REPORT OF PRELIMINARY GEOTECHNICAL EXPLORATION

Coastal Technology Park

Georgetown County, South Carolina
S&ME Project No. 1633-11-275

Prepared By:

1330 Highway 501 Business
Conway, South Carolina 29526

November 28, 2011

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Reference: **Report of Preliminary Geotechnical Exploration**
Coastal Technology Park
Georgetown County, South Carolina
S&ME Project No. 1633-11-275

S&ME, Inc. has completed the preliminary geotechnical exploration for the referenced project after receiving authorization to proceed on November 1, 2011. Our exploration was conducted in general accordance with our Proposal No. 1633-0335-11, dated October 28, 2011.

The purpose of this exploration was to characterize the general surface and subsurface conditions of the site, to provide the recommended seismic site classification according to IBC 2006, and to offer preliminary recommendations regarding site preparation, suitability of on-site soils for use in construction and potential foundation types. This investigation was performed to aid in evaluation of the site's suitability for industrial and commercial development. The recommendations contained herein are not valid for design without the confirmation of an additional design level subsurface investigation after the locations of proposed structures, pavements and general site features are determined.

PROJECT INFORMATION

Project information was provided to us in your email transmittal on September 7, 2011, which included topographic, location, and aerial photographic maps of the site, prepared by Millikan Forestry, dated January 2011. The project site is comprised of approximately 220 acres and is located west of U.S.Highway 17, near its intersection with S.C. Highway 23 (Whitehall Road) and East CCC Road in Georgetown County, South Carolina. The site is heavily wooded with thick underbrush, with interior access available by several unpaved roads.

EXPLORATION PROCEDURES

Field Exploration

On November 3 through 7, 2011, representatives of S&ME, Inc. visited the site. Using the information provided, we performed the following tasks:

- We performed a site walkover, observing features of topography, existing structures, ground cover, and surface soils at the project site.
- We performed Multi-Channel Analysis of Surface Waves (MASW) and Microtremor Array Method (MAM) test methods for near surface characterization of shear-wave velocity.
- We established five cone penetration test (CPT) sounding locations spread widely throughout the site. The approximate sounding locations are shown on the test location sketch included as Figure 2 in Appendix A.
- Four CPT soundings were advanced to depths of about 30 feet, and one to a depth of about 43 feet.
- Soil samples were obtained at regular depths from hand auger borings performed at each of the sounding locations to a depth of about 5 feet. The samples were transported to the laboratory for further observation.

A description of the field tests performed during the exploration as well as the CPT sounding logs is attached in Appendix B.

Laboratory Testing

After the recovered soil samples were brought to our laboratory, a geotechnical professional examined each sample to estimate its distribution of grain sizes, plasticity, organic content, moisture condition, color, presence of lenses and seams, and apparent geologic origin in general accordance with ASTM D 2488, *"Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)"*.

The resulting classifications are presented on the sounding logs, included in Appendix B. Similar soils were grouped into representative strata on the logs. The strata contact lines represent approximate boundaries between soil types. The actual transitions between soil types in the field are likely more gradual in both the vertical and horizontal directions than those which are indicated on the logs.

SURFACE CONDITIONS

The site is located in Georgetown near US Highway 17 and SC Highway 23. Currently the site is heavily wooded with dense underbrush with interior access provided by some unpaved roads. Most locations were populated with evergreen trees, generally ranging in height from 20 feet to over 50 feet.

Ground surface elevations were not surveyed at the CPT sounding locations for the purposes of this report. From visual observation, the site appears to be relatively level to gently sloping. Organic topsoil was encountered at all sounding locations and ranged from 2 to 12 inches in thickness.

SUBSURFACE CONDITIONS

Geology

The site is located in the Coastal Plain Physiographic Region of South Carolina. This area is dominated topographically by a series of relic beach terraces, which progressively increase in surface altitude as they proceed inland. These terraces have been extensively mapped and correlated over wide areas. Surface soils penetrated in the CPT soundings have been interpreted to be a part of the Socastee Formation, consisting of relatively recent marine deposits laid down approximately 200,000 years ago.

While not penetrated by our CPT soundings, soils below the Socastee Formation are mapped as sands and silts of the Black Mingo Formation. These are Paleocene-age (early Tertiary) materials that were laid down approximately 55 to 65 million years ago.

USDA Soil Survey Information

USDA Soils Conservation Service soils mapping for Georgetown County indicates the sands and loamy sands described in Table 1 as the general soil series composition at the site. Soil map units are also described in terms of some relevant engineering properties or in terms of relative suitability for use in land development. High water elevations are generally given for the winter and spring months (November through April).

Table 1 – USDA Soil Survey Soil Series

Soil Group	Depth to Seasonal GWT (feet)	Permeability	Remarks
Leon sand (10)	0 – 1	Moderate to rapid	Nearly level slopes
Centenary fine sand (20)	3.5 – 5	Moderately rapid to rapid	Nearly level slopes
Echaw sand (28)	2.5 – 5	Moderately rapid to rapid	Nearly level slopes
Chipley fine sand (54A)	2 – 3	Rapid	0 to 2 percent slopes
Witherbee fine sand (55)	0 – 2	Rapid to very rapid	Nearly level slopes
Yemassee loamy fine sand (61)	1 – 1.5	Moderate	Nearly level slopes

Interpreted Subsurface Profile

The generalized subsurface conditions at the site are described below. For more detailed descriptions and stratifications at a test location, the respective sounding logs should be reviewed in Appendix B. One subsurface cross-sectional profile of the site soils is attached in Appendix A as Figure 3. The cross-section orientations in plan view are shown on Figure 2. These cross-sections are given to provide a general representation of the subsurface conditions encountered at widely-spaced locations across the site. The strata indicated in the profiles are characterized in the following section. Note that the profiles are not to scale. The subsurface profiles were prepared for illustrative purposes only. Subsurface stratifications may be more gradual than indicated, and conditions may vary between test locations.

The soils encountered at each of the sounding locations were grouped into three main general strata based upon estimated soil types of the recovered samples. Below the topsoil, our sounding location explorations generally encountered soils classified as gravelly sands and clean to silty sands (Stratum I) to depths ranging from 11.5 to 22 feet. Underlying Stratum I, a layer of clays and silty clays was observed to depths ranging from 26 to 28.5 feet (Stratum II). Beneath Stratum II, a layer of sand mixtures and silt mixtures was observed (Stratum III).

Stratum I: Upper Sands

Underlying the topsoil at all test locations, an upper layer of medium dense to dense sands were encountered to depths ranging from about 11.5 to 22 feet. These soils were classified as clean to silty sands and gravelly sands. Soil samples recovered from hand auger borings were tan and light gray and were typically moist to saturated.

Stratum II: Intermediate Clays

Underlying Stratum I, all soundings encountered a layer of very soft to firm clays and silty clays, with some isolated embedded medium dense sand seams, to depths of 26 to 28.5 feet. The thickness of this stratum generally increased from the north to south across the site in our soundings, varying from about six feet in thickness within soundings C-1 and C-2, to about 18 feet in thickness within soundings C-3 and C-5.

The relatively soft layers of Stratum II soils would likely be compressible if subjected to significant stress increases under applied loads. Further, consolidation settlements within the clayey soils may occur slowly over time. The potential settlement magnitude that would occur under applied light to moderate column and wall loads may not significantly impact site development due to the encountered layer depth beneath the existing ground surface. Typically these building loads would not impose significant stresses upon soil layers which lie beneath depths of about 15 to 20 feet of the applied loads. However, stresses imposed by areas loads associated with fill placement and/or floor loads would typically extend deeper within the subsurface profile, and thus may impact development, depending on the nature of loads and thickness of the compressible layers.

Stratum III: Lower Sands

Underlying Stratum II, a layer of medium dense to very dense clean to silty and gravelly sands, and sand and silt mixtures were encountered to the sounding termination depths of about 30 to 43 feet. These soils were interpreted to represent the upper surface of soils of the Black Mingo formation.

Shear Wave Velocities

Shear wave velocity measurements were obtained from MASW testing at the site to a depth of about 150 ft. The measured shear wave velocities ranged from approximately 485 to 1,565 feet per second (fps) with a characteristic shear wave velocity of 960 fps for the upper 100 ft. A graph presenting the shear wave velocity measurements is included in Appendix B.

