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Date **February 26, 2010** By **LY Frost**

REVISED HYDROGEOLOGIC STUDY

INDUSTRIAL LANDFILL #1

DUKE ENERGY – MARSHALL STEAM STATION

TERRELL, NORTH CAROLINA

S&ME PROJECT NO. 1356-08-122

Volume 2

Prepared for:

526 South Church Street
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May 2009

May 8, 2009

North Carolina Department of Environment and Natural Resources
Asheville Regional Office – Division of Solid Waste
2090 US Highway 70
Swannanoa, North Carolina 28778

Attention: Mr. Larry Frost, Regional Engineer

Reference: **Marshall Steam Station Industrial Landfill #1**
Landfill Permit Application – Revised Hydrogeologic Study, Volume 2
Duke Energy – Marshall Steam Station
Terrell, North Carolina
S&ME Project No. 1356-08-122

Dear Mr. Frost:

S&ME is pleased to submit this revision to the Marshall Steam Station Industrial Landfill #1 Hydrogeologic Study, Volume 2. This revised report supersedes the Hydrogeologic Study dated June 19, 2008 (S&ME Project 1411-07-103). This revised report presents the changes to the footprint and includes additional boring and hydrogeologic data collected since the previous report. As requested, we have provided two copies of this report revision with CDs containing an electronic version. If you have any questions please contact us at your convenience.

Respectfully Submitted,

S&ME, Inc.

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INTRODUCTION

S&ME has completed a revised hydrogeologic study for the proposed Industrial Landfill #1 ("landfill") for Duke Energy's Marshall Steam Station (MSS) located on Highway 150 in Terrell, Catawba County, North Carolina. This report is a revision to the original hydrogeologic study submitted for the site on June 19, 2008. The revision is due to additional geotechnical and hydrogeological work performed at the site to investigate various proposed landfill footprint options. The various footprint options reviewed, and the final footprint selected, are presented in the Site Suitability Report. The single footprint represented in this Revised Hydrogeologic Study is the final footprint selected from the Site Suitability Report.

The purpose of this study was to evaluate the general subsurface conditions in the proposed landfill area to obtain hydrogeologic information required by the North Carolina Solid Waste Management Rule 15A NCAC 13B .0504. Results of our field and laboratory testing are summarized in the tables and included in Appendices I and II. Calculations for the estimated long-term seasonal high groundwater elevations are included in **Appendix III** and the hydrogeologic drawings are included with the Figures.

1.0 PROJECT DESCRIPTION

To meet on-going needs for combustion product disposal, Duke Energy engaged S&ME to conduct a hydrogeological study for an industrial landfill within the confines of the MSS property. The prospective landfill site is illustrated on ***Figure 1 - Topographic Site Map*** and ***Figure 2 – Aerial Site Map***.

The proposed Industrial Landfill #1 will be located on the northern portion of the MSS property which will encompass approximately 116 acres. The proposed landfill will include a double liner system consistent with recent state legislation specific to combustion product landfills.

The proposed landfill will contain combustion product residuals including fly ash, bottom ash, boiler slag, mill rejects, and flue gas desulferization residue generated at the Marshall Steam Station. The landfill could also potentially receive on-site construction and demolition waste, as well as asbestos from MSS and/or other Duke Energy Facilities. The proposed landfill will have a lifespan of approximately 15 to 20 years, in which it is anticipated that the average annual disposal rate will be approximately 750,000 cubic yards.

2.0 SITE CONDITIONS

The proposed landfill is located on the northern portion of the MSS property northwest of the existing asbestos and C&D landfills. The site is predominately wooded and has not been previously developed and is characterized by rolling topography consisting of ridges and valleys typical of the Piedmont of North Carolina. The proposed landfill area generally slopes from north to south towards a former portion of the existing ash basin. The former portion of the ash basin encompasses the low lying areas of the site in

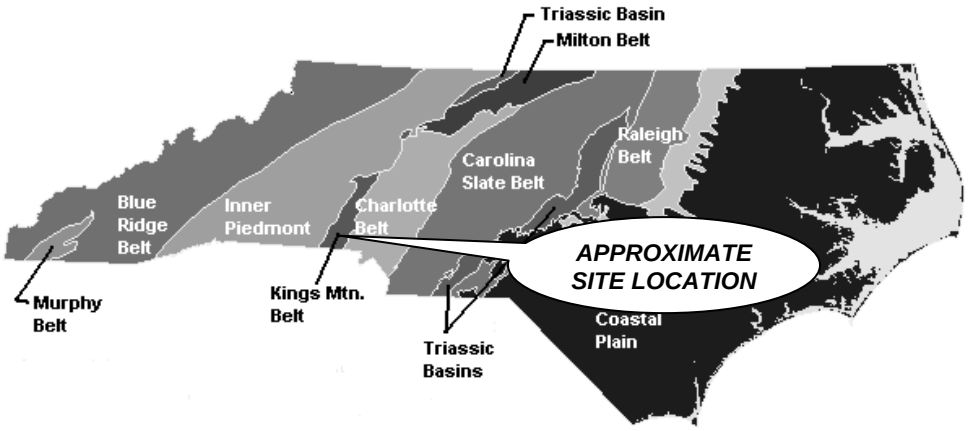
between the residual ridge lines. The ash basin is predominately dry with isolated areas of surface water. The former ash portion of the basin is separated from the current ash basin by a dike which runs to the southeast of the proposed landfill footprint.

3.0 REGIONAL GEOLOGY AND HYDROGEOLOGY

The MSS is situated in the King's Mountain Belt of the Piedmont Physiographic Province of North Carolina. The area is underlain by metamorphic rock covered by a thick layer of residual soil and weathered rock (regolith) in most places. Groundwater occurs in the soil/weathered rock layer and in the underlying bedrock. Springs and seeps may be common along drainage features and surface water bodies. Lake Norman is adjacent to and east of the MSS.

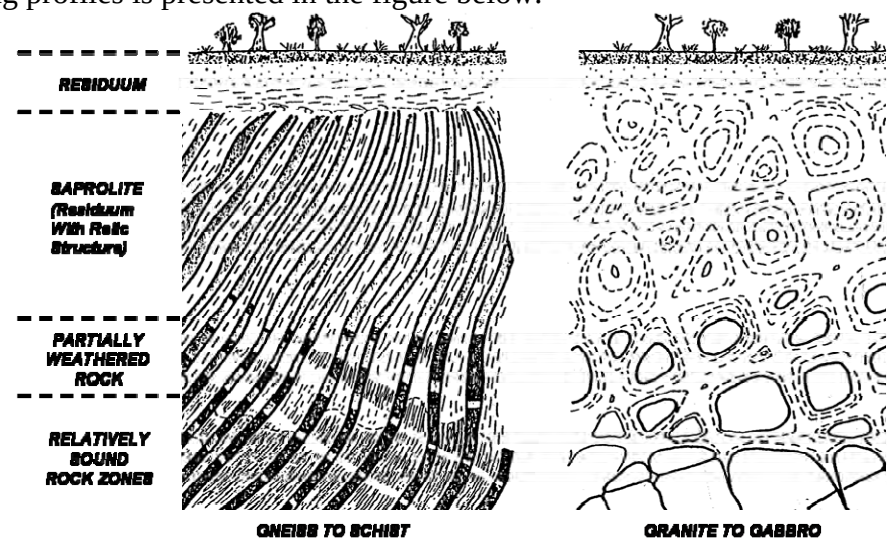
3.1 Geology and Topography

The MSS is located in the Piedmont Geologic Province, specifically within the King's Mountain Belt. Igneous and metamorphic rock, which is covered by a thick layer of residual soil and weathered rock (regolith), predominantly underlie this region of North Carolina. Rock consists largely of schist, gneiss, diorite and granite formed during the Precambrian and Paleozoic Eras as illustrated on ***Figure 3 - Geologic Map***. Foliation and/or contacts between rock types strike northeast-southwest, with dip angles ranging from vertical to 45 degrees in the area. While numerous types of rock occur in Catawba County, mica schist, gneiss and granite are the most prevalent rock types within the landfill property and surrounding area.



The topography and relief of the Piedmont has developed from differential weathering of the igneous and metamorphic rock. Ridges and hills have developed over the more resistant rock, whereas gently rolling, subdued topography has developed on the more easily weathered and erodible rock. Because of continued weathering, the rock in the Piedmont Province is now generally covered with a mantle of soil that has formed from the in-place weathering of the parent bedrock. The soils that overlie bedrock have variable thickness, and are generally referred to as residuum (residual soils) and saprolite. The residuum is typically finer grained, has a higher clay content, and retains less of the

original rock and mineral structure than the underlying saprolite because of the advanced weathering. Similarly, the soils typically become coarser grained with increasing depth because of decreased weathering. As the degree of weathering decreases, residuum grades into saprolite, which generally retains the overall appearance, texture, gradation, foliation and structure of the parent rock. Saprolite generally grades into partially weathered rock and fractured rock with increasing depth as the unweathered bedrock is approached. The transition between residuum, saprolite and partially weathered rock is gradational and varies laterally and vertically. A graphic depiction of typical Piedmont weathering profiles is presented in the figure below.



Typical Piedmont Weathering Profiles (After Sowers/Richardson, 1983)

3.2 Hydrogeology

Groundwater generally occurs within the residuum and saprolite under unconfined aquifer conditions. Because of the heterogeneous texture and structure of saprolite, alternating layers of differing moisture content are common. The residuum and saprolite typically have a high total porosity, but a low permeability. Therefore, these soils store water from precipitation and slowly recharge the underlying bedrock aquifer by downward infiltration. The partially weathered rock layer is a transition layer from the overlying saprolite to the underlying bedrock, and is often more permeable than the underlying material, depending on the percentage of fine-grained sediment and secondary porosity.

Groundwater occurs in the bedrock along fractures, joints and other openings created by weathering. The groundwater surface may occur within the bedrock when the bedrock is relatively close to the ground surface. Within the Piedmont, low permeable units or aquitards do not typically exist that would result in a confining layer separating the bedrock from the overlying soils. Thus the soils and bedrock are generally in hydraulic connection.

The number of fractures in the bedrock generally decreases with depth. As a result, the highest water bearing zones generally are encountered within the upper 30 feet of the bedrock.

Groundwater percolation to deeper portions of the bedrock is restricted by the decrease in available flow paths (fractures) with depth. The groundwater is forced to follow fractures to discharge points near streams and springs. Thus, movement of groundwater is from recharge areas (topographic highs) to discharge areas (streams and springs). Groundwater fluctuations are typically the result of changes in precipitation and seasonal evapotranspiration. Groundwater levels generally begin to decline in April or May due to increasing evapotranspiration and continue to decline through October/November after plants become dormant and temperatures decrease. Long-term changes in the groundwater levels occur due to abnormal wet or dry periods. During winter months, precipitation recharges the aquifer as evapotranspiration losses decrease and with an increase in frontal-type rainfall events. Generally, the highest groundwater levels occur between March and May. Groundwater fluctuations due to withdrawal by pumped wells is not great in the region (LeGrand, 1961).

In the Catawba County area, most industrial and domestic water supplies are obtained from wells. Dug and bored wells are common in rural areas and obtain water from the weathered zone above bedrock. Wells drilled into bedrock typically have higher yields than bored or dug wells. However, drilled wells that do not intersect water-bearing fractures can have very low yields. As a result individual wells show a great range of yield in the area. Generally, wells drilled on ridges and hills are lower producing than wells drilled on flat areas and in draws and valleys.

The depth to groundwater table varies from zero in valleys, to more than 100 ft below the ground surface on sharply rising hills. In general, and under natural conditions, the groundwater surface is a subdued reflection of the land surface.

Groundwater quality in the Catawba County area varies due to local variations in rock type. The majority of groundwater aquifers meet primary and secondary drinking water standards. Excessive iron, manganese or sulfate may occur in some areas.

4.0 SITE GEOTECHNICAL EVALUATION

4.1 Field Exploration

Beginning on October 31, 2007 and ending on October 3, 2008, forty-seven (47) soil test borings were drilled within proposed landfill area. Locations of the soil test borings are included on the attached ***Figure 4 – Boring and Well Location Plan***. The borings were advanced with a truck mounted and an all terrain vehicle (ATV) mounted drill rigs equipped with hollow stem augers (HSA) and casing advancer. The truck rig was used in easily accessible areas where minimal clearing was required. The ATV rig was used in areas where more clearing was needed to access the boring locations.

Standard penetration tests (SPT) as specified in ASTM D-1586-84 were used to collect soil samples from the borings. The soil samples were collected at five-foot intervals and classified by the on-site geologist for textural and lithological characteristics. The soil test borings were drilled to casing or auger refusal. Detailed descriptions of the

subsurface conditions encountered at the boring locations are presented on the boring logs in **Appendix I**.

At boring location M-2, the boring was extended beyond the refusal depth by NQ rock coring methods. A total core run of ten feet was performed, and a rock recovery rate of 74% was measured. A rock quality designation (RQD) of 60% was calculated for rock recovered from the M-2 boring.

Bulk samples from five (5), ten (10) and fifteen (15) feet below the ground surface were collected at boring locations M-1, M-2, M-3, M-4, M-6, M-7, M-8, and M-16. Bulk samples were also collected from various five-foot interval depths at boring locations M-17, M-18, M-19, M-20, M-21, M-23, M-24, M-25, M-26, M-28, M-31, M-33, M-35, M-39, M-40, M-41, and M-42.

4.2 Laboratory Testing

Each bulk sample referenced above was transported to our Spartanburg, South Carolina or Charlotte, North Carolina soil laboratories for classification. The bulk samples were analyzed for natural moisture content, grain size distribution with hydrometer, standard proctor, and Atterberg Limits. Remolded constant head permeability test were performed on selected bulk samples from borings M-2, M-6, M-7, and M-8. Hydrometer testing was also run on select split spoon samples. Some hydrometer samples were selected from lithologically representative soils within screened intervals, while others were selected for site characterization purposes. A summary of laboratory tests performed on soil samples is included in ***Table 7 – Summary of Laboratory Test Data***, and laboratory data sheets are included in **Appendix II**.

4.3 Subsurface Conditions

The subsurface conditions within the proposed landfill site consist of residual soils and partially weathered rock (PWR) which have formed by the in-place weathering of the parent bedrock. Ash was overlying the residual soils within the retired portion of the ash basin. The residual soils grade with depth into zones of PWR that generally overlie the underlying bedrock.

Subsurface generalizations are depicted on ***Figure 8 – Cross Section Location Plan, Figure 9 – Cross Sections A-A'/B-B'***, and ***Figure 10 – Cross Sections C-C'/D-D'***. More detailed information is provided on boring logs and rock core photos included in **Appendix I**. In general, the transition between the material types is gradual (in the vertical and horizontal dimensions) and may not be an abrupt change as depicted in the boring logs or cross sections. Actual soil profiles and conditions intermediate of boring locations should be expected to vary.

The following Sections include generalized descriptions of the five (5) subsurface materials encountered within the site. A summary of depths in which the five (5) subsurface materials were encountered is included in ***Table 3 – Geologic and Hydrogeologic Data***.

Residuum: Residuum is the weathered, unconsolidated material usually found beneath the topsoil. Very little of the physical characteristics of the parent bedrock are retained. Residuum was primarily encountered from the ground surface to depths ranging from two to 24 feet below ground surface. The residuum encountered ranged from silty clays to clayey silts and sandy silts.

Ash: Ash is the by-product of coal combustion. Where encountered, the ash had textural characteristics of fine sandy silts and silty fine sands. Ash was encountered at boring M-5 from the ground surface to about 30 feet.

Saprolite: Saprolite is the product of weathered bedrock and usually retains some physical characteristics of the parent bedrock. Saprolite is an unconsolidated material that usually grades with depth into PWR or bedrock. The saprolite encountered was predominantly silty sands, sandy silts, and clayey silts. The saprolite extends to depths ranging from ground surface to 90 feet below ground surface.

Partially Weathered Rock (PWR): PWR is defined as material exhibiting Standard Penetration Resistances in excess of 100 blows per foot and is often classified as penetrable, residual materials which when sampled typically become coarse to fine sandy silt or silty coarse to fine sand. Lithologically, the PWR found in the borings is characterized as silty coarse to fine sands and coarse to fine sands. The PWR encountered extended to depths ranging from ground surface to 109.5 feet below ground surface.

Bedrock: For the purpose of this assessment, bedrock is defined as material that could not be penetrated with the drill rig equipment used on the project. When sampled, the bedrock from the core samples was classified as granite. Horizontal to high-angle fractures are present in the upper ten feet of bedrock. Many fractures are iron stained indicating flow of oxidizing groundwater. Bedrock was encountered at depths ranging from 12.2 to 109.5 feet below ground surface in the borings. The bedrock surface was not encountered in borings M-61 and M-62. Bedrock surface contours are included on ***Figure 7 – Top of Bedrock Map***.

5.0 SITE HYDROGEOLOGICAL EVALUATION

5.1 Observation Well Installation and Development

Observation wells were installed in thirty-seven (37) of the borings drilled during this assessment. The wells were constructed of either one or two-inch PVC screen and casing. The wells were constructed through the HSA or casing with varying screen lengths in an attempt to bracket the groundwater surface with the screened interval. A medium grain filter sand was installed around and above the screened section of each well. Above the filter sand, bentonite pellets were installed and hydrated. The remaining annular space above the bentonite seal was filled with a mixture of Portland cement and powdered bentonite.

Each well was completed above grade with a lockable steel casing and a two-foot by two-foot concrete pad. At locations designated by Duke Energy, protective bollards were

installed around the observation wells. Well locations are shown on the attached ***Figure 4 – Boring and Well Location Plan***. The well construction details are summarized in ***Table 1 – Survey and Well Construction Data***. Well logs are included in **Appendix I**.

After the observation wells were installed, they were surveyed by a North Carolina Registered Land Surveyor with Chas H. Sells, Inc. for state plane coordinates, ground surface elevation, and top of PVC casing elevation.

Also following installation, the wells were developed by purging with an electrical pump and polyethylene tubing. Development continued until the water discharge was relatively clear and free of suspended sediment.

5.1.1 Regulatory Documentation

After well completion, S&ME submitted well records to the North Carolina Department of Environment and Natural Resources (NCDENR) on behalf of Duke Energy. Copies of the well records are included in **Appendix I**.

5.2 Field Testing for Permeability

In-situ falling head permeability testing was conducted within saturated soils of borings M-1, M-2, M-5, M-6, M-8, and M-16. The permeability testing was conducted by installing three-inch steel casing into the desired soils and/or ash, filling the inside of the casing with water and measuring the change in the water level with time within the casing with a down hole pressure transducer/data logger.

Six (6) falling head permeability tests performed within the saprolite indicated hydraulic conductivity ranging from 8.5E-05 to 1.1E-04 cm/sec. Five (5) falling head tests performed within the PWR indicated hydraulic conductivity ranging from 6.1E-06 to 3.0E-05 cm/sec. One (1) falling head test performed in ash indicated a hydraulic conductivity of 1.2E-03 cm/sec. Results of falling head permeability testing are summarized in ***Table 4 - Summary of Permeability Data***, and test data evaluation sheets are included in **Appendix II**.

After installation and development of the observation wells (discussed above), in-situ rising head permeability tests (slug tests) were performed in selected observation wells to evaluate the horizontal permeability or hydraulic conductivity of the subsurface materials. In-situ tests were performed using a rising head technique that was accomplished by measuring the static water level within the well, removing a portion of the water within the well by pumping and measuring the rate of water level recovery with respect to time with a down hole pressure transducer/data logger. The data for these tests were analyzed using the Bouwer and Rice Graphical method as presented in **Appendix II**.

Slug testing of four (4) wells screened predominantly within the saprolite indicated a hydraulic conductivity range from 1.0E-04 to 1.0E-03 cm/sec. Slug testing of four (4) wells screened predominantly within the PWR indicated a hydraulic conductivity ranging from 2.0E-04 to 8.4E-04 cm/sec. Results of rising head permeability testing are summarized in

Table 4 - Summary of Permeability Data, and test data evaluation sheets are included in **Appendix II**.

5.3 Hydrogeologic Calculations

5.3.1 Groundwater Levels and Groundwater Surface

Water levels were measured in the observation wells at time of installation, at 24-hours following installation and periodically thereafter. Water level data collected in the observation wells are provided in ***Table 2 – Groundwater Level Elevations***. The groundwater level data collected on November 26, 2008 is presented on ***Figure 5 - Groundwater Surface Map***. The water levels from the observation wells in the proposed landfill area and the site topography were used to create the Groundwater Surface Map.

5.3.2 Hydraulic Conductivity

Estimation of hydraulic conductivity based on grain size was calculated for each soil sample in which a grain size with hydrometer laboratory test was performed. The method used to calculate the hydraulic conductivity is Harleman et al. (1963). The calculation sheets detailing the formulas are presented in **Appendix III**, and estimates are presented in ***Table 4 - Summary of Permeability Data***. Based on this method, hydraulic conductivity ranged from 5.70E-05 to 3.56E-04 cm/sec in the residuum, from 1.12E-06 to 2.89E-02 cm/sec in the saprolite, and from 5.84E-06 to 2.76E-02 cm/sec in the PWR.

Based on work within the Duke Energy Allen Steam Station Retired Ash Basin, hydraulic conductivity for ash should be similar to the ash encountered at the Marshall Steam Station site. The results of the Allen Steam Station Study found hydraulic conductivity for ash to range from 1.1E-03 to 4.1E-02 cm/sec.

5.3.3 Total and Effective Porosity

Total and effective porosity values were estimated for each soil sample in which a grain size with hydrometer laboratory test was performed. Estimates calculated from grain size were based on the soil classification and the "Variation of Porosity, Specific Yield, and Specific Retention with Grain Size" table (Bear, J., 1972) in conjunction with the textural classification triangle for unconsolidated materials showing the relationship between particle size and specific yield (Fetter, C.W., 1994). The estimated total porosity value ranged from 44% to 50% in residuum, from 42% to 50% in saprolite, and from 42% to 45% in PWR. Calculations are presented in **Appendix III**, and estimates are included in ***Table 5 - Summary of Porosity Data***.

Based on work within the Duke Energy Allen Steam Station Retired Ash Basin, total porosity for ash should be similar to the ash encountered at the Marshall Steam Station site. The results of the Allen Steam Station Study found total porosity for ash to range from 43% to 46%.

5.3.4 Horizontal Hydraulic Gradients

Horizontal hydraulic gradients were calculated between thirty-two (32) well locations within the proposed landfill area by dividing the difference in elevation head by the distance between two end points of a projected groundwater flow path through the observation well that intersects the upgradient and/or downgradient equipotentials. Horizontal hydraulic gradients ranged from 0.002 to 0.043 ft/ft. Calculations are included in **Appendix III**.

5.3.5 Groundwater Flow Rates

Horizontal groundwater flow rates in the landfill observation wells were calculated and summarized in ***Table 6 – Groundwater Flow Velocity***. These flow rates are based on the horizontal hydraulic gradients obtained from ***Figure 5 - Groundwater Surface Map***, estimated effective porosity for the predominant lithologic unit in the saturated interval of the screen, and the calculated hydraulic conductivity based on the in-situ permeability tests. As presented in Table 6, groundwater flow rates could range from 11 to 60 feet per year (geometric average of 24 feet per year) in the landfill.

Groundwater flows from higher potential to lower potential, perpendicular to the contours of equal potential shown on ***Figure 5 – Groundwater Surface Map***. In general, the uppermost aquifer in the landfill area is expected to be typical of local and regional conditions. The predominant groundwater discharge areas are expected to be the ash basin located south of the proposed landfill area and ultimately discharging into Lake Norman.

5.3.6 Estimated Long-Term Seasonal High Groundwater

Figure 6 - Estimated Long-Term Seasonal High Groundwater Surface Map, was generated based on historical water level data from five existing groundwater monitoring wells located on the Duke Energy property (MW-1 through MW-5), water level measurement data collected in the landfill observation wells, and local precipitation data. Hydrographs of the water levels were developed for the on-site monitoring wells to evaluate long-term seasonal high water levels relative to precipitation. Hydrographs of the observation wells were also developed to evaluate trends in water level elevations on-site. Groundwater level data used for the evaluation and historical monthly rainfall data is presented in **Appendix III**.

The on-site monitor well hydrographs (MW-1 through MW-5) from 1989 to 2008 indicate that seasonal high water levels generally occur during the months of February and March. Water level elevations in the monitoring wells were compared with precipitation data for the period from August 1989 through February 2008. Groundwater fluctuations were calculated as the difference between maximum water levels and minimum water levels. The groundwater fluctuations range from approximately 3.07 feet in M-3 to 10.77 feet in M-4.

The estimated long-term seasonal high calculation was performed statistically to take into account the high water levels recorded during unseasonably wet periods and the low water levels recorded during drought conditions. Data was used from the on-site monitoring wells (MW-1 through MW-5), because these wells have the longest period of water level information on-site and include data from both peak water levels to low water levels. The

estimated long-term seasonal high groundwater (ELSHG) elevations for each "MW" well were computed by adding the mean (average) to 1.80 times the standard deviation.

Once the ELSHG elevation was calculated for the on-site monitor wells (MW-1 through MW-5), the ELSHG elevation was compared to the January 2009 water level elevations on-site and the difference was calculated. The ELSHG elevations ranged from 0.97 feet higher in MW-2 to 10.05 feet higher in MW-4 than the January 2009 water level elevations.

To calculate the long-term seasonal high elevations for the observation wells, a modification factor (in feet) was established and added to their respective January 2009 water level elevation. The modification factor was established by correlating (1) the depth to groundwater in January 2009 for the monitoring wells, (2) the topographic position (i.e. ground surface elevation and proximity to the drainage features) of the observation wells with the monitoring wells and (3) the trend in water levels for the years 2007 to 2009.

Modification factors were selected from 3 to 10 feet, based on topographic setting. Topographic high areas showing a downward trend in water level elevations received a modification factor of 10 feet. Topographic low areas showing an upward trend in water level elevations received a 3-foot modification factor. Areas on low ridges and side slopes showing a slight decreasing trend in water level elevations received a modification factor of 6.5 feet. A summary of estimated long-term seasonal high groundwater calculations are included in **Appendix III**.

5.4 Fracture Trace Analysis

S&ME performed a fracture trace analysis of the Marshall Steam Station Site and surrounding areas. Information about the structural geology of the area was obtained by reviewing topographic maps for fracture traces within a 2-mile radius of the proposed landfill. Fracture traces are recognized on maps as relatively straight-line, non-man made topographic depressions, which are interpreted as surface expressions of underlying fracture zones in the bedrock. The identification of such straight-line features was limited to features greater than or equal to 1,000 feet in length. The location of such fracture traces may aid in the location of zones of high hydraulic conductivity. Sixty-eight (68) fracture traces were identified within a 2-mile radius of the site and are included on ***Figure 11 – Fracture Trace Survey***.

The fracture traces were plotted on a rose diagram, included as ***Figure 12 – Fracture Trace Orientations***, which graphically represents the percentage of fracture traces with orientations occurring in each 10°-azimuth increment. The principle direction bearing of NNE-SSW is indicated on the diagram.

TABLES

Table 1
Survey and Well Construction Data

Marshall Steam Station - Industrial Landfill #1
S&ME Project No. 1356-08-122

Well ID	Northing	Easting	Ground Surface Elevation (ft-msl)	Top of Casing Elevation (ft-msl)	Stick-up (ft-als)	Riser Interval (ft-bls)			Screen Interval (ft-bls)			Grout Interval (ft-bls)			Bentonite Interval (ft-bls)			Sand Pack Interval (ft-bls)		
M-1	687075.01	1413867.46	859.07	862.08	3.01	0	to	27	27	to	42	0	to	21	21	to	24	24	to	64
M-2	686774.57	1414098.95	874.39	877.13	2.74	0	to	34	34	to	49	0	to	23	23	to	25	25	to	64
M-3	686163.24	1413443.01	863.19	865.88	2.69	0	to	31.5	31.5	to	46.5	0	to	25.5	25.5	to	27.5	27.5	to	47.5
M-4	687301.05	1413270.16	861.37	864.24	2.87	0	to	30	30	to	45	0	to	25.7	25.7	to	28	28	to	50
M-5	685668.07	1412934.33	822.47	825.42	2.95	0	to	3	3	to	13	0	to	1	1	to	2	2	to	13
M-6	686179.43	1412744.60	836.36	839.22	2.86	0	to	15	15	to	30	0	to	10	10	to	13	13	to	86.7
M-7	686621.67	1412692.59	851.33	854.05	2.72	0	to	29	29	to	44	0	to	25	25	to	27	27	to	80
M-8	687227.07	1412672.82	888.98	891.04	2.06	0	to	42.5	42.5	to	57.5	0	to	33	33	to	35	35	to	62.5
M-16	685522.45	1413572.10	845.85	848.64	2.79	0	to	28	28	to	43	0	to	18.5	18.5	to	21	21	to	55.5
M-18	687148.90	1414082.50	874.03	876.78	2.75	0	to	40	40	to	50				0	to	38	38	to	51
M-19	687440.10	1413711.50	864.82	867.10	2.28	0	to	34	34	to	44				0	to	32	32	to	45
M-20	687428.80	1413132.30	873.40	876.37	2.97	0	to	39.8	39.8	to	49.8				0	to	37	37	to	49.8
M-21	687077.00	1412573.90	880.11	882.72	2.61	0	to	22.6	22.6	to	32.6				0	to	20	20	to	32.6
M-23	687192.10	1413001.80	837.73	840.24	2.51	0	to	12.3	12.3	to	22.3				0	to	10	10	to	22.3
M-25	687001.50	1413600.10	844.33	847.22	2.89	0	to	18	18	to	28				0	to	16	16	to	29
M-26	686948.80	1413298.10	840.87	843.40	2.53	0	to	22	22	to	32				0	to	20	20	to	33
M-28	686958.90	1412819.90	849.69	852.45	2.76	0	to	14.4	14.4	to	24.4				0	to	12	12	to	24.4
M-29	686756.50	1412530.80	840.75	843.36	2.61	0	to	1.4	1.4	to	11.4				0	to	0.5	0.5	to	11.4
M-31	686676.70	1412122.00	878.93	881.36	2.43	0	to	36.9	36.9	to	46.9				0	to	35	35	to	46.9
M-34	686721.40	1413165.80	827.97	830.49	2.52	0	to	4	4	to	14				0	to	2	2	to	15
M-36	686908.30	1413841.80	838.81	842.03	3.22	0	to	10	10	to	20				0	to	8	8	to	21
M-37	686621.10	1413940.70	872.73	875.30	2.57	0	to	34.2	34.2	to	44.2				0	to	32	32	to	44.2
M-38	686612.20	1413666.20	857.75	860.38	2.63	0	to	27	27	to	37				0	to	25	25	to	38
M-39	686575.40	1414077.20	854.21	856.89	2.68	0	to	20.3	20.3	to	30.3				0	to	18	18	to	31.3
M-41	686254.00	1413872.10	866.96	869.85	2.89	0	to	36	36	to	46				0	to	32	32	to	46
M-42	685888.10	1413616.70	858.17	861.03	2.86	0	to	37	37	to	47				0	to	35	35	to	48
M-43	685942.90	1413207.30	833.29	835.94	2.65	0	to	10	10	to	20				0	to	8	8	to	20
M-45	686248.80	1413326.10	846.22	848.81	2.59	0	to	24	24	to	34				0	to	22	22	to	35
M-46	685886.30	1412736.30	827.82	830.38	2.56	0	to	8	8	to	18				0	to	6	6	to	19
M-57	687338.20	1412364.70	881.99	884.85	2.86	0	to	26.5	26.5	to	36.5	0	to	21	21	to	24.5	24.5	to	36.5
M-58	687627.60	1412913.10	876.38	879.36	2.98	0	to	28.6	28.6	to	38.6	0	to	22	22	to	27	27	to	38.6
M-59	687647.40	1413492.80	874.48	877.41	2.93	0	to	49	49	to	59	0	to	38.5	38.5	to	41	41	to	59
M-60	987661.10	1413911.80	873.26	876.09	2.83	0	to	52	52	to	62	0	to	47.5	47.5	to	49	49	to	63
M-61	687658.60	1414471.90	874.64	877.65	3.01	0	to	41	41	to	51	0	to	35	35	to	38	38	to	52
M-62	687513.00	1414188.40	868.34	871.34	3.00	0	to	49	49	to	59	0	to	41	41	to	43	43	to	60
M-63	686515.40	1414391.40	859.39	862.50	3.11	0	to	30	30	to	40	0	to	26.5	26.5	to	28	28	to	41
M-64	686391.20	1414172.20	842.37	845.36	2.99	0	to	10	10	to	20	0	to	6	6	to	8	8	to	21

Notes:

ft-msl: Feet - mean sea level

ft-als: Feet - above land surface

ft-bls: Feet - below land surface

Table 2 **Marshall Steam Station - Industrial Landfill #1**
Groundwater Level Elevations **S&ME Project No. 1356-08-122**

Well ID	Installation Date	TOC Elev.	Time of Boring		24-Hour		December 17, 2007	
			DTW-TOC	WL Elev	DTW-TOC	WL Elev	DTW-TOC	WL Elev
M-1	11/6/07	862.08	36.51	825.57	36.71	825.37	36.81	825.27
M-2	11/12/07	877.13	47.74	829.39	NM	NM	46.66	830.47
M-3	11/1/07	865.88	46.00	819.88	NM	NM	46.87	819.01
M-4	11/30/07	864.24	46.87	817.37	46.87	817.37	40.92	823.32
M-5	11/13/07	825.42	10.95	814.47	8.75	816.67	10.12	815.30
M-6	11/19/07	839.22	23.36	815.86	23.36	815.86	23.96	815.26
M-7	11/27/07	854.05	42.72	811.33	36.72	817.33	36.69	817.36
M-8	11/13/07	891.04	51.06	839.98	NM	NM	58.75	832.29
M-16	11/6/07	848.64	38.79	809.85	39.54	809.10	37.64	811.00
M-18	5/1/08	876.78	NM	NM	44.75	832.03		
M-19	5/21/08	867.10	NM	NM	39.00	828.10		
M-20	5/13/08	876.37	NM	NM	46.80	829.57		
M-21	5/15/08	882.72	Dry	Dry	NM	NM		
M-23	5/14/08	840.24	17.00	823.24	NM	NM		
M-25	5/6/08	847.22	23.80	823.42	NM	NM		
M-26	5/8/08	843.40	28.00	815.40	NM	NM		
M-28	5/14/08	852.45	Dry	Dry	NM	NM		
M-29	5/15/08	843.36	Dry	Dry	NM	NM		
M-31	5/29/08	881.36	Dry	Dry	Dry	Dry		
M-34	5/7/08	830.49	13.00	817.49	NM	NM		
M-36	5/1/08	842.03	16.20	825.83	NM	NM		
M-37	5/21/08	875.30	42.80	832.50	42.60	832.70		
M-38	5/22/08	860.38	38.00	822.38	34.00	826.38		
M-39	5/13/08	856.89	36.50	820.39	24.40	832.49		
M-41	5/13/08	869.85	42.00	827.85	41.30	828.55		
M-42	5/15/08	861.03	NM	NM	42.00	819.03		
M-43	5/15/08	835.94	18.00	817.94	NM	NM		
M-45	5/14/08	848.81	30.40	818.41	29.10	819.71		
M-46	5/21/08	830.38	15.90	814.48	NM	NM		
M-57	9/30/08	884.85	NM	NM	NM	NM		
M-58	9/30/08	879.36	NM	NM	NM	NM		
M-59	10/1/08	877.41	NM	NM	NM	NM		
M-60	10/1/08	876.09	NM	NM	NM	NM		
M-61	10/3/08	877.65	NM	NM	NM	NM		
M-62	10/2/08	871.34	NM	NM	NM	NM		
M-63	10/3/08	862.50	NM	NM	NM	NM		
M-64	10/2/08	845.36	NM	NM	NM	NM		

Notes:

TOC Top of casing
DTW-TOC Depth to water below top of casing
WL-Elev Water level elavation

Table 2 **Marshall Steam Station - Industrial Landfill #1**
Groundwater Level Elevations **S&ME Project No. 1356-08-122**

Well ID	Installation Date	TOC Elev.	January 8, 2008		February 6, 2008		March 14, 2008	
			DTW-TOC	WL Elev	DTW-TOC	WL Elev	DTW-TOC	WL Elev
M-1	11/6/07	862.08	36.65	825.43	36.54	825.54	36.30	825.78
M-2	11/12/07	877.13	46.88	830.25	47.20	829.93	47.61	829.52
M-3	11/1/07	865.88	46.80	819.08	47.01	818.87	47.00	818.88
M-4	11/30/07	864.24	41.10	823.14	40.75	823.49	40.60	823.64
M-5	11/13/07	825.42	8.97	816.45	8.24	817.18	8.23	817.19
M-6	11/19/07	839.22	22.55	816.67	21.60	817.62	24.50	814.72
M-7	11/27/07	854.05	35.52	818.53	34.70	819.35	33.80	820.25
M-8	11/13/07	891.04	56.83	834.21	56.52	834.52	57.14	833.90
M-16	11/6/07	848.64	37.40	811.24	37.09	811.55	36.46	812.18
M-18	5/1/08	876.78						
M-19	5/21/08	867.10						
M-20	5/13/08	876.37						
M-21	5/15/08	882.72						
M-23	5/14/08	840.24						
M-25	5/6/08	847.22						
M-26	5/8/08	843.40						
M-28	5/14/08	852.45						
M-29	5/15/08	843.36						
M-31	5/29/08	881.36						
M-34	5/7/08	830.49						
M-36	5/1/08	842.03						
M-37	5/21/08	875.30						
M-38	5/22/08	860.38						
M-39	5/13/08	856.89						
M-41	5/13/08	869.85						
M-42	5/15/08	861.03						
M-43	5/15/08	835.94						
M-45	5/14/08	848.81						
M-46	5/21/08	830.38						
M-57	9/30/08	884.85						
M-58	9/30/08	879.36						
M-59	10/1/08	877.41						
M-60	10/1/08	876.09						
M-61	10/3/08	877.65						
M-62	10/2/08	871.34						
M-63	10/3/08	862.50						
M-64	10/2/08	845.36						

Notes:

TOC	Top of casing
DTW-TOC	Depth to water below top of casing
WL-Elev	Water level elavation

Table 2 **Marshall Steam Station - Industrial Landfill #1**
Groundwater Level Elevations **S&ME Project No. 1356-08-122**

Well ID	Installation Date	TOC Elev.	April 18, 2008		May 21, 2008		June 25, 2008	
			DTW-TOC	WL Elev	DTW-TOC	WL Elev	DTW-TOC	WL Elev
M-1	11/6/07	862.08	35.88	826.20	35.57	826.51	36.38	825.70
M-2	11/12/07	877.13	47.95	829.18	48.25	828.88	48.57	828.56
M-3	11/1/07	865.88	46.95	818.93	46.77	819.11	47.02	818.86
M-4	11/30/07	864.24	40.43	823.81	40.56	823.68	40.92	823.32
M-5	11/13/07	825.42	8.14	817.28	8.11	817.31	9.01	816.41
M-6	11/19/07	839.22	19.97	819.25	20.20	819.02	21.76	817.46
M-7	11/27/07	854.05	33.42	820.63	33.14	820.91	34.02	820.03
M-8	11/13/07	891.04	57.20	833.84	57.31	833.73	57.43	833.61
M-16	11/6/07	848.64	36.25	812.39	35.68	812.96	36.57	812.07
M-18	5/1/08	876.78			47.80	828.98	47.25	829.53
M-19	5/21/08	867.10			40.78	826.32	41.84	825.26
M-20	5/13/08	876.37			50.07	826.30	50.29	826.08
M-21	5/15/08	882.72			Dry	Dry	Dry	Dry
M-23	5/14/08	840.24			15.09	825.15	15.62	824.62
M-25	5/6/08	847.22			24.76	822.46	26.10	821.12
M-26	5/8/08	843.40			21.52	821.88	23.09	820.31
M-28	5/14/08	852.45			Dry	Dry	Dry	Dry
M-29	5/15/08	843.36			14.13	829.23	14.13	829.23
M-31	5/29/08	881.36			Dry	Dry	Dry	Dry
M-34	5/7/08	830.49			11.61	818.88	13.73	816.76
M-36	5/1/08	842.03			15.76	826.27	17.97	824.06
M-37	5/21/08	875.30			NM	NM	45.75	829.55
M-38	5/22/08	860.38			NM	NM	37.04	823.34
M-39	5/13/08	856.89			27.41	829.48	27.66	829.23
M-41	5/13/08	869.85			44.73	825.12	44.95	824.90
M-42	5/15/08	861.03			42.93	818.10	43.45	817.58
M-43	5/15/08	835.94			18.53	817.41	19.36	816.58
M-45	5/14/08	848.81			31.04	817.77	31.67	817.14
M-46	5/21/08	830.38			12.58	817.80	14.31	816.07
M-57	9/30/08	884.85						
M-58	9/30/08	879.36						
M-59	10/1/08	877.41						
M-60	10/1/08	876.09						
M-61	10/3/08	877.65						
M-62	10/2/08	871.34						
M-63	10/3/08	862.50						
M-64	10/2/08	845.36						

Notes:

TOC Top of casing
DTW-TOC Depth to water below top of casing
WL-Elev Water level elavation

Table 2 **Marshall Steam Station - Industrial Landfill #1**
Groundwater Level Elevations **S&ME Project No. 1356-08-122**

Well ID	Installation Date	TOC Elev.	July 18, 2008		September 3, 2008		September 23, 2008	
			DTW-TOC	WL Elev	DTW-TOC	WL Elev	DTW-TOC	WL Elev
M-1	11/6/07	862.08	36.57	825.51	36.78	825.30	36.82	825.26
M-2	11/12/07	877.13	48.72	828.41	49.20	827.93	49.40	827.73
M-3	11/1/07	865.88	47.17	818.71	47.46	818.42	47.41	818.47
M-4	11/30/07	864.24	41.04	823.20	41.27	822.97	41.38	822.86
M-5	11/13/07	825.42	8.45	816.97	7.71	817.71	7.76	817.66
M-6	11/19/07	839.22	21.02	818.20	20.75	818.47	20.46	818.76
M-7	11/27/07	854.05	33.75	820.30	33.95	820.10	33.73	820.32
M-8	11/13/07	891.04	57.66	833.38	58.03	833.01	58.17	832.87
M-16	11/6/07	848.64	36.55	812.09	36.95	811.69	36.38	812.26
M-18	5/1/08	876.78	47.28	829.50	Dry	Dry	Dry	Dry
M-19	5/21/08	867.10	42.15	824.95	42.66	824.44	42.75	824.35
M-20	5/13/08	876.37	50.44	825.93	50.77	825.60	50.90	825.47
M-21	5/15/08	882.72	Dry	Dry	Dry	Dry	Dry	Dry
M-23	5/14/08	840.24	15.52	824.72	15.36	824.88	15.93	824.31
M-25	5/6/08	847.22	25.91	821.31	25.38	821.84	25.69	821.53
M-26	5/8/08	843.40	23.02	820.38	23.15	820.25	22.75	820.65
M-28	5/14/08	852.45	Dry	Dry	Dry	Dry	Dry	Dry
M-29	5/15/08	843.36	14.10	829.26	14.10	829.26	14.14	829.22
M-31	5/29/08	881.36	Dry	Dry	Dry	Dry	Dry	Dry
M-34	5/7/08	830.49	12.46	818.03	11.72	818.77	11.85	818.64
M-36	5/1/08	842.03	17.77	824.26	16.70	825.33	17.27	824.76
M-37	5/21/08	875.30	45.96	829.34	46.21	829.09	46.31	828.99
M-38	5/22/08	860.38	37.35	823.03	37.85	822.53	37.95	822.43
M-39	5/13/08	856.89	27.85	829.04	28.17	828.72	28.29	828.60
M-41	5/13/08	869.85	45.16	824.69	45.54	824.31	45.56	824.29
M-42	5/15/08	861.03	43.69	817.34	44.17	816.86	44.10	816.93
M-43	5/15/08	835.94	18.90	817.04	18.37	817.57	18.34	817.60
M-45	5/14/08	848.81	31.56	817.25	31.61	817.20	31.23	817.58
M-46	5/21/08	830.38	13.07	817.31	12.52	817.86	12.29	818.09
M-57	9/30/08	884.85						
M-58	9/30/08	879.36						
M-59	10/1/08	877.41						
M-60	10/1/08	876.09						
M-61	10/3/08	877.65						
M-62	10/2/08	871.34						
M-63	10/3/08	862.50						
M-64	10/2/08	845.36						

Notes:

TOC Top of casing
DTW-TOC Depth to water below top of casing
WL-Elev Water level elavation

Table 2 **Marshall Steam Station - Industrial Landfill #1**
Groundwater Level Elevations **S&ME Project No. 1356-08-122**

Well ID	Installation Date	TOC Elev.	October 6, 2008		October 23, 2008		November 26, 2008	
			DTW-TOC	WL Elev	DTW-TOC	WL Elev	DTW-TOC	WL Elev
M-1	11/6/07	862.08	36.90	825.18	37.07	825.01	37.31	824.77
M-2	11/12/07	877.13	49.40	827.73	49.65	827.48	49.90	827.23
M-3	11/1/07	865.88	47.25	818.63	47.31	818.57	47.23	818.65
M-4	11/30/07	864.24	41.40	822.84	41.45	822.79	41.55	822.69
M-5	11/13/07	825.42	NM	NM	7.92	817.50	7.80	817.62
M-6	11/19/07	839.22	20.30	818.92	20.56	818.66	20.32	818.90
M-7	11/27/07	854.05	33.55	820.50	33.67	820.38	33.36	820.69
M-8	11/13/07	891.04	58.25	832.79	58.25	832.79	58.50	832.54
M-16	11/6/07	848.64	35.95	812.69	36.05	812.59	35.71	812.93
M-18	5/1/08	876.78	47.85	828.93	Dry	Dry	Dry	Dry
M-19	5/21/08	867.10	42.80	824.30	42.92	824.18	43.21	823.89
M-20	5/13/08	876.37	51.00	825.37	51.03	825.34	51.20	825.17
M-21	5/15/08	882.72	Dry	Dry	Dry	Dry	Dry	Dry
M-23	5/14/08	840.24	16.00	824.24	16.16	824.08	16.29	823.95
M-25	5/6/08	847.22	25.70	821.52	25.98	821.24	26.16	821.06
M-26	5/8/08	843.40	22.75	820.65	22.79	820.61	23.08	820.32
M-28	5/14/08	852.45	Dry	Dry	Dry	Dry	Dry	Dry
M-29	5/15/08	843.36	14.20	829.16	14.50	828.86	14.14	829.22
M-31	5/29/08	881.36	Dry	Dry	Dry	Dry	Dry	Dry
M-34	5/7/08	830.49	11.95	818.54	12.22	818.27	11.91	818.58
M-36	5/1/08	842.03	17.50	824.53	17.86	824.17	18.22	823.81
M-37	5/21/08	875.30	45.95	829.35	Dry	Dry	Dry	Dry
M-38	5/22/08	860.38	37.90	822.48	37.97	822.41	38.05	822.33
M-39	5/13/08	856.89	28.35	828.54	18.46	838.43	28.65	828.24
M-41	5/13/08	869.85	45.60	824.25	45.70	824.15	45.86	823.99
M-42	5/15/08	861.03	43.85	817.18	43.91	817.12	43.63	817.40
M-43	5/15/08	835.94	18.35	817.59	18.46	817.48	18.41	817.53
M-45	5/14/08	848.81	31.10	817.71	31.15	817.66	31.10	817.71
M-46	5/21/08	830.38	12.20	818.18	12.57	817.81	12.00	818.38
M-57	9/30/08	884.85			Dry	Dry	Dry	Dry
M-58	9/30/08	879.36			40.56	838.80	40.77	838.59
M-59	10/1/08	877.41			52.84	824.57	53.04	824.37
M-60	10/1/08	876.09			50.20	825.89	51.40	824.69
M-61	10/3/08	877.65			46.63	831.02	46.93	830.72
M-62	10/2/08	871.34			42.18	829.16	42.47	828.87
M-63	10/3/08	862.50			36.57	825.93	Damaged	Damaged
M-64	10/2/08	845.36			18.65	826.71	19.31	826.05

Notes:

TOC Top of casing
DTW-TOC Depth to water below top of casing
WL-Elev Water level elavation

Table 2 **Marshall Steam Station - Industrial Landfill #1**
Groundwater Level Elevations **S&ME Project No. 1356-08-122**

Well ID	Installation Date	TOC Elev.	January 19, 2009	
			DTW-TOC	WL Elev
M-1	11/6/07	862.08	36.19	825.89
M-2	11/12/07	877.13	50.15	826.98
M-3	11/1/07	865.88	47.01	818.87
M-4	11/30/07	864.24	41.14	823.10
M-5	11/13/07	825.42	7.54	817.88
M-6	11/19/07	839.22	19.08	820.14
M-7	11/27/07	854.05	32.47	821.58
M-8	11/13/07	891.04	58.62	832.42
M-16	11/6/07	848.64	34.27	814.37
M-18	5/1/08	876.78	48.00	828.78
M-19	5/21/08	867.10	43.04	824.06
M-20	5/13/08	876.37	51.12	825.25
M-21	5/15/08	882.72	Dry	Dry
M-23	5/14/08	840.24	14.63	825.61
M-25	5/6/08	847.22	23.98	823.24
M-26	5/8/08	843.40	21.16	822.24
M-28	5/14/08	852.45	Dry	Dry
M-29	5/15/08	843.36	14.15	829.21
M-31	5/29/08	881.36	Dry	Dry
M-34	5/7/08	830.49	10.29	820.20
M-36	5/1/08	842.03	14.70	827.33
M-37	5/21/08	875.30	46.43	828.87
M-38	5/22/08	860.38	37.79	822.59
M-39	5/13/08	856.89	28.66	828.23
M-41	5/13/08	869.85	45.96	823.89
M-42	5/15/08	861.03	43.11	817.92
M-43	5/15/08	835.94	17.85	818.09
M-45	5/14/08	848.81	30.56	818.25
M-46	5/21/08	830.38	10.87	819.51
M-57	9/30/08	884.85	Dry	Dry
M-58	9/30/08	879.36	41.09	838.27
M-59	10/1/08	877.41	53.26	824.15
M-60	10/1/08	876.09	52.20	823.89
M-61	10/3/08	877.65	47.24	830.41
M-62	10/2/08	871.34	42.47	828.87
M-63	10/3/08	862.50	Damaged	Damaged
M-64	10/2/08	845.36	18.15	827.21

Notes:

TOC	Top of casing
DTW-TOC	Depth to water below top of casing
WL-Elev	Water level elavation

Table 3
Geologic and Hydrogeologic Data

Marshall Steam Station - Industrial Landfill #1
S&ME Project No. 1356-08-122

Information By Location

Well ID	Ground Surface Elevation (ft-msl)	Ash Interval (ft-bls)	Residuum Interval (ft-bls)	Saprolite Interval (ft-bls)	PWR Interval (ft-bls)	Top of Bedrock (ft-bls)	Total Borehole Depth (ft-bls)	Total Borehole Depth (ft-msl)	Screen Interval (ft-bls)	Oct. 23, 2008 Water Level DTW (ft-bls)	Predominant Geologic Unit in Saturated Screened Interval	Predominant Soil Description in Saturated Screened Interval
M-1	859.07	Not Encountered	0 to 15	15 to 37	37 to 64	64	64	795.07	27 to 42	34.06	Saprolite	Silty F/M Sand
M-2	874.39	Not Encountered	0 to 10	10 to 37	37 to 54	54	64	820.39	34 to 49	46.91	PWR	Silty F/M Sand
M-3	863.19	Not Encountered	0 to 10	10 to 43	43 to 47.5	47.5	47.5	815.69	31.5 to 46.5	44.62	PWR	Silty F/C Sand
M-4	861.37	Not Encountered	Not Encountered	0 to 36 42 to 47	36 to 42 47 to 50	50	50	811.37	30 to 45	38.58	Saprolite	Silty F/M Sand
M-5	822.47	0 to 30	Not Encountered	30 to 40 46 to 57	40 to 46 57 to 59.7	59.7	59.7	762.77	3 to 13	4.97	Ash	Fine Sandy Silt
M-6	836.36	Not Encountered	0 to 15	15 to 67	67 to 86.7	86.7	86.7	749.66	15 to 30	17.70	Saprolite	Silty F/M Sand
M-7	851.33	Not Encountered	0 to 20	20 to 67	67 to 80	80	80	771.33	29 to 44	30.95	Saprolite	Silty F/M Sand
M-8	888.98	Not Encountered	0 to 24	24 to 47	47 to 62.5	62.5	62.5	826.48	42.5 to 57.5	56.19	PWR	Silty F/M Sand
M-16	845.85	Not Encountered	0 to 6	Not Encountered	6 to 55.5	55.5	55.5	790.35	28 to 43	33.26	PWR	Silty F/M Sand
M-17	882.30	Not Encountered	0 to 8	8 to 73.2	73.2 to 109.5	109.5	109.5	772.80	N/A	N/A	N/A	N/A
M-18	874.03	Not Encountered	0 to 5.5	5.5 to 59	59 to 63.1	63.1	63.1	810.93	40 to 50	Dry	Saprolite	Fine Sandy Silt
M-19	864.82	Not Encountered	0 to 5	5 to 45	45 to 62.9	62.9	62.9	801.92	34 to 44	40.64	Saprolite	F/M Sandy Silt
M-20	873.40	Not Encountered	0 to 6	6 to 33.7	33.7 to 49.8	49.8	49.8	823.60	39.8 to 49.8	48.06	PWR	Gravel (weathered Gneiss fragments)
M-21	880.11	Not Encountered	0 to 5	5 to 18.3	18.3 to 33	33	33	847.11	22.6 to 32.6	Dry	PWR	Silty F/C Sand
M-22	841.50	Not Encountered	0 to 5	5 to 8.1	8.1 to 38.1	38.1	38.1	803.40	N/A	N/A	N/A	N/A
M-23	837.73	Not Encountered	0 to 10	10 to 18.8	18.8 to 25.2	25.2	25.2	812.53	12.3 to 22.3	13.65	Saprolite	Silty F/C Sand
M-24	856.50	Not Encountered	Not Encountered	0 to 63.3	63.3 to 73.2	73.2	73.2	783.30	N/A	N/A	N/A	N/A
M-25	844.33	Not Encountered	0 to 21	21 to 59	59 to 65	65	65	779.33	18 to 28	23.09	Saprolite	Silt
M-26	840.87	Not Encountered	0 to 10	10 to 68.5	68.5 to 81.6	81.6	81.6	759.27	22 to 32	20.26	Saprolite	Silt
M-27	837.70	Not Encountered	0 to 5	5 to 28.4	28.4 to 54.8	54.8	54.8	782.90	N/A	N/A	N/A	N/A
M-28	849.69	Not Encountered	0 to 5	5 to 23.5	23.5 to 24.4	24.4	24.4	825.29	14.4 to 24.4	Dry	Saprolite	Silt
M-29	840.75	Not Encountered	Not Encountered	Not Encountered	0 to 12.2	12.2	12.2	828.55	1.4 to 11.4	11.89	PWR	F/C Sand
M-30	845.10	Not Encountered	0 to 5	5 to 28.4	28.4 to 34	34	34	811.10	N/A	N/A	N/A	N/A
M-31	878.93	Not Encountered	0 to 5	5 to 23.4 28.4 to 46.9	23.4 to 28.4	46.9	46.9	832.03	36.9 to 46.9	Dry	Saprolite	Clayey Silt
M-33	838.60	Not Encountered	0 to 15	15 to 38.5	38.5 to 44.9	44.9	44.9	793.70	N/A	N/A	N/A	N/A
M-34	827.97	Not Encountered	0 to 5	5 to 63.5	63.5 to 70	70	70	757.97	4 to 14	9.70	Saprolite	F/C Sandy Silt
M-35	835.50	Not Encountered	0 to 10	10 to 33.1	33.1 to 61.3	61.3	61.3	774.20	N/A	N/A	N/A	N/A
M-36	838.81	Not Encountered	0 to 5	5 to 29 43.6 to 53.6	29 to 43.6 53.6 to 57.6	57.6	57.6	781.21	10 to 20	14.64	Saprolite	Silt
M-37	872.73	Not Encountered	0 to 6	6 to 39.4	39.4 to 44.2	44.2	44.2	828.53	34.2 to 44.2	Dry	Saprolite	C/vC Sand
M-38	857.75	Not Encountered	0 to 7	7 to 64.6	64.6 to 88.4	88.4	88.4	769.35	27 to 37	35.34	Saprolite	Silty F/C Sand
M-39	854.21	Not Encountered	0 to 6	6 to 29.3	29.3 to 48.1	48.1	48.1	806.11	20.3 to 30.3	15.78	Saprolite	F/M Sandy Silt
M-40	873.00	Not Encountered	0 to 6	6 to 29.2	29.2 to 45.1	45.1	45.1	827.90	N/A	N/A	N/A	N/A

Table 3
Geologic and Hydrogeologic Data

Marshall Steam Station - Industrial Landfill #1
S&ME Project No. 1356-08-122

Information By Location

Well ID	Ground Surface Elevation (ft-msl)	Ash Interval (ft-bls)	Residuum Interval (ft-bls)	Saprolite Interval (ft-bls)	PWR Interval (ft-bls)	Top of Bedrock (ft-bls)	Total Borehole Depth (ft-bls)	Total Borehole Depth (ft-msl)	Screen Interval (ft-bls)	Oct. 23, 2008 Water Level DTW (ft-bls)	Predominant Geologic Unit in Saturated Screened Interval	Predominant Soil Description in Saturated Screened Interval
M-41	866.96	Not Encountered	0 to 6	6 to 49.3	Not Encountered	49.3	49.3	817.66	36 to 46	42.81	Saprolite	F/C Sandy Silt
M-42	858.17	Not Encountered	0 to 6	6 to 29.5 39.5 to 49.5	29.5 to 39.5 49.5 to 57.4	57.4	57.4	800.77	37 to 47	41.05	Saprolite	Silty F/C Sand
M-43	833.29	Not Encountered	0 to 6	6 to 24.3	24.3 to 26.2	26.2	26.2	807.09	10 to 20	15.81	Saprolite	Silty F/C Sand
M-44	829.70	Not Encountered	0 to 12	12 to 19.6 29.6 to 39.6	19.6 to 29.6 39.6 to 47	47	47	782.7	N/A	N/A	N/A	N/A
M-45	846.22	Not Encountered	0 to 10.5	10.5 to 24.6	24.6 to 40.7	40.7	40.7	805.52	24 to 34	28.56	PWR	C/vC Sand
M-46	827.82	Not Encountered	0 to 5	5 to 43.2	43.2 to 52.8	52.8	52.8	775.02	8 to 18	10.01	Saprolite	F/M Sandy Silt
M-47	829.40	Not Encountered	0 to 6	6 to 28.8	28.8 to 45.2	45.2	45.2	784.20	N/A	N/A	N/A	N/A
M-57	881.99	Not Encountered	0 to 7	7 to 36.5	Not Encountered	36.5	36.5	845.49	26.5 to 36.5	Dry	Saprolite	Silty F/M Sand
M-58	876.38	Not Encountered	0 to 7	7 to 28.5	28.5 to 38.6	38.6	38.6	837.78	28.6 to 38.6	37.58	PWR	Silty F/M Sand
M-59	874.48	Not Encountered	0 to 7	7 to 53.5	53.5 to 59	59	59	815.48	49 to 59	49.91	PWR	Silty F/M Sand
M-60	873.26	Not Encountered	0 to 7	7 to 78.5	78.5 to 79	79	79	794.26	52 to 62	47.37	Saprolite	Silty Fine Sand
M-61	874.64	Not Encountered	0 to 4.5	4.5 to 78.5 83.5 to 88.5	78.5 to 83.5 88.5 to 89	Not Encountered	89	785.64	41 to 51	43.62	Saprolite	Silty Fine Sand
M-62	868.34	Not Encountered	0 to 7	7 to 90	Not Encountered	Not Encountered	90	778.34	49 to 59	39.18	Saprolite	Very Fine Sandy Silt
M-63	859.39	Not Encountered	0 to 2	2 to 33.5	33.5 to 46	46	46	813.39	30 to 40	33.46	PWR	Silty Fine Sand
M-64	842.37	Not Encountered	0 to 4.5	4.5 to 30.5	30.5 to 32	32	32	810.37	10 to 20	15.66	Saprolite	Silty Very Fine Sand

Information By Geologic Unit

Geologic Unit	Depth Range Encountered (ft-bls)	Hydraulic Conductivity Range Based on Slug Test Data (cm/sec)	Hydraulic Conductivity Range Based on Grain Size Data (cm/sec)	Hydraulic Conductivity Range Based on Laboratory Data (cm/sec)	Total Porosity Range Based on Laboratory Data (%)
Ash*	0 to 30	1.3E-03	Not Estimated	Not Estimated	Not Estimated
Residuum	0 to 24	Not Estimated	5.70E-05 to 3.56E-04	6.42E-07 to 1.71E-05	44 to 50
Saprolite	0 to 90	1.0E-04 to 1.0E-03	1.12E-06 to 2.89E-02	2.95E-07 to 4.38E-05	42 to 50
PWR	0 to 109.5	2.0E-4 to 8.4E-4	5.84E-06 to 2.76E-02	Not Estimated	42 to 45

* The ash characteristics listed above are from the structural fill area. The ash in the ash basins in Site 1 could not be accecessed at the time of exploration, however similar data was obtained from previous studies at Duke Energy's Allen Steam Station. The results are as follows:

Hydraulic Conductivity Range Based on Slug Test Data (cm/sec)
Hydraulic Conductivity Range Based on Laboratory Data (cm/sec)
Total Porosity Range Based on Laboratory Data (%)

ft-msl: feet relative to mean sea level
ft-bls: feet below land surface
N/A: not applicable
cm/sec: centimeters per second

Table 4 **Marshall Steam Station - Industrial Landfill #1**

Summary of Permeability Data **S&ME Project No. 1356-08-122**

FIELD - RISING HEAD TESTS

Well ID	Saturated Depths (ft-bls)	Soil Description	Predominant Geologic Unit	Hydraulic Conductivity (ft/day)	Hydraulic Conductivity (cm/sec)	Test Method Rising Head
M-1	33.56-42	Silty F/M Sand	Saprolite	2.9E+00	1.0E-03	Slug Test
M-2	43.89-49	Silty F/M Sand	PWR	1.0E+00	3.6E-04	Slug Test
M-3	44.11-46.5	Silty F/C Sand	PWR	2.4E+00	8.4E-04	Slug Test
M-4	37.53-45	Silty F/M Sand	Saprolite	1.9E+00	6.9E-04	Slug Test
M-5	7.33-13	Fine Sandy Silt	Ash	3.8E+00	1.3E-03	Slug Test
M-6	21.16-30	Silty F/M Sand	Saprolite	1.4E+00	4.8E-04	Slug Test
M-7	33.7-44	Silty F/M Sand	Saprolite	2.8E-01	1.0E-04	Slug Test
M-8	54.76-57	Silty F/M Sand	PWR	5.7E-01	2.0E-04	Slug Test
M-16	37.59-43	Silty F/M Sand	PWR	9.1E-01	3.2E-04	Slug Test
Geometric Average (All)					4.6E-04	
Arithmetic Average (All)					5.9E-04	
Geometric Average (Saprolite)					4.3E-04	
Arithmetic Average (Saprolite)					5.7E-04	
Geometric Average (PWR)					3.7E-04	
Arithmetic Average (PWR)					4.3E-04	

Notes:

Geometric averages were obtained by taking the natural log of the individual hydraulic conductivity values, finding the mean of the natural logs for the geologic unit, and then obtaining the exponential of that value.

Example: Geometric Average (selected saprolite wells)

Well ID	K	ln(K)
M-1	1.0E-03	-6.89
M-4	6.9E-04	-7.29
M-6	4.8E-04	-7.64
	mean ln(K) =	-7.27
	exp(mean ln(K))=	7.0E-04

Table 4 **Marshall Steam Station - Industrial Landfill #1**

Summary of Permeability Data **S&ME Project No. 1356-08-122**

FIELD - FALLING HEAD TESTS

Well ID	Saturated Depths (ft-bls)	Soil Description	Predominant Geologic Unit	Hydraulic Conductivity (ft/day)	Hydraulic Conductivity (cm/sec)	Test Method Falling Head
M-1	38-41	Micaceous Silty F/M Sand	PWR	1.1E-02	3.7E-06	Open Hole
M-2	44-47	Micaceous Silty F/M Sand	PWR	8.5E-02	3.0E-05	Open Hole
M-5	10.1	Ash	Ash	3.3E+00	1.2E-03	Flush Bottom
M-5	35.1-38.1	Silty F/M Sand	Saprolite	1.5E-01	5.3E-05	Open Hole
M-5	40.1-43.1	Micaceous Silty F/M Sand	Saprolite	9.2E-02	3.3E-05	Open Hole
M-5	44.3-47.3	Micaceous Silty F/M Sand	Saprolite	8.3E-02	2.9E-05	Open Hole
M-6	18.6-21.6	Micaceous Silty F/M Sand	Saprolite	2.4E-01	8.5E-05	Open Hole
M-6	28.4-31.4	Micaceous Silty F/M Sand	Saprolite	3.1E-01	1.1E-04	Open Hole
M-6	38.4-41.4	Micaceous Silty F/M Sand	Saprolite	3.8E-02	1.4E-05	Open Hole
M-6	68.1-71.1	Micaceous Silty F/M Sand	PWR	1.7E-02	6.1E-06	Open Hole
M-8	48.5-51.5	Micaceous Silty F/M Sand	PWR	3.4E-02	1.2E-05	Open Hole
M-16	38-41	Micaceous Silty F/M Sand	PWR	6.4E-02	2.3E-05	Open Hole
Geometric Average (All)					3.4E-05	
Arithmetic Average (All)					1.3E-04	
Geometric Average (Ash)					1.2E-03	
Arithmetic Average (Ash)					1.2E-03	
Geometric Average (Saprolite)					4.3E-05	
Arithmetic Average (Saprolite)					5.4E-05	
Geometric Average (PWR)					1.2E-05	
Arithmetic Average (PWR)					1.5E-05	

Notes:

Geometric averages were obtained by taking the natural log of the individual hydraulic conductivity values, finding the mean of the natural logs for the geologic unit, and then obtaining the exponential of that value.

Table 4 **Marshall Steam Station - Industrial Landfill #1**

Summary of Permeability Data **S&ME Project No. 1356-08-122**

LABORATORY - REMOLDED SAMPLES

Well ID	Sample Depth (ft-bls)	Soil Description	Predominant Geologic Unit	Sample Type	Confining Pressure (psi)	Hydraulic Conductivity (cm/sec)
M-2	10'-15'	Micaceous Silty fine Sand	Saprolite	Bag	2.5	4.38E-05
M-4	0-5'	Silty Clay with fine Sand	Saprolite	Bag	2.5	2.95E-07
M-6	0-5'	Clayey Silt with trace fine Sand	Residuum	Bag	2.5	1.18E-06
M-6	5'-10'	Clayey Silt with fine Sand	Residuum	Bag	2.5	1.97E-06
M-6	10'-15'	Mica Clayey Silt with F Sand	Residuum	Bag	2.5	1.71E-05
M-7	0-5'	F/M Sandy Silty Clay	Residuum	Bag	2.5	3.50E-06
M-8	5'-10'	Fine Sandy Silty Clay	Residuum	Bag	2.5	6.42E-07

CALCULATED - BASED ON GRAIN SIZE

Well ID	Sample Depth (ft-bls)	Soil Description	Predominant Geologic Unit	d_{10} Grain Size (cm)	Estimated Hydraulic Conductivity (cm/sec)
M-1	10-15	Fine Sandy Clayey Silt	Residuum	1.30E-04	9.64E-07
M-2	5-10	Micaceous fine Sandy Silt	Residuum	2.50E-04	3.56E-06
M-2	10-15	Micaceous Silty fine Sand	Saprolite	5.00E-04	1.43E-05
M-2	44.1-45.6	Micaceous Silty F/M Sand	PWR	1.95E-03	2.17E-04
M-3	10-15	Micaceous F/M Sandy Clayey Silt	Saprolite	1.38E-04	1.09E-06
M-3	42.8-43.5	Micaceous Silty F/M Sand	Saprolite	2.25E-03	2.89E-04
M-5	8.6-10.1	Silt with fine Sand	Ash	1.45E-03	1.20E-04
M-6	23.3-24.8	Micaceous fine Sandy Silt	Saprolite	4.75E-04	1.29E-05
M-8	5-10	Fine Sandy Silty Clay	Residuum	1.36E-04	1.05E-06
M-8	10-15	Fine Sandy Silty Clay	Residuum	1.00E-04	5.70E-07
M-8	38.5-40	Fine Sandy Silt	Saprolite	7.50E-04	3.21E-05
M-16	8-10	Micaceous Clayey Silty Fine Sand	PWR	1.18E-04	7.87E-07
M-16	13-15	Micaceous Clayey Silty F/M Sand	PWR	1.37E-04	1.07E-06
M-16	39-40	Micaceous Silty Fine Sand	PWR	3.20E-03	5.84E-04
M-17	20-25	Micaceous Fine Sandy Silt	Saprolite	2.50E-04	3.56E-06
M-18	19-24	Clayey Silty Fine Sand	Saprolite	1.50E-04	1.28E-06
M-24	15-20	Fine Sandy Silty Clay	Saprolite	1.50E-04	1.28E-06
M-40	29.2-34.2	Micaceous Clayey Silty F/M Sand	PWR	3.20E-04	5.84E-06
M-41	24.5-29.5	Micaceous Fine Sandy Clayey Silt	Saprolite	2.50E-04	3.56E-06
M-42	14.5-19.5	Micaceous Fine Sandy Silt	Saprolite	1.40E-04	1.12E-06
M-57	13.5-15'	Micaceous Silty Medium to Fine Sand	Saprolite	1.50E-03	1.28E-04
M-58	28.5-30'	Silty Medium to Fine Sand	PWR	2.30E-03	3.02E-04
M-59	28.5-30'	Medium to Fine Sandy Silt	Saprolite	3.50E-04	6.99E-06
M-60	68.5-70'	Medium to Fine Sandy Silt	Saprolite	8.50E-04	4.12E-05
M-61	18.5-20'	Silty Medium to Fine Sand	Saprolite	9.50E-04	5.15E-05
M-61	78.5-80'	Medium to Fine Sandy Silt	PWR	9.50E-04	5.15E-05
M-62	33.5-35'	Fine Sandy Silt	Saprolite	8.00E-04	3.65E-05
M-63	8.5-10'	Silty Coarse to Fine Sand	Saprolite	1.50E-03	1.28E-04
M-64	13.5-15'	Silty Coarse to Fine Sand	Saprolite	1.80E-03	1.85E-04

Table 5

Summary of Porosity Data

Marshall Steam Station - Industrial Landfill #1

S&ME Project No. 1356-08-122

Well ID	Sample Type	Sample Depth	Soil Desription	Predominant Geologic Unit	USCS Classification	Soil Laboratory Data Used For Calculation	Effective Porosity	Total Porosity
M-1	BAG	0-5'	Clayey Silt with fine Sand	Residuum	MH	Hydrometer	0.03	0.48
M-1	BAG	5'-10'	Clayey Silt with fine Sand	Residuum	MH	Hydrometer	0.04	0.47
M-1	BAG	10'-15'	fine Sandy Clayey Silt	Residuum	ML	Hydrometer	0.05	0.46
							AVE	**0.47**
M-2	BAG	0-5'	Micaceous fine Sandy Clayey Silt	Residuum	ML	Hydrometer	0.04	0.48
M-2	BAG	5'-10'	Micaceous fine Sandy Silt	Residuum	ML	Hydrometer	0.17	0.44
M-2	BAG	10'-15'	Micaceous Silty fine Sand	Saprolite	SM	Hydrometer	0.21	0.44
M-2	SPOON	44.1'-45.6'	Micaceous Silty fine to medium Sand	PWR		Hydrometer	0.29	0.42
							AVE	**0.45**
M-3	BAG	0-5'	fine Sandy Clayey Silt	Residuum	ML	Hydrometer	0.04	0.47
M-3	BAG	5'-10'	Micaceous medium to fine Sandy Clayey Silt	Residuum	ML	Hydrometer	0.12	0.45
M-3	BAG	10'-15'	Micaceous medium to fine Sandy Clayey Silt	Saprolite	ML	Hydrometer	0.14	0.45
M-3	SPOON	42.8'-43.5'	Micaceous Silty fine to medium Sand	Saprolite		Hydrometer	0.29	0.42
							AVE	**0.45**
M-4	BAG	0-5'	Silty Clay with fine Sand	Saprolite	CH	Hydrometer	0.02	0.49
M-4	BAG	5'-10'	fine Sandy Clayey Silt	Saprolite	ML	Hydrometer	0.03	0.48
M-4	BAG	10'-15'	fine Sandy Clayey Silt	Saprolite	ML	Hydrometer	0.04	0.47
							AVE	**0.48**
M-5	SPOON	8.6'-10.1'	Silt with fine Sand	Ash		Hydrometer	0.18	0.44
M-6	BAG	0-5'	Clayey Silt with trace fine Sand	Residuum	MH	Hydrometer	0.01	0.50
M-6	BAG	5'-10'	Clayey Silt with fine Sand	Residuum	MH	Hydrometer	0.03	0.48
M-6	BAG	10'-15'	Micaceous Clayey Silt with fine Sand	Residuum	ML	Hydrometer	0.06	0.46
M-6	SPOON	23.3'-24.8'	Micaceous fine Sandy Silt	Saprolite		Hydrometer	0.18	0.44
							AVE	**0.47**
M-7	BAG	0-5'	medium to fine Sandy Silty Clay	Residuum	CL	Hydrometer	0.04	0.47
M-7	BAG	5'-10'	Clayey Silty fine Sand	Residuum	SC-SM	Hydrometer	0.14	0.45
M-7	BAG	10'-15'	fine Sandy Clayey Silt	Residuum	ML	Hydrometer	0.08	0.45
							AVE	**0.46**
M-8	BAG	0-5'	fine Sandy Silty Clay	Residuum	CL	Hydrometer	0.05	0.46
M-8	BAG	5'-10'	fine Sandy Silty Clay	Residuum	CL	Hydrometer	0.13	0.45
M-8	BAG	10'-15'	fine Sandy Silty Clay	Residuum	CL	Hydrometer	0.11	0.45
M-8	SPOON	38.5'-40'	fine Sandy Silt	Saprolite		Hydrometer	0.22	0.43
							AVE	**0.45**
M-16	BAG	3'-5'	fine Sandy Silty Clay	Residuum	CL	Hydrometer	0.05	0.46
M-16	BAG	8'-10'	Micaceous Clayey Silty fine Sand	PWR	SC	Hydrometer	0.13	0.45
M-16	BAG	13'-15'	Micaceous Clayey Silty medium to fine Sand	PWR	SC	Hydrometer	0.15	0.44
M-16	SPOON	39'-40'	Micaceous Silty fine Sand	PWR		Hydrometer	0.30	0.42
							AVE	**0.44**

Notes:

Porosity from Hydrometers was calculated from Fetter and Bear diagrams based on Grain size (Calculation in App III).

Porosity from Proctors calculated in Appendix III, based on Maximum Dry Density.

Porosity from Permeabilities calculated the same as from proctors, except dry density was taken from unit weight of soil in shelby tube.

Table 5

Summary of Porosity Data

Marshall Steam Station - Industrial Landfill #1

S&ME Project No. 1356-08-122

Well ID	Sample Type	Sample Depth	Soil Desription	Predominant Geologic Unit	USCS Classification	Soil Laboratory Data Used For Calculation	Effective Porosity	Total Porosity
M-17	BAG	20-25'	Micaceous Fine Sandy Clayey Silt	Saprolite	ML	Hydrometer	0.16	0.44
							AVE	**0.44**
M-18	BAG	19-24'	Clayey Silty Fine Sand	Saprolite	SC-SM	Hydrometer	0.13	0.45
							AVE	**0.45**
M-19	BAG	3.3-8.3'	Clayey Silt with Fine Sand	Saprolite	ML	Hydrometer	0.03	0.47
							AVE	**0.47**
M-20	BAG	13.7-18.7'	Clayey Silt with Fine Sand	Saprolite	MH	Hydrometer	0.04	0.46
							AVE	**0.46**
M-21	BAG	3.3-8.3'	Fine Sandy Silty Clay	Saprolite	CL	Hydrometer	0.04	0.47
							AVE	**0.47**
M-23	BAG	3.8-11.8'	Silty Clayey Fine Sand	Residuum	SC	Hydrometer	0.06	0.45
							AVE	**0.45**
M-24	BAG	15-20'	Fine Sandy Silty Clay	Saprolite	CL	Hydrometer	0.12	0.45
							AVE	**0.45**
M-25	BAG	0-5'	Fine Sandy Silty Clay	Residuum	CH	Hydrometer	0.02	0.50
							AVE	**0.50**
M-26	BAG	3.5-8.5'	Medium to Fine Sandy Clayey Silt	Residuum	ML	Hydrometer	0.11	0.45
							AVE	**0.45**
M-28	BAG	3.5-8.5'	Fine Sandy Silty Clay	Saprolite	CL	Hydrometer	0.03	0.50
							AVE	**0.50**
M-31	BAG	0-5'	Clayey Silt with Fine Sand	Residuum	MH	Hydrometer	0.01	0.50
							AVE	**0.50**
M-33	BAG	3.5-8.5'	Fine Sandy Clayey Silt	Residuum	ML	Hydrometer	0.04	0.49
							AVE	**0.49**
M-35	BAG	3-8'	Fine Sandy Silty Clay	Residuum	CH	Hydrometer	0.01	0.50
							AVE	**0.50**
M-39	BAG	1-9'	Fine Sandy Clayey Silt	Residuum	ML	Hydrometer	0.04	0.49
							AVE	**0.49**
M-40	BAG	29.2-34.2'	Micaceous Clayey Silty Medium to Fine Sand	PWR	SM	Hydrometer	0.17	0.44
							AVE	**0.44**
M-41	BAG	24.5-29.5'	Micaceous Fine Sandy Clayey Silt	Saprolite	ML	Hydrometer	0.16	0.44
							AVE	**0.44**
M-42	BAG	14.5-19.5'	Micaceous Fine Sandy Clayey Silt	Saprolite	ML	Hydrometer	0.14	0.44
							AVE	**0.44**
M-57	SPOON	13.5'-15'	Micaceous Silty Medium to Fine Sand	Saprolite	SM	Hydrometer	0.24	0.43
							AVE	**0.43**
M-58	SPOON	28.5'-30'	Silty Medium to Fine Sand	Saprolite	SM	Hydrometer	0.29	0.42
							AVE	**0.42**
M-59	SPOON	3.5'-5'	Fine Sandy Clayey Silt	Residuum	MH	Hydrometer	0.04	0.47
M-59	SPOON	28.5'-30'	Medium to Fine Sandy Silt	Saprolite	ML	Hydrometer	0.16	0.43
							AVE	**0.45**
M-60	SPOON	68.5'-70'	Medium to Fine Sandy Silt	Saprolite	ML	Hydrometer	0.21	0.44
							AVE	**0.44**
M-61	SPOON	18.5'-20'	Silty Medium to Fine Sand	Saprolite	SM	Hydrometer	0.23	0.43
M-61	SPOON	78.5'-80'	Medium to Fine Sandy Silt	PWR	SM	Hydrometer	0.20	0.44
							AVE	**0.43**
M-62	SPOON	33.5'-35'	Fine Sandy Silt	Saprolite	ML	Hydrometer	0.19	0.44
							AVE	**0.44**
M-63	SPOON	8.5'-10'	Silty Coarse to Fine Sand	Saprolite	SM	Hydrometer	0.26	0.43
							AVE	**0.43**
M-64	SPOON	13.5'-15'	Silty Coarse to Fine Sand	Saprolite	SM	Hydrometer	0.29	0.42
							AVE	**0.42**

Notes:

Porosity from Hydrometers was calculated from Fetter and Bear diagrams based on Grain size (Calculation in App III).

Porosity from Proctors calculated in Appendix III, based on Maximum Dry Density.

Porosity from Permeabilities calculated the same as from proctors, except dry density was taken from unit weight of soil in shelby tube.

Table 6

Groundwater Flow Velocity

Marshall Steam Station - Industrial Landfill #1

S&ME Project No. 1356-08-122

					11/26/2008				
		K	*n*				*I*	*v*	
Well ID	**TOC Elev.**	**Hydraulic Cond. (ft/day)**	**porosity effective (ne)**	**porosity total (n)**	**DTW-TOC (ft)**	**WL-Elev. (ft)**	**Gradient (ft/ft)**	**Flow Velocity (ft/yr)**	**Predominant Geologic Unit**
M-1	862.08	2.9E+00	18%	44%	37.31	824.77	0.01	59	Saprolite
M-2	877.13	1.0E+00	29%	42%	49.90	827.23	0.01	13	PWR
M-3	865.80	2.4E+00	29%	42%	47.23	818.65	0.02	60	PWR
M-4	864.24	1.9E+00	18%	44%	41.55	822.69	0.01	39	Saprolite
M-5	825.42	3.8E+00	18%	44%	7.80	817.62	0.002	15	Ash
M-6	839.22	1.4E+00	18%	44%	20.32	818.90	0.01	28	Saprolite
M-7	854.05	2.8E-01	18%	44%	33.36	820.69	0.02	11	Saprolite
M-8	891.04	5.7E-01	22%	43%	58.50	832.54	0.03	28	PWR
M-16	848.64	9.1E-01	30%	42%	35.71	812.93	0.01	11	PWR
							Geometric Average	24	
							ArithmetricAverage	29	

Notes:

Flow Velocity = (K*I)/ne

Shaded numbers indicate value estimated from similar soil types

K value from Bouwer and Rice Slug Test Data

Table 7
Summary of Laboratory Test Data

Marshall Steam Station - Industrial Landfill #1
S&ME Project No. 1356-08-122

Boring Number	Sample Depth	Sample Type[1]	Lithologic Unit	USCS Symbol[2]	Natural Moisture[3] (%)	Percent Finer #200 (%)	Percent Silt (%)	Percent Clay (%)	Atterberg Limits[4] LL (%)	Atterberg Limits[4] Plastic Index	Standard Proctor[5] MDD, γ_d (pcf)	Standard Proctor[5] OMC (%)	Remolded Constant Head Permeability[5] MDD, γ_d (pcf)	Remolded Constant Head Permeability[5] W (%)	Remolded Constant Head Permeability[5] Avg. K (cm/sec)
M-1	0-5'	Bulk	Residuum	MH	25.4	73.7	33.2	40.5	58	23	101.6	19.5			
M-1	5-10'	Bulk	Residuum	MH	27.2	80.9	46.9	34.0	57	19	97.0	23.0			
M-1	10-15'	Bulk	Residuum	ML	21.7	68.2	40.7	27.5	47	15	104.7	18.7			
M-2	0-5'	Bulk	Residuum	ML	12.9	64.3	28.8	35.5	46	10	98.2	22.0			
M-2	5-10'	Bulk	Residuum	ML	9.9	50.8	37.5	13.3	33	2	102.2	18.0			
M-2	10-15'	Bulk	Saprolite	SM	7.0	44.1	34.1	10.0	31	2	107.1	16.4	102.3	18.2	4.38E-05
M-3	0-5'	Bulk	Residuum	ML	22.1	63.6	28.1	35.5	48	15	99.3	22.5			
M-3	5-10'	Bulk	Residuum	ML	19.2	54.1	33.6	20.5	41	7	101.9	20.0			
M-3	10-15'	Bulk	Saprolite	ML	16.1	51.5	34.2	17.3	37	4	104.5	17.6			
M-4	0-5'	Bulk	Saprolite	CH	22.9	70.9	25.9	45.0	53	25	96.5	24.1	91.3	26.3	2.95E-07
M-4	5-10'	Bulk	Saprolite	ML	16.4	67.5	30.5	37.0	45	17	105.0	18.7			
M-4	10-15'	Bulk	Saprolite	ML	16.1	63.1	30.6	32.5	40	14	108.1	17.0			
M-5	8.6-10.1'	SS	Ash			77.4	73.1	4.3							
M-6	0-5'	Bulk	Residuum	MH	31.9	89.2	31.4	57.8	68	30	89.4	29.5	85.1	31	1.18E-06
M-6	5-10'	Bulk	Residuum	MH	32.7	81.7	43.7	38.0	54	18	93.0	27.0	89	29.9	1.97E-06
M-6	10-15'	Bulk	Residuum	ML	32.8	70.4	44.4	26.0	45	6	90.6	27.2	86.1	29.5	1.71E-05
M-6	23.3-24.8'	SS	Saprolite			59.4	48.9	10.5							
M-7	0-5'	Bulk	Residuum	CL	18.8	53.5	20.0	33.5	41	16	106.5	17.0	101.5	19.3	3.50E-06
M-7	5-10'	Bulk	Residuum	SC-SM	12.9	44.7	26.7	18.0	28	7	115.8	13.3			
M-7	10-15'	Bulk	Residuum	ML	11.2	59.8	36.3	23.5	35	8	110.9	16.2			
M-8	0-5'	Bulk	Residuum	CL	9.4	61.4	33.7	27.7	44	23	114.5	15.0			
M-8	5-10'	Bulk	Residuum	CL	7.4	53.5	37.5	16.0	36	13	117.7	12.0	112.6	14.2	6.42E-07
M-8	10-15'	Bulk	Residuum	CL	10.8	61.5	41.8	19.7	38	15	113.8	14.0			
M-8	38.5-40'	SS	Saprolite			50.7	42.9	7.8							
M-16	3-5'	Bulk	Residuum	CL	16.4	57.4	27.6	29.8	34	16	114.7	15.7			
M-16	8-10'	Bulk	PWR	SC	6.3	45.0	27.7	17.3	27	9	125.5	11.0			
M-16	13-15'	Bulk	PWR	SC	6.6	44.7	28.2	16.5	27	9	127.8	10.0			
M-16	39'-40'	SS	PWR			21.9	18.4	3.5							

Notes:

1 Sample type: SS = split spoon sample; Bulk = bulk sample.

2 Unified Soil Classification System (USCS) symbol: MH = inorganic silts with plasticity; ML = inorganic silts with slight plasticity; SC = clayey sand; SM = silty sand; GM = silty gravel; CH = inorganic clay with plasticity; CL = inorganic clay with slight plasticity.

3 Natural moisture content was obtained from triaxial, one-dimensional consolidation, permeability, or other laboratory test reports. Values reported are averages where more than one result was reported.

4 Atterberg Limits: LL = Liquid Limit.

5 MDD, γ_d = maximum dry density; OMC = optimum moisture content; W = moisture content; Avg. K = Average Permeability.

Table 7
Summary of Laboratory Test Data

Marshall Steam Station - Industrial Landfill #1
S&ME Project No. 1356-08-122

Boring Number	Sample Depth	Sample Type[1]	Lithologic Unit	USCS Symbol[2]	Natural Moisture[3] (%)	Percent Finer #200 (%)	Percent Silt (%)	Percent Clay (%)	Atterberg Limits[4]		Standard Proctor[5]		Remolded Constant Head Permeability[5]		
									LL (%)	Plastic Index	MDD, γ_d (pcf)	OMC (%)	MDD, γ_d (pcf)	W (%)	Avg. K (cm/sec)
M-17	20-25'	Bulk	Saprolite	ML	13.7	55.2	41.2	14.0	33	4	103.0	18.4			
M-18	19-24'	Bulk	Saprolite	SC-SM	13.8	48.4	30.9	17.5	28	7	119.6	12.9			
M-19	3.3-8.3'	Bulk	Saprolite	ML	21.2	75.3	39.3	36.0	48	17					
M-20	13.7-18.7'	Bulk	Saprolite	MH	23.1	79.3	47.3	32.0	53	20					
M-21	3.3-8.3'	Bulk	Saprolite	CL	17.5	70.2	34.7	35.5	44	19	106.5	17.7			
M-23	3.8-11.8'	Bulk	Residuum	SC	14.5	45.8	22.1	23.7	24	11	121.7	10.8			
M-24	15-20'	Bulk	Saprolite	CL	18.8	51.8	32.8	19.0	32	9	113.6	14.8			
M-25	0-5'	Bulk	Residuum	CH	24.6	64.8	20.8	44.0	50	23	105.1	20.1			
M-26	3.5-8.5'	Bulk	Residuum	ML	17.0	52.2	29.7	22.5	39	13	113.1	15.1			
M-28	3.5-8.5'	Bulk	Saprolite	CL	16.7	57.1	19.6	37.5	38	20	109.9	17.0			
M-31	0-5'	Bulk	Residuum	MH	27.4	78.1	28.6	49.5	58	26					
M-33	3.5-8.5'	Bulk	Residuum	ML	24.3	65.3	35.3	30.0	41	13					
M-35	3-8'	Bulk	Residuum	CH	34.3	70.7	19.7	51.0	65	33	95.7	24.8			
M-39	1-9'	Bulk	Residuum	ML	25.4	59.0	26.5	32.5	45	12					
M-40	29.2-34.2'	Bulk	PWR	SM	13.3	45.8	32.8	13.0	33	2					
M-41	24.5-29.5'	Bulk	Saprolite	ML	9.1	56.2	41.3	14.9	37	10					
M-42	14.5-19.5'	Bulk	Saprolite	ML	15.8	56.3	40.0	16.3	38	7					

Notes:

1 Sample type: SS = split spoon sample; Bulk = bulk sample.

2 Unified Soil Classification System (USCS) symbol: MH = inorganic silts with plasticity; ML = inorganic silts with slight plasticity; SC = clayey sand; SM = silty sand; GM = silty gravel; CH = inorganic clay with plasticity; CL = inorganic clay with slight plasticity.

3 Natural moisture content was obtained from triaxial, one-dimensional consolidation, permeability, or other laboratory test reports. Values reported are averages where more than one result was reported.

4 Atterberg Limits: LL = Liquid Limit.

5 MDD, γ_d = maximum dry density; OMC = optimum moisture content; W = moisture content; Avg. K = Average Permeability.

Table 7
Summary of Laboratory Test Data

Marshall Steam Station - Industrial Landfill #1
S&ME Project No. 1356-08-122

Boring Number	Sample Depth	Sample Type[1]	Lithologic Unit	USCS Symbol[2]	Natural Moisture[3] (%)	Percent Finer #200 (%)	Percent Silt (%)	Percent Clay (%)	Atterberg Limits[4]		Standard Proctor[5]		Remolded Constant Head Permeability[5]		
									LL (%)	Plastic Index	MDD, γ_d (pcf)	OMC (%)	MDD, γ_d (pcf)	W (%)	Avg. K (cm/sec)
M-57	13.5-15'	SS	Saprolite	SM		46.2	42.2	4.0	NP	NP					
M-58	28.5-30'	SS	PWR	SM		29.4	26.9	2.5	NP	NP					
M-59	3.5-5'	SS	Residuum	MH		66.4	29.4	37.0	51	16					
M-59	28.5-30'	SS	Saprolite	ML		57.3	43.8	13.5	38	3					
M-60	68.5-70'	SS	Saprolite	ML		53.8	47.8	6.0	40	7					
M-61	18.5-20'	SS	Saprolite	SM		45.9	40.9	5.0	60	2					
M-61	78.5-80'	SS	PWR	ML		56.5	50.5	6.0	28	0					
M-62	33.5-35'	SS	Saprolite	ML		59.9	52.9	7.0	40	0					
M-63	8.5-10'	SS	Saprolite	SM		34.0	30.5	NP	35	NP					
M-64	13.5-15'	SS	Saprolite	SM		21.0	17.0	4.0	NP	NP					

Notes:

1 Sample type: SS = split spoon sample; Bulk = bulk sample.

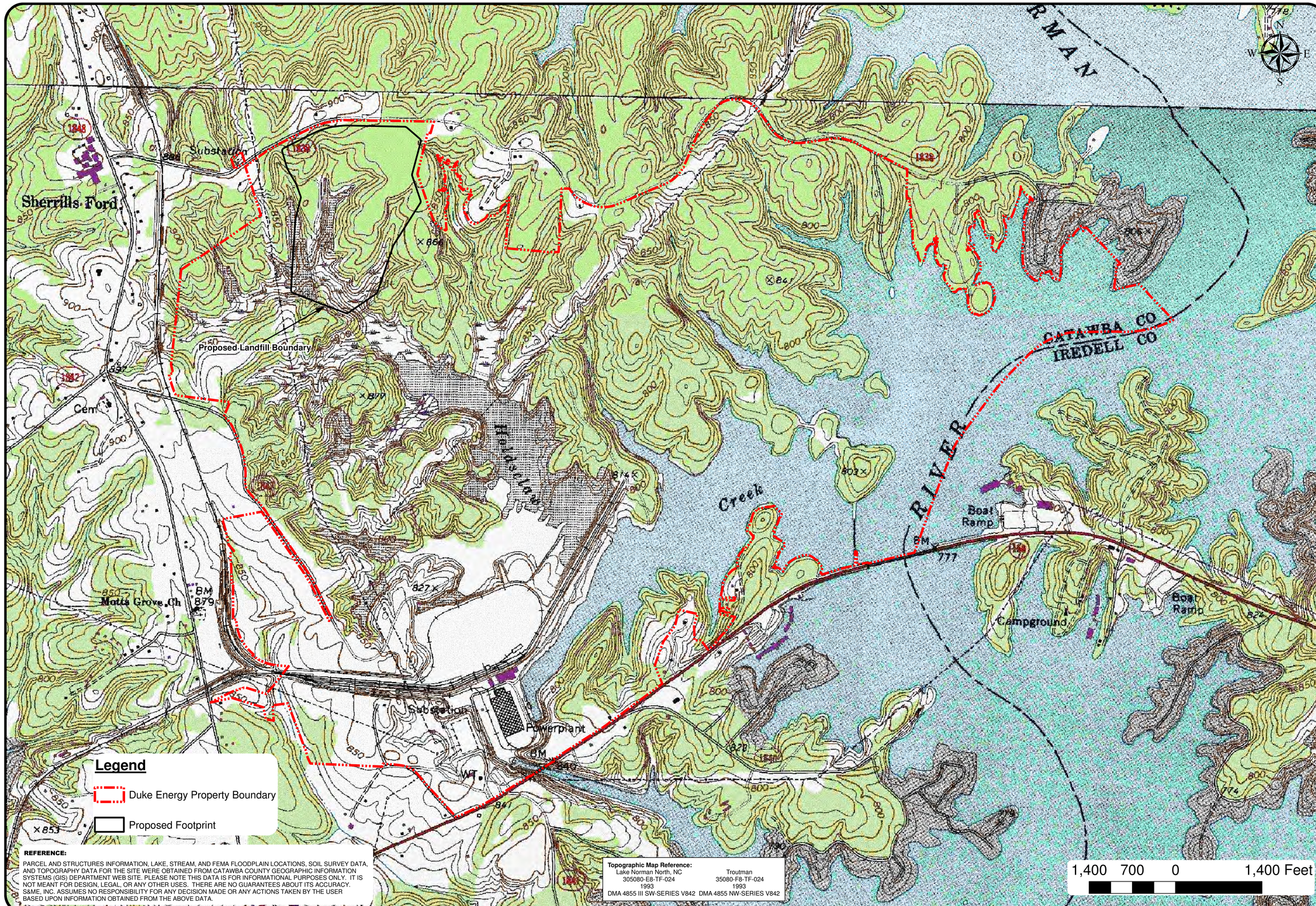
2 Unified Soil Classification System (USCS) symbol: MH = inorganic silts with plasticity; ML = inorganic silts with slight plasticity; SC = clayey sand; SM = silty sand; GM = silty gravel; CH = inorganic clay with plasticity; CL = inorganic clay with slight plasticity.

3 Natural moisture content was obtained from triaxial, one-dimensional consolidation, permeability, or other laboratory test reports. Values reported are averages where more than one result was reported.

4 Atterberg Limits: LL = Liquid Limit.

5 MDD, γ_d = maximum dry density; OMC = optimum moisture content; W = moisture content; Avg. K = Average Permeability.

FIGURES



REFERENCE:

PARCEL AND STRUCTURES INFORMATION, LAKE, STREAM, AND FEMA FLOODPLAIN LOCATIONS, SOIL SURVEY DATA, AND TOPOGRAPHY DATA FOR THE SITE WERE OBTAINED FROM CATAWBA COUNTY GEOGRAPHIC INFORMATION SYSTEMS (GIS) DEPARTMENT WEB SITE. PLEASE NOTE THIS DATA IS FOR INFORMATIONAL PURPOSES ONLY. IT IS NOT MEANT FOR DESIGN, LEGAL, OR ANY OTHER USES. THERE ARE NO GUARANTEES ABOUT ITS ACCURACY. S&ME, INC. ASSUMES NO RESPONSIBILITY FOR ANY DECISION MADE OR ANY ACTIONS TAKEN BY THE USER BASED UPON INFORMATION OBTAINED FROM THE ABOVE DATA.

Topographic Map Reference:

Lake Norman North, NC	Troutman
305080-E8-TF-024	35080-F8-TF-024
1993	1993
DMA 4855 III SW-SERIES V842	DMA 4855 NW-SERIES V842

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NO.	DATE	DESCRIPTION	BY
-	5/08/2009	Revised - Issued for Permit Application	JOF

Topographic Site Map
Industrial Landfill Fill #1

Marshall Steam Station
Terrell, NC

DRAWN BY: JOF	CHECKED BY: WMM
DESIGNED BY:	APPROVED BY: LTA
PROJECT NO: 1356-08-122	
SCALE: 1" = 700'	DATE: 5/08/2009
DRAWING: 1	OF: 12

DRAWING PATH:

REFERENCE:

PARCEL AND STRUCTURES INFORMATION, LAKE, STREAM, AND FEMA FLOODPLAIN LOCATIONS, SOIL SURVEY DATA, AND TOPOGRAPHY DATA FOR THE SITE WERE OBTAINED FROM CATAWBA COUNTY GEOGRAPHIC INFORMATION SYSTEMS (GIS) DEPARTMENT WEB SITE. PLEASE NOTE THIS DATA IS FOR INFORMATIONAL PURPOSES ONLY. IT IS NOT MEANT FOR DESIGN, LEGAL, OR ANY OTHER USES. THERE ARE NO GUARANTEES ABOUT ITS ACCURACY. S&ME, INC. ASSUMES NO RESPONSIBILITY FOR ANY DECISION MADE OR ANY ACTIONS TAKEN BY THE USER BASED UPON INFORMATION OBTAINED FROM THE ABOVE DATA.

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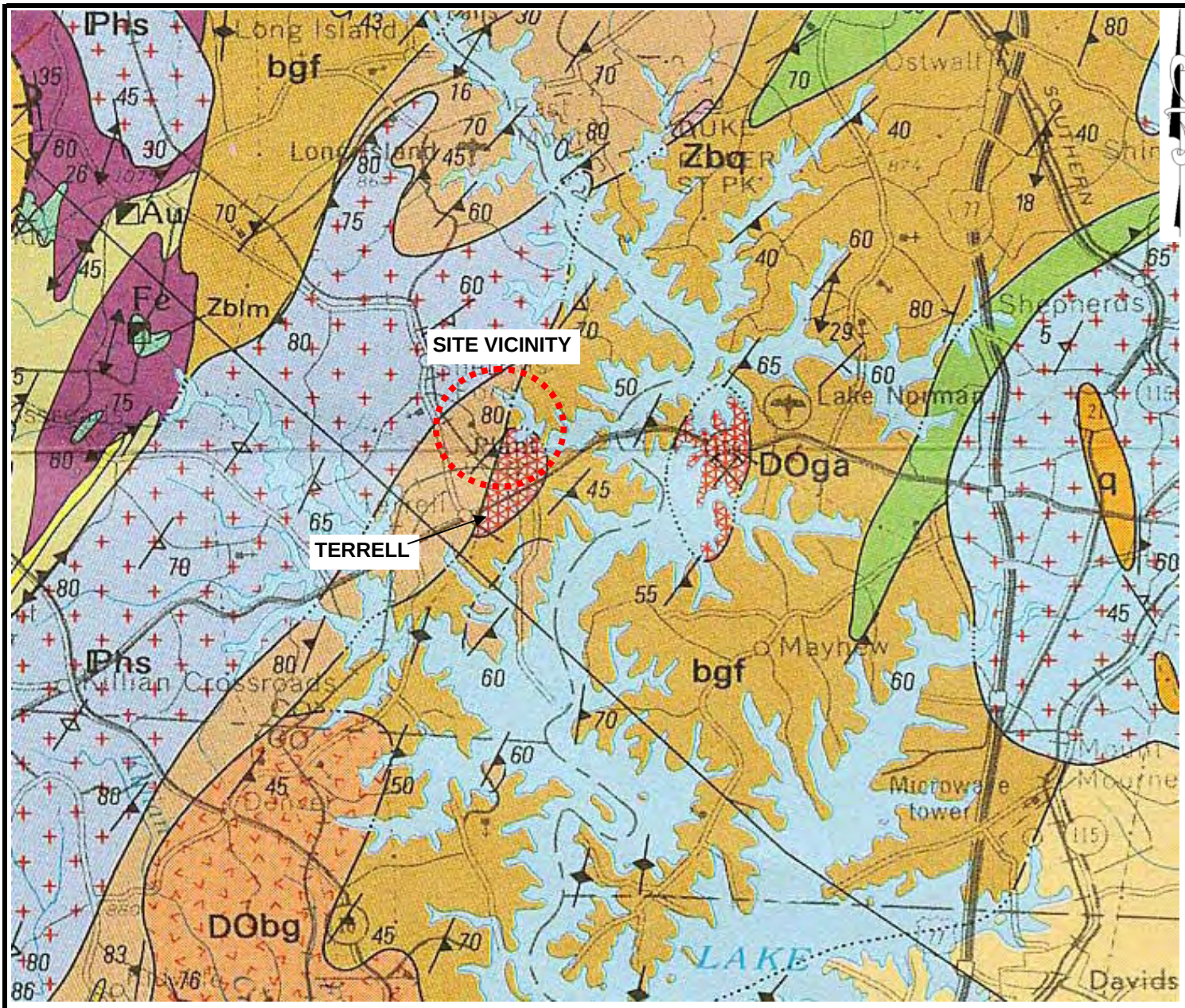
NO.	DATE	DESCRIPTION	BY
-	5/08/2009	Revised - Issued for Permit Application	JOF

Aerial Site Map
Industrial Landfill # 1

Marshall Steam Station
Terrell, NC

DRAWN BY: JOF	CHECKED BY: WMM
DESIGNED BY:	APPROVED BY: LTA
PROJECT NO: 1356-08-122	
SCALE: 1" = 200'	DATE: 5/08/2009
DRAWING: 2	OF: 12

DRAWING PATH:



Battleground Formation (Late Proterozoic)

Zbs — Quartz-sericite schist—Very fine to medium-grained quartz-sericite schist and phyllite. Very light gray, light-bluish-gray, light-brown, or yellowish-gray. Composed largely of quartz (typically >50%) and sericitic white mica (muscovite and paragonite). Accessory minerals may include chloritoid, biotite, pyrite, hematite, kyanite, andalusite, sillimanite, staurolite, garnet, oligoclase or albite, chlorite, tourmaline, zircon, and graphite

DOga — **Alaskitic granite**—Fine-grained, light-gray, muscovite-biotite alaskitic granite. Massive, locally with weak flow foliation

bgf — Fine-grained biotite gneiss—Dominantly of granodioritic composition. Probably metamorphosed dacitic volcanics

Source: Charlotte Geologic Map

SCALE: NTS	S&ME	**GEOLOGIC MAP** Marshall Steam Station - Industrial Landfill #1 Terrell, North Carolina	Figure **3**
CHECKED BY:			
DRAWN BY: JRP			
DATE: 5/8/2009		JOB NO. 1356-08-122	

S&ME
WWW.SMEINC.COM

NORTH CAROLINA
SEAL
1955
GEOLOGIST
JULIE R. PETERSON
5/8/09

NO.	DATE	DESCRIPTION	BY
1	5-8-09	REVISED - ISSUED FOR PERMIT APPLICATION	

BORING LOCATION PLAN
INDUSTRIAL LANDFILL #1

MARSHALL STEAM STATION
TERRELL, NORTH CAROLINA

DRAWN BY: CLD	CHECKED BY:
DESIGNED BY: JRP	APPROVED BY:
PROJECT NUMBER 1356-08-122	
SCALE: AS SHOWN	DATE: 5-8-09
DRAWING: 4	OF: 12

DRAWING PATH: Q:\ESS\VAUE ENERGY\09-2123 MARSHALL IL FAN\CAD\INDUSTRIAL LANDFILL #1\SITE STUDY\BORING LOCATION PLAN.DWG

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5/8/09

NO.	DATE	DESCRIPTION	BY
1	5-8-09	REVISED - ISSUED FOR PERMIT APPLICATION	

GROUNDWATER SURFACE MAP INDUSTRIAL LANDFILL #1

MARSHALL STEAM STATION TERRELL, NORTH CAROLINA

DRAWN BY: CLD	CHECKED BY:
DESIGNED BY: JRP	APPROVED BY:
PROJECT NUMBER 1356-08-122	
SCALE: AS SHOWN	DATE: 5-8-09
DRAWING: 5	OF: 12

DRAWING PATH: G:\1356\DUKE ENERGY\08-122 MARSHALL LANDFILL J\SITE STUDY\GROUNDWATER.DWG

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GEOLOGIST
JULIE R. PETERSEN
5/8/09

NO.	DATE	DESCRIPTION	BY
1	5-8-09	REVISED – ISSUED FOR PERMIT APPLICATION	

LONG-TERM SEASONAL HIGH GROUNDWATER
INDUSTRIAL LANDFILL #1

MARSHALL STEAM STATION
TERRELL, NORTH CAROLINA

DRAWN BY: CLD	CHECKED BY:
DESIGNED BY: JRP	APPROVED BY:
PROJECT NUMBER 1356-08-122	
SCALE: AS SHOWN	DATE: 5-8-09
DRAWING: 6	OF: 12

DRAWING PATH: Q:\1356\DUKE ENERGY\08-122 MARSHALL ELF\DWG\INDUSTRIAL LANDFILL #1\SITE STUDY\SEASONAL HIGH.DWG

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NORTH CAROLINA PROFESSIONAL SEAL GEOLOGIST JULIE R. PETERSEN 5/8/09

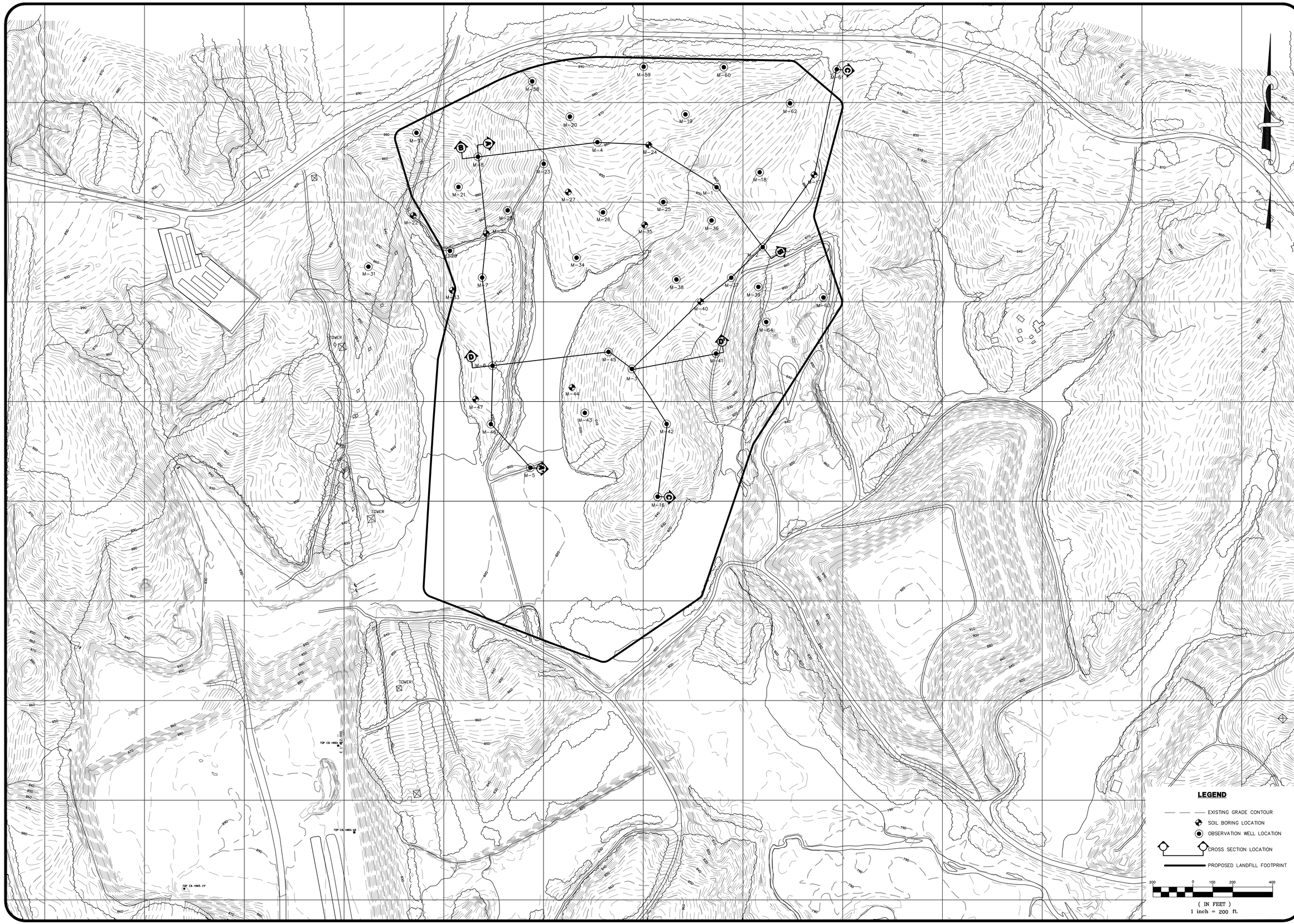
NO.	DATE	DESCRIPTION	BY
1	5-8-09	REVISED - ISSUED FOR PERMIT APPLICATION	

TOP OF BEDROCK MAP INDUSTRIAL LANDFILL #1

MARSHALL STEAM STATION TERRELL, NORTH CAROLINA

DRAWN BY: CLD	CHECKED BY:
DESIGNED BY: JRP	APPROVED BY:
PROJECT NUMBER 1356-08-122	
SCALE: AS SHOWN	DATE: 5-8-09
DRAWING: 7	OF: 12

DRAWING PATH: Q:\1356\DUKE ENERGY\08-122 MARSHALL LF\INDUSTRIAL LANDFILL #1\SITE STUDY\TOP OF BEDROCK.DWG



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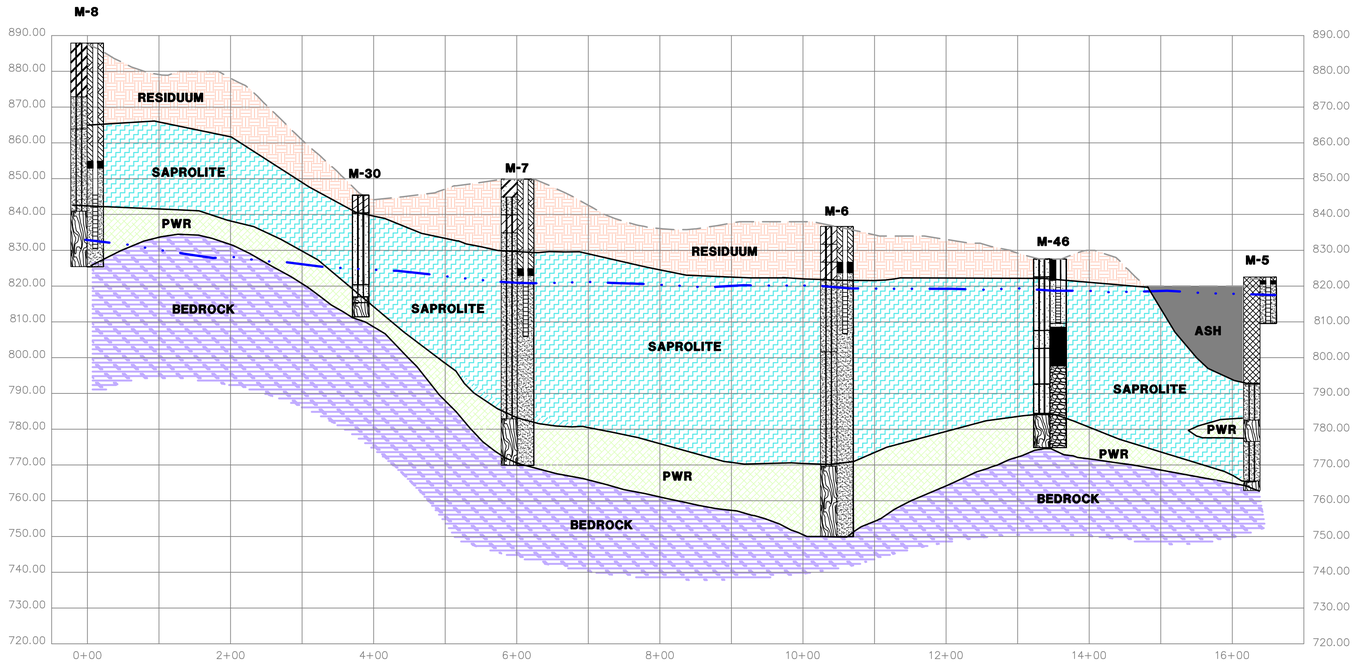
NO.	DATE	DESCRIPTION	BY
1	5-8-09	REVISED - ISSUED FOR PERMIT APPLICATION	

CROSS SECTION LOCATION PLAN
INDUSTRIAL LANDFILL #1

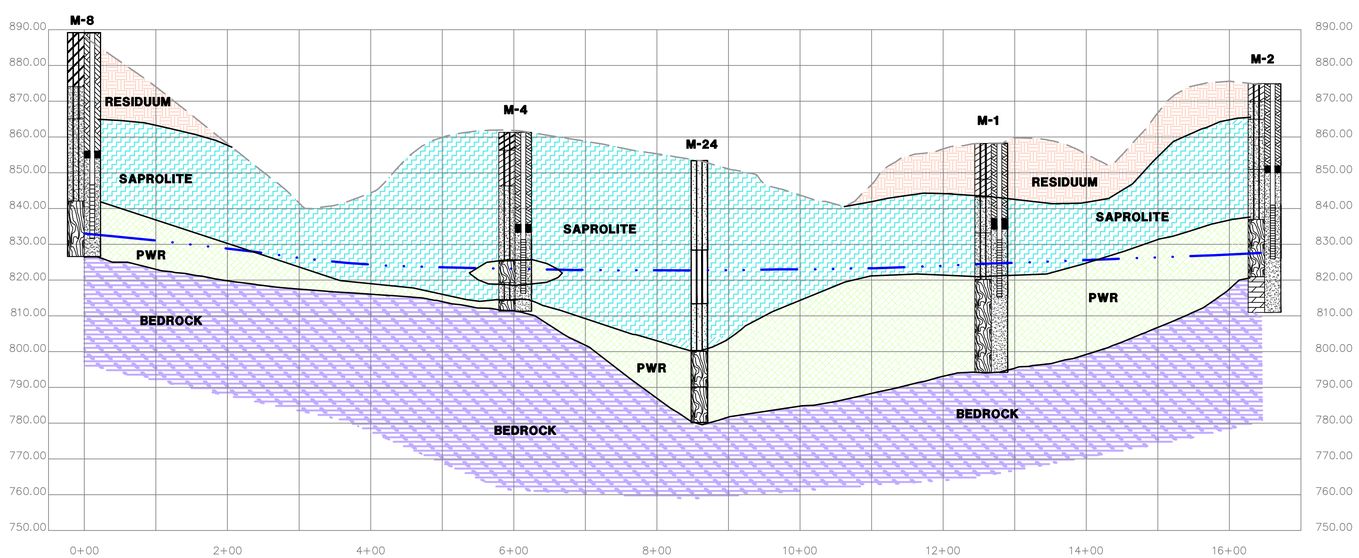
MARSHALL STEAM STATION
TERRELL, NORTH CAROLINA

DRAWN BY: CLD	CHECKED BY:
DESIGNED BY: JRP	APPROVED BY:
PROJECT NUMBER 1356-08-122	
SCALE: AS SHOWN	DATE: 5-8-09
DRAWING: 8	OF: 12

DRAWING PATH: Q:\1356\DUKE ENERGY\08-122 MARSHALL ELF\INDUSTRIAL LANDFILL #1\SITE STUDY\CROSS SECTIONS.DWG



A-A'



B-B'

LEGEND

- EXISTING GRADE
- GROUNDWATER (11/26/08)
- ASH
- RESIDUUM
- SAPROLITE
- PARTIALLY WEATHERED ROCK (PWR)
- BEDROCK
- GROUT
- BENTONITE
- FILTER SAND
- CAVE-IN

VERTICAL SCALE

20 0 10 20 40

(IN FEET)
1 inch = 20 ft.

HORIZONTAL SCALE

100 0 50 100 200

(IN FEET)
1 inch = 100 ft.

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NORTH CAROLINA
JULIE R. PETERS
SEAL
1585
GEOLOGIST
5/8/09

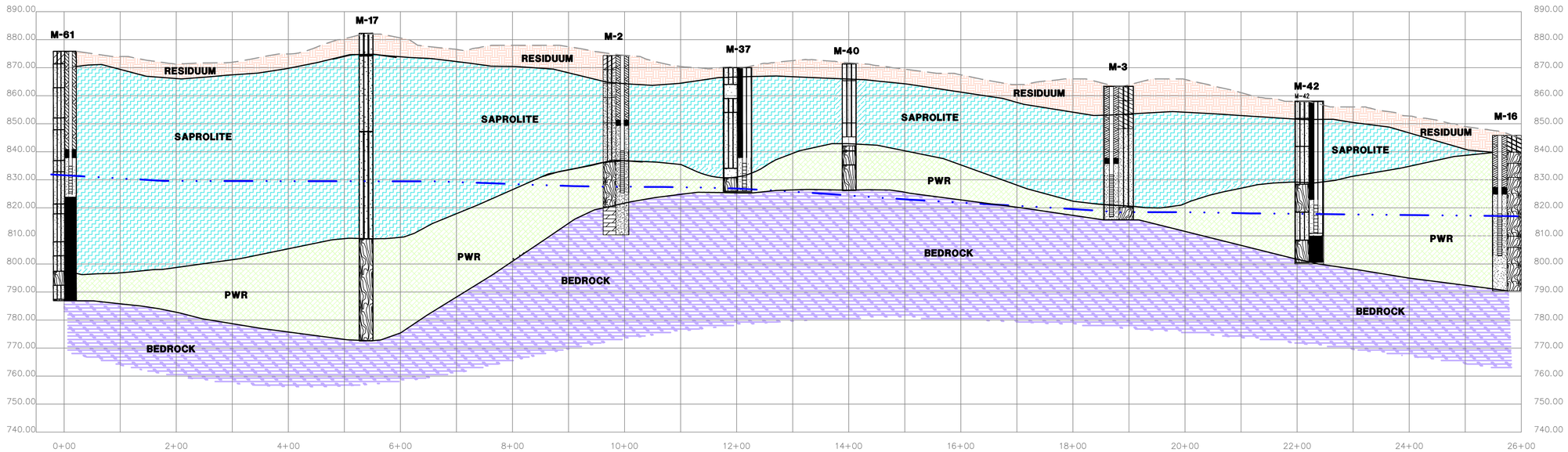
NO.	DATE	DESCRIPTION	BY
1	5-8-09	REVISED - ISSUED FOR PERMIT APPLICATION	

CROSS SECTIONS A-A' / B-B'
INDUSTRIAL LANDFILL #1

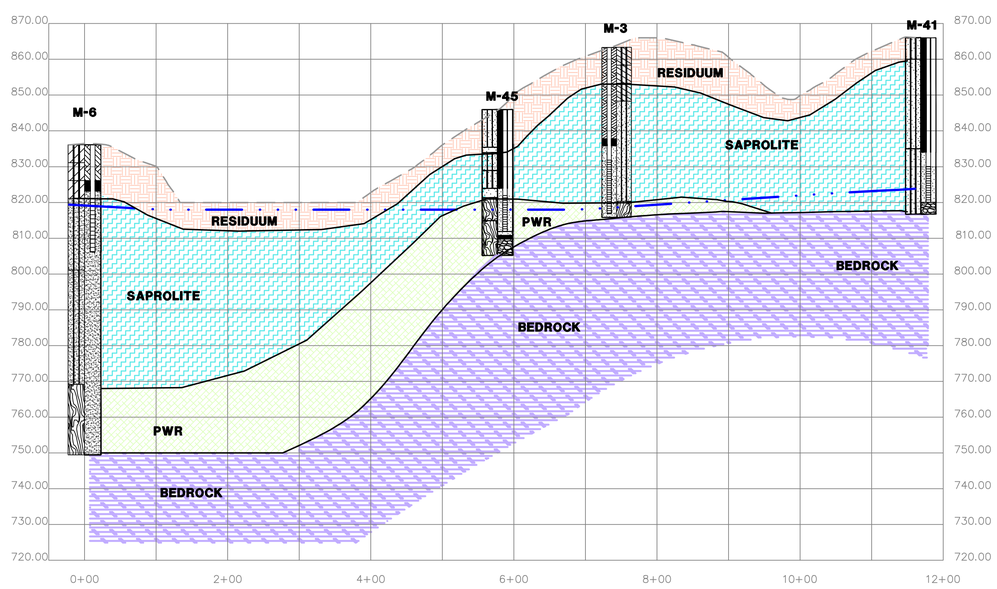
MARSHALL STEAM STATION
TERRELL, NORTH CAROLINA

DRAWN BY: CLD	CHECKED BY:
DESIGNED BY: CRW	APPROVED BY:
PROJECT NUMBER 1356-08-122	
SCALE: AS SHOWN	DATE: 5-8-09
DRAWING: 9	OF: 12

DRAWING PATH: Q:\1356\DUKE ENERGY\08-122 MARSHALL ELP\MS\INDUSTRIAL LANDFILL #1\SITE STUDY\CROSS SECTIONS.DWG



C-C'



D-D'

LEGEND

- EXISTING GRADE
- GROUNDWATER (11/26/08)
- ASH
- RESIDUUM
- SAPROLITE
- PARTIALLY WEATHERED ROCK (PWR)
- BEDROCK
- GROUT
- BENTONITE
- FILTER SAND
- CAVE-IN

VERTICAL SCALE

20 0 10 20 40

(IN FEET)
1 inch = 20 ft.

HORIZONTAL SCALE

100 0 50 100 200

(IN FEET)
1 inch = 100 ft.

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NORTH CAROLINA PROFESSIONAL SEAL 1585 GEOLOGIST JULIE R. PETERSEN
5/8/09

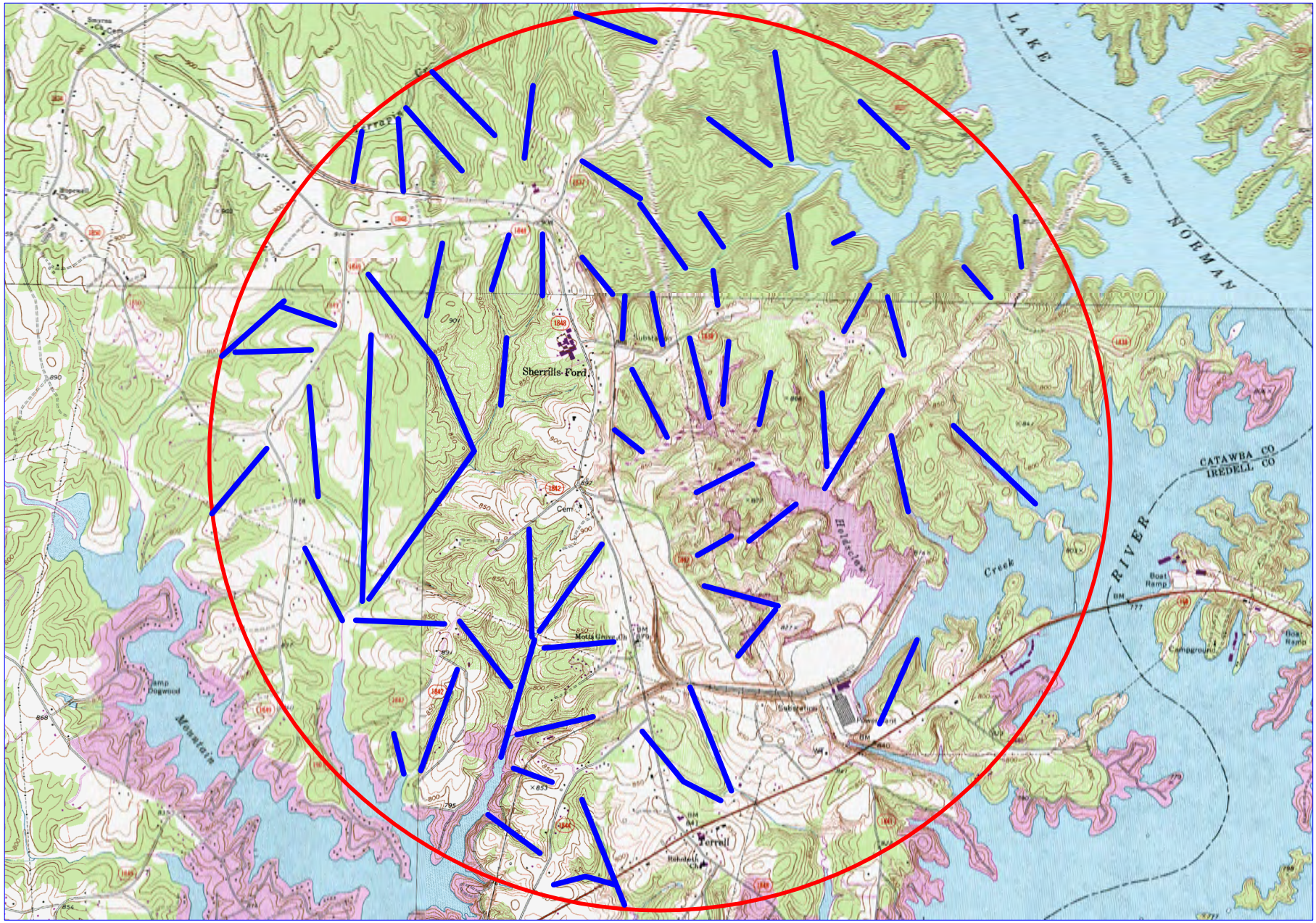
NO.	DATE	DESCRIPTION	BY
1	5-8-09	REVISED - ISSUED FOR PERMIT APPLICATION	

CROSS SECTIONS C-C'/D-D' INDUSTRIAL LANDFILL #1

MARSHALL STEAM STATION TERRELL, NORTH CAROLINA

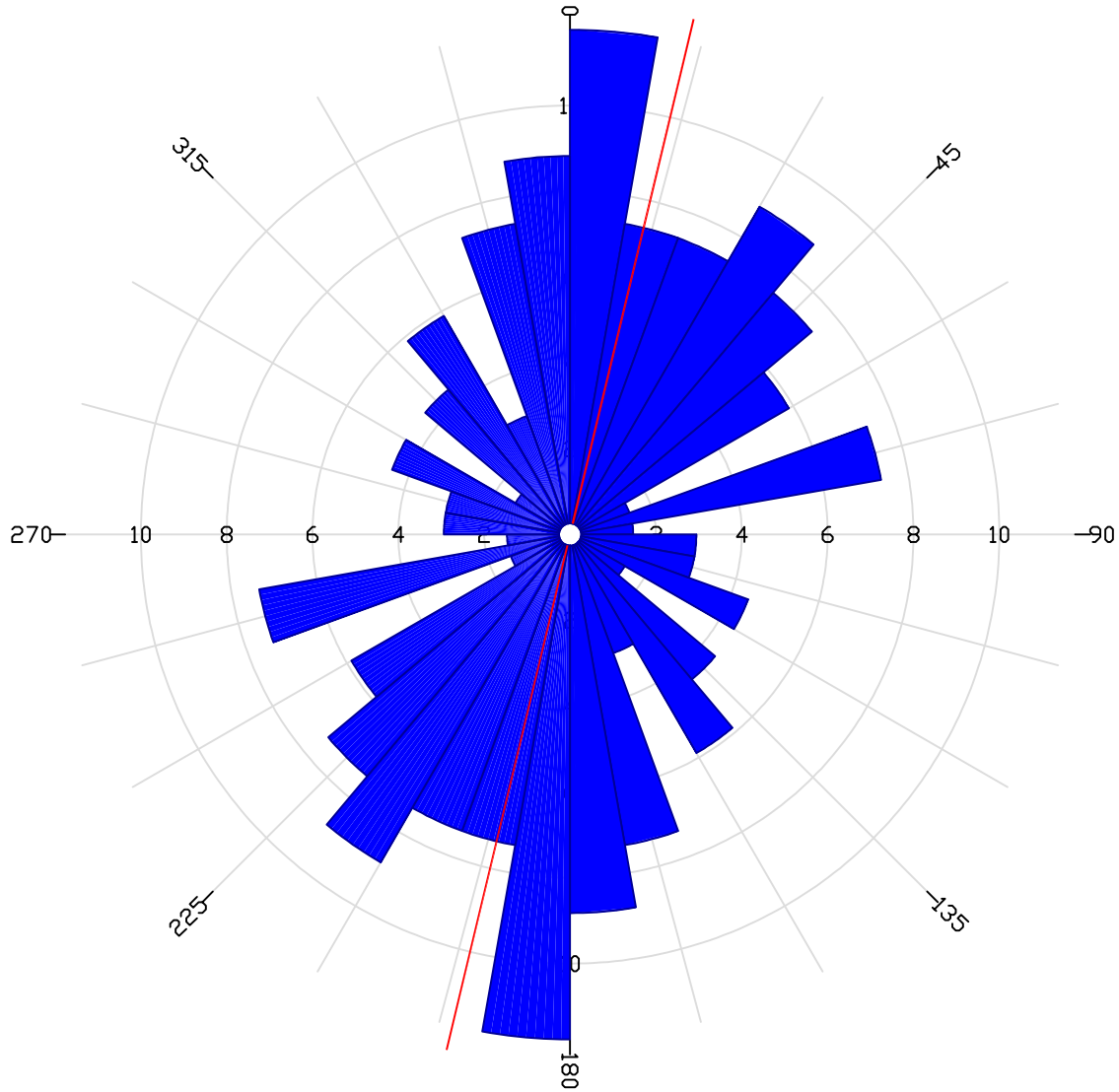
DRAWN BY: CLD	CHECKED BY:
DESIGNED BY: CRW	APPROVED BY:
PROJECT NUMBER 1356-08-122	
SCALE: AS SHOWN	DATE: 5-8-09
DRAWING: 10	OF: 12

DRAWING PATH: Q:\ESA\DUKE ENERGY\08-122 MARSHALL ILF\MS\INDUSTRIAL LANDFILL #1\SITE STUDY\CROSS SECTIONS.DWG



SCALE: ~1"=3500'	DATE: 05/08/2009	S&ME WWW.SMEINC.COM	FRACTURE TRACE SURVEY INDUSTRIAL LANDFILL #1 MARSHALL STEAM STATION TERRELL, NC	FIGURE NO. 11
PROJECT NO. 1356-08-122	DRAWN BY: MRO			
	CHECKED BY: JW			

Marshall Steam Station - Ash Landfill



Statistical Summary	
Calculation Method:	Frequency
Class Interval:	10 Degrees
Azimuth Filtering:	Deactivated
Data Type:	Bidirectional
Rotation Amount:	90.0 Degrees
Population:	68
Maximum Percentage:	11.8 Percent
Mean Percentage:	5.6 Percent
Standard Deviation:	2.9 Percent
Vector Mean:	13.5 Degrees
	193.46 Degrees
Confidence Interval:	32.5 Degrees
	(95 Percent)
R-mag:	0.29

SCALE: N/A	DATE: 5/08/2009	S&ME WWW.SMEINC.COM	FRACTURE TRACE ORIENTATIONS INDUSTRIAL LANDFILL #1 MARSHALL STEAM STATION TERRELL, NC
PROJECT NO. 1356-08-122	DRAWN BY: MRO		FIGURE NO. 12
	CHECKED BY:		

APPENDIX I

Boring Logs, Well Logs, and Well Construction Records

S&ME
ENGINEERING • TESTING
ENVIRONMENTAL SERVICES

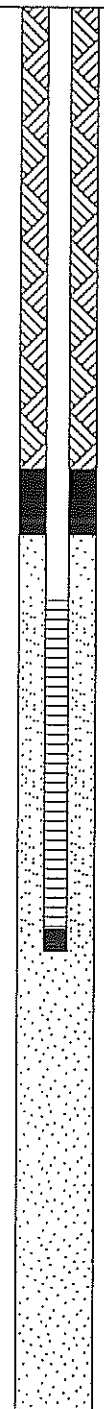
S&ME, Inc.
9751 Southern Pine Blvd.
Charlotte, North Carolina
Telephone: 704-523-4726
Fax: 704-525-3953

1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.
2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

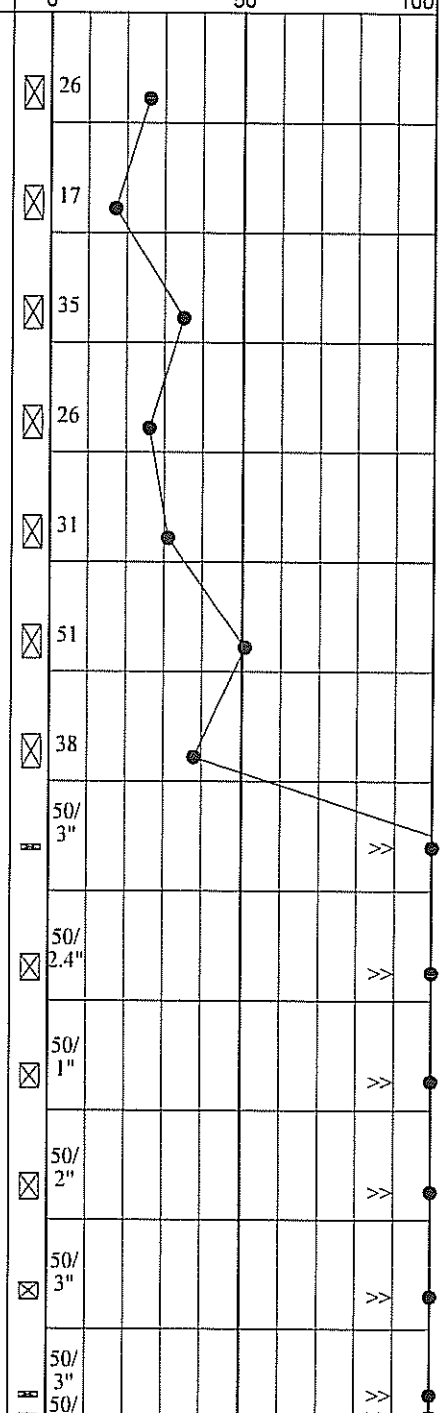
Project: **Marshall Steam Station Industrial Fill #1**			**Boring No. M-1**
Location: **Terrell, North Carolina**		Number: **1356-08-122**	Sheet No. 1 of 1
Boring Depth (ft): **64.0**	Elevation (ft): **859.1**	Driller: **Ted Miller**	Date Drilled: **11/2/07**
Logged By: **Matthew Osborne**	Water Level: **33.64 ft bls on 01-08-08**		Drilling Method: **4¼" H.S.A.**

Elev. (Feet)	Depth (Feet)	Lith-ology	Material Description
855, 850	0–10		Residuum: Very Stiff Red Brown Clayey Silt with fine Sand (MH)
850, 845	10–15		Residuum: Hard Brown fine Sandy Clayey Silt (ML)
845, 840, 835	15–25		Saprolite: Medium Dense to Dense Brown White micaceous Silty fine Sand
835, 830, 825	25–35		Saprolite: Dense to Very Dense Gray White micaceous Silty fine to medium Sand with increasing Quartz content
825, 820, 815, 810, 805, 800	35–60		Partially Weathered Rock: When sampled becomes Very Dense Gray White micaceous Silty fine to medium Sand with increasing Quartz content
	60		Auger Refusal at 64 ft bls

Well Construction



Penetration Resistance (Blows/Foot)



BORING LOG WITH WELL MARSHALL STEAM STATION BORING LOGS 01-2009.GPJ LAGWGN01.GDT 1/29/09

COMPLETION REPORT OF WELL No. M-1

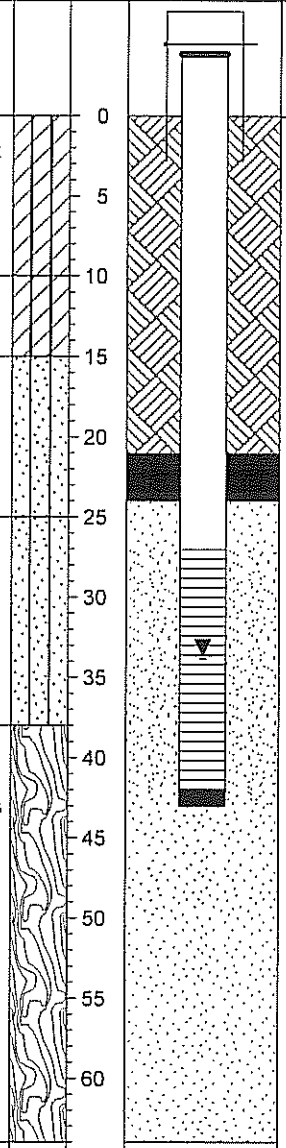
PROJECT: **Marshall Steam Station Industrial Fill #1**
PROJECT NO: **1356-08-122**
PROJECT LOCATION: **Terrell, North Carolina**

WATER LEVEL: **33.64 ft bls on 01-08-08**

LATITUDE: **35.621848°**
LONGITUDE: **80.972404°**
TOP OF CASING ELEVATION: **862.08**
DATUM: **MSL**
LOGGED BY: **Matthew Osborne**

DRILLING CONTRACTOR: **S&ME, Inc.**
DRILLING METHOD: **4¼" H.S.A.**
DATE DRILLED: **11/2/07**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)
				0.00		859.07
Residuum: Very Stiff Red Brown Clayey Silt with fine Sand (MH)		0, 5				
Residuum: Hard Brown fine Sandy Clayey Silt (ML)		10				
Saprolite: Medium Dense to Dense Brown White micaceous Silty fine Sand		15, 20				
Saprolite: Dense to Very Dense Gray White micaceous Silty fine to medium Sand with increasing Quartz content		25, 30, 35				
Partially Weathered Rock: When sampled becomes Very Dense Gray White micaceous Silty fine to medium Sand with increasing Quartz content		40, 45, 50, 55, 60		64.00		795.07



WELL CONSTRUCTION DETAILS

PROTECTIVE CASING
Diameter: **Four Inch**
Type: **Steel**
Interval: **Above-Ground**

RISER CASING
Diameter: **Two Inch**
Type: **Sch 40 PVC**
Interval: **3.01 Feet ALS to 27 Feet BLS**

GROUT
Type: **Portland**
Interval: **GS to 21 Feet BLS**

SEAL
Type: **Bentonite Pellets**
Interval: **21 to 24 Feet BLS**

FILTERPACK
Type: **Medium Sand**
Interval: **24 to 64 Feet BLS**

SCREEN
Diameter: **Two Inch**
Type: **Sch 40 PVC 0.010 Inch Slot**
Interval: **27 to 42 Feet BLS**

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

MONITORING WELL MARSHALL STEAM STATION BORING LOGS 01-2009.GPJ S&ME.GDT 1/29/09

S&ME
ENGINEERING • TESTING
ENVIRONMENTAL SERVICES
9751 Southern Pine Blvd.
Charlotte, North Carolina

COMPLETION REPORT OF WELL No. M-1

NON RESIDENTIAL WELL CONSTRUCTION RECORD

North Carolina Department of Environment and Natural Resources- Division of Water Quality

WELL CONTRACTOR CERTIFICATION # 2626

1. WELL CONTRACTOR:

Ted Miller
Well Contractor (Individual) Name

S&ME, Inc.
Well Contractor Company Name

STREET ADDRESS 155 Tradd Street

Spartanburg SC 29301
City or Town State Zip Code

(864)- 574-2360
Area code- Phone number

2. WELL INFORMATION:

SITE WELL ID #(if applicable) M-1

STATE WELL PERMIT#(if applicable)

DWQ or OTHER PERMIT #(if applicable)

WELL USE (Check Applicable Box) Monitoring ☐ Municipal/Public ☐ Industrial/Commercial ☐ Agricultural ☐ Recovery ☐ Injection ☐ Irrigation ☐ Other ☒ (list use) Observation

DATE DRILLED 11/6/07

TIME COMPLETED 1630 AM ☐ PM ☒

3. WELL LOCATION:

CITY: Terrell COUNTY Catawba

8320 NC Highway 150E, Marshall Steam Station, 28682
(Street Name, Numbers, Community, Subdivision, Lot No., Parcel, Zip Code)

TOPOGRAPHIC / LAND SETTING:
☒ Slope ☐ Valley ☐ Flat ☐ Ridge ☐ Other
(check appropriate box)

LATITUDE 35.621848
LONGITUDE -80.972404

May be in degrees, minutes, seconds or in a decimal format

Latitude/longitude source: ☒ GPS ☐ Topographic map
(location of well must be shown on a USGS topo map and attached to this form if not using GPS)

4. FACILITY- is the name of the business where the well is located.

FACILITY ID #(if applicable)

NAME OF FACILITY Marshall Steam Station

STREET ADDRESS 8320 NC Highway 150E

Terrell NC 28682
City or Town State Zip Code

CONTACT PERSON Darrell Wolfe

MAILING ADDRESS 8320 NC Highway 150E

Terrell NC 28682
City or Town State Zip Code

(828)- 478-7829
Area code - Phone number

5. WELL DETAILS:

a. TOTAL DEPTH: 42

b. DOES WELL REPLACE EXISTING WELL? YES ☐ NO ☒

c. WATER LEVEL Below Top of Casing: 36.81 FT.
(Use "+" if Above Top of Casing)

d. TOP OF CASING IS 3.01 FT. Above Land Surface*
*Top of casing terminated at/or below land surface may require a variance in accordance with 15A NCAC 2C .0118.

e. YIELD (gpm): METHOD OF TEST

f. DISINFECTION: Type Amount

g. WATER ZONES (depth):
From 36.81 To From To
From To From To
From To From To

6. CASING:

From	To	Ft.	Diameter	Thickness/ Weight	Material
0	27		2	sch.40	PVC

7. GROUT:

From	To	Ft.	Material	Method
0	21		Neat Cement	tremie pump
21	24			

8. SCREEN:

From	To	Ft.	Diameter	Slot Size	Material
27	42		2 in.	.010 in.	PVC
			in.	in.	
			in.	in.	

9. SAND/GRAVEL PACK:

From	To	Ft.	Size	Material
24	63.9		#2	Sand

10. DRILLING LOG

From To	Formation Description
0-15	Very Stiff to Hard Mica Fine Sandy Silt
15-25	Med. Dense to Dense Mica Silt Fine Sand
25-64	v.Dense Mica Silt Fine to Med Sand with Increasing Quartz content.

11. REMARKS:

I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

[signature] 1-18-08
SIGNATURE OF CERTIFIED WELL CONTRACTOR DATE

Ted Miller
PRINTED NAME OF PERSON CONSTRUCTING THE WELL

Submit the original to the Division of Water Quality within 30 days. Attn: Information Mgt., 1617 Mail Service Center – Raleigh, NC 27699-1617 Phone No. (919) 733-7015 ext 568.

Form GW-1b
Rev. 7/05

S&ME
ENGINEERING • TESTING
ENVIRONMENTAL SERVICES

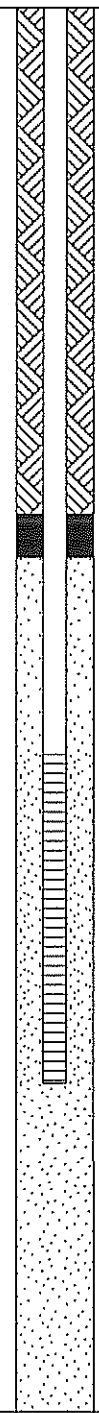
S&ME, Inc.
9751 Southern Pine Blvd.
Charlotte, North Carolina
Telephone: 704-523-4726
Fax: 704-525-3953

1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.
2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

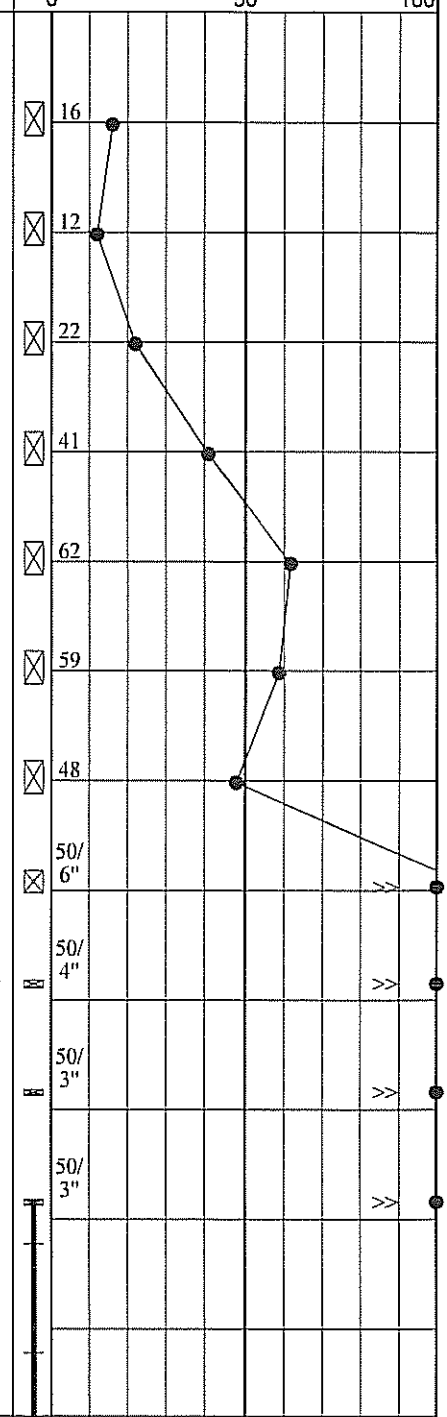
Project: **Marshall Steam Station Industrial Fill #1**			**Boring No. M-2**
Location: **Terrell, North Carolina**		Number: **1356-08-122**	Sheet No. 1 of 1
Boring Depth (ft): **64.0**	Elevation (ft): **874.4**	Driller: **Joey Donnahoo**	Date Drilled: **11/8/07**
Logged By: **John Whitehead**	Water Level: **44.14 ft bls on 01-08-08**		Drilling Method: **4¼" H.S.A.**

Elev. (Feet)	Depth (Feet)	Lith-ology	Material Description
			Residuum: Very Stiff Red Brown micaceous fine Sandy Clayey Silt (ML)
870	5		Residuum: Stiff Light Brown micaceous fine Sandy Silt (ML)
865	10		Saprolite: Medium Dense Tan micaceous Silty fine Sand (SM)
860	15		Saprolite: Medium Dense to Dense Tan Brown micaceous Silty fine Sand
855	20		
850	25		Saprolite: Dense to Very Dense Tan White micaceous Silty fine to medium Sand
845	30		
840	35		
835	40		Partially Weathered Rock: When sampled becomes Very Dense Tan White micaceous Silty fine to medium Sand
830	45		
825	50		
820	55		Auger Refusal at 54 Feet Bedrock: Foliated Feldspar Granite, High Angle (50°- 60°) Fractures and Bedding.
815	60		
			Boring Terminated at 64 ft bls

Well Construction



Penetration Resistance (Blows/Foot)



BORING LOG WITH WELL MARSHALL STEAM STATION BORING LOGS 01-2009.GPJ LAGWGN01.GDT 1/29/09

CLASSIFICATION:

54 to 64 ft. bls Foliated Feldspar Granite

Start of Run #1
54 to 56 ft bls
Recovery = 90%
RQD = 75%

Start of Run #2
56 to 61 ft bls
Recovery = 55%
RQD = 35%

Start of Run #3
61 to 64 ft bls
Recovery = 93%
RQD = 90%

SCALE:	As Shown
CHECKED BY:	
DRAWN BY:	MRO
DATE:	4/8/2008

S&ME

ROCK CORE M-2
Industrial Landfill #1
Marshall Steam Station, Terrell, NC

JOB NO. 1356-08-122

COMPLETION REPORT OF WELL No. M-2

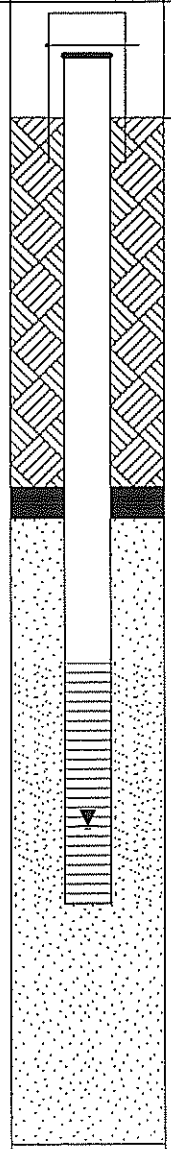
PROJECT: **Marshall Steam Station Industrial Fill #1**
PROJECT NO: **1356-08-122**
PROJECT LOCATION: **Terrell, North Carolina**

WATER LEVEL: **44.14 ft bls on 01-08-08**

LATITUDE: **35.621036°**
LONGITUDE: **80.971605°**
TOP OF CASING ELEVATION: **877.13**
DATUM: **MSL**
LOGGED BY: **John Whitehead**

DRILLING CONTRACTOR: **S&ME, Inc.**
DRILLING METHOD: **4¼" H.S.A.**
DATE DRILLED: **11/8/07**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)
Residuum: Very Stiff Red Brown micaceous fine Sandy Clayey Silt (ML)		0		0.00		874.39
Residuum: Stiff Light Brown micaceous fine Sandy Silt (ML)		5				
Saprolite: Medium Dense Tan micaceous Silty fine Sand (SM)		10				
Saprolite: Medium Dense to Dense Tan Brown micaceous Silty fine Sand		15, 20				
Saprolite: Dense to Very Dense Tan White micaceous Silty fine to medium Sand		25, 30, 35				
Partially Weathered Rock: When sampled becomes Very Dense Tan White micaceous Silty fine to medium Sand		40, 45, 50				
Bedrock: Foliated Feldspar Granite, High Angle (50°- 60°) Fractures and Bedding.		55, 60		64.00		810.39



WELL CONSTRUCTION DETAILS

PROTECTIVE CASING
Diameter: **Four Inch**
Type: **Steel**
Interval: **Above-Ground**

RISER CASING
Diameter: **Two Inch**
Type: **Sch 40 PVC**
Interval: **2.74 Feet ALS to 34 Feet BLS**

GROUT
Type: **Portland**
Interval: **GS to 23 Feet BLS**

SEAL
Type: **Bentonite Pellets**
Interval: **23 to 25 Feet BLS**

FILTERPACK
Type: **Medium Sand**
Interval: **25 to 64 Feet BLS**

SCREEN
Diameter: **Two Inch**
Type: **Sch 40 PVC 0.010 Inch Slot**
Interval: **34 to 49 Feet BLS**

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

S&ME
ENGINEERING • TESTING
ENVIRONMENTAL SERVICES
9751 Southern Pine Blvd.
Charlotte, North Carolina

COMPLETION REPORT OF WELL No. M-2

NON RESIDENTIAL WELL CONSTRUCTION RECORD

North Carolina Department of Environment and Natural Resources- Division of Water Quality

WELL CONTRACTOR CERTIFICATION # 2626

1. WELL CONTRACTOR:

Ted Miller
Well Contractor (Individual) Name

S&ME, Inc.
Well Contractor Company Name

STREET ADDRESS 155 Tradd Street

Spartanburg SC 29301
City or Town State Zip Code

(864)- 574-2360
Area code- Phone number

2. WELL INFORMATION:

SITE WELL ID #(if applicable) M-2

STATE WELL PERMIT#(if applicable)

DWQ or OTHER PERMIT #(if applicable)

WELL USE (Check Applicable Box) Monitoring ☐ Municipal/Public ☐ Industrial/Commercial ☐ Agricultural ☐ Recovery ☐ Injection ☐ Irrigation ☐ Other ☒ (list use) Observation

DATE DRILLED 11/12/07

TIME COMPLETED 1400 AM ☐ PM ☒

3. WELL LOCATION:

CITY: Terrell COUNTY Catawba

8320 NC Highway 150E, Marshall Steam Station, 28682
(Street Name, Numbers, Community, Subdivision, Lot No., Parcel, Zip Code)

TOPOGRAPHIC / LAND SETTING:
☐ Slope ☐ Valley ☐ Flat ☒ Ridge ☐ Other
(check appropriate box)

LATITUDE 35.621036
LONGITUDE -80.971605

May be in degrees, minutes, seconds or in a decimal format

Latitude/longitude source: ☒ GPS ☐ Topographic map
(location of well must be shown on a USGS topo map and attached to this form if not using GPS)

4. FACILITY- Is the name of the business where the well is located.

FACILITY ID #(if applicable)

NAME OF FACILITY Marshall Steam Station

STREET ADDRESS 8320 NC Highway 150E

Terrell NC 28682
City or Town State Zip Code

CONTACT PERSON Darrell Wolfe

MAILING ADDRESS 8320 NC Highway 150E

Terrell NC 28682
City or Town State Zip Code

(828)- 478-7829
Area code - Phone number

5. WELL DETAILS:

a. TOTAL DEPTH: 49

b. DOES WELL REPLACE EXISTING WELL? YES ☐ NO ☒

c. WATER LEVEL Below Top of Casing: 46.66 FT.
(Use "+" if Above Top of Casing)

d. TOP OF CASING IS 2.74 FT. Above Land Surface*
*Top of casing terminated at/or below land surface may require a variance in accordance with 15A NCAC 2C .0118.

e. YIELD (gpm): METHOD OF TEST

f. DISINFECTION: Type Amount

g. WATER ZONES (depth):
From 46.66 To From To
From To From To
From To From To

6. CASING:

From	To	Ft.	Diameter	Thickness/ Weight	Material
0	34		2	sch.40	PVC

7. GROUT:

From	To	Ft.	Material	Method
0	23		Neat Cement	tremie pump
23	25		Bentonite Pellet	poured

8. SCREEN:

From	To	Ft.	Diameter	Slot Size	Material
34	49		2 in.	.010 in.	PVC
			in.	in.	
			in.	in.	

9. SAND/GRAVEL PACK:

From	To	Ft.	Size	Material
25	64		#2	Sand

10. DRILLING LOG

From	To	Formation Description
0	7	v.Stiff Mica fine Sandy Silt
7	24	Med. Dense to dense Mica Silt Fine Sand
24	54	v. Dense Mica Silty fine to med. Sand

11. REMARKS:

I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

Ted Miller 1-18-08
SIGNATURE OF CERTIFIED WELL CONTRACTOR DATE

Ted Miller Ted Miller
PRINTED NAME OF PERSON CONSTRUCTING THE WELL

Submit the original to the Division of Water Quality within 30 days. Attn: Information Mgt., 1617 Mail Service Center – Raleigh, NC 27699-1617 Phone No. (919) 733-7015 ext 568.

Form GW-1b
Rev. 7/05

S&ME
ENGINEERING • TESTING
ENVIRONMENTAL SERVICES

S&ME, Inc.
9751 Southern Pine Blvd.
Charlotte, North Carolina
Telephone: 704-523-4726
Fax: 704-525-3953

1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.
2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

Project: **Marshall Steam Station Industrial Fill #1**			**Boring No. M-3**
Location: **Terrell, North Carolina**		Number: **1356-08-122**	Sheet No. 1 of 1
Boring Depth (ft): **47.5**	Elevation (ft): **863.2**	Driller: **Joey Donnahoo**	Date Drilled: **11/1/07**
Logged By: **John Whitehead**	Water Level: **44.11 ft bls on 01-08-08**		Drilling Method: **4¼" H.S.A.**

Elev. (Feet)	Depth (Feet)	Lithology	Material Description	Well Construction	Penetration Resistance (Blows/Foot) 0 50 100
860			Residuum: Very Stiff Red Brown fine Sandy Clayey Silt (ML)		17
	5		Residuum: Very Stiff Brown Tan micaceous medium to fine Sandy Clayey Silt (ML)		19
855					
	10		Saprolite: Very Stiff Brown Tan micaceous medium to fine Sandy Clayey Silt (ML)		17
850					
	15		Saprolite: Medium Dense to Dense Tan Brown White micaceous Silty fine to medium Sand		18
845					
	20				43
840					
	25				15
835					
	30				19
830					
	35				31
825					
	40				50/1" >>
820			Partially Weathered Rock: When sampled becomes Very Dense Black White Silty fine to coarse Sand		
	45				50/1" >>
			Auger Refusal at 47.5 ft bls		

BORING LOG WITH WELL MARSHALL STEAM STATION BORING LOGS 01-2009.GPJ LAGWGN01.GDT 1/29/09

COMPLETION REPORT OF WELL No. M-3

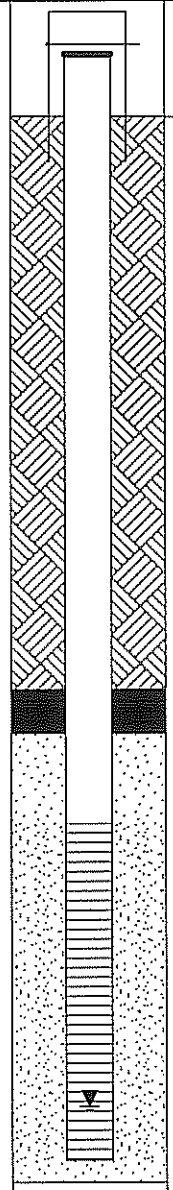
PROJECT: **Marshall Steam Station Industrial Fill #1**
PROJECT NO: **1356-08-122**
PROJECT LOCATION: **Terrell, North Carolina**

WATER LEVEL: **44.11 ft bls on 01-08-08**

LATITUDE: **35.619321°**
LONGITUDE: **80.973771°**
TOP OF CASING ELEVATION: **865.88**
DATUM: **MSL**
LOGGED BY: **John Whitehead**

DRILLING CONTRACTOR: **S&ME, Inc.**
DRILLING METHOD: **4¼" H.S.A.**
DATE DRILLED: **11/1/07**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)
				0.00		863.19
Residuum: Very Stiff Red Brown fine Sandy Clayey Silt (ML)		0				
Residuum: Very Stiff Brown Tan micaceous medium to fine Sandy Clayey Silt (ML)		5				
Saprolite: Very Stiff Brown Tan micaceous medium to fine Sandy Clayey Silt (ML)		10				
Saprolite: Medium Dense to Dense Tan Brown White micaceous Silty fine to medium Sand		15, 20, 25, 30, 35, 40				
Partially Weathered Rock: When sampled becomes Very Dense Black White Silty fine to coarse Sand		45		47.50		815.69



WELL CONSTRUCTION DETAILS

PROTECTIVE CASING
Diameter: **Four Inch**
Type: **Steel**
Interval: **Above-Ground**

RISER CASING
Diameter: **Two Inch**
Type: **Sch 40 PVC**
Interval: **2.69 Feet ALS to 31.5 Feet BLS**

GROUT
Type: **Portland**
Interval: **GS to 25.5 Feet BLS**

SEAL
Type: **Bentonite Pellets**
Interval: **25.5 to 27.5 Feet BLS**

FILTERPACK
Type: **Medium Sand**
Interval: **27.5 to 47.5 Feet BLS**

SCREEN
Diameter: **Two Inch**
Type: **Sch 40 PVC 0.010 Inch Slot**
Interval: **31.5 to 46.5 Feet BLS**

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

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9751 Southern Pine Blvd.
Charlotte, North Carolina

COMPLETION REPORT OF WELL No. M-3

NON RESIDENTIAL WELL CONSTRUCTION RECORD

North Carolina Department of Environment and Natural Resources- Division of Water Quality

WELL CONTRACTOR CERTIFICATION # 2626

1. WELL CONTRACTOR:

Ted Miller
Well Contractor (Individual) Name

S&ME, Inc.
Well Contractor Company Name

STREET ADDRESS 155 Tradd Street

Spartanburg SC 29301
City or Town State Zip Code

(864)- 574-2360
Area code- Phone number

2. WELL INFORMATION:

SITE WELL ID #(if applicable) M-3

STATE WELL PERMIT#(if applicable)

DWQ or OTHER PERMIT #(if applicable)

WELL USE (Check Applicable Box) Monitoring ☐ Municipal/Public ☐ Industrial/Commercial ☐ Agricultural ☐ Recovery ☐ Injection ☐ Irrigation ☐ Other ☒ (list use) Observation

DATE DRILLED 11/1/07

TIME COMPLETED 1630 AM ☐ PM ☒

3. WELL LOCATION:

CITY: Terrell COUNTY Catawba

8320 NC Highway 150E, Marshall Steam Station, 28682
(Street Name, Numbers, Community, Subdivision, Lot No., Parcel, Zip Code)

TOPOGRAPHIC / LAND SETTING:
☐ Slope ☐ Valley ☐ Flat ☒ Ridge ☐ Other
(check appropriate box)

LATITUDE 35.619321
LONGITUDE -80.973771

May be in degrees, minutes, seconds or in a decimal format

Latitude/longitude source: ☒ GPS ☐ Topographic map
(location of well must be shown on a USGS topo map and attached to this form if not using GPS)

4. FACILITY- is the name of the business where the well is located.

FACILITY ID #(if applicable)

NAME OF FACILITY Marshall Steam Station

STREET ADDRESS 8320 NC Highway 150E

Terrell NC 28682
City or Town State Zip Code

CONTACT PERSON Darrell Wolfe

MAILING ADDRESS 8320 NC Highway 150E

Terrell NC 28682
City or Town State Zip Code

(828)- 478-7829
Area code - Phone number

5. WELL DETAILS:

a. TOTAL DEPTH: 46.5

b. DOES WELL REPLACE EXISTING WELL? YES ☐ NO ☒

c. WATER LEVEL Below Top of Casing: 46.87 FT.
(Use "+" if Above Top of Casing)

d. TOP OF CASING IS 2.69 FT. Above Land Surface*
*Top of casing terminated at/or below land surface may require a variance in accordance with 15A NCAC 2C .0118.

e. YIELD (gpm): METHOD OF TEST

f. DISINFECTION: Type Amount

g. WATER ZONES (depth):
From 46.87 To From To
From To From To
From To From To

6. CASING:

From	To	Ft.	Diameter	Thickness/ Weight	Material
0	31.5		2	sch.40	PVC

7. GROUT:

From	To	Ft.	Material	Method
0	25.5		Neat Cement	tremie pump
25.5	27.5			

8. SCREEN:

From	To	Ft.	Diameter	Slot Size	Material
31.5	46.5		2 in.	.010 in.	PVC
			in.	in.	
			in.	in.	

9. SAND/GRAVEL PACK:

From	To	Ft.	Size	Material
27.5	46.5		#2	Sand

10. DRILLING LOG

From	To	Formation Description
0	10	v stiff micaceous fine sandy Silt
10	40	md dense-dense silty fine Sand
40	48.2	v dense silty med-coarse Sand

11. REMARKS:

I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

Ted Miller 1-18-08
SIGNATURE OF CERTIFIED WELL CONTRACTOR DATE

Ted Miller
PRINTED NAME OF PERSON CONSTRUCTING THE WELL

Submit the original to the Division of Water Quality within 30 days. Attn: Information Mgt., 1617 Mail Service Center – Raleigh, NC 27699-1617 Phone No. (919) 733-7015 ext 568.

Form GW-1b
Rev. 7/05

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ENVIRONMENTAL SERVICES

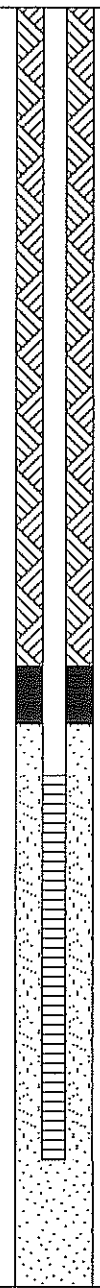
S&ME, Inc.
9751 Southern Pine Blvd.
Charlotte, North Carolina
Telephone: 704-523-4726
Fax: 704-525-3953

1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.
2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

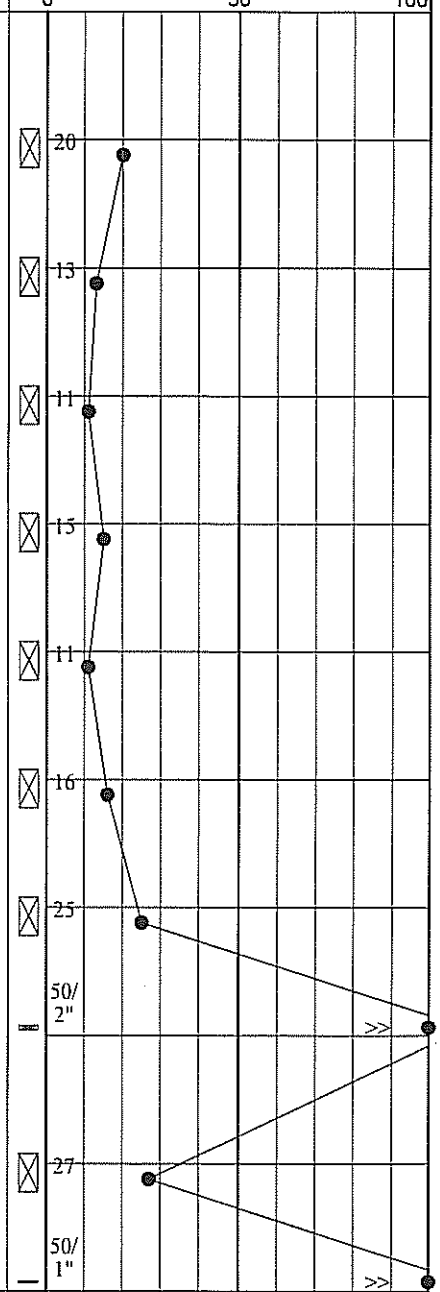
Project: **Marshall Steam Station Industrial Fill #1**			**Boring No. M-4**
Location: **Terrell, North Carolina**		Number: **1356-08-122**	Sheet No. 1 of 1
Boring Depth (ft): **50.0**	Elevation (ft): **861.4**	Driller: **Ted Miller**	Date Drilled: **11/29/07**
Logged By: **Matthew Osborne**	Water Level: **38.23 ft bls on 01-08-08**		Drilling Method: **4¼" H.S.A.**

Elev. (Feet)	Depth (Feet)	Lith-ology	Material Description
860			Saprolite: Very Stiff Red Brown Silty Clay with fine Sand (CH)
855	5		Saprolite: Stiff Red Orange Brown fine Sandy Clayey Silt (ML)
850	10		
845	15		Saprolite: Medium Dense Red Brown Orange Silty fine Sand
840	20		
835	25		
830	30		
825	35		Partially Weathered Rock: When sampled becomes Very Dense Tan Brown micaceous Silty fine to medium Sand
820	40		
815	45		Saprolite: Medium Dense Tan Brown micaceous Silty fine to medium Sand
	50		Partially Weathered Rock: When sampled becomes Very Dense Tan Brown micaceous Silty fine to medium Sand
			Auger Refusal at 50 ft bls

Well Construction



Penetration Resistance (Blows/Foot)



BORING LOG WITH WELL MARSHALL STEAM STATION BORING LOGS 01-2009.GPJ LAGWGN01.GDT 1/29/09

COMPLETION REPORT OF WELL No. M-4

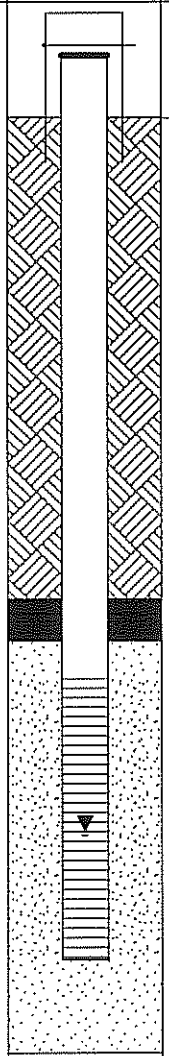
PROJECT: **Marshall Steam Station Industrial Fill #1**
PROJECT NO: **1356-08-122**
PROJECT LOCATION: **Terrell, North Carolina**

WATER LEVEL: **38.23 ft bls on 01-08-08**

LATITUDE: **35.622437°**
LONGITUDE: **80.974429°**
TOP OF CASING ELEVATION: **864.24**
DATUM: **MSL**
LOGGED BY: **Matthew Osborne**

DRILLING CONTRACTOR: **S&ME, Inc.**
DRILLING METHOD: **4¼" H.S.A.**
DATE DRILLED: **11/29/07**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)
				0.00		861.37
Saprolite: Very Stiff Red Brown Silty Clay with fine Sand (CH)		0				
Saprolite: Stiff Red Orange Brown fine Sandy Clayey Silt (ML)		5, 10				
Saprolite: Medium Dense Red Brown Orange Silty fine Sand		15, 20, 25, 30, 35				
Partially Weathered Rock: When sampled becomes Very Dense Tan Brown micaceous Silty fine to medium Sand		40				
Saprolite: Medium Dense Tan Brown micaceous Silty fine to medium Sand		45				
Partially Weathered Rock: When sampled becomes Very Dense Tan Brown micaceous Silty fine to medium Sand		50		50.00		811.37



WELL CONSTRUCTION DETAILS

PROTECTIVE CASING
Diameter: **Four Inch**
Type: **Steel**
Interval: **Above-Ground**

RISER CASING
Diameter: **Two Inch**
Type: **Sch 40 PVC**
Interval: **2.87 Feet ALS to 30 Feet BLS**

GROUT
Type: **Portland**
Interval: **GS to 25.7 Feet BLS**

SEAL
Type: **Bentonite Pellets**
Interval: **25.7 to 28 Feet BLS**

FILTERPACK
Type: **Medium Sand**
Interval: **28 to 50 Feet BLS**

SCREEN
Diameter: **Two Inch**
Type: **Sch 40 PVC 0.010 Inch Slot**
Interval: **30 to 45 Feet BLS**

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

MONITORING WELL MARSHALL STEAM STATION BORING LOGS 01-2009.GPJ S&ME.GDT 1/29/09

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9751 Southern Pine Blvd.
Charlotte, North Carolina

COMPLETION REPORT OF WELL No. M-4

NON RESIDENTIAL WELL CONSTRUCTION RECORD

North Carolina Department of Environment and Natural Resources- Division of Water Quality

WELL CONTRACTOR CERTIFICATION # 2626

1. WELL CONTRACTOR:

Ted Miller
Well Contractor (Individual) Name

S&ME, Inc.
Well Contractor Company Name

STREET ADDRESS 155 Tradd Street

Spartanburg SC 29301
City or Town State Zip Code

(864)- 574-2360
Area code- Phone number

2. WELL INFORMATION:

SITE WELL ID #(if applicable) M-4

STATE WELL PERMIT#(if applicable)

DWQ or OTHER PERMIT #(if applicable)

WELL USE (Check Applicable Box) Monitoring ☐ Municipal/Public ☐ Industrial/Commercial ☐ Agricultural ☐ Recovery ☐ Injection ☐ Irrigation ☐ Other ☒ (list use) Observation

DATE DRILLED 11/30/07

TIME COMPLETED 1500 AM ☐ PM ☒

3. WELL LOCATION:

CITY: Terrell COUNTY Catawba

8320 NC Highway 150E, Marshall Steam Station, 28682
(Street Name, Numbers, Community, Subdivision, Lot No., Parcel, Zip Code)

TOPOGRAPHIC / LAND SETTING:
☒ Slope ☐ Valley ☐ Flat ☐ Ridge ☐ Other
(check appropriate box)

LATITUDE 35.622437
LONGITUDE -80.974429

May be in degrees, minutes, seconds or in a decimal format

Latitude/longitude source: ☒ GPS ☐ Topographic map
(location of well must be shown on a USGS topo map and attached to this form if not using GPS)

4. FACILITY- is the name of the business where the well is located.

FACILITY ID #(if applicable)

NAME OF FACILITY Marshall Steam Station

STREET ADDRESS 8320 NC Highway 150E

Terrell NC 28682
City or Town State Zip Code

CONTACT PERSON Darrell Wolfe

MAILING ADDRESS 8320 NC Highway 150E

Terrell NC 28682
City or Town State Zip Code

(828)- 478-7829
Area code - Phone number

5. WELL DETAILS:

a. TOTAL DEPTH: 45

b. DOES WELL REPLACE EXISTING WELL? YES ☐ NO ☒

c. WATER LEVEL Below Top of Casing: 40.92 FT.
(Use "+" if Above Top of Casing)

d. TOP OF CASING IS 2.87 FT. Above Land Surface*
*Top of casing terminated at/or below land surface may require a variance in accordance with 15A NCAC 2C .0118.

e. YIELD (gpm): METHOD OF TEST

f. DISINFECTION: Type Amount

g. WATER ZONES (depth):
From 40.92 To From To
From To From To
From To From To

6. CASING:

From	To	Ft.	Diameter	Thickness/ Weight	Material
0	30		2	sch.40	PVC

7. GROUT:

From	To	Ft.	Material	Method
0	25.7		Neat Cement	tremie pump
25.7	28			

8. SCREEN:

From	To	Ft.	Diameter	Slot Size	Material
30	45		2 in.	.010 in.	PVC
			in.	in.	
			in.	in.	

9. SAND/GRAVEL PACK:

From	To	Ft.	Size	Material
28	49.8		#2	Sand

10. DRILLING LOG

From	To	Formation Description
0	36	Med. Dense Silty fine Sand
36	50	Med. to v. Dense Silty fine to med. Sand

11. REMARKS:

I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

Ted Miller 1-18-08
SIGNATURE OF CERTIFIED WELL CONTRACTOR DATE

Ted Miller
PRINTED NAME OF PERSON CONSTRUCTING THE WELL

Submit the original to the Division of Water Quality within 30 days. Attn: Information Mgt., 1617 Mail Service Center – Raleigh, NC 27699-1617 Phone No. (919) 733-7015 ext 568.

Form GW-1b
Rev. 7/05

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Charlotte, North Carolina
Telephone: 704-523-4726
Fax: 704-525-3953

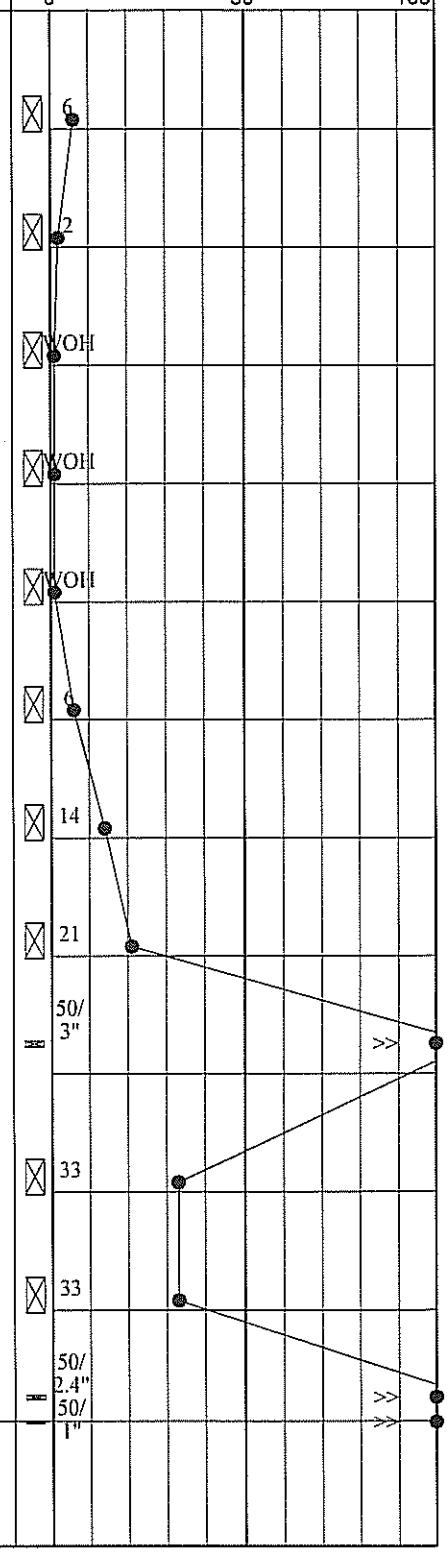
1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.
2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

Project: **Marshall Steam Station Industrial Fill #1**			**Boring No. M-5**
Location: **Terrell, North Carolina**		Number: **1356-08-122**	Sheet No. 1 of 1
Boring Depth (ft): **59.7**	Elevation (ft): **822.5**	Driller: **Ted Miller**	Date Drilled: **11/8/07**
Logged By: **Matthew Osborne**	Water Level: **6.02 ft bls on 01-08-08**		Drilling Method: **4¼" H.S.A.**

Elev. (Feet)	Depth (Feet)	Lith-ology	Material Description
820	0		Ash: Very Soft to Firm Gray fine Sandy Silt
815	5		
810	10		
805	15		
800	20		
795	25		
790	30		Saprolite: Medium Dense Orange Tan Brown Silty fine to medium Sand
785	35		
780	40		Partially Weathered Rock: When sampled becomes Very Dense Black White Tan micaceous Silty fine to medium Sand
775	45		Saprolite: Medium Dense to Very Dense Black White Tan micaceous Silty fine to medium Sand
770	50		
765	55		Partially Weathered Rock: When sampled becomes Very Dense Black White Tan micaceous Silty fine to medium Sand
			Auger Refusal at 59.7 ft bls

Well Construction

Penetration Resistance (Blows/Foot)



BORING LOG WITH WELL MARSHALL STEAM STATION BORING LOGS 01-2009.GPJ LAGWGN01.GDT 1/29/09

COMPLETION REPORT OF WELL No. M-5

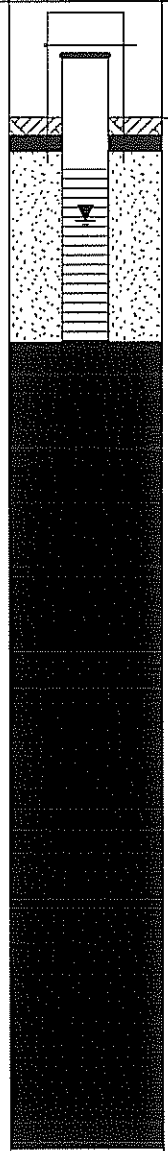
PROJECT: **Marshall Steam Station Industrial Fill #1**
PROJECT NO: **1356-08-122**
PROJECT LOCATION: **Terrell, North Carolina**

WATER LEVEL: **6.02 ft bls on 01-08-08**

LATITUDE: **35.617933°**
LONGITUDE: **80.975449°**
TOP OF CASING ELEVATION: **825.42**
DATUM: **MSL**
LOGGED BY: **Matthew Osborne**

DRILLING CONTRACTOR: **S&ME, Inc.**
DRILLING METHOD: **4¼" H.S.A.**
DATE DRILLED: **11/8/07**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)
				0.00		822.47
Ash: Very Soft to Firm Gray fine Sandy Silt		0, 5, 10, 15, 20, 25, 30		13.00		809.47
Saprolite: Medium Dense Orange Tan Brown Silty fine to medium Sand		35				
Partially Weathered Rock: When sampled becomes Very Dense Black White Tan micaceous Silty fine to medium Sand		40, 45				
Saprolite: Medium Dense to Very Dense Black White Tan micaceous Silty fine to medium Sand		50, 55				
Partially Weathered Rock: When sampled becomes Very Dense Black White Tan micaceous Silty fine to medium Sand				59.70		762.77



WELL CONSTRUCTION DETAILS

PROTECTIVE CASING
Diameter: **Four Inch**
Type: **Steel**
Interval: **Above-Ground**

RISER CASING
Diameter: **Two Inch**
Type: **Sch 40 PVC**
Interval: **2.95 Feet ALS to 3 Feet BLS**

GROUT
Type: **Portland**
Interval: **GS to 1 Foot BLS**

SEAL
Type: **Bentonite Pellets**
Interval: **1 to 2 Feet BLS**

FILTERPACK
Type: **Medium Sand**
Interval: **2 to 13 Feet BLS**

SCREEN
Diameter: **Two Inch**
Type: **Sch 40 PVC 0.010 Inch Slot**
Interval: **3 to 13 Feet BLS**

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

MONITORING WELL MARSHALL STEAM STATION BORING LOGS 01-2009.GPJ S&ME.GDT 1/29/09

S&ME
ENGINEERING • TESTING
ENVIRONMENTAL SERVICES
9751 Southern Pine Blvd.
Charlotte, North Carolina

COMPLETION REPORT OF WELL No. M-5

NON RESIDENTIAL WELL CONSTRUCTION RECORD

North Carolina Department of Environment and Natural Resources- Division of Water Quality

WELL CONTRACTOR CERTIFICATION # 2626

1. WELL CONTRACTOR:

Ted Miller
Well Contractor (Individual) Name

S&ME, Inc.
Well Contractor Company Name

STREET ADDRESS 155 Tradd Street

Spartanburg SC 29301
City or Town State Zip Code

(864)- 574-2360
Area code- Phone number

2. WELL INFORMATION:

SITE WELL ID #(if applicable) M-5

STATE WELL PERMIT#(if applicable)

DWQ or OTHER PERMIT #(if applicable)

WELL USE (Check Applicable Box) Monitoring ☐ Municipal/Public ☐ Industrial/Commercial ☐ Agricultural ☐ Recovery ☐ Injection ☐ Irrigation ☐ Other ☒ (list use) Observation

DATE DRILLED 11/13/07

TIME COMPLETED 1345 AM ☐ PM ☒

3. WELL LOCATION:

CITY: Terrell COUNTY Catawba

8320 NC Highway 150E, Marshall Steam Station, 28682
(Street Name, Numbers, Community, Subdivision, Lot No., Parcel, Zip Code)

TOPOGRAPHIC / LAND SETTING:
☐ Slope ☒ Valley ☐ Flat ☐ Ridge ☐ Other
(check appropriate box)

LATITUDE 35.617933
LONGITUDE -80.975449

May be in degrees, minutes, seconds or in a decimal format

Latitude/longitude source: ☒ GPS ☐ Topographic map
(location of well must be shown on a USGS topo map and attached to this form if not using GPS)

4. FACILITY- Is the name of the business where the well is located.

FACILITY ID #(if applicable)

NAME OF FACILITY Marshall Steam Station

STREET ADDRESS 8320 NC Highway 150E

Terrell NC 28682
City or Town State Zip Code

CONTACT PERSON Darrell Wolfe

MAILING ADDRESS 8320 NC Highway 150E

Terrell NC 28682
City or Town State Zip Code

(828)- 478-7829
Area code - Phone number

5. WELL DETAILS:

a. TOTAL DEPTH: 13

b. DOES WELL REPLACE EXISTING WELL? YES ☐ NO ☒

c. WATER LEVEL Below Top of Casing: 10.12 FT.
(Use "+" if Above Top of Casing)

d. TOP OF CASING IS 2.95 FT. Above Land Surface*
*Top of casing terminated at/or below land surface may require a variance in accordance with 15A NCAC 2C .0118.

e. YIELD (gpm): METHOD OF TEST

f. DISINFECTION: Type Amount

g. WATER ZONES (depth):
From 10.12 To From To
From To From To
From To From To

6. CASING:

From	To	Ft.	Diameter	Thickness/ Weight	Material
0	3		2	sch.40	PVC

7. GROUT:

From	To	Ft.	Material	Method
0	1		Neat Cement	tremie pump
1	2			

8. SCREEN:

From	To	Ft.	Diameter	Slot Size	Material
3	13		2 in.	.010 in.	PVC
			in.	in.	
			in.	in.	

9. SAND/GRAVEL PACK:

From	To	Ft.	Size	Material
2	13		#2	Sand

10. DRILLING LOG

From	To	Formation Description
0	13	Ash

11. REMARKS:

I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

Ted Miller 1-18-08
SIGNATURE OF CERTIFIED WELL CONTRACTOR DATE

Ted Miller
PRINTED NAME OF PERSON CONSTRUCTING THE WELL

Submit the original to the Division of Water Quality within 30 days. Attn: Information Mgt., 1617 Mail Service Center – Raleigh, NC 27699-1617 Phone No. (919) 733-7015 ext 568.

Form GW-1b
Rev. 7/05

S&ME
ENGINEERING • TESTING
ENVIRONMENTAL SERVICES

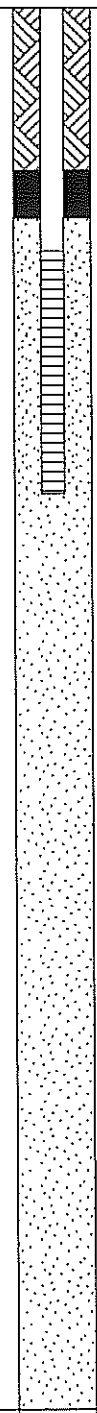
S&ME, Inc.
9751 Southern Pine Blvd.
Charlotte, North Carolina
Telephone: 704-523-4726
Fax: 704-525-3953

1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.
2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

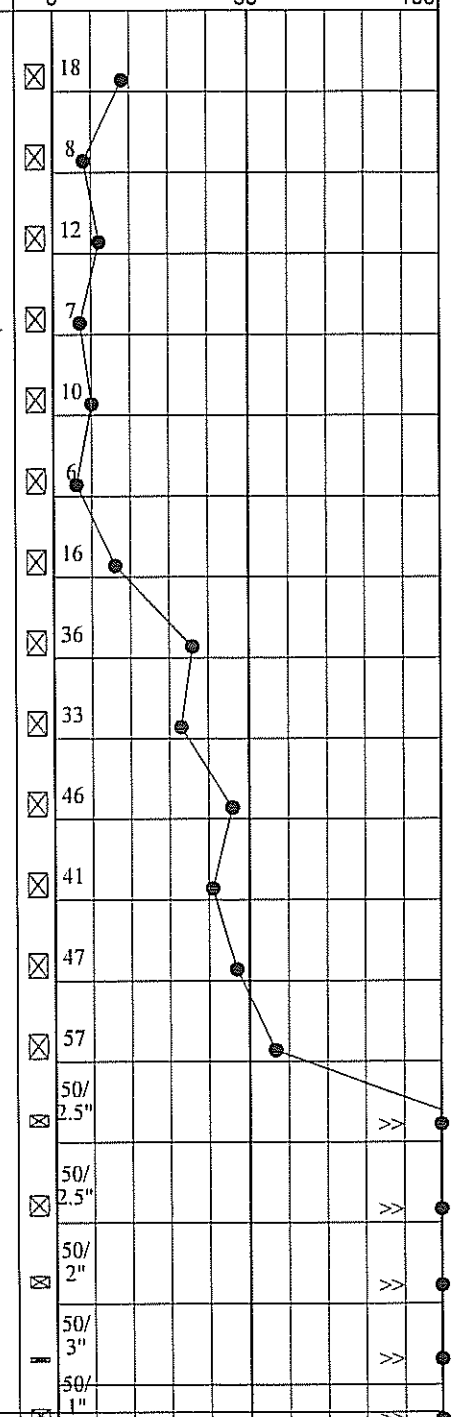
Project: **Marshall Steam Station Industrial Fill #1**			**Boring No. M-6**
Location: **Terrell, North Carolina**		Number: **1356-08-122**	Sheet No. 1 of 1
Boring Depth (ft): **86.7**	Elevation (ft): **836.4**	Driller: **Ted Miller**	Date Drilled: **11/14/07**
Logged By: **Matthew Osborne**	Water Level: **19.69 ft bls on 01-08-08**		Drilling Method: **4¼" H.S.A.**

Elev. (Feet)	Depth (Feet)	Lith-ology	Material Description
835			Residuum: Very Stiff Red Brown Clayey Silt with trace fine Sand (MH)
830	5		Residuum: Firm Red Brown Clayey Silt with fine Sand (MH)
825	10		Residuum: Stiff Brown Red micaceous Clayey Silt with fine Sand (ML)
820	15		Saprolite: Loose to Medium Dense Orange Tan Brown micaceous Silty fine to medium Sand
815	20		
810	25		
805	30		
800	35		Saprolite: Dense to Very Dense Gray Black Brown micaceous Silty fine to medium Sand
795	40		
790	45		
785	50		
780	55		
775	60		
770	65		Partially Weathered Rock: When sampled becomes Very Dense Gray Black Brown micaceous Silty fine to medium Sand
765	70		
760	75		
755	80		
750	85		Auger Refusal at 86.7 ft bls

Well Construction



Penetration Resistance (Blows/Foot)



BORING LOG WITH WELL MARSHALL STEAM STATION BORING LOGS 01-2009.GPJ LAGWGN01.GDT 1/29/09

COMPLETION REPORT OF WELL No. M-6

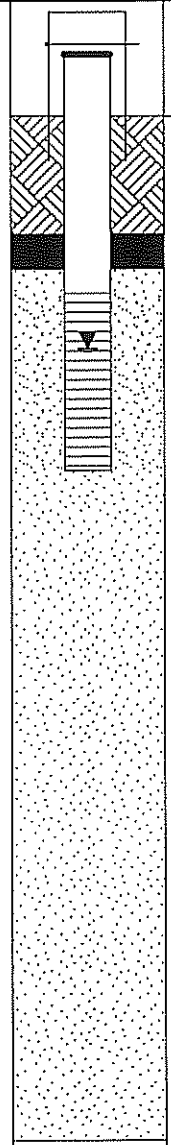
PROJECT: **Marshall Steam Station Industrial Fill #1**
PROJECT NO: **1356-08-122**
PROJECT LOCATION: **Terrell, North Carolina**

WATER LEVEL: **19.69 ft bls on 01-08-08**

LATITUDE: **35.619327°**
LONGITUDE: **80.976122°**
TOP OF CASING ELEVATION: **839.22**
DATUM: **MSL**
LOGGED BY: **Matthew Osborne**

DRILLING CONTRACTOR: **S&ME, Inc.**
DRILLING METHOD: **4¼" H.S.A.**
DATE DRILLED: **11/14/07**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)
				0.00		836.36
Residuum: Very Stiff Red Brown Clayey Silt with trace fine Sand (MH)		0, 5				
Residuum: Firm Red Brown Clayey Silt with fine Sand (MH)		10				
Residuum: Stiff Brown Red micaceous Clayey Silt with fine Sand (ML)		15, 20				
Saprolite: Loose to Medium Dense Orange Tan Brown micaceous Silty fine to medium Sand		25, 30				
Saprolite: Dense to Very Dense Gray Black Brown micaceous Silty fine to medium Sand		35, 40, 45, 50, 55, 60, 65				
Partially Weathered Rock: When sampled becomes Very Dense Gray Black Brown micaceous Silty fine to medium Sand		70, 75, 80, 85		86.70		749.66



WELL CONSTRUCTION DETAILS

PROTECTIVE CASING
Diameter: **Four Inch**
Type: **Steel**
Interval: **Above-Ground**

RISER CASING
Diameter: **Two Inch**
Type: **Sch 40 PVC**
Interval: **2.86 Feet ALS to 15 Feet BLS**

GROUT
Type: **Portland**
Interval: **GS to 10 Feet BLS**

SEAL
Type: **Bentonite Pellets**
Interval: **10 to 13 Feet BLS**

FILTERPACK
Type: **Medium Sand**
Interval: **13 to 86.7 Feet BLS**

SCREEN
Diameter: **Two Inch**
Type: **Sch 40 PVC 0.010 Inch Slot**
Interval: **15 to 30 Feet BLS**

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

MONITORING WELL MARSHALL STEAM STATION BORING LOGS 01-2009.GPJ S&ME.GDT 1/29/09

S&ME
ENGINEERING • TESTING
ENVIRONMENTAL SERVICES
9751 Southern Pine Blvd.
Charlotte, North Carolina

COMPLETION REPORT OF WELL No. M-6

NON RESIDENTIAL WELL CONSTRUCTION RECORD

North Carolina Department of Environment and Natural Resources- Division of Water Quality

WELL CONTRACTOR CERTIFICATION # 2626

1. WELL CONTRACTOR:

Ted Miller
Well Contractor (Individual) Name

S&ME, Inc.
Well Contractor Company Name

STREET ADDRESS 155 Tradd Street

Spartanburg SC 29301
City or Town State Zip Code

(864)- 574-2360
Area code- Phone number

2. WELL INFORMATION:

SITE WELL ID #(if applicable) M-6

STATE WELL PERMIT#(if applicable)

DWQ or OTHER PERMIT #(if applicable)

WELL USE (Check Applicable Box) Monitoring ☐ Municipal/Public ☐ Industrial/Commercial ☐ Agricultural ☐ Recovery ☐ Injection ☐ Irrigation ☐ Other ☒ (list use) Observation

DATE DRILLED 11/19/07

TIME COMPLETED 1630 AM ☐ PM ☒

3. WELL LOCATION:

CITY: Terrell COUNTY Catawba

8320 NC Highway 150E, Marshall Steam Station, 28682
(Street Name, Numbers, Community, Subdivision, Lot No., Parcel, Zip Code)

TOPOGRAPHIC / LAND SETTING:
☐ Slope ☒ Valley ☐ Flat ☒ Ridge ☐ Other
(check appropriate box)

LATITUDE 35.619327
LONGITUDE -80.976122

May be in degrees, minutes, seconds or in a decimal format

Latitude/longitude source: ☒ GPS ☐ Topographic map
(location of well must be shown on a USGS topo map and attached to this form if not using GPS)

4. FACILITY- is the name of the business where the well is located.

FACILITY ID #(if applicable)

NAME OF FACILITY Marshall Steam Station

STREET ADDRESS 8320 NC Highway 150E

Terrell NC 28682
City or Town State Zip Code

CONTACT PERSON Darrell Wolfe

MAILING ADDRESS 8320 NC Highway 150E

Terrell NC 28682
City or Town State Zip Code

(828)- 478-7829
Area code - Phone number

5. WELL DETAILS:

a. TOTAL DEPTH: 30

b. DOES WELL REPLACE EXISTING WELL? YES ☐ NO ☒

c. WATER LEVEL Below Top of Casing: 23.96 FT.
(Use "+" if Above Top of Casing)

d. TOP OF CASING IS 2.86 FT. Above Land Surface*
*Top of casing terminated at/or below land surface may require a variance in accordance with 15A NCAC 2C .0118.

e. YIELD (gpm): _____ METHOD OF TEST _____

f. DISINFECTION: Type _____ Amount _____

g. WATER ZONES (depth):
From 23.96 To _____ From _____ To _____
From _____ To _____ From _____ To _____
From _____ To _____ From _____ To _____

6. CASING:

From	To	Ft.	Diameter	Thickness/ Weight	Material
0	15		2	sch.40	PVC

7. GROUT:

From	To	Ft.	Depth	Material	Method
0	10			Neat Cement	tremie pump
10	13				

8. SCREEN:

From	To	Ft.	Depth	Diameter	Slot Size	Material
15	30			2 in.	.010 in.	PVC
				in.	in.	
				in.	in.	

9. SAND/GRAVEL PACK:

From	To	Ft.	Depth	Size	Material
13	85.6			#2	Sand

10. DRILLING LOG

From	To	Formation Description
0-15		firm to v. stiff clay fine sandy Silt
15-35		lse to md dense mica silt fine to md Sand
35-86.7		dense to v dense mica silt fine to md Sand

11. REMARKS:

I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

Ted Miller 1-18-08
SIGNATURE OF CERTIFIED WELL CONTRACTOR DATE

Ted Miller
PRINTED NAME OF PERSON CONSTRUCTING THE WELL

Submit the original to the Division of Water Quality within 30 days. Attn: Information Mgt., 1617 Mail Service Center – Raleigh, NC 27699-1617 Phone No. (919) 733-7015 ext 568.

Form GW-1b
Rev. 7/05

S&ME
ENGINEERING • TESTING
ENVIRONMENTAL SERVICES

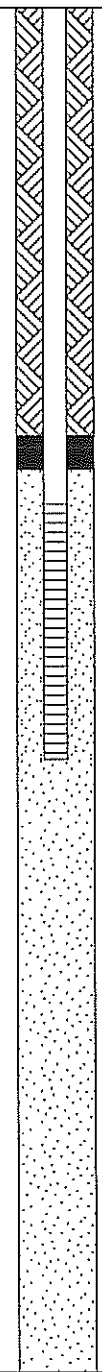
S&ME, Inc.
9751 Southern Pine Blvd.
Charlotte, North Carolina
Telephone: 704-523-4726
Fax: 704-525-3953

1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.
2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

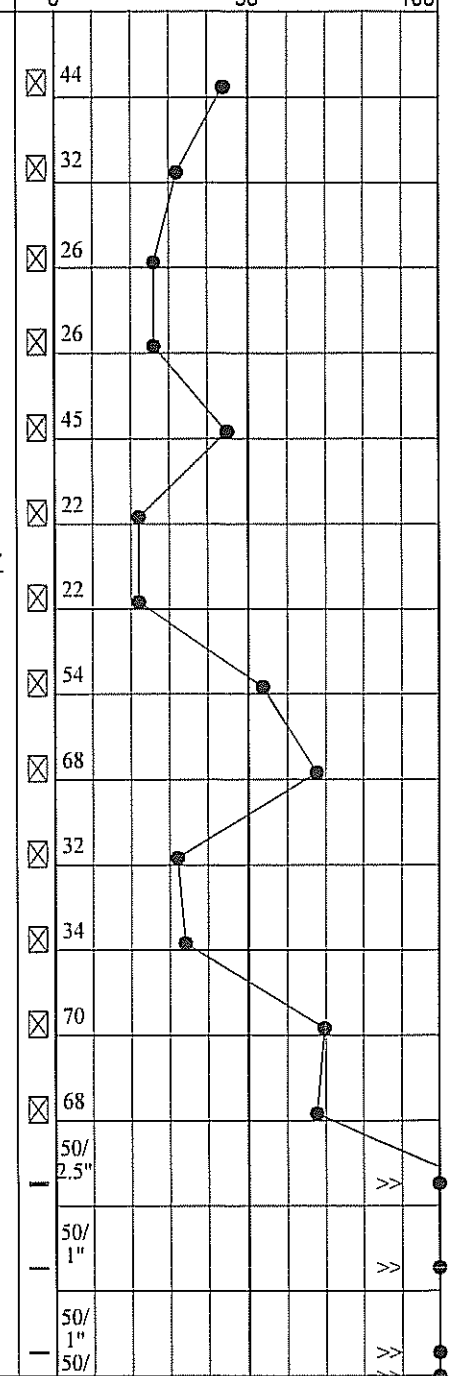
Project: **Marshall Steam Station Industrial Fill #1**			**Boring No. M-7**
Location: **Terrell, North Carolina**		Number: **1356-08-122**	Sheet No. 1 of 1
Boring Depth (ft): **80.0**	Elevation (ft): **851.3**	Driller: **Ted Miller**	Date Drilled: **11/27/07**
Logged By: **Matthew Osborne**	Water Level: **32.80 ft bls on 01-08-08**		Drilling Method: **4¼" H.S.A.**

Elev. (Feet)	Depth (Feet)	Lithology	Material Description
850			Residuum: Hard Brown Red medium to fine Sandy Silty Clay (CL)
845	5		Residuum: Dense Brown Red Clayey Silty fine Sand (SC-SM)
840	10		Residuum: Very Stiff Red Brown fine Sandy Clayey Silt (ML)
835	15		Residuum: Medium Dense Red Brown micaceous Silty fine to medium Sand
830	20		Saprolite: Medium Dense to Very Dense Brown White Black micaceous Silty fine to medium Sand
825	25		
820	30		
815	35		
810	40		
805	45		
800	50		
795	55		
790	60		
785	65		
780	70		Partially Weathered Rock: When sampled becomes Very Dense Tan Orange fine to coarse Sand
775	75		
	80		Auger Refusal at 80 ft bls

Well Construction



Penetration Resistance (Blows/Foot)



BORING LOG WITH WELL MARSHALL STEAM STATION BORING LOGS 01-2009.GPJ LAGWGN01.GDT 1/29/09

COMPLETION REPORT OF WELL No. M-7

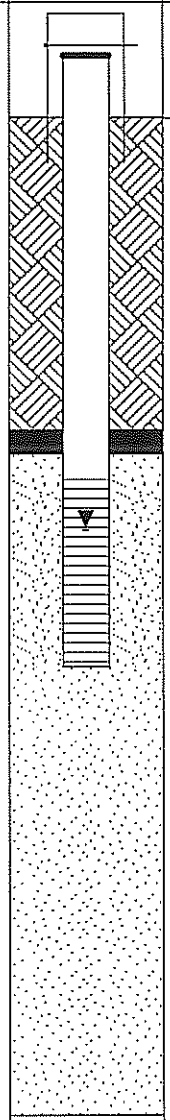
PROJECT: **Marshall Steam Station Industrial Fill #1**
PROJECT NO: **1356-08-122**
PROJECT LOCATION: **Terrell, North Carolina**

WATER LEVEL: **32.80 ft bls on 01-08-08**

LATITUDE: **35.620539°**
LONGITUDE: **80.976326°**
TOP OF CASING ELEVATION: **854.05**
DATUM: **MSL**
LOGGED BY: **Matthew Osborne**

DRILLING CONTRACTOR: **S&ME, Inc.**
DRILLING METHOD: **4¼" H.S.A.**
DATE DRILLED: **11/27/07**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)
Residuum: Hard Brown Red medium to fine Sandy Silty Clay (CL)		0		0.00		851.33
Residuum: Dense Brown Red Clayey Silty fine Sand (SC-SM)		5				
Residuum: Very Stiff Red Brown fine Sandy Clayey Silt (ML)		10				
Residuum: Medium Dense Red Brown micaceous Silty fine to medium Sand		15				
Saprolite: Medium Dense to Very Dense Brown White Black micaceous Silty fine to medium Sand		20				
		25				
		30				
		35				
		40				
		45				
		50				
		55				
		60				
		65				
Partially Weathered Rock: When sampled becomes Very Dense Tan Orange fine to coarse Sand		70				
		75				
		80		80.00		771.33



WELL CONSTRUCTION DETAILS

PROTECTIVE CASING
Diameter: **Four Inch**
Type: **Steel**
Interval: **Above-Ground**

RISER CASING
Diameter: **Two Inch**
Type: **Sch 40 PVC**
Interval: **2.72 Feet ALS to 29 Feet BLS**

GROUT
Type: **Portland**
Interval: **GS to 25 Feet BLS**

SEAL
Type: **Bentonite Pellets**
Interval: **25 to 27 Feet BLS**

FILTERPACK
Type: **Medium Sand**
Interval: **27 to 80 Feet BLS**

SCREEN
Diameter: **Two Inch**
Type: **Sch 40 PVC 0.010 Inch Slot**
Interval: **29 to 44 Feet BLS**

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

MONITORING WELL MARSHALL STEAM STATION BORING LOGS 01-2009.GPJ S&ME.GDT 1/29/09

S&ME
ENGINEERING • TESTING
ENVIRONMENTAL SERVICES
9751 Southern Pine Blvd.
Charlotte, North Carolina

COMPLETION REPORT OF WELL No. M-7

NON RESIDENTIAL WELL CONSTRUCTION RECORD

North Carolina Department of Environment and Natural Resources- Division of Water Quality

WELL CONTRACTOR CERTIFICATION # 2626

1. WELL CONTRACTOR:

Ted Miller
Well Contractor (Individual) Name

S&ME, Inc.
Well Contractor Company Name

STREET ADDRESS 155 Tradd Street

Spartanburg SC 29301
City or Town State Zip Code

(864)- 574-2360
Area code- Phone number

2. WELL INFORMATION:

SITE WELL ID #(if applicable) M-7

STATE WELL PERMIT#(if applicable)

DWQ or OTHER PERMIT #(if applicable)

WELL USE (Check Applicable Box) Monitoring ☐ Municipal/Public ☐ Industrial/Commercial ☐ Agricultural ☐ Recovery ☐ Injection ☐ Irrigation ☐ Other ☒ (list use) Observation

DATE DRILLED 11/27/07

TIME COMPLETED 1600 AM ☐ PM ☒

3. WELL LOCATION:

CITY: Terrell COUNTY Catawba

8320 NC Highway 150E, Marshall Steam Station, 28682
(Street Name, Numbers, Community, Subdivision, Lot No., Parcel, Zip Code)

TOPOGRAPHIC / LAND SETTING:
☐ Slope ☐ Valley ☐ Flat ☒ Ridge ☐ Other
(check appropriate box)

LATITUDE 35.620539
LONGITUDE -80.976326

May be in degrees, minutes, seconds or in a decimal format

Latitude/longitude source: ☒ GPS ☐ Topographic map
(location of well must be shown on a USGS topo map and attached to this form if not using GPS)

4. FACILITY- is the name of the business where the well is located.

FACILITY ID #(if applicable)

NAME OF FACILITY Marshall Steam Station

STREET ADDRESS 8320 NC Highway 150E

Terrell NC 28682
City or Town State Zip Code

CONTACT PERSON Darrell Wolfe

MAILING ADDRESS 8320 NC Highway 150E

Terrell NC 28682
City or Town State Zip Code

(828)- 478-7829
Area code - Phone number

5. WELL DETAILS:

a. TOTAL DEPTH: 44

b. DOES WELL REPLACE EXISTING WELL? YES ☐ NO ☒

c. WATER LEVEL Below Top of Casing: 36.39 FT.
(Use "+" if Above Top of Casing)

d. TOP OF CASING IS 2.72 FT. Above Land Surface*
*Top of casing terminated at/or below land surface may require a variance in accordance with 15A NCAC 2C .0118.

e. YIELD (gpm): METHOD OF TEST

f. DISINFECTION: Type Amount

g. WATER ZONES (depth):

From 36.39	To	From	To
From	To	From	To
From	To	From	To

6. CASING:

Depth		Diameter	Thickness/ Weight	Material
From 0	To 27 Ft.	2	sch.40	PVC
From	To Ft.			
From	To Ft.			

7. GROUT:

Depth		Material	Method
From 0	To 25 Ft.	Neat Cement	tremie pump
From 25	To 27 Ft.		
From	To Ft.		

8. SCREEN:

Depth		Diameter	Slot Size	Material
From 29	To 44 Ft.	2 in.	.010 in.	PVC
From	To Ft.	in.	in.	
From	To Ft.	in.	in.	

9. SAND/GRAVEL PACK:

Depth		Size	Material
From 27	To 80.2 Ft.	#2	Sand
From	To Ft.		
From	To Ft.		

10. DRILLING LOG

From To	Formation Description
0-20	md dense - dense micn silt fine - md Sand
20-70	md dense - v dense micn silt fine-md Sand
70-80	v dense fine to coarse Sand

11. REMARKS:

I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

SIGNATURE OF CERTIFIED WELL CONTRACTOR — DATE 1-14-08

Ted Miller
PRINTED NAME OF PERSON CONSTRUCTING THE WELL

Submit the original to the Division of Water Quality within 30 days. Attn: Information Mgt., 1617 Mail Service Center – Raleigh, NC 27699-1617 Phone No. (919) 733-7015 ext 568.

Form GW-1b
Rev. 7/05

S&ME
ENGINEERING • TESTING
ENVIRONMENTAL SERVICES

S&ME, Inc.
9751 Southern Pine Blvd.
Charlotte, North Carolina
Telephone: 704-523-4726
Fax: 704-525-3953

1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.
2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

Project: **Marshall Steam Station Industrial Fill #1**			**Boring No. M-8**
Location: **Terrell, North Carolina**		Number: **1356-08-122**	Sheet No. 1 of 1
Boring Depth (ft): **62.5**	Elevation (ft): **889.0**	Driller: **Joey Donnahoo**	Date Drilled: **11/13/07**
Logged By: **John Whitehead**	Water Level: **54.77 ft bls on 01-08-08**		Drilling Method: **4¼" H.S.A.**

Elev. (Feet)	Depth (Feet)	Lith-ology	Material Description	Well Construction	Penetration Resistance (Blows/Foot) 0 50 100
885	5		Residuum: Hard to Very Hard Tan Brown fine Sandy Silty Clay (CL)		50/3" >>
880	10				40
875	15				32
870	20		Residuum: Hard to Very Hard Tan Brown fine Sandy Silt		50/3" >>
865	25		Saprolite: Very Dense Tan Brown Silty fine Sand		50/5" >>
860	30				57
855	35				68
850	40				64
845	45				64
840	50		Partially Weathered Rock: When sampled becomes Very Dense Gray Brown micaceous Silty fine to medium Sand		50/4" >>
835	55				50/3" >>
830	60				50/5" >>
			Auger Refusal at 62.5 ft bls		50/3" >>

COMPLETION REPORT OF WELL No. M-8

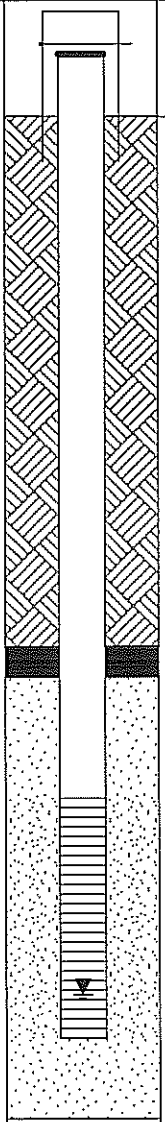
PROJECT: **Marshall Steam Station Industrial Fill #1**
PROJECT NO: **1356-08-122**
PROJECT LOCATION: **Terrell, North Carolina**

WATER LEVEL: **54.77 ft bls on 01-08-08**

LATITUDE: **35.622201°**
LONGITUDE: **80.976433°**
TOP OF CASING ELEVATION: **891.04**
DATUM: **MSL**
LOGGED BY: **John Whitehead**

DRILLING CONTRACTOR: **S&ME, Inc.**
DRILLING METHOD: **4¼" H.S.A.**
DATE DRILLED: **11/13/07**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)
				0.00		888.98
Residuum: Hard to Very Hard Tan Brown fine Sandy Silty Clay (CL)		0, 5, 10				
Residuum: Hard to Very Hard Tan Brown fine Sandy Silt		15, 20				
Saprolite: Very Dense Tan Brown Silty fine Sand		25, 30, 35, 40, 45				
Partially Weathered Rock: When sampled becomes Very Dense Gray Brown micaceous Silty fine to medium Sand		50, 55, 60		62.50		826.48



WELL CONSTRUCTION DETAILS

PROTECTIVE CASING
Diameter: **Four Inch**
Type: **Steel**
Interval: **Above-Ground**

RISER CASING
Diameter: **Two Inch**
Type: **Sch 40 PVC**
Interval: **2.06 Feet ALS to 42.5 Feet BLS**

GROUT
Type: **Portland**
Interval: **GS to 33 Feet BLS**

SEAL
Type: **Bentonite Pellets**
Interval: **33 to 35 Feet BLS**

FILTERPACK
Type: **Medium Sand**
Interval: **35 to 62.5 Feet BLS**

SCREEN
Diameter: **Two Inch**
Type: **Sch 40 PVC 0.010 Inch Slot**
Interval: **42.5 to 57.5 Feet BLS**

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

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9751 Southern Pine Blvd.
Charlotte, North Carolina

COMPLETION REPORT OF WELL No. M-8

NON RESIDENTIAL WELL CONSTRUCTION RECORD

North Carolina Department of Environment and Natural Resources- Division of Water Quality

WELL CONTRACTOR CERTIFICATION # 2626

1. WELL CONTRACTOR:

Ted Miller
Well Contractor (Individual) Name

S&ME, Inc.
Well Contractor Company Name

STREET ADDRESS 155 Tradd Street

Spartanburg SC 29301
City or Town State Zip Code

(864)- 574-2360
Area code- Phone number

2. WELL INFORMATION:

SITE WELL ID #(if applicable) M-8

STATE WELL PERMIT#(if applicable)

DWQ or OTHER PERMIT #(if applicable)

WELL USE (Check Applicable Box) Monitoring ☐ Municipal/Public ☐ Industrial/Commercial ☐ Agricultural ☐ Recovery ☐ Injection ☐ Irrigation ☐ Other ☒ (list use) Observation

DATE DRILLED 11/13/07

TIME COMPLETED 1645 AM ☐ PM ☒

3. WELL LOCATION:

CITY: Terrell COUNTY Catawba

8320 NC Highway 150E, Marshall Steam Station, 28682
(Street Name, Numbers, Community, Subdivision, Lot No., Parcel, Zip Code)

TOPOGRAPHIC / LAND SETTING:
☐ Slope ☐ Valley ☐ Flat ☒ Ridge ☐ Other
(check appropriate box)

LATITUDE 35.622201
LONGITUDE -80.976433

May be in degrees, minutes, seconds or in a decimal format

Latitude/longitude source: ☒ GPS ☐ Topographic map
(location of well must be shown on a USGS topo map and attached to this form if not using GPS)

4. FACILITY- is the name of the business where the well is located.

FACILITY ID #(if applicable)

NAME OF FACILITY Marshall Steam Station

STREET ADDRESS 8320 NC Highway 150E

Terrell NC 28682
City or Town State Zip Code

CONTACT PERSON Darrell Wolfe

MAILING ADDRESS 8320 NC Highway 150E

Terrell NC 28682
City or Town State Zip Code

(828)- 478-7829
Area code - Phone number

5. WELL DETAILS:

a. TOTAL DEPTH: 57

b. DOES WELL REPLACE EXISTING WELL? YES ☐ NO ☒

c. WATER LEVEL Below Top of Casing: 58.75 FT.
(Use "+" if Above Top of Casing)

d. TOP OF CASING IS 2.06 FT. Above Land Surface*
*Top of casing terminated at/or below land surface may require a variance in accordance with 15A NCAC 2C .0118.

e. YIELD (gpm): _____ METHOD OF TEST _____

f. DISINFECTION: Type _____ Amount _____

g. WATER ZONES (depth):
From 58.75 To _____ From _____ To _____
From _____ To _____ From _____ To _____
From _____ To _____ From _____ To _____

6. CASING:

From	To	Ft.	Diameter	Thickness/ Weight	Material
0	42		2	sch.40	PVC

7. GROUT:

From	To	Ft.	Material	Method
0	33		Neat Cement	tremie pump
33	35			

8. SCREEN:

From	To	Ft.	Diameter	Slot Size	Material
42	57		2 in.	.010 in.	PVC
			in.	in.	
			in.	in.	

9. SAND/GRAVEL PACK:

From	To	Ft.	Size	Material
35	62.5		#2	Sand

10. DRILLING LOG

From	To	Formation Description
0	24	hard-v hard fine sandy silt
24	44	v dense silty fine Sand
44	62.5	v dense mica silty fine-md Sand

11. REMARKS:

I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

Ted Miller 1-18-08
SIGNATURE OF CERTIFIED WELL CONTRACTOR DATE

Ted Miller
PRINTED NAME OF PERSON CONSTRUCTING THE WELL

Submit the original to the Division of Water Quality within 30 days. Attn: Information Mgt., 1617 Mail Service Center – Raleigh, NC 27699-1617 Phone No. (919) 733-7015 ext 568.

Form GW-1b
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Project: **Marshall Steam Station Industrial Fill #1**			**Boring No. M-16**
Location: **Terrell, North Carolina**		Number: **1356-08-122**	Sheet No. 1 of 1
Boring Depth (ft): **55.5**	Elevation (ft): **845.9**	Driller: **Joey Donnahoo**	Date Drilled: **11/6/07**
Logged By: **John Whitehead**	Water Level: **34.61 ft bls on 01-08-08**		Drilling Method: **4¼" H.S.A.**

Elev. (Feet)	Depth (Feet)	Lith-ology	Material Description	Well Construction	Penetration Resistance (Blows/Foot) 0 50 100
845			Residuum: Hard Tan Brown fine Sandy Silty Clay (CL)		38
840	5		Partially Weathered Rock: When sampled becomes Very Dense Tan Olive Brown micaceous Clayey Silty fine Sand (SC)		50/5"
835	10		Partially Weathered Rock: When sampled becomes Very Dense Olive Brown micaceous Clayey Silty medium to fine Sand (SC)		50/4"
830	15		Partially Weathered Rock: When sampled becomes Very Dense Gray White micaceous Silty fine to medium Sand		50/3"
825	20				50/3"
820	25				50/4"
815	30		Partially Weathered Rock: When sampled becomes Very Hard Gray Black very micaceous fine to medium Sandy Silt		72
810	35		Partially Weathered Rock: When sampled becomes Very Dense Gray Olive micaceous Silty fine Sand		50/5"
805	40		Partially Weathered Rock: When sampled becomes Very Dense Black Gray micaceous Silty fine to medium Sand		50/3"
800	45				50/5"
795	50				50/4"
	55		Auger Refusal at 55.5 ft bls		50/5"

BORING LOG WITH WELL MARSHALL STEAM STATION BORING LOGS 01-2009.GPJ LAGWGN01.GDT 1/29/09

COMPLETION REPORT OF WELL No. M-16

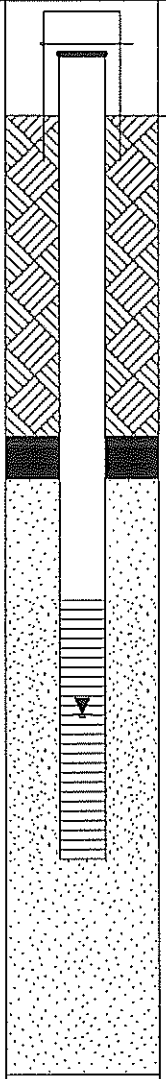
PROJECT: **Marshall Steam Station Industrial Fill #1**
PROJECT NO: **1356-08-122**
PROJECT LOCATION: **Terrell, North Carolina**

WATER LEVEL: **34.61 ft bls on 01-08-08**

LATITUDE: **35.617567°**
LONGITUDE: **80.973294°**
TOP OF CASING ELEVATION: **848.64**
DATUM: **MSL**
LOGGED BY: **John Whitehead**

DRILLING CONTRACTOR: **S&ME, Inc.**
DRILLING METHOD: **4¼" H.S.A.**
DATE DRILLED: **11/6/07**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)
				0.00		845.85
Residuum: Hard Tan Brown fine Sandy Silty Clay (CL)		0				
		5				
Partially Weathered Rock: When sampled becomes Very Dense Tan Olive Brown micaceous Clayey Silty fine Sand (SC)		10				
Partially Weathered Rock: When sampled becomes Very Dense Olive Brown micaceous Clayey Silty medium to fine Sand (SC)		15				
		20				
Partially Weathered Rock: When sampled becomes Very Dense Gray White micaceous Silty fine to medium Sand		25				
		30				
Partially Weathered Rock: When sampled becomes Very Hard Gray Black very micaceous fine to medium Sandy Silt		35				
		40				
Partially Weathered Rock: When sampled becomes Very Dense Gray Olive micaceous Silty fine Sand		45				
Partially Weathered Rock: When sampled becomes Very Dense Black Gray micaceous Silty fine to medium Sand		50				
		55		55.50		790.35



WELL CONSTRUCTION DETAILS

PROTECTIVE CASING
Diameter: **Four Inch**
Type: **Steel**
Interval: **Above-Ground**

RISER CASING
Diameter: **Two Inch**
Type: **Sch 40 PVC**
Interval: **2.79 Feet ALS to 28 Feet BLS**

GROUT
Type: **Portland**
Interval: **GS to 18.5 Feet BLS**

SEAL
Type: **Bentonite Pellets**
Interval: **18.5 to 21 Feet BLS**

FILTERPACK
Type: **Medium Sand**
Interval: **21 to 55.5 Feet BLS**

SCREEN
Diameter: **Two Inch**
Type: **Sch 40 PVC 0.010 Inch Slot**
Interval: **28 to 43 Feet BLS**

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

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Charlotte, North Carolina

COMPLETION REPORT OF WELL No. M-16

NON RESIDENTIAL WELL CONSTRUCTION RECORD

North Carolina Department of Environment and Natural Resources- Division of Water Quality

WELL CONTRACTOR CERTIFICATION # 2626

1. WELL CONTRACTOR:

Ted Miller
Well Contractor (Individual) Name

S&ME, Inc.
Well Contractor Company Name

STREET ADDRESS 155 Tradd Street

Spartanburg | SC | 29301
City or Town | State | Zip Code

(864)- 574-2360
Area code- Phone number

2. WELL INFORMATION:

SITE WELL ID #(if applicable) M-16

STATE WELL PERMIT#(if applicable)

DWQ or OTHER PERMIT #(if applicable)

WELL USE (Check Applicable Box) Monitoring ☐ Municipal/Public ☐ Industrial/Commercial ☐ Agricultural ☐ Recovery ☐ Injection ☐ Irrigation ☐ Other ☒ (list use) Observation

DATE DRILLED 11/6/07

TIME COMPLETED 1600 AM ☐ PM ☒

3. WELL LOCATION:

CITY: Terrell COUNTY Catawba

8320 NC Highway 150E, Marshall Steam Station, 28682
(Street Name, Numbers, Community, Subdivision, Lot No., Parcel, Zip Code)

TOPOGRAPHIC / LAND SETTING:
☐ Slope ☐ Valley ☐ Flat ☒ Ridge ☐ Other
(check appropriate box)

LATITUDE 35.617567
LONGITUDE -80.973294

May be in degrees, minutes, seconds or in a decimal format

Latitude/longitude source: ☒ GPS ☐ Topographic map
(location of well must be shown on a USGS topo map and attached to this form if not using GPS)

4. FACILITY- Is the name of the business where the well is located.

FACILITY ID #(if applicable)

NAME OF FACILITY Marshall Steam Station

STREET ADDRESS 8320 NC Highway 150E

Terrell | NC | 28682
City or Town | State | Zip Code

CONTACT PERSON Darrell Wolfe

MAILING ADDRESS 8320 NC Highway 150E

Terrell | NC | 28682
City or Town | State | Zip Code

(828)- 478-7829
Area code - Phone number

5. WELL DETAILS:

a. TOTAL DEPTH: 43

b. DOES WELL REPLACE EXISTING WELL? YES ☐ NO ☒

c. WATER LEVEL Below Top of Casing: 37.64 FT.
(Use "+" if Above Top of Casing)

d. TOP OF CASING IS 2.79 FT. Above Land Surface*
*Top of casing terminated at/or below land surface may require a variance in accordance with 15A NCAC 2C .0118.

e. YIELD (gpm): METHOD OF TEST

f. DISINFECTION: Type Amount

g. WATER ZONES (depth):
From 37.64 To From To
From To From To
From To From To

6. CASING:

	Depth		Diameter	Thickness/ Weight	Material
From 0	To 28	Ft.	2	sch.40	PVC
From	To	Ft.			
From	To	Ft.			

7. GROUT:

	Depth		Material	Method
From 0	To 18.5	Ft.	Neat Cement	tremie pump
From 18.5	To 21	Ft.		
From	To	Ft.		

8. SCREEN:

	Depth		Diameter		Slot Size		Material
From 28	To 43	Ft.	2	in.	.010	in.	PVC
From	To	Ft.		in.		in.	
From	To	Ft.		in.		in.	

9. SAND/GRAVEL PACK:

	Depth		Size	Material
From 21	To 55.5	Ft.	#2	Sand
From	To	Ft.		
From	To	Ft.		

10. DRILLING LOG

From To	Formation Description
0-6	dense silty fine-med Sand
6-29	v dense mica silty fine-med Sand
29-36	v hard v mica fine-med sandy Silt
36-55.5	v dense mica silty fine-med Sand

11. REMARKS:

I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

Ted Miller 1-18-08
SIGNATURE OF CERTIFIED WELL CONTRACTOR DATE

Ted Miller
PRINTED NAME OF PERSON CONSTRUCTING THE WELL

Submit the original to the Division of Water Quality within 30 days. Attn: Information Mgt., 1617 Mail Service Center – Raleigh, NC 27699-1617 Phone No. (919) 733-7015 ext 568.

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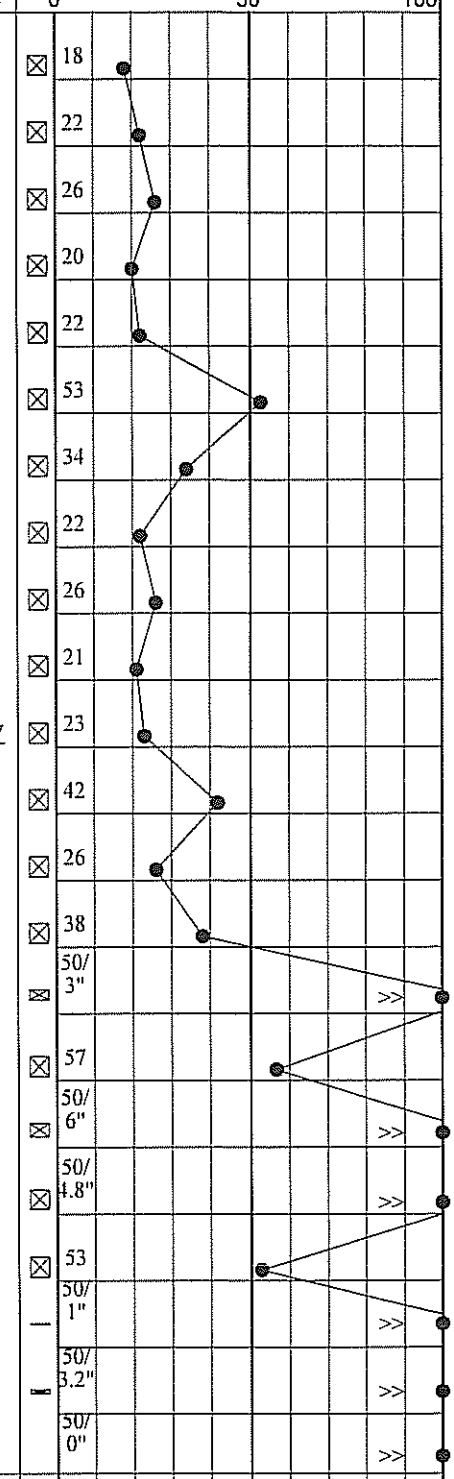
2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

Project: **Marshall Steam Station Industrial Fill #1**			**Boring No. M-17**
Location: **Terrell, North Carolina**		Number: **1356-08-122**	Sheet No. 1 of 1
Boring Depth (ft): **109.5**	Elevation (ft): **882.3**	Driller: **Joey Donnahoo**	Date Drilled: **4/30/08**
Logged By: **Matthew Osborne**	Water Level: **54.70 ft bls at TOB**		Drilling Method: **3¼" H.S.A.**

Elev. (Feet)	Depth (Feet)	Lithology	Material Description	Well Construction
880	5		Residuum: Very Stiff Red micaceous Clayey fine Sandy Silt	
875	10		Saprolite: Medium Dense to Very Dense Black White and Brown micaceous Silty fine to medium Sand with intermittent weathered Quartz beds	
870	15			
865	20			
860	25			
855	30			
850	35			
845	40		Saprolite: Very Stiff to Very Hard Gray Tan and Brown micaceous fine to coarse Sandy Silt with intermittent weathered Quartz beds	
840	45			
835	50			
830	55			▽
825	60			
820	65			
815	70			
810	75		Partially Weathered Rock: When sampled becomes Very Dense Brown and Gray micaceous Silty very fine Sand with partially weathered Quartz beds	
805	80			
800	85			
795	90			
790	95			
785	100			
780	105			
775			Auger Refusal at 109.5 ft bls	

Penetration Resistance (Blows/Foot)



BORING LOG WITH WELL MARSHALL STEAM STATION BORING LOGS 01-2009.GPJ LAGWGN01.GDT 1/29/09

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2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

Project: **Marshall Steam Station Industrial Fill #1**			**Boring No. M-18**
Location: **Terrell, North Carolina**		Number: **1356-08-122**	Sheet No. 1 of 1
Boring Depth (ft): **63.1**	Elevation (ft): **874.0**	Driller: **Joey Donnahoo**	Date Drilled: **4/30/08**
Logged By: **Matthew Osborne**	Water Level: **45.05 ft bls on 05-21-08**		Drilling Method: **3¼" H.S.A.**

Elev. (Feet)	Depth (Feet)	Lithology	Material Description	Well Construction	Penetration Resistance (Blows/Foot) 0 50 100
870	5		Residuum: Hard Red Brown fine Sandy Silt		25
865	10		Saprolite: Dense to Very Dense Black Red and Tan Silty fine to coarse Sand		35
860	15				45
855	20				50/5"
850	25		Saprolite: Very Stiff to Hard White Tan and Orange fine Sandy Silt		21
845	30				39
840	35				25
835	40		Saprolite: Very Stiff to Hard White Tan Orange fine Sandy Silt with abundant Manganese veins		18
830	45			▼	38
825	50				29
820	55				63
815	60		Partially Weathered Rock: When Sampled Becomes Very Dense Gray Brown micaceous very fine to medium Sand		50/2.4"
			Auger Refusal at 63.1 ft bls		

COMPLETION REPORT OF WELL No. M-18

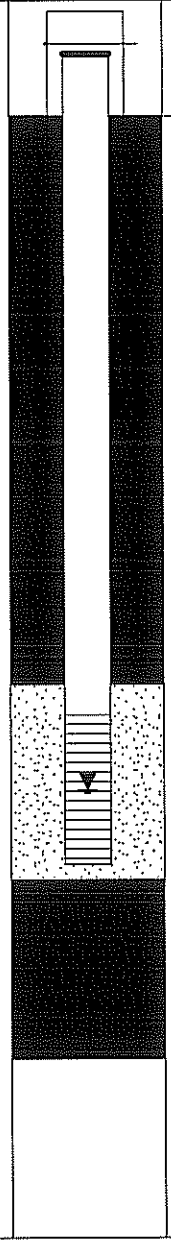
PROJECT: **Marshall Steam Station Industrial Fill #1**
PROJECT NO: **1356-08-122**
PROJECT LOCATION: **Terrell, North Carolina**

WATER LEVEL: **45.05 ft bls on 05-21-08**

LATITUDE: **35.622063°**
LONGITUDE: **80.971686°**
TOP OF CASING ELEVATION: **876.78**
DATUM: **MSL**
LOGGED BY: **Matthew Osborne**

DRILLING CONTRACTOR: **S&ME, Inc.**
DRILLING METHOD: **3¼" H.S.A.**
DATE DRILLED: **4/30/08**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)
				0.00		874.03
Residuum: Hard Red Brown fine Sandy Silt		0				
Saprolite: Dense to Very Dense Black Red and Tan Silty fine to coarse Sand		5, 10, 15				
Saprolite: Very Stiff to Hard White Tan and Orange fine Sandy Silt		20, 25, 30				
Saprolite: Very Stiff to Hard White Tan Orange fine Sandy Silt with abundant Manganese veins		35, 40, 45, 50, 55				
Partially Weathered Rock: When Sampled Becomes Very Dense Gray Brown micaceous very fine to medium Sand		60				



WELL CONSTRUCTION DETAILS

PROTECTIVE CASING
Diameter: **Four Inch**
Type: **Steel**
Interval: **Above-Ground**

RISER CASING
Diameter: **One Inch**
Type: **Sch 40 PVC**
Interval: **3 Feet ALS to 40 Feet BLS**

GROUT
Type:
Interval:

SEAL
Type: **Bentonite Pellets**
Interval: **GS to 38 Feet BLS**

FILTERPACK
Type: **Medium Sand**
Interval: **38 to 51 Feet BLS**

SCREEN
Diameter: **One Inch**
Type: **Sch 40 PVC 0.010 Inch Slot**
Interval: **40 to 50 Feet BLS**

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

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9751 Southern Pine Blvd.
Charlotte, North Carolina

COMPLETION REPORT OF WELL No. M-18

Sheet 1 of 1

NON RESIDENTIAL WELL CONSTRUCTION RECORD

North Carolina Department of Environment and Natural Resources- Division of Water Quality

WELL CONTRACTOR CERTIFICATION # 2251

1. WELL CONTRACTOR:

Travis Costello
Well Contractor (Individual) Name

S&ME, Inc.
Well Contractor Company Name

STREET ADDRESS 155 Tradd Street

Spartanburg SC 29301
City or Town State Zip Code

(864)- 574-2360
Area code- Phone number

2. WELL INFORMATION:

SITE WELL ID #(if applicable) M-18

STATE WELL PERMIT#(if applicable)

DWQ or OTHER PERMIT #(if applicable)

WELL USE (Check Applicable Box) Monitoring ☐ Municipal/Public ☐ Industrial/Commercial ☐ Agricultural ☐ Recovery ☐ Injection ☐ Irrigation ☐ Other ☒ (list use) observation

DATE DRILLED

TIME COMPLETED AM ☐ PM ☐

3. WELL LOCATION:

CITY: Terrell COUNTY Catawba

8320 NC Highway 150E, Marshall Steam Station, 28682
(Street Name, Numbers, Community, Subdivision, Lot No., Parcel, Zip Code)

TOPOGRAPHIC / LAND SETTING:
☐ Slope ☐ Valley ☐ Flat ☐ Ridge ☐ Other
(check appropriate box)

LATITUDE 35.622063
LONGITUDE -80.971686

May be in degrees, minutes, seconds or in a decimal format

Latitude/longitude source: ☒ GPS ☐ Topographic map
(location of well must be shown on a USGS topo map and attached to this form if not using GPS)

4. FACILITY- is the name of the business where the well is located.

FACILITY ID #(if applicable)

NAME OF FACILITY Marshall Steam Station

STREET ADDRESS 8320 NC Highway 150E

Terrell NC 28682
City or Town State Zip Code

CONTACT PERSON Darrell Wolfe

MAILING ADDRESS 8320 NC Highway 150E

Terrell NC 28682
City or Town State Zip Code

(828)- 478-7829
Area code - Phone number

5. WELL DETAILS:

a. TOTAL DEPTH: 50

b. DOES WELL REPLACE EXISTING WELL? YES ☐ NO ☒

c. WATER LEVEL Below Top of Casing: 47.8 FT.
(Use "+" if Above Top of Casing)

d. TOP OF CASING IS 2.75 FT. Above Land Surface*
*Top of casing terminated at/or below land surface may require a variance in accordance with 15A NCAC 2C .0118.

e. YIELD (gpm): METHOD OF TEST

f. DISINFECTION: Type Amount

g. WATER ZONES (depth):
From 47.8 To From To
From To From To
From To From To

6. CASING:

	Depth		Diameter	Thickness/ Weight	Material
From 0	To 40	Ft.	2	sch.40	PVC
From	To	Ft.			
From	To	Ft.			

7. GROUT:

	Depth		Material	Method
From 0	To 38	Ft.	Bentonite	poured
From	To	Ft.		
From	To	Ft.		

8. SCREEN:

	Depth		Diameter	Slot Size	Material
From 40	To 50	Ft.	2 in.	.010 in.	PVC
From	To	Ft.	in.	in.	
From	To	Ft.	in.	in.	

9. SAND/GRAVEL PACK:

	Depth		Size	Material
From 38	To 51	Ft.	#2	Sand
From	To	Ft.		
From	To	Ft.		

10. DRILLING LOG

From To	Formation Description
0-5.5	hard fine sandy Silt
5.5-20	dense-v dense silty fine-coarse Sand
20-45.5	v stiff-hard fine sandy Silt
45.5-64	dense-v dense mic. v fine-med Sand

11. REMARKS:

I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

Norman T. Costello 8/27/08
SIGNATURE OF CERTIFIED WELL CONTRACTOR DATE

Norman T. Costello
PRINTED NAME OF PERSON CONSTRUCTING THE WELL

Submit the original to the Division of Water Quality within 30 days. Attn: Information Mgt., 1617 Mail Service Center – Raleigh, NC 27699-1617 Phone No. (919) 733-7015 ext 568.

Form GW-1b
Rev. 7/05

S&ME
ENGINEERING • TESTING
ENVIRONMENTAL SERVICES

S&ME, Inc.
9751 Southern Pine Blvd.
Charlotte, North Carolina
Telephone: 704-523-4726
Fax: 704-525-3953

1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.
2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

Project: **Marshall Steam Station Industrial Fill #1**			**Boring No. M-19**
Location: **Terrell, North Carolina**		Number: **1356-08-122**	Sheet No. 1 of 1
Boring Depth (ft): **62.9**	Elevation (ft): **864.8**	Driller: **Joey Donnahoo**	Date Drilled: **5/20/08**
Logged By: **Matthew Osborne**	Water Level: **38.50 ft bls on 05-21-08**		Drilling Method: **3¼" H.S.A.**

Elev. (Feet)	Depth (Feet)	Lith-ology	Material Description	Well Construction	Penetration Resistance (Blows/Foot) 0 50 100
			Residuum: Very Stiff Red micaceous Clayey Silt		26
860	5		Saprolite: Very Stiff Red Orange and Tan micaceous fine Sandy Silt		29
855	10				27
850	15		Saprolite: Very Stiff to Very Hard Red Tan and Brown micaceous fine to medium Sandy Silt with weathered Quartz beds and highly weathered Schist fragments		19
845	20				24
840	25				21
835	30				52
830	35				36
825	40				40
820	45		Partially Weathered Rock: When sampled becomes Very Dense Gray and Brown micaceous Silty fine to medium Sand		50/5" >>
815	50				50/5" >>
810	55				50/6" >>
805	60				
			Auger Refusal at 62.9 ft bls		

BORING LOG WITH WELL MARSHALL STEAM STATION BORING LOGS 01-2009.GPJ LAGWGN01.GDT 1/29/09

COMPLETION REPORT OF WELL No. M-19

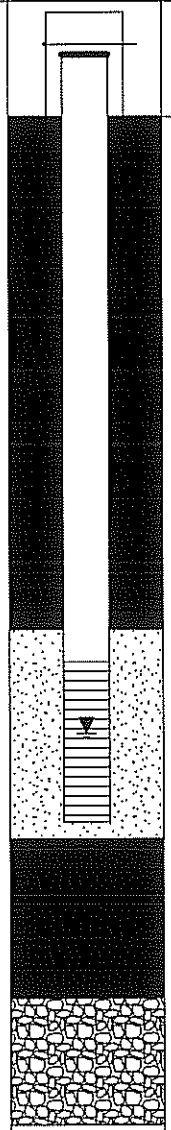
PROJECT: **Marshall Steam Station Industrial Fill #1**
PROJECT NO: **1356-08-122**
PROJECT LOCATION: **Terrell, North Carolina**

WATER LEVEL: **38.50 ft bls on 05-21-08**

LATITUDE: **35.622843°**
LONGITUDE: **80.972953°**
TOP OF CASING ELEVATION: **867.10**
DATUM: **MSL**
LOGGED BY: **Matthew Osborne**

DRILLING CONTRACTOR: **S&ME, Inc.**
DRILLING METHOD: **3¼" H.S.A.**
DATE DRILLED: **5/20/08**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)
				0.00		864.82
Residuum: Very Stiff Red micaceous Clayey Silt		0				
Saprolite: Very Stiff Red Orange and Tan micaceous fine Sandy Silt		5, 10				
Saprolite: Very Stiff to Very Hard Red Tan and Brown micaceous fine to medium Sandy Silt with weathered Quartz beds and highly weathered Schist fragments		15, 20, 25, 30, 35, 40				
Partially Weathered Rock: When sampled becomes Very Dense Gray and Brown micaceous Silty fine to medium Sand		45, 50, 55, 60				



WELL CONSTRUCTION DETAILS

PROTECTIVE CASING
Diameter: **Four Inch**
Type: **Steel**
Interval: **Above-Ground**

RISER CASING
Diameter: **One Inch**
Type: **Sch 40 PVC**
Interval: **3 Feet ALS to 34 Feet BLS**

GROUT
Type:
Interval:

SEAL
Type: **Bentonite Pellets**
Interval: **GS to 32 Feet BLS**

FILTERPACK
Type: **Medium Sand**
Interval: **32 to 45 Feet BLS**

SCREEN
Diameter: **One Inch**
Type: **Sch 40 PVC 0.010 Inch Slot**
Interval: **34 to 44 Feet BLS**

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

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Charlotte, North Carolina

COMPLETION REPORT OF WELL No. M-19

NON RESIDENTIAL WELL CONSTRUCTION RECORD

North Carolina Department of Environment and Natural Resources- Division of Water Quality

WELL CONTRACTOR CERTIFICATION # 2251-A

1. WELL CONTRACTOR:

Travis Costello
Well Contractor (Individual) Name

S&ME, Inc.
Well Contractor Company Name

STREET ADDRESS 155 Tradd Street

Spartanburg SC 29301
City or Town State Zip Code

(864)- 574-2360
Area code- Phone number

2. WELL INFORMATION:

SITE WELL ID #(if applicable) M-19

STATE WELL PERMIT#(if applicable)

DWQ or OTHER PERMIT #(if applicable)

WELL USE (Check Applicable Box) Monitoring ☐ Municipal/Public ☐ Industrial/Commercial ☐ Agricultural ☐ Recovery ☐ Injection ☐ Irrigation ☐ Other ☒ (list use) observation

DATE DRILLED

TIME COMPLETED AM ☐ PM ☐

3. WELL LOCATION:

CITY: Terrell COUNTY Catawba

8320 NC Highway 150E, Marshall Steam Station, 28682
(Street Name, Numbers, Community, Subdivision, Lot No., Parcel, Zip Code)

TOPOGRAPHIC / LAND SETTING:
☐ Slope ☐ Valley ☐ Flat ☐ Ridge ☐ Other
(check appropriate box)

LATITUDE 35.622843
LONGITUDE -80.972953

May be in degrees, minutes, seconds or in a decimal format

Latitude/longitude source: ☒ GPS ☐ Topographic map
(location of well must be shown on a USGS topo map and attached to this form if not using GPS)

4. FACILITY- is the name of the business where the well is located.

FACILITY ID #(if applicable)

NAME OF FACILITY Marshall Steam Station

STREET ADDRESS 8320 NC Highway 150E

Terrell NC 28682
City or Town State Zip Code

CONTACT PERSON Darrell Wolfe

MAILING ADDRESS 8320 NC Highway 150E

Terrell NC 28682
City or Town State Zip Code

(828)- 478-7829
Area code - Phone number

5. WELL DETAILS:

a. TOTAL DEPTH: 44

b. DOES WELL REPLACE EXISTING WELL? YES ☐ NO ☒

c. WATER LEVEL Below Top of Casing: 40.75 FT.
(Use "+" if Above Top of Casing)

d. TOP OF CASING IS 2.28 FT. Above Land Surface*
*Top of casing terminated at/or below land surface may require a variance in accordance with 15A NCAC 2C .0118.

e. YIELD (gpm): METHOD OF TEST

f. DISINFECTION: Type Amount

g. WATER ZONES (depth):
From 40.75 To From To
From To From To
From To From To

6. CASING:

	Depth		Diameter	Thickness/ Weight	Material
From 0	To 34	Ft.	2	sch.40	PVC
From	To	Ft.			
From	To	Ft.			

7. GROUT:

	Depth		Material	Method
From 0	To 32	Ft.	Bentonite	poured
From	To	Ft.		
From	To	Ft.		

8. SCREEN:

	Depth		Diameter	Slot Size	Material
From 34	To 44	Ft.	2 in.	.010 in.	PVC
From	To	Ft.	in.	in.	
From	To	Ft.	in.	in.	

9. SAND/GRAVEL PACK:

	Depth		Size	Material
From 32	To 45	Ft.	#2	Sand
From	To	Ft.		
From	To	Ft.		

10. DRILLING LOG

From To	Formation Description
0-5	v stiff mic. clayey Silt
5-15	v stiff mic. fine sandy Silt
15-45	v stiff-v hard mic fine-med sandy Silt
45-63	v dense mic. silty fine-med Sand

11. REMARKS:

I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

Norman T. Costello 8/27/08
SIGNATURE OF CERTIFIED WELL CONTRACTOR DATE

Norman T. Costello
PRINTED NAME OF PERSON CONSTRUCTING THE WELL

Submit the original to the Division of Water Quality within 30 days. Attn: Information Mgt., 1617 Mail Service Center – Raleigh, NC 27699-1617 Phone No. (919) 733-7015 ext 568.

Form GW-1b
Rev. 7/05

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1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.
2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

Project: **Marshall Steam Station Industrial Fill #1**			**Boring No. M-20**
Location: **Terrell, North Carolina**		Number: **1356-08-122**	Sheet No. 1 of 1
Boring Depth (ft): **49.8**	Elevation (ft): **873.4**	Driller: **Joey Donnahoo**	Date Drilled: **5/12/08**
Logged By: **Matthew Osborne**	Water Level: **47.10 ft bls on 05-21-08**		Drilling Method: **3¼" H.S.A.**

Elev. (Feet)	Depth (Feet)	Lith-ology	Material Description	Well Construction	Penetration Resistance (Blows/Foot) 0 50 100
870	5		Residuum: Very Stiff Red and Orange Clayey Silt		24
865	10		Saprolite: Very Stiff to Hard Brown and Tan micaceous fine Sandy Silt		36
860	15				26
855	20				38
850	25		Saprolite: Very Stiff to Hard Brown and Tan micaceous Silt with weathered Quartz beds		25
845	30				34
840	35		Saprolite: Very Dense Brown and Tan micaceous Silty very fine to medium Sand		50/2.4" >>
835	40		Partially Weathered Rock: When sampled becomes White and Black weathered Gneiss rock fragments.		50/2.4" >>
830	45				50/2.4" >>
825					50/1.2" >>
			Auger Refusal at 49.8 ft bls		

BORING LOG WITH WELL MARSHALL STEAM STATION BORING LOGS 01-2009.GPJ LAGWGN01.GDT 1/29/09

COMPLETION REPORT OF WELL No. M-20

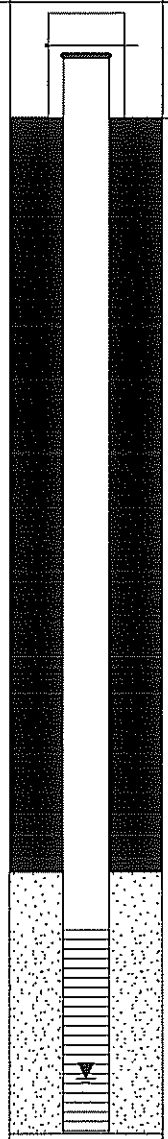
PROJECT: **Marshall Steam Station Industrial Fill #1**
PROJECT NO: **1356-08-122**
PROJECT LOCATION: **Terrell, North Carolina**

WATER LEVEL: **47.10 ft bls on 05-21-08**

LATITUDE: **35.622800°**
LONGITUDE: **80.974901°**
TOP OF CASING ELEVATION: **876.37**
DATUM: **MSL**
LOGGED BY: **Matthew Osborne**

DRILLING CONTRACTOR: **S&ME, Inc.**
DRILLING METHOD: **3¼" H.S.A.**
DATE DRILLED: **5/12/08**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)
				0.00		873.40
Residuum: Very Stiff Red and Orange Clayey Silt		0				
		5				
Saprolite: Very Stiff to Hard Brown and Tan micaceous fine Sandy Silt		10				
		15				
		20				
Saprolite: Very Stiff to Hard Brown and Tan micaceous Silt with weathered Quartz beds		25				
		30				
Saprolite: Very Dense Brown and Tan micaceous Silty very fine to medium Sand		35				
Partially Weathered Rock: When sampled becomes White and Black weathered Gneiss rock fragments.		40				
		45				



WELL CONSTRUCTION DETAILS

PROTECTIVE CASING
Diameter: **Four Inch**
Type: **Steel**
Interval: **Above-Ground**

RISER CASING
Diameter: **One Inch**
Type: **Sch 40 PVC**
Interval: **3 Feet ALS to 40 Feet BLS**

GROUT
Type:
Interval:

SEAL
Type: **Bentonite Pellets**
Interval: **GS to 37 Feet BLS**

FILTERPACK
Type: **Medium Sand**
Interval: **37 to 49.8 Feet BLS**

SCREEN
Diameter: **One Inch**
Type: **Sch 40 PVC 0.010 Inch Slot**
Interval: **39.8 to 49.8 Feet BLS**

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

MONITORING WELL MARSHALL STEAM STATION BORING LOGS 01-2009.GPJ S&ME.GDT 1/29/09

S&ME
ENGINEERING • TESTING
ENVIRONMENTAL SERVICES
9751 Southern Pine Blvd.
Charlotte, North Carolina

COMPLETION REPORT OF WELL No. M-20

NON RESIDENTIAL WELL CONSTRUCTION RECORD

North Carolina Department of Environment and Natural Resources- Division of Water Quality

WELL CONTRACTOR CERTIFICATION # 2251-A

1. WELL CONTRACTOR:

Travis Costello
Well Contractor (Individual) Name

S&ME, Inc.
Well Contractor Company Name

STREET ADDRESS 155 Tradd Street

Spartanburg SC 29301
City or Town State Zip Code

(864)- 574-2360
Area code- Phone number

2. WELL INFORMATION:

SITE WELL ID #(if applicable) M-20

STATE WELL PERMIT#(if applicable)

DWQ or OTHER PERMIT #(if applicable)

WELL USE (Check Applicable Box) Monitoring ☐ Municipal/Public ☐ Industrial/Commercial ☐ Agricultural ☐ Recovery ☐ Injection ☐ Irrigation ☐ Other ☒ (list use) observation

DATE DRILLED

TIME COMPLETED AM ☐ PM ☐

3. WELL LOCATION:

CITY: Terrell COUNTY Catawba

8320 NC Highway 150E, Marshall Steam Station, 28682
(Street Name, Numbers, Community, Subdivision, Lot No., Parcel, Zip Code)

TOPOGRAPHIC / LAND SETTING:
☐ Slope ☐ Valley ☐ Flat ☐ Ridge ☐ Other
(check appropriate box)

LATITUDE 35.622800
LONGITUDE -80.974901

May be in degrees, minutes, seconds or in a decimal format

Latitude/longitude source: ☐ GPS ☐ Topographic map
(location of well must be shown on a USGS topo map and attached to this form if not using GPS)

4. FACILITY- is the name of the business where the well is located.

FACILITY ID #(if applicable)

NAME OF FACILITY Marshall Steam Station

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City or Town State Zip Code

CONTACT PERSON Darrell Wolfe

MAILING ADDRESS 8320 NC Highway 150E

Terrell NC 28682
City or Town State Zip Code

(828)- 478-7829
Area code - Phone number

5. WELL DETAILS:

a. TOTAL DEPTH: 50

b. DOES WELL REPLACE EXISTING WELL? YES ☐ NO ☒

c. WATER LEVEL Below Top of Casing: 50 FT.
(Use "+" if Above Top of Casing)

d. TOP OF CASING IS 2.97 FT. Above Land Surface*
*Top of casing terminated at/or below land surface may require a variance in accordance with 15A NCAC 2C .0118.

e. YIELD (gpm): METHOD OF TEST

f. DISINFECTION: Type Amount

g. WATER ZONES (depth):
From 50 To From To
From To From To
From To From To

6. CASING:

	Depth		Diameter	Thickness/ Weight	Material
From 0	To 40	Ft.	2	sch.40	PVC
From	To	Ft.			
From	To	Ft.			

7. GROUT:

	Depth		Material	Method
From 0	To 37	Ft.	Bentonite	poured
From	To	Ft.		
From	To	Ft.		

8. SCREEN:

	Depth		Diameter	Slot Size	Material
From 40	To 50	Ft.	2 in.	.010 in.	PVC
From	To	Ft.	in.	in.	
From	To	Ft.	in.	in.	

9. SAND/GRAVEL PACK:

	Depth		Size	Material
From 37	To 50	Ft.	#2	Sand
From	To	Ft.		
From	To	Ft.		

10. DRILLING LOG

From To	Formation Description
0-6	v stiff clayey Silt
6-21	v stiff-hard mic. fine sandy Silt
21-31	v stiff-hard mic. Silt
31-44	v dense mic. silty v fine-med Sand
44-49	weathered Gneiss

11. REMARKS:

I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

Norman T. Costello 8/27/08
SIGNATURE OF CERTIFIED WELL CONTRACTOR DATE

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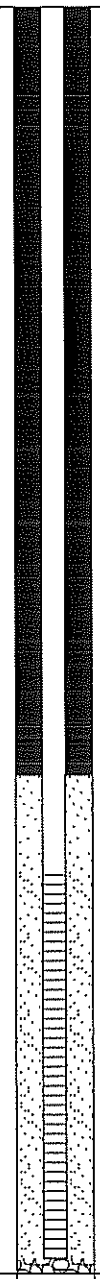
2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

Project: **Marshall Steam Station Industrial Fill #1**			**Boring No. M-21**
Location: **Terrell, North Carolina**		Number: **1356-08-122**	Sheet No. 1 of 1
Boring Depth (ft): **33.0**	Elevation (ft): **880.1**	Driller: **Joey Donnahoo**	Date Drilled: **5/15/08**
Logged By: **Matthew Osborne**	Water Level: **Dry on 05-21-08**		Drilling Method: **3¼" H.S.A.**

Elev. (Feet)	Depth (Feet)	Lith-ology	Material Description	Well Construction	Penetration Resistance (Blows/Foot) 0 50 100
			Residuum: Dense Red Clayey fine to medium Sand		31
875	5		Saprolite: Dense to Very Dense Tan and Brown Silty fine to coarse Sand		44
870	10				34
865	15				50/4.5" >>
860	20		Partially Weathered Rock: When sampled becomes Very Dense Tan and Brown Silty fine to coarse Sand		50/2" >>
855	25				50/4.5" >>
850	30				
			Auger Refusal at 33 ft bls		



COMPLETION REPORT OF WELL No. M-21

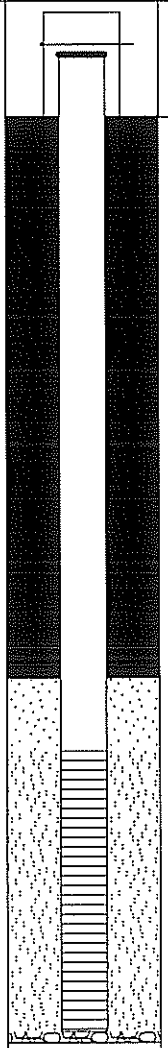
PROJECT: **Marshall Steam Station Industrial Fill #1**
PROJECT NO: **1356-08-122**
PROJECT LOCATION: **Terrell, North Carolina**

WATER LEVEL: **Dry on 05-21-08**

LATITUDE: **35.621783°**
LONGITUDE: **80.976756°**
TOP OF CASING ELEVATION: **882.72**
DATUM: **MSL**
LOGGED BY: **Matthew Osborne**

DRILLING CONTRACTOR: **S&ME, Inc.**
DRILLING METHOD: **3¼" H.S.A.**
DATE DRILLED: **5/15/08**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)
				0.00		880.11
Residuum: Dense Red Clayey fine to medium Sand		0				
Saprolite: Dense to Very Dense Tan and Brown Silty fine to coarse Sand		5, 10, 15				
Partially Weathered Rock: When sampled becomes Very Dense Tan and Brown Silty fine to coarse Sand		20, 25, 30				



WELL CONSTRUCTION DETAILS

PROTECTIVE CASING
Diameter: **Four Inch**
Type: **Steel**
Interval: **Above-Ground**

RISER CASING
Diameter: **One Inch**
Type: **Sch 40 PVC**
Interval: **3 Feet ALS to 23 Feet BLS**

GROUT
Type:
Interval:

SEAL
Type: **Bentonite Pellets**
Interval: **GS to 20 Feet BLS**

FILTERPACK
Type: **Medium Sand**
Interval: **20 to 32.6 Feet BLS**

SCREEN
Diameter: **One Inch**
Type: **Sch 40 PVC 0.010 Inch Slot**
Interval: **22.6 to 32.6 Feet BLS**

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

MONITORING WELL MARSHALL STEAM STATION BORING LOGS 01-2009.GPJ S&ME.GDT 1/29/09

S&ME
ENGINEERING • TESTING
ENVIRONMENTAL SERVICES
9751 Southern Pine Blvd.
Charlotte, North Carolina

COMPLETION REPORT OF WELL No. M-21

NON RESIDENTIAL WELL CONSTRUCTION RECORD

North Carolina Department of Environment and Natural Resources- Division of Water Quality

WELL CONTRACTOR CERTIFICATION # 2251-A

1. WELL CONTRACTOR:

Travis Costello
Well Contractor (Individual) Name

S&ME, Inc.
Well Contractor Company Name

STREET ADDRESS 155 Tradd Street

Spartanburg SC 29301
City or Town State Zip Code

(864)- 574-2360
Area code- Phone number

2. WELL INFORMATION:

SITE WELL ID #(if applicable) M-21

STATE WELL PERMIT#(if applicable)

DWQ or OTHER PERMIT #(if applicable)

WELL USE (Check Applicable Box) Monitoring ☐ Municipal/Public ☐ Industrial/Commercial ☐ Agricultural ☐ Recovery ☐ Injection ☐ Irrigation ☐ Other ☒ (list use) observation

DATE DRILLED

TIME COMPLETED AM ☐ PM ☐

3. WELL LOCATION:

CITY: Terrell COUNTY Catawba

8320 NC Highway 150E, Marshall Steam Station, 28682
(Street Name, Numbers, Community, Subdivision, Lot No., Parcel, Zip Code)

TOPOGRAPHIC / LAND SETTING:
☐ Slope ☐ Valley ☐ Flat ☐ Ridge ☐ Other
(check appropriate box)

LATITUDE 35.621783
LONGITUDE -80.976756

May be in degrees, minutes, seconds or in a decimal format

Latitude/longitude source: ☒ GPS ☐ Topographic map
(location of well must be shown on a USGS topo map and attached to this form if not using GPS)

4. FACILITY- is the name of the business where the well is located.

FACILITY ID #(if applicable)

NAME OF FACILITY Marshall Steam Station

STREET ADDRESS 8320 NC Highway 150E

Terrell NC 28682
City or Town State Zip Code

CONTACT PERSON Darrell Wolfe

MAILING ADDRESS 8320 NC Highway 150E

Terrell NC 28682
City or Town State Zip Code

(828)- 478-7829
Area code - Phone number

5. WELL DETAILS:

a. TOTAL DEPTH: 32.5

b. DOES WELL REPLACE EXISTING WELL? YES ☐ NO ☒

c. WATER LEVEL Below Top of Casing: DRY FT.
(Use "+" if Above Top of Casing)

d. TOP OF CASING IS 2.61 FT. Above Land Surface*
*Top of casing terminated at/or below land surface may require a variance in accordance with 15A NCAC 2C .0118.

e. YIELD (gpm): METHOD OF TEST

f. DISINFECTION: Type Amount

g. WATER ZONES (depth):

From To From To
From To From To
From To From To

6. CASING:

From	To	Ft.	Diameter	Thickness/ Weight	Material
0	22.5		2	sch.40	PVC

7. GROUT:

From	To	Ft.	Material	Method
0	20		Bentonite	poured

8. SCREEN:

From	To	Ft.	Diameter in.	Slot Size in.	Material
22.5	32.5		2	.010	PVC

9. SAND/GRAVEL PACK:

From	To	Ft.	Size	Material
20	32.5		#2	Sand

10. DRILLING LOG

From	To	Formation Description
0	5	dense Clayey fine to medium Sand
5	33	dense to v dense Silty fine-coarse Sand

11. REMARKS:

I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

Norman T. Costello 8/27/08
SIGNATURE OF CERTIFIED WELL CONTRACTOR DATE

Norman T. Costello
PRINTED NAME OF PERSON CONSTRUCTING THE WELL

Submit the original to the Division of Water Quality within 30 days. Attn: Information Mgt., 1617 Mail Service Center – Raleigh, NC 27699-1617 Phone No. (919) 733-7015 ext 568.

Form GW-1b
Rev. 7/05

S&ME
ENGINEERING • TESTING
ENVIRONMENTAL SERVICES

S&ME, Inc.
9751 Southern Pine Blvd.
Charlotte, North Carolina
Telephone: 704-523-4726
Fax: 704-525-3953

1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.
2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

Project: **Marshall Steam Station Industrial Fill #1**			**Boring No. M-22**
Location: **Terrell, North Carolina**		Number: **1356-08-122**	Sheet No. 1 of 1
Boring Depth (ft): **38.1**	Elevation (ft): **841.5**	Driller: **Joey Donnahoo**	Date Drilled: **5/16/08**
Logged By: **Matthew Osborne**	Water Level: **15.40 ft bls at TOB**		Drilling Method: **3¼" H.S.A.**

Elev. (Feet)	Depth (Feet)	Lith-ology	Material Description	Well Construction	Penetration Resistance (Blows/Foot) 0 50 100
840			Residuum: Hard Orange Clayey Silt with Quartz Sand		44
	5		Saprolite: Very Dense Tan and Brown micaceous Silty very fine to medium Sand with Quartz		50/6" >>
835			Partially Weathered Rock: When sampled becomes Very Dense Tan and Brown micaceous Silty very fine to medium Sand with Quartz		
	10				50/1" >>
830			Partially Weathered Rock: When sampled becomes White Weathered Quartz fragments		
	15		Partially Weathered Rock: When sampled becomes Very Hard Black and Brown micaceous fine Sandy Silt with Quartz beds	▽	50/3.7" >>
825					
	20				50/5.8" >>
820					
	25				50/3" >>
815					
	30				50/2.3" >>
810					
	35				50/0" >>
805					
			Auger Refusal at 38.1 ft bls		

BORING LOG WITH WELL MARSHALL STEAM STATION BORING LOGS 01-2009.GPJ LAGWGN01.GDT 1/29/09

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1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.
2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

Project: **Marshall Steam Station Industrial Fill #1**			**Boring No. M-23**
Location: **Terrell, North Carolina**		Number: **1356-08-122**	Sheet No. 1 of 1
Boring Depth (ft): **25.2**	Elevation (ft): **837.7**	Driller: **Joey Donnahoo**	Date Drilled: **5/14/08**
Logged By: **Matthew Osborne**	Water Level: **12.58 ft bls on 05-21-08**		Drilling Method: **3¼" H.S.A.**

Elev. (Feet)	Depth (Feet)	Material Description	Penetration Resistance (Blows/Foot)
835		Residuum: Very Stiff to Hard Gray and Buff Silty Clay with Quartz Sand	27
830	5		46
825	10	Saprolite: Very Hard Red and Brown micaceous fine Sandy Silt with Quartz beds	68
820	15	Saprolite: Very Dense Black and Brown micaceous Silty fine to Coarse Sand with Quartz beds	50/1"
815	20	Partially Weathered Rock: When sampled becomes Very Dense Black and Brown micaceous Silty fine to Coarse Sand with Quartz beds	50/3.1"
	25	Auger Refusal at 25.2 ft bls	

Penetration Resistance (Blows/Foot): 0 — 50 — 100

Well Construction

BORING LOG WITH WELL MARSHALL STEAM STATION BORING LOGS 01-2009.GPJ LAGWGN01.GDT 1/29/09

COMPLETION REPORT OF WELL No. M-23

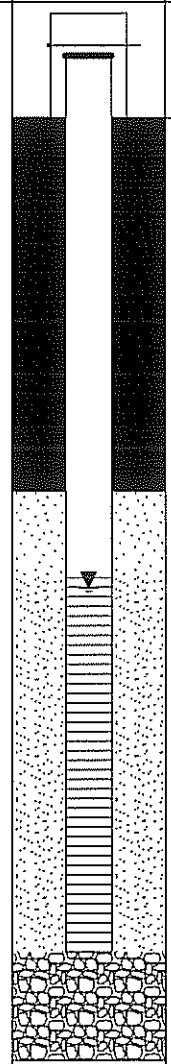
PROJECT: **Marshall Steam Station Industrial Fill #1**
PROJECT NO: **1356-08-122**
PROJECT LOCATION: **Terrell, North Carolina**

WATER LEVEL: **12.58 ft bls on 05-21-08**

LATITUDE: **35.622123°**
LONGITUDE: **80.975324°**
TOP OF CASING ELEVATION: **840.24**
DATUM: **MSL**
LOGGED BY: **Matthew Osborne**

DRILLING CONTRACTOR: **S&ME, Inc.**
DRILLING METHOD: **3¼" H.S.A.**
DATE DRILLED: **5/14/08**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)
				0.00		837.73
Residuum: Very Stiff to Hard Gray and Buff Silty Clay with Quartz Sand		0				
		5				
Saprolite: Very Hard Red and Brown micaceous fine Sandy Silt with Quartz beds		10				
Saprolite: Very Dense Black and Brown micaceous Silty fine to Coarse Sand with Quartz beds		15				
Partially Weathered Rock: When sampled becomes Very Dense Black and Brown micaceous Silty fine to Coarse Sand with Quartz beds		20				
		25				



WELL CONSTRUCTION DETAILS

PROTECTIVE CASING
Diameter: **Four Inch**
Type: **Steel**
Interval: **Above-Ground**

RISER CASING
Diameter: **One Inch**
Type: **Sch 40 PVC**
Interval: **3 Feet ALS to 12 Feet BLS**

GROUT
Type:
Interval:

SEAL
Type: **Bentonite Pellets**
Interval: **GS to 10 Feet BLS**

FILTERPACK
Type: **Medium Sand**
Interval: **10 to 22.3 Feet BLS**

SCREEN
Diameter: **One Inch**
Type: **Sch 40 PVC 0.010 Inch Slot**
Interval: **12.3 to 22.3 Feet BLS**

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

MONITORING WELL MARSHALL STEAM STATION BORING LOGS 01-2009.GPJ S&ME.GDT 1/29/09

S&ME
ENGINEERING • TESTING
ENVIRONMENTAL SERVICES
9751 Southern Pine Blvd.
Charlotte, North Carolina

COMPLETION REPORT OF WELL No. M-23

NON RESIDENTIAL WELL CONSTRUCTION RECORD

North Carolina Department of Environment and Natural Resources- Division of Water Quality

WELL CONTRACTOR CERTIFICATION # 2251-A

1. WELL CONTRACTOR:

Travis Costello
Well Contractor (Individual) Name

S&ME, Inc.
Well Contractor Company Name

STREET ADDRESS 155 Tradd Street

Spartanburg SC 29301
City or Town State Zip Code

(864)- 574-2360
Area code- Phone number

2. WELL INFORMATION:

SITE WELL ID #(if applicable) M-23

STATE WELL PERMIT#(if applicable)

DWQ or OTHER PERMIT #(if applicable)

WELL USE (Check Applicable Box) Monitoring ☐ Municipal/Public ☐ Industrial/Commercial ☐ Agricultural ☐ Recovery ☐ Injection ☐ Irrigation ☐ Other ☒ (list use) observation

DATE DRILLED

TIME COMPLETED AM ☐ PM ☐

3. WELL LOCATION:

CITY: Terrell COUNTY Catawba

8320 NC Highway 150E, Marshall Steam Station, 28682
(Street Name, Numbers, Community, Subdivision, Lot No., Parcel, Zip Code)

TOPOGRAPHIC / LAND SETTING:
☐ Slope ☐ Valley ☐ Flat ☐ Ridge ☐ Other
(check appropriate box)

LATITUDE 35.622123
LONGITUDE -80.975324

May be in degrees, minutes, seconds or in a decimal format

Latitude/longitude source: ☒ GPS ☐ Topographic map
(location of well must be shown on a USGS topo map and attached to this form if not using GPS)

4. FACILITY- is the name of the business where the well is located.

FACILITY ID #(if applicable)

NAME OF FACILITY Marshall Steam Station

STREET ADDRESS 8320 NC Highway 150E

Terrell NC 28682
City or Town State Zip Code

CONTACT PERSON Darrell Wolfe

MAILING ADDRESS 8320 NC Highway 150E

Terrell NC 28682
City or Town State Zip Code

(828)- 478-7829
Area code - Phone number

5. WELL DETAILS:

a. TOTAL DEPTH: 22

b. DOES WELL REPLACE EXISTING WELL? YES ☐ NO ☒

c. WATER LEVEL Below Top of Casing: 15 FT.
(Use "+" if Above Top of Casing)

d. TOP OF CASING IS 2.51 FT. Above Land Surface*
*Top of casing terminated at/or below land surface may require a variance in accordance with 15A NCAC 2C .0118.

e. YIELD (gpm): METHOD OF TEST

f. DISINFECTION: Type Amount

g. WATER ZONES (depth):
From 15 To From To
From To From To
From To From To

6. CASING:

From	To	Ft.	Diameter	Thickness/ Weight	Material
0	12		2	sch.40	PVC

7. GROUT:

From	To	Ft.	Material	Method
0	10		Bentonite	poured

8. SCREEN:

From	To	Ft.	Diameter	Slot Size	Material
12	22		2 in.	.010 in.	PVC
			in.	in.	
			in.	in.	

9. SAND/GRAVEL PACK:

From	To	Ft.	Size	Material
10	22		#2	Sand

10. DRILLING LOG

From	To	Formation Description
0	10	v stiff-hard Silty Clay
10	15	v hard mic. fine Sandy Silt
15	25	v dense mic. Silty fine-coarse Sand

11. REMARKS:

I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

Norman T. Costello 8/27/08
SIGNATURE OF CERTIFIED WELL CONTRACTOR DATE

Norman T. Costello
PRINTED NAME OF PERSON CONSTRUCTING THE WELL

Submit the original to the Division of Water Quality within 30 days. Attn: Information Mgt., 1617 Mail Service Center – Raleigh, NC 27699-1617 Phone No. (919) 733-7015 ext 568.

