BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL, ENVIRONMENTAL AND CONSTRUCTION MATERIALS CONSULTANTS

DESIGN HYDROGEOLOGIC REPORT
PHASE 3 (CELL NO. 1)

MACON COUNTY MSW LANDFILL
FRANKLIN, NORTH CAROLINA
FACILITY PERMIT NUMBER 57-03

Prepared For:

MACON COUNTY SOLID WASTE MANAGEMENT DEPARTMENT
109 Sierra Drive
Franklin, North Carolina 28734

Prepared By:

BUNNELL-LAMMONS ENGINEERING, INC.
6004 Ponders Court
Greenville, South Carolina 29615

BLE North Carolina Business License C-1538
BLE Project Number J13-1101-06

May 27, 2015

NORTH CAROLINA LICENSED SEAL 1043 GEOLOGIST MARK S. PREDDY 5/27/15

NORTH CAROLINA PROFESSIONAL SEAL 13814 ENGINEER DANIEL B. BUNNELL 5/27/15

BUNNELL-LAMMONS ENGINEERING, INC.
GEOTECHNICAL, ENVIRONMENTAL AND CONSTRUCTION MATERIALS CONSULTANTS

May 27, 2015

Macon County Solid Waste Management Department
109 Sierra Drive
Franklin, North Carolina 28734

Attention: Mr. Chris Stahl
Director

Subject: **Design Hydrogeologic Report – Phase 3 (Cell No. 1)**
Macon County MSW Landfill
Facility Permit Number 57-03
Macon County, North Carolina
BLE North Carolina Business License C-1538
BLE Project Number J13-1101-06

Gentlemen:

As authorized, Bunnell-Lammons Engineering, Inc. (BLE) has completed the Design Hydrogeologic Study for Phase 3 (Cell No. 1) at the Macon County MSW Landfill. This report addresses the relevant site application requirements as outlined in the North Carolina Rules for Solid Waste Management, 15A NCAC 13B .1623 (b). The attached report describes the work performed and presents the results obtained.

We appreciate the opportunity to serve as your geological, hydrogeological, and geotechnical consultant on this project and look forward to continue working with you at the Macon County MSW Landfill. If you have any questions, please contact us at (864) 288-1265.

Sincerely,

BUNNELL-LAMMONS ENGINEERING, INC.

NORTH CAROLINA LICENSED SEAL 1043 GEOLOGIST MARK S. PREDDY
5/27/15

Mark S. Preddy, P.G.
Senior Hydrogeologist
Registered, North Carolina No. 1043

NORTH CAROLINA PROFESSIONAL SEAL 13814 ENGINEER DANIEL B. BUNNELL
5/27/15

Daniel B. Bunnell, P.E.
Principal Geotechnical Engineer
Registered, North Carolina No. 13814

cc: Dave Pasko, P.E. – McGill Associates, P.A.
Mark Cathey, P.E. – McGill Associates, P.A.
Andrew Alexander, P.G. – Bunnell-Lammons Engineering, Inc.

c:\msp files\macon co lf nc\1101-06 dhr ph 3 c1\7 report\1101-06 macon co lf ph3 c1 dhr.docx

6004 PONDERS COURT
GREENVILLE, SOUTH CAROLINA 29615
PHONE (864) 288-1265
FAX (864) 288-4430

TABLE OF CONTENTS

PAGE

LIST OF TABLES iii

LIST OF FIGURES iii

LIST OF APPENDICES iii

REPORT CROSS-REFERENCE INDEX OF APPLICABLE NORTH CAROLINA STATE SOLID WASTE REGULATIONS iv

1.0 PROJECT INFORMATION 1

2.0 FIELD INVESTIGATION 1

- **2.1 TEST BORING AND SOIL SAMPLING** 2
- **2.2 GROUNDWATER INVESTIGATION** 2
- **2.3 LABORATORY TESTING** 3
- **2.4 FRACTURE TRACE ANALYSIS** 3
- **2.5 FIELD RECONNAISSANCE** 3

