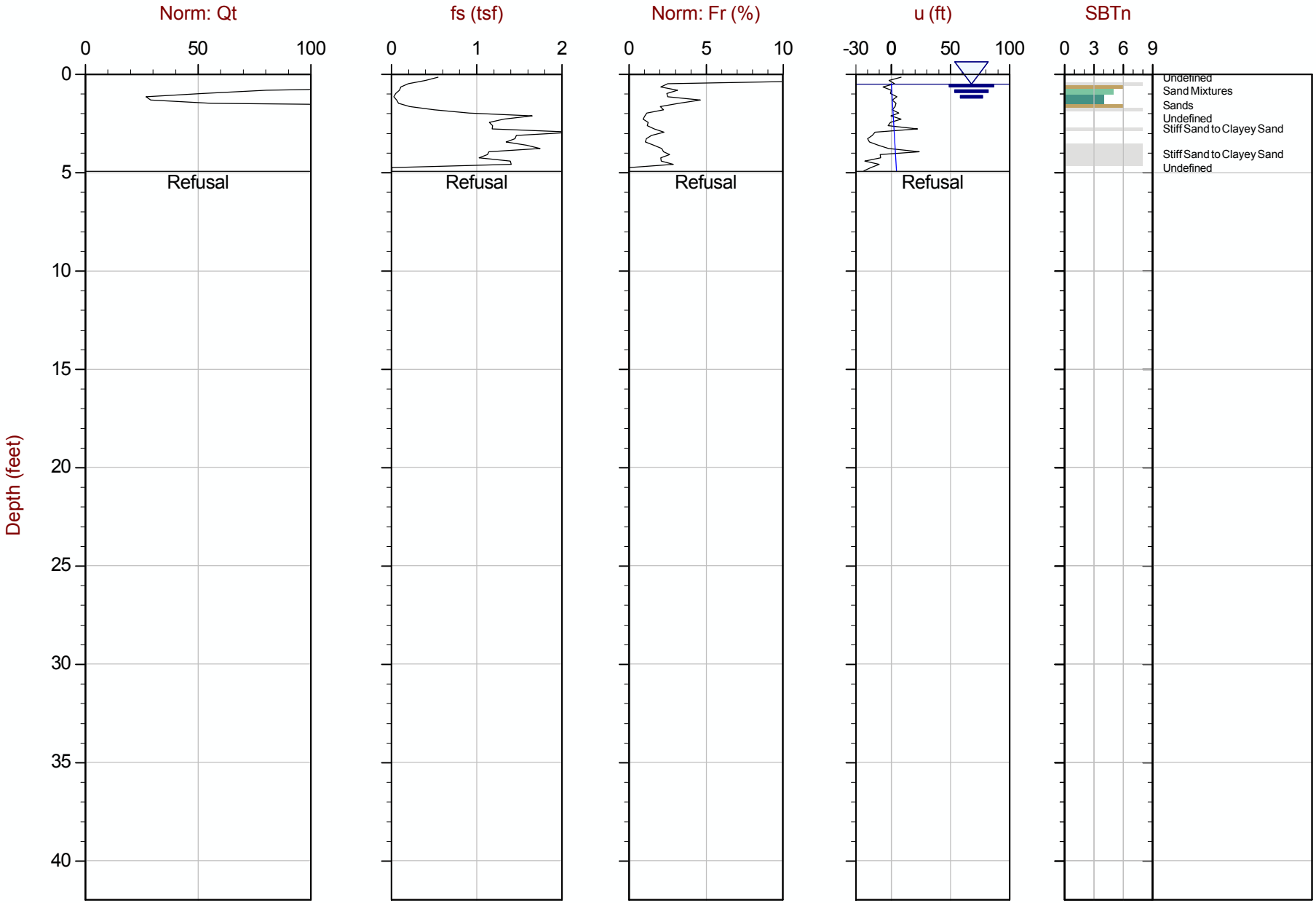
SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 18 N: 4494621 E: 566150

CONETEC

Michael Baker Jr.

Job No: 12-741
Date: 07:12:12 11:49
Site: Rahway Arch

Sounding: CPT-11
Cone: 302:T1500F15U500



Max Depth: 1.500 m / 4.92 ft
Depth Inc: 0.050 m / 0.164 ft

File: 741CP11.COR

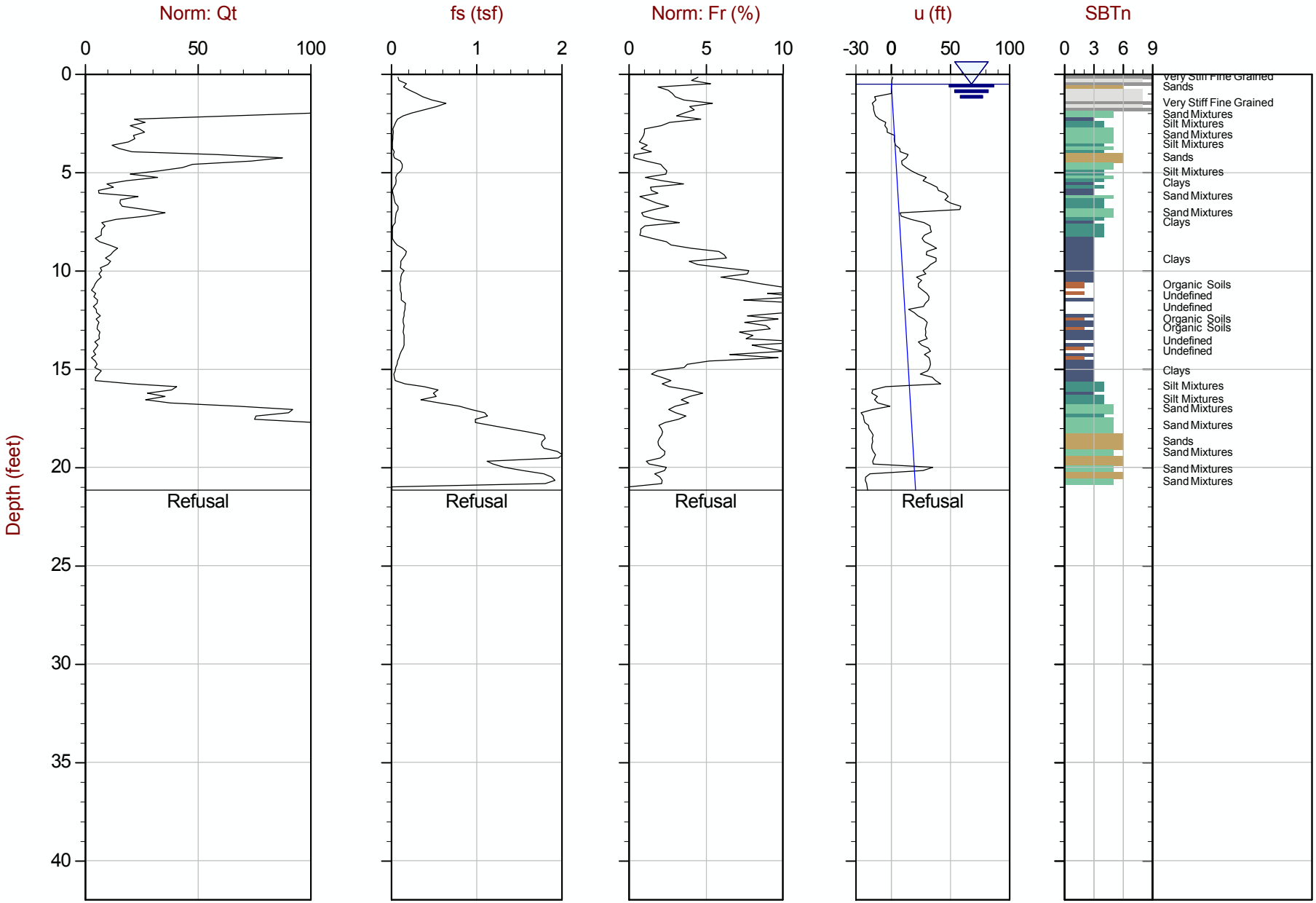
SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 18 N: 4494109 E: 566210

CONETEC

Michael Baker Jr.

Job No: 12-741
Date: 07:12:12 12:10
Site: Rahway Arch

Sounding: CPT-11A
Cone: 302:T1500F15U500



Max Depth: 6.450 m / 21.16 ft
Depth Inc: 0.050 m / 0.164 ft

File: 741CP11A.COR

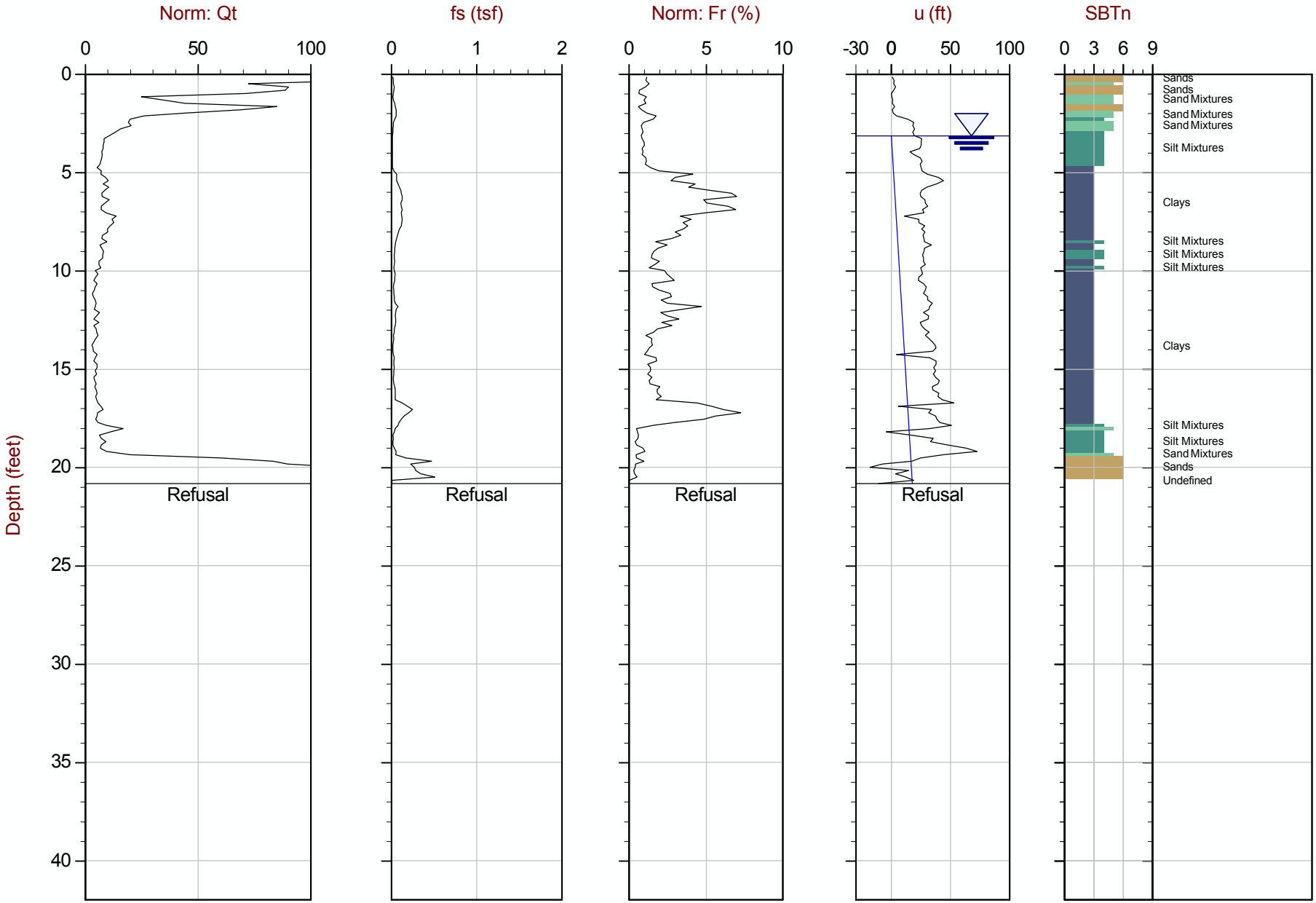
SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 18 N: 4494117 E: 566189

CONETEC

Michael Baker Jr.

Job No: 12-741
Date: 07:16:12 06:56
Site: Rahway Arch

Sounding: CPT-12
Cone: 302:T1500F15U500



Max Depth: 6.350 m / 20.83 ft
Depth Inc: 0.050 m / 0.164 ft

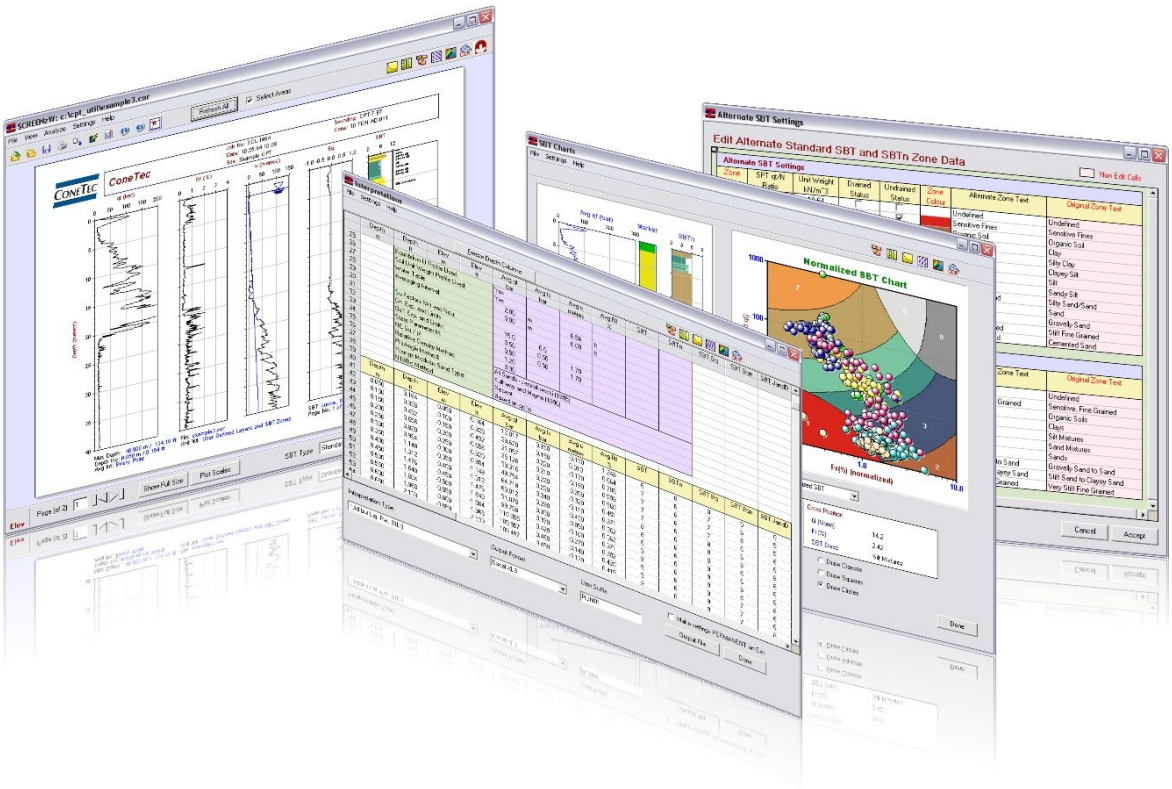
File: 741CP12.COR

SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 18 N: 4494164 E: 566559

Appendix B

CONETEC INTERPRETATION METHODS

A Detailed Description of the Methods Used in ConeTec's CPT Interpretation and Plotting Software



Revision SZW-Rev 05
January 16, 2011

Prepared by Jim Greig

ConeTec Interpretations as of January 16, 2011

ConeTec's interpretation routine provides a tabular output of geotechnical parameters based on current published CPT correlations and is subject to change to reflect the current state of practice. The interpreted values are not considered valid for all soil types. The interpretations are presented only as a guide for geotechnical use and should be carefully scrutinized for consideration in any geotechnical design. Reference to current literature is strongly recommended. ConeTec does not warranty the correctness or the applicability of any of the geotechnical parameters interpreted by the program and does not assume liability for any use of the results in any design or review. Representative hand calculations should be made for any parameter that is critical for design purposes. The end user of the interpreted output should also be fully aware of the techniques and the limitations of any method used in this program. The purpose of this document is to inform the user as to which methods were used and what the appropriate papers and/or publications are for further reference.

The CPT interpretations are based on values of tip, sleeve friction and pore pressure averaged over a user specified interval (e.g. 0.20m). Note that q_t is the tip resistance corrected for pore pressure effects and q_c is the recorded tip resistance. Since all ConeTec cones have equal end area friction sleeves, pore pressure corrections to sleeve friction, f_s, are not required.

The tip correction is: $q_t = q_c + (1-a) \cdot u_2$

where: q_t is the corrected tip resistance
q_c is the recorded tip resistance
u_2 is the recorded dynamic pore pressure behind the tip (u_2 position)
a is the Net Area Ratio for the cone (typically 0.80 for ConeTec cones)

The total stress calculations are based on soil unit weights that have been assigned to the Soil Behavior Type zones, from a user defined unit weight profile or by using a single value throughout the profile.

Effective vertical overburden stresses are calculated based on a hydrostatic distribution of equilibrium pore pressures below the water table or from a user defined equilibrium pore pressure profile (this can be obtained from CPT dissipation tests). For over water projects the effects of the column of water have been taken into account as has the appropriate unit weight of water. How this is done depends on where the instruments were zeroed (i.e. on deck or at mud line).

Details regarding the interpretation methods for all of the interpreted parameters are provided in Table 1. The appropriate references cited in Table 1 are listed in Table 2. Where methods are based on charts or techniques that are too complex to describe in this summary the user should refer to the cited material.

The estimated Soil Behavior Types (normalized and non-normalized) are based on the charts developed by Robertson and Campanella shown in Figures 1 and 2. Alternate classification charts, such as the Bq SBTcharts, are shown in Figure 3.

Where the results of a calculation/interpretation are declared *'invalid'* the value will be represented by the text strings "-9999" or "-9999.0". In some cases the value 0 will be used. Invalid results will occur because of (and not limited to) one or a combination of:

1. Invalid or undefined CPT data (e.g. drilled out section or data gap).

2. Where the interpretation method is inappropriate, for example, drained parameters in an undrained material (and vice versa).

3. Where interpretation input values are beyond the range of the referenced charts or specified limitations of the interpretation method.

4. Where pre-requisite or intermediate interpretation calculations are invalid.

The parameters selected for output from the program are often specific to a particular project. As such, not all of the interpreted parameters listed in Table 1 may be included in the output files delivered with this report.

The output files are provided in Microsoft Excel XLS format. The ConeTec software has several options for output depending on the number or types of interpreted parameters desired. Each output file will be named using the original COR file basename followed by a three or four letter indicator of the interpretation set selected (e.g. BSC, TBL, NLI or IFI) and possibly followed by an operator selected suffix identifying the characteristics of the particular interpretation run.

Table 1
CPT Interpretation Methods

Interpreted Parameter	Description	Equation	Ref
Depth	Mid Layer Depth *(where interpretations are done at each point then Mid Layer Depth = Recorded Depth)*	*Depth (Layer Top) + Depth (Layer Bottom) / 2.0*	
Elevation	Elevation of Mid Layer based on sounding collar elevation supplied by client	Elevation = Collar Elevation - Depth	
Avgqc	Averaged recorded tip value (q_c)	$Avgqc = \frac{1}{n}\sum_{i=1}^{n} q_c$ *n=1 when interpretations are done at each point*	
Avgqt	Averaged corrected tip (q_t) where: $q_t = q_c + (1-a) \bullet u$	$Avgqt = \frac{1}{n}\sum_{i=1}^{n} q_t$ *n=1 when interpretations are done at each point*	
Avgfs	Averaged sleeve friction (f_s)	$Avgfs = \frac{1}{n}\sum_{i=1}^{n} fs$ *n=1 when interpretations are done at each point*	
AvgRf	Averaged friction ratio (Rf) where friction ratio is defined as: $Rf = 100\% \bullet \frac{fs}{qt}$	$AvgRf = 100\% \cdot \frac{Avgfs}{Avgqt}$ *n=1 when interpretations are done at each point*	
Avgu	Averaged dynamic pore pressure *(u)*	$Avgu = \frac{1}{n}\sum_{i=1}^{n} u_i$ *n=1 when interpretations are done at each point*	
AvgRes	Averaged Resistivity (this data is not always available since it is a specialized test requiring an additional module)	$Avgu = \frac{1}{n}\sum_{i=1}^{n} RESISTIVITY_i$ *n=1 when interpretations are done at each point*	
AvgUVIF	Averaged UVIF ultra-violet induced fluorescence (this data is not always available since it is a specialized test requiring an additional module)	$Avgu = \frac{1}{n}\sum_{i=1}^{n} UVIF_i$ *n=1 when interpretations are done at each point*	
AvgTemp	Averaged Temperature (this data is not always available since it is a specialized test)	$Avgu = \frac{1}{n}\sum_{i=1}^{n} TEMPERATURE_i$ *n=1 when interpretations are done at each point*	
AvgGamma	Averaged Gamma Counts (this data is not always available since it is a specialized test requiring an additional module)	$Avgu = \frac{1}{n}\sum_{i=1}^{n} GAMMA_i$ *n=1 when interpretations are done at each point*	
SBT	Soil Behavior Type as defined by Robertson and Campanella	See Figure 1	2, 5

Interpreted Parameter	Description	Equation	Ref
U.Wt.	Unit Weight of soil determined from one of the following user selectable options: 1) uniform value 2) value assigned to each SBT zone 3) user supplied unit weight profile	See references	5
T. Stress σ_v	Total vertical overburden stress at Mid Layer Depth. *A layer is defined as the averaging interval specified by the user. For data interpreted at each point the Mid Layer Depth is the same as the recorded depth.*	$TStress = \sum_{i=1}^{n} \gamma_i h_i$ *where* γ_i is layer unit weight h_i is layer thickness	
E. Stress σ_v'	Effective vertical overburden stress at Mid Layer Depth	$Estress = Tstress - u_{eq}$	
Ueq	Equilibrium pore pressure determined from one of the following user selectable options: 1) hydrostatic from water table depth 2) user supplied profile	For hydrostatic option: $u_{eq} = \gamma_w \cdot (D - D_{wt})$ where u_{eq} is equilibrium pore pressure γ_w is unit weight of water D is the current depth D_{wt} is the depth to the water table	
Cn	SPT N_{60} overburden correction factor	$Cn=(\sigma_v')^{-0.5}$ where σ_v' *is in tsf* $0.5 < C_n < 2.0$	
N_{60}	SPT N value at 60% energy calculated from qt/N ratios assigned to each SBT zone. This method has abrupt N value changes at zone boundaries.	*See Figure 1*	4, 5
$(N_1)_{60}$	SPT N_{60} value corrected for overburden pressure	$(N_1)_{60} = Cn \cdot N_{60}$	4
$N_{60}I_c$	SPT N_{60} values based on the Ic parameter	$(qt/pa)/ N_{60} = 8.5 (1 – Ic/4.6)$	5
$(N_1)_{60}Ic$	SPT N_{60} value corrected for overburden pressure (using N_{60} I_c). User has 2 options.	1) $(N_1)_{60}Ic= Cn \cdot (N_{60}\, Ic)$ 2) $q_{c1n}/ (N_1)_{60}Ic = 8.5 (1 – Ic/4.6)$	4 5
$(N_1)_{60cs}Ic$	Clean sand equivalent SPT $(N_1)_{60}Ic$. User has 3 options.	1) $(N_1)_{60cs}Ic = \alpha + \beta((N_1)_{60}Ic)$ 2) $(N_1)_{60cs}Ic = K_{SPT} * ((N_1)_{60}Ic)$ 3) $q_{c1ncs})/ (N_1)_{60cs}Ic = 8.5 (1 – Ic/4.6)$ FC ≤ 5%: $\alpha = 0$, $\beta=1.0$ FC ≥ 35% $\alpha = 5.0$, $\beta=1.2$ 5% < FC < 35% $\alpha = \exp[1.76 – (190/FC^2)]$ $\beta = [0.99 + (FC^{1.5}/1000)]$	10 10 5
Su	Undrained shear strength based on q_t Su factor N_{kt} is user selectable	$Su = \frac{qt - \sigma_v}{N_{kt}}$	1, 5
Su	Undrained shear strength based on pore pressure Su factor $N_{\Delta u}$ is user selectable	$Su = \frac{u_2 - u_{eq}}{N_{\Delta u}}$	1, 5
k	Coefficient of permeability (assigned to each SBT zone)		5
Bq	Pore pressure parameter	$Bq = \frac{\Delta u}{qt - \sigma_v}$ *where:* $\Delta u = u - u_{eq}$ *and* u = *dynamic pore pressure* u_{eq} = *equilibrium pore pressure*	1, 5

Interpreted Parameter	Description	Equation	Ref
Q_t	Normalized q_t for Soil Behavior Type classification as defined by Robertson, 1990	$Qt = \frac{qt - \sigma_v}{\sigma'_v}$	2, 5
F_r	Normalized Friction Ratio for Soil Behavior Type classification as defined by Robertson, 1990	$Fr = 100\% \cdot \frac{fs}{qt - \sigma_v}$	2, 5
Net qt	Net tip resistance	$qt - \sigma_v$	
qe	Effective tip resistance	$qt - u_2$	
qeNorm	Normalized effective tip resistance	$\frac{qt - u_2}{\sigma'_v}$	
SBTn	Normalized Soil Behavior Type as defined by Robertson and Campanella	See Figure 2	2, 5
SBT-BQ	Non-normalized Soil Behavior type based on the Bq parameter	See Figure 3	2, 5
SBT-BQn	Normalized Soil Behavior based on the Bq parameter	See Figure 3	2, 5
SBT-JandD	Soil Behaviour Type as defined by Jeffries and Davies	See Figure 3	7
SBT-BQn	Normalized Soil Behavior base on the Bq parameter	See Figure 3	2, 5
I_c	Soil index for estimating grain characteristics	$Ic = [(3.47 - \log_{10}Q)^2 + (\log_{10} Fr + 1.22)^2]^{0.5}$ *Where:* $Q = \left(\frac{qt - \sigma_v}{P_{a2}}\right)\left(\frac{P_a}{\sigma'_v}\right)^n$ *And* *Fr is in percent* *P_a = atmospheric pressure* *P_{a2} = atmospheric pressure* *n varies from 0.5 to 1.0 and is selected in an iterative manner based on the resulting I_c*	3, 8
FC	Apparent fines content (%)	*$FC=1.75(Ic^{3.25}) - 3.7$* *FC=100 for Ic > 3.5* *FC=0 for Ic < 1.26* *FC = 5% if 1.64 < Ic < 2.6 AND F_r<0.5*	3
Ic Zone	This parameter is the Soil Behavior Type zone based on the Ic parameter (valid for zones 2 through 7 on SBTn chart)	Ic < 1.31 Zone = 7 1.31 < Ic < 2.05 Zone = 6 2.05 < Ic < 2.60 Zone = 5 2.60 < Ic < 2.95 Zone = 4 2.95 < Ic < 3.60 Zone = 3 Ic > 3.60 Zone = 2	3
PHI ϕ	Friction Angle determined from one of the following user selectable options: a) Campanella and Robertson b) Durgunoglu and Mitchel c) Janbu d) Kulhawy and Mayne	See reference	5 5 5 11
Dr	Relative Density determined from one of the following user selectable options: a) Ticino Sand b) Hokksund Sand c) Schmertmann 1976 d) Jamiolkowski - All Sands	See reference	5

Interpreted Parameter	Description	Equation	Ref
OCR	Over Consolidation Ratio	a) Based on Schmertmann's method involving a plot of S_u/σ_v' /($S_u/\sigma_v')_{NC}$ and OCR where the Su/p' ratio for NC clay is user selectable	9
State Parameter	The state parameter is used to describe whether a soil is contractive (SP is positive) or dilative (SP is negative) at large strains based on the work by Been and Jefferies	See reference	8, 6, 5
Es/qt	Intermediate parameter for calculating Young's Modulus, E, in sands. It is the Y axis of the reference chart.	Based on Figure 5.59 in the reference	5
Young's Modulus E	Young's Modulus based on the work done in Italy. There are three types of sands considered in this technique. The user selects the appropriate type for the site from: a) OC Sands b) Aged NC Sands c) Recent NC Sands Each sand type has a family of curves that depend on mean normal stress. The program calculates mean normal stress and linearly interpolates between the two extremes provided in the Es/qt chart.	Mean normal stress is evaluated from: $\sigma'_m = \frac{1}{3}\left(\sigma'_v + \sigma'_h + \sigma'_h\right)^3$ where σ_v'= vertical effective stress σ_h'= horizontal effective stress and $\sigma_h = K_o \cdot \sigma_v'$ with Ko assumed to be 0.5	5
q_{c1}	q_t normalized for overburden stress used for seismic analysis	$q_{c1} = q_t \cdot (Pa/\sigma_v')^{0.5}$ where: Pa = atm. Pressure q_t is in MPa	3
q_{c1n}	q_{c1} in dimensionless form used for seismic analysis	$q_{c1n} = (q_{c1} / Pa)(Pa/\sigma_v')^n$ where: Pa = atm. Pressure and n ranges from 0.5 to 0.75 based on Ic.	3
K_{SPT}	Equivalent clean sand factor for $(N_1)60$	$K_{SPT} = 1 + ((0.75/30) \cdot (FC - 5))$	10
K_{CPT}	Equivalent clean sand correction for q_{c1N}	$K_{cpt} = 1.0$ for $I_c \leq 1.64$ $K_{cpt} = f(I_c)$ for $I_c > 1.64$ (see reference)	10
q_{c1ncs}	Clean sand equivalent q_{c1n}	$q_{c1ncs} = q_{c1n} \cdot K_{cpt}$	3
CRR	Cyclic Resistance Ratio (for Magnitude 7.5)	$q_{c1ncs} < 50$: $CRR_{7.5} = 0.833\ [(q_{c1ncs}/1000] + 0.05$ $50 \leq q_{c1ncs} < 160$: $CRR_{7.5} = 93\ [(q_{c1ncs}/1000]^3 + 0.08$	10
CSR	Cyclic Stress Ratio	$CSR = (\tau_{av}/\sigma_v') = 0.65\ (a_{max} / g)\ (\sigma_v/ \sigma_v')\ r_d$ $r_d = 1.0 - 0.00765\ z$ $z \leq 9.15$m $r_d = 1.174 - 0.0267\ z$ $9.15 < z \leq 23$m $r_d = 0.744 - 0.008\ z$ $23 < z \leq 30$m $r_d = 0.50$ $z > 30$m	10

Interpreted Parameter	Description	Equation	Ref
MSF	Magnitude Scaling Factor	See Reference	10
FofS	Factor of Safety against Liquefaction	FS = ($CRR_{7.5}$ / CSR) MSF	10
Liquefaction Status	Statement indicating possible liquefaction	Takes into account FofS and limitations based on I_c and q_{c1ncs}.	10
Cont/Dilat Tip	Contractive / Dilative qc1 Boundary based on $(N_1)_{60}$	$(\sigma_v')_{boundary} = 9.58 \times 10^{-4} [(N_1)_{60}]^{-4.79}$ qc1 is calculated from specified qt(MPa)/N ratio	11
Su(Liq)/s'v	Liquefied Shear Strength Ratio	$\frac{Su(Liq)}{\sigma_v'} = 0.03 + 0.0143(q_{c1})$	12

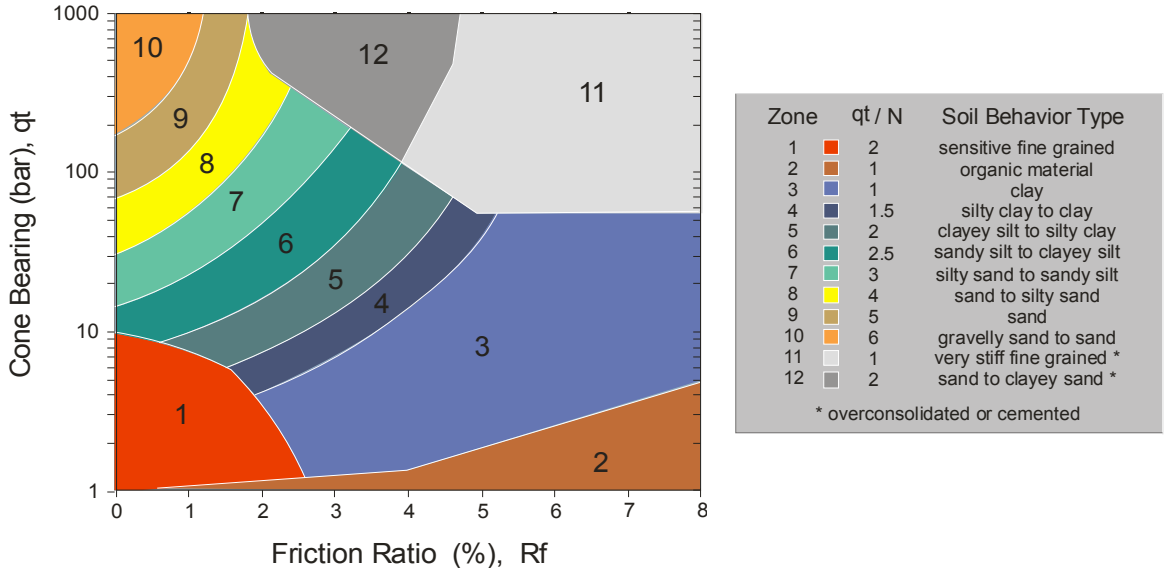


Figure 1 Non-Normalized Behavior Type Classification Chart

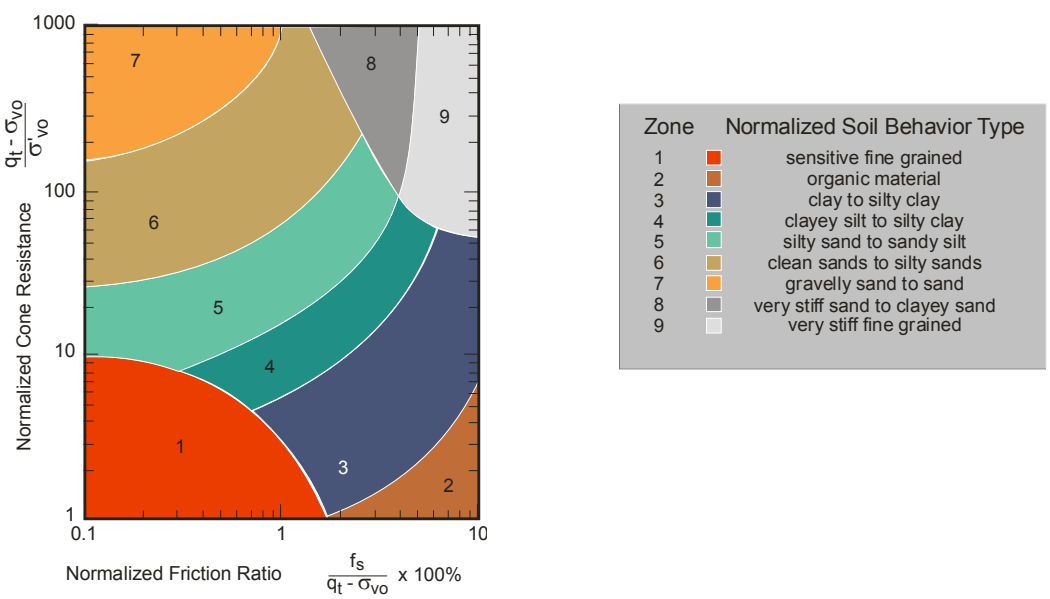


Figure 2 Normalized Behavior Type Classification Chart

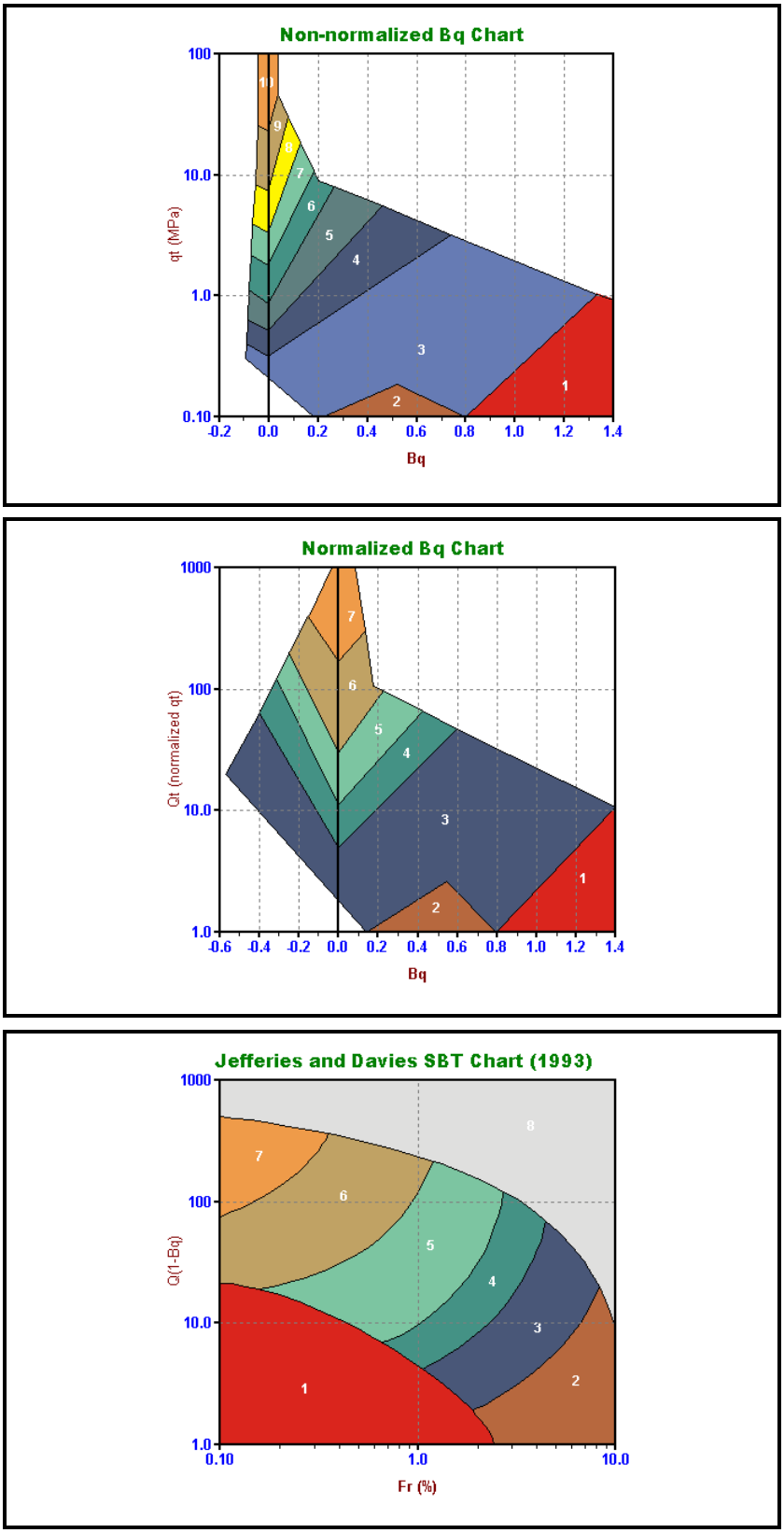


Figure 3 – Alternate Soil Behaviour Type Charts

Table 2 References

No.	References
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2	Robertson, P.K., 1990, "Soil Classification Using the Cone Penetration Test", Canadian Geotechnical Journal, Volume 27.
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5	Lunne, T., Robertson, P.K. and Powell, J. J. M., 1997, " Cone Penetration Testing in Geotechnical Practice," Blackie Academic and Professional.
6	Plewes, H.D., Davies, M.P. and Jefferies, M.G., 1992, "CPT Based Screening Procedure for Evaluating Liquefaction Susceptibility", 45th Canadian Geotechnical Conference, Toronto, Ontario, October 1992.
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10	Proceedings of theNCEER Workshop on Evaluation of Liquefaction Resistance of Soils, Salt LakeCity, 1996. Chaired by Leslie Youd. 11
11	Kulhawy, F.H. and Mayne, P.W. ,1990, "Manual on Estimating Soil Properties for Foundation Design, *Report No. EL-6800"*, Electric Power Research Institute, Palo Alto, CA, August 1990, 306 p.
12	Oslon, Scott M. and Stark, Timothy D., 2003, "Yield Strength Ratio and Liquefaction Analysis of Slopes and Embankments", Journal of Geotechnical and Geoenvironmental Engineering, ASCE, August 2003.

Appendix C

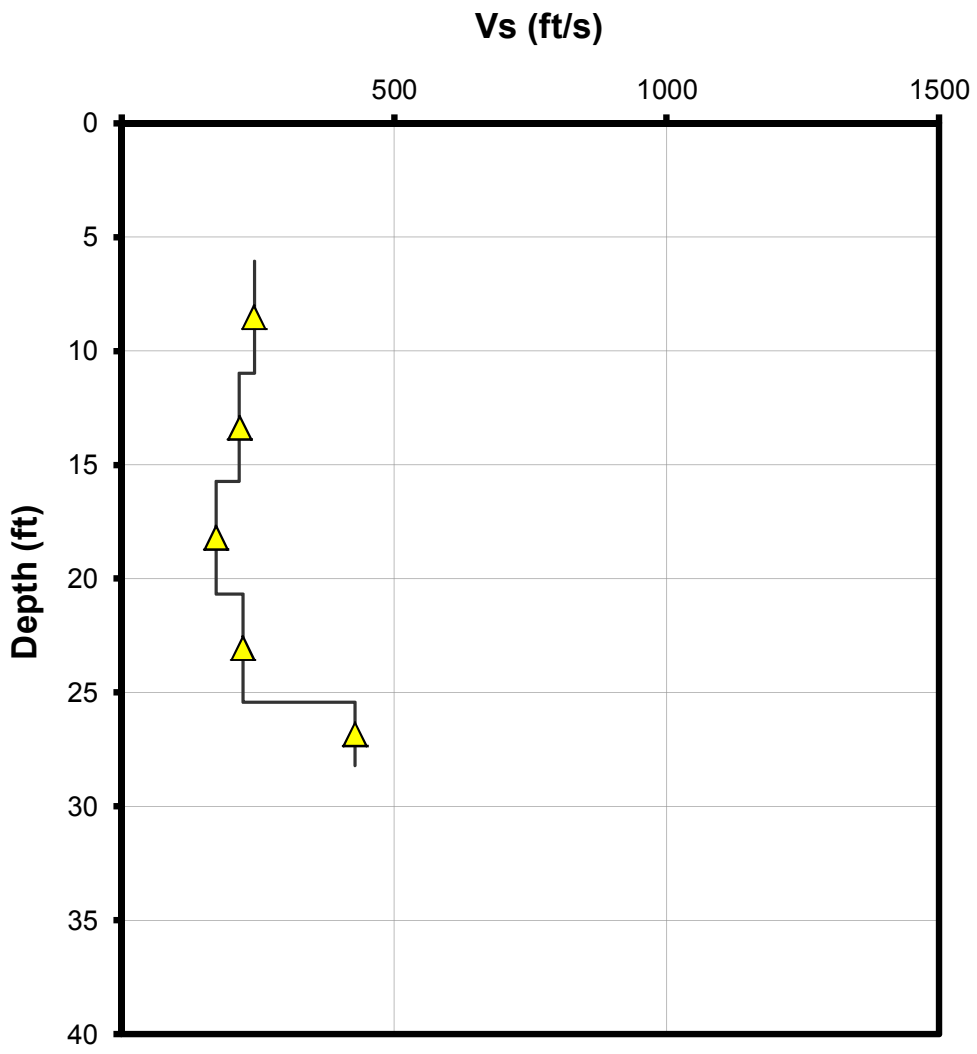
Job No	12-741
Client	Michael Baker Jr.
Project Title	Rahway Arch
Hole	CPT-01
Site	Carteret, New Jersey
Date	7/12/2012

Seismic Source:	Beam	
Source Offset:	4.50	(ft)
Source Depth:	0.00	(ft)
Geophone Offset:	0.66	(ft)

SEISMIC TEST RESULTS - Vs

Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Depth Interval (ft)	Time Interval (ms)	Mid-layer Depth (ft)	Vs Interval Velocity (ft/s)
6.73	6.07	7.56				
11.65	10.99	11.88	4.32	17.77	8.53	243
16.40	15.74	16.37	4.50	20.81	13.37	216
21.33	20.67	21.16	4.78	27.58	18.21	173
26.08	25.42	25.82	4.66	20.98	23.05	222
28.87	28.21	28.57	2.75	6.43	26.82	428

Job No: 12-741
Client: Michael Baker Jr.
Project: Rahway Arch
Sounding: CPT-01
Date: July 12, 2012



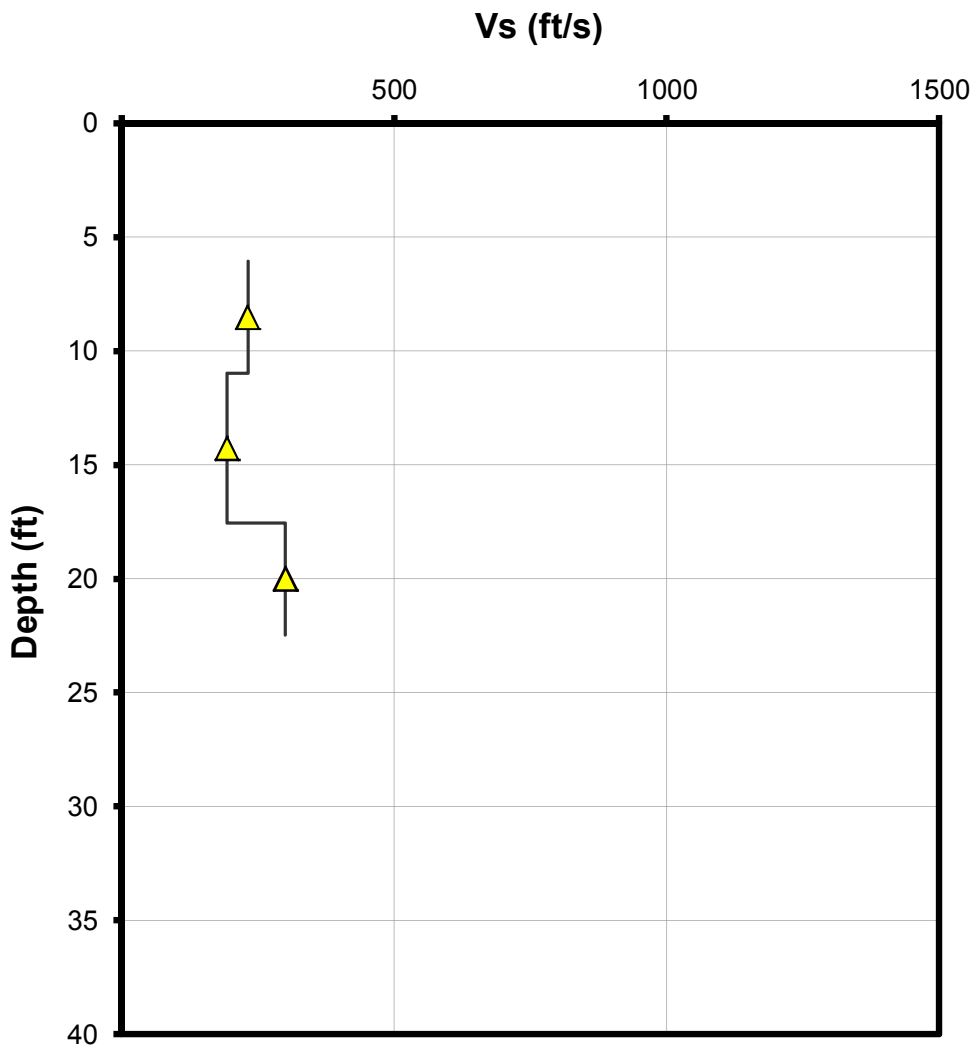
Job No	12-741
Client	Michael Baker Jr.
Project Title	Rahway Arch
Hole	CPT-02
Site	Carteret, New Jersey
Date	7/13/2012

Seismic Source:	Beam	
Source Offset:	4.50	(ft)
Source Depth:	0.00	(ft)
Geophone Offset:	0.66	(ft)

SEISMIC TEST RESULTS - Vs

Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Depth Interval (ft)	Time Interval (ms)	Mid-layer Depth (ft)	Vs Interval Velocity (ft/s)
6.73	6.07	7.56				
11.65	10.99	11.88	4.32	18.65	8.53	232
18.21	17.55	18.12	6.24	32.31	14.27	193
23.13	22.47	22.92	4.80	15.97	20.01	300

Job No: 12-741
Client: Michael Baker Jr.
Project: Rahway Arch
Sounding: CPT-02
Date: July 13, 2012



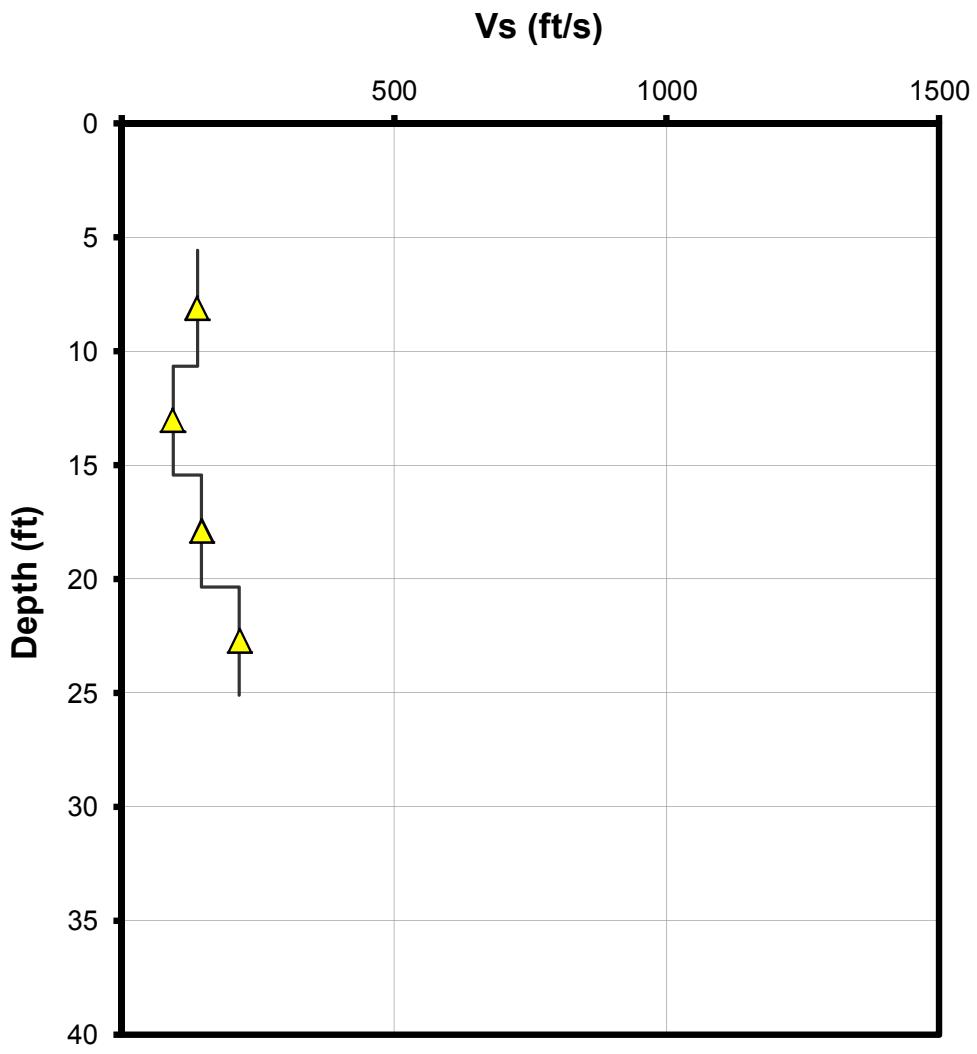
Job No	12-741
Client	Michael Baker Jr.
Project Title	Rahway Arch
Hole	CPT-04
Site	Carteret, New Jersey
Date	7/10/2012

Seismic Source:	Beam	
Source Offset:	4.50	(ft)
Source Depth:	0.00	(ft)
Geophone Offset:	0.66	(ft)

SEISMIC TEST RESULTS - Vs

Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Depth Interval (ft)	Time Interval (ms)	Mid-layer Depth (ft)	Vs Interval Velocity (ft/s)
6.23	5.57	7.16				
11.32	10.66	11.57	4.41	31.73	8.12	139
16.08	15.42	16.07	4.49	47.80	13.04	94
21.00	20.34	20.84	4.77	32.57	17.88	146
25.75	25.09	25.49	4.66	21.57	22.72	216

Job No: 12-741
Client: Michael Baker Jr.
Project: Rahway Arch
Sounding: CPT-04
Date: July 10, 2012



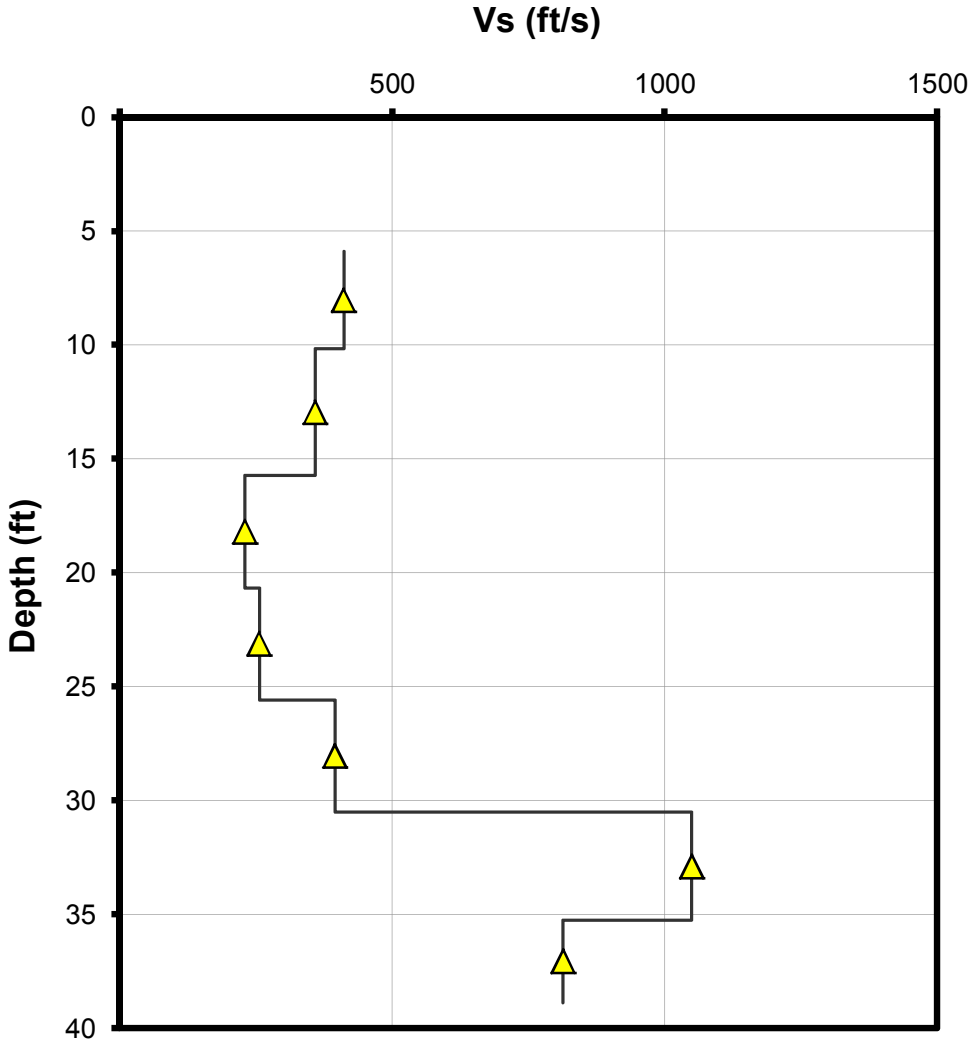
Job No	12-741
Client	Michael Baker Jr.
Project Title	Rahway Arch
Hole	CPT-05
Site	Carteret, New Jersey
Date	7/10/2012

Seismic Source:	Beam	
Source Offset:	4.75	(ft)
Source Depth:	0.00	(ft)
Geophone Offset:	0.66	(ft)

SEISMIC TEST RESULTS - Vs

Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Depth Interval (ft)	Time Interval (ms)	Mid-layer Depth (ft)	Vs Interval Velocity (ft/s)
6.56	5.90	7.58				
10.83	10.17	11.23	3.65	8.88	8.04	411
16.40	15.74	16.44	5.22	14.55	12.96	359
21.33	20.67	21.21	4.77	20.77	18.21	230
26.25	25.59	26.03	4.82	18.82	23.13	256
31.17	30.51	30.88	4.85	12.27	28.05	395
35.92	35.26	35.58	4.70	4.48	32.89	1049
39.53	38.87	39.16	3.58	4.40	37.07	814

Job No: 12-741
Client: Michael Baker Jr.
Project: Rahway Arch
Sounding: CPT-05
Date: July 10, 2012



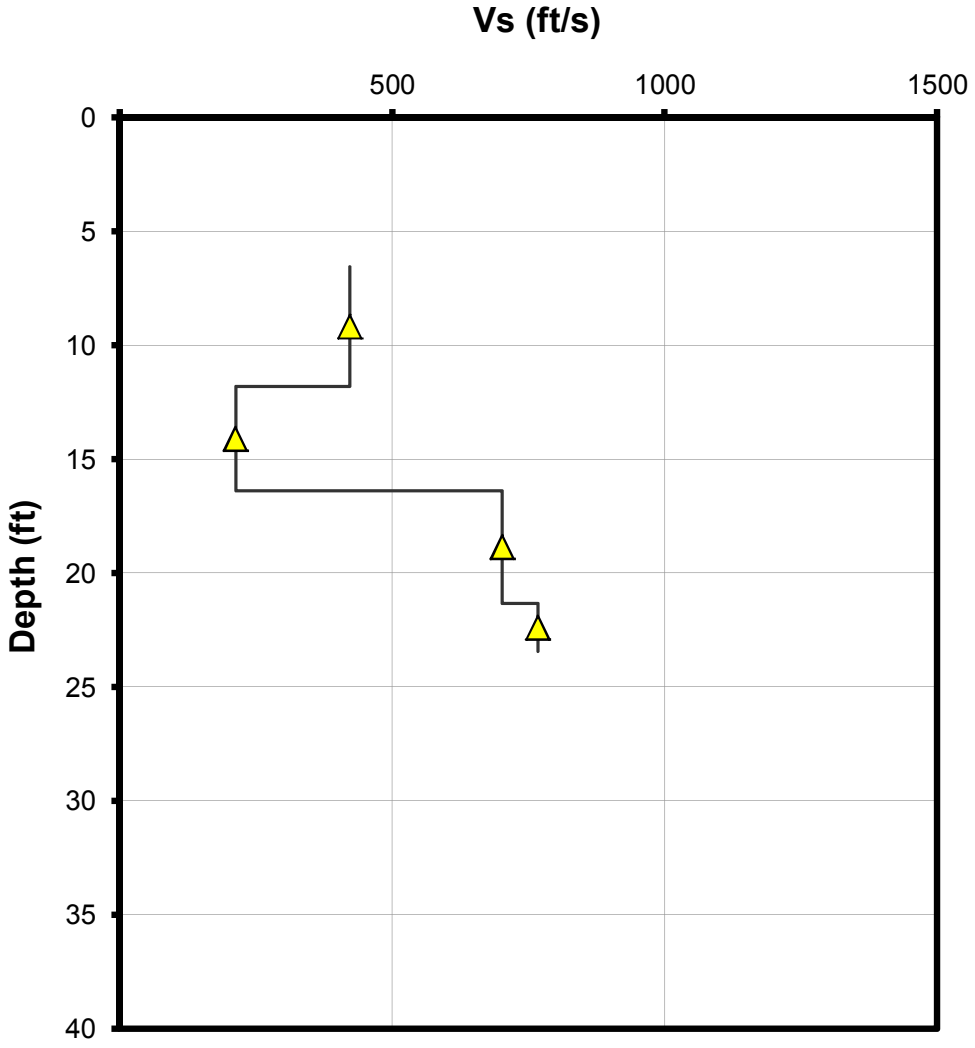
Job No	12-741
Client	Michael Baker Jr.
Project Title	Rahway Arch
Hole	CPT-08
Site	Carteret, New Jersey
Date	7/10/2012

Seismic Source:	Beam	
Source Offset:	5.00	(ft)
Source Depth:	0.00	(ft)
Geophone Offset:	0.66	(ft)

SEISMIC TEST RESULTS - Vs

Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Depth Interval (ft)	Time Interval (ms)	Mid-layer Depth (ft)	Vs Interval Velocity (ft/s)
7.22	6.56	8.25				
12.47	11.81	12.83	4.58	10.83	9.19	423
17.06	16.40	17.15	4.32	20.30	14.11	213
21.98	21.32	21.90	4.75	6.77	18.86	702
24.11	23.45	23.98	2.08	2.71	22.39	767

Job No: 12-741
Client: Michael Baker Jr.
Project: Rahway Arch
Sounding: CPT-08
Date: July 10, 2012



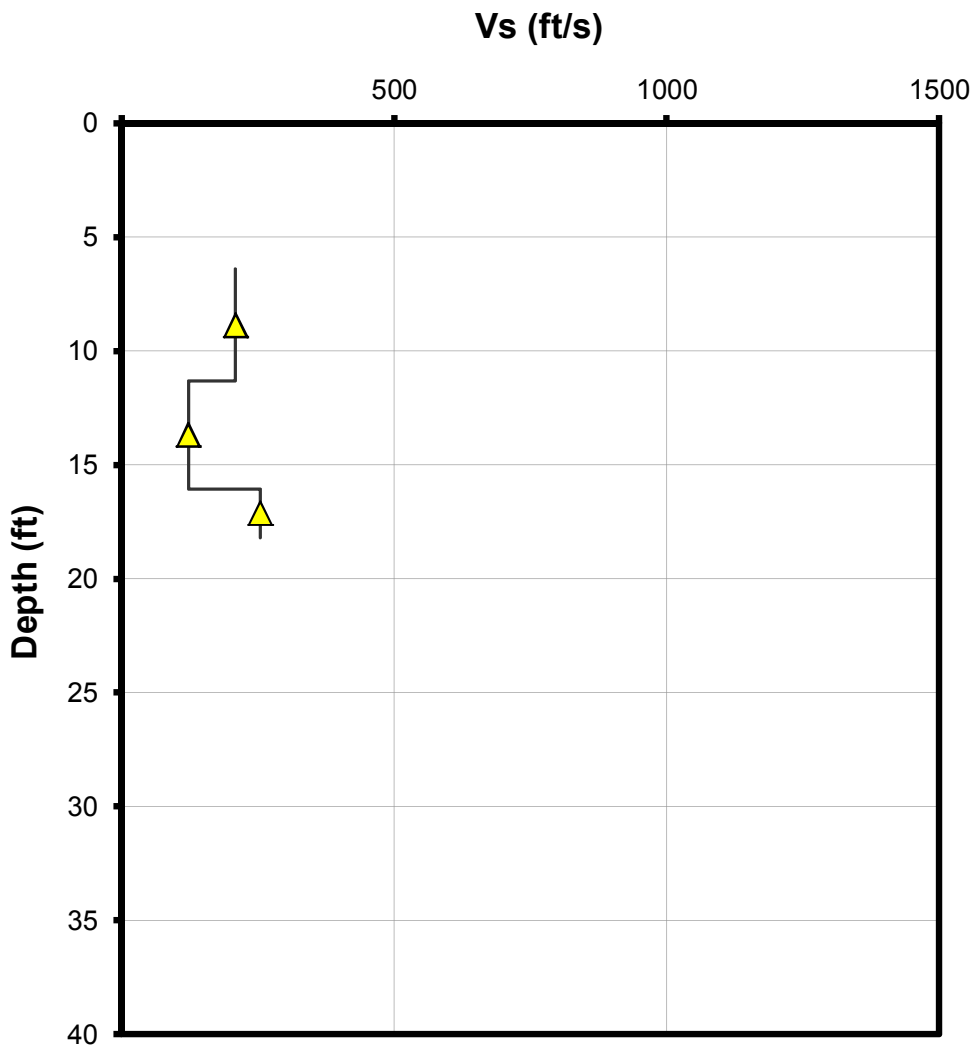
Job No	12-741
Client	Michael Baker Jr.
Project Title	Rahway Arch
Hole	CPT-09D
Site	Carteret, New Jersey
Date	7/13/2012

Seismic Source:	Beam	
Source Offset:	4.75	(ft)
Source Depth:	0.00	(ft)
Geophone Offset:	0.66	(ft)

SEISMIC TEST RESULTS - Vs

Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Depth Interval (ft)	Time Interval (ms)	Mid-layer Depth (ft)	Vs Interval Velocity (ft/s)
7.05	6.39	7.97				
11.98	11.32	12.28	4.31	20.66	8.86	209
16.73	16.07	16.76	4.48	36.39	13.70	123
18.86	18.20	18.81	2.05	8.07	17.14	254

Job No: 12-741
Client: Michael Baker Jr.
Project: Rahway Arch
Sounding: CPT-09D
Date: July 13, 2012



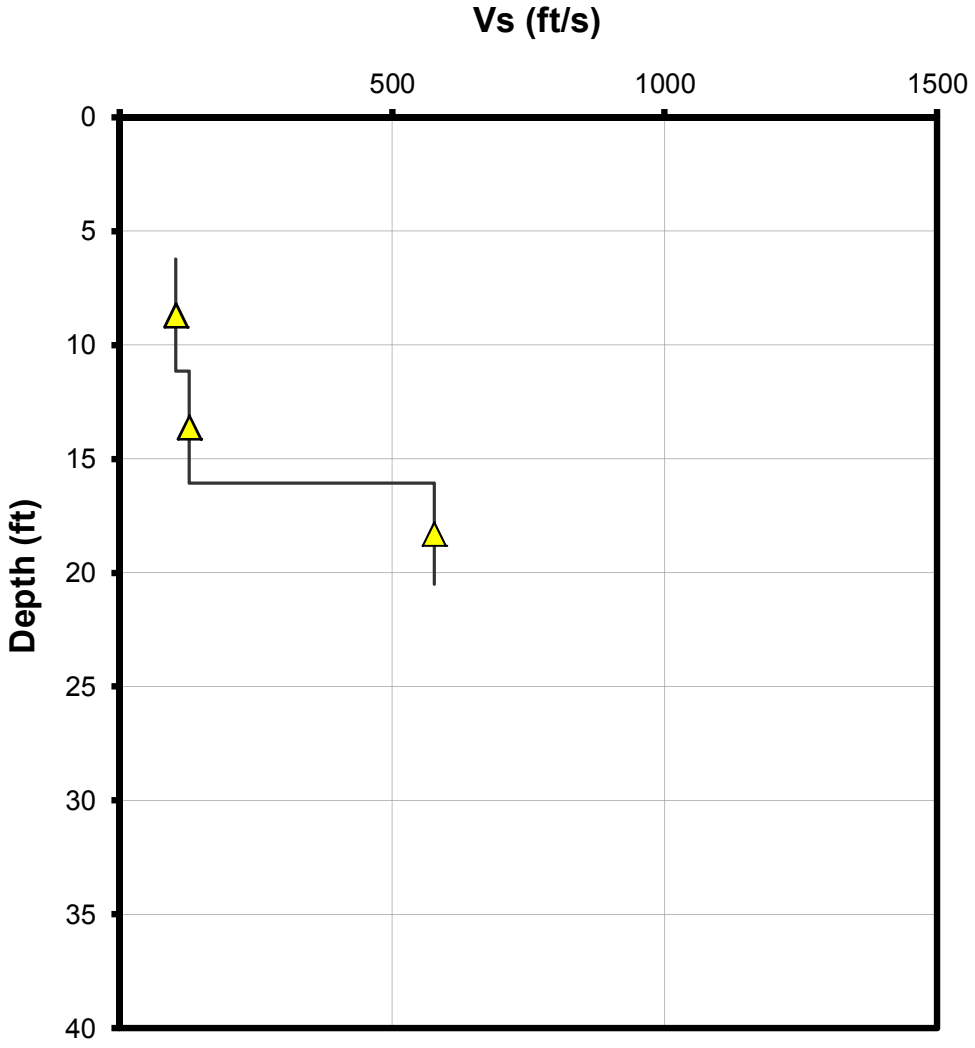
Job No	12-741
Client	Michael Baker Jr.
Project Title	Rahway Arch
Hole	CPT-11A
Site	Carteret, New Jersey
Date	7/12/2012

Seismic Source:	Beam	
Source Offset:	4.50	(ft)
Source Depth:	0.00	(ft)
Geophone Offset:	0.66	(ft)

SEISMIC TEST RESULTS - Vs

Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Depth Interval (ft)	Time Interval (ms)	Mid-layer Depth (ft)	Vs Interval Velocity (ft/s)
6.89	6.23	7.69				
11.81	11.15	12.03	4.34	42.09	8.69	103
16.73	16.07	16.69	4.66	36.51	13.61	128
21.16	20.50	20.99	4.30	7.45	18.29	577

Job No: 12-741
Client: Michael Baker Jr.
Project: Rahway Arch
Sounding: CPT-11A
Date: July 12, 2012



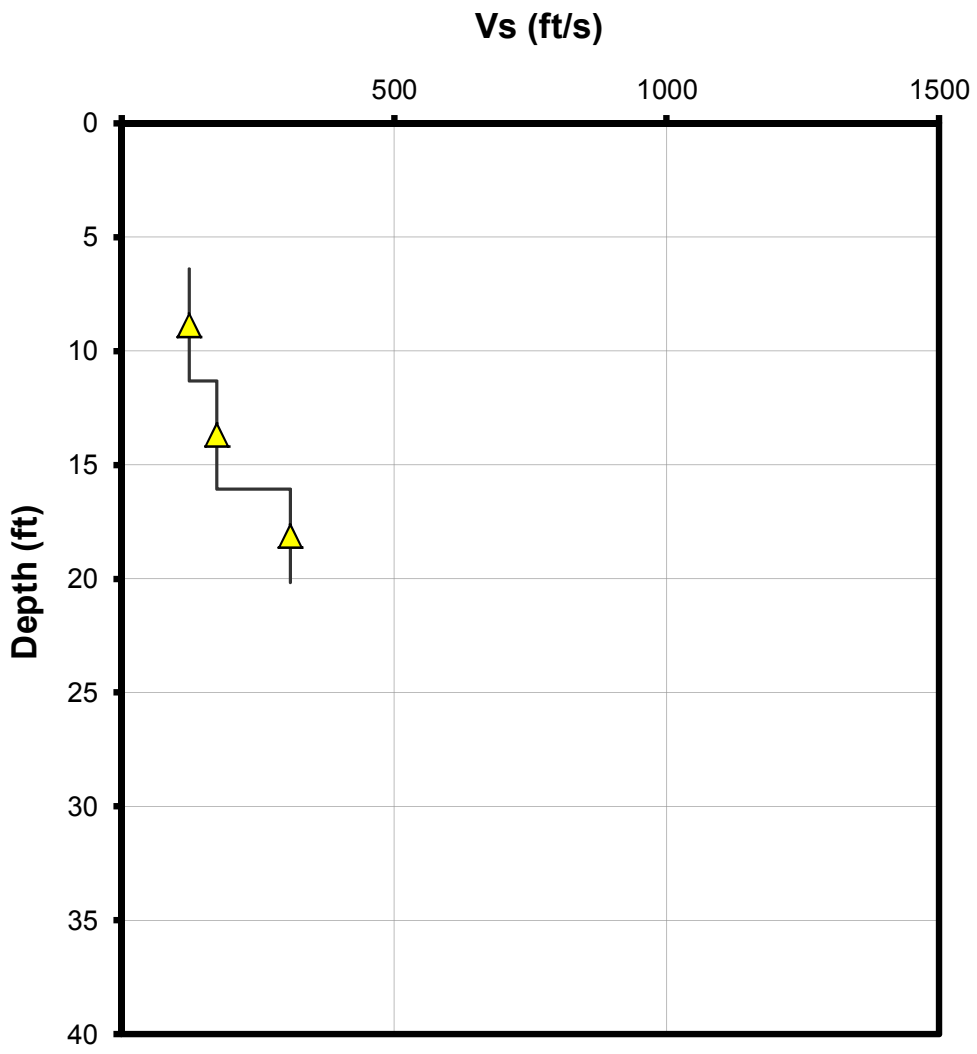
Job No	12-741
Client	Michael Baker Jr.
Project Title	Rahway Arch
Hole	CPT-12
Site	Carteret, New Jersey
Date	7/16/2012

Seismic Source:	Beam	
Source Offset:	4.50	(ft)
Source Depth:	0.00	(ft)
Geophone Offset:	0.66	(ft)

SEISMIC TEST RESULTS - Vs

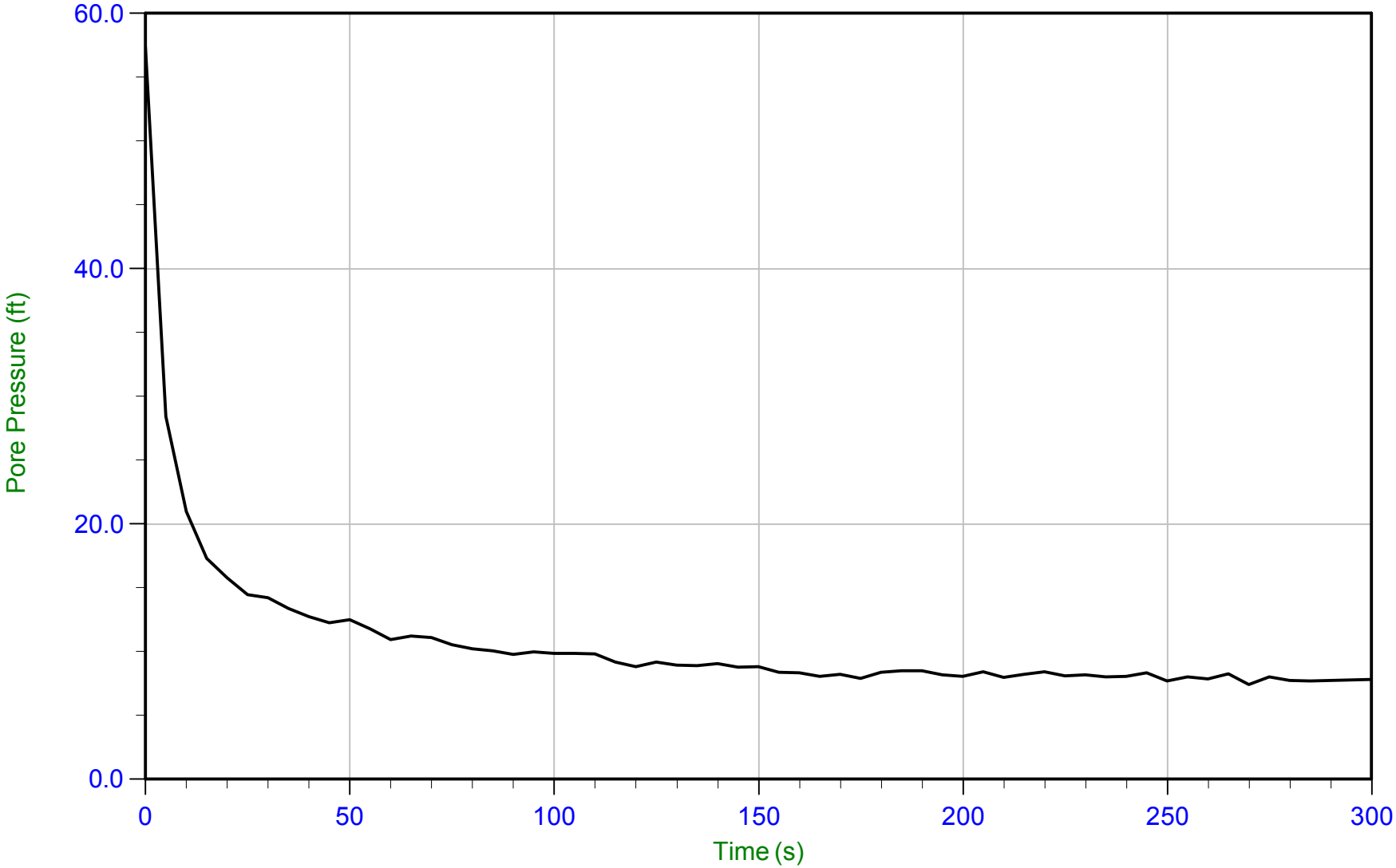
Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Depth Interval (ft)	Time Interval (ms)	Mid-layer Depth (ft)	Vs Interval Velocity (ft/s)
7.05	6.39	7.82				
11.98	11.32	12.19	4.37	35.28	8.86	124
16.73	16.07	16.69	4.51	25.80	13.70	175
20.83	20.17	20.67	3.98	12.86	18.12	309

Job No: 12-741
Client: Michael Baker Jr.
Project: Rahway Arch
Sounding: CPT-12
Date: July 16, 2012



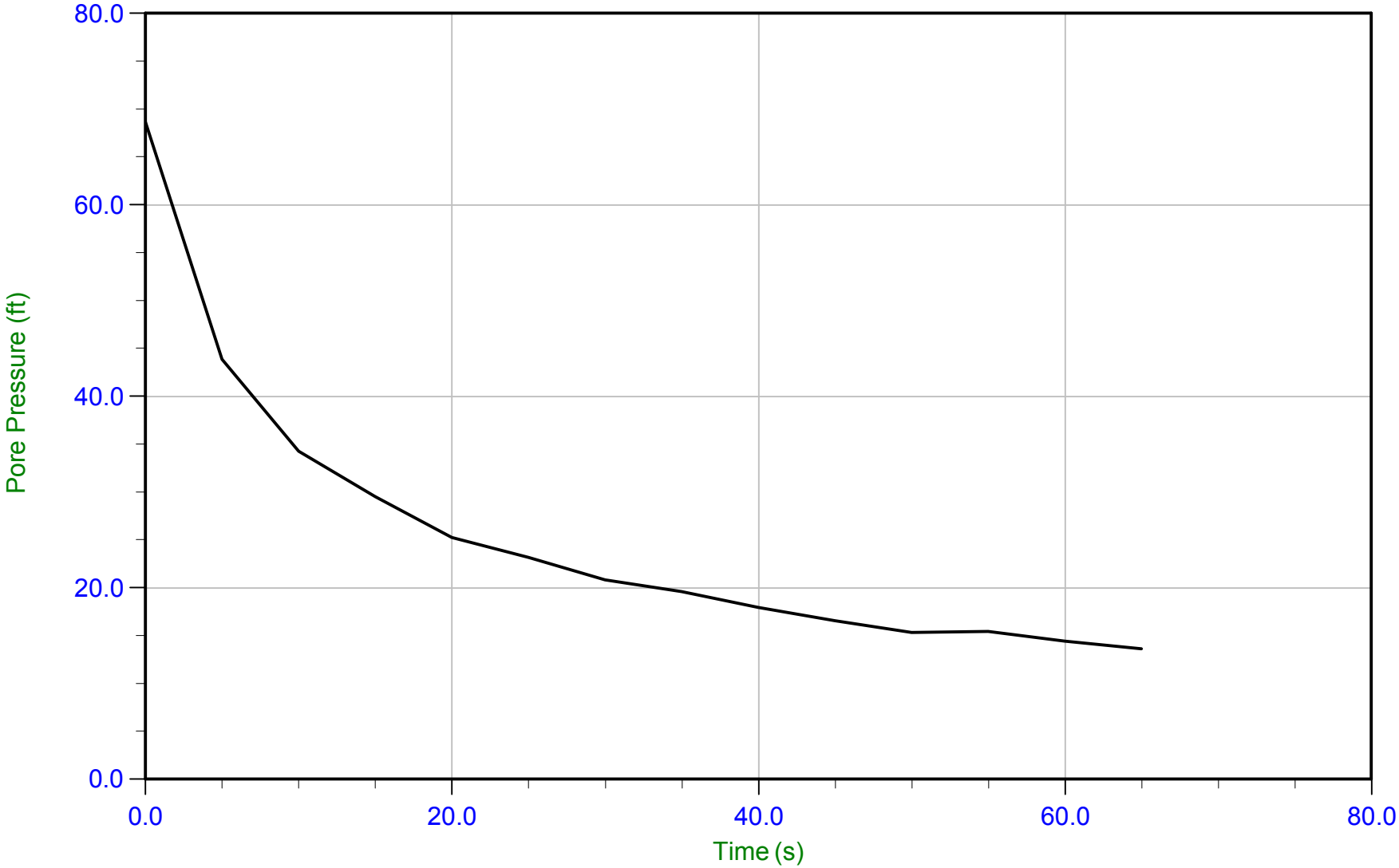
Appendix D

CONETEC	*Michael Baker Jr.*	Job No: 12-741 Date: 07/12/2012 07:18 Site: Rahway Arch	Sounding: CPT-01 Cone: 302:T1500F15U500 Cone Area: 15 sq cm