Form GW-1b
Rev. 7/05

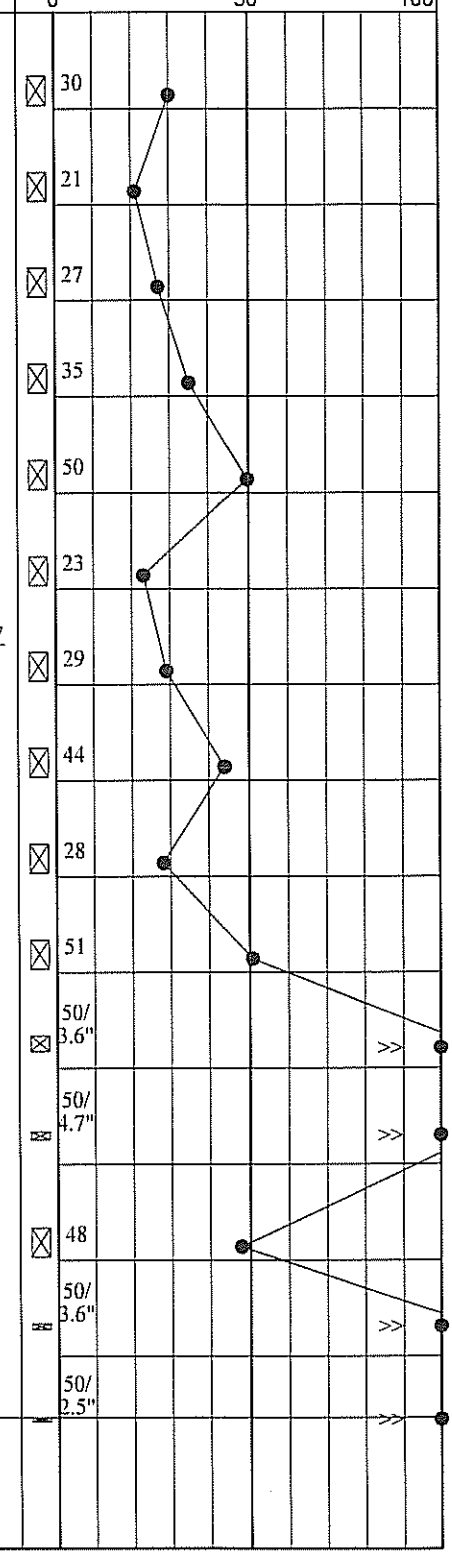
S&ME
ENGINEERING • TESTING
ENVIRONMENTAL SERVICES

S&ME, Inc.
9751 Southern Pine Blvd.
Charlotte, North Carolina
Telephone: 704-523-4726
Fax: 704-525-3953

1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.
2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

Project: **Marshall Steam Station Industrial Fill #1**			**Boring No. M-24**
Location: **Terrell, North Carolina**		Number: **1356-08-122**	Sheet No. 1 of 1
Boring Depth (ft): **73.2**	Elevation (ft): **856.5**	Driller: **Joey Donnahoo**	Date Drilled: **5/7/08**
Logged By: **Matthew Osborne**	Water Level: **32.90 ft bls at TOB**		Drilling Method: **3¼" H.S.A.**

Elev. (Feet)	Depth (Feet)	Lithology	Material Description	Well Construction	Penetration Resistance (Blows/Foot)
855, 850, 845, 840, 835	0–25		Saprolite: Medium Dense to Dense Brown and Red Silty fine to coarse Sand with Quartz beds		30, 21, 27, 35, 50
830, 825, 820	25–40		Saprolite: Very Stiff to Hard Red Black and Brown micaceous Silt with Quartz Sands	▽	23, 29, 44
815, 810, 805	40–55		Saprolite: Medium Dense to Very Dense Black Orange and Brown micaceous Silty fine to coarse Sand		28, 51, 50/3.6"
800, 795	55–65		Partially Weathered Rock: When sampled becomes Very Dense Black Orange and Brown micaceous Silty fine to coarse Sand		50/4.7", 48
790, 785	65–70		Partially Weathered Rock: When sampled becomes Very Dense Black Brown and Orange micaceous fine to coarse Sand		50/3.6", 50/2.5"
	70		Auger Refusal at 73.2 ft bls		



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S&ME, Inc.
9751 Southern Pine Blvd.
Charlotte, North Carolina
Telephone: 704-523-4726
Fax: 704-525-3953

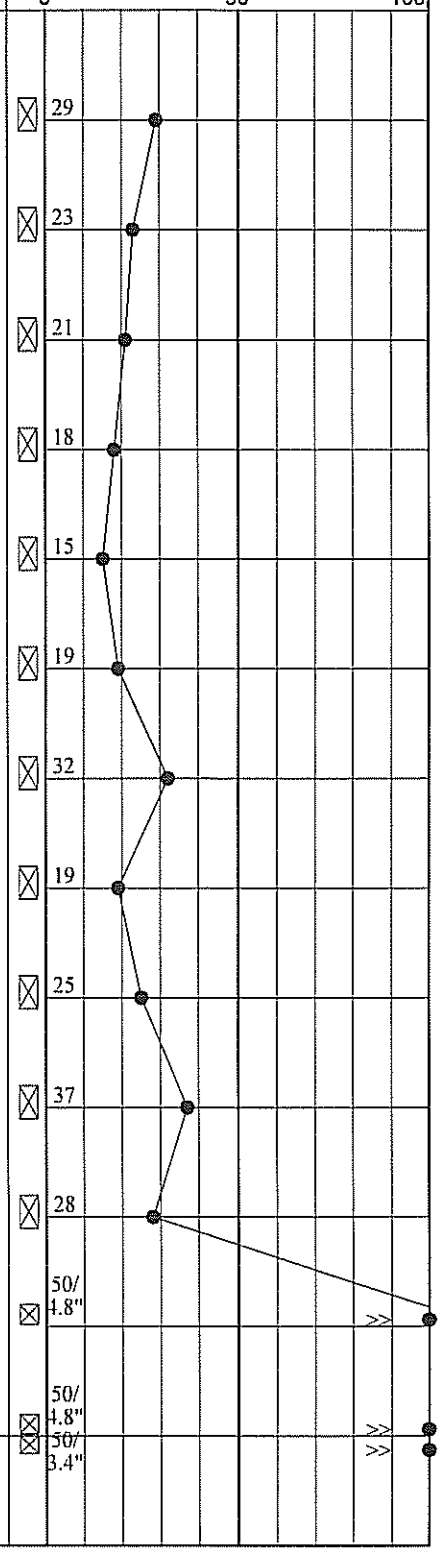
1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.
2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

Project: **Marshall Steam Station Industrial Fill #1**			**Boring No. M-25**
Location: **Terrell, North Carolina**		Number: **1356-08-122**	Sheet No. 1 of 1
Boring Depth (ft): **65.0**	Elevation (ft): **844.3**	Driller: **Joey Donnahoo**	Date Drilled: **5/6/08**
Logged By: **Matthew Osborne**	Water Level: **21.87 ft bls on 05-21-08**		Drilling Method: **3¼" H.S.A.**

Elev. (Feet)	Depth (Feet)	Lith-ology	Material Description
840	5		Residuum: Very Stiff Tan and Red Slightly Clayey Silt with Quartz pebbles
835	10		
830	15		
825	20		
820	25		Saprolite: Stiff Brown and Tan micaceous Silt with Manganese staining
815	30		Saprolite: Medium Dense to Dense Tan Quartz Silty fine to coarse Sand
810	35		
805	40		
800	45		Saprolite: Very Stiff to Very Hard Black and Brown micaceous Silt with White weathered Quartz beds
795	50		
790	55		
785	60		Partially Weathered Rock: When sampled becomes Very Stiff to Very Hard Black and Brown micaceous Silt with White weathered Quartz beds
780	65		Auger Refusal at 65 ft bls

Well Construction

Penetration Resistance (Blows/Foot)



BORING LOG WITH WELL MARSHALL STEAM STATION BORING LOGS 01-2009.GPJ LAGWGN01.GDT 1/29/09

COMPLETION REPORT OF WELL No. M-25

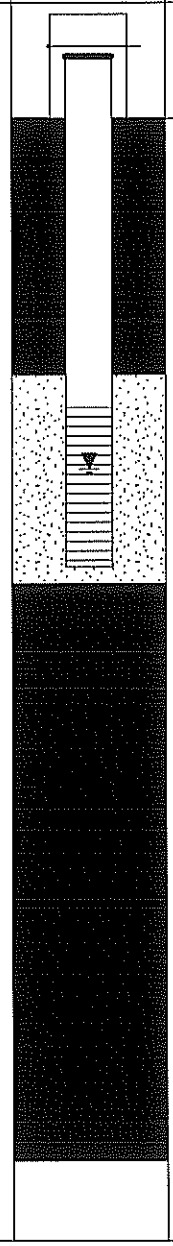
PROJECT: **Marshall Steam Station Industrial Fill #1**
PROJECT NO: **1356-08-122**
PROJECT LOCATION: **Terrell, North Carolina**

WATER LEVEL: **21.87 ft bls on 05-21-08**

LATITUDE: **35.621632°**
LONGITUDE: **80.973299°**
TOP OF CASING ELEVATION: **847.22**
DATUM: **MSL**
LOGGED BY: **Matthew Osborne**

DRILLING CONTRACTOR: **S&ME, Inc.**
DRILLING METHOD: **3¼" H.S.A.**
DATE DRILLED: **5/6/08**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)
				0.00		844.33
Residuum: Very Stiff Tan and Red Slightly Clayey Silt with Quartz pebbles		0, 5, 10, 15, 20				
Saprolite: Stiff Brown and Tan micaceous Silt with Manganese staining		25				
Saprolite: Medium Dense to Dense Tan Quartz Silty fine to coarse Sand		30, 35, 40				
Saprolite: Very Stiff to Very Hard Black and Brown micaceous Silt with White weathered Quartz beds		45, 50, 55				
Partially Weathered Rock: When sampled becomes Very Stiff to Very Hard Black and Brown micaceous Silt with White weathered Quartz beds		60, 65				



WELL CONSTRUCTION DETAILS

PROTECTIVE CASING
Diameter: **Four Inch**
Type: **Steel**
Interval: **Above-Ground**

RISER CASING
Diameter: **One Inch**
Type: **Sch 40 PVC**
Interval: **3 Feet ALS to 18 Feet BLS**

GROUT
Type:
Interval:

SEAL
Type: **Bentonite Pellets**
Interval: **GS to 16 Feet BLS**

FILTERPACK
Type: **Medium Sand**
Interval: **16 to 29 Feet BLS**

SCREEN
Diameter: **One Inch**
Type: **Sch 40 PVC 0.010 Inch Slot**
Interval: **18 to 28 Feet BLS**

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

MONITORING WELL MARSHALL STEAM STATION BORING LOGS 01-2009.GPJ S&ME.GDT 1/29/09

S&ME
ENGINEERING • TESTING
ENVIRONMENTAL SERVICES
9751 Southern Pine Blvd.
Charlotte, North Carolina

COMPLETION REPORT OF WELL No. M-25

NON RESIDENTIAL WELL CONSTRUCTION RECORD

North Carolina Department of Environment and Natural Resources- Division of Water Quality

WELL CONTRACTOR CERTIFICATION # 2251-A

1. WELL CONTRACTOR:

Travis Costello
Well Contractor (Individual) Name

S&ME, Inc.
Well Contractor Company Name

STREET ADDRESS 155 Tradd Street

Spartanburg SC 29301
City or Town State Zip Code

(864)- 574-2360
Area code- Phone number

2. WELL INFORMATION:

SITE WELL ID #(if applicable) M-25

STATE WELL PERMIT#(if applicable)

DWQ or OTHER PERMIT #(if applicable)

WELL USE (Check Applicable Box) Monitoring ☐ Municipal/Public ☐ Industrial/Commercial ☐ Agricultural ☐ Recovery ☐ Injection ☐ Irrigation ☐ Other ☒ (list use) observation

DATE DRILLED

TIME COMPLETED AM ☐ PM ☐

3. WELL LOCATION:

CITY: Terrell COUNTY Catawba

8320 NC Highway 150E, Marshall Steam Station, 28682
(Street Name, Numbers, Community, Subdivision, Lot No., Parcel, Zip Code)

TOPOGRAPHIC / LAND SETTING:
☐ Slope ☐ Valley ☐ Flat ☐ Ridge ☐ Other
(check appropriate box)

LATITUDE 35.621632
LONGITUDE -80.973299

May be in degrees, minutes, seconds or in a decimal format

Latitude/longitude source: ☒ GPS ☐ Topographic map
(location of well must be shown on a USGS topo map and attached to this form if not using GPS)

4. FACILITY- is the name of the business where the well is located.

FACILITY ID #(if applicable)

NAME OF FACILITY Marshall Steam Station

STREET ADDRESS 8320 NC Highway 150E

Terrell NC 28682
City or Town State Zip Code

CONTACT PERSON Darrell Wolfe

MAILING ADDRESS 8320 NC Highway 150E

Terrell NC 28682
City or Town State Zip Code

(828)- 478-7829
Area code - Phone number

5. WELL DETAILS:

a. TOTAL DEPTH: 28

b. DOES WELL REPLACE EXISTING WELL? YES ☐ NO ☒

c. WATER LEVEL Below Top of Casing: 24.75 FT.
(Use "+" if Above Top of Casing)

d. TOP OF CASING IS 2.89 FT. Above Land Surface*
*Top of casing terminated at/or below land surface may require a variance in accordance with 15A NCAC 2C .0118.

e. YIELD (gpm): METHOD OF TEST

f. DISINFECTION: Type Amount

g. WATER ZONES (depth):
From 24.75 To From To
From To From To
From To From To

6. CASING:

	Depth		Diameter	Thickness/ Weight	Material
From 0	To 18	Ft.	2	sch.40	PVC
From	To	Ft.			
From	To	Ft.			

7. GROUT:

	Depth		Material	Method
From 0	To 16	Ft.	Bentonite	poured
From	To	Ft.		
From	To	Ft.		

8. SCREEN:

	Depth		Diameter	Slot Size	Material
From 18	To 28	Ft.	2 in.	.010 in.	PVC
From	To	Ft.	in.	in.	
From	To	Ft.	in.	in.	

9. SAND/GRAVEL PACK:

	Depth		Size	Material
From 16	To 29	Ft.	#2	Sand
From	To	Ft.		
From	To	Ft.		

10. DRILLING LOG

From To	Formation Description
0-21	v stiff Clayey Silt
21-26	stiff mic. Silt
26-41	med dense-dense Silty fine-coarse Sand
41-65	v stiff-v hard mic. Silt

11. REMARKS:

I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

Norman T. Costello 8/27/08
SIGNATURE OF CERTIFIED WELL CONTRACTOR DATE

Norman T. Costello
PRINTED NAME OF PERSON CONSTRUCTING THE WELL

Submit the original to the Division of Water Quality within 30 days. Attn: Information Mgt., 1617 Mail Service Center – Raleigh, NC 27699-1617 Phone No. (919) 733-7015 ext 568.

Form GW-1b
Rev. 7/05

S&ME
ENGINEERING • TESTING
ENVIRONMENTAL SERVICES

S&ME, Inc.
9751 Southern Pine Blvd.
Charlotte, North Carolina
Telephone: 704-523-4726
Fax: 704-525-3953

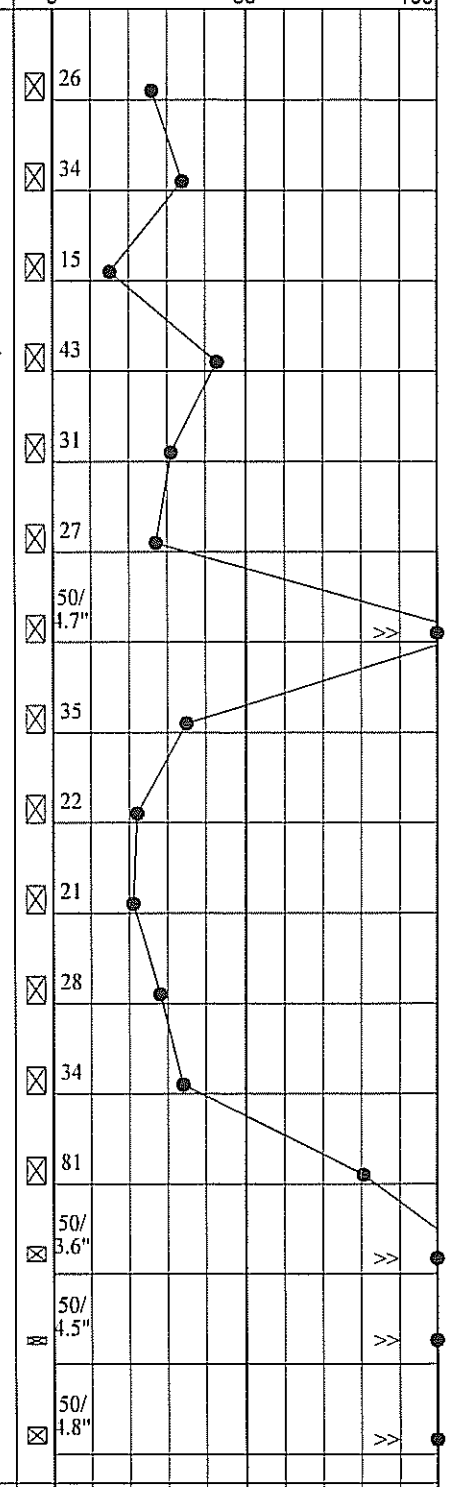
1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.
2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

Project: **Marshall Steam Station Industrial Fill #1**			**Boring No. M-26**
Location: **Terrell, North Carolina**		Number: **1356-08-122**	Sheet No. 1 of 1
Boring Depth (ft): **81.6**	Elevation (ft): **840.9**	Driller: **Joey Donnahoo**	Date Drilled: **5/8/08**
Logged By: **Matthew Osborne**	Water Level: **18.99 ft bls on 05-21-08**		Drilling Method: **3¼" H.S.A.**

Elev. (Feet)	Depth (Feet)	Lith-ology	Material Description
840			Residuum: Medium Dense to Dense Orange and Red Silty fine to medium Sand
835	5		
830	10		Saprolite: Stiff to Hard Purple Red and Tan fine to coarse Sandy Silt with Quartz
825	15		
820	20		
815	25		Saprolite: Very Stiff to Very Hard Orange Brown and Tan micaceous Silt with Quartz sand and Iron Staining
810	30		
805	35		
800	40		
795	45		
790	50		Saprolite: Very Stiff to Very Hard Orange Gray and Brown micaceous quartz fine to coarse Sandy Silt with weathered Schist
785	55		
780	60		
775	65		
770	70		Partially Weathered Rock: When sampled becomes Very Stiff to Very Hard Orange Gray and Brown micaceous quartz fine to coarse Sandy Silt with weathered Schist
765	75		
760	80		
			Auger Refusal at 81.6 ft bls

Well Construction

Penetration Resistance (Blows/Foot)



BORING LOG WITH WELL MARSHALL STEAM STATION BORING LOGS 01-2009.GPJ LAGWGN01.GDT 1/29/09

COMPLETION REPORT OF WELL No. M-26

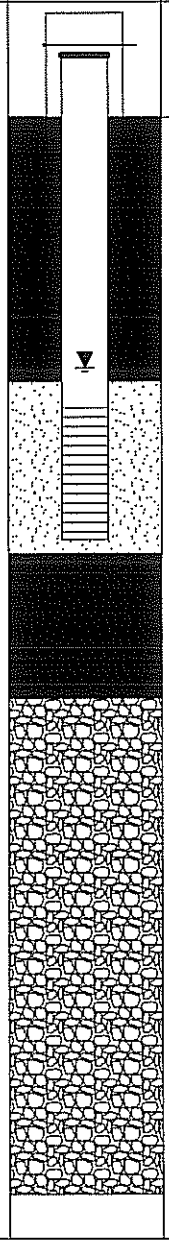
PROJECT: **Marshall Steam Station Industrial Fill #1**
PROJECT NO: **1356-08-122**
PROJECT LOCATION: **Terrell, North Carolina**

WATER LEVEL: **18.99 ft bls on 05-21-08**

LATITUDE: **35.624171°**
LONGITUDE: **80.974311°**
TOP OF CASING ELEVATION: **843.40**
DATUM: **MSL**
LOGGED BY: **Matthew Osborne**

DRILLING CONTRACTOR: **S&ME, Inc.**
DRILLING METHOD: **3¼" H.S.A.**
DATE DRILLED: **5/8/08**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)
				0.00		840.87
Residuum: Medium Dense to Dense Orange and Red Silty fine to medium Sand		0, 5				
Saprolite: Stiff to Hard Purple Red and Tan fine to coarse Sandy Silt with Quartz		10, 15, 20				
Saprolite: Very Stiff to Very Hard Orange Brown and Tan micaceous Silt with Quartz sand and Iron Staining		25, 30, 35, 40, 45				
Saprolite: Very Stiff to Very Hard Orange Gray and Brown micaceous quartz fine to coarse Sandy Silt with weathered Schist		50, 55, 60, 65				
Partially Weathered Rock: When sampled becomes Very Stiff to Very Hard Orange Gray and Brown micaceous quartz fine to coarse Sandy Silt with weathered Schist		70, 75, 80				



WELL CONSTRUCTION DETAILS

PROTECTIVE CASING
Diameter: **Four Inch**
Type: **Steel**
Interval: **Above-Ground**

RISER CASING
Diameter: **One Inch**
Type: **Sch 40 PVC**
Interval: **3 Feet ALS to 22 Feet BLS**

GROUT
Type:
Interval:

SEAL
Type: **Bentonite Pellets**
Interval: **GS to 20 Feet BLS**

FILTERPACK
Type: **Medium Sand**
Interval: **20 to 33 Feet BLS**

SCREEN
Diameter: **One Inch**
Type: **Sch 40 PVC 0.010 Inch Slot**
Interval: **22 to 32 Feet BLS**

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

S&ME
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ENVIRONMENTAL SERVICES
9751 Southern Pine Blvd.
Charlotte, North Carolina

COMPLETION REPORT OF WELL No. M-26

NON RESIDENTIAL WELL CONSTRUCTION RECORD

North Carolina Department of Environment and Natural Resources- Division of Water Quality

WELL CONTRACTOR CERTIFICATION # 2251-A

1. WELL CONTRACTOR:

Travis Costello
Well Contractor (Individual) Name

S&ME, Inc.
Well Contractor Company Name

STREET ADDRESS 155 Tradd Street

Spartanburg SC 29301
City or Town State Zip Code

(864)- 574-2360
Area code- Phone number

2. WELL INFORMATION:

SITE WELL ID #(if applicable) M-26

STATE WELL PERMIT#(if applicable)

DWQ or OTHER PERMIT #(if applicable)

WELL USE (Check Applicable Box) Monitoring ☐ Municipal/Public ☐ Industrial/Commercial ☐ Agricultural ☐ Recovery ☐ Injection ☐ Irrigation ☐ Other ☒ (list use) observation

DATE DRILLED

TIME COMPLETED AM ☐ PM ☐

3. WELL LOCATION:

CITY: Terrell COUNTY Catawba

8320 NC Highway 150E, Marshall Steam Station, 28682
(Street Name, Numbers, Community, Subdivision, Lot No., Parcel, Zip Code)

TOPOGRAPHIC / LAND SETTING:
☐ Slope ☐ Valley ☐ Flat ☐ Ridge ☐ Other
(check appropriate box)

LATITUDE 35.621471
LONGITUDE -80.974311

May be in degrees, minutes, seconds or in a decimal format

Latitude/longitude source: ☒ GPS ☐ Topographic map
(location of well must be shown on a USGS topo map and attached to this form if not using GPS)

4. FACILITY- is the name of the business where the well is located.

FACILITY ID #(if applicable)

NAME OF FACILITY Marshall Steam Station

STREET ADDRESS 8320 NC Highway 150E

Terrell NC 28682
City or Town State Zip Code

CONTACT PERSON Darrell Wolfe

MAILING ADDRESS 8320 NC Highway 150E

Terrell NC 28682
City or Town State Zip Code

(828)- 478-7829
Area code - Phone number

5. WELL DETAILS:

a. TOTAL DEPTH: 32

b. DOES WELL REPLACE EXISTING WELL? YES ☐ NO ☒

c. WATER LEVEL Below Top of Casing: 21.5 FT.
(Use "+" If Above Top of Casing)

d. TOP OF CASING IS 2.53 FT. Above Land Surface*
*Top of casing terminated at/or below land surface may require a variance in accordance with 15A NCAC 2C .0118.

e. YIELD (gpm): METHOD OF TEST

f. DISINFECTION: Type Amount

g. WATER ZONES (depth):
From 21.5 To From To
From To From To
From To From To

6. CASING:

From	To	Ft.	Diameter	Thickness/ Weight	Material
0	22		2	sch.40	PVC

7. GROUT:

From	To	Ft.	Material	Method
0	20		Bentonite	poured

8. SCREEN:

From	To	Ft.	Diameter in.	Slot Size in.	Material
22	32		2	.010	PVC

9. SAND/GRAVEL PACK:

From	To	Ft.	Size	Material
20	33		#2	Sand

10. DRILLING LOG

From To	Formation Description
0-10	med dense-dense Silty fine-med Sand
10-25	stiff-hard fine-coarse Sandy Silt
25-50	v stiff-v hard mic. Silt
50-81	v stiff-v hard mic. fine-coarse Sandy Silt

11. REMARKS:

I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

Norman T. Costello 8/27/08
SIGNATURE OF CERTIFIED WELL CONTRACTOR DATE

Norman T. Costello
PRINTED NAME OF PERSON CONSTRUCTING THE WELL

Submit the original to the Division of Water Quality within 30 days. Attn: Information Mgt., 1617 Mail Service Center – Raleigh, NC 27699-1617 Phone No. (919) 733-7015 ext 568.

Form GW-1b
Rev. 7/05

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Project: **Marshall Steam Station Industrial Fill #1**			**Boring No. M-27**
Location: **Terrell, North Carolina**		Number: **1356-08-122**	Sheet No. 1 of 1
Boring Depth (ft): **54.8**	Elevation (ft): **837.7**	Driller: **Joey Donnahoo**	Date Drilled: **5/9/08**
Logged By: **Matthew Osborne**	Water Level: **17.00 ft bls at TOB**		Drilling Method: **3¼" H.S.A.**

Elev. (Feet)	Depth (Feet)	Lithology	Material Description	Well Construction	Penetration Resistance (Blows/Foot) 0 50 100
835			Residuum: Very Stiff Brown and Tan Clayey Silt		21
	5		Saprolite: Very Stiff Orange Tan and Brown fine Sandy Silt		
830					20
	10				
825					21
	15		Saprolite: Dense to Very Dense Tan Silty fine to coarse Sand with Manganese Staining	▽	
820					32
	20				
815					38
	25				
810			Partially Weathered Rock: When sampled becomes Very Dense Tan Silty fine to coarse Sand with Manganese Staining		50/6" >>
	30				
805					50/1" >>
	35		Partially Weathered Rock: When sampled becomes Very Dense Tan and Brown micaceous Quartz fine to coarse Sand		
800					50/6" >>
	40				
795					50/4" >>
	45				
790					50/3" >>
	50				
785					50/3" >>
			Auger Refusal at 54.8 ft bls		

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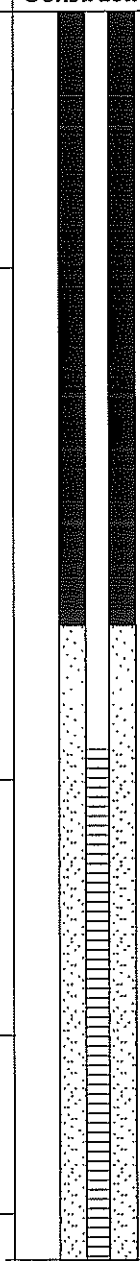
2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

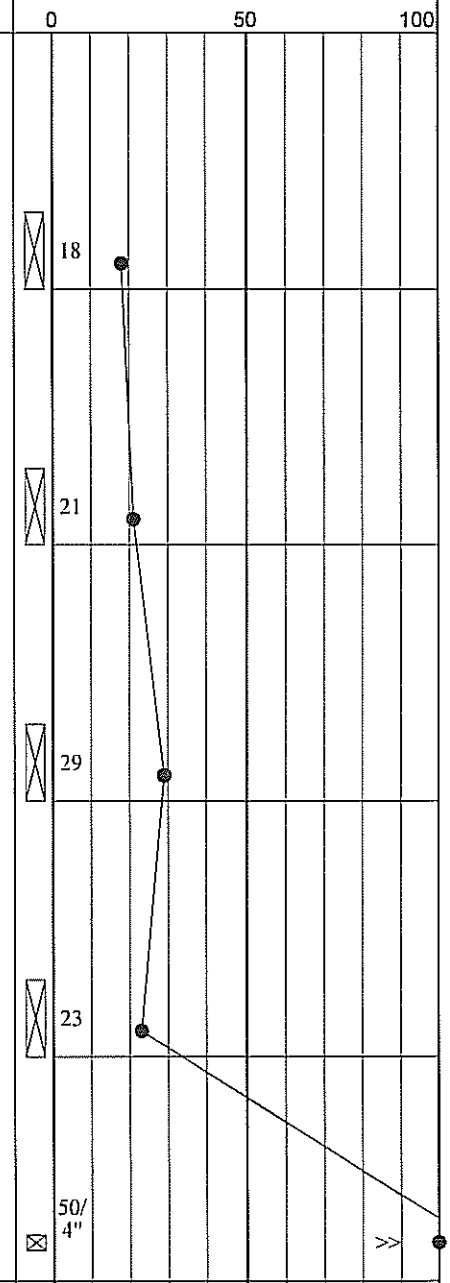
Project: **Marshall Steam Station Industrial Fill #1**			**Boring No. M-28**
Location: **Terrell, North Carolina**		Number: **1356-08-122**	Sheet No. 1 of 1
Boring Depth (ft): **24.4**	Elevation (ft): **849.7**	Driller: **Joey Donnahoo**	Date Drilled: **5/14/08**
Logged By: **Matthew Osborne**	Water Level: **Dry on 05-21-08**		Drilling Method: **3¼" H.S.A.**

Elev. (Feet)	Depth (Feet)	Lith-ology	Material Description
			Residuum: Very Stiff Red fine Sandy Silty Clay
845	5		Saprolite: Very Stiff Tan micaceous very fine to fine Sandy Silt
840	10		
835	15		Saprolite: Very Stiff Gray and Brown micaceous Silt
830	20		Saprolite: Very Dense Brown and Tan micaceous Silty fine Sand with weathered Schist fragments
			Partially Weathered Rock: When sampled becomes Very Dense Brown and Tan micaceous Silty fine Sand with weathered Schist fragments
			Auger Refusal at 24.4 ft bls

Well Construction



Penetration Resistance (Blows/Foot)



BORING LOG WITH WELL MARSHALL STEAM STATION BORING LOGS 01-2009.GPJ LAGWGN01.GDT 1/29/09

COMPLETION REPORT OF WELL No. M-28

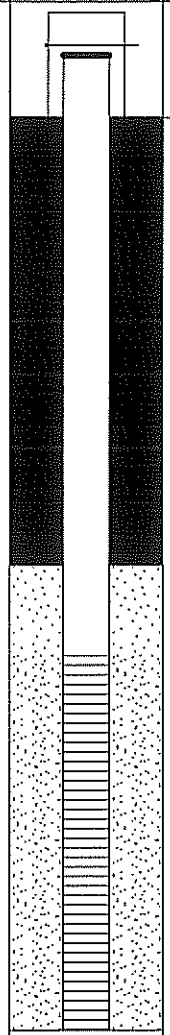
PROJECT: **Marshall Steam Station Industrial Fill #1**
PROJECT NO: **1356-08-122**
PROJECT LOCATION: **Terrell, North Carolina**

WATER LEVEL: **Dry on 05-21-08**

LATITUDE: **35.621472°**
LONGITUDE: **80.975921°**
TOP OF CASING ELEVATION: **852.45**
DATUM: **MSL**
LOGGED BY: **Matthew Osborne**

DRILLING CONTRACTOR: **S&ME, Inc.**
DRILLING METHOD: **3¼" H.S.A.**
DATE DRILLED: **5/14/08**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)
				0.00		849.69
Residuum: Very Stiff Red fine Sandy Silty Clay		0				
Saprolite: Very Stiff Tan micaceous very fine to fine Sandy Silt		5				
		10				
Saprolite: Very Stiff Gray and Brown micaceous Silt		15				
Saprolite: Very Dense Brown and Tan micaceous Silty fine Sand with weathered Schist fragments		20				
Partially Weathered Rock: When sampled becomes Very Dense Brown and Tan micaceous Silty fine Sand with weathered Schist fragments						



WELL CONSTRUCTION DETAILS

PROTECTIVE CASING
Diameter: **Four Inch**
Type: **Steel**
Interval: **Above-Ground**

RISER CASING
Diameter: **One Inch**
Type: **Sch 40 PVC**
Interval: **3 Feet ALS to 14 Feet BLS**

GROUT
Type:
Interval:

SEAL
Type: **Bentonite Pellets**
Interval: **GS to 12 Feet BLS**

FILTERPACK
Type: **Medium Sand**
Interval: **12 to 24.4 Feet BLS**

SCREEN
Diameter: **One Inch**
Type: **Sch 40 PVC 0.010 Inch Slot**
Interval: **14.4 to 24.4 Feet BLS**

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

MONITORING WELL MARSHALL STEAM STATION BORING LOGS 01-2009.GPJ S&ME.GDT 1/29/09

S&ME
ENGINEERING • TESTING
ENVIRONMENTAL SERVICES
9751 Southern Pine Blvd.
Charlotte, North Carolina

COMPLETION REPORT OF WELL No. M-28

NON RESIDENTIAL WELL CONSTRUCTION RECORD

North Carolina Department of Environment and Natural Resources- Division of Water Quality

WELL CONTRACTOR CERTIFICATION # 2251-A

1. WELL CONTRACTOR:

Travis Costello
Well Contractor (Individual) Name

S&ME, Inc.
Well Contractor Company Name

STREET ADDRESS 155 Tradd Street

Spartanburg SC 29301
City or Town State Zip Code

(864)- 574-2360
Area code- Phone number

2. WELL INFORMATION:

SITE WELL ID #(if applicable) M-28

STATE WELL PERMIT#(if applicable)

DWQ or OTHER PERMIT #(if applicable)

WELL USE (Check Applicable Box) Monitoring ☐ Municipal/Public ☐ Industrial/Commercial ☐ Agricultural ☐ Recovery ☐ Injection ☐ Irrigation ☐ Other ☒ (list use) observation

DATE DRILLED

TIME COMPLETED AM ☐ PM ☐

3. WELL LOCATION:

CITY: Terrell COUNTY Catawba

8320 NC Highway 150E, Marshall Steam Station, 28682
(Street Name, Numbers, Community, Subdivision, Lot No., Parcel, Zip Code)

TOPOGRAPHIC / LAND SETTING:
☐ Slope ☐ Valley ☐ Flat ☐ Ridge ☐ Other
(check appropriate box)

LATITUDE 35.621472
LONGITUDE -80.975921

May be in degrees, minutes, seconds or in a decimal format

Latitude/longitude source: ☒ GPS ☐ Topographic map
(location of well must be shown on a USGS topo map and attached to this form if not using GPS)

4. FACILITY- Is the name of the business where the well is located.

FACILITY ID #(if applicable)

NAME OF FACILITY Marshall Steam Station

STREET ADDRESS 8320 NC Highway 150E

Terrell NC 28682
City or Town State Zip Code

CONTACT PERSON Darrell Wolfe

MAILING ADDRESS 8320 NC Highway 150E

Terrell NC 28682
City or Town State Zip Code

(828)- 478-7829
Area code - Phone number

5. WELL DETAILS:

a. TOTAL DEPTH: 25

b. DOES WELL REPLACE EXISTING WELL? YES ☐ NO ☒

c. WATER LEVEL Below Top of Casing: DRY FT.
(Use "+" if Above Top of Casing)

d. TOP OF CASING IS 2.76 FT. Above Land Surface*
*Top of casing terminated at/or below land surface may require a variance in accordance with 15A NCAC 2C .0118.

e. YIELD (gpm): METHOD OF TEST

f. DISINFECTION: Type Amount

g. WATER ZONES (depth):
From DRY To From To
From To From To
From To From To

6. CASING:

From	To	Depth	Diameter	Thickness/ Weight	Material
0	15	Ft.	2	sch.40	PVC
		Ft.			
		Ft.			

7. GROUT:

From	To	Depth	Material	Method
0	12	Ft.	Bentonite	poured
		Ft.		
		Ft.		

8. SCREEN:

From	To	Depth	Diameter	Slot Size	Material
15	25	Ft.	2 in.	.010 in.	PVC
		Ft.	in.	in.	
		Ft.	in.	in.	

9. SAND/GRAVEL PACK:

From	To	Depth	Size	Material
12	25	Ft.	#2	Sand
		Ft.		
		Ft.		

10. DRILLING LOG

From	To	Formation Description
0	5	v stiff Sandy Silty Clay
5	15	v stiff mic. v fine-fine Sandy Silt
15	20	v stiff mic. Silt
20	25	v dense mic. Silty fine Sand

11. REMARKS:

I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

Norman T. Costello 8/27/08
SIGNATURE OF CERTIFIED WELL CONTRACTOR DATE

Norman T. Costello
PRINTED NAME OF PERSON CONSTRUCTING THE WELL

Submit the original to the Division of Water Quality within 30 days. Attn: Information Mgt., 1617 Mail Service Center – Raleigh, NC 27699-1617 Phone No. (919) 733-7015 ext 568.

Form GW-1b
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2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

Project: **Marshall Steam Station Industrial Fill #1**			**Boring No. M-29**
Location: **Terrell, North Carolina**		Number: **1356-08-122**	Sheet No. 1 of 1
Boring Depth (ft): **12.2**	Elevation (ft): **840.8**	Driller: **Joey Donnahoo**	Date Drilled: **5/15/08**
Logged By: **Matthew Osborne**	Water Level: **11.52 ft bls on 05-21-08**		Drilling Method: **3¼" H.S.A.**

Elev. (Feet)	Depth (Feet)	Lith-ology	Material Description	Well Construction	Penetration Resistance (Blows/Foot) 0 50 100
840			Partially Weathered Rock: When sampled becomes Very Dense Tan Quartz Silty fine to coarse Sand		50/ 2.5" >>
	5		Partially Weathered Rock: When sampled becomes Very Dense Black and Gray Quartz fine to coarse Sand with weathered Schist fragments		
835					50/ 5.9" >>
	10				
830					
			Auger Refusal at 12.2 ft bls		

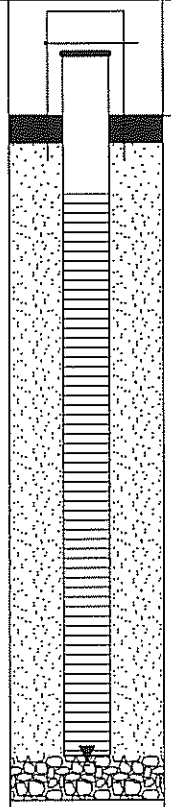
COMPLETION REPORT OF WELL No. M-29

PROJECT: **Marshall Steam Station Industrial Fill #1**
PROJECT NO: **1356-08-122**
PROJECT LOCATION: **Terrell, North Carolina**

WATER LEVEL: **11.52 ft bls on 05-21-08**

LATITUDE: **35.620900°**
LONGITUDE: **80.976880°**
TOP OF CASING ELEVATION: **843.36**
DATUM: **MSL**
LOGGED BY: **Matthew Osborne**

DRILLING CONTRACTOR: **S&ME, Inc.**
DRILLING METHOD: **3¼" H.S.A.**
DATE DRILLED: **5/15/08**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)
				0.00		840.75
Partially Weathered Rock: When sampled becomes Very Dense Tan Quartz Silty fine to coarse Sand		0				
Partially Weathered Rock: When sampled becomes Very Dense Black and Gray Quartz fine to coarse Sand with weathered Schist fragments		5				
		10				

WELL CONSTRUCTION DETAILS

PROTECTIVE CASING
Diameter: **Four Inch**
Type: **Steel**
Interval: **Above-Ground**

RISER CASING
Diameter: **One Inch**
Type: **Sch 40 PVC**
Interval: **3 Feet ALS to 2 Feet BLS**

GROUT
Type:
Interval:

SEAL
Type: **Bentonite Pellets**
Interval: **GS to .5 Feet BLS**

FILTERPACK
Type: **Medium Sand**
Interval: **.5 to 11.4 Feet BLS**

SCREEN
Diameter: **One Inch**
Type: **Sch 40 PVC 0.010 Inch Slot**
Interval: **1.4 to 11.4 Feet BLS**

LEGEND

FILTER PACK
BENTONITE
CEMENT GROUT
CUTTINGS / BACKFILL
STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

S&ME
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9751 Southern Pine Blvd.
Charlotte, North Carolina

COMPLETION REPORT OF WELL No. M-29

NON RESIDENTIAL WELL CONSTRUCTION RECORD

North Carolina Department of Environment and Natural Resources- Division of Water Quality

WELL CONTRACTOR CERTIFICATION # 2251-A

1. WELL CONTRACTOR:

Travis Costello
Well Contractor (Individual) Name

S&ME, Inc.
Well Contractor Company Name

STREET ADDRESS 155 Tradd Street

Spartanburg SC 29301
City or Town State Zip Code

(864)- 574-2360
Area code- Phone number

2. WELL INFORMATION:

SITE WELL ID #(if applicable) M-29

STATE WELL PERMIT#(if applicable)

DWQ or OTHER PERMIT #(if applicable)

WELL USE (Check Applicable Box) Monitoring ☐ Municipal/Public ☐ Industrial/Commercial ☐ Agricultural ☐ Recovery ☐ Injection ☐ Irrigation ☐ Other ☒ (list use) observation

DATE DRILLED

TIME COMPLETED AM ☐ PM ☐

3. WELL LOCATION:

CITY: Terrell COUNTY Catawba

8320 NC Highway 150E, Marshall Steam Station, 28682
(Street Name, Numbers, Community, Subdivision, Lot No., Parcel, Zip Code)

TOPOGRAPHIC / LAND SETTING:
☐ Slope ☐ Valley ☐ Flat ☐ Ridge ☐ Other
(check appropriate box)

LATITUDE 35.620900
LONGITUDE -80.976880

May be in degrees, minutes, seconds or in a decimal format

Latitude/longitude source: ☒ GPS ☐ Topographic map
(location of well must be shown on a USGS topo map and attached to this form if not using GPS)

4. FACILITY- is the name of the business where the well is located.

FACILITY ID #(if applicable)

NAME OF FACILITY Marshall Steam Station

STREET ADDRESS 8320 NC Highway 150E

Terrell NC 28682
City or Town State Zip Code

CONTACT PERSON Darrell Wolfe

MAILING ADDRESS 8320 NC Highway 150E

Terrell NC 28682
City or Town State Zip Code

(828)- 478-7829
Area code - Phone number

5. WELL DETAILS:

a. TOTAL DEPTH: 12

b. DOES WELL REPLACE EXISTING WELL? YES ☐ NO ☒

c. WATER LEVEL Below Top of Casing: 14 FT.
(Use "+" if Above Top of Casing)

d. TOP OF CASING IS 2.61 FT. Above Land Surface*
*Top of casing terminated at/or below land surface may require a variance in accordance with 15A NCAC 2C .0118.

e. YIELD (gpm): METHOD OF TEST

f. DISINFECTION: Type Amount

g. WATER ZONES (depth):
From 14 To From To
From To From To
From To From To

6. CASING:

	Depth		Diameter	Thickness/ Weight	Material
From 0	To 2	Ft.	2	sch.40	PVC
From	To	Ft.			
From	To	Ft.			

7. GROUT:

	Depth		Material	Method
From 0	To .5	Ft.	Bentonite	poured
From	To	Ft.		
From	To	Ft.		

8. SCREEN:

	Depth		Diameter	Slot Size	Material
From 2	To 12	Ft.	2 in.	.010 in.	PVC
From	To	Ft.	in.	in.	
From	To	Ft.	in.	in.	

9. SAND/GRAVEL PACK:

	Depth		Size	Material
From .5	To 12	Ft.	#2	Sand
From	To	Ft.		
From	To	Ft.		

10. DRILLING LOG

From To	Formation Description
0-5	v dense Silty fine-coarse Sand
5-12	v dense fine-coarse Sand

11. REMARKS:

I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

Norman T. Costello 8/27/08
SIGNATURE OF CERTIFIED WELL CONTRACTOR DATE

Norman T. Costello
PRINTED NAME OF PERSON CONSTRUCTING THE WELL

Submit the original to the Division of Water Quality within 30 days. Attn: Information Mgt., 1617 Mail Service Center – Raleigh, NC 27699-1617 Phone No. (919) 733-7015 ext 568.

Form GW-1b
Rev. 7/05

S&ME
ENGINEERING • TESTING
ENVIRONMENTAL SERVICES

S&ME, Inc.
9751 Southern Pine Blvd.
Charlotte, North Carolina
Telephone: 704-523-4726
Fax: 704-525-3953

1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.
2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

Project: **Marshall Steam Station Industrial Fill #1**			**Boring No. M-30**
Location: **Terrell, North Carolina**		Number: **1356-08-122**	Sheet No. 1 of 1
Boring Depth (ft): **34.0**	Elevation (ft): **845.1**	Driller: **Joey Donnahoo**	Date Drilled: **5/15/08**
Logged By: **Matthew Osborne**	Water Level: **26.6 ft bls at TOB**		Drilling Method: **3¼" H.S.A.**

Elev. (Feet)	Depth (Feet)	Lith-ology	Material Description	Well Construction	Penetration Resistance (Blows/Foot) 0 50 100
			Residuum: Very Stiff Tan and Orange fine Sandy Clayey Silt		26
840	5		Saprolite: Stiff to Hard Orange Brown and Tan micaceous fine Sandy Silt with Quartz beds		14
835	10				17
830	15				37
825	20				37
820	25		Saprolite: Very Dense Orange and Tan micaceous Silty very fine to medium Sand with Quartz beds	▽	50/2.5" >>
815	30		Partially Weathered Rock: When sampled becomes Very Dense Orange and Tan micaceous Silty very fine to medium Sand with Quartz beds		
			Partially Weathered Rock: When sampled becomes Brown Weathered Schist fragments		50/1.1" >>
			Auger Refusal at 34 ft bls		

BORING LOG WITH WELL MARSHALL STEAM STATION BORING LOGS 01-2009.GPJ LAGWGN01.GDT 1/29/09

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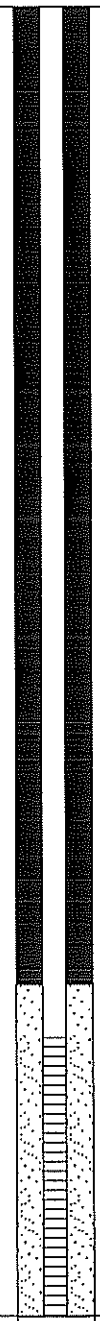
1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.
2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

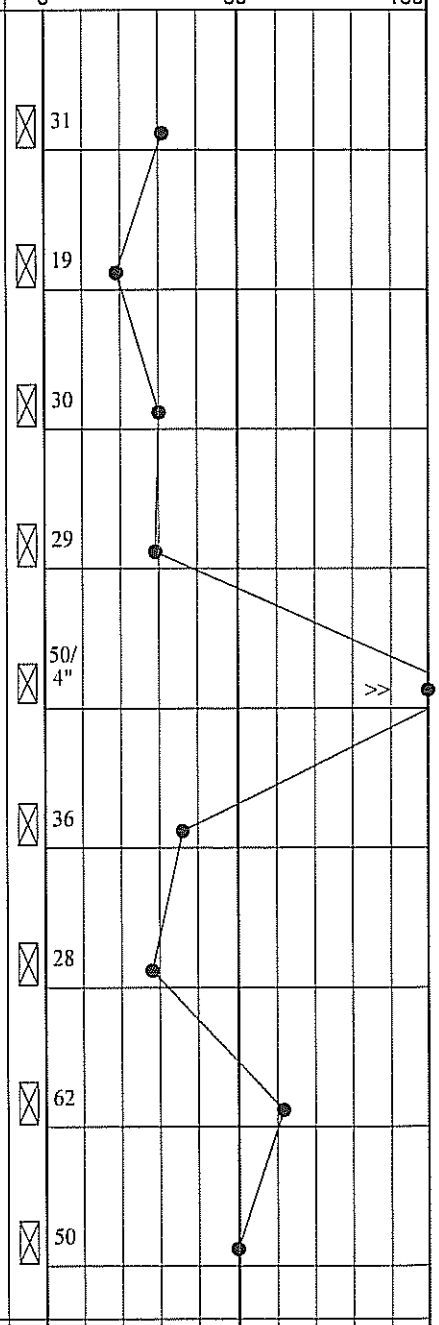
Project: **Marshall Steam Station Industrial Fill #1**			**Boring No. M-31**
Location: **Terrell, North Carolina**		Number: **1356-08-122**	Sheet No. 1 of 1
Boring Depth (ft): **46.9**	Elevation (ft): **878.9**	Driller: **Joey Donnahoo**	Date Drilled: **5/28/08**
Logged By: **Matthew Osborne**	Water Level: **Dry on 06-25-08**		Drilling Method: **3¼" H.S.A.**

Elev. (Feet)	Depth (Feet)	Material Description	Penetration Resistance (Blows/Foot)
875	5	Residuum: Hard Tan and Red Clayey fine Sandy Silt	31
870	10	Saprolite: Very Stiff Brown micaceous Silt	19
865	15	Saprolite: Very Stiff to Very Hard White Black Tan and Brown micaceous Quartz Silty fine to medium Sand	30
860	20	Saprolite: Very Stiff White and Brown micaceous fine to medium Sandy Silt with weathered Quartz beds	29
855	25	Partially Weathered Rock: When sampled becomes Very Hard White and Brown micaceous fine to medium Sandy Silt with weathered Quartz beds	50/4" >>
850	30	Saprolite: Very Stiff to Very Hard White and Brown micaceous fine to medium Sandy Silt with weathered Quartz beds	36
845	35		28
840	40	Saprolite: Hard Yellow Brown Tan Clayey Silt with White and Smokey Quartz rock fragments from 44 to 44.5 ft bls	62
835	45	Saprolite: Very Dense Orange and Tan Silty fine Sand	50
		Auger Refusal at 46.9 ft bls	

Well Construction



Penetration Resistance (Blows/Foot)



COMPLETION REPORT OF WELL No. M-31

PROJECT: **Marshall Steam Station Industrial Fill #1**
PROJECT NO: **1356-08-122**
PROJECT LOCATION: **Terrell, North Carolina**

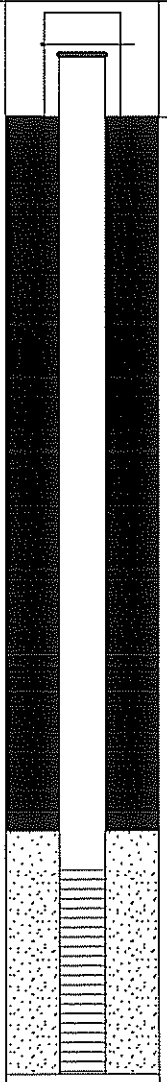
WATER LEVEL: **Dry on 06-25-08**

LATITUDE:
LONGITUDE:
TOP OF CASING ELEVATION: **881.36**
DATUM: **MSL**
LOGGED BY: **Matthew Osborne**

DRILLING CONTRACTOR: **S&ME, Inc.**
DRILLING METHOD: **3¼" H.S.A.**
DATE DRILLED: **5/28/08**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)
Residuum: Hard Tan and Red Clayey fine Sandy Silt		0
Saprolite: Very Stiff Brown micaceous Silt		5
Saprolite: Very Stiff to Very Hard White Black Tan and Brown micaceous Quartz Silty fine to medium Sand		10, 15
Saprolite: Very Stiff White and Brown micaceous fine to medium Sandy Silt with weathered Quartz beds		20
Partially Weathered Rock: When sampled becomes Very Hard White and Brown micaceous fine to medium Sandy Silt with weathered Quartz beds		25, 30
Saprolite: Very Stiff to Very Hard White and Brown micaceous fine to medium Sandy Silt with weathered Quartz beds		35
Saprolite: Hard Yellow Brown Tan Clayey Silt with White and Smokey Quartz rock fragments from 44 to 44.5 ft bls		40
Saprolite: Very Dense Orange and Tan Silty fine Sand		45

WELL DETAILS



DEPTH (ft.)	LEGEND	ELEVATION (ft.)
0.00		878.93

WELL CONSTRUCTION DETAILS

PROTECTIVE CASING
Diameter: **Four Inch**
Type: **Steel**
Interval: **Above-Ground**

RISER CASING
Diameter: **One Inch**
Type: **Sch 40 PVC**
Interval: **3 Feet ALS to 37 Feet BLS**

GROUT
Type:
Interval:

SEAL
Type: **Bentonite Pellets**
Interval: **GS to 35 Feet BLS**

FILTERPACK
Type: **Medium Sand**
Interval: **35 to 46.9 Feet BLS**

SCREEN
Diameter: **One Inch**
Type: **Sch 40 PVC 0.010 Inch Slot**
Interval: **36.9 to 46.9 Feet BLS**

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

MONITORING WELL MARSHALL STEAM STATION BORING LOGS 01-2009.GPJ S&ME.GDT 1/29/09

S&ME
ENGINEERING • TESTING
ENVIRONMENTAL SERVICES
9751 Southern Pine Blvd.
Charlotte, North Carolina

COMPLETION REPORT OF WELL No. M-31

NON RESIDENTIAL WELL CONSTRUCTION RECORD

North Carolina Department of Environment and Natural Resources- Division of Water Quality

WELL CONTRACTOR CERTIFICATION # 2251-A

1. WELL CONTRACTOR:

Travis Costello
Well Contractor (Individual) Name

S&ME, Inc.
Well Contractor Company Name

STREET ADDRESS 155 Tradd Street

Spartanburg SC 29301
City or Town State Zip Code

(864)- 574-2360
Area code- Phone number

2. WELL INFORMATION:

SITE WELL ID #(if applicable) M-31

STATE WELL PERMIT#(if applicable)

DWQ or OTHER PERMIT #(if applicable)

WELL USE (Check Applicable Box) Monitoring ☐ Municipal/Public ☐ Industrial/Commercial ☐ Agricultural ☐ Recovery ☐ Injection ☐ Irrigation ☐ Other ☒ (list use) observation

DATE DRILLED

TIME COMPLETED AM ☐ PM ☐

3. WELL LOCATION:

CITY: Terrell COUNTY Catawba

8320 NC Highway 150E, Marshall Steam Station, 28682
(Street Name, Numbers, Community, Subdivision, Lot No., Parcel, Zip Code)

TOPOGRAPHIC / LAND SETTING:
☐ Slope ☐ Valley ☐ Flat ☐ Ridge ☐ Other
(check appropriate box)

LATITUDE 35.620659
LONGITUDE -80.978249

May be in degrees, minutes, seconds or in a decimal format

Latitude/longitude source: ☒ GPS ☐ Topographic map
(location of well must be shown on a USGS topo map and attached to this form if not using GPS)

4. FACILITY- Is the name of the business where the well is located.

FACILITY ID #(if applicable)

NAME OF FACILITY Marshall Steam Station

STREET ADDRESS 8320 NC Highway 150E

Terrell NC 28682
City or Town State Zip Code

CONTACT PERSON Darrell Wolfe

MAILING ADDRESS 8320 NC Highway 150E

Terrell NC 28682
City or Town State Zip Code

(828)- 478-7829
Area code - Phone number

5. WELL DETAILS:

a. TOTAL DEPTH: 47

b. DOES WELL REPLACE EXISTING WELL? YES ☐ NO ☒

c. WATER LEVEL Below Top of Casing: DRY FT.
(Use "+" if Above Top of Casing)

d. TOP OF CASING IS 2.43 FT. Above Land Surface*
*Top of casing terminated at/or below land surface may require a variance in accordance with 15A NCAC 2C .0118.

e. YIELD (gpm): METHOD OF TEST

f. DISINFECTION: Type Amount

g. WATER ZONES (depth):

From DRY	To	From	To
From	To	From	To
From	To	From	To

6. CASING:

From	To	Ft.	Diameter	Thickness/ Weight	Material
0	37		2	sch.40	PVC

7. GROUT:

From	To	Ft.	Material	Method
0	35		Bentonite	poured

8. SCREEN:

From	To	Ft.	Diameter	Slot Size	Material
37	47		2 in.	.010 in.	PVC
			in.	in.	
			in.	in.	

9. SAND/GRAVEL PACK:

From	To	Ft.	Size	Material
35	47		#2	Sand

10. DRILLING LOG

From To	Formation Description
0-5	hard Clayey fine Sandy Silt
5-10	v stiff mic. Silt
10-40	v stiff-v hard mic. fine-med Sandy Silt
40-44	hard Clayey Silt
44-44.5	Quartz Bed
44.5-47	v hard Silty fine Sand

11. REMARKS:

I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

Norman T. Costello 8/27/08
SIGNATURE OF CERTIFIED WELL CONTRACTOR DATE

Norman T. Costello
PRINTED NAME OF PERSON CONSTRUCTING THE WELL

Submit the original to the Division of Water Quality within 30 days. Attn: Information Mgt., 1617 Mail Service Center – Raleigh, NC 27699-1617 Phone No. (919) 733-7015 ext 568.

Form GW-1b
Rev. 7/05

S&ME
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ENVIRONMENTAL SERVICES

S&ME, Inc.
9751 Southern Pine Blvd.
Charlotte, North Carolina
Telephone: 704-523-4726
Fax: 704-525-3953

1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.
2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

Project: **Marshall Steam Station Industrial Fill #1**			**Boring No. M-33**
Location: **Terrell, North Carolina**		Number: **1356-08-122**	Sheet No. 1 of 1
Boring Depth (ft): **44.9**	Elevation (ft): **838.6**	Driller: **Joey Donnahoo**	Date Drilled: **5/19/08**
Logged By: **Matthew Osborne**	Water Level: **17.9 ft bls at TOB**		Drilling Method: **3¼" H.S.A.**

Elev. (Feet)	Depth (Feet)	Lithology	Material Description	Well Construction	Penetration Resistance (Blows/Foot) 0 50 100
			Residuum: Very Stiff to Hard Tan and Red Clayey Silt with Manganese staining		
835	5				32
830	10				23
825	15				23
			Saprolite: Very Stiff to Very Hard Orange Tan and Brown micaceous Quartz very fine to coarse Sandy Silt	▽	
820	20				25
815	25				33
810	30				28
805	35				64
			Saprolite: Very Dense Orange and Brown micaceous Quartz Silty fine to coarse Sand		50/3" >>
800	40		Partially Weathered Rock: When sampled becomes Very Dense Orange and Brown micaceous Quartz Silty fine to coarse Sand		
			Partially Weathered Rock: When sampled becomes Very Dense Tan and Orange Quartz coarse Sand		50/4.5" >>
795			Auger Refusal at 44.9 ft bls		

BORING LOG WITH WELL MARSHALL STEAM STATION BORING LOGS 01-2009.GPJ LAGWGN01.GDT 1/29/09

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S&ME, Inc.
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Charlotte, North Carolina
Telephone: 704-523-4726
Fax: 704-525-3953

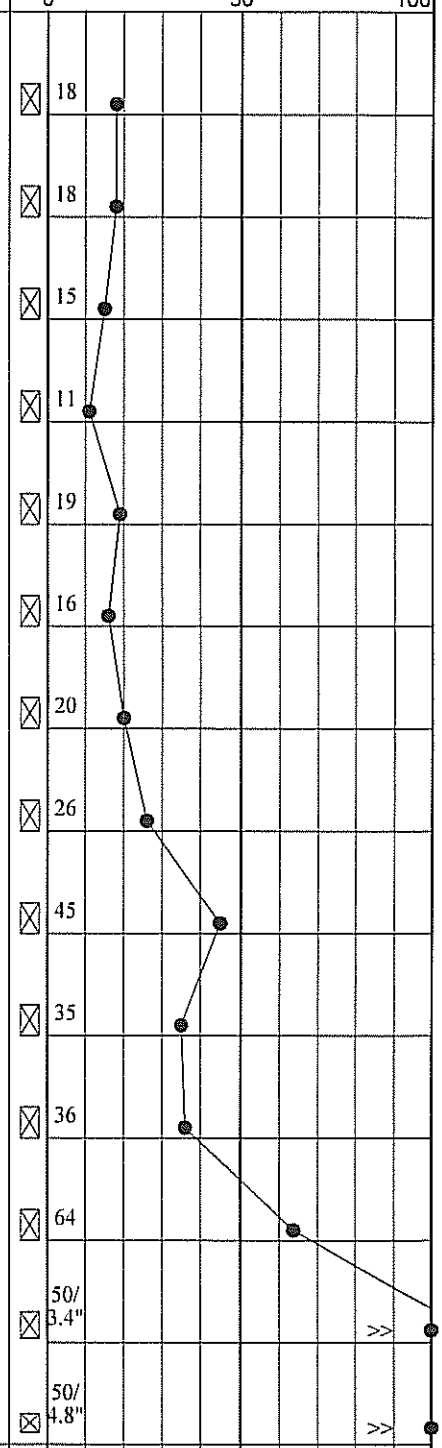
1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.
2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

Project: **Marshall Steam Station Industrial Fill #1**			**Boring No. M-34**
Location: **Terrell, North Carolina**		Number: **1356-08-122**	Sheet No. 1 of 1
Boring Depth (ft): **70.0**	Elevation (ft): **828.0**	Driller: **Joey Donnahoo**	Date Drilled: **5/7/08**
Logged By: **Matthew Osborne**	Water Level: **9.09 ft bls on 05-21-08**		Drilling Method: **3¼" H.S.A.**

Elev. (Feet)	Depth (Feet)	Lith-ology	Material Description
825	0–5		Residuum: Very Stiff Red and Tan slightly Clayey Silt
820, 815, 810, 805, 800	5–30		Saprolite: Stiff to Very Stiff Black and Brown micaceous Quartz fine to coarse Sandy Silt
795, 790, 785, 780	30–50		Saprolite: Very Stifff to Hard Tan Gray and Brown micaceous Silt
775	50–55		Saprolite: Hard Orange Brown and Tan micaceous Quartz fine to coarse Sandy Silt
770, 765	55–65		Saprolite: Very Dense Black Gray and Brown micaceous Silty very fine to coarse Sand with weathered Quartz beds
760	65–70		Partially Weathered Rock: When sampled becomes Very Dense Black Gray and Brown micaceous Silty very fine to coarse Sand with weathered Quartz beds
	70		Auger Refusal at 70 ft bls

Well Construction

Penetration Resistance (Blows/Foot)



BORING LOG WITH WELL MARSHALL STEAM STATION BORING LOGS 01-2009.GPJ LAGWGN01.GDT 1/29/09

COMPLETION REPORT OF WELL No. M-34

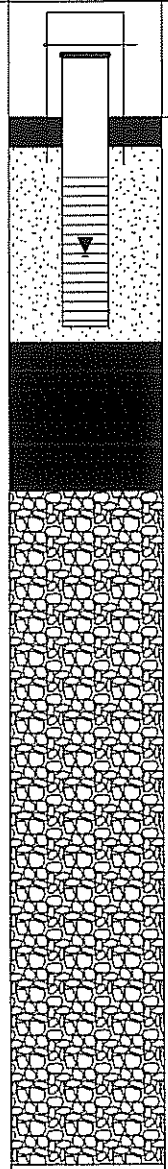
PROJECT: **Marshall Steam Station Industrial Fill #1**
PROJECT NO: **1356-08-122**
PROJECT LOCATION: **Terrell, North Carolina**

WATER LEVEL: **9.09 ft bls on 05-21-08**

LATITUDE:
LONGITUDE:
TOP OF CASING ELEVATION: **830.49**
DATUM: **MSL**
LOGGED BY: **Matthew Osborne**

DRILLING CONTRACTOR: **S&ME, Inc.**
DRILLING METHOD: **3¼" H.S.A.**
DATE DRILLED: **5/7/08**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)
				0.00		827.97
Residuum: Very Stiff Red and Tan slightly Clayey Silt		0				
Saprolite: Stiff to Very Stiff Black and Brown micaceous Quartz fine to coarse Sandy Silt		5, 10, 15, 20, 25				
Saprolite: Very Stifff to Hard Tan Gray and Brown micaceous Silt		30, 35, 40, 45				
Saprolite: Hard Orange Brown and Tan micaceous Quartz fine to coarse Sandy Silt		50, 55				
Saprolite: Very Dense Black Gray and Brown micaceous Silty very fine to coarse Sand with weathered Quartz beds		60, 65				
Partially Weathered Rock: When sampled becomes Very Dense Black Gray and Brown micaceous Silty very		70				



WELL CONSTRUCTION DETAILS

PROTECTIVE CASING
Diameter: **Four Inch**
Type: **Steel**
Interval: **Above-Ground**

RISER CASING
Diameter: **One Inch**
Type: **Sch 40 PVC**
Interval: **3 Feet ALS to 4 Feet BLS**

GROUT
Type:
Interval:

SEAL
Type: **Bentonite Pellets**
Interval: **GS to 2 Feet BLS**

FILTERPACK
Type: **Medium Sand**
Interval: **2 to 15 Feet BLS**

SCREEN
Diameter: **One Inch**
Type: **Sch 40 PVC 0.010 Inch Slot**
Interval: **4 to 14 Feet BLS**

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

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Charlotte, North Carolina

COMPLETION REPORT OF WELL No. M-34

PROJECT: **Marshall Steam Station Industrial Fill #1**
PROJECT NO: **1356-08-122**
PROJECT LOCATION: **Terrell, North Carolina**

GROUND SURFACE ELEVATION: **828.0**
LOGGED BY: **Matthew Osborr**
CHECKED BY: **Bill Miller**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)	WELL CONSTRUCTION DETAILS
							(See Page 1)
fine to coarse Sand with weathered Quartz beds							

LEGEND

FILTER PACK	TOC	TOP OF CASING
BENTONITE	GS	GROUND SURFACE
CEMENT GROUT	BS	BENTONITE SEAL
CUTTINGS / BACKFILL	FP	FILTER PACK
STATIC WATER LEVEL	TSC	TOP OF SCREEN
	BSC	BOTTOM OF SCREEN
	TD	TOTAL DEPTH
	CG	CEMENT GROUT

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9751 Southern Pine Blvd.
Charlotte, North Carolina

COMPLETION REPORT OF WELL No. M-34

NON RESIDENTIAL WELL CONSTRUCTION RECORD

North Carolina Department of Environment and Natural Resources- Division of Water Quality

WELL CONTRACTOR CERTIFICATION # 2251-A

1. WELL CONTRACTOR:

Travis Costello
Well Contractor (Individual) Name

S&ME, Inc.
Well Contractor Company Name

STREET ADDRESS 155 Tradd Street

Spartanburg SC 29301
City or Town State Zip Code

(864)- 574-2360
Area code- Phone number

2. WELL INFORMATION:

SITE WELL ID #(if applicable) M-34

STATE WELL PERMIT#(if applicable)

DWQ or OTHER PERMIT #(if applicable)

WELL USE (Check Applicable Box) Monitoring ☐ Municipal/Public ☐ Industrial/Commercial ☐ Agricultural ☐ Recovery ☐ Injection ☐ Irrigation ☐ Other ☒ (list use) observation

DATE DRILLED

TIME COMPLETED AM ☐ PM ☐

3. WELL LOCATION:

CITY: Terrell COUNTY Catawba

8320 NC Highway 150E, Marshall Steam Station, 28682
(Street Name, Numbers, Community, Subdivision, Lot No., Parcel, Zip Code)

TOPOGRAPHIC / LAND SETTING:
☐ Slope ☐ Valley ☐ Flat ☐ Ridge ☐ Other
(check appropriate box)

LATITUDE 35.620839
LONGITUDE -80.974741

May be in degrees, minutes, seconds or in a decimal format

Latitude/longitude source: ☒ GPS ☐ Topographic map
(location of well must be shown on a USGS topo map and attached to this form if not using GPS)

4. FACILITY- is the name of the business where the well is located.

FACILITY ID #(if applicable)

NAME OF FACILITY Marshall Steam Station

STREET ADDRESS 8320 NC Highway 150E

Terrell NC 28682
City or Town State Zip Code

CONTACT PERSON Darrell Wolfe

MAILING ADDRESS 8320 NC Highway 150E

Terrell NC 28682
City or Town State Zip Code

(828)- 478-7829
Area code - Phone number

5. WELL DETAILS:

a. TOTAL DEPTH: 14

b. DOES WELL REPLACE EXISTING WELL? YES ☐ NO ☒

c. WATER LEVEL Below Top of Casing: 11.5 FT.
(Use "+" if Above Top of Casing)

d. TOP OF CASING IS 2.52 FT. Above Land Surface*
*Top of casing terminated at/or below land surface may require a variance in accordance with 15A NCAC 2C .0118.

e. YIELD (gpm): METHOD OF TEST

f. DISINFECTION: Type Amount

g. WATER ZONES (depth):
From 11.5 To From To
From To From To
From To From To

6. CASING:

	Depth		Diameter	Thickness/ Weight	Material
From 0	To 4	Ft.	2	sch.40	PVC
From	To	Ft.			
From	To	Ft.			

7. GROUT:

	Depth		Material	Method
From 0	To 2	Ft.	Bentonite	poured
From	To	Ft.		
From	To	Ft.		

8. SCREEN:

	Depth		Diameter	Slot Size	Material
From 4	To 14	Ft.	2 in.	.010 in.	PVC
From	To	Ft.	in.	in.	
From	To	Ft.	in.	in.	

9. SAND/GRAVEL PACK:

	Depth		Size	Material
From 2	To 15	Ft.	#2	Sand
From	To	Ft.		
From	To	Ft.		

10. DRILLING LOG

From To	Formation Description
0-5	v stiff Clayey Silt
5-15	stiff-v stiff mic. fine-coarse Sandy Silt

11. REMARKS:

I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

Norman T. Costello 8/27/08
SIGNATURE OF CERTIFIED WELL CONTRACTOR DATE

Norman T. Costello
PRINTED NAME OF PERSON CONSTRUCTING THE WELL

Submit the original to the Division of Water Quality within 30 days. Attn: Information Mgt., 1617 Mail Service Center – Raleigh, NC 27699-1617 Phone No. (919) 733-7015 ext 568.

Form GW-1b
Rev. 7/05

S&ME
ENGINEERING • TESTING
ENVIRONMENTAL SERVICES

S&ME, Inc.
9751 Southern Pine Blvd.
Charlotte, North Carolina
Telephone: 704-523-4726
Fax: 704-525-3953

1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.
2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

Project: **Marshall Steam Station Industrial Fill #1**			**Boring No. M-35**
Location: **Terrell, North Carolina**		Number: **1356-08-122**	Sheet No. 1 of 1
Boring Depth (ft): **61.3**	Elevation (ft): **835.5**	Driller: **Joey Donnahoo**	Date Drilled: **5/2/08**
Logged By: **Matthew Osborne**	Water Level: **20.00 ft bls at TOB**		Drilling Method: **3¼" H.S.A.**

Elev. (Feet)	Depth (Feet)	Lith-ology	Material Description	Well Construction	Penetration Resistance (Blows/Foot) 0 50 100
835			Residuum: Very Stiff Buff and Red Clayey Silt		22
830	5				17
825	10		Saprolite: Very Stiff Brown and Tan micaceous fine to medium Sandy Silt		17
820	15		Saprolite: Stiff to Very Hard Tan micaceous Silt with Manganese Staining and intermittent weathered Quartz and very fine Sand beds		12
815	20			▽	18
810	25				30
805	30				50/4.8"
800	35		Partially Weathered Rock: When sampled becomes Very Hard Tan micaceous Silt with Manganese Staining and intermittent weathered Quartz and very fine Sand beds		50/3.6"
795	40		Partially Weathered Rock: When sampled becomes Very Dense Tan Silty fine to medium Sand with weathered Quartz		50/2.4" 50/1"
790	45		Partially Weathered Rock: When sampled becomes Very Dense Brown and Gray Clayey Silty very fine Sand		50/3.6"
785	50		Partially Weathered Rock: When sampled becomes Very Dense Brown Weathered Schist fragments with Manganese staining on fracture surfaces		50/2.4
780	55				50/2.4"
775	60		Auger Refusal at 61.3 ft bls		

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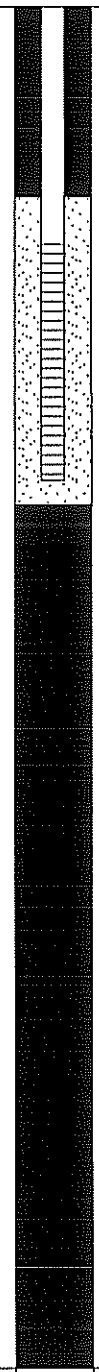
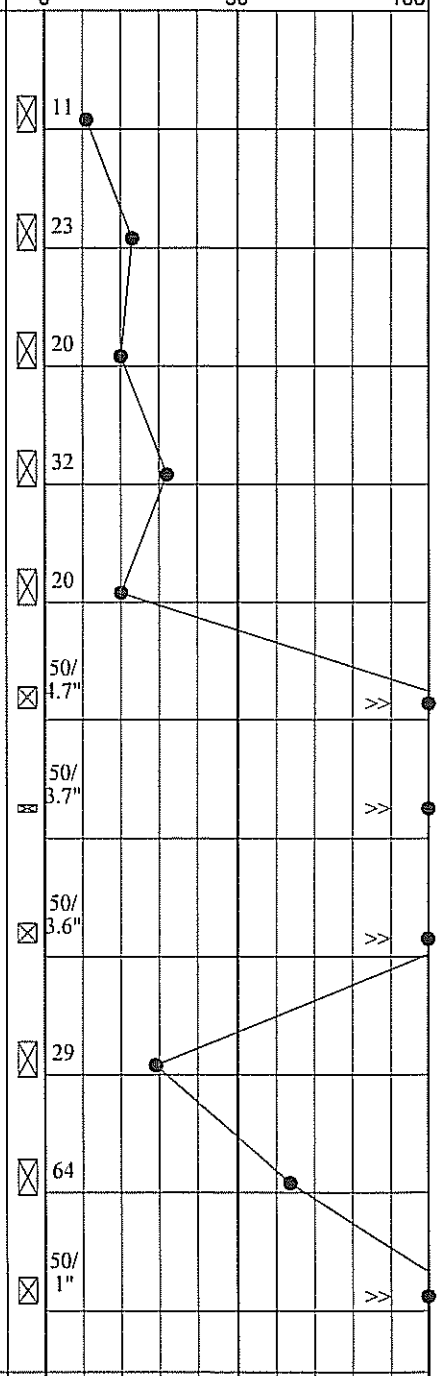
Project: **Marshall Steam Station Industrial Fill #1**			**Boring No. M-36**
Location: **Terrell, North Carolina**		Number: **1356-08-122**	Sheet No. 1 of 1
Boring Depth (ft): **57.6**	Elevation (ft): **838.8**	Driller: **Joey Donnahoo**	Date Drilled: **5/1/08**
Logged By: **Matthew Osborne**	Water Level: **12.54 ft bls on 05-21-08**		Drilling Method: **3¼" H.S.A.**

Elev. (Feet)	Depth (Feet)	Lith-ology	Material Description	Penetration Resistance (Blows/Foot)
835	5		Residuum: Medium Dense Red micaceous Silty fine to medium Sand	11
830	10		Saprolite: Very Stiff Orange Red and Tan mcaceous fine Sandy Silt with Quartz beds	23
825	15		Saprolite: Very Stiff to Very Hard Tan and Orange Silt with Manganese Staining and fine Sand	20
820	20			32
815	25			20
810	30		Partially Weathered Rock: When sampled becomes Very Hard Purple Tan and Orange fine to medium Sandy Silt	50/4.7" >>
805	35		Partially Weathered Rock: When sampled becomes Very Dense Red White and Tan Silty fine to coarse Sand	50/3.7" >>
800	40			50/3.6" >>
795	45		Saprolite: Medium Dense to Very Dense Red White and Tan Silty fine to coarse Sand	29
790	50		Saprolite: Very Dense Orange and Tan fine to medium Sand with Manganese staining	64
785	55		Saprolite: Very Hard Gray Orange Tan fine Sandy Silt	50/1" >>
			Partially Weathered Rock: When sampled becomes Very Hard Gray Orange Tan fine Sandy Silt	
			Auger Refusal at 57.6 ft bls	

Well Construction



Penetration Resistance (Blows/Foot)



BORING LOG WITH WELL MARSHALL STEAM STATION BORING LOGS 01-2009.GPJ LAGWGN01.GDT 1/29/09

COMPLETION REPORT OF WELL No. M-36

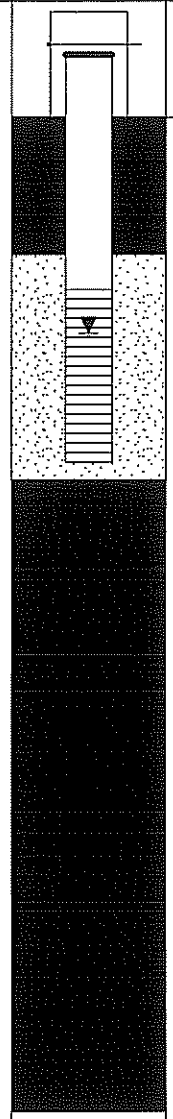
PROJECT: **Marshall Steam Station Industrial Fill #1**
PROJECT NO: **1356-08-122**
PROJECT LOCATION: **Terrell, North Carolina**

WATER LEVEL: **12.54 ft bls on 05-21-08**

LATITUDE:
LONGITUDE:
TOP OF CASING ELEVATION: **842.03**
DATUM: **MSL**
LOGGED BY: **Matthew Osborne**

DRILLING CONTRACTOR: **S&ME, Inc.**
DRILLING METHOD: **3¼" H.S.A.**
DATE DRILLED: **5/1/08**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)
				0.00		838.81
Residuum: Medium Dense Red micaceous Silty fine to medium Sand		0				
Saprolite: Very Stiff Orange Red and Tan mcaceous fine Sandy Silt with Quartz beds		5				
Saprolite: Very Stiff to Very Hard Tan and Orange Silt with Manganese Staining and fine Sand		10				
		15				
		20				
		25				
Partially Weathered Rock: When sampled becomes Very Hard Purple Tan and Orange fine to medium Sandy Silt		30				
Partially Weathered Rock: When sampled becomes Very Dense Red White and Tan Silty fine to coarse Sand		35				
Saprolite: Medium Dense to Very Dense Red White and Tan Silty fine to coarse Sand		40				
Saprolite: Very Dense Orange and Tan fine to medium Sand with Manganese staining		45				
Saprolite: Very Hard Gray Orange Tan fine Sandy Silt		50				
Partially Weathered Rock: When sampled		55				



WELL CONSTRUCTION DETAILS

PROTECTIVE CASING
Diameter: **Four Inch**
Type: **Steel**
Interval: **Above-Ground**

RISER CASING
Diameter: **One Inch**
Type: **Sch 40 PVC**
Interval: **3 Feet ALS to 10 Feet BLS**

GROUT
Type:
Interval:

SEAL
Type: **Bentonite Pellets**
Interval: **GS to 8 Feet BLS**

FILTERPACK
Type: **Medium Sand**
Interval: **8 to 21 Feet BLS**

SCREEN
Diameter: **One Inch**
Type: **Sch 40 PVC 0.010 Inch Slot**
Interval: **10 to 20 Feet BLS**

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

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Charlotte, North Carolina

COMPLETION REPORT OF WELL No. M-36

PROJECT: **Marshall Steam Station Industrial Fill #1**
PROJECT NO: **1356-08-122**
PROJECT LOCATION: **Terrell, North Carolina**

GROUND SURFACE ELEVATION: **838.8**
LOGGED BY: **Matthew Osborr**
CHECKED BY: **Bill Miller**

STRATA			WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)	WELL CONSTRUCTION DETAILS
DESCRIPTION	SYMBOL	DEPTH (ft.)					
							(See Page 1)
becomes Very Hard Gray Orange Tan fine Sandy Silt							

LEGEND

FILTER PACK	TOC	TOP OF CASING
BENTONITE	GS	GROUND SURFACE
CEMENT GROUT	BS	BENTONITE SEAL
CUTTINGS / BACKFILL	FP	FILTER PACK
STATIC WATER LEVEL	TSC	TOP OF SCREEN
	BSC	BOTTOM OF SCREEN
	TD	TOTAL DEPTH
	CG	CEMENT GROUT

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Charlotte, North Carolina

COMPLETION REPORT OF WELL No. M-36

MONITORING WELL MARSHALL STEAM STATION BORING LOGS 01-2009.GPJ S&ME.GDT 1/29/09

NON RESIDENTIAL WELL CONSTRUCTION RECORD

North Carolina Department of Environment and Natural Resources- Division of Water Quality

WELL CONTRACTOR CERTIFICATION # 2251-A

1. WELL CONTRACTOR:

Travis Costello
Well Contractor (Individual) Name

S&ME, Inc.
Well Contractor Company Name

STREET ADDRESS 155 Tradd Street

Spartanburg SC 29301
City or Town State Zip Code

(864)- 574-2360
Area code- Phone number

2. WELL INFORMATION:

SITE WELL ID #(if applicable) M-36

STATE WELL PERMIT#(if applicable)

DWQ or OTHER PERMIT #(if applicable)

WELL USE (Check Applicable Box) Monitoring ☐ Municipal/Public ☐ Industrial/Commercial ☐ Agricultural ☐ Recovery ☐ Injection ☐ Irrigation ☐ Other ☒ (list use) observation

DATE DRILLED

TIME COMPLETED AM ☐ PM ☐

3. WELL LOCATION:

CITY: Terrell COUNTY Catawba

8320 NC Highway 150E, Marshall Steam Station, 28682
(Street Name, Numbers, Community, Subdivision, Lot No., Parcel, Zip Code)

TOPOGRAPHIC / LAND SETTING:
☐ Slope ☐ Valley ☐ Flat ☐ Ridge ☐ Other
(check appropriate box)

LATITUDE 35.621390
LONGITUDE -80.972479

May be in degrees, minutes, seconds or in a decimal format

Latitude/longitude source: ☒ GPS ☐ Topographic map
(location of well must be shown on a USGS topo map and attached to this form if not using GPS)

4. FACILITY- is the name of the business where the well is located.

FACILITY ID #(if applicable)

NAME OF FACILITY Marshall Steam Station

STREET ADDRESS 8320 NC Highway 150E

Terrell NC 28682
City or Town State Zip Code

CONTACT PERSON Darrell Wolfe

MAILING ADDRESS 8320 NC Highway 150E

Terrell NC 28682
City or Town State Zip Code

(828)- 478-7829
Area code - Phone number

5. WELL DETAILS:

a. TOTAL DEPTH: 20

b. DOES WELL REPLACE EXISTING WELL? YES ☐ NO ☒

c. WATER LEVEL Below Top of Casing: 15.75 FT.
(Use "+" if Above Top of Casing)

d. TOP OF CASING IS 3.22 FT. Above Land Surface*
*Top of casing terminated at/or below land surface may require a variance in accordance with 15A NCAC 2C .0118.

e. YIELD (gpm): METHOD OF TEST

f. DISINFECTION: Type Amount

g. WATER ZONES (depth):
From 15.75 To From To
From To From To
From To From To

6. CASING:

From	To	Ft.	Diameter	Thickness/ Weight	Material
0	10		2	sch.40	PVC

7. GROUT:

From	To	Ft.	Material	Method
0	8		Bentonite	poured

8. SCREEN:

From	To	Ft.	Diameter in.	Slot Size in.	Material
10	20		2	.010	PVC

9. SAND/GRAVEL PACK:

From	To	Ft.	Size	Material
8	21		#2	Sand

10. DRILLING LOG

From To	Formation Description
0-5	med dense mic. Silty fine-med Sand
5-10	v stiff mic. fine Sandy Silt
10-21	v stiff-v hard Silt

11. REMARKS:

I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

Norman T. Costello 8/27/08
SIGNATURE OF CERTIFIED WELL CONTRACTOR DATE

Norman T. Costello
PRINTED NAME OF PERSON CONSTRUCTING THE WELL

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Form GW-1b
Rev. 7/05

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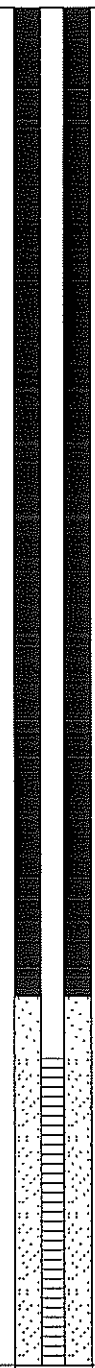
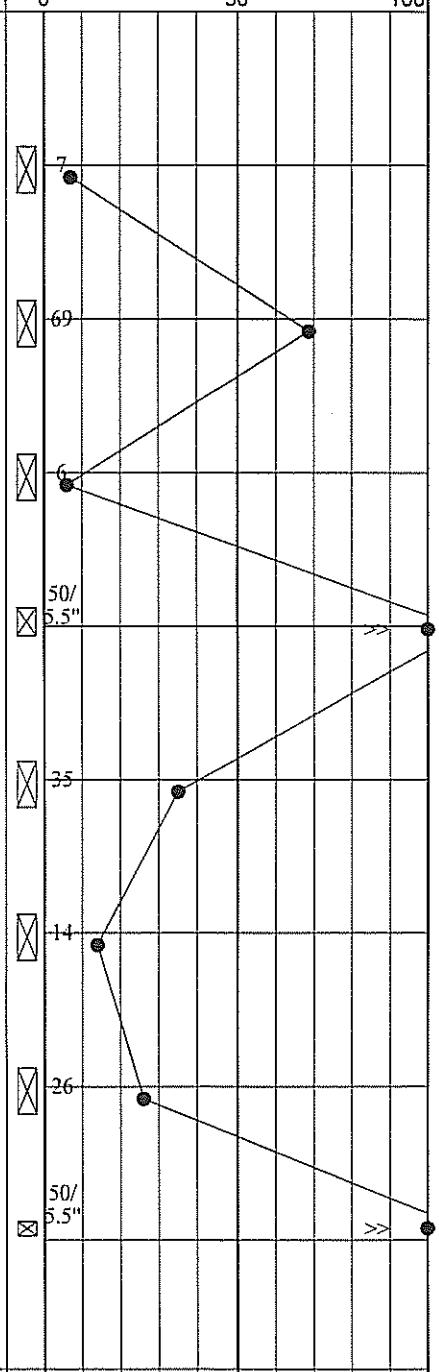
Project: **Marshall Steam Station Industrial Fill #1**			**Boring No. M-37**
Location: **Terrell, North Carolina**		Number: **1356-08-122**	Sheet No. 1 of 1
Boring Depth (ft): **44.2**	Elevation (ft): **872.7**	Driller: **Justin Millwood**	Date Drilled: **5/22/08**
Logged By: **Ben Boland**	Water Level: **43.18 ft bls on 06-25-08**		Drilling Method: **3¼" H.S.A.**

Elev. (Feet)	Depth (Feet)	Lith-ology	Material Description
870	0–5		Residuum: Loose Red Orange micaceous Silty fine Sand
865	5–10		Saprolite: Very Dense Tan and Gray fine to coarse Sand with weathered rock fragments
860	10–15		Saprolite: Firm Tan micaceous fine to medium Sandy Silt
855, 850, 845, 840	15–35		Saprolite: Medium Dense to Very Dense Gray Orange Brown and Tan micaceous Silty fine to medium Sand
835	35–40		Saprolite: Very Dense Gray and Tan micaceous coarse to very coarse Sand with rock fragments
830	40–44.2		Partially Weathered Rock: When sampled becomes Very Dense Gray and Tan micaceous coarse to very coarse Sand with rock fragments
	44.2		Auger Refusal at 44.2 ft bls

Well Construction



Penetration Resistance (Blows/Foot)



BORING LOG WITH WELL MARSHALL STEAM STATION BORING LOGS 01-2009.GPJ LAGWGN01.GDT 1/29/09

COMPLETION REPORT OF WELL No. M-37

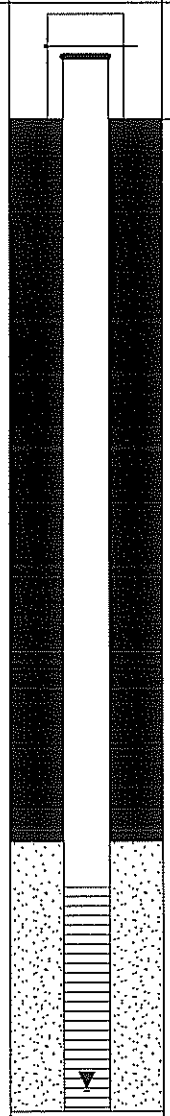
PROJECT: **Marshall Steam Station Industrial Fill #1**
PROJECT NO: **1356-08-122**
PROJECT LOCATION: **Terrell, North Carolina**

WATER LEVEL: **43.18 ft bls on 06-25-08**

LATITUDE:
LONGITUDE:
TOP OF CASING ELEVATION: **875.30**
DATUM: **MSL**
LOGGED BY: **Ben Boland**

DRILLING CONTRACTOR: **S&ME, Inc.**
DRILLING METHOD: **3¼" H.S.A.**
DATE DRILLED: **5/22/08**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)
				0.00		872.73
Residuum: Loose Red Orange micaceous Silty fine Sand		0				
		5				
Saprolite: Very Dense Tan and Gray fine to coarse Sand with weathered rock fragments		10				
Saprolite: Firm Tan micaceous fine to medium Sandy Silt		15				
Saprolite: Medium Dense to Very Dense Gray Orange Brown and Tan micaceous Silty fine to medium Sand		20				
		25				
		30				
		35				
Saprolite: Very Dense Gray and Tan micaceous coarse to very coarse Sand with rock fragments		40				
Partially Weathered Rock: When sampled becomes Very Dense Gray and Tan micaceous coarse to very coarse Sand with rock fragments						



WELL CONSTRUCTION DETAILS

PROTECTIVE CASING
Diameter: **Four Inch**
Type: **Steel**
Interval: **Above-Ground**

RISER CASING
Diameter: **One Inch**
Type: **Sch 40 PVC**
Interval: **3 Feet ALS to 34 Feet BLS**

GROUT
Type:
Interval:

SEAL
Type: **Bentonite Pellets**
Interval: **GS to 32 Feet BLS**

FILTERPACK
Type: **Medium Sand**
Interval: **32 to 44.2 Feet BLS**

SCREEN
Diameter: **One Inch**
Type: **Sch 40 PVC 0.010 Inch Slot**
Interval: **34.2 to 44.2 Feet BLS**

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

MONITORING WELL MARSHALL STEAM STATION BORING LOGS 01-2009.GPJ S&ME.GDT 1/29/09

S&ME
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ENVIRONMENTAL SERVICES
9751 Southern Pine Blvd.
Charlotte, North Carolina

COMPLETION REPORT OF WELL No. M-37

NON RESIDENTIAL WELL CONSTRUCTION RECORD

North Carolina Department of Environment and Natural Resources- Division of Water Quality

WELL CONTRACTOR CERTIFICATION # 2251-A

1. WELL CONTRACTOR:

Travis Costello
Well Contractor (Individual) Name

S&ME, Inc.
Well Contractor Company Name

STREET ADDRESS 155 Tradd Street

Spartanburg SC 29301
City or Town State Zip Code

(864)- 574-2360
Area code- Phone number

2. WELL INFORMATION:

SITE WELL ID #(if applicable) M-37

STATE WELL PERMIT#(if applicable)

DWQ or OTHER PERMIT #(if applicable)

WELL USE (Check Applicable Box) Monitoring ☐ Municipal/Public ☐ Industrial/Commercial ☐ Agricultural ☐ Recovery ☐ Injection ☐ Irrigation ☐ Other ☒ (list use) observation

DATE DRILLED

TIME COMPLETED AM ☐ PM ☐

3. WELL LOCATION:

CITY: Terrell COUNTY Catawba

8320 NC Highway 150E, Marshall Steam Station, 28682
(Street Name, Numbers, Community, Subdivision, Lot No., Parcel, Zip Code)

TOPOGRAPHIC / LAND SETTING:
☐ Slope ☐ Valley ☐ Flat ☐ Ridge ☐ Other
(check appropriate box)

LATITUDE 35.620606
LONGITUDE -80.972127

May be in degrees, minutes, seconds or in a decimal format

Latitude/longitude source: ☒ GPS ☐ Topographic map
(location of well must be shown on a USGS topo map and attached to this form if not using GPS)

4. FACILITY- is the name of the business where the well is located.

FACILITY ID #(if applicable)

NAME OF FACILITY Marshall Steam Station

STREET ADDRESS 8320 NC Highway 150E

Terrell NC 28682
City or Town State Zip Code

CONTACT PERSON Darrell Wolfe

MAILING ADDRESS 8320 NC Highway 150E

Terrell NC 28682
City or Town State Zip Code

(828)- 478-7829
Area code - Phone number

5. WELL DETAILS:

a. TOTAL DEPTH: 44

b. DOES WELL REPLACE EXISTING WELL? YES ☐ NO ☒

c. WATER LEVEL Below Top of Casing: 46 FT.
(Use "+" if Above Top of Casing)

d. TOP OF CASING IS 2.57 FT. Above Land Surface*
*Top of casing terminated at/or below land surface may require a variance in accordance with 15A NCAC 2C .0118.

e. YIELD (gpm): METHOD OF TEST

f. DISINFECTION: Type Amount

g. WATER ZONES (depth):
From 43 To From To
From To From To
From To From To

6. CASING:

From	To	Ft.	Diameter	Thickness/ Weight	Material
0	34		2	sch.40	PVC

7. GROUT:

From	To	Ft.	Material	Method
0	32		Bentonite	poured

8. SCREEN:

From	To	Ft.	Diameter	Slot Size	Material
34	44		2 in.	.010 in.	PVC
			in.	in.	
			in.	in.	

9. SAND/GRAVEL PACK:

From	To	Ft.	Size	Material
32	44		#2	Sand

10. DRILLING LOG

From	To	Formation Description
0	6	loose mic. Silty fine Sand
6	11	v dense fine-coarse Sand
11	16	firm mic. fine-medium Sandy Silt
16	36	med-v dense mic. Silty fine-med Sand
36	44	v dense course-v course Sand

11. REMARKS:

I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

Norman T. Costello 8/27/08
SIGNATURE OF CERTIFIED WELL CONTRACTOR DATE

Norman T. Costello
PRINTED NAME OF PERSON CONSTRUCTING THE WELL

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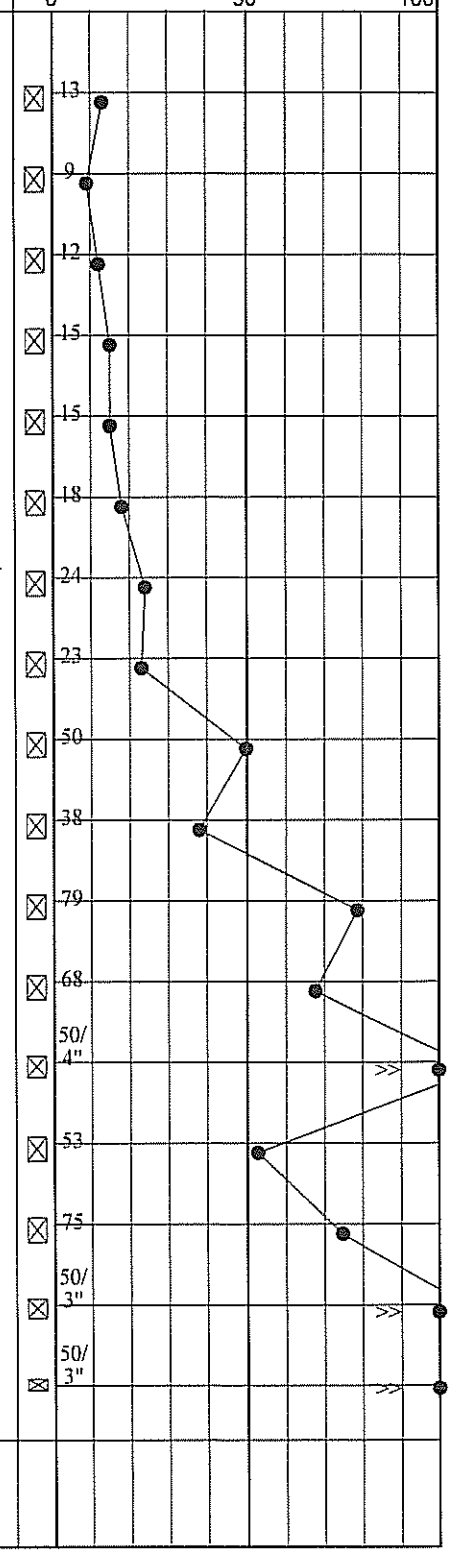
Project: **Marshall Steam Station Industrial Fill #1**			**Boring No. M-38**
Location: **Terrell, North Carolina**		Number: **1356-08-122**	Sheet No. 1 of 1
Boring Depth (ft): **88.4**	Elevation (ft): **857.8**	Driller: **Justin Millwood**	Date Drilled: **5/21/08**
Logged By: **Ben Boland**	Water Level: **34.41 ft bls on 06-25-08**		Drilling Method: **3¼" H.S.A.**

Elev. (Feet)	Depth (Feet)	Lith-ology	Material Description
855	5		Residuum: Medium Dense Red and Orange micaceous Clayey Silty fine to medium Sand
850	10		Saprolite: Loose to Medium Dense Red Tan and Orange micaceous Silty fine to coarse Sand
845	15		
840	20		
835	25		
830	30		
825	35		Saprolite: Medium Dense to Very Dense Gray Tan Black and Brown micaceous Silty fine to coarse Sand with Quartz beds and weathered rock fragments
820	40		
815	45		
810	50		
805	55		
800	60		
795	65		Partially Weathered Rock: When sampled becomes Very Hard Tan micaceous fine Sandy Silt
790	70		
785	75		Partially Weathered Rock: When sampled becomes Very Dense Gray micaceous Silty fine to medium Sand
780	80		Partially Weathered Rock: When sampled becomes Very Hard Gray and Tan micaceous fine to coarse Sandy Silt
775	85		Partially Weathered Rock: When sampled becomes Very Hard Gray and Tan micaceous fine to coarse Sandy Silt
770			Auger Refusal at 88.4 ft bls

Well Construction

Penetration Resistance (Blows/Foot)



BORING LOG WITH WELL MARSHALL STEAM STATION BORING LOGS 01-2009.GPJ LAGWGN01.GDT 1/29/09

COMPLETION REPORT OF WELL No. M-38

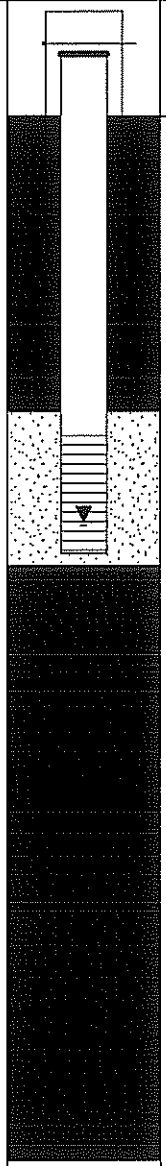
PROJECT: **Marshall Steam Station Industrial Fill #1**
PROJECT NO: **1356-08-122**
PROJECT LOCATION: **Terrell, North Carolina**

WATER LEVEL: **34.41 ft bls on 06-25-08**

LATITUDE:
LONGITUDE:
TOP OF CASING ELEVATION: **860.38**
DATUM: **MSL**
LOGGED BY: **Ben Boland**

DRILLING CONTRACTOR: **S&ME, Inc.**
DRILLING METHOD: **3¼" H.S.A.**
DATE DRILLED: **5/21/08**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)
		0		0.00		857.75
Residuum: Medium Dense Red and Orange micaceous Clayey Silty fine to medium Sand		5				
Saprolite: Loose to Medium Dense Red Tan and Orange micaceous Silty fine to coarse Sand		10, 15, 20, 25, 30				
Saprolite: Medium Dense to Very Dense Gray Tan Black and Brown micaceous Silty fine to coarse Sand with Quartz beds and weathered rock fragments		35, 40, 45, 50, 55, 60				
Partially Weathered Rock: When sampled becomes Very Hard Tan micaceous fine Sandy Silt		65, 70				
Partially Weathered Rock: When sampled becomes Very Dense Gray micaceous Silty fine to medium Sand		75, 80				
Partially Weathered Rock: When sampled becomes Very Hard Gray and Tan micaceous fine to		85				



WELL CONSTRUCTION DETAILS

PROTECTIVE CASING
Diameter: **Four Inch**
Type: **Steel**
Interval: **Above-Ground**

RISER CASING
Diameter: **One Inch**
Type: **Sch 40 PVC**
Interval: **3 Feet ALS to 27 Feet BLS**

GROUT
Type:
Interval:

SEAL
Type: **Bentonite Pellets**
Interval: **GS to 25 Feet BLS**

FILTERPACK
Type: **Medium Sand**
Interval: **25 to 38 Feet BLS**

SCREEN
Diameter: **One Inch**
Type: **Sch 40 PVC 0.010 Inch Slot**
Interval: **27 to 37 Feet BLS**

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

MONITORING WELL MARSHALL STEAM STATION BORING LOGS 01-2009.GPJ S&ME.GDT 1/29/09

S&ME
ENGINEERING • TESTING
ENVIRONMENTAL SERVICES
9751 Southern Pine Blvd.
Charlotte, North Carolina

COMPLETION REPORT OF WELL No. M-38

PROJECT: **Marshall Steam Station Industrial Fill #1**
PROJECT NO: **1356-08-122**
PROJECT LOCATION: **Terrell, North Carolina**

GROUND SURFACE ELEVATION: **857.8**
LOGGED BY: **Ben Boland**
CHECKED BY: **Bill Miller**

STRATA			WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)	WELL CONSTRUCTION DETAILS
DESCRIPTION	SYMBOL	DEPTH (ft.)					
							(See Page 1)
coarse Sandy Silt Partially Weathered Rock: When sampled becomes Very Hard Gray and Tan micaceous fine to coarse Sandy Silt							

LEGEND

	FILTER PACK	TOC	TOP OF CASING
	BENTONITE	GS	GROUND SURFACE
	CEMENT GROUT	BS	BENTONITE SEAL
	CUTTINGS / BACKFILL	FP	FILTER PACK
	STATIC WATER LEVEL	TSC	TOP OF SCREEN
		BSC	BOTTOM OF SCREEN
		TD	TOTAL DEPTH
		CG	CEMENT GROUT

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9751 Southern Pine Blvd.
Charlotte, North Carolina

COMPLETION REPORT OF WELL No. M-38

MONITORING WELL MARSHALL STEAM STATION BORING LOGS 01-2009.GPJ S&ME.GDT 1/29/09

NON RESIDENTIAL WELL CONSTRUCTION RECORD

North Carolina Department of Environment and Natural Resources- Division of Water Quality

WELL CONTRACTOR CERTIFICATION # 2251-A

1. WELL CONTRACTOR:

Travis Costello
Well Contractor (Individual) Name

S&ME, Inc.
Well Contractor Company Name

STREET ADDRESS 155 Tradd Street

Spartanburg SC 29301
City or Town State Zip Code

(864)- 574-2360
Area code- Phone number

2. WELL INFORMATION:

SITE WELL ID #(if applicable) M-38

STATE WELL PERMIT#(if applicable)

DWQ or OTHER PERMIT #(if applicable)

WELL USE (Check Applicable Box) Monitoring ☐ Municipal/Public ☐ Industrial/Commercial ☐ Agricultural ☐ Recovery ☐ Injection ☐ Irrigation ☐ Other ☒ (list use) observation

DATE DRILLED

TIME COMPLETED AM ☐ PM ☐

3. WELL LOCATION:

CITY: Terrell COUNTY Catawba

8320 NC Highway 150E, Maarshall Steam Station, 28682
(Street Name, Numbers, Community, Subdivision, Lot No., Parcel, Zip Code)

TOPOGRAPHIC / LAND SETTING:
☐ Slope ☐ Valley ☐ Flat ☐ Ridge ☐ Other
(check appropriate box)

LATITUDE 35.620566
LONGITUDE -80.973050

May be in degrees, minutes, seconds or in a decimal format

Latitude/longitude source: ☒ GPS ☐ Topographic map
(location of well must be shown on a USGS topo map and attached to this form if not using GPS)

4. FACILITY- is the name of the business where the well is located.

FACILITY ID #(if applicable)

NAME OF FACILITY Marshall Steam Station

STREET ADDRESS 8320 NC Highway 150E

Terrell NC 28682
City or Town State Zip Code

CONTACT PERSON Darrell Wolfe

MAILING ADDRESS 8320 NC Highway 150E

Terrell NC 28682
City or Town State Zip Code

(828)- 478-7829
Area code - Phone number

5. WELL DETAILS:

a. TOTAL DEPTH: 37

b. DOES WELL REPLACE EXISTING WELL? YES ☐ NO ☒

c. WATER LEVEL Below Top of Casing: 37 FT.
(Use "+" if Above Top of Casing)

d. TOP OF CASING IS 2.63 FT. Above Land Surface*
*Top of casing terminated at/or below land surface may require a variance in accordance with 15A NCAC 2C .0118.

e. YIELD (gpm): METHOD OF TEST

f. DISINFECTION: Type Amount

g. WATER ZONES (depth):
From 35 To From To
From To From To
From To From To

6. CASING:

	Depth		Diameter	Thickness/ Weight	Material
From 0	To 27	Ft.	2	sch.40	PVC
From	To	Ft.			
From	To	Ft.			

7. GROUT:

	Depth		Material	Method
From 0	To 25	Ft.	Bentonite	poured
From	To	Ft.		
From	To	Ft.		

8. SCREEN:

	Depth		Diameter	Slot Size	Material
From 27	To 37	Ft.	2 in.	.010 in.	PVC
From	To	Ft.	in.	in.	
From	To	Ft.	in.	in.	

9. SAND/GRAVEL PACK:

	Depth		Size	Material
From 25	To 38	Ft.	#2	Sand
From	To	Ft.		
From	To	Ft.		

10. DRILLING LOG

From To	Formation Description
0-7	med dense mic. Clayey Silty fine-md Sand
7-32	loose-md dense mic. Silty fine-coarse Sand
32-38	med-v dense mic. Silty fine-coarse Sand

11. REMARKS:

I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

Norman T. Costello 8/27/08
SIGNATURE OF CERTIFIED WELL CONTRACTOR DATE

Norman T. Costello
PRINTED NAME OF PERSON CONSTRUCTING THE WELL

Submit the original to the Division of Water Quality within 30 days. Attn: Information Mgt., 1617 Mail Service Center – Raleigh, NC 27699-1617 Phone No. (919) 733-7015 ext 568.

Form GW-1b
Rev. 7/05

S&ME
ENGINEERING • TESTING
ENVIRONMENTAL SERVICES

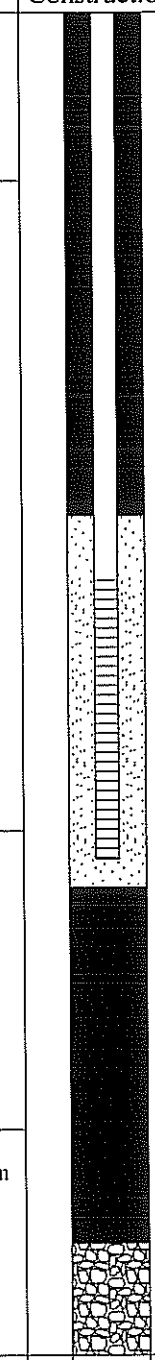
S&ME, Inc.
9751 Southern Pine Blvd.
Charlotte, North Carolina
Telephone: 704-523-4726
Fax: 704-525-3953

1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.
2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

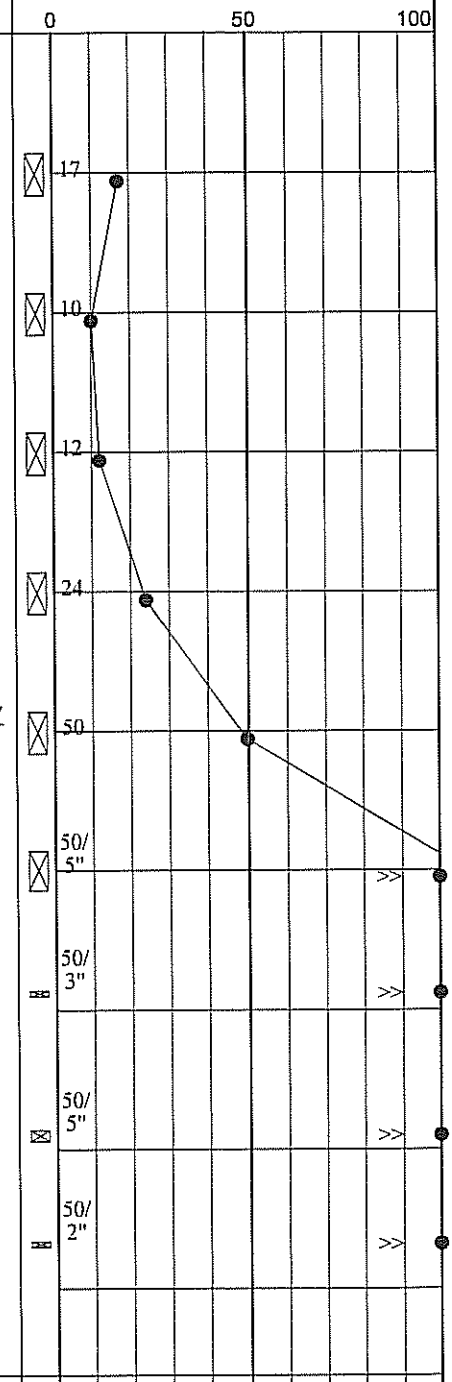
Project: **Marshall Steam Station Industrial Fill #1**			**Boring No. M-39**
Location: **Terrell, North Carolina**		Number: **1356-08-122**	Sheet No. 1 of 1
Boring Depth (ft): **48.1**	Elevation (ft): **854.2**	Driller: **Justin Millwood**	Date Drilled: **5/12/08**
Logged By: **Ben Boland**	Water Level: **24.73 ft bls on 05-21-08**		Drilling Method: **3¼" H.S.A.**

Elev. (Feet)	Depth (Feet)	Lithology	Material Description
850	5		Residuum: Very Stiff Red micaceous Clayey fine to medium Sandy Silt
845	10		Saprolite: Stiff to Very Hard Orange Gray and Tan micaceous fine to medium Sandy Silt
840	15		
835	20		
830	25		
825	30		Partially Weathered Rock: When sampled becomes Very Hard Orange Gray and Tan micaceous fine to medium Sandy Silt
820	35		
815	40		Partially Weathered Rock: When sampled becomes Very Dense Gray and Brown micaceous Silty very fine to medium Sand with Quartz fragments
810	45		
			Auger Refusal at 48.1 ft bls

Well Construction



Penetration Resistance (Blows/Foot)



BORING LOG WITH WELL MARSHALL STEAM STATION BORING LOGS 01-2009.GPJ LAGWGN01.GDT 1/29/09

COMPLETION REPORT OF WELL No. M-39

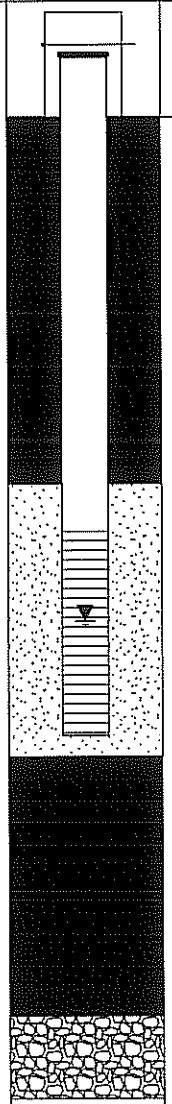
PROJECT: **Marshall Steam Station Industrial Fill #1**
PROJECT NO: **1356-08-122**
PROJECT LOCATION: **Terrell, North Carolina**

WATER LEVEL: **24.73 ft bls on 05-21-08**

LATITUDE:
LONGITUDE:
TOP OF CASING ELEVATION: **856.89**
DATUM: **MSL**
LOGGED BY: **Ben Boland**

DRILLING CONTRACTOR: **S&ME, Inc.**
DRILLING METHOD: **3¼" H.S.A.**
DATE DRILLED: **5/12/08**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)
				0.00		854.21
Residuum: Very Stiff Red micaceous Clayey fine to medium Sandy Silt		0				
		5				
Saprolite: Stiff to Very Hard Orange Gray and Tan micaceous fine to medium Sandy Silt		10				
		15				
		20				
		25				
Partially Weathered Rock: When sampled becomes Very Hard Orange Gray and Tan micaceous fine to medium Sandy Silt		30				
		35				
Partially Weathered Rock: When sampled becomes Very Dense Gray and Brown micaceous Silty very fine to medium Sand with Quartz fragments		40				
		45				



WELL CONSTRUCTION DETAILS

PROTECTIVE CASING
Diameter: **Four Inch**
Type: **Steel**
Interval: **Above-Ground**

RISER CASING
Diameter: **One Inch**
Type: **Sch 40 PVC**
Interval: **3 Feet ALS to 20 Feet BLS**

GROUT
Type:
Interval:

SEAL
Type: **Bentonite Pellets**
Interval: **GS to 18 Feet BLS**

FILTERPACK
Type: **Medium Sand**
Interval: **18 to 31.3 Feet BLS**

SCREEN
Diameter: **One Inch**
Type: **Sch 40 PVC 0.010 Inch Slot**
Interval: **20.3 to 30.3 Feet BLS**

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

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ENVIRONMENTAL SERVICES

9751 Southern Pine Blvd.
Charlotte, North Carolina

COMPLETION REPORT OF WELL No. M-39

MONITORING WELL MARSHALL STEAM STATION BORING LOGS 01-2009.GPJ S&ME.GDT 1/29/09

NON RESIDENTIAL WELL CONSTRUCTION RECORD

North Carolina Department of Environment and Natural Resources- Division of Water Quality

WELL CONTRACTOR CERTIFICATION # 2251-A

1. WELL CONTRACTOR:

Travis Costello
Well Contractor (Individual) Name

S&ME, Inc.
Well Contractor Company Name

STREET ADDRESS 155 Tradd Street

Spartanburg | SC | 29301
City or Town | State | Zip Code

(864)- 574-2360
Area code- Phone number

2. WELL INFORMATION:

SITE WELL ID #(if applicable) M-39

STATE WELL PERMIT#(if applicable)

DWQ or OTHER PERMIT #(if applicable)

WELL USE (Check Applicable Box) Monitoring ☐ Municipal/Public ☐ Industrial/Commercial ☐ Agricultural ☐ Recovery ☐ Injection ☐ Irrigation ☐ Other ☒ (list use) observation

DATE DRILLED

TIME COMPLETED AM ☐ PM ☐

3. WELL LOCATION:

CITY: Terrell COUNTY Catawba

8320 NC Highway 150E, Marshall Steam Station, 28682
(Street Name, Numbers, Community, Subdivision, Lot No., Parcel, Zip Code)

TOPOGRAPHIC / LAND SETTING:
☐ Slope ☐ Valley ☐ Flat ☐ Ridge ☐ Other
(check appropriate box)

LATITUDE 35.620487
LONGITUDE -80.971665

May be in degrees, minutes, seconds or in a decimal format

Latitude/longitude source: ☒ GPS ☐ Topographic map
(location of well must be shown on a USGS topo map and attached to this form if not using GPS)

4. FACILITY- is the name of the business where the well is located.

FACILITY ID #(if applicable)

NAME OF FACILITY Marshall Steam Station

STREET ADDRESS 8320 NC Highway 150E

Terrell | NC | 28682
City or Town | State | Zip Code

CONTACT PERSON Darrell Wolfe

MAILING ADDRESS 8320 NC Highway 150E

Terrell | NC | 28682
City or Town | State | Zip Code

(828)- 478-7829
Area code - Phone number

5. WELL DETAILS:

a. TOTAL DEPTH: 30

b. DOES WELL REPLACE EXISTING WELL? YES ☐ NO ☒

c. WATER LEVEL Below Top of Casing: 27.5 FT.
(Use "+" if Above Top of Casing)

d. TOP OF CASING IS 2.68 FT. Above Land Surface*
*Top of casing terminated at/or below land surface may require a variance in accordance with 15A NCAC 2C .0118.

e. YIELD (gpm): METHOD OF TEST

f. DISINFECTION: Type Amount

g. WATER ZONES (depth):
From 27.5 To From To
From To From To
From To From To

6. CASING:

From	To	Depth	Diameter	Thickness/ Weight	Material
0	20	Ft.	2	sch.40	PVC
		Ft.			
		Ft.			

7. GROUT:

From	To	Depth	Material	Method
0	18	Ft.	Bentonite	poured
		Ft.		
		Ft.		

8. SCREEN:

From	To	Depth	Diameter	Slot Size	Material
20	30	Ft.	2 in.	.010 in.	PVC
		Ft.	in.	in.	
		Ft.	in.	in.	

9. SAND/GRAVEL PACK:

From	To	Depth	Size	Material
18	31	Ft.	#2	Sand
		Ft.		
		Ft.		

10. DRILLING LOG

From	To	Formation Description
0	6	v stiff mic. Clayey fine-med Sandy Silt
6	31	stiff-v hard mic. fine-med Sandy Silt

11. REMARKS:

I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

Norman T. Costello 8/27/08
SIGNATURE OF CERTIFIED WELL CONTRACTOR DATE

Norman T. Costello
PRINTED NAME OF PERSON CONSTRUCTING THE WELL

Submit the original to the Division of Water Quality within 30 days. Attn: Information Mgt., 1617 Mail Service Center – Raleigh, NC 27699-1617 Phone No. (919) 733-7015 ext 568.

Form GW-1b
Rev. 7/05

S&ME
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ENVIRONMENTAL SERVICES

S&ME, Inc.
9751 Southern Pine Blvd.
Charlotte, North Carolina
Telephone: 704-523-4726
Fax: 704-525-3953

1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.
2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

Project: **Marshall Steam Station Industrial Fill #1**			**Boring No. M-40**
Location: **Terrell, North Carolina**		Number: **1356-08-122**	Sheet No. 1 of 1
Boring Depth (ft): **45.1**	Elevation (ft): **873.0**	Driller: **Justin Millwood**	Date Drilled: **5/13/08**
Logged By: **Ben Boland**	Water Level: **Dry at TOB**		Drilling Method: **3¼" H.S.A.**

Elev. (Feet)	Depth (Feet)	Lith-ology	Material Description	Well Construction	Penetration Resistance (Blows/Foot) 0 50 100
870	5		Residuum: Stiff Orange and Tan micaceous fine Sandy Silt		9
865	10		Saprolite: Firm to Stiff Orange and Tan micaceous fine to medium Sandy Silt		8
860	15				14
855	20				15
850	25		Saprolite: Stiff Orange Brown and Tan micaceous Silt		12
845	30		Saprolite: Very Dense Gray micaceous medium to coarse Sand		50/5.8"
840	35		Partially Weathred Rock: When sampled becomes Very Dense Gray micaceous medium to coarse Sand Partially Weathered Rock: When sampled becomes Very Dense Tan and Black micaceous Silty fine to coarse Sand		39
835	40		Partially Weathered Rock: When sampled becomes Very Dense Gray Tan and Brown Silty medium to coarse Sand with weathered rock fragments		50/3"
830	45				50/25"
			Auger Refusal at 45.1 ft bls		

BORING LOG WITH WELL MARSHALL STEAM STATION BORING LOGS 01-2009.GPJ LAGWGN01.GDT 1/29/09

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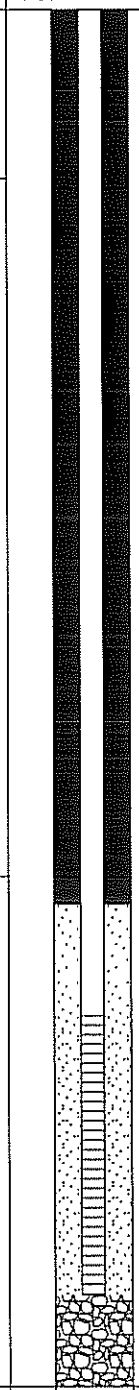
9751 Southern Pine Blvd.
Charlotte, North Carolina
Telephone: 704-523-4726
Fax: 704-525-3953

1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.
2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

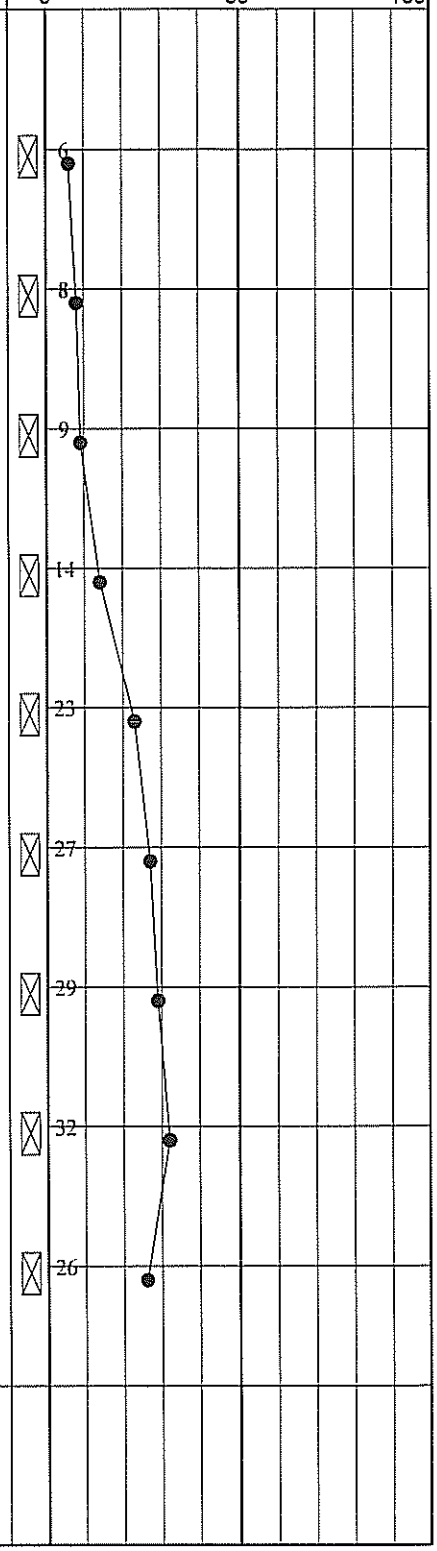
Project: **Marshall Steam Station Industrial Fill #1**			**Boring No. M-41**
Location: **Terrell, North Carolina**		Number: **1356-08-122**	Sheet No. 1 of 1
Boring Depth (ft): **49.3**	Elevation (ft): **867.0**	Driller: **Justin Millwood**	Date Drilled: **5/13/08**
Logged By: **Ben Boland**	Water Level: **41.84 ft bls on 05-21-08**		Drilling Method: **3¼" H.S.A.**

Elev. (Feet)	Depth (Feet)	Lith-ology	Material Description
865	5		Residuum: Firm Orange micaceous fine to medium Sandy Silt
860	10		Saprolite: Loose to Medium Dense Brown White and Tan Silty very fine to coarse Sand
855	15		
850	20		
845	25		
840	30		
835	35		Saprolite: Very Stiff Brown and Tan micaceous fine to coarse Sandy Silt with Quartz fragments
830	40		
825	45		
820			Auger Refusal at 49.3 ft bls

Well Construction



Penetration Resistance (Blows/Foot)



COMPLETION REPORT OF WELL No. M-41

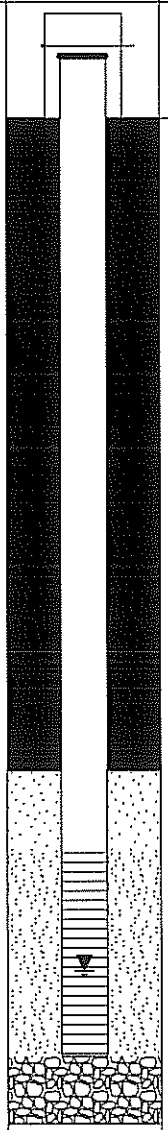
PROJECT: **Marshall Steam Station Industrial Fill #1**
PROJECT NO: **1356-08-122**
PROJECT LOCATION: **Terrell, North Carolina**

WATER LEVEL: **41.84 ft bls on 05-21-08**

LATITUDE:
LONGITUDE:
TOP OF CASING ELEVATION: **869.85**
DATUM: **MSL**
LOGGED BY: **Ben Boland**

DRILLING CONTRACTOR: **S&ME, Inc.**
DRILLING METHOD: **3¼" H.S.A.**
DATE DRILLED: **5/13/08**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)
				0.00		866.96
Residuum: Firm Orange micaceous fine to medium Sandy Silt		0				
		5				
Saprolite: Loose to Medium Dense Brown White and Tan Silty very fine to coarse Sand		10				
		15				
		20				
		25				
		30				
Saprolite: Very Stiff Brown and Tan micaceous fine to coarse Sandy Silt with Quartz fragments		35				
		40				
		45				



WELL CONSTRUCTION DETAILS

PROTECTIVE CASING
Diameter: **Four Inch**
Type: **Steel**
Interval: **Above-Ground**

RISER CASING
Diameter: **One Inch**
Type: **Sch 40 PVC**
Interval: **3 Feet ALS to 36 Feet BLS**

GROUT
Type:
Interval:

SEAL
Type: **Bentonite Pellets**
Interval: **GS to 32 Feet BLS**

FILTERPACK
Type: **Medium Sand**
Interval: **32 to 46 Feet BLS**

SCREEN
Diameter: **One Inch**
Type: **Sch 40 PVC 0.010 Inch Slot**
Interval: **36 to 46 Feet BLS**

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

S&ME
ENGINEERING • TESTING
ENVIRONMENTAL SERVICES
9751 Southern Pine Blvd.
Charlotte, North Carolina

COMPLETION REPORT OF WELL No. M-41

NON RESIDENTIAL WELL CONSTRUCTION RECORD

North Carolina Department of Environment and Natural Resources- Division of Water Quality

WELL CONTRACTOR CERTIFICATION # 2251-A

1. WELL CONTRACTOR:

Travis Costello
Well Contractor (Individual) Name

S&ME, Inc.
Well Contractor Company Name

STREET ADDRESS 155 Tradd Street

Spartanburg SC 29301
City or Town State Zip Code

(864)- 574-2360
Area code- Phone number

2. WELL INFORMATION:

SITE WELL ID #(if applicable) M-41

STATE WELL PERMIT#(if applicable)

DWQ or OTHER PERMIT #(if applicable)

WELL USE (Check Applicable Box) Monitoring ☐ Municipal/Public ☐ Industrial/Commercial ☐ Agricultural ☐ Recovery ☐ Injection ☐ Irrigation ☐ Other ☒ (list use) observation

DATE DRILLED

TIME COMPLETED AM ☐ PM ☐

3. WELL LOCATION:

CITY: Terrell COUNTY Catawba

8320 NC Highway 150E, Maurshall Steam Station, 28682
(Street Name, Numbers, Community, Subdivision, Lot No., Parcel, Zip Code)

TOPOGRAPHIC / LAND SETTING:
☐ Slope ☐ Valley ☐ Flat ☐ Ridge ☐ Other
(check appropriate box)

LATITUDE 35.619593
LONGITUDE -80.972334

May be in degrees, minutes, seconds or in a decimal format

Latitude/longitude source: ☒ GPS ☐ Topographic map
(location of well must be shown on a USGS topo map and attached to this form if not using GPS)

4. FACILITY- is the name of the business where the well is located.

FACILITY ID #(if applicable)

NAME OF FACILITY Marshall Steam Station

STREET ADDRESS 8320 NC Highway 150E

Terrell NC 28682
City or Town State Zip Code

CONTACT PERSON Darrell Wolfe

MAILING ADDRESS 8320 NC Highway 150E

Terrell NC 28682
City or Town State Zip Code

(828)- 478-7829
Area code - Phone number

5. WELL DETAILS:

a. TOTAL DEPTH: 46

b. DOES WELL REPLACE EXISTING WELL? YES ☐ NO ☒

c. WATER LEVEL Below Top of Casing: 44.75 FT.
(Use "+" if Above Top of Casing)

d. TOP OF CASING IS 2.89 FT. Above Land Surface*
*Top of casing terminated at/or below land surface may require a variance in accordance with 15A NCAC 2C .0116.

e. YIELD (gpm): METHOD OF TEST

f. DISINFECTION: Type Amount

g. WATER ZONES (depth):
From 44.75 To From To
From To From To
From To From To

6. CASING:

	Depth		Diameter	Thickness/ Weight	Material
From 0	To 36	Ft.	2	sch.40	PVC
From	To	Ft.			
From	To	Ft.			

7. GROUT:

	Depth		Material	Method
From 0	To 32	Ft.	Bentonite	poured
From	To	Ft.		
From	To	Ft.		

8. SCREEN:

	Depth		Diameter	Slot Size	Material
From 36	To 46	Ft.	2 in.	.010 in.	PVC
From	To	Ft.	in.	in.	
From	To	Ft.	in.	in.	

9. SAND/GRAVEL PACK:

	Depth		Size	Material
From 32	To 46	Ft.	#2	Sand
From	To	Ft.		
From	To	Ft.		

10. DRILLING LOG

From To	Formation Description
0-6	firm mic. fine-med Sandy Silt
6-31	loose-med dense Silty v fine-coarse Sand
31-46	v stiff mic. fine-coarse Sandy Silt

11. REMARKS:

I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

Norman T. Costello 8/27/08
SIGNATURE OF CERTIFIED WELL CONTRACTOR DATE

Norman T. Costello
PRINTED NAME OF PERSON CONSTRUCTING THE WELL

Submit the original to the Division of Water Quality within 30 days. Attn: Information Mgt., 1617 Mail Service Center – Raleigh, NC 27699-1617 Phone No. (919) 733-7015 ext 568.

Form GW-1b
Rev. 7/05

S&ME, Inc.
9751 Southern Pine Blvd.
Charlotte, North Carolina
Telephone: 704-523-4726
Fax: 704-525-3953

ENGINEERING • TESTING
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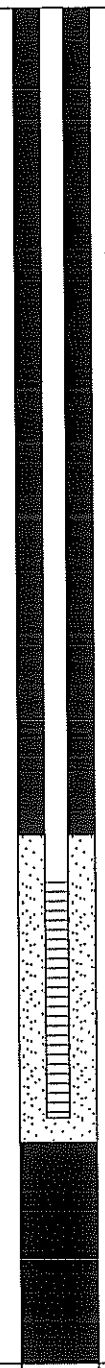
1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.
2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

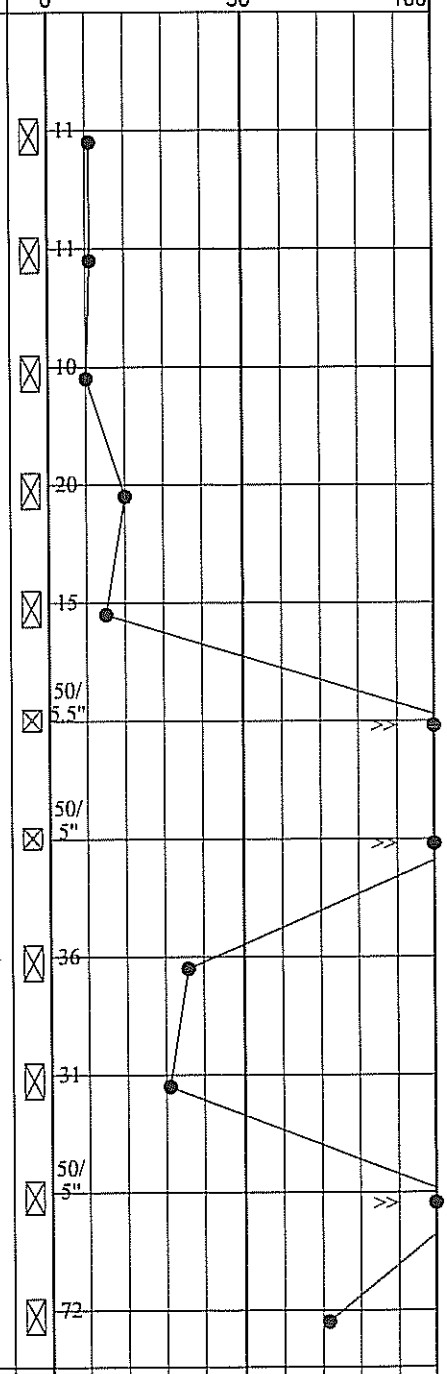
Project: **Marshall Steam Station Industrial Fill #1**			**Boring No. M-42**
Location: **Terrell, North Carolina**		Number: **1356-08-122**	Sheet No. 1 of 1
Boring Depth (ft): **57.4**	Elevation (ft): **858.2**	Driller: **Justin Millwood**	Date Drilled: **5/15/08**
Logged By: **Ben Boland**	Water Level: **40.07 ft bls on 05-21-08**		Drilling Method: **3¼" H.S.A.**

Elev. (Feet)	Depth (Feet)	Lith-ology	Material Description
855	5		Residuum: Stiff Red and Orange micaceous Clayey fine to medium Sandy Silt
850	10		Saprolite: Medium Dense Tan Red and Orange micaceous Silty fine to coarse Sand
845	15		
840	20		Saprolite: Medium Dense to Very Dense Gray Orange and Tan micaceous Silty fine to coarse Sand with Quartz and rock fragments
835	25		
830	30		Partially Weathered Rock: When sampled becomes Very Dense Gray Orange and Tan micaceous Silty fine to coarse Sand with Quartz and rock fragments
825	35		
820	40		Saprolite: Medium Dense to Very Dense Gray Orange and Tan micaceous Silty fine to coarse Sand with Quartz and rock fragments
815	45		
810	50		Partially Weathered Rock: When sampled becomes Very Dense Gray Orange and Tan micaceous Silty fine to coarse Sand with Quartz and rock fragments
805	55		
			Auger Refusal at 57.4 ft bls

Well Construction



Penetration Resistance (Blows/Foot)



BORING LOG WITH WELL MARSHALL STEAM STATION BORING LOGS 01-2009.GPJ LAGWGN01.GDT 3/10/09

COMPLETION REPORT OF WELL No. M-42

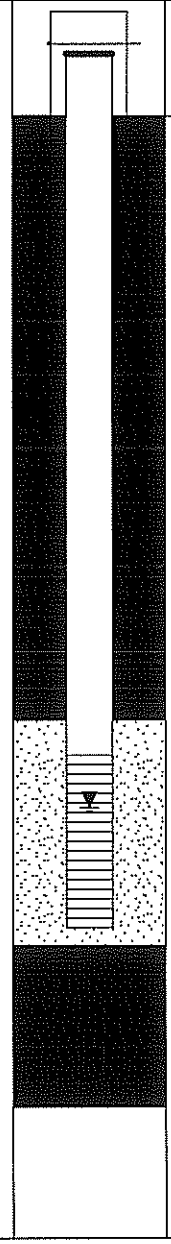
PROJECT: **Marshall Steam Station Industrial Fill #1**
PROJECT NO: **1356-08-122**
PROJECT LOCATION: **Terrell, North Carolina**

WATER LEVEL: **40.07 ft bls on 05-21-08**

LATITUDE:
LONGITUDE:
TOP OF CASING ELEVATION: **861.03**
DATUM: **MSL**
LOGGED BY: **Ben Boland**

DRILLING CONTRACTOR: **S&ME, Inc.**
DRILLING METHOD: **3¼" H.S.A.**
DATE DRILLED: **5/15/08**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)
				0.00		858.17
Residuum: Stiff Red and Orange micaceous Clayey fine to medium Sandy Silt		0				
		5				
Saprolite: Medium Dense Tan Red and Orange micaceous Silty fine to coarse Sand		10				
		15				
Saprolite: Medium Dense to Very Dense Gray Orange and Tan micaceous Silty fine to coarse Sand with Quartz and rock fragments		20				
		25				
Partially Weathered Rock: When sampled becomes Very Dense Gray Orange and Tan micaceous Silty fine to coarse Sand with Quartz and rock fragments		30				
		35				
Saprolite: Medium Dense to Very Dense Gray Orange and Tan micaceous Silty fine to coarse Sand with Quartz and rock fragments		40				
		45				
Partially Weathered Rock: When sampled becomes Very Dense Gray Orange and Tan micaceous Silty fine to coarse Sand with Quartz and rock fragments		50				
		55				



WELL CONSTRUCTION DETAILS

PROTECTIVE CASING
Diameter: **Four Inch**
Type: **Steel**
Interval: **Above-Ground**

RISER CASING
Diameter: **One Inch**
Type: **Sch 40 PVC**
Interval: **3 Feet ALS to 37 Feet BLS**

GROUT
Type:
Interval:

SEAL
Type: **Bentonite Pellets**
Interval: **GS to 35 Feet BLS**

FILTERPACK
Type: **Medium Sand**
Interval: **35 to 48 Feet BLS**

SCREEN
Diameter: **One Inch**
Type: **Sch 40 PVC 0.010 Inch Slot**
Interval: **37 to 47 Feet BLS**

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

MONITORING WELL MARSHALL STEAM STATION BORING LOGS 01-2009.GPJ S&ME.GDT 3/10/09

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9751 Southern Pine Blvd.
Charlotte, North Carolina

COMPLETION REPORT OF WELL No. M-42

NON RESIDENTIAL WELL CONSTRUCTION RECORD

North Carolina Department of Environment and Natural Resources- Division of Water Quality

WELL CONTRACTOR CERTIFICATION # 2251-A

1. WELL CONTRACTOR:

Travis Costello
Well Contractor (Individual) Name

S&ME, Inc.
Well Contractor Company Name

STREET ADDRESS 155 Tradd Street

Spartanburg SC 29301
City or Town State Zip Code

(864)- 574-2360
Area code- Phone number

2. WELL INFORMATION:

SITE WELL ID #(if applicable) M-42

STATE WELL PERMIT#(if applicable)

DWQ or OTHER PERMIT #(if applicable)

WELL USE (Check Applicable Box) Monitoring ☐ Municipal/Public ☐ Industrial/Commercial ☐ Agricultural ☐ Recovery ☐ Injection ☐ Irrigation ☐ Other ☒ (list use) observation

DATE DRILLED

TIME COMPLETED AM ☐ PM ☐

3. WELL LOCATION:

CITY: Terrell COUNTY Catawba

8320 NC Highway 150E, Marshall Steam Station, 28682
(Street Name, Numbers, Community, Subdivision, Lot No., Parcel, Zip Code)

TOPOGRAPHIC / LAND SETTING:
☐ Slope ☐ Valley ☐ Flat ☐ Ridge ☐ Other
(check appropriate box)

LATITUDE 35.618574
LONGITUDE -80.973168

May be in degrees, minutes, seconds or in a decimal format

Latitude/longitude source: ☒ GPS ☐ Topographic map
(location of well must be shown on a USGS topo map and attached to this form if not using GPS)

4. FACILITY- is the name of the business where the well is located.

FACILITY ID #(if applicable)

NAME OF FACILITY Marshall Steam Station

STREET ADDRESS 8320 NC Highway 150E

Terrell NC 28682
City or Town State Zip Code

CONTACT PERSON Darrell Wolfe

MAILING ADDRESS 8320 NC Highway 150E

Terrell NC 28682
City or Town State Zip Code

(828)- 478-7829
Area code - Phone number

5. WELL DETAILS:

a. TOTAL DEPTH: 47

b. DOES WELL REPLACE EXISTING WELL? YES ☐ NO ☒

c. WATER LEVEL Below Top of Casing: 43 FT.
(Use "+" If Above Top of Casing)

d. TOP OF CASING IS 2.86 FT. Above Land Surface*
*Top of casing terminated at/or below land surface may require a variance in accordance with 15A NCAC 2C .0118.

e. YIELD (gpm): METHOD OF TEST

f. DISINFECTION: Type Amount

g. WATER ZONES (depth):
From 43 To From To
From To From To
From To From To

6. CASING:

From	To	Ft.	Diameter	Thickness/ Weight	Material
0	37		2	sch.40	PVC

7. GROUT:

From	To	Ft.	Material	Method
0	35		Bentonite	poured

8. SCREEN:

From	To	Ft.	Diameter in.	Slot Size in.	Material
37	47		2	.010	PVC

9. SAND/GRAVEL PACK:

From	To	Ft.	Size	Material
35	48		#2	Sand

10. DRILLING LOG

From To	Formation Description
0-6	stiff mic. Clayey fine-med Sandy Silt
6-16	med dense mic. Silty fine-coarse Sand
16-48	med-v dense mic. Silty fine-coarse Sand

11. REMARKS:

I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

Norman T. Costello 8/27/08
SIGNATURE OF CERTIFIED WELL CONTRACTOR DATE

Norman T. Costello
PRINTED NAME OF PERSON CONSTRUCTING THE WELL

Submit the original to the Division of Water Quality within 30 days. Attn: Information Mgt., 1617 Mail Service Center – Raleigh, NC 27699-1617 Phone No. (919) 733-7015 ext 568.

Form GW-1b
Rev. 7/05

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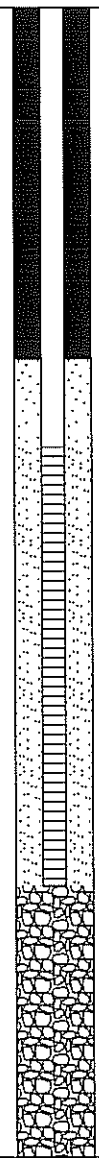
1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.
2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

Project: **Marshall Steam Station Industrial Fill #1**			**Boring No. M-43**
Location: **Terrell, North Carolina**		Number: **1356-08-122**	Sheet No. 1 of 1
Boring Depth (ft): **26.2**	Elevation (ft): **833.3**	Driller: **Justin Millwood**	Date Drilled: **5/15/08**
Logged By: **Ben Boland**	Water Level: **15.88 ft bls on 05-21-08**		Drilling Method: **3¼" H.S.A.**

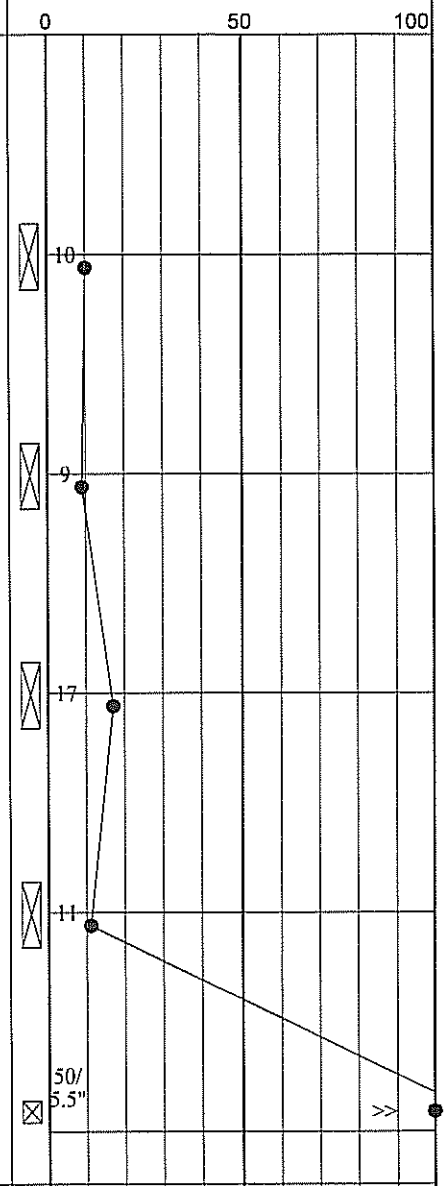
Elev. (Feet)	Depth (Feet)	Lith-ology	Material Description
			Residuum: Stiff Red and Tan micaceous Clayey fine to medium Sandy Silt
			Saprolite: Loose to Medium Dense Brown Tan and Gray micaceous Silty fine to coarse Sand
			Saprolite: Stiff Red Orange Black and Tan fine to medium Sandy Silt
			Saprolite: Very Dense Gray and Tan Silty coarse to very coarse Sand with rock fragments and Quartz
			Partially Weathered Rock: When sampled becomes Very Dense Gray and Tan Silty coarse to very coarse Sand with Quartz and rock fragments
			Auger Refusal at 26.2 ft bls

Elev. (Feet): 830, 825, 820, 815, 810
Depth (Feet): 5, 10, 15, 20, 25

Well Construction



Penetration Resistance (Blows/Foot)



BORING LOG WITH WELL MARSHALL STEAM STATION BORING LOGS 01-2009.GPJ LAGWGN01.GDT 1/29/09

COMPLETION REPORT OF WELL No. M-43

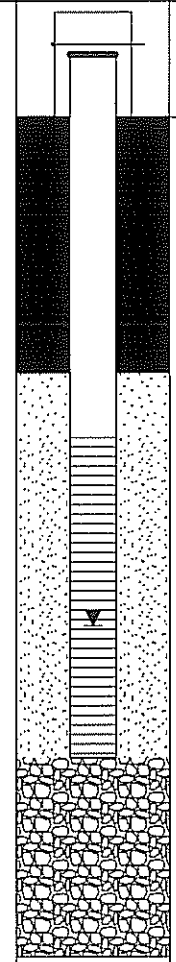
PROJECT: **Marshall Steam Station Industrial Fill #1**
PROJECT NO: **1356-08-122**
PROJECT LOCATION: **Terrell, North Carolina**

WATER LEVEL: **15.88 ft bls on 05-21-08**

LATITUDE:
LONGITUDE:
TOP OF CASING ELEVATION: **835.94**
DATUM: **MSL**
LOGGED BY: **Ben Boland**

DRILLING CONTRACTOR: **S&ME, Inc**
DRILLING METHOD: **3¼" H.S.A.**
DATE DRILLED: **5/15/08**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)
				0.00		833.29
Residuum: Stiff Red and Tan micaceous Clayey fine to medium Sandy Silt		0				
		5				
Saprolite: Loose to Medium Dense Brown Tan and Gray micaceous Silty fine to coarse Sand		10				
		15				
Saprolite: Stiff Red Orange Black and Tan fine to medium Sandy Silt		20				
Saprolite: Very Dense Gray and Tan Silty coarse to very coarse Sand with rock fragments and Quartz						
Partially Weathered Rock: When sampled becomes Very Dense Gray and Tan Silty coarse to very coarse Sand with Quartz and rock fragments		25				



WELL CONSTRUCTION DETAILS

PROTECTIVE CASING
Diameter: **Four Inch**
Type: **Steel**
Interval: **Above-Ground**

RISER CASING
Diameter: **One Inch**
Type: **Sch 40 PVC**
Interval: **3 Feet ALS to 10 Feet BLS**

GROUT
Type:
Interval:

SEAL
Type: **Bentonite Pellets**
Interval: **GS to 8 Feet BLS**

FILTERPACK
Type: **Medium Sand**
Interval: **8 to 20 Feet BLS**

SCREEN
Diameter: **One Inch**
Type: **Sch 40 PVC 0.010 Inch Slot**
Interval: **10 to 20 Feet BLS**

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

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Charlotte, North Carolina

COMPLETION REPORT OF WELL No. M-43

NON RESIDENTIAL WELL CONSTRUCTION RECORD

North Carolina Department of Environment and Natural Resources- Division of Water Quality

WELL CONTRACTOR CERTIFICATION # 2251-A

1. WELL CONTRACTOR:

Travis Costello
Well Contractor (Individual) Name

S&ME, Inc.
Well Contractor Company Name

STREET ADDRESS 155 Tradd Street

Spartanburg SC 29301
City or Town State Zip Code

(864)- 574-2360
Area code- Phone number

2. WELL INFORMATION:

SITE WELL ID #(if applicable) M-43

STATE WELL PERMIT#(if applicable)

DWQ or OTHER PERMIT #(if applicable)

WELL USE (Check Applicable Box) Monitoring ☐ Municipal/Public ☐ Industrial/Commercial ☐ Agricultural ☐ Recovery ☐ Injection ☐ Irrigation ☐ Other ☒ (list use) observation

DATE DRILLED

TIME COMPLETED AM ☐ PM ☐

3. WELL LOCATION:

CITY: Terrell COUNTY Catawba

8320 NC Highway 150E, Marshall Steam Station, 28682
(Street Name, Numbers, Community, Subdivision, Lot No., Parcel, Zip Code)

TOPOGRAPHIC / LAND SETTING:
☐ Slope ☐ Valley ☐ Flat ☐ Ridge ☐ Other
(check appropriate box)

LATITUDE 35.618703

LONGITUDE -80.974549

May be in degrees, minutes, seconds or in a decimal format

Latitude/longitude source: ☒ GPS ☐ Topographic map
(location of well must be shown on a USGS topo map and attached to this form if not using GPS)

4. FACILITY- is the name of the business where the well is located.

FACILITY ID #(if applicable)

NAME OF FACILITY Marshall Steam Station

STREET ADDRESS 8320 NC Highway 150E

Terrell NC 28682
City or Town State Zip Code

CONTACT PERSON Darrell Wolfe

MAILING ADDRESS 8320 NC Highway 150E

Terrell NC 28682
City or Town State Zip Code

(828)- 478-7829
Area code - Phone number

5. WELL DETAILS:

a. TOTAL DEPTH: 20

b. DOES WELL REPLACE EXISTING WELL? YES ☐ NO ☒

c. WATER LEVEL Below Top of Casing: 18.5 FT.
(Use "+" if Above Top of Casing)

d. TOP OF CASING IS 2.65 FT. Above Land Surface*
*Top of casing terminated at/or below land surface may require a variance in accordance with 15A NCAC 2C .0118.

e. YIELD (gpm): METHOD OF TEST

f. DISINFECTION: Type Amount

g. WATER ZONES (depth):
From 18.5 To From To
From To From To
From To From To

6. CASING:

From	To	Ft.	Diameter	Thickness/ Weight	Material
0	10		2	sch.40	PVC

7. GROUT:

From	To	Ft.	Material	Method
0	8		Bentonite	poured

8. SCREEN:

From	To	Ft.	Diameter in.	Slot Size in.	Material
10	20		2	.010	PVC

9. SAND/GRAVEL PACK:

From	To	Ft.	Size	Material
8	20		#2	Sand

10. DRILLING LOG

From To	Formation Description
0-6	stiff mic. Clayey fine-med Sandy Silt
6-16	loose-md dense mic. Silty fine-coarse Sand
16-20	stiff fine-med Sandy Silt

11. REMARKS:

I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

Norman T. Costello 8/27/08
SIGNATURE OF CERTIFIED WELL CONTRACTOR DATE

Norman T. Costello
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Project: **Marshall Steam Station Industrial Fill #1**			**Boring No. M-44**
Location: **Terrell, North Carolina**		Number: **1356-08-122**	Sheet No. 1 of 1
Boring Depth (ft): **47.0**	Elevation (ft): **829.7**	Driller: **Justin Millwood**	Date Drilled: **5/15/08**
Logged By: **Ben Boland**	Water Level: **8.00 ft bls at TOB**		Drilling Method: **3¼" H.S.A.**

Elev. (Feet)	Depth (Feet)	Lith-ology	Material Description	Well Construction	Penetration Resistance (Blows/Foot) 0 50 100
			Residuum: Soft to Firm Orange and Tan micaceous fine Sandy Silt		
825	5				5
820	10				3
			Saprolite: Loose Tan Gray and Brown micaceous fine to coarse Silty Sand with weathered rock fragments		
815	15				9
810	20		Partially Weathered Rock: When sampled becomes Very Dense Tan Gray and Brown micaceous fine to coarse Silty Sand with weathered rock fragments		50/4" >>
805	25		Partially Weathered Rock: When sampled becomes Very Dense Black White and Gray coarse to very coarse Sand with weathered rock fragments		50/5" >>
			Partially Weathered Rock: When sampled becomes Very Stiff Red Gray Orange and Tan micaceous fine to coarse Sandy Silt		
800	30		Saprolite: Very Stiff Red Gray Orange and Tan micaceous fine to coarse Sandy Silt		31
795	35				24
			Saprolite: Dense Black White and Gray medium to very coarse Sand		
790	40		Partially Weathered Rock: When sampled becomes Very Dense Black White and Gray medium to very coarse Sand		50/5.5" >>
785	45				50/1.5" >>
			Auger Refusal at 47 ft bls		

BORING LOG WITH WELL MARSHALL STEAM STATION BORING LOGS 01-2009.GPJ LAGWGN01.GDT 1/29/09

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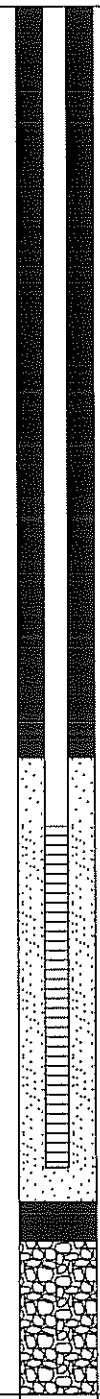
1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.
2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

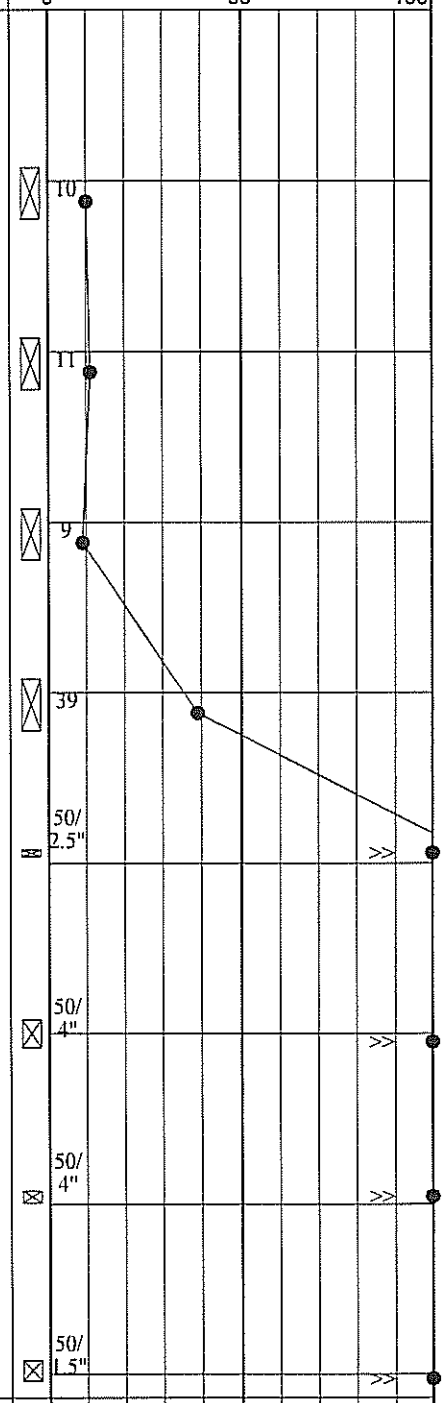
Project: **Marshall Steam Station Industrial Fill #1**			**Boring No. M-45**
Location: **Terrell, North Carolina**		Number: **1356-08-122**	Sheet No. 1 of 1
Boring Depth (ft): **40.7**	Elevation (ft): **846.2**	Driller: **Justin Millwood**	Date Drilled: **5/14/08**
Logged By: **Ben Boland**	Water Level: **28.45 ft bls on 05-21-08**		Drilling Method: **3¼" H.S.A.**

Elev. (Feet)	Depth (Feet)	Lith-ology	Material Description
845			Residuum: Loose Yellow and Orange Clayey Silty coarse Sand
840	5		
835	10		Saprolite: Medium Dense Gray and White micaceous fine to medium Sand with weathered rock fragments
830	15		Saprolite: Loose Orange and Tan micaceous Silty fine to medium Sand
825	20		Saprolite: Hard Orange and Tan micaceous medium to coarse Sandy Silt with weathered rock fragments
820	25		Saprolite: Very Dense Gray coarse to very coarse Sand with weathered rock fragments
815	30		Partially Weathered Rock: When sampled becomes Very Dense Gray coarse to very coarse Sand with weathered rock fragments
810	35		Partially Weathered Rock: When sampled becomes Very Dense Gray micaceous Silty medium to very coarse Sand with weathered rock fragments
	40		Auger Refusal at 40.7 ft bls

Well Construction



Penetration Resistance (Blows/Foot)



BORING LOG WITH WELL MARSHALL STEAM STATION BORING LOGS 01-2009.GPJ LAGWGN01.GDT 1/29/09

COMPLETION REPORT OF WELL No. M-45

PROJECT: **Marshall Steam Station Industrial Fill #1**
PROJECT NO: **1356-08-122**
PROJECT LOCATION: **Terrell, North Carolina**

WATER LEVEL: **28.45 ft bls on 05-21-08**

LATITUDE:
LONGITUDE:
TOP OF CASING ELEVATION: **848.81**
DATUM: **MSL**
LOGGED BY: **Ben Boland**

DRILLING CONTRACTOR: **S&ME, Inc.**
DRILLING METHOD: **3¼" H.S.A.**
DATE DRILLED: **5/14/08**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)
				0.00		846.22
Residuum: Loose Yellow and Orange Clayey Silty coarse Sand		0				
		5				
		10				
Saprolite: Medium Dense Gray and White micaceous fine to medium Sand with weathered rock fragments						
		15				
Saprolite: Loose Orange and Tan micaceous Silty fine to medium Sand						
		20				
Saprolite: Hard Orange and Tan micaceous medium to coarse Sandy Silt with weathered rock fragments						
		25				
Saprolite: Very Dense Gray coarse to very coarse Sand with weathered rock fragments						
		30				
Partially Weathered Rock: When sampled becomes Very Dense Gray coarse to very coarse Sand with weathered rock fragments						
		35				
Partially Weathered Rock: When sampled becomes Very Dense Gray micaceous Silty medium to very coarse Sand with weathered rock fragments						
		40				

WELL CONSTRUCTION DETAILS

PROTECTIVE CASING
Diameter: **Four Inch**
Type: **Steel**
Interval: **Above-Ground**

RISER CASING
Diameter: **One Inch**
Type: **Sch 40 PVC**
Interval: **3 Feet ALS to 24 Feet BLS**

GROUT
Type:
Interval:

SEAL
Type: **Bentonite Pellets**
Interval: **GS to 22 Feet BLS**

FILTERPACK
Type: **Medium Sand**
Interval: **22 to 35 Feet BLS**

SCREEN
Diameter: **One Inch**
Type: **Sch 40 PVC 0.010 Inch Slot**
Interval: **24 to 34 Feet BLS**

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

S&ME
ENGINEERING • TESTING
ENVIRONMENTAL SERVICES
9751 Southern Pine Blvd.
Charlotte, North Carolina

COMPLETION REPORT OF WELL No. M-45

NON RESIDENTIAL WELL CONSTRUCTION RECORD

North Carolina Department of Environment and Natural Resources- Division of Water Quality

WELL CONTRACTOR CERTIFICATION # 2251-A

1. WELL CONTRACTOR:

Travis Costello
Well Contractor (Individual) Name

S&ME, Inc.
Well Contractor Company Name

STREET ADDRESS 155 Tradd Street

Spartanburg SC 29301
City or Town State Zip Code

(864)- 574-2360
Area code- Phone number

2. WELL INFORMATION:

SITE WELL ID #(if applicable) M-45

STATE WELL PERMIT#(if applicable)

DWQ or OTHER PERMIT #(if applicable)

WELL USE (Check Applicable Box) Monitoring ☐ Municipal/Public ☐ Industrial/Commercial ☐ Agricultural ☐ Recovery ☐ Injection ☐ Irrigation ☐ Other ☒ (list use) observation

DATE DRILLED

TIME COMPLETED AM ☐ PM ☐

3. WELL LOCATION:

CITY: Terrell COUNTY Catawba

8320 NC Highway 150E, Marshall Steam Station, 28682
(Street Name, Numbers, Community, Subdivision, Lot No., Parcel, Zip Code)

TOPOGRAPHIC / LAND SETTING:
☐ Slope ☐ Valley ☐ Flat ☐ Ridge ☐ Other
(check appropriate box)

LATITUDE 35.619549
LONGITUDE -80.974170

May be in degrees, minutes, seconds or in a decimal format

Latitude/longitude source: ☒ GPS ☐ Topographic map
(location of well must be shown on a USGS topo map and attached to this form if not using GPS)

4. FACILITY- Is the name of the business where the well is located.

FACILITY ID #(if applicable)

NAME OF FACILITY Marshall Steam Station

STREET ADDRESS 8320 NC Highway 150E

Terrell NC 28682
City or Town State Zip Code

CONTACT PERSON Darrell Wolfe

MAILING ADDRESS 8320 NC Highway 150E

Terrell NC 28682
City or Town State Zip Code

(828)- 478-7829
Area code - Phone number

5. WELL DETAILS:

a. TOTAL DEPTH: 34

b. DOES WELL REPLACE EXISTING WELL? YES ☐ NO ☒

c. WATER LEVEL Below Top of Casing: 31 FT.
(Use "+" if Above Top of Casing)

d. TOP OF CASING IS 2.61 FT. Above Land Surface*
*Top of casing terminated at/or below land surface may require a variance in accordance with 15A NCAC 2C .0118.

e. YIELD (gpm): METHOD OF TEST

f. DISINFECTION: Type Amount

g. WATER ZONES (depth):
From 31.04 To From To
From To From To
From To From To

6. CASING:

From	To	Ft.	Diameter	Thickness/ Weight	Material
0	24		2	sch.40	PVC

7. GROUT:

From	To	Ft.	Material	Method
0	22		Bentonite	poured

8. SCREEN:

From	To	Ft.	Diameter	Slot Size	Material
24	34		2 in.	.010 in.	PVC
			in.	in.	
			in.	in.	

9. SAND/GRAVEL PACK:

From	To	Ft.	Size	Material
22	35		#2	Sand

10. DRILLING LOG

From - To	Formation Description
0-10	loose Clayey Silty coarse Sand
10-12	med Dense mic. fine-med Sand
12-17	loose mic. Silty fine-med Sand
17-22	hard mic. med-coarse Sandy Silt
22-31	v dense coarse-v coarse Sand
31-35	v dense mic. Silty med-v coarse Sand

11. REMARKS:

I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

Norman T. Costello 8/27/05
SIGNATURE OF CERTIFIED WELL CONTRACTOR DATE

Norman T. Costello
PRINTED NAME OF PERSON CONSTRUCTING THE WELL

Submit the original to the Division of Water Quality within 30 days. Attn: Information Mgt., 1617 Mail Service Center – Raleigh, NC 27699-1617 Phone No. (919) 733-7015 ext 568.

Form GW-1b
Rev. 7/05

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ENVIRONMENTAL SERVICES

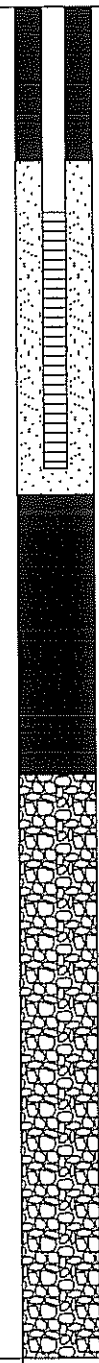
S&ME, Inc.
9751 Southern Pine Blvd.
Charlotte, North Carolina
Telephone: 704-523-4726
Fax: 704-525-3953

1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.
2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

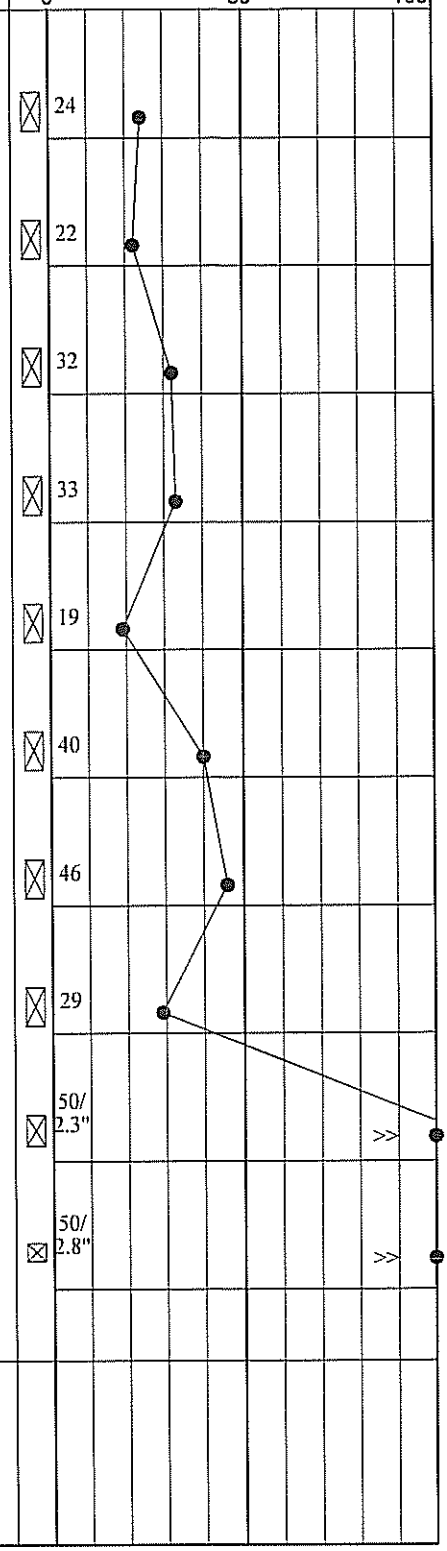
Project: **Marshall Steam Station Industrial Fill #1**			**Boring No. M-46**
Location: **Terrell, North Carolina**		Number: **1356-08-122**	Sheet No. 1 of 1
Boring Depth (ft): **52.8**	Elevation (ft): **827.8**	Driller: **Joey Donnahoo**	Date Drilled: **5/20/08**
Logged By: **Matthew Osborne**	Water Level: **10.02 ft bls on 05-21-08**		Drilling Method: **3¼" H.S.A.**

Elev. (Feet)	Depth (Feet)	Lith-ology	Material Description
825			Residuum: Very Stiff Orange and Red micaceous fine to medium Sandy Silt with Quartz
820	5		Saprolite: Very Stiff to Hard Pink Brown and Gray micaceous fine to medium Sandy Silt with Quartz and Manganese staining
815	10		
810	15		
805	20		Saprolite: Medium Dense Gray and White micaceous Silty fine to coarse Sand
800	25		Saprolite: Hard Brown micaceous Silt with Quartz fragments
795	30		
790	35		Saprolite: Hard to Very Hard Tan Brown Gray micaceous very fine to medium Sandy Silt
785	40		
780	45		Partially Weathered Rock: When sampled becomes Very Hard Tan Brown Gray micaceous very fine to medium Sandy Silt
	50		
			Auger Refusal at 52.8 ft bls

Well Construction



Penetration Resistance (Blows/Foot)



COMPLETION REPORT OF WELL No. M-46

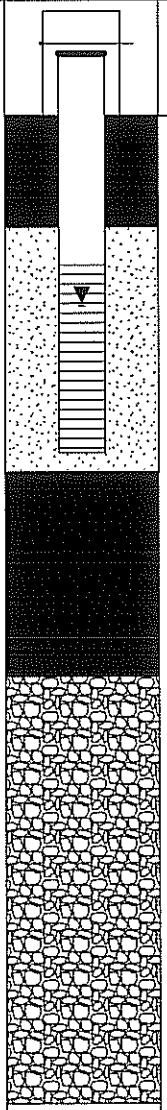
PROJECT: **Marshall Steam Station Industrial Fill #1**
PROJECT NO: **1356-08-122**
PROJECT LOCATION: **Terrell, North Carolina**

WATER LEVEL: **10.02 ft bls on 05-21-08**

LATITUDE:
LONGITUDE:
TOP OF CASING ELEVATION: **830.38**
DATUM: **MSL**
LOGGED BY: **Matthew Osborne**

DRILLING CONTRACTOR: **S&ME, Inc.**
DRILLING METHOD: **3¼" H.S.A.**
DATE DRILLED: **5/20/08**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)
Residuum: Very Stiff Orange and Red micaceous fine to medium Sandy Silt with Quartz		0		0.00		827.82
Saprolite: Very Stiff to Hard Pink Brown and Gray micaceous fine to medium Sandy Silt with Quartz and Manganese staining		5, 10, 15				
Saprolite: Medium Dense Gray and White micaceous Silty fine to coarse Sand		20				
Saprolite: Hard Brown micaceous Silt with Quartz fragments		25, 30				
Saprolite: Hard to Very Hard Tan Brown Gray micaceous very fine to medium Sandy Silt		35, 40				
Partially Weathered Rock: When sampled becomes Very Hard Tan Brown Gray micaceous very fine to medium Sandy Silt		45, 50				



WELL CONSTRUCTION DETAILS

PROTECTIVE CASING
Diameter: **Four Inch**
Type: **Steel**
Interval: **Above-Ground**

RISER CASING
Diameter: **One Inch**
Type: **Sch 40 PVC**
Interval: **3 Feet ALS to 8 Feet BLS**

GROUT
Type:
Interval:

SEAL
Type: **Bentonite Pellets**
Interval: **GS to 6 Feet BLS**

FILTERPACK
Type: **Medium Sand**
Interval: **6 to 19 Feet BLS**

SCREEN
Diameter: **One Inch**
Type: **Sch 40 PVC 0.010 Inch Slot**
Interval: **8 to 18 Feet BLS**

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

MONITORING WELL MARSHALL STEAM STATION BORING LOGS 01-2009.GPJ S&ME.GDT 1/29/09

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9751 Southern Pine Blvd.
Charlotte, North Carolina

COMPLETION REPORT OF WELL No. M-46

NON RESIDENTIAL WELL CONSTRUCTION RECORD

North Carolina Department of Environment and Natural Resources- Division of Water Quality

WELL CONTRACTOR CERTIFICATION # 2251-A

1. WELL CONTRACTOR:

Travis Costello
Well Contractor (Individual) Name

S&ME, Inc.
Well Contractor Company Name

STREET ADDRESS 155 Tradd Street

Spartanburg SC 29301
City or Town State Zip Code

(864)- 574-2360
Area code- Phone number

2. WELL INFORMATION:

SITE WELL ID #(if applicable) M-46

STATE WELL PERMIT#(if applicable)

DWQ or OTHER PERMIT #(if applicable)

WELL USE (Check Applicable Box) Monitoring ☐ Municipal/Public ☐

Industrial/Commercial ☐ Agricultural ☐ Recovery ☐ Injection ☐

Irrigation☐ Other ☒ (list use) observation

DATE DRILLED

TIME COMPLETED AM ☐ PM ☐

3. WELL LOCATION:

CITY: Terrell COUNTY Catawba

8320 NC Highway 150E, Marshall Steam Station, 28682
(Street Name, Numbers, Community, Subdivision, Lot No., Parcel, Zip Code)

TOPOGRAPHIC / LAND SETTING:

☐Slope ☐Valley ☐Flat ☐Ridge ☐ Other
(check appropriate box)

LATITUDE 35.618521

LONGITUDE -80.976130

May be in degrees, minutes, seconds or in a decimal format

Latitude/longitude source: ☒GPS ☐Topographic map

(location of well must be shown on a USGS topo map and attached to this form if not using GPS)

4. FACILITY- is the name of the business where the well is located.

FACILITY ID #(if applicable)

NAME OF FACILITY Marshall Steam Station

STREET ADDRESS 8320 NC Highway 150E

Terrell NC 28682
City or Town State Zip Code

CONTACT PERSON Darrell Wolfe

MAILING ADDRESS 8320 NC Highway 150E

Terrell NC 28682
City or Town State Zip Code

(828)- 478-7829
Area code - Phone number

5. WELL DETAILS:

a. TOTAL DEPTH: 18

b. DOES WELL REPLACE EXISTING WELL? YES ☐ NO ☒

c. WATER LEVEL Below Top of Casing: 12.6 FT.
(Use "+" if Above Top of Casing)

d. TOP OF CASING IS 2.66 FT. Above Land Surface*
*Top of casing terminated at/or below land surface may require a variance in accordance with 15A NCAC 2C .0118.

e. YIELD (gpm): METHOD OF TEST

f. DISINFECTION: Type Amount

g. WATER ZONES (depth):

From 12.58 To From To
From To From To
From To From To

6. CASING:

From	To	Ft.	Diameter	Thickness/ Weight	Material
0	8		2	sch.40	PVC

7. GROUT:

From	To	Ft.	Material	Method
0	6		Bentonite	poured

8. SCREEN:

From	To	Ft.	Diameter	Slot Size	Material
8	18		2 in.	.010 in.	PVC
			in.	in.	
			in.	in.	

9. SAND/GRAVEL PACK:

From	To	Ft.	Size	Material
6	19		#2	Sand

10. DRILLING LOG

From To	Formation Description
0-10	loose Clayey Silty coarse Sand
10-12	med mic. fine-med Sand
12-17	loose mic. Silty fine-med Sand
17-19	hard mic. med-coarse Sandy Silt

11. REMARKS:

I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

Norman T. Costello 8/27/08
SIGNATURE OF CERTIFIED WELL CONTRACTOR DATE

Norman T. Costello
PRINTED NAME OF PERSON CONSTRUCTING THE WELL

Submit the original to the Division of Water Quality within 30 days. Attn: Information Mgt., 1617 Mail Service Center – Raleigh, NC 27699-1617 Phone No. (919) 733-7015 ext 568.

Form GW-1b
Rev. 7/05

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9751 Southern Pine Blvd.
Charlotte, North Carolina
Telephone: 704-523-4726
Fax: 704-525-3953

1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.
2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

Project: **Marshall Steam Station Industrial Fill #1**			**Boring No. M-47**
Location: **Terrell, North Carolina**		Number: **1356-08-122**	Sheet No. 1 of 1
Boring Depth (ft): **45.2**	Elevation (ft): **829.4**	Driller: **Joey Donnahoo**	Date Drilled: **5/19/08**
Logged By: **Matthew Osborne**	Water Level: **10.50 ft bls at TOB**		Drilling Method: **3¼" H.S.A.**

Elev. (Feet)	Depth (Feet)	Lith-ology	Material Description	Well Construction	Penetration Resistance (Blows/Foot) 0 50 100
825	5		Residuum: Very Stiff Red micaceous Clayey fine Sandy Silt		25
820	10		Saprolite: Stiff to Very Stiff micaceous fine to medium Sandy Silt with Manganese nodules	▽	15
815	15				12
810	20				16
805	25		Saprolite: Brown Black micaceous Silt		18
			Saprolite: Very Hard Black and Brown micaceous fine Sandy Silt wth Quartz and weathered Schist fragments		50/ 2.2" >>
800	30		Partially Weathered Rock: When sampled becomes Very Hard Black and Brown micaceous fine Sandy Silt wth Quartz and weathered Schist fragments		50/ 3.8" >>
795	35		Partially Weathered Rock: When sampled becomes Very Hard Gray Brown and Orange Silt with weathered Schist fragments		50/ 4.5" >>
790	40				50/ 2" >>
785	45		Auger Refusal at 45.2 ft bls		

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Telephone: 704-523-4726
Fax: 704-525-3953

1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.
2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

Project: **Marshall Steam Station**			**Boring No. MW-57**
Location: **Terrell, North Carolina**		Number: **1356-08-122**	Sheet No. 1 of 1
Boring Depth (ft): **36.5**	Elevation (ft): **882.0**	Driller: **Jay Little, NC Cert No. 2717**	Date Drilled: **9/30/08**
Logged By: **Courtney Withers**	Water Level: **DRY**		Drilling Method: **2¼" H.S.A.**

Elev. (Feet)	Depth (Feet)	Lith-ology	Material Description	Well Construction	Penetration Resistance (Blows/Foot) 0 50 100
880	5		RESIDUUM: Yellow-Red, Medium-Dense, Micaceous, Silty, Fine **SAND**		13
875	10		SAPROLITE: Tan and White, Medium-Dense, Micaceous, Silty, Medium to Fine **SAND** (SM)		7
870	15				9
865	20				19
860	25		SAPROLITE: Tan, Orange, and Green, Medium-Dense, Micaecous, Slightly Clayey, Silty, Fine **SAND** With Manganese Staining		11
855	30		SAPROLITE: Tan and White, Medium-Dense, Micaceous, Silty, Very Fine **SAND**		26
850	35		SAPROLITE: Tan, White, and Orange, Very Dense, Micaceous, Silty, Medium to Fine **SAND**		54
			Auger Refusal at 36.5 ft bls		

BORING LOG WITH WELL MARSHALL LOGS - FOOTPRINT EXPANSION.GPJ LAGWGN01.GDT 1/29/09

COMPLETION REPORT OF WELL No. MW-57

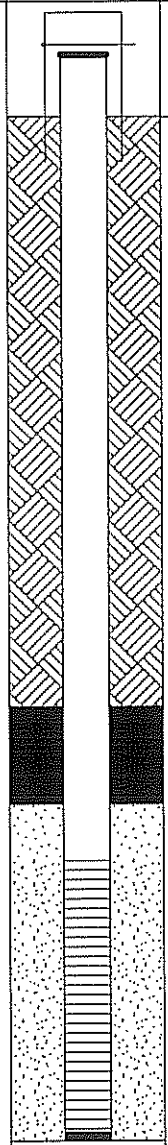
PROJECT: **Marshall Steam Station**
PROJECT NO: **1356-08-122**
PROJECT LOCATION: **Terrell, North Carolina**

WATER LEVEL: **DRY**

LATITUDE: **35 37 20.96**
LONGITUDE: **80 58 38.92**
TOP OF CASING ELEVATION: **884.85**
DATUM: **MSL**
LOGGED BY: **Courtney Withers**

DRILLING CONTRACTOR: **S&ME, Inc.**
DRILLING METHOD: **2¼" H.S.A.**
DATE DRILLED: **9/30/08**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)
				0.00		881.99
RESIDUUM: Yellow-Red, Medium-Dense, Micaceous, Silty, Fine **SAND**		0				
		5				
SAPROLITE: Tan and White, Medium-Dense, Micaceous, Silty, Medium to Fine **SAND** (SM)		10				
		15				
		20		21.00		860.99
SAPROLITE: Tan, Orange, and Green, Medium-Dense, Micaecous, Slightly Clayey, Silty, Fine **SAND** With Manganese Staining		25		24.50		857.49
SAPROLITE: Tan and White, Medium-Dense, Micaceous, Silty, Very Fine **SAND**		30				
SAPROLITE: Tan, White, and Orange, Very Dense, Micaceous, Silty, Medium to Fine **SAND**		35		36.20 36.50		845.79 845.49



WELL CONSTRUCTION DETAILS

PROTECTIVE CASING
Diameter: **4" X 4"**
Type: **Square Steel**
Interval: **+3.5 als to 1.5 ft bls**

RISER CASING
Diameter: **1"**
Type: **Sch. 40 PVC**
Interval: **+3 ft als to 26.5 ft bls**

GROUT
Type: **Neat Cement**
Interval: **0 to 21 ft bls**

SEAL
Type: **Bentonite**
Interval: **21 to 24.5 ft bls**

FILTERPACK
Type: **#2 Silica Sand**
Interval: **24.5 to 36.5 ft bls**

SCREEN
Diameter: **1"**
Type: **0.010" Slotted PVC**
Interval: **26.5 to 36.5 ft bls**

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

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9751 Southern Pine Blvd.
Charlotte, North Carolina

COMPLETION REPORT OF WELL No. MW-57

NON RESIDENTIAL WELL CONSTRUCTION RECORD

North Carolina Department of Environment and Natural Resources- Division of Water Quality

WELL CONTRACTOR CERTIFICATION # 2717 - A

1. WELL CONTRACTOR:

Jay Little
Well Contractor (Individual) Name

S&ME, Inc.
Well Contractor Company Name

STREET ADDRESS 9751 Southern Pine Blvd

Charlotte, North Carolina 28273
City or Town State Zip Code

(704)- 523-4726
Area code- Phone number

2. WELL INFORMATION:

SITE WELL ID #(if applicable) M-57

STATE WELL PERMIT#(if applicable)

DWQ or OTHER PERMIT #(if applicable)

WELL USE (Check Applicable Box) Monitoring ☐ Municipal/Public ☐

Industrial/Commercial ☐ Agricultural ☐ Recovery ☐ Injection ☐

Irrigation☐ Other ☒ (list use) observation

DATE DRILLED 9/30/08

TIME COMPLETED 12:00 AM ☐ PM ☒

3. WELL LOCATION:

CITY: Terrell COUNTY Catawba

Island Point Rd
(Street Name, Numbers, Community, Subdivision, Lot No., Parcel, Zip Code)

TOPOGRAPHIC / LAND SETTING:

☐Slope ☐Valley ☐Flat ☒Ridge ☐ Other
(check appropriate box)

LATITUDE 33 44' 45.47"

LONGITUDE 85 11' 40.24"

May be in degrees, minutes, seconds or in a decimal format

Latitude/longitude source: ☒GPS ☐Topographic map

(location of well must be shown on a USGS topo map and attached to this form if not using GPS)

4. FACILITY- is the name of the business where the well is located.

FACILITY ID #(if applicable)

NAME OF FACILITY Marshall Steam Station

STREET ADDRESS 8320 East Hwy 150

Terrell, North Carolina 28682
City or Town State Zip Code

CONTACT PERSON Ed Sullivan

MAILING ADDRESS 526 South Church Street

Charlotte, North Carolina 28202
City or Town State Zip Code

(980)- 373-3719
Area code - Phone number

5. WELL DETAILS:

a. **TOTAL DEPTH:** 36.5 ft bls

b. **DOES WELL REPLACE EXISTING WELL?** YES ☐ NO ☒

c. **WATER LEVEL** Below Top of Casing: DRY FT.
(Use "+" if Above Top of Casing)

d. **TOP OF CASING IS** 3 FT. Above Land Surface*
*Top of casing terminated at/or below land surface may require a variance in accordance with 15A NCAC 2C .0118.

e. **YIELD (gpm):** _____ **METHOD OF TEST** _____

f. **DISINFECTION: Type** _____ **Amount** _____

g. **WATER ZONES** (depth):

From ____ To ____ From ____ To ____
From ____ To ____ From ____ To ____
From ____ To ____ From ____ To ____

6. CASING:

	Depth		Diameter	Thickness/ Weight	Material
From 0	To 26.5	Ft.	1"	Sch. 40	PVC
From	To	Ft.			
From	To	Ft.			

7. GROUT:

	Depth		Material	Method
From 0	To 21	Ft.	Neat Cement	pour
From 21	To 24.5	Ft.	Bentonite	pour
From	To	Ft.		

8. SCREEN:

	Depth		Diameter	Slot Size	Material
From 26.5	To 36.5	Ft.	1 in.	0.010 in.	PVC
From	To	Ft.	in.	in.	
From	To	Ft.	in.	in.	

9. SAND/GRAVEL PACK:

	Depth		Size	Material
From 24.5	To 36.5	Ft.	#2	Silica Sand
From	To	Ft.		
From	To	Ft.		

10. DRILLING LOG

From To	Formation Description
0 to 36.5	Silty Sand

11. REMARKS:

I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

Jay A. Little 11-2-08
SIGNATURE OF CERTIFIED WELL CONTRACTOR DATE

JAY A. LITTLE
PRINTED NAME OF PERSON CONSTRUCTING THE WELL

Submit the original to the Division of Water Quality within 30 days. Attn: Information Mgt., 1617 Mail Service Center – Raleigh, NC 27699-1617 Phone No. (919) 733-7015 ext 568.

Form GW-1b
Rev. 7/05

S&ME
ENGINEERING • TESTING
ENVIRONMENTAL SERVICES

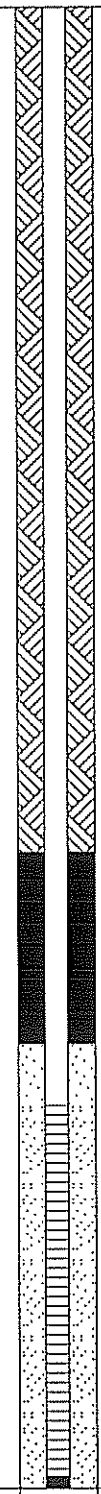
S&ME, Inc.
9751 Southern Pine Blvd.
Charlotte, North Carolina
Telephone: 704-523-4726
Fax: 704-525-3953

1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.
2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

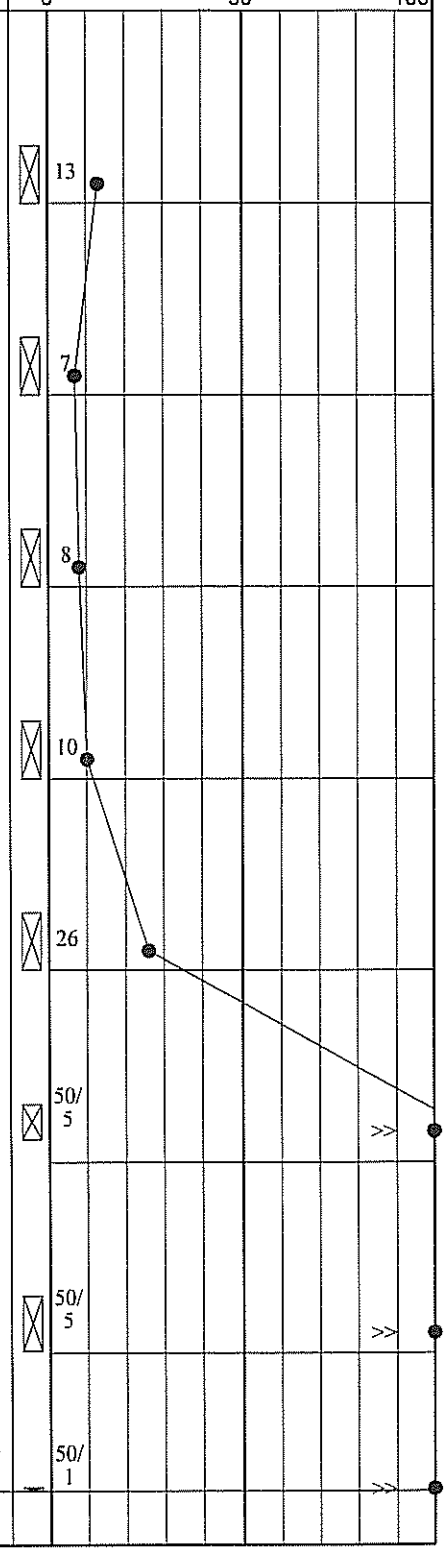
Project: **Marshall Steam Station**			**Boring No. MW-58**
Location: **Terrell, North Carolina**		Number: **1356-08-122**	Sheet No. 1 of 1
Boring Depth (ft): **38.6**	Elevation (ft): **876.4**	Driller: **Jay Little, NC Cert No. 2717**	Date Drilled: **9/30/08**
Logged By: **Courtney Withers**	Water Level: **Stabilized Water Level at 37.77 ft bls**		Drilling Method: **2¼" H.S.A.**

Elev. (Feet)	Depth (Feet)	Lith-ology	Material Description
875			RESIDUUM: Yellow-Red, Stiff, Slightly Clayey, **SILT**
870	5		
865	10		SAPROLITE: Tan, White, and Orange, Loose, Micaceous, Silty, Fine **SAND** With Manganese Staining and Quartz Rock Fragments From 11 to 12 ft bls
860	15		SAPROLITE: Tan, White, and Orange, Firm to Stiff, Micaceous, Fine Sandy, **SILT** With Manganese Staining
855	20		SAPROLITE: Tan, White, and Orange, Medium-Dense, Micaceous, Silty, Fine **SAND** With Manganese Staining
850	25		
845	30		PARTIALLY WEATHERED ROCK: When Sampled Becomes White, Tan, Green, and Pink, Very Dense, Micaceous, Silty, Medium to Fine **SAND** (SM)
840	35		PARTIALLY WEATHERED ROCK: When Sampled Becomes Black, White, and Brown, Very Dense, Micaceous, Silty, Fine **SAND** With Manganese Staining and Rock Fragments
			Auger Refusal at 38.6 ft bls

Well Construction



Penetration Resistance (Blows/Foot)



BORING LOG WITH WELL MARSHALL LOGS - FOOTPRINT EXPANSION.GPJ LAGWGN01.GDT 1/29/09

COMPLETION REPORT OF WELL No. MW-58

PROJECT: **Marshall Steam Station**
PROJECT NO: **1356-08-122**
PROJECT LOCATION: **Terrell, North Carolina**

WATER LEVEL: **Stabilized Water Level at 37.77 ft bls**
LATITUDE: **35 37 23.93**
LONGITUDE: **80 58 32.35**
TOP OF CASING ELEVATION: **879.36**
DATUM: **MSL**
LOGGED BY: **Courtney Withers**

DRILLING CONTRACTOR: **S&ME, Inc.**
DRILLING METHOD: **2¼" H.S.A.**
DATE DRILLED: **9/30/08**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)
				0.00		876.38
RESIDUUM: Yellow-Red, Stiff, Slightly Clayey, **SILT**		0, 5				
SAPROLITE: Tan, White, and Orange, Loose, Micaceous, Silty, Fine **SAND** With Manganese Staining and Quartz Rock Fragments From 11 to 12 ft bls		10				
SAPROLITE: Tan, White, and Orange, Firm to Stiff, Micaceous, Fine Sandy, **SILT** With Manganese Staining		15				
SAPROLITE: Tan, White, and Orange, Medium-Dense, Micaceous, Silty, Fine **SAND** With Manganese Staining		20, 25		22.00		854.38
PARTIALLY WEATHERED ROCK: When Sampled Becomes White, Tan, Green, and Pink, Very Dense, Micaceous, Silty, Medium to Fine **SAND** (SM)		30, 35		27.00		849.38
PARTIALLY WEATHERED ROCK: When Sampled Becomes Black, White, and Brown, Very Dense				38.30		838.08
				38.60		837.78

WELL CONSTRUCTION DETAILS

PROTECTIVE CASING
Diameter: **4" X 4"**
Type: **Square Steel**
Interval: **+3.5 als to 1.5 ft bls**

RISER CASING
Diameter: **1"**
Type: **Sch. 40 PVC**
Interval: **+3 ft als to 28.6 ft bls**

GROUT
Type: **Neat Cement**
Interval: **0 to 22 ft bls**

SEAL
Type: **Bentonite**
Interval: **22 to 27 ft bls**

FILTERPACK
Type: **#2 Silica Sand**
Interval: **27 to 38.6 ft bls**

SCREEN
Diameter: **1"**
Type: **0.010" Slotted PVC**
Interval: **28.6 to 38.6 ft bls**

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

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COMPLETION REPORT OF WELL No. MW-58

PROJECT: **Marshall Steam Station**
PROJECT NO: **1356-08-122**
PROJECT LOCATION: **Terrell, North Carolina**

GROUND SURFACE ELEVATION: **876.4**
LOGGED BY: **Courtney Wither**
CHECKED BY:

STRATA			WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)	WELL CONSTRUCTION DETAILS
DESCRIPTION	SYMBOL	DEPTH (ft.)					
							(See Page 1)
Micaceous, Silty, Fine **SAND** With Manganese Staining and Rock Fragments							

LEGEND

FILTER PACK	TOC	TOP OF CASING
BENTONITE	GS	GROUND SURFACE
CEMENT GROUT	BS	BENTONITE SEAL
CUTTINGS / BACKFILL	FP	FILTER PACK
STATIC WATER LEVEL	TSC	TOP OF SCREEN
	BSC	BOTTOM OF SCREEN
	TD	TOTAL DEPTH
	CG	CEMENT GROUT

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COMPLETION REPORT OF WELL No. MW-58

MONITORING WELL MARSHALL LOGS - FOOTPRINT EXPANSION.GPJ S&ME.GDT 1/29/09

NON RESIDENTIAL WELL CONSTRUCTION RECORD

North Carolina Department of Environment and Natural Resources- Division of Water Quality

WELL CONTRACTOR CERTIFICATION # 2717 -A

1. WELL CONTRACTOR:

Jay Little
Well Contractor (Individual) Name

S&ME, Inc.
Well Contractor Company Name

STREET ADDRESS 9751 Southern Pine Blvd

Charlotte, North Carolina 28273
City or Town State Zip Code

(704)- 523-4726
Area code- Phone number

2. WELL INFORMATION:

SITE WELL ID #(if applicable) M-58

STATE WELL PERMIT#(if applicable)

DWQ or OTHER PERMIT #(if applicable)

WELL USE (Check Applicable Box) Monitoring ☐ Municipal/Public ☐

Industrial/Commercial ☐ Agricultural ☐ Recovery ☐ Injection ☐

Irrigation☐ Other ☒ (list use) observation

DATE DRILLED 9/30/08

TIME COMPLETED 3:00 AM ☐ PM ☒

3. WELL LOCATION:

CITY: Terrell COUNTY Catawba

Island Point Rd
(Street Name, Numbers, Community, Subdivision, Lot No., Parcel, Zip Code)

TOPOGRAPHIC / LAND SETTING:

☐ Slope ☐ Valley ☐ Flat ☒ Ridge ☐ Other
(check appropriate box)

LATITUDE 3 3 44' 45.74"

LONGITUDE 85 11' 39.71"

May be in degrees, minutes, seconds or in a decimal format

Latitude/longitude source: ☒ GPS ☐ Topographic map

(location of well must be shown on a USGS topo map and attached to this form if not using GPS)

4. FACILITY- is the name of the business where the well is located.

FACILITY ID #(if applicable)

NAME OF FACILITY Marshall Steam Station

STREET ADDRESS 8320 East Hwy 150

Terrell, North Carolina 28682
City or Town State Zip Code

CONTACT PERSON Ed Sullivan

MAILING ADDRESS 526 South Church Street

Charlotte, North Carolina 28202
City or Town State Zip Code

(980)- 373-3719
Area code - Phone number

5. WELL DETAILS:

a. **TOTAL DEPTH:** 38.6 ft bls

b. **DOES WELL REPLACE EXISTING WELL?** YES ☐ NO ☒

c. **WATER LEVEL** Below Top of Casing: DRY FT.
(Use "+" if Above Top of Casing)

d. **TOP OF CASING IS** 3 FT. Above Land Surface*
*Top of casing terminated at/or below land surface may require a variance in accordance with 15A NCAC 2C .0118.

e. **YIELD (gpm):** METHOD OF TEST

f. **DISINFECTION: Type** Amount

g. **WATER ZONES** (depth):

From To From To
From To From To
From To From To

6. CASING:

	Depth		Diameter	Thickness/ Weight	Material
From 0	To 26.5	Ft.	1"	Sch. 40	PVC
From	To	Ft.			
From	To	Ft.			

7. GROUT:

	Depth		Material	Method
From 0	To 22	Ft.	Neat Cement	pour
From 22	To 27	Ft.	Bentonite	pour
From	To	Ft.		

8. SCREEN:

	Depth		Diameter	Slot Size	Material
From 28.6	To 38.6	Ft.	1 in.	0.010 in.	PVC
From	To	Ft.	in.	in.	
From	To	Ft.	in.	in.	

9. SAND/GRAVEL PACK:

	Depth		Size	Material
From 27	To 38.6	Ft.	#2	Silica Sand
From	To	Ft.		
From	To	Ft.		

10. DRILLING LOG

From To	Formation Description
0 to 7	Clayey Silt
7 to 11	Silty Sand
11 to 12	PWR
12 to 19	Sandy Silt
19 to 28.5	Silty Sand
28.5 to 38.6	PWR

11. REMARKS:

I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

Jay A. Little 11-1-08
SIGNATURE OF CERTIFIED WELL CONTRACTOR DATE

Jay A. Little
PRINTED NAME OF PERSON CONSTRUCTING THE WELL

Submit the original to the Division of Water Quality within 30 days. Attn: Information Mgt., 1617 Mail Service Center – Raleigh, NC 27699-1617 Phone No. (919) 733-7015 ext 568.

Form GW-1b
Rev. 7/05

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9751 Southern Pine Blvd.
Charlotte, North Carolina
Telephone: 704-523-4726
Fax: 704-525-3953

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1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.
2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

Project: **Marshall Steam Station**			**Boring No. MW-59**
Location: **Terrell, North Carolina**		Number: **1356-08-122**	Sheet No. 1 of 2
Boring Depth (ft): **59.0**	Elevation (ft): **874.5**	Driller: **Jay Little, NC Cert No. 2717**	Date Drilled: **10/1/08**
Logged By: **Courtney Withers**	Water Level: **Stabilized Water Level at 49.84 ft bls**		Drilling Method: **2¼" H.S.A.**

Elev. (Feet)	Depth (Feet)	Lith-ology	Material Description	Well Construction	Penetration Resistance (Blows/Foot) 0 50 100
870	5		RESIDUUM: Red, Stiff, Micaceous, Medium to Fine Sandy, Clayey, **SILT** (MH)		11
865	10		SAPROLITE: Yellow-Red and Tan, Firm, Micaceous, Very Fine Sandy, **SILT** With Manganese Staining		8
860	15				8
855	20				7
850	25				8
845	30		SAPROLITE: Orange and Tan, Firm to Stiff, Micaceous, Medium to Fine Sandy, **SILT** (ML) With Manganese Staining. **QUARTZ** Rock Lense From 39.0 to 39.2 ft bls.		7
840					11

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1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.
2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

Project: **Marshall Steam Station**			**Boring No. MW-59**
Location: **Terrell, North Carolina**		Number: **1356-08-122**	Sheet No. 2 of 2
Boring Depth (ft): **59.0**	Elevation (ft): **874.5**	Driller: **Jay Little, NC Cert No. 2717**	Date Drilled: **10/1/08**
Logged By: **Courtney Withers**	Water Level: **Stabilized Water Level at 49.84 ft bls**		Drilling Method: **2¼" H.S.A.**

Elev. (Feet)	Depth (Feet)	Lithology	Material Description	Well Construction	Penetration Resistance (Blows/Foot) 0 50 100
835	40		SAPROLITE: Tan and White, Hard, Micaceous, Fine Sandy, **SILT**		45
			SAPROLITE: Orange, Tan, and White, Dense, Micaceous, Silty, Medium to Fine **SAND**		
			SAPROLITE: Orange and Tan, Stiff, Micaceous, Fine Sandy, **SILT**		15
830	45		SAPROLITE: Orange, Tan, White, and Black, Medium-Dense, Micaceous, Silty, Fine **SAND**		
			SAPROLITE: Tan and White, Very Dense, Micaceous, Silty, Very Fine **SAND**		55
825	50				
820	55		PARTIALLY WEATHERED ROCK: When Sampled Becomes Tan and White, Very Dense, Micaceous, Silty, Medium to Fine **SAND** With Rock Fragments		50/5.5 >>
					50/2 >>
			Auger Refusal at 59.0 ft bls		

COMPLETION REPORT OF WELL No. MW-59

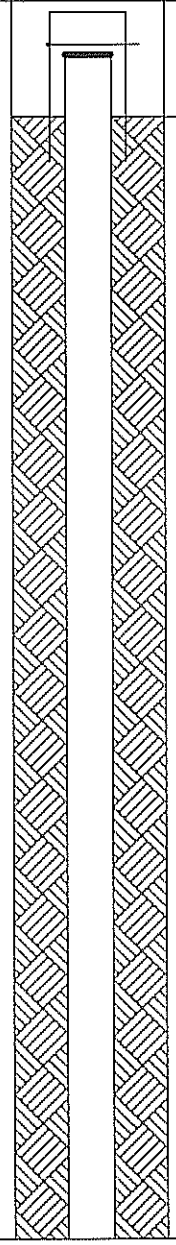
PROJECT: **Marshall Steam Station**
PROJECT NO: **1356-08-122**
PROJECT LOCATION: **Terrell, North Carolina**

WATER LEVEL: **Stabilized Water Level at 49.84 ft bls**

LATITUDE: **35 37 24.24**
LONGITUDE: **80 58 25.33**
TOP OF CASING ELEVATION: **877.41**
DATUM: **MSL**
LOGGED BY: **Courtney Withers**

DRILLING CONTRACTOR: **S&ME, Inc.**
DRILLING METHOD: **2¼" H.S.A.**
DATE DRILLED: **10/1/08**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)
				0.00		874.48
RESIDUUM: Red, Stiff, Micaceous, Medium to Fine Sandy, Clayey, **SILT** (MH)		0				
		5				
SAPROLITE: Yellow-Red and Tan, Firm, Micaceous, Very Fine Sandy, **SILT** With Manganese Staining		10				
		15				
		20				
		25				
SAPROLITE: Orange and Tan, Firm to Stiff, Micaceous, Medium to Fine Sandy, **SILT** (ML) With Manganese Staining. **QUARTZ** Rock Lense From 39.0 to 39.2 ft bls.		30				



WELL CONSTRUCTION DETAILS

PROTECTIVE CASING
Diameter: **4" X 4"**
Type: **Square Steel**
Interval: **+3.5 als to 1.5 ft bls**

RISER CASING
Diameter: **1"**
Type: **Sch. 40 PVC**
Interval: **+3 ft als to 49 ft bls**

GROUT
Type: **Neat Cement**
Interval: **0 to 38.5 ft bls**

SEAL
Type: **Bentonite**
Interval: **38.5 to 41 ft bls**

FILTERPACK
Type: **#2 Silica Sand**
Interval: **41 to 59 ft bls**

SCREEN
Diameter: **1"**
Type: **0.010" Slotted PVC**
Interval: **49 to 59 ft bls**

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

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Charlotte, North Carolina

COMPLETION REPORT OF WELL No. MW-59

PROJECT: **Marshall Steam Station**
PROJECT NO: **1356-08-122**
PROJECT LOCATION: **Terrell, North Carolina**

GROUND SURFACE ELEVATION: **874.5**
LOGGED BY: **Courtney Wither**
CHECKED BY:

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)	WELL CONSTRUCTION DETAILS
							(See Page 1)
		35		38.50		835.98	
SAPROLITE: Tan and White, Hard, Micaceous, Fine Sandy, **SILT**		40		41.00		833.48	
SAPROLITE: Orange, Tan, and White, Dense, Micaceous, Silty, Medium to Fine **SAND**		45					
SAPROLITE: Orange and Tan, Stiff, Micaceous, Fine Sandy, **SILT**							
SAPROLITE: Orange, Tan, White, and Black, Medium-Dense, Micaceous, Silty, Fine **SAND**		50					
SAPROLITE: Tan and White, Very Dense, Micaceous, Silty, Very Fine **SAND**		55					
PARTIALLY WEATHERED ROCK: When Sampled Becomes Tan and White, Very Dense, Micaceous, Silty, Medium to Fine **SAND** With Rock Fragments				58.70 59.00		815.78 815.48	

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

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COMPLETION REPORT OF WELL No. MW-59

MONITORING WELL MARSHALL LOGS - FOOTPRINT EXPANSION.GPJ S&ME.GDT 1/29/09

NON RESIDENTIAL WELL CONSTRUCTION RECORD

North Carolina Department of Environment and Natural Resources- Division of Water Quality

WELL CONTRACTOR CERTIFICATION # 2717 – A

1. WELL CONTRACTOR:

Jay Little
Well Contractor (Individual) Name

S&ME, Inc.
Well Contractor Company Name

STREET ADDRESS 9751 Southern Pine Blvd

Charlotte, North Carolina 28273
City or Town State Zip Code

(704)- 523-4726
Area code- Phone number

2. WELL INFORMATION:

SITE WELL ID #(if applicable) M-59

STATE WELL PERMIT#(if applicable)

DWQ or OTHER PERMIT #(if applicable)

WELL USE (Check Applicable Box) Monitoring ☐ Municipal/Public ☐

Industrial/Commercial ☐ Agricultural ☐ Recovery ☐ Injection ☐

Irrigation☐ Other ☒ (list use) observation

DATE DRILLED 10/1/08

TIME COMPLETED 10:30 AM ☒ PM ☐

3. WELL LOCATION:

CITY: Terrell COUNTY Catawba

Island Point Rd
(Street Name, Numbers, Community, Subdivision, Lot No., Parcel, Zip Code)

TOPOGRAPHIC / LAND SETTING:

☐Slope ☐Valley ☐Flat ☒Ridge ☐ Other
(check appropriate box)

LATITUDE 33 44' 45.78"

LONGITUDE 85 11' 39.15"

May be in degrees, minutes, seconds or in a decimal format

Latitude/longitude source: ☒GPS ☐Topographic map

(location of well must be shown on a USGS topo map and attached to this form if not using GPS)

4. FACILITY- is the name of the business where the well is located.

FACILITY ID #(if applicable)

NAME OF FACILITY Marshall Steam Station

STREET ADDRESS 8320 East Hwy 150

Terrell, North Carolina 28682
City or Town State Zip Code

CONTACT PERSON Ed Sullivan

MAILING ADDRESS 526 South Church Street

Charlotte, North Carolina 28202
City or Town State Zip Code

(980)- 373-3719
Area code - Phone number

5. WELL DETAILS:

a. **TOTAL DEPTH:** 59 ft bls

b. **DOES WELL REPLACE EXISTING WELL?** YES ☐ NO ☒

c. **WATER LEVEL** Below Top of Casing: 57 FT.
(Use "+" if Above Top of Casing)

d. **TOP OF CASING IS** 3 FT. Above Land Surface*
*Top of casing terminated at/or below land surface may require a variance in accordance with 15A NCAC 2C .0118.

e. **YIELD (gpm):** **METHOD OF TEST**

f. **DISINFECTION: Type** **Amount**

g. **WATER ZONES** (depth):

From To From To
From To From To
From To From To

6. CASING:

	Depth		Diameter	Thickness/ Weight	Material
From 0	To 49	Ft.	1"	Sch. 40	PVC
From	To	Ft.			
From	To	Ft.			

7. GROUT:

	Depth		Material	Method
From 0	To 38.5	Ft.	Neat Cement	pour
From 38.5	To 41	Ft.	Bentonite	pour
From	To	Ft.		

8. SCREEN:

	Depth		Diameter	Slot Size	Material
From 49	To 59	Ft.	1 in.	0.010 in.	PVC
From	To	Ft.	in.	in.	
From	To	Ft.	in.	in.	

9. SAND/GRAVEL PACK:

	Depth		Size	Material
From 41	To 59	Ft.	#2	Silica Sand
From	To	Ft.		
From	To	Ft.		

10. DRILLING LOG

From To	Formation Description
0 to 7	Clayey Silt
7 to 39.5	Sandy Silt
39.5 to 42	Silty Sand
42 to 44.5	Sandy Silt
44.5 to 53.5	Silty Sand
53.5 to 59	PWR

11. REMARKS:

I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

Jay A. Little 11-1-08
SIGNATURE OF CERTIFIED WELL CONTRACTOR DATE

Jay A. Little
PRINTED NAME OF PERSON CONSTRUCTING THE WELL

Submit the original to the Division of Water Quality within 30 days. Attn: Information Mgt., 1617 Mail Service Center – Raleigh, NC 27699-1617 Phone No. (919) 733-7015 ext 568.

Form GW-1b
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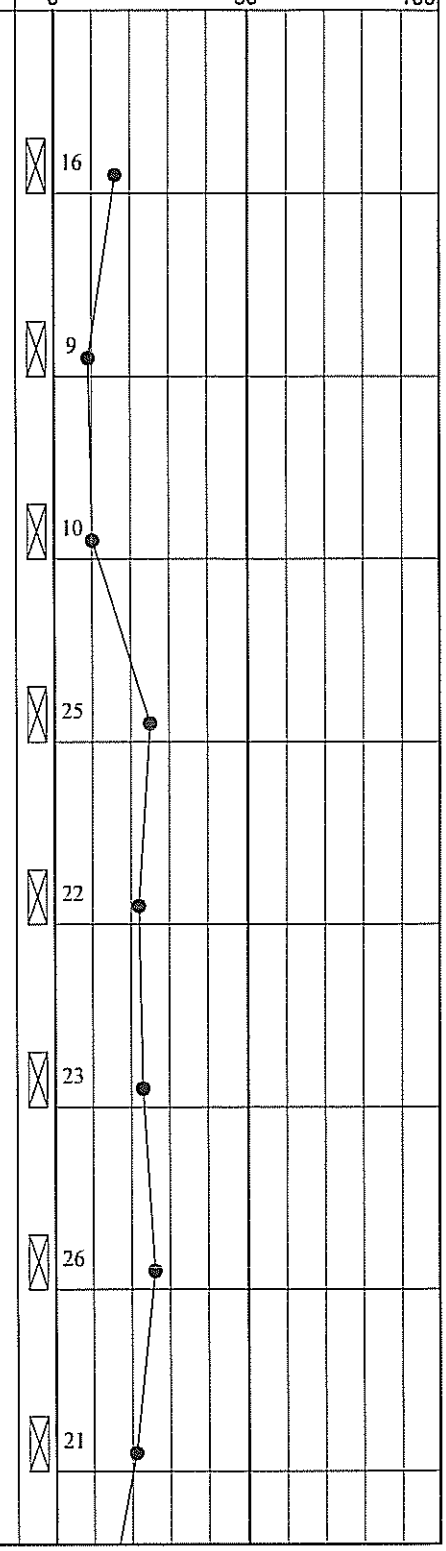
Fax: 704-525-3953

1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.
2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

Project: **Marshall Steam Station**			**Boring No. MW-60**
Location: **Terrell, North Carolina**		Number: **1356-08-122**	Sheet No. 1 of 2
Boring Depth (ft): **79.0**	Elevation (ft): **873.3**	Driller: **Jay Little, NC Cert No. 2717**	Date Drilled: **10/1/08**
Logged By: **Courtney Withers**	Water Level: **Stabilized Water Level at 47.20 ft bls**		Drilling Method: **2¼" H.S.A.**

Elev. (Feet)	Depth (Feet)	Lith-ology	Material Description	Well Construction	Penetration Resistance (Blows/Foot)
870	5		RESIDUUM: Red, Very Stiff, Micaceous, Clayey, **SILT**		16
865	10		SAPROLITE: Red and Yellow-Tan, Loose to Medium-Dense, Micaceous, Silty, Fine **SAND** With Manganese Staining. White Medium to Fine **SAND** Lense From 19.7 to 20.2 ft bls.		9
860	15				10
855	20				25
850	25				22
845	30		SAPROLITE: Orange-Tan and White, Medium-Dense, Micaceous, Slightly Clayey, Silty, Very Fine**SAND** With Manganese Staining		23
840	35		SAPROLITE: Red and Yellow-Tan, Medium-Dense, Micaceous, Slightly Clayey, Silty, Fine**SAND** With Manganese Staining. White, Medium to Fine **SAND** Lense at 39.6 ft bls.		26
835	40				21



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ENVIRONMENTAL SERVICES

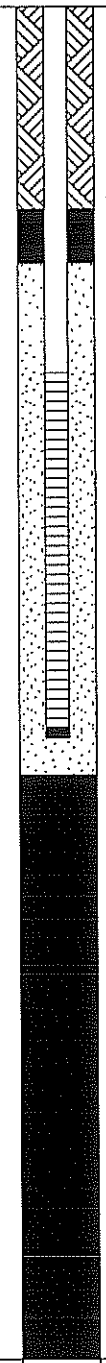
S&ME, Inc.
9751 Southern Pine Blvd.
Charlotte, North Carolina
Telephone: 704-523-4726
Fax: 704-525-3953

1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.
2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

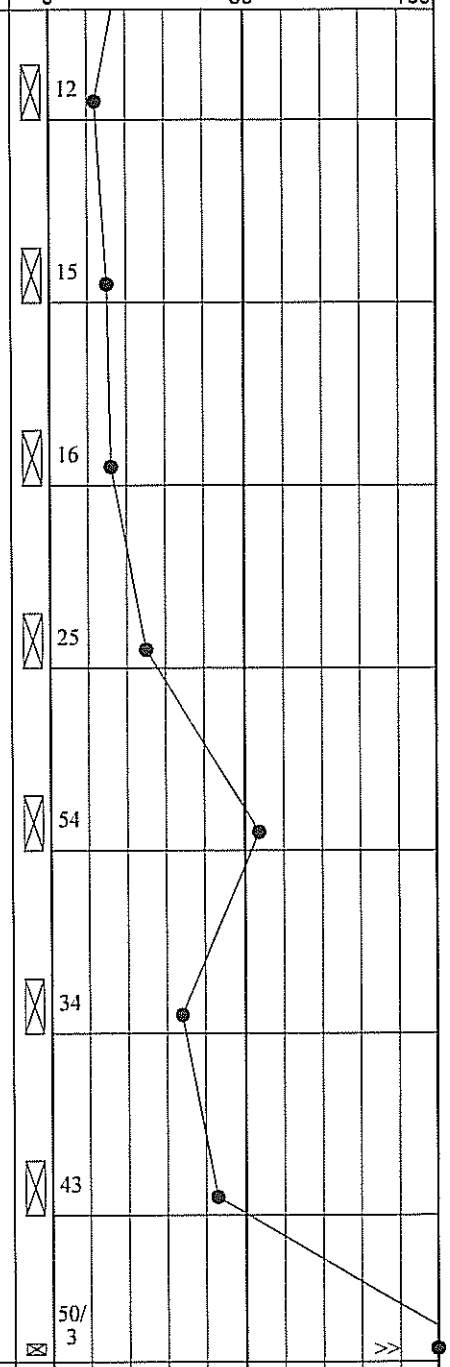
Project: **Marshall Steam Station**			**Boring No. MW-60**
Location: **Terrell, North Carolina**		Number: **1356-08-122**	Sheet No. 2 of 2
Boring Depth (ft): **79.0**	Elevation (ft): **873.3**	Driller: **Jay Little, NC Cert No. 2717**	Date Drilled: **10/1/08**
Logged By: **Courtney Withers**	Water Level: **Stabilized Water Level at 47.20 ft bls**		Drilling Method: **2¼" H.S.A.**

Elev. (Feet)	Depth (Feet)	Lith-ology	Material Description	Penetration Resistance (Blows/Foot)
830	45		SAPROLITE: Orange-Tan, Medium-Dense, Slightly Clayey, Silty, Fine **SAND** With Manganese Staining	12
825	50		SAPROLITE: Red, Yellow-Tan, White, and Black, Medium-Dense, Micaceous, Slightly Clayey, Silty, Fine **SAND** With Manganese Staining	15
820	55			16
815	60		SAPROLITE: White, Tan, and Orange, Hard to Very Hard, Micaceous, Silty, Medium to Fine Sandy **SILT** (ML) With Manganese Staining	25
810	65			54
805	70			34
800	75			43
795			PARTIALLY WEATHERED ROCK: When Sampled Becomes White, Tan, and Orange, Very Dense, Micaceous, Silty, Medium to Fine **SAND** With Manganese Staining **Auger Refusal at 79.0 ft bls**	50/3 >>

Well Construction



Penetration Resistance (Blows/Foot)



BORING LOG WITH WELL MARSHALL LOGS - FOOTPRINT EXPANSION.GPJ LAGWGN01.GDT 1/29/09

COMPLETION REPORT OF WELL No. MW-60

PROJECT: **Marshall Steam Station**
PROJECT NO: **1356-08-122**
PROJECT LOCATION: **Terrell, North Carolina**

WATER LEVEL: **Stabilized Water Level at 47.20 ft bls**
LATITUDE: **35 37 24.46**
LONGITUDE: **80 58 20.26**
TOP OF CASING ELEVATION: **876.09**
DATUM: **MSL**
LOGGED BY: **Courtney Withers**

DRILLING CONTRACTOR: **S&ME, Inc.**
DRILLING METHOD: **2¼" H.S.A.**
DATE DRILLED: **10/1/08**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)
				0.00		873.26
RESIDUUM: Red, Very Stiff, Micaceous, Clayey, **SILT**		0				
		5				
SAPROLITE: Red and Yellow-Tan, Loose to Medium-Dense, Micaceous, Silty, Fine **SAND** With Manganese Staining. White Medium to Fine **SAND** Lense From 19.7 to 20.2 ft bls.		10				
		15				
		20				
		25				
SAPROLITE: Orange-Tan and White, Medium-Dense, Micaceous, Slightly Clayey, Silty, Very Fine **SAND** With Manganese Staining		30				
		35				
		40				

WELL CONSTRUCTION DETAILS

PROTECTIVE CASING
Diameter: **4" X 4"**
Type: **Square Steel**
Interval: **+3.5 als to 1.5 ft bls**

RISER CASING
Diameter: **1"**
Type: **Sch. 40 PVC**
Interval: **+3 ft als to 52 ft bls**

GROUT
Type: **Neat Cement**
Interval: **0 to 47.5 ft bls**

SEAL
Type: **Bentonite**
Interval: **47.5 to 49 ft bls**

FILTERPACK
Type: **#2 Silica Sand**
Interval: **49 to 63 ft bls**

SCREEN
Diameter: **1"**
Type: **0.010" Slotted PVC**
Interval: **52 to 62 ft bls**

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

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Charlotte, North Carolina

COMPLETION REPORT OF WELL No. MW-60

PROJECT: **Marshall Steam Station**
PROJECT NO: **1356-08-122**
PROJECT LOCATION: **Terrell, North Carolina**

GROUND SURFACE ELEVATION: **873.3**
LOGGED BY:
CHECKED BY: **Courtney Wither**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)	WELL CONSTRUCTION DETAILS
							(See Page 1)
SAPROLITE: Red and Yellow-Tan, Medium-Dense, Micaceous, Slightly Clayey, Silty, Fine **SAND** With Manganese Staining.		45		47.50		825.76	
White, Medium to Fine **SAND** Lense at 39.6 ft bls. *(continued)*		50		49.00		824.26	
SAPROLITE: Orange-Tan, Medium-Dense, Slightly Clayey, Silty, Fine **SAND** With Manganese Staining		55					
SAPROLITE: Red, Yellow-Tan, White, and Black, Medium-Dense, Micaceous, Slightly Clayey, Silty, Fine **SAND** With Manganese Staining		60		61.70 62.00		811.56 811.26	
SAPROLITE: White, Tan, and Orange, Hard to Very Hard, Micaceous, Silty, Medium to Fine Sandy **SILT** (ML) With Manganese Staining		65 70 75		63.00		810.26	
PARTIALLY WEATHERED ROCK: When Sampled Becomes White, Tan, and Orange, Very Dense, Micaceous, Silty, Medium to Fine **SAND** With Manganese Staining				79.00		794.26	

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

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COMPLETION REPORT OF WELL No. MW-60

MONITORING WELL MARSHALL LOGS - FOOTPRINT EXPANSION.GPJ S&ME.GDT 1/29/09

NON RESIDENTIAL WELL CONSTRUCTION RECORD

North Carolina Department of Environment and Natural Resources- Division of Water Quality

WELL CONTRACTOR CERTIFICATION # 2717 – A

1. WELL CONTRACTOR:

Jay Little
Well Contractor (Individual) Name

S&ME, Inc.
Well Contractor Company Name

STREET ADDRESS 9751 Southern Pine Blvd

Charlotte, North Carolina 28273
City or Town State Zip Code

(704)- 523-4726
Area code- Phone number

2. WELL INFORMATION:

SITE WELL ID #(if applicable) M-60

STATE WELL PERMIT#(if applicable)

DWQ or OTHER PERMIT #(if applicable)

WELL USE (Check Applicable Box) Monitoring ☐ Municipal/Public ☐

Industrial/Commercial ☐ Agricultural ☐ Recovery ☐ Injection ☐

Irrigation ☐ Other ☒ (list use) observation

DATE DRILLED 10/1/08

TIME COMPLETED 4:00 AM ☐ PM ☒

3. WELL LOCATION:

CITY: Terrell COUNTY Catawba

Island Point Rd
(Street Name, Numbers, Community, Subdivision, Lot No., Parcel, Zip Code)

TOPOGRAPHIC / LAND SETTING:

☐ Slope ☐ Valley ☐ Flat ☒ Ridge ☐ Other
(check appropriate box)

LATITUDE 33 44' 45.81"

LONGITUDE 85 11' 38.74"

May be in degrees, minutes, seconds or in a decimal format

Latitude/longitude source: ☒ GPS ☐ Topographic map

(location of well must be shown on a USGS topo map and attached to this form if not using GPS)

4. FACILITY- is the name of the business where the well is located.

FACILITY ID #(if applicable)

NAME OF FACILITY Marshall Steam Station

STREET ADDRESS 8320 East Hwy 150

Terrell, North Carolina 28682
City or Town State Zip Code

CONTACT PERSON Ed Sullivan

MAILING ADDRESS 526 South Church Street

Charlotte, North Carolina 28202
City or Town State Zip Code

(980)- 373-3719
Area code - Phone number

5. WELL DETAILS:

a. **TOTAL DEPTH:** 62 ft bls

b. **DOES WELL REPLACE EXISTING WELL?** YES ☐ NO ☒

c. **WATER LEVEL** Below Top of Casing: 48.8 FT.
(Use "+" if Above Top of Casing)

d. **TOP OF CASING IS** 3 FT. Above Land Surface*
*Top of casing terminated at/or below land surface may require a variance in accordance with 15A NCAC 2C .0118.

e. **YIELD (gpm):** **METHOD OF TEST**

f. **DISINFECTION: Type** **Amount**

g. **WATER ZONES** (depth):

From To From To
From To From To
From To From To

6. CASING:

	Depth		Diameter	Thickness/ Weight	Material
From 0	To 52	Ft.	1"	Sch. 40	PVC
From	To	Ft.			
From	To	Ft.			

7. GROUT:

	Depth		Material	Method
From 0	To 47.5	Ft.	Neat Cement	pour
From 47.5	To 49	Ft.	Bentonite	pour
From	To	Ft.		

8. SCREEN:

	Depth		Diameter	Slot Size	Material
From 52	To 62	Ft.	1 in.	0.010 in.	PVC
From	To	Ft.	in.	in.	
From	To	Ft.	in.	in.	

9. SAND/GRAVEL PACK:

	Depth		Size	Material
From 49	To 62	Ft.	#2	Silica Sand
From	To	Ft.		
From	To	Ft.		

10. DRILLING LOG

From To	Formation Description
0 to 7	Clayey Silt
7 to 62	Silty Sand

11. REMARKS:

I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

Jay A. Little 11-1-08
SIGNATURE OF CERTIFIED WELL CONTRACTOR DATE

JAY A. Little
PRINTED NAME OF PERSON CONSTRUCTING THE WELL

Submit the original to the Division of Water Quality within 30 days. Attn: Information Mgt., 1617 Mail Service Center – Raleigh, NC 27699-1617 Phone No. (919) 733-7015 ext 568.

Form GW-1b
Rev. 7/05

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Telephone: 704-523-4726
Fax: 704-525-3953

1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.
2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

Project: **Marshall Steam Station**			**Boring No. MW-61**
Location: **Terrell, North Carolina**		Number: **1356-08-122**	Sheet No. 1 of 3
Boring Depth (ft): **89.0**	Elevation (ft): **874.6**	Driller: **Jay Little, NC Cert No. 2717**	Date Drilled: **10/3/08**
Logged By: **Courtney Withers**	Water Level: **Stabilized Water Level at 43.63 ft bls**		Drilling Method: **2¼" H.S.A.**

Elev. (Feet)	Depth (Feet)	Material Description	Penetration Resistance (Blows/Foot)
		RESIDUUM: Red, Stiff, Micaceous, Clayey, **SILT**	
870	5	SAPROLITE: Red, Yellow-Tan, White, and Brown, Medium-Dense, Micaceous, Silty, Fine **SAND**	10
865	10		13
860	15	SAPROLITE: Purple-Red and White, Loose, Micaceous, Silty, Medium to Fine **SAND** (SM) With Manganese Staining	9
855	20		10
850	25	SAPROLITE: Red, Brown, and White, Loose, Micaceous, Silty, Fine **SAND**	9
845	30	SAPROLITE: Brown, Tan, White, Orange, and Red, Medium-Dense, Micaceous, Silty, Fine **SAND**	14
840			17

Well Construction

Penetration Resistance (Blows/Foot): 0 — 50 — 100

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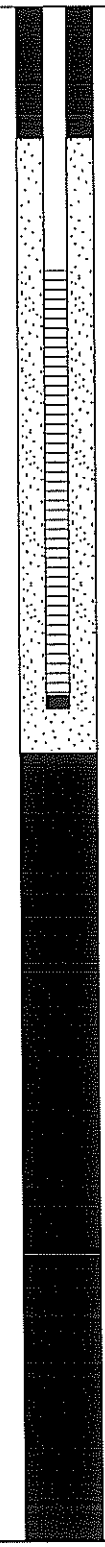
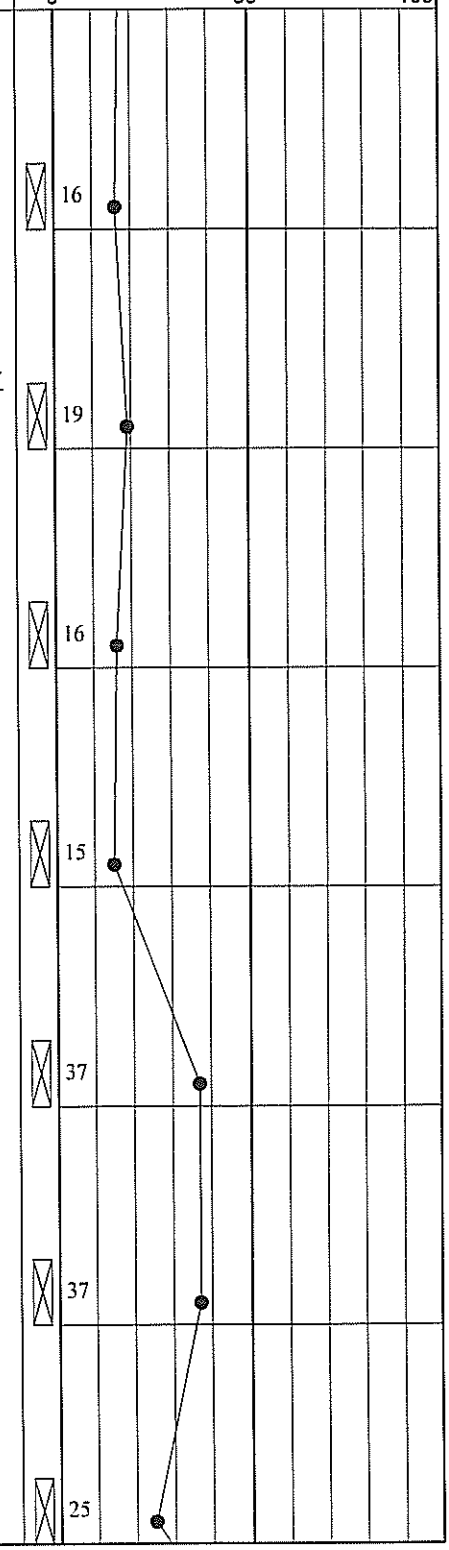
Project: **Marshall Steam Station**			**Boring No. MW-61**
Location: **Terrell, North Carolina**		Number: **1356-08-122**	Sheet No. 2 of 3
Boring Depth (ft): **89.0**	Elevation (ft): **874.6**	Driller: **Jay Little, NC Cert No. 2717**	Date Drilled: **10/3/08**
Logged By: **Courtney Withers**	Water Level: **Stabilized Water Level at 43.63 ft bls**		Drilling Method: **2¼" H.S.A.**

Elev. (Feet)	Depth (Feet)	Lithology	Material Description
835	40		SAPROLITE: Brown, Orange, White, and Black, Medium-Dense, Micaceous, Silty, Medium to Fine **SAND**
830	45		SAPROLITE: Tan, White, and Orange, Medium-Dense, Micaceous, Silty, Fine **SAND**
825	50		
820	55		SAPROLITE: Tan, Stiff, Micaceous, Very Fine Sandy, **SILT**
815	60		SAPROLITE: Orange, White, and Tan, Dense, Micaceous, Silty, Medium to Fine **SAND** With Manganese Staining
810	65		
805			SAPROLITE: White, Tan, Orange, and Black, Medium-Dense, Micaceous, Silty, Coarse to Fine **SAND** With Manganese Staining

Well Construction



Penetration Resistance (Blows/Foot)



BORING LOG WITH WELL MARSHALL LOGS - FOOTPRINT EXPANSION.GPJ LAGWGN01.GDT 1/29/09

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2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

Project: **Marshall Steam Station**			**Boring No. MW-61**
Location: **Terrell, North Carolina**		Number: **1356-08-122**	Sheet No. 3 of 3
Boring Depth (ft): **89.0**	Elevation (ft): **874.6**	Driller: **Jay Little, NC Cert No. 2717**	Date Drilled: **10/3/08**
Logged By: **Courtney Withers**	Water Level: **Stabilized Water Level at 43.63 ft bls**		Drilling Method: **2¼" H.S.A.**

Elev. (Feet)	Depth (Feet)	Lith-ology	Material Description	Well Construction	Penetration Resistance (Blows/Foot) 0 50 100
800	75		SAPROLITE: Brown, Orange, and White, Very Dense, Micaceous, Silty, Fine **SAND**		63
795	80		PARTIALLY WEATHERED ROCK: When Sampled Becomes Brown, Orange, and White, Very Hard, Micaceous, Medium to Fine Sandy, **SILT** (ML)		50/3 >>
790	85		SAPROLITE: Black and White, Dense, Micaceous, Silty, Fine **SAND** With Manganese Staining		35
			PARTIALLY WEATHERED ROCK: When Sampled Becomes Black and White, Very Dense, Micaceous, Silty, Fine **SAND** With Manganese Staining		50/4 >>
			Boring Terminated at 89 ft bls		

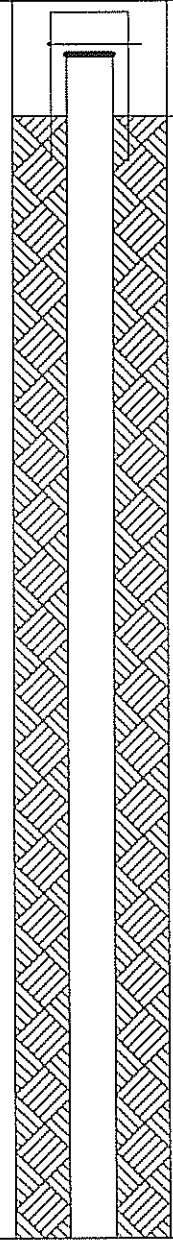
COMPLETION REPORT OF WELL No. MW-61

PROJECT: **Marshall Steam Station**
PROJECT NO: **1356-08-122**
PROJECT LOCATION: **Terrell, North Carolina**

DRILLING CONTRACTOR: **S&ME, Inc.**
DRILLING METHOD: **2¼" H.S.A.**
DATE DRILLED: **10/3/08**

WATER LEVEL: **Stabilized Water Level at 43.63 ft bls**
LATITUDE: **35 37 24.54**
LONGITUDE: **80 58 13.47**
TOP OF CASING ELEVATION: **877.65**
DATUM: **MSL**
LOGGED BY: **Courtney Withers**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)
				0.00		874.64
RESIDUUM: Red, Stiff, Micaceous, Clayey, **SILT**		0				
SAPROLITE: Red, Yellow-Tan, White, and Brown, Medium-Dense, Micaceous, Silty, Fine **SAND**		5 10				
SAPROLITE: Purple-Red and White, Loose, Micaceous, Silty, Medium to Fine **SAND** (SM) With Manganese Staining		15 20				
SAPROLITE: Red, Brown, and White, Loose, Micaceous, Silty, Fine **SAND**		25				
SAPROLITE: Brown, Tan, White, Orange, and Red, Medium-Dense, Micaceous, Silty, Fine **SAND**		30		35.00		839.64



WELL CONSTRUCTION DETAILS

PROTECTIVE CASING
Diameter: **4" X 4"**
Type: **Square Steel**
Interval: **+3.5 als to 1.5 ft bls**

RISER CASING
Diameter: **1"**
Type: **Sch. 40 PVC**
Interval: **+3 ft als to 41 ft bls**

GROUT
Type: **Neat Cement**
Interval: **0 to 35 ft bls**

SEAL
Type: **Bentonite**
Interval: **35 to 38 ft bls**

FILTERPACK
Type: **#2 Silica Sand**
Interval: **38 to 52 ft bls**

SCREEN
Diameter: **1"**
Type: **0.010" Slotted PVC**
Interval: **41 to 51 ft bls**

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

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COMPLETION REPORT OF WELL No. MW-61

PROJECT: **Marshall Steam Station**
PROJECT NO: **1356-08-122**
PROJECT LOCATION: **Terrell, North Carolina**

GROUND SURFACE ELEVATION: **874.6**
LOGGED BY: **Courtney Wither**
CHECKED BY:

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)	WELL CONSTRUCTION DETAILS
							(See Page 1)
		35		38.00		836.64	
SAPROLITE: Brown, Orange, White, and Black, Medium-Dense, Micaceous, Silty, Medium to Fine **SAND**		40					
SAPROLITE: Tan, White, and Orange, Medium-Dense, Micaceous, Silty, Fine **SAND**		45					
		50		50.70 51.00 52.00		823.94 823.64 822.64	
SAPROLITE: Tan, Stiff, Micaceous, Very Fine Sandy, **SILT**		55					
SAPROLITE: Orange, White, and Tan, Dense, Micaceous, Silty, Medium to Fine **SAND** With Manganese Staining		60					
		65					
SAPROLITE: White, Tan, Orange, and Black, Medium-Dense, Micaceous, Silty, Coarse to Fine **SAND** With Manganese Staining		70					
SAPROLITE: Brown, Orange, and White, Very Dense, Micaceous, Silty, Fine **SAND**		75					

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

MONITORING WELL MARSHALL LOGS - FOOTPRINT EXPANSION.GPJ S&ME.GDT 1/29/09

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COMPLETION REPORT OF WELL No. MW-61

PROJECT: **Marshall Steam Station**
PROJECT NO: **1356-08-122**
PROJECT LOCATION: **Terrell, North Carolina**

GROUND SURFACE ELEVATION: **874.6**
LOGGED BY: **Courtney Wither**
CHECKED BY:

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)	WELL CONSTRUCTION DETAILS
							(See Page 1)
PARTIALLY WEATHERED ROCK: When Sampled Becomes Brown, Orange, and White, Very Hard, Micaceous, Medium to Fine Sandy, **SILT** (ML) *(continued)*		80					
SAPROLITE: Black and White, Dense, Micaceous, Silty, Fine **SAND** With Manganese Staining		85		89.00		785.64	
PARTIALLY WEATHERED ROCK: When Sampled Becomes Black and White, Very Dense, Micaceous, Silty, Fine **SAND** With Manganese Staining							

LEGEND

	FILTER PACK	TOC	TOP OF CASING
	BENTONITE	GS	GROUND SURFACE
	CEMENT GROUT	BS	BENTONITE SEAL
	CUTTINGS / BACKFILL	FP	FILTER PACK
	STATIC WATER LEVEL	TSC	TOP OF SCREEN
		BSC	BOTTOM OF SCREEN
		TD	TOTAL DEPTH
		CG	CEMENT GROUT

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COMPLETION REPORT OF WELL No. MW-61

MONITORING WELL MARSHALL LOGS - FOOTPRINT EXPANSION.GPJ S&ME.GDT 1/29/09

NON RESIDENTIAL WELL CONSTRUCTION RECORD

North Carolina Department of Environment and Natural Resources- Division of Water Quality

WELL CONTRACTOR CERTIFICATION # 2717 – A

1. WELL CONTRACTOR:

Jay Little
Well Contractor (Individual) Name

S&ME, Inc.
Well Contractor Company Name

STREET ADDRESS 9751 Southern Pine Blvd

Charlotte, North Carolina 28273
City or Town State Zip Code

(704)- 523-4726
Area code- Phone number

2. WELL INFORMATION:

SITE WELL ID #(if applicable) M-61

STATE WELL PERMIT#(if applicable)

DWQ or OTHER PERMIT #(if applicable)

WELL USE (Check Applicable Box) Monitoring ☐ Municipal/Public ☐ Industrial/Commercial ☐ Agricultural ☐ Recovery ☐ Injection ☐ Irrigation ☐ Other ☒ (list use) observation

DATE DRILLED 10/3/08

TIME COMPLETED 4:00 AM ☐ PM ☒

3. WELL LOCATION:

CITY: Terrell COUNTY Catawba

Island Point Rd
(Street Name, Numbers, Community, Subdivision, Lot No., Parcel, Zip Code)

TOPOGRAPHIC / LAND SETTING:
☐ Slope ☐ Valley ☒ Flat ☐ Ridge ☐ Other
(check appropriate box)

LATITUDE 35 44' 45.84"

LONGITUDE 85 11' 38.19

May be in degrees, minutes, seconds or in a decimal format

Latitude/longitude source: ☒ GPS ☐ Topographic map
(location of well must be shown on a USGS topo map and attached to this form if not using GPS)

4. FACILITY- is the name of the business where the well is located.

FACILITY ID #(if applicable)

NAME OF FACILITY Marshall Steam Station

STREET ADDRESS 8320 East Hwy 150

Terrell, North Carolina 28682
City or Town State Zip Code

CONTACT PERSON Ed Sullivan

MAILING ADDRESS 526 South Church Street

Charlotte, North Carolina 28202
City or Town State Zip Code

(980)- 373-3719
Area code - Phone number

5. WELL DETAILS:

a. **TOTAL DEPTH:** 51 ft bls

b. **DOES WELL REPLACE EXISTING WELL?** YES ☐ NO ☒

c. **WATER LEVEL** Below Top of Casing: 47 FT.
(Use "+" if Above Top of Casing)

d. **TOP OF CASING IS** 3 FT. Above Land Surface*
*Top of casing terminated at/or below land surface may require a variance in accordance with 15A NCAC 2C .0118.

e. **YIELD (gpm):** _____ **METHOD OF TEST** _____

f. **DISINFECTION: Type** _____ **Amount** _____

g. **WATER ZONES** (depth):

From ____ To ____ From ____ To ____
From ____ To ____ From ____ To ____
From ____ To ____ From ____ To ____

6. CASING:

	Depth		Diameter	Thickness/ Weight	Material
From 0	To 41	Ft.	1"	Sch. 40	PVC
From	To	Ft.			
From	To	Ft.			

7. GROUT:

	Depth		Material	Method
From 0	To 35	Ft.	Neat Cement	pour
From 35	To 38	Ft.	Bentonite	pour
From	To	Ft.		

8. SCREEN:

	Depth		Diameter	Slot Size	Material
From 41	To 51	Ft.	1 in.	0.010 in.	PVC
From	To	Ft.	in.	in.	
From	To	Ft.	in.	in.	

9. SAND/GRAVEL PACK:

	Depth		Size	Material
From 38	To 51	Ft.	#2	Silica Sand
From	To	Ft.		
From	To	Ft.		

10. DRILLING LOG

From To	Formation Description
0 to 4.5	Clayey Silt
4.5 to 51	Silty Sand

11. REMARKS:

I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

Jay A. Little — 11-1-08
SIGNATURE OF CERTIFIED WELL CONTRACTOR — DATE

Jay A. Little
PRINTED NAME OF PERSON CONSTRUCTING THE WELL

Submit the original to the Division of Water Quality within 30 days. Attn: Information Mgt., 1617 Mail Service Center – Raleigh, NC 27699-1617 Phone No. (919) 733-7015 ext 568.

Form GW-1b
Rev. 7/05

S&ME, Inc.
9751 Southern Pine Blvd.
Charlotte, North Carolina
Telephone: 704-523-4726
Fax: 704-525-3953

ENGINEERING • TESTING
ENVIRONMENTAL SERVICES

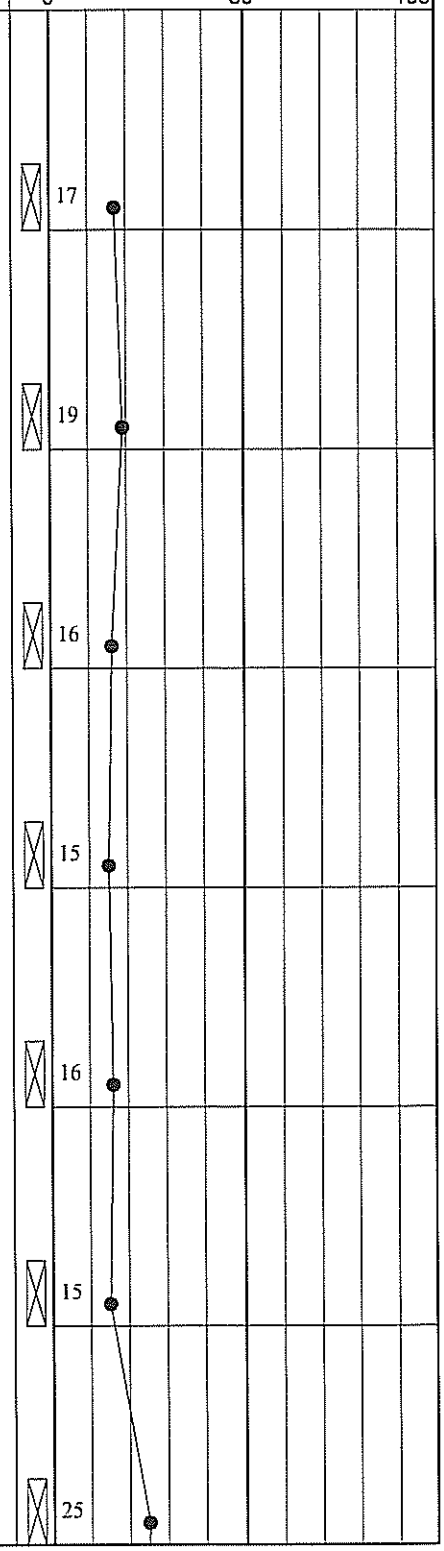
1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.
2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

Project: **Marshall Steam Station**			**Boring No. MW-62**
Location: **Terrell, North Carolina**		Number: **1356-08-122**	Sheet No. 1 of 3
Boring Depth (ft): **90.0**	Elevation (ft): **868.3**	Driller: **Jay Little, NC Cert No. 2717**	Date Drilled: **10/2/08**
Logged By: **Courtney Withers**	Water Level: **Stabilized Water Level at 39.18 ft bls**		Drilling Method: **2¼" H.S.A.**

Elev. (Feet)	Depth (Feet)	Material Description
		RESIDUUM: Red, Very Stiff, Micaceous, Clayey, **SILT** With Manganese Staining and Rock Fragments
865	5	
		SAPROLITE: Purple-Red, Yellow-Tan, and White, Medium-Dense, Micaceous, Slightly Clayey, Silty, Fine **SAND** With Manganese Staining
860	10	
855	15	
		SAPROLITE: Red, Yellow-Tan, and White, Medium-Dense, Micaceous, Silty, Fine **SAND** With Manganese Staining
850	20	
845	25	SAPROLITE: Red, White, Orange, and Tannish-Gray, Medium-Dense, Micaceous, Silty, Very Fine **SAND**
840	30	SAPROLITE: Tannish-Gray, Stiff to Very Stiff, Micaceous, Fine Sandy, **SILT** (ML) With Manganese Staining
835		

Well Construction

Penetration Resistance (Blows/Foot)



BORING LOG WITH WELL MARSHALL LOGS - FOOTPRINT EXPANSION.GPJ LAGWGN01.GDT 1/29/09

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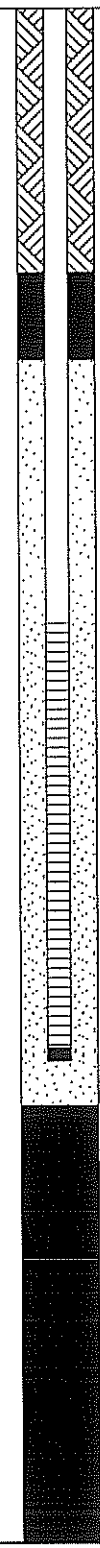
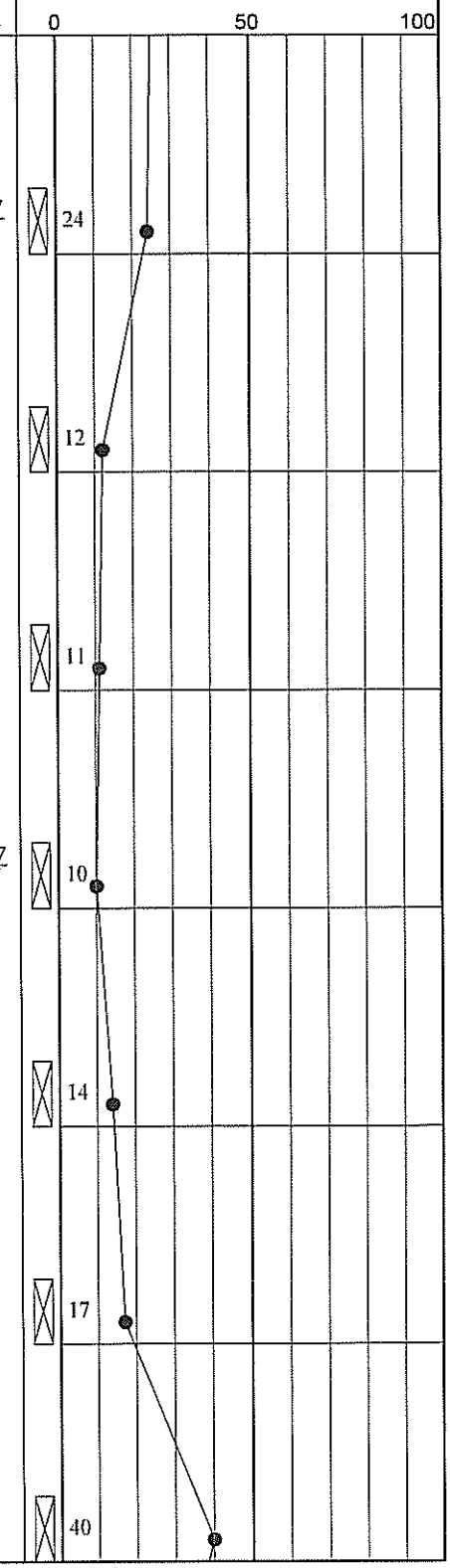
Project: **Marshall Steam Station**			**Boring No. MW-62**
Location: **Terrell, North Carolina**		Number: **1356-08-122**	Sheet No. 2 of 3
Boring Depth (ft): **90.0**	Elevation (ft): **868.3**	Driller: **Jay Little, NC Cert No. 2717**	Date Drilled: **10/2/08**
Logged By: **Courtney Withers**	Water Level: **Stabilized Water Level at 39.18 ft bls**		Drilling Method: **2¼" H.S.A.**

Elev. (Feet)	Depth (Feet)	Lith-ology	Material Description
830	40		
825	45		SAPROLITE: Tan, Orange, Brown, and White, Medium-Dense, Micaceous, Slightly Clayey, Silty, Fine **SAND** With Manganese Staining
820	50		SAPROLITE: Tan, White, and Gold, Stiff, Micaceous, Very Fine Sandy, **SILT** With Manganese Staining
815	55		
810	60		SAPROLITE: Tan, White, and Orange, Medium-Dense to Dense, Micaceous, Silty, Fine **SAND** With Manganese Staining. White, Coarse to Medium **SAND** Lense at 69.7 ft bls.
805	65		
800			

Well Construction



Penetration Resistance (Blows/Foot)



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1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.
2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

Project: **Marshall Steam Station**			**Boring No. MW-62**
Location: **Terrell, North Carolina**		Number: **1356-08-122**	Sheet No. 3 of 3
Boring Depth (ft): **90.0**	Elevation (ft): **868.3**	Driller: **Jay Little, NC Cert No. 2717**	Date Drilled: **10/2/08**
Logged By: **Courtney Withers**	Water Level: **Stabilized Water Level at 39.18 ft bls**		Drilling Method: **2¼" H.S.A.**

Elev. (Feet)	Depth (Feet)	Lith-ology	Material Description	Well Construction	Penetration Resistance (Blows/Foot) 0 50 100
795					
	75				25
790					
	80				17
785					
	85				22
780					
	90				21
			Boring Terminated at 90.0 ft bls		

COMPLETION REPORT OF WELL No. MW-62

PROJECT: **Marshall Steam Station**
PROJECT NO: **1356-08-122**
PROJECT LOCATION: **Terrell, North Carolina**

WATER LEVEL: **Stabilized Water Level at 39.18 ft bls**
LATITUDE: **35 37 23.05**
LONGITUDE: **80 58 16.87**
TOP OF CASING ELEVATION: **871.34**
DATUM: **MSL**
LOGGED BY: **Courtney Withers**

DRILLING CONTRACTOR: **S&ME, Inc.**
DRILLING METHOD: **2¼" H.S.A.**
DATE DRILLED: **10/2/08**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)
				0.00		868.34
RESIDUUM: Red, Very Stiff, Micaceous, Clayey, **SILT** With Manganese Staining and Rock Fragments		0				
		5				
SAPROLITE: Purple-Red, Yellow-Tan, and White, Medium-Dense, Micaceous, Slightly Clayey, Silty, Fine **SAND** With Manganese Staining		10				
		15				
SAPROLITE: Red, Yellow-Tan, and White, Medium-Dense, Micaceous, Silty, Fine **SAND** With Manganese Staining		20				
SAPROLITE: Red, White, Orange, and Tannish-Gray, Medium-Dense, Micaceous, Silty, Very Fine **SAND**		25				
SAPROLITE: Tannish-Gray, Stiff to Very Stiff, Micaceous, Fine Sandy, **SILT** (ML) With Manganese Staining		30				

WELL CONSTRUCTION DETAILS

PROTECTIVE CASING
Diameter: **4" X 4"**
Type: **Square Steel**
Interval: **+3.5 als to 1.5 ft bls**

RISER CASING
Diameter: **1"**
Type: **Sch. 40 PVC**
Interval: **+3 ft als to 49 ft bls**

GROUT
Type: **Neat Cement**
Interval: **0 to 41 ft bls**

SEAL
Type: **Bentonite**
Interval: **41 to 43 ft bls**

FILTERPACK
Type: **#2 Silica Sand**
Interval: **43 to 60 ft bls**

SCREEN
Diameter: **1"**
Type: **0.010" Slotted PVC**
Interval: **49 to 59 ft bls**

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

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Charlotte, North Carolina

COMPLETION REPORT OF WELL No. MW-62

PROJECT: **Marshall Steam Station**
PROJECT NO: **1356-08-122**
PROJECT LOCATION: **Terrell, North Carolina**

GROUND SURFACE ELEVATION: **868.3**
LOGGED BY: **Courtney Wither**
CHECKED BY:

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)	WELL CONSTRUCTION DETAILS
							(See Page 1)
SAPROLITE: Tannish-Gray, Stiff to Very Stiff, Micaceous, Fine Sandy, **SILT** (ML) With Manganese Staining *(continued)*		35					
		40		41.00		827.34	
				43.00		825.34	
SAPROLITE: Tan, Orange, Brown, and White, Medium-Dense, Micaceous, Slightly Clayey, Silty, Fine **SAND** With Manganese Staining		45					
SAPROLITE: Tan, White, and Gold, Stiff, Micaceous, Very Fine Sandy, **SILT** With Manganese Staining		50					
		55					
SAPROLITE: Tan, White, and Orange, Medium-Dense to Dense, Micaceous, Silty, Fine **SAND** With Manganese Staining. White, Coarse to Medium **SAND** Lense at 69.7 ft bls.				58.70		809.64	
				59.00		809.34	
		60		60.00		808.34	
		65					
		70					
		75					

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

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Charlotte, North Carolina

COMPLETION REPORT OF WELL No. MW-62

PROJECT: **Marshall Steam Station**
PROJECT NO: **1356-08-122**
PROJECT LOCATION: **Terrell, North Carolina**

GROUND SURFACE ELEVATION: **868.3**
LOGGED BY: **Courtney Wither**
CHECKED BY:

STRATA			WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)	WELL CONSTRUCTION DETAILS
DESCRIPTION	SYMBOL	DEPTH (ft.)					
							(See Page 1)
SAPROLITE: Tan, White, and Orange, Medium-Dense to Dense, Micaceous, Silty, Fine **SAND** With Manganese Staining. White, Coarse to Medium **SAND** Lense at 69.7 ft bls. *(continued)*		80 85 90		90.00		778.34	

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

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Charlotte, North Carolina

COMPLETION REPORT OF WELL No. MW-62

MONITORING WELL MARSHALL LOGS - FOOTPRINT EXPANSION.GPJ S&ME.GDT 1/29/09

NON RESIDENTIAL WELL CONSTRUCTION RECORD

North Carolina Department of Environment and Natural Resources- Division of Water Quality

WELL CONTRACTOR CERTIFICATION # 2717 – A

1. WELL CONTRACTOR:

Jay Little
Well Contractor (Individual) Name

S&ME, Inc.
Well Contractor Company Name

STREET ADDRESS 9751 Southern Pine Blvd

Charlotte, North Carolina 28273
City or Town State Zip Code

(704)- 523-4726
Area code- Phone number

2. WELL INFORMATION:

SITE WELL ID #(if applicable) M-62

STATE WELL PERMIT#(if applicable)

DWQ or OTHER PERMIT #(if applicable)

WELL USE (Check Applicable Box) Monitoring ☐ Municipal/Public ☐ Industrial/Commercial ☐ Agricultural ☐ Recovery ☐ Injection ☐ Irrigation ☐ Other ☒ (list use) observation

DATE DRILLED 10/2/08

TIME COMPLETED 2:30 AM ☐ PM ☒

3. WELL LOCATION:

CITY: Terrell COUNTY Catawba

Island Point Rd
(Street Name, Numbers, Community, Subdivision, Lot No., Parcel, Zip Code)

TOPOGRAPHIC / LAND SETTING:
☐ Slope ☐ Valley ☒ Flat ☐ Ridge ☐ Other
(check appropriate box)

LATITUDE 33 44' 45.71"

LONGITUDE 85 11' 38.46"

May be in degrees, minutes, seconds or in a decimal format

Latitude/longitude source: ☒ GPS ☐ Topographic map

(location of well must be shown on a USGS topo map and attached to this form if not using GPS)

4. FACILITY- is the name of the business where the well is located.

FACILITY ID #(if applicable)

NAME OF FACILITY Marshall Steam Station

STREET ADDRESS 8320 East Hwy 150

Terrell, North Carolina 28682
City or Town State Zip Code

CONTACT PERSON Ed Sullivan

MAILING ADDRESS 526 South Church Street

Charlotte, North Carolina 28202
City or Town State Zip Code

(980)- 373-3719
Area code - Phone number

5. WELL DETAILS:

a. **TOTAL DEPTH:** 59 ft bls

b. **DOES WELL REPLACE EXISTING WELL?** YES ☐ NO ☒

c. **WATER LEVEL** Below Top of Casing: 57 FT.
(Use "+" if Above Top of Casing)

d. **TOP OF CASING IS** 3 FT. Above Land Surface*
*Top of casing terminated at/or below land surface may require a variance in accordance with 15A NCAC 2C .0118.

e. **YIELD (gpm):** _____ **METHOD OF TEST** _____

f. **DISINFECTION: Type** _____ **Amount** _____

g. **WATER ZONES** (depth):

From ____ To ____ From ____ To ____
From ____ To ____ From ____ To ____
From ____ To ____ From ____ To ____

6. CASING:

	Depth		Diameter	Thickness/ Weight	Material
From 0	To 49	Ft.	1"	Sch. 40	PVC
From	To	Ft.			
From	To	Ft.			

7. GROUT:

	Depth		Material	Method
From 0	To 41	Ft.	Neat Cement	pour
From 41	To 43	Ft.	Bentonite	pour
From	To	Ft.		

8. SCREEN:

	Depth		Diameter	Slot Size	Material
From 49	To 59	Ft.	1 in.	0.010 in.	PVC
From	To	Ft.	in.	in.	
From	To	Ft.	in.	in.	

9. SAND/GRAVEL PACK:

	Depth		Size	Material
From 43	To 59	Ft.	#2	Silica Sand
From	To	Ft.		
From	To	Ft.		

10. DRILLING LOG

From To	Formation Description
0 to 7	Clayey Silt
7 to 28	Silty Sand
28 to 43	Sandy Silt
43 to 48	Silty Sand
48 to 56	Sandy Silt
56 to 59	Silty Sand

11. REMARKS:

I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

Jay A. Little 11-1-08
SIGNATURE OF CERTIFIED WELL CONTRACTOR DATE

JAY A. LITTLE
PRINTED NAME OF PERSON CONSTRUCTING THE WELL

Submit the original to the Division of Water Quality within 30 days. Attn: Information Mgt., 1617 Mail Service Center – Raleigh, NC 27699-1617 Phone No. (919) 733-7015 ext 568.

Form GW-1b
Rev. 7/05

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Fax: 704-525-3953

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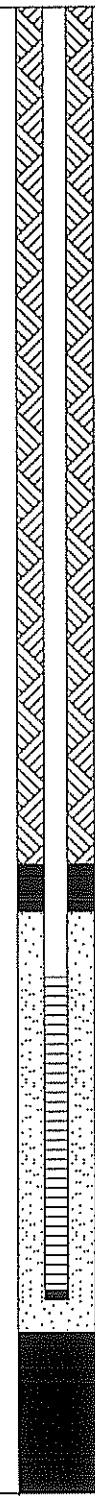
2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

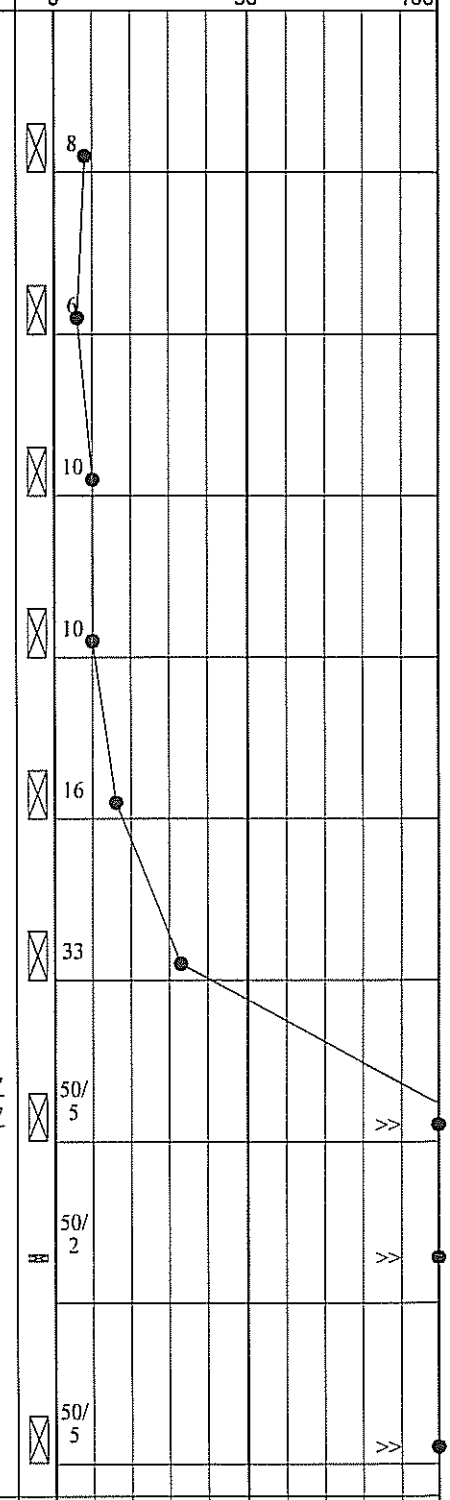
Project: **Marshall Steam Station**			**Boring No. MW-63**
Location: **Terrell, North Carolina**		Number: **1356-08-122**	Sheet No. 1 of 1
Boring Depth (ft): **46.0**	Elevation (ft): **859.4**	Driller: **Jay Little, NC Cert No. 2717**	Date Drilled: **10/3/08**
Logged By: **Courtney Withers**	Water Level: **Stabilized Water Level at 33.57 ft bls**		Drilling Method: **2¼" H.S.A.**

Elev. (Feet)	Depth (Feet)	Lith-ology	Material Description
			RESIDUUM: Red, Firm, Micaceous, Clayey, **SILT**
855	5		SAPROLITE: Yellow-Red, Tan, White, and Orange, Loose, Micaceous, Silty, Coarse to Fine **SAND** (SM)
850	10		
845	15		
840	20		SAPROLITE: Tan, Loose, Micaceous, Silty, Very Fine **SAND** With Intermittent White, Medium to Fine **SAND** Lenses
835	25		SAPROLITE: Tan, White, and Orange, Medium-Dense to Dense, Micaceous, Silty, Fine **SAND**
830	30		
825	35		PARTIALLY WEATHERED ROCK: When Sampled Becomes Tan, White, and Orange, Very Dense, Micaceous, Silty, Fine **SAND**
820	40		PARTIALLY WEATHERED ROCK: When Sampled Becomes White, Tan, Black, and Orange, Very Dense, Micaceous, Silty, Medium to Fine **SAND**
815	45		
			Auger Refusal at 46.0 ft bls

Well Construction



Penetration Resistance (Blows/Foot)



BORING LOG WITH WELL MARSHALL LOGS - FOOTPRINT EXPANSION.GPJ LAGWGN01.GDT 1/29/09

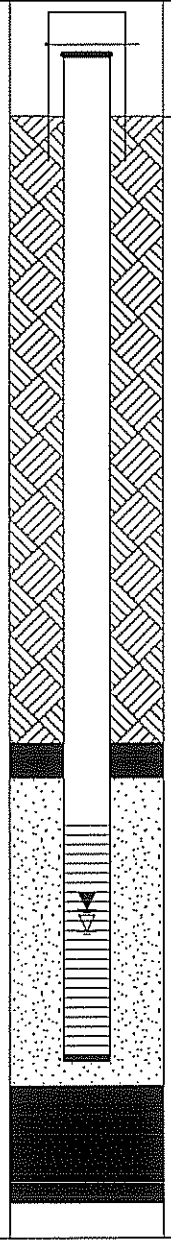
COMPLETION REPORT OF WELL No. MW-63

PROJECT: **Marshall Steam Station**
PROJECT NO: **1356-08-122**
PROJECT LOCATION: **Terrell, North Carolina**

DRILLING CONTRACTOR: **S&ME, Inc.**
DRILLING METHOD: **2¼" H.S.A.**
DATE DRILLED: **10/3/08**

WATER LEVEL: **Stabilized Water Level at 33.57 ft bls**
LATITUDE: **35 37 13.22**
LONGITUDE: **80 58 14.17**
TOP OF CASING ELEVATION: **862.50**
DATUM: **MSL**
LOGGED BY: **Courtney Withers**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)
				0.00		859.39
RESIDUUM: Red, Firm, Micaceous, Clayey, **SILT**		0				
SAPROLITE: Yellow-Red, Tan, White, and Orange, Loose, Micaceous, Silty, Coarse to Fine **SAND** (SM)		5, 10, 15				
SAPROLITE: Tan, Loose, Micaceous, Silty, Very Fine **SAND** With Intermittent White, Medium to Fine **SAND** Lenses		20				
SAPROLITE: Tan, White, and Orange, Medium-Dense to Dense, Micaceous, Silty, Fine **SAND**		25, 30		26.50 28.00		832.89 831.39
PARTIALLY WEATHERED ROCK: When Sampled Becomes Tan, White, and Orange, Very Dense, Micaceous, Silty, Fine **SAND**		35, 40		39.70 40.00		819.69 819.39
PARTIALLY WEATHERED ROCK: When Sampled Becomes White, Tan, Black, and Orange, Very Dense, Micaceous, Silty,		45		41.00 46.00		818.39 813.39



WELL CONSTRUCTION DETAILS

PROTECTIVE CASING
Diameter: **4" X 4"**
Type: **Square Steel**
Interval: **+3.5 als to 1.5 ft bls**

RISER CASING
Diameter: **1"**
Type: **Sch. 40 PVC**
Interval: **+3 ft als to 30 ft bls**

GROUT
Type: **Neat Cement**
Interval: **0 to 26.5 ft bls**

SEAL
Type: **Bentonite**
Interval: **26.5 to 28 ft bls**

FILTERPACK
Type: **#2 Silica Sand**
Interval: **28 to 41 ft bls**

SCREEN
Diameter: **1"**
Type: **0.010" Slotted PVC**
Interval: **30 to 40 ft bls**

LEGEND

FILTER PACK
BENTONITE
CEMENT GROUT
CUTTINGS / BACKFILL
STATIC WATER LEVEL

TOC TOP OF CASING
GS GROUND SURFACE
BS BENTONITE SEAL
FP FILTER PACK
TSC TOP OF SCREEN
BSC BOTTOM OF SCREEN
TD TOTAL DEPTH
CG CEMENT GROUT

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COMPLETION REPORT OF WELL No. MW-63

PROJECT: **Marshall Steam Station**
PROJECT NO: **1356-08-122**
PROJECT LOCATION: **Terrell, North Carolina**

GROUND SURFACE ELEVATION: **859.4**
LOGGED BY:
CHECKED BY: **Courtney Wither**

STRATA			WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)	WELL CONSTRUCTION DETAILS
DESCRIPTION	SYMBOL	DEPTH (ft.)					
							(See Page 1)
Medium to Fine SAND							

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

S&ME
ENGINEERING • TESTING
ENVIRONMENTAL SERVICES
9751 Southern Pine Blvd.
Charlotte, North Carolina

COMPLETION REPORT OF WELL No. MW-63

NON RESIDENTIAL WELL CONSTRUCTION RECORD

North Carolina Department of Environment and Natural Resources- Division of Water Quality

WELL CONTRACTOR CERTIFICATION # 2717 – A

1. WELL CONTRACTOR:

Jay Little
Well Contractor (Individual) Name

S&ME, Inc.
Well Contractor Company Name

STREET ADDRESS 9751 Southern Pine Blvd

Charlotte, North Carolina 28273
City or Town State Zip Code

(704)- 523-4726
Area code- Phone number

2. WELL INFORMATION:

SITE WELL ID #(if applicable) M-63

STATE WELL PERMIT#(if applicable)

DWQ or OTHER PERMIT #(if applicable)

WELL USE (Check Applicable Box) Monitoring ☐ Municipal/Public ☐

Industrial/Commercial ☐ Agricultural ☐ Recovery ☐ Injection ☐

Irrigation ☐ Other ☒ (list use) observation

DATE DRILLED 10/3/08

TIME COMPLETED 12:00 AM ☐ PM ☒

3. WELL LOCATION:

CITY: Terrell COUNTY Catawba

Island Point Rd
(Street Name, Numbers, Community, Subdivision, Lot No., Parcel, Zip Code)

TOPOGRAPHIC / LAND SETTING:

☐ Slope ☐ Valley ☒ Flat ☐ Ridge ☐ Other
(check appropriate box)

LATITUDE 3 3 44' 44.89"

LONGITUDE 85 11' 38.19"

May be in degrees, minutes, seconds or in a decimal format

Latitude/longitude source: ☒ GPS ☐ Topographic map

(location of well must be shown on a USGS topo map and attached to this form if not using GPS)

4. FACILITY- is the name of the business where the well is located.

FACILITY ID #(if applicable)

NAME OF FACILITY Marshall Steam Station

STREET ADDRESS 8320 East Hwy 150

Terrell, North Carolina 28682
City or Town State Zip Code

CONTACT PERSON Ed Sullivan

MAILING ADDRESS 526 South Church Street

Charlotte, North Carolina 28202
City or Town State Zip Code

(980)- 373-3719
Area code - Phone number

5. WELL DETAILS:

a. **TOTAL DEPTH:** 40 ft bls

b. **DOES WELL REPLACE EXISTING WELL?** YES ☐ NO ☒

c. **WATER LEVEL** Below Top of Casing: 37.5 FT.
(Use "+" if Above Top of Casing)

d. **TOP OF CASING IS** 3 FT. Above Land Surface*
*Top of casing terminated at/or below land surface may require a variance in accordance with 15A NCAC 2C .0118.

e. **YIELD (gpm):** _____ **METHOD OF TEST** _____

f. **DISINFECTION: Type** _____ **Amount** _____

g. **WATER ZONES** (depth):

From ____ To ____ From ____ To ____
From ____ To ____ From ____ To ____
From ____ To ____ From ____ To ____

6. CASING:

	Depth		Diameter	Thickness/ Weight	Material
From 0	To 30	Ft.	1"	Sch. 40	PVC
From	To	Ft.			
From	To	Ft.			

7. GROUT:

	Depth		Material	Method
From 0	To 26.5	Ft.	Neat Cement	pour
From 26.5	To 28	Ft.	Bentonite	pour
From	To	Ft.		

8. SCREEN:

	Depth		Diameter	Slot Size	Material
From 30	To 40	Ft.	1 in.	0.010 in.	PVC
From	To	Ft.	in.	in.	
From	To	Ft.	in.	in.	

9. SAND/GRAVEL PACK:

	Depth		Size	Material
From 28	To 40	Ft.	#2	Silica Sand
From	To	Ft.		
From	To	Ft.		

10. DRILLING LOG

From To	Formation Description
0 to 2	Clayey Silt
2 to 33.5	Silty Sand
33.5 to 40	PWR

11. REMARKS:

I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

Jay A. Little 11-1-08
SIGNATURE OF CERTIFIED WELL CONTRACTOR DATE

JAY A. LITTLE
PRINTED NAME OF PERSON CONSTRUCTING THE WELL

Submit the original to the Division of Water Quality within 30 days. Attn: Information Mgt., 1617 Mail Service Center – Raleigh, NC 27699-1617 Phone No. (919) 733-7015 ext 568.

Form GW-1b
Rev. 7/05

S&ME
ENGINEERING • TESTING
ENVIRONMENTAL SERVICES

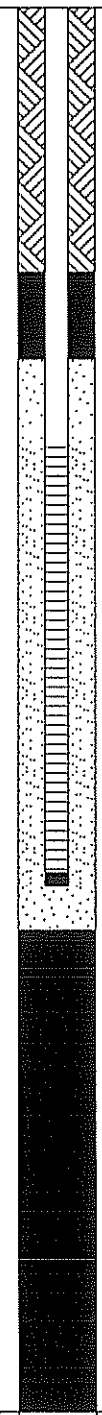
S&ME, Inc.
9751 Southern Pine Blvd.
Charlotte, North Carolina
Telephone: 704-523-4726
Fax: 704-525-3953

1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.
2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

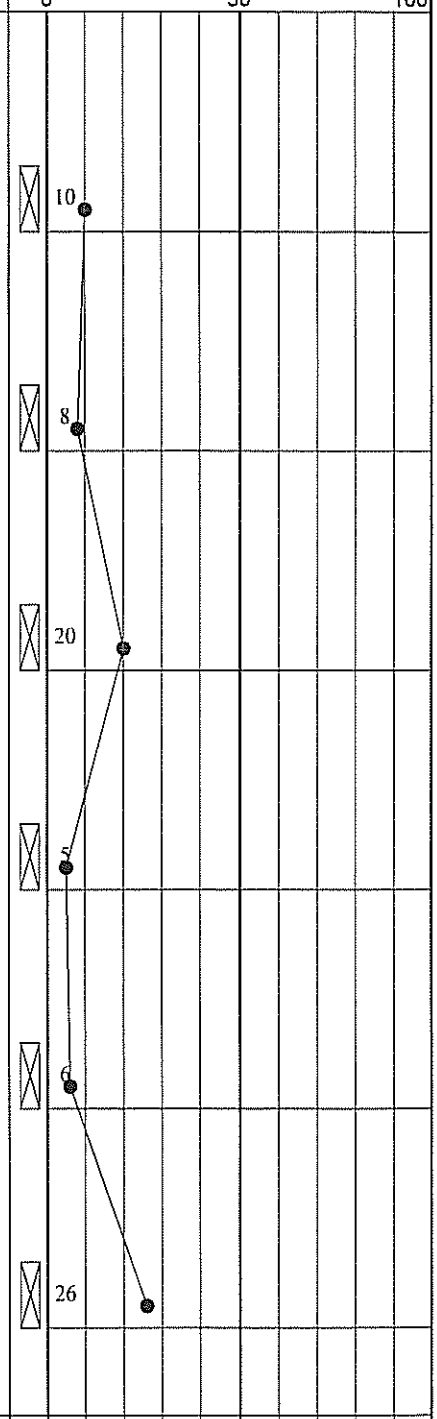
Project: **Marshall Steam Station**			**Boring No. MW-64**
Location: **Terrell, North Carolina**		Number: **1356-08-122**	Sheet No. 1 of 1
Boring Depth (ft): **32.0**	Elevation (ft): **842.4**	Driller: **Jay Little, NC Cert No. 2717**	Date Drilled: **10/2/08**
Logged By: **Courtney Withers**	Water Level: **Stabilized Water Level at 15.65 ft bls**		Drilling Method: **2¼" H.S.A.**

Elev. (Feet)	Depth (Feet)	Material Description
840		RESIDUUM: Red and Brown, Stiff, Micaceous, Clayey, **SILT**
	5	SAPROLITE: Red, Orange, White, and Tan, Loose, Micaceous, Silty, Fine **SAND**
835		
		SAPROLITE: Orange and Brown, Firm, Micaceous, Slightly Clayey, Fine Sandy, **SILT**
	10	SAPROLITE: Orange, White, and Tan, Loose, Micaceous, Silty, Fine **SAND**
830		
		SAPROLITE: Black and White, Medium-Dense, Micaceous, Silty, Very Fine **SAND**
	15	SAPROLITE: White, Medium-Dense, Coarse to Fine **SAND** (SM)
		SAPROLITE: Brown, Tan, Orange, and White, Loose, Micaceous, Silty, Very Fine **SAND** With Manganese Staining
825		
	20	
820		
	25	
815		
	30	SAPROLITE: Black, White, and Orange, Medium-Dense, Micaceous, Slightly Clayey, Silty, Fine **SAND**
		PARTIALLY WEATHERED ROCK: When Sampled Becomes Black, White, and Orange, Very Dense, Micaceous, Slightly Clayey, Silty, Fine **SAND**
		Auger Refusal at 32.0 ft bls

Well Construction



Penetration Resistance (Blows/Foot)



BORING LOG WITH WELL MARSHALL LOGS - FOOTPRINT EXPANSION.GPJ LAGWGN01.GDT 1/29/09

COMPLETION REPORT OF WELL No. MW-64

PROJECT: **Marshall Steam Station**
PROJECT NO: **1356-08-122**
PROJECT LOCATION: **Terrell, North Carolina**

WATER LEVEL: **Stabilized Water Level at 15.65 ft bls**
LATITUDE: **35 37 11.95**
LONGITUDE: **80 58 16.80**
TOP OF CASING ELEVATION: **845.36**
DATUM: **MSL**
LOGGED BY: **Courtney Withers**

DRILLING CONTRACTOR: **S&ME, Inc.**
DRILLING METHOD: **2¼" H.S.A.**
DATE DRILLED: **10/2/08**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)
				0.00		842.37
RESIDUUM: Red and Brown, Stiff, Micaceous, Clayey, **SILT**		0				
SAPROLITE: Red, Orange, White, and Tan, Loose, Micaceous, Silty, Fine **SAND**		5		6.00		836.37
				8.00		834.37
SAPROLITE: Orange and Brown, Firm, Micaceous, Slightly Clayey, Fine Sandy, **SILT**		10				
SAPROLITE: Orange, White, and Tan, Loose, Micaceous, Silty, Fine **SAND**		15				
SAPROLITE: Black and White, Medium-Dense, Micaceous, Silty, Very Fine **SAND**				19.70		822.67
SAPROLITE: White, Medium-Dense, Coarse to Fine **SAND** (SM)		20		20.00		822.37
				21.00		821.37
SAPROLITE: Brown, Tan, Orange, and White, Loose, Micaceous, Silty, Very Fine **SAND** With Manganese Staining		25				
SAPROLITE: Black, White, and Orange, Medium-Dense, Micaceous, Slightly Clayey, Silty, Fine **SAND**		30		32.00		810.37
PARTIALLY WEATHERED ROCK:						

WELL CONSTRUCTION DETAILS

PROTECTIVE CASING
Diameter: **4" X 4"**
Type: **Square Steel**
Interval: **+3.5 als to 1.5 ft bls**

RISER CASING
Diameter: **1"**
Type: **Sch. 40 PVC**
Interval: **+3 ft als to 10 ft bls**

GROUT
Type: **Neat Cement**
Interval: **0 to 6 ft bls**

SEAL
Type: **Bentonite**
Interval: **6 to 8 ft bls**

FILTERPACK
Type: **#2 Silica Sand**
Interval: **8 to 21 ft bls**

SCREEN
Diameter: **1"**
Type: **0.010" Slotted PVC**
Interval: **10 to 20 ft bls**

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

S&ME
ENGINEERING • TESTING
ENVIRONMENTAL SERVICES
9751 Southern Pine Blvd.
Charlotte, North Carolina

COMPLETION REPORT OF WELL No. MW-64

MONITORING WELL MARSHALL LOGS - FOOTPRINT EXPANSION.GPJ S&ME.GDT 1/29/09

PROJECT: **Marshall Steam Station**
PROJECT NO: **1356-08-122**
PROJECT LOCATION: **Terrell, North Carolina**

GROUND SURFACE ELEVATION: **842.4**
LOGGED BY:
CHECKED BY: **Courtney Wither**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)	WELL CONSTRUCTION DETAILS
							(See Page 1)
When Sampled Becomes Black, White, and Orange, Very Dense, Micaceous, Slightly Clayey, Silty, Fine **SAND**							

LEGEND

	FILTER PACK	TOC	TOP OF CASING
	BENTONITE	GS	GROUND SURFACE
	CEMENT GROUT	BS	BENTONITE SEAL
	CUTTINGS / BACKFILL	FP	FILTER PACK
	STATIC WATER LEVEL	TSC	TOP OF SCREEN
		BSC	BOTTOM OF SCREEN
		TD	TOTAL DEPTH
		CG	CEMENT GROUT

S&ME
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Charlotte, North Carolina

COMPLETION REPORT OF WELL No. MW-64

NON RESIDENTIAL WELL CONSTRUCTION RECORD

North Carolina Department of Environment and Natural Resources- Division of Water Quality

WELL CONTRACTOR CERTIFICATION # 2717 – A

1. WELL CONTRACTOR:

Jay Little
Well Contractor (Individual) Name

S&ME, Inc.
Well Contractor Company Name

STREET ADDRESS 9751 Southern Pine Blvd

Charlotte, North Carolina 28273
City or Town State Zip Code

(704)- 523-4726
Area code- Phone number

2. WELL INFORMATION:

SITE WELL ID #(if applicable) M-64

STATE WELL PERMIT#(if applicable)

DWQ or OTHER PERMIT #(if applicable)

WELL USE (Check Applicable Box) Monitoring ☐ Municipal/Public ☐

Industrial/Commercial ☐ Agricultural ☐ Recovery ☐ Injection ☐

Irrigation ☐ Other ☒ (list use) observation

DATE DRILLED 10/2/08

TIME COMPLETED 4:00 AM ☐ PM ☒

3. WELL LOCATION:

CITY: Terrell COUNTY Catawba

Island Point Rd
(Street Name, Numbers, Community, Subdivision, Lot No., Parcel, Zip Code)

TOPOGRAPHIC / LAND SETTING:

☐ Slope ☐ Valley ☒ Flat ☐ Ridge ☐ Other
(check appropriate box)

LATITUDE 33 44' 44.78"

LONGITUDE 85 11' 38.40"

May be in degrees, minutes, seconds or in a decimal format

Latitude/longitude source: ☒ GPS ☐ Topographic map

(location of well must be shown on a USGS topo map and attached to this form if not using GPS)

4. FACILITY- is the name of the business where the well is located.

FACILITY ID #(if applicable)

NAME OF FACILITY Marshall Steam Station

STREET ADDRESS 8320 East Hwy 150

Terrell, North Carolina 28682
City or Town State Zip Code

CONTACT PERSON Ed Sullivan

MAILING ADDRESS 526 South Church Street

Charlotte, North Carolina 28202
City or Town State Zip Code

(980)- 373-3719
Area code - Phone number

5. WELL DETAILS:

a. **TOTAL DEPTH:** 20 ft bls

b. **DOES WELL REPLACE EXISTING WELL?** YES ☐ NO ☒

c. **WATER LEVEL** Below Top of Casing: 18 FT.
(Use "+" if Above Top of Casing)

d. **TOP OF CASING IS** 3 FT. Above Land Surface*
*Top of casing terminated at/or below land surface may require a variance in accordance with 15A NCAC 2C .0118.

e. **YIELD (gpm):** _____ **METHOD OF TEST** _____

f. **DISINFECTION: Type** _____ **Amount** _____

g. **WATER ZONES** (depth):

From ____ To ____ From ____ To ____
From ____ To ____ From ____ To ____
From ____ To ____ From ____ To ____

6. CASING:

	Depth		Diameter	Thickness/ Weight	Material
From 0	To 10	Ft.	1"	Sch. 40	PVC
From	To	Ft.			
From	To	Ft.			