3.0 RESULTS OF INVESTIGATION 4

- **3.1 REGIONAL GEOLOGY** 4
- **3.2 REGIONAL HYDROGEOLOGY** 4
- **3.3 STUDY AREA PHYSIOGRAPHY AND TOPOGRAPHY** 5
- **3.4 STUDY AREA SUBSURFACE CONDITIONS** 5
  - **3.4.1 Geologic Unit Description** 5
    - **3.4.1.1 Residual Soil** 5
    - **3.4.1.2 Partially Weathered Rock (PWR)** 6
    - **3.4.1.3 Fractured Bedrock** 6
  - **3.4.2 Fracture Trace Analysis** 6
  - **3.4.3 Laboratory Testing Results** 7
- **3.5 STUDY AREA HYDROGEOLOGY** 7
  - **3.5.1 Piezometer Construction and Nomenclature** 8
    - **3.5.1.1 Deep Residual Soil Piezometers** 8
    - **3.5.1.2 Partially Weathered Rock Piezometers** 8
    - **3.5.1.3 Bedrock Piezometers** 8
  - **3.5.2 Seasonal High Groundwater Elevations** 8
  - **3.5.3 Estimated Long-Term Seasonal High Groundwater Elevations** 9
  - **3.5.4 Groundwater Flow Direction** 9
  - **3.5.5 Man-made Influences to Groundwater Levels** 10
  - **3.5.6 Hydraulic Coefficients and Groundwater Flow Velocity** 10
    - **3.5.6.1 Hydraulic Conductivity** 10

3.5.6.2 Hydraulic Gradient 11
3.5.6.3 Effective Porosity and Specific Yield 11
3.5.6.4 Groundwater Flow Velocity 11
3.6 LOCATION RESTRICTIONS 12
3.6.1 Fault Areas 12
3.6.2 Seismic Impact Zones 12
3.6.3 Unstable Areas 13
3.7 GEOTECHNICAL CONSIDERATIONS 13
3.7.1 Excavation 13
3.7.2 Engineered Fill 14
3.7.3 Settlement Analysis 15
3.7.4 Stability Analysis 16

4.0 CONCLUSIONS 16

5.0 ANNOTATED BIBLIOGRAPHY 17

LIST OF TABLES

Table 1 – Monitoring Well, Piezometer, and Boring Survey Information
Table 2 – Soil Test Boring and Piezometer Construction Details – Phase 3
Table 3 – Groundwater Elevation Measurements
Table 4 – Summary of *In Situ* Hydraulic Conductivity Testing – Slug Test Results
Table 5 – Summary of Soil Laboratory Results
Table 6 – Interstitial Groundwater Flow Velocity Calculations – Phase 3
Table 7 – Summary of Geologic and Hydrogeologic Characteristics of Geologic Units – Phase 3

LIST OF FIGURES

Figure 1 – Site Location Map
Figure 2 – Generalized Geologic Map of North Carolina
Figure 3 – Site Topography and Boring Location Plan
Figure 4 – Geologic Profiles: Cross-Sections A-A', B-B' and C-C'
Figure 5 – Top of Bedrock (Auger Refusal) Elevation Contour Map
Figure 6 – Groundwater Elevation Contour Map – September 26, 2014
Figure 7 – Seasonal High Groundwater Elevation Contour Map – September 2013 to September 2014
Figure 8 – Estimated Long-Term Seasonal High Groundwater Elevation Contour Map

LIST OF APPENDICES

Appendix A – Drilling and Sampling Procedures
Appendix B – Soil and Rock Boring Records and Well Diagrams
Appendix C – Piezometer Installation Procedures
Appendix D – Precipitation Data
Appendix E – Slug Test Procedures and Results
Appendix F – Soil Laboratory Test Procedures
Appendix G – Soil Laboratory Test Results
Appendix H – Fracture Trace Analysis Data
Appendix I – Geotechnical Calculations