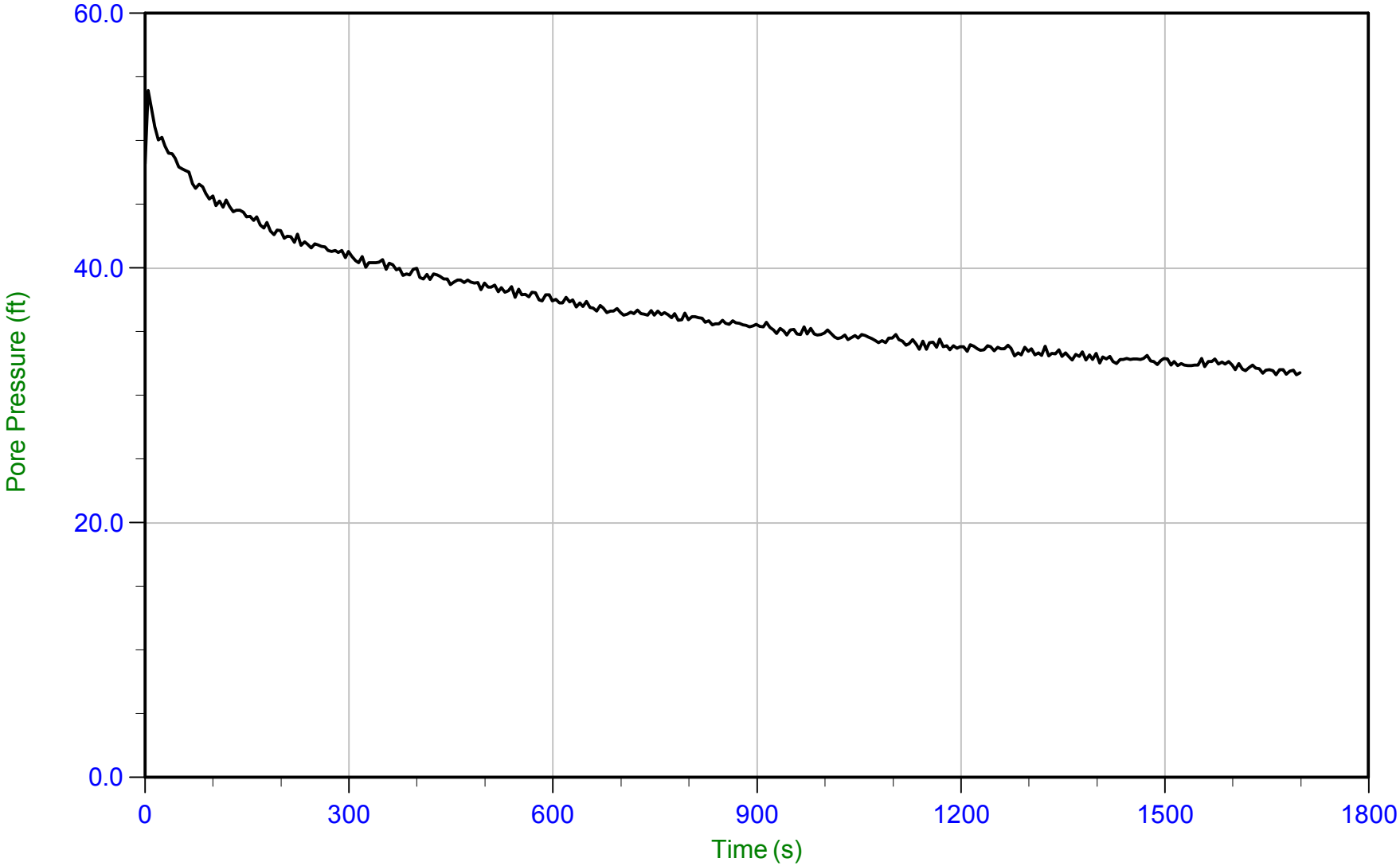
Trace Summary:				
	Filename: 741CP01.PPD	U Min: 7.4 ft	WT: 0.122 m / 0.400 ft	T(50): 4.3 s
	Depth: 2.450 m / 8.038 ft	U Max: 57.4 ft	Ueq: 7.6 ft	Ir: 100
	Duration: 300.0 s		U(50): 32.52 ft	Ch: 163.5 sq cm/min

CONETEC	Michael Baker Jr.	Job No: 12-741 Date: 07/12/2012 07:18 Site: Rahway Arch	Sounding: CPT-01 Cone: 302:T1500F15U500 Cone Area: 15 sq cm



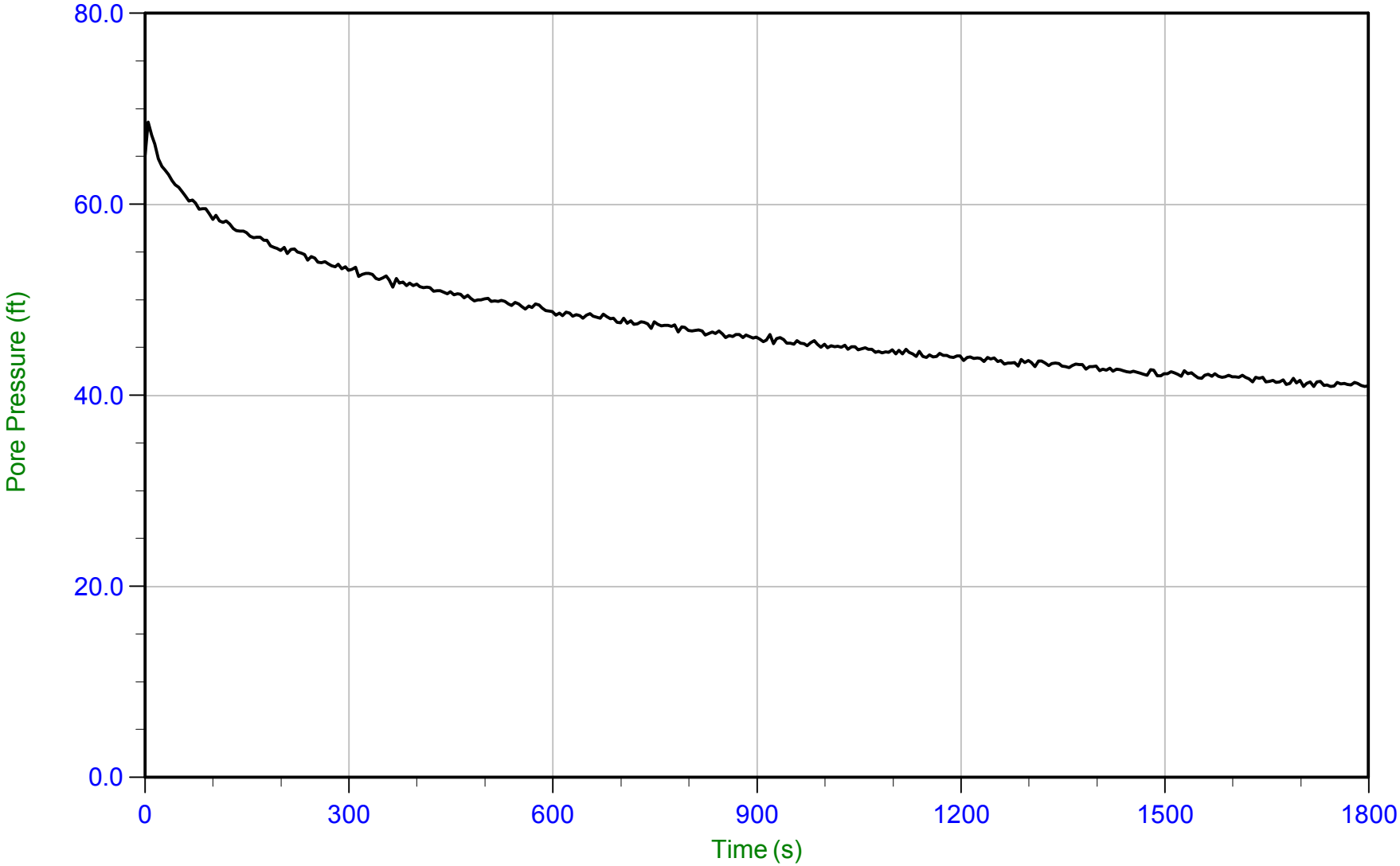
Trace Summary:				
	Filename: 741CP01.PPD	U Min: 13.6 ft	WT: 0.122 m / 0.400 ft	T(50): 7.5 s
	Depth: 3.050 m / 10.006 ft	U Max: 68.7 ft	Ueq: 9.6 ft	Ir: 100
	Duration: 65.0 s		U(50): 39.15 ft	Ch: 94.1 sq cm/min

CONETEC	*Michael Baker Jr.*	Job No: 12-741 Date: 07/12/2012 07:18 Site: Rahway Arch	Sounding: CPT-01 Cone: 302:T1500F15U500 Cone Area: 15 sq cm



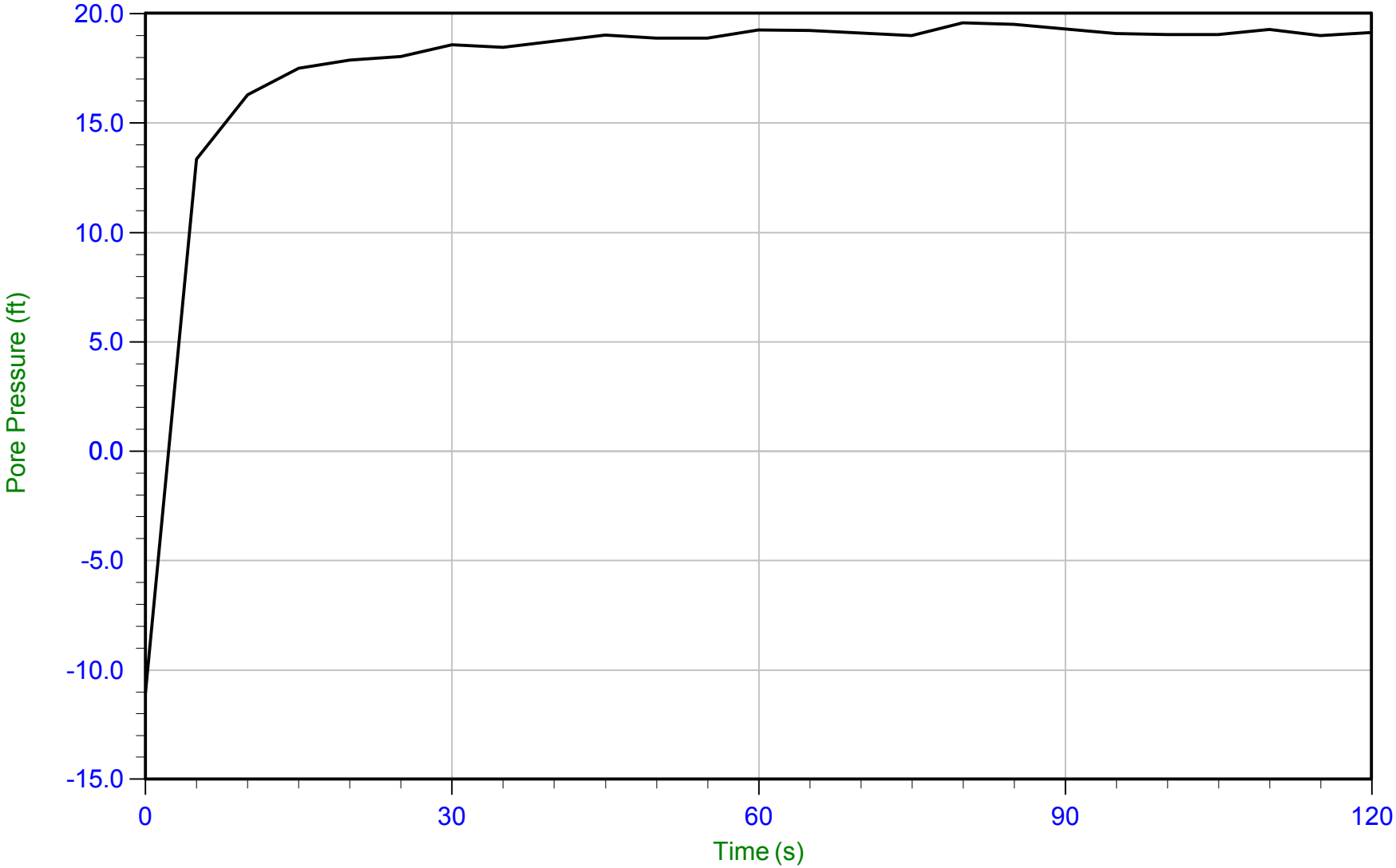
Trace Summary:				
	Filename: 741CP01.PPD	U Min: 31.6 ft	WT: 0.123 m / 0.404 ft	T(50): 923.0 s
	Depth: 5.000 m / 16.404 ft	U Max: 53.9 ft	Ueq: 16.0 ft	Ir: 100
	Duration: 1700.0 s		U(50): 34.97 ft	Ch: 0.8 sq cm/min

CONETEC	Michael Baker Jr.	Job No: 12-741 Date: 07/12/2012 07:18 Site: Rahway Arch	Sounding: CPT-01 Cone: 302:T1500F15U500 Cone Area: 15 sq cm



Trace Summary:				
	Filename: 741CP01.PPD	U Min: 40.9 ft	WT: 0.123 m / 0.404 ft	T(50): 1065.9 s
	Depth: 6.500 m / 21.325 ft	U Max: 68.6 ft	Ueq: 20.9 ft	Ir: 100
	Duration: 1800.0 s		U(50): 44.77 ft	Ch: 0.7 sq cm/min

CONETEC	Michael Baker Jr.	Job No: 12-741 Date: 07/13/2012 13:02 Site: Rahway Arch	Sounding: CPT-03 Cone: 302:T1500F15U500 Cone Area: 15 sq cm



Trace Summary:

Filename: 741CP03.PPD
Depth: 6.050 m / 19.849 ft
Duration: 120.0 s

U Min: -11.1 ft
U Max: 19.6 ft

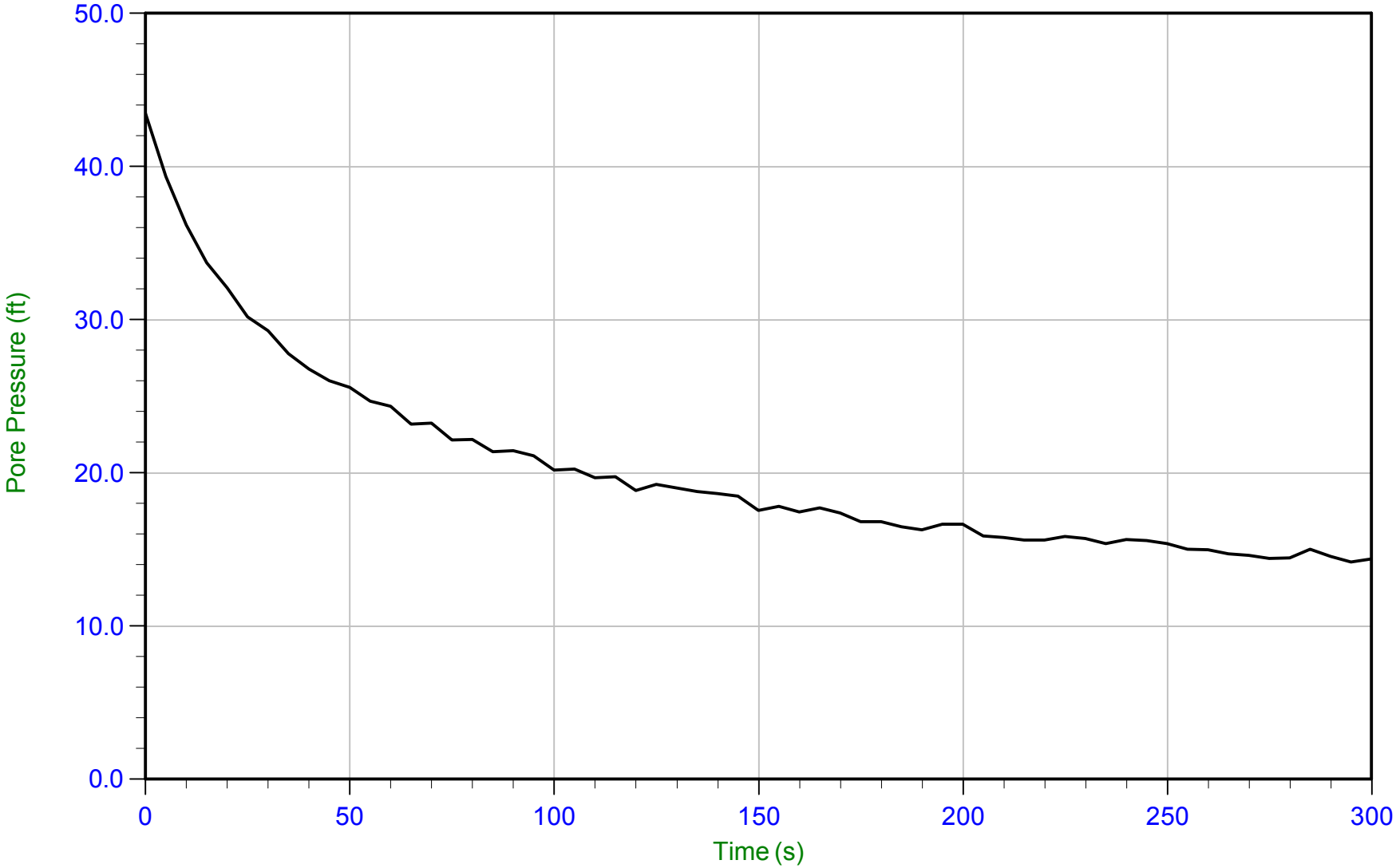
WT: 0.242 m / 0.794 ft
Ueq: 19.1 ft

CONETEC

Michael Baker Jr.

Job No: 12-741
Date: 07/10/2012 12:07
Site: Rahway Arch

Sounding: CPT-04
Cone: 302:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

Filename: 741CP04.PPD
Depth: 3.450 m / 11.319 ft
Duration: 300.0 s

U Min: 14.2 ft
U Max: 43.5 ft

WT: 1.464 m / 4.803 ft
Ueq: 6.5 ft
U(50): 24.99 ft

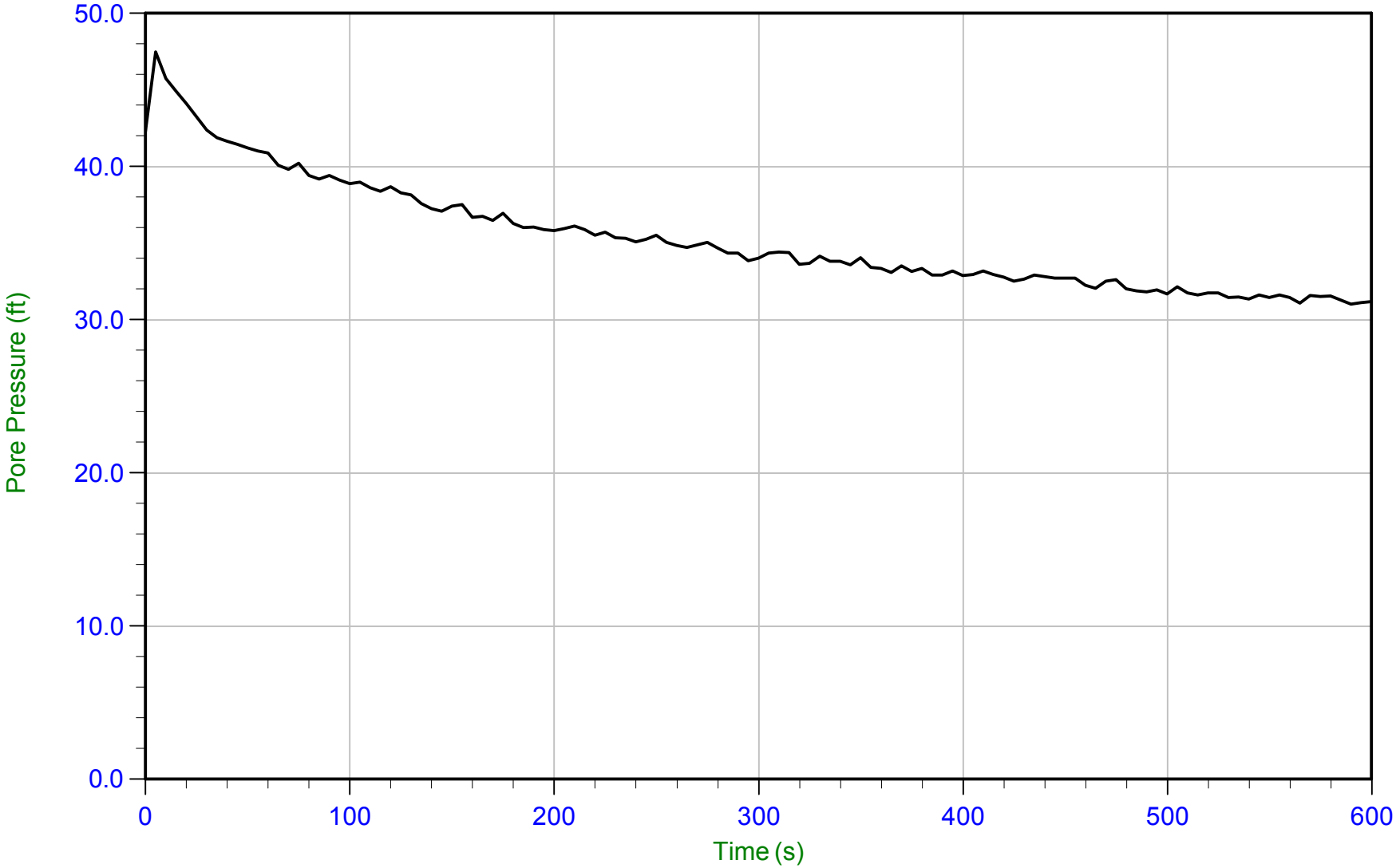
T(50): 53.3 s
Ir: 100
Ch: 13.2 sq cm/min

CONETEC

Michael Baker Jr.

Job No: 12-741
Date: 07/10/2012 12:07
Site: Rahway Arch

Sounding: CPT-04
Cone: 302:T1500F15U500
Cone Area: 15 sq cm



Trace Summary:

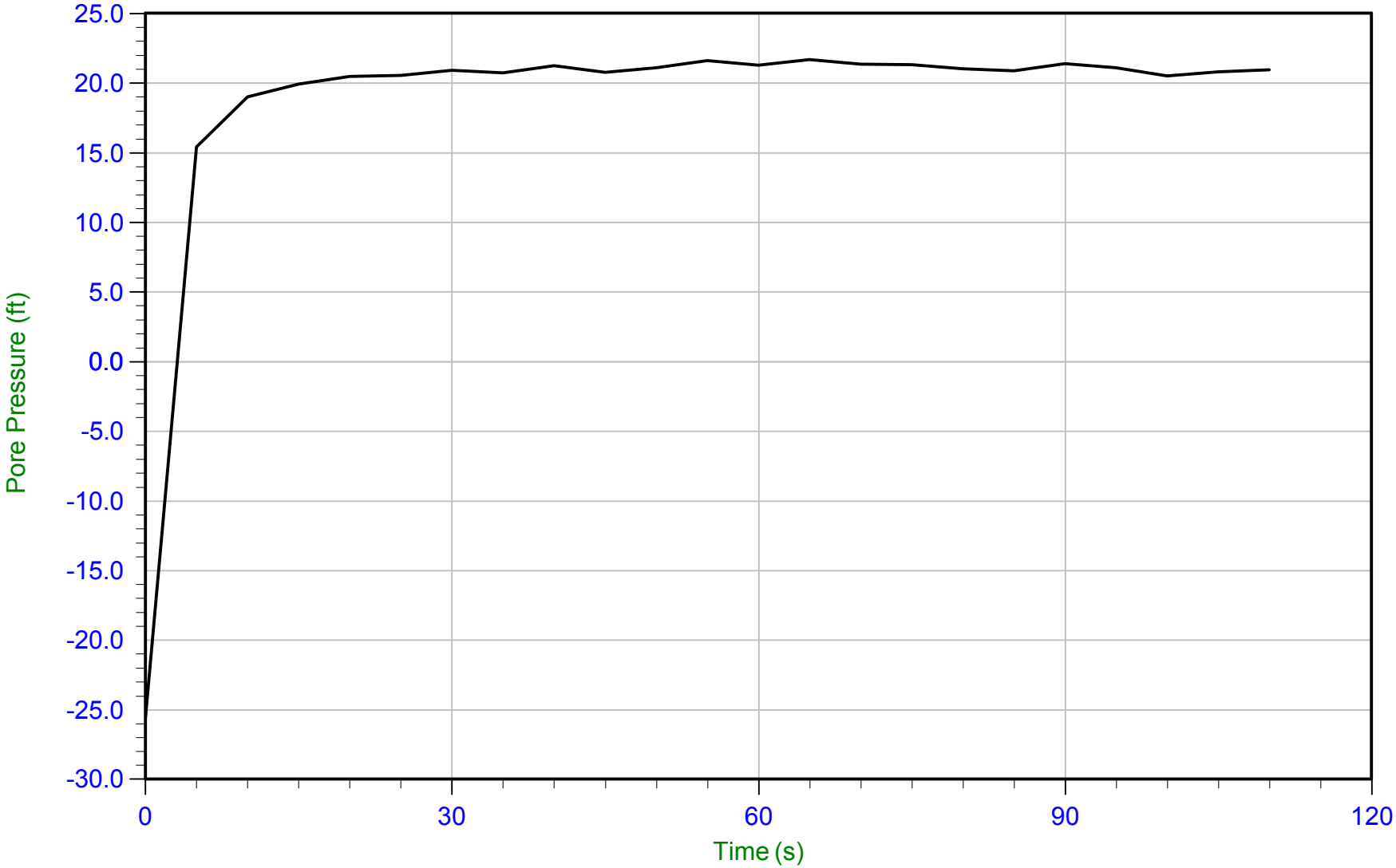
Filename: 741CP04.PPD
Depth: 5.900 m / 19.357 ft
Duration: 600.0 s

U Min: 31.0 ft
U Max: 47.5 ft

WT: 1.464 m / 4.803 ft
Ueq: 14.6 ft
U(50): 31.01 ft

T(50): 585.0 s
Ir: 100
Ch: 1.2 sq cm/min

CONETEC	*Michael Baker Jr.*	Job No: 12-741 Date: 07/10/2012 12:07 Site: Rahway Arch	Sounding: CPT-04 Cone: 302:T1500F15U500 Cone Area: 15 sq cm



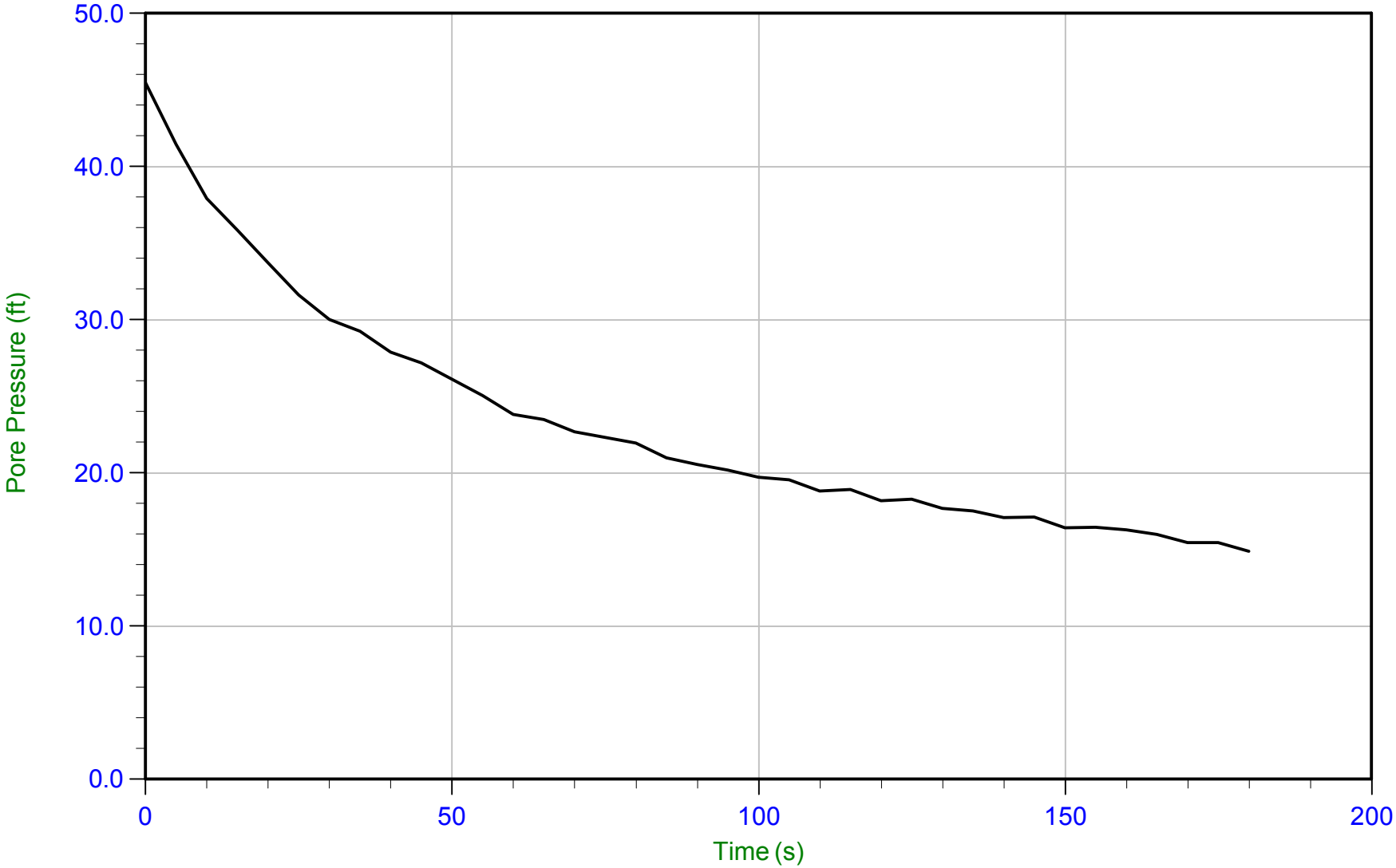
Trace Summary:

Filename: 741CP04.PPD
Depth: 8.100 m / 26.574 ft
Duration: 110.0 s

U Min: -25.6 ft
U Max: 21.7 ft

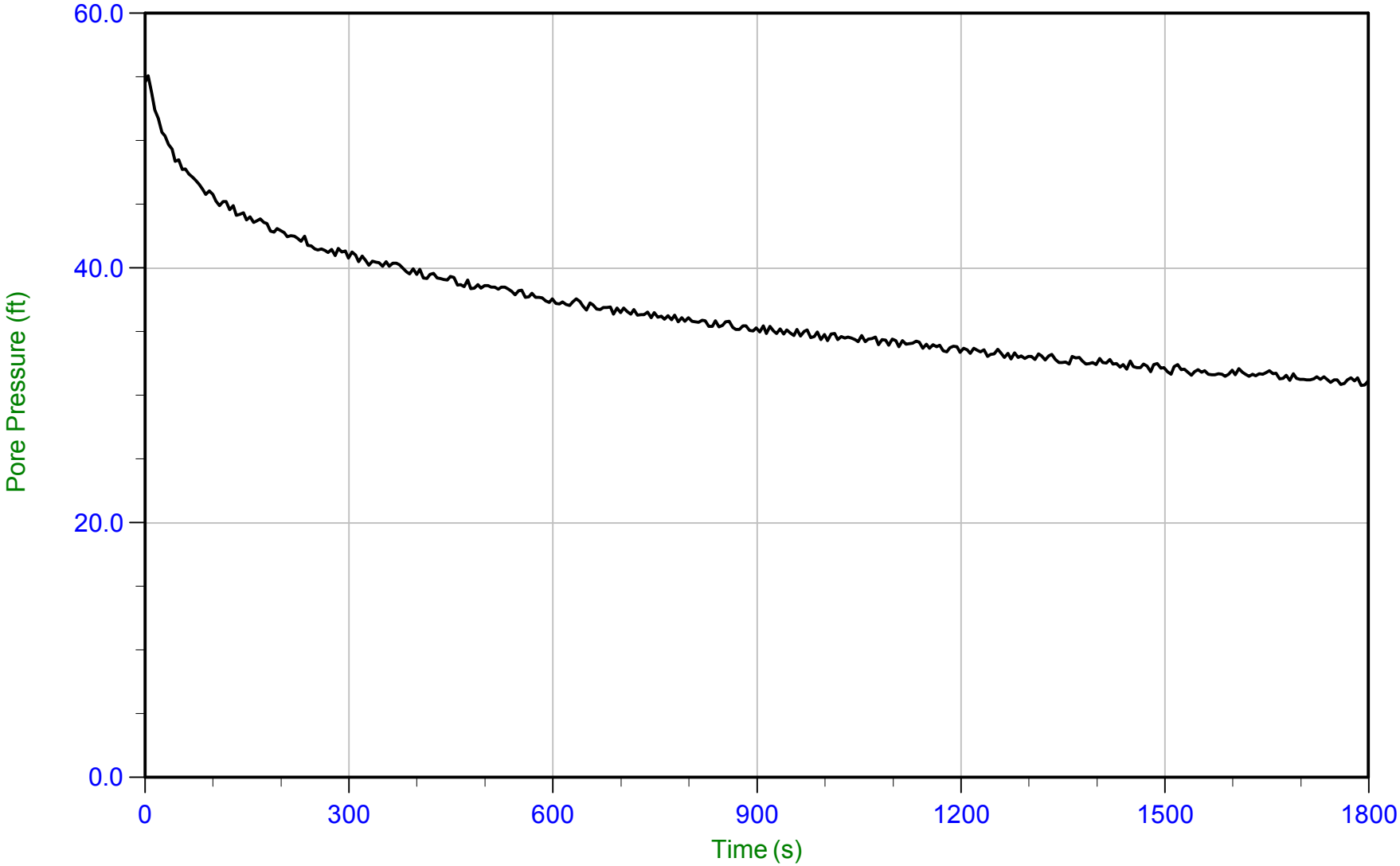
WT: 1.464 m / 4.803 ft
Ueq: 21.8 ft

CONETEC	Michael Baker Jr.	Job No: 12-741 Date: 07/10/2012 13:34 Site: Rahway Arch	Sounding: CPT-05 Cone: 302:T1500F15U500 Cone Area: 15 sq cm



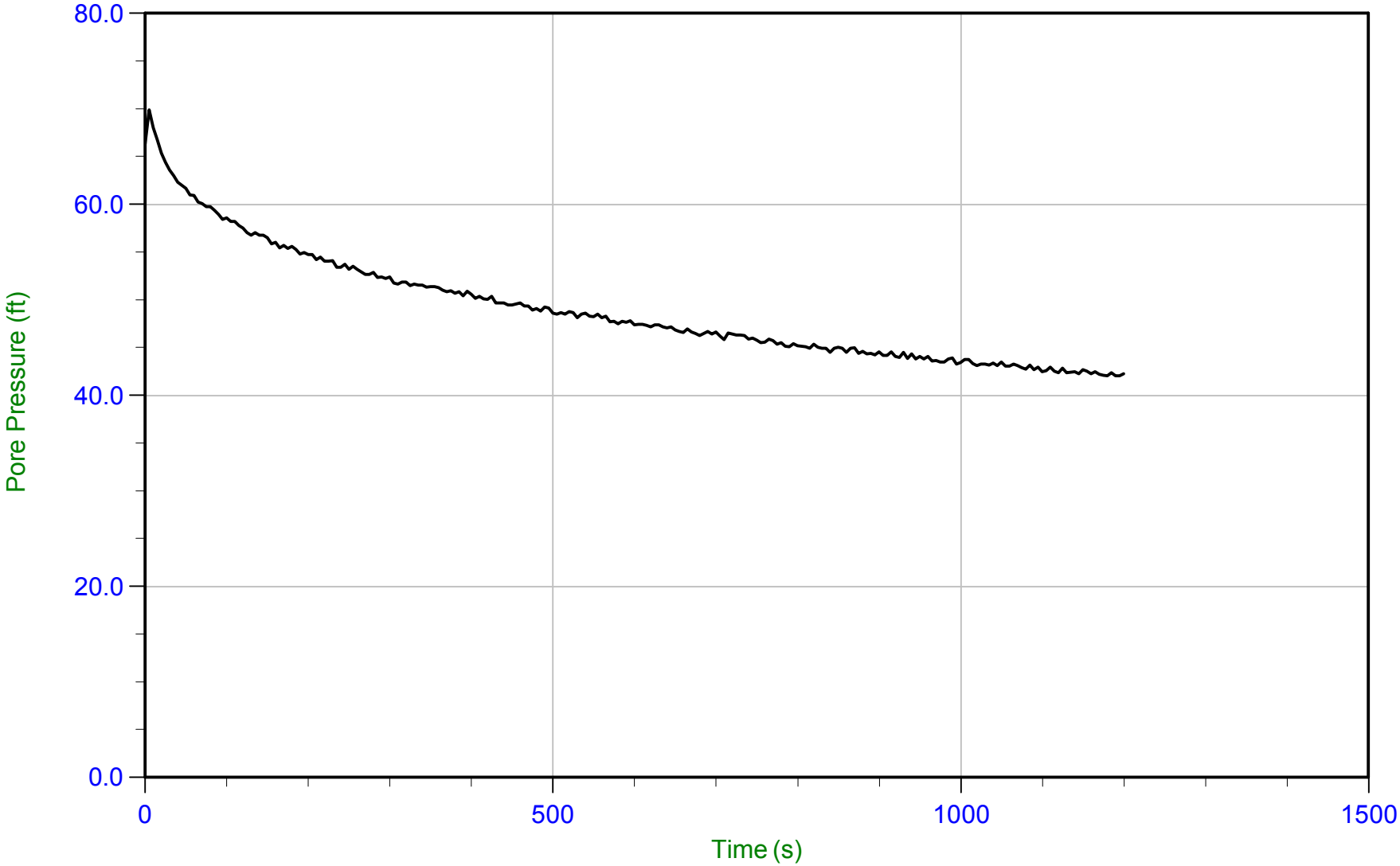
Trace Summary:				
	Filename: 741CP05.PPD	U Min: 14.9 ft	WT: 0.610 m / 2.001 ft	T(50): 45.2 s
	Depth: 3.300 m / 10.827 ft	U Max: 45.5 ft	Ueq: 8.8 ft	Ir: 100
	Duration: 180.0 s		U(50): 27.15 ft	Ch: 15.5 sq cm/min

CONETEC	*Michael Baker Jr.*	Job No: 12-741 Date: 07/10/2012 13:34 Site: Rahway Arch	Sounding: CPT-05 Cone: 302:T1500F15U500 Cone Area: 15 sq cm



Trace Summary:				
	Filename: 741CP05.PPD	U Min: 30.8 ft	WT: 0.610 m / 2.001 ft	T(50): 948.6 s
	Depth: 5.000 m / 16.404 ft	U Max: 55.1 ft	Ueq: 14.4 ft	Ir: 100
	Duration: 1800.0 s		U(50): 34.74 ft	Ch: 0.7 sq cm/min

CONETEC	Michael Baker Jr.	Job No: 12-741 Date: 07/10/2012 13:34 Site: Rahway Arch	Sounding: CPT-05 Cone: 302:T1500F15U500 Cone Area: 15 sq cm



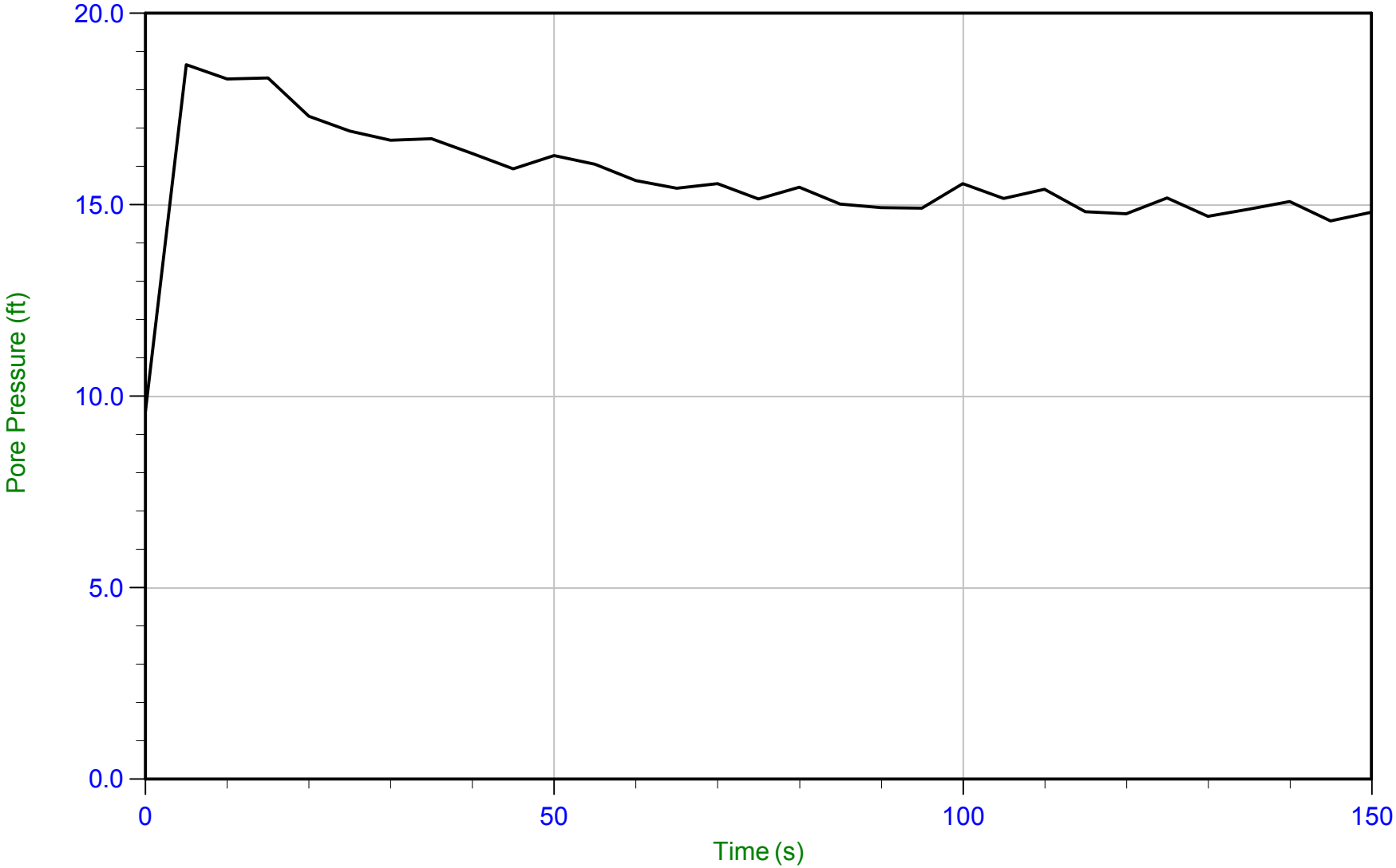
Trace Summary:

Filename: 741CP05.PPD
Depth: 6.500 m / 21.325 ft
Duration: 1200.0 s

U Min: 42.1 ft
U Max: 69.9 ft

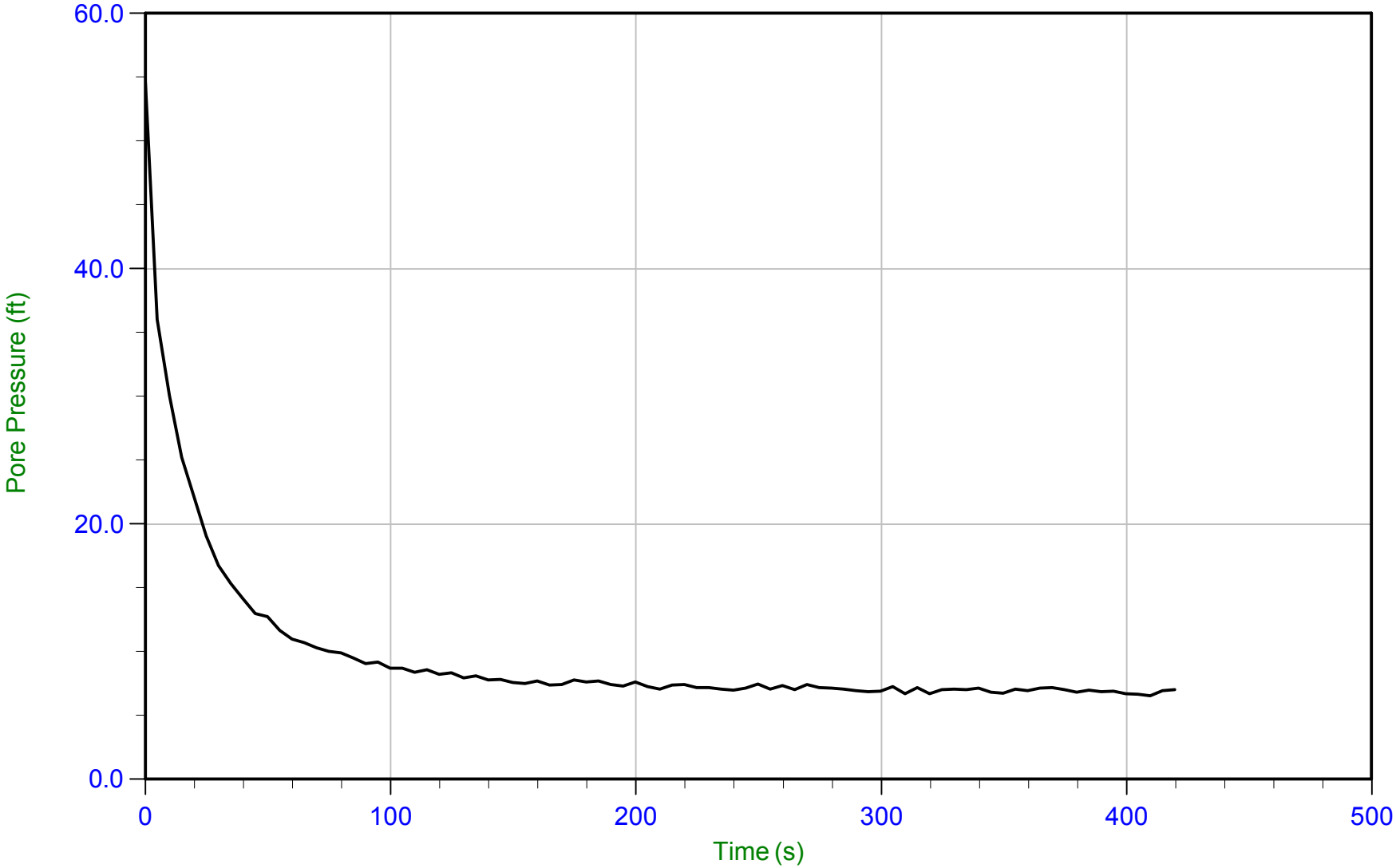
WT: 0.610 m / 2.001 ft
Ueq: 19.3 ft

CONETEC	Michael Baker Jr.	Job No: 12-741 Date: 07/12/2012 13:47 Site: Rahway Arch	Sounding: CPT-06A Cone: 302:T1500F15U500 Cone Area: 15 sq cm



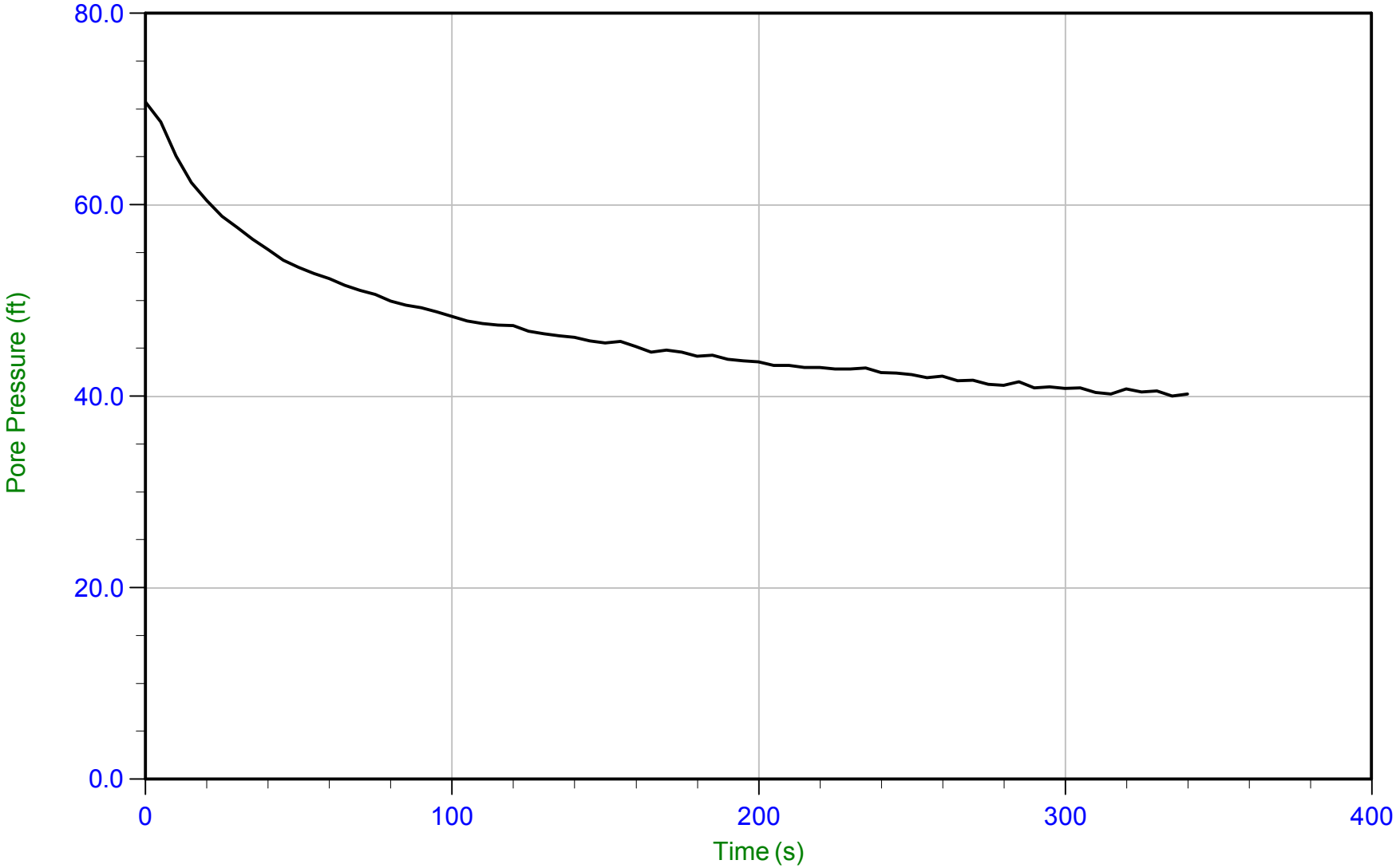
Trace Summary:				
	Filename: 741CP06A.PPD	U Min: 9.6 ft	WT: 3.749 m / 12.300 ft	T(50): 31.3 s
	Depth: 8.200 m / 26.903 ft	U Max: 18.7 ft	Ueq: 14.6 ft	Ir: 100
	Duration: 150.0 s		U(50): 16.63 ft	Ch: 22.4 sq cm/min

CONETEC	Michael Baker Jr.	Job No: 12-741 Date: 07/10/2012 09:49 Site: Rahway Arch	Sounding: CPT-08 Cone: 302:T1500F15U500 Cone Area: 15 sq cm



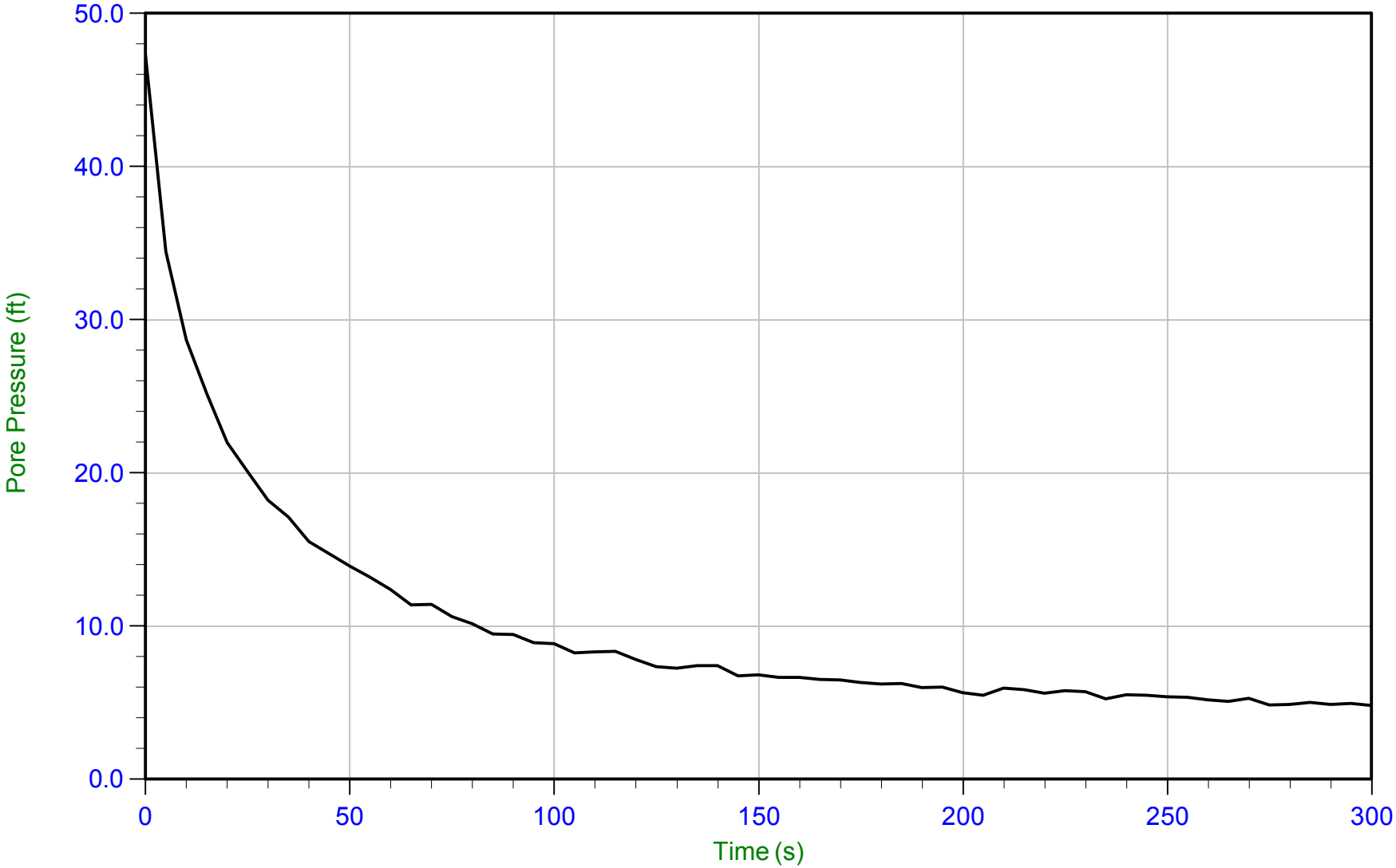
Trace Summary:				
	Filename: 741CP08.PPD	U Min: 6.5 ft	WT: 1.205 m / 3.953 ft	T(50): 9.6 s
	Depth: 3.200 m / 10.499 ft	U Max: 54.6 ft	Ueq: 6.5 ft	Ir: 100
	Duration: 420.0 s		U(50): 30.56 ft	Ch: 73.3 sq cm/min

CONETEC	Michael Baker Jr.	Job No: 12-741 Date: 07/10/2012 09:49 Site: Rahway Arch	Sounding: CPT-08 Cone: 302:T1500F15U500 Cone Area: 15 sq cm



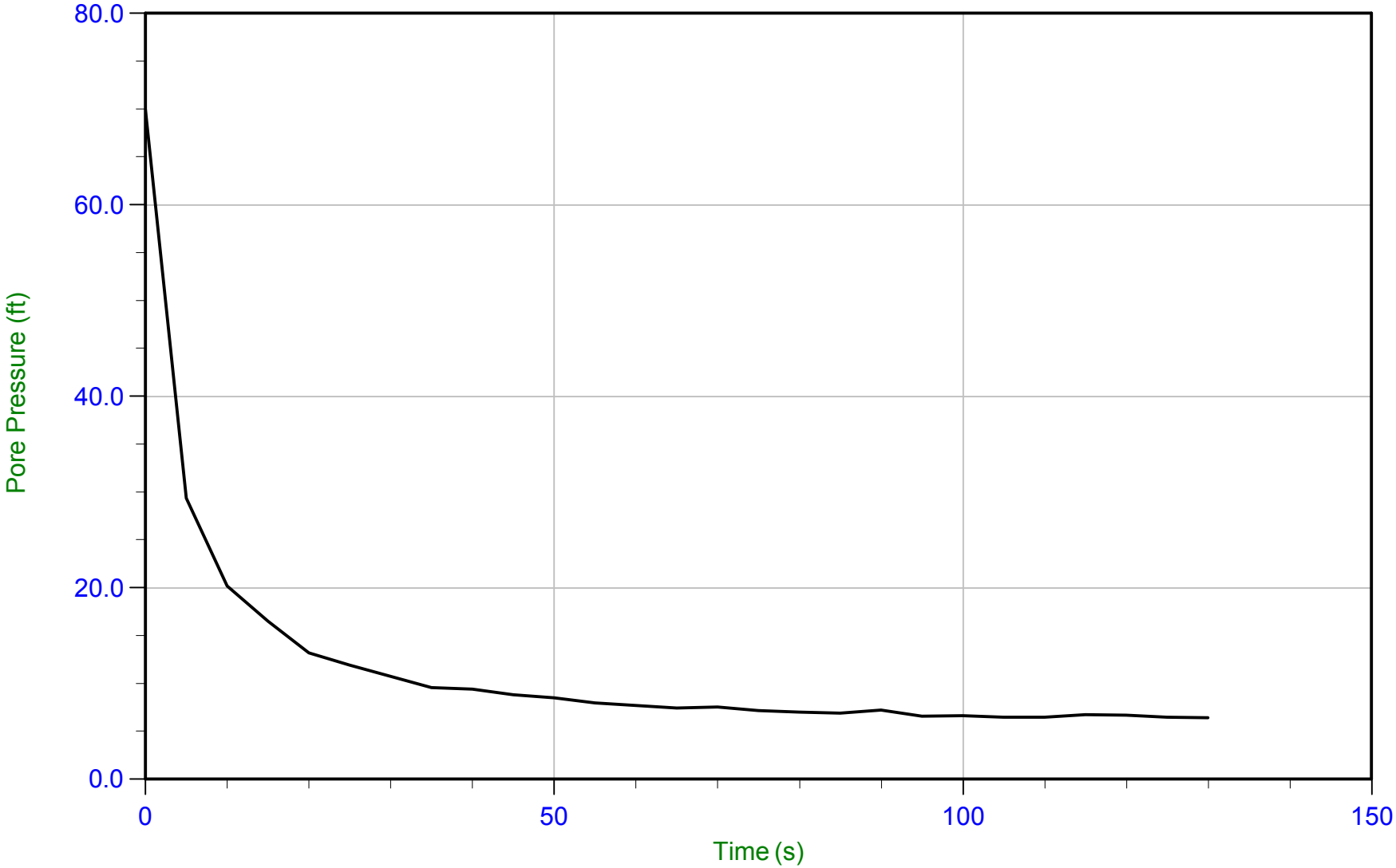
Trace Summary:				
	Filename: 741CP08.PPD	U Min: 40.0 ft	WT: 1.204 m / 3.950 ft	T(50): 239.7 s
	Depth: 5.550 m / 18.208 ft	U Max: 70.7 ft	Ueq: 14.3 ft	Ir: 100
	Duration: 340.0 s		U(50): 42.49 ft	Ch: 2.9 sq cm/min

CONETEC	*Michael Baker Jr.*	Job No: 12-741 Date: 07/13/2012 08:40 Site: Rahway Arch	Sounding: CPT-09D Cone: 302:T1500F15U500 Cone Area: 15 sq cm



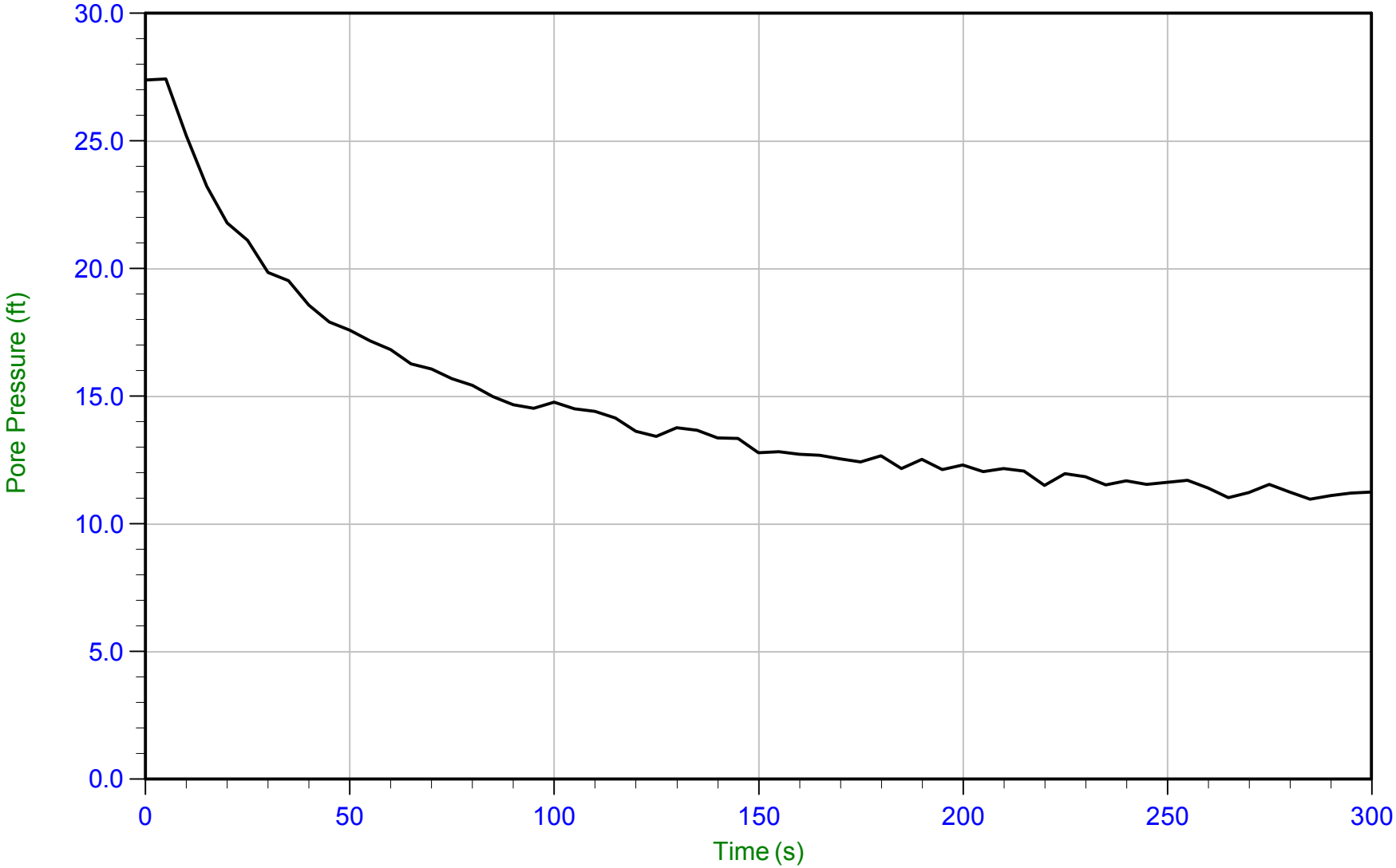
Trace Summary:				
	Filename: 741CP09D.PPD	U Min: 4.8 ft	WT: 0.889 m / 2.917 ft	T(50): 14.2 s
	Depth: 2.150 m / 7.054 ft	U Max: 47.3 ft	Ueq: 4.1 ft	Ir: 100
	Duration: 300.0 s		U(50): 25.73 ft	Ch: 49.3 sq cm/min

CONETEC	*Michael Baker Jr.*	Job No: 12-741 Date: 07/12/2012 12:10 Site: Rahway Arch	Sounding: CPT-11A Cone: 302:T1500F15U500 Cone Area: 15 sq cm



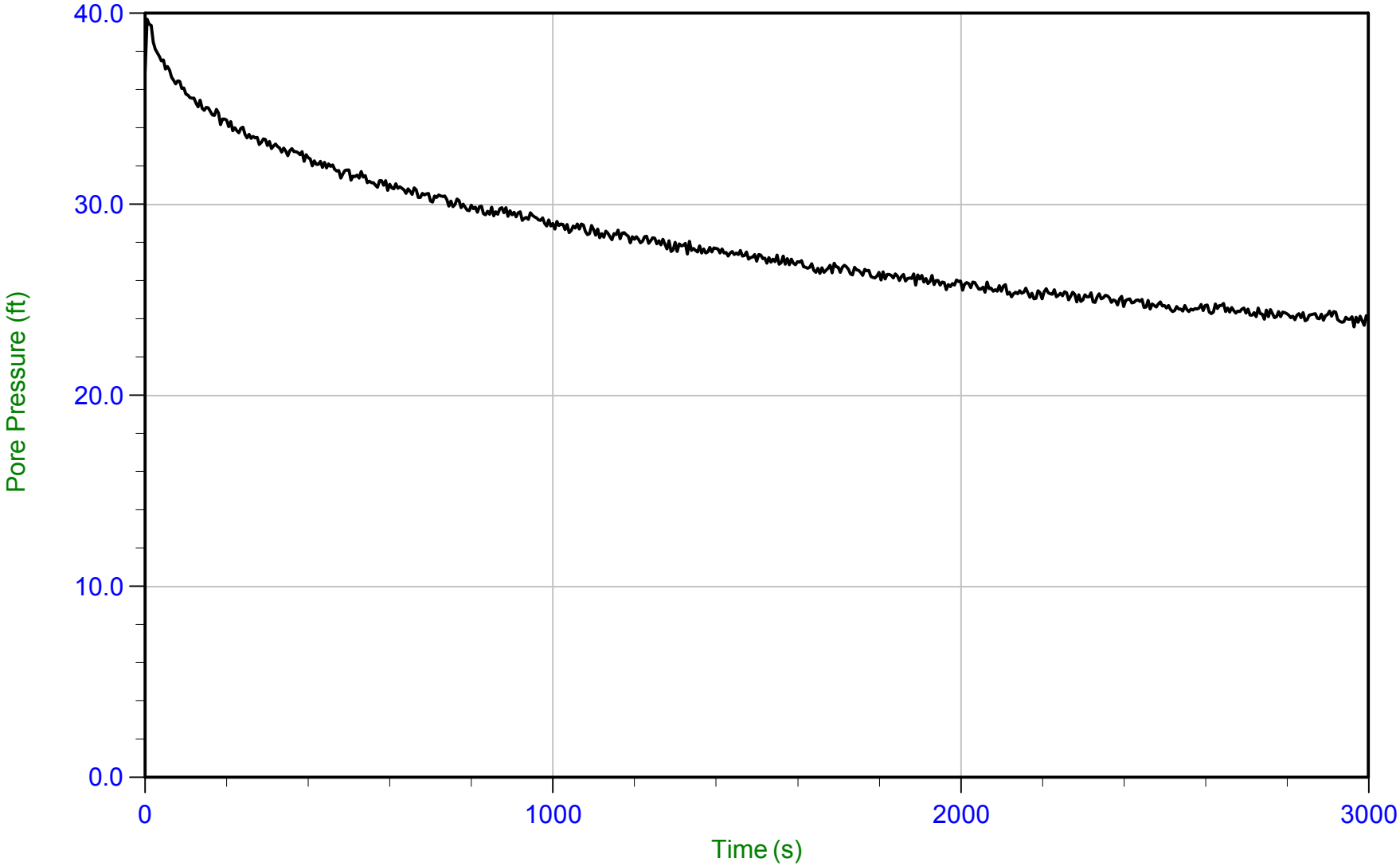
Trace Summary:	Filename: 741CP11A.PPD Depth: 2.100 m / 6.890 ft Duration: 130.0 s	U Min: 6.4 ft U Max: 69.9 ft	WT: 0.149 m / 0.489 ft Ueq: 6.4 ft

CONETEC	*Michael Baker Jr.*	Job No: 12-741 Date: 07/16/2012 06:56 Site: Rahway Arch	Sounding: CPT-12 Cone: 302:T1500F15U500 Cone Area: 15 sq cm



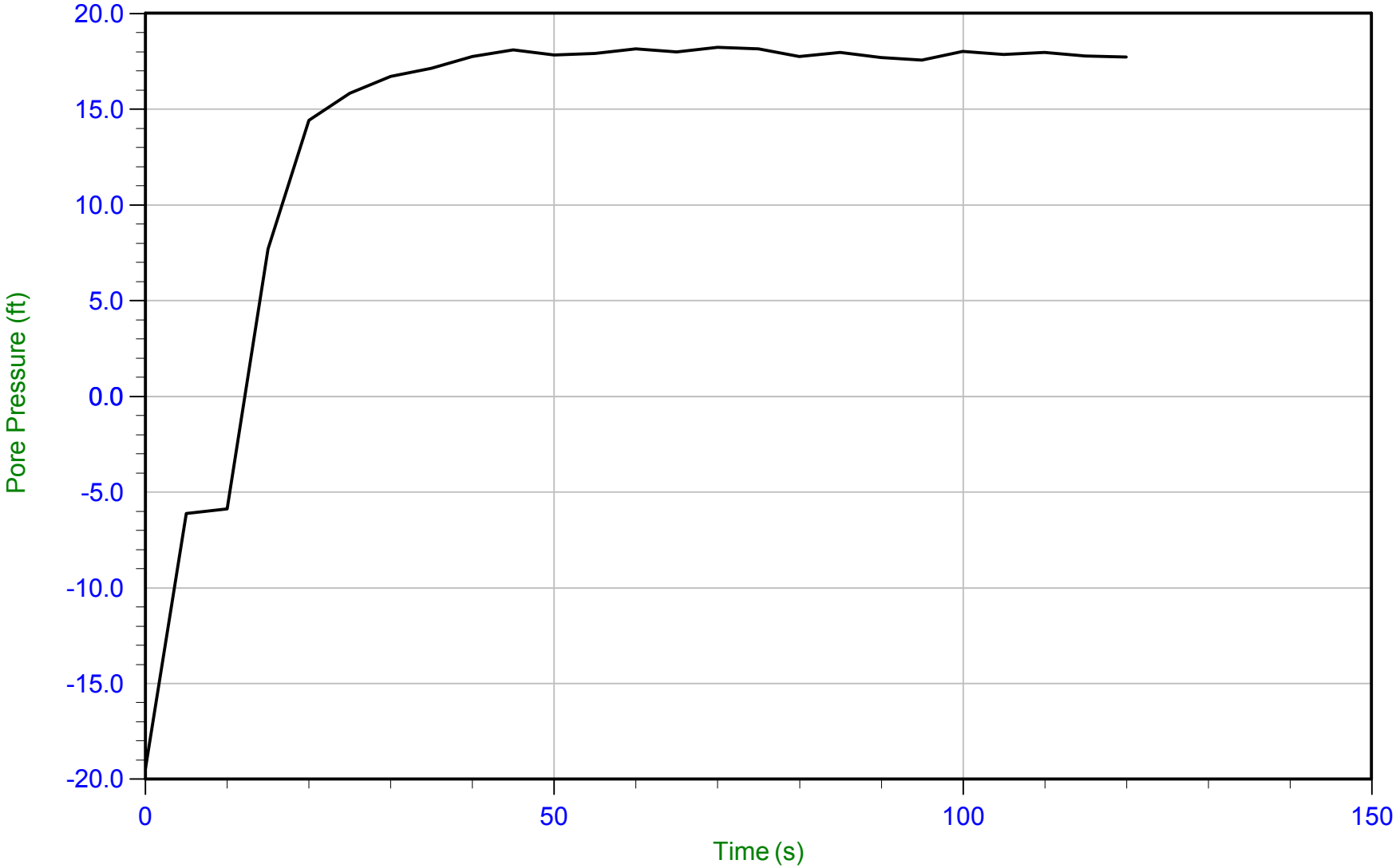
Trace Summary:				
	Filename: 741CP12.PPD	U Min: 11.0 ft	WT: 0.956 m / 3.136 ft	T(50): 70.4 s
	Depth: 2.150 m / 7.054 ft	U Max: 27.4 ft	Ueq: 3.9 ft	Ir: 100
	Duration: 300.0 s		U(50): 15.68 ft	Ch: 10.0 sq cm/min

CONETEC	Michael Baker Jr.	Job No: 12-741 Date: 07/16/2012 06:56 Site: Rahway Arch	Sounding: CPT-12 Cone: 302:T1500F15U500 Cone Area: 15 sq cm



Trace Summary:				
	Filename: 741CP12.PPD	U Min: 23.6 ft	WT: 0.956 m / 3.136 ft	T(50): 2109.5 s
	Depth: 4.300 m / 14.107 ft	U Max: 39.7 ft	Ueq: 11.0 ft	Ir: 100
	Duration: 3000.0 s		U(50): 25.33 ft	Ch: 0.3 sq cm/min

CONETEC	*Michael Baker Jr.*	Job No: 12-741 Date: 07/16/2012 06:56 Site: Rahway Arch	Sounding: CPT-12 Cone: 302:T1500F15U500 Cone Area: 15 sq cm



Trace Summary:

Filename: 741CP12.PPD
Depth: 6.350 m / 20.833 ft
Duration: 120.0 s

U Min: -19.5 ft
U Max: 18.2 ft

WT: 0.956 m / 3.136 ft
Ueq: 17.7 ft

Appendix E

Electronic Data Files

The released data contains the following folders:

1. CPT Data - .cor files in ASCII format, and or .xls files.
2. Pore Pressure Dissipation Data - .ppd files in Excel format
3. CPT Plots - .pdf files
4. Data Interpretation - .xls files contain common engineering values
5. Shear Wave Velocity Data - .pdf files of tabular and graphical seismic data.

ConeTec Digital File Formats

CPT Data Files (COR Extension)

ConeTec data files are stored in ASCII text files that are readable by almost any text editor. ConeTec CPT data files are named such that the first 3 characters contain the job number, the next two characters are CP followed by two characters indicating the sounding number. The last 8th character position is reserved for the letters a, b, c, d etc to uniquely identify multiple soundings at the same location. The CPT sounding file has the extension COR, and pore pressure dissipation files have the extension PPD or PPF. As an example, for job number 06-127 the first sounding will have file names 127CP01.COR and 127CP01.PPD.

The sounding (COR) file consists of the following components:

1. Two lines of header information
2. Data records
3. End of data marker
4. Units information

Header Lines

Line 1: Columns 1-6 may be blank or may indicate the version number of the recording software
Columns 7-21 contain the sounding Date and Time
Columns 22-36 contain the sounding Operator

Line 2: Columns 1-16 contain the Job Location
Columns 17-31 contain the Cone ID
Columns 32-47 contain the sounding number

Data Records

The data records contain 4 or more columns of data in floating point format. A comma (and spaces) separates each data item:

Column 1:	Sounding Depth (meters)
Column 2:	Tip (q_c) data uncorrected for pore pressure effects. Recorded in units selected by the operator.
Column 3:	Sleeve (f_s) data. Recorded in units selected by the operator
Column 4:	Dynamic pore pressure readings. Recorded in units selected by the operator
Column 5:	Empty, Resistivity, UVIF or Gamma data

End of Data Marker

After the last line of data there will be a line containing ASCII 26 (CTL-Z) and a newline (carriage return/ line feed) character. This is used to mark the end of data.

Units Information

The last section of the file contains information about the units that were selected for the sounding. A separator bar makes up the first line. The second line contains the type of units used for depth, q_c, f_s and u. The third line contains the conversion values required for ConeTec's software to convert the recorded data to an internal set of base units (bar for q_c, bar for f_s and meters for u).

CPT Dissipation Files (PPx Extension)

CPT Dissipation files have the same naming convention as the CPT sounding files and have the extension PPD, PPF or PPM. PPF (PPM and PPD) files consist of the following components:

1. Two lines of header information
2. Data records

Header Lines (same as COR file):

Line 1: Columns 1-6 may be blank or may indicate the version number of the recording software
Columns 7-21 contain the sounding Date and Time
Columns 22-36 contain the sounding Operator

Line 2: Columns 1-16 contain the Job Location
Columns 17-31 contain the Cone ID
Columns 32-47 contain the sounding number

Data Records

The data records immediately follow the header lines. Each data record can occupy several lines in the file and is a complete record of a dissipation test at a particular depth. Each data record starts with a line containing two values separated by spaces; the first value being an index number (not currently used by the Software) and the second being the dissipation test depth in meters. Following this line are the dissipation pore pressure values stored at 5 second intervals with a maximum of 12 entries per line. The last line of the dissipation record may not contain a full 12 entries. The data record is terminated with an ASCII 30 character (appears as a triangle in some editors).