7. GROUT:

	Depth		Material	Method
From 0	To 6	Ft.	Neat Cement	pour
From 6	To 8	Ft.	Bentonite	pour
From	To	Ft.		

8. SCREEN:

	Depth		Diameter	Slot Size	Material
From 10	To 20	Ft.	1 in.	0.010 in.	PVC
From	To	Ft.	in.	in.	
From	To	Ft.	in.	in.	

9. SAND/GRAVEL PACK:

	Depth		Size	Material
From 8	To 20	Ft.	#2	Silica Sand
From	To	Ft.		
From	To	Ft.		

10. DRILLING LOG

From To	Formation Description
0 to 4.5	Clayey Silt
4.5 to 8.5	Silty Sand
8.5 to 9	Sandy Silt
9 to 14	Silty Sand
14 to 15	Sand
15 to 20	Silty Sand

11. REMARKS:

I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

Jay A. Little — 11-1-08
SIGNATURE OF CERTIFIED WELL CONTRACTOR — DATE

JAY A. LITTLE
PRINTED NAME OF PERSON CONSTRUCTING THE WELL

Submit the original to the Division of Water Quality within 30 days. Attn: Information Mgt., 1617 Mail Service Center – Raleigh, NC 27699-1617 Phone No. (919) 733-7015 ext 568.

Form GW-1b
Rev. 7/05

APPENDIX II

Field and Laboratory Data

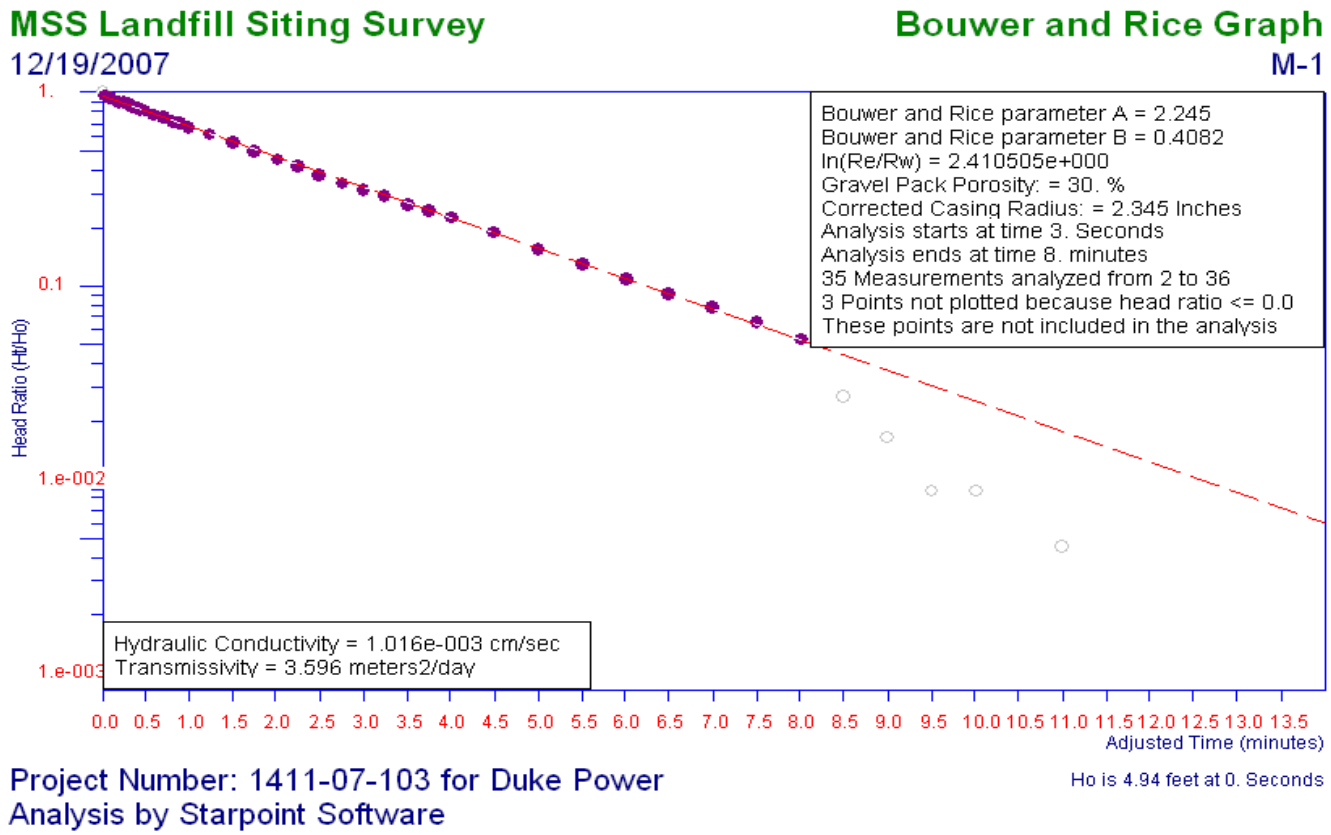
Rising Head Test Data Sheets

Calculation of Permeability By The Rising Head Method (Slug Test)

Site Name:	MSS Landfill Siting Survey	
Test Date:	12/19/2007	
Well Label:	M-1	
Aquifer Thickness:	13.44	feet
Screen Length:	15	feet
Casing Radius:	1	inches
Effective Radius:	4	inches
Static Water Level:	36.57	feet
Water Table to Screen Bottom:	8.44	feet
Anisotropy Ratio:	1	
Time Adjustment:	0	seconds

Test starts with trial 0
There are 44 time and drawdown measurements
Maximum head is 4.94 feet
Minimum head is -2.2×10^{-2} feet

Calculation by Bouwer and Rice Graphical Method



PERMEABILITY

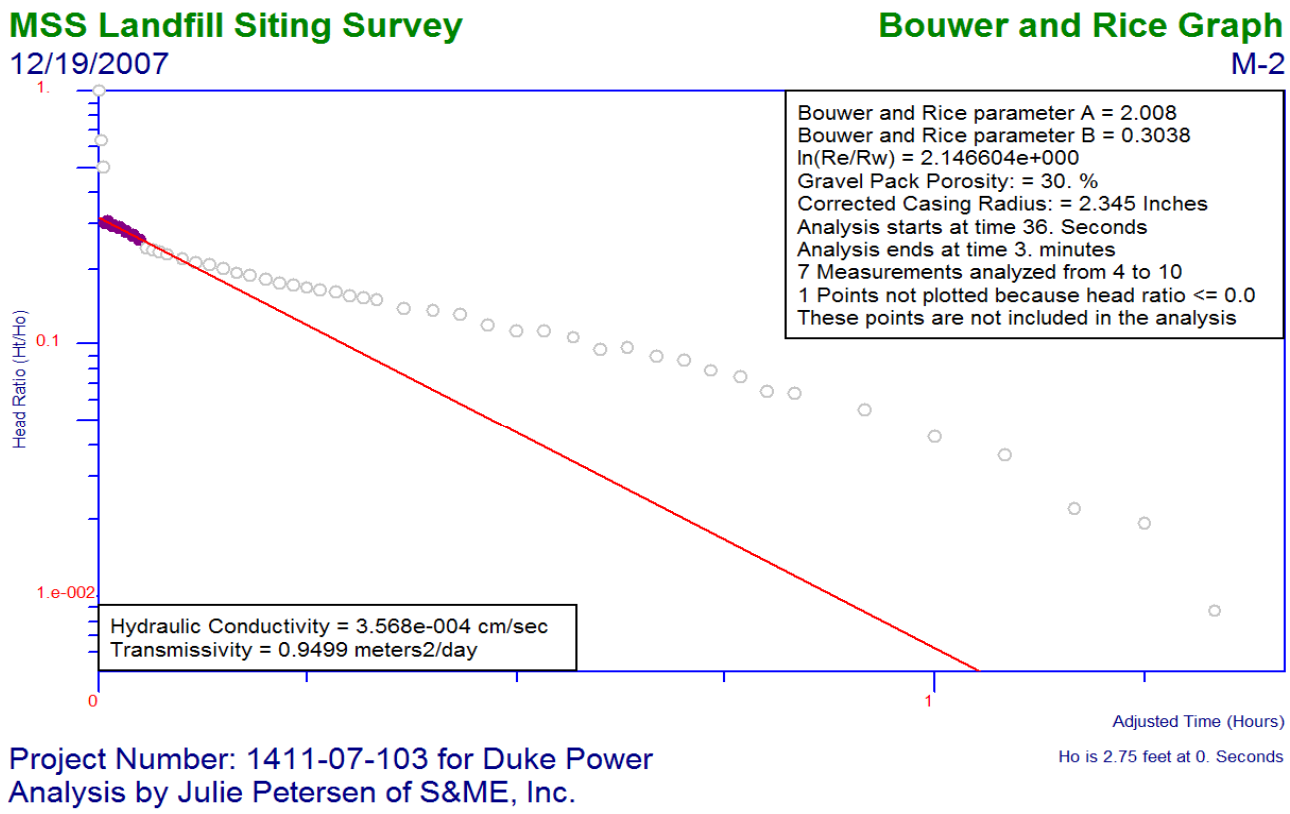
1.016×10^{-3} cm/sec

Calculation of Permeability By The Rising Head Method (Slug Test)

Site Name:	MSS Landfill Siting Survey	
Test Date:	12/19/2007	
Well Label:	M-2	
Aquifer Thickness:	10.11	feet
Screen Length:	15	feet
Casing Radius:	1	inches
Effective Radius:	4	inches
Static Water Level:	46.63	feet
Water Table to Screen Bottom:	5.11	feet
Anisotropy Ratio:	1	
Time Adjustment:	0	seconds

Test starts with trial 0
There are 51 time and drawdown measurements
Maximum head is 2.75 feet
Minimum head is -3 x 10^{-2} feet

Calculation by Bouwer and Rice Graphical Method



Project Number: 1411-07-103 for Duke Power
Analysis by Julie Petersen of S&ME, Inc.

<u>PERMEABILITY</u>

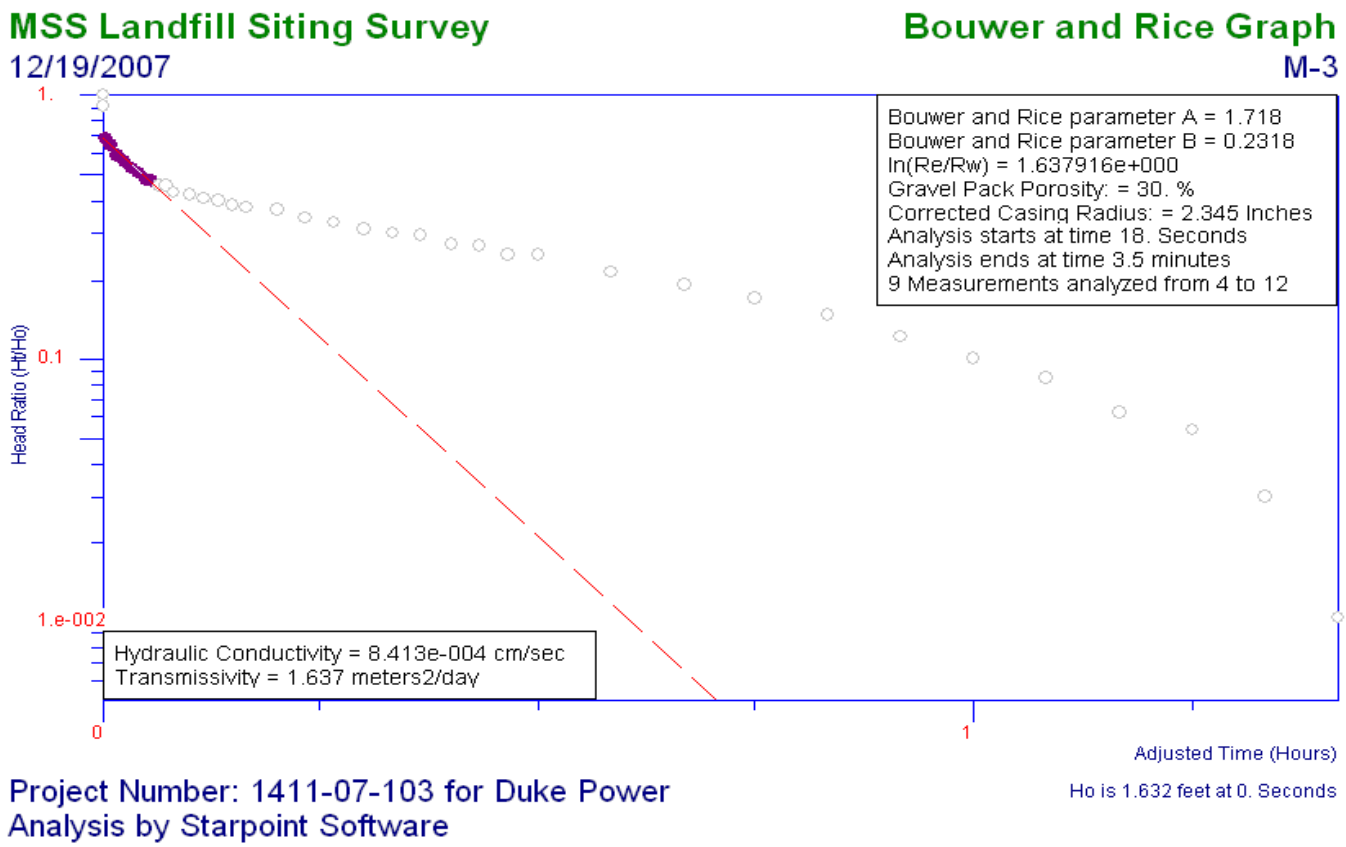
3.568 x 10^{-4} cm/sec

Calculation of Permeability By The Rising Head Method (Slug Test)

Site Name:	MSS Landfill Siting Survey	
Test Date:	12/19/2007	
Well Label:	M-3	
Aquifer Thickness:	7.39	feet
Screen Length:	15	feet
Casing Radius:	1	inches
Effective Radius:	4	inches
Static Water Level:	46.8	feet
Water Table to Screen Bottom:	2.39	feet
Anisotropy Ratio:	1	
Time Adjustment:	0	seconds

Test starts with trial 0
There are 41 time and drawdown measurements
Maximum head is 1.632 feet
Minimum head is 0. feet

Calculation by Bouwer and Rice Graphical Method



PERMEABILITY

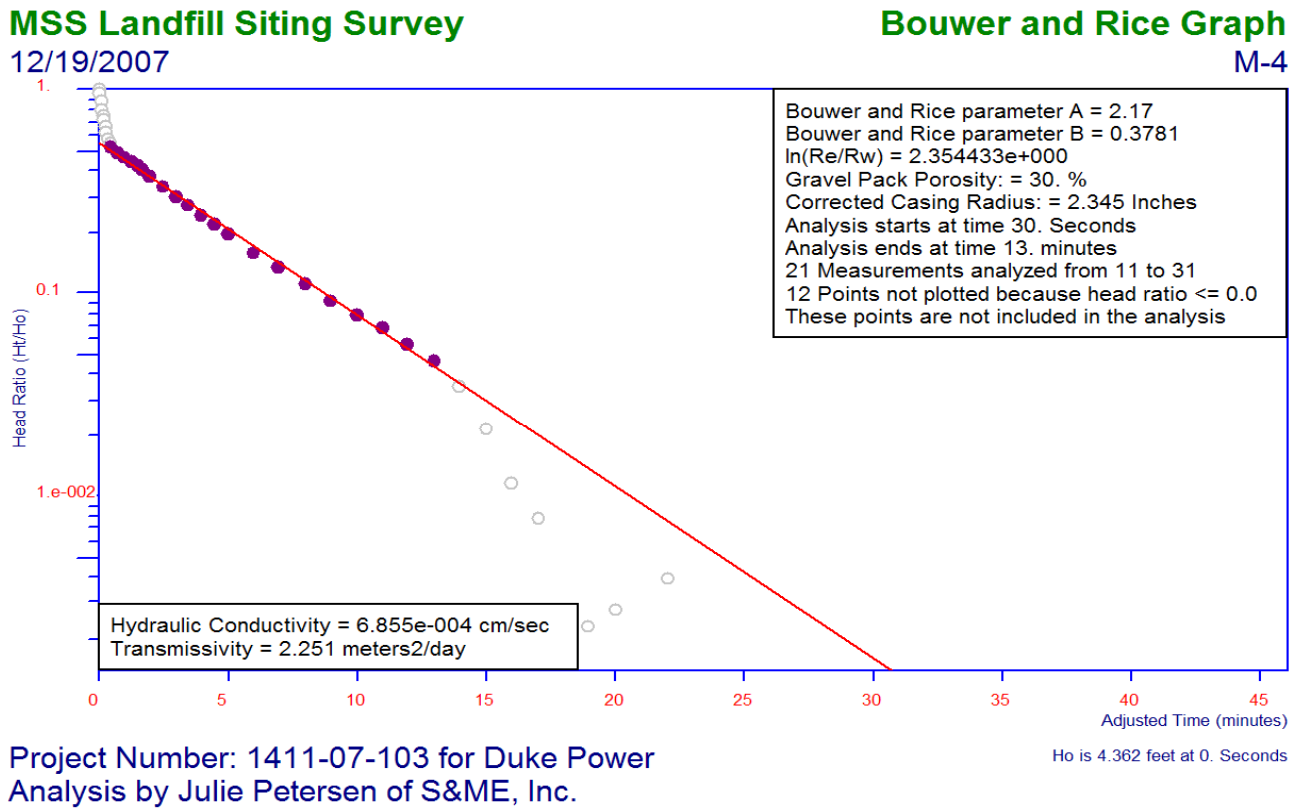
8.413×10^{-4} cm/sec

Calculation of Permeability By The Rising Head Method (Slug Test)

Site Name:	MSS Landfill Siting Survey	
Test Date:	12/19/2007	
Well Label:	M-4	
Aquifer Thickness:	12.47	feet
Screen Length:	15	feet
Casing Radius:	1	inches
Effective Radius:	4	inches
Static Water Level:	40.4	feet
Water Table to Screen Bottom:	7.47	feet
Anisotropy Ratio:	1	
Time Adjustment:	0	seconds

Test starts with trial 0
There are 51 time and drawdown measurements
Maximum head is 4.367 feet
Minimum head is -1.6×10^{-2} feet

Calculation by Bouwer and Rice Graphical Method



Project Number: 1411-07-103 for Duke Power
Analysis by Julie Petersen of S&ME, Inc.

PERMEABILITY

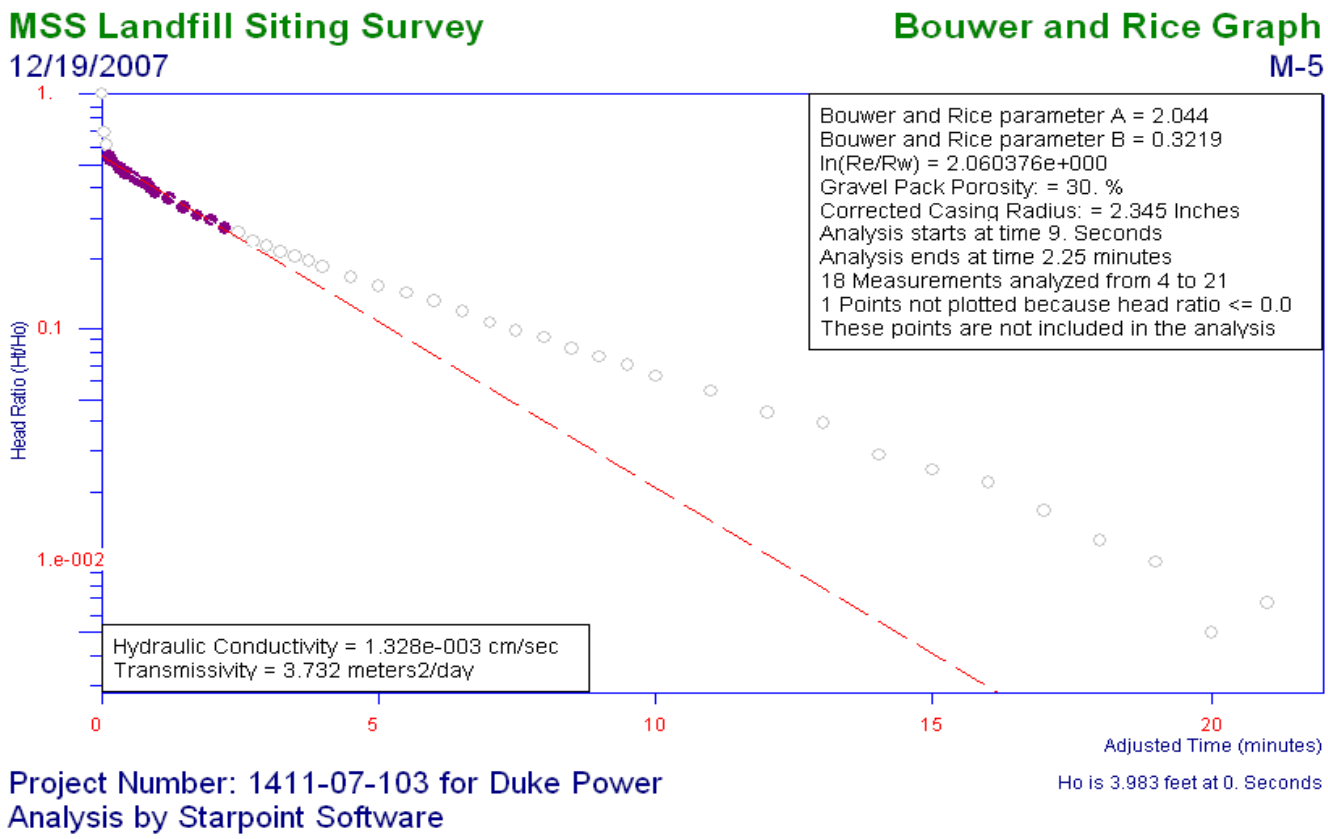
6.855×10^{-4} cm/sec

Calculation of Permeability By The Rising Head Method (Slug Test)

Site Name:	MSS Landfill Siting Survey	
Test Date:	12/19/2007	
Well Label:	M-5	
Aquifer Thickness:	10.67	feet
Screen Length:	10	feet
Casing Radius:	1	inches
Effective Radius:	4	inches
Static Water Level:	10.28	feet
Water Table to Screen Bottom:	5.67	feet
Anisotropy Ratio:	1	
Time Adjustment:	0	seconds

Test starts with trial 0
There are 52 time and drawdown measurements
Maximum head is 3.983 feet
Minimum head is 0 feet

Calculation by Bouwer and Rice Graphical Method



PERMEABILITY

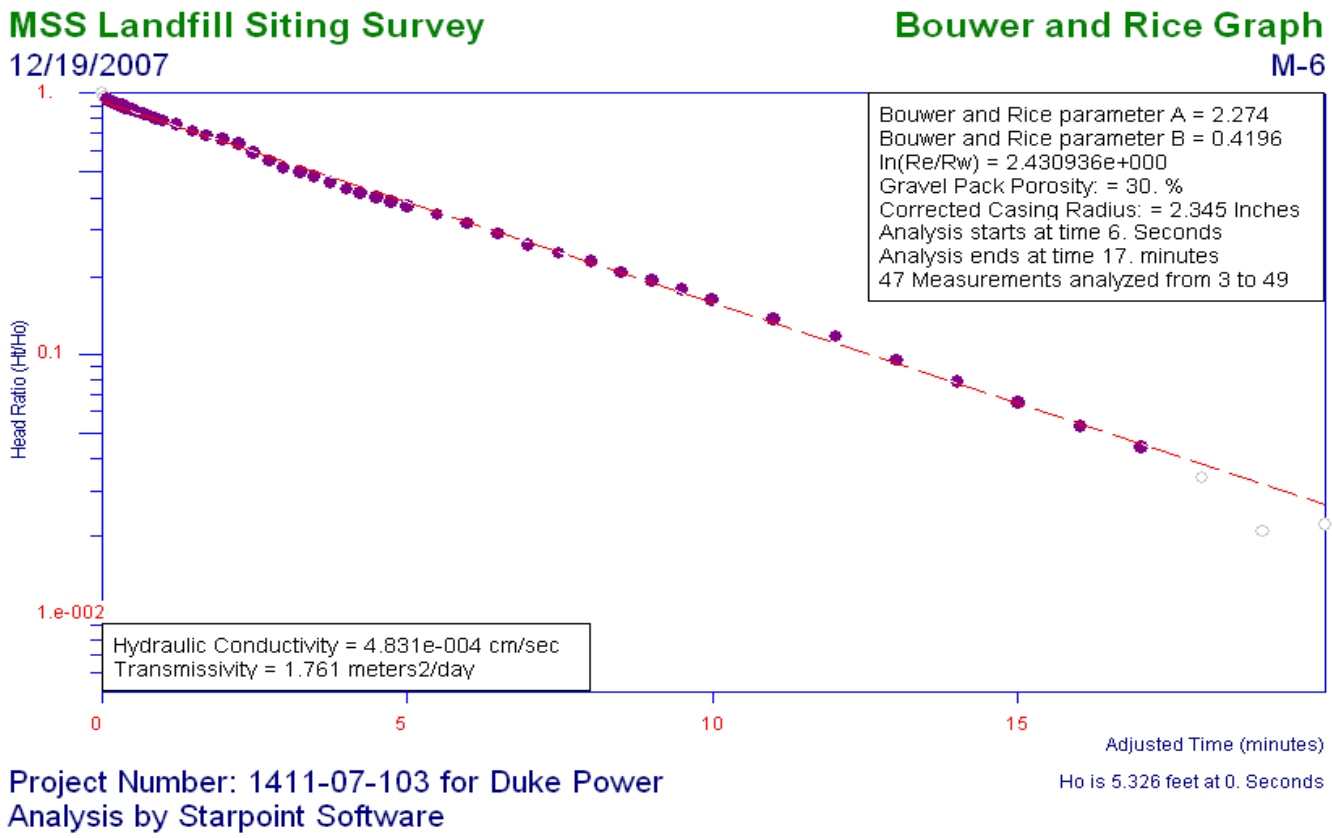
1.328×10^{-3} cm/sec

Calculation of Permeability By The Rising Head Method (Slug Test)

Site Name:	MSS Landfill Siting Survey	
Test Date:	12/19/2007	
Well Label:	M-6	
Aquifer Thickness:	13.84	feet
Screen Length:	15	feet
Casing Radius:	1	inches
Effective Radius:	4	inches
Static Water Level:	24.02	feet
Water Table to Screen Bottom:	8.84	feet
Anisotropy Ratio:	1	
Time Adjustment:	0	seconds

Test starts with trial 0
There are 52 time and drawdown measurements
Maximum head is 5.326 feet
Minimum head is 0 feet

Calculation by Bouwer and Rice Graphical Method



PERMEABILITY

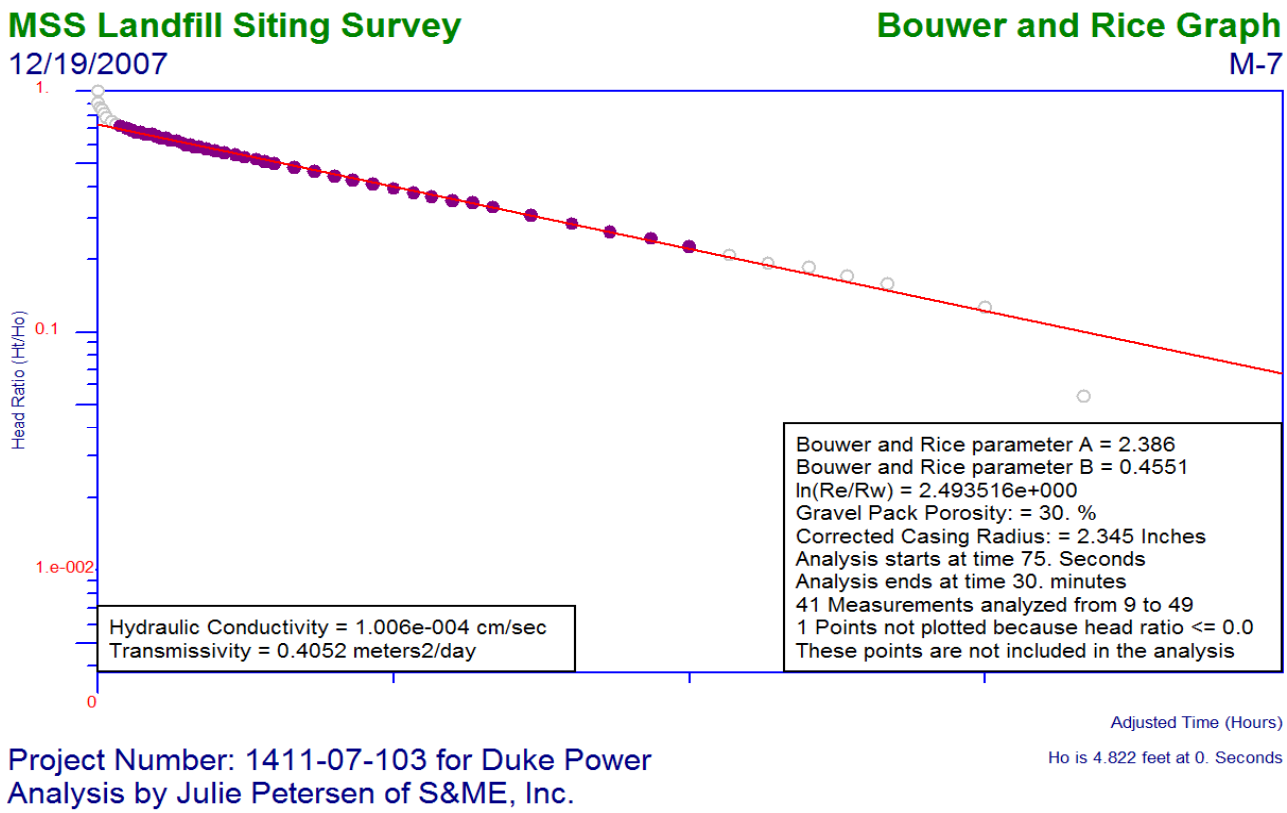
4.831×10^{-4} cm/sec

Calculation of Permeability By The Rising Head Method (Slug Test)

Site Name:	MSS Landfill Siting Survey	
Test Date:	12/19/2007	
Well Label:	M-7	
Aquifer Thickness:	15.3	feet
Screen Length:	15	feet
Casing Radius:	1	inches
Effective Radius:	4	inches
Static Water Level:	36.42	feet
Water Table to Screen Bottom:	10.3	feet
Anisotropy Ratio:	1	
Time Adjustment:	0	seconds

Test starts with trial 0
There are 58 time and drawdown measurements
Maximum head is 4.822 feet
Minimum head is 0 feet

Calculation by Bouwer and Rice Graphical Method



Project Number: 1411-07-103 for Duke Power
Analysis by Julie Petersen of S&ME, Inc.

<u>PERMEABILITY</u>

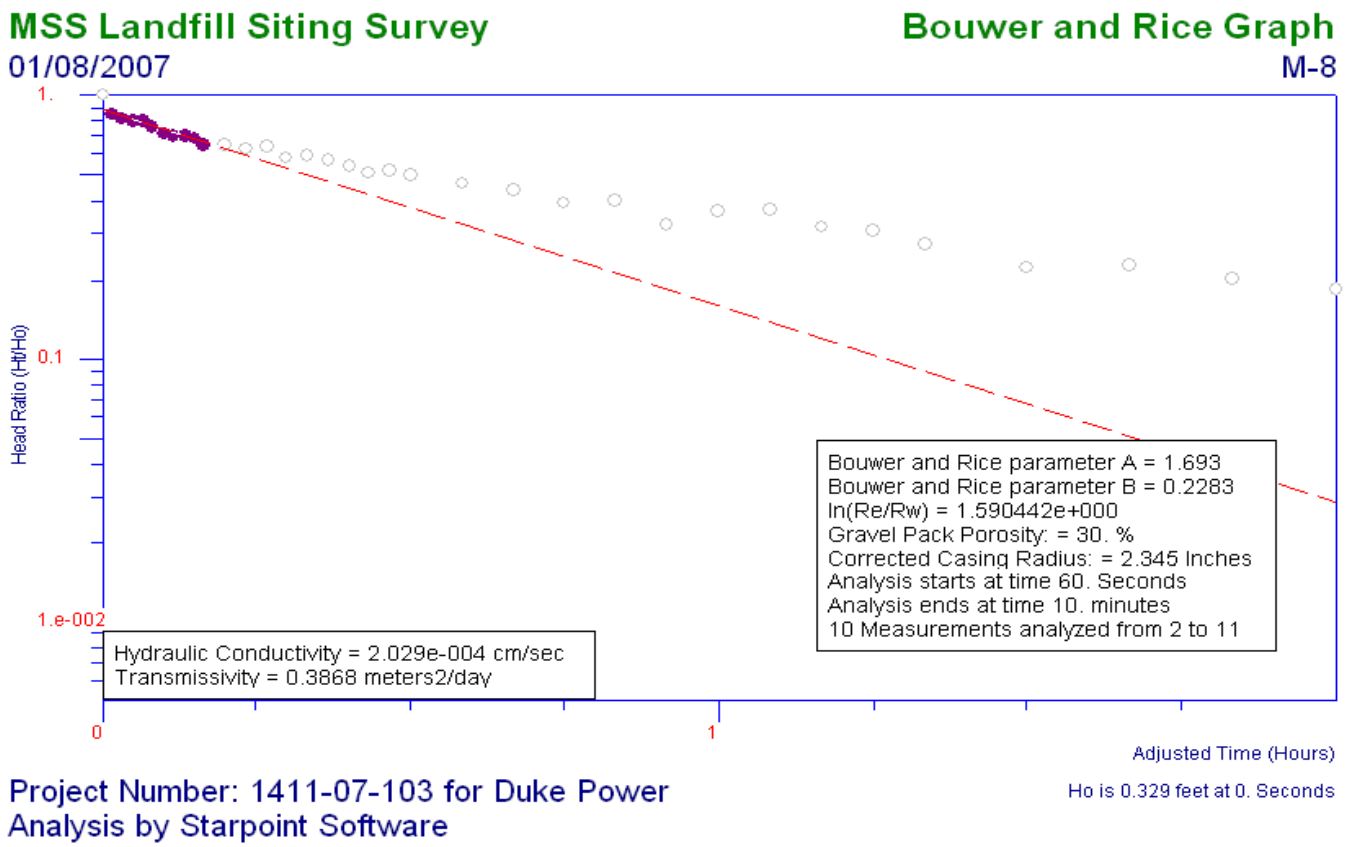
1.006×10^{-4} cm/sec

Calculation of Permeability By The Rising Head Method (Slug Test)

Site Name:	MSS Landfill Siting Survey	
Test Date:	1/8/2008	
Well Label:	M-8	
Aquifer Thickness:	7.24	feet
Screen Length:	15	feet
Casing Radius:	1	inches
Effective Radius:	4	inches
Static Water Level:	56.82	feet
Water Table to Screen Bottom:	2.24	feet
Anisotropy Ratio:	1	
Time Adjustment:	0	seconds

Test starts with trial 0
There are 35 time and drawdown measurements
Maximum head is 0.329 feet
Minimum head is 0 feet

Calculation by Bouwer and Rice Graphical Method



PERMEABILITY

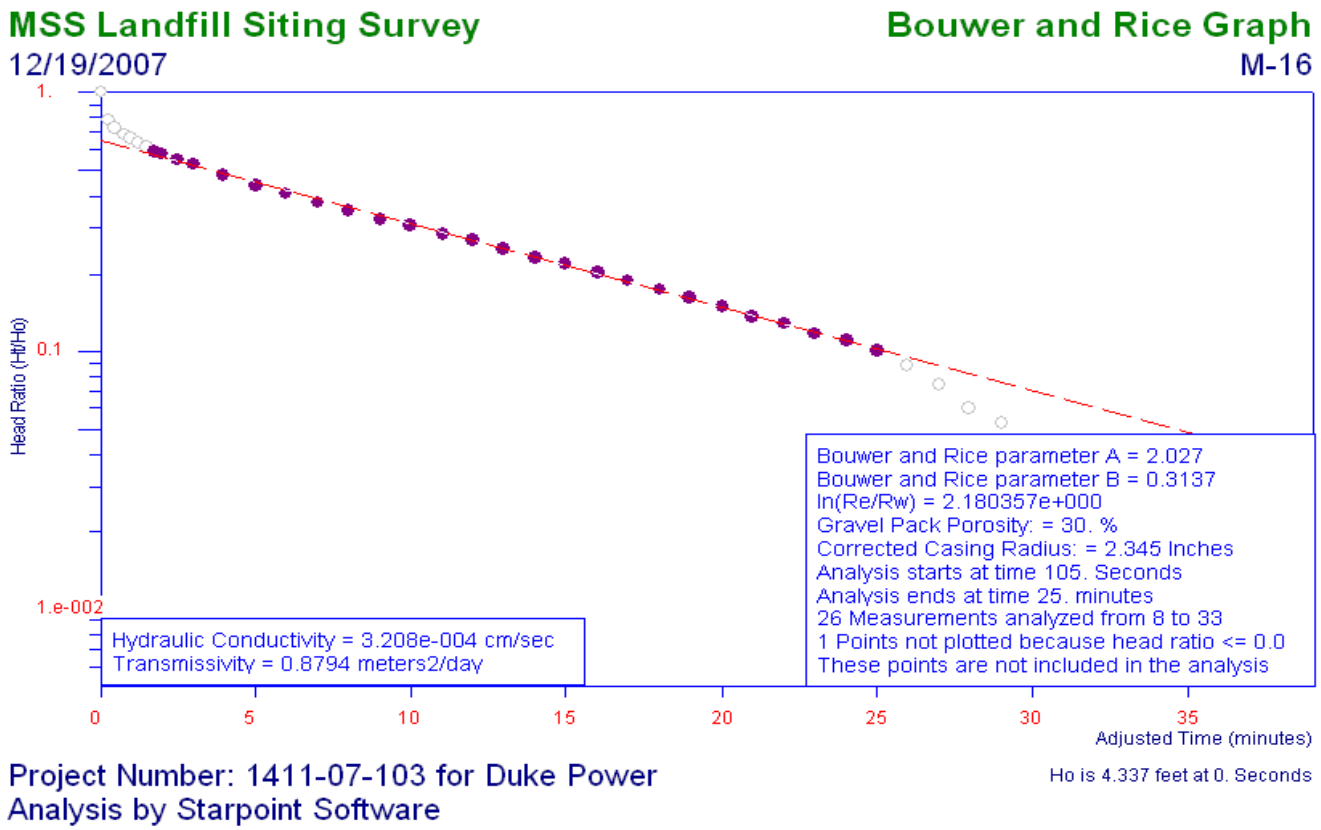
2.029×10^{-4} cm/sec

Calculation of Permeability By The Rising Head Method (Slug Test)

Site Name:	MSS Landfill Siting Survey
Test Date:	12/19/2007
Well Label:	M-16
Aquifer Thickness:	10.41
Screen Length:	15
Casing Radius:	1
Effective Radius:	4
Static Water Level:	37.59
Water Table to Screen Bottom:	5.41
Anisotropy Ratio:	1
Time Adjustment:	0

Test starts with trial 0
There are 47 time and drawdown measurements
Maximum head is 4.387 feet
Minimum head is -2×10^{-4} feet

Calculation by Bouwer and Rice Graphical Method



PERMEABILITY

3.208×10^{-4} cm/sec

Falling Head Test Data Sheets

CALCULATION OF PERMEABILITY BY THE FALLING HEAD METHOD
(Open Hole in Uniform Material)

Site Name:	MSS Landfill Siting Survey	
Date:	11/5/2007	
Boring I.D.	M-1	
Test Interval:	38-41	(Partially Weathered Rock)
Total Depth of Hole:	41	1249.68 cm
Length of Open Hole:	3	91.44 cm
Transformation Ratio m=	1	
Performed by:	Matthew R. Osborne	

Time (sec)	Head (cm)	Permeability (cm/sec)
0	1266.25	
60	1265.21	3.44E-06
120	1263.99	4.05E-06
180	1262.87	3.75E-06
240	1262.07	2.64E-06
300	1260.91	3.86E-06
360	1259.88	3.46E-06
420	1258.60	4.28E-06
480	1257.29	4.38E-06
540	1256.43	2.86E-06
600	1255.12	4.39E-06
900	1249.45	3.81E-06
1200	1243.69	3.89E-06
1500	1238.17	3.74E-06
1800	1232.44	3.90E-06
2400	1221.71	3.68E-06
3000	1211.28	3.60E-06
3600	1200.30	3.83E-06

Calculations

$$K_h = \frac{d^2 \cdot \ln\left(\frac{2mL}{D}\right)}{8 \cdot L \cdot (t_2 - t_1)} \cdot \ln\frac{H_1}{H_2}$$

for $\frac{mL}{D} \rangle 4$

Where:

K_h	is the Horizontal Coefficient of Permeability (cm/sec)
H_1	is the Piezometric Head for time; $t = t_1$ (cm)
H_2	is the Piezometric Head for time; $t = t_2$ (cm)
D	is the Diameter of the Standpipe (cm)
d	is the diameter of the Open Length (cm),
m	is the Transformation Ratio, Where

$$m = \sqrt{K_h / K_v}$$

K_h is the Horizontal Permeability
K_v is the Vertical Permeability

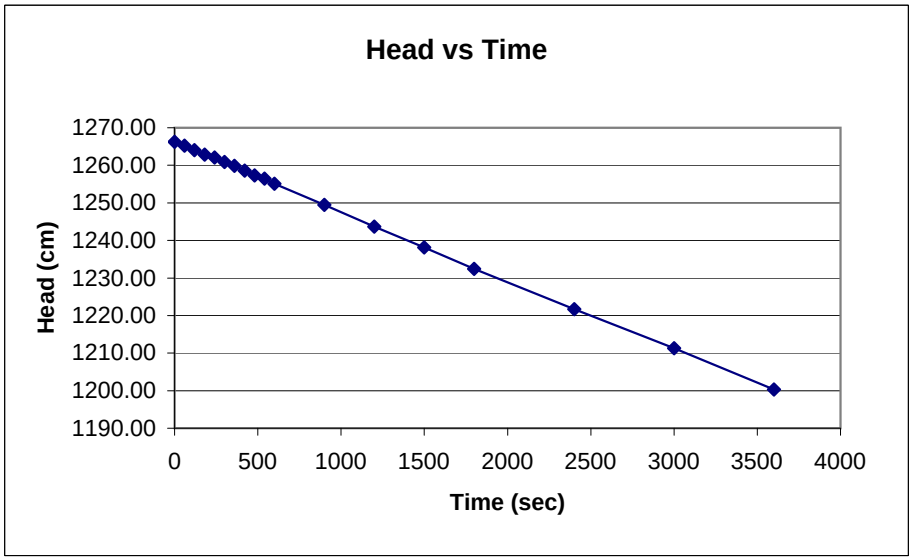
L	is the Open Length of Hole (cm)

Spreadsheet assumes 3" ID Pipe; Borehole OD = 3"

MEAN PERMEABILITY (cm/sec)

3.74E-06

Graph of Field Data



CALCULATION OF PERMEABILITY BY THE FALLING HEAD METHOD
(Open Hole in Uniform Material)

Site Name:	MSS Landfill Siting Survey	
Date:	11/8/2007	
Boring I.D.	M-2	
Test Interval:	44 to 47	(Partially Weathered Rock)
Total Depth of Hole:	47 ft	1432.56 cm
Length of Open Hole:	3	91.44 cm
Transformation Ratio m=	1	
Performed by:	Julie Petersen	

Time (sec)	Head (cm)	Permeability (cm/sec)
0	1326.59	
60	1316.07	3.35E-05
120	1306.62	3.03E-05
180	1296.19	3.37E-05
240	1285.98	3.33E-05
300	1274.97	3.61E-05
360	1265.09	3.27E-05
420	1254.51	3.53E-05
480	1244.79	3.27E-05
540	1235.85	3.03E-05
600	1226.77	3.10E-05
900	1185.95	2.85E-05
1200	1147.41	2.78E-05
1500	1110.40	2.76E-05
1800	1075.00	2.72E-05
2400	1012.13	2.53E-05
3000	959.70	2.24E-05
3600	913.60	2.07E-05

Calculations

$$K_h = \frac{d^2 \cdot \ln\left(\frac{2mL}{D}\right)}{8 \cdot L \cdot (t_2 - t_1)} \cdot \ln\frac{H_1}{H_2}$$

for $\frac{mL}{D} \rangle 4$

Where:

K_h	is the Horizontal Coefficient of Permeability (cm/sec)
H_1	is the Piezometric Head for time; $t = t_1$ (cm)
H_2	is the Piezometric Head for time; $t = t_2$ (cm)
D	is the Diameter of the Standpipe (cm)
d	is the diameter of the Open Length (cm),
m	is the Transformation Ratio, Where

$$m = \sqrt{K_h / K_v}$$

K_h is the Horizontal Permeability
K_v is the Vertical Permeability

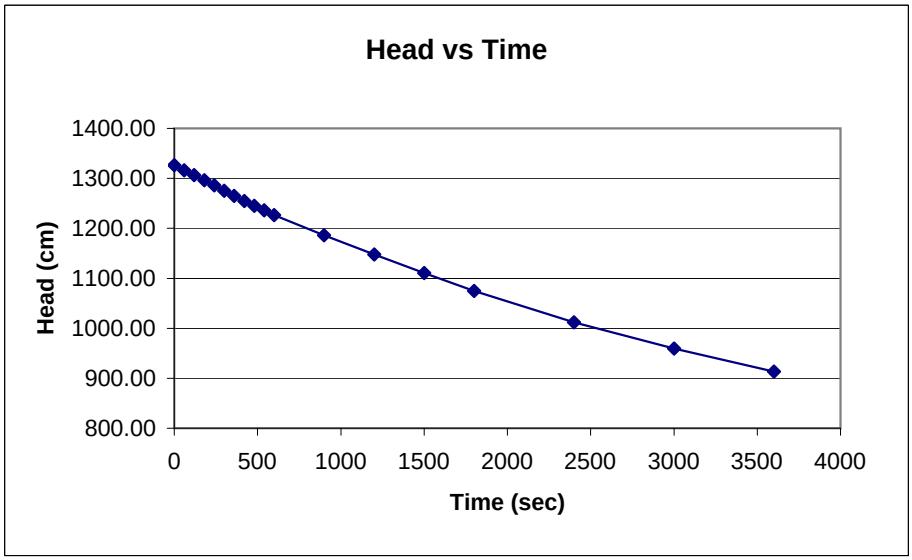
L	is the Open Length of Hole (cm)

Spreadsheet assumes 3" ID Pipe; Borehole OD = 3"

MEAN PERMEABILITY (cm/sec)

2.99E-05

Graph of Field Data



CALCULATION OF PERMEABILITY BY THE FALLING HEAD METHOD (FLUSH BOTTOM IN UNIFORM SOIL)

SITE NAME:	MSS Landfill Siting Survey	
DATE:	11/8/2007	
BORING ID:	M-5	
DEPTH AT WHICH TEST WAS RUN:	10.1 ft bls (Ash)	Bottom of Cased Interval
TOTAL LENGTH OF CASING:	12.1 ft	368.808 cm
CASING ID:	3 in.	7.62 cm
PERFORMED BY:	Matthew R Osborne	
EQUIPMENT USED:	Level Troll Data Logger	

Time (sec)	Length of Casing (cm)	Head (cm)	Permeability (cm/sec)
0	368.808	344.27	
60	368.808	330.27	1.50E-03
120	368.808	317.32	1.45E-03
180	368.808	305.67	1.36E-03
240	368.808	295.34	1.25E-03
300	368.808	286.55	1.09E-03
360	368.808	277.80	1.12E-03
420	368.808	270.21	1.00E-03
480	368.808	262.59	1.04E-03
540	368.808	255.76	9.56E-04
600	368.808	249.54	8.93E-04

CALCULATION

$$K_m=\pi*D/11(t_2-t_1)*\ln(H_1/H_2)$$

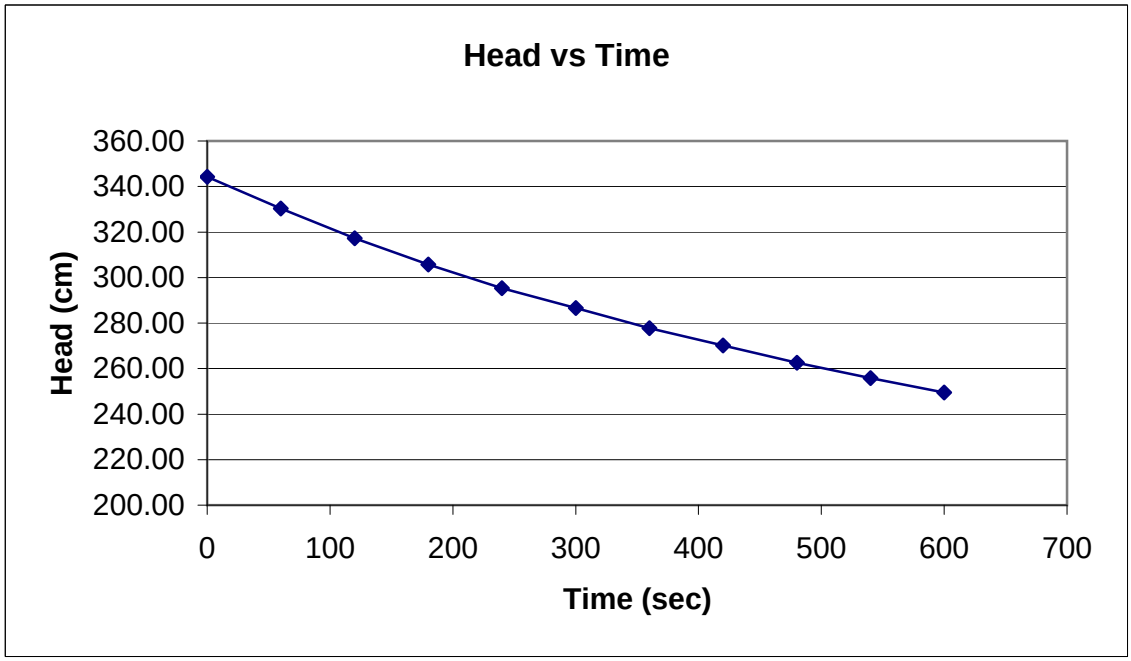
Where:

- K_m is the mean coeffient of permeability
- H_1 is the head for time: $t=t_1$
- H_2 is the head for time: $t=t_2$
- D is the diameter of the casing

MEAN PERMEABILITY (cm/sec)

1.17E-03

GRAPH OF FIELD DATA



CALCULATION OF PERMEABILITY BY THE FALLING HEAD METHOD
(Open Hole in Uniform Material)

Site Name:	MSS Landfill Siting Survey		
Date:	11/8/2007		
Boring I.D.	M-5		
Test Interval:	35.1 to 38.1	(Saprolite)	
Total Depth of Hole:	38.1	1161.288	cm
Length of Open Hole:	3	91.44	cm
Transformation Ratio m=	1		
Performed by:	Matthew R Osborne		

Time (sec)	Head (cm)	Permeability (cm/sec)
0	1094.27	
60	1075.70	7.19E-05
120	1057.96	6.99E-05
180	1042.68	6.11E-05
240	1027.74	6.07E-05
300	1013.96	5.68E-05
360	1001.52	5.19E-05
420	990.00	4.87E-05
480	979.33	4.56E-05
540	969.27	4.34E-05
600	959.63	4.20E-05
900	920.40	3.51E-05

Calculations

$$K_h = \frac{d^2 \cdot \ln\left(\frac{2mL}{D}\right)}{8 \cdot L \cdot (t_2 - t_1)} \cdot \ln\frac{H_1}{H_2}$$

for $\frac{mL}{D} \rangle 4$

Where:

K_h	is the Horizontal Coefficient of Permeability (cm/sec)
H_1	is the Piezometric Head for time; $t = t_1$ (cm)
H_2	is the Piezometric Head for time; $t = t_2$ (cm)
D	is the Diameter of the Standpipe (cm)
d	is the diameter of the Open Length (cm),
m	is the Transformation Ratio, Where

$$m = \sqrt{K_h / K_v}$$

K_h is the Horizontal Permeability
K_v is the Vertical Permeability

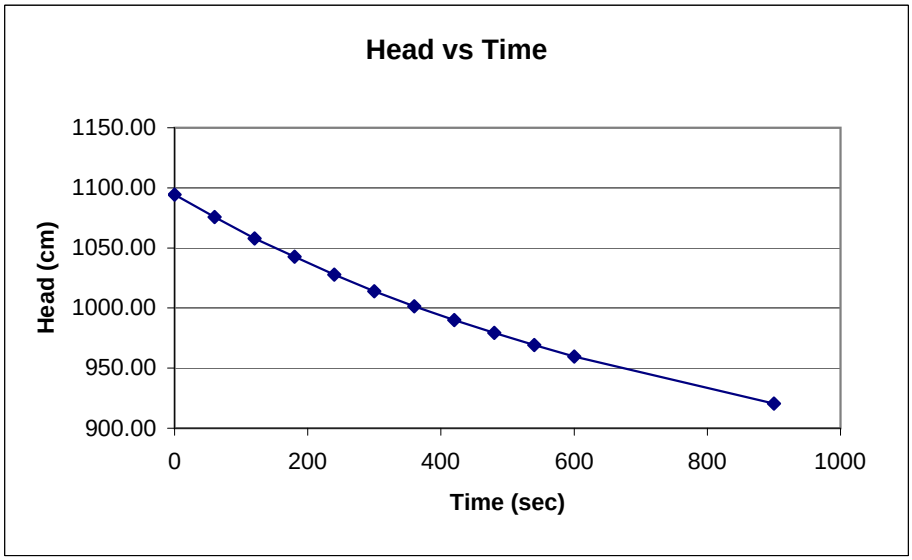
L	is the Open Length of Hole (cm)

Spreadsheet assumes 3" ID Pipe; Borehole OD = 3"

MEAN PERMEABILITY (cm/sec)

5.34E-05

Graph of Field Data



CALCULATION OF PERMEABILITY BY THE FALLING HEAD METHOD
(Open Hole in Uniform Material)

Site Name:	MSS Landfill Siting Survey		
Date:	11/12/2007		
Boring I.D.	M-5		
Test Interval:	40.1 to 43.1	(Saprolite)	
Total Depth of Hole:	43.1	1313.688	cm
Length of Open Hole:	3	91.44	cm
Transformation Ratio m=	1		
Performed by:	Matthew R Osborne		

Time (sec)	Head (cm)	Permeability (cm/sec)
0	1349.57	
60	1336.83	3.99E-05
120	1324.70	3.83E-05
180	1312.68	3.83E-05
240	1301.62	3.56E-05
300	1291.13	3.40E-05
360	1280.98	3.32E-05
420	1270.98	3.29E-05
480	1261.59	3.12E-05
540	1252.32	3.10E-05
600	1243.81	2.87E-05
900	1206.34	2.57E-05
1200	1176.28	2.12E-05

Calculations

$$K_h = \frac{d^2 \cdot \ln\left(\frac{2mL}{D}\right)}{8 \cdot L \cdot (t_2 - t_1)} \cdot \ln\frac{H_1}{H_2}$$

for $\frac{mL}{D} \rangle 4$

Where:

K_h	is the Horizontal Coefficient of Permeability (cm/sec)
H_1	is the Piezometric Head for time; $t = t_1$ (cm)
H_2	is the Piezometric Head for time; $t = t_2$ (cm)
D	is the Diameter of the Standpipe (cm)
d	is the diameter of the Open Length (cm),
m	is the Transformation Ratio, Where

$$m = \sqrt{K_h / K_v}$$

K_h is the Horizontal Permeability
K_v is the Vertical Permeability

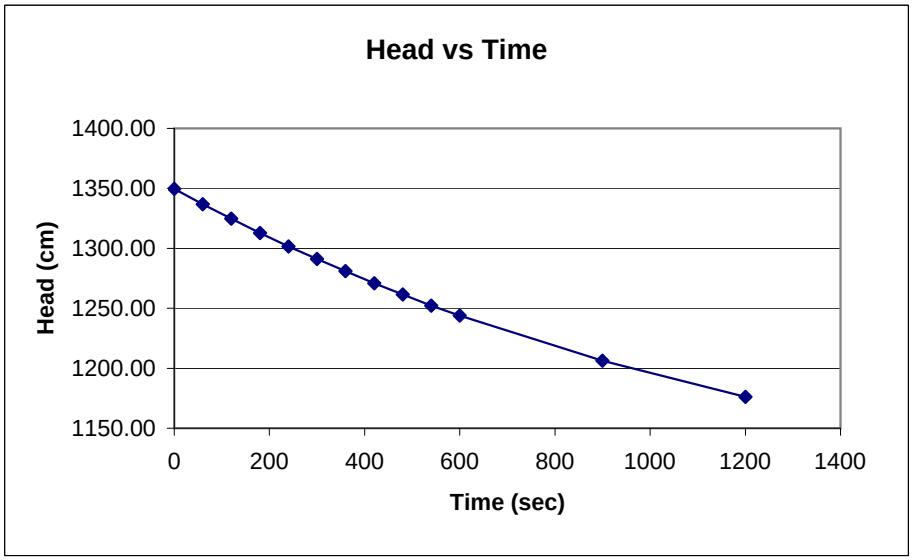
L	is the Open Length of Hole (cm)

Spreadsheet assumes 3" ID Pipe; Borehole OD = 3"

MEAN PERMEABILITY (cm/sec)

3.25E-05

Graph of Field Data



CALCULATION OF PERMEABILITY BY THE FALLING HEAD METHOD
(Open Hole in Uniform Material)

Site Name:	MSS Landfill Siting Survey		
Date:	11/12/2007		
Boring I.D.	M-5		
Test Interval:	44.3 to 47.3	(Saprolite)	
Total Depth of Hole:	47.3	1441.704	cm
Length of Open Hole:	3	91.44	cm
Transformation Ratio m=	1		
Performed by:	Matthew R Osborne		

Time (sec)	Head (cm)	Permeability (cm/sec)
0	1472.29	
60	1450.49	6.27E-05
120	1439.36	3.24E-05
180	1428.14	3.29E-05
240	1417.77	3.06E-05
300	1408.48	2.77E-05
360	1399.33	2.74E-05
420	1389.39	3.00E-05
480	1381.43	2.41E-05
540	1372.56	2.71E-05
600	1364.39	2.51E-05
900	1327.23	2.32E-05
1200	1297.07	1.93E-05
1500	1271.13	1.70E-05

Calculations

$$K_h = \frac{d^2 \cdot \ln\left(\frac{2mL}{D}\right)}{8 \cdot L \cdot (t_2 - t_1)} \cdot \ln\frac{H_1}{H_2}$$

for $\frac{mL}{D} \rangle 4$

Where:

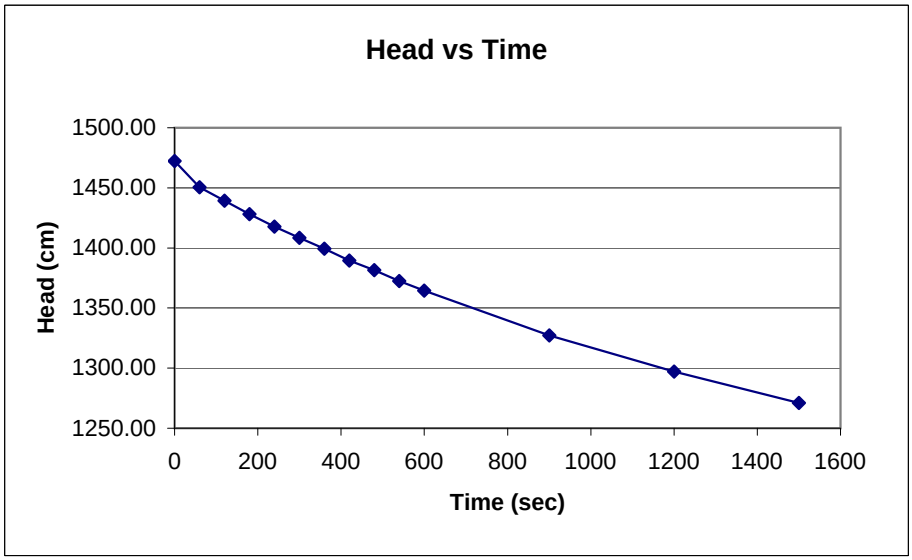
K_h	is the Horizontal Coefficient of Permeability (cm/sec)
H_1	is the Piezometric Head for time; $t = t_1$ (cm)
H_2	is the Piezometric Head for time; $t = t_2$ (cm)
D	is the Diameter of the Standpipe (cm)
d	is the diameter of the Open Length (cm),
m	is the Transformation Ratio, Where
	$m = \sqrt{K_h / K_v}$ — K_h is the Horizontal Permeability; K_v is the Vertical Permeability
L	is the Open Length of Hole (cm)

Spreadsheet assumes 3" ID Pipe; Borehole OD = 3"

MEAN PERMEABILITY (cm/sec)

2.92E-05

Graph of Field Data



CALCULATION OF PERMEABILITY BY THE FALLING HEAD METHOD
(Open Hole in Uniform Material)

Site Name:	MSS Landfil Siting Survey		
Date:	11/14/2007		
Boring I.D.	M-6		
Test Interval:	18.6-21.6	(Saprolite)	
Total Depth of Hole:	21.6		658.368 cm
Length of Open Hole:	3		91.44 cm
Transformation Ratio m=	1		
Performed by:	Matthew R Osborne		

Time (sec)	Head (cm)	Permeability (cm/sec)
0	677.71	
60	664.73	8.14E-05
120	650.37	9.18E-05
180	636.65	8.96E-05
240	623.54	8.75E-05
300	610.49	8.89E-05
360	598.41	8.40E-05
420	586.01	8.81E-05
480	574.51	8.33E-05
540	563.08	8.45E-05
600	551.95	8.39E-05
900	500.95	8.15E-05
1200	456.34	7.84E-05

Calculations

$$K_h = \frac{d^2 \cdot \ln\left(\frac{2mL}{D}\right)}{8 \cdot L \cdot (t_2 - t_1)} \cdot \ln\frac{H_1}{H_2}$$

for $\frac{mL}{D} \rangle 4$

Where:

K_h	is the Horizontal Coefficient of Permeability (cm/sec)
H_1	is the Piezometric Head for time; $t = t_1$ (cm)
H_2	is the Piezometric Head for time; $t = t_2$ (cm)
D	is the Diameter of the Standpipe (cm)
d	is the diameter of the Open Length (cm),
m	is the Transformation Ratio, Where

$$m = \sqrt{K_h / K_v}$$

K_h is the Horizontal Permeability
K_v is the Vertical Permeability

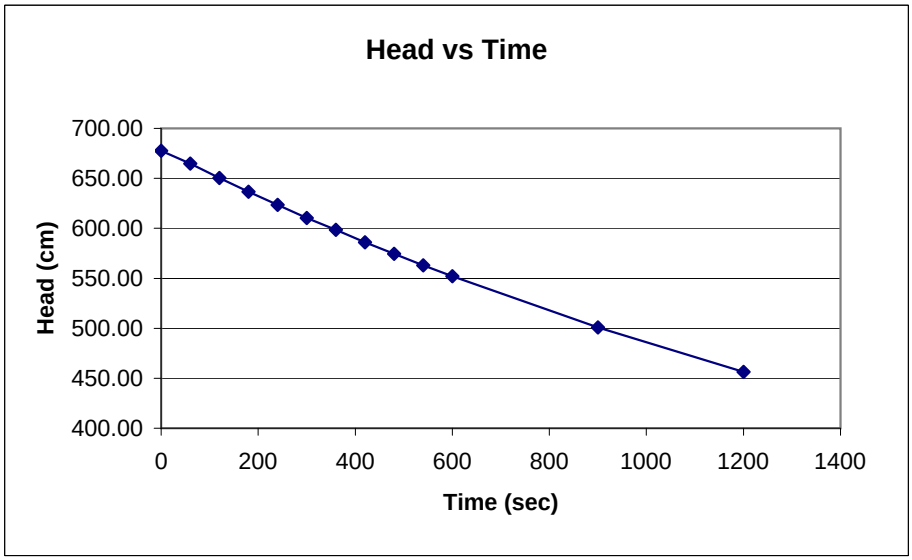
L	is the Open Length of Hole (cm)

Spreadsheet assumes 3" ID Pipe; Borehole OD = 3"

MEAN PERMEABILITY (cm/sec)

8.52E-05

Graph of Field Data



CALCULATION OF PERMEABILITY BY THE FALLING HEAD METHOD
(Open Hole in Uniform Material)

Site Name:	MSS Landfil Siting Survey		
Date:	11/15/2007		
Boring I.D.	M-6		
Test Interval:	28.4 to 31.4	(Saprolite)	
Total Depth of Hole:	31.4	957.072	cm
Length of Open Hole:	3	91.44	cm
Transformation Ratio m=	1		
Performed by:	Matthew R Osborne		

Time (sec)	Head (cm)	Permeability (cm/sec)
0	982.26	
60	954.73	1.20E-04
120	928.29	1.18E-04
180	902.80	1.17E-04
240	879.12	1.12E-04
300	856.04	1.12E-04
360	833.72	1.11E-04
420	813.05	1.06E-04
480	792.93	1.05E-04
540	772.80	1.08E-04
600	754.30	1.02E-04
900	672.41	9.66E-05

Calculations

$$K_h = \frac{d^2 \cdot \ln\left(\frac{2mL}{D}\right)}{8 \cdot L \cdot (t_2 - t_1)} \cdot \ln\frac{H_1}{H_2}$$

for $\frac{mL}{D} \rangle 4$

Where:

K_h	is the Horizontal Coefficient of Permeability (cm/sec)
H_1	is the Piezometric Head for time; $t = t_1$ (cm)
H_2	is the Piezometric Head for time; $t = t_2$ (cm)
D	is the Diameter of the Standpipe (cm)
d	is the diameter of the Open Length (cm),
m	is the Transformation Ratio, Where

$$m = \sqrt{K_h / K_v}$$

K_h is the Horizontal Permeability
K_v is the Vertical Permeability

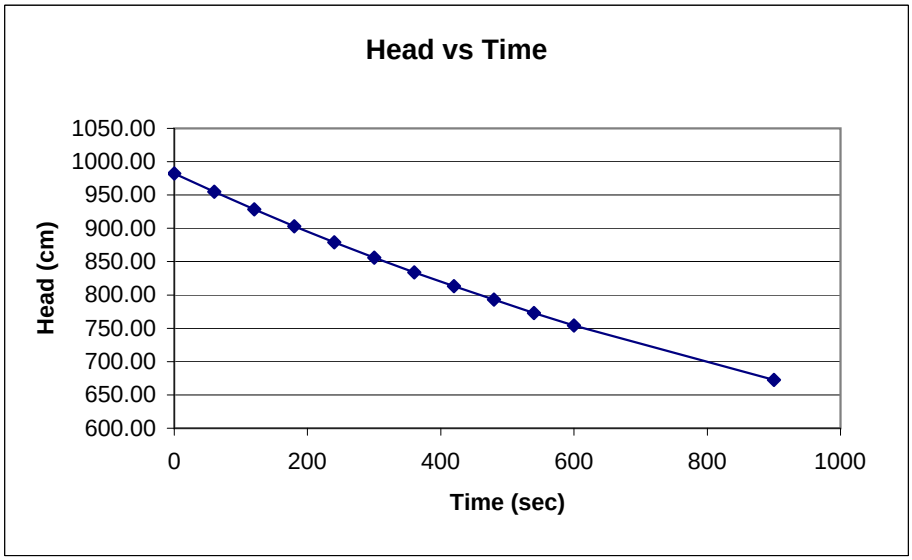
L	is the Open Length of Hole (cm)

Spreadsheet assumes 3" ID Pipe; Borehole OD = 3"

MEAN PERMEABILITY (cm/sec)

1.10E-04

Graph of Field Data



CALCULATION OF PERMEABILITY BY THE FALLING HEAD METHOD
(Open Hole in Uniform Material)

Site Name:	MSS Landfil Siting Survey		
Date:	11/15/2007		
Boring I.D.	M-6		
Test Interval:	38.4 to 41.4	(Saprolite)	
Total Depth of Hole:	41.4	1261.872	cm
Length of Open Hole:	3	91.44	cm
Transformation Ratio m=	1		
Performed by:	Matthew R Osborne		

Time (sec)	Head (cm)	Permeability (cm/sec)
0	1263.48	
60	1259.94	1.18E-05
120	1256.10	1.28E-05
180	1251.95	1.39E-05
240	1248.02	1.32E-05
300	1243.84	1.41E-05
360	1240.00	1.30E-05
420	1236.04	1.35E-05
480	1231.55	1.53E-05
540	1227.74	1.30E-05
600	1223.48	1.46E-05
900	1203.75	1.37E-05

Calculations

$$K_h = \frac{d^2 \cdot \ln\left(\frac{2mL}{D}\right)}{8 \cdot L \cdot (t_2 - t_1)} \cdot \ln\frac{H_1}{H_2}$$

for $\frac{mL}{D} \rangle 4$

Where:

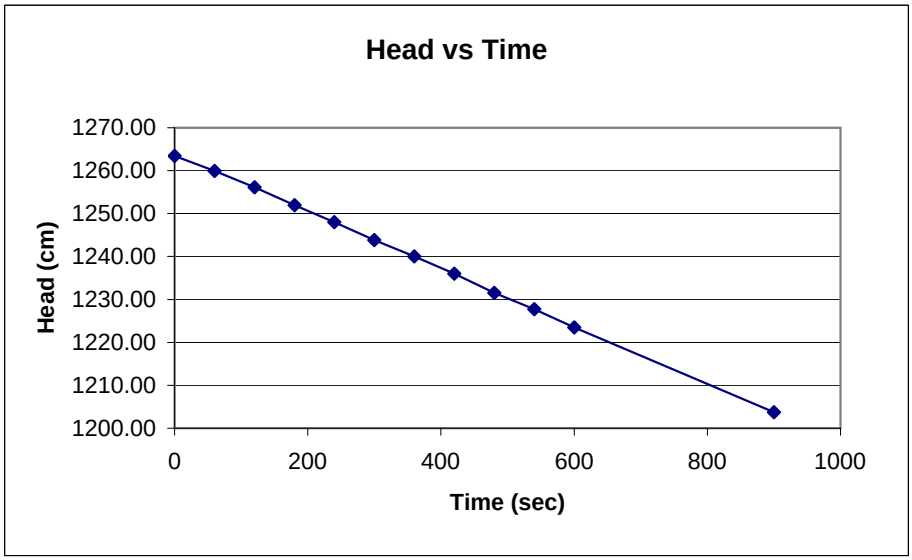
K_h	is the Horizontal Coefficient of Permeability (cm/sec)
H_1	is the Piezometric Head for time; $t = t_1$ (cm)
H_2	is the Piezometric Head for time; $t = t_2$ (cm)
D	is the Diameter of the Standpipe (cm)
d	is the diameter of the Open Length (cm),
m	is the Transformation Ratio, Where
	$m = \sqrt{K_h / K_v}$ K_h is the Horizontal Permeability; K_v is the Vertical Permeability
L	is the Open Length of Hole (cm)

Spreadsheet assumes 3" ID Pipe; Borehole OD = 3"

MEAN PERMEABILITY (cm/sec)

1.35E-05

Graph of Field Data



CALCULATION OF PERMEABILITY BY THE FALLING HEAD METHOD
(Open Hole in Uniform Material)

Site Name:	MSS Landfil Siting Survey	
Date:	11/16/2007	
Boring I.D.	M-6	
Test Interval:	68.1 to 71.1	(Partially Weathered Rock)
Total Depth of Hole:	71.1	2167.128 cm
Length of Open Hole:	3	91.44 cm
Transformation Ratio m=	1	
Performed by:	Matthew R Osborne	

Time (sec)	Head (cm)	Permeability (cm/sec)
0	2189.30	
60	2187.13	4.16E-06
120	2184.33	5.40E-06
180	2180.40	7.58E-06
240	2177.47	5.65E-06
300	2174.09	6.54E-06
360	2170.70	6.55E-06
420	2166.74	7.68E-06
480	2163.72	5.86E-06
540	2160.43	6.40E-06
600	2157.38	5.94E-06
900	2140.73	6.51E-06
1200	2124.85	6.26E-06
1500	2109.24	6.20E-06
1800	2093.66	6.23E-06
2400	2064.12	5.97E-06
3000	2036.22	5.72E-06
3600	2009.48	5.56E-06

Calculations

$$K_h = \frac{d^2 \cdot \ln\left(\frac{2mL}{D}\right)}{8 \cdot L \cdot (t_2 - t_1)} \cdot \ln\frac{H_1}{H_2}$$

for $\frac{mL}{D} \rangle 4$

Where:

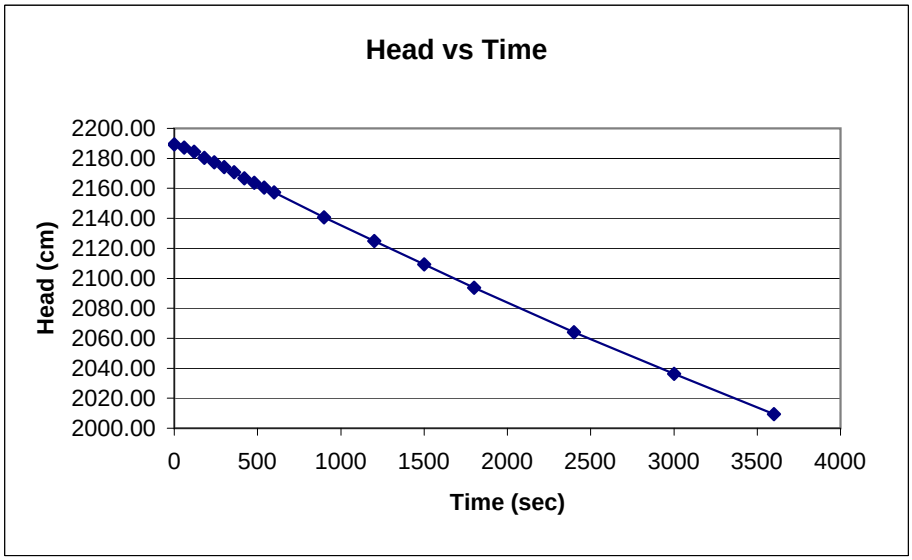
K_h	is the Horizontal Coefficient of Permeability (cm/sec)
H_1	is the Piezometric Head for time; $t = t_1$ (cm)
H_2	is the Piezometric Head for time; $t = t_2$ (cm)
D	is the Diameter of the Standpipe (cm)
d	is the diameter of the Open Length (cm),
m	is the Transformation Ratio, Where
	$m = \sqrt{K_h / K_v}$ — K_h is the Horizontal Permeability; K_v is the Vertical Permeability
L	is the Open Length of Hole (cm)

Spreadsheet assumes 3" ID Pipe; Borehole OD = 3"

MEAN PERMEABILITY (cm/sec)

6.13E-06

Graph of Field Data



CALCULATION OF PERMEABILITY BY THE FALLING HEAD METHOD
(Open Hole in Uniform Material)

Site Name:	MSS Landfill Siting Survey		
Date:	11/29/2007		
Boring I.D.	M-12		
Test Interval:	63 to 65	(Saprolite)	
Total Depth of Hole:	65		1981.2 cm
Length of Open Hole:	2		60.96 cm
Transformation Ratio m=	1		
Performed by:	Matthew R Osborne		

Time (sec)	Head (cm)	Permeability (cm/sec)
0	1997.56	
60	1991.04	1.80E-05
120	1986.95	1.13E-05
180	1980.64	1.75E-05
240	1975.03	1.56E-05
300	1969.82	1.45E-05
360	1965.00	1.35E-05
420	1961.04	1.11E-05
480	1956.40	1.30E-05
540	1951.31	1.43E-05
600	1947.68	1.02E-05
900	1926.31	1.21E-05
1200	1907.87	1.06E-05
1500	1894.09	7.98E-06
1800	1880.61	7.86E-06

Calculations

$$K_h = \frac{d^2 \cdot \ln\left(\frac{2mL}{D}\right)}{8 \cdot L \cdot (t_2 - t_1)} \cdot \ln\frac{H_1}{H_2}$$

for $\frac{mL}{D} \rangle 4$

Where:

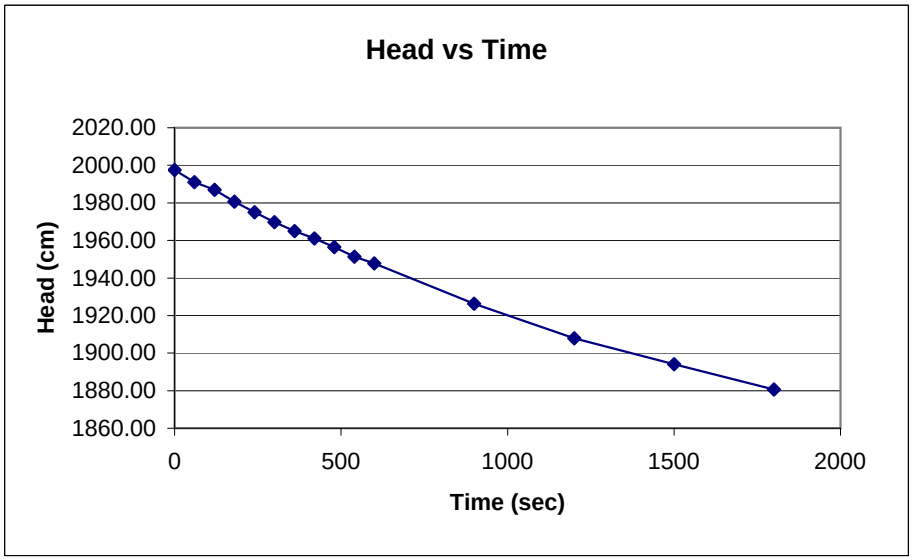
K_h	is the Horizontal Coefficient of Permeability (cm/sec)
H_1	is the Piezometric Head for time; $t = t_1$ (cm)
H_2	is the Piezometric Head for time; $t = t_2$ (cm)
D	is the Diameter of the Standpipe (cm)
d	is the diameter of the Open Length (cm),
m	is the Transformation Ratio, Where
	$m = \sqrt{K_h / K_v}$ — K_h is the Horizontal Permeability; K_v is the Vertical Permeability
L	is the Open Length of Hole (cm)

Spreadsheet assumes 3" ID Pipe; Borehole OD = 3"

MEAN PERMEABILITY (cm/sec)

1.27E-05

Graph of Field Data



CALCULATION OF PERMEABILITY BY THE FALLING HEAD METHOD
(Open Hole in Uniform Material)

Site Name:	MSS Landfill Siting Survey	
Date:	11/6/2007	
Boring I.D.	M-16	
Test Interval:	38 to 41	(Partially Weathered Rock)
Total Depth of Hole:	41	1249.68 cm
Length of Open Hole:	3	91.44 cm
Transformation Ratio m=	1	
Performed by:	Matthew R Osborne	

Time (sec)	Head (cm)	Permeability (cm/sec)
0	1348.87	
60	1336.68	3.82E-05
120	1335.03	5.18E-06
180	1328.69	2.00E-05
240	1301.59	8.66E-05
300	1289.33	3.98E-05
360	1287.29	6.67E-06
420	1285.52	5.78E-06
480	1282.10	1.12E-05
540	1278.45	1.20E-05
600	1268.93	3.14E-05
900	1240.95	1.88E-05
1200	1208.63	2.22E-05
1500	1188.72	1.40E-05
1800	1168.51	1.44E-05
2400	1129.12	1.44E-05
3000	1083.96	1.72E-05
3600	1013.72	2.82E-05

Calculations

$$K_h = \frac{d^2 \cdot \ln\left(\frac{2mL}{D}\right)}{8 \cdot L \cdot (t_2 - t_1)} \cdot \ln\frac{H_1}{H_2}$$

for $\frac{mL}{D} > 4$

Where:

K_h	is the Horizontal Coefficient of Permeability (cm/sec)
H_1	is the Piezometric Head for time; $t = t_1$ (cm)
H_2	is the Piezometric Head for time; $t = t_2$ (cm)
D	is the Diameter of the Standpipe (cm)
d	is the diameter of the Open Length (cm),
m	is the Transformation Ratio, Where

$$m = \sqrt{K_h / K_v}$$

K_h is the Horizontal Permeability
K_v is the Vertical Permeability

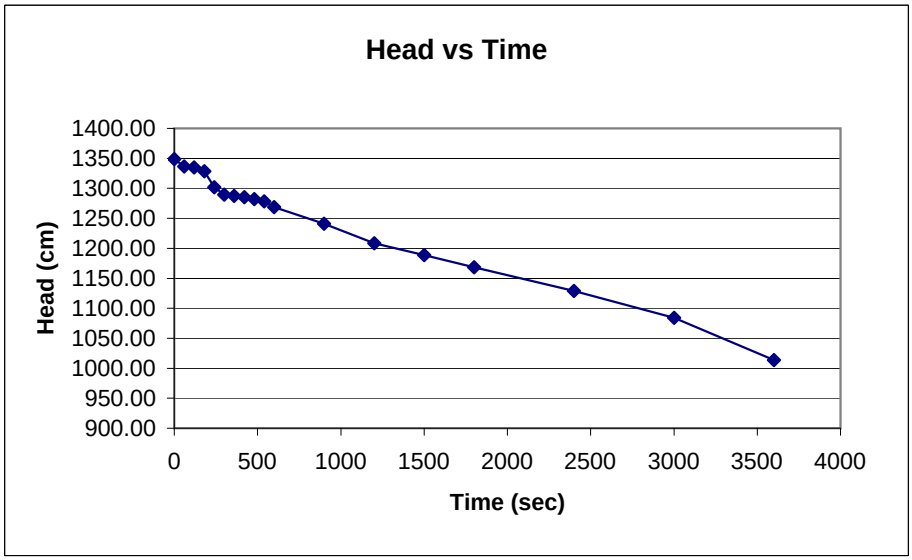
L	is the Open Length of Hole (cm)

Spreadsheet assumes 3" ID Pipe; Borehole OD = 3"

MEAN PERMEABILITY (cm/sec)

2.27E-05

Graph of Field Data



Soil Laboratory Data Sheets

Particle Size Analysis of Soils

ASTM D 422

S&ME

Project #: 1411-07-103
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Charlotte, NC

Test Date(s): 11/19 - 11/21/07
Report Date: 11/26/07

Boring #: M-1 Sample #: 476 Sample Date: 11/2/07
Location: Bulk Offset: N/A Elevation: 0-5'
Sample Description: Red brown clayey SILT with fine sand (MH)

Pan #:	1	Beaker #:	1
Hydrometer Jar #:			1
Pan Tare Weight (grams):			0.00
Total Sample Air Dried Wt. + tare wt. (grams):			514.90
Weight of Total Sample Air Dried:			514.90
Weight of Air Dried Hydrometer Sample (g):			53.56
Total Sample Oven Dried:			508.91
Hydrometer Sample Oven Dried (W):			52.93
% Passing #10:			98.9%
Correction Factor a (Table 1):			1.00

Specific Gravity 2.650

	Moisture Content	Hygroscopic	Natural
	Tare #	W-1	304
A	Tare Wt.	10.59	0.00
B	Wet Wt. + A	23.35	227.70
C	Dry Wt. + A	23.20	181.65
D	Water Wt. (B-C)	0.15	46.05
E	Dry Wt. (C-A)	12.61	181.65
	% Moisture (100 x D/E)	1.19%	25.4%

Sieve	Retained Wt.	Percent Passing	
3.0"	0.0	Pan # (washed) 51	100.0%
1.5"	0.0		100.0%
1.0"	0.0		100.0%
3/4"	0.0		100.0%
1/2"	0.0		100.0%
3/8"	0.0		100.0%
#4	2.1	Soil Mortar	99.6%
#10	5.5	**100.0%**	98.9%
#20	0.9	98.4%	97.3%
#40	2.2	95.8%	94.8%
#60	3.9	92.7%	91.7%
#100	7.1	86.7%	85.7%
#200	13.5	74.5%	73.7%

Notes: Description of Sand & Gravel Particles — Rounded ☐ Angular ☒ — Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:	4.75 mm	
% Gravel:	0.4%	< 75 mm and > 4.75 mm
Coarse Sand:	0.7%	< 4.75 mm and > 2.00 mm
Medium Sand:	4.1%	< 2.00 mm and > 0.425 mm
Fine Sand:	21.1%	< 0.425 mm and > 0.075 mm

Total Sand:	25.9%	< 4.74 mm and > 0.075 mm
Silt & Clay:	73.7%	< 0.075
Silt:	33.2%	< 0.075 and > 0.005 mm
Clay:	40.5%	< 0.005 mm
Colloids:	25.0%	< 0.001 mm

Type: Mechanical Stirring Apparatus (A)
Dispersion Time: 1 min.
Sodium Hexametaphosphate: 40 g./ Liter

Liquid Limit 58 Plastic Limit 35 Plastic Index 23

Control Cylinder ☐ Composite Correction ☒
Hydrometer: 151H ☐ 152H ☒

Time		Temp.	Hydrometer	Corrections		Hydrometer	Percent Passing		Effective Depth	Table 3	Diameter
Clock	T (Min.)	(0.5 °C)	Reading	Control Cylinder	Composite Correction	R	P(-#10) = (R x a / W) x 100	P (total) = P x % Passing #10	L	K	D = K x ((L/T)^1/2
	2	22.3	40.5		5.15	35.35	66.8%	66.1%	10.5	0.01332	0.03052
	5	22.3	38.0		5.15	32.85	62.1%	61.4%	10.9	0.01332	0.01967
	15	22.3	34.5		5.15	29.35	55.5%	54.9%	11.5	0.01332	0.01165
	30	22.3	31.5		5.15	26.35	49.8%	49.2%	12.0	0.01332	0.00842
	60	22.3	28.5		5.15	23.35	44.1%	43.6%	12.5	0.01332	0.00607
	250	22.8	23.5		5.10	18.40	34.8%	34.4%	13.3	0.01325	0.00305
	1440	22.7	19.5		5.15	14.35	27.1%	26.8%	13.9	0.01325	0.00130
	2880	22.5	18.5		5.15	13.30	25.1%	24.9%	14.1	0.01325	0.00093

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Effective Depth (cm)
L=L1+0.5(L2-(VB/A))
(152H) .164cm per increment,
V_B=67.0cm^3, L_2=14cm, A=27.8cm^2

Technician Name: M. Jacobs

Technical Responsibility: Brian Vaughan, P.E.

Certification #

Signature

QC Manager
Position

S&ME, INC. 155 Tradd Street Spartanburg, SC 29301

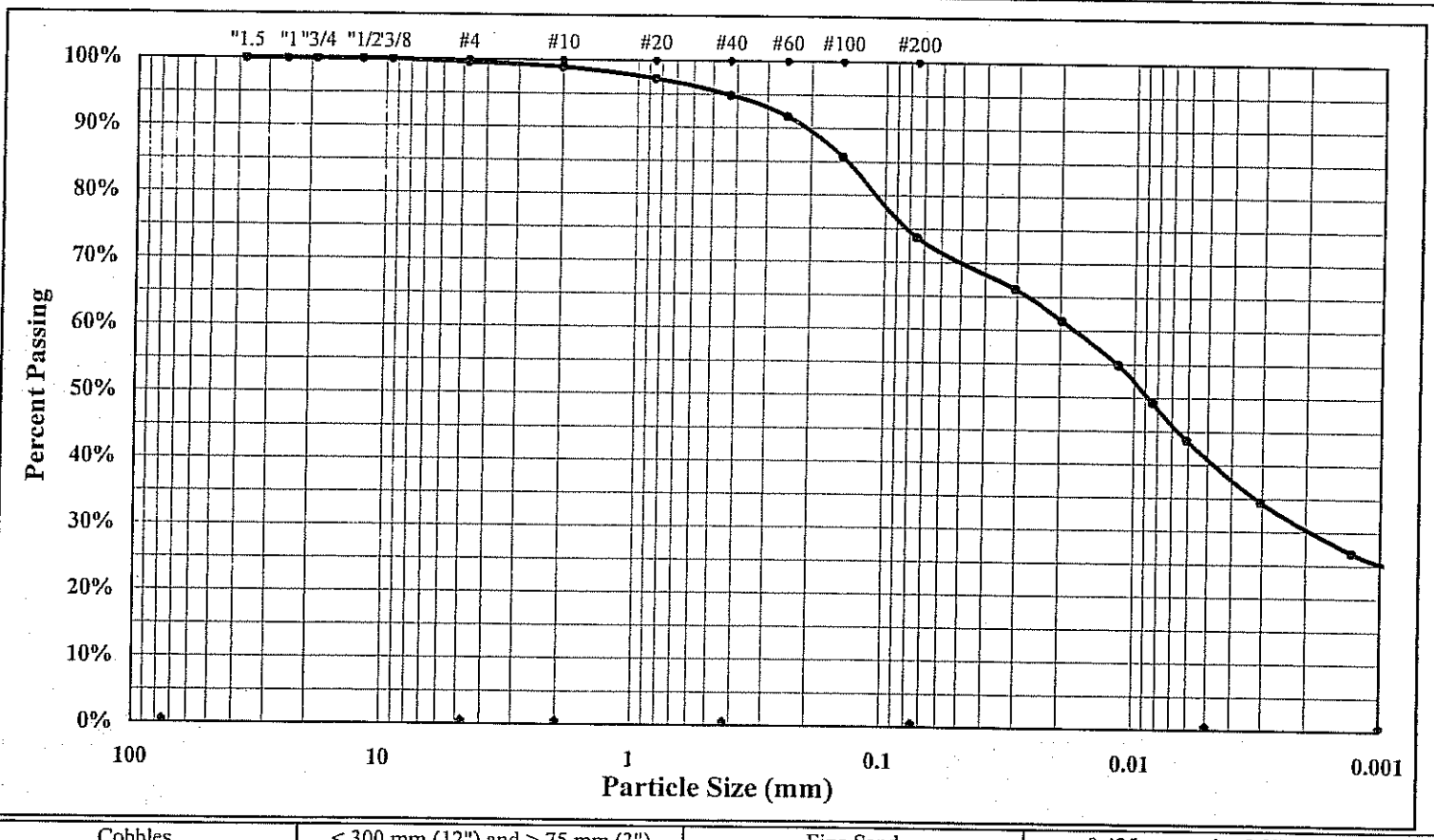
Hydrometer #476 (M-1, 0-5') 11-26-07.xls

Particle Size Analysis of Soils

ASTM D 422

S&ME Project #:	**1411-07-103**	Report Date:	11/26/07
Project Name:	**Marshall Steam Station**	Test Date(s):	11/19 - 11/21/07
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-1	Sample #:	476	Sample Date:	11/2/07
Location:	Bulk	Offset:	N/A	Elevation:	0-5'
Sample Description:	Red brown clayey SILT with fine sand (MH)				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	4.75 mm	Gravel	0.4%	Silt	33.2%
Silt & Clay (% Passing #200)	73.7%	Sand	25.9%	Clay	40.5%
Specific Gravity	2.650	Moisture Content	25.4%	Colloids	25.0%
Liquid Limit	58	Plastic Limit	35	Plastic Index	23

Description of Sand & Gravel Particles Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Mechanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

References: ASTM D 422: Particle Size Analysis of Soils
ASTM D 421: Dry Preparation of Soil Samples
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 854: Specific Gravity of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. _____ QC Manager

Signature Position

Moisture - Density Relationship

S&ME

S&ME Project #:	**1411-07-103**	Test Date(s):	November 28, 2007
Project Name:	Marshall Steam Station	Report Date:	November 29, 2007
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-1	Sample #:	476	Sample Date:	November 2, 2007
Location:	Bulk	Offset:	N/A	Depth:	0-5'

Sample Description: Red brown clayey SILT with fine sand (MH)

Liquid Limit:	58	Specific Gravity:	2.650
Plastic Limit:	35	Plastic Index:	23

Natural Moisture Content: 25.4%

Moisture Content of the Oversize Fraction:

NOTES:

Sieve Size	% Passing
#4	99.6
#10	98.9
#20	97.3
#40	94.8
#60	91.7
#100	85.7
#200	73.7

MDD: 101.6 **Opt. MC %: 19.5**

Water Content

Water Content requires GP 2 Balance (0.1 gram Readability).

ASTM D2216 ☒ AASHTO T265 ☐ ASTM D4959 ☐ ASTM D4643 ☐

	Sample #:	1	2	3	4	5	6
	Water Added:						
	Tare #:						
A. Tare Weight	A.	0	0	0	0	0	0
B. Wet Wt + Tare Wt	B.	500	500	500	500	500	500
C. Dry Wt. + Tare Wt.	C.	431	420.9	413.3	406.2		
D. Water Weight	B-C	69	79.1	86.7	93.8	500	500
E. Dry Weight	C-A	431	420.9	413.3	406.2	0	0
F. Moisture Content	100*D/E	**16.0%**	**18.8%**	**21.0%**	**23.1%**	**#DIV/0!**	**#DIV/0!**

Compaction Data

The Compaction Test requires a GP 5 Balance for ASTM (1 gram or .0022 Lb. readability).

G. Wt of Soil + Mold	G.	13.166	13.318	13.378	13.382		
H. Wt. of Mold	H.	9.304	9.304	9.304	9.304	9.304	9.304
I. Wt. of Soil (g. or lbs.)	G-H	3.862	4.014	4.074	4.078	-9.304	-9.304
J. Wt of Soil (Lbs.)	I/453.6 or I	3.862	4.014	4.074	4.078	-9.304	-9.304
K. Mold Volume Factor	K.	30.039	30.039	30.039	30.039	30.039	30.039
L. Wet Density	J*K	116.0	120.6	122.4	122.5	-279.5	-279.5
M. Dry Density	L/(1+F)	**100.0**	**101.5**	**101.2**	**99.5**	**#DIV/0!**	**#DIV/0!**

ASTM D558 ☐ ASTM D 698 ☒ ASTM D1557 ☐ AASHTO T99 ☐ AASHTO T180 ☐

Method A ☒ Method B ☐ Method C ☐ Method D (ASTM 1978) ☐ AASHTO Method D ☐

Moisture-Density Relation of: Fine Fraction ☒ Corrected for Coarse Fraction (ASTM D 4718) ☐

Sieve Size used to separate the Oversize Fraction: #4 Sieve ☒ 3/8 inch Sieve ☐ 3/4 inch Sieve ☐

Mechanical Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

Soil Plasticity: ASTM D 4318 ☒ AASHTO T 89 ☐ AASHTO T 90 ☐

Sieve Analysis / Particle Size Analysis: ASTM C136 ☐ AASHTO T 27 ☐ ASTM D 422 ☒ AASHTO T 88 ☐

Specific Gravity of Soil: ASTM D 854 ☒ AASHTO T 100 ☐

Bulk Gravity of Oversize Fraction: ASTM C 127 ☐ AASHTO T 85 ☐

Soil Classification: ASTM D 2487 ☒ ASTM D 2488 ☐ AASHTO M 145 ☐

Technician Name: M. Jacobs

Certification #

Technical Responsibility: Brian Vaughan, P.E. Signature Construction Services Manager Position

Laboratory Report Version 4.2

Moisture - Density Report

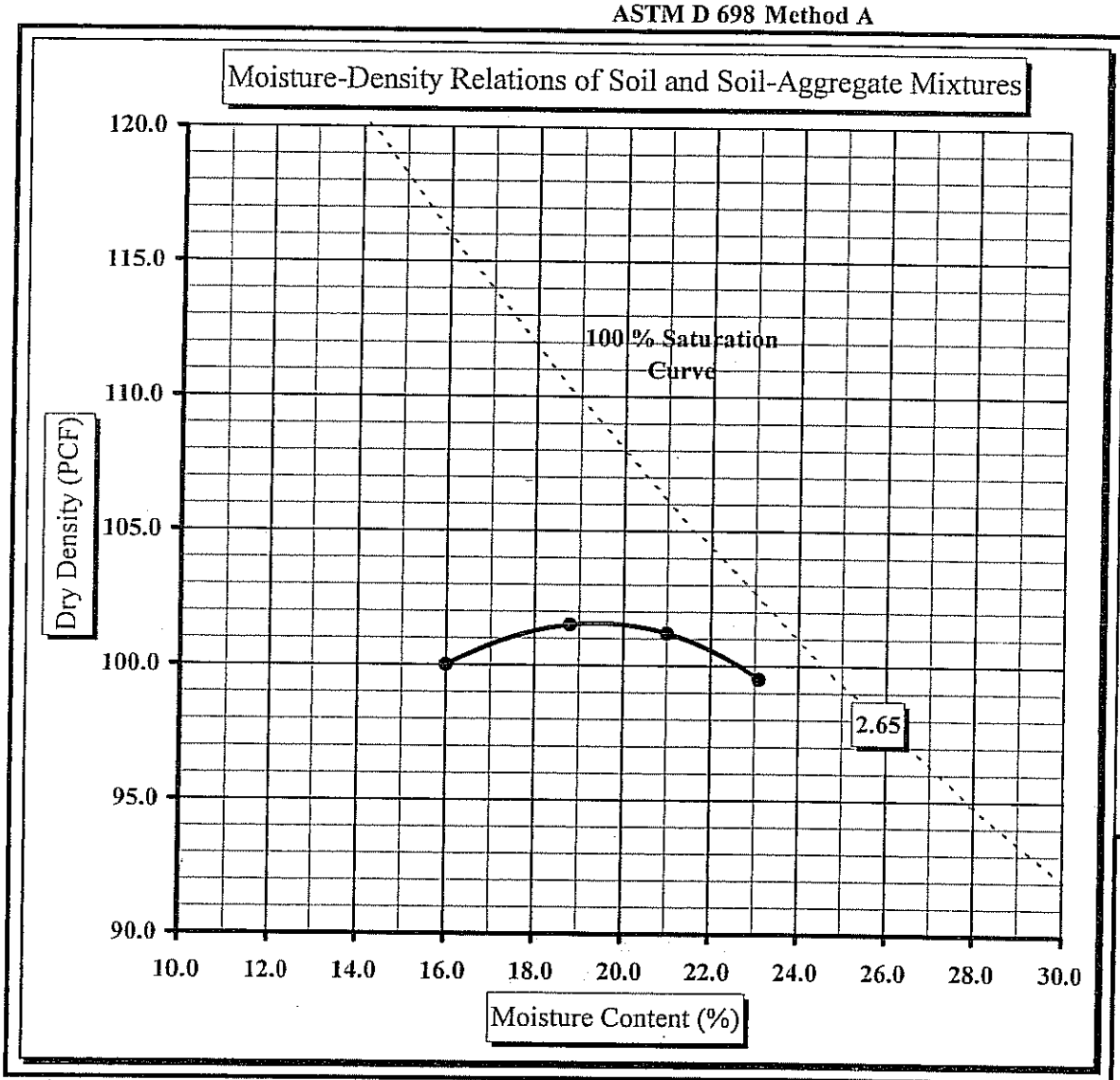
S&ME

S&ME Project #:	**1411-07-103**	Report Date:	November 29, 2007
Project Name:	**Marshall Steam Station**	Test Date(s):	November 28, 2007
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-1	Sample #:	476	Sample Date:	November 2, 2007
Location:	Bulk	Offset:	N/A	Depth:	0-5'
Sample Description:	Red brown clayey SILT with fine sand (MH)				

Maximum Dry Density **101.6** **PCF.** **Optimum Moisture Content** **19.5** **%**

ASTM D 698 Method A



Soil Properties

Natural Moisture Content:	25.4%
Liquid Limit:	58
Plastic Limit:	35
Plastic Index:	23
Specific Gravity:	2.650

% Passing

#4	99.6
#10	98.9
#20	97.3
#40	94.8
#60	91.7
#100	85.7
#200	73.7

Oversize Fraction

Bulk Sp. Gravity
% Moisture
Oversize Fraction
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 Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

References: ASTM D 698: Laboratory Compaction Characteristics of Soil Using Standard Effort
ASTM D 2216: Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D 422: Particle Size Analysis of Soils
ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. Construction Services Manager

S&ME

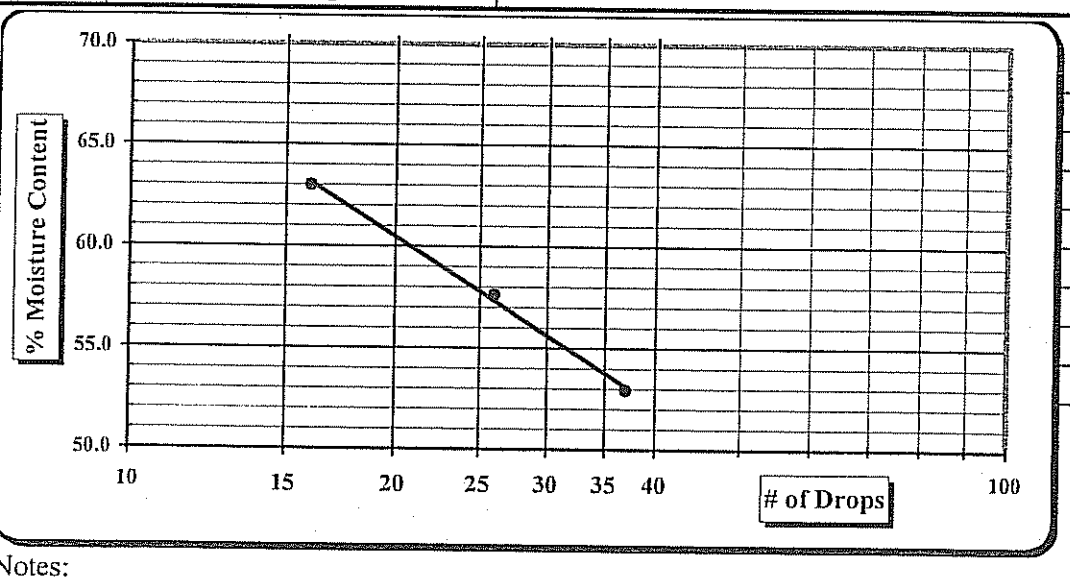
Liquid Limit, Plastic Limit, and Plastic Index

Project #: **1411-07-103**
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Charlotte, NC

Report Date: 11/29/07
Test Date(s): 11/28/07

Boring #: M-1 Sample #: 476 Sample Date: 11/2/07
Location: Bulk Offset: N/A Elevation: 0-5'
Sample Description: Red brown clayey SILT with fine sand (MH)

Pan #		Liquid Limit						Plastic Limit		
	Test #	1	2	3	4	5	6	1	2	3
	Tare #	P-1	P-2	P-3				1	2	
A	Tare Weight	16.56	15.45	16.55				10.59	10.85	
B	Wet Soil Weight + A	37.74	37.36	36.94				18.21	17.95	
C	Dry Soil Weight + A	30.41	29.35	29.06				16.23	16.12	
D	Water Weight (B-C)	7.33	8.01	7.88				1.98	1.83	
E	Dry Soil Weight (C-A)	13.85	13.90	12.51				5.64	5.27	
F	% Moisture Content (D/E)*100	52.9%	57.6%	63.0%				35.1%	34.7%	
N	# OF DROPS	37	26	16				*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average							34.9%		



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes:

Special Sampling Methods:

Sample Preparation:	Wet Preparation ☐	Dry Preparation ☒	Air Dried ☒	% Passing #200 Sieve:	73.7
Liquid limit Test:	Multipoint Method ☒	One-point Method ☐		NP, Non-Plastic	☐
Classification:	ASTM D 2487 ☒	AASHTO M 145 ☐		Liquid Limit	58
Liquid limit Test:	ASTM D 4318 ☒	AASHTO T 89 ☐		Plastic Limit	35
Plastic limit Test:	ASTM D 4318 ☒	AASHTO T 90 ☐		Plastic Index	23
				Group Symbol	MH

Technician Name: M. Jacobs

Certification #

Technical Responsibility: Brian Vaughan, P.E. Signature QC Manager Position

Particle Size Analysis of Soils

ASTM D 422

S&ME

Project #: 1411-07-103
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Charlotte, NC

Test Date(s): 11/19 - 11/21/07
Report Date: 11/26/07

Boring #: M-1 Sample #: 476 Sample Date: 11/2/07
Location: Bulk Offset: N/A Elevation: 5-10'
Sample Description: Brown red clayey SILT with fine sand (MH)

Pan #:	2	Beaker #:	2
Hydrometer Jar #:			2
Pan Tare Weight (grams):			0.00
Total Sample Air Dried Wt. + tare wt. (grams):			447.18
Weight of Total Sample Air Dried:			447.18
Weight of Air Dried Hydrometer Sample (g):			53.31
Total Sample Oven Dried:			441.16
Hydrometer Sample Oven Dried (W):			52.59
% Passing #10:			99.9%
Correction Factor a (Table 1):			1.00

Specific Gravity 2.650

	Moisture Content	Hygroscopic	Natural
	Tare #	T-2	326
A	Tare Wt.	10.85	0.00
B	Wet Wt. + A	23.46	206.11
C	Dry Wt. + A	23.29	162.03
D	Water Wt. (B-C)	0.17	44.08
E	Dry Wt. (C-A)	12.44	162.03
	% Moisture (100 x D/E)	1.37%	27.2%

Sieve	Retained Wt.	Percent Passing	
3.0"	0.0	Pan # (washed) 52	100.0%
1.5"	0.0		100.0%
1.0"	0.0		100.0%
3/4"	0.0		100.0%
1/2"	0.0		100.0%
3/8"	0.0		100.0%
#4	0.0	Soil Mortar	100.0%
#10	0.6	**100.0%**	99.9%
#20	0.2	99.7%	99.5%
#40	0.5	99.1%	99.0%
#60	1.1	98.0%	97.8%
#100	3.4	93.6%	93.5%
#200	10.0	81.0%	80.9%

Notes: Description of Sand & Gravel Particles Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:	2.00 mm	
% Gravel:	0.0%	< 75 mm and > 4.75 mm
Coarse Sand:	0.1%	< 4.75 mm and > 2.00 mm
Medium Sand:	0.9%	< 2.00 mm and > 0.425 mm
Fine Sand:	18.1%	< 0.425 mm and > 0.075 mm

Total Sand:	19.1%	< 4.74 mm and > 0.075 mm
Silt & Clay:	80.9%	< 0.075
Silt:	46.9%	< 0.075 and > 0.005 mm
Clay:	34.0%	< 0.005 mm
Colloids:	14.0%	< 0.001 mm

Type: Mechanical Stirring Apparatus (A)
Dispersion Time: 1 min.
Sodium Hexametaphosphate: 40 g./ Liter

Liquid Limit 57 Plastic Limit 38 Plastic Index 19

Control Cylinder ☐ Composite Correction ☒
Hydrometer: 151H ☐ 152H ☒

Time		Temp.	Hydrometer	Corrections		Hydrometer	Percent Passing		Effective Depth	Table 3	Diameter
Clock	T (Min.)	(0.5 °C)	Reading	Control Cylinder	Composite Correction	R	P(-#10) = (R x a / W) x 100	P (total) = P x % Passing #10	L	K	D = K x ((L/T)^1/2
	2	22.2	42.0		5.20	36.80	70.0%	69.9%	10.3	0.01332	0.03017
	5	22.2	38.5		5.20	33.30	63.3%	63.2%	10.8	0.01332	0.01961
	15	22.2	33.5		5.20	28.30	53.8%	53.7%	11.7	0.01332	0.01174
	30	22.2	29.0		5.20	23.80	45.3%	45.2%	12.4	0.01332	0.00856
	60	22.2	25.0		5.20	19.80	37.6%	37.6%	13.0	0.01332	0.00621
	250	22.8	18.5		5.10	13.40	25.5%	25.4%	14.1	0.01325	0.00315
	1440	22.7	13.5		5.15	8.35	15.9%	15.9%	14.9	0.01325	0.00135
	2880	22.5	12.5		5.15	7.35	14.0%	14.0%	15.1	0.01325	0.00096

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Effective Depth (cm)
L=L1+0.5(L2-(VB/A))

Technician Name: M. Jacobs

Technical Responsibility: Brian Vaughan, P.E.

Certification #

Signature

QC Manager
Position

(152H) .164cm per increment,
V_B=67.0cm^3, L_2=14cm, A=27.8cm^2

S&ME, INC.
155 Tradd Street Spartanburg, SC 29301

Hydrometer #476 (M-1, 5-10') 11-26-07.xls

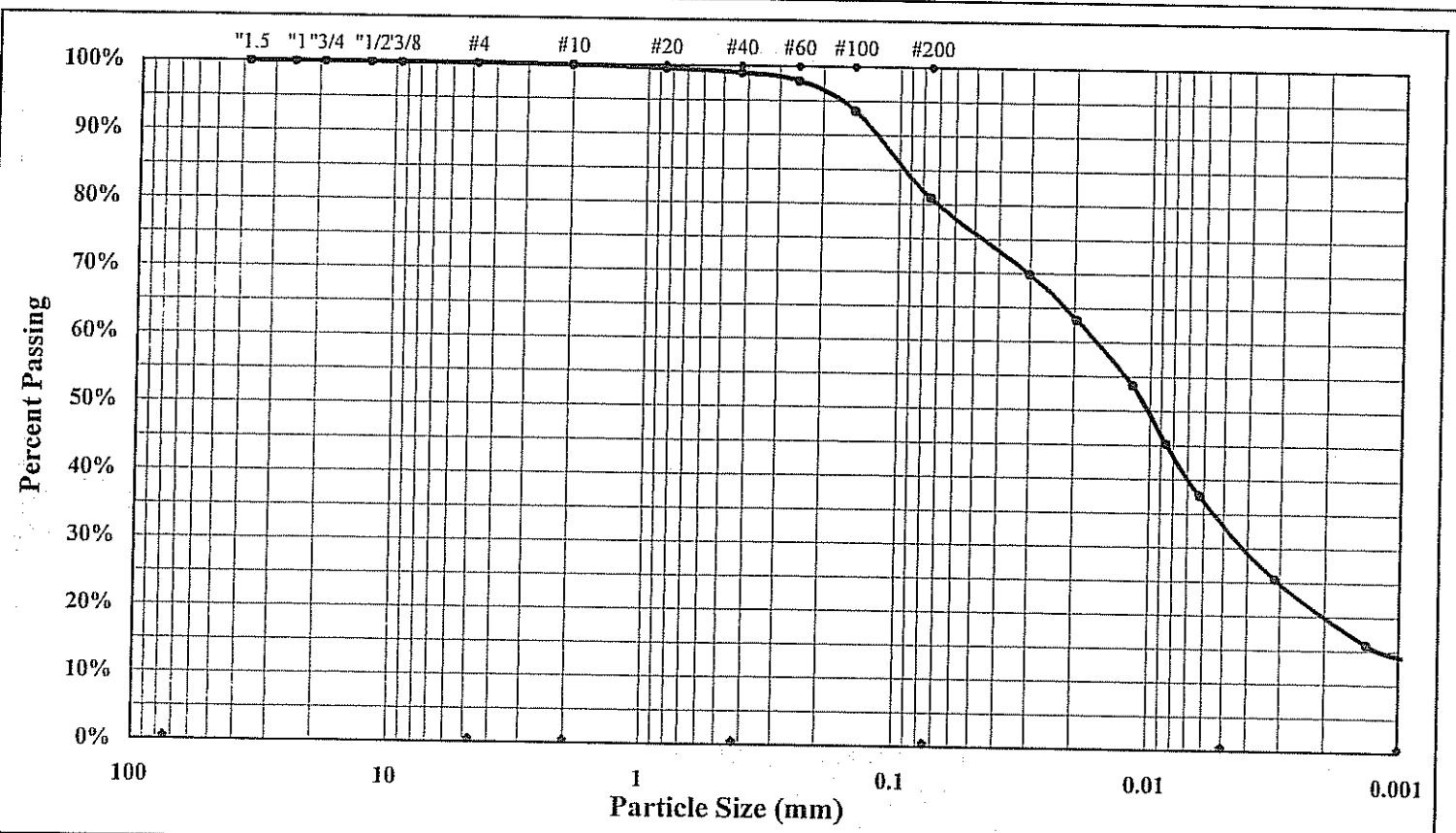
Particle Size Analysis of Soils

ASTM D 422

S&ME

S&ME Project #:	**1411-07-103**	Report Date:	11/26/07
Project Name:	**Marshall Steam Station**	Test Date(s):	11/19 - 11/21/07
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-1	Sample #:	476	Sample Date:	11/2/07
Location:	Bulk	Offset:	N/A	Elevation:	5-10'
Sample Description:	Brown red clayey SILT with fine sand (MH)				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	2.00 mm	Gravel	0.0%	Silt	46.9%
Silt & Clay (% Passing #200)	80.9%	Sand	19.1%	Clay	34.0%
Specific Gravity	2.650	Moisture Content	27.2%	Colloids	14.0%
Liquid Limit	57	Plastic Limit	38	Plastic Index	19

Description of Sand & Gravel Particles Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Mechanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

References: ASTM D 422: Particle Size Analysis of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 421: Dry Preparation of Soil Samples
ASTM D 854: Specific Gravity of Soils

Technical Responsibility: Brian Vaughan, P.E. _____ QC Manager
Signature Position

Moisture - Density Relationship

S&ME

S&ME Project #:	**1411-07-103**	Test Date(s):	November 28, 2007
Project Name:	Marshall Steam Station	Report Date:	November 29, 2007
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-1	Sample #:	476	Sample Date:	November 2, 2007
Location:	Bulk	Offset:	N/A	Depth:	5-10'

Sample Description: Brown red clayey SILT with fine sand (MH)

Liquid Limit:	57	Specific Gravity:	2.650
Plastic Limit:	38	Plastic Index:	19

Natural Moisture Content: 27.2%

Moisture Content of the Oversize Fraction:

NOTES:

Sieve Size	% Passing
#4	100.0
#10	99.9
#20	99.5
#40	99.0
#60	97.8
#100	93.5
#200	80.9

MDD: 97.0 **Opt. MC %:** 23.0

Water Content

Water Content requires GP 2 Balance (0.1 gram Readability).

ASTM D2216 ☒ AASHTO T265 ☐ ASTM D4959 ☐ ASTM D4643 ☐

	Sample #:	1	2	3	4	5	6
	Water Added:						
	Tare #:						
A. Tare Weight	A.	0	0	0	0	0	0
B. Wet Wt + Tare Wt	B.	500	500	500	500	500	500
C. Dry Wt. + Tare Wt.	C.	419.5	411.8	404.9	398.8		
D. Water Weight	B-C	80.5	88.2	95.1	101.2	500	500
E. Dry Weight	C-A	419.5	411.8	404.9	398.8	0	0
F. Moisture Content	100*D/E	**19.2%**	**21.4%**	**23.5%**	**25.4%**	**#DIV/0!**	**#DIV/0!**

Compaction Data

The Compaction Test requires a GP 5 Balance for ASTM (1 gram or .0022 Lb. readability).

G. Wt of Soil + Mold	G.	13.092	13.200	13.286	13.254		
H. Wt. of Mold	H.	9.304	9.304	9.304	9.304	9.304	9.304
I. Wt. of Soil (g. or lbs.)	G-H	3.788	3.896	3.982	3.950	-9.304	-9.304
J. Wt of Soil (Lbs.)	I/453.6 or I	3.788	3.896	3.982	3.950	-9.304	-9.304
K. Mold Volume Factor	K.	30.039	30.039	30.039	30.039	30.039	30.039
L. Wet Density	J*K	113.8	117.0	119.6	118.7	-279.5	-279.5
M. Dry Density	L/(1+F)	**95.5**	**96.4**	**96.9**	**94.6**	**#DIV/0!**	**#DIV/0!**

ASTM D558 ☐ ASTM D 698 ☒ ASTM D1557 ☐ AASHTO T99 ☐ AASHTO T180 ☐

Method A ☒ Method B ☐ Method C ☐ Method D (ASTM 1978) ☐ AASHTO Method D ☐

Moisture-Density Relation of: Fine Fraction ☒ Corrected for Coarse Fraction (ASTM D 4718) ☐

Sieve Size used to separate the Oversize Fraction: #4 Sieve ☒ 3/8 inch Sieve ☐ 3/4 inch Sieve ☐

Mechanical Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

Soil Plasticity: ASTM D 4318 ☒ AASHTO T 89 ☐ AASHTO T 90 ☐

Sieve Analysis / Particle Size Analysis: ASTM C136 ☐ AASHTO T 27 ☐ ASTM D 422 ☒ AASHTO T 88 ☐

Specific Gravity of Soil: ASTM D 854 ☒ AASHTO T 100 ☐

Bulk Gravity of Oversize Fraction: ASTM C 127 ☐ AASHTO T 85 ☐

Soil Classification: ASTM D 2487 ☒ ASTM D 2488 ☐ AASHTO M 145 ☐

Technician Name: M. Jacobs

Certification #

Technical Responsibility: Brian Vaughan, P.E.

Signature

Construction Services Manager

Position

Moisture - Density Report

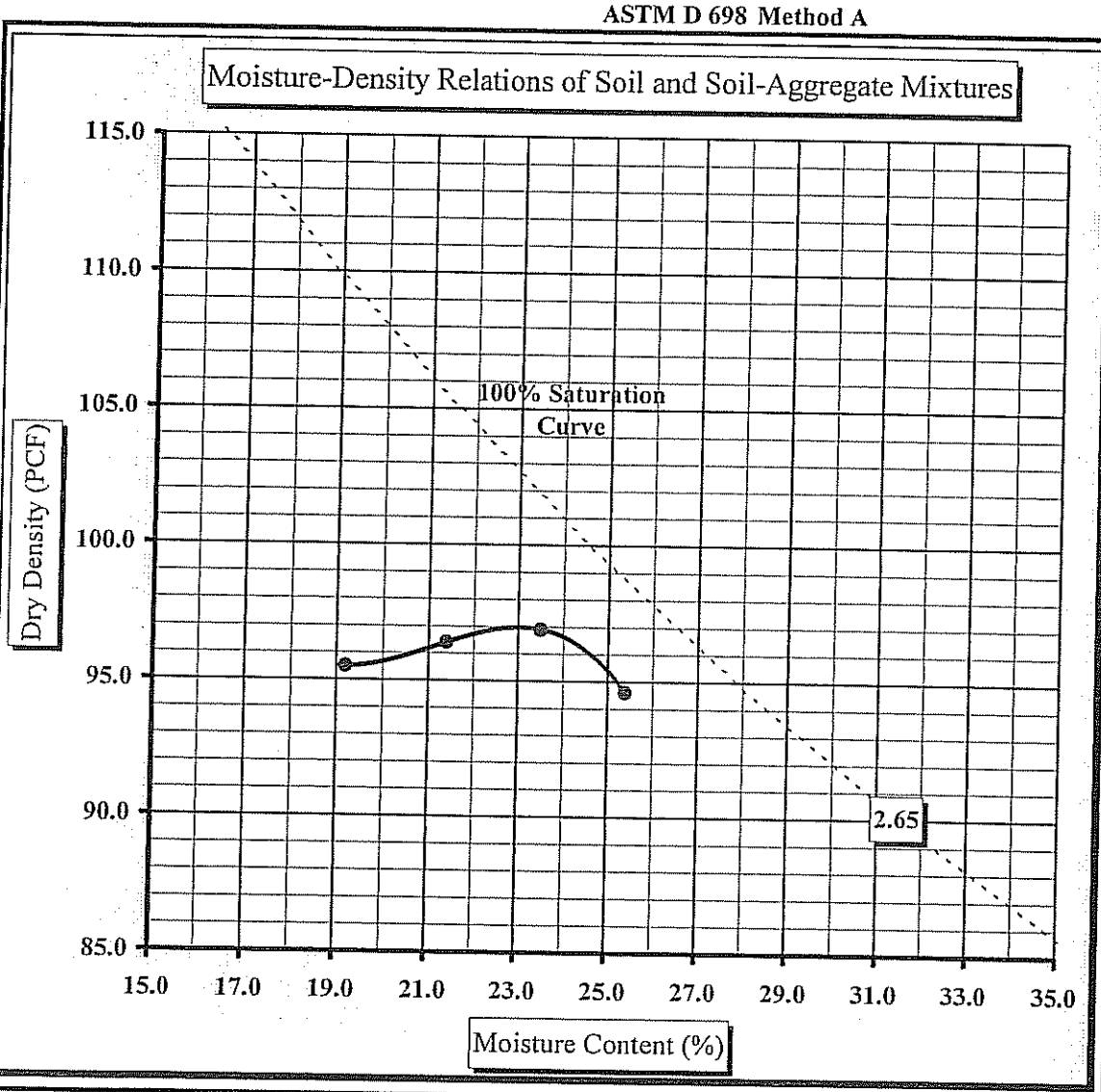
S&ME

S&ME Project #:	**1411-07-103**	Report Date:	November 29, 2007
Project Name:	**Marshall Steam Station**	Test Date(s):	November 28, 2007
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-1	Sample #:	476	Sample Date:	November 2, 2007
Location:	Bulk	Offset:	N/A	Depth:	5-10'
Sample Description:	Brown red clayey SILT with fine sand (MH)				

Maximum Dry Density **97.0** **PCF.** **Optimum Moisture Content** **23.0** **%**

ASTM D 698 Method A



Soil Properties

Natural Moisture Content:	27.2%
Liquid Limit:	57
Plastic Limit:	38
Plastic Index:	19
Specific Gravity:	2.650

% Passing

#4	100
#10	99.9
#20	99.5
#40	99.0
#60	97.8
#100	93.5
#200	80.9

Oversize Fraction

Bulk Sp. Gravity
% Moisture
Oversize Fraction
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 Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

References: ASTM D 698: Laboratory Compaction Characteristics of Soil Using Standard Effort
ASTM D 2216: Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D 422: Particle Size Analysis of Soils
ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. Construction Services Manager

Laboratory Record Version 4.2

S&ME

Liquid Limit, Plastic Limit, and Plastic Index

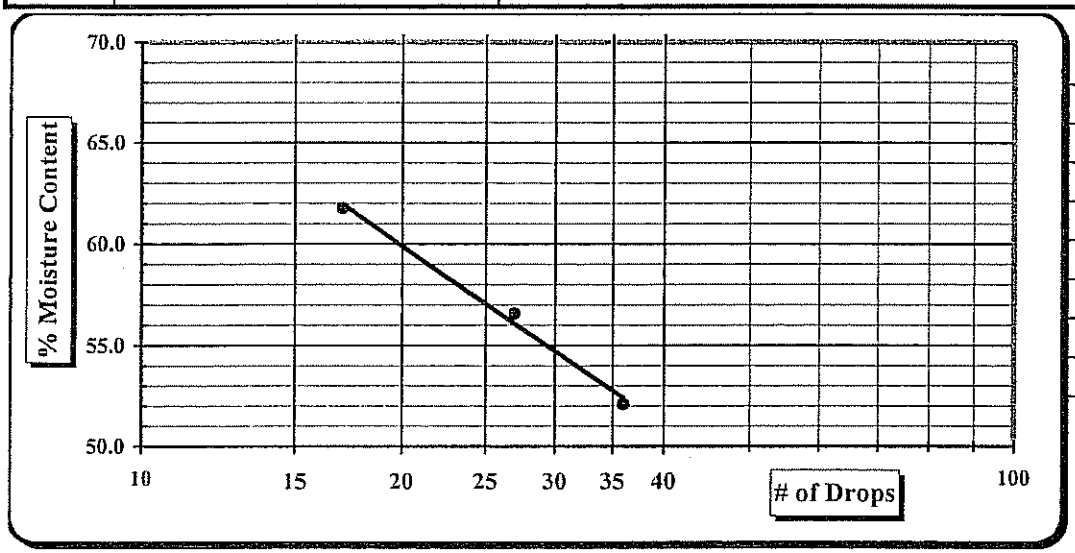
Project #:	**1411-07-103**	Report Date:	11/29/07
Project Name:	Marshall Steam Station	Test Date(s):	11/28/07
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #: M-1 Sample #: 476 Sample Date: 11/2/07

Location: Bulk Offset: N/A Elevation: 5-10'

Sample Description: Brown red clayey SILT with fine sand (MH)

Pan #		Liquid Limit						Plastic Limit		
	Test #	1	2	3	4	5	6	1	2	3
	Tare #	Q-1	Q-2	Q-3				3	4	
A	Tare Weight	16.80	16.78	15.76				**10.87**	10.97	
B	Wet Soil Weight + A	38.67	37.32	37.53				18.19	18.31	
C	Dry Soil Weight + A	31.18	29.90	29.22				16.17	16.30	
D	Water Weight (B-C)	7.49	7.42	8.31				2.02	2.02	
E	Dry Soil Weight (C-A)	14.38	13.12	13.46				5.30	5.33	
F	% Moisture Content (D/E)*100	52.1%	56.6%	61.7%				38.1%	37.8%	
N	# OF DROPS	36	27	17				*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average							38.0%		



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes:

Special Sampling Methods:

Sample Preparation:	Wet Preparation	☐	Dry Preparation	☒	Air Dried	☒	
Liquid limit Test:	Multipoint Method	☒	One-point Method	☐			
Classification:	ASTM D 2487	☒	AASHTO M 145	☐			
Liquid limit Test:	ASTM D 4318	☒	AASHTO T 89	☐			
Plastic limit Test:	ASTM D 4318	☒	AASHTO T 90	☐			

% Passing #200 Sieve:	80.9
NP, Non-Plastic	☐
Liquid Limit	57
Plastic Limit	38
Plastic Index	19
Group Symbol	MH

Technician Name: M. Jacobs

Certification #

Technical Responsibility: Brian Vaughan, P.E.

Signature

QC Manager

Position

Particle Size Analysis of Soils

ASTM D 422

S&ME

Project #: **1411-07-103**
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Charlotte, NC

Test Date(s): 11/19 - 11/21/07
Report Date: 11/26/07

Boring #: M-1 Sample #: 476 Sample Date: 11/2/07
Location: Bulk Offset: N/A Elevation: 10-15'
Sample Description: Brown fine sandy clayey SILT (ML)

Pan #:	3	Beaker #:	3
Hydrometer Jar #:			3
Pan Tare Weight (grams):			0.00
Total Sample Air Dried Wt. + tare wt. (grams):			483.01
Weight of Total Sample Air Dried:			483.01
Weight of Air Dried Hydrometer Sample (g):			53.05
Total Sample Oven Dried:			477.86
Hydrometer Sample Oven Dried (W):			52.47
% Passing #10:			98.2%
Correction Factor a (Table 1):			1.00

Specific Gravity 2.650

	Moisture Content	Hygroscopic	Natural
	Tare #	Z-3	333
A	Tare Wt.	16.77	0.00
B	Wet Wt. + A	29.66	256.31
C	Dry Wt. + A	29.52	210.59
D	Water Wt. (B-C)	0.14	45.72
E	Dry Wt. (C-A)	12.75	210.59
	% Moisture (100 x D/E)	1.10%	21.7%

Sieve	Retained Wt.	Percent Passing	
3.0"	0.0	Pan # (washed)	100.0%
1.5"	0.0		100.0%
1.0"	0.0		100.0%
3/4"	0.0	53	100.0%
1/2"	0.0		100.0%
3/8"	1.5		99.7%
#4	4.3	Soil Mortar	99.1%
#10	8.6	**100.0%**	98.2%
#20	1.3	97.5%	95.8%
#40	3.6	93.2%	91.5%
#60	5.5	89.6%	88.0%
#100	8.6	83.7%	82.2%
#200	16.1	69.4%	68.2%

Notes: Description of Sand & Gravel Particles — Rounded ☐ Angular ☒ — Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:	9.50 mm	
% Gravel:	0.9%	< 75 mm and > 4.75 mm
Coarse Sand:	0.9%	< 4.75 mm and > 2.00 mm
Medium Sand:	6.7%	< 2.00 mm and > 0.425 mm
Fine Sand:	23.4%	< 0.425 mm and > 0.075 mm

Total Sand:	30.9%	< 4.74 mm and > 0.075 mm
Silt & Clay:	68.2%	< 0.075
Silt:	40.7%	< 0.075 and > 0.005 mm
Clay:	27.5%	< 0.005 mm
Colloids:	9.1%	< 0.001 mm

Type: Mechanical Stirring Apparatus (A)
Dispersion Time: 1 min.
Sodium Hexametaphosphate: 40 g./ Liter

Liquid Limit 47 Plastic Limit 32 Plastic Index 15

Control Cylinder ☐ **Composite Correction** ☒
Hydrometer: 151H ☐ 152H ☒

Time		Temp.	Hydrometer	Corrections		Hydrometer	Percent Passing		Effective Depth	Table 3	Diameter
Clock	T (Min.)	(0.5 °C)	Reading	Control Cylinder	Composite Correction	R	P(-#10) = (R x a / W) x 100	P (total) = P x % Passing #10	L	K	D = K x ((L/T)^1/2
	2	22.2	35.0		5.20	29.80	56.8%	55.8%	11.4	0.01332	0.03181
	5	22.2	32.0		5.20	26.80	51.1%	50.2%	11.9	0.01332	0.02055
	15	22.2	28.0		5.20	22.80	43.5%	42.7%	12.6	0.01332	0.01219
	30	22.2	25.0		5.20	19.80	37.7%	37.1%	13.0	0.01332	0.00878
	60	22.2	22.0		5.20	16.80	32.0%	31.4%	13.5	0.01332	0.00633
	250	22.8	16.0		5.10	10.90	20.8%	20.4%	14.5	0.01325	0.00319
	1440	22.7	11.0		5.15	5.85	11.1%	10.9%	15.3	0.01325	0.00137
	2880	22.5	10.0		5.15	4.85	9.2%	9.1%	15.5	0.01325	0.00097

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Effective Depth (cm)
L=L1+0.5(L2-(VB/A))
(152H) .164cm per increment,
V_B=67.0cm^3, L_2=14cm, A=27.8cm^2

Technician Name: M. Jacobs

Technical Responsibility: Brian Vaughan, P.E.

Certification #

Signature

OC Manager
Position

S&ME, INC.
155 Tradd Street Spartanburg, SC 29301

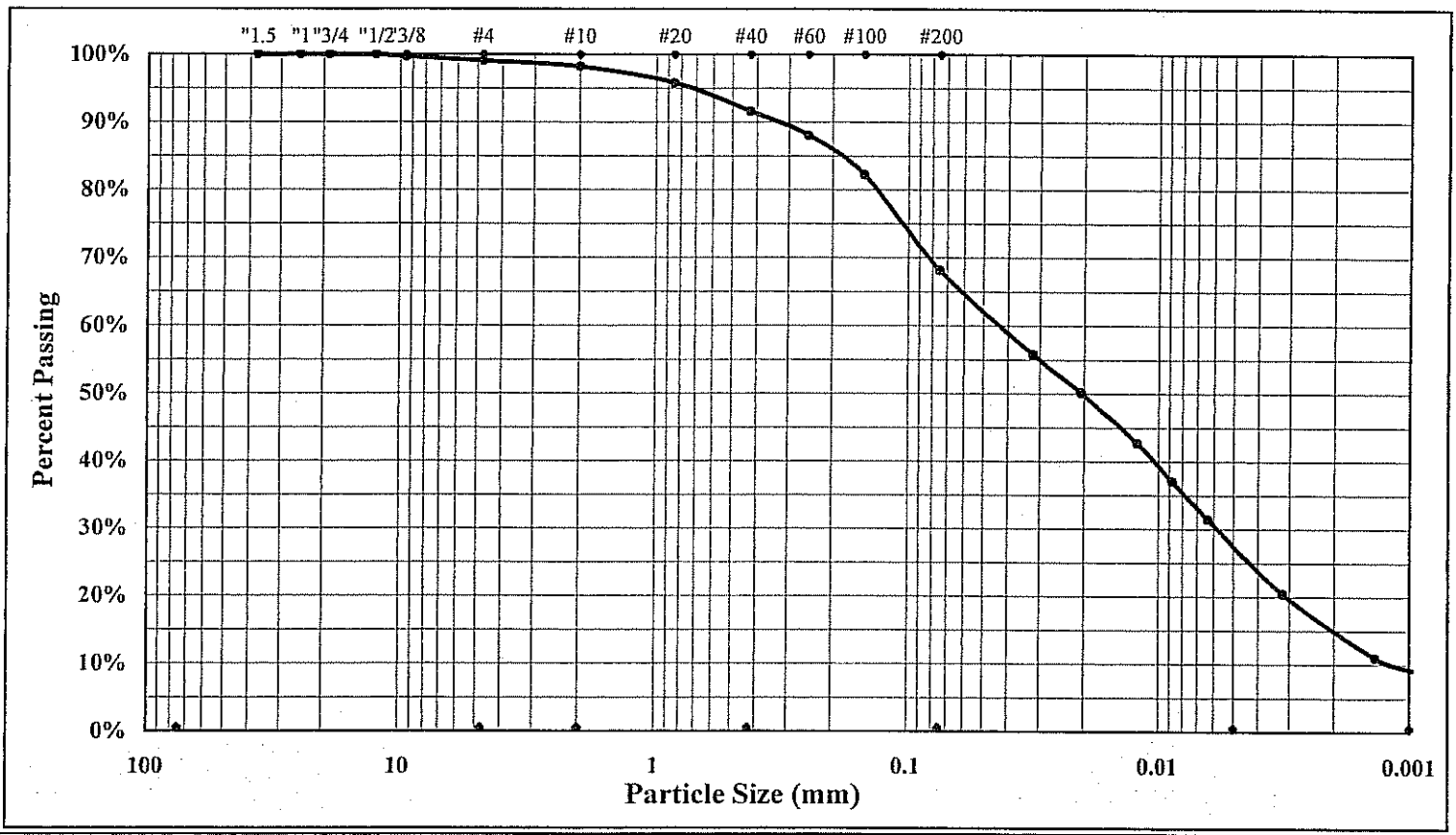
Hydrometer #476 (M-1, 10-15') 11-26-07.xls

Particle Size Analysis of Soils

ASTM D 422

S&ME Project #:	**1411-07-103**	Report Date:	11/26/07
Project Name:	**Marshall Steam Station**	Test Date(s):	11/19 - 11/21/07
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-1	Sample #:	476	Sample Date:	11/2/07
Location:	Bulk	Offset:	N/A	Elevation:	10-15'
Sample Description:	Brown fine sandy clayey SILT (ML)				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	9.50 mm	Gravel	0.9%	Silt	40.7%
Silt & Clay (% Passing #200)	68.2%	Sand	30.9%	Clay	27.5%
Specific Gravity	2.650	Moisture Content	21.7%	Colloids	9.1%
Liquid Limit	47	Plastic Limit	32	Plastic Index	15

Description of Sand & Gravel Particles Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Mechanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 854: Specific Gravity of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. _____ QC Manager
Signature Position

Moisture - Density Relationship

S&ME

S&ME Project #:	**1411-07-103**	Test Date(s):	November 28, 2007
Project Name:	Marshall Steam Station	Report Date:	November 29, 2007
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-1	Sample #:	476	Sample Date:	November 2, 2007
Location:	Bulk	Offset:	N/A	Depth:	10-15'

Sample Description: Brown fine sandy clayey SILT (ML)

Liquid Limit:	47	Specific Gravity:	2.650
Plastic Limit:	32	Plastic Index:	15

Natural Moisture Content: 21.7%

Moisture Content of the Oversize Fraction:

NOTES:

Sieve Size	% Passing
3/8"	99.7
#4	99.1
#10	98.2
#20	95.8
#40	91.5
#60	88.0
#100	82.2
#200	68.2

MDD: 104.7 **Opt. MC %: 18.7**

Water Content

Water Content requires GP 2 Balance (0.1 gram Readability).

ASTM D2216 ☒ AASHTO T265 ☐ ASTM D4959 ☐ ASTM D4643 ☐

	Sample #:	1	2	3	4	5	6
	Water Added:						
	Tare #:						
A. Tare Weight	A.	0	0	0	0	0	0
B. Wet Wt + Tare Wt	B.	500	500	500	500	500	500
C. Dry Wt. + Tare Wt.	C.	436.7	429	423.1	415.9		
D. Water Weight	B-C	63.3	71	76.9	84.1	500	500
E. Dry Weight	C-A	436.7	429	423.1	415.9	0	0
F. Moisture Content	100*D/E	**14.5%**	**16.6%**	**18.2%**	**20.2%**	**#DIV/0!**	**#DIV/0!**

Compaction Data

The Compaction Test requires a GP 5 Balance for ASTM (1 gram or .0022 Lb. readability).

G. Wt of Soil + Mold	G.	13.132	13.286	13.414	13.416		
H. Wt. of Mold	H.	9.304	9.304	9.304	9.304	9.304	9.304
I. Wt. of Soil (g. or lbs.)	G-H	3.828	3.982	4.110	4.112	-9.304	-9.304
J. Wt of Soil (Lbs.)	I/453.6 or I	3.828	3.982	4.110	4.112	-9.304	-9.304
K. Mold Volume Factor	K.	30.039	30.039	30.039	30.039	30.039	30.039
L. Wet Density	J*K	115.0	119.6	123.5	123.5	-279.5	-279.5
M. Dry Density	L/(1+F)	**100.4**	**102.6**	**104.5**	**102.7**	**#DIV/0!**	**#DIV/0!**

ASTM D558 ☐ ASTM D 698 ☒ ASTM D1557 ☐ AASHTO T99 ☐ AASHTO T180 ☐

Method A ☒ Method B ☐ Method C ☐ Method D (ASTM 1978) ☐ AASHTO Method D ☐

Moisture-Density Relation of: Fine Fraction ☒ Corrected for Coarse Fraction (ASTM D 4718) ☐

Sieve Size used to separate the Oversize Fraction: #4 Sieve ☒ 3/8 inch Sieve ☐ 3/4 inch Sieve ☐

Mechanical Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

Soil Plasticity: ASTM D 4318 ☒ AASHTO T 89 ☐ AASHTO T 90 ☐

Sieve Analysis / Particle Size Analysis: ASTM C136 ☐ AASHTO T 27 ☐ ASTM D 422 ☒ AASHTO T 88 ☐

Specific Gravity of Soil: ASTM D 854 ☒ AASHTO T 100 ☐

Bulk Gravity of Oversize Fraction: ASTM C 127 ☐ AASHTO T 85 ☐

Soil Classification: ASTM D 2487 ☒ ASTM D 2488 ☐ AASHTO M 145 ☐

Technician Name: B. Hatton

Certification #

Technical Responsibility: Brian Vaughan, P.E. Signature Construction Services Manager Position

Moisture - Density Report

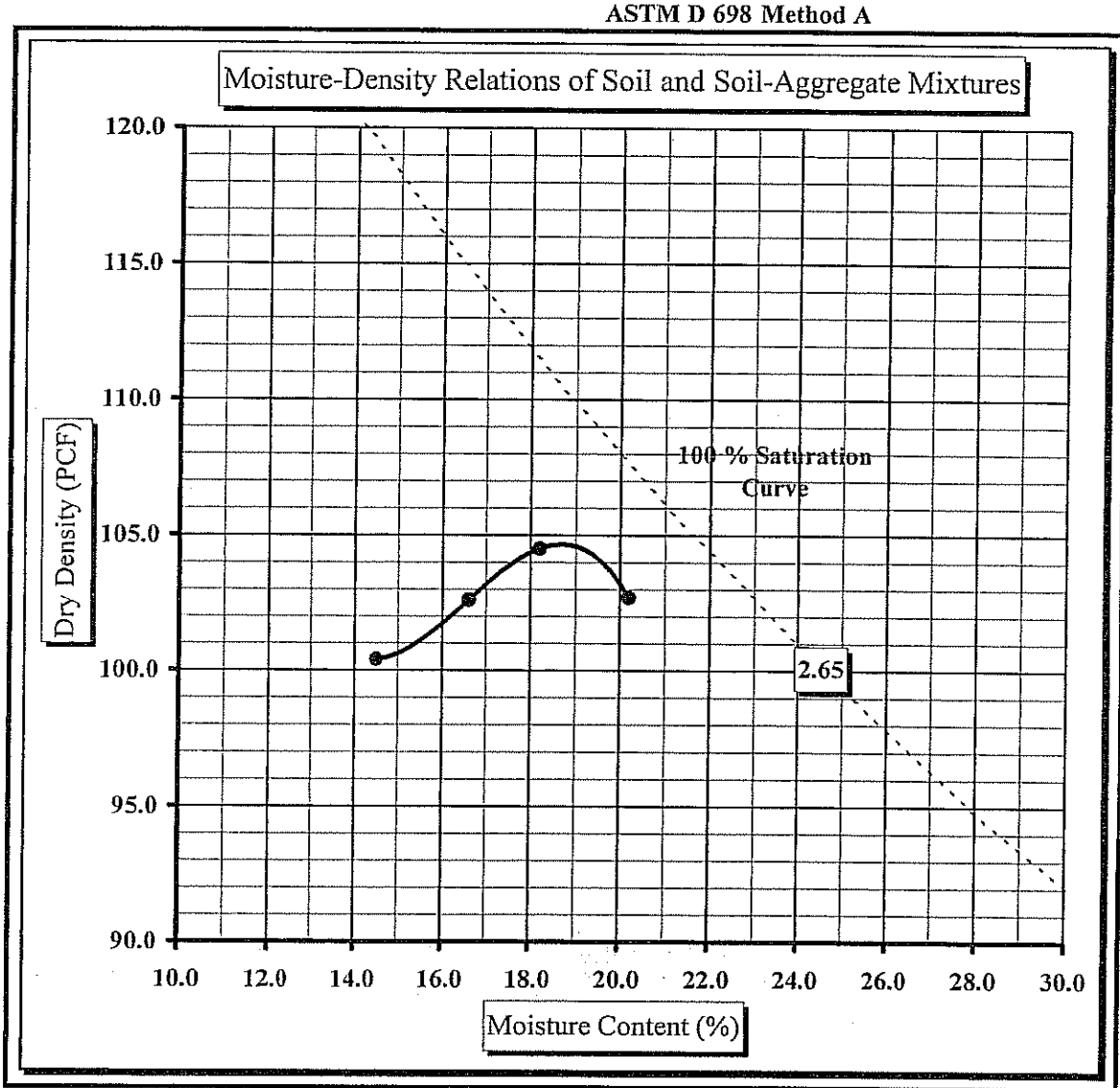
S&ME

S&ME Project #:	**1411-07-103**	Report Date:	November 29, 2007
Project Name:	**Marshall Steam Station**	Test Date(s):	November 28, 2007
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-1	Sample #:	476	Sample Date:	November 2, 2007
Location:	Bulk	Offset:	N/A	Depth:	10-15'
Sample Description:	Brown fine sandy clayey SILT (ML)				

Maximum Dry Density **104.7** **PCF.** **Optimum Moisture Content** **18.7** **%**

ASTM D 698 Method A



Soil Properties

Natural Moisture Content:	21.7%
Liquid Limit:	47
Plastic Limit:	32
Plastic Index:	15
Specific Gravity:	2.650

% Passing	
3/8"	99.7
#4	99.1
#10	98.2
#20	95.8
#40	91.5
#60	88.0
#100	82.2
#200	68.2

Oversize Fraction

Bulk Sp. Gravity
% Moisture
Oversize Fraction
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 Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

References: ASTM D 698: Laboratory Compaction Characteristics of Soil Using Standard Effort
ASTM D 2216: Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D 422: Particle Size Analysis of Soils ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. Construction Services Manager

S&ME

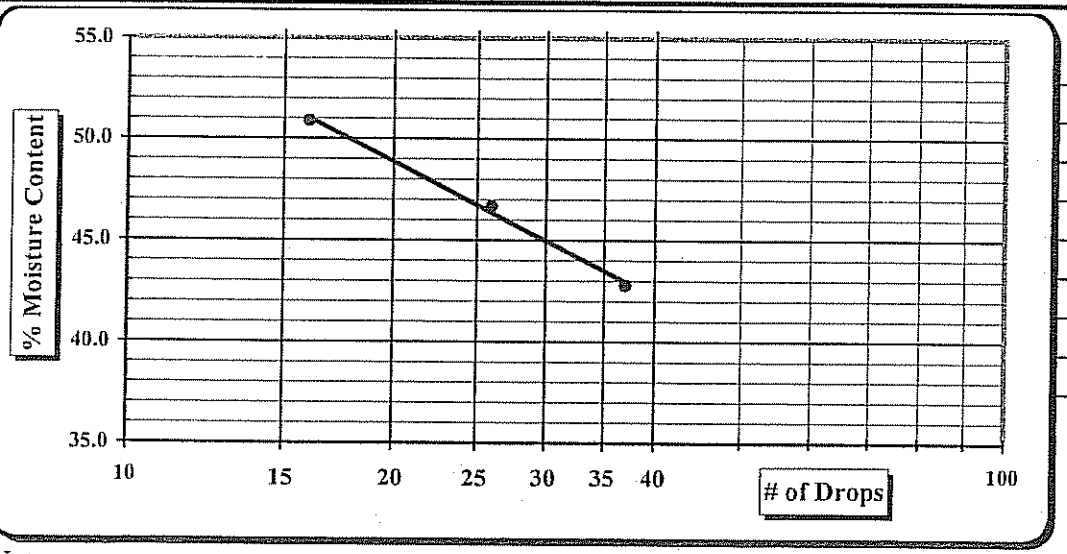
Liquid Limit, Plastic Limit, and Plastic Index

Project #: **1411-07-103**
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Charlotte, NC

Report Date: 11/29/07
Test Date(s): 11/28/07

Boring #: M-1 Sample #: 476 Sample Date: 11/2/07
Location: Bulk Offset: N/A Elevation: 10-15'
Sample Description: Brown fine sandy clayey SILT (ML)

Pan #		Liquid Limit						Plastic Limit		
	Test #	1	2	3	4	5	6	1	2	3
	Tare #	Y-1	Y-2	Y-3				5	6	
A	Tare Weight	16.53	16.56	17.00				**10.84**	10.91	
B	Wet Soil Weight + A	37.29	37.94	37.73				18.29	18.50	
C	Dry Soil Weight + A	31.07	31.14	30.74				16.47	16.66	
D	Water Weight (B-C)	6.22	6.80	6.99				1.82	1.84	
E	Dry Soil Weight (C-A)	14.54	14.58	13.74				5.63	5.75	
F	% Moisture Content (D/E)*100	42.8%	46.6%	50.9%				32.3%	32.0%	
N	# OF DROPS	37	26	16				*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average							32.2%		



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes:

pecial Sampling Methods:

ample Preparation:	Wet Preparation	☐	Dry Preparation	☒	Air Dried	☒
iquid limit Test:	Multipoint Method	☒	One-point Method	☐		
lassification:	ASTM D 2487	☒	AASHTO M 145	☐		
iquid limit Test:	ASTM D 4318	☒	AASHTO T 89	☐		
lastic limit Test:	ASTM D 4318	☒	AASHTO T 90	☐		

% Passing #200 Sieve:	68.2
NP, Non-Plastic	☐
Liquid Limit	47
Plastic Limit	32
Plastic Index	15
Group Symbol	ML

echnician Name: M. Jacobs

Certification #

echnical Responsibility: Brian Vaughan, P.E.

Signature

QC Manager
Position

Particle Size Analysis of Soils

ASTM D 422

S&ME

Project #: 1411-07-103
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Charlotte, NC

Test Date(s): 11/19 - 11/21/07
Report Date: 11/26/07

Boring #: M-2 Sample #: 476 Sample Date: 11/7/07
Location: Bulk Offset: N/A Elevation: 0-5'
Sample Description: Red brown micaceous fine sandy clayey SILT (ML)

Pan #:	4	Beaker #:	4
Hydrometer Jar #:			4
Pan Tare Weight (grams):			0.00
Total Sample Air Dried Wt. + tare wt. (grams):			482.00
Weight of Total Sample Air Dried:			482.00
Weight of Air Dried Hydrometer Sample (g):			53.17
Total Sample Oven Dried:			475.22
Hydrometer Sample Oven Dried (W):			52.42
% Passing #10:			100.0%
Correction Factor a (Table 1):			1.00

Specific Gravity 2.650

	Moisture Content	Hygroscopic	Natural
	Tare #	P-4	340
A	Tare Wt.	16.70	0.00
B	Wet Wt. + A	29.49	160.23
C	Dry Wt. + A	29.31	141.89
D	Water Wt. (B-C)	0.18	18.34
E	Dry Wt. (C-A)	12.61	141.89
	% Moisture (100 x D/E)	1.43%	12.9%

Sieve	Retained Wt.	Percent Passing	
3.0"	0.0	Pan # (washed)	100.0%
1.5"	0.0		100.0%
1.0"	0.0		100.0%
3/4"	0.0	55	100.0%
1/2"	0.0		100.0%
3/8"	0.0		100.0%
#4	0.0	Soil Mortar	100.0%
#10	0.2	**100.0%**	100.0%
#20	0.1	99.8%	99.8%
#40	0.9	98.3%	98.3%
#60	4.2	91.9%	91.9%
#100	10.3	80.4%	80.3%
#200	18.7	64.4%	64.3%

Notes: Description of Sand & Gravel Particles Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:	2.00 mm	
% Gravel:	0.0%	< 75 mm and > 4.75 mm
Coarse Sand:	0.0%	< 4.75 mm and > 2.00 mm
Medium Sand:	1.7%	< 2.00 mm and > 0.425 mm
Fine Sand:	33.9%	< 0.425 mm and > 0.075 mm

Total Sand:	35.7%	< 4.74 mm and > 0.075 mm
Silt & Clay:	64.3%	< 0.075
Silt:	28.8%	< 0.075 and > 0.005 mm
Clay:	35.5%	< 0.005 mm
Colloids:	28.5%	< 0.001 mm

Type: Mechanical Stirring Apparatus (A)
Dispersion Time: 1 min.
Sodium Hexametaphosphate: 40 g./ Liter

Control Cylinder ☐ Composite Correction ☒

Liquid Limit 46 Plastic Limit 36 Plastic Index 10 Hydrometer: 151H ☐ 152H ☒

Time		Temp.	Hydrometer	Corrections		Hydrometer	Percent Passing		Effective Depth	Table 3	Diameter
Clock	T (Min.)	(0.5 °C)	Reading	Control Cylinder	Composite Correction	R	P(-#10) = (R x a / W) x 100	P (total) = P x % Passing #10	L	K	D = K x ((L/T)^1/2
	2	22.3	34.0		5.15	28.85	55.0%	55.0%	11.6	0.01332	0.03203
	5	22.3	31.5		5.15	26.35	50.3%	50.2%	12.0	0.01332	0.02061
	15	22.3	28.0		5.15	22.85	43.6%	43.6%	12.5	0.01332	0.01218
	30	22.3	26.0		5.15	20.85	39.8%	39.8%	12.9	0.01332	0.00873
	60	22.3	24.5		5.15	19.35	36.9%	36.9%	13.1	0.01332	0.00623
	250	22.9	22.5		5.10	17.40	33.2%	33.2%	13.4	0.01325	0.00307
	1440	22.8	21.0		5.10	15.90	30.3%	30.3%	13.7	0.01325	0.00129
	2880	22.5	20.0		5.15	14.85	28.3%	28.3%	13.9	0.01325	0.00092

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Effective Depth (cm)
$L=L1+0.5(L2-(VB/A))$
(152H) .164cm per increment,
$V_B=67.0cm^3$, $L_2=14cm$, $A=27.8cm^2$

Technician Name: M. Jacobs
Certification #

Technical Responsibility: Brian Vaughan, P.E.
Signature

OC Manager
Position

S&ME, INC. 155 Tradd Street Spartanburg, SC 29301

Hydrometer #476 (M-2, 0-5') 11-26-07.xls

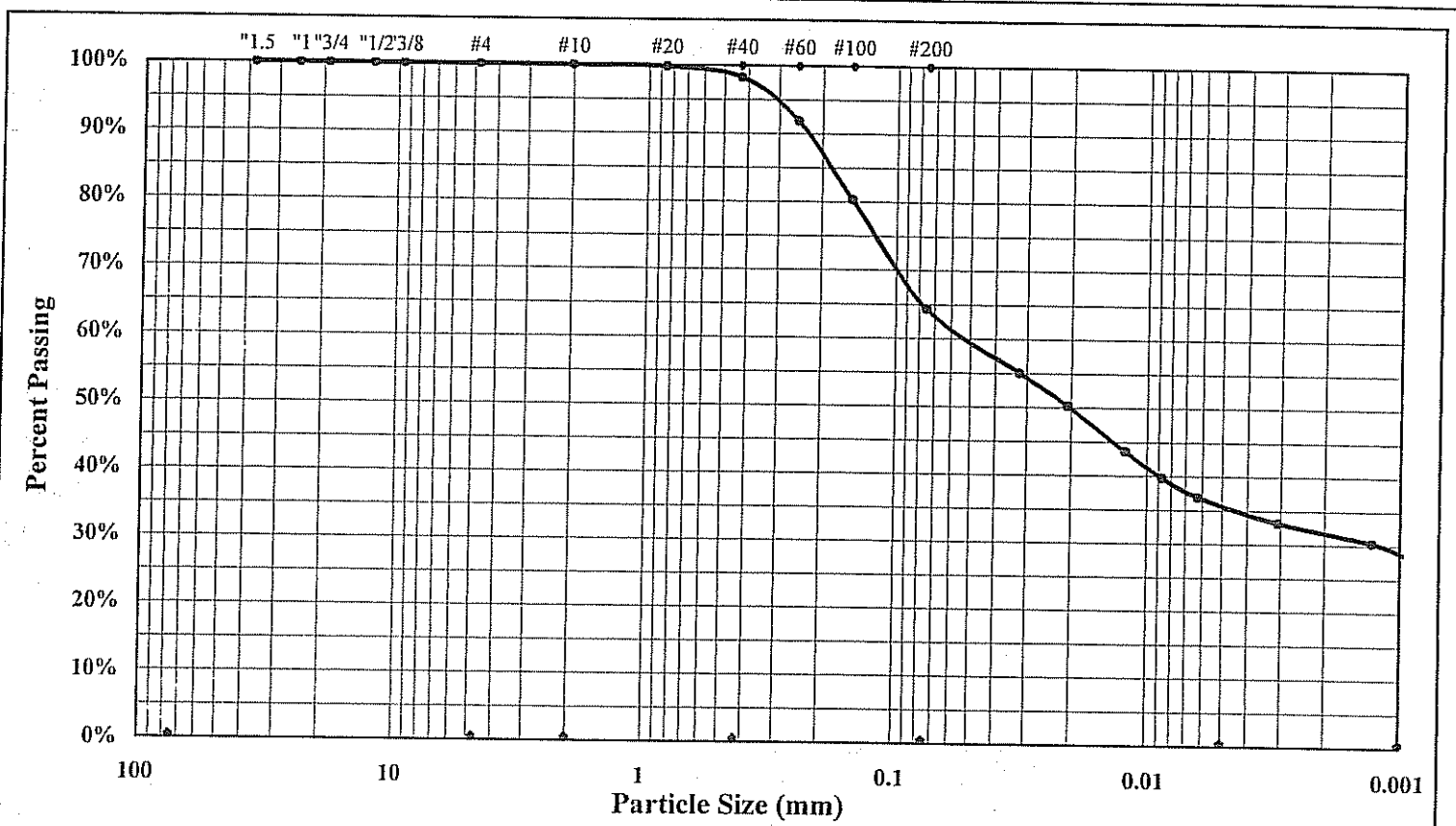
Particle Size Analysis of Soils

ASTM D 422

S&ME

S&ME Project #:	**1411-07-103**	Report Date:	11/26/07
Project Name:	**Marshall Steam Station**	Test Date(s):	11/19 - 11/21/07
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-2	Sample #:	476	Sample Date:	11/7/07
Location:	Bulk	Offset:	N/A	Elevation:	0-5'
Sample Description:	Red brown micaceous fine sandy clayey SILT (ML)				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	2.00 mm	Gravel	0.0%	Silt	28.8%
Silt & Clay (% Passing #200)	64.3%	Sand	35.7%	Clay	35.5%
Specific Gravity	2.650	Moisture Content	12.9%	Colloids	28.5%
Liquid Limit	46	Plastic Limit	36	Plastic Index	10

scription of Sand & Gravel Particles Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

chanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

ferences: ASTM D 422: Particle Size Analysis of Soils
TM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
TM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 421: Dry Preparation of Soil Samples
ASTM D 854: Specific Gravity of Soils

chnical Responsibility: Brian Vaughan, P.E. _____ (Signature) QC Manager (Position)

Moisture - Density Relationship

S&ME

S&ME Project #:	**1411-07-103**	Test Date(s):	November 30, 2007
Project Name:	Marshall Steam Station	Report Date:	December 3, 2007
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-2	Sample #:	476	Sample Date:	November 7, 2007
Location:	Bulk	Offset:	N/A	Depth:	0-5'

Sample Description: Red brown micaceous fine sandy clayey SILT (ML)

Liquid Limit:	46	Specific Gravity:	2.650
Plastic Limit:	36	Plastic Index:	10

Natural Moisture Content: 12.9%

Moisture Content of the Oversize Fraction:

NOTES:

Sieve Size	% Passing
#4	100.0
#10	100.0
#20	99.8
#40	98.3
#60	91.9
#100	80.3
#200	64.3

MDD: 98.2 **Opt. MC %:** 22.0

Water Content

Water Content requires GP 2 Balance (0.1 gram Readability).

ASTM D2216 ☒ AASHTO T265 ☐ ASTM D4959 ☐ ASTM D4643 ☐

	Sample #:	1	2	3	4	5	6
	Water Added:						
	Tare #:						
A. Tare Weight	A.	0	0	0	0	0	0
B. Wet Wt + Tare Wt	B.	500	500	500	500	500	500
C. Dry Wt. + Tare Wt.	C.	419.6	411.2	403.7	396.3		
D. Water Weight	B-C	80.4	88.8	96.3	103.7	500	500
E. Dry Weight	C-A	419.6	411.2	403.7	396.3	0	0
F. Moisture Content	100*D/E	**19.2%**	**21.6%**	**23.9%**	**26.2%**	**#DIV/0!**	**#DIV/0!**

Compaction Data

The Compaction Test requires a GP 5 Balance for ASTM (1 gram or .0022 Lb. readability).

G. Wt of Soil + Mold	G.	13.138	13.280	13.324	13.286		
H. Wt. of Mold	H.	9.304	9.304	9.304	9.304	9.304	9.304
I. Wt. of Soil (g. or lbs.)	G-H	3.834	3.976	4.020	3.982	-9.304	-9.304
J. Wt of Soil (Lbs.)	I/453.6 or I	3.834	3.976	4.020	3.982	-9.304	-9.304
K. Mold Volume Factor	K.	30.039	30.039	30.039	30.039	30.039	30.039
L. Wet Density	J*K	115.2	119.4	120.8	119.6	-279.5	-279.5
M. Dry Density	L/(1+F)	**96.7**	**98.2**	**97.5**	**94.8**	**#DIV/0!**	**#DIV/0!**

ASTM D558 ☐ ASTM D 698 ☒ ASTM D1557 ☐ AASHTO T99 ☐ AASHTO T180 ☐

Method A ☒ Method B ☐ Method C ☐ Method D (ASTM 1978) ☐ AASHTO Method D ☐

Moisture-Density Relation of: Fine Fraction ☒ Corrected for Coarse Fraction (ASTM D 4718) ☐

Sieve Size used to separate the Oversize Fraction: #4 Sieve ☒ 3/8 inch Sieve ☐ 3/4 inch Sieve ☐

Mechanical Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

Soil Plasticity:	ASTM D 4318 ☒	AASHTO T 89 ☐		AASHTO T 90 ☐
Sieve Analysis / Particle Size Analysis:	ASTM C136 ☐	AASHTO T 27 ☐	ASTM D 422 ☒	AASHTO T 88 ☐
Specific Gravity of Soil:		ASTM D 854 ☒		AASHTO T 100 ☐
Bulk Gravity of Oversize Fraction:		ASTM C 127 ☐		AASHTO T 85 ☐
Soil Classification:	ASTM D 2487 ☒	ASTM D 2488 ☐		AASHTO M 145 ☐

Technician Name: B. Hatton

Certification #

Technical Responsibility: Brian Vaughan, P.E.

Signature

Construction Services Manager

Position

Moisture - Density Report

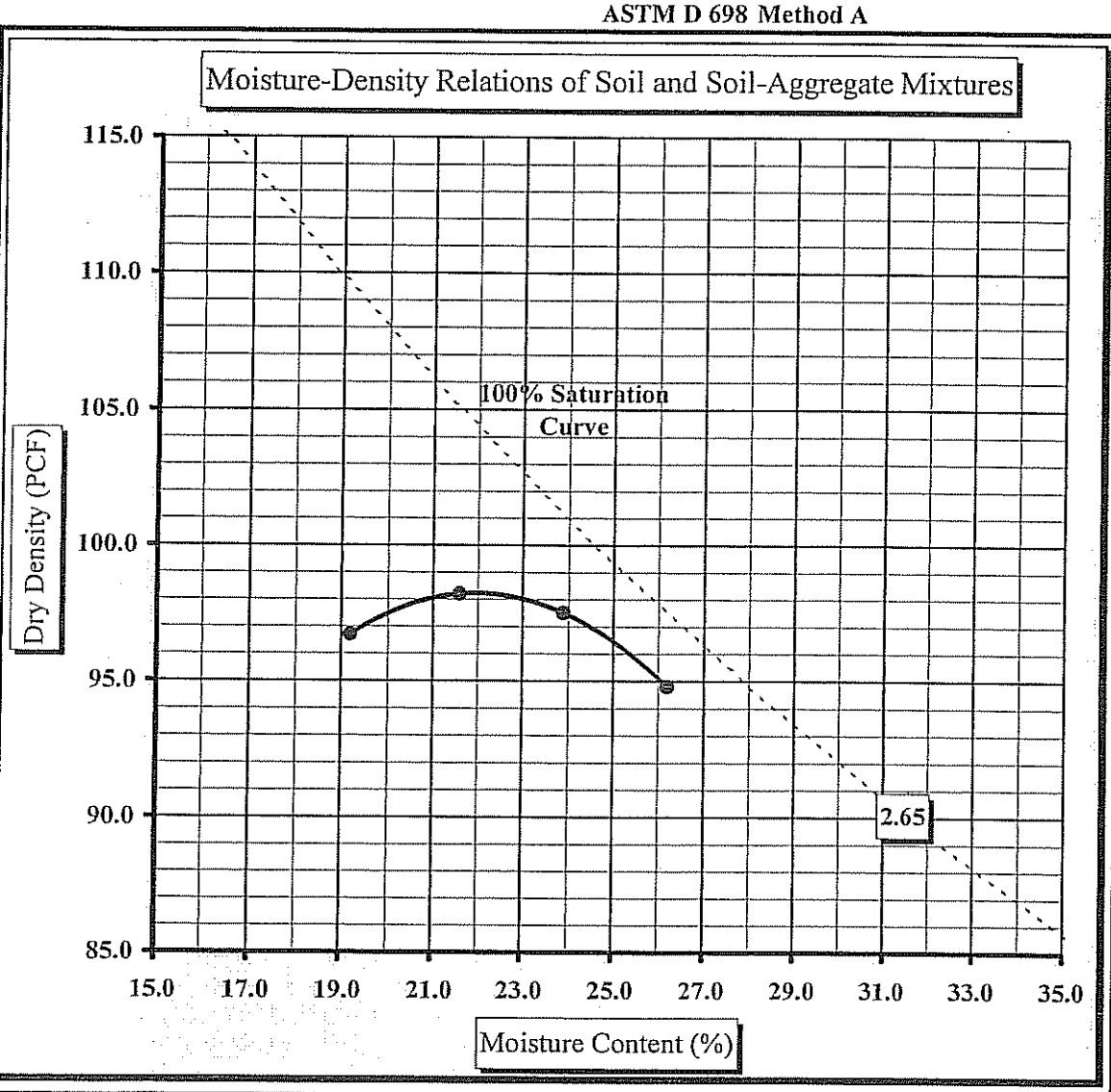
S&ME

S&ME Project #:	**1411-07-103**	Report Date:	December 3, 2007
Project Name:	**Marshall Steam Station**	Test Date(s):	November 30, 2007
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-2	Sample #:	476	Sample Date:	November 7, 2007
Location:	Bulk	Offset:	N/A	Depth:	0-5'
Sample Description:	Red brown micaceous fine sandy clayey SILT (ML)				

Maximum Dry Density **98.2** **PCF.** **Optimum Moisture Content** **22.0** **%**

ASTM D 698 Method A



Soil Properties

Natural Moisture Content:	12.9%
Liquid Limit:	46
Plastic Limit:	36
Plastic Index:	10
Specific Gravity:	2.650

% Passing

#4	100
#10	100
#20	99.8
#40	98.3
#60	91.9
#100	80.3
#200	64.3

Oversize Fraction

Bulk Sp. Gravity
% Moisture
Oversize Fraction
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 Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

References: ASTM D 698: Laboratory Compaction Characteristics of Soil Using Standard Effort
ASTM D 2216: Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D 422: Particle Size Analysis of Soils ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. Construction Services Manager

Laboratory Record Version 4.2

S&ME

Liquid Limit, Plastic Limit, and Plastic Index

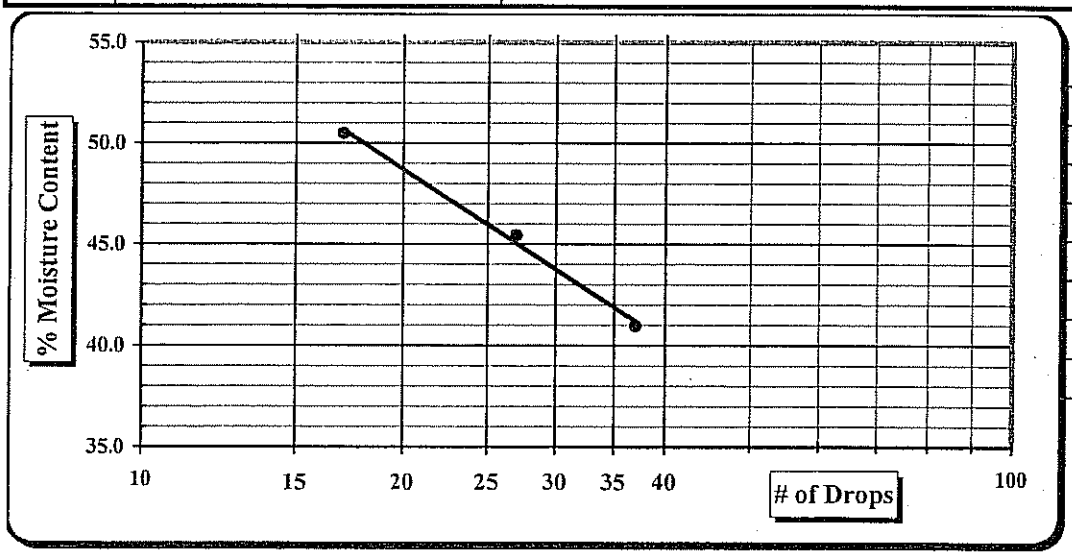
Project #:	**1411-07-103**	Report Date:	12/12/07
Project Name:	Marshall Steam Station	Test Date(s):	12/11/07
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #: M-2 Sample #: 476 Sample Date: 11/7/07

Location: Bulk Offset: N/A Elevation: 0-5'

Sample Description: Red brown micaceous fine sandy clayey SILT (ML)

Pan #		Liquid Limit						Plastic Limit		
	Test #	1	2	3	4	5	6	1	2	3
	Tare #	P-1	P-2	P-3				1	2	
A	Tare Weight	16.56	15.45	16.55				**10.59**	10.91	
B	Wet Soil Weight + A	40.31	40.52	39.86				18.53	18.76	
C	Dry Soil Weight + A	33.41	32.69	32.04				16.41	16.68	
D	Water Weight (B-C)	6.90	7.83	7.82				2.12	2.08	
E	Dry Soil Weight (C-A)	16.85	17.24	15.49				5.82	5.77	
F	% Moisture Content (D/E)*100	40.9%	45.4%	50.5%				36.4%	36.0%	
N	# OF DROPS	37	27	17				*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average							36.2%		



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes:

Special Sampling Methods:

Sample Preparation:	Wet Preparation	☐	Dry Preparation	☒	Air Dried	☒	
Liquid limit Test:	Multipoint Method	☒	One-point Method	☐			
Classification:	ASTM D 2487	☒	AASHTO M 145	☐			
Liquid limit Test:	ASTM D 4318	☒	AASHTO T 89	☐			
Plastic limit Test:	ASTM D 4318	☒	AASHTO T 90	☐			

% Passing #200 Sieve:	64.3
NP, Non-Plastic	☐
Liquid Limit	46
Plastic Limit	36
Plastic Index	10
Group Symbol	ML

Technician Name: M. Jacobs

Certification #

Technical Responsibility: Brian Vaughan, P.E.

Signature

QC Manager

Position

Particle Size Analysis of Soils

ASTM D 422

S&ME

Project #: 1411-07-103
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Charlotte, NC

Test Date(s): 11/19 - 11/21/07
Report Date: 11/26/07

Boring #: M-2 Sample #: 476 Sample Date: 11/7/07
Location: Bulk Offset: N/A Elevation: 5-10'
Sample Description: Light brown micaceous fine sandy SILT (ML)

Pan #:	10	Beaker #:	5
Hydrometer Jar #:			5
Pan Tare Weight (grams):			0.00
Total Sample Air Dried Wt. + tare wt. (grams):			532.04
Weight of Total Sample Air Dried:			532.04
Weight of Air Dried Hydrometer Sample (g):			52.31
Total Sample Oven Dried:			527.26
Hydrometer Sample Oven Dried (W):			51.84
% Passing #10:			100.0%
Correction Factor a (Table 1):			1.00

Specific Gravity 2.650

	Moisture Content	Hygroscopic	Natural
	Tare #	Q-5	349
A	Tare Wt.	16.92	0.00
B	Wet Wt. + A	29.15	193.90
C	Dry Wt. + A	29.04	176.45
D	Water Wt. (B-C)	0.11	17.45
E	Dry Wt. (C-A)	12.12	176.45
	% Moisture (100 x D/E)	0.91%	9.9%

Sieve	Retained Wt.	Percent Passing	
3.0"	0.0	Pan # (washed)	100.0%
1.5"	0.0		100.0%
1.0"	0.0		100.0%
3/4"	0.0	57	100.0%
1/2"	0.0		100.0%
3/8"	0.0		100.0%
#4	0.0	Soil Mortar	100.0%
#10	0.2	**100.0%**	100.0%
#20	0.4	99.3%	99.2%
#40	2.1	95.9%	95.9%
#60	6.8	86.9%	86.9%
#100	14.8	71.5%	71.5%
#200	25.5	50.8%	50.8%

Notes: Description of Sand & Gravel Particles — Rounded ☐ Angular ☒ — Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:	2.00 mm	
% Gravel:	0.0%	< 75 mm and > 4.75 mm
Coarse Sand:	0.0%	< 4.75 mm and > 2.00 mm
Medium Sand:	4.1%	< 2.00 mm and > 0.425 mm
Fine Sand:	45.0%	< 0.425 mm and > 0.075 mm

Total Sand:	49.2%	< 4.74 mm and > 0.075 mm
Silt & Clay:	50.8%	< 0.075
Silt:	37.5%	< 0.075 and > 0.005 mm
Clay:	13.3%	< 0.005 mm
Colloids:	7.4%	< 0.001 mm

Type: Mechanical Stirring Apparatus (A)
Dispersion Time: 1 min.
Sodium Hexametaphosphate: 40 g./ Liter

Liquid Limit 33 Plastic Limit 31 Plastic Index 2

Control Cylinder ☐ Composite Correction ☒
Hydrometer: 151H ☐ 152H ☒

Time		Temp.	Hydrometer	Corrections		Hydrometer	Percent Passing		Effective Depth	Table 3	Diameter
Clock	T (Min.)	(0.5 °C)	Reading	Control Cylinder	Composite Correction	R	P(-#10) = (R x a / W) x 100	P (total) = P x % Passing #10	L	K	D = K x ((L/T)^1/2
	2	22.4	23.5		5.15	18.35	35.4%	35.4%	13.3	0.01332	0.03433
	5	22.4	20.0		5.15	14.85	28.6%	28.6%	13.9	0.01332	0.02218
	15	22.4	16.5		5.15	11.35	21.9%	21.9%	14.4	0.01332	0.01307
	30	22.4	14.5		5.15	9.35	18.0%	18.0%	14.8	0.01332	0.00934
	60	22.4	13.0		5.15	7.85	15.1%	15.1%	15.0	0.01332	0.00666
	250	22.9	11.0		5.10	5.90	11.4%	11.4%	15.3	0.01325	0.00328
	1440	22.7	9.5		5.15	4.35	8.4%	8.4%	15.6	0.01325	0.00138
	2880	22.5	9.0		5.15	3.85	7.4%	7.4%	15.7	0.01325	0.00098

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Effective Depth (cm)
L=L1+0.5(L2-(VB/A))
(152H) .164cm per increment,
V_B=67.0cm^3, L_2=14cm, A=27.8cm^2

Technician Name: M. Jacobs

Technical Responsibility: Brian Vaughan, P.E.

Certification #

Signature

OC Manager
Position

S&ME, INC.
155 Tradd Street Spartanburg, SC 29301

Hydrometer #476 (M-2, 5-10') 11-26-07.xls

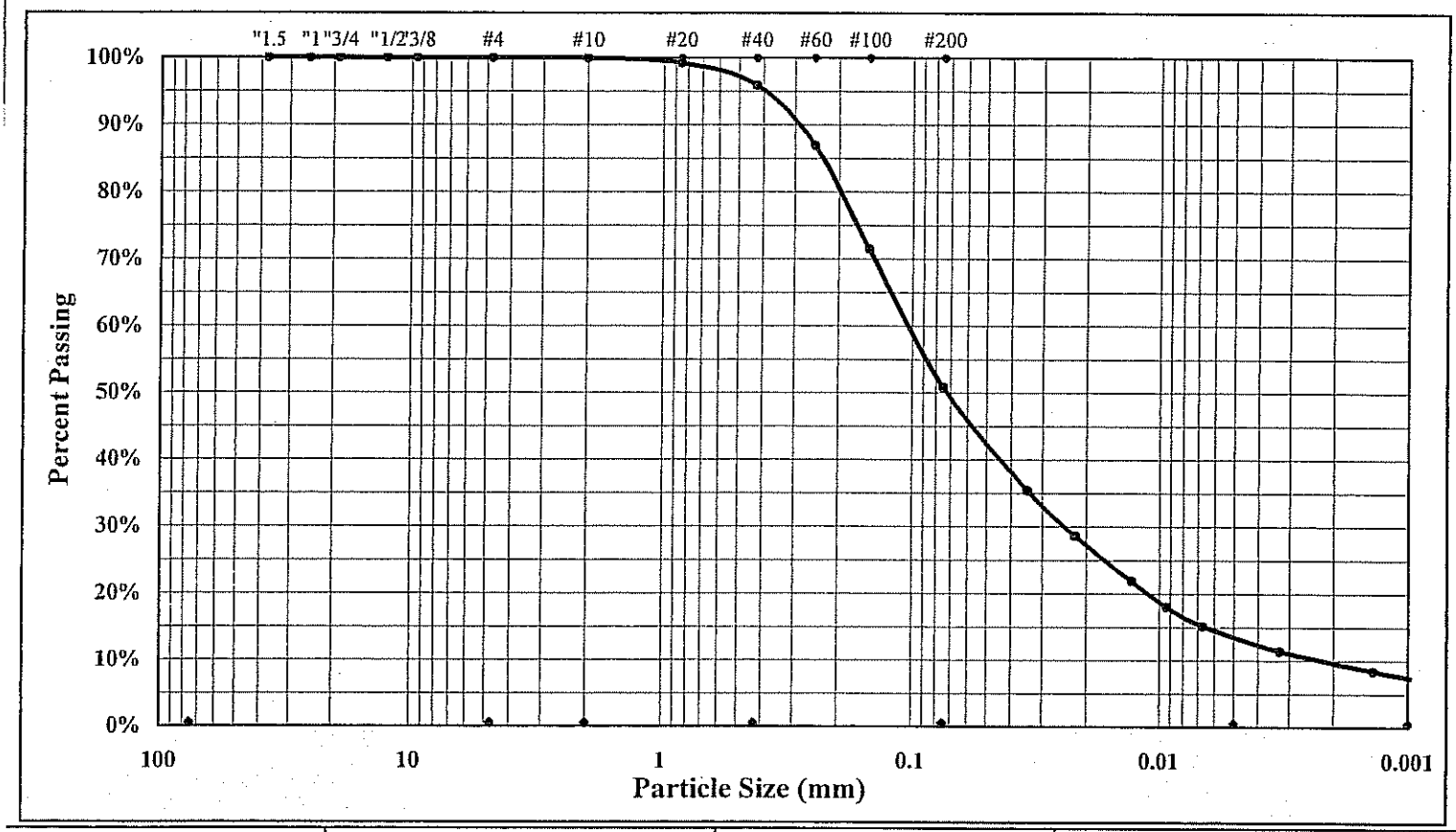
Laboratory Report Version 4.2

Particle Size Analysis of Soils

ASTM D 422

S&ME Project #:	**1411-07-103**	Report Date:	11/26/07
Project Name:	**Marshall Steam Station**	Test Date(s):	11/19 - 11/21/07
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-2	Sample #:	476	Sample Date:	11/7/07
Location:	Bulk	Offset:	N/A	Elevation:	5-10'
Sample Description:	Light brown micaceous fine sandy SILT (ML)				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	2.00 mm	Gravel	0.0%	Silt	37.5%
Silt & Clay (% Passing #200)	50.8%	Sand	49.2%	Clay	13.3%
Specific Gravity	2.650	Moisture Content	9.9%	Colloids	7.4%
Liquid Limit	33	Plastic Limit	31	Plastic Index	2

Description of Sand & Gravel Particles Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Mechanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 854: Specific Gravity of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. _____ QC Manager
Signature *Position*

Moisture - Density Relationship

S&ME

S&ME Project #:	**1411-07-103**	Test Date(s):	November 30, 2007
Project Name:	Marshall Steam Station	Report Date:	December 3, 2007
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-2	Sample #:	476	Sample Date:	November 7, 2007
Location:	Bulk	Offset:	N/A	Depth:	5-10'

Sample Description: Light brown micaceous fine sandy SILT (ML)

Liquid Limit:	33	Specific Gravity:	2.650
Plastic Limit:	31	Plastic Index:	2

Natural Moisture Content: 9.9%

Moisture Content of the Oversize Fraction:

NOTES:

Sieve Size	% Passing
#4	100.0
#10	100.0
#20	99.2
#40	95.9
#60	86.9
#100	71.5
#200	50.8

MDD: 102.2 **Opt. MC %: 18.0**

Water Content

Water Content requires GP 2 Balance (0.1 gram Readability).

ASTM D2216 ☒ AASHTO T265 ☐ ASTM D4959 ☐ ASTM D4643 ☐

	Sample #:	1	2	3	4	5	6
	Water Added:						
	Tare #:						
A. Tare Weight	A.	0	0	0	0	0	0
B. Wet Wt + Tare Wt	B.	500	500	500	500	500	500
C. Dry Wt. + Tare Wt.	C.	439.8	431.5	424	418	410.3	
D. Water Weight	B-C	60.2	68.5	76	82	89.7	500
E. Dry Weight	C-A	439.8	431.5	424	418	410.3	0
F. Moisture Content	100*D/E	**13.7%**	**15.9%**	**17.9%**	**19.6%**	**21.9%**	**#DIV/0!**

Compaction Data

The Compaction Test requires a GP 5 Balance for ASTM (1 gram or .0022 Lb. readability).

G. Wt of Soil + Mold	G.	13.112	13.230	13.318	13.356	13.328	
H. Wt. of Mold	H.	9.304	9.304	9.304	9.304	9.304	9.304
I. Wt. of Soil (g. or lbs.)	G-H	3.808	3.926	4.014	4.052	4.024	-9.304
J. Wt of Soil (Lbs.)	I/453.6 or I	3.808	3.926	4.014	4.052	4.024	-9.304
K. Mold Volume Factor	K.	30.039	30.039	30.039	30.039	30.039	30.039
L. Wet Density	J*K	114.4	117.9	120.6	121.7	120.9	-279.5
M. Dry Density	L/(1+F)	**100.6**	**101.8**	**102.2**	**101.8**	**99.2**	**#DIV/0!**

ASTM D558 ☐ ASTM D 698 ☒ ASTM D1557 ☐ AASHTO T99 ☐ AASHTO T180 ☐

Method A ☒ Method B ☐ Method C ☐ Method D (ASTM 1978) ☐ AASHTO Method D ☐

Moisture-Density Relation of: Fine Fraction ☒ Corrected for Coarse Fraction (ASTM D 4718) ☐

Sieve Size used to separate the Oversize Fraction: #4 Sieve ☒ 3/8 inch Sieve ☐ 3/4 inch Sieve ☐

Mechanical Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

Soil Plasticity: ASTM D 4318 ☒ AASHTO T 89 ☐ AASHTO T 90 ☐

Sieve Analysis / Particle Size Analysis: ASTM C136 ☐ AASHTO T 27 ☐ ASTM D 422 ☒ AASHTO T 88 ☐

Specific Gravity of Soil: ASTM D 854 ☒ AASHTO T 100 ☐

Bulk Gravity of Oversize Fraction: ASTM C 127 ☐ AASHTO T 85 ☐

Soil Classification: ASTM D 2487 ☒ ASTM D 2488 ☐ AASHTO M 145 ☐

Technician Name: B. Hatton

Certification #

Technical Responsibility: Brian Vaughan, P.E. Signature Construction Services Manager Position

Moisture - Density Report

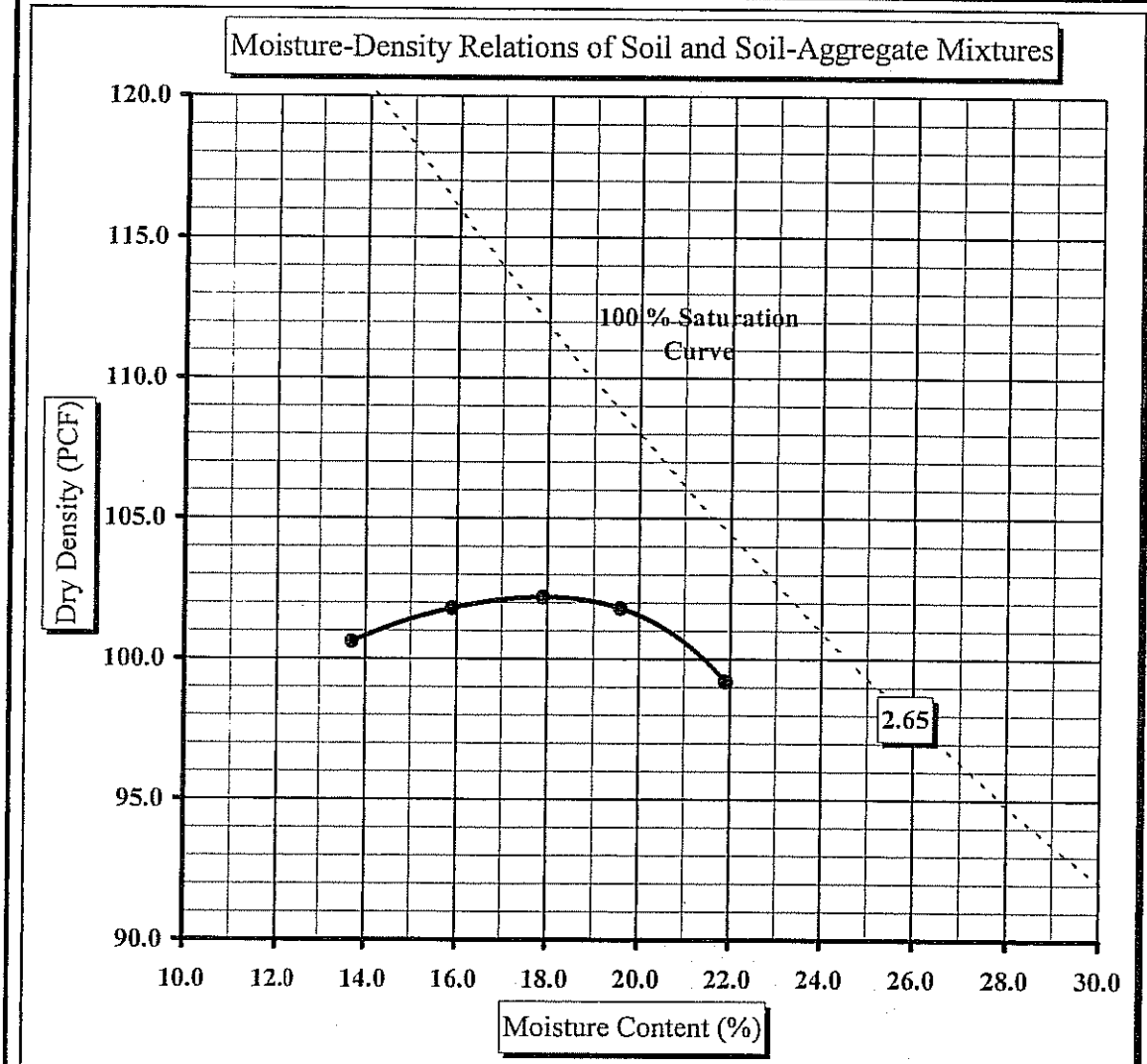
S&ME

S&ME Project #:	**1411-07-103**	Report Date:	December 3, 2007
Project Name:	**Marshall Steam Station**	Test Date(s):	November 30, 2007
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-2	Sample #:	476	Sample Date:	November 7, 2007
Location:	Bulk	Offset:	N/A	Depth:	5-10'
Sample Description:	Light brown micaceous fine sandy SILT (ML)				

Maximum Dry Density 102.2 PCF. **Optimum Moisture Content 18.0 %**

ASTM D 698 Method A



Soil Properties

Natural Moisture Content:	9.9%
Liquid Limit:	33
Plastic Limit:	31
Plastic Index:	2
Specific Gravity:	2.650

% Passing

#4	100
#10	100
#20	99.2
#40	95.9
#60	86.9
#100	71.5
#200	50.8

Oversize Fraction

Bulk Sp. Gravity
% Moisture
Oversize Fraction
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 Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

References: ASTM D 698: Laboratory Compaction Characteristics of Soil Using Standard Effort
ASTM D 2216: Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D 422: Particle Size Analysis of Soils ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. Construction Services Manager

S&ME

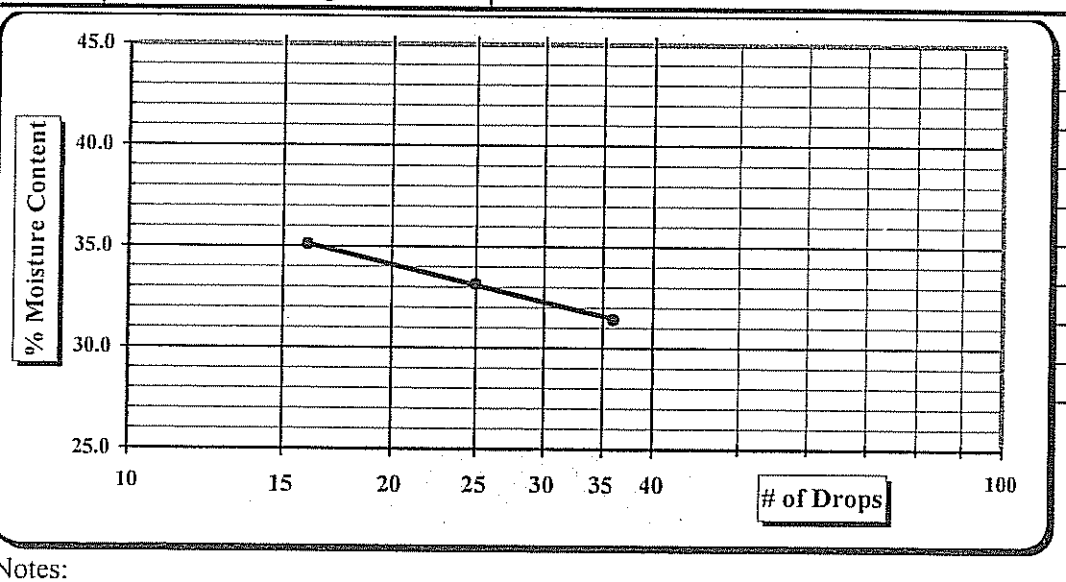
Liquid Limit, Plastic Limit, and Plastic Index

Project #: **1411-07-103**
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Charlotte, NC

Report Date: 12/12/07
Test Date(s): 12/11/07

Boring #: M-2 Sample #: 476 Sample Date: 11/7/07
Location: Bulk Offset: N/A Elevation: 5-10'
Sample Description: Light brown micaceous fine sandy SILT (ML)

Pan #		Liquid Limit						Plastic Limit		
	Test #	1	2	3	4	5	6	1	2	3
	Tare #	Q-1	Q-2	Q-3				3	4	
A	Tare Weight	16.80	16.78	15.75				**10.87**	10.89	
B	Wet Soil Weight + A	41.06	40.56	40.20				17.97	18.14	
C	Dry Soil Weight + A	35.26	34.64	33.85				16.28	16.43	
D	Water Weight (B-C)	5.80	5.92	6.35				1.69	1.71	
E	Dry Soil Weight (C-A)	18.46	17.86	18.10				5.41	5.54	
F	% Moisture Content (D/E)*100	31.4%	33.1%	35.1%				31.2%	30.9%	
N	# OF DROPS	36	25	16				*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average							31.1%		



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes:

Special Sampling Methods:

Sample Preparation:	Wet Preparation	☐	Dry Preparation	☒	Air Dried	☒	% Passing #200 Sieve: 50.8
Liquid limit Test:	Multipoint Method	☒	One-point Method	☐			NP, Non-Plastic ☐
Classification:	ASTM D 2487	☒	AASHTO M 145	☐			Liquid Limit 33
Liquid limit Test:	ASTM D 4318	☒	AASHTO T 89	☐			Plastic Limit 31
Plastic limit Test:	ASTM D 4318	☒	AASHTO T 90	☐			Plastic Index 2
							Group Symbol ML

Technician Name: M. Jacobs

Certification #

Technical Responsibility: Brian Vaughan, P.E. Signature QC Manager Position

Particle Size Analysis of Soils

ASTM D 422

S&ME

Project #:	1411-07-103
Project Name:	Marshall Steam Station
Client Name:	Duke Energy
Client Address:	Charlotte, NC

Test Date(s):	11/19 - 11/21/07
Report Date:	11/26/07

Boring #: M-2 Sample #: 476 Sample Date: 11/7/07

Location: Bulk Offset: N/A Elevation: 10-15'

Sample Description: Tan micaceous silty fine SAND (SM)

Pan #:	11	Beaker #:	6
Hydrometer Jar #:			6
Pan Tare Weight (grams):			0.00
Total Sample Air Dried Wt. + tare wt. (grams):			545.71
Weight of Total Sample Air Dried:			545.71
Weight of Air Dried Hydrometer Sample (g):			52.91
Total Sample Oven Dried:			541.96
Hydrometer Sample Oven Dried (W):			52.55
% Passing #10:			99.7%
Correction Factor a (Table 1):			1.00

Specific Gravity 2.650

	Moisture Content	Hygroscopic	Natural
	Tare #	Y-6	352
A	Tare Wt.	15.91	0.00
B	Wet Wt. + A	28.98	222.18
C	Dry Wt. + A	28.89	207.71
D	Water Wt. (B-C)	0.09	14.47
E	Dry Wt. (C-A)	12.98	207.71
	% Moisture (100 x D/E)	0.69%	7.0%

Sieve	Retained Wt.	Percent Passing	
3.0"	0.0	Pan # (washed)	100.0%
1.5"	0.0		100.0%
1.0"	0.0		100.0%
3/4"	0.0	58	100.0%
1/2"	0.0		100.0%
3/8"	0.0		100.0%
#4	0.5	Soil Mortar	99.9%
#10	1.8	**100.0%**	99.7%
#20	1.0	98.0%	97.7%
#40	4.9	90.6%	90.3%
#60	10.7	79.6%	79.4%
#100	18.8	64.2%	64.0%
#200	29.3	44.2%	44.1%

Notes: Description of Sand & Gravel Particles — Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:	4.75 mm	
% Gravel:	0.1%	< 75 mm and > 4.75 mm
Coarse Sand:	0.2%	< 4.75 mm and > 2.00 mm
Medium Sand:	9.3%	< 2.00 mm and > 0.425 mm
Fine Sand:	46.3%	< 0.425 mm and > 0.075 mm

Total Sand:	55.8%	< 4.74 mm and > 0.075 mm
Silt & Clay:	44.1%	< 0.075
Silt:	34.1%	< 0.075 and > 0.005 mm
Clay:	10.0%	< 0.005 mm
Colloids:	4.5%	< 0.001 mm

Type: Mechanical Stirring Apparatus (A)

Dispersion Time: 1 min.

Sodium Hexametaphosphate: 40 g./ Liter

Control Cylinder ☐ Composite Correction ☒

Liquid Limit **31** Plastic Limit **29** Plastic Index **2** Hydrometer: 151H ☐ 152H ☒

Time		Temp.	Hydrometer	Corrections		Hydrometer	Percent Passing		Effective Depth	Table 3	Diameter
Clock	T (Min.)	(0.5 °C)	Reading	Control Cylinder	Composite Correction	R	P(-#10) = (R x a / W) x 100	P (total) = P x % Passing #10	L	K	D = K x ((L/T)^1/2
	2	22.9	21.5		5.10	16.40	31.2%	31.1%	13.6	0.01325	0.03455
	5	22.9	18.0		5.10	12.90	24.6%	24.5%	14.2	0.01325	0.02230
	15	22.9	15.0		5.10	9.90	18.8%	18.8%	14.7	0.01325	0.01310
	30	22.9	13.0		5.10	7.90	15.0%	15.0%	15.0	0.01325	0.00937
	60	22.9	11.5		5.10	6.40	12.2%	12.1%	15.2	0.01325	0.00668
	250	23.2	9.0		5.10	3.90	7.4%	7.4%	15.7	0.01317	0.00330
	1440	22.5	8.0		5.15	2.85	5.4%	5.4%	15.8	0.01325	0.00139
	2880	22.5	7.5		5.15	2.35	4.5%	4.5%	15.9	0.01325	0.00098

References: ASTM D 422: Particle Size Analysis of Soils; ASTM D 421: Dry Preparation of Soil Samples; ASTM D 854: Specific Gravity of Soils; ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils; ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Effective Depth (cm)

L=L1+0.5(L2-(VB/A))

(152H) .164cm per increment,

V_B=67.0cm^3, L_2=14cm, A=27.8cm^2

Technician Name: M. Jacobs

Technical Responsibility: Brian Vaughan, P.E.

Certification #

Signature

OC Manager

Position

S&ME, INC.

155 Tradd Street Spartanburg, SC 29301

Hydrometer #476 (M-2, 10-15') 11-26-07.xls

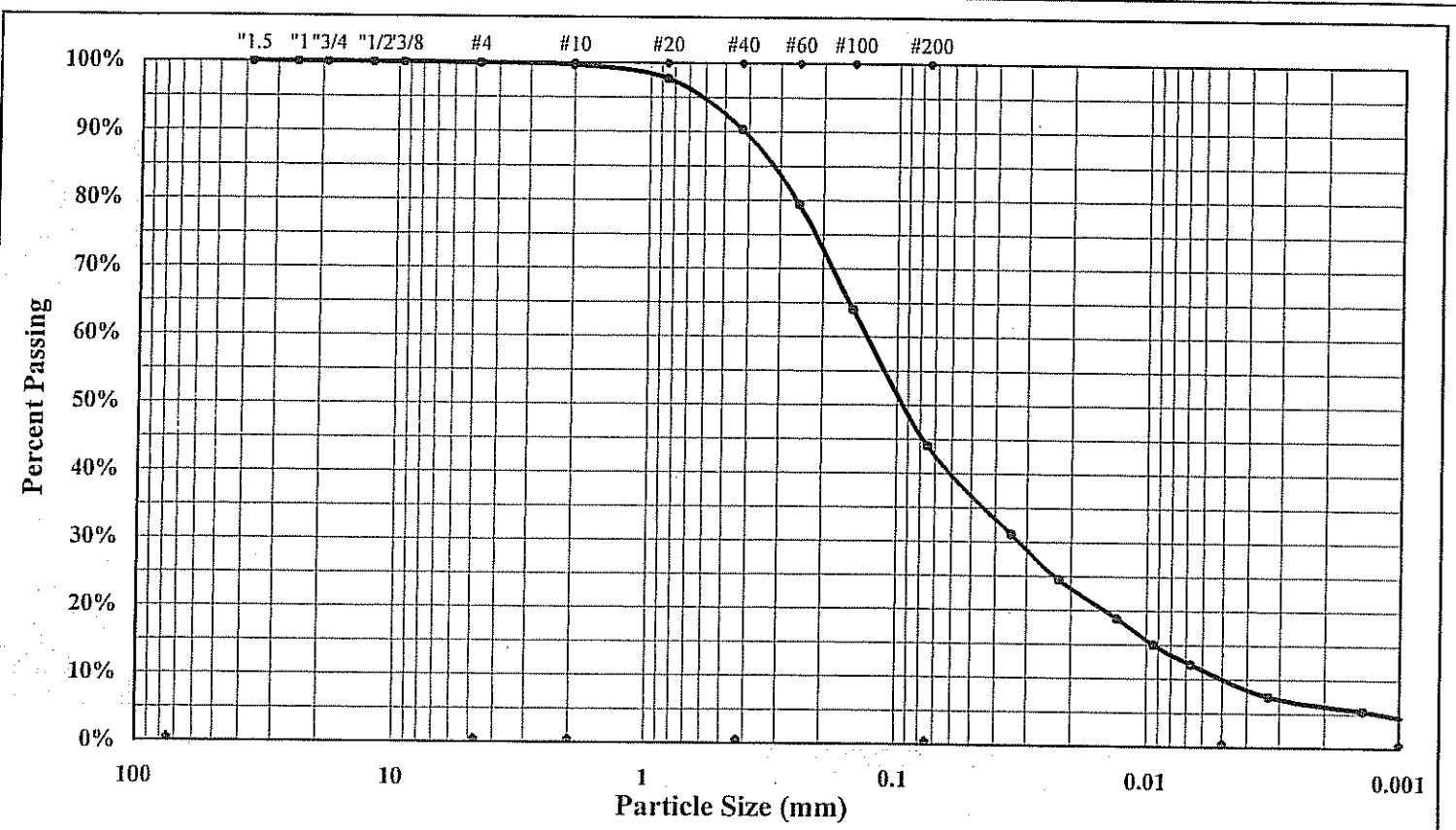
Particle Size Analysis of Soils

S&ME

ASTM D 422

S&ME Project #:	**1411-07-103**	Report Date:	11/26/07
Project Name:	**Marshall Steam Station**	Test Date(s):	11/19 - 11/21/07
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-2	Sample #:	476	Sample Date:	11/7/07
Location:	Bulk	Offset:	N/A	Elevation:	10-15'
Sample Description:	Tan micaceous silty fine SAND (SM)				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	4.75 mm	Gravel	0.1%	Silt	34.1%
Silt & Clay (% Passing #200)	44.1%	Sand	55.8%	Clay	10.0%
Specific Gravity	2.650	Moisture Content	7.0%	Colloids	4.5%
Liquid Limit	31	Plastic Limit	29	Plastic Index	2

Description of Sand & Gravel Particles Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Mechanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

References: ASTM D 422: Particle Size Analysis of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 421: Dry Preparation of Soil Samples
ASTM D 854: Specific Gravity of Soils

Technical Responsibility: Brian Vaughan, P.E. _____ QC Manager
Signature Position

Moisture - Density Relationship

S&ME

S&ME Project #:	**1411-07-103**	Test Date(s):	November 30, 2007
Project Name:	Marshall Steam Station	Report Date:	December 3, 2007
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-2	Sample #:	476	Sample Date:	November 7, 2007
Location:	Bulk	Offset:	N/A	Depth:	10-15'

Sample Description: Tan micaceous silty fine SAND (SM)

Liquid Limit:	31	Specific Gravity:	2.650
Plastic Limit:	29	Plastic Index:	2

Natural Moisture Content: 7.0%

Moisture Content of the Oversize Fraction:

NOTES:

Sieve Size	% Passing
#4	99.9
#10	99.7
#20	97.7
#40	90.3
#60	79.4
#100	64.0
#200	44.1

MDD: 107.1 **Opt. MC %:** 16.4

Water Content Water Content requires GP 2 Balance (0.1 gram Readability).

ASTM D2216 ☒ AASHTO T265 ☐ ASTM D4959 ☐ ASTM D4643 ☐

	Sample #:	1	2	3	4	5	6
	Water Added:						
	Tare #:						
A. Tare Weight	A.	0	0	0	0	0	0
B. Wet Wt + Tare Wt	B.	500	500	500	500	500	500
C. Dry Wt. + Tare Wt.	C.	442.1	434	427.4	420.2		
D. Water Weight	B-C	57.9	66	72.6	79.8	500	500
E. Dry Weight	C-A	442.1	434	427.4	420.2	0	0
F. Moisture Content	100*D/E	**13.1%**	**15.2%**	**17.0%**	**19.0%**	**#DIV/0!**	**#DIV/0!**

Compaction Data The Compaction Test requires a GP 5 Balance for ASTM (1 gram or .0022 Lb. readability).

G. Wt of Soil + Mold	G.	13.288	13.400	13.470	13.422		
H. Wt. of Mold	H.	9.304	9.304	9.304	9.304	9.304	9.304
I. Wt. of Soil (g. or lbs.)	G-H	3.984	4.096	4.166	4.118	-9.304	-9.304
J. Wt of Soil (Lbs.)	I/453.6 or I	3.984	4.096	4.166	4.118	-9.304	-9.304
K. Mold Volume Factor	K.	30.039	30.039	30.039	30.039	30.039	30.039
L. Wet Density	J*K	119.7	123.0	125.1	123.7	-279.5	-279.5
M. Dry Density	L/(1+F)	**105.8**	**106.8**	**107.0**	**104.0**	**#DIV/0!**	**#DIV/0!**

ASTM D558 ☐ ASTM D 698 ☒ ASTM D1557 ☐ AASHTO T99 ☐ AASHTO T180 ☐

Method A ☒ Method B ☐ Method C ☐ Method D (ASTM 1978) ☐ AASHTO Method D ☐

Moisture-Density Relation of: Fine Fraction ☒ Corrected for Coarse Fraction (ASTM D 4718) ☐

Sieve Size used to separate the Oversize Fraction: #4 Sieve ☒ 3/8 inch Sieve ☐ 3/4 inch Sieve ☐

Mechanical Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

Soil Plasticity:	ASTM D 4318 ☒	AASHTO T 89 ☐		AASHTO T 90 ☐
Sieve Analysis / Particle Size Analysis:	ASTM C136 ☐	AASHTO T 27 ☐	ASTM D 422 ☒	AASHTO T 88 ☐
Specific Gravity of Soil:		ASTM D 854 ☒		AASHTO T 100 ☐
Bulk Gravity of Oversize Fraction:		ASTM C 127 ☐		AASHTO T 85 ☐
Soil Classification:	ASTM D 2487 ☒	ASTM D 2488 ☐		AASHTO M 145 ☐

Technician Name: B. Hatton

Certification #

Technical Responsibility: Brian Vaughan, P.E. Signature Construction Services Manager Position

Moisture - Density Report

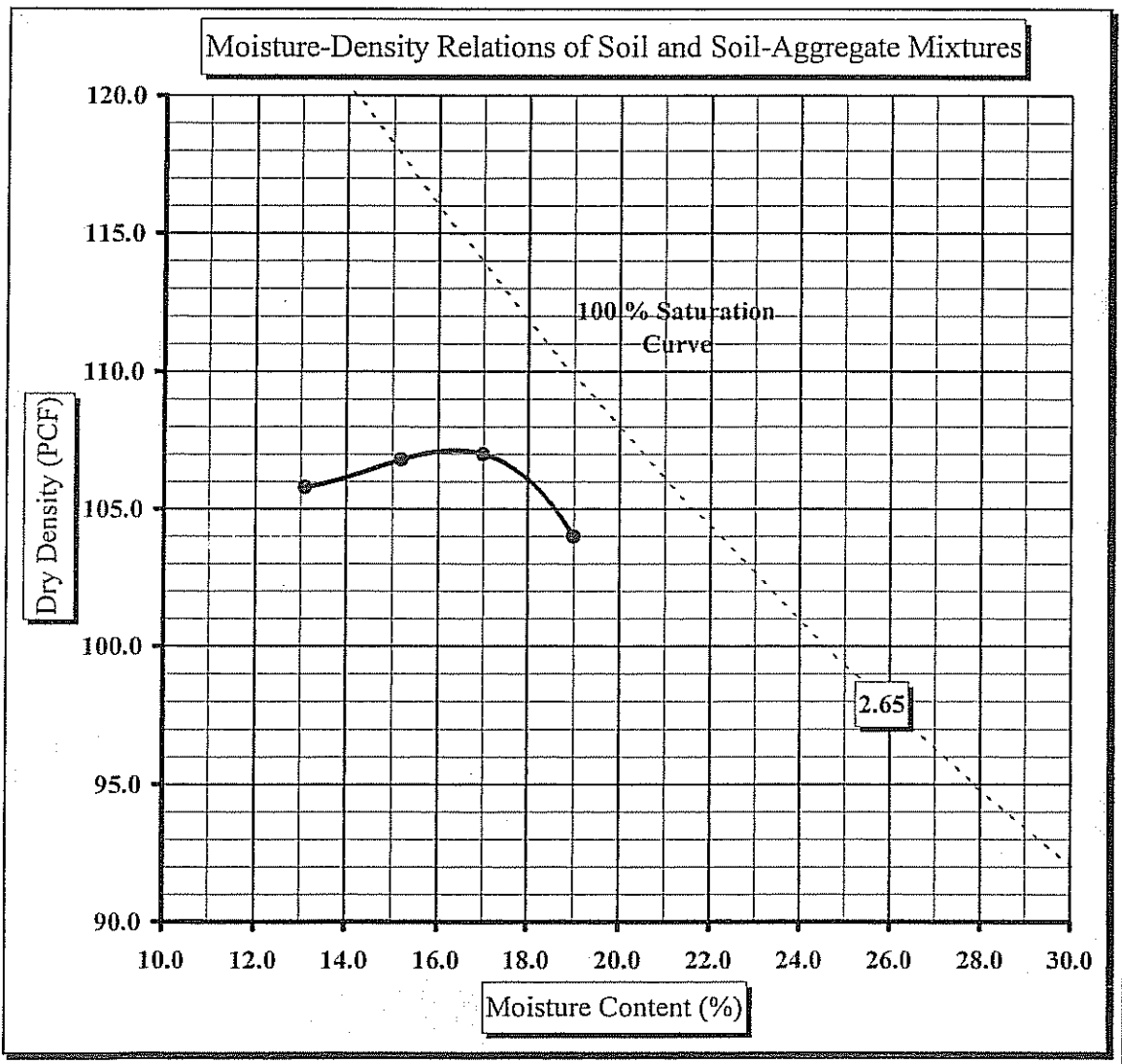
S&ME

S&ME Project #:	**1411-07-103**	Report Date:	December 3, 2007
Project Name:	**Marshall Steam Station**	Test Date(s):	November 30, 2007
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-2	Sample #:	476	Sample Date:	November 7, 2007
Location:	Bulk	Offset:	N/A	Depth:	10-15'
Sample Description:	Tan micaceous silty fine SAND (SM)				

Maximum Dry Density 107.1 PCF. **Optimum Moisture Content 16.4 %**

ASTM D 698 Method A



Soil Properties

Natural Moisture Content:	7.0%
Liquid Limit:	31
Plastic Limit:	29
Plastic Index:	2
Specific Gravity:	2.650

% Passing

#4	99.9
#10	99.7
#20	97.7
#40	90.3
#60	79.4
#100	64.0
#200	44.1

Oversize Fraction

Bulk Sp. Gravity
% Moisture
Oversize Fraction
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 Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

References: ASTM D 698: Laboratory Compaction Characteristics of Soil Using Standard Effort
ASTM D 2216: Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D 422: Particle Size Analysis of Soils ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. Construction Services Manager

Laboratory Record Version 4.2

S&ME

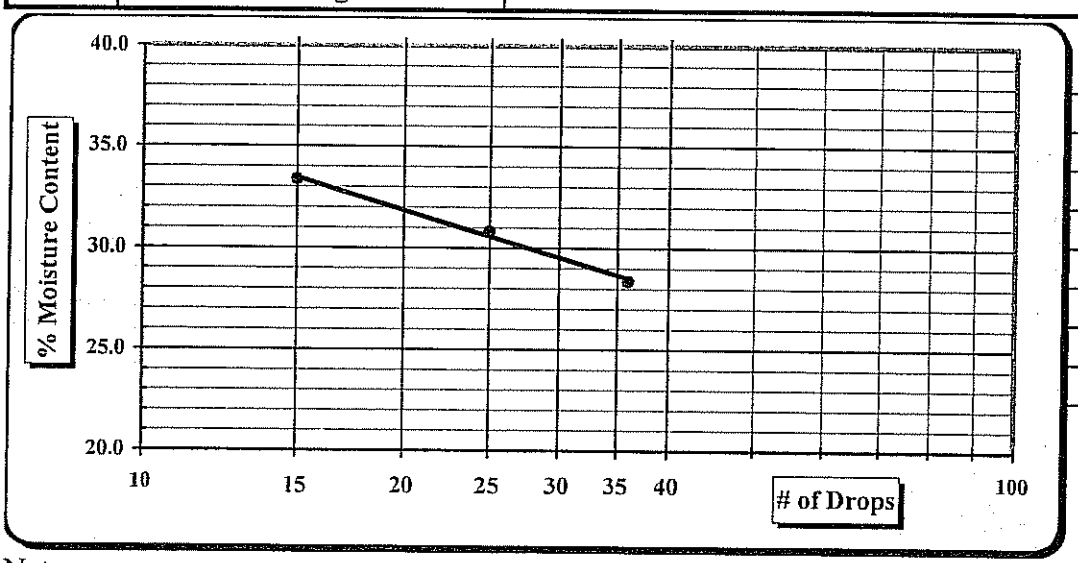
Liquid Limit, Plastic Limit, and Plastic Index

Project #: **1411-07-103**
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Charlotte, NC

Report Date: 12/12/07
Test Date(s): 12/11/07

Boring #: M-2 Sample #: 476 Sample Date: 11/7/07
Location: Bulk Offset: N/A Elevation: 10-15'
Sample Description: Tan micaceous silty fine SAND (SM)

Pan #		Liquid Limit						Plastic Limit		
	Test #	1	2	3	4	5	6	1	2	3
	Tare #	Y-1	Y-2	Y-3				5	6	
A	Tare Weight	16.53	16.56	16.99				**10.82**	10.91	
B	Wet Soil Weight + A	42.78	42.21	42.06				18.21	18.04	
C	Dry Soil Weight + A	36.98	36.17	35.79				16.57	16.45	
D	Water Weight (B-C)	5.80	6.04	6.27				1.64	1.59	
E	Dry Soil Weight (C-A)	20.45	19.61	18.80				5.75	5.54	
F	% Moisture Content (D/E)*100	28.4%	30.8%	33.4%				28.5%	28.7%	
N	# OF DROPS	36	25	15				*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average							28.6%		



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes:

Special Sampling Methods:

Sample Preparation:	Wet Preparation	☐	Dry Preparation	☒	Air Dried	☒
Liquid limit Test:	Multipoint Method	☒	One-point Method	☐		
Classification:	ASTM D 2487	☒	AASHTO M 145	☐		
Liquid limit Test:	ASTM D 4318	☒	AASHTO T 89	☐		
Plastic limit Test:	ASTM D 4318	☒	AASHTO T 90	☐		

% Passing #200 Sieve:	44.1
NP, Non-Plastic	☐
Liquid Limit	31
Plastic Limit	29
Plastic Index	2
Group Symbol	SM

Technician Name: M. Jacobs

Certification #

Technical Responsibility: Brian Vaughan, P.E.

Signature

QC Manager
Position

CONSTANT HEAD PERMEABILITY

ASTM D5084

S&ME Project Number: 1411-07-103 Project Name: Marshall Steam Station

Sample Name: M-2 476 (10-15') 3/3/2008

Sample Description: Tan Micaceous Silty Fine Sand (SM)

Type of Sample: Remolded

Sample Data		Molding Moisture Content		Target Molding Conditon		Additonal Data	
Diam. (cm)	7.277	Tare No.	S-7	γ_{wet} (pcf)	121.0	Panel No	1
Leng. (cm)	7.65	WWS+ Tare (gm)	420.2	γ_{dry} (pcf)	101.7	Cell P (psi)	82.5
Area (cm^2)	41.59	WDS+Tare (gm)	368.02	w (%)	18.9	Influent P (psi)	80.1
Vol. (cm^3)	318.17	WT of Water (gm)	52.18	Actual Molding Condition		Effluent P (psi)	80.0
WWS (gm)	616.2	WT of TARE (gm)	81.57	γ_{wet} (pcf)	120.9		
		WT Dry Soil (gm)	286.45	γ_{dry} (pcf)	102.3	Gradient	0.9
		w (%)	18.2	w (%)	18.2		

K = (Q x L) / (t x H x A)

Run	Temp. (°C)	Hour	Minute	Time, t (sec)	Cell Burette (cc)	Influent Burette(cc)	Effluent Burette (cc)	Q (cc)	Δ H (cm)	Temp Corr.	K(cm/sec)
1		3	18		19.5	0.6	24.0				
	22	4	7	2940	19.5	9.9	14.9	9.2	7.0	0.9530	7.79E-05
2		4	9		19.5	0.3	23.8				
	22	5	50	6060	19.5	9.4	14.6	9.2	7.0	0.9530	3.76E-05
3		11	59		19.6	0.1	23.3				
	22	14	42	9780	19.6	9.7	13.6	9.7	7.0	0.9530	2.46E-05
4		14	43		19.6	0.3	24.3				
	22	16	31	6480	19.6	16.8	7.8	16.5	7.0	0.9530	6.34E-05
5		11	1		19.6	0.2	23.8				
	22	12	54	6780	19.6	13.6	10.4	13.4	7.0	0.9563	4.94E-05
6											
										Ave. K (cm/sec)	4.38E-05
										(Runs 2 thru 5)	
										Ave. K (m/sec)	4.38E-07

Particle Size Analysis of Soils

ASTM D 422

S&ME

Project #: **1411-07-103**
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Charlotte, NC

Test Date(s): 4/2 - 4/4/08
Report Date: 4/7/08

Boring #: M-2 Sample #: 85 Sample Date: 11/7/07
Location: sample 9 Offset: N/A Elevation: 44.1-45.6'
Sample Description: Gray tan white micaceous silty medium to fine SAND with p.w.r.

Pan #:	1	Beaker #:	1	Specific Gravity	2.650		
Hydrometer Jar #:			1				
Pan Tare Weight (grams):			0.00	Moisture Content		Hygroscopic	
Total Sample Air Dried Wt. + tare wt. (grams):			146.34		Tare #	Z-1	
Weight of Total Sample Air Dried:			146.34	A	Tare Wt.	15.99	
Weight of Air Dried Hydrometer Sample (g):			102.24	B	Wet Wt. + A	27.00	
Total Sample Oven Dried:			145.95	C	Dry Wt. + A	26.97	
Hydrometer Sample Oven Dried (W):			101.96	D	Water Wt. (B-C)	0.03	
% Passing #10:			97.5%	E	Dry Wt. (C-A)	10.98	
Correction Factor a (Table 1):			1.00		% Moisture (100 x D/E)	0.27%	

Sieve	Retained Wt.	Percent Passing	
3.0"	0.0	Pan # (washed)	100.0%
1.5"	0.0		100.0%
1.0"	0.0		100.0%
3/4"	0.0	51	100.0%
1/2"	0.0		100.0%
3/8"	0.0		100.0%
#4	0.0	Soil Mortar	100.0%
#10	3.6	**100.0%**	97.5%
#20	5.8	94.3%	92.0%
#40	20.7	79.7%	77.7%
#60	36.9	63.8%	62.2%
#100	53.5	47.5%	46.3%
#200	72.4	29.0%	28.3%

Notes: Description of Sand & Gravel Particles — Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:	2.00 mm		Total Sand:	71.7%	< 4.74 mm and > 0.075 mm	Type:	Mechanical Stirring Apparatus (A)
% Gravel:	0.0%	< 75 mm and > 4.75 mm	Silt & Clay:	28.3%	< 0.075	Dispersion Time:	1 min.
Coarse Sand:	2.5%	< 4.75 mm and > 2.00 mm	Silt:	24.6%	< 0.075 and > 0.005 mm	Sodium Hexametaphosphate:	40 g./ Liter
Medium Sand:	19.8%	< 2.00 mm and > 0.425 mm	Clay:	3.7%	< 0.005 mm		
Fine Sand:	49.4%	< 0.425 mm and > 0.075 mm	Colloids:	1.8%	< 0.001 mm	Control Cylinder ☐	Composite Correction ☒

Liquid Limit N/A Plastic Limit N/A Plastic Index N/A Hydrometer: 151H ☐ 152H ☒

Time		Temp.	Hydrometer	Corrections		Hydrometer	Percent Passing		Effective Depth	Table 3	Diameter
Clock	T (Min.)	(0.5 °C)	Reading	Control Cylinder	Composite Correction	R	P(-#10) = (R x a / W) x 100	P (total) = P x % Passing #10	L	K	D = K x ((L/T)^1/2
	2	23.2	21.5		5.10	16.40	16.1%	15.7%	13.6	0.01317	0.03435
	5	23.2	17.0		5.10	11.90	11.7%	11.4%	14.3	0.01317	0.02231
	15	23.2	13.0		5.10	7.90	7.7%	7.6%	15.0	0.01317	0.01317
	30	23.2	11.4		5.10	6.30	6.2%	6.0%	15.3	0.01317	0.00939
	60	23.2	10.0		5.10	4.90	4.8%	4.7%	15.5	0.01317	0.00669
	250	23.1	8.0		5.10	2.90	2.8%	2.8%	15.8	0.01317	0.00331
	1440	23.1	7.0		5.10	1.90	1.9%	1.8%	16.0	0.01317	0.00139
	2880	22.6	7.0		5.15	1.85	1.8%	1.8%	16.0	0.01325	0.00099

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Effective Depth (cm)
L=L1+0.5(L2-(VB/A))
(152H) .164cm per increment,
V_B=67.0cm^3, L_2=14cm, A=27.8cm^2

Technician Name: M. Jacobs
Certification #

Technical Responsibility: Brian Vaughan, P.E.
Signature

QC Manager
Position

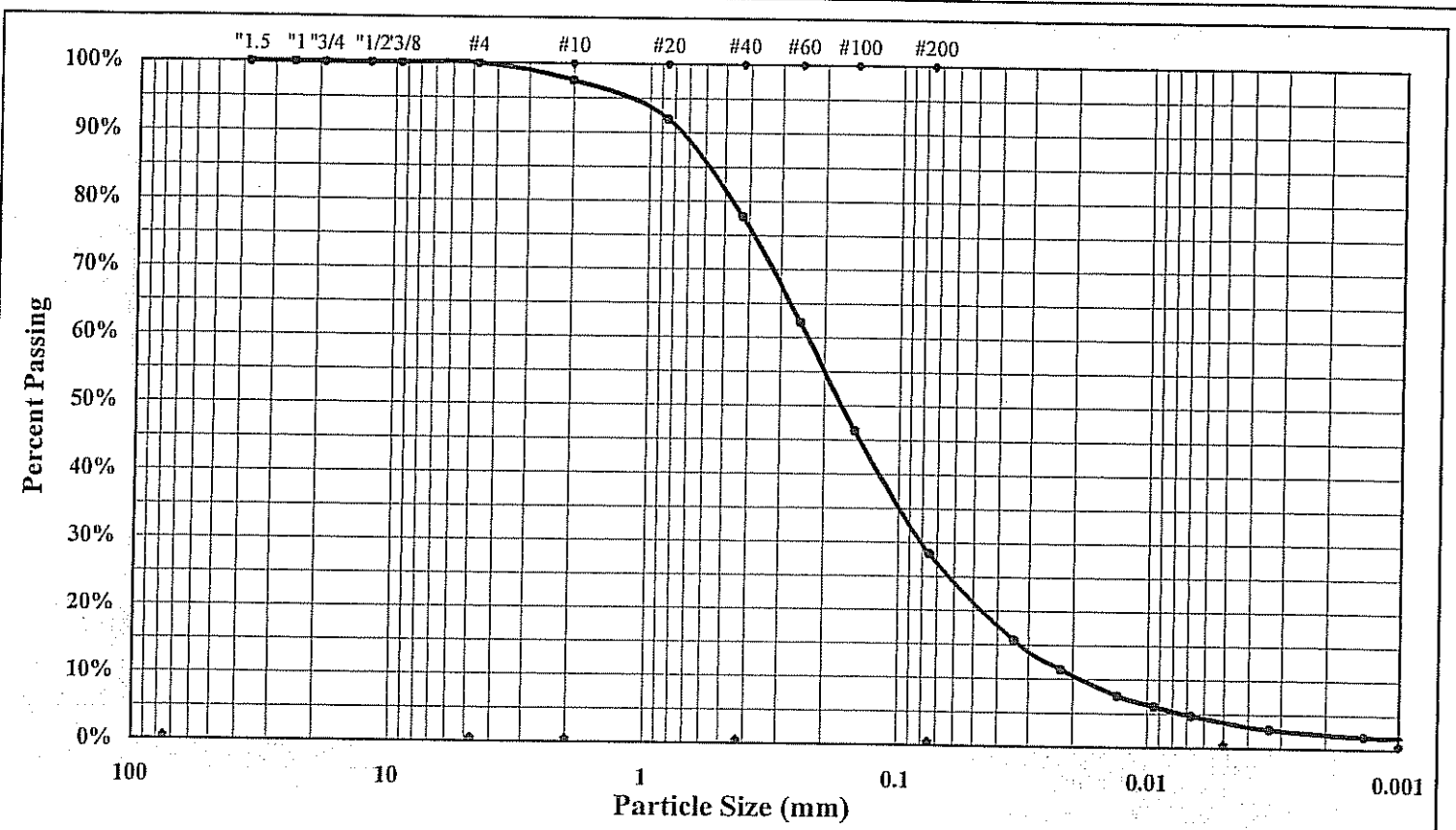
Particle Size Analysis of Soils

ASTM D 422

S&ME

S&ME Project #:	**1411-07-103**	Report Date:	4/7/08
Project Name:	**Marshall Steam Station**	Test Date(s):	4/2 - 4/4/08
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-2	Sample #:	85	Sample Date:	11/7/07
Location:	sample 9	Offset:	N/A	Elevation:	44.1-45.6'
Sample Description:	Gray tan white micaceous silty medium to fine SAND with p.w.r.				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	2.00 mm	Gravel	0.0%	Silt	24.6%
Silt & Clay (% Passing #200)	28.3%	Sand	71.7%	Clay	3.7%
Specific Gravity	2.650			Colloids	1.8%
Liquid Limit	N/A	Plastic Limit	N/A	Plastic Index	N/A

Description of Sand & Gravel Particles Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Mechanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

References: ASTM D 422: Particle Size Analysis of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 421: Dry Preparation of Soil Samples
ASTM D 854: Specific Gravity of Soils

Technical Responsibility: Brian Vaughan, P.E. _____ (Signature) QC Manager (Position)

Particle Size Analysis of Soils

ASTM D 422

S&ME

Project #: **1411-07-103**
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Charlotte, NC

Test Date(s): 11/27 - 11/29/07
Report Date: 11/30/07

Boring #: M-3 Sample #: 476 Sample Date: 11/1/07
Location: Bulk Offset: N/A Elevation: 0-5'
Sample Description: Red brown fine sandy clayey SILT (ML)

Pan #:	12	Beaker #:	7
Hydrometer Jar #:			7
Pan Tare Weight (grams):			0.00
Total Sample Air Dried Wt. + tare wt. (grams):			473.70
Weight of Total Sample Air Dried:			473.70
Weight of Air Dried Hydrometer Sample (g):			52.50
Total Sample Oven Dried:			464.31
Hydrometer Sample Oven Dried (W):			51.46
% Passing #10:			99.7%
Correction Factor a (Table 1):			1.00

Specific Gravity 2.650

	Moisture Content	Hygroscopic	Natural
	Tare #	V-1	353
A	Tare Wt.	10.90	0.00
B	Wet Wt. + A	24.49	190.88
C	Dry Wt. + A	24.22	156.30
D	Water Wt. (B-C)	0.27	34.58
E	Dry Wt. (C-A)	13.32	156.30
	% Moisture (100 x D/E)	2.03%	22.1%

Sieve	Retained Wt.	Percent Passing	
3.0"	0.0	Pan # (washed)	100.0%
1.5"	0.0		100.0%
1.0"	0.0		100.0%
3/4"	0.0	59	100.0%
1/2"	0.0		100.0%
3/8"	0.0		100.0%
#4	0.0	Soil Mortar	100.0%
#10	1.2	**100.0%**	99.7%
#20	0.7	98.7%	98.5%
#40	3.8	92.6%	92.4%
#60	7.5	85.4%	85.1%
#100	12.4	76.0%	75.8%
#200	18.6	63.8%	63.6%

Notes: Description of Sand & Gravel Particles — Rounded ☐ Angular ☒ — Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:	2.00 mm		Total Sand:	36.4%	< 4.74 mm and > 0.075 mm	Type:	Mechanical Stirring Apparatus (A)
% Gravel:	0.0%	< 75 mm and > 4.75 mm	Silt & Clay:	63.6%	< 0.075	Dispersion Time:	1 min.
Coarse Sand:	0.3%	< 4.75 mm and > 2.00 mm	Silt:	28.1%	< 0.075 and > 0.005 mm	Sodium Hexametaphosphate:	40 g./ Liter
Medium Sand:	7.4%	< 2.00 mm and > 0.425 mm	Clay:	35.5%	< 0.005 mm		
Fine Sand:	28.7%	< 0.425 mm and > 0.075 mm	Colloids:	27.0%	< 0.001 mm	**Control Cylinder** ☐	**Composite Correction** ☒

Liquid Limit **48** Plastic Limit **33** Plastic Index **15** Hydrometer: 151H ☐ 152H ☒

Time		Temp.	Hydrometer	Corrections		Hydrometer	Percent Passing		Effective Depth	Table 3	Diameter
Clock	T (Min.)	(0.5 °C)	Reading	Control Cylinder	Composite Correction	R	P(-#10) = (R x a / W) x 100	P (total) = P x % Passing #10	L	K	D = K x ((L/T)^1/2
	2	22.5	33.5		5.15	28.35	55.1%	54.9%	11.6	0.01325	0.03196
	5	22.5	31.0		5.15	25.85	50.2%	50.1%	12.1	0.01325	0.02057
	15	22.5	28.0		5.15	22.85	44.4%	44.3%	12.5	0.01325	0.01211
	30	22.5	26.0		5.15	20.85	40.5%	40.4%	12.9	0.01325	0.00868
	60	22.6	24.5		5.15	19.35	37.6%	37.5%	13.1	0.01325	0.00619
	250	23.2	21.5		5.10	16.40	31.9%	31.8%	13.6	0.01317	0.00307
	1440	22.1	19.5		5.20	14.30	27.8%	27.7%	13.9	0.01332	0.00131
	2880	21.9	19.0		5.20	13.80	26.8%	26.7%	14.0	0.01340	0.00094

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Effective Depth (cm)
L=L1+0.5(L2-(VB/A))

Technician Name: M. Jacobs

Technical Responsibility: Brian Vaughan, P.E.

Certification #

Signature

QC Manager
Position

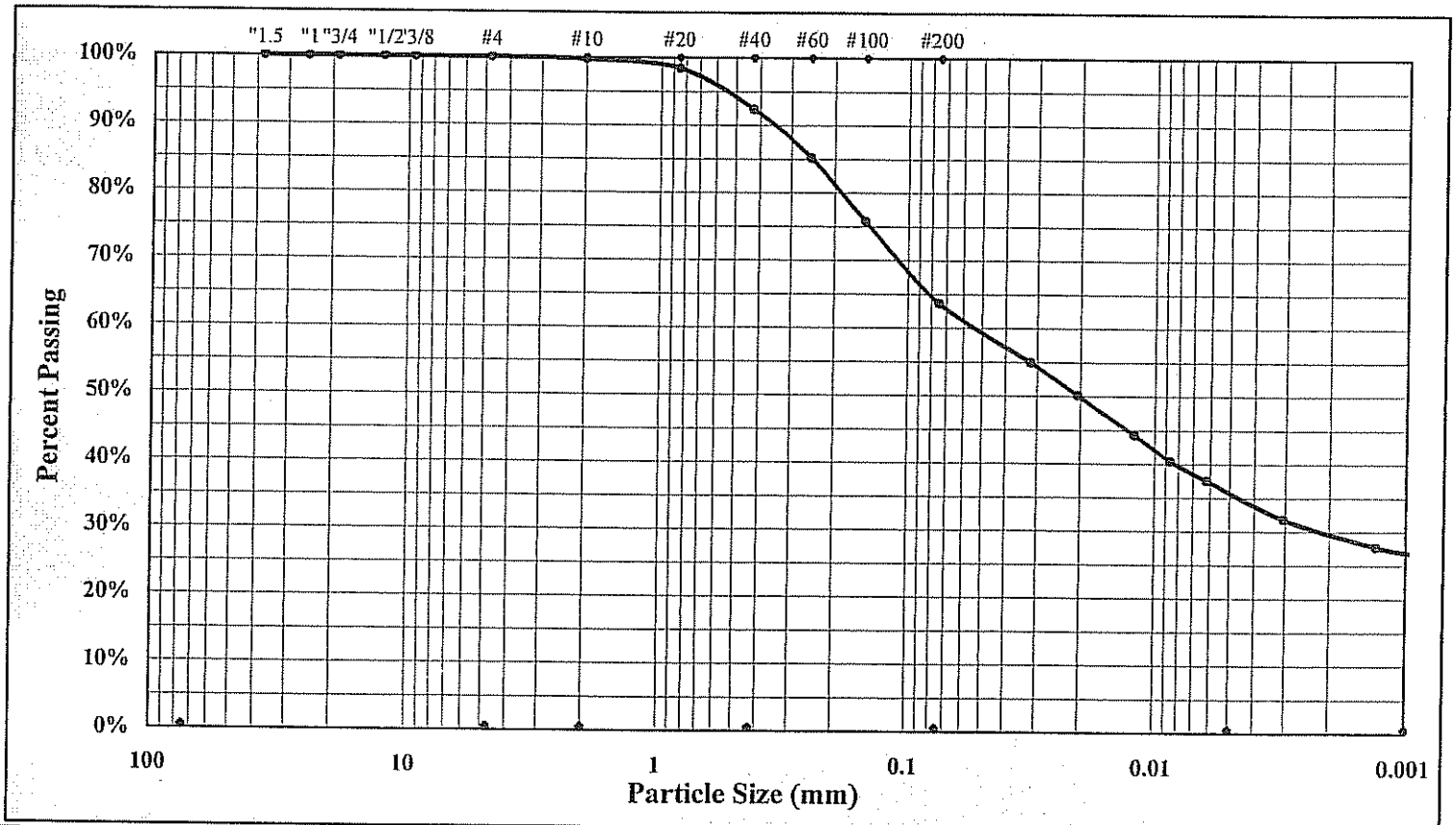
(152H) .164cm per increment,
V_B=67.0cm^3, L_2=14cm, A=27.8cm^2

Particle Size Analysis of Soils

ASTM D 422

S&ME Project #:	**1411-07-103**	Report Date:	11/30/07
Project Name:	**Marshall Steam Station**	Test Date(s):	11/27 - 11/29/07
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-3	Sample #:	476	Sample Date:	11/1/07
Location:	Bulk	Offset:	N/A	Elevation:	0-5'
Sample Description:	Red brown fine sandy clayey SILT (ML)				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	2.00 mm	Gravel	0.0%	Silt	28.1%
Silt & Clay (% Passing #200)	63.6%	Sand	36.4%	Clay	35.5%
Specific Gravity	2.650	Moisture Content	22.1%	Colloids	27.0%
Liquid Limit	48	Plastic Limit	33	Plastic Index	15

Description of Sand & Gravel Particles Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Mechanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

References: ASTM D 422: Particle Size Analysis of Soils
ASTM D 421: Dry Preparation of Soil Samples
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 854: Specific Gravity of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. _____ QC Manager
Signature *Position*

Moisture - Density Relationship

S&ME

S&ME Project #:	**1411-07-103**	Test Date(s):	December 12, 2007
Project Name:	Marshall Steam Station	Report Date:	December 13, 2007
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-3	Sample #:	476	Sample Date:	November 1, 2007
Location:	Bulk	Offset:	N/A	Depth:	0-5'

Sample Description: Red brown fine sandy clayey SILT (ML)

Liquid Limit:	48	Specific Gravity:	2.650
Plastic Limit:	33	Plastic Index:	15

Natural Moisture Content: 22.1%

Moisture Content of the Oversize Fraction:

NOTES:

Sieve Size	% Passing
#4	100.0
#10	99.7
#20	98.5
#40	92.4
#60	85.1
#100	75.8
#200	63.6

MDD: 99.3 **Opt. MC %: 22.5**

Water Content

Water Content requires GP 2 Balance (0.1 gram Readability).

ASTM D2216 ☒ AASHTO T265 ☐ ASTM D4959 ☐ ASTM D4643 ☐

	Sample #:	1	2	3	4	5	6
	Water Added:						
	Tare #:						
A. Tare Weight	A.	0	0	0	0	0	0
B. Wet Wt + Tare Wt	B.	500	500	500	500	500	500
C. Dry Wt. + Tare Wt.	C.	420.7	413.9	407.3	401.1		
D. Water Weight	B-C	79.3	86.1	92.7	98.9	500	500
E. Dry Weight	C-A	420.7	413.9	407.3	401.1	0	0
F. Moisture Content	100*D/E	**18.8%**	**20.8%**	**22.8%**	**24.7%**	**#DIV/0!**	**#DIV/0!**

Compaction Data

The Compaction Test requires a GP 5 Balance for ASTM (1 gram or .0022 Lb. readability).

G. Wt of Soil + Mold	G.	13.098	13.262	13.358	13.340		
H. Wt. of Mold	H.	9.304	9.304	9.304	9.304	9.304	9.304
I. Wt. of Soil (g. or lbs.)	G-H	3.794	3.958	4.054	4.036	-9.304	-9.304
J. Wt of Soil (Lbs.)	I/453.6 or I	3.794	3.958	4.054	4.036	-9.304	-9.304
K. Mold Volume Factor	K.	30.039	30.039	30.039	30.039	30.039	30.039
L. Wet Density	J*K	114.0	118.9	121.8	121.2	-279.5	-279.5
M. Dry Density	L/(1+F)	**95.9**	**98.4**	**99.2**	**97.3**	**#DIV/0!**	**#DIV/0!**

ASTM D558 ☐ ASTM D 698 ☒ ASTM D1557 ☐ AASHTO T99 ☐ AASHTO T180 ☐

Method A ☒ Method B ☐ Method C ☐ Method D (ASTM 1978) ☐ AASHTO Method D ☐

Moisture-Density Relation of: Fine Fraction ☒ Corrected for Coarse Fraction (ASTM D 4718) ☐

Sieve Size used to separate the Oversize Fraction: #4 Sieve ☒ 3/8 inch Sieve ☐ 3/4 inch Sieve ☐

Mechanical Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

Soil Plasticity:	ASTM D 4318 ☒	AASHTO T 89 ☐		AASHTO T 90 ☐
Sieve Analysis / Particle Size Analysis:	ASTM C136 ☐	AASHTO T 27 ☐	ASTM D 422 ☒	AASHTO T 88 ☐
Specific Gravity of Soil:		ASTM D 854 ☒		AASHTO T 100 ☐
Bulk Gravity of Oversize Fraction:		ASTM C 127 ☐		AASHTO T 85 ☐
Soil Classification:	ASTM D 2487 ☒	ASTM D 2488 ☐		AASHTO M 145 ☐

Technician Name: C. Amick

Certification #

Technical Responsibility: Brian Vaughan, P.E.

Signature

Construction Services Manager

Position

Moisture - Density Report

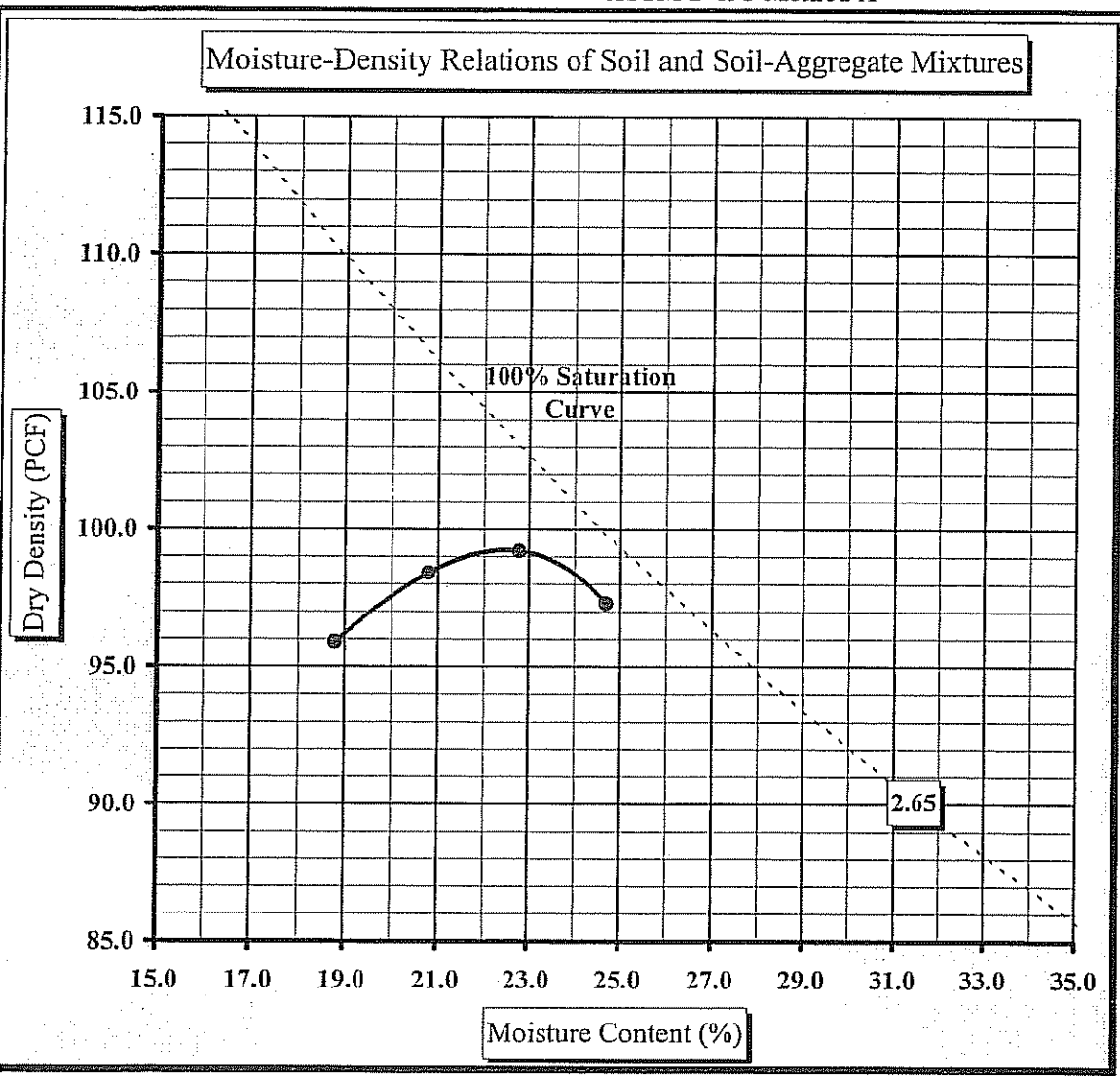
S&ME

S&ME Project #:	**1411-07-103**	Report Date:	December 13, 2007
Project Name:	**Marshall Steam Station**	Test Date(s):	December 12, 2007
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-3	Sample #:	476	Sample Date:	November 1, 2007
Location:	Bulk	Offset:	N/A	Depth:	0-5'
Sample Description:	Red brown fine sandy clayey SILT (ML)				

Maximum Dry Density **99.3** **PCF.** **Optimum Moisture Content** **22.5** **%**

ASTM D 698 Method A



Soil Properties

Natural Moisture Content:	22.1%
Liquid Limit:	48
Plastic Limit:	33
Plastic Index:	15
Specific Gravity:	2.650

% Passing

#4	100
#10	99.7
#20	98.5
#40	92.4
#60	85.1
#100	75.8
#200	63.6

Oversize Fraction

Bulk Sp. Gravity
% Moisture
Oversize Fraction
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 Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

References: ASTM D 698: Laboratory Compaction Characteristics of Soil Using Standard Effort
ASTM D 2216: Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D 422: Particle Size Analysis of Soils ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. Construction Services Manager

Laboratory Record Version 4.2

S&ME

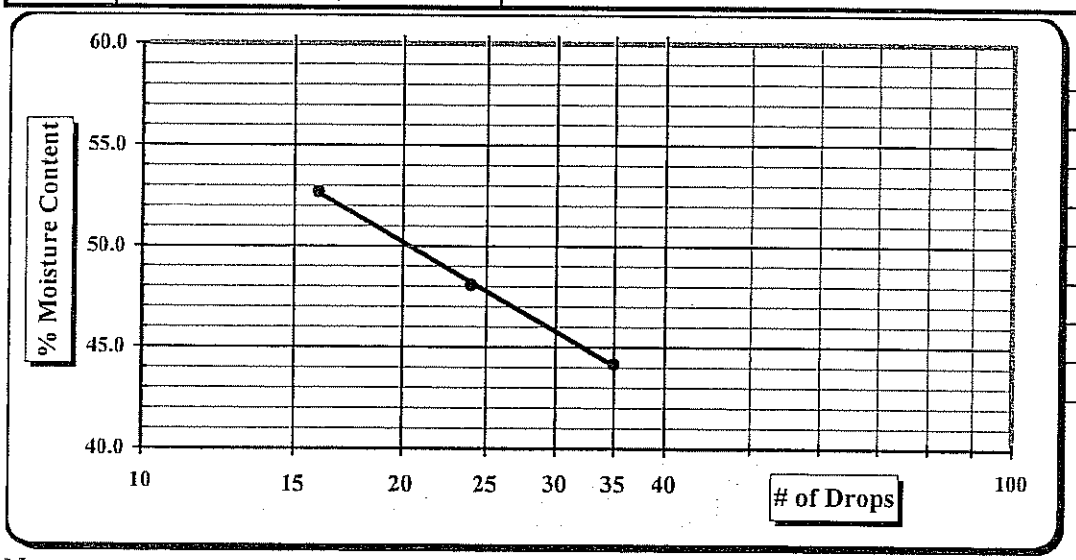
Liquid Limit, Plastic Limit, and Plastic Index

Project #: **1411-07-103**
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Charlotte, NC

Report Date: 12/28/07
Test Date(s): 12/27/07

Boring #: M-3 Sample #: 476 Sample Date: 11/1/07
Location: Bulk Offset: N/A Elevation: 0-5'
Sample Description: Red brown fine sandy clayey SILT (ML)

Pan #		Liquid Limit						Plastic Limit		
	Test #	1	2	3	4	5	6	1	2	3
	Tare #	P-1	P-2	P-3				1	2	
A	Tare Weight	16.56	15.45	16.55				**10.90**	10.91	
B	Wet Soil Weight + A	38.11	37.60	39.04				17.73	17.96	
C	Dry Soil Weight + A	31.51	30.41	31.28				16.04	16.23	
D	Water Weight (B-C)	6.60	7.19	7.76				1.69	1.73	
E	Dry Soil Weight (C-A)	14.95	14.96	14.73				5.14	5.32	
F	% Moisture Content (D/E)*100	44.1%	48.1%	52.7%				32.9%	32.5%	
N	# OF DROPS	35	24	16				*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average							32.7%		



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes:

Special Sampling Methods:

Sample Preparation:	Wet Preparation	☐	Dry Preparation	☒	Air Dried	☒	% Passing #200 Sieve: 63.6
Liquid limit Test:	Multipoint Method	☒	One-point Method	☐			NP, Non-Plastic ☐
Classification:	ASTM D 2487	☒	AASHTO M 145	☐			Liquid Limit 48
Liquid limit Test:	ASTM D 4318	☒	AASHTO T 89	☐			Plastic Limit 33
Plastic limit Test:	ASTM D 4318	☒	AASHTO T 90	☐			Plastic Index 15
							Group Symbol ML

Technician Name: M. Jacobs

Certification #

Technical Responsibility: Brian Vaughan, P.E. Signature QC Manager Position

Laboratory Record Version 4.2

Particle Size Analysis of Soils

ASTM D 422

S&ME

Project #: **1411-07-103**
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Charlotte, NC

Test Date(s): 11/27 - 11/29/07
Report Date: 11/30/07

Boring #: M-3 Sample #: 476 Sample Date: 11/1/07
Location: Bulk Offset: N/A Elevation: 5-10'
Sample Description: Brown red micaceous medium to fine sandy clayey SILT (ML)

Pan #:	13	Beaker #:	8
Hydrometer Jar #:			8
Pan Tare Weight (grams):			0.00
Total Sample Air Dried Wt. + tare wt. (grams):			475.78
Weight of Total Sample Air Dried:			475.78
Weight of Air Dried Hydrometer Sample (g):			52.28
Total Sample Oven Dried:			468.37
Hydrometer Sample Oven Dried (W):			51.46
% Passing #10:			99.5%
Correction Factor a (Table 1):			1.00

Specific Gravity 2.650

	Moisture Content	Hygroscopic	Natural
	Tare #	T-2	363
A	Tare Wt.	10.85	0.00
B	Wet Wt. + A	22.99	214.58
C	Dry Wt. + A	22.80	179.99
D	Water Wt. (B-C)	0.19	34.59
E	Dry Wt. (C-A)	11.95	179.99
	% Moisture (100 x D/E)	1.59%	19.2%

Sieve	Retained Wt.	Percent Passing	
3.0"	0.0	Pan # (washed)	100.0%
1.5"	0.0		100.0%
1.0"	0.0		100.0%
3/4"	0.0	60	100.0%
1/2"	0.0		100.0%
3/8"	0.0		100.0%
#4	0.3	Soil Mortar	99.9%
#10	2.3	**100.0%**	99.5%
#20	1.3	97.4%	96.9%
#40	5.5	89.4%	88.9%
#60	9.9	80.8%	80.4%
#100	15.5	69.9%	69.5%
#200	23.5	54.4%	54.1%

Notes: Description of Sand & Gravel Particles Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:	4.75 mm	Total Sand:	45.8%	< 4.74 mm and > 0.075 mm	Type: Mechanical Stirring Apparatus (A)
% Gravel:	0.1%	< 75 mm and > 4.75 mm	Silt & Clay:	54.1%	< 0.075	Dispersion Time: 1 min.
Coarse Sand:	0.4%	< 4.75 mm and > 2.00 mm	Silt:	33.6%	< 0.075 and > 0.005 mm	Sodium Hexametaphosphate: 40 g./ Liter
Medium Sand:	10.6%	< 2.00 mm and > 0.425 mm	Clay:	20.5%	< 0.005 mm	
Fine Sand:	34.8%	< 0.425 mm and > 0.075 mm	Colloids:	13.1%	< 0.001 mm	**Control Cylinder** ☐ **Composite Correction** ☒

Liquid Limit **41** Plastic Limit **34** Plastic Index **7** Hydrometer: 151H ☐ 152H ☒

Time		Temp.	Hydrometer	Corrections		Hydrometer	Percent Passing		Effective Depth	Table 3	Diameter
Clock	T (Min.)	(0.5 °C)	Reading	Control Cylinder	Composite Correction	R	P(-#10) = (R x a / W) x 100	P (total) = P x % Passing #10	L	K	D = K x ((L/T)^1/2
	2	22.5	28.0		5.15	22.85	44.4%	44.2%	12.5	0.01325	0.03318
	5	22.5	25.0		5.15	19.85	38.6%	38.4%	13.0	0.01325	0.02139
	15	22.5	21.0		5.15	15.85	30.8%	30.6%	13.7	0.01325	0.01266
	30	22.6	19.0		5.15	13.85	26.9%	26.8%	14.0	0.01325	0.00906
	60	22.7	17.0		5.15	11.85	23.0%	22.9%	14.4	0.01325	0.00648
	250	23.2	14.0		5.10	8.90	17.3%	17.2%	14.8	0.01317	0.00321
	1440	22.2	12.5		5.20	7.30	14.2%	14.1%	15.1	0.01332	0.00136
	2880	22.0	12.0		5.20	6.80	13.2%	13.1%	15.2	0.01332	0.00097

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Effective Depth (cm)
L=L1+0.5(L2-(VB/A))
(152H) .164cm per increment,
V_B=67.0cm^3, L_2=14cm, A=27.8cm^2

Technician Name: M. Jacobs

Technical Responsibility: Brian Vaughan, P.E.

Certification #

Signature

OC Manager
Position

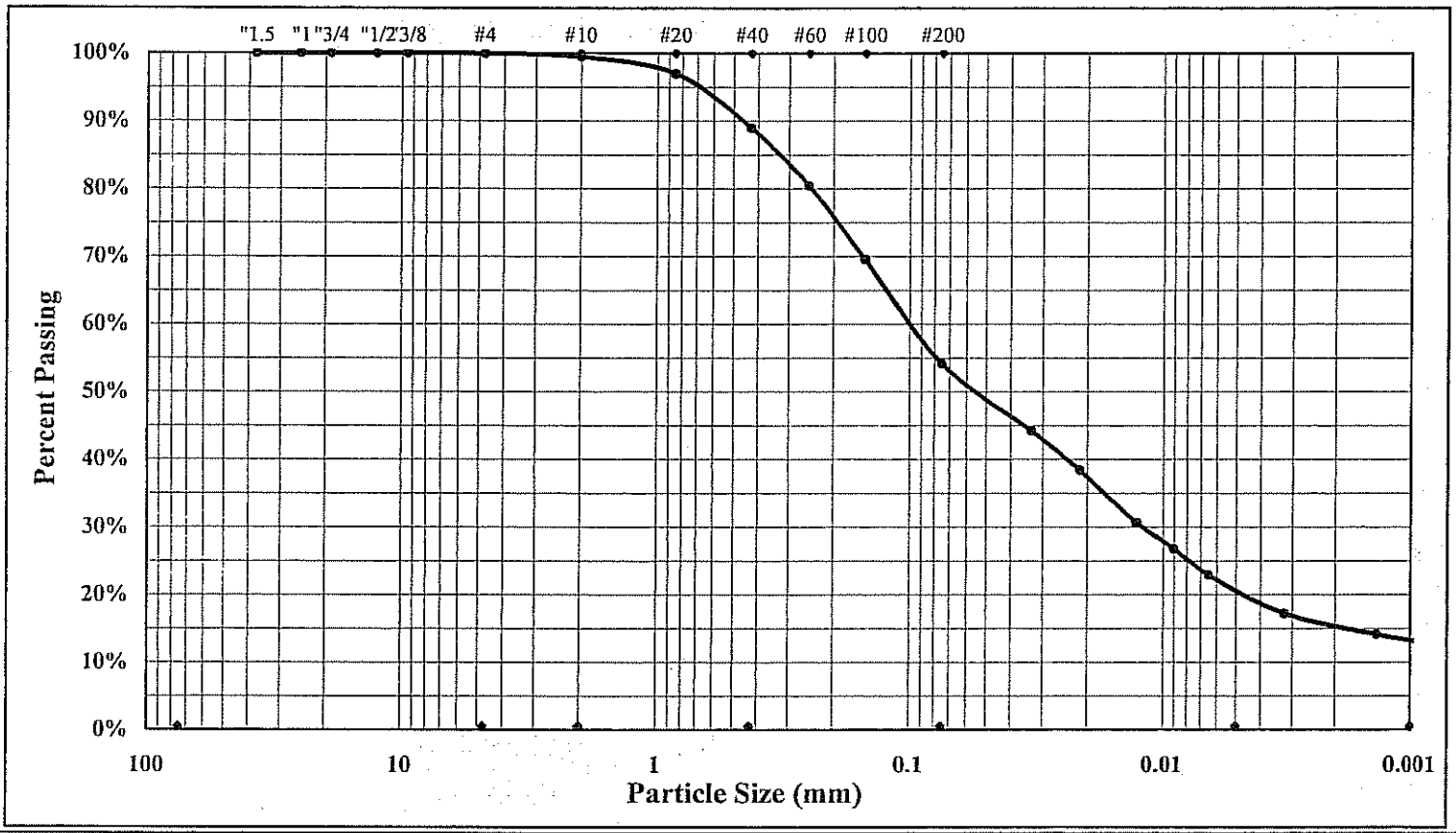
S&ME, INC.
155 Tradd Street, Spartanburg, SC 29301

Particle Size Analysis of Soils

ASTM D 422

S&ME Project #:	**1411-07-103**	Report Date:	11/30/07
Project Name:	**Marshall Steam Station**	Test Date(s):	11/27 - 11/29/07
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-3	Sample #:	476	Sample Date:	11/1/07
Location:	Bulk	Offset:	N/A	Elevation:	5-10'
Sample Description:	Brown red micaceous medium to fine sandy clayey SILT (ML)				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	4.75 mm	Gravel	0.1%	Silt	33.6%
Silt & Clay (% Passing #200)	54.1%	Sand	45.8%	Clay	20.5%
Specific Gravity	2.650	Moisture Content	19.2%	Colloids	13.1%
Liquid Limit	41	Plastic Limit	34	Plastic Index	7

Description of Sand & Gravel Particles Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Mechanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 854: Specific Gravity of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. _____ QC Manager

Signature *Position*

Moisture - Density Relationship

S&ME

S&ME Project #:	**1411-07-103**	Test Date(s):	December 12, 2007
Project Name:	Marshall Steam Station	Report Date:	December 13, 2007
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-3	Sample #:	476	Sample Date:	November 1, 2007
Location:	Bulk	Offset:	N/A	Depth:	5-10'

Sample Description: Brown red micaceous medium to fine sandy clayey SILT (ML)

Liquid Limit:	41	Specific Gravity:	2.650
Plastic Limit:	34	Plastic Index:	7

Natural Moisture Content: 19.2%

Moisture Content of the Oversize Fraction:

NOTES:

Sieve Size	% Passing
#4	99.9
#10	99.5
#20	96.9
#40	88.9
#60	80.4
#100	69.5
#200	54.1

MDD: 101.9 **Opt. MC %: 20.0**

Water Content

Water Content requires GP 2 Balance (0.1 gram Readability).

ASTM D2216 ☒ AASHTO T265 ☐ ASTM D4959 ☐ ASTM D4643 ☐

	Sample #:	1	2	3	4	5	6
	Water Added:						
	Tare #:						
A. Tare Weight	A.	0	0	0	0	0	0
B. Wet Wt + Tare Wt	B.	500	500	500	500	500	500
C. Dry Wt. + Tare Wt.	C.	429.6	422	413.8	407.3		
D. Water Weight	B-C	70.4	78	86.2	92.7	500	500
E. Dry Weight	C-A	429.6	422	413.8	407.3	0	0
F. Moisture Content	100*D/E	**16.4%**	**18.5%**	**20.8%**	**22.8%**	**#DIV/0!**	**#DIV/0!**

Compaction Data

The Compaction Test requires a GP 5 Balance for ASTM (1 gram or .0022 Lb. readability).

G. Wt of Soil + Mold	G.	13.194	13.306	13.394	13.376		
H. Wt. of Mold	H.	9.304	9.304	9.304	9.304	9.304	9.304
I. Wt. of Soil (g. or lbs.)	G-H	3.890	4.002	4.090	4.072	-9.304	-9.304
J. Wt of Soil (Lbs.)	I/453.6 or I	3.890	4.002	4.090	4.072	-9.304	-9.304
K. Mold Volume Factor	K.	30.039	30.039	30.039	30.039	30.039	30.039
L. Wet Density	J*K	116.9	120.2	122.9	122.3	-279.5	-279.5
M. Dry Density	L/(1+F)	**100.4**	**101.5**	**101.7**	**99.6**	**#DIV/0!**	**#DIV/0!**

ASTM D558 ☐ ASTM D 698 ☒ ASTM D1557 ☐ AASHTO T99 ☐ AASHTO T180 ☐

Method A ☒ Method B ☐ Method C ☐ Method D (ASTM 1978) ☐ AASHTO Method D ☐

Moisture-Density Relation of: Fine Fraction ☒ Corrected for Coarse Fraction (ASTM D 4718) ☐

Sieve Size used to separate the Oversize Fraction: #4 Sieve ☒ 3/8 inch Sieve ☐ 3/4 inch Sieve ☐

Mechanical Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

Soil Plasticity: ASTM D 4318 ☒ AASHTO T 89 ☐ AASHTO T 90 ☐

Sieve Analysis / Particle Size Analysis: ASTM C136 ☐ AASHTO T 27 ☐ ASTM D 422 ☒ AASHTO T 88 ☐

Specific Gravity of Soil: ASTM D 854 ☒ AASHTO T 100 ☐

Bulk Gravity of Oversize Fraction: ASTM C 127 ☐ AASHTO T 85 ☐

Soil Classification: ASTM D 2487 ☒ ASTM D 2488 ☐ AASHTO M 145 ☐

Technician Name: C. Amick

Certification #

Technical Responsibility: Brian Vaughan, P.E. Signature Construction Services Manager Position

Laboratory Report Version 4.2

Moisture - Density Report

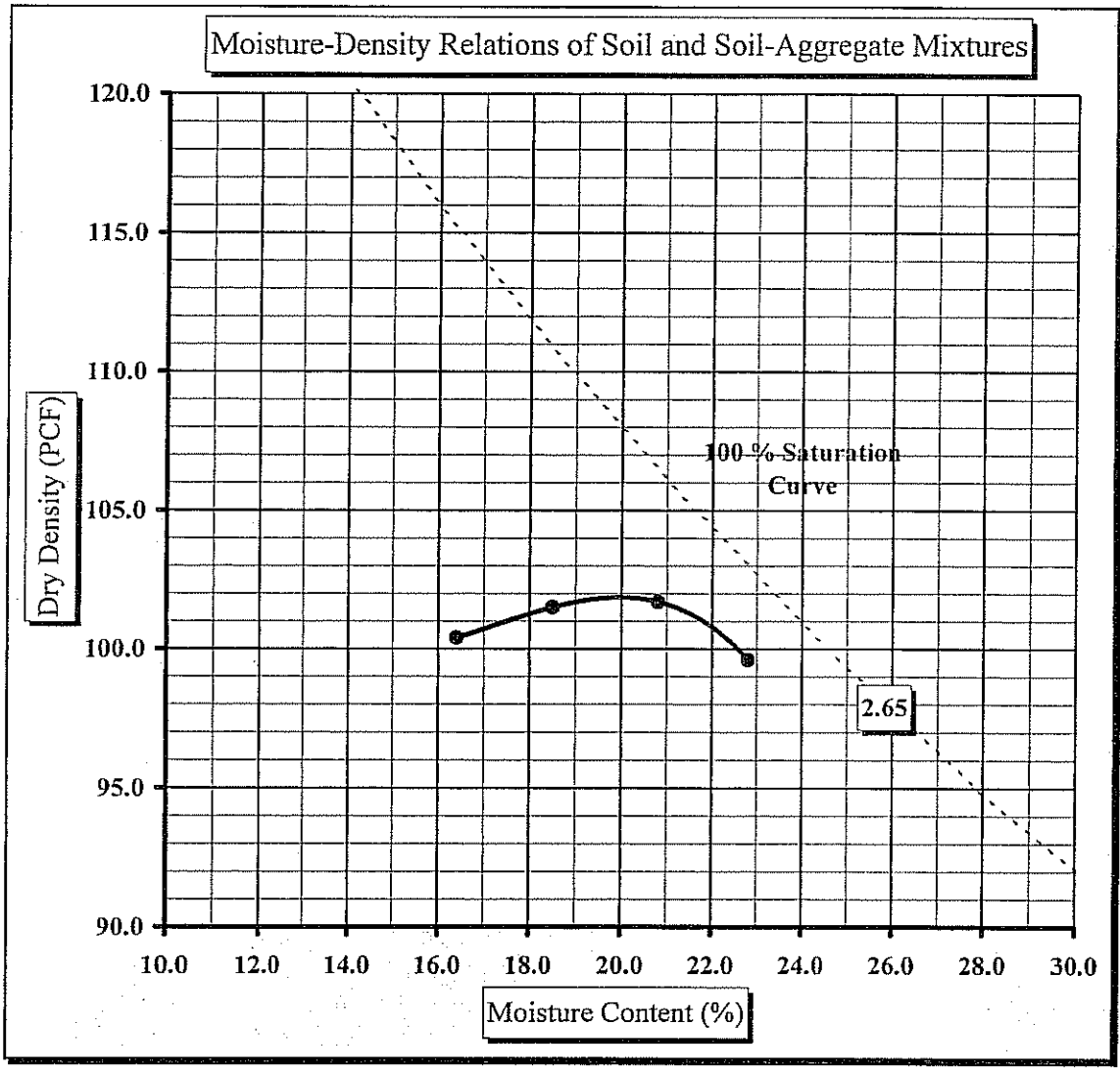
S&ME

S&ME Project #:	**1411-07-103**	Report Date:	December 13, 2007
Project Name:	**Marshall Steam Station**	Test Date(s):	December 12, 2007
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-3	Sample #:	476	Sample Date:	November 1, 2007
Location:	Bulk	Offset:	N/A	Depth:	5-10'
Sample Description:	Brown red micaceous medium to fine sandy clayey SILT (ML)				

Maximum Dry Density 101.9 PCF. **Optimum Moisture Content 20.0 %**

ASTM D 698 Method A



Soil Properties

Natural Moisture Content:	19.2%
Liquid Limit:	41
Plastic Limit:	34
Plastic Index:	7
Specific Gravity:	2.650

% Passing

#4	99.9
#10	99.5
#20	96.9
#40	88.9
#60	80.4
#100	69.5
#200	54.1

Oversize Fraction

Bulk Sp. Gravity
% Moisture
Oversize Fraction
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 Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

References: ASTM D 698: Laboratory Compaction Characteristics of Soil Using Standard Effort
ASTM D 2216: Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D 422: Particle Size Analysis of Soils
ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. Construction Services Manager

S&ME

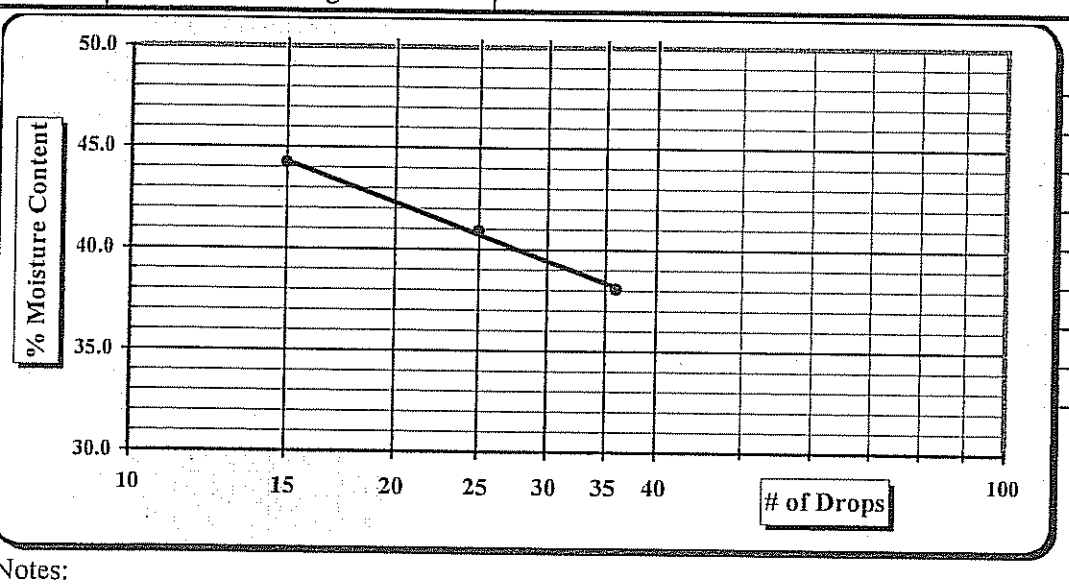
Liquid Limit, Plastic Limit, and Plastic Index

Project #: **1411-07-103**
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Charlotte, NC

Report Date: 12/28/07
Test Date(s): 12/27/07

Boring #: M-3 Sample #: 476 Sample Date: 11/1/07
Location: Bulk Offset: N/A Elevation: 5-10'
Sample Description: Brown red micaceous medium to fine sandy clayey SILT (ML)

Pan #		Liquid Limit						Plastic Limit		
	Test #	1	2	3	4	5	6	1	2	3
	Tare #	Q-1	Q-2	Q-3				3	4	
A	Tare Weight	16.81	16.78	15.75				**10.87**	10.97	
B	Wet Soil Weight + A	40.86	40.14	39.82				18.24	18.05	
C	Dry Soil Weight + A	34.23	33.36	32.44				16.37	16.27	
D	Water Weight (B-C)	6.63	6.78	7.38				1.87	1.78	
E	Dry Soil Weight (C-A)	17.42	16.58	16.69				5.50	5.30	
F	% Moisture Content (D/E)*100	38.1%	40.9%	44.2%				34.0%	33.6%	
N	# OF DROPS	36	25	15				*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average							33.8%		



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes:

Special Sampling Methods:

Sample Preparation:	Wet Preparation ☐	Dry Preparation ☒	Air Dried ☒	% Passing #200 Sieve:	54.1
Liquid limit Test:	Multipoint Method ☒	One-point Method ☐		NP, Non-Plastic	☐
Classification:	ASTM D 2487 ☒	AASHTO M 145 ☐		Liquid Limit	41
Liquid limit Test:	ASTM D 4318 ☒	AASHTO T 89 ☐		Plastic Limit	34
Plastic limit Test:	ASTM D 4318 ☒	AASHTO T 90 ☐		Plastic Index	7
				Group Symbol	ML

Technician Name: M. Jacobs

Certification #

Technical Responsibility: Brian Vaughan, P.E. Signature QC Manager Position

Particle Size Analysis of Soils

ASTM D 422

S&ME

Project #: **1411-07-103**
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Charlotte, NC

Test Date(s): 11/27 - 11/29/07
Report Date: 11/30/07

Boring #: M-3 Sample #: 476 Sample Date: 11/1/07
Location: Bulk Offset: N/A Elevation: 10-15'
Sample Description: Brown tan micaceous medium to fine sandy clayey SILT (ML)

Pan #:	14	Beaker #:	9		Specific Gravity		2.650		
Hydrometer Jar #:			9						
Pan Tare Weight (grams):			0.00		**Moisture Content**	Hygroscopic	Natural		
Total Sample Air Dried Wt. + tare wt. (grams):			484.06		Tare #	V-3	365		
Weight of Total Sample Air Dried:			484.06	A	Tare Wt.	10.76	0.00		
Weight of Air Dried Hydrometer Sample (g):			52.00	B	Wet Wt. + A	22.90	205.18		
Total Sample Oven Dried:			479.34	C	Dry Wt. + A	22.78	176.76		
Hydrometer Sample Oven Dried (W):			51.49	D	Water Wt. (B-C)	0.12	28.42		
% Passing #10:			98.6%	E	Dry Wt. (C-A)	12.02	176.76		
Correction Factor a (Table 1):			1.00		% Moisture (100 x D/E)	1.00%	16.1%		

Sieve	Retained Wt.	Percent Passing	
3.0"	0.0	Pan # (washed)	100.0%
1.5"	0.0		100.0%
1.0"	0.0		100.0%
3/4"	0.0	62	100.0%
1/2"	0.0		100.0%
3/8"	0.0		100.0%
#4	1.4	Soil Mortar	99.7%
#10	6.9	**100.0%**	98.6%
#20	1.6	97.0%	95.6%
#40	6.5	87.4%	86.2%
#60	11.7	77.3%	76.1%
#100	17.3	66.4%	65.4%
#200	24.6	52.3%	51.5%

Notes: Description of Sand & Gravel Particles Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:	4.75 mm		Total Sand:	48.2%	< 4.74 mm and > 0.075 mm	Type:	Mechanical Stirring Apparatus (A)
% Gravel:	0.3%	< 75 mm and > 4.75 mm	Silt & Clay:	51.5%	< 0.075	Dispersion Time:	1 min.
Coarse Sand:	1.2%	< 4.75 mm and > 2.00 mm	Silt:	34.2%	< 0.075 and > 0.005 mm	Sodium Hexametaphosphate:	40 g./ Liter
Medium Sand:	12.4%	< 2.00 mm and > 0.425 mm	Clay:	17.3%	< 0.005 mm		
Fine Sand:	34.6%	< 0.425 mm and > 0.075 mm	Colloids:	9.2%	< 0.001 mm	**Control Cylinder** ☐	**Composite Correction** ☒

Liquid Limit **37** Plastic Limit **33** Plastic Index **4** Hydrometer: 151H ☐ 152H ☒

Time		Temp.	Hydrometer	Corrections		Hydrometer	Percent Passing		Effective Depth	Table 3	Diameter
Clock	T (Min.)	(0.5 °C)	Reading	Control Cylinder	Composite Correction	R	P(-#10) = (R x a / W) x 100	P (total) = P x % Passing #10	L	K	D = K x ((L/T)^1/2
	2	22.8	26.5		5.10	21.40	41.6%	41.0%	12.8	0.01325	0.03349
	5	22.8	23.0		5.10	17.90	34.8%	34.3%	13.4	0.01325	0.02165
	15	22.8	19.5		5.10	14.40	28.0%	27.6%	13.9	0.01325	0.01277
	30	22.9	17.0		5.10	11.90	23.1%	22.8%	14.3	0.01325	0.00916
	60	23.0	15.0		5.10	9.90	19.2%	19.0%	14.7	0.01317	0.00651
	250	23.3	12.5		5.05	7.45	14.5%	14.3%	15.1	0.01317	0.00323
	1440	22.3	10.5		5.15	5.35	10.4%	10.2%	15.4	0.01332	0.00138
	2880	22.1	10.0		5.20	4.80	9.3%	9.2%	15.5	0.01332	0.00098

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Effective Depth (cm)
L=L1+0.5(L2-(VB/A))

Technician Name: M. Jacobs

Certification #

Technical Responsibility: Brian Vaughan, P.E.