REPORT CROSS-REFERENCE INDEX OF
APPLICABLE NORTH CAROLINA STATE SOLID WASTE REGULATIONS

15A NCAC 13B .1623 (b) Design Hydrogeologic Report Requirements

STATE REGULATIONS	LOCATION IN REPORT
(b) (1) (A)	Sections 3.4.1.3, 3.5.2, 3.6.3; Table 3; Figures 5, 7; Appendix D
(b) (1) (B)	Sections 3.4, 3.5; Tables 3, 4, 5, 6, 7 Figures 4, 5, 6, 7; Appendices B, E, G, H
(b) (2) (A)	From 15A NCAC 13B .1623(a)
(a) (4) (A)	Sections 2.1, 3.4.1; Appendices A, B
(a) (4) (B)	Sections 2.3, 3.4.3; Tables 5, 7; Appendices F, G
(a) (4) (C)	Sections 3.4.1, 3.4.3; Tables 5, 7; Appendices B, G
(a) (4) (D)	Sections 3.4; Tables 5, 7; Appendices B
(a) (4) (E)	Sections 3.4.3, 3.5.6; Tables 4, 5, 7; Appendices E, G
(a) (5)	Sections 2.4, 3.4.2; Appendix H
(a) (6)	Figure 4
(a) (7) (A)	Table 3
(a) (7) (B)	Table 3
(a) (7) (C)	Section 3.5.3; Table 3; Figure 8
(a) (7) (D)	Sections 3.2, 3.5.2, 3.5.3, 3.5.5
(a) (8)	Sections 3.5.4, 3.5.6; Tables 4, 5, 6, 7; Figures 4, 6, 7, 8; Appendix E, G
(a) (9)	Figures 6, 7, 8
(a) (10)	Figure 3
(a) (11)	Appendices B
(a) (12)	Sections 3.3, 3.4.2, 3.5.4, 3.5.5; Appendix H
(b) (2) (B)	Sections 3.0; Tables 3, 4, 5, 6, 7; Figures 4, 5, 6, 7, 8
(b) (2) (C)	Sections 3.0
(b) (2) (D)	Sections 2.1, 3.4.1.3, 3.4.2, 3.5.1.3; Figure 5; Appendices B, H
(b) (2) (E)	Figure 8
(b) (2) (F)	Figure 5
(b) (2) (G)	Figure 4
(b) (2) (H)	Section 3.5; Tables 3, 4, 5, 6, 7; Figures 4, 6, 7, 8
(b) (2) (I)	Section 2.2
(b) (3) (A)	Separate Document at a Later Date
(b) (3) (B)	Separate Document at a Later Date
(b) (3) (C)	Separate Document at a Later Date

1.0 PROJECT INFORMATION

The existing Macon County Municipal Solid Waste (MSW) Landfill is located on Lakeside Drive in Franklin, North Carolina (**Figure 1**). The landfill is owned and operated by Macon County. The existing facility boundary covers approximately 189.5 acres consisting of Phase 1 (Cell 1) and Phase 2 (Cell 2). Macon County now plans to develop Phase 3 located east of the recycling center, and not contiguous to the existing Phase 1 and Phase 2 waste cell units. Initial Phase 3 development will be an approximate 7.6-acre area designated as Phase 3 (Cell No. 1). As part of the current Permit to Construct (PTC) prepared by McGill Associates, P.A. (McGill), Macon County plans to expand and revise the site's permitted facility boundary; **Figures 3, 5, 6, 7**, and **8** of this report show both the *currently permitted* and *proposed* facility boundaries. The proposed facility boundary covers approximately 197.6 acres, and portions of future built-out Phase 3 cell area may be located within the facility expansion area. Therefore, a *Site Hydrogeologic Report* (SHR) will be prepared in the future representing the investigation of the facility expansion area.

The landfill development is being implemented in phases, as new solid waste cells are needed. This *Design Hydrogeologic Report* (DHR) addresses the geological, hydrogeological, and geotechnical investigation required for the construction permitting process of proposed Phase 3 (Cell No. 1). The investigation was performed in accordance with the applicable North Carolina Rules for Solid Waste Management (15A NCAC 13B .1623 (b)). Relevant data pertaining to Phase 3 were also compiled in this report from the following two reports:

- *Site Suitability Study For Macon County Landfill, Franklin North Carolina*, dated 1990, prepared by Westinghouse Environmental and Geotechnical Services, Inc. (Project No. 1351-89-369; and
- *Addendum to Site Hydrogeologic Report, Macon County MSWLF, Macon County, North Carolina* dated February 28, 1997, prepared by Pin-Point Environmental Services, Inc.

2.0 FIELD INVESTIGATION

The Phase 3 area field investigation was conducted from August 2013 to September 2014. The investigation of Phase 3 has included:

- conducting soil test borings and rock coring borings;
- installing piezometers;
- collecting monthly water level measurements from the piezometers;
- conducting hydraulic conductivity (slug) testing in piezometers;
- performing soil laboratory testing;
- measuring joint and bedding orientations from rock outcrops;
- performing a fracture trace study for the site and surrounding area; and
- performing an evaluation of location restrictions as outlined in the applicable solid waste regulations.