This sequence is repeated for every dissipation test in the sounding. No marker is used to indicate end of file. Units information is not stored in this file. Users need to check the CPT file for the units that were used.

CPT Basic Interpretations (TBL Extension)

ConeTec's basic CPT interpretation output files are generally delivered in text files with a TBL extension. The root file name is the same as the COR files. A number of calculated geotechnical parameters are presented in these files. The files are stored as ASCII text files that can be viewed using any text editor such as Notepad or Wordpad. The files do not contain any page formatting. These files are not distributed if the enhanced interpretation files are provided.

CPT Enhanced Interpretations (IFI, IFP, XLS Extension)

ConeTec's enhanced CPT interpretation output files are delivered in several formats, each file type containing the exact same information but formatted slightly differently. The files typically have any of the following file extensions:

1. IFI — an importable TAB delimited ASCII text file containing approximately 47 data columns of geotechnical interpretations. The file is designed for easy import to Excel. A companion document describes the techniques used for the interpretations (usually reproduced at the beginning of the Interpretation Appendix). Text editors can be used to view the file contents, however, they may remove the tabs or replace the tabs with spaces upon saving the file destroying the feature that makes them easy to import into Excel.

   Because Excel imports the data as text and the sheet is protected two steps may be necessary to modify the data or use the values in certain Excel functions:

   a) Under Tools (Excel 2000) Select the Protection Option and then Unprotect the sheet
   b) Select the entire sheet, copy and then use Paste Special to paste as values to a second sheet.

   Future versions of our interpretation routine will address these inconveniences.

2. IFP — a printable ASCII text file containing the same 47 columns of geotechnical interpretations as the IFI file. This file type has been formatted as a multi-page document with up to 132 characters per line and up to 68 lines per page. Each page has been separated into multiple sections to accommodate all the data fields. Each physical page has a header section and a page/section number. The file is designed for direct printing to laser printers set into compressed font mode. This output is typically provided in the Interpretation Appendix.

   An abbreviated set of interpretations (containing 36 columns of output) may be generated instead. These files usually have the extensions NLI and NLP. XLS files can be generated from these as well.

3. XLS — an Excel format file that has been generated directly from the corresponding IFI file. IFI and IFP files are not distributed if the XLS files are generated. The XLS files may have been generated from abbreviated NLI interpretation files.

In each case root file name is the same as the COR files.

CPT Interpretations (Excel Format)

ConeTec's latest software (September 2007) outputs CPT interpretations directly to Excel format (XLS extension) without creating intermediate ASCII files. Because of the desires of various clients, there are several different configurations of output parameters in ConeTec's interpretation files. Since the Excel format file must have the XLS extension a suffix is used after the basename of the source CPT data file (COR) to identify the format of the file. The configurations still follow the formats described above and use the same extensions but now as suffixes. To allow for various runs (e.g. using a different water table, or user supplied equilibrium profile, or different methods for a particular parameter) of the same data an additional suffix may be specified by the engineer post processing the data to identify each particular run. This suffix will follow the one used to identify the format of the file.

For example:

If the selected format is ConeTec's TBL configuration and each run is identified by a run number. The resultant files generated for 278CP01.COR would be:

78CP01-TBL-RUN01.XLS
78CP01-TBL-RUN02.XLS
78CP01-TBL-RUN03.XLS

CPT Data in Excel Format

ConeTec can now provide the equivalent of the ASCII COR files in Excel Format. These files will have the same basename as the COR files and an XLS extension.

Pore Pressure Dissipation Data in Excel Format

ConeTec can now provide the equivalent of the ASCII PPD format files in Excel format. These files will contain each dissipation trace that exceeds a minimum duration (selected by the engineer during post-processing) in a particular Excel spreadsheet column. The first column (Column A) will contain the time in seconds and the second column (Column B) will contain the time in minutes. Subsequent columns will contain dissipation trace data. The time columns will extend to the longest trace of the data set.

Detailed header information is provided at the top of the spreadsheet. The test depth in meters and feet, the number of points in the trace and the particular units are identified at the top of each trace column.

The Excel format file names will have the same basename as the original PPD format file followed by the suffix -PPD and then followed by a second suffix that the engineer doing the post processing can specify. Because the engineer can select various types of units for the dissipation data output (which can be different from the units used in the original recording) the secondary suffix is often used to identify the units in the XLS file, however, the original recorded units and the output units are clearly identified within the XLS spreadsheet file.

LABORATORY TEST RESULTS

APPENDIX C

Project: Michael Baker Jr., Inc.: Rahway Arch
Project No.: 19998709

URS

SUMMARY OF LABORATORY TEST RESULTS

Boring and Sample Number	Depth (feet)	Classification	USCS and AASHTO Symbols	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits		Specific Gravity	Organic Content (%)	Grain Size		Compaction	Consolidation	Analytical Results (ppm)		Triaxial Compression		Unconfined Compression		pH
						Liquid Limit	Plastic Limit			<#200 (%)	<2μ (%)			Chloride	Sulfate	UU	CIU	Stress (psi)	Strain (%)	
BD-01R T-1	24.0-26.0	Gray ELASTIC SILT with SAND	MH A-7-5(133)	72.9		291	173	2.36	14.76	79	16									6.9
BD-01R T-1	—			66.3	58.2											*				
BD-03 T-1	23.0-25.0	Gray SANDY ELASTIC SILT	MH A-7-5(42)	65.1		105	45	2.53		66	18									
BD-03 T-1	—			80.9	51.4												*			
BD-03 T-1	—			75.4	53.9												*			
BD-03 T-1	—			59.0	51.4												*			
BD-03 S-12	25.0-27.0	Gray SANDY FAT CLAY	CH A-7-5(28)	73.8		89	35			57	14									
BD-04R T-1	21.0-23.0	Gray FAT CLAY	CH A-7-5(65)	75.0		98	41			93	18									
BD-04R T-1	—			81.9	51.2								*							
BD-04R T-1	—			77.1	52.6											*				
BD-05 S-5	14.0-16.0	Gray FAT CLAY with SAND	CH A-7-5(41)	70.9		78	34		5.7	82	16									6.6
BS-01 S-9	16.0-18.0	Brown SANDY LEAN CLAY	CL A-4(3)	20.4		25	17			65	17									
BS-02 T-1	7.0-9.0	Dark Gray SANDY ELASTIC SILT	MH A-7-5(158)	375.7		467	256	2.14	19.3	62	21									6.7
BS-02 T-1	—			384.1	13.6								*							
BS-02 T-1	—			384.0	13.6											*				
BS-04 T-1	23.0-25.0	Brown FAT CLAY	CH A-7-5(57)	71.9		93	38			87	21									
BS-04 T-1	—			110.5	45.6											*				
BS-04 S-12	25.0-27.0	Brown SILTY SAND	SM A-2-4(0)	45.0						32										
BS-08 T-1	15.0-17.0	Brown SILT with SAND	ML A-4(0)	20.1		20	18			71	7									

The soil classification and USCS symbols are based partially on visual classification unless both Atterberg limits and grain size analysis tests are performed.

* Refer to Laboratory Test Curves

Project: Michael Baker Jr., Inc.: Rahway Arch
Project No.: 19998709

URS

SUMMARY OF LABORATORY TEST RESULTS

Boring and Sample Number	Depth (feet)	Classification	USCS and AASHTO Symbols	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits		Specific Gravity	Organic Content (%)	Grain Size		Compaction	Consolidation	Analytical Results (ppm)		Triaxial Compression		Unconfined Compression		pH
						Liquid Limit	Plastic Limit			<#200 (%)	<2μ (%)			Chloride	Sulfate	UU	CIU	Stress (psi)	Strain (%)	
BS-08 T-1	—			19.4	109.9											*				6.5
BS-08 S-10	21.0-23.0	Brown SILT with SAND	ML A-4(0)	16.0						80										
BS-09 T-1	12.0-14.0	Gray SILTY SAND	SM A-7-5(43)	58.6		241	113	2.52	2.9	43	8									
BS-09 T-1	—			170.9	28.4												*			
BS-09 T-1	—			154.2	24.3												*			
BS-09 T-1	—			59.0	92.6												*			
BS-09 T-1	—			48.6	69.0								*							
ID-06 U-2	14.0-16.0	Dark Gray FAT CLAY	CH A-7-5(99)	120.9		130	43	2.58		94	32									
ID-06 U-2	--			96.4	46.5								*							
IS-02 U-1	19.0-21.0	Dark Gray SANDY LEAN CLAY	CL A-6(6)	99.3		33	22	2.63		69	14									
IS-02 U-1	—			223.1	22.7								*							
IS-02 U-1	—			37.5	86.2											*				
W-05 T-1	15.0-17.0	Brown SANDY LEAN CLAY	CL A-4(2)	26.1		25	15			53	15									
W-05 T-1	—			27.0	97.3											*				
W-08 U-1	14.0-16.0	Gray LEAN CLAY	CL A-6(17)			36	16			87	33									
W-08 U-1	—			30.4	91.9											*				

The soil classification and USCS symbols are based partially on visual classification unless both Atterberg limits and grain size analysis tests are performed.

* Refer to Laboratory Test Curves

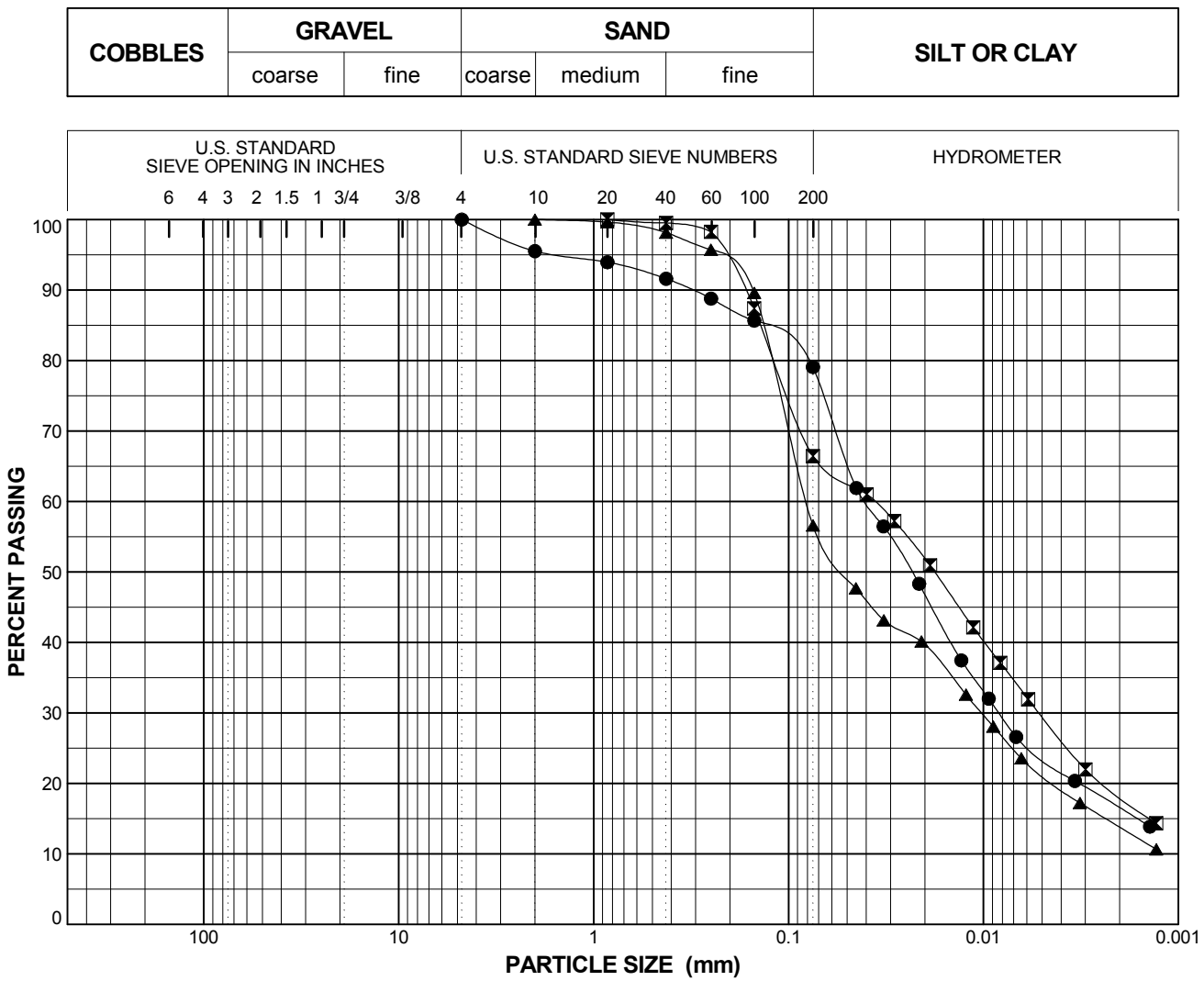
URS Corporation #19998709
Rahway Arch Site Carteret, New Jersey
LABORATORY TESTING DATA SUMMARY

BORING	SAMPLE	DEPTH	IDENTIFICATION TESTS										PERMEABILITY	STRENGTH			CONSOLIDATION		REMARKS
																	INITIAL CONDITIONS		
NO.	NO.	(ft)	WATER CONTENT (%)	LIQUID LIMIT (-)	PLASTIC LIMIT (-)	PLAS. INDEX (-)	USCS SYMB. (1)	SIEVE MINUS NO. 200 (%)	HYDRO. % MINUS 2 μm (%)	TOTAL UNIT WEIGHT (pcf)	DRY UNIT WEIGHT (pcf)	SPECIFIC GRAVITY (-)	(cm/sec)	TEST TYPE	PEAK SHEAR STRESS (ksf)	AXIAL STRAIN @ PEAK STRESS (%)	VOID RATIO* (-)	SATUR-ATION* (%)	/Test ID
BS-03R	T-1	8-10								91.3									
BS-03R	T-1A	8.35	90.9				MH			96.4	50.5			CIU@0.2	1.1	17.5			T3303
BS-03R	T-1	8.65	120.0																
BS-03R	T-1B	8.9	108.1				MH			91.7	44.0			CIU@2	1.3	3.0			T3304
BS-03R	T-1	9.2	116.4																
BS-03R	T-1C	9.45	106.7				MH			94.1	45.5			CIU@5	3.3	2.5			T3305
BS-03R	T-1	9.75	87.3																
BS-03R	T-1D	10.0	124.3				MH	93.0	18	91.3	40.7	3.173					3.866	102	C12129
BS-06	U-1	2-4								85.3									
BS-06	U-1	2.75	77.4																
BS-06	U-1	3.3	73.6																
BS-06	U-1C	3.55	84.9				MH	96.0	21	94.4	51.1	3.100					2.790	94	C12128
ID-01	S-3	4-6	134.3	59	49	10	MH	96.6	5										
ID03R	T-1	0-2								79.3									
ID03R	T-1	0.45	114.5																
ID03R	T-1	1.0	170.1																
ID03R	T-1C	1.25	157.1				MH	86.7	26	83.6	32.5	2.756					4.289	101	C12127
ID-04	T-1	8-10								72.6									
ID-04	T-1	8.6	269.9				PT											Disturbed, no test	
ID-06	U-1	0-2								76.5								Disturbed, no test	
ID-06	S-2	2-4	109.2	62	61	1	MH												

URS Corporation #19998709
Rahway Arch Site Carteret, New Jersey
LABORATORY TESTING DATA SUMMARY

BORING NO.	SAMPLE NO.	DEPTH (ft)	IDENTIFICATION TESTS: WATER CONTENT (%)	LIQUID LIMIT (-)	PLASTIC LIMIT (-)	PLAS. INDEX (-)	USCS SYMB. (1)	SIEVE MINUS NO. 200 (%)	HYDRO. % MINUS 2 μm (%)	TOTAL UNIT WEIGHT (pcf)	DRY UNIT WEIGHT (pcf)	SPECIFIC GRAVITY (-)	PERMEABILITY (cm/sec)	STRENGTH: TEST TYPE	PEAK SHEAR STRESS (ksf)	AXIAL STRAIN @ PEAK STRESS (%)	CONSOLIDATION INITIAL CONDITIONS: VOID RATIO* (-)	SATUR-ATION* (%)	REMARKS /Test ID
Sludge Composite (2)				NP	64		MH												
Sludge Composite (2)			115.8				MH			93.2	43.2			UU@1	0.0	1.4			
Sludge Composite (2)			112.3				MH			92.9	43.8						3.704	100	C12146
Sludge Composite (2)			94.5				MH			91.1	46.8		6.4E-6						P9528
Sludge Composite (2)			100.8				MH			91.5	45.6			CIU@0.2	0.3	18.9			T3315
Sludge Composite (2)			97.9				MH			92.5	46.7			CIU@ 2	2.1	20.0			T3316
Sludge Composite (2)			94.3				MH			94.3	47.5			CIU@ 5	5.1	20.7			T3317

Note: (1) USCS symbol based on visual observation and Sieve reported.
(2) Composite from sludge materials in BS-03R T-1, BS-06 U-1, and ID03R T-1
* Saturation and Void Ratio based on measured specific gravities



SYMBOL	●	⧗	▲
Boring	BD-01R	BD-03	BD-03
Sample	T-1	T-1	S-12
Spec			
Depth (ft)	24.0-26.0	23.0-25.0	25.0-27.0
% +3"	0.0	0.0	0.0
% Gravel	0.0	0.0	0.0
% Sand	20.9	33.5	43.4
% Fines	79.1	66.5	56.6
% -2μ	16.5	18.3	13.8
Cc			
Cu			
LL	291	105	89
PL	173	45	35
PI	118	60	54
USCS	MH	MH	CH
w (%)	72.9	65.1	73.8

Particle Size (Sieve #)	PERCENT FINER ●	⧗	▲
4"			
3"			
1-1/2"			
3/4"			
3/8"			
4	100.0		
10	95.5		100.0
20	94.0	100.0	99.6
40	91.6	99.5	98.1
60	88.8	98.3	95.7
100	85.7	87.4	89.6
200	79.1	66.5	56.6

SYMBOL	DESCRIPTION AND REMARKS
●	Gray ELASTIC SILT with SAND (MH)
⧗	Gray SANDY ELASTIC SILT (MH)
▲	Gray SANDY FAT CLAY (CH)

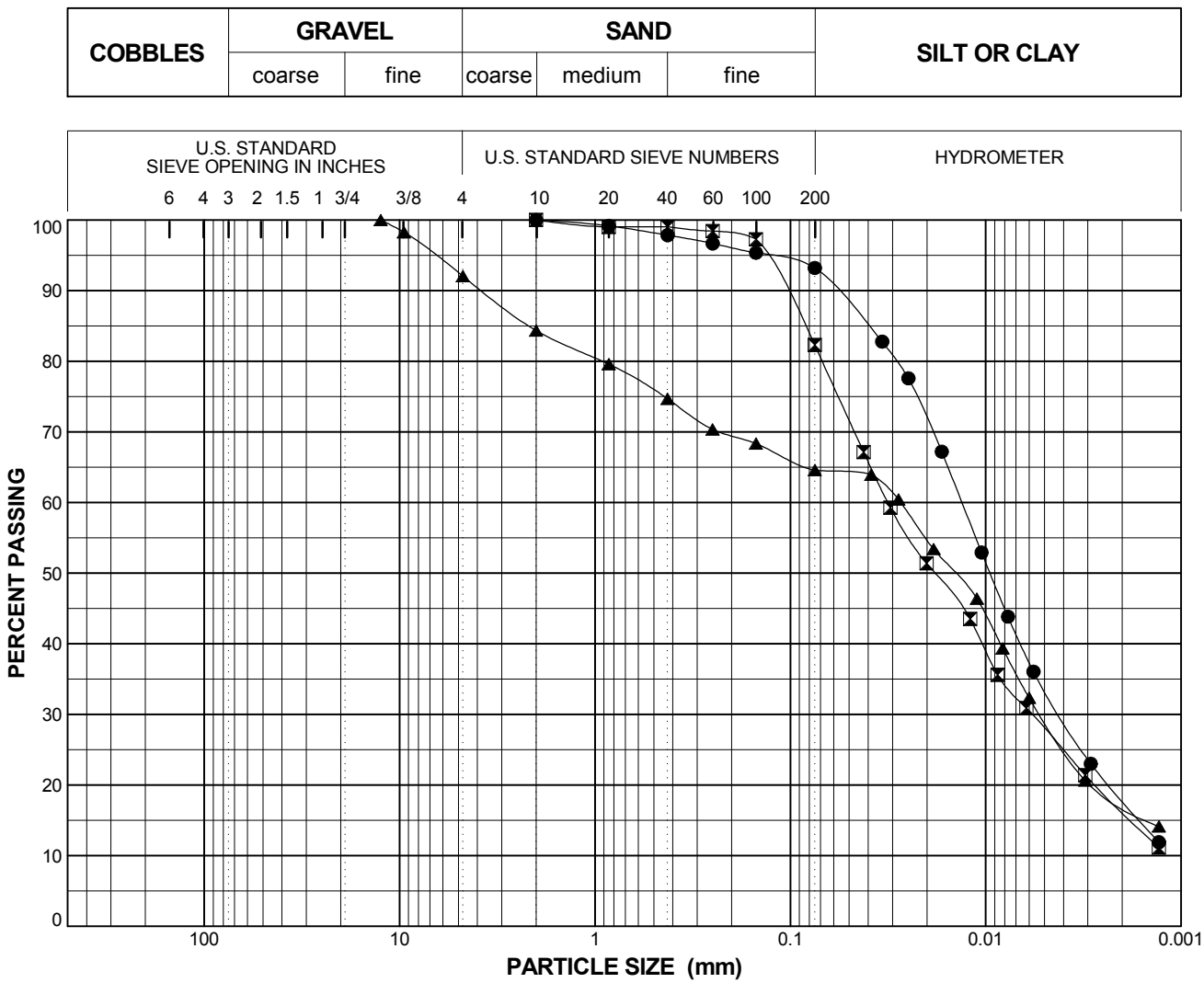
PARTICLE SIZE DISTRIBUTION

Michael Baker Jr., Inc.: Rahway Arch

Project Number 19998709	September 2012	Figure 1

URS

SIEVE_BLUEBELL 19998709 RAHWAY ARCH.GPJ URS_BLUE.GDT 10/1/12



SYMBOL	●	⧗	▲
Boring	BD-04R	BD-05	BS-01
Sample	T-1	S-5	S-9
Spec			
Depth (ft)	21.0-23.0	14.0-16.0	16.0-18.0
% +3"	0.0	0.0	0.0
% Gravel	0.0	0.0	7.9
% Sand	6.8	17.7	27.5
% Fines	93.2	82.3	64.6
% -2μ	17.9	16.2	17.4
Cc			
Cu			
LL	98	78	25
PL	41	34	17
PI	57	44	8
USCS	CH	CH	CL
w (%)	75.0	70.9	20.4

Particle Size (Sieve #)	PERCENT FINER ●	⧗	▲
4"			
3"			
1-1/2"			
3/4"			
3/8"			98.3
4			92.1
10	100.0	100.0	84.3
20	99.2	99.0	79.6
40	97.8	99.0	74.7
60	96.7	98.4	70.4
100	95.4	97.3	68.3
200	93.2	82.3	64.6

SYMBOL	DESCRIPTION AND REMARKS
●	Gray FAT CLAY (CH)
⧗	Gray FAT CLAY with SAND (CH)
▲	Brown SANDY LEAN CLAY (CL)

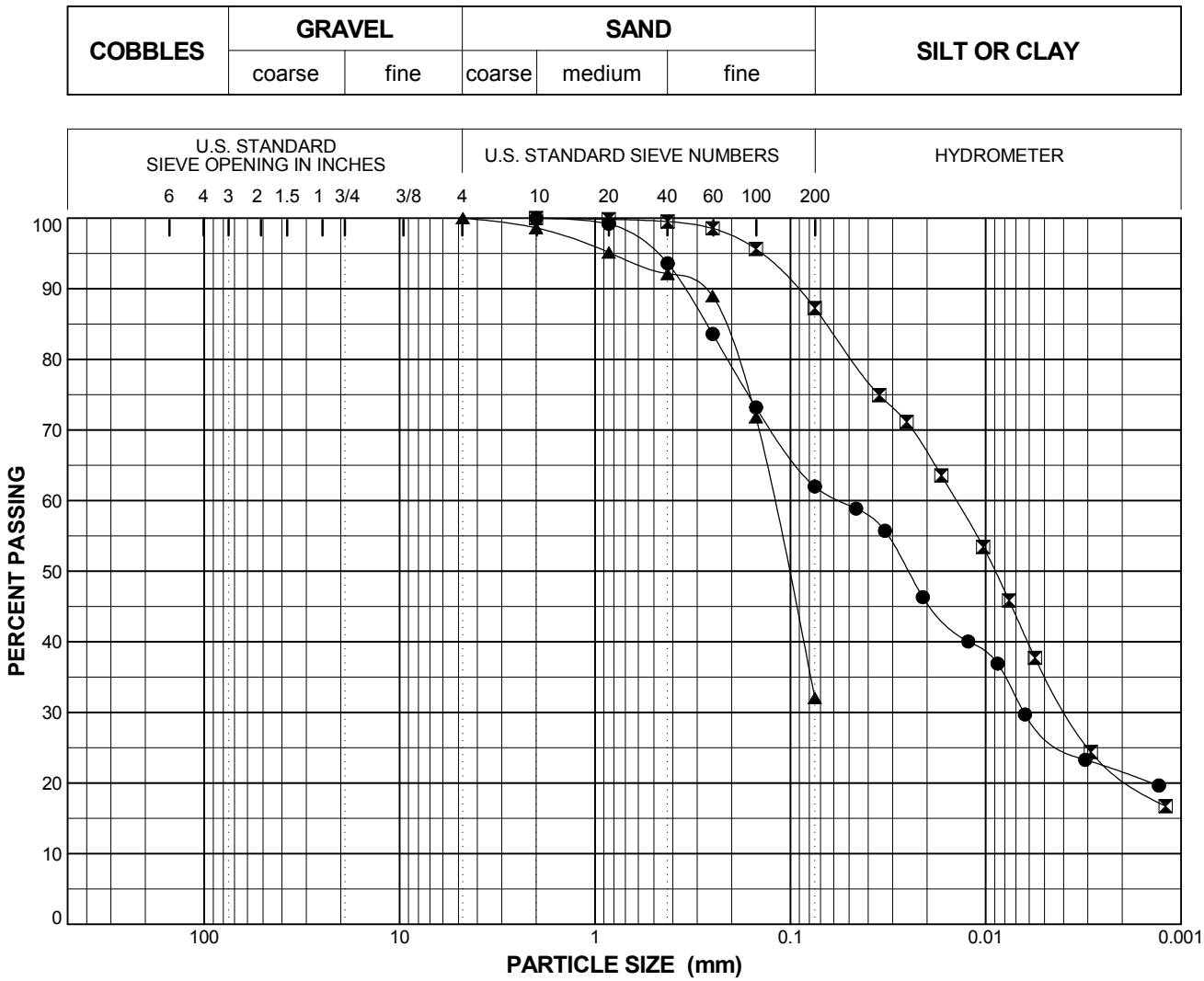
PARTICLE SIZE DISTRIBUTION

Michael Baker Jr., Inc.: Rahway Arch

Project Number 19998709	September 2012	Figure 2

URS

SIEVE_BLUEBELL 19998709 RAHWAY ARCH.GPJ URS_BLUE.GDT 10/1/12



SYMBOL	●	⧗	▲
Boring	BS-02	BS-04	BS-04
Sample	T-1	T-1	S-12
Spec			
Depth (ft)	7.0-9.0	23.0-25.0	25.0-27.0
% +3"	0.0	0.0	0.0
% Gravel	0.0	0.0	0.0
% Sand	38.0	12.7	68.0
% Fines	62.0	87.3	32.0
% -2μ	21.5	21.2	
Cc			
Cu			
LL	467	93	
PL	256	38	
PI	211	55	
USCS	MH	CH	SM
w (%)	375.7	71.9	45.0

Particle Size (Sieve #)	PERCENT FINER ●	⧗	▲
4"			
3"			
1-1/2"			
3/4"			
3/8"			
4			100.0
10	100.0	100.0	98.6
20	99.2	99.8	95.1
40	93.6	99.5	92.1
60	83.6	98.5	89.0
100	73.2	95.6	71.8
200	62.0	87.3	32.0

SYMBOL	DESCRIPTION AND REMARKS
●	Dark Gray SANDY ELASTIC SILT (MH)
⧗	Brown FAT CLAY (CH)
▲	Brown SILTY SAND (SM)

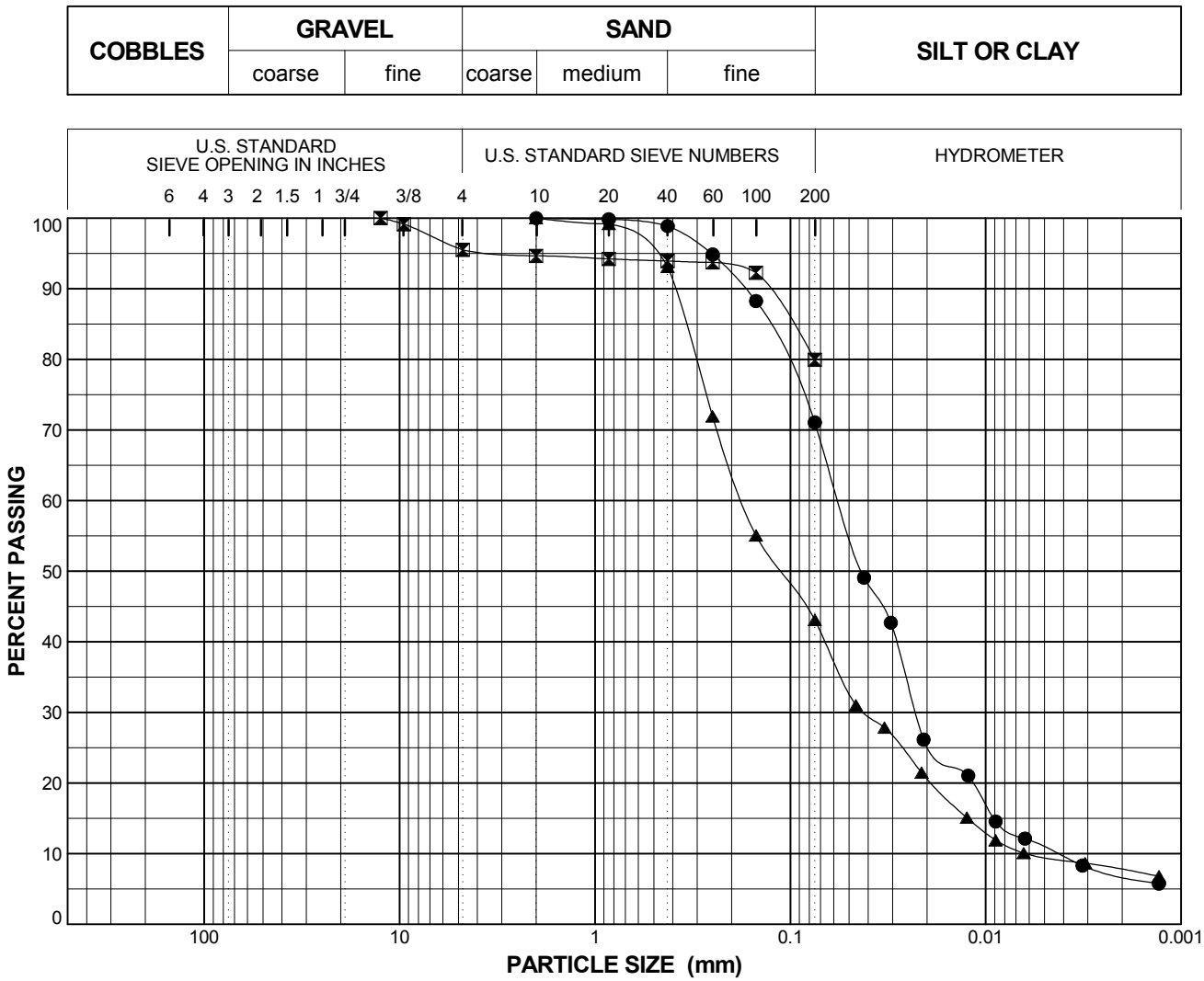
PARTICLE SIZE DISTRIBUTION

Michael Baker Jr., Inc.: Rahway Arch

Project Number 19998709	September 2012	Figure 3

URS

SIEVE_BLUEBELL 19998709 RAHWAY ARCH.GPJ URS_BLUE.GDT 10/1/12



SYMBOL	●	⧗	▲
Boring	BS-08	BS-08	BS-09
Sample	T-1	S-10	T-1
Spec			
Depth (ft)	15.0-17.0	21.0-23.0	12.0-14.0
% +3"	0.0	0.0	0.0
% Gravel	0.0	4.5	0.0
% Sand	28.9	15.6	56.9
% Fines	71.1	80.0	43.1
% -2μ	7.0		7.7
Cc	2.14		1.61
Cu	12.98		28.37
LL	20		241
PL	18		113
PI	2		128
USCS	ML	ML	SM
w (%)	20.1	16.0	58.6

Particle Size (Sieve #)	PERCENT FINER ●	⧗	▲
4"			
3"			
1-1/2"			
3/4"			
3/8"		99.1	
4		95.5	
10	100.0	94.7	100.0
20	99.8	94.2	99.2
40	98.9	93.9	93.1
60	94.9	93.7	72.0
100	88.3	92.3	55.1
200	71.1	80.0	43.1

SYMBOL	DESCRIPTION AND REMARKS
●	Brown SILT with SAND (ML)
⧗	Brown SILT with SAND (ML)
▲	Gray SILTY SAND (SM)

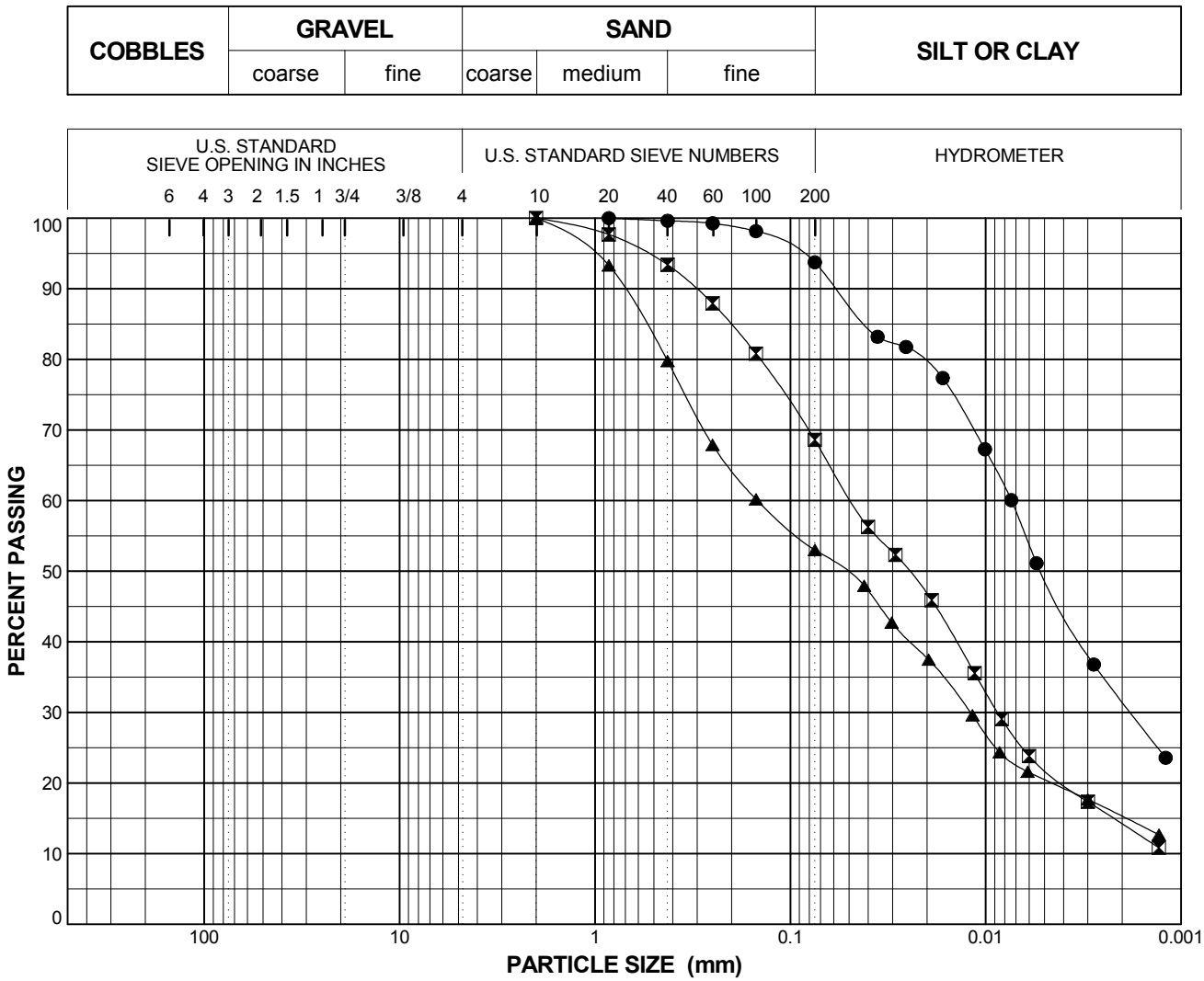
PARTICLE SIZE DISTRIBUTION

Michael Baker Jr., Inc.: Rahway Arch

Project Number 19998709	September 2012	Figure 4

URS

SIEVE_BLUEBELL 19998709 RAHWAY ARCH.GPJ URS_BLUE.GDT 10/1/12



SYMBOL	●	⧗	▲
Boring	ID-06	IS-02	W-05
Sample	U-2	U-1	T-1
Spec			
Depth (ft)	14.0-16.0	19.0-21.0	15.0-17.0
% +3"	0.0	0.0	0.0
% Gravel	0.0	0.0	0.0
% Sand	6.3	31.4	47.0
% Fines	93.8	68.6	53.0
% -2μ	31.5	14.2	15.3
Cc			
Cu			
LL	130	33	25
PL	43	22	15
PI	87	11	10
USCS	CH	CL	CL
w (%)	120.9	99.3	26.1

Particle Size (Sieve #)	PERCENT FINER ●	⧗	▲
4"			
3"			
1-1/2"			
3/4"			
3/8"			
4			
10		100.0	100.0
20	100.0	97.7	93.3
40	99.6	93.4	79.8
60	99.3	87.9	67.9
100	98.2	80.8	60.2
200	93.8	68.6	53.0

SYMBOL	DESCRIPTION AND REMARKS
●	Dark Gray FAT CLAY (CH)
⧗	Dark Gray SANDY LEAN CLAY (CL)
▲	Brown SANDY LEAN CLAY (CL)

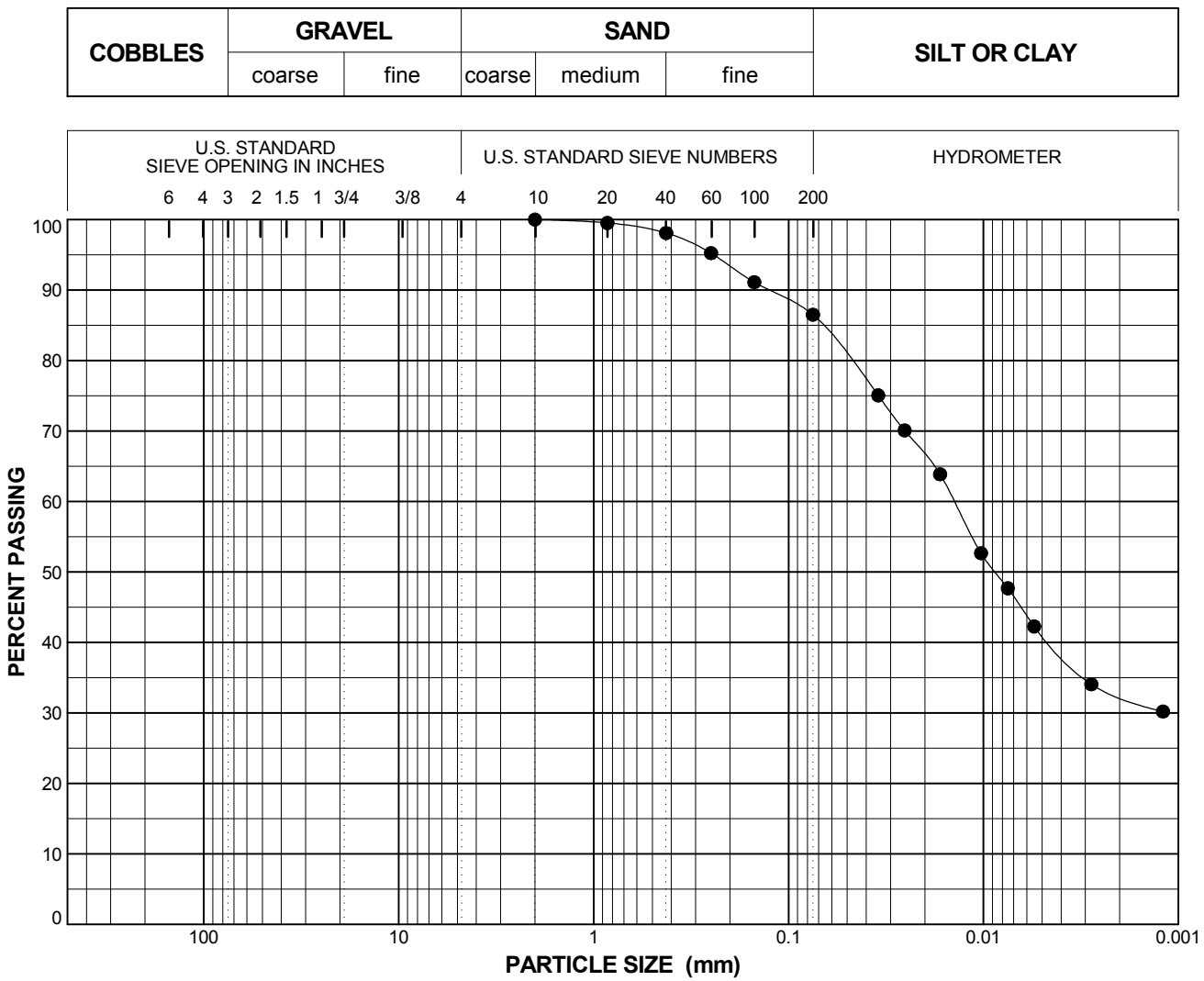
PARTICLE SIZE DISTRIBUTION

Michael Baker Jr., Inc.: Rahway Arch

Project Number 19998709	September 2012	Figure 5

URS

SIEVE_BLUEBELL 19998709 RAHWAY ARCH.GPJ URS_BLUE.GDT 10/1/12



SYMBOL	●		
Boring	W-08		
Sample	U-1		
Spec			
Depth (ft)	14.0-16.0		
% +3"	0.0		
% Gravel	0.0		
% Sand	13.5		
% Fines	86.5		
% -2μ	32.5		
Cc			
Cu			
LL	36		
PL	16		
PI	20		
USCS	CL		
w (%)			

Particle Size (Sieve #)	PERCENT FINER ●		
4"			
3"			
1-1/2"			
3/4"			
3/8"			
4			
10	100.0		
20	99.5		
40	98.1		
60	95.2		
100	91.1		
200	86.5		

SYMBOL	DESCRIPTION AND REMARKS
●	Gray LEAN CLAY (CL)

PARTICLE SIZE DISTRIBUTION

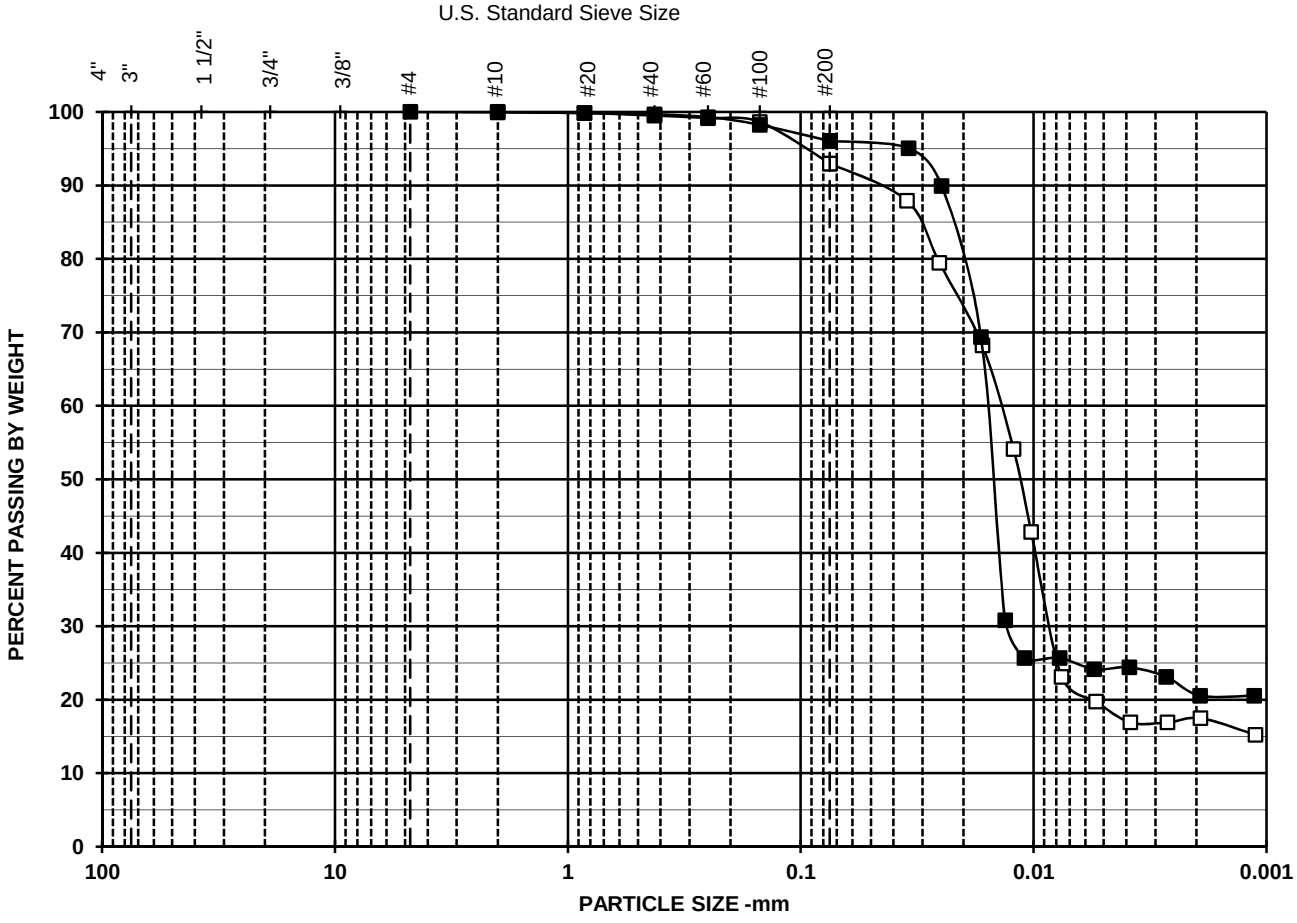
Michael Baker Jr., Inc.: Rahway Arch

Project Number 19998709	September 2012	Figure 6

URS

SIEVE_BLUEBELL 19998709 RAHWAY ARCH.GPJ URS_BLUE.GDT 10/1/12

COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	



Symbol	□	■	○
Boring	BS-03R	BS-06	
Sample	T-1D	U-1C	
Depth	10	3.55	
% +3"	0.0	0.0	
% Gravel	0.0	0.0	
% SAND	7.0	4.0	
%C SAND	0.0	0.1	
%M SAND	0.5	0.3	
%F SAND	6.5	3.6	
% FINES	93.0	96.0	
% -2μ	18	21	
D_{100} (mm)	2.00	4.75	
D_{60} (mm)	0.01	0.02	
D_{30} (mm)	0.01	0.01	
D_{10} (mm)			
Cc			
Cu			

Particle Size	PERCENT FINER		
(Sieve #)	□	■	○
4"			
3"			
1 1/2"			
3/4"			
3/8"			
4		100.0	
10	100.0	99.9	
20	99.8	99.9	
40	99.5	99.7	
60	99.2	99.3	
100	98.6	98.2	
200	93.0	96.0	

SYMBOL	w (%)	LL	PL	PI	USCS	DESCRIPTION AND REMARKS	Date Tested
□					MH	Gray, Elastic silt	8/13/2012
■					MH	Gray, Elastic silt	8/13/2012
○							

TerraSense, LLC	URS
T19998709	19998709

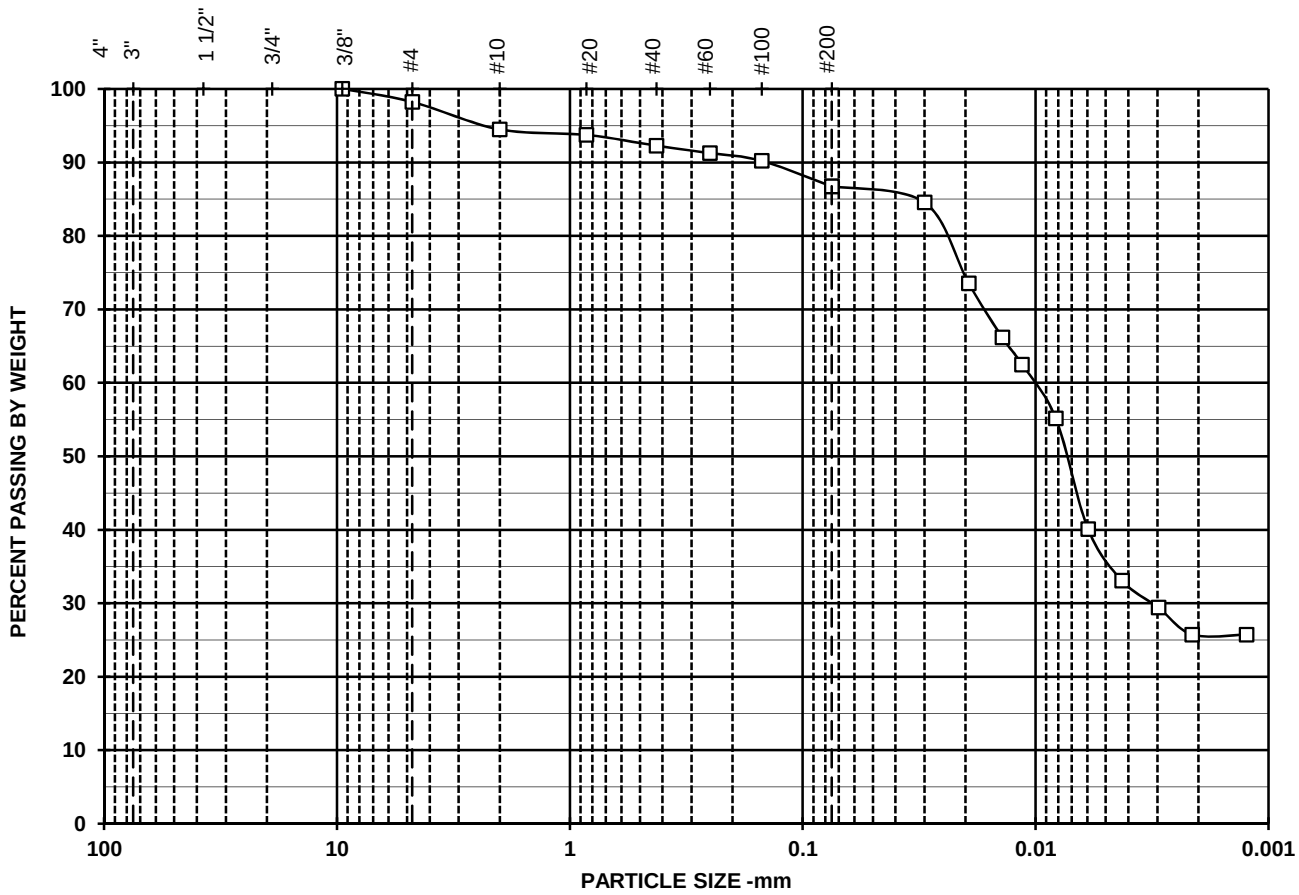
PARTICLE SIZE DISTRIBUTION

Rahway Arch Site, Carteret, New Jersey

Analysis File: 3SV-MasterRev3

siev1a.xlsx 9/11/2012

COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	



SYMBOL	w (%)	LL	PL	PI	USCS	DESCRIPTION AND REMARKS	Date Tested
□					MH	Gray, Elastic silt	8/13/2012
■							
○							

Symbol	□	■	○
Boring	ID-03R		
Sample	T-1C		
Depth	1.25		
% +3"	0.0		
% Gravel	1.8		
% SAND	11.5		
%C SAND	3.7		
%M SAND	2.2		
%F SAND	5.6		
% FINES	86.7		
% -2μ	26		
D_{100} (mm)	9.50		
D_{60} (mm)	0.01		
D_{30} (mm)	0.00		
D_{10} (mm)			
Cc			
Cu			

Particle Size	PERCENT FINER		
(Sieve #)	□	■	○
4"			
3"			
1 1/2"			
3/4"			
3/8"	100.0		
4	98.2		
10	94.5		
20	93.7		
40	92.3		
60	91.3		
100	90.2		
200	86.7		

TerraSense, LLC	URS
T19998709	19998709

PARTICLE SIZE DISTRIBUTION

Rahway Arch Site, Carteret, New Jersey

PERMEABILITY TEST: FALLING HEAD - CONSTANT VOLUME U-TUBE
ASTM D 5084 - Method F

Project No.: T19998709 | BORING: | Test No.: p9528

Project Name: Rahway Arch Site | SAMPLE: Sludge Composite | DEPTH (ft):

Specimen - Apparatus set-up - Test Information | Cell No. H-6 | Apparatus No. 1 | Stage No.: 3

Preliminary Length/Area Calculations

Lo =	4.117	in	Lo=	10.456	cm
dLc=	0.059	in	Ao =	19.31	cm^2
Lc=	4.058	in	Vo =	201.87	cm^3
			Lc=	10.306	cm
dVc = 3 Vo * (dLc/Lo)			dVc=	8.68	cm^3
			Vc =	193.19	cm^3
Sc =	0.550	cm^{-1}	Ac=	18.746	cm^2

1) Specimen Tested in :	x	Triaxial Cell or		Compaction Mold or		
	x	with stones or		Stones with filter paper or		top + bottom
2) Specimen orientation for:	x	Vertical or		Horizontal permeability determination		
3) During saturation: Water flushed up sides of specimen to remove air			x	No		Yes
4) During consolidation:	x	Top and bottom drainage or		Top		Bottom only
5) Direction of permeant :	x	Up during or		Down during permeation		
6) Permeant: water used	x	Tap		Distilled		
or		Demineralized		0.005 N calcium sulfate (CaSO4)		Permeability

Equations Used

Kt = - 0.0000757 * Sc/dT(min) * ln (ho/hf)

RT = (-0.02452*(ave. temp in C) + 1.495)

K @ 20 ºC = RT * Kt TubeC= 1.3127

Consol Stage- Trial No.	Temp. º C	Date	Time hr	Time min	Time sec	Initial σ_c psi	Initial Ub psi	U-tube Reading Head (cm) (cc)	U-tube Reading Tail (cm) (cc)	Flow in/out gradient	Preliminary Final at 20ºC cm/sec Dev. from Ave.
initial	22.0	10/9/12	10	13	00	105.0	100.0	49.00	40.84	0.98	5.48E-06
final	22.0	10/9/12	10	18	00			46.00	41.80		6.41E-06
1	RT = 0.956	dT =	5.00 min			σ'_c =	0.7 ksf	0.225	0.230	io= 10.0	0%
initial	22.0	10/9/12	10	20	00	105.0	100.0	49.00	40.84	0.96	5.52E-06
final	22.2	10/9/12	10	32	00			44.05	42.45		6.44E-06
2	RT = 0.953	dT =	12.00 min			σ'_c =	0.7 ksf	0.371	0.386	io= 10.0	0%
initial	22.2	10/9/12	10	33	00	105.0	100.0	49.00	40.84	0.96	5.52E-06
final	22.3	10/9/12	10	40	00			45.24	42.07		6.41E-06
3	RT = 0.949	dT =	7.00 min			σ'_c =	0.7 ksf	0.282	0.295	io= 10.0	0%
initial	22.3	10/9/12	10	41	00	105.0	100.0	49.00	40.84	0.96	5.55E-06
final	22.3	10/9/12	10	54	00			43.88	42.50		6.45E-06
4	RT = 0.948	dT =	13.00 min			σ'_c =	0.7 ksf	0.384	0.398	io= 10.0	0%
initial											
final											
5											
initial											
final											
6											

TEST SUMMARY

Final Specimen and Test Conditions

Lc =	10.306	cm	ε_{axial} =	1.4%
Ac =	15.308	cm^2		
Vc=	157.77	cm^3	ε_{vol} =	21.8%
Sc =	0.673	cm^{-1}	Sc = Lc / Ac , final	

	w (%)	γ_τ (pcf)	γ_d (pcf)	S (%)
Initial	94.54	91.1	46.8	93.6
PreTest	71.89	103.0	59.9	100.0

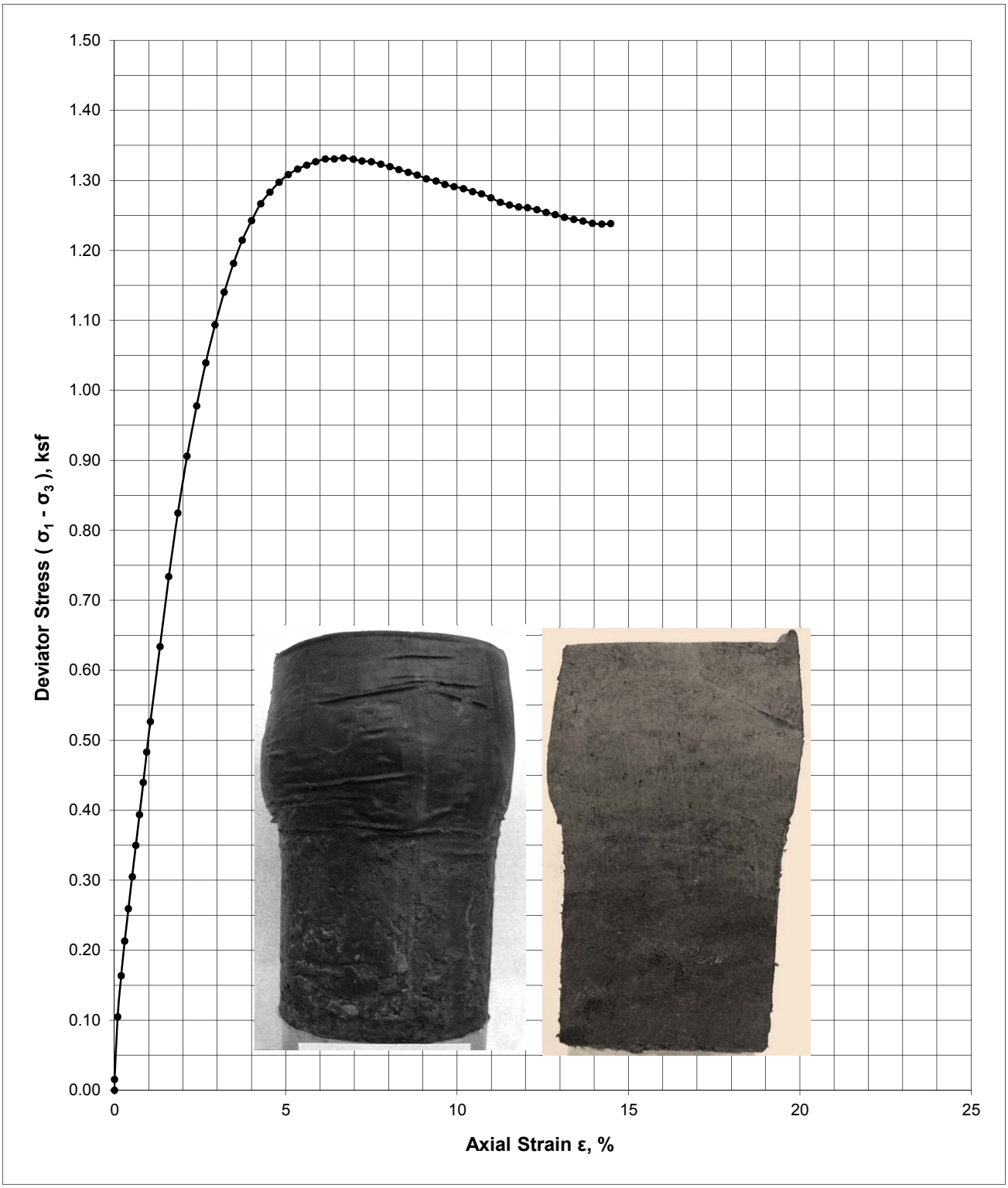
HYDRAULIC CONDUCTIVITY SUMMARY

Averages for trials: 1-4

ave K @ 20 ºC: **6.43E-06** cm/sec

(i_o)ave = 10.0

Tested By: DT Reviewed By: G. Thomas

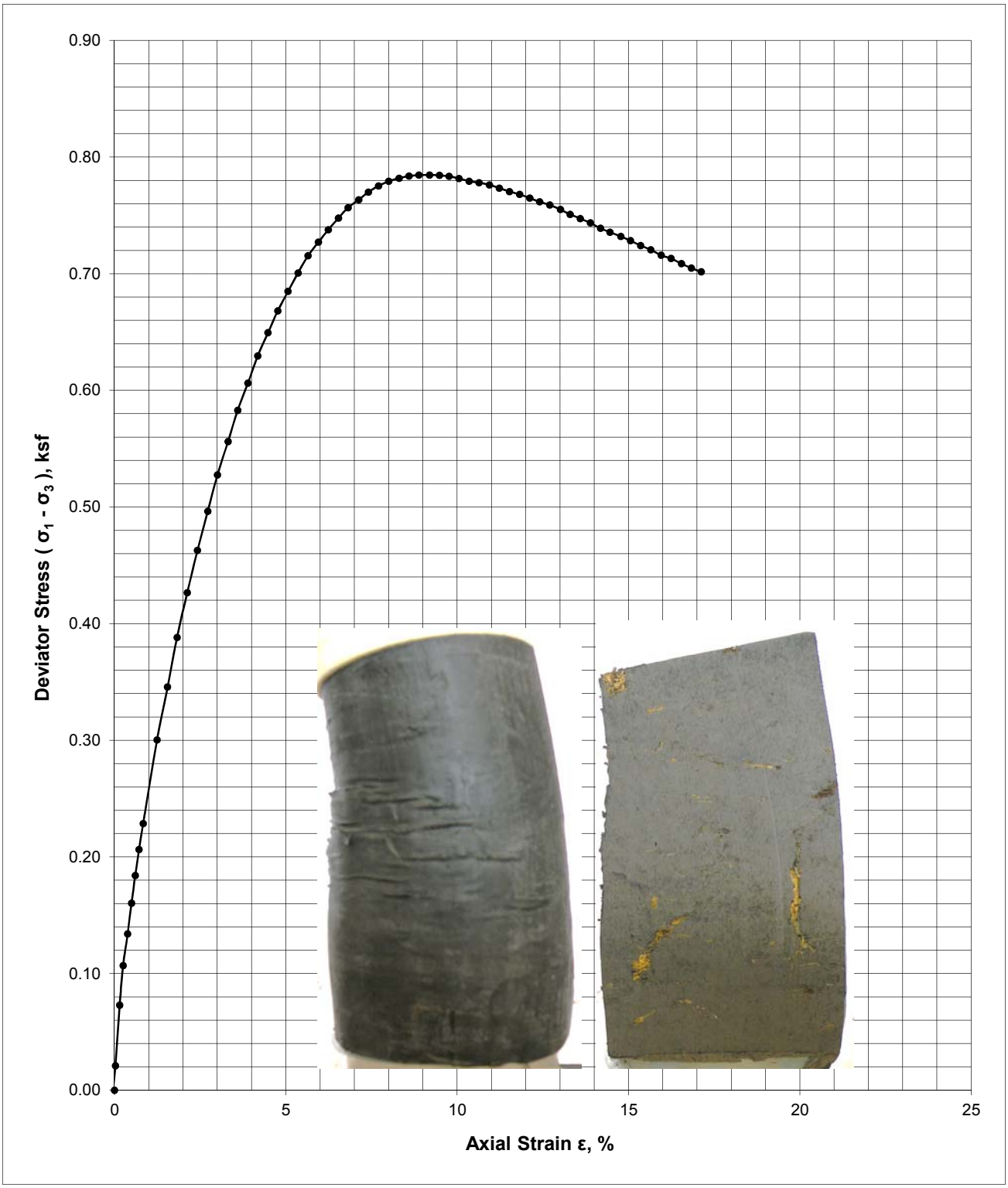


Specimen Information							Test Summary			
Water Content (%)	Wet Unit Weight (pcf)	Dry Unit Weight (pcf)	Atterberg Limits LL	Atterberg Limits PL	Initial Length (in)	Initial Dia. (in)	σ_3 (ksf)	$(\sigma_1 - \sigma_3)_{max}$ (ksf)	ε_f %	Strain Rate (%/min)
66.3	96.8	58.2	291	173	5.59	2.87	2.0	1.33	6.7	1.0
Description:	Gray Elastic SILT						Tested by: RM		Reviewed by: EM	

Project No.:	Project Name:	Unconsolidated-Undrained Triaxial Compression (UU) Test
19998709	**Rahway Arch**	**ASTM D 2850**

Boring No.: BD-01R	Sample No.: T-1	Sample Depth (ft): 24.0-26.0	Date: 9/6/2012

URS

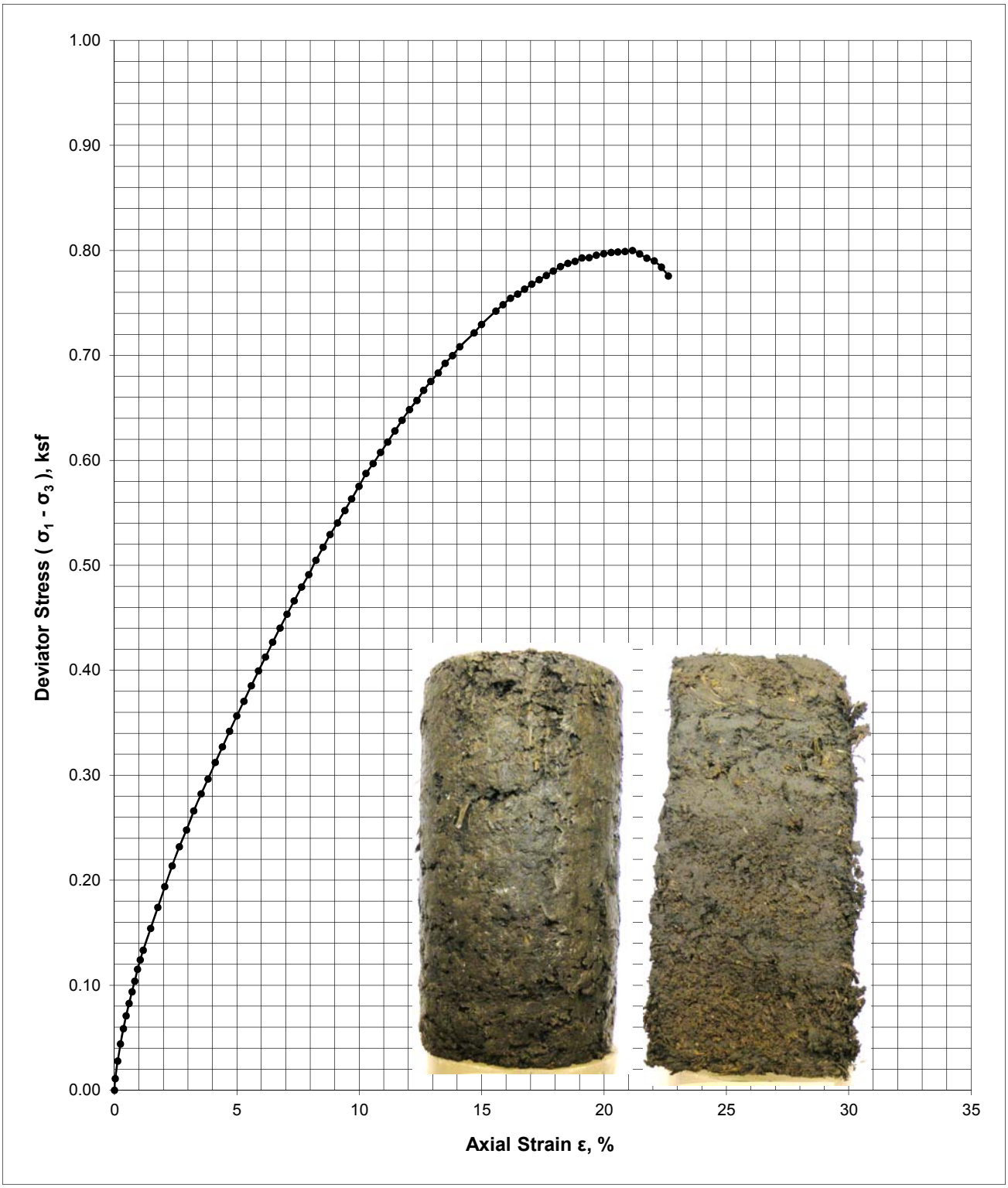


Specimen Information							Test Summary			
Water Content (%)	Wet Unit Weight (pcf)	Dry Unit Weight (pcf)	Atterberg Limits LL	Atterberg Limits PL	Initial Length (in)	Initial Dia. (in)	σ_3 (ksf)	$(\sigma_1 - \sigma_3)_{max}$ (ksf)	ε_f %	Strain Rate (%/min)
77.1	93.1	52.6	291	173	5.59	2.88	2.5	0.78	9.2	1.0
Description:	Dark Gray Fat CLAY						Tested by: TV		Reviewed by: EM	

Project No.:	Project Name:	Unconsolidated-Undrained Triaxial Compression (UU) Test
19998709	**Rahway Arch**	**ASTM D 2850**

Boring No.: BD-04R	Sample No.: T-1	Sample Depth (ft): 21.0-23.0	Date: 8/20/2012

URS

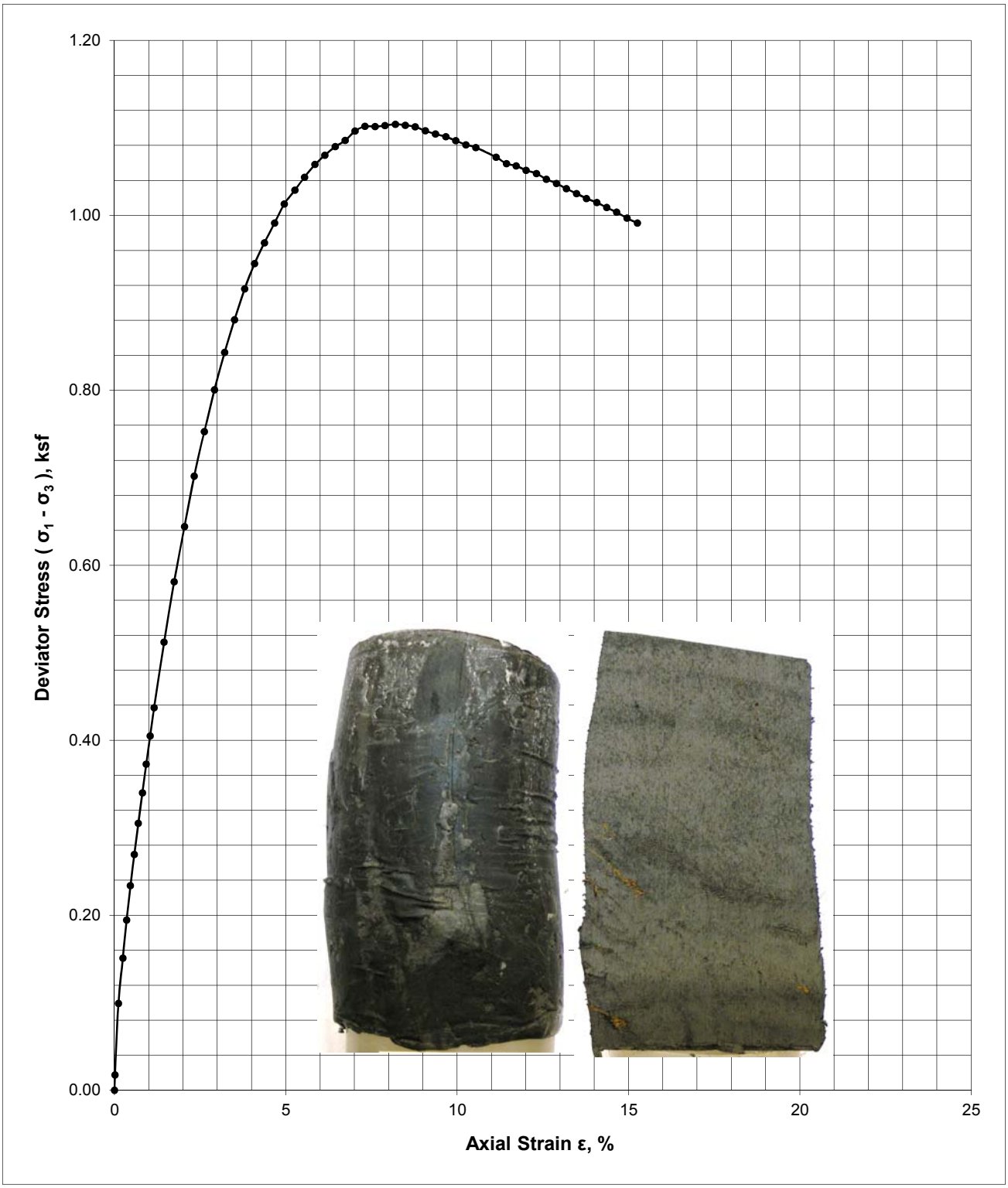


Specimen Information							Test Summary			
Water Content (%)	Wet Unit Weight (pcf)	Dry Unit Weight (pcf)	Atterberg Limits LL	Atterberg Limits PL	Initial Length (in)	Initial Dia. (in)	σ_3 (ksf)	$(\sigma_1 - \sigma_3)_{max}$ (ksf)	ε_f %	Strain Rate (%/min)
384.1	65.9	13.6	467	256	5.59	2.87	0.9	0.72	15.0	1.0
Description:	Dark Gray Sandy Elastic SILT						Tested by: TV		Reviewed by: EM	

Project No.:	Project Name:	Unconsolidated-Undrained Triaxial Compression (UU) Test
19998709	**Rahway Arch**	**ASTM D 2850**

Boring No.: BS-02	Sample No.: T-1	Sample Depth (ft): 7.0-9.0	Date: 8/20/2012

URS

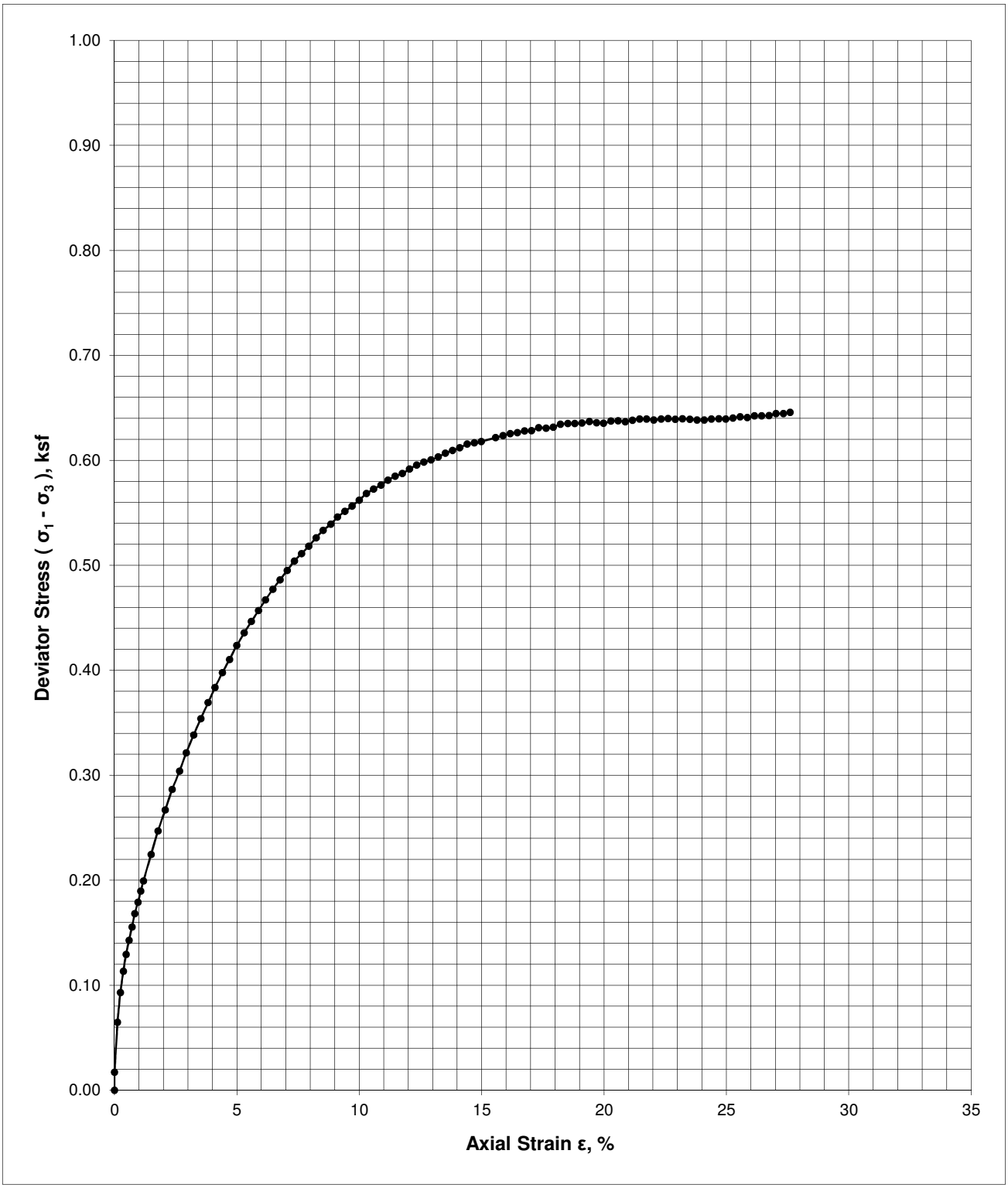


Specimen Information							Test Summary			
Water Content (%)	Wet Unit Weight (pcf)	Dry Unit Weight (pcf)	Atterberg Limits LL	Atterberg Limits PL	Initial Length (in)	Initial Dia. (in)	σ_3 (ksf)	$(\sigma_1 - \sigma_3)_{max}$ (ksf)	ε_f %	Strain Rate (%/min)
110.5	95.9	45.6	93	38	5.59	2.88	2.8	1.10	8.2	1.0
Description:	Brown Fat CLAY						Tested by: TV		Reviewed by: EM	