Subsurface Water

During the CPT sounding tests, subsurface water depths were interpreted to range between about 4 to 5 feet below the existing ground surface. Water levels may fluctuate seasonally at the site, being influenced by rainfall variation and other factors such as site construction activities.

SEISMIC CONSIDERATIONS

Seismic induced ground shaking at the foundation is the effect taken into account by seismic-resistant design provisions of the 2006 International Building Code (IBC). Other effects, including soil liquefaction, are not addressed in building codes but must also be considered.

IBC Site Class

This site has been classified according to one of the Site Classes defined in IBC Section 1613.5 (Table 1613.5.2) using the procedures described in Section 1613.5.5.1. The Site Class is used in conjunction with mapped spectral accelerations S_S and S_1 to determine Site Coefficients F_A and F_V in IBC Section 1613.5.3, tables 1613.5.3(1) and 1613.5.3(2).

The initial step in site class definition is a check for the four conditions described for Site Class F which would require a site specific evaluation to determine site coefficients F_A and F_V. Soils vulnerable to potential failure under item 1) including quick and highly sensitive clays or collapsible weakly cemented soils, were not observed in the soundings. Three other conditions, 2) peats and highly organic clays; 3) very high plasticity clays; and 4) very thick soft/medium stiff clays, were also not evident in the soundings performed. The remaining vulnerability, liquefaction, appears unlikely at this site due to the relative density of the soils, fines content, geologic age of the materials encountered and/or measured shear wave velocities.

We then compared site conditions to the three conditions described for Site Class E. These are soft soils vulnerable to large strains under seismic motion. Soundings did not indicate the presence of soil layers at least 10 feet having 1) plasticity index greater than

20, 2) moisture content greater than 40 percent, and 3) undrained shear strength less than 500 psf.

Shear wave velocities obtained during the MASW and MAM testing were between 485 and 1,565 feet per second. The shear wave velocity profiles were averaged at each interval for a depth of 100 feet. The calculated weighted average shear wave velocity using the procedures described in Section 1615.1.5.1 was 959 fps. Based on this data and our knowledge of the general geologic profile of this area, it appears a Seismic Site Class of D will be available over a large portion of the site. However, we recommend further seismic testing and evaluations be performed once specific structure locations are determined.

Design Spectral Values

S&ME determined the spectral response parameters for the site using the general procedures outlined under the 2006 International Building Code Section 1613.5. This approach utilizes a mapped acceleration response spectrum corresponding to an earthquake having a 2 percent statistical probability of exceedance in 50 years to determine the spectral response acceleration at the top of seismic bedrock for any period. The 2006 International Building Code seismic provisions of Section 1613 use the 2002 Seismic Hazard Maps published by the National Earthquake Hazard Reduction Program (NEHRP) to define the base rock motion spectra. The 2002 seismic hazard maps used in Section 1613 of the 2006 IBC have been updated several times since their original publication, reflecting updated knowledge of the probabilistic hazard in different parts of the country as well as advances in the understanding of seismic wave propagation and damping through the various soil and rock strata. As of July 1, 2008, the USGS 2002 updated gridded spectral values in computation of the bedrock spectral response at this site may be used.

The Site Class is used in conjunction with mapped spectral accelerations S_S and S_1 to determine Site Coefficients F_A and F_V in IBC Section 1613.5.3, tables 1613.5.3(1) and 1613.5.3(2). For purposes of computation, the Code includes mapped induced acceleration at frequencies of 5 hertz (S_S) and 1 hertz (S_1), which are then used to derive the remainder of the response spectra at all other frequencies. Mapped S_S and S_1 values represent motion at the top of bedrock. The surface ground motion response spectrum, accounting for inertial effects within the soil column overlying rock, is then determined for the design earthquake using spectral coefficients F_A and F_V for the appropriate Site Class.

The design ground motion at any period is taken as 2/3 of the smoothed spectral acceleration as allowed in section 1613.5.4. The design spectral response acceleration values at short periods S_{DS} and at one second periods S_{D1} are tabulated below for the unimproved soil profile. Peak ground acceleration (PGA) was obtained by dividing the S_{DS} value by 2.5.

Table 2 – Design Spectral Values

Value	2002 Seismic Hazard Maps Site Class D
S_{DS}	0.727 g
S_{D1}	0.321 g
PGA	0.291 g
Design Category	D

For a structure having an Occupancy Category classification of I, II, or III, the S_{DS} and S_{D1} values obtained from the 2006 IBC (2002 Seismic Hazard Maps) are consistent with the Seismic Design Categories noted in Table 2 and as defined in section 1613.5.6.

CONCLUSIONS AND RECOMMENDATIONS

The preliminary conclusions and recommendations included in this section are based on the project information outlined previously and the data obtained during our exploration. The recommendations provided below are preliminary in nature and should be considered as such. When the final site layout is determined, S&ME, Inc. should be retained to complete a design-grade geotechnical exploration.

Site Preparation and Earthwork

Stripping depths will likely be about 4 to 12 inches over the majority of the site. In drainage features, or within heavily wooded areas of the site, stripping depths may be considerably greater.

Sandy soils were encountered within the upper subsurface profile at all of our sounding locations. Our past experience with similar soil types indicates that they are typically adaptable for site development provided that effective site drainage is established prior to construction and maintained during construction. When observed to be wet and/or unstable in the opinion of the geotechnical engineer, stabilization of conditions may be required by a combination of drying and densification of sandy soils, undercutting and/or placement of crushed stone and geogrids, or other methods depending on site conditions. Stabilization of site conditions by drying and densification can often be accomplished by the contractor through plowing and scarifying sandy soils during favorable weather conditions.

On-Site Fill Suitability

Soil types similar to the sandy soils of Stratum I that were encountered during our exploration are generally recommended for reuse as structural fill material.

The clays and silty clays encountered within our soundings and identified as Stratum II soils are not recommended as reuse as structural fill due to their relatively low strength and pavement support characteristics.

Preliminary Fill Placement and Compaction Recommendations

Where fill soil is required, structural fill within building pads and parking areas must be compacted throughout to the degree of compaction determined necessary during the final design-grade geotechnical exploration. Compacted soils should be stable and must not exhibit pumping or rutting under equipment traffic. Loose lifts of fill should be no more than 8 inches in thickness prior to compaction. Structural fill should extend at least 10 feet from the edge of building and parking areas before either sloping or being allowed to exhibit a lower level of compaction.

Potential Foundation Types

The soil profiles encountered appear generally suitable for development for light to medium industrial use, considering static loading. The use of shallow foundations for support of column loads up to about 200 kips would likely be feasible for typical light to medium industrial structural column configurations, provided footings are properly constructed and settlements of up to about one inch can be tolerated. Area loads imposed by new fill placement, floor slab loads, stacked materials, large vessels or tanks can likely be supported by mat or strip footings, provided that several inches of settlement can be withstood by the structure, or possibly in conjunction with ground improvement by surcharging.

Once building locations are established, test soundings and/or borings should be conducted within each building footprint prior to design of foundations.

Groundwater and Surface Runoff Control

Depending on proposed site grades, seasonal fluctuations and other factors, groundwater may be encountered within 4 to 5 feet of the existing ground surface elevations, as indicated on the sounding logs. Due to the highly variable nature of the subsurface water levels in the site vicinity, groundwater may also be encountered in areas of the site not tested in this preliminary subsurface investigation.

If perched water or groundwater is encountered during grading, ditching will be necessary to provide a stable bearing surface for foundations or pavements. In areas were machine pits may be constructed, ditching or excavation of sumps and pumping may be necessary to control potential perched water conditions. Capacity of sediment or detention ponds may also be limited in areas where shallow groundwater is encountered. In areas of proposed construction where shallow groundwater is encountered, it may be desirable to raise site grades to help reduce the impact of groundwater on construction.

During normal rainfall periods, ditching or other provisions for drainage should be provided prior to stripping and grading in low areas. If subsurface water or infiltrating surface water is not properly controlled during construction, the subgrade soils that will support foundations, as well as pavements or floor slabs, may be damaged. Furthermore, construction equipment mobility may be impaired. The design and installation of

permanent underdrainge systems may be required to reduce the potential impact of shallow subsurface water, and should be further evaluated during the design phase of development.

