REPORT OF
GEOTECHNICAL EXPLORATION

Chester Research & Development
Park Entrance Road
Chester County, South Carolina
S&ME Project No. 1611-10-404

Prepared For:

Alliance Consulting Engineers, Inc.
PO Box 8147
Columbia, South Carolina 29202-8147

Prepared By:

S&ME, Inc.
134 Suber Road
Columbia, South Carolina 29210

November 2, 2010

S&ME

November 2, 2010

Alliance Consulting Engineers, Inc.
Post Office Box 8147
Columbia, South Carolina 29202-8147

Attention: Garrett Wine, EIT

Reference: **Report of Geotechnical Exploration**
Chester Research & Development Park Entrance Road
Chester County, South Carolina
S&ME Project No. 1611-10-404

Dear Mr. Wine:

As requested, S&ME, Inc. (S&ME) has completed field and laboratory testing for the proposed entrance road for the Chester Research and Development Park in Chester County, South Carolina. Our work was performed in general accordance with our proposal No. 1611-7818-10, dated October 25, 2010. This report provides information regarding site preparation, the suitability of on-site soils for use as structural fill, compaction requirements for fill placement, and recommendations regarding pavement section thicknesses.

S&ME appreciates this opportunity to work with you as your geotechnical engineering consultant on this project. Please contact us at (803) 561-9024 if you have any questions or need any additional information regarding this report.

Sincerely,
S&ME, Inc.

SOUTH CAROLINA LICENSED PROFESSIONAL ENGINEER No. 25467 MICHAEL D. HARRIS, JR. 11/02/10

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

Michael (Trapp) Harris, PE
Geotechnical Dept. Manager

James T. Palmer, PE
Engineering Manager

PROJECT INFORMATION

Information about the project was obtained on July 15, 2010 via email from Garrett Wine of Alliance to Trapp Harris and Andy Whitfield of S&ME. Included in the email were a site location map and a conceptual site plan. A topographic survey of the site was also provided via email from Garrett Wine of Alliance on November 1, 2010.

The site is located off Richburg Road (SC Hwy. 99) in Chester County, South Carolina approximately halfway between its intersection with Lancaster Highway (SC Hwy. 9) and Great Falls Highway (SC Hwy. 97). S&ME understands the proposed project involves the construction of approximately 500 linear feet of entrance roadway for the new Chester Research and Development Park, originating from Richburg Road and heading east into the property.

The project site is currently a grassed field on the east side of Richburg Road, directly across from Mt. Nebo Church and is currently used as a hay field. Existing elevations along the alignment range from approximately 457 to 462 feet, based on the provided topographic survey. Proposed elevations of the new alignment have not been provided, but we have assumed 2 to 3 feet of cut and fill or less will be required on the site.

EXPLORATION PROCEDURES

Prior to the subsurface exploration, aerial photos of the property and the provided scaled site conceptual plan were reviewed to develop the proposed testing plan. On October 20, 2010, a representative of S&ME visited the site to perform the following tasks:

- Observe topography, ground cover, and surface soils in the proposed project area.
- Lay out locations for 4 soil test borings by rough measurement from site features.

Using an ATV-mounted rig, four soil test borings were performed to depths of 10 feet each within areas of the proposed roadway alignment. Total soil test boring footage at the site was 40 feet. We also collected one bulk sample of representative subgrade soils for laboratory testing. Groundwater, if encountered, was measured at the time of boring and prior to leaving the site. No survey of boring locations or elevation was conducted by S&ME.

Subsurface Exploration

The subsurface exploration of this project included Standard Penetration Test (SPT) borings. The methods used to perform these tasks are described below. The approximate locations of each of the boring locations detailed below are shown in the attached Boring Location Plan (Figure 2).

Soil Test Boring with Hollow-Stem Auger

Soil sampling and penetration testing were performed in general accordance with ASTM D1586, *"Standard Test Method for Penetration Test and Split Barrel Sampling of Soils"*. Shallow borings are made by mechanically twisting a continuous steel hollow stem auger into the soil. At regular intervals, soil samples were obtained with a standard 1.4 inch I. D., two-inch O. D., split barrel sampler. The sampler was first seated six inches to penetrate any loose cuttings, and then driven an additional 12 inches with blows of a 140-pound hammer falling approximately 30 inches. The number of hammer blows required to drive the sampler through the two final six inch increments was recorded as the penetration resistance (SPT N) value. The N-value, when properly interpreted by qualified professional staff, is an index of the soil strength and foundation support capability. The soil test boring data is attached in the Appendix.

Laboratory Testing

Recovered disturbed samples and field logs were transported to our laboratory. After the samples were returned to our laboratory, a geotechnical professional classified the samples. We conducted the following qualitative laboratory tests:

- 1 Standard Proctor moisture density relationship test.
- 1 California Bearing Ratio (CBR) test (three points, soaked).

The Standard Proctor and CBR tests were used to estimate subgrade support for the proposed pavement sections. Standard Proctor tests were also used to help determine the on-site soil's suitability for use as structural fill. Laboratory results are included in the Appendix. Results from laboratory standard Proctor and CBR tests are summarized in the following table:

Table 1 – Summary of Laboratory Test Results

Sample	Soil Type	Standard Proctor Maximum Dry Density	Optimum Moisture Content	California Bearing Ratio
Bulk No. 1 (B-2, 0 - 10 ft)	Silty Sand (SM)	117.5 pcf	13.6%	90% compaction = 1% 95% compaction = 3% 100% compaction = 4%

SITE CONDITIONS

Surface Conditions

The proposed alignment is primarily located within an open field currently used as a hay field. An existing ditch also runs parallel to SC Hwy 99. The site is gently sloping downward generally from the center of the proposed alignment to the east and west. Approximately 5 feet of elevation change occurs within the proposed roadway alignment according to the provided topographic survey. A small pond is indicated just to the east of the proposed road. No standing water or rock outcrops were noted during our site visit.

Subsurface Conditions

Site Geology

The site lies within the Piedmont Physiographic Province of South Carolina, an area underlain by soils weathered in place from the parent crystalline bedrock material. Residual soils of the Carolina Piedmont consist of stiff or very stiff micaceous silts and clays, grading to firm sands with depth. These soils have been completely weathered in place from the parent bedrock material, but below depths of a few feet retain most of the relict rock structure. Soil strength derives largely from relict intermolecular bonding and remolded materials generally less exhibit lower shear strength than do undisturbed samples. Piedmont soils are normally consolidated to slightly overconsolidated.

The term *partially weathered rock (PWR)* is applied to very dense micaceous sands or silty sands of the Carolina Piedmont, which register SPT N-values in excess of 100 blows per foot. PWR generally varies widely within even small areas owing to minute differences in the chemical properties of the parent bedrock, which results in widely varying rates of weathering. Isolated lenses or seams of PWR often are present within Piedmont Residuum well above the overall PWR level within a given area. PWR is considered excellent bearing material for foundations and is relatively incompressible except in highly stressed deep foundations.

USDA Soil Survey Information

USDA Soils Conservation Service soils mapping for Chester County indicate predominantly Iredell sandy loam series to be located within 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. A description of the soils series mapped within the proposed site is summarized in Table 1.

Table 2 – USDA Soil Survey Soil Series

Soil Series	Soil Type	Depth to Seasonal High GW Table	Depth to Rock	Remarks
Iredell sandy loam (IdB)	<7" SM 7-24" CH 24-27" CL,CH,SC <27" variable	1 – 2 ft. (perched, Nov. – Mar.)	> 60 in.	Gently sloping soil on broad ridges, moderately well-drained, slow permeability, medium to neutral acidity, high to very high shrink-swell potential.