Project No.:	Project Name:	Unconsolidated-Undrained Triaxial Compression (UU) Test
19998709	**Rahway Arch**	**ASTM D 2850**

Boring No.: BS-04	Sample No.: T-1	Sample Depth (ft): 23.0-25.0	Date: 8/20/2012

URS

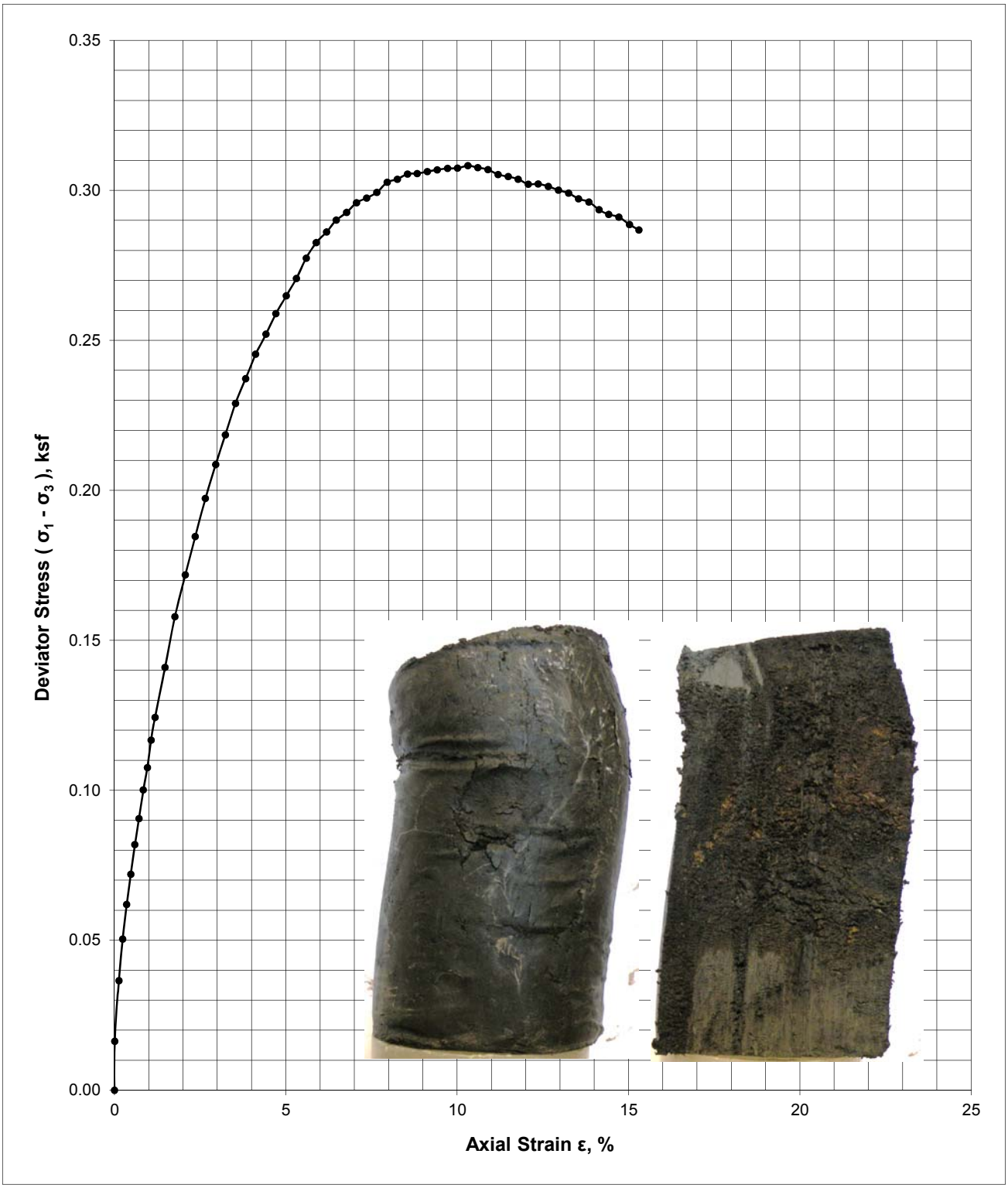


Specimen Information							Test Summary			
Water Content (%)	Wet Unit Weight (pcf)	Dry Unit Weight (pcf)	Atterberg Limits LL	Atterberg Limits PL	Initial Length (in)	Initial Dia. (in)	σ_3 (ksf)	$(\sigma_1 - \sigma_3)_{max}$ (ksf)	ε_f %	Strain Rate (%/min)
19.4	131.2	109.9	20	18	5.59	2.87	1.7	0.61	15.0	1.0
Description:	0						Tested by: TV		Reviewed by: EM	

Project No.:	Project Name:	Unconsolidated-Undrained Triaxial Compression (UU) Test
19998709	**Rahway Arch**	**ASTM D 2850**

Boring No.: BS-08	Sample No.: T-1	Sample Depth (ft): 14.0-16.0	Date: 8/15/2012

URS

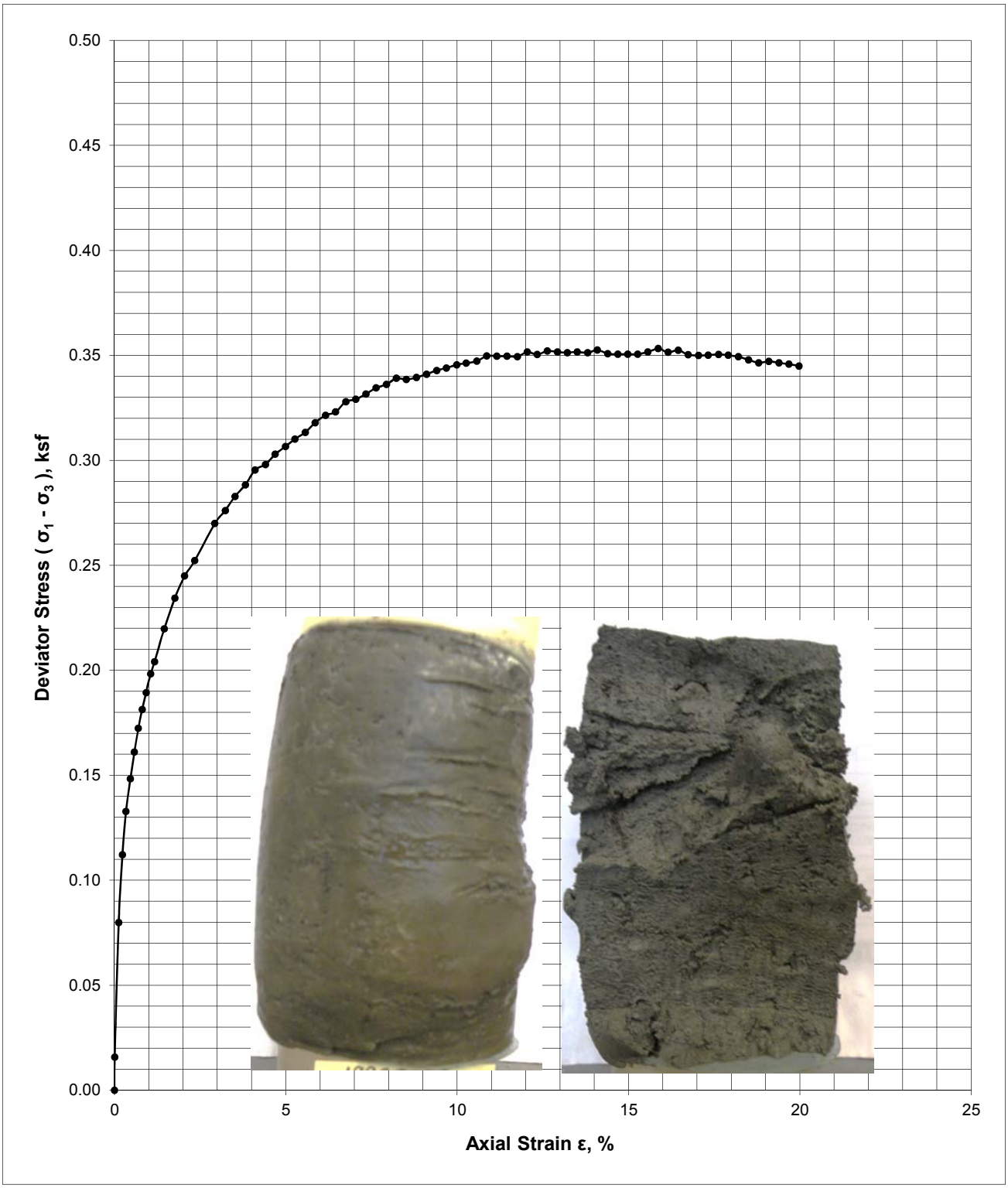


Specimen Information							Test Summary			
Water Content (%)	Wet Unit Weight (pcf)	Dry Unit Weight (pcf)	Atterberg Limits LL	Atterberg Limits PL	Initial Length (in)	Initial Dia. (in)	σ_3 (ksf)	$(\sigma_1 - \sigma_3)_{max}$ (ksf)	ε_f %	Strain Rate (%/min)
223.1	73.2	22.7	33	22	5.59	2.88	2.3	0.31	10.3	1.0
Description:	Dark Gray Sandy Lean CLAY						Tested by: TV		Reviewed by: EM	

Project No.:	Project Name:	Unconsolidated-Undrained Triaxial Compression (UU) Test
19998709	**Rahway Arch**	**ASTM D 2850**

Boring No.: IS-02	Sample No.: U-1	Sample Depth (ft): 19.0-21.0	Date: 8/20/2012

URS

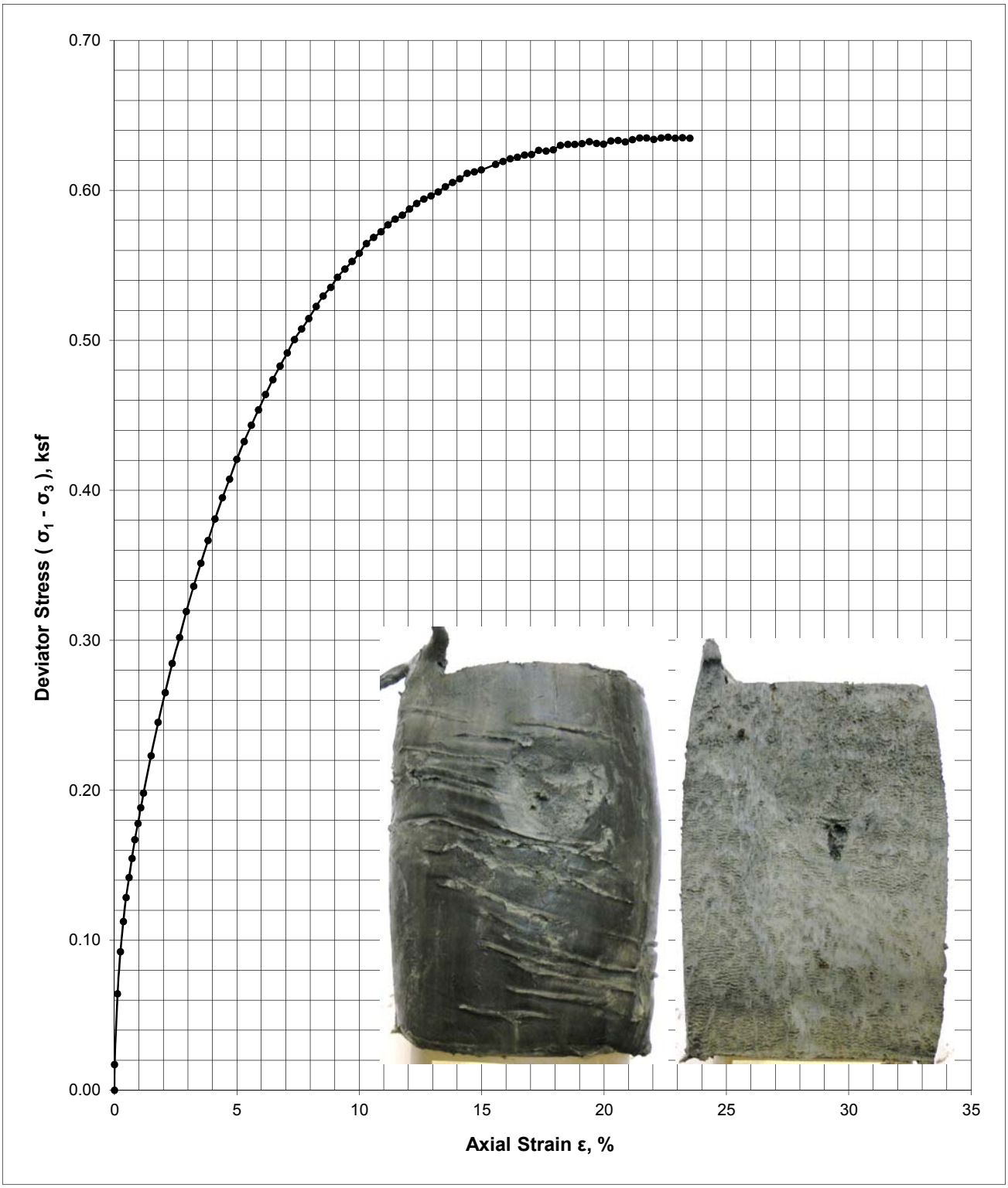


Specimen Information							Test Summary			
Water Content (%)	Wet Unit Weight (pcf)	Dry Unit Weight (pcf)	Atterberg Limits LL	Atterberg Limits PL	Initial Length (in)	Initial Dia. (in)	σ_3 (ksf)	$(\sigma_1 - \sigma_3)_{max}$ (ksf)	ε_f %	Strain Rate (%/min)
27.0	123.5	97.3	25	15	5.59	2.87	1.6	0.35	15.0	1.0
Description:	Brown Sandy Lean CLAY						Tested by: TV		Reviewed by: EM	

Project No.:	Project Name:	Unconsolidated-Undrained Triaxial Compression (UU) Test
19998709	**Rahway Arch**	**ASTM D 2850**

Boring No.: W-05	Sample No.: T-1	Sample Depth (ft): 15.0-17.0	Date: 9/6/2012

URS



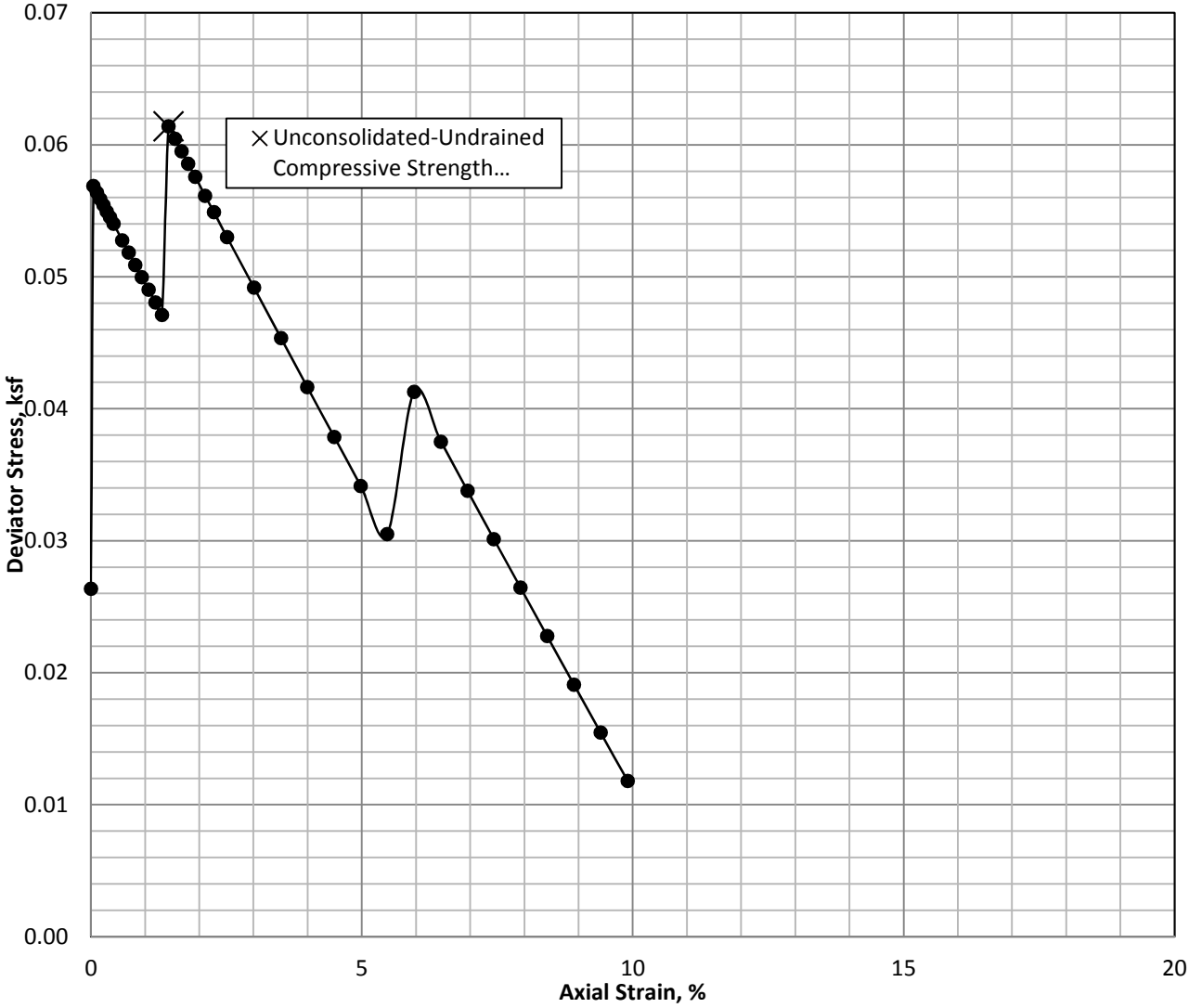
Specimen Information							Test Summary			
Water Content (%)	Wet Unit Weight (pcf)	Dry Unit Weight (pcf)	Atterberg Limits LL	Atterberg Limits PL	Initial Length (in)	Initial Dia. (in)	σ_3 (ksf)	$(\sigma_1 - \sigma_3)_{max}$ (ksf)	ε_f %	Strain Rate (%/min)
30.4	119.9	91.9	36	16	5.59	2.88	1.7	0.61	15.0	1.0
Description:	Gray Lean CLAY						Tested by: TV		Reviewed by: EM	

Project No.: 19998709	Project Name: **Rahway Arch**	**Unconsolidated-Undrained Triaxial Compression (UU) Test ASTM D 2850**

Boring No.: W-08	Sample No.: U-1	Sample Depth (ft): 14.0-16.0	Date: 8/20/2012

URS

UNCONSOLIDATED-UNDRAINED COMPRESSIVE STRENGTH TEST, ASTM METHOD D2850



Specimen and Material Property Information

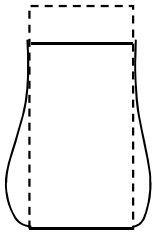
Sample Type: Intact

Description and/or Classification: MH, dark gray SILT

Cell Pressure (ksf)	Water (1) Content (%)	Wet Unit Weight (pcf)	Dry Unit (1) Weight (pcf)	Void Ratio (-)	Saturation(2) (%)	Length (inch)	Diameter (inch)	L/D (-)	LL/ PL (-)	PI (-)	Specific (2) Gravity (-)
0 (Initial)	115.8	93.2	43.2	3.77	101.4	4.000	1.953	2.0	NP		3.30
1.0	115.8	93.2	43.2	3.77	101.4	4.000	1.953	2.0	64		

Failure Summary

U-U Compressive Strength (ksf)	U-U Shear Strength, s_u (ksf)	Strain to to Peak (%)	Strain Rate (%/min)
0.06	0.03	1.4	0.74



FAILURE SKETCH

Remarks and Notes:

(1) Water Content determined after shear from partial specimen.

(2) Assumed specific gravity

Tested by: DT Reviewed by: GET

Test Date: 9/21/2012 Review Date: 10/9/2012

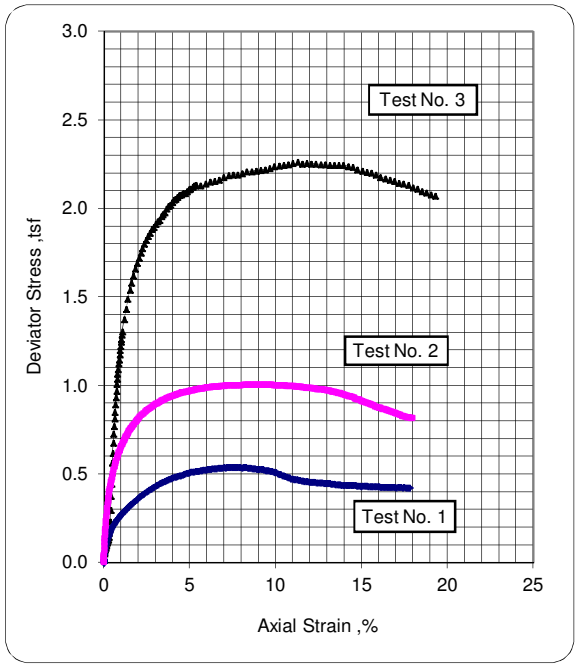
URS Corporation **Project # 19998709**	**Rahway Arch Site** **Carteret, New Jersey**	**UNCONSOLIDATED-UNDRAINED COMPRESSION TEST**
TerraSense, LLC **Project # T19998709**		**Sample: Composite**

URS

ASTMD 4767 Isotropically Consolidated Undrained Triaxial Test Series(With Pore Pressure Measurements)

Project No.: 19998709 **File No.:** 19998709 CIU-1

Project Name: Rahway Arch **Date:** August 22, 2012

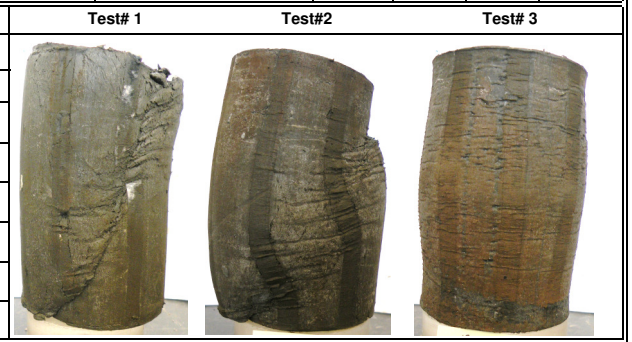


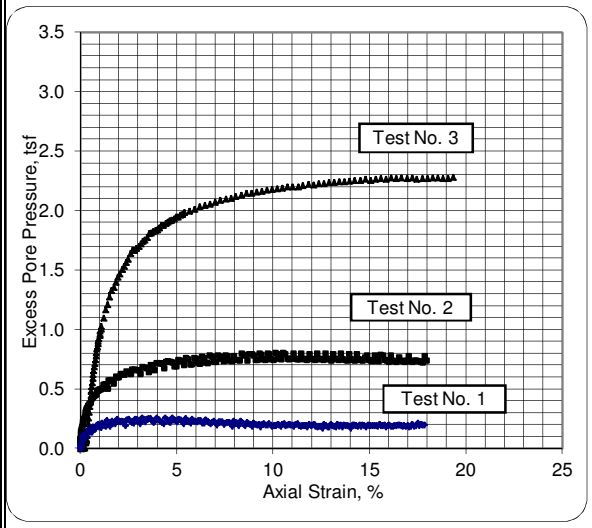
Test Sample Summary

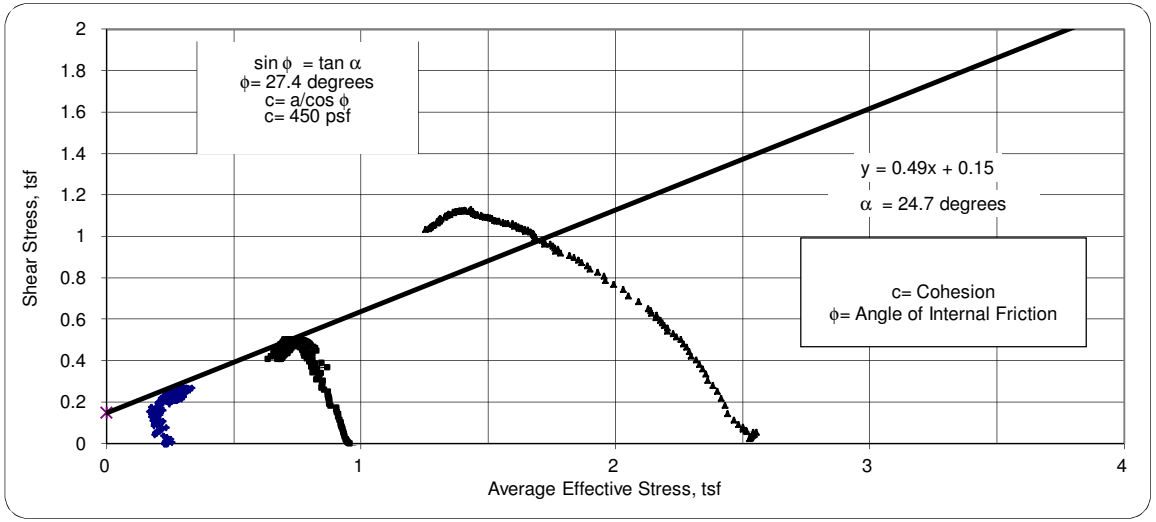
Test No.	Boring No.	Sample No./Depth	Water Content, % Initial	Water Content, % Final	Dry Density, pcf Initial	Dry Density, pcf Final	Degree of Saturation, % Initial	Degree of Saturation, % Final	B Factor,%	Void Ratio Initial	Void Ratio Final	$\bar{\sigma}_c$ tsf
1	BD-03	T-1/23-25	80.9	80.2	51.4	52.2	98.7	100.2	100.0	2.075	2.026	0.25
2	BD-03	T-1/23-25	75.4	67.7	53.9	58.3	98.9	100.3	100.0	1.928	1.708	1.00
3	BD-03	T-1/23-25	59.0	57.7	51.4	64.6	97.3	101.0	100.0	2.072	1.446	2.50
Specific Gravity=			2.53	Measured			Liquid Limit, %		105			
Stain Rate, %/hr.			1.0				Plastic Limit, %		45			
Note: Atterberg Limits were conducted on Test No.1 only.							Liquidity Index		0.60	0.51	0.23	

Test Series Summary

Test No.	Max. Deviator Stress, tsf	Value at Maximum Shear Stress: Axial Strain, %	Obliquity	A- Factor
1	0.54	7.3	23.602	0.420
2	1.00	8.9	5.801	0.787
3	2.26	11.3	8.577	0.973
4				
5				
6				





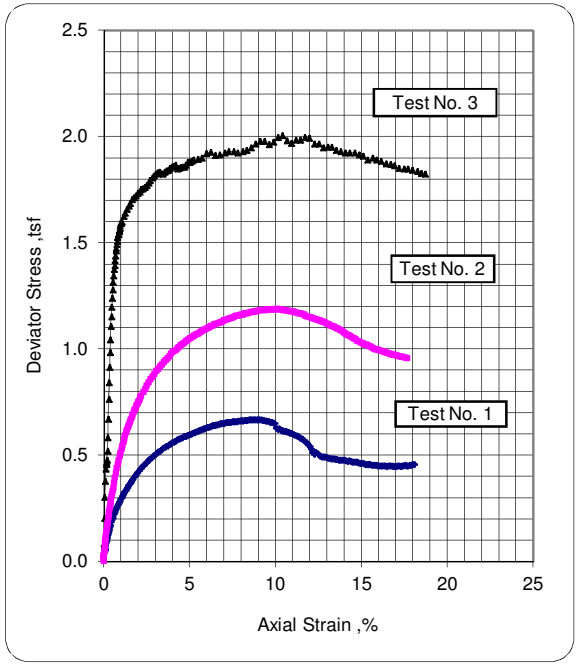


URS

ASTMD 4767 Isotropically Consolidated Undrained Triaxial Test Series(With Pore Pressure Measurements)

Project No.: 19998709 **File No.:** 19998709 CIU-2

Project Name: Rahway Arch **Date:** August 23, 2012



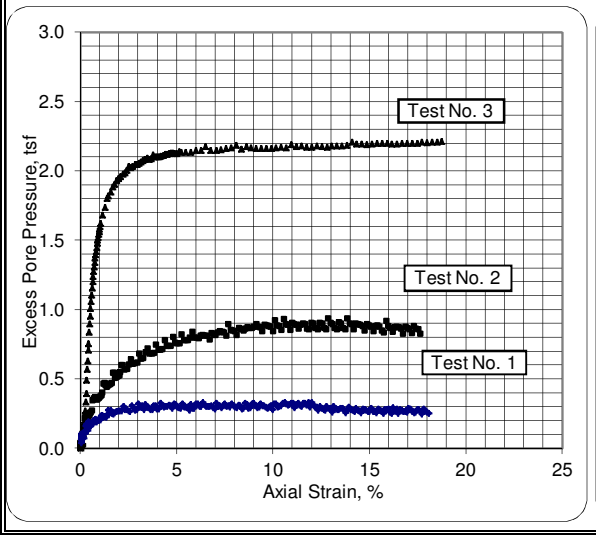
Test Sample Summary

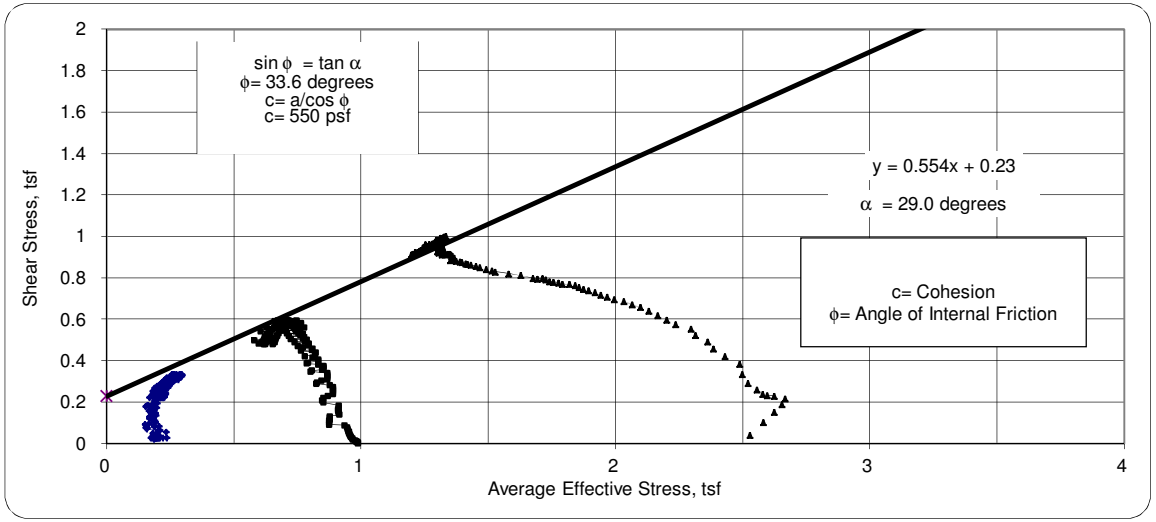
Test No.	Boring No.	Sample No./Depth	Water Content, % Initial	Water Content, % Final	Dry Density, pcf Initial	Dry Density, pcf Final	Degree of Saturation, % Initial	Degree of Saturation, % Final	B Factor,%	Void Ratio Initial	Void Ratio Final	$\bar{\sigma}_c$ tsf
1	BS-09	T-1/12-14	170.9	166.8	28.4	30.4	95.1	100.7	100.0	4.530	4.175	0.25
2	BS-09	T-1/12-14	201.2	154.2	24.3	33.2	92.4	103.8	100.0	5.484	3.743	1.00
3	BS-09	T-1/12-14	59.0	20.8	92.6	105.2	100.2	106.0	100.0	0.698	0.495	2.50
Specific Gravity=			2.52	Measured			Liquid Limit, %		241			
Stain Rate, %/hr.			1.0				Plastic Limit, %		113			
Note: Atterberg Limits were conducted on Test No.1 only.							Liquidity Index		0.45	0.69	-0.42	

Test Series Summary

Test No.	Max. Deviator Stress, tsf	Value at Maximum Shear Stress: Axial Strain, %	Obliquity	A- Factor
1	0.67	8.6	-8.672	0.477
2	1.19	10.1	16.194	0.776
3	2.01	10.4	7.126	1.083
4				
5				
6				

Test# 1 Test#2 Test# 3





SUMMARY FOR STATIC CIU' TRIAXIAL TESTS SPECIMENS

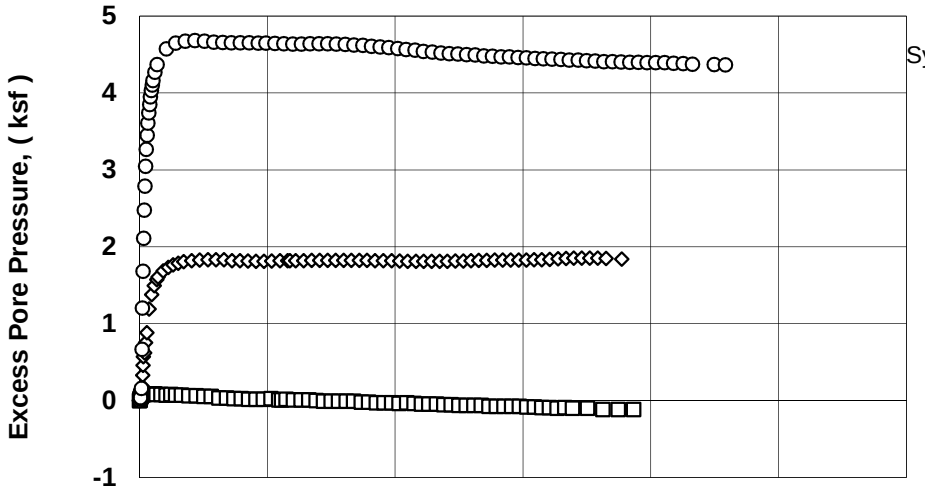
Test No	Boring No	Sample Section No	Depth Elev (ft)	USCS Group Symbol Gs	w_o w_c (%)	$\gamma_{t,o}$ $\gamma_{t,c}$ (pcf)	$\gamma_{d,o}$ $\gamma_{d,c}$ (pcf)	$\sigma'_{c,max}$ OCR (ksf)	$\sigma'_{v,c}$ $K_c = \frac{\sigma'_{v,c}}{\sigma'_{h,c}}$ (ksf)	$\varepsilon_{a,c}$ $\varepsilon_{v,c}$ (%)	B factor (%) ε_{rate} (%/hr)	at Peak Deviator Stress: ε_a (%)	at Peak Obliquity: $\frac{\sigma_1 - \sigma_3}{2}$ (ksf)	$\frac{\sigma'_1 + \sigma'_3}{2}$ (ksf)	σ'_1 / σ'_3	A factor	ϕ' for c'=0
T3303	BS-03R	T-1A	8.35	MH	90.9	96.4	50.5	0.20	0.20	1.1		17.5	1.07	1.37	8.13	-0.046	51.3
				(3.17)	88.5	98.1	52.0	1.0	1.00	3.0	1.5	10.4	0.98	1.21	9.55	-0.014	54.1
T3304	BS-03R	T-1B	8.9	MH	108.1	91.7	44.0	2.00	2.00	5.4	99.2	3.0	1.32	1.49	16.60	0.695	62.4
				(3.17)	94.7	96.3	49.5	1.0	1.00	11.0	1.6	3.0	1.32	1.49	16.60	0.695	62.4
T3305	BS-03R	T-1C	9.45	MH	106.7	94.1	45.5	5.00	5.00	14.5	98.1	2.5	3.34	3.66	21.63	0.700	65.7
				(3.17)	79.4	101.0	56.3	1.0	1.00	19.1	1.0	2.2	3.34	3.65	22.19	0.701	66.0

Test No	Description of Material Tested and Remarks
T3303	MH, gray silt
T3304	MH, gray silt
T3305	MH, gray silt

Strength Envelope Summary						
Test Series	Failure Criteria	ϕ' (deg)	c' (ksf)	α' (deg)	a' (ksf)	Correlation Coefficient
1	1	63.4	0.000	41.8	0.000	--
	2	64.3	0.000	42.0	0.000	--

Failure Criteria: 1 - Peak Deviator Stress
2 - Peak Obliquity

Project No. T19998709	URS Corporation #19998709 Rahway Arch Site	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements BS-03R T-1 SUMMARY	September 2012
	TerraSense, LLC		

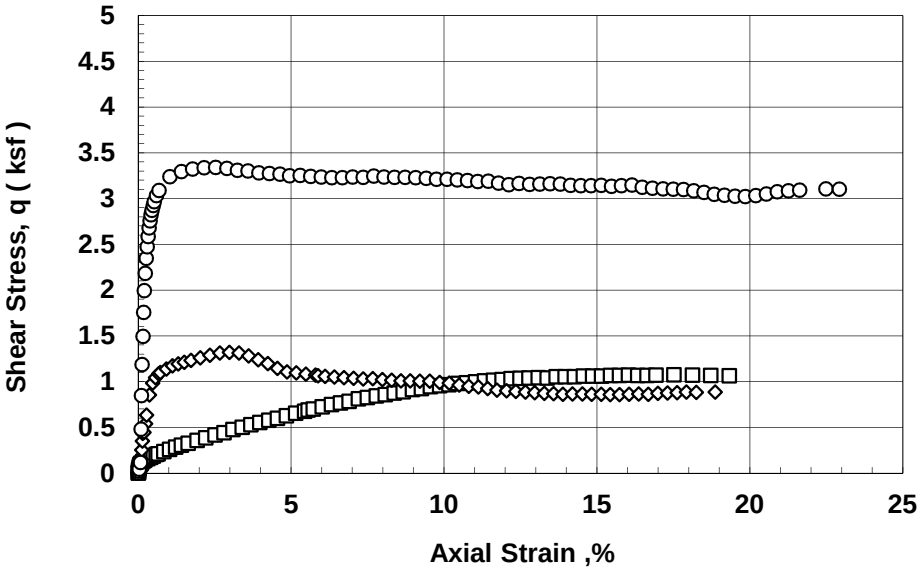


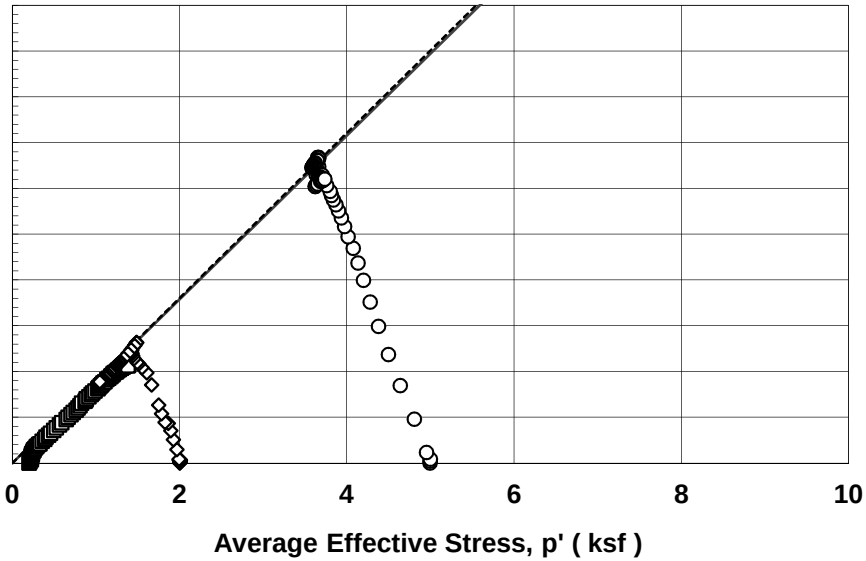
LEGEND AND SUMMARY INFORMATION

Symbol	Test	Boring	Sample	Depth (ft)	w_o (%)	γ_{to} (pcf)	σ'_c (ksf)
□	T3303	BS-03R	T-1A	8.4	90.9	96.4	0.20
◊	T3304	BS-03R	T-1B	8.9	108.1	91.7	2.00
○	T3305	BS-03R	T-1C	9.5	106.7	94.1	5.00

SERIES SUMMARY

Notation	Failure Criteria	c' (ksf)	Φ' (degrees)
———	Peak Deviator Stress	0.00	63.4
·····	Peak Obliquity	0.00	64.3

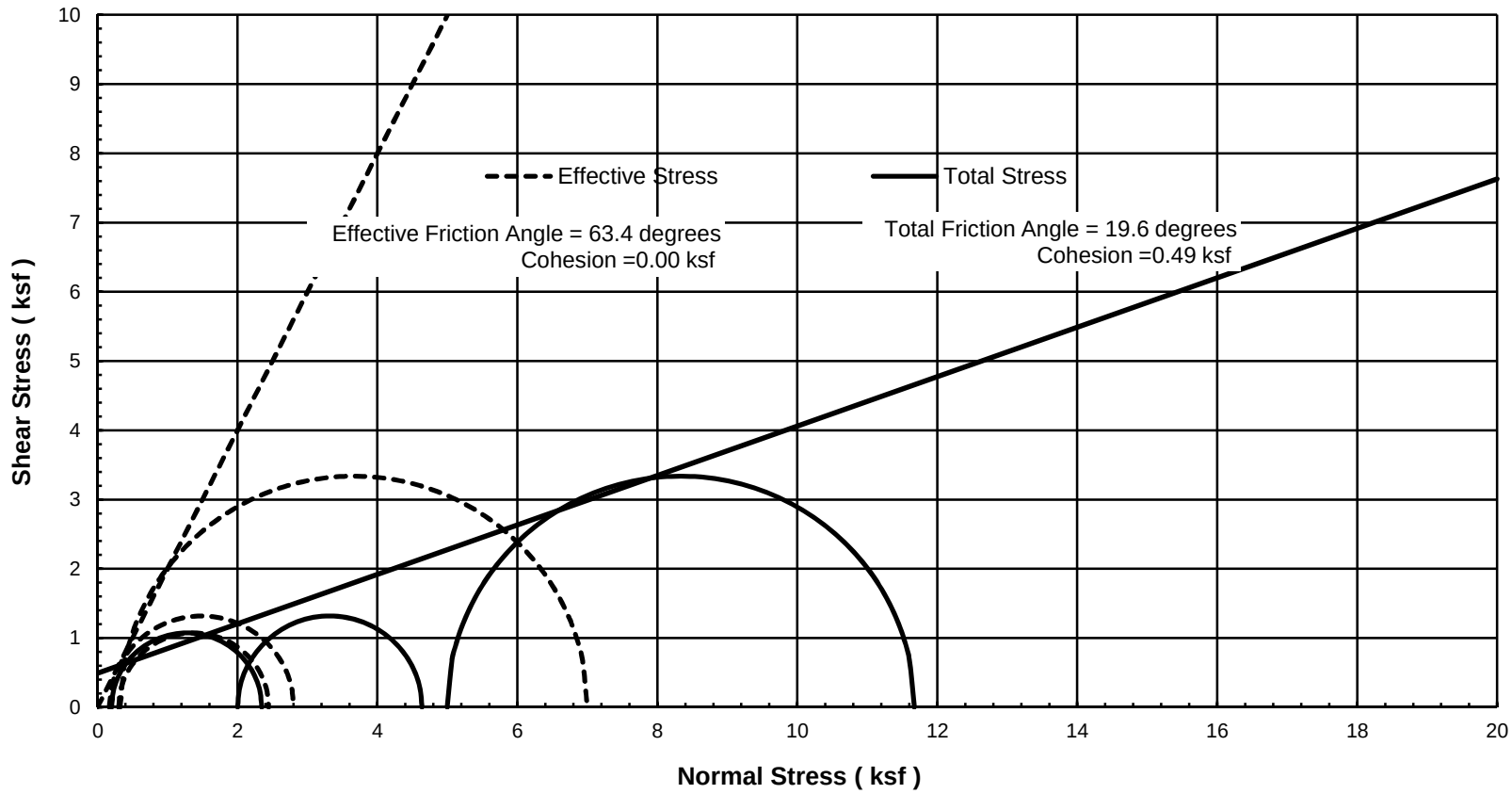




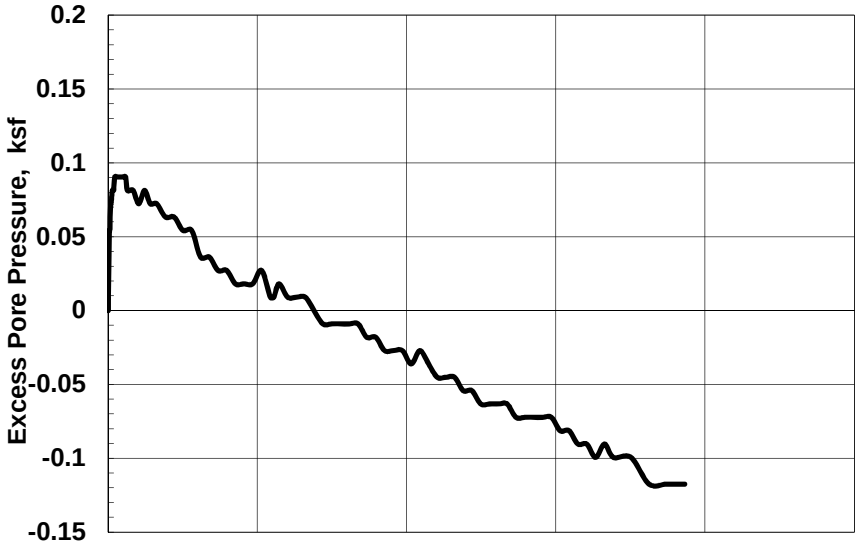
Project No. T19998709	**URS Corporation #19998709 Rahway Arch Site**	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements BS-03R T-1 SUMMARY	Figure 1
Prepared by: CMJ Checked by: G. Thomas	**TerraSense, LLC**		September 2012

Analysis File: Cu'sum3v4

10/9/2012 Test: Ciusum1.xlsx



Project No. T19998709	URS Corporation #19998709 Rahway Arch Site	Mohr Circles of Total and Effective Stresses at Peak CIU' Triaxial Test	Figure 2
TerraSense, LLC		BS-03R T-1 SUMMARY	September 2012



SAMPLE INFORMATION

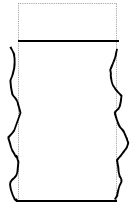
Boring: BS-03R Sample: T-1A Depth: 8.35ft
Type: Intact tube sample
Description: MH, gray silt

SPECIMEN INFORMATION (Initial)

Height: 5.98 inch Diameter: 2.81 inch Area: 6.22 in²
Water Content: 90.9 % Total Unit Weight: 96.4 pcf

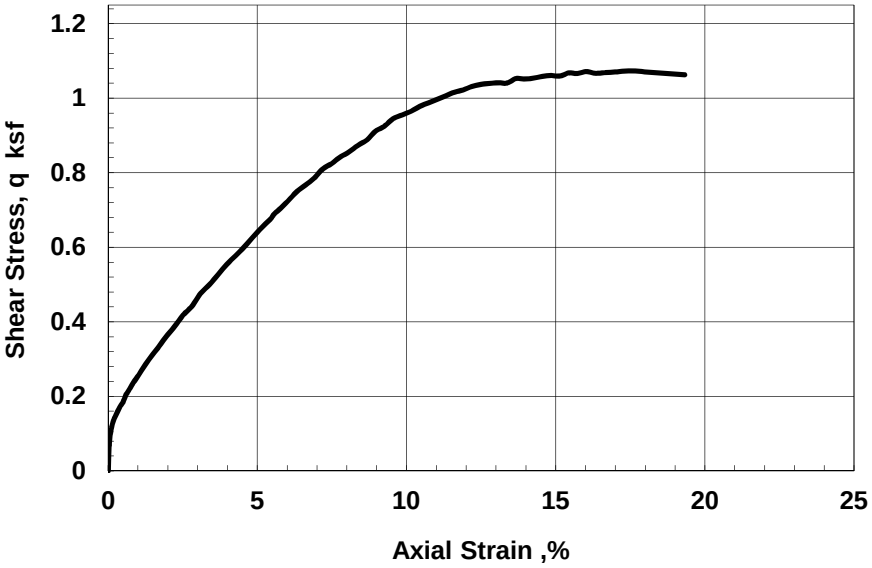
TEST SUMMARY

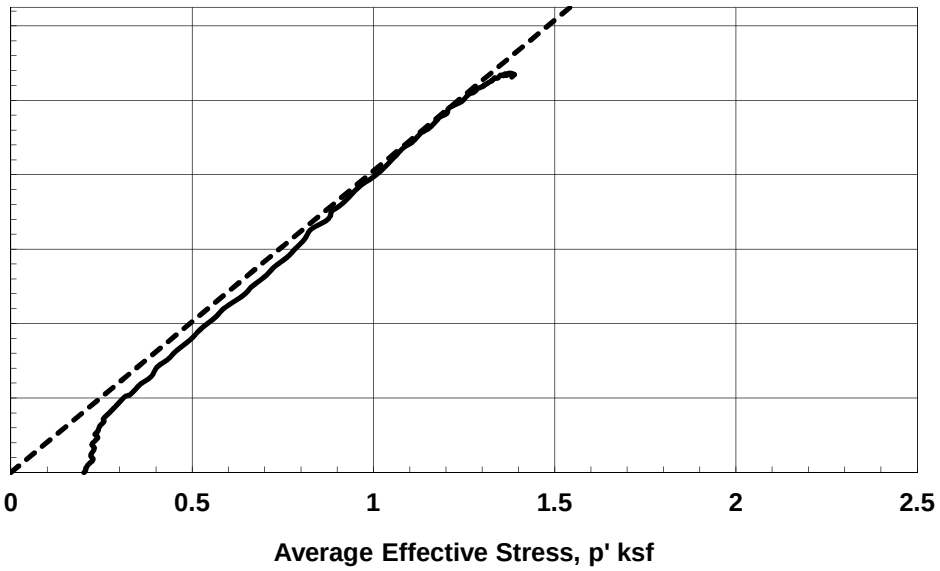
Consolidation Stresses: 0.20 ksf vertical, 0.20 ksf lateral
Water Content: 88.5 % Total Unit Weight: 98.1 pcf
B Coefficient: Strain Rate: 0.024 %/min
Peak Shear Strength: 1.07 ksf @ 17.5 % Strain
Peak Effective Friction Angle: 54.1°



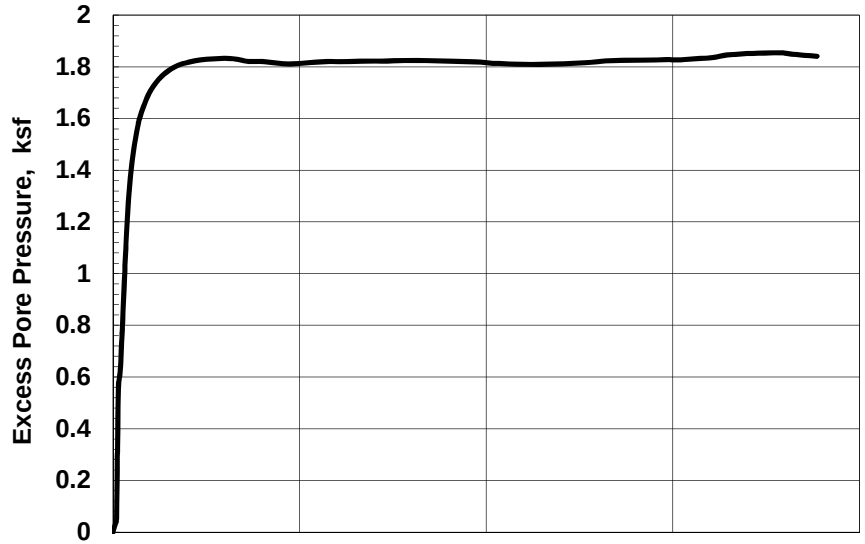
Failure Sketch

REMARKS:





Test by: DT	Project No. T19998709	URS #19998709 Rahway Arch Site	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements
Checked by: GET	**TerraSense, LLC**		Boring: BS-03R Sample: T-1A
			October-12



SAMPLE INFORMATION

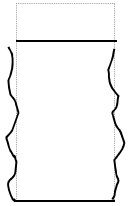
Boring: BS-03R Sample: T-1B Depth: 8.9ft
Type: Intact tube sample
Description: MH, gray silt

SPECIMEN INFORMATION (Initial)

Height: 5.95 inch Diameter: 2.83 inch Area: 6.28 in²
Water Content: 108.1 % Total Unit Weight: 91.7 pcf

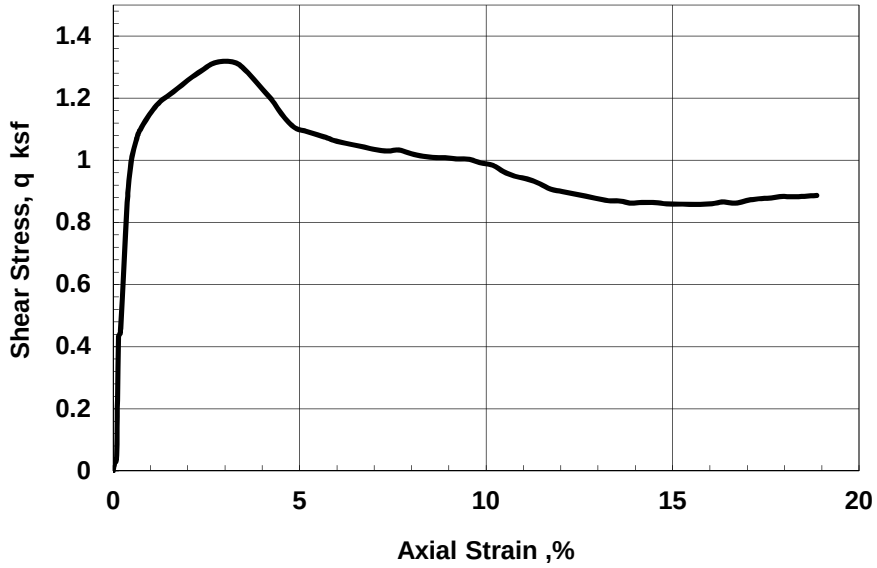
TEST SUMMARY

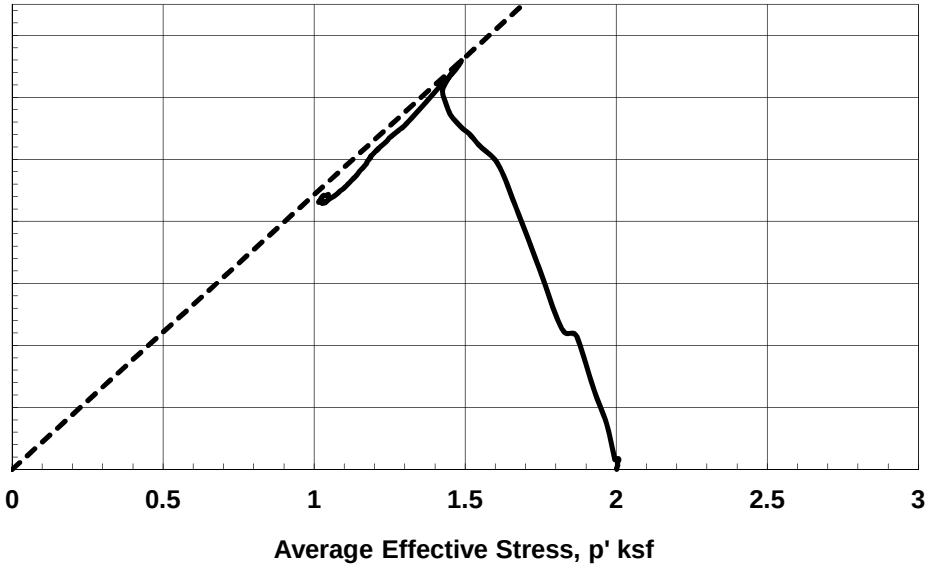
Consolidation Stresses: 2.00 ksf vertical, 2.00 ksf lateral
Water Content: 94.7 % Total Unit Weight: 96.3 pcf
B Coefficient: 99.2 Strain Rate: 0.026 %/min
Peak Shear Strength: 1.32 ksf @ 3.0 % Strain
Peak Effective Friction Angle: 62.4°



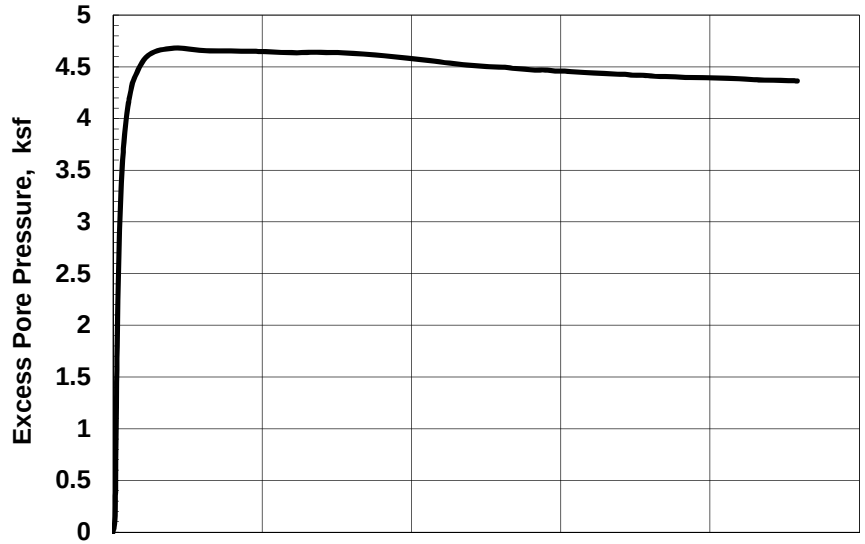
Failure Sketch

REMARKS:





Test by: DT	Project No. T19998709	URS #19998709 Rahway Arch Site	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements
Checked by: GET	**TerraSense, LLC**		Boring: BS-03R Sample: T-1B
			October-12



SAMPLE INFORMATION

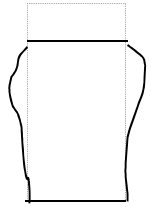
Boring: BS-03R Sample: T-1C Depth: 9.45ft
Type: Intact tube sample
Description: MH, gray silt

SPECIMEN INFORMATION (Initial)

Height: 5.99 inch Diameter: 2.84 inch Area: 6.32 in²
Water Content: 106.7 % Total Unit Weight: 94.1 pcf

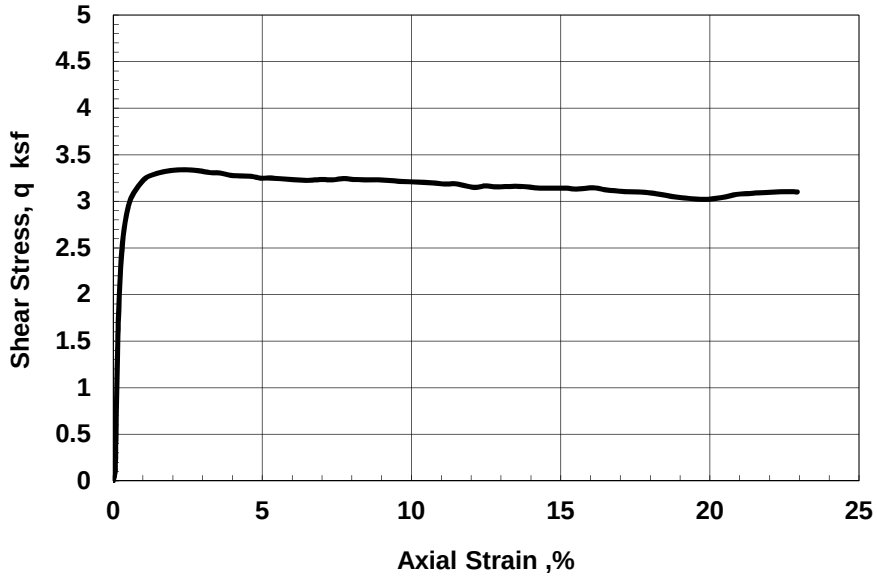
TEST SUMMARY

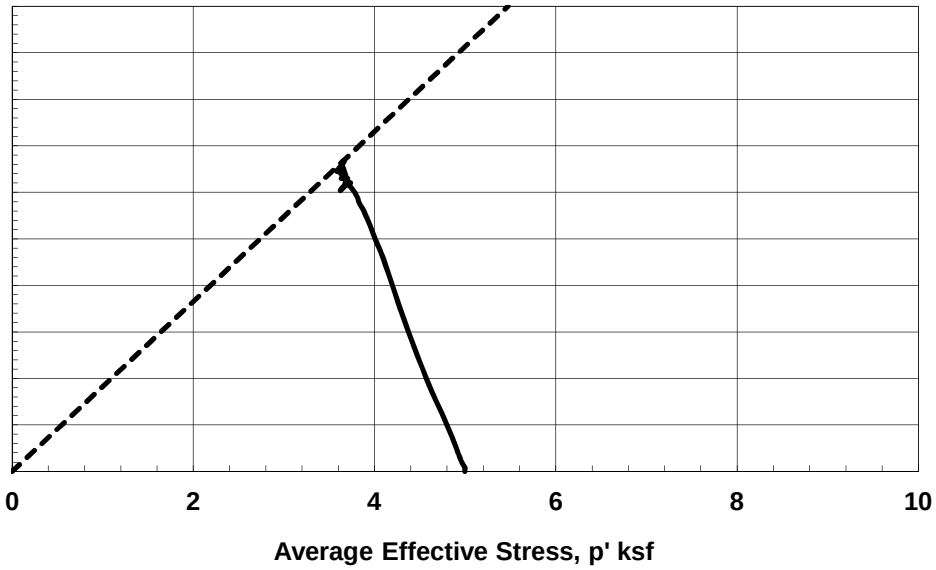
Consolidation Stresses: 5.00 ksf vertical, 5.00 ksf lateral
Water Content: 79.4 % Total Unit Weight: 101.0 pcf
B Coefficient: 98.1 Strain Rate: 0.017 %/min
Peak Shear Strength: 3.34 ksf @ 2.5 % Strain
Peak Effective Friction Angle: 66.0°



Failure Sketch

REMARKS:





Test by: DT	Project No. T19998709	URS #19998709 Rahway Arch Site	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements
Checked by: GET	**TerraSense, LLC**		Boring: BS-03R Sample: T-1C
			October-12

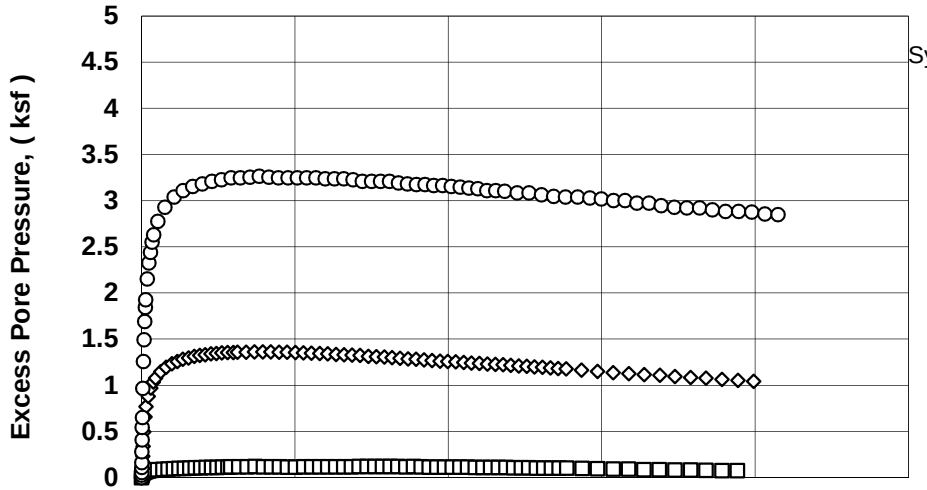
SUMMARY FOR STATIC CIU' TRIAXIAL TESTS SPECIMENS

Test No	Boring No	Sample Section No	USCS Group Symbol	w_o	$\gamma_{t,o}$	$\gamma_{d,o}$	$\sigma'_{c,max}$ (ksf)	$\sigma'_{v,c}$ (ksf)	$\varepsilon_{a,c}$	B factor (%)	at Peak Deviator Stress					
											at Peak Obliquity					
			Gs	w_c (%)	$\gamma_{t,c}$ (pcf)	$\gamma_{d,c}$ (pcf)	OCR	$K_c = \frac{\sigma'_{v,c}}{\sigma'_{h,c}}$	$\varepsilon_{v,c}$ (%)	ε_{rate} (%/hr)	ε_a (%)	$\frac{\sigma_1 - \sigma_3}{2}$ (ksf)	$\frac{\sigma'_1 + \sigma'_3}{2}$ (ksf)	σ'_1 / σ'_3	A factor	ϕ' for c'=0
T3315	Sludge Composite		MH	100.8	91.5	45.6	0.20	0.20	0.2	99.3	18.9	0.30	0.42	5.87	0.126	45.1
			(3.10)	72.9	102.7	59.4	1.0	1.00	23.2	1.3	18.4	0.30	0.42	5.96	0.131	45.5
T3316	Sludge Composite		MH	97.9	92.5	46.7	2.00	2.00	2.4	99.4	20.0	2.12	3.08	5.41	0.246	43.5
			(3.10)	63.1	106.8	65.5	1.0	1.00	28.6	1.3	20.0	2.12	3.08	5.41	0.246	43.5
T3317	Sludge Composite		MH	94.3	92.3	47.5	5.00	5.00	4.9	97.9	20.7	5.06	7.21	5.71	0.281	44.6
			(3.10)	55.4	110.7	71.2	1.0	1.00	33.3	1.0	20.7	5.06	7.21	5.71	0.281	44.6

Test No	
T3315	MH, gray silt; sludge
T3316	MH, gray silt; sludge
T3317	MH, gray silt; sludge

Strength Envelope Summary						
Test Series	Failure Criteria	ϕ' (deg)	c' (ksf)	α' (deg)	a' (ksf)	Correlation Coefficient
1	1	44.4	0.000	35.0	0.000	--
	2	44.4	0.000	35.0	0.000	--
Failure Criteria:	1 - Peak Deviator Stress 2 - Peak Obliquity					

Project No. T19998709	**URS Corporation #19998709** **Rahway Arch Site**	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements Sludge Composite SUMMARY	October 2012
TerraSense, LLC			

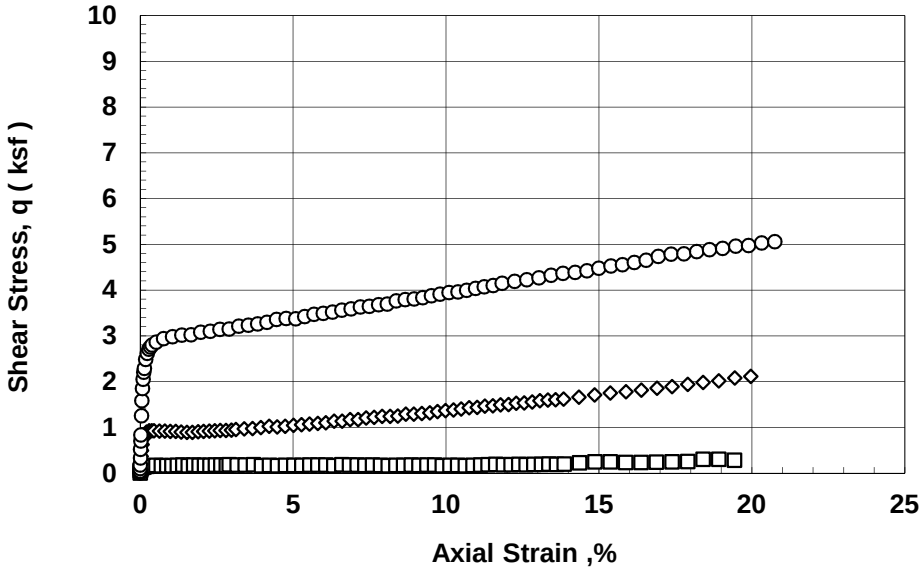


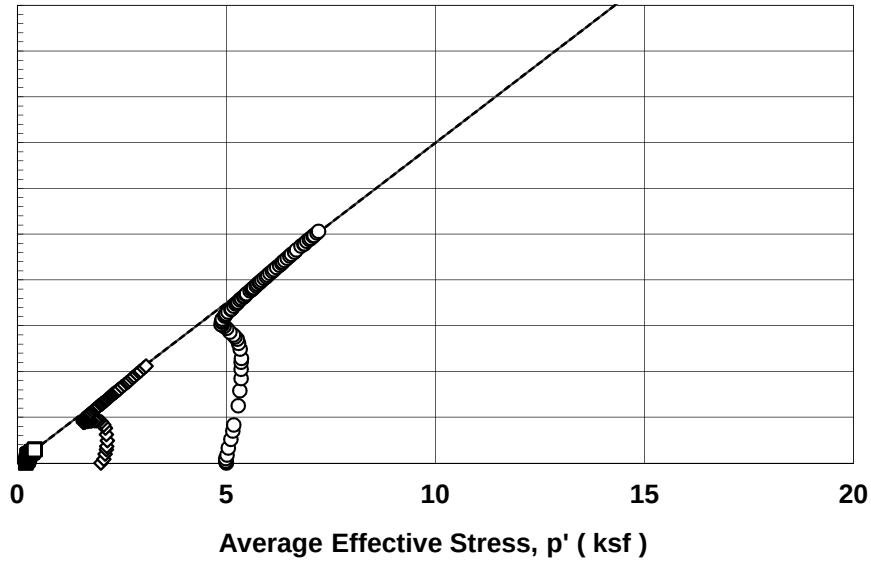
LEGEND AND SUMMARY INFORMATION

Symbol	Test	Boring	Sample	Depth (ft)	w_o (%)	γ_{to} (pcf)	σ'_c (ksf)
□	T3315	Sludge Composite			100.8	91.5	0.20
◊	T3316	Sludge Composite			97.9	92.5	2.00
○	T3317	Sludge Composite			94.3	92.3	5.00

SERIES SUMMARY

Notation	Failure Criteria	c' (ksf)	Φ' (degrees)
———	Peak Deviator Stress	0.00	44.4
·····	Peak Obliquity	0.00	44.4

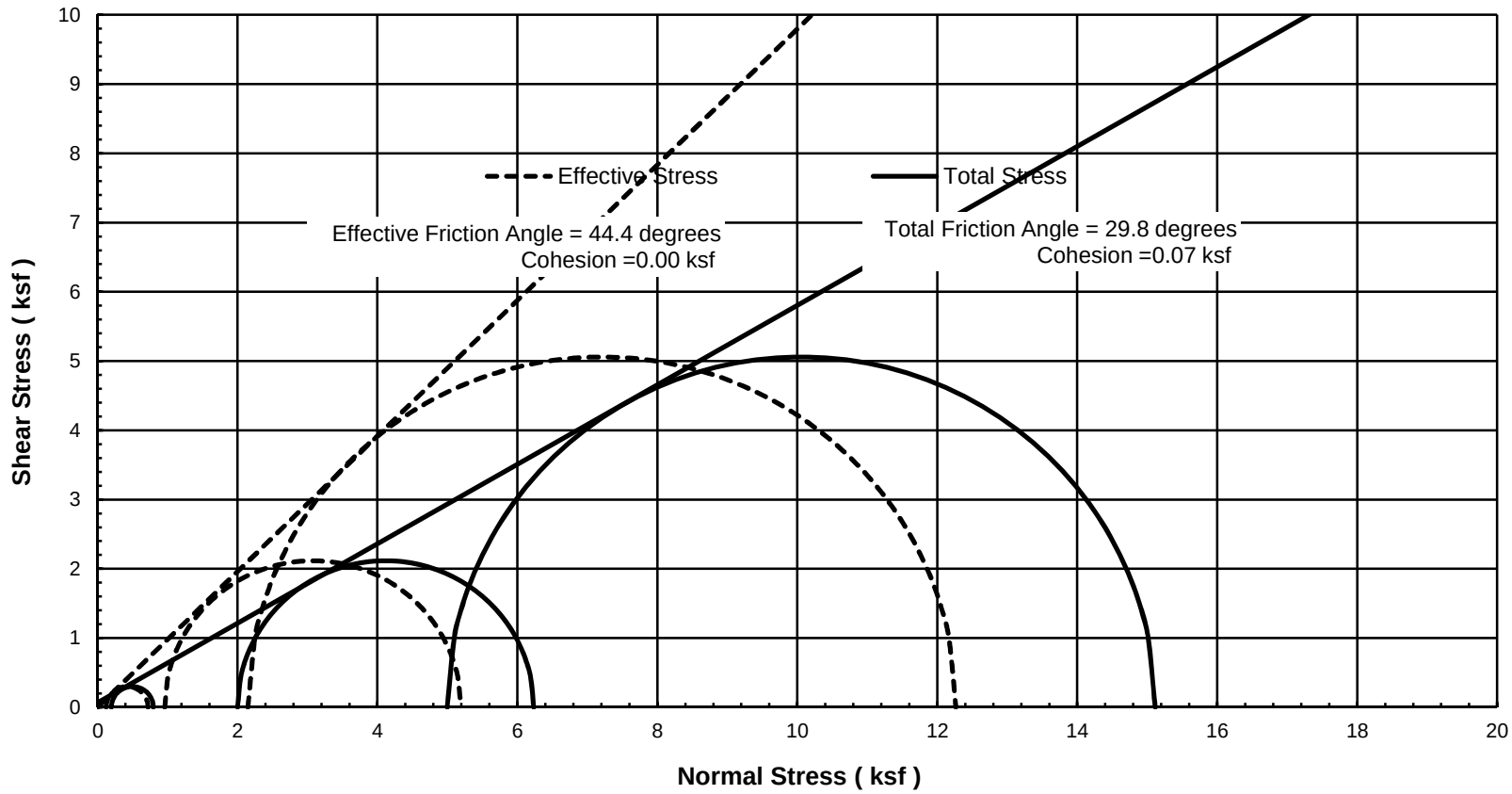




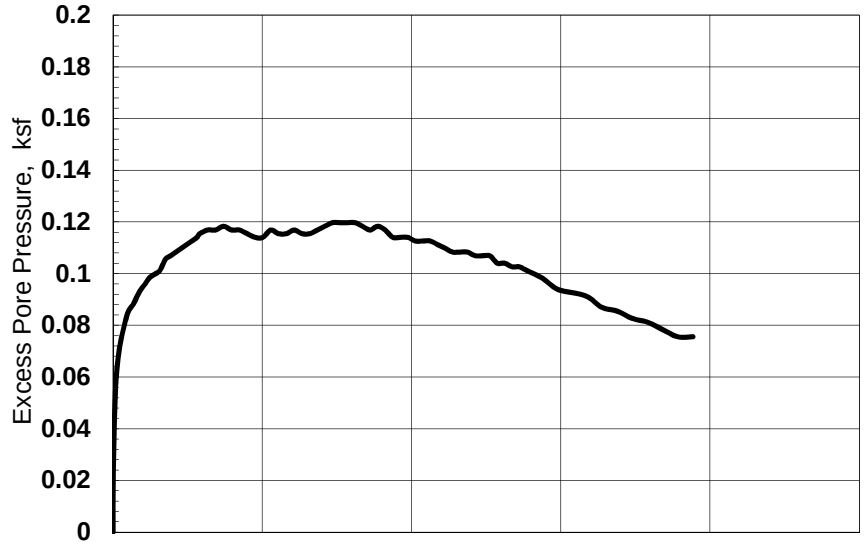
Project No. T19998709	**URS Corporation #19998709 Rahway Arch Site**	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements Sludge Composite SUMMARY	Figure 1
Prepared by: CMJ Checked by: G. Thomas	**TerraSense, LLC**		October 2012

Analysis File: Cu'sum3v4

10/10/2012 Test: Ciusum1b.xlsx



Project No. **T19998709**	**URS Corporation #19998709** **Rahway Arch Site**	**Mohr Circles of Total and Effective Stresses at Peak** **CIU' Triaxial Test**	**Figure** **2**
TerraSense, LLC		**Sludge Composite SUMMARY**	**October 2012**



SAMPLE INFORMATION

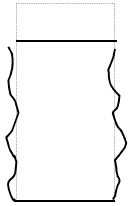
Sample: Sludge Composite
Type: Reconstituted
Description: MH, gray silt; sludge

SPECIMEN INFORMATION (Initial)

Height: 4.01 inch Diameter: 1.96 inch Area: 3.01 in²
Water Content: 100.8 % Total Unit Weight: 91.5 pcf

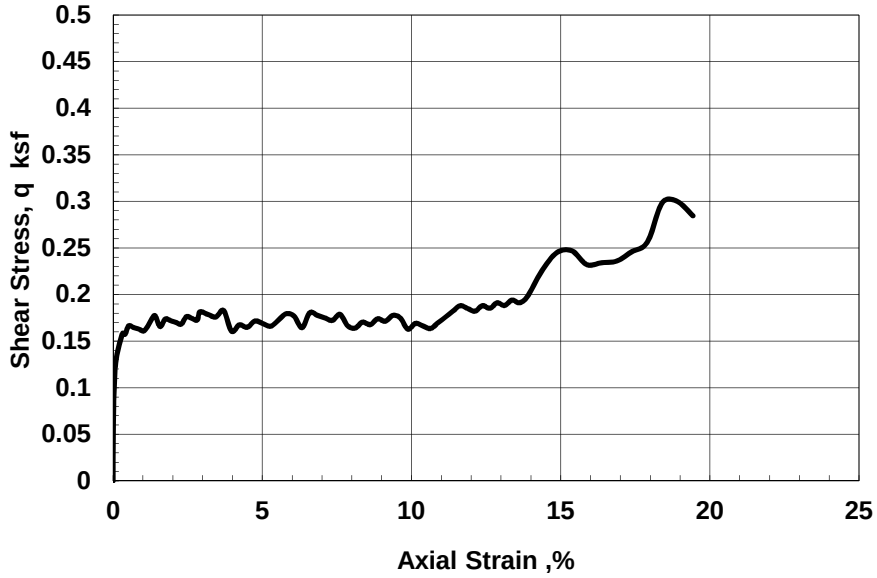
TEST SUMMARY

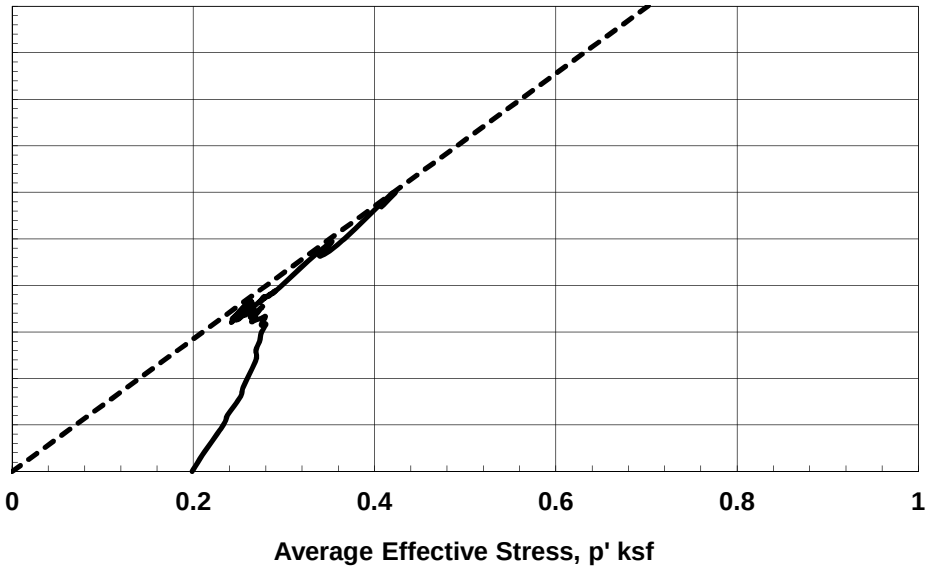
Consolidation Stresses: 0.20 ksf vertical, 0.20 ksf lateral
Water Content: 72.9 % Total Unit Weight: 102.7 pcf
B Coefficient: 99.3 Strain Rate: 0.021 %/min
Peak Shear Strength: 0.30 ksf @ 18.9 % Strain
Peak Effective Friction Angle: 45.5°