Grade Slab Support and Construction

It is likely that grade slabs may be supported upon properly prepared existing soils or borrow soils.

1. Surficial sandy soils similar to those penetrated by our soundings will generally provide adequate support to soil-supported slabs, assuming proper preparation, moisture control, and compaction of the subgrade for static load conditions.

2. A capillary break of at least 4 inches of clean sand or crushed stone placed below floor slabs will be required.

3. We recommend that a vapor barrier be installed to limit moisture infiltration into finished space, or other areas where moisture infiltration will potentially cause problems. The vapor barrier should be placed below the capillary break material.

Pavement Subgrade and Base Material Preparation

The near-surface sands encountered in the CPT soundings will likely provide adequate soil support characteristics for pavements, provided that subgrades are well compacted and stable.

Drainage of subgrade material plays an important role in the performance of pavement sections. Site preparation should allow for drainage that results in groundwater elevations being maintained at least 2 ft. below the top of the pavement section. Laboratory California Bearing Ratio (CBR) testing should be performed upon representative soil samples of each soil type during the design geotechnical exploration. This is to establish the relationship between relative compaction and CBR for the existing soils, and to develop recommendations for pavement section design and construction.

RECOMMENDATION FOR ADDITIONAL WORK

It was not within the scope of this preliminary report to explore areas of proposed structures or pavements. A design-grade geotechnical report should be performed, which should include an exploration program designed by the geotechnical engineer, including Standard Penetration Test (SPT) borings or Cone Penetration Test (CPT) soundings with seismic design considerations within the areas of any proposed structures and pavements. The exploration program should also include laboratory testing to evaluate engineering properties of subsurface soils and facilitate development recommendations for design and construction.

LIMITATIONS OF REPORT

This report has been prepared in accordance with generally accepted geotechnical engineering practice for specific application to this project. The conclusions and recommendations in this report are based on the applicable standards of our practice in

this geographic area at the time this report was prepared. No other warranty, express or implied, is made.

The analyses and recommendations submitted herein are based, in part, upon the data obtained from the subsurface exploration. The nature and extent of variations of the soils at the site to those encountered at our test locations will not become evident until construction. If variations appear evident, then we will re-evaluate the recommendations of this report. In the event that any changes in the nature, design, or location of the development are planned, the conclusions and recommendations contained in this report will not be considered valid unless the changes are reviewed and conclusions modified or verified in writing by the submitting engineers.

Assessment of site environmental conditions; sampling of soils, ground water or other materials for environmental contaminants; identification of jurisdictional wetlands, rare or endangered species, geological hazards or potential air quality and noise impacts were beyond the scope of this geotechnical exploration.

CLOSURE

S&ME appreciates this opportunity to work with you, as your geotechnical engineering consultant. If you should have any questions concerning this preliminary geotechnical report, please do not hesitate to contact us.

Very truly yours,
S&ME, Inc.

Andrew Bornemann, E.I.
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SOUTH CAROLINA LICENSED PROFESSIONAL ENGINEER No. 26538 11/28/11 CHRISTOPHER M. DOUTON

Thomas C. Still, P.E.
Senior Engineer

SOUTH CAROLINA CERTIFICATE OF AUTHORIZATION S&ME, INC. No. C00473

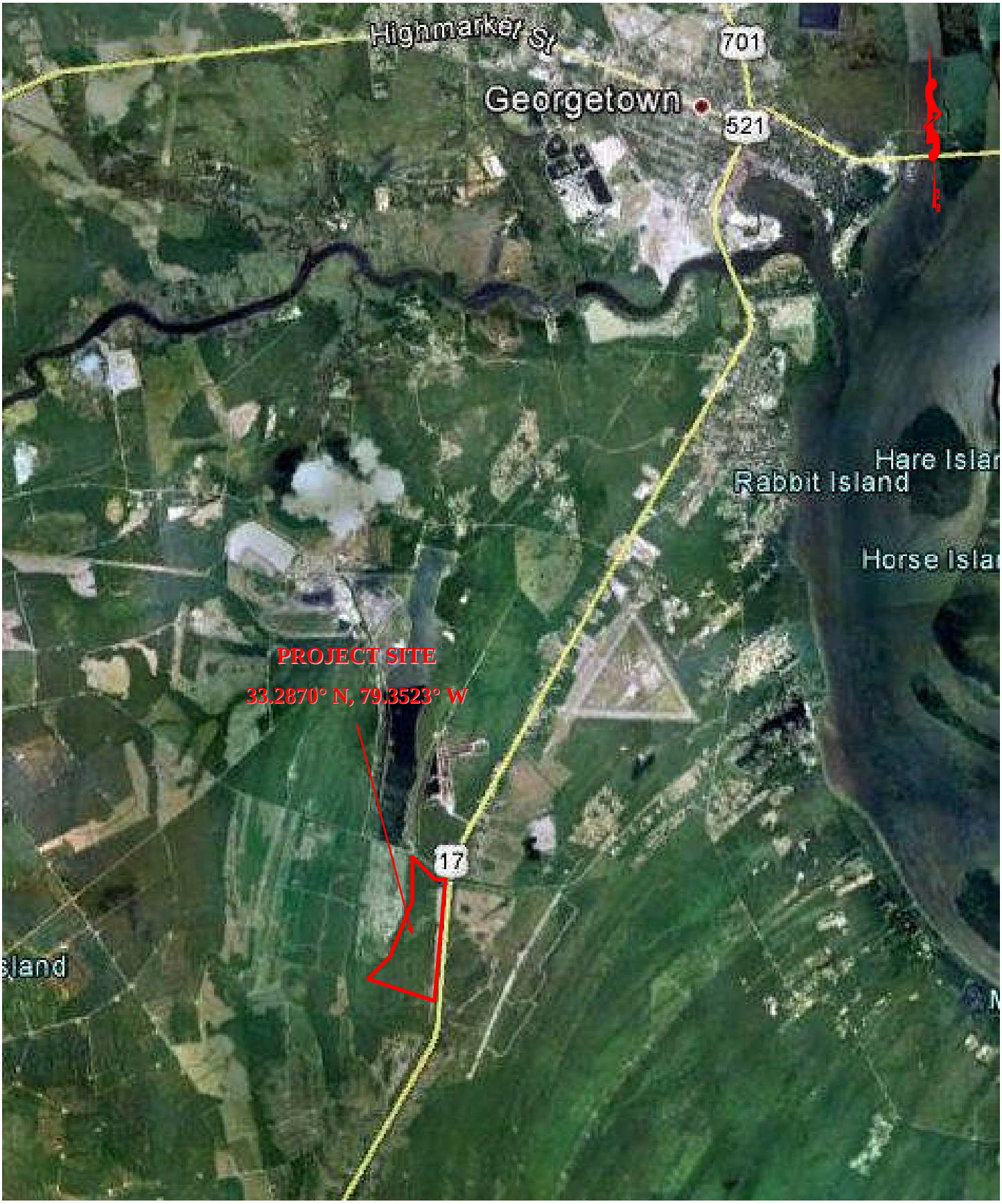
Attachments: Appendix A
Appendix B

APPENDIX A

SITE VICINITY PLAN

TEST LOCATION PLAN

SUBSURFACE PROFILE



SCALE:	Not To Scale
SOURCE:	Google Earth
SOURCE DATE:	June, 2006
DATE:	November, 2011

S&ME

SITE VICINITY PLAN

Coastal Technology Park
Georgetown County, South Carolina

JOB NO. **1633-11-275**

FIGURE NO

1

SCALE:	Not To Scale
SOURCE:	Google Earth
SOURCE DATE:	June, 2006
DATE:	November, 2011