The seasonal high groundwater table as indicated by the Soil Survey appears to be higher than the groundwater measurements made during our subsurface exploration. However, the Survey indicates that the perched water conditions generally occur between November and March and our subsurface exploration was conducted prior to these months. The near-surface soils encountered on site tend to inhibit the downward infiltration of surface water. Therefore, the potential exists that perched water may be encountered at higher elevations than indicated on the boring logs during wet weather.

Iredell soils are present across the majority of the site according to the Soil Survey. These soils have a high to very high shrink-swell hazard potential associated with them when exposed to significant changes in moisture content. Silts and high plasticity clays potentially susceptible to shrink-well were encountered in the majority of our borings on site, though the high plasticity clays were only encountered in one of the borings.

Interpreted Subsurface Profile

The generalized subsurface conditions at the site are described below. Subsurface conditions between the borings will likely vary. The nature and extent of variations between the sampling points will not become evident until construction, and stratification lines shown are not warranted. For detailed descriptions and stratification at a particular boring location, the respective boring record should be reviewed. Soil test boring logs are attached in the Appendix.

<u>Surface Soils</u>

Organic topsoil thicknesses encountered at our boring locations were typically 6 to 8 inches. Topsoil or plowzone material is likely present across much of the site since the primary use of the property has been for farming. Topsoil or plowzone thicknesses may be greater in areas not explored by our borings.

<u>Subsurface Soils</u>

Below the topsoil, our borings generally encountered medium dense to very dense silty sands and very stiff to very to hard sandy silts and clays to termination of the borings at 10 feet. These soils exhibited SPT N-values ranging from 20 to 62 blows per foot (bpf). Partially weather rock sampled as silty sand was encountered in boring B-1 from 9 feet to termination of the boring at 10 feet and in boring B-3 from a depth of approximately 6 to 8 feet. The PWR exhibited SPT N-values in excess of 100 bpf.

The clayey sands were moist and were green, brown, tan, or a combination of these colors with some black or orange. The silts exhibited low to moderate plasticity when remolded by hand, while the clays encountered in the upper 3 feet of boring B-4 exhibited moderate to high plasticity when remolded by hand. These clays will generally not be suitable as subgrade support for the proposed pavements. Additionally, because the surface soils shown by the Soil Survey are indicated as having a high shrink-swell potential, subgrade soils will need to be closely observed in the field to evaluate their suitability for subgrade support of the proposed pavements. Providing good drainage of the subgrade soils will play a critical role in proper performance of the pavement.

The potential need for stabilization should be based on the nature of the soils encountered during construction and their performance during grading and proofrolling operations. Based on our borings stabilization depths will likely be on the order of 3 feet or less below the ground surface, but could be greater in other areas of the site not explored by our borings. Undercut material would generally not be suitable for re-use as fill and would need to be wasted in non-structural areas of the site, stockpiled, or trucked off-site

Groundwater

Groundwater was not encountered in our borings at the time of boring or prior to leaving the site. Medium dense to very dense silty sand soils and very stiff to hard silts were encountered in our borings. These soils will likely limit rain water infiltration and perched groundwater is likely during periods of normal or above normal rainfall. If perched water is encountered, it can likely be controlled by ditching.

By comparing estimated groundwater elevations to existing site grades, the presence of groundwater will likely not significantly impact proposed construction across the majority of the roadway alignment. Construction may be impacted by surface water depending on planned site grades. It will be necessary to control perched water if encountered. We note that groundwater levels are influenced by precipitation, long term climatic variations, and nearby construction. Groundwater measurements made at different times than our exploration may indicate groundwater levels substantially different than indicated on the boring records in the Appendix.

CONCLUSIONS AND RECOMMENDATIONS

Continued satisfactory performance of pavement sections is highly dependent on control of water within the subgrade. Where possible, pavement sections should be designed with crowning and ditching. Where crowning and ditching are not possible, underdrains or French drains may be required. Provisions should also be made to provide drainage of water away from the pavement section. Site preparation should allow for drainage that results in groundwater elevations being maintained at least 2 ft. below the top of the pavement section.

The following paragraphs include our conclusions and recommendations for site preparation, for fill placement and compaction and for design and construction of pavement sections. The conclusions and recommendations included in this report are based on our sampling and laboratory testing of representative soil from the proposed roadway location, on the information obtained during our subsurface investigation and on our experience with similar projects.

Site Preparation

A grading plan has not been provided and we have assumed planned pavements will 2 to 3 feet of cut and fill. Grading and subgrade preparation will consist of removing topsoil or organic plowzone soils within the proposed roadway alignment and cutting subgrade soils at higher elevations and placing properly compacted fill at lower elevations.

1. Strip and grub all vegetation, topsoil or plow zone soils, and root bulbs from within the proposed roadway alignment. Topsoil or plow zone soil thicknesses were measured at approximately 6 to 8 inches at our boring locations but may vary in unexplored areas.

2. After removal of all unsuitable surface materials and cutting to grade, the upper 12 inches of existing soils within the roadway alignment should be compacted to at least 98 percent of standard Proctor maximum dry density. Exposed surfaces should be proofrolled using a heavily loaded tandem axle truck to identify soft areas prior to placement of fill materials. Areas which rut or pump excessively under the proofrolling operation will need to be stabilized prior to placement of fill soil. If left in place soft, wet or unstable soils may make it difficult to achieve the required compaction and will exhibit substantially lower bearing for pavements.

3. Stabilization, if required, may consist undercutting (removal) of the moderate to high plasticity clays from beneath the pavement areas or stabilization by other means, such as cement or lime stabilization. The need for stabilization should be based on the nature of the soils encountered during construction and their performance during grading and proofrolling operations. Based on the USDA Soils Conservation Service soils mapping information, some removal or stabilization of subgrade soils should be expected.

   The volume of soils requiring stabilization will be dependent on final grading plans. It should also be noted that the moderate to highly plastic soils removed from cut areas or undercut excavations will generally not be suitable for use as subgrade fill within pavement footprints, other than deep (below about 10 feet) fill areas below pavements. However, these soils will likely be very difficult to work during site grading. The geotechnical engineer or a representative of the geotechnical engineer should be present to observe and document surface preparation and proofrolling.

4. To help reduce disturbance of the subgrade soils in pavement areas, you may wish to leave the pavement subgrades 4 to 6 inches above final grade until just prior to placement of base course stone. This will help reduce disturbance that might occur during other construction activities and reduce the potential of degrading an otherwise acceptable subgrade.

5. We recommend ditching be placed at the start of site grading to help reduce water retention within the roadway alignment.

Fill Placement and Compaction

The silty sands encountered near the ground surface in our borings are likely suitable for re-use as fill for pavement subgrades. However, the silty sands will require proper moisture conditioning during placement. These soils have a tendency to retain moisture and extended drying times may be required during wet weather grading. Sandy silts similar to those encountered on the site have been used successfully in the past as fill when placed with proper moisture control. However these soils have a tendency to retain moisture and may not provide adequate subgrade support if allow to become wet during site grading. The moderate to high plasticity clays should not be used as fill with the proposed pavement footprint.

All fill placed in pavement areas should comprise soils free of organic matter and other deleterious materials. Before beginning to place fill, sample and test each proposed fill material to determine its maximum dry density, optimum moisture content, natural moisture content, and suitability as a structural fill material. The fill should be uniformly spread in relatively thin lifts (8 inches, loose) and compacted to at least 98 percent of the soil's maximum dry density as determined by a laboratory standard Proctor compaction test (ASTM D-698). The moisture content should be controlled to within plus to minus 3 percent of optimum. In addition to meeting the compaction requirement, fill material should be stable under movement of the construction equipment and should not exhibit rutting or pumping.

It is very important that all fill is uniformly well compacted. Accordingly, fill placement should be monitored by a qualified material technician working under the direction of the geotechnical engineer. In addition to this visual evaluation, the technician should perform a sufficient number of in-place field density tests.