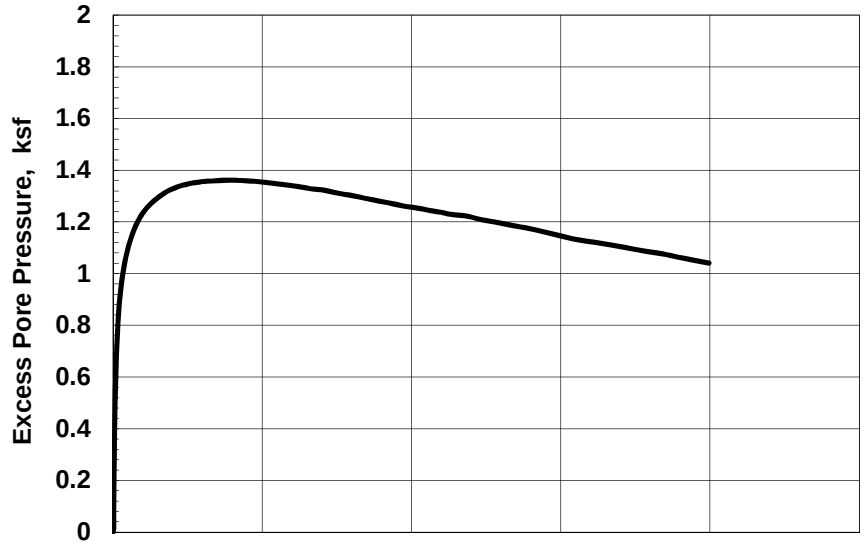
Failure Sketch

REMARKS:





Test by: DT	Project No. T19998709	URS #19998709 Rahway Arch Site	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements
Checked by: GET	**TerraSense, LLC**		Sample: Sludge Composite
			October-12



SAMPLE INFORMATION

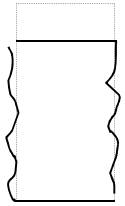
Sample: Sludge Composite
Type: Reconstituted
Description: MH, gray silt; sludge

SPECIMEN INFORMATION (Initial)

Height: 4.00 inch Diameter: 1.95 inch Area: 2.99 in²
Water Content: 97.9 % Total Unit Weight: 92.5 pcf

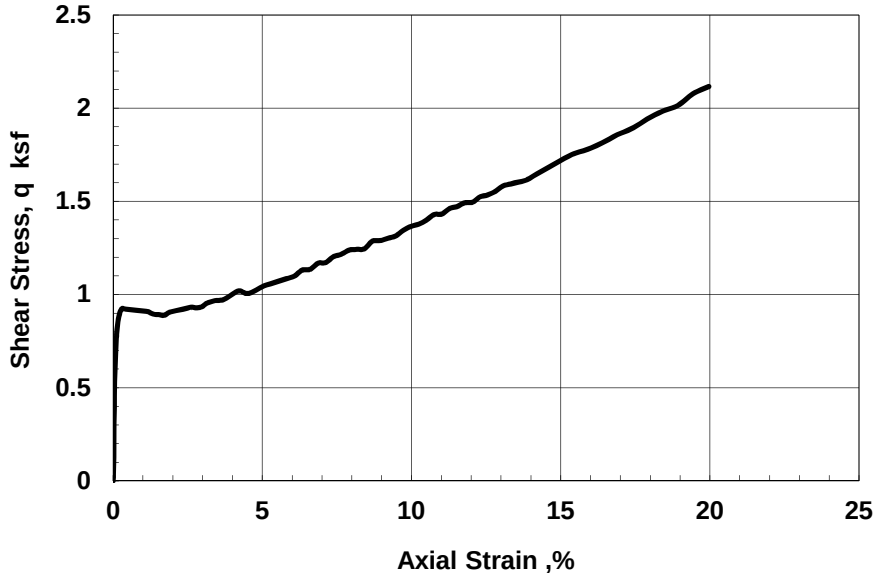
TEST SUMMARY

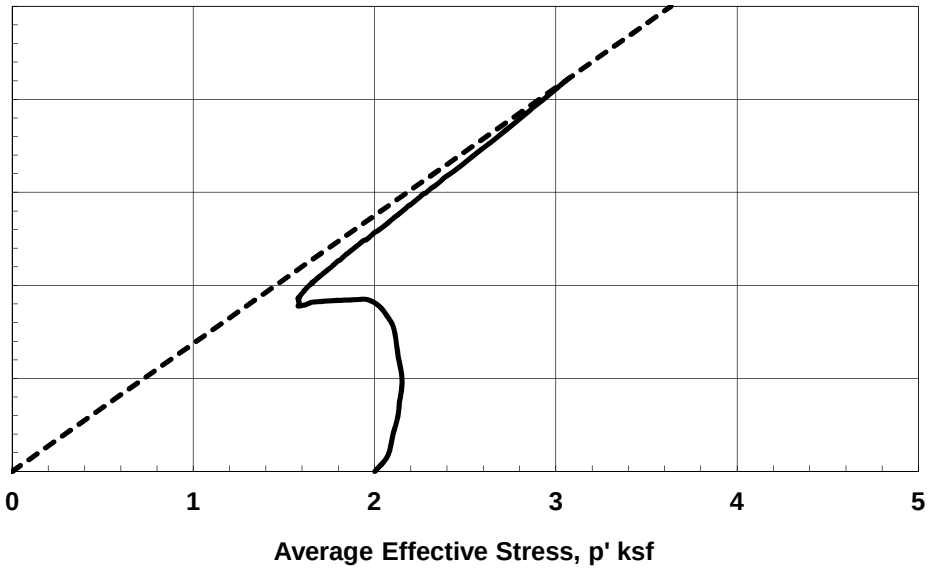
Consolidation Stresses: 2.00 ksf vertical, 2.00 ksf lateral
Water Content: 63.1 % Total Unit Weight: 106.8 pcf
B Coefficient: 99.4 Strain Rate: 0.022 %/min
Peak Shear Strength: 2.12 ksf @ 20.0 % Strain
Peak Effective Friction Angle: 43.5°



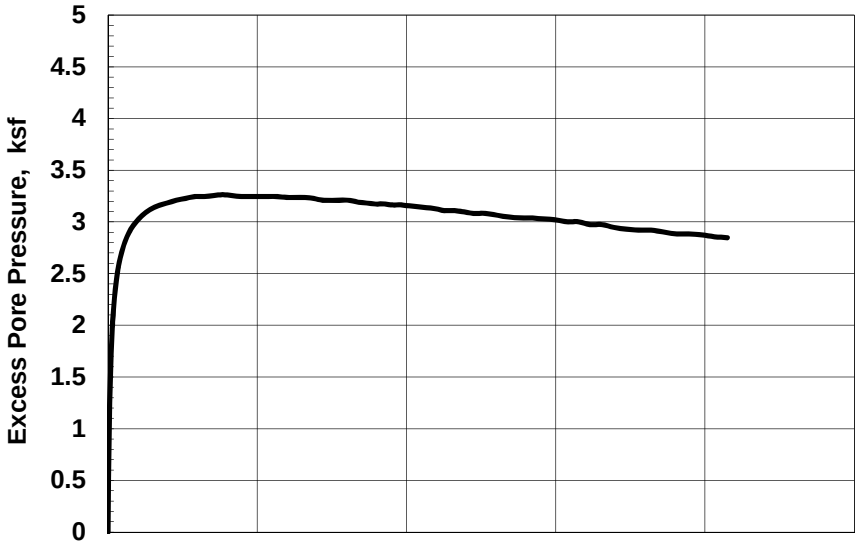
Failure Sketch

REMARKS:





Test by: DT	Project No. T19998709	URS #19998709 Rahway Arch Site	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements
Checked by: GET	**TerraSense, LLC**		Sample: Sludge Composite
			October-12



SAMPLE INFORMATION

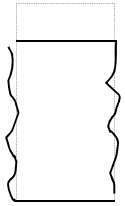
Sample: Sludge Composite
Type: Reconstituted
Description: MH, gray silt; sludge
LL = NP PL = 64 PI = NP

SPECIMEN INFORMATION (Initial)

Height: 4.00 inch Diameter: 1.95 inch Area: 3.00 in²
Water Content: 94.3 % Total Unit Weight: 92.3 pcf

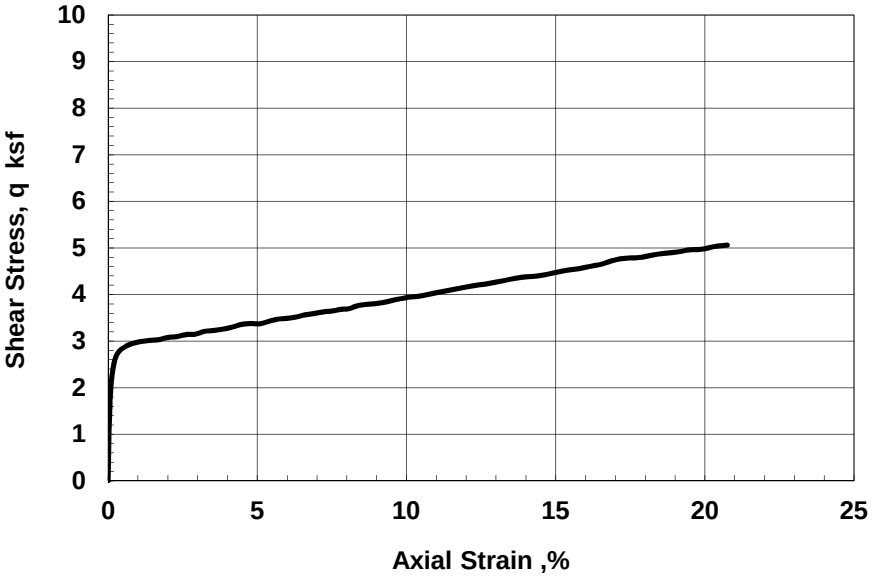
TEST SUMMARY

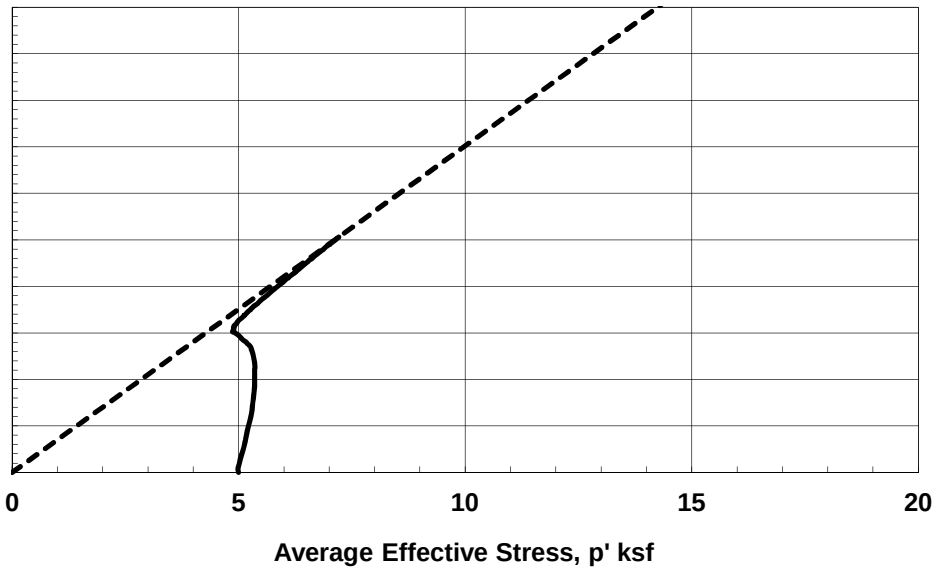
Consolidation Stresses: 5.00 ksf vertical, 5.00 ksf lateral
Water Content: 55.4 % Total Unit Weight: 110.7 pcf
B Coefficient: 97.9 Strain Rate: 0.017 %/min
Peak Shear Strength: 5.06 ksf @ 20.7 % Strain
Peak Effective Friction Angle: 44.6°



Failure Sketch

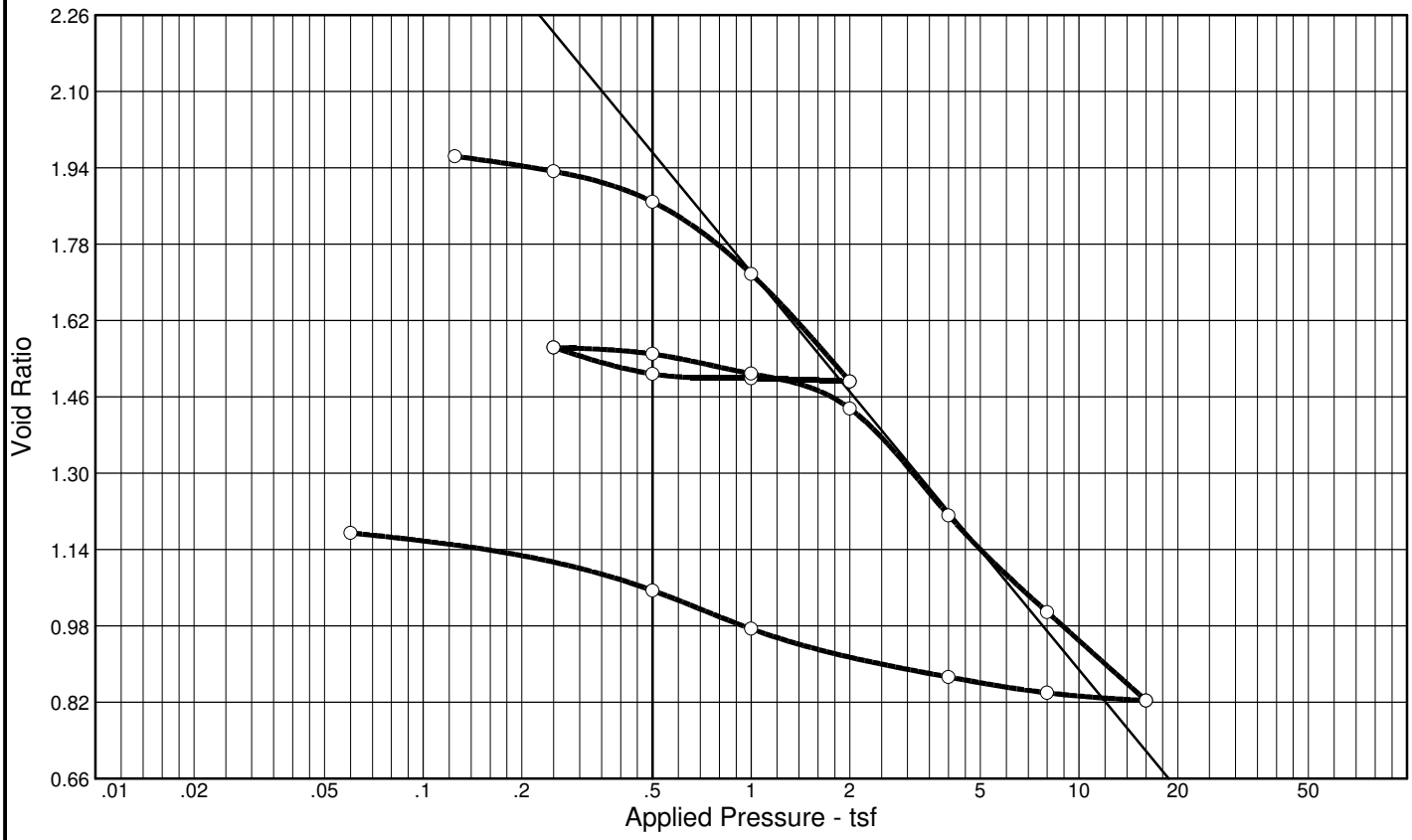
REMARKS:





Test by: DT	Project No. T19998709	URS #19998709 Rahway Arch Site	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements
Checked by: GET	**TerraSense, LLC**		Sample: Sludge Composite
			October-12

CONSOLIDATION TEST REPORT



Coefficients of Consolidation and Secondary Consolidation											
No.	Load (tsf)	C_v (ft.^{2}/day)	C_α	No.	Load (tsf)	C_v (ft.^{2}/day)	C_α	No.	Load (tsf)	C_v (ft.^{2}/day)	C_α
2	0.25	0.08	0.002								
3	0.50	0.10	0.005								
4	1.00	0.04	0.013								
5	2.00	0.03	0.007								
9	0.50	0.20	0.000								
10	1.00	0.10	0.003								
11	2.00	0.07	0.004								
12	4.00	0.03	0.021								
13	8.00	0.02	0.014								
14	16.00	0.03	0.023								

Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (tsf)	P_c (tsf)	C_c	C_r	Initial Void Ratio
Saturation	Moisture									
101.6 %	81.9 %	51.6	98	57	2.48		0.72	0.83	0.13	2.000

MATERIAL DESCRIPTION	USCS	AASHTO
Dark Gray Fat CLAY	CH	

Project No. 19998709 **Client:** Michael Baker Jr., Inc.

Project: Rahway Arch

Source: BD-04R **Sample No.:** T-1 **Elev./Depth:** 21.0-23.0

URS CORPORATION

Fort Washington, PA

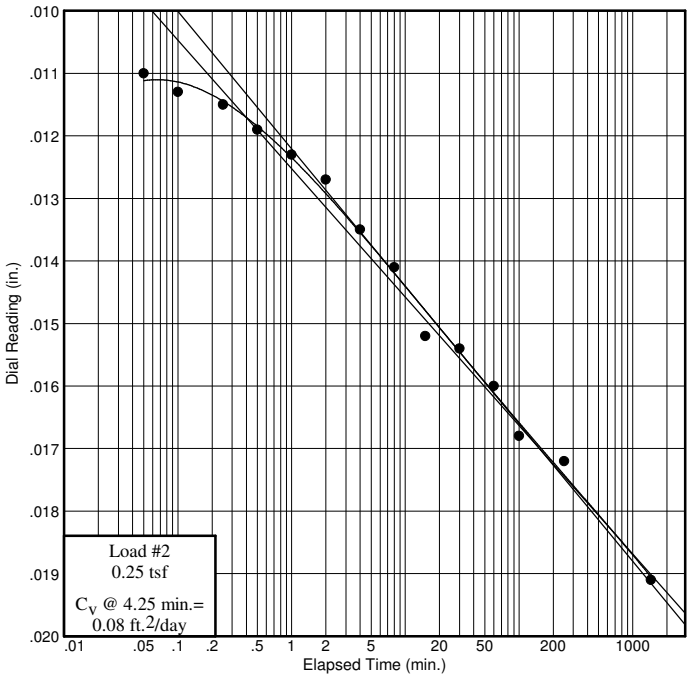
Remarks:

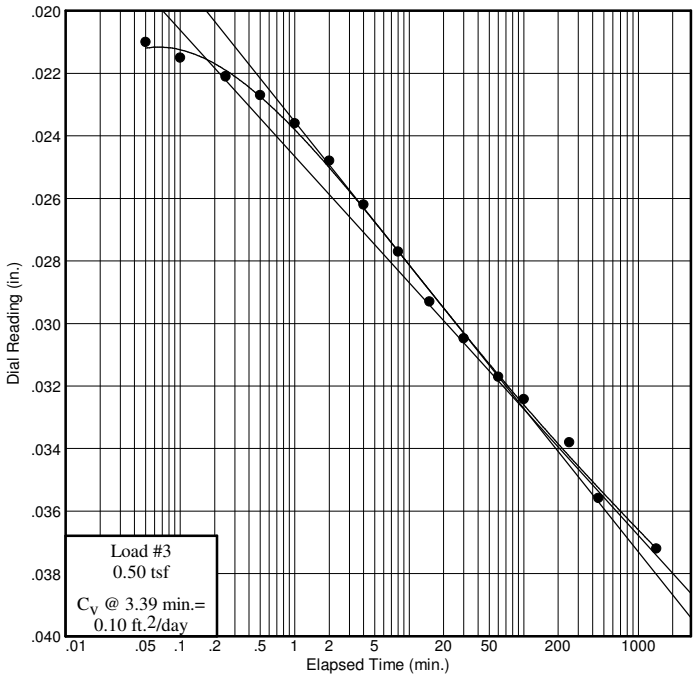
Figure

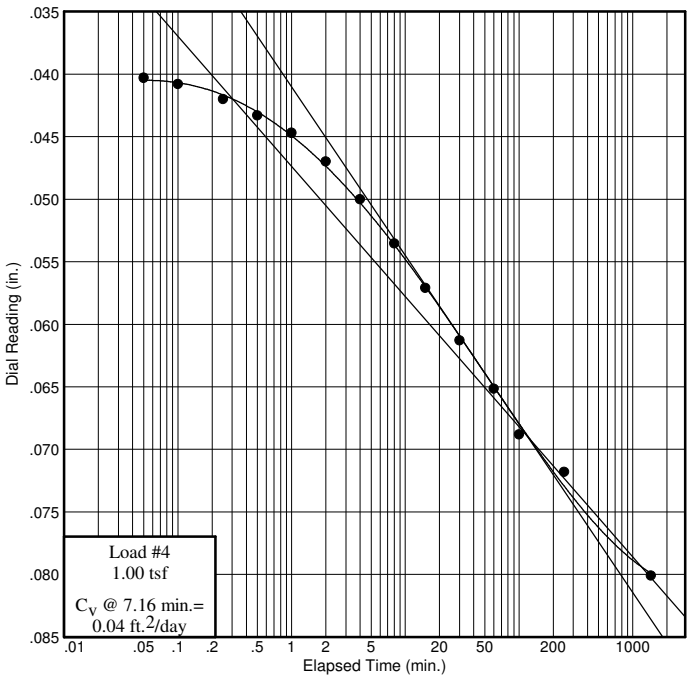
Dial Reading vs. Time

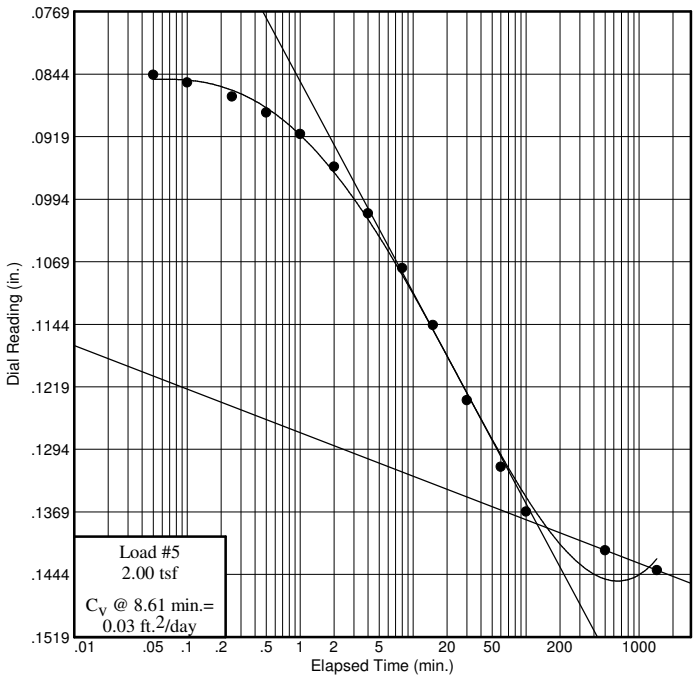
Project No.: 19998709
Project: Rahway Arch

Source: BD-04R Sample No.: T-1 Elev./Depth: 21.0-23.0









URS CORPORATION

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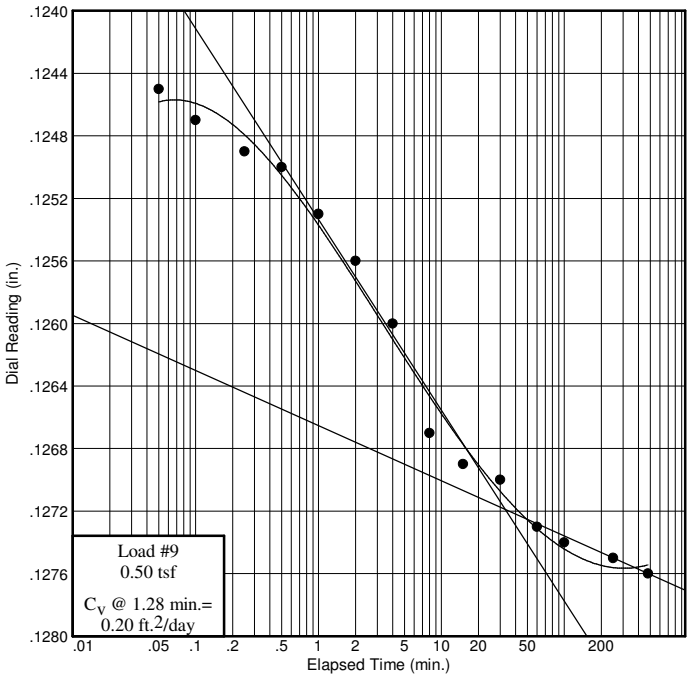
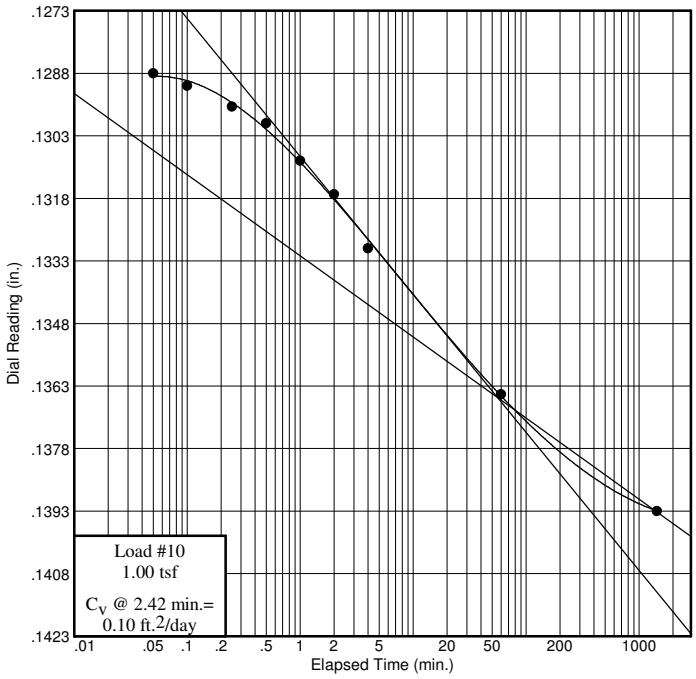
Figure

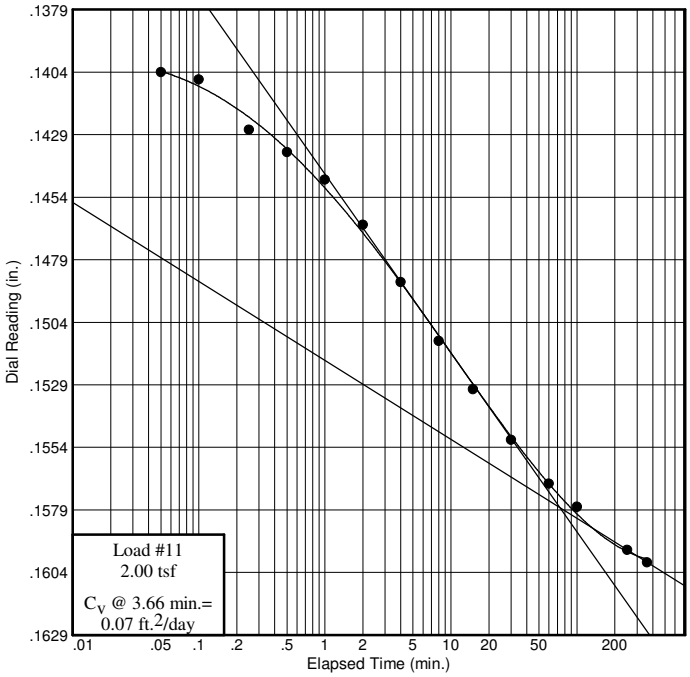
Dial Reading vs. Time

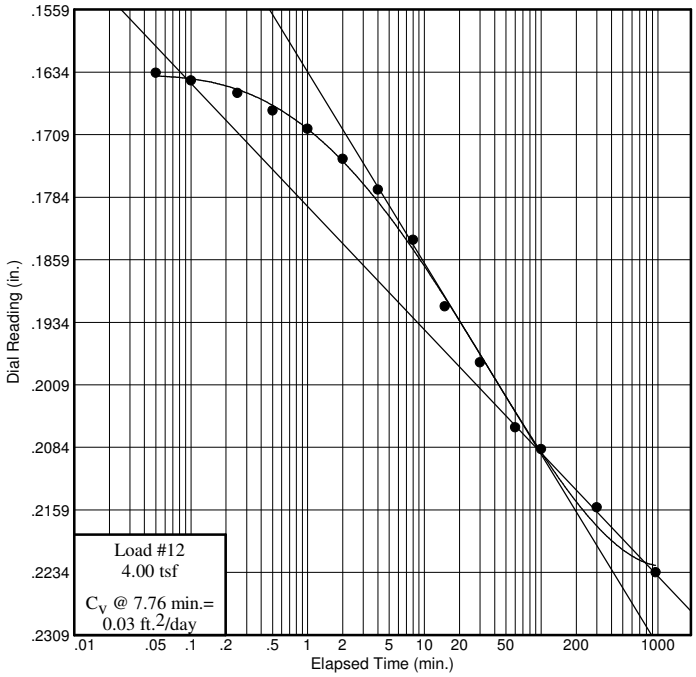
Project No.: 19998709
Project: Rahway Arch

Source: BD-04R Sample No.: T-1 Elev./Depth: 21.0-23.0









URS CORPORATION

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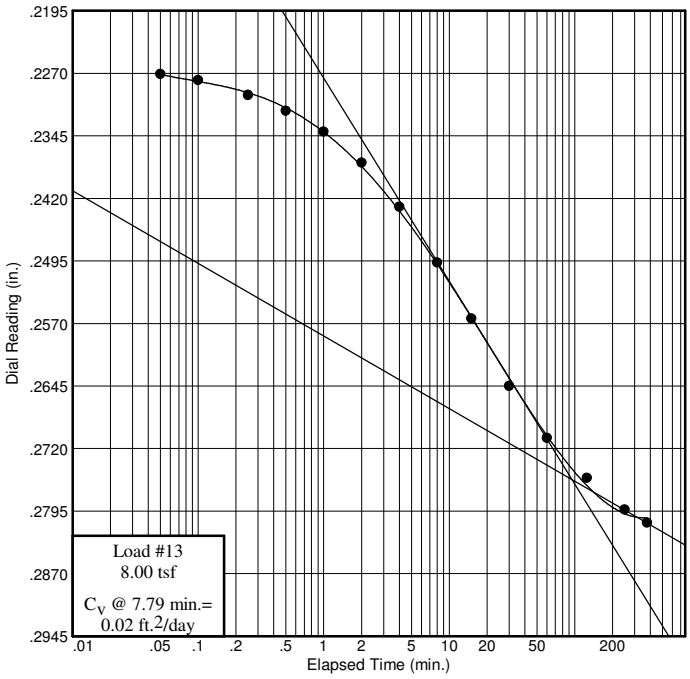
Figure

Dial Reading vs. Time

Project No.: 19998709
Project: Rahway Arch

Source: BD-04R Sample No.: T-1 Elev./Depth: 21.0-23.0



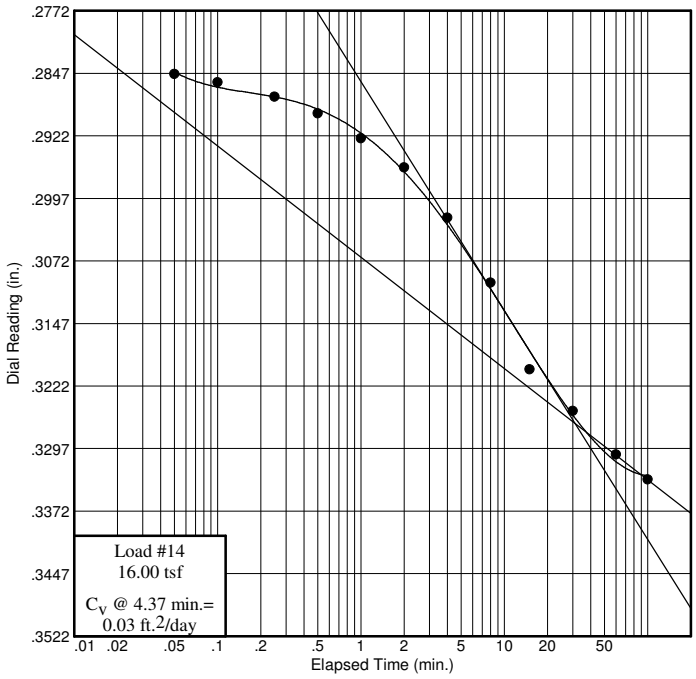


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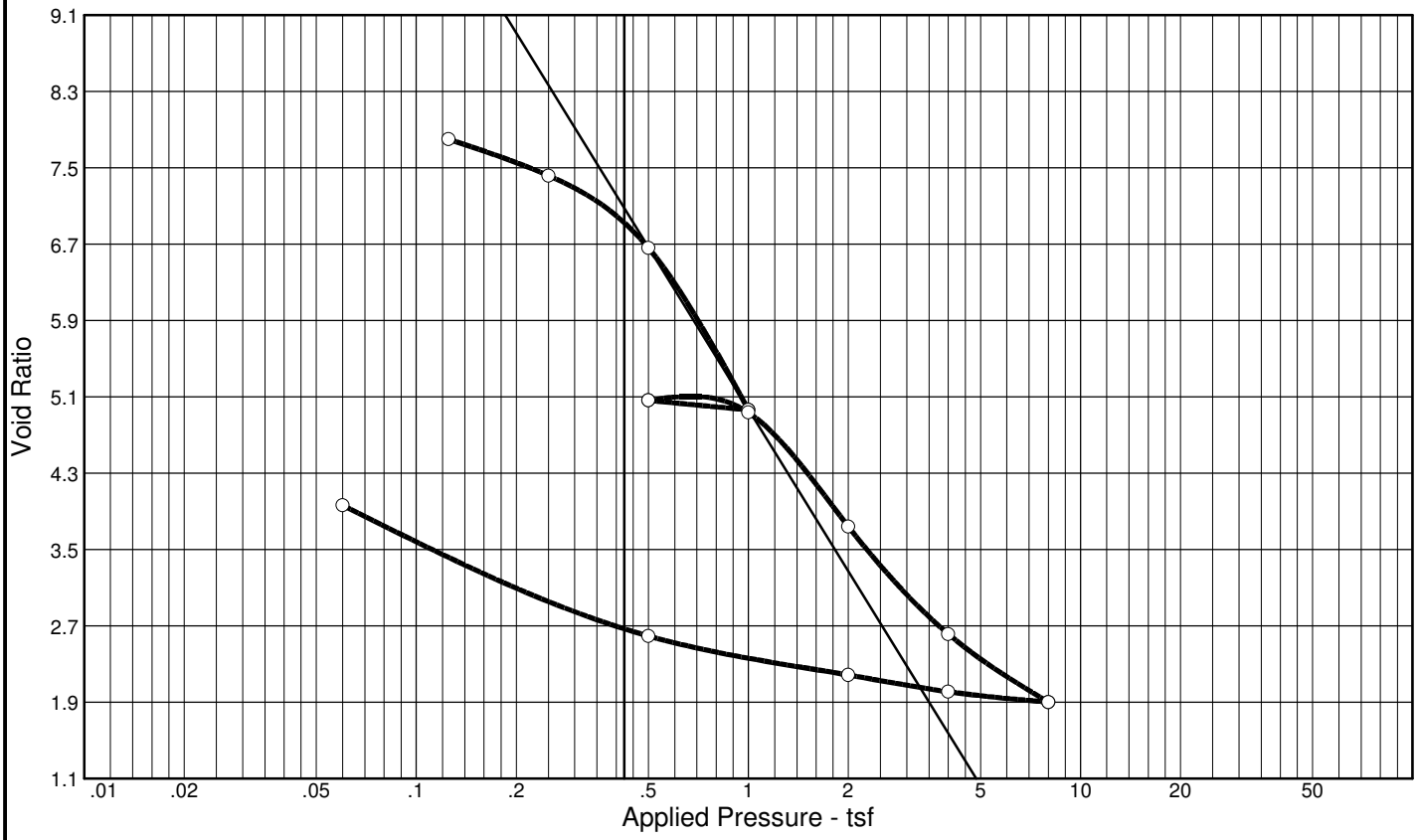
Figure

CONSOLIDATION TEST REPORT



Coefficients of Consolidation and Secondary Consolidation											
No.	Load (tsf)	C_v (ft.^{2}/day)	C_α	No.	Load (tsf)	C_v (ft.^{2}/day)	C_α	No.	Load (tsf)	C_v (ft.^{2}/day)	C_α
1	0.13	0.02	0.010								
2	0.25	0.11	0.012								
3	0.50	0.06	0.018								
4	1.00	0.14	0.046								
7	2.00	0.01	0.049								
8	4.00	0.01	0.045								
9	8.00	0.00	0.027								

Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (tsf)	P_c (tsf)	C_c	C_r	Initial Void Ratio
Saturation	Moisture									
99.8 %	464.9 %	11.9	467	211	1.75		0.46	5.64	0.64	8.150

MATERIAL DESCRIPTION	USCS	AASHTO
Dark Gray Sandy Elastic Silt	MH	

Project No. 19998709 **Client:** Michael Baker Jr., Inc.

Project: Rahway Arch

Source: BS-02 **Sample No.:** T-1 **Elev./Depth:** 7.0-9.0

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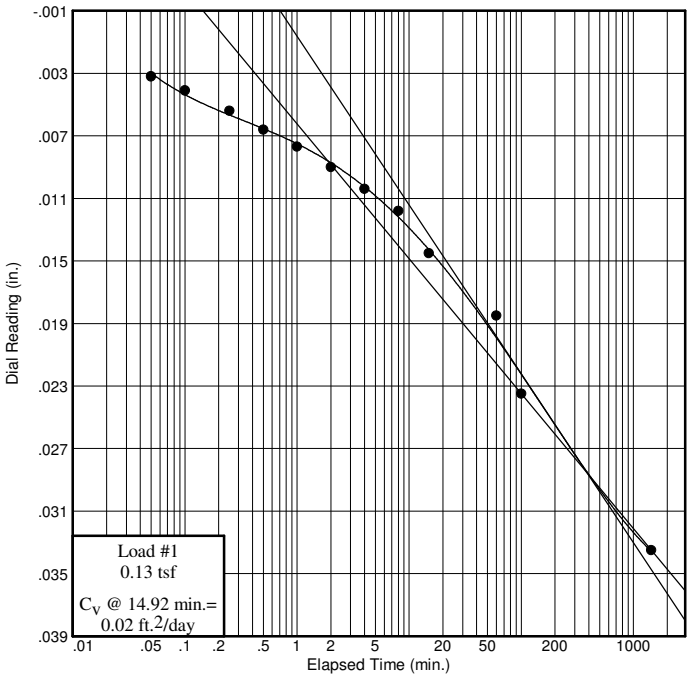
Remarks:

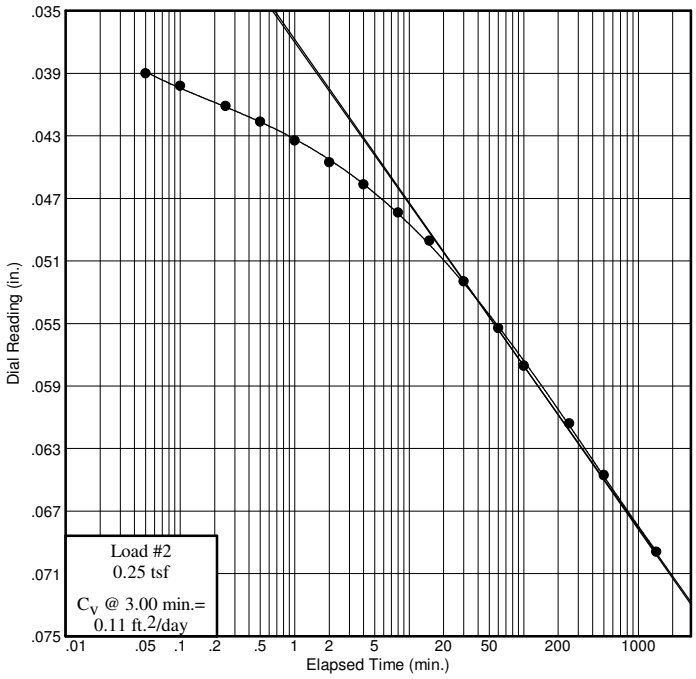
Figure

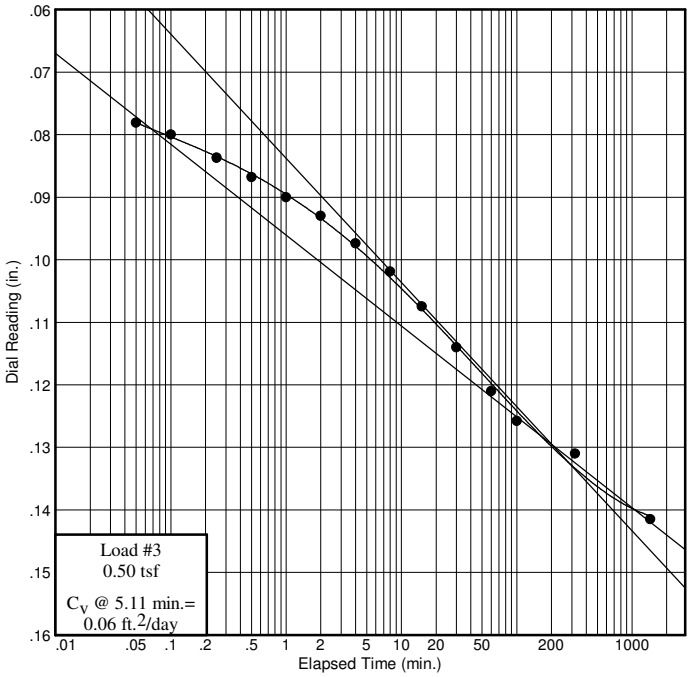
Dial Reading vs. Time

Project No.: 19998709
Project: Rahway Arch

Source: BS-02 Sample No.: T-1 Elev./Depth: 7.0-9.0







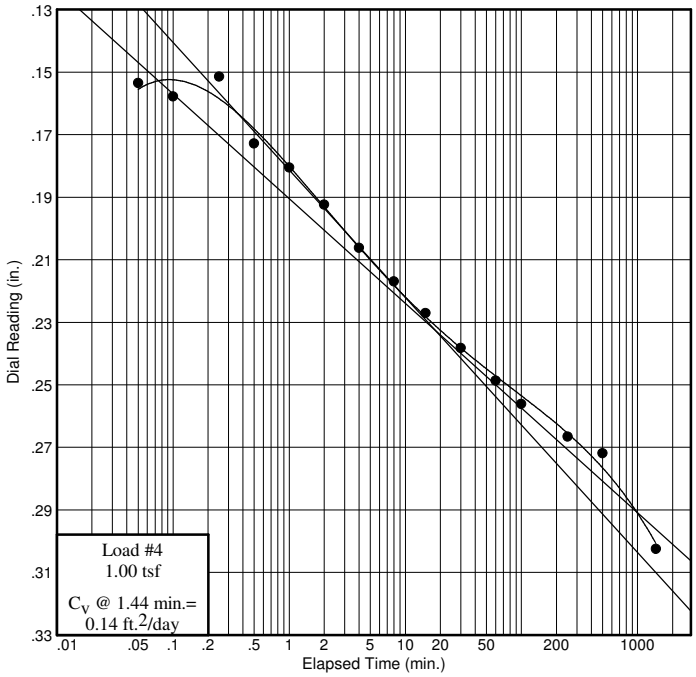


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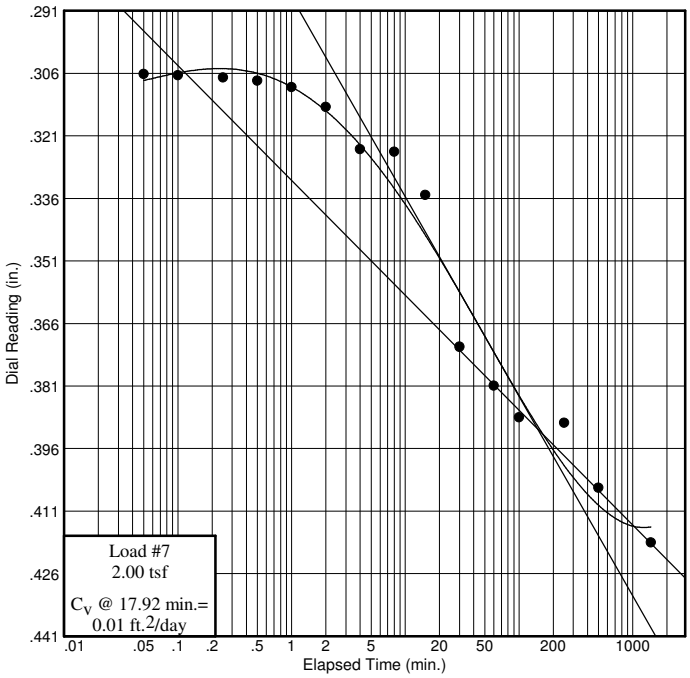
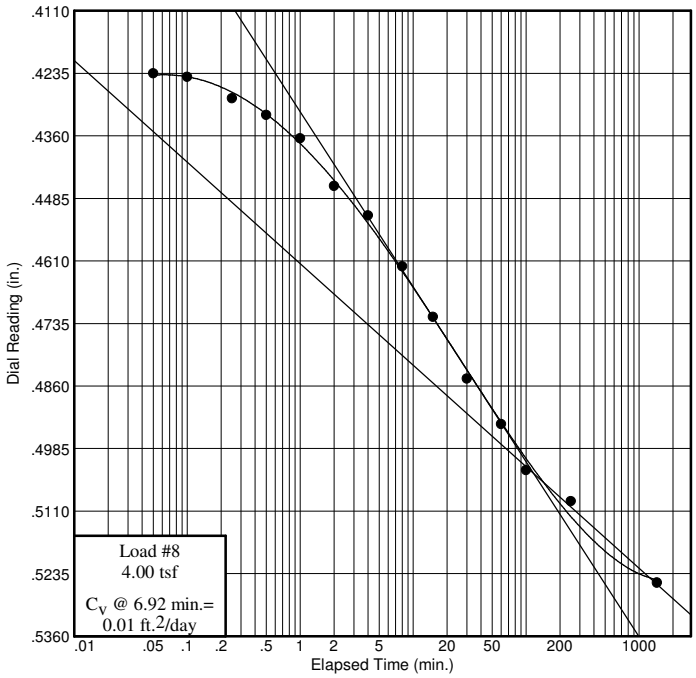
Figure

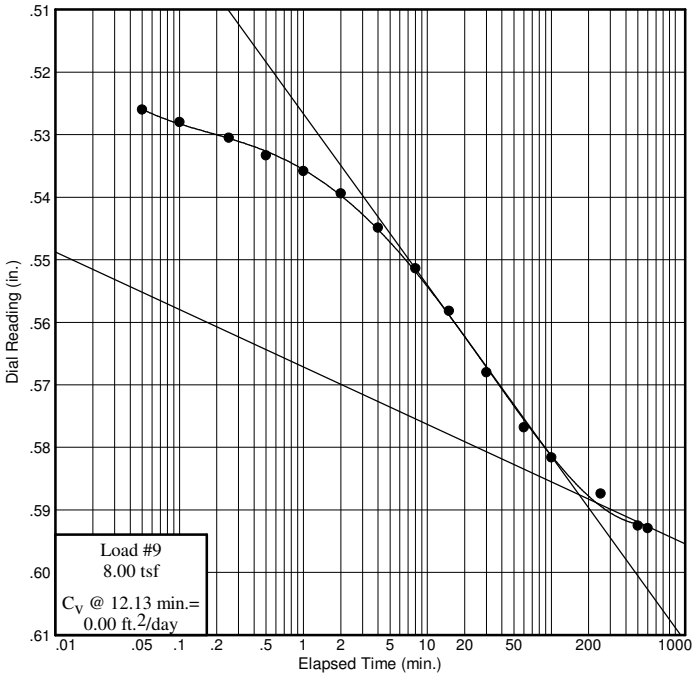
Dial Reading vs. Time

Project No.: 19998709
Project: Rahway Arch

Source: BS-02 Sample No.: T-1 Elev./Depth: 7.0-9.0







URS CORPORATION

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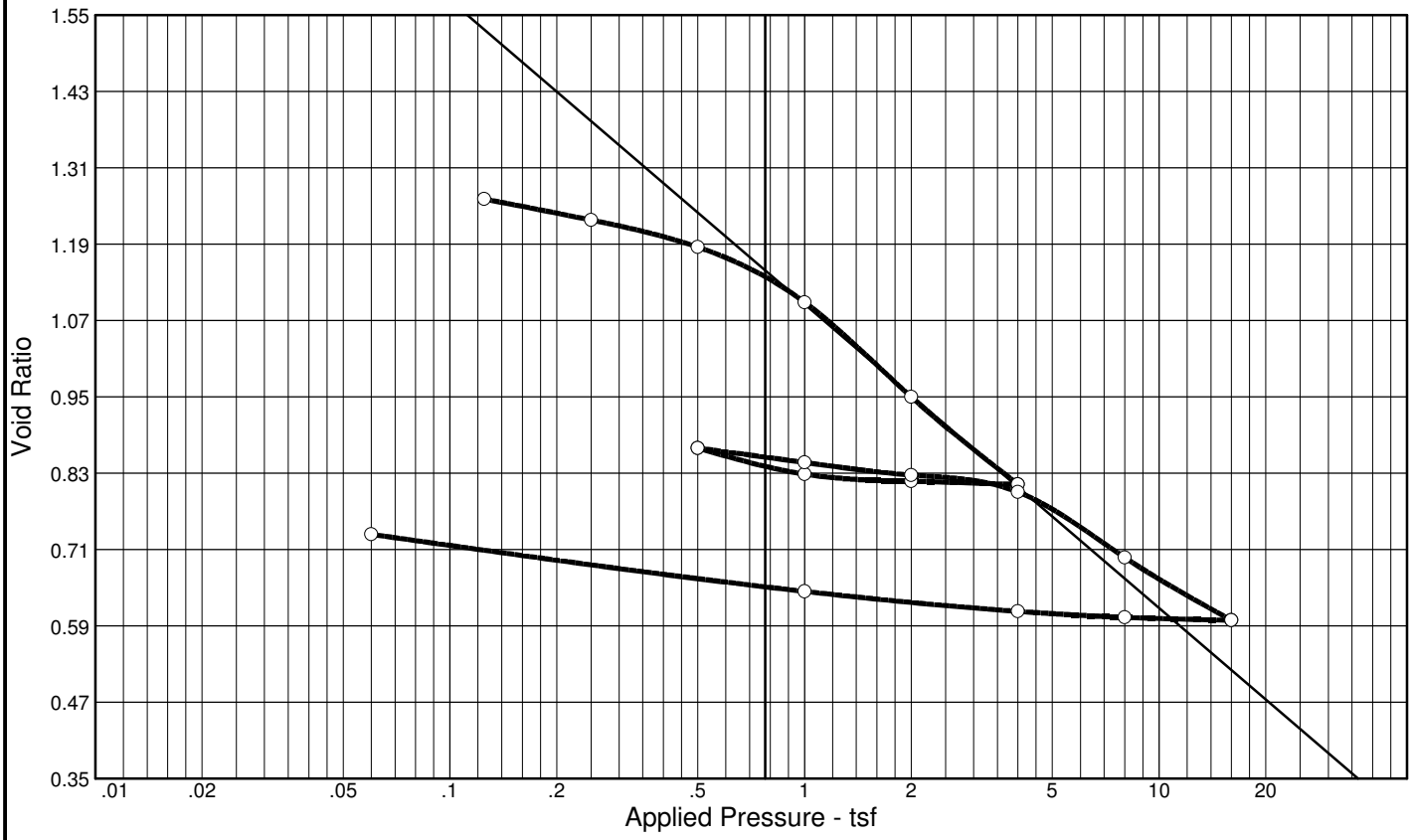
Figure

CONSOLIDATION TEST REPORT



Coefficients of Consolidation and Secondary Consolidation											
No.	Load (tsf)	C_v (ft.^{2}/day)	C_α	No.	Load (tsf)	C_v (ft.^{2}/day)	C_α	No.	Load (tsf)	C_v (ft.^{2}/day)	C_α
3	0.50	0.20	0.003								
4	1.00	0.12	0.002								
5	2.00	0.44	0.012								
6	4.00	0.28	0.012								
11	2.00	2.07	0.001								
12	4.00	0.61	0.003								
13	8.00	0.13	0.006								
14	16.00	0.28	0.011								

Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (tsf)	P_c (tsf)	C_c	C_r	Initial Void Ratio
Saturation	Moisture									
95.7 %	48.6 %	69.0	241	128	2.52		0.83	0.48	0.06	1.279

MATERIAL DESCRIPTION	USCS	AASHTO
Gray Silty Sand	SM	

Project No. 19998709 **Client:** Michael Baker Jr., Inc.

Project: Rahway Arch

Source: BS-09 **Sample No.:** T-1 **Elev./Depth:** 12.0-14.0

URS CORPORATION

Fort Washington, PA

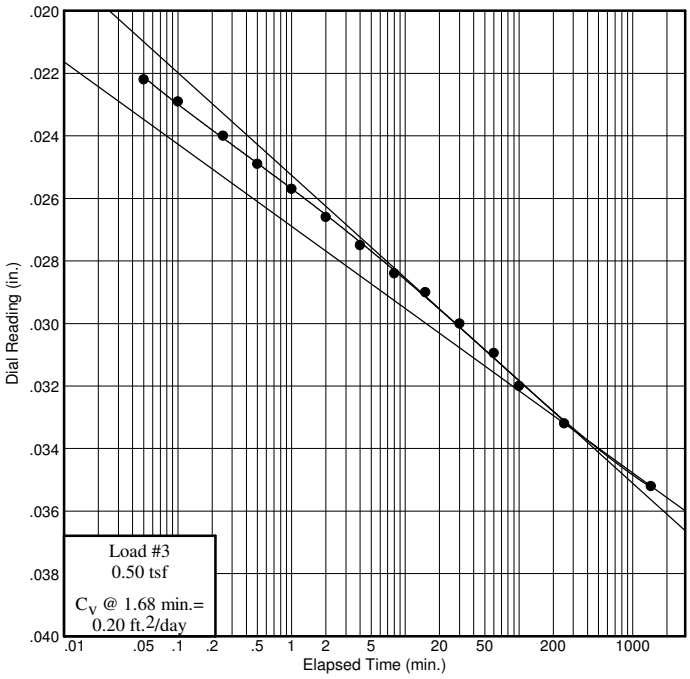
Remarks:

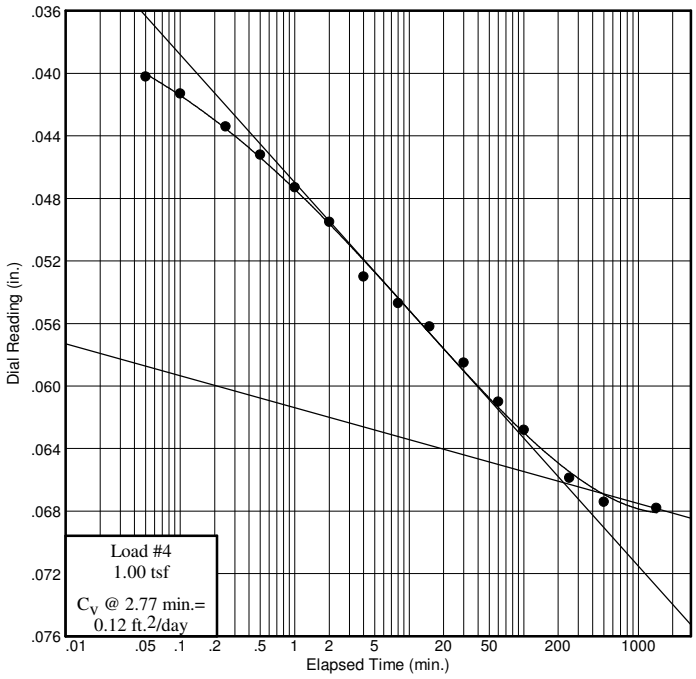
Figure

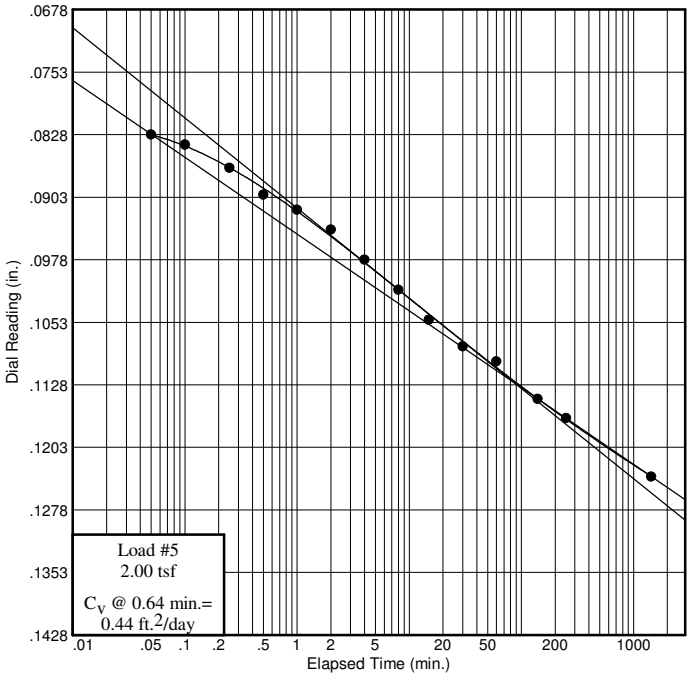
Dial Reading vs. Time

Project No.: 19998709
Project: Rahway Arch

Source: BS-09 Sample No.: T-1 Elev./Depth: 12.0-14.0







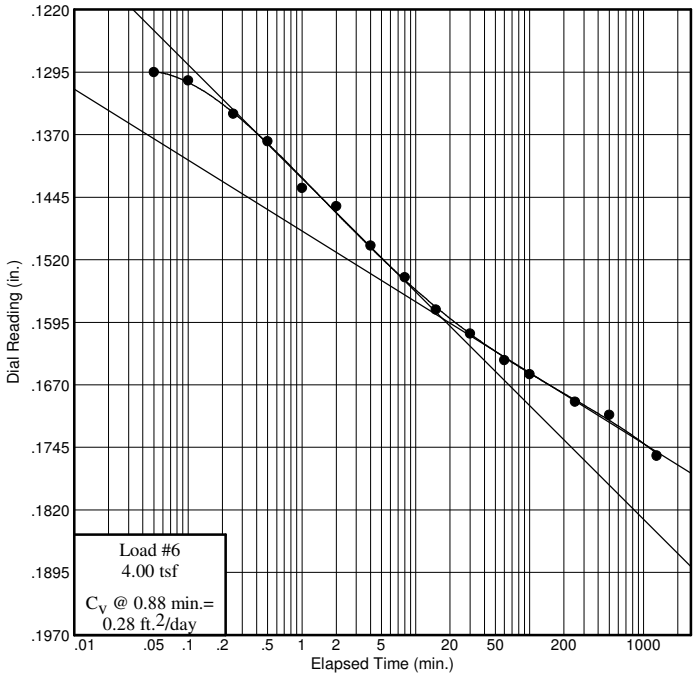


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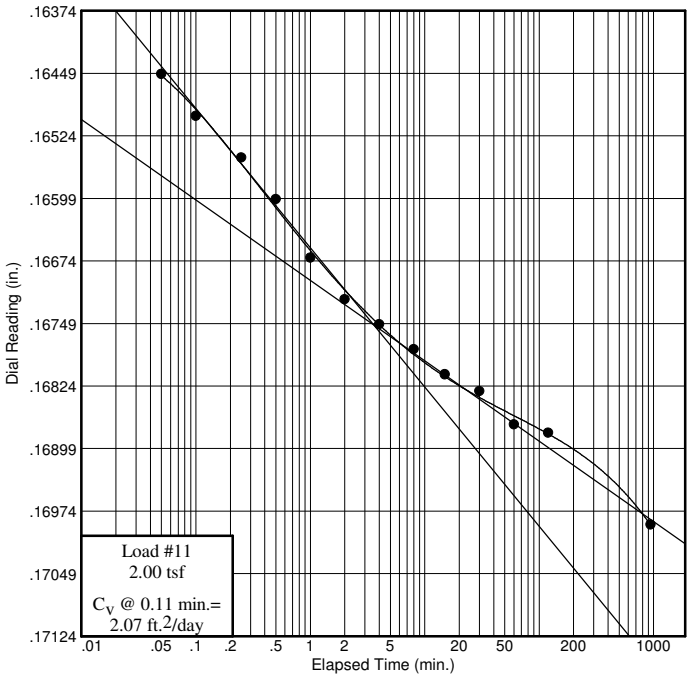
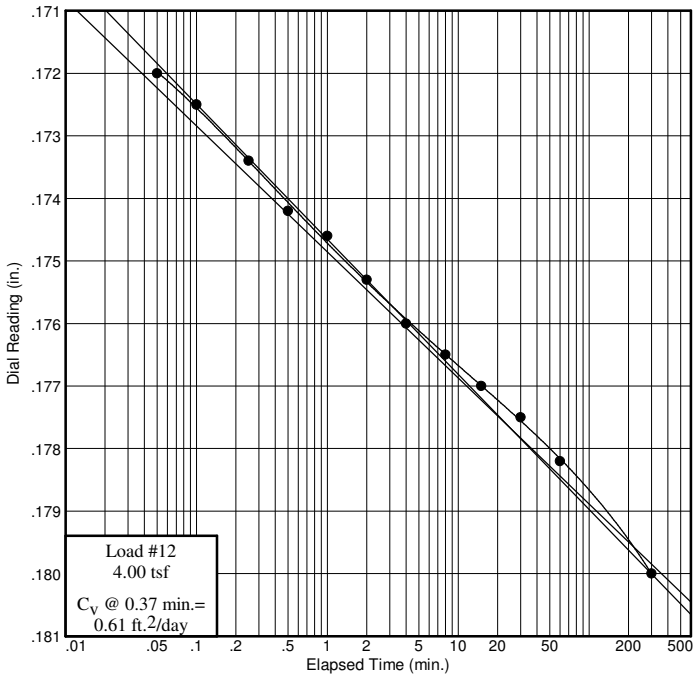
Figure

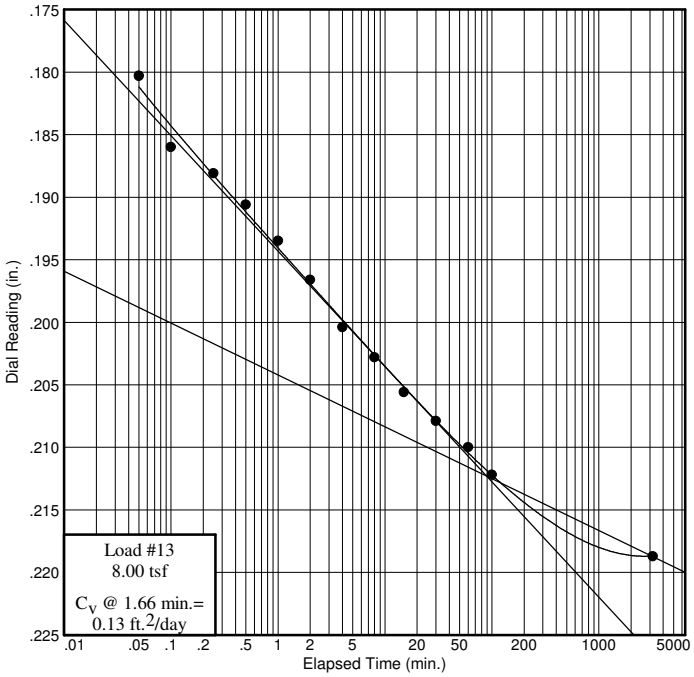
Dial Reading vs. Time

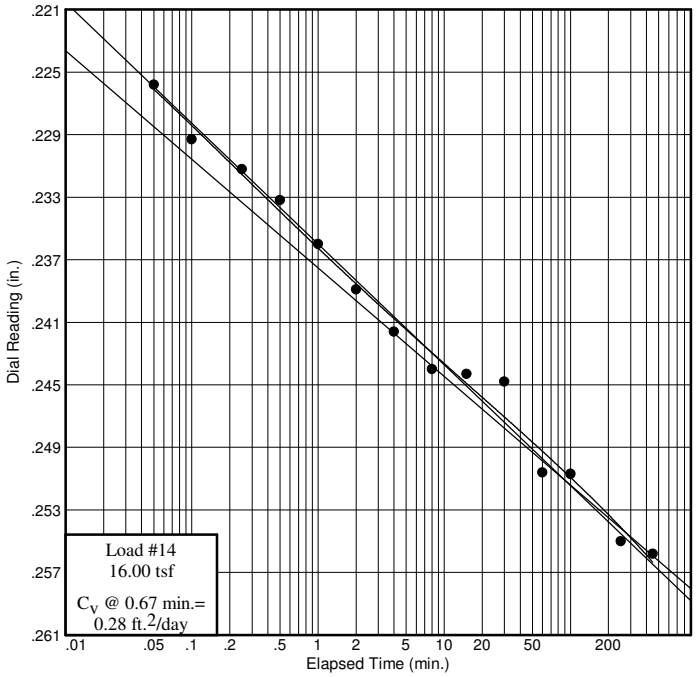
Project No.: 19998709
Project: Rahway Arch

Source: BS-09 Sample No.: T-1 Elev./Depth: 12.0-14.0









URS CORPORATION

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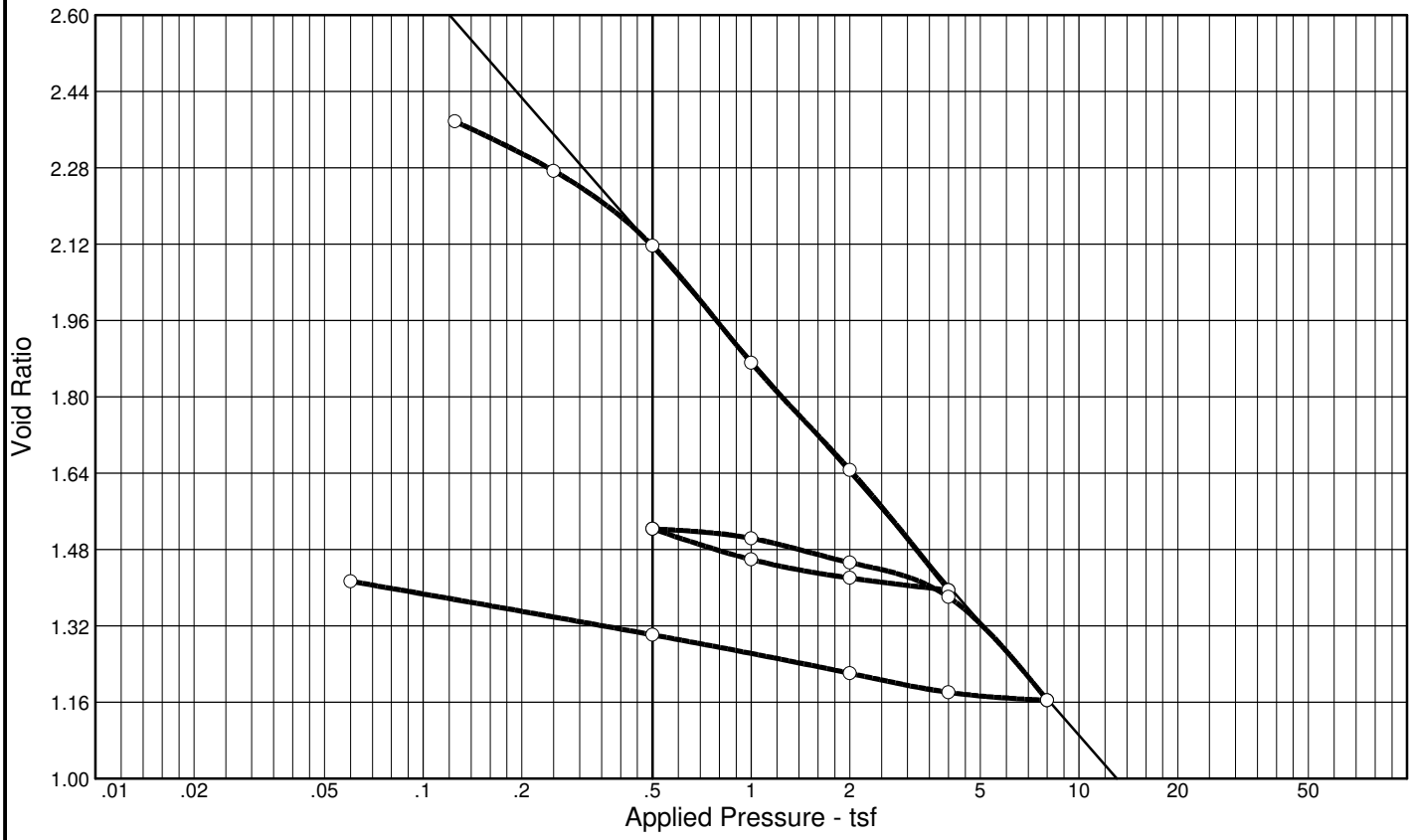
Figure

CONSOLIDATION TEST REPORT



Coefficients of Consolidation and Secondary Consolidation											
No.	Load (tsf)	C_v (ft.^{2}/day)	C_α	No.	Load (tsf)	C_v (ft.^{2}/day)	C_α	No.	Load (tsf)	C_v (ft.^{2}/day)	C_α
2	0.25	0.09	0.011								
3	0.50	0.02	0.014								
4	1.00	0.01	0.025								
5	2.00	0.02	0.016								
6	4.00	0.03	0.016								
11	2.00	0.11	0.002								
12	4.00	0.07	0.006								
13	8.00	0.02	0.016								

Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (tsf)	P_c (tsf)	C_c	C_r	Initial Void Ratio
Saturation	Moisture									
100.9 %	96.4 %	46.5	130	87	2.58		0.49	0.79	0.13	2.466

MATERIAL DESCRIPTION	USCS	AASHTO
Dark Gray Fat Clay	CH	

Project No. 19998709 **Client:** Michael Baker Jr., Inc.