S&ME

TEST LOCATION PLAN

Coastal Technology Park
Georgetown County, South Carolina

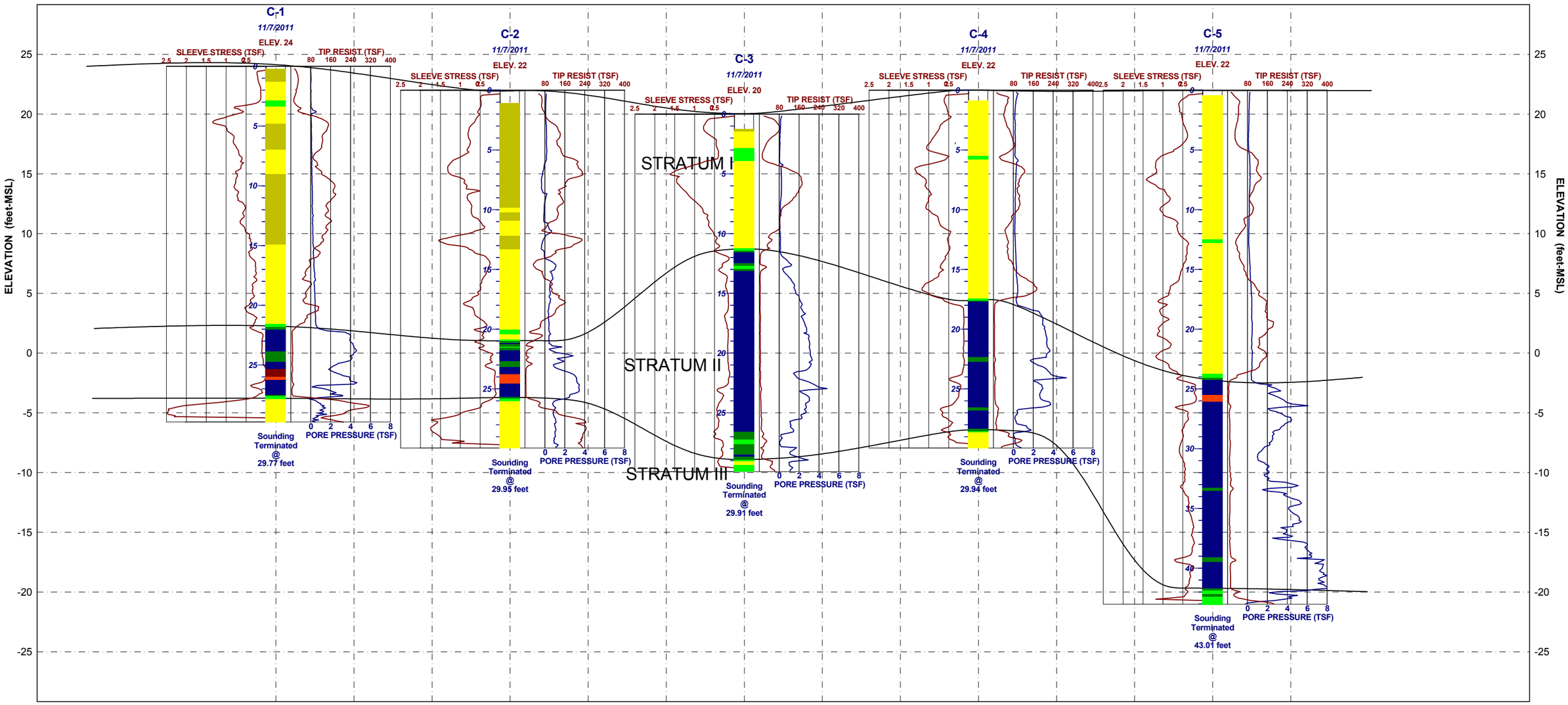
JOB NO. 1633-11-275

FIGURE NO

2

A (NORTH)

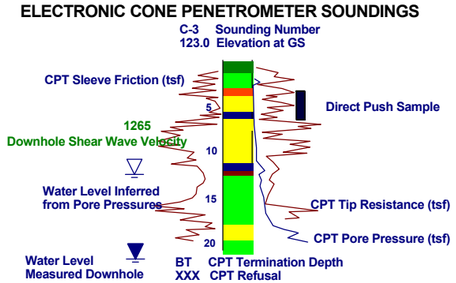
A' (SOUTH)



CPT/DMT MATERIAL GRAPHICS

- Sensitive Fine Grained Soils
- Organic Soils, Peats
- Clay to Silty Clay
- Clayey Silt to Silty Clay
- Silty Sand to Sandy Silt
- Clean Sand to Silty Sand
- Gravelly Sand to Sand
- OC Sand to Clayey Sand
- OC Fine Grained Soils

ELECTRONIC CONE PENETROMETER SOUNDINGS



STRATUM I: UPPER SANDS
STRATUM II: INTERMEDIATE CLAYS
STRATUM III: LOWER SANDS

FACING EAST

The depicted stratigraphy is shown for illustrative purposes only and is not warranted. Separations between different strata may be gradual and likely vary considerably from those shown. Profiles between nearby borings have been estimated using reasonable engineering care and judgment. The actual subsurface conditions will vary between boring locations.

SUBSURFACE PROFILE

PROJECT: Coastal Technology Park

LOCATION: Georgetown County, SC

FIGURE: 3

JOB NO: 1633-11-275

DATE: 11/18/11

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APPENDIX B

SUMMARY OF EXPLORATION PROCEDURES

SOIL CLASSIFICATION LEGEND

CPT SOUNDING LOGS

SHEAR WAVE VELOCITY PROFILE

SUMMARY OF EXPLORATION PROCEDURES

The American Society for Testing and Materials (ASTM) publishes standard methods to explore soil, rock and ground water conditions in Practice D-420-98, "*Standard Guide to Site Characterization for Engineering Design and Construction Purposes.*" The boring and sampling plan must consider the geologic or topographic setting. It must consider the proposed construction. It must also allow for the background, training, and experience of the geotechnical engineer. While the scope and extent of the exploration may vary with the objectives of the client, each exploration includes the following key tasks:

- Reconnaissance of the Project Area
- Preparation of Exploration Plan
- Layout and Access to Field Sampling Locations
- Field Sampling and Testing of Earth Materials
- Laboratory Evaluation of Recovered Field Samples
- Evaluation of Subsurface Conditions

The standard methods do not apply to all conditions or to every site. Nor do they replace education and experience, which together make up engineering judgment. Finally, ASTM D 420 does not apply to environmental investigations.

RECONNAISSANCE OF THE PROJECT AREA

Where practical, we reviewed available topographic maps, county soil surveys, reports of nearby investigations and aerial photographs when preparing the boring and sampling plan. Then we walked over the site to note land use, topography, ground cover, and surface drainage. We observed general access to proposed sampling points and noted any existing structures.

Checks for Hazardous Conditions - State law requires that we notify the Palmetto Utility Protection Service (PUPS) before we drill or excavate at any site. PUPS is operated by the major water, sewer, electrical, telephone, CATV, and natural gas suppliers of South Carolina. PUPS forwarded our location request to the participating utilities. Location crews then marked buried lines with colored flags within 72 hours. They did not mark utility lines beyond junction boxes or meters. We checked proposed sampling points for conflicts with marked utilities, overhead power lines, tree limbs, or man-made structures during the site walkover.

SOUNDINGS AND SAMPLING

Electronic Cone Penetrometer (CPT) Soundings

CPT soundings consist of a conical pointed penetrometer which is hydraulically pushed into the soil at a slow, measured rate. Procedures for measurement of the tip resistance and side friction resistance to push generally follow those described by ASTM D-5778, "*Standard Test Method for Performing Electronic Friction Cone and Piezocone Penetration Testing of Soils*."

A penetrometer with a conical tip having a 60 degree apex angle and a cone base area of 10 cm^2 was advanced into the soil at a constant rate of 20 mm/s. The force on the conical point required to penetrate the soil was measured electronically every 50 mm penetration to obtain the *cone*

resistance q_c. A friction sleeve is present on the penetrometer immediately behind the cone tip. The force exerted on the sleeve was measured electronically at a minimum of every 50 mm penetration and divided by the surface area of the sleeve to obtain the *friction sleeve resistance value* f_s A pore pressure element mounted immediately behind the cone tip was used to measure the pore pressure induced during advancement of the cone into the soil.

CPT Soil Stratification

Using ASTM D-5778 soil samples are not obtained. Soil classification was made on the basis of comparison of the tip resistance, sleeve resistance and pore pressure values to values measured at other locations in known soil types, using experience with similar soils and exercising engineering judgment.