Wet Weather Grading

Our experience indicates that the movement of clearing and construction equipment on areas of standing water or saturated soils will result in degradation of the subgrade soils. Repeated passes of equipment may cause rutting and degradation of what might otherwise be acceptable subgrade soils and movement of construction equipment on saturated soils should be avoided where possible.

Based on our experience, the silty sands and sandy silts and clays similar to those encountered in our borings may be difficult to work if allowed to become wet. If allowed to become wet these soils will likely impede the movement of construction equipment. These soils may also require extended drying times once wet. To help reduce the potential for these upper soils becoming wet during rain events, we recommend the surface be "sealed" with a smooth drum roller if rain is pending. Positive drainage from the roadway surface should also be maintained.

Groundwater was not encountered in our borings at the time of drilling. Medium dense to dense silty sands and very stiff to hard fine grained soils similar to those encountered in the upper 5 to 10 feet of the soil profile may inhibit downward infiltration of rainfall, and formation of a perched water table at relatively shallow depths is possible during wet periods. If perched water or groundwater is encountered during grading, ditching will be necessary to provide a stable bearing surface for foundations or pavements.

Pavement Thickness Recommendations

One soaked laboratory California Bearing Ratio (CBR) test was performed on a representative bulk sample obtained at a depth of approximately 5 feet from auger cuttings from our borings. The sample was compacted (remolded) to approximately 90, 95, and 100 percent of the standard Proctor maximum dry density near the optimum moisture content. We recommend a CBR value of 3 percent for design. This is assuming that the upper 12 inches of subgrade material is compacted to at least 98 percent of the standard Proctor maximum dry density. This also assumes that any fill material placed within the proposed pavement area is placed and compacted according to the recommendations given in this report. Imported fill should be tested to determine that it exhibits a CBR of at least 3 percent, though we recommend imported fill have a higher CBR value if used as subgrade material.

Design procedures are based on the AASHTO Guide for Design of Pavement Structures and associated literature. Based on the subsurface conditions and assuming our grading recommendations will be implemented as specified, the following presents our recommendations regarding pavement sections and materials.

Flexible Pavements

Our pavement analysis was performed using DARWin Pavement Design and Analysis System software. DARWin uses the AASHTO '93 Flexible Pavement Design Method for analysis of the unreinforced pavement section. Structural design DARWin input data included an initial serviceability of 4.2, a terminal serviceability of 2.0, a reliability level of 85 percent, and an overall standard deviation of 0.49.

Traffic volumes were not made available as of the writing of this report, so traffic volumes were assumed and are not guaranteed to represent the actual traffic volumes. The theoretical equivalent 18-kip equivalent single axle loads (ESAL's) noted are the design ESAL's for the proposed pavement sections. The period over which that number of ESAL's is applied is the design life of the pavement. However, it should be noted that pavements typically begin showing signs of wear at 7 to 10 years. Also, some areas could require repair in a shorter time period.

The cross section of each asphalt pavement was estimated using structural coefficients published in the South Carolina Department of Transportation's Draft Pavement Design Policy for common paving materials in South Carolina. Structural coefficients of each layer were multiplied by the layer thickness to provide the required structural number.

Table 3 – Recommended Flexible Pavement Section Thickness Alternatives

Design ESAL's	Required Structural Number	Type 1 or Type C Asphalt Surface Course (inches)	Type 1 or Type C Asphalt Binder Course (inches)	Compacted Graded Aggregate Base Course [GABC] (inches)
1,025,000	3.88	2.0	4.0	8.0
3,207,000	4.56	4.0	4.0	8.0

Note: Pavement materials should conform with and be placed in accordance with the South Carolina DOT Standard Specifications for Highway Construction for Type 1 or Type C asphalt.

Assuming the road is open to traffic 365 days per year and a 20 year design life, the 6-inch asphalt pavement section could support about 140 ESAL's per day. This would be about 51 trucks and 2000 passenger vehicles per day assuming 2.5 ESAL's per truck and 0.006 ESAL's per passenger vehicle for the 6-inch asphalt pavement section. Based on our analysis, the 8-inch asphalt pavement section could support about 439 ESAL's per day. This would be about 128 trucks and 2000 passenger vehicles per day assuming 2.5 ESAL's per truck and 0.006 ESAL's per passenger vehicle for the 8-inch asphalt pavement section.

Placement of 2 to 3 feet of well compacted granular fill within the proposed pavement areas will result in increased support for pavement sections. Once a final grading plan is provided, pavement recommendations may need to be modified to account for change in site grades and subgrade support. It may also be desirable to stabilize subgrades using lime or cement to reduce pavement section thicknesses. Design of lime or cement stabilization was beyond our current scope of work.

The aggregate base course should consist of Macadam Base Course (Refer to SCDOT Standard Specifications, Section 305 page 209). This base course should be compacted to at least 100 percent of the maximum dry density, as determined by the modified Proctor compaction test (ASTM D 1557-90 or AASHTO T 180-90). To confirm that the base course has been uniformly compacted, in-place field density tests should be performed by a qualified Materials Technician, and the area should be methodically proofrolled under his evaluation.

Construction of Flexible Pavement Sections

Sufficient testing should be performed during flexible pavement installation to confirm that the required thickness, density, and quality requirements of the pavement specifications are followed. This is very important for the long-term performance of the pavement, and can be performed by S&ME, Inc. as part of our construction materials testing services. In addition, the following guidelines should be considered during construction:

1. Prior to pavement installation, all exposed pavement subgrades should be methodically proofrolled at final subgrade elevation under the observation of the S&ME, Inc. geotechnical engineer, and any identified unstable areas should be repaired as directed.

2. Depending upon conditions at the time of construction, pavement under drainage, French drains, and/or ditches may be required in some areas to control perched groundwater and stabilize subgrades.

3. The crushed stone graded aggregate base course (GABC) used in pavement section construction should meet the requirements of Section 305 of the South Carolina Department of Transportation 2007 Standard Specifications for Highway Construction, and should consist of "Macadam Base Course" as defined by Section 305.2.4.2 of the SCDOT specification.

4. All material and construction should be in accordance with the applicable sections of the South Carolina Department of Transportation 2007 Standard Specifications for Highway Construction.

5. As stated in the SCDOT Section 305 specification, new base course should be compacted to at least **100 percent** of the modified Proctor maximum dry density (ASTM D 1557), and should not exhibit pumping or rutting under equipment traffic. Heavy compaction equipment is likely to be required in order to achieve the required base course compaction, and the moisture content of the material will likely need to be maintained very near the optimum moisture content in order to facilitate proper compaction. S&ME, Inc. should be contacted to perform field density and thickness testing of the base course prior to paving.

6. The asphaltic concrete section eventually selected for construction will consist of hot mix asphaltic concrete surface and binder courses built on top of the properly prepared graded aggregate base course. The surface and binder course material should classify as SCDOT Type 1 or Type C.

7. Construct the binder and surface courses in accordance with the specifications of Section 402 and 403 of the South Carolina Department of Transportation 2007 Standard Specifications for Highway Construction, respectively.

8. Experience indicates that, for asphalt surfaced roads designed for a 20 year design life, a surface overlay of asphalt pavement may be required in about 7 to 10 years

due to normal wear and weathering of the surface. Such wear is typically visible in several forms of pavement distress, such as aggregate exposure and polishing, aggregate stripping, asphalt bleeding, and various types of cracking. There are means to methodically estimate the remaining pavement life based on a systematic statistical evaluation of pavement distress density and mode of failure. We recommend the pavement be evaluated in about 7 years to assess the pavement condition and remaining life.

Construction Considerations

Pavement performance is very dependent on subgrade condition. Drainage will have a major impact on subgrade condition. Drainage should be designed to result in subsurface water levels being at least 2 feet below the top of the pavement subgrade. Design should not result in water standing on the pavement surface or behind curbing. Design should result in positive drainage being available from the stone base material. Areas adjacent to pavements (embankments, landscaped island, ditching, etc.) which can drain water (rainwater or sprinklers) should be designed so that water does not seep below the pavements. This may require the use of French drains or swales in these areas.