Project: Rahway Arch

Source: ID-06 **Sample No.:** U-2 **Elev./Depth:** 14.0-16.0

URS CORPORATION

Fort Washington, PA

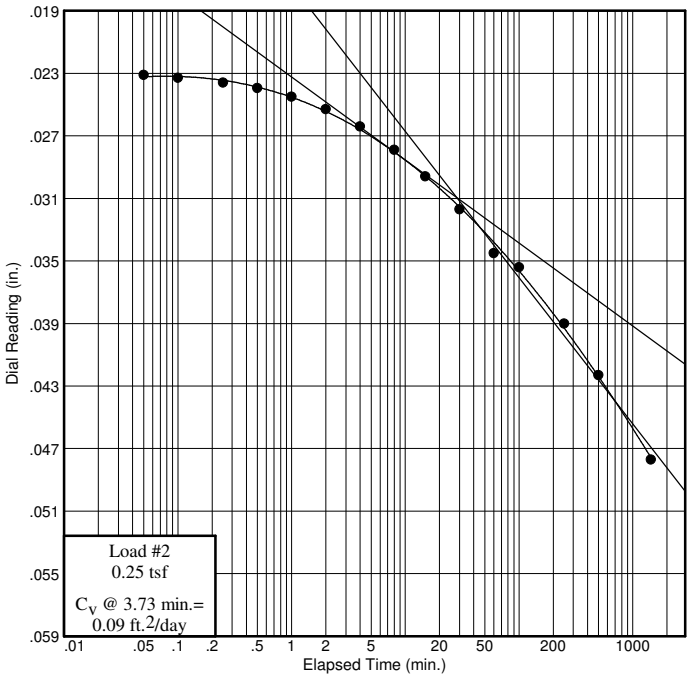
Remarks:

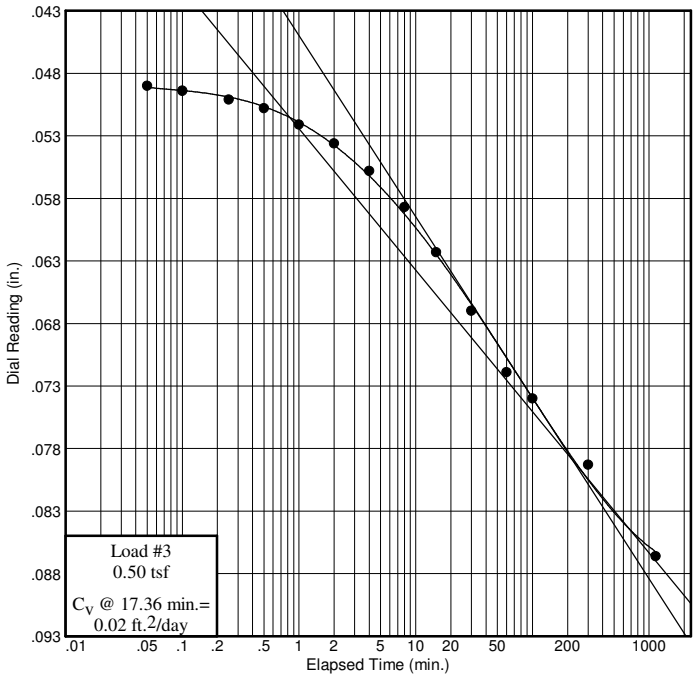
Figure

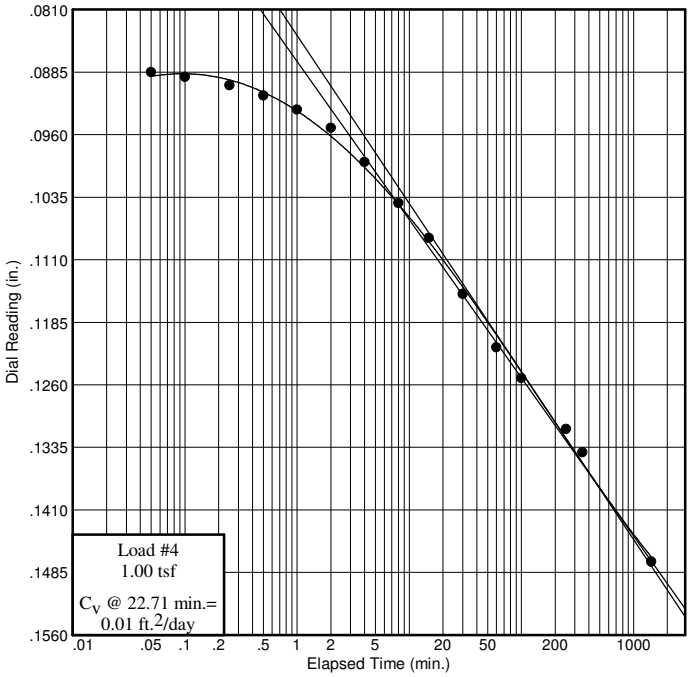
Dial Reading vs. Time

Project No.: 19998709
Project: Rahway Arch

Source: ID-06 Sample No.: U-2 Elev./Depth: 14.0-16.0







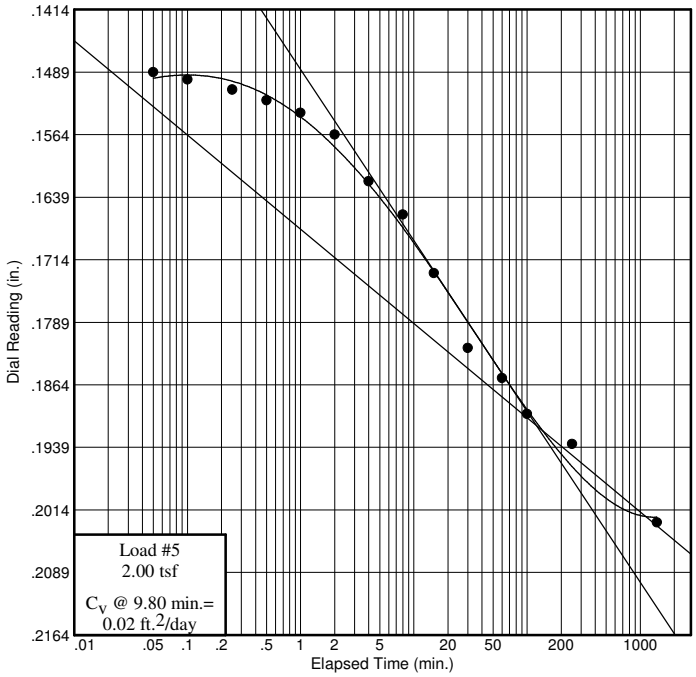


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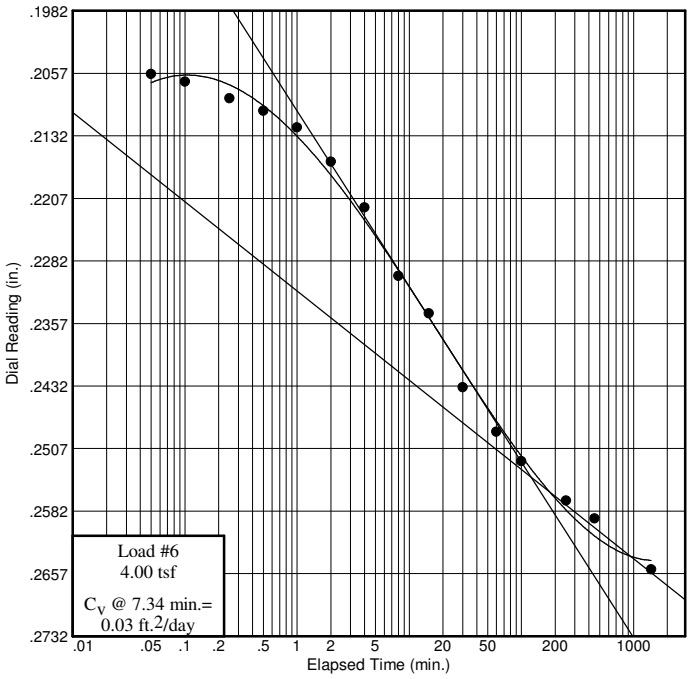
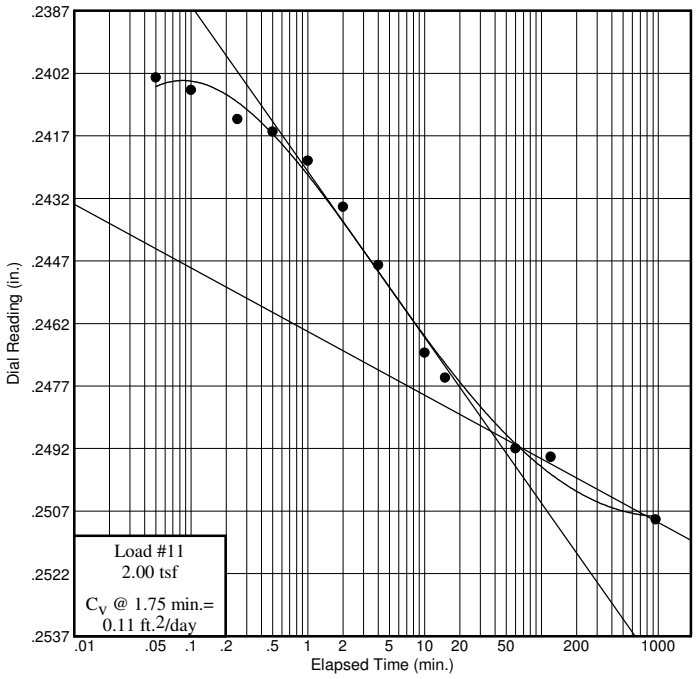
Figure

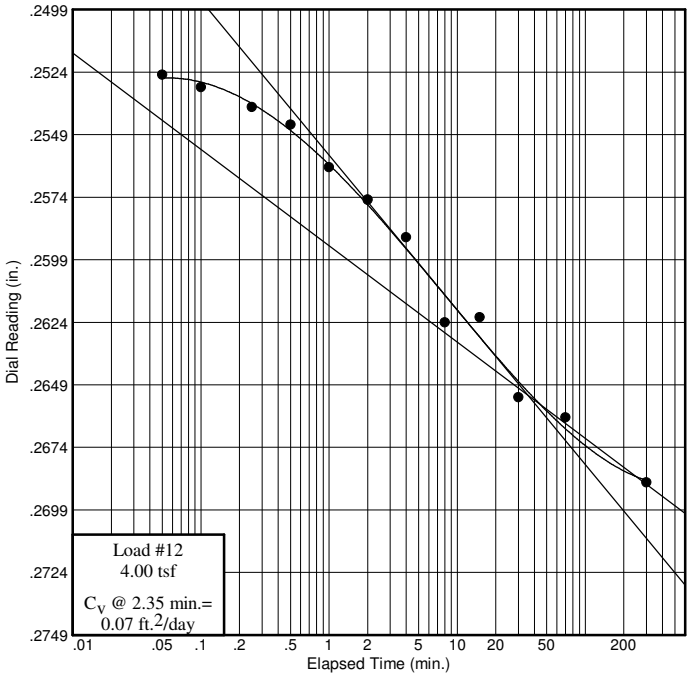
Dial Reading vs. Time

Project No.: 19998709
Project: Rahway Arch

Source: ID-06 Sample No.: U-2 Elev./Depth: 14.0-16.0







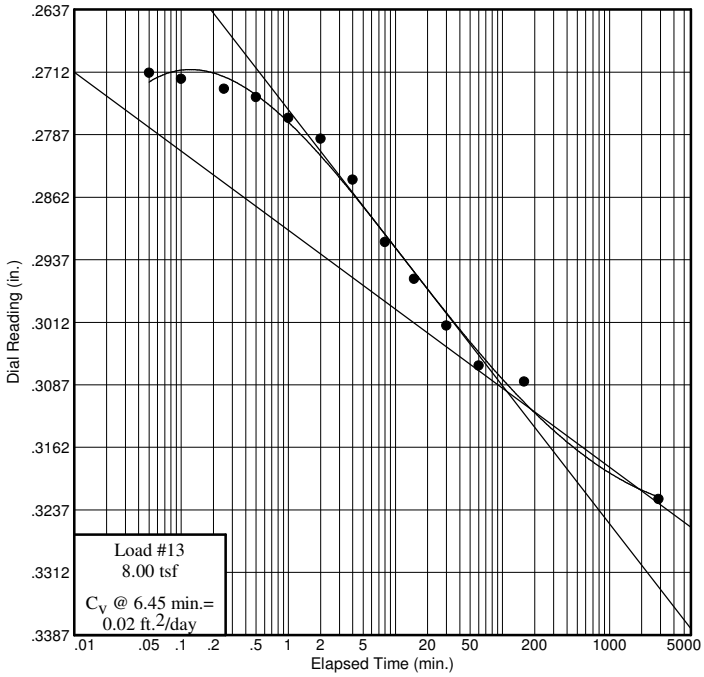


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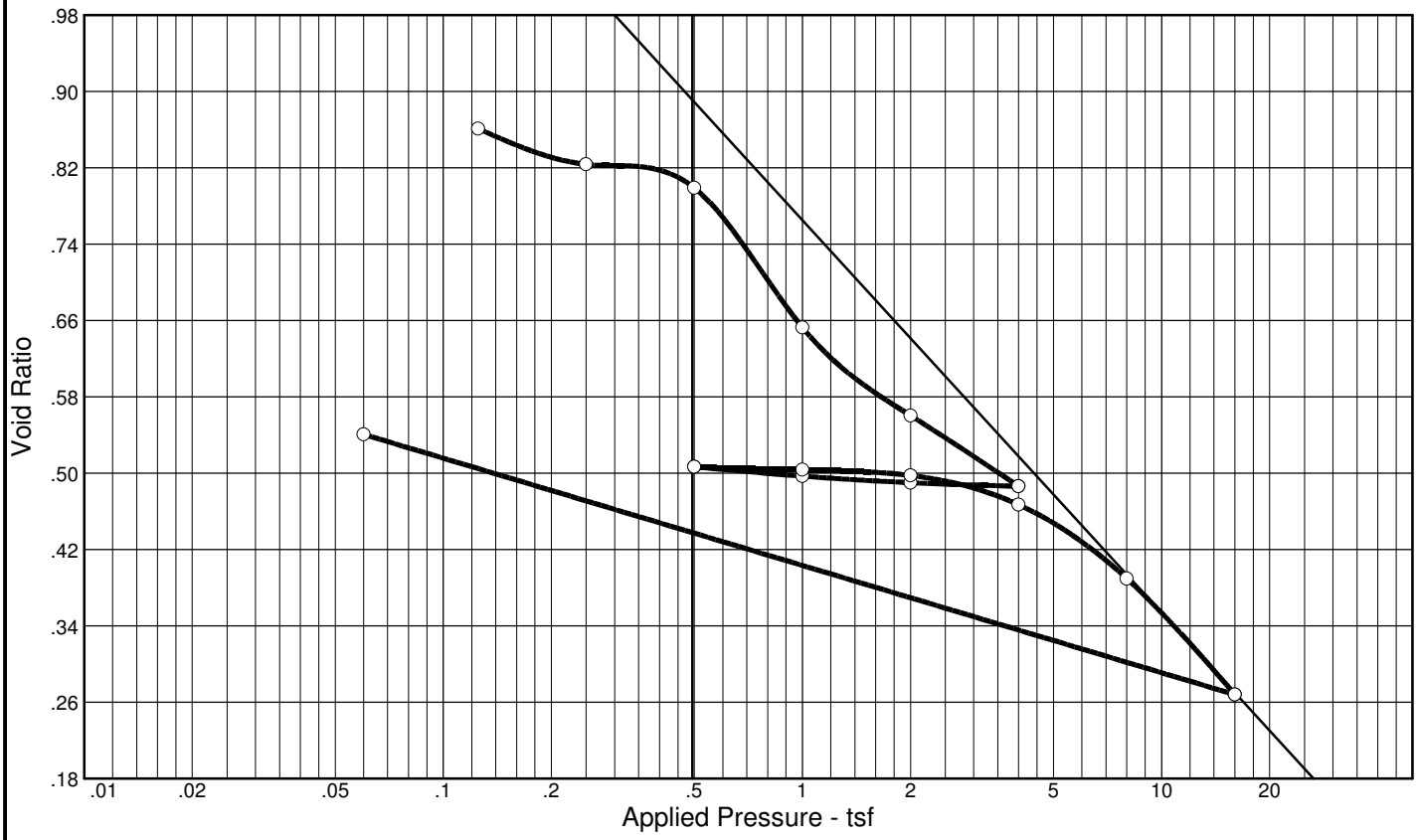
Figure

CONSOLIDATION TEST REPORT



Coefficients of Consolidation and Secondary Consolidation											
No.	Load (tsf)	C_v (ft.^{2}/day)	C_α	No.	Load (tsf)	C_v (ft.^{2}/day)	C_α	No.	Load (tsf)	C_v (ft.^{2}/day)	C_α
12	4.00	0.02	0.012								
13	8.00	0.30	0.023								

Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (tsf)	P_c (tsf)	C_c	C_r	Initial Void Ratio
Saturation	Moisture									
109.0 %	37.5 %	86.2	33	11	2.63		1.08	0.41	0.04	0.904

MATERIAL DESCRIPTION	USCS	AASHTO
Dark Gray Sandy Lean CLAY	CL	

Project No. 19998709 **Client:** Michael Baker Jr., Inc.

Project: Rahway Arch

Source: IS-02 **Sample No.:** U-1 **Elev./Depth:** 19.0-21.0

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Remarks:

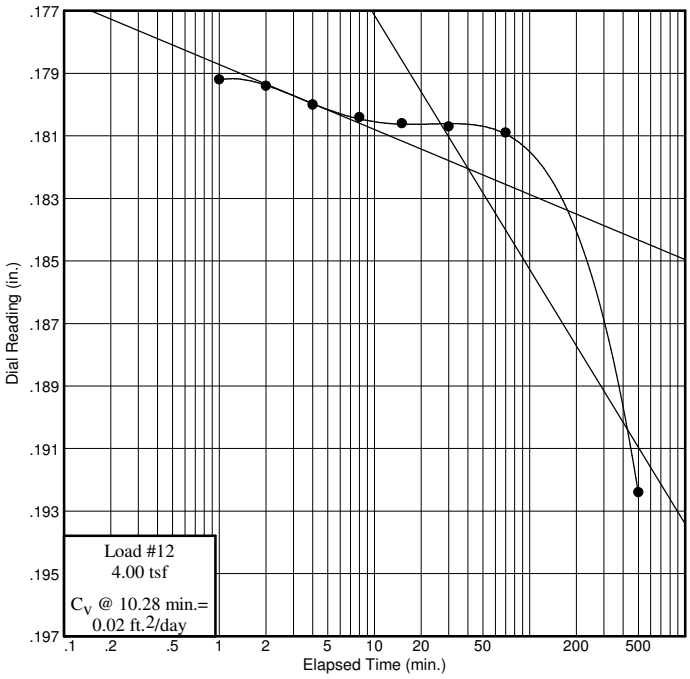
After initial 2.0 tsf, needle start sticking.Time curves are skewed. Sample maybe disturbed.

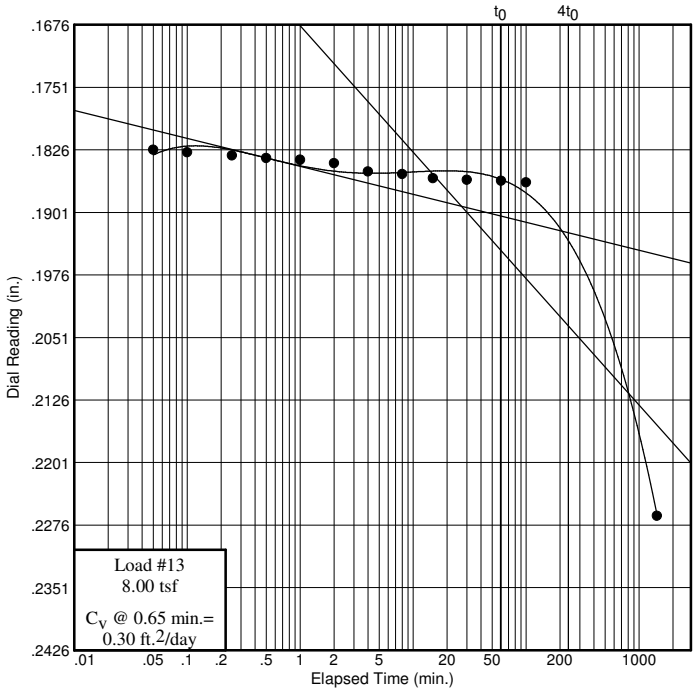
Figure

Dial Reading vs. Time

Project No.: 19998709
Project: Rahway Arch

Source: IS-02 Sample No.: U-1 Elev./Depth: 19.0-21.0





URS CORPORATION

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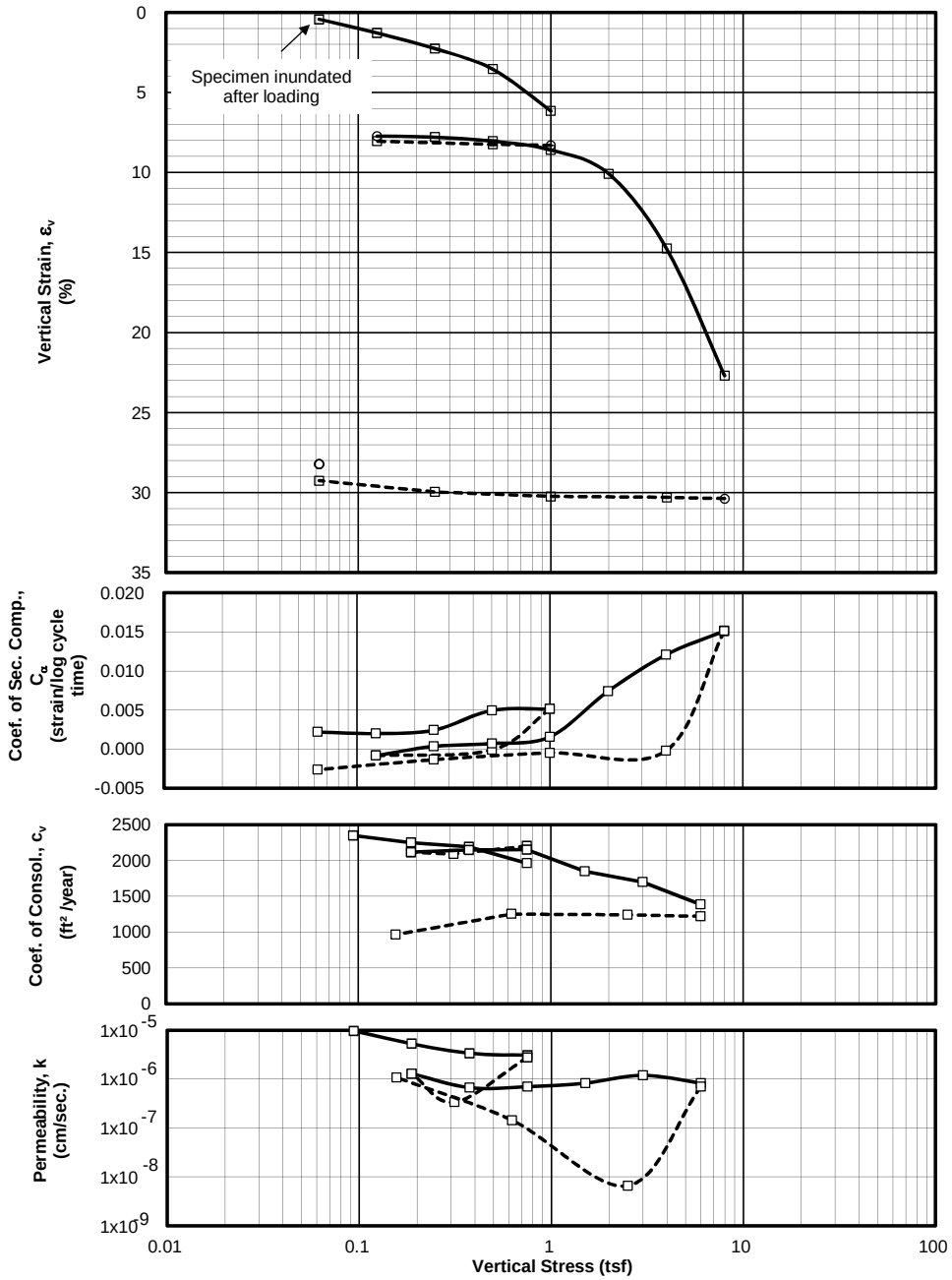
Figure



SAMPLE INFORMATION

Boring: BS-03R
Sample: T-1D
Depth: 10.00 feet
Elevation:
Type: 3-inch thin wall tube
Description: MH, gray elastic silt

Remarks: Significant creep noted in addition to primary and secondary consolidation

SPECIMEN INFORMATION

(NOTE: Initial and final states refer to beginning and end of test)

Initial height: 0.61 inch
Diameter: 2.50 inch

Initial water content:	124.3	%
Initial total unit weight:	91.3	pcf
Initial dry unit weight:	40.7	pcf
Initial void ratio:	3.866	
Initial degree of saturation:	102 *	%
Final water content:	84.1	%
Final total unit weight:	100.2	pcf
Final dry unit weight:	54.4	pcf
Final void ratio:	2.638	
Final degree of saturation:	101 *	%

(* for measured specific gravity = 3.17)

TEST SUMMARY

Construction Method:	Taylor (Square Root)
Estimated preconsolidation stress (tsf):	2.4 (Range: 2.0 to 2.6)
Estimated in situ effective overburden stress (tsf):	
Compression Ratio (strain per log cycle stress):	0.264
Compression Index (void ratio per log cycle stress):	1.285
Swell Ratio (strain per log cycle stress):	0.003
Swell Index (void ratio per log cycle stress):	0.015
Recompression Ratio (strain per log cycle stress):	0.006
Recompression Index (void ratio per log cycle stress):	0.029

LEGEND: □ End of primary o End of Stage ——— Loading - - - - - - Unloading

Test Date: 8/15/12 Tested By: TK/CMJ Checked By: GET

URS Corporation Project No. 19998709	Rahway Arch Site Carteret, New Jersey	ONE DIMENSIONAL CONSOLIDATION TEST Boring: BS-03R Depth: 10.00 feet
TerraSense, LLC	Project No. T19998709	September 2012

PROJECT:	Rahway Arch Site				
PROJECT NO.:	T19998709	Initial height:	0.609 inch	Final height:	0.455 inch
BORING:	BS-03R	Initial water content:	124.3 %	Final water content:	84.1 %
SAMPLE:	T-1D	Initial dry density:	40.7 pcf	Final dry density:	54.4 pcf
TEST:	C12129	Initial total density:	91.3 pcf	Final total density:	100.2 pcf
DEPTH, feet:	10	Initial saturation:	102 %	Final saturation:	101 %
BY:	TK/CMJ	Initial void ratio:	3.866	Final void ratio:	2.638
TEST DATE:	8/15/2012			Final strain:	25.2 %

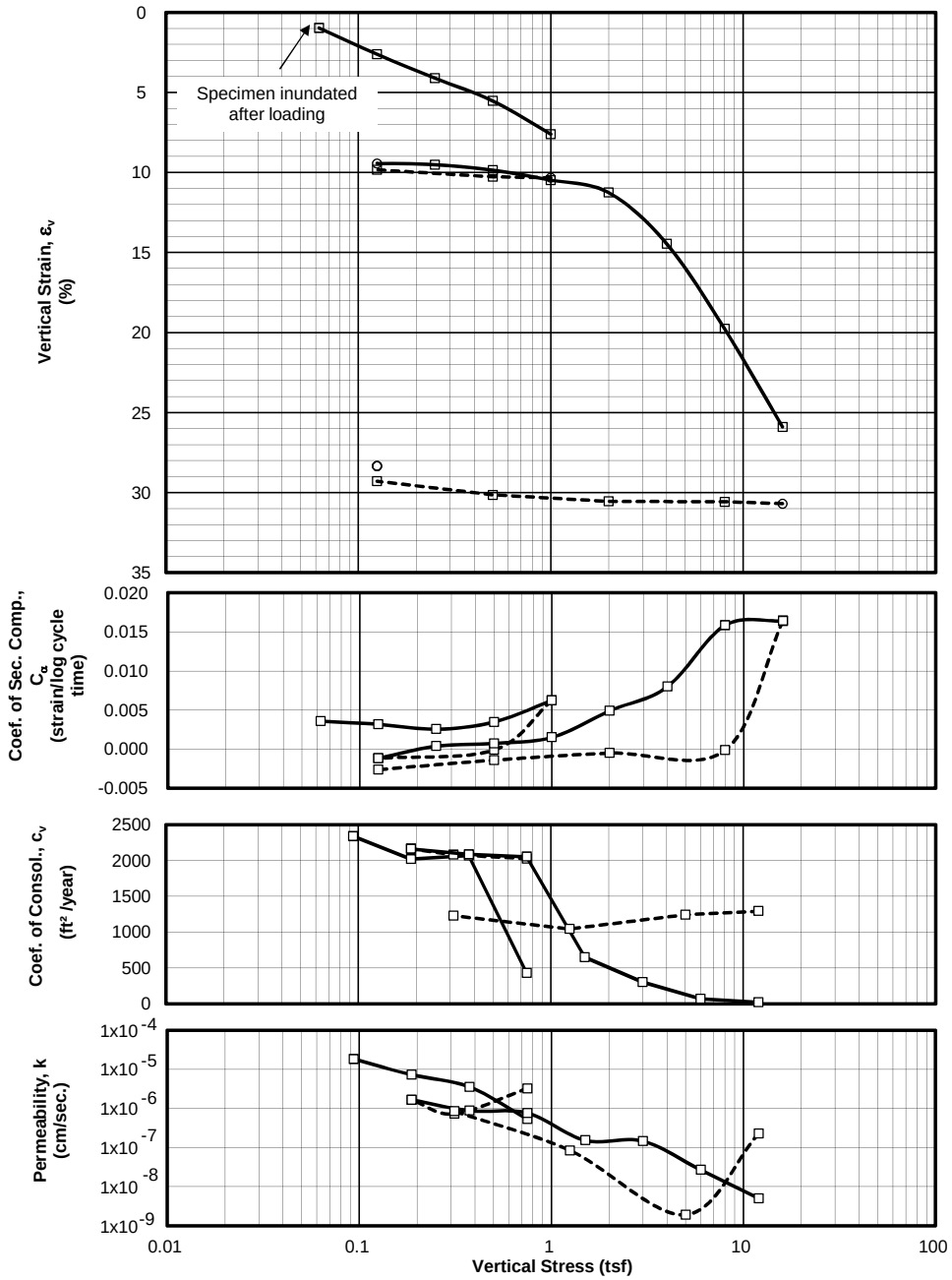
EQUIPMENT: SPECIMEN DESCRIPTION: MH, gray elastic silt

Load Frame No.: 3

Ring Diameter: 2.5 inch

G	LL	PL	PI
3.173			

Load No.	Load (tsf)	d_{100} (inch)	t_{100} Strain (%)	t_{100} Void Ratio (-)	Final Strain (%)	Final Void Ratio (-)	c_v (ft²/year)	C_α (strain/logt)	Constrained Modulus (tsf)	Permeability (cm/sec)
1	0.063	0.0026	0.428	3.845	1.054	3.815	2501.75	0.0022	14.61	5.16E-06
2	0.125	0.0078	1.287	3.803	2.084	3.765	2347.77	0.0020	7.27	9.74E-06
3	0.250	0.0138	2.268	3.756	3.278	3.706	2249.69	0.0024	12.74	5.33E-06
4	0.500	0.0216	3.553	3.693	5.873	3.580	2189.02	0.0049	19.46	3.39E-06
5	1.00	0.0375	6.163	3.566	8.308	3.462	1960.48	0.0051	19.16	3.09E-06
6	0.500	0.0503	8.251	3.464	8.232	3.465	2201.08	-0.0001	23.94	2.77E-06
7	0.125	0.0490	8.051	3.474	7.734	3.490	2090.00	-0.0008	187.00	3.37E-07
8	0.250	0.0475	7.796	3.487	7.904	3.481	2114.72	0.0003	49.11	1.30E-06
9	0.500	0.0491	8.056	3.474	8.364	3.459	2147.75	0.0007	96.46	6.72E-07
10	1.00	0.0524	8.596	3.448	9.334	3.412	2151.90	0.0016	92.49	7.02E-07
11	2.00	0.0614	10.089	3.375	13.202	3.224	1847.62	0.0074	67.01	8.32E-07
12	4.00	0.0899	14.759	3.148	19.887	2.898	1696.96	0.0121	42.82	1.20E-06
13	8.00	0.1383	22.701	2.761	30.378	2.388	1386.26	0.0151	50.36	8.30E-07
14	4.00	0.1845	30.296	2.392	30.330	2.390	1217.78	-0.0002	52.67	6.98E-07
15	1.00	0.1842	30.244	2.394	30.119	2.400	1242.91	-0.0005	5702.70	6.58E-09
16	0.250	0.1824	29.958	2.408	29.432	2.434	1252.13	-0.0014	262.34	1.44E-07
17	0.063	0.1782	29.258	2.442	28.224	2.493	965.63	-0.0027	26.79	1.09E-06



SAMPLE INFORMATION

Boring: BS-06
Sample: U-1C
Depth: 3.55 feet
Elevation:
Type: 3-inch thin wall tube
Description: MH, light gray elastic silt

Remarks: Significant creep noted in addition to primary and secondary consolidation

SPECIMEN INFORMATION

(NOTE: Initial and final states refer to beginning and end of test)

Initial height: 0.61 inch
Diameter: 2.50 inch

Initial water content:	84.9	%
Initial total unit weight:	94.4	pcf
Initial dry unit weight:	51.1	pcf
Initial void ratio:	2.790	
Initial degree of saturation:	94 *	%
Final water content:	63.9	%
Final total unit weight:	106.0	pcf
Final dry unit weight:	64.7	pcf
Final void ratio:	1.993	
Final degree of saturation:	99 *	%

(* for measured specific gravity = 3.10)

TEST SUMMARY

Construction Method:	Taylor (Square Root)
Estimated preconsolidation stress (tsf):	3.2 (Range: 2.1 to 3.4)
Estimated in situ effective overburden stress (tsf):	
Compression Ratio (strain per log cycle stress):	0.203
Compression Index (void ratio per log cycle stress):	0.769
Swell Ratio (strain per log cycle stress):	0.007
Swell Index (void ratio per log cycle stress):	0.027
Recompression Ratio (strain per log cycle stress):	0.008
Recompression Index (void ratio per log cycle stress):	0.030
Remarks:	

LEGEND: □ End of primary o End of Stage ——— Loading - - - - - - Unloading

Test Date: 8/14/12 Tested By: TK/CMJ Checked By: GET

URS Corporation Project No. 19998709	Rahway Arch Site Carteret, New Jersey	ONE DIMENSIONAL CONSOLIDATION TEST Boring: BS-06 Depth: 3.55 feet
TerraSense, LLC	Project No. T19998709	September 2012

PROJECT:	Rahway Arch Site				
PROJECT NO.:	T19998709	Initial height:	0.614 inch	Final height:	0.484 inch
BORING:	BS-06	Initial water content:	84.9 %	Final water content:	63.9 %
SAMPLE:	U-1C	Initial dry density:	51.1 pcf	Final dry density:	64.7 pcf
TEST:	C12128	Initial total density:	94.4 pcf	Final total density:	106.0 pcf
DEPTH, feet:	3.55	Initial saturation:	94 %	Final saturation:	99 %
BY:	TK/CMJ	Initial void ratio:	2.790	Final void ratio:	1.993
TEST DATE:	8/14/2012			Final strain:	21.0 %

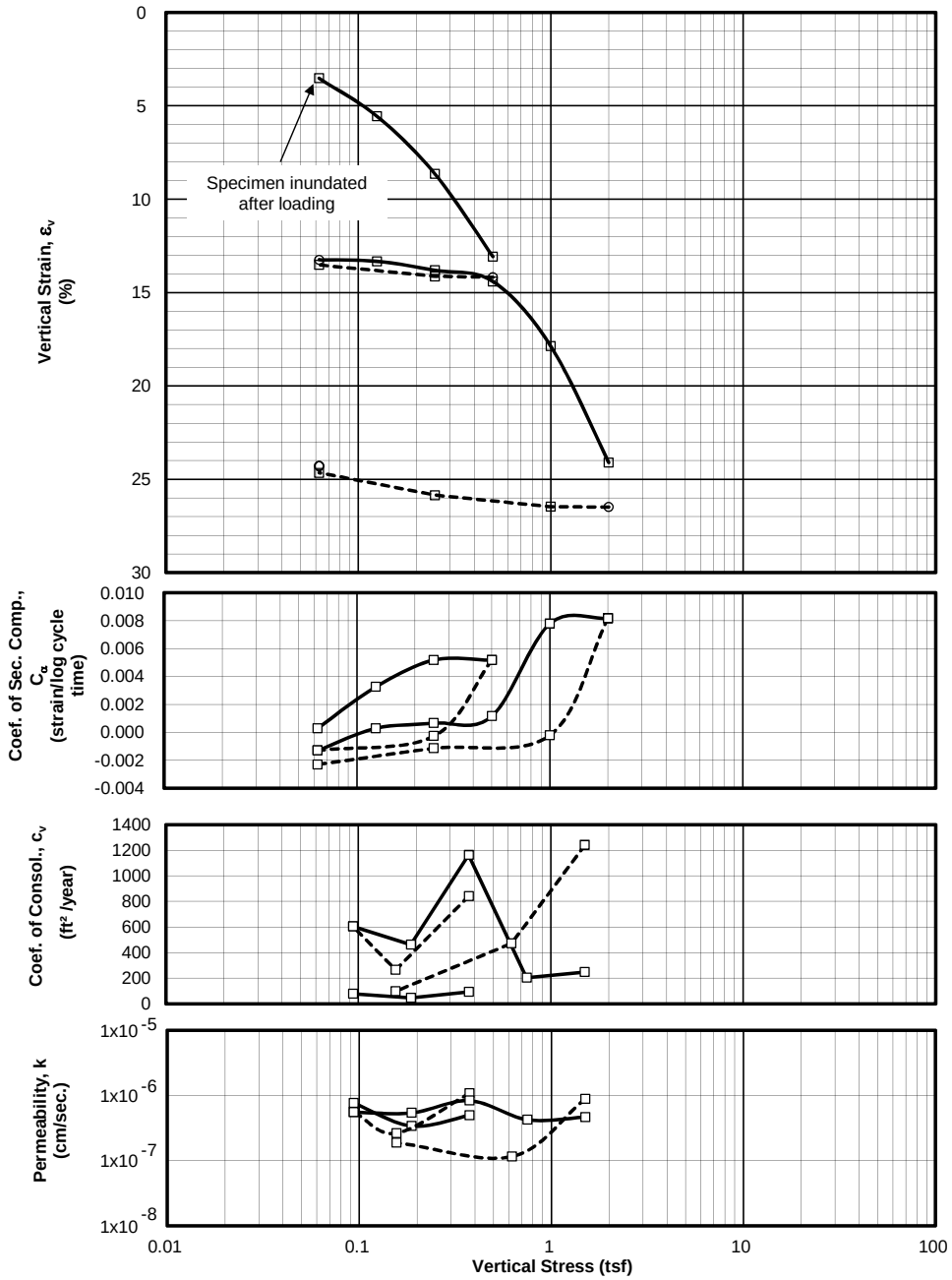
EQUIPMENT: SPECIMEN DESCRIPTION: MH, light gray elastic silt

Load Frame No.: 2

Ring Diameter: 2.5 inch

G	LL	PL	PI
3.1			

Load No.	Load (tsf)	d_{100} (inch)	t_{100} Strain (%)	t_{100} Void Ratio (-)	Final Strain (%)	Final Void Ratio (-)	c_v (ft²/year)	C_α (strain/logt)	Constrained Modulus (tsf)	Permeability (cm/sec)
1	0.063	0.0060	0.973	2.753	1.993	2.715	2619.82	0.0036	6.42	1.23E-05
2	0.125	0.0160	2.615	2.691	3.850	2.644	2338.76	0.0032	3.81	1.85E-05
3	0.250	0.0252	4.110	2.635	5.292	2.590	2020.07	0.0025	8.36	7.29E-06
4	0.500	0.0340	5.536	2.580	7.095	2.521	2067.04	0.0035	17.53	3.56E-06
5	1.00	0.0467	7.607	2.502	10.325	2.399	428.94	0.0062	24.14	5.36E-07
6	0.500	0.0630	10.267	2.401	10.223	2.403	2022.34	-0.0001	18.80	3.25E-06
7	0.125	0.0603	9.831	2.418	9.436	2.433	2080.65	-0.0012	86.01	7.30E-07
8	0.250	0.0584	9.512	2.430	9.643	2.425	2161.05	0.0004	39.17	1.66E-06
9	0.500	0.0605	9.860	2.417	10.228	2.403	2085.46	0.0007	71.84	8.76E-07
10	1.00	0.0643	10.477	2.393	11.163	2.367	2051.61	0.0015	81.09	7.63E-07
11	2.00	0.0691	11.261	2.363	13.475	2.280	646.59	0.0049	127.55	1.53E-07
12	4.00	0.0887	14.450	2.243	17.195	2.139	302.90	0.0080	62.70	1.46E-07
13	8.00	0.1213	19.768	2.041	23.776	1.889	66.77	0.0158	75.23	2.68E-08
14	16.0	0.1589	25.893	1.809	30.692	1.627	21.71	0.0164	130.60	5.02E-09
15	8.00	0.1876	30.574	1.631	30.868	1.620	1292.06	-0.0001	170.91	2.28E-07
16	2.00	0.1874	30.544	1.633	30.407	1.638	1240.93	-0.0005	19693.98	1.90E-09
17	0.500	0.1850	30.143	1.648	29.509	1.672	1043.36	-0.0014	374.62	8.40E-08
18	0.125	0.1797	29.286	1.680	28.330	1.717	1229.64	-0.0026	43.72	8.49E-07



SAMPLE INFORMATION

Boring:	ID-03R
Sample:	T-1C
Depth:	1.25 feet
Elevation:	
Type:	3-inch thin wall tube
Description:	MH, gray elastic silt (crystal formations noted)

SPECIMEN INFORMATION

(NOTE: Initial and final states refer to beginning and end of test)

Initial height:	0.60	inch
Diameter:	2.50	inch

Initial water content:	157.1	%
Initial total unit weight:	83.6	pcf
Initial dry unit weight:	32.5	pcf
Initial void ratio:	4.289	
Initial degree of saturation:	101 *	%

Final water content:	114.6	%
Final total unit weight:	89.1	pcf
Final dry unit weight:	41.5	pcf
Final void ratio:	3.145	
Final degree of saturation:	100 *	%

(* for measured specific gravity = 2.76)

TEST SUMMARY

Construction Method:	Casagrande (Log)
Estimated preconsolidation stress (tsf):	0.4 (Range: 0.3 to 0.5)
Estimated in situ effective overburden stress (tsf):	
Compression Ratio (strain per log cycle stress):	0.207
Compression Index (void ratio per log cycle stress):	1.095
Swell Ratio (strain per log cycle stress):	0.010
Swell Index (void ratio per log cycle stress):	0.053
Recompression Ratio (strain per log cycle stress):	0.010
Recompression Index (void ratio per log cycle stress):	0.053
Remarks:	

LEGEND: □ End of primary o End of Stage ——— Loading - - - - - - Unloading

Test Date: 8/13/12 Tested By: TK/CMJ Checked By: GET

URS Corporation Project No. 19998709	Rahway Arch Site Carteret, New Jersey	ONE DIMENSIONAL CONSOLIDATION TEST Boring: ID-03R Depth: 1.25 feet
TerraSense, LLC	Project No. T19998709	September 2012

PROJECT:	Rahway Arch Site				
PROJECT NO.:	T19998709	Initial height:	0.602 inch	Final height:	0.472 inch
BORING:	ID-03R	Initial water content:	157.1 %	Final water content:	114.6 %
SAMPLE:	T-1C	Initial dry density:	32.5 pcf	Final dry density:	41.5 pcf
TEST:	C12127	Initial total density:	83.6 pcf	Final total density:	89.1 pcf
DEPTH, feet:	1.25	Initial saturation:	101 %	Final saturation:	100 %
BY:	TK/CMJ	Initial void ratio:	4.289	Final void ratio:	3.145
TEST DATE:	8/13/2012			Final strain:	21.6 %

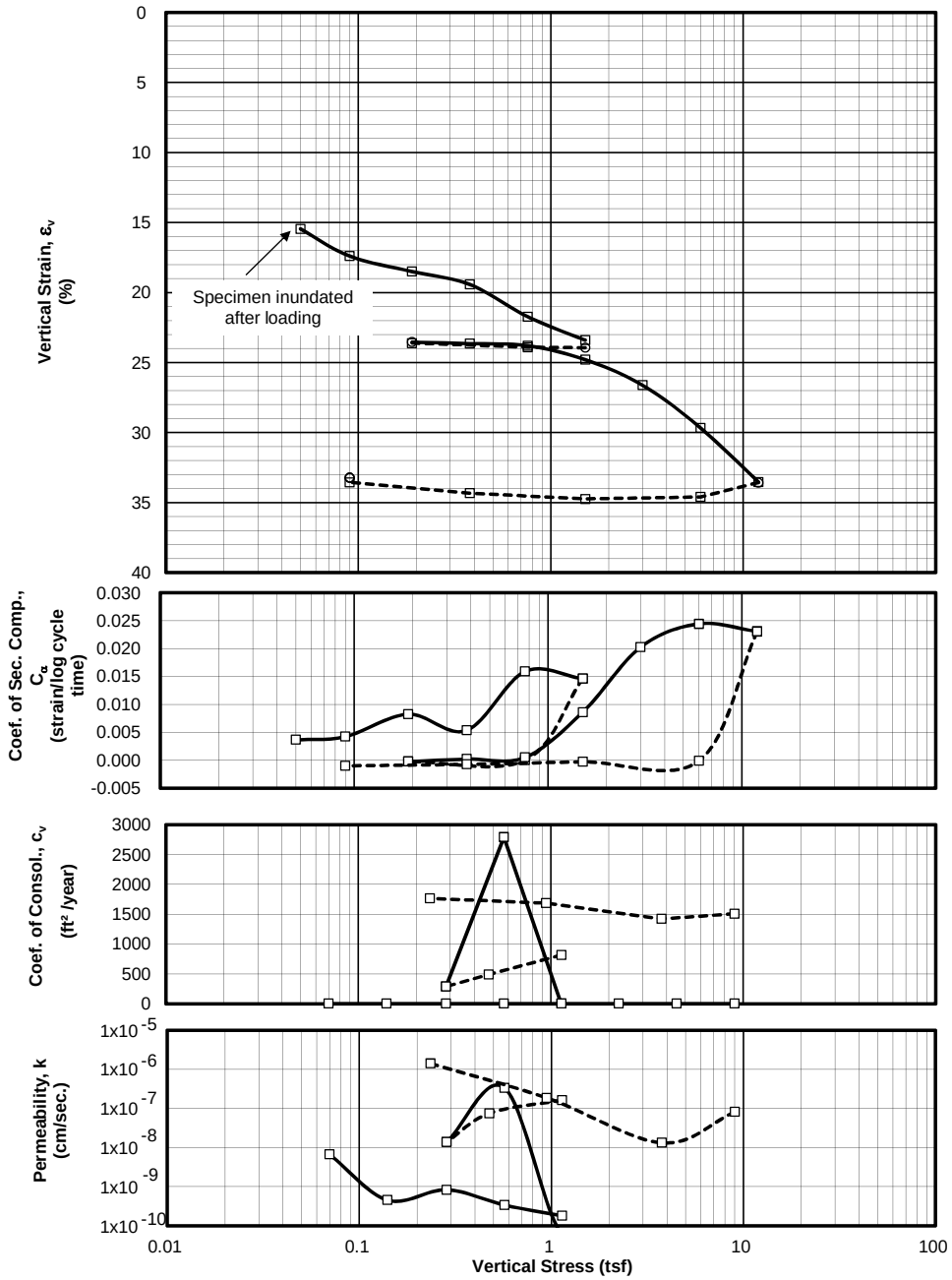
EQUIPMENT: SPECIMEN DESCRIPTION: MH, gray elastic silt (crystal formations noted)

Load Frame No.: 6

Ring Diameter: 2.5 inch

G	LL	PL	PI
2.756			

Load No.	Load (tsf)	d_{100} (inch)	t_{100} Strain (%)	t_{100} Void Ratio (-)	Final Strain (%)	Final Void Ratio (-)	c_v (ft²/year)	C_α (strain/logt)	Constrained Modulus (tsf)	Permeability (cm/sec)
1	0.063	0.0212	3.527	4.102	3.599	4.098	82.34	0.0003	1.77	1.40E-06
2	0.125	0.0335	5.565	3.994	6.230	3.959	77.66	0.0033	3.07	7.64E-07
3	0.250	0.0520	8.647	3.831	9.251	3.799	45.50	0.0052	4.06	3.38E-07
4	0.500	0.0787	13.078	3.597	14.182	3.539	93.03	0.0052	5.64	4.97E-07
5	0.250	0.0851	14.138	3.541	14.054	3.545	839.61	-0.0003	23.57	1.07E-06
6	0.063	0.0814	13.518	3.574	13.245	3.588	263.93	-0.0013	30.22	2.64E-07
7	0.125	0.0802	13.328	3.584	13.391	3.580	604.11	0.0003	33.00	5.52E-07
8	0.250	0.0831	13.814	3.558	13.958	3.550	460.70	0.0007	25.76	5.40E-07
9	0.500	0.0867	14.407	3.527	14.722	3.510	1162.31	0.0012	42.16	8.32E-07
10	1.00	0.1076	17.872	3.343	19.075	3.280	203.27	0.0078	14.43	4.25E-07
11	2.00	0.1450	24.098	3.014	26.482	2.888	246.90	0.0082	16.06	4.64E-07
12	1.00	0.1593	26.463	2.889	26.358	2.895	1239.99	-0.0002	42.28	8.85E-07
13	0.250	0.1556	25.853	2.921	25.591	2.935	470.44	-0.0011	122.99	1.15E-07
14	0.063	0.1484	24.656	2.985	24.290	3.004	97.84	-0.0023	15.66	1.88E-07



SAMPLE INFORMATION

Boring:	Sludge Composite
Sample:	
Depth:	
Elevation:	
Type:	Reconstituted
Description:	MH, gray SILT
	Sample initially self-consolidated in ring

SPECIMEN INFORMATION

(NOTE: Initial and final states refer to beginning and end of test)

Initial height:	0.61	inch
Diameter:	2.50	inch

Initial water content:	112.3	%
Initial total unit weight:	92.9	pcf
Initial dry unit weight:	43.8	pcf
Initial void ratio:	3.704	
Initial degree of saturation:	100	%
Final water content:	67.1	%
Final total unit weight:	107.0	pcf
Final dry unit weight:	64.0	pcf
Final void ratio:	2.214	
Final degree of saturation:	100	% (assumed specific gravity = 3.30)

TEST SUMMARY

Construction Method:	Casagrande (Log)
Estimated preconsolidation stress (tsf):	
Estimated in situ effective overburden stress (tsf):	
Compression Ratio (strain per log cycle stress):	0.128
Compression Index (void ratio per log cycle stress):	0.602
Swell Ratio (strain per log cycle stress):	0.005
Swell Index (void ratio per log cycle stress):	0.024
Recompression Ratio (strain per log cycle stress):	0.012
Recompression Index (void ratio per log cycle stress):	0.056
Remarks:	

LEGEND: □ End of primary o End of Stage ——— Loading - - - - - - Unloading

Test Date: 9/21/12 Tested By: TK/CMJ Checked By: GET

URS Corporation Project No. 19998709	Rahway Arch Site Carteret, New Jersey	ONE DIMENSIONAL CONSOLIDATION TEST Sludge Composite
TerraSense, LLC	Project No. T19998709	October 2012

PROJECT:	Rahway Arch Site				
PROJECT NO.:	T19998709	Initial height:	0.610 inch	Final height:	0.417 inch
BORING:	Sludge Composite	Initial water content:	112.3 %	Final water content:	67.1 %
SAMPLE:		Initial dry density:	43.8 pcf	Final dry density:	64.0 pcf
TEST:	C12146	Initial total density:	92.9 pcf	Final total density:	107.0 pcf
DEPTH, feet:		Initial saturation:	100 %	Final saturation:	100 %
BY:	TK/CMJ	Initial void ratio:	3.704	Final void ratio:	2.214
TEST DATE:	9/21/2012			Final strain:	31.7 %

EQUIPMENT:
Load Frame No.: 2
Ring Diameter: 2.5 inch

SPECIMEN DESCRIPTION: MH, gray SILT
Sample initially self-consolidated in ring

G	LL	PL	PI
3.297			

Load No.	Load (tsf)	d_{100} (inch)	t_{100} Strain (%)	t_{100} Void Ratio (-)	Final Strain (%)	Final Void Ratio (-)	c_v (ft²/year)	C_α (strain/logt)	Constrained Modulus (tsf)	Permeability (cm/sec)
1	0.050	0.0942	15.456	2.977	16.017	2.950	97.93	0.0036	0.32	9.13E-06
2	0.090	0.1061	17.401	2.885	17.464	2.882	0.45570	0.0042	2.06	6.68E-09
3	0.190	0.1128	18.500	2.834	18.684	2.825	0.13633	0.0082	9.09	4.52E-10
4	0.380	0.1185	19.429	2.790	19.974	2.764	0.56313	0.0053	20.46	8.30E-10
5	0.760	0.1325	21.736	2.681	21.800	2.678	0.18388	0.0159	16.47	3.37E-10
6	1.51	0.1427	23.402	2.603	23.935	2.578	0.26725	0.0146	45.01	1.79E-10
7	0.760	0.1458	23.904	2.579	23.977	2.576	814.03	0.0000	149.60	1.64E-07
8	0.190	0.1440	23.614	2.593	23.542	2.596	489.30	-0.0002	196.55	7.51E-08
9	0.380	0.1442	23.644	2.592	23.742	2.587	288.76	0.0002	629.37	1.38E-08
10	0.760	0.1451	23.796	2.584	24.076	2.571	2789.00	0.0005	249.26	3.38E-07
11	1.51	0.1512	24.799	2.537	24.920	2.532	0.14345	0.0086	74.81	5.78E-11
12	3.00	0.1623	26.618	2.452	26.842	2.441	0.13228	0.0202	81.92	4.87E-11
13	6.00	0.1809	29.670	2.308	29.911	2.297	0.16002	0.0244	98.28	4.91E-11
14	12.0	0.2044	33.523	2.127	33.572	2.125	0.15376	0.0231	155.75	2.98E-11
15	6.00	0.2110	34.597	2.076	34.833	2.065	1503.38	-0.0001	558.44	8.12E-08
16	1.51	0.2118	34.735	2.070	34.625	2.075	1419.88	-0.0003	3244.23	1.32E-08
17	0.380	0.2093	34.320	2.089	34.027	2.103	1684.73	-0.0007	272.16	1.87E-07
18	0.090	0.2046	33.547	2.126	33.210	2.142	1763.28	-0.0010	37.51	1.42E-06

CALCULATIONS

Company Confidential Information

APPENDIX D

PROPRIETARY

APPENDIX F
CALCULATIONS

- **Plan & Elevation View for Analysis Section**
- **Global Stability**
- **Existing Berm Check -**
  (Overturning & Sliding – Hand Calc.)
- **Settlement**
- **X-Sections Used**

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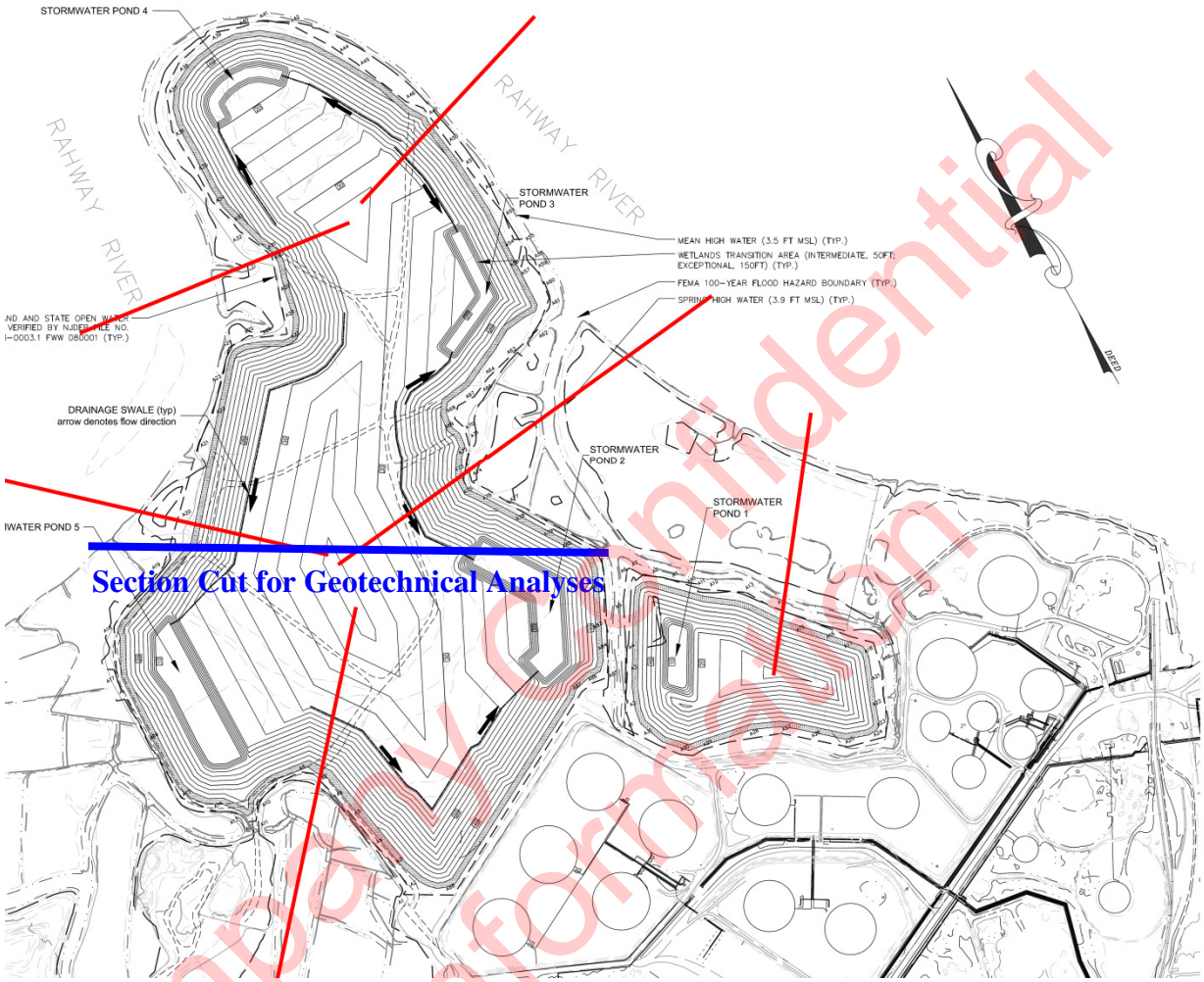
PROPRIETARY



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S.O. No. _____

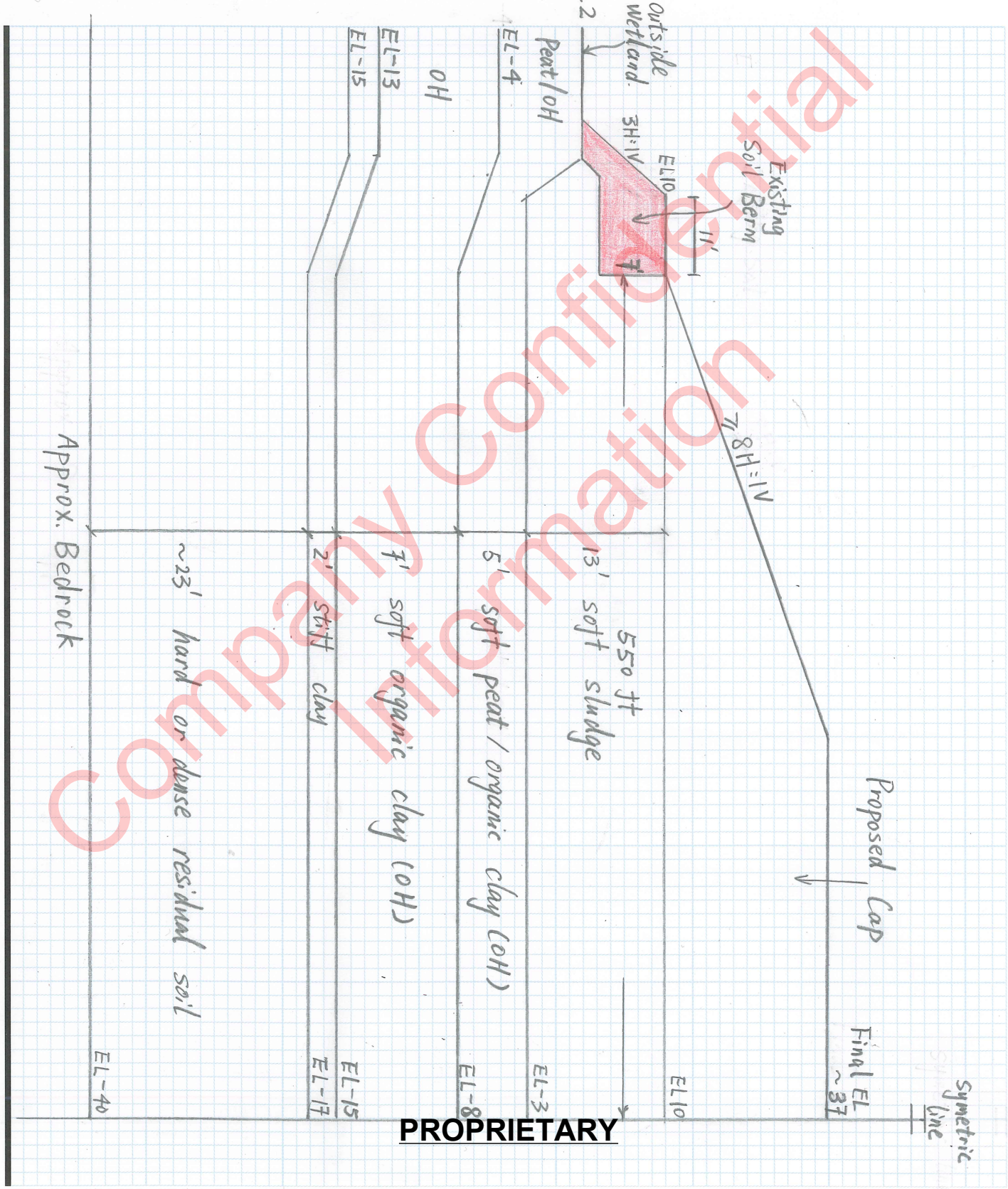
Subject: _____ **PROPRIETARY**

_____ Sheet No. _____ of _____

_____ Drawing No. _____

Computed by _____ Checked By _____ Date _____

Baker



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PROPRIETARY

PROPRIETARY

Global Stability Analysis

Summary Table

Construction Stage	Construction Height (ft)	Factor of Safety
Initial Drainage Blanket (Short Term)	3	1.21
End of Fill Cap Construction (Before Consolidation - Short Term	32	1.20
End of Fill Cap Construction (Completion of Consolidation - Long Term)	32	1.50

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PROPRIETARY

PROPRIETARY

Global Stability Analysis

3-ft Drainage Blanket – Short Term

Company Confidential Information

PROPRIETARY

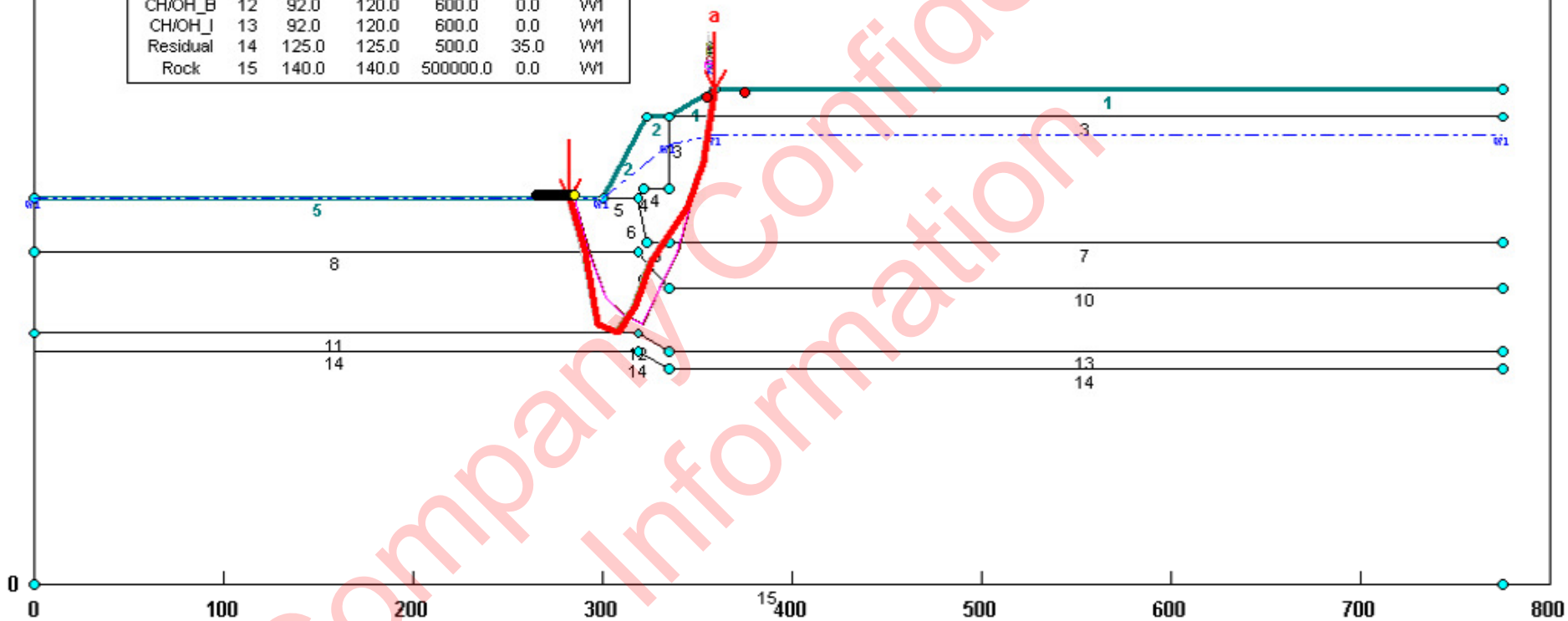
Rahwat Arch 3-ft_DrainageLayer_8H:1V

C:\STEDWI~1\RAHWAY\3FT_SIMP.PL2 Run By: Michael Baker 10/14/2012 8:37PM

#	FS
a	1.21
b	1.23
c	1.23
d	1.24
e	1.24
f	1.24
g	1.24
h	1.25
i	1.27
j	1.27

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
Drainage	1	120.0	125.0	0.0	34.0	W1
Ex. Berm	2	120.0	125.0	100.0	34.0	W1
Sludge I	3	72.0	92.0	200.0	0.0	W1
Sludge B	4	72.0	92.0	220.0	0.0	W1
PT_W	5	68.0	80.0	190.0	0.0	W1
PT_B	6	72.0	82.0	260.0	0.0	W1
PT_I	7	72.0	82.0	240.0	0.0	W1
OH_W	8	68.0	85.0	190.0	0.0	W1
OH_B	9	72.0	95.0	260.0	0.0	W1
OH_I	10	72.0	95.0	240.0	0.0	W1
CH/OH_W	11	90.0	110.0	400.0	0.0	W1
CH/OH_B	12	92.0	120.0	600.0	0.0	W1
CH/OH_I	13	92.0	120.0	600.0	0.0	W1
Residual	14	125.0	125.0	500.0	35.0	W1
Rock	15	140.0	140.0	500000.0	0.0	W1

PROPRIETARY



STABL6H FSmin=1.21

Safety Factors Are Calculated By The Modified Janbu Method

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Baker

PROPRIETARY

** STABL6H **
by
Purdue University

1

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date: 10/14/2012
Time of Run: 9:35PM
Run By: Michael Baker
Input Data Filename: C:3ft_simp.dat

Output Filename: C:3ft_simp.OUT

Plotted Output Filename: C:3ft_simp.PLT

PROBLEM DESCRIPTION Rahwat Arch
3-ft_DrainageLayer_8H:1V

BOUNDARY COORDINATES

5 Top Boundaries
23 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	42.00	300.00	42.00	5
2	300.00	42.00	324.00	50.00	2
3	324.00	50.00	335.00	50.00	2
4	335.00	50.00	359.00	53.00	1
5	359.00	53.00	775.00	53.00	1
6	335.00	50.00	775.00	50.00	3
7	300.00	42.00	319.00	42.00	5
8	319.00	42.00	322.00	43.00	4
9	322.00	43.00	335.00	43.00	4
10	335.00	43.00	335.01	50.00	3
11	319.00	42.00	324.00	37.00	6
12	324.00	37.00	335.00	37.00	6
13	335.00	37.00	775.00	37.00	7
14	0.00	36.00	319.00	36.00	8
15	319.00	36.00	335.00	32.00	9
16	335.00	32.00	775.00	32.00	10
17	0.00	27.00	319.00	27.00	11
18	319.00	27.00	335.00	25.00	12
19	335.00	25.00	775.00	25.00	13

20	0.00	25.00	319.00	25.00	14
21	319.00	25.00	335.00	23.00	14
22	335.00	23.00	775.00	23.00	14
23	0.00	0.00	775.00	0.00	15

1

ISOTROPIC SOIL PARAMETERS

15 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	120.0	125.0	0.0	34.0	0.00	0.0	1
2	120.0	125.0	100.0	34.0	0.00	0.0	1
3	72.0	92.0	200.0	0.0	0.00	0.0	1
4	72.0	92.0	220.0	0.0	0.00	0.0	1
5	68.0	80.0	190.0	0.0	0.00	0.0	1
6	72.0	82.0	260.0	0.0	0.00	0.0	1
7	72.0	82.0	240.0	0.0	0.00	0.0	1
8	68.0	85.0	190.0	0.0	0.00	0.0	1
9	72.0	95.0	260.0	0.0	0.00	0.0	1
10	72.0	95.0	240.0	0.0	0.00	0.0	1
11	90.0	110.0	400.0	0.0	0.00	0.0	1
12	92.0	120.0	600.0	0.0	0.00	0.0	1
13	92.0	120.0	600.0	0.0	0.00	0.0	1
14	125.0	125.0	500.0	35.0	0.00	0.0	1
15	140.0	140.0	500000.0	0.0	0.00	0.0	1

1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 5 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	0.00	42.00
2	300.00	42.00
3	335.00	47.00
4	359.00	48.50
5	775.00	48.50

1

A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Irregular Surfaces, Has Been Specified.

1200 Trial Surfaces Have Been Generated.

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30 Surfaces Initiate From Each Of 40 Points Equally Spaced
Along The Ground Surface Between X = 265.00 ft.
and X = 285.00 ft.

Each Surface Terminates Between X = 355.00 ft.
and X = 375.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = 24.00 ft.

10.00 ft. Line Segments Define Each Trial Failure Surface.

1

Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Examined. They Are Ordered - Most Critical
First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 10 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	285.00	42.00
2	292.85	35.80
3	300.14	28.96
4	309.68	25.97
5	319.27	28.80
6	327.49	34.50
7	336.48	38.89
8	346.03	41.84
9	354.53	47.11
10	358.63	52.95

*** 1.211 ***

Failure Surface Specified By 10 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	282.95	42.00
2	290.50	35.44
3	297.62	28.42
4	307.58	27.51
5	317.33	29.74
6	325.75	35.13
7	335.28	38.15
8	345.04	40.34
9	353.40	45.82

10	359.06	53.00

*** 1.213 ***

1

Failure Surface Specified By 10 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	284.49	42.00
2	292.34	35.80
3	299.62	28.96
4	309.17	25.97
5	318.76	28.80
6	326.98	34.50
7	335.97	38.89
8	345.52	41.84
9	354.02	47.11
10	358.06	52.88

*** 1.218 ***

Failure Surface Specified By 10 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	283.97	42.00
2	291.82	35.80
3	299.11	28.96
4	308.66	25.97
5	318.25	28.80
6	326.47	34.50
7	335.45	38.89
8	345.01	41.84
9	353.50	47.11
10	357.50	52.81

*** 1.225 ***

1

Failure Surface Specified By 10 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	282.44	42.00
2	289.99	35.44
3	297.11	28.42
4	307.07	27.51

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3ft_simp

5	316.82	29.74
6	325.24	35.13
7	334.77	38.15
8	344.53	40.34
9	352.89	45.82
10	358.49	52.94

*** 1.226 ***

Failure Surface Specified By 10 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	285.00	42.00
2	293.22	36.31
3	301.64	30.91
4	311.51	29.30
5	321.48	28.54
6	330.70	32.42
7	339.92	36.30
8	348.22	41.87
9	355.76	48.45
10	357.52	52.81

*** 1.238 ***

1

Failure Surface Specified By 10 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	281.92	42.00
2	289.47	35.44
3	296.60	28.42
4	306.55	27.51
5	316.30	29.74
6	324.72	35.13
7	334.26	38.15
8	344.01	40.34
9	352.38	45.82
10	357.93	52.87

*** 1.240 ***

Failure Surface Specified By 10 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)

3ft_simp

1	282.95	42.00
2	290.80	35.80
3	298.09	28.96
4	307.63	25.97
5	317.22	28.80
6	325.44	34.50
7	334.43	38.89
8	343.98	41.84
9	352.48	47.11
10	356.38	52.67

*** 1.243 ***

1

Failure Surface Specified By 11 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	285.00	42.00
2	292.10	34.96
3	300.16	29.04
4	309.87	26.66
5	318.79	31.19
6	328.15	34.72
7	336.92	39.52
8	346.91	40.02
9	356.57	42.61
10	361.75	51.16
11	363.95	53.00

*** 1.247 ***

Failure Surface Specified By 10 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	285.00	42.00
2	292.16	35.02
3	301.87	32.61
4	310.73	27.98
5	320.59	29.66
6	329.50	34.19
7	336.45	41.38
8	345.20	46.22
9	354.44	50.05
10	357.48	52.81

*** 1.252 ***

1

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3ft_simp

```
          Y           A     X     I     S           F     T

          0.00     96.88    193.75    290.63    387.50    484.38
X      0.00 *--**-----+---------+---------+---------+---------+
            -
            -
            -
            -
            -
      96.88 +
            -
            -
            -
            -
            -
A    193.75 +
            -
            -
            -
            -   .
            -  .5
X    290.63 + .21
            - .1*
            - .***
            - ****
            -  .6*
            -  ..9
I    387.50 +
            -
            -
            -
            -
            -
S    484.38 +
            -
            -
            -
            -
            -
     581.25 +
            -
            -
            -
            -
            -
F    678.13 +
            -
            -
            -
            -
            -
T    775.00 * ****
```


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Global Stability Analysis
32-ft Full Height Embankment – Short Term (End of Construction Prior to Consolidation)

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Rahwat Arch 32-ft_Fill_AfterConstruct_8H1V_ShortTerm

C:\STEDWI~1\RAHWAY\32FT_S~1.PL2 Run By: Michael Baker 10/14/2012 10:12PM

#	FS
a	1.20
b	1.20
c	1.20
d	1.20
e	1.20
f	1.20
g	1.20
h	1.20
i	1.20
j	1.20

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
Cap Fill	1	120.0	127.0	0.0	33.0	W1
Ex. Berm	2	120.0	125.0	100.0	34.0	W1
Sludge I	3	92.0	100.0	220.0	0.0	W1
Sludge B	4	92.0	100.0	250.0	0.0	W1
PT_W	5	68.0	80.0	220.0	0.0	W1
PT_B	6	72.0	82.0	450.0	0.0	W1
PT_I	7	72.0	82.0	400.0	0.0	W1
OH_W	8	68.0	95.0	220.0	0.0	W1
OH_B	9	80.0	105.0	450.0	0.0	W1
OH_I	10	80.0	105.0	400.0	0.0	W1
CH/OH_W	11	90.0	120.0	800.0	0.0	W1
CH/OH_B	12	92.0	120.0	1000.0	0.0	W1
CH/OH_I	13	92.0	120.0	1000.0	0.0	W1
Residual	14	125.0	125.0	500.0	35.0	W1
Rock	15	140.0	140.0	500000.0	0.0	W1

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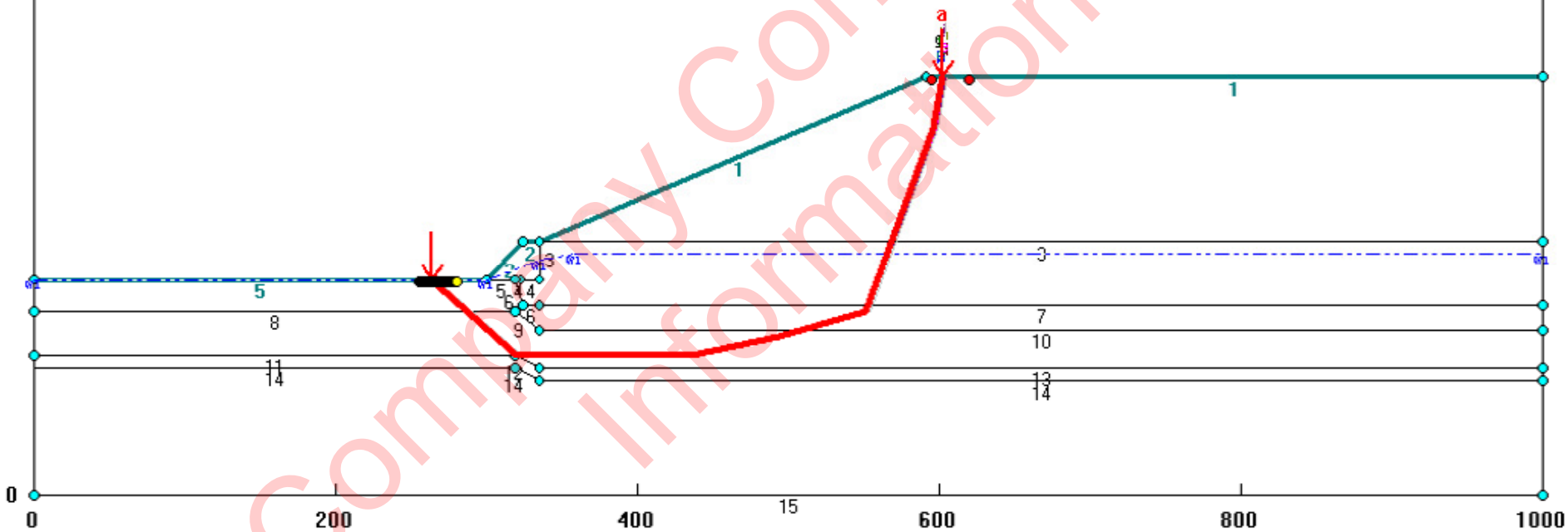

STABL6H FSmin=1.20

Safety Factors Are Calculated By The Modified Janbu Method

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** STABL6H **
by
Purdue University

1

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date: 10/15/2012
Time of Run: 12:13AM
Run By: Michael Baker
Input Data Filename: C:32ft_s~1.dat

Output Filename: C:32ft_s~1.OUT

Plotted Output Filename: C:32ft_s~1.PLT

PROBLEM DESCRIPTION Rahwat Arch
32-ft_Fill_AfterConstruct_8H1V_ShortTerm

BOUNDARY COORDINATES

5 Top Boundaries
23 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	42.00	300.00	42.00	5
2	300.00	42.00	324.00	50.00	2
3	324.00	50.00	335.00	50.00	2
4	335.00	50.00	591.00	82.00	1
5	591.00	82.00	1000.00	82.00	1
6	335.00	50.00	1000.00	50.00	3
7	300.00	42.00	319.00	42.00	5
8	319.00	42.00	322.00	43.00	4
9	322.00	43.00	335.00	43.00	4
10	335.00	43.00	335.01	50.00	3
11	319.00	42.00	324.00	37.00	6
12	324.00	37.00	335.00	37.00	6
13	335.00	37.00	1000.00	37.00	7
14	0.00	36.00	319.00	36.00	8
15	319.00	36.00	335.00	32.00	9
16	335.00	32.00	1000.00	32.00	10
17	0.00	27.00	319.00	27.00	11
18	319.00	27.00	335.00	25.00	12
19	335.00	25.00	1000.00	25.00	13

20	0.00	25.00	319.00	25.00	14
21	319.00	25.00	335.00	23.00	14
22	335.00	23.00	1000.00	23.00	14
23	0.00	0.00	1000.00	0.00	15

1

ISOTROPIC SOIL PARAMETERS

15 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	120.0	127.0	0.0	33.0	0.00	0.0	1
2	120.0	125.0	100.0	34.0	0.00	0.0	1
3	92.0	100.0	220.0	0.0	0.00	0.0	1
4	92.0	100.0	250.0	0.0	0.00	0.0	1
5	68.0	80.0	220.0	0.0	0.00	0.0	1
6	72.0	82.0	450.0	0.0	0.00	0.0	1
7	72.0	82.0	400.0	0.0	0.00	0.0	1
8	68.0	95.0	220.0	0.0	0.00	0.0	1
9	80.0	105.0	450.0	0.0	0.00	0.0	1
10	80.0	105.0	400.0	0.0	0.00	0.0	1
11	90.0	110.0	600.0	0.0	0.00	0.0	1
12	92.0	120.0	800.0	0.0	0.00	0.0	1
13	92.0	120.0	800.0	0.0	0.00	0.0	1
14	125.0	125.0	500.0	35.0	0.00	0.0	1
15	140.0	140.0	500000.0	0.0	0.00	0.0	1

1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 5 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	0.00	42.00
2	300.00	42.00
3	335.00	46.00
4	359.00	48.00
5	1000.00	48.00

1

A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Irregular Surfaces, Has Been Specified.

1200 Trial Surfaces Have Been Generated.

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30 Surfaces Initiate From Each Of 40 Points Equally Spaced
Along The Ground Surface Between X = 255.00 ft.
and X = 280.00 ft.

Each Surface Terminates Between X = 595.00 ft.
and X = 620.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = 0.00 ft.

58.00 ft. Line Segments Define Each Trial Failure Surface.