Signature

QC Manager
Position

(152H) .164cm per increment,
V_B=67.0cm^3, L_2=14cm, A=27.8cm^2

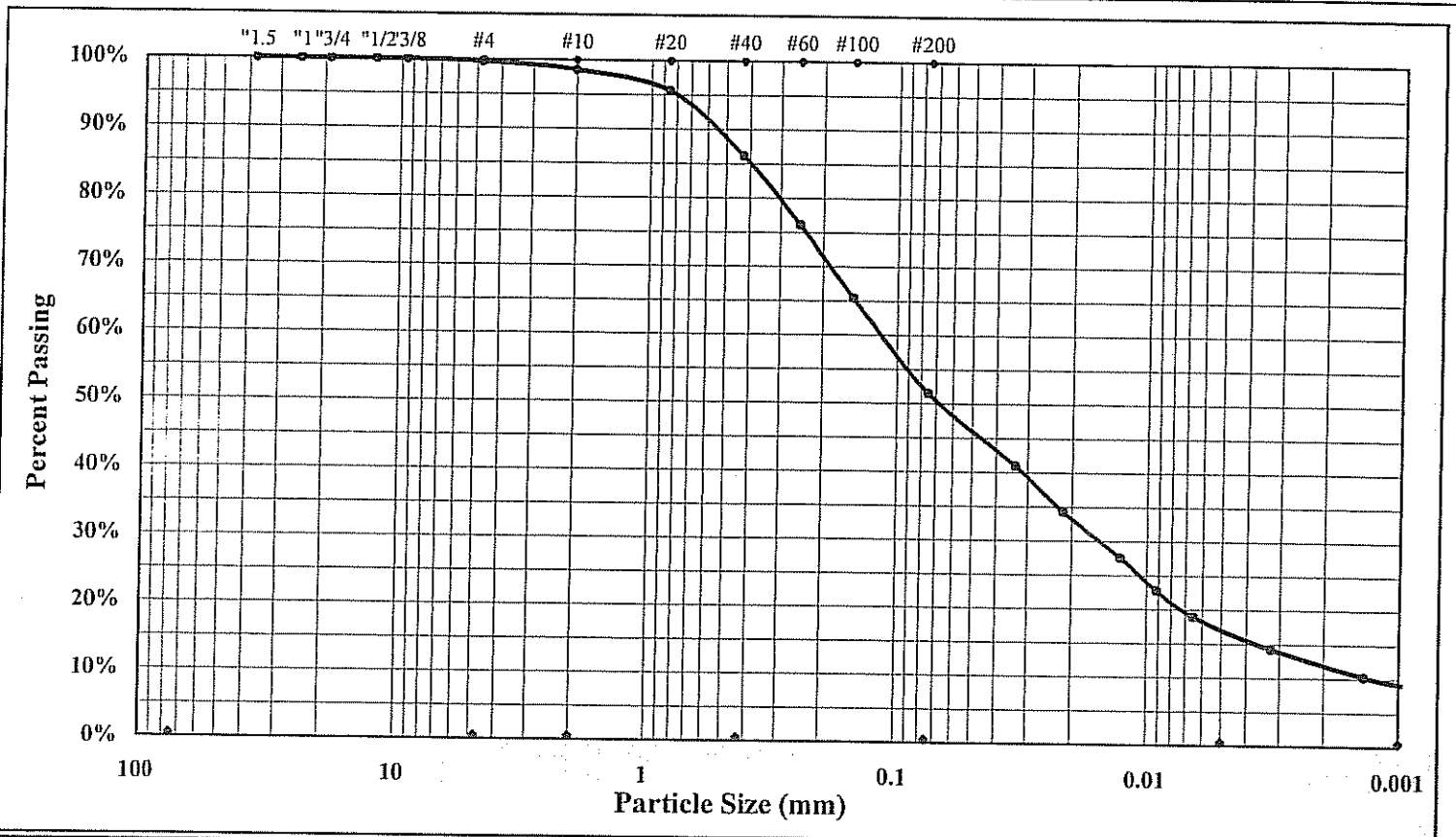
Particle Size Analysis of Soils

ASTM D 422

S&ME

S&ME Project #:	**1411-07-103**	Report Date:	11/30/07
Project Name:	**Marshall Steam Station**	Test Date(s):	11/27 - 11/29/07
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-3	Sample #:	476	Sample Date:	11/1/07
Location:	Bulk	Offset:	N/A	Elevation:	10-15'
Sample Description:	Brown tan micaceous medium to fine sandy clayey SILT (ML)				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	4.75 mm	Gravel	0.3%	Silt	34.2%
Silt & Clay (% Passing #200)	51.5%	Sand	48.2%	Clay	17.3%
Specific Gravity	2.650	Moisture Content	16.1%	Colloids	9.2%
Liquid Limit	37	Plastic Limit	33	Plastic Index	4

scription of Sand & Gravel Particles Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

chanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

ferences: ASTM D 422: Particle Size Analysis of Soils
TM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
TM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 421: Dry Preparation of Soil Samples
ASTM D 854: Specific Gravity of Soils

chnical Responsibility: Brian Vaughan, P.E. _____ QC Manager
Signature Position

Moisture - Density Relationship

S&ME

S&ME Project #:	**1411-07-103**	Test Date(s):	December 12, 2007
Project Name:	Marshall Steam Station	Report Date:	December 13, 2007
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-3	Sample #:	476	Sample Date:	November 1, 2007
Location:	Bulk	Offset:	N/A	Depth:	10-15'

Sample Description: Brown tan micaceous medium to fine sandy clayey SILT (ML)

Liquid Limit:	37	Specific Gravity:	2.650
Plastic Limit:	33	Plastic Index:	4

Natural Moisture Content: 16.1%

Moisture Content of the Oversize Fraction:

NOTES:

Sieve Size	% Passing
#4	99.7
#10	98.6
#20	95.6
#40	86.2
#60	76.1
#100	65.4
#200	51.5

MDD: 104.5 **Opt. MC %: 17.6**

Water Content

Water Content requires GP 2 Balance (0.1 gram Readability).

ASTM D2216 ☒ AASHTO T265 ☐ ASTM D4959 ☐ ASTM D4643 ☐

	Sample #:	1	2	3	4	5	6
	Water Added:						
	Tare #:						
A. Tare Weight	A.	0	0	0	0	0	0
B. Wet Wt + Tare Wt	B.	500	500	500	500	500	500
C. Dry Wt. + Tare Wt.	C.	432.3	424.1	416.9	410.5	440.4	
D. Water Weight	B-C	67.7	75.9	83.1	89.5	59.6	500
E. Dry Weight	C-A	432.3	424.1	416.9	410.5	440.4	0
F. Moisture Content	100*D/E	**15.7%**	**17.9%**	**19.9%**	**21.8%**	**13.5%**	**#DIV/0!**

Compaction Data

The Compaction Test requires a GP 5 Balance for ASTM (1 gram or .0022 Lb. readability).

G. Wt of Soil + Mold	G.	13.298	13.404	13.432	13.370	13.132	
H. Wt. of Mold	H.	9.304	9.304	9.304	9.304	9.304	9.304
I. Wt. of Soil (g. or lbs.)	G-H	3.994	4.100	4.128	4.066	3.828	-9.304
J. Wt of Soil (Lbs.)	I/453.6 or I	3.994	4.100	4.128	4.066	3.828	-9.304
K. Mold Volume Factor	K.	30.039	30.039	30.039	30.039	30.039	30.039
L. Wet Density	J*K	120.0	123.2	124.0	122.1	115.0	-279.5
M. Dry Density	L/(1+F)	**103.7**	**104.5**	**103.4**	**100.3**	**101.3**	**#DIV/0!**

ASTM D558 ☐ ASTM D 698 ☒ ASTM D1557 ☐ AASHTO T99 ☐ AASHTO T180 ☐

Method A ☒ Method B ☐ Method C ☐ Method D (ASTM 1978) ☐ AASHTO Method D ☐

Moisture-Density Relation of: Fine Fraction ☒ Corrected for Coarse Fraction (ASTM D 4718) ☐

Sieve Size used to separate the Oversize Fraction: #4 Sieve ☒ 3/8 inch Sieve ☐ 3/4 inch Sieve ☐

Mechanical Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

Soil Plasticity:	ASTM D 4318 ☒	AASHTO T 89 ☐		AASHTO T 90 ☐
Sieve Analysis / Particle Size Analysis:	ASTM C136 ☐	AASHTO T 27 ☐	ASTM D 422 ☒	AASHTO T 88 ☐
Specific Gravity of Soil:		ASTM D 854 ☒		AASHTO T 100 ☐
Bulk Gravity of Oversize Fraction:		ASTM C 127 ☐		AASHTO T 85 ☐
Soil Classification:	ASTM D 2487 ☒	ASTM D 2488 ☐		AASHTO M 145 ☐

Technician Name: B. Hatton _____ *Certification #*

Technical Responsibility: Brian Vaughan, P.E. _____ *Signature* Construction Services Manager *Position*

Moisture - Density Report

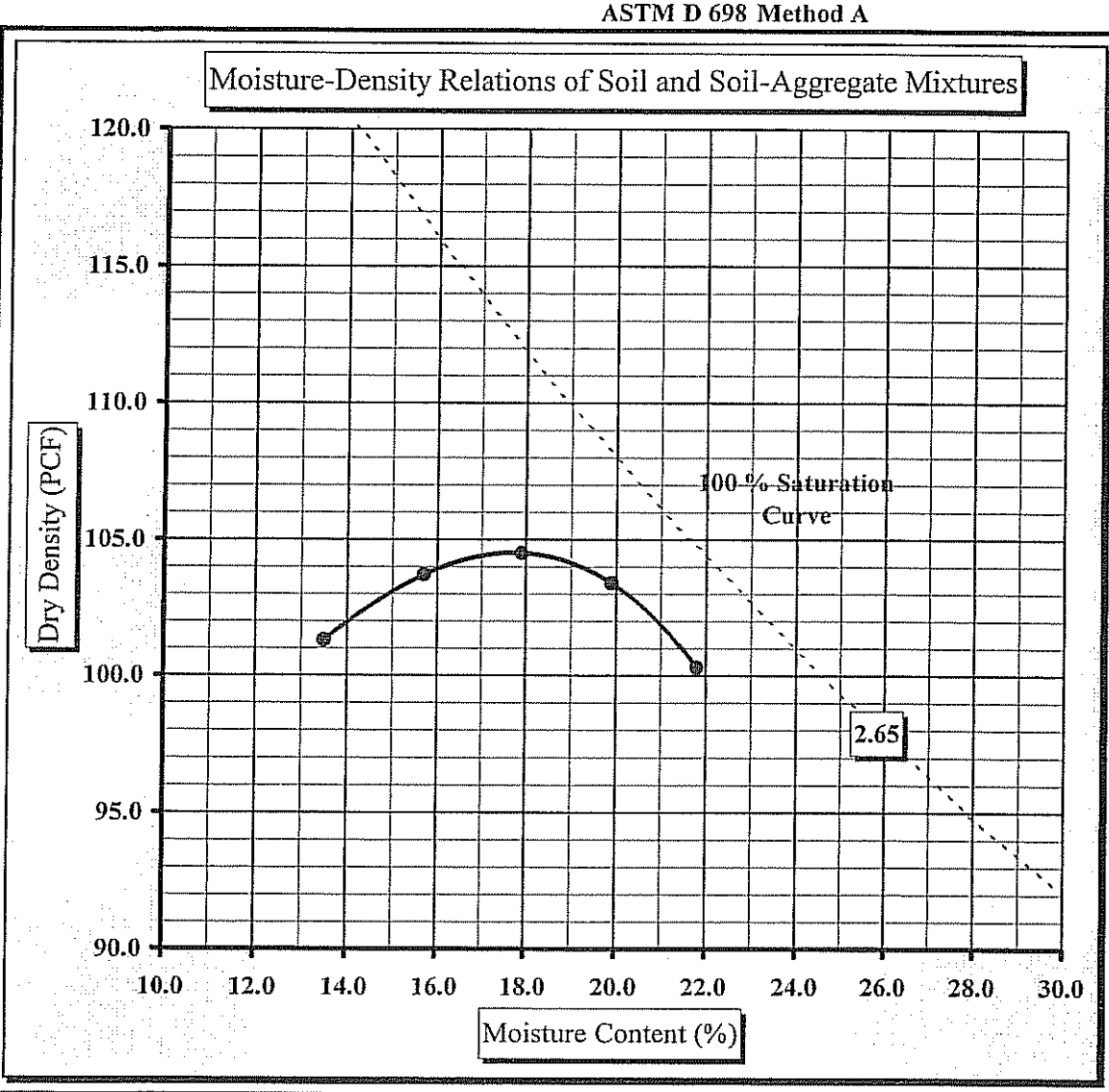
S&ME

S&ME Project #:	**1411-07-103**	Report Date:	December 13, 2007
Project Name:	**Marshall Steam Station**	Test Date(s):	December 12, 2007
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-3	Sample #:	476	Sample Date:	November 1, 2007
Location:	Bulk	Offset:	N/A	Depth:	10-15'
Sample Description:	Brown tan micaceous medium to fine sandy clayey SILT (ML)				

Maximum Dry Density **104.5** **PCF.** **Optimum Moisture Content** **17.6** **%**

ASTM D 698 Method A



Soil Properties

Natural Moisture Content:	16.1%
Liquid Limit:	37
Plastic Limit:	33
Plastic Index:	4
Specific Gravity:	2.650

% Passing

#4	99.7
#10	98.6
#20	95.6
#40	86.2
#60	76.1
#100	65.4
#200	51.5

Oversize Fraction

Bulk Sp. Gravity
% Moisture
Oversize Fraction
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 Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

References: ASTM D 698: Laboratory Compaction Characteristics of Soil Using Standard Effort
ASTM D 2216: Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D 422: Particle Size Analysis of Soils ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. Construction Services Manager

Laboratory Record Version 4.2

S&ME

Liquid Limit, Plastic Limit, and Plastic Index

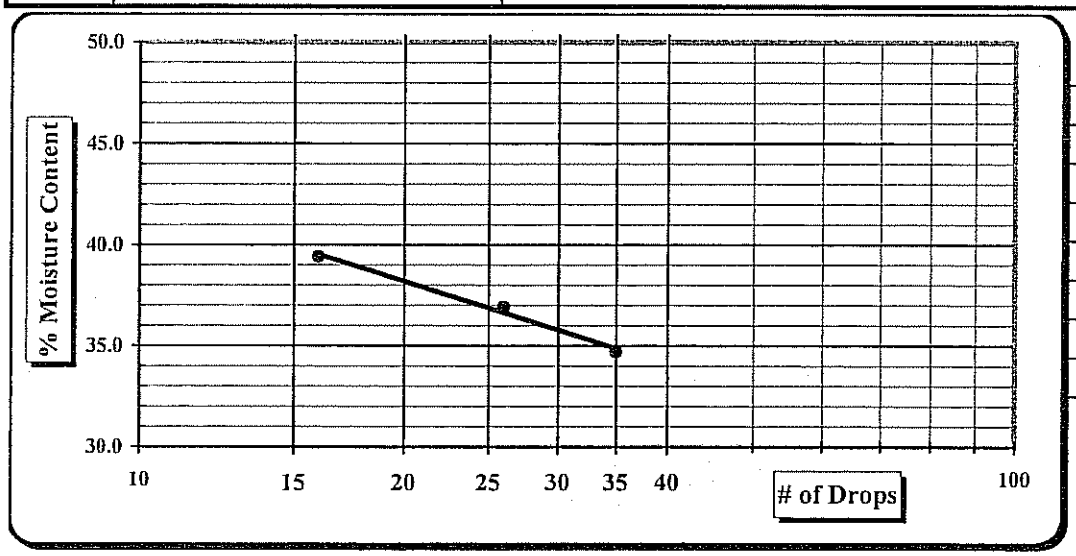
Project #:	**1411-07-103**	Report Date:	12/28/07
Project Name:	Marshall Steam Station	Test Date(s):	12/27/07
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #: M-3 Sample #: 476 Sample Date: 11/1/07

Location: Bulk Offset: N/A Elevation: 10-15'

Sample Description: Brown tan micaceous medium to fine sandy clayey SILT (ML)

Pan #		Liquid Limit						Plastic Limit		
	Test #	1	2	3	4	5	6	1	2	3
	Tare #	Y-1	Y-2	Y-3				5	6	
A	Tare Weight	16.53	16.56	17.00				**10.82**	10.92	
B	Wet Soil Weight + A	39.44	39.78	39.22				17.04	17.31	
C	Dry Soil Weight + A	33.54	33.52	32.94				15.48	15.72	
D	Water Weight (B-C)	5.90	6.26	6.28				1.56	1.59	
E	Dry Soil Weight (C-A)	17.01	16.96	15.94				4.66	4.80	
F	% Moisture Content (D/E)*100	34.7%	36.9%	39.4%				33.5%	33.1%	
N	# OF DROPS	35	26	16				*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average							33.3%		



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes:

Special Sampling Methods:

Sample Preparation:	Wet Preparation	☐	Dry Preparation	☒	Air Dried	☒	
Liquid limit Test:	Multipoint Method	☒	One-point Method	☐			
Classification:	ASTM D 2487	☒	AASHTO M 145	☐			
Liquid limit Test:	ASTM D 4318	☒	AASHTO T 89	☐			
Plastic limit Test:	ASTM D 4318	☒	AASHTO T 90	☐			

% Passing #200 Sieve:	51.5
NP, Non-Plastic	☐
Liquid Limit	37
Plastic Limit	33
Plastic Index	4
Group Symbol	ML

Technician Name: M. Jacobs

Certification #

Technical Responsibility: Brian Vaughan, P.E. QC Manager

Signature *Position*

Particle Size Analysis of Soils

ASTM D 422

S&ME

Project #: **1411-07-103**
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Charlotte, NC

Test Date(s): 4/2 - 4/4/08
Report Date: 4/7/08

Boring #: M-3 Sample #: 85 Sample Date: 11/1/07
Location: sample 9 Offset: N/A Elevation: 42.8-43.5'
Sample Description: Gray brown white micaceous silty medium to fine SAND with p.w.r.

Pan #:	2	Beaker #:	2	**Specific Gravity**	**2.650**
Hydrometer Jar #:			2		
Pan Tare Weight (grams):			0.00		
Total Sample Air Dried Wt. + tare wt. (grams):			184.37		
Weight of Total Sample Air Dried:			184.37		
Weight of Air Dried Hydrometer Sample (g):			102.15		
Total Sample Oven Dried:			183.09		
Hydrometer Sample Oven Dried (W):			101.44		
% Passing #10:			99.5%		
Correction Factor a (Table 1):			1.00		

Moisture Content		Hygroscopic
	Tare #	Z-2
A	Tare Wt.	16.71
B	Wet Wt. + A	31.03
C	Dry Wt. + A	30.93
D	Water Wt. (B-C)	0.10
E	Dry Wt. (C-A)	14.22
	% Moisture (100 x D/E)	0.70%

Sieve	Retained Wt.	Percent Passing	
3.0"	0.0	Pan # (washed) 52	100.0%
1.5"	0.0		100.0%
1.0"	0.0		100.0%
3/4"	0.0		100.0%
1/2"	0.0		100.0%
3/8"	0.0		100.0%
#4	0.0	Soil Mortar	100.0%
#10	0.9	**100.0%**	99.5%
#20	2.0	98.1%	97.6%
#40	12.0	88.2%	87.7%
#60	28.7	71.7%	71.4%
#100	49.7	51.0%	50.7%
#200	73.7	27.4%	27.2%

Notes: Description of Sand & Gravel Particles — Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:	2.00 mm		Total Sand:	72.8%	< 4.74 mm and > 0.075 mm	Type:	Mechanical Stirring Apparatus (A)
% Gravel:	0.0%	< 75 mm and > 4.75 mm	Silt & Clay:	27.2%	< 0.075	Dispersion Time:	1 min.
Coarse Sand:	0.5%	< 4.75 mm and > 2.00 mm	Silt:	23.5%	< 0.075 and > 0.005 mm	Sodium Hexametaphosphate:	40 g./ Liter
Medium Sand:	11.8%	< 2.00 mm and > 0.425 mm	Clay:	3.7%	< 0.005 mm		
Fine Sand:	60.5%	< 0.425 mm and > 0.075 mm	Colloids:	1.8%	< 0.001 mm	**Control Cylinder** ☐	**Composite Correction** ☒

Liquid Limit N/A Plastic Limit N/A Plastic Index N/A Hydrometer: 151H ☐ 152H ☒

Time		Temp.	Hydrometer	Corrections		Hydrometer	Percent Passing		Effective Depth	Table 3	Diameter
Clock	T (Min.)	(0.5 °C)	Reading	Control Cylinder	Composite Correction	R	P(-#10) = (R x a / W) x 100	P (total) = P x % Passing #10	L	K	D = K x ((L/T)^1/2
	2	23.3	19.5		5.05	14.45	14.2%	14.2%	13.9	0.01317	0.03475
	5	23.3	15.5		5.05	10.45	10.3%	10.3%	14.6	0.01317	0.02249
	15	23.3	12.5		5.05	7.45	7.3%	7.3%	15.1	0.01317	0.01320
	30	23.2	11.0		5.10	5.90	5.8%	5.8%	15.3	0.01317	0.00941
	60	23.2	10.0		5.10	4.90	4.8%	4.8%	15.5	0.01317	0.00669
	250	23.0	8.0		5.10	2.90	2.9%	2.8%	15.8	0.01317	0.00331
	1440	23.0	7.0		5.10	1.90	1.9%	1.9%	16.0	0.01317	0.00139
	2880	22.6	7.0		5.15	1.85	1.8%	1.8%	16.0	0.01325	0.00099

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Effective Depth (cm)
L=L1+0.5(L2-(VB/A))
(152H) .164cm per increment,
V_B=67.0cm^3, L_2=14cm, A=27.8cm^2

Technician Name: M. Jacobs
Certification #

Technical Responsibility: Brian Vaughan, P.E.
Signature

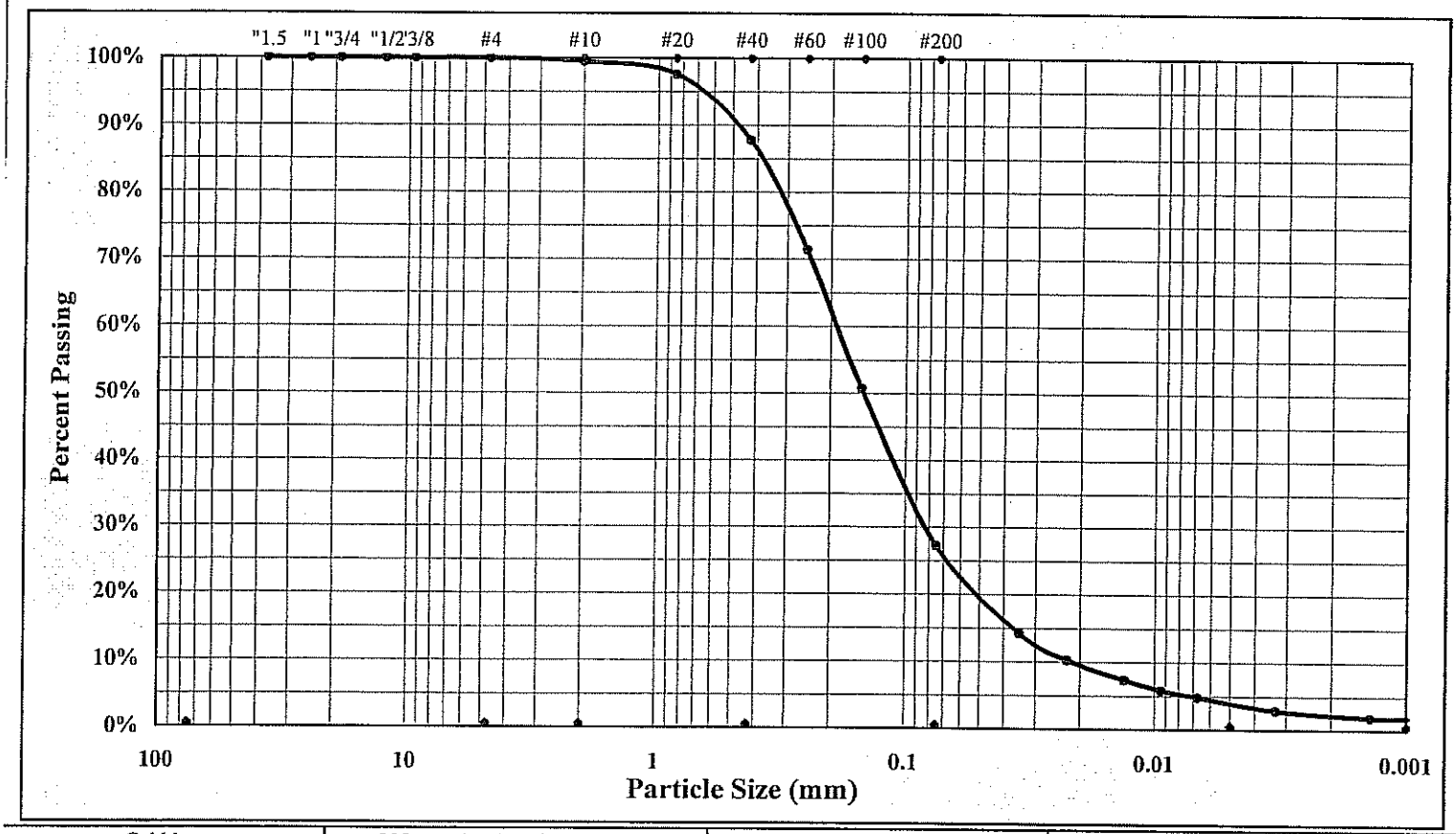
QC Manager
Position

Particle Size Analysis of Soils

ASTM D 422

S&ME Project #:	**1411-07-103**	Report Date:	4/7/08
Project Name:	**Marshall Steam Station**	Test Date(s):	4/2 - 4/4/08
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-3	Sample #:	85	Sample Date:	11/1/07
Location:	sample 9	Offset:	N/A	Elevation:	42.8-43.5'
Sample Description:	Gray brown white micaceous silty medium to fine SAND with p.w.r.				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	2.00 mm	Gravel	0.0%	Silt	23.5%
Silt & Clay (% Passing #200)	27.2%	Sand	72.8%	Clay	3.7%
Specific Gravity	2.650			Colloids	1.8%
Liquid Limit	N/A	Plastic Limit	N/A	Plastic Index	N/A

Description of Sand & Gravel Particles Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Mechanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

References: ASTM D 422: Particle Size Analysis of Soils
ASTM D 421: Dry Preparation of Soil Samples
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 854: Specific Gravity of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. _____ QC Manager

Signature *Position*

Particle Size Analysis of Soils

ASTM D 422

S&ME

Project #: **1411-07-103**
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Charlotte, NC

Test Date(s): 12/19 - 12/21/07
Report Date: 12/26/07

Boring #: M-4 Sample #: 492 Sample Date: 11/29/07
Location: Bulk Offset: N/A Elevation: 0-5'
Sample Description: Red brown silty CLAY with fine sand (CH)

Pan #:	1	Beaker #:	1
Hydrometer Jar #:			1
Pan Tare Weight (grams):			0.00
Total Sample Air Dried Wt. + tare wt. (grams):			449.76
Weight of Total Sample Air Dried:			449.76
Weight of Air Dried Hydrometer Sample (g):			52.83
Total Sample Oven Dried:			434.30
Hydrometer Sample Oven Dried (W):			50.92
% Passing #10:			94.8%
Correction Factor a (Table 1):			1.00

Specific Gravity **2.650**

	Moisture Content	Hygroscopic	Natural
	Tare #	Q-1	341
A	Tare Wt.	16.81	0.00
B	Wet Wt. + A	30.08	248.12
C	Dry Wt. + A	29.60	201.86
D	Water Wt. (B-C)	0.48	46.26
E	Dry Wt. (C-A)	12.79	201.86
	% Moisture (100 x D/E)	3.75%	22.9%

Sieve	Retained Wt.	Percent Passing	
3.0"	0.0	Pan # (washed)	100.0%
1.5"	0.0		100.0%
1.0"	0.0		100.0%
3/4"	0.0	51	100.0%
1/2"	0.0		100.0%
3/8"	1.7		99.6%
#4	10.3	Soil Mortar	97.6%
#10	22.4	**100.0%**	94.8%
#20	0.9	98.2%	93.1%
#40	2.0	96.1%	91.1%
#60	3.6	93.0%	88.2%
#100	6.9	86.5%	82.0%
#200	12.9	74.7%	70.9%

Notes: Description of Sand & Gravel Particles — Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:	9.50 mm		Total Sand:	26.8%	< 4.74 mm and > 0.075 mm	Type:	Mechanical Stirring Apparatus (A)
% Gravel:	2.4%	< 75 mm and > 4.75 mm	Silt & Clay:	70.9%	< 0.075	Dispersion Time:	1 min.
Coarse Sand:	2.8%	< 4.75 mm and > 2.00 mm	Silt:	25.9%	< 0.075 and > 0.005 mm	Sodium Hexametaphosphate:	40 g./ Liter
Medium Sand:	3.7%	< 2.00 mm and > 0.425 mm	Clay:	45.0%	< 0.005 mm		
Fine Sand:	20.3%	< 0.425 mm and > 0.075 mm	Colloids:	33.2%	< 0.001 mm	**Control Cylinder** ☐	**Composite Correction** ☒

Liquid Limit **53** Plastic Limit **28** Plastic Index **25** Hydrometer: 151H ☐ 152H ☒

Time		Temp.	Hydrometer	Corrections		Hydrometer	Percent Passing		Effective Depth	Table 3	Diameter
Clock	T (Min.)	(0.5 °C)	Reading	Control Cylinder	Composite Correction	R	P(-#10) = (R x a / W) x 100	P (total) = P x % Passing #10	L	K	D = K x ((L/T)^1/2
	2	22.0	39.0		5.20	33.80	66.4%	63.0%	10.8	0.01332	0.03088
	5	22.0	37.0		5.20	31.80	62.5%	59.2%	11.1	0.01332	0.01983
	15	22.0	34.5		5.20	29.30	57.5%	54.6%	11.5	0.01332	0.01166
	30	22.0	32.5		5.20	27.30	53.6%	50.9%	11.8	0.01332	0.00836
	60	22.0	30.5		5.20	25.30	49.7%	47.1%	12.1	0.01332	0.00599
	250	22.5	27.0		5.15	21.85	42.9%	40.7%	12.7	0.01325	0.00299
	1440	21.5	24.0		5.25	18.75	36.8%	34.9%	13.2	0.01340	0.00128
	2880	21.3	23.0		5.25	17.75	34.9%	33.1%	13.4	0.01348	0.00092

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Effective Depth (cm)
L=L1+0.5(L2-(VB/A))
(152H) .164cm per increment,
V_B=67.0cm^3, L_2=14cm, A=27.8cm^2

Technician Name: M. Jacobs
Certification #

Technical Responsibility: Brian Vaughan, P.E.
Signature

OC Manager
Position

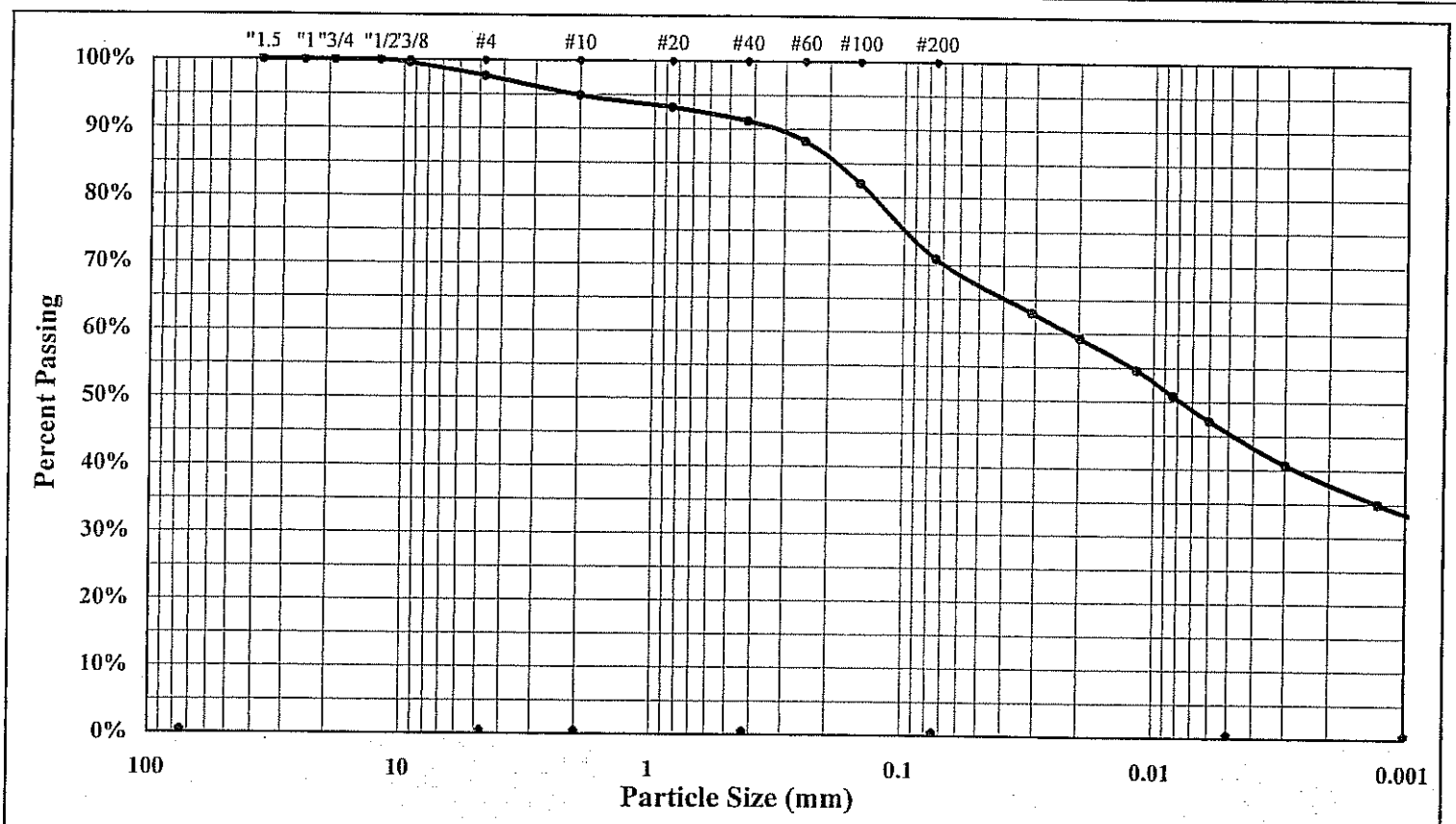
Laboratory Report Version 4.2

Particle Size Analysis of Soils

ASTM D 422

S&ME Project #:	**1411-07-103**	Report Date:	12/26/07
Project Name:	**Marshall Steam Station**	Test Date(s):	12/19 - 12/21/07
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-4	Sample #:	492	Sample Date:	11/29/07
Location:	Bulk	Offset:	N/A	Elevation:	0-5'
Sample Description:	Red brown silty CLAY with fine sand (CH)				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	9.50 mm	Gravel	2.4%	Silt	25.9%
Silt & Clay (% Passing #200)	70.9%	Sand	26.8%	Clay	45.0%
Specific Gravity	2.650	Moisture Content	22.9%	Colloids	33.2%
Liquid Limit	53	Plastic Limit	28	Plastic Index	25

Description of Sand & Gravel Particles Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Mechanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

References: ASTM D 422: Particle Size Analysis of Soils
ASTM D 421: Dry Preparation of Soil Samples
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 854: Specific Gravity of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. _____ QC Manager

Signature Position

Moisture - Density Relationship

S&ME

S&ME Project #:	**1411-07-103**	Test Date(s):	January 4, 2008
Project Name:	Marshall Steam Station	Report Date:	January 7, 2008
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-4	Sample #:	492	Sample Date:	November 29, 2007
Location:	Bulk	Offset:	N/A	Depth:	0-5'

Sample Description: Red brown silty CLAY with fine sand (CH)

Liquid Limit:	53	Specific Gravity:	2.650
Plastic Limit:	28	Plastic Index:	25

Natural Moisture Content: 22.9%

Moisture Content of the Oversize Fraction:

NOTES:

Sieve Size	% Passing
3/8"	99.6
#4	97.6
#10	94.8
#20	93.1
#40	91.1
#60	88.2
#100	82.0
#200	70.9

MDD: 96.5 **Opt. MC %:** 24.1

Water Content

Water Content requires GP 2 Balance (0.1 gram Readability).

ASTM D2216 ☒ AASHTO T265 ☐ ASTM D4959 ☐ ASTM D4643 ☐

	Sample #:	1	2	3	4	5	6
	Water Added:						
	Tare #:						
A. Tare Weight	A.	0	0	0	0	0	0
B. Wet Wt + Tare Wt	B.	500	500	500	500	500	500
C. Dry Wt. + Tare Wt.	C.	415.4	408.6	402.4	396.1		
D. Water Weight	B-C	84.6	91.4	97.6	103.9	500	500
E. Dry Weight	C-A	415.4	408.6	402.4	396.1	0	0
F. Moisture Content	100*D/E	**20.4%**	**22.4%**	**24.3%**	**26.2%**	**#DIV/0!**	**#DIV/0!**

Compaction Data

The Compaction Test requires a GP 5 Balance for ASTM (1 gram or .0022 Lb. readability).

G. Wt of Soil + Mold	G.	13.100	13.212	13.296	13.278		
H. Wt. of Mold	H.	9.304	9.304	9.304	9.304	9.304	9.304
I. Wt. of Soil (g. or lbs.)	G-H	3.796	3.908	3.992	3.974	-9.304	-9.304
J. Wt of Soil (Lbs.)	I/453.6 or I	3.796	3.908	3.992	3.974	-9.304	-9.304
K. Mold Volume Factor	K.	30.039	30.039	30.039	30.039	30.039	30.039
L. Wet Density	J*K	114.0	117.4	119.9	119.4	-279.5	-279.5
M. Dry Density	L/(1+F)	**94.7**	**95.9**	**96.5**	**94.6**	**#DIV/0!**	**#DIV/0!**

ASTM D558 ☐ ASTM D 698 ☒ ASTM D1557 ☐ AASHTO T99 ☐ AASHTO T180 ☐

Method A ☒ Method B ☐ Method C ☐ Method D (ASTM 1978) ☐ AASHTO Method D ☐

Moisture-Density Relation of: Fine Fraction ☒ Corrected for Coarse Fraction (ASTM D 4718) ☐

Sieve Size used to separate the Oversize Fraction: #4 Sieve ☒ 3/8 inch Sieve ☐ 3/4 inch Sieve ☐

Mechanical Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

Soil Plasticity: ASTM D 4318 ☒ AASHTO T 89 ☐ AASHTO T 90 ☐

Sieve Analysis / Particle Size Analysis: ASTM C136 ☐ AASHTO T 27 ☐ ASTM D 422 ☒ AASHTO T 88 ☐

Specific Gravity of Soil: ASTM D 854 ☒ AASHTO T 100 ☐

Bulk Gravity of Oversize Fraction: ASTM C 127 ☐ AASHTO T 85 ☐

Soil Classification: ASTM D 2487 ☒ ASTM D 2488 ☐ AASHTO M 145 ☐

Technician Name: B. Hatton

Certification #

Technical Responsibility: Brian Vaughan, P.E. Signature Construction Services Manager Position

Moisture - Density Report

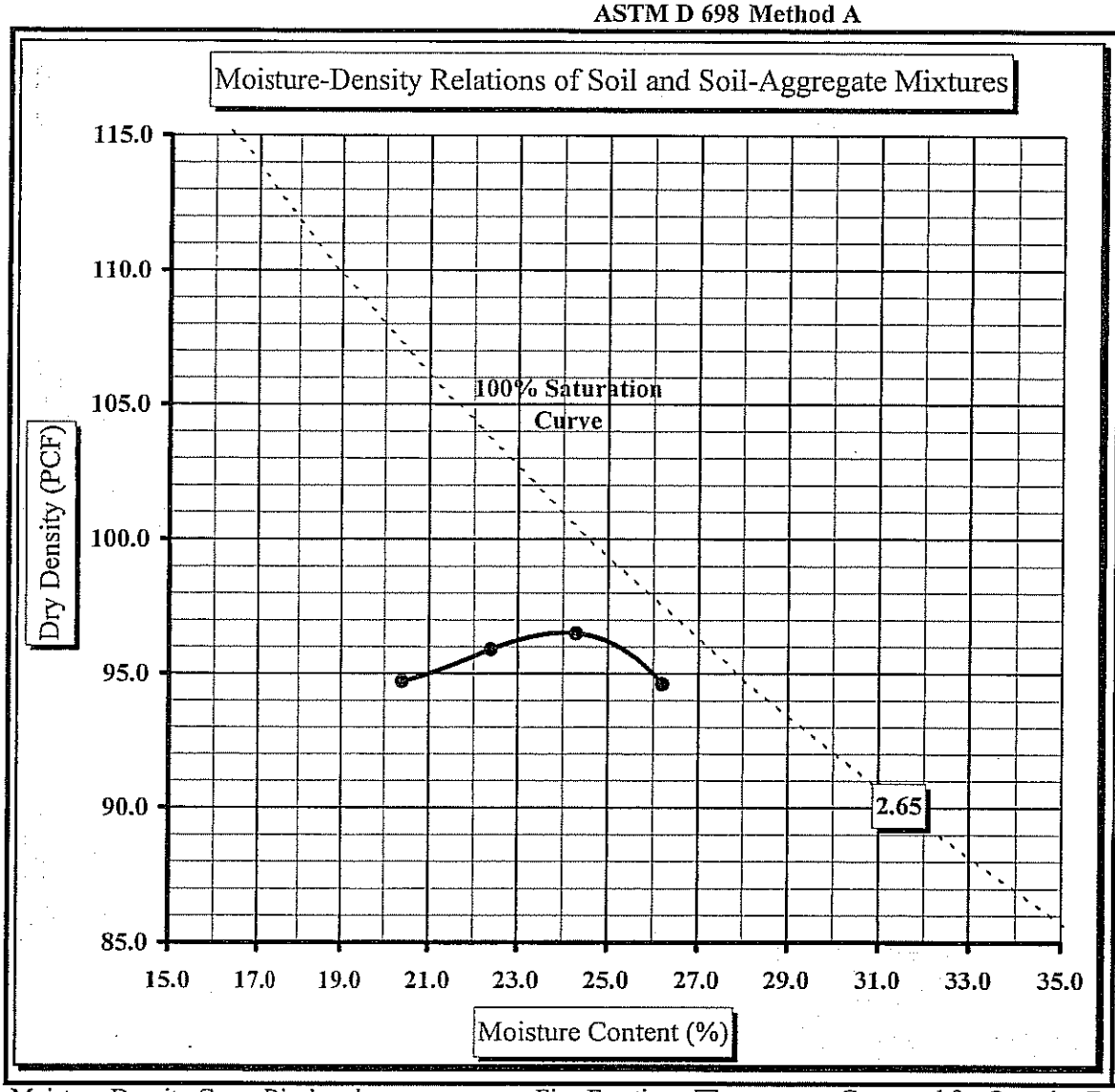
S&ME

S&ME Project #:	**1411-07-103**	Report Date:	January 7, 2008
Project Name:	**Marshall Steam Station**	Test Date(s):	January 4, 2008
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-4	Sample #:	492	Sample Date:	November 29, 2007
Location:	Bulk	Offset:	N/A	Depth:	0-5'
Sample Description:	Red brown silty CLAY with fine sand (CH)				

Maximum Dry Density **96.5** **PCF.** **Optimum Moisture Content** **24.1** **%**

ASTM D 698 Method A



Soil Properties

Natural Moisture Content:	22.9%
Liquid Limit:	53
Plastic Limit:	28
Plastic Index:	25
Specific Gravity:	2.650

% Passing	
3/8"	99.6
#4	97.6
#10	94.8
#20	93.1
#40	91.1
#60	88.2
#100	82.0
#200	70.9

Oversize Fraction

Bulk Sp. Gravity
% Moisture
Oversize Fraction
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 Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

References: ASTM D 698: Laboratory Compaction Characteristics of Soil Using Standard Effort
ASTM D 2216: Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D 422: Particle Size Analysis of Soils ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. Construction Services Manager

S&ME

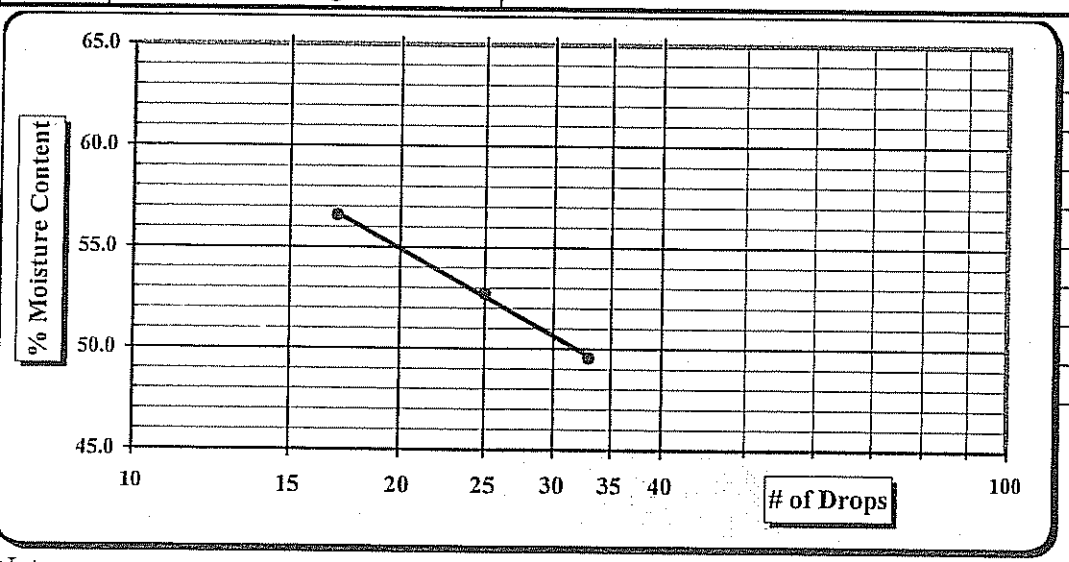
Liquid Limit, Plastic Limit, and Plastic Index

Project #: **1411-07-103**
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Charlotte, NC

Report Date: 1/24/08
Test Date(s): 1/23/08

Boring #: M-4 Sample #: 492 Sample Date: 11/29/07
Location: Bulk Offset: N/A Elevation: 0-5'
Sample Description: Red brown silty CLAY with fine sand (CH)

Pan #		Liquid Limit						Plastic Limit		
	Test #	1	2	3	4	5	6	1	2	3
	Tare #	Y-4	Y-5	Y-6				13	14	
A	Tare Weight	16.87	16.79	15.91				12.10	12.16	
B	Wet Soil Weight + A	35.92	36.75	36.42				19.15	18.93	
C	Dry Soil Weight + A	29.61	29.86	29.01				17.59	17.45	
D	Water Weight (B-C)	6.31	6.89	7.41				1.56	1.48	
E	Dry Soil Weight (C-A)	12.74	13.07	13.10				5.49	5.29	
F	% Moisture Content (D/E)*100	49.5%	52.7%	56.6%				28.4%	28.0%	
N	# OF DROPS	33	25	17				*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average							28.2%		



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes:

Special Sampling Methods:

Sample Preparation:	Wet Preparation ☐	Dry Preparation ☒	Air Dried ☒	% Passing #200 Sieve:	70.9
Liquid limit Test:	Multipoint Method ☒	One-point Method ☐		NP, Non-Plastic	☐
Classification:	ASTM D 2487 ☒	AASHTO M 145 ☐		Liquid Limit	53
Liquid limit Test:	ASTM D 4318 ☒	AASHTO T 89 ☐		Plastic Limit	28
Plastic limit Test:	ASTM D 4318 ☒	AASHTO T 90 ☐		Plastic Index	25
				Group Symbol	CH

Technician Name: M. Jacobs
Certification #

Technical Responsibility: Brian Vaughan, P.E. Signature QC Manager Position

CONSTANT HEAD PERMEABILITY

ASTM D5084

S&ME Project Number: 1411-07-103 Project Name: Marshall Steam Station 3/1/2008

Sample Name: M-4 492 (0-5')

Sample Description: Red Brown Silty Clay w/Fine Sand (CH)

Type of Sample: Remolded

Sample Data		Molding Moisture Content		Target Molding Conditon				Additonal Data	
Diam. (cm)	7.275	Tare No.	S-7	γ_{wet} (pcf)	116.1			Panel No	9
Leng. (cm)	7.699	WWS+ Tare (gm)	338.61	γ_{dry} (pcf)	91.7			Cell P (psi)	82.5
Area (cm^2)	41.57	WDS+Tare (gm)	285.03	w (%)	26.6			Influent P (psi)	80.1
Vol. (cm^3)	320.03	WT of Water (gm)	53.58	Actual Molding Condition				Effluent P (psi)	80.0
WWS (gm)	590.7	WT of TARE (gm)	81.55	γ_{wet} (pcf)	115.3				
		WT Dry Soil (gm)	203.48	γ_{dry} (pcf)	91.3			Gradient	0.9
		w (%)	26.3	w (%)	26.3				

K = (Q x L) / (t x H x A)

Run	Temp. (°C)	Hour	Minute	Time, t (sec)	Cell Burette (cc)	Influent Burette(cc)	Effluent Burette (cc)	Q (cc)	Δ H (cm)	Temp Corr.	K(cm/sec)
1		14	41		13.4	0.7	23.7				
	22	16	0	4740	13.4	1.0	23.4	0.3	7.0	0.9530	1.59E-06
2		9	3		13.5	1.0	23.4				
	22	13	9	14760	13.6	1.2	23.3	0.1	7.0	0.9530	2.55E-07
3		13	10		13.6	0.1	24.4				
	22	17	38	16080	13.6	0.3	24.2	0.2	7.0	0.9530	3.12E-07
4		9	13		13.6	0.3	24.2				
	22	11	50	9420	13.6	0.4	24.1	0.1	7.0	0.9530	2.66E-07
5		11	51		13.6	0.8	24.3				
	22	17	53	21720	13.6	1.1	24.0	0.3	7.0	0.9530	3.46E-07
6										Ave. K (cm/sec)	2.95E-07
										(Runs 2 thru 5)	
										Ave. K (m/sec)	2.95E-09

Particle Size Analysis of Soils

ASTM D 422

S&ME

Project #: **1411-07-103**
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Charlotte, NC

Test Date(s): 12/19 - 12/21/07
Report Date: 12/26/07

Boring #: M-4 Sample #: 492 Sample Date: 11/29/07
Location: Bulk Offset: N/A Elevation: 5-10'
Sample Description: Red orange brown fine sandy clayey SILT (ML)

Pan #:	2	Beaker #:	2
Hydrometer Jar #:			2
Pan Tare Weight (grams):			0.00
Total Sample Air Dried Wt. + tare wt. (grams):			463.43
Weight of Total Sample Air Dried:			463.43
Weight of Air Dried Hydrometer Sample (g):			52.34
Total Sample Oven Dried:			454.89
Hydrometer Sample Oven Dried (W):			51.35
% Passing #10:			97.1%
Correction Factor a (Table 1):			1.00

Specific Gravity 2.650

	Moisture Content	Hygroscopic	Natural
	Tare #	Q-2	349
A	Tare Wt.	16.78	0.00
B	Wet Wt. + A	29.44	243.98
C	Dry Wt. + A	29.20	209.56
D	Water Wt. (B-C)	0.24	34.42
E	Dry Wt. (C-A)	12.42	209.56
	% Moisture (100 x D/E)	1.93%	16.4%

Sieve	Retained Wt.	Percent Passing	
3.0"	0.0	Pan # (washed) 52	100.0%
1.5"	0.0		100.0%
1.0"	0.0		100.0%
3/4"	0.0		100.0%
1/2"	0.0		100.0%
3/8"	0.0		100.0%
#4	2.9	Soil Mortar	99.4%
#10	13.2	**100.0%**	97.1%
#20	0.8	98.5%	95.7%
#40	1.9	96.4%	93.6%
#60	3.9	92.4%	89.7%
#100	8.4	83.7%	81.2%
#200	15.7	69.5%	67.5%

Notes: Description of Sand & Gravel Particles — Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:	4.75 mm	
% Gravel:	0.6%	< 75 mm and > 4.75 mm
Coarse Sand:	2.3%	< 4.75 mm and > 2.00 mm
Medium Sand:	3.5%	< 2.00 mm and > 0.425 mm
Fine Sand:	26.1%	< 0.425 mm and > 0.075 mm

Total Sand:	31.9%	< 4.74 mm and > 0.075 mm
Silt & Clay:	67.5%	< 0.075
Silt:	30.5%	< 0.075 and > 0.005 mm
Clay:	37.0%	< 0.005 mm
Colloids:	22.3%	< 0.001 mm

Type: Mechanical Stirring Apparatus (A)
Dispersion Time: 1 min.
Sodium Hexametaphosphate: 40 g./ Liter

Liquid Limit **45** Plastic Limit **28** Plastic Index **17**

Control Cylinder ☐ **Composite Correction** ☒
Hydrometer: 151H ☐ 152H ☒

Time		Temp.	Hydrometer	Corrections		Hydrometer	Percent Passing		Effective Depth	Table 3	Diameter
Clock	T (Min.)	(0.5 °C)	Reading	Control Cylinder	Composite Correction	R	P(-#10) = (R x a / W) x 100	P (total) = P x % Passing #10	L	K	D = K x ((L/T)^1/2
	2	22.0	36.5		5.20	31.30	61.0%	59.2%	11.2	0.01332	0.03147
	5	22.0	34.0		5.20	28.80	56.1%	54.5%	11.6	0.01332	0.02026
	15	22.0	30.5		5.20	25.30	49.3%	47.8%	12.1	0.01332	0.01199
	30	22.0	28.0		5.20	22.80	44.4%	43.1%	12.6	0.01332	0.00862
	60	22.1	26.0		5.20	20.80	40.5%	39.3%	12.9	0.01332	0.00617
	250	22.6	22.0		5.15	16.85	32.8%	31.9%	13.5	0.01325	0.00308
	1440	21.5	18.0		5.25	12.75	24.8%	24.1%	14.2	0.01340	0.00133
	2880	21.3	17.0		5.25	11.75	22.9%	22.2%	14.4	0.01348	0.00095

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Effective Depth (cm)
L=L1+0.5(L2-(VB/A))
(152H) .164cm per increment,
V_B=67.0cm^3, L_2=14cm, A=27.8cm^2

Technician Name: M. Jacobs

Technical Responsibility: Brian Vaughan, P.E.

Certification #

Signature

QC Manager
Position

S&ME, INC.
155 Tradd Street Spartanburg, SC 29301

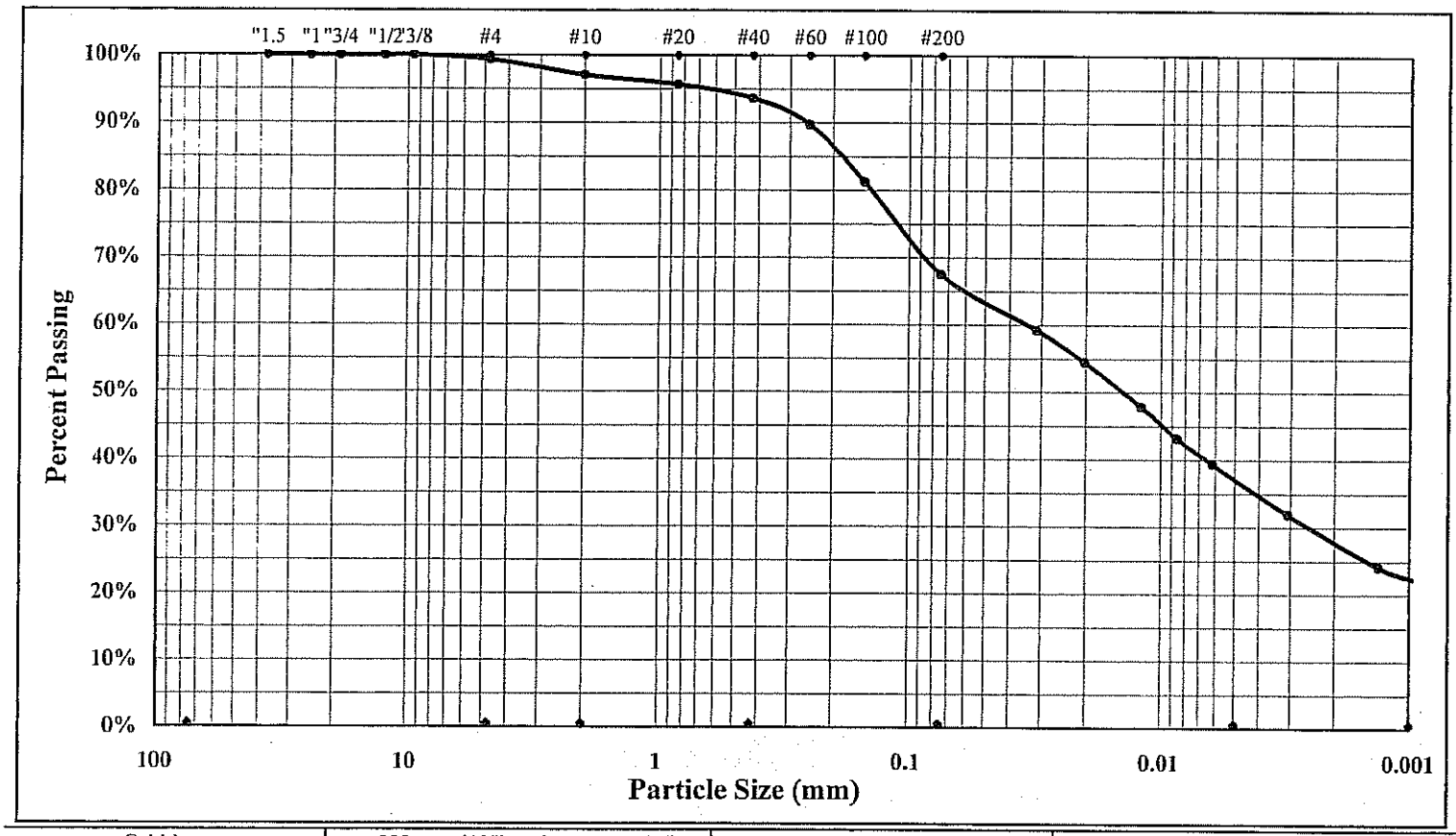
Hydrometer #492 (M-4, 5-10') 12-26-07.xls

Particle Size Analysis of Soils

ASTM D 422

S&ME Project #:	**1411-07-103**	Report Date:	12/26/07
Project Name:	**Marshall Steam Station**	Test Date(s):	12/19 - 12/21/07
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-4	Sample #:	492	Sample Date:	11/29/07
Location:	Bulk	Offset:	N/A	Elevation:	5-10'
Sample Description:	Red orange brown fine sandy clayey SILT (ML)				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	4.75 mm	Gravel	0.6%	Silt	30.5%
Silt & Clay (% Passing #200)	67.5%	Sand	31.9%	Clay	37.0%
Specific Gravity	2.650	Moisture Content	16.4%	Colloids	22.3%
Liquid Limit	45	Plastic Limit	28	Plastic Index	17

Description of Sand & Gravel Particles Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Mechanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./Liter

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 854: Specific Gravity of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. _____ QC Manager
Signature *Position*

Moisture - Density Relationship

S&ME

S&ME Project #:	**1411-07-103**	Test Date(s):	January 4, 2008
Project Name:	Marshall Steam Station	Report Date:	January 7, 2008
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-4	Sample #:	492	Sample Date:	November 29, 2007
Location:	Bulk	Offset:	N/A	Depth:	5-10'

Sample Description: Red orange brown fine sandy clayey SILT (ML)

Liquid Limit:	45	Specific Gravity:	2.650
Plastic Limit:	28	Plastic Index:	17

Natural Moisture Content: 16.4%

Moisture Content of the Oversize Fraction:

NOTES:

MDD: 105.0 **Opt. MC %: 18.7**

Sieve Size	% Passing
#4	99.4
#10	97.1
#20	95.7
#40	93.6
#60	89.7
#100	81.2
#200	67.5

Water Content

Water Content requires GP 2 Balance (0.1 gram Readability).

ASTM D2216 ☒ AASHTO T265 ☐ ASTM D4959 ☐ ASTM D4643 ☐

	Sample #:	1	2	3	4	5	6
	Water Added:						
	Tare #:						
A. Tare Weight	A.	0	0	0	0	0	0
B. Wet Wt + Tare Wt	B.	500	500	500	500	500	500
C. Dry Wt. + Tare Wt.	C.	430.4	422.8	416.1	409		
D. Water Weight	B-C	69.6	77.2	83.9	91	500	500
E. Dry Weight	C-A	430.4	422.8	416.1	409	0	0
F. Moisture Content	100*D/E	**16.2%**	**18.3%**	**20.2%**	**22.2%**	**#DIV/0!**	**#DIV/0!**

Compaction Data

The Compaction Test requires a GP 5 Balance for ASTM (1 gram or .0022 Lb. readability).

G. Wt of Soil + Mold	G.	13.308	13.432	13.476	13.418		
H. Wt. of Mold	H.	9.304	9.304	9.304	9.304	9.304	9.304
I. Wt. of Soil (g. or lbs.)	G-H	4.004	4.128	4.172	4.114	-9.304	-9.304
J. Wt of Soil (Lbs.)	I/453.6 or I	4.004	4.128	4.172	4.114	-9.304	-9.304
K. Mold Volume Factor	K.	30.039	30.039	30.039	30.039	30.039	30.039
L. Wet Density	J*K	120.3	124.0	125.3	123.6	-279.5	-279.5
M. Dry Density	L/(1+F)	**103.5**	**104.9**	**104.3**	**101.1**	**#DIV/0!**	**#DIV/0!**

ASTM D558 ☐ ASTM D 698 ☒ ASTM D1557 ☐ AASHTO T99 ☐ AASHTO T180 ☐

Method A ☒ Method B ☐ Method C ☐ Method D (ASTM 1978) ☐ AASHTO Method D ☐

Moisture-Density Relation of: Fine Fraction ☒ Corrected for Coarse Fraction (ASTM D 4718) ☐

Sieve Size used to separate the Oversize Fraction: #4 Sieve ☒ 3/8 inch Sieve ☐ 3/4 inch Sieve ☐

Mechanical Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

Soil Plasticity: ASTM D 4318 ☒ AASHTO T 89 ☐ AASHTO T 90 ☐

Sieve Analysis / Particle Size Analysis: ASTM C136 ☐ AASHTO T 27 ☐ ASTM D 422 ☒ AASHTO T 88 ☐

Specific Gravity of Soil: ASTM D 854 ☒ AASHTO T 100 ☐

Bulk Gravity of Oversize Fraction: ASTM C 127 ☐ AASHTO T 85 ☐

Soil Classification: ASTM D 2487 ☒ ASTM D 2488 ☐ AASHTO M 145 ☐

Technician Name: B. Hatton

Certification #

Technical Responsibility: Brian Vaughan, P.E. Signature Construction Services Manager Position

Moisture - Density Report

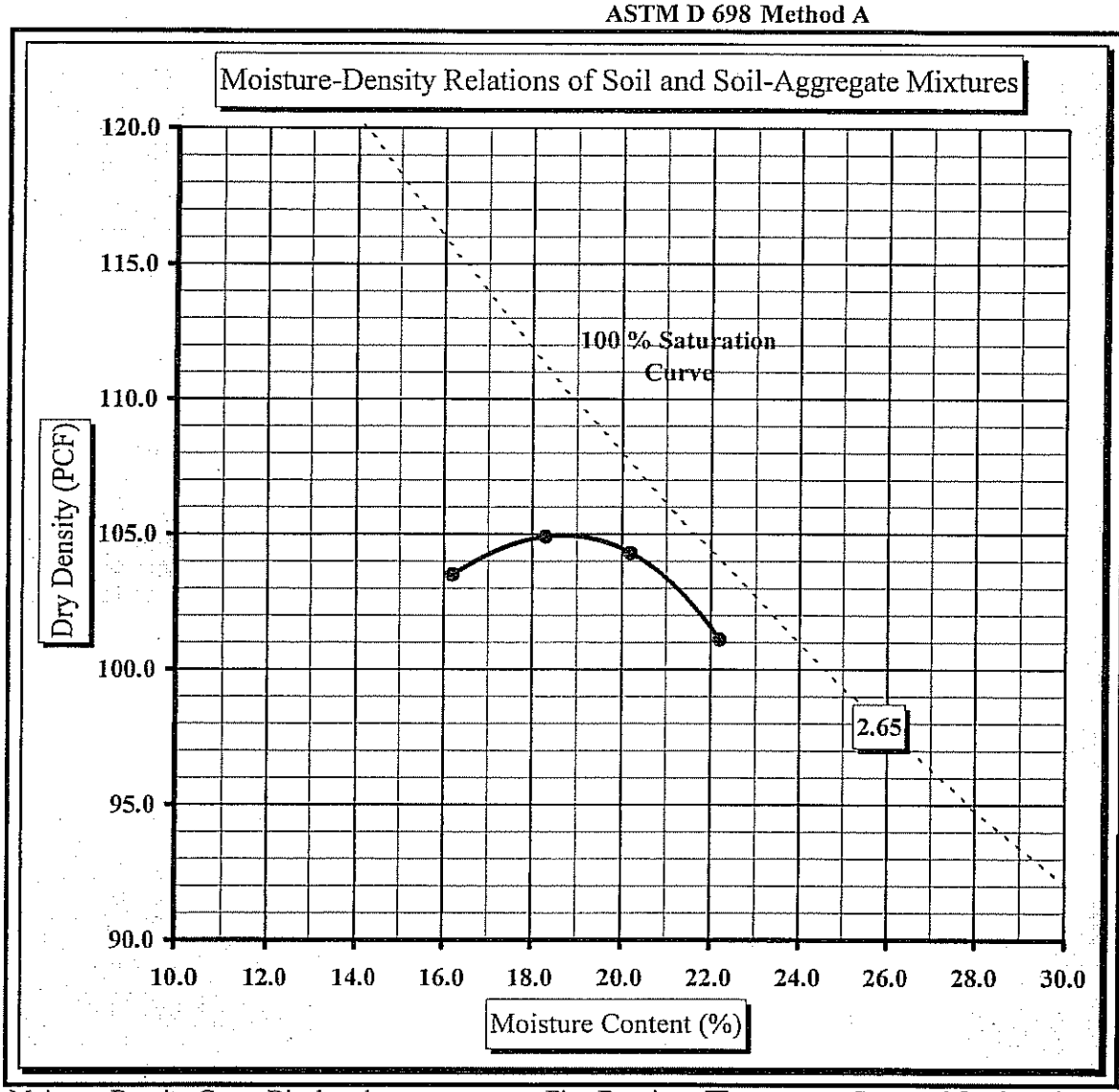
S&ME

S&ME Project #:	**1411-07-103**	Report Date:	January 7, 2008
Project Name:	**Marshall Steam Station**	Test Date(s):	January 4, 2008
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-4	Sample #:	492	Sample Date:	November 29, 2007
Location:	Bulk	Offset:	N/A	Depth:	5-10'
Sample Description:	Red orange brown fine sandy clayey SILT (ML)				

Maximum Dry Density **105.0** **PCF.** **Optimum Moisture Content** **18.7** **%**

ASTM D 698 Method A



Soil Properties

Natural Moisture Content:	16.4%
Liquid Limit:	45
Plastic Limit:	28
Plastic Index:	17
Specific Gravity:	2.650

% Passing

#4	99.4
#10	97.1
#20	95.7
#40	93.6
#60	89.7
#100	81.2
#200	67.5

Oversize Fraction

Bulk Sp. Gravity
% Moisture
Oversize Fraction
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 Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

References: ASTM D 698: Laboratory Compaction Characteristics of Soil Using Standard Effort
ASTM D 2216: Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D 422: Particle Size Analysis of Soils ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. Construction Services Manager

S&ME

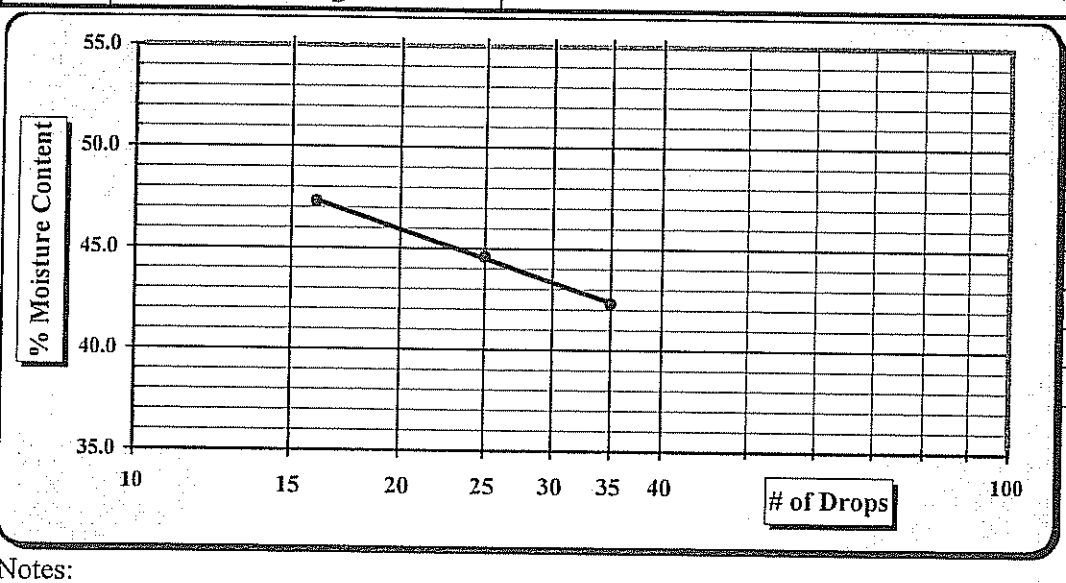
Liquid Limit, Plastic Limit, and Plastic Index

Project #: **1411-07-103**
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Charlotte, NC

Report Date: 1/24/08
Test Date(s): 1/23/08

Boring #: M-4 Sample #: 492 Sample Date: 11/29/07
Location: Bulk Offset: N/A Elevation: 5-10'
Sample Description: Red orange brown fine sandy clayey SILT (ML)

Pan #		Liquid Limit						Plastic Limit		
	Test #	1	2	3	4	5	6	1	2	3
	Tare #	Z-4	Z-5	Z-6				18	22	
A	Tare Weight	15.80	15.62	16.91				**12.11**	11.92	
B	Wet Soil Weight + A	36.69	36.24	35.94				19.94	19.70	
C	Dry Soil Weight + A	30.48	29.88	29.83				18.23	18.02	
D	Water Weight (B-C)	6.21	6.36	6.11				1.71	1.69	
E	Dry Soil Weight (C-A)	14.68	14.26	12.92				6.12	6.10	
F	% Moisture Content (D/E)*100	42.3%	44.6%	47.3%				27.9%	27.6%	
N	# OF DROPS	35	25	16				*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average							27.8%		



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes:

Special Sampling Methods:

Sample Preparation:	Wet Preparation ☐	Dry Preparation ☒	Air Dried ☒	% Passing #200 Sieve:	67.5
Liquid limit Test:	Multipoint Method ☒	One-point Method ☐		NP, Non-Plastic	☐
Classification:	ASTM D 2487 ☒	AASHTO M 145 ☐		Liquid Limit	45
Liquid limit Test:	ASTM D 4318 ☒	AASHTO T 89 ☐		Plastic Limit	28
Plastic limit Test:	ASTM D 4318 ☒	AASHTO T 90 ☐		Plastic Index	17
				Group Symbol	ML

Technician Name: M. Jacobs

Certification #

Technical Responsibility: Brian Vaughan, P.E. Signature QC Manager Position

Particle Size Analysis of Soils

ASTM D 422

S&ME

Project #: 1411-07-103
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Charlotte, NC

Test Date(s): 12/19 - 12/21/07
Report Date: 12/26/07

Boring #: M-4 Sample #: 492 Sample Date: 11/29/07
Location: Bulk Offset: N/A Elevation: 10-15'
Sample Description: Red orange brown fine sandy clayey SILT (ML)

Pan #:	3	Beaker #:	3
Hydrometer Jar #:			3
Pan Tare Weight (grams):			0.00
Total Sample Air Dried Wt. + tare wt. (grams):			455.34
Weight of Total Sample Air Dried:			455.34
Weight of Air Dried Hydrometer Sample (g):			53.01
Total Sample Oven Dried:			447.35
Hydrometer Sample Oven Dried (W):			52.05
% Passing #10:			97.0%
Correction Factor a (Table 1):			1.00

Specific Gravity 2.650

	Moisture Content	Hygroscopic	Natural
	Tare #	Q-3	350
A	Tare Wt.	15.76	0.00
B	Wet Wt. + A	29.04	243.09
C	Dry Wt. + A	28.80	209.35
D	Water Wt. (B-C)	0.24	33.74
E	Dry Wt. (C-A)	13.04	209.35
	% Moisture (100 x D/E)	1.84%	16.1%

Sieve	Retained Wt.	Percent Passing	
3.0"	0.0	Pan # (washed)	100.0%
1.5"	0.0		100.0%
1.0"	0.0		100.0%
3/4"	0.0	53	100.0%
1/2"	0.0		100.0%
3/8"	0.0		100.0%
#4	7.7	Soil Mortar	98.3%
#10	13.3	**100.0%**	97.0%
#20	0.7	98.7%	95.8%
#40	2.4	95.4%	92.6%
#60	5.7	89.1%	86.4%
#100	11.1	78.8%	76.4%
#200	18.2	65.0%	63.1%

Notes: Description of Sand & Gravel Particles — Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:	4.75 mm	Total Sand:	35.2%	< 4.74 mm and > 0.075 mm	Type: Mechanical Stirring Apparatus (A)
% Gravel:	1.7%	< 75 mm and > 4.75 mm	Silt & Clay:	63.1%	< 0.075 — Dispersion Time: 1 min.
Coarse Sand:	1.3%	< 4.75 mm and > 2.00 mm	Silt:	30.6%	< 0.075 and > 0.005 mm — Sodium Hexametaphosphate: 40 g./ Liter
Medium Sand:	4.4%	< 2.00 mm and > 0.425 mm	Clay:	32.5%	< 0.005 mm
Fine Sand:	29.5%	< 0.425 mm and > 0.075 mm	Colloids:	18.2%	< 0.001 mm — Control Cylinder ☐ Composite Correction ☒

Liquid Limit 40 Plastic Limit 26 Plastic Index 14 Hydrometer: 151H ☐ 152H ☒

Time		Temp.	Hydrometer	Corrections		Hydrometer	Percent Passing		Effective Depth	Table 3	Diameter
Clock	T (Min.)	(0.5 °C)	Reading	Control Cylinder	Composite Correction	R	P(-#10) = (R x a / W) x 100	P (total) = P x % Passing #10	L	K	D = K x ((L/T)^1/2
	2	22.0	35.0		5.20	29.80	57.3%	55.5%	11.4	0.01332	0.03181
	5	22.0	32.5		5.20	27.30	52.4%	50.9%	11.8	0.01332	0.02048
	15	22.0	29.0		5.20	23.80	45.7%	44.4%	12.4	0.01332	0.01211
	30	22.1	26.5		5.20	21.30	40.9%	39.7%	12.8	0.01332	0.00870
	60	22.1	24.0		5.20	18.80	36.1%	35.0%	13.2	0.01332	0.00625
	250	22.6	20.0		5.15	14.85	28.5%	27.7%	13.9	0.01325	0.00312
	1440	21.6	16.0		5.25	10.75	20.7%	20.0%	14.5	0.01340	0.00135
	2880	21.4	15.0		5.25	9.75	18.7%	18.2%	14.7	0.01348	0.00096

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Effective Depth (cm)
L=L1+0.5(L2-(VB/A))
(152H) .164cm per increment,
V_B=67.0cm^3, L_2=14cm, A=27.8cm^2

Technician Name: M. Jacobs

Technical Responsibility: Brian Vaughan, P.E.

Certification #

Signature

QC Manager
Position

S&ME, INC. 155 Tradd Street Spartanburg, SC 29301

Hydrometer #492 (M-4, 10-15') 12-26-07.xls

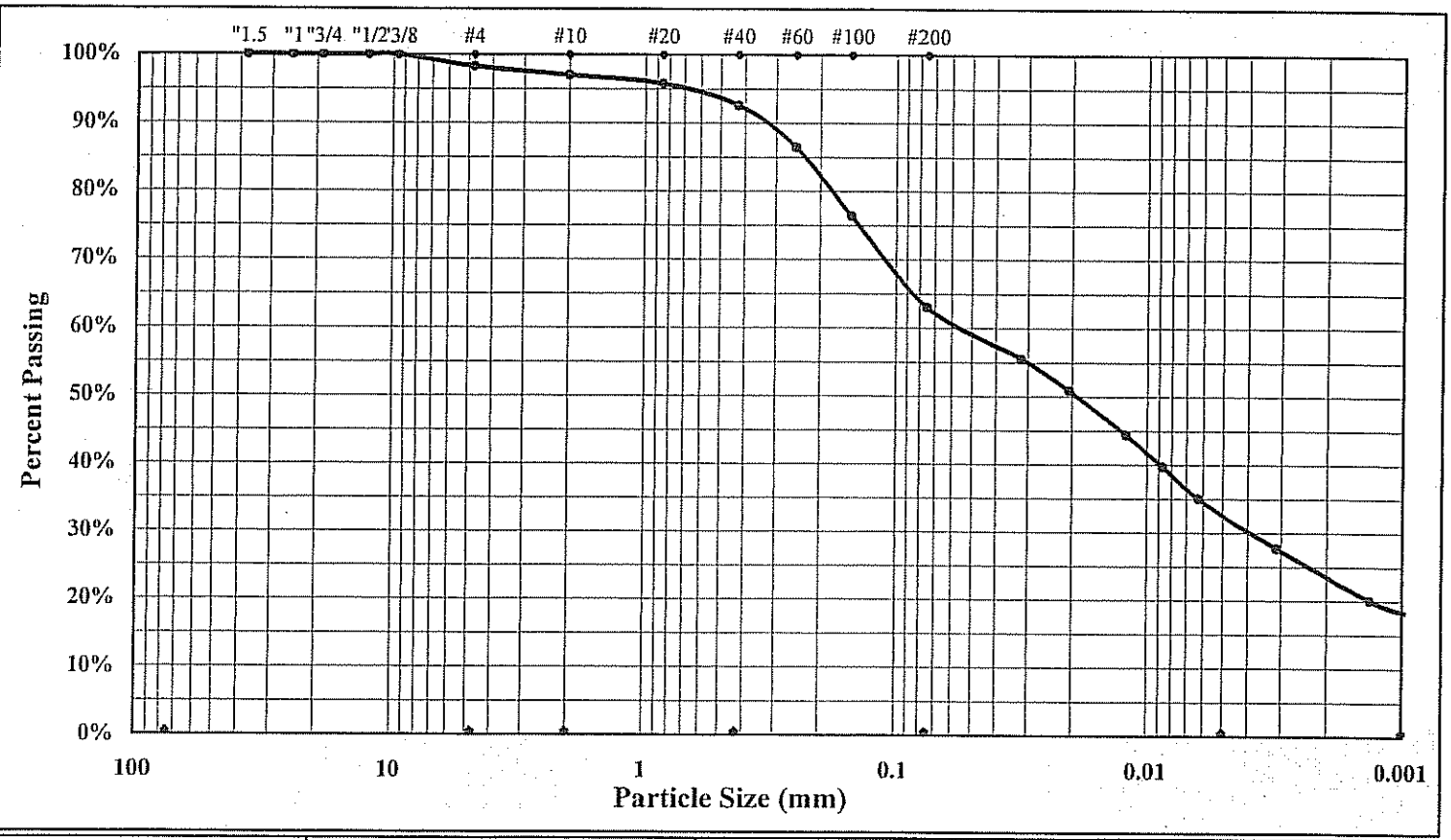
Particle Size Analysis of Soils

ASTM D 422

S&ME

S&ME Project #:	**1411-07-103**	Report Date:	12/26/07
Project Name:	**Marshall Steam Station**	Test Date(s):	12/19 - 12/21/07
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-4	Sample #:	492	Sample Date:	11/29/07
Location:	Bulk	Offset:	N/A	Elevation:	10-15'
Sample Description:	Red orange brown fine sandy clayey SILT (ML)				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	4.75 mm	Gravel	1.7%	Silt	30.6%
Silt & Clay (% Passing #200)	63.1%	Sand	35.2%	Clay	32.5%
Specific Gravity	2.650	Moisture Content	16.1%	Colloids	18.2%
Liquid Limit	40	Plastic Limit	26	Plastic Index	14

Description of Sand & Gravel Particles Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Mechanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

References: ASTM D 422: Particle Size Analysis of Soils
ASTM D 421: Dry Preparation of Soil Samples
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 854: Specific Gravity of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. _____ QC Manager
Signature Position

Moisture - Density Relationship

S&ME

S&ME Project #:	**1411-07-103**	Test Date(s):	January 4, 2008
Project Name:	Marshall Steam Station	Report Date:	January 7, 2008
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-4	Sample #:	492	Sample Date:	November 29, 2007
Location:	Bulk	Offset:	N/A	Depth:	10-15'

Sample Description: Red orange brown fine sandy clayey SILT (ML)

Liquid Limit:	40	Specific Gravity:	2.650
Plastic Limit:	26	Plastic Index:	14

Natural Moisture Content: 16.1%

Moisture Content of the Oversize Fraction:

NOTES:

Sieve Size	% Passing
#4	98.3
#10	97.0
#20	95.8
#40	92.6
#60	86.4
#100	76.4
#200	63.1

MDD: 108.1 **Opt. MC %: 17.0**

Water Content

Water Content requires GP 2 Balance (0.1 gram Readability).

ASTM D2216 ☒ AASHTO T265 ☐ ASTM D4959 ☐ ASTM D4643 ☐

	Sample #:	1	2	3	4	5	6
	Water Added:						
	Tare #:						
A. Tare Weight	A.	0	0	0	0	0	0
B. Wet Wt + Tare Wt	B.	500	500	500	500	500	500
C. Dry Wt. + Tare Wt.	C.	439.2	432	425	418.3		
D. Water Weight	B-C	60.8	68	75	81.7	500	500
E. Dry Weight	C-A	439.2	432	425	418.3	0	0
F. Moisture Content	100*D/E	**13.8%**	**15.7%**	**17.6%**	**19.5%**	**#DIV/0!**	**#DIV/0!**

Compaction Data

The Compaction Test requires a GP 5 Balance for ASTM (1 gram or .0022 Lb. readability).

G. Wt of Soil + Mold	G.	13.294	13.446	13.532	13.486		
H. Wt. of Mold	H.	9.304	9.304	9.304	9.304	9.304	9.304
I. Wt. of Soil (g. or lbs.)	G-H	3.990	4.142	4.228	4.182	-9.304	-9.304
J. Wt of Soil (Lbs.)	I/453.6 or I	3.990	4.142	4.228	4.182	-9.304	-9.304
K. Mold Volume Factor	K.	30.039	30.039	30.039	30.039	30.039	30.039
L. Wet Density	J*K	119.9	124.4	127.0	125.6	-279.5	-279.5
M. Dry Density	L/(1+F)	**105.3**	**107.5**	**108.0**	**105.1**	**#DIV/0!**	**#DIV/0!**

ASTM D558 ☐ ASTM D 698 ☒ ASTM D1557 ☐ AASHTO T99 ☐ AASHTO T180 ☐

Method A ☒ Method B ☐ Method C ☐ Method D (ASTM 1978) ☐ AASHTO Method D ☐

Moisture-Density Relation of: Fine Fraction ☒ Corrected for Coarse Fraction (ASTM D 4718) ☐

Sieve Size used to separate the Oversize Fraction: #4 Sieve ☒ 3/8 inch Sieve ☐ 3/4 inch Sieve ☐

Mechanical Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

Soil Plasticity:	ASTM D 4318 ☒	AASHTO T 89 ☐		AASHTO T 90 ☐
Sieve Analysis / Particle Size Analysis:	ASTM C136 ☐	AASHTO T 27 ☐	ASTM D 422 ☒	AASHTO T 88 ☐
Specific Gravity of Soil:		ASTM D 854 ☒		AASHTO T 100 ☐
Bulk Gravity of Oversize Fraction:		ASTM C 127 ☐		AASHTO T 85 ☐
Soil Classification:	ASTM D 2487 ☒	ASTM D 2488 ☐		AASHTO M 145 ☐

Technician Name: B. Hatton

Certification #

Technical Responsibility: Brian Vaughan, P.E. Signature Construction Services Manager Position

Moisture - Density Report

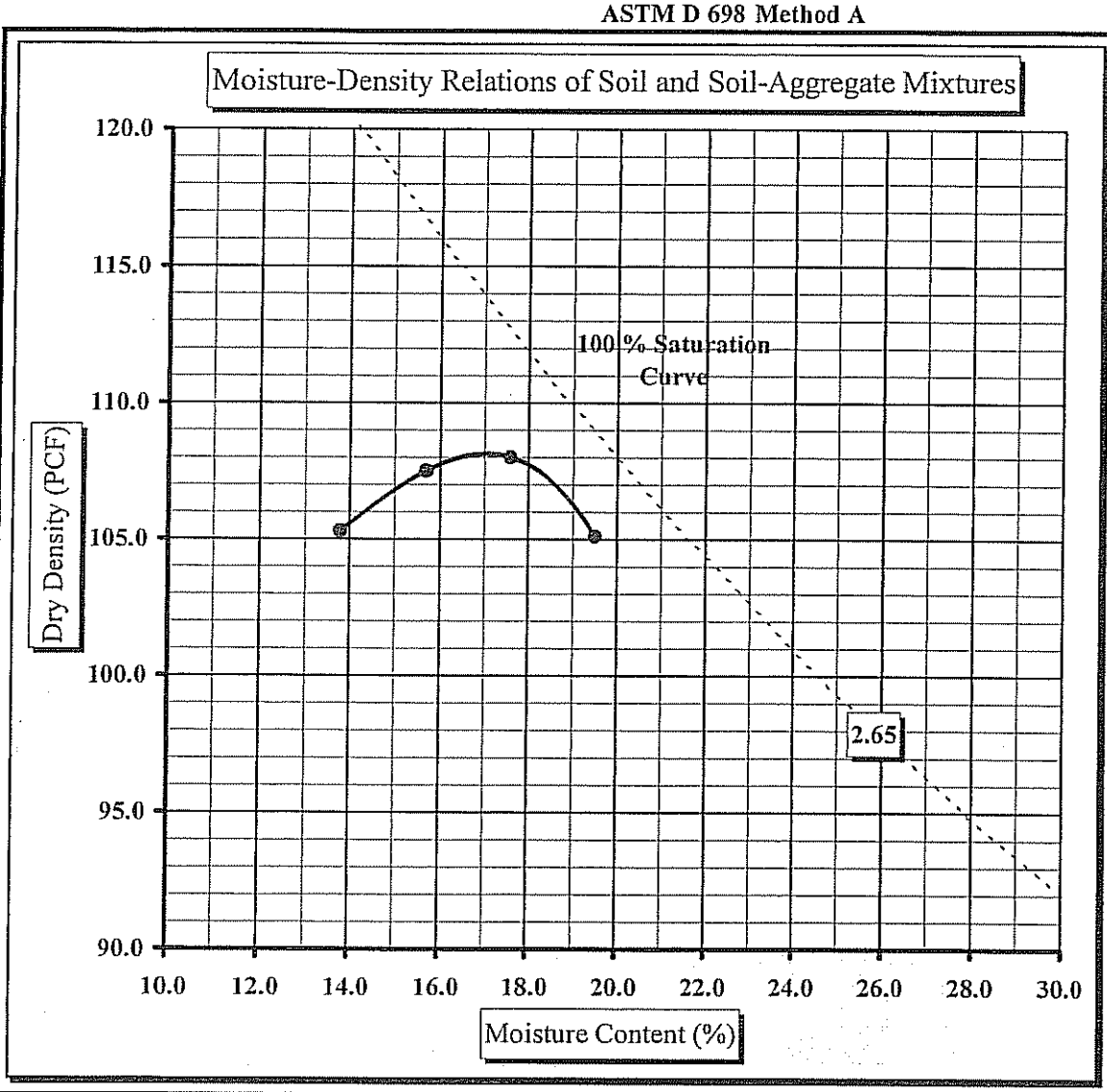
S&ME

S&ME Project #:	**1411-07-103**	Report Date:	January 7, 2008
Project Name:	**Marshall Steam Station**	Test Date(s):	January 4, 2008
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-4	Sample #:	492	Sample Date:	November 29, 2007
Location:	Bulk	Offset:	N/A	Depth:	10-15'
Sample Description:	Red orange brown fine sandy clayey SILT (ML)				

Maximum Dry Density 108.1 PCF. **Optimum Moisture Content 17.0 %**

ASTM D 698 Method A



Soil Properties

Natural Moisture Content:	16.1%
Liquid Limit:	40
Plastic Limit:	26
Plastic Index:	14
Specific Gravity:	2.650

% Passing

#4	98.3
#10	97.0
#20	95.8
#40	92.6
#60	86.4
#100	76.4
#200	63.1

Oversize Fraction

Bulk Sp. Gravity
% Moisture
Oversize Fraction
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 Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

References: ASTM D 698: Laboratory Compaction Characteristics of Soil Using Standard Effort
ASTM D 2216: Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D 422: Particle Size Analysis of Soils ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

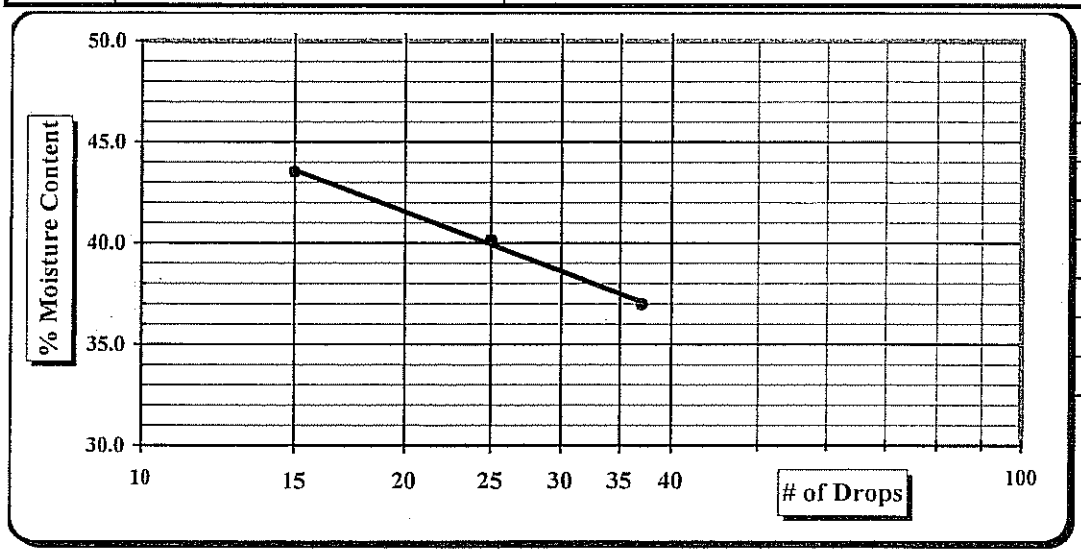
Technical Responsibility: Brian Vaughan, P.E. Construction Services Manager

S&ME

Liquid Limit, Plastic Limit, and Plastic Index

Project #: **1411-07-103** Report Date: 1/24/08
Project Name: Marshall Steam Station Test Date(s): 1/23/08
Client Name: Duke Energy
Client Address: Charlotte, NC
Boring #: M-4 Sample #: 492 Sample Date: 11/29/07
Location: Bulk Offset: N/A Elevation: 10-15'
Sample Description: Red orange brown fine sandy clayey SILT (ML)

Pan #		Liquid Limit						Plastic Limit		
	Test #	1	2	3	4	5	6	1	2	3
	Tare #	P-7	P-8	P-9				22	25	
A	Tare Weight	15.82	15.73	15.94				**11.91**	11.67	
B	Wet Soil Weight + A	38.16	37.77	37.38				19.60	19.31	
C	Dry Soil Weight + A	32.13	31.46	30.88				18.04	17.75	
D	Water Weight (B-C)	6.03	6.31	6.50				1.56	1.57	
E	Dry Soil Weight (C-A)	16.31	15.73	14.94				6.13	6.08	
F	% Moisture Content (D/E)*100	37.0%	40.1%	43.5%				25.4%	25.8%	
N	# OF DROPS	37	25	15				*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average							25.6%		



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes:

Special Sampling Methods:

Sample Preparation:	Wet Preparation	☐	Dry Preparation	☒	Air Dried	☒	% Passing #200 Sieve: 63.1
Liquid limit Test:	Multipoint Method	☒	One-point Method	☐			NP, Non-Plastic ☐
Classification:	ASTM D 2487	☒	AASHTO M 145	☐			Liquid Limit 40
Liquid limit Test:	ASTM D 4318	☒	AASHTO T 89	☐			Plastic Limit 26
Plastic limit Test:	ASTM D 4318	☒	AASHTO T 90	☐			Plastic Index 14
							Group Symbol ML

Technician Name: M. Jacobs _____ *Certification #*

Technical Responsibility: Brian Vaughan, P.E. _____ *Signature* QC Manager *Position*

Particle Size Analysis of Soils

ASTM D 422

S&ME

Project #: **1411-07-103**
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Charlotte, NC

Test Date(s): 4/2 - 4/4/08
Report Date: 4/7/08

Boring #: M-5 Sample #: 85 Sample Date: 11/8/07
Location: sample 2 Offset: N/A Elevation: 8.6-10.1'
Sample Description: Dark gray SILT with fine sand

Pan #:	3	Beaker #:	3
Hydrometer Jar #:			3
Pan Tare Weight (grams):			0.00
Total Sample Air Dried Wt. + tare wt. (grams):			106.80
Weight of Total Sample Air Dried:			106.80
Weight of Air Dried Hydrometer Sample (g):			95.45
Total Sample Oven Dried:			106.39
Hydrometer Sample Oven Dried (W):			95.08
% Passing #10:			99.2%
Correction Factor a (Table 1):			1.00

Specific Gravity 2.650

	Moisture Content	Hygroscopic
	Tare #	Z-3
A	Tare Wt.	16.77
B	Wet Wt. + A	27.03
C	Dry Wt. + A	26.99
D	Water Wt. (B-C)	0.04
E	Dry Wt. (C-A)	10.22
	% Moisture (100 x D/E)	0.39%

Sieve	Retained Wt.	Percent Passing	
3.0"	0.0	Pan # (washed)	100.0%
1.5"	0.0		100.0%
1.0"	0.0		100.0%
3/4"	0.0	53	100.0%
1/2"	0.0		100.0%
3/8"	0.0		100.0%
#4	0.1	Soil Mortar	99.9%
#10	0.9	**100.0%**	99.2%
#20	0.5	99.4%	98.6%
#40	1.2	98.7%	97.9%
#60	2.3	97.6%	96.8%
#100	6.4	93.3%	92.5%
#200	20.9	78.0%	77.4%

Notes: Description of Sand & Gravel Particles — Rounded ☐ Angular ☒ | Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:	4.75 mm		Total Sand:	22.5%	< 4.74 mm and > 0.075 mm	Type:	Mechanical Stirring Apparatus (A)
% Gravel:	0.1%	< 75 mm and > 4.75 mm	Silt & Clay:	77.4%	< 0.075	Dispersion Time:	1 min.
Coarse Sand:	0.7%	< 4.75 mm and > 2.00 mm	Silt:	73.1%	< 0.075 and > 0.005 mm	Sodium Hexametaphosphate:	40 g./ Liter
Medium Sand:	1.3%	< 2.00 mm and > 0.425 mm	Clay:	4.3%	< 0.005 mm		
Fine Sand:	20.5%	< 0.425 mm and > 0.075 mm	Colloids:	1.4%	< 0.001 mm	**Control Cylinder** ☐	**Composite Correction** ☒

Liquid Limit N/A Plastic Limit N/A Plastic Index N/A Hydrometer: 151H ☐ 152H ☒

Time		Temp.	Hydrometer	Corrections		Hydrometer	Percent Passing		Effective Depth	Table 3	Diameter
Clock	T (Min.)	(0.5 °C)	Reading	Control Cylinder	Composite Correction	R	P(-#10) = (R x a / W) x 100	P (total) = P x % Passing #10	L	K	D = K x ((L/T)^1/2
	2	23.3	45.0		5.05	39.95	42.0%	41.7%	9.7	0.01317	0.02907
	5	23.3	24.5		5.05	19.45	20.5%	20.3%	13.1	0.01317	0.02132
	15	23.3	15.0		5.05	9.95	10.5%	10.4%	14.7	0.01317	0.01302
	30	23.3	12.5		5.05	7.45	7.8%	7.8%	15.1	0.01317	0.00934
	60	23.3	10.5		5.05	5.45	5.7%	5.7%	15.4	0.01317	0.00667
	250	22.9	8.0		5.10	2.90	3.1%	3.0%	15.8	0.01325	0.00333
	1440	23.0	7.0		5.10	1.90	2.0%	2.0%	16.0	0.01317	0.00139
	2880	22.6	6.5		5.15	1.35	1.4%	1.4%	16.1	0.01325	0.00099

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Effective Depth (cm)
L=L1+0.5(L2-(VB/A))

(152H) .164cm per increment,
V_B=67.0cm^3, L_2=14cm, A=27.8cm^2

Technician Name: M. Jacobs

Technical Responsibility: Brian Vaughan, P.E.

Certification #

Signature

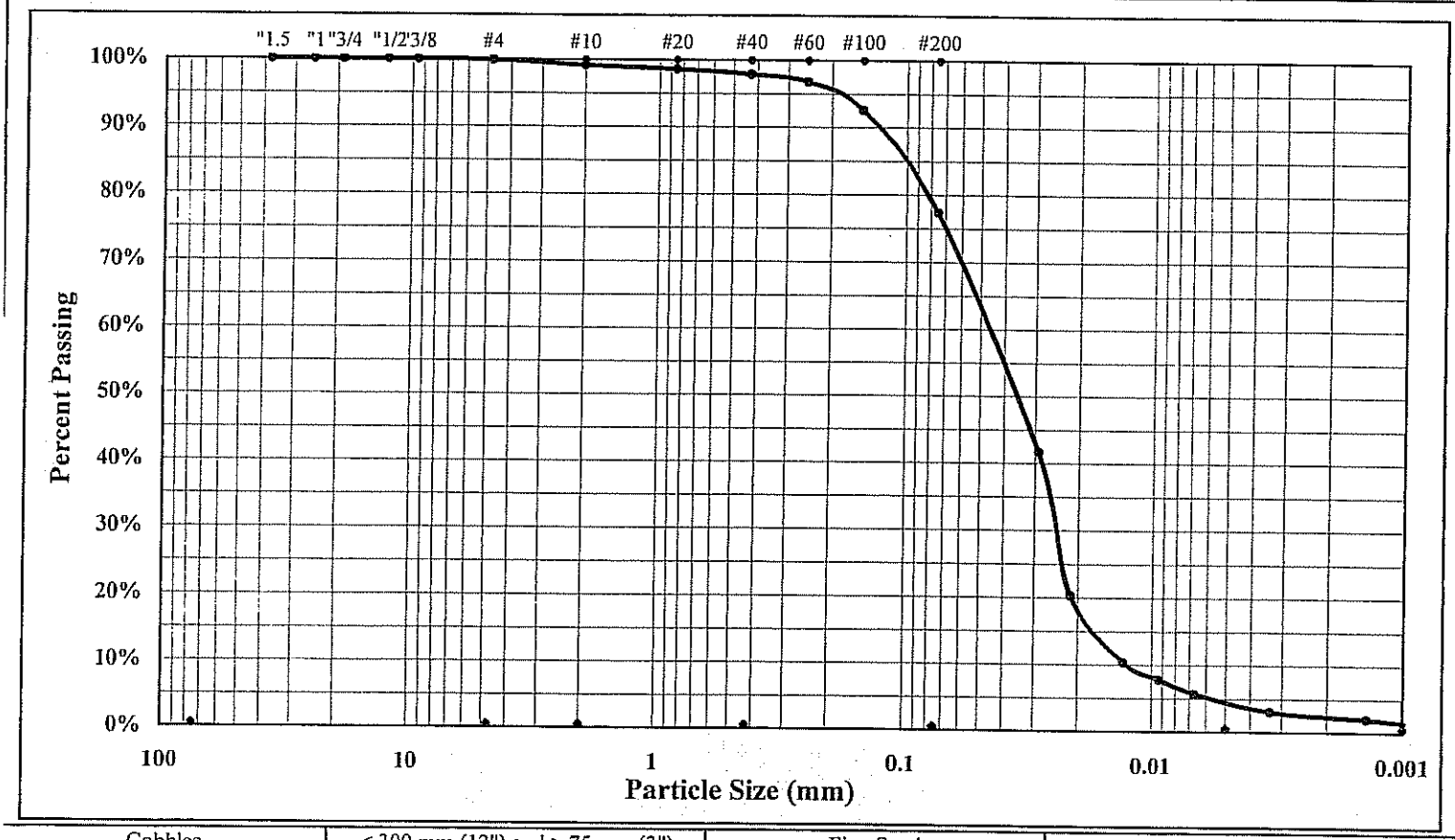
QC Manager
Position

Particle Size Analysis of Soils

ASTM D 422

S&ME Project #:	**1411-07-103**	Report Date:	4/7/08
Project Name:	**Marshall Steam Station**	Test Date(s):	4/2 - 4/4/08
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-5	Sample #:	85	Sample Date:	11/8/07
Location:	sample 2	Offset:	N/A	Elevation:	8.6-10.1'
Sample Description:	Dark gray SILT with fine sand				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	4.75 mm	Gravel	0.1%	Silt	73.1%
Silt & Clay (% Passing #200)	77.4%	Sand	22.5%	Clay	4.3%
Specific Gravity	2.650			Colloids	1.4%
Liquid Limit	N/A	Plastic Limit	N/A	Plastic Index	N/A

Description of Sand & Gravel Particles Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Mechanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

References: ASTM D 422: Particle Size Analysis of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 421: Dry Preparation of Soil Samples
ASTM D 854: Specific Gravity of Soils

Technical Responsibility: Brian Vaughan, P.E. _____ QC Manager
Signature *Position*

Particle Size Analysis of Soils

ASTM D 422

S&ME

Project #: 1411-07-103
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Charlotte, NC

Test Date(s): 12/11 - 12/13/07
Report Date: 12/14/07

Boring #: M-6 Sample #: 483 Sample Date: 11/14/07
Location: Bulk Offset: N/A Elevation: 0-5'
Sample Description: Red brown clayey SILT with trace fine sand (MH)

Pan #:	1	Beaker #:	1	Specific Gravity	2.650		
Hydrometer Jar #:			1				
Pan Tare Weight (grams):			0.00	Moisture Content		Hygroscopic	Natural
Total Sample Air Dried Wt. + tare wt. (grams):			448.71		Tare #	P-1	301
Weight of Total Sample Air Dried:			448.71	A	Tare Wt.	16.57	0.00
Weight of Air Dried Hydrometer Sample (g):			52.92	B	Wet Wt. + A	29.48	237.81
Total Sample Oven Dried:			434.19	C	Dry Wt. + A	29.06	180.26
Hydrometer Sample Oven Dried (W):			51.20	D	Water Wt. (B-C)	0.42	57.55
% Passing #10:			99.5%	E	Dry Wt. (C-A)	12.49	180.26
Correction Factor a (Table 1):			1.00		% Moisture (100 x D/E)	3.36%	31.9%

Sieve	Retained Wt.	Percent Passing	
3.0"	0.0	Pan # (washed) 51	100.0%
1.5"	0.0		100.0%
1.0"	0.0		100.0%
3/4"	0.0		100.0%
1/2"	0.0		100.0%
3/8"	0.0		100.0%
#4	0.6	Soil Mortar	99.9%
#10	2.3	**100.0%**	99.5%
#20	0.3	99.4%	98.9%
#40	0.6	98.7%	98.2%
#60	1.2	97.6%	97.1%
#100	2.3	95.4%	94.9%
#200	5.3	89.7%	89.2%

Notes: Description of Sand & Gravel Particles — Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:	4.75 mm		Total Sand:	10.7%	< 4.74 mm and > 0.075 mm	Type:	Mechanical Stirring Apparatus (A)
% Gravel:	0.1%	< 75 mm and > 4.75 mm	Silt & Clay:	89.2%	< 0.075	Dispersion Time:	1 min.
Coarse Sand:	0.4%	< 4.75 mm and > 2.00 mm	Silt:	31.4%	< 0.075 and > 0.005 mm	Sodium Hexametaphosphate:	40 g./ Liter
Medium Sand:	1.2%	< 2.00 mm and > 0.425 mm	Clay:	57.8%	< 0.005 mm		
Fine Sand:	9.0%	< 0.425 mm and > 0.075 mm	Colloids:	45.2%	< 0.001 mm	Control Cylinder ☐	Composite Correction ☒

Liquid Limit 68 Plastic Limit 38 Plastic Index 30 Hydrometer: 151H ☐ 152H ☒

Time		Temp.	Hydrometer	Corrections		Hydrometer	Percent Passing		Effective Depth	Table 3	Diameter
Clock	T (Min.)	(0.5 °C)	Reading	Control Cylinder	Composite Correction	R	P(-#10) = (R x a / W) x 100	P (total) = P x % Passing #10	L	K	D = K x ((L/T)^1/2
	2	23.5	46.0		5.05	40.95	80.0%	79.6%	9.6	0.01309	0.02865
	5	23.5	43.5		5.05	38.45	75.1%	74.7%	10.0	0.01309	0.01850
	15	23.5	40.0		5.05	34.95	68.3%	67.9%	10.6	0.01309	0.01098
	30	23.5	37.5		5.05	32.45	63.4%	63.1%	11.0	0.01309	0.00792
	60	23.5	35.5		5.05	30.45	59.5%	59.2%	11.3	0.01309	0.00568
	250	23.3	32.0		5.05	26.95	52.6%	52.4%	11.9	0.01317	0.00287
	1440	23.3	29.0		5.05	23.95	46.8%	46.5%	12.4	0.01317	0.00122
	2880	23.4	28.0		5.05	22.95	44.8%	44.6%	12.5	0.01317	0.00087

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Effective Depth (cm)
L=L1+0.5(L2-(VB/A))

Technician Name: M. Jacobs

Certification #

Technical Responsibility: Brian Vaughan, P.E.

Signature

OC Manager
Position

(152H) .164cm per increment,
V_B=67.0cm^3, L_2=14cm, A=27.8cm^2

S&ME, INC. **155 Tradd Street Spartanburg, SC 29301**

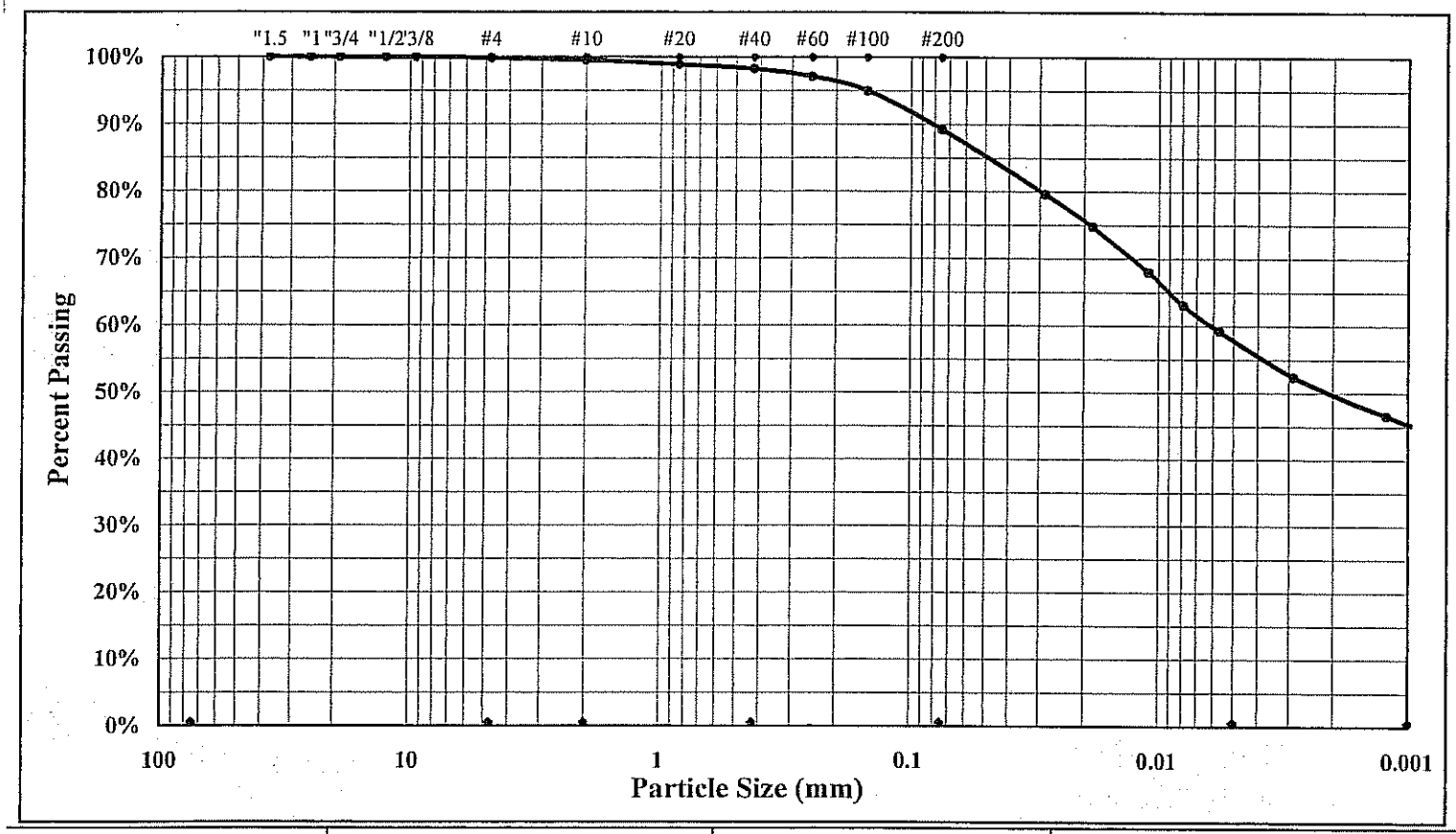
Hydrometer #483 (M-6, 0-5') 12-14-07.xls

Particle Size Analysis of Soils

ASTM D 422

S&ME Project #:	**1411-07-103**	Report Date:	12/14/07
Project Name:	**Marshall Steam Station**	Test Date(s):	12/11 - 12/13/07
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-6	Sample #:	483	Sample Date:	11/14/07
Location:	Bulk	Offset:	N/A	Elevation:	0-5'
Sample Description:	Red brown clayey SILT with trace fine sand (MH)				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	4.75 mm	Gravel	0.1%	Silt	31.4%
Silt & Clay (% Passing #200)	89.2%	Sand	10.7%	Clay	57.8%
Specific Gravity	2.650	Moisture Content	31.9%	Colloids	45.2%
Liquid Limit	68	Plastic Limit	38	Plastic Index	30

Description of Sand & Gravel Particles Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Mechanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 854: Specific Gravity of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. _____ QC Manager
Signature *Position*

Moisture - Density Relationship

S&ME

S&ME Project #:	**1411-07-103**	Test Date(s):	December 20, 2007
Project Name:	Marshall Steam Station	Report Date:	December 21, 2007
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-6	Sample #:	483	Sample Date:	November 14, 2007
Location:	Bulk	Offset:	N/A	Depth:	0-5'

Sample Description: Red brown clayey SILT with trace fine sand (MH)

Liquid Limit:	68	Specific Gravity:	2.650
Plastic Limit:	38	Plastic Index:	30

Natural Moisture Content: 31.9%

Moisture Content of the Oversize Fraction:

NOTES:

Sieve Size	% Passing
#4	99.9
#10	99.5
#20	98.9
#40	98.2
#60	97.1
#100	94.9
#200	89.2

MDD: 89.4 **Opt. MC %:** 29.5

Water Content Water Content requires GP 2 Balance (0.1 gram Readability).

ASTM D2216 ☒ AASHTO T265 ☐ ASTM D4959 ☐ ASTM D4643 ☐

	Sample #:	1	2	3	4	5	6
	Water Added:						
	Tare #:						
A. Tare Weight	A.	0	0	0	0	0	0
B. Wet Wt + Tare Wt	B.	500	500	500	500	500	500
C. Dry Wt. + Tare Wt.	C.	394.8	387.8	381.7	375.9		
D. Water Weight	B-C	105.2	112.2	118.3	124.1	500	500
E. Dry Weight	C-A	394.8	387.8	381.7	375.9	0	0
F. Moisture Content	100*D/E	**26.6%**	**28.9%**	**31.0%**	**33.0%**	**#DIV/0!**	**#DIV/0!**

Compaction Data The Compaction Test requires a GP 5 Balance for ASTM (1 gram or .0022 Lb. readability).

G. Wt of Soil + Mold	G.	13.028	13.136	13.184	13.162		
H. Wt. of Mold	H.	9.304	9.304	9.304	9.304	9.304	9.304
I. Wt. of Soil (g. or lbs.)	G-H	3.724	3.832	3.880	3.858	-9.304	-9.304
J. Wt of Soil (Lbs.)	I/453.6 or I	3.724	3.832	3.880	3.858	-9.304	-9.304
K. Mold Volume Factor	K.	30.039	30.039	30.039	30.039	30.039	30.039
L. Wet Density	J*K	111.9	115.1	116.6	115.9	-279.5	-279.5
M. Dry Density	L/(1+F)	**88.3**	**89.3**	**89.0**	**87.1**	**#DIV/0!**	**#DIV/0!**

ASTM D558 ☐ ASTM D 698 ☒ ASTM D1557 ☐ AASHTO T99 ☐ AASHTO T180 ☐

Method A ☒ Method B ☐ Method C ☐ Method D (ASTM 1978) ☐ AASHTO Method D ☐

Moisture-Density Relation of: Fine Fraction ☒ Corrected for Coarse Fraction (ASTM D 4718) ☐

Sieve Size used to separate the Oversize Fraction: #4 Sieve ☒ 3/8 inch Sieve ☐ 3/4 inch Sieve ☐

Mechanical Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

Soil Plasticity: ASTM D 4318 ☒ AASHTO T 89 ☐ AASHTO T 90 ☐

Sieve Analysis / Particle Size Analysis: ASTM C136 ☐ AASHTO T 27 ☐ ASTM D 422 ☒ AASHTO T 88 ☐

Specific Gravity of Soil: ASTM D 854 ☒ AASHTO T 100 ☐

Bulk Gravity of Oversize Fraction: ASTM C 127 ☐ AASHTO T 85 ☐

Soil Classification: ASTM D 2487 ☒ ASTM D 2488 ☐ AASHTO M 145 ☐

Technician Name: B. Hatton

Certification #

Technical Responsibility: Brian Vaughan, P.E. Signature Construction Services Manager Position

Moisture - Density Report

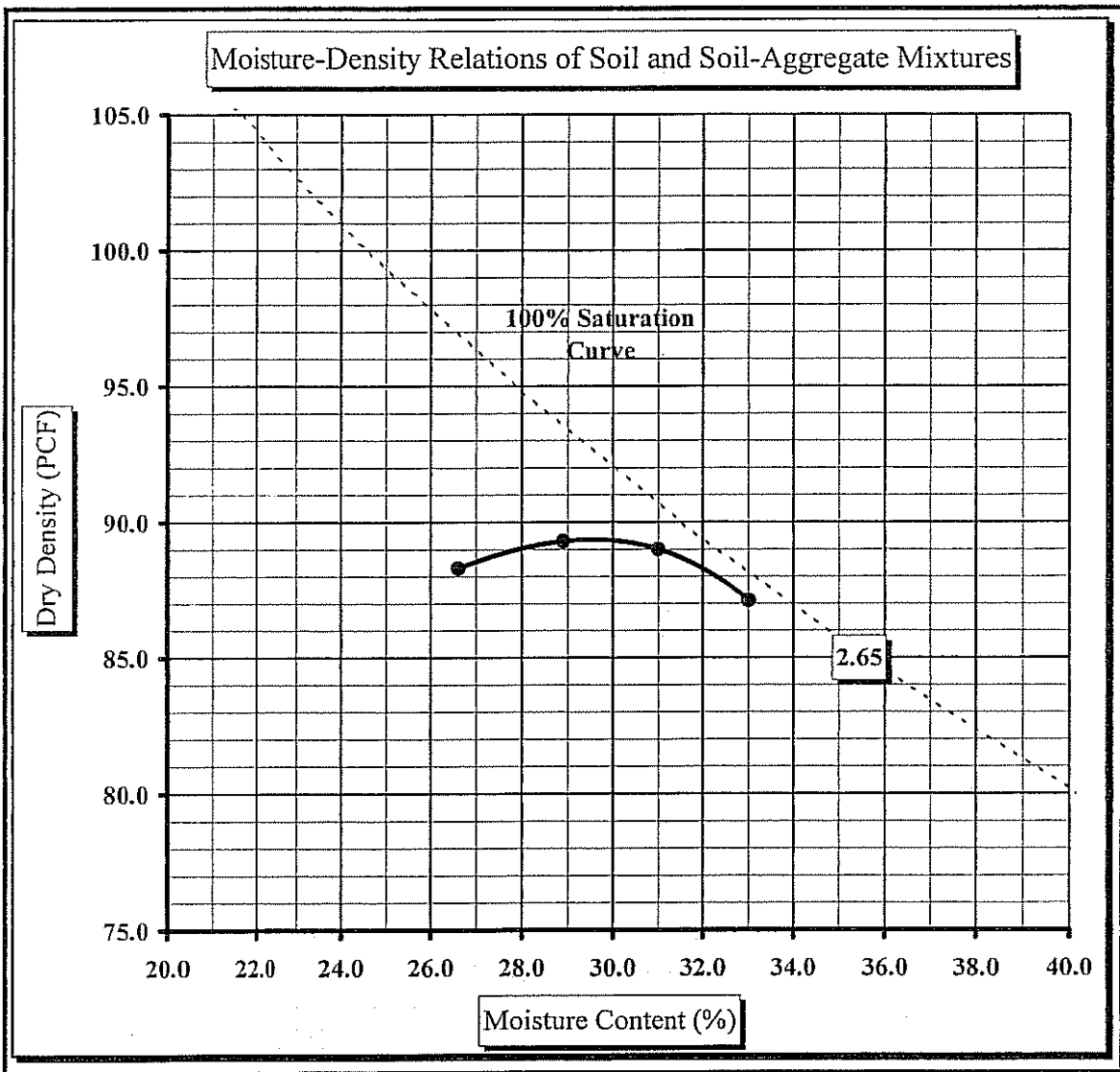
S&ME

S&ME Project #:	**1411-07-103**	Report Date:	December 21, 2007
Project Name:	**Marshall Steam Station**	Test Date(s):	December 20, 2007
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-6	Sample #:	483	Sample Date:	November 14, 2007
Location:	Bulk	Offset:	N/A	Depth:	0-5'
Sample Description:	Red brown clayey SILT with trace fine sand (MH)				

Maximum Dry Density **89.4** **PCF.** **Optimum Moisture Content** **29.5** **%**

ASTM D 698 Method A



Soil Properties

Natural Moisture Content:	31.9%
Liquid Limit:	68
Plastic Limit:	38
Plastic Index:	30
Specific Gravity:	2.650

% Passing

#4	99.9
#10	99.5
#20	98.9
#40	98.2
#60	97.1
#100	94.9
#200	89.2

Oversize Fraction

Bulk Sp. Gravity
% Moisture
Oversize Fraction
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 Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

References: ASTM D 698: Laboratory Compaction Characteristics of Soil Using Standard Effort
ASTM D 2216: Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D 422: Particle Size Analysis of Soils ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. Construction Services Manager

S&ME

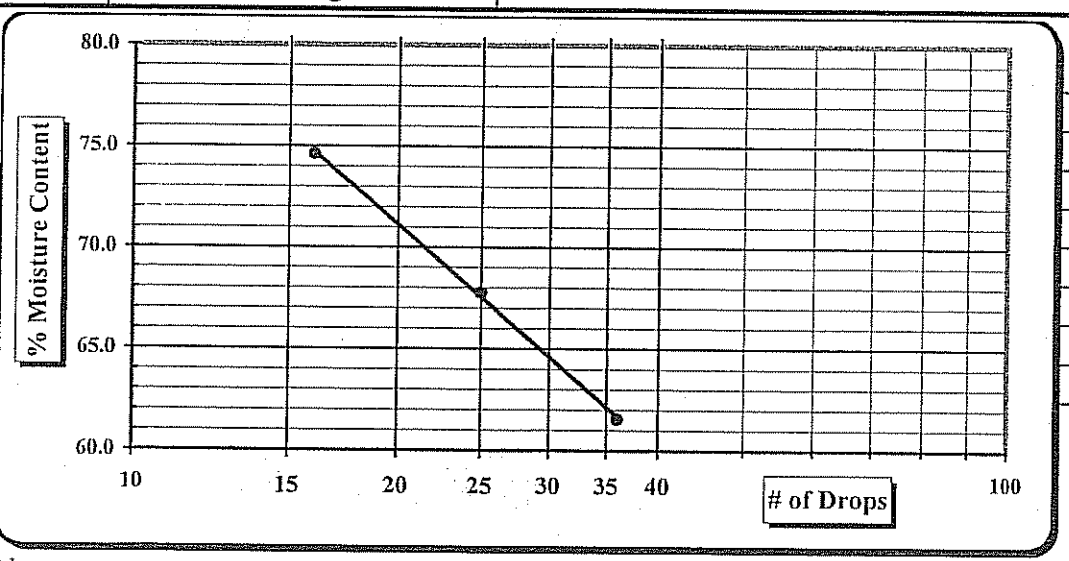
Liquid Limit, Plastic Limit, and Plastic Index

Project #: **1411-07-103**
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Charlotte, NC

Report Date: 1/22/08
Test Date(s): 1/21/08

Boring #: M-6 Sample #: 483 Sample Date: 11/14/07
Location: Bulk Offset: N/A Elevation: 0-5'
Sample Description: Red brown clayey SILT with trace fine sand (MH)

Pan #		Liquid Limit						Plastic Limit		
	Test #	1	2	3	4	5	6	1	2	3
	Tare #	P-1	P-2	P-3				1	2	
A	Tare Weight	16.56	15.44	16.55				**10.89**	10.86	
B	Wet Soil Weight + A	37.40	37.75	37.26				18.05	18.31	
C	Dry Soil Weight + A	29.46	28.74	28.41				16.08	16.27	
D	Water Weight (B-C)	7.94	9.01	8.85				1.97	2.04	
E	Dry Soil Weight (C-A)	12.90	13.30	11.86				5.19	5.41	
F	% Moisture Content (D/E)*100	61.6%	67.7%	74.6%				38.0%	37.7%	
N	# OF DROPS	36	25	16				*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average							37.8%		



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes:

Special Sampling Methods:

Sample Preparation:	Wet Preparation ☐	Dry Preparation ☒	Air Dried ☒	% Passing #200 Sieve:	89.2
Liquid limit Test:	Multipoint Method ☒	One-point Method ☐		NP, Non-Plastic	☐
Classification:	ASTM D 2487 ☒	AASHTO M 145 ☐		Liquid Limit	68
Liquid limit Test:	ASTM D 4318 ☒	AASHTO T 89 ☐		Plastic Limit	38
Plastic limit Test:	ASTM D 4318 ☒	AASHTO T 90 ☐		Plastic Index	30
				Group Symbol	MH

Technician Name: M. Jacobs
Certification #

Technical Responsibility: Brian Vaughan, P.E. Signature QC Manager Position

CONSTANT HEAD PERMEABILITY

ASTM D5084

S&ME Project Number: 1411-07-103 Project Name: Marshall Steam Station 2/28/2008

Sample Name: M-6 483 (0-5')

Sample Description: Red Brown Clayey Silt w/trace Fine Sand (MH)

Type of Sample: Remolded

Sample Data		Molding Moisture Content		Target Molding Conditon				Additonal Data	
Diam. (cm)	7.275	Tare No.	G-10	γ_{wet} (pcf)	112.1			Panel No	8
Leng. (cm)	7.699	WWS+ Tare (gm)	358.15	γ_{dry} (pcf)	84.9			Cell P (psi)	82.5
Area (cm^2)	41.57	WDS+Tare (gm)	292.61	w (%)	32.0			Influent P (psi)	80.1
Vol. (cm^3)	320.03	WT of Water (gm)	65.54	Actual Molding Condition				Effluent P (psi)	80.0
WWS (gm)	571.2	WT of TARE (gm)	81.46	γ_{wet} (pcf)	111.5				
		WT Dry Soil (gm)	211.15	γ_{dry} (pcf)	85.1			Gradient	0.9
		w (%)	31.0	w (%)	31.0				

$K = (Q \times L) / (t \times H \times A)$

Run	Temp. (^{0}C)	Hour	Minute	Time, t (sec)	Cell Burette (cc)	Influent Burette(cc)	Effluent Burette (cc)	Q (cc)	Δ H (cm)	Temp Corr.	K(cm/sec)
1		1	58		1.7	0.4	24.1				
	22	3	13	4500	1.7	0.7	24.0	0.2	7.0	0.9530	1.11E-06
2		3	14		1.8	0.2	24.4				
	22	4	30	4560	1.8	0.4	24.2	0.2	7.0	0.9530	1.10E-06
3		9	4		1.8	0.4	24.3				
	22	10	55	6660	1.8	0.9	24.0	0.4	7.0	0.9530	1.51E-06
4		10	56		1.8	0.4	24.5				
	22	13	3	7620	1.8	0.7	24.2	0.3	7.0	0.9530	9.87E-07
5		11	52		1.8	0.1	24.5				
	22	17	4	18720	1.8	1.0	23.7	0.9	7.0	0.9530	1.14E-06
6										Ave. K (cm/sec)	1.18E-06
										(Runs 2 thru 5)	
										Ave. K (m/sec)	1.18E-08

Particle Size Analysis of Soils

ASTM D 422

S&ME

Project #: **1411-07-103**
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Charlotte, NC

Test Date(s): 12/11 - 12/13/07
Report Date: 12/14/07

Boring #: M-6 Sample #: 483 Sample Date: 11/14/07
Location: Bulk Offset: N/A Elevation: 5-10'
Sample Description: Red brown clayey SILT with fine sand (MH)

Pan #:	2	Beaker #:	2
Hydrometer Jar #:			2
Pan Tare Weight (grams):			0.00
Total Sample Air Dried Wt. + tare wt. (grams):			443.63
Weight of Total Sample Air Dried:			443.63
Weight of Air Dried Hydrometer Sample (g):			53.08
Total Sample Oven Dried:			427.87
Hydrometer Sample Oven Dried (W):			51.19
% Passing #10:			99.7%
Correction Factor a (Table 1):			1.00

Specific Gravity 2.650

	Moisture Content	Hygroscopic	Natural
	Tare #	P-2	310
A	Tare Wt.	15.45	0.00
B	Wet Wt. + A	27.80	222.51
C	Dry Wt. + A	27.36	167.67
D	Water Wt. (B-C)	0.44	54.84
E	Dry Wt. (C-A)	11.91	167.67
	% Moisture (100 x D/E)	3.69%	32.7%

Sieve	Retained Wt.	Percent Passing	
3.0"	0.0	Pan # (washed) 52	100.0%
1.5"	0.0		100.0%
1.0"	0.0		100.0%
3/4"	0.0		100.0%
1/2"	0.0		100.0%
3/8"	0.0		100.0%
#4	0.6	Soil Mortar	99.9%
#10	1.4	**100.0%**	99.7%
#20	0.3	99.4%	99.1%
#40	0.8	98.4%	98.1%
#60	1.8	96.5%	96.2%
#100	4.0	92.1%	91.8%
#200	9.2	82.0%	81.7%

Notes: Description of Sand & Gravel Particles — Rounded ☐ Angular ☒ — Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:	4.75 mm	
% Gravel:	0.1%	< 75 mm and > 4.75 mm
Coarse Sand:	0.2%	< 4.75 mm and > 2.00 mm
Medium Sand:	1.6%	< 2.00 mm and > 0.425 mm
Fine Sand:	16.3%	< 0.425 mm and > 0.075 mm

Total Sand:	18.2%	< 4.74 mm and > 0.075 mm
Silt & Clay:	81.7%	< 0.075
Silt:	43.7%	< 0.075 and > 0.005 mm
Clay:	38.0%	< 0.005 mm
Colloids:	23.4%	< 0.001 mm

Type: Mechanical Stirring Apparatus (A)
Dispersion Time: 1 min.
Sodium Hexametaphosphate: 40 g./ Liter

Control Cylinder ☐ **Composite Correction** ☒

Liquid Limit **54** Plastic Limit **36** Plastic Index **18** Hydrometer: 151H ☐ 152H ☒

Time		Temp.	Hydrometer	Corrections		Hydrometer	Percent Passing		Effective Depth	Table 3	Diameter
Clock	T (Min.)	(0.5 °C)	Reading	Control Cylinder	Composite Correction	R	P(-#10) = (R x a / W) x 100	P (total) = P x % Passing #10	L	K	D = K x ((L/T)^1/2
	2	23.5	39.5		5.05	34.45	67.3%	67.1%	10.6	0.01309	0.03020
	5	23.5	36.0		5.05	30.95	60.5%	60.3%	11.2	0.01309	0.01961
	15	23.5	31.0		5.05	25.95	50.7%	50.5%	12.0	0.01309	0.01173
	30	23.5	28.2		5.05	23.15	45.2%	45.1%	12.5	0.01309	0.00845
	60	23.4	26.0		5.05	20.95	40.9%	40.8%	12.9	0.01317	0.00610
	250	23.3	22.0		5.05	16.95	33.1%	33.0%	13.5	0.01317	0.00306
	1440	23.3	18.0		5.05	12.95	25.3%	25.2%	14.2	0.01317	0.00131
	2880	23.4	17.0		5.05	11.95	23.3%	23.3%	14.3	0.01317	0.00093

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Effective Depth (cm)
L=L1+0.5(L2-(VB/A))
(152H) .164cm per increment,
V_B=67.0cm^3, L_2=14cm, A=27.8cm^2

Technician Name: M. Jacobs

Technical Responsibility: Brian Vaughan, P.E.

Certification #

Signature

OC Manager
Position

S&ME, INC.
155 Tradd Street Spartanburg, SC 29301

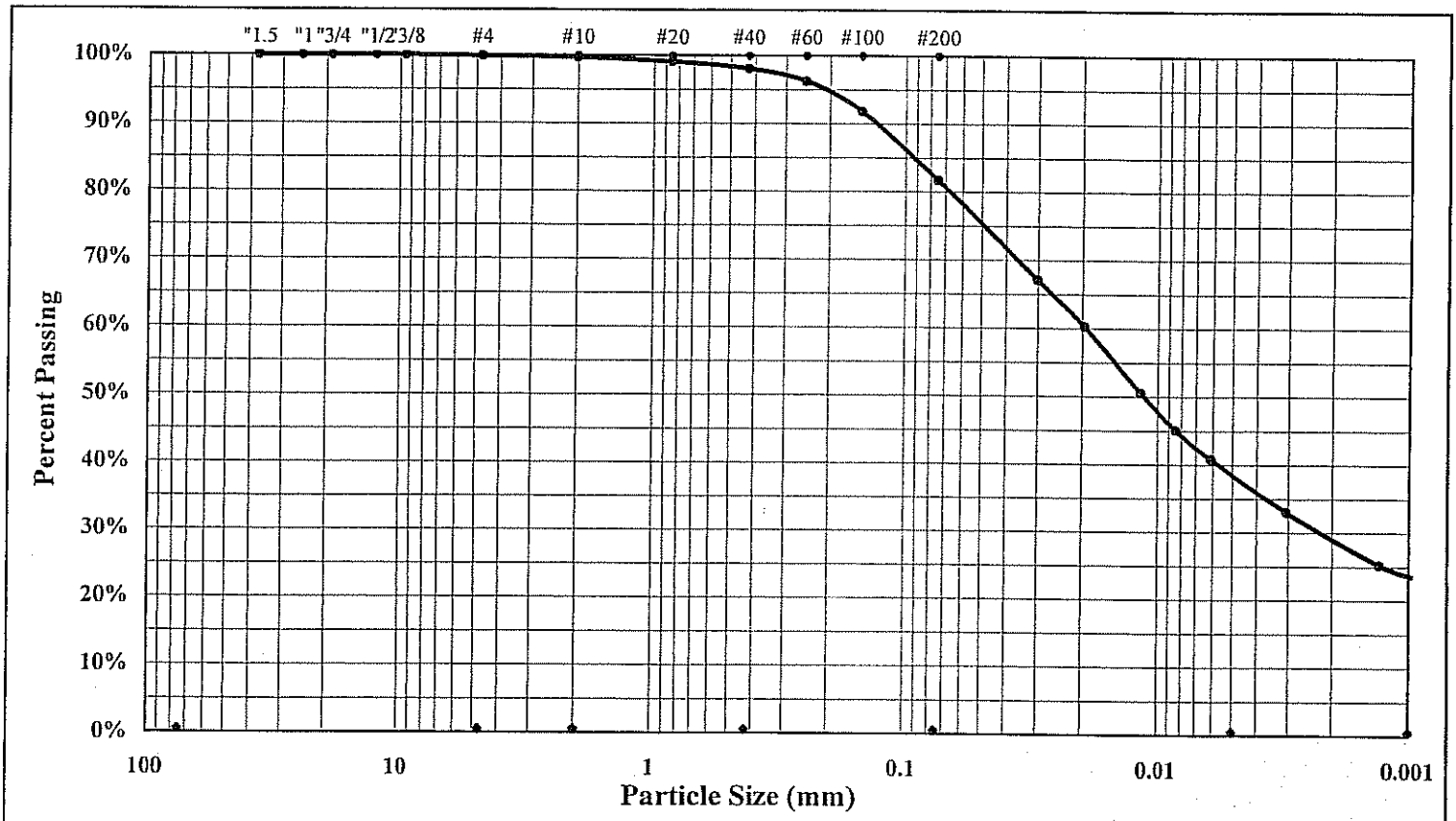
Hydrometer #483 (M-6, 5-10') 12-14-07.xls

Particle Size Analysis of Soils

ASTM D 422

S&ME Project #:	**1411-07-103**	Report Date:	12/14/07
Project Name:	**Marshall Steam Station**	Test Date(s):	12/11 - 12/13/07
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-6	Sample #:	483	Sample Date:	11/14/07
Location:	Bulk	Offset:	N/A	Elevation:	5-10'
Sample Description:	Red brown clayey SILT with fine sand (MH)				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	4.75 mm	Gravel	0.1%	Silt	43.7%
Silt & Clay (% Passing #200)	81.7%	Sand	18.2%	Clay	38.0%
Specific Gravity	2.650	Moisture Content	32.7%	Colloids	23.4%
Liquid Limit	54	Plastic Limit	36	Plastic Index	18

Description of Sand & Gravel Particles Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Mechanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

References: ASTM D 422: Particle Size Analysis of Soils
ASTM D 421: Dry Preparation of Soil Samples
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 854: Specific Gravity of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. _____ QC Manager

Signature *Position*

Moisture - Density Relationship

S&ME

S&ME Project #:	**1411-07-103**	Test Date(s):	December 20, 2007
Project Name:	Marshall Steam Station	Report Date:	December 21, 2007
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-6	Sample #:	483	Sample Date:	November 14, 2007
Location:	Bulk	Offset:	N/A	Depth:	5-10'

Sample Description: Red brown clayey SILT with fine sand (MH)

Liquid Limit:	54	Specific Gravity:	2.650
Plastic Limit:	36	Plastic Index:	18

Natural Moisture Content: 32.7%

Moisture Content of the Oversize Fraction:

NOTES:

Sieve Size	% Passing
#4	99.9
#10	99.7
#20	99.1
#40	98.1
#60	96.2
#100	91.8
#200	81.7

MDD: 93.0 **Opt. MC %: 27.0**

Water Content

Water Content requires GP 2 Balance (0.1 gram Readability).

ASTM D2216 ☒ AASHTO T265 ☐ ASTM D4959 ☐ ASTM D4643 ☐

	Sample #:	1	2	3	4	5	6
	Water Added:						
	Tare #:						
A. Tare Weight	A.	0	0	0	0	0	0
B. Wet Wt + Tare Wt	B.	500	500	500	500	500	500
C. Dry Wt. + Tare Wt.	C.	401.6	395.1	387.8	381.8		
D. Water Weight	B-C	98.4	104.9	112.2	118.2	500	500
E. Dry Weight	C-A	401.6	395.1	387.8	381.8	0	0
F. Moisture Content	100*D/E	**24.5%**	**26.6%**	**28.9%**	**31.0%**	**#DIV/0!**	**#DIV/0!**

Compaction Data

The Compaction Test requires a GP 5 Balance for ASTM (1 gram or .0022 Lb. readability).

G. Wt of Soil + Mold	G.	13.078	13.218	13.252	13.200		
H. Wt. of Mold	H.	9.304	9.304	9.304	9.304	9.304	9.304
I. Wt. of Soil (g. or lbs.)	G-H	3.774	3.914	3.948	3.896	-9.304	-9.304
J. Wt of Soil (Lbs.)	I/453.6 or I	3.774	3.914	3.948	3.896	-9.304	-9.304
K. Mold Volume Factor	K.	30.039	30.039	30.039	30.039	30.039	30.039
L. Wet Density	J*K	113.4	117.6	118.6	117.0	-279.5	-279.5
M. Dry Density	L/(1+F)	**91.1**	**92.9**	**92.0**	**89.4**	**#DIV/0!**	**#DIV/0!**

ASTM D558 ☐ ASTM D 698 ☒ ASTM D1557 ☐ AASHTO T99 ☐ AASHTO T180 ☐

Method A ☒ Method B ☐ Method C ☐ Method D (ASTM 1978) ☐ AASHTO Method D ☐

Moisture-Density Relation of: Fine Fraction ☒ Corrected for Coarse Fraction (ASTM D 4718) ☐

Sieve Size used to separate the Oversize Fraction: #4 Sieve ☒ 3/8 inch Sieve ☐ 3/4 inch Sieve ☐

Mechanical Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

Soil Plasticity: ASTM D 4318 ☒ AASHTO T 89 ☐ AASHTO T 90 ☐

Sieve Analysis / Particle Size Analysis: ASTM C136 ☐ AASHTO T 27 ☐ ASTM D 422 ☒ AASHTO T 88 ☐

Specific Gravity of Soil: ASTM D 854 ☒ AASHTO T 100 ☐

Bulk Gravity of Oversize Fraction: ASTM C 127 ☐ AASHTO T 85 ☐

Soil Classification: ASTM D 2487 ☒ ASTM D 2488 ☐ AASHTO M 145 ☐

Technician Name: B. Hatton

Certification #

Technical Responsibility: Brian Vaughan, P.E. Signature Construction Services Manager Position

Moisture - Density Report

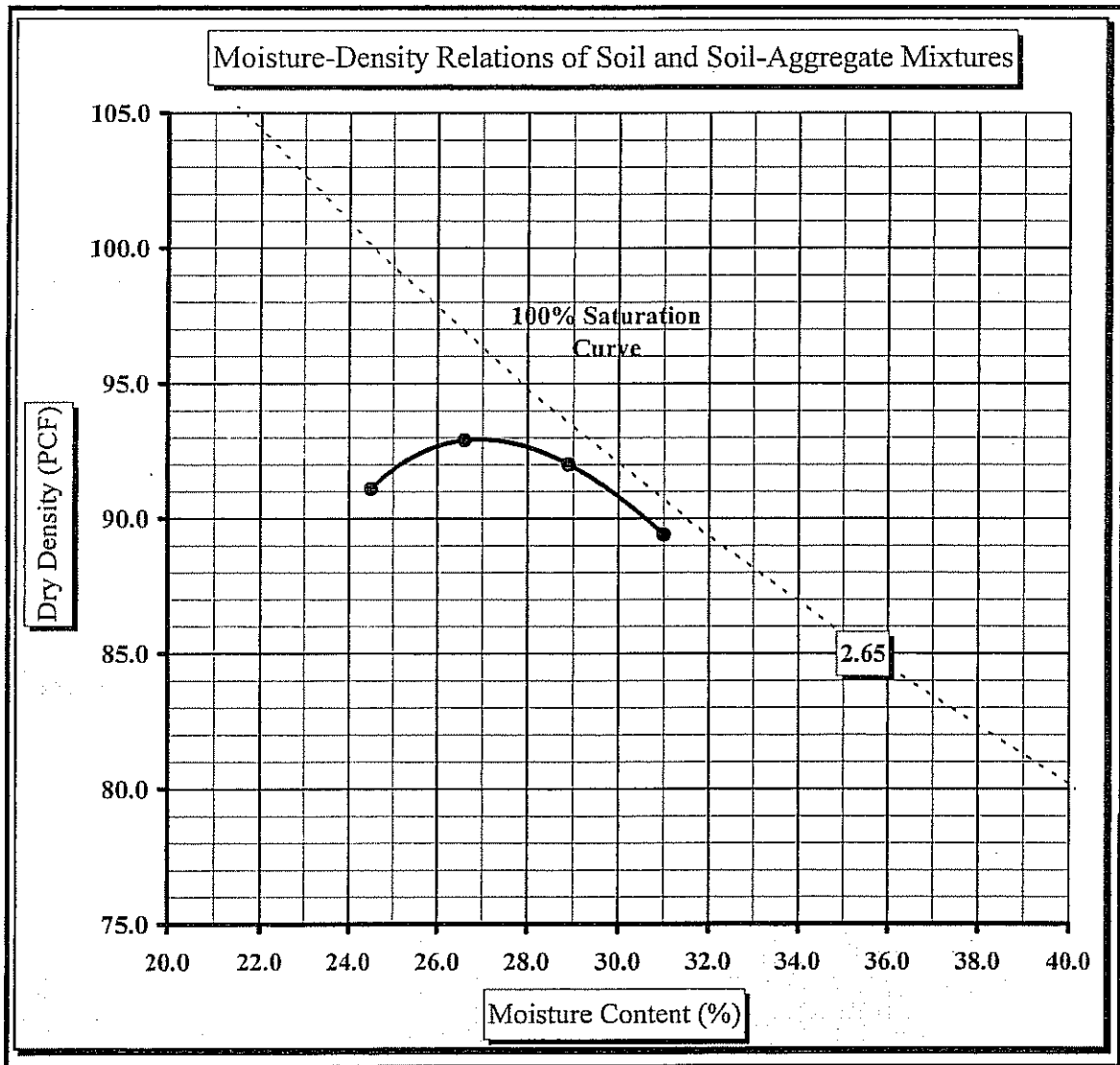
S&ME

S&ME Project #:	**1411-07-103**	Report Date:	December 21, 2007
Project Name:	**Marshall Steam Station**	Test Date(s):	December 20, 2007
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-6	Sample #:	483	Sample Date:	November 14, 2007
Location:	Bulk	Offset:	N/A	Depth:	5-10'
Sample Description:	Red brown clayey SILT with fine sand (MH)				

Maximum Dry Density 93.0 PCF. **Optimum Moisture Content 27.0 %**

ASTM D 698 Method A



Soil Properties

Natural Moisture Content:	32.7%
Liquid Limit:	54
Plastic Limit:	36
Plastic Index:	18
Specific Gravity:	2.650

% Passing

#4	99.9
#10	99.7
#20	99.1
#40	98.1
#60	96.2
#100	91.8
#200	81.7

Oversize Fraction

Bulk Sp. Gravity
% Moisture
Oversize Fraction
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 Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

References: ASTM D 698: Laboratory Compaction Characteristics of Soil Using Standard Effort
ASTM D 2216: Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D 422: Particle Size Analysis of Soils ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. Construction Services Manager

S&ME

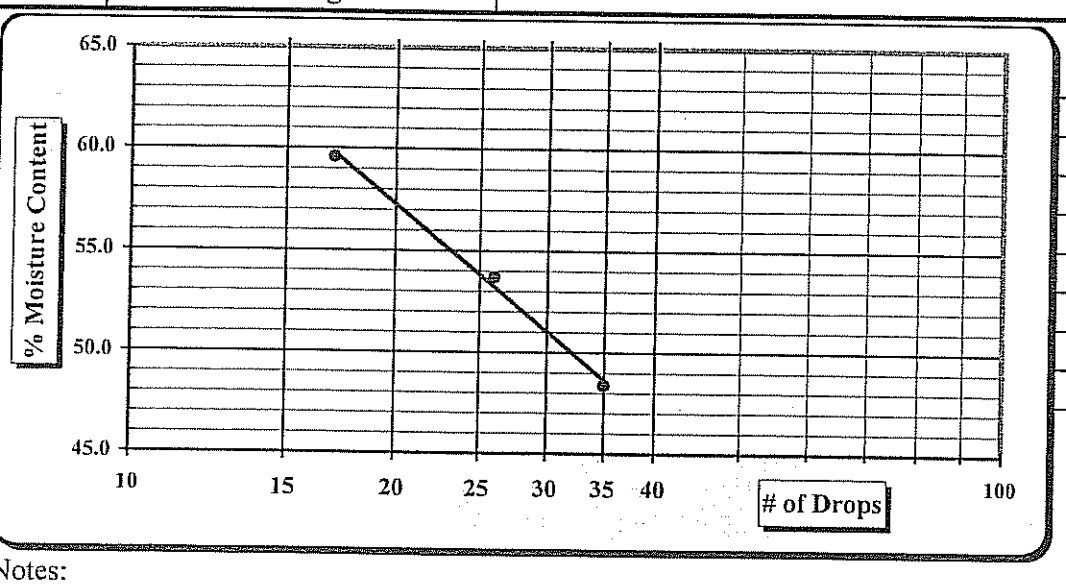
Liquid Limit, Plastic Limit, and Plastic Index

Project #: **1411-07-103**
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Charlotte, NC

Report Date: 1/22/08
Test Date(s): 1/21/08

Boring #: M-6 Sample #: 483 Sample Date: 11/14/07
Location: Bulk Offset: N/A Elevation: 5-10'
Sample Description: Red brown clayey SILT with fine sand (MH)

Pan #		Liquid Limit						Plastic Limit		
	Test #	1	2	3	4	5	6	1	2	3
	Tare #	Q-1	Q-2	Q-3				3	4	
A	Tare Weight	16.80	16.77	15.75				**10.87**	10.98	
B	Wet Soil Weight + A	38.73	38.90	38.33				17.45	17.76	
C	Dry Soil Weight + A	31.58	31.17	29.90				15.70	15.97	
D	Water Weight (B-C)	7.15	7.73	8.43				1.75	1.79	
E	Dry Soil Weight (C-A)	14.78	14.40	14.15				4.83	4.99	
F	% Moisture Content (D/E)*100	48.4%	53.7%	59.6%				36.2%	35.9%	
N	# OF DROPS	35	26	17				*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average							36.1%		



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes:

pecial Sampling Methods:

ample Preparation: Wet Preparation ☐ Dry Preparation ☒ Air Dried ☒
iquid limit Test: Multipoint Method ☒ One-point Method ☐
lassification: ASTM D 2487 ☒ AASHTO M 145 ☐
iquid limit Test: ASTM D 4318 ☒ AASHTO T 89 ☐
lastic limit Test: ASTM D 4318 ☒ AASHTO T 90 ☐

% Passing #200 Sieve:	81.7
NP, Non-Plastic	☐
Liquid Limit	54
Plastic Limit	36
Plastic Index	18
Group Symbol	MH

echnician Name: M. Jacobs

Certification #

echnical Responsibility: Brian Vaughan, P.E. Signature QC Manager Position

CONSTANT HEAD PERMEABILITY

ASTM D5084

S&ME Project Number: 1411-07-103 Project Name: Marshall Steam Station 2/27/2008

Sample Name: M-6 483 (5-10')

Sample Description: Red Brown Clayey Silt w/Fine Sand (MH)

Type of Sample: Remolded

Sample Data		Molding Moisture Content		Target Molding Conditon				Additonal Data	
Diam. (cm)	7.448	Tare No.	T-4	γ_{wet} (pcf)	114.4			Panel No	7
Leng. (cm)	7.275	WWS+ Tare (gm)	364.62	γ_{dry} (pcf)	88.4			Cell P (psi)	82.5
Area (cm^2)	43.57	WDS+Tare (gm)	299.43	w (%)	29.5			Influent P (psi)	80.1
Vol. (cm^3)	316.96	WT of Water (gm)	65.19	Actual Molding Condition				Effluent P (psi)	80.0
WWS (gm)	582.5	WT of TARE (gm)	81.63	γ_{wet} (pcf)	115.7				
		WT Dry Soil (gm)	217.8	γ_{dry} (pcf)	89.0			Gradient	1.0
		w (%)	29.9	w (%)	29.9				

K = (Q x L) / (t x H x A)

Run	Temp. (^{0}C)	Hour	Minute	Time, t (sec)	Cell Burette (cc)	Influent Burette(cc)	Effluent Burette (cc)	Q (cc)	Δ H (cm)	Temp Corr.	K(cm/sec)
1		14	32		11.8	1.3	23.5				
	22	16	23	6660	11.8	2.0	22.8	0.7	7.0	0.9530	2.38E-06
2		10	0		12.4	2.0	22.5				
	22	10	59	3540	12.4	2.5	22.4	0.3	7.0	0.9530	1.92E-06
3		11	28		12.4	2.7	22.4				
	22	12	34	3960	12.4	3.1	22.1	0.3	7.0	0.9530	2.00E-06
4		12	34		12.4	3.1	22.1				
	22	13	51	4620	12.4	3.5	21.7	0.4	7.0	0.9530	1.96E-06
5		10	57		12.5	0.2	24.2				
	22	13	35	9480	12.5	1.2	23.5	0.9	7.0	0.9530	2.03E-06
6										Ave. K (cm/sec)	1.97E-06
										(Runs 2 thru 5)	
										Ave. K (m/sec)	1.97E-08

Particle Size Analysis of Soils

ASTM D 422

S&ME

Project #: **1411-07-103**
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Charlotte, NC

Test Date(s): 12/11 - 12/13/07
Report Date: 12/14/07

Boring #: M-6 Sample #: 483 Sample Date: 11/14/07
Location: Bulk Offset: N/A Elevation: 10-15'
Sample Description: Brown red micaceous clayey SILT with fine sand (ML)

Pan #:	3	Beaker #:	3
Hydrometer Jar #:			3
Pan Tare Weight (grams):			0.00
Total Sample Air Dried Wt. + tare wt. (grams):			432.26
Weight of Total Sample Air Dried:			432.26
Weight of Air Dried Hydrometer Sample (g):			52.69
Total Sample Oven Dried:			417.41
Hydrometer Sample Oven Dried (W):			50.87
% Passing #10:			99.4%
Correction Factor a (Table 1):			1.00

Specific Gravity 2.650

	Moisture Content	Hygroscopic	Natural
	Tare #	P-3	315
A	Tare Wt.	16.56	0.00
B	Wet Wt. + A	29.01	206.83
C	Dry Wt. + A	28.58	155.77
D	Water Wt. (B-C)	0.43	51.06
E	Dry Wt. (C-A)	12.02	155.77
	% Moisture (100 x D/E)	3.58%	32.8%

Sieve	Retained Wt.	Percent Passing	
3.0"	0.0	Pan # (washed)	100.0%
1.5"	0.0		100.0%
1.0"	0.0		100.0%
3/4"	0.0	53	100.0%
1/2"	0.0		100.0%
3/8"	0.0		100.0%
#4	0.3	Soil Mortar	99.9%
#10	2.4	**100.0%**	99.4%
#20	0.6	98.9%	98.3%
#40	1.6	97.0%	96.4%
#60	3.4	93.3%	92.8%
#100	7.8	84.7%	84.2%
#200	14.8	70.8%	70.4%

Notes: Description of Sand & Gravel Particles — Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:	4.75 mm	Total Sand:	29.5%	< 4.74 mm and > 0.075 mm	Type: Mechanical Stirring Apparatus (A)
% Gravel:	0.1%	< 75 mm and > 4.75 mm	Silt & Clay:	70.4%	< 0.075 — Dispersion Time: 1 min.
Coarse Sand:	0.5%	< 4.75 mm and > 2.00 mm	Silt:	44.4%	< 0.075 and > 0.005 mm — Sodium Hexametaphosphate: 40 g./ Liter
Medium Sand:	3.0%	< 2.00 mm and > 0.425 mm	Clay:	26.0%	< 0.005 mm
Fine Sand:	26.0%	< 0.425 mm and > 0.075 mm	Colloids:	13.6%	< 0.001 mm — **Control Cylinder** ☐ **Composite Correction** ☒

Liquid Limit **45** Plastic Limit **39** Plastic Index **6** Hydrometer: 151H ☐ 152H ☒

Time		Temp.	Hydrometer	Corrections		Hydrometer	Percent Passing		Effective Depth	Table 3	Diameter
Clock	T (Min.)	(0.5 °C)	Reading	Control Cylinder	Composite Correction	R	P(-#10) = (R x a / W) x 100	P (total) = P x % Passing #10	L	K	D = K x ((L/T)^1/2
	2	23.5	33.5		5.05	28.45	55.9%	55.6%	11.6	0.01309	0.03156
	5	23.5	29.5		5.05	24.45	48.1%	47.8%	12.3	0.01309	0.02052
	15	23.5	25.0		5.05	19.95	39.2%	39.0%	13.0	0.01309	0.01220
	30	23.4	22.5		5.05	17.45	34.3%	34.1%	13.4	0.01317	0.00881
	60	23.4	20.0		5.05	14.95	29.4%	29.2%	13.8	0.01317	0.00633
	250	23.2	16.0		5.10	10.90	21.4%	21.3%	14.5	0.01317	0.00317
	1440	23.3	13.0		5.05	7.95	15.6%	15.5%	15.0	0.01317	0.00134
	2880	23.4	12.0		5.05	6.95	13.7%	13.6%	15.2	0.01317	0.00096

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Effective Depth (cm)
$L=L1+0.5(L2-(VB/A))$
(152H) .164cm per increment,
$V_B=67.0cm^3$, $L_2=14cm$, $A=27.8cm^2$

Technician Name: M. Jacobs

Technical Responsibility: Brian Vaughan, P.E.

Certification #

Signature

QC Manager
Position

S&ME, INC.
155 Tradd Street Spartanburg, SC 29301

Hydrometer #483 (M-6, 10-15') 12-14-07.xls

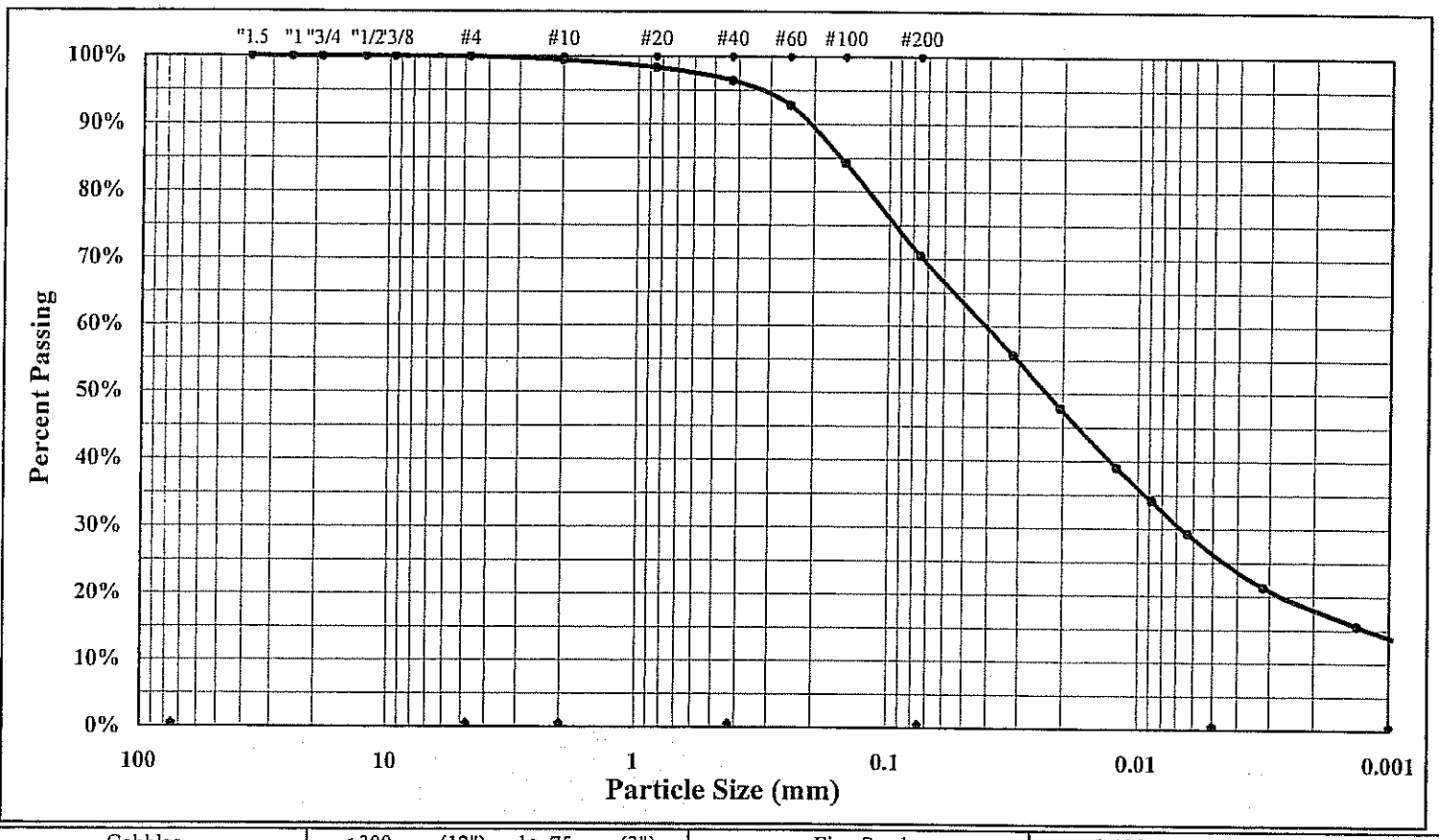
Particle Size Analysis of Soils

S&ME

ASTM D 422

S&ME Project #:	**1411-07-103**	Report Date:	12/14/07
Project Name:	**Marshall Steam Station**	Test Date(s):	12/11 - 12/13/07
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-6	Sample #:	483	Sample Date:	11/14/07
Location:	Bulk	Offset:	N/A	Elevation:	10-15'
Sample Description:	Brown red micaceous clayey SILT with fine sand (ML)				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	4.75 mm	Gravel	0.1%	Silt	44.4%
Silt & Clay (% Passing #200)	70.4%	Sand	29.5%	Clay	26.0%
Specific Gravity	2.650	Moisture Content	32.8%	Colloids	13.6%
Liquid Limit	45	Plastic Limit	39	Plastic Index	6

Description of Sand & Gravel Particles Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Mechanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

References: ASTM D 422: Particle Size Analysis of Soils
ASTM D 421: Dry Preparation of Soil Samples
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 854: Specific Gravity of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. _____ QC Manager

Signature Position

Moisture - Density Relationship

S&ME

S&ME Project #:	**1411-07-103**	Test Date(s):	December 20, 2007
Project Name:	Marshall Steam Station	Report Date:	December 21, 2007
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		
Boring #: M-6	Sample #: 483	Sample Date:	November 14, 2007
Location: Bulk	Offset: N/A	Depth:	10-15'
Sample Description:	Brown red micaceous clayey SILT with fine sand (ML)		

Liquid Limit: 45 Specific Gravity: 2.650
Plastic Limit: 39 Plastic Index: 6

Natural Moisture Content: 32.8%
Moisture Content of the Oversize Fraction:

NOTES:

Sieve Size	% Passing
#4	99.9
#10	99.4
#20	98.3
#40	96.4
#60	92.8
#100	84.2
#200	70.4

MDD: 90.6 **Opt. MC %:** 27.2

Water Content Water Content requires GP 2 Balance (0.1 gram Readability).

ASTM D2216 ☒ AASHTO T265 ☐ ASTM D4959 ☐ ASTM D4643 ☐

	Sample #:	1	2	3	4	5	6
	Water Added:						
	Tare #:						
A. Tare Weight	A.	0	0	0	0	0	0
B. Wet Wt + Tare Wt	B.	500	500	500	500	500	500
C. Dry Wt. + Tare Wt.	C.	401.1	394.8	388.9	383.4		
D. Water Weight	B-C	98.9	105.2	111.1	116.6	500	500
E. Dry Weight	C-A	401.1	394.8	388.9	383.4	0	0
F. Moisture Content	100*D/E	**24.7%**	**26.6%**	**28.6%**	**30.4%**	**#DIV/0!**	**#DIV/0!**

Compaction Data The Compaction Test requires a GP 5 Balance for ASTM (1 gram or .0022 Lb. readability).

G. Wt of Soil + Mold	G.	13.010	13.120	13.164	13.154		
H. Wt. of Mold	H.	9.304	9.304	9.304	9.304	9.304	9.304
I. Wt. of Soil (g. or lbs.)	G-H	3.706	3.816	3.860	3.850	-9.304	-9.304
J. Wt of Soil (Lbs.)	I/453.6 or I	3.706	3.816	3.860	3.850	-9.304	-9.304
K. Mold Volume Factor	K.	30.039	30.039	30.039	30.039	30.039	30.039
L. Wet Density	J*K	111.3	114.6	116.0	115.7	-279.5	-279.5
M. Dry Density	L/(1+F)	**89.3**	**90.5**	**90.2**	**88.7**	**#DIV/0!**	**#DIV/0!**

ASTM D558 ☐ ASTM D 698 ☒ ASTM D1557 ☐ AASHTO T99 ☐ AASHTO T180 ☐
Method A ☒ Method B ☐ Method C ☐ Method D (ASTM 1978) ☐ AASHTO Method D ☐
Moisture-Density Relation of: Fine Fraction ☒ Corrected for Coarse Fraction (ASTM D 4718) ☐
Sieve Size used to separate the Oversize Fraction: #4 Sieve ☒ 3/8 inch Sieve ☐ 3/4 inch Sieve ☐
Mechanical Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐
Soil Plasticity: ASTM D 4318 ☒ AASHTO T 89 ☐ AASHTO T 90 ☐
Sieve Analysis / Particle Size Analysis: ASTM C136 ☐ AASHTO T 27 ☐ ASTM D 422 ☒ AASHTO T 88 ☐
Specific Gravity of Soil: ASTM D 854 ☒ AASHTO T 100 ☐
Bulk Gravity of Oversize Fraction: ASTM C 127 ☐ AASHTO T 85 ☐
Soil Classification: ASTM D 2487 ☒ ASTM D 2488 ☐ AASHTO M 145 ☐

Technician Name: B. Hatton
Certification #

Technical Responsibility: Brian Vaughan, P.E. Construction Services Manager
Signature Position

Moisture - Density Report

S&ME

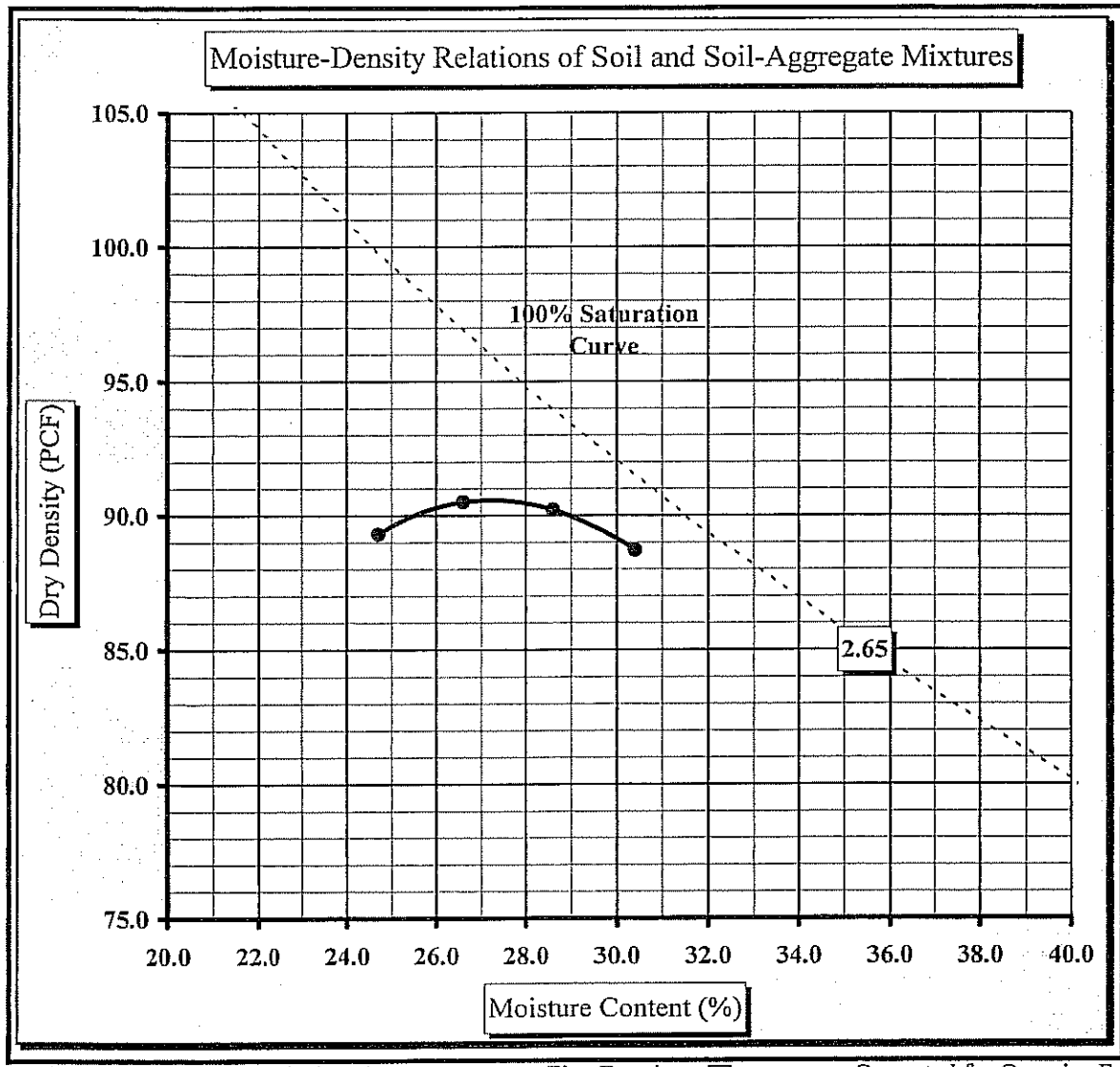
S&ME Project #:	**1411-07-103**	Report Date:	December 21, 2007
Project Name:	**Marshall Steam Station**	Test Date(s):	December 20, 2007
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-6	Sample #:	483	Sample Date:	November 14, 2007
Location:	Bulk	Offset:	N/A	Depth:	10-15'

Sample Description: Brown red micaceous clayey SILT with fine sand (ML)

Maximum Dry Density 90.6 PCF. **Optimum Moisture Content 27.2 %**

ASTM D 698 Method A



Soil Properties

Natural Moisture Content:	32.8%
Liquid Limit:	45
Plastic Limit:	39
Plastic Index:	6
Specific Gravity:	2.650

% Passing

#4	99.9
#10	99.4
#20	98.3
#40	96.4
#60	92.8
#100	84.2
#200	70.4

Oversize Fraction

Bulk Sp. Gravity
% Moisture
Oversize Fraction
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 Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

References: ASTM D 698: Laboratory Compaction Characteristics of Soil Using Standard Effort
ASTM D 2216: Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D 422: Particle Size Analysis of Soils ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. Construction Services Manager

S&ME

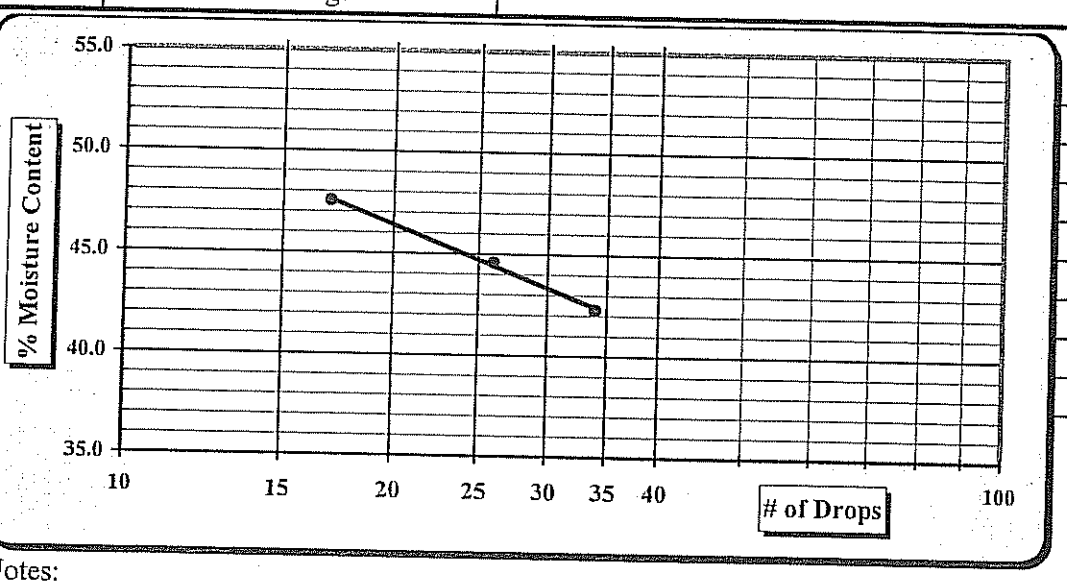
Liquid Limit, Plastic Limit, and Plastic Index

Project #: **1411-07-103**
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Charlotte, NC

Report Date: 1/22/08
Test Date(s): 1/21/08

Boring #: M-6 Sample #: 483 Sample Date: 11/14/07
Location: Bulk Offset: N/A Elevation: 10-15'
Sample Description: Brown red micaceous clayey SILT with fine sand (ML)

Pan #		Liquid Limit						Plastic Limit		
	Test #	1	2	3	4	5	6	1	2	3
	Tare #	Y-1	Y-2	Y-3				5	6	
A	Tare Weight	16.52	16.56	16.99				**10.84**	10.91	
B	Wet Soil Weight + A	40.34	39.75	39.40				18.45	18.22	
C	Dry Soil Weight + A	33.26	32.60	32.18				16.31	16.18	
D	Water Weight (B-C)	7.08	7.15	7.22				2.14	2.04	
E	Dry Soil Weight (C-A)	16.74	16.04	15.19				5.47	5.27	
F	% Moisture Content (D/E)*100	42.3%	44.6%	47.5%				39.1%	38.7%	
N	# OF DROPS	34	26	17				*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average							38.9%		



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes:

Special Sampling Methods:

Sample Preparation:	Wet Preparation ☐	Dry Preparation ☒	Air Dried ☒	% Passing #200 Sieve:	70.4
Liquid limit Test:	Multipoint Method ☒	One-point Method ☐		NP, Non-Plastic	☐
Classification:	ASTM D 2487 ☒	AASHTO M 145 ☐		Liquid Limit	45
Liquid limit Test:	ASTM D 4318 ☒	AASHTO T 89 ☐		Plastic Limit	39
Plastic limit Test:	ASTM D 4318 ☒	AASHTO T 90 ☐		Plastic Index	6
				Group Symbol	ML

Technician Name: M. Jacobs
Certification #

Technical Responsibility: Brian Vaughan, P.E. Signature QC Manager Position

CONSTANT HEAD PERMEABILITY

ASTM D5084

S&ME Project Number: 1411-07-103 Project Name: Marshall Steam Station 3/1/2008

Sample Name: M-6 483 (10-15')

Sample Description: Brown Red Micaceous Clayey Silt w/Fine Sand (ML)

Type of Sample: Remolded

Sample Data		Molding Moisture Content		Target Molding Conditon				Additonal Data	
Diam. (cm)	7.272	Tare No.	G-15	γ_{wet} (pcf)	111.6			Panel No	16
Leng. (cm)	7.673	WWS+ Tare (gm)	360.74	γ_{dry} (pcf)	86.1			Cell P (psi)	82.5
Area (cm^2)	41.53	WDS+Tare (gm)	297.16	w (%)	29.7			Influent P (psi)	80.1
Vol. (cm^3)	318.69	WT of Water (gm)	63.58	Actual Molding Condition				Effluent P (psi)	80.0
WWS (gm)	569	WT of TARE (gm)	81.3	γ_{wet} (pcf)	111.5				
		WT Dry Soil (gm)	215.86	γ_{dry} (pcf)	86.1			Gradient	0.9
		w (%)	29.5	w (%)	29.5				

K = (Q x L) / (t x H x A)

Run	Temp. (°C)	Hour	Minute	Time, t (sec)	Cell Burette (cc)	Influent Burette(cc)	Effluent Burette (cc)	Q (cc)	Δ H (cm)	Temp Corr.	K(cm/sec)
1		14	47		12.7	0.0	24.8				
	22	16	31	6240	12.7	5.7	19.0	5.8	7.0	0.9530	2.31E-05
2		9	8		12.7	0.2	24.9				
	22	11	2	6840	12.8	5.2	20.2	4.9	7.0	0.9530	1.77E-05
3		11	3		12.8	0.0	24.0				
	22	12	52	6540	12.8	4.6	19.2	4.7	7.0	0.9530	1.80E-05
4		12	53		12.9	0.1	24.5				
	22	16	41	13680	12.9	9.6	15.0	9.5	7.0	0.9530	1.74E-05
5		9	18		12.9	0.3	24.7				
	22	11	55	9420	12.9	6.1	19.0	5.8	7.0	0.9530	1.53E-05
										Ave. K (cm/sec)	1.71E-05
										(Runs 2 thru 5)	
										Ave. K (m/sec)	1.71E-07

Particle Size Analysis of Soils

ASTM D 422

S&ME

Project #: **1411-07-103**
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Charlotte, NC

Test Date(s): 4/2 - 4/4/08
Report Date: 4/7/08

Boring #: M-6 Sample #: 85 Sample Date: 11/15/07
Location: sample 5 Offset: N/A Elevation: 23.3-24.8'
Sample Description: Brown orange white micaceous fine sandy SILT

Pan #:	4	Beaker #:	4
Hydrometer Jar #:			4
Pan Tare Weight (grams):			0.00
Total Sample Air Dried Wt. + tare wt. (grams):			155.78
Weight of Total Sample Air Dried:			155.78
Weight of Air Dried Hydrometer Sample (g):			53.59
Total Sample Oven Dried:			149.51
Hydrometer Sample Oven Dried (W):			51.41
% Passing #10:			98.8%
Correction Factor a (Table 1):			1.00

Specific Gravity 2.650

	Moisture Content	Hygroscopic
	Tare #	Z-4
A	Tare Wt.	15.80
B	Wet Wt. + A	30.28
C	Dry Wt. + A	29.69
D	Water Wt. (B-C)	0.59
E	Dry Wt. (C-A)	13.89
	% Moisture (100 x D/E)	4.25%

Sieve	Retained Wt.	Percent Passing	
3.0"	0.0	Pan # (washed)	100.0%
1.5"	0.0		100.0%
1.0"	0.0		100.0%
3/4"	0.0	55	100.0%
1/2"	0.0		100.0%
3/8"	0.0		100.0%
#4	0.0	Soil Mortar	100.0%
#10	1.8	**100.0%**	98.8%
#20	1.2	97.8%	96.6%
#40	3.0	94.1%	93.0%
#60	5.5	89.2%	88.2%
#100	12.2	76.2%	75.3%
#200	20.5	60.1%	59.4%

Notes: Description of Sand & Gravel Particles — Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:	2.00 mm	
% Gravel:	0.0%	< 75 mm and > 4.75 mm
Coarse Sand:	1.2%	< 4.75 mm and > 2.00 mm
Medium Sand:	5.8%	< 2.00 mm and > 0.425 mm
Fine Sand:	33.6%	< 0.425 mm and > 0.075 mm

Total Sand:	40.6%	< 4.74 mm and > 0.075 mm
Silt & Clay:	59.4%	< 0.075
Silt:	48.9%	< 0.075 and > 0.005 mm
Clay:	10.5%	< 0.005 mm
Colloids:	5.5%	< 0.001 mm

Type: Mechanical Stirring Apparatus (A)
Dispersion Time: 1 min.
Sodium Hexametaphosphate: 40 g./ Liter

Liquid Limit N/A Plastic Limit N/A Plastic Index N/A

Control Cylinder ☐ **Composite Correction** ☒
Hydrometer: 151H ☐ 152H ☒

Time		Temp.	Hydrometer	Corrections		Hydrometer	Percent Passing		Effective Depth	Table 3	Diameter
Clock	T (Min.)	(0.5 °C)	Reading	Control Cylinder	Composite Correction	R	P(-#10) = (R x a / W) x 100	P (total) = P x % Passing #10	L	K	D = K x ((L/T)^1/2
	2	23.3	24.0		5.05	18.95	36.9%	36.4%	13.2	0.01317	0.03382
	5	23.3	20.0		5.05	14.95	29.1%	28.7%	13.8	0.01317	0.02191
	15	23.3	16.0		5.05	10.95	21.3%	21.0%	14.5	0.01317	0.01295
	30	23.3	13.5		5.05	8.45	16.4%	16.2%	14.9	0.01317	0.00928
	60	23.3	11.5		5.05	6.45	12.5%	12.4%	15.2	0.01317	0.00664
	250	22.9	9.5		5.10	4.40	8.6%	8.5%	15.6	0.01325	0.00331
	1440	23.0	8.0		5.10	2.90	5.6%	5.6%	15.8	0.01317	0.00138
	2880	22.6	8.0		5.15	2.85	5.5%	5.5%	15.8	0.01325	0.00098

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Effective Depth (cm)
L=L1+0.5(L2-(VB/A))
(152H) .164cm per increment,
V_B=67.0cm^3, L_2=14cm, A=27.8cm^2

Technician Name: M. Jacobs

Technical Responsibility: Brian Vaughan, P.E.

Certification #

Signature

OC Manager
Position

S&ME, INC.
155 Tradd Street Spartanburg, SC 29301

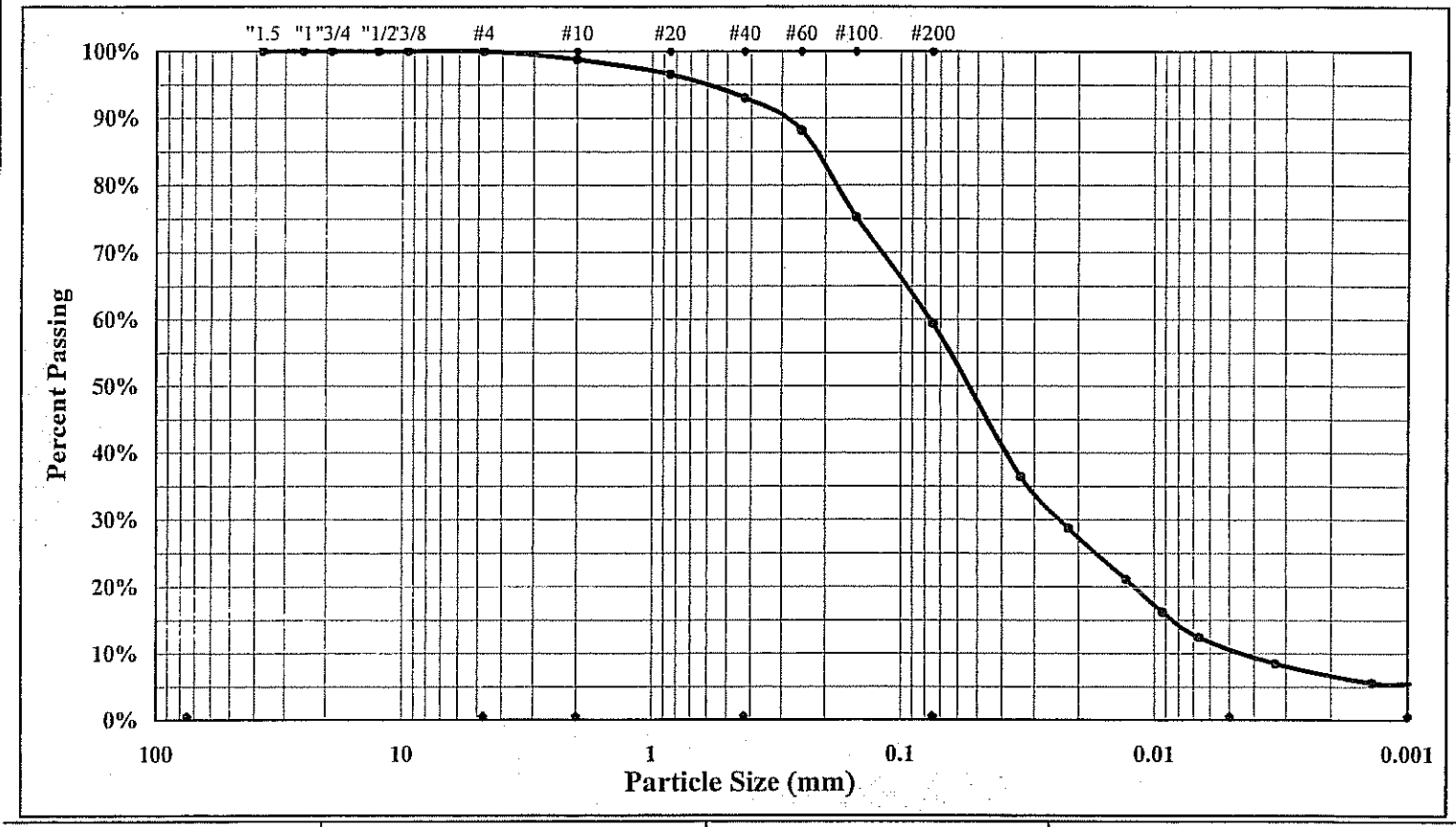
Hydrometer #85 (M-6, 23.3-24.8') 4-7-08.xls

Particle Size Analysis of Soils

ASTM D 422

S&ME Project #:	**1411-07-103**	Report Date:	4/7/08
Project Name:	**Marshall Steam Station**	Test Date(s):	4/2 - 4/4/08
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-6	Sample #:	85	Sample Date:	11/15/07
Location:	sample 5	Offset:	N/A	Elevation:	23.3-24.8'
Sample Description:	Brown orange white micaceous fine sandy SILT				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	2.00 mm	Gravel	0.0%	Silt	48.9%
Silt & Clay (% Passing #200)	59.4%	Sand	40.6%	Clay	10.5%
Specific Gravity	2.650			Colloids	5.5%
Liquid Limit	N/A	Plastic Limit	N/A	Plastic Index	N/A

Description of Sand & Gravel Particles Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Mechanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 854: Specific Gravity of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. _____ QC Manager
Signature *Position*

Particle Size Analysis of Soils

ASTM D 422

S&ME

Project #: 1411-07-103
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Charlotte, NC

Test Date(s): 12/19 - 12/21/07
Report Date: 12/26/07

Boring #: M-7 Sample #: 492 Sample Date: 11/26/07
Location: Bulk Offset: N/A Elevation: 0-5'
Sample Description: Brown red medium to fine sandy silty CLAY (CL)

Pan #:	4	Beaker #:	4
Hydrometer Jar #:			4
Pan Tare Weight (grams):			0.00
Total Sample Air Dried Wt. + tare wt. (grams):			452.72
Weight of Total Sample Air Dried:			452.72
Weight of Air Dried Hydrometer Sample (g):			52.81
Total Sample Oven Dried:			444.27
Hydrometer Sample Oven Dried (W):			51.80
% Passing #10:			97.1%
Correction Factor a (Table 1):			1.00

Specific Gravity 2.650

	Moisture Content	Hygroscopic	Natural
	Tare #	Q-4	352
A	Tare Wt.	16.75	0.00
B	Wet Wt. + A	29.25	229.76
C	Dry Wt. + A	29.01	193.46
D	Water Wt. (B-C)	0.24	36.30
E	Dry Wt. (C-A)	12.26	193.46
	% Moisture (100 x D/E)	1.96%	18.8%

Sieve	Retained Wt.	Percent Passing	
3.0"	0.0	Pan # (washed)	100.0%
1.5"	0.0		100.0%
1.0"	0.0		100.0%
3/4"	0.0		100.0%
1/2"	0.0	55	100.0%
3/8"	1.1		99.8%
#4	5.7	Soil Mortar	98.7%
#10	12.8	**100.0%**	97.1%
#20	2.0	96.2%	93.4%
#40	5.2	90.0%	87.4%
#60	9.9	80.9%	78.6%
#100	16.3	68.5%	66.5%
#200	23.3	55.1%	53.5%

Notes: Description of Sand & Gravel Particles — Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:	9.50 mm		Total Sand:	45.2%	< 4.74 mm and > 0.075 mm	Type: Mechanical Stirring Apparatus (A)
% Gravel:	1.3%	< 75 mm and > 4.75 mm	Silt & Clay:	53.5%	< 0.075	Dispersion Time: 1 min.
Coarse Sand:	1.6%	< 4.75 mm and > 2.00 mm	Silt:	20.0%	< 0.075 and > 0.005 mm	Sodium Hexametaphosphate: 40 g./ Liter
Medium Sand:	9.8%	< 2.00 mm and > 0.425 mm	Clay:	33.5%	< 0.005 mm	
Fine Sand:	33.9%	< 0.425 mm and > 0.075 mm	Colloids:	24.0%	< 0.001 mm	Control Cylinder ☐ Composite Correction ☒

Liquid Limit 41 Plastic Limit 25 Plastic Index 16 Hydrometer: 151H ☐ 152H ☒

Time		Temp.	Hydrometer	Corrections		Hydrometer	Percent Passing		Effective Depth	Table 3	Diameter
Clock	T (Min.)	(0.5 °C)	Reading	Control Cylinder	Composite Correction	R	P(-#10) = (R x a / W) x 100	P (total) = P x % Passing #10	L	K	D = K x ((L/T)^1/2
	2	22.1	30.5		5.20	25.30	48.8%	47.4%	12.1	0.01332	0.03282
	5	22.1	29.0		5.20	23.80	45.9%	44.6%	12.4	0.01332	0.02097
	15	22.1	27.0		5.20	21.80	42.1%	40.9%	12.7	0.01332	0.01227
	30	22.1	25.5		5.20	20.30	39.2%	38.1%	13.0	0.01332	0.00876
	60	22.2	24.0		5.20	18.80	36.3%	35.3%	13.2	0.01332	0.00625
	250	22.7	21.0		5.15	15.85	30.6%	29.7%	13.7	0.01325	0.00310
	1440	21.7	19.0		5.25	13.75	26.5%	25.8%	14.0	0.01340	0.00132
	2880	21.5	18.0		5.25	12.75	24.6%	23.9%	14.2	0.01340	0.00094

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technician Name: M. Jacobs

Technical Responsibility: Brian Vaughan, P.E.

Certification #

Signature

OC Manager
Position

Effective Depth (cm)
L=L1+0.5(L2-(VB/A))
(152H) .164cm per increment,
V_B=67.0cm^3, L_2=14cm, A=27.8cm^2

S&ME, INC.
155 Tradd Street Spartanburg, SC 29301

Hydrometer #492 (M-7, 0-5') 12-26-07.xls

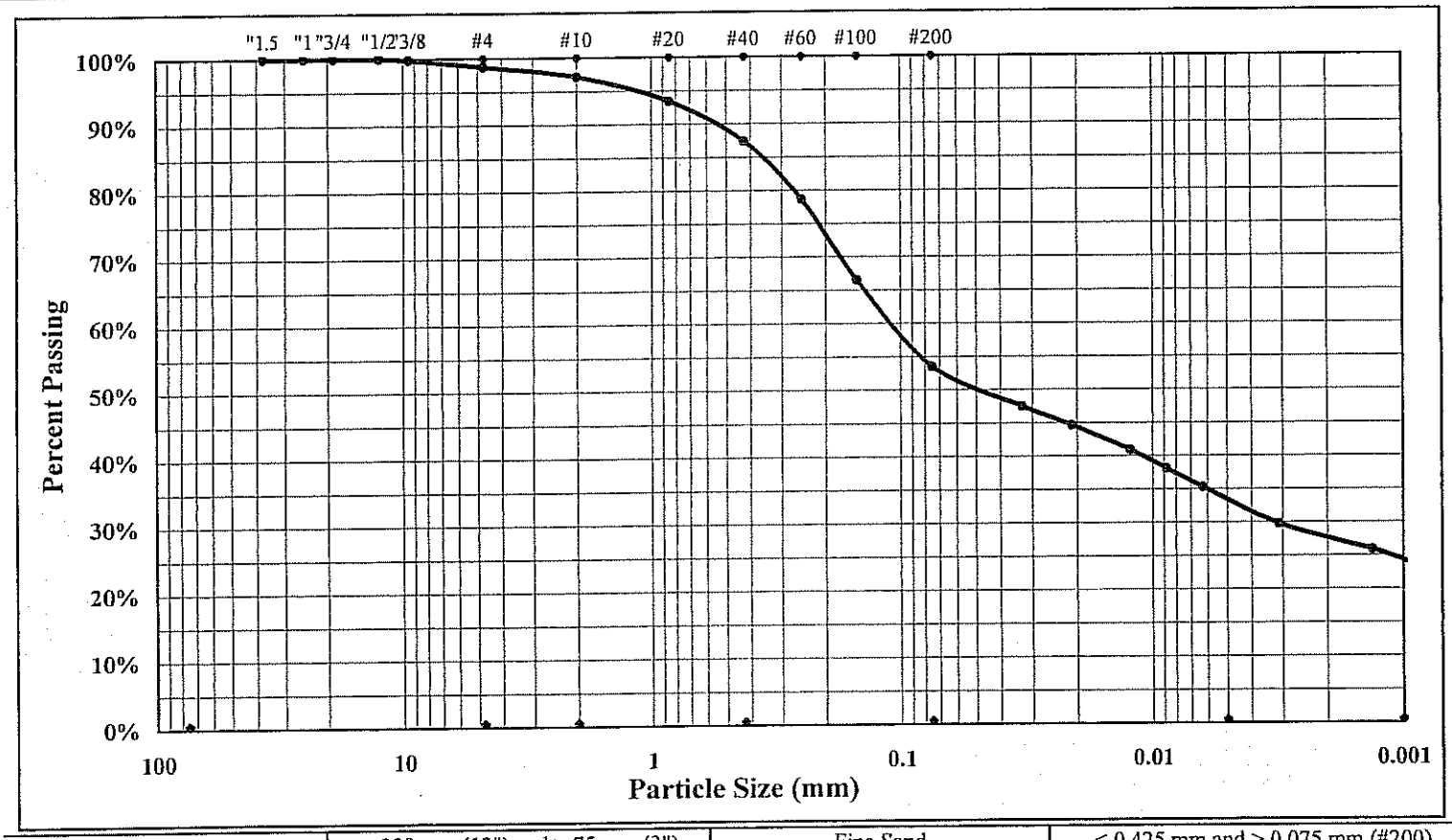
Particle Size Analysis of Soils

ASTM D 422

S&ME

S&ME Project #:	**1411-07-103**	Report Date:	12/26/07
Project Name:	**Marshall Steam Station**	Test Date(s):	12/19 - 12/21/07
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-7	Sample #:	492	Sample Date:	11/26/07
Location:	Bulk	Offset:	N/A	Elevation:	0-5'
Sample Description:	Brown red medium to fine sandy silty CLAY (CL)				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	9.50 mm	Gravel	1.3%	Silt	20.0%
Silt & Clay (% Passing #200)	53.5%	Sand	45.2%	Clay	33.5%
Specific Gravity	2.650	Moisture Content	18.8%	Colloids	24.0%
Liquid Limit	41	Plastic Limit	25	Plastic Index	16

Description of Sand & Gravel Particles Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Mechanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

References: ASTM D 422: Particle Size Analysis of Soils
ASTM D 421: Dry Preparation of Soil Samples
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 854: Specific Gravity of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. _____ QC Manager
Signature *Position*

Moisture - Density Relationship

S&ME

S&ME Project #:	**1411-07-103**	Test Date(s):	January 10, 2008
Project Name:	Marshall Steam Station	Report Date:	January 11, 2008
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-7	Sample #:	492	Sample Date:	November 26, 2007
Location:	Bulk	Offset:	N/A	Depth:	0-5'

Sample Description: Brown red medium to fine sandy silty CLAY (CL)

Liquid Limit:	41	Specific Gravity:	2.650
Plastic Limit:	25	Plastic Index:	16

Natural Moisture Content: 18.8%

Moisture Content of the Oversize Fraction:

NOTES:

Sieve Size	% Passing
3/8"	99.8
#4	98.7
#10	97.1
#20	93.4
#40	87.4
#60	78.6
#100	66.5
#200	53.5

MDD: 106.5 **Opt. MC %:** 17.0

Water Content

Water Content requires GP 2 Balance (0.1 gram Readability).

ASTM D2216 ☒ AASHTO T265 ☐ ASTM D4959 ☐ ASTM D4643 ☐

	Sample #:	1	2	3	4	5	6
	Water Added:						
	Tare #:						
A. Tare Weight	A.	0	0	0	0	0	0
B. Wet Wt + Tare Wt	B.	500	500	500	500	500	500
C. Dry Wt. + Tare Wt.	C.	443.2	435	428.1	420.8	413.6	
D. Water Weight	B-C	56.8	65	71.9	79.2	86.4	500
E. Dry Weight	C-A	443.2	435	428.1	420.8	413.6	0
F. Moisture Content	100*D/E	**12.8%**	**14.9%**	**16.8%**	**18.8%**	**20.9%**	**#DIV/0!**

Compaction Data

The Compaction Test requires a GP 5 Balance for ASTM (1 gram or .0022 Lb. readability).

G. Wt of Soil + Mold	G.	13.126	13.334	13.442	13.486	13.454	
H. Wt. of Mold	H.	9.304	9.304	9.304	9.304	9.304	9.304
I. Wt. of Soil (g. or lbs.)	G-H	3.822	4.030	4.138	4.182	4.150	-9.304
J. Wt of Soil (Lbs.)	I/453.6 or I	3.822	4.030	4.138	4.182	4.150	-9.304
K. Mold Volume Factor	K.	30.039	30.039	30.039	30.039	30.039	30.039
L. Wet Density	J*K	114.8	121.1	124.3	125.6	124.7	-279.5
M. Dry Density	L/(1+F)	**101.8**	**105.3**	**106.4**	**105.7**	**103.1**	**#DIV/0!**

ASTM D558 ☐ ASTM D 698 ☒ ASTM D1557 ☐ AASHTO T99 ☐ AASHTO T180 ☐

Method A ☒ Method B ☐ Method C ☐ Method D (ASTM 1978) ☐ AASHTO Method D ☐

Moisture-Density Relation of: Fine Fraction ☒ Corrected for Coarse Fraction (ASTM D 4718) ☐

Sieve Size used to separate the Oversize Fraction: #4 Sieve ☒ 3/8 inch Sieve ☐ 3/4 inch Sieve ☐

Mechanical Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

Soil Plasticity: ASTM D 4318 ☒ AASHTO T 89 ☐ AASHTO T 90 ☐

Sieve Analysis / Particle Size Analysis: ASTM C136 ☐ AASHTO T 27 ☐ ASTM D 422 ☒ AASHTO T 88 ☐

Specific Gravity of Soil: ASTM D 854 ☒ AASHTO T 100 ☐

Bulk Gravity of Oversize Fraction: ASTM C 127 ☐ AASHTO T 85 ☐

Soil Classification: ASTM D 2487 ☒ ASTM D 2488 ☐ AASHTO M 145 ☐

Technician Name: B. Hatton

Certification #

Technical Responsibility: Brian Vaughan, P.E. Signature Construction Services Manager Position

Moisture - Density Report

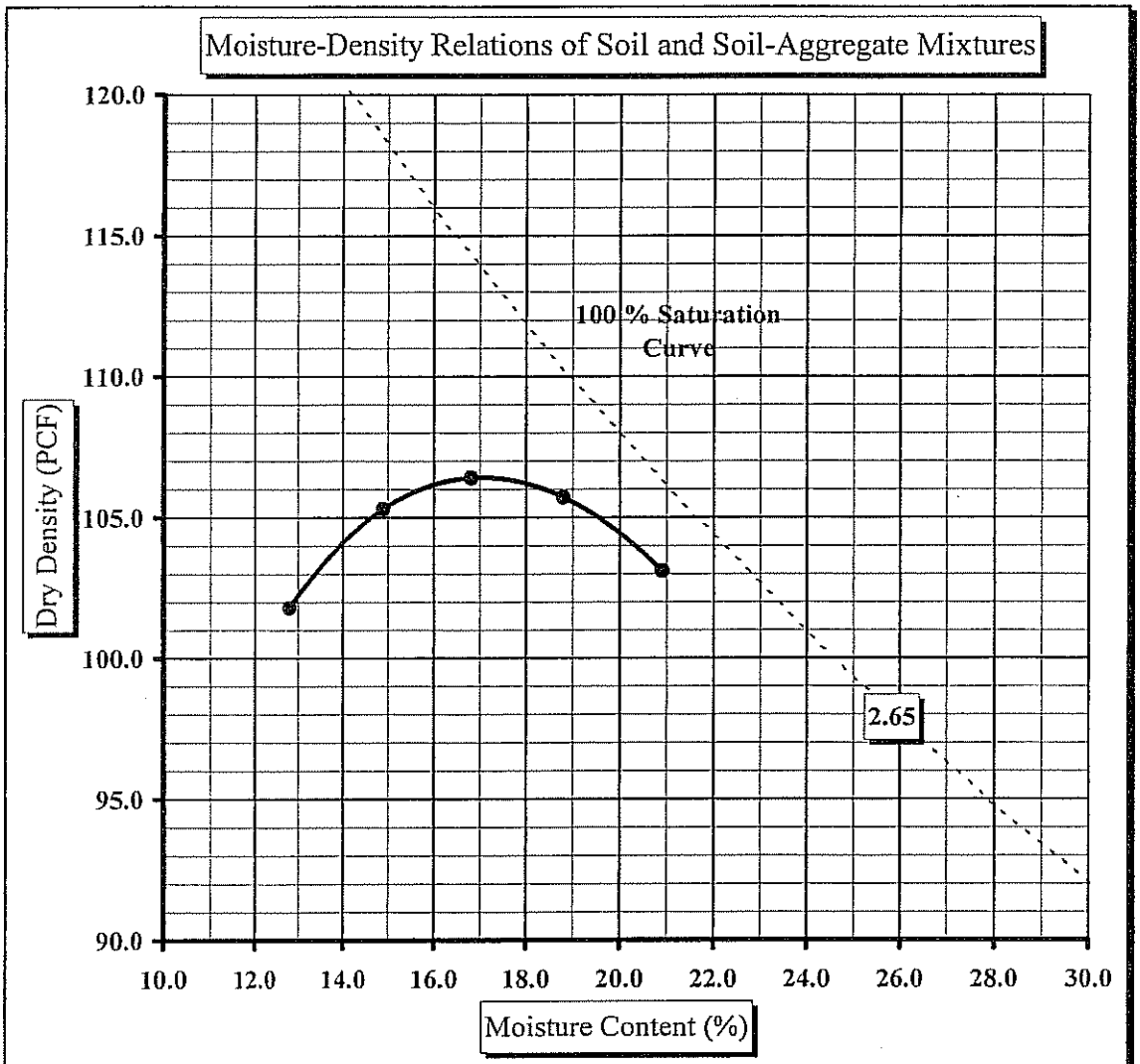
S&ME

S&ME Project #:	**1411-07-103**	Report Date:	January 11, 2008
Project Name:	**Marshall Steam Station**	Test Date(s):	January 10, 2008
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-7	Sample #:	492	Sample Date:	November 26, 2007
Location:	Bulk	Offset:	N/A	Depth:	0-5'
Sample Description:	Brown red medium to fine sandy silty CLAY (CL)				

Maximum Dry Density 106.5 PCF. **Optimum Moisture Content 17.0 %**

ASTM D 698 Method A



Soil Properties

Natural Moisture Content:	18.8%
Liquid Limit:	41
Plastic Limit:	25
Plastic Index:	16
Specific Gravity:	2.650

% Passing	
3/8"	99.8
#4	98.7
#10	97.1
#20	93.4
#40	87.4
#60	78.6
#100	66.5
#200	53.5

Oversize Fraction

Bulk Sp. Gravity
% Moisture
Oversize Fraction
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 Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

References: ASTM D 698: Laboratory Compaction Characteristics of Soil Using Standard Effort
ASTM D 2216: Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D 422: Particle Size Analysis of Soils
ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. Construction Services Manager

S&ME

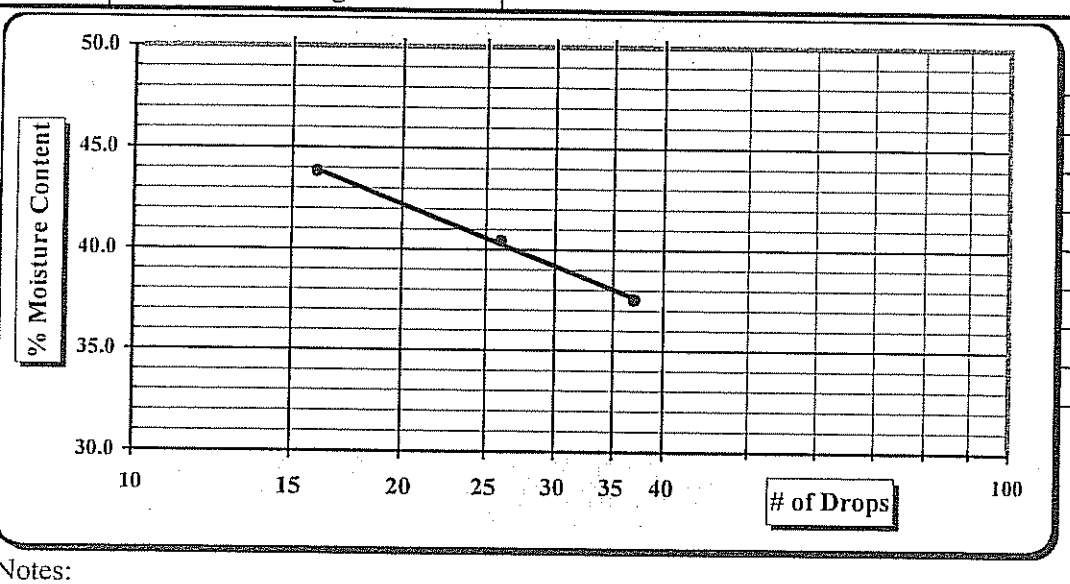
Liquid Limit, Plastic Limit, and Plastic Index

Project #: **1411-07-103**
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Charlotte, NC

Report Date: 1/25/08
Test Date(s): 1/24/08

Boring #: M-7 Sample #: 492 Sample Date: 11/26/07
Location: Bulk Offset: N/A Elevation: 0-5'
Sample Description: Brown red medium to fine sandy silty CLAY (CL)

Pan #		Liquid Limit						Plastic Limit		
	Test #	1	2	3	4	5	6	1	2	3
	Tare #	P-1	P-2	P-3				1	2	
A	Tare Weight	16.56	15.45	16.55				**10.90**	10.85	
B	Wet Soil Weight + A	38.95	37.79	38.31				18.63	18.38	
C	Dry Soil Weight + A	32.84	31.36	31.68				17.07	16.86	
D	Water Weight (B-C)	6.11	6.43	6.63				1.56	1.53	
E	Dry Soil Weight (C-A)	16.28	15.91	15.13				6.17	6.01	
F	% Moisture Content (D/E)*100	37.5%	40.4%	43.8%				25.3%	25.4%	
N	# OF DROPS	37	26	16				*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average							25.3%		



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes:

Special Sampling Methods:

Sample Preparation:	Wet Preparation ☐	Dry Preparation ☒	Air Dried ☒	% Passing #200 Sieve:	53.5
Liquid limit Test:	Multipoint Method ☒	One-point Method ☐		NP, Non-Plastic	☐
Classification:	ASTM D 2487 ☒	AASHTO M 145 ☐		Liquid Limit	41
Liquid limit Test:	ASTM D 4318 ☒	AASHTO T 89 ☐		Plastic Limit	25
Plastic limit Test:	ASTM D 4318 ☒	AASHTO T 90 ☐		Plastic Index	16
				Group Symbol	CL

Technician Name: M. Jacobs

Certification #

Technical Responsibility: Brian Vaughan, P.E.

Signature

QC Manager
Position

CONSTANT HEAD PERMEABILITY

ASTM D5084

S&ME Project Number: 1411-07-103 Project Name: Marshall Steam Station 3/3/2008

Sample Name: M-7 492 (0-5')

Sample Description: Brown Red Medium to Fine Sandy Silty Clay (CL)

Type of Sample: Remolded

Sample Data		Molding Moisture Content		Target Molding Conditon				Additonal Data	
Diam. (cm)	7.282	Tare No.	G-15	γ_{wet} (pcf)	120.9			Panel No	2
Leng. (cm)	7.62	WWS+ Tare (gm)	384.58	γ_{dry} (pcf)	101.2			Cell P (psi)	82.5
Area (cm^2)	41.65	WDS+Tare (gm)	335.45	w (%)	19.5			Influent P (psi)	80.1
Vol. (cm^3)	317.36	WT of Water (gm)	49.13	Actual Molding Condition				Effluent P (psi)	80.0
WWS (gm)	614.9	WT of TARE (gm)	61.24	γ_{wet} (pcf)	121.0				
		WT Dry Soil (gm)	254.21	γ_{dry} (pcf)	101.5			Gradient	0.9
		w (%)	19.3	w (%)	19.3				

K = (Q x L) / (t x H x A)

Run	Temp. (°C)	Hour	Minute	Time, t (sec)	Cell Burette (cc)	Influent Burette(cc)	Effluent Burette (cc)	Q (cc)	Δ H (cm)	Temp Corr.	K(cm/sec)
1		9	16		14.6	0.3	23.6				
	22	12	55	13140	14.6	5.1	23.1	2.7	7.0	0.9530	5.00E-06
2		12	56		14.6	0.3	23.2				
	22	17	40	17040	14.6	3.5	20.1	3.2	7.0	0.9530	4.58E-06
3		9	17		14.6	0.2	24.4				
	22	11	53	9360	14.6	1.5	23.3	1.2	7.0	0.9530	3.18E-06
4		11	54		14.7	0.3	24.0				
	22	17	5	18660	14.7	2.6	21.8	2.3	7.0	0.9530	2.99E-06
5		11	24		14.8	0.2	24.3				
	22	14	8	9840	14.8	1.6	23.1	1.3	7.0	0.9530	3.27E-06
6										Ave. K (cm/sec)	3.50E-06
										(Runs 2 thru 5)	
										Ave. K (m/sec)	3.5E-08

Particle Size Analysis of Soils

ASTM D 422

S&ME

Project #: 1411-07-103
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Charlotte, NC

Test Date(s): 12/19 - 12/21/07
Report Date: 12/26/07

Boring #: M-7 Sample #: 492 Sample Date: 11/26/07
Location: Bulk Offset: N/A Elevation: 5-10'
Sample Description: Brown red clayey silty fine SAND (SC-SM)

Pan #:	10	Beaker #:	5
Hydrometer Jar #:			5
Pan Tare Weight (grams):			0.00
Total Sample Air Dried Wt. + tare wt. (grams):			490.36
Weight of Total Sample Air Dried:			490.36
Weight of Air Dried Hydrometer Sample (g):			52.44
Total Sample Oven Dried:			487.30
Hydrometer Sample Oven Dried (W):			52.11
% Passing #10:			98.5%
Correction Factor a (Table 1):			1.00

Specific Gravity 2.650

	Moisture Content	Hygroscopic	Natural
	Tare #	Q-5	353
A	Tare Wt.	16.91	0.00
B	Wet Wt. + A	29.55	237.62
C	Dry Wt. + A	29.47	210.51
D	Water Wt. (B-C)	0.08	27.11
E	Dry Wt. (C-A)	12.56	210.51
	% Moisture (100 x D/E)	0.64%	12.9%

Sieve	Retained Wt.	Percent Passing	
3.0"	0.0	Pan # (washed) 57	100.0%
1.5"	0.0		100.0%
1.0"	0.0		100.0%
3/4"	0.0		100.0%
1/2"	0.0		100.0%
3/8"	0.0		100.0%
#4	3.0	Soil Mortar	99.4%
#10	7.4	**100.0%**	98.5%
#20	1.7	96.8%	95.4%
#40	4.8	90.9%	89.5%
#60	10.3	80.2%	78.9%
#100	19.2	63.1%	62.1%
#200	28.4	45.4%	44.7%

Notes: Description of Sand & Gravel Particles — Rounded ☐ Angular ☒ — Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:	4.75 mm		Total Sand:	54.7%	< 4.74 mm and > 0.075 mm	Type: Mechanical Stirring Apparatus (A)
% Gravel:	0.6%	< 75 mm and > 4.75 mm	Silt & Clay:	44.7%	< 0.075	Dispersion Time: 1 min.
Coarse Sand:	0.9%	< 4.75 mm and > 2.00 mm	Silt:	26.7%	< 0.075 and > 0.005 mm	Sodium Hexametaphosphate: 40 g./ Liter
Medium Sand:	9.0%	< 2.00 mm and > 0.425 mm	Clay:	18.0%	< 0.005 mm	
Fine Sand:	44.8%	< 0.425 mm and > 0.075 mm	Colloids:	10.9%	< 0.001 mm	Control Cylinder ☐ Composite Correction ☒

Liquid Limit 28 Plastic Limit 21 Plastic Index 7 Hydrometer: 151H ☐ 152H ☒

Time		Temp.	Hydrometer	Corrections		Hydrometer	Percent Passing		Effective Depth	Table 3	Diameter
Clock	T (Min.)	(0.5 °C)	Reading	Control Cylinder	Composite Correction	R	P(-#10) = (R x a / W) x 100	P (total) = P x % Passing #10	L	K	D = K x ((L/T)^1/2
	2	22.1	24.0		5.20	18.80	36.1%	35.5%	13.2	0.01332	0.03423
	5	22.1	22.0		5.20	16.80	32.2%	31.7%	13.5	0.01332	0.02192
	15	22.1	19.3		5.20	14.10	27.1%	26.6%	14.0	0.01332	0.01286
	30	22.1	17.5		5.20	12.30	23.6%	23.2%	14.3	0.01332	0.00919
	60	22.2	16.0		5.20	10.80	20.7%	20.4%	14.5	0.01332	0.00655
	250	22.7	13.0		5.15	7.85	15.1%	14.8%	15.0	0.01325	0.00325
	1440	21.9	11.5		5.20	6.30	12.1%	11.9%	15.3	0.01340	0.00138
	2880	21.6	11.0		5.25	5.75	11.0%	10.9%	15.4	0.01340	0.00098

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Effective Depth (cm)
L=L1+0.5(L2-(VB/A))
(152H) .164cm per increment,
V_B=67.0cm^3, L_2=14cm, A=27.8cm^2

Technician Name: M. Jacobs

Technical Responsibility: Brian Vaughan, P.E.

Certification #

Signature

OC Manager
Position

S&ME, INC.
155 Tradd Street Spartanburg, SC 29301

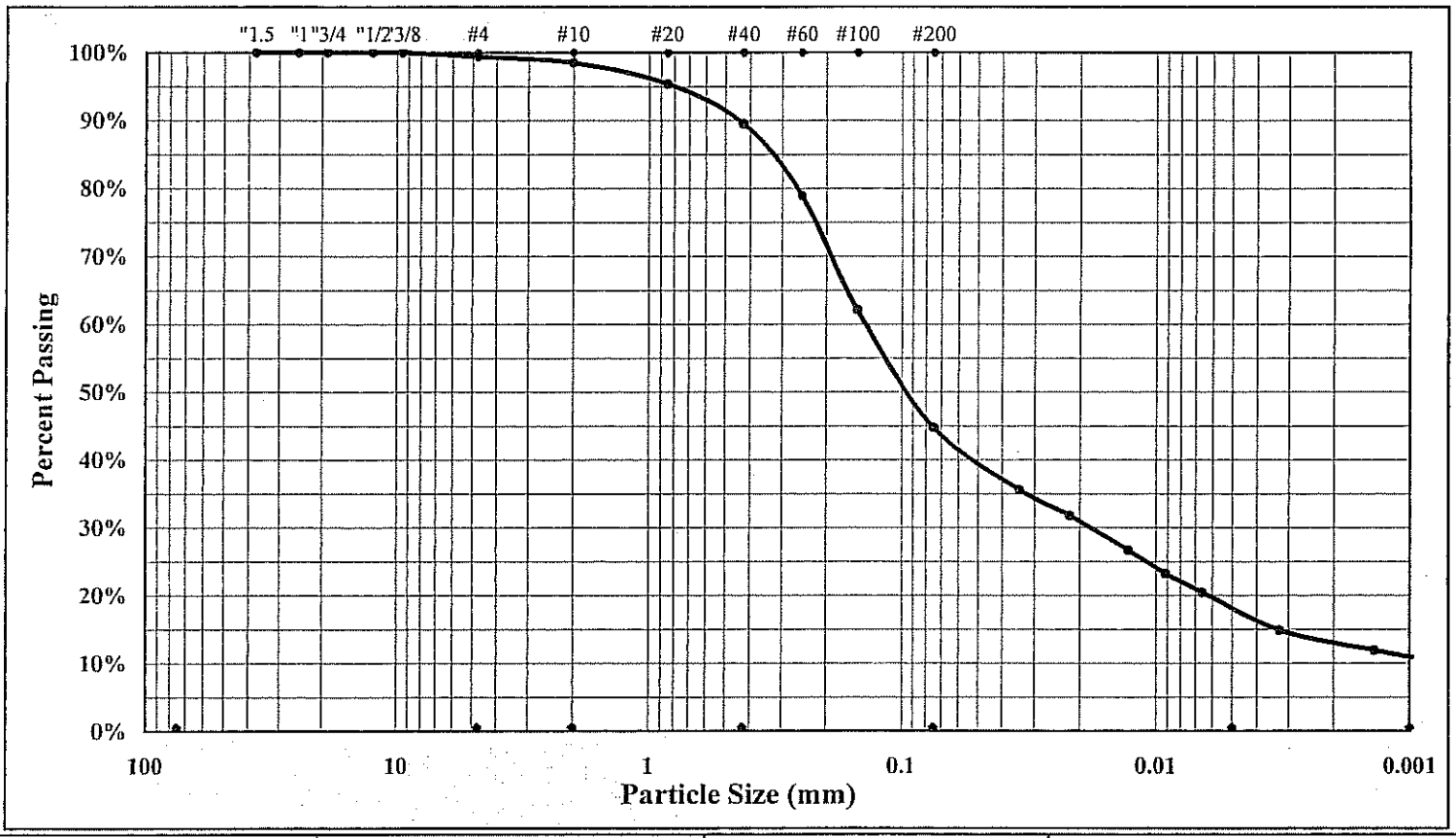
Hydrometer #492 (M-7, 5-10') 12-26-07.xls

Particle Size Analysis of Soils

ASTM D 422

S&ME Project #:	**1411-07-103**	Report Date:	12/26/07
Project Name:	**Marshall Steam Station**	Test Date(s):	12/19 - 12/21/07
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-7	Sample #:	492	Sample Date:	11/26/07
Location:	Bulk	Offset:	N/A	Elevation:	5-10'
Sample Description:	Brown red clayey silty fine SAND (SC-SM)				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	4.75 mm	Gravel	0.6%	Silt	26.7%
Silt & Clay (% Passing #200)	44.7%	Sand	54.7%	Clay	18.0%
Specific Gravity	2.650	Moisture Content	12.9%	Colloids	10.9%
Liquid Limit	28	Plastic Limit	21	Plastic Index	7

Description of Sand & Gravel Particles Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Mechanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 854: Specific Gravity of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. _____ QC Manager
Signature *Position*

Moisture - Density Relationship

S&ME

S&ME Project #:	**1411-07-103**	Test Date(s):	January 10, 2008
Project Name:	Marshall Steam Station	Report Date:	January 11, 2008
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-7	Sample #:	492	Sample Date:	November 26, 2007
Location:	Bulk	Offset:	N/A	Depth:	5-10'

Sample Description: Brown red clayey silty fine SAND (SC-SM)

Liquid Limit:	28	Specific Gravity:	2.650
Plastic Limit:	21	Plastic Index:	7

Natural Moisture Content: 12.9%

Moisture Content of the Oversize Fraction:

NOTES:

Sieve Size	% Passing
#4	99.4
#10	98.5
#20	95.4
#40	89.5
#60	78.9
#100	62.1
#200	44.7

MDD: 115.8 **Opt. MC %: 13.3**

Water Content Water Content requires GP 2 Balance (0.1 gram Readability).

ASTM D2216 ☒ AASHTO T265 ☐ ASTM D4959 ☐ ASTM D4643 ☐

	Sample #:	1	2	3	4	5	6
	Water Added:						
	Tare #:						
A. Tare Weight	A.	0	0	0	0	0	0
B. Wet Wt + Tare Wt	B.	500	500	500	500	500	500
C. Dry Wt. + Tare Wt.	C.	457.1	449.5	442.1	434.5		
D. Water Weight	B-C	42.9	50.5	57.9	65.5	500	500
E. Dry Weight	C-A	457.1	449.5	442.1	434.5	0	0
F. Moisture Content	100*D/E	**9.4%**	**11.2%**	**13.1%**	**15.1%**	**#DIV/0!**	**#DIV/0!**

Compaction Data The Compaction Test requires a GP 5 Balance for ASTM (1 gram or .0022 Lb. readability).

G. Wt of Soil + Mold	G.	13.424	13.550	13.664	13.682		
H. Wt. of Mold	H.	9.304	9.304	9.304	9.304	9.304	9.304
I. Wt. of Soil (g. or lbs.)	G-H	4.120	4.246	4.360	4.378	-9.304	-9.304
J. Wt of Soil (Lbs.)	I/453.6 or I	4.120	4.246	4.360	4.378	-9.304	-9.304
K. Mold Volume Factor	K.	30.039	30.039	30.039	30.039	30.039	30.039
L. Wet Density	J*K	123.8	127.5	131.0	131.5	-279.5	-279.5
M. Dry Density	L/(1+F)	**113.1**	**114.7**	**115.8**	**114.3**	**#DIV/0!**	**#DIV/0!**

ASTM D558 ☐ ASTM D 698 ☒ ASTM D1557 ☐ AASHTO T99 ☐ AASHTO T180 ☐

Method A ☒ Method B ☐ Method C ☐ Method D (ASTM 1978) ☐ AASHTO Method D ☐

Moisture-Density Relation of: Fine Fraction ☒ Corrected for Coarse Fraction (ASTM D 4718) ☐

Sieve Size used to separate the Oversize Fraction: #4 Sieve ☒ 3/8 inch Sieve ☐ 3/4 inch Sieve ☐

Mechanical Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

Soil Plasticity: ASTM D 4318 ☒ AASHTO T 89 ☐ AASHTO T 90 ☐

Sieve Analysis / Particle Size Analysis: ASTM C136 ☐ AASHTO T 27 ☐ ASTM D 422 ☒ AASHTO T 88 ☐

Specific Gravity of Soil: ASTM D 854 ☒ AASHTO T 100 ☐

Bulk Gravity of Oversize Fraction: ASTM C 127 ☐ AASHTO T 85 ☐

Soil Classification: ASTM D 2487 ☒ ASTM D 2488 ☐ AASHTO M 145 ☐

Technician Name: B. Hatton

Certification #

Technical Responsibility: Brian Vaughan, P.E. Signature Construction Services Manager Position

Moisture - Density Report

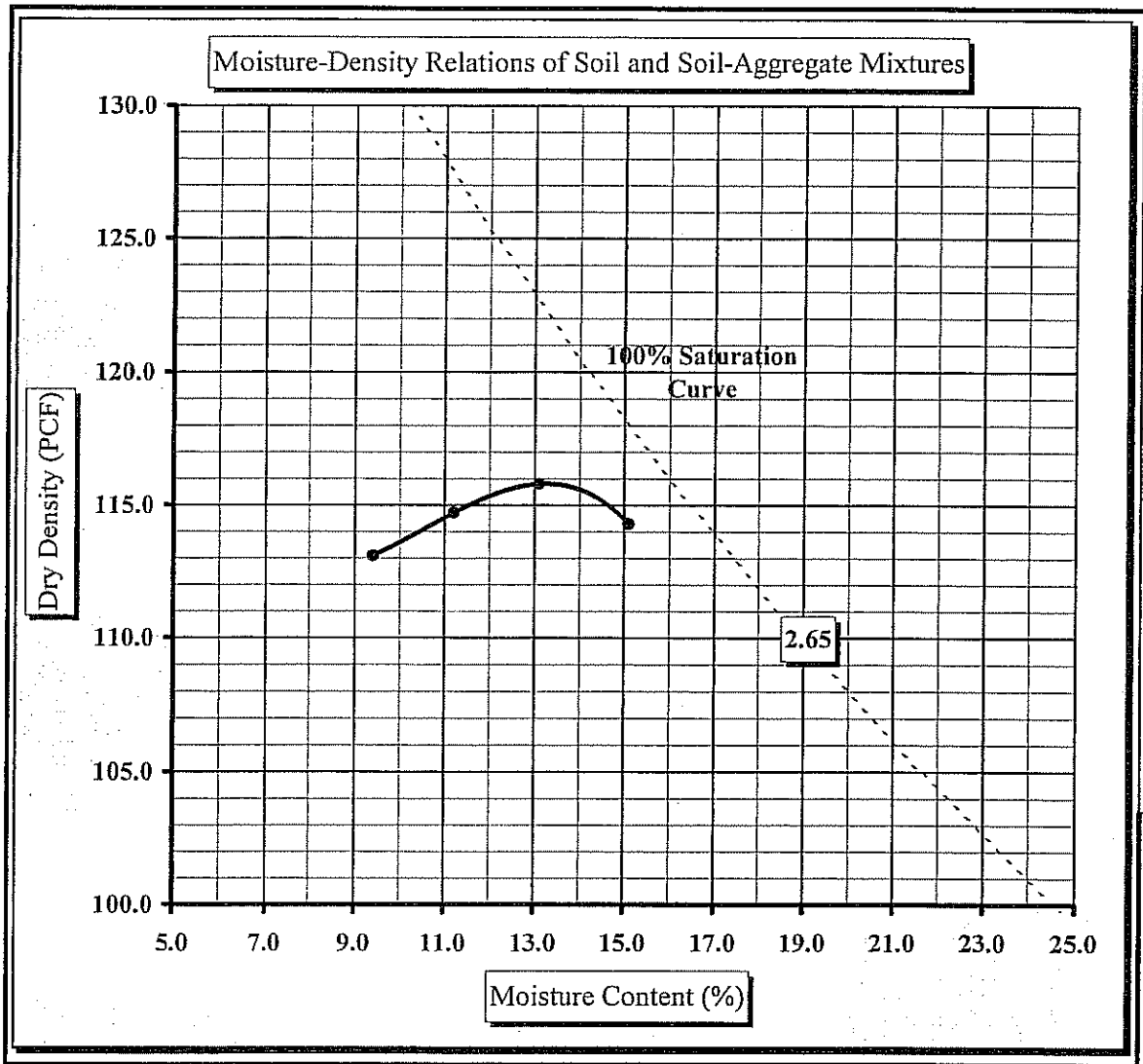
S&ME

S&ME Project #:	**1411-07-103**	Report Date:	January 11, 2008
Project Name:	**Marshall Steam Station**	Test Date(s):	January 10, 2008
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-7	Sample #:	492	Sample Date:	November 26, 2007
Location:	Bulk	Offset:	N/A	Depth:	5-10'
Sample Description:	Brown red clayey silty fine SAND (SC-SM)				

Maximum Dry Density **115.8** **PCF.** **Optimum Moisture Content** **13.3** **%**

ASTM D 698 Method A



Soil Properties

Natural Moisture Content:	12.9%
Liquid Limit:	28
Plastic Limit:	21
Plastic Index:	7
Specific Gravity:	2.650

% Passing

#4	99.4
#10	98.5
#20	95.4
#40	89.5
#60	78.9
#100	62.1
#200	44.7

Oversize Fraction

Bulk Sp. Gravity
% Moisture
Oversize Fraction
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 Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

References: ASTM D 698: Laboratory Compaction Characteristics of Soil Using Standard Effort
ASTM D 2216: Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D 422: Particle Size Analysis of Soils ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. Construction Services Manager
Position

S&ME

Liquid Limit, Plastic Limit, and Plastic Index

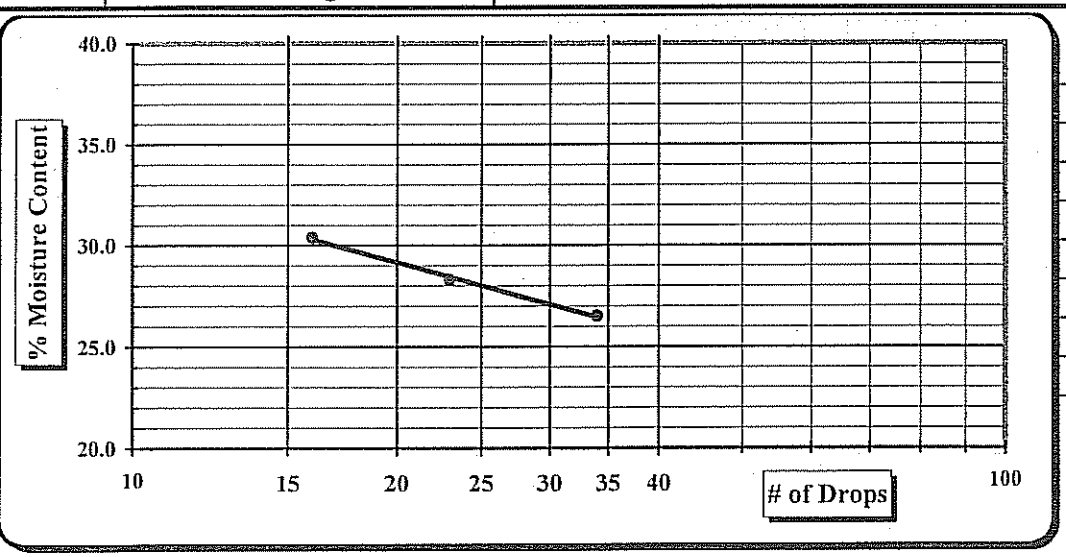
Project #:	**1411-07-103**	Report Date:	1/25/08
Project Name:	Marshall Steam Station	Test Date(s):	1/24/08
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #: M-7 Sample #: 492 Sample Date: 11/26/07

Location: Bulk Offset: N/A Elevation: 5-10'

Sample Description: Brown red clayey silty fine SAND (SC-SM)

Pan #		Liquid Limit						Plastic Limit		
	Test #	1	2	3	4	5	6	1	2	3
	Tare #	Q-1	Q-2	Q-3				3	4	
A	Tare Weight	16.80	16.78	15.75				**10.92**	10.89	
B	Wet Soil Weight + A	43.81	42.27	42.64				18.21	18.46	
C	Dry Soil Weight + A	38.15	36.65	36.38				16.93	17.14	
D	Water Weight (B-C)	5.66	5.62	6.27				1.28	1.32	
E	Dry Soil Weight (C-A)	21.35	19.87	20.63				6.01	6.25	
F	% Moisture Content (D/E)*100	26.5%	28.3%	30.4%				21.3%	21.1%	
N	# OF DROPS	34	23	16				*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average							21.2%		



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes:

Special Sampling Methods:

Sample Preparation:	Wet Preparation	☐	Dry Preparation	☒	Air Dried	☒	% Passing #200 Sieve: 44.7
Liquid limit Test:	Multipoint Method	☒	One-point Method	☐			NP, Non-Plastic ☐
Classification:	ASTM D 2487	☒	AASHTO M 145	☐			Liquid Limit 28
Liquid limit Test:	ASTM D 4318	☒	AASHTO T 89	☐			Plastic Limit 21
Plastic limit Test:	ASTM D 4318	☒	AASHTO T 90	☐			Plastic Index 7
							Group Symbol SC-SM

Technician Name: M. Jacobs

Certification #

Technical Responsibility: Brian Vaughan, P.E. *Signature* QC Manager *Position*

Particle Size Analysis of Soils

ASTM D 422

S&ME

Project #: **1411-07-103**
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Charlotte, NC

Test Date(s): 12/19 - 12/21/07
Report Date: 12/26/07

Boring #: M-7 Sample #: 492 Sample Date: 11/26/07
Location: Bulk Offset: N/A Elevation: 10-15'
Sample Description: Red brown fine sandy clayey SILT (ML)

Pan #:	11	Beaker #:	6		Specific Gravity		2.650
Hydrometer Jar #:			6				
Pan Tare Weight (grams):			0.00		Moisture Content	Hygroscopic	Natural
Total Sample Air Dried Wt. + tare wt. (grams):			459.82		Tare #	Q-6	354
Weight of Total Sample Air Dried:			459.82	A	Tare Wt.	16.80	0.00
Weight of Air Dried Hydrometer Sample (g):			53.32	B	Wet Wt. + A	30.06	240.30
Total Sample Oven Dried:			454.71	C	Dry Wt. + A	29.91	216.13
Hydrometer Sample Oven Dried (W):			52.72	D	Water Wt. (B-C)	0.15	24.17
% Passing #10:			98.2%	E	Dry Wt. (C-A)	13.11	216.13
Correction Factor a (Table 1):			1.00		% Moisture (100 x D/E)	1.14%	11.2%

Sieve	Retained Wt.	Percent Passing	
3.0"	0.0	Pan # (washed)	100.0%
1.5"	0.0		100.0%
1.0"	0.0		100.0%
3/4"	0.0		100.0%
1/2"	0.0		100.0%
3/8"	0.0		100.0%
#4	2.3	Soil Mortar	99.5%
#10	8.0	**100.0%**	98.2%
#20	1.3	97.6%	95.9%
#40	3.6	93.2%	91.6%
#60	6.8	87.0%	85.5%
#100	12.5	76.3%	75.0%
#200	20.7	60.8%	59.8%

Notes: Description of Sand & Gravel Particles — Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:	4.75 mm		Total Sand:	39.7%	< 4.74 mm and > 0.075 mm	Type:	Mechanical Stirring Apparatus (A)
% Gravel:	0.5%	< 75 mm and > 4.75 mm	Silt & Clay:	59.8%	< 0.075	Dispersion Time:	1 min.
Coarse Sand:	1.3%	< 4.75 mm and > 2.00 mm	Silt:	36.3%	< 0.075 and > 0.005 mm	Sodium Hexametaphosphate:	40 g./ Liter
Medium Sand:	6.7%	< 2.00 mm and > 0.425 mm	Clay:	23.5%	< 0.005 mm		
Fine Sand:	31.8%	< 0.425 mm and > 0.075 mm	Colloids:	12.7%	< 0.001 mm	**Control Cylinder** ☐	**Composite Correction** ☒

Liquid Limit **35** Plastic Limit **27** Plastic Index **8** Hydrometer: 151H ☐ 152H ☒

Time		Temp.	Hydrometer	Corrections		Hydrometer	Percent Passing		Effective Depth	Table 3	Diameter
Clock	T (Min.)	(0.5 °C)	Reading	Control Cylinder	Composite Correction	R	P(-#10) = (R x a / W) x 100	P (total) = P x % Passing #10	L	K	D = K x ((L/T)^1/2
	2	22.2	30.5		5.20	25.30	48.0%	47.1%	12.1	0.01332	0.03282
	5	22.2	27.5		5.20	22.30	42.3%	41.6%	12.6	0.01332	0.02118
	15	22.2	23.5		5.20	18.30	34.7%	34.1%	13.3	0.01332	0.01254
	30	22.3	21.0		5.15	15.85	30.1%	29.5%	13.7	0.01332	0.00900
	60	22.4	19.0		5.15	13.85	26.3%	25.8%	14.0	0.01332	0.00644
	250	22.7	15.5		5.15	10.35	19.6%	19.3%	14.6	0.01325	0.00320
	1440	22.0	12.5		5.20	7.30	13.8%	13.6%	15.1	0.01332	0.00136
	2880	21.8	12.0		5.20	6.80	12.9%	12.7%	15.2	0.01340	0.00097

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Effective Depth (cm)
L=L1+0.5(L2-(VB/A))
(152H) .164cm per increment,
V_B=67.0cm^3, L_2=14cm, A=27.8cm^2

Technician Name: M. Jacobs

Certification #

Technical Responsibility: Brian Vaughan, P.E.

Signature

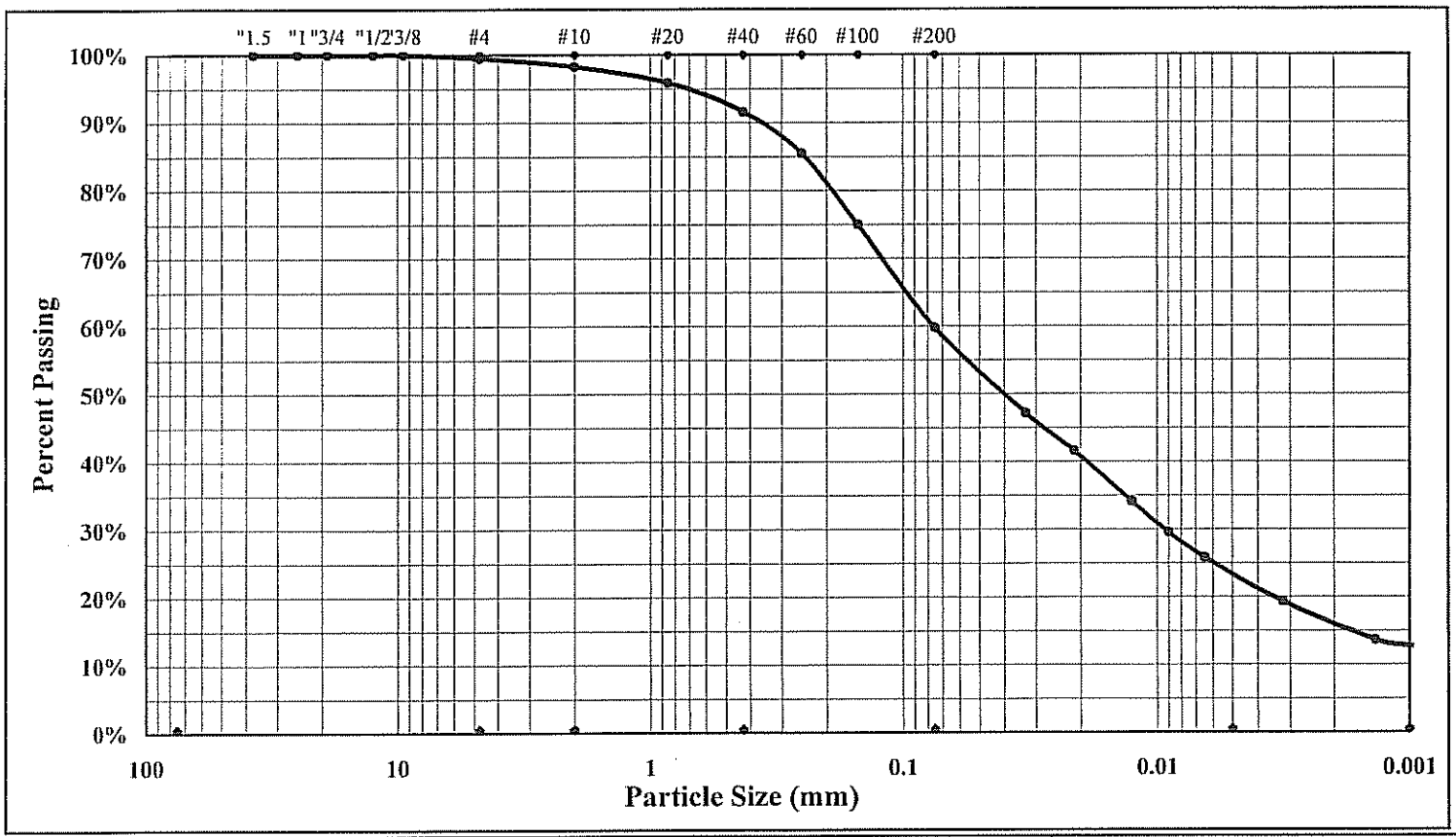
OC Manager
Position

Particle Size Analysis of Soils

ASTM D 422

S&ME Project #:	**1411-07-103**	Report Date:	12/26/07
Project Name:	**Marshall Steam Station**	Test Date(s):	12/19 - 12/21/07
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-7	Sample #:	492	Sample Date:	11/26/07
Location:	Bulk	Offset:	N/A	Elevation:	10-15'
Sample Description:	Red brown fine sandy clayey SILT (ML)				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	4.75 mm	Gravel	0.5%	Silt	36.3%
Silt & Clay (% Passing #200)	59.8%	Sand	39.7%	Clay	23.5%
Specific Gravity	2.650	Moisture Content	11.2%	Colloids	12.7%
Liquid Limit	35	Plastic Limit	27	Plastic Index	8

Description of Sand & Gravel Particles Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Mechanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

References: ASTM D 422: Particle Size Analysis of Soils
ASTM D 421: Dry Preparation of Soil Samples
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 854: Specific Gravity of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. _____ QC Manager
Signature *Position*

Moisture - Density Relationship

S&ME

S&ME Project #:	**1411-07-103**	Test Date(s):	January 10, 2008
Project Name:	Marshall Steam Station	Report Date:	January 11, 2008
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-7	Sample #:	492	Sample Date:	November 26, 2007
Location:	Bulk	Offset:	N/A	Depth:	10-15'

Sample Description: Red brown fine sandy clayey SILT (ML)

Liquid Limit:	35	Specific Gravity:	2.650
Plastic Limit:	27	Plastic Index:	8

Natural Moisture Content: 11.2%

Moisture Content of the Oversize Fraction:

NOTES:

Sieve Size	% Passing
#4	99.5
#10	98.2
#20	95.9
#40	91.6
#60	85.5
#100	75.0
#200	59.8

MDD: 110.9 **Opt. MC %: 16.2**

Water Content

Water Content requires GP 2 Balance (0.1 gram Readability).

ASTM D2216 ☒ AASHTO T265 ☐ ASTM D4959 ☐ ASTM D4643 ☐

	Sample #:	1	2	3	4	5	6
	Water Added:						
	Tare #:						
A. Tare Weight	A.	0	0	0	0	0	0
B. Wet Wt + Tare Wt	B.	500	500	500	500	500	500
C. Dry Wt. + Tare Wt.	C.	445.8	438.2	431.3	423.6		
D. Water Weight	B-C	54.2	61.8	68.7	76.4	500	500
E. Dry Weight	C-A	445.8	438.2	431.3	423.6	0	0
F. Moisture Content	100*D/E	**12.2%**	**14.1%**	**15.9%**	**18.0%**	**#DIV/0!**	**#DIV/0!**

Compaction Data

The Compaction Test requires a GP 5 Balance for ASTM (1 gram or .0022 Lb. readability).

G. Wt of Soil + Mold	G.	13.322	13.460	13.580	13.582		
H. Wt. of Mold	H.	9.304	9.304	9.304	9.304	9.304	9.304
I. Wt. of Soil (g. or lbs.)	G-H	4.018	4.156	4.276	4.278	-9.304	-9.304
J. Wt of Soil (Lbs.)	I/453.6 or I	4.018	4.156	4.276	4.278	-9.304	-9.304
K. Mold Volume Factor	K.	30.039	30.039	30.039	30.039	30.039	30.039
L. Wet Density	J*K	120.7	124.8	128.4	128.5	-279.5	-279.5
M. Dry Density	L/(1+F)	**107.6**	**109.4**	**110.8**	**108.9**	**#DIV/0!**	**#DIV/0!**

ASTM D558 ☐ ASTM D 698 ☒ ASTM D1557 ☐ AASHTO T99 ☐ AASHTO T180 ☐

Method A ☒ Method B ☐ Method C ☐ Method D (ASTM 1978) ☐ AASHTO Method D ☐

Moisture-Density Relation of: Fine Fraction ☒ Corrected for Coarse Fraction (ASTM D 4718) ☐

Sieve Size used to separate the Oversize Fraction: #4 Sieve ☒ 3/8 inch Sieve ☐ 3/4 inch Sieve ☐

Mechanical Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

Soil Plasticity:	ASTM D 4318 ☒	AASHTO T 89 ☐		AASHTO T 90 ☐
Sieve Analysis / Particle Size Analysis:	ASTM C136 ☐	AASHTO T 27 ☐	ASTM D 422 ☒	AASHTO T 88 ☐
Specific Gravity of Soil:		ASTM D 854 ☒		AASHTO T 100 ☐
Bulk Gravity of Oversize Fraction:		ASTM C 127 ☐		AASHTO T 85 ☐
Soil Classification:	ASTM D 2487 ☒	ASTM D 2488 ☐		AASHTO M 145 ☐

Technician Name: B. Hatton

Certification #

Technical Responsibility: Brian Vaughan, P.E. Signature Construction Services Manager Position

Moisture - Density Report

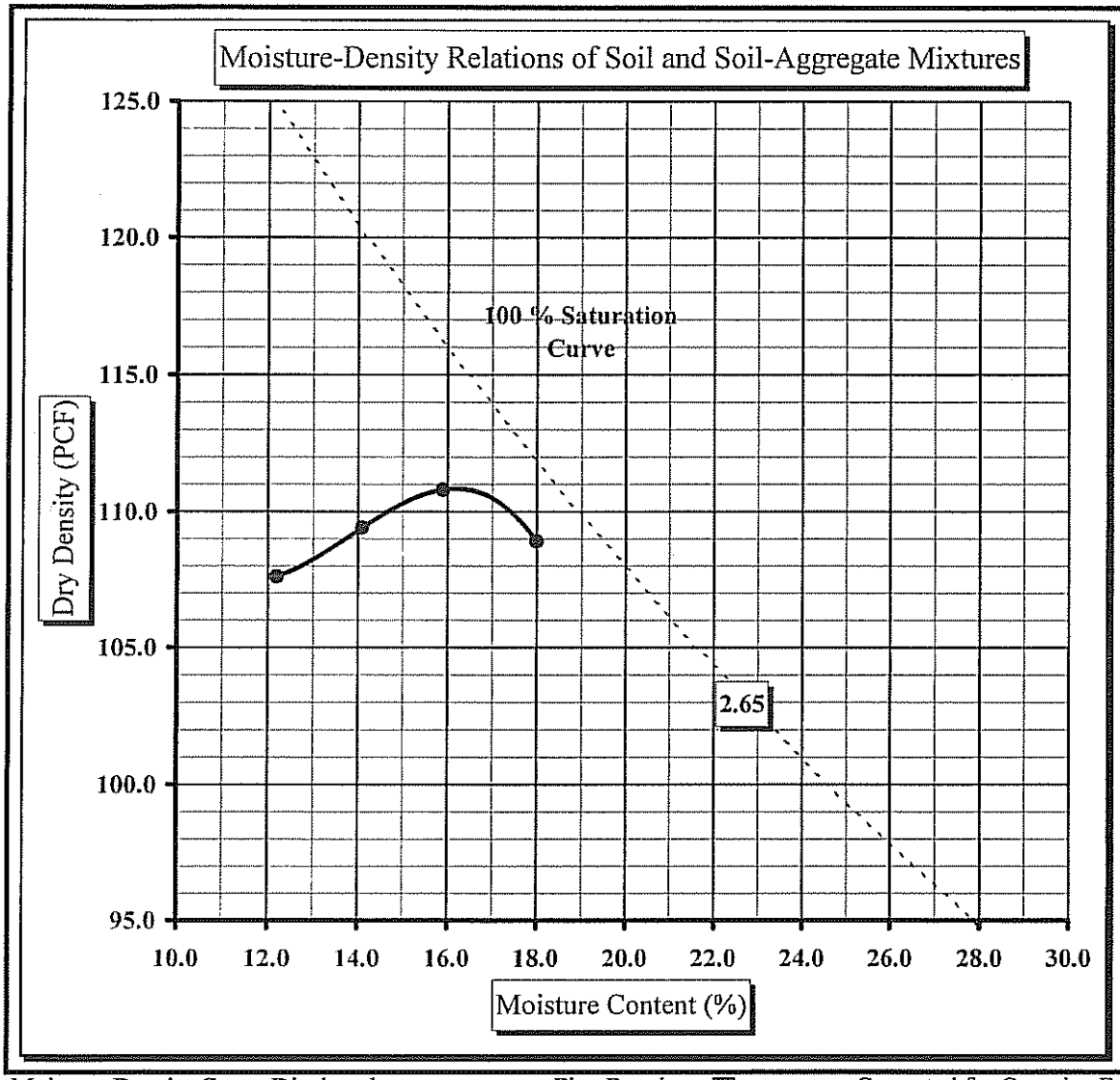
S&ME

S&ME Project #:	**1411-07-103**	Report Date:	January 11, 2008
Project Name:	**Marshall Steam Station**	Test Date(s):	January 10, 2008
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-7	Sample #:	492	Sample Date:	November 26, 2007
Location:	Bulk	Offset:	N/A	Depth:	10-15'
Sample Description:	Red brown fine sandy clayey SILT (ML)				

Maximum Dry Density 110.9 PCF. **Optimum Moisture Content 16.2 %**

ASTM D 698 Method A



Soil Properties

Natural Moisture Content:	11.2%
Liquid Limit:	35
Plastic Limit:	27
Plastic Index:	8
Specific Gravity:	2.650

% Passing

#4	99.5
#10	98.2
#20	95.9
#40	91.6
#60	85.5
#100	75.0
#200	59.8

Oversize Fraction

Bulk Sp. Gravity
% Moisture
Oversize Fraction
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 Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

References: ASTM D 698: Laboratory Compaction Characteristics of Soil Using Standard Effort
ASTM D 2216: Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D 422: Particle Size Analysis of Soils ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. Construction Services Manager

Laboratory Record Version 4.2

S&ME

Liquid Limit, Plastic Limit, and Plastic Index

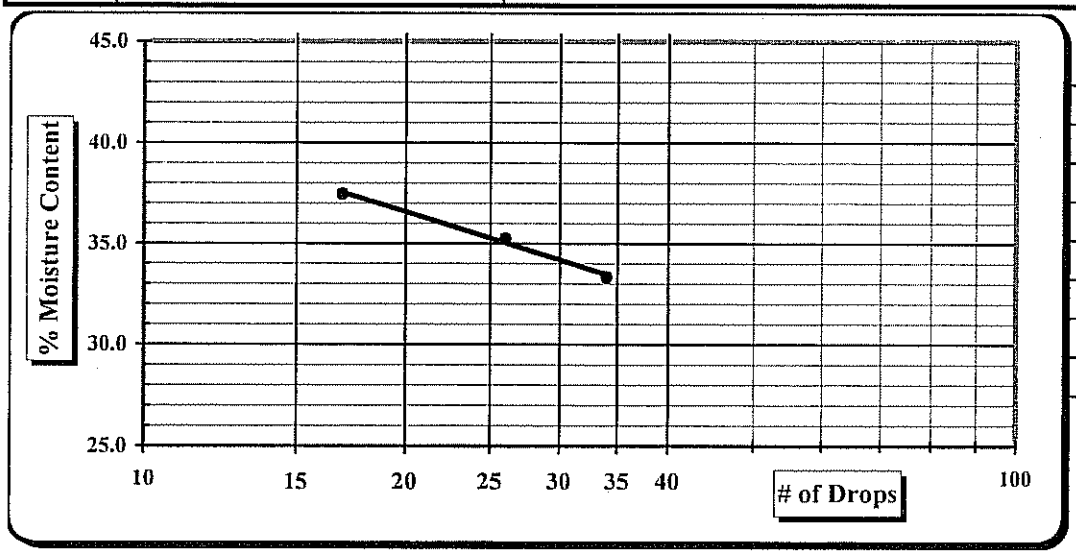
Project #:	**1411-07-103**	Report Date:	1/25/08
Project Name:	Marshall Steam Station	Test Date(s):	1/24/08
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #: M-7 Sample #: 492 Sample Date: 11/26/07

Location: Bulk Offset: N/A Elevation: 10-15'

Sample Description: Red brown fine sandy clayey SILT (ML)

Pan #		Liquid Limit						Plastic Limit		
	Test #	1	2	3	4	5	6	1	2	3
	Tare #	Y-1	Y-2	Y-3				5	6	
A	Tare Weight	16.53	16.56	16.99				**10.94**	10.88	
B	Wet Soil Weight + A	43.90	40.78	42.06				18.94	18.61	
C	Dry Soil Weight + A	37.06	34.47	35.23				17.25	16.99	
D	Water Weight (B-C)	6.84	6.31	6.83				1.69	1.62	
E	Dry Soil Weight (C-A)	20.53	17.91	18.24				6.31	6.11	
F	% Moisture Content (D/E)*100	33.3%	35.2%	37.4%				26.8%	26.5%	
N	# OF DROPS	34	26	17				*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average							26.6%		



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes:

Special Sampling Methods:

Sample Preparation:	Wet Preparation	☐	Dry Preparation	☒	Air Dried	☒	% Passing #200 Sieve: 59.8
Liquid limit Test:	Multipoint Method	☒	One-point Method	☐			NP, Non-Plastic ☐
Classification:	ASTM D 2487	☒	AASHTO M 145	☐			Liquid Limit 35
Liquid limit Test:	ASTM D 4318	☒	AASHTO T 89	☐			Plastic Limit 27
Plastic limit Test:	ASTM D 4318	☒	AASHTO T 90	☐			Plastic Index 8
							Group Symbol ML

Technician Name: M. Jacobs

Certification #

Technical Responsibility: Brian Vaughan, P.E.

Signature

QC Manager

Position

Particle Size Analysis of Soils

ASTM D 422

S&ME

Project #: **1411-07-103**
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Charlotte, NC

Test Date(s): 12/11 - 12/13/07
Report Date: 12/14/07

Boring #: M-8 Sample #: 483 Sample Date: 11/13/07
Location: Bulk Offset: N/A Elevation: 0-5'
Sample Description: Tan brown fine sandy silty CLAY (CL)

Pan #:	4	Beaker #:	4
Hydrometer Jar #:			4
Pan Tare Weight (grams):			0.00
Total Sample Air Dried Wt. + tare wt. (grams):			525.10
Weight of Total Sample Air Dried:			525.10
Weight of Air Dried Hydrometer Sample (g):			52.66
Total Sample Oven Dried:			512.15
Hydrometer Sample Oven Dried (W):			51.30
% Passing #10:			95.8%
Correction Factor a (Table 1):			1.00

Specific Gravity 2.650

	Moisture Content	Hygroscopic	Natural
	Tare #	P-4	319
A	Tare Wt.	16.70	0.00
B	Wet Wt. + A	30.30	245.82
C	Dry Wt. + A	29.95	224.78
D	Water Wt. (B-C)	0.35	21.04
E	Dry Wt. (C-A)	13.25	224.78
	% Moisture (100 x D/E)	2.64%	9.4%

Sieve	Retained Wt.	Percent Passing	
3.0"	0.0	Pan # (washed)	100.0%
1.5"	0.0		100.0%
1.0"	0.0		100.0%
3/4"	0.0	55	100.0%
1/2"	0.0		100.0%
3/8"	0.0		100.0%
#4	5.7	Soil Mortar	98.9%
#10	21.8	**100.0%**	95.8%
#20	2.0	96.0%	92.0%
#40	4.5	91.3%	87.4%
#60	7.2	86.0%	82.3%
#100	11.4	77.8%	74.5%
#200	18.4	64.1%	61.4%

Notes: Description of Sand & Gravel Particles — Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:	4.75 mm		Total Sand:	37.5%	< 4.74 mm and > 0.075 mm	Type: Mechanical Stirring Apparatus (A)
% Gravel:	1.1%	< 75 mm and > 4.75 mm	Silt & Clay:	61.4%	< 0.075	Dispersion Time: 1 min.
Coarse Sand:	3.1%	< 4.75 mm and > 2.00 mm	Silt:	33.7%	< 0.075 and > 0.005 mm	Sodium Hexametaphosphate: 40 g./ Liter
Medium Sand:	8.3%	< 2.00 mm and > 0.425 mm	Clay:	27.7%	< 0.005 mm	
Fine Sand:	26.1%	< 0.425 mm and > 0.075 mm	Colloids:	17.7%	< 0.001 mm	**Control Cylinder** ☐ **Composite Correction** ☒

Liquid Limit **44** Plastic Limit **21** Plastic Index **23** Hydrometer: 151H ☐ 152H ☒

Time		Temp.	Hydrometer	Corrections		Hydrometer	Percent Passing		Effective Depth	Table 3	Diameter
				Control Cylinder	Composite Correction		P(-#10) =	P (total) =			D =
Clock	T (Min.)	(0.5 °C)	Reading			R	(R x a / W) x 100	P x % Passing #10	L	K	K x ((L/T)^1/2
	2	23.5	30.0		5.05	24.95	48.6%	46.6%	12.2	0.01309	0.03233
	5	23.5	27.0		5.05	21.95	42.8%	41.0%	12.7	0.01309	0.02086
	15	23.5	24.0		5.05	18.95	36.9%	35.4%	13.2	0.01309	0.01227
	30	23.5	22.5		5.05	17.45	34.0%	32.6%	13.4	0.01309	0.00876
	60	23.5	21.0		5.05	15.95	31.1%	29.8%	13.7	0.01309	0.00625
	250	23.1	18.0		5.10	12.90	25.1%	24.1%	14.2	0.01317	0.00314
	1440	23.3	15.5		5.05	10.45	20.4%	19.5%	14.6	0.01317	0.00133
	2880	23.3	14.5		5.05	9.45	18.4%	17.6%	14.7	0.01317	0.00094

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Effective Depth (cm)
L=L1+0.5(L2-(VB/A))
(152H) .164cm per increment,
V_B=67.0cm^3, L_2=14cm, A=27.8cm^2

Technician Name: M. Jacobs
Certification #

Technical Responsibility: Brian Vaughan, P.E.
Signature

OC Manager
Position

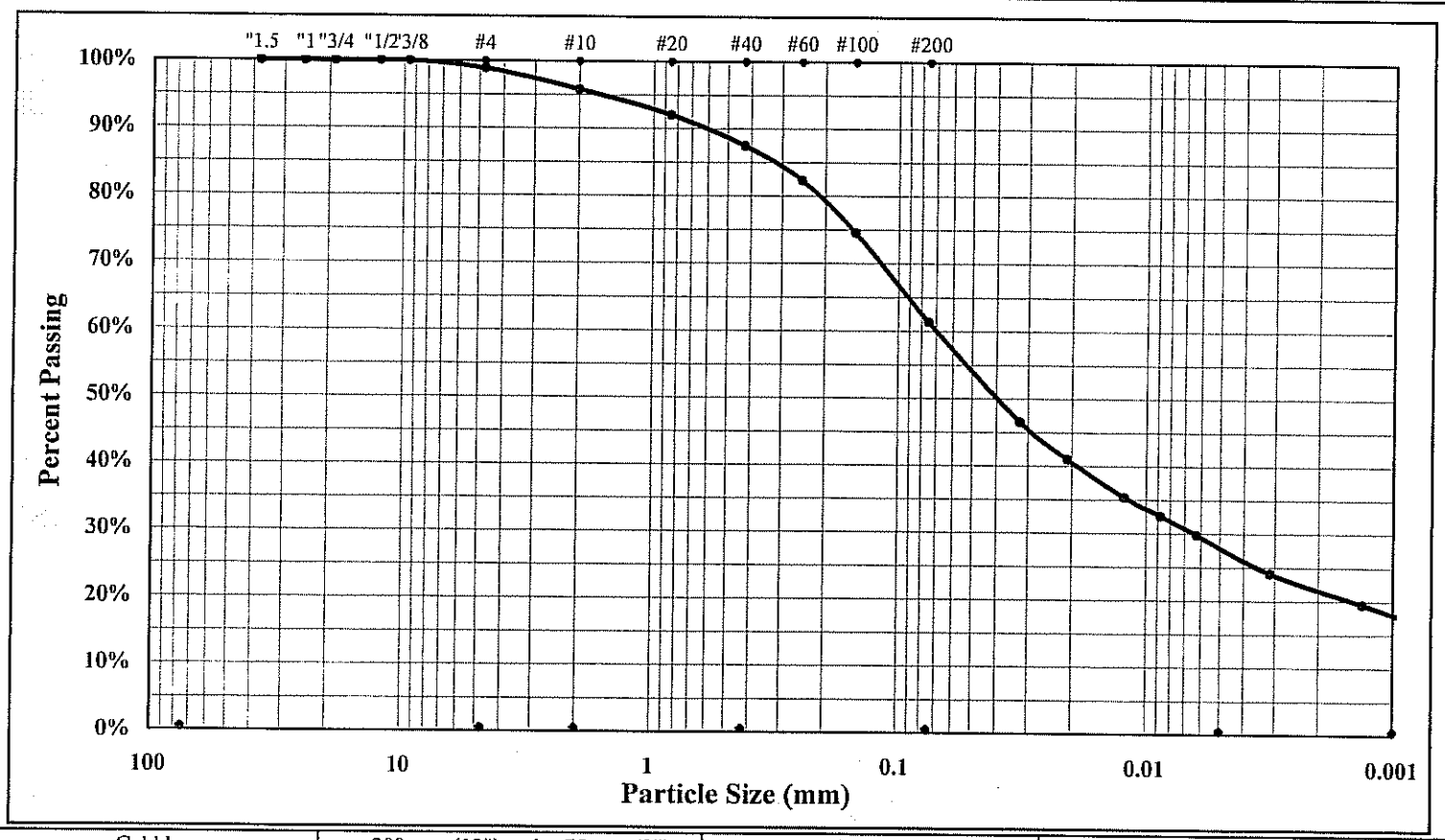
Particle Size Analysis of Soils

ASTM D 422

S&ME

S&ME Project #:	**1411-07-103**	Report Date:	12/14/07
Project Name:	**Marshall Steam Station**	Test Date(s):	12/11 - 12/13/07
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-8	Sample #:	483	Sample Date:	11/13/07
Location:	Bulk	Offset:	N/A	Elevation:	0-5'
Sample Description:	Tan brown fine sandy silty CLAY (CL)				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	4.75 mm	Gravel	1.1%	Silt	33.7%
Silt & Clay (% Passing #200)	61.4%	Sand	37.5%	Clay	27.7%
Specific Gravity	2.650	Moisture Content	9.4%	Colloids	17.7%
Liquid Limit	44	Plastic Limit	21	Plastic Index	23

Description of Sand & Gravel Particles Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Mechanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

References: ASTM D 422: Particle Size Analysis of Soils
ASTM D 421: Dry Preparation of Soil Samples
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 854: Specific Gravity of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. _____ QC Manager

Signature Position

Moisture - Density Relationship

S&ME

S&ME Project #:	**1411-07-103**	Test Date(s):	December 28, 2007
Project Name:	Marshall Steam Station	Report Date:	January 2, 2008
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-8	Sample #:	483	Sample Date:	November 13, 2007
Location:	Bulk	Offset:	N/A	Depth:	0-5'

Sample Description: Tan brown fine sandy silty CLAY (CL)

Liquid Limit:	44	Specific Gravity:	2.650
Plastic Limit:	21	Plastic Index:	23

Natural Moisture Content: 9.4%

Moisture Content of the Oversize Fraction:

NOTES:

Sieve Size	% Passing
#4	98.9
#10	95.8
#20	92.0
#40	87.4
#60	82.3
#100	74.5
#200	61.4

MDD: 114.5 **Opt. MC %: 15.0**

Water Content

Water Content requires GP 2 Balance (0.1 gram Readability).

ASTM D2216 ☒ AASHTO T265 ☐ ASTM D4959 ☐ ASTM D4643 ☐

	Sample #:	1	2	3	4	5	6
	Water Added:						
	Tare #:						
A. Tare Weight	A.	0	0	0	0	0	0
B. Wet Wt + Tare Wt	B.	500	500	500	500	500	500
C. Dry Wt. + Tare Wt.	C.	446.4	438.7	430.7	423.7		
D. Water Weight	B-C	53.6	61.3	69.3	76.3	500	500
E. Dry Weight	C-A	446.4	438.7	430.7	423.7	0	0
F. Moisture Content	100*D/E	**12.0%**	**14.0%**	**16.1%**	**18.0%**	**#DIV/0!**	**#DIV/0!**

Compaction Data

The Compaction Test requires a GP 5 Balance for ASTM (1 gram or .0022 Lb. readability).

G. Wt of Soil + Mold	G.	13.500	13.638	13.708	13.664		
H. Wt. of Mold	H.	9.304	9.304	9.304	9.304	9.304	9.304
I. Wt. of Soil (g. or lbs.)	G-H	4.196	4.334	4.404	4.360	-9.304	-9.304
J. Wt of Soil (Lbs.)	I/453.6 or I	4.196	4.334	4.404	4.360	-9.304	-9.304
K. Mold Volume Factor	K.	30.039	30.039	30.039	30.039	30.039	30.039
L. Wet Density	J*K	126.0	130.2	132.3	131.0	-279.5	-279.5
M. Dry Density	L/(1+F)	**112.5**	**114.2**	**114.0**	**111.0**	**#DIV/0!**	**#DIV/0!**

ASTM D558 ☐ ASTM D 698 ☒ ASTM D1557 ☐ AASHTO T99 ☐ AASHTO T180 ☐

Method A ☒ Method B ☐ Method C ☐ Method D (ASTM 1978) ☐ AASHTO Method D ☐

Moisture-Density Relation of: Fine Fraction ☒ Corrected for Coarse Fraction (ASTM D 4718) ☐

Sieve Size used to separate the Oversize Fraction: #4 Sieve ☒ 3/8 inch Sieve ☐ 3/4 inch Sieve ☐

Mechanical Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

Soil Plasticity:	ASTM D 4318 ☒	AASHTO T 89 ☐		AASHTO T 90 ☐
Sieve Analysis / Particle Size Analysis:	ASTM C136 ☐	AASHTO T 27 ☐	ASTM D 422 ☒	AASHTO T 88 ☐
Specific Gravity of Soil:		ASTM D 854 ☒		AASHTO T 100 ☐
Bulk Gravity of Oversize Fraction:		ASTM C 127 ☐		AASHTO T 85 ☐
Soil Classification:	ASTM D 2487 ☒	ASTM D 2488 ☐		AASHTO M 145 ☐

Technician Name: B. Hatton

Certification #

Technical Responsibility: Brian Vaughan, P.E. Signature Construction Services Manager Position

Laboratory Report Version 4.2

Moisture - Density Report

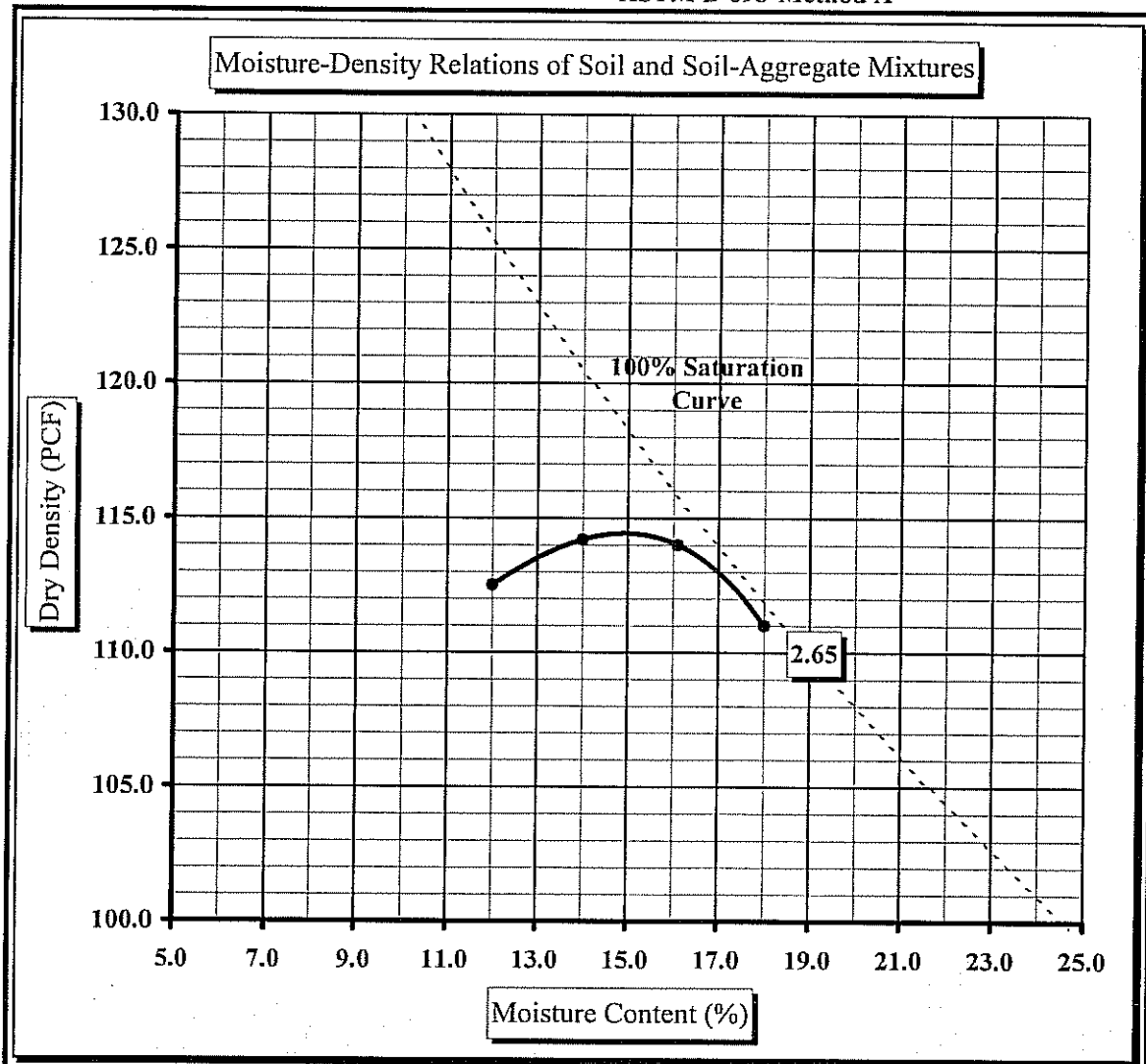
S&ME

S&ME Project #:	**1411-07-103**	Report Date:	January 2, 2008
Project Name:	**Marshall Steam Station**	Test Date(s):	December 28, 2007
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-8	Sample #:	483	Sample Date:	November 13, 2007
Location:	Bulk	Offset:	N/A	Depth:	0-5'
Sample Description:	Tan brown fine sandy silty CLAY (CL)				

Maximum Dry Density **114.5** **PCF.** **Optimum Moisture Content** **15.0** **%**

ASTM D 698 Method A



Soil Properties

Natural Moisture Content:	9.4%
Liquid Limit:	44
Plastic Limit:	21
Plastic Index:	23
Specific Gravity:	2.650

% Passing

#4	98.9
#10	95.8
#20	92.0
#40	87.4
#60	82.3
#100	74.5
#200	61.4

Oversize Fraction

Bulk Sp. Gravity
% Moisture
Oversize Fraction
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 Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

References: ASTM D 698: Laboratory Compaction Characteristics of Soil Using Standard Effort
ASTM D 2216: Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D 422: Particle Size Analysis of Soils ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Soil Description is based on a visual classification.

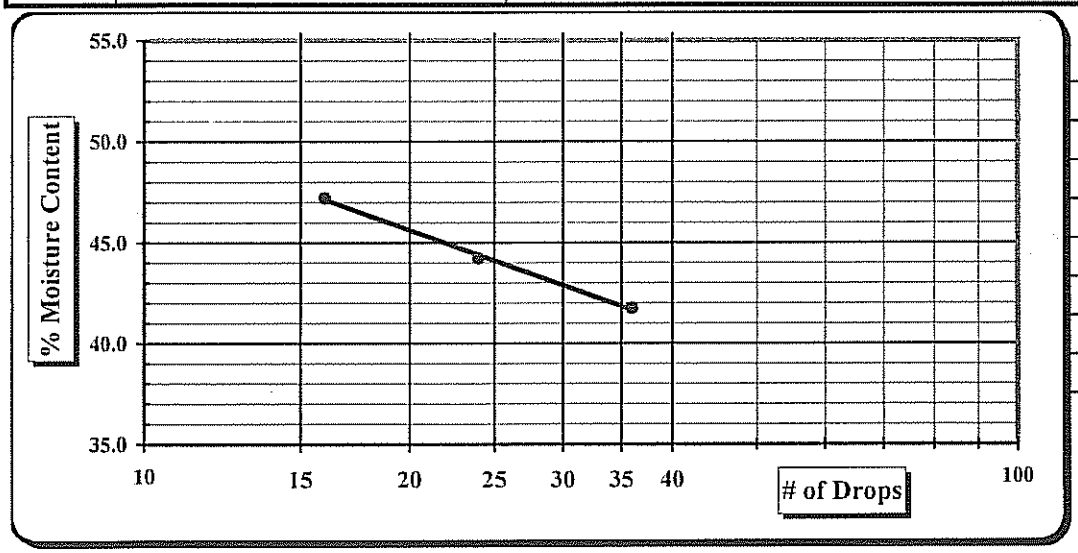
Technical Responsibility: Brian Vaughan, P.E. Construction Services Manager
Position

S&ME

Liquid Limit, Plastic Limit, and Plastic Index

Project #: **1411-07-103** Report Date: 1/23/08
Project Name: Marshall Steam Station Test Date(s): 1/22/08
Client Name: Duke Energy
Client Address: Charlotte, NC
Boring #: M-8 Sample #: 483 Sample Date: 11/13/07
Location: Bulk Offset: N/A Elevation: 0-5'
Sample Description: Tan brown fine sandy silty CLAY (CL)

Pan #		Liquid Limit						Plastic Limit		
	Test #	1	2	3	4	5	6	1	2	3
	Tare #	Z-1	Z-2	Z-3				1	2	
A	Tare Weight	15.99	16.71	16.77				**10.59**	10.86	
B	Wet Soil Weight + A	35.86	37.75	36.54				18.12	17.88	
C	Dry Soil Weight + A	30.01	31.30	30.20				16.83	16.67	
D	Water Weight (B-C)	5.85	6.45	6.34				1.29	1.22	
E	Dry Soil Weight (C-A)	14.02	14.59	13.43				6.24	5.81	
F	% Moisture Content (D/E)*100	41.7%	44.2%	47.2%				20.7%	20.9%	
N	# OF DROPS	36	24	16				*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average							20.8%		



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes:

Special Sampling Methods:

% Passing #200 Sieve: 61.4

Sample Preparation:	Wet Preparation	☐	Dry Preparation	☒	Air Dried ☒	NP, Non-Plastic	☐
Liquid limit Test:	Multipoint Method	☒	One-point Method	☐		Liquid Limit	44
Classification:	ASTM D 2487	☒	AASHTO M 145	☐		Plastic Limit	21
Liquid limit Test:	ASTM D 4318	☒	AASHTO T 89	☐		Plastic Index	23
Plastic limit Test:	ASTM D 4318	☒	AASHTO T 90	☐		Group Symbol	CL

Technician Name: M. Jacobs

Certification #

Technical Responsibility: Brian Vaughan, P.E.