Plots of normalized tip resistance versus friction ratio and normalized tip resistance versus penetration pore pressure were used to determine soil classification (Soil Behavior Type, SBT) as a function of depth using empirical charts developed by P.K. Robertson (1990). The friction ratio soil classification is determined from the chart in the appendix using the normalized corrected tip stress and the normalized corrected tip stress and the normalized friction ratio.

At some depths, the CPT data fell outside of the range of the classification chart. When this occurred, no data was plotted and a break was shown in the classification profile. This occasionally occurred at the top of a penetration as the effective vertical stress is very small and commonly produced normalized tip resistances greater than 1000.

To provide a simplified soil stratigraphy for general interpretation and for comparison to standard boring logs, a statistical layering and classification system was applied the field classification values. Layer thicknesses were determined based on the variability of the soil classification profile, based upon changes in the standard deviation of the SBT classification number with depth. The average SBT number was determined for each successive 6-inch layer, beginning at the surface. Whenever an additional 6-inch increment deviated from the previous increment, a new layer was started, otherwise, this material was added to the layer above and the next 6-inch section evaluated. The soil behavior type for the layer was determined by the mean value for the complete layer.

Hand Auger Borings

Auger borings were advanced using hand operated augers. The soils encountered were identified in the field by cuttings brought to the surface. Representative samples of the cuttings were placed in glass jars and later transported to the laboratory. Soil consistency was qualitatively estimated by the relative difficulty of advancing the augers.

Water Level Determination

CPT penetration pore pressures include the *in-situ equilibrium pore pressure*, controlled by the local ground water regime, and the *excess pore pressure*, generated by insertion of the probe. In clays and silts, penetration is essentially undrained and recorded pore pressures significantly exceed in-situ equilibrium pore pressures. In sands and gravels, penetration is essentially drained and recorded pore pressures are essentially equal to the in-situ equilibrium pore pressure. The piezometric surface, defined as the point of zero equilibrium pore pressure, was obtained by plotting in-situ equilibrium pore pressure vs. depth using only pore pressure data from sand or

gravel soils. Where possible, derived piezometric surface was verified by tape measurement through the sounding opening after removal of the CPT rod and before collapse of the soils.

Multi-Channel Analysis of Surface Waves (MASW)

Shear wave velocities were measured at the site using MASW (Multi-Channel Analysis of Surface Waves) and MAM (Microtremor Array Method) with non-linear array geometry, combining the dispersion curves from both tests prior to the inversion process. Performing both MASW and MAM provides the greater depth of penetration associated with microtremor analyses (low frequency surface waves) without sacrificing resolution at shallower depths from MASW (higher frequency surface waves). In addition, our experience indicates using a combination of both methods to develop a shear wave velocity profile is more accurate than using Refraction Microtremor (ReMi™) exclusively, particularly when the ReMi™ array geometry is linear.

The MASW and MAM testing was conducted using the 16-channel Geometrics ES3000 seismograph and 4.5 Hz vertical geophones. For the MASW testing, the geophones were spaced in a linear geometry at intervals of 5 and 10 feet and surface waves generated by an 8-pound sledgehammer striking a metal plate. MAM testing was conducted using an "L-shaped" array geometry with geophone spacing of 30 feet. Because the source locations of the microtremors are not known, the 2-dimensional array geometry is used for the MAM. The analysis was conducted using the OYO Corporation's SeisImager/SW software (*Pickwin v. 3.14* and *WaveEq).*

A combination of active and passive sources was used to develop the wave frequencies required to obtain velocities to a depth of 150 feet. The results of the active and passive sources were combined to produce a single shear wave velocity profile. Based on the IBC 2006, the calculated weighted average shear wave velocity, v_s, using the developed Shear Wave Velocity Profile was determined.

LABORATORY TESTING PROCEDURES

Examination of Recovered Soil Samples

Soil and field records were reviewed in the laboratory by the geotechnical professional. Soils were classified in general accordance with the visual-manual method described in ASTM D 2488, "*Standard Practice for Description and Identification of Soils (Visual-Manual Method)*".

FIELD TESTING PROCEDURES

Cone Penetrometer Test (CPT) Sounding

The cone penetrometer test soundings (ASTM D 5778) were performed by hydraulically pushing an electronically instrumented cone penetrometer through the soil at a constant rate. As the cone penetrometer tip was advanced through the soil, nearly continuous readings of point stress, sleeve friction and pore water pressure were recorded and stored in the on-site computers. Using theoretical and empirical relationships, CPT data can be used to determine soil stratigraphy and estimate soil properties and parameters such as effective stress, friction angle, Young's Modulus and undrained shear strength.

The consistency and relative density designations, which are based on the cone tip resistance, q_t for sands and cohesive soils (silts and clays) are as follows:

SANDS		**SILTS AND CLAYS**	
Cone Tip Resistance, q_t (tsf)	**Relative Density**	**Cone Tip Resistance, q_t (tsf)**	**Consistency**
<20	Very Loose	<5	Very Soft
20 – 40	Loose	5 – 10	Soft
40 – 120	Medium Dense	10 – 15	Firm
		15 – 30	Stiff
120 – 200	Dense	30 –60	Very Stiff
>200	Very Dense	>60	Hard

CPT Correlations

References are in parenthesis next to the appropriate equation.

General

p_a = atmospheric pressure (for unit normalization)
q_t = corrected cone tip resistance (tsf)
f_s = friction sleeve resistance (tsf)
$R_f = 100\% * (f_s/q_t)$
u_2 = pore pressure behind cone tip (tsf)
u_0 = hydrostatic pressure
$B_q = (u_2-u_0)/(q_t-\sigma_{v0})$
$Q_t = (q_t-\sigma_{v0})/ \sigma'_{v0}$
$F_r = 100\% * f_s/(q_t- \sigma_{v0})$
$I_c = ((3.47-\log Q_t)^2+(\log F_r+1.22)^2)^{0.5}$

N-Value
$N_{60} = (q_t/pa)/[8.5(1-I_c/4.6)]$ (6)

(6) Jefferies, M.G. and Davies, M.P., (1993), "Use of CPTu to estimate equivalent SPT N60", ASTM Geotechnical Testing Journal, Vol. 16, No. 4

CPT Soil Classification Legend

Zone	Q_t/N	Description
1	2	Sensitive, Fine Grained
2	1	Organic Soils-Peats
3	1.5	Clays-Clay to Silty Clay
4	2	Silt Mixtures-Clayey Silt to Silty Clay
5	3	Sand Mixtures-Silty Sand to Sandy Silt
6	4.5	Sands-Clean Sand to Silty Sand
7	6	Gravelly Sand to Sand
8	1	Very Stiff Clay to Clayey Sand*
9	2	Very Stiff, Fine Grained*

(*) Heavily Overconsolidated or Cemented

Robertson's Soil Behavior Type (SBT), 1990			
Group #	**Description**	**Ic**	
		Min	**Max**
1	Sensitive, fine grained	N/A	
2	Organic soils - peats	3.60	N/A
3	Clays - silty clay to clay	2.95	3.60
4	Silt mixtures - clayey silt to silty clay	2.60	2.95
5	Sand mixtures - silty sand to sandy silt	2.05	2.60
6	Sands - clean sand to silty sand	1.31	2.05
7	Gravelly sand to dense sand	N/A	1.31
8	Very stiff sand to clayey sand (High OCR or cemented)	N/A	
9	Very stiff, fine grained (High OCR or cemented)	N/A	

Soil behavior type is based on empirical data and may not be representative of soil classification based on plasticity and grain size distribution.