Where possible, ditches should be excavated adjacent to the pavement shoulders. Shoulder maintenance also plays an important role in continued performance of the pavement section. Shoulders should be maintained such that water does not stand adjacent to the pavement.

The performance of the pavement will be influenced by a number of factors including the actual condition of subgrade soils at the time of pavement installation, installed thicknesses and compaction, and drainage. The subgrade soils should be reevaluated by proofrolling immediately prior to placement of base course stone and any unstable areas repaired. Sufficient tests and inspections should be performed during pavement installation to confirm that the required thickness, density, and quality requirements of the specifications are followed.

QUALIFICATIONS OF REPORT

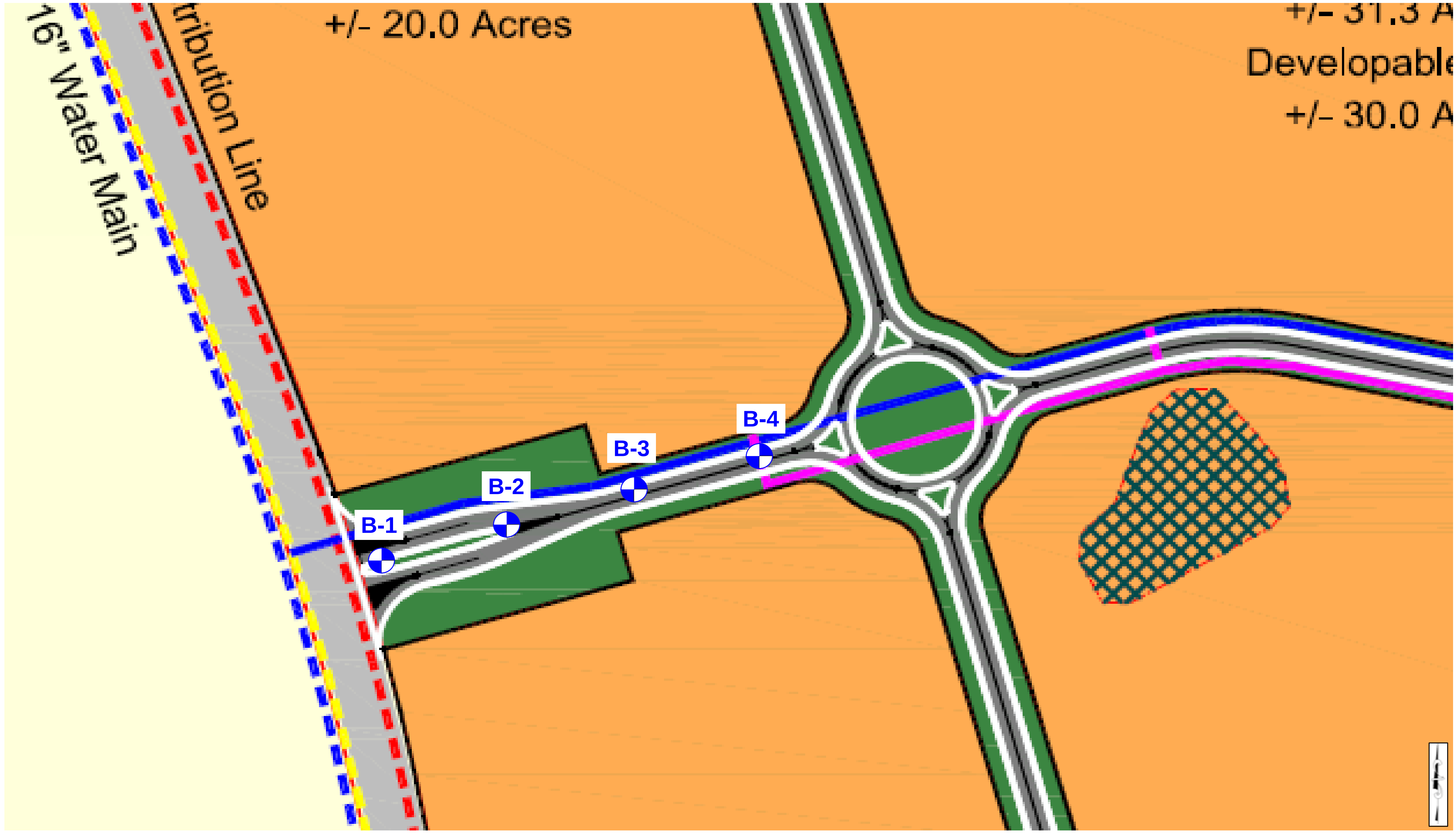
This report has been prepared in accordance with generally accepted geotechnical engineering practice for specific application to this project. The conclusions and recommendations contained in this report were based on the applicable standards of our profession at the time this report was prepared. No other warranty, express or implied is made.

The analyses and recommendations submitted in this report are based, in part, upon the data obtained from the subsurface exploration. The nature and extent of variations between the borings may not become evident until construction. Due to the distance between each soil test location, subsurface conditions can be expected to vary from the conditions described herein.

In the event that any changes in the nature, design, or location of the project are planned, the conclusions and recommendations contained in this report will not be considered valid unless the changes are reviewed and conclusions of the report modified or verified in writing by us.

SOURCE: Google Maps 2010

SCALE:	NTS	S&ME	**SITE LOCATION MAP** Chester Research & Development Park Entrance Road Chester County, South Carolina	FIGURE NO:
CHECKED BY:	JTP			1
DRAWN BY:	TH			
DATE:	10/29/10		JOB NO. 1611-10-404	



APPROXIMATE BORING LOCATION

SOURCE: Alliance Consulting Engineers

DRAWING: Conceptual Master Plan dated August 2010

SCALE:	NTS
CHECKED BY:	JTP
DRAWN BY:	TH
DATE:	10/29/10

S&ME

BORING LOCATION PLAN

Chester R&D Park Entrance Road

Chester County, South Carolina

PROJECT NO. 1611-10-404

FIGURE NO. 2

LEGEND TO SOIL CLASSIFICATION AND SYMBOLS

SOIL TYPES

(Shown in Graphic Log)

- Fill
- Asphalt
- Concrete
- Topsoil
- Gravel
- Sand
- Silt
- Clay
- Organic
- Silty Sand
- Clayey Sand
- Sandy Silt
- Partially Weathered Rock (PWR)
- Sandy Clay
- Rock
- Incompetent Rock
- Boulder

WATER LEVELS

(Shown in Water Level Column)

- ▽ = Water Level At Termination of Boring
- ▼ = Water Level Taken After 24 Hours
- ◄ = Loss of Drilling Water
- HC = Hole Cave

CONSISTENCY OF COHESIVE SOILS

CONSISTENCY	STD. PENETRATION RESISTANCE BLOWS/FOOT
Very Soft	0 to 2
Soft	3 to 4
Firm	5 to 8
Stiff	9 to 15
Very Stiff	16 to 30
Hard	31 to 50
Very Hard	Over 50

RELATIVE DENSITY OF COHESIONLESS SOILS

RELATIVE DENSITY	STD. PENETRATION RESISTANCE BLOWS/FOOT
Very Loose	0 to 4
Loose	5 to 10
Medium Dense	11 to 30
Dense	31 to 50
Very Dense	Over 50

SAMPLER TYPES

(Shown in Samples Column)

- Shelby Tube
- Split Spoon
- Rock Core
- No Recovery

TERMS

Standard Penetration Resistance - The Number of Blows of 140 lb. Hammer Falling 30 in. Required to Drive 1.4 in. I.D. Split Spoon Sampler 1 Foot. As Specified in ASTM D-1586.