Signature

QC Manager
Position

Particle Size Analysis of Soils

ASTM D 422

S&ME

Project #: **1411-07-103**
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Charlotte, NC

Test Date(s): 12/11 - 12/13/07
Report Date: 12/14/07

Boring #: M-8 Sample #: 483 Sample Date: 11/13/07
Location: Bulk Offset: N/A Elevation: 5-10'
Sample Description: Tan brown fine sandy silty CLAY (CL)

Pan #:	10	Beaker #:	5
Hydrometer Jar #:			5
Pan Tare Weight (grams):			0.00
Total Sample Air Dried Wt. + tare wt. (grams):			527.19
Weight of Total Sample Air Dried:			527.19
Weight of Air Dried Hydrometer Sample (g):			52.21
Total Sample Oven Dried:			519.06
Hydrometer Sample Oven Dried (W):			51.34
% Passing #10:			92.5%
Correction Factor a (Table 1):			1.00

Specific Gravity 2.650

	Moisture Content	Hygroscopic	Natural
	Tare #	P-5	320
A	Tare Wt.	16.72	0.00
B	Wet Wt. + A	29.94	262.66
C	Dry Wt. + A	29.72	244.62
D	Water Wt. (B-C)	0.22	18.04
E	Dry Wt. (C-A)	13.00	244.62
	% Moisture (100 x D/E)	1.69%	7.4%

Sieve	Retained Wt.	Percent Passing	
3.0"	0.0	Pan # (washed)	100.0%
1.5"	0.0		100.0%
1.0"	0.0		100.0%
3/4"	0.0	57	100.0%
1/2"	0.0		100.0%
3/8"	1.7		99.7%
#4	16.9	Soil Mortar	96.8%
#10	38.9	**100.0%**	92.5%
#20	2.2	95.7%	88.5%
#40	4.8	90.7%	83.9%
#60	7.7	85.0%	78.7%
#100	12.6	75.4%	69.8%
#200	21.6	57.9%	53.5%

Notes: Description of Sand & Gravel Particles — Rounded ☐ Angular ☒ — Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:	9.50 mm		Total Sand:	43.2%	< 4.74 mm and > 0.075 mm
% Gravel:	3.2%	< 75 mm and > 4.75 mm	Silt & Clay:	53.5%	< 0.075
Coarse Sand:	4.2%	< 4.75 mm and > 2.00 mm	Silt:	37.5%	< 0.075 and > 0.005 mm
Medium Sand:	8.6%	< 2.00 mm and > 0.425 mm	Clay:	16.0%	< 0.005 mm
Fine Sand:	30.4%	< 0.425 mm and > 0.075 mm	Colloids:	8.9%	< 0.001 mm

Type: Mechanical Stirring Apparatus (A)
Dispersion Time: 1 min.
Sodium Hexametaphosphate: 40 g./ Liter

Control Cylinder ☐ **Composite Correction** ☒

Liquid Limit **36** Plastic Limit **23** Plastic Index **13** Hydrometer: 151H ☐ 152H ☒

Time		Temp.	Hydrometer	Corrections		Hydrometer	Percent Passing		Effective Depth	Table 3	Diameter
Clock	T (Min.)	(0.5 °C)	Reading	Control Cylinder	Composite Correction	R	P(-#10) = (R x a / W) x 100	P (total) = P x % Passing #10	L	K	D = K x ((L/T)^1/2
	2	23.4	26.0		5.05	20.95	40.8%	37.7%	12.9	0.01317	0.03339
	5	23.4	22.5		5.05	17.45	34.0%	31.4%	13.4	0.01317	0.02159
	15	23.4	19.0		5.05	13.95	27.2%	25.1%	14.0	0.01317	0.01273
	30	23.4	17.0		5.05	11.95	23.3%	21.5%	14.3	0.01317	0.00910
	60	23.4	15.0		5.05	9.95	19.4%	17.9%	14.7	0.01317	0.00651
	250	23.0	12.5		5.10	7.40	14.4%	13.3%	15.1	0.01317	0.00323
	1440	23.3	10.5		5.05	5.45	10.6%	9.8%	15.4	0.01317	0.00136
	2880	23.3	10.0		5.05	4.95	9.6%	8.9%	15.5	0.01317	0.00097

References: ASTM D 422: Particle Size Analysis of Soils — ASTM D 421: Dry Preparation of Soil Samples — ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils — ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Effective Depth (cm)
L=L1+0.5(L2-(VB/A))
(152H) .164cm per increment,
V_B=67.0cm^3, L_2=14cm, A=27.8cm^2

Technician Name: M. Jacobs

Technical Responsibility: Brian Vaughan, P.E.

Certification #

Signature

OC Manager
Position

S&ME, INC.
155 Tradd Street Spartanburg, SC 29301

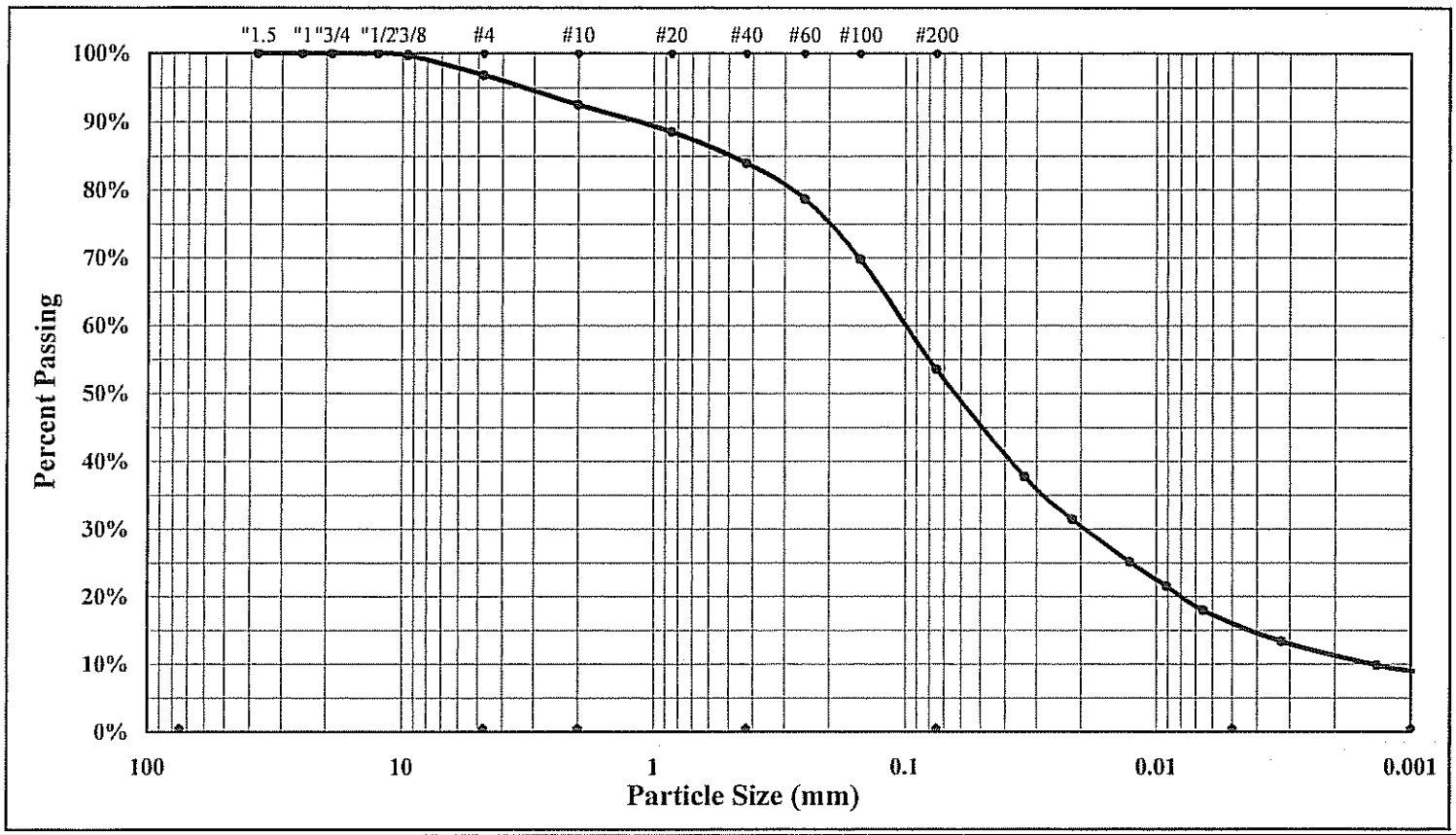
Hydrometer #483 (M-8, 5-10') 12-14-07.xls

Particle Size Analysis of Soils

ASTM D 422

S&ME Project #:	**1411-07-103**	Report Date:	12/14/07
Project Name:	**Marshall Steam Station**	Test Date(s):	12/11 - 12/13/07
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-8	Sample #:	483	Sample Date:	11/13/07
Location:	Bulk	Offset:	N/A	Elevation:	5-10'
Sample Description:	Tan brown fine sandy silty CLAY (CL)				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	9.50 mm	Gravel	3.2%	Silt	37.5%
Silt & Clay (% Passing #200)	53.5%	Sand	43.2%	Clay	16.0%
Specific Gravity	2.650	Moisture Content	7.4%	Colloids	8.9%
Liquid Limit	36	Plastic Limit	23	Plastic Index	13

Description of Sand & Gravel Particles Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Mechanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 854: Specific Gravity of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. _____ QC Manager
Signature *Position*

Moisture - Density Relationship

S&ME

S&ME Project #:	**1411-07-103**	Test Date(s):	December 28, 2007
Project Name:	Marshall Steam Station	Report Date:	January 2, 2008
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-8	Sample #:	483	Sample Date:	November 13, 2007
Location:	Bulk	Offset:	N/A	Depth:	5-10'

Sample Description: Tan brown fine sandy silty CLAY (CL)

Liquid Limit:	36	Specific Gravity:	2.650
Plastic Limit:	23	Plastic Index:	13

Natural Moisture Content: 7.4%

Moisture Content of the Oversize Fraction:

NOTES:

Sieve Size	% Passing
3/8"	99.7
#4	96.8
#10	92.5
#20	88.5
#40	83.9
#60	78.7
#100	69.8
#200	53.5

MDD: 117.7 **Opt. MC %: 12.0**

Water Content

Water Content requires GP 2 Balance (0.1 gram Readability).

ASTM D2216 ☒ AASHTO T265 ☐ ASTM D4959 ☐ ASTM D4643 ☐

	Sample #:	1	2	3	4	5	6
	Water Added:						
	Tare #:						
A. Tare Weight	A.	0	0	0	0	0	0
B. Wet Wt + Tare Wt	B.	500	500	500	500	500	500
C. Dry Wt. + Tare Wt.	C.	452.5	444.9	437.5	430.3	460.8	
D. Water Weight	B-C	47.5	55.1	62.5	69.7	39.2	500
E. Dry Weight	C-A	452.5	444.9	437.5	430.3	460.8	0
F. Moisture Content	100*D/E	**10.5%**	**12.4%**	**14.3%**	**16.2%**	**8.5%**	**#DIV/0!**

Compaction Data

The Compaction Test requires a GP 5 Balance for ASTM (1 gram or .0022 Lb. readability).

G. Wt of Soil + Mold	G.	13.618	13.704	13.730	13.680	13.492	
H. Wt. of Mold	H.	9.304	9.304	9.304	9.304	9.304	9.304
I. Wt. of Soil (g. or lbs.)	G-H	4.314	4.400	4.426	4.376	4.188	-9.304
J. Wt of Soil (Lbs.)	I/453.6 or I	4.314	4.400	4.426	4.376	4.188	-9.304
K. Mold Volume Factor	K.	30.039	30.039	30.039	30.039	30.039	30.039
L. Wet Density	J*K	129.6	132.2	133.0	131.5	125.8	-279.5
M. Dry Density	L/(1+F)	**117.3**	**117.6**	**116.3**	**113.1**	**115.9**	**#DIV/0!**

ASTM D558 ☐ ASTM D 698 ☒ ASTM D1557 ☐ AASHTO T99 ☐ AASHTO T180 ☐

Method A ☒ Method B ☐ Method C ☐ Method D (ASTM 1978) ☐ AASHTO Method D ☐

Moisture-Density Relation of: Fine Fraction ☒ Corrected for Coarse Fraction (ASTM D 4718) ☐

Sieve Size used to separate the Oversize Fraction: #4 Sieve ☒ 3/8 inch Sieve ☐ 3/4 inch Sieve ☐

Mechanical Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

Soil Plasticity: ASTM D 4318 ☒ AASHTO T 89 ☐ AASHTO T 90 ☐

Sieve Analysis / Particle Size Analysis: ASTM C136 ☐ AASHTO T 27 ☐ ASTM D 422 ☒ AASHTO T 88 ☐

Specific Gravity of Soil: ASTM D 854 ☒ AASHTO T 100 ☐

Bulk Gravity of Oversize Fraction: ASTM C 127 ☐ AASHTO T 85 ☐

Soil Classification: ASTM D 2487 ☒ ASTM D 2488 ☐ AASHTO M 145 ☐

Technician Name: B. Hatton

Certification #

Technical Responsibility: Brian Vaughan, P.E.

Signature

Construction Services Manager

Position

Moisture - Density Report

S&ME

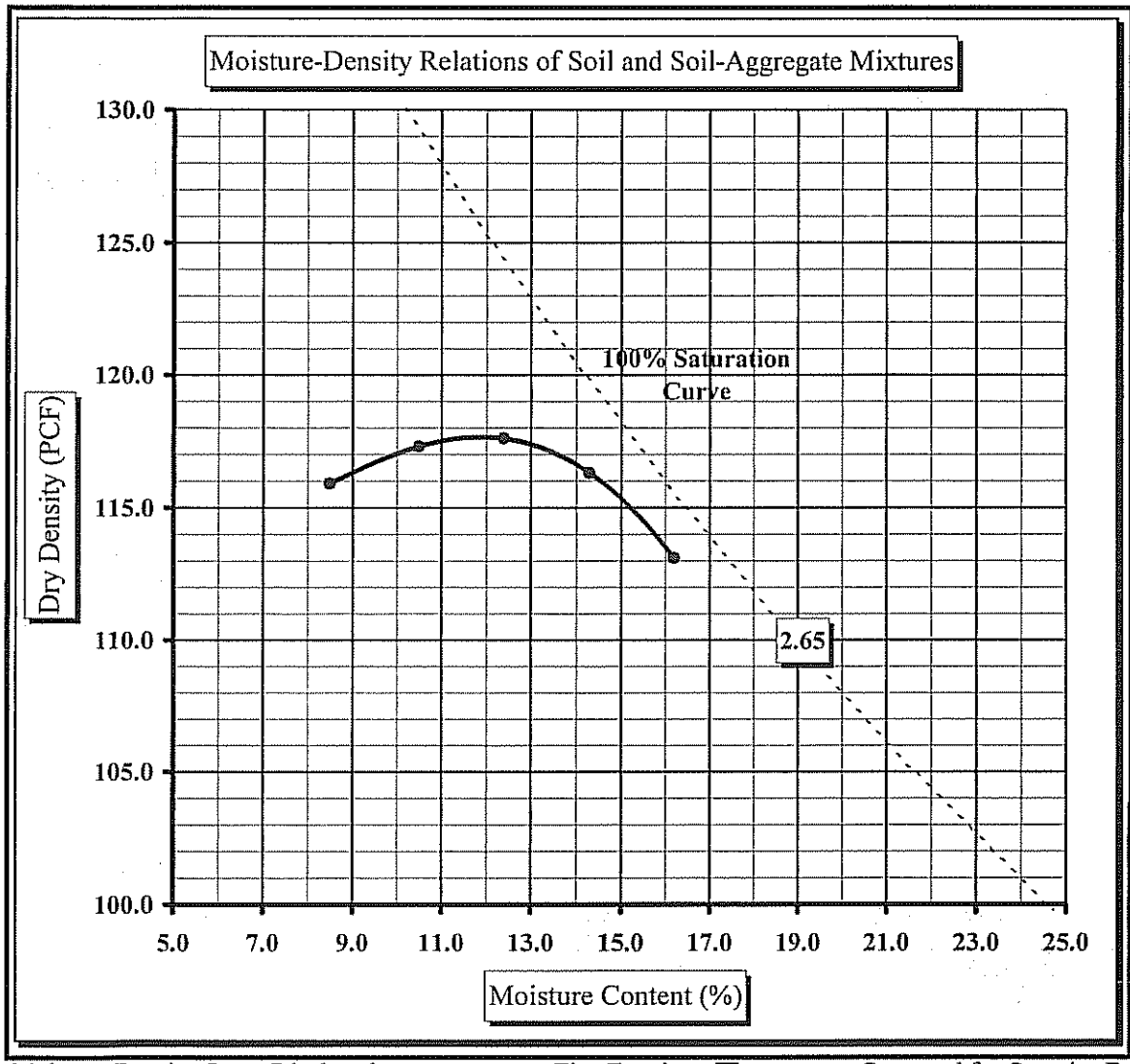
S&ME Project #:	**1411-07-103**	Report Date:	January 2, 2008
Project Name:	**Marshall Steam Station**	Test Date(s):	December 28, 2007
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-8	Sample #:	483	Sample Date:	November 13, 2007
Location:	Bulk	Offset:	N/A	Depth:	5-10'

Sample Description: Tan brown fine sandy silty CLAY (CL)

Maximum Dry Density 117.7 PCF. **Optimum Moisture Content 12.0 %**

ASTM D 698 Method A



Soil Properties

Natural Moisture Content:	7.4%
Liquid Limit:	36
Plastic Limit:	23
Plastic Index:	13
Specific Gravity:	2.650

% Passing	
3/8"	99.7
#4	96.8
#10	92.5
#20	88.5
#40	83.9
#60	78.7
#100	69.8
#200	53.5

Oversize Fraction

Bulk Sp. Gravity
% Moisture
Oversize Fraction
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 Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

References: ASTM D 698: Laboratory Compaction Characteristics of Soil Using Standard Effort
ASTM D 2216: Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D 422: Particle Size Analysis of Soils
ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. Construction Services Manager
Position

Laboratory Record Version 4.2

S&ME

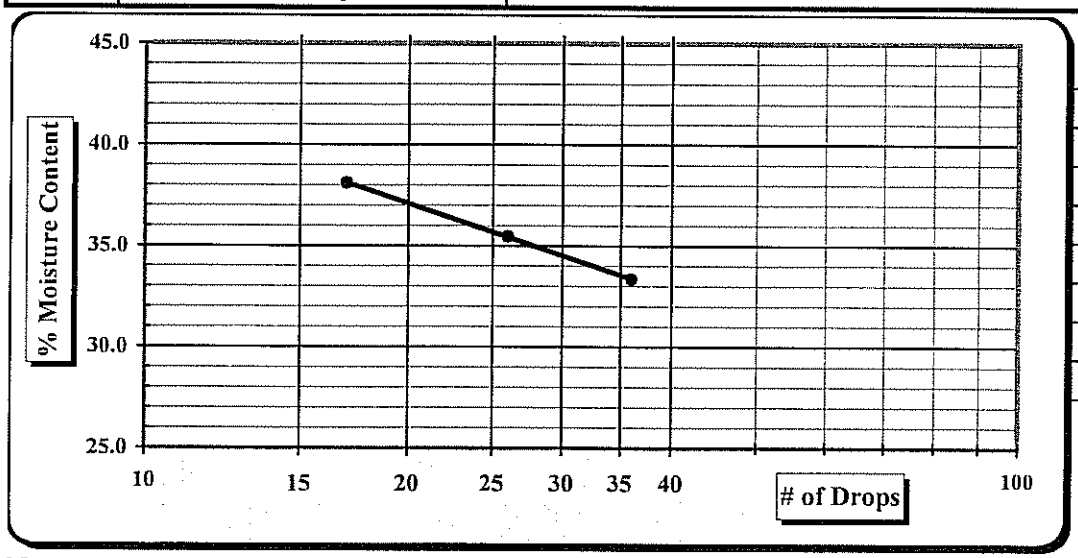
Liquid Limit, Plastic Limit, and Plastic Index

Project #: **1411-07-103**
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Charlotte, NC

Report Date: 1/23/08
Test Date(s): 1/22/08

Boring #: M-8 Sample #: 483 Sample Date: 11/13/07
Location: Bulk Offset: N/A Elevation: 5-10'
Sample Description: Tan brown fine sandy silty CLAY (CL)

Pan #		Liquid Limit						Plastic Limit		
	Test #	1	2	3	4	5	6	1	2	3
	Tare #	P-4	P-5	P-6				3	4	
A	Tare Weight	16.70	16.72	15.97				**10.76**	10.97	
B	Wet Soil Weight + A	38.10	37.81	37.65				18.47	18.71	
C	Dry Soil Weight + A	32.75	32.29	31.67				17.06	17.28	
D	Water Weight (B-C)	5.35	5.52	5.98				1.42	1.44	
E	Dry Soil Weight (C-A)	16.05	15.57	15.70				6.30	6.31	
F	% Moisture Content (D/E)*100	33.3%	35.5%	38.1%				22.5%	22.8%	
N	# OF DROPS	36	26	17				*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average							22.6%		



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes:

Special Sampling Methods:

Sample Preparation:	Wet Preparation	☐	Dry Preparation	☒	Air Dried	☒	% Passing #200 Sieve: 53.5
Liquid limit Test:	Multipoint Method	☒	One-point Method	☐			NP, Non-Plastic ☐
Classification:	ASTM D 2487	☒	AASHTO M 145	☐			Liquid Limit 36
Liquid limit Test:	ASTM D 4318	☒	AASHTO T 89	☐			Plastic Limit 23
Plastic limit Test:	ASTM D 4318	☒	AASHTO T 90	☐			Plastic Index 13
							Group Symbol CL

Technician Name: M. Jacobs

Certification #

Technical Responsibility: Brian Vaughan, P.E.

Signature

QC Manager
Position

CONSTANT HEAD PERMEABILITY

ASTM D5084

S&ME Project Number: 1411-07-103 Project Name: Marshall Steam Station 2/27/2008

Sample Name: M-8 483 (5-10')

Sample Description: Brown Fine Sandy Silty Clay (CH)

Type of Sample: Remolded

Sample Data		Molding Moisture Content		Target Molding Conditon				Additonal Data	
Diam. (cm)	7.275	Tare No.	G-5	γ_{wet} (pcf)	128.0			Panel No	6
Leng. (cm)	7.62	WWS+ Tare (gm)	356.2	γ_{dry} (pcf)	111.8			Cell P (psi)	82.5
Area (cm^2)	41.57	WDS+Tare (gm)	322.26	w (%)	14.5			Influent P (psi)	80.1
Vol. (cm^3)	316.75	WT of Water (gm)	33.94	Actual Molding Condition				Effluent P (psi)	80.0
WWS (gm)	651.7	WT of TARE (gm)	82.42	γ_{wet} (pcf)	128.5				
		WT Dry Soil (gm)	239.84	γ_{dry} (pcf)	112.6			Gradient	0.9
		w (%)	14.2	w (%)	14.2				

K = (Q x L) / (t x H x A)

Run	Temp. (^{0}C)	Hour	Minute	Time, t (sec)	Cell Burette (cc)	Influent Burette(cc)	Effluent Burette (cc)	Q (cc)	Δ H (cm)	Temp Corr.	K(cm/sec)
1		11	29		15.2	1.0	23.4				
	22	12	34	3900	15.2	1.1	23.3	0.1	7.0	0.9530	6.36E-07
2		12	34		15.2	1.1	23.3				
	22	13	52	4680	15.2	1.3	23.2	0.2	7.0	0.9530	7.96E-07
3		10	58		15.2	1.5	23.3				
	22	13	4	7560	15.3	1.8	23.2	0.2	7.0	0.9530	6.57E-07
4		13	5		15.3	0.3	24.0				
	22	17	39	16440	15.3	0.6	23.7	0.3	7.0	0.9530	4.53E-07
5		9	16		15.4	0.6	23.7				
	22	11	52	9360	15.4	0.9	23.5	0.3	7.0	0.9530	6.63E-07
6										Ave. K (cm/sec)	6.42E-07
										(Runs 2 thru 5)	
										Ave. K (m/sec)	6.42E-09

Particle Size Analysis of Soils

ASTM D 422

S&ME

Project #: **1411-07-103**
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Charlotte, NC

Test Date(s): 12/11 - 12/13/07
Report Date: 12/14/07

Boring #: M-8 Sample #: 483 Sample Date: 11/13/07
Location: Bulk Offset: N/A Elevation: 10-15'
Sample Description: Tan brown fine sandy silty CLAY (CL)

Pan #:	11	Beaker #:	6
Hydrometer Jar #:			6
Pan Tare Weight (grams):			0.00
Total Sample Air Dried Wt. + tare wt. (grams):			484.22
Weight of Total Sample Air Dried:			484.22
Weight of Air Dried Hydrometer Sample (g):			52.43
Total Sample Oven Dried:			474.83
Hydrometer Sample Oven Dried (W):			51.39
% Passing #10:			97.8%
Correction Factor a (Table 1):			1.00

Specific Gravity 2.650

	Moisture Content	Hygroscopic	Natural
	Tare #	P-6	323
A	Tare Wt.	15.98	0.00
B	Wet Wt. + A	28.60	249.59
C	Dry Wt. + A	28.35	225.21
D	Water Wt. (B-C)	0.25	24.38
E	Dry Wt. (C-A)	12.37	225.21
	% Moisture (100 x D/E)	2.02%	10.8%

Sieve	Retained Wt.	Percent Passing	
3.0"	0.0	Pan # (washed)	100.0%
1.5"	0.0		100.0%
1.0"	0.0		100.0%
3/4"	0.0	58	100.0%
1/2"	0.0		100.0%
3/8"	0.0		100.0%
#4	3.2	Soil Mortar	99.3%
#10	10.3	**100.0%**	97.8%
#20	1.0	98.1%	96.0%
#40	2.8	94.6%	92.6%
#60	5.5	89.4%	87.4%
#100	10.3	80.0%	78.2%
#200	19.1	62.9%	61.5%

Notes: Description of Sand & Gravel Particles Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:	4.75 mm		Total Sand:	37.8%	< 4.74 mm and > 0.075 mm	Type: Mechanical Stirring Apparatus (A)
% Gravel:	0.7%	< 75 mm and > 4.75 mm	Silt & Clay:	61.5%	< 0.075	Dispersion Time: 1 min.
Coarse Sand:	1.5%	< 4.75 mm and > 2.00 mm	Silt:	41.8%	< 0.075 and > 0.005 mm	Sodium Hexametaphosphate: 40 g./ Liter
Medium Sand:	5.3%	< 2.00 mm and > 0.425 mm	Clay:	19.7%	< 0.005 mm	
Fine Sand:	31.0%	< 0.425 mm and > 0.075 mm	Colloids:	9.3%	< 0.001 mm	**Control Cylinder** ☐ **Composite Correction** ☒

Liquid Limit **38** Plastic Limit **23** Plastic Index **15** Hydrometer: 151H ☐ 152H ☒

Time		Temp.	Hydrometer	Corrections		Hydrometer	Percent Passing		Effective Depth	Table 3	Diameter
Clock	T (Min.)	(0.5 °C)	Reading	Control Cylinder	Composite Correction	R	P(-#10) = (R x a / W) x 100	P (total) = P x % Passing #10	L	K	D = K x ((L/T)^1/2
	2	23.5	28.5		5.05	23.45	45.6%	44.6%	12.4	0.01309	0.03266
	5	23.5	25.0		5.05	19.95	38.8%	38.0%	13.0	0.01309	0.02113
	15	23.5	21.0		5.05	15.95	31.0%	30.4%	13.7	0.01309	0.01250
	30	23.5	18.5		5.05	13.45	26.2%	25.6%	14.1	0.01309	0.00897
	60	23.5	16.5		5.05	11.45	22.3%	21.8%	14.4	0.01309	0.00642
	250	23.1	13.5		5.10	8.40	16.3%	16.0%	14.9	0.01317	0.00322
	1440	23.2	11.0		5.10	5.90	11.5%	11.2%	15.3	0.01317	0.00136
	2880	23.2	10.0		5.10	4.90	9.5%	9.3%	15.5	0.01317	0.00097

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Effective Depth (cm)
L=L1+0.5(L2-(VB/A))
(152H) .164cm per increment,
V_B=67.0cm^3, L_2=14cm, A=27.8cm^2

Technician Name: M. Jacobs

Technical Responsibility: Brian Vaughan, P.E.

Certification #

Signature

QC Manager
Position

S&ME, INC.
155 Tradd Street Spartanburg, SC 29301

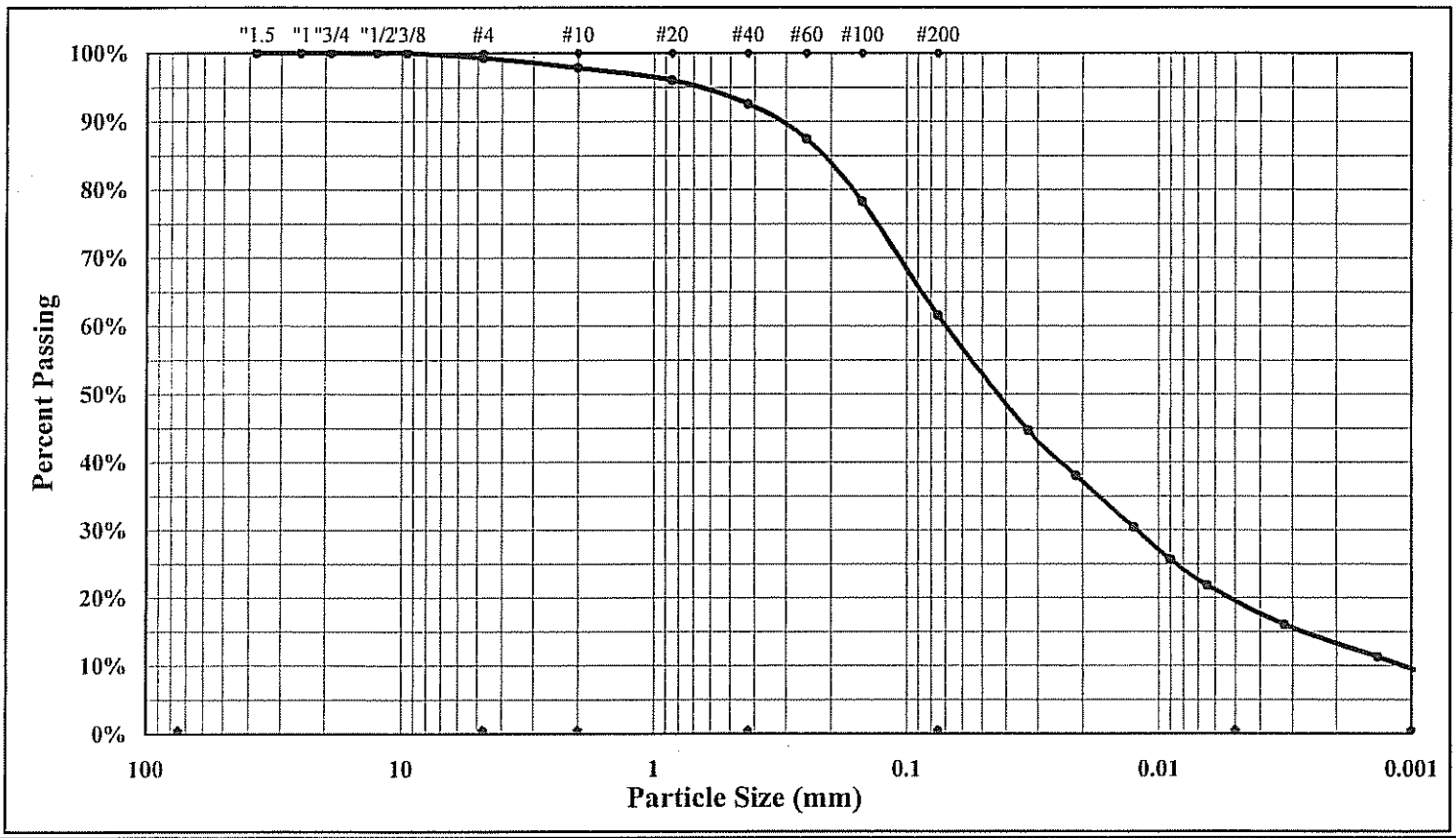
Hydrometer #483 (M-8, 10-15') 12-14-07.xls

Particle Size Analysis of Soils

ASTM D 422

S&ME Project #:	**1411-07-103**	Report Date:	12/14/07
Project Name:	**Marshall Steam Station**	Test Date(s):	12/11 - 12/13/07
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-8	Sample #:	483	Sample Date:	11/13/07
Location:	Bulk	Offset:	N/A	Elevation:	10-15'
Sample Description:	Tan brown fine sandy silty CLAY (CL)				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	4.75 mm	Gravel	0.7%	Silt	41.8%
Silt & Clay (% Passing #200)	61.5%	Sand	37.8%	Clay	19.7%
Specific Gravity	2.650	Moisture Content	10.8%	Colloids	9.3%
Liquid Limit	38	Plastic Limit	23	Plastic Index	15

Description of Sand & Gravel Particles Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Mechanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 854: Specific Gravity of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. _____ QC Manager
Signature *Position*

Moisture - Density Relationship

S&ME

S&ME Project #:	**1411-07-103**	Test Date(s):	December 28, 2007
Project Name:	Marshall Steam Station	Report Date:	January 2, 2008
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-8	Sample #:	483	Sample Date:	November 13, 2007
Location:	Bulk	Offset:	N/A	Depth:	10-15'

Sample Description: Tan brown fine sandy silty CLAY (CL)

Liquid Limit:	38	Specific Gravity:	2.650
Plastic Limit:	23	Plastic Index:	15

Natural Moisture Content: 10.8%

Moisture Content of the Oversize Fraction:

NOTES:

Sieve Size	% Passing
#4	99.3
#10	97.8
#20	96.0
#40	92.6
#60	87.4
#100	78.2
#200	61.5

MDD: 113.8 **Opt. MC %: 14.0**

Water Content

Water Content requires GP 2 Balance (0.1 gram Readability).

ASTM D2216 ☒ AASHTO T265 ☐ ASTM D4959 ☐ ASTM D4643 ☐

	Sample #:	1	2	3	4	5	6
	Water Added:						
	Tare #:						
A. Tare Weight	A.	0	0	0	0	0	0
B. Wet Wt + Tare Wt	B.	500	500	500	500	500	500
C. Dry Wt. + Tare Wt.	C.	449.7	442.5	434.8	427		
D. Water Weight	B-C	50.3	57.5	65.2	73	500	500
E. Dry Weight	C-A	449.7	442.5	434.8	427	0	0
F. Moisture Content	100*D/E	**11.2%**	**13.0%**	**15.0%**	**17.1%**	**#DIV/0!**	**#DIV/0!**

Compaction Data

The Compaction Test requires a GP 5 Balance for ASTM (1 gram or .0022 Lb. readability).

G. Wt of Soil + Mold	G.	13.442	13.572	13.650	13.636		
H. Wt. of Mold	H.	9.304	9.304	9.304	9.304	9.304	9.304
I. Wt. of Soil (g. or lbs.)	G-H	4.138	4.268	4.346	4.332	-9.304	-9.304
J. Wt of Soil (Lbs.)	I/453.6 or I	4.138	4.268	4.346	4.332	-9.304	-9.304
K. Mold Volume Factor	K.	30.039	30.039	30.039	30.039	30.039	30.039
L. Wet Density	J*K	124.3	128.2	130.5	130.1	-279.5	-279.5
M. Dry Density	L/(1+F)	**111.8**	**113.5**	**113.5**	**111.1**	**#DIV/0!**	**#DIV/0!**

ASTM D558 ☐ ASTM D 698 ☒ ASTM D1557 ☐ AASHTO T99 ☐ AASHTO T180 ☐

Method A ☒ Method B ☐ Method C ☐ Method D (ASTM 1978) ☐ AASHTO Method D ☐

Moisture-Density Relation of: Fine Fraction ☒ Corrected for Coarse Fraction (ASTM D 4718) ☐

Sieve Size used to separate the Oversize Fraction: #4 Sieve ☒ 3/8 inch Sieve ☐ 3/4 inch Sieve ☐

Mechanical Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

Soil Plasticity: ASTM D 4318 ☒ AASHTO T 89 ☐ AASHTO T 90 ☐

Sieve Analysis / Particle Size Analysis: ASTM C136 ☐ AASHTO T 27 ☐ ASTM D 422 ☒ AASHTO T 88 ☐

Specific Gravity of Soil: ASTM D 854 ☒ AASHTO T 100 ☐

Bulk Gravity of Oversize Fraction: ASTM C 127 ☐ AASHTO T 85 ☐

Soil Classification: ASTM D 2487 ☒ ASTM D 2488 ☐ AASHTO M 145 ☐

Technician Name: B. Hatton

Certification #

Technical Responsibility: Brian Vaughan, P.E.

Signature

Construction Services Manager

Position

Moisture - Density Report

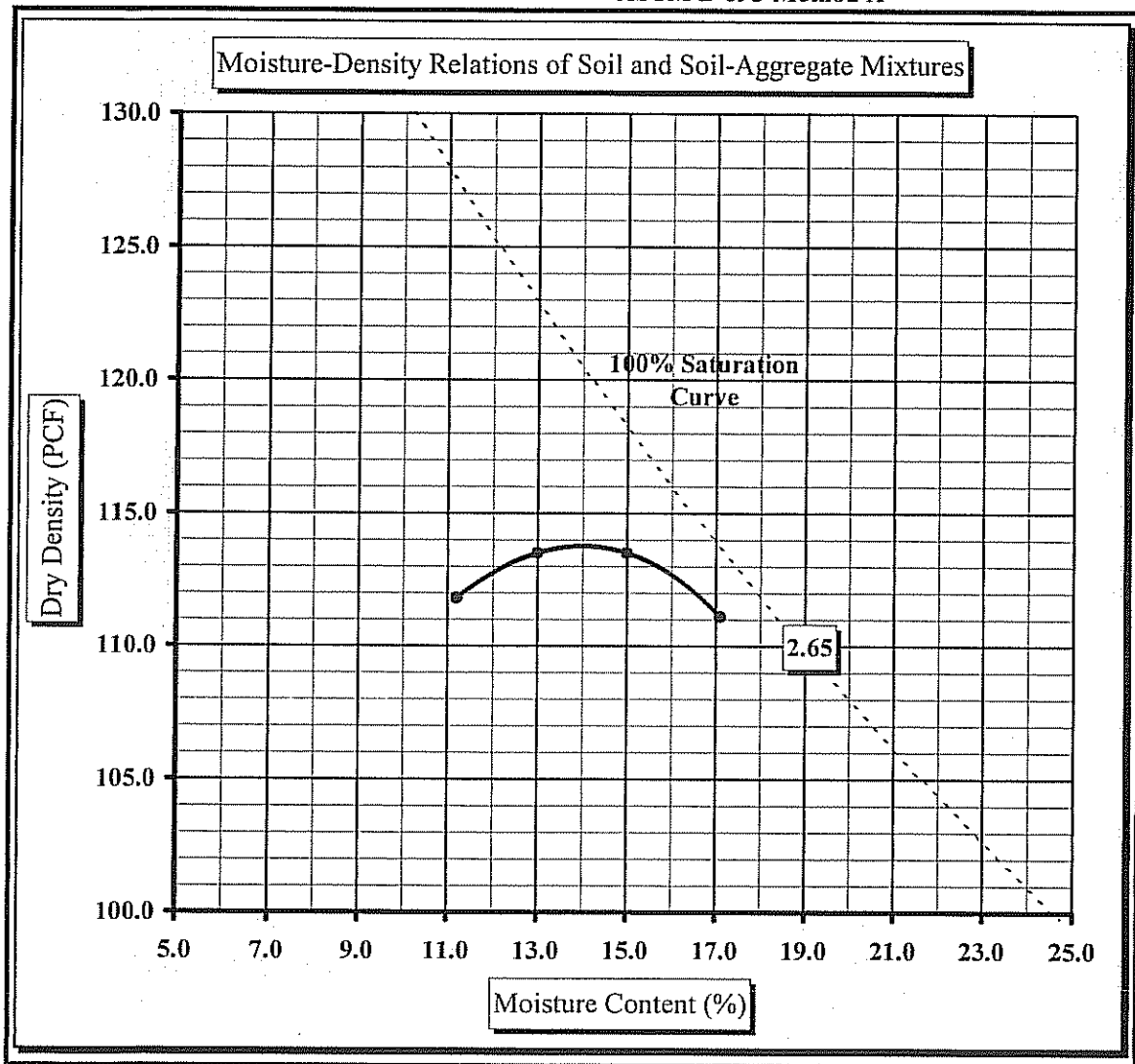
S&ME

S&ME Project #:	**1411-07-103**	Report Date:	January 2, 2008
Project Name:	**Marshall Steam Station**	Test Date(s):	December 28, 2007
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-8	Sample #:	483	Sample Date:	November 13, 2007
Location:	Bulk	Offset:	N/A	Depth:	10-15'
Sample Description:	Tan brown fine sandy silty CLAY (CL)				

Maximum Dry Density **113.8** **PCF.** **Optimum Moisture Content** **14.0** **%**

ASTM D 698 Method A



Soil Properties

Natural Moisture Content:	10.8%
Liquid Limit:	38
Plastic Limit:	23
Plastic Index:	15
Specific Gravity:	2.650

% Passing

#4	99.3
#10	97.8
#20	96.0
#40	92.6
#60	87.4
#100	78.2
#200	61.5

Oversize Fraction

Bulk Sp. Gravity
% Moisture
Oversize Fraction
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 Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

References: ASTM D 698: Laboratory Compaction Characteristics of Soil Using Standard Effort
ASTM D 2216: Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D 422: Particle Size Analysis of Soils ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. Construction Services Manager
Position

Laboratory Record Version 4.2

S&ME

Liquid Limit, Plastic Limit, and Plastic Index

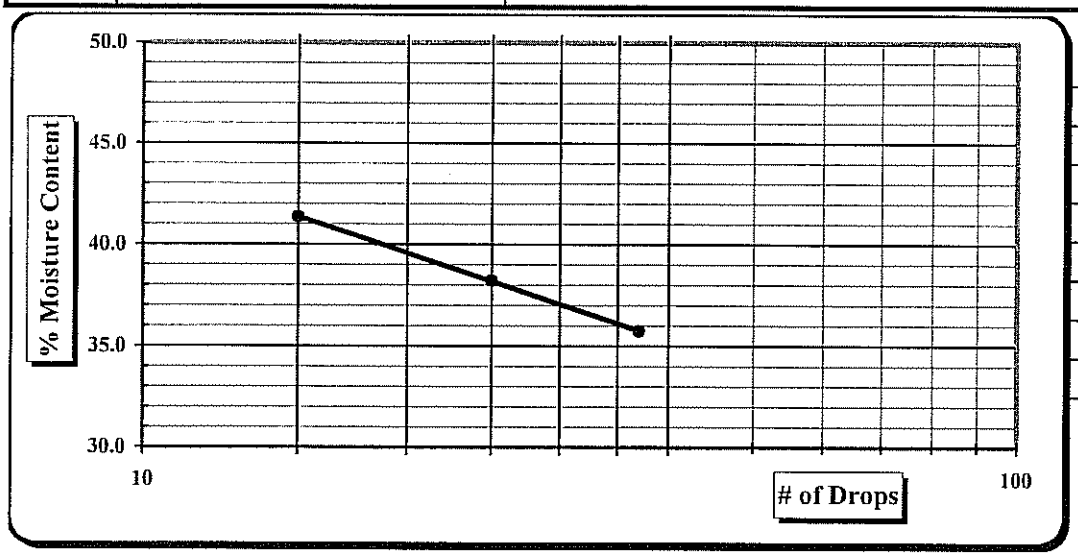
Project #:	**1411-07-103**	Report Date:	1/23/08
Project Name:	Marshall Steam Station	Test Date(s):	1/22/08
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #: M-8 Sample #: 483 Sample Date: 11/13/07

Location: Bulk Offset: N/A Elevation: 10-15'

Sample Description: Tan brown fine sandy silty CLAY (CL)

Pan #		Liquid Limit						Plastic Limit		
	Test #	1	2	3	4	5	6	1	2	3
	Tare #	Q-4	Q-5	Q-6				5	6	
A	Tare Weight	16.74	16.92	16.80				**10.81**	10.90	
B	Wet Soil Weight + A	37.29	37.14	37.66				18.50	18.21	
C	Dry Soil Weight + A	31.88	31.55	31.56				17.04	16.84	
D	Water Weight (B-C)	5.41	5.59	6.10				1.47	1.37	
E	Dry Soil Weight (C-A)	15.14	14.63	14.76				6.23	5.94	
F	% Moisture Content (D/E)*100	35.7%	38.2%	41.3%				23.5%	23.1%	
N	# OF DROPS	37	25	15				*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average							23.3%		



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes:

Special Sampling Methods:

Sample Preparation:	Wet Preparation	☐	Dry Preparation	☒	Air Dried	☒	% Passing #200 Sieve: 61.5
Liquid limit Test:	Multipoint Method	☒	One-point Method	☐			NP, Non-Plastic ☐
Classification:	ASTM D 2487	☒	AASHTO M 145	☐			Liquid Limit 38
Liquid limit Test:	ASTM D 4318	☒	AASHTO T 89	☐			Plastic Limit 23
Plastic limit Test:	ASTM D 4318	☒	AASHTO T 90	☐			Plastic Index 15
							Group Symbol CL

Technician Name: M. Jacobs

Certification #

Technical Responsibility: Brian Vaughan, P.E.

Signature

QC Manager

Position

Particle Size Analysis of Soils

ASTM D 422

S&ME

Project #: **1411-07-103**
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Charlotte, NC

Test Date(s): 4/2 - 4/4/08
Report Date: 4/7/08

Boring #: M-8 Sample #: 85 Sample Date: 11/13/07
Location: sample 8 Offset: N/A Elevation: 38.5-40'
Sample Description: Tan brown fine sandy SILT

Pan #:	5	Beaker #:	5
Hydrometer Jar #:			5
Pan Tare Weight (grams):			0.00
Total Sample Air Dried Wt. + tare wt. (grams):			205.41
Weight of Total Sample Air Dried:			205.41
Weight of Air Dried Hydrometer Sample (g):			53.38
Total Sample Oven Dried:			203.71
Hydrometer Sample Oven Dried (W):			52.94
% Passing #10:			99.9%
Correction Factor a (Table 1):			1.00

Specific Gravity 2.650

	Moisture Content	Hygroscopic
	Tare #	Z-5
A	Tare Wt.	15.62
B	Wet Wt. + A	30.07
C	Dry Wt. + A	29.95
D	Water Wt. (B-C)	0.12
E	Dry Wt. (C-A)	14.33
	% Moisture (100 x D/E)	0.84%

Sieve	Retained Wt.	Percent Passing	
3.0"	0.0	Pan # (washed)	100.0%
1.5"	0.0		100.0%
1.0"	0.0		100.0%
3/4"	0.0	57	100.0%
1/2"	0.0		100.0%
3/8"	0.0		100.0%
#4	0.0	Soil Mortar	100.0%
#10	0.1	**100.0%**	99.9%
#20	0.3	99.5%	99.4%
#40	1.3	97.5%	97.5%
#60	4.2	92.1%	92.0%
#100	11.9	77.6%	77.5%
#200	26.1	50.8%	50.7%

Notes: Description of Sand & Gravel Particles — Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:	2.00 mm		Total Sand:	49.3%	< 4.74 mm and > 0.075 mm	Type:	Mechanical Stirring Apparatus (A)
% Gravel:	0.0%	< 75 mm and > 4.75 mm	Silt & Clay:	50.7%	< 0.075	Dispersion Time:	1 min.
Coarse Sand:	0.1%	< 4.75 mm and > 2.00 mm	Silt:	42.9%	< 0.075 and > 0.005 mm	Sodium Hexametaphosphate:	40 g./ Liter
Medium Sand:	2.5%	< 2.00 mm and > 0.425 mm	Clay:	7.8%	< 0.005 mm		
Fine Sand:	46.8%	< 0.425 mm and > 0.075 mm	Colloids:	2.5%	< 0.001 mm	**Control Cylinder** ☐	**Composite Correction** ☒

Liquid Limit N/A Plastic Limit N/A Plastic Index N/A Hydrometer: 151H ☐ 152H ☒

Time		Temp.	Hydrometer	Corrections		Hydrometer	Percent Passing		Effective Depth	Table 3	Diameter
Clock	T (Min.)	(0.5 °C)	Reading	Control Cylinder	Composite Correction	R	P(-#10) = (R x a / W) x 100	P (total) = P x % Passing #10	L	K	D = K x ((L/T)^1/2
	2	23.4	20.5		5.05	15.45	29.2%	29.2%	13.8	0.01317	0.03455
	5	23.4	16.5		5.05	11.45	21.6%	21.6%	14.4	0.01317	0.02236
	15	23.4	13.0		5.05	7.95	15.0%	15.0%	15.0	0.01317	0.01317
	30	23.4	11.2		5.05	6.15	11.6%	11.6%	15.3	0.01317	0.00940
	60	23.3	10.0		5.05	4.95	9.4%	9.3%	15.5	0.01317	0.00669
	250	22.9	8.5		5.10	3.40	6.4%	6.4%	15.7	0.01325	0.00332
	1440	23.0	7.0		5.10	1.90	3.6%	3.6%	16.0	0.01317	0.00139
	2880	22.6	6.5		5.15	1.35	2.6%	2.5%	16.1	0.01325	0.00099

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Effective Depth (cm)
L=L1+0.5(L2-(VB/A))
(152H) .164cm per increment,
V_B=67.0cm^3, L_2=14cm, A=27.8cm^2

Technician Name: M. Jacobs

Technical Responsibility: Brian Vaughan, P.E.

Certification #

Signature

OC Manager
Position

S&ME, INC. **155 Tradd Street Spartanburg, SC 29301**

Hydrometer #85 (M-8, 38.5-40') 4-7-08.xls

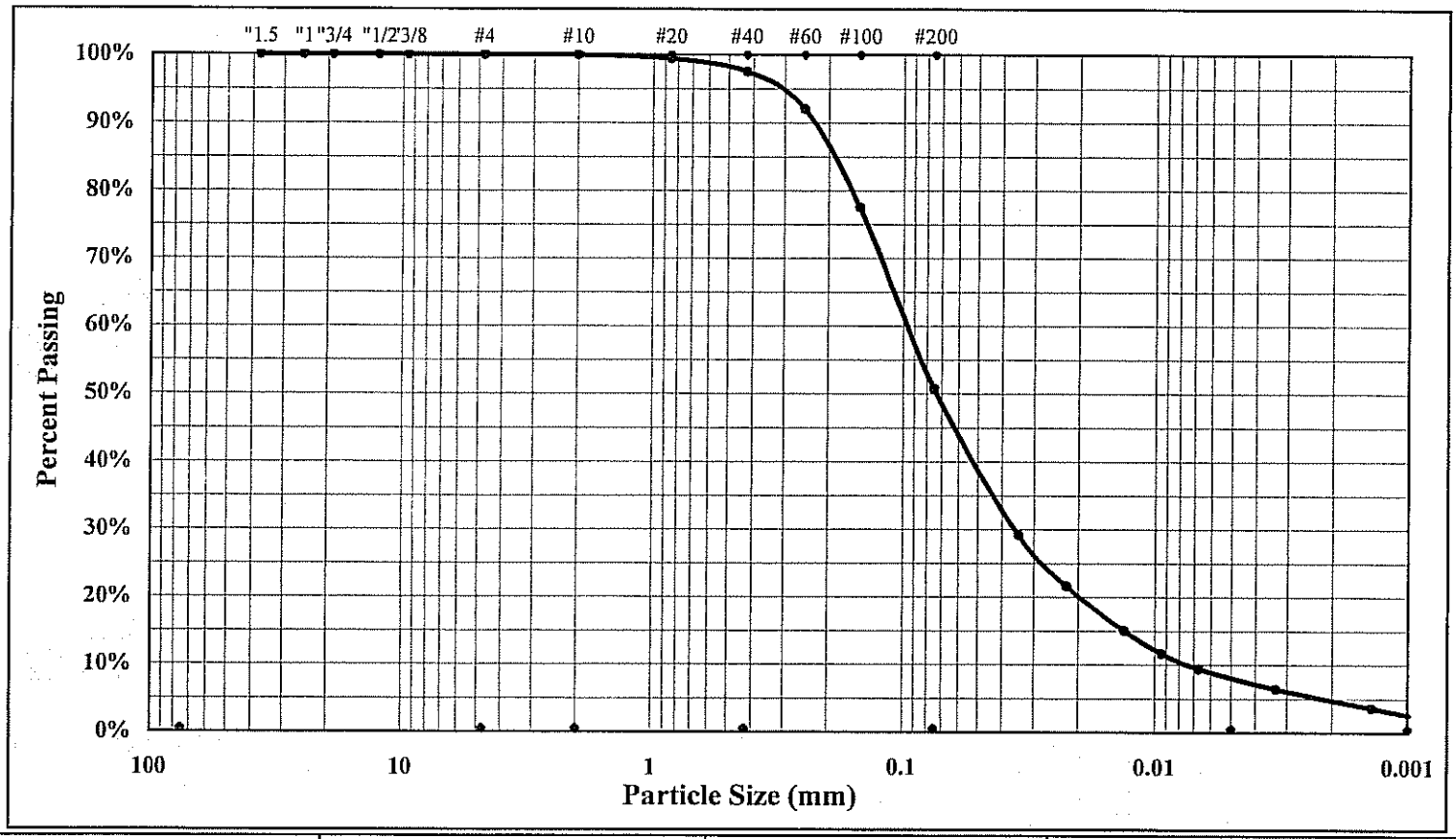
Particle Size Analysis of Soils

ASTM D 422

S&ME

S&ME Project #:	**1411-07-103**	Report Date:	4/7/08
Project Name:	**Marshall Steam Station**	Test Date(s):	4/2 - 4/4/08
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-8	Sample #:	85	Sample Date:	11/13/07
Location:	sample 8	Offset:	N/A	Elevation:	38.5-40'
Sample Description:	Tan brown fine sandy SILT				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	2.00 mm	Gravel	0.0%	Silt	42.9%
Silt & Clay (% Passing #200)	50.7%	Sand	49.3%	Clay	7.8%
Specific Gravity	2.650			Colloids	2.5%
Liquid Limit	N/A	Plastic Limit	N/A	Plastic Index	N/A

Description of Sand & Gravel Particles Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Mechanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

References: ASTM D 422: Particle Size Analysis of Soils; ASTM D 421: Dry Preparation of Soil Samples; ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils; ASTM D 854: Specific Gravity of Soils; ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. _____ QC Manager

Signature *Position*

Particle Size Analysis of Soils

ASTM D 422

S&ME

Project #: **1411-07-103**
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Charlotte, NC

Test Date(s): 11/27 - 11/29/07
Report Date: 11/30/07

Boring #: M-16 Sample #: 476 Sample Date: 11/5/07
Location: Bulk Offset: N/A Elevation: 3-5'
Sample Description: Tan brown fine sandy silty CLAY (CL)

Pan #:	15	Beaker #:	10
Hydrometer Jar #:			10
Pan Tare Weight (grams):			0.00
Total Sample Air Dried Wt. + tare wt. (grams):			501.74
Weight of Total Sample Air Dried:			501.74
Weight of Air Dried Hydrometer Sample (g):			53.44
Total Sample Oven Dried:			490.60
Hydrometer Sample Oven Dried (W):			52.25
% Passing #10:			99.5%
Correction Factor a (Table 1):			1.00

Specific Gravity 2.650

	Moisture Content	Hygroscopic	Natural
	Tare #	X-4	378
A	Tare Wt.	10.98	0.00
B	Wet Wt. + A	24.42	270.47
C	Dry Wt. + A	24.12	232.31
D	Water Wt. (B-C)	0.30	38.16
E	Dry Wt. (C-A)	13.14	232.31
	% Moisture (100 x D/E)	2.28%	16.4%

Sieve	Retained Wt.	Percent Passing	
3.0"	0.0	Pan # (washed)	100.0%
1.5"	0.0		100.0%
1.0"	0.0		100.0%
3/4"	0.0	64	100.0%
1/2"	0.0		100.0%
3/8"	0.0		100.0%
#4	0.2	Soil Mortar	100.0%
#10	2.5	**100.0%**	99.5%
#20	0.6	98.8%	98.3%
#40	2.1	96.1%	95.6%
#60	5.6	89.2%	88.8%
#100	12.7	75.7%	75.3%
#200	22.1	57.7%	57.4%

Notes: Description of Sand & Gravel Particles — Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:	4.75 mm		Total Sand:	42.6%	< 4.74 mm and > 0.075 mm	Type:	Mechanical Stirring Apparatus (A)
% Gravel:	0.0%	< 75 mm and > 4.75 mm	Silt & Clay:	57.4%	< 0.075	Dispersion Time:	1 min.
Coarse Sand:	0.5%	< 4.75 mm and > 2.00 mm	Silt:	27.6%	< 0.075 and > 0.005 mm	Sodium Hexametaphosphate:	40 g./ Liter
Medium Sand:	3.9%	< 2.00 mm and > 0.425 mm	Clay:	29.8%	< 0.005 mm		
Fine Sand:	38.2%	< 0.425 mm and > 0.075 mm	Colloids:	19.7%	< 0.001 mm	**Control Cylinder** ☐	**Composite Correction** ☒

Liquid Limit **34** Plastic Limit **18** Plastic Index **16** Hydrometer: 151H ☐ 152H ☒

Time		Temp.	Hydrometer	Corrections		Hydrometer	Percent Passing		Effective Depth	Table 3	Diameter
Clock	T (Min.)	(0.5 °C)	Reading	Control Cylinder	Composite Correction	R	P(-#10) = (R x a / W) x 100	P (total) = P x % Passing #10	L	K	D = K x ((L/T)^1/2
	2	22.9	29.5		5.10	24.40	46.7%	46.5%	12.3	0.01325	0.03284
	5	22.9	27.0		5.10	21.90	41.9%	41.7%	12.7	0.01325	0.02111
	15	22.9	24.5		5.10	19.40	37.1%	36.9%	13.1	0.01325	0.01238
	30	22.9	23.0		5.10	17.90	34.3%	34.1%	13.4	0.01325	0.00884
	60	23.0	21.5		5.10	16.40	31.4%	31.2%	13.6	0.01317	0.00627
	250	23.3	19.0		5.05	13.95	26.7%	26.6%	14.0	0.01317	0.00312
	1440	22.5	16.5		5.15	11.35	21.7%	21.6%	14.4	0.01325	0.00133
	2880	22.2	15.5		5.20	10.30	19.7%	19.6%	14.6	0.01332	0.00095

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Effective Depth (cm)
L=L1+0.5(L2-(VB/A))
(152H) .164cm per increment,
V_B=67.0cm^3, L_2=14cm, A=27.8cm^2

Technician Name: M. Jacobs
Certification #

Technical Responsibility: Brian Vaughan, P.E.
Signature

QC Manager
Position

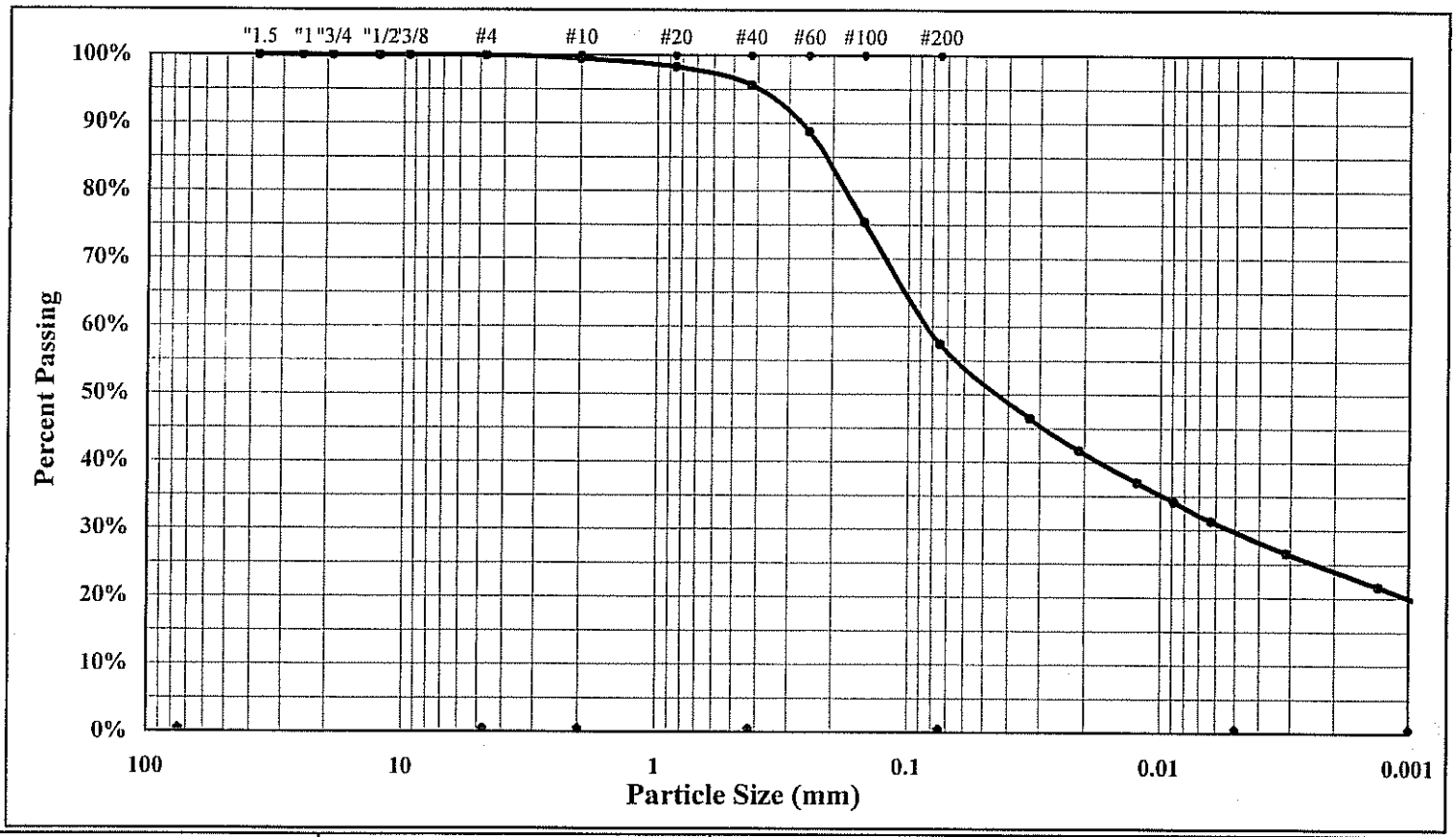
Particle Size Analysis of Soils

ASTM D 422

S&ME

S&ME Project #:	**1411-07-103**	Report Date:	11/30/07
Project Name:	**Marshall Steam Station**	Test Date(s):	11/27 - 11/29/07
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-16	Sample #:	476	Sample Date:	11/5/07
Location:	Bulk	Offset:	N/A	Elevation:	3-5'
Sample Description:	Tan brown fine sandy silty CLAY (CL)				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	4.75 mm	Gravel	0.0%	Silt	27.6%
Silt & Clay (% Passing #200)	57.4%	Sand	42.6%	Clay	29.8%
Specific Gravity	2.650	Moisture Content	16.4%	Colloids	19.7%
Liquid Limit	34	Plastic Limit	18	Plastic Index	16

Description of Sand & Gravel Particles Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Mechanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

References: ASTM D 422: Particle Size Analysis of Soils
ASTM D 421: Dry Preparation of Soil Samples
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 854: Specific Gravity of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. _____ QC Manager

Signature Position

Moisture - Density Relationship

S&ME

S&ME Project #:	**1411-07-103**	Test Date(s):	December 19, 2007
Project Name:	Marshall Steam Station	Report Date:	December 20, 2007
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-16	Sample #:	476	Sample Date:	November 5, 2007
Location:	Bulk	Offset:	N/A	Depth:	3-5'

Sample Description: Tan brown fine sandy silty CLAY (CL)

Liquid Limit:	34	Specific Gravity:	2.650
Plastic Limit:	18	Plastic Index:	16

Natural Moisture Content: 16.4%

Moisture Content of the Oversize Fraction:

NOTES:

Sieve Size	% Passing
#4	100.0
#10	99.5
#20	98.3
#40	95.6
#60	88.8
#100	75.3
#200	57.4

MDD: 114.7 **Opt. MC %: 15.7**

Water Content

Water Content requires GP 2 Balance (0.1 gram Readability).

ASTM D2216 ☒ AASHTO T265 ☐ ASTM D4959 ☐ ASTM D4643 ☐

	Sample #:	1	2	3	4	5	6
	Water Added:						
	Tare #:						
A. Tare Weight	A.	0	0	0	0	0	0
B. Wet Wt + Tare Wt	B.	500	500	500	500	500	500
C. Dry Wt. + Tare Wt.	C.	447.1	438.6	431.9	426		
D. Water Weight	B-C	52.9	61.4	68.1	74	500	500
E. Dry Weight	C-A	447.1	438.6	431.9	426	0	0
F. Moisture Content	100*D/E	**11.8%**	**14.0%**	**15.8%**	**17.4%**	**#DIV/0!**	**#DIV/0!**

Compaction Data

The Compaction Test requires a GP 5 Balance for ASTM (1 gram or .0022 Lb. readability).

G. Wt of Soil + Mold	G.	13.418	13.598	13.720	13.680		
H. Wt. of Mold	H.	9.304	9.304	9.304	9.304	9.304	9.304
I. Wt. of Soil (g. or lbs.)	G-H	4.114	4.294	4.416	4.376	-9.304	-9.304
J. Wt of Soil (Lbs.)	I/453.6 or I	4.114	4.294	4.416	4.376	-9.304	-9.304
K. Mold Volume Factor	K.	30.039	30.039	30.039	30.039	30.039	30.039
L. Wet Density	J*K	123.6	129.0	132.7	131.5	-279.5	-279.5
M. Dry Density	L/(1+F)	**110.5**	**113.1**	**114.6**	**112.0**	**#DIV/0!**	**#DIV/0!**

ASTM D558 ☐ ASTM D 698 ☒ ASTM D1557 ☐ AASHTO T99 ☐ AASHTO T180 ☐

Method A ☒ Method B ☐ Method C ☐ Method D (ASTM 1978) ☐ AASHTO Method D ☐

Moisture-Density Relation of: Fine Fraction ☒ Corrected for Coarse Fraction (ASTM D 4718) ☐

Sieve Size used to separate the Oversize Fraction: #4 Sieve ☒ 3/8 inch Sieve ☐ 3/4 inch Sieve ☐

Mechanical Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

Soil Plasticity:	ASTM D 4318 ☒	AASHTO T 89 ☐		AASHTO T 90 ☐
Sieve Analysis / Particle Size Analysis:	ASTM C136 ☐	AASHTO T 27 ☐	ASTM D 422 ☒	AASHTO T 88 ☐
Specific Gravity of Soil:		ASTM D 854 ☒		AASHTO T 100 ☐
Bulk Gravity of Oversize Fraction:		ASTM C 127 ☐		AASHTO T 85 ☐
Soil Classification:	ASTM D 2487 ☒	ASTM D 2488 ☐		AASHTO M 145 ☐

Technician Name: B. Hatton

Certification #

Technical Responsibility: Brian Vaughan, P.E. Signature Construction Services Manager Position

Laboratory Report Version 4.2

Moisture - Density Report

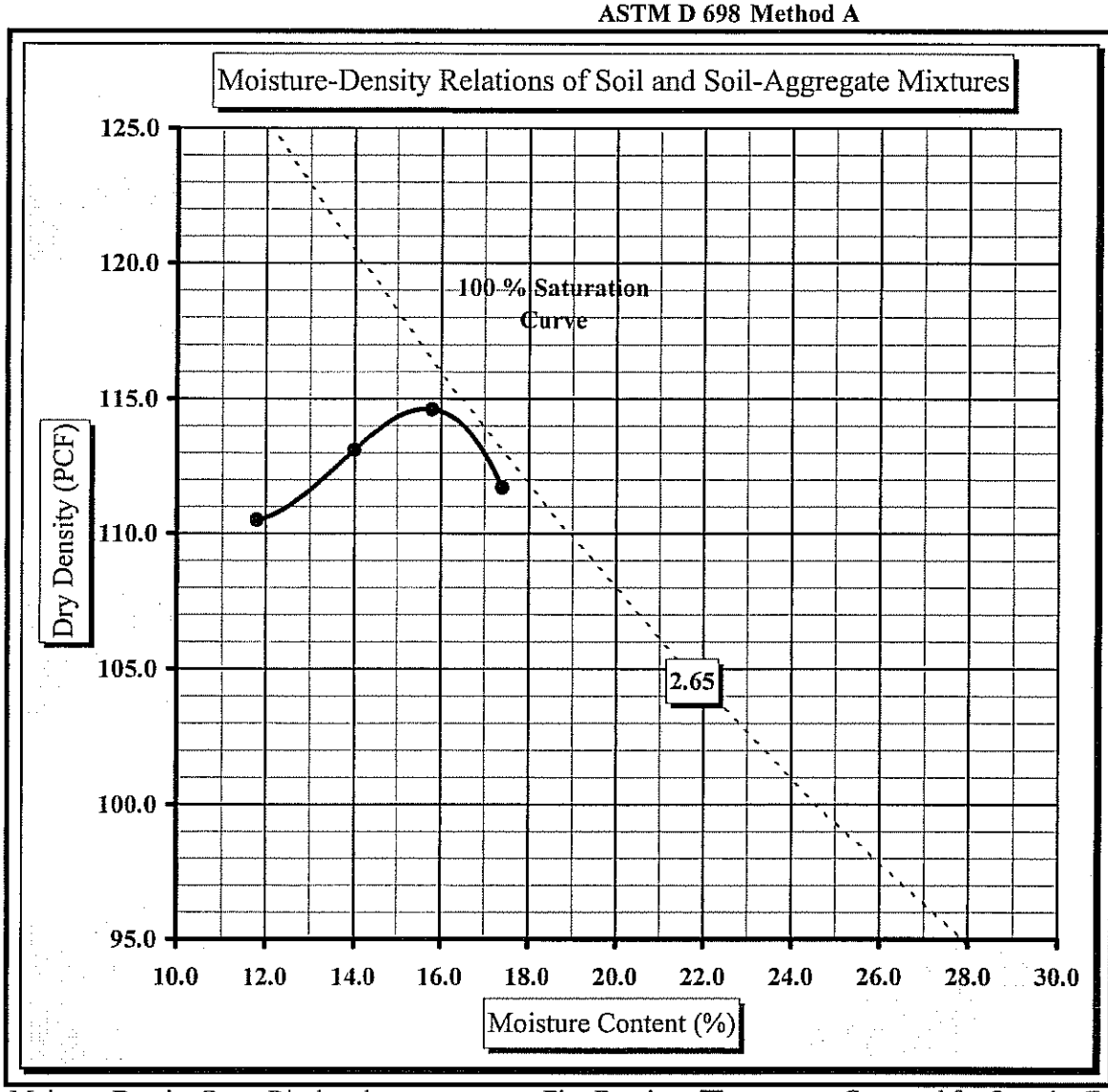
S&ME

S&ME Project #:	**1411-07-103**	Report Date:	December 20, 2007
Project Name:	**Marshall Steam Station**	Test Date(s):	December 19, 2007
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-16	Sample #:	476	Sample Date:	November 5, 2007
Location:	Bulk	Offset:	N/A	Depth:	3-5'
Sample Description:	Tan brown fine sandy silty CLAY (CL)				

Maximum Dry Density **114.7** **PCF.** **Optimum Moisture Content** **15.7** **%**

ASTM D 698 Method A



Soil Properties

Natural Moisture Content:	16.4%
Liquid Limit:	34
Plastic Limit:	18
Plastic Index:	16
Specific Gravity:	2.650

% Passing

#4	100
#10	99.5
#20	98.3
#40	95.6
#60	88.8
#100	75.3
#200	57.4

Oversize Fraction

Bulk Sp. Gravity
% Moisture
Oversize Fraction
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 Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

References: ASTM D 698: Laboratory Compaction Characteristics of Soil Using Standard Effort
ASTM D 2216: Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D 422: Particle Size Analysis of Soils ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

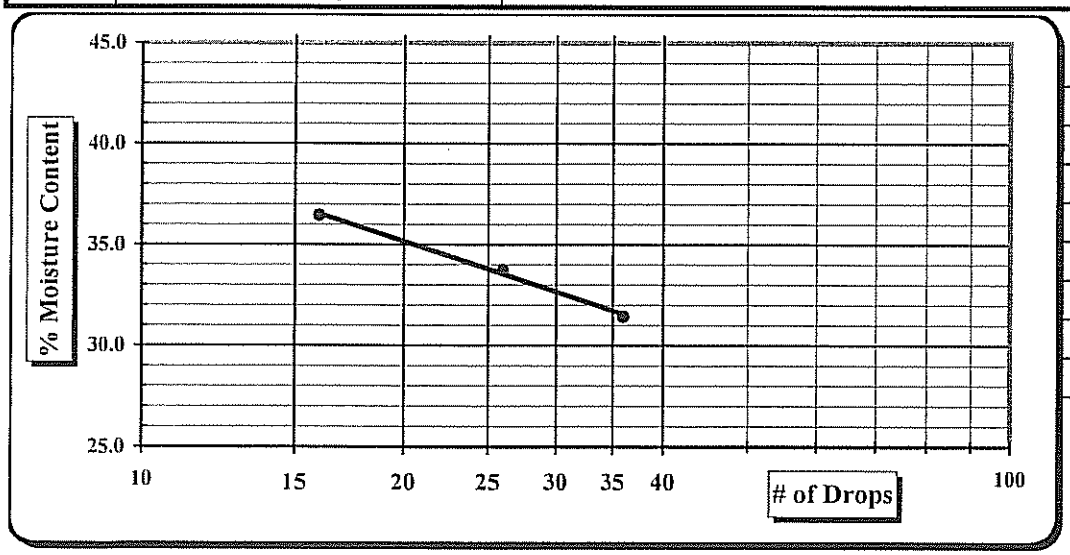
Technical Responsibility: Brian Vaughan, P.E. Construction Services Manager

S&ME

Liquid Limit, Plastic Limit, and Plastic Index

Project #: **1411-07-103** Report Date: 1/2/08
Project Name: Marshall Steam Station Test Date(s): 12/28/07
Client Name: Duke Energy
Client Address: Charlotte, NC
Boring #: M-16 Sample #: 476 Sample Date: 11/5/07
Location: Bulk Offset: N/A Elevation: 3-5'
Sample Description: Tan brown fine sandy silty CLAY (CL)

Pan #		Liquid Limit						Plastic Limit		
	Test #	1	2	3	4	5	6	1	2	3
	Tare #	Z-1	Z-2	Z-3				1	2	
A	Tare Weight	16.00	16.71	16.77				**10.89**	10.91	
B	Wet Soil Weight + A	40.30	42.44	41.63				18.69	18.40	
C	Dry Soil Weight + A	34.49	35.95	34.99				17.51	17.28	
D	Water Weight (B-C)	5.81	6.49	6.64				1.18	1.12	
E	Dry Soil Weight (C-A)	18.49	19.24	18.22				6.62	6.37	
F	% Moisture Content (D/E)*100	31.4%	33.7%	36.4%				17.8%	17.6%	
N	# OF DROPS	36	26	16				*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average							17.7%		



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes:

Special Sampling Methods:

Sample Preparation:	Wet Preparation	☐	Dry Preparation	☒	Air Dried	☒	% Passing #200 Sieve: 57.4
Liquid limit Test:	Multipoint Method	☒	One-point Method	☐			NP, Non-Plastic ☐
Classification:	ASTM D 2487	☒	AASHTO M 145	☐			Liquid Limit 34
Liquid limit Test:	ASTM D 4318	☒	AASHTO T 89	☐			Plastic Limit 18
Plastic limit Test:	ASTM D 4318	☒	AASHTO T 90	☐			Plastic Index 16
							Group Symbol CL

Technician Name: M. Jacobs

Certification #

Technical Responsibility: Brian Vaughan, P.E. Signature QC Manager Position

Particle Size Analysis of Soils

ASTM D 422

S&ME

Project #: **1411-07-103**
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Charlotte, NC

Test Date(s): 11/27 - 11/29/07
Report Date: 11/30/07

Boring #: M-16 Sample #: 476 Sample Date: 11/5/07
Location: Bulk Offset: N/A Elevation: 8-10'
Sample Description: Tan olive brown micaceous clayey silty fine SAND (SC)

Pan #:	16	Beaker #:	11
Hydrometer Jar #:			11
Pan Tare Weight (grams):			0.00
Total Sample Air Dried Wt. + tare wt. (grams):			522.08
Weight of Total Sample Air Dried:			522.08
Weight of Air Dried Hydrometer Sample (g):			53.57
Total Sample Oven Dried:			514.67
Hydrometer Sample Oven Dried (W):			52.80
% Passing #10:			98.6%
Correction Factor a (Table 1):			1.00

Specific Gravity 2.650

	Moisture Content	Hygroscopic	Natural
	Tare #	T-5	388
A	Tare Wt.	10.85	0.00
B	Wet Wt. + A	24.05	255.18
C	Dry Wt. + A	23.86	240.03
D	Water Wt. (B-C)	0.19	15.15
E	Dry Wt. (C-A)	13.01	240.03
	% Moisture (100 x D/E)	1.46%	6.3%

Sieve	Retained Wt.	Percent Passing	
3.0"	0.0	Pan # (washed) 66	100.0%
1.5"	0.0		100.0%
1.0"	0.0		100.0%
3/4"	0.0		100.0%
1/2"	0.0		100.0%
3/8"	0.0		100.0%
#4	1.5	Soil Mortar	99.7%
#10	7.2	**100.0%**	98.6%
#20	1.4	97.3%	96.0%
#40	4.6	91.2%	90.0%
#60	10.4	80.4%	79.3%
#100	18.7	64.7%	63.8%
#200	28.7	45.7%	45.0%

Notes: Description of Sand & Gravel Particles — Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:	4.75 mm	Total Sand:	54.7%	< 4.74 mm and > 0.075 mm	Type: Mechanical Stirring Apparatus (A)
% Gravel:	0.3%	< 75 mm and > 4.75 mm	Silt & Clay:	45.0%	< 0.075 — Dispersion Time: 1 min.
Coarse Sand:	1.1%	< 4.75 mm and > 2.00 mm	Silt:	27.7%	< 0.075 and > 0.005 mm — Sodium Hexametaphosphate: 40 g./ Liter
Medium Sand:	8.6%	< 2.00 mm and > 0.425 mm	Clay:	17.3%	< 0.005 mm
Fine Sand:	44.9%	< 0.425 mm and > 0.075 mm	Colloids:	9.1%	< 0.001 mm — **Control Cylinder** ☐ **Composite Correction** ☒

Liquid Limit **27** Plastic Limit **18** Plastic Index **9** Hydrometer: 151H ☐ 152H ☒

Time		Temp.	Hydrometer	Corrections		Hydrometer	Percent Passing		Effective Depth	Table 3	Diameter
Clock	T (Min.)	(0.5 °C)	Reading	Control Cylinder	Composite Correction	R	P(-#10) = (R x a / W) x 100	P (total) = P x % Passing #10	L	K	D = K x ((L/T)^1/2
	2	22.9	23.0		5.10	17.90	33.9%	33.4%	13.4	0.01325	0.03423
	5	22.9	20.5		5.10	15.40	29.2%	28.8%	13.8	0.01325	0.02198
	15	22.9	18.0		5.10	12.90	24.4%	24.1%	14.2	0.01325	0.01288
	30	22.9	16.5		5.10	11.40	21.6%	21.3%	14.4	0.01325	0.00918
	60	23.1	15.0		5.10	9.90	18.8%	18.5%	14.7	0.01317	0.00651
	250	23.3	13.0		5.05	7.95	15.1%	14.8%	15.0	0.01317	0.00323
	1440	22.6	11.0		5.15	5.85	11.1%	10.9%	15.3	0.01325	0.00137
	2880	22.3	10.0		5.15	4.85	9.2%	9.1%	15.5	0.01332	0.00098

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Effective Depth (cm)
L=L1+0.5(L2-(VB/A))
(152H) .164cm per increment,
V_B=67.0cm^3, L_2=14cm, A=27.8cm^2

Technician Name: M. Jacobs

Technical Responsibility: Brian Vaughan, P.E.

Certification #

Signature

QC Manager
Position

S&ME, INC.
155 Tradd Street Spartanburg, SC 29301

Hydrometer #476 (M-16, 8-10') 11-26-07.xls

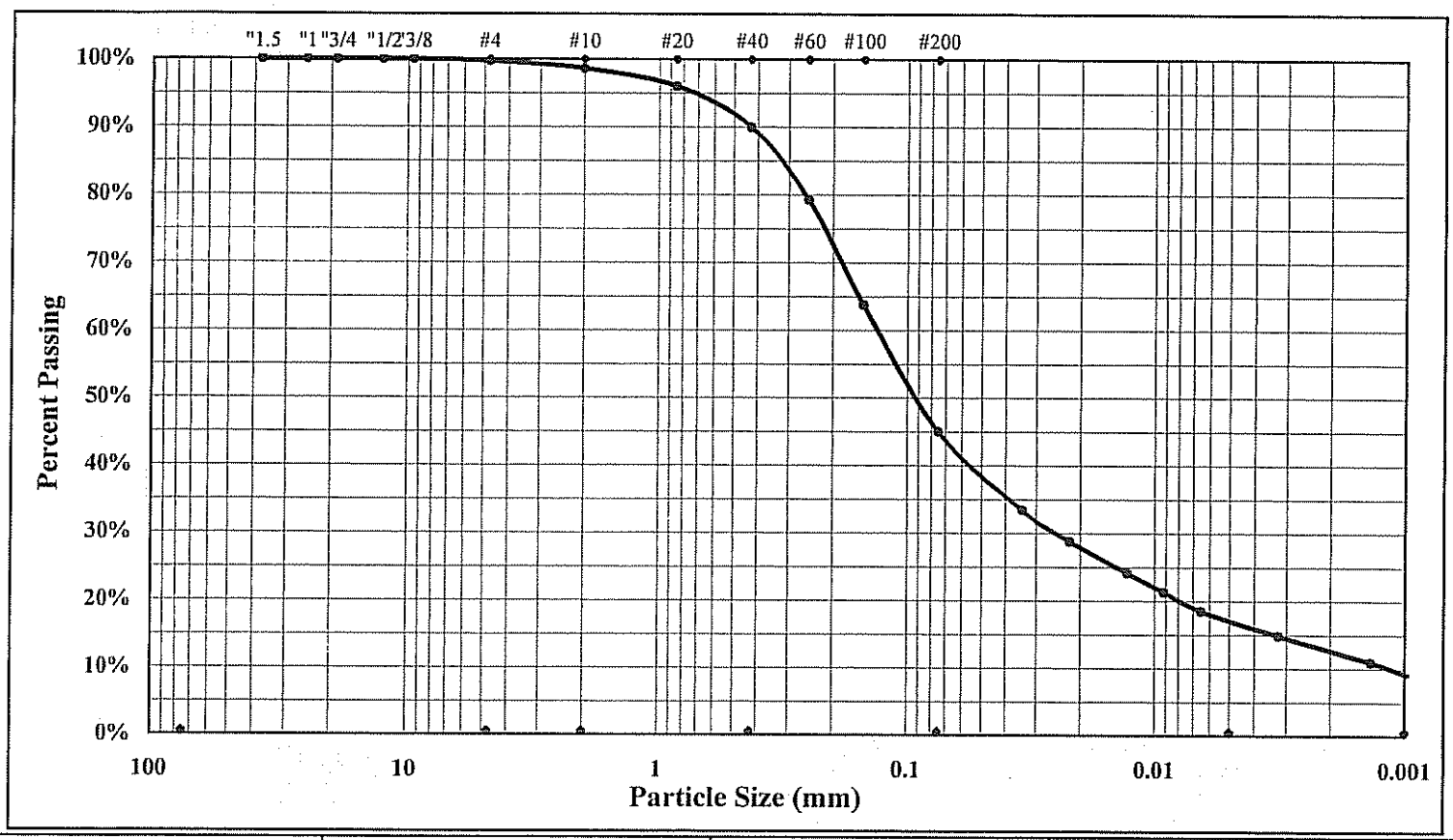
Particle Size Analysis of Soils

ASTM D 422

S&ME Project #:	**1411-07-103**	Report Date:	11/30/07
Project Name:	**Marshall Steam Station**	Test Date(s):	11/27 - 11/29/07
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-16	Sample #:	476	Sample Date:	11/5/07
Location:	Bulk	Offset:	N/A	Elevation:	8-10'

Sample Description: Tan olive brown micaceous clayey silty fine SAND (SC)



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	4.75 mm	Gravel	0.3%	Silt	27.7%
Silt & Clay (% Passing #200)	45.0%	Sand	54.7%	Clay	17.3%
Specific Gravity	2.650	Moisture Content	6.3%	Colloids	9.1%
Liquid Limit	27	Plastic Limit	18	Plastic Index	9

Description of Sand & Gravel Particles Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Mechanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

References: ASTM D 422: Particle Size Analysis of Soils
ASTM D 421: Dry Preparation of Soil Samples
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 854: Specific Gravity of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. _____ QC Manager
Signature Position

Moisture - Density Relationship

S&ME

S&ME Project #:	**1411-07-103**	Test Date(s):	December 19, 2007
Project Name:	Marshall Steam Station	Report Date:	December 20, 2007
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-16	Sample #:	476	Sample Date:	November 5, 2007
Location:	Bulk	Offset:	N/A	Depth:	8-10'

Sample Description: Tan olive brown micaceous clayey silty fine SAND (SC)

Liquid Limit:	27	Specific Gravity:	2.650
Plastic Limit:	18	Plastic Index:	9

Natural Moisture Content: 6.3%

Moisture Content of the Oversize Fraction:

NOTES:

Sieve Size	% Passing
#4	99.7
#10	98.6
#20	96.0
#40	90.0
#60	79.3
#100	63.8
#200	45.0

MDD: 125.5 **Opt. MC %: 11.0**

Water Content

Water Content requires GP 2 Balance (0.1 gram Readability).

ASTM D2216 ☒ AASHTO T265 ☐ ASTM D4959 ☐ ASTM D4643 ☐

	Sample #:	1	2	3	4	5	6
	Water Added:						
	Tare #:						
A. Tare Weight	A.	0	0	0	0	0	0
B. Wet Wt + Tare Wt	B.	500	500	500	500	500	500
C. Dry Wt. + Tare Wt.	C.	463.4	455.1	446.7	439.7		
D. Water Weight	B-C	36.6	44.9	53.3	60.3	500	500
E. Dry Weight	C-A	463.4	455.1	446.7	439.7	0	0
F. Moisture Content	100*D/E	**7.9%**	**9.9%**	**11.9%**	**13.7%**	**#DIV/0!**	**#DIV/0!**

Compaction Data

The Compaction Test requires a GP 5 Balance for ASTM (1 gram or .0022 Lb. readability).

G. Wt of Soil + Mold	G.	13.712	13.876	13.960	13.876		
H. Wt. of Mold	H.	9.304	9.304	9.304	9.304	9.304	9.304
I. Wt. of Soil (g. or lbs.)	G-H	4.408	4.572	4.656	4.572	-9.304	-9.304
J. Wt of Soil (Lbs.)	I/453.6 or I	4.408	4.572	4.656	4.572	-9.304	-9.304
K. Mold Volume Factor	K.	30.039	30.039	30.039	30.039	30.039	30.039
L. Wet Density	J*K	132.4	137.3	139.9	137.3	-279.5	-279.5
M. Dry Density	L/(1+F)	**122.7**	**125.0**	**125.0**	**120.8**	**#DIV/0!**	**#DIV/0!**

ASTM D558 ☐ ASTM D 698 ☒ ASTM D1557 ☐ AASHTO T99 ☐ AASHTO T180 ☐

Method A ☒ Method B ☐ Method C ☐ Method D (ASTM 1978) ☐ AASHTO Method D ☐

Moisture-Density Relation of: Fine Fraction ☒ Corrected for Coarse Fraction (ASTM D 4718) ☐

Sieve Size used to separate the Oversize Fraction: #4 Sieve ☒ 3/8 inch Sieve ☐ 3/4 inch Sieve ☐

Mechanical Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

Soil Plasticity: ASTM D 4318 ☒ AASHTO T 89 ☐ AASHTO T 90 ☐

Sieve Analysis / Particle Size Analysis: ASTM C136 ☐ AASHTO T 27 ☐ ASTM D 422 ☒ AASHTO T 88 ☐

Specific Gravity of Soil: ASTM D 854 ☒ AASHTO T 100 ☐

Bulk Gravity of Oversize Fraction: ASTM C 127 ☐ AASHTO T 85 ☐

Soil Classification: ASTM D 2487 ☒ ASTM D 2488 ☐ AASHTO M 145 ☐

Technician Name: B. Hatton

Certification #

Technical Responsibility: Brian Vaughan, P.E.

Signature

Construction Services Manager

Position

Moisture - Density Report

S&ME

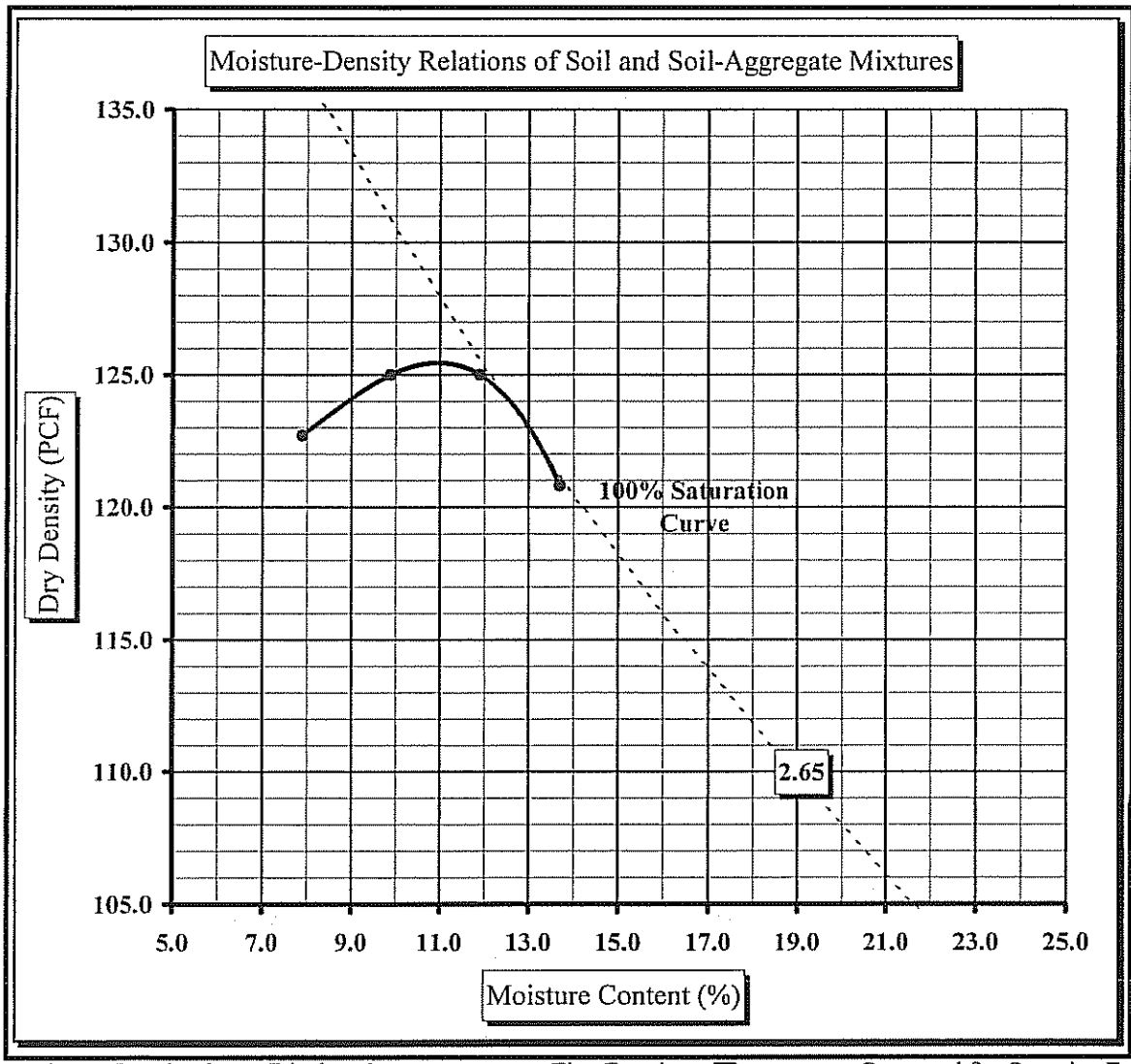
S&ME Project #:	**1411-07-103**	Report Date:	December 20, 2007
Project Name:	**Marshall Steam Station**	Test Date(s):	December 19, 2007
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-16	Sample #:	476	Sample Date:	November 5, 2007
Location:	Bulk	Offset:	N/A	Depth:	8-10'

Sample Description: Tan olive brown micaceous clayey silty fine SAND (SC)

Maximum Dry Density 125.5 PCF. **Optimum Moisture Content 11.0 %**

ASTM D 698 Method A



Soil Properties

Natural Moisture Content:	6.3%
Liquid Limit:	27
Plastic Limit:	18
Plastic Index:	9
Specific Gravity:	2.650

% Passing

#4	99.7
#10	98.6
#20	96.0
#40	90.0
#60	79.3
#100	63.8
#200	45.0

Oversize Fraction

Bulk Sp. Gravity
% Moisture
Oversize Fraction
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 Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

References: ASTM D 698: Laboratory Compaction Characteristics of Soil Using Standard Effort
ASTM D 2216: Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D 422: Particle Size Analysis of Soils ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. Construction Services Manager
Position

Laboratory Record Version 4.2

S&ME

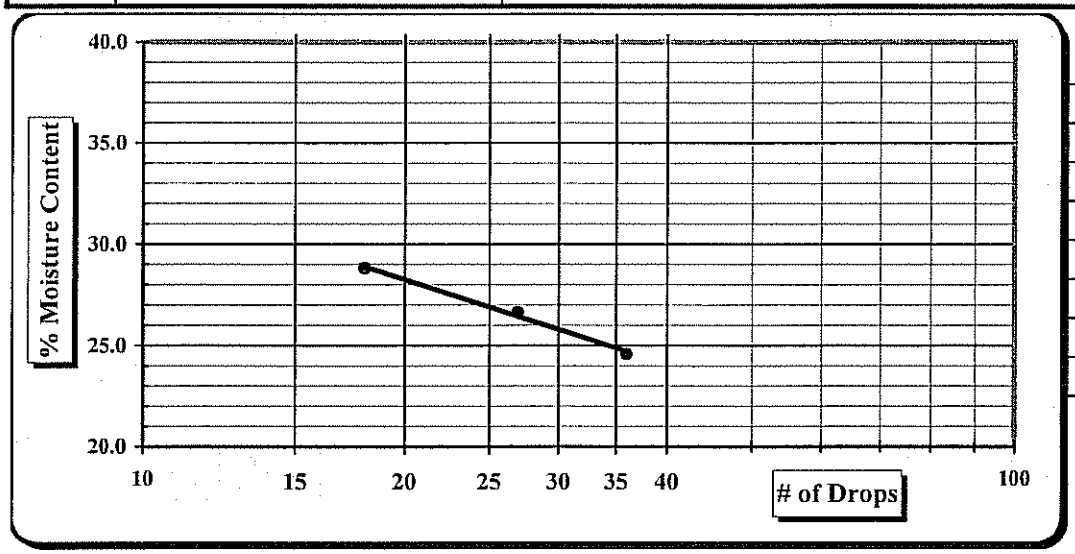
Liquid Limit, Plastic Limit, and Plastic Index

Project #: **1411-07-103**
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Charlotte, NC

Report Date: 1/2/08
Test Date(s): 12/28/07

Boring #: M-16 Sample #: 476 Sample Date: 11/5/07
Location: Bulk Offset: N/A Elevation: 8-10'
Sample Description: Tan olive brown micaceous clayey silty fine SAND (SC)

Pan #		Liquid Limit						Plastic Limit		
	Test #	1	2	3	4	5	6	1	2	3
	Tare #	P-4	P-5	P-6				3	4	
A	Tare Weight	16.70	16.72	15.97				**10.87**	10.97	
B	Wet Soil Weight + A	43.98	41.83	42.36				19.47	19.20	
C	Dry Soil Weight + A	38.60	36.55	36.46				18.17	17.97	
D	Water Weight (B-C)	5.38	5.28	5.90				1.30	1.23	
E	Dry Soil Weight (C-A)	21.90	19.83	20.49				7.30	7.00	
F	% Moisture Content (D/E)*100	24.6%	26.6%	28.8%				17.8%	17.6%	
N	# OF DROPS	36	27	18				*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average							17.7%		



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes:

Special Sampling Methods:

Sample Preparation:	Wet Preparation	☐	Dry Preparation	☒	Air Dried	☒	
Liquid limit Test:	Multipoint Method	☒	One-point Method	☐			
Classification:	ASTM D 2487	☒	AASHTO M 145	☐			
Liquid limit Test:	ASTM D 4318	☒	AASHTO T 89	☐			
Plastic limit Test:	ASTM D 4318	☒	AASHTO T 90	☐			

% Passing #200 Sieve:	45.0
NP, Non-Plastic	☐
Liquid Limit	27
Plastic Limit	18
Plastic Index	9
Group Symbol	SC

Technician Name: M. Jacobs

Certification #

Technical Responsibility: Brian Vaughan, P.E.

Signature

QC Manager

Position

Particle Size Analysis of Soils

ASTM D 422

S&ME

Project #: **1411-07-103**
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Charlotte, NC

Test Date(s): 11/27 - 11/29/07
Report Date: 11/30/07

Boring #: M-16 Sample #: 476 Sample Date: 11/5/07
Location: Bulk Offset: N/A Elevation: 13-15'
Sample Description: Olive brown micaceous clayey silty medium to fine SAND (SC)

Pan #:	X	Beaker #:	12	Specific Gravity	**2.650**
Hydrometer Jar #:			12		
Pan Tare Weight (grams):			0.00		
Total Sample Air Dried Wt. + tare wt. (grams):			522.78		
Weight of Total Sample Air Dried:			522.78		
Weight of Air Dried Hydrometer Sample (g):			52.28		
Total Sample Oven Dried:			515.57		
Hydrometer Sample Oven Dried (W):			51.53		
% Passing #10:			96.7%		
Correction Factor a (Table 1):			1.00		

	Moisture Content	Hygroscopic	Natural
	Tare #	S-6	392
A	Tare Wt.	10.87	0.00
B	Wet Wt. + A	23.50	315.27
C	Dry Wt. + A	23.32	295.62
D	Water Wt. (B-C)	0.18	19.65
E	Dry Wt. (C-A)	12.45	295.62
	% Moisture (100 x D/E)	1.45%	6.6%

Sieve	Retained Wt.	Percent Passing	
3.0"	0.0	Pan # (washed)	100.0%
1.5"	0.0		100.0%
1.0"	0.0		100.0%
3/4"	0.0	68	100.0%
1/2"	0.0		100.0%
3/8"	0.0		100.0%
#4	5.3	Soil Mortar	99.0%
#10	16.8	**100.0%**	96.7%
#20	1.9	96.4%	93.2%
#40	5.7	89.0%	86.1%
#60	11.2	78.4%	75.8%
#100	18.4	64.2%	62.1%
#200	27.7	46.3%	44.7%

Notes: Description of Sand & Gravel Particles — Rounded ☐ Angular ☒ — Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:	4.75 mm		Total Sand:	54.2%	< 4.74 mm and > 0.075 mm	Type:	Mechanical Stirring Apparatus (A)
% Gravel:	1.0%	< 75 mm and > 4.75 mm	Silt & Clay:	44.7%	< 0.075	Dispersion Time:	1 min.
Coarse Sand:	2.2%	< 4.75 mm and > 2.00 mm	Silt:	28.2%	< 0.075 and > 0.005 mm	Sodium Hexametaphosphate:	40 g./ Liter
Medium Sand:	10.7%	< 2.00 mm and > 0.425 mm	Clay:	16.5%	< 0.005 mm		
Fine Sand:	41.3%	< 0.425 mm and > 0.075 mm	Colloids:	9.1%	< 0.001 mm	**Control Cylinder** ☐	**Composite Correction** ☒

Liquid Limit **27** Plastic Limit **18** Plastic Index **9** Hydrometer: 151H ☐ 152H ☒

Time		Temp.	Hydrometer	Corrections		Hydrometer	Percent Passing		Effective Depth	Table 3	Diameter
Clock	T (Min.)	(0.5 °C)	Reading	Control Cylinder	Composite Correction	R	P(-#10) = (R x a / W) x 100	P (total) = P x % Passing #10	L	K	D = K x ((L/T)^1/2
	2	23.1	23.0		5.10	17.90	34.7%	33.6%	13.4	0.01317	0.03404
	5	23.1	20.5		5.10	15.40	29.9%	28.9%	13.8	0.01317	0.02186
	15	23.1	18.0		5.10	12.90	25.0%	24.2%	14.2	0.01317	0.01280
	30	23.1	16.5		5.10	11.40	22.1%	21.4%	14.4	0.01317	0.00913
	60	23.2	15.0		5.10	9.90	19.2%	18.6%	14.7	0.01317	0.00651
	250	23.4	12.0		5.05	6.95	13.5%	13.0%	15.2	0.01317	0.00324
	1440	22.7	10.5		5.15	5.35	10.4%	10.0%	15.4	0.01325	0.00137
	2880	22.4	10.0		5.15	4.85	9.4%	9.1%	15.5	0.01332	0.00098

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Effective Depth (cm)
L=L1+0.5(L2-(VB/A))
(152H) .164cm per increment,
V_B=67.0cm^3, L_2=14cm, A=27.8cm^2

Technician Name: M. Jacobs
Certification #

Technical Responsibility: Brian Vaughan, P.E.
Signature

QC Manager
Position

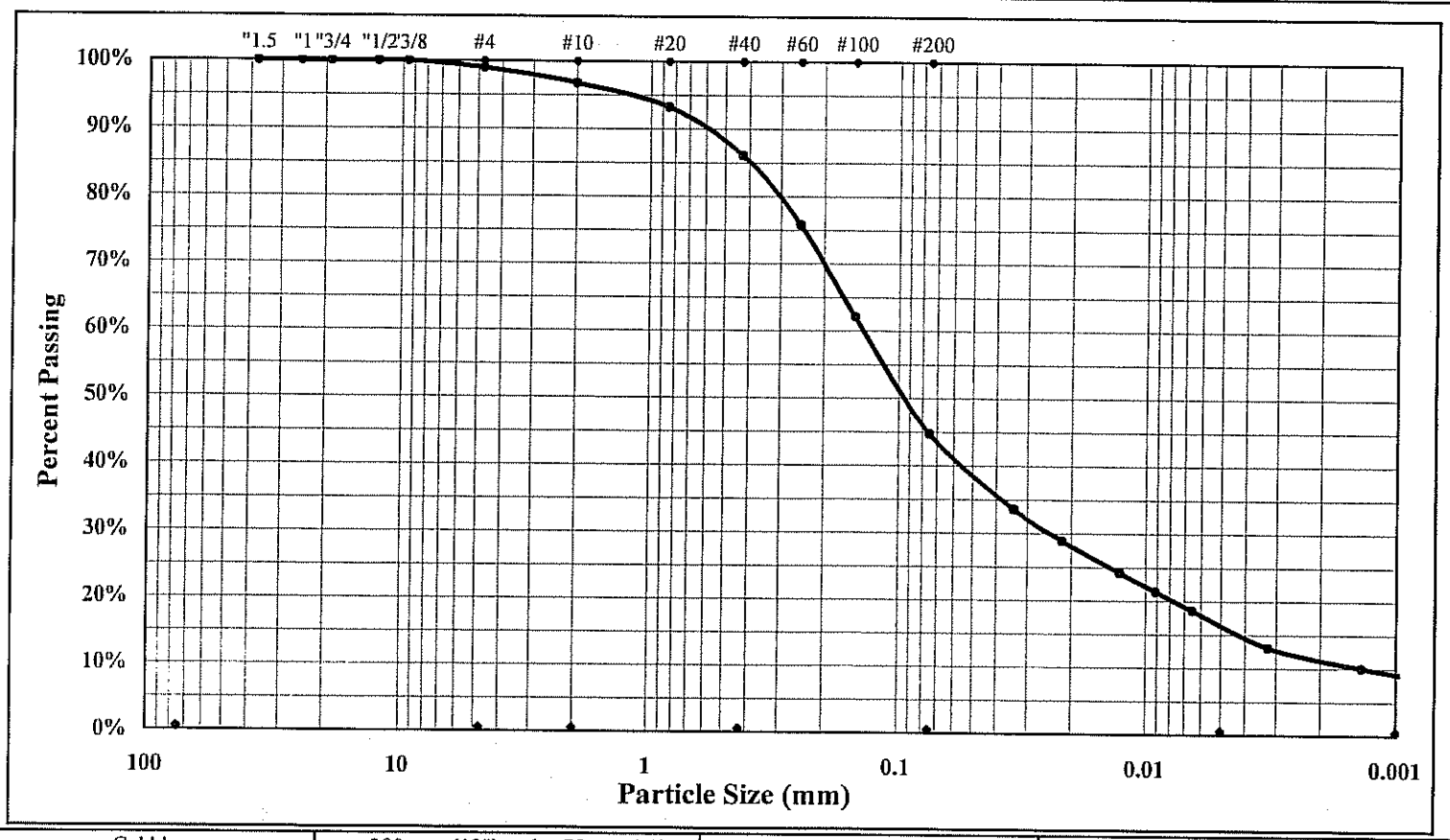
Particle Size Analysis of Soils

ASTM D 422

S&ME

S&ME Project #:	**1411-07-103**	Report Date:	11/30/07
Project Name:	**Marshall Steam Station**	Test Date(s):	11/27 - 11/29/07
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-16	Sample #:	476	Sample Date:	11/5/07
Location:	Bulk	Offset:	N/A	Elevation:	13-15'
Sample Description:	Olive brown micaceous clayey silty medium to fine SAND (SC)				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	4.75 mm	Gravel	1.0%	Silt	28.2%
Silt & Clay (% Passing #200)	44.7%	Sand	54.2%	Clay	16.5%
Specific Gravity	2.650	Moisture Content	6.6%	Colloids	9.1%
Liquid Limit	27	Plastic Limit	18	Plastic Index	9

Description of Sand & Gravel Particles Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Mechanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

References: ASTM D 422: Particle Size Analysis of Soils
ASTM D 421: Dry Preparation of Soil Samples
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 854: Specific Gravity of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. _____ QC Manager

Signature Position

Moisture - Density Relationship

S&ME

S&ME Project #:	**1411-07-103**	Test Date(s):	December 19, 2007
Project Name:	Marshall Steam Station	Report Date:	December 20, 2007
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-16	Sample #:	476	Sample Date:	November 5, 2007
Location:	Bulk	Offset:	N/A	Depth:	13-15'

Sample Description: Olive brown micaceous clayey silty medium to fine SAND (SC)

Liquid Limit:	27	Specific Gravity:	2.650
Plastic Limit:	18	Plastic Index:	9

Natural Moisture Content: 6.6%

Moisture Content of the Oversize Fraction:

NOTES:

Sieve Size	% Passing
#4	99.0
#10	96.7
#20	93.2
#40	86.1
#60	75.8
#100	62.1
#200	44.7

MDD: 127.8 **Opt. MC %: 10.0**

Water Content

Water Content requires GP 2 Balance (0.1 gram Readability).

ASTM D2216 ☒ AASHTO T265 ☐ ASTM D4959 ☐ ASTM D4643 ☐

	Sample #:	1	2	3	4	5	6
	Water Added:						
	Tare #:						
A. Tare Weight	A.	0	0	0	0	0	0
B. Wet Wt + Tare Wt	B.	500	500	500	500	500	500
C. Dry Wt. + Tare Wt.	C.	462.9	454.5	446.4	471.5		
D. Water Weight	B-C	37.1	45.5	53.6	28.5	500	500
E. Dry Weight	C-A	462.9	454.5	446.4	471.5	0	0
F. Moisture Content	100*D/E	**8.0%**	**10.0%**	**12.0%**	**6.0%**	**#DIV/0!**	**#DIV/0!**

Compaction Data

The Compaction Test requires a GP 5 Balance for ASTM (1 gram or .0022 Lb. readability).

G. Wt of Soil + Mold	G.	13.844	13.986	13.976	13.646		
H. Wt. of Mold	H.	9.304	9.304	9.304	9.304	9.304	9.304
I. Wt. of Soil (g. or lbs.)	G-H	4.540	4.682	4.672	4.342	-9.304	-9.304
J. Wt of Soil (Lbs.)	I/453.6 or I	4.540	4.682	4.672	4.342	-9.304	-9.304
K. Mold Volume Factor	K.	30.039	30.039	30.039	30.039	30.039	30.039
L. Wet Density	J*K	136.4	140.6	140.3	130.4	-279.5	-279.5
M. Dry Density	L/(1+F)	**126.3**	**127.8**	**125.3**	**123.0**	**#DIV/0!**	**#DIV/0!**

ASTM D558 ☐ ASTM D 698 ☒ ASTM D1557 ☐ AASHTO T99 ☐ AASHTO T180 ☐

Method A ☒ Method B ☐ Method C ☐ Method D (ASTM 1978) ☐ AASHTO Method D ☐

Moisture-Density Relation of: Fine Fraction ☒ Corrected for Coarse Fraction (ASTM D 4718) ☐

Sieve Size used to separate the Oversize Fraction: #4 Sieve ☒ 3/8 inch Sieve ☐ 3/4 inch Sieve ☐

Mechanical Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

Soil Plasticity: ASTM D 4318 ☒ AASHTO T 89 ☐ AASHTO T 90 ☐

Sieve Analysis / Particle Size Analysis: ASTM C136 ☐ AASHTO T 27 ☐ ASTM D 422 ☒ AASHTO T 88 ☐

Specific Gravity of Soil: ASTM D 854 ☒ AASHTO T 100 ☐

Bulk Gravity of Oversize Fraction: ASTM C 127 ☐ AASHTO T 85 ☐

Soil Classification: ASTM D 2487 ☒ ASTM D 2488 ☐ AASHTO M 145 ☐

Technician Name: B. Hatton

Certification #

Technical Responsibility: Brian Vaughan, P.E.

Signature

Construction Services Manager

Position

Laboratory Report Version 4.2

Moisture - Density Report

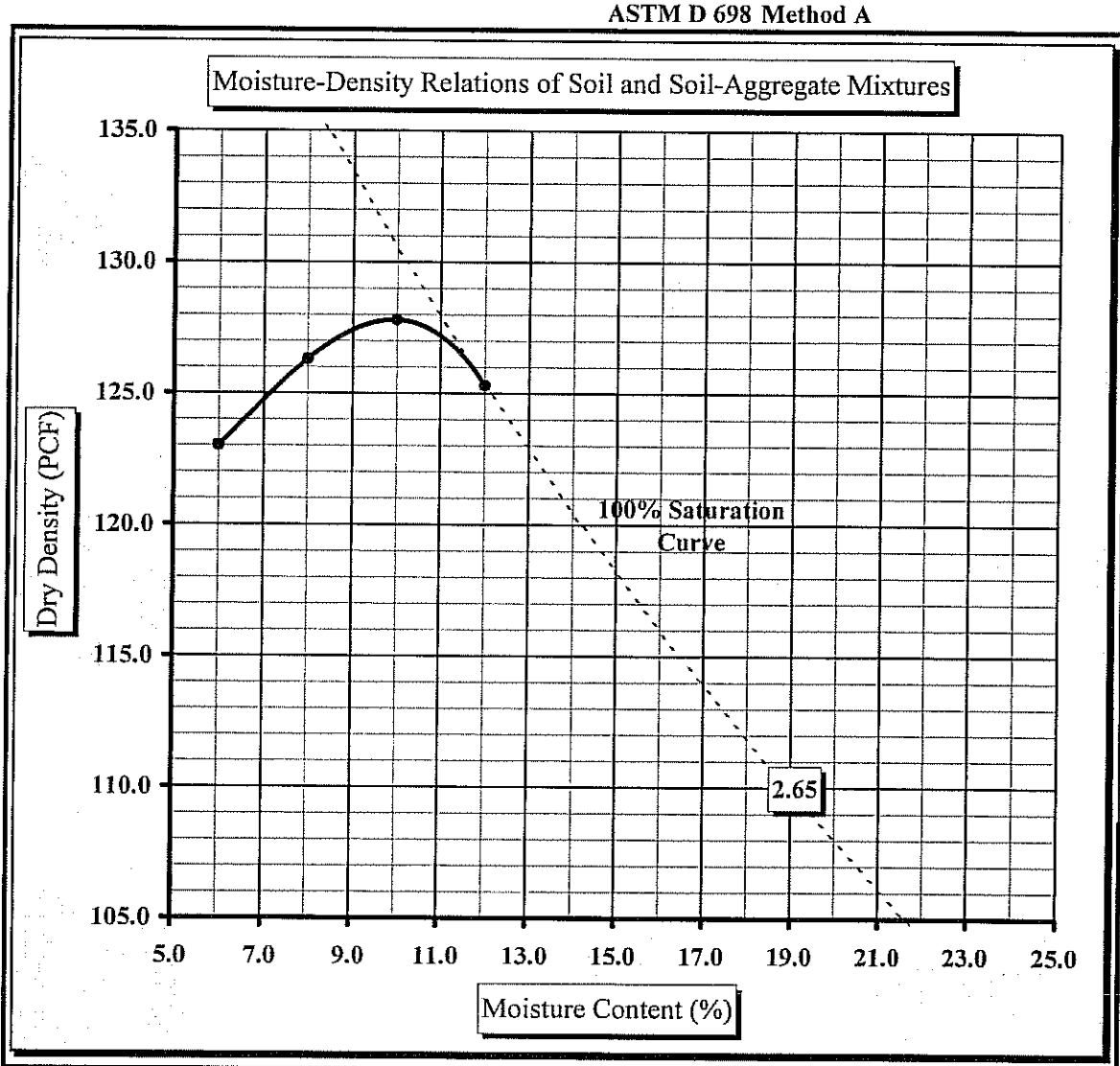
S&ME

S&ME Project #:	**1411-07-103**	Report Date:	December 20, 2007
Project Name:	**Marshall Steam Station**	Test Date(s):	December 19, 2007
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-16	Sample #:	476	Sample Date:	November 5, 2007
Location:	Bulk	Offset:	N/A	Depth:	13-15'
Sample Description:	Olive brown micaceous clayey silty medium to fine SAND (SC)				

Maximum Dry Density **127.8** **PCF.** **Optimum Moisture Content** **10.0** **%**

ASTM D 698 Method A



Soil Properties

Natural Moisture Content:	6.6%
Liquid Limit:	27
Plastic Limit:	18
Plastic Index:	9
Specific Gravity:	2.650

% Passing

#4	99.0
#10	96.7
#20	93.2
#40	86.1
#60	75.8
#100	62.1
#200	44.7

Oversize Fraction

Bulk Sp. Gravity
% Moisture
Oversize Fraction
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 Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

References: ASTM D 698: Laboratory Compaction Characteristics of Soil Using Standard Effort
ASTM D 2216: Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D 422: Particle Size Analysis of Soils ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

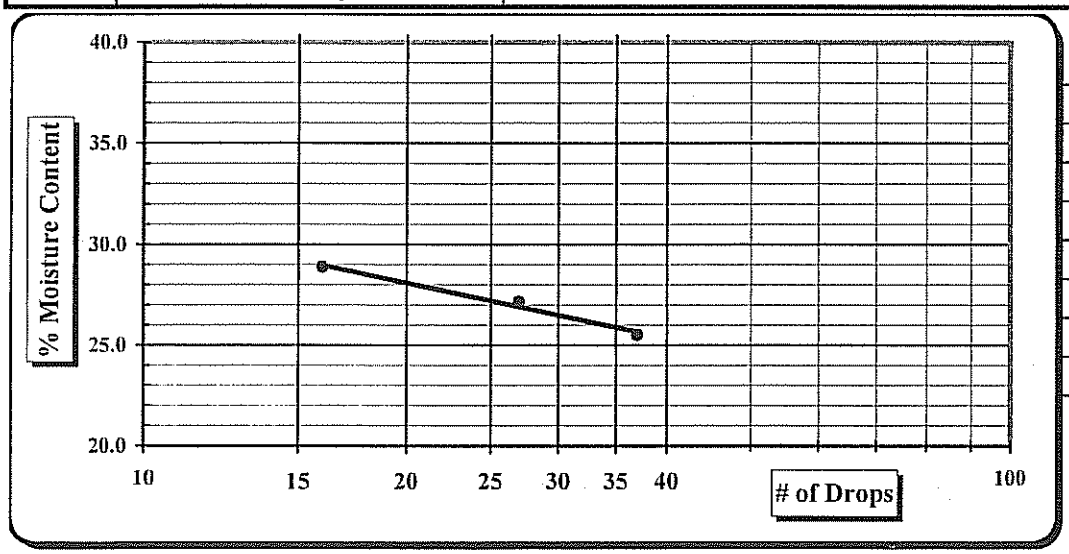
Technical Responsibility: Brian Vaughan, P.E. Construction Services Manager
Position

S&ME

Liquid Limit, Plastic Limit, and Plastic Index

Project #: **1411-07-103** Report Date: 1/2/08
Project Name: Marshall Steam Station Test Date(s): 12/28/07
Client Name: Duke Energy
Client Address: Charlotte, NC
Boring #: M-16 Sample #: 476 Sample Date: 11/5/07
Location: Bulk Offset: N/A Elevation: 13-15'
Sample Description: Olive brown micaceous clayey silty medium to fine SAND (SC)

Pan #		Liquid Limit						Plastic Limit		
	Test #	1	2	3	4	5	6	1	2	3
	Tare #	Q-4	Q-5	Q-6				5	6	
A	Tare Weight	16.73	16.91	16.80				**10.94**	10.92	
B	Wet Soil Weight + A	43.74	42.16	42.51				19.52	19.28	
C	Dry Soil Weight + A	38.25	36.77	36.75				18.24	18.02	
D	Water Weight (B-C)	5.49	5.39	5.76				1.28	1.26	
E	Dry Soil Weight (C-A)	21.52	19.86	19.95				7.30	7.10	
F	% Moisture Content (D/E)*100	25.5%	27.1%	28.9%				17.5%	17.7%	
N	# OF DROPS	37	27	16				*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average							17.6%		



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes:

Special Sampling Methods:

Sample Preparation:	Wet Preparation	☐	Dry Preparation	☒	Air Dried	☒	% Passing #200 Sieve: 44.7
Liquid limit Test:	Multipoint Method	☒	One-point Method	☐			NP, Non-Plastic ☐
Classification:	ASTM D 2487	☒	AASHTO M 145	☐			Liquid Limit 27
Liquid limit Test:	ASTM D 4318	☒	AASHTO T 89	☐			Plastic Limit 18
Plastic limit Test:	ASTM D 4318	☒	AASHTO T 90	☐			Plastic Index 9
							Group Symbol SC

Technician Name: M. Jacobs

Certification #

Technical Responsibility: Brian Vaughan, P.E. Signature QC Manager Position

Particle Size Analysis of Soils

ASTM D 422

S&ME

Project #: **1411-07-103**
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Charlotte, NC

Test Date(s): 2/28 - 3/1/08
Report Date: 3/3/08

Boring #: M-16 Sample #: 41 Sample Date: 11/5/07
Location: sample 8 Offset: N/A Elevation: 39-40'
Sample Description: Gray olive micaceous silty fine SAND

Pan #:	11	Beaker #:	6	**Specific Gravity**	**2.650**
Hydrometer Jar #:			6		
Pan Tare Weight (grams):			0.00		
Total Sample Air Dried Wt. + tare wt. (grams):			242.87		
Weight of Total Sample Air Dried:			242.87		
Weight of Air Dried Hydrometer Sample (g):			101.89		
Total Sample Oven Dried:			239.94		
Hydrometer Sample Oven Dried (W):			100.65		
% Passing #10:			99.1%		
Correction Factor a (Table 1):			1.00		

Moisture Content		Hygroscopic
	Tare #	P-6
A	Tare Wt.	15.98
B	Wet Wt. + A	28.30
C	Dry Wt. + A	28.15
D	Water Wt. (B-C)	0.15
E	Dry Wt. (C-A)	12.17
	% Moisture (100 x D/E)	1.23%

Sieve	Retained Wt.	Percent Passing	
3.0"	0.0	Pan # (washed)	100.0%
1.5"	0.0		100.0%
1.0"	0.0		100.0%
3/4"	0.0	58	100.0%
1/2"	0.0		100.0%
3/8"	0.0		100.0%
#4	0.0	Soil Mortar	100.0%
#10	2.2	**100.0%**	99.1%
#20	2.1	97.9%	97.0%
#40	12.5	87.6%	86.8%
#60	31.1	69.2%	68.5%
#100	54.3	46.1%	45.6%
#200	78.4	22.1%	21.9%

Notes: Description of Sand & Gravel Particles — Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:	2.00 mm		Total Sand:	78.1%	< 4.74 mm and > 0.075 mm	Type:	Mechanical Stirring Apparatus (A)
% Gravel:	0.0%	< 75 mm and > 4.75 mm	Silt & Clay:	21.9%	< 0.075	Dispersion Time:	1 min.
Coarse Sand:	0.9%	< 4.75 mm and > 2.00 mm	Silt:	18.4%	< 0.075 and > 0.005 mm	Sodium Hexametaphosphate:	40 g./ Liter
Medium Sand:	12.3%	< 2.00 mm and > 0.425 mm	Clay:	3.5%	< 0.005 mm		
Fine Sand:	64.9%	< 0.425 mm and > 0.075 mm	Colloids:	2.2%	< 0.001 mm	**Control Cylinder** ☐	**Composite Correction** ☒

Liquid Limit **N/A** Plastic Limit **N/A** Plastic Index **N/A** Hydrometer: 151H ☐ 152H ☒

Time		Temp.	Hydrometer	Corrections		Hydrometer	Percent Passing		Effective Depth	Table 3	Diameter
Clock	T (Min.)	(0.5 °C)	Reading	Control Cylinder	Composite Correction	R	P(-#10) = (R x a / W) x 100	P (total) = P x % Passing #10	L	K	D = K x ((L/T)^1/2
	2	22.3	16.5		5.15	11.35	11.3%	11.2%	14.4	0.01332	0.03578
	5	22.3	13.5		5.15	8.35	8.3%	8.2%	14.9	0.01332	0.02301
	15	22.3	11.0		5.15	5.85	5.8%	5.8%	15.3	0.01332	0.01347
	30	22.4	10.0		5.15	4.85	4.8%	4.8%	15.5	0.01332	0.00957
	60	22.5	9.0		5.15	3.85	3.8%	3.8%	15.7	0.01325	0.00677
	250	22.5	8.5		5.15	3.35	3.3%	3.3%	15.7	0.01325	0.00332
	1440	21.5	8.0		5.25	2.75	2.7%	2.7%	15.8	0.01340	0.00141
	2880	21.6	7.5		5.25	2.25	2.2%	2.2%	15.9	0.01340	0.00100

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Effective Depth (cm)
L=L1+0.5(L2-(VB/A))
(152H) .164cm per increment,
V_B=67.0cm^3, L_2=14cm, A=27.8cm^2

Technician Name: M. Jacobs

Technical Responsibility: Brian Vaughan, P.E.

Certification #

Signature

OC Manager
Position

S&ME, INC. **155 Tradd Street Spartanburg, SC 29301**

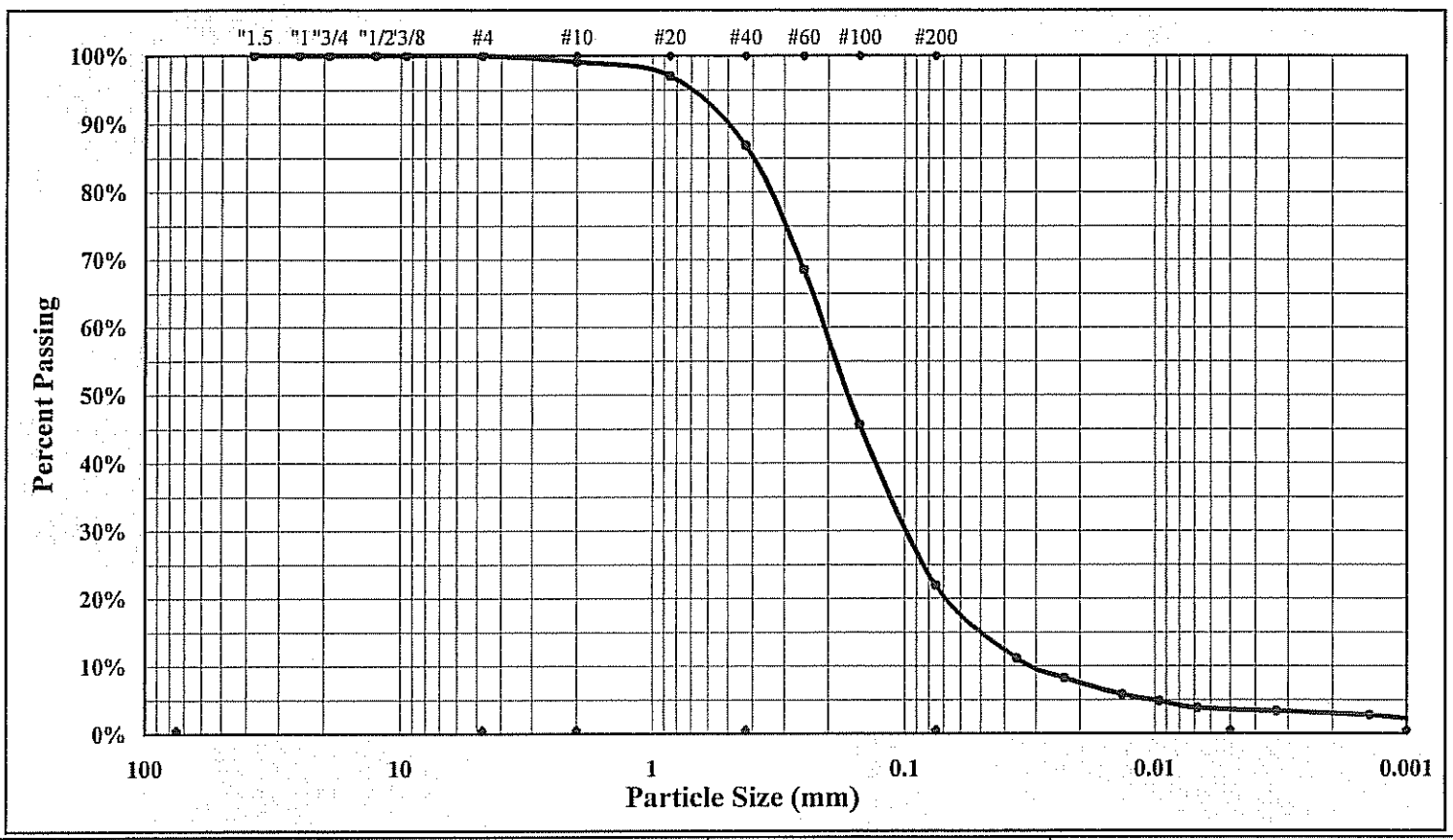
Hydrometer #41 (M-16, 39-40') 3-3-08.xls

Particle Size Analysis of Soils

ASTM D 422

S&ME Project #:	**1411-07-103**	Report Date:	3/3/08
Project Name:	**Marshall Steam Station**	Test Date(s):	2/28 - 3/1/08
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-16	Sample #:	41	Sample Date:	11/5/07
Location:	sample 8	Offset:	N/A	Elevation:	39-40'
Sample Description:	Gray olive micaceous silty fine SAND				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	2.00 mm	Gravel	0.0%	Silt	18.4%
Silt & Clay (% Passing #200)	21.9%	Sand	78.1%	Clay	3.5%
Specific Gravity	2.650			Colloids	2.2%
Liquid Limit	N/A	Plastic Limit	N/A	Plastic Index	N/A

Description of Sand & Gravel Particles Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Mechanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

References: ASTM D 422: Particle Size Analysis of Soils
ASTM D 421: Dry Preparation of Soil Samples
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 854: Specific Gravity of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. _____ QC Manager
Signature *Position*

Particle Size Analysis of Soils

ASTM D 422

S&ME

Project #: **1411-07-103**
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Charlotte, NC

Test Date(s): 5/14 - 5/16/08
Report Date: 5/19/08

Boring #: M-17 Sample #: 134 Sample Date: 4/29/08
Location: Bulk Offset: N/A Elevation: 20-25'
Sample Description: Tan gray micaceous fine sandy clayey SILT (ML)

Pan #:	1	Beaker #:	1
Hydrometer Jar #:			1
Pan Tare Weight (grams):			0.00
Total Sample Air Dried Wt. + tare wt. (grams):			461.18
Weight of Total Sample Air Dried:			461.18
Weight of Air Dried Hydrometer Sample (g):			102.24
Total Sample Oven Dried:			455.96
Hydrometer Sample Oven Dried (W):			101.07
% Passing #10:			99.2%
Correction Factor a (Table 1):			1.00

Specific Gravity 2.650

	Moisture Content	Hygroscopic	Natural
	Tare #	Z-1	300
A	Tare Wt.	15.99	0.00
B	Wet Wt. + A	29.15	211.82
C	Dry Wt. + A	29.00	186.24
D	Water Wt. (B-C)	0.15	25.58
E	Dry Wt. (C-A)	13.01	186.24
	% Moisture (100 x D/E)	1.15%	13.7%

Sieve	Retained Wt.	Percent Passing	
3.0"	0.0	Pan # (washed) 51	100.0%
1.5"	0.0		100.0%
1.0"	0.0		100.0%
3/4"	0.0		100.0%
1/2"	0.0		100.0%
3/8"	0.0		100.0%
#4	0.5	Soil Mortar	99.9%
#10	3.6	**100.0%**	99.2%
#20	1.4	98.6%	97.8%
#40	6.8	93.2%	92.5%
#60	13.2	86.9%	86.2%
#100	22.6	77.6%	77.0%
#200	44.8	55.6%	55.2%

Notes: Description of Sand & Gravel Particles — Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:	4.75 mm		Total Sand:	44.7%	< 4.74 mm and > 0.075 mm	Type:	Mechanical Stirring Apparatus (A)
% Gravel:	0.1%	< 75 mm and > 4.75 mm	Silt & Clay:	55.2%	< 0.075	Dispersion Time:	1 min.
Coarse Sand:	0.7%	< 4.75 mm and > 2.00 mm	Silt:	41.2%	< 0.075 and > 0.005 mm	Sodium Hexametaphosphate:	40 g./ Liter
Medium Sand:	6.7%	< 2.00 mm and > 0.425 mm	Clay:	14.0%	< 0.005 mm		
Fine Sand:	37.3%	< 0.425 mm and > 0.075 mm	Colloids:	6.3%	< 0.001 mm	**Control Cylinder** ☐	**Composite Correction** ☒

Liquid Limit **33** Plastic Limit **29** Plastic Index **4** Hydrometer: 151H ☐ 152H ☒

Time		Temp.	Hydrometer	Corrections		Hydrometer	Percent Passing		Effective Depth	Table 3	Diameter
Clock	T (Min.)	(0.5 °C)	Reading	Control Cylinder	Composite Correction	R	P(-#10) = (R x a / W) x 100	P (total) = P x % Passing #10	L	K	D = K x ((L/T)^1/2
	2	23.7	39.5		5.05	34.45	34.1%	33.8%	10.6	0.01309	0.03020
	5	23.7	32.5		5.05	27.45	27.2%	26.9%	11.8	0.01309	0.02010
	15	23.6	26.5		5.05	21.45	21.2%	21.1%	12.8	0.01309	0.01208
	30	23.6	23.5		5.05	18.45	18.3%	18.1%	13.3	0.01309	0.00871
	60	23.6	21.0		5.05	15.95	15.8%	15.7%	13.7	0.01309	0.00625
	250	23.0	16.5		5.10	11.40	11.3%	11.2%	14.4	0.01317	0.00316
	1440	23.3	12.5		5.05	7.45	7.4%	7.3%	15.1	0.01317	0.00135
	2880	23.2	11.5		5.10	6.40	6.3%	6.3%	15.2	0.01317	0.00096

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Effective Depth (cm)
L=L1+0.5(L2-(VB/A))
(152H) .164cm per increment,
V_B=67.0cm^3, L_2=14cm, A=27.8cm^2

Technician Name: M. Jacobs
Certification #

Technical Responsibility: Brian Vaughan, P.E.
Signature

QC Manager
Position

S&ME, INC. **155 Tradd Street Spartanburg, SC 29301**

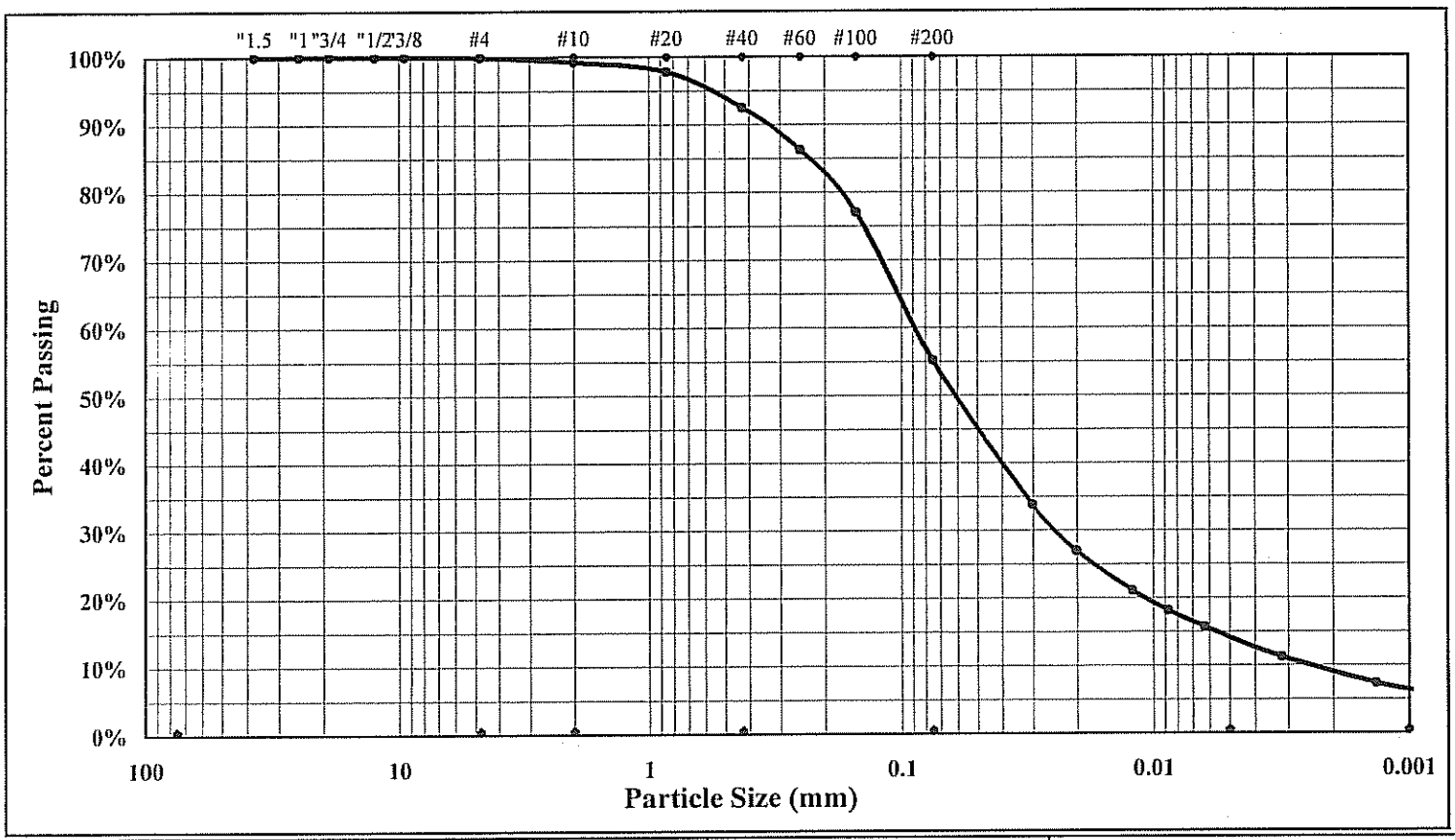
Hydrometer #134 (M-17, 20-25') 5-19-08.xls

Particle Size Analysis of Soils

ASTM D 422

S&ME Project #:	**1411-07-103**	Report Date:	5/19/08
Project Name:	**Marshall Steam Station**	Test Date(s):	5/14 - 5/16/08
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-17	Sample #:	134	Sample Date:	4/29/08
Location:	Bulk	Offset:	N/A	Elevation:	20-25'
Sample Description:	Tan gray micaceous fine sandy clayey SILT (ML)				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	4.75 mm	Gravel	0.1%	Silt	41.2%
Silt & Clay (% Passing #200)	55.2%	Sand	44.7%	Clay	14.0%
Specific Gravity	2.650	Moisture Content	13.7%	Colloids	6.3%
Liquid Limit	33	Plastic Limit	29	Plastic Index	4

Description of Sand & Gravel Particles Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Mechanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

References: ASTM D 422: Particle Size Analysis of Soils
ASTM D 421: Dry Preparation of Soil Samples
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 854: Specific Gravity of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. _____ QC Manager
Signature *Position*

Moisture - Density Relationship

S&ME

S&ME Project #:	**1411-07-103**	Test Date(s):	May 8, 2008
Project Name:	Marshall Steam Station	Report Date:	May 9, 2008
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-17	Sample #:	134	Sample Date:	April 29, 2008
Location:	Bulk	Offset:	N/A	Depth:	20-25'

Sample Description: Tan gray micaceous fine sandy clayey SILT (ML)

Liquid Limit:	33	Specific Gravity:	2.650
Plastic Limit:	29	Plastic Index:	4

Natural Moisture Content: 13.7%

Moisture Content of the Oversize Fraction:

NOTES:

Sieve Size	% Passing
#4	99.9
#10	99.2
#20	97.8
#40	92.5
#60	86.2
#100	77.0
#200	55.2

MDD: 103.0 **Opt. MC %: 18.4**

Water Content

Water Content requires GP 2 Balance (0.1 gram Readability).

ASTM D2216 ☒ AASHTO T265 ☐ ASTM D4959 ☐ ASTM D4643 ☐

	Sample #:	1	2	3	4	5	6
	Water Added:						
	Tare #:						
A. Tare Weight	A.	0	0	0	0	0	0
B. Wet Wt + Tare Wt	B.	500	500	500	500	500	500
C. Dry Wt. + Tare Wt.	C.	438.6	430.6	423.4	416.1	408.7	
D. Water Weight	B-C	61.4	69.4	76.6	83.9	91.3	500
E. Dry Weight	C-A	438.6	430.6	423.4	416.1	408.7	0
F. Moisture Content	100*D/E	**14.0%**	**16.1%**	**18.1%**	**20.2%**	**22.3%**	**#DIV/0!**

Compaction Data

The Compaction Test requires a GP 5 Balance for ASTM (1 gram or .0022 Lb. readability).

G. Wt of Soil + Mold	G.	13.128	13.260	13.344	13.396	13.366	
H. Wt. of Mold	H.	9.304	9.304	9.304	9.304	9.304	9.304
I. Wt. of Soil (g. or lbs.)	G-H	3.824	3.956	4.040	4.092	4.062	-9.304
J. Wt of Soil (Lbs.)	I/453.6 or I	3.824	3.956	4.040	4.092	4.062	-9.304
K. Mold Volume Factor	K.	30.093	30.093	30.093	30.093	30.093	30.093
L. Wet Density	J*K	115.1	119.0	121.6	123.1	122.2	-280.0
M. Dry Density	L/(1+F)	**100.9**	**102.5**	**103.0**	**102.5**	**99.9**	**#DIV/0!**

ASTM D558 ☐ ASTM D 698 ☒ ASTM D1557 ☐ AASHTO T99 ☐ AASHTO T180 ☐

Method A ☒ Method B ☐ Method C ☐ Method D (ASTM 1978) ☐ AASHTO Method D ☐

Moisture-Density Relation of: Fine Fraction ☒ Corrected for Coarse Fraction (ASTM D 4718) ☐

Sieve Size used to separate the Oversize Fraction: #4 Sieve ☒ 3/8 inch Sieve ☐ 3/4 inch Sieve ☐

Mechanical Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

Soil Plasticity:	ASTM D 4318 ☒	AASHTO T 89 ☐		AASHTO T 90 ☐
Sieve Analysis / Particle Size Analysis:	ASTM C136 ☐	AASHTO T 27 ☐	ASTM D 422 ☒	AASHTO T 88 ☐
Specific Gravity of Soil:		ASTM D 854 ☒		AASHTO T 100 ☐
Bulk Gravity of Oversize Fraction:		ASTM C 127 ☐		AASHTO T 85 ☐
Soil Classification:	ASTM D 2487 ☒	ASTM D 2488 ☐		AASHTO M 145 ☐

Technician Name: B. Hatton

Certification #

Technical Responsibility: Brian Vaughan, P.E. Signature Construction Services Manager Position

Moisture - Density Report

S&ME

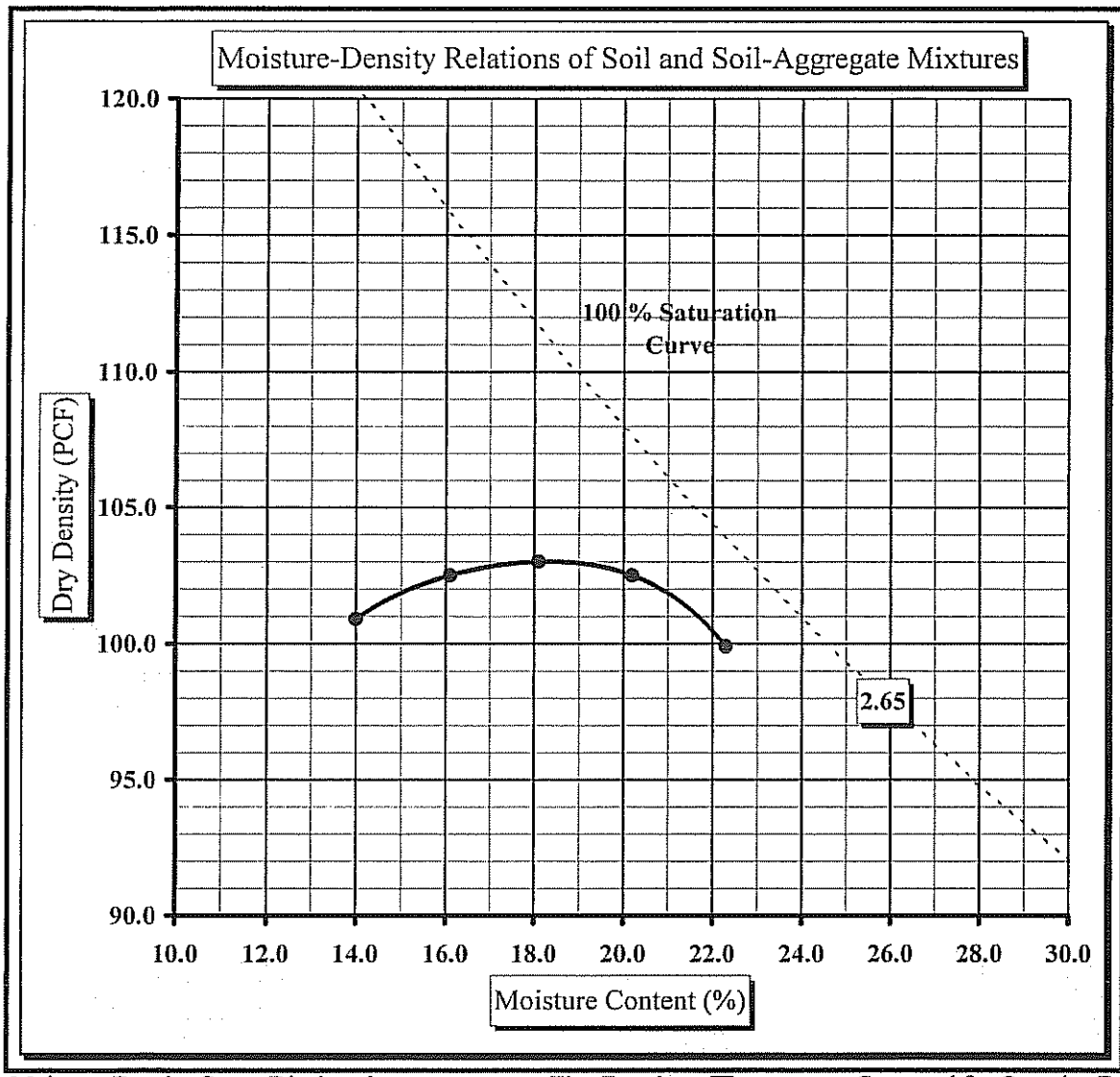
S&ME Project #:	**1411-07-103**	Report Date:	May 9, 2008
Project Name:	**Marshall Steam Station**	Test Date(s):	May 8, 2008
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-17	Sample #:	134	Sample Date:	April 29, 2008
Location:	Bulk	Offset:	N/A	Depth:	20-25'

Sample Description: Tan gray micaceous fine sandy clayey SILT (ML)

Maximum Dry Density 103.0 PCF. **Optimum Moisture Content 18.4 %**

ASTM D 698 Method A



Soil Properties

Natural Moisture Content:	13.7%
Liquid Limit:	33
Plastic Limit:	29
Plastic Index:	4
Specific Gravity:	2.650

% Passing

#4	99.9
#10	99.2
#20	97.8
#40	92.5
#60	86.2
#100	77.0
#200	55.2

Oversize Fraction

Bulk Sp. Gravity
% Moisture
Oversize Fraction
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 Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

References: ASTM D 698: Laboratory Compaction Characteristics of Soil Using Standard Effort
ASTM D 2216: Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D 422: Particle Size Analysis of Soils
ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. Construction Services Manager

Laboratory Record Version 4.2

S&ME

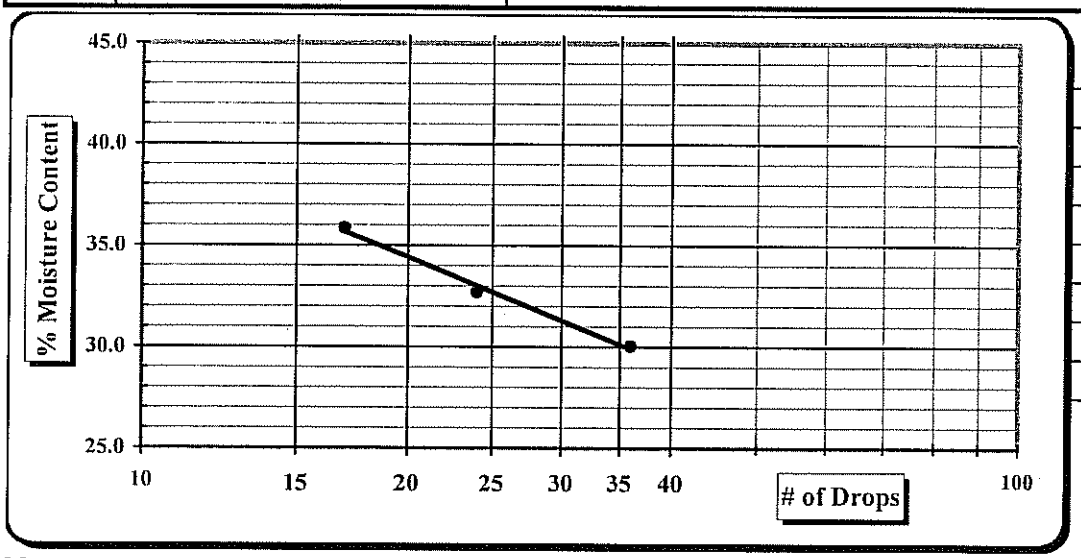
Liquid Limit, Plastic Limit, and Plastic Index

Project #: **1411-07-103**
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Charlotte, NC

Report Date: 5/19/08
Test Date(s): 5/16/08

Boring #: M-17 Sample #: 134 Sample Date: 4/29/08
Location: Bulk Offset: N/A Elevation: 20-25'
Sample Description: Tan gray micaceous fine sandy clayey SILT (ML)

Pan #		Liquid Limit						Plastic Limit		
	Test #	1	2	3	4	5	6	1	2	3
	Tare #	P-1	P-2	P-3				1	2	
A	Tare Weight	16.55	15.44	16.55				**10.90**	10.86	
B	Wet Soil Weight + A	38.81	38.78	39.52				18.14	17.91	
C	Dry Soil Weight + A	33.67	33.03	33.46				16.49	16.32	
D	Water Weight (B-C)	5.14	5.75	6.06				1.65	1.60	
E	Dry Soil Weight (C-A)	17.12	17.59	16.91				5.59	5.46	
F	% Moisture Content (D/E)*100	30.0%	32.7%	35.8%				29.5%	29.2%	
N	# OF DROPS	36	24	17				*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average							29.4%		



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes:

Special Sampling Methods:

Sample Preparation:	Wet Preparation	☐	Dry Preparation	☒	Air Dried	☒	% Passing #200 Sieve: 55.2
Liquid limit Test:	Multipoint Method	☒	One-point Method	☐			NP, Non-Plastic ☐
Classification:	ASTM D 2487	☒	AASHTO M 145	☐			Liquid Limit 33
Liquid limit Test:	ASTM D 4318	☒	AASHTO T 89	☐			Plastic Limit 29
Plastic limit Test:	ASTM D 4318	☒	AASHTO T 90	☐			Plastic Index 4
							Group Symbol ML

Technician Name: M. Jacobs

Certification #

Technical Responsibility: Brian Vaughan, P.E. _____ QC Manager

Signature *Position*

Particle Size Analysis of Soils

ASTM D 422

S&ME

Project #: **1411-07-103**
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Charlotte, NC

Test Date(s): 5/14 - 5/16/08
Report Date: 5/19/08

Boring #: M-18 Sample #: 134 Sample Date: 4/30/08
Location: Bulk Offset: N/A Elevation: 19-24'
Sample Description: Brown orange clayey silty fine SAND (SC-SM)

Pan #:	2	Beaker #:	2
Hydrometer Jar #:			2
Pan Tare Weight (grams):			0.00
Total Sample Air Dried Wt. + tare wt. (grams):			515.02
Weight of Total Sample Air Dried:			515.02
Weight of Air Dried Hydrometer Sample (g):			102.72
Total Sample Oven Dried:			511.83
Hydrometer Sample Oven Dried (W):			102.06
% Passing #10:			96.0%
Correction Factor a (Table 1):			1.00

Specific Gravity 2.650

	Moisture Content	Hygroscopic	Natural
	Tare #	Z-2	301
A	Tare Wt.	16.71	0.00
B	Wet Wt. + A	30.66	265.92
C	Dry Wt. + A	30.57	233.68
D	Water Wt. (B-C)	0.09	32.24
E	Dry Wt. (C-A)	13.86	233.68
	% Moisture (100 x D/E)	0.65%	13.8%

Sieve	Retained Wt.	Percent Passing	
3.0"	0.0	Pan # (washed) 52	100.0%
1.5"	0.0		100.0%
1.0"	0.0		100.0%
3/4"	0.0		100.0%
1/2"	0.0		100.0%
3/8"	0.0		100.0%
#4	10.0	Soil Mortar	98.1%
#10	20.4	**100.0%**	96.0%
#20	3.0	97.1%	93.2%
#40	10.1	90.2%	86.6%
#60	19.3	81.1%	77.9%
#100	32.4	68.2%	65.5%
#200	50.6	50.4%	48.4%

Notes: Description of Sand & Gravel Particles — Rounded ☐ Angular ☒ | Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:	4.75 mm	Total Sand:	49.6%	< 4.74 mm and > 0.075 mm	Type: Mechanical Stirring Apparatus (A)
% Gravel:	1.9% < 75 mm and > 4.75 mm	Silt & Clay:	48.4%	< 0.075	Dispersion Time: 1 min.
Coarse Sand:	2.0% < 4.75 mm and > 2.00 mm	Silt:	30.9%	< 0.075 and > 0.005 mm	Sodium Hexametaphosphate: 40 g./ Liter
Medium Sand:	9.5% < 2.00 mm and > 0.425 mm	Clay:	17.5%	< 0.005 mm	
Fine Sand:	38.1% < 0.425 mm and > 0.075 mm	Colloids:	7.9%	< 0.001 mm	**Control Cylinder** ☐ **Composite Correction** ☒

Liquid Limit **28** Plastic Limit **21** Plastic Index **7** Hydrometer: 151H ☐ 152H ☒

Time		Temp.	Hydrometer	Corrections		Hydrometer	Percent Passing		Effective Depth	Table 3	Diameter
Clock	T (Min.)	(0.5 °C)	Reading	Control Cylinder	Composite Correction	R	P(-#10) = (R x a / W) x 100	P (total) = P x % Passing #10	L	K	D = K x ((L/T)^1/2
	2	23.7	42.0		5.05	36.95	36.2%	34.8%	10.2	0.01309	0.02961
	5	23.7	37.0		5.05	31.95	31.3%	30.1%	11.1	0.01309	0.01946
	15	23.6	31.5		5.05	26.45	25.9%	24.9%	12.0	0.01309	0.01169
	30	23.6	28.0		5.05	22.95	22.5%	21.6%	12.5	0.01309	0.00846
	60	23.6	25.0		5.05	19.95	19.5%	18.8%	13.0	0.01309	0.00610
	250	23.0	20.5		5.10	15.40	15.1%	14.5%	13.8	0.01317	0.00309
	1440	23.3	15.0		5.05	9.95	9.7%	9.4%	14.7	0.01317	0.00133
	2880	23.2	13.5		5.10	8.40	8.2%	7.9%	14.9	0.01317	0.00095

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Effective Depth (cm)
L=L1+0.5(L2-(VB/A))
(152H) .164cm per increment,
V_B=67.0cm^3, L_2=14cm, A=27.8cm^2

Technician Name: M. Jacobs
Certification #

Technical Responsibility: Brian Vaughan, P.E.
Signature

QC Manager
Position

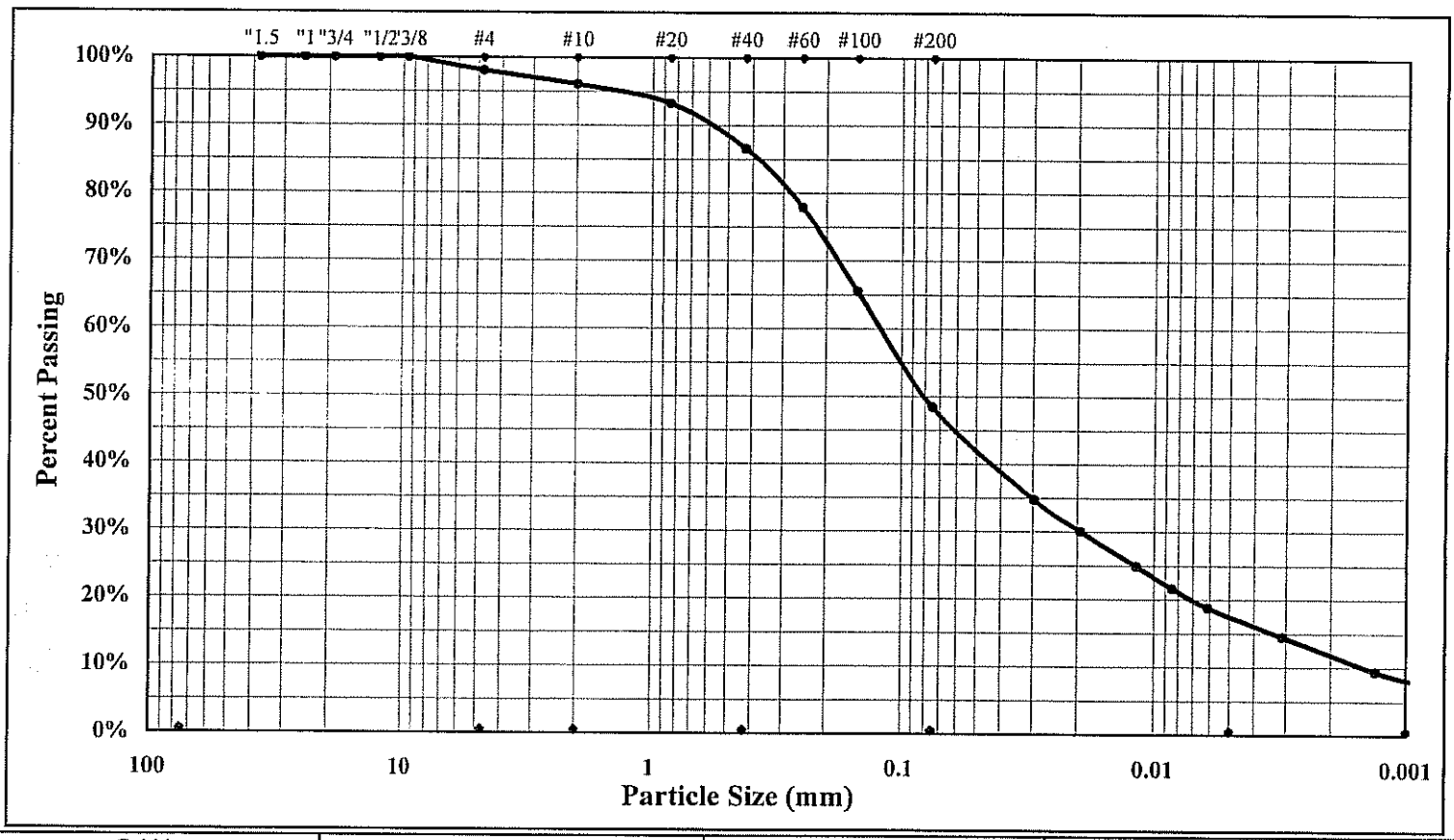
Particle Size Analysis of Soils

ASTM D 422

S&ME

S&ME Project #:	**1411-07-103**	Report Date:	5/19/08
Project Name:	**Marshall Steam Station**	Test Date(s):	5/14 - 5/16/08
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-18	Sample #:	134	Sample Date:	4/30/08
Location:	Bulk	Offset:	N/A	Elevation:	19-24'
Sample Description:	Brown orange clayey silty fine SAND (SC-SM)				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	4.75 mm	Gravel	1.9%	Silt	30.9%
Silt & Clay (% Passing #200)	48.4%	Sand	49.6%	Clay	17.5%
Specific Gravity	2.650	Moisture Content	13.8%	Colloids	7.9%
Liquid Limit	28	Plastic Limit	21	Plastic Index	7

Description of Sand & Gravel Particles Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Mechanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

References: ASTM D 422: Particle Size Analysis of Soils
ASTM D 421: Dry Preparation of Soil Samples
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 854: Specific Gravity of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. _____ QC Manager

Signature Position

Moisture - Density Relationship

S&ME

S&ME Project #:	**1411-07-103**	Test Date(s):	May 8, 2008
Project Name:	Marshall Steam Station	Report Date:	May 9, 2008
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-18	Sample #:	134	Sample Date:	April 30, 2008
Location:	Bulk	Offset:	N/A	Depth:	19-24'

Sample Description: Brown orange clayey silty fine SAND (SC-SM)

Liquid Limit:	28	Specific Gravity:	2.650
Plastic Limit:	21	Plastic Index:	7

Natural Moisture Content: 13.8%

Moisture Content of the Oversize Fraction:

NOTES:

Sieve Size	% Passing
#4	98.1
#10	96.0
#20	93.2
#40	86.6
#60	77.9
#100	65.5
#200	48.4

MDD: 119.6 **Opt. MC %: 12.9**

Water Content

Water Content requires GP 2 Balance (0.1 gram Readability).

ASTM D2216 ☒ AASHTO T265 ☐ ASTM D4959 ☐ ASTM D4643 ☐

	Sample #:	1	2	3	4	5	6
	Water Added:						
	Tare #:						
A. Tare Weight	A.	0	0	0	0	0	0
B. Wet Wt + Tare Wt	B.	500	500	500	500	500	500
C. Dry Wt. + Tare Wt.	C.	455.4	447.2	440.8	432.6		
D. Water Weight	B-C	44.6	52.8	59.2	67.4	500	500
E. Dry Weight	C-A	455.4	447.2	440.8	432.6	0	0
F. Moisture Content	100*D/E	**9.8%**	**11.8%**	**13.4%**	**15.6%**	**#DIV/0!**	**#DIV/0!**

Compaction Data

The Compaction Test requires a GP 5 Balance for ASTM (1 gram or .0022 Lb. readability).

G. Wt of Soil + Mold	G.	13.580	13.734	13.808	13.736		
H. Wt. of Mold	H.	9.304	9.304	9.304	9.304	9.304	9.304
I. Wt. of Soil (g. or lbs.)	G-H	4.276	4.430	4.504	4.432	-9.304	-9.304
J. Wt of Soil (Lbs.)	I/453.6 or I	4.276	4.430	4.504	4.432	-9.304	-9.304
K. Mold Volume Factor	K.	30.093	30.093	30.093	30.093	30.093	30.093
L. Wet Density	J*K	128.7	133.3	135.5	133.4	-280.0	-280.0
M. Dry Density	L/(1+F)	**117.2**	**119.2**	**119.5**	**115.4**	**#DIV/0!**	**#DIV/0!**

ASTM D558 ☐ ASTM D 698 ☒ ASTM D1557 ☐ AASHTO T99 ☐ AASHTO T180 ☐

Method A ☒ Method B ☐ Method C ☐ Method D (ASTM 1978) ☐ AASHTO Method D ☐

Moisture-Density Relation of: Fine Fraction ☒ Corrected for Coarse Fraction (ASTM D 4718) ☐

Sieve Size used to separate the Oversize Fraction: #4 Sieve ☒ 3/8 inch Sieve ☐ 3/4 inch Sieve ☐

Mechanical Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

Soil Plasticity:	ASTM D 4318 ☒	AASHTO T 89 ☐		AASHTO T 90 ☐
Sieve Analysis / Particle Size Analysis:	ASTM C136 ☐	AASHTO T 27 ☐	ASTM D 422 ☒	AASHTO T 88 ☐
Specific Gravity of Soil:		ASTM D 854 ☒		AASHTO T 100 ☐
Bulk Gravity of Oversize Fraction:		ASTM C 127 ☐		AASHTO T 85 ☐
Soil Classification:	ASTM D 2487 ☒	ASTM D 2488 ☐		AASHTO M 145 ☐

Technician Name: B. Hatton

Certification #

Technical Responsibility: Brian Vaughan, P.E. Signature Construction Services Manager Position

Laboratory Report Version 4.2

Moisture - Density Report

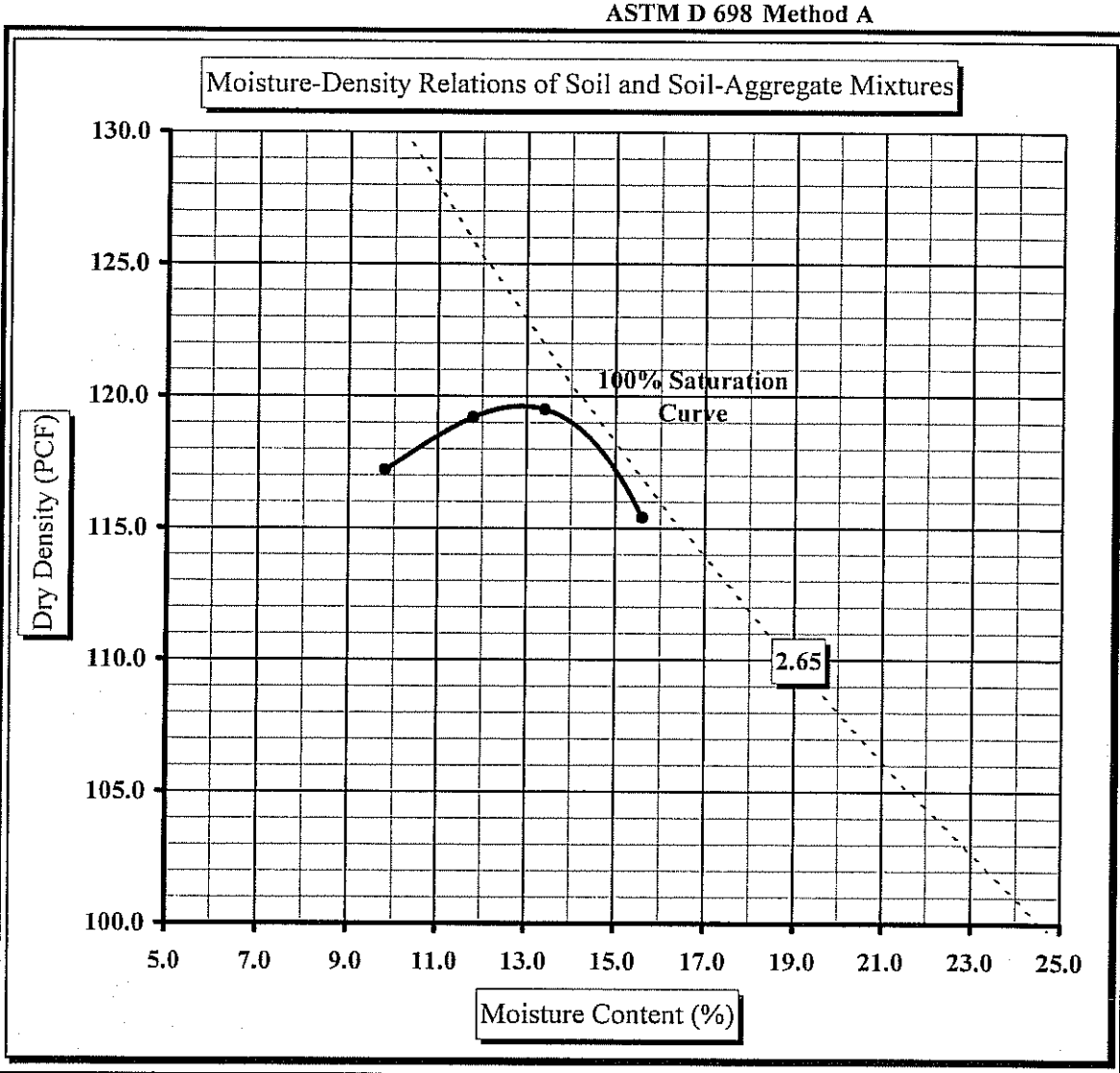
S&ME

S&ME Project #:	**1411-07-103**	Report Date:	May 9, 2008
Project Name:	**Marshall Steam Station**	Test Date(s):	May 8, 2008
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-18	Sample #:	134	Sample Date:	April 30, 2008
Location:	Bulk	Offset:	N/A	Depth:	19-24'
Sample Description:	Brown orange clayey silty fine SAND (SC-SM)				

Maximum Dry Density **119.6** **PCF.** **Optimum Moisture Content** **12.9** **%**

ASTM D 698 Method A



Soil Properties

Natural Moisture Content:	13.8%
Liquid Limit:	28
Plastic Limit:	21
Plastic Index:	7
Specific Gravity:	2.650

% Passing

#4	98.1
#10	96.0
#20	93.2
#40	86.6
#60	77.9
#100	65.5
#200	48.4

Oversize Fraction

Bulk Sp. Gravity
% Moisture
Oversize Fraction
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 Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

References: ASTM D 698: Laboratory Compaction Characteristics of Soil Using Standard Effort
ASTM D 2216: Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D 422: Particle Size Analysis of Soils ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

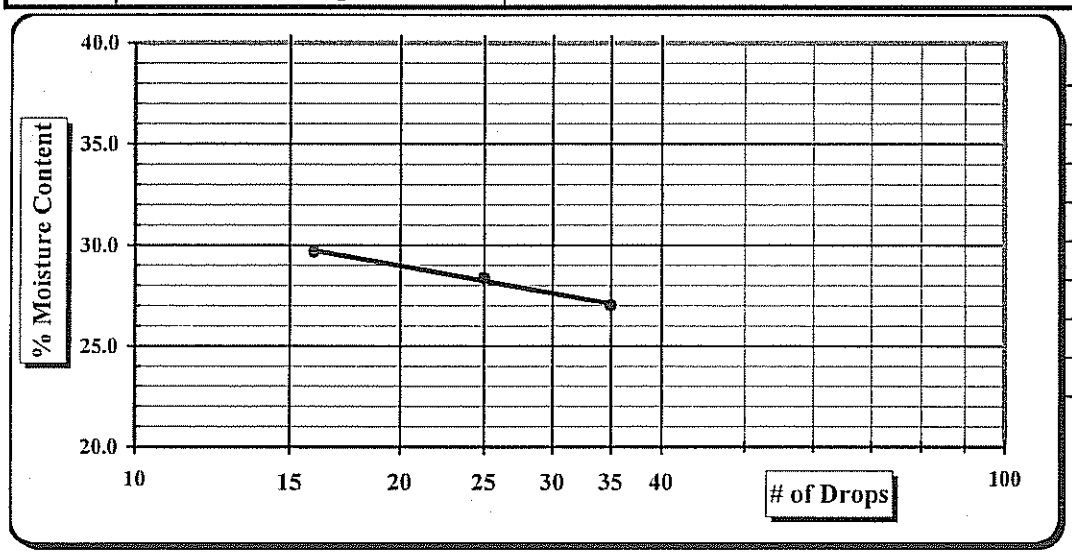
Technical Responsibility: Brian Vaughan, P.E. Construction Services Manager
Position

S&ME

Liquid Limit, Plastic Limit, and Plastic Index

Project #: **1411-07-103** Report Date: 5/19/08
Project Name: Marshall Steam Station Test Date(s): 5/16/08
Client Name: Duke Energy
Client Address: Charlotte, NC
Boring #: M-18 Sample #: 134 Sample Date: 4/30/08
Location: Bulk Offset: N/A Elevation: 19-24'
Sample Description: Brown orange clayey silty fine SAND (SC-SM)

Pan #		Liquid Limit						Plastic Limit		
	Test #	1	2	3	4	5	6	1	2	3
	Tare #	Q-1	Q-2	Q-3				3	4	
A	Tare Weight	16.80	16.77	15.76				**10.87**	10.98	
B	Wet Soil Weight + A	40.59	39.26	39.62				18.90	18.63	
C	Dry Soil Weight + A	35.53	34.29	34.16				17.53	17.30	
D	Water Weight (B-C)	5.06	4.97	5.46				1.37	1.33	
E	Dry Soil Weight (C-A)	18.73	17.52	18.40				6.66	6.32	
F	% Moisture Content (D/E)*100	27.0%	28.4%	29.7%				20.6%	21.0%	
N	# OF DROPS	35	25	16				*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average							20.8%		



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes:

Special Sampling Methods:

Sample Preparation:	Wet Preparation	☐	Dry Preparation	☒	Air Dried	☒	% Passing #200 Sieve: 48.4
Liquid limit Test:	Multipoint Method	☒	One-point Method	☐			NP, Non-Plastic ☐
Classification:	ASTM D 2487	☒	AASHTO M 145	☐			Liquid Limit 28
Liquid limit Test:	ASTM D 4318	☒	AASHTO T 89	☐			Plastic Limit 21
Plastic limit Test:	ASTM D 4318	☒	AASHTO T 90	☐			Plastic Index 7
							Group Symbol SC-SM

Technician Name: M. Jacobs _____ *Certification #*

Technical Responsibility: Brian Vaughan, P.E. _____ *Signature* QC Manager *Position*

Particle Size Analysis of Soils

ASTM D 422

S&ME

Project #: **1411-07-103**
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Charlotte, NC

Test Date(s): 6/11 - 6/13/08
Report Date: 6/16/08

Boring #: M-19 Sample #: 181 Sample Date: 5/20/08
Location: Bulk Offset: N/A Elevation: 3.3-8.3'
Sample Description: Red tan clayey SILT with fine sand (ML)

Pan #:	1	Beaker #:	1
Hydrometer Jar #:			1
Pan Tare Weight (grams):			0.00
Total Sample Air Dried Wt. + tare wt. (grams):			491.05
Weight of Total Sample Air Dried:			491.05
Weight of Air Dried Hydrometer Sample (g):			53.19
Total Sample Oven Dried:			482.12
Hydrometer Sample Oven Dried (W):			52.21
% Passing #10:			98.5%
Correction Factor a (Table 1):			1.00

Specific Gravity 2.650

	Moisture Content	Hygroscopic	Natural
	Tare #	Z-1	301
A	Tare Wt.	16.00	0.00
B	Wet Wt. + A	27.91	270.44
C	Dry Wt. + A	27.69	223.17
D	Water Wt. (B-C)	0.22	47.27
E	Dry Wt. (C-A)	11.69	223.17
	% Moisture (100 x D/E)	1.88%	21.2%

Sieve	Retained Wt.	Percent Passing	
3.0"	0.0	Pan # (washed) 51	100.0%
1.5"	0.0		100.0%
1.0"	0.0		100.0%
3/4"	0.0		100.0%
1/2"	0.0		100.0%
3/8"	2.0		99.6%
#4	6.3	Soil Mortar	98.7%
#10	7.4	**100.0%**	98.5%
#20	0.4	99.2%	97.7%
#40	1.3	97.5%	96.0%
#60	2.7	94.8%	93.4%
#100	6.0	88.5%	87.2%
#200	12.3	76.4%	75.3%

Notes: Description of Sand & Gravel Particles Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:	9.50 mm	Total Sand:	23.4%	< 4.74 mm and > 0.075 mm	Type: Mechanical Stirring Apparatus (A)
% Gravel:	1.3%	< 75 mm and > 4.75 mm	Silt & Clay:	75.3%	< 0.075 — Dispersion Time: 1 min.
Coarse Sand:	0.2%	< 4.75 mm and > 2.00 mm	Silt:	39.3%	< 0.075 and > 0.005 mm — Sodium Hexametaphosphate: 40 g./ Liter
Medium Sand:	2.5%	< 2.00 mm and > 0.425 mm	Clay:	36.0%	< 0.005 mm
Fine Sand:	20.7%	< 0.425 mm and > 0.075 mm	Colloids:	19.0%	< 0.001 mm — **Control Cylinder** ☐ **Composite Correction** ☒

Liquid Limit **48** Plastic Limit **31** Plastic Index **17** Hydrometer: 151H ☐ 152H ☒

Time		Temp.	Hydrometer	Corrections		Hydrometer	Percent Passing		Effective Depth	Table 3	Diameter
Clock	T (Min.)	(0.5 °C)	Reading	Control Cylinder	Composite Correction	R	P(-#10) = (R x a / W) x 100	P (total) = P x % Passing #10	L	K	D = K x ((L/T)^1/2
	2	23.0	39.5		5.10	34.40	65.9%	64.9%	10.7	0.01317	0.03040
	5	23.0	36.0		5.10	30.90	59.2%	58.3%	11.2	0.01317	0.01974
	15	23.1	31.0		5.10	25.90	49.6%	48.9%	12.0	0.01317	0.01180
	30	23.2	28.5		5.10	23.40	44.8%	44.1%	12.5	0.01317	0.00849
	60	23.5	25.5		5.05	20.45	39.2%	38.6%	12.9	0.01309	0.00608
	250	23.4	21.0		5.05	15.95	30.6%	30.1%	13.7	0.01317	0.00308
	1440	23.5	16.5		5.05	11.45	21.9%	21.6%	14.4	0.01309	0.00131
	2880	23.8	15.0		5.00	10.00	19.2%	18.9%	14.7	0.01309	0.00093

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Effective Depth (cm)
L=L1+0.5(L2-(VB/A))
(152H) .164cm per increment,
V_B=67.0cm^3, L_2=14cm, A=27.8cm^2

Technician Name: M. Jacobs

Technical Responsibility: William C. Schwartz, Jr., P.E.

Certification #

Signature

QC Manager
Position

S&ME, INC. **155 Tradd Street Spartanburg, SC 29301**

Hydrometer #181 (M-19, 3.3-8.3') 6-16-08.xls

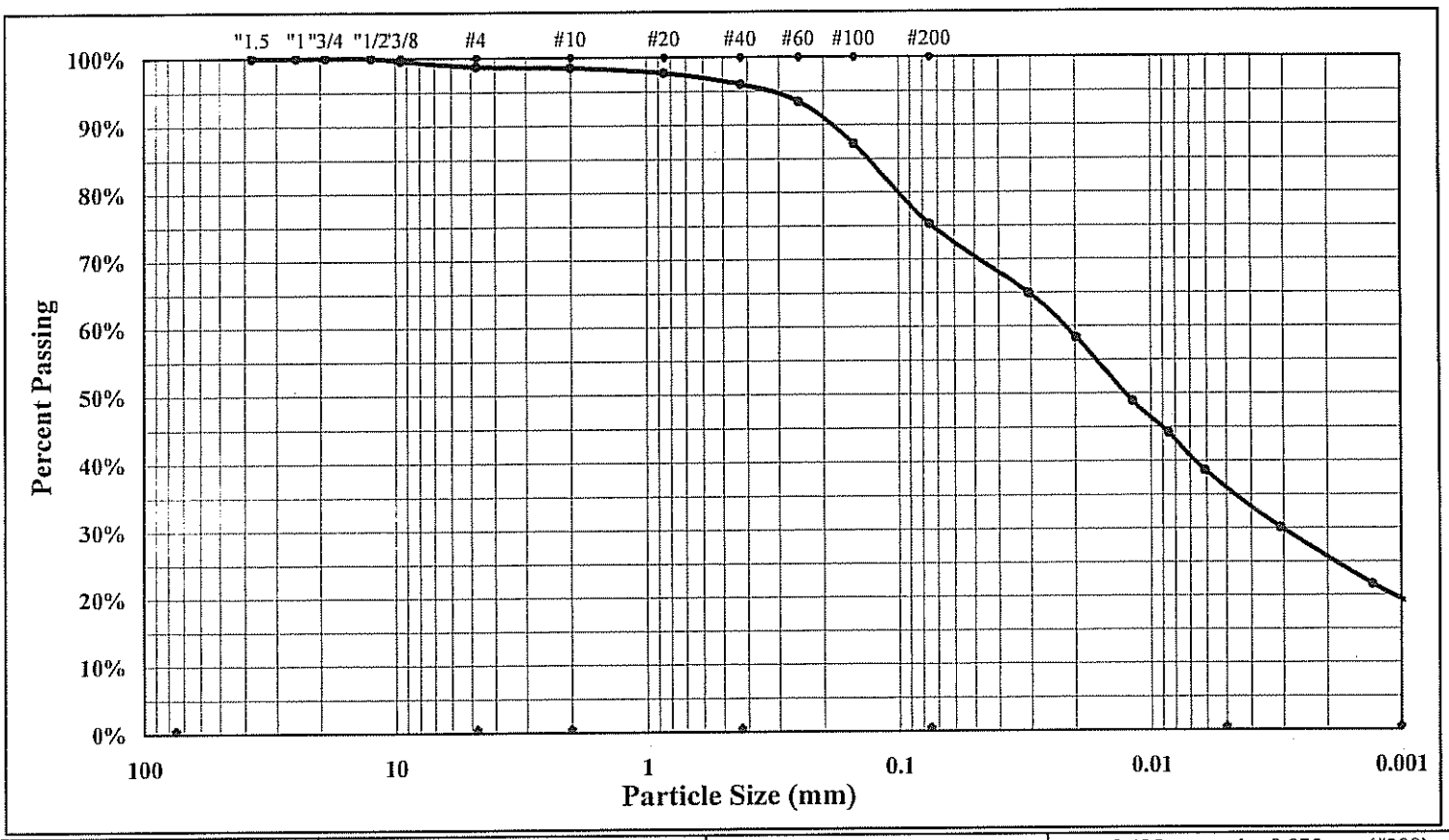
Particle Size Analysis of Soils

ASTM D 422

S&ME

S&ME Project #:	**1411-07-103**	Report Date:	6/16/08
Project Name:	**Marshall Steam Station**	Test Date(s):	6/11 - 6/13/08
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-19	Sample #:	181	Sample Date:	5/20/08
Location:	Bulk	Offset:	N/A	Elevation:	3.3-8.3'
Sample Description:	Red tan clayey SILT with fine sand (ML)				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	9.50 mm	Gravel	1.3%	Silt	39.3%
Silt & Clay (% Passing #200)	75.3%	Sand	23.4%	Clay	36.0%
Specific Gravity	2.650	Moisture Content	21.2%	Colloids	19.0%
Liquid Limit	48	Plastic Limit	31	Plastic Index	17

Description of Sand & Gravel Particles Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Mechanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

References: ASTM D 422: Particle Size Analysis of Soils
ASTM D 421: Dry Preparation of Soil Samples
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 854: Specific Gravity of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: William C. Schwartz, Jr., P.E. _____ QC Manager
Signature Position

Laboratory Record Version 4.2

S&ME

Liquid Limit, Plastic Limit, and Plastic Index

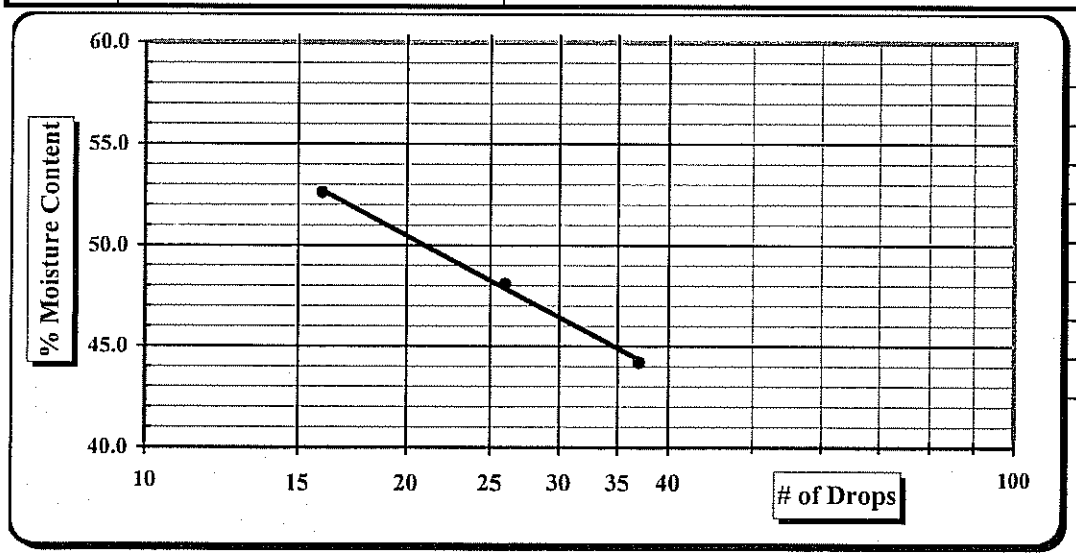
Project #:	**1411-07-103**	Report Date:	6/17/08
Project Name:	Marshall Steam Station	Test Date(s):	6/16/08
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #: M-19 Sample #: 181 Sample Date: 5/20/08

Location: Bulk Offset: N/A Elevation: 3.3-8.3'

Sample Description: Red tan clayey SILT with fine sand (ML)

Pan #		Liquid Limit						Plastic Limit		
	Test #	1	2	3	4	5	6	1	2	3
	Tare #	P-1	P-2	P-3				1	2	
A	Tare Weight	16.56	15.44	16.55				**10.83**	10.85	
B	Wet Soil Weight + A	38.03	37.43	37.12				18.32	18.61	
C	Dry Soil Weight + A	31.45	30.29	30.03				16.54	16.78	
D	Water Weight (B-C)	6.58	7.14	7.09				1.78	1.84	
E	Dry Soil Weight (C-A)	14.89	14.85	13.48				5.71	5.93	
F	% Moisture Content (D/E)*100	44.2%	48.1%	52.6%				31.2%	31.0%	
N	# OF DROPS	37	26	16				*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average							31.1%		



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes:

Special Sampling Methods:

Sample Preparation:	Wet Preparation	☐	Dry Preparation	☒	Air Dried	☒	% Passing #200 Sieve: 75.3
Liquid limit Test:	Multipoint Method	☒	One-point Method	☐			NP, Non-Plastic ☐
Classification:	ASTM D 2487	☒	AASHTO M 145	☐			Liquid Limit 48
Liquid limit Test:	ASTM D 4318	☒	AASHTO T 89	☐			Plastic Limit 31
Plastic limit Test:	ASTM D 4318	☒	AASHTO T 90	☐			Plastic Index 17
							Group Symbol ML

Technician Name: M. Jacobs

Certification #

Technical Responsibility: Brian Vaughan, P.E. _____ QC Manager

Signature *Position*

Particle Size Analysis of Soils

ASTM D 422

S&ME

Project #: **1411-07-103**
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Charlotte, NC

Test Date(s): 6/11 - 6/13/08
Report Date: 6/16/08

Boring #: M-20 Sample #: 181 Sample Date: 5/12/08
Location: Bulk Offset: N/A Elevation: 13.7-18.7'
Sample Description: Light brown orange clayey SILT with fine sand (MH)

Pan #:	2	Beaker #:	2
Hydrometer Jar #:			2
Pan Tare Weight (grams):			0.00
Total Sample Air Dried Wt. + tare wt. (grams):			493.66
Weight of Total Sample Air Dried:			493.66
Weight of Air Dried Hydrometer Sample (g):			52.52
Total Sample Oven Dried:			474.73
Hydrometer Sample Oven Dried (W):			50.45
% Passing #10:			97.2%
Correction Factor a (Table 1):			1.00

Specific Gravity 2.650

	Moisture Content	Hygroscopic	Natural
	Tare #	Z-2	302
A	Tare Wt.	16.71	0.00
B	Wet Wt. + A	29.91	236.75
C	Dry Wt. + A	29.39	192.30
D	Water Wt. (B-C)	0.52	44.45
E	Dry Wt. (C-A)	12.68	192.30
	% Moisture (100 x D/E)	4.10%	23.1%

Sieve	Retained Wt.	Percent Passing	
3.0"	0.0	Pan # (washed) 52	100.0%
1.5"	0.0		100.0%
1.0"	0.0		100.0%
3/4"	0.0		100.0%
1/2"	0.0		100.0%
3/8"	0.0		100.0%
#4	6.2	Soil Mortar	98.7%
#10	13.2	**100.0%**	97.2%
#20	0.3	99.5%	96.7%
#40	0.8	98.4%	95.7%
#60	1.9	96.3%	93.7%
#100	4.1	92.0%	89.4%
#200	9.3	81.5%	79.3%

Notes: Description of Sand & Gravel Particles — Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:	4.75 mm	Total Sand:	19.4%	< 4.74 mm and > 0.075 mm	Type: Mechanical Stirring Apparatus (A)
% Gravel:	1.3%	< 75 mm and > 4.75 mm	Silt & Clay:	79.3%	< 0.075 — Dispersion Time: 1 min.
Coarse Sand:	1.5%	< 4.75 mm and > 2.00 mm	Silt:	47.3%	< 0.075 and > 0.005 mm — Sodium Hexametaphosphate: 40 g./ Liter
Medium Sand:	1.5%	< 2.00 mm and > 0.425 mm	Clay:	32.0%	< 0.005 mm
Fine Sand:	16.4%	< 0.425 mm and > 0.075 mm	Colloids:	15.3%	< 0.001 mm — **Control Cylinder** ☐ **Composite Correction** ☒

Liquid Limit **53** Plastic Limit **33** Plastic Index **20** Hydrometer: 151H ☐ 152H ☒

Time		Temp.	Hydrometer	Corrections		Hydrometer	Percent Passing		Effective Depth	Table 3	Diameter
Clock	T (Min.)	(0.5 °C)	Reading	Control Cylinder	Composite Correction	R	P(-#10) = (R x a / W) x 100	P (total) = P x % Passing #10	L	K	D = K x ((L/T)^1/2
	2	22.9	38.5		5.10	33.40	66.2%	64.4%	10.8	0.01325	0.03080
	5	22.9	35.0		5.10	29.90	59.3%	57.6%	11.4	0.01325	0.01999
	15	23.0	29.5		5.10	24.40	48.4%	47.0%	12.3	0.01317	0.01192
	30	23.1	26.0		5.10	20.90	41.4%	40.3%	12.9	0.01317	0.00863
	60	23.4	23.0		5.05	17.95	35.6%	34.6%	13.4	0.01317	0.00621
	250	23.4	18.0		5.05	12.95	25.7%	25.0%	14.2	0.01317	0.00314
	1440	23.3	14.0		5.05	8.95	17.7%	17.2%	14.8	0.01317	0.00134
	2880	23.7	13.0		5.05	7.95	15.8%	15.3%	15.0	0.01309	0.00094

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Effective Depth (cm)
L=L1+0.5(L2-(VB/A))
(152H) .164cm per increment,
V_B=67.0cm^3, L_2=14cm, A=27.8cm^2

Technician Name: M. Jacobs
Certification #

Technical Responsibility: William C. Schwartz, Jr., P.E.
Signature

QC Manager
Position

S&ME, INC. **155 Tradd Street Spartanburg, SC 29301**

Hydrometer #181 (M-20, 13.7-18.7') 6-16-08.xls

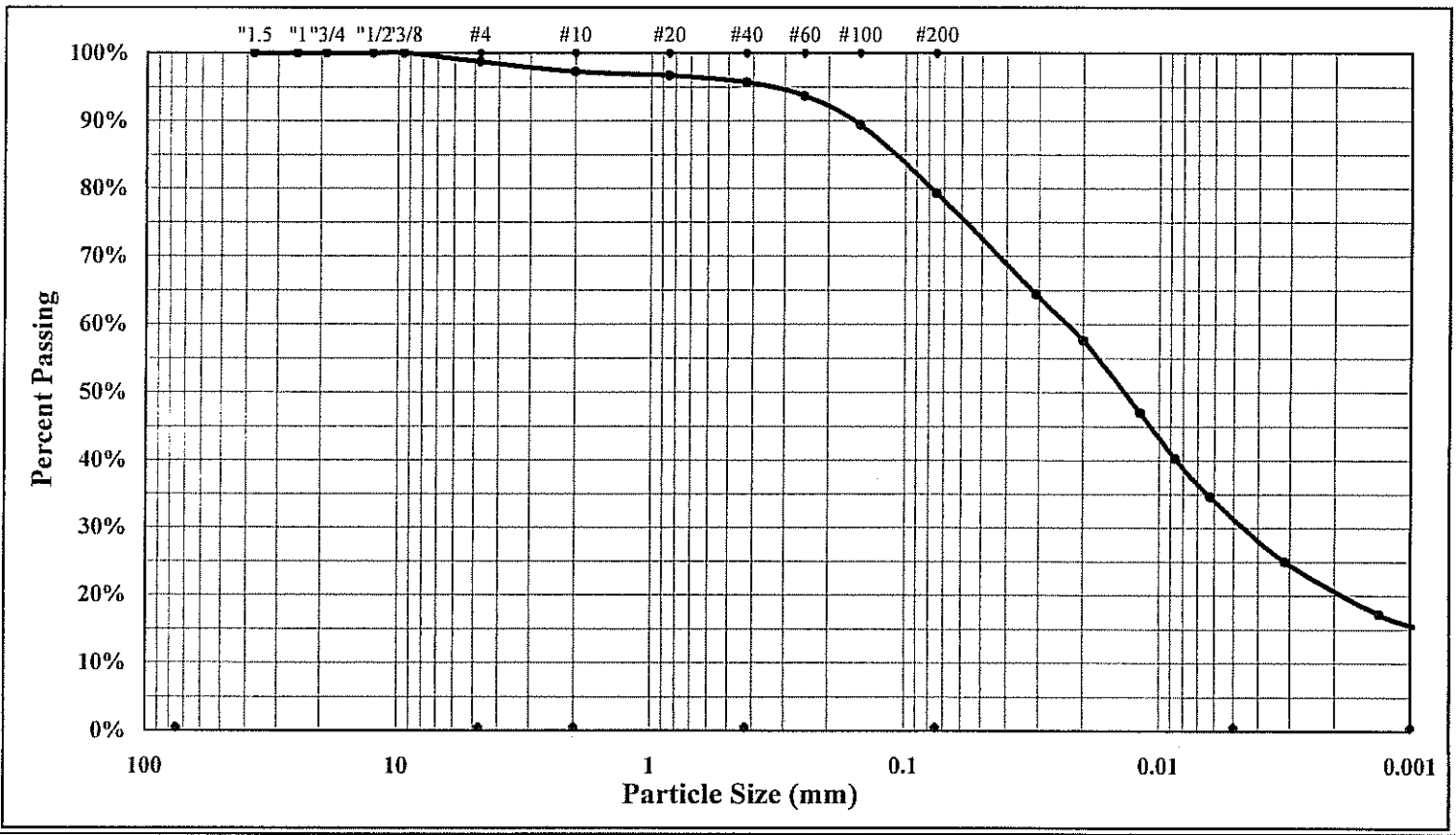
Particle Size Analysis of Soils

ASTM D 422

S&ME

S&ME Project #:	**1411-07-103**	Report Date:	6/16/08
Project Name:	**Marshall Steam Station**	Test Date(s):	6/11 - 6/13/08
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-20	Sample #:	181	Sample Date:	5/12/08
Location:	Bulk	Offset:	N/A	Elevation:	13.7-18.7'
Sample Description:	Light brown orange clayey SILT with fine sand (MH)				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	4.75 mm	Gravel	1.3%	Silt	47.3%
Silt & Clay (% Passing #200)	79.3%	Sand	19.4%	Clay	32.0%
Specific Gravity	2.650	Moisture Content	23.1%	Colloids	15.3%
Liquid Limit	53	Plastic Limit	33	Plastic Index	20

Description of Sand & Gravel Particles Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Mechanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 854: Specific Gravity of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: William C. Schwartz, Jr., P.E. _____ QC Manager
Signature Position

S&ME

Liquid Limit, Plastic Limit, and Plastic Index

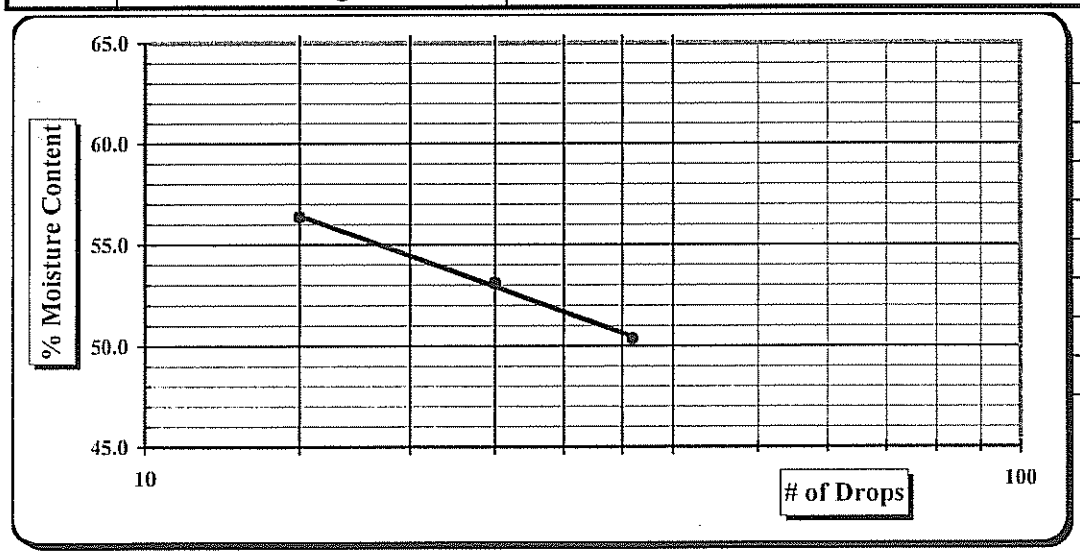
Project #:	**1411-07-103**	Report Date:	6/17/08
Project Name:	Marshall Steam Station	Test Date(s):	6/16/08
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #: M-20 Sample #: 181 Sample Date: 5/12/08

Location: Bulk Offset: N/A Elevation: 13.7-18.7'

Sample Description: Light brown orange clayey SILT with fine sand (MH)

Pan #		Liquid Limit						Plastic Limit		
	Test #	1	2	3	4	5	6	1	2	3
	Tare #	Q-1	Q-2	Q-3				3	4	
A	Tare Weight	16.80	16.77	15.75				**10.87**	10.82	
B	Wet Soil Weight + A	34.36	35.31	34.87				19.07	18.76	
C	Dry Soil Weight + A	28.48	28.88	27.98				17.02	16.79	
D	Water Weight (B-C)	5.88	6.43	6.89				2.05	1.97	
E	Dry Soil Weight (C-A)	11.68	12.11	12.23				6.15	5.97	
F	% Moisture Content (D/E)*100	50.3%	53.1%	56.3%				33.3%	33.0%	
N	# OF DROPS	36	25	15				*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average							33.2%		



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes:

Special Sampling Methods:

Sample Preparation:	Wet Preparation	☐	Dry Preparation	☒	Air Dried	☒	% Passing #200 Sieve: 79.3
Liquid limit Test:	Multipoint Method	☒	One-point Method	☐			NP, Non-Plastic ☐
Classification:	ASTM D 2487	☒	AASHTO M 145	☐			Liquid Limit 53
Liquid limit Test:	ASTM D 4318	☒	AASHTO T 89	☐			Plastic Limit 33
Plastic limit Test:	ASTM D 4318	☒	AASHTO T 90	☐			Plastic Index 20
							Group Symbol MH

Technician Name: M. Jacobs

Certification #

Technical Responsibility: Brian Vaughan, P.E. Signature QC Manager Position

Particle Size Analysis of Soils

ASTM D 422

S&ME

Project #:	**1411-07-103**
Project Name:	Marshall Steam Station
Client Name:	Duke Energy
Client Address:	Charlotte, NC

Test Date(s): 6/11 - 6/13/08
Report Date: 6/16/08

Boring #: M-21 Sample #: 181 Sample Date: 5/15/08
Location: Bulk Offset: N/A Elevation: 3.3-8.3'
Sample Description: Orange brown fine sandy silty CLAY (CL)

Pan #:	3	Beaker #:	3
Hydrometer Jar #:			3
Pan Tare Weight (grams):			0.00
Total Sample Air Dried Wt. + tare wt. (grams):			523.32
Weight of Total Sample Air Dried:			523.32
Weight of Air Dried Hydrometer Sample (g):			102.58
Total Sample Oven Dried:			512.22
Hydrometer Sample Oven Dried (W):			100.39
% Passing #10:			99.5%
Correction Factor a (Table 1):			1.00

Specific Gravity 2.650

	Moisture Content	Hygroscopic	Natural
	Tare #	Z-3	308
A	Tare Wt.	16.77	0.00
B	Wet Wt. + A	30.38	274.42
C	Dry Wt. + A	30.09	233.46
D	Water Wt. (B-C)	0.29	40.96
E	Dry Wt. (C-A)	13.32	233.46
	% Moisture (100 x D/E)	2.18%	17.5%

Sieve	Retained Wt.	Percent Passing	
3.0"	0.0	Pan # (washed) 53	100.0%
1.5"	0.0		100.0%
1.0"	0.0		100.0%
3/4"	0.0		100.0%
1/2"	0.0		100.0%
3/8"	0.0		100.0%
#4	1.3	Soil Mortar	99.7%
#10	2.4	**100.0%**	99.5%
#20	0.4	99.6%	99.2%
#40	2.1	97.9%	97.5%
#60	7.2	92.9%	92.4%
#100	15.9	84.1%	83.7%
#200	29.5	70.6%	70.2%

Notes: Description of Sand & Gravel Particles — Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:	4.75 mm	Total Sand:	29.5%	< 4.74 mm and > 0.075 mm	Type: Mechanical Stirring Apparatus (A)
% Gravel:	0.3%	< 75 mm and > 4.75 mm	Silt & Clay:	70.2%	< 0.075 — Dispersion Time: 1 min.
Coarse Sand:	0.2%	< 4.75 mm and > 2.00 mm	Silt:	34.7%	< 0.075 and > 0.005 mm — Sodium Hexametaphosphate: 40 g./ Liter
Medium Sand:	2.1%	< 2.00 mm and > 0.425 mm	Clay:	35.5%	< 0.005 mm
Fine Sand:	27.2%	< 0.425 mm and > 0.075 mm	Colloids:	22.6%	< 0.001 mm — **Control Cylinder** ☐ **Composite Correction** ☒

Liquid Limit **44** Plastic Limit **25** Plastic Index **19** Hydrometer: 151H ☐ 152H ☒

Time		Temp.	Hydrometer	Corrections		Hydrometer	Percent Passing		Effective Depth	Table 3	Diameter
Clock	T (Min.)	(0.5 °C)	Reading	Control Cylinder	Composite Correction	R	P(-#10) = (R x a / W) x 100	P (total) = P x % Passing #10	L	K	D = K x ((L/T)^1/2
	2	22.6	61.0		5.15	55.85	55.6%	55.4%	7.1	0.01325	0.02502
	5	22.6	56.5		5.15	51.35	51.1%	50.9%	7.9	0.01325	0.01662
	15	22.7	50.5		5.15	45.35	45.2%	45.0%	8.9	0.01325	0.01018
	30	22.9	46.0		5.10	40.90	40.7%	40.5%	9.6	0.01325	0.00749
	60	23.1	42.0		5.10	36.90	36.8%	36.6%	10.2	0.01317	0.00544
	250	23.3	35.5		5.05	30.45	30.3%	30.2%	11.3	0.01317	0.00280
	1440	23.3	29.0		5.05	23.95	23.9%	23.7%	12.4	0.01317	0.00122
	2880	23.5	27.5		5.05	22.45	22.4%	22.3%	12.6	0.01309	0.00087

References: ASTM D 422: Particle Size Analysis of Soils; ASTM D 421: Dry Preparation of Soil Samples; ASTM D 854: Specific Gravity of Soils; ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils; ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Effective Depth (cm)
L=L1+0.5(L2-(VB/A))
(152H) .164cm per increment,
V_B=67.0cm^3, L_2=14cm, A=27.8cm^2

Technician Name: M. Jacobs

Technical Responsibility: William C. Schwartz, Jr., P.E.

Certification #

Signature

QC Manager
Position

S&ME, INC. **155 Tradd Street Spartanburg, SC 29301**

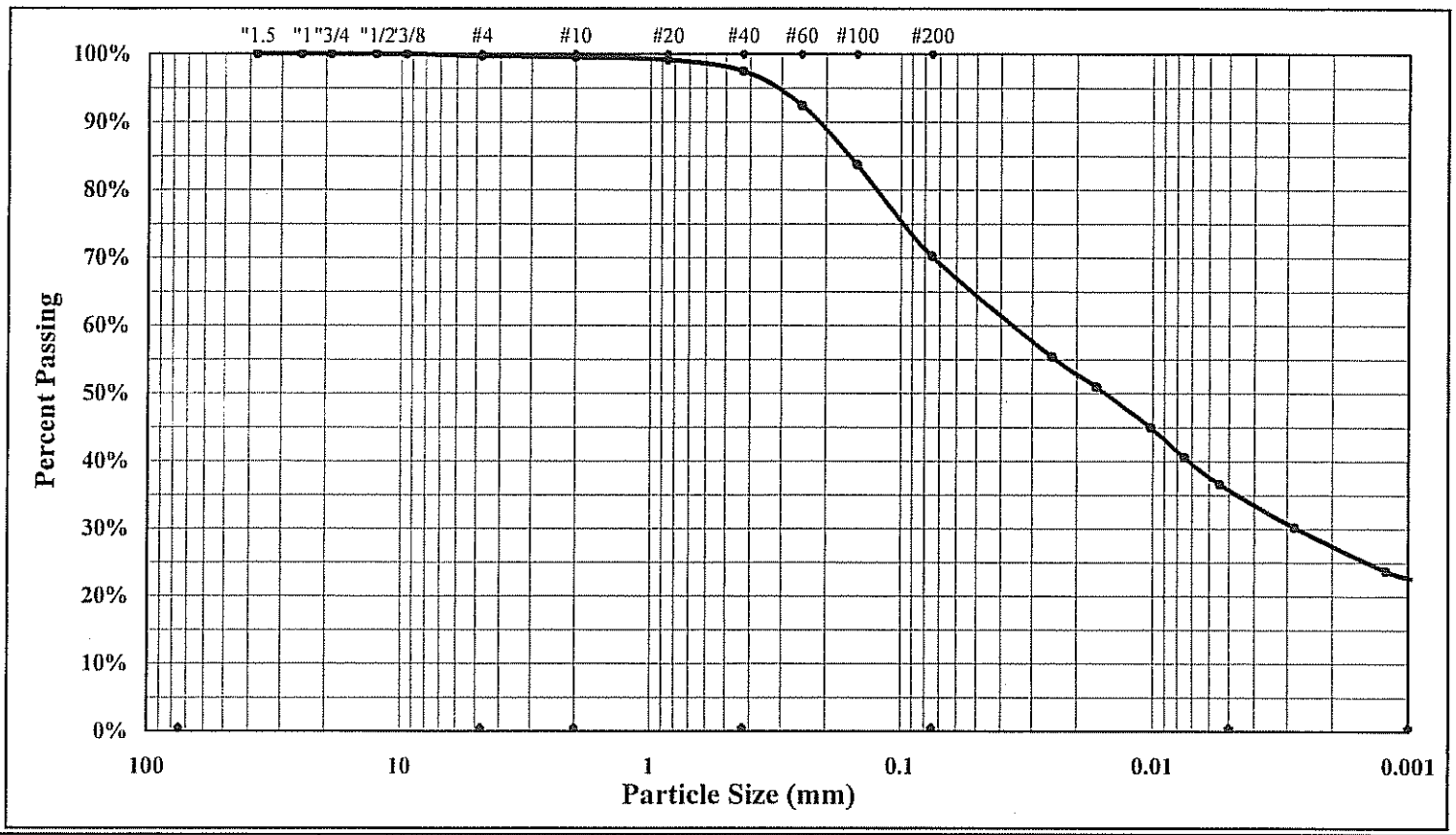
Hydrometer #181 (M-21, 3.3-8.3') 6-16-08.xls

Particle Size Analysis of Soils

ASTM D 422

S&ME Project #:	**1411-07-103**	Report Date:	6/16/08
Project Name:	**Marshall Steam Station**	Test Date(s):	6/11 - 6/13/08
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-21	Sample #:	181	Sample Date:	5/15/08
Location:	Bulk	Offset:	N/A	Elevation:	3.3-8.3'
Sample Description:	Orange brown fine sandy silty CLAY (CL)				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	4.75 mm	Gravel	0.3%	Silt	34.7%
Silt & Clay (% Passing #200)	70.2%	Sand	29.5%	Clay	35.5%
Specific Gravity	2.650	Moisture Content	17.5%	Colloids	22.6%
Liquid Limit	44	Plastic Limit	25	Plastic Index	19

Description of Sand & Gravel Particles Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Mechanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 854: Specific Gravity of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: William C. Schwartz, Jr., P.E. _____ QC Manager
Signature *Position*

Moisture - Density Relationship

S&ME

S&ME Project #:	**1411-07-103**	Test Date(s):	June 6, 2008
Project Name:	Marshall Steam Station	Report Date:	June 9, 2008
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-21	Sample #:	181	Sample Date:	May 15, 2008
Location:	Bulk	Offset:	N/A	Depth:	3.3-8.3'

Sample Description: Orange brown fine sandy silty CLAY (CL)

Liquid Limit:	44	Specific Gravity:	2.650
Plastic Limit:	25	Plastic Index:	19

Natural Moisture Content: 17.5%

Moisture Content of the Oversize Fraction:

NOTES:

Sieve Size	% Passing
#4	99.7
#10	99.5
#20	99.2
#40	97.5
#60	92.4
#100	83.7
#200	70.2

MDD: 106.5 **Opt. MC %:** 17.7

Water Content

Water Content requires GP 2 Balance (0.1 gram Readability).

ASTM D2216 ☒ AASHTO T265 ☐ ASTM D4959 ☐ ASTM D4643 ☐

	Sample #:	1	2	3	4	5	6
	Water Added:						
	Tare #:						
A. Tare Weight	A.	0	0	0	0	0	0
B. Wet Wt + Tare Wt	B.	500	500	500	500	500	500
C. Dry Wt. + Tare Wt.	C.	437.3	427.6	420	413.2		
D. Water Weight	B-C	62.7	72.4	80	86.8	500	500
E. Dry Weight	C-A	437.3	427.6	420	413.2	0	0
F. Moisture Content	100*D/E	**14.3%**	**16.9%**	**19.0%**	**21.0%**	**#DIV/0!**	**#DIV/0!**

Compaction Data

The Compaction Test requires a GP 5 Balance for ASTM (1 gram or .0022 Lb. readability).

G. Wt of Soil + Mold	G.	13.238	13.434	13.496	13.468		
H. Wt. of Mold	H.	9.304	9.304	9.304	9.304	9.304	9.304
I. Wt. of Soil (g. or lbs.)	G-H	3.934	4.130	4.192	4.164	-9.304	-9.304
J. Wt of Soil (Lbs.)	I/453.6 or I	3.934	4.130	4.192	4.164	-9.304	-9.304
K. Mold Volume Factor	K.	30.093	30.093	30.093	30.093	30.093	30.093
L. Wet Density	J*K	118.4	124.3	126.1	125.3	-280.0	-280.0
M. Dry Density	L/(1+F)	**103.5**	**106.3**	**106.0**	**103.6**	**#DIV/0!**	**#DIV/0!**

ASTM D558 ☐ ASTM D 698 ☒ ASTM D1557 ☐ AASHTO T99 ☐ AASHTO T180 ☐

Method A ☒ Method B ☐ Method C ☐ Method D (ASTM 1978) ☐ AASHTO Method D ☐

Moisture-Density Relation of: Fine Fraction ☒ Corrected for Coarse Fraction (ASTM D 4718) ☐

Sieve Size used to separate the Oversize Fraction: #4 Sieve ☒ 3/8 inch Sieve ☐ 3/4 inch Sieve ☐

Mechanical Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

Soil Plasticity:	ASTM D 4318 ☒	AASHTO T 89 ☐		AASHTO T 90 ☐
Sieve Analysis / Particle Size Analysis:	ASTM C136 ☐	AASHTO T 27 ☐	ASTM D 422 ☒	AASHTO T 88 ☐
Specific Gravity of Soil:		ASTM D 854 ☒		AASHTO T 100 ☐
Bulk Gravity of Oversize Fraction:		ASTM C 127 ☐		AASHTO T 85 ☐
Soil Classification:	ASTM D 2487 ☒	ASTM D 2488 ☐		AASHTO M 145 ☐

Technician Name: B. Hatton

Certification #

Technical Responsibility: Brian Vaughan, P.E. Signature Construction Services Manager Position

Moisture - Density Report

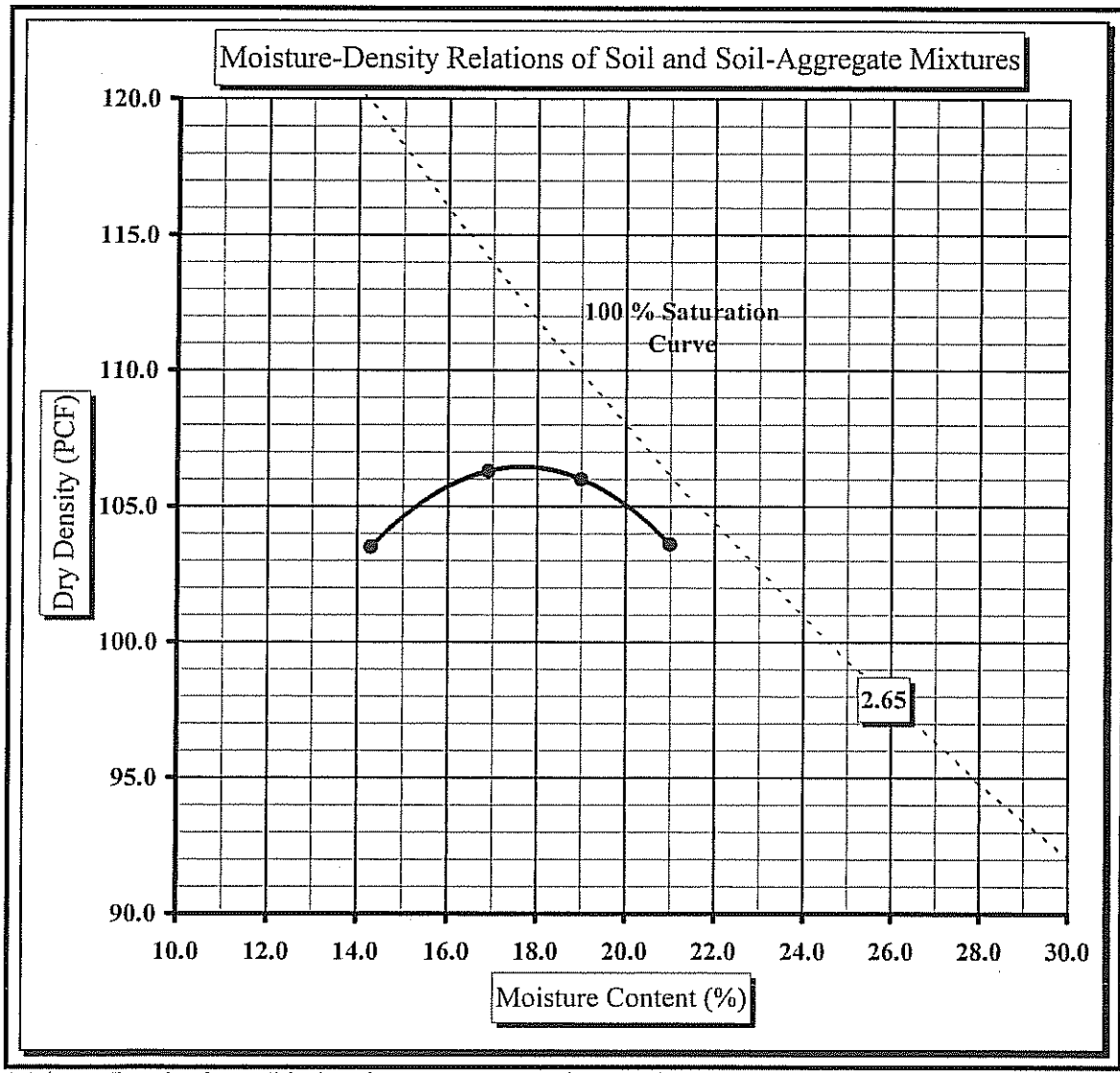
S&ME

S&ME Project #:	**1411-07-103**	Report Date:	June 9, 2008
Project Name:	**Marshall Steam Station**	Test Date(s):	June 6, 2008
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-21	Sample #:	181	Sample Date:	May 15, 2008
Location:	Bulk	Offset:	N/A	Depth:	3.3-8.3'
Sample Description:	Orange brown fine sandy silty CLAY (CL)				

Maximum Dry Density 106.5 PCF. **Optimum Moisture Content 17.7 %**

ASTM D 698 Method A



Soil Properties

Natural Moisture Content:	17.5%
Liquid Limit:	44
Plastic Limit:	25
Plastic Index:	19
Specific Gravity:	2.650

% Passing

#4	99.7
#10	99.5
#20	99.2
#40	97.5
#60	92.4
#100	83.7
#200	70.2

Oversize Fraction

Bulk Sp. Gravity
% Moisture
Oversize Fraction
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 Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

References: ASTM D 698: Laboratory Compaction Characteristics of Soil Using Standard Effort
ASTM D 2216: Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D 422: Particle Size Analysis of Soils ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. Construction Services Manager

Laboratory Record Version 4.2

S&ME

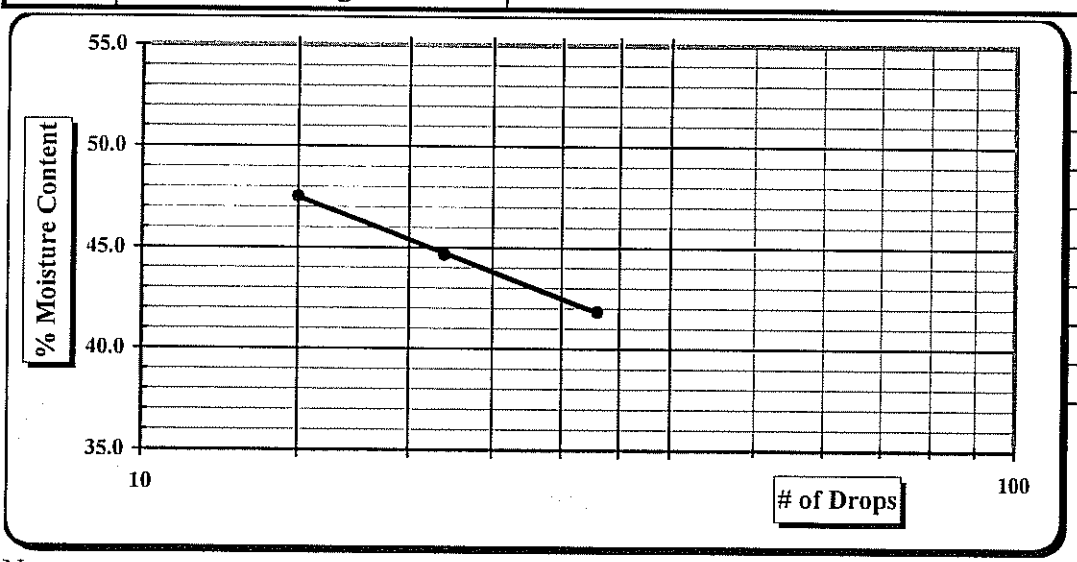
Liquid Limit, Plastic Limit, and Plastic Index

Project #:	**1411-07-103**	Report Date:	6/17/08
Project Name:	Marshall Steam Station	Test Date(s):	6/16/08
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-21	Sample #: 181		Sample Date:	5/15/08
Location:	Bulk	Offset: N/A		Elevation:	3.3-8.3'

Sample Description: Orange brown fine sandy silty CLAY (CL)

Pan #		Liquid Limit						Plastic Limit		
	Test #	1	2	3	4	5	6	1	2	3
	Tare #	Y-1	Y-2	Y-3				5	6	
A	Tare Weight	16.52	16.56	17.00				**10.95**	10.93	
B	Wet Soil Weight + A	38.46	38.04	37.46				20.40	19.62	
C	Dry Soil Weight + A	31.99	31.41	30.87				18.51	17.90	
D	Water Weight (B-C)	6.47	6.63	6.59				1.89	1.72	
E	Dry Soil Weight (C-A)	15.47	14.85	13.87				7.56	6.97	
F	% Moisture Content (D/E)*100	41.8%	44.6%	47.5%				25.0%	24.7%	
N	# OF DROPS	33	22	15				*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average							24.8%		



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes:

Special Sampling Methods:

Sample Preparation:	Wet Preparation	☐	Dry Preparation	☒	Air Dried	☒	% Passing #200 Sieve: 70.2
Liquid limit Test:	Multipoint Method	☒	One-point Method	☐			NP, Non-Plastic ☐
Classification:	ASTM D 2487	☒	AASHTO M 145	☐			Liquid Limit 44
Liquid limit Test:	ASTM D 4318	☒	AASHTO T 89	☐			Plastic Limit 25
Plastic limit Test:	ASTM D 4318	☒	AASHTO T 90	☐			Plastic Index 19
							Group Symbol CL

Technician Name: M. Jacobs

Certification #

Technical Responsibility: Brian Vaughan, P.E.

Signature

QC Manager

Position

Particle Size Analysis of Soils

ASTM D 422

S&ME

Project #: **1411-07-103**
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Charlotte, NC

Test Date(s): 6/11 - 6/13/08
Report Date: 6/16/08

Boring #: M-23 Sample #: 181 Sample Date: 5/14/08
Location: Bulk Offset: N/A Elevation: 3.8-11.8'
Sample Description: Tan olive gray silty clayey fine SAND (SC)

Pan #:	4	Beaker #:	4
Hydrometer Jar #:			4
Pan Tare Weight (grams):			0.00
Total Sample Air Dried Wt. + tare wt. (grams):			565.28
Weight of Total Sample Air Dried:			565.28
Weight of Air Dried Hydrometer Sample (g):			102.66
Total Sample Oven Dried:			559.53
Hydrometer Sample Oven Dried (W):			101.58
% Passing #10:			96.3%
Correction Factor a (Table 1):			1.00

Specific Gravity 2.650

	Moisture Content	Hygroscopic	Natural
	Tare #	Z-4	323
A	Tare Wt.	15.80	0.00
B	Wet Wt. + A	29.06	296.84
C	Dry Wt. + A	28.92	259.35
D	Water Wt. (B-C)	0.14	37.49
E	Dry Wt. (C-A)	13.12	259.35
	% Moisture (100 x D/E)	1.07%	14.5%

Sieve	Retained Wt.	Percent Passing	
3.0"	0.0	Pan # (washed)	100.0%
1.5"	0.0		100.0%
1.0"	0.0		100.0%
3/4"	0.0	55	100.0%
1/2"	0.0		100.0%
3/8"	0.0		100.0%
#4	6.8	Soil Mortar	98.8%
#10	20.4	**100.0%**	96.3%
#20	2.6	97.4%	93.9%
#40	8.2	91.9%	88.6%
#60	17.4	82.8%	79.8%
#100	32.4	68.1%	65.6%
#200	53.3	47.5%	45.8%

Notes: Description of Sand & Gravel Particles — Rounded ☐ Angular ☒ — Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:	4.75 mm	Total Sand:	53.0%	< 4.74 mm and > 0.075 mm	Type: Mechanical Stirring Apparatus (A)
% Gravel:	1.2%	< 75 mm and > 4.75 mm	Silt & Clay:	45.8%	< 0.075 — Dispersion Time: 1 min.
Coarse Sand:	2.4%	< 4.75 mm and > 2.00 mm	Silt:	22.1%	< 0.075 and > 0.005 mm — Sodium Hexametaphosphate: 40 g./ Liter
Medium Sand:	7.8%	< 2.00 mm and > 0.425 mm	Clay:	23.7%	< 0.005 mm
Fine Sand:	42.8%	< 0.425 mm and > 0.075 mm	Colloids:	14.4%	< 0.001 mm — **Control Cylinder** ☐ **Composite Correction** ☒

Liquid Limit **24** Plastic Limit **13** Plastic Index **11** Hydrometer: 151H ☐ 152H ☒

Time		Temp.	Hydrometer	Corrections		Hydrometer	Percent Passing		Effective Depth	Table 3	Diameter
Clock	T (Min.)	(0.5 °C)	Reading	Control Cylinder	Composite Correction	R	P(-#10) = (R x a / W) x 100	P (total) = P x % Passing #10	L	K	D = K x ((L/T)^1/2
	2	22.4	42.0		5.15	36.85	36.3%	35.0%	10.3	0.01332	0.03016
	5	22.4	39.0		5.15	33.85	33.3%	32.1%	10.7	0.01332	0.01953
	15	22.6	36.0		5.15	30.85	30.4%	29.3%	11.2	0.01325	0.01146
	30	22.8	33.5		5.10	28.40	28.0%	26.9%	11.6	0.01325	0.00825
	60	23.0	31.0		5.10	25.90	25.5%	24.6%	12.0	0.01317	0.00590
	250	23.3	27.0		5.05	21.95	21.6%	20.8%	12.7	0.01317	0.00297
	1440	23.2	22.0		5.10	16.90	16.6%	16.0%	13.5	0.01317	0.00128
	2880	23.5	20.0		5.05	14.95	14.7%	14.2%	13.8	0.01309	0.00091

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Effective Depth (cm)
L=L1+0.5(L2-(VB/A))
(152H) .164cm per increment,
V_B=67.0cm^3, L_2=14cm, A=27.8cm^2

Technician Name: M. Jacobs

Technical Responsibility: William C. Schwartz, Jr., P.E.

Certification #

Signature

QC Manager
Position

S&ME, INC. **155 Tradd Street Spartanburg, SC 29301**

Hydrometer #181 (M-23, 3.8-11.8') 6-16-08.xls

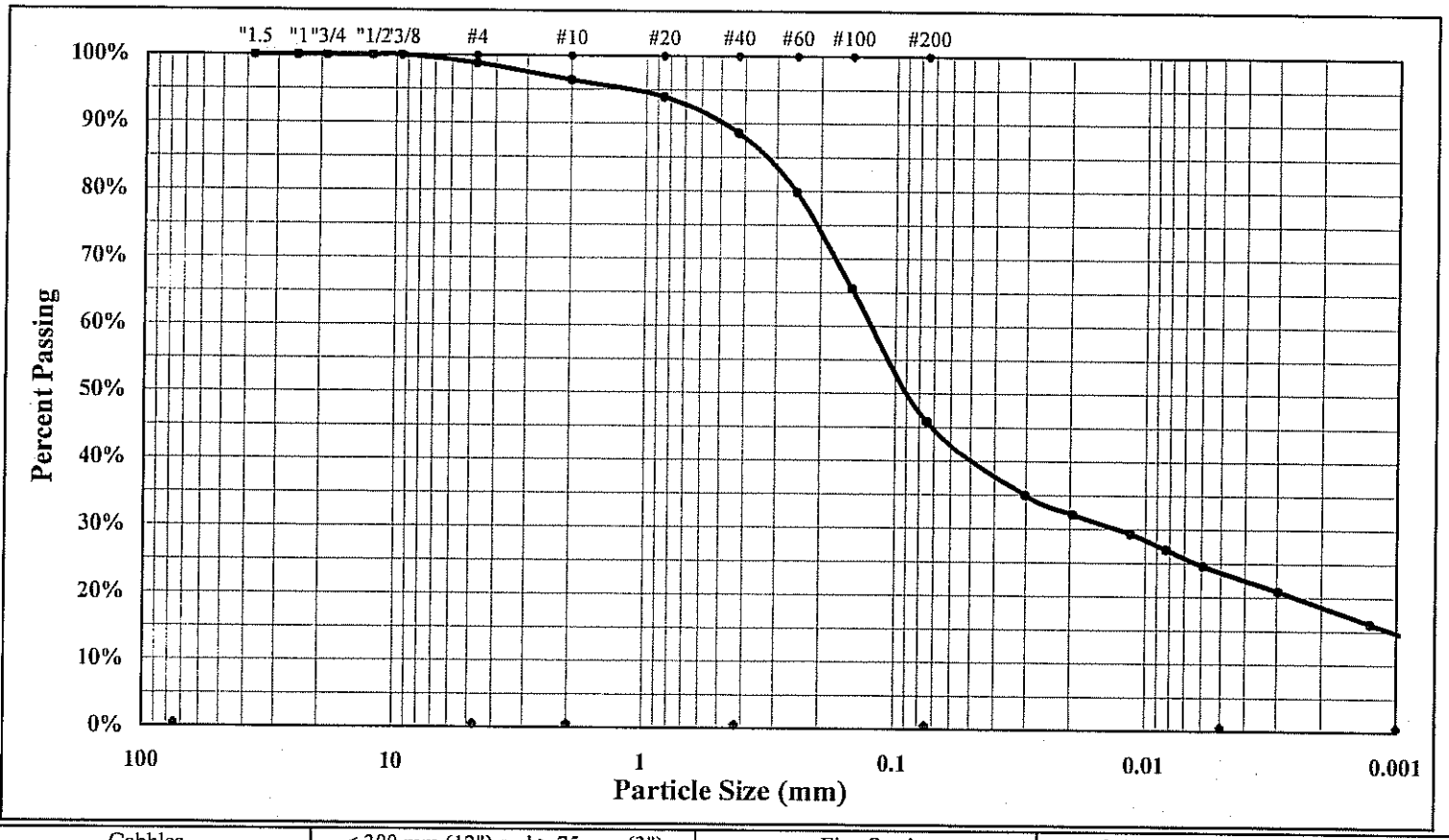
Particle Size Analysis of Soils

ASTM D 422

S&ME

S&ME Project #:	**1411-07-103**	Report Date:	6/16/08
Project Name:	**Marshall Steam Station**	Test Date(s):	6/11 - 6/13/08
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-23	Sample #:	181	Sample Date:	5/14/08
Location:	Bulk	Offset:	N/A	Elevation:	3.8-11.8'
Sample Description:	Tan olive gray silty clayey fine SAND (SC)				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	4.75 mm	Gravel	1.2%	Silt	22.1%
Silt & Clay (% Passing #200)	45.8%	Sand	53.0%	Clay	23.7%
Specific Gravity	2.650	Moisture Content	14.5%	Colloids	14.4%
Liquid Limit	24	Plastic Limit	13	Plastic Index	11

escription of Sand & Gravel Particles Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

echanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

eferences: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples
TM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 854: Specific Gravity of Soils
TM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

echnical Responsibility: William C. Schwartz, Jr., P.E. _____ QC Manager
Signature Position

Moisture - Density Relationship

S&ME

S&ME Project #:	**1411-07-103**	Test Date(s):	June 6, 2008
Project Name:	Marshall Steam Station	Report Date:	June 9, 2008
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-23	Sample #:	181	Sample Date:	May 14, 2008
Location:	Bulk	Offset:	N/A	Depth:	3.8-11.8'

Sample Description: Tan olive gray silty clayey fine SAND (SC)

Liquid Limit:	24	Specific Gravity:	2.650
Plastic Limit:	13	Plastic Index:	11

Natural Moisture Content: 14.5%

Moisture Content of the Oversize Fraction:

NOTES:

Sieve Size	% Passing
#4	98.8
#10	96.3
#20	93.9
#40	88.6
#60	79.8
#100	65.6
#200	45.8

MDD: 121.7 **Opt. MC %: 10.8**

Water Content

Water Content requires GP 2 Balance (0.1 gram Readability).

ASTM D2216 ☒ AASHTO T265 ☐ ASTM D4959 ☐ ASTM D4643 ☐

	Sample #:	1	2	3	4	5	6
	Water Added:						
	Tare #:						
A. Tare Weight	A.	0	0	0	0	0	0
B. Wet Wt + Tare Wt	B.	500	500	500	500	500	500
C. Dry Wt. + Tare Wt.	C.	466.5	458.4	450.3	442.8		
D. Water Weight	B-C	33.5	41.6	49.7	57.2	500	500
E. Dry Weight	C-A	466.5	458.4	450.3	442.8	0	0
F. Moisture Content	100*D/E	**7.2%**	**9.1%**	**11.0%**	**12.9%**	**#DIV/0!**	**#DIV/0!**

Compaction Data

The Compaction Test requires a GP 5 Balance for ASTM (1 gram or .0022 Lb. readability).

G. Wt of Soil + Mold	G.	13.414	13.656	13.794	13.764		
H. Wt. of Mold	H.	9.304	9.304	9.304	9.304	9.304	9.304
I. Wt. of Soil (g. or lbs.)	G-H	4.110	4.352	4.490	4.460	-9.304	-9.304
J. Wt of Soil (Lbs.)	I/453.6 or I	4.110	4.352	4.490	4.460	-9.304	-9.304
K. Mold Volume Factor	K.	30.093	30.093	30.093	30.093	30.093	30.093
L. Wet Density	J*K	123.7	131.0	135.1	134.2	-280.0	-280.0
M. Dry Density	L/(1+F)	**115.4**	**120.1**	**121.7**	**118.9**	**#DIV/0!**	**#DIV/0!**

ASTM D558 ☐ ASTM D 698 ☒ ASTM D1557 ☐ AASHTO T99 ☐ AASHTO T180 ☐

Method A ☒ Method B ☐ Method C ☐ Method D (ASTM 1978) ☐ AASHTO Method D ☐

Moisture-Density Relation of: Fine Fraction ☒ Corrected for Coarse Fraction (ASTM D 4718) ☐

Sieve Size used to separate the Oversize Fraction: #4 Sieve ☒ 3/8 inch Sieve ☐ 3/4 inch Sieve ☐

Mechanical Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

Soil Plasticity:	ASTM D 4318 ☒	AASHTO T 89 ☐		AASHTO T 90 ☐
Sieve Analysis / Particle Size Analysis:	ASTM C136 ☐	AASHTO T 27 ☐	ASTM D 422 ☒	AASHTO T 88 ☐
Specific Gravity of Soil:		ASTM D 854 ☒		AASHTO T 100 ☐
Bulk Gravity of Oversize Fraction:		ASTM C 127 ☐		AASHTO T 85 ☐
Soil Classification:	ASTM D 2487 ☒	ASTM D 2488 ☐		AASHTO M 145 ☐

Technician Name: B. Hatton

Certification #

Technical Responsibility: Brian Vaughan, P.E. Signature Construction Services Manager Position

Laboratory Report Version 4.2

Moisture - Density Report

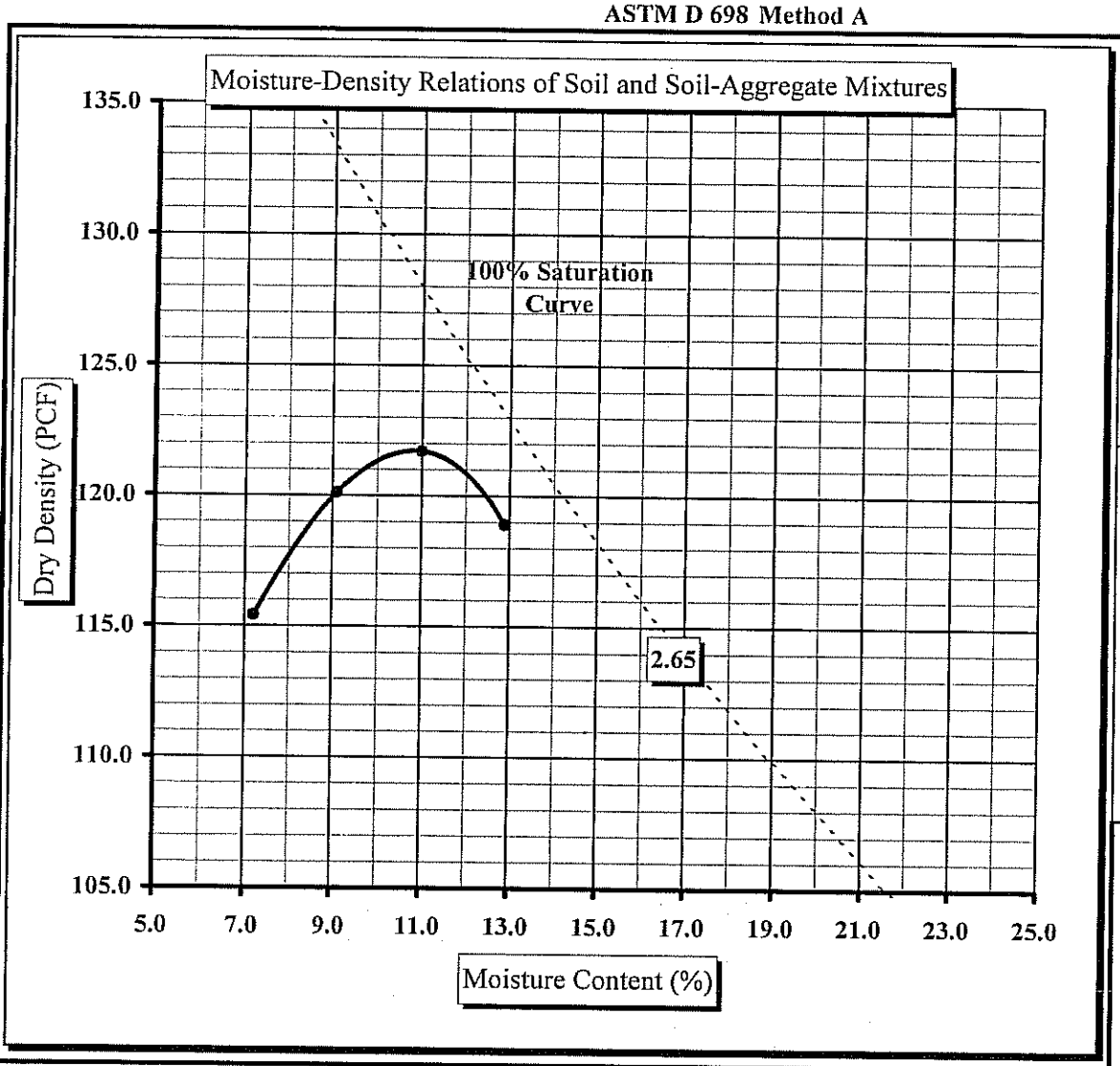
S&ME

S&ME Project #:	**1411-07-103**	Report Date:	June 9, 2008
Project Name:	**Marshall Steam Station**	Test Date(s):	June 6, 2008
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-23	Sample #:	181	Sample Date:	May 14, 2008
Location:	Bulk	Offset:	N/A	Depth:	3.8-11.8'
Sample Description:	Tan olive gray silty clayey fine SAND (SC)				

Maximum Dry Density **121.7** **PCF.** **Optimum Moisture Content** **10.8** **%**

ASTM D 698 Method A



Soil Properties

Natural Moisture Content:	14.5%
Liquid Limit:	24
Plastic Limit:	13
Plastic Index:	11
Specific Gravity:	2.650

% Passing

#4	98.8
#10	96.3
#20	93.9
#40	88.6
#60	79.8
#100	65.6
#200	45.8

Oversize Fraction

Bulk Sp. Gravity
% Moisture
Oversize Fraction
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 Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

References: ASTM D 698: Laboratory Compaction Characteristics of Soil Using Standard Effort
ASTM D 2216: Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D 422: Particle Size Analysis of Soils
ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. Construction Services Manager
Position

S&ME

Liquid Limit, Plastic Limit, and Plastic Index

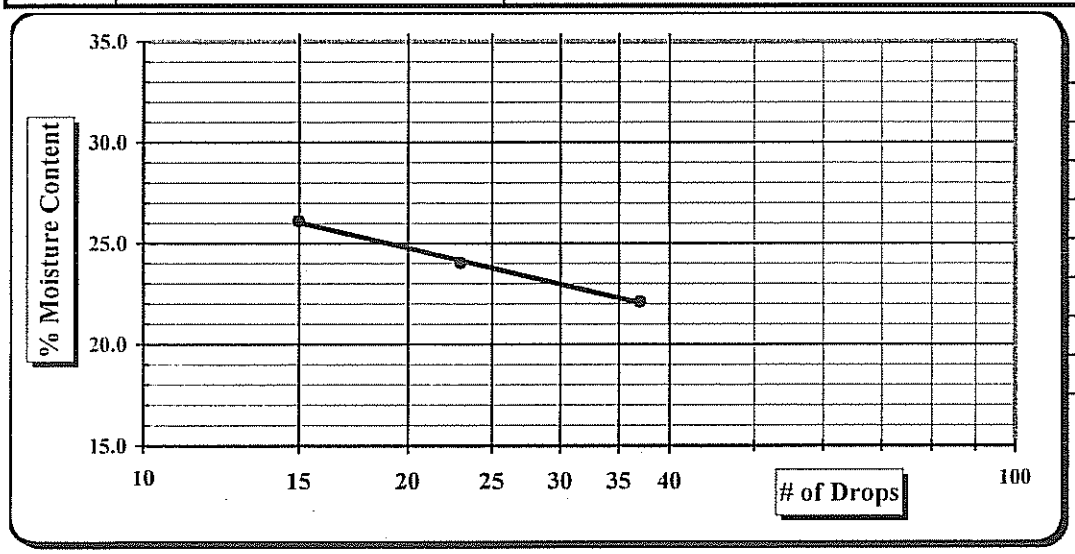
Project #:	**1411-07-103**	Report Date:	6/17/08
Project Name:	Marshall Steam Station	Test Date(s):	6/16/08
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #: M-23 Sample #: 181 Sample Date: 5/14/08

Location: Bulk Offset: N/A Elevation: 3.8-11.8'

Sample Description: Tan olive gray silty clayey fine SAND (SC)

Pan #		Liquid Limit						Plastic Limit		
	Test #	1	2	3	4	5	6	1	2	3
	Tare #	Z-1	Z-2	Z-3				13	14	
A	Tare Weight	15.99	16.71	16.77				**12.10**	12.15	
B	Wet Soil Weight + A	37.82	38.91	38.13				20.76	20.22	
C	Dry Soil Weight + A	33.87	34.61	33.71				19.77	19.31	
D	Water Weight (B-C)	3.95	4.30	4.42				0.99	0.91	
E	Dry Soil Weight (C-A)	17.88	17.90	16.94				7.67	7.16	
F	% Moisture Content (D/E)*100	22.1%	24.0%	26.1%				12.9%	12.7%	
N	# OF DROPS	37	23	15				*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average							12.8%		



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes:

Special Sampling Methods:

Sample Preparation:	Wet Preparation	☐	Dry Preparation	☒	Air Dried	☒	% Passing #200 Sieve: 45.8
Liquid limit Test:	Multipoint Method	☒	One-point Method	☐			NP, Non-Plastic ☐
Classification:	ASTM D 2487	☒	AASHTO M 145	☐			Liquid Limit 24
Liquid limit Test:	ASTM D 4318	☒	AASHTO T 89	☐			Plastic Limit 13
Plastic limit Test:	ASTM D 4318	☒	AASHTO T 90	☐			Plastic Index 11
							Group Symbol SC

Technician Name: M. Jacobs

Certification #

Technical Responsibility: Brian Vaughan, P.E. Signature QC Manager Position

Particle Size Analysis of Soils

ASTM D 422

S&ME

Project #: **1411-07-103**
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Charlotte, NC

Test Date(s): 5/28 - 5/30/08
Report Date: 6/2/08

Boring #: M-24 Sample #: 146 Sample Date: 5/6/08
Location: Bulk Offset: N/A Elevation: 15-20'
Sample Description: Light brown red fine sandy silty CLAY (CL)

Pan #:	4	Beaker #:	4
Hydrometer Jar #:			4
Pan Tare Weight (grams):			0.00
Total Sample Air Dried Wt. + tare wt. (grams):			488.69
Weight of Total Sample Air Dried:			488.69
Weight of Air Dried Hydrometer Sample (g):			103.82
Total Sample Oven Dried:			484.86
Hydrometer Sample Oven Dried (W):			102.96
% Passing #10:			94.7%
Correction Factor a (Table 1):			1.00

Specific Gravity 2.650

	Moisture Content	Hygroscopic	Natural
	Tare #	Z-4	303
A	Tare Wt.	15.80	0.00
B	Wet Wt. + A	29.08	265.99
C	Dry Wt. + A	28.97	223.97
D	Water Wt. (B-C)	0.11	42.02
E	Dry Wt. (C-A)	13.17	223.97
	% Moisture (100 x D/E)	0.84%	18.8%

Sieve	Retained Wt.	Percent Passing	
3.0"	0.0	Pan # (washed)	100.0%
1.5"	0.0		100.0%
1.0"	0.0		100.0%
3/4"	0.0	55	100.0%
1/2"	0.0		100.0%
3/8"	3.1		99.4%
#4	13.9	Soil Mortar	97.1%
#10	25.9	**100.0%**	94.7%
#20	2.5	97.6%	92.4%
#40	7.6	92.7%	87.7%
#60	15.2	85.3%	80.7%
#100	29.3	71.5%	67.7%
#200	46.6	54.7%	51.8%

Notes: Description of Sand & Gravel Particles Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:	9.50 mm		Total Sand:	45.3%	< 4.74 mm and > 0.075 mm
% Gravel:	2.9%	< 75 mm and > 4.75 mm	Silt & Clay:	51.8%	< 0.075
Coarse Sand:	2.5%	< 4.75 mm and > 2.00 mm	Silt:	32.8%	< 0.075 and > 0.005 mm
Medium Sand:	7.0%	< 2.00 mm and > 0.425 mm	Clay:	19.0%	< 0.005 mm
Fine Sand:	35.9%	< 0.425 mm and > 0.075 mm	Colloids:	8.4%	< 0.001 mm

Type: Mechanical Stirring Apparatus (A)
Dispersion Time: 1 min.
Sodium Hexametaphosphate: 40 g./ Liter

Control Cylinder ☐ **Composite Correction** ☒

Liquid Limit **32** Plastic Limit **23** Plastic Index **9** Hydrometer: 151H ☐ 152H ☒

Time		Temp.	Hydrometer	Corrections		Hydrometer	Percent Passing		Effective Depth	Table 3	Diameter
Clock	T (Min.)	(0.5 °C)	Reading	Control Cylinder	Composite Correction	R	P(-#10) = (R x a / W) x 100	P (total) = P x % Passing #10	L	K	D = K x ((L/T)^1/2
	2	23.9	47.5		5.00	42.50	41.3%	39.1%	9.3	0.01309	0.02826
	5	23.9	42.5		5.00	37.50	36.4%	34.5%	10.1	0.01309	0.01865
	15	23.9	36.5		5.00	31.50	30.6%	29.0%	11.1	0.01309	0.01128
	30	23.8	32.5		5.00	27.50	26.7%	25.3%	11.8	0.01309	0.00820
	60	23.8	28.0		5.00	23.00	22.3%	21.1%	12.5	0.01309	0.00598
	250	23.5	20.5		5.05	15.45	15.0%	14.2%	13.8	0.01309	0.00307
	1440	23.8	15.5		5.00	10.50	10.2%	9.7%	14.6	0.01309	0.00132
	2880	23.9	14.0		5.00	9.00	8.7%	8.3%	14.8	0.01309	0.00094

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Effective Depth (cm)
$L=L1+0.5(L2-(VB/A))$
(152H) .164cm per increment,
$V_B=67.0cm^3$, $L_2=14cm$, $A=27.8cm^2$

Technician Name: M. Jacobs

Technical Responsibility: Brian Vaughan, P.E.

Certification #

Signature

QC Manager
Position

S&ME, INC.
155 Tradd Street Spartanburg, SC 29301

Hydrometer #146 (M-24, 15-20') 6-2-08.xls

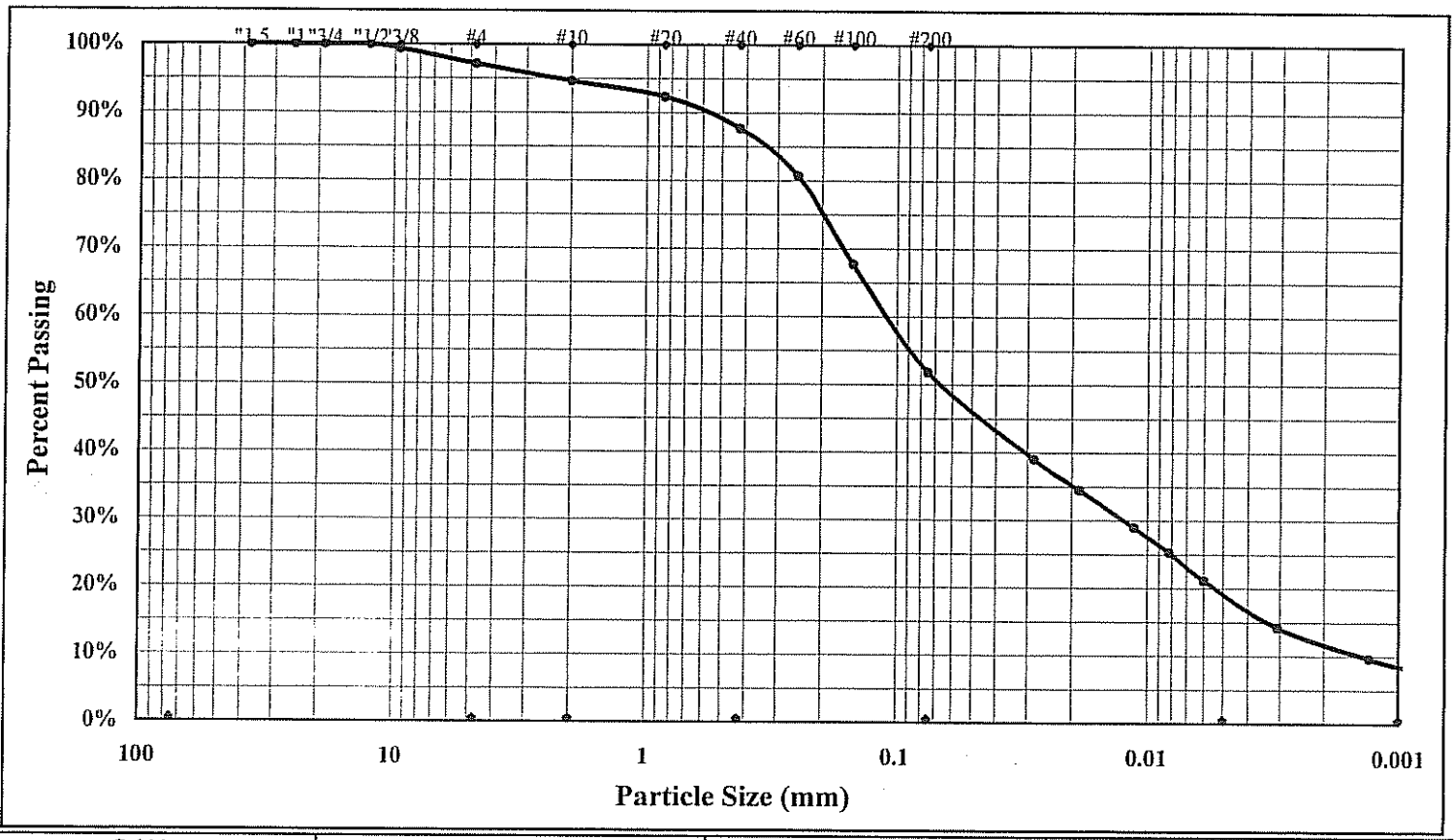
Particle Size Analysis of Soils

S&ME

ASTM D 422

S&ME Project #:	**1411-07-103**	Report Date:	6/2/08
Project Name:	**Marshall Steam Station**	Test Date(s):	5/28 - 5/30/08
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-24	Sample #:	146	Sample Date:	5/6/08
Location:	Bulk	Offset:	N/A	Elevation:	15-20'
Sample Description:	Light brown red fine sandy silty CLAY (CL)				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	9.50 mm	Gravel	2.9%	Silt	32.8%
Silt & Clay (% Passing #200)	51.8%	Sand	45.3%	Clay	19.0%
Specific Gravity	2.650	Moisture Content	18.8%	Colloids	8.4%
Liquid Limit	32	Plastic Limit	23	Plastic Index	9

Description of Sand & Gravel Particles Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Mechanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

References: ASTM D 422: Particle Size Analysis of Soils; ASTM D 421: Dry Preparation of Soil Samples; ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils; ASTM D 854: Specific Gravity of Soils; ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. _____ (Signature) QC Manager (Position)

Moisture - Density Relationship

S&ME

S&ME Project #:	**1411-07-103**	Test Date(s):	May 15, 2008
Project Name:	Marshall Steam Station	Report Date:	May 16, 2008
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-24	Sample #:	146	Sample Date:	May 6, 2008
Location:	Bulk	Offset:	N/A	Depth:	15-20'

Sample Description: Light brown red fine sandy silty CLAY (CL)

Liquid Limit:	32	Specific Gravity:	2.650
Plastic Limit:	23	Plastic Index:	9

Natural Moisture Content: 18.8%

Moisture Content of the Oversize Fraction:

NOTES:

Sieve Size	% Passing
3/8"	99.4
#4	97.1
#10	94.7
#20	92.4
#40	87.7
#60	80.7
#100	67.7
#200	51.8

MDD: 113.6 **Opt. MC %: 14.8**

Water Content

Water Content requires GP 2 Balance (0.1 gram Readability).

ASTM D2216 ☒ AASHTO T265 ☐ ASTM D4959 ☐ ASTM D4643 ☐

	Sample #:	1	2	3	4	5	6
	Water Added:						
	Tare #:						
A. Tare Weight	A.	0	0	0	0	0	0
B. Wet Wt + Tare Wt	B.	500	500	500	500	500	500
C. Dry Wt. + Tare Wt.	C.	452	443.8	436.5	429		
D. Water Weight	B-C	48	56.2	63.5	71	500	500
E. Dry Weight	C-A	452	443.8	436.5	429	0	0
F. Moisture Content	100*D/E	**10.6%**	**12.7%**	**14.5%**	**16.6%**	**#DIV/0!**	**#DIV/0!**

Compaction Data

The Compaction Test requires a GP 5 Balance for ASTM (1 gram or .0022 Lb. readability).

G. Wt of Soil + Mold	G.	13.370	13.506	13.626	13.630		
H. Wt. of Mold	H.	9.304	9.304	9.304	9.304	9.304	9.304
I. Wt. of Soil (g. or lbs.)	G-H	4.066	4.202	4.322	4.326	-9.304	-9.304
J. Wt of Soil (Lbs.)	I/453.6 or I	4.066	4.202	4.322	4.326	-9.304	-9.304
K. Mold Volume Factor	K.	30.093	30.093	30.093	30.093	30.093	30.093
L. Wet Density	J*K	122.4	126.5	130.1	130.2	-280.0	-280.0
M. Dry Density	L/(1+F)	**110.6**	**112.2**	**113.5**	**111.7**	**#DIV/0!**	**#DIV/0!**

ASTM D558 ☐ ASTM D 698 ☒ ASTM D1557 ☐ AASHTO T99 ☐ AASHTO T180 ☐

Method A ☒ Method B ☐ Method C ☐ Method D (ASTM 1978) ☐ AASHTO Method D ☐

Moisture-Density Relation of: Fine Fraction ☒ Corrected for Coarse Fraction (ASTM D 4718) ☐

Sieve Size used to separate the Oversize Fraction: #4 Sieve ☒ 3/8 inch Sieve ☐ 3/4 inch Sieve ☐

Mechanical Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

Soil Plasticity: ASTM D 4318 ☒ AASHTO T 89 ☐ AASHTO T 90 ☐

Sieve Analysis / Particle Size Analysis: ASTM C136 ☐ AASHTO T 27 ☐ ASTM D 422 ☒ AASHTO T 88 ☐

Specific Gravity of Soil: ASTM D 854 ☒ AASHTO T 100 ☐

Bulk Gravity of Oversize Fraction: ASTM C 127 ☐ AASHTO T 85 ☐

Soil Classification: ASTM D 2487 ☒ ASTM D 2488 ☐ AASHTO M 145 ☐

Technician Name: B. Hatton

Certification #

Technical Responsibility: Brian Vaughan, P.E. Signature Construction Services Manager Position

Moisture - Density Report

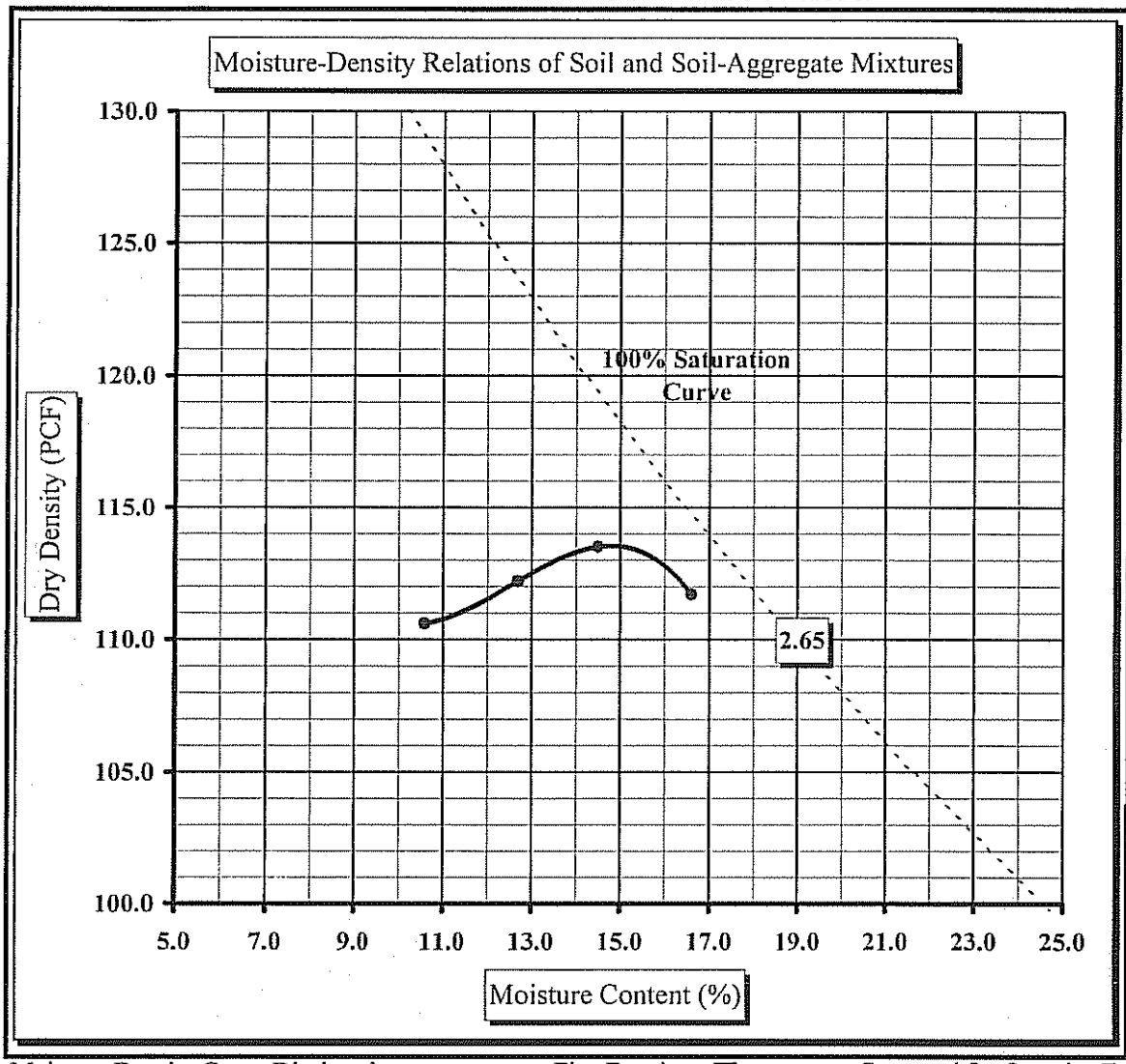
S&ME

S&ME Project #:	**1411-07-103**	Report Date:	May 16, 2008
Project Name:	**Marshall Steam Station**	Test Date(s):	May 15, 2008
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-24	Sample #:	146	Sample Date:	May 6, 2008
Location:	Bulk	Offset:	N/A	Depth:	15-20'
Sample Description:	Light brown red fine sandy silty CLAY (CL)				

Maximum Dry Density 113.6 PCF. **Optimum Moisture Content 14.8 %**

ASTM D 698 Method A



Soil Properties

Natural Moisture Content:	18.8%
Liquid Limit:	32
Plastic Limit:	23
Plastic Index:	9
Specific Gravity:	2.650

% Passing	
3/8"	99.4
#4	97.1
#10	94.7
#20	92.4
#40	87.7
#60	80.7
#100	67.7
#200	51.8

Oversize Fraction

Bulk Sp. Gravity
% Moisture
Oversize Fraction
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 Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

References: ASTM D 698: Laboratory Compaction Characteristics of Soil Using Standard Effort
ASTM D 2216: Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D 422: Particle Size Analysis of Soils ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. Construction Services Manager
Position

Laboratory Record Version 4.2

S&ME

Liquid Limit, Plastic Limit, and Plastic Index

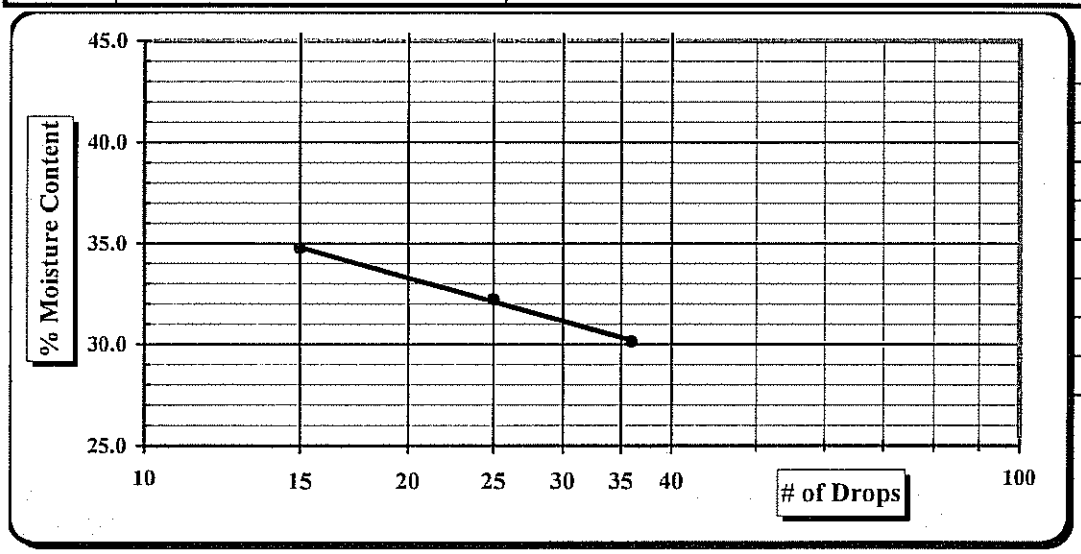
Project #:	**1411-07-103**	Report Date:	5/30/08
Project Name:	Marshall Steam Station	Test Date(s):	5/29/08
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #: M-24 Sample #: 146 Sample Date: 5/6/08

Location: Bulk Offset: N/A Elevation: 15-20'

Sample Description: Light brown red fine sandy silty CLAY (CL)

Pan #		Liquid Limit						Plastic Limit		
	Test #	1	2	3	4	5	6	1	2	3
	Tare #	Y-1	Y-2	Y-3				5	6	
A	Tare Weight	16.51	16.56	17.00				**10.93**	10.93	
B	Wet Soil Weight + A	39.79	39.92	39.22				18.58	18.72	
C	Dry Soil Weight + A	34.40	34.23	33.49				17.15	17.28	
D	Water Weight (B-C)	5.39	5.69	5.73				1.43	1.45	
E	Dry Soil Weight (C-A)	17.89	17.67	16.49				6.22	6.35	
F	% Moisture Content (D/E)*100	30.1%	32.2%	34.7%				23.0%	22.8%	
N	# OF DROPS	36	25	15				*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average							22.9%		



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes:

Special Sampling Methods:

Sample Preparation:	Wet Preparation	☐	Dry Preparation	☒	Air Dried	☒	% Passing #200 Sieve: 51.8
Liquid limit Test:	Multipoint Method	☒	One-point Method	☐			NP, Non-Plastic ☐
Classification:	ASTM D 2487	☒	AASHTO M 145	☐			Liquid Limit 32
Liquid limit Test:	ASTM D 4318	☒	AASHTO T 89	☐			Plastic Limit 23
Plastic limit Test:	ASTM D 4318	☒	AASHTO T 90	☐			Plastic Index 9
							Group Symbol CL

Technician Name: M. Jacobs

Certification #

Technical Responsibility: Brian Vaughan, P.E.

Signature

QC Manager

Position

Particle Size Analysis of Soils

ASTM D 422

S&ME

Project #: **1411-07-103**
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Charlotte, NC

Test Date(s): 5/28 - 5/30/08
Report Date: 6/2/08

Boring #: M-25 Sample #: 146 Sample Date: 5/6/08
Location: Bulk Offset: N/A Elevation: 0-5'
Sample Description: Red brown fine sandy silty CLAY (CH)

Pan #:	8	Beaker #:	5			Specific Gravity	2.650		
Hydrometer Jar #:			5						
Pan Tare Weight (grams):			0.00		Moisture Content	Hygroscopic	Natural		
Total Sample Air Dried Wt. + tare wt. (grams):			458.87		Tare #	Z-5	304		
Weight of Total Sample Air Dried:			458.87	A	Tare Wt.	15.62	0.00		
Weight of Air Dried Hydrometer Sample (g):			52.29	B	Wet Wt. + A	28.97	259.82		
Total Sample Oven Dried:			451.47	C	Dry Wt. + A	28.75	208.58		
Hydrometer Sample Oven Dried (W):			51.43	D	Water Wt. (B-C)	0.22	51.24		
% Passing #10:			97.9%	E	Dry Wt. (C-A)	13.13	208.58		
Correction Factor a (Table 1):			1.00		% Moisture (100 x D/E)	1.68%	24.6%		

Sieve	Retained Wt.	Percent Passing	
3.0"	0.0	Pan # (washed)	100.0%
1.5"	0.0		100.0%
1.0"	0.0		100.0%
3/4"	0.0	57	100.0%
1/2"	0.0		100.0%
3/8"	0.0		100.0%
#4	2.5	Soil Mortar	99.5%
#10	9.6	**100.0%**	97.9%
#20	0.9	98.3%	96.2%
#40	2.5	95.2%	93.2%
#60	5.1	90.1%	88.2%
#100	10.0	80.5%	78.8%
#200	17.4	66.2%	64.8%

Notes: Description of Sand & Gravel Particles — Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:	4.75 mm		Total Sand:	34.6%	< 4.74 mm and > 0.075 mm	Type:	Mechanical Stirring Apparatus (A)
% Gravel:	0.5%	< 75 mm and > 4.75 mm	Silt & Clay:	64.8%	< 0.075	Dispersion Time:	1 min.
Coarse Sand:	1.6%	< 4.75 mm and > 2.00 mm	Silt:	20.8%	< 0.075 and > 0.005 mm	Sodium Hexametaphosphate:	40 g./ Liter
Medium Sand:	4.7%	< 2.00 mm and > 0.425 mm	Clay:	44.0%	< 0.005 mm		
Fine Sand:	28.4%	< 0.425 mm and > 0.075 mm	Colloids:	34.5%	< 0.001 mm	**Control Cylinder** ☐	**Composite Correction** ☒

Liquid Limit **50** Plastic Limit **27** Plastic Index **23** Hydrometer: 151H ☐ 152H ☒

Time		Temp.	Hydrometer	Corrections		Hydrometer	Percent Passing		Effective Depth	Table 3	Diameter
Clock	T (Min.)	(0.5 °C)	Reading	Control Cylinder	Composite Correction	R	P(-#10) = (R x a / W) x 100	P (total) = P x % Passing #10	L	K	D = K x ((L/T)^1/2
	2	23.7	36.0		5.05	30.95	60.2%	58.9%	11.2	0.01309	0.03100
	5	23.7	34.5		5.05	29.45	57.3%	56.0%	11.5	0.01309	0.01982
	15	23.7	32.5		5.05	27.45	53.4%	52.2%	11.8	0.01309	0.01161
	30	23.7	30.8		5.05	25.70	50.0%	48.9%	12.1	0.01309	0.00831
	60	23.7	29.0		5.05	23.95	46.6%	45.6%	12.4	0.01309	0.00594
	250	23.4	26.0		5.05	20.95	40.7%	39.9%	12.9	0.01317	0.00299
	1440	23.8	24.0		5.00	19.00	36.9%	36.2%	13.2	0.01309	0.00125
	2880	23.8	23.0		5.00	18.00	35.0%	34.3%	13.3	0.01309	0.00089

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Effective Depth (cm)
L=L1+0.5(L2-(VB/A))
(152H) .164cm per increment,
V_B=67.0cm^3, L_2=14cm, A=27.8cm^2

Technician Name: M. Jacobs

Technical Responsibility: Brian Vaughan, P.E.

Certification #

Signature

QC Manager
Position

S&ME, INC. **155 Tradd Street Spartanburg, SC 29301**

Hydrometer #146 (M-25, 0-5') 6-2-08.xls

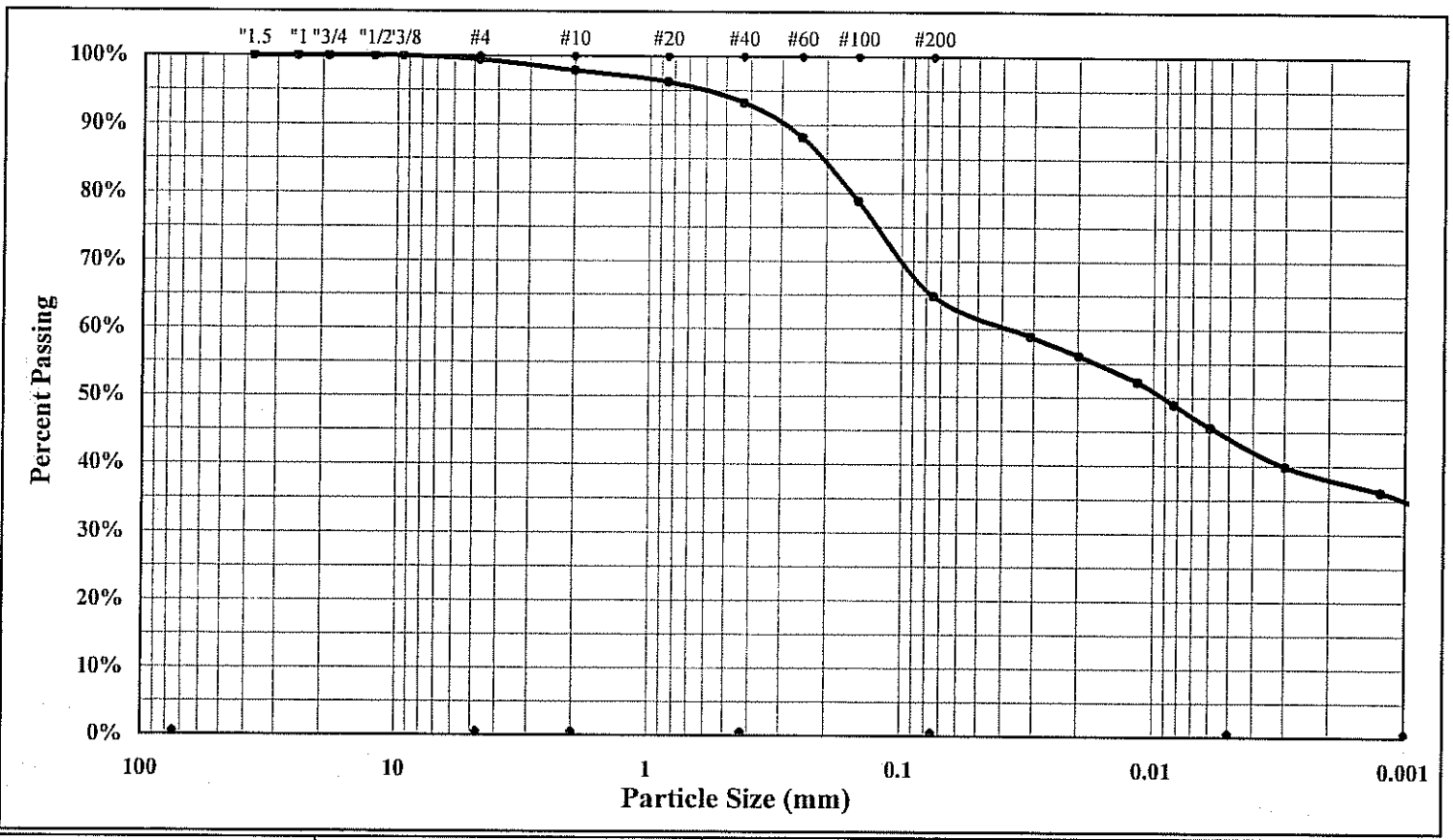
Particle Size Analysis of Soils

ASTM D 422

S&ME

S&ME Project #:	**1411-07-103**	Report Date:	6/2/08
Project Name:	**Marshall Steam Station**	Test Date(s):	5/28 - 5/30/08
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-25	Sample #:	146	Sample Date:	5/6/08
Location:	Bulk	Offset:	N/A	Elevation:	0-5'
Sample Description:	Red brown fine sandy silty CLAY (CH)				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	4.75 mm	Gravel	0.5%	Silt	20.8%
Silt & Clay (% Passing #200)	64.8%	Sand	34.6%	Clay	44.0%
Specific Gravity	2.650	Moisture Content	24.6%	Colloids	34.5%
Liquid Limit	50	Plastic Limit	27	Plastic Index	23

Description of Sand & Gravel Particles Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Mechanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

References: ASTM D 422: Particle Size Analysis of Soils
ASTM D 421: Dry Preparation of Soil Samples
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 854: Specific Gravity of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. _____ QC Manager

Signature Position

Moisture - Density Relationship

S&ME

S&ME Project #:	**1411-07-103**	Test Date(s):	May 15, 2008
Project Name:	Marshall Steam Station	Report Date:	May 16, 2008
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-25	Sample #:	146	Sample Date:	May 6, 2008
Location:	Bulk	Offset:	N/A	Depth:	0-5'

Sample Description: Red brown fine sandy silty CLAY (CH)

Liquid Limit:	50	Specific Gravity:	2.650
Plastic Limit:	27	Plastic Index:	23

Natural Moisture Content: 24.6%

Moisture Content of the Oversize Fraction:

NOTES:

Sieve Size	% Passing
#4	99.5
#10	97.9
#20	96.2
#40	93.2
#60	88.2
#100	78.8
#200	64.8

MDD: 105.1 **Opt. MC %: 20.1**

Water Content

Water Content requires GP 2 Balance (0.1 gram Readability).

ASTM D2216 ☒ AASHTO T265 ☐ ASTM D4959 ☐ ASTM D4643 ☐

	Sample #:	1	2	3	4	5	6
	Water Added:						
	Tare #:						
A. Tare Weight	A.	0	0	0	0	0	0
B. Wet Wt + Tare Wt	B.	500	500	500	500	500	500
C. Dry Wt. + Tare Wt.	C.	433.6	425.7	417.9	409.7		
D. Water Weight	B-C	66.4	74.3	82.1	90.3	500	500
E. Dry Weight	C-A	433.6	425.7	417.9	409.7	0	0
F. Moisture Content	100*D/E	**15.3%**	**17.5%**	**19.6%**	**22.0%**	**#DIV/0!**	**#DIV/0!**

Compaction Data

The Compaction Test requires a GP 5 Balance for ASTM (1 gram or .0022 Lb. readability).