Relative Density and Consistency Table			
SANDS		SILTS and CLAYS	
Cone Tip Stress, qt (tsf)	Relative Density	Cone Tip Stress, qt (tsf)	Consistency
Less than 20	Very Loose	Less than 5	Very Soft
20 - 40	Loose	5 - 15	Soft to Firm
40 - 120	Medium Dense	15 - 30	Stiff
120 - 200	Dense	30 - 60	Very Stiff
Greater than 200	Very Dense	Greater than 60	Hard

S&ME

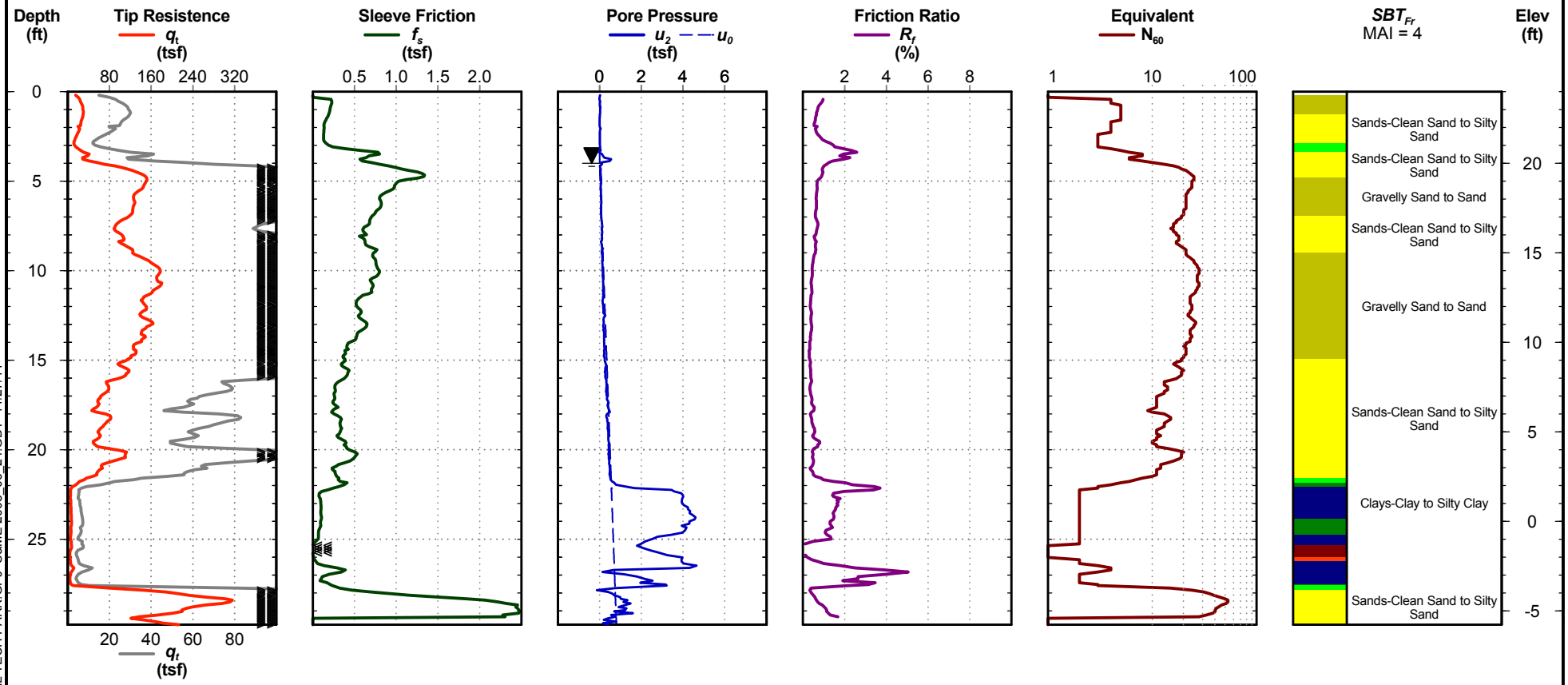
Coastal Technology Park
Georgetown County, SC
S&ME Project No: 1633-11-275

Cone Penetration Test

C-1

Date: Nov. 7, 2011
Estimated Water Depth: 4 ft
Rig/Operator: Michael | Russell

Total Depth: 29.8 ft
Termination Criteria: Target Depth
Cone Size: 1.44



CPT REPORT - DYNAMIC 1633-11-275 COASTAL TECH PARK.GPJ S&ME 2008_06_24.GDT 11/27/11

Electronic Filename: G07N1101C.DAT

C-1

S&ME

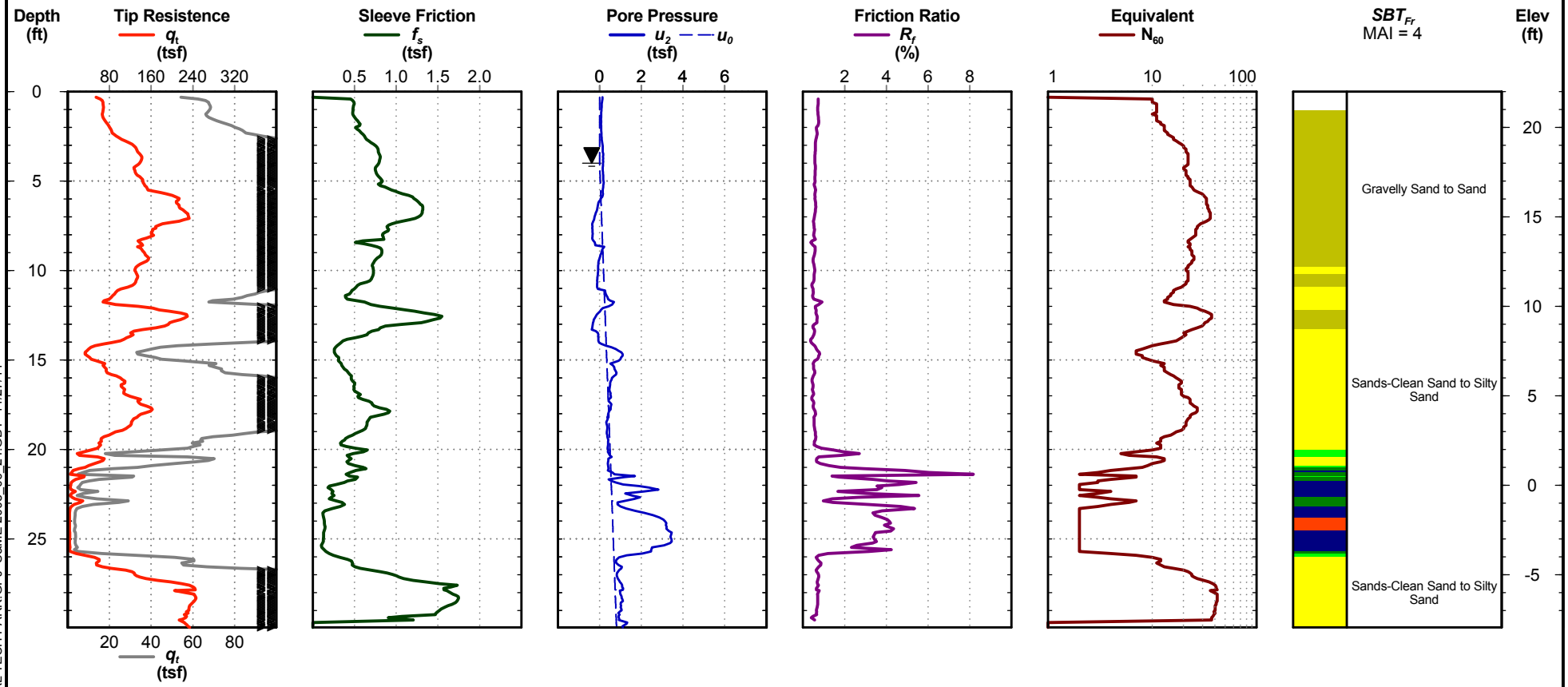
Coastal Technology Park
Georgetown County, SC
S&ME Project No: 1633-11-275