1

Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Examined. They Are Ordered - Most Critical
First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	263.33	42.00
2	319.43	27.28
3	377.43	27.29
4	435.43	27.28
5	493.28	31.54
6	551.06	36.60
7	596.48	72.66
8	602.14	82.00

*** 1.195 ***

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	263.97	42.00
2	320.08	27.28
3	378.08	27.29
4	436.08	27.28
5	493.92	31.54
6	551.70	36.60
7	597.12	72.66
8	602.78	82.00

*** 1.195 ***

1

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	263.97	42.00
2	320.08	27.28
3	378.08	27.29
4	436.08	27.28
5	493.92	31.54
6	551.70	36.60
7	597.12	72.66
8	602.78	82.00

*** 1.195 ***

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	264.62	42.00
2	320.72	27.28
3	378.72	27.29
4	436.72	27.28
5	494.56	31.54
6	552.34	36.60
7	597.76	72.66
8	603.42	82.00

*** 1.195 ***

1

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	264.62	42.00
2	320.72	27.28
3	378.72	27.29
4	436.72	27.28
5	494.56	31.54
6	552.34	36.60
7	597.76	72.66
8	603.42	82.00

*** 1.195 ***

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Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	262.69	42.00
2	318.79	27.28
3	376.79	27.29
4	434.79	27.28
5	492.64	31.54
6	550.42	36.60
7	595.84	72.66
8	601.50	82.00

*** 1.195 ***

1

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Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	262.69	42.00
2	318.79	27.28
3	376.79	27.29
4	434.79	27.28
5	492.64	31.54
6	550.42	36.60
7	595.84	72.66
8	601.50	82.00

*** 1.195 ***

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	265.26	42.00
2	321.36	27.28
3	379.36	27.29
4	437.36	27.28
5	495.20	31.54
6	552.98	36.60
7	598.40	72.66
8	604.06	82.00

*** 1.196 ***

1

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	265.26	42.00
2	321.36	27.28
3	379.36	27.29
4	437.36	27.28
5	495.20	31.54
6	552.98	36.60
7	598.40	72.66
8	604.06	82.00

*** 1.196 ***

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	265.90	42.00
2	322.00	27.28
3	380.00	27.29
4	438.00	27.28
5	495.84	31.54
6	553.62	36.60
7	599.04	72.66
8	604.70	82.00

*** 1.196 ***

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1

```
                Y           A     X     I     S           F     T

                0.00    125.00    250.00    375.00    500.00    625.00
X       0.00 *-**------+---------+---------+---------+---------+
             -
             -
             -
             -
             -
      125.00 +
             -
             -
             -
             -
             -
A     250.00 +  .
             -  1
             .  *
```


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                 ..**
                 ..***
                 ..  W
X     375.00     ..1.
                 ...
                 .....
                 ..1.
                 ... .
                 .....
I     500.00     ...1
                 .....
                 ...1...
                 . .4...
                 -   ...*
                 -   ..11
S     625.00     +      .
                 -
                 -
                 -
                 -
                 -
      750.00     +
                 -
                 -
                 -
                 -
                 -
F     875.00     +
                 -
                 -
                 -
                 -
                 -
T    1000.00     * ***  *
```


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PROPRIETARY

Global Stability Analysis
32-ft Full Height Embankment – Long Term (After Consolidation)

Company Confidential Information

PROPRIETARY

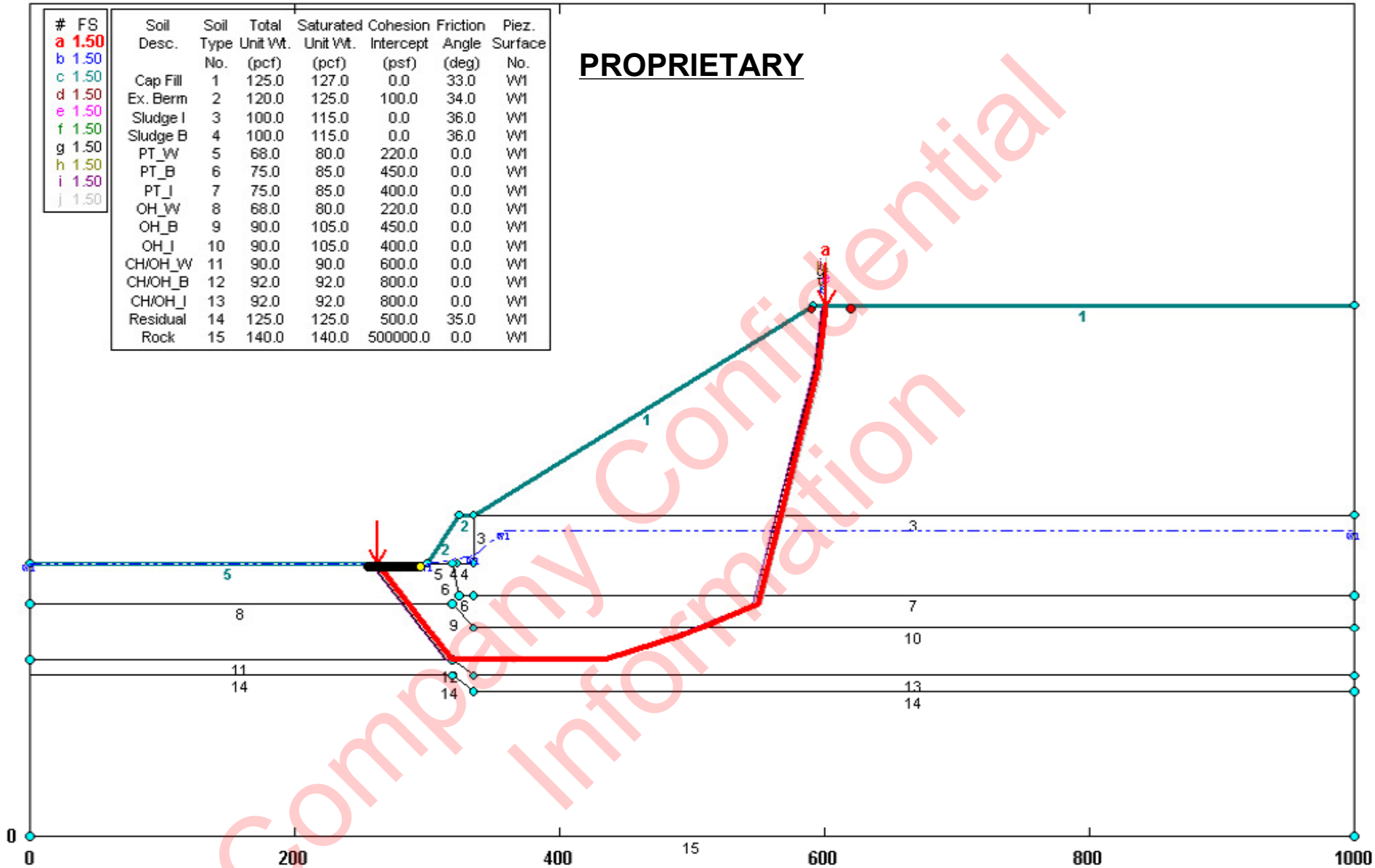
Rahwat Arch 32ft_8H1V_After Consolidation-LongTerm

C:\STEDWI~1\RAHWAY\32FT_3YR.PL2 Run By: Michael Baker 10/15/2012 12:25AM

#	FS
a	1.50
b	1.50
c	1.50
d	1.50
e	1.50
f	1.50
g	1.50
h	1.50
i	1.50
j	1.50

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
Cap Fill	1	125.0	127.0	0.0	33.0	W1
Ex. Berm	2	120.0	125.0	100.0	34.0	W1
Sludge I	3	100.0	115.0	0.0	36.0	W1
Sludge B	4	100.0	115.0	0.0	36.0	W1
PT_W	5	68.0	80.0	220.0	0.0	W1
PT_B	6	75.0	85.0	450.0	0.0	W1
PT_I	7	75.0	85.0	400.0	0.0	W1
OH_W	8	68.0	80.0	220.0	0.0	W1
OH_B	9	90.0	105.0	450.0	0.0	W1
OH_I	10	90.0	105.0	400.0	0.0	W1
CH/OH_W	11	90.0	90.0	600.0	0.0	W1
CH/OH_B	12	92.0	92.0	800.0	0.0	W1
CH/OH_I	13	92.0	92.0	800.0	0.0	W1
Residual	14	125.0	125.0	500.0	35.0	W1
Rock	15	140.0	140.0	500000.0	0.0	W1

PROPRIETARY



STABL6H FSmin=1.50

Safety Factors Are Calculated By The Modified Janbu Method

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Baker

PROPRIETARY

** STABL6H **
by
Purdue University

1

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date: 10/15/2012
Time of Run: 12:53AM
Run By: Michael Baker
Input Data Filename: C:32ft_3yr.dat

Output Filename: C:32ft_3yr.OUT

Plotted Output Filename: C:32ft_3yr.PLT

PROBLEM DESCRIPTION Rahwat Arch
32ft_8H1V_After Consolidation-LongTerm

BOUNDARY COORDINATES

5 Top Boundaries
23 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	42.00	300.00	42.00	5
2	300.00	42.00	324.00	50.00	2
3	324.00	50.00	335.00	50.00	2
4	335.00	50.00	591.00	82.00	1
5	591.00	82.00	1000.00	82.00	1
6	335.00	50.00	1000.00	50.00	3
7	300.00	42.00	319.00	42.00	5
8	319.00	42.00	322.00	43.00	4
9	322.00	43.00	335.00	43.00	4
10	335.00	43.00	335.01	50.00	3
11	319.00	42.00	324.00	37.00	6
12	324.00	37.00	335.00	37.00	6
13	335.00	37.00	1000.00	37.00	7
14	0.00	36.00	319.00	36.00	8
15	319.00	36.00	335.00	32.00	9
16	335.00	32.00	1000.00	32.00	10
17	0.00	27.00	319.00	27.00	11
18	319.00	27.00	335.00	25.00	12
19	335.00	25.00	1000.00	25.00	13

20	0.00	25.00	319.00	25.00	14
21	319.00	25.00	335.00	23.00	14
22	335.00	23.00	1000.00	23.00	14
23	0.00	0.00	1000.00	0.00	15

1

ISOTROPIC SOIL PARAMETERS

15 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	125.0	127.0	0.0	33.0	0.00	0.0	1
2	120.0	125.0	100.0	34.0	0.00	0.0	1
3	100.0	115.0	0.0	36.0	0.00	0.0	1
4	100.0	115.0	0.0	36.0	0.00	0.0	1
5	68.0	80.0	220.0	0.0	0.00	0.0	1
6	75.0	85.0	450.0	0.0	0.00	0.0	1
7	75.0	85.0	400.0	0.0	0.00	0.0	1
8	68.0	80.0	220.0	0.0	0.00	0.0	1
9	90.0	105.0	450.0	0.0	0.00	0.0	1
10	90.0	105.0	400.0	0.0	0.00	0.0	1
11	105.0	112.0	600.0	0.0	0.00	0.0	1
12	115.0	123.0	800.0	0.0	0.00	0.0	1
13	115.0	123.0	800.0	0.0	0.00	0.0	1
14	125.0	125.0	500.0	35.0	0.00	0.0	1
15	140.0	140.0	500000.0	0.0	0.00	0.0	1

1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 5 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	0.00	42.00
2	300.00	42.00
3	335.00	47.00
4	359.00	48.00
5	1000.00	48.00

1

A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Irregular Surfaces, Has Been Specified.

1200 Trial Surfaces Have Been Generated.

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32ft_3yr

30 Surfaces Initiate From Each Of 40 Points Equally Spaced
Along The Ground Surface Between X = 255.00 ft.
and X = 295.00 ft.

Each Surface Terminates Between X = 590.00 ft.
and X = 620.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = 0.00 ft.

58.00 ft. Line Segments Define Each Trial Failure Surface.

1

Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Examined. They Are Ordered - Most Critical
First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	262.18	42.00
2	318.28	27.28
3	376.28	27.29
4	434.28	27.28
5	492.12	31.54
6	549.90	36.60
7	595.33	72.66
8	600.99	82.00

*** 1.498 ***

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	261.15	42.00
2	317.26	27.28
3	375.26	27.29
4	433.26	27.28
5	491.10	31.54
6	548.88	36.60
7	594.30	72.66
8	599.96	82.00

*** 1.498 ***

1

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	261.15	42.00
2	317.26	27.28
3	375.26	27.29
4	433.26	27.28
5	491.10	31.54
6	548.88	36.60
7	594.30	72.66
8	599.96	82.00

*** 1.498 ***

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	260.13	42.00
2	316.23	27.28
3	374.23	27.29
4	432.23	27.28
5	490.07	31.54
6	547.85	36.60
7	593.28	72.66
8	598.93	82.00

*** 1.498 ***

1

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	263.21	42.00
2	319.31	27.28
3	377.31	27.29
4	435.31	27.28
5	493.15	31.54
6	550.93	36.60
7	596.35	72.66
8	602.01	82.00

*** 1.498 ***

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Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	263.21	42.00
2	319.31	27.28
3	377.31	27.29
4	435.31	27.28
5	493.15	31.54
6	550.93	36.60
7	596.35	72.66
8	602.01	82.00

*** 1.498 ***

1

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Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	259.10	42.00
2	315.20	27.28
3	373.20	27.29
4	431.20	27.28
5	489.05	31.54
6	546.83	36.60
7	592.25	72.66
8	597.91	82.00

*** 1.498 ***

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	258.08	42.00
2	314.18	27.28
3	372.18	27.29
4	430.18	27.28
5	488.02	31.54
6	545.80	36.60
7	591.22	72.66
8	596.88	82.00

*** 1.499 ***

1

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	258.08	42.00
2	314.18	27.28
3	372.18	27.29
4	430.18	27.28
5	488.02	31.54
6	545.80	36.60
7	591.22	72.66
8	596.88	82.00

*** 1.499 ***

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	264.23	42.00
2	320.33	27.28
3	378.33	27.29
4	436.33	27.28
5	494.18	31.54
6	551.95	36.60
7	597.38	72.66
8	603.04	82.00

*** 1.499 ***

PROPRIETARY

1

```
                Y            A     X     I     S            F     T

                0.00    125.00    250.00    375.00    500.00    625.00

X       0.00 *-**------+---------+---------+---------+---------+
             -
             -
             -
             -
             -
      125.00 +
             -
             -
             -
             -
             -
A     250.00 +  4
             -  1
             .  *
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                ..**
                ..***
                ....W
X     375.00 ..1.
                .....
                .....
                ..1.
                ... .
                ...7..
I     500.00 ...1..
                .....
                ...1...
                .....
                - ....4*
                -   ..11
S     625.00 +   ....
                -
                -
                -
                -
                -
      750.00 +
                -
                -
                -
                -
                -
F     875.00 +
                -
                -
                -
                -
                -
T    1000.00 * ***  *
```


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Global Stability Analysis
3-ft Drainage Blanket –
Check Critical Failure Plane along the Base of Existing Berm
Short Term F.S. = 2.36 OK

Company Confidential Information

PROPRIETARY

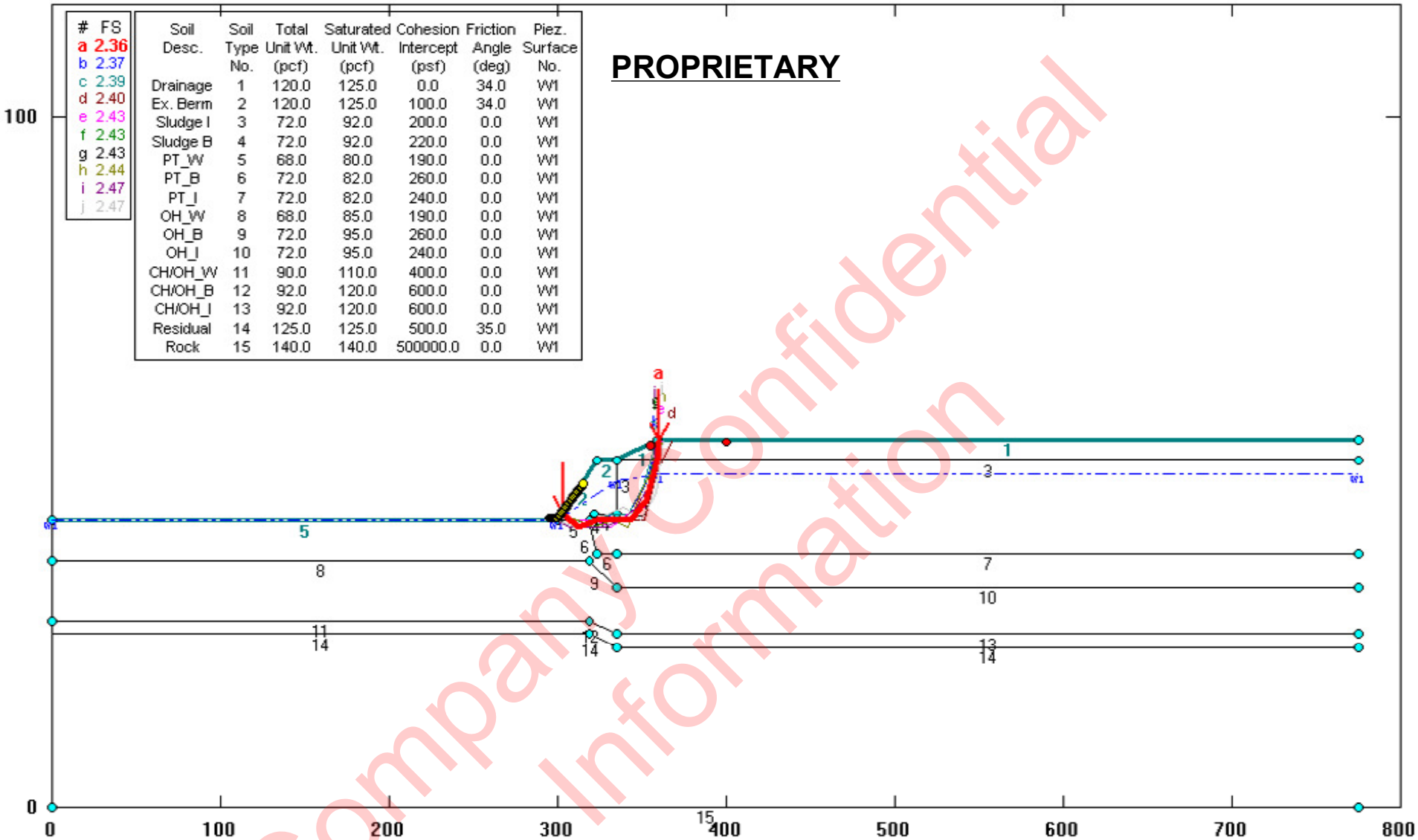
Rahwat Arch 3-ft_DrainageLayer_8H:1V

C:\STEDWI~1\RAHWAY\3FT_BERM.PL2 Run By: Michael Baker 10/14/2012 8:56PM

PROPRIETARY

#	FS
a	2.36
b	2.37
c	2.39
d	2.40
e	2.43
f	2.43
g	2.43
h	2.44
i	2.47
j	2.47

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
Drainage	1	120.0	125.0	0.0	34.0	W1
Ex. Berm	2	120.0	125.0	100.0	34.0	W1
Sludge I	3	72.0	92.0	200.0	0.0	W1
Sludge B	4	72.0	92.0	220.0	0.0	W1
PT_W	5	68.0	80.0	190.0	0.0	W1
PT_B	6	72.0	82.0	260.0	0.0	W1
PT_I	7	72.0	82.0	240.0	0.0	W1
OH_W	8	68.0	85.0	190.0	0.0	W1
OH_B	9	72.0	95.0	260.0	0.0	W1
OH_I	10	72.0	95.0	240.0	0.0	W1
CH/OH_W	11	90.0	110.0	400.0	0.0	W1
CH/OH_B	12	92.0	120.0	600.0	0.0	W1
CH/OH_I	13	92.0	120.0	600.0	0.0	W1
Residual	14	125.0	125.0	500.0	35.0	W1
Rock	15	140.0	140.0	500000.0	0.0	W1



STABL6H FSmin=2.36

Safety Factors Are Calculated By The Modified Janbu Method

Company Confidential Information

Baker

PROPRIETARY

** STABL6H **
by
Purdue University

1

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date: 10/14/2012
Time of Run: 8:56PM
Run By: Michael Baker
Input Data Filename: C:3ft_berm.dat

Output Filename: C:3ft_berm.OUT

Plotted Output Filename: C:3ft_berm.PLT

PROBLEM DESCRIPTION Rahwat Arch
3-ft_DrainageLayer_8H:1V

BOUNDARY COORDINATES

5 Top Boundaries
23 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	42.00	300.00	42.00	5
2	300.00	42.00	324.00	50.00	2
3	324.00	50.00	335.00	50.00	2
4	335.00	50.00	359.00	53.00	1
5	359.00	53.00	775.00	53.00	1
6	335.00	50.00	775.00	50.00	3
7	300.00	42.00	319.00	42.00	5
8	319.00	42.00	322.00	43.00	4
9	322.00	43.00	335.00	43.00	4
10	335.00	43.00	335.01	50.00	3
11	319.00	42.00	324.00	37.00	6
12	324.00	37.00	335.00	37.00	6
13	335.00	37.00	775.00	37.00	7
14	0.00	36.00	319.00	36.00	8
15	319.00	36.00	335.00	32.00	9
16	335.00	32.00	775.00	32.00	10
17	0.00	27.00	319.00	27.00	11
18	319.00	27.00	335.00	25.00	12
19	335.00	25.00	775.00	25.00	13

20	0.00	25.00	319.00	25.00	14
21	319.00	25.00	335.00	23.00	14
22	335.00	23.00	775.00	23.00	14
23	0.00	0.00	775.00	0.00	15

1

ISOTROPIC SOIL PARAMETERS

15 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	120.0	125.0	0.0	34.0	0.00	0.0	1
2	120.0	125.0	100.0	34.0	0.00	0.0	1
3	72.0	92.0	200.0	0.0	0.00	0.0	1
4	72.0	92.0	220.0	0.0	0.00	0.0	1
5	68.0	80.0	190.0	0.0	0.00	0.0	1
6	72.0	82.0	260.0	0.0	0.00	0.0	1
7	72.0	82.0	240.0	0.0	0.00	0.0	1
8	68.0	85.0	190.0	0.0	0.00	0.0	1
9	72.0	95.0	260.0	0.0	0.00	0.0	1
10	72.0	95.0	240.0	0.0	0.00	0.0	1
11	90.0	110.0	400.0	0.0	0.00	0.0	1
12	92.0	120.0	600.0	0.0	0.00	0.0	1
13	92.0	120.0	600.0	0.0	0.00	0.0	1
14	125.0	125.0	500.0	35.0	0.00	0.0	1
15	140.0	140.0	500000.0	0.0	0.00	0.0	1

1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 5 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	0.00	42.00
2	300.00	42.00
3	335.00	47.00
4	359.00	48.50
5	775.00	48.50

1

A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Irregular Surfaces, Has Been Specified.

1200 Trial Surfaces Have Been Generated.

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3ft_berm

30 Surfaces Initiate From Each Of 40 Points Equally Spaced
Along The Ground Surface Between X = 295.00 ft.
and X = 315.00 ft.

Each Surface Terminates Between X = 355.00 ft.
and X = 400.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = 41.00 ft.

10.00 ft. Line Segments Define Each Trial Failure Surface.

1

Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Examined. They Are Ordered - Most Critical
First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	303.21	43.07
2	312.99	41.01
3	322.98	41.40
4	332.97	41.84
5	342.97	41.95
6	352.58	44.74
7	360.30	51.09
8	360.86	53.00

*** 2.357 ***

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	302.18	42.73
2	312.03	41.01
3	322.00	41.75
4	331.97	42.54
5	341.96	43.00
6	351.46	46.12
7	358.96	52.73
8	359.03	53.00

*** 2.368 ***

1

Failure Surface Specified By 7 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	301.67	42.56
2	311.56	41.08
3	321.55	41.55
4	331.53	42.16
5	341.52	42.62
6	350.73	46.52
7	357.11	52.76

*** 2.395 ***

Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	301.67	42.56
2	311.62	41.60
3	321.60	41.01
4	331.56	41.90
5	341.55	41.39
6	351.54	41.83
7	358.65	48.86
8	367.83	52.84
9	368.05	53.00

*** 2.402 ***

1

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	301.67	42.56
2	311.57	41.18
3	321.55	41.87
4	331.52	41.11
5	341.40	42.68
6	351.38	43.31
7	358.64	50.18
8	361.81	53.00

*** 2.431 ***

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Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	301.15	42.38
2	311.12	41.55
3	321.11	41.15
4	331.10	41.58
5	341.10	41.89
6	351.00	43.31
7	357.05	51.27
8	358.25	52.91

*** 2.433 ***

1

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	301.67	42.56
2	311.62	41.60
3	321.61	41.08
4	331.60	41.38
5	341.60	41.57
6	351.52	42.87
7	357.66	50.76
8	359.36	53.00

*** 2.434 ***

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	302.18	42.73
2	312.06	41.18
3	322.06	41.15
4	332.05	41.50
5	342.04	41.05
6	350.65	46.15
7	359.65	50.50
8	362.52	53.00

*** 2.445 ***

1

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	297.05	42.00
2	307.01	41.04
3	317.01	41.09
4	327.01	41.04
5	337.00	41.34
6	346.73	43.65
7	355.76	47.94
8	358.09	52.89

*** 2.472 ***

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	299.62	42.00
2	309.57	41.01
3	319.52	41.95
4	329.49	42.70
5	339.45	43.67
6	349.15	41.26
7	358.25	45.42
8	362.17	53.00

*** 2.474 ***

1

```
                Y           A     X     I     S           F     T

                0.00     96.88    193.75    290.63    387.50    484.38
X       0.00 *--**-----+---------+---------+---------+---------+
             -
             -
             -
             -
             -
       96.88 +
             -
             -
             -
             -
             -
A     193.75 +
             -
             -
```


PROPRIETARY

Company Information Confidential

PROPRIETARY

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                                3ft_berm
                -
                -
                -
X     290.63 +   9
                -   *.
                -  ***
                - ****
                -   4*
                -   .4
I     387.50 +   ..
                -    .
                -
                -
                -
                -
S     484.38 +
                -
                -
                -
                -
                -
      581.25 +
                -
                -
                -
                -
                -
F     678.13 +
                -
                -
                -
                -
                -
T     775.00 * ****
```


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Global Stability Analysis
32-ft Full Height Embankment – Check Critical Failure along Various Portion of the Proposed Slope and along the Base of Existing Berm
Short Term (End of Construction Prior to Consolidation)

Company Confidential Information

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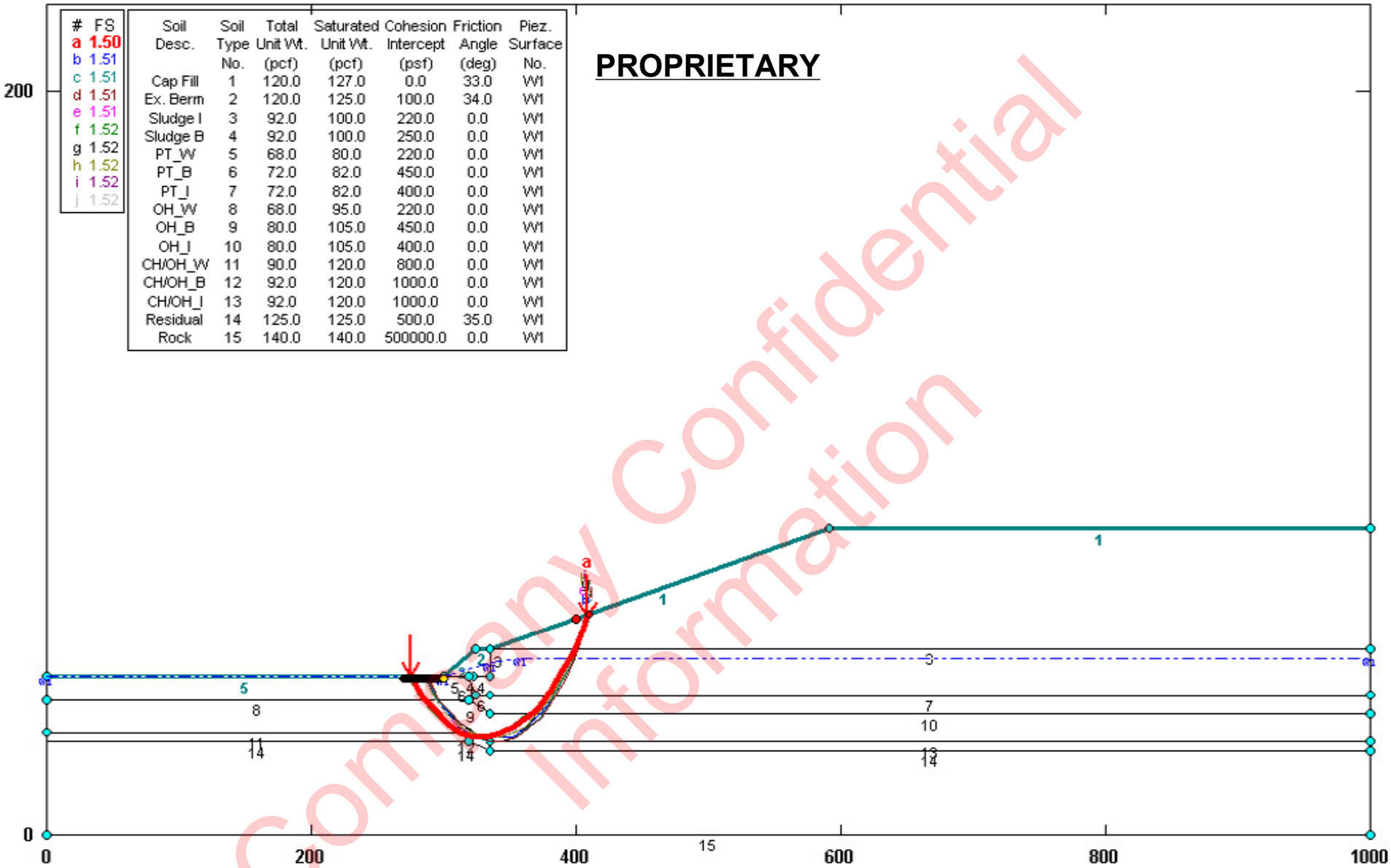
Rahwat Arch 32-ft_Fill_ExistingBermLowerslopePortion

C:\STEDWI~1\RAHWAY\32FTOVT2.PL2 Run By: Michael Baker 10/16/2012 12:50PM

PROPRIETARY

#	FS
a	1.50
b	1.51
c	1.51
d	1.51
e	1.51
f	1.52
g	1.52
h	1.52
i	1.52
j	1.52

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
Cap Fill	1	120.0	127.0	0.0	33.0	W1
Ex. Berm	2	120.0	125.0	100.0	34.0	W1
Sludge I	3	92.0	100.0	220.0	0.0	W1
Sludge B	4	92.0	100.0	250.0	0.0	W1
PT_W	5	68.0	80.0	220.0	0.0	W1
PT_B	6	72.0	82.0	450.0	0.0	W1
PT_I	7	72.0	82.0	400.0	0.0	W1
OH_W	8	68.0	95.0	220.0	0.0	W1
OH_B	9	80.0	105.0	450.0	0.0	W1
OH_I	10	80.0	105.0	400.0	0.0	W1
CH/OH_W	11	90.0	120.0	800.0	0.0	W1
CH/OH_B	12	92.0	120.0	1000.0	0.0	W1
CH/OH_I	13	92.0	120.0	1000.0	0.0	W1
Residual	14	125.0	125.0	500.0	35.0	W1
Rock	15	140.0	140.0	500000.0	0.0	W1



STABL6H FSmin=1.50

Safety Factors Are Calculated By The Modified Bishop Method

Company Confidential Information

Baker

PROPRIETARY

** STABL6H **
by
Purdue University

1

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date: 10/16/2012
Time of Run: 12:50PM
Run By: Michael Baker
Input Data Filename: C:32ftovt2.dat

Output Filename: C:32ftovt2.OUT

Plotted Output Filename: C:32ftovt2.PLT

PROBLEM DESCRIPTION Rahwat Arch
32-ft_Fill_ExistingBermLowerslopePortion

BOUNDARY COORDINATES

5 Top Boundaries
23 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	42.00	300.00	42.00	5
2	300.00	42.00	324.00	50.00	2
3	324.00	50.00	335.00	50.00	2
4	335.00	50.00	591.00	82.00	1
5	591.00	82.00	1000.00	82.00	1
6	335.00	50.00	1000.00	50.00	3
7	300.00	42.00	319.00	42.00	5
8	319.00	42.00	322.00	43.00	4
9	322.00	43.00	335.00	43.00	4
10	335.00	43.00	335.01	50.00	3
11	319.00	42.00	324.00	37.00	6
12	324.00	37.00	335.00	37.00	6
13	335.00	37.00	1000.00	37.00	7
14	0.00	36.00	319.00	36.00	8
15	319.00	36.00	335.00	32.00	9
16	335.00	32.00	1000.00	32.00	10
17	0.00	27.00	319.00	27.00	11
18	319.00	27.00	335.00	25.00	12
19	335.00	25.00	1000.00	25.00	13

20	0.00	25.00	319.00	25.00	14
21	319.00	25.00	335.00	23.00	14
22	335.00	23.00	1000.00	23.00	14
23	0.00	0.00	1000.00	0.00	15

1

ISOTROPIC SOIL PARAMETERS

15 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	120.0	127.0	0.0	33.0	0.00	0.0	1
2	120.0	125.0	100.0	34.0	0.00	0.0	1
3	92.0	100.0	220.0	0.0	0.00	0.0	1
4	92.0	100.0	250.0	0.0	0.00	0.0	1
5	68.0	80.0	220.0	0.0	0.00	0.0	1
6	72.0	82.0	450.0	0.0	0.00	0.0	1
7	72.0	82.0	400.0	0.0	0.00	0.0	1
8	68.0	95.0	220.0	0.0	0.00	0.0	1
9	80.0	105.0	450.0	0.0	0.00	0.0	1
10	80.0	105.0	400.0	0.0	0.00	0.0	1
11	90.0	120.0	800.0	0.0	0.00	0.0	1
12	92.0	120.0	1000.0	0.0	0.00	0.0	1
13	92.0	120.0	1000.0	0.0	0.00	0.0	1
14	125.0	125.0	500.0	35.0	0.00	0.0	1
15	140.0	140.0	500000.0	0.0	0.00	0.0	1

1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 5 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	0.00	42.00
2	300.00	42.00
3	335.00	46.00
4	359.00	48.00
5	1000.00	48.00

1

A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Circular Surfaces, Has Been Specified.

800 Trial Surfaces Have Been Generated.

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20 Surfaces Initiate From Each Of 40 Points Equally Spaced
Along The Ground Surface Between X = 270.00 ft.
and X = 300.00 ft.

Each Surface Terminates Between X = 400.00 ft.
and X = 410.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = 0.00 ft.

10.00 ft. Line Segments Define Each Trial Failure Surface.

1

Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Examined. They Are Ordered - Most Critical
First.

* * Safety Factors Are Calculated By The Modified Bishop Method * *

Failure Surface Specified By 16 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	275.39	42.00
2	284.17	37.22
3	293.36	33.27
4	302.87	30.19
5	312.63	28.00
6	322.54	26.72
7	332.54	26.36
8	342.52	26.92
9	352.41	28.40
10	362.12	30.79
11	371.57	34.07
12	380.68	38.20
13	389.36	43.16
14	397.55	48.90
15	405.18	55.37
16	408.97	59.25

Circle Center At X = 331.4 ; Y = 134.6 and Radius, 108.2

*** 1.500 ***

Failure Surface Specified By 15 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	286.15	42.00

2	294.65	36.73
3	303.68	32.42
4	313.12	29.13
5	322.86	26.88
6	332.79	25.71
7	342.79	25.63
8	352.74	26.64
9	362.52	28.74
10	372.01	31.89
11	381.10	36.06
12	389.68	41.19
13	397.65	47.23
14	404.91	54.11
15	409.31	59.29

Circle Center At X = 338.5 ; Y = 117.0 and Radius, 91.4

*** 1.510 ***

1

Failure Surface Specified By 15 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	286.92	42.00
2	295.39	36.69
3	304.40	32.34
4	313.83	29.01
5	323.57	26.75
6	333.50	25.58
7	343.50	25.51
8	353.45	26.55
9	363.22	28.67
10	372.70	31.87
11	381.76	36.09
12	390.30	41.29
13	398.22	47.40
14	405.41	54.34
15	409.54	59.32

Circle Center At X = 339.1 ; Y = 115.8 and Radius, 90.4

*** 1.512 ***

Failure Surface Specified By 15 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	288.46	42.00
2	296.83	36.53
3	305.78	32.06
4	315.17	28.63
5	324.90	26.30

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6	334.82	25.10
7	344.82	25.04
8	354.77	26.12
9	364.52	28.33
10	373.96	31.64
11	382.95	36.01
12	391.39	41.37
13	399.16	47.67
14	406.16	54.81
15	409.68	59.34

Circle Center At X = 340.4 ; Y = 112.3 and Radius, 87.4

*** 1.513 ***

1

Failure Surface Specified By 15 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	284.62	42.00
2	293.13	36.76
3	302.18	32.49
4	311.63	29.23
5	321.38	27.03
6	331.32	25.91
7	341.32	25.89
8	351.26	26.96
9	361.03	29.12
10	370.50	32.33
11	379.56	36.57
12	388.10	41.77
13	396.02	47.87
14	403.23	54.81
15	406.69	58.96

Circle Center At X = 336.5 ; Y = 116.9 and Radius, 91.1

*** 1.514 ***

Failure Surface Specified By 16 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	272.31	42.00
2	281.19	37.41
3	290.44	33.60
4	299.98	30.61
5	309.75	28.47
6	319.67	27.18
7	329.66	26.76
8	339.65	27.21
9	349.56	28.53

10	359.32	30.71
11	368.86	33.72
12	378.09	37.55
13	386.96	42.17
14	395.39	47.55
15	403.33	53.64
16	409.52	59.32

Circle Center At X = 329.5 ; Y = 141.6 and Radius, 114.9

*** 1.516 ***

1

Failure Surface Specified By 15 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	285.39	42.00
2	293.96	36.85
3	303.03	32.64
4	312.49	29.42
5	322.25	27.23
6	332.19	26.10
7	342.19	26.03
8	352.14	27.02
9	361.92	29.08
10	371.44	32.17
11	380.56	36.25
12	389.20	41.28
13	397.26	47.21
14	404.63	53.96
15	409.33	59.29

Circle Center At X = 337.8 ; Y = 119.5 and Radius, 93.6

*** 1.516 ***

Failure Surface Specified By 15 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	285.39	42.00
2	293.92	36.78
3	302.96	32.52
4	312.42	29.28
5	322.18	27.08
6	332.12	25.96
7	342.12	25.93
8	352.06	26.99
9	361.83	29.13
10	371.31	32.32
11	380.38	36.52
12	388.94	41.69

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13	396.89	47.76
14	404.13	54.66
15	407.88	59.11

Circle Center At X = 337.4 ; Y = 117.4 and Radius, 91.6

*** 1.517 ***

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Failure Surface Specified By 16 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	273.08	42.00
2	281.93	37.36
3	291.17	33.52
4	300.71	30.53
5	310.48	28.40
6	320.40	27.15
7	330.40	26.80
8	340.38	27.33
9	350.28	28.76
10	360.01	31.06
11	369.50	34.23
12	378.67	38.23
13	387.44	43.03
14	395.75	48.59
15	403.52	54.88
16	407.90	59.11

Circle Center At X = 329.4 ; Y = 138.7 and Radius, 111.9

*** 1.518 ***

Failure Surface Specified By 15 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	283.08	42.00
2	291.75	37.02
3	300.88	32.95
4	310.38	29.83
5	320.15	27.70
6	330.09	26.58
7	340.09	26.48
8	350.05	27.40
9	359.86	29.33
10	369.42	32.26
11	378.63	36.14
12	387.40	40.95
13	395.63	46.63
14	403.24	53.12
15	409.11	59.26

Circle Center At X = 336.1 ; Y = 124.2 and Radius, 97.8

*** 1.519 ***

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                Y            A     X     I     S            F     T

                0.00    125.00    250.00    375.00    500.00    625.00
X        0.00 *-**------+---------+---------+---------+---------+
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S      625.00 +
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T   1000.00 * ***  *
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Rahwat Arch 32-ft_Fill_ExistingBermUpperSlopePortion

C:\STEDWI~1\RAHWAY\32FTOVT.PL2 Run By: Michael Baker 10/16/2012 12:48PM

#	FS
a	1.43
b	1.43
c	1.43
d	1.43
e	1.43
f	1.43
g	1.43
h	1.43
i	1.43
j	1.43

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
Cap Fill	1	120.0	127.0	0.0	33.0	W1
Ex. Berm	2	120.0	125.0	100.0	34.0	W1
Sludge I	3	92.0	100.0	220.0	0.0	W1
Sludge B	4	92.0	100.0	250.0	0.0	W1
PT_W	5	68.0	80.0	220.0	0.0	W1
PT_B	6	72.0	82.0	450.0	0.0	W1
PT_I	7	72.0	82.0	400.0	0.0	W1
OH_W	8	68.0	95.0	220.0	0.0	W1
OH_B	9	80.0	105.0	450.0	0.0	W1
OH_I	10	80.0	105.0	400.0	0.0	W1
CH/OH_W	11	90.0	120.0	800.0	0.0	W1
CH/OH_B	12	92.0	120.0	1000.0	0.0	W1
CH/OH_I	13	92.0	120.0	1000.0	0.0	W1
Residual	14	125.0	125.0	500.0	35.0	W1
Rock	15	140.0	140.0	500000.0	0.0	W1

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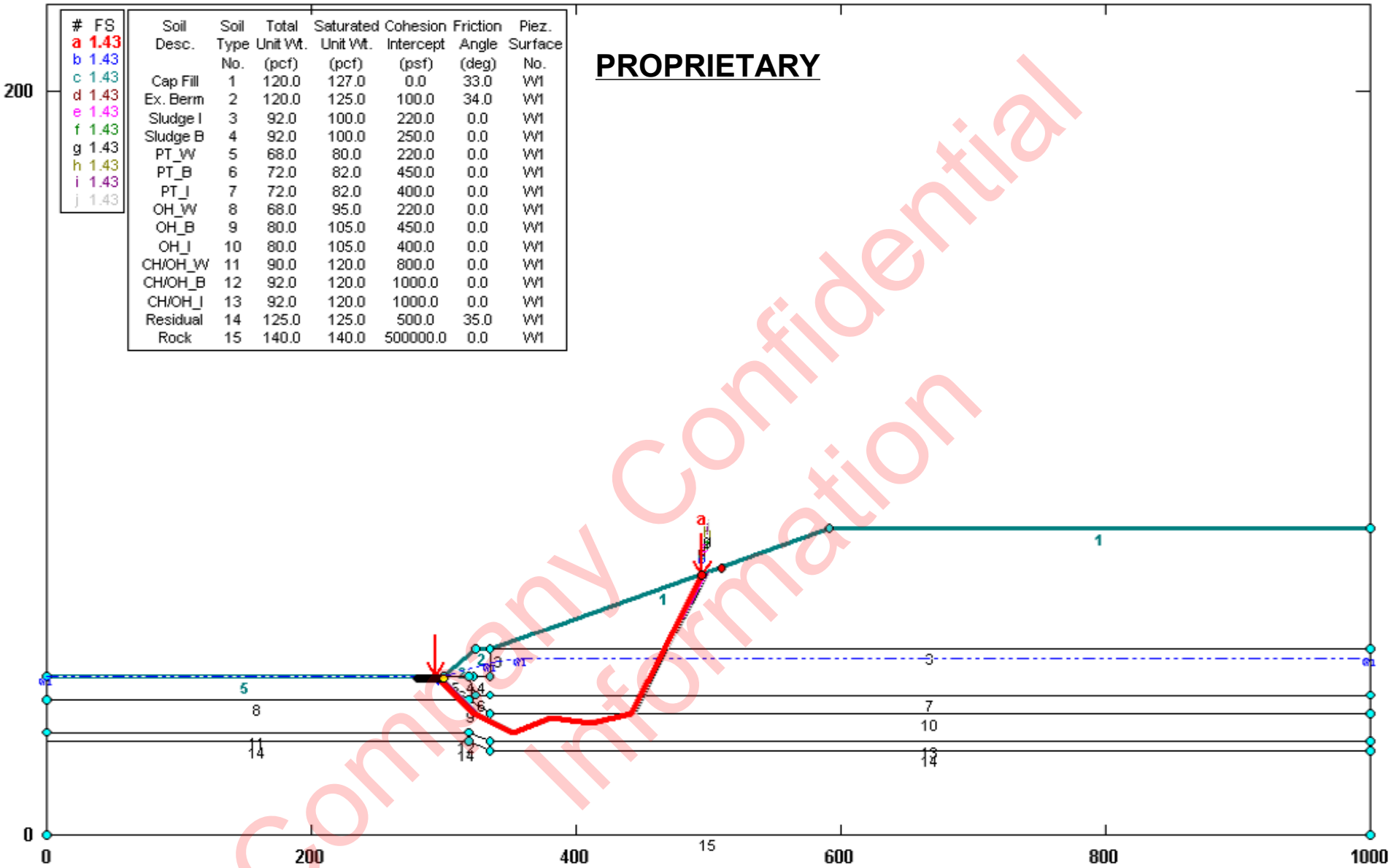

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STABL6H FSmin=1.43

Safety Factors Are Calculated By The Modified Janbu Method

Baker

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** STABL6H **
by
Purdue University

1

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date: 10/16/2012
Time of Run: 12:48PM
Run By: Michael Baker
Input Data Filename: C:32ftovt.dat

Output Filename: C:32ftovt.OUT

Plotted Output Filename: C:32ftovt.PLT

PROBLEM DESCRIPTION Rahwat Arch
32-ft_Fill_ExistingBermUpperSlopePortion

BOUNDARY COORDINATES

5 Top Boundaries
23 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	42.00	300.00	42.00	5
2	300.00	42.00	324.00	50.00	2
3	324.00	50.00	335.00	50.00	2
4	335.00	50.00	591.00	82.00	1
5	591.00	82.00	1000.00	82.00	1
6	335.00	50.00	1000.00	50.00	3
7	300.00	42.00	319.00	42.00	5
8	319.00	42.00	322.00	43.00	4
9	322.00	43.00	335.00	43.00	4
10	335.00	43.00	335.01	50.00	3
11	319.00	42.00	324.00	37.00	6
12	324.00	37.00	335.00	37.00	6
13	335.00	37.00	1000.00	37.00	7
14	0.00	36.00	319.00	36.00	8
15	319.00	36.00	335.00	32.00	9
16	335.00	32.00	1000.00	32.00	10
17	0.00	27.00	319.00	27.00	11
18	319.00	27.00	335.00	25.00	12
19	335.00	25.00	1000.00	25.00	13

20	0.00	25.00	319.00	25.00	14
21	319.00	25.00	335.00	23.00	14
22	335.00	23.00	1000.00	23.00	14
23	0.00	0.00	1000.00	0.00	15

1

ISOTROPIC SOIL PARAMETERS

15 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	120.0	127.0	0.0	33.0	0.00	0.0	1
2	120.0	125.0	100.0	34.0	0.00	0.0	1
3	92.0	100.0	220.0	0.0	0.00	0.0	1
4	92.0	100.0	250.0	0.0	0.00	0.0	1
5	68.0	80.0	220.0	0.0	0.00	0.0	1
6	72.0	82.0	450.0	0.0	0.00	0.0	1
7	72.0	82.0	400.0	0.0	0.00	0.0	1
8	68.0	95.0	220.0	0.0	0.00	0.0	1
9	80.0	105.0	450.0	0.0	0.00	0.0	1
10	80.0	105.0	400.0	0.0	0.00	0.0	1
11	90.0	120.0	800.0	0.0	0.00	0.0	1
12	92.0	120.0	1000.0	0.0	0.00	0.0	1
13	92.0	120.0	1000.0	0.0	0.00	0.0	1
14	125.0	125.0	500.0	35.0	0.00	0.0	1
15	140.0	140.0	500000.0	0.0	0.00	0.0	1

1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 5 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	0.00	42.00
2	300.00	42.00
3	335.00	46.00
4	359.00	48.00
5	1000.00	48.00

1

A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Irregular Surfaces, Has Been Specified.

800 Trial Surfaces Have Been Generated.

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20 Surfaces Initiate From Each Of 40 Points Equally Spaced
Along The Ground Surface Between X = 280.00 ft.
and X = 300.00 ft.

Each Surface Terminates Between X = 495.00 ft.
and X = 510.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = 0.00 ft.

30.00 ft. Line Segments Define Each Trial Failure Surface.

1

Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Examined. They Are Ordered - Most Critical
First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	293.85	42.00
2	322.41	32.84
3	352.00	27.90
4	381.75	31.76
5	411.72	30.35
6	441.68	31.93
7	465.98	49.52
8	490.60	66.66
9	495.54	70.07

*** 1.426 ***

Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	294.36	42.00
2	322.93	32.84
3	352.52	27.90
4	382.27	31.76
5	412.23	30.35
6	442.19	31.93
7	466.50	49.52
8	491.12	66.66
9	496.17	70.15

*** 1.426 ***

1

Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	294.87	42.00
2	323.44	32.84
3	353.03	27.90
4	382.78	31.76
5	412.75	30.35
6	442.71	31.93
7	467.01	49.52
8	491.63	66.66
9	496.79	70.22

*** 1.427 ***

Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	294.87	42.00
2	323.44	32.84
3	353.03	27.90
4	382.78	31.76
5	412.75	30.35
6	442.71	31.93
7	467.01	49.52
8	491.63	66.66
9	496.79	70.22

*** 1.427 ***

1

Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	295.39	42.00
2	323.95	32.84
3	353.54	27.90
4	383.29	31.76
5	413.26	30.35
6	443.22	31.93
7	467.52	49.52
8	492.14	66.66

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9	497.42	70.30

*** 1.428 ***

Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	297.44	42.00
2	326.00	32.84
3	355.59	27.90
4	385.34	31.76
5	415.31	30.35
6	445.27	31.93
7	469.57	49.52
8	494.19	66.66
9	499.92	70.62

*** 1.431 ***

1

Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	297.44	42.00
2	326.00	32.84
3	355.59	27.90
4	385.34	31.76
5	415.31	30.35
6	445.27	31.93
7	469.57	49.52
8	494.19	66.66
9	499.92	70.62

*** 1.431 ***

Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	297.95	42.00
2	326.52	32.84
3	356.11	27.90
4	385.86	31.76
5	415.82	30.35
6	445.78	31.93
7	470.08	49.52

8	494.71	66.66
9	500.55	70.69

*** 1.432 ***

1

Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	297.95	42.00
2	326.52	32.84
3	356.11	27.90
4	385.86	31.76
5	415.82	30.35
6	445.78	31.93
7	470.08	49.52
8	494.71	66.66
9	500.55	70.69

*** 1.432 ***

Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	298.46	42.00
2	327.03	32.84
3	356.62	27.90
4	386.37	31.76
5	416.34	30.35
6	446.30	31.93
7	470.60	49.52
8	495.22	66.66
9	501.17	70.77

*** 1.433 ***

1

```
                Y           A     X     I     S           F     T

               0.00    125.00    250.00    375.00    500.00    625.00

X       0.00 *-**------+---------+---------+---------+---------+
             -
             -
             -
             -
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A     250.00 +
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      750.00 +
                -
                -
                -
                -
                -
F     875.00 +
                -
                -
                -
                -
                -
T    1000.00 * ***  *
```


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Rahwat Arch 32-ft_Fill_ExistingBermSliding

C:\STEDWI~1\RAHWAY\32FTSLID.PL2 Run By: Michael Baker 10/14/2012 11:02PM

#	FS
a	2.25
b	2.36
c	2.49
d	2.50
e	2.50
f	2.52
g	2.54
h	2.55
i	2.56
j	2.56

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
Cap Fill	1	120.0	127.0	0.0	33.0	W1
Ex. Berm	2	120.0	125.0	100.0	34.0	W1
Sludge I	3	92.0	100.0	220.0	0.0	W1
Sludge B	4	92.0	100.0	250.0	0.0	W1
PT_W	5	68.0	80.0	220.0	0.0	W1
PT_B	6	72.0	82.0	450.0	0.0	W1
PT_I	7	72.0	82.0	400.0	0.0	W1
OH_W	8	68.0	95.0	220.0	0.0	W1
OH_B	9	80.0	105.0	450.0	0.0	W1
OH_I	10	80.0	105.0	400.0	0.0	W1
CH/OH_W	11	90.0	120.0	800.0	0.0	W1
CH/OH_B	12	92.0	120.0	1000.0	0.0	W1
CH/OH_I	13	92.0	120.0	1000.0	0.0	W1
Residual	14	125.0	125.0	500.0	35.0	W1
Rock	15	140.0	140.0	500000.0	0.0	W1

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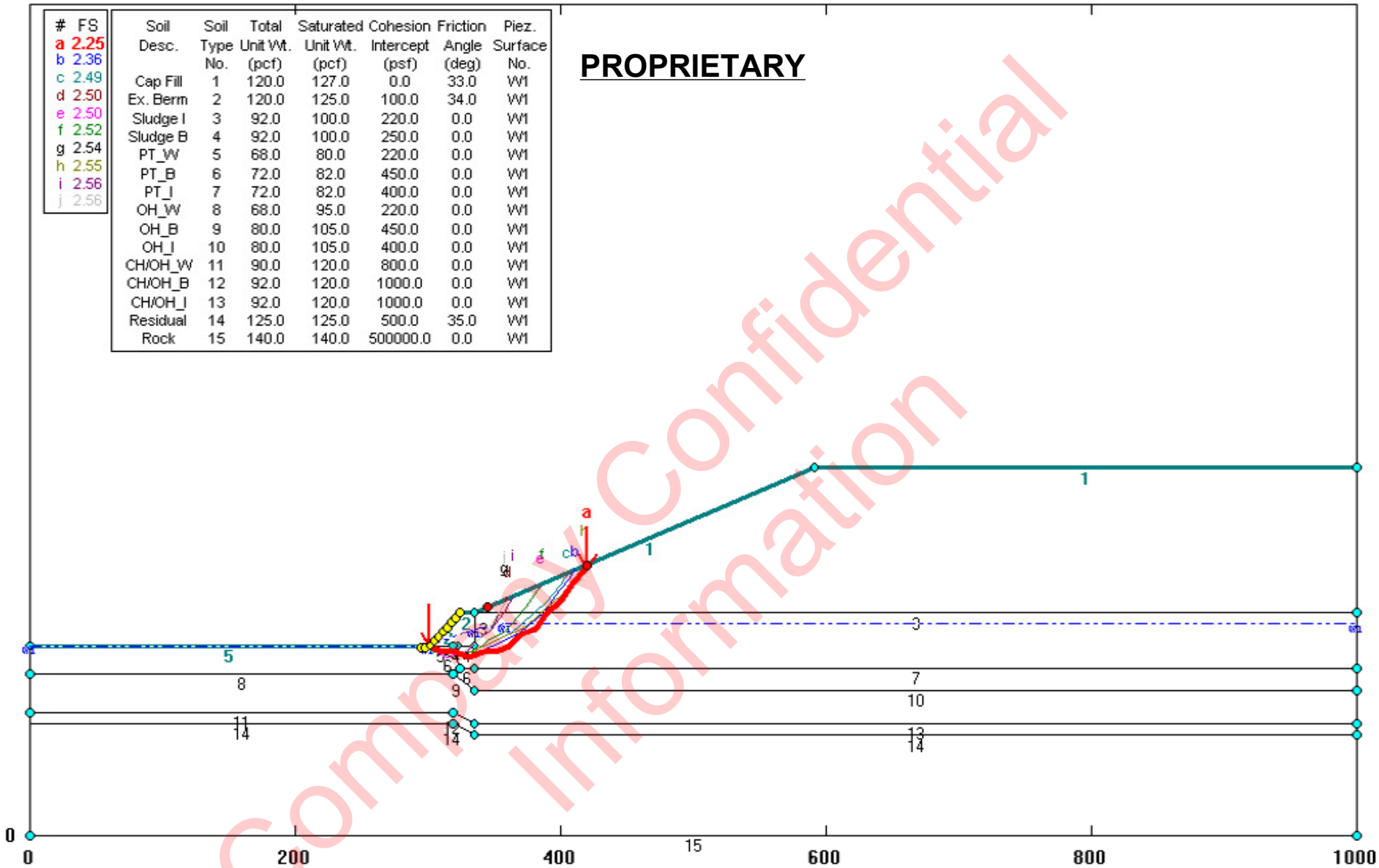

STABL6H FSmin=2.25

Safety Factors Are Calculated By The Modified Bishop Method

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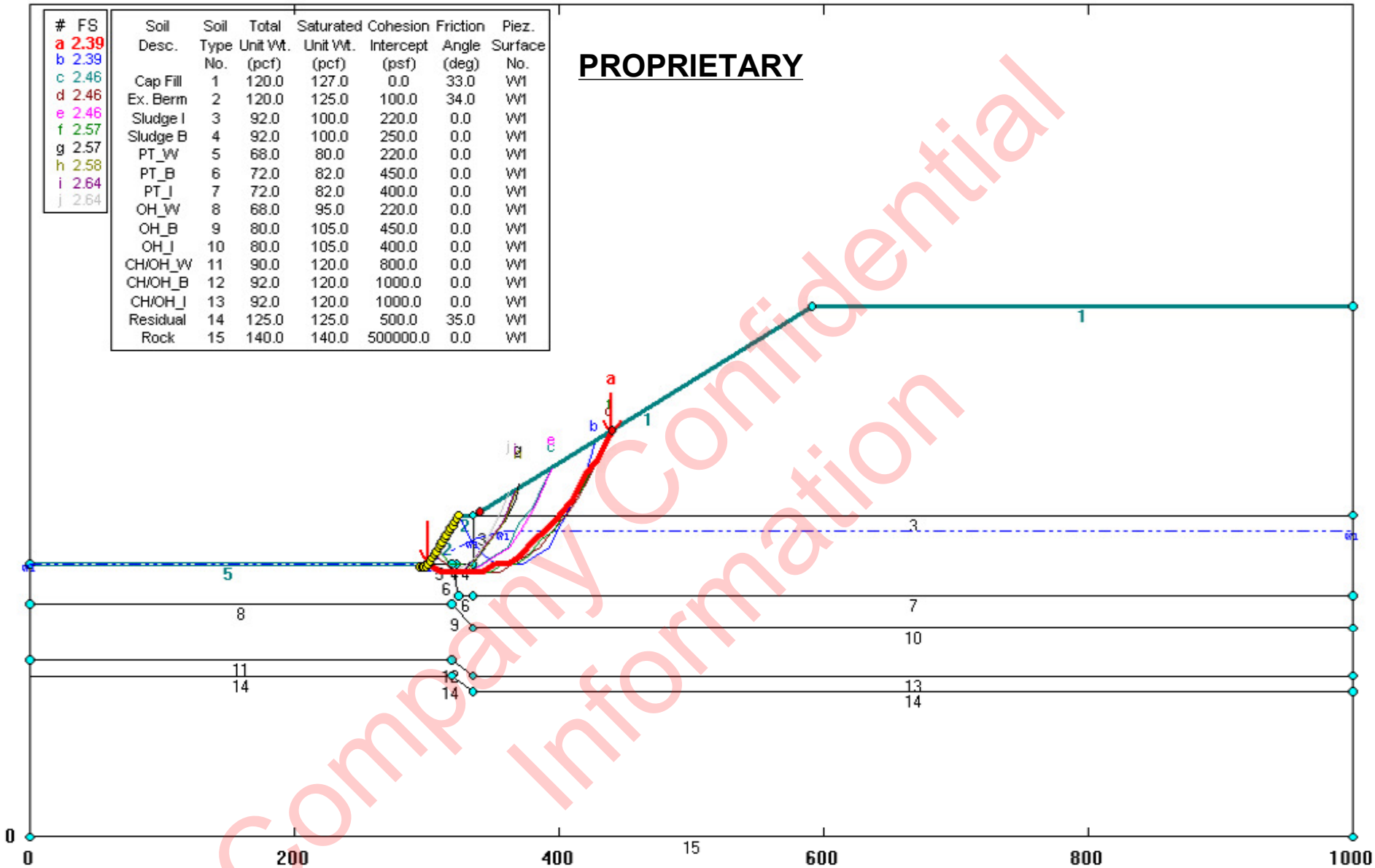
Rahwat Arch 32-ft_Fill_ExistingBermSliding

C:\STEDWI~1\RAHWAY\32FTSLID.PL2 Run By: Michael Baker 10/14/2012 11:14PM

#	FS
a	2.39
b	2.39
c	2.46
d	2.46
e	2.46
f	2.57
g	2.57
h	2.58
i	2.64
j	2.64

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
Cap Fill	1	120.0	127.0	0.0	33.0	W1
Ex. Berm	2	120.0	125.0	100.0	34.0	W1
Sludge I	3	92.0	100.0	220.0	0.0	W1
Sludge B	4	92.0	100.0	250.0	0.0	W1
PT_W	5	68.0	80.0	220.0	0.0	W1
PT_B	6	72.0	82.0	450.0	0.0	W1
PT_I	7	72.0	82.0	400.0	0.0	W1
OH_W	8	68.0	95.0	220.0	0.0	W1
OH_B	9	80.0	105.0	450.0	0.0	W1
OH_I	10	80.0	105.0	400.0	0.0	W1
CH/OH_W	11	90.0	120.0	800.0	0.0	W1
CH/OH_B	12	92.0	120.0	1000.0	0.0	W1
CH/OH_I	13	92.0	120.0	1000.0	0.0	W1
Residual	14	125.0	125.0	500.0	35.0	W1
Rock	15	140.0	140.0	500000.0	0.0	W1

PROPRIETARY



STABL6H FSmin=2.39

Safety Factors Are Calculated By The Modified Bishop Method

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32FTSLID
** STABL6H **
by
Purdue University

1

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date: 10/14/2012
Time of Run: 11:14PM
Run By: Michael Baker
Input Data Filename: C:32FTSLID.DAT

Output Filename: C:32FTSLID.OUT

Plotted Output Filename: C:32FTSLID.PLT

PROBLEM DESCRIPTION Rahwat Arch
32-ft_Fill_ExistingBermSliding

BOUNDARY COORDINATES

5 Top Boundaries
23 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	42.00	300.00	42.00	5
2	300.00	42.00	324.00	50.00	2
3	324.00	50.00	335.00	50.00	2
4	335.00	50.00	591.00	82.00	1
5	591.00	82.00	1000.00	82.00	1
6	335.00	50.00	1000.00	50.00	3
7	300.00	42.00	319.00	42.00	5
8	319.00	42.00	322.00	43.00	4
9	322.00	43.00	335.00	43.00	4
10	335.00	43.00	335.01	50.00	3
11	319.00	42.00	324.00	37.00	6
12	324.00	37.00	335.00	37.00	6
13	335.00	37.00	1000.00	37.00	7
14	0.00	36.00	319.00	36.00	8
15	319.00	36.00	335.00	32.00	9
16	335.00	32.00	1000.00	32.00	10
17	0.00	27.00	319.00	27.00	11
18	319.00	27.00	335.00	25.00	12
19	335.00	25.00	1000.00	25.00	13

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20	0.00	25.00	319.00	25.00	14
21	319.00	25.00	335.00	23.00	14
22	335.00	23.00	1000.00	23.00	14
23	0.00	0.00	1000.00	0.00	15

1

ISOTROPIC SOIL PARAMETERS

15 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	120.0	127.0	0.0	33.0	0.00	0.0	1
2	120.0	125.0	100.0	34.0	0.00	0.0	1
3	92.0	100.0	220.0	0.0	0.00	0.0	1
4	92.0	100.0	250.0	0.0	0.00	0.0	1
5	68.0	80.0	220.0	0.0	0.00	0.0	1
6	72.0	82.0	450.0	0.0	0.00	0.0	1
7	72.0	82.0	400.0	0.0	0.00	0.0	1
8	68.0	95.0	220.0	0.0	0.00	0.0	1
9	80.0	105.0	450.0	0.0	0.00	0.0	1
10	80.0	105.0	400.0	0.0	0.00	0.0	1
11	90.0	120.0	800.0	0.0	0.00	0.0	1
12	92.0	120.0	1000.0	0.0	0.00	0.0	1
13	92.0	120.0	1000.0	0.0	0.00	0.0	1
14	125.0	125.0	500.0	35.0	0.00	0.0	1
15	140.0	140.0	500000.0	0.0	0.00	0.0	1

1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 5 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	0.00	42.00
2	300.00	42.00
3	335.00	46.00
4	359.00	48.00
5	1000.00	48.00

1

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

400 Trial Surfaces Have Been Generated.

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20 Surfaces Initiate From Each Of 20 Points Equally Spaced
Along The Ground Surface Between X = 295.00 ft.
and X = 324.00 ft.

Each Surface Terminates Between X = 340.00 ft.
and X = 440.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = 41.00 ft.

10.00 ft. Line Segments Define Each Trial Failure Surface.

1

Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Examined. They Are Ordered - Most Critical
First.

* * Safety Factors Are Calculated By The Modified Bishop Method * *

Failure Surface Specified By 16 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	301.11	42.37
2	311.08	41.60
3	321.07	41.17
4	331.07	41.08
5	341.06	41.34
6	351.05	41.94
7	361.00	42.89
8	370.92	44.17
9	380.78	45.80
10	390.59	47.76
11	400.32	50.06
12	409.97	52.69
13	419.52	55.65
14	428.97	58.94
15	438.29	62.55
16	439.50	63.06

Circle Center At X = 328.5 ; Y = 332.3 and Radius, 291.2

*** 2.392 ***

Failure Surface Specified By 12 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	324.00	50.00

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2	333.43	46.68
3	343.13	44.23
4	353.01	42.68
5	362.99	42.02
6	372.98	42.28
7	382.91	43.44
8	392.70	45.50
9	402.26	48.44
10	411.51	52.24
11	420.38	56.86
12	427.73	61.59

Circle Center At X = 365.2 ; Y = 152.0 and Radius, 110.0

*** 2.394 ***

1

Failure Surface Specified By 11 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	301.11	42.37
2	311.06	41.45
3	321.06	41.11
4	331.05	41.36
5	341.02	42.20
6	350.92	43.61
7	360.72	45.61
8	370.38	48.17
9	379.88	51.30
10	389.18	54.98
11	394.47	57.43

Circle Center At X = 321.8 ; Y = 211.8 and Radius, 170.7

*** 2.463 ***

Failure Surface Specified By 15 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	305.68	43.89
2	315.60	42.59
3	325.56	41.71
4	335.55	41.26
5	345.55	41.24
6	355.54	41.65
7	365.51	42.48
8	375.43	43.75
9	385.28	45.44
10	395.06	47.55
11	404.73	50.08
12	414.29	53.03

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13	423.71	56.38
14	432.98	60.14
15	439.35	63.04

Circle Center At X = 341.0 ; Y = 273.8 and Radius, 232.6

*** 2.464 ***

1

Failure Surface Specified By 11 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	302.63	42.88
2	312.56	41.64
3	322.54	41.07
4	332.54	41.15
5	342.51	41.90
6	352.41	43.30
7	362.20	45.36
8	371.83	48.05
9	381.26	51.38
10	390.45	55.32
11	394.65	57.46

Circle Center At X = 326.2 ; Y = 192.4 and Radius, 151.3

*** 2.464 ***

Failure Surface Specified By 15 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	307.21	44.40
2	317.12	43.08
3	327.08	42.19
4	337.07	41.73
5	347.07	41.70
6	357.06	42.11
7	367.03	42.96
8	376.95	44.23
9	386.80	45.94
10	396.57	48.07
11	406.24	50.63
12	415.79	53.60
13	425.19	56.99
14	434.45	60.78
15	439.36	63.05

Circle Center At X = 342.6 ; Y = 271.6 and Radius, 230.0

*** 2.570 ***

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1

Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	299.58	42.00
2	309.54	41.10
3	319.54	41.03
4	329.51	41.79
5	339.38	43.38
6	349.09	45.78
7	358.56	48.98
8	367.74	52.95
9	370.51	54.44

Circle Center At X = 315.4 ; Y = 161.2 and Radius, 120.2

*** 2.571 ***

Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	299.58	42.00
2	309.54	41.11
3	319.54	41.06
4	329.51	41.85
5	339.37	43.48
6	349.07	45.94
7	358.52	49.20
8	367.66	53.26
9	369.62	54.33

Circle Center At X = 315.1 ; Y = 159.4 and Radius, 118.5

*** 2.580 ***

1

Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	298.05	42.00
2	308.01	41.10
3	318.01	41.05
4	327.98	41.85
5	337.84	43.50
6	347.53	45.97

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```
    7        356.98       49.26
    8        366.11       53.33
    9        367.41       54.05

Circle Center At X =  313.6 ; Y =  158.7  and Radius,  117.8

      ***     2.638   ***


Failure Surface Specified By  8 Coordinate Points

  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)

    1        299.58       42.00
    2        309.53       41.05
    3        319.53       41.08
    4        329.48       42.09
    5        339.29       44.06
    6        348.85       46.98
    7        358.08       50.82
    8        363.10       53.51

Circle Center At X =  314.2 ; Y =  143.2  and Radius,  102.2

      ***     2.644   ***


1

            Y           A     X     I     S            F     T

            0.00    125.00    250.00    375.00    500.00    625.00

X      0.00 *-**------+---------+---------+---------+---------+
            -
            -
            -
            -
            -
     125.00 +
            -
            -
            -
            -
            -
A    250.00 +
            -
            -  *
            - **4
            - ***
            -  1W
X    375.00 +  21
            -   13
            -   12
            -    1
            -
```

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```
                -
I     500.00 +
                -
                -
                -
                -       *
                -
S     625.00 +
                -
                -
                -
                -
                -
      750.00 +
                -
                -
                -
                -
                -
F     875.00 +
                -
                -
                -
                -
                -
T    1000.00 * ***   *
```

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Stability Analyses of Existing Berm

Summary:

Overturn F.S. >> 3 OK

Sliding F.S >1.3 OK

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S.O. No. 128911

Subject: Rahway Arch Site Reclain - Existing Berm Stability Check

Sheet No. 1 of 3

Drawing No.

Computed by GSH Checked By Date 10/15/2012

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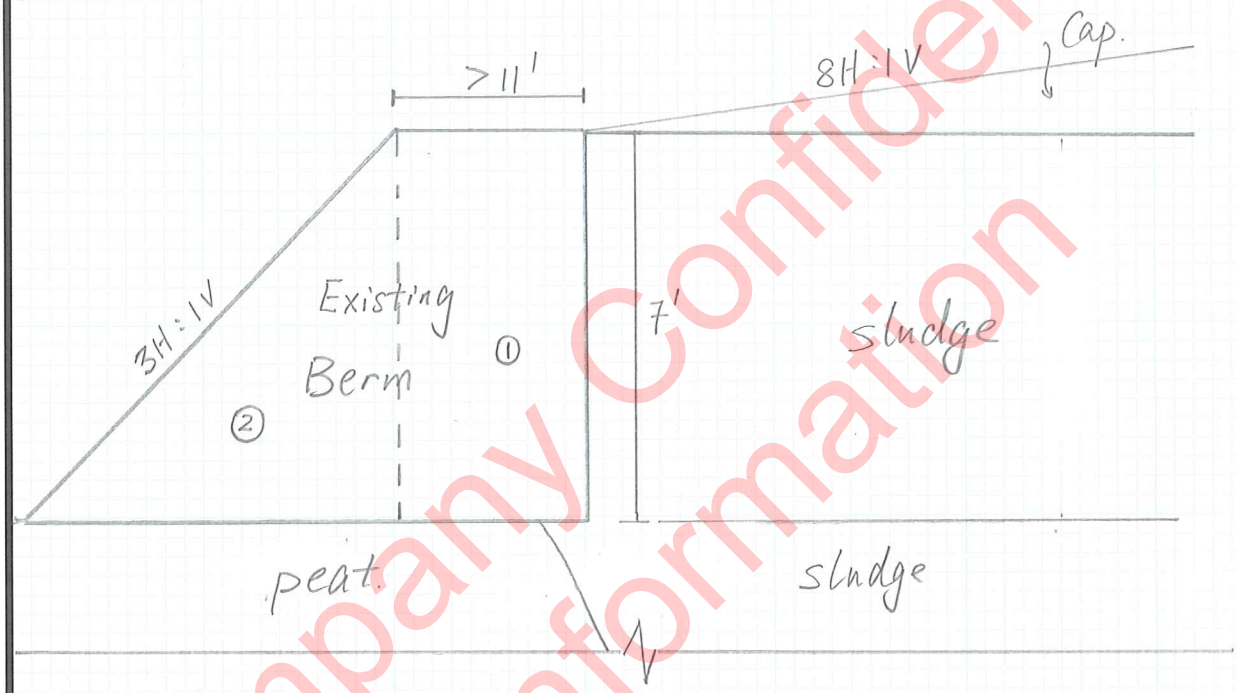

Sludge: assume $c = 200$ psf (initial), $\phi = 5°$, $\gamma = 91$ pcf

Existing Berm: $\phi = 34°$, $c =$ psf, $\gamma = 120$ pcf.

Cap: $\phi = 33°$, $\gamma = 120$ pcf. $c = 0$ psf.

The top width of the berm, according to the x-sections, shall be at least 20'. Existing berm had a min. width of 11'. Try 11' first.

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S.O. No. 128911

Subject: Rahway Arch Site Reclaim - Existing Berm Stability Check

PROPRIETARY

Sheet No. 2 of 3

Drawing No.

Computed by GSH Checked By Date 10/15/2012

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K_a of sludge: $\tan^2(45 - \phi/2) = 0.84$.

$\sigma_a = \sigma_o \cdot K_a - 2C \times \sqrt{K_a} + \sigma_w \cdot K_w (=1)$

$= (91-62.4) \times 0.84 \times 7' - 2 \times 200 \times 0.92 + 62.4 \times 7'$

$= 237$ psf.

$P_{saturated\ sludge} = \frac{1}{2} \sigma_a \times H = \frac{1}{2} \times 237 \times 7 = 829$ lb/ft

upper cap, treated as a "surcharge"

slope = 8H:1V, height = 27' from top of the berm.

$q = \underset{(\gamma)}{125} \times (\underset{H}{27'} \times 0.5)$ ⇒ equiv. to a "rectangular" surcharge.

$= 1687.5$ psf.

$K q H = 0.84 \times 1687.5 \times 7'$ ($P_{surcharge}$) $= 9923$ lb/ft

Weight of the berm:

① $B_1 = 11$, $H = 7$ ⇒ $W_1 = 120 \times 11 \times 7 = 9240$ lb/ft

② $B_2 = 21'$ (3H:1V), $H = 7'$, ⇒ $W_2 = 120 \times 21 \times 7/2 = 8820$ lb./ft

Overturning check: @ the slope toe of existing berm:

Driving Force × Arm =

$829 \times \frac{1}{3} \times 7' + 9923 \times 7' \times \frac{1}{2} = 36894$ lb-ft/ft.

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S.O. No. 128911

Subject: Railway Arch Site Reclaim. – Existing Berm stability check

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Sheet No. 3 of 3

Drawing No.

Computed by GSH Checked By Date 10/15/2012

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Resistant Force X Arm =

$9240 \times (11/2 + 21) + 8820 \times (21/2) = 337470$ lb-ft/ft

$M_R / M_d = 337470/36894 >> 3.$ OK.

Sliding check:

Driving Force = 9923 + 829 = 10752 lb/ft.

Resist. Force:

Friction Btw berm & foundation soil (sludge: USCS: mL).

$\tan\delta = 0.19$ ($\delta = 11°$) (smallest number from AASHTO 3.11.5.3-1, 2008)

$\Sigma V \tan\delta + B \cdot C_a$

$= (9240 + 8820) \times 0.19 + (11+21) \times 350$ psf (peat Su. (conservative))

$= 14631.4$ lb/ft.

$F_{resist} / F_{drive} = 14631 / 10752 = 1.36$ OK

Conclusion: due to the gentle slope proposed for cap, (8H:1V is a good design) the existing berm is stable.

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Settlement Analysis

Summary:

32-ft full Height Embankment: 5.3 ft Consolidation

3-ft Drainage Blanket: 1 ft consolidation

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Settlement Analysis

3-ft Drainage Blanket

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Rahway Arch

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PROJECT IDENTIFICATION

Title:	Rahway Arch
Project Number:	-
Client:	Soil Safe
Designer:	Gang Shen
Station Number:	

Description:

Company's information:

Name:	Michael Baker Jr., Inc.
Street:	300 American Metro Blvd Hamilton, NJ 08619
Telephone #:	609-807-9500
Fax #:	609-807-9550
E-Mail:	

Original file path and name: H:\GEOTECH ..... awhay Arch Site\Analysis\Settle\Stage1_3ftSand.2ST
Original date and time of creating this file: Mon Oct 08 22:14:13 2012

GEOMETRY: Analysis of a 2D geometry

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INPUT DATA -- FOUNDATION LAYERS -- 7 layers

	Wet Unit Weight, γ [lb/ft³]	Poisson's Ratio μ	Description of Soil
1	125.00	0.30	"Crust"
2	91.00	0.49	Sludge
3	80.00	0.47	Peat
4	80.00	0.47	Soft Organic Clay
5	98.00	0.40	Stiff Clay
6	125.00	0.30	Residual Soil
7	140.00	0.20	Bedrock

INPUT DATA -- EMBANKMENT LAYERS -- 1 layers

	Wet Unit Weight, γ [lb/ft³]	Description of Soil
1	125.00	

INPUT DATA OF WATER

Point #	Coordinates (X, Z) : (X) [ft.]	(Z) [ft.]
1	0.00	1.00
2	200.00	1.00
3	219.00	1.00
4	235.00	4.00
5	260.00	8.00
6	500.00	8.00
7	800.00	8.00
8	1050.00	8.00
9	1310.00	8.00
10	1335.00	4.00
11	1351.00	1.00
12	1370.00	1.00

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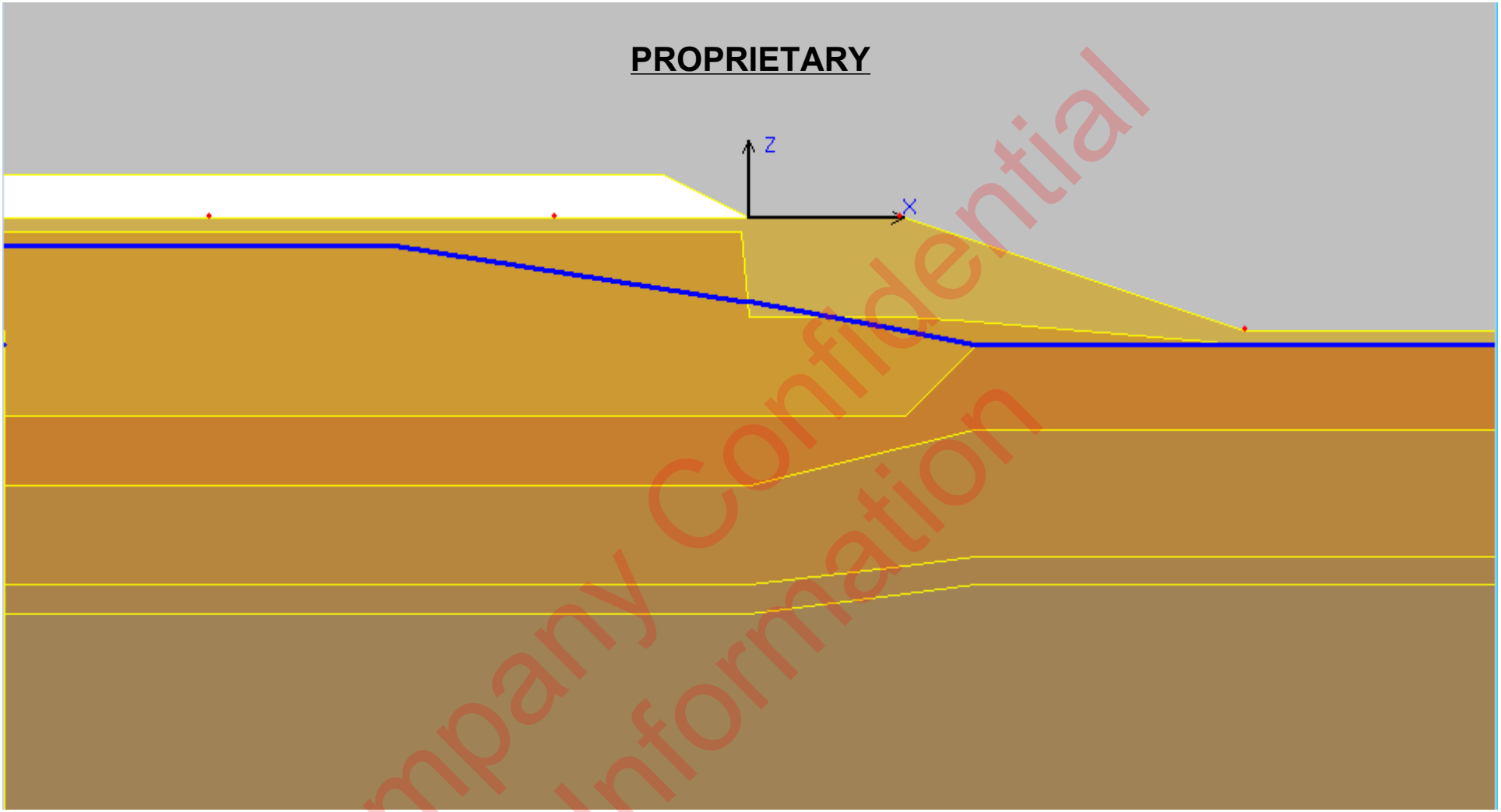

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INPUT DATA FOR CONSOLIDATION -- $\alpha = 1/2$

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Layer #	Underging Consolidation [Yes/No]	OCR = Pc / Po	Cc	Cr	e0	Cv [ft ²/day]	Drains at :
1	No	N/A	N/A	N/A	N/A	N/A	N/A
2	Yes	1.35	1.155	0.028	2.420	5.0000	Top
3	Yes	1.70	2.750	0.386	4.730	1.0000	Top
4	Yes	2.00	2.750	0.386	4.730	0.0500	Top
5	Yes	3.00	0.788	0.086	1.620	0.0260	Bottom
6	No	N/A	N/A	N/A	N/A	N/A	N/A
7	No	N/A	N/A	N/A	N/A	N/A	N/A

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IMMEDIATE SETTLEMENT, Si

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Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
1	778.00	0.00	1	600000	0.3000	0.0005	10.00	9.94	0.06
			2	28000	0.4900	0.0304			
			3	40000	0.4700	0.0107			
			4	40000	0.4700	0.0149			
			5	1008000	0.4000	0.0003			
			6	1600000	0.3000	0.0032			
			7	9000000	0.2000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

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ULTIMATE SETTLEMENT, Sc

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Node #	X [ft.]	Y [ft.]	Original Z [ft.]	Settlement Sc [ft.]	Final Z * [ft.]
1	200.00	0.00	2.00	0.01	1.99
2	224.38	0.00	10.00	0.02	9.98
3	248.75	0.00	10.00	0.70	9.30
4	273.12	0.00	10.00	0.99	9.01
5	297.50	0.00	10.00	0.99	9.01
6	321.88	0.00	10.00	1.00	9.00
7	346.25	0.00	10.00	1.00	9.00
8	370.62	0.00	10.00	1.00	9.00
9	395.00	0.00	10.00	1.00	9.00
10	419.37	0.00	10.00	1.00	9.00
11	443.75	0.00	10.00	1.00	9.00
12	468.13	0.00	10.00	1.00	9.00
13	492.50	0.00	10.00	1.00	9.00
14	516.88	0.00	10.00	1.00	9.00
15	541.25	0.00	10.00	1.00	9.00
16	565.63	0.00	10.00	1.00	9.00
17	590.00	0.00	10.00	1.00	9.00
18	614.37	0.00	10.00	1.00	9.00
19	638.75	0.00	10.00	1.00	9.00
20	663.13	0.00	10.00	1.00	9.00
21	687.50	0.00	10.00	1.00	9.00
22	711.88	0.00	10.00	1.00	9.00
23	736.25	0.00	10.00	1.00	9.00
24	760.63	0.00	10.00	1.00	9.00
25	785.00	0.00	10.00	1.00	9.00

*Note: Final Z is calculated assuming only 'Ultimate Settlement' exists.