G. Wt of Soil + Mold	G.	13.038	13.278	13.476	13.452		
H. Wt. of Mold	H.	9.304	9.304	9.304	9.304	9.304	9.304
I. Wt. of Soil (g. or lbs.)	G-H	3.734	3.974	4.172	4.148	-9.304	-9.304
J. Wt of Soil (Lbs.)	1/453.6 or I	3.734	3.974	4.172	4.148	-9.304	-9.304
K. Mold Volume Factor	K.	30.093	30.093	30.093	30.093	30.093	30.093
L. Wet Density	J*K	112.4	119.6	125.5	124.8	-280.0	-280.0
M. Dry Density	L/(1+F)	**97.4**	**101.8**	**104.9**	**102.3**	**#DIV/0!**	**#DIV/0!**

ASTM D558 ☐ ASTM D 698 ☒ ASTM D1557 ☐ AASHTO T99 ☐ AASHTO T180 ☐

Method A ☒ Method B ☐ Method C ☐ Method D (ASTM 1978) ☐ AASHTO Method D ☐

Moisture-Density Relation of: Fine Fraction ☒ Corrected for Coarse Fraction (ASTM D 4718) ☐

Sieve Size used to separate the Oversize Fraction: #4 Sieve ☒ 3/8 inch Sieve ☐ 3/4 inch Sieve ☐

Mechanical Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

Soil Plasticity:	ASTM D 4318 ☒	AASHTO T 89 ☐		AASHTO T 90 ☐
Sieve Analysis / Particle Size Analysis:	ASTM C136 ☐	AASHTO T 27 ☐	ASTM D 422 ☒	AASHTO T 88 ☐
Specific Gravity of Soil:		ASTM D 854 ☒		AASHTO T 100 ☐
Bulk Gravity of Oversize Fraction:		ASTM C 127 ☐		AASHTO T 85 ☐
Soil Classification:	ASTM D 2487 ☒	ASTM D 2488 ☐		AASHTO M 145 ☐

Technician Name: B. Hatton

Certification #

Technical Responsibility: Brian Vaughan, P.E. Signature Construction Services Manager Position

Moisture - Density Report

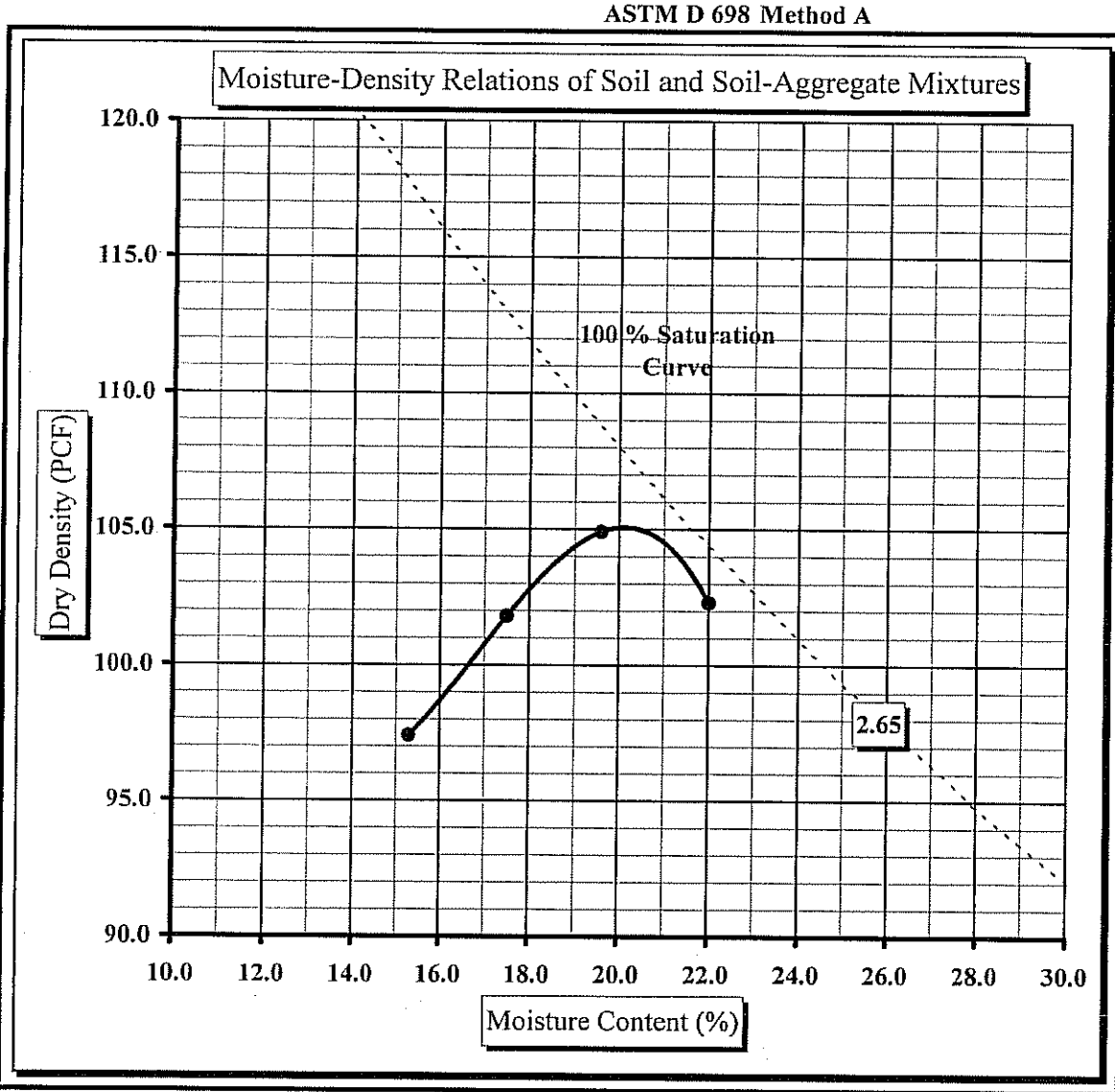
S&ME

S&ME Project #:	**1411-07-103**	Report Date:	May 16, 2008
Project Name:	**Marshall Steam Station**	Test Date(s):	May 15, 2008
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-25	Sample #:	146	Sample Date:	May 6, 2008
Location:	Bulk	Offset:	N/A	Depth:	0-5'
Sample Description:	Red brown fine sandy silty CLAY (CH)				

Maximum Dry Density **105.1** **PCF.** **Optimum Moisture Content** **20.1** **%**

ASTM D 698 Method A



Soil Properties

Natural Moisture Content:	24.6%
Liquid Limit:	50
Plastic Limit:	27
Plastic Index:	23
Specific Gravity:	2.650

% Passing

#4	99.5
#10	97.9
#20	96.2
#40	93.2
#60	88.2
#100	78.8
#200	64.8

Oversize Fraction

Bulk Sp. Gravity
% Moisture
Oversize Fraction
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 Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

References: ASTM D 698: Laboratory Compaction Characteristics of Soil Using Standard Effort
ASTM D 2216: Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D 422: Particle Size Analysis of Soils ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

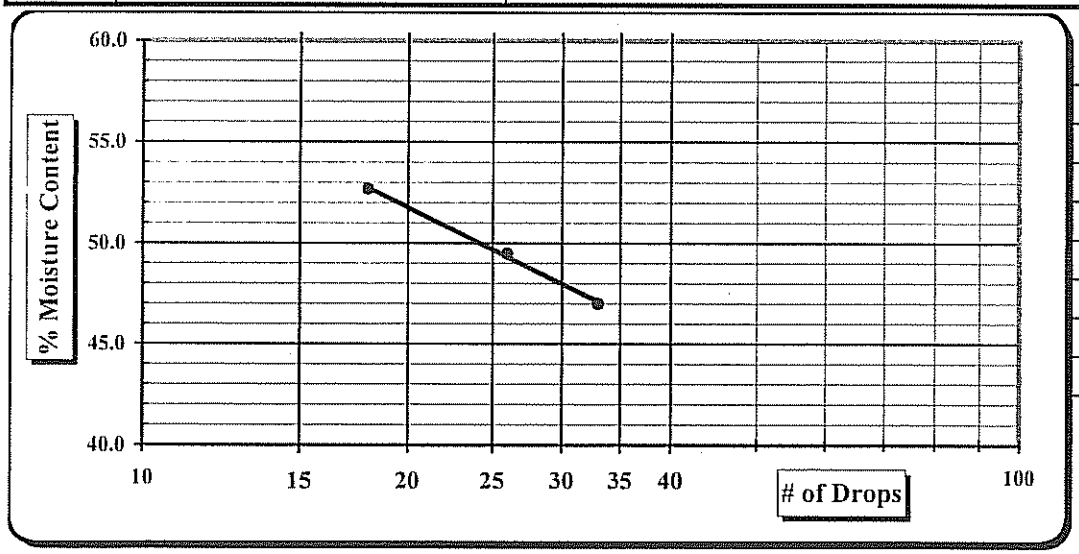
Technical Responsibility: Brian Vaughan, P.E. Construction Services Manager

S&ME

Liquid Limit, Plastic Limit, and Plastic Index

Project #: **1411-07-103** Report Date: 5/30/08
Project Name: Marshall Steam Station Test Date(s): 5/29/08
Client Name: Duke Energy
Client Address: Charlotte, NC
Boring #: M-25 Sample #: 146 Sample Date: 5/6/08
Location: Bulk Offset: N/A Elevation: 0-5'
Sample Description: Red brown fine sandy silty CLAY (CH)

Pan #		Liquid Limit						Plastic Limit		
	Test #	1	2	3	4	5	6	1	2	3
	Tare #	Z-1	Z-2	Z-3				13	18	
A	Tare Weight	15.99	16.71	16.78				**12.10**	12.11	
B	Wet Soil Weight + A	38.20	37.65	37.91				21.01	20.73	
C	Dry Soil Weight + A	31.10	30.72	30.62				19.13	18.93	
D	Water Weight (B-C)	7.10	6.93	7.29				1.88	1.81	
E	Dry Soil Weight (C-A)	15.11	14.01	13.84				7.03	6.82	
F	% Moisture Content (D/E)*100	47.0%	49.5%	52.7%				26.7%	26.5%	
N	# OF DROPS	33	26	18				*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average							26.6%		



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes:

Special Sampling Methods:

% Passing #200 Sieve: 64.8

Sample Preparation:	Wet Preparation ☐	Dry Preparation ☒	Air Dried ☒	NP, Non-Plastic	☐
Liquid limit Test:	Multipoint Method ☒	One-point Method ☐		Liquid Limit	50
Classification:	ASTM D 2487 ☒	AASHTO M 145 ☐		Plastic Limit	27
Liquid limit Test:	ASTM D 4318 ☒	AASHTO T 89 ☐		Plastic Index	23
Plastic limit Test:	ASTM D 4318 ☒	AASHTO T 90 ☐		Group Symbol	CH

Technician Name: M. Jacobs

Certification #

Technical Responsibility: Brian Vaughan, P.E. Signature QC Manager Position

Particle Size Analysis of Soils

ASTM D 422

S&ME

Project #: **1411-07-103**
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Charlotte, NC

Test Date(s): 5/28 - 5/30/08
Report Date: 6/2/08

Boring #: M-26 Sample #: 146 Sample Date: 5/8/08
Location: Bulk Offset: N/A Elevation: 3.5-8.5'
Sample Description: Tan orange red medium to fine sandy clayey SILT (ML)

Pan #:	9	Beaker #:	6			Specific Gravity	2.650		
Hydrometer Jar #:			6						
Pan Tare Weight (grams):			0.00		Moisture Content	Hygroscopic	Natural		
Total Sample Air Dried Wt. + tare wt. (grams):			526.53		Tare #	Z-6	306		
Weight of Total Sample Air Dried:			526.53	A	Tare Wt.	16.91	0.00		
Weight of Air Dried Hydrometer Sample (g):			103.58	B	Wet Wt. + A	30.34	268.28		
Total Sample Oven Dried:			520.42	C	Dry Wt. + A	30.18	229.25		
Hydrometer Sample Oven Dried (W):			102.35	D	Water Wt. (B-C)	0.16	39.03		
% Passing #10:			97.4%	E	Dry Wt. (C-A)	13.27	229.25		
Correction Factor a (Table 1):			1.00		% Moisture (100 x D/E)	1.21%	17.0%		

Sieve	Retained Wt.	Percent Passing	
3.0"	0.0	Pan # (washed)	100.0%
1.5"	0.0		100.0%
1.0"	0.0		100.0%
3/4"	0.0	58	100.0%
1/2"	0.0		100.0%
3/8"	0.0		100.0%
#4	4.8	Soil Mortar	99.1%
#10	13.4	**100.0%**	97.4%
#20	4.1	96.0%	93.5%
#40	12.0	88.2%	86.0%
#60	20.2	80.3%	78.2%
#100	32.0	68.7%	67.0%
#200	47.5	53.6%	52.2%

Notes: Description of Sand & Gravel Particles — Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:	4.75 mm		Total Sand:	46.8%	< 4.74 mm and > 0.075 mm	Type:	Mechanical Stirring Apparatus (A)
% Gravel:	0.9%	< 75 mm and > 4.75 mm	Silt & Clay:	52.2%	< 0.075	Dispersion Time:	1 min.
Coarse Sand:	1.6%	< 4.75 mm and > 2.00 mm	Silt:	29.7%	< 0.075 and > 0.005 mm	Sodium Hexametaphosphate:	40 g./ Liter
Medium Sand:	11.5%	< 2.00 mm and > 0.425 mm	Clay:	22.5%	< 0.005 mm		
Fine Sand:	33.7%	< 0.425 mm and > 0.075 mm	Colloids:	12.4%	< 0.001 mm	**Control Cylinder** ☐	**Composite Correction** ☒

Liquid Limit **39** Plastic Limit **26** Plastic Index **13** Hydrometer: 151H ☐ 152H ☒

Time		Temp.	Hydrometer	Corrections		Hydrometer	Percent Passing		Effective Depth	Table 3	Diameter
Clock	T (Min.)	(0.5 °C)	Reading	Control Cylinder	Composite Correction	R	P(-#10) = (R x a / W) x 100	P (total) = P x % Passing #10	L	K	D = K x ((L/T)^1/2
	2	23.9	48.0		5.00	43.00	42.0%	40.9%	9.2	0.01309	0.02814
	5	23.9	44.0		5.00	39.00	38.1%	37.1%	9.9	0.01309	0.01842
	15	23.8	38.0		5.00	33.00	32.2%	31.4%	10.9	0.01309	0.01115
	30	23.8	34.0		5.00	29.00	28.3%	27.6%	11.5	0.01309	0.00812
	60	23.8	30.5		5.00	25.50	24.9%	24.3%	12.1	0.01309	0.00588
	250	23.4	23.0		5.05	17.95	17.5%	17.1%	13.4	0.01317	0.00304
	1440	23.6	19.0		5.05	13.95	13.6%	13.3%	14.0	0.01309	0.00129
	2880	23.7	18.0		5.05	12.95	12.7%	12.3%	14.2	0.01309	0.00092

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Effective Depth (cm)
L=L1+0.5(L2-(VB/A))
(152H) .164cm per increment,
V_B=67.0cm^3, L_2=14cm, A=27.8cm^2

Technician Name: M. Jacobs

Technical Responsibility: Brian Vaughan, P.E.

Certification #

Signature

OC Manager
Position

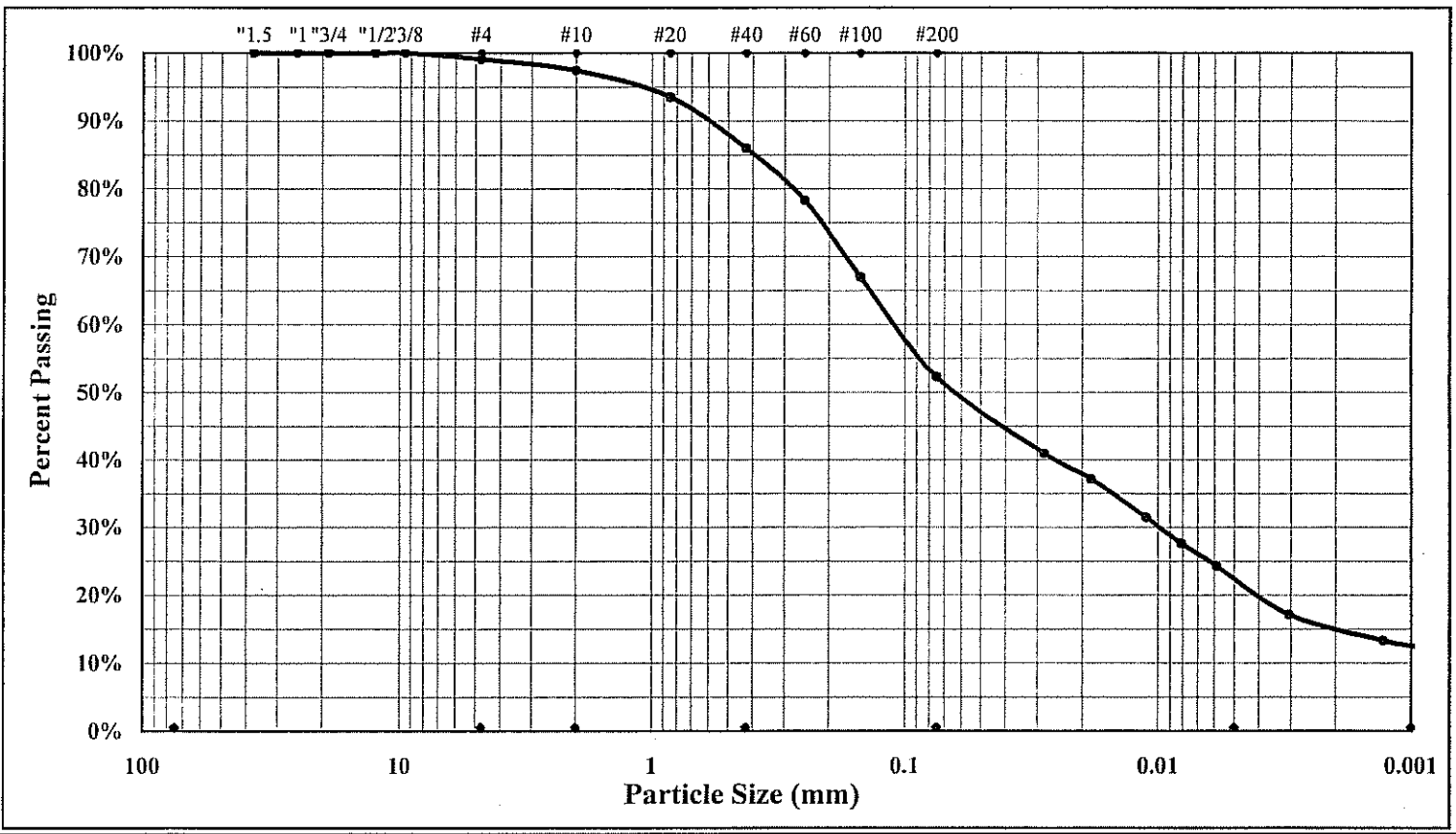
Laboratory Report Version 4.2

Particle Size Analysis of Soils

ASTM D 422

S&ME Project #:	**1411-07-103**	Report Date:	6/2/08
Project Name:	**Marshall Steam Station**	Test Date(s):	5/28 - 5/30/08
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-26	Sample #:	146	Sample Date:	5/8/08
Location:	Bulk	Offset:	N/A	Elevation:	3.5-8.5'
Sample Description:	Tan orange red medium to fine sandy clayey SILT (ML)				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	4.75 mm	Gravel	0.9%	Silt	29.7%
Silt & Clay (% Passing #200)	52.2%	Sand	46.8%	Clay	22.5%
Specific Gravity	2.650	Moisture Content	17.0%	Colloids	12.4%
Liquid Limit	39	Plastic Limit	26	Plastic Index	13

Description of Sand & Gravel Particles Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Mechanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 854: Specific Gravity of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. _____ QC Manager
Signature Position

Moisture - Density Relationship

S&ME

S&ME Project #:	**1411-07-103**	Test Date(s):	May 15, 2008
Project Name:	Marshall Steam Station	Report Date:	May 16, 2008
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-26	Sample #:	146	Sample Date:	May 8, 2008
Location:	Bulk	Offset:	N/A	Depth:	3.5-8.5'

Sample Description: Tan orange red medium to fine sandy clayey SILT (ML)

Liquid Limit:	39	Specific Gravity:	2.650
Plastic Limit:	26	Plastic Index:	13

Natural Moisture Content: 17.0%

Moisture Content of the Oversize Fraction:

NOTES:

Sieve Size	% Passing
#4	99.1
#10	97.4
#20	93.5
#40	86.0
#60	78.2
#100	67.0
#200	52.2

MDD: 113.1 **Opt. MC %: 15.1**

Water Content

Water Content requires GP 2 Balance (0.1 gram Readability).

ASTM D2216 ☒ AASHTO T265 ☐ ASTM D4959 ☐ ASTM D4643 ☐

	Sample #:	1	2	3	4	5	6
	Water Added:						
	Tare #:						
A. Tare Weight	A.	0	0	0	0	0	0
B. Wet Wt + Tare Wt	B.	500	500	500	500	500	500
C. Dry Wt. + Tare Wt.	C.	450.4	442.1	433.1	425.5		
D. Water Weight	B-C	49.6	57.9	66.9	74.5	500	500
E. Dry Weight	C-A	450.4	442.1	433.1	425.5	0	0
F. Moisture Content	100*D/E	**11.0%**	**13.1%**	**15.4%**	**17.5%**	**#DIV/0!**	**#DIV/0!**

Compaction Data

The Compaction Test requires a GP 5 Balance for ASTM (1 gram or .0022 Lb. readability).

G. Wt of Soil + Mold	G.	13.374	13.522	13.642	13.638		
H. Wt. of Mold	H.	9.304	9.304	9.304	9.304	9.304	9.304
I. Wt. of Soil (g. or lbs.)	G-H	4.070	4.218	4.338	4.334	-9.304	-9.304
J. Wt of Soil (Lbs.)	I/453.6 or I	4.070	4.218	4.338	4.334	-9.304	-9.304
K. Mold Volume Factor	K.	30.093	30.093	30.093	30.093	30.093	30.093
L. Wet Density	J*K	122.5	126.9	130.5	130.4	-280.0	-280.0
M. Dry Density	L/(1+F)	**110.3**	**112.2**	**113.1**	**111.0**	**#DIV/0!**	**#DIV/0!**

ASTM D558 ☐ ASTM D 698 ☒ ASTM D1557 ☐ AASHTO T99 ☐ AASHTO T180 ☐

Method A ☒ Method B ☐ Method C ☐ Method D (ASTM 1978) ☐ AASHTO Method D ☐

Moisture-Density Relation of: Fine Fraction ☒ Corrected for Coarse Fraction (ASTM D 4718) ☐

Sieve Size used to separate the Oversize Fraction: #4 Sieve ☒ 3/8 inch Sieve ☐ 3/4 inch Sieve ☐

Mechanical Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

Soil Plasticity: ASTM D 4318 ☒ AASHTO T 89 ☐ AASHTO T 90 ☐

Sieve Analysis / Particle Size Analysis: ASTM C136 ☐ AASHTO T 27 ☐ ASTM D 422 ☒ AASHTO T 88 ☐

Specific Gravity of Soil: ASTM D 854 ☒ AASHTO T 100 ☐

Bulk Gravity of Oversize Fraction: ASTM C 127 ☐ AASHTO T 85 ☐

Soil Classification: ASTM D 2487 ☒ ASTM D 2488 ☐ AASHTO M 145 ☐

Technician Name: B. Hatton

Certification #

Technical Responsibility: Brian Vaughan, P.E. Signature Construction Services Manager Position

Laboratory Report Version 4.2

Moisture - Density Report

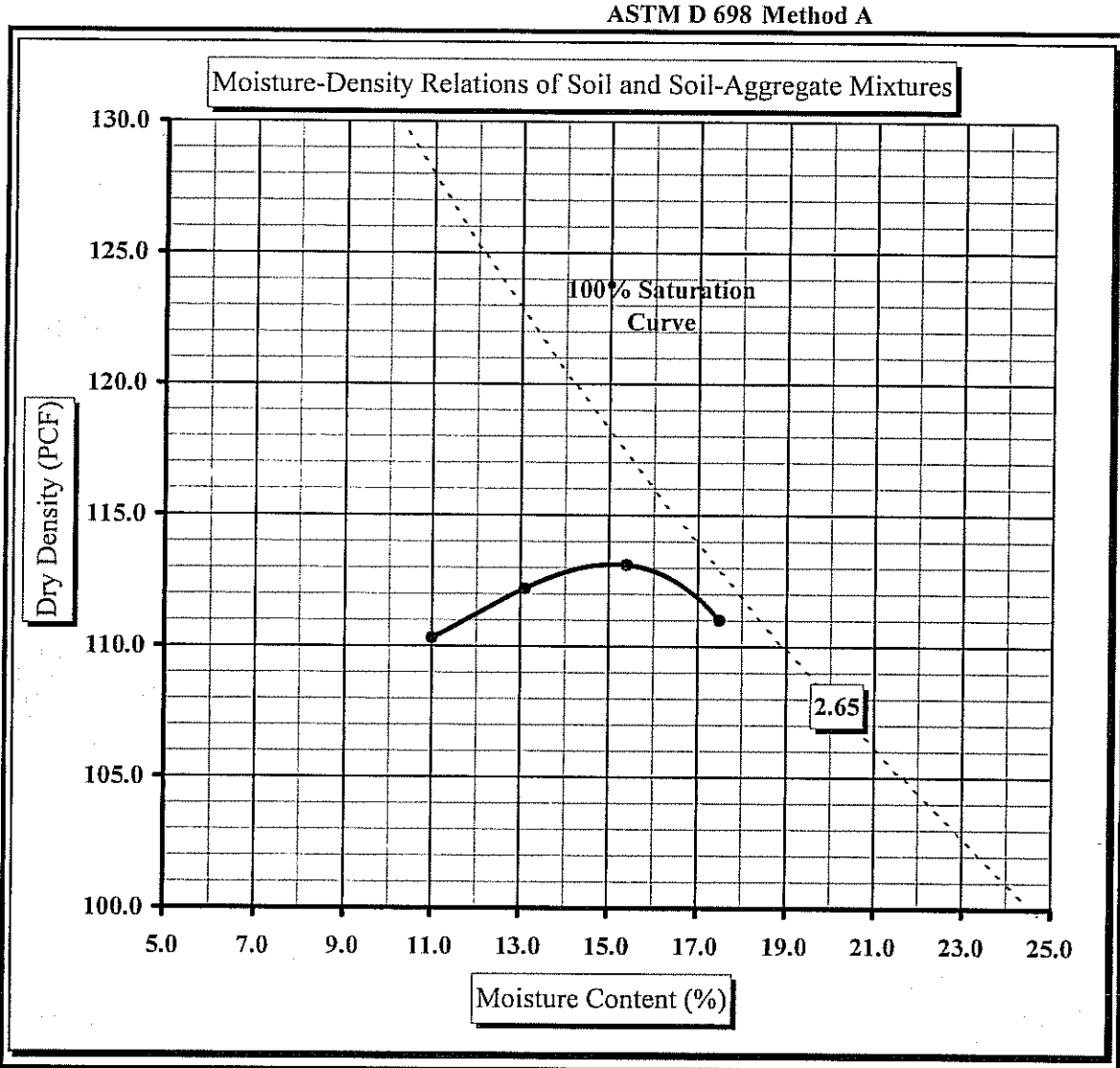
S&ME

S&ME Project #:	**1411-07-103**	Report Date:	May 16, 2008
Project Name:	**Marshall Steam Station**	Test Date(s):	May 15, 2008
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-26	Sample #:	146	Sample Date:	May 8, 2008
Location:	Bulk	Offset:	N/A	Depth:	3.5-8.5'
Sample Description:	Tan orange red medium to fine sandy clayey SILT (ML)				

Maximum Dry Density **113.1** **PCF.** **Optimum Moisture Content** **15.1** **%**

ASTM D 698 Method A



Soil Properties

Natural Moisture Content:	17.0%
Liquid Limit:	39
Plastic Limit:	26
Plastic Index:	13
Specific Gravity:	2.650

% Passing

#4	99.1
#10	97.4
#20	93.5
#40	86.0
#60	78.2
#100	67.0
#200	52.2

Oversize Fraction

Bulk Sp. Gravity
% Moisture
Oversize Fraction
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 Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

References: ASTM D 698: Laboratory Compaction Characteristics of Soil Using Standard Effort
ASTM D 2216: Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D 422: Particle Size Analysis of Soils ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. Construction Services Manager
Position

S&ME

Liquid Limit, Plastic Limit, and Plastic Index

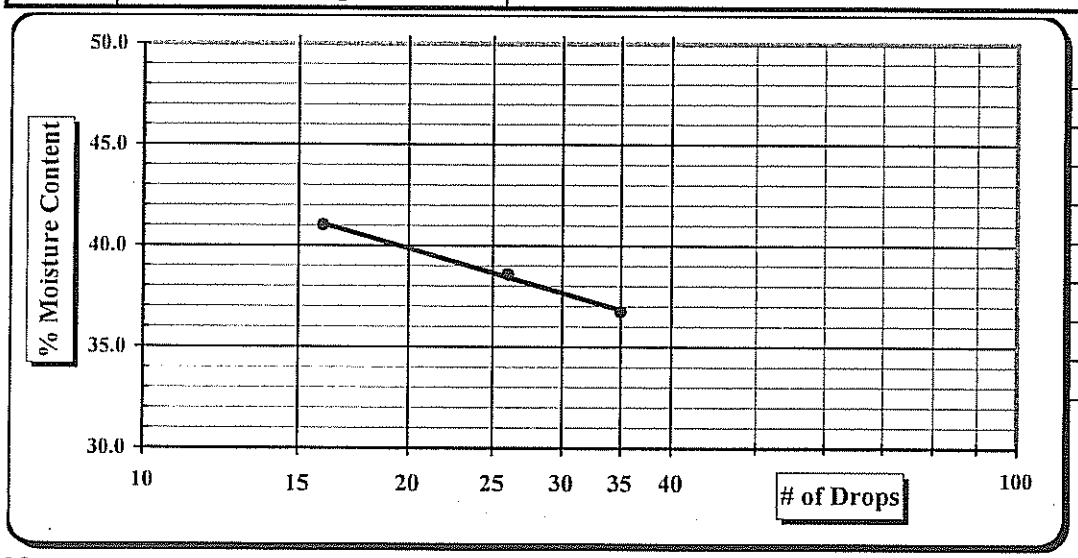
Project #:	**1411-07-103**	Report Date:	5/30/08
Project Name:	Marshall Steam Station	Test Date(s):	5/29/08
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #: M-26 Sample #: 146 Sample Date: 5/8/08

Location: Bulk Offset: N/A Elevation: 3.5-8.5'

Sample Description: Tan orange red medium to fine sandy clayey SILT (ML)

Pan #		Liquid Limit						Plastic Limit		
	Test #	1	2	3	4	5	6	1	2	3
	Tare #	P-4	P-5	P-6				37	45	
A	Tare Weight	16.70	16.72	15.97				**11.56**	11.57	
B	Wet Soil Weight + A	39.11	38.31	38.56				21.39	20.61	
C	Dry Soil Weight + A	33.09	32.30	31.99				19.39	18.76	
D	Water Weight (B-C)	6.02	6.01	6.57				2.00	1.85	
E	Dry Soil Weight (C-A)	16.39	15.58	16.02				7.83	7.19	
F	% Moisture Content (D/E)*100	36.7%	38.6%	41.0%				25.5%	25.7%	
N	# OF DROPS	35	26	16				*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average							25.6%		



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes:

Special Sampling Methods:

Sample Preparation:	Wet Preparation	☐	Dry Preparation	☒	Air Dried	☒	% Passing #200 Sieve: 52.2
Liquid limit Test:	Multipoint Method	☒	One-point Method	☐			NP, Non-Plastic ☐
Classification:	ASTM D 2487	☒	AASHTO M 145	☐			Liquid Limit 39
Liquid limit Test:	ASTM D 4318	☒	AASHTO T 89	☐			Plastic Limit 26
Plastic limit Test:	ASTM D 4318	☒	AASHTO T 90	☐			Plastic Index 13
							Group Symbol ML

Technician Name: M. Jacobs

Certification #

Technical Responsibility: Brian Vaughan, P.E. Signature QC Manager Position

Particle Size Analysis of Soils

ASTM D 422

S&ME

Project #:	1411-07-103		
Project Name:	Marshall Steam Station	Test Date(s):	6/11 - 6/13/08
Client Name:	Duke Energy	Report Date:	6/16/08
Client Address:	Charlotte, NC		

Boring #: M-28 Sample #: 181 Sample Date: 5/14/08

Location: Bulk Offset: N/A Elevation: 3.5-8.5'

Sample Description: Brown red orange fine sandy silty CLAY (CL)

Pan #:	8	Beaker #:	5	Specific Gravity	2.650				
Hydrometer Jar #:			5						
Pan Tare Weight (grams):			0.00	Moisture Content		Hygroscopic	Natural		
Total Sample Air Dried Wt. + tare wt. (grams):			537.43		Tare #	Z-5	349		
Weight of Total Sample Air Dried:			537.43	A	Tare Wt.	15.62	0.00		
Weight of Air Dried Hydrometer Sample (g):			103.43	B	Wet Wt. + A	29.79	298.54		
Total Sample Oven Dried:			527.95	C	Dry Wt. + A	29.53	255.72		
Hydrometer Sample Oven Dried (W):			101.53	D	Water Wt. (B-C)	0.26	42.82		
% Passing #10:			96.0%	E	Dry Wt. (C-A)	13.91	255.72		
Correction Factor a (Table 1):			1.00		% Moisture (100 x D/E)	1.87%	16.7%		

Sieve	Retained Wt.	Percent Passing	
3.0"	0.0	Pan # (washed)	100.0%
1.5"	0.0		100.0%
1.0"	0.0		100.0%
3/4"	0.0	57	100.0%
1/2"	3.3		99.4%
3/8"	5.2		99.0%
#4	12.6	Soil Mortar	97.6%
#10	21.0	**100.0%**	96.0%
#20	1.9	98.2%	94.3%
#40	5.3	94.8%	91.1%
#60	11.2	89.0%	85.4%
#100	22.8	77.5%	74.4%
#200	41.2	59.4%	57.1%

Notes: Description of Sand & Gravel Particles — Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:	12.50 mm	Total Sand:	40.5%	< 4.74 mm and > 0.075 mm	Type:	Mechanical Stirring Apparatus (A)	
% Gravel:	2.4%	< 75 mm and > 4.75 mm	Silt & Clay:	57.1%	< 0.075	Dispersion Time:	1 min.
Coarse Sand:	1.6%	< 4.75 mm and > 2.00 mm	Silt:	19.6%	< 0.075 and > 0.005 mm	Sodium Hexametaphosphate:	40 g./ Liter
Medium Sand:	5.0%	< 2.00 mm and > 0.425 mm	Clay:	37.5%	< 0.005 mm		
Fine Sand:	34.0%	< 0.425 mm and > 0.075 mm	Colloids:	27.5%	< 0.001 mm	**Control Cylinder** ☐	**Composite Correction** ☒

Liquid Limit **38** Plastic Limit **18** Plastic Index **20** Hydrometer: 151H ☐ 152H ☒

Time		Temp.	Hydrometer	Corrections		Hydrometer	Percent Passing		Effective Depth	Table 3	Diameter
Clock	T (Min.)	(0.5 °C)	Reading	Control Cylinder	Composite Correction	R	P(-#10) = (R x a / W) x 100	P (total) = P x % Passing #10	L	K	D = K x ((L/T)^1/2
	2	22.5	56.0		5.15	50.85	50.1%	48.1%	8.0	0.01325	0.02642
	5	22.5	53.0		5.15	47.85	47.1%	45.3%	8.4	0.01325	0.01722
	15	22.6	50.0		5.15	44.85	44.2%	42.4%	8.9	0.01325	0.01023
	30	22.8	47.5		5.10	42.40	41.8%	40.1%	9.3	0.01325	0.00739
	60	22.9	45.0		5.10	39.90	39.3%	37.7%	9.8	0.01325	0.00534
	250	23.3	41.0		5.05	35.95	35.4%	34.0%	10.4	0.01317	0.00269
	1440	23.1	35.5		5.10	30.40	29.9%	28.8%	11.3	0.01317	0.00117
	2880	23.5	33.0		5.05	27.95	27.5%	26.4%	11.7	0.01309	0.00083

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Effective Depth (cm)
L=L1+0.5(L2-(VB/A))
(152H) .164cm per increment,
V_B=67.0cm^3, L_2=14cm, A=27.8cm^2

Technician Name: M. Jacobs

Certification #

Technical Responsibility: William C. Schwartz, Jr., P.E.

Signature

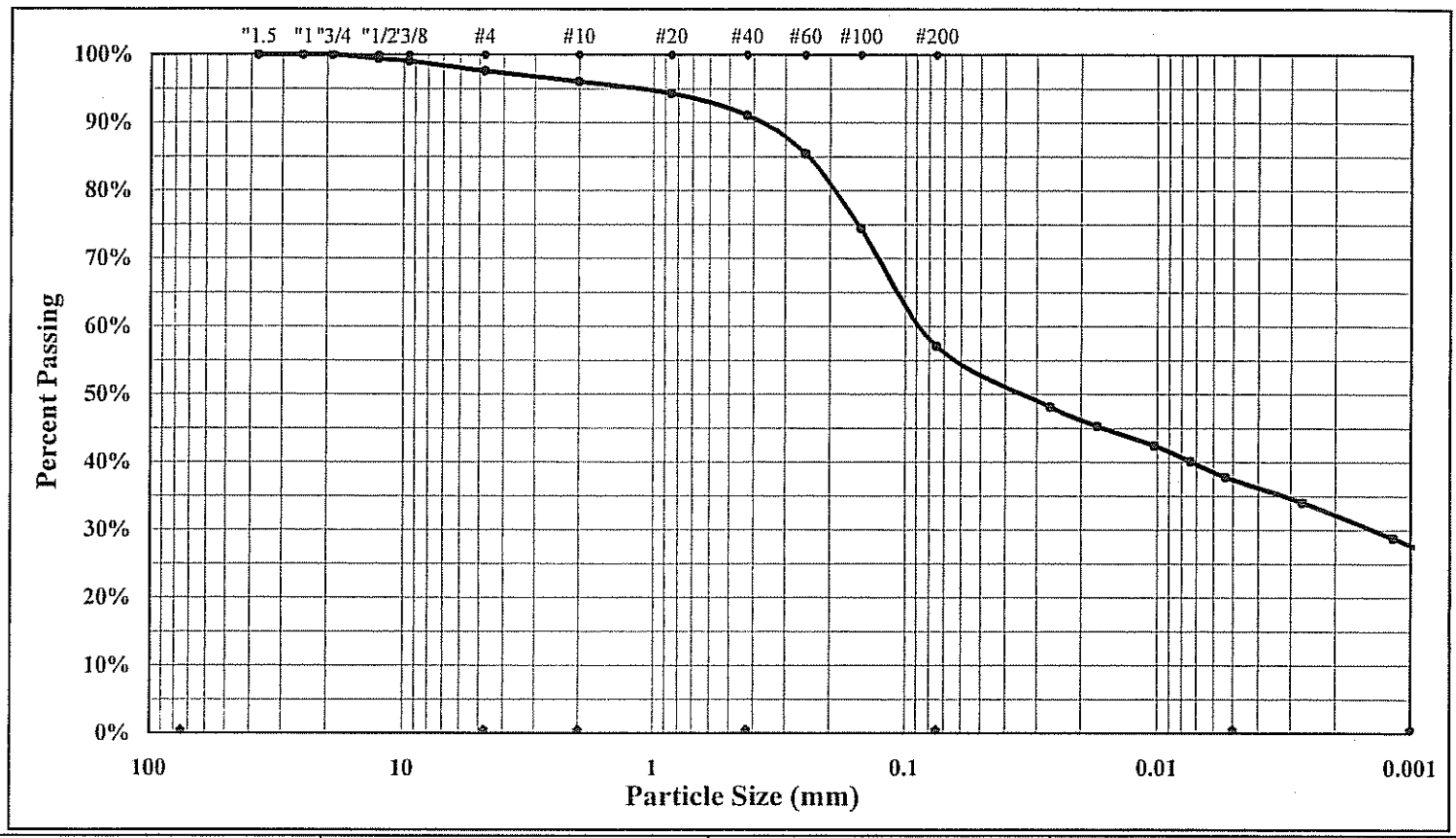
OC Manager
Position

Particle Size Analysis of Soils

ASTM D 422

S&ME Project #:	**1411-07-103**	Report Date:	6/16/08
Project Name:	**Marshall Steam Station**	Test Date(s):	6/11 - 6/13/08
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-28	Sample #:	181	Sample Date:	5/14/08
Location:	Bulk	Offset:	N/A	Elevation:	3.5-8.5'
Sample Description:	Brown red orange fine sandy silty CLAY (CL)				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	12.50 mm	Gravel	2.4%	Silt	19.6%
Silt & Clay (% Passing #200)	57.1%	Sand	40.5%	Clay	37.5%
Specific Gravity	2.650	Moisture Content	16.7%	Colloids	27.5%
Liquid Limit	38	Plastic Limit	18	Plastic Index	20

Description of Sand & Gravel Particles Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Mechanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 854: Specific Gravity of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: William C. Schwartz, Jr., P.E. _____ QC Manager
Signature *Position*

Moisture - Density Relationship

S&ME

S&ME Project #:	**1411-07-103**	Test Date(s):	June 6, 2008
Project Name:	Marshall Steam Station	Report Date:	June 9, 2008
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-28	Sample #:	181	Sample Date:	May 14, 2008
Location:	Bulk	Offset:	N/A	Depth:	3.5-8.5'

Sample Description: Brown red orange fine sandy silty CLAY (CL)

Liquid Limit:	38	Specific Gravity:	2.650
Plastic Limit:	18	Plastic Index:	20

Natural Moisture Content: 16.7%

Moisture Content of the Oversize Fraction:

NOTES:

Sieve Size	% Passing
1/2"	99.4
3/8"	99.0
#4	97.6
#10	96.0
#20	94.3
#40	91.1
#60	85.4
#100	74.4
#200	57.1

MDD: 109.9 **Opt. MC %:** 17.0

Water Content

Water Content requires GP 2 Balance (0.1 gram Readability).

ASTM D2216 ☒ AASHTO T265 ☐ ASTM D4959 ☐ ASTM D4643 ☐

	Sample #:	1	2	3	4	5	6
	Water Added:						
	Tare #:						
A. Tare Weight	A.	0	0	0	0	0	0
B. Wet Wt + Tare Wt	B.	500	500	500	500	500	500
C. Dry Wt. + Tare Wt.	C.	443.1	434.6	426.2	417.0		
D. Water Weight	B-C	56.9	65.4	73.8	83.0	500	500
E. Dry Weight	C-A	443.1	434.6	426.2	417.0	0	0
F. Moisture Content	100*D/E	**12.8%**	**15.0%**	**17.3%**	**19.9%**	**#DIV/0!**	**#DIV/0!**

Compaction Data

The Compaction Test requires a GP 5 Balance for ASTM (1 gram or .0022 Lb. readability).

G. Wt of Soil + Mold	G.	13.210	13.450	13.586	13.534		
H. Wt. of Mold	H.	9.304	9.304	9.304	9.304	9.304	9.304
I. Wt. of Soil (g. or lbs.)	G-H	3.906	4.146	4.282	4.230	-9.304	-9.304
J. Wt of Soil (Lbs.)	I/453.6 or I	3.906	4.146	4.282	4.230	-9.304	-9.304
K. Mold Volume Factor	K.	30.093	30.093	30.093	30.093	30.093	30.093
L. Wet Density	J*K	117.5	124.8	128.9	127.3	-280.0	-280.0
M. Dry Density	L/(1+F)	**104.2**	**108.4**	**109.8**	**106.2**	**#DIV/0!**	**#DIV/0!**

ASTM D558 ☐ ASTM D 698 ☒ ASTM D1557 ☐ AASHTO T99 ☐ AASHTO T180 ☐

Method A ☒ Method B ☐ Method C ☐ Method D (ASTM 1978) ☐ AASHTO Method D ☐

Moisture-Density Relation of: Fine Fraction ☒ Corrected for Coarse Fraction (ASTM D 4718) ☐

Sieve Size used to separate the Oversize Fraction: #4 Sieve ☒ 3/8 inch Sieve ☐ 3/4 inch Sieve ☐

Mechanical Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

Soil Plasticity: ASTM D 4318 ☒ AASHTO T 89 ☐ AASHTO T 90 ☐

Sieve Analysis / Particle Size Analysis: ASTM C136 ☐ AASHTO T 27 ☐ ASTM D 422 ☒ AASHTO T 88 ☐

Specific Gravity of Soil: ASTM D 854 ☒ AASHTO T 100 ☐

Bulk Gravity of Oversize Fraction: ASTM C 127 ☐ AASHTO T 85 ☐

Soil Classification: ASTM D 2487 ☒ ASTM D 2488 ☐ AASHTO M 145 ☐

Technician Name: B. Hatton

Certification #

Technical Responsibility: Brian Vaughan, P.E.

Signature

Construction Services Manager

Position

Moisture - Density Report

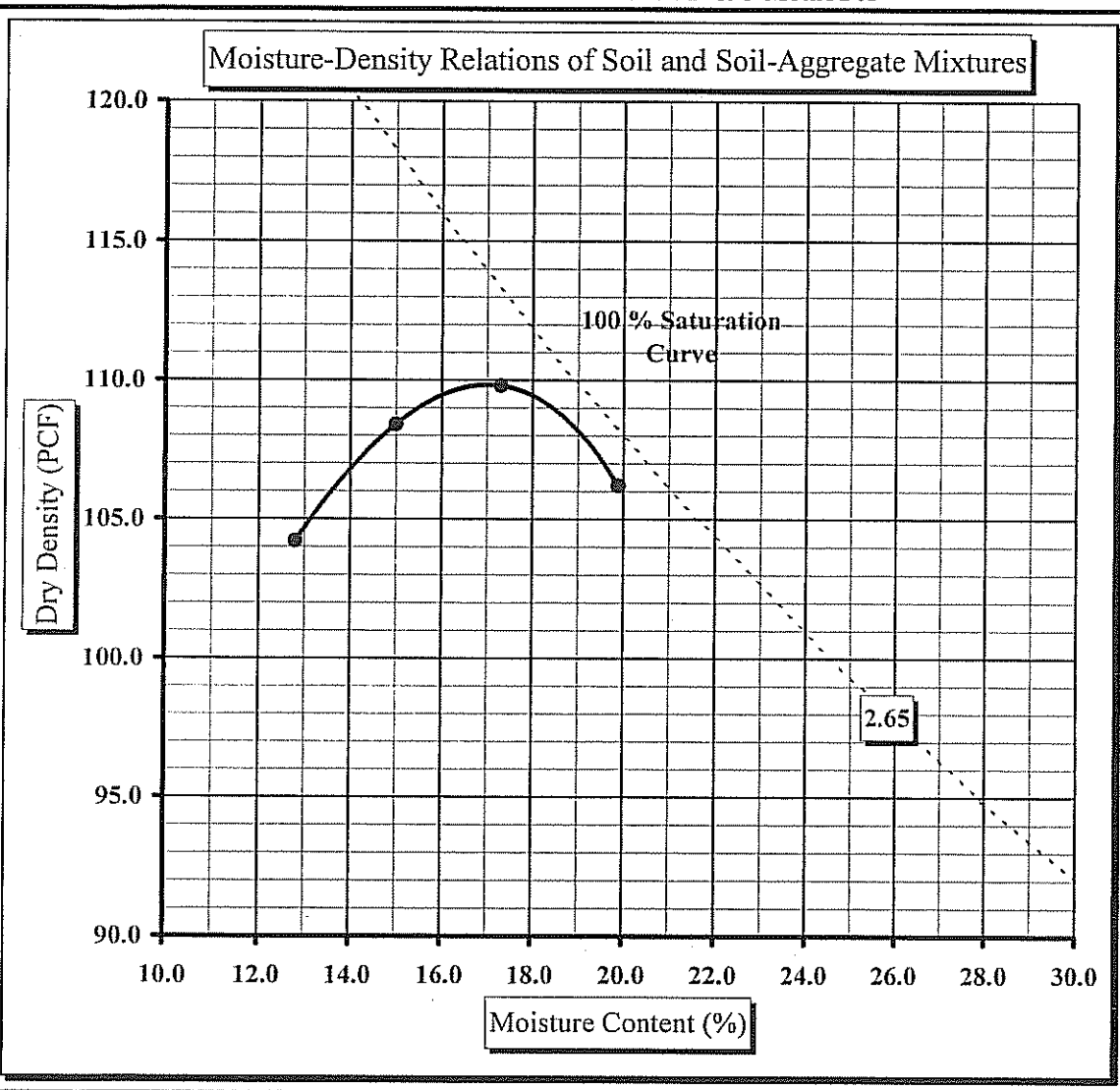
S&ME

S&ME Project #:	**1411-07-103**	Report Date:	June 9, 2008
Project Name:	**Marshall Steam Station**	Test Date(s):	June 6, 2008
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-28	Sample #:	181	Sample Date:	May 14, 2008
Location:	Bulk	Offset:	N/A	Depth:	3.5-8.5'
Sample Description:	Brown red orange fine sandy silty CLAY (CL)				

Maximum Dry Density 109.9 PCF. **Optimum Moisture Content 17.0 %**

ASTM D 698 Method A



Soil Properties

Natural Moisture Content:	16.7%
Liquid Limit:	38
Plastic Limit:	18
Plastic Index:	20
Specific Gravity:	2.650

% Passing	
1/2"	99.4
3/8"	99.0
#4	97.6
#10	96.0
#20	94.3
#40	91.1
#60	85.4
#100	74.4
#200	57.1

Oversize Fraction

Bulk Sp. Gravity
% Moisture
Oversize Fraction
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 Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

References: ASTM D 698: Laboratory Compaction Characteristics of Soil Using Standard Effort
ASTM D 2216: Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D 422: Particle Size Analysis of Soils ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. Construction Services Manager

Laboratory Record Version 4.2

S&ME

Liquid Limit, Plastic Limit, and Plastic Index

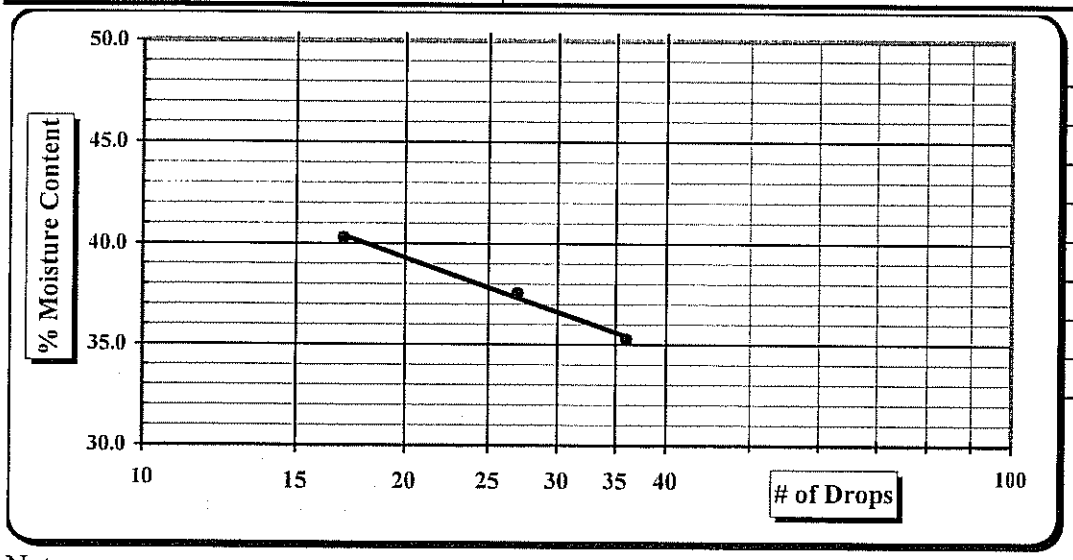
Project #:	**1411-07-103**	Report Date:	6/17/08
Project Name:	Marshall Steam Station	Test Date(s):	6/16/08
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #: M-28 Sample #: 181 Sample Date: 5/14/08

Location: Bulk Offset: N/A Elevation: 3.5-8.5'

Sample Description: Brown red orange fine sandy silty CLAY (CL)

Pan #		Liquid Limit						Plastic Limit		
	Test #	1	2	3	4	5	6	1	2	3
	Tare #	Q-4	Q-5	Q-6				25	26	
A	Tare Weight	16.73	16.92	16.80				**11.67**	11.53	
B	Wet Soil Weight + A	40.63	38.98	39.47				19.71	19.51	
C	Dry Soil Weight + A	34.40	32.96	32.96				18.49	18.32	
D	Water Weight (B-C)	6.23	6.02	6.51				1.22	1.20	
E	Dry Soil Weight (C-A)	17.67	16.04	16.16				6.82	6.79	
F	% Moisture Content (D/E)*100	35.3%	37.5%	40.3%				17.9%	17.6%	
N	# OF DROPS	36	27	17				*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average							17.8%		



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes:

Special Sampling Methods:

Sample Preparation:	Wet Preparation	☐	Dry Preparation	☒	Air Dried	☒	% Passing #200 Sieve: 57.1
Liquid limit Test:	Multipoint Method	☒	One-point Method	☐			NP, Non-Plastic ☐
Classification:	ASTM D 2487	☒	AASHTO M 145	☐			Liquid Limit 38
Liquid limit Test:	ASTM D 4318	☒	AASHTO T 89	☐			Plastic Limit 18
Plastic limit Test:	ASTM D 4318	☒	AASHTO T 90	☐			Plastic Index 20
							Group Symbol CL

Technician Name: M. Jacobs

Certification #

Technical Responsibility: Brian Vaughan, P.E. Signature QC Manager Position

Particle Size Analysis of Soils

ASTM D 422

S&ME

Project #: **1411-07-103**
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Charlotte, NC

Test Date(s): 6/23 - 6/25/08
Report Date: 6/26/08

Boring #: M-31 Sample #: 181 Sample Date: 5/28/08
Location: Bulk Offset: N/A Elevation: 0-5'
Sample Description: Red brown clayey SILT with fine sand (MH)

Pan #:	9	Beaker #:	2
Hydrometer Jar #:			2
Pan Tare Weight (grams):			0.00
Total Sample Air Dried Wt. + tare wt. (grams):			507.63
Weight of Total Sample Air Dried:			507.63
Weight of Air Dried Hydrometer Sample (g):			102.56
Total Sample Oven Dried:			496.39
Hydrometer Sample Oven Dried (W):			100.28
% Passing #10:			99.8%
Correction Factor a (Table 1):			1.00

Specific Gravity 2.650

	Moisture Content	Hygroscopic	Natural
	Tare #	Z-1	352
A	Tare Wt.	15.99	0.00
B	Wet Wt. + A	29.06	252.49
C	Dry Wt. + A	28.77	198.17
D	Water Wt. (B-C)	0.29	54.32
E	Dry Wt. (C-A)	12.78	198.17
	% Moisture (100 x D/E)	2.27%	27.4%

Sieve	Retained Wt.	Percent Passing	
3.0"	0.00	Pan # (washed)	100.0%
1.5"	0.00		100.0%
1.0"	0.00		100.0%
3/4"	0.00		100.0%
1/2"	0.00		100.0%
3/8"	0.00		100.0%
#4	0.06	Soil Mortar	100.0%
#10	1.08	**100.0%**	99.8%
#20	0.58	99.4%	99.2%
#40	3.63	96.4%	96.2%
#60	8.53	91.5%	91.3%
#100	14.51	85.5%	85.3%
#200	21.75	78.3%	78.1%

Notes: Description of Sand & Gravel Particles — Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:	4.75 mm	
% Gravel:	0.0%	< 75 mm and > 4.75 mm
Coarse Sand:	0.2%	< 4.75 mm and > 2.00 mm
Medium Sand:	3.6%	< 2.00 mm and > 0.425 mm
Fine Sand:	18.0%	< 0.425 mm and > 0.075 mm

Total Sand:	21.8%	< 4.74 mm and > 0.075 mm
Silt & Clay:	78.1%	< 0.075
Silt:	28.6%	< 0.075 and > 0.005 mm
Clay:	49.5%	< 0.005 mm
Colloids:	37.3%	< 0.001 mm

Type: Mechanical Stirring Apparatus (A)
Dispersion Time: 1 min.
Sodium Hexametaphosphate: 40 g./ Liter

Control Cylinder ☐ **Composite Correction** ☒

Liquid Limit **58** Plastic Limit **32** Plastic Index **26** Hydrometer: 151H ☐ 152H ☒

Time		Temp.	Hydrometer	Corrections		Hydrometer	Percent Passing		Effective Depth	Table 3	Diameter
Clock	T (Min.)	(0.5 °C)	Reading	Control Cylinder	Composite Correction	R	P(-#10) = (R x a / W) x 100	P (total) = P x % Passing #10	L	K	D = K x ((L/T)^1/2
	2	23.7	68.5		5.05	63.45	63.3%	63.1%	5.9	0.01309	0.02246
	5	23.7	65.0		5.05	59.95	59.8%	59.6%	6.5	0.01309	0.01488
	15	23.7	61.0		5.05	55.95	55.8%	55.7%	7.1	0.01309	0.00902
	30	23.7	58.0		5.05	52.95	52.8%	52.7%	7.6	0.01309	0.00659
	60	23.6	54.5		5.05	49.45	49.3%	49.2%	8.2	0.01309	0.00483
	250	23.3	48.5		5.05	43.45	43.3%	43.2%	9.2	0.01317	0.00252
	1440	23.0	43.0		5.10	37.90	37.8%	37.7%	10.1	0.01317	0.00110
	2880	23.0	41.0		5.10	35.90	35.8%	35.7%	10.4	0.01317	0.00079

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Effective Depth (cm)
L=L1+0.5(L2-(VB/A))

(152H) .164cm per increment,
V_B=67.0cm^3, L_2=14cm, A=27.8cm^2

Technician Name: M. Jacobs
Certification #

Technical Responsibility: Brian Vaughan, P.E.
Signature

OC Manager
Position

S&ME, INC. **155 Tradd Street Spartanburg, SC 29301**

Hydrometer #181 (M-31, 0-5') 6-26-08.xls

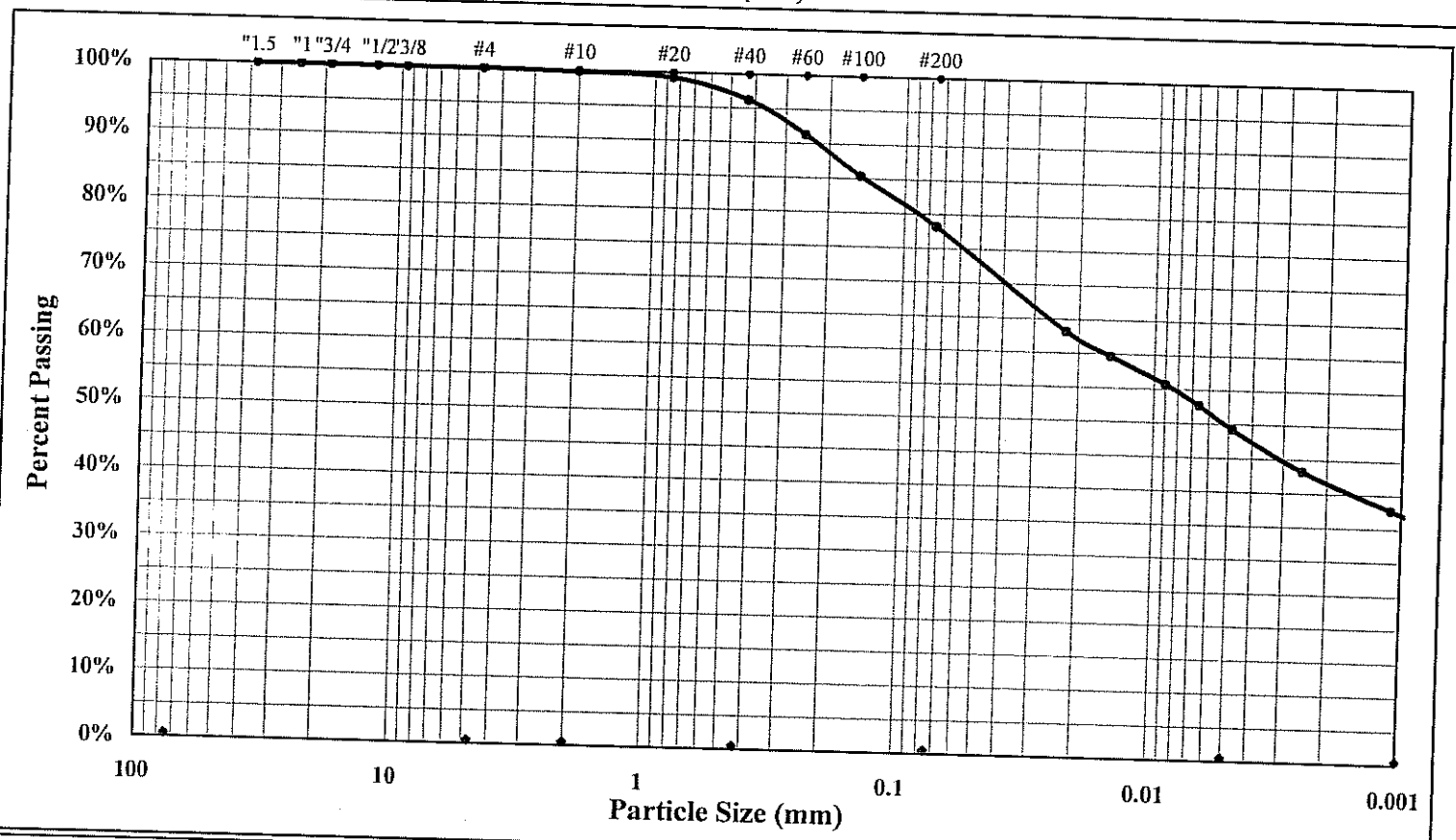
Particle Size Analysis of Soils

ASTM D 422

S&ME

S&ME Project #:	**1411-07-103**	Report Date:	6/26/08
Project Name:	**Marshall Steam Station**	Test Date(s):	6/23 - 6/25/08
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-31	Sample #:	181	Sample Date:	5/28/08
Location:	Bulk	Offset:	N/A	Elevation:	0-5'
Sample Description:	Red brown clayey SILT with fine sand (MH)				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	4.75 mm	Gravel	0.0%	Silt	28.6%
Silt & Clay (% Passing #200)	78.1%	Sand	21.8%	Clay	49.5%
Specific Gravity	2.650	Moisture Content	27.4%	Colloids	37.3%
Liquid Limit	58	Plastic Limit	32	Plastic Index	26

cription of Sand & Gravel Particles Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

hanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

erences: ASTM D 422: Particle Size Analysis of Soils
M D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
M D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 421: Dry Preparation of Soil Samples
ASTM D 854: Specific Gravity of Soils

hnical Responsibility: Brian Vaughan, P.E. _____ Signature QC Manager Position

S&ME

Liquid Limit, Plastic Limit, and Plastic Index

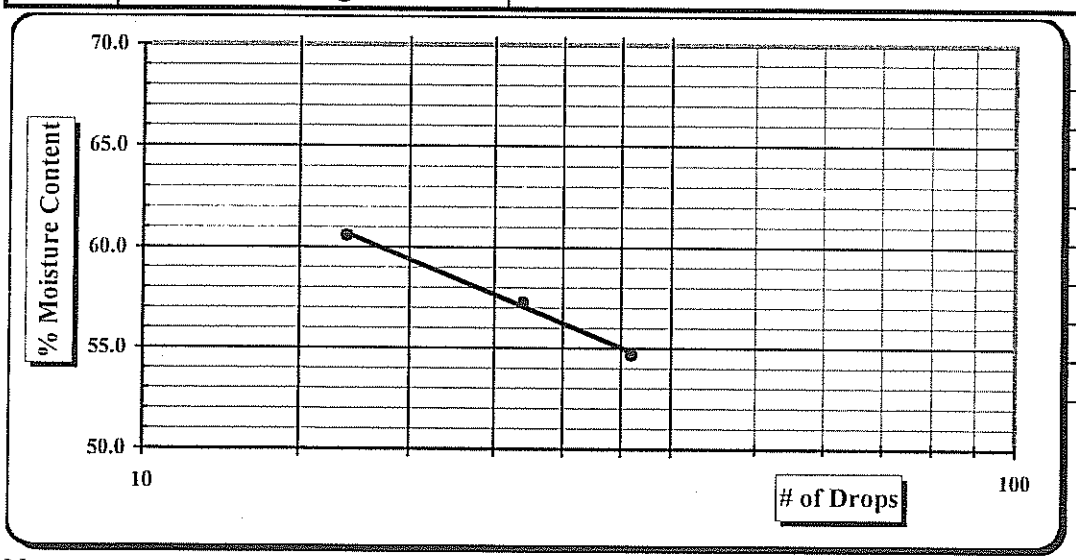
Project #:	**1411-07-103**	Report Date:	6/27/08
Project Name:	Marshall Steam Station	Test Date(s):	6/26/08
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #: M-31 Sample #: 181 Sample Date: 5/28/08

Location: Bulk Offset: N/A Elevation: 0-5'

Sample Description: Red brown clayey SILT with fine sand (MH)

Pan #		Liquid Limit						Plastic Limit		
	Test #	1	2	3	4	5	6	1	2	3
	Tare #	P-1	P-2	P-3				1	2	
A	Tare Weight	16.55	15.44	16.56				**10.83**	10.90	
B	Wet Soil Weight + A	34.94	34.39	34.12				18.51	18.20	
C	Dry Soil Weight + A	28.44	27.49	27.50				16.63	16.43	
D	Water Weight (B-C)	6.50	6.90	6.63				1.88	1.77	
E	Dry Soil Weight (C-A)	11.89	12.05	10.94				5.80	5.53	
F	% Moisture Content (D/E)*100	54.7%	57.3%	60.6%				32.4%	32.0%	
N	# OF DROPS	36	27	17				*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average							32.2%		



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes:

Special Sampling Methods:

Sample Preparation:	Wet Preparation	☐	Dry Preparation	☒	Air Dried	☒	
Liquid limit Test:	Multipoint Method	☒	One-point Method	☐			
Classification:	ASTM D 2487	☒	AASHTO M 145	☐			
Liquid limit Test:	ASTM D 4318	☒	AASHTO T 89	☐			
Plastic limit Test:	ASTM D 4318	☒	AASHTO T 90	☐			

% Passing #200 Sieve:	78.1
NP, Non-Plastic	☐
Liquid Limit	58
Plastic Limit	32
Plastic Index	26
Group Symbol	MH

Technician Name: M. Jacobs

Certification #

Technical Responsibility: Brian Vaughan, P.E.

Signature

QC Manager

Position

Particle Size Analysis of Soils

ASTM D 422

S&ME

Project #: **1411-07-103**
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Charlotte, NC

Test Date(s): 6/23 - 6/25/08
Report Date: 6/26/08

Boring #: M-33 Sample #: 181 Sample Date: 5/19/08
Location: Bulk Offset: N/A Elevation: 3.5-8.5'
Sample Description: Red tan fine sandy clayey SILT (ML)

Pan #:	10	Beaker #:	3
Hydrometer Jar #:			3
Pan Tare Weight (grams):			0.00
Total Sample Air Dried Wt. + tare wt. (grams):			491.98
Weight of Total Sample Air Dried:			491.98
Weight of Air Dried Hydrometer Sample (g):			102.42
Total Sample Oven Dried:			485.33
Hydrometer Sample Oven Dried (W):			101.02
% Passing #10:			98.6%
Correction Factor a (Table 1):			1.00

Specific Gravity 2.650

	Moisture Content	Hygroscopic	Natural
	Tare #	Z-2	353
A	Tare Wt.	16.71	0.00
B	Wet Wt. + A	30.58	258.76
C	Dry Wt. + A	30.39	208.22
D	Water Wt. (B-C)	0.19	50.54
E	Dry Wt. (C-A)	13.68	208.22
	% Moisture (100 x D/E)	1.39%	24.3%

Sieve	Retained Wt.	Percent Passing	
3.0"	0.00	Pan # (washed)	100.0%
1.5"	0.00		100.0%
1.0"	0.00		100.0%
3/4"	0.00		100.0%
1/2"	0.00		100.0%
3/8"	0.00		100.0%
#4	2.96	Soil Mortar	99.4%
#10	6.57	**100.0%**	98.6%
#20	0.99	99.0%	97.7%
#40	3.74	96.3%	95.0%
#60	9.71	90.4%	89.2%
#100	19.84	80.4%	79.3%
#200	34.13	66.2%	65.3%

Notes: Description of Sand & Gravel Particles — Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:	4.75 mm	
% Gravel:	0.6%	< 75 mm and > 4.75 mm
Coarse Sand:	0.7%	< 4.75 mm and > 2.00 mm
Medium Sand:	3.7%	< 2.00 mm and > 0.425 mm
Fine Sand:	29.7%	< 0.425 mm and > 0.075 mm

Total Sand:	34.1%	< 4.74 mm and > 0.075 mm
Silt & Clay:	65.3%	< 0.075
Silt:	35.3%	< 0.075 and > 0.005 mm
Clay:	30.0%	< 0.005 mm
Colloids:	17.5%	< 0.001 mm

Type: Mechanical Stirring Apparatus (A)
Dispersion Time: 1 min.
Sodium Hexametaphosphate: 40 g./ Liter

Control Cylinder ☐ **Composite Correction** ☒

Liquid Limit **41** Plastic Limit **28** Plastic Index **13** Hydrometer: 151H ☐ 152H ☒

Time		Temp.	Hydrometer	Corrections		Hydrometer	Percent Passing		Effective Depth	Table 3	Diameter
Clock	T (Min.)	(0.5 °C)	Reading	Control Cylinder	Composite Correction	R	P(-#10) = (R x a / W) x 100	P (total) = P x % Passing #10	L	K	D = K x $(L/T)^{1/2}$
	2	23.5	57.5		5.05	52.45	51.9%	51.2%	7.7	0.01309	0.02567
	5	23.5	52.5		5.05	47.45	47.0%	46.3%	8.5	0.01309	0.01708
	15	23.4	46.0		5.05	40.95	40.5%	40.0%	9.6	0.01317	0.01052
	30	23.4	41.5		5.05	36.45	36.1%	35.6%	10.3	0.01317	0.00772
	60	23.5	37.0		5.05	31.95	31.6%	31.2%	11.1	0.01309	0.00562
	250	23.3	31.0		5.05	25.95	25.7%	25.3%	12.0	0.01317	0.00289
	1440	23.0	24.5		5.10	19.40	19.2%	18.9%	13.1	0.01317	0.00126
	2880	23.0	22.5		5.10	17.40	17.2%	17.0%	13.4	0.01317	0.00090

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Effective Depth (cm)
L=L1+0.5(L2-(VB/A))
(152H) .164cm per increment,
V_B=67.0cm^3, L_2=14cm, A=27.8cm^2

Technician Name: M. Jacobs
Certification #

Technical Responsibility: Brian Vaughan, P.E.
Signature

OC Manager
Position

S&ME, INC.
155 Tradd Street Spartanburg, SC 29301

Hydrometer #181 (M-33, 3.5-8.5') 6-26-08.xls

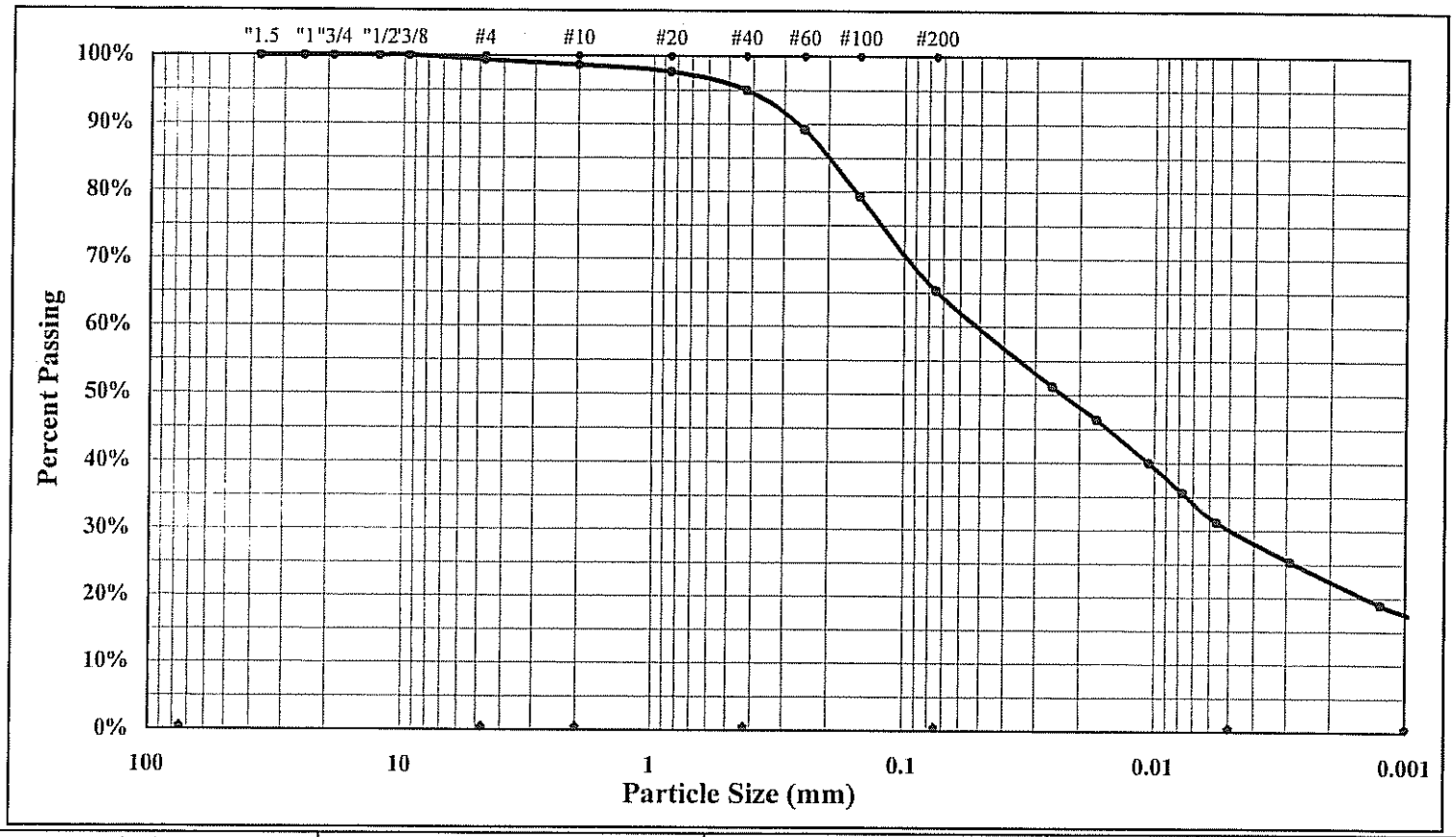
Particle Size Analysis of Soils

ASTM D 422

S&ME

S&ME Project #:	**1411-07-103**	Report Date:	6/26/08
Project Name:	**Marshall Steam Station**	Test Date(s):	6/23 - 6/25/08
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-33	Sample #:	181	Sample Date:	5/19/08
Location:	Bulk	Offset:	N/A	Elevation:	3.5-8.5'
Sample Description:	Red tan fine sandy clayey SILT (ML)				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	4.75 mm	Gravel	0.6%	Silt	35.3%
Silt & Clay (% Passing #200)	65.3%	Sand	34.1%	Clay	30.0%
Specific Gravity	2.650	Moisture Content	24.3%	Colloids	17.5%
Liquid Limit	41	Plastic Limit	28	Plastic Index	13

Description of Sand & Gravel Particles Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Mechanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

References: ASTM D 422: Particle Size Analysis of Soils
ASTM D 421: Dry Preparation of Soil Samples
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 854: Specific Gravity of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. _____ QC Manager
Signature Position

Laboratory Record Version 4.2

S&ME

Liquid Limit, Plastic Limit, and Plastic Index

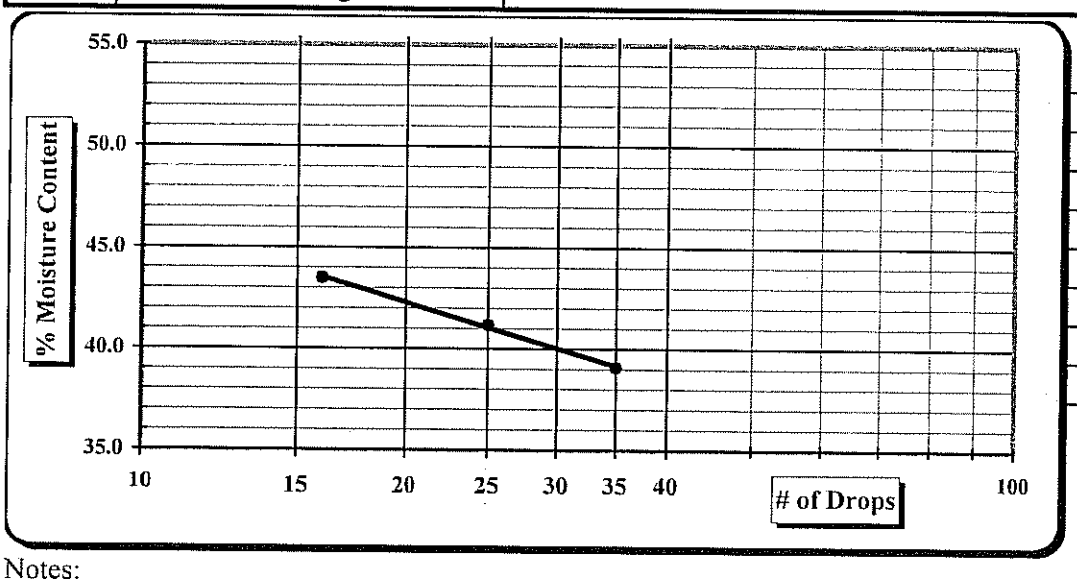
Project #:	**1411-07-103**	Report Date:	6/27/08
Project Name:	Marshall Steam Station	Test Date(s):	6/26/08
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #: M-33 Sample #: 181 Sample Date: 5/19/08

Location: Bulk Offset: N/A Elevation: 3.5-8.5'

Sample Description: Red tan fine sandy clayey SILT (ML)

Pan #		Liquid Limit						Plastic Limit		
	Test #	1	2	3	4	5	6	1	2	3
	Tare #	Q-1	Q-2	Q-3				3	4	
A	Tare Weight	16.79	16.77	15.75				**10.87**	10.82	
B	Wet Soil Weight + A	38.75	38.38	37.86				18.97	18.63	
C	Dry Soil Weight + A	32.58	32.08	31.16				17.21	16.92	
D	Water Weight (B-C)	6.17	6.30	6.70				1.76	1.72	
E	Dry Soil Weight (C-A)	15.79	15.31	15.41				6.34	6.10	
F	% Moisture Content (D/E)*100	39.1%	41.1%	43.5%				27.8%	28.1%	
N	# OF DROPS	35	25	16				*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average							27.9%		



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes:

Special Sampling Methods:

Sample Preparation:	Wet Preparation	☐	Dry Preparation	☒	Air Dried	☒	% Passing #200 Sieve: 65.3
Liquid limit Test:	Multipoint Method	☒	One-point Method	☐			NP, Non-Plastic ☐
Classification:	ASTM D 2487	☒	AASHTO M 145	☐			Liquid Limit 41
Liquid limit Test:	ASTM D 4318	☒	AASHTO T 89	☐			Plastic Limit 28
Plastic limit Test:	ASTM D 4318	☒	AASHTO T 90	☐			Plastic Index 13
							Group Symbol ML

Technician Name: M. Jacobs

Certification #

Technical Responsibility: Brian Vaughan, P.E. Signature QC Manager Position

Particle Size Analysis of Soils

ASTM D 422

S&ME

Project #: **1411-07-103**
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Charlotte, NC

Test Date(s): 5/14 - 5/16/08
Report Date: 5/19/08

Boring #: M-35 Sample #: 134 Sample Date: 5/2/08
Location: Bulk Offset: N/A Elevation: 3-8'
Sample Description: Red tan fine sandy silty CLAY (CH)

Pan #:	3	Beaker #:	3
Hydrometer Jar #:			3
Pan Tare Weight (grams):			0.00
Total Sample Air Dried Wt. + tare wt. (grams):			346.97
Weight of Total Sample Air Dried:			346.97
Weight of Air Dried Hydrometer Sample (g):			53.96
Total Sample Oven Dried:			341.80
Hydrometer Sample Oven Dried (W):			53.14
% Passing #10:			98.4%
Correction Factor a (Table 1):			1.00

Specific Gravity 2.650

	Moisture Content	Hygroscopic	Natural
	Tare #	Z-3	302
A	Tare Wt.	16.77	0.00
B	Wet Wt. + A	29.99	276.53
C	Dry Wt. + A	29.79	205.89
D	Water Wt. (B-C)	0.20	70.64
E	Dry Wt. (C-A)	13.02	205.89
	% Moisture (100 x D/E)	1.54%	34.3%

Sieve	Retained Wt.	Percent Passing	
3.0"	0.0	Pan # (washed) 53	100.0%
1.5"	0.0		100.0%
1.0"	0.0		100.0%
3/4"	0.0		100.0%
1/2"	0.0		100.0%
3/8"	0.0		100.0%
#4	2.1	Soil Mortar	99.4%
#10	5.3	**100.0%**	98.4%
#20	0.8	98.5%	97.0%
#40	2.7	94.8%	93.4%
#60	5.4	89.9%	88.5%
#100	9.3	82.4%	81.1%
#200	15.0	71.8%	70.7%

Notes: Description of Sand & Gravel Particles — Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:	4.75 mm		Total Sand:	28.7%	< 4.74 mm and > 0.075 mm	Type:	Mechanical Stirring Apparatus (A)
% Gravel:	0.6%	< 75 mm and > 4.75 mm	Silt & Clay:	70.7%	< 0.075	Dispersion Time:	1 min.
Coarse Sand:	1.0%	< 4.75 mm and > 2.00 mm	Silt:	19.7%	< 0.075 and > 0.005 mm	Sodium Hexametaphosphate:	40 g./ Liter
Medium Sand:	5.1%	< 2.00 mm and > 0.425 mm	Clay:	51.0%	< 0.005 mm		
Fine Sand:	22.7%	< 0.425 mm and > 0.075 mm	Colloids:	38.5%	< 0.001 mm	**Control Cylinder** ☐	**Composite Correction** ☒

Liquid Limit **65** Plastic Limit **32** Plastic Index **33** Hydrometer: 151H ☐ 152H ☒

Time		Temp.	Hydrometer	Corrections		Hydrometer	Percent Passing		Effective Depth	Table 3	Diameter
Clock	T (Min.)	(0.5 °C)	Reading	Control Cylinder	Composite Correction	R	P(-#10) = (R x a / W) x 100	P (total) = P x % Passing #10	L	K	D = K x ((L/T)^1/2
	2	23.8	40.0		5.00	35.00	65.9%	64.8%	10.6	0.01309	0.03007
	5	23.8	38.5		5.00	33.50	63.0%	62.1%	10.8	0.01309	0.01924
	15	23.7	36.5		5.05	31.45	59.2%	58.3%	11.1	0.01309	0.01128
	30	23.7	34.7		5.05	29.65	55.8%	54.9%	11.4	0.01309	0.00808
	60	23.6	33.0		5.05	27.95	52.6%	51.8%	11.7	0.01309	0.00578
	250	22.9	30.5		5.10	25.40	47.8%	47.1%	12.1	0.01325	0.00292
	1440	23.3	27.0		5.05	21.95	41.3%	40.7%	12.7	0.01317	0.00124
	2880	23.2	25.5		5.10	20.40	38.4%	37.8%	12.9	0.01317	0.00088

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Effective Depth (cm)
L=L1+0.5(L2-(VB/A))
(152H) .164cm per increment,
V_B=67.0cm^3, L_2=14cm, A=27.8cm^2

Technician Name: M. Jacobs

Technical Responsibility: Brian Vaughan, P.E.

Certification #

Signature

OC Manager
Position

S&ME, INC. **155 Tradd Street Spartanburg, SC 29301**

Hydrometer #134 (M-35, 3-8') 5-19-08.xls

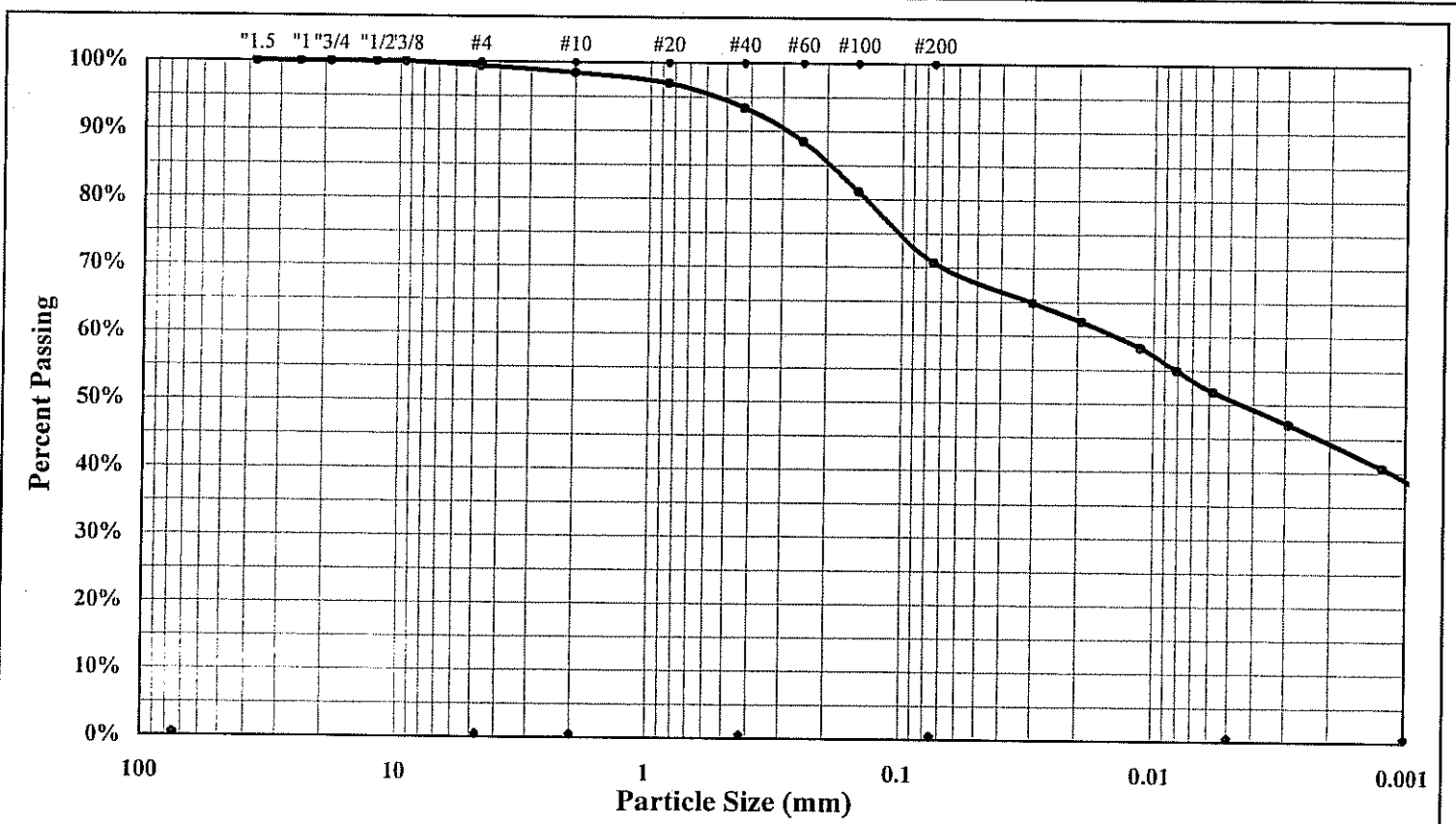
Particle Size Analysis of Soils

ASTM D 422

S&ME

S&ME Project #:	**1411-07-103**	Report Date:	5/19/08
Project Name:	**Marshall Steam Station**	Test Date(s):	5/14 - 5/16/08
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-35	Sample #:	134	Sample Date:	5/2/08
Location:	Bulk	Offset:	N/A	Elevation:	3-8'
Sample Description:	Red tan fine sandy silty CLAY (CH)				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	4.75 mm	Gravel	0.6%	Silt	19.7%
Silt & Clay (% Passing #200)	70.7%	Sand	28.7%	Clay	51.0%
Specific Gravity	2.650	Moisture Content	34.3%	Colloids	38.5%
Liquid Limit	65	Plastic Limit	32	Plastic Index	33

Description of Sand & Gravel Particles Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Mechanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

References: ASTM D 422: Particle Size Analysis of Soils
ASTM D 421: Dry Preparation of Soil Samples
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 854: Specific Gravity of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. _____ QC Manager

Signature Position

Moisture - Density Relationship

S&ME

S&ME Project #:	**1411-07-103**	Test Date(s):	May 8, 2008
Project Name:	Marshall Steam Station	Report Date:	May 9, 2008
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-35	Sample #:	134	Sample Date:	May 2, 2008
Location:	Bulk	Offset:	N/A	Depth:	3-8'

Sample Description: Red tan fine sandy silty CLAY (CH)

Liquid Limit:	65	Specific Gravity:	2.650
Plastic Limit:	32	Plastic Index:	33

Natural Moisture Content: 34.3%

Moisture Content of the Oversize Fraction:

NOTES:

Sieve Size	% Passing
#4	99.4
#10	98.4
#20	97.0
#40	93.4
#60	88.5
#100	81.1
#200	70.7

MDD: 95.7 **Opt. MC %: 24.8**

Water Content

Water Content requires GP 2 Balance (0.1 gram Readability).

ASTM D2216 ☒ AASHTO T265 ☐ ASTM D4959 ☐ ASTM D4643 ☐

	Sample #:	1	2	3	4	5	6
	Water Added:						
	Tare #:						
A. Tare Weight	A.	0	0	0	0	0	0
B. Wet Wt + Tare Wt	B.	500	500	500	500	500	500
C. Dry Wt. + Tare Wt.	C.	409.4	403.7	395.9	389.2		
D. Water Weight	B-C	90.6	96.3	104.1	110.8	500	500
E. Dry Weight	C-A	409.4	403.7	395.9	389.2	0	0
F. Moisture Content	100*D/E	**22.1%**	**23.9%**	**26.3%**	**28.5%**	**#DIV/0!**	**#DIV/0!**

Compaction Data

The Compaction Test requires a GP 5 Balance for ASTM (1 gram or .0022 Lb. readability).

G. Wt of Soil + Mold	G.	13.050	13.232	13.288	13.240		
H. Wt. of Mold	H.	9.304	9.304	9.304	9.304	9.304	9.304
I. Wt. of Soil (g. or lbs.)	G-H	3.746	3.928	3.984	3.936	-9.304	-9.304
J. Wt of Soil (Lbs.)	I/453.6 or I	3.746	3.928	3.984	3.936	-9.304	-9.304
K. Mold Volume Factor	K.	30.093	30.093	30.093	30.093	30.093	30.093
L. Wet Density	J*K	112.7	118.2	119.9	118.4	-280.0	-280.0
M. Dry Density	L/(1+F)	**92.3**	**95.4**	**94.9**	**92.2**	**#DIV/0!**	**#DIV/0!**

ASTM D558 ☐ ASTM D 698 ☒ ASTM D1557 ☐ AASHTO T99 ☐ AASHTO T180 ☐

Method A ☒ Method B ☐ Method C ☐ Method D (ASTM 1978) ☐ AASHTO Method D ☐

Moisture-Density Relation of: Fine Fraction ☒ Corrected for Coarse Fraction (ASTM D 4718) ☐

Sieve Size used to separate the Oversize Fraction: #4 Sieve ☒ 3/8 inch Sieve ☐ 3/4 inch Sieve ☐

Mechanical Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

Soil Plasticity: ASTM D 4318 ☒ AASHTO T 89 ☐ AASHTO T 90 ☐

Sieve Analysis / Particle Size Analysis: ASTM C136 ☐ AASHTO T 27 ☐ ASTM D 422 ☒ AASHTO T 88 ☐

Specific Gravity of Soil: ASTM D 854 ☒ AASHTO T 100 ☐

Bulk Gravity of Oversize Fraction: ASTM C 127 ☐ AASHTO T 85 ☐

Soil Classification: ASTM D 2487 ☒ ASTM D 2488 ☐ AASHTO M 145 ☐

Technician Name: B. Hatton

Certification #

Technical Responsibility: Brian Vaughan, P.E. Signature Construction Services Manager Position

Laboratory Report Version 4.2

Moisture - Density Report

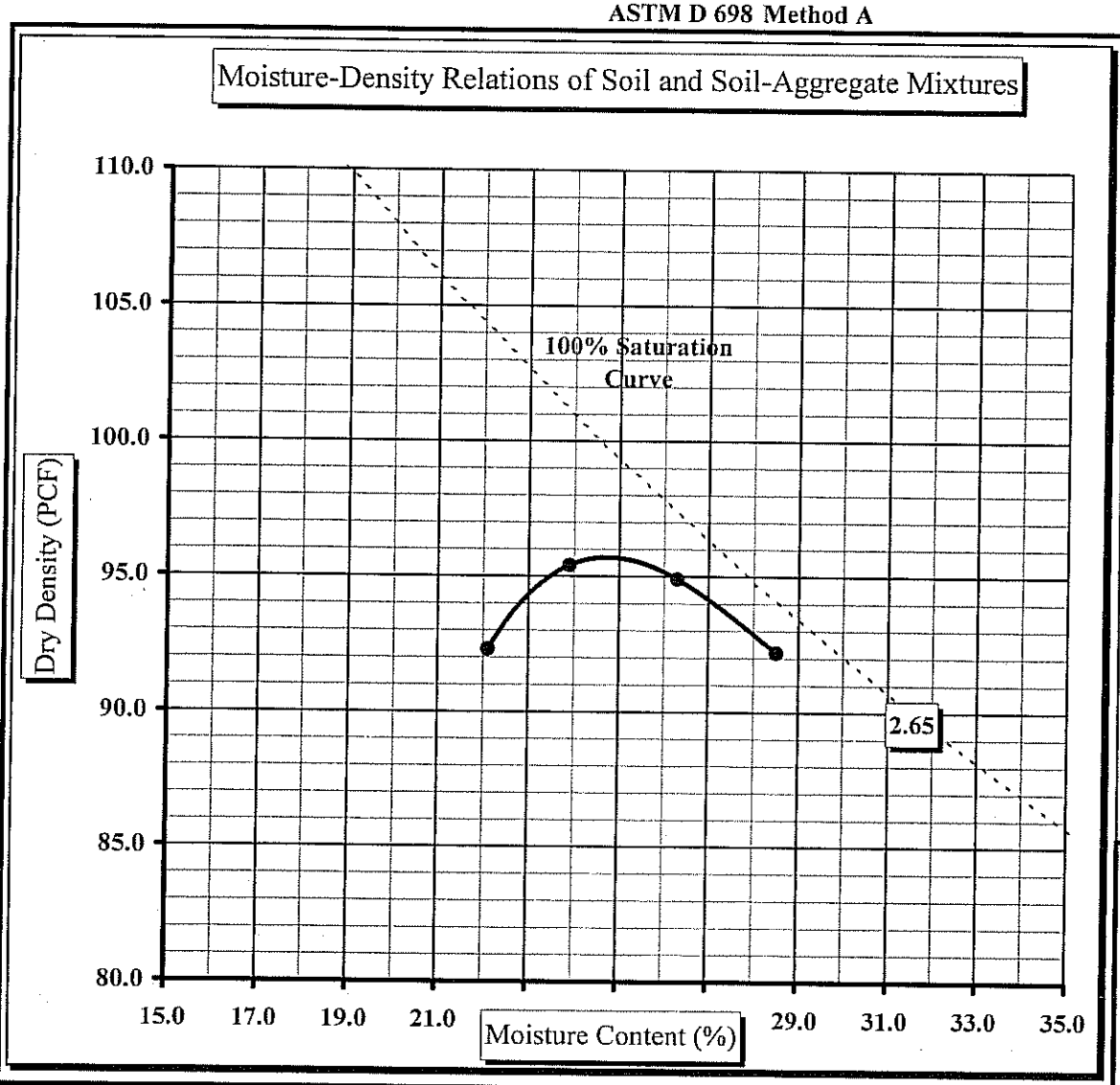
S&ME

S&ME Project #:	**1411-07-103**	Report Date:	May 9, 2008
Project Name:	**Marshall Steam Station**	Test Date(s):	May 8, 2008
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-35	Sample #:	134	Sample Date:	May 2, 2008
Location:	Bulk	Offset:	N/A	Depth:	3-8'
Sample Description:	Red tan fine sandy silty CLAY (CH)				

Maximum Dry Density **95.7** **PCF.** **Optimum Moisture Content** **24.8** **%**

ASTM D 698 Method A



Soil Properties

Natural Moisture Content:	34.3%
Liquid Limit:	65
Plastic Limit:	32
Plastic Index:	33
Specific Gravity:	2.650

% Passing

#4	99.4
#10	98.4
#20	97.0
#40	93.4
#60	88.5
#100	81.1
#200	70.7

Oversize Fraction

Bulk Sp. Gravity
% Moisture
Oversize Fraction
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 Hammer ☐ Manual Hammer ☒ Moist Preparation ☒ Dry Preparation ☐

References: ASTM D 698: Laboratory Compaction Characteristics of Soil Using Standard Effort
ASTM D 2216: Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D 422: Particle Size Analysis of Soils ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

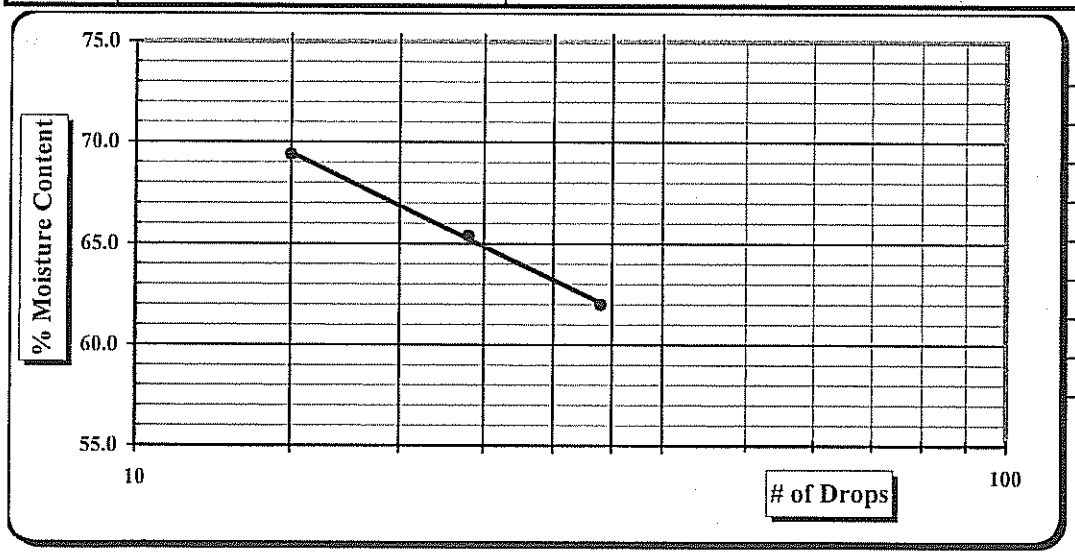
Technical Responsibility: Brian Vaughan, P.E. Construction Services Manager

S&ME

Liquid Limit, Plastic Limit, and Plastic Index

Project #: **1411-07-103** Report Date: 5/19/08
Project Name: Marshall Steam Station Test Date(s): 5/16/08
Client Name: Duke Energy
Client Address: Charlotte, NC
Boring #: M-35 Sample #: 134 Sample Date: 5/2/08
Location: Bulk Offset: N/A Elevation: 3-8'
Sample Description: Red tan fine sandy silty CLAY (CH)

Pan #		Liquid Limit						Plastic Limit		
	Test #	1	2	3	4	5	6	1	2	3
	Tare #	Y-1	Y-2	Y-3				5	6	
A	Tare Weight	16.52	16.55	17.00				**10.93**	10.91	
B	Wet Soil Weight + A	36.12	35.70	35.26				19.13	18.90	
C	Dry Soil Weight + A	28.62	28.13	27.78				17.13	16.94	
D	Water Weight (B-C)	7.50	7.57	7.48				2.00	1.96	
E	Dry Soil Weight (C-A)	12.10	11.58	10.78				6.20	6.03	
F	% Moisture Content (D/E)*100	62.0%	65.4%	69.4%				32.3%	32.5%	
N	# OF DROPS	34	24	15				*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average							32.4%		



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes:

Special Sampling Methods:

Sample Preparation:	Wet Preparation	☐	Dry Preparation	☒	Air Dried	☒	% Passing #200 Sieve: 70.7
Liquid limit Test:	Multipoint Method	☒	One-point Method	☐			NP, Non-Plastic ☐
Classification:	ASTM D 2487	☒	AASHTO M 145	☐			Liquid Limit 65
Liquid limit Test:	ASTM D 4318	☒	AASHTO T 89	☐			Plastic Limit 32
Plastic limit Test:	ASTM D 4318	☒	AASHTO T 90	☐			Plastic Index 33
							Group Symbol CH

Technician Name: M. Jacobs

Certification #

Technical Responsibility: Brian Vaughan, P.E. Signature QC Manager Position

Particle Size Analysis of Soils

ASTM D 422

S&ME

Project #: **1411-07-103**
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Charlotte, NC

Test Date(s): 6/23 - 6/25/08
Report Date: 6/26/08

Boring #: M-39 Sample #: 181 Sample Date: 5/12/08
Location: Bulk Offset: N/A Elevation: 1-9'
Sample Description: Brown red micaceous fine sandy clayey SILT (ML)

Pan #:	11	Beaker #:	4
Hydrometer Jar #:			4
Pan Tare Weight (grams):			0.00
Total Sample Air Dried Wt. + tare wt. (grams):			455.30
Weight of Total Sample Air Dried:			455.30
Weight of Air Dried Hydrometer Sample (g):			102.98
Total Sample Oven Dried:			439.85
Hydrometer Sample Oven Dried (W):			99.48
% Passing #10:			99.8%
Correction Factor a (Table 1):			1.00

Specific Gravity 2.650

	Moisture Content	Hygroscopic	Natural
	Tare #	Z-3	362
A	Tare Wt.	16.78	0.00
B	Wet Wt. + A	29.72	186.77
C	Dry Wt. + A	29.28	148.97
D	Water Wt. (B-C)	0.44	37.80
E	Dry Wt. (C-A)	12.50	148.97
	% Moisture (100 x D/E)	3.52%	25.4%

Sieve	Retained Wt.	Percent Passing	
3.0"	0.00	Pan # (washed)	100.0%
1.5"	0.00		100.0%
1.0"	0.00		100.0%
3/4"	0.00		100.0%
1/2"	0.00		100.0%
3/8"	0.00		100.0%
#4	0.32	Soil Mortar	99.9%
#10	1.04	**100.0%**	99.8%
#20	0.79	99.2%	99.0%
#40	6.48	93.5%	93.3%
#60	15.26	84.7%	84.5%
#100	27.29	72.6%	72.4%
#200	40.66	59.1%	59.0%

Notes: Description of Sand & Gravel Particles Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:	4.75 mm		Total Sand:	40.9%	< 4.74 mm and > 0.075 mm
% Gravel:	0.1%	< 75 mm and > 4.75 mm	Silt & Clay:	59.0%	< 0.075
Coarse Sand:	0.2%	< 4.75 mm and > 2.00 mm	Silt:	26.5%	< 0.075 and > 0.005 mm
Medium Sand:	6.5%	< 2.00 mm and > 0.425 mm	Clay:	32.5%	< 0.005 mm
Fine Sand:	34.3%	< 0.425 mm and > 0.075 mm	Colloids:	25.0%	< 0.001 mm

Type: Mechanical Stirring Apparatus (A)
Dispersion Time: 1 min.
Sodium Hexametaphosphate: 40 g./ Liter

Control Cylinder ☐ **Composite Correction** ☒

Liquid Limit **45** Plastic Limit **33** Plastic Index **12** Hydrometer: 151H ☐ 152H ☒

Time		Temp.	Hydrometer	Corrections		Hydrometer	Percent Passing		Effective Depth	Table 3	Diameter
Clock	T (Min.)	(0.5 °C)	Reading	Control Cylinder	Composite Correction	R	P(-#10) = (R x a / W) x 100	P (total) = P x % Passing #10	L	K	D = K x ((L/T)^1/2
	2	23.5	52.5		5.05	47.45	47.7%	47.6%	8.5	0.01309	0.02701
	5	23.5	48.5		5.05	43.45	43.7%	43.6%	9.2	0.01309	0.01773
	15	23.5	44.0		5.05	38.95	39.2%	39.1%	9.9	0.01309	0.01064
	30	23.5	41.0		5.05	35.95	36.1%	36.1%	10.4	0.01309	0.00771
	60	23.5	38.0		5.05	32.95	33.1%	33.0%	10.9	0.01309	0.00558
	250	23.3	33.5		5.05	28.45	28.6%	28.5%	11.6	0.01317	0.00284
	1440	22.8	30.5		5.10	25.40	25.5%	25.5%	12.1	0.01325	0.00122
	2880	22.9	29.0		5.10	23.90	24.0%	24.0%	12.4	0.01325	0.00087

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Effective Depth (cm)
L=L1+0.5(L2-(VB/A))
(152H) .164cm per increment,
V_B=67.0cm^3, L_2=14cm, A=27.8cm^2

Technician Name: M. Jacobs

Technical Responsibility: Brian Vaughan, P.E.

Certification #

Signature

QC Manager
Position

S&ME, INC. **155 Tradd Street Spartanburg, SC 29301**

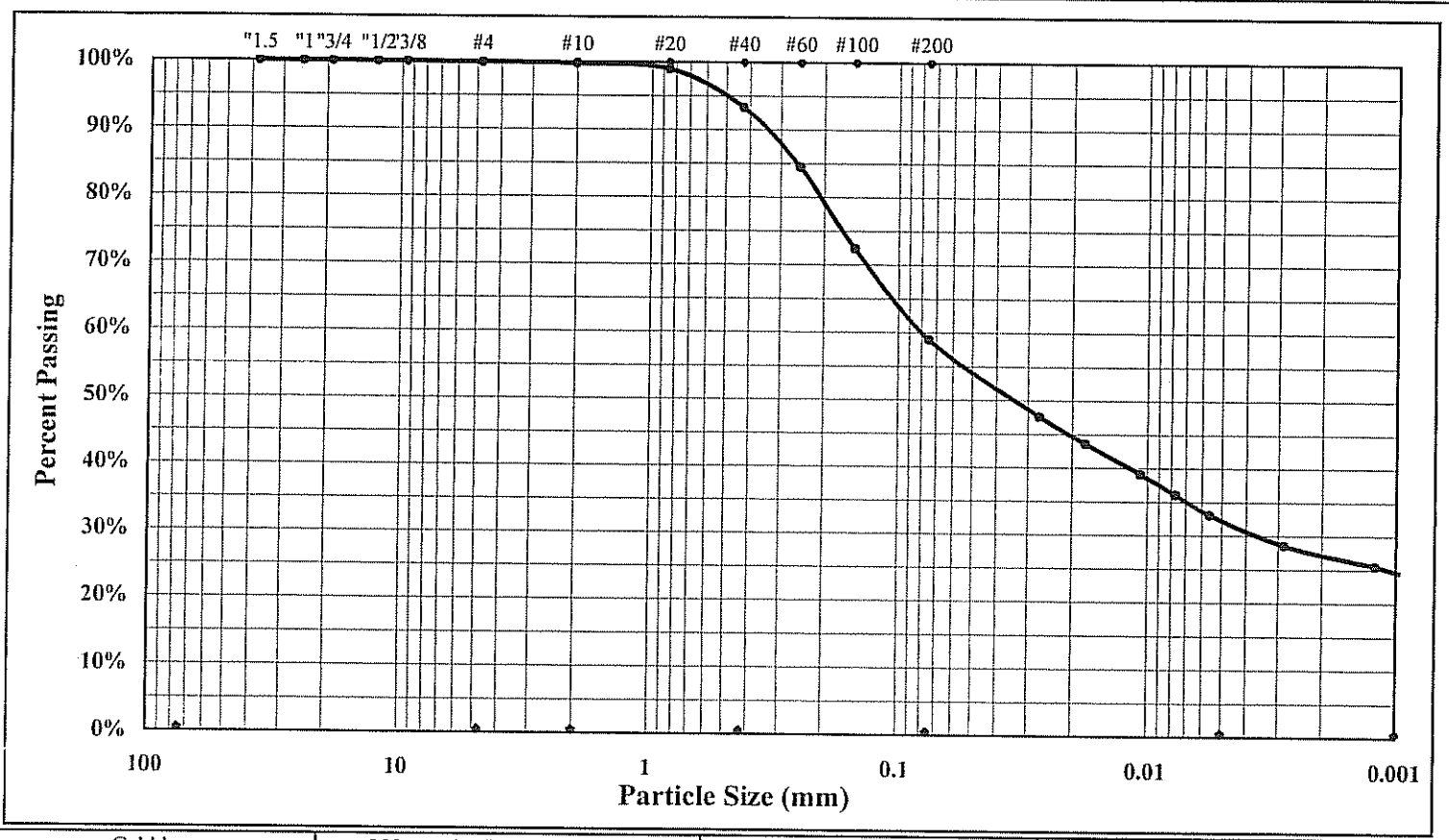
Hydrometer #181 (M-39, 1-9') 6-26-08.xls

Particle Size Analysis of Soils

ASTM D 422

S&ME Project #:	**1411-07-103**	Report Date:	6/26/08
Project Name:	**Marshall Steam Station**	Test Date(s):	6/23 - 6/25/08
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-39	Sample #:	181	Sample Date:	5/12/08
Location:	Bulk	Offset:	N/A	Elevation:	1-9'
Sample Description:	Brown red micaceous fine sandy clayey SILT (ML)				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	4.75 mm	Gravel	0.1%	Silt	26.5%
Silt & Clay (% Passing #200)	59.0%	Sand	40.9%	Clay	32.5%
Specific Gravity	2.650	Moisture Content	25.4%	Colloids	25.0%
Liquid Limit	45	Plastic Limit	33	Plastic Index	12

escription of Sand & Gravel Particles Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

echanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

eferences: ASTM D 422: Particle Size Analysis of Soils
STM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
STM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 421: Dry Preparation of Soil Samples
ASTM D 854: Specific Gravity of Soils

echnical Responsibility: Brian Vaughan, P.E. _____ QC Manager
Signature *Position*

Laboratory Record Version 4.2

S&ME

Liquid Limit, Plastic Limit, and Plastic Index

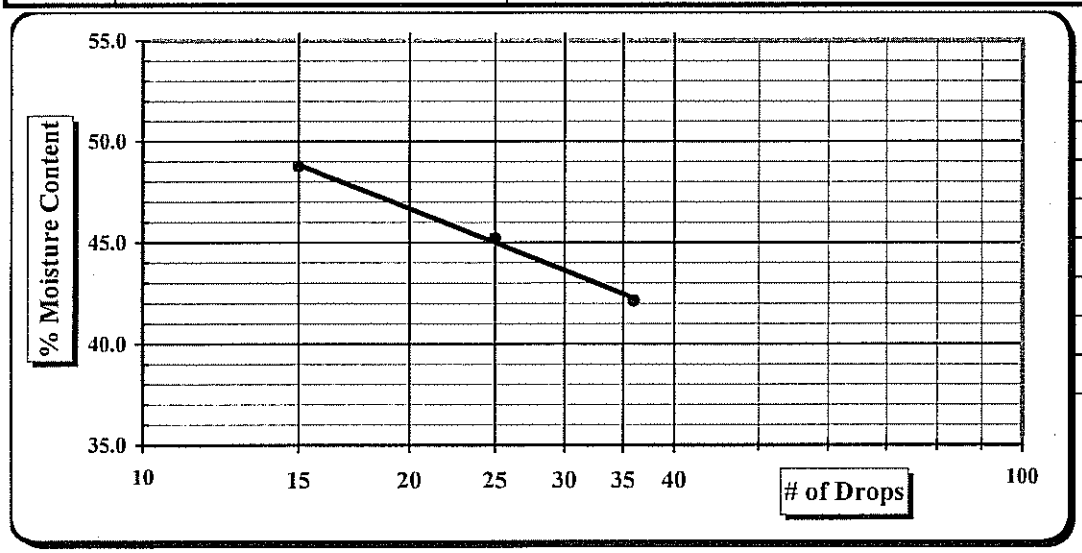
Project #:	**1411-07-103**	Report Date:	6/27/08
Project Name:	Marshall Steam Station	Test Date(s):	6/26/08
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #: M-39 Sample #: 181 Sample Date: 5/12/08

Location: Bulk Offset: N/A Elevation: 1-9'

Sample Description: Brown red micaceous fine sandy clayey SILT (ML)

Pan #		Liquid Limit						Plastic Limit		
	Test #	1	2	3	4	5	6	1	2	3
	Tare #	Y-1	Y-2	Y-3				5	6	
A	Tare Weight	16.52	16.55	17.00				**10.94**	10.90	
B	Wet Soil Weight + A	37.91	36.31	37.14				19.16	18.61	
C	Dry Soil Weight + A	31.57	30.16	30.54				17.11	16.70	
D	Water Weight (B-C)	6.34	6.15	6.60				2.05	1.91	
E	Dry Soil Weight (C-A)	15.05	13.61	13.54				6.17	5.80	
F	% Moisture Content (D/E)*100	42.1%	45.2%	48.7%				33.2%	32.9%	
N	# OF DROPS	36	25	15				*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average							33.1%		



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes:

Special Sampling Methods:

Sample Preparation:	Wet Preparation	☐	Dry Preparation	☒	Air Dried	☒	% Passing #200 Sieve: 59.0
Liquid limit Test:	Multipoint Method	☒	One-point Method	☐			NP, Non-Plastic ☐
Classification:	ASTM D 2487	☒	AASHTO M 145	☐			Liquid Limit 45
Liquid limit Test:	ASTM D 4318	☒	AASHTO T 89	☐			Plastic Limit 33
Plastic limit Test:	ASTM D 4318	☒	AASHTO T 90	☐			Plastic Index 12
							Group Symbol ML

Technician Name: M. Jacobs

Certification #

Technical Responsibility: Brian Vaughan, P.E.

Signature

QC Manager

Position

Particle Size Analysis of Soils

ASTM D 422

S&ME

Project #: **1411-07-103**
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Charlotte, NC

Test Date(s): 6/23 - 6/25/08
Report Date: 6/26/08

Boring #: M-40 Sample #: 181 Sample Date: 5/13/08
Location: Bulk Offset: N/A Elevation: 29.2-34.2'
Sample Description: Light brown micaceous clayey silty medium to fine SAND (SM)

Pan #:	12	Beaker #:	5
Hydrometer Jar #:			5
Pan Tare Weight (grams):			0.00
Total Sample Air Dried Wt. + tare wt. (grams):			576.08
Weight of Total Sample Air Dried:			576.08
Weight of Air Dried Hydrometer Sample (g):			102.05
Total Sample Oven Dried:			566.41
Hydrometer Sample Oven Dried (W):			100.29
% Passing #10:			97.3%
Correction Factor a (Table 1):			1.00

Specific Gravity 2.650

	Moisture Content	Hygroscopic	Natural
	Tare #	Z-4	363
A	Tare Wt.	15.80	0.00
B	Wet Wt. + A	28.55	217.75
C	Dry Wt. + A	28.33	192.11
D	Water Wt. (B-C)	0.22	25.64
E	Dry Wt. (C-A)	12.53	192.11
	% Moisture (100 x D/E)	1.76%	13.3%

Sieve	Retained Wt.	Percent Passing	
3.0"	0.00	Pan # (washed)	100.0%
1.5"	0.00		100.0%
1.0"	0.00		100.0%
3/4"	0.00		100.0%
1/2"	0.00		100.0%
3/8"	0.00		100.0%
#4	3.42	Soil Mortar	99.4%
#10	15.45	**100.0%**	97.3%
#20	3.52	96.5%	93.9%
#40	13.12	86.9%	84.5%
#60	24.27	75.8%	73.7%
#100	37.71	62.4%	60.7%
#200	53.03	47.1%	45.8%

Notes: Description of Sand & Gravel Particles — Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:	4.75 mm	Total Sand:	53.6%	< 4.74 mm and > 0.075 mm	Type: Mechanical Stirring Apparatus (A)
% Gravel:	0.6%	< 75 mm and > 4.75 mm	Silt & Clay:	45.8%	< 0.075 — Dispersion Time: 1 min.
Coarse Sand:	2.1%	< 4.75 mm and > 2.00 mm	Silt:	32.8%	< 0.075 and > 0.005 mm — Sodium Hexametaphosphate: 40 g./ Liter
Medium Sand:	12.7%	< 2.00 mm and > 0.425 mm	Clay:	13.0%	< 0.005 mm
Fine Sand:	38.7%	< 0.425 mm and > 0.075 mm	Colloids:	5.2%	< 0.001 mm — **Control Cylinder** ☐ **Composite Correction** ☒

Liquid Limit **33** Plastic Limit **31** Plastic Index **2** Hydrometer: 151H ☐ 152H ☒

Time		Temp.	Hydrometer	Corrections		Hydrometer	Percent Passing		Effective Depth	Table 3	Diameter
Clock	T (Min.)	(0.5 °C)	Reading	Control Cylinder	Composite Correction	R	P(-#10) = (R x a / W) x 100	P (total) = P x % Passing #10	L	K	D = K x ((L/T)^1/2
	2	23.5	37.5		5.05	32.45	32.4%	31.5%	11.0	0.01309	0.03066
	5	23.5	32.0		5.05	26.95	26.9%	26.1%	11.9	0.01309	0.02017
	15	23.5	26.0		5.05	20.95	20.9%	20.3%	12.9	0.01309	0.01212
	30	23.5	23.0		5.05	17.95	17.9%	17.4%	13.4	0.01309	0.00873
	60	23.5	20.0		5.05	14.95	14.9%	14.5%	13.8	0.01309	0.00629
	250	23.2	15.5		5.10	10.40	10.4%	10.1%	14.6	0.01317	0.00318
	1440	22.8	12.0		5.10	6.90	6.9%	6.7%	15.2	0.01325	0.00136
	2880	22.9	10.5		5.10	5.40	5.4%	5.2%	15.4	0.01325	0.00097

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Effective Depth (cm)
L=L1+0.5(L2-(VB/A))
(152H) .164cm per increment,
V_B=67.0cm^3, L_2=14cm, A=27.8cm^2

Technician Name: M. Jacobs
Certification #

Technical Responsibility: Brian Vaughan, P.E.
Signature

QC Manager
Position

S&ME, INC. **155 Tradd Street Spartanburg, SC 29301** **Hydrometer #181 (M-40, 29.2-34.2') 6-26-08.xls**

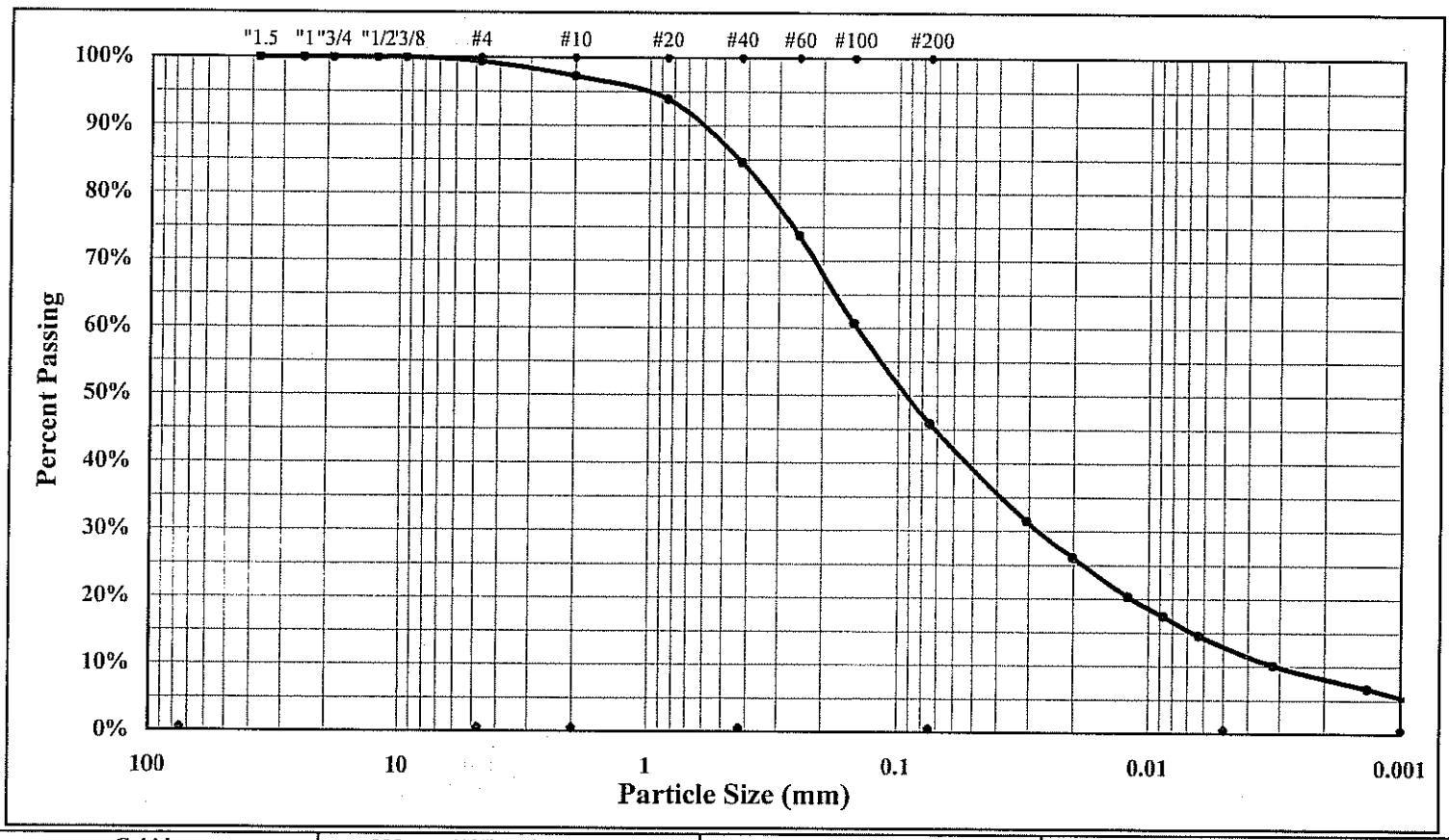
Particle Size Analysis of Soils

ASTM D 422

S&ME

S&ME Project #:	**1411-07-103**	Report Date:	6/26/08
Project Name:	**Marshall Steam Station**	Test Date(s):	6/23 - 6/25/08
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-40	Sample #:	181	Sample Date:	5/13/08
Location:	Bulk	Offset:	N/A	Elevation:	29.2-34.2'
Sample Description:	Light brown micaceous clayey silty medium to fine SAND (SM)				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	4.75 mm	Gravel	0.6%	Silt	32.8%
Silt & Clay (% Passing #200)	45.8%	Sand	53.6%	Clay	13.0%
Specific Gravity	2.650	Moisture Content	13.3%	Colloids	5.2%
Liquid Limit	33	Plastic Limit	31	Plastic Index	2

Description of Sand & Gravel Particles Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Mechanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

References: ASTM D 422: Particle Size Analysis of Soils
ASTM D 421: Dry Preparation of Soil Samples
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 854: Specific Gravity of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. _____ QC Manager

Signature *Position*

S&ME

Liquid Limit, Plastic Limit, and Plastic Index

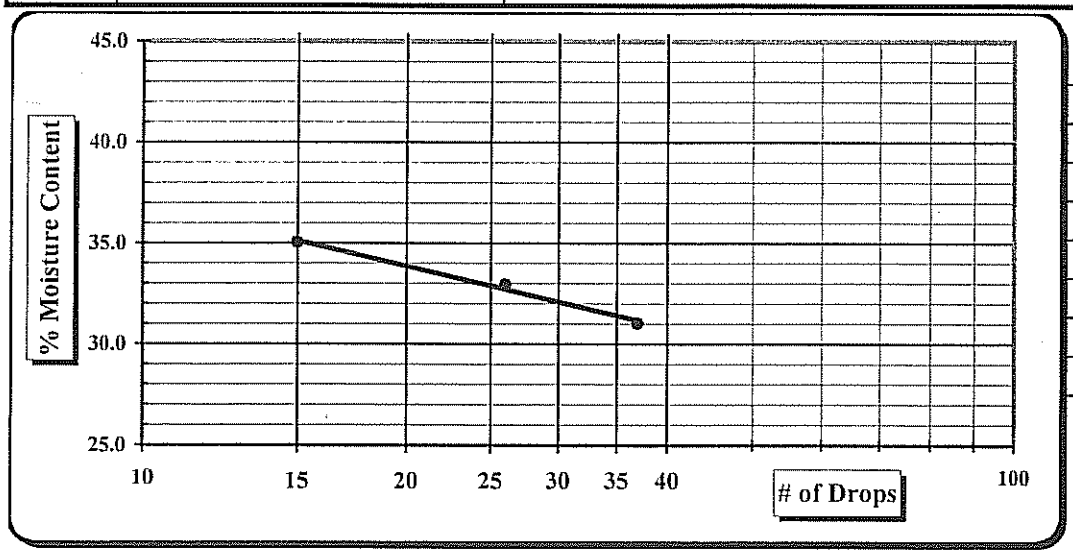
Project #:	**1411-07-103**	Report Date:	6/27/08
Project Name:	Marshall Steam Station	Test Date(s):	6/26/08
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #: M-40 Sample #: 181 Sample Date: 5/13/08

Location: Bulk Offset: N/A Elevation: 29.2-34.2'

Sample Description: Light brown micaceous clayey silty medium to fine SAND (SM)

Pan #		Liquid Limit						Plastic Limit		
	Test #	1	2	3	4	5	6	1	2	3
	Tare #	Z-1	Z-2	Z-3				13	14	
A	Tare Weight	15.98	16.71	16.77				**12.10**	12.15	
B	Wet Soil Weight + A	38.45	39.19	38.13				19.76	19.30	
C	Dry Soil Weight + A	33.13	33.62	32.59				17.96	17.64	
D	Water Weight (B-C)	5.32	5.57	5.54				1.80	1.67	
E	Dry Soil Weight (C-A)	17.15	16.91	15.82				5.86	5.49	
F	% Moisture Content (D/E)*100	31.0%	32.9%	35.0%				30.7%	30.4%	
N	# OF DROPS	37	26	15				*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average							30.5%		



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes:

Special Sampling Methods:

Sample Preparation:	Wet Preparation	☐	Dry Preparation	☒	Air Dried	☒	% Passing #200 Sieve: 45.8
Liquid limit Test:	Multipoint Method	☒	One-point Method	☐			NP, Non-Plastic ☐
Classification:	ASTM D 2487	☒	AASHTO M 145	☐			Liquid Limit 33
Liquid limit Test:	ASTM D 4318	☒	AASHTO T 89	☐			Plastic Limit 31
Plastic limit Test:	ASTM D 4318	☒	AASHTO T 90	☐			Plastic Index 2
							Group Symbol SM

Technician Name: M. Jacobs

Certification #

Technical Responsibility: Brian Vaughan, P.E. *Signature* QC Manager *Position*

Particle Size Analysis of Soils

ASTM D 422

S&ME

Project #: 1411-07-103
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Charlotte, NC

Test Date(s): 6/23 - 6/25/08
Report Date: 6/26/08

Boring #: M-41 Sample #: 181 Sample Date: 5/13/08
Location: Bulk Offset: N/A Elevation: 24.5-29.5'
Sample Description: Brown tan micaceous fine sandy clayey SILT (ML)

Pan #:	13	Beaker #:	6
Hydrometer Jar #:			6
Pan Tare Weight (grams):			0.00
Total Sample Air Dried Wt. + tare wt. (grams):			514.54
Weight of Total Sample Air Dried:			514.54
Weight of Air Dried Hydrometer Sample (g):			52.41
Total Sample Oven Dried:			508.15
Hydrometer Sample Oven Dried (W):			51.75
% Passing #10:			99.1%
Correction Factor a (Table 1):			1.00

Specific Gravity 2.650

	Moisture Content	Hygroscopic	Natural
	Tare #	Z-5	365
A	Tare Wt.	15.61	0.00
B	Wet Wt. + A	28.38	206.74
C	Dry Wt. + A	28.22	189.42
D	Water Wt. (B-C)	0.16	17.32
E	Dry Wt. (C-A)	12.61	189.42
	% Moisture (100 x D/E)	1.27%	9.1%

Sieve	Retained Wt.	Percent Passing	
3.0"	0.00	Pan # (washed)	100.0%
1.5"	0.00		100.0%
1.0"	0.00		100.0%
3/4"	0.00		100.0%
1/2"	0.00		100.0%
3/8"	0.00		100.0%
#4	0.70	Soil Mortar	99.9%
#10	4.54	**100.0%**	99.1%
#20	0.66	98.7%	97.8%
#40	3.34	93.5%	92.7%
#60	7.74	85.0%	84.3%
#100	13.98	73.0%	72.3%
#200	22.42	56.7%	56.2%

Notes: Description of Sand & Gravel Particles — Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:	4.75 mm	
% Gravel:	0.1%	< 75 mm and > 4.75 mm
Coarse Sand:	0.8%	< 4.75 mm and > 2.00 mm
Medium Sand:	6.4%	< 2.00 mm and > 0.425 mm
Fine Sand:	36.5%	< 0.425 mm and > 0.075 mm

Total Sand:	43.7%	< 4.74 mm and > 0.075 mm
Silt & Clay:	56.2%	< 0.075
Silt:	41.3%	< 0.075 and > 0.005 mm
Clay:	14.9%	< 0.005 mm
Colloids:	6.5%	< 0.001 mm

Type: Mechanical Stirring Apparatus (A)
Dispersion Time: 1 min.
Sodium Hexametaphosphate: 40 g./ Liter

Control Cylinder ☐ Composite Correction ☒

Liquid Limit 37 Plastic Limit 27 Plastic Index 10 Hydrometer: 151H ☐ 152H ☒

Time Clock	Time T (Min.)	Temp. (0.5 °C)	Hydrometer Reading	Corrections Control Cylinder	Corrections Composite Correction	Hydrometer R	Percent Passing P(-#10) = (R x a / W) x 100	Percent Passing P (total) = P x % Passing #10	Effective Depth L	Table 3 K	Diameter D = K x ((L/T)^1/2
	2	23.3	25.0		5.05	19.95	38.5%	38.2%	13.0	0.01317	0.03361
	5	23.3	21.5		5.05	16.45	31.8%	31.5%	13.6	0.01317	0.02172
	15	23.3	18.0		5.05	12.95	25.0%	24.8%	14.2	0.01317	0.01280
	30	23.3	16.0		5.05	10.95	21.2%	21.0%	14.5	0.01317	0.00916
	60	23.3	14.0		5.05	8.95	17.3%	17.1%	14.8	0.01317	0.00655
	250	23.2	11.0		5.10	5.90	11.4%	11.3%	15.3	0.01317	0.00326
	1440	22.8	9.0		5.10	3.90	7.5%	7.5%	15.7	0.01325	0.00138
	2880	22.9	8.5		5.10	3.40	6.6%	6.5%	15.7	0.01325	0.00098

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Effective Depth (cm)
L=L1+0.5(L2-(VB/A))
(152H) .164cm per increment,
V_B=67.0cm^3, L_2=14cm, A=27.8cm^2

Technician Name: M. Jacobs

Technical Responsibility: Brian Vaughan, P.E.

Certification #

Signature

OC Manager
Position

S&ME, INC.
155 Tradd Street Spartanburg, SC 29301

Hydrometer #181 (M-41, 24.5-29.5') 6-26-08.xls

Particle Size Analysis of Soils

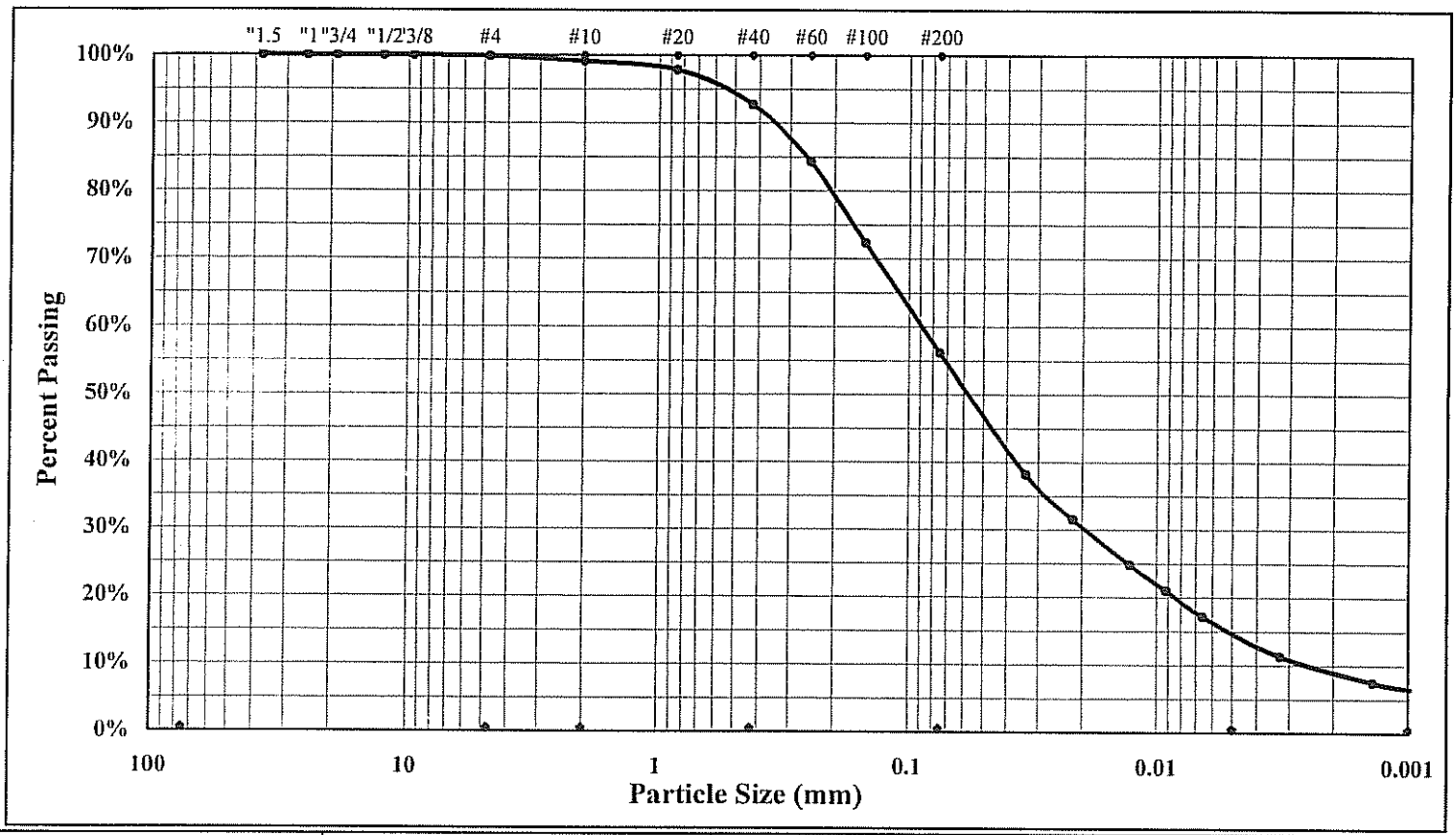
S&ME

ASTM D 422

S&ME Project #:	**1411-07-103**	Report Date:	6/26/08
Project Name:	**Marshall Steam Station**	Test Date(s):	6/23 - 6/25/08
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-41	Sample #:	181	Sample Date:	5/13/08
Location:	Bulk	Offset:	N/A	Elevation:	24.5-29.5'

Sample Description: Brown tan micaceous fine sandy clayey SILT (ML)



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	4.75 mm	Gravel	0.1%	Silt	41.3%
Silt & Clay (% Passing #200)	56.2%	Sand	43.7%	Clay	14.9%
Specific Gravity	2.650	Moisture Content	9.1%	Colloids	6.5%
Liquid Limit	37	Plastic Limit	27	Plastic Index	10

Description of Sand & Gravel Particles Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Mechanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 854: Specific Gravity of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. _____ QC Manager
Signature Position

Laboratory Record Version 4.2

S&ME

Liquid Limit, Plastic Limit, and Plastic Index

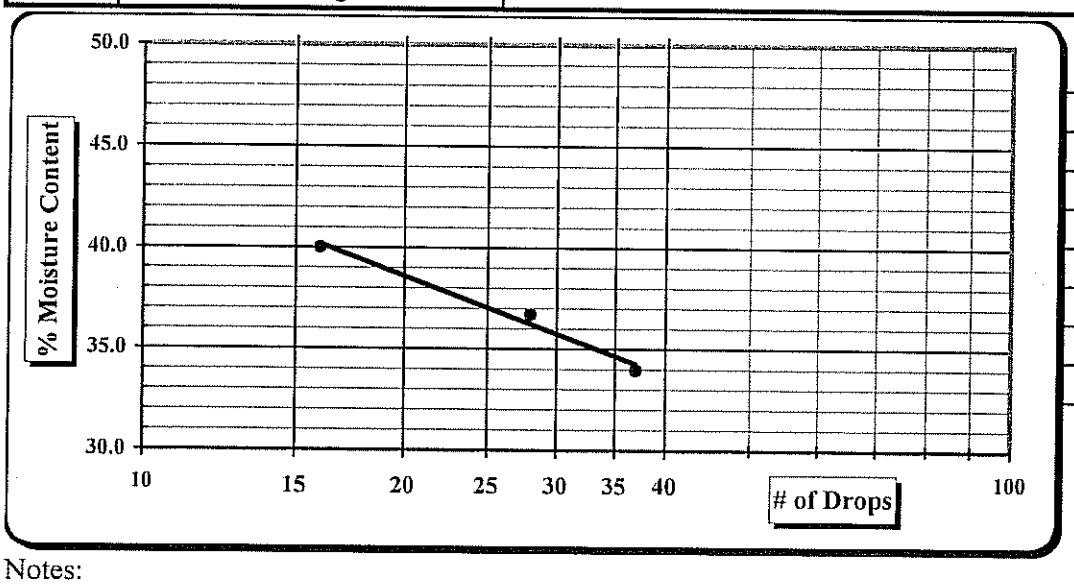
Project #:	**1411-07-103**	Report Date:	6/27/08
Project Name:	Marshall Steam Station	Test Date(s):	6/26/08
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #: M-41 Sample #: 181 Sample Date: 5/13/08

Location: Bulk Offset: N/A Elevation: 24.5-29.5'

Sample Description: Brown tan micaceous fine sandy clayey SILT (ML)

Pan #		Liquid Limit						Plastic Limit		
	Test #	1	2	3	4	5	6	1	2	3
	Tare #	P-4	P-5	P-6				18	21	
A	Tare Weight	16.69	16.71	15.97				**12.10**	12.07	
B	Wet Soil Weight + A	39.50	38.43	37.95				20.57	19.36	
C	Dry Soil Weight + A	33.72	32.60	31.67				18.77	17.80	
D	Water Weight (B-C)	5.78	5.83	6.28				1.80	1.57	
E	Dry Soil Weight (C-A)	17.03	15.89	15.70				6.67	5.73	
F	% Moisture Content (D/E)*100	33.9%	36.7%	40.0%				27.0%	27.3%	
N	# OF DROPS	37	28	16				*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average							27.2%		



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes:

Special Sampling Methods:

Sample Preparation:	Wet Preparation	☐	Dry Preparation	☒	Air Dried	☒	% Passing #200 Sieve: 56.2
Liquid limit Test:	Multipoint Method	☒	One-point Method	☐			NP, Non-Plastic ☐
Classification:	ASTM D 2487	☒	AASHTO M 145	☐			Liquid Limit 37
Liquid limit Test:	ASTM D 4318	☒	AASHTO T 89	☐			Plastic Limit 27
Plastic limit Test:	ASTM D 4318	☒	AASHTO T 90	☐			Plastic Index 10
							Group Symbol ML

Technician Name: M. Jacobs

Certification #

Technical Responsibility: Brian Vaughan, P.E.

Signature

QC Manager

Position

Particle Size Analysis of Soils

ASTM D 422

S&ME

Project #: **1411-07-103**
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Charlotte, NC

Test Date(s): 6/23 - 6/25/08
Report Date: 6/26/08

Boring #: M-42 Sample #: 181 Sample Date: 5/15/08
Location: Bulk Offset: N/A Elevation: 14.5-19.5'
Sample Description: Brown red micaceous fine sandy clayey SILT (ML)

Pan #:	14	Beaker #:	7
Hydrometer Jar #:			7
Pan Tare Weight (grams):			0.00
Total Sample Air Dried Wt. + tare wt. (grams):			548.13
Weight of Total Sample Air Dried:			548.13
Weight of Air Dried Hydrometer Sample (g):			52.59
Total Sample Oven Dried:			540.61
Hydrometer Sample Oven Dried (W):			51.86
% Passing #10:			99.2%
Correction Factor a (Table 1):			1.00

Specific Gravity 2.650

	Moisture Content	Hygroscopic	Natural
	Tare #	Z-6	374
A	Tare Wt.	16.91	0.00
B	Wet Wt. + A	29.20	197.20
C	Dry Wt. + A	29.03	170.30
D	Water Wt. (B-C)	0.17	26.90
E	Dry Wt. (C-A)	12.12	170.30
	% Moisture (100 x D/E)	1.40%	15.8%

Sieve	Retained Wt.	Percent Passing	
3.0"	0.00	Pan # (washed)	100.0%
1.5"	0.00		100.0%
1.0"	0.00		100.0%
3/4"	0.00		100.0%
1/2"	0.00		100.0%
3/8"	0.00		100.0%
#4	1.03	Soil Mortar	99.8%
#10	4.57	**100.0%**	99.2%
#20	0.41	99.2%	98.4%
#40	2.69	94.8%	94.0%
#60	6.83	86.8%	86.1%
#100	13.09	74.8%	74.1%
#200	22.43	56.8%	56.3%

Notes: Description of Sand & Gravel Particles — Rounded ☐ Angular ☒ — Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:	4.75 mm	Total Sand:	43.5%	< 4.74 mm and > 0.075 mm	Type: Mechanical Stirring Apparatus (A)
% Gravel:	0.2%	< 75 mm and > 4.75 mm	Silt & Clay:	56.3%	< 0.075 — Dispersion Time: 1 min.
Coarse Sand:	0.7%	< 4.75 mm and > 2.00 mm	Silt:	40.0%	< 0.075 and > 0.005 mm — Sodium Hexametaphosphate: 40 g./ Liter
Medium Sand:	5.1%	< 2.00 mm and > 0.425 mm	Clay:	16.3%	< 0.005 mm
Fine Sand:	37.7%	< 0.425 mm and > 0.075 mm	Colloids:	9.4%	< 0.001 mm — **Control Cylinder** ☐ **Composite Correction** ☒

Liquid Limit **38** Plastic Limit **31** Plastic Index **7** Hydrometer: 151H ☐ 152H ☒

Time		Temp.	Hydrometer	Corrections		Hydrometer	Percent Passing		Effective Depth	Table 3	Diameter
Clock	T (Min.)	(0.5 °C)	Reading	Control Cylinder	Composite Correction	R	P(-#10) = (R x a / W) x 100	P (total) = P x % Passing #10	L	K	D = K x ((L/T)^1/2
	2	23.4	25.0		5.05	19.95	38.5%	38.1%	13.0	0.01317	0.03361
	5	23.4	21.0		5.05	15.95	30.8%	30.5%	13.7	0.01317	0.02178
	15	23.4	17.5		5.05	12.45	24.0%	23.8%	14.3	0.01317	0.01284
	30	23.4	16.0		5.05	10.95	21.1%	20.9%	14.5	0.01317	0.00916
	60	23.3	14.5		5.05	9.45	18.2%	18.1%	14.7	0.01317	0.00653
	250	23.3	12.5		5.05	7.45	14.4%	14.2%	15.1	0.01317	0.00323
	1440	22.7	10.5		5.15	5.35	10.3%	10.2%	15.4	0.01325	0.00137
	2880	22.9	10.0		5.10	4.90	9.4%	9.4%	15.5	0.01325	0.00097

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Effective Depth (cm)
L=L1+0.5(L2-(VB/A))
(152H) .164cm per increment,
V_B=67.0cm^3, L_2=14cm, A=27.8cm^2

Technician Name: M. Jacobs
Certification #

Technical Responsibility: Brian Vaughan, P.E.
Signature

QC Manager
Position

S&ME, INC. **155 Tradd Street Spartanburg, SC 29301**

Hydrometer #181 (M-42, 14.5-19.5') 6-26-08.xls

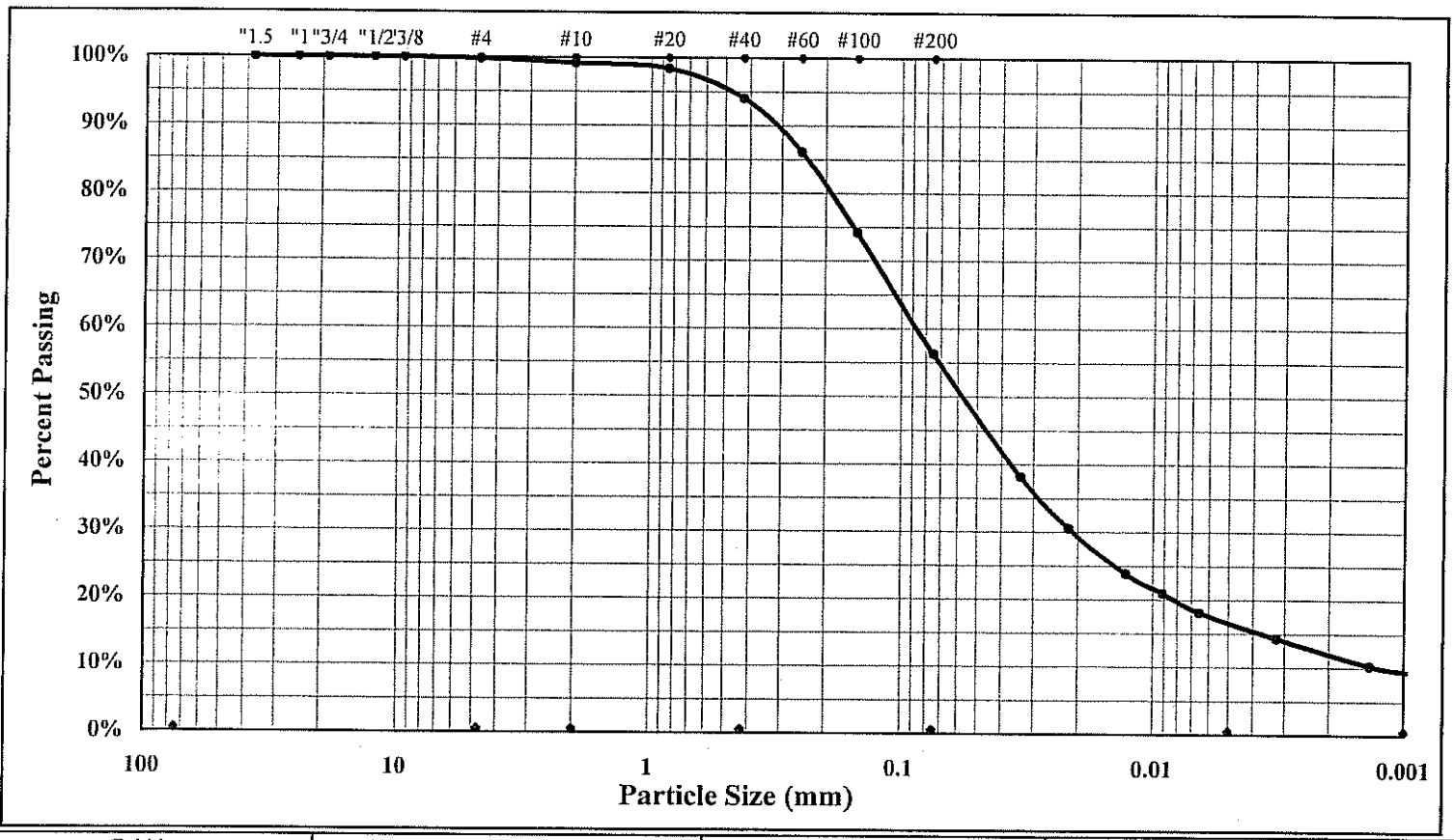
Particle Size Analysis of Soils

ASTM D 422

S&ME

S&ME Project #:	**1411-07-103**	Report Date:	6/26/08
Project Name:	**Marshall Steam Station**	Test Date(s):	6/23 - 6/25/08
Client Name:	Duke Energy		
Client Address:	Charlotte, NC		

Boring #:	M-42	Sample #:	181	Sample Date:	5/15/08
Location:	Bulk	Offset:	N/A	Elevation:	14.5-19.5'
Sample Description:	Brown red micaceous fine sandy clayey SILT (ML)				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	4.75 mm	Gravel	0.2%	Silt	40.0%
Silt & Clay (% Passing #200)	56.3%	Sand	43.5%	Clay	16.3%
Specific Gravity	2.650	Moisture Content	15.8%	Colloids	9.4%
Liquid Limit	38	Plastic Limit	31	Plastic Index	7

Description of Sand & Gravel Particles Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Mechanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

References: ASTM D 422: Particle Size Analysis of Soils
ASTM D 421: Dry Preparation of Soil Samples
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 854: Specific Gravity of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Brian Vaughan, P.E. _____ QC Manager

Signature Position

Particle Size Analysis of Soils

ASTM D 422

S&ME

Project #: 1356-08-122
Project Name: Marshall Steam Station Industrial Landfill
Client Name: Duke Energy
Client Address: Terrel, NC

Test Date(s): 10/22-27/08
Report Date: 10/27/08

Boring #: M-57 Sample #: SS-3 Sample Date:
Location: Offset: Depth: 13.5 - 15'
Sample Description: Tan and White Micaceous Silty Medium to Fine Sand (SM)

Pan #:		Beaker #:		Apparent Relative Density (Assumed)		2.650	
Hydrometer Jar #:							
Pan Tare Weight (grams):				Moisture Content	Hygroscopic	Natural	
Total Sample Air Dried Wt. + tare wt. (grams):		181.78		Tare #	QQ		
Weight of Total Sample Air Dried:		181.78	A	Tare Wt.	16.89		
Weight of Air Dried Hydrometer Sample (g):		50.02	B	Wet Wt. + A	28.87		
Total Sample Oven Dried:		180.72	C	Dry Wt. + A	28.80		
Hydrometer Sample Oven Dried (W):		49.73	D	Water Wt. (B-C)	0.07		
% Passing #10:		100.0%	E	Dry Wt. (C-A)	11.91		
Correction Factor a (Table 1):		1.00		% Moisture (100 x D/E)	0.59%		

Sieve	Retained Wt.	Percent Passing	
3.0"	0.0	Pan # (washed)	100.0%
1.5"	0.0		100.0%
1.0"	0.0		100.0%
3/4"	0.0		100.0%
1/2"	0.0		100.0%
3/8"	0.0		100.0%
#4	0.0	Soil Mortar	100.0%
#10	0.0	**100.0%**	100.0%
#20	0.0	100.0%	100.0%
#40	0.8	98.4%	98.4%
#60	4.3	91.4%	91.4%
#100	13.1	73.6%	73.6%
#200	26.8	46.2%	46.2%

Notes: Description of Sand & Gravel Particles Rounded ☐ Angular ☐ Hard & Durable ☐ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:			Total Sand:	53.8%	< 4.74 mm and > 0.075 mm	Type:	Mechanical Stirring Apparatus (A)
% Gravel:	0.0%	< 75 mm and > 4.75 mm	Silt & Clay:	46.2%	< 0.075	Dispersion Time:	1 min.
Coarse Sand:	0.0%	< 4.75 mm and > 2.00 mm	Silt:	42.2%	< 0.075 and > 0.005 mm	Sodium Hexametaphosphate:	40 g./ Liter
Medium Sand:	1.6%	< 2.00 mm and > 0.425 mm	Clay:	4.0%	< 0.005 mm		
Fine Sand:	52.3%	< 0.425 mm and > 0.075 mm	Colloids:		< 0.001 mm	Control Cylinder ☒	Composite Correction ☐

Liquid Limit NP Plastic Limit NP Plastic Index NP Hydrometer: 151H ☐ 152H ☒

Time		Temp.	Hydrometer	Corrections		Hydrometer	Percent Passing		Effective Depth	Table 3	Diameter
Clock	T (Min.)	(0.5 °C)	Reading	Control Cylinder	Composite Correction	R	P(-#10) = (R x a / W) x 100	P (total) = P x % Passing #10	L	K	D = K x ((L/T)^1/2)
	1	23.0	25.0	5.0		20.00	40.2%	40.2%	13.0	0.01317	0.04751
	2	23.0	18.5	5.0		13.50	27.1%	27.1%	14.1	0.01317	0.03495
	5	23.0	15.0	5.0		10.00	20.1%	20.1%	14.7	0.01317	0.02255
	15	23.0	9.5	5.0		4.50	9.0%	9.0%	15.6	0.01317	0.01341
	30	23.0	7.5	5.0		2.50	5.0%	5.0%	15.9	0.01317	0.00958
	60	23.0	7.0	5.0		2.00	4.0%	4.0%	16.0	0.01317	0.00679
	250	24.0	5.5	4.0		1.50	3.0%	3.0%	16.0	0.01301	0.00330
	1440	23.0	5.0	5.0		0.00	0.0%	0.0%	16.3	0.01317	0.00140

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Effective Depth (cm)
L=L1+0.5(L2-(VB/A))

(152H) .164cm per increment,
V_B=67.0cm^3, L_2=14cm, A=27.8cm^2

Technician Name: Karen Warner 117900
Certification #

Technical Responsibility: Courtney Withers *Staff Professional*
Signature *Position*

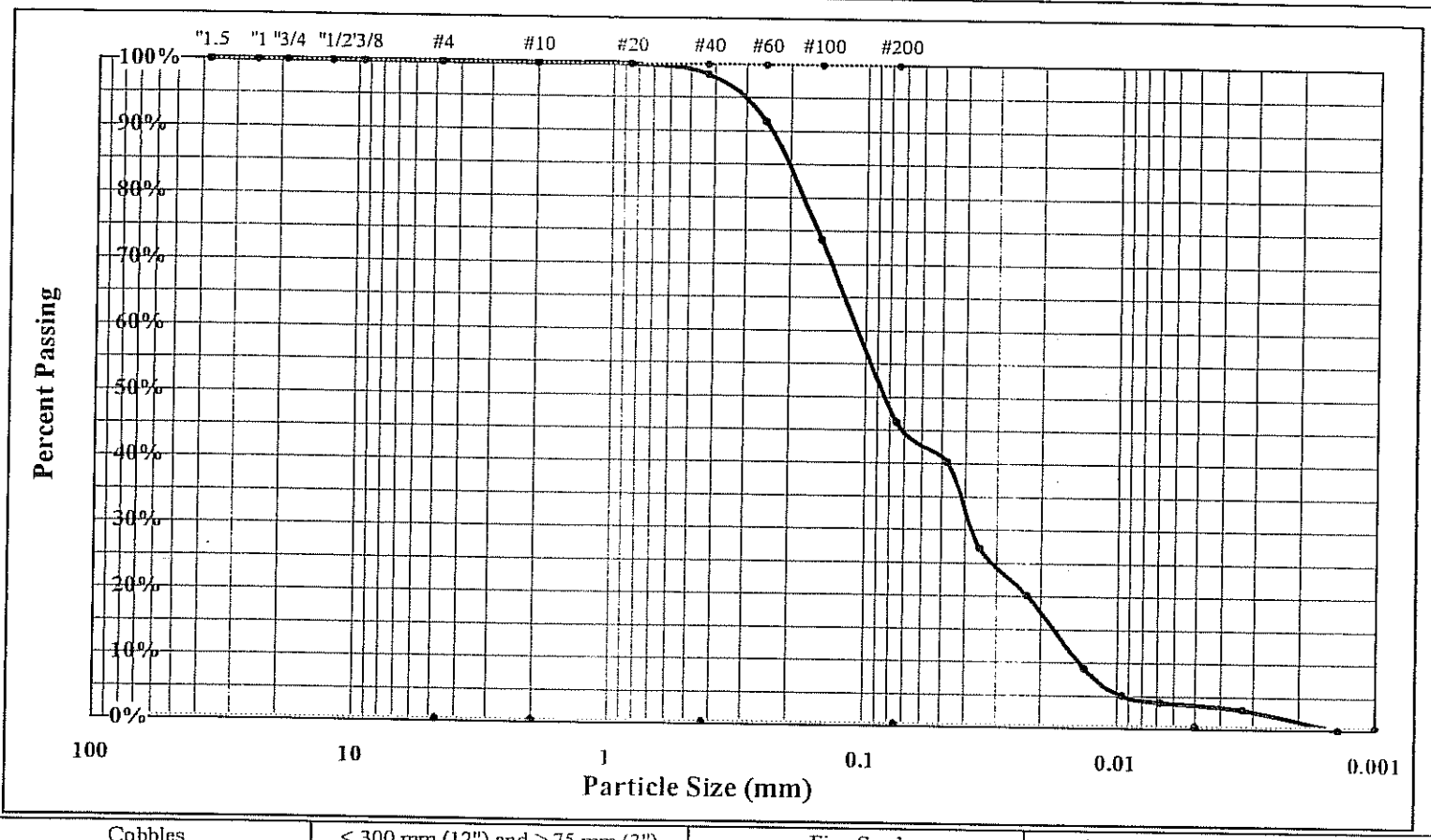
Particle Size Analysis of Soils

ASTM D 422

S&ME

S&ME Project #:	**1356-08-122**	Report Date:	10/27/08
Project Name:	**Marshall Steam Station Industrial Landfill**	Test Date(s):	10/22-27/08
Client Name:	Duke Energy		
Client Address:	Terrel, NC		

Boring #:	M-57	Sample #:	SS-3	Sample Date:	
Location:		Offset:		Depth:	13.5 - 15'
Sample Description:	Tan and White Micaceous Silty Medium to Fine Sand (SM)				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	0	Gravel	0.0%	Silt	42.2%
Silt & Clay (% Passing #200)	46.2%	Sand	53.8%	Clay	4.0%
Apparent Relative Density (Assumed)	2.650	Moisture Content		Colloids	
Liquid Limit	NP	Plastic Limit	NP	Plastic Index	NP

escription of Sand & Gravel Particles Rounded ☐ Angular ☐ Hard & Durable ☐ Soft ☐ Weathered & Friable ☐

echanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

eferences: ASTM D 422: Particle Size Analysis of Soils
TM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
TM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 421: Dry Preparation of Soil Samples
ASTM D 854: Specific Gravity of Soils

echnical Responsibility: Courtney Withers _____ Staff Professional
Signature Position

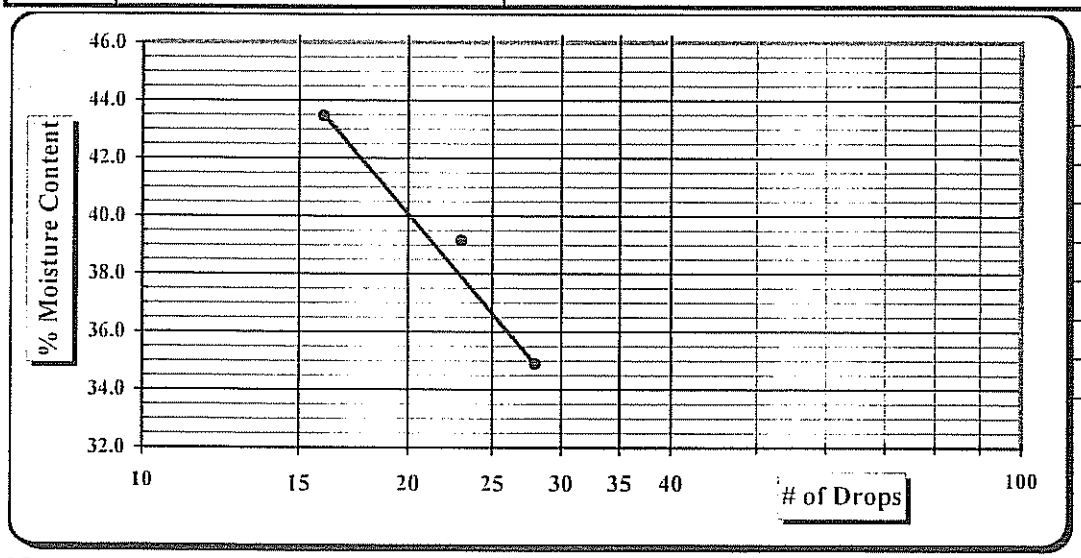
S&ME, INC. 9751 Southern Pine Blvd., Charlotte, NC

Liquid Limit, Plastic Limit, and Plastic Index

S&ME

Project #: **1356-08-122** Report Date: 12/12/08
Project Name: Marshall Steam Station Industrial Landfill Test Date(s): 10/22-12/12/08
Client Name: Duke Energy
Project Address: Terrell, NC
Boring #: M-57 Sample #: SS-3 Sample Date: 10/08
Location: Offset: Depth: 13.5-15'
Sample Description: Tan & White Micaceous Silty Medium to Fine Sand (SM)

Pan #		Liquid Limit						Plastic Limit		
	Test #							1	2	3
	Tare #	5	XX	4				PP	10	
A	Tare Weight	15.72	16.04	13.97				16.14	13.99	
B	Wet Soil Weight + A	26.97	26.31	27.27				22.29	20.60	
C	Dry Soil Weight + A	24.06	23.42	23.24				20.53	18.68	
D	Water Weight (B-C)	2.91	2.89	4.03				1.76	1.92	
E	Dry Soil Weight (C-A)	8.34	7.38	9.27				4.39	4.69	
F	% Moisture Content (D/E)*100	34.9%	39.2%	43.5%				40.1%	40.9%	
N	# OF DROPS	28	23	16				*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average							40.5%		



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes: Estimate the % Retained on the #40 Sieve

Special Sampling Methods:

Sample Preparation:	Wet Preparation ☐	Dry Preparation ☒	Air Dried ☒	NP, Non-Plastic	☒
Liquid limit Test:	Multipoint Method ☒	One-point Method ☐		Liquid Limit	
Classification:	ASTM D 2487 ☒	AASHTO M 145 ☐		Plastic Limit	
Liquid limit Test:	ASTM D 4318 ☒	AASHTO T 89 ☐		Plastic Index	
Plastic limit Test:	ASTM D 4318 ☒	AASHTO T 90 ☐		Group Symbol	SM

Technician Name: Karen Warner 117900 (Certification #)

Technical Responsibility: Courtney Withers _____ (Signature) Staff Professional (Position)

Particle Size Analysis of Soils

ASTM D 422

S&ME

Project #: 1356-08-122
Project Name: Marshall Steam Station Industrial Landfill
Client Name: Duke Energy
Client Address: Terrel, NC

Test Date(s): 10/22-27/08
Report Date: 10/27/08

Boring #: M-58 Sample #: SS-6 Sample Date:
Location: Offset: Depth: 28.5 - 30'
Sample Description: White Tan Green Pink Silty Medium to Fine Sand (SM)

Pan #:		Beaker #:	
Hydrometer Jar #:			
Pan Tare Weight (grams):			
Total Sample Air Dried Wt. + tare wt. (grams):	234.47		
Weight of Total Sample Air Dried:	234.47		
Weight of Air Dried Hydrometer Sample (g):	100.01		
Total Sample Oven Dried:	233.83		
Hydrometer Sample Oven Dried (W):	99.74		
% Passing #10:	100.0%		
Correction Factor a (Table 1):	1.00		

Apparent Relative Density (Assumed) 2.650

	Moisture Content	Hygroscopic	Natural
	Tare #	36	
A	Tare Wt.	15.66	
B	Wet Wt. + A	26.59	
C	Dry Wt. + A	26.56	
D	Water Wt. (B-C)	0.03	
E	Dry Wt. (C-A)	10.90	
	% Moisture (100 x D/E)	0.28%	

Sieve	Retained Wt.	Percent Passing	
3.0"	0.0	Pan # (washed)	100.0%
1.5"	0.0		100.0%
1.0"	0.0		100.0%
3/4"	0.0		100.0%
1/2"	0.0		100.0%
3/8"	0.0		100.0%
#4	0.0	Soil Mortar	100.0%
#10	0.0	**100.0%**	100.0%
#20	0.8	99.2%	99.2%
#40	7.3	92.7%	92.7%
#60	23.4	76.6%	76.6%
#100	42.1	57.8%	57.8%
#200	70.4	29.4%	29.4%

Notes: Description of Sand & Gravel Particles Rounded ☐ Angular ☐ Hard & Durable ☐ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:			Total Sand:	70.6%	< 4.74 mm and > 0.075 mm
% Gravel:	0.0%	< 75 mm and > 4.75 mm	Silt & Clay:	29.4%	< 0.075
Coarse Sand:	0.0%	< 4.75 mm and > 2.00 mm	Silt:	26.9%	< 0.075 and > 0.005 mm
Medium Sand:	7.3%	< 2.00 mm and > 0.425 mm	Clay:	2.5%	< 0.005 mm
Fine Sand:	63.3%	< 0.425 mm and > 0.075 mm	Colloids:		< 0.001 mm

Type: Mechanical Stirring Apparatus (A)
Dispersion Time: 1 min.
Sodium Hexametaphosphate: 40 g./ Liter

Control Cylinder ☒ Composite Correction ☐

Liquid Limit NP Plastic Limit NP Plastic Index NP Hydrometer: 151H ☐ 152H ☒

Time		Temp.	Hydrometer	Corrections		Hydrometer	Percent Passing		Effective Depth	Table 3	Diameter
Clock	T (Min.)	(0.5 °C)	Reading	Control Cylinder	Composite Correction	R	P(-#10) = (R x a / W) x 100	P (total) = P x % Passing #10	L	K	D = K x ((L/T)^1/2
	1	23.0	26.5	5.0		21.50	21.6%	21.6%	12.8	0.01317	0.04706
	2	23.0	20.0	5.0		15.00	15.0%	15.0%	13.8	0.01317	0.03464
	5	23.0	15.5	5.0		10.50	10.5%	10.5%	14.6	0.01317	0.02248
	15	23.0	11.0	5.0		6.00	6.0%	6.0%	15.3	0.01317	0.01331
	30	23.0	9.0	5.0		4.00	4.0%	4.0%	15.6	0.01317	0.00951
	60	23.0	7.5	5.0		2.50	2.5%	2.5%	15.9	0.01317	0.00678
	250	24.0	5.5	4.0		1.50	1.5%	1.5%	16.0	0.01301	0.00330
	1440	23.0	5.0	5.0		0.00	0.0%	0.0%	16.3	0.01317	0.00140

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Effective Depth (cm)
L=L1+0.5(L2-(VB/A))
(152H) .164cm per increment,
V_B=67.0cm^3, L_2=14cm, A=27.8cm^2

Technician Name: Karen Warner 117900 (Certification #)

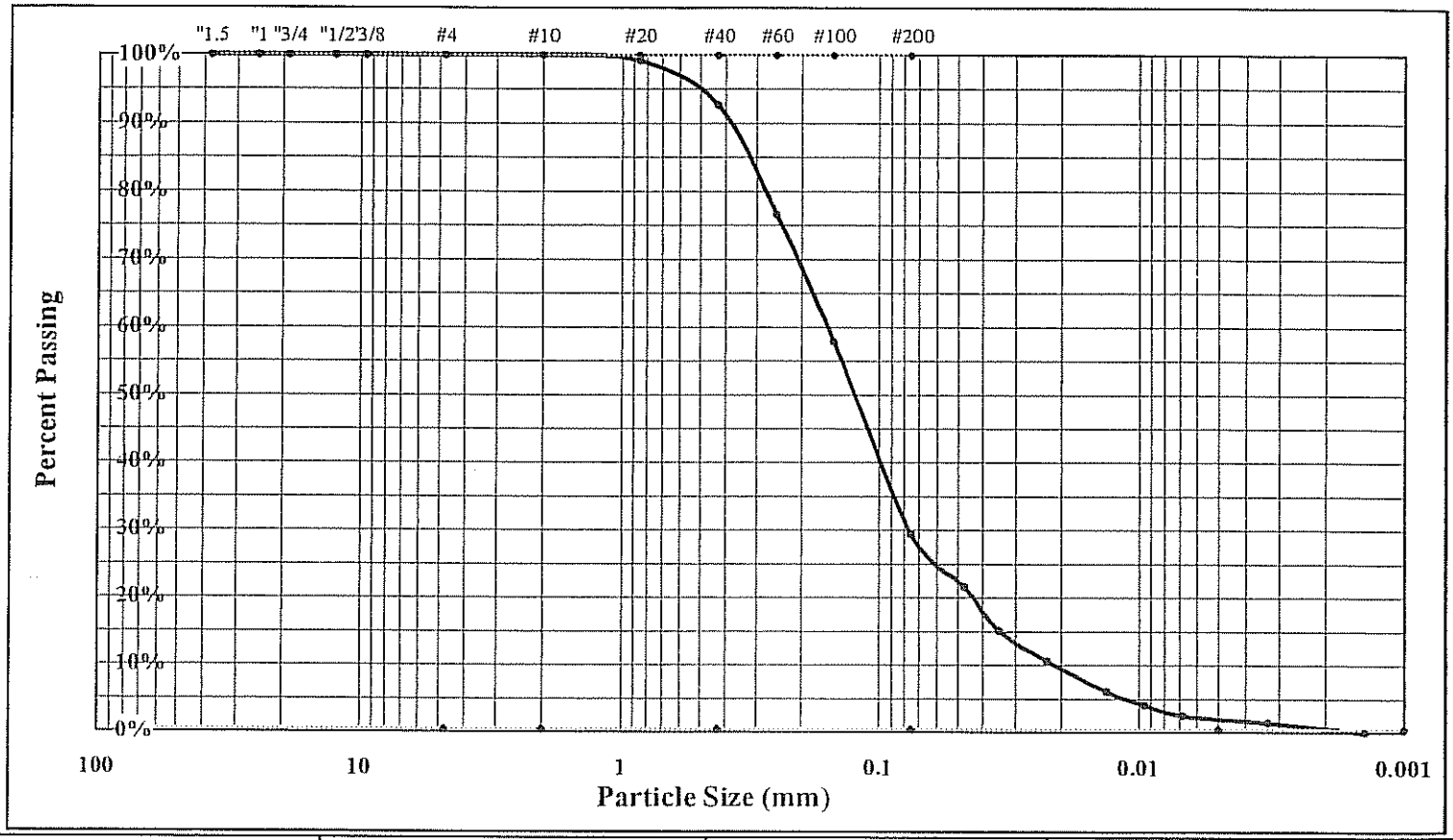
Technical Responsibility: Courtney Withers _____ (Signature) *Staff Professional* (Position)

Particle Size Analysis of Soils

ASTM D 422

S&ME Project #:	**1356-08-122**	Report Date:	10/27/08
Project Name:	**Marshall Steam Station Industrial Landfill**	Test Date(s):	10/22-27/08
Client Name:	Duke Energy		
Client Address:	Terrel, NC		

Boring #:	M-58	Sample #:	SS-6	Sample Date:	
Location:		Offset:		Depth:	28.5 - 30'
Sample Description:	White Tan Green Pink Silty Medium to Fine Sand (SM)				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	0	Gravel	0.0%	Silt	26.9%
Silt & Clay (% Passing #200)	29.4%	Sand	70.6%	Clay	2.5%
Apparent Relative Density (Assumed)	2.650	Moisture Content		Colloids	
Liquid Limit	NP	Plastic Limit	NP	Plastic Index	NP

Description of Sand & Gravel Particles Rounded ☐ Angular ☐ Hard & Durable ☐ Soft ☐ Weathered & Friable ☐

Mechanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 854: Specific Gravity of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Courtney Withers _____ Staff Professional
Signature Position

Liquid Limit, Plastic Limit, and Plastic Index

S&ME

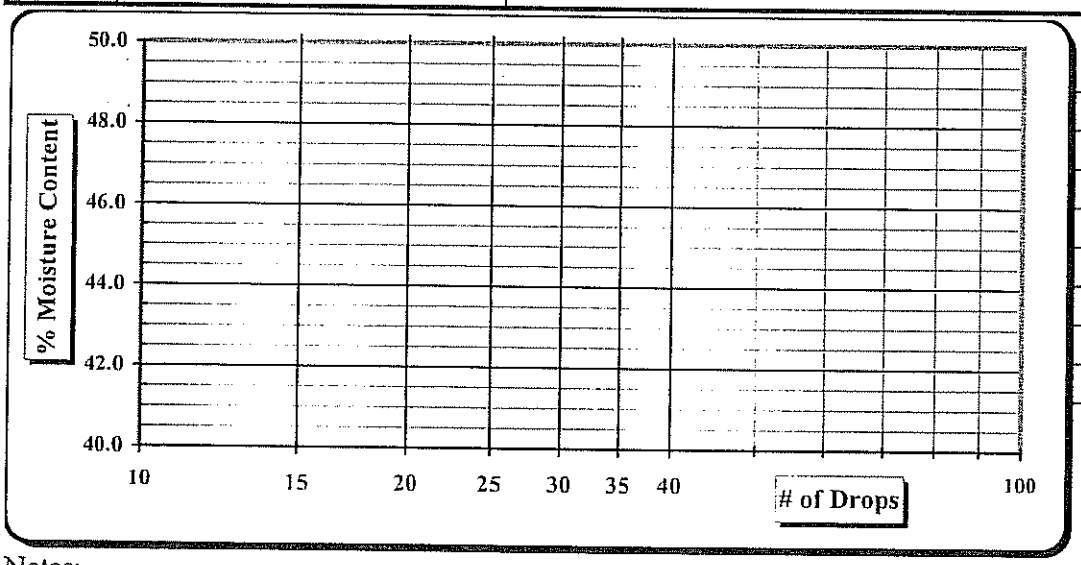
Project #:	1356-08-122	Report Date:	12/12/08
Project Name:	Marshall Steam Station Industrial Landfill	Test Date(s):	10/22-12/12/08
Client Name:	Duke Energy		
Project Address:	Terrell, NC		

Boring #: M-58 Sample #: SS-6 Sample Date: 10/08

Location: Offset: Depth: 28.5-30'

Sample Description: White Tan Green Pink Silty Medium to Fine Sand (SM)

Pan #		Liquid Limit						Plastic Limit		
	Test #							1	2	3
	Tare #									
A	Tare Weight									
B	Wet Soil Weight + A									
C	Dry Soil Weight + A									
D	Water Weight (B-C)									
E	Dry Soil Weight (C-A)									
F	% Moisture Content (D/E)*100									
N	# OF DROPS							*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average									



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes: Estimate the % Retained on the #40 Sieve

Special Sampling Methods:

Sample Preparation:	Wet Preparation ☐	Dry Preparation ☐	Air Dried ☒	NP, Non-Plastic	☒
Liquid limit Test:	Multipoint Method ☐	One-point Method ☐		Liquid Limit	
Classification:	ASTM D 2487 ☒	AASHTO M 145 ☐		Plastic Limit	
Liquid limit Test:	ASTM D 4318 ☒	AASHTO T 89 ☐		Plastic Index	
Plastic limit Test:	ASTM D 4318 ☒	AASHTO T 90 ☐		Group Symbol	SM

Technician Name: Karen Warner 117900 (Certification #)

Technical Responsibility: Courtney Withers (Signature) Staff Professional (Position)

Particle Size Analysis of Soils

ASTM D 422

S&ME

Project #: 1356-08-122
Project Name: Marshall Steam Station
Client Name: Duke Energy
Client Address: Terrel, NC

Test Date(s): 10/22-27/08
Report Date: 10/27/08

Boring #: M-59 Sample #: SS-1 Sample Date:
Location: Offset: Depth: 3.5 - 5'
Sample Description: Red Medium to Fine Sandy Clayey Silt (MH)

Pan #:		Beaker #:	
Hydrometer Jar #:			
Pan Tare Weight (grams):			
Total Sample Air Dried Wt. + tare wt. (grams):	142.25		
Weight of Total Sample Air Dried:	142.25		
Weight of Air Dried Hydrometer Sample (g):	50.01		
Total Sample Oven Dried:	140.26		
Hydrometer Sample Oven Dried (W):	49.31		
% Passing #10:	100.0%		
Correction Factor a (Table 1):	1.00		

Apparent Relative Density (Assumed) 2.650

Moisture Content		Hygroscopic	Natural
	Tare #	*	
A	Tare Wt.	15.52	
B	Wet Wt. + A	26.24	
C	Dry Wt. + A	26.09	
D	Water Wt. (B-C)	0.15	
E	Dry Wt. (C-A)	10.57	
	% Moisture (100 x D/E)	1.42%	

Sieve	Retained Wt.	Percent Passing	
3.0"	0.0	Pan # (washed)	100.0%
1.5"	0.0		100.0%
1.0"	0.0		100.0%
3/4"	0.0		100.0%
1/2"	0.0		100.0%
3/8"	0.0		100.0%
#4	0.0	Soil Mortar	100.0%
#10	0.0	**100.0%**	100.0%
#20	0.1	99.8%	99.8%
#40	0.7	98.6%	98.6%
#60	3.1	93.7%	93.7%
#100	8.5	82.7%	82.7%
#200	16.6	66.4%	66.4%

Notes: Description of Sand & Gravel Particles Rounded ☐ Angular ☐ Hard & Durable ☐ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:			Total Sand:	33.6%	< 4.74 mm and > 0.075 mm
% Gravel:	0.0%	< 75 mm and > 4.75 mm	Silt & Clay:	66.4%	< 0.075
Coarse Sand:	0.0%	< 4.75 mm and > 2.00 mm	Silt:	29.4%	< 0.075 and > 0.005 mm
Medium Sand:	1.4%	< 2.00 mm and > 0.425 mm	Clay:	37.0%	< 0.005 mm
Fine Sand:	32.2%	< 0.425 mm and > 0.075 mm	Colloids:		< 0.001 mm

Type: Mechanical Stirring Apparatus (A)
Dispersion Time: 1 min.
Sodium Hexametaphosphate: 40 g./ Liter

Liquid Limit 51 Plastic Limit 35 Plastic Index 16

Control Cylinder ☒ Composite Correction ☐
Hydrometer: 151H ☐ 152H ☒

Time		Temp.	Hydrometer	Corrections		Hydrometer	Percent Passing		Effective Depth	Table 3	Diameter
Clock	T (Min.)	(0.5 °C)	Reading	Control Cylinder	Composite Correction	R	P(-#10) = (R x a / W) x 100	P (total) = P x % Passing #10	L	K	D = K x ((L/T)^1/2
	1	23.5	36.0	4.5		31.50	63.9%	63.9%	11.1	0.01309	0.04367
	2	23.5	34.0	4.5		29.50	59.8%	59.8%	11.5	0.01309	0.03133
	5	23.5	31.0	4.5		26.50	53.7%	53.7%	11.9	0.01309	0.02024
	15	23.5	26.5	4.5		22.00	44.6%	44.6%	12.7	0.01309	0.01204
	30	23.5	24.5	4.5		20.00	40.6%	40.6%	13.0	0.01309	0.00862
	60	24.0	23.0	4.0		19.00	38.5%	38.5%	13.2	0.01301	0.00610
	250	24.0	20.5	4.0		16.50	33.5%	33.5%	13.6	0.01301	0.00303
	1440	23.5	18.5	4.5		14.00	28.4%	28.4%	14.0	0.01309	0.00129

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technician Name: Karen Warner

Technical Responsibility: Courtney Withers

S&ME, INC.

117900
Certification #

Signature

Staff Professional
Position

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Effective Depth (cm)
L=L1+0.5(L2-(VB/A))
(152H) .164cm per increment,
V_B=67.0cm^3, L_2=14cm, A=27.8cm^2

1356-08-122 M-59 SS-1 (3.5-5) Hydro.xls

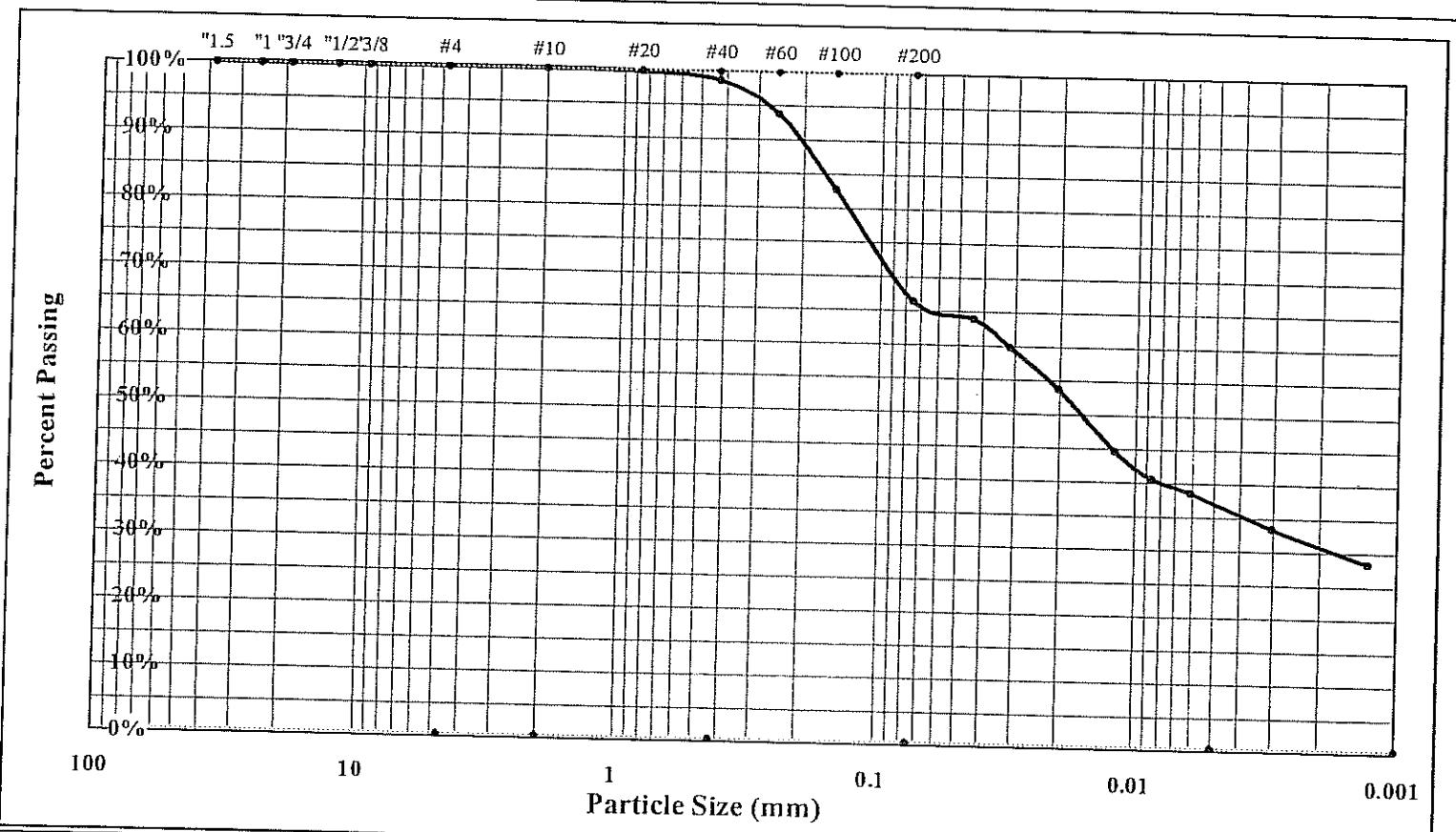
Particle Size Analysis of Soils

ASTM D 422

S&ME

S&ME Project #:	**1356-08-122**	Report Date:	10/27/08
Project Name:	**Marshall Steam Station**	Test Date(s):	10/22-27/08
Client Name:	Duke Energy		
Client Address:	Terrel, NC		

Boring #:	M-59	Sample #:	SS-1	Sample Date:	
Location:		Offset:		Depth:	3.5 - 5'
Sample Description:	Red Medium to Fine Sandy Clayey Silt (MH)				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	0	Gravel	0.0%	Silt	29.4%
Silt & Clay (% Passing #200)	66.4%	Sand	33.6%	Clay	37.0%
Apparent Relative Density (Assumed)	2.650	Moisture Content		Colloids	
Liquid Limit	51	Plastic Limit	35	Plastic Index	16

escription of Sand & Gravel Particles Rounded ☐ Angular ☐ Hard & Durable ☐ Soft ☐ Weathered & Friable ☐

chanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

ferences: ASTM D 422: Particle Size Analysis of Soils
TM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
TM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 421: Dry Preparation of Soil Samples
ASTM D 854: Specific Gravity of Soils

chnical Responsibility: Courtney Withers _____ Signature Staff Professional Position

S&ME, INC. 9751 Southern Pine Blvd., Charlotte, NC

Liquid Limit, Plastic Limit, and Plastic Index

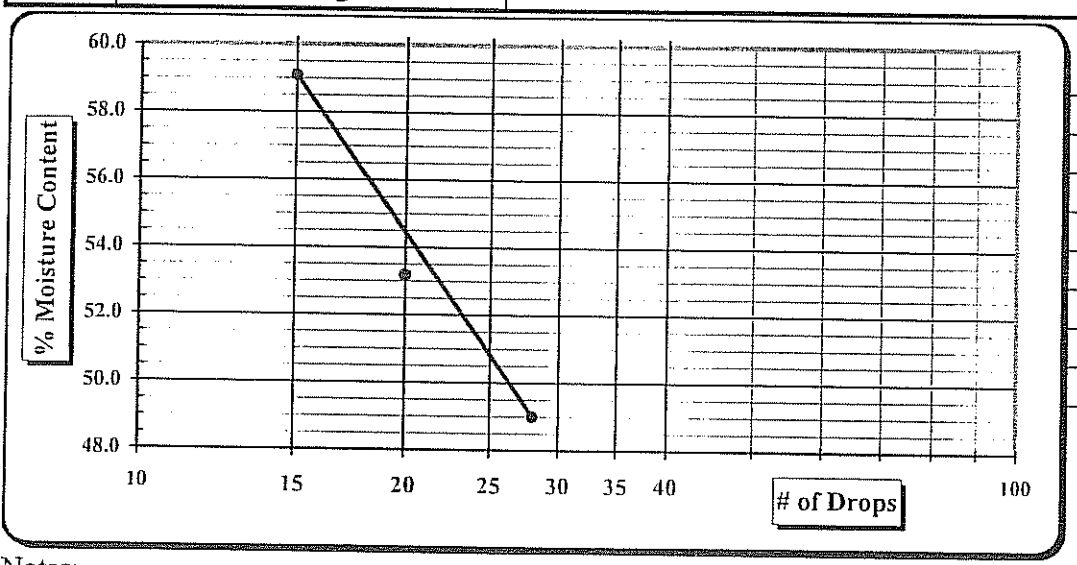
S&ME

Project #: 1356-08-122
Project Name: Marshall Steam Station Industrial Landfill
Client Name: Duke Energy
Project Address: Terrell, NC

Report Date: 12/12/08
Test Date(s): 10/22-12/12/08

Boring #: M-59 Sample #: SS-1 Sample Date:
Location: Offset: Depth: 3.5-5'
Sample Description: Red Fine to Medium Sandy Clayey Silt (MH)

Pan #		Liquid Limit						Plastic Limit		
	Test #							1	2	3
	Tare #	KK	E	17				Z	ZY	
A	Tare Weight	16.05	15.07	13.98				16.88	15.53	
B	Wet Soil Weight + A	24.23	23.25	23.24				24.17	22.24	
C	Dry Soil Weight + A	21.54	20.41	19.80				22.25	20.50	
D	Water Weight (B-C)	2.69	2.84	3.44				1.92	1.74	
E	Dry Soil Weight (C-A)	5.49	5.34	5.82				5.37	4.97	
F	% Moisture Content (D/E)*100	49.0%	53.2%	59.1%				35.8%	35.0%	
N	# OF DROPS	28	20	15				*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average							35.4%		



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes: Estimate the % Retained on the #40 Sieve

Special Sampling Methods:

Sample Preparation:	Wet Preparation ☐	Dry Preparation ☒	Air Dried ☒	NP, Non-Plastic	☐
Liquid limit Test:	Multipoint Method ☒	One-point Method ☐		Liquid Limit	51
Classification:	ASTM D 2487 ☒	AASHTO M 145 ☐		Plastic Limit	35
Liquid limit Test:	ASTM D 4318 ☒	AASHTO T 89 ☐		Plastic Index	16
Plastic limit Test:	ASTM D 4318 ☒	AASHTO T 90 ☐		Group Symbol	MH

Technician Name: Karen Warner 117900 (Certification #)

Technical Responsibility: Courtney Withers (Signature) Staff Professional (Position)

Particle Size Analysis of Soils

ASTM D 422

S&ME

Project #: 1356-08-122
Project Name: Marshall Steam Station Industrial Landfill
Client Name: Duke Energy
Client Address: Terrel, NC

Test Date(s): 10/22-27/08
Report Date: 10/27/08

Boring #: M-59 Sample #: SS-6 Sample Date: 10/08
Location: Offset: Depth: 28.5 - 30'
Sample Description: Orange & Tan Medium to Fine Sand Silt (ML)

Pan #:		Beaker #:	
Hydrometer Jar #:			
Pan Tare Weight (grams):			
Total Sample Air Dried Wt. + tare wt. (grams):	156.79		
Weight of Total Sample Air Dried:	156.79		
Weight of Air Dried Hydrometer Sample (g):	50.04		
Total Sample Oven Dried:	154.91		
Hydrometer Sample Oven Dried (W):	49.44		
% Passing #10:	100.0%		
Correction Factor a (Table 1):	1.00		

Apparent Relative Density (Assumed) 2.650

	Moisture Content	Hygroscopic	Natural
	Tare #	31	
A	Tare Wt.	13.94	
B	Wet Wt. + A	24.77	
C	Dry Wt. + A	24.64	
D	Water Wt. (B-C)	0.13	
E	Dry Wt. (C-A)	10.70	
	% Moisture (100 x D/E)	1.21%	

Sieve	Retained Wt.	Percent Passing	
3.0"	0.0	Pan # (washed)	100.0%
1.5"	0.0		100.0%
1.0"	0.0		100.0%
3/4"	0.0		100.0%
1/2"	0.0		100.0%
3/8"	0.0		100.0%
#4	0.0	Soil Mortar	100.0%
#10	0.0	**100.0%**	100.0%
#20	0.2	99.7%	99.7%
#40	1.2	97.5%	97.5%
#60	3.9	92.2%	92.2%
#100	10.0	79.7%	79.7%
#200	21.1	57.3%	57.3%

Notes: Description of Sand & Gravel Particles Rounded ☐ Angular ☐ Hard & Durable ☐ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:		
% Gravel:	0.0%	< 75 mm and > 4.75 mm
Coarse Sand:	0.0%	< 4.75 mm and > 2.00 mm
Medium Sand:	2.5%	< 2.00 mm and > 0.425 mm
Fine Sand:	40.2%	< 0.425 mm and > 0.075 mm

Total Sand:	42.7%	< 4.74 mm and > 0.075 mm
Silt & Clay:	57.3%	< 0.075
Silt:	43.8%	< 0.075 and > 0.005 mm
Clay:	13.5%	< 0.005 mm
Colloids:		< 0.001 mm

Type: Mechanical Stirring Apparatus (A)
Dispersion Time: 1 min.
Sodium Hexametaphosphate: 40 g./ Liter

Liquid Limit 38 Plastic Limit 35 Plastic Index 3

Control Cylinder ☒ **Composite Correction** ☐
Hydrometer: 151H ☐ 152H ☒

Time		Temp.	Hydrometer	Corrections		Hydrometer	Percent Passing		Effective Depth	Table 3	Diameter
Clock	T (Min.)	(0.5 °C)	Reading	Control Cylinder	Composite Correction	R	P(-#10) = (R x a / W) x 100	P (total) = P x % Passing #10	L	K	D = K x ((L/T)^1/2
	1	23.0	28.0	5.0		23.00	46.5%	46.5%	12.5	0.01317	0.04661
	2	23.0	24.5	5.0		19.50	39.4%	39.4%	13.1	0.01317	0.03370
	5	23.0	20.5	5.0		15.50	31.4%	31.4%	13.8	0.01317	0.02184
	15	23.0	16.0	5.0		11.00	22.2%	22.2%	14.5	0.01317	0.01294
	30	23.0	14.0	5.0		9.00	18.2%	18.2%	14.8	0.01317	0.00926
	60	23.0	12.5	5.0		7.50	15.2%	15.2%	15.1	0.01317	0.00660
	250	24.0	9.0	4.0		5.00	10.1%	10.1%	15.5	0.01301	0.00324
	1440	23.0	6.0	5.0		1.00	2.0%	2.0%	16.1	0.01317	0.00139

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Effective Depth (cm)
L=L1+0.5(L2-(VB/A))
(152H) .164cm per increment,
V_B=67.0cm^3, L_2=14cm, A=27.8cm^2

Technician Name: Karen Warner 117900 *Certification #*

Technical Responsibility: Courtney Withers *Signature* *Staff Professional* *Position*

S&ME, INC. 9751Southern Pine Blvd., Charlotte, NC 28273

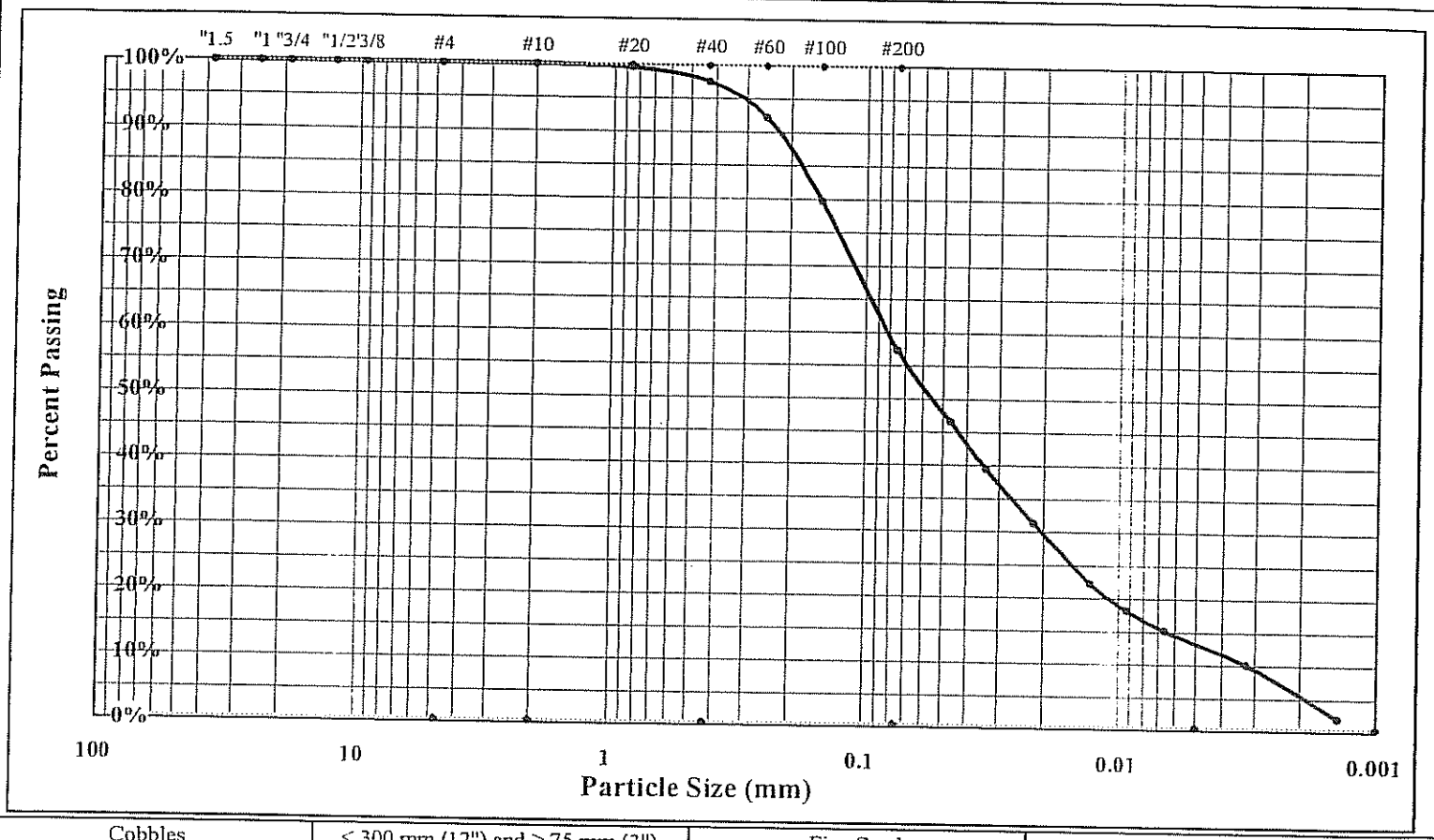
Particle Size Analysis of Soils

ASTM D 422

S&ME

S&ME Project #:	1356-08-122	Report Date:	10/27/08
Project Name:	Marshall Steam Station Industrial Landfill	Test Date(s):	10/22-27/08
Client Name:	Duke Energy		
Client Address:	Terrel, NC		

Boring #:	M-59	Sample #:	SS-6	Sample Date:	10/08
Location:		Offset:		Depth:	28.5 - 30'
Sample Description:	Orange & Tan Medium to Fine Sand Silt (ML)				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	0	Gravel	0.0%	Silt	43.8%
Silt & Clay (% Passing #200)	57.3%	Sand	42.7%	Clay	13.5%
Apparent Relative Density (Assumed)	2.650	Moisture Content		Colloids	
Liquid Limit	38	Plastic Limit	35	Plastic Index	3

Description of Sand & Gravel Particles Rounded ☐ Angular ☐ Hard & Durable ☐ Soft ☐ Weathered & Friable ☐

Mechanical Stirring Apparatus (A) Length of Dispersion Period: 1 min Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

References: ASTM D 422: Particle Size Analysis of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 421: Dry Preparation of Soil Samples
ASTM D 854: Specific Gravity of Soils

Technical Responsibility: Courtney Withers _____ Staff Professional

Signature Position

Liquid Limit, Plastic Limit, and Plastic Index

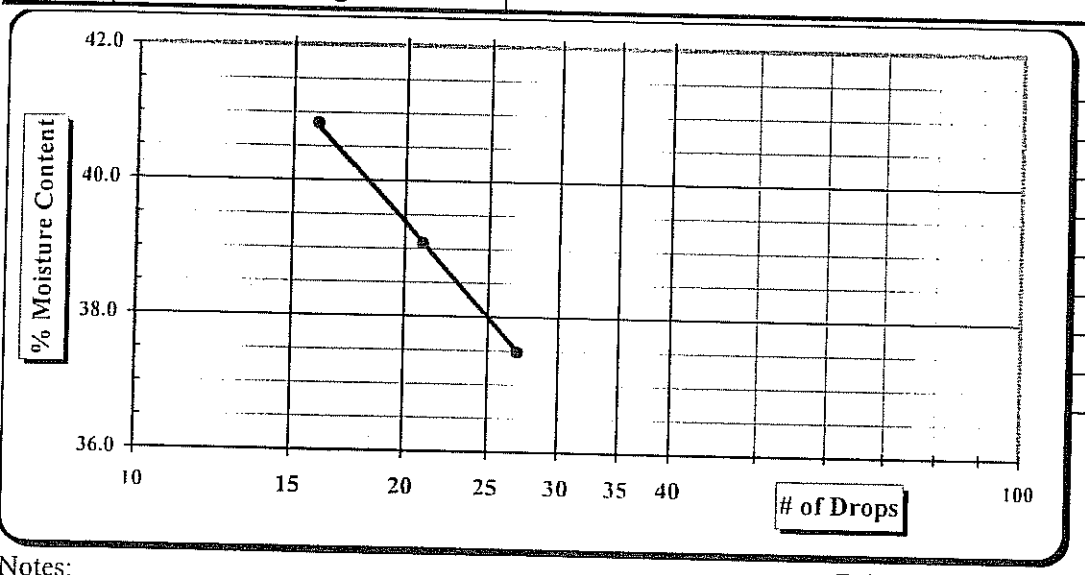
S&ME

Project #: **1356-08-122**
Project Name: Marshall Steam Station Industrial Landfill
Client Name: Duke Energy
Project Address: Terrell, NC

Report Date: 12/12/08
Test Date(s): 10/22-12/12/08

Boring #: M-59 Sample #: SS-6 Sample Date: 10/08
Location: Offset: Depth: 28.5-30'
Sample Description: Orange & Tan Medium to Fine Sandy Silt (ML)

Pan #		Liquid Limit						Plastic Limit		
	Test #							1	2	3
	Tare #	RR	2	29				46	24	
A	Tare Weight	15.28	15.78	14.12				**13.76**	13.92	
B	Wet Soil Weight + A	24.23	25.14	22.12				20.68	20.14	
C	Dry Soil Weight + A	21.79	22.51	19.80				18.92	18.53	
D	Water Weight (B-C)	2.44	2.63	2.32				1.76	1.61	
E	Dry Soil Weight (C-A)	6.51	6.73	5.68				5.16	4.61	
F	% Moisture Content (D/E)*100	37.5%	39.1%	40.8%				34.1%	34.9%	
N	# OF DROPS	27	21	16				*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average							34.5%		



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes: Estimate the % Retained on the #40 Sieve

Special Sampling Methods:

Sample Preparation:	Wet Preparation ☐	Dry Preparation ☒	Air Dried ☒	NP, Non-Plastic	☐
Liquid limit Test:	Multipoint Method ☐	One-point Method ☐		Liquid Limit	38
Classification:	ASTM D 2487 ☒	AASHTO M 145 ☐		Plastic Limit	35
Liquid limit Test:	ASTM D 4318 ☒	AASHTO T 89 ☐		Plastic Index	3
Plastic limit Test:	ASTM D 4318 ☒	AASHTO T 90 ☐		Group Symbol	ML

Technician Name: Karen Warner 117900 (Certification #)

Technical Responsibility: Courtney Withers _____ (Signature) Staff Professional (Position)

Particle Size Analysis of Soils

ASTM D 422

S&ME

Project #: 1356-08-122
Project Name: Marshall Steam Station Industrial Landfill
Client Name: Duke Energy
Client Address: Terrel, NC

Test Date(s): 10/22-27/08
Report Date: 10/27/08

Boring #: M-60 Sample #: SS-14 Sample Date:
Location: Offset: Depth: 68.5 - 70'
Sample Description: White Tan Orange Medium to Fine Sandy Silt (ML)

Pan #:		Beaker #:	
Hydrometer Jar #:			
Pan Tare Weight (grams):			
Total Sample Air Dried Wt. + tare wt. (grams):	200.39		
Weight of Total Sample Air Dried:	200.39		
Weight of Air Dried Hydrometer Sample (g):	50.00		
Total Sample Oven Dried:	198.45		
Hydrometer Sample Oven Dried (W):	49.52		
% Passing #10:	99.7%		
Correction Factor a (Table 1):	1.00		

Apparent Relative Density (Assumed) 2.650

Moisture Content		Hygroscopic	Natural
	Tare #	II	
A	Tare Wt.	16.88	
B	Wet Wt. + A	27.20	
C	Dry Wt. + A	27.10	
D	Water Wt. (B-C)	0.10	
E	Dry Wt. (C-A)	10.22	
	% Moisture (100 x D/E)	0.98%	

Sieve	Retained Wt.	Percent Passing	
3.0"	0.0	Pan # (washed)	100.0%
1.5"	0.0		100.0%
1.0"	0.0		100.0%
3/4"	0.0		100.0%
1/2"	0.0		100.0%
3/8"	0.0		100.0%
#4	0.0	Soil Mortar	100.0%
#10	0.5	100.0%	99.7%
#20	1.7	96.6%	96.3%
#40	4.0	91.9%	91.7%
#60	7.3	85.2%	85.0%
#100	13.2	73.3%	73.1%
#200	22.8	54.0%	53.8%

Notes: Description of Sand & Gravel Particles Rounded ☐ Angular ☐ Hard & Durable ☐ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:			Total Sand:	46.2%	< 4.74 mm and > 0.075 mm
% Gravel:	0.0%	< 75 mm and > 4.75 mm	Silt & Clay:	53.8%	< 0.075
Coarse Sand:	0.3%	< 4.75 mm and > 2.00 mm	Silt:	47.8%	< 0.075 and > 0.005 mm
Medium Sand:	8.0%	< 2.00 mm and > 0.425 mm	Clay:	6.0%	< 0.005 mm
Fine Sand:	37.9%	< 0.425 mm and > 0.075 mm	Colloids:		< 0.001 mm

Type: Mechanical Stirring Apparatus (A)
Dispersion Time: 1 min.
Sodium Hexametaphosphate: 40 g./ Liter

Liquid Limit 40 Plastic Limit 33 Plastic Index 7

Control Cylinder ☒ Composite Correction ☐
Hydrometer: 151H ☐ 152H ☒

Time		Temp.	Hydrometer	Corrections		Hydrometer	Percent Passing		Effective Depth	Table 3	Diameter
Clock	T (Min.)	(0.5 °C)	Reading	Control Cylinder	Composite Correction	R	P(-#10) = (R x a / W) x 100	P (total) = P x % Passing #10	L	K	D = K x ((L/T)^1/2
	1	23.0	25.0	5.0		20.00	40.4%	40.3%	13.0	0.01317	0.04751
	2	23.0	21.0	5.0		16.00	32.3%	32.2%	13.7	0.01317	0.03443
	5	23.0	16.5	5.0		11.50	23.2%	23.2%	14.4	0.01317	0.02236
	15	23.0	12.5	5.0		7.50	15.1%	15.1%	15.1	0.01317	0.01320
	30	23.0	11.0	5.0		6.00	12.1%	12.1%	15.3	0.01317	0.00941
	60	23.0	8.5	5.0		3.50	7.1%	7.0%	15.7	0.01317	0.00674
	250	24.0	6.5	4.0		2.50	5.0%	5.0%	15.9	0.01301	0.00328
	1440	23.0	5.5	5.0		0.50	1.0%	1.0%	16.2	0.01317	0.00140

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technician Name: Karen Warner

Technical Responsibility: Courtney Withers

117900
Certification #

Signature

Staff Professional
Position

Effective Depth (cm)
L=L1+0.5(L2-(VB/A))
(152H) .164cm per increment,
V_B=67.0cm^3, L_2=14cm, A=27.8cm^2

S&ME, INC.
9751Southern Pine Blvd., Charlotte, NC 28273

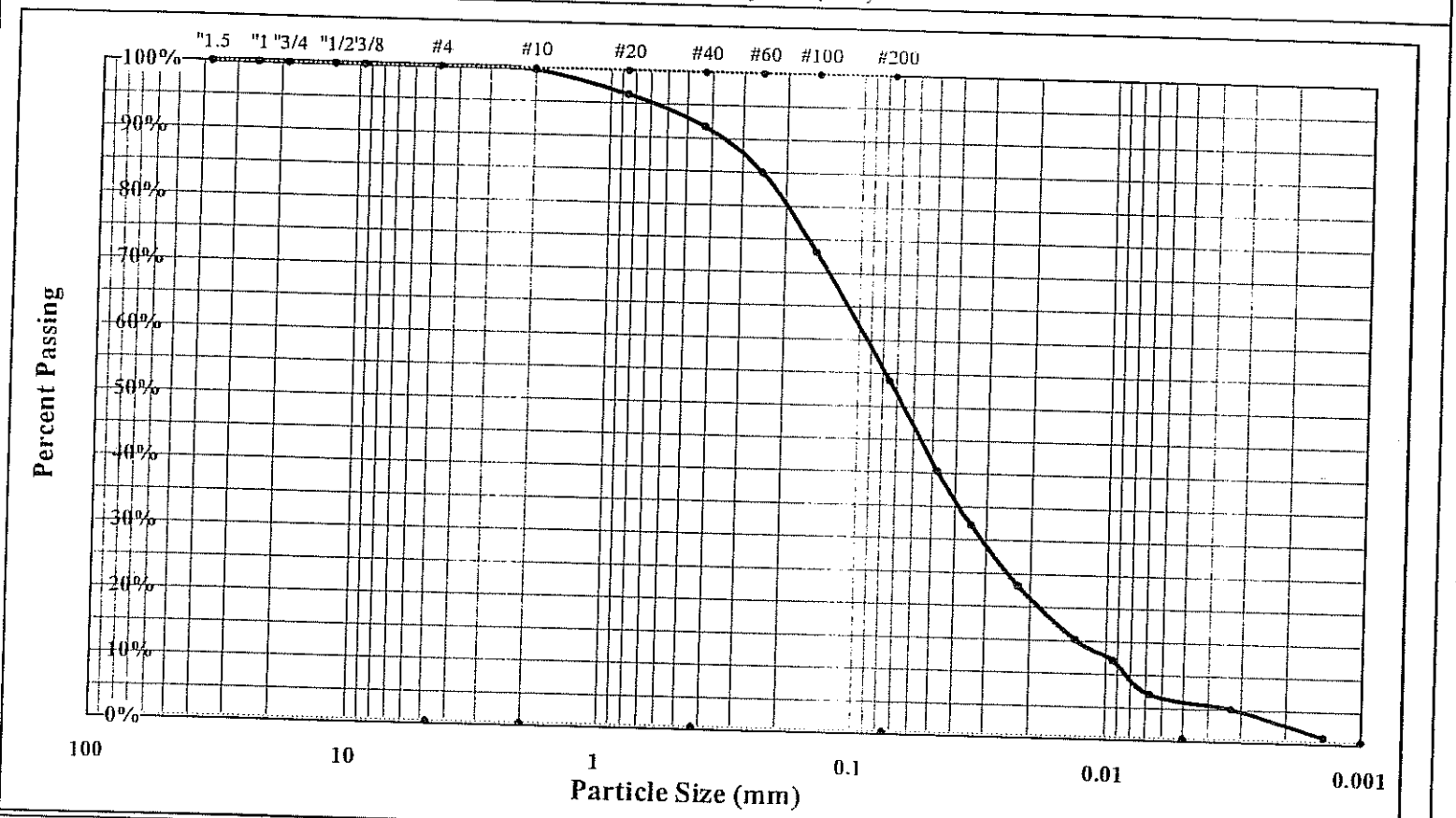
Particle Size Analysis of Soils

ASTM D 422

S&ME

S&ME Project #:	**1356-08-122**	Report Date:	10/27/08
Project Name:	**Marshall Steam Station Industrial Landfill**	Test Date(s):	10/22-27/08
Client Name:	Duke Energy		
Client Address:	Terrel, NC		

Boring #:	M-60	Sample #:	SS-14	Sample Date:	
Location:		Offset:		Depth:	68.5 - 70'
Sample Description:	White Tan Orange Medium to Fine Sandy Silt (ML)				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	0	Gravel	0.0%	Silt	47.8%
Silt & Clay (% Passing #200)	53.8%	Sand	46.2%	Clay	6.0%
Apparent Relative Density (Assumed)	2.650	Moisture Content		Colloids	
Liquid Limit	40	Plastic Limit	33	Plastic Index	7

Description of Sand & Gravel Particles Rounded ☐ Angular ☐ Hard & Durable ☐ Soft ☐ Weathered & Friable ☐

Mechanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

References: ASTM D 422: Particle Size Analysis of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 421: Dry Preparation of Soil Samples
ASTM D 854: Specific Gravity of Soils

Technical Responsibility: Courtney Withers _____ Staff Professional

Signature Position

S&ME, INC. 9751 Southern Pine Blvd.

Liquid Limit, Plastic Limit, and Plastic Index

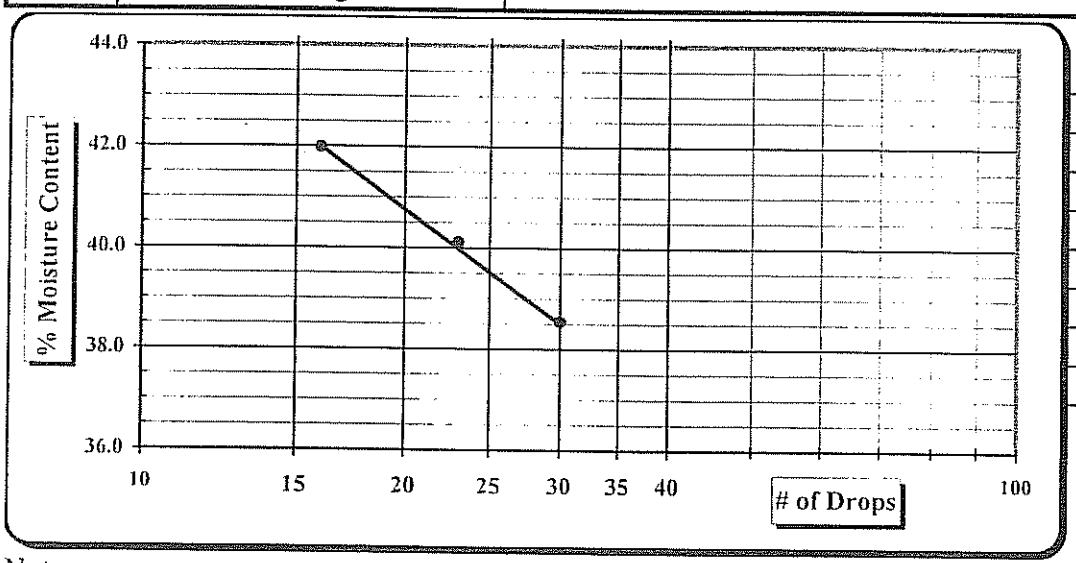
S&ME

Project #: **1356-08-122**
Project Name: Marshall Steam Station Industrial Landfill
Client Name: Duke Energy
Project Address: Terrell, NC

Report Date: 12/12/08
Test Date(s): 10/22-12/12/08

Boring #: M-60 Sample #: SS-14 Sample Date: 10/08
Location: Offset: Depth: 68.5-70'
Sample Description: White Tan Orange Medium to Fine Sandy Silt (ML)

Pan #		Liquid Limit						Plastic Limit		
	Test #							1	2	3
	Tare #	37	16	44				5	18	
A	Tare Weight	15.88	15.71	15.66				**15.67**	15.71	
B	Wet Soil Weight + A	27.31	25.14	24.52				22.72	22.52	
C	Dry Soil Weight + A	24.13	22.44	21.90				20.98	20.82	
D	Water Weight (B-C)	3.18	2.70	2.62				1.74	1.70	
E	Dry Soil Weight (C-A)	8.25	6.73	6.24				5.31	5.11	
F	% Moisture Content (D/E)*100	38.5%	40.1%	42.0%				32.8%	33.3%	
N	# OF DROPS	30	23	16				*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average							33.0%		



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes: Estimate the % Retained on the #40 Sieve

Special Sampling Methods:

Sample Preparation:	Wet Preparation ☐	Dry Preparation ☒	Air Dried ☒	NP, Non-Plastic	☐
Liquid limit Test:	Multipoint Method ☒	One-point Method ☐		Liquid Limit	40
Classification:	ASTM D 2487 ☒	AASHTO M 145 ☐		Plastic Limit	33
Liquid limit Test:	ASTM D 4318 ☒	AASHTO T 89 ☐		Plastic Index	7
Plastic limit Test:	ASTM D 4318 ☒	AASHTO T 90 ☐		Group Symbol	ML

Technician Name: Karen Warner 117900 (Certification #)

Technical Responsibility: Courtney Withers _____ (Signature) Staff Professional (Position)

Particle Size Analysis of Soils

ASTM D 422

S&ME

Project #:	1356-08-122
Project Name:	Marshall Steam Station
Client Name:	Duke Energy
Client Address:	Terrel, NC

Test Date(s):	10/22-27/08
Report Date:	10/27/08

Boring #: M-61 Sample #: SS-4 Sample Date:

Location: Offset: Depth: 18.5 - 20'

Sample Description: Purple Red & White Silty Medium to Fine Sand (SM)

Pan #:		Beaker #:	
Hydrometer Jar #:			
Pan Tare Weight (grams):			
Total Sample Air Dried Wt. + tare wt. (grams):	127.17		
Weight of Total Sample Air Dried:	127.17		
Weight of Air Dried Hydrometer Sample (g):	50.00		
Total Sample Oven Dried:	126.09		
Hydrometer Sample Oven Dried (W):	49.57		
% Passing #10:	100.0%		
Correction Factor a (Table 1):	0.99		

Apparent Relative Density (Assumed) 2.700

	Moisture Content	Hygroscopic	Natural
	Tare #	ZY	
A	Tare Wt.	15.53	
B	Wet Wt. + A	26.08	
C	Dry Wt. + A	25.99	
D	Water Wt. (B-C)	0.09	
E	Dry Wt. (C-A)	10.46	
	% Moisture (100 x D/E)	0.86%	

Sieve	Retained Wt.	Percent Passing	
3.0"	0.0	Pan # (washed)	100.0%
1.5"	0.0		100.0%
1.0"	0.0		100.0%
3/4"	0.0		100.0%
1/2"	0.0		100.0%
3/8"	0.0		100.0%
#4	0.0	Soil Mortar	100.0%
#10	0.0	**100.0%**	100.0%
#20	0.1	99.8%	99.8%
#40	0.4	99.1%	99.1%
#60	2.7	94.6%	94.6%
#100	13.0	73.9%	73.9%
#200	26.8	45.9%	45.9%

Notes: Description of Sand & Gravel Particles Rounded ☐ Angular ☐ Hard & Durable ☐ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:		
% Gravel:	0.0%	< 75 mm and > 4.75 mm
Coarse Sand:	0.0%	< 4.75 mm and > 2.00 mm
Medium Sand:	0.9%	< 2.00 mm and > 0.425 mm
Fine Sand:	53.2%	< 0.425 mm and > 0.075 mm

Total Sand:	54.1%	< 4.74 mm and > 0.075 mm
Silt & Clay:	45.9%	< 0.075
Silt:	40.9%	< 0.075 and > 0.005 mm
Clay:	5.0%	< 0.005 mm
Colloids:		< 0.001 mm

Type:	Mechanical Stirring Apparatus (A)
Dispersion Time:	1 min.
Sodium Hexametaphosphate:	40 g./ Liter

Liquid Limit 60 Plastic Limit 58 Plastic Index 2

Control Cylinder ☒ **Composite Correction** ☐

Hydrometer: 151H ☐ 152H ☒

Time		Temp.	Hydrometer	Corrections		Hydrometer	Percent Passing		Effective Depth	Table 3	Diameter
Clock	T (Min.)	(0.5 °C)	Reading	Control Cylinder	Composite Correction	R	P(-#10) = (R x a / W) x 100	P (total) = P x % Passing #10	L	K	D = K x ((L/T)^1/2
	1	23.0	27.0	5.0		22.00	43.9%	43.9%	12.7	0.01297	0.04621
	2	23.0	25.5	5.0		20.50	40.9%	40.9%	12.9	0.01297	0.03299
	5	23.0	18.0	5.0		13.00	26.0%	26.0%	14.2	0.01297	0.02184
	15	23.0	13.0	5.0		8.00	16.0%	16.0%	15.0	0.01297	0.01297
	30	23.0	10.0	5.0		5.00	10.0%	10.0%	15.5	0.01297	0.00932
	60	23.5	8.0	4.5		3.50	7.0%	7.0%	15.7	0.01290	0.00660
	250	24.0	5.5	4.0		1.50	3.0%	3.0%	16.0	0.01282	0.00325
	1440	23.5	5.5	4.5		1.00	2.0%	2.0%	16.1	0.01290	0.00136

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Effective Depth (cm)
L=L1+0.5(L2-(VB/A))

(152H) .164cm per increment,
V_B=67.0cm^3, L_2=14cm, A=27.8cm^2

Technician Name: Karen Warner

Technical Responsibility: Courtney Withers

117900
Certification #

Signature

Staff Professional
Position

S&ME, INC.

9751Southern Pine Blvd., Charlotte, NC 28273

1356-08-122 M-61 SS-4 (18.5-20) Hydro.xls

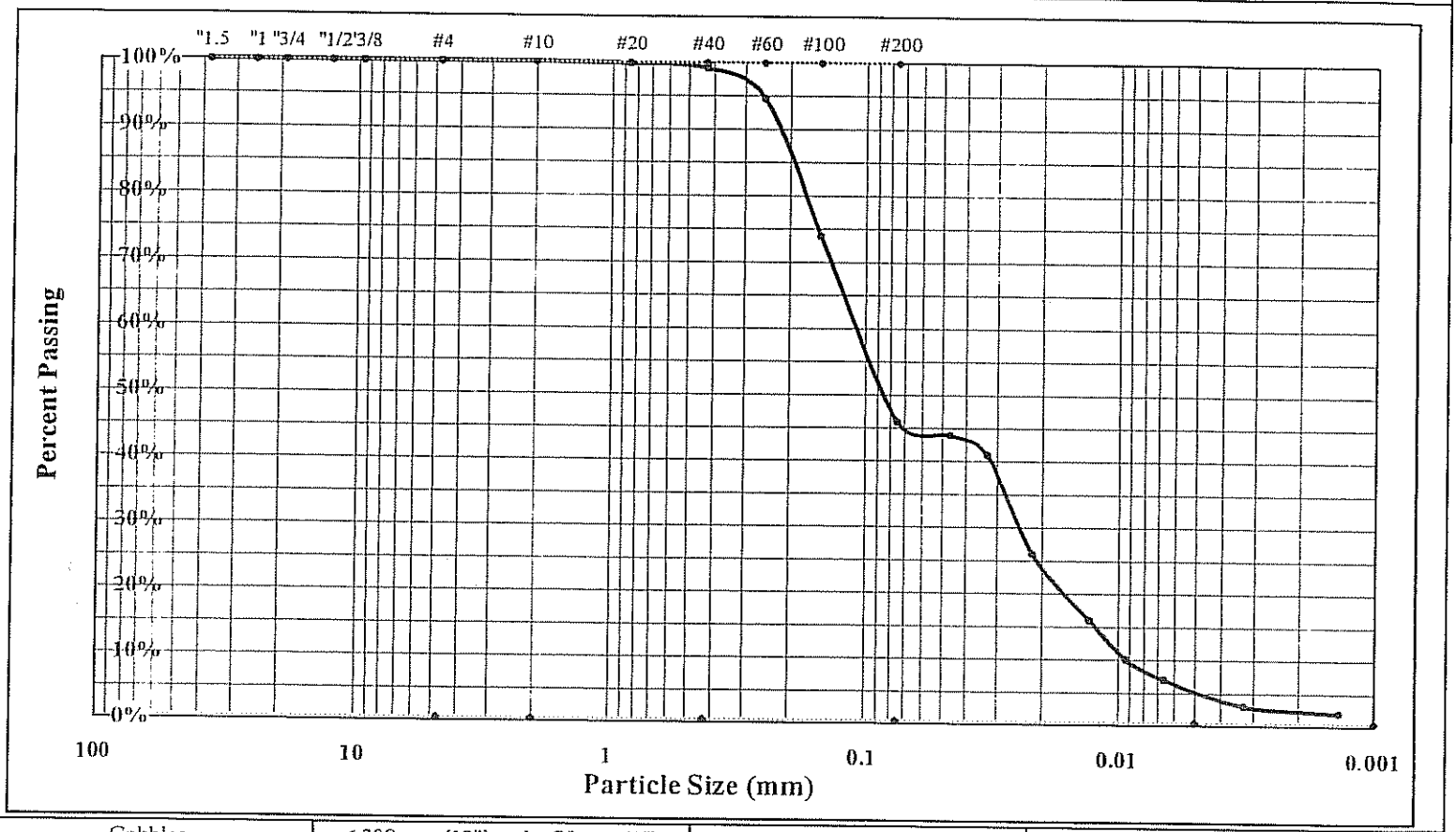
Particle Size Analysis of Soils

ASTM D 422

S&ME

S&ME Project #:	**1356-08-122**	Report Date:	10/27/08
Project Name:	**Marshall Steam Station**	Test Date(s):	10/22-27/08
Client Name:	Duke Energy		
Client Address:	Terrel, NC		

Boring #:	M-61	Sample #:	SS-4	Sample Date:	
Location:		Offset:		Depth:	18.5 - 20'
Sample Description:	Purple Red & White Silty Medium to Fine Sand (SM)				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	0	Gravel	0.0%	Silt	40.9%
Silt & Clay (% Passing #200)	45.9%	Sand	54.1%	Clay	5.0%
Apparent Relative Density (Assumed)	2.700	Moisture Content		Colloids	
Liquid Limit	60	Plastic Limit	58	Plastic Index	2

Description of Sand & Gravel Particles Rounded ☐ Angular ☐ Hard & Durable ☐ Soft ☐ Weathered & Friable ☐

Mechanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g / Liter

References: ASTM D 422: Particle Size Analysis of Soils
ASTM D 421: Dry Preparation of Soil Samples
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 854: Specific Gravity of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Technical Responsibility: Courtney Withers _____ Staff Professional
Signature Position

Liquid Limit, Plastic Limit, and Plastic Index

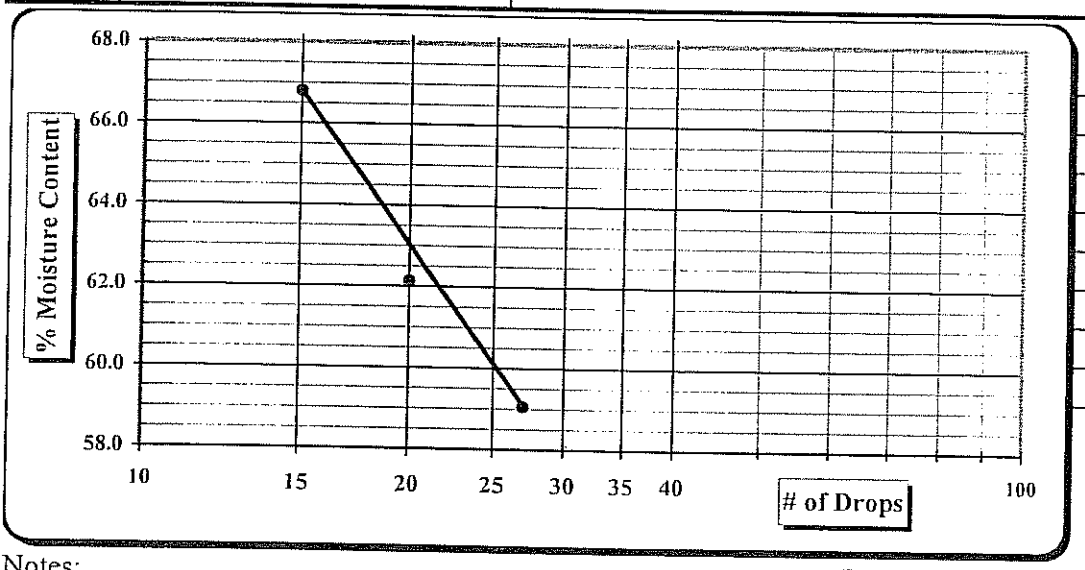
S&ME

Project #: **1356-08-122**
Project Name: Marshall Steam Station Industrial Landfill
Client Name: Duke Energy
Project Address: Terrell, NC

Report Date: 12/12/08
Test Date(s): 10/22-12/12/08

Boring #: M-61 Sample #: SS-4 Sample Date:
Location: Offset: Depth: 18.5-20'
Sample Description: Purple-Red & White Silty Medium to Fine Sand (SM)

Pan #		Liquid Limit						Plastic Limit		
	Test #							1	2	3
	Tare #	QQ	II	TT				48	49	
A	Tare Weight	16.88	16.88	13.83				**13.99**	15.66	
B	Wet Soil Weight + A	29.08	27.37	22.32				19.31	21.29	
C	Dry Soil Weight + A	24.55	23.35	18.92				17.35	19.24	
D	Water Weight (B-C)	4.53	4.02	3.40				1.96	2.05	
E	Dry Soil Weight (C-A)	7.67	6.47	5.09				3.36	3.58	
F	% Moisture Content (D/E)*100	59.1%	62.1%	66.8%				58.3%	57.3%	
N	# OF DROPS	27	20	15				*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average							57.8%		



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes: Estimate the % Retained on the #40 Sieve

Special Sampling Methods:

Sample Preparation:	Wet Preparation ☐	Dry Preparation ☒	Air Dried ☒	NP, Non-Plastic	☐
Liquid limit Test:	Multipoint Method ☒	One-point Method ☐		Liquid Limit	60
Classification:	ASTM D 2487 ☒	AASHTO M 145 ☐		Plastic Limit	58
Liquid limit Test:	ASTM D 4318 ☒	AASHTO T 89 ☐		Plastic Index	2
Plastic limit Test:	ASTM D 4318 ☒	AASHTO T 90 ☐		Group Symbol	SM

Technician Name: Karen Warner 117900 *Certification #*

Technical Responsibility: Courtney Withers *Signature* Staff Professional *Position*

S&ME, INC. 9751 Southern Pine Blvd., Charlotte, NC 28273

Particle Size Analysis of Soils

ASTM D 422

S&ME

Project #: 1356-08-122
Project Name: Marshall Steam Station Industrial Landfill
Client Name: Duke Energy
Project Address: Terrel, NC

Test Date(s): 10/22-27/08
Report Date: 10/27/08

Boring #: M-61 Sample #: SS-16 Sample Date: 10/08
Location: Offset: Depth: 78.5 - 80'
Sample Description: Brown Orange White Medium to Fine Sandy Silt (ML)

Pan #:		Beaker #:	
Hydrometer Jar #:			
Pan Tare Weight (grams):			
Total Sample Air Dried Wt. + tare wt. (grams):	227.25		
Weight of Total Sample Air Dried:	227.25		
Weight of Air Dried Hydrometer Sample (g):	50.03		
Total Sample Oven Dried:	225.59		
Hydrometer Sample Oven Dried (W):	49.66		
% Passing #10:	100.0%		
Correction Factor a (Table 1):	0.98		

Apparent Relative Density (Assumed) 2.740

	Moisture Content	Hygroscopic	Natural
	Tare #	RL	
A	Tare Wt.	15.26	
B	Wet Wt. + A	28.92	
C	Dry Wt. + A	28.82	
D	Water Wt. (B-C)	0.10	
E	Dry Wt. (C-A)	13.56	
	% Moisture (100 x D/E)	0.74%	

Sieve	Retained Wt.	Percent Passing	
3.0"		Pan # (washed)	100.0%
1.5"			100.0%
1.0"			100.0%
3/4"			100.0%
1/2"			100.0%
3/8"			100.0%
#4		Soil Mortar	100.0%
#10	0.0	**100.0%**	100.0%
#20	0.4	99.3%	99.3%
#40	1.9	96.1%	96.1%
#60	7.0	85.9%	85.9%
#100	13.6	72.7%	72.7%
#200	21.6	56.5%	56.5%

Notes: Description of Sand & Gravel Particles Rounded ☐ Angular ☐ Hard & Durable ☐ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:			Total Sand:	43.5%	< 4.74 mm and > 0.075 mm
% Gravel:	0.0%	< 75 mm and > 4.75 mm	Silt & Clay:	56.5%	< 0.075
Coarse Sand:	0.0%	< 4.75 mm and > 2.00 mm	Silt:	50.5%	< 0.075 and > 0.005 mm
Medium Sand:	3.9%	< 2.00 mm and > 0.425 mm	Clay:	6.0%	< 0.005 mm
Fine Sand:	39.6%	< 0.425 mm and > 0.075 mm	Colloids:		< 0.001 mm

Type: Mechanical Stirring Apparatus (A)
Dispersion Time: 1 min.
Sodium Hexametaphosphate: 40 g./ Liter

Control Cylinder ☒ **Composite Correction** ☐

Liquid Limit 28 Plastic Limit 28 Plastic Index 0 Hydrometer: 151H ☐ 152H ☒

Time		Temp.	Hydrometer	Corrections		Hydrometer	Percent Passing		Effective Depth	Table 3	Diameter
				Control Cylinder	Composite Correction		P(-#10) = (R x a / W) x 100	P (total) = P x % Passing #10			D = K x ((L/T)^1/2
Clock	T (Min.)	(0.5 °C)	Reading			R			L	K	
	1	23.0	26.5	5.0		21.50	42.4%	42.4%	12.8	0.01282	0.04583
	2	23.0	21.0	5.0		16.00	31.6%	31.6%	13.7	0.01282	0.03353
	5	23.0	16.0	5.0		11.00	21.7%	21.7%	14.5	0.01282	0.02183
	15	23.0	13.0	5.0		8.00	15.8%	15.8%	15.0	0.01282	0.01282
	30	23.0	10.0	5.0		5.00	9.9%	9.9%	15.5	0.01282	0.00921
	60	23.0	8.5	5.0		3.50	6.9%	6.9%	15.7	0.01282	0.00656
	250	24.0	6.5	4.0		2.50	4.9%	4.9%	15.9	0.01267	0.00319
	1440	23.0	5.5	5.0		0.50	1.0%	1.0%	16.2	0.01282	0.00136

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Effective Depth (cm)
L=L1+0.5(L2-(VB/A))
(152H) .164cm per increment,
V_B=67.0cm^3, L_2=14cm, A=27.8cm^2

Technician Name: Karen Warner 117900 *Certification #*

Technical Responsibility: Courtney Withers _____ *Signature* *Staff Professional* *Position*

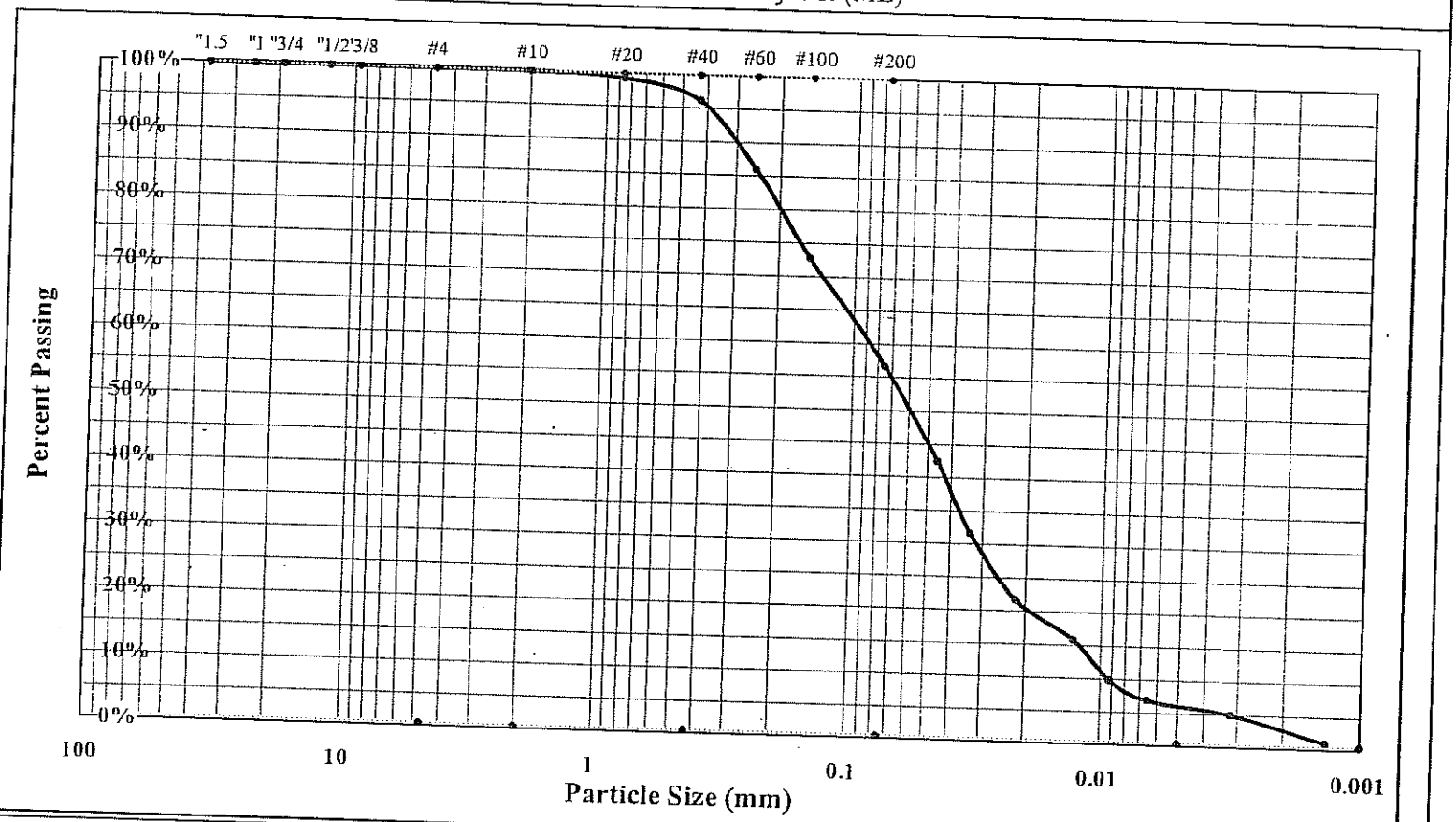
Particle Size Analysis of Soils

ASTM D 422

S&ME

S&ME Project #:	**1356-08-122**		
Project Name:	**Marshall Steam Station Industrial Landfill**	Report Date:	10/27/08
Client Name:	Duke Energy	Test Date(s):	10/22-27/08
Project Address:	Terrel, NC		

Boring #:	M-61	Sample #:	SS-16	Sample Date:	10/08
Location:		Offset:		Depth:	78.5 - 80'
Sample Description:	Brown Orange White Medium to Fine Sandy Silt (ML)				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	0	Gravel	0.0%	Silt	50.5%
Silt & Clay (% Passing #200)	56.5%	Sand	43.5%	Clay	6.0%
pparent Relative Density (Assumed)	2.740	Moisture Content		Colloids	
Liquid Limit	28	Plastic Limit	28	Plastic Index	0

scription of Sand & Gravel Particles Rounded ☐ Angular ☐ Hard & Durable ☐ Soft ☐ Weathered & Friable ☐

hanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./ Liter

erences: ASTM D 422: Particle Size Analysis of Soils
M D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
M D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 421: Dry Preparation of Soil Samples
ASTM D 854: Specific Gravity of Soils

hnical Responsibility: Courtney Withers _____ Staff Professional

Signature Position

S&ME, INC. 9751 Southern Pine Blvd., Charlotte

Liquid Limit, Plastic Limit, and Plastic Index

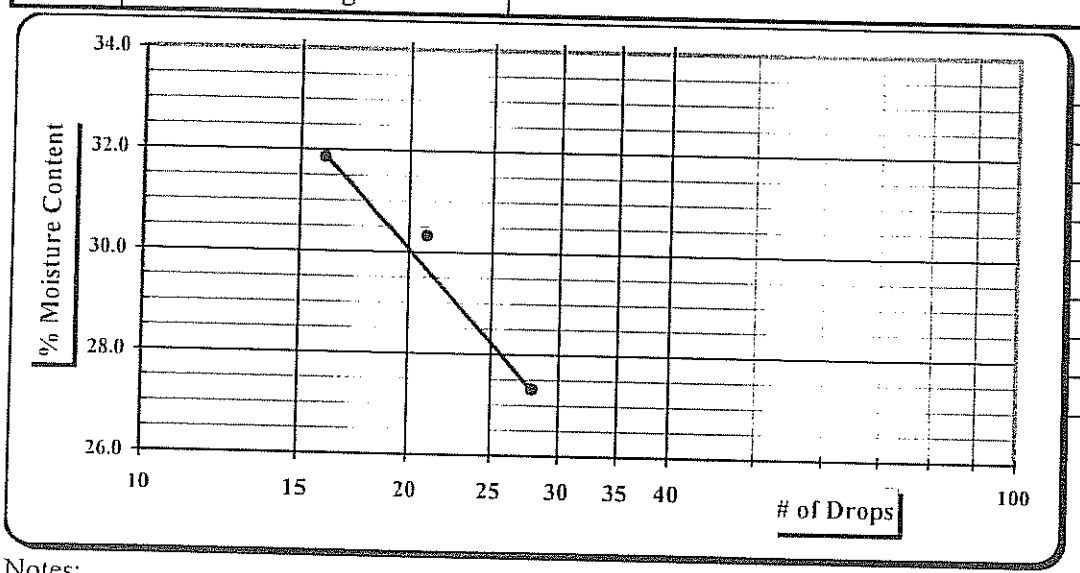
S&ME

Project #: 1356-08-122
Project Name: Marshall Steam Station Industrial Landfill
Client Name: Duke Energy
Project Address: Terrell, NC

Report Date: 12/12/08
Test Date(s): 10/22-12/12/08

Boring #: M-61 Sample #: SS-16 Sample Date: 10/08
Location: Offset: Depth: 78.5-80'
Sample Description: Brown Orange White Medium to Fine Sandy Silt (ML)

Pan #		Liquid Limit						Plastic Limit		
	Test #							1	2	3
	Tare #	39	Aa	13				38	30	
A	Tare Weight	13.94	15.14	13.96				15.81	15.88	
B	Wet Soil Weight + A	22.84	26.57	27.37				22.30	23.24	
C	Dry Soil Weight + A	20.93	23.91	24.13				20.89	21.64	
D	Water Weight (B-C)	1.91	2.66	3.24				1.41	1.60	
E	Dry Soil Weight (C-A)	6.99	8.77	10.17				5.08	5.76	
F	% Moisture Content (D/E)*100	27.3%	30.3%	31.9%				27.8%	27.8%	
N	# OF DROPS	28	21	16				*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average							27.8%		



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes: Estimate the % Retained on the #40 Sieve

Special Sampling Methods:

Sample Preparation:	Wet Preparation ☐	Dry Preparation ☒	Air Dried ☒	NP, Non-Plastic	☐
Liquid limit Test:	Multipoint Method ☒	One-point Method ☐		Liquid Limit	28
Classification:	ASTM D 2487 ☒	AASHTO M 145 ☐		Plastic Limit	28
Liquid limit Test:	ASTM D 4318 ☒	AASHTO T 89 ☐		Plastic Index	0
Plastic limit Test:	ASTM D 4318 ☒	AASHTO T 90 ☐		Group Symbol	ML

Technician Name: Karen Warner 117900 (Certification #)

Technical Responsibility: Courtney Withers (Signature) Staff Professional (Position)

Particle Size Analysis of Soils

ASTM D 422

S&ME

Project #:	1356-08-122
Project Name:	Marshall Steam Station
Client Name:	Duke Energy
Client Address:	Terrel, NC

Test Date(s):	10/22-27/08
Report Date:	10/27/08

Boring #: M-62 Sample #: SS-7 Sample Date:

Location: Offset: Depth: 33.5 - 35'

Sample Description: Tannish Gray Fine Sandy Silt (ML)

Pan #:		Beaker #:	
Hydrometer Jar #:			
Pan Tare Weight (grams):			
Total Sample Air Dried Wt. + tare wt. (grams):	222.92		
Weight of Total Sample Air Dried:	222.92		
Weight of Air Dried Hydrometer Sample (g):	50.00		
Total Sample Oven Dried:	220.91		
Hydrometer Sample Oven Dried (W):	49.55		
% Passing #10:	100.0%		
Correction Factor a (Table 1):	0.99		

Apparent Relative Density (Assumed) 2.720

	Moisture Content	Hygroscopic	Natural
	Tare #	57	
A	Tare Wt.	13.88	
B	Wet Wt. + A	24.97	
C	Dry Wt. + A	24.87	
D	Water Wt. (B-C)	0.10	
E	Dry Wt. (C-A)	10.99	
	% Moisture (100 x D/E)	0.91%	

Sieve	Retained Wt.	Percent Passing	
3.0"	0.0	Pan # (washed)	100.0%
1.5"	0.0		100.0%
1.0"	0.0		100.0%
3/4"	0.0		100.0%
1/2"	0.0		100.0%
3/8"	0.0		100.0%
#4	0.0	Soil Mortar	100.0%
#10	0.0	**100.0%**	100.0%
#20	0.1	99.8%	99.8%
#40	0.2	99.6%	99.6%
#60	0.6	98.8%	98.8%
#100	6.3	87.3%	87.3%
#200	19.9	59.9%	59.9%

Notes: Description of Sand & Gravel Particles Rounded ☐ Angular ☐ Hard & Durable ☐ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:		
% Gravel:	0.0%	< 75 mm and > 4.75 mm
Coarse Sand:	0.0%	< 4.75 mm and > 2.00 mm
Medium Sand:	0.4%	< 2.00 mm and > 0.425 mm
Fine Sand:	39.7%	< 0.425 mm and > 0.075 mm

Total Sand:	40.1%	< 4.74 mm and > 0.075 mm
Silt & Clay:	59.9%	< 0.075
Silt:	52.9%	< 0.075 and > 0.005 mm
Clay:	7.0%	< 0.005 mm
Colloids:		< 0.001 mm

Type:	Mechanical Stirring Apparatus (A)
Dispersion Time:	1 min.
Sodium Hexametaphosphate:	40 g./ Liter

Liquid Limit 40 Plastic Limit 40 Plastic Index 0

Control Cylinder ☒ **Composite Correction** ☐

Hydrometer: 151H ☐ 152H ☒

Time		Temp.	Hydrometer	Corrections		Hydrometer	Percent Passing		Effective Depth	Table 3	Diameter
Clock	T (Min.)	(0.5 °C)	Reading	Control Cylinder	Composite Correction	R	P(-#10) = (R x a / W) x 100	P (total) = P x % Passing #10	L	K	D = K x ((L/T)^1/2
	1	23.0	30.0	5.0		25.00	50.0%	50.0%	12.2	0.01290	0.04505
	2	23.0	23.5	5.0		18.50	37.0%	37.0%	13.3	0.01290	0.03322
	5	23.0	18.5	5.0		13.50	27.0%	27.0%	14.1	0.01290	0.02165
	15	23.0	13.0	5.0		8.00	16.0%	16.0%	15.0	0.01290	0.01289
	30	23.0	10.5	5.0		5.50	11.0%	11.0%	15.4	0.01290	0.00924
	60	23.5	9.0	4.5		4.50	9.0%	9.0%	15.6	0.01282	0.00653
	250	24.0	6.0	4.0		2.00	4.0%	4.0%	16.0	0.01274	0.00322
	1440	23.0	6.0	5.0		1.00	2.0%	2.0%	16.1	0.01290	0.00137

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Effective Depth (cm)
L=L1+0.5(L2-(VB/A))
(152H) .164cm per increment,
V_B=67.0cm^3, L_2=14cm, A=27.8cm^2

Technician Name: Karen Warner

Technical Responsibility: Courtney Withers

117900
Certification #

Signature

Staff Professional
Position

S&ME, INC. 9751Southern Pine Blvd., Charlotte, NC 28273

1356-08-122 M-62 SS-7 (33.5-35) Hydro.xls

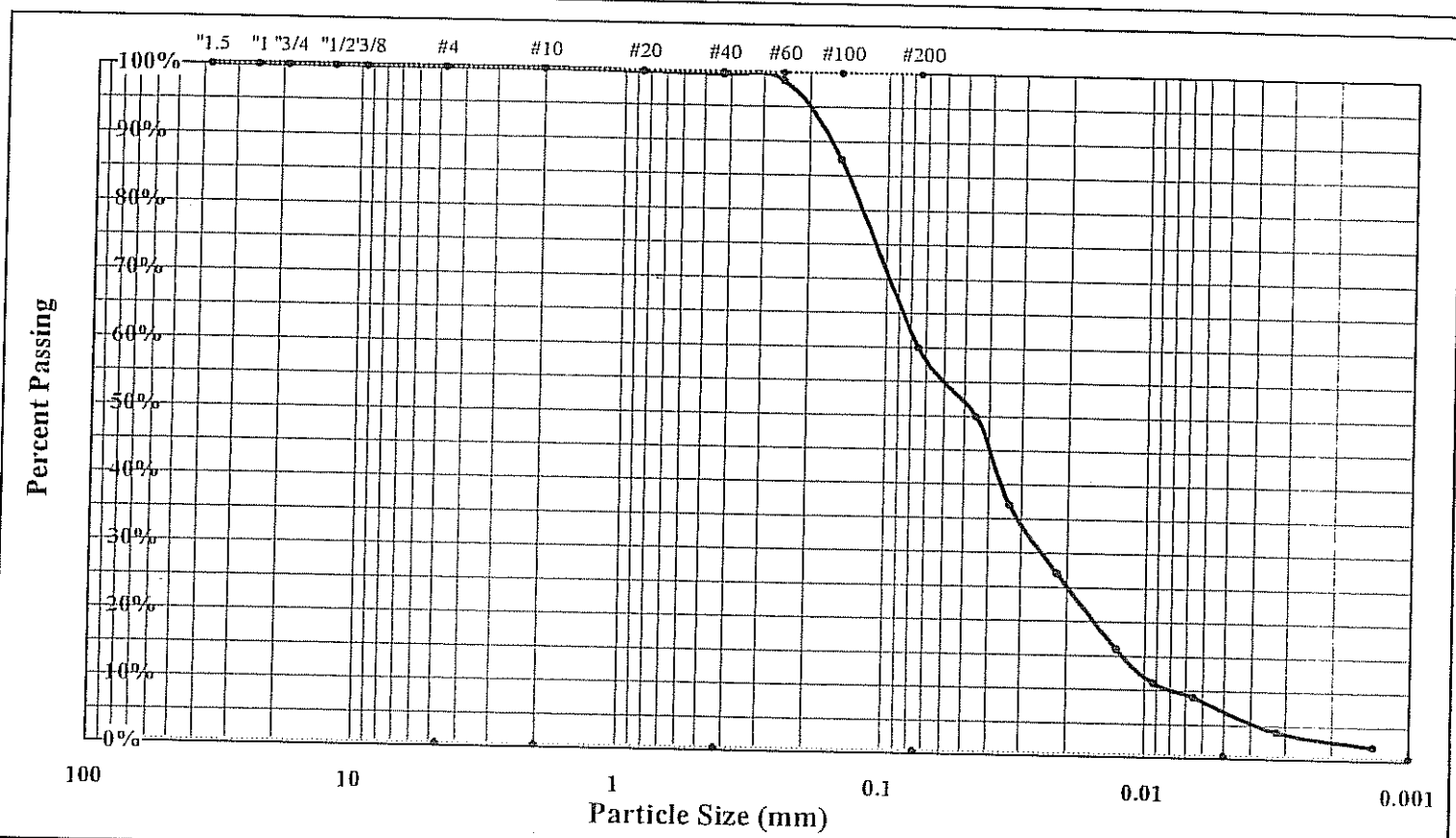
Particle Size Analysis of Soils

ASTM D 422

S&ME

S&ME Project #:	**1356-08-122**	Report Date:	10/27/08
Project Name:	**Marshall Steam Station**	Test Date(s):	10/22-27/08
Client Name:	Duke Energy		
Client Address:	Terrel, NC		

Boring #:	M-62	Sample #:	SS-7	Sample Date:	
Location:		Offset:		Depth:	33.5 - 35'
Sample Description:	Tannish Gray Fine Sandy Silt (ML)				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	0	Gravel	0.0%	Silt	52.9%
Silt & Clay (% Passing #200)	59.9%	Sand	40.1%	Clay	7.0%
pparent Relative Density (Assumed)	2.720	Moisture Content		Colloids	
Liquid Limit	40	Plastic Limit	40	Plastic Index	0

scription of Sand & Gravel Particles Rounded ☐ Angular ☐ Hard & Durable ☐ Soft ☐ Weathered & Friable ☐

hanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g./Liter

erences: ASTM D 422: Particle Size Analysis of Soils
M D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
M D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 421: Dry Preparation of Soil Samples
ASTM D 854: Specific Gravity of Soils

chnical Responsibility: Courtney Withers (Signature) Staff Professional (Position)

Laboratory Record Version 4.2

Liquid Limit, Plastic Limit, and Plastic Index

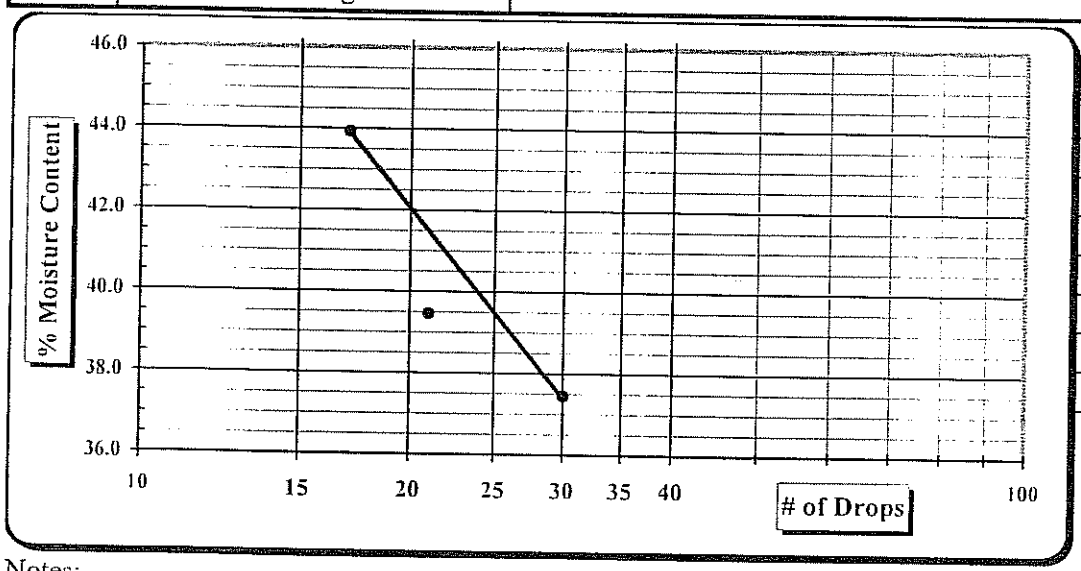
S&ME

Project #: **1356-08-122**
Project Name: Marshall Steam Station Industrial Landfill
Client Name: Duke Energy
Project Address: Terrell, NC

Report Date: 12/12/08
Test Date(s): 10/22-12/12/08

Boring #: M-62 Sample #: SS-7 Sample Date:
Location: Offset: Depth: 33.5-35'
Sample Description: Tannish-Gray Fine Sandy Silt (ML)

Pan #		Liquid Limit						Plastic Limit		
	Test #							1	2	3
	Tare #	28	40	60				15	7	
A	Tare Weight	14.05	15.79	13.86				**13.96**	15.71	
B	Wet Soil Weight + A	23.96	26.18	23.23				21.69	23.28	
C	Dry Soil Weight + A	21.26	23.24	20.37				19.52	21.13	
D	Water Weight (B-C)	2.70	2.94	2.86				2.17	2.15	
E	Dry Soil Weight (C-A)	7.21	7.45	6.51				5.56	5.42	
F	% Moisture Content (D/E)*100	37.4%	39.5%	43.9%				39.0%	39.7%	
N	# OF DROPS	30	21	17				*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average							39.3%		



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes: Estimate the % Retained on the #40 Sieve

Special Sampling Methods:

Sample Preparation:	Wet Preparation ☐	Dry Preparation ☒	Air Dried ☒	NP, Non-Plastic	☐
Liquid limit Test:	Multipoint Method ☒	One-point Method ☐		Liquid Limit	40
Classification:	ASTM D 2487 ☒	AASHTO M 145 ☐		Plastic Limit	40
Liquid limit Test:	ASTM D 4318 ☒	AASHTO T 89 ☐		Plastic Index	0
Plastic limit Test:	ASTM D 4318 ☒	AASHTO T 90 ☐		Group Symbol	ML

Technician Name: Karen Warner 117900 (Certification #)

Technical Responsibility: Courtney Withers (Signature) Staff Professional (Position)

Particle Size Analysis of Soils

ASTM D 422

S&ME

Project #: 1356-08-122
Project Name: Marshall Steam Station Industrial Landfill
Client Name: Duke Energy
Client Address: Terrel, NC

Test Date(s): 10/22-27/08
Report Date: 10/27/08

Boring #: M-63 Sample #: SS-2 Sample Date: 10/08
Location: Offset: Depth: 8.5 - 10'
Sample Description: Yellow-Red Tan White Orange Silty Coarse to Fine Sand (SM)

Pan #:		Beaker #:	
Hydrometer Jar #:			
Pan Tare Weight (grams):			
Total Sample Air Dried Wt. + tare wt. (grams):	148.13		
Weight of Total Sample Air Dried:	148.13		
Weight of Air Dried Hydrometer Sample (g):	50.00		
Total Sample Oven Dried:	146.55		
Hydrometer Sample Oven Dried (W):	49.47		
% Passing #10:	99.4%		
Correction Factor a (Table 1):	1.00		

Apparent Relative Density (Assumed) 2.650

	Moisture Content	Hygroscopic	Natural
	Tare #	54	
A	Tare Wt.	14.10	
B	Wet Wt. + A	26.25	
C	Dry Wt. + A	26.12	
D	Water Wt. (B-C)	0.13	
E	Dry Wt. (C-A)	12.02	
	% Moisture (100 x D/E)	1.08%	

Sieve	Retained Wt.	Percent Passing	
3.0"	0.0	Pan # (washed)	100.0%
1.5"	0.0		100.0%
1.0"	0.0		100.0%
3/4"	0.0		100.0%
1/2"	0.0		100.0%
3/8"	0.0		100.0%
#4	0.0	Soil Mortar	100.0%
#10	0.8	**100.0%**	99.4%
#20	1.2	97.5%	96.9%
#40	5.6	88.7%	88.2%
#60	11.5	76.8%	76.4%
#100	20.7	58.1%	57.8%
#200	32.6	34.2%	34.0%

Notes: Description of Sand & Gravel Particles Rounded ☐ Angular ☐ Hard & Durable ☐ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:			Total Sand:	66.0%	< 4.74 mm and > 0.075 mm	Type: Mechanical Stirring Apparatus (A)
% Gravel:	0.0%	< 75 mm and > 4.75 mm	Silt & Clay:	34.0%	< 0.075	Dispersion Time: 1 min.
Coarse Sand:	0.6%	< 4.75 mm and > 2.00 mm	Silt:	30.5%	< 0.075 and > 0.005 mm	Sodium Hexametaphosphate: 40 g./ Liter
Medium Sand:	11.2%	< 2.00 mm and > 0.425 mm	Clay:	3.5%	< 0.005 mm	
Fine Sand:	54.2%	< 0.425 mm and > 0.075 mm	Colloids:		< 0.001 mm	Control Cylinder ☒ Composite Correction ☐

Liquid Limit NP Plastic Limit NP Plastic Index NP Hydrometer: 151H ☐ 152H ☒

Time		Temp.	Hydrometer	Corrections		Hydrometer	Percent Passing		Effective Depth	Table 3	Diameter
Clock	T (Min.)	(0.5 °C)	Reading	Control Cylinder	Composite Correction	R	P(-#10) = (R x a / W) x 100	P (total) = P x % Passing #10	L	K	D = K x ((L/T)^1/2
	1	23.0	20.0	5.0		15.00	30.3%	30.2%	13.8	0.01317	0.04899
	2	23.0	16.0	5.0		11.00	22.2%	22.1%	14.5	0.01317	0.03545
	5	23.0	13.0	5.0		8.00	16.2%	16.1%	15.0	0.01317	0.02280
	15	23.0	10.0	5.0		5.00	10.1%	10.1%	15.5	0.01317	0.01338
	30	23.0	8.0	5.0		3.00	6.1%	6.0%	15.8	0.01317	0.00956
	60	23.5	7.0	4.5		2.50	5.1%	5.0%	15.9	0.01309	0.00674
	250	24.0	5.0	4.0		1.00	2.0%	2.0%	16.1	0.01301	0.00330
	1440	23.0	5.0	5.0		0.00	0.0%	0.0%	16.3	0.01317	0.00140

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Effective Depth (cm)
L=L1+0.5(L2-(VB/A))
(152H) .164cm per increment,
V_B=67.0cm^3, L_2=14cm, A=27.8cm^2

Technician Name: Karen Warner 117900 *Certification #*

Technical Responsibility: Courtney Withers *Signature* *Staff Professional* *Position*

S&ME, INC. 9751Southern Pine Blvd., Charlotte, NC 28273

1356-08-122 M-63 SS-2 (8.5-10) Hydro.xls

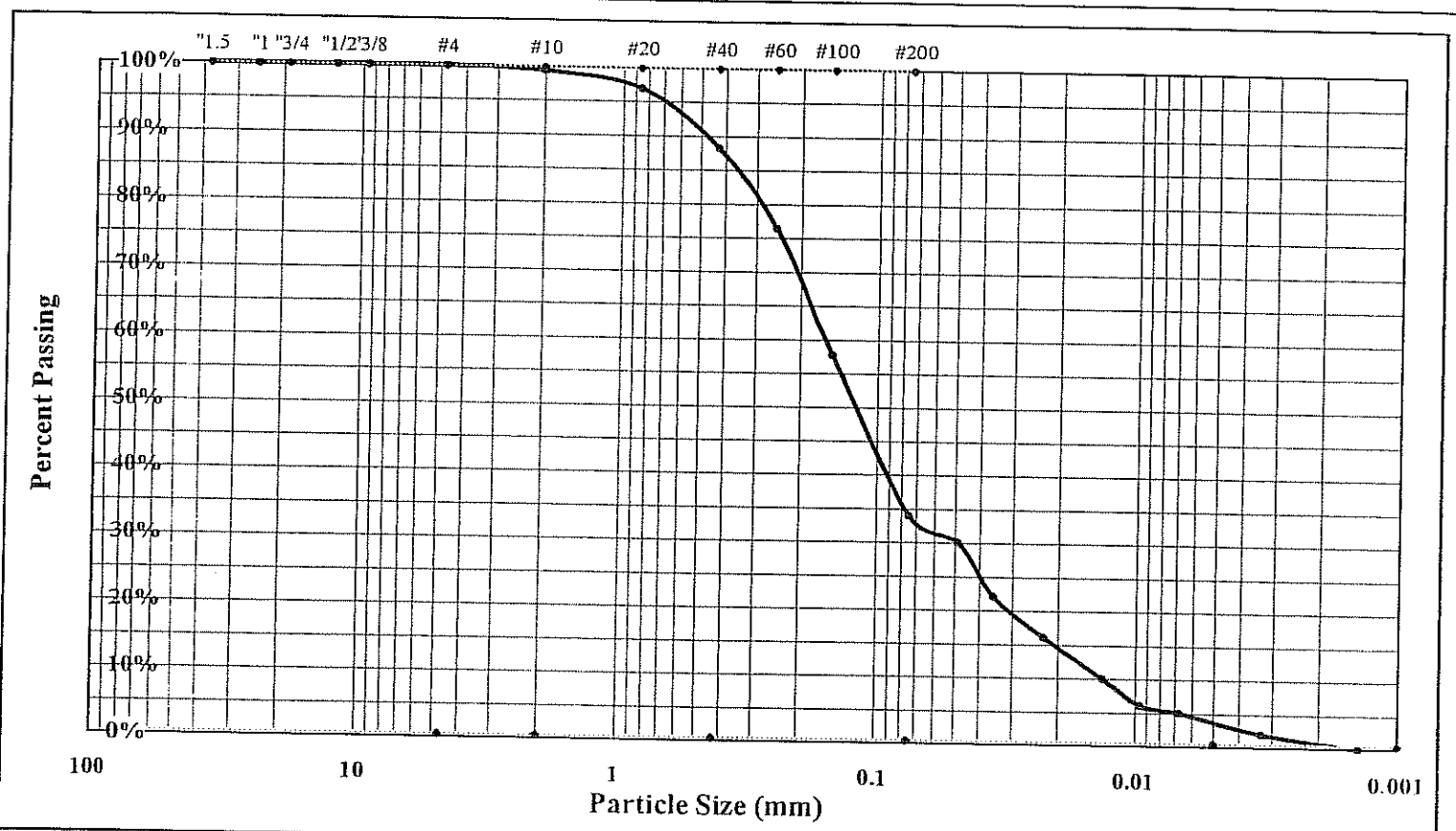
Particle Size Analysis of Soils

ASTM D 422

S&ME

S&ME Project #:	**1356-08-122**	Report Date:	10/27/08
Project Name:	**Marshall Steam Station Industrial Landfill**	Test Date(s):	10/22-27/08
Client Name:	Duke Energy		
Client Address:	Terrel, NC		

Boring #:	M-63	Sample #:	SS-2	Sample Date:	10/08
Location:		Offset:		Depth:	8.5 - 10'
Sample Description:	Yellow-Red Tan White Orange Silty Coarse to Fine Sand (SM)				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	0	Gravel	0.0%	Silt	30.5%
Silt & Clay (% Passing #200)	34.0%	Sand	66.0%	Clay	3.5%
Apparent Relative Density (Assumed)	2.650	Moisture Content		Colloids	
Liquid Limit	NP	Plastic Limit	NP	Plastic Index	NP

escription of Sand & Gravel Particles Rounded ☐ Angular ☐ Hard & Durable ☐ Soft ☐ Weathered & Friable ☐

chanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 40 g / Liter

ferences: ASTM D 422: Particle Size Analysis of Soils
TM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
TM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 421: Dry Preparation of Soil Samples
ASTM D 854: Specific Gravity of Soils

chnical Responsibility: Courtney Withers _____ Staff Professional

Signature Position

S&ME, INC. 9751 Southern Pine Blvd., Charlotte, NC

Liquid Limit, Plastic Limit, and Plastic Index

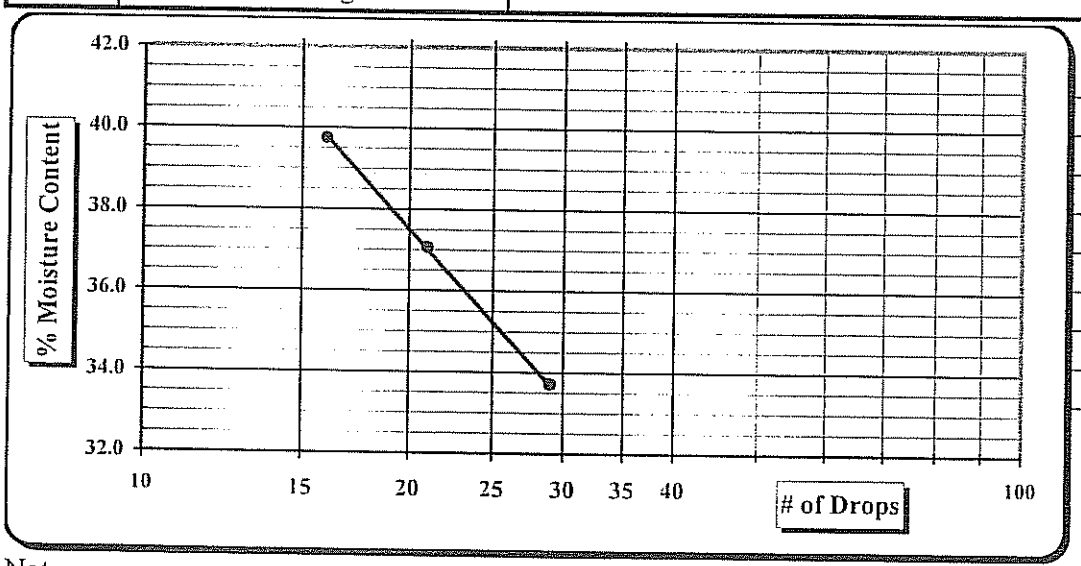
S&ME

Project #: 1356-08-122
Project Name: Marshall Steam Station Industrial Landfill
Client Name: Duke Energy
Project Address: Terrell, NC

Report Date: 12/12/08
Test Date(s): 10/22-12/12/08

Boring #: M-63 Sample #: SS-2 Sample Date: 10/08
Location: Offset: Depth: 8.5-10'
Sample Description: Yellow-Red Tan White Orange Micaceous Silty Coarse to Fine Sand (M)

Pan #		Liquid Limit						Plastic Limit		
	Test #							1	2	3
	Tare #	EE	TH	WN				22	32	
A	Tare Weight	16.92	15.30	16.56				13.92	13.91	
B	Wet Soil Weight + A	26.24	25.21	28.16				21.05	21.23	
C	Dry Soil Weight + A	23.89	22.53	24.86				19.12	19.27	
D	Water Weight (B-C)	2.35	2.68	3.30				1.93	1.96	
E	Dry Soil Weight (C-A)	6.97	7.23	8.30				5.20	5.36	
F	% Moisture Content (D/E)*100	33.7%	37.1%	39.8%				37.1%	36.6%	
N	# OF DROPS	29	21	16				*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average							36.8%		



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes: Estimate the % Retained on the #40 Sieve

Special Sampling Methods:

Sample Preparation:	Wet Preparation ☐	Dry Preparation ☒	Air Dried ☒	NP, Non-Plastic	☒
Liquid limit Test:	Multipoint Method ☒	One-point Method ☐		Liquid Limit	
Classification:	ASTM D 2487 ☒	AASHTO M 145 ☐		Plastic Limit	
Liquid limit Test:	ASTM D 4318 ☒	AASHTO T 89 ☐		Plastic Index	
Plastic limit Test:	ASTM D 4318 ☒	AASHTO T 90 ☐		Group Symbol	SM

Technician Name: Karen Warner 117900 (Certification #)

Technical Responsibility: Courtney Withers (Signature) Staff Professional (Position)

Particle Size Analysis of Soils

ASTM D 422

S&ME

Project #: 1356-08-122
Project Name: Marshall Steam Station Industrial Landfill
Client Name: Duke Energy
Client Address: Terrel, NC

Test Date(s): 10/22-27/08
Report Date: 10/27/08

Boring #: M-64 Sample #: SS-3 Sample Date: 10/08
Location: Offset: Depth: 13.5 - 15'
Sample Description: White Silty Coarse to Fine to Medium Sand (SM)

Pan #:		Beaker #:	
Hydrometer Jar #:			
Pan Tare Weight (grams):			
Total Sample Air Dried Wt. + tare wt. (grams):	222.56		
Weight of Total Sample Air Dried:	222.56		
Weight of Air Dried Hydrometer Sample (g):	100.00		
Total Sample Oven Dried:	222.13		
Hydrometer Sample Oven Dried (W):	99.80		
% Passing #10:	98.1%		
Correction Factor a (Table 1):	1.00		

Apparent Relative Density (Assumed) 2.650

	Moisture Content	Hygroscopic	Natural
	Tare #	KK	
A	Tare Wt.	16.05	
B	Wet Wt. + A	26.28	
C	Dry Wt. + A	26.26	
D	Water Wt. (B-C)	0.02	
E	Dry Wt. (C-A)	10.21	
	% Moisture (100 x D/E)	0.20%	

Sieve	Retained Wt.	Percent Passing	
3.0"	0.0	Pan # (washed)	100.0%
1.5"	0.0		100.0%
1.0"	0.0		100.0%
3/4"	0.0		100.0%
1/2"	0.0		100.0%
3/8"	0.0		100.0%
#4	2.1	Soil Mortar	99.1%
#10	4.3	**100.0%**	98.1%
#20	16.3	83.6%	82.0%
#40	40.6	59.3%	58.2%
#60	54.2	45.7%	44.8%
#100	65.6	34.2%	33.6%
#200	78.4	21.5%	21.0%

Notes: Description of Sand & Gravel Particles Rounded ☐ Angular ☐ Hard & Durable ☐ Soft ☐ Weathered & Friable ☐

Maximum Particle Size:			Total Sand:	78.0%	< 4.74 mm and > 0.075 mm
% Gravel:	0.9%	< 75 mm and > 4.75 mm	Silt & Clay:	21.0%	< 0.075
Coarse Sand:	1.0%	< 4.75 mm and > 2.00 mm	Silt:	17.0%	< 0.075 and > 0.005 mm
Medium Sand:	39.9%	< 2.00 mm and > 0.425 mm	Clay:	4.0%	< 0.005 mm
Fine Sand:	37.1%	< 0.425 mm and > 0.075 mm	Colloids:		< 0.001 mm

Type: Mechanical Stirring Apparatus (A)
Dispersion Time: 1 min.
Sodium Hexametaphosphate: 40 g./ Liter

Liquid Limit NP Plastic Limit NP Plastic Index NP

Control Cylinder ☒ Composite Correction ☐
Hydrometer: 151H ☐ 152H ☒

Time		Temp.	Hydrometer	Corrections		Hydrometer	Percent Passing		Effective Depth	Table 3	Diameter
Clock	T (Min.)	(0.5 °C)	Reading	Control Cylinder	Composite Correction	R	P(-#10) = (R x a / W) x 100	P (total) = P x % Passing #10	L	K	D = K x ((L/T)^1/2
	1	23.0	24.0	5.0		19.00	19.0%	18.7%	13.2	0.01317	0.04781
	2	23.0	20.0	5.0		15.00	15.0%	14.7%	13.8	0.01317	0.03464
	5	23.0	17.0	5.0		12.00	12.0%	11.8%	14.3	0.01317	0.02229
	15	23.0	13.0	5.0		8.00	8.0%	7.9%	15.0	0.01317	0.01316
	30	23.0	11.0	5.0		6.00	6.0%	5.9%	15.3	0.01317	0.00941
	60	23.0	9.5	5.0		4.50	4.5%	4.4%	15.6	0.01317	0.00671
	250	24.0	7.0	4.0		3.00	3.0%	2.9%	15.8	0.01301	0.00327
	1440	23.0	6.0	5.0		1.00	1.0%	1.0%	16.1	0.01317	0.00139

References: ASTM D 422: Particle Size Analysis of Soils ASTM D 421: Dry Preparation of Soil Samples ASTM D 854: Specific Gravity of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Effective Depth (cm)
$L=L1+0.5(L2-(VB/A))$
(152H) .164cm per increment,
$V_B=67.0cm^3$, $L_2=14cm$, $A=27.8cm^2$

Technician Name: Karen Warner 117900 *Certification #*

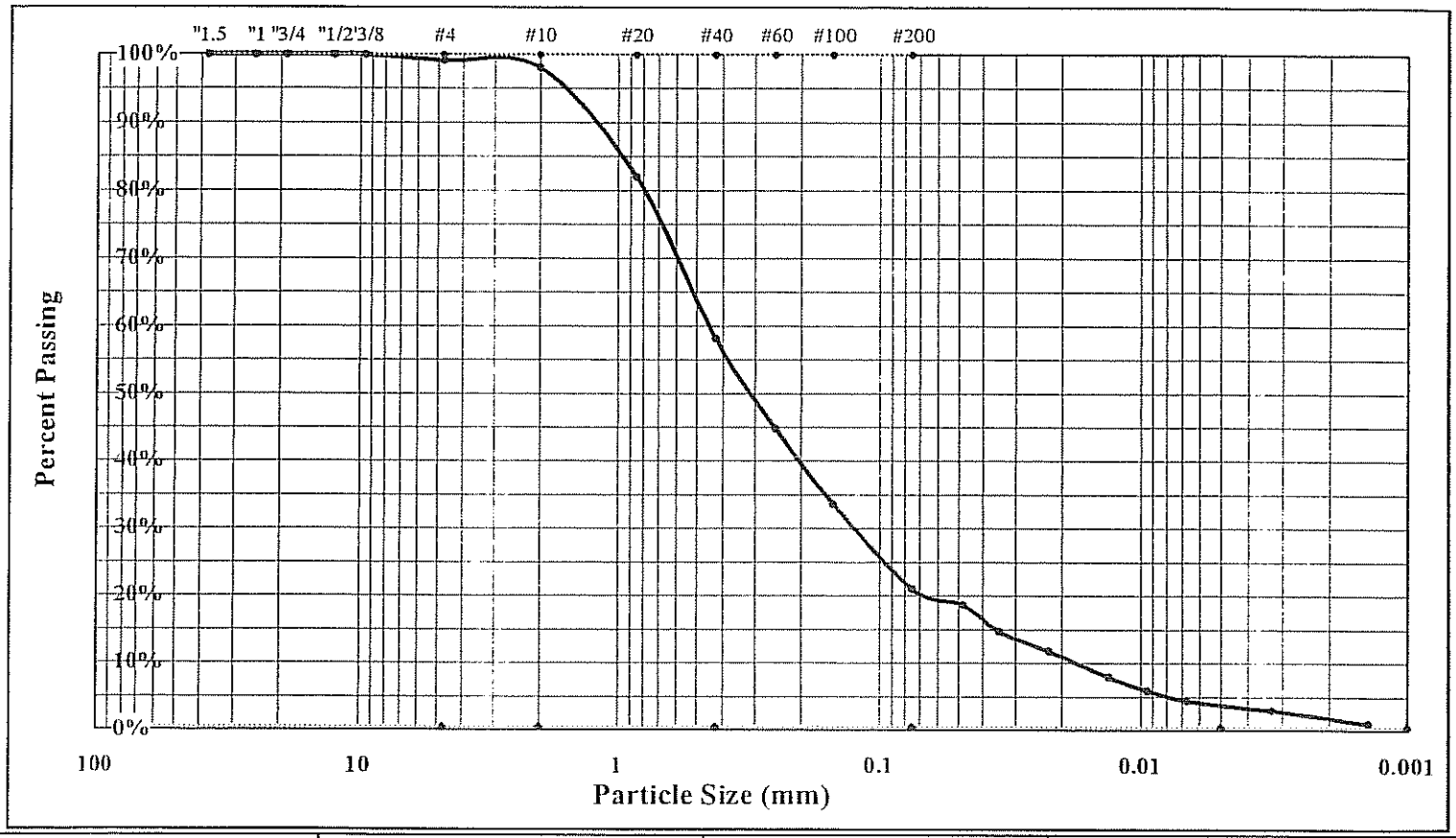
Technical Responsibility: Courtney Withers *Signature* *Staff Professional* *Position*

Particle Size Analysis of Soils

ASTM D 422

S&ME Project #:	**1356-08-122**	Report Date:	10/27/08
Project Name:	**Marshall Steam Station Industrial Landfill**	Test Date(s):	10/22-27/08
Client Name:	Duke Energy		
Client Address:	Terrel, NC		

Boring #:	M-64	Sample #:	SS-3	Sample Date:	10/08
Location:		Offset:		Depth:	13.5 - 15'
Sample Description:	White Silty Coarse to Fine to Medium Sand (SM)				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size	0	Gravel	0.9%	Silt	17.0%
Silt & Clay (% Passing #200)	21.0%	Sand	78.0%	Clay	4.0%
Apparent Relative Density (Assumed)	2.650	Moisture Content		Colloids	
Liquid Limit	NP	Plastic Limit	NP	Plastic Index	NP

Description of Sand & Gravel Particles Rounded ☐ Angular ☐ Hard & Durable ☐ Soft ☐ Weathered & Friable ☐

Mechanical Stirring Apparatus (A) Length of Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate 40 g./ Liter

References: ASTM D 422: Particle Size Analysis of Soils
ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils
ASTM D 2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 421: Dry Preparation of Soil Samples
ASTM D 854: Specific Gravity of Soils

Technical Responsibility: Courtney Withers _____ Staff Professional
Signature Position

Liquid Limit, Plastic Limit, and Plastic Index

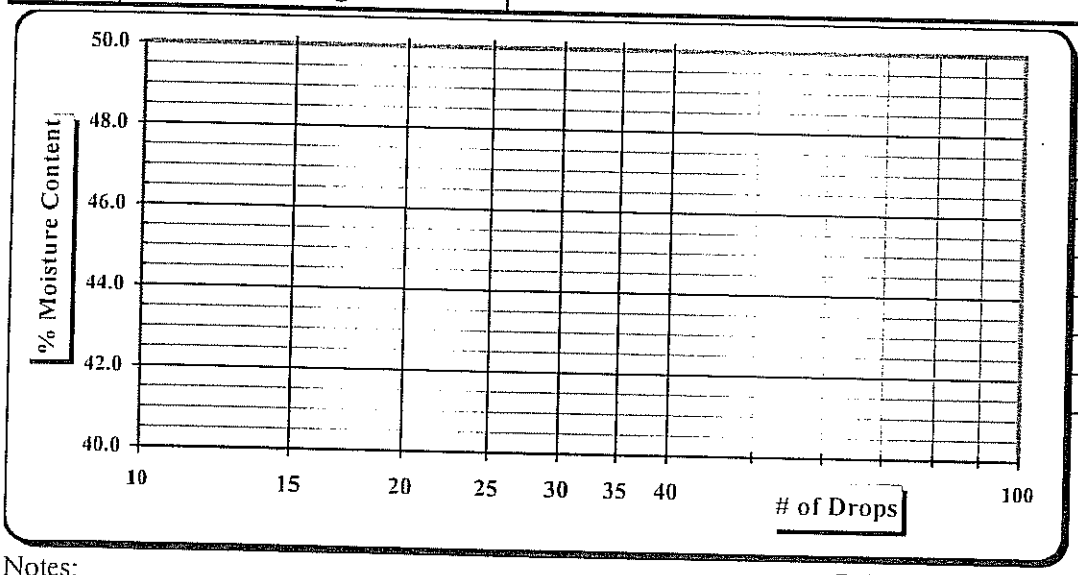
S&ME

Project #: 1356-08-122
Project Name: Marshall Steam Station Industrial Landfill
Client Name: Duke Energy
Project Address: Terrell, NC

Report Date: 12/12/08
Test Date(s): 10/22-12/12/08

Boring #: M-64 Sample #: SS-3 Sample Date: 10/08
Location: Offset: Depth: 13.5-15'
Sample Description: White Silty Coarse to Fine to Medium Sand (SM)

Pan #		Liquid Limit						Plastic Limit		
	Test #							1	2	3
	Tare #									
A	Tare Weight									
B	Wet Soil Weight + A									
C	Dry Soil Weight + A									
D	Water Weight (B-C)									
E	Dry Soil Weight (C-A)									
F	% Moisture Content (D/E)*100									
N	# OF DROPS									
LL	LL = F * FACTOR							*Moisture Contents determined by ASTM D 2216*		
Ave.	Average									



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes: Estimate the % Retained on the #40 Sieve

Special Sampling Methods:

Sample Preparation:	Wet Preparation ☐	Dry Preparation ☒	Air Dried ☒	NP, Non-Plastic	☒
Liquid limit Test:	Multipoint Method ☐	One-point Method ☐		Liquid Limit	
Classification:	ASTM D 2487 ☒	AASHTO M 145 ☐		Plastic Limit	
Liquid limit Test:	ASTM D 4318 ☒	AASHTO T 89 ☐		Plastic Index	
Plastic limit Test:	ASTM D 4318 ☒	AASHTO T 90 ☐		Group Symbol	SM

Technician Name: Karen Warner 117900 (Certification #)

Technical Responsibility: Courtney Withers (Signature) Staff Professional (Position)

APPENDIX III

Calculations

Estimated Long-Term Seasonal High Groundwater

Estimated Long - Term Seasonal High Groundwater Calculations

Marshall Steam Station - Industrial Landfill #1
S&ME Project No. 1356-08-122

		A		B	C		D	E		F		G	H	I	
Monitor Well ID	Ground Surface Elevation	Highest Recorded		Number of Data Points	Mean		STD DEV	Calculated Long - Term Seasonal High		January 2009 WL Data.		Difference	Mod. Factor	Estimated Long - Term Seasonal High	
								(C + 1.80D)				(E - F)		(F + H)	
	(ft msl)	(ft msl)	(ft bls)		(ft msl)	(ft bls)		(ft msl)	(ft bls)	(ft msl)	(ft bls)		(ft)	(ft bls)	(ft msl)
MW-1	821.20	776.35	44.85	41	773.16	48.04	1.18	775.29	45.91	772.55	48.65	2.74	n/a	n/a	n/a
MW-2	794.90	791.77	3.13	41	789.96	4.94	0.89	791.57	3.33	790.60	4.30	0.97	n/a	n/a	n/a
MW-3	811.00	806.70	4.30	42	805.19	5.81	0.69	806.42	4.58	805.07	5.93	1.35	n/a	n/a	n/a
MW-4	864.50	838.48	26.02	40	832.76	31.74	2.78	837.76	26.74	827.71	36.79	10.05	n/a	n/a	n/a
MW-5	822.69	799.34	23.35	16	797.41	25.28	1.46	800.04	22.65	797.54	25.15	2.50	n/a	n/a	n/a
M-1	859.07	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	825.89	33.18	n/a	6.5	26.68	832.39
M-2	874.39	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	826.98	47.41	n/a	10.0	37.41	836.98
M-3	863.19	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	818.87	44.32	n/a	6.5	37.82	825.37
M-4	861.37	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	823.10	38.27	n/a	6.5	31.77	829.60
M-5	822.47	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	817.88	4.59	n/a	3.0	1.59	820.88
M-6	836.36	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	820.14	16.22	n/a	3.0	13.22	823.14
M-7	851.33	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	821.58	29.75	n/a	3.0	26.75	824.58
M-8	888.98	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	832.42	56.56	n/a	10.0	46.56	842.42
M-16	845.85	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	814.37	31.48	n/a	3.0	28.48	817.37
M-18	874.03	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	828.78	45.25	n/a	10.0	35.25	838.78
M-19	864.82	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	824.06	40.76	n/a	10.0	30.76	834.06
M-20	873.40	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	825.25	48.15	n/a	10.0	38.15	835.25
M-21	880.11	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Dry	Dry	n/a	n/a	n/a	n/a
M-23	837.73	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	825.61	12.12	n/a	6.5	5.62	832.11
M-25	844.33	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	823.24	21.09	n/a	3.0	18.09	826.24
M-26	840.87	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	822.24	18.63	n/a	3.0	15.63	825.24
M-28	849.69	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Dry	Dry	n/a	n/a	n/a	n/a
M-29	840.75	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	829.21	11.54	n/a	6.5	5.04	835.71
M-31	878.93	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Dry	Dry	n/a	n/a	n/a	n/a
M-34	827.97	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	820.20	7.77	n/a	3.0	4.77	823.20

Estimated Long - Term Seasonal High Groundwater Calculations

Marshall Steam Station - Industrial Landfill #1
S&ME Project No. 1356-08-122

		A		B	C		D	E		F		G	H	I	
Monitor Well ID	Ground Surface Elevation	Highest Recorded		Number of Data Points	Mean		STD DEV	Calculated Long - Term Seasonal High		January 2009 WL Data.		Difference	Mod. Factor	Estimated Long - Term Seasonal High	
								(C + 1.80D)				(E - F)		(F + H)	
	(ft msl)	(ft msl)	(ft bls)		(ft msl)	(ft bls)		(ft msl)	(ft bls)	(ft msl)	(ft bls)		(ft)	(ft bls)	(ft msl)
M-36	838.81	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	827.33	11.48	n/a	3.0	8.48	830.33
M-37	872.73	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	828.87	43.86	n/a	10.0	33.86	838.87
M-38	857.75	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	822.59	35.16	n/a	10.0	25.16	832.59
M-39	854.21	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	828.23	25.98	n/a	10.0	15.98	838.23
M-41	866.96	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	823.89	43.07	n/a	10.0	33.07	833.89
M-42	858.17	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	817.92	40.25	n/a	6.5	33.75	824.42
M-43	833.29	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	818.09	15.2	n/a	3.0	12.20	821.09
M-45	846.22	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	818.25	27.97	n/a	3.0	24.97	821.25
M-46	827.82	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	819.51	8.31	n/a	3.0	5.31	822.51
M-57	881.99	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Dry	Dry	n/a	n/a	n/a	n/a
M-58	876.38	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	838.27	38.11	n/a	10.0	28.11	848.27
M-59	874.48	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	824.15	50.33	n/a	10.0	40.33	834.15
M-60	873.26	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	823.89	49.37	n/a	10.0	39.37	833.89
M-61	874.64	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	830.41	44.23	n/a	10.0	34.23	840.41
M-62	868.34	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	828.87	39.47	n/a	10.0	29.47	838.87
M-63	859.39	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Damaged	Damaged	n/a	n/a	n/a	n/a
M-64	842.37	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	827.21	15.16	n/a	3.0	12.16	830.21

Notes:

1. n/a - not applicable
2. ft msl - feet mean sea level
3. ft bls - feet below land surface
4. G.S. - Groundsurface
5. Modification factors selected from 3 to 10 feet, based on topographic setting. Topographic high areas showing a downward trend in water level elevations received a modification factor of 10 feet. Topographic low areas showing an upward trend in water level elevations received a 3-foot modification factor. Areas on low ridges and side slopes showing a slight decreasing trend in water level elevations received a modification factor of 6.5 feet.