REC - Total Length of Rock Recovered in the Core Barrel Divided by the Total Length of the Core Run Times 100%.

RQD - Total Length of Sound Rock Segments Recovered that are Longer Than or Equal to 4" (mechanical breaks excluded) Divided by the Total Length of the Core Run Times 100%.

S&ME
ENGINEERING • TESTING
ENVIRONMENTAL SERVICES

PROJECT:	Chester R&D Park Entrance Road Chester County, South Carolina S&ME Project No. 1611-10-404

BORING LOG B-1

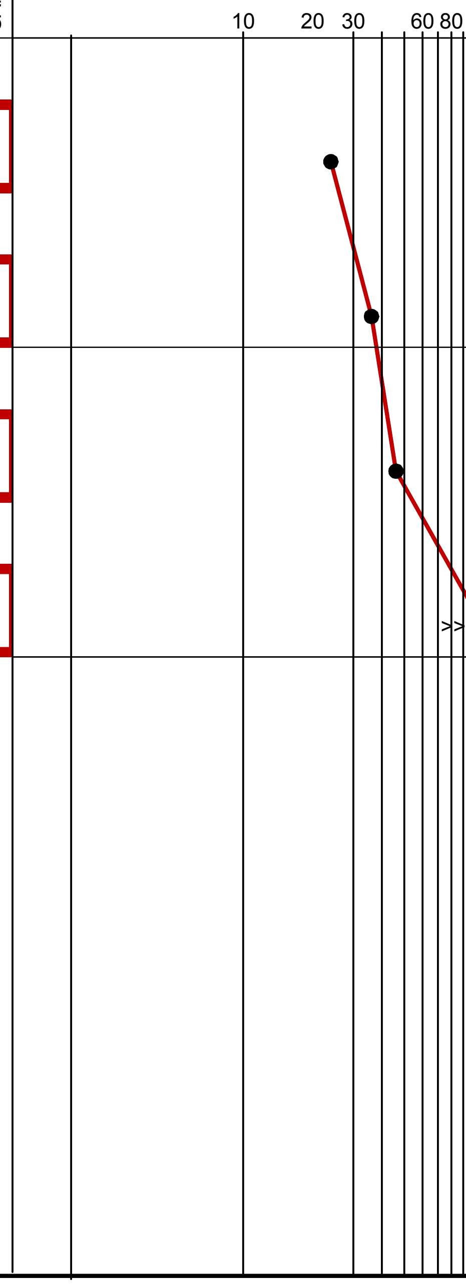
DATE DRILLED:	10/20/2010	ELEVATION:	
DRILLING METHOD:	2¼" H.S.A.	BORING DEPTH:	10
LOGGED BY:	WMJ	WATER LEVEL:	Not encountered
DRILLER:	Howard Wessinger	DRILL RIG:	CME 550

NOTES: Borings conducted at the approximate locations shown on Figure 2. No survey of boring locations or elevations was conducted by S&ME, Inc.

DEPTH (feet)	MATERIAL DESCRIPTION
0	**TOPSOIL** - approximately 8 inches of topsoil/plowzone.
	SILTY SAND (SM) - mostly fine to medium sands, some low to medium plasticity fines, moist, green, brown, trace black, medium dense to dense.
5	- increase in low to medium plasticity fines.
	PARTIALLY WEATHERED ROCK (PWR) - mostly fine to medium sands, some low plasticity fines, moist, dark green, brown, very dense.
10	BORING TERMINATED AT 10 FEET.

Columns: WATER LEVEL | ELEVATION (feet-MSL) | SAMPLE NO. | SAMPLE TYPE

STANDARD PENETRATION TEST DATA (blows/ft)



SAMPLE NO.	N VALUE
1	24
2	36
3	46
4	50/4"

BORING LOG 10-404LOGS.GPJ WITH CPT.GDT 11/2/10

NOTES:

1. *THIS LOG IS ONLY A PORTION OF A REPORT PREPARED FOR THE NAMED PROJECT AND MUST ONLY BE USED TOGETHER WITH THAT REPORT.*
2. *BORING, SAMPLING AND PENETRATION TEST DATA IN GENERAL ACCORDANCE WITH ASTM D-1586.*
3. *STRATIFICATION AND GROUNDWATER DEPTHS ARE NOT EXACT.*
4. *WATER LEVEL IS AT TIME OF EXPLORATION AND WILL VARY.*

S&ME ENGINEERING • TESTING ENVIRONMENTAL SERVICES

PROJECT: **Chester R&D Park Entrance Road**
Chester County, South Carolina
S&ME Project No. 1611-10-404

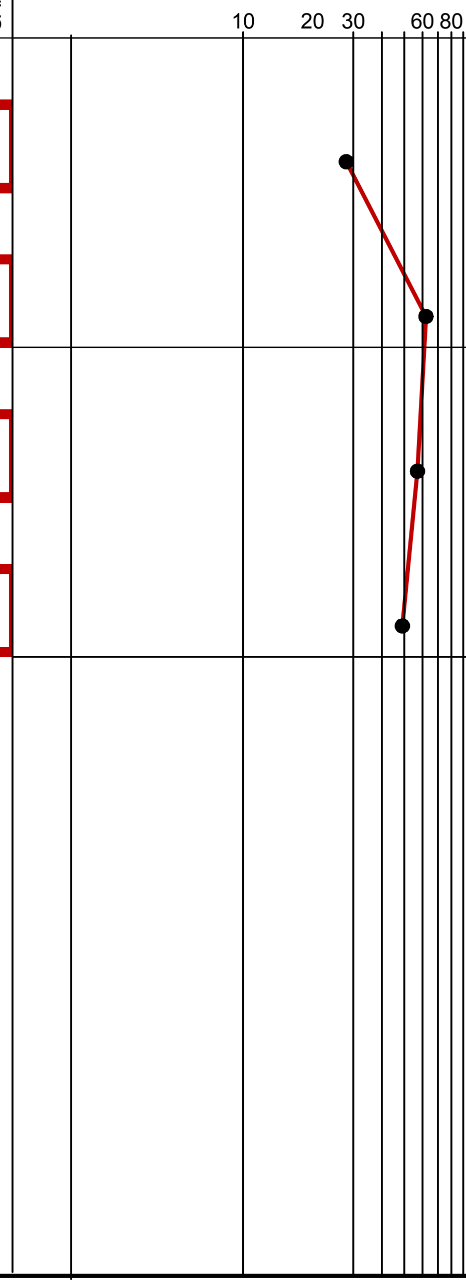
BORING LOG B-2

DATE DRILLED:	10/20/2010	ELEVATION:	
DRILLING METHOD:	2¼" H.S.A.	BORING DEPTH:	10
LOGGED BY:	WMJ	WATER LEVEL:	Not encountered
DRILLER:	Howard Wessinger	DRILL RIG:	CME 550

NOTES: Borings conducted at the approximate locations shown on Figure 2. No survey of boring locations or elevations was conducted by S&ME, Inc.

DEPTH (feet)	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet-MSL)	SAMPLE NO.	N VALUE
0–0.7	**TOPSOIL** - approximately 8 inches of topsoil/plowzone.				
0.7–3	**SANDY SILT (ML)** - mostly low to medium plasticity fines, some fine to medium sands, moist, dark green, brown, very stiff.			1	28
3–10	**SILTY SAND (SM)** - mostly fine to medium sand, some low to medium plasticity fines, moist, dark green, brown, dense to very dense.			2	62
				3	57
				4	49
10	BORING TERMINATED AT 10 FEET.				