Cone Penetration Test

C-2

Date: Nov. 7, 2011
Estimated Water Depth: 4 ft
Rig/Operator: Michael | Russell

Total Depth: 30.0 ft
Termination Criteria: Target Depth
Cone Size: 1.44



CPT REPORT - DYNAMIC 1633-11-275 COASTAL TECH PARK.GPJ S&ME 2008_06_24.GDT 11/27/11

Electronic Filename: G07N1102C.DAT

C-2

S&ME

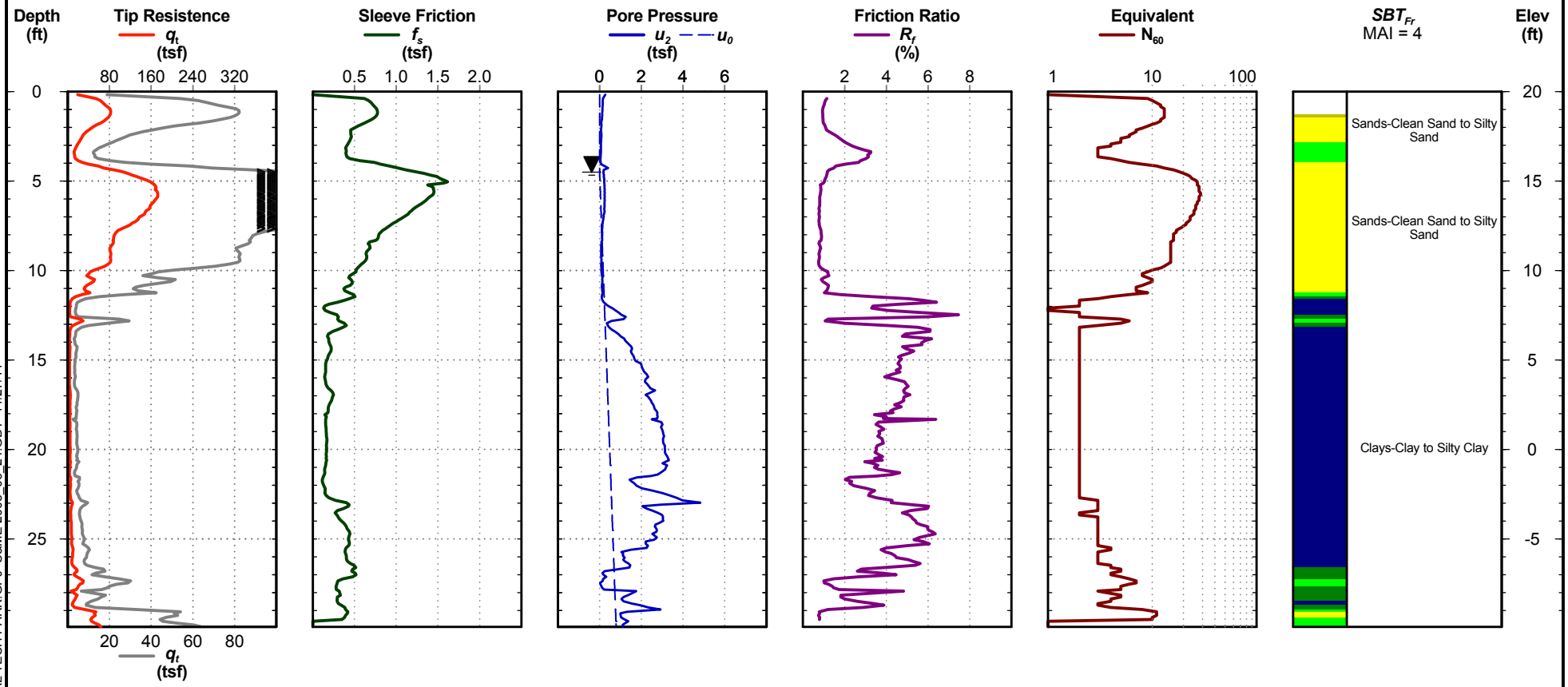
Coastal Technology Park
Georgetown County, SC
S&ME Project No: 1633-11-275

Cone Penetration Test

C-3

Date: Nov. 7, 2011
Estimated Water Depth: 4.5 ft
Rig/Operator: Michael | Russell

Total Depth: 29.9 ft
Termination Criteria: Target Depth
Cone Size: 1.44



CPT REPORT - DYNAMIC 1633-11-275 COASTAL TECH PARK.GPJ S&ME 2008_06_24.GDT 11/27/11

Electronic Filename: G07N1103C.DAT

C-3

S&ME

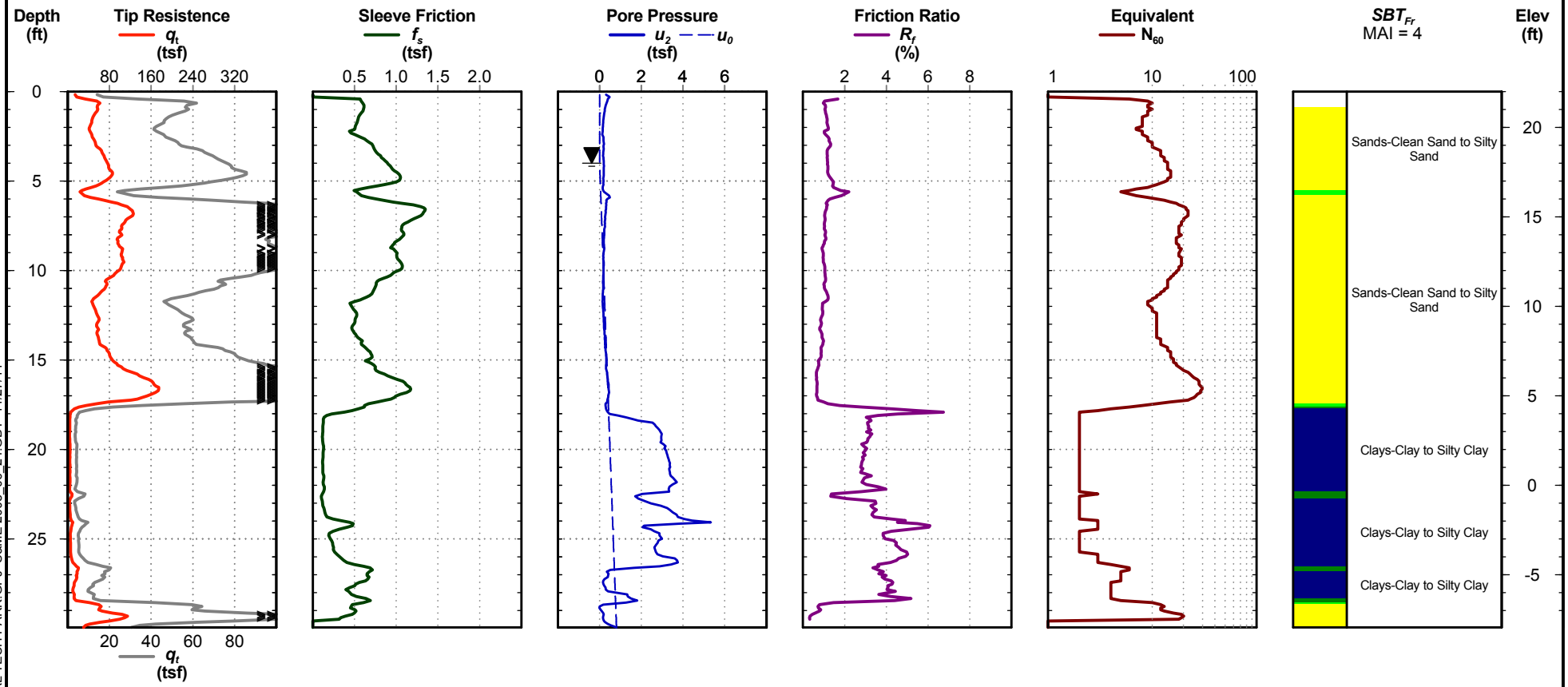
Coastal Technology Park
Georgetown County, SC
S&ME Project No: 1633-11-275