Precipitation Data

Marshall Steam Station - Industrial Landfill #1

S&ME Project No. 1356-08-122

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1989	2.05	4.94	2.92	3.47	4.59	6.22	6.88	4.52	6.43	4.66	3.09	2.8	52.57
1990	1.55	6.4	5.23	2.37	7.26	2.32	4.69	3.33	0.73	11.94	1.8	3.22	50.84
1991	4.07	2.41	7.65	6.65	2.32	2.7	3.78	5.27	4.41	0.82	1.4	3.21	44.69
1992	2.47	3.26	4.02	3.35	2.87	3.94	2.11	2.74	3.98	4.34	6.98	4.19	44.25
1993	6.28	3.55	7	3.14	3.16	1.82	6.62	3.18	3.12	1.36	4.28	4.44	47.95
1994	5.02	2.99	7.03	2.35	2.74	7.57	9.29	4.6	4.39	1.64	2.94	1.47	52.03
1995	3.95	3.64	2.75	0.36	2.99	8.03	2.07	4.66	4.48	7.58	3.84	1.69	46.04
1996	2.9	3.8	4.07	2.39	3.57	4.46	2.01	7.73	3.83	1.45	4.95	5.16	46.32
1997	3.54	4.99	4.76	7.14	1.71	2.24	8.2	1.07	3.18	3.58	2.66	7.84	50.91
1998	7.9	3.87	3.09	5.45	2.4	4.24	2	2.21	2.84	1.55	1.81	4.6	41.96
1999	4.46	3.01	2.72	3.29	2.42	3.99	1.56	5.28	3.38	3.35	2.01	2.49	37.96
2000	4.16	2.01	3.5	5.79	1.52	3.35	1.87	2.89	7.5	0	2.1	2.05	36.74
2001	2.37	2.56	5.25	1.52	1.19	4.2	6.87	2.57	1.7	0.98	0.8	3.16	33.17
2002	4.94	1.53	3.99	0.46	3.31	2.39	5.32	5.53	4.38	6.67	4.47	5.58	48.57
2003	1.88	5.52	8.64	9.28	7.6	8.55	7.44	5.27	4.61	2	2.97	2.79	66.55
2004	0.89	3.67	2.11	3.19	2.04	6.12	2.43	2.65	9.13	1.34	5.84	3.95	43.36
2005	2.97	2.44	4.52	3.91	1.18	2.51	5.76	2.16	0.11	5.57	1.85	3.95	36.93
2006	3.49	0.59	0.92	3.38	0.58	7.07	1.05	0.47	3.4	2.81	3.19	1.74	28.69
2007	3.55	1.32	2.98	1.71	0.33	1.42	1.17	0.47	0.91	2.38	0.72	3.23	20.19
2008	0.78	---	---	---	---	---	---	---	---	---	---	---	---
AVG	**3.461**	**3.289474**	**4.376316**	**3.642105**	**2.830526**	**4.375789**	**4.269474**	**3.505263**	**3.816316**	**3.369474**	**3.036842**	**3.555789**	**43.66947**

SOURCE: State Climate Office of North Carolina
Station: CONOVER OXFORD SHOAL
State: NC
ID: 311990
Latitude: 35.82 degrees
Longitude: -81.19 degrees
Elevation: 883 feet

Well ID	TOC Elev (ft-msl)	Date	DTW TOC (ft)	GW Elev (ft-msl)
MW-1	823.70	08/29/89	49.20	774.50
MW-1	823.70	10/16/90	48.20	775.50
MW-1	823.70	11/12/91		
MW-1	823.70	08/27/92	49.00	774.70
MW-1	823.70	03/30/93	47.35	776.35
MW-1	823.70	08/02/93	47.35	776.35
MW-1	823.70	02/01/94	49.90	773.80
MW-1	823.70	08/08/94	49.26	774.44
MW-1	823.70	02/01/95	50.08	773.62
MW-1	823.70	03/16/95	50.34	773.36
MW-1	823.70	08/08/95	50.42	773.28
MW-1	823.70	02/13/96	50.87	772.83
MW-1	823.70	08/23/96	50.04	773.66
MW-1	823.70	09/25/96	50.44	773.26
MW-1	823.70	02/12/97	51.54	772.16
MW-1	823.70	08/05/97	50.00	773.70
MW-1	823.70	03/11/98	50.91	772.79
MW-1	823.70	08/05/98	50.01	773.69
MW-1	823.70	02/23/99	51.25	772.45
MW-1	823.70	08/25/99	51.14	772.56
MW-1	823.70	02/07/00	51.92	771.78
MW-1	823.70	08/09/00	51.78	771.92
MW-1	823.70	02/20/01	51.86	771.84
MW-1	823.70	08/06/01	51.47	772.23
MW-1	823.70	02/04/02	52.14	771.56
MW-1	823.70	08/21/02	51.88	771.82
MW-1	823.70	02/13/03	51.83	771.87
MW-1	823.70	08/08/03	48.58	775.12
MW-1	823.70	02/09/04	50.61	773.09
MW-1	823.70	08/17/04	50.82	772.88
MW-1	823.70	01/05/05	50.27	773.43
MW-1	823.70	01/12/05	50.33	773.37
MW-1	823.70	01/29/05	50.53	773.17
MW-1	823.70	02/14/05	50.79	772.91
MW-1	823.70	08/08/05	50.73	772.97
MW-1	823.70	02/27/06	51.23	772.47
MW-1	823.70	08/08/06	51.60	772.10
MW-1	823.70	02/05/07	51.19	772.51
MW-1	823.70	08/01/07	51.54	772.16
MW-1	823.70	02/12/08	51.33	772.37
MW-1	823.70	08/12/08	51.28	772.42
MW-1	823.70	01/19/09	51.15	772.55

Well ID	TOC Elev (ft-msl)	Date	DTW TOC (ft)	GW Elev (ft-msl)
MW-2	797.22	08/29/89	35.10	790.98
MW-2	797.22	10/16/90	6.10	791.12
MW-2	797.22	11/12/91	7.10	790.12
MW-2	797.22	08/27/92	6.50	790.72
MW-2	797.22	03/30/93	5.45	791.77
MW-2	797.22	08/02/93	6.83	790.39
MW-2	797.22	02/01/94	6.47	790.75
MW-2	797.22	08/08/94	7.30	789.92
MW-2	797.22	02/01/95	6.84	790.38
MW-2	797.22	08/08/95	7.21	790.01
MW-2	797.22	02/13/96	7.83	789.39
MW-2	797.22	08/23/96	8.65	788.57
MW-2	797.22	09/25/96	9.30	787.92
MW-2	797.22	02/12/97	8.41	788.81
MW-2	797.22	08/05/97	8.05	789.17
MW-2	797.22	03/11/98	7.60	789.62
MW-2	797.22	08/05/98	9.09	788.13
MW-2	797.22	02/23/99	7.77	789.45
MW-2	797.22	08/25/99	9.13	788.09
MW-2	797.22	02/07/00	8.20	789.02
MW-2	797.22	08/09/00	7.89	789.33
MW-2	797.22	02/20/01	7.42	789.80
MW-2	797.22	08/06/01	7.93	789.29
MW-2	797.22	02/04/02	7.41	789.81
MW-2	797.22	08/21/02	7.17	790.05
MW-2	797.22	02/13/03	7.14	790.08
MW-2	797.22	08/08/03	6.62	790.60
MW-2	797.22	02/09/04	6.94	790.28
MW-2	797.22	08/17/04	6.63	790.59
MW-2	797.22	01/05/05	5.62	791.60
MW-2	797.22	01/12/05	6.10	791.12
MW-2	797.22	01/29/05	6.40	790.82
MW-2	797.22	02/14/05	6.96	790.26
MW-2	797.22	08/08/05	6.93	790.29
MW-2	797.22	02/27/06	6.88	790.34
MW-2	797.22	08/08/06	7.52	789.70
MW-2	797.22	02/05/07	6.93	790.29
MW-2	797.22	08/01/07	7.81	789.41
MW-2	797.22	02/12/08	6.99	790.23
MW-2	797.22	08/12/08	7.57	789.65
MW-2	797.22	01/19/09	6.62	790.6

Well ID	TOC Elev (ft-msl)	Date	DTW TOC (ft)	GW Elev (ft-msl)
MW-3	813.07	08/29/89	8.90	804.17
MW-3	813.07	10/16/90	8.65	804.42
MW-3	813.07	11/12/91	8.60	804.47
MW-3	813.07	08/27/92	8.52	804.55
MW-3	813.07	03/30/93	7.24	805.83
MW-3	813.07	08/02/93	8.69	804.38
MW-3	813.07	02/01/94	7.99	805.08
MW-3	813.07	08/08/94	8.40	804.67
MW-3	813.07	02/01/95	7.87	805.20
MW-3	813.07	03/16/95	7.62	805.45
MW-3	813.07	08/08/95	8.65	804.42
MW-3	813.07	02/13/96	7.48	805.59
MW-3	813.07	08/23/96	7.94	805.13
MW-3	813.07	09/25/96	8.42	804.65
MW-3	813.07	02/12/97	7.62	805.45
MW-3	813.07	08/05/97	8.01	805.06
MW-3	813.07	03/11/98	7.18	805.89
MW-3	813.07	08/05/98	8.25	804.82
MW-3	813.07	02/23/99	7.70	805.37
MW-3	813.07	08/25/99	8.80	804.27
MW-3	813.07	02/07/00	7.97	805.10
MW-3	813.07	08/09/00	8.75	804.32
MW-3	813.07	02/20/01	7.85	805.22
MW-3	813.07	08/06/01	8.53	804.54
MW-3	813.07	02/04/02	8.11	804.96
MW-3	813.07	08/21/02	9.44	803.63
MW-3	813.07	02/13/03	7.76	805.31
MW-3	813.07	08/08/03	7.11	805.96
MW-3	813.07	02/09/04	7.23	805.84
MW-3	813.07	08/17/04	7.65	805.42
MW-3	813.07	01/05/05	7.01	806.06
MW-3	813.07	01/12/05	7.03	806.04
MW-3	813.07	01/29/05	6.88	806.19
MW-3	813.07	02/14/05	7.00	806.07
MW-3	813.07	08/08/05	7.07	806.00
MW-3	813.07	02/27/06	6.37	806.70
MW-3	813.07	08/08/06	6.95	806.12
MW-3	813.07	02/05/07	7.15	805.92
MW-3	813.07	08/01/07	8.35	804.72
MW-3	813.07	02/12/08	8.16	804.91
MW-3	813.07	08/12/08	8.24	804.83
MW-3	813.07	01/19/09	8.00	805.07

Well ID	TOC Elev (ft-msl)	Date	DTW TOC (ft)	GW Elev (ft-msl)
MW-4	867.15	08/29/89	33.70	833.45
MW-4	867.15	10/16/90	31.95	835.20
MW-4	867.15	11/12/91	32.20	834.95
MW-4	867.15	08/27/92	31.80	835.35
MW-4	867.15	03/30/93	28.67	838.48
MW-4	867.15	08/02/93	29.53	837.62
MW-4	867.15	02/01/94	32.18	834.97
MW-4	867.15	08/08/94	32.09	835.06
MW-4	867.15	02/01/95	32.99	834.16
MW-4	867.15	08/08/95	33.02	834.13
MW-4	867.15	02/13/96	32.30	834.85
MW-4	867.15	08/23/96	32.46	834.69
MW-4	867.15	09/25/96	33.14	834.01
MW-4	867.15	02/12/97	32.91	834.24
MW-4	867.15	08/05/97	31.18	835.97
MW-4	867.15	03/11/98	32.45	834.70
MW-4	867.15	08/05/98	31.50	835.65
MW-4	867.15	02/23/99	34.16	832.99
MW-4	867.15	08/25/99	34.44	832.71
MW-4	867.15	02/07/00	35.89	831.26
MW-4	867.15	08/09/00	36.76	830.39
MW-4	867.15	02/20/01	37.62	829.53
MW-4	867.15	08/06/01	38.07	829.08
MW-4	867.15	02/04/02	38.83	828.32
MW-4	867.15	08/21/02	39.32	827.83
MW-4	867.15	02/13/03	38.65	828.50
MW-4	867.15	08/08/03	32.23	834.92
MW-4	867.15	02/09/04	33.75	833.40
MW-4	867.15	08/17/04	34.34	832.81
MW-4	867.15	01/12/05	34.41	832.74
MW-4	867.15	01/29/05	34.34	832.81
MW-4	867.15	02/14/05	34.28	832.87
MW-4	867.15	08/08/05	34.04	833.11
MW-4	867.15	02/27/06	34.56	832.59
MW-4	867.15	08/08/06	35.51	831.64
MW-4	867.15	02/05/07	36.20	830.95
MW-4	867.15	08/01/07	36.82	830.33
MW-4	867.15	02/12/08	38.71	828.44
MW-4	867.15	08/12/08	39.35	827.80
MW-4	867.15	01/19/09	39.44	827.71

Well ID	TOC Elev (ft-msl)	Date	DTW TOC (ft)	GW Elev (ft-msl)
MW-5	822.69	08/09/00	25.82	796.87
MW-5	822.69	02/20/01	23.90	798.79
MW-5	822.69	08/06/01	24.96	797.73
MW-5	822.69	02/04/02	24.86	797.83
MW-5	822.69	08/26/02	26.88	795.81
MW-5	822.69	02/13/03	23.60	799.09
MW-5	822.69	02/14/05	23.35	799.34
MW-5	822.69	08/08/05	23.70	798.99
MW-5	822.69	02/27/06	23.68	799.01
MW-5	822.69	08/08/06	25.99	796.70
MW-5	822.69	02/05/07	24.13	798.56
MW-5	822.69	08/01/07	27.04	795.65
MW-5	822.69	02/12/08	26.79	795.90
MW-5	822.69	8/12/2008	27.31	795.38
MW-5	822.69	1/19/2009	25.15	797.54

Notes: Elevations provided by Duke Energy
GW : Groundwater
TOC : Top of Casing
Elev : Elevation
DTW: Depth to Water
ft-msl: Feet mean seal level
ft: Feet

Well Statistics

Marshall Steam Station - Industrial Landfill #1
S&ME Project No. 1356-08-122

Sorted from highest to lowest groundsurface elevation

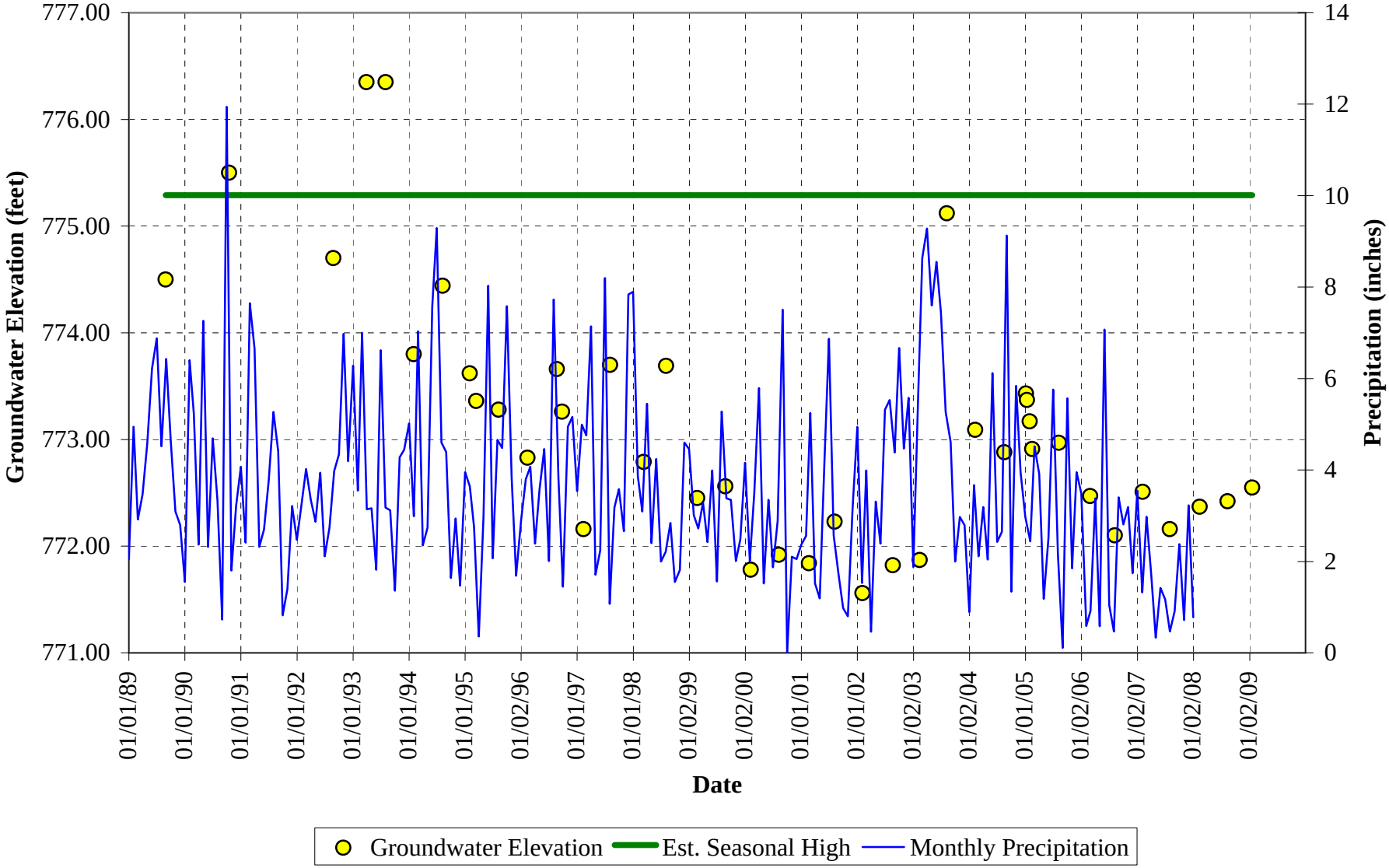
Well ID	G.S. Elev. (ft-msl)	Mean DTW (ft-bls)	STD DEV	No. Data Points	Highest Recorded DTW (ft-bls)	Lowest Recorded DTW (ft-bls)	GW Flux	W.L. Trend	Proposed Modification Factor
M-8	888.98	55.70	0.70	14	56.69	54.46	2.23	Down	10
M-58	876.38	37.83	0.27	3	38.11	37.58	0.53	Down	10
M-61	874.64	43.92	0.31	3	44.23	43.62	0.61	Down	10
M-59	874.48	50.12	0.21	3	50.33	49.91	0.42	Down	10
M-2	874.39	45.80	1.14	14	47.41	43.92	3.49	Down	10
M-18	874.03	44.89	0.35	5	45.25	44.50	0.75	Down	10
M-20	873.40	47.79	0.40	9	48.23	47.10	1.13	Down	10
M-60	873.26	48.44	1.01	3	49.37	47.37	2.00	Down	10
M-37	872.73	43.53	0.26	6	43.86	43.18	0.68	Down	10
M-62	868.34	39.37	0.17	3	39.47	39.18	0.29	Down	10
M-41	866.96	42.56	0.42	9	43.07	41.84	1.23	Down	10
M-19	864.82	40.18	0.76	9	40.93	38.50	2.43	Down	10
MW-4	864.50	31.74	2.78	40	36.79	26.02	10.77	Down	n/a
M-3	863.19	44.40	0.22	14	44.77	44.08	0.69	Sl. Down	6.5
M-4	861.37	38.17	0.36	14	38.68	37.56	1.12	Sl. Down	6.5
M-1	859.07	33.55	0.46	14	34.30	32.56	1.74	Sl. Down	6.5
M-42	858.17	40.79	0.42	9	41.31	40.07	1.24	Sl. Down	6.5
M-38	857.75	35.11	0.35	8	35.42	34.41	1.01	Down	10
M-39	854.21	25.49	0.44	9	25.98	24.73	1.25	Down	10
M-7	851.33	31.24	0.99	14	33.67	29.75	3.92	Up	3
M-45	846.22	28.63	0.35	9	29.08	27.97	1.11	Up	3
M-16	845.85	33.56	0.84	14	34.85	31.48	3.37	Up	3
M-25	844.33	22.63	0.72	9	23.27	21.09	2.18	Up	3
M-64	842.37	15.71	0.58	3	16.32	15.16	1.16	Up	3
M-26	840.87	20.06	0.73	9	20.62	18.63	1.99	Up	3
M-29	840.75	11.57	0.12	9	11.89	11.49	0.40	Sl. Down	6.5
M-36	838.81	13.86	1.17	9	15.00	11.48	3.52	Up	3
M-23	837.73	13.11	0.54	9	13.78	12.12	1.66	Sl. Down	6.5
M-6	836.36	18.36	1.53	14	21.64	16.22	5.42	Up	3
M-43	833.29	15.86	0.42	9	16.71	15.20	1.51	Up	3
M-34	827.97	9.45	0.90	9	11.21	7.77	3.44	Up	3
M-46	827.82	9.93	0.91	9	11.75	8.31	3.44	Up	3
MW-5	822.69	25.28	1.46	16	27.31	23.35	3.96	Up	n/a
M-5	822.47	5.36	0.71	13	7.17	4.59	2.58	Up	3
MW-1	821.20	48.04	1.18	41	49.64	44.85	4.79	Up	n/a
MW-3	811.00	5.81	0.69	42	7.37	4.30	3.07	Up	n/a
MW-2	794.90	4.94	0.89	41	6.98	3.13	3.85	Up	n/a

Notes:

(1) G.S Elev. Groundsurface elevation
(2) DTW Depth to water
(3) STD DEV Standard deviation
(4) No. Number
(5) ft-msl Feet mean sea level
(6) ft-bls Feet below land surface
(7) Monitoring wells are highlighted.
(8) GW Flux Differenece between higest and lowest recorded water levels
(9) W.L. Trend Linear trend from hydrographs taken from 2007 to present data.
(10) Proposed modification factor is the amount in feet to be added to the January 2009 W.L data for the observations wells to reach long-term seasonal high elevations.

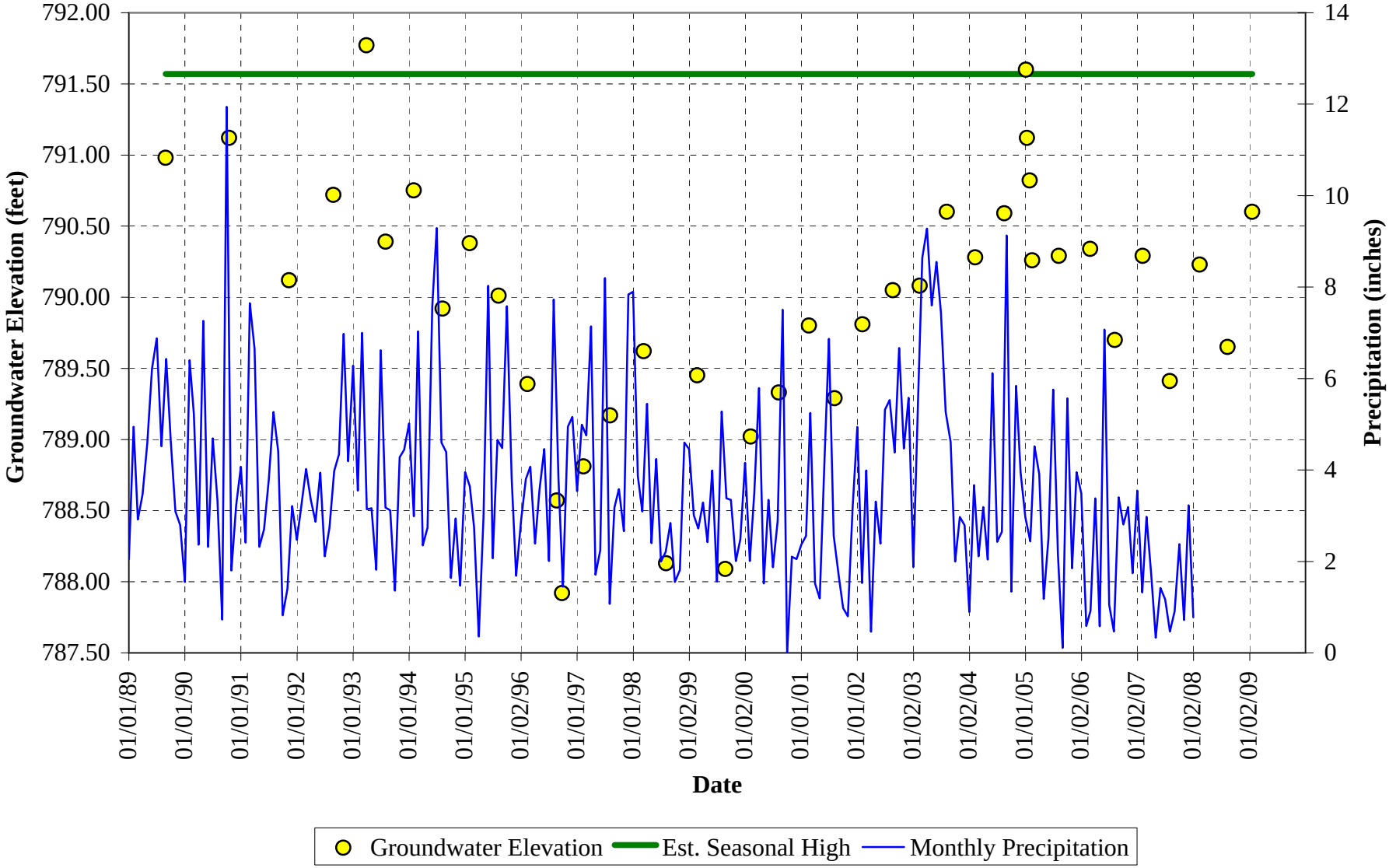
Hydrograph
MW-1
Marshall Steam Station

Highest Recorded = 776.35, 3/30/93 & 8/02/93
Lowest Recorded = 771.56, 2/4/02
Difference = 4.79 ft



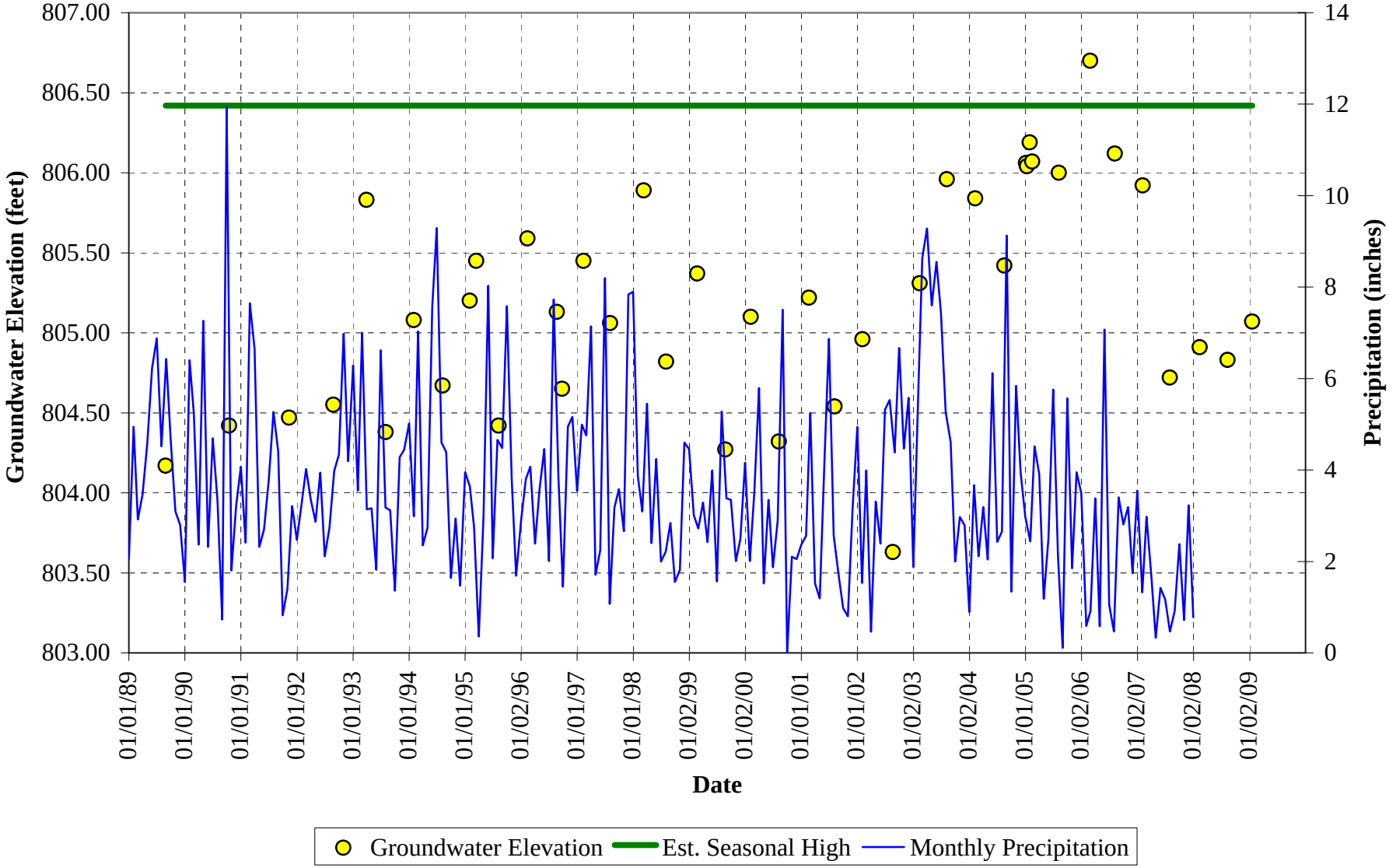
Hydrograph
MW-2
Marshall Steam Station

Highest Recorded = 791.77, 3/30/93
Lowest Recorded = 787.92, 9/25/96
Difference = 3.85 ft



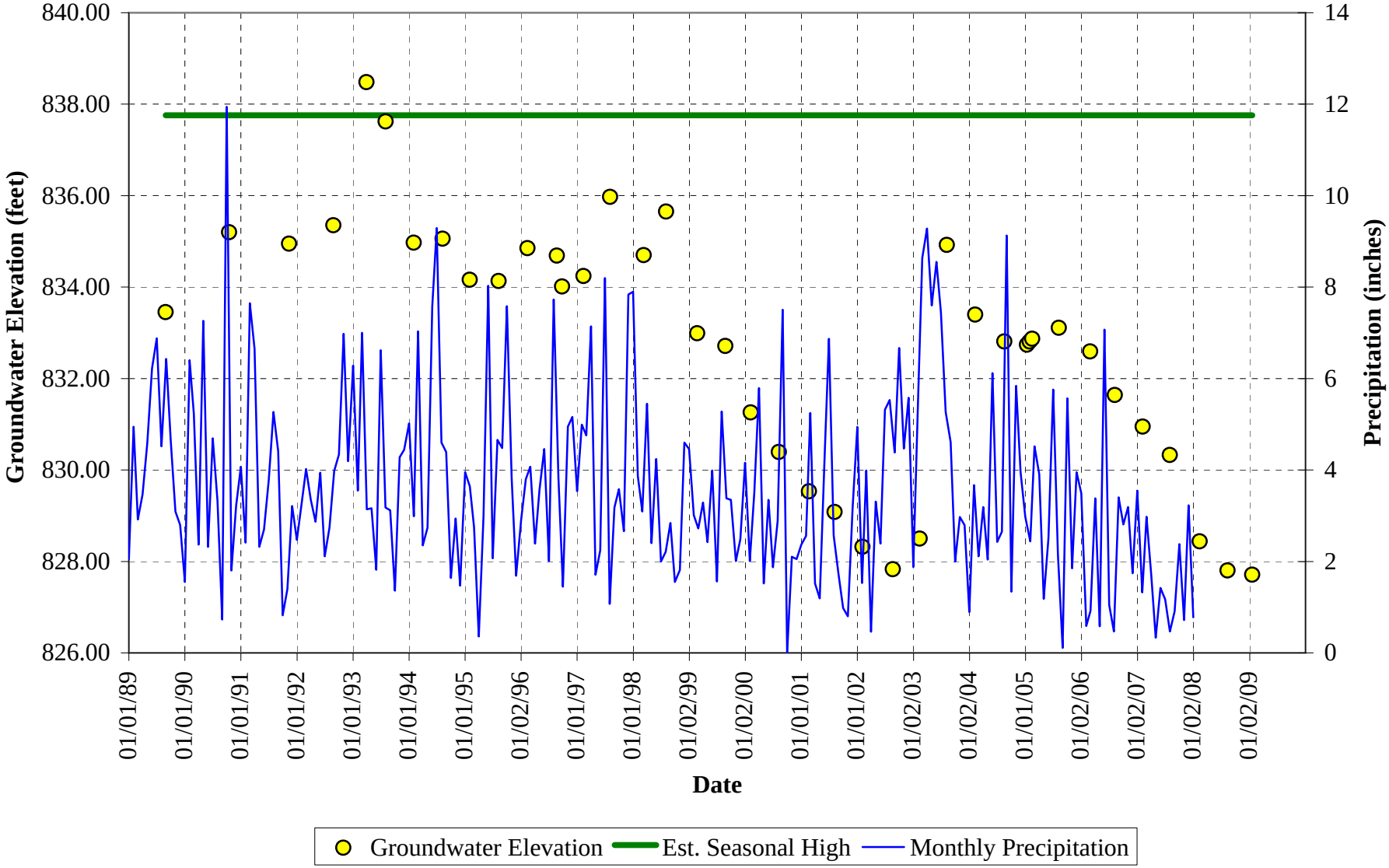
Hydrograph
MW-3
Marshall Steam Station

Highest Recorded = 806.70, 2/27/06
Lowest Recorded = 803.63, 8/21/02
Difference = 3.07 ft



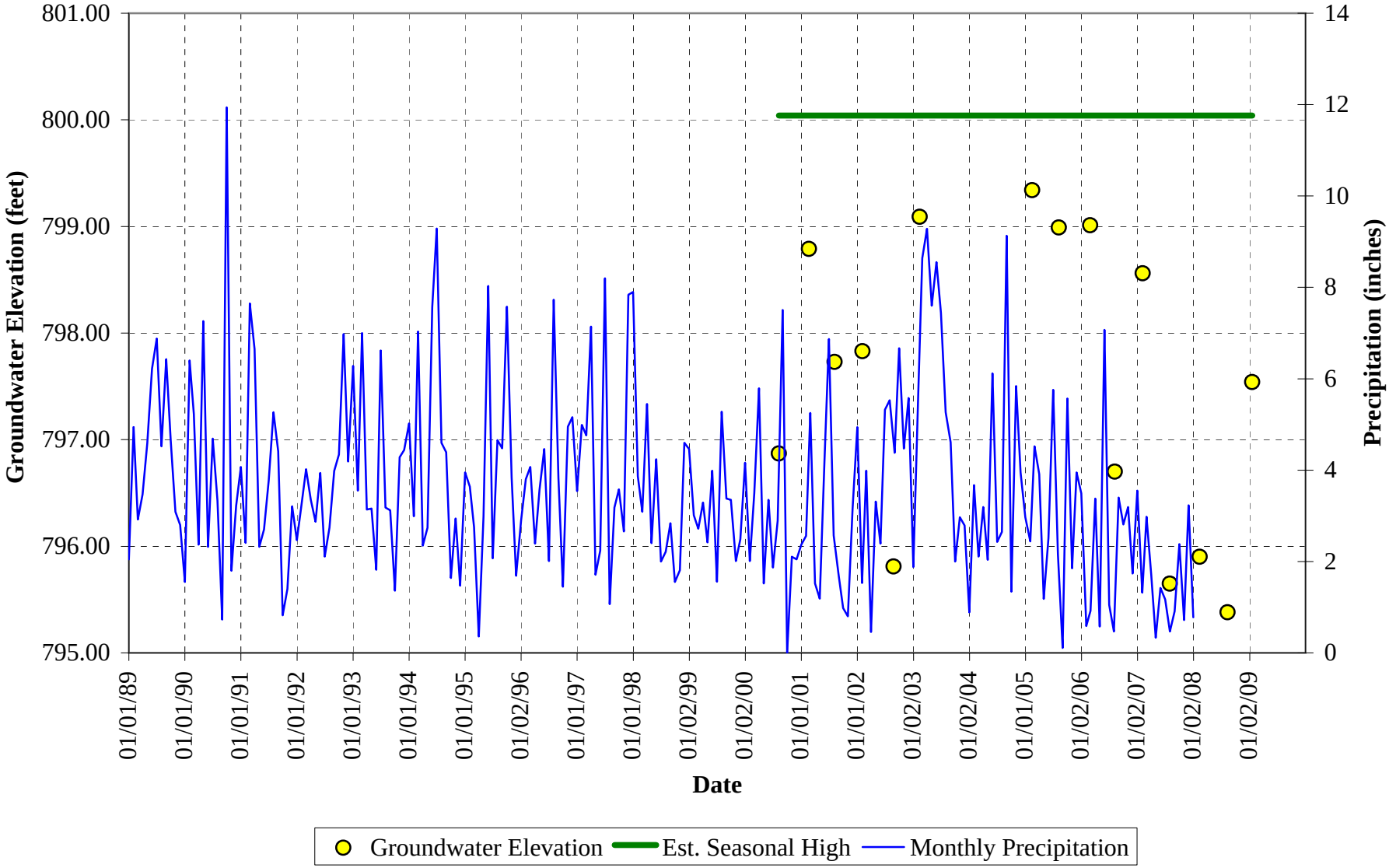
Hydrograph
MW-4
Marshall Steam Station

Highest Recorded = 838.48, 3/30/93
Lowest Recorded = 827.71, 1/19/09
Difference = 10.77 ft



Hydrograph
MW-5
Marshall Steam Station

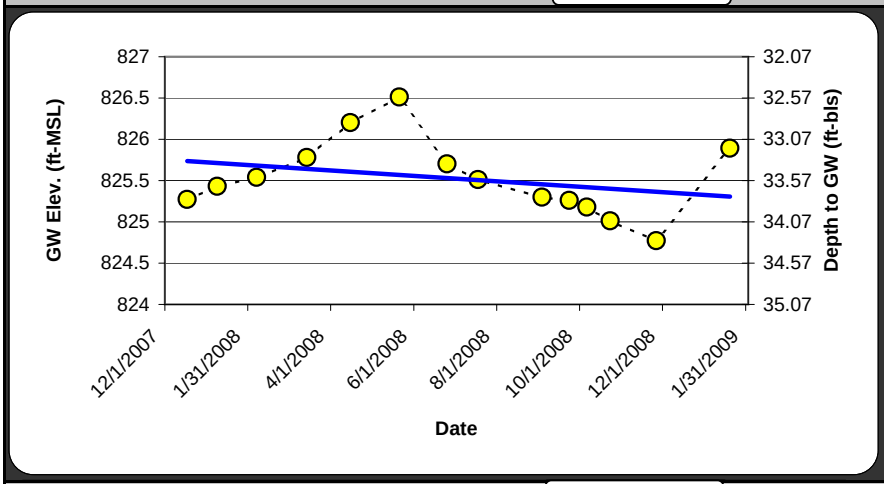
Highest Recorded = 799.34, 2/14/05
Lowest Recorded = 795.38, 8/12/08
Difference = 3.96 ft



Observation Well Hydrographs

Marshall Steam Station - Industrial Landfill #1
S&ME Project No. 1356-08-122

M-1

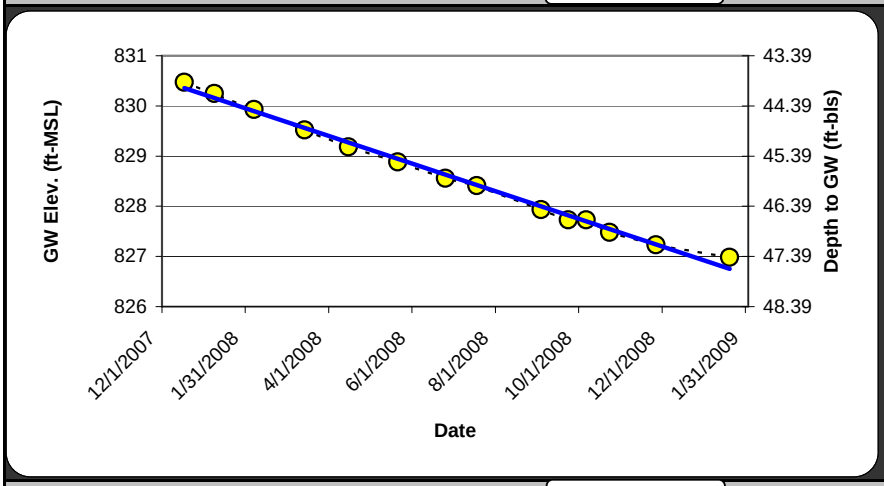


▶ **Predominant Geologic Unit in Saturated Screened Interval:**
Saprolite

▶ **Topographic Setting:**
Side Slope - Groundsurface Elevation 859.07 ft MSL

Linear Trend Line

M-2

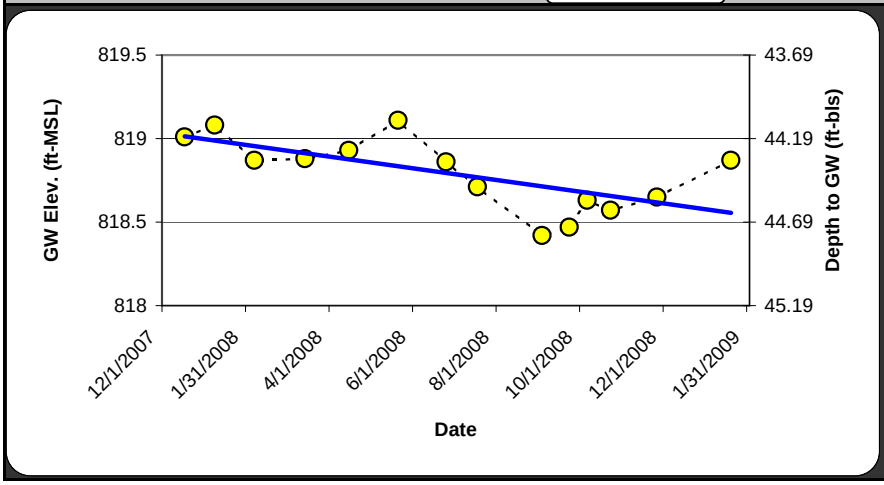


▶ **Predominant Geologic Unit in Saturated Screened Interval:**
Partially Weathered Rock

▶ **Topographic Setting:**
High Ridge - Groundsurface Elevation 874.39 ft MSL

Linear Trend Line

M-3



▶ **Predominant Geologic Unit in Saturated Screened Interval:**
Partially Weathered Rock

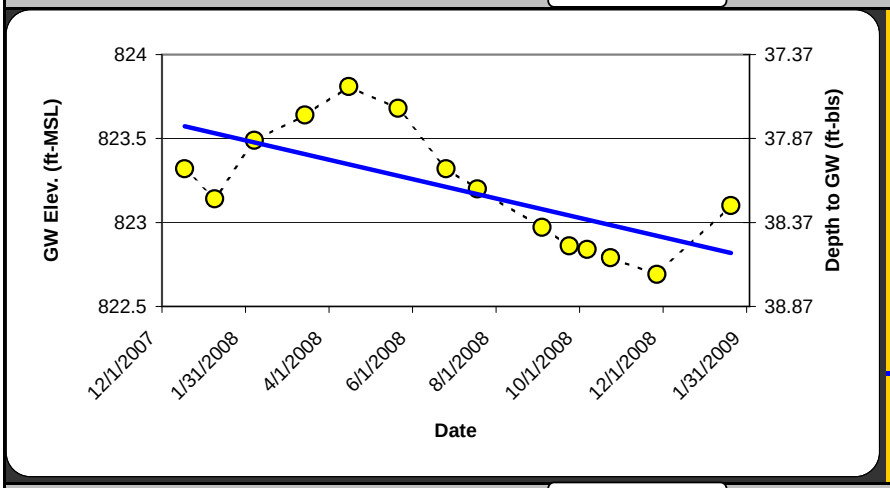
▶ **Topographic Setting:**
Intermediate Ridge - Groundsurface Elevation 863.19 ft MSL

Linear Trend Line

Observation Well Hydrographs

Marshall Steam Station - Industrial Landfill #1
S&ME Project No. 1356-08-122

M-4

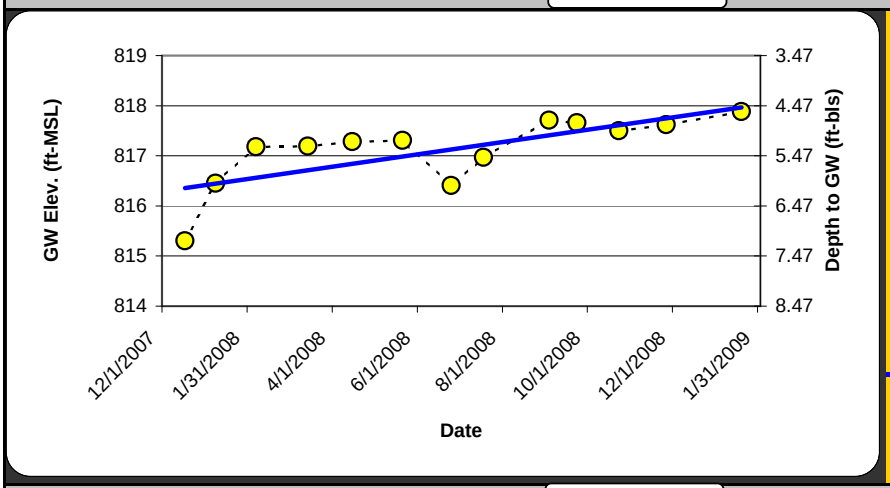


▶ **Predominant Geologic Unit in Saturated Screened Interval:**
Saprolite

▶ **Topographic Setting:**
Side Slope - Groundsurface Elevation 861.37 ft MSL

Linear Trend Line

M-5

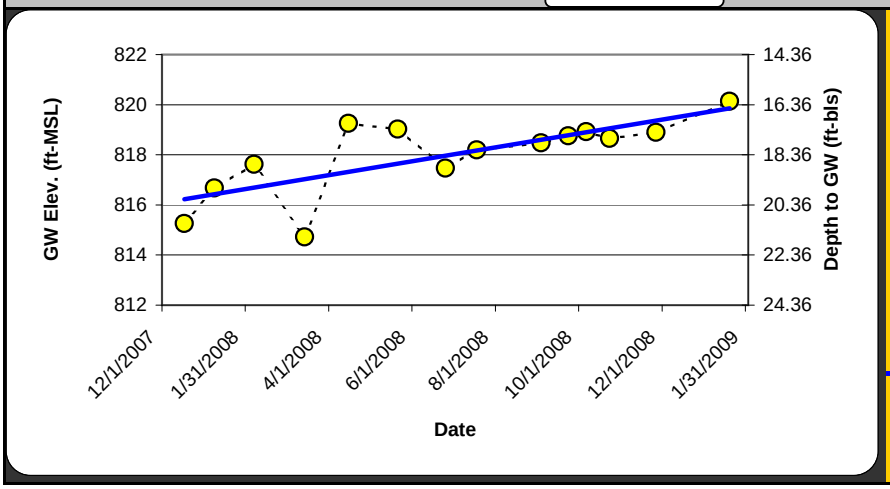


▶ **Predominant Geologic Unit in Saturated Screened Interval:**
Ash

▶ **Topographic Setting:**
Dike Across Ash Pond - Groundsurface Elevation 822.47 ft MSL

Linear Trend Line

M-6



▶ **Predominant Geologic Unit in Saturated Screened Interval:**
Saprolite

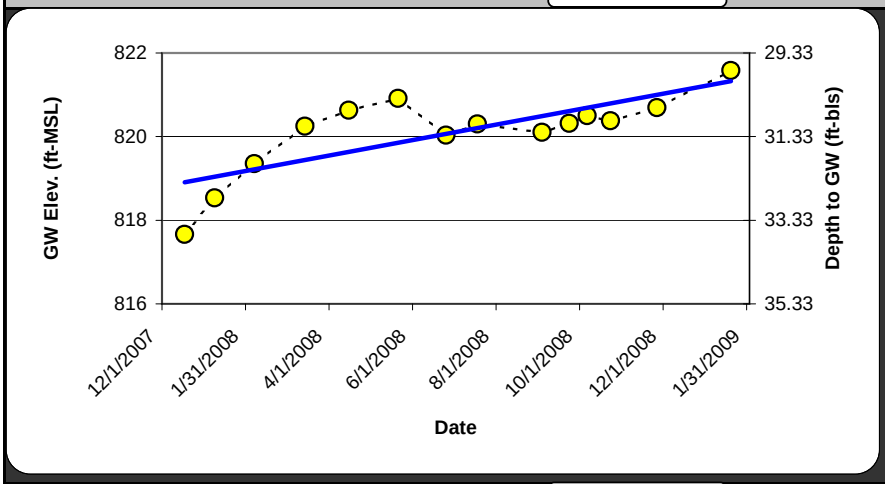
▶ **Topographic Setting:**
Low Ridge - Groundsurface Elevation 836.36 ft MSL

Linear Trend Line

Observation Well Hydrographs

Marshall Steam Station - Industrial Landfill #1
S&ME Project No. 1356-08-122

M-7

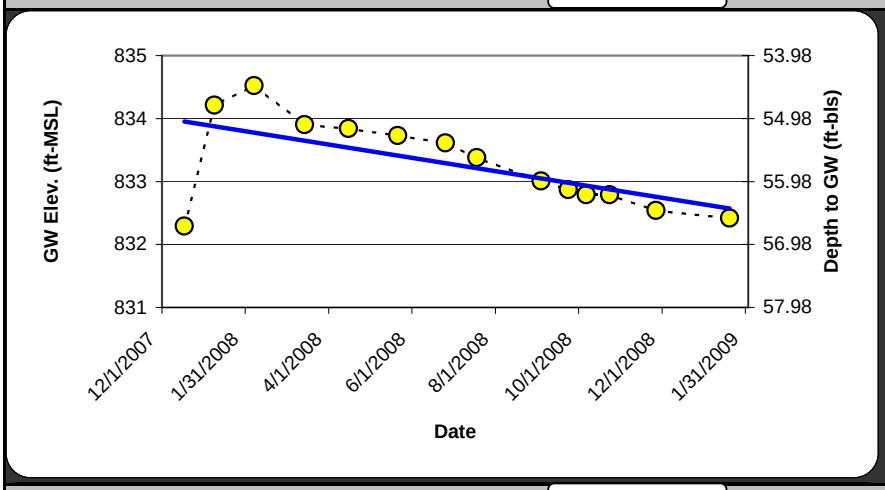


▶ **Predominant Geologic Unit in Saturated Screened Interval:**
Saprolite

▶ **Topographic Setting:**
Intermediate Ridge - Groundsurface Elevation 851.33 ft MSL

Linear Trend Line

M-8

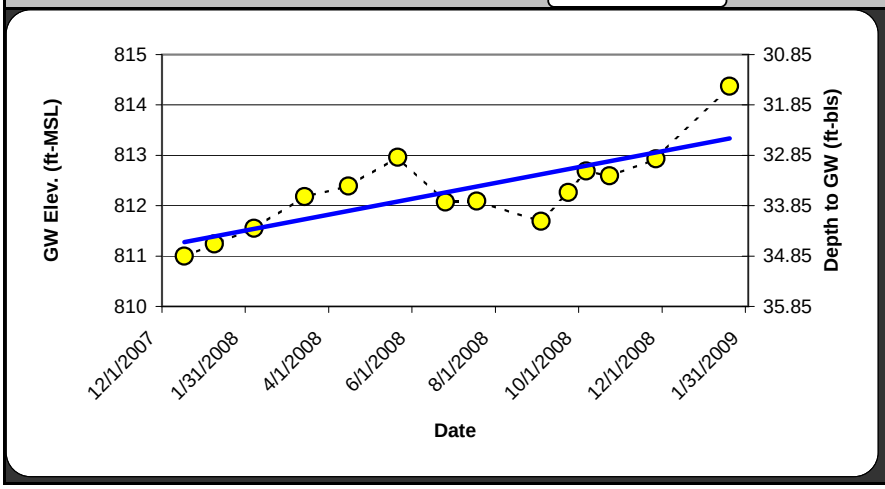


▶ **Predominant Geologic Unit in Saturated Screened Interval:**
Partially Weathered Rock

▶ **Topographic Setting:**
High Ridge - Groundsurface Elevation 888.98 ft MSL

Linear Trend Line

M-16



▶ **Predominant Geologic Unit in Saturated Screened Interval:**
Partially Weathered Rock

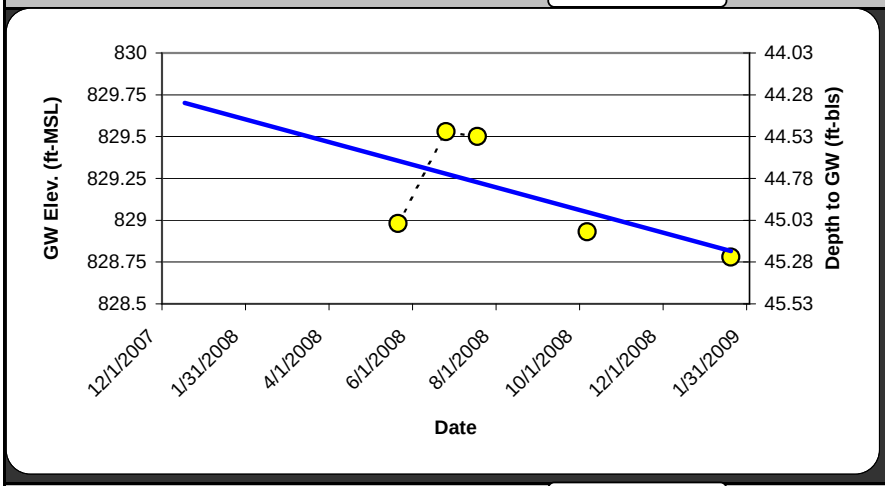
▶ **Topographic Setting:**
Intermediate Ridge - Groundsurface Elevation 845.85 ft MSL

Linear Trend Line

Observation Well Hydrographs

Marshall Steam Station - Industrial Landfill #1
S&ME Project No. 1356-08-122

M-18

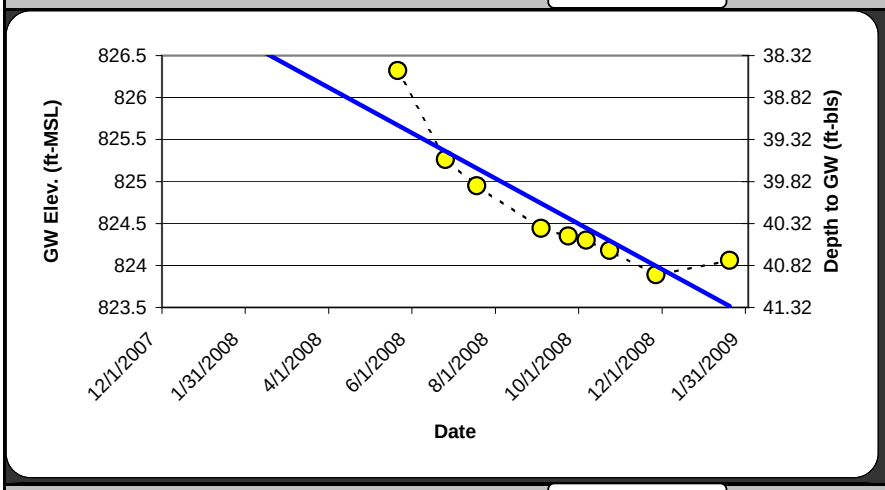


▶ **Predominant Geologic Unit in Saturated Screened Interval:**
Saprolite

▶ **Topographic Setting:**
Side Slope - Groundsurface Elevation 874.03 ft MSL

Linear Trend Line

M-19

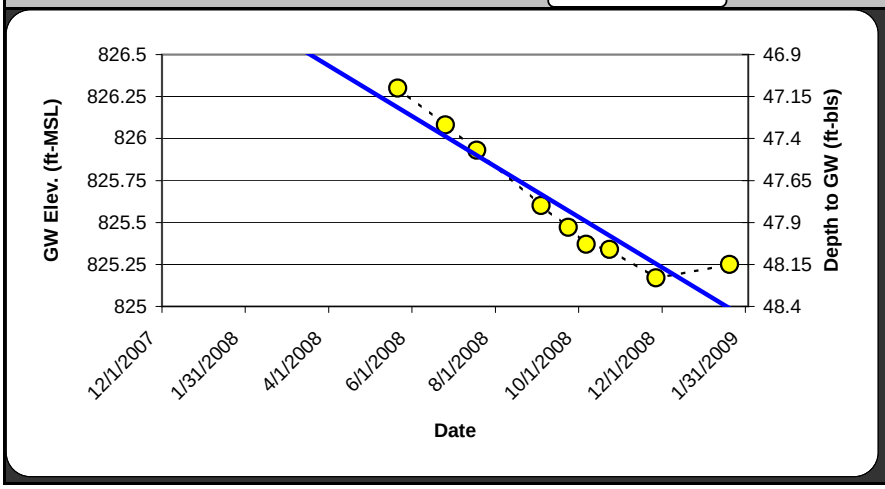


▶ **Predominant Geologic Unit in Saturated Screened Interval:**
Saprolite

▶ **Topographic Setting:**
Side Slope - Groundsurface Elevation 864.82 ft MSL

Linear Trend Line

M-20

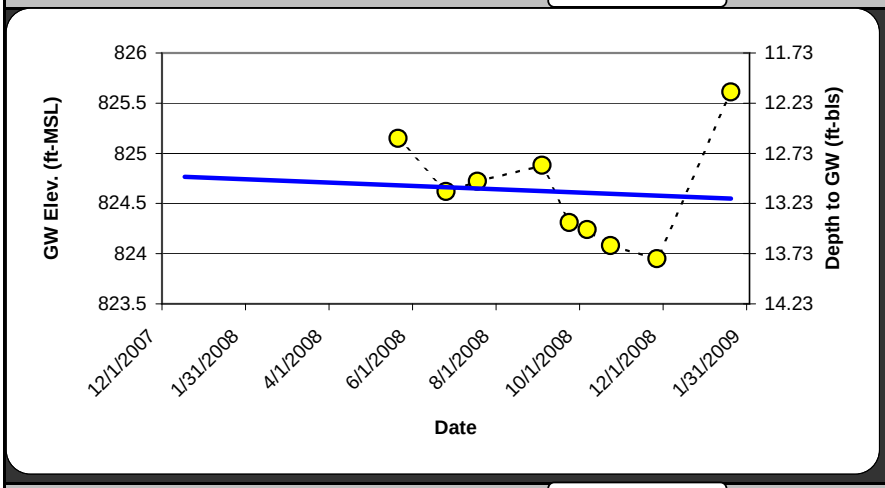


▶ **Predominant Geologic Unit in Saturated Screened Interval:**
Partially Weathered Rock

▶ **Topographic Setting:**
Side Slope - Groundsurface Elevation 873.40 ft MSL

Linear Trend Line

M-23

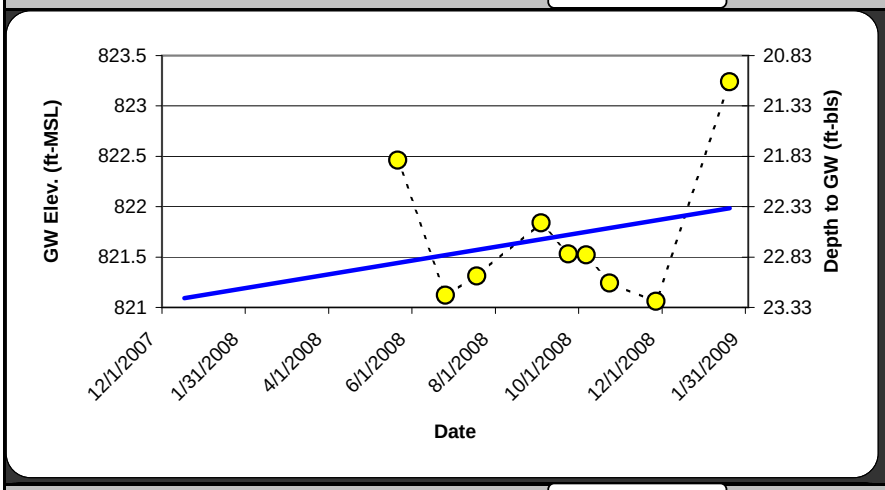


▶ **Predominant Geologic Unit in Saturated Screened Interval:**
Saprolite

▶ **Topographic Setting:**
Valley - Groundsurface Elevation 837.73 ft MSL

Linear Trend Line

M-25

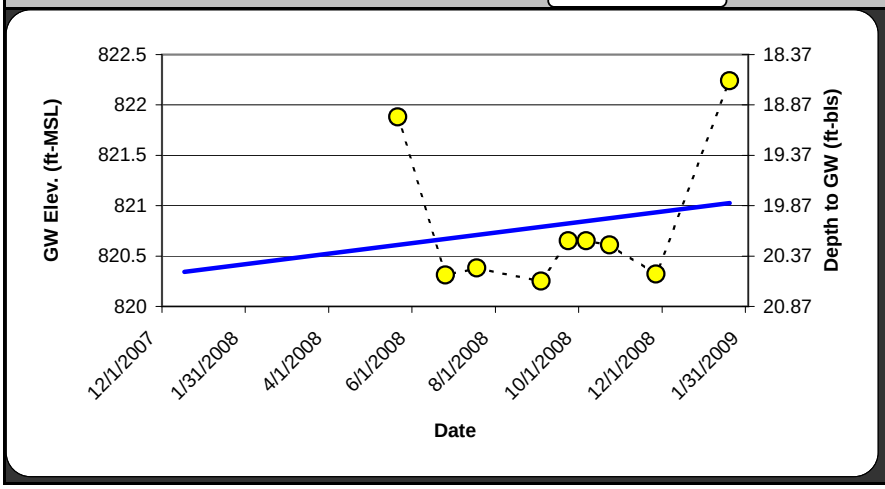


▶ **Predominant Geologic Unit in Saturated Screened Interval:**
Saprolite

▶ **Topographic Setting:**
Side Slope - Groundsurface Elevation 844.33 ft MSL

Linear Trend Line

M-26

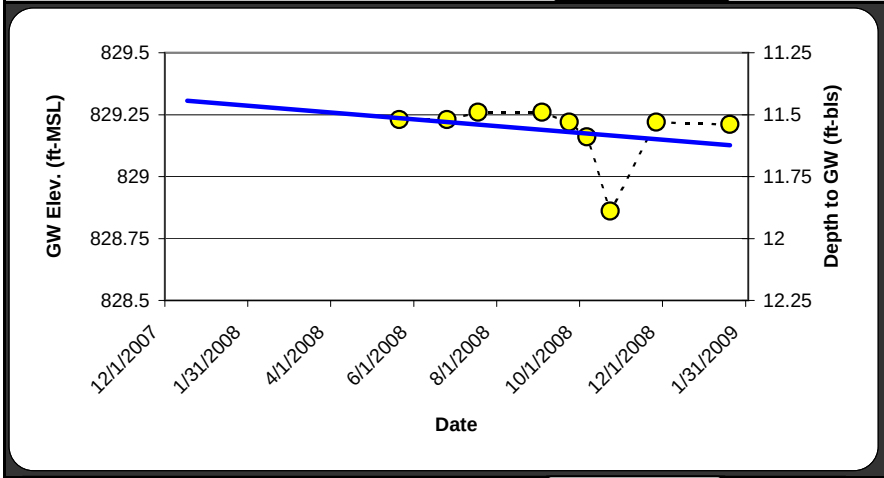


▶ **Predominant Geologic Unit in Saturated Screened Interval:**
Saprolite

▶ **Topographic Setting:**
Side Slope - Groundsurface Elevation 840.87 ft MSL

Linear Trend Line

M-29

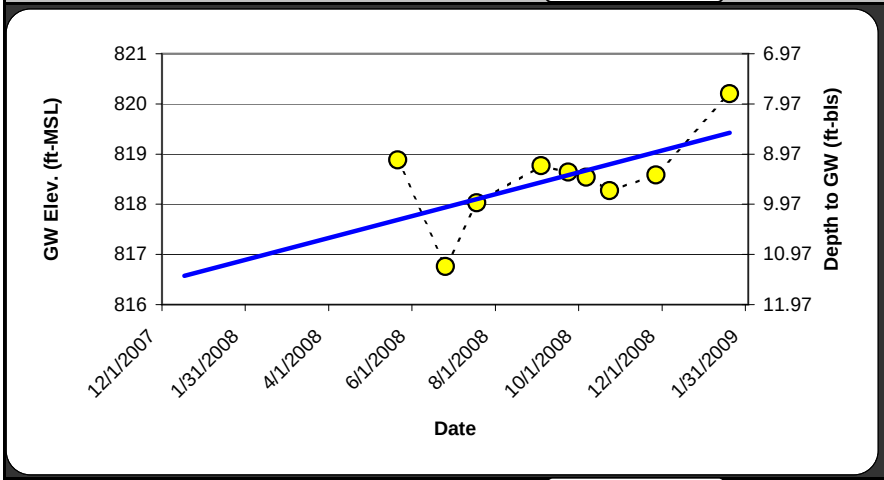


▶ **Predominant Geologic Unit in Saturated Screened Interval:**
Partially Weathered Rock

▶ **Topographic Setting:**
Side Slope - Groundsurface Elevation 840.75 ft MSL

Linear Trend Line

M-34

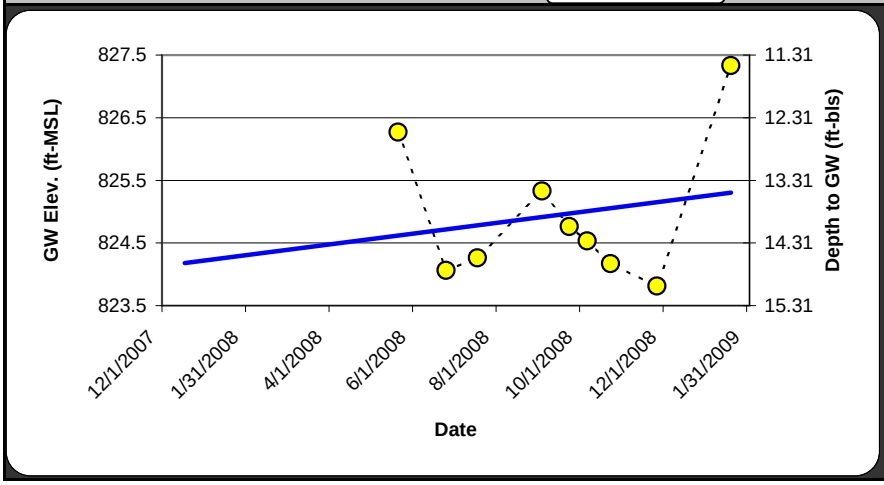


▶ **Predominant Geologic Unit in Saturated Screened Interval:**
Saprolite

▶ **Topographic Setting:**
Side Slope - Groundsurface Elevation 827.97 ft MSL

Linear Trend Line

M-36

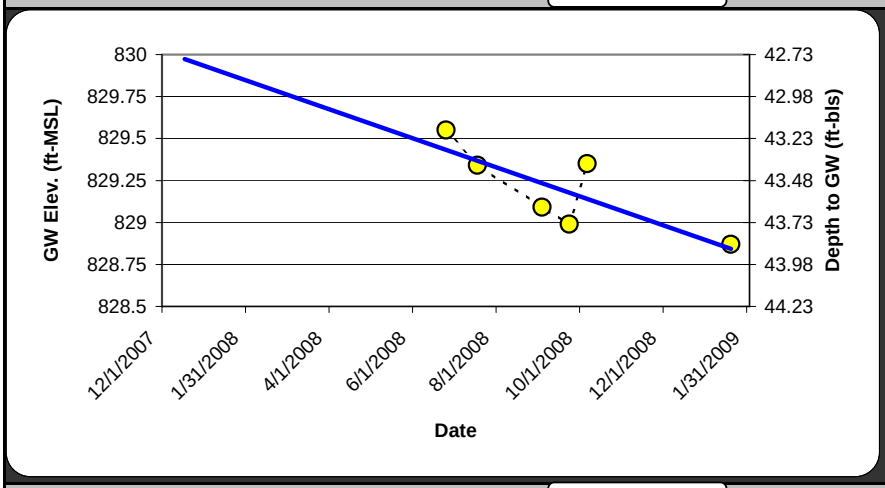


▶ **Predominant Geologic Unit in Saturated Screened Interval:**
Saprolite

▶ **Topographic Setting:**
Valley - Groundsurface Elevation 838.81 ft MSL

Linear Trend Line

M-37

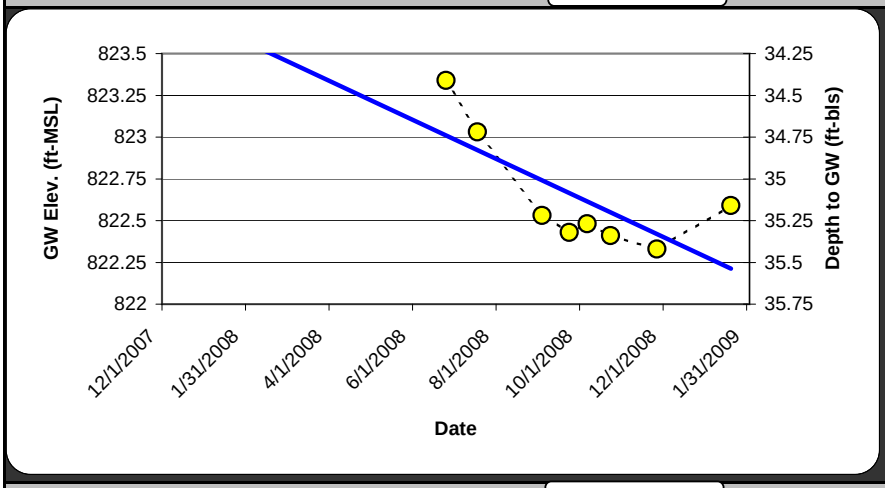


▶ **Predominant Geologic Unit in Saturated Screened Interval:**
Saprolite

▶ **Topographic Setting:**
High Ridge - Groundsurface Elevation 872.73 ft MSL

Linear Trend Line

M-38

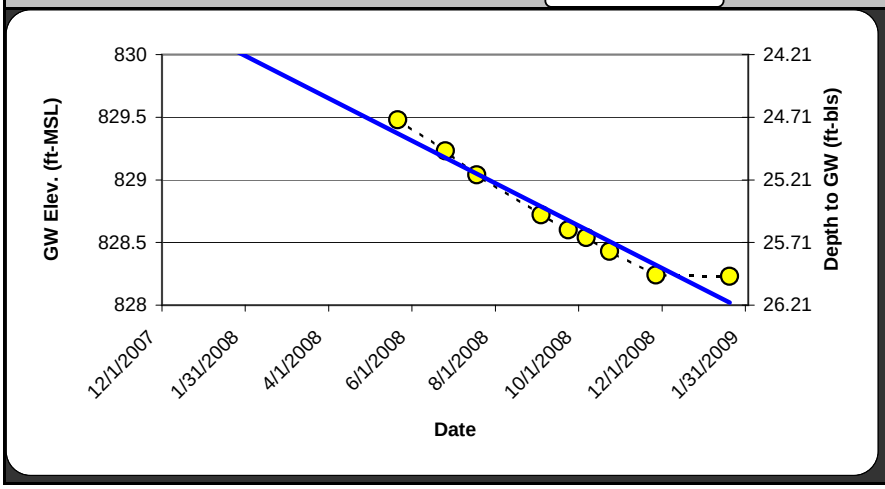


▶ **Predominant Geologic Unit in Saturated Screened Interval:**
Saprolite

▶ **Topographic Setting:**
Side Slope - Groundsurface Elevation 857.75 ft MSL

Linear Trend Line

M-39

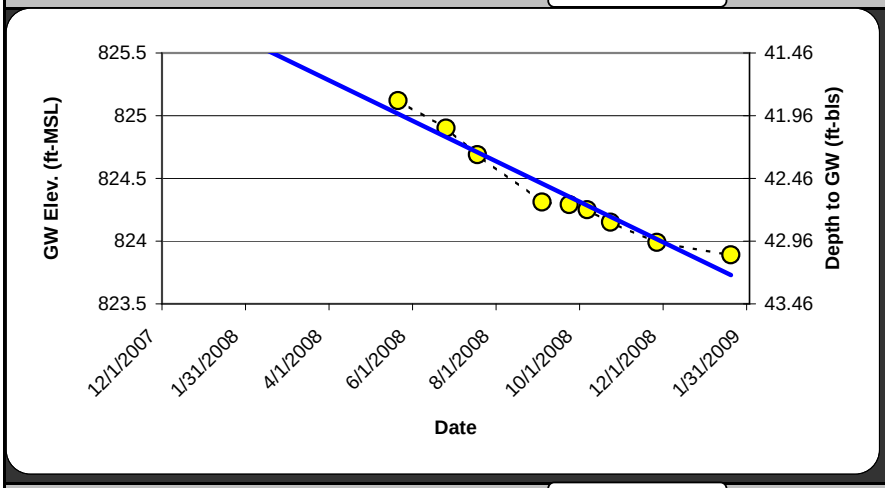


▶ **Predominant Geologic Unit in Saturated Screened Interval:**
Saprolite

▶ **Topographic Setting:**
Side Slope - Groundsurface Elevation 854.21 ft MSL

Linear Trend Line

M-41

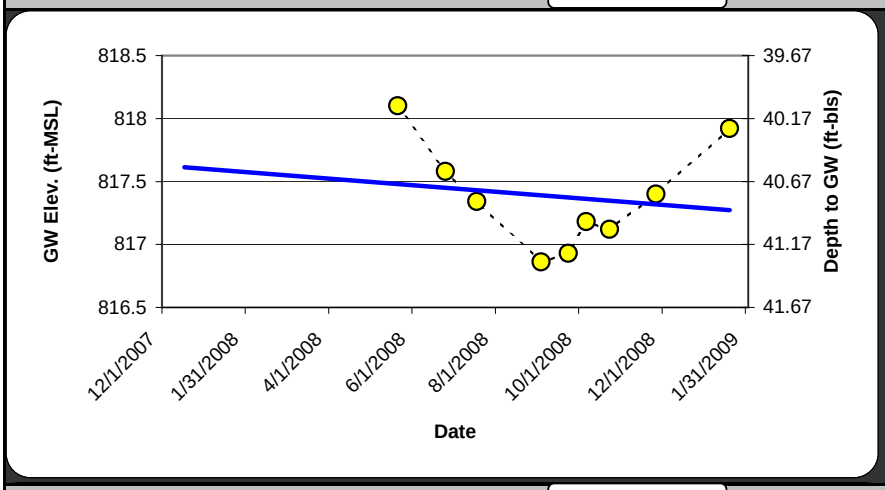


▶ **Predominant Geologic Unit in Saturated Screened Interval:**
Saprolite

▶ **Topographic Setting:**
Intermediate Ridge - Groundsurface Elevation 866.96 ft MSL

Linear Trend Line

M-42

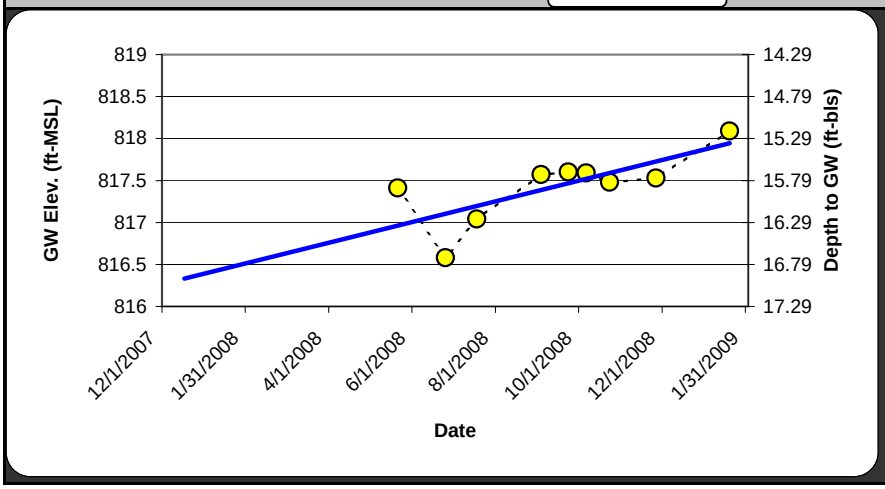


▶ **Predominant Geologic Unit in Saturated Screened Interval:**
Saprolite

▶ **Topographic Setting:**
Intermediate Ridge - Groundsurface Elevation 858.17 ft MSL

Linear Trend Line

M-43

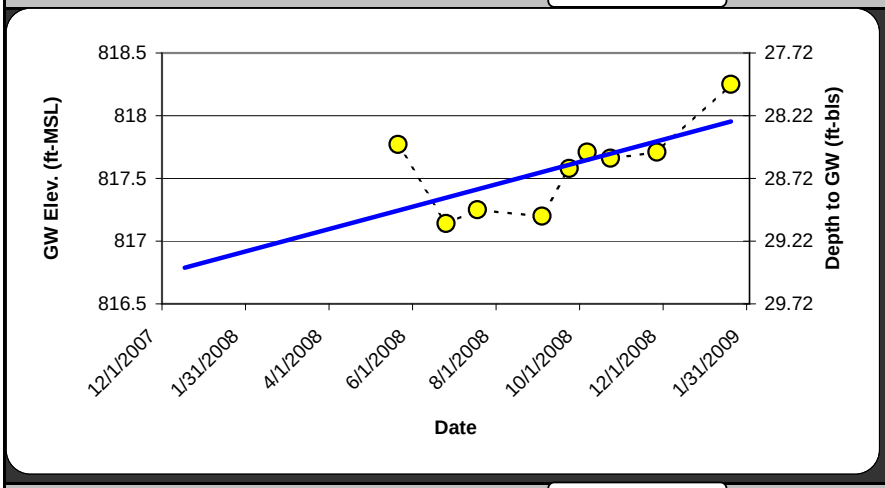


▶ **Predominant Geologic Unit in Saturated Screened Interval:**
Saprolite

▶ **Topographic Setting:**
Side Slope - Groundsurface Elevation 833.29 ft MSL

Linear Trend Line

M-45

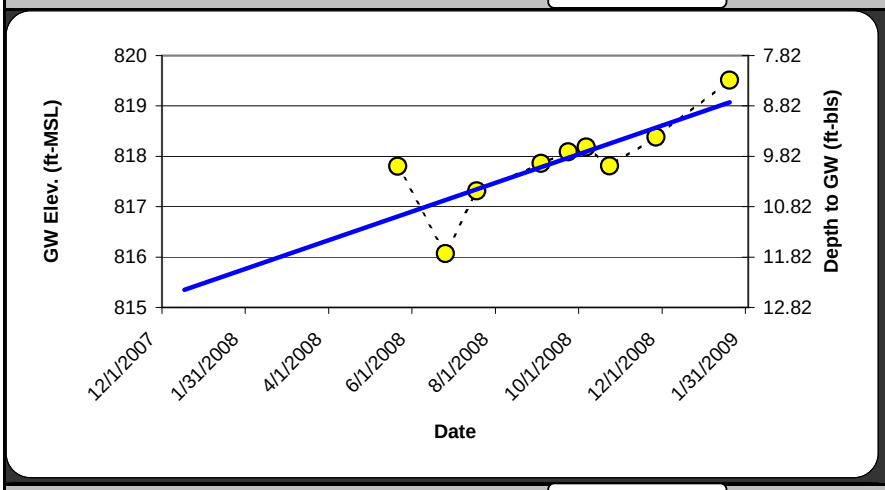


▶ **Predominant Geologic Unit in Saturated Screened Interval:**
Partially Weathered Rock

▶ **Topographic Setting:**
Side Slope - Groundsurface Elevation 846.22 ft MSL

Linear Trend Line

M-46

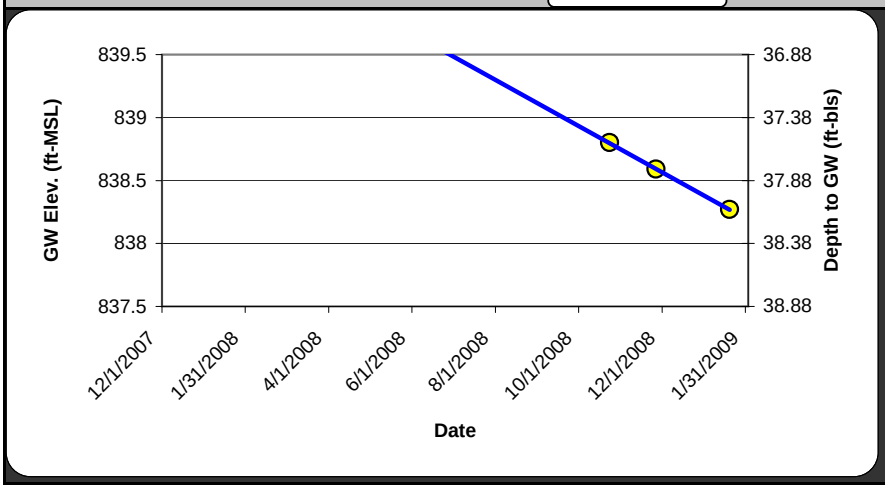


▶ **Predominant Geologic Unit in Saturated Screened Interval:**
Saprolite

▶ **Topographic Setting:**
Side Slope - Groundsurface Elevation 827.82 ft MSL

Linear Trend Line

M-58

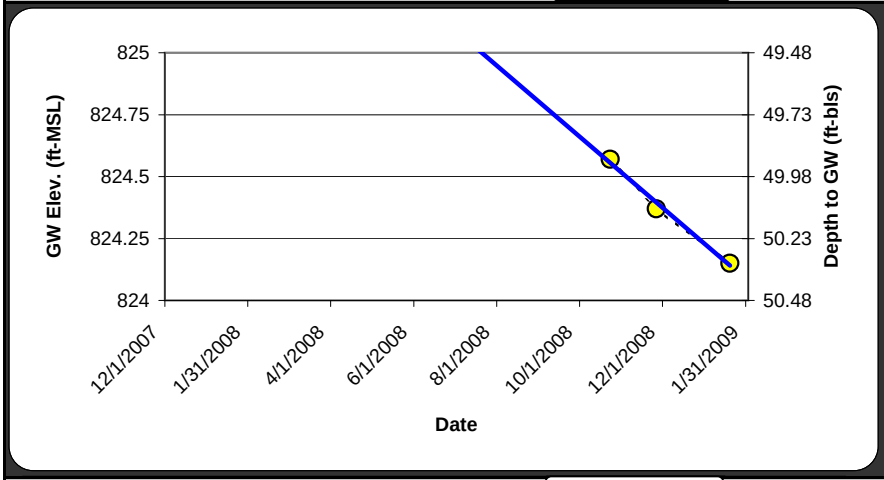


▶ **Predominant Geologic Unit in Saturated Screened Interval:**
Partially Weathered Rock

▶ **Topographic Setting:**
Valley - Groundsurface Elevation 876.38 ft MSL

Linear Trend Line

M-59

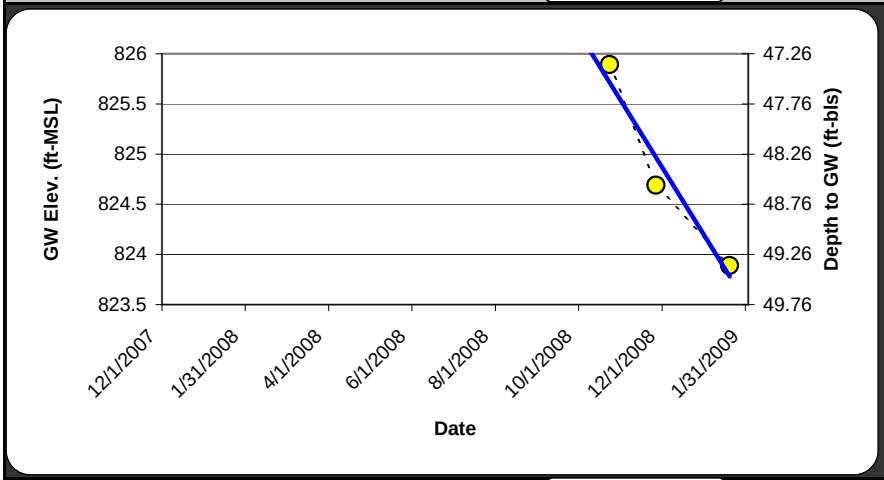


▶ Predominant Geologic Unit in Saturated Screened Interval:
Partially Weathered Rock

▶ Topographic Setting:
Side Slope - Groundsurface Elevation 874.48 ft MSL

Linear Trend Line

M-60

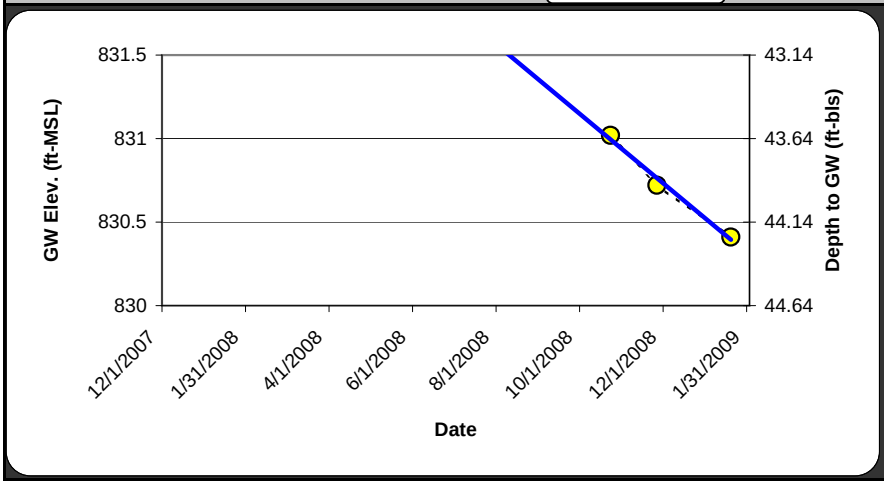


▶ Predominant Geologic Unit in Saturated Screened Interval:
Saprolite

▶ Topographic Setting:
Side Slope - Groundsurface Elevation 873.26 ft MSL

Linear Trend Line

M-61

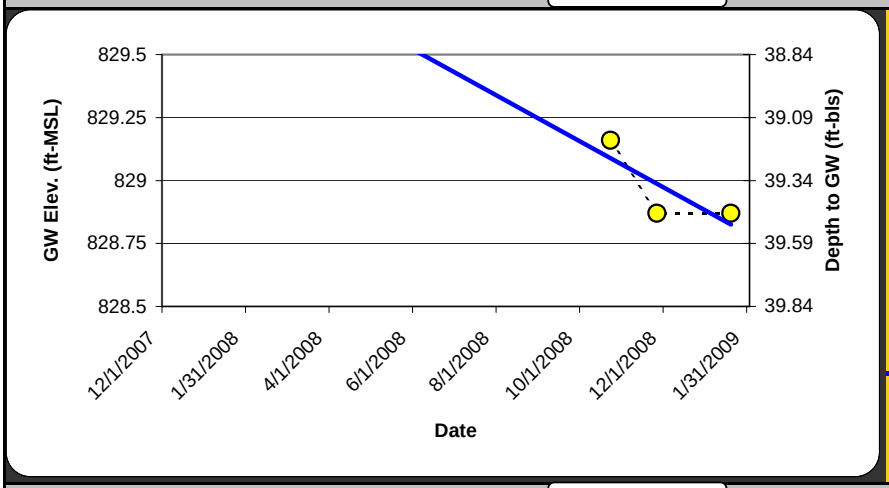


▶ Predominant Geologic Unit in Saturated Screened Interval:
Saprolite

▶ Topographic Setting:
Side Slope - Groundsurface Elevation 874.64 ft MSL

Linear Trend Line

M-62

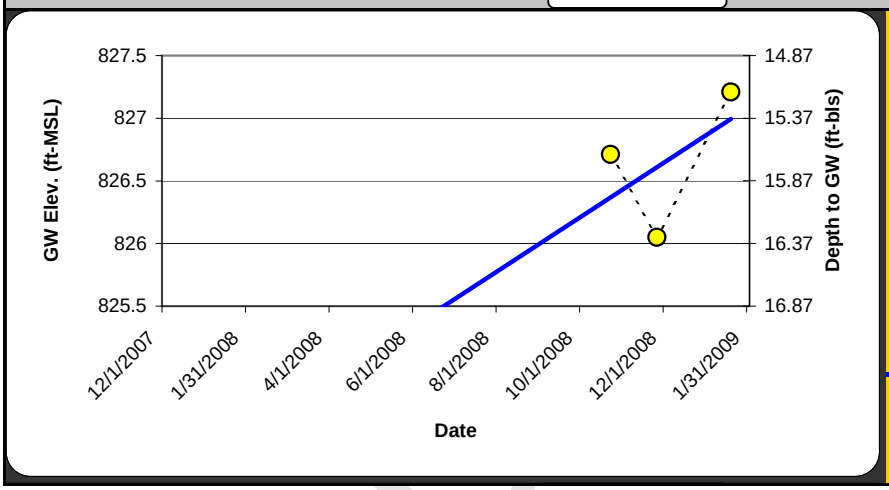


▶ **Predominant Geologic Unit in Saturated Screened Interval:**
Saprolite

▶ **Topographic Setting:**
Side Slope - Groundsurface Elevation 868.34 ft MSL

Linear Trend Line

M-64



▶ **Predominant Geologic Unit in Saturated Screened Interval:**
Saprolite

▶ **Topographic Setting:**
Side Slope - Groundsurface Elevation 842.37 ft MSL

Linear Trend Line

Estimation of Hydraulic Conductivity
Based on Grain Size

FORMULA

Harleman et al (1963)

$$k=(6.54E-04)d^2$$

Where: k permeability (cm^2)
d_{10} characteristic particle diameter (cm)

Conversion from permeability to hydraulic conductivity

$$K=k\ (pg/\mu)$$

Where: K Hydraulic conductivity (cm/sec)
k permeability (cm^2)
p fluid density - 1.0 g/cm^3
g gravitational constant - 980 cm/sec^2
μ dynamic viscosity - 0.01124 g/sec*cm

CALCULATIONS

Sample Number: M-1 **Geologic Unit:** Residuum
Sample Depth: 10-15 ft bls
Soil Classification: Brown fine sandy clayey SILT (ML)
d_{10} (from grain size analysis): 1.30E-04 cm

constant= 6.54E-04 k = $(6.54E-04)d^2$
d^2= 1.69E-08 cm **k = 1.11E-11 cm^2**

p= 1.0 g/cm^3
g= 980 cm/sec^2 K = k (pg/μ)
μ= 0.01124 g/sec*cm **K = 9.64E-07 cm/sec**

Sample Number: M-2 **Geologic Unit:** Residuum
Sample Depth: 5-10 ft bls
Soil Classification: Light brown micaceous fine sandy SILT (ML)
d_{10} (from grain size analysis): 2.50E-04 cm

constant= 6.54E-04 k = $(6.54E-04)d^2$
d^2= 6.25E-08 cm **k = 4.09E-11 cm^2**

p= 1.0 g/cm^3
g= 980 cm/sec^2 K = k (pg/μ)
μ= 0.01124 g/sec*cm **K = 3.56E-06 cm/sec**

Sample Number: M-2 **Geologic Unit:** Saprolite
Sample Depth: 10-15 ft bls
Soil Classification: Tan micaceous silty fine SAND (SM)
d_{10} (from grain size analysis): 5.00E-04 cm

constant= 6.54E-04 k = $(6.54E-04)d^2$
d^2= 2.50E-07 cm **k = 1.64E-10 cm^2**

p= 1.0 g/cm^3
g= 980 cm/sec^2 K = k (pg/μ)
μ= 0.01124 g/sec*cm **K = 1.43E-05 cm/sec**

Sample Number: M-2 **Geologic Unit:** PWR
Sample Depth: 44.1-45.6 ft bls
Soil Classification: Gray tan white micaceous silty medium to fine SAND
d_{10} (from grain size analysis): 1.95E-03 cm

constant= 6.54E-04 k = (6.54E-04)d^2

d^2= 3.80E-06 cm **k = 2.49E-09 cm^2**

p= 1.0 g/cm^3

g= 980 cm/sec^2 K = k (pg/μ)

μ= 0.01124 g/sec*cm **K = 2.17E-04 cm/sec**

Sample Number: M-3 **Geologic Unit:** Saprolite
Sample Depth: 10-15 ft bls
Soil Classification: Brown tan micaceous medium to fine sandy clayey SILT (ML)
d_{10} (from grain size analysis): 1.38E-04 cm

constant= 6.54E-04 k = (6.54E-04)d^2

d^2= 1.90E-08 cm **k = 1.25E-11 cm^2**

p= 1.0 g/cm^3

g= 980 cm/sec^2 K = k (pg/μ)

μ= 0.01124 g/sec*cm **K = 1.09E-06 cm/sec**

Sample Number: M-3 **Geologic Unit:** Saprolite
Sample Depth: 42.8-43.5 ft bls
Soil Classification: Gray brown white micaceous silty medium to fine SAND
d_{10} (from grain size analysis): 2.25E-03 cm

constant= 6.54E-04 k = (6.54E-04)d^2

d^2= 5.06E-06 cm **k = 3.31E-09 cm^2**

p= 1.0 g/cm^3

g= 980 cm/sec^2 K = k (pg/μ)

μ= 0.01124 g/sec*cm **K = 2.89E-04 cm/sec**

Sample Number: M-5 **Geologic Unit:** Ash
Sample Depth: 8.6-10.1 ft bls
Soil Classification: Dark gray SILT with fine sand
d_{10} (from grain size analysis): 1.45E-03 cm

constant= 6.54E-04 k = (6.54E-04)d^2

d^2= 2.10E-06 cm **k = 1.38E-09 cm^2**

p= 1.0 g/cm^3

g= 980 cm/sec^2 K = k (pg/μ)

μ= 0.01124 g/sec*cm **K = 1.20E-04 cm/sec**

Sample Number: M-6 **Geologic Unit:** Saprolite
Sample Depth: 23.3-24.8 ft bls
Soil Classification: Brown orange white micaceous fine sandy SILT
d_{10} (from grain size analysis): 4.75E-04 cm

constant= 6.54E-04 $k = (6.54E-04)d^2$

d^2= 2.26E-07 cm **k = 1.48E-10 cm^2**

p= 1.0 g/cm^3

g= 980 cm/sec^2 K = k (pg/μ)

μ= 0.01124 g/sec*cm **K = 1.29E-05 cm/sec**

Sample Number: M-8 **Geologic Unit:** Residuum
Sample Depth: 5-10 ft bls
Soil Classification: Tan brown fine sandy silty CLAY (CL)
d_{10} (from grain size analysis): 1.36E-04 cm

constant= 6.54E-04 $k = (6.54E-04)d^2$

d^2= 1.85E-08 cm **k = 1.21E-11 cm^2**

p= 1.0 g/cm^3

g= 980 cm/sec^2 K = k (pg/μ)

μ= 0.01124 g/sec*cm **K = 1.05E-06 cm/sec**

Sample Number: M-8 **Geologic Unit:** Residuum
Sample Depth: 10-15 ft bls
Soil Classification: Tan brown fine sandy silty CLAY (CL)
d_{10} (from grain size analysis): 1.00E-04 cm

constant= 6.54E-04 $k = (6.54E-04)d^2$

d^2= 1.00E-08 cm **k = 6.54E-12 cm^2**

p= 1.0 g/cm^3

g= 980 cm/sec^2 K = k (pg/μ)

μ= 0.01124 g/sec*cm **K = 5.70E-07 cm/sec**

Sample Number: M-8 **Geologic Unit:** Saprolite
Sample Depth: 38.5-40 ft bls
Soil Classification: Tan brown fine sandy SILT
d_{10} (from grain size analysis): 7.50E-04 cm

constant= 6.54E-04 $k = (6.54E-04)d^2$

d^2= 5.63E-07 cm **k = 3.68E-10 cm^2**

p= 1.0 g/cm^3

g= 980 cm/sec^2 K = k (pg/μ)

μ= 0.01124 g/sec*cm **K = 3.21E-05 cm/sec**

Sample Number: M-16 **Geologic Unit:** PWR
Sample Depth: 8-10 ft bls
Soil Classification: Tan olive brown micaceous clayey silty fine SAND (SC)
d_{10} (from grain size analysis): 1.18E-04 cm

constant= 6.54E-04 k = (6.54E-04)d^2

d^2= 1.38E-08 cm **k = 9.03E-12 cm^2**

p= 1.0 g/cm^3

g= 980 cm/sec^2 K = k (pg/μ)

μ= 0.01124 g/sec*cm **K = 7.87E-07 cm/sec**

Sample Number: M-16 **Geologic Unit:** PWR
Sample Depth: 13-15 ft bls
Soil Classification: Olive brown micaceous clayey silty medium to fine SAND (SC)
d_{10} (from grain size analysis): 1.37E-04 cm

constant= 6.54E-04 k = (6.54E-04)d^2

d^2= 1.88E-08 cm **k = 1.23E-11 cm^2**

p= 1.0 g/cm^3

g= 980 cm/sec^2 K = k (pg/μ)

μ= 0.01124 g/sec*cm **K = 1.07E-06 cm/sec**

Sample Number: M-16 **Geologic Unit:** PWR
Sample Depth: 39-40 ft bls
Soil Classification: Gray olive micaceous silty fine SAND
d_{10} (from grain size analysis): 3.20E-03 cm

constant= 6.54E-04 k = (6.54E-04)d^2

d^2= 1.02E-05 cm **k = 6.70E-09 cm^2**

p= 1.0 g/cm^3

g= 980 cm/sec^2 K = k (pg/μ)

μ= 0.01124 g/sec*cm **K = 5.84E-04 cm/sec**

Sample Number: M-17 **Geologic Unit:** Saprolite
Sample Depth: 20-25 ft bls
Soil Classification: Micaceous Fine Sandy Silt
d_{10} (from grain size analysis): 2.50E-04 cm

constant= 6.54E-04 k = (6.54E-04)d^2

d^2= 6.25E-08 cm **k = 4.09E-11 cm^2**

p= 1.0 g/cm^3

g= 980 cm/sec^2 K = k (pg/μ)

μ= 0.01124 g/sec*cm **K = 3.56E-06 cm/sec**

Sample Number: M-18 **Geologic Unit:** Saprolite
Sample Depth: 19-24 ft bls
Soil Classification: Clayey Silty Fine Sand
d_{10} (from grain size analysis): 1.50E-04 cm

constant= 6.54E-04 k = (6.54E-04)d^2

d^2= 2.25E-08 cm **k = 1.47E-11 cm^2**

p= 1.0 g/cm^3

g= 980 cm/sec^2 K = k (pg/μ)

μ= 0.01124 g/sec*cm **K = 1.28E-06 cm/sec**

Sample Number: M-24 **Geologic Unit:** Saprolite
Sample Depth: 15-20 ft bls
Soil Classification: Fine Sandy Silty Clay
d_{10} (from grain size analysis): 1.50E-04 cm

constant= 6.54E-04 k = (6.54E-04)d^2

d^2= 2.25E-08 cm **k = 1.47E-11 cm^2**

p= 1.0 g/cm^3

g= 980 cm/sec^2 K = k (pg/μ)

μ= 0.01124 g/sec*cm **K = 1.28E-06 cm/sec**

Sample Number: M-40 **Geologic Unit:** PWR
Sample Depth: 29.2-34.2 ft bls
Soil Classification: Micaceous Clayey Silty F/M Sand
d_{10} (from grain size analysis): 3.20E-04 cm

constant= 6.54E-04 k = (6.54E-04)d^2

d^2= 1.02E-07 cm **k = 6.70E-11 cm^2**

p= 1.0 g/cm^3

g= 980 cm/sec^2 K = k (pg/μ)

μ= 0.01124 g/sec*cm **K = 5.84E-06 cm/sec**

Sample Number: M-41 **Geologic Unit:** Saprolite
Sample Depth: 24.5-29.5 ft bls
Soil Classification: Micaceous Fine Sandy Clayey Silt
d_{10} (from grain size analysis): 2.50E-04 cm

constant= 6.54E-04 k = (6.54E-04)d^2

d^2= 6.25E-08 cm **k = 4.09E-11 cm^2**

p= 1.0 g/cm^3

g= 980 cm/sec^2 K = k (pg/μ)

μ= 0.01124 g/sec*cm **K = 3.56E-06 cm/sec**

Sample Number: M-42 **Geologic Unit:** Saprolite
Sample Depth: 14.5-19.5 ft bls
Soil Classification: Micaceous Fine Sandy Silt
d_{10} (from grain size analysis): 1.40E-04 cm

constant= 6.54E-04 k = (6.54E-04)d^2

d^2= 1.96E-08 cm **k = 1.28E-11 cm^2**

p= 1.0 g/cm^3

g= 980 cm/sec^2 K = k (pg/μ)

μ= 0.01124 g/sec*cm **K = 1.12E-06 cm/sec**

Sample Number: M-57 **Geologic Unit:** Saprolite
Sample Depth: 13.5-15' ft bls
Soil Classification: Micaceous Silty Medium to Fine Sand
d_{10} (from grain size analysis): 1.50E-03 cm

constant= 6.54E-04 k = (6.54E-04)d^2

d^2= 2.25E-06 cm **k = 1.47E-09 cm^2**

p= 1.0 g/cm^3

g= 980 cm/sec^2 K = k (pg/μ)

μ= 0.01124 g/sec*cm **K = 1.28E-04 cm/sec**

Sample Number: M-58 **Geologic Unit:** PWR
Sample Depth: 28.5-30' ft bls
Soil Classification: Silty Medium to Fine Sand
d_{10} (from grain size analysis): 2.30E-03 cm

constant= 6.54E-04 k = (6.54E-04)d^2

d^2= 5.29E-06 cm **k = 3.46E-09 cm^2**

p= 1.0 g/cm^3

g= 980 cm/sec^2 K = k (pg/μ)

μ= 0.01124 g/sec*cm **K = 3.02E-04 cm/sec**

Sample Number: M-59 **Geologic Unit:** Saprolite
Sample Depth: 28.5-30' ft bls
Soil Classification: Medium to Fine Sandy Silt
d_{10} (from grain size analysis): 3.50E-04 cm

constant= 6.54E-04 k = (6.54E-04)d^2

d^2= 1.23E-07 cm **k = 8.01E-11 cm^2**

p= 1.0 g/cm^3

g= 980 cm/sec^2 K = k (pg/μ)

μ= 0.01124 g/sec*cm **K = 6.99E-06 cm/sec**

Sample Number: M-60 **Geologic Unit:** Saprolite
Sample Depth: 68.5-70' ft bls
Soil Classification: Medium to Fine Sandy Silt
d_{10} (from grain size analysis): 8.50E-04 cm

constant= 6.54E-04 k = (6.54E-04)d^2

d^2= 7.23E-07 cm **k = 4.73E-10 cm^2**

p= 1.0 g/cm^3

g= 980 cm/sec^2 K = k (pg/μ)

μ= 0.01124 g/sec*cm **K = 4.12E-05 cm/sec**

Sample Number: M-61 **Geologic Unit:** Saprolite
Sample Depth: 18.5-20' ft bls
Soil Classification: Silty Medium to Fine Sand
d_{10} (from grain size analysis): 9.50E-04 cm

constant= 6.54E-04 k = (6.54E-04)d^2

d^2= 9.03E-07 cm **k = 5.90E-10 cm^2**

p= 1.0 g/cm^3

g= 980 cm/sec^2 K = k (pg/μ)

μ= 0.01124 g/sec*cm **K = 5.15E-05 cm/sec**

Sample Number: M-61 **Geologic Unit:** PWR
Sample Depth: 78.5-80' ft bls
Soil Classification: Medium to Fine Sandy Silt
d_{10} (from grain size analysis): 9.50E-04 cm

constant= 6.54E-04 k = (6.54E-04)d^2

d^2= 9.03E-07 cm **k = 5.90E-10 cm^2**

p= 1.0 g/cm^3

g= 980 cm/sec^2 K = k (pg/μ)

μ= 0.01124 g/sec*cm **K = 5.15E-05 cm/sec**

Sample Number: M-62 **Geologic Unit:** Saprolite
Sample Depth: 33.5-35' ft bls
Soil Classification: Fine Sandy Silt
d_{10} (from grain size analysis): 8.00E-04 cm

constant= 6.54E-04 k = (6.54E-04)d^2

d^2= 6.40E-07 cm **k = 4.19E-10 cm^2**

p= 1.0 g/cm^3

g= 980 cm/sec^2 K = k (pg/μ)

μ= 0.01124 g/sec*cm **K = 3.65E-05 cm/sec**

Sample Number: M-63 **Geologic Unit:** Saprolite
Sample Depth: 8.5-10' ft bls
Soil Classification: Silty Coarse to Fine Sand
d_{10} (from grain size analysis): 1.50E-03 cm

constant= 6.54E-04 $k = (6.54E-04)d^2$

d^2= 2.25E-06 cm **k = 1.47E-09 cm^2**

p= 1.0 g/cm^3

g= 980 cm/sec^2 K = k (pg/μ)

μ= 0.01124 g/sec*cm **K = 1.28E-04 cm/sec**

Sample Number: M-64 **Geologic Unit:** Saprolite
Sample Depth: 13.5-15' ft bls
Soil Classification: Silty Coarse to Fine Sand
d_{10} (from grain size analysis): 1.80E-03 cm

constant= 6.54E-04 $k = (6.54E-04)d^2$

d^2= 3.24E-06 cm **k = 2.12E-09 cm^2**

p= 1.0 g/cm^3

g= 980 cm/sec^2 K = k (pg/μ)

μ= 0.01124 g/sec*cm **K = 1.85E-04 cm/sec**

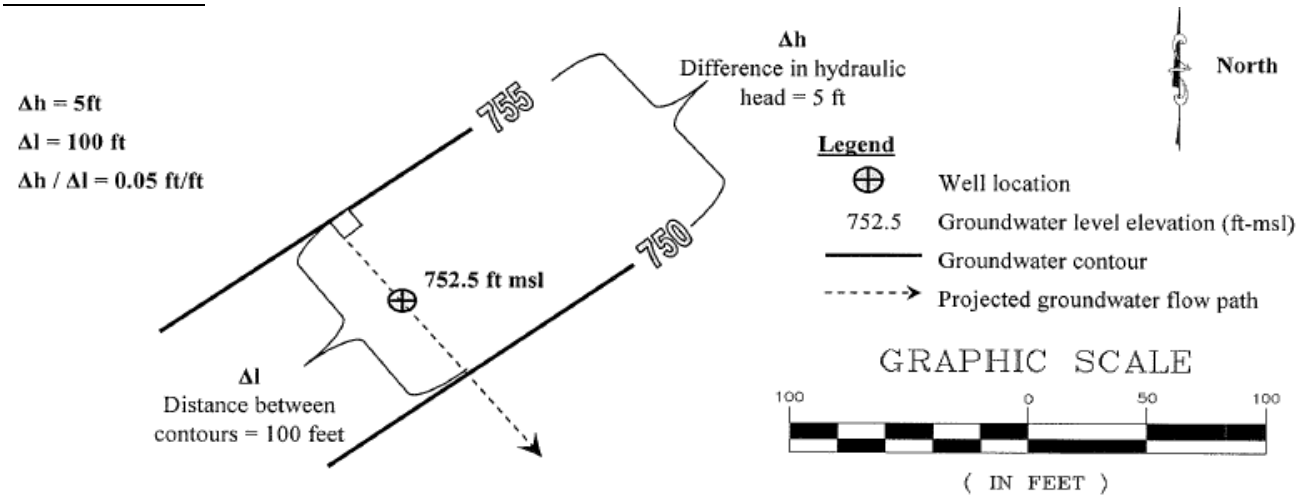
Horizontal Hydraulic Gradient Calculations

FORMULA

Horizontal hydraulic gradients are based on a change in hydraulic head (Δh) over a measured distance (Δl).

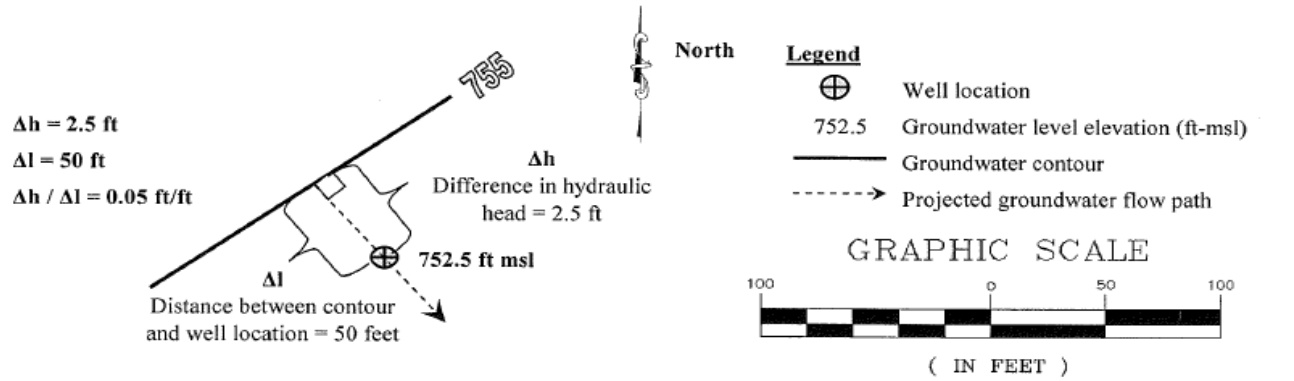
For wells located between two groundwater contours, the gradient is calculated by taking the change in head (the difference in elevation between the upgradient and downgradient groundwater contours) and dividing by the distance between the groundwater contours following a projected flow path through the well location. Projected flow paths are perpendicular to the upgradient groundwater contour and bisect the well being calculated, but may not be a straight line.

CALCULATION



For wells that are not located between two groundwater contours, the gradient is calculated by taking the change in head (the difference between an upgradient or downgradient groundwater contour and the groundwater elevation at the well location) and dividing by the distance between the groundwater contour and the well location following a projected groundwater flow path through the well location.

CALCULATION



Well ID	Δh	Δl	Δh/Δl
M-1	2	145	0.014
M-2	2	175	0.011
M-3	2	130	0.015
M-4	2	220	0.009
M-5	0.38	170	0.002
M-6	2	180	0.011
M-7	2	115	0.017
M-8	2	60	0.033
M-16	5.07	370	0.014
M-18	2	190	0.011
M-19	2	410	0.005
M-20	2	110	0.018
M-23	2	60	0.033
M-25	2	60	0.033
M-26	2	270	0.007
M-28	2	60	0.033
M-29	3.22	75	0.043
M-34	2	190	0.011
M-36	2	150	0.013
M-37	2	130	0.015
M-38	2	100	0.020
M-39	2.24	140	0.016
M-41	2	140	0.014
M-42	2.6	165	0.016
M-43	2.47	420	0.006
M-45	2.29	190	0.012
M-58	2.59	60	0.043
M-59	2.37	540	0.004
M-60	3.31	300	0.011
M-61	2.72	230	0.012
M-62	2	170	0.012
M-64	2	140	0.014

Maximum Value	0.043
Minimum Value	0.002
Average Value	0.017

Legend

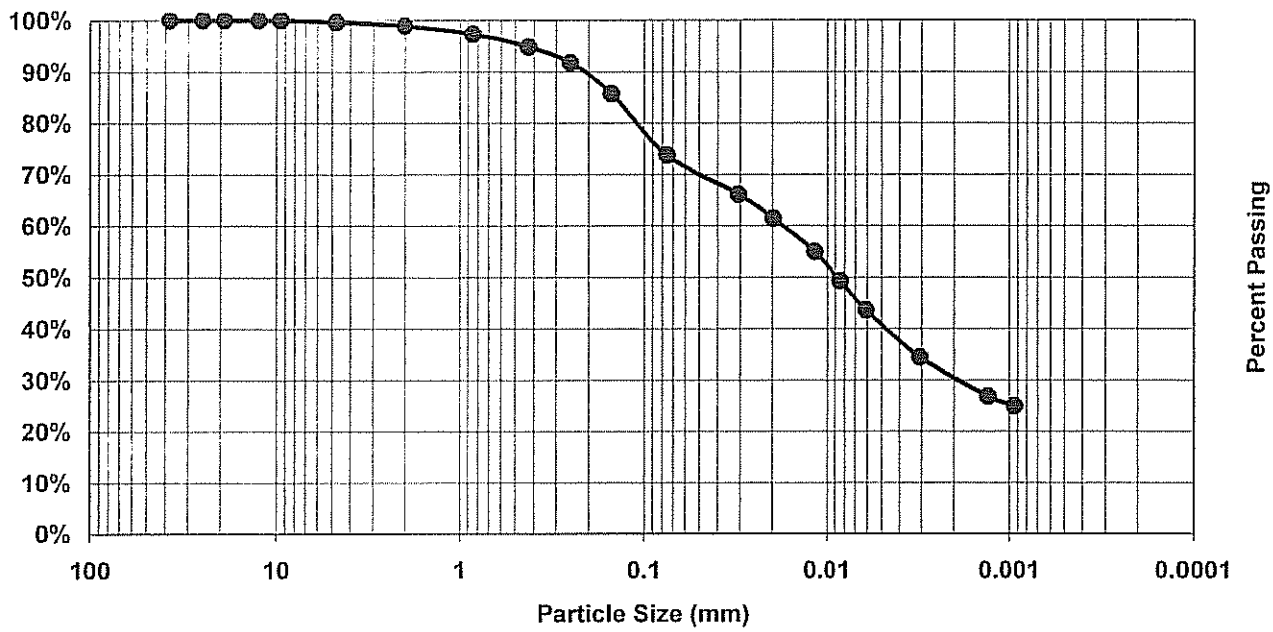
Δh Change in Head
Δl Change in Horizontal Distance
Δh/Δl Horizontal Hydraulic Gradient

Fetter and Bear Diagrams

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-1	M-1 (0-5)	0 to 5 ft bls

Sample Description:
Red brown clayey SILT with fine sand (MH)



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 1.1%	% Sand 26.9%	% Silt 33.5%	% Clay 38.5%
Adjusted for Calculations	**0%**	**27%**	**34%**	**39%**

Notes:
Grain size distribution taken from grain size with hydrometer data located in Appendix II.
Gravel, sand, silt and clay sizes based on Wentworth Scale.

S&ME Project:
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S&ME Project No.:
1411-07-103

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FETTER AND BEAR DIAGRAMS

S&ME PROJECT: MSS Landfill Siting Survey
S&ME PROJECT NO.: 1411-07-103

Boring No. M-1

Sample Depth: 0 to 5 ft bls

% Sand: 27%

% Silt: 34%

% Clay: 39%

Estimated Specific Yield: 2.75%

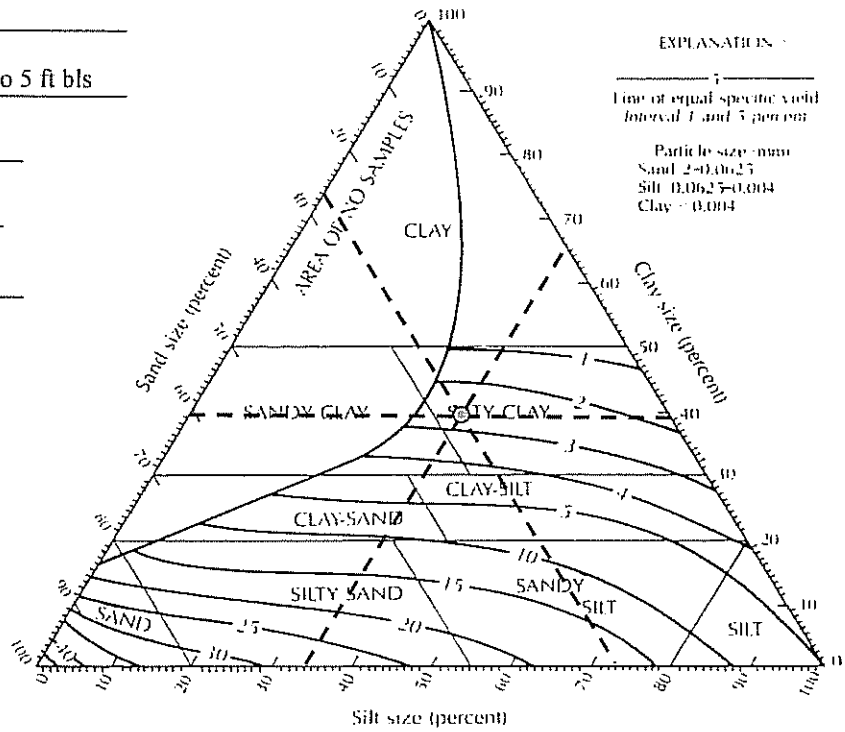
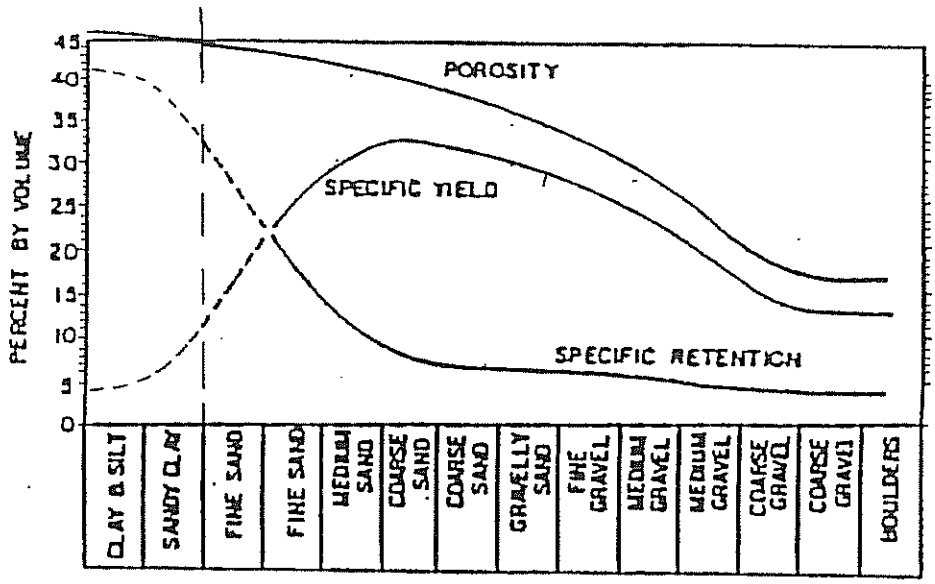


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



Estimated Porosity: 48%**

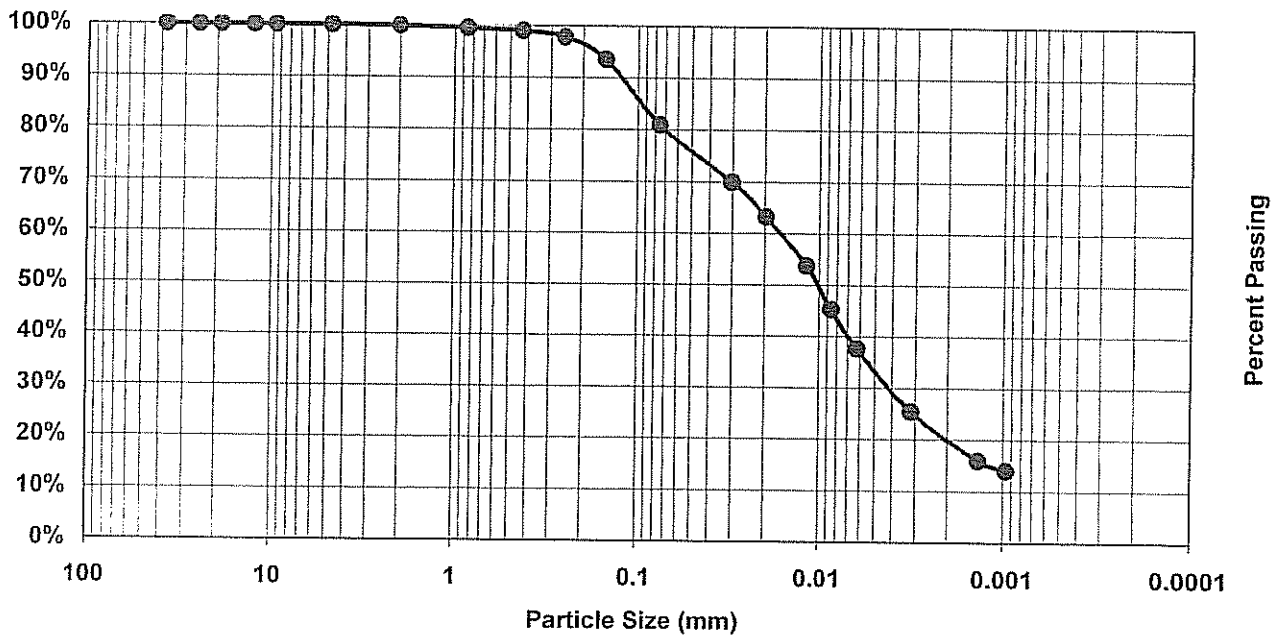
**Based on Table of Selected Values of Porosity, Specific Yield and Specific Retention, USGS Water Supply Paper 2220.

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-1	M-1 (5-10)	5 to 10 ft bls

Sample Description:
Red brown clayey SILT with fine sand (MH)



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 0.1%	% Sand 21.5%	% Silt 48.6%	% Clay 29.9%
Adjusted for Calculations	**0%**	**21%**	**49%**	**30%**

Notes:
Grain size distribution taken from grain size with hydrometer data located in Appendix II.
Gravel, sand, silt and clay sizes based on Wentworth Scale.

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FETTER AND BEAR DIAGRAMS

S&ME PROJECT: MSS Landfill Siting Survey
S&ME PROJECT NO.: 1411-07-103

Boring No. M-1

Sample Depth: 5 to 10 ft bls

% Sand: 21%

% Silt: 49%

% Clay: 30%

Estimated Specific Yield: 4%

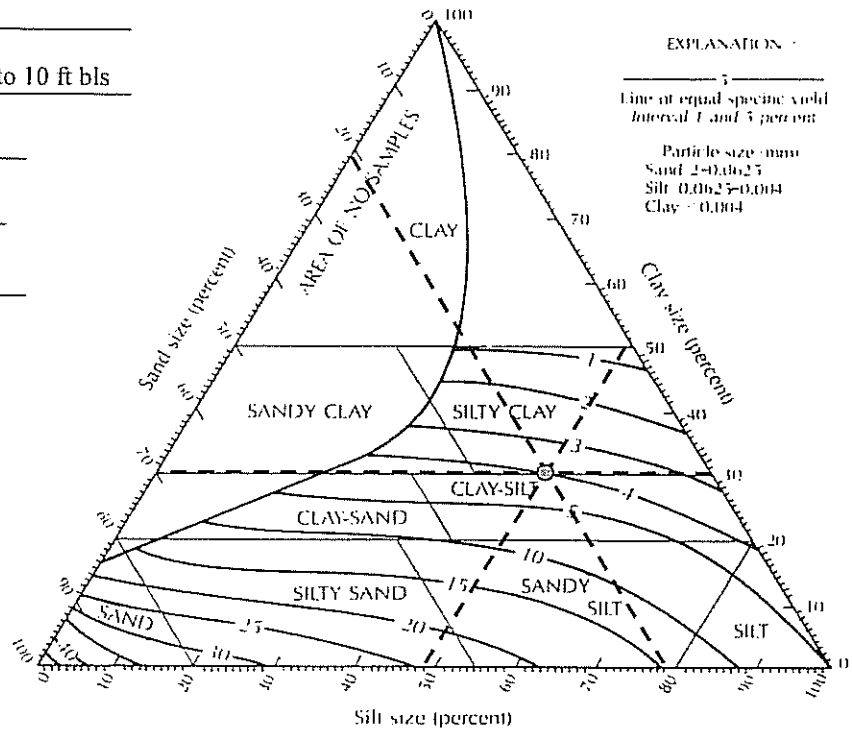
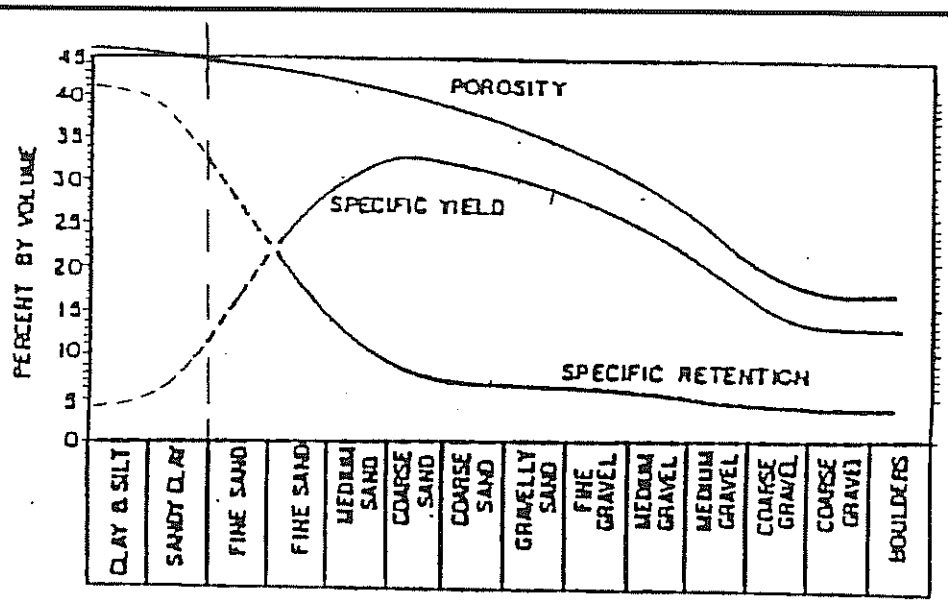


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



Estimated Porosity: 47%**

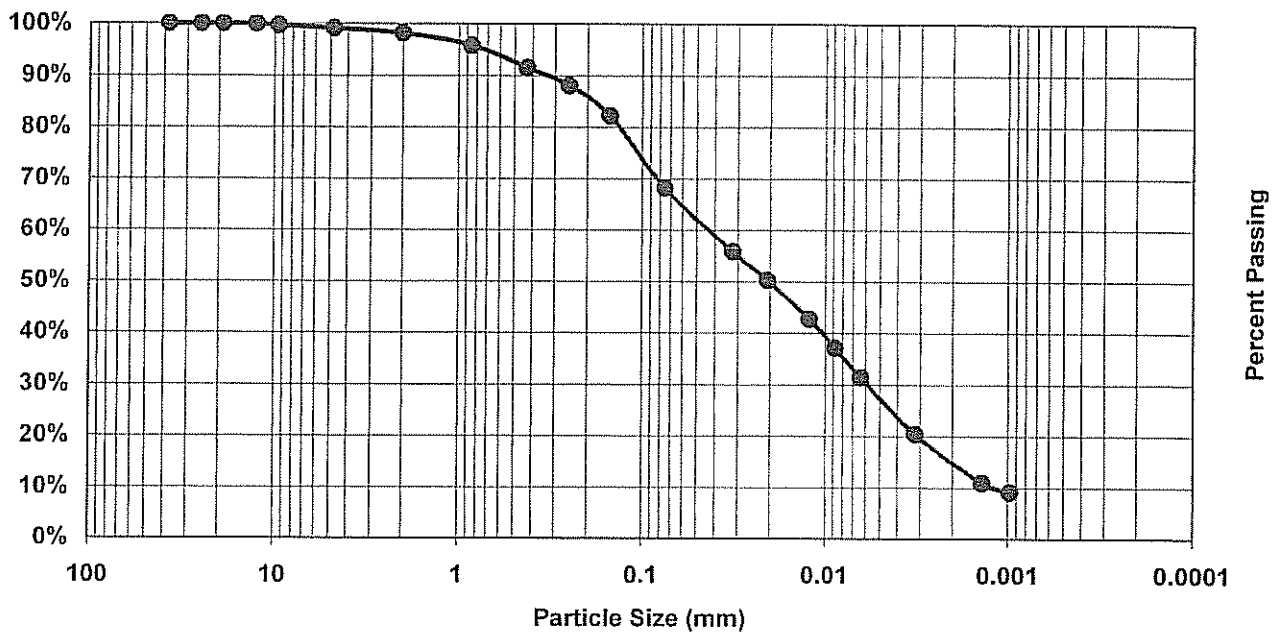
**Based on Table of Selected Values of Porosity, Specific Yield and Specific Retention, USGS Water Supply Paper 2220.

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-1	M-1 (10-15)	10 to 15 ft bls

Sample Description:
Brown fine sandy clayey SILT (ML)



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 1.8%	% Sand 32.9%	% Silt 40.7%	% Clay 24.6%
Adjusted for Calculations	**0%**	**33%**	**41%**	**25%**

Notes:
Grain size distribution taken from grain size with hydrometer data located in Appendix II.
Gravel, sand, silt and clay sizes based on Wentworth Scale.

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FETTER AND BEAR DIAGRAMS

S&ME PROJECT: MSS Landfill Siting Survey
S&ME PROJECT NO.: 1411-07-103

Boring No. M-1

Sample Depth: 10 to 15 ft bls

% Sand: 33%

% Silt: 41%

% Clay: 25%

Estimated Specific Yield: 5%

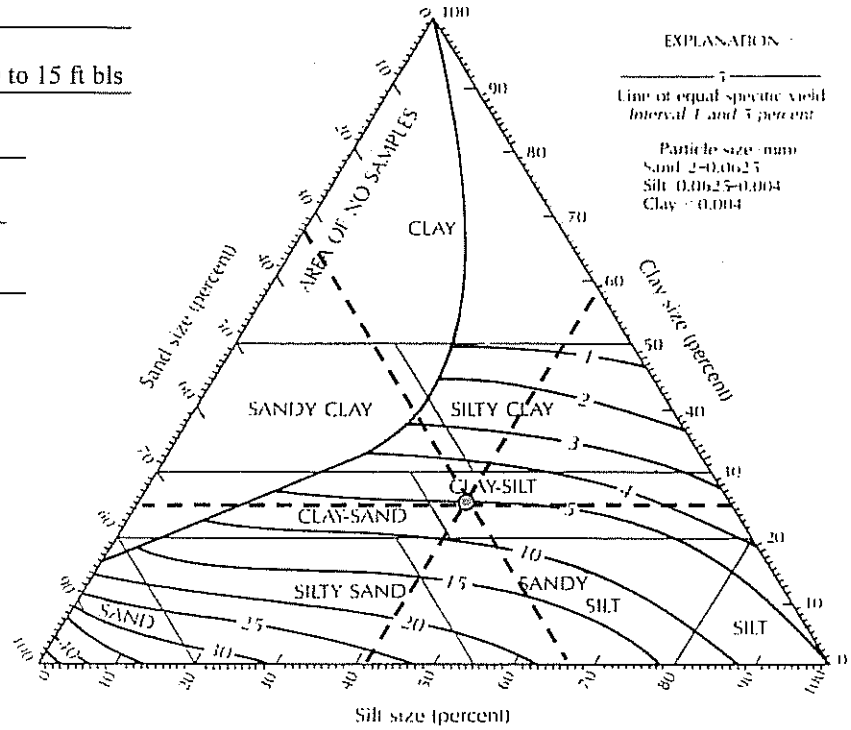
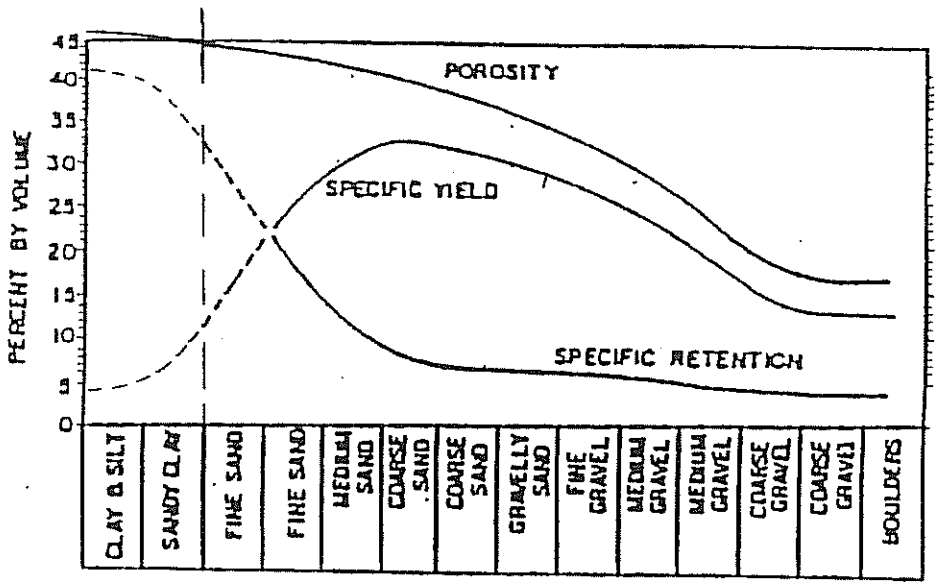


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



Estimated Porosity: 46%**

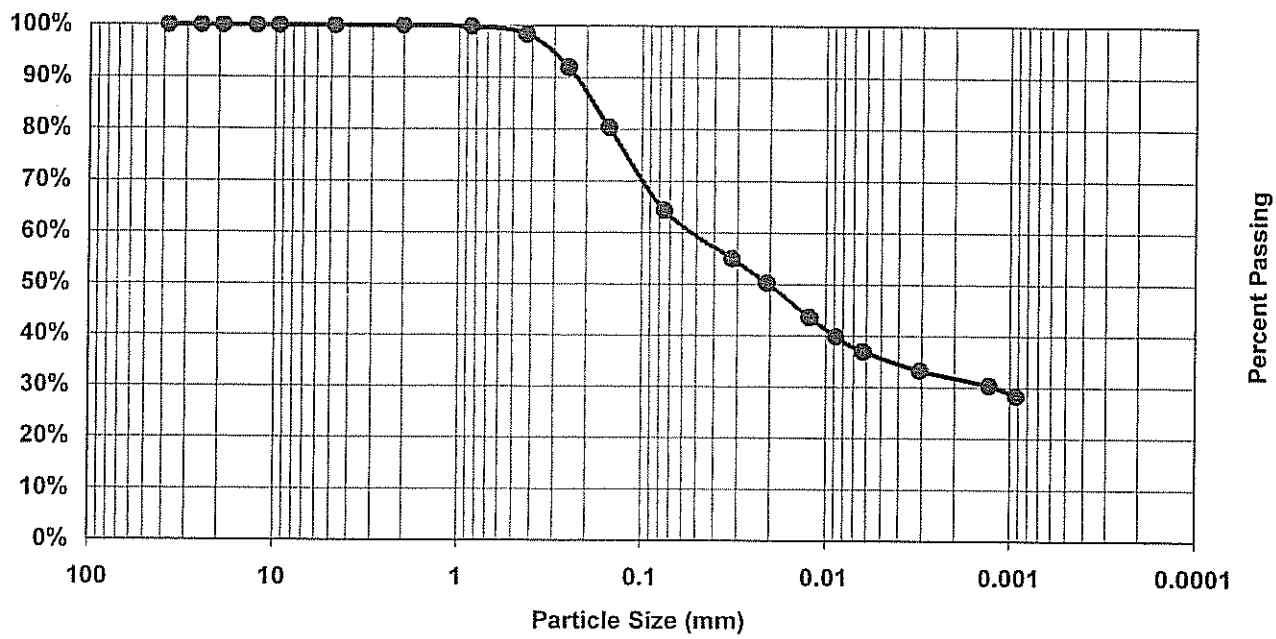
**Based on Table of Selected Values of Porosity, Specific Yield and Specific Retention, USGS Water Supply Paper 2220.

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-2	M-2 (0-5)	0 to 5 ft bls

Sample Description:
Red brown micaceous fine sandy clayey SILT (ML)



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 0.0%	% Sand 37.9%	% Silt 27.4%	% Clay 34.7%
Adjusted for Calculations	**0%**	**38%**	**27%**	**35%**

Notes:
Grain size distribution taken from grain size with hydrometer data located in Appendix II.
Gravel, sand, silt and clay sizes based on Wentworth Scale.

S&ME Project:
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S&ME Project No.:
1411-07-103

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FETTER AND BEAR DIAGRAMS

S&ME PROJECT: MSS Landfill Siting Survey
S&ME PROJECT NO.: 1411-07-103

Boring No. M-2

Sample Depth: 0 to 5 ft bls

% Sand: 38%

% Silt: 27%

% Clay: 35%

Estimated Specific Yield: 3.5%

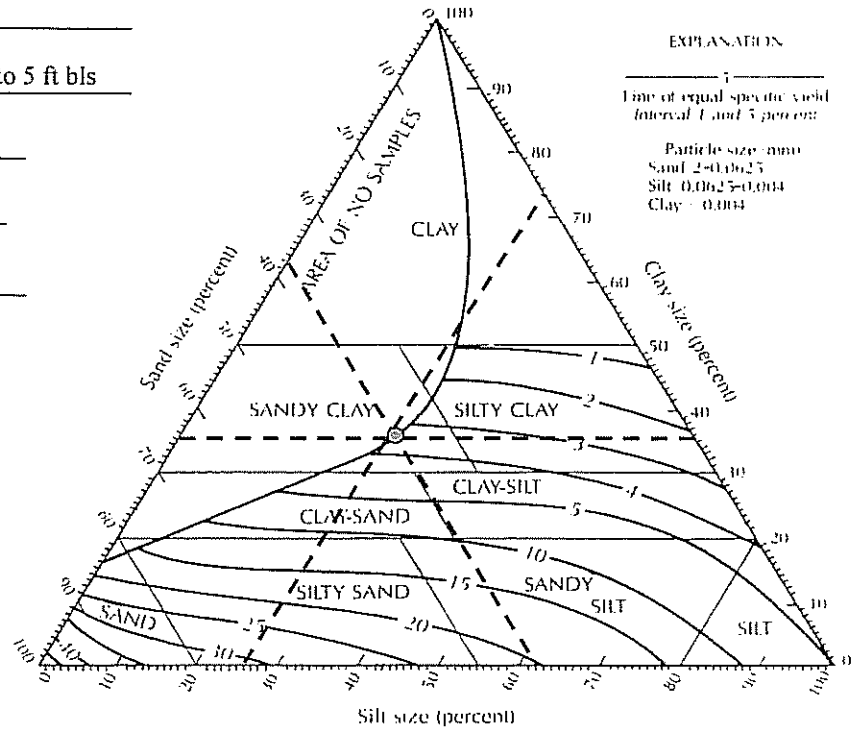
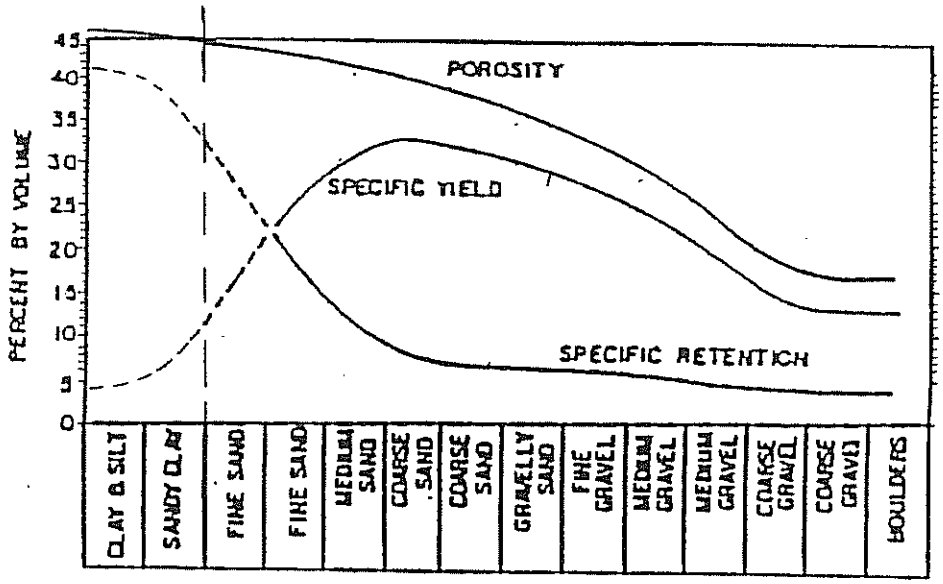


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



Estimated Porosity: 48%**

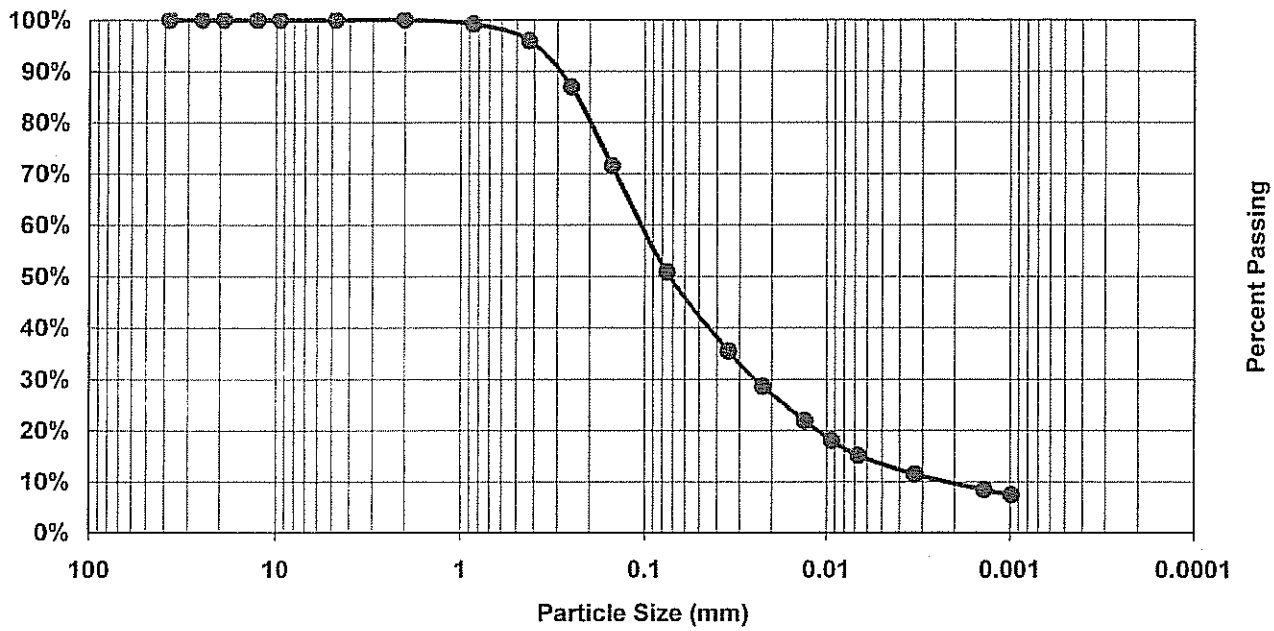
**Based on Table of Selected Values of Porosity, Specific Yield and Specific Retention, USGS Water Supply Paper 2220.

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-2	M-2 (5-10)	5 to 10 ft bls

Sample Description:
Light brown micaceous fine sandy SILT (ML)



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 0.0%	% Sand 53.0%	% Silt 34.5%	% Clay 12.5%
Adjusted for Calculations	**0%**	**53%**	**34%**	**13%**

Notes:
Grain size distribution taken from grain size with hydrometer data located in Appendix II.
Gravel, sand, silt and clay sizes based on Wentworth Scale.

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FETTER AND BEAR DIAGRAMS

S&ME PROJECT: MSS Landfill Siting Survey
S&ME PROJECT NO.: 1411-07-103

Boring No. M-2

Sample Depth: 5 to 10 ft bls

% Sand: 53%

% Silt: 34%

% Clay: 13%

Estimated Specific Yield: 17%

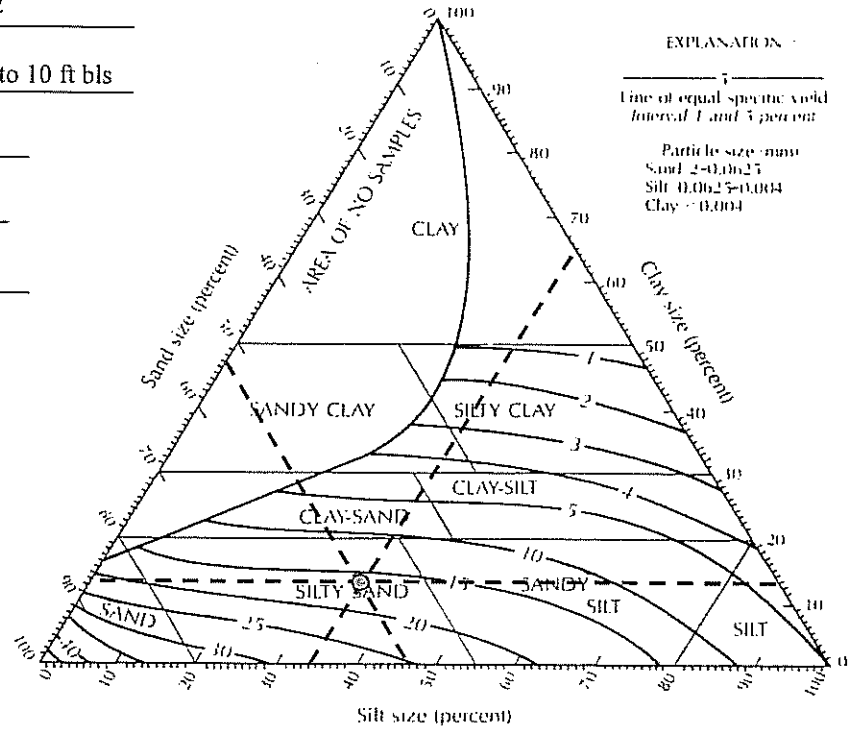
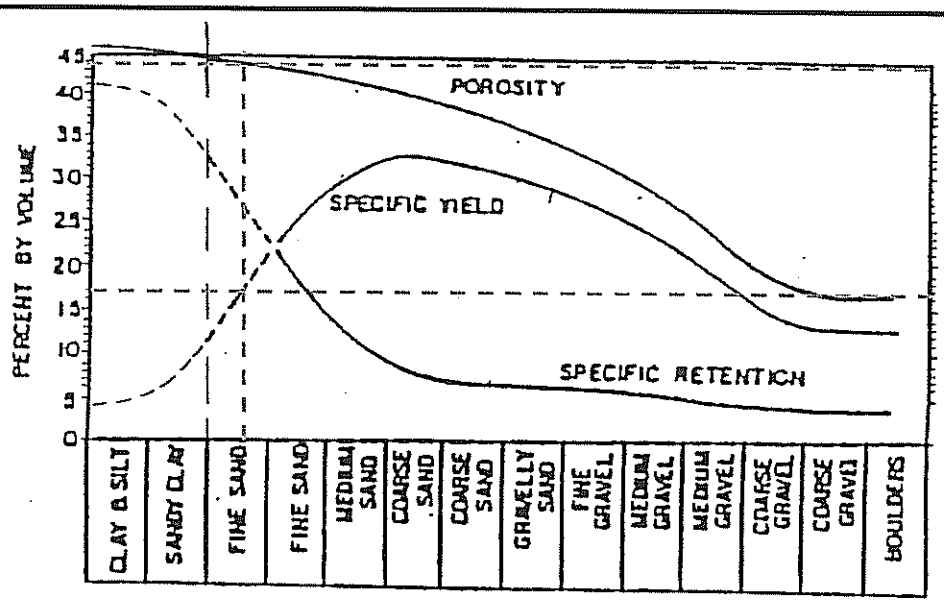


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



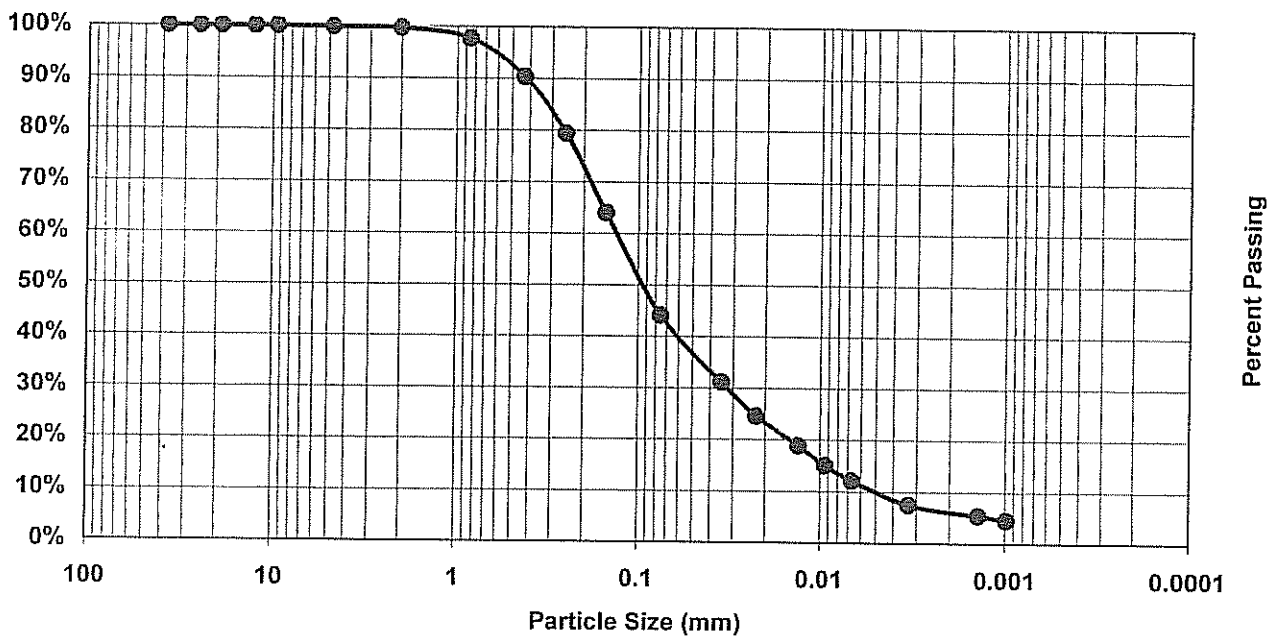
Estimated Porosity: 44%

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-2	M-2 (10-15)	10 to 15 ft bls

Sample Description:
Tan micaceous silty fine SAND (SM)



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 0.3%	% Sand 58.8%	% Silt 32.8%	% Clay 8.1%
Adjusted for Calculations	**0%**	**59%**	**33%**	**8%**

Notes:
Grain size distribution taken from grain size with hydrometer data located in Appendix II.
Gravel, sand, silt and clay sizes based on Wentworth Scale.

S&ME Project:
MSS Landfill Siting Survey

S&ME Project No.:
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FETTER AND BEAR DIAGRAMS

S&ME PROJECT: MSS Landfill Siting Survey
S&ME PROJECT NO.: 1411-07-103

Boring No. M-2

Sample Depth: 10 to 15 ft bls

% Sand: 59%

% Silt: 33%

% Clay: 8%

Estimated Specific Yield: 21%

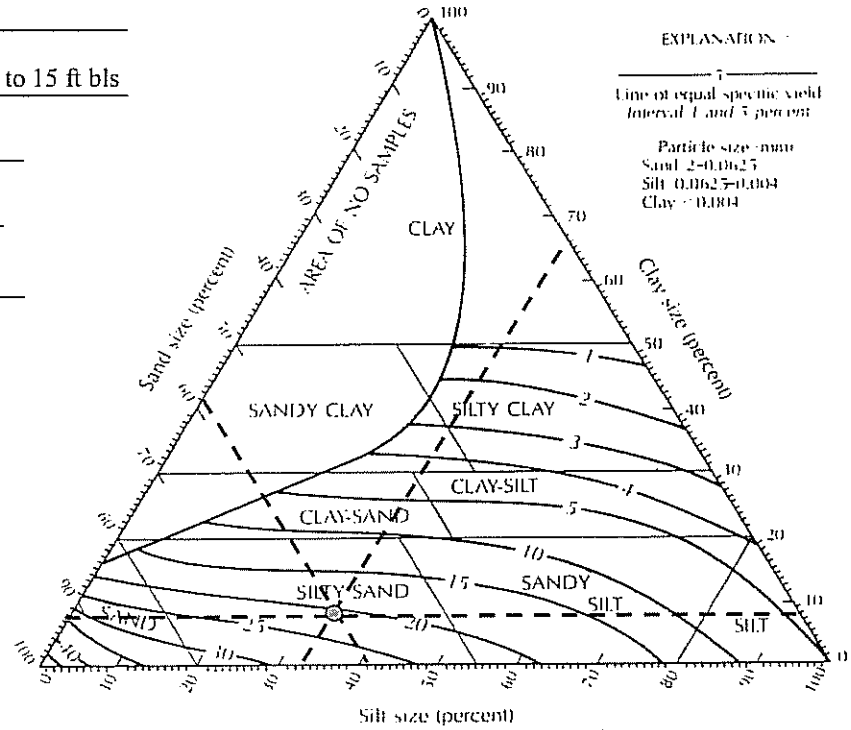
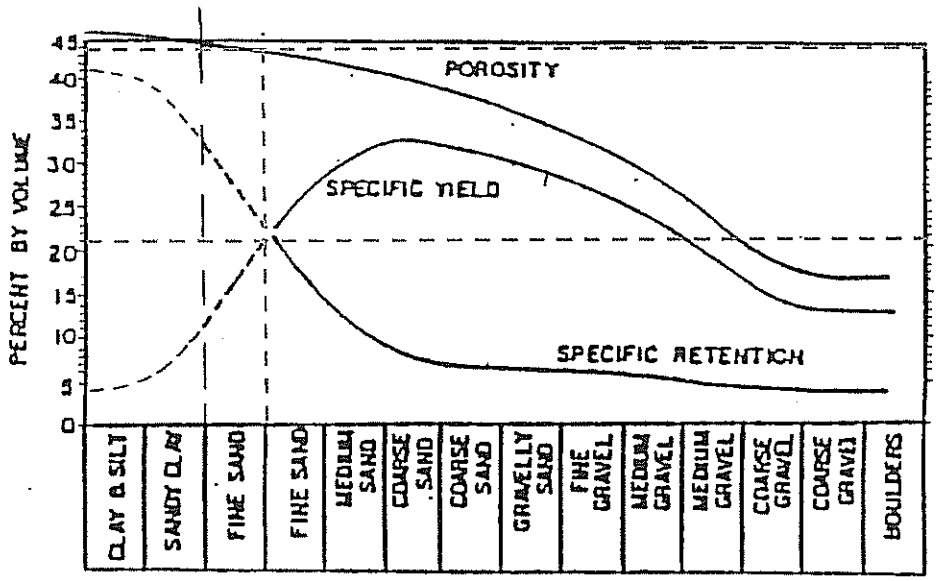


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



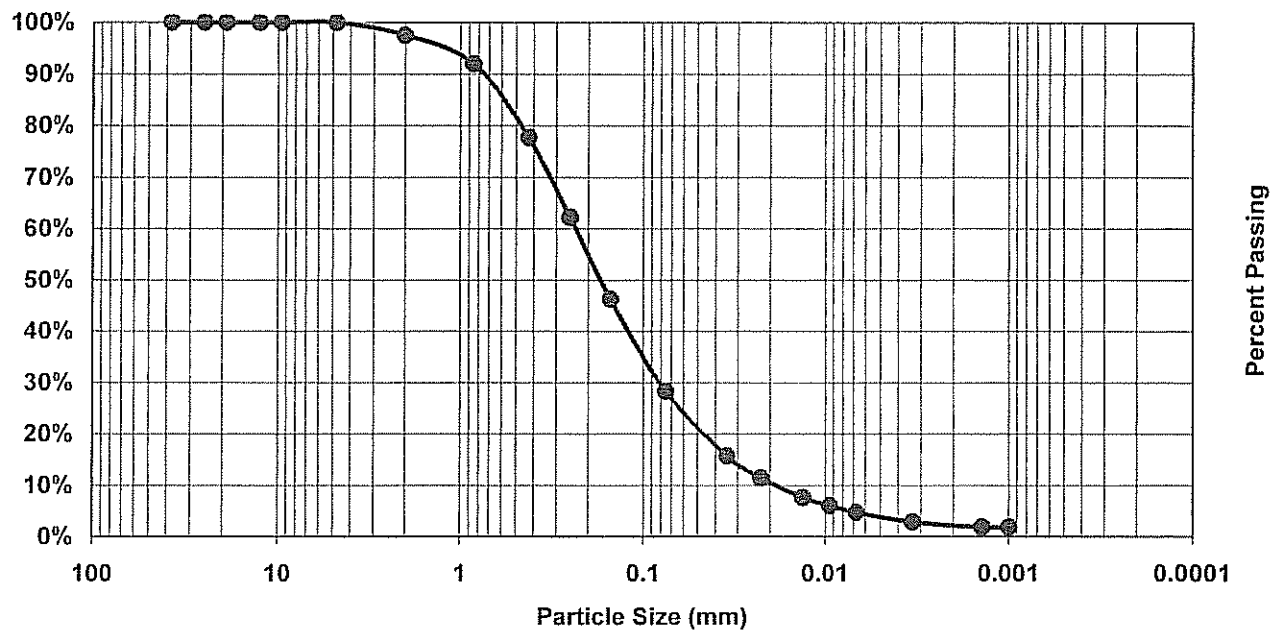
Estimated Porosity: 44%

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-2	M-2 (44.1'-45.6')	44.1 to 45.6 ft bls

Sample Description:
Gray tan white micaceous silty medium to fine SAND



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 2.5%	% Sand 72.3%	% Silt 22.0%	% Clay 3.2%
Adjusted for Calculations	**0%**	**74%**	**23%**	**3%**

Notes:
Grain size distribution taken from grain size with hydrometer data located in Appendix II.
Gravel, sand, silt and clay sizes based on Wentworth Scale.

S&ME Project:
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FETTER AND BEAR DIAGRAMS

S&ME PROJECT: MSS Landfill Siting Survey
S&ME PROJECT NO.: 1411-07-103

Boring No. M-2

Sample Depth: 44.1 to 45.6 ft bls

% Sand: 74%

% Silt: 23%

% Clay: 3%

Estimated Specific Yield: 29%

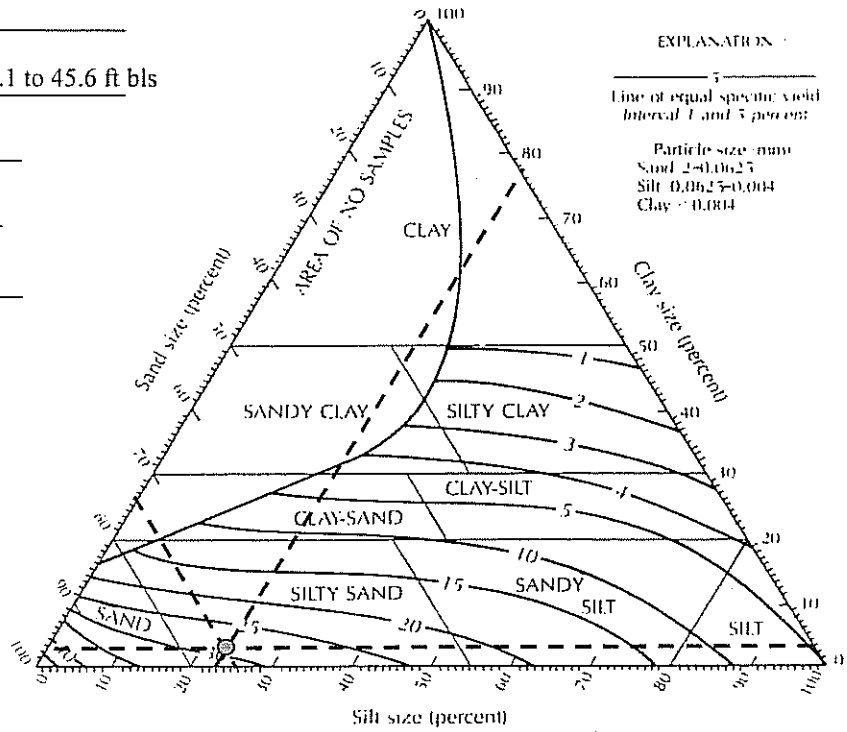
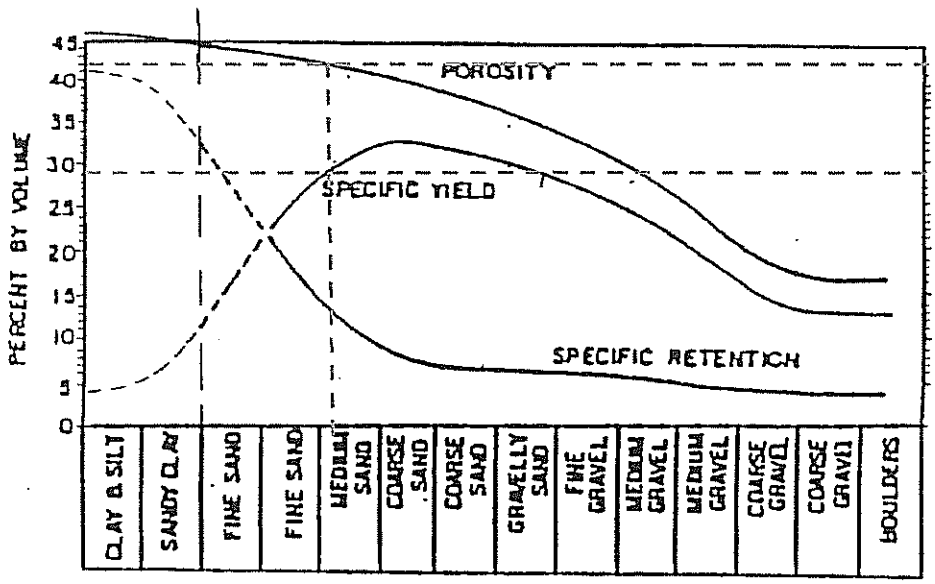


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



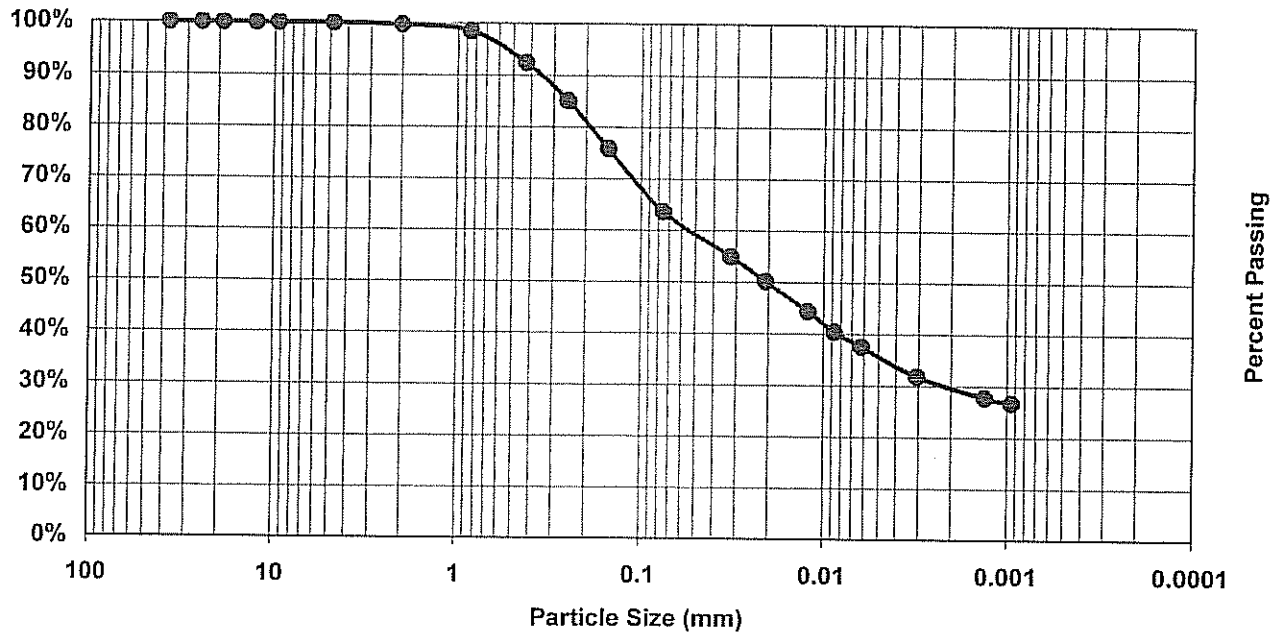
Estimated Porosity: 42%

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-3	M-3 (0-5)	0 to 5 ft bls

Sample Description:
Red brown fine sandy clayey SILT (ML)



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 0.3%	% Sand 38.1%	% Silt 27.6%	% Clay 34.0%
Adjusted for Calculations	**0%**	**38%**	**28%**	**34%**

Notes:
Grain size distribution taken from grain size with hydrometer data located in Appendix II.
Gravel, sand, silt and clay sizes based on Wentworth Scale.

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FETTER AND BEAR DIAGRAMS

S&ME PROJECT: MSS Landfill Siting Survey
S&ME PROJECT NO.: 1411-07-103

Boring No. M-3

Sample Depth: 0 to 5 ft bls

% Sand: 38%

% Silt: 28%

% Clay: 34%

Estimated Specific Yield: 3.75%

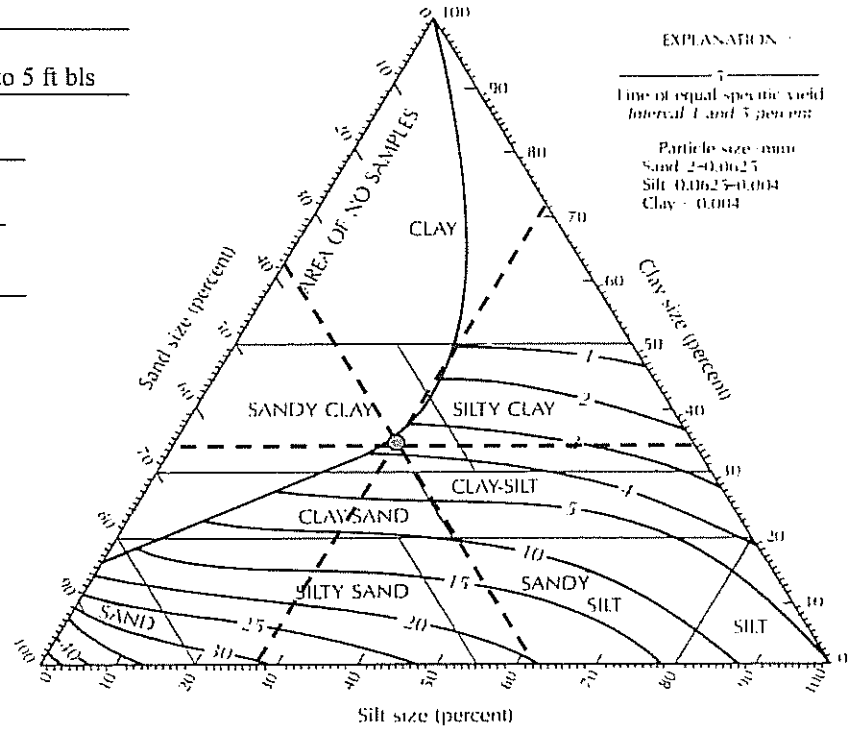
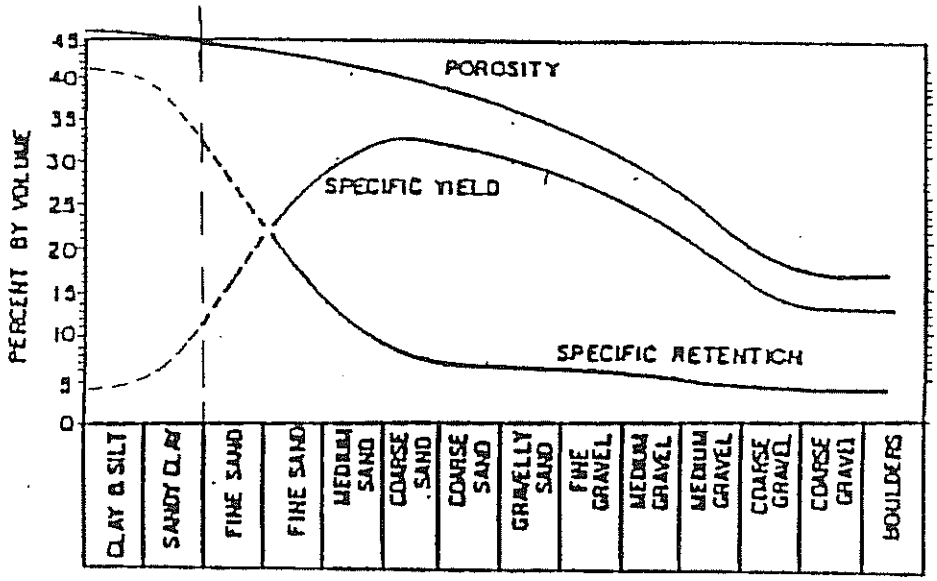


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



Estimated Porosity: 47%**

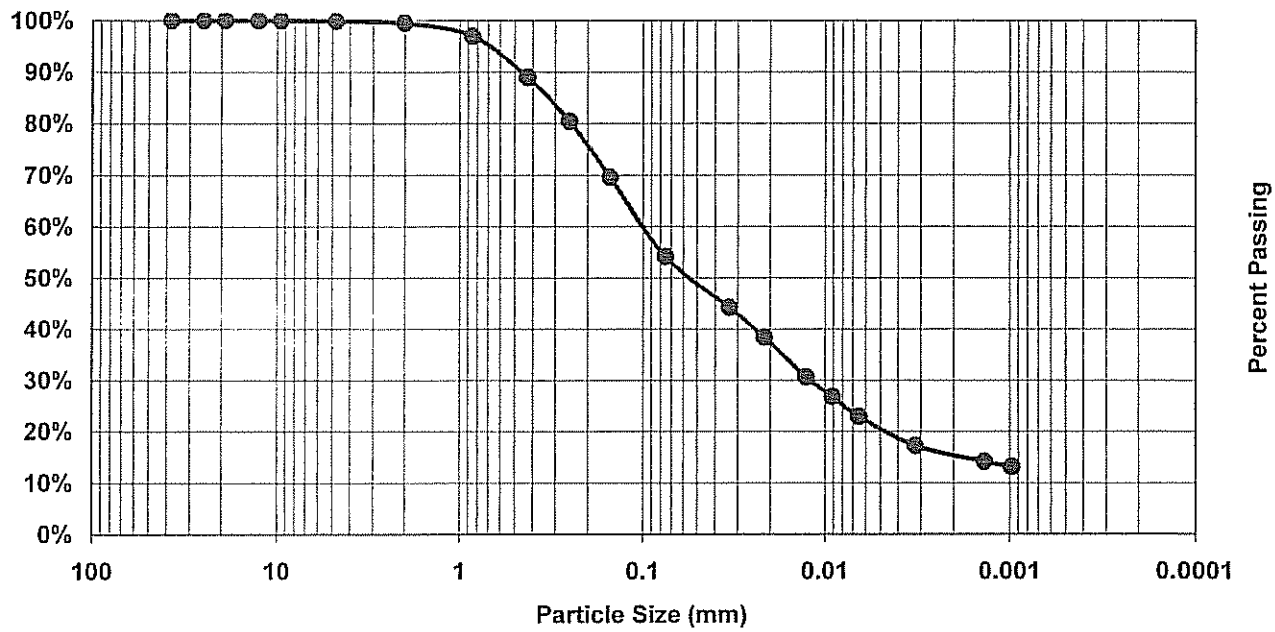
**Based on Table of Selected Values of Porosity, Specific Yield and Specific Retention, USGS Water Supply Paper 2220.

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-3	M-3 (5-10)	5 to 10 ft bls

Sample Description:
Brown red micaceous medium to fine sandy clayey SILT (ML)



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 0.5%	% Sand 47.8%	% Silt 33.2%	% Clay 18.5%
Adjusted for Calculations	**0%**	**48%**	**33%**	**19%**

Notes:
Grain size distribution taken from grain size with hydrometer data located in Appendix II.
Gravel, sand, silt and clay sizes based on Wentworth Scale.

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FETTER AND BEAR DIAGRAMS

S&ME PROJECT: MSS Landfill Siting Survey
S&ME PROJECT NO.: 1411-07-103

Boring No. M-3

Sample Depth: 5 to 10 ft bls

% Sand: 48%

% Silt: 33%

% Clay: 19%

Estimated Specific Yield: 12%

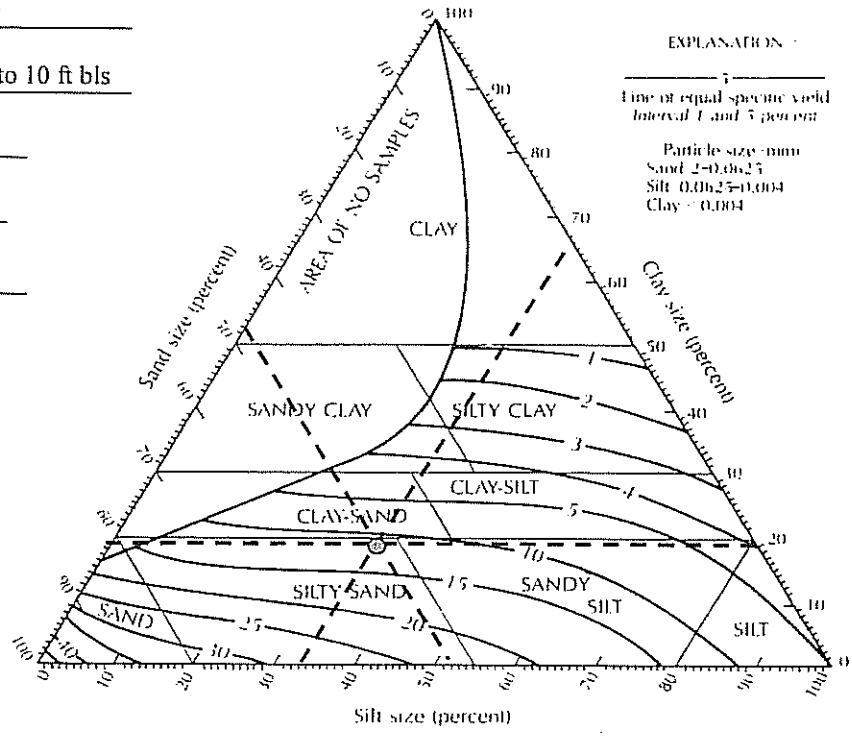
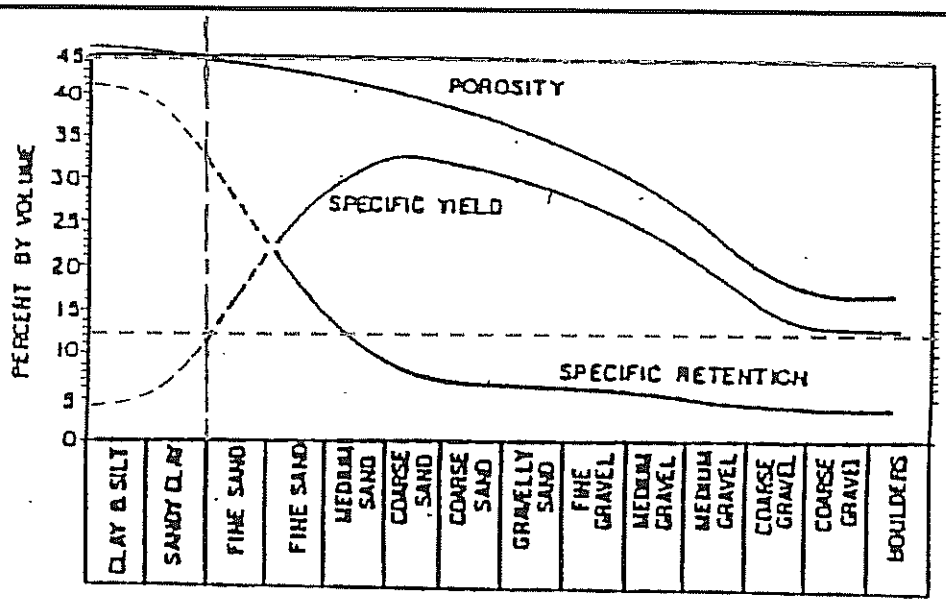


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



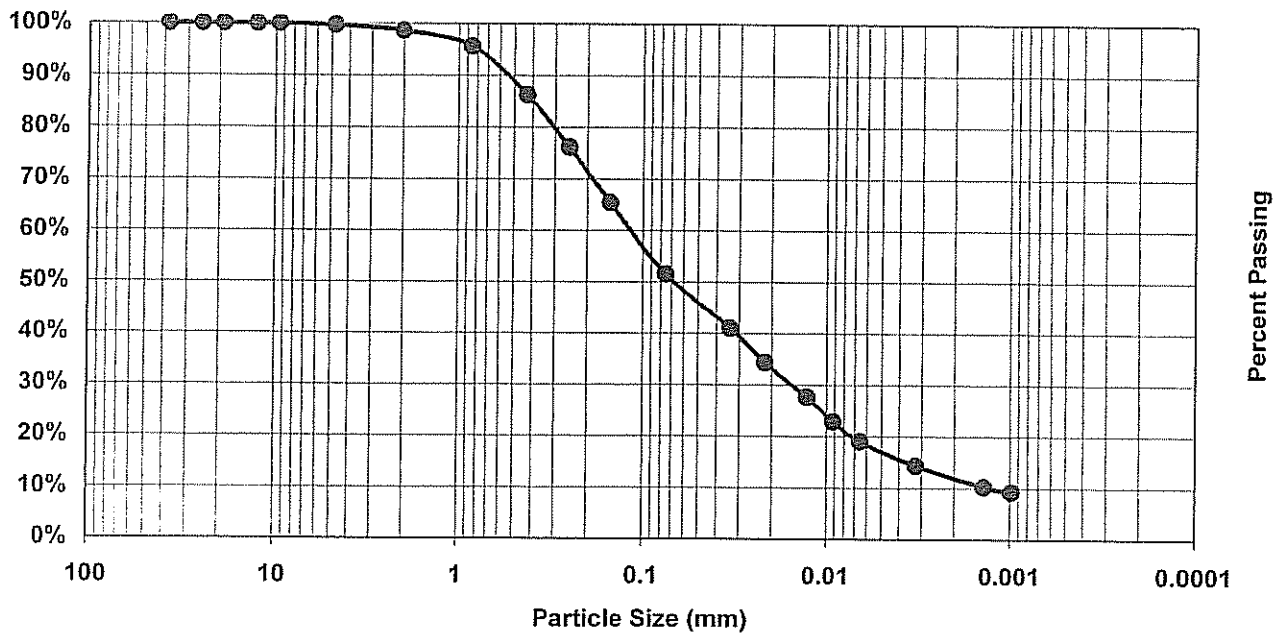
Estimated Porosity: 45%

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-3	M-3 (10-15)	10 to 15 ft bls

Sample Description:
Brown tan micaceous medium to fine sandy clayey SILT (ML)



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 1.4%	% Sand 49.6%	% Silt 33.0%	% Clay 16.0%
Adjusted for Calculations	**0%**	**50%**	**33%**	**16%**

Notes:
Grain size distribution taken from grain size with hydrometer data located in Appendix II.
Gravel, sand, silt and clay sizes based on Wentworth Scale.

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FETTER AND BEAR DIAGRAMS

S&ME PROJECT: MSS Landfill Siting Survey
S&ME PROJECT NO.: 1411-07-103

Boring No. M-3

Sample Depth: 10 to 15 ft bls

% Sand: 50%

% Silt: 33%

% Clay: 16%

Estimated Specific Yield: 14%

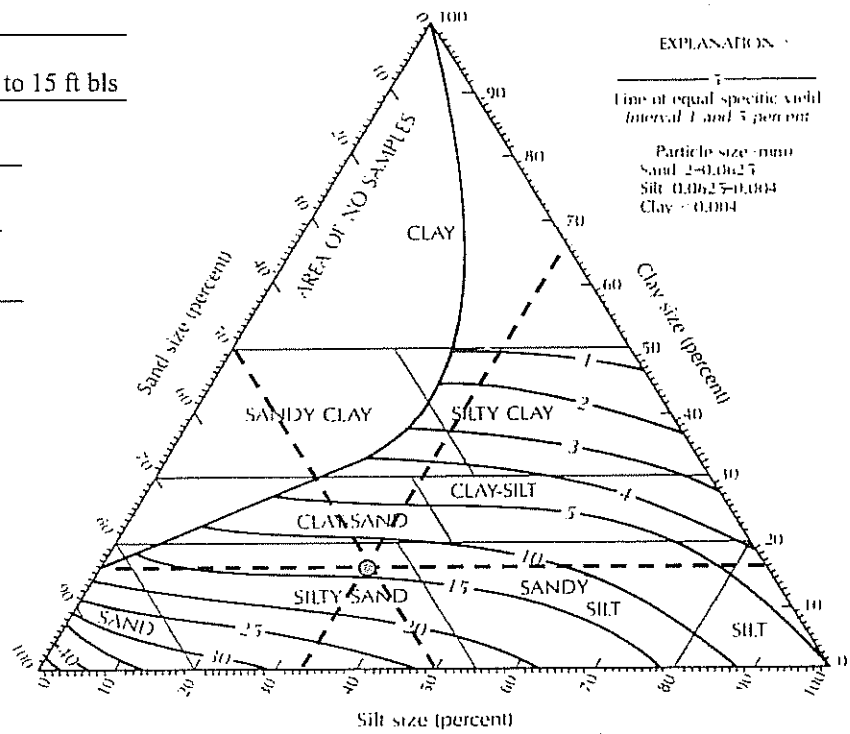
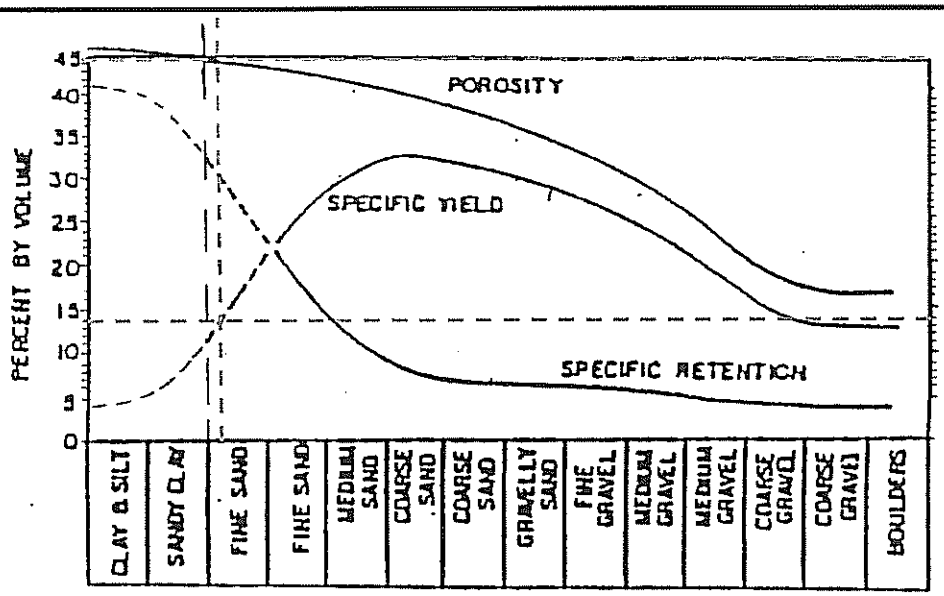


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



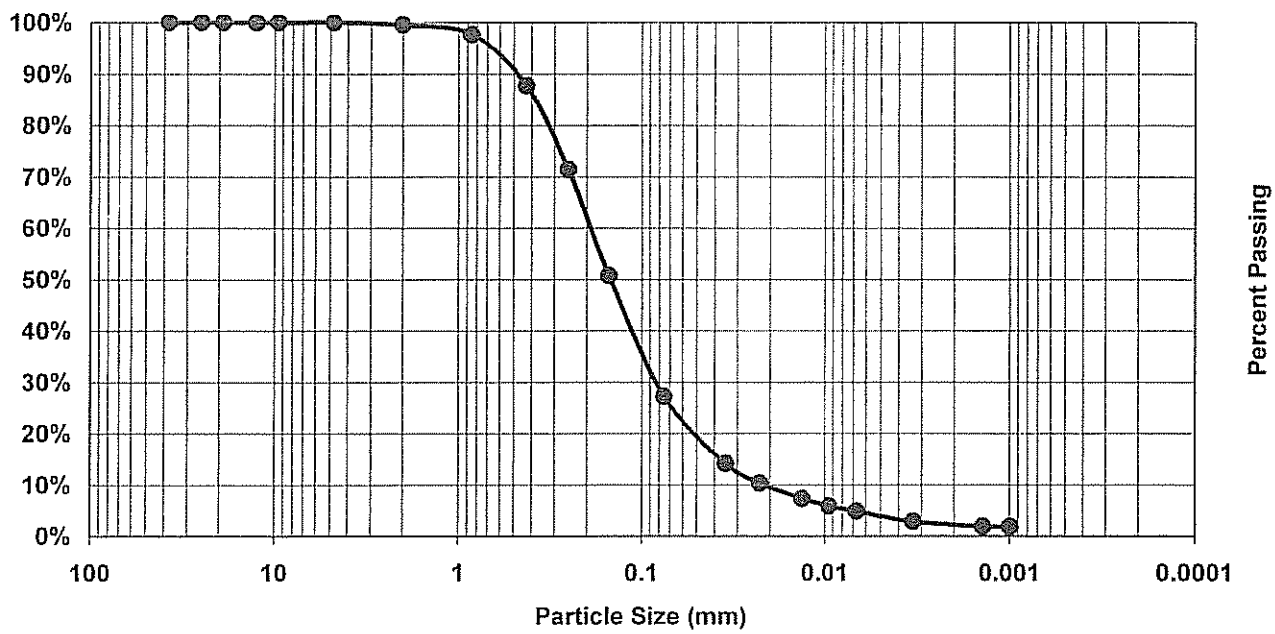
Estimated Porosity: 45%

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-3	M-3 (42.8'-43.5')	42.8 to 43.5 ft bls

Sample Description:
Gray brown white micaceous silty medium to fine SAND



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 0.5%	% Sand 75.5%	% Silt 20.8%	% Clay 3.1%
Adjusted for Calculations	**0%**	**76%**	**21%**	**3%**

Notes:
Grain size distribution taken from grain size with hydrometer data located in Appendix II.
Gravel, sand, silt and clay sizes based on Wentworth Scale.

S&ME Project:
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FETTER AND BEAR DIAGRAMS

S&ME PROJECT: MSS Landfill Siting Survey
S&ME PROJECT NO.: 1411-07-103

Boring No. M-3

Sample Depth: 42.8 to 43.5 ft bls

% Sand: 76%

% Silt: 21%

% Clay: 3%

Estimated Specific Yield: 29%

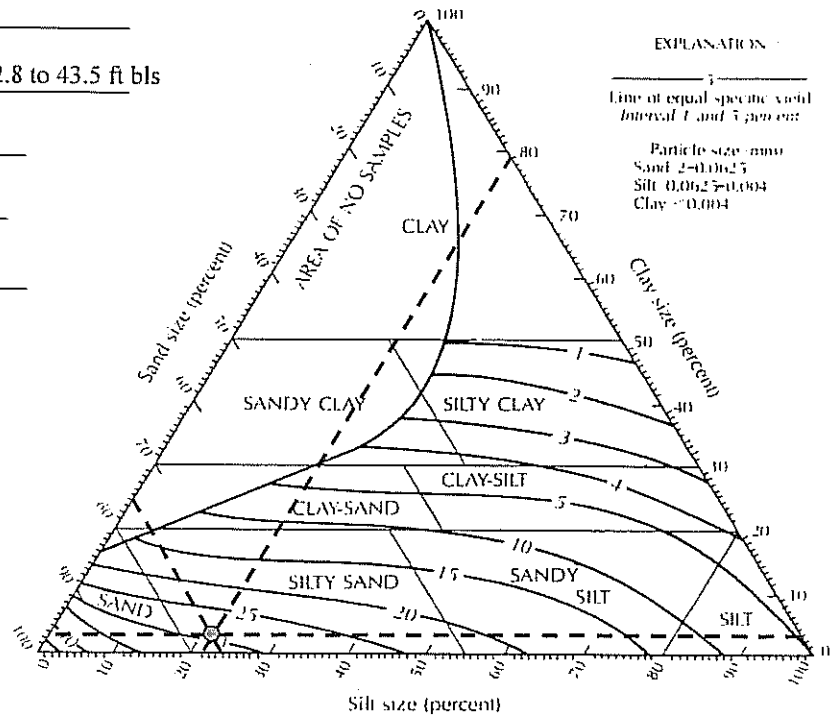
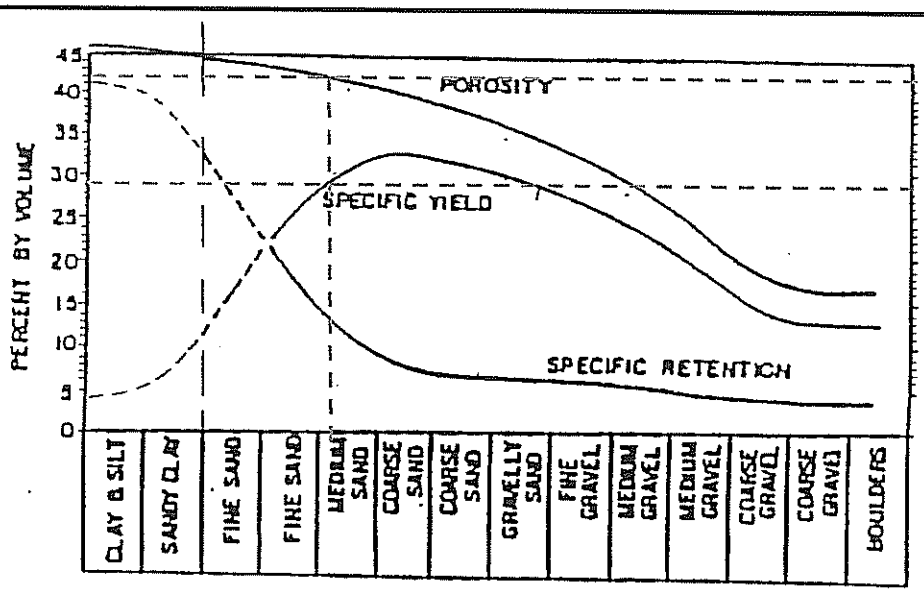


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



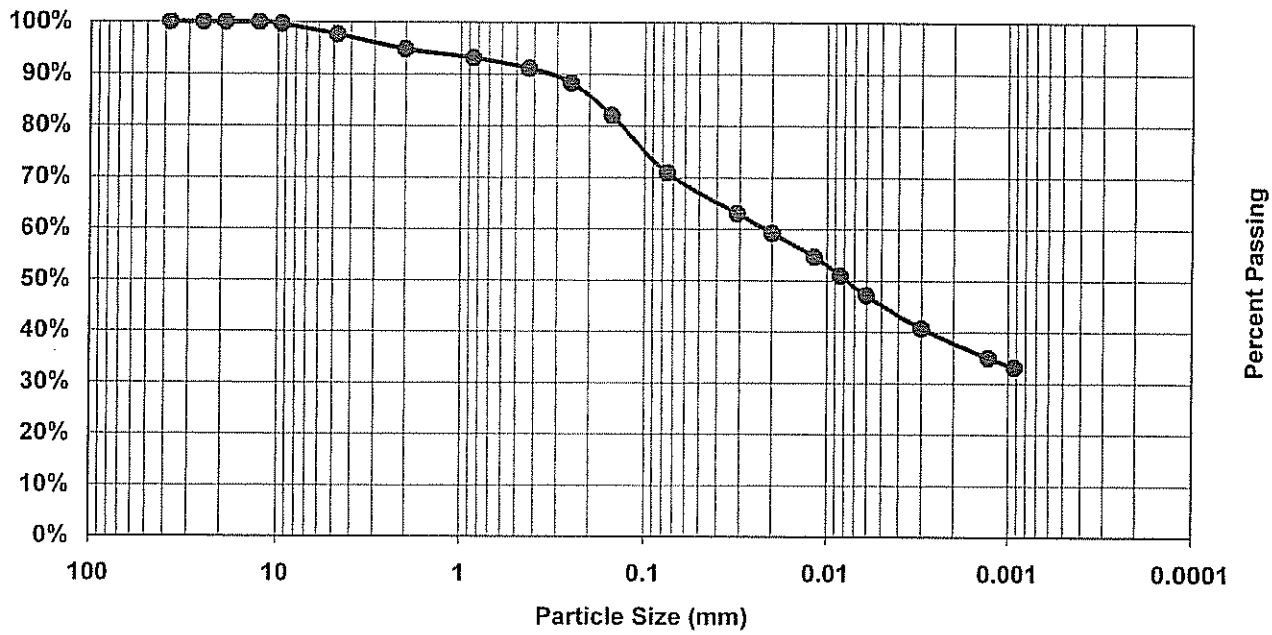
Estimated Porosity: 42%

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-4	M-4 (0-5)	0 to 5 ft bls

Sample Description:
Red brown silty CLAY with fine sand (CH)



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 5.2%	% Sand 25.7%	% Silt 25.0%	% Clay 44.1%
Adjusted for Calculations	**0%**	**27%**	**26%**	**47%**

Notes:
Grain size distribution taken from grain size with hydrometer data located in Appendix II.
Gravel, sand, silt and clay sizes based on Wentworth Scale.

S&ME Project:
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FETTER AND BEAR DIAGRAMS

S&ME PROJECT: MSS Landfill Siting Survey
S&ME PROJECT NO.: 1411-07-103

Boring No. M-4

Sample Depth: 0 to 5 ft bls

% Sand: 27%

% Silt: 26%

% Clay: 47%

Estimated Specific Yield: 1.5%

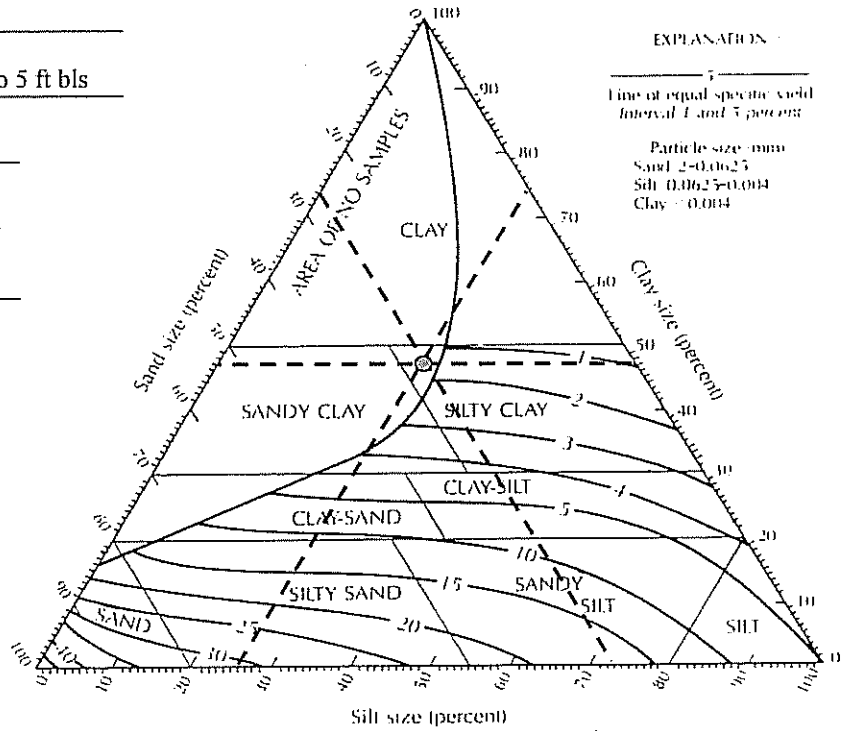
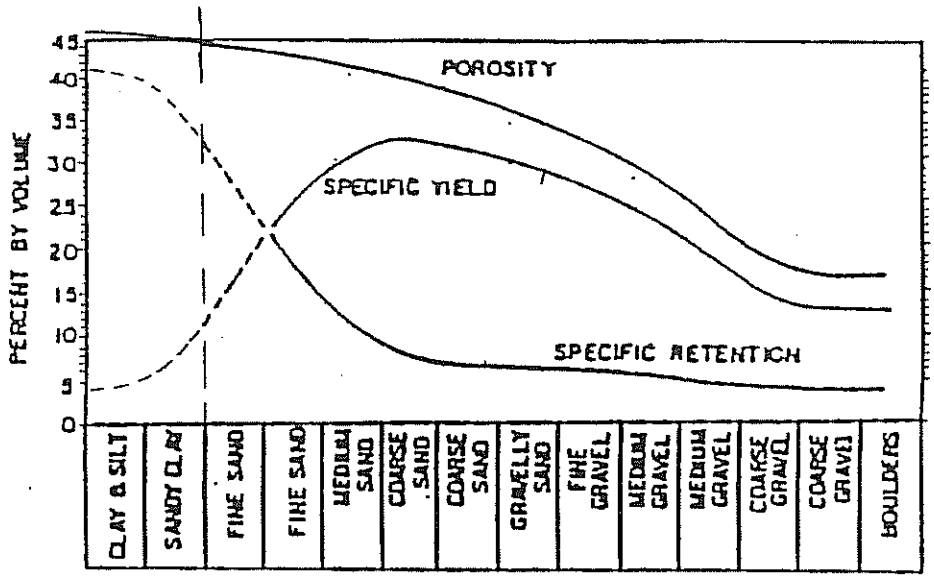


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



Estimated Porosity: 49%**

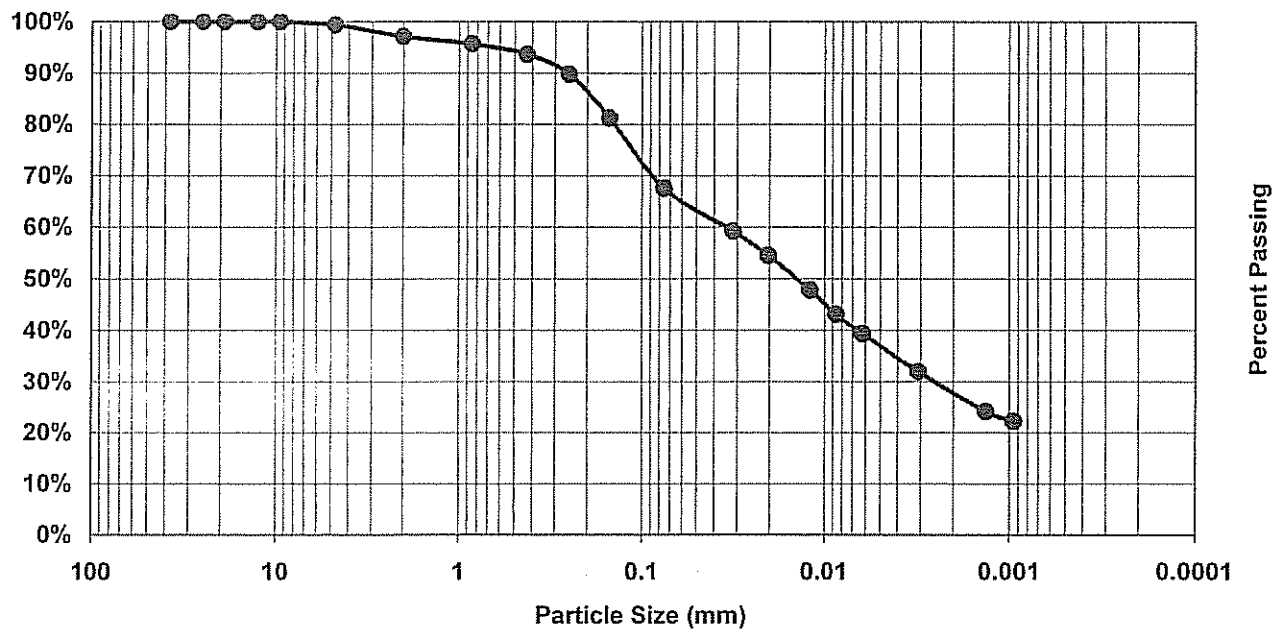
**Based on Table of Selected Values of Porosity, Specific Yield and Specific Retention, USGS Water Supply Paper 2220.

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-4	M-4 (5-10)	5 to 10 ft bls

Sample Description:
Red orange brown fine sandy clayey SILT (ML)



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 2.9%	% Sand 31.5%	% Silt 29.6%	% Clay 36.0%
Adjusted for Calculations	**0%**	**32%**	**30%**	**37%**

Notes:
Grain size distribution taken from grain size with hydrometer data located in Appendix II.
Gravel, sand, silt and clay sizes based on Wentworth Scale.

S&ME Project:
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S&ME Project No.:
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FETTER AND BEAR DIAGRAMS

S&ME PROJECT: MSS Landfill Siting Survey
S&ME PROJECT NO.: 1411-07-103

Boring No. M-4

Sample Depth: 5 to 10 ft bls

% Sand: 32%

% Silt: 30%

% Clay: 37%

Estimated Specific Yield: 3%

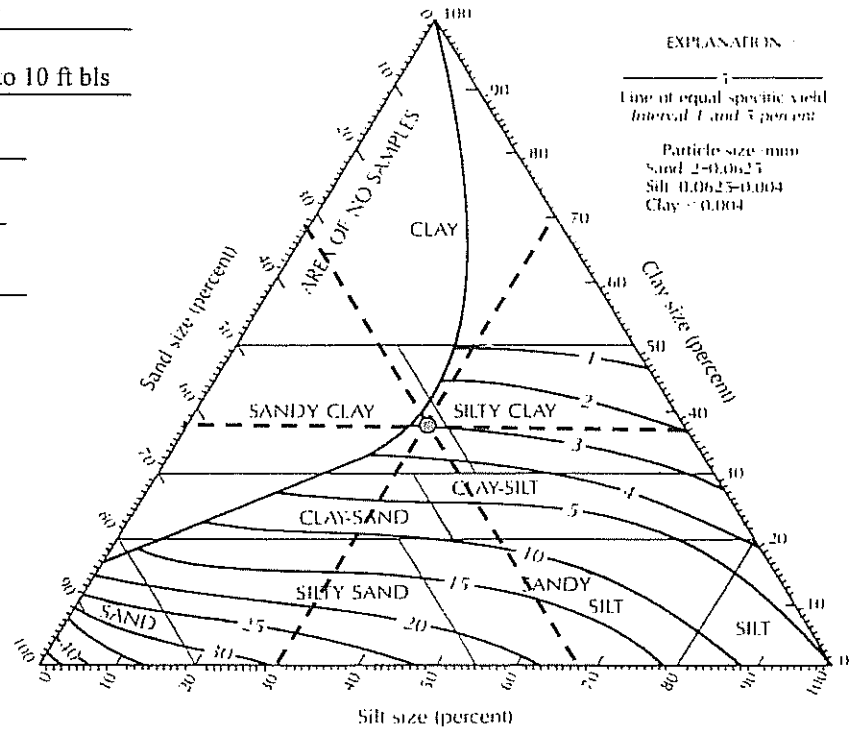
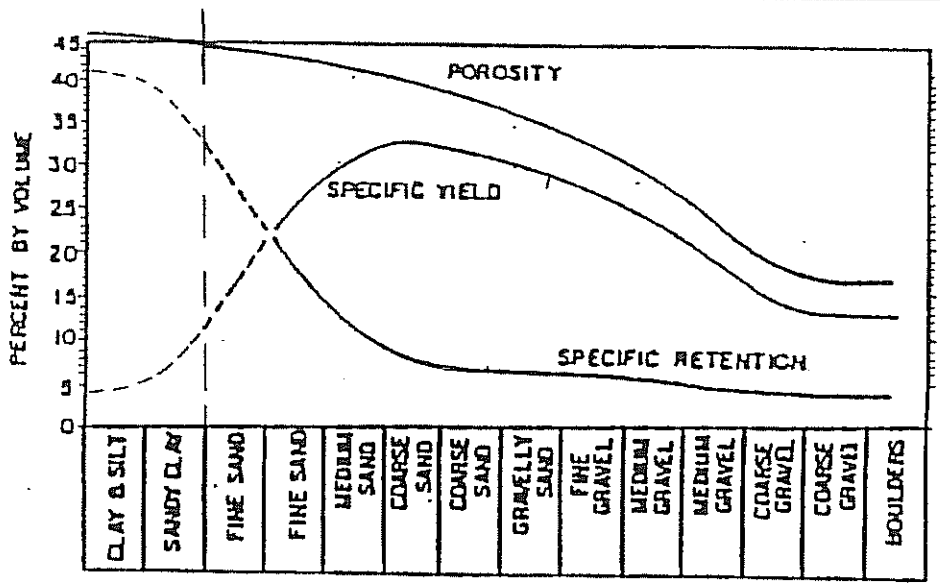


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



Estimated Porosity: 48%**

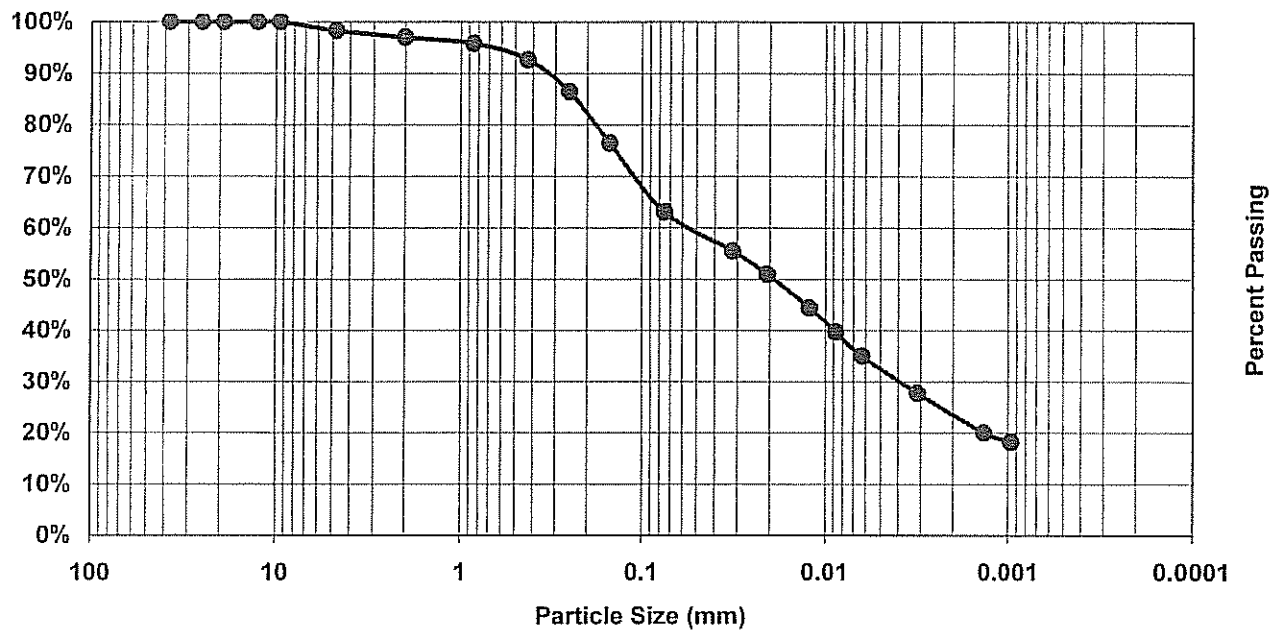
**Based on Table of Selected Values of Porosity, Specific Yield and Specific Retention, USGS Water Supply Paper 2220.

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-4	M-4 (10-15)	10 to 15 ft bls

Sample Description:
Red orange brown fine sandy clayey SILT (ML)



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 3.0%	% Sand 35.7%	% Silt 29.8%	% Clay 31.5%
Adjusted for Calculations	**0%**	**37%**	**31%**	**33%**

Notes:
Grain size distribution taken from grain size with hydrometer data located in Appendix II.
Gravel, sand, silt and clay sizes based on Wentworth Scale.

S&ME Project:
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S&ME Project No.:
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FETTER AND BEAR DIAGRAMS

S&ME PROJECT: MSS Landfill Siting Survey
S&ME PROJECT NO.: 1411-07-103

Boring No. M-4

Sample Depth: 10 to 15 ft bls

% Sand: 37%

% Silt: 31%

% Clay: 33%

Estimated Specific Yield: 4%

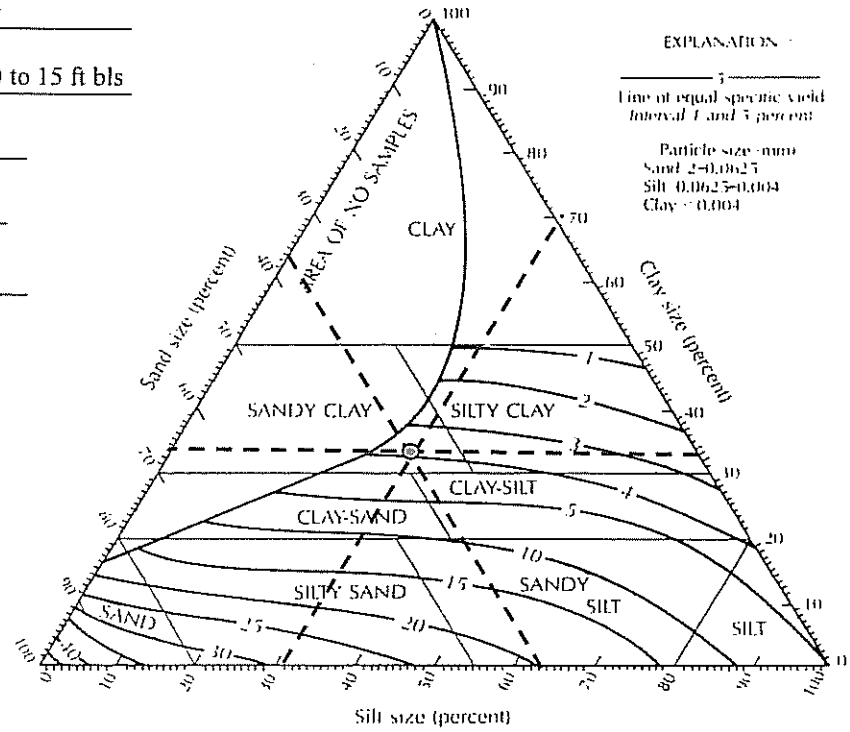
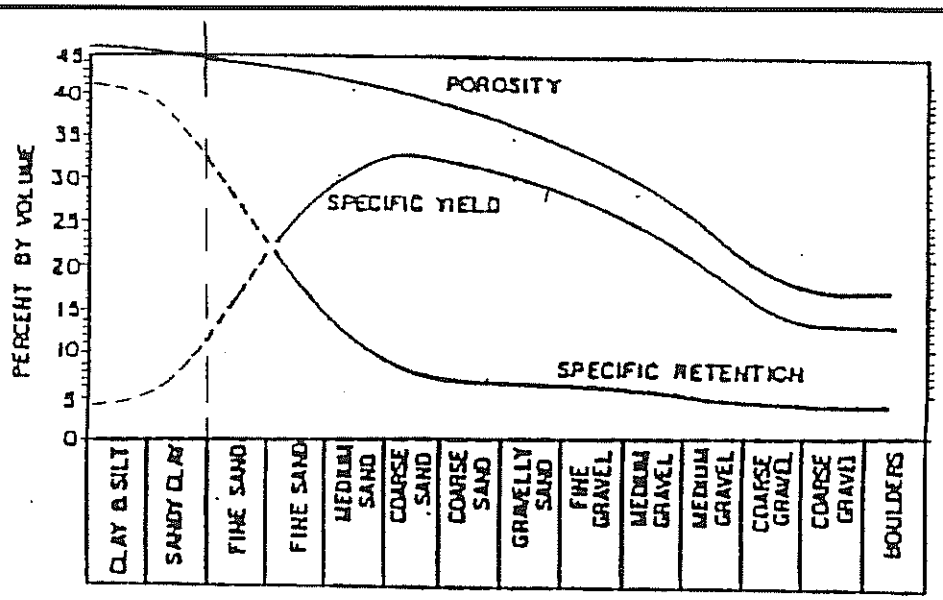


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



Estimated Porosity: 47%**

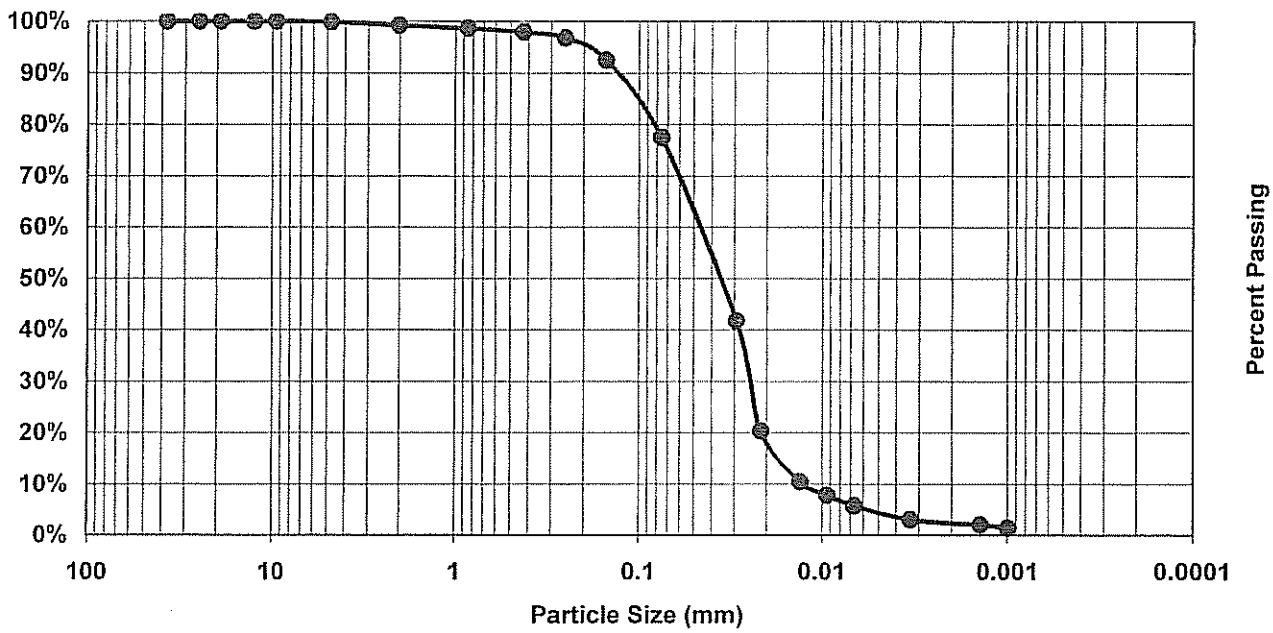
**Based on Table of Selected Values of Porosity, Specific Yield and Specific Retention, USGS Water Supply Paper 2220.

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-5	M-5 (8.6'-10.1')	8.6 to 10.1 ft bls

Sample Description:
Dark gray SILT with fine sand (ASH)



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 0.8%	% Sand 29.6%	% Silt 66.3%	% Clay 3.3%
Adjusted for Calculations	**0%**	**30%**	**67%**	**3%**

Notes:
Grain size distribution taken from grain size with hydrometer data located in Appendix II.
Gravel, sand, silt and clay sizes based on Wentworth Scale.

S&ME Project:
MSS Landfill Siting Survey

S&ME Project No.:
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FETTER AND BEAR DIAGRAMS

S&ME PROJECT: MSS Landfill Siting Survey
S&ME PROJECT NO.: 1411-07-103

Boring No. M-5

Sample Depth: 8.6 to 10.1 ft bls

% Sand: 30%

% Silt: 67%

% Clay: 3%

Estimated Specific Yield: 18%

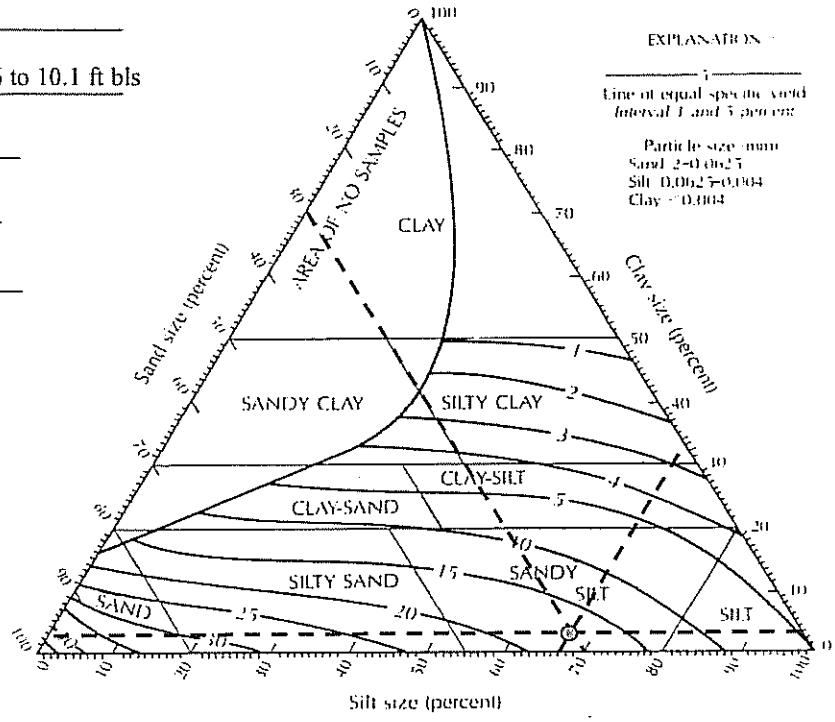
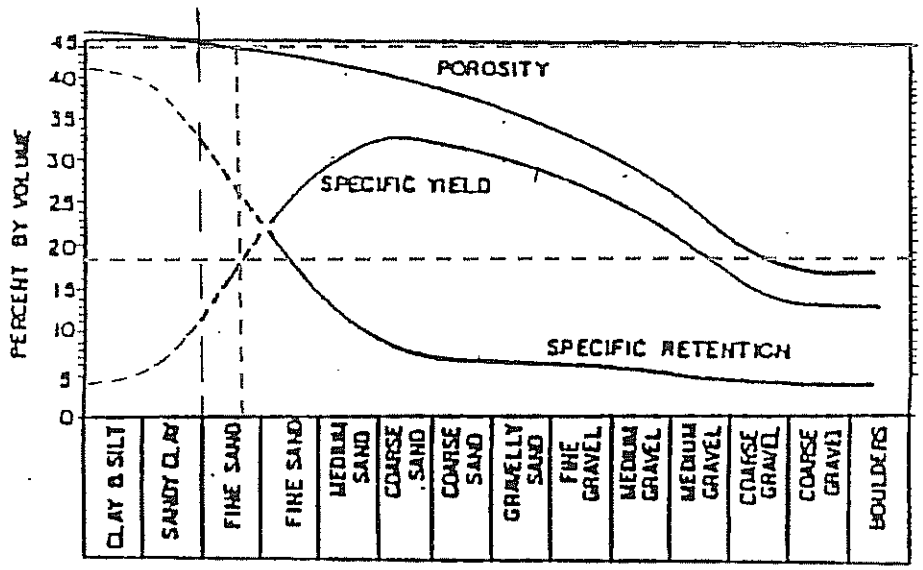


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



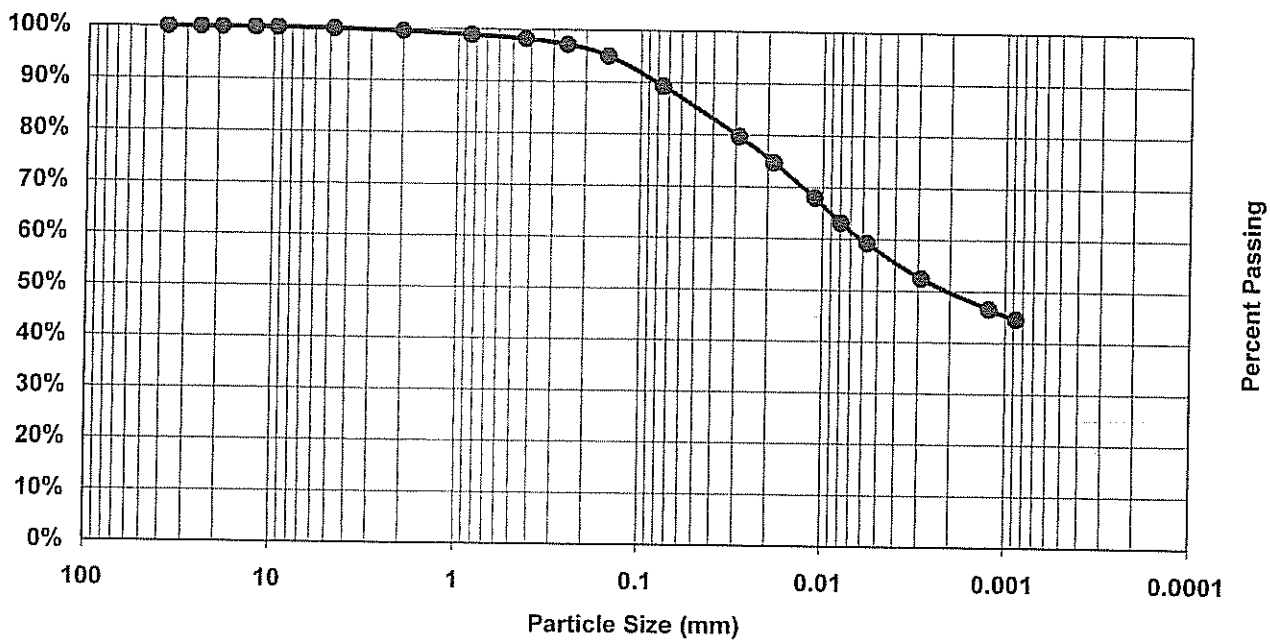
Estimated Porosity: 44%

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-6	M-6 (0-5)	0 to 5 ft bls

Sample Description:
Red brown clayey SILT with trace fine sand (MH)



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 0.5%	% Sand 12.4%	% Silt 30.7%	% Clay 56.4%
Adjusted for Calculations	**0%**	**12%**	**31%**	**57%**

Notes:
Grain size distribution taken from grain size with hydrometer data located in Appendix II.
Gravel, sand, silt and clay sizes based on Wentworth Scale.

S&ME Project:
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FETTER AND BEAR DIAGRAMS

S&ME PROJECT: MSS Landfill Siting Survey
S&ME PROJECT NO.: 1411-07-103

Boring No. M-6

Sample Depth: 0 to 5 ft bls

% Sand: 12%

% Silt: 31%

% Clay: 57%

Estimated Specific Yield: < 1%

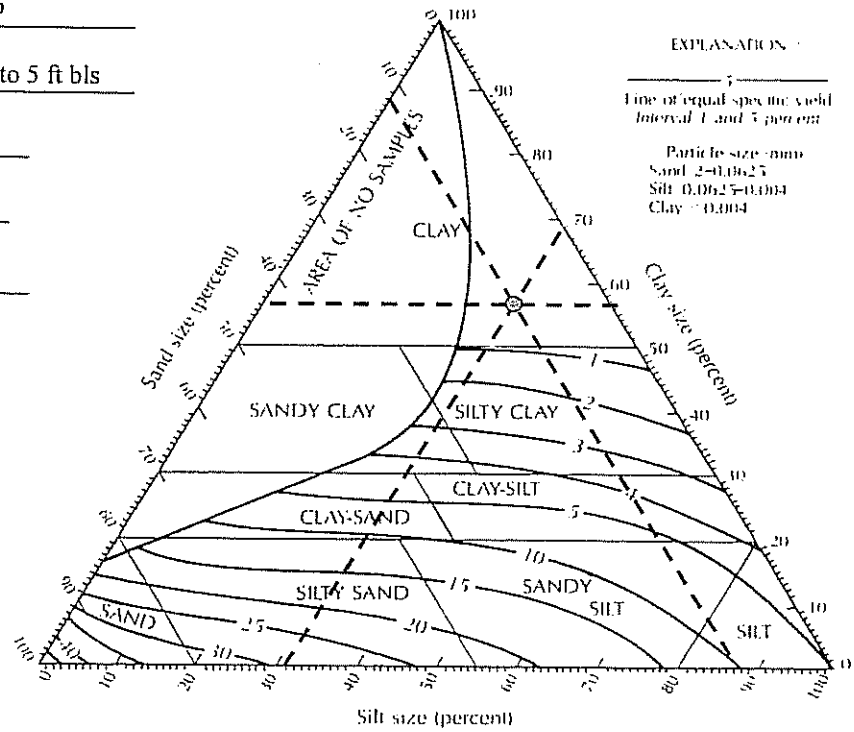
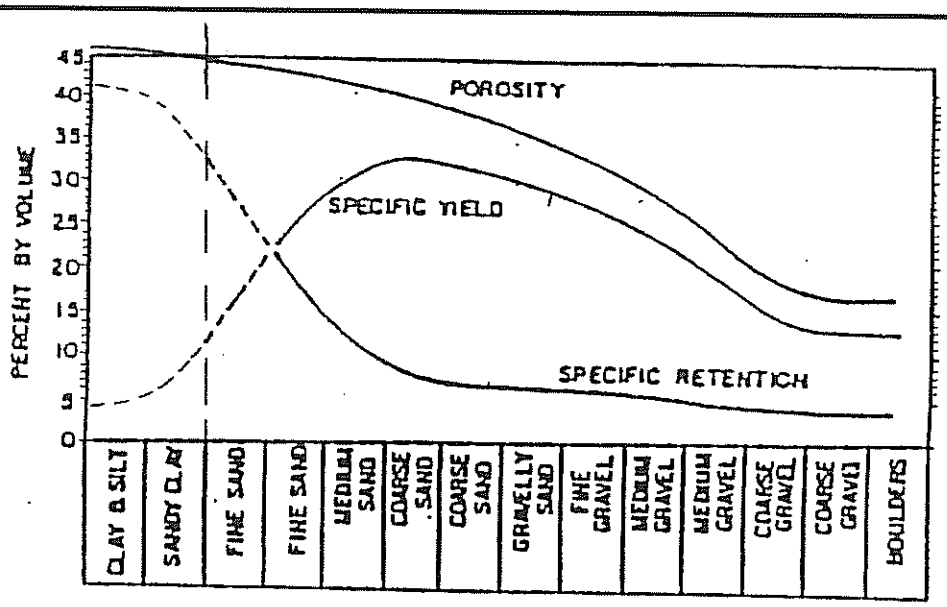


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



Estimated Porosity: 50%**

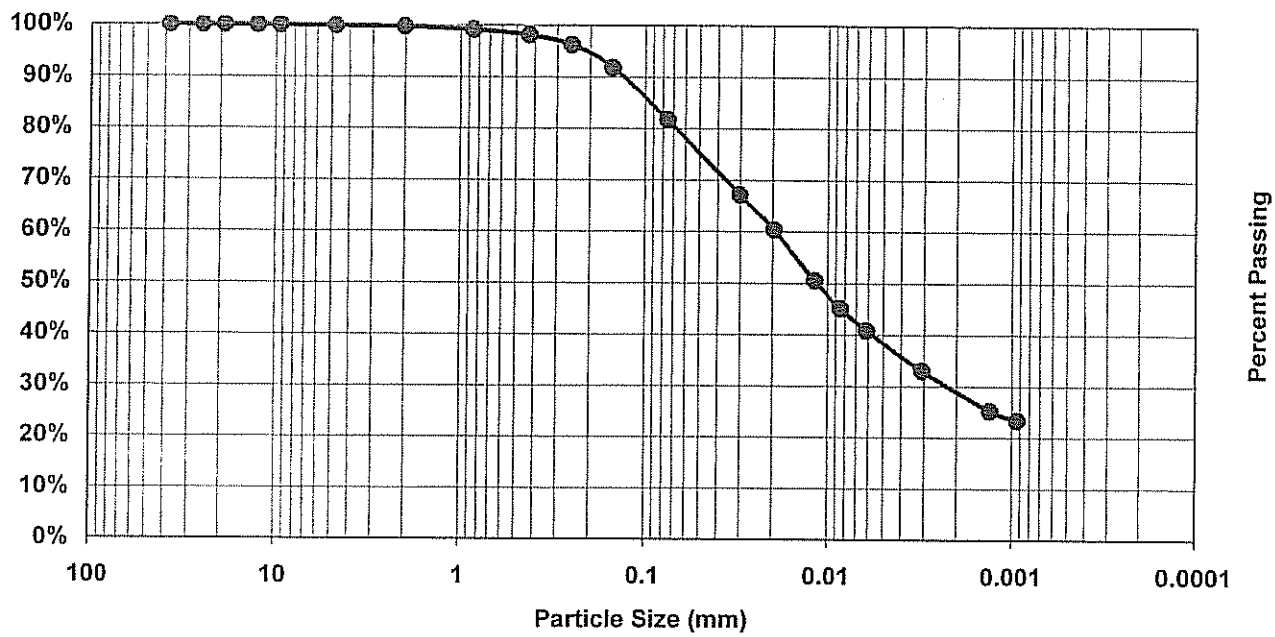
**Based on Table of Selected Values of Porosity, Specific Yield and Specific Retention, USGS Water Supply Paper 2220.

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-6	M-6 (5-10)	5 to 10 ft bls

Sample Description:
Red brown clayey SILT with fine sand (MH)



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 0.3%	% Sand 21.3%	% Silt 41.3%	% Clay 37.2%
Adjusted for Calculations	**0%**	**21%**	**41%**	**37%**

Notes:
Grain size distribution taken from grain size with hydrometer data located in Appendix II.
Gravel, sand, silt and clay sizes based on Wentworth Scale.

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FETTER AND BEAR DIAGRAMS

S&ME PROJECT: MSS Landfill Siting Survey
S&ME PROJECT NO.: 1411-07-103

Boring No. M-6

Sample Depth: 5 to 10 ft bls

% Sand: 21%

% Silt: 41%

% Clay: 37%

Estimated Specific Yield: 2.9%

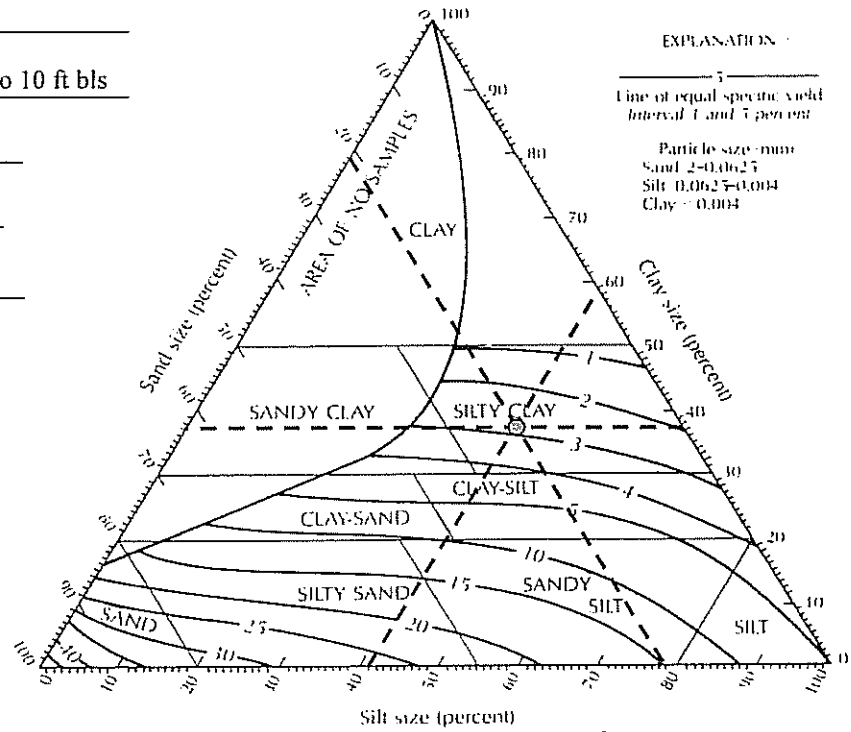
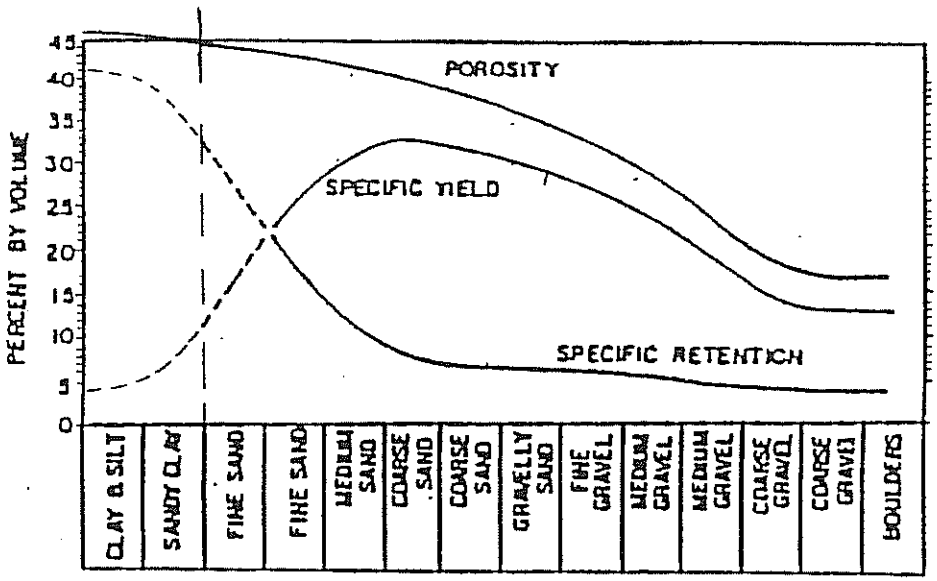


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



Estimated Porosity: 48%**

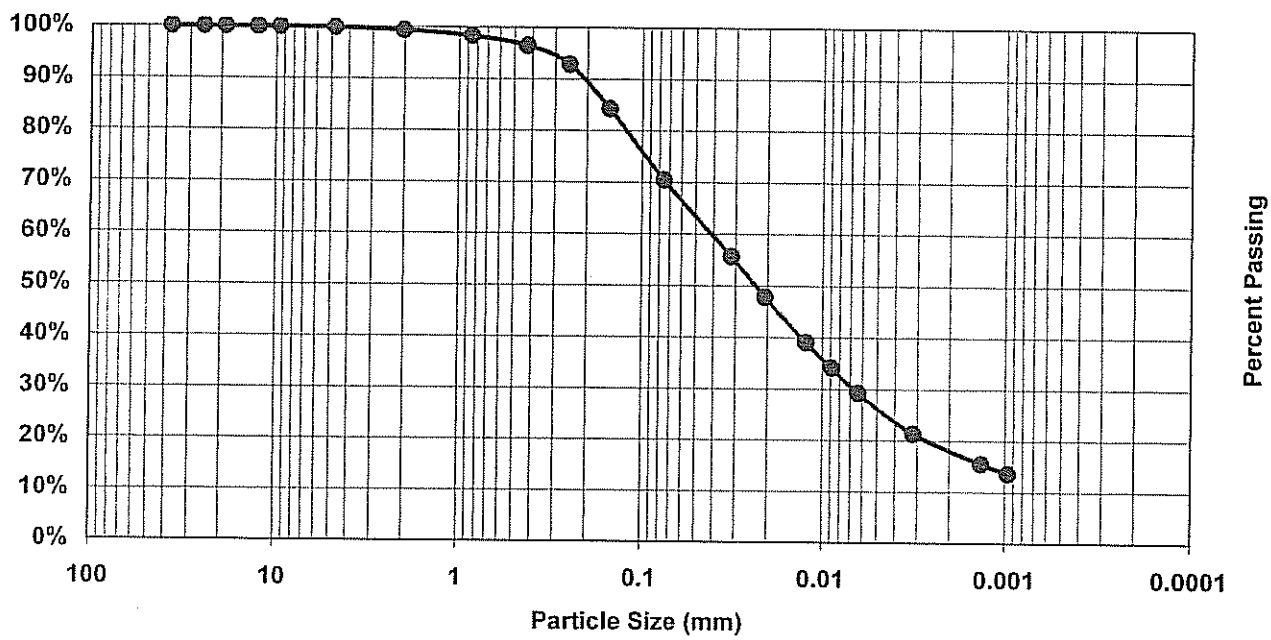
**Based on Table of Selected Values of Porosity, Specific Yield and Specific Retention, USGS Water Supply Paper 2220.

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-6	M-6 (10-15)	10 to 15 ft bls

Sample Description:
Brown red micaceous clayey SILT with fine sand (ML)



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 0.6%	% Sand 32.4%	% Silt 43.1%	% Clay 23.9%
Adjusted for Calculations	**0%**	**33%**	**43%**	**24%**

Notes:
Grain size distribution taken from grain size with hydrometer data located in Appendix II.
Gravel, sand, silt and clay sizes based on Wentworth Scale.

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FETTER AND BEAR DIAGRAMS

S&ME PROJECT: MSS Landfill Siting Survey
S&ME PROJECT NO.: 1411-07-103

Boring No. M-6

Sample Depth: 10 to 15 ft bls

% Sand: 33%

% Silt: 43%

% Clay: 24%

Estimated Specific Yield: 6%

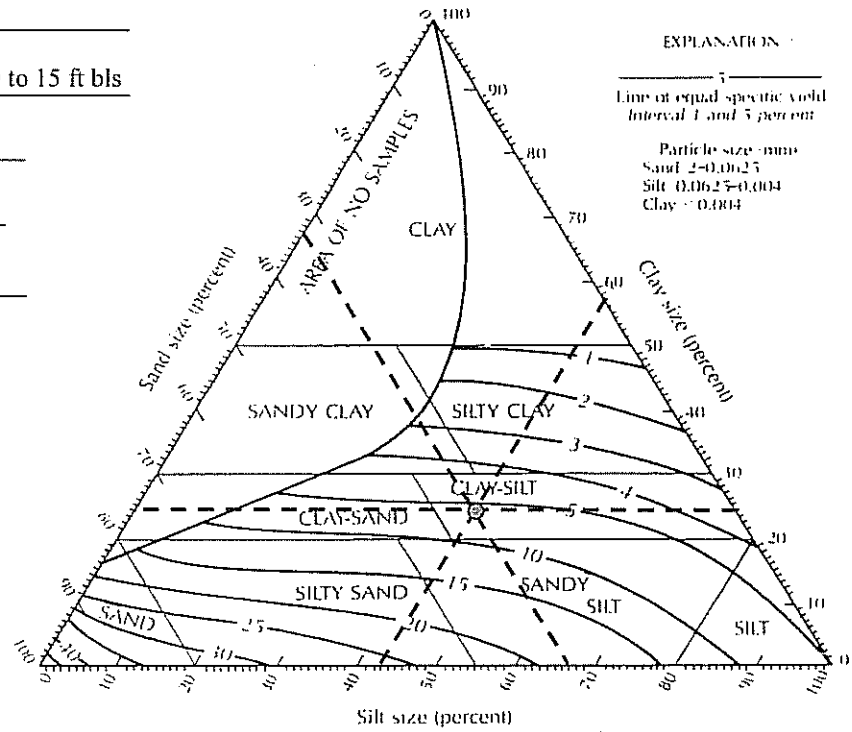
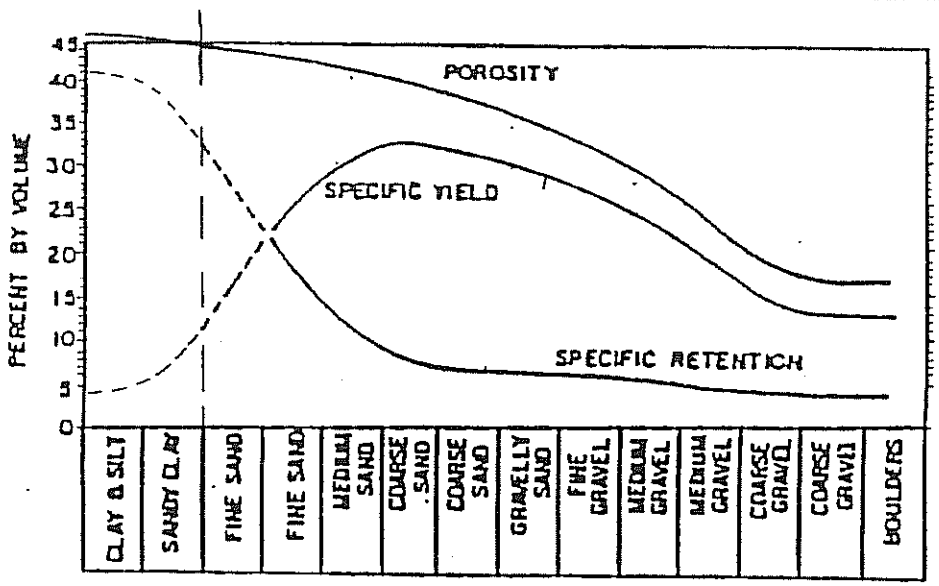


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



Estimated Porosity: 46%**

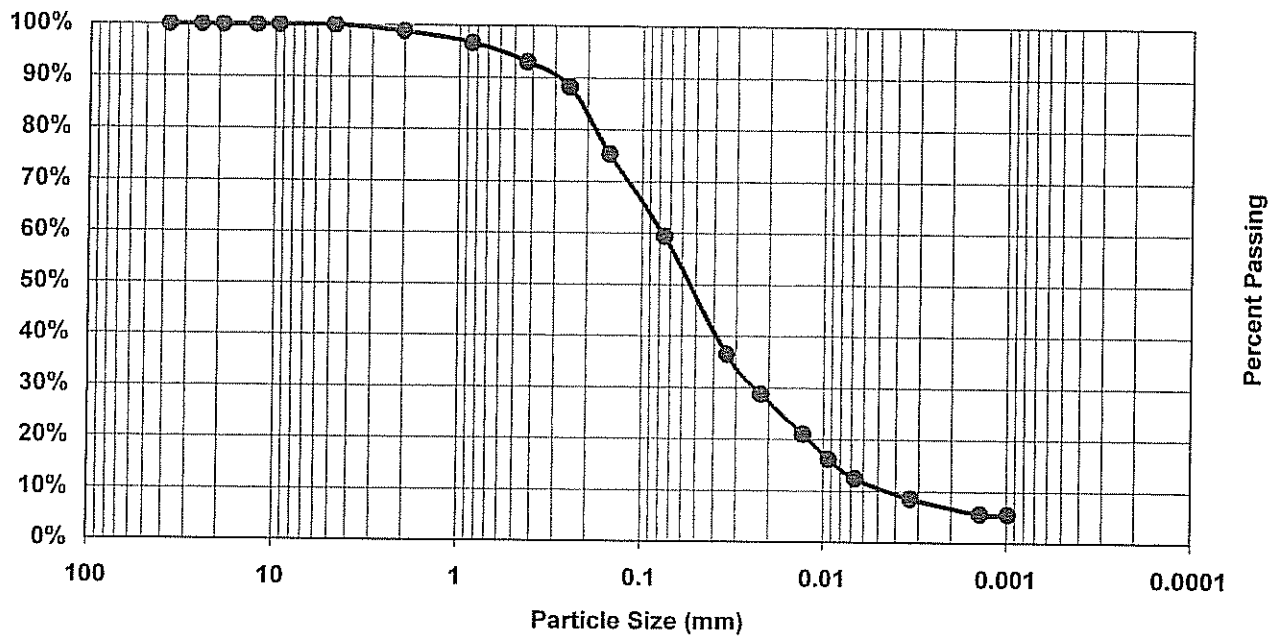
**Based on Table of Selected Values of Porosity, Specific Yield and Specific Retention, USGS Water Supply Paper 2220.

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-6	M-6 (23.3'-24.8')	23.3 to 24.8 ft bls

Sample Description:
Brown orange white micaceous fine sandy SILT



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 1.2%	% Sand 45.0%	% Silt 44.3%	% Clay 9.5%
Adjusted for Calculations	**0%**	**46%**	**45%**	**10%**

Notes:
Grain size distribution taken from grain size with hydrometer data located in Appendix II.
Gravel, sand, silt and clay sizes based on Wentworth Scale.

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FETTER AND BEAR DIAGRAMS

S&ME PROJECT: MSS Landfill Siting Survey
S&ME PROJECT NO.: 1411-07-103

Boring No. M-6

Sample Depth: 23.3 to 24.8 ft bls

% Sand: 46%

% Silt: 45%

% Clay: 10%

Estimated Specific Yield: 18%

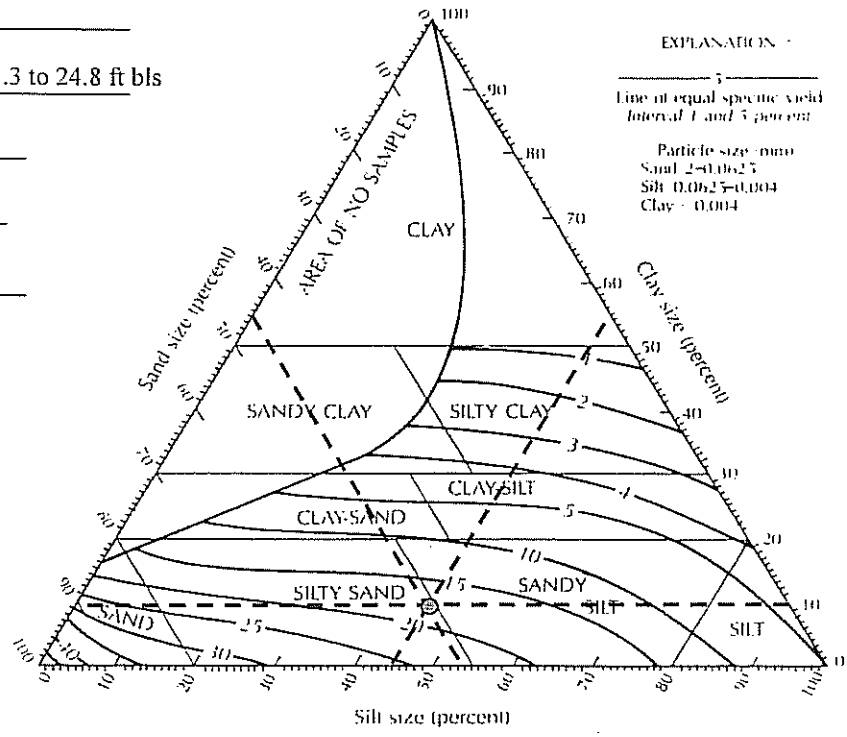
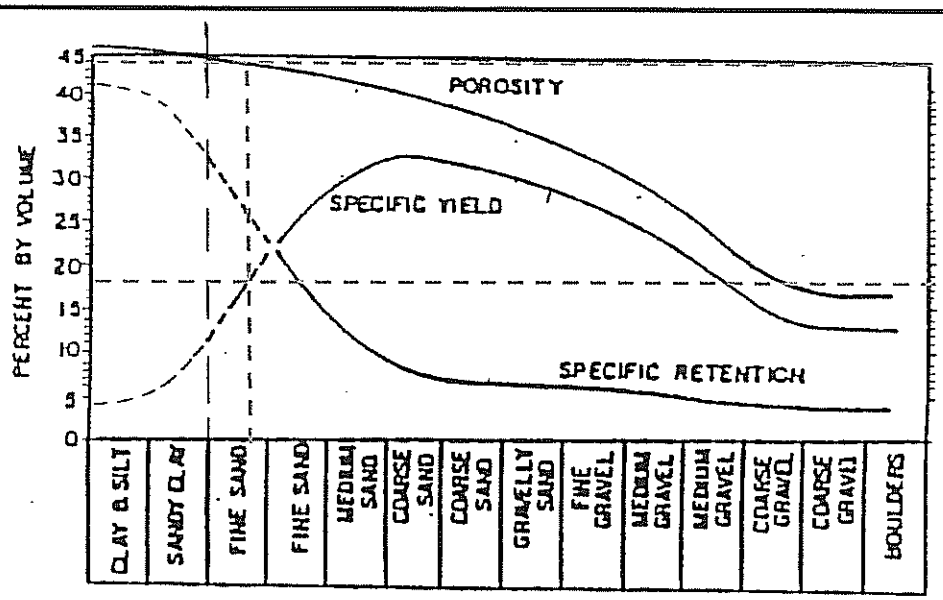


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



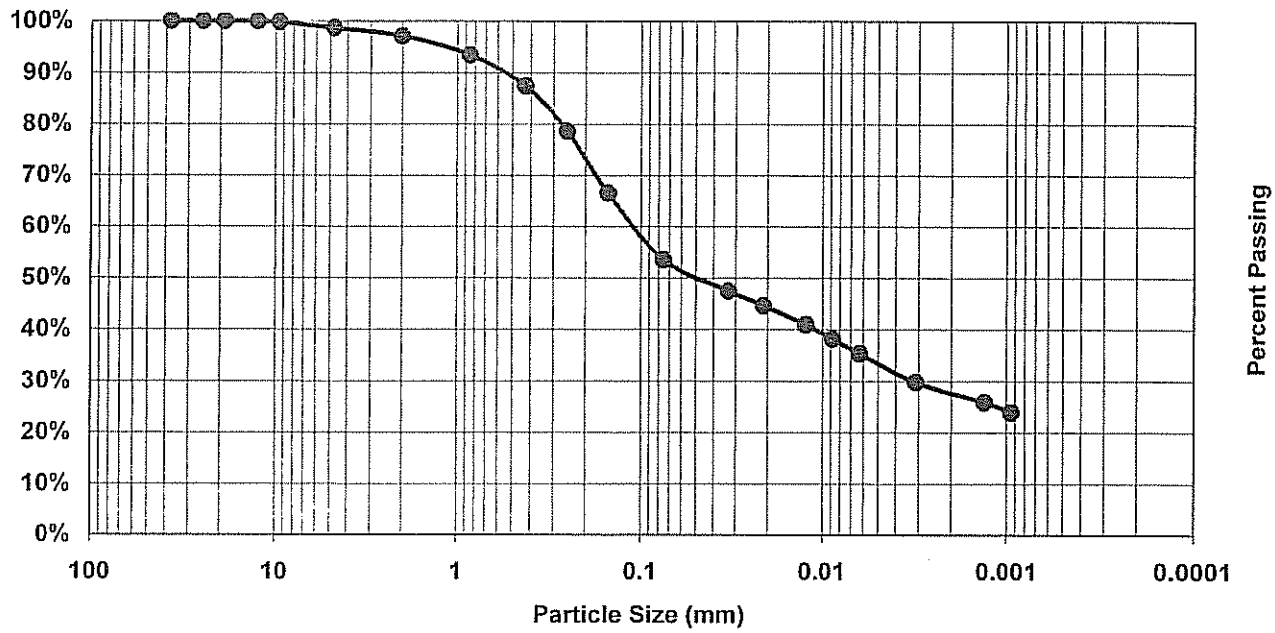
Estimated Porosity: 44%

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-7	M-7 (0-5)	0 to 5 ft bls

Sample Description:
Brown red medium to fine sandy silty CLAY (CL)



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 2.9%	% Sand 45.0%	% Silt 20.4%	% Clay 31.7%
Adjusted for Calculations	**0%**	**46%**	**21%**	**33%**

Notes:
Grain size distribution taken from grain size with hydrometer data located in Appendix II.
Gravel, sand, silt and clay sizes based on Wentworth Scale.

S&ME Project:
MSS Landfill Siting Survey

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FETTER AND BEAR DIAGRAMS

S&ME PROJECT: MSS Landfill Siting Survey
S&ME PROJECT NO.: 1411-07-103

Boring No. M-7

Sample Depth: 0 to 5 ft bls

% Sand: 46%

% Silt: 21%

% Clay: 33%

Estimated Specific Yield: 4%

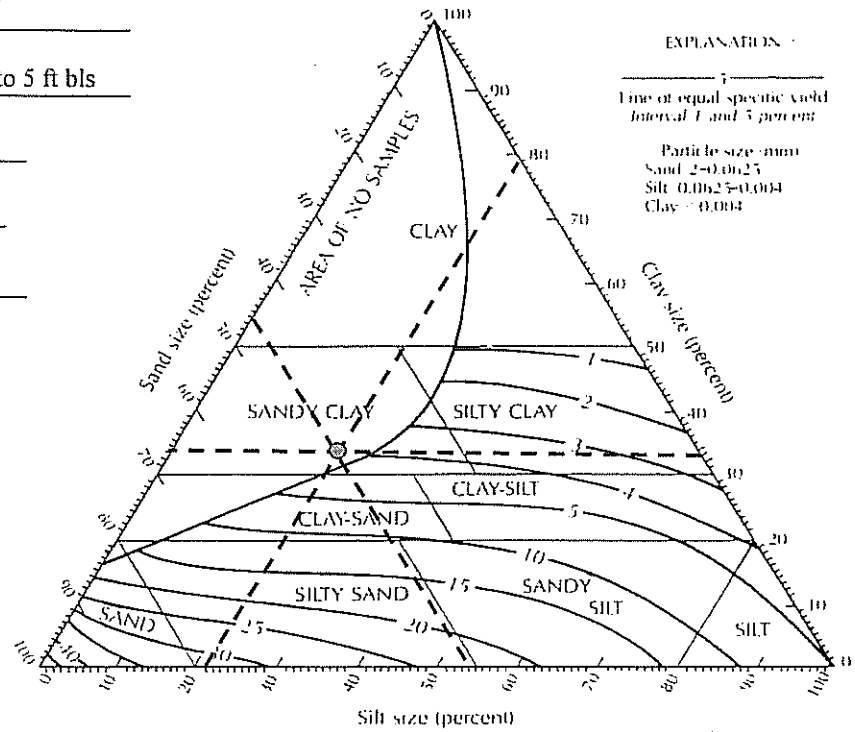
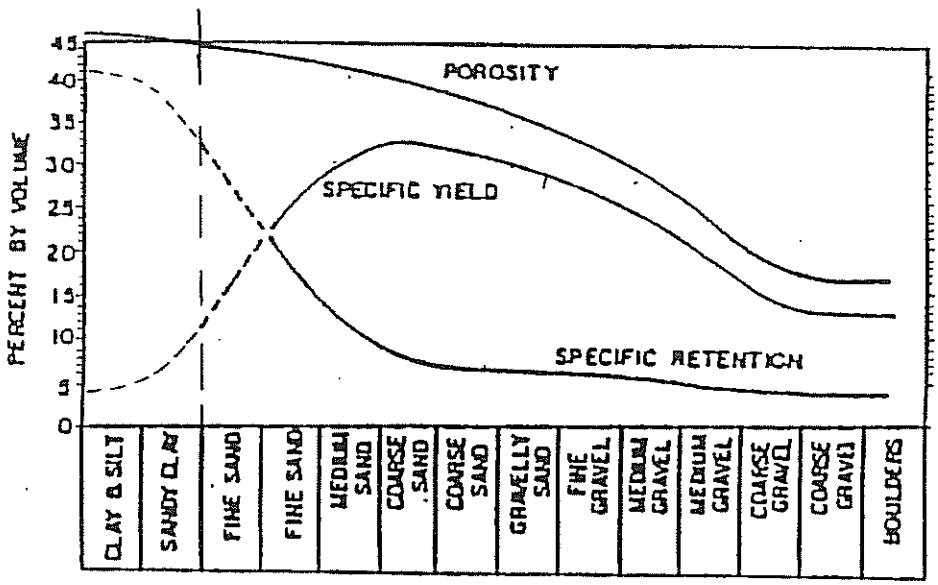


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



Estimated Porosity: 47%**

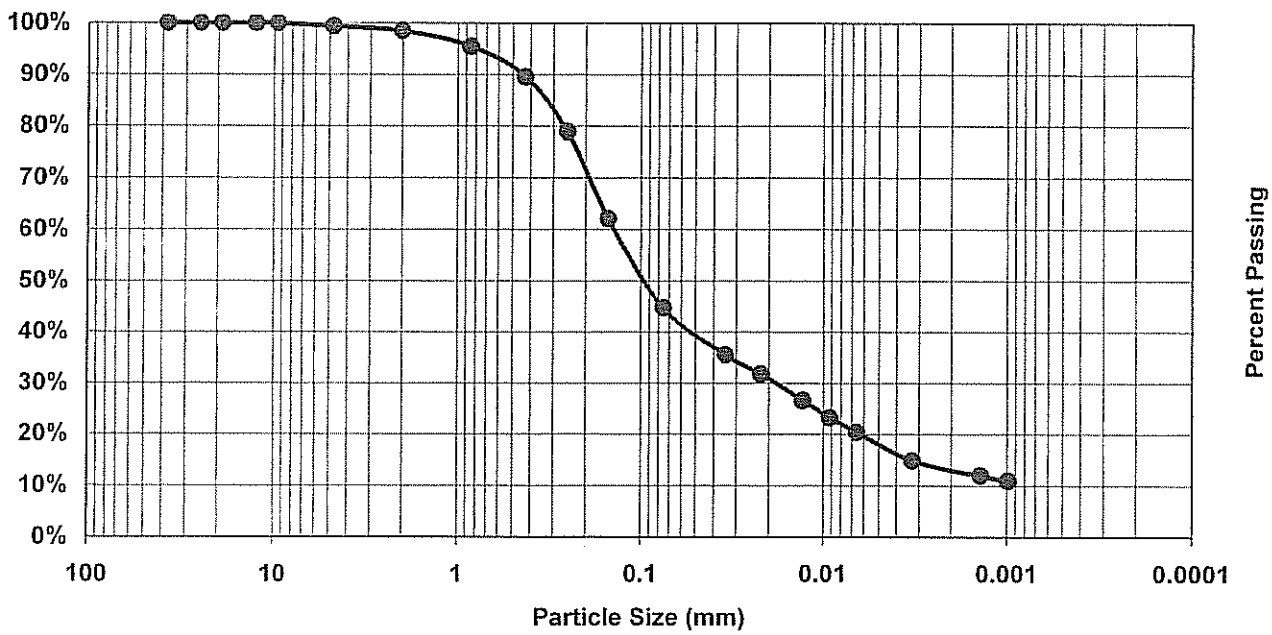
**Based on Table of Selected Values of Porosity, Specific Yield and Specific Retention, USGS Water Supply Paper 2220.