STANDARD PENETRATION TEST DATA (blows/ft)



BORING LOG 10-404LOGS.GPJ WITH CPT.GDT 11/2/10

NOTES:

1. ***THIS LOG IS ONLY A PORTION OF A REPORT PREPARED FOR THE NAMED PROJECT AND MUST ONLY BE USED TOGETHER WITH THAT REPORT.***
2. ***BORING, SAMPLING AND PENETRATION TEST DATA IN GENERAL ACCORDANCE WITH ASTM D-1586.***
3. ***STRATIFICATION AND GROUNDWATER DEPTHS ARE NOT EXACT.***
4. ***WATER LEVEL IS AT TIME OF EXPLORATION AND WILL VARY.***

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PROJECT:	Chester R&D Park Entrance Road Chester County, South Carolina S&ME Project No. 1611-10-404	**BORING LOG B-3**

DATE DRILLED:	10/20/2010	ELEVATION:	
DRILLING METHOD:	2¼" H.S.A.	BORING DEPTH:	10
LOGGED BY:	WMJ	WATER LEVEL:	Not encountered
DRILLER:	Howard Wessinger	DRILL RIG:	CME 550

NOTES:
Borings conducted at the approximate locations shown on Figure 2. No survey of boring locations or elevations was conducted by S&ME, Inc.

DEPTH (feet)	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet-MSL)	SAMPLE NO.	STANDARD PENETRATION TEST DATA (blows/ft)	N VALUE
	TOPSOIL - approximately 6 inches of topsoil/plowzone.					
	SANDY SILT (ML) - mostly low to medium plasticity fines, some fine to medium sands, moist, brown, tan, trace orange, very stiff.			1		20
5	**SILTY SAND (SM)** - mostly fine to medium sands, some low plasticity fines, moist, brown, tan, green, trace orange, dense.			2		41
	PARTIALLY WEATHERED ROCK (PWR) - mostly fine to coarse sands, little low plasticity fines, moist, light brown, tan with white, very dense.			3	>>	50/5"
10	**SILTY SAND (SM)** - mostly fine sands, little low plasticity fines, moist, brown, tan, green, trace orange, dense.			4		38
	BORING TERMINATED AT 10 FEET.					

SPT scale: 10 20 30 60 80

NOTES:

1. *THIS LOG IS ONLY A PORTION OF A REPORT PREPARED FOR THE NAMED PROJECT AND MUST ONLY BE USED TOGETHER WITH THAT REPORT.*
2. *BORING, SAMPLING AND PENETRATION TEST DATA IN GENERAL ACCORDANCE WITH ASTM D-1586.*
3. *STRATIFICATION AND GROUNDWATER DEPTHS ARE NOT EXACT.*
4. *WATER LEVEL IS AT TIME OF EXPLORATION AND WILL VARY.*

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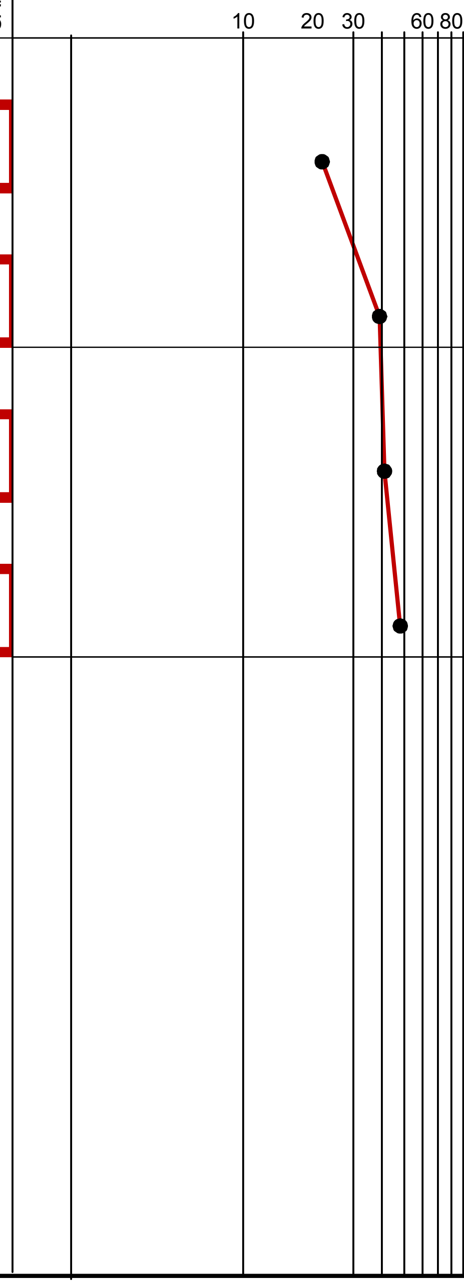
PROJECT:	Chester R&D Park Entrance Road Chester County, South Carolina S&ME Project No. 1611-10-404	**BORING LOG B-4**

DATE DRILLED: 10/20/2010	ELEVATION:	NOTES: Borings conducted at the approximate locations shown on Figure 2. No survey of boring locations or elevations was conducted by S&ME, Inc.
DRILLING METHOD: 2¼" H.S.A.	BORING DEPTH: 10	
LOGGED BY: WMJ	WATER LEVEL: Not encountered	
DRILLER: Howard Wessinger	DRILL RIG: CME 550	

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet-MSL)	SAMPLE NO.	SAMPLE TYPE	N VALUE
0		**TOPSOIL** - approximately 7 inches of topsoil/plowzone.					
		SANDY FAT CLAY (CH) - mostly medium to high plasticity fines, some fine to medium sands, moist, brown, very stiff.			1		22
		SANDY SILT (ML) - mostly low to medium plasticity fines, some fine sands, moist, green, tan, black, trace orange, hard.			2		39
5					3		41
		- micaceous, brown with tan, trace black.			4		48
10		BORING TERMINATED AT 10 FEET.					

STANDARD PENETRATION TEST DATA (blows/ft)



NOTES:

1. *THIS LOG IS ONLY A PORTION OF A REPORT PREPARED FOR THE NAMED PROJECT AND MUST ONLY BE USED TOGETHER WITH THAT REPORT.*
2. *BORING, SAMPLING AND PENETRATION TEST DATA IN GENERAL ACCORDANCE WITH ASTM D-1586.*
3. *STRATIFICATION AND GROUNDWATER DEPTHS ARE NOT EXACT.*
4. *WATER LEVEL IS AT TIME OF EXPLORATION AND WILL VARY.*