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ULTIMATE SETTLEMENT, Sc

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Node #	X [ft.]	Y [ft.]	Original Z [ft.]	Settlement Sc [ft.]	Final Z * [ft.]
26	809.37	0.00	10.00	1.00	9.00
27	833.75	0.00	10.00	1.00	9.00
28	858.13	0.00	10.00	1.00	9.00
29	882.50	0.00	10.00	1.00	9.00
30	906.88	0.00	10.00	1.00	9.00
31	931.25	0.00	10.00	1.00	9.00
32	955.63	0.00	10.00	1.00	9.00
33	980.00	0.00	10.00	1.00	9.00
34	1004.37	0.00	10.00	1.00	9.00
35	1028.75	0.00	10.00	1.00	9.00
36	1053.12	0.00	10.00	1.00	9.00
37	1077.50	0.00	10.00	1.00	9.00
38	1101.88	0.00	10.00	1.00	9.00
39	1126.25	0.00	10.00	1.00	9.00
40	1150.63	0.00	10.00	1.00	9.00
41	1175.00	0.00	10.00	1.00	9.00
42	1199.38	0.00	10.00	1.00	9.00
43	1223.75	0.00	10.00	1.00	9.00
44	1248.12	0.00	10.00	1.00	9.00
45	1272.50	0.00	10.00	0.99	9.01
46	1296.88	0.00	10.00	0.99	9.01
47	1321.25	0.00	10.00	0.70	9.30
48	1345.63	0.00	10.00	0.02	9.98
49	1370.00	0.00	2.00	0.01	1.99

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TABULATED GEOMETRY: INPUT OF FOUNDATION SOILS

Found. Soil #	Point #	Coordinates (X, Z) : (X) [ft.]	(Z) [ft.]	DESCRIPTION
1	1	0.00	2.00	"Crust"
	2	200.00	2.00	
	3	224.00	10.00	
	4	235.00	10.00	
	5	500.00	10.00	
	6	800.00	10.00	
	7	1050.00	10.00	
	8	1335.00	10.00	
	9	1346.00	10.00	
	10	1370.00	2.00	
	11	1570.00	2.00	
2	1	0.00	1.00	Sludge
	2	200.00	1.00	
	3	224.00	3.00	
	4	235.00	3.00	
	5	235.50	9.00	
	6	500.00	9.00	
	7	800.00	9.00	
	8	1050.00	9.00	
	9	1334.50	9.00	
	10	1335.00	3.00	
	11	1346.00	3.00	
	12	1370.00	1.00	
3	1	0.00	0.90	Peat
	2	200.00	0.90	
	3	219.00	0.90	
	4	224.00	-4.00	
	5	235.00	-4.00	
	6	500.00	-4.00	
	7	800.00	-4.00	
	8	1050.00	-4.00	
	9	1335.00	-4.00	
	10	1346.00	-4.00	
	11	1351.00	0.90	
	12	1370.00	0.90	
4	1	0.00	-5.00	Soft Organic Clay
	2	200.00	-5.00	
	3	219.00	-5.00	
	4	235.00	-9.00	
	5	500.00	-9.00	
	6	800.00	-9.00	
	7	1050.00	-9.00	
	8	1335.00	-9.00	
	9	1351.00	-5.00	
	10	1370.00	-5.00	

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TABULATED GEOMETRY: INPUT OF FOUNDATION SOILS

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Found. Soil #	Point #	Coordinates (X, Z) : (X) [ft.]	(Z) [ft.]	DESCRIPTION
5	1	0.00	-14.00	Stiff Clay
	2	200.00	-14.00	
	3	219.00	-14.00	
	4	235.00	-16.00	
	5	500.00	-16.00	
	6	800.00	-16.00	
	7	1050.00	-16.00	
	8	1335.00	-16.00	
	9	1351.00	-14.00	
	10	1370.00	-14.00	
6	1	0.00	-16.00	Residual Soil
	2	200.00	-16.00	
	3	219.00	-16.00	
	4	235.00	-18.00	
	5	500.00	-18.00	
	6	800.00	-18.00	
	7	1050.00	-18.00	
	8	1335.00	-18.00	
	9	1351.00	-16.00	
	10	1370.00	-16.00	
7	1	0.00	-41.00	Bedrock
	2	200.00	-41.00	
	3	219.00	-41.00	
	4	235.00	-41.00	
	5	500.00	-41.00	
	6	800.00	-41.00	
	7	1050.00	-41.00	
	8	1335.00	-41.00	
	9	1351.00	-41.00	
	10	1370.00	-41.00	

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TABULATED GEOMETRY: INPUT OF EMBANKMENT SOILS

Embank. Soil #		Point #	Coordinates (X, Z) : (X) [ft.]	(Z) [ft.]	DESCRIPTION
1	X1 = 235.00 [ft]	1	235.00	10.00	
	X2 = 1335.00 [ft]	2	241.00	13.00	
		3	1329.00	13.00	
		4	1335.00	10.00	

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Settlement Analysis

32-ft Full Height Embankment

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Rahway Arch

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PROJECT IDENTIFICATION

Title:	Rahway Arch
Project Number:	-
Client:	Soil Safe
Designer:	Gang Shen
Station Number:	

Description:

Company's information:

Name:	Michael Baker Jr., Inc.
Street:	300 American Metro Blvd Hamilton, NJ 08619
Telephone #:	609-807-9500
Fax #:	609-807-9550
E-Mail:	

Original file path and name: H:\GEOTECH ..... Site\Analysis\Settle\FullHeightAfterStage1-Pc.2ST
Original date and time of creating this file: Mon Oct 08 22:14:13 2012

GEOMETRY: Analysis of a 2D geometry

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INPUT DATA -- FOUNDATION LAYERS -- 8 layers

	Wet Unit Weight, γ [lb/ft³]	Poisson's Ratio μ	Description of Soil
1	125.00	0.30	Sand Blanket
2	125.00	0.30	Existing Berm
3	102.00	0.49	Sludge
4	82.00	0.47	Peat
5	81.00	0.47	Soft Organic Clay
6	98.00	0.40	Stiff Clay
7	125.00	0.30	Residual Soil
8	140.00	0.20	Bedrock

INPUT DATA -- EMBANKMENT LAYERS -- 1 layers

	Wet Unit Weight, γ [lb/ft³]	Description of Soil
1	125.00	

INPUT DATA OF WATER

Point #	Coordinates (X, Z) : (X) [ft.]	(Z) [ft.]
1	0.00	1.00
2	200.00	1.00
3	219.00	1.00
4	235.00	4.00
5	260.00	8.00
6	500.00	8.00
7	800.00	8.00
8	1050.00	8.00
9	1310.00	8.00
10	1335.00	4.00
11	1351.00	1.00
12	1370.00	1.00

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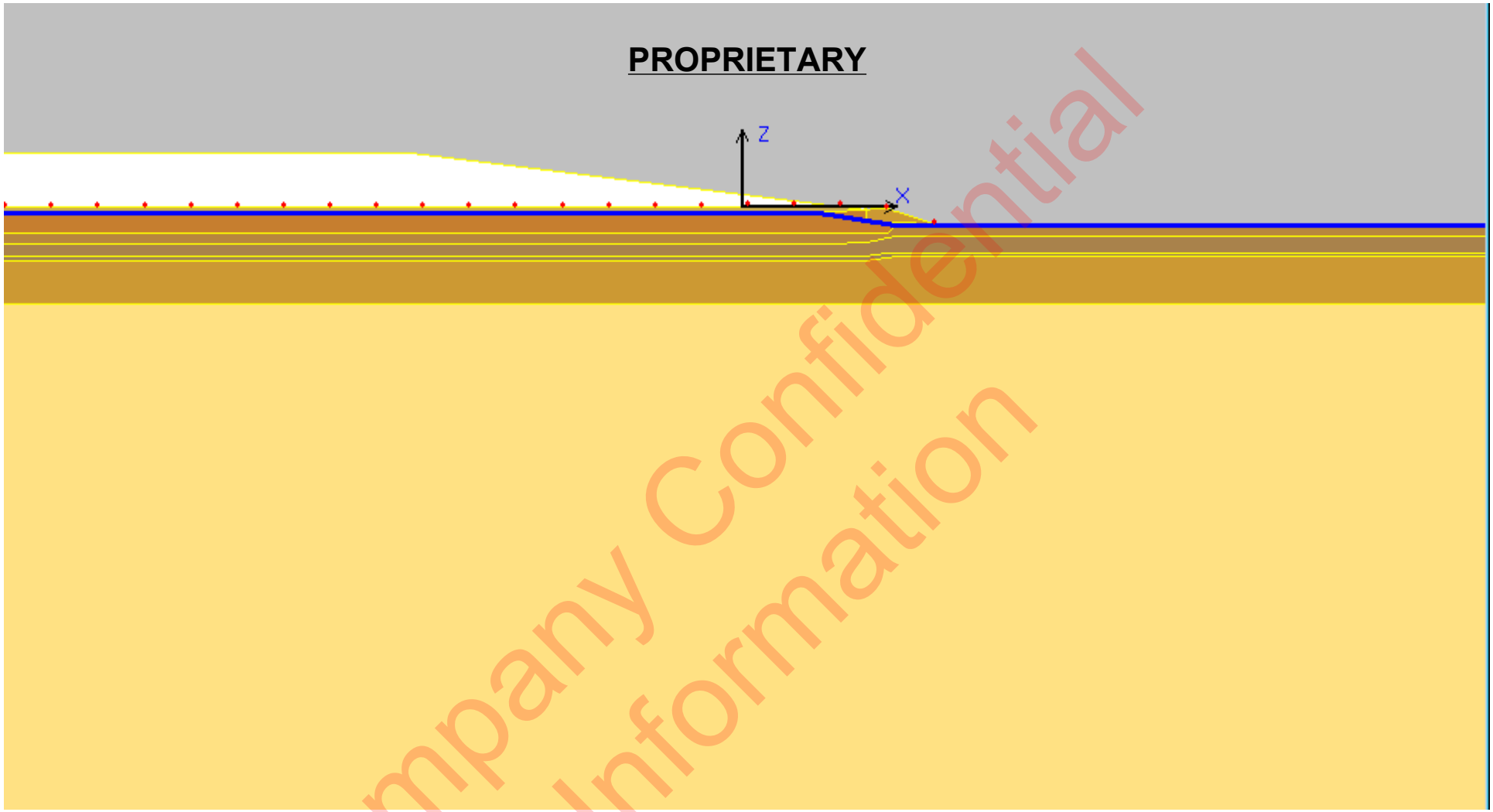

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INPUT DATA FOR CONSOLIDATION -- $\alpha = 1/2$

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Layer #	Underging Consolidation [Yes/No]	$(\sigma'_p - \sigma'_o)$ given at layer's boundaries in [lb/ft²] at Top	Bottom	Cc	Cr	e0	Cv [ft ²/day]	Drains at :
1	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3	Yes	570.0	115.0	1.155	0.028	2.120	4.0000	Top
4	Yes	865.0	800.0	2.750	0.386	4.597	1.0000	Top
5	Yes	867.0	936.8	2.750	0.386	4.597	0.0500	Top
6	Yes	2136.8	2065.6	0.788	0.086	1.620	0.0260	Bottom
7	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A

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IMMEDIATE SETTLEMENT, Si

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Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
1	785.00	0.00	1	600000	0.3000	0.0108	11.38	10.98	0.40
			2	600000	0.3000	0.0000			
			3	28000	0.4900	0.1719			
			4	40000	0.4700	0.0758			
			5	40000	0.4700	0.1071			
			6	1008000	0.4000	0.0027			
			7	1600000	0.3000	0.0296			
			8	9000000	0.2000	0.0004			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

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ULTIMATE SETTLEMENT, Sc

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Node #	X [ft.]	Y [ft.]	Original Z [ft.]	Settlement Sc [ft.]	Final Z * [ft.]
1	200.00	0.00	1.99	0.00	1.99
2	224.38	0.00	9.95	0.00	9.94
3	248.75	0.00	11.76	0.03	11.73
4	273.12	0.00	11.39	0.26	11.13
5	297.50	0.00	11.38	0.87	10.51
6	321.88	0.00	11.38	1.68	9.69
7	346.25	0.00	11.38	2.48	8.90
8	370.62	0.00	11.38	3.15	8.23
9	395.00	0.00	11.38	3.74	7.64
10	419.37	0.00	11.38	4.28	7.10
11	443.75	0.00	11.38	4.76	6.62
12	468.13	0.00	11.38	5.16	6.21
13	492.50	0.00	11.38	5.30	6.07
14	516.88	0.00	11.38	5.31	6.06
15	541.25	0.00	11.38	5.32	6.06
16	565.63	0.00	11.38	5.32	6.06
17	590.00	0.00	11.38	5.32	6.06
18	614.37	0.00	11.38	5.32	6.06
19	638.75	0.00	11.38	5.32	6.06
20	663.13	0.00	11.38	5.32	6.06
21	687.50	0.00	11.38	5.32	6.06
22	711.88	0.00	11.38	5.32	6.06
23	736.25	0.00	11.38	5.32	6.06
24	760.63	0.00	11.38	5.32	6.06
25	785.00	0.00	11.38	5.32	6.06

*Note: Final Z is calculated assuming only 'Ultimate Settlement' exists.

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ULTIMATE SETTLEMENT, Sc

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Node #	X [ft.]	Y [ft.]	Original Z [ft.]	Settlement Sc [ft.]	Final Z * [ft.]
26	809.37	0.00	11.38	5.32	6.06
27	833.75	0.00	11.38	5.32	6.06
28	858.13	0.00	11.38	5.32	6.06
29	882.50	0.00	11.38	5.32	6.06
30	906.88	0.00	11.38	5.32	6.06
31	931.25	0.00	11.38	5.32	6.06
32	955.63	0.00	11.38	5.32	6.06
33	980.00	0.00	11.38	5.32	6.06
34	1004.37	0.00	11.38	5.32	6.06
35	1028.75	0.00	11.38	5.32	6.06
36	1053.12	0.00	11.38	5.32	6.06
37	1077.50	0.00	11.38	5.30	6.07
38	1101.88	0.00	11.38	5.16	6.21
39	1126.25	0.00	11.38	4.76	6.62
40	1150.63	0.00	11.38	4.28	7.10
41	1175.00	0.00	11.38	3.74	7.63
42	1199.38	0.00	11.38	3.15	8.23
43	1223.75	0.00	11.38	2.48	8.90
44	1248.12	0.00	11.38	1.68	9.69
45	1272.50	0.00	11.38	0.87	10.51
46	1296.88	0.00	11.39	0.26	11.13
47	1321.25	0.00	11.76	0.03	11.73
48	1345.63	0.00	9.95	0.00	9.94
49	1370.00	0.00	1.99	0.00	1.99

*Note: Final Z is calculated assuming only 'Ultimate Settlement' exists.

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TABULATED GEOMETRY: INPUT OF FOUNDATION SOILS

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Found. Soil #	Point #	Coordinates (X, Z) : (X) [ft.]	(Z) [ft.]	DESCRIPTION
1	1	0.00	2.00	Sand Blanket
	2	200.00	1.99	
	3	220.00	8.65	
	4	224.00	9.95	
	5	230.00	9.92	
	6	235.00	9.51	
	7	240.00	12.10	
	8	250.00	11.71	
	9	260.00	11.41	
	10	270.00	11.39	
	11	280.00	11.38	
	12	290.00	11.38	
	13	300.00	11.38	
	14	500.00	11.38	
	15	800.00	11.38	
	16	1050.00	11.38	
	17	1270.00	11.38	
	18	1280.00	11.38	
	19	1290.00	11.38	
	20	1300.00	11.39	
	21	1310.00	11.41	
	22	1320.00	11.71	
	23	1330.00	12.10	
	24	1335.00	9.51	
	25	1340.00	9.92	
	26	1346.00	9.95	
	27	1350.00	8.65	
	28	1370.00	1.99	
	29	1570.00	2.00	

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TABULATED GEOMETRY: INPUT OF FOUNDATION SOILS

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Found. Soil #	Point #	Coordinates (X, Z) : (X) [ft.]	(Z) [ft.]	DESCRIPTION
2	1	0.00	1.99	Existing Berm
	2	200.00	1.98	
	3	220.00	8.65	
	4	224.00	9.95	
	5	230.00	9.92	
	6	235.00	9.51	
	7	240.00	9.10	
	8	250.00	8.71	
	9	260.00	8.41	
	10	270.00	8.39	
	11	280.00	8.38	
	12	290.00	8.38	
	13	300.00	8.38	
	14	500.00	8.38	
	15	800.00	8.38	
	16	1050.00	8.38	
	17	1270.00	8.38	
	18	1280.00	8.38	
	19	1290.00	8.38	
	20	1300.00	8.39	
	21	1310.00	8.41	
	22	1320.00	8.71	
	23	1330.00	9.10	
	24	1335.00	9.51	
	25	1340.00	9.92	
	26	1346.00	9.95	
	27	1350.00	8.65	
	28	1370.00	1.98	
	29	1570.00	1.99	

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TABULATED GEOMETRY: INPUT OF FOUNDATION SOILS

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Found. Soil #	Point #	Coordinates (X, Z) : (X) [ft.]	(Z) [ft.]	DESCRIPTION
3	1	0.00	1.98	Sludge
	2	200.00	1.97	
	3	220.00	2.66	
	4	224.00	2.97	
	5	230.00	2.95	
	6	235.00	2.57	
	7	235.50	9.45	
	8	240.00	9.09	
	9	250.00	8.70	
	10	260.00	8.40	
	11	270.00	8.38	
	12	280.00	8.37	
	13	290.00	8.37	
	14	300.00	8.37	
	15	500.00	8.37	
	16	800.00	8.37	
	17	1050.00	8.37	
	18	1270.00	8.37	
	19	1280.00	8.37	
	20	1290.00	8.37	
	21	1300.00	8.38	
	22	1310.00	8.40	
	23	1320.00	8.70	
	24	1330.00	9.09	
	25	1334.50	9.45	
	26	1335.00	2.57	
	27	1340.00	2.95	
	28	1346.00	2.97	
	29	1350.00	2.66	
	30	1370.00	1.98	

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TABULATED GEOMETRY: INPUT OF FOUNDATION SOILS

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Found. Soil #	Point #	Coordinates (X, Z) : (X) [ft.]	(Z) [ft.]	DESCRIPTION
4	1	0.00	1.97	Peat
	2	200.00	1.90	
	3	219.00	1.90	
	4	224.00	-3.00	
	5	230.00	-3.01	
	6	235.00	-3.02	
	7	240.00	-3.04	
	8	250.00	-3.06	
	9	260.00	-3.12	
	10	270.00	-3.13	
	11	280.00	-3.14	
	12	290.00	-3.14	
	13	300.00	-3.14	
	14	500.00	-3.14	
	15	800.00	-3.14	
	16	1050.00	-3.14	
	17	1270.00	-3.14	
	18	1280.00	-3.14	
	19	1290.00	-3.14	
	20	1300.00	-3.13	
	21	1310.00	-3.12	
	22	1320.00	-3.06	
	23	1330.00	-3.04	
	24	1335.00	-3.02	
	25	1340.00	-3.01	
	26	1346.00	-3.00	
	27	1351.00	1.90	
	28	1370.00	1.90	
5	1	0.00	-4.00	Soft Organic Clay
	2	200.00	-4.01	
	3	219.00	-4.01	
	4	230.00	-7.02	
	5	235.00	-8.03	
	6	240.00	-8.04	
	7	250.00	-8.06	
	8	260.00	-8.08	
	9	270.00	-8.08	
	10	280.00	-8.09	
	11	290.00	-8.09	
	12	300.00	-8.09	
	13	500.00	-8.09	
	14	800.00	-8.09	
	15	1050.00	-8.09	
	16	1270.00	-8.09	
	17	1280.00	-8.09	
	18	1290.00	-8.09	
	19	1300.00	-8.08	
	20	1310.00	-8.08	
	21	1320.00	-8.06	
	22	1330.00	-8.04	
	23	1335.00	-8.03	
	24	1340.00	-7.02	
	25	1351.00	-4.01	
	26	1370.00	-4.01	

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TABULATED GEOMETRY: INPUT OF FOUNDATION SOILS

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Found. Soil #	Point #	Coordinates (X, Z) : (X) [ft.]	(Z) [ft.]	DESCRIPTION
6	1	0.00	-13.00	Stiff Clay
	2	200.00	-13.00	
	3	219.00	-13.00	
	4	230.00	-14.50	
	5	235.00	-15.00	
	6	240.00	-15.01	
	7	250.00	-15.01	
	8	260.00	-15.01	
	9	270.00	-15.01	
	10	280.00	-15.01	
	11	290.00	-15.01	
	12	300.00	-15.01	
	13	500.00	-15.01	
	14	800.00	-15.01	
	15	1050.00	-15.01	
	16	1270.00	-15.01	
	17	1280.00	-15.01	
	18	1290.00	-15.01	
	19	1300.00	-15.01	
	20	1310.00	-15.01	
	21	1320.00	-15.01	
	22	1330.00	-15.01	
	23	1335.00	-15.00	
	24	1340.00	-14.50	
	25	1351.00	-13.00	
	26	1370.00	-13.00	
7	1	0.00	-15.00	Residual Soil
	2	200.00	-15.00	
	3	219.00	-15.00	
	4	235.00	-17.00	
	5	500.00	-17.00	
	6	800.00	-17.00	
	7	1050.00	-17.00	
	8	1335.00	-17.00	
	9	1351.00	-15.00	
	10	1370.00	-15.00	
8	1	0.00	-40.00	Bedrock
	2	200.00	-40.00	
	3	219.00	-40.00	
	4	235.00	-40.00	
	5	500.00	-40.00	
	6	800.00	-40.00	
	7	1050.00	-40.00	
	8	1335.00	-40.00	
	9	1351.00	-40.00	
	10	1370.00	-40.00	

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TABULATED GEOMETRY: INPUT OF EMBANKMENT SOILS

Embank. Soil #		Point #	Coordinates (X, Z) : (X) [ft.]	(Z) [ft.]	DESCRIPTION
1	X1 = 235.00 [ft]	1	235.00	9.51	
	X2 = 1335.00 [ft]	2	475.00	39.51	
		3	1095.00	39.51	
		4	1335.00	9.51	

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Cross Sections for Existing Site Contours

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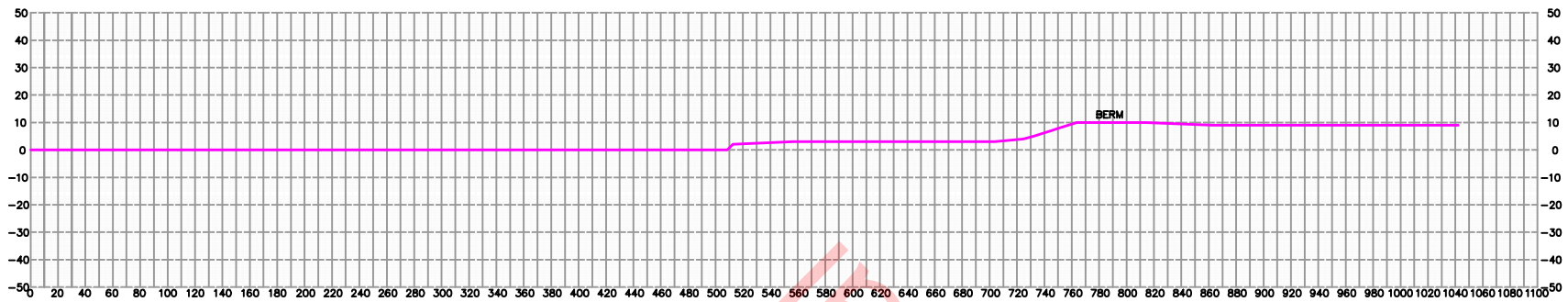
CROSS SECTION 1



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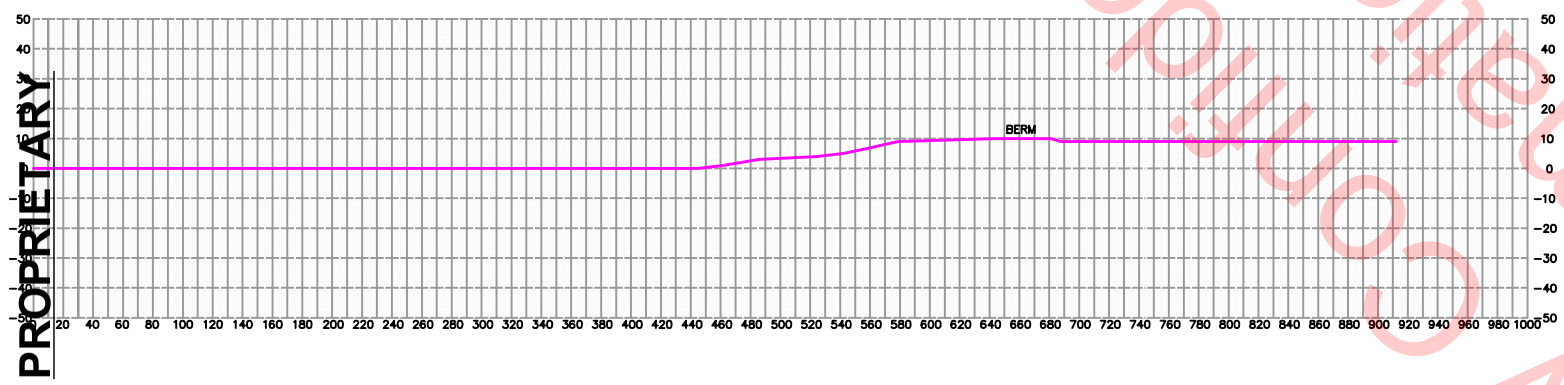

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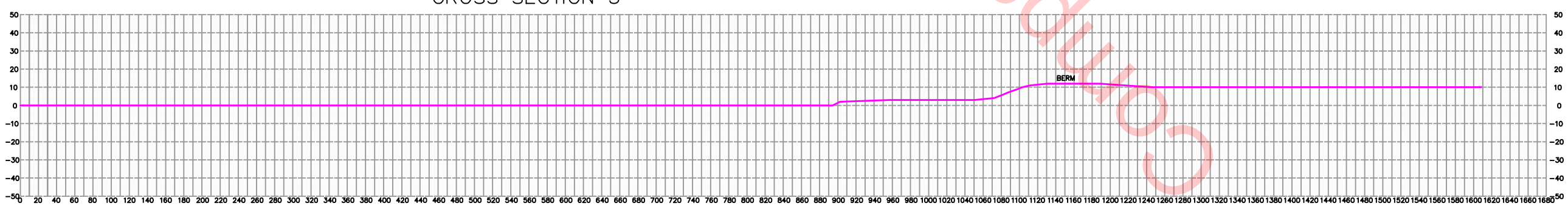

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LEGEND AND GENERAL NOTES
PROPOSED SOIL SAFE METRO12
CLASS B RECYCLING FACILITY

BLOCK 10 LOTS 8-10, 12-21
BLOCK 11.01 LOTS 8, 10-14, & 28

BOROUGH OF CARTERET
MIDDLESEX COUNTY, NJ

EastStar Environmental Group, Incorporated
10632 Little Patuxent Parkway, Suite 106
Columbia, Maryland 21044

Engineer

Albert P. Free, P.E., CSP, LSRP
NJ PE Number 24GE03816200

Project I-028	Filename Existing Cross Sections
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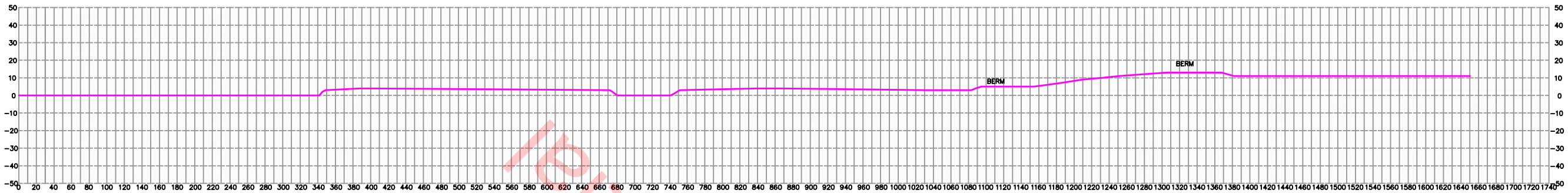

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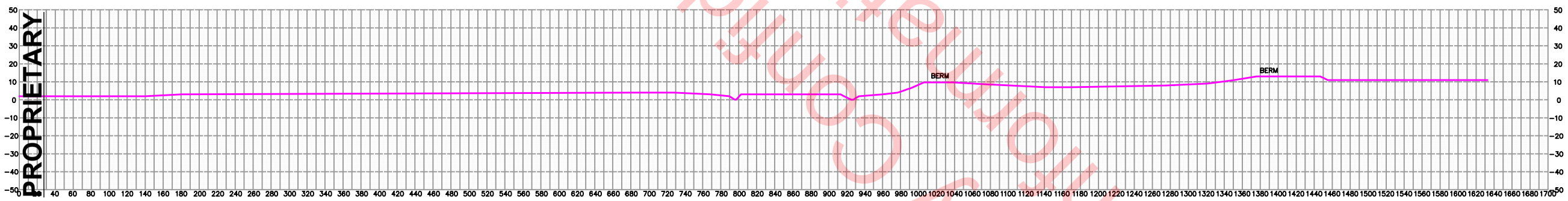

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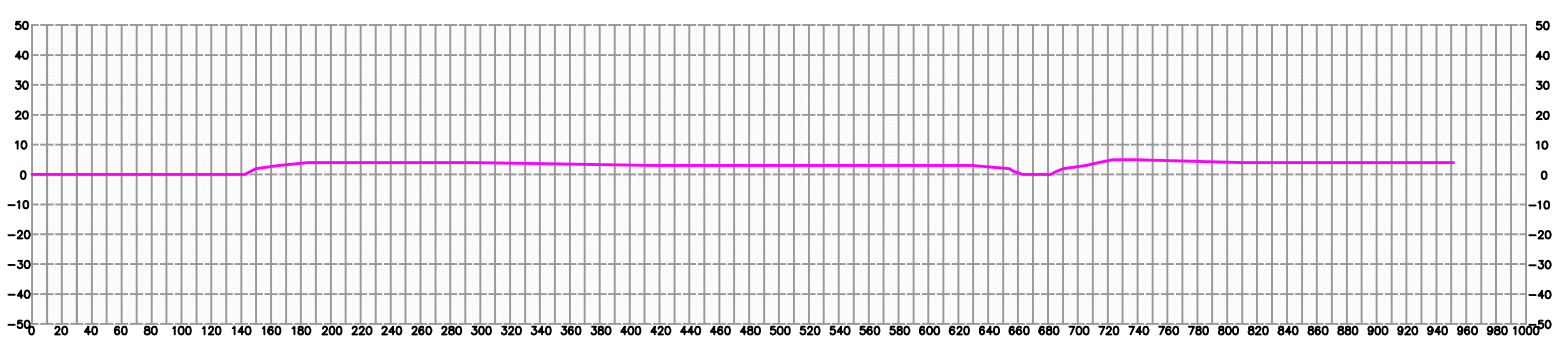

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Cross Sections for Proposed Planning

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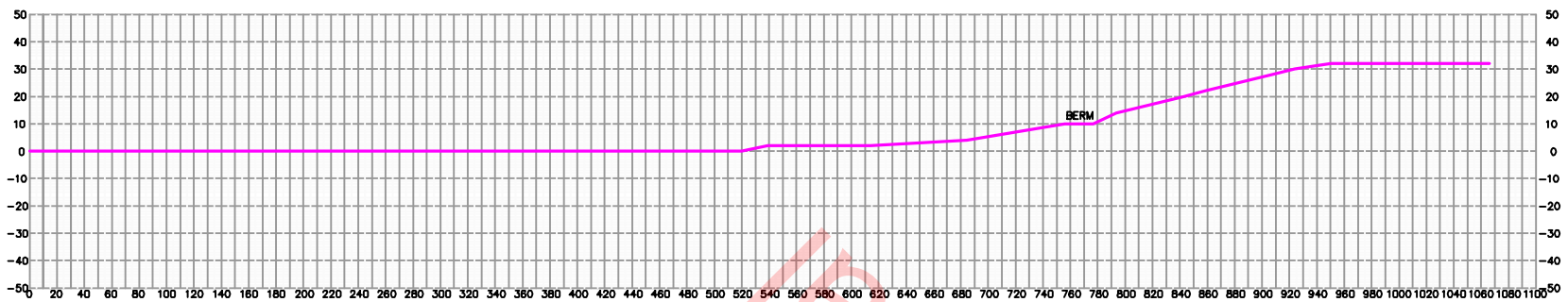

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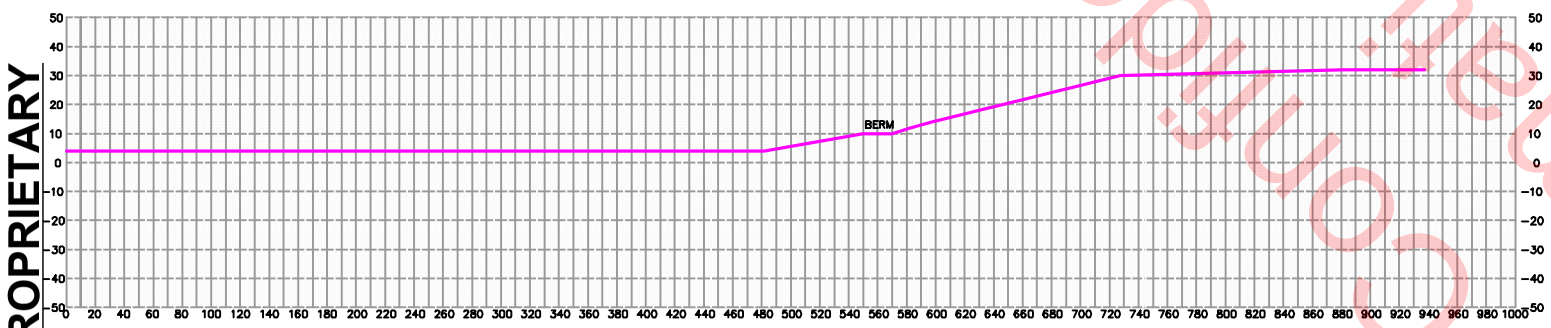

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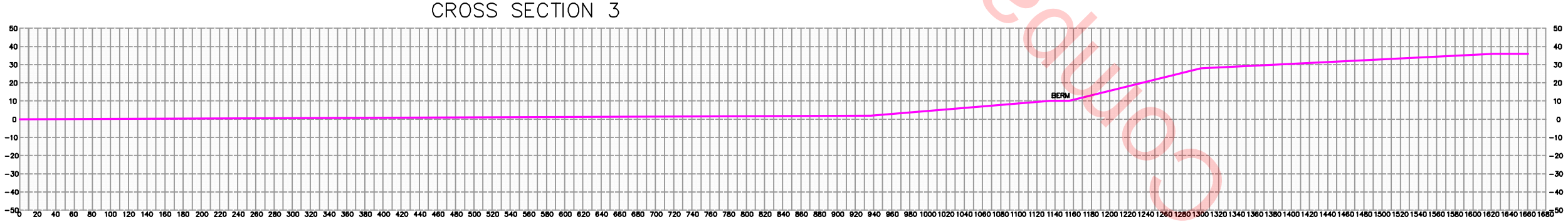

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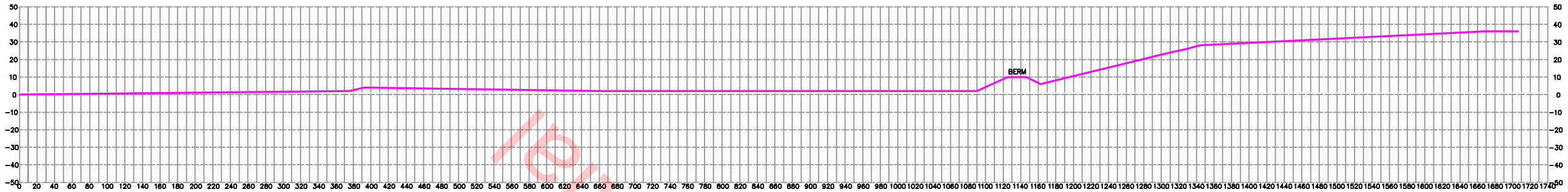

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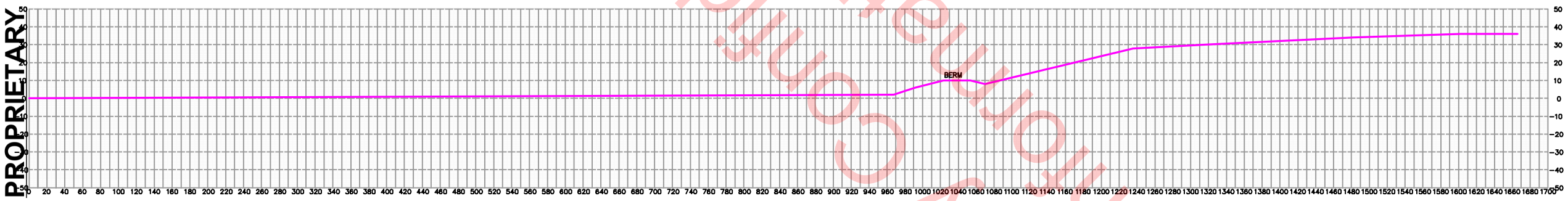

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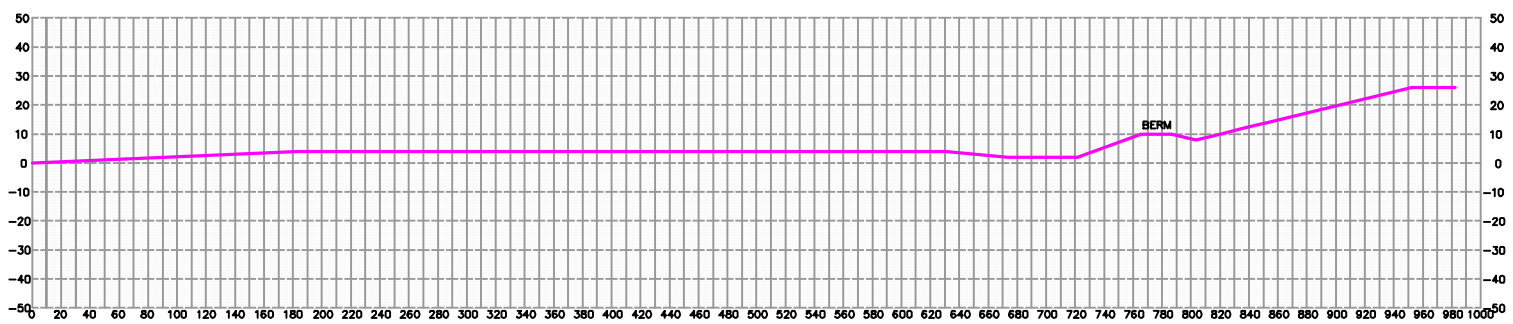

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Engineer
Albert P. Free, P.E., CSP, LSRP
NJ PE Number 24GE03816200

Project: I-028	Filename: Proposed Cross Sections
Date: 12/19/2011	Last Revised
Designed by: SMA	Approved by: APF
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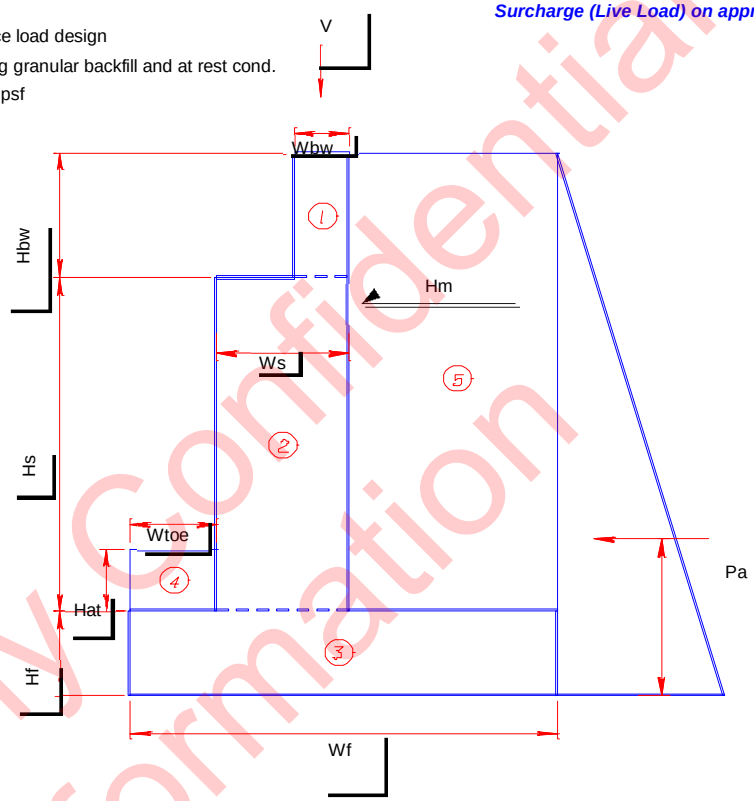
S.O. No.	*128911*		
Subject:	*Rahway Arch Property*		
		Sheet No.	**of**
	Existing Bridge Abutment W/Backwall	**Drawing No.**	
Comp by	*TEM*	**Checked by**	**Date**

(Input values are shown underlined and in italics.)

Backwall in place
Superstructure in place
Surcharge (Live Load) on approach

Abutment Length = *18.00* ft.
Weight of backfill = 0.12 kcf
Weight of concrete = 0.15 kcf
Coeff. of earth pressure, β_E = *1.00* <-- for service load design
Earth pressure coefficient = 0.40 <-- assuming granular backfill and at rest cond.
Equivalent Fluid Pressure (EFP) = *60* psf

Surcharge = *2.00* ft.



Dead Loads

Width of Backwall (W_{bw}) = *0.00* ft.
Height of Backwall (H_{bw}) = 0.00 ft.

Width of Stem (W_s) = *0.83* ft.
Height of Stem (H_s) = *2.76* ft.

Width of Footing (W_f) = *6.00* ft.
Height of Footing (H_f) = *2.50* ft.

Weight of Backwall = 0 kips
Weight of Stem = 6 kips
Weight of Footing = 41 kips
Weight of approach slab = 0 kips

W_{toe} = *3.43* ft.
H_{at} = *0* ft.

Dead Load Reactions from BSDI Output:
DC1 = *0* kips
DC2 = *0* kips
FWS = *0* kips
Total = 0 kips
Total Dead Load = 47 kips

Appr. slab wt. On abut.= *0.00* k/ft <-- assumed 1/3 of total wt. of approach slab
Temperature load, per Beam = *0.00* k/beam
Long. Force, per Beam = *0.00* k/beam
No. of beams = *2* nos.

Calculate Total Load (V)

Total Live Load = *80* kips

Total Dead + Live Load = 127 kips

V = (Total Dead + Live Load)/(Abutment Length) = 7.04 k/unit length

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S.O. No. *128911*
Subject: *Rahway Arch Property*
Sheet No. _____ of _____
Existing Bridge Abutment W/Backwall Drawing No. _____
Comp by *TEM* Checked by _____ Date _____

(Input values are shown underlined and in italics.)

Check Bearing

(Method from Das' Principles of Foundation Engineering. Ed.4)

	Hor. Force/unit length	Moment Arm	Mtoe
1. Active Pressure, Pa = H^2/2*EFP/1000 =	2 kips	2.420 ft.	4 k-ft
2. Temperature, Hm	0.00 kips	5.260 ft.	0 k-ft
3. Long. Force	0.00 kips	5.260 ft.	0 k-ft

Section	Area	Weight/unit length	Moment Arm	Mtoe
1	0.00 ft^2	0.00 kips	4.260 ft.	0 k-ft
2	2.30 ft^2	0.35 kips	3.844 ft.	1 k-ft
3	15.00 ft^2	2.25 kips	3.000 ft.	7 k-ft
4	0.00 ft^2	0.00 kips	1.714 ft.	0 k-ft
5	4.80 ft^2	0.58 kips	5.130 ft.	3 k-ft
approach slab		0.00 kips	4.010 ft.	0 k-ft
Superstructure Reactions		4.44 kips	4.927 ft.	22 k-ft
	SP_v=	7.62 kips		ΣM_R = 33 k-ft

ΣM_0 = Pa*H/3 = 3.83 k-ft

$M_{net} = \Sigma M_R - \Sigma M_O$ = 29.10 k-ft

$X_{bar} = M_{net}/V$ = 3.82 ft.

e = $(W_f/2) - X_{bar}$ = -0.82 ft. < $W_f/6$ = 1.00 OK
< $W_f/4$ = 1.50 OK

$q_{min} = V/W_f*(1-(6e/W_f))$ = 2.31 ksf OK OK

$q_{max} = V/W_f*(1+(6e/W_f))$ = 0.23 ksf OK

q_u = *3* ksf (based on boring BS-09, phi = 30 degrees)

FS = q_u/q_{max} > 1.0 1.30 OK

Check Overturning

<-- Live load not considered since it is transient, approach slab wt. on abutment can be zero, therefore not considered

Section	Area	Weight/unit length	Moment Arm	Mtoe
1	0.00 ft^2	0.00 kips	4.260 ft.	0 k-ft
2	2.30 ft^2	0.35 kips	3.844 ft.	1 k-ft
3	15.00 ft^2	2.25 kips	3.000 ft.	7 k-ft
4	0.00 ft^2	0.00 kips	1.714 ft.	0 k-ft
5	4.80 ft^2	0.58 kips	5.130 ft.	3 k-ft
Superstructure dead load Reactions		0.00 kips	4.927 ft.	0 k-ft
	SP_v=	3.17 kips		ΣM_R = 11 k-ft

ΣM_D = Pa*H/3 = 3.83 k-ft

FS = $\Sigma M_R/\Sigma M_D$ > 1.5 2.88 OK

Check Sliding

Coefficient of Friction = *0.5*
Passive Resistance, Rp = *0.35* tns/ft^2 Kp = 1.87 (assume phi = 30 degrees)
Depth below top of soil, D = *2.50* ft.

Passive Pressure of Soil, Pp = D*Rp*2 kips/tn = 1.75 kips

ΣF_R = (Coefficient of Friction*V) + Pp = 3.34 kips

ΣF_D = Pa = 1.58 kips

FS = $\Sigma F_R/\Sigma F_D$ > 1.50 2.11 OK

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Baker

PROJECT: Rahway Arch Property

SUBJECT: Liquefaction Evaluation

CALCULATED BY: TEM **DATE:** 11/8/12 **CHECKED BY:** **DATE:**

PROPRIETARY

REFERENCES :

1. AASHTO LRFD Bridge Design Specifications, (2004, Third Edition with 2005, 2006 Interims)
2. Youd, T. L., et. Al, (2001), "Liquefaction Resistance of Soils: Summary Report From the 1996 NCEER and 1998 NCEER/NSF Workshops on Evaluation of Liquefaction Resistance of Soils," ASCE Journal of Geotechnical and Geoenvironmental Engineering, Vol, 127, No. 10, pp 817-833.

Boring No.: **ID-03R**

Ground Water Depth: 0.00 ft = 0.000 m.

Earthquake Moment Magnitude, M_w: 5.0

Peak Ground Acceleration at Ground Surface, a_{max} (g): 0.09

C_E, Correction for Hammer Energy Ratio: 1.00

C_B, Correction Factor for Borhole Diameter: 1.00

Note: Hammer Type: Safety

Note: Borehole Diameter (inch): 6.00

Length of Drilling Rod above Ground: 3.00 ft = 0.914 m

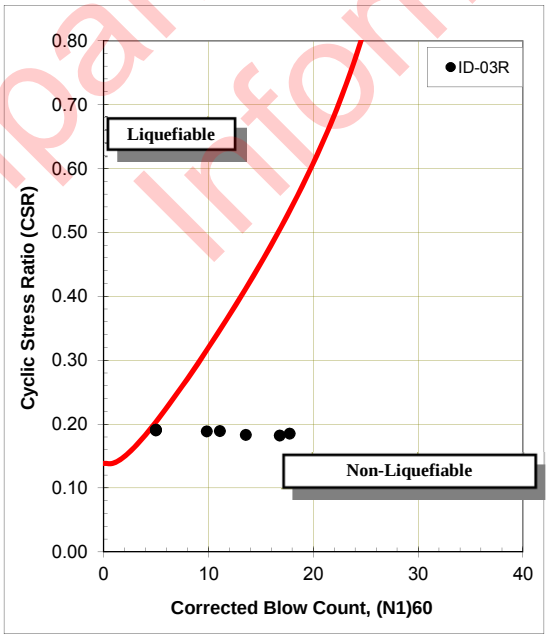
C_s, Correction For Sampler with or without Liners: 1.0

Standard Sampler? (Yes or Not) Yes

Average Unit Weight of Soil: 90.0 pcf 14.13 kN/m^3

Earthquake Magnitude Scale Factor, MSF: $MSF = 10^{2.24} / M_w^{2.56} =$ **2.823**

Depth (ft)	Effective Overburden Pressure (kPa)	SPT Blow Counts (blows/ft)	Fine Contents (%)	Over Burden Correction, C_N	$(N_1)_{,60}$	$(N_1)_{,60cs}$	CSR	CRR	FS	Liquefaction?
0.1	0.13	0	90.00	1.700	0.0	5.0	0.191	0.203	1.06	**No**
2.0	2.63	0	90.00	1.700	0.0	5.0	0.191	0.203	1.07	**No**
4.0	5.27	0	90.00	1.700	0.0	5.0	0.190	0.203	1.07	**No**
6.0	7.90	4	90.00	1.700	5.1	11.1	0.189	0.348	1.84	**No**
8.0	10.53	3	90.00	1.687	4.0	9.9	0.188	0.316	1.68	**No**
10.0	13.17	26	90.00	1.654	34.4	46.3	0.187	Large N	Large N	**No, (Large SPT Value)**
12.0	15.80	25	90.00	1.622	34.5	46.4	0.187	Large N	Large N	**No, (Large SPT Value)**
14.0	18.43	26	70.00	1.592	35.2	47.2	0.186	Large N	Large N	**No, (Large SPT Value)**
16.0	21.07	8	70.00	1.563	10.6	17.8	0.185	0.534	2.89	**No**
20.0	26.34	5	70.00	1.507	7.2	13.6	0.183	0.413	2.25	**No**
22.0	28.97	7	70.00	1.481	9.8	16.8	0.182	0.505	2.77	**No**
24.0	31.60	21	75.00	1.455	29.0	39.8	0.181	Large N	Large N	**No, (Large SPT Value)**
30.0	39.50	44	35.00	1.384	60.9	78.1	0.176	Large N	Large N	**No, (Large SPT Value)**
35.0	46.09	200	35.00	1.329	265.8	324.0	0.170	Large N	Large N	**No, (Large SPT Value)**



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Evaluation for Cyclic Stress Ratio:

$$\mathrm{CSR} = (\tau_{av}/\sigma'_{vo}) = 0.65(a_{max}/g)(\sigma_{vo}/\sigma'_{vo})r_d \qquad (1)$$

Where: a_{max}: Peak horizontal acceleration at the ground surface generated by the earthquake

σ_{vo}, σ'_{v0} : Total and effective overburden stresses, respectively

r_d: Stress reduction coefficient that accounts for flexibility of soil profile

For $z \le 9.15$ m, $r_d = 1.00 - 0.00765z$ (2a)

For $9.15\ \mathrm{m} < r_d \le 23$ m, $r_d = 1.174 - 0.0267z$ (2b)

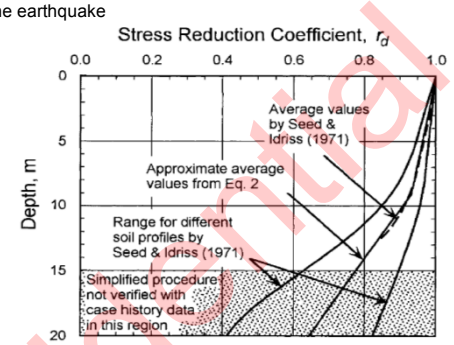

FIG. 1. r_d versus Depth Curves Developed by Seed and Idriss (1971) with Added Mean-Value Lines Plotted from Eq. (2)

Evaluation of Liquefaction Resistance (CRR):

Clean sand base curve in Figure 2:

$$\mathrm{CRR}_{7.5} = \frac{1}{34-(N_1)_{60}} + \frac{(N_1)_{60}}{135} + \frac{50}{[10\cdot(N_1)_{60}+45]^2} - \frac{1}{200} \qquad (3)$$

This equation is valid for $(N_1)_{60}$ <30, For $(N_1)_{60}$ >= 30, clean granular soils are too dense to liquefy and classified as non-liquefiable.

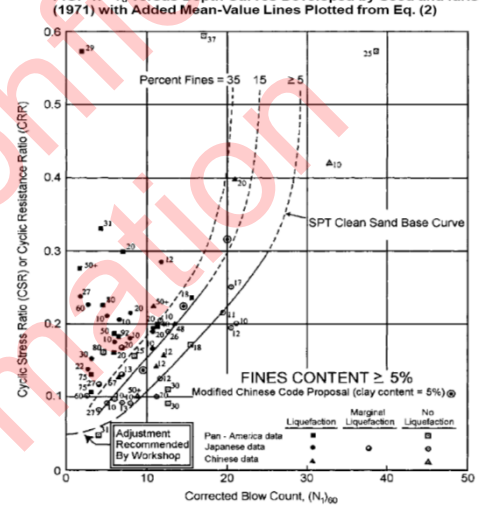

FIG. 2. SPT Clean-Sand Base Curve for Magnitude 7.5 Earthquakes with Data from Liquefaction Case Histories (Modified from Seed et al. 1985)

Influence of Fines Content:

The following equations were developed for correction of (N1)60 to equivalent clean sand value, $(N_1)_{60cs}$:

$$(N_1)_{60cs} = \alpha + \beta(N_1)_{60} \qquad (4)$$

where α and β = coefficients determined from the following relationships

$$\alpha = 0 \quad \text{for FC} \le 5\%$$

$$\alpha = \exp[1.76 - (190/\mathrm{FC}^2)] \quad \text{for } 5\% < \mathrm{FC} < 35\%$$

$$\alpha = 5.0 \quad \text{for FC} \ge 35\%$$

$$\beta = 1.0 \quad \text{for FC} \le 5\%$$

$$\beta = [0.99 + (\mathrm{FC}^{1.5}/1{,}000)] \quad \text{for } 5\% < \mathrm{FC} < 35\%$$

$$\beta = 1.2 \quad \text{for FC} \ge 35\%$$

Other Corrections:

Several factors in additipon to fines and content and grain characteristics influence SPT results, as noted in the table. Eq. (5) incorporates these correlations.

$$(N_1)_{60} = N_m C_N C_E C_B C_R C_S \qquad (5)$$

Where:

N_m: Measured standard penetration resistance

C_N: Factor to normalize Nm to a common reference effective overburden resistance $C_N = 2.2/(1.2+\sigma'_{v0}/P_a) <= 1.7$

C_E: Correction for hammer energy ratio (ER)

C_B: Correction factor for borhole diameter

C_R: Correction factor for rod length

C_S: Correction factor for samplers with or without liners

TABLE Corrections to SPT (Modified from Skempton 1986) as Listed by Robertson and Wride (1998)

Factor (1)	Equipment variable (2)	Term (3)	Correction (4)
Overburden pressure	—	C_N	$(P_a/\sigma'_{vo})^{0.5}$
Overburden pressure	—	C_N	$C_N \le 1.7$
Energy ratio	Donut hammer	C_E	0.5–1.0
Energy ratio	Safety hammer	C_E	0.7–1.2
Energy ratio	Automatic-trip Donut-type hammer	C_E	0.8–1.3
Borehole diameter	65–115 mm	C_B	1.0
Borehole diameter	150 mm	C_B	1.05
Borehole diameter	200 mm	C_B	1.15
Rod length	<3 m	C_R	0.75
Rod length	3–4 m	C_R	0.8
Rod length	4–6 m	C_R	0.85
Rod length	6–10 m	C_R	0.95
Rod length	10–30 m	C_R	1.0
Sampling method	Standard sampler	C_S	1.0
Sampling method	Sampler without liners	C_S	1.1–1.3

Magnitude Scaling Factors (MSFs)

To account the influence of magnitude scaling factors on calculated hazard, the equation for factor of safety (FS) against liquefaction is written in terms of CRR, CSR, and MSF as follows:

$$\mathrm{FS} = (\mathrm{CRR}_{7.5}/\mathrm{CSR})\mathrm{MSF} \qquad (6)$$

Revised Idriss Scaling Factors

$$\mathrm{MSF} = 10^{2.24}/M_w^{2.56} \qquad (7)$$

The revised scaling factors are significantly higher thatn the original scaling factors for magnitudes <7.5 and somewhat lower than the original factors for magnitudes >7.5. Relative to the original scaling factors, the revised factors lead to a reduced liquefaction hazard for magnitudes <7.5.

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Baker

PROJECT: Rahway Arch Property

SUBJECT: CPT Based Liquefaction Evaluation

CALCULATED BY: TEM **DATE:** 11/8/12 **CHECKED BY** **DATE:**

PROPRIETARY

REFERENCES : 1. I. M. Idriss and R. W. Boulanger (2008), "Soil Liquefaction During Earthquake", Earthquake Engineering Research Institute Monograph 12.

Boring No.: CPT-02

Ground Water Depth: 0.00 ft = 0.000 m.

Average γ above water table (kN/m) 14.0

Average γ below water table (kN/m) 15.0

Earthquake Moment Magnitude, M_w: 5.0

Peak Ground Acceleration at Ground Surface, a_{max} (g): 0.09

Groundwater Depth (ft) 0.0 = 0.0 meters

Earthquake Magnitude Scale Factor, MSF: $MSF = 6.9EXP\left(\frac{-M}{4}\right) - 0.058$ $MSF \leq 1.8 =$ 1.80

Depth (m)	Tip Resistance (normalized)	Friction	Total Over Burden Stress (kPa)	Effective Stress (kPa)	Normalized Cone Resistance Q	Normalized Friction Ratio (%)	Soil Behavior Type, Ic	Layer	Flag "Clay" or "Unsaturated"	Fines (%)	Interpreted q_{CN} near interface	Thin Layer Factor	Interpreted q_{CN}	C_N	q_{c1N}	$q_{c1N\text{-}cs}$	Stress Reduction Coeff, r_d	CSR	K_σ for sand	CRR for M=7.5 & σ'_{vc}=1 atm	CRR	Factor of Safety
0.05	312.4	0.076	1	0	121576.2	0.02	1.66	1		1			312	1.70	531.0	531.0	1.00	0.1690751	1.10	2.000	3.96	23.421538
0.10	139.8	0.100	2	1	11125.3	0.07	0.58	2		1			140	1.70	237.7	237.7	1.00	0.104	1.10	2.000	3.960	38.18
0.15	47.8	0.092	5	3	1593.3	0.19	0.57	3		1			48	1.70	81.3	81.3	1.00	0.087	1.10	0.114	0.227	2.61
0.20	57.1	0.081	8	6	1039.3	0.14	0.59	4		1			57	1.70	97.0	97.0	1.00	0.079	1.10	0.138	0.273	3.44
0.25	39.2	0.057	11	9	448.6	0.15	0.90	5		1			39	1.70	66.6	66.6	1.00	0.075	1.10	0.095	0.189	2.53
0.30	21.1	0.045	16	13	165.2	0.21	1.37	6		1			21	1.70	35.9	35.9	1.00	0.072	1.10	0.065	0.129	1.80
0.35	21.5	0.036	21	18	122.5	0.17	1.45	7		1			22	1.70	36.6	36.6	1.00	0.070	1.10	0.066	0.131	1.87
0.40	18.87	0.044	27	23	81.4	0.24	1.67	8		2			19	1.70	32.1	32.1	1.00	0.068	1.09	0.063	0.123	1.79
0.45	17.193	0.053	34	29	58.0	0.31	1.85	9		3			17	1.70	29.2	29.2	1.00	0.067	1.07	0.061	0.117	1.74
0.50	25.02	0.086	41	36	68.4	0.35	1.80	10		4			25	1.70	42.5	42.5	1.00	0.066	1.07	0.071	0.136	2.05
0.55	32.416	0.089	50	44	73.1	0.28	1.74	11		5			32	1.70	55.1	55.1	1.00	0.066	1.06	0.083	0.158	2.41
0.60	23.371	0.073	59	53	43.8	0.32	1.97	12		6			23	1.54	36.0	36.2	1.00	0.065	1.04	0.066	0.123	1.89
0.65	9.3	0.057	68	62	14.1	0.66	2.54	13		7			9	1.44	13.3	14.2	1.00	0.064	1.02	0.053	0.098	1.52
0.70	10.624	0.034	79	72	13.8	0.35	2.45	14		8			11	1.32	14.1	16.4	1.00	0.064	1.02	0.054	0.099	1.55
0.75	6.706	0.027	90	83	7.1	0.46	2.76	15	clay	9			7	1.18	n.a.	n.a.	1.00	0.063	1.06	n.a.	n.a.	n.a.
0.80	5.587	0.015	102	94	4.9	0.33	2.87	16	clay	10			6	1.02	n.a.	n.a.	0.99	0.063	1.02	n.a.	n.a.	n.a.
0.85	5.676	0.012	115	106	4.3	0.26	2.91	17	clay	11			6	0.98	n.a.	n.a.	0.99	0.063	0.98	n.a.	n.a.	n.a.
0.90	4.894	0.01	128	119	3.1	0.28	3.06	18	clay	12			5	0.95	n.a.	n.a.	0.99	0.062	0.95	n.a.	n.a.	n.a.
0.95	4.863	0.011	143	133	2.6	0.32	3.14	19	clay	13			5	0.92	n.a.	n.a.	0.99	0.062	0.92	n.a.	n.a.	n.a.
1.00	4.698	0.012	158	148	2.1	0.38	3.24	20	clay	14			5	0.89	n.a.	n.a.	0.99	0.062	0.89	n.a.	n.a.	n.a.
1.05	5.131	0.012	173	163	2.1	0.35	3.24	21	clay	15			5	0.86	n.a.	n.a.	0.99	0.062	0.86	n.a.	n.a.	n.a.
1.10	4.948	0.011	190	179	1.7	0.36	3.32	22	clay	16			5	0.84	n.a.	n.a.	0.99	0.061	0.83	n.a.	n.a.	n.a.
1.15	4.184	0.012	207	196	1.1	0.56	3.56	23	clay	17			4	0.82	n.a.	n.a.	0.99	0.061	0.80	n.a.	n.a.	n.a.
1.20	3.754	0.012	225	213	0.7	0.79	3.78	24	clay	18			4	0.80	n.a.	n.a.	0.99	0.061	0.78	n.a.	n.a.	n.a.
1.25	3.543	0.011	244	231	0.5	0.97	3.97	25	clay	19			4	0.78	n.a.	n.a.	0.99	0.061	0.75	n.a.	n.a.	n.a.
1.3	4.265	0.011	263	250	0.7	0.66	3.79	26	clay	20			4	0.76	n.a.	n.a.	0.98	0.061	0.73	n.a.	n.a.	n.a.

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Rahwat Arch 32ft_8H1V_After Consolidation-LongTerm

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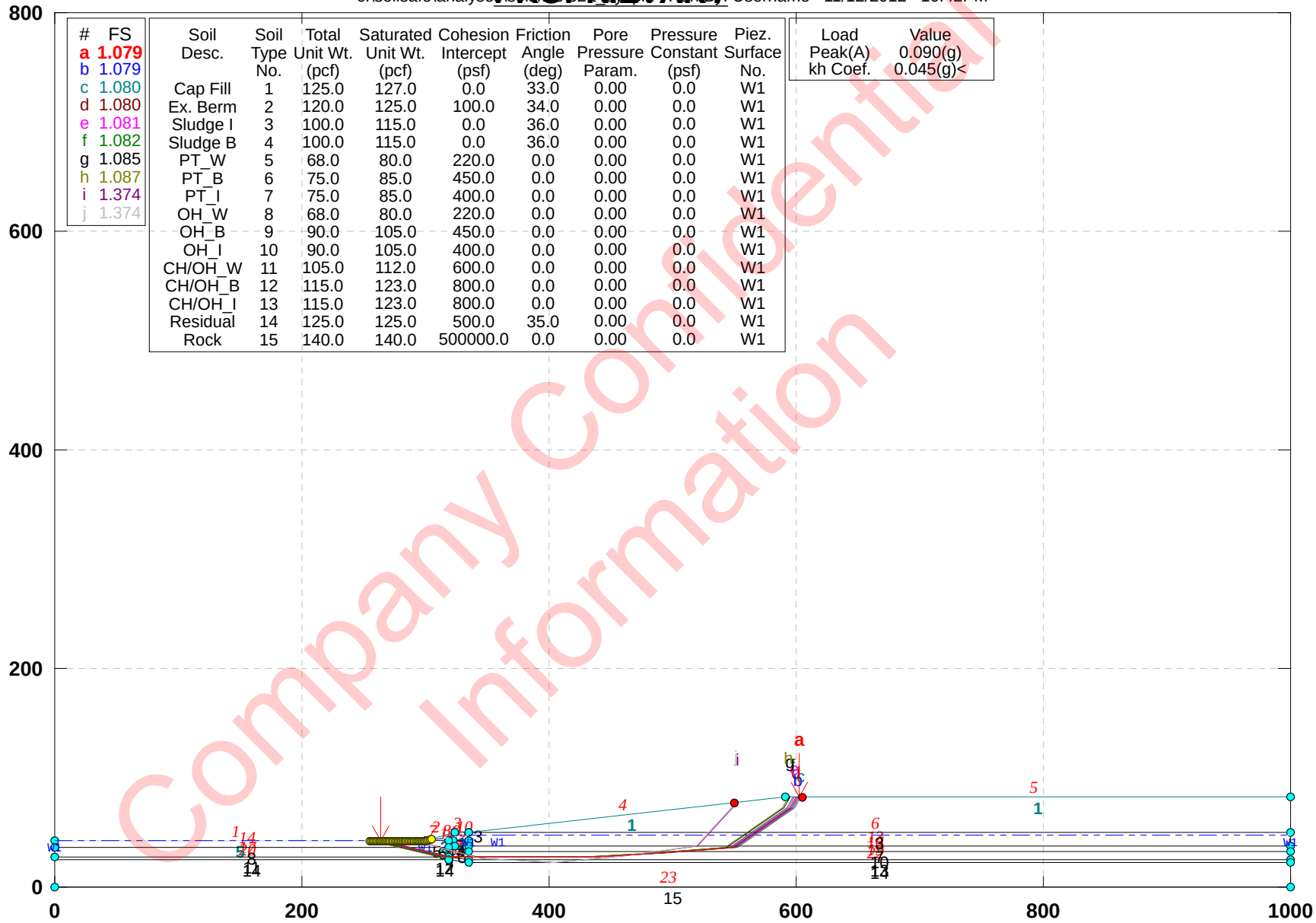
c:\soilsafe\analyses\[illegible] Run By: Username 11/12/2012 10:42PM

#	FS
a	1.079
b	1.079
c	1.080
d	1.080
e	1.081
f	1.082
g	1.085
h	1.087
i	1.374
j	1.374

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
Cap Fill	1	125.0	127.0	0.0	33.0	0.00	0.0	W1
Ex. Berm	2	120.0	125.0	100.0	34.0	0.00	0.0	W1
Sludge I	3	100.0	115.0	0.0	36.0	0.00	0.0	W1
Sludge B	4	100.0	115.0	0.0	36.0	0.00	0.0	W1
PT_W	5	68.0	80.0	220.0	0.0	0.00	0.0	W1
PT_B	6	75.0	85.0	450.0	0.0	0.00	0.0	W1
PT_I	7	75.0	85.0	400.0	0.0	0.00	0.0	W1
OH_W	8	68.0	80.0	220.0	0.0	0.00	0.0	W1
OH_B	9	90.0	105.0	450.0	0.0	0.00	0.0	W1
OH_I	10	90.0	105.0	400.0	0.0	0.00	0.0	W1
CH/OH_W	11	105.0	112.0	600.0	0.0	0.00	0.0	W1
CH/OH_B	12	115.0	123.0	800.0	0.0	0.00	0.0	W1
CH/OH_I	13	115.0	123.0	800.0	0.0	0.00	0.0	W1
Residual	14	125.0	125.0	500.0	35.0	0.00	0.0	W1
Rock	15	140.0	140.0	500000.0	0.0	0.00	0.0	W1

Load	Value
Peak(A)	0.090(g)
kh Coef.	0.045(g)<



GSTABL7 v.2 FSmin=1.079

Safety Factors Are Calculated By The Simplified Janbu Method

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GSTABL7

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*** GSTABL7 ***

** GSTABL7 by Garry H. Gregory, P.E. **

** Original Version 1.0, January 1996; Current Version 2.005, Sept. 2006 **

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SLOPE STABILITY ANALYSIS SYSTEM

Modified Bishop, Simplified Janbu, or GLE Method of Slices.
(Includes Spencer & Morgenstern-Price Type Analysis)
Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
Nonlinear Undrained Shear Strength, Curved Phi Envelope,
Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.

****

Analysis Run Date: 11/12/2012
Time of Run: 10:42PM
Run By: Username
Input Data Filename: C:\SoilSafe\Analyses\Seismic\32ft_3yr.dat
Output Filename: C:\SoilSafe\Analyses\Seismic\32ft_3yr.OUT
Unit System: English
Plotted Output Filename: C:\SoilSafe\Analyses\Seismic\32ft_3yr.PLT
PROBLEM DESCRIPTION: Rahwat Arch
32ft_8H1V_After Consolidation-LongTerm

BOUNDARY COORDINATES
5 Top Boundaries
23 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	42.00	300.00	42.00	5
2	300.00	42.00	324.00	50.00	2
3	324.00	50.00	335.00	50.00	2
4	335.00	50.00	591.00	82.00	1
5	591.00	82.00	1000.00	82.00	1
6	335.00	50.00	1000.00	50.00	3
7	300.00	42.00	319.00	42.00	5
8	319.00	42.00	322.00	43.00	4
9	322.00	43.00	335.00	43.00	4
10	335.00	43.00	335.01	50.00	3
11	319.00	42.00	324.00	37.00	6
12	324.00	37.00	335.00	37.00	6
13	335.00	37.00	1000.00	37.00	7
14	0.00	36.00	319.00	36.00	8
15	319.00	36.00	335.00	32.00	9
16	335.00	32.00	1000.00	32.00	10
17	0.00	27.00	319.00	27.00	11
18	319.00	27.00	335.00	25.00	12
19	335.00	25.00	1000.00	25.00	13
20	0.00	25.00	319.00	25.00	14
21	319.00	25.00	335.00	23.00	14
22	335.00	23.00	1000.00	23.00	14
23	0.00	0.00	1000.00	0.00	15

Default Y-Origin = 0.00(ft)
Default X-Plus Value = 0.00(ft)
Default Y-Plus Value = 0.00(ft)

ISOTROPIC SOIL PARAMETERS
15 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	125.0	127.0	0.0	33.0	0.00	0.0	1
2	120.0	125.0	100.0	34.0	0.00	0.0	1
3	100.0	115.0	0.0	36.0	0.00	0.0	1
4	100.0	115.0	0.0	36.0	0.00	0.0	1
5	68.0	80.0	220.0	0.0	0.00	0.0	1
6	75.0	85.0	450.0	0.0	0.00	0.0	1
7	75.0	85.0	400.0	0.0	0.00	0.0	1
8	68.0	80.0	220.0	0.0	0.00	0.0	1
9	90.0	105.0	450.0	0.0	0.00	0.0	1
10	90.0	105.0	400.0	0.0	0.00	0.0	1
11	105.0	112.0	600.0	0.0	0.00	0.0	1
12	115.0	123.0	800.0	0.0	0.00	0.0	1
13	115.0	123.0	800.0	0.0	0.00	0.0	1

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 14   125.0    125.0     500.0     35.0    0.00       0.0      1
 15   140.0    140.0  500000.0      0.0    0.00       0.0      1
1 PIEZOMETRIC SURFACE(S) SPECIFIED
Unit Weight of Water =  62.40 (pcf)
Piezometric Surface No.  1 Specified by  5 Coordinate Points
Pore Pressure Inclination Factor =  0.50
  Point      X-Water     Y-Water
   No.         (ft)        (ft)
    1          0.00       42.00
    2        300.00       42.00
    3        335.00       47.00
    4        359.00       48.00
    5       1000.00       48.00
Specified Peak Ground Acceleration Coefficient (A) =   0.090(g)
Specified Horizontal Earthquake Coefficient (kh) =   0.045(g)
Specified Vertical Earthquake Coefficient (kv) =   0.000(g)
Specified Seismic Pore-Pressure Factor =   0.000
A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Irregular Surfaces, Has Been Specified.
1200 Trial Surfaces Have Been Generated.
  30 Surface(s) Initiate(s) From Each Of    40 Points Equally Spaced
Along The Ground Surface Between  X = 255.00(ft)
                              and  X = 305.00(ft)
Each Surface Terminates Between   X = 550.00(ft)
                             and   X = 605.00(ft)
Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is  Y =      0.00(ft)
58.00(ft) Line Segments Define Each Trial Failure Surface.
Following Are Displayed The Ten Most Critical Of The Trial
      Failure Surfaces Evaluated. They Are
      Ordered - Most Critical First.
      * * Safety Factors Are Calculated By The Simplified Janbu Method * *
      Total Number of Trial Surfaces Attempted =  1200
      Number of Trial Surfaces With Valid FS = 1200
      Statistical Data On All Valid FS Values:
         FS Max =   3.839   FS Min =   1.079   FS Ave =   2.798
         Standard Deviation =   0.339   Coefficient of Variation =   12.10 %
      Failure Surface Specified By  8 Coordinate Points
        Point      X-Surf      Y-Surf
         No.        (ft)        (ft)
          1       263.974      42.000
          2       320.075      27.279
          3       378.075      27.289
          4       436.075      27.279
          5       493.918      31.538
          6       551.697      36.598
          7       597.121      72.663
          8       602.780      82.000
             Factor of Safety
            ***    1.079   ***
          Individual data on the    21  slices
                    Water  Water     Tie     Tie     Earthquake
                    Force  Force    Force   Force       Force   Surcharge
Slice  Width   Weight    Top    Bot     Norm     Tan     Hor     Ver    Load
 No.    (ft)    (lbs)   (lbs)  (lbs)    (lbs)   (lbs)   (lbs)   (lbs)   (lbs)
  1     22.9    5487.7     0.0  4425.4       0.      0.   246.9     0.0      0.0
  2     13.2    8134.6     0.0  6559.8       0.      0.   366.1     0.0      0.0
  3     19.0   25494.3     0.0 16143.2       0.      0.  1147.2     0.0      0.0
  4      1.1    2383.5     0.0  1192.7       0.      0.   107.3     0.0      0.0
  5      1.9    4476.4     0.0  2107.9       0.      0.   201.4     0.0      0.0
  6      2.0    4902.4     0.0  2224.7       0.      0.   220.6     0.0      0.0
  7     11.0   27424.7     0.0 12866.0       0.      0.  1234.1     0.0      0.0
  8      0.0      13.5     0.0     7.0       0.      0.     0.6     0.0      0.0
  9      0.0      10.2     0.0     5.3       0.      0.     0.5     0.0      0.0
 10     24.0   61534.6     0.0 30237.1       0.      0.  2769.1     0.0      0.0
 11     19.1   55485.7     0.0 24653.4       0.      0.  2496.9     0.0      0.0
 12     58.0  203656.9     0.0 74974.4       0.      0.  9164.6     0.0      0.0
 13     57.8  242555.9     0.0 67286.7       0.      0. 10915.0     0.0      0.0
 14      5.3   23428.4     0.0  [illegible]  0.      0.  1054.3     0.0      0.0
 15     52.5  245195.0     0.0 45057.2       0.      0. 11033.8     0.0      0.0
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16	0.5	2468.7	0.0	452.2	0.	0.	111.1	0.0	0.0
17	13.9	60051.9	0.0	6071.2	0.	0.	2702.3	0.0	0.0
18	2.5	9395.7	0.0	0.0	0.	0.	422.8	0.0	0.0
19	22.4	60813.1	0.0	0.0	0.	0.	2736.6	0.0	0.0
20	6.1	9002.8	0.0	0.0	0.	0.	405.1	0.0	0.0
21	5.7	3302.3	0.0	0.0	0.	0.	148.6	0.0	0.0

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	262.692	42.000
2	318.793	27.279
3	376.793	27.289
4	434.793	27.279
5	492.636	31.538
6	550.415	36.598
7	595.839	72.663
8	601.498	82.000

Factor of Safety
*** 1.079 ***

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	265.256	42.000
2	321.357	27.279
3	379.357	27.289
4	437.357	27.279
5	495.201	31.538
6	552.979	36.598
7	598.403	72.663
8	604.062	82.000

Factor of Safety
*** 1.080 ***

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	261.410	42.000
2	317.511	27.279
3	375.511	27.289
4	433.511	27.279
5	491.354	31.538
6	549.133	36.598
7	594.557	72.663
8	600.216	82.000

Factor of Safety
*** 1.080 ***

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	260.128	42.000
2	316.229	27.279
3	374.229	27.289
4	432.229	27.279
5	490.072	31.538
6	547.851	36.598
7	593.275	72.663
8	598.934	82.000

Factor of Safety
*** 1.081 ***

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	258.846	42.000
2	314.947	27.279
3	372.947	27.289
4	430.947	27.279
5	488.790	31.538
6	546.569	36.598
7	591.993	72.663
8	597.651	82.000

Factor of Safety

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      ***     1.082    ***
Failure Surface Specified By  8 Coordinate Points
  Point       X-Surf       Y-Surf
   No.         (ft)         (ft)
    1        256.282       42.000
    2        312.383       27.279
    3        370.383       27.289
    4        428.383       27.279
    5        486.226       31.538
    6        544.005       36.598
    7        589.429       72.663
    8        595.087       82.000
       Factor of Safety
      ***     1.085    ***
Failure Surface Specified By  8 Coordinate Points
  Point       X-Surf       Y-Surf
   No.         (ft)         (ft)
    1        255.000       42.000
    2        311.101       27.279
    3        369.101       27.289
    4        427.101       27.279
    5        484.944       31.538
    6        542.723       36.598
    7        588.146       72.663
    8        593.805       82.000
       Factor of Safety
      ***     1.087    ***
Failure Surface Specified By  6 Coordinate Points
  Point       X-Surf       Y-Surf
   No.         (ft)         (ft)
    1        290.897       42.000
    2        346.572       25.741
    3        404.486       22.594
    4        462.133       28.984
    5        519.520       37.395
    6        552.936       77.242
       Factor of Safety
      ***     1.374    ***
Failure Surface Specified By  6 Coordinate Points
  Point       X-Surf       Y-Surf
   No.         (ft)         (ft)
    1        289.615       42.000
    2        345.290       25.741
    3        403.204       22.594
    4        460.851       28.984
    5        518.238       37.395
    6        551.504       77.063
       Factor of Safety
      ***     1.374    ***
          **** END OF GSTABL7 OUTPUT ****
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