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-7	M-7 (5-10)	5 to 10 ft bls

Sample Description:
Brown red clayey silty fine SAND (SC-SM)



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 1.5%	% Sand 56.1%	% Silt 26.5%	% Clay 16.0%
Adjusted for Calculations	**0%**	**57%**	**27%**	**16%**

Notes:
Grain size distribution taken from grain size with hydrometer data located in Appendix II.
Gravel, sand, silt and clay sizes based on Wentworth Scale.

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FETTER AND BEAR DIAGRAMS

S&ME PROJECT: MSS Landfill Siting Survey
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Boring No. M-7

Sample Depth: 5 to 10 ft bls

% Sand: 57%

% Silt: 27%

% Clay: 16%

Estimated Specific Yield: 14%

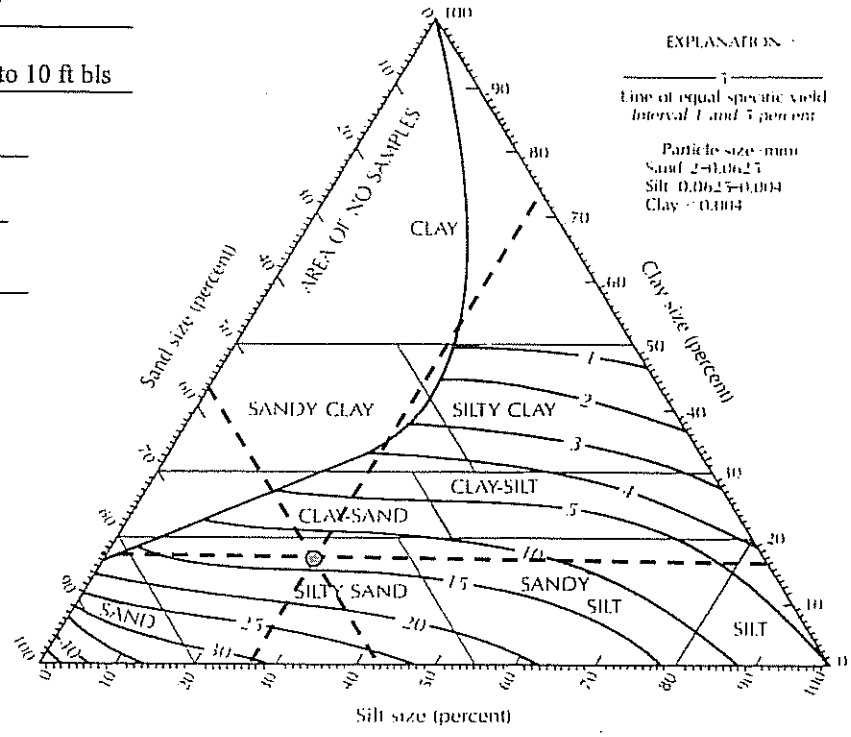
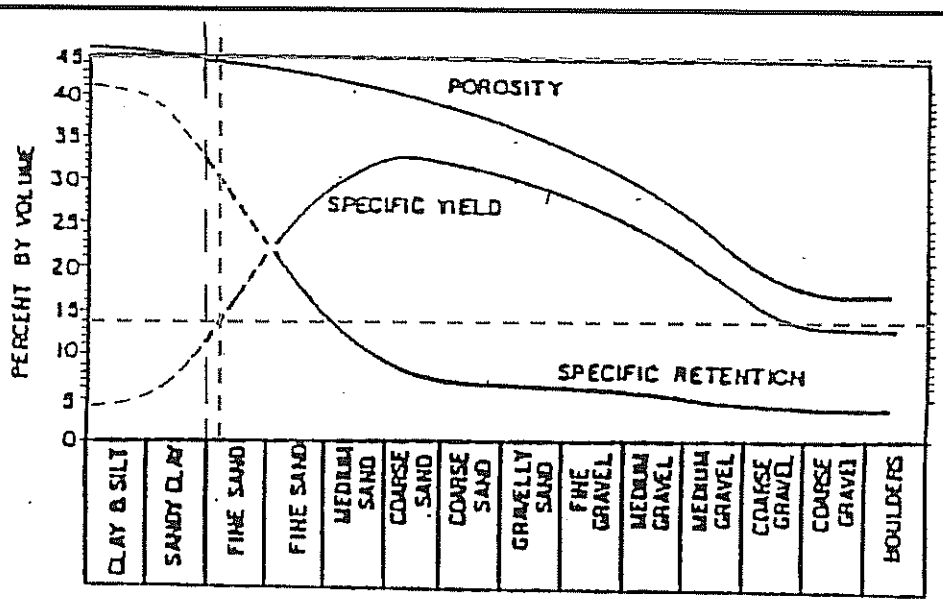


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



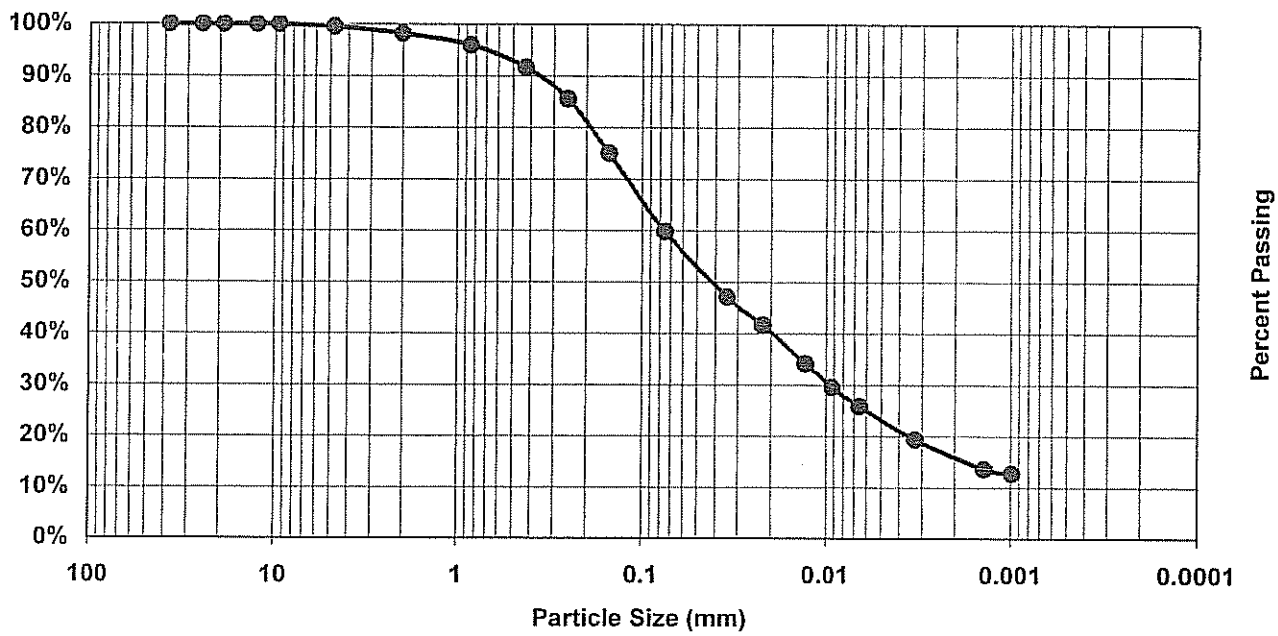
Estimated Porosity: 45%

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-7	M-7 (10-15)	10 to 15 ft bls

Sample Description:
Red brown fine sandy clayey SILT (ML)



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 1.8%	% Sand 41.5%	% Silt 35.1%	% Clay 21.6%
Adjusted for Calculations	**0%**	**42%**	**36%**	**22%**

Notes:
Grain size distribution taken from grain size with hydrometer data located in Appendix II.
Gravel, sand, silt and clay sizes based on Wentworth Scale.

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FETTER AND BEAR DIAGRAMS

S&ME PROJECT: MSS Landfill Siting Survey
S&ME PROJECT NO.: 1411-07-103

Boring No. M-7

Sample Depth: 10 to 15 ft bls

% Sand: 42%

% Silt: 36%

% Clay: 22%

Estimated Specific Yield: 8%

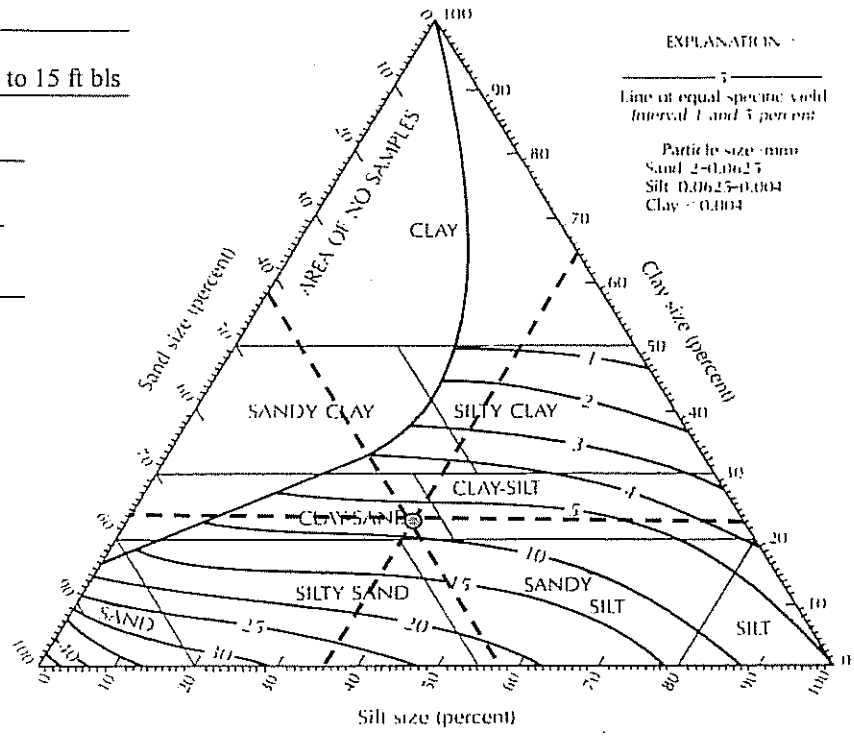
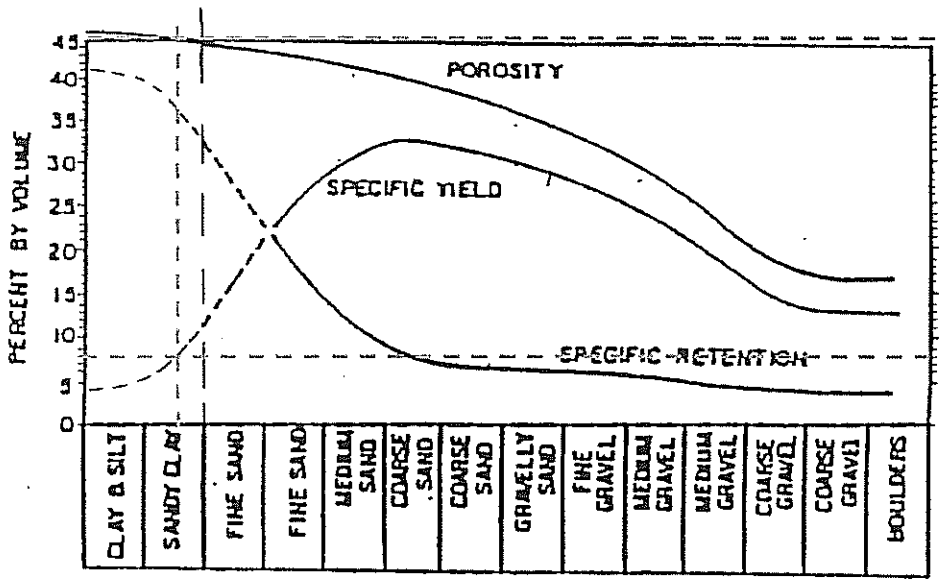


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



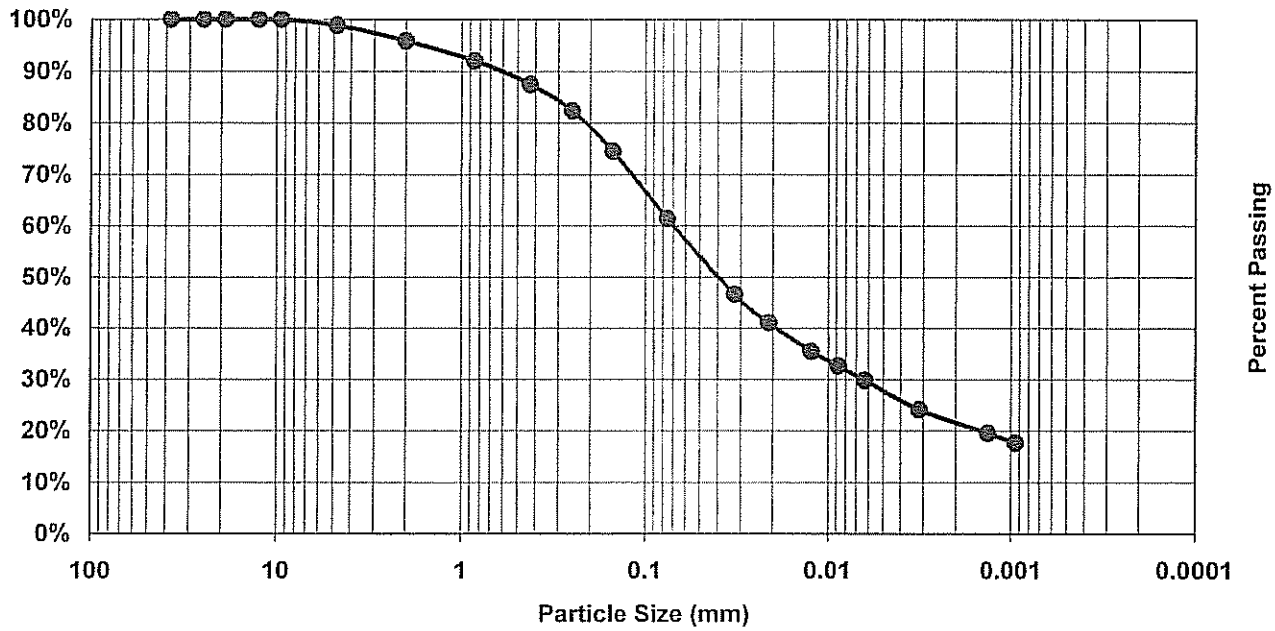
Estimated Porosity: 45%

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-8	M-8 (0-5)	0 to 5 ft bls

Sample Description:
Tan brown fine sandy silty CLAY (CL)



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 4.2%	% Sand 37.9%	% Silt 31.6%	% Clay 26.3%
Adjusted for Calculations	**0%**	**40%**	**33%**	**27%**

Notes:
Grain size distribution taken from grain size with hydrometer data located in Appendix II.
Gravel, sand, silt and clay sizes based on Wentworth Scale.

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FETTER AND BEAR DIAGRAMS

S&ME PROJECT: MSS Landfill Siting Survey
S&ME PROJECT NO.: 1411-07-103

Boring No. M-8

Sample Depth: 0 to 5 ft bls

% Sand: 40%

% Silt: 33%

% Clay: 27%

Estimated Specific Yield: 4.75%

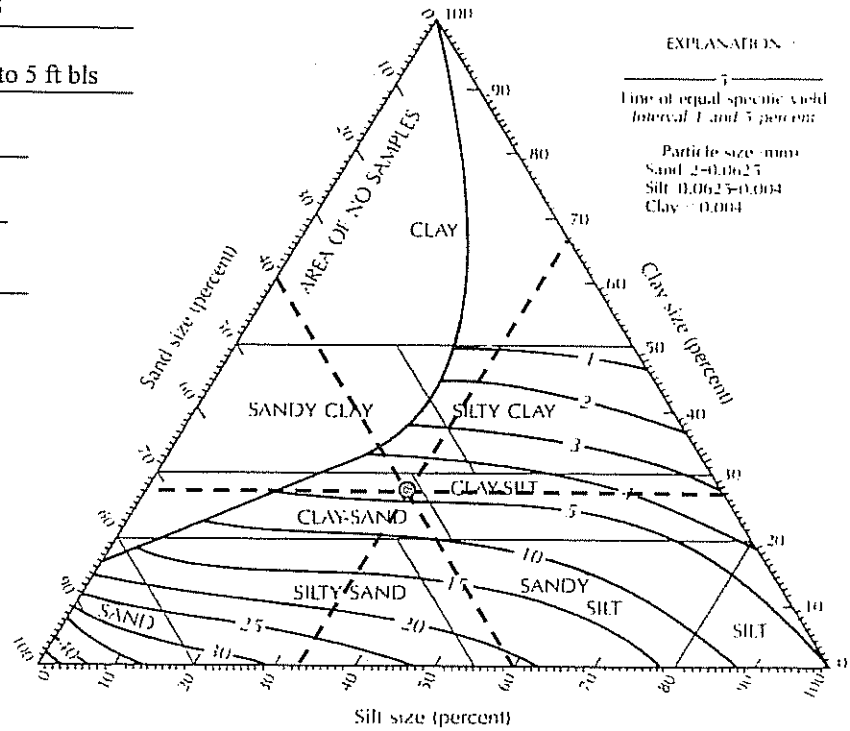
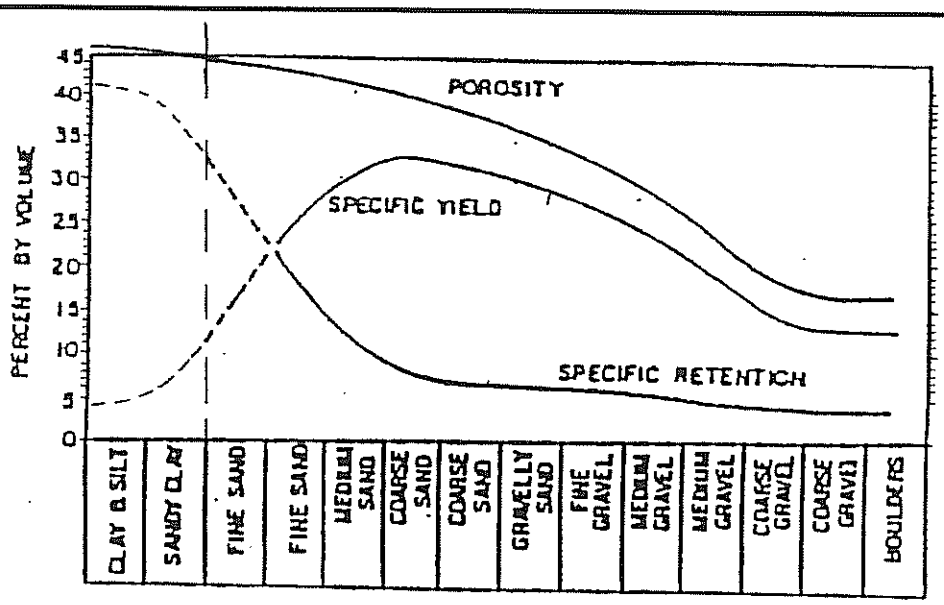


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



Estimated Porosity: 46%**

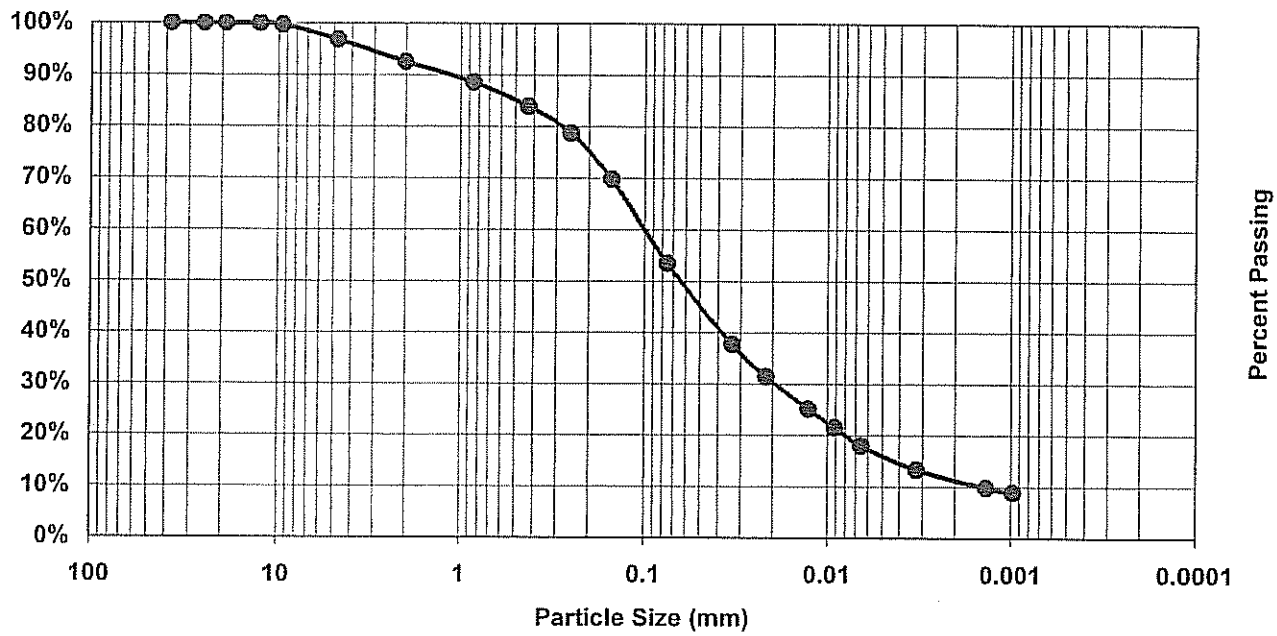
**Based on Table of Selected Values of Porosity, Specific Yield and Specific Retention, USGS Water Supply Paper 2220.

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-8	M-8 (5-10)	5 to 10 ft bls

Sample Description:
Tan brown fine sandy silty CLAY (CL)



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 7.5%	% Sand 42.8%	% Silt 35.0%	% Clay 14.7%
Adjusted for Calculations	**0%**	**46%**	**38%**	**16%**

Notes:
Grain size distribution taken from grain size with hydrometer data located in Appendix II.
Gravel, sand, silt and clay sizes based on Wentworth Scale.

S&ME Project:
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FETTER AND BEAR DIAGRAMS

S&ME PROJECT: MSS Landfill Siting Survey
S&ME PROJECT NO.: 1411-07-103

Boring No. M-8

Sample Depth: 5 to 10 ft bls

% Sand: 46%

% Silt: 38%

% Clay: 16%

Estimated Specific Yield: 13%

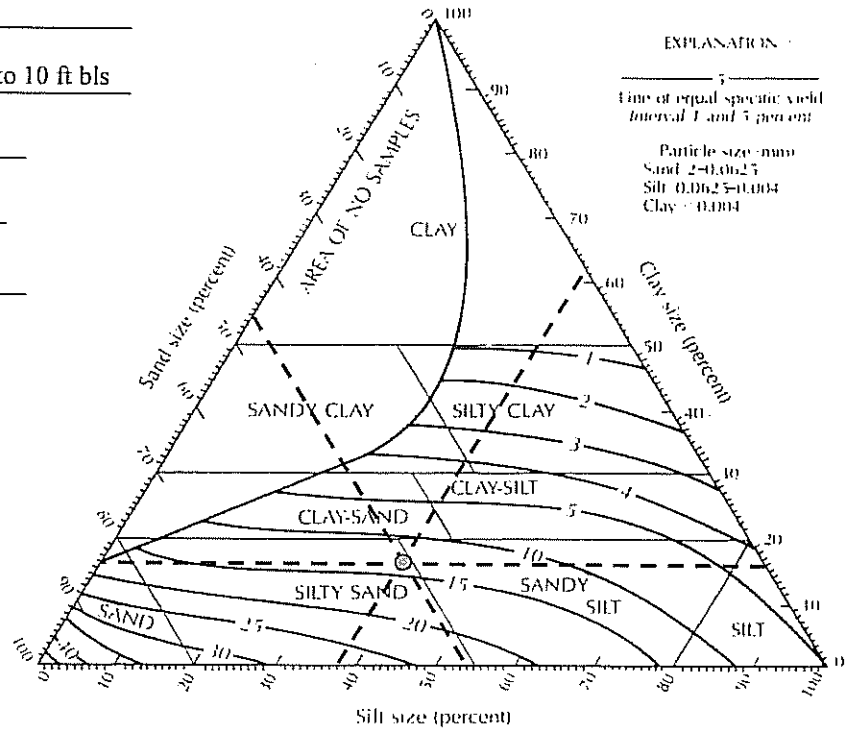
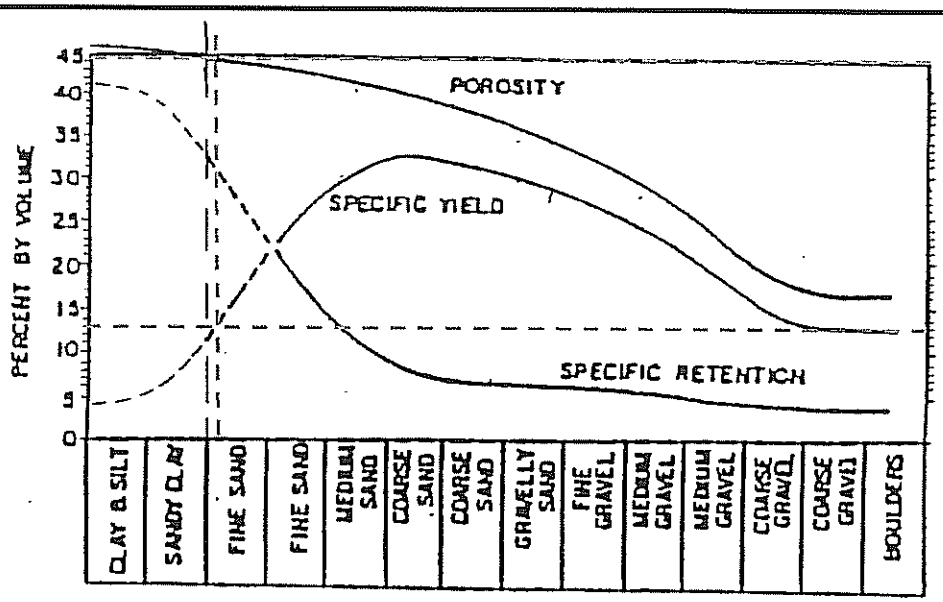


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



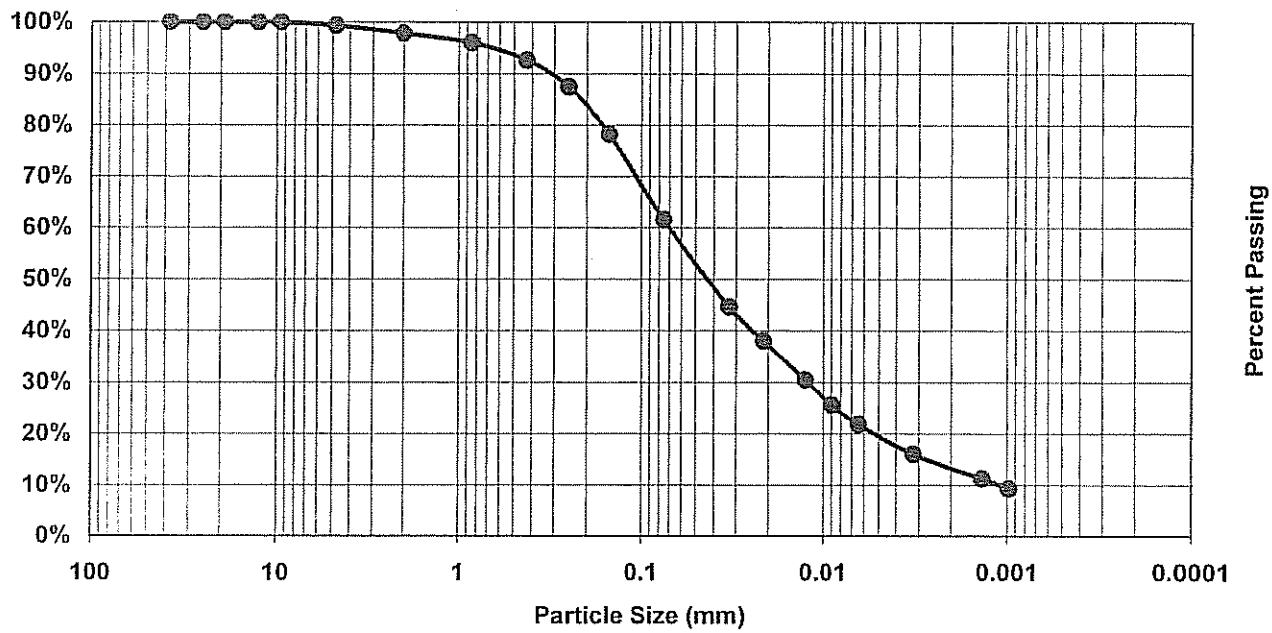
Estimated Porosity: 45%

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-8	M-8 (10-15)	10 to 15 ft bls

Sample Description:
Tan brown fine sandy silty CLAY (CL)



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 2.2%	% Sand 40.3%	% Silt 39.5%	% Clay 18.0%
Adjusted for Calculations	**0%**	**41%**	**40%**	**18%**

Notes:
Grain size distribution taken from grain size with hydrometer data located in Appendix II.
Gravel, sand, silt and clay sizes based on Wentworth Scale.

S&ME Project:
MSS Landfill Siting Survey

S&ME Project No.:
1411-07-103

S&ME

FETTER AND BEAR DIAGRAMS

S&ME PROJECT: MSS Landfill Siting Survey
S&ME PROJECT NO.: 1411-07-103

Boring No. M-8

Sample Depth: 10 to 15 ft bls

% Sand: 41%

% Silt: 40%

% Clay: 18%

Estimated Specific Yield: 11%

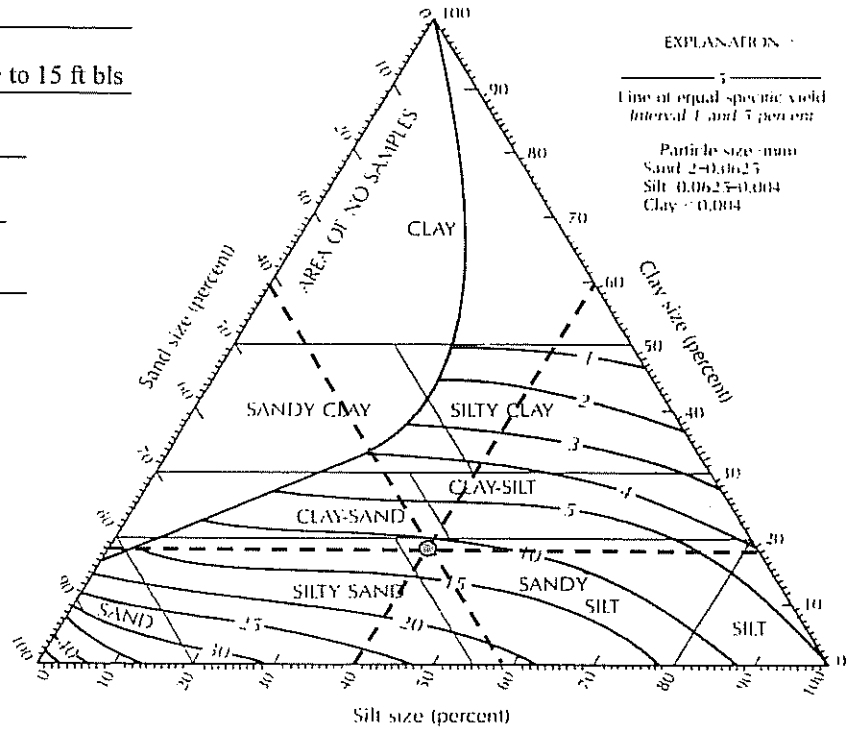
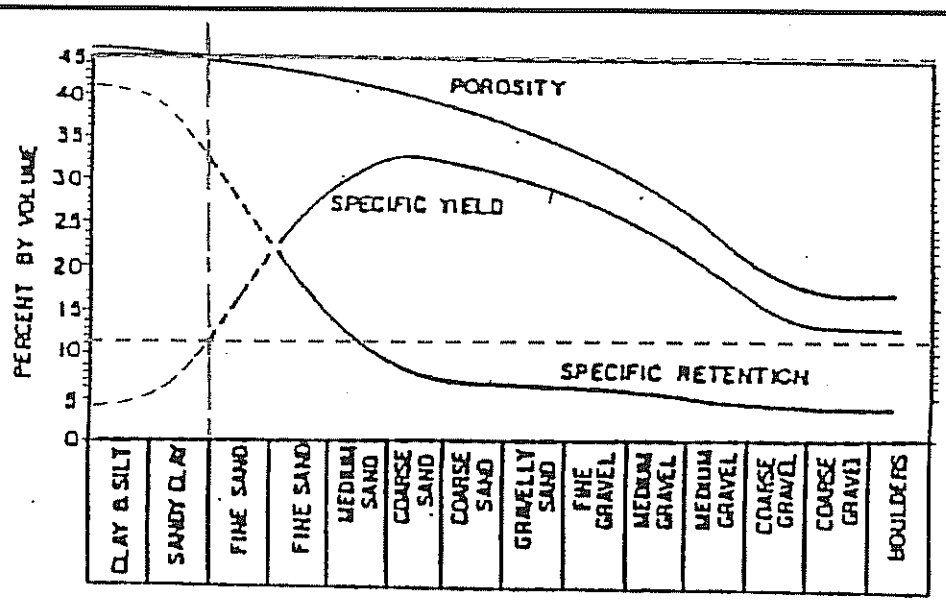


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



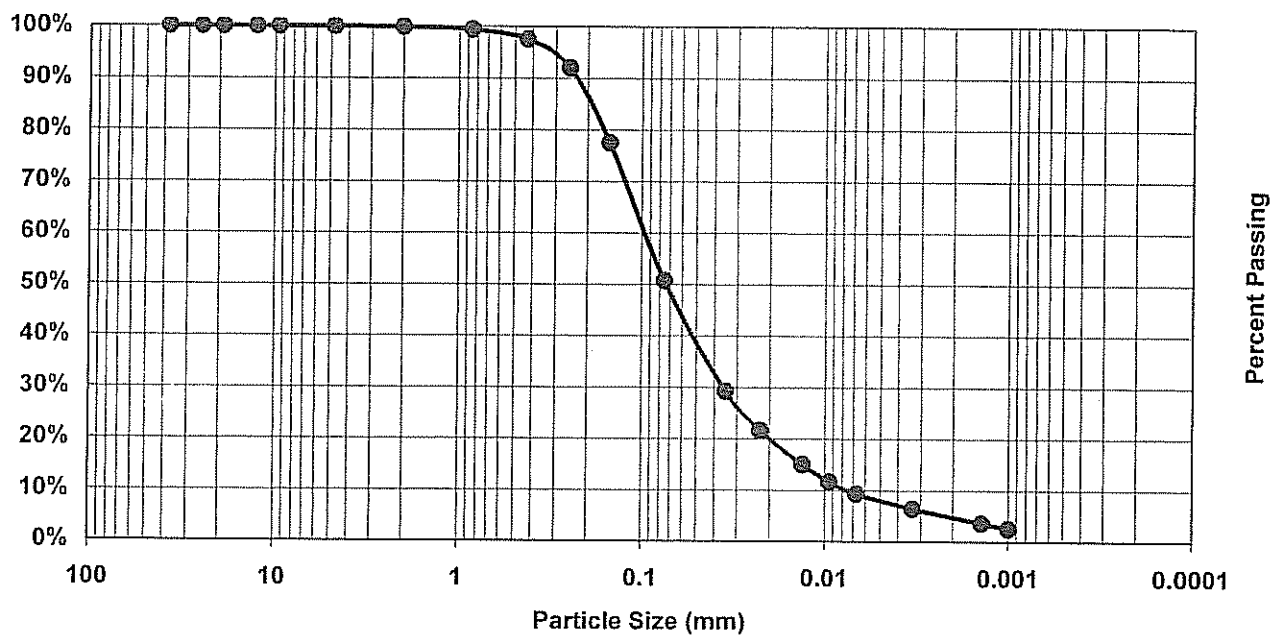
Estimated Porosity: 45%

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-8	M-8 (38.5'-40')	38.5 to 40 ft bls

Sample Description:
Tan Brown fine sandy SILT



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 0.1%	% Sand 54.5%	% Silt 38.0%	% Clay 7.4%
Adjusted for Calculations	**0%**	**55%**	**38%**	**7%**

Notes:
Grain size distribution taken from grain size with hydrometer data located in Appendix II.
Gravel, sand, silt and clay sizes based on Wentworth Scale.

S&ME Project:
MSS Landfill Siting Survey

S&ME Project No.:
1411-07-103

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FETTER AND BEAR DIAGRAMS

S&ME PROJECT: MSS Landfill Siting Survey
S&ME PROJECT NO.: 1411-07-103

Boring No. M-8

Sample Depth: 38.5 to 40 ft bls

% Sand: 55%

% Silt: 38%

% Clay: 7%

Estimated Specific Yield: 22%

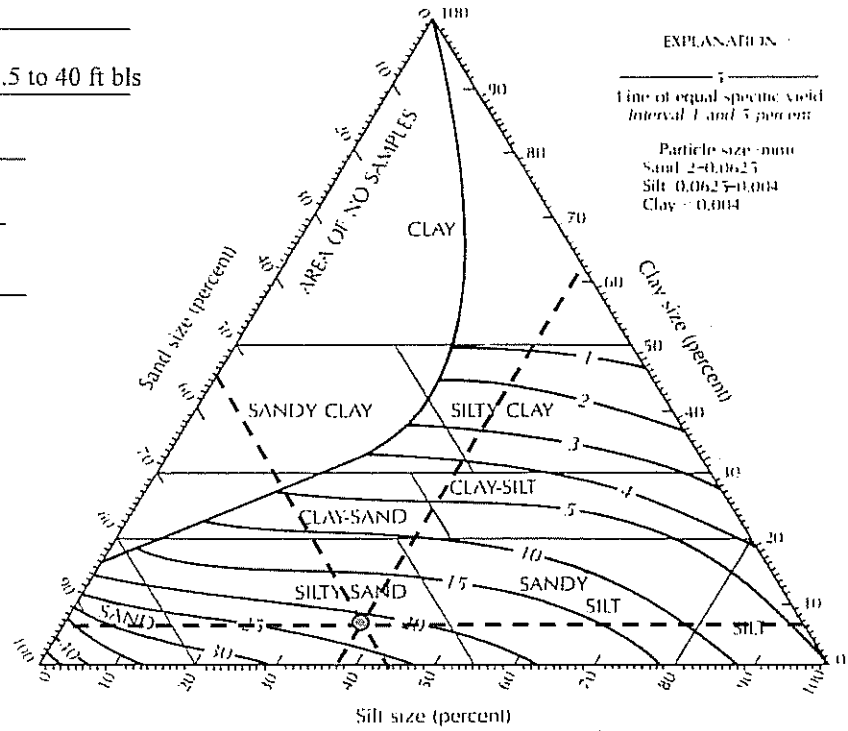
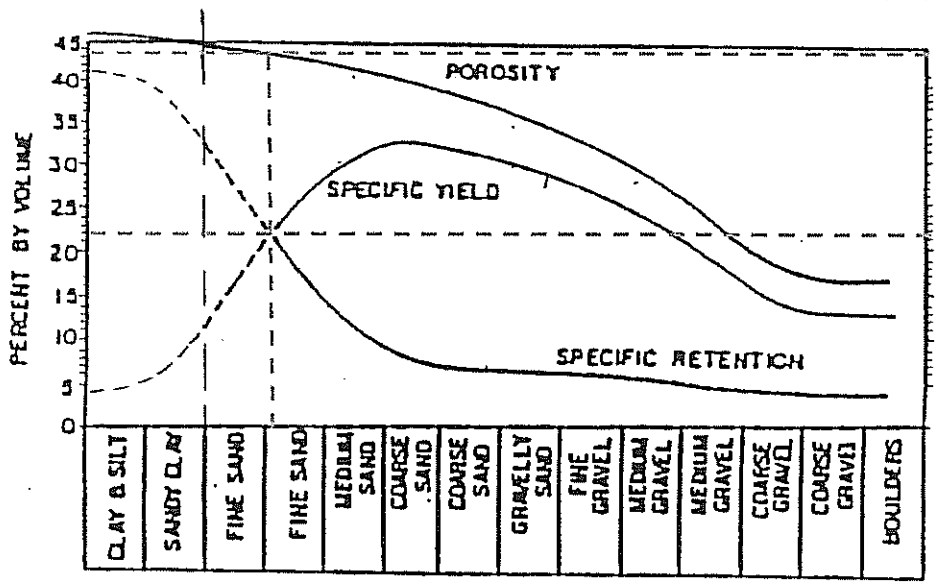


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



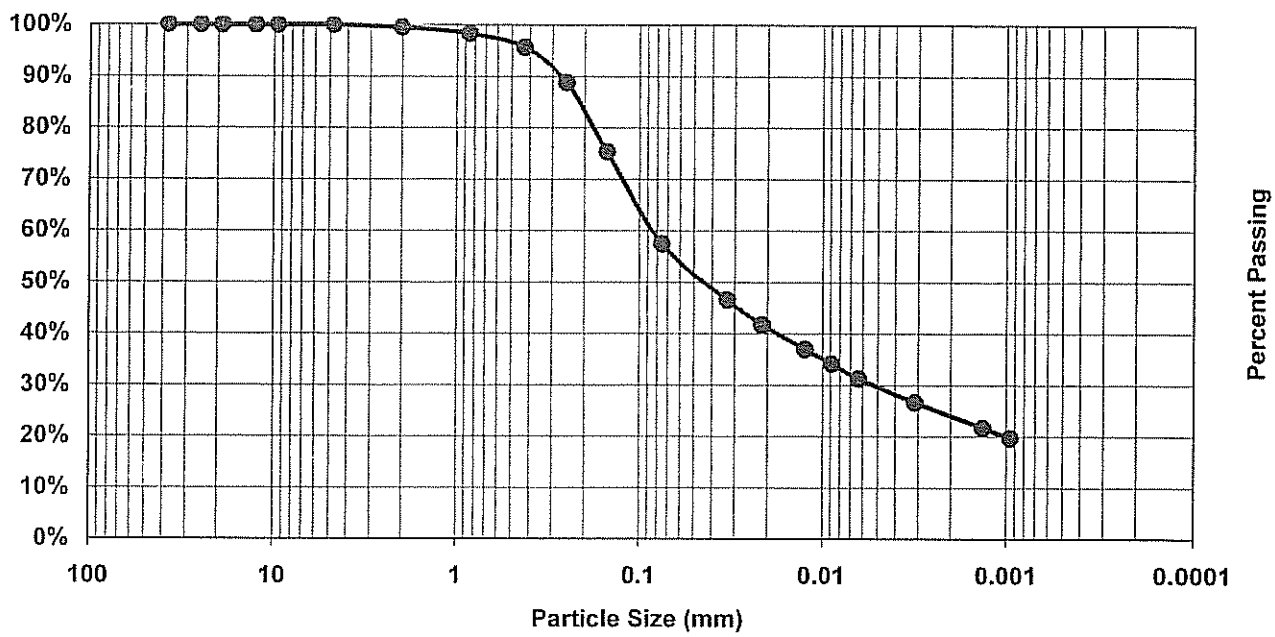
Estimated Porosity: 43%

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-16	M-16 (3-5)	3 to 5 ft bls

Sample Description:
Tan brown fine sandy silty CLAY (CL)



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 0.5%	% Sand 44.7%	% Silt 25.8%	% Clay 29.1%
Adjusted for Calculations	**0%**	**45%**	**26%**	**29%**

Notes:
Grain size distribution taken from grain size with hydrometer data located in Appendix II.
Gravel, sand, silt and clay sizes based on Wentworth Scale.

S&ME Project:
MSS Landfill Siting Survey

S&ME Project No.:
1411-07-103

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FETTER AND BEAR DIAGRAMS

S&ME PROJECT: MSS Landfill Siting Survey
S&ME PROJECT NO.: 1411-07-103

Boring No. M-16

Sample Depth: 3 to 5 ft bls

% Sand: 45%

% Silt: 26%

% Clay: 29%

Estimated Specific Yield: 4.5%

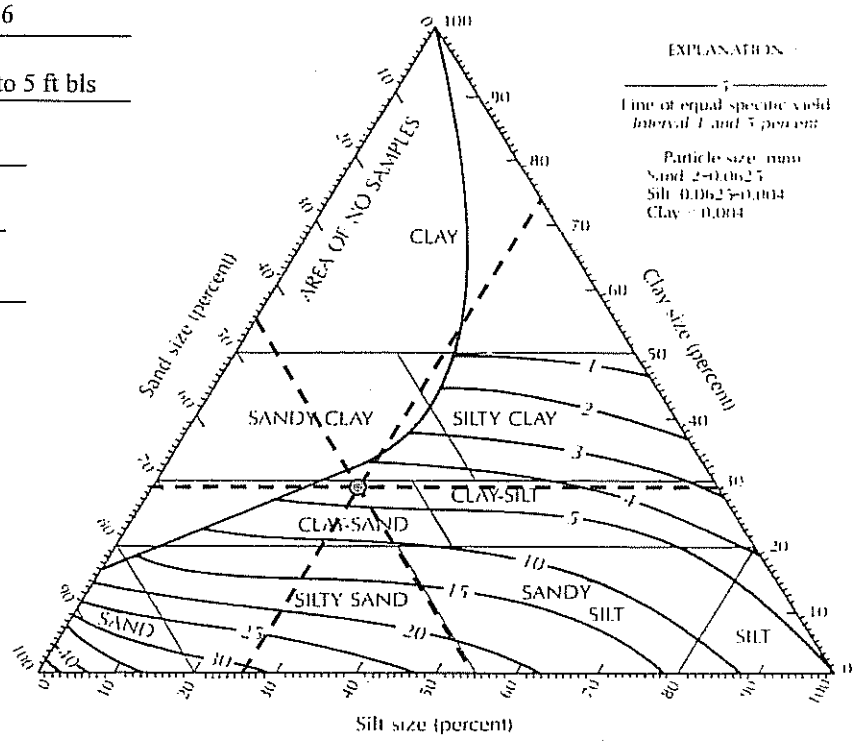
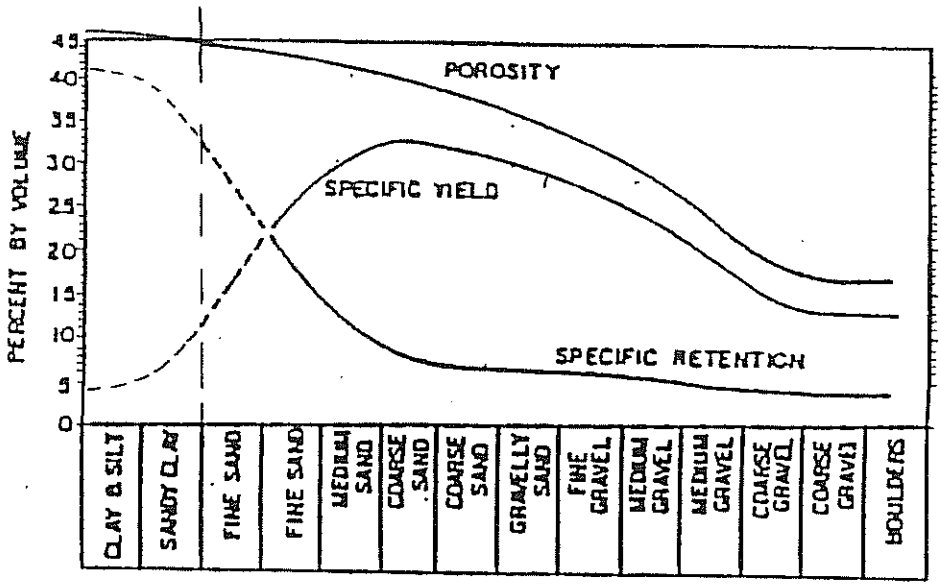


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



Estimated Porosity: 46%**

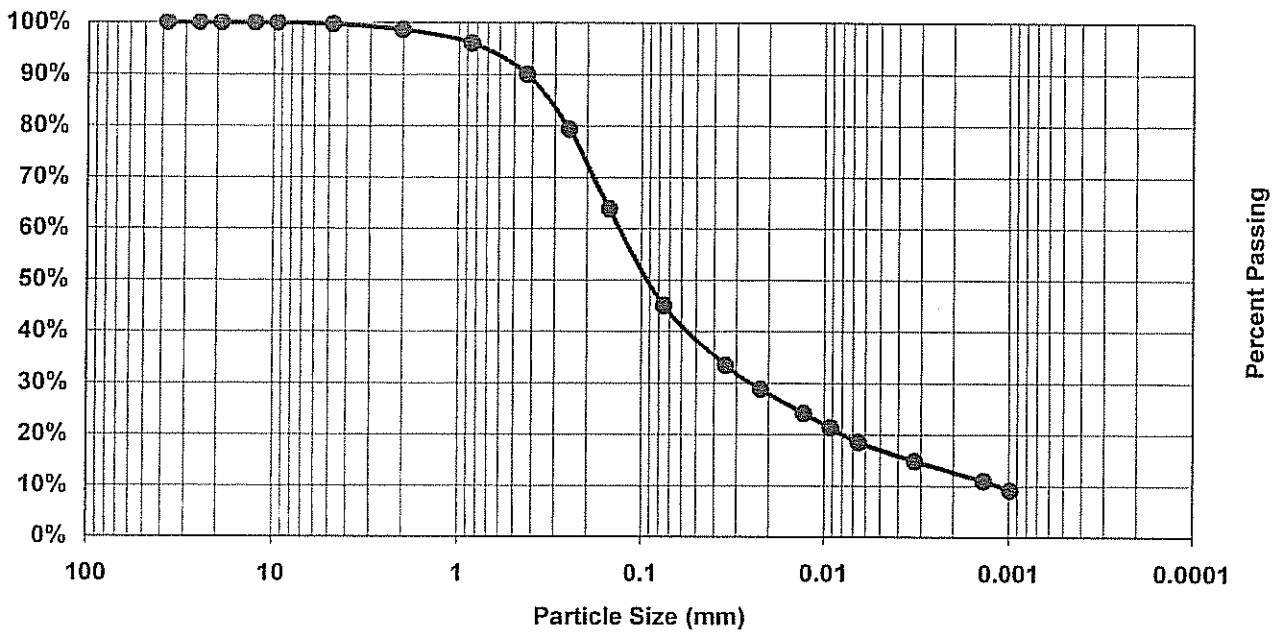
**Based on Table of Selected Values of Porosity, Specific Yield and Specific Retention, USGS Water Supply Paper 2220.

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-16	M-16 (8-10)	8 to 10 ft bls

Sample Description:
Tan olive brown micaceous clayey silty fine SAND (SC)



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 1.4%	% Sand 56.4%	% Silt 25.7%	% Clay 16.4%
Adjusted for Calculations	**0%**	**57%**	**26%**	**17%**

Notes:
Grain size distribution taken from grain size with hydrometer data located in Appendix II.
Gravel, sand, silt and clay sizes based on Wentworth Scale.

S&ME Project:
MSS Landfill Siting Survey

S&ME Project No.:
1411-07-103

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FETTER AND BEAR DIAGRAMS

S&ME PROJECT: MSS Landfill Siting Survey
S&ME PROJECT NO.: 1411-07-103

Boring No. M-16

Sample Depth: 8 to 10 ft bls

% Sand: 57%

% Silt: 26%

% Clay: 17%

Estimated Specific Yield: 13%

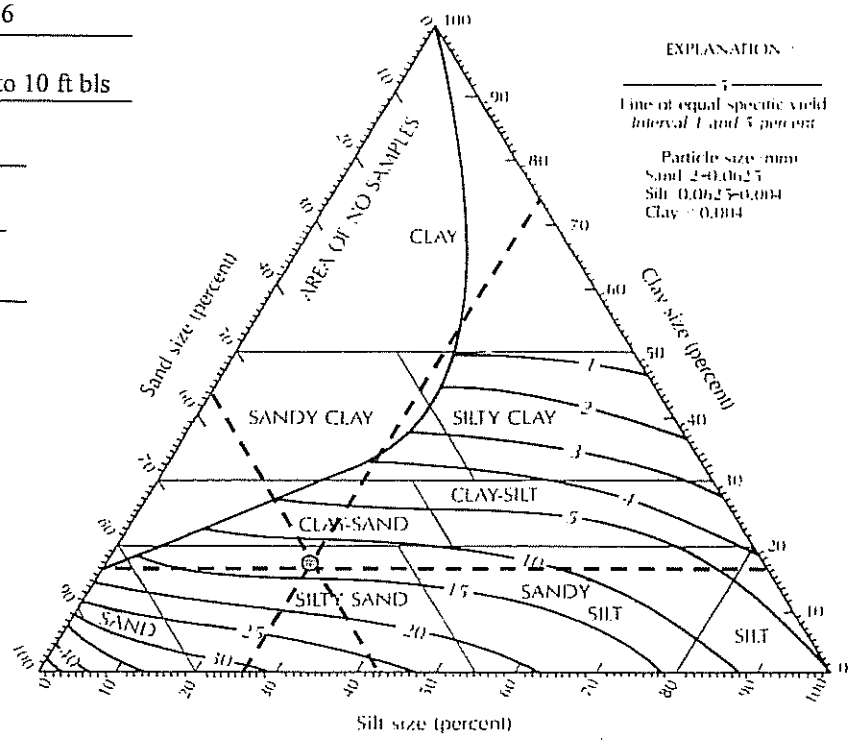
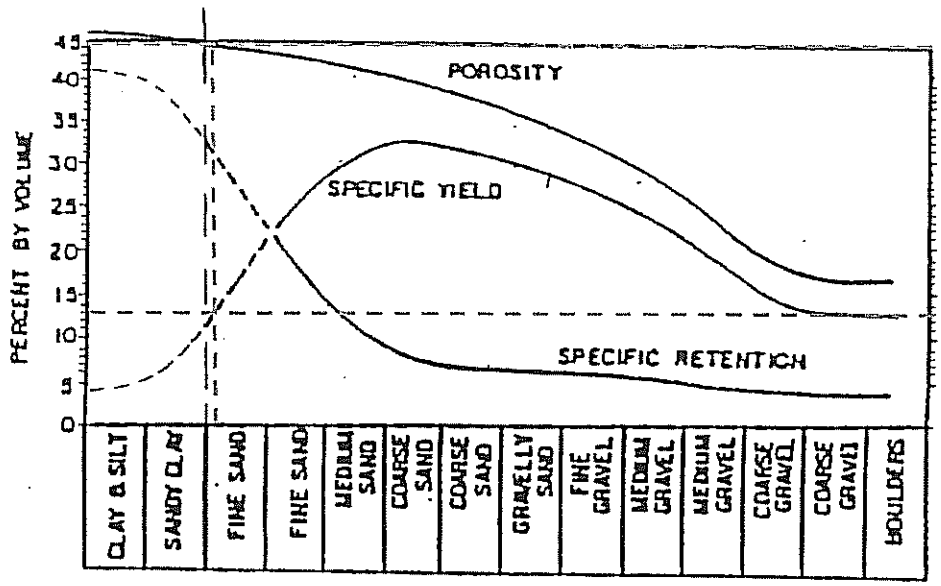


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



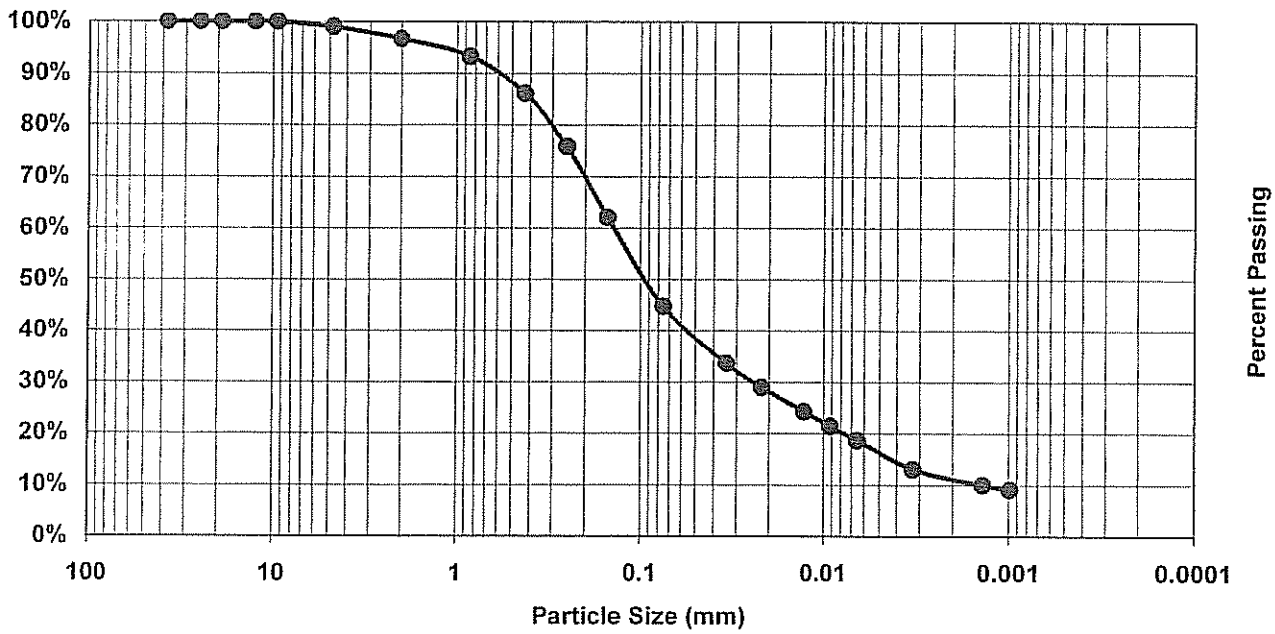
Estimated Porosity: 45%

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-16	M-16 (13-15)	13 to 15 ft bls

Sample Description:
Olive brown micaceous clayey silty medium to fine SAND (SC)



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 3.3%	% Sand 54.7%	% Silt 27.8%	% Clay 14.2%
Adjusted for Calculations	**0%**	**57%**	**29%**	**15%**

Notes:
Grain size distribution taken from grain size with hydrometer data located in Appendix II.
Gravel, sand, silt and clay sizes based on Wentworth Scale.

S&ME Project:
MSS Landfill Siting Survey

S&ME Project No.:
1411-07-103

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FETTER AND BEAR DIAGRAMS

S&ME PROJECT: MSS Landfill Siting Survey
S&ME PROJECT NO.: 1411-07-103

Boring No. M-16

Sample Depth: 13 to 15 ft bls

% Sand: 57%

% Silt: 29%

% Clay: 15%

Estimated Specific Yield: 15%

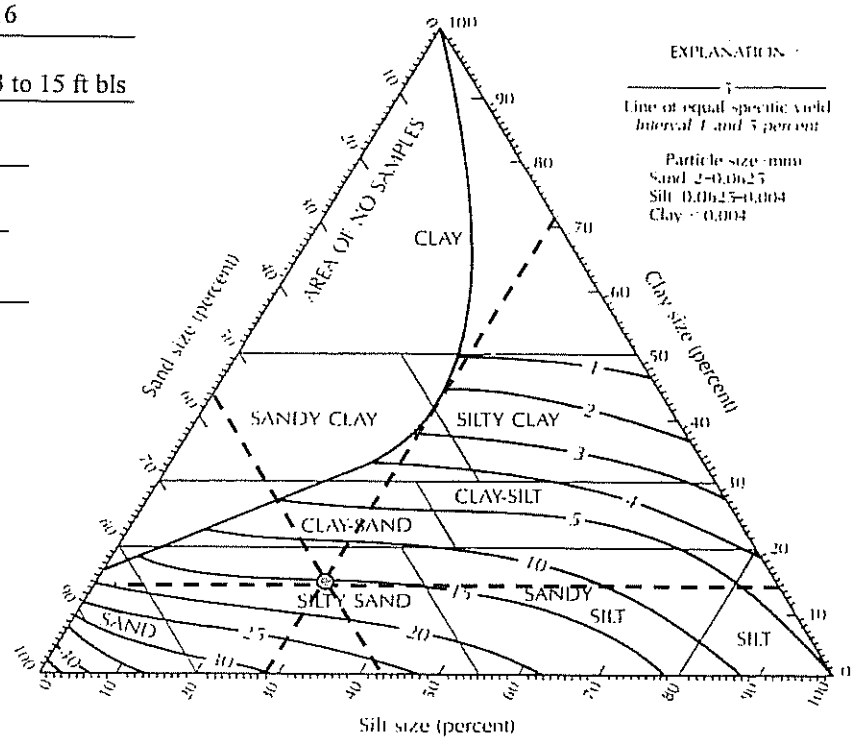
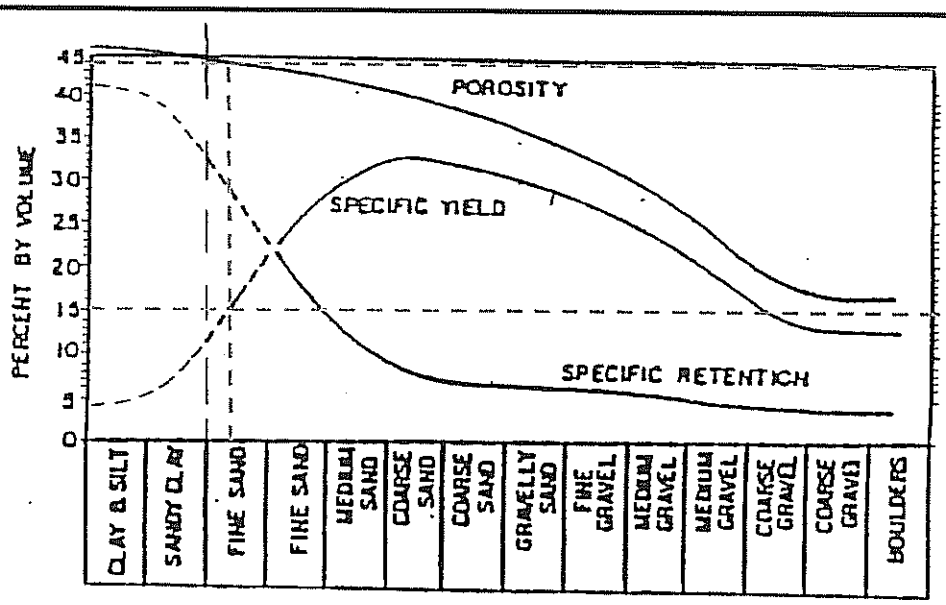


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



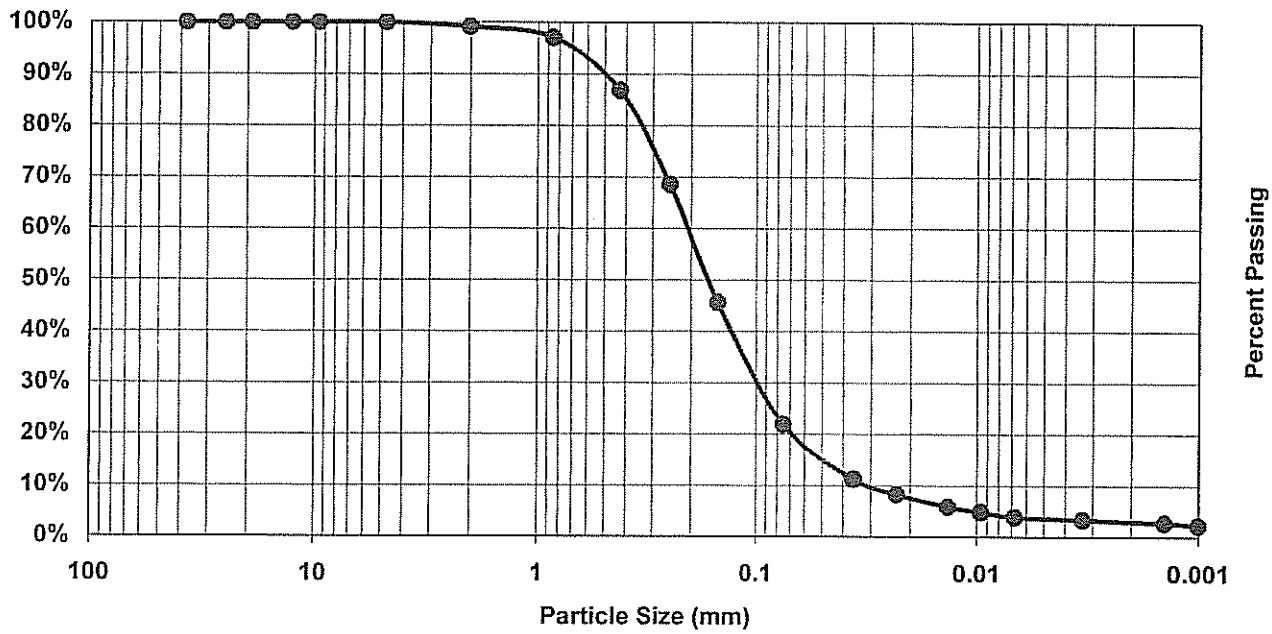
Estimated Porosity: 44%

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-16	M-16 (39'-40')	39 to 40 ft bls

Sample Description:
Gray olive micaceous silty fine SAND



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 0.9%	% Sand 79.9%	% Silt 15.7%	% Clay 3.5%
Adjusted for Calculations	**0%**	**81%**	**16%**	**4%**

Notes:
Grain size distribution taken from grain size with hydrometer data located in Appendix II.
Gravel, sand, silt and clay sizes based on Wentworth Scale.

S&ME Project:
MSS Landfill Siting Survey

S&ME Project No.:
1411-07-103

S&ME

FETTER AND BEAR DIAGRAMS

S&ME PROJECT: MSS Landfill Siting Survey
S&ME PROJECT NO.: 1411-07-103

Boring No. M-16

Sample Depth: 39 to 40 ft bls

% Sand: 81%

% Silt: 16%

% Clay: 4%

Estimated Specific Yield: 30%

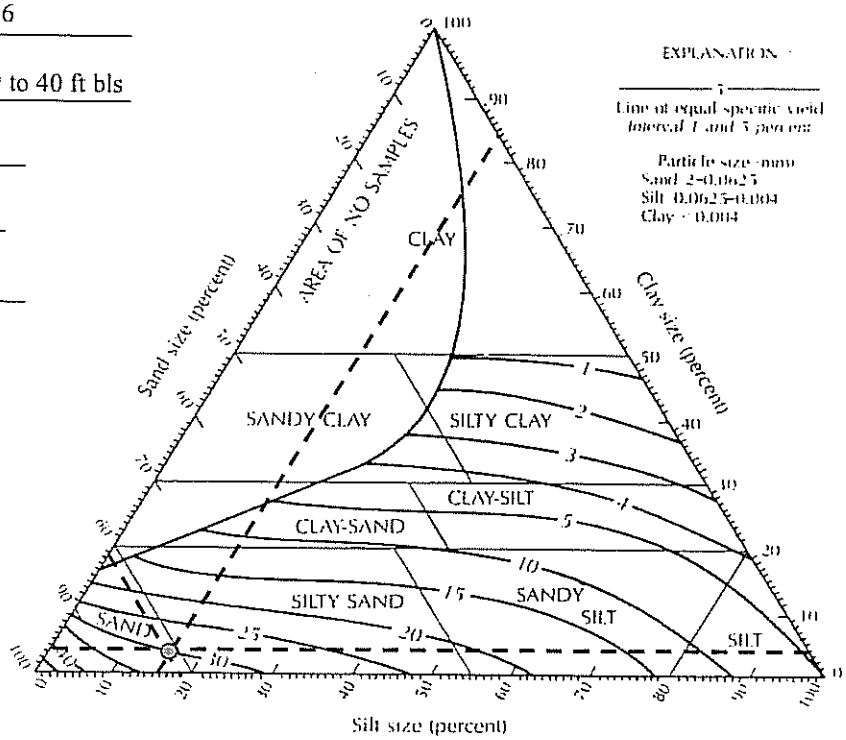
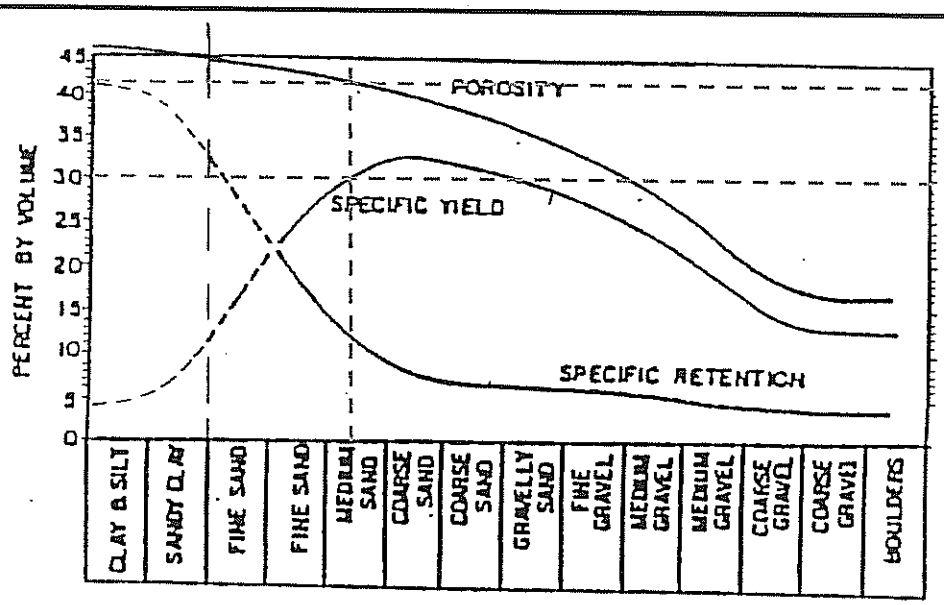


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



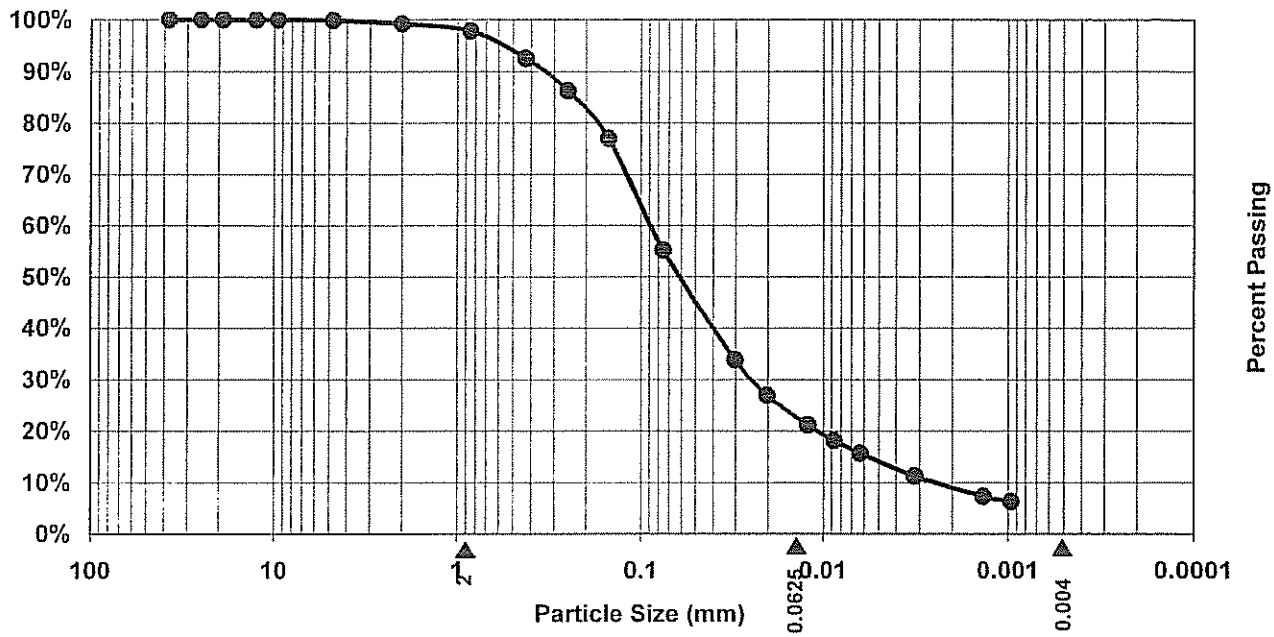
Estimated Porosity: 42%

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-17	Bulk	20 to 25 ft bls

Sample Description: Tan and Gray Micaceous Fine Sandy Clayey Silt (ML)



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 0.8%	% Sand 48.8%	% Silt 37.4%	% Clay 13.0%
Adjusted for Calculations	**0%**	**49%**	**38%**	**13%**

Notes:

Grain size distribution taken from grain size with hydrometer data located in Appendix II.

Gravel, sand, silt and clay sizes based on Wentworth Scale.

S&ME Project:
Allen Steam Station RAB Landfill

S&ME Project No.:
1356-06-825

S&ME

FETTER AND BEAR DIAGRAMS

S&ME PROJECT: Marshall Steam Station Industrial Landfill
S&ME PROJECT NO.: 1356-08-122

Boring No. M-17

Boring Depth: 20 to 25 ft bls

% Sand: 49%

% Silt: 38%

% Clay: 13%

Estimated Specific Yield: 16%

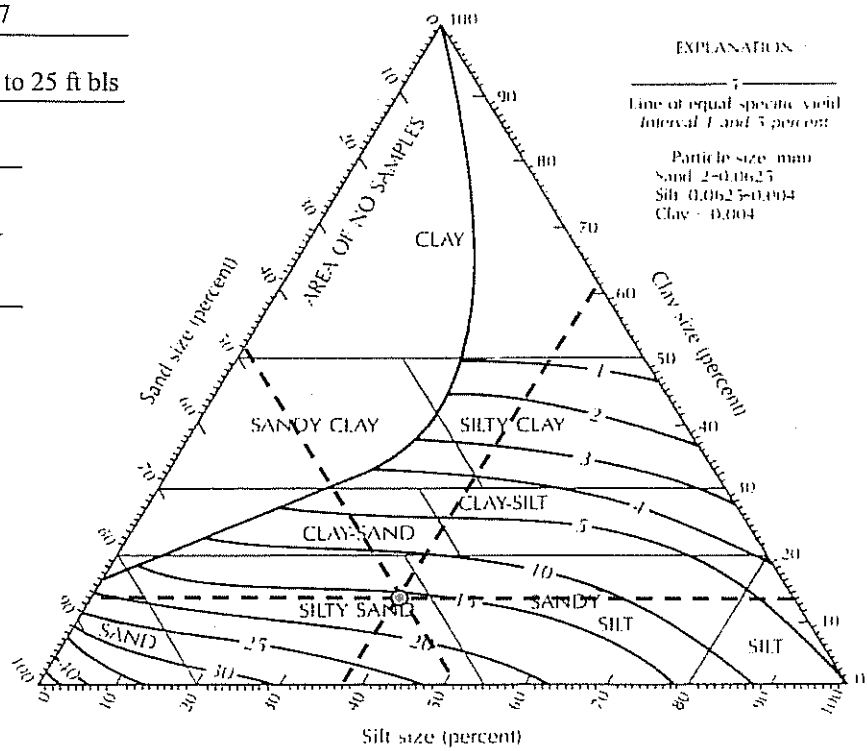
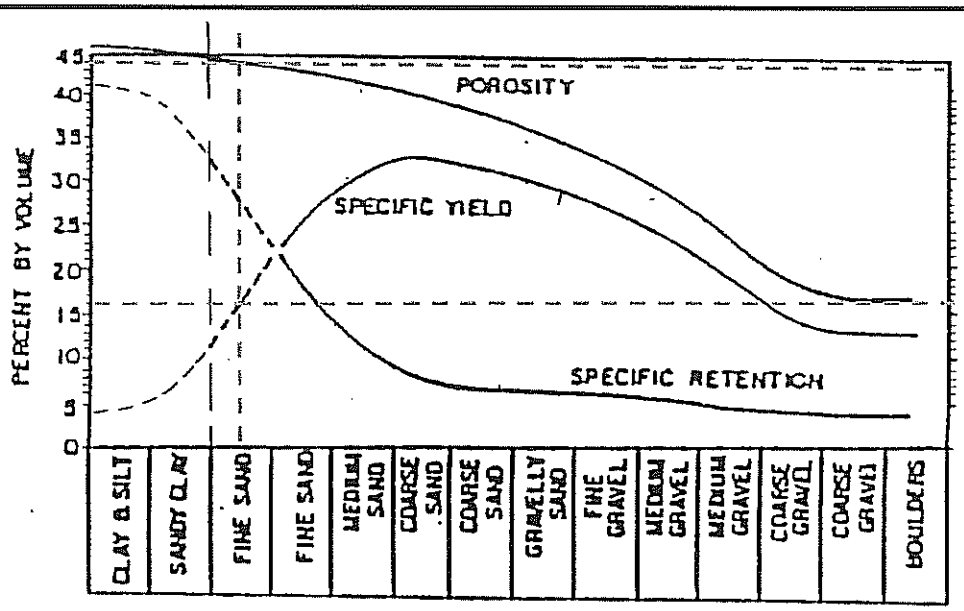


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



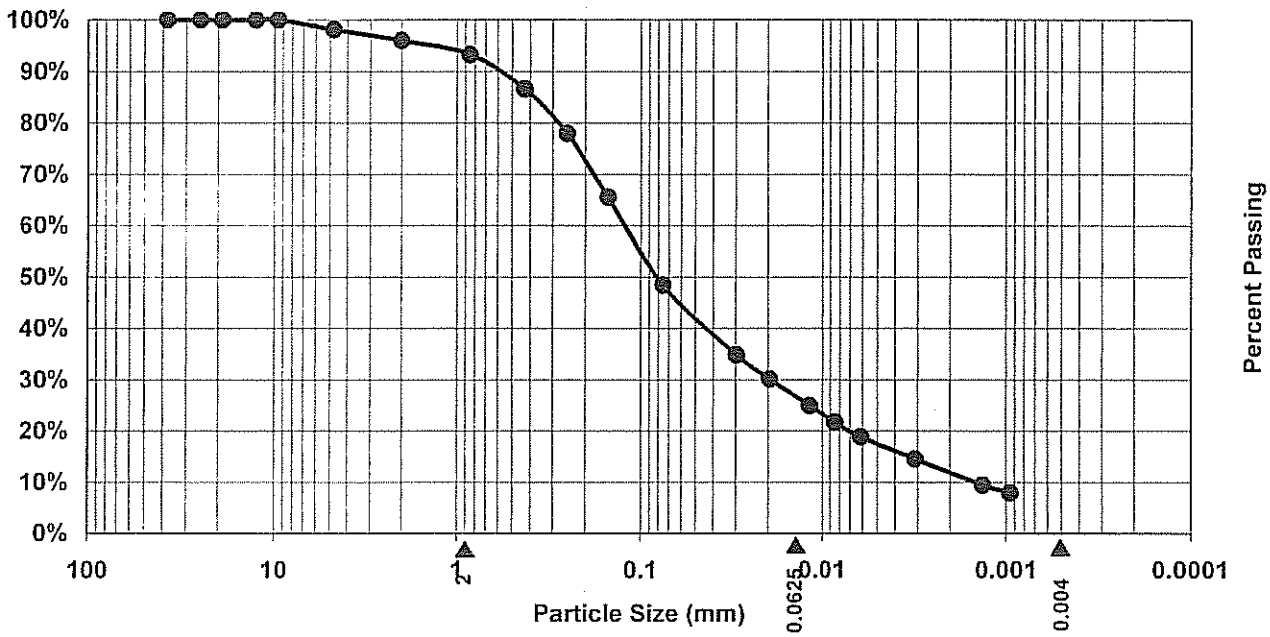
Estimated Porosity: 44%

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-18	Bulk	19 to 24 ft bls

Sample Description: Brown and Orange Clayey Silty Fine Sand (SC-SM)



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 4.0%	% Sand 50.6%	% Silt 28.3%	% Clay 17.1%
Adjusted for Calculations	**0%**	**53%**	**29%**	**18%**

Notes:

Grain size distribution taken from grain size with hydrometer data located in Appendix II.

Gravel, sand, silt and clay sizes based on Wentworth Scale.

S&ME Project:
Allen Steam Station RAB Landfill

S&ME Project No.:
1356-06-825

S&ME

FETTER AND BEAR DIAGRAMS

S&ME PROJECT: Marshall Steam Station Industrial Landfill
S&ME PROJECT NO.: 1356-08-122

Boring No. M-18

Boring Depth: 19 to 24 ft bls

% Sand: 53%

% Silt: 29%

% Clay: 18%

Estimated Specific Yield: 13%

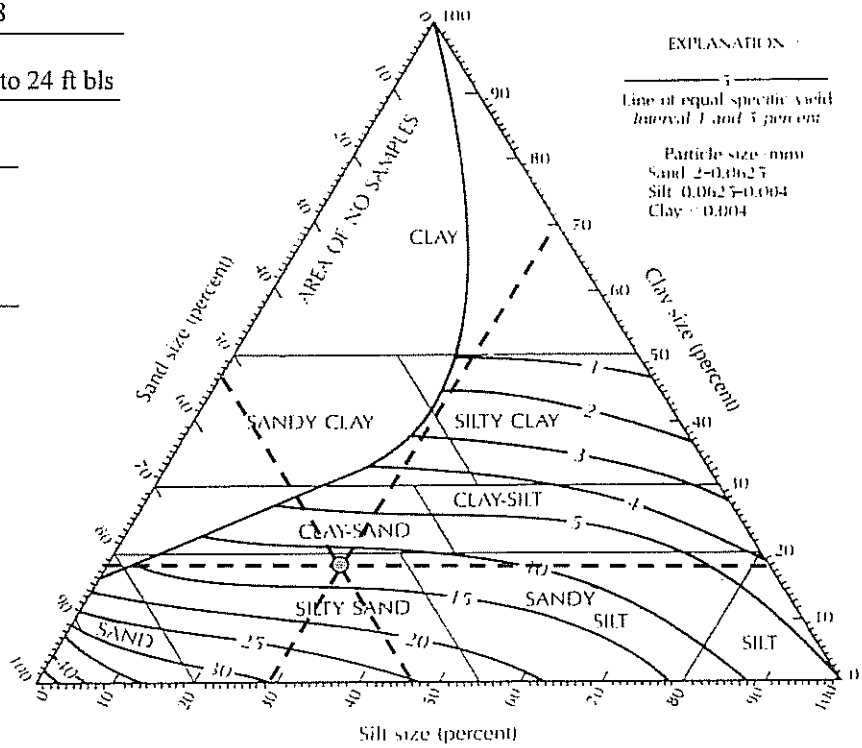
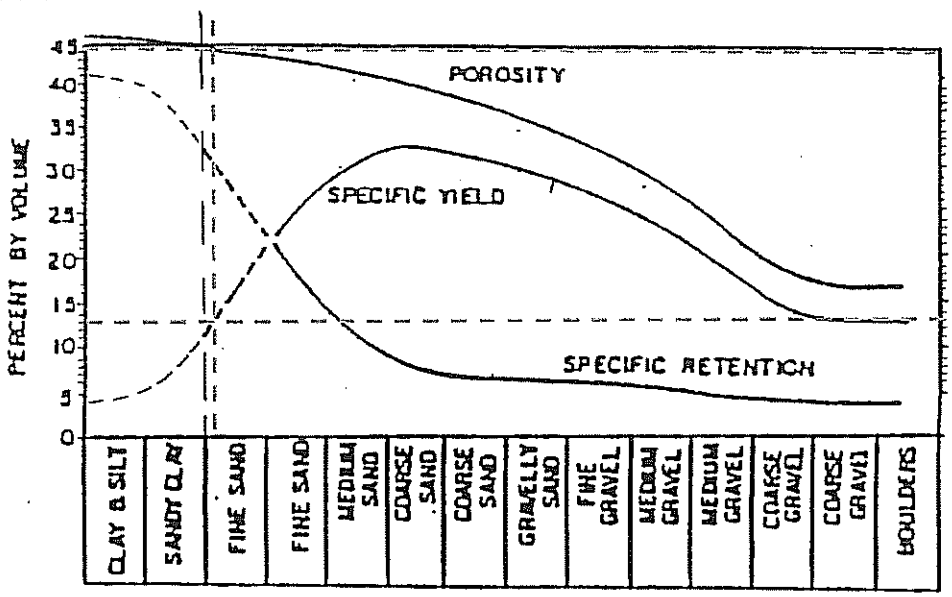


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



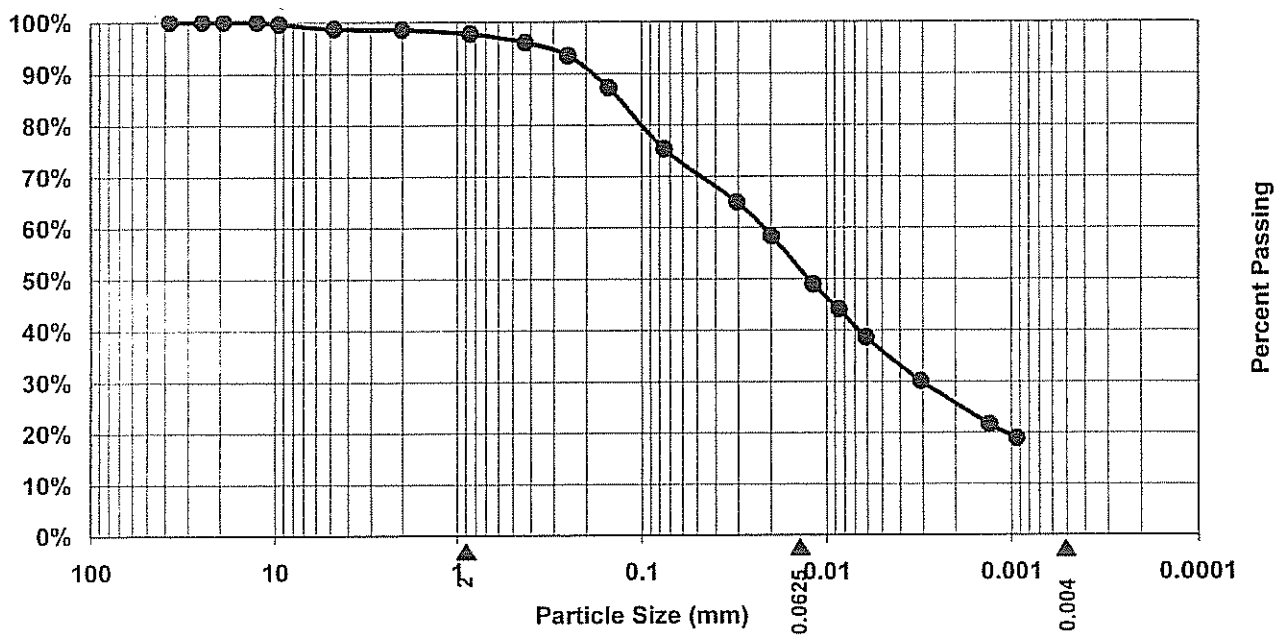
Estimated Porosity: 44.5%

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-19	Bulk	3.3 to 8.3 ft bls

Sample Description: Red and Tan Clayey Silt with Fine Sand (ML)



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 1.5%	% Sand 25.5%	% Silt 38.5%	% Clay 34.5%
Adjusted for Calculations	**0%**	**26%**	**39%**	**35%**

Notes:

Grain size distribution taken from grain size with hydrometer data located in Appendix II.

Gravel, sand, silt and clay sizes based on Wentworth Scale.

S&ME Project:
Allen Steam Station RAB Landfill

S&ME Project No.:
1356-06-825

S&ME

FETTER AND BEAR DIAGRAMS

S&ME PROJECT: Marshall Steam Station Industrial Landfill
S&ME PROJECT NO.: 1356-08-122

Boring No. M-19

Boring Depth: 3.3 to 8.3 ft bls

% Sand: 26%

% Silt: 39%

% Clay: 35%

Estimated Specific Yield: 3.2%

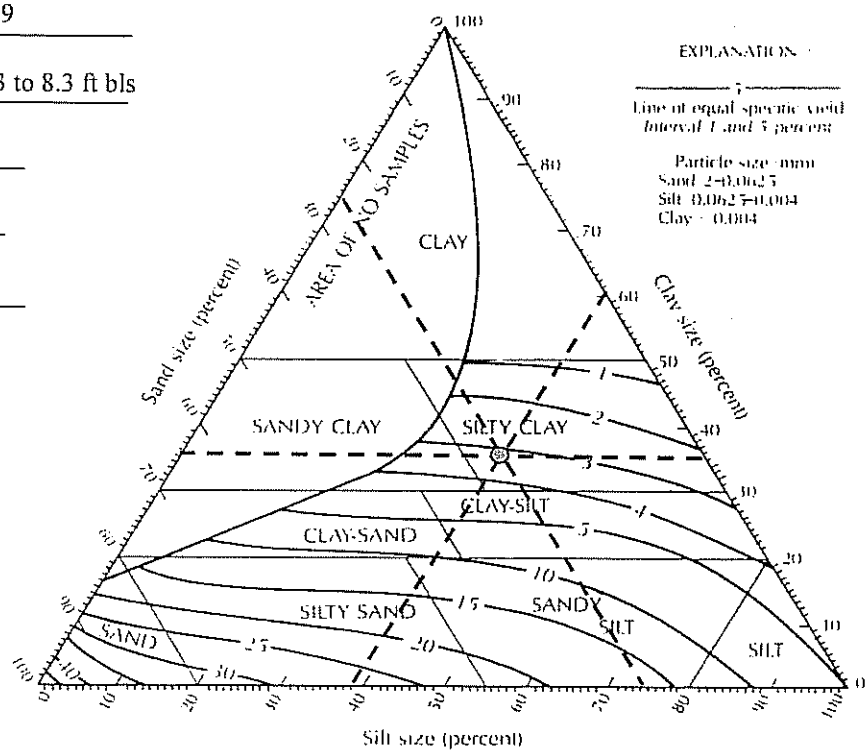
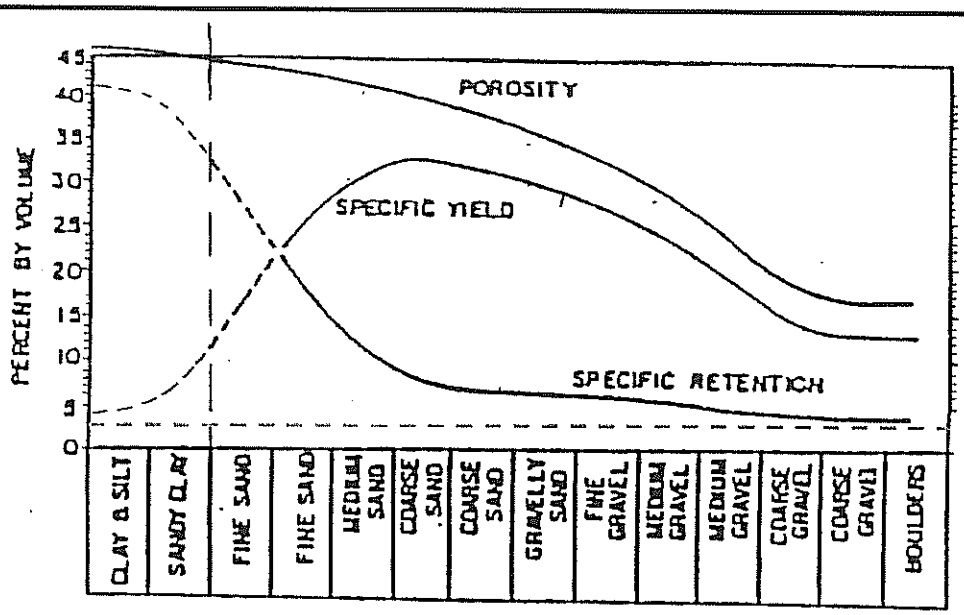


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



Estimated Porosity: 47%**

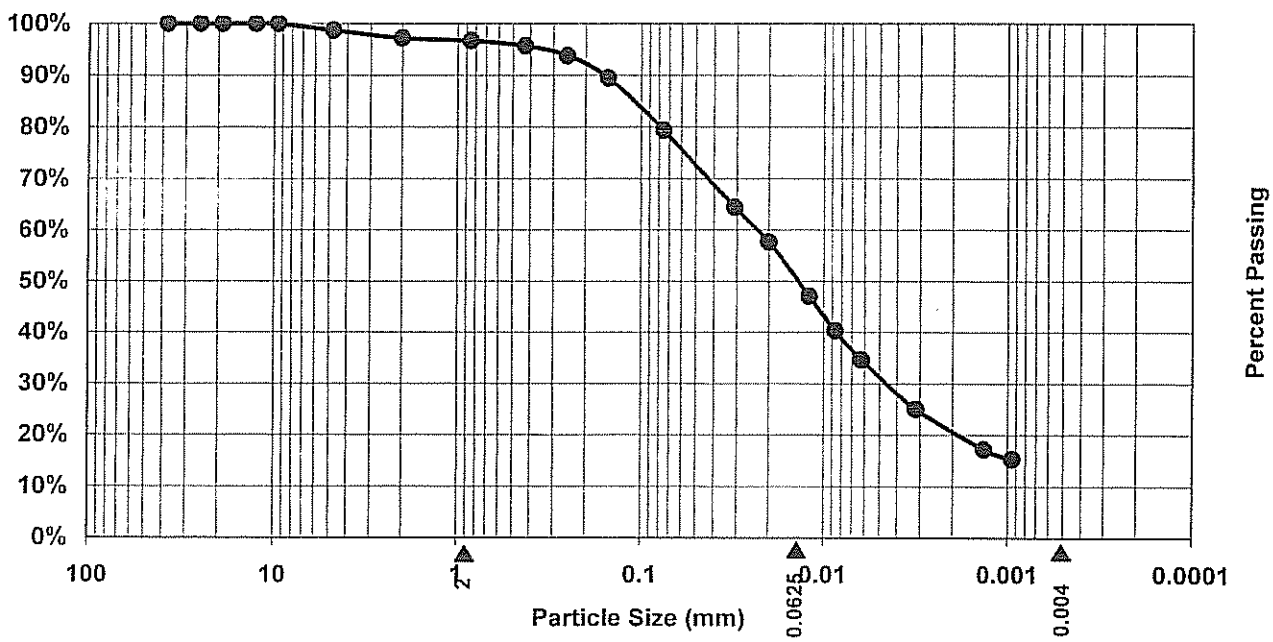
**Based on Table of Selected Values of Porosity, Specific Yield and Specific Retention, USGS Water Supply Paper 2220.

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-20	Bulk	13.7 to 18.7 ft bls

Sample Description: Light Brown and Orange Clayey Silt with Fine Sand (MH)



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 2.8%	% Sand 21.3%	% Silt 47.2%	% Clay 28.7%
Adjusted for Calculations	**0%**	**22%**	**49%**	**30%**

Notes:

Grain size distribution taken from grain size with hydrometer data located in Appendix II.

Gravel, sand, silt and clay sizes based on Wentworth Scale.

S&ME Project:
Allen Steam Station RAB Landfill

S&ME Project No.:
1356-06-825

S&ME

FETTER AND BEAR DIAGRAMS

S&ME PROJECT: Marshall Steam Station Industrial Landfill
S&ME PROJECT NO.: 1356-08-122

Boring No. M-20

Boring Depth: 13.7 to 18.7 ft bls

% Sand: 22%

% Silt: 49%

% Clay: 30%

Estimated Specific Yield: 4%

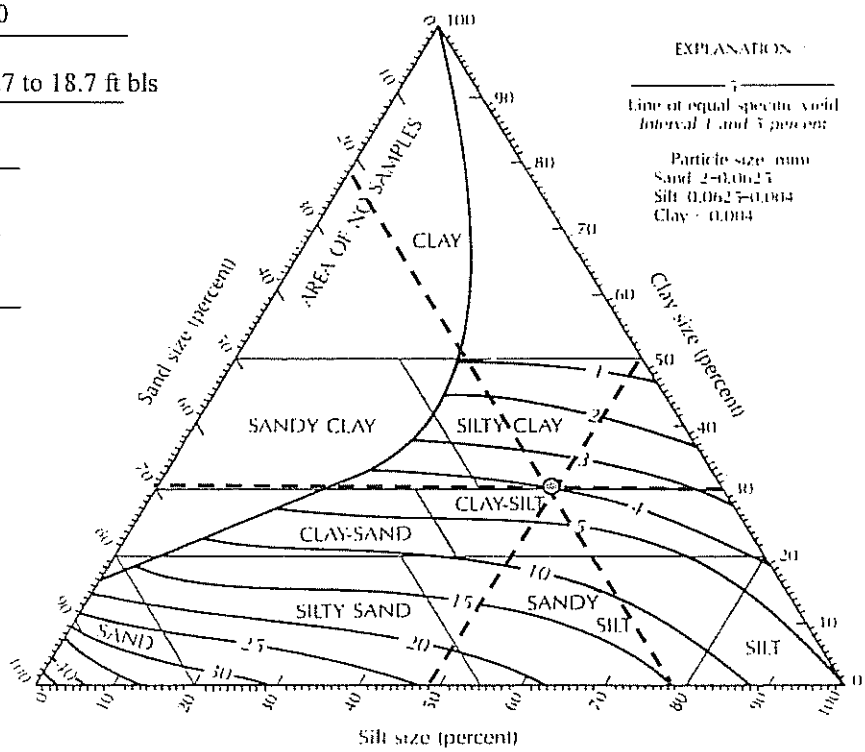
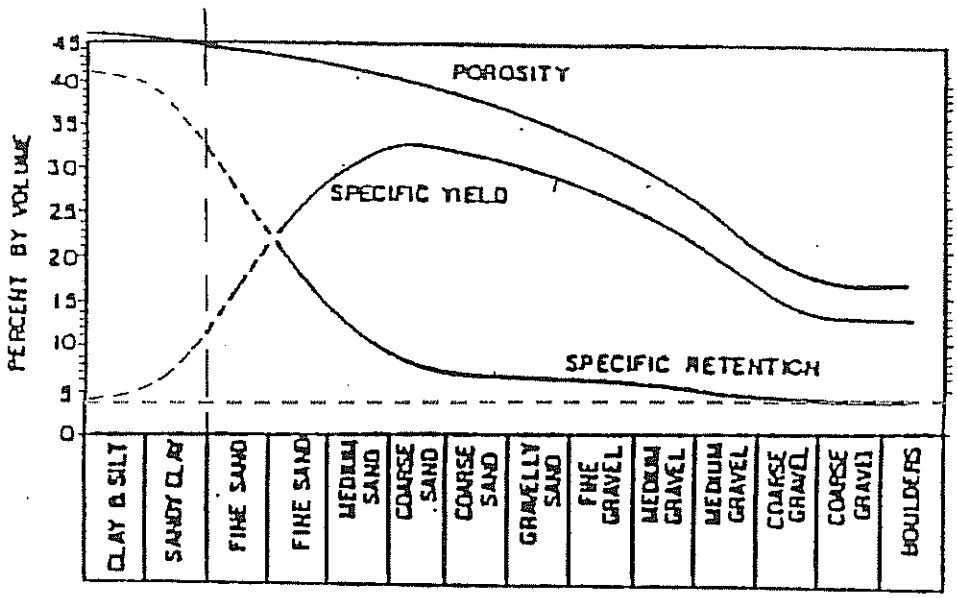


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



Estimated Porosity: 46%**

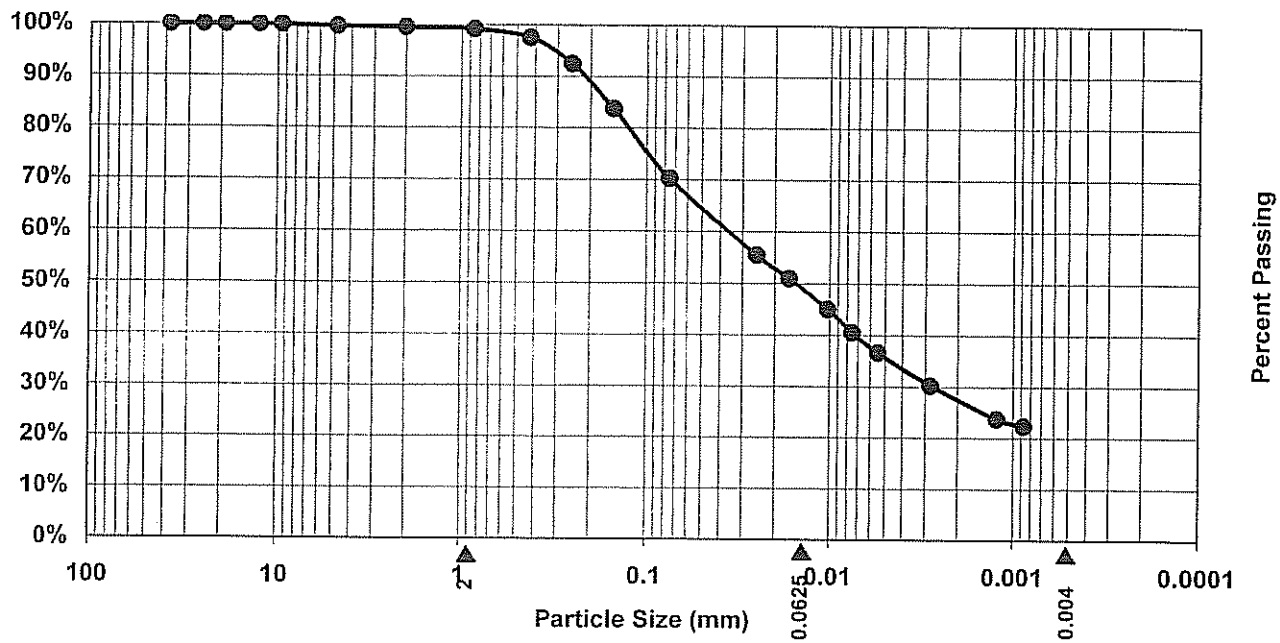
**Based on Table of Selected Values of Porosity, Specific Yield and Specific Retention, USGS Water Supply Paper 2220.

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-21	Bulk	3.3 to 8.3 ft bls

Sample Description: Orange and Brown Fine Sandy Silty Clay (CL)



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 0.5%	% Sand 32.3%	% Silt 32.1%	% Clay 35.1%
Adjusted for Calculations	**0%**	**32%**	**32%**	**35%**

Notes:

Grain size distribution taken from grain size with hydrometer data located in Appendix II.

Gravel, sand, silt and clay sizes based on Wentworth Scale.

S&ME Project:
Allen Steam Station RAB Landfill

S&ME Project No.:
1356-06-825

S&ME

FETTER AND BEAR DIAGRAMS

S&ME PROJECT: Marshall Steam Station Industrial Landfill
S&ME PROJECT NO.: 1356-08-122

Boring No. M-21

Boring Depth: 3.3 to 8.3 ft bls

% Sand: 32%

% Silt: 32%

% Clay: 35%

Estimated Specific Yield: 3.5%

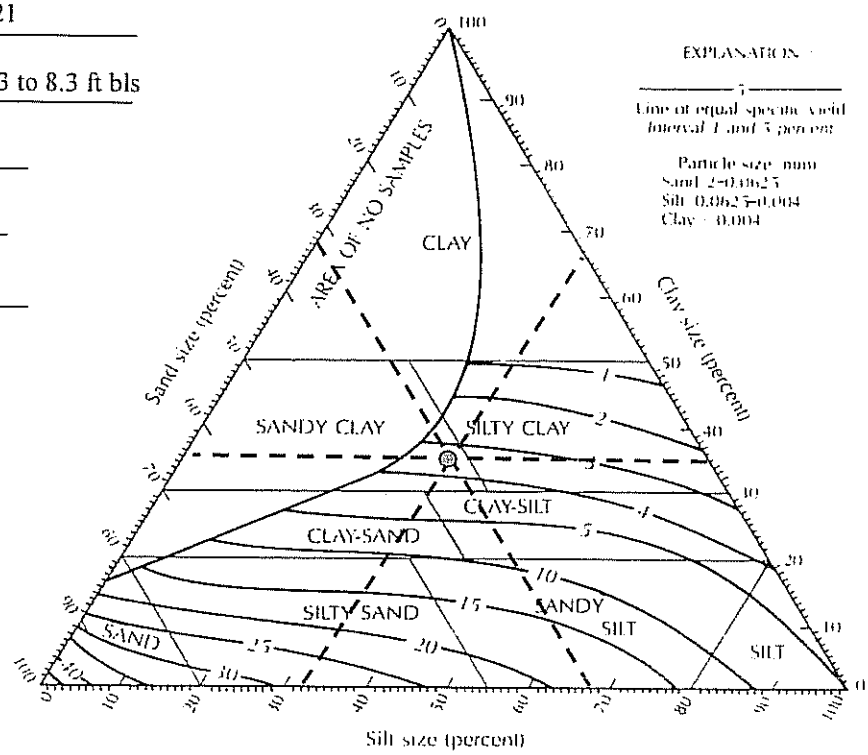
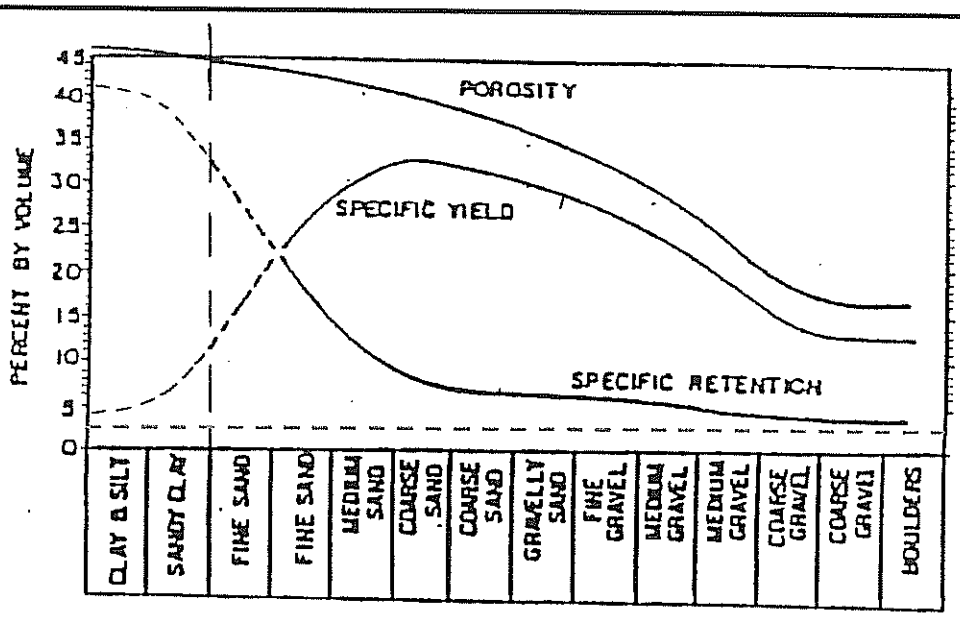


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



Estimated Porosity: 47%**

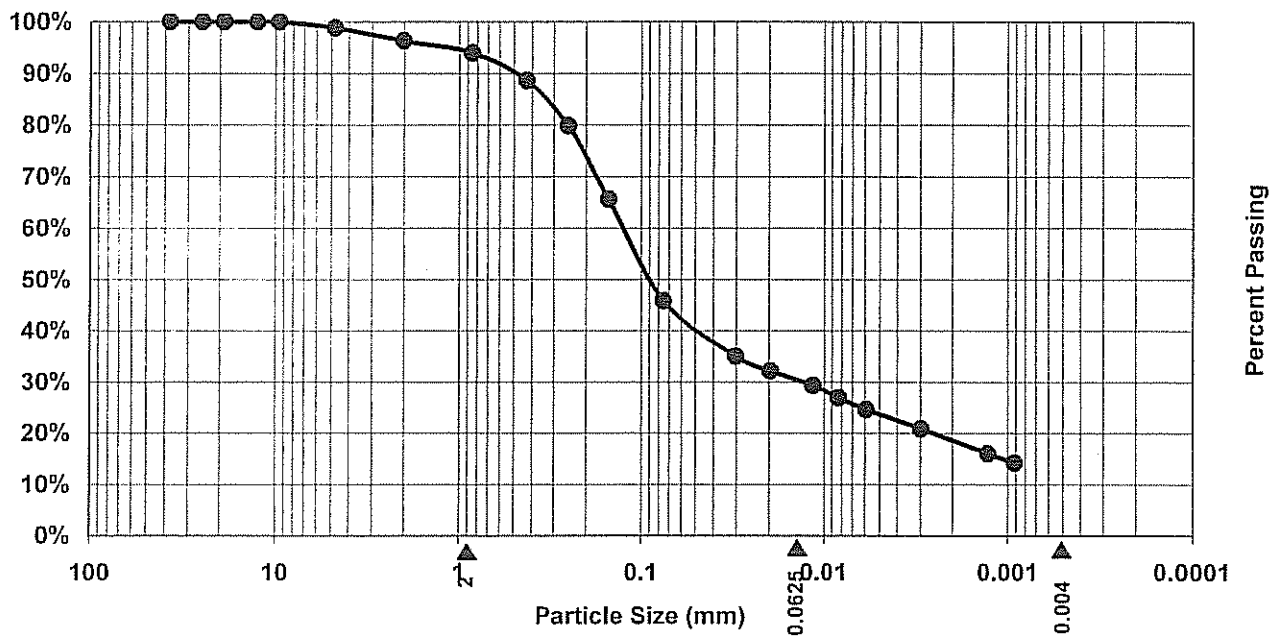
**Based on Table of Selected Values of Porosity, Specific Yield and Specific Retention, USGS Water Supply Paper 2220.

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-23	Bulk	3.8 to 11.8 ft bls

Sample Description: Tan, Olive, and Gray Silty Clayey Fine Sand (SC)



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 3.7%	% Sand 52.9%	% Silt 19.7%	% Clay 23.7%
Adjusted for Calculations	**0%**	**55%**	**20%**	**25%**

Notes:

Grain size distribution taken from grain size with hydrometer data located in Appendix II.

Gravel, sand, silt and clay sizes based on Wentworth Scale.

S&ME Project:
Allen Steam Station RAB Landfill

S&ME Project No.:
1356-06-825

S&ME

FETTER AND BEAR DIAGRAMS

S&ME PROJECT: Marshall Steam Station Industrial Landfill
S&ME PROJECT NO.: 1356-08-122

Boring No. M-23

Boring Depth: 3.8 to 11.8 ft bls

% Sand: 55%

% Silt: 20%

% Clay: 25%

Estimated Specific Yield: 6%

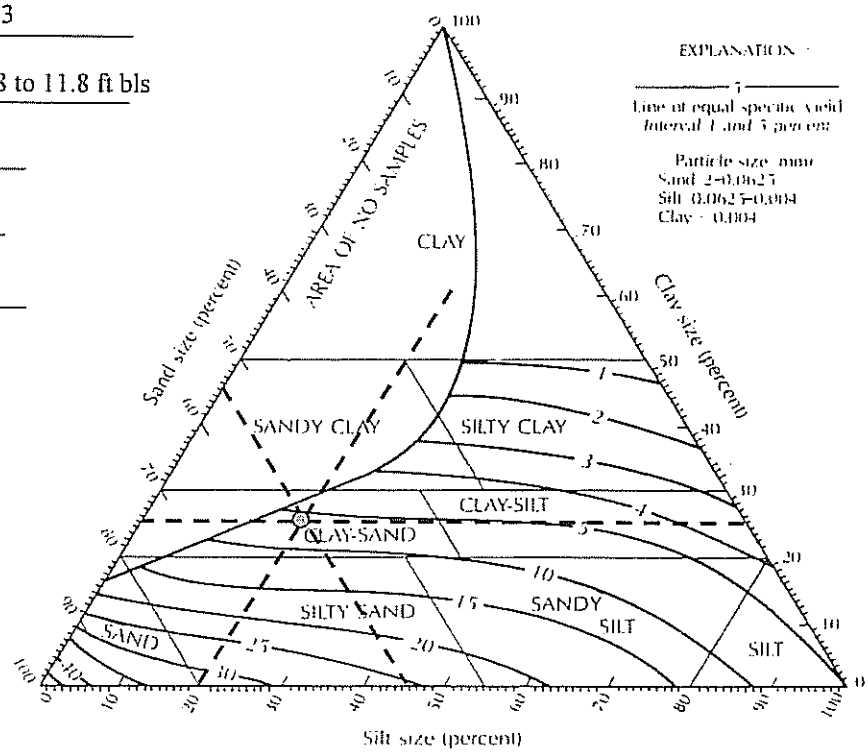
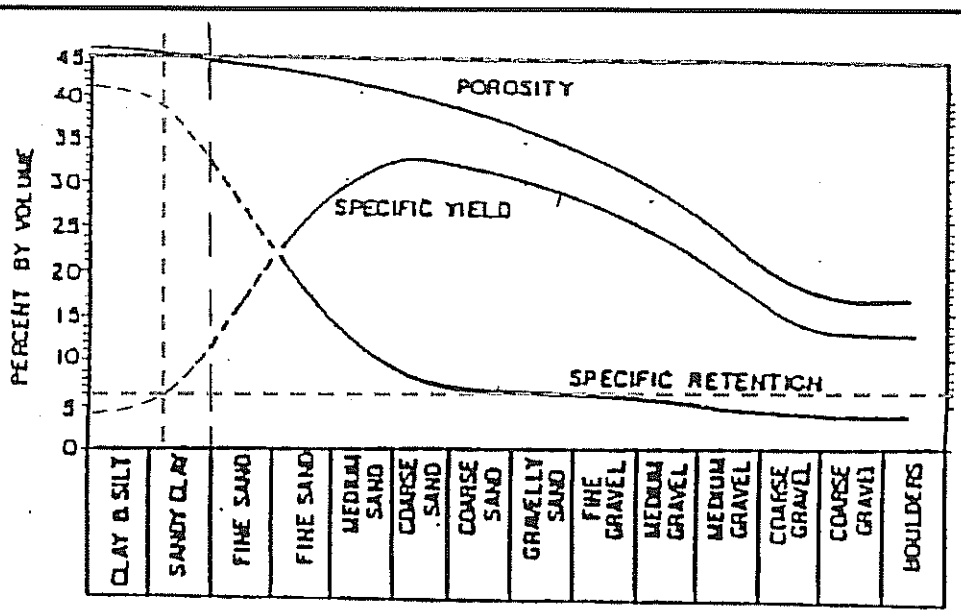


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



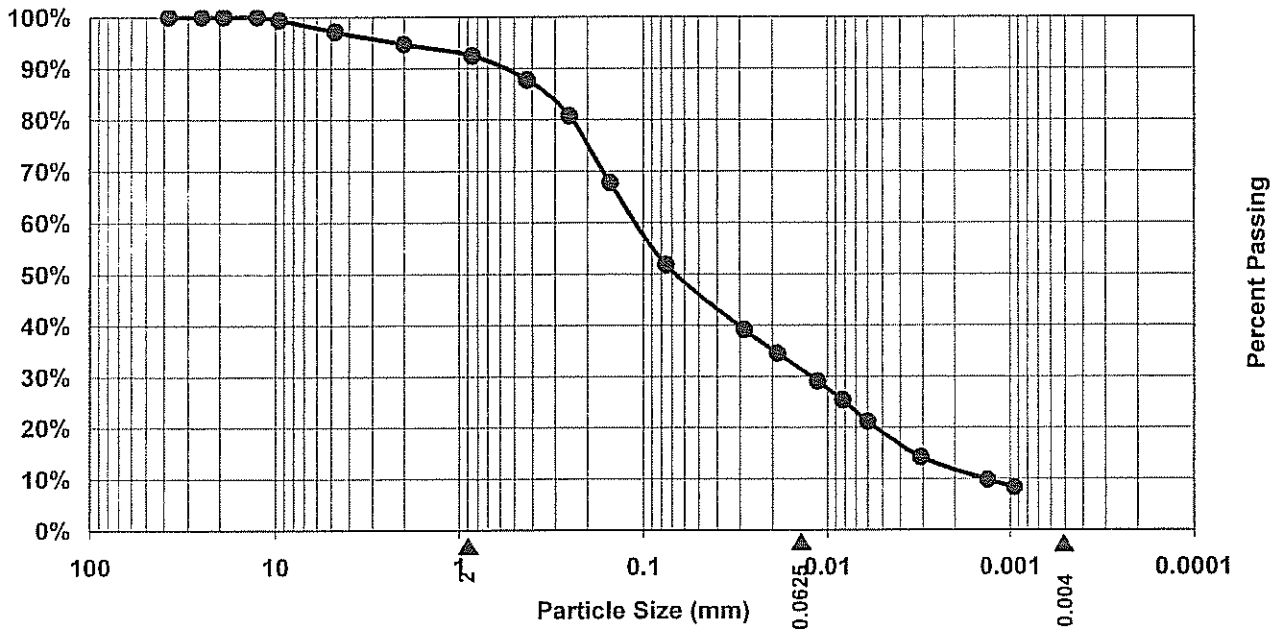
Estimated Porosity: 45%

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-24	Bulk	15 to 20 ft bls

Sample Description: Light Brown and Red Fine Sandy Silty Clay (CL)



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 5.3%	% Sand 45.6%	% Silt 32.5%	% Clay 16.6%
Adjusted for Calculations	**0%**	**48%**	**34%**	**18%**

Notes:

Grain size distribution taken from grain size with hydrometer data located in Appendix II.

Gravel, sand, silt and clay sizes based on Wentworth Scale.

S&ME Project:
Allen Steam Station RAB Landfill

S&ME Project No.:
1356-06-825

S&ME

FETTER AND BEAR DIAGRAMS

S&ME PROJECT: Marshall Steam Station Industrial Landfill
S&ME PROJECT NO.: 1356-08-122

Boring No. M-24

Boring Depth: 15 to 20 ft bls

% Sand: 48%

% Silt: 34%

% Clay: 18%

Estimated Specific Yield: 12%

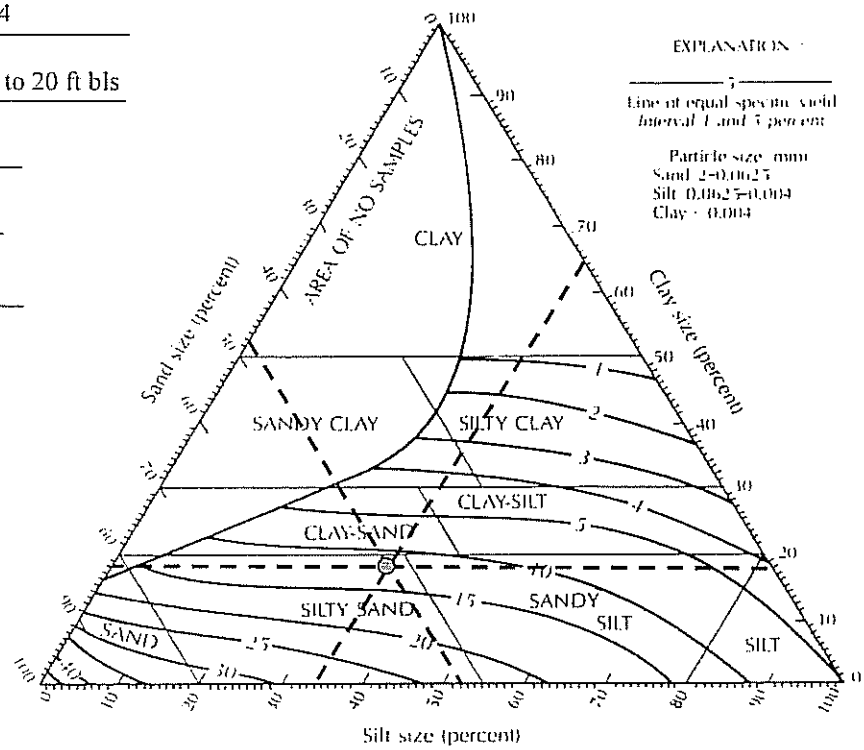
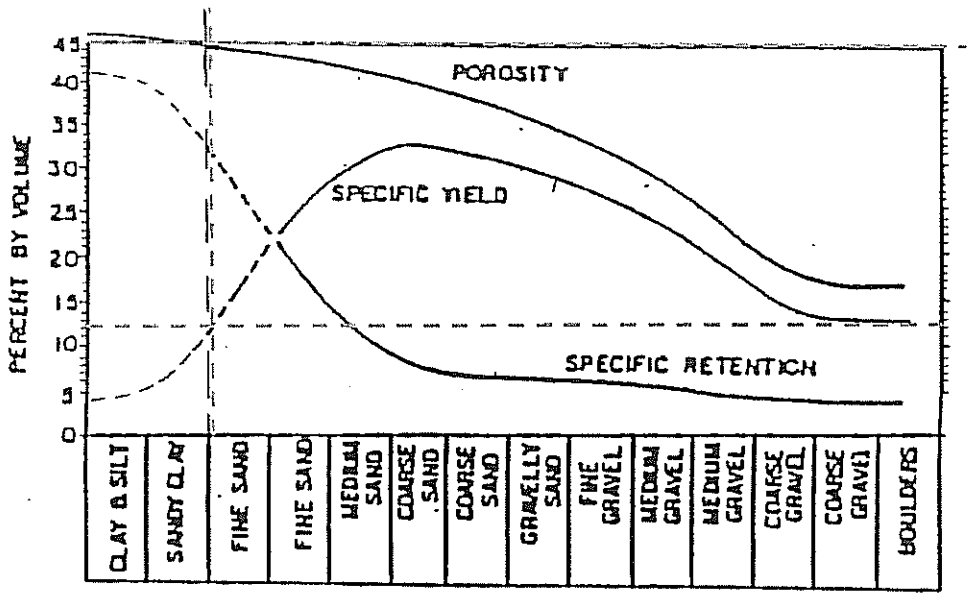


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



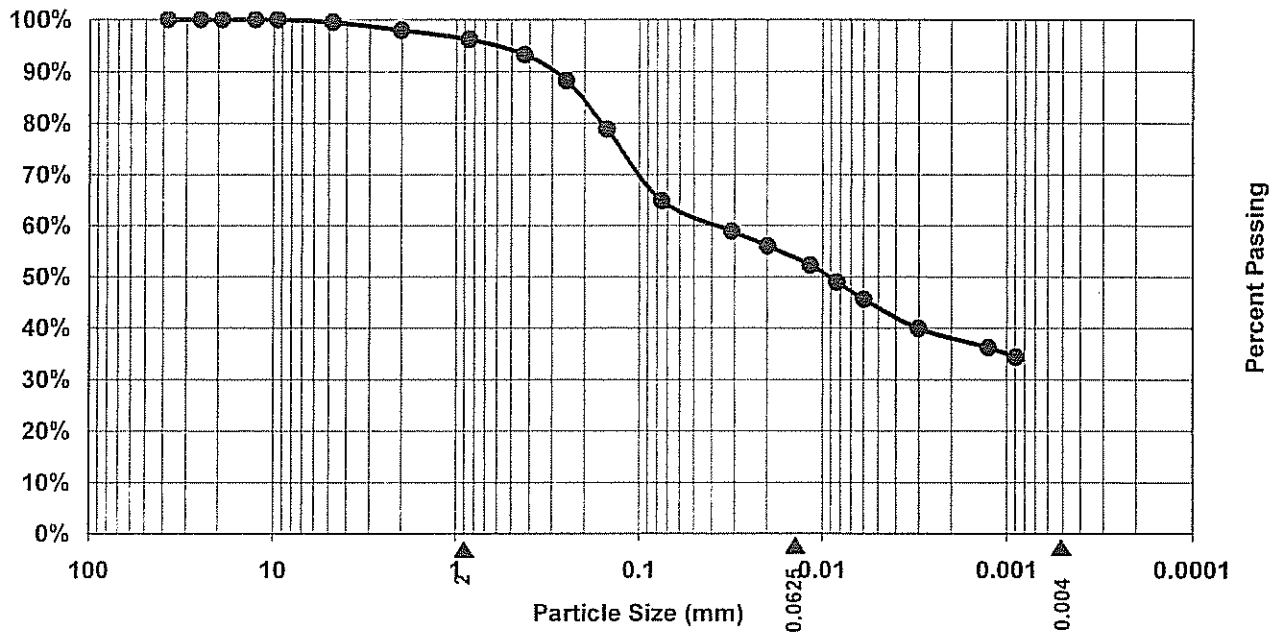
Estimated Porosity: 45%

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-25	Bulk	0 to 5 ft bls

Sample Description: Red and Brown Fine Sandy Silty Clay (CH)



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 2.1%	% Sand 34.4%	% Silt 21.4%	% Clay 42.0%
Adjusted for Calculations	**0%**	**35%**	**22%**	**43%**

Notes:

Grain size distribution taken from grain size with hydrometer data located in Appendix II.

Gravel, sand, silt and clay sizes based on Wentworth Scale.

S&ME Project:
Allen Steam Station RAB Landfill

S&ME Project No.:
1356-06-825

S&ME

FETTER AND BEAR DIAGRAMS

S&ME PROJECT: Marshall Steam Station Industrial Landfill
S&ME PROJECT NO.: 1356-08-122

Boring No. M-25

Boring Depth: 0 to 5 ft bls

% Sand: 35%

% Silt: 22%

% Clay: 43%

Estimated Specific Yield: 2.2%*

*Estimated Value

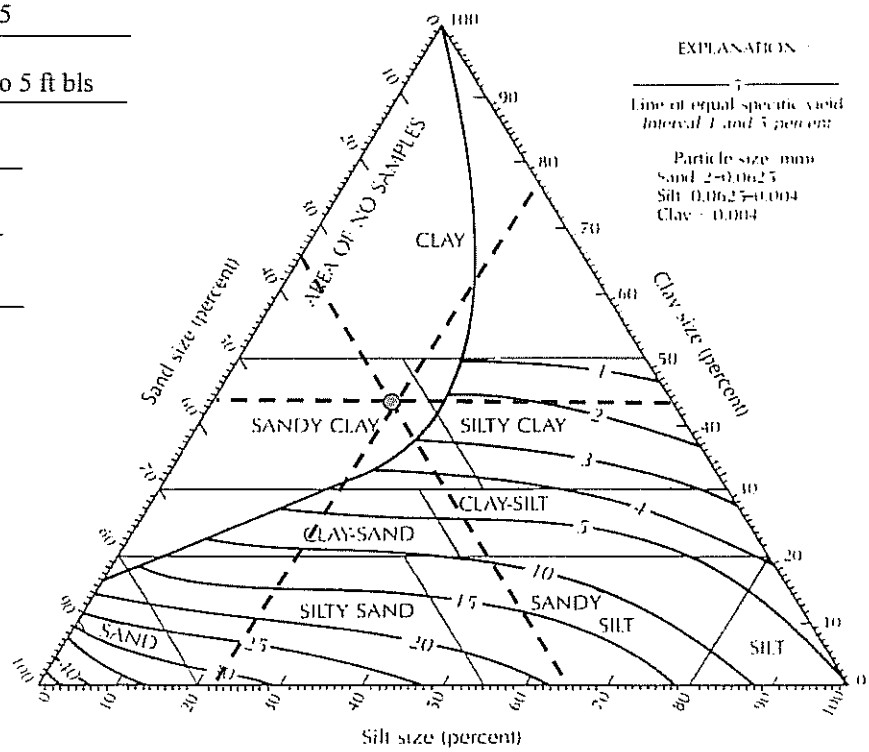
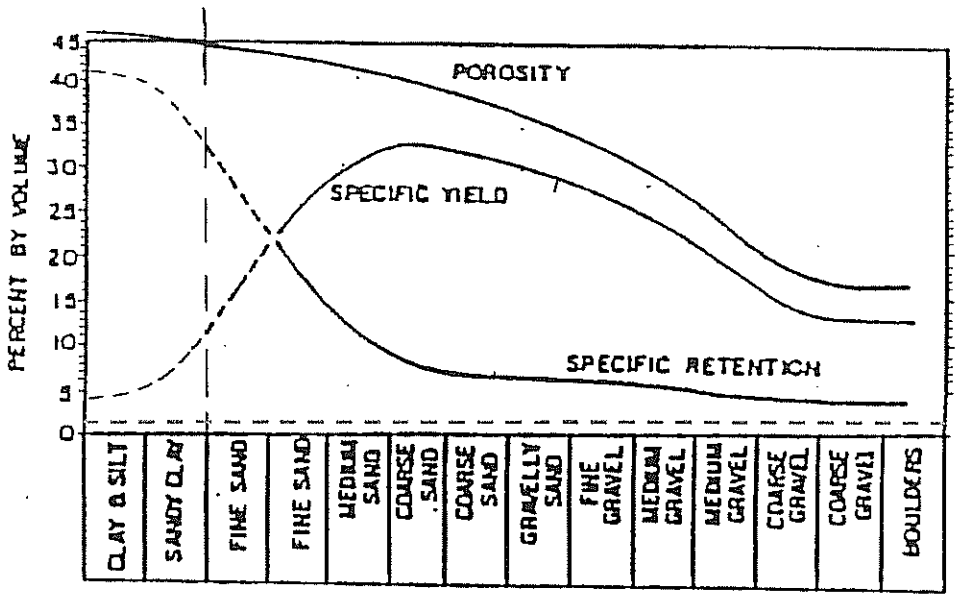


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



Estimated Porosity: 50%**

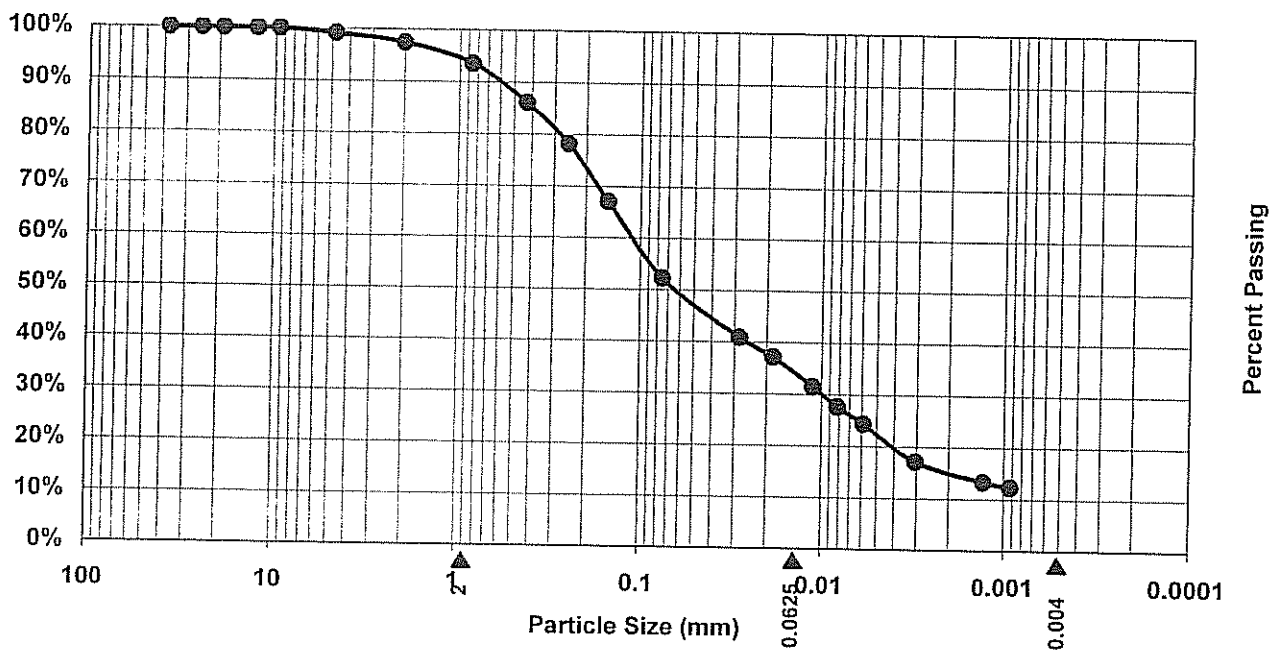
**Based on Table of Selected Values of Porosity, Specific Yield and Specific Retention, USGS Water Supply Paper 2220.

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-26	Bulk	3.5 to 8.5 ft bls

Sample Description: Tan, Orange, and Red Medium to Fine Sandy Clayey Silt (ML)



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 2.6%	% Sand 47.6%	% Silt 30.6%	% Clay 19.2%
Adjusted for Calculations	**0%**	**49%**	**31%**	**20%**

Notes:

Grain size distribution taken from grain size with hydrometer data located in Appendix II.

Gravel, sand, silt and clay sizes based on Wentworth Scale.

S&ME Project:
Allen Steam Station RAB Landfill

S&ME Project No.:
1356-06-825

S&ME

FETTER AND BEAR DIAGRAMS

S&ME PROJECT: Marshall Steam Station Industrial Landfill
S&ME PROJECT NO.: 1356-08-122

Boring No. M-26

Boring Depth: 3.5 to 8.5 ft bls

% Sand: 49%

% Silt: 31%

% Clay: 20%

Estimated Specific Yield: 11%

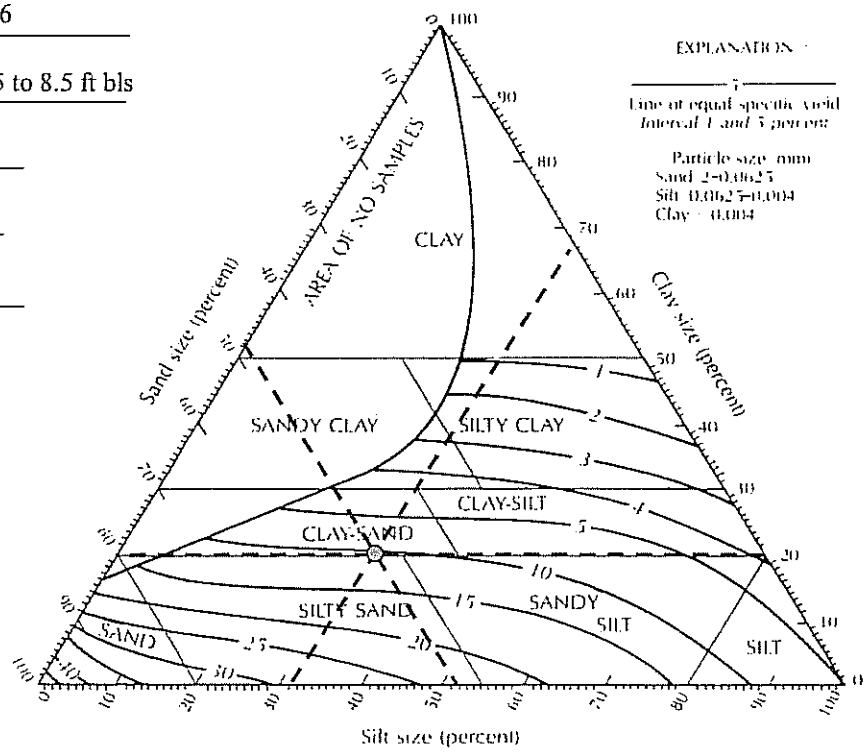
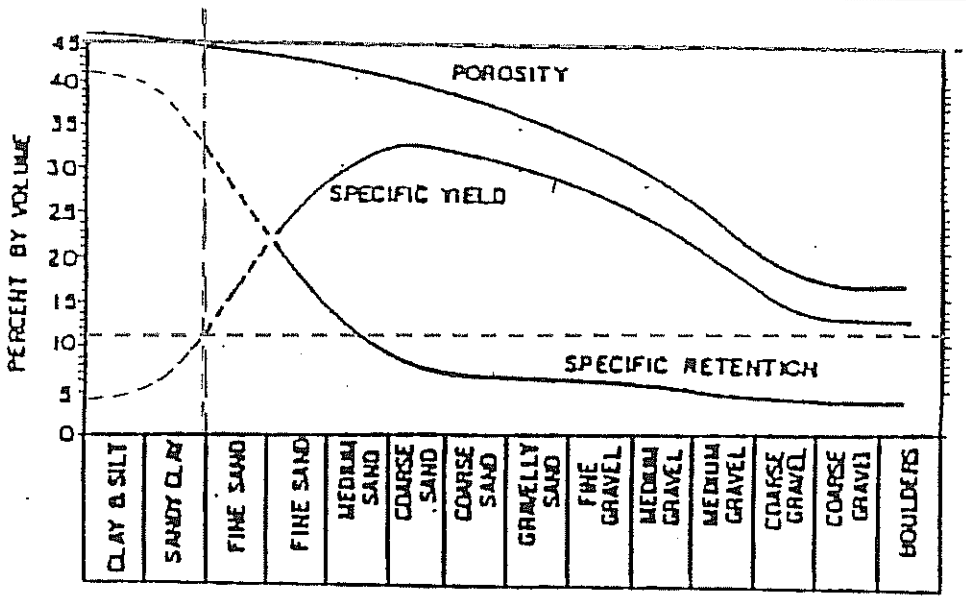


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



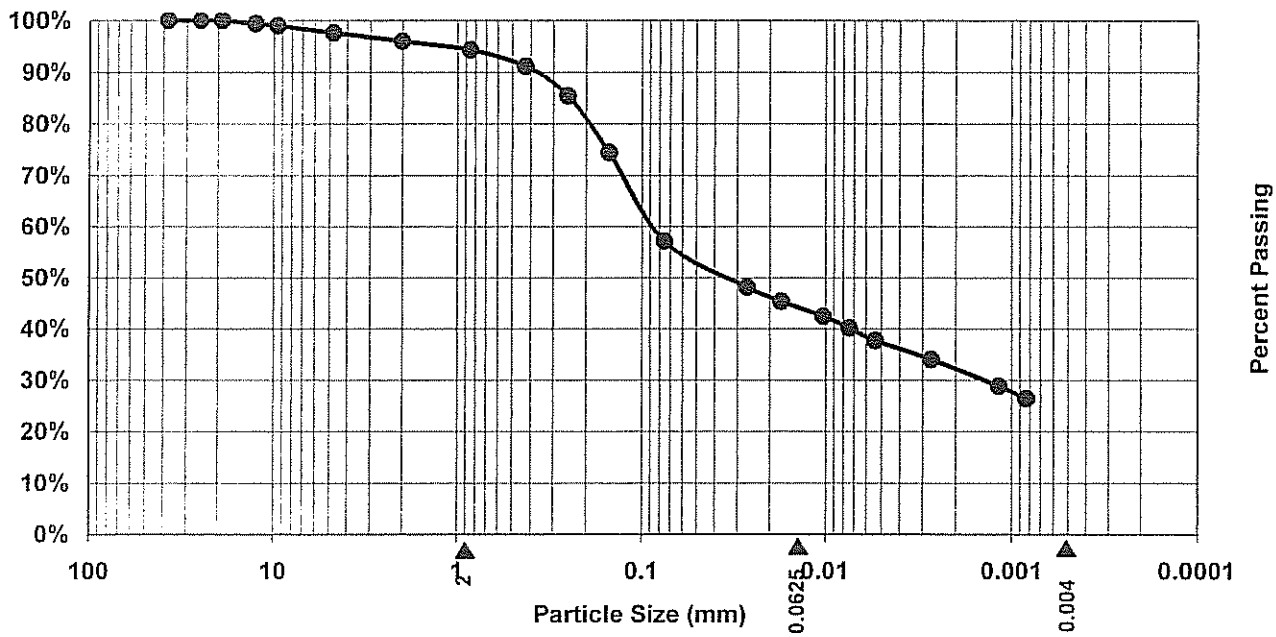
Estimated Porosity: 45%

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-28	Bulk	3.5 to 8.5 ft bls

Sample Description: Brown, Red, and Orange Fine Sandy Silty Clay (CL)



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 4.0%	% Sand 40.8%	% Silt 16.8%	% Clay 38.5%
Adjusted for Calculations	**0%**	**42%**	**17%**	**40%**

Notes:

Grain size distribution taken from grain size with hydrometer data located in Appendix II.

Gravel, sand, silt and clay sizes based on Wentworth Scale.

S&ME Project:
Allen Steam Station RAB Landfill

S&ME Project No.:
1356-06-825

S&ME

FETTER AND BEAR DIAGRAMS

S&ME PROJECT: Marshall Steam Station Industrial Landfill
S&ME PROJECT NO.: 1356-08-122

Boring No. M-28

Boring Depth: 3.5 to 8.5 ft bls

% Sand: 42%

% Silt: 17%

% Clay: 40%

Estimated Specific Yield: 2.8%*

*Estimated Value

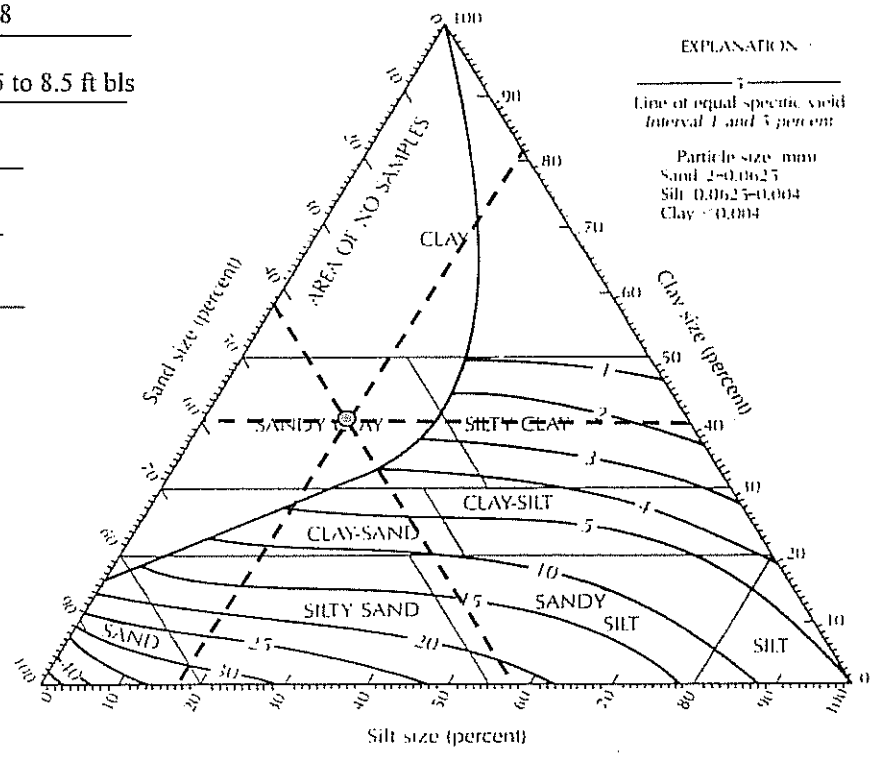
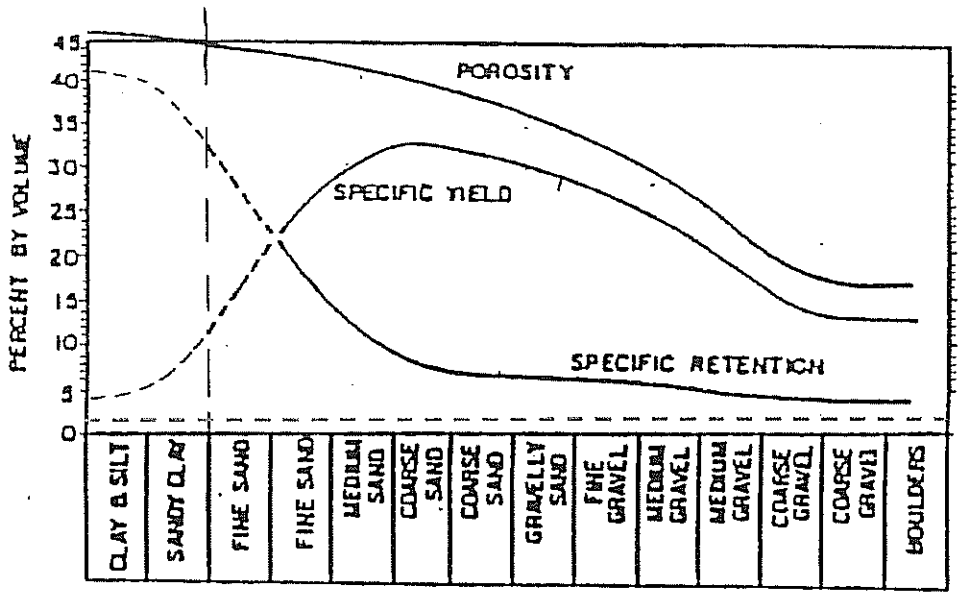


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



Estimated Porosity: 50%**

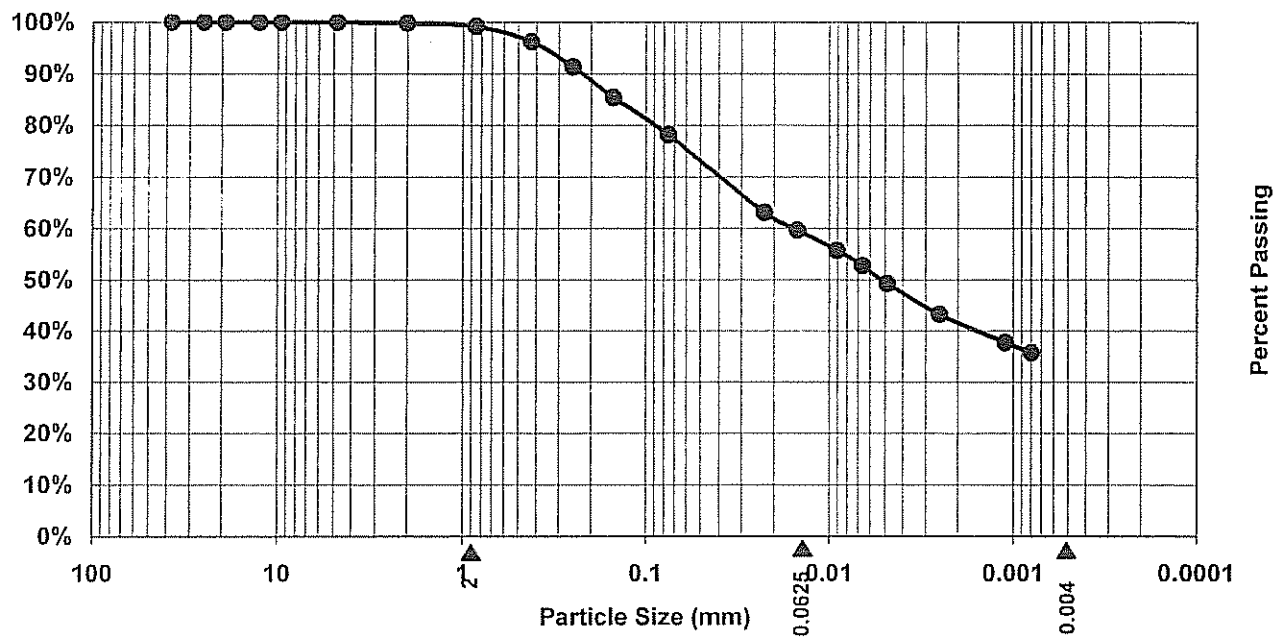
**Based on Table of Selected Values of Porosity, Specific Yield and Specific Retention, USGS Water Supply Paper 2220.

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-31	Bulk	0 to 5 ft bls

Sample Description: Red and Brown Clayey Silt with Fine Sand (MH)



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 0.2%	% Sand 24.6%	% Silt 26.3%	% Clay 48.9%
Adjusted for Calculations	**0%**	**25%**	**26%**	**49%**

Notes:

Grain size distribution taken from grain size with hydrometer data located in Appendix II.

Gravel, sand, silt and clay sizes based on Wentworth Scale.

S&ME Project:
Allen Steam Station RAB Landfill

S&ME Project No.:
1356-06-825

S&ME

FETTER AND BEAR DIAGRAMS

S&ME PROJECT: Marshall Steam Station Industrial Landfill
S&ME PROJECT NO.: 1356-08-122

Boring No. M-31

Boring Depth: 0 to 5 ft bls

% Sand: 25%

% Silt: 26%

% Clay: 49%

Estimated Specific Yield: 1%

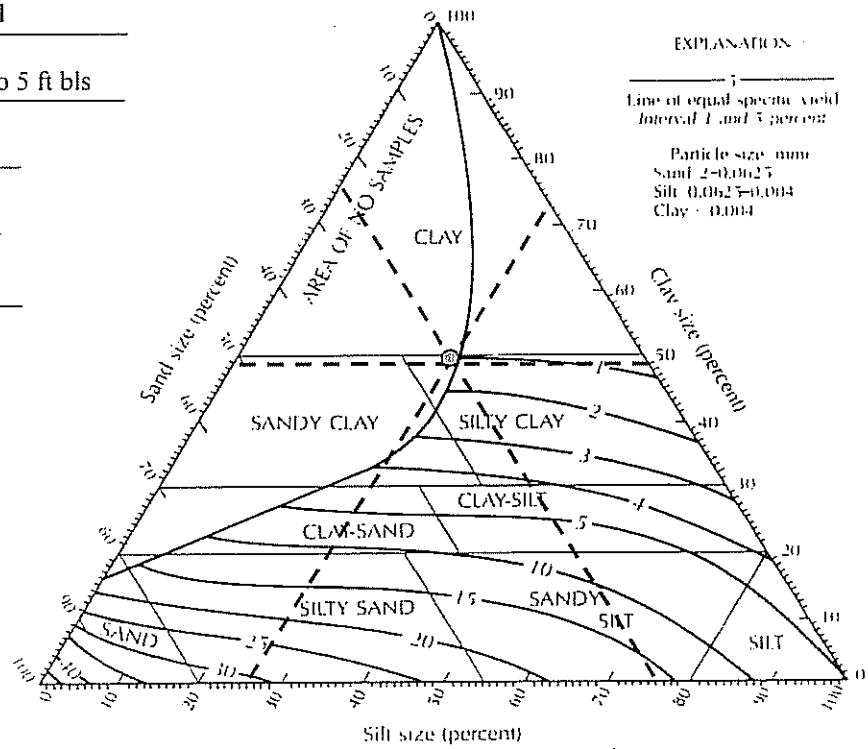
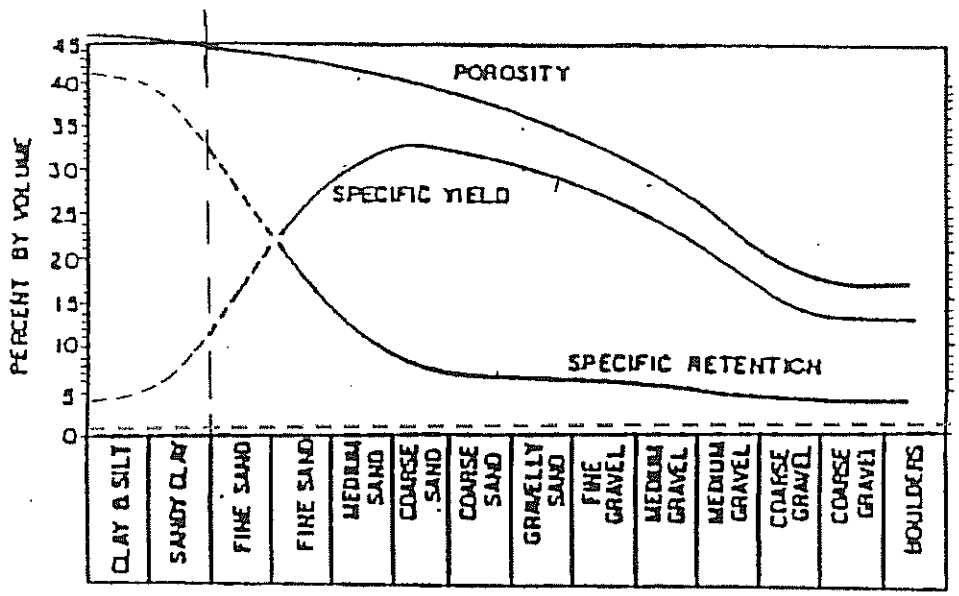


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



Estimated Porosity: 50%**

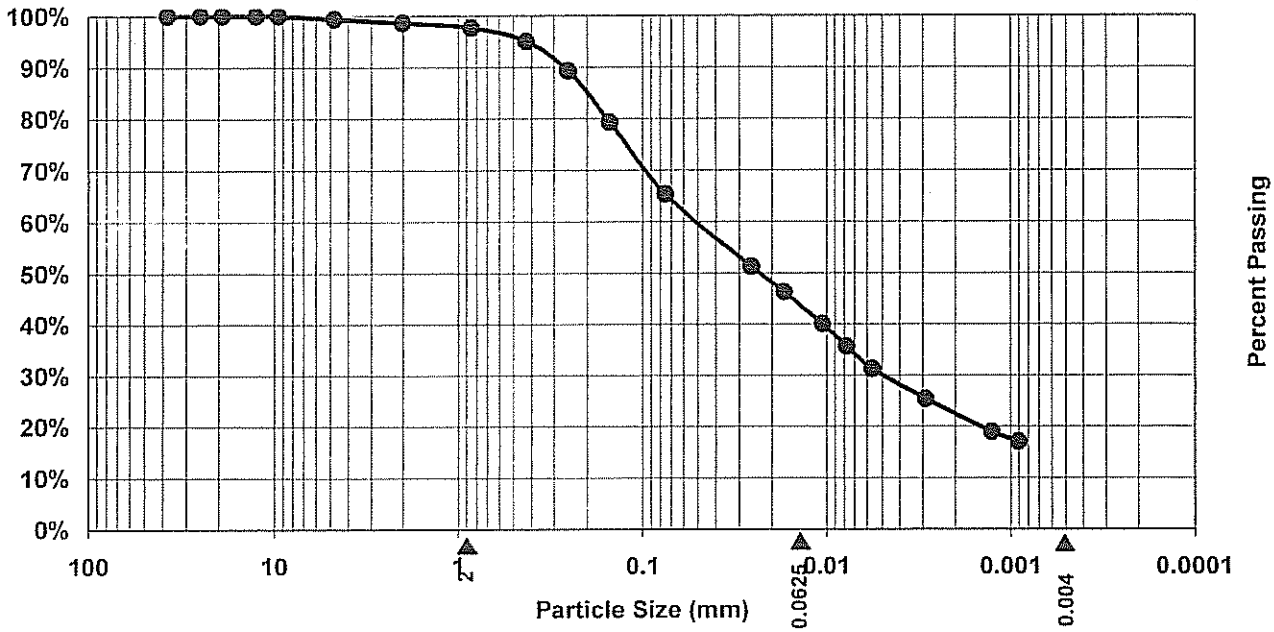
**Based on Table of Selected Values of Porosity, Specific Yield and Specific Retention, USGS Water Supply Paper 2220.

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-33	Bulk	3.5 to 8.5 ft bls

Sample Description: Red and Tan Fine Sandy Clayey Silt (ML)



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 1.4%	% Sand 36.2%	% Silt 32.8%	% Clay 29.7%
Adjusted for Calculations	**0%**	**37%**	**33%**	**30%**

Notes:

Grain size distribution taken from grain size with hydrometer data located in Appendix II.

Gravel, sand, silt and clay sizes based on Wentworth Scale.

S&ME Project:
Allen Steam Station RAB Landfill

S&ME Project No.:
1356-06-825

S&ME

FETTER AND BEAR DIAGRAMS

S&ME PROJECT: Marshall Steam Station Industrial Landfill
S&ME PROJECT NO.: 1356-08-122

Boring No. M-33

Boring Depth: 3.5 to 8.5 ft bls

% Sand: 37%

% Silt: 33%

% Clay: 30%

Estimated Specific Yield: 4.2%

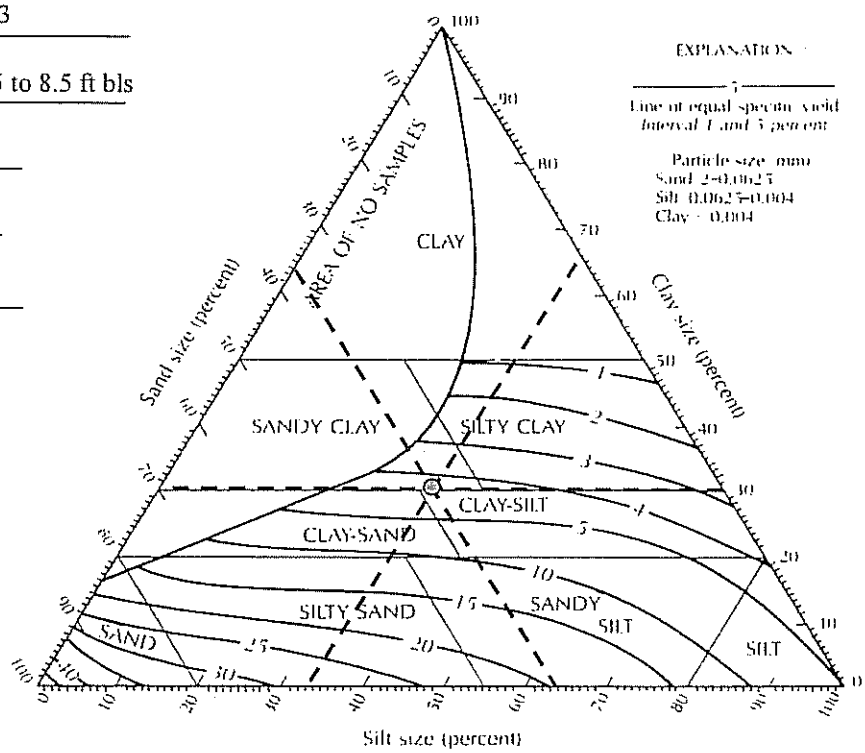
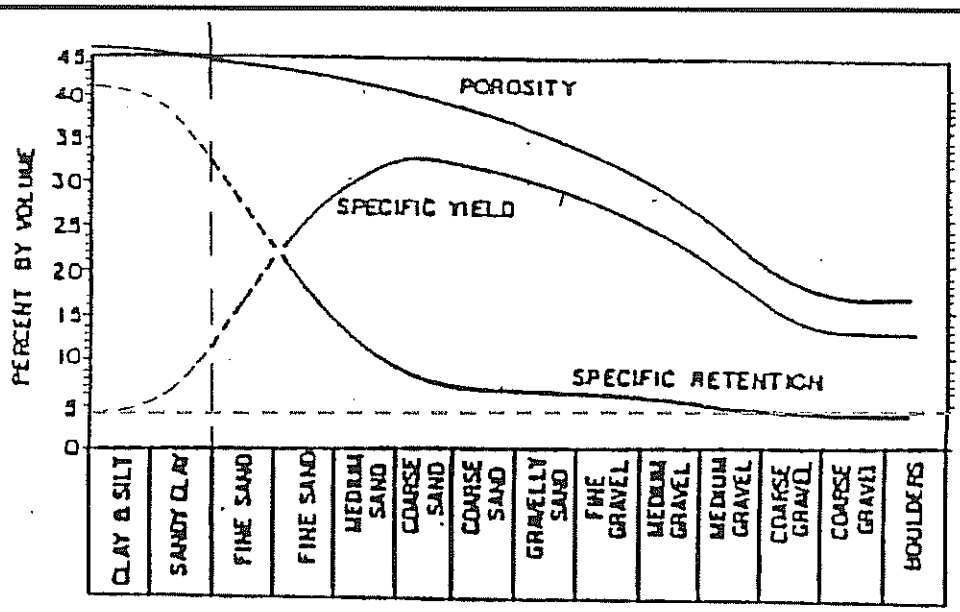


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



Estimated Porosity: 49%**

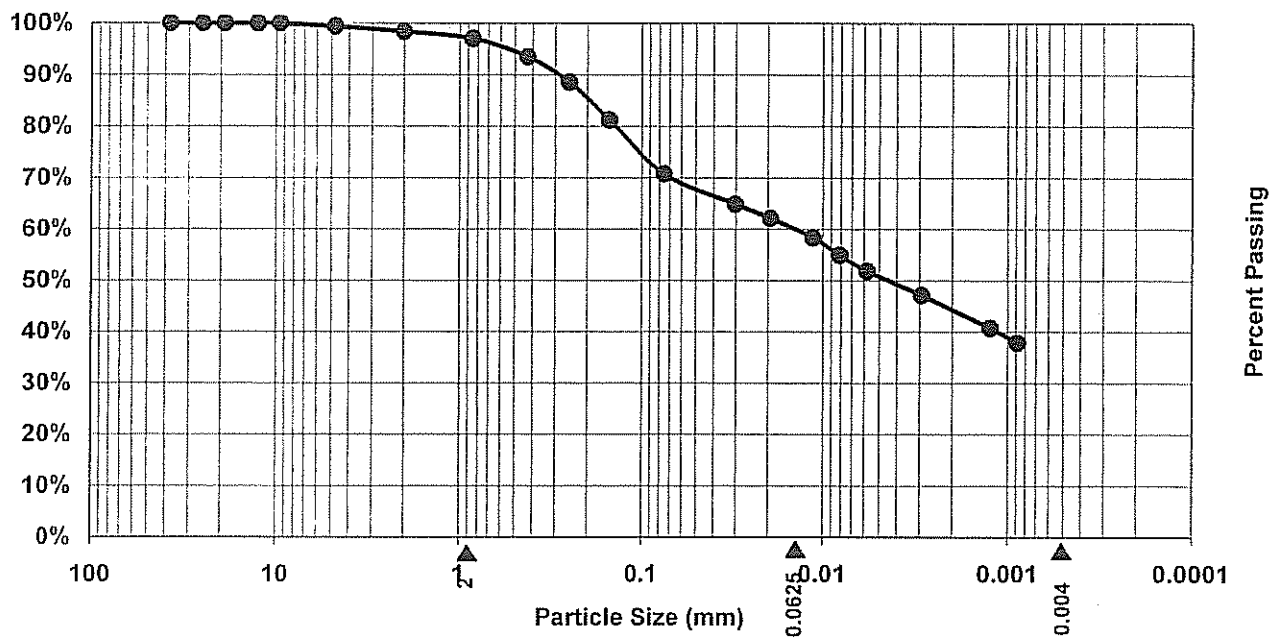
**Based on Table of Selected Values of Porosity, Specific Yield and Specific Retention, USGS Water Supply Paper 2220.

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-35	Bulk	3 to 8 ft bls

Sample Description: Red and Tan Fine Sandy Silty Clay (CH)



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 1.6%	% Sand 29.0%	% Silt 18.2%	% Clay 51.2%
Adjusted for Calculations	**0%**	**29%**	**18%**	**52%**

Notes:

Grain size distribution taken from grain size with hydrometer data located in Appendix II.

Gravel, sand, silt and clay sizes based on Wentworth Scale.

S&ME Project:
Allen Steam Station RAB Landfill

S&ME Project No.:
1356-06-825

S&ME

FETTER AND BEAR DIAGRAMS

S&ME PROJECT: Marshall Steam Station Industrial Landfill
S&ME PROJECT NO.: 1356-08-122

Boring No. M-35

Boring Depth: 3 to 8 ft bls

% Sand: 29%

% Silt: 18%

% Clay: 52%

Estimated Specific Yield: 0.8%

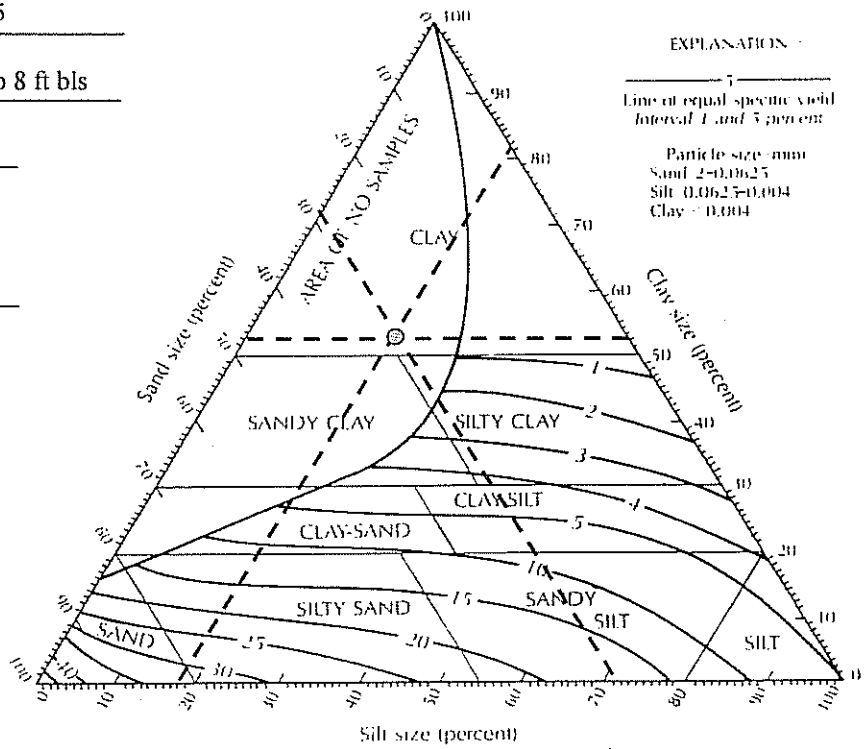
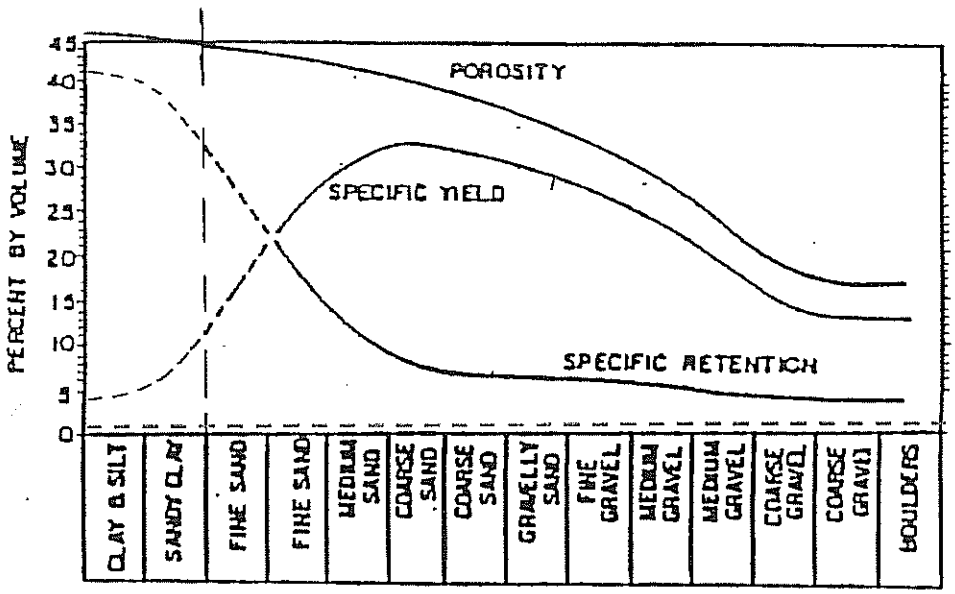


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



Estimated Porosity: 50%**

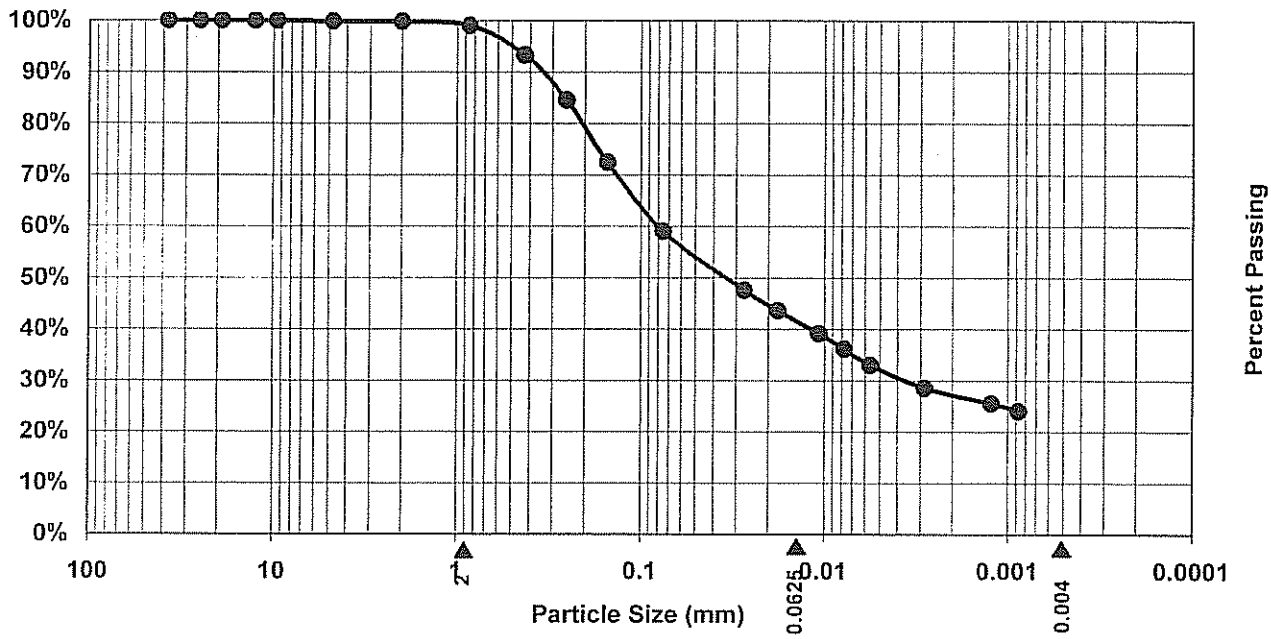
**Based on Table of Selected Values of Porosity, Specific Yield and Specific Retention, USGS Water Supply Paper 2220.

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-39	Bulk	1 to 9 ft bls

Sample Description: Brown and Red micaceous Fine Sandy Clayey Silt (ML)



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 0.2%	% Sand 43.2%	% Silt 26.0%	% Clay 30.6%
Adjusted for Calculations	**0%**	**43%**	**26%**	**31%**

Notes:

Grain size distribution taken from grain size with hydrometer data located in Appendix II.

Gravel, sand, silt and clay sizes based on Wentworth Scale.

S&ME Project:
Allen Steam Station RAB Landfill

S&ME Project No.:
1356-06-825

S&ME

FETTER AND BEAR DIAGRAMS

S&ME PROJECT: Marshall Steam Station Industrial Landfill
S&ME PROJECT NO.: 1356-08-122

Boring No. M-39

Boring Depth: 1 to 9 ft bls

% Sand: 43%

% Silt: 26%

% Clay: 31%

Estimated Specific Yield: 4.2%

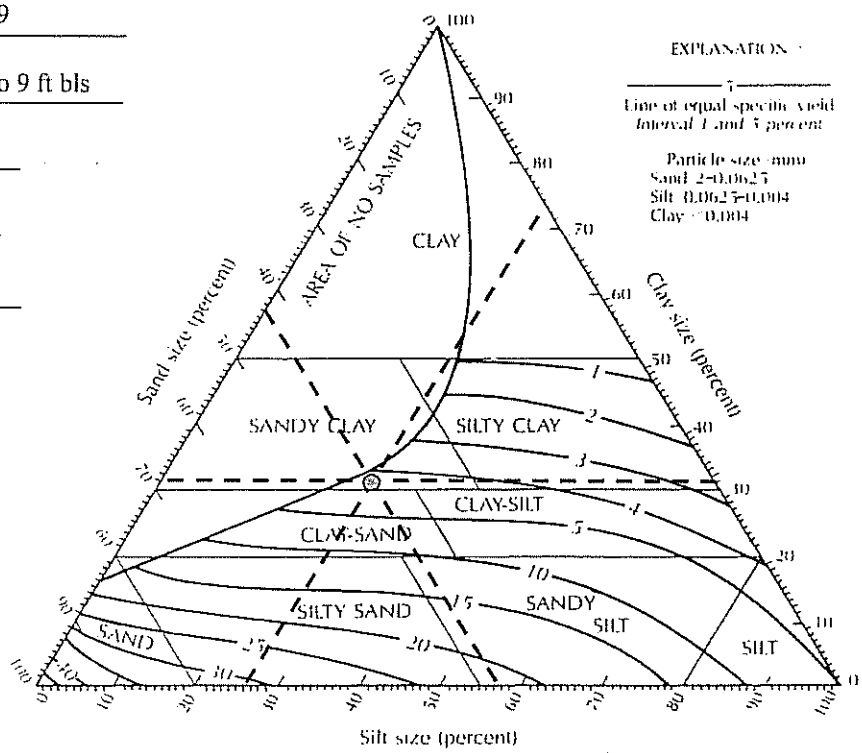
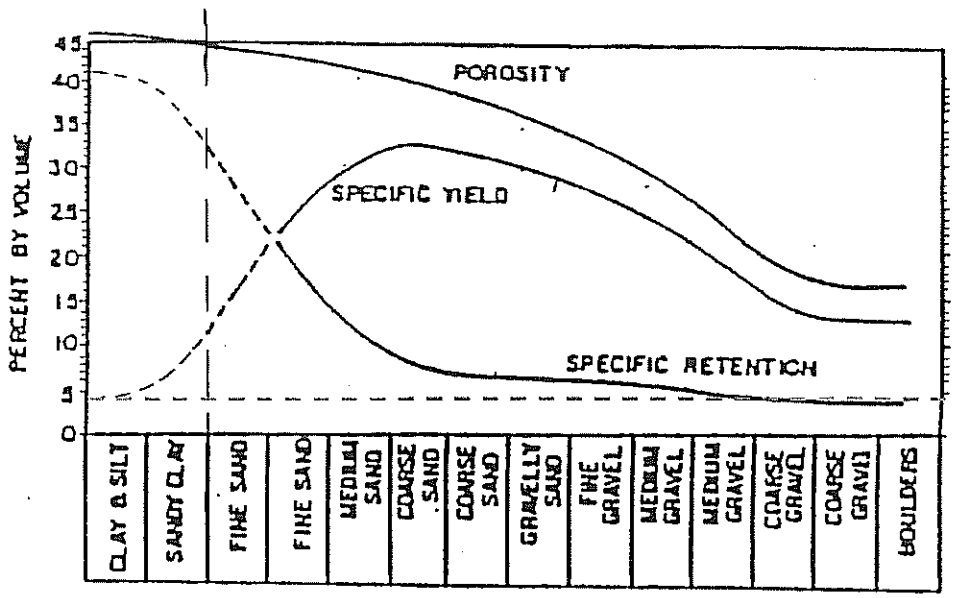


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



Estimated Porosity: 49%**

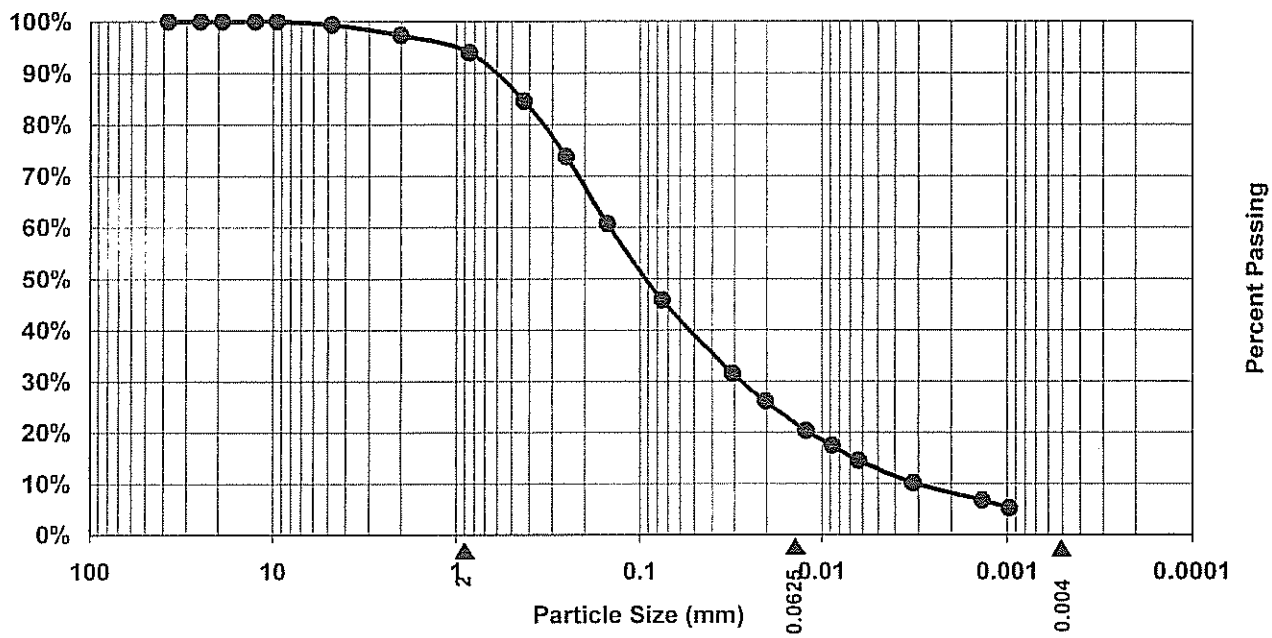
**Based on Table of Selected Values of Porosity, Specific Yield and Specific Retention, USGS Water Supply Paper 2220.

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-40	Bulk	29.2 to 34.2 ft bls

Sample Description: Light Brown Micaceous Clayey Silty Medium to Fine Sand (SM)



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 2.7%	% Sand 54.7%	% Silt 30.9%	% Clay 11.6%
Adjusted for Calculations	**0%**	**56%**	**32%**	**12%**

Notes:

Grain size distribution taken from grain size with hydrometer data located in Appendix II.

Gravel, sand, silt and clay sizes based on Wentworth Scale.

S&ME Project:
Allen Steam Station RAB Landfill

S&ME Project No.:
1356-06-825

S&ME

FETTER AND BEAR DIAGRAMS

S&ME PROJECT: Marshall Steam Station Industrial Landfill
S&ME PROJECT NO.: 1356-08-122

Boring No. M-40

Boring Depth: 29.2 to 34.2 ft bls

% Sand: 56%

% Silt: 32%

% Clay: 12%

Estimated Specific Yield: 17%

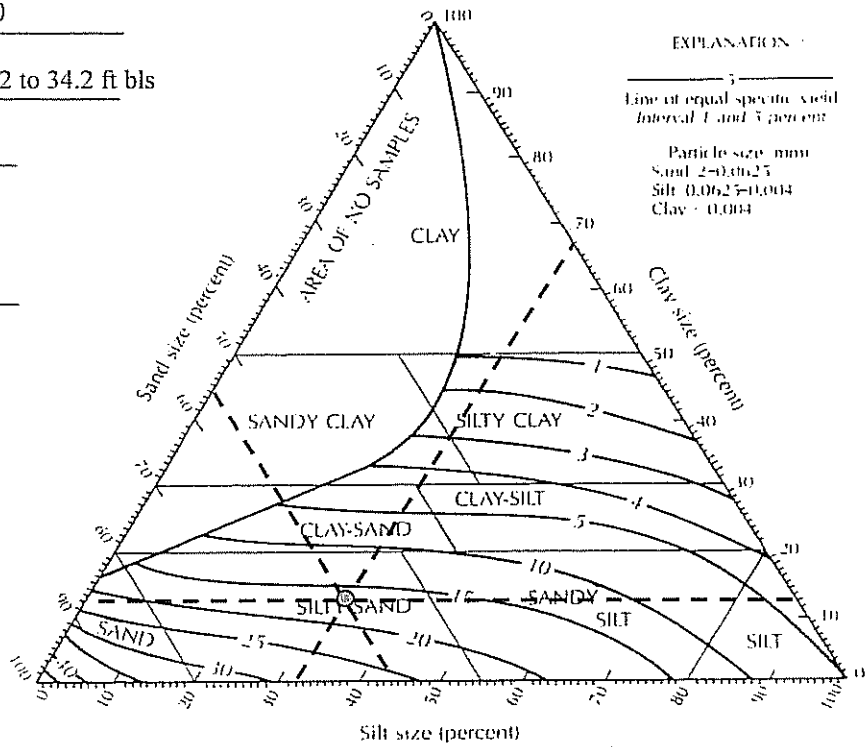
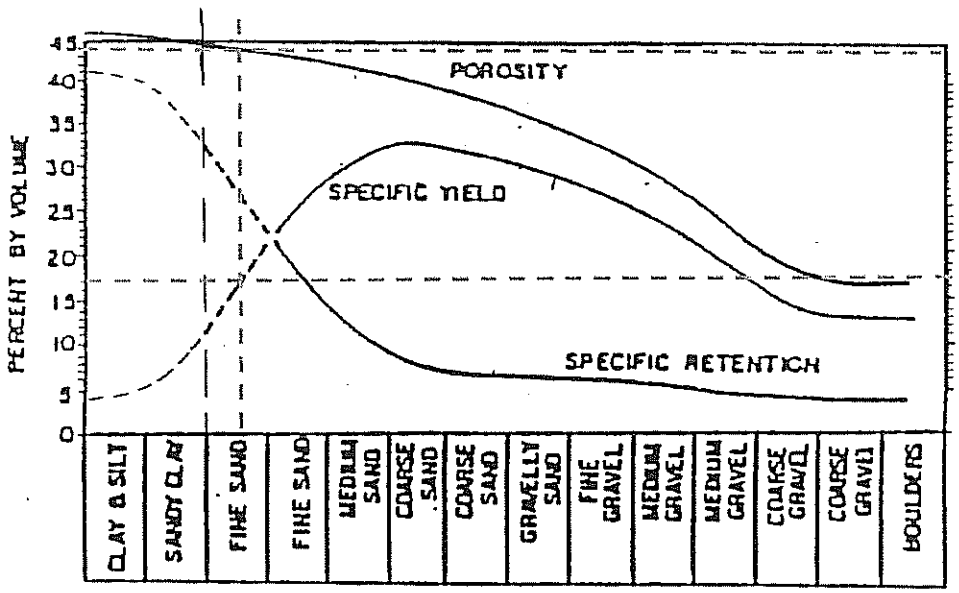


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



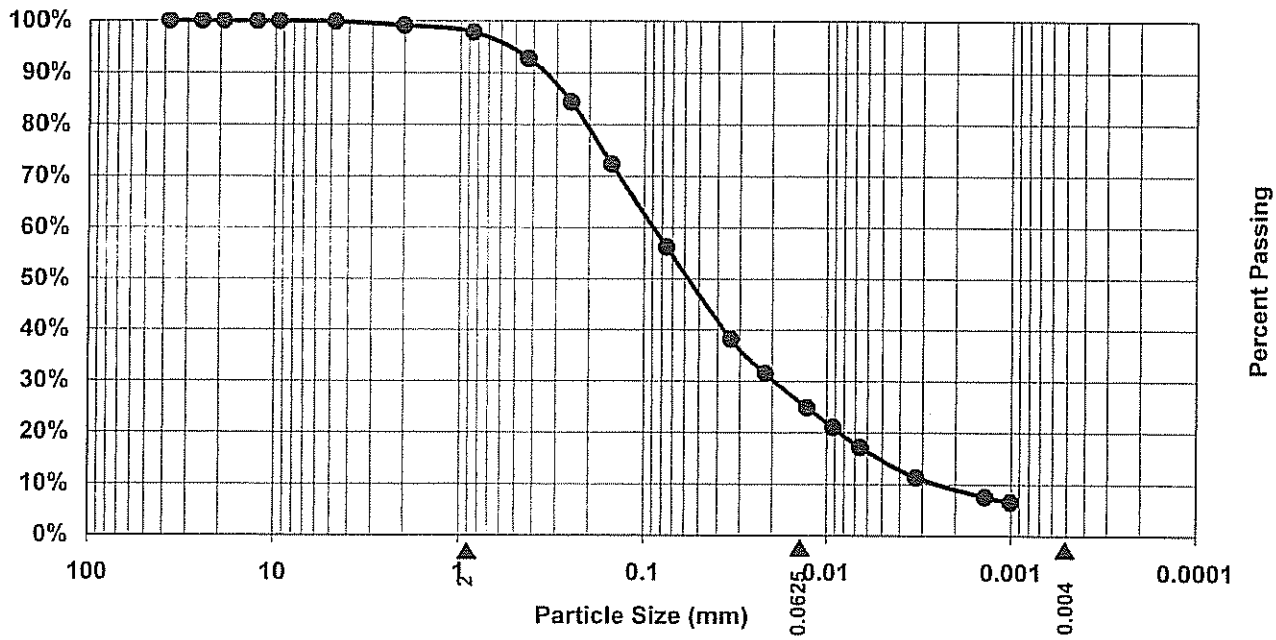
Estimated Porosity: 44%

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-41	Bulk	24.5 to 29.5 ft bls

Sample Description: Brown and Tan Micaceous Fine Sandy Clayey Silt (ML)



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 0.9%	% Sand 47.2%	% Silt 39.1%	% Clay 12.8%
Adjusted for Calculations	**0%**	**48%**	**39%**	**13%**

Notes:

Grain size distribution taken from grain size with hydrometer data located in Appendix II.

Gravel, sand, silt and clay sizes based on Wentworth Scale.

S&ME Project:
Allen Steam Station RAB Landfill

S&ME Project No.:
1356-06-825

S&ME

FETTER AND BEAR DIAGRAMS

S&ME PROJECT: Marshall Steam Station Industrial Landfill
S&ME PROJECT NO.: 1356-08-122

Boring No. M-41

Boring Depth: 24.5 to 29.5 ft bls

% Sand: 48%

% Silt: 39%

% Clay: 13%

Estimated Specific Yield: 16%

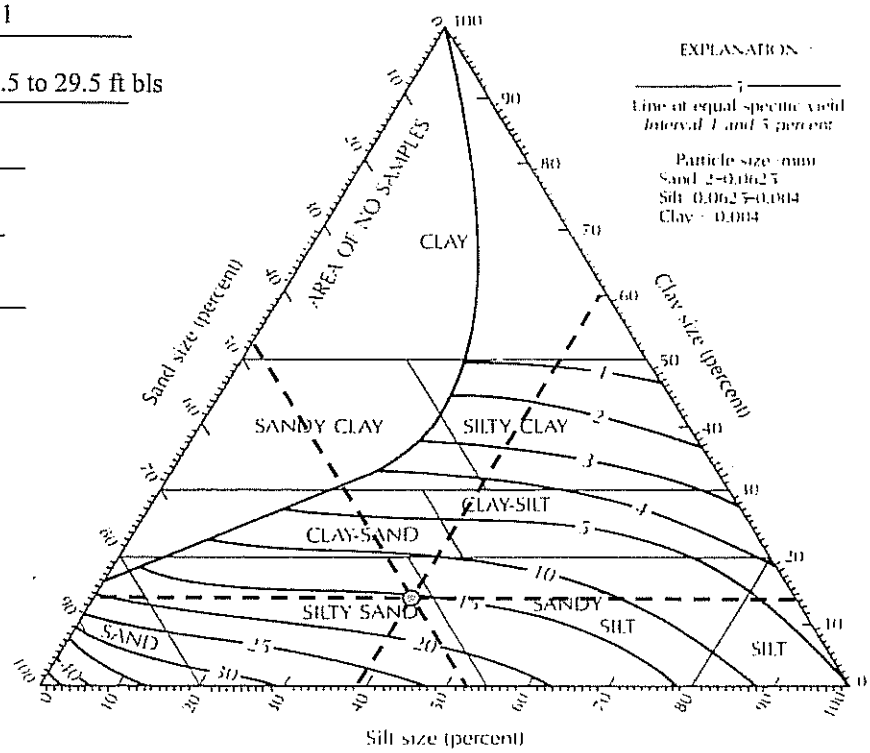
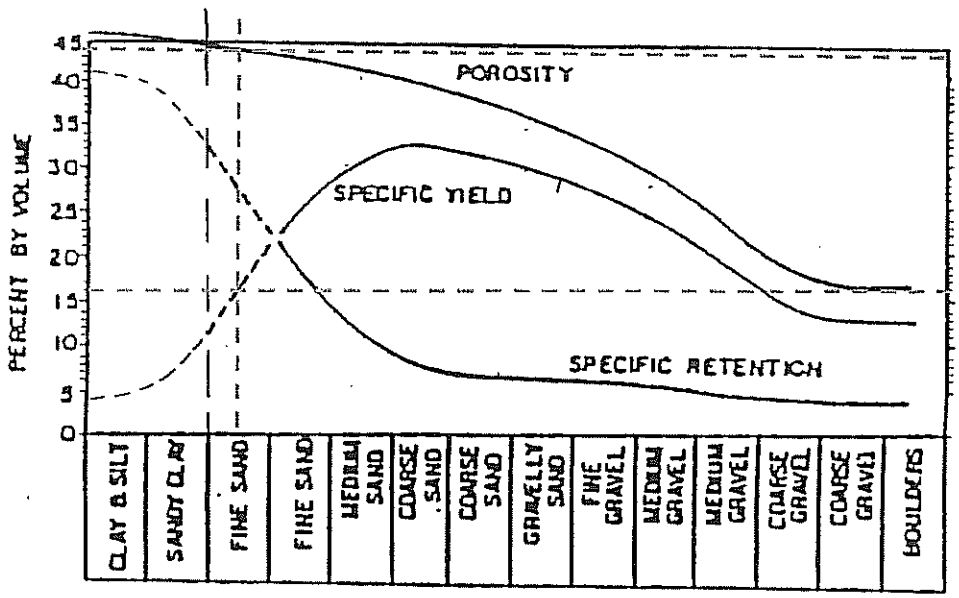


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



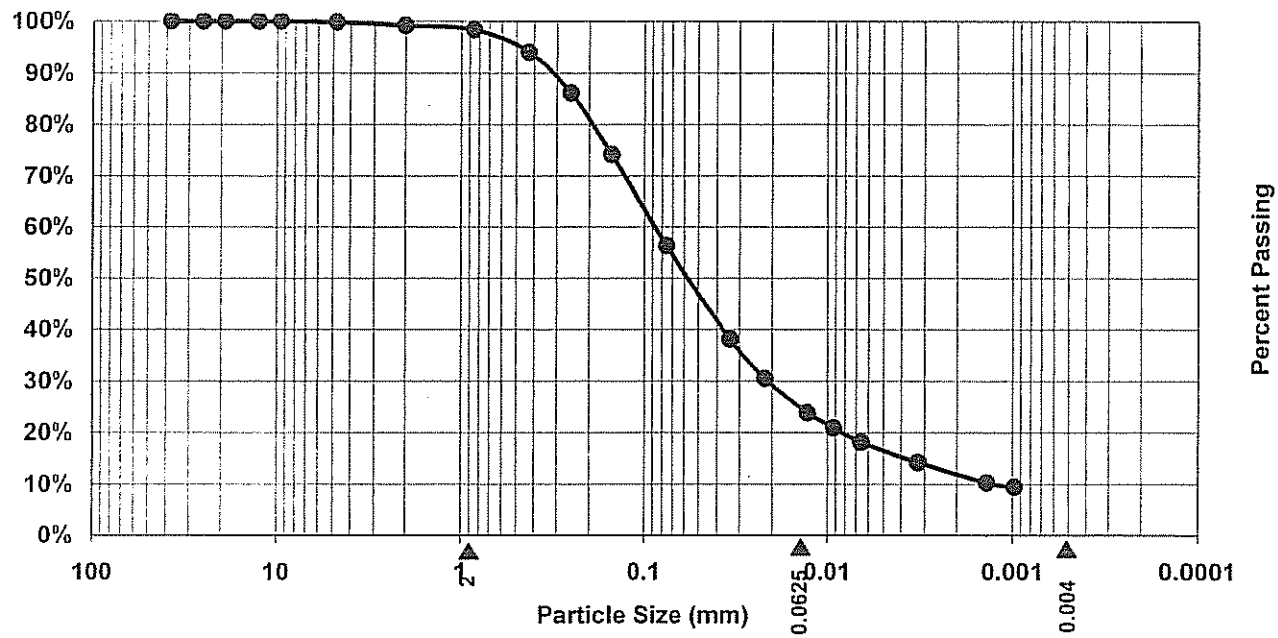
Estimated Porosity: 44%

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-42	Bulk	14.5 to 19.5 ft bls

Sample Description: Brown and Red Micaceous Fine Sandy Clayey Silt (ML)



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 0.8%	% Sand 47.3%	% Silt 36.0%	% Clay 15.9%
Adjusted for Calculations	**0%**	**48%**	**36%**	**16%**

Notes:

Grain size distribution taken from grain size with hydrometer data located in Appendix II.

Gravel, sand, silt and clay sizes based on Wentworth Scale.

S&ME Project:
Allen Steam Station RAB Landfill

S&ME Project No.:
1356-06-825

S&ME

FETTER AND BEAR DIAGRAMS

S&ME PROJECT: Marshall Steam Station Industrial Landfill
S&ME PROJECT NO.: 1356-08-122

Boring No. M-42

Boring Depth: 14.5 to 19.5 ft bls

% Sand: 48%

% Silt: 36%

% Clay: 16%

Estimated Specific Yield: 14%

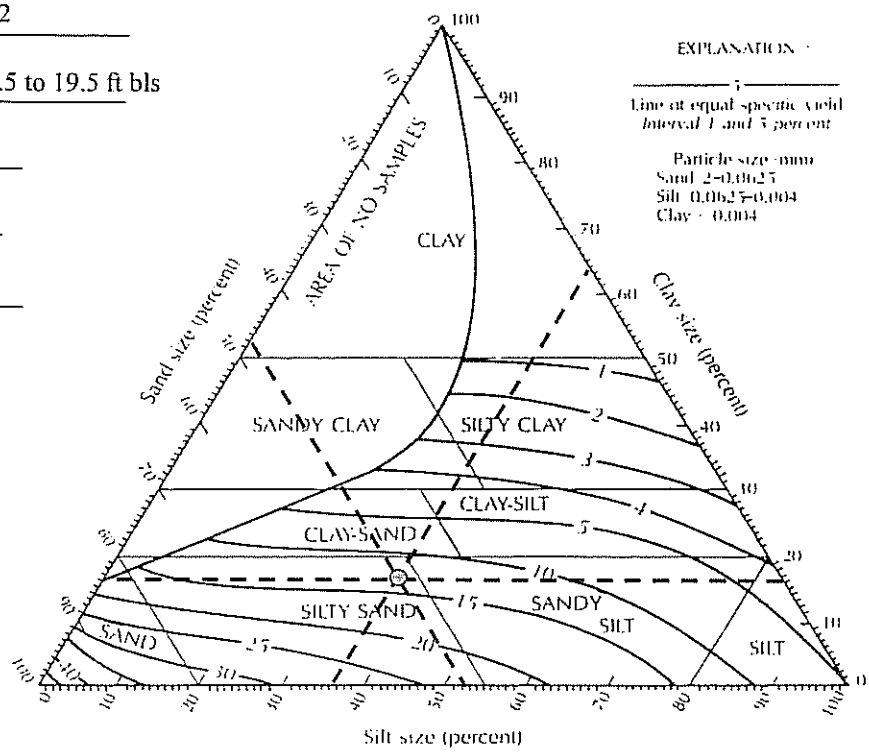
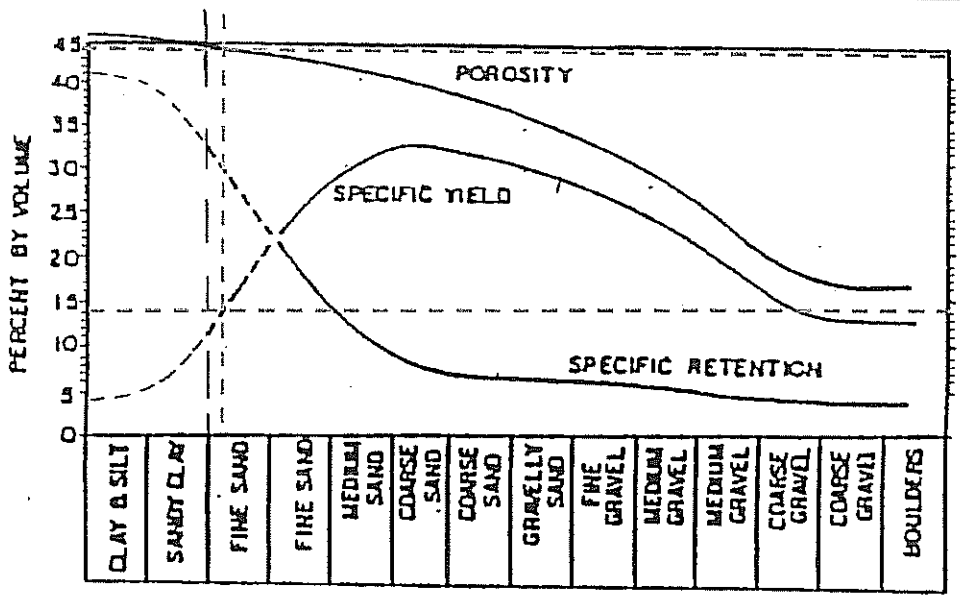


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



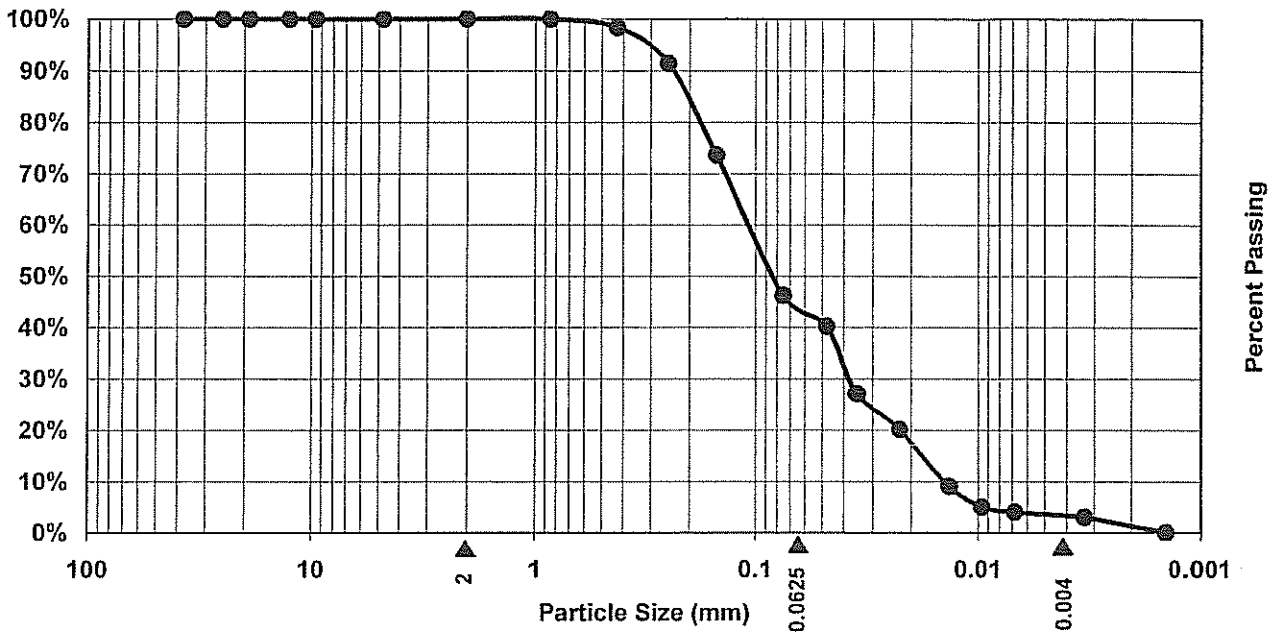
Estimated Porosity: 44%

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-57	SS-3	13.5 to 15 ft bls

Sample Description: Tan and White Micaceous Silty Medium to Fine Sand (SM)



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 0.0%	% Sand 56.0%	% Silt 40.8%	% Clay 3.2%
Adjusted for Calculations	**0%**	**56%**	**41%**	**3%**

Notes:

Grain size distribution taken from grain size with hydrometer data located in Appendix II.

Gravel, sand, silt and clay sizes based on Wentworth Scale.

S&ME Project:
Allen Steam Station RAB Landfill

S&ME Project No.:
1356-06-825

S&ME

FETTER AND BEAR DIAGRAMS

S&ME PROJECT: Marshall Steam Station Industrial Landfill
S&ME PROJECT NO.: 1356-08-122

Boring No. M-57

Boring Depth: 13.5 to 15 ft bls

% Sand: 56%

% Silt: 41%

% Clay: 3%

Estimated Specific Yield: 24%

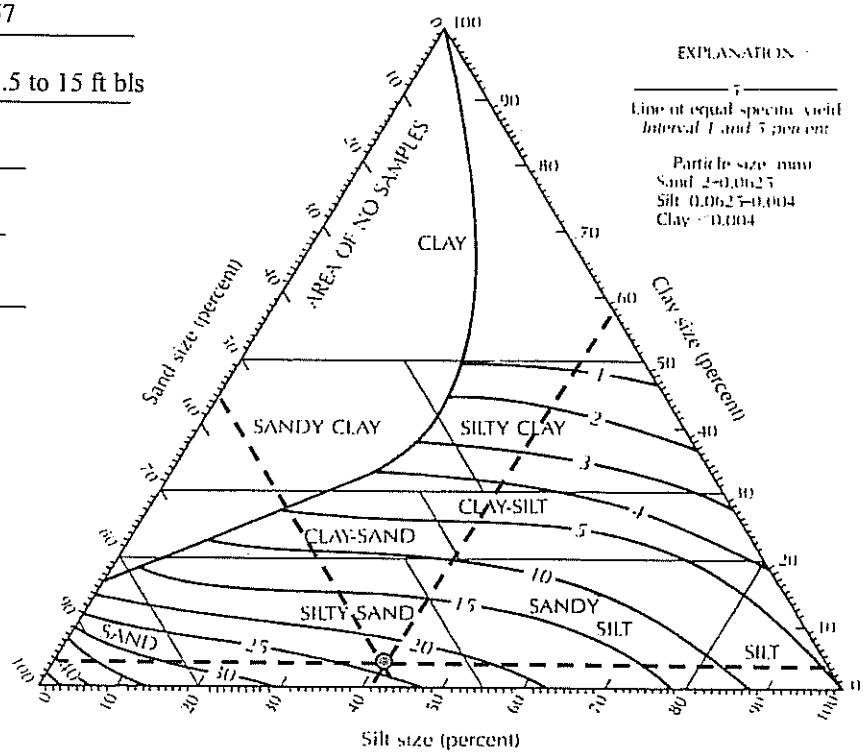
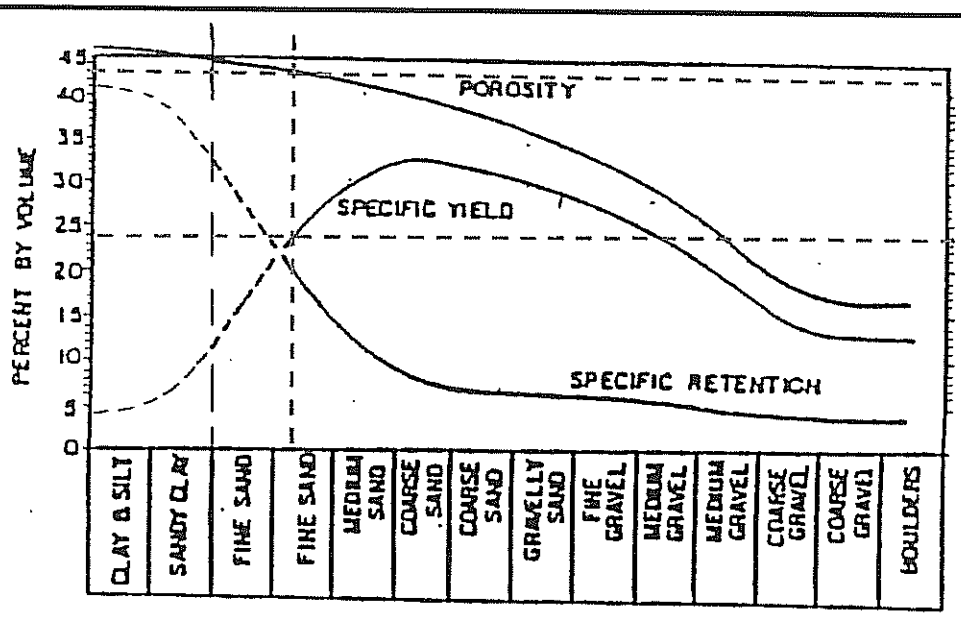


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



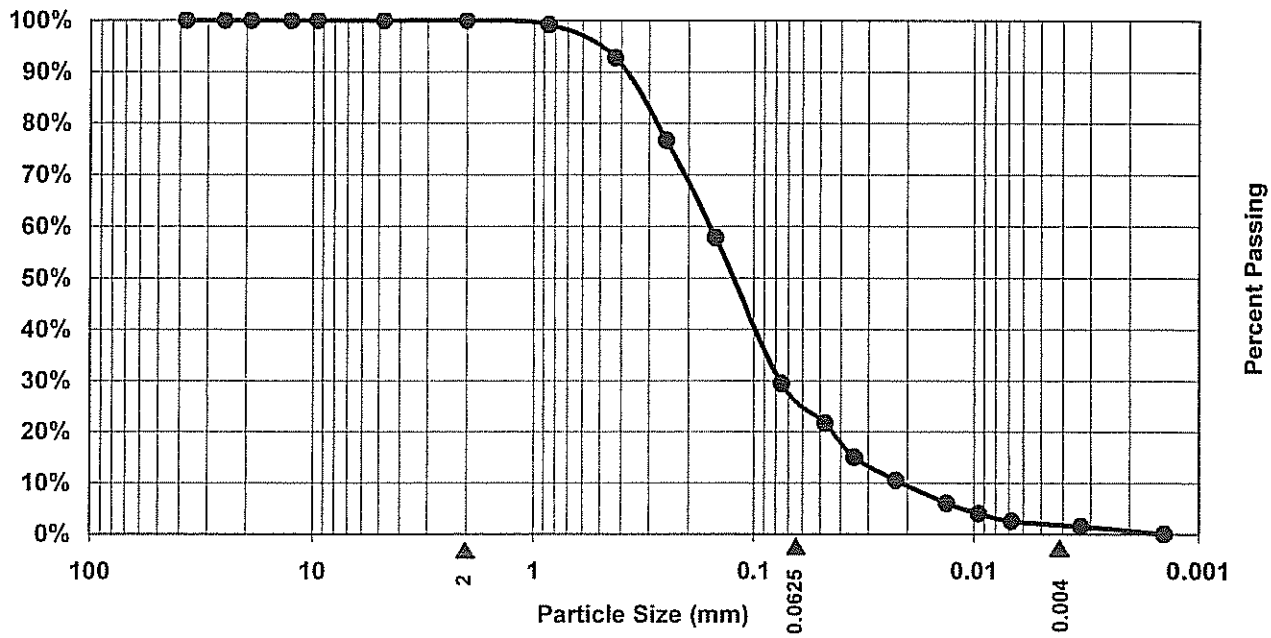
Estimated Porosity: 43%

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-58	SS-6	28.5 to 30 ft bls

Sample Description: White, Tan, Green, Pink, Silty Medium to Fine Sand (SM)



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 0.0%	% Sand 73.4%	% Silt 24.9%	% Clay 1.7%
Adjusted for Calculations	**0%**	**73%**	**25%**	**2%**

Notes:

Grain size distribution taken from grain size with hydrometer data located in Appendix II.

Gravel, sand, silt and clay sizes based on Wentworth Scale.

S&ME Project:
Allen Steam Station RAB Landfill

S&ME Project No.:
1356-06-825

S&ME

FETTER AND BEAR DIAGRAMS

S&ME PROJECT: Marshall Steam Station Industrial Landfill
S&ME PROJECT NO.: 1356-08-122

Boring No. M-58

Boring Depth: 28.5 to 30 ft bls

% Sand: 73%

% Silt: 25%

% Clay: 2%

Estimated Specific Yield: 29%

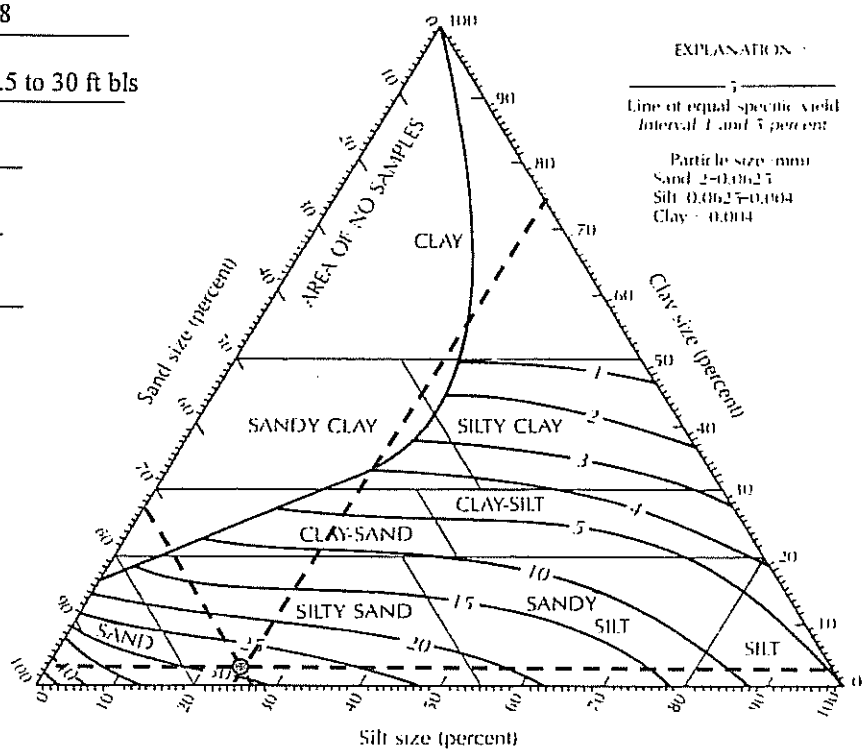
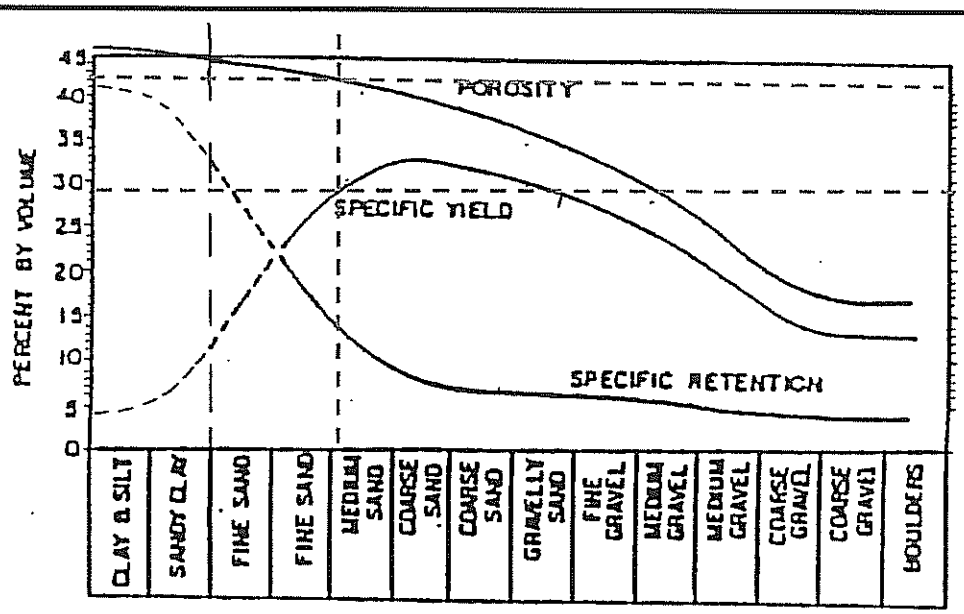


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



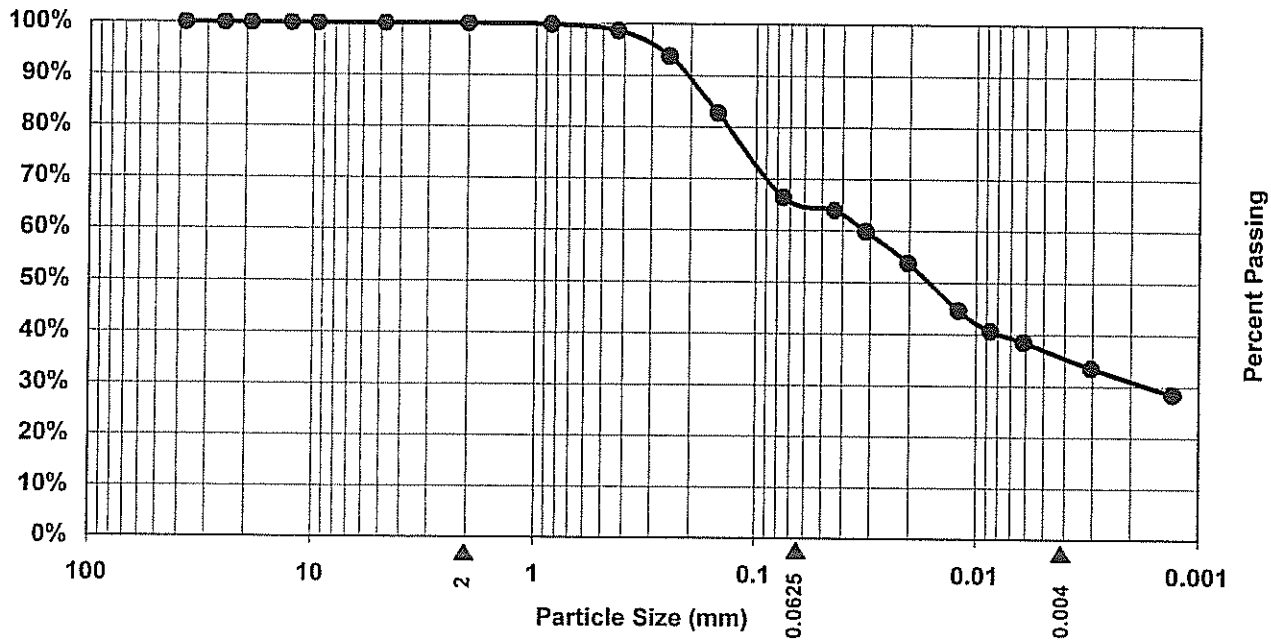
Estimated Porosity: 42%

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-59	SS-1	3.5 to 5 ft bls

Sample Description: Red Medium to Fine Sandy Clayey Silt (MH)



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 0.0%	% Sand 34.4%	% Silt 30.5%	% Clay 35.1%
Adjusted for Calculations	**0%**	**34%**	**31%**	**35%**

Notes:

Grain size distribution taken from grain size with hydrometer data located in Appendix II.

Gravel, sand, silt and clay sizes based on Wentworth Scale.

S&ME Project:
Allen Steam Station RAB Landfill

S&ME Project No.:
1356-06-825

S&ME

FETTER AND BEAR DIAGRAMS

S&ME PROJECT: Marshall Steam Station Industrial Landfill
S&ME PROJECT NO.: 1356-08-122

Boring No. M-59

Boring Depth: 3.5 to 5 ft bls

% Sand: 34%

% Silt: 31%

% Clay: 35%

Estimated Specific Yield: 3.5%

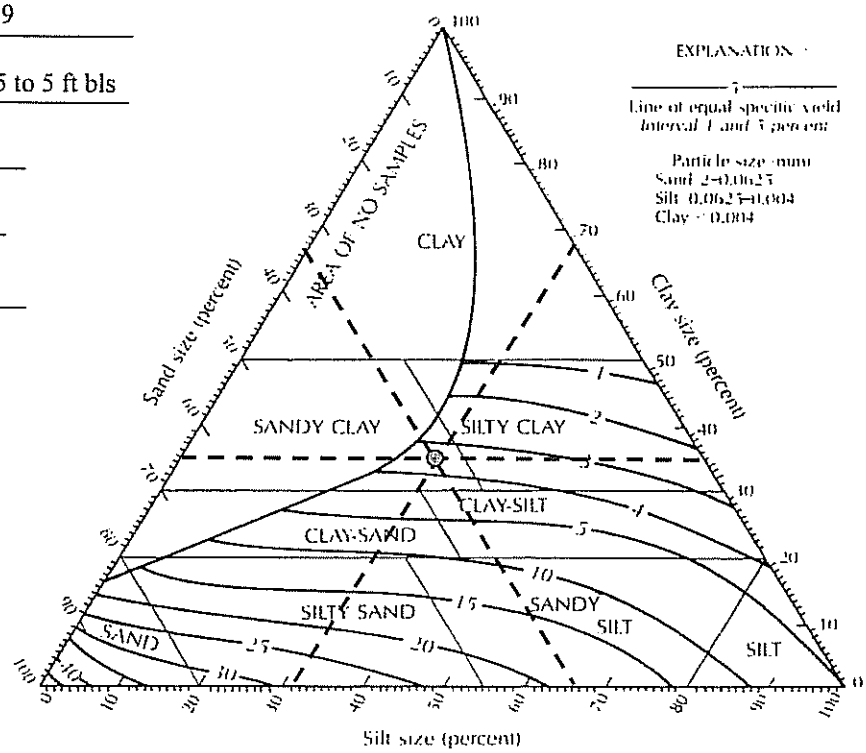
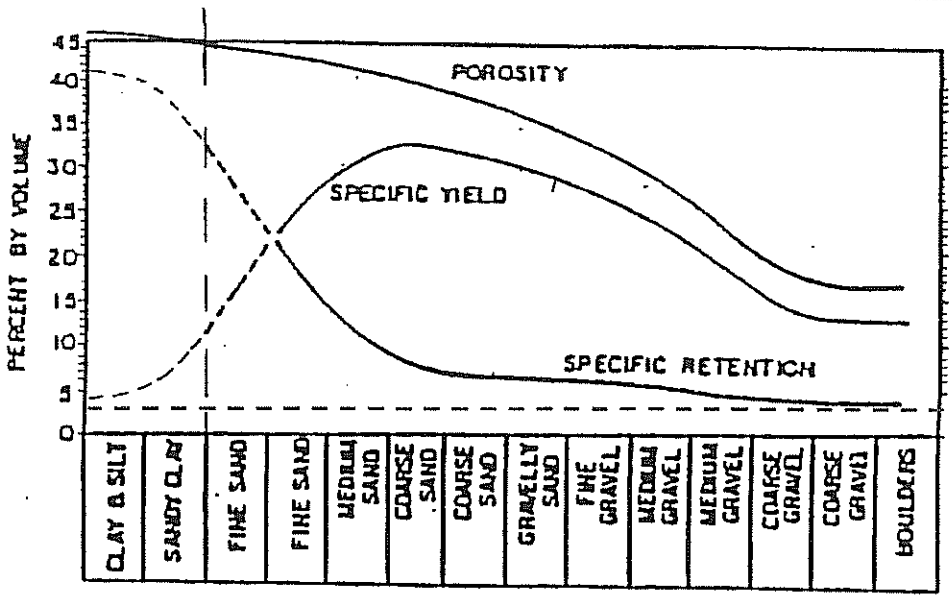


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



Estimated Porosity: 47%**

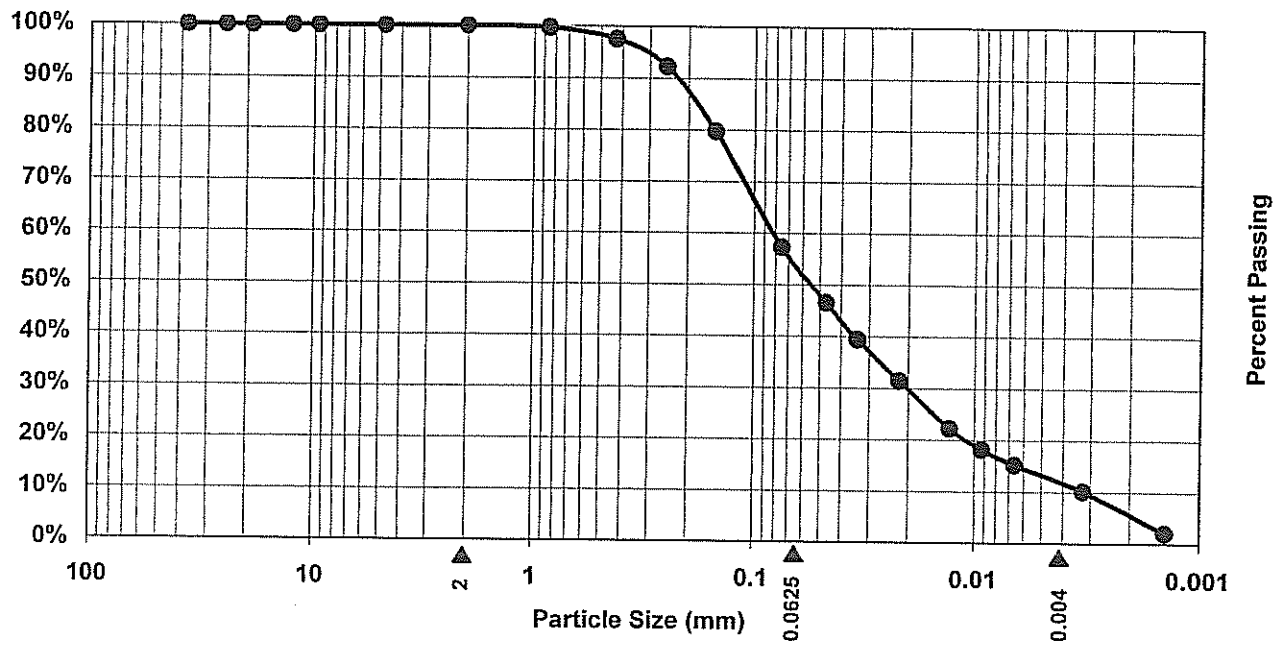
**Based on Table of Selected Values of Porosity, Specific Yield and Specific Retention, USGS Water Supply Paper 2220.

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

S&ME PROJECT NO.: 1356-08-M-59	Sample No.: SS-6	Depth: 28.5 to 30 ft bls

Sample Description: Orange & Tan Medium to Fine Sandy Silt (ML)



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 0.0%	% Sand 46.5%	% Silt 42.2%	% Clay 11.3%
Adjusted for Calculations	**0%**	**47%**	**42%**	**11%**

Notes:

Grain size distribution taken from grain size with hydrometer data located in Appendix II.

Gravel, sand, silt and clay sizes based on Wentworth Scale.

S&ME Project:
Allen Steam Station RAB Landfill

S&ME Project No.:
1356-06-825

S&ME

FETTER AND BEAR DIAGRAMS

S&ME PROJECT: Marshall Steam Station Industrial Landfill
S&ME PROJECT NO.: 1356-08-122

Boring No. M-59

Boring Depth: 28.5 to 30 ft bls

% Sand: 47%

% Silt: 42%

% Clay: 11%

Estimated Specific Yield: 16%

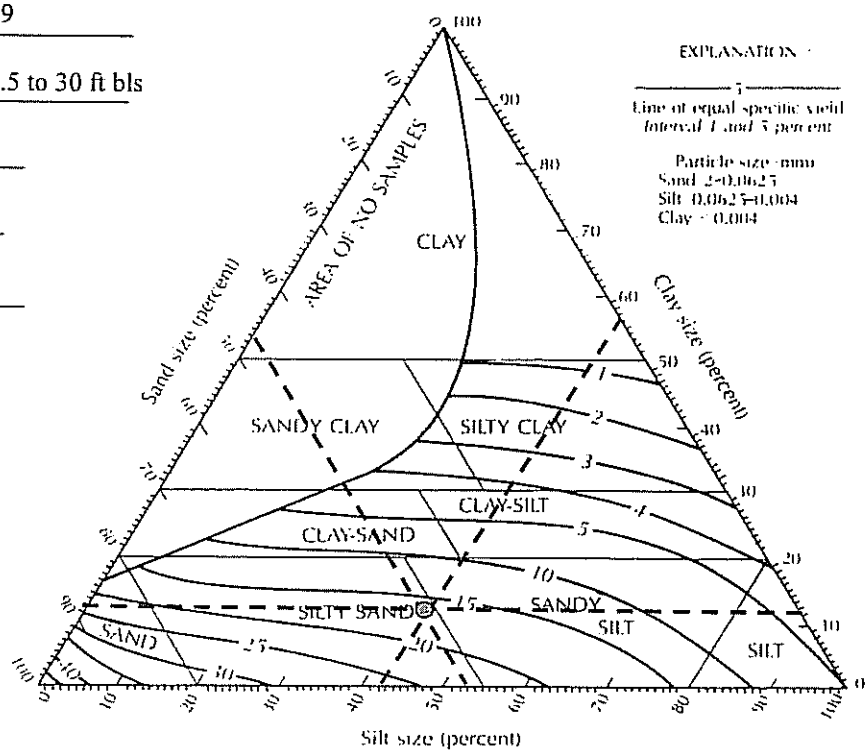
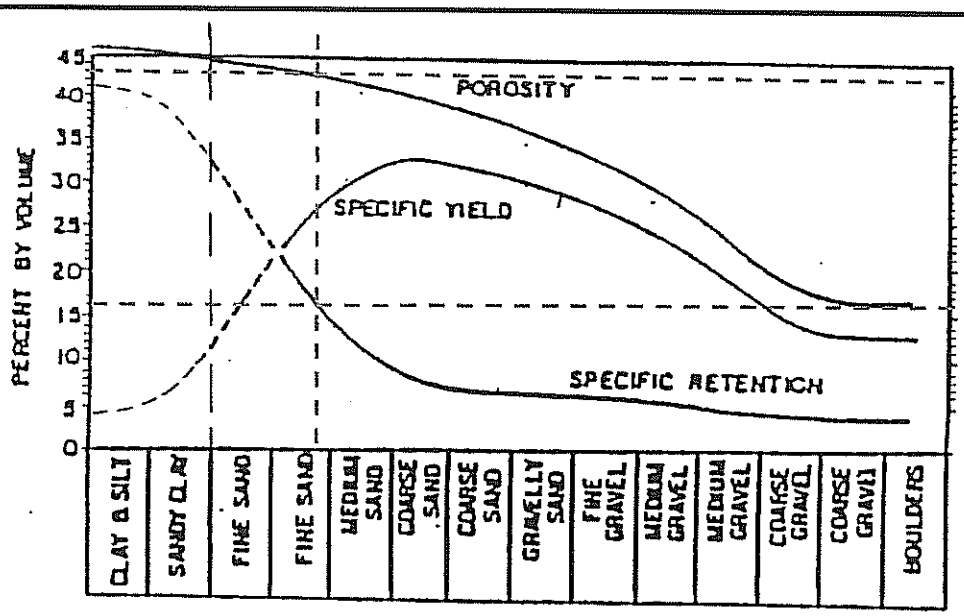


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



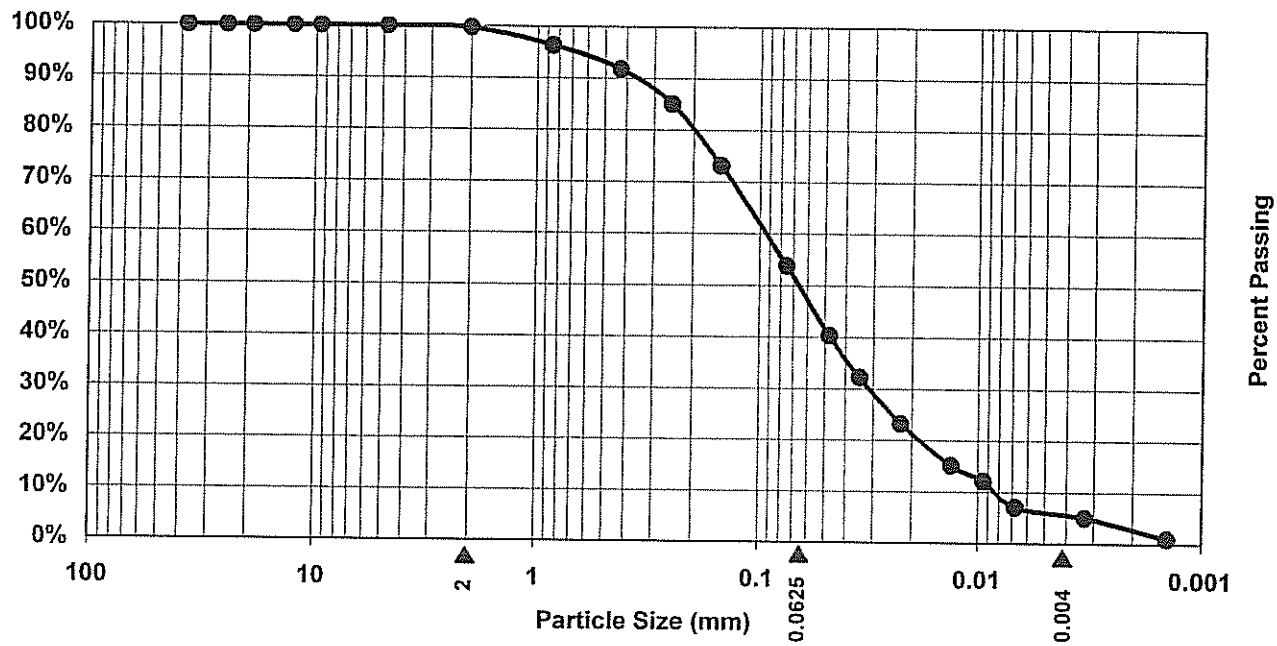
Estimated Porosity: 43%

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-60	SS-14	68.5 to 70 ft bls

Sample Description: White, Tan, Orange Medium to Fine Sandy Silt (ML)



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 0.3%	% Sand 50.8%	% Silt 43.5%	% Clay 5.4%
Adjusted for Calculations	**0%**	**51%**	**44%**	**5%**

Notes:

Grain size distribution taken from grain size with hydrometer data located in Appendix II.

Gravel, sand, silt and clay sizes based on Wentworth Scale.

S&ME Project:

Allen Steam Station RAB Landfill

S&ME Project No.:

1356-06-825

S&ME

FETTER AND BEAR DIAGRAMS

S&ME PROJECT: Marshall Steam Station Industrial Landfill
S&ME PROJECT NO.: 1356-08-122

Boring No. M-60

Boring Depth: 68.5 to 70 ft bls

% Sand: 51%

% Silt: 44%

% Clay: 5%

Estimated Specific Yield: 21%

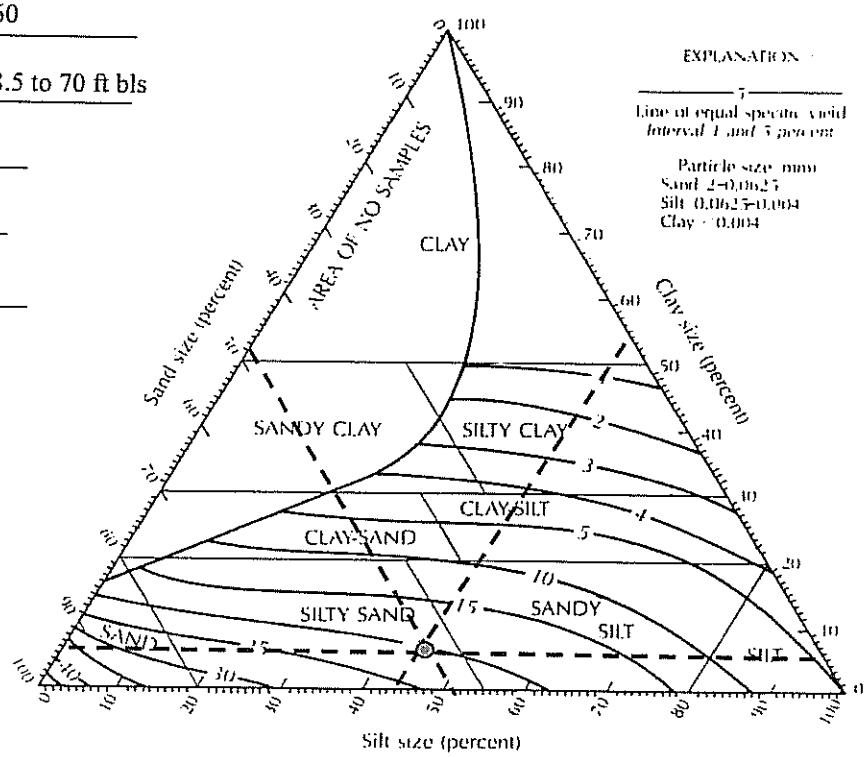
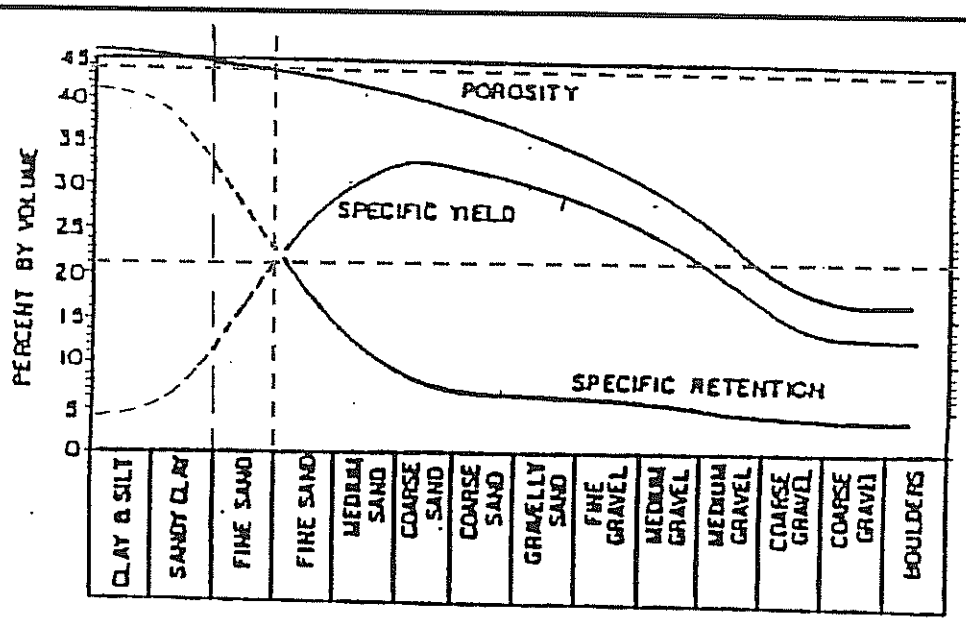


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



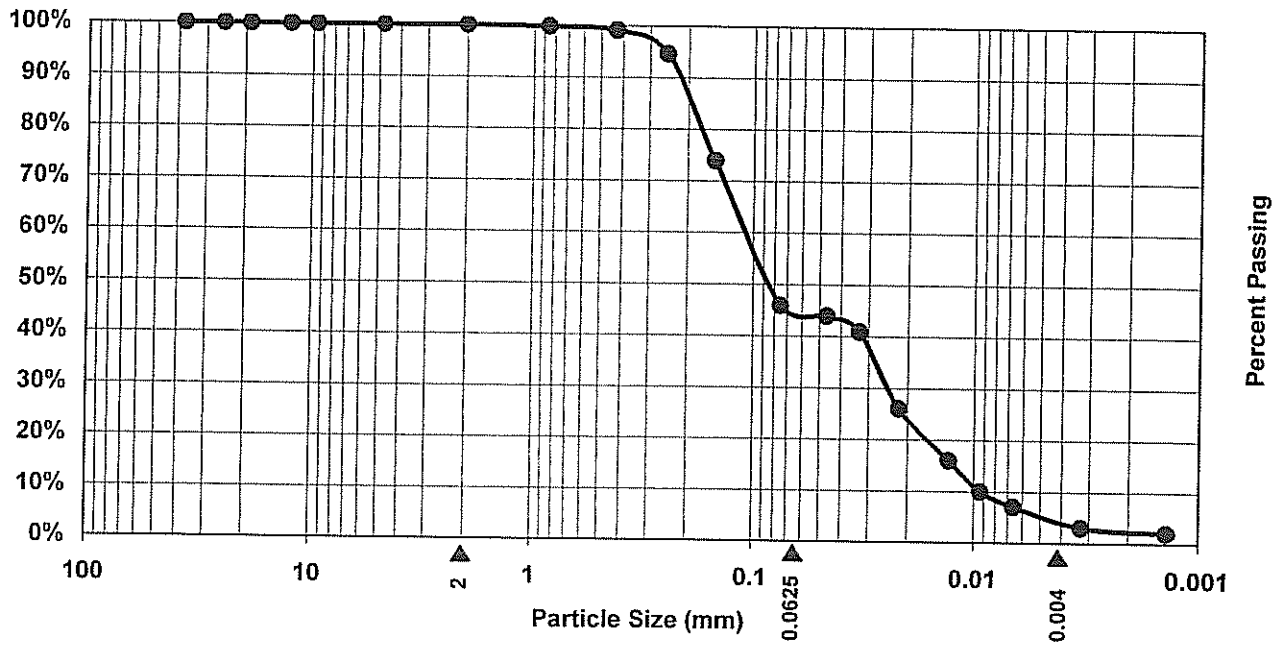
Estimated Porosity: 43.5%

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-61	SS-4	18.5 to 20 ft bls

Sample Description: Purple, Red, White Silty Medium to Fine Sand (SM)



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 0.0%	% Sand 54.8%	% Silt 41.3%	% Clay 3.9%
Adjusted for Calculations	**0%**	**55%**	**41%**	**4%**

Notes:

Grain size distribution taken from grain size with hydrometer data located in Appendix II.

Gravel, sand, silt and clay sizes based on Wentworth Scale.

S&ME Project:
Allen Steam Station RAB Landfill

S&ME Project No.:
1356-06-825

S&ME

FETTER AND BEAR DIAGRAMS

S&ME PROJECT: Marshall Steam Station Industrial Landfill
S&ME PROJECT NO.: 1356-08-122

Boring No. M-61

Boring Depth: 18.5 to 20 ft bls

% Sand: 55%

% Silt: 41%

% Clay: 4%

Estimated Specific Yield: 23%

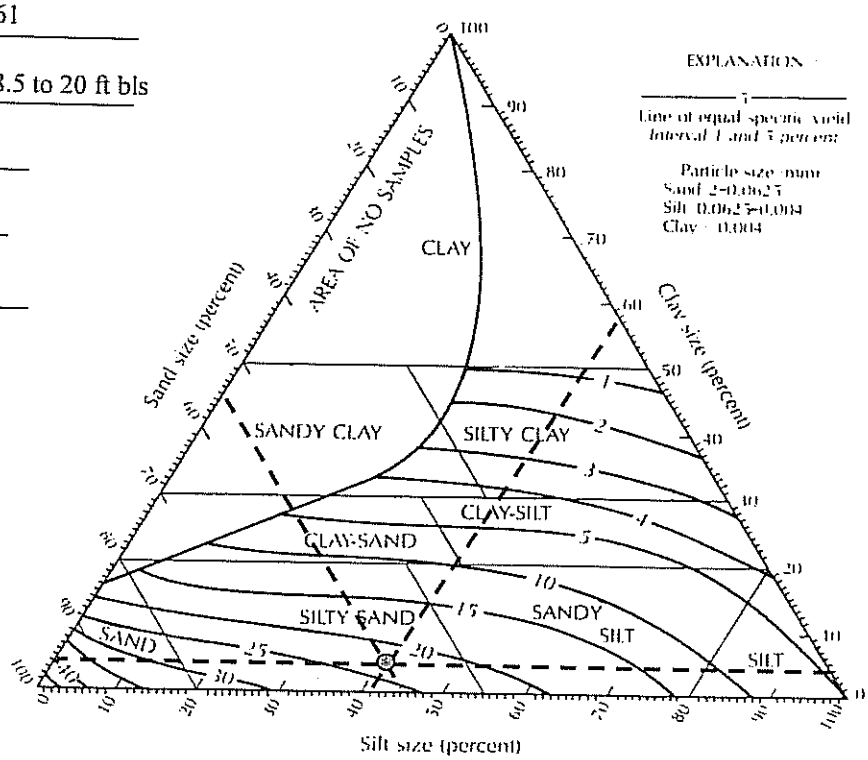
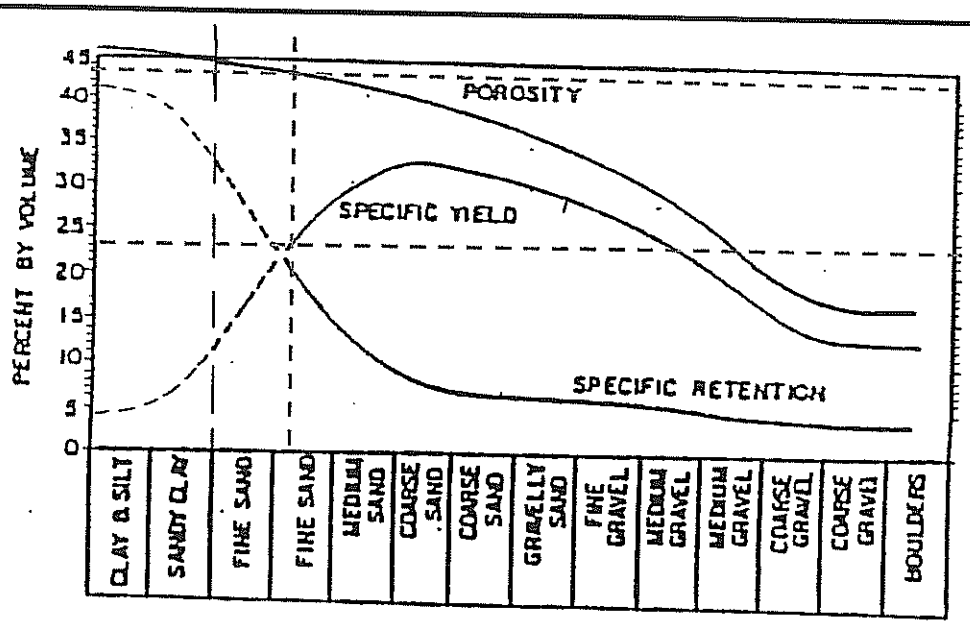


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



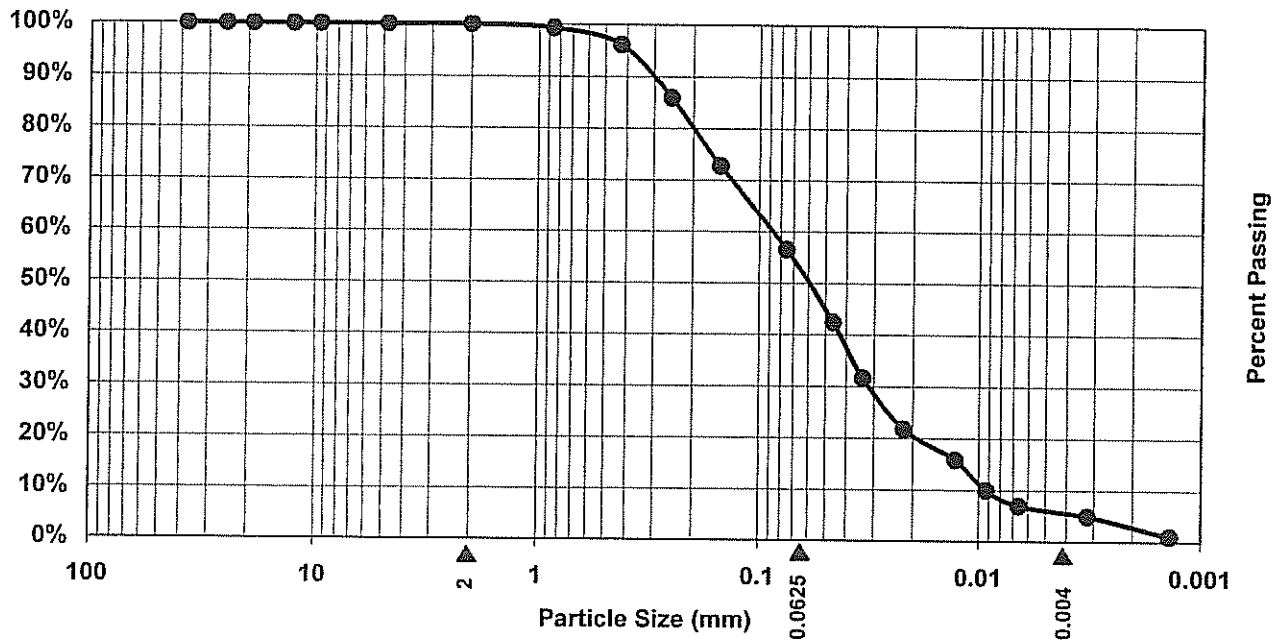
Estimated Porosity: 43%

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-61	SS-16	78.5 to 80 ft bls

Sample Description: Brown, Orange, White Medium to Fine Sandy Silt (ML)



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 0.0%	% Sand 48.3%	% Silt 46.3%	% Clay 5.4%
Adjusted for Calculations	**0%**	**48%**	**46%**	**5%**

Notes:

Grain size distribution taken from grain size with hydrometer data located in Appendix II.

Gravel, sand, silt and clay sizes based on Wentworth Scale.

S&ME Project:
Allen Steam Station RAB Landfill

S&ME Project No.:
1356-06-825

S&ME

FETTER AND BEAR DIAGRAMS

S&ME PROJECT: Marshall Steam Station Industrial Landfill
S&ME PROJECT NO.: 1356-08-122

Boring No. M-61

Boring Depth: 78.5 to 80 ft bls

% Sand: 48%

% Silt: 46%

% Clay: 5%

Estimated Specific Yield: 20%

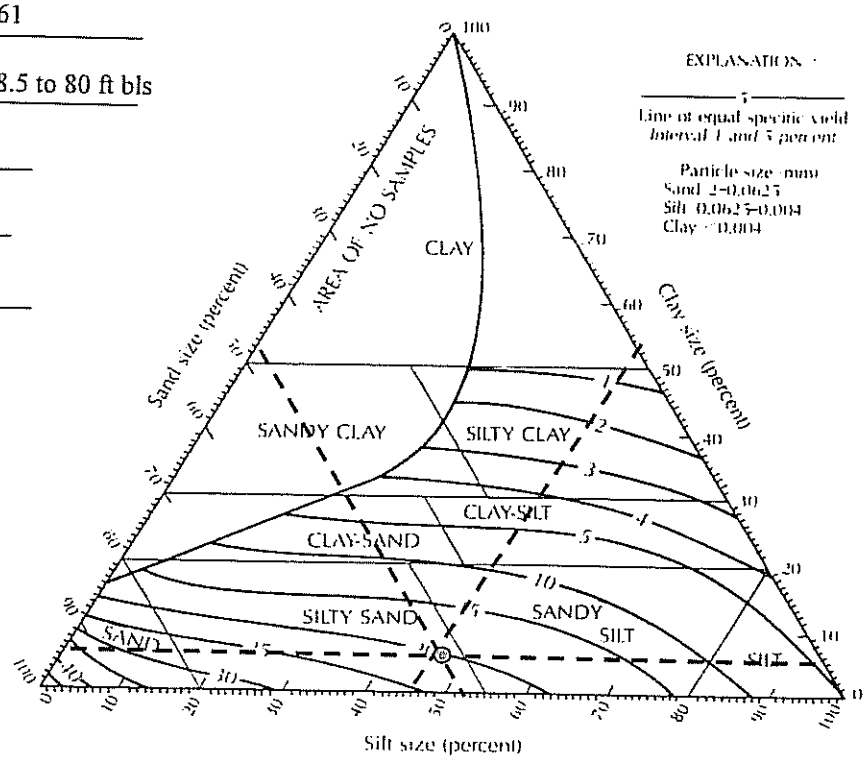
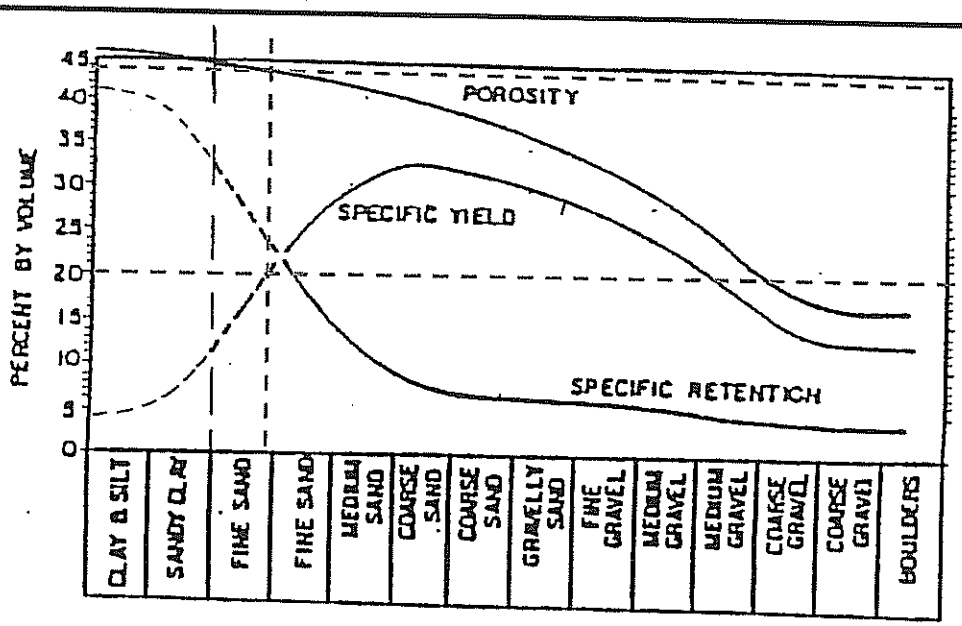


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



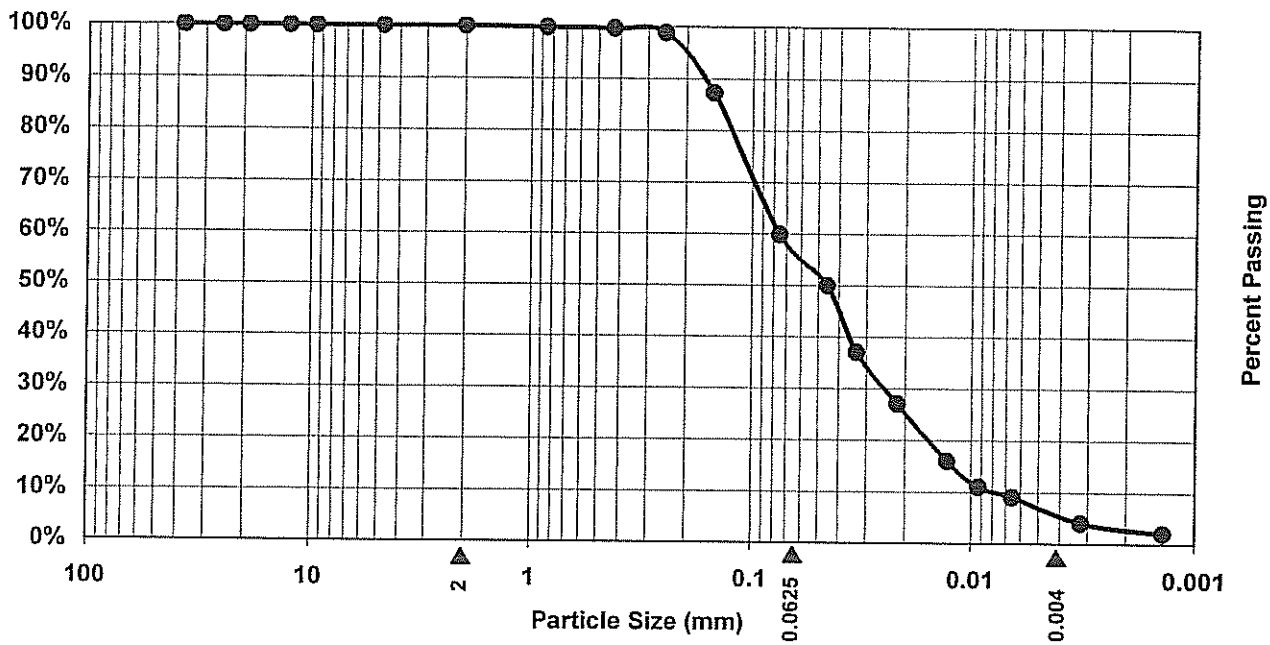
Estimated Porosity: 43.5%

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-62	SS-7	33.5 to 35 ft bls

Sample Description: Tannish Gray Fine Sandy Silt (ML)



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 0.0%	% Sand 43.4%	% Silt 51.4%	% Clay 5.2%
Adjusted for Calculations	**0%**	**43%**	**51%**	**5%**

Notes:

Grain size distribution taken from grain size with hydrometer data located in Appendix II.

Gravel, sand, silt and clay sizes based on Wentworth Scale.

S&ME Project:
Allen Steam Station RAB Landfill

S&ME Project No.:
1356-06-825

S&ME

FETTER AND BEAR DIAGRAMS

S&ME PROJECT: Marshall Steam Station Industrial Landfill
S&ME PROJECT NO.: 1356-08-122

Boring No. M-62

Boring Depth: 33.5 to 35 ft bls

% Sand: 43%

% Silt: 51%

% Clay: 5%

Estimated Specific Yield: 19%

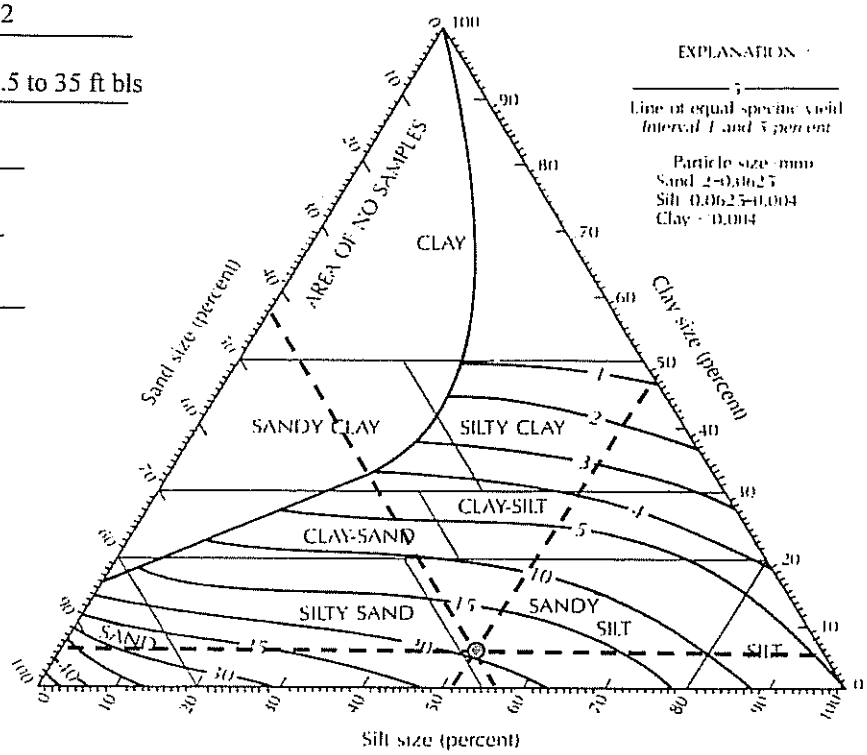
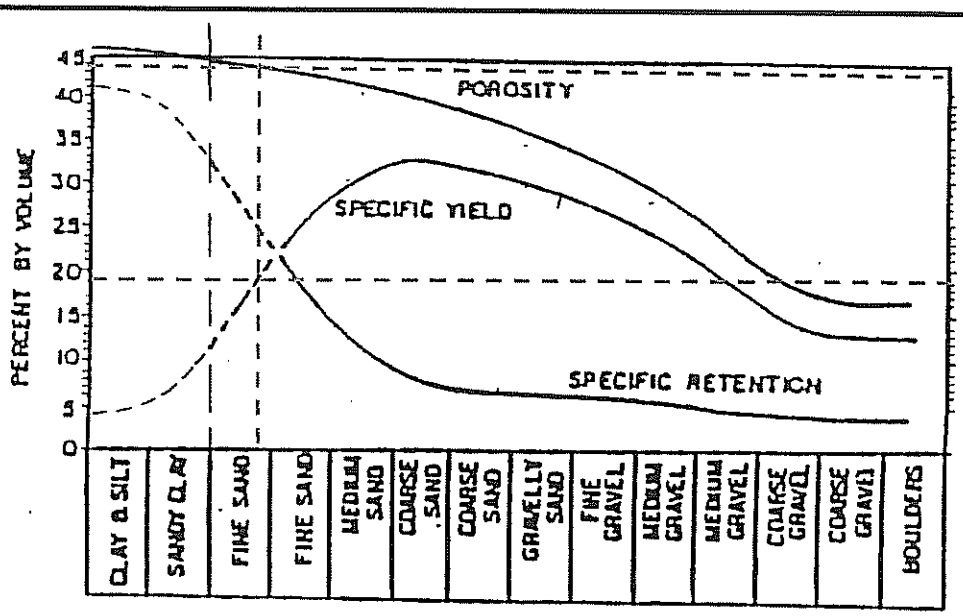


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



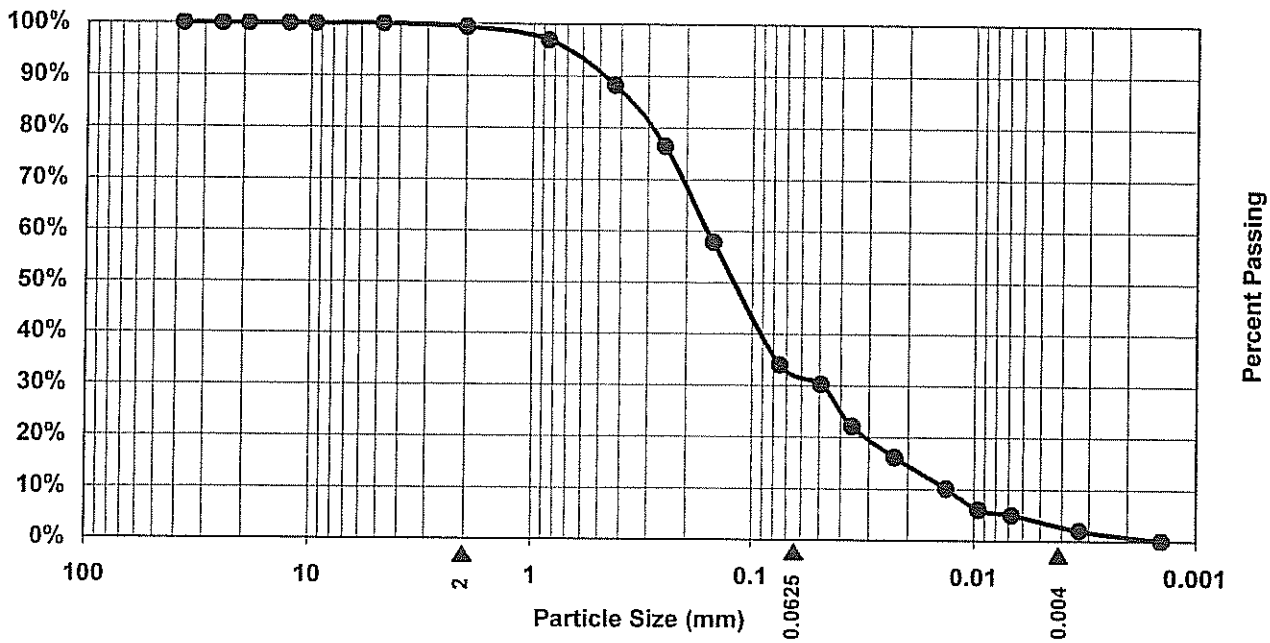
Estimated Porosity: 43.5%

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-63	SS-2	8.5 to 10 ft bls

Sample Description: Yellow-Red, Tan, White, Orange Silty Coarse to Fine Sand (SM)



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 0.6%	% Sand 66.9%	% Silt 29.9%	% Clay 2.6%
Adjusted for Calculations	**0%**	**67%**	**30%**	**3%**

Notes:

Grain size distribution taken from grain size with hydrometer data located in Appendix II.

Gravel, sand, silt and clay sizes based on Wentworth Scale.

S&ME Project:
Allen Steam Station RAB Landfill

S&ME Project No.:
1356-06-825

S&ME

FETTER AND BEAR DIAGRAMS

S&ME PROJECT: Marshall Steam Station Industrial Landfill
S&ME PROJECT NO.: 1356-08-122

Boring No. M-63

Boring Depth: 8.5 to 10 ft bls

% Sand: 67%

% Silt: 30%

% Clay: 3%

Estimated Specific Yield: 26%

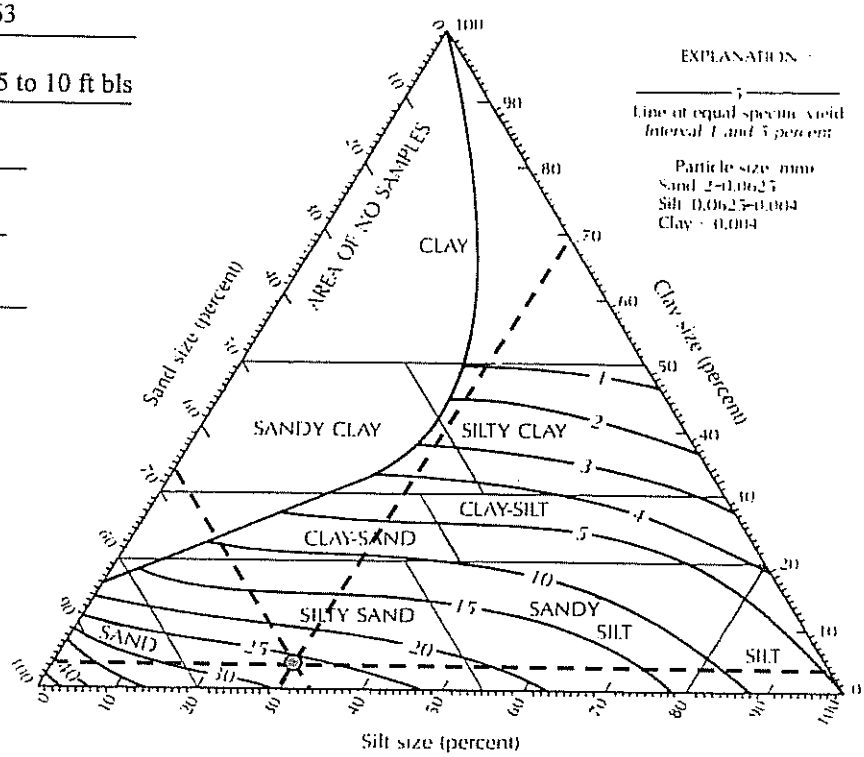
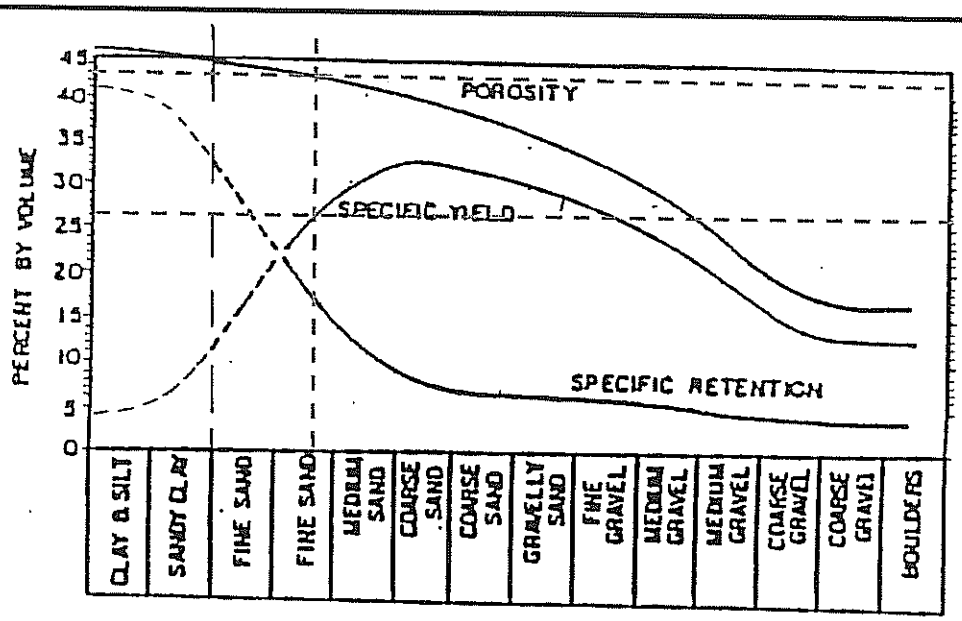


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.



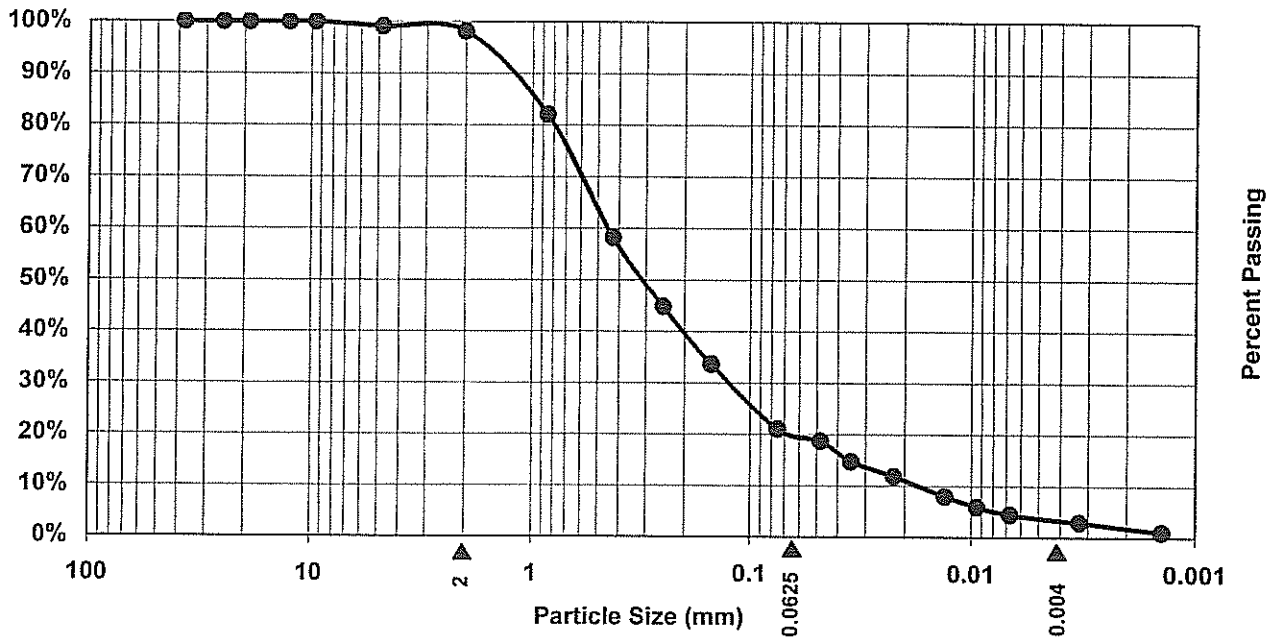
Estimated Porosity: 43%

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)

PARTICLE SIZE ANALYSIS OF SOILS
FOR USE IN FETTER AND BEAR DIAGRAMS

Boring No.:	Sample No.:	Depth:
M-64	SS-3	13.5 to 15 ft bls

Sample Description: White Silty Coarse to Fine Sand (SM)



	> 2 mm	2 mm - 0.0625 mm	0.0625 mm - 0.004 mm	<0.004 mm
From Graph:	% Gravel 1.9%	% Sand 77.9%	% Silt 16.9%	% Clay 3.2%
Adjusted for Calculations	**0%**	**79%**	**17%**	**3%**

Notes:

Grain size distribution taken from grain size with hydrometer data located in Appendix II.

Gravel, sand, silt and clay sizes based on Wentworth Scale.

S&ME Project:
Allen Steam Station RAB Landfill

S&ME Project No.:
1356-06-825

S&ME

FETTER AND BEAR DIAGRAMS

S&ME PROJECT: Marshall Steam Station Industrial Landfill
S&ME PROJECT NO.: 1356-08-122

Boring No. M-64

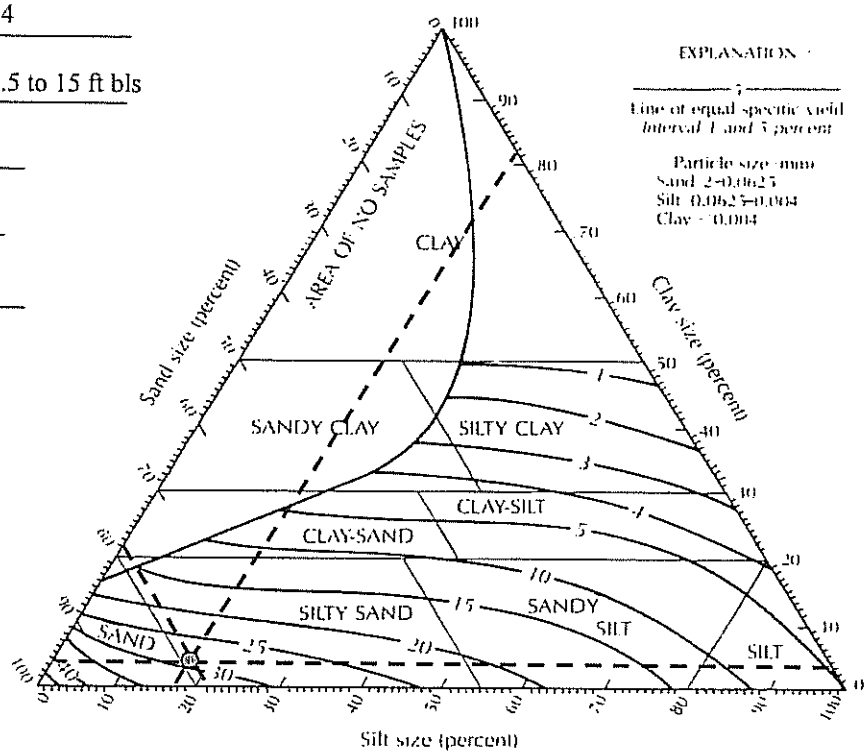
Boring Depth: 13.5 to 15 ft bls

% Sand: 79%

% Silt: 17%

% Clay: 3%

Estimated Specific Yield: 29%



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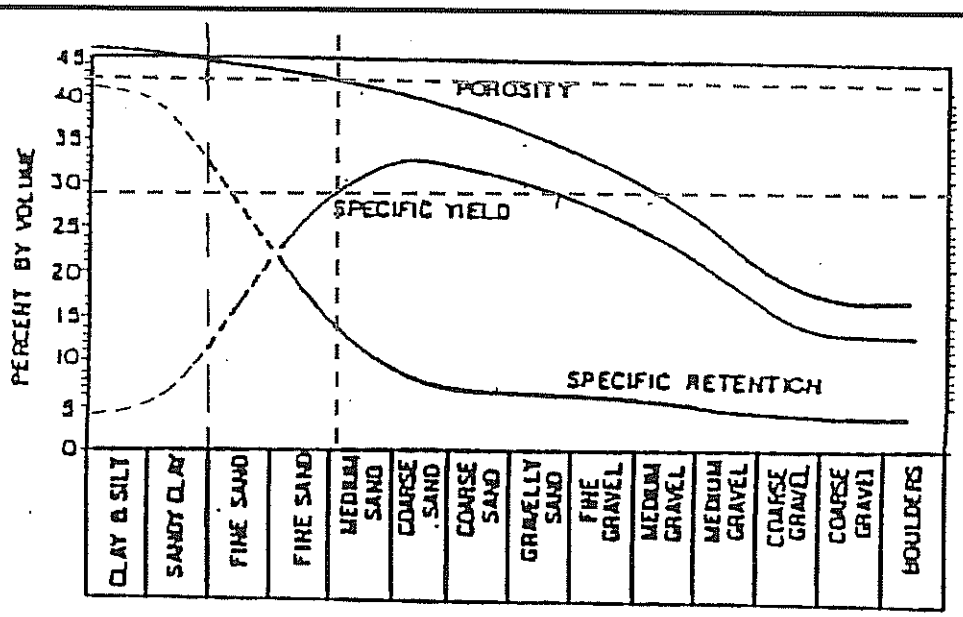

Estimated Porosity: 42%

Variation of Porosity, Specific Yield, and Specific Retention with Grain Size (after Bear, 1972)