A discussion of the investigative methodologies used in the site evaluation is provided below. The field activities reported below were performed under the direction of a North Carolina licensed geologist and engineer. A North Carolina licensed driller from Landprobe, Inc. of Greenville, South Carolina performed the borings and piezometer installation during this phase of work. The new boring and piezometer locations were surveyed for horizontal and vertical control, by McGill

Associates, P.A. of Asheville, North Carolina, (PLS-4626) after completion of the drilling activities.

2.1 TEST BORING AND SOIL SAMPLING

The North Carolina Solid Waste Section (Section) requires that Design Hydrogeologic Studies include the drilling of one boring per acre of permitted cell area. The Phase 3 area is approximately 33.8 acres; therefore, at least 34 borings are needed for the entire Phase 3 investigation. However, only a portion of the Phase 3 area was investigated and 29 borings have been performed within or adjacent to portions of the Phase 3 area (**Table 1** and **Figure 3**). Borings BLE-1 through BLE-22, B-5R, B-6R, B-16R, and B-18R were performed by BLE during the recent investigation; the other borings in the Phase 3 area shown on **Table 1** and **Figure 3** were performed by Westinghouse (1990). Phase 3 (Cell No. 1) covers approximately 7.6 acres and 11 borings have been performed in its vicinity (**Figure 3**). The information from the other borings included in this investigation that are not part of Phase 3 (Cell No. 1) were performed in accordance with the Section's Solid Waste Management Rules 15A NCAC 13B .1623 (b) and can be used in the future for DHR studies of other Phase 3 cells.

The new soil test boring locations and depths were selected to comply with the applicable Section rules. Soil samples were obtained from the new soil test borings at 2.5-foot intervals within the upper ten feet below the ground surface, and at five-foot intervals deeper than ten feet below the ground surface. Drilling techniques during this recent investigation consisted of hollow-stem augering and rock coring. Refer to **Appendix A** for discussion of the various drilling techniques used.

Soil test boring logs were produced in the field by a geologist. The soil descriptions were based on visual examination and grain-size estimations in accordance with the Unified Soil Classification System (USCS). Upon completion of laboratory grain-size and Atterberg Limit analyses, the preliminary field classifications were adjusted accordingly on the final boring logs. The final boring log records are included in **Appendix B**.

2.2 GROUNDWATER INVESTIGATION

Twenty-four (24) new piezometers were installed to monitor groundwater elevations and further characterize the study area hydrogeology. Three of the piezometers (B-6R, B-16R, and B-18R) were installed in the approximate locations of the soil test borings completed by Westinghouse (1990) for the site suitability study. Piezometer installation records are included with the boring logs in **Appendix B**, and piezometer installation procedures are described in **Appendix C**. Survey information for the soil borings, piezometers, and monitoring wells is presented on **Table 1** and in **Appendix B**, and piezometer construction details are summarized on **Table 2**.

Groundwater elevations were measured in the new piezometers at the time of boring and after 24 hours (**Table 3**). Additionally, monthly measurements were taken in the piezometers and monitoring wells on site during the period from September 2013 to September 2014 to determine the seasonal high groundwater levels. Historical water level data from December 2004 through April 2013 are also provided on **Table 3** and precipitation data for the Macon County region is included in **Appendix D**.

Field permeability (slug) tests were performed in ten piezometers in the study area to measure the *in situ* hydraulic conductivity of different units of the water table aquifer. Slug test field procedures and data plots are presented in **Appendix E** and the results are summarized on **Table 4**.

The piezometers are intended only for investigation use, were not constructed as permanent monitoring wells, and will not be part of the permanent groundwater monitoring system. Prior to landfill cell construction activities, the piezometers will be permanently abandoned in accordance with 15A NCAC 2C, Rule .0113(a)(2) by drilling them out and filling the resulting boreholes with a bentonite-cement grout mixture.

2.3 LABORATORY TESTING

Laboratory testing of soil samples was conducted to confirm the field classifications and quantify pertinent engineering soil properties. Soil samples were collected using split-spoon samplers, Shelby tubes (undisturbed), and auger cuttings (bulk bag samples). The laboratory tests were performed in general accordance with applicable ASTM specifications, where available. Brief descriptions of the test procedures are included in **Appendix F**. Soil laboratory testing results are included in **Appendix G** and are summarized on **Table 5**.

2.4 FRACTURE TRACE ANALYSIS

The fracture trace analysis consisted of evaluating exposed rock outcrops and topographic fracture traces and lineaments as discussed below. The data plots are included in **Appendix H**.