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Moisture - Density Report

Quality Assurance

S&ME, Inc. Columbia Branch, 134 Suber Road, Columbia SC 29210

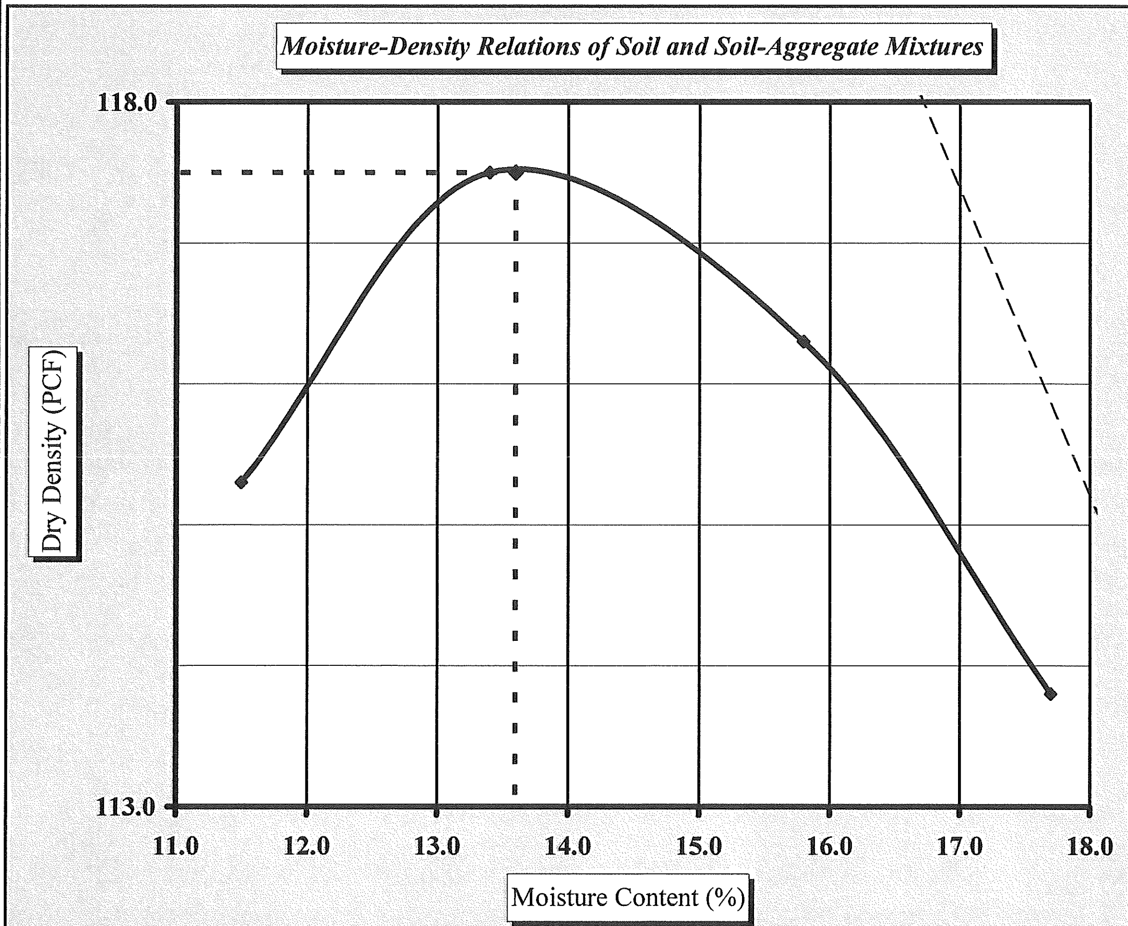
S&ME Project #:	**1611-10-404**	Report Date:	10/22/10
Project Name:	Chester Research & Development Park Entrance Road	Test Date(s):	10/22/10
Client Name:	Alliance Consulting Engineers, Inc.		
Client Address:	P.O. Box 8147, Columbia, South Carolina 29202-8147		

Boring #:	2	Sample #:	Bulk 1	Sample Date:	10/20/2010
Location:	B-2			Depth:	0-5.0'

Sample Description: Silty Sand (SM) low plast., fine to med. sand, yellowish-brown and green

Maximum Dry Density 117.5 PCF. **Optimum Moisture Content 13.6%**

ASTM D 698 -- Method A



Soil Properties

Natural Moisture Content	**8.8%**
Specific Gravity of Soil (D854)	
Liquid Limit	
Plastic Limit	
Plastic Index	

% Passing

#200	34.1%

Oversize Fraction

Bulk Gravity
% Moisture
% Oversize
MDD
Opt. MC

Moisture-Density Curve Displayed: Fine Fraction ☒ Corrected for Oversize Fraction (ASTM D 4718) ☐
Sieve Size used to separate the Oversize Fraction: #4 Sieve ☒ 3/8 inch Sieve ☐ 3/4 inch Sieve ☐
Mechanical Rammer ☒ Manual Rammer ☐ Moist Preparation ☐ Dry Preparation ☒

References / Comments / Deviations: ASTM D 854: Specific Gravity of Soils

ASTM D 2216: Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D 698: Laboratory Compaction Characteristics of Soil Using Standard Effort

William Jones		Staff Professional	10/22/2010
Technical Responsibility	*Signature*	*Position*	*Date*

Form No: TR-D1140-2
Revision No. 0
Revision Date: 10/26/07

Material Finer than the #200 Sieve

ASTM D1140

S&ME

Quality Assurance

S&ME, Inc. Columbia Branch, 134 Suber Road, Columbia SC 29210

Project #:	**1611-10-404**	Report Date:	10/22/10
Project Name:	Chester Research & Development Entrance Road	Test Date(s):	10/21/10-10/22/10
Client Name:	Alliance Consulting Engineers, Inc.		
Client Address:	P.O. Box 8147, Columbia, South Carolina 29202-8147		
Sample by:	Drillers	Sample Dates:	10/20/10
Sampling Method:			

Boring No. 2 | Sample No. Bulk 1 | Sample Depth: 0-5.0'

Sample Description: Silty Sand (SM) low plast., fine to medium sand, yellowish-brown and green

☐ *Auxiliary* | *#200 Wash* | Method A ☒ | Method B ☐

	Tare #:	211	Soaked ☒ *Soak Time*	6 hrs.
	Tare Wt. (T)	0.00	Original Dry Mass of Sample (B)	**289.41**
	Wet Wt + T	314.81	After 200 Wash + Tare Wt. (C_T)	190.66
	Dry Wt + T	289.41	Dry Mass Retained on #200 Sieve (C)	**190.66**
	Moisture Content (MC)	**8.8%**	**% Passing #200 Sieve (A)**	**34.1%**

Boring No. | Sample No. | Sample Depth:

Sample Description

☐ *Auxiliary* | *#200 Wash* | Method A ☐ | Method B ☐

	Tare #:		Soaked ☐ *Soak Time*	
	Tare Wt. (T)		Original Dry Mass of Sample (B)	
	Wet Wt (W) + T		After 200 Wash + Tare Wt. (C_T)	
	Dry Wt (D) + T		Dry Mass Retained on #200 Sieve (C)	
	Moisture Content (MC)		**% Passing #200 Sieve (A)**	

Boring No. | Sample No. | Sample Depth:

Sample Description

☐ *Auxiliary* | *#200 Wash* | Method A ☐ | Method B ☐

	Tare #:	B5	Soaked ☐ *Soak Time*	6 hrs.
	Tare Wt. (T)		Original Dry Mass of Sample (B)	
	Wet Wt (W) + T		After 200 Wash + Tare Wt. (C_T)	
	Dry Wt (D) + T		Dry Mass Retained on #200 Sieve (C)	
	Moisture Content (MC)		**% Passing #200 Sieve (A)**	

Balance ID. ***21294*** *Calibration Date:* ***1/25/10-11*** *#200 Sieve* ***21601*** *Calibration Date:* ***7/18/10***

Notes / Deviations / References: ASTM D1140: Amount of Material in Soil Finer Than the No. 200 (75-um)) Sieve

ASTM D 2216: Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass

% Passing #200 = A = [(B-C)/B] * 100

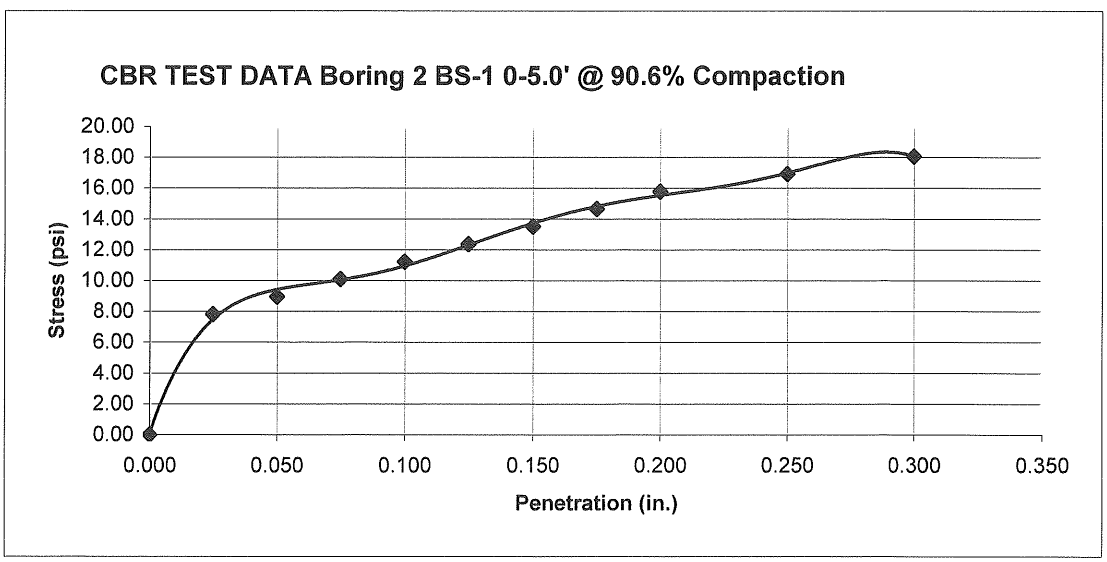
Brian Urban	______________	103699	10/22/2010
Technician Name	*Signature*	*Certification Type/No.*	*Date*
William Jones	______________	Staff Professional	10/22/2010
Technical Responsibility	*Signature*	*Position*	*Date*