Cone Penetration Test

C-4

Date: Nov. 7, 2011
Estimated Water Depth: 4 ft
Rig/Operator: Michael | Russell

Total Depth: 29.9 ft
Termination Criteria: Target Depth
Cone Size: 1.44



CPT REPORT - DYNAMIC 1633-11-275 COASTAL TECH PARK.GPJ S&ME 2008_06_24.GDT 11/27/11

Electronic Filename: G07N1104C.DAT

C-4

S&ME

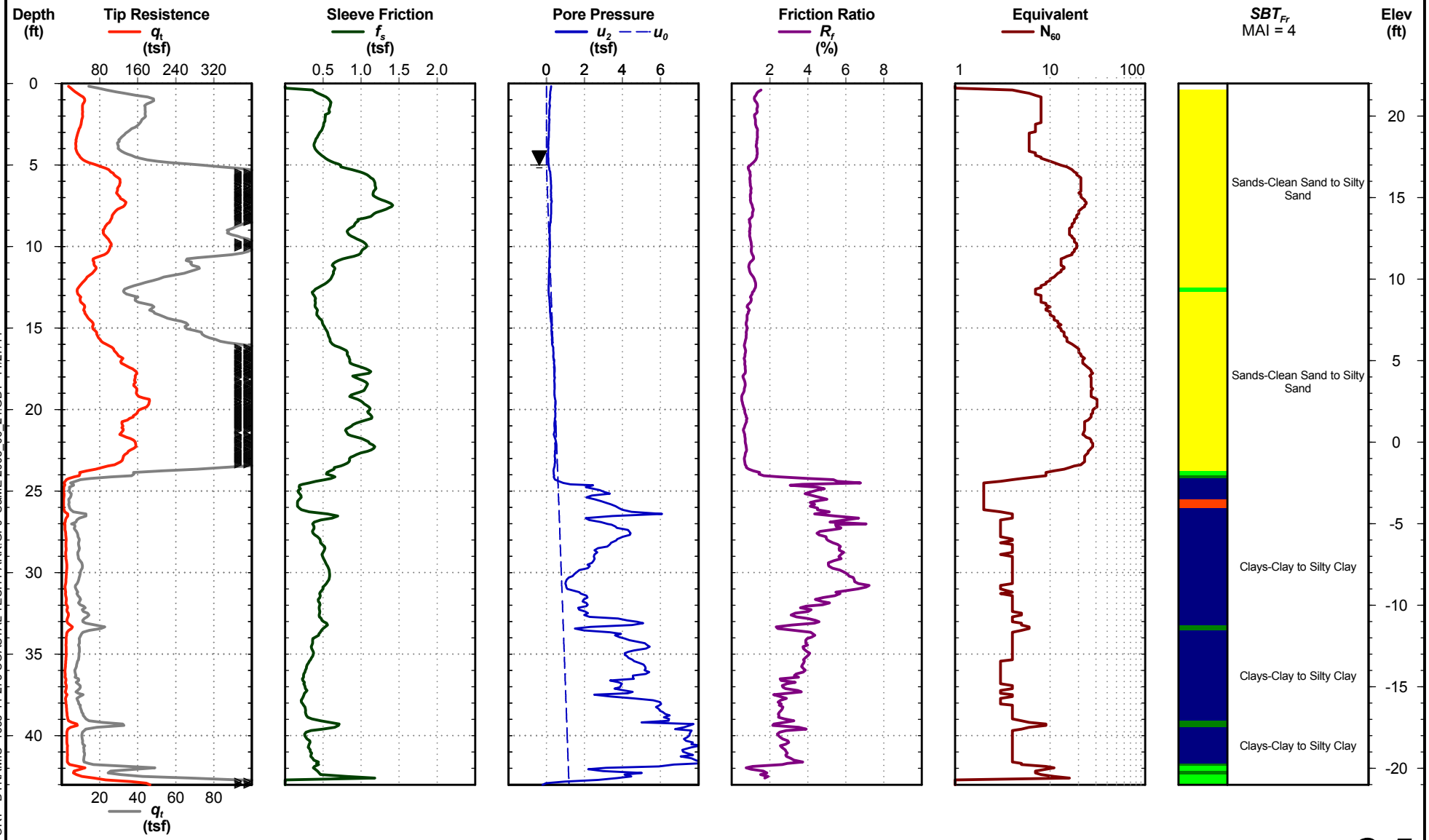
Coastal Technology Park
Georgetown County, SC
S&ME Project No: 1633-11-275

Cone Penetration Test

C-5

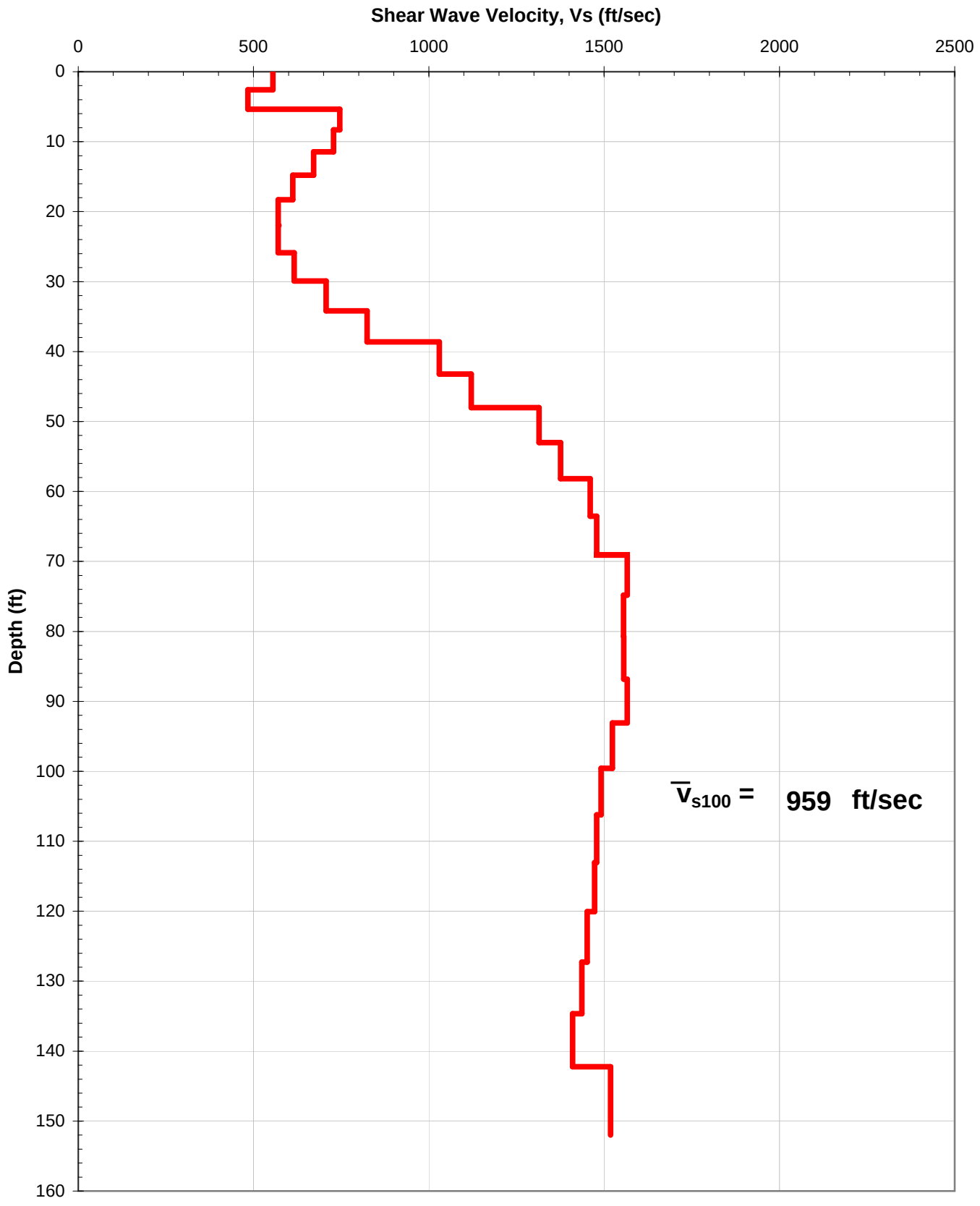
Date: Nov. 7, 2011
Estimated Water Depth: 5 ft
Rig/Operator: Michael | Russell

Total Depth: 43.0 ft
Termination Criteria: Target Depth
Cone Size: 1.44



CPT REPORT - DYNAMIC 1633-11-275 COASTAL TECH PARK.GPJ S&ME 2008_06_24.GDT 11/27/11

Electronic Filename: G07N1105C.DAT



SHEAR WAVE VELOCITY PROFILE	S&ME	**Location:**	Near C-2	**Drawn By:**	JBC
Coastal Technology Park		**Date:**	November, 2011	**Approved By:**	CMD
Georgetown County, South Carolina		**Project No.:**	1633-11-275	**Figure:**	4