Exposed Rock Outcrops: Using a Brunton compass, the orientations of exposed bedrock fractures (open joints, open foliation, open bedding planes) were measured. The field measurements were plotted on a Schmidt lower hemisphere equal-area stereonet and Rose diagrams.

Topographic Fracture Traces and Lineaments: Regionally, pronounced depressions typically develop along zones of weakness in the bedrock where fractures induce preferential weathering. This preferential weathering along the bedrock fractures is ultimately expressed topographically as linear valleys. The trend of fracture traces and lineaments greater than 1,000 feet in length within a 1.5-mile radius of the site were measured from topographic maps and plotted as data on Rose diagrams.

2.5 FIELD RECONNAISSANCE

The Phase 3 study area was traversed to map rock outcrops and surface drainage features. The information obtained was integrated with the geologic information already collected at the site during previous phases of work. Bedrock fracture orientations were measured from the rock outcrops as part of the fracture trace analysis.

3.0 RESULTS OF INVESTIGATION

3.1 REGIONAL GEOLOGY

The subject site is located within the Blue Ridge geologic belt (**Figure 2**). The geology of the Blue Ridge Belt consists of metamorphic Precambrian basement rock overlain with unconformable younger Precambrian metamorphosed sedimentary and igneous rocks. The Blue Ridge belt is bordered to the southeast by the Brevard belt and to the northwest by the Valley and Ridge. The Precambrian basement has undergone several episodes of uplift, deformation, faulting, intrusion, metamorphism and erosion.

Locally, the site is geologically underlain by the lower portion of the Middle/Late Proterozoic Coweeta Group known as the Persimmon Creek Gneiss, which overlies the Tallulah Falls Formation (*Hatcher, 1979; Rhodes and Conrad, 1985; Horton and Zullo, 1991*). The Persimmon Creek Gneiss consists of migmatitic feldspar-quartz-biotite gneiss interlayered and gradational with biotite-garnet gneiss and amphibolite. The original protolith of the gneiss bedrock is most likely highly metamorphosed clastic sediments.

The typical residual soil profile consists of clayey and silty soils near the surface, where soil weathering is more advanced, underlain by micaceous sandy silts and silty sands. Residual soil zones develop by the *in situ* chemical weathering of bedrock, and are commonly referred to as "saprolite." Saprolite usually consists of micaceous sand with large rock fragments and lesser amounts of clay and silt. The boundary between soil and rock is not sharply defined.

A transitional zone of partially weathered rock (PWR) is normally found overlying the parent bedrock. Partially weathered rock is defined, for engineering purposes, as residual material with standard penetration resistance (ASTM D 1586) in excess of 100 blows per foot (bpf). Fractures, joints, and the presence of less resistant rock types facilitate weathering. Consequently, the profile of the partially weathered rock and hard rock is quite irregular and erratic, even over short horizontal distances. Also, it is not unusual to find lenses and boulders of hard rock and zones of partially weathered rock within the soil mantle, well above the general bedrock level.

3.2 REGIONAL HYDROGEOLOGY

Groundwater in the Blue Ridge Belt usually occurs as unconfined, water table aquifers in three primary geologic zones: 1) residual soil; 2) partially weathered rock; and 3) fractured bedrock. These zones are typically interconnected through open fractures and pore spaces. The configuration of the water table aquifer generally resembles the local topography.

In the residual soil, and partially weathered rock zone, groundwater is stored within the pore spaces and is released to the underlying bedrock through gravity drainage. Groundwater within the bedrock zones occurs primarily in fracture voids. Generally, fractures within the bedrock are very small but may extend to several hundred feet.

Infiltration of precipitation to recharge the water table aquifer is primarily affected by rainfall intensity and duration, pre-existing soil moisture conditions, temperature (evaporation), and plant uptake (transpiration). Seasonal high-water tables are typically observed during the spring to early

summer months of the year when maximum infiltration efficiency occurs due to lower temperatures and less plant uptake (i.e., many plants are dormant). Seasonal low-water tables are typically observed during the fall months when minimum infiltration efficiency occurs due to higher temperatures and greater plant uptake of water.

3.3 STUDY AREA PHYSIOGRAPHY AND TOPOGRAPHY

The landfill is located in Macon County, North Carolina, as shown on **Figure 1**. The Phase 3 area is bounded on the west by the recycling center, a drainage feature, and a retention pond, on the north by