ENVIRONMENTAL SERVICES
ENGINEERING • TESTING

CBR TEST DATA SHEET ASTM NO. D 1883-94

JOB NAME	Chester Research and Development Park			**Description**	Silty Sand (SM)
JOB NO.	1611-10-404	**Sample**	B-2	**WEIGHT OF SOIL + MOLD**	43.6645 lb.
TEST	1	**Blows**	10	**WEIGHT OF MOLD**	34.619 lb.
MAX DRY DENSITY		117.5	PCF	**WEIGHT OF WET SOIL**	9.0455 lb.
OPT MOISTURE CONTENT		13.6%		**WET UNIT WEIGHT**	120.8 pcf
% H2O after soak		24.4%		**% H2O pre soak**	13.5%
CBR PUNCH AREA		3.1416	Sq. in.	**DRY UNIT WEIGHT**	106.4 pcf
CBR SERIAL NO		459		**% COMPACTION**	**90.6%**
LOAD RING RATIO		1.7887			
LOAD RING CONSTANT		13.827		**% WATER ABSORBED**	10.9%
PERFORMED BY		BU		**PERCENT SWELL**	2.6 %

Actual Deformation (in)	Load Dial Reading	Stress (psi)	CBR	Corrected Stress	Corrected CBR
0	0	0.00			
0.025	6	7.82			
0.05	8	8.96			
0.075	10	10.09			
0.1	12	11.23	1.1	0	1
0.125	14	12.37			
0.15	16	13.51			
0.175	18	14.65			
0.2	20	15.79	1.1	0	1
0.25	22	16.93			
0.3	24	18.07			



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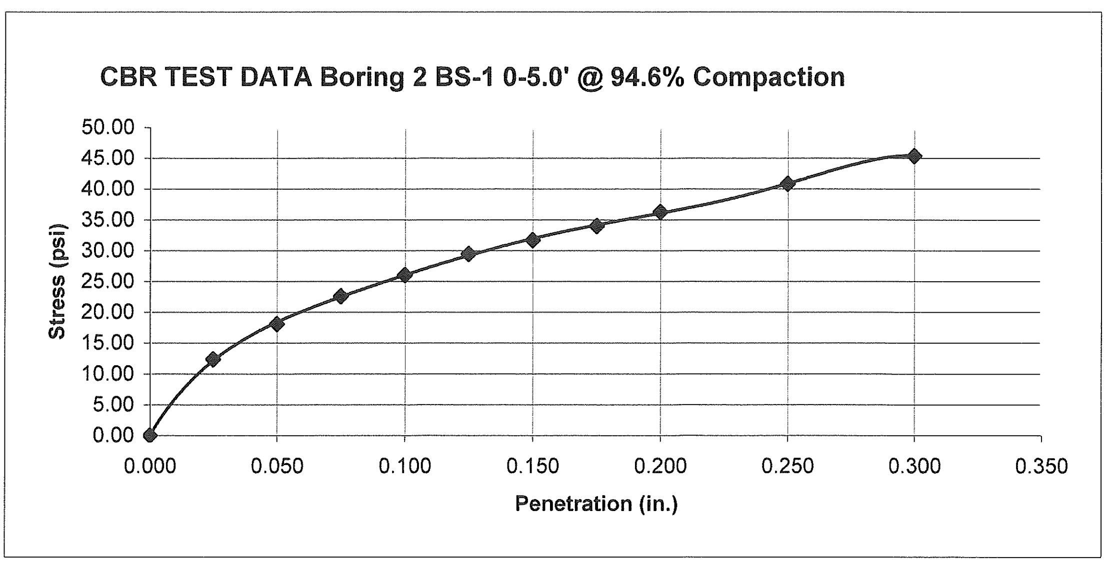
CBR TEST DATA SHEET ASTM NO. D 1883-94

JOB NAME	Chester Research and Development Park	**Description**	Silty Sand (SM)
JOB NO.	1611-10-404 **Sample** B-2	**WEIGHT OF SOIL + MOLD**	44.209 lb.
TEST	2 **Blows** 25	**WEIGHT OF MOLD**	34.758 lb.
MAX DRY DENSITY	117.5 PCF	**WEIGHT OF WET SOIL**	9.451 lb.
OPT MOISTURE CONTENT	13.6%	**WET UNIT WEIGHT**	126.2 pcf
% H2O after soak	20.4%	**% H2O pre soak**	13.5%
CBR PUNCH AREA	3.1416 Sq. in.	**DRY UNIT WEIGHT**	111.2 pcf
CBR SERIAL NO	459	**% COMPACTION**	**94.6%**
LOAD RING RATIO	1.7887		
LOAD RING CONSTANT	13.827	**% WATER ABSORBED**	6.9%
PERFORMED BY	BU	**PERCENT SWELL**	2.7 %

Actual Deformation (in)	Load Dial Reading	Stress (psi)	CBR	Corrected Stress	Corrected CBR
0	0	0.00			
0.025	14	12.37			
0.05	24	18.07			
0.075	32	22.62			
0.1	38	26.04	2.6	0	3
0.125	44	29.45			
0.15	48	31.73			
0.175	52	34.01			
0.2	56	36.29	2.4	0	2
0.25	64	40.84			
0.3	72	45.40			



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CBR TEST DATA SHEET ASTM NO. D 1883-94

JOB NAME	Chester Research and Development Park	**Description**	Silty Sand (SM)
JOB NO.	1611-10-404 **Sample** B-2	**WEIGHT OF SOIL + MOLD**	44.665 lb.
TEST	3 **Blows** 52	**WEIGHT OF MOLD**	34.706 lb.
MAX DRY DENSITY	117.5 PCF	**WEIGHT OF WET SOIL**	9.959 lb.
OPT MOISTURE CONTENT	13.6%	**WET UNIT WEIGHT**	133.0 pcf
% H2O after soak	19.4%	**% H2O pre soak**	13.4%
CBR PUNCH AREA	3.1416 Sq. in.	**DRY UNIT WEIGHT**	117.3 pcf
CBR SERIAL NO	459	**% COMPACTION**	**99.8%**
LOAD RING RATIO	1.7887		
LOAD RING CONSTANT	13.827	**% WATER ABSORBED**	6.0%
PERFORMED BY	BU	**PERCENT SWELL**	2.8 %

Actual Deformation (in)	Load Dial Reading	Stress (psi)	CBR	Corrected Stress	Corrected CBR
0	0	0.00			
0.025	18	14.65			
0.05	32	22.62			
0.075	44	29.45			
0.1	58	37.42	3.7	0	4
0.125	68	43.12			
0.15	78	48.81			
0.175	88	54.50			
0.2	96	59.06	3.9	0	4
0.25	110	67.03			
0.3	122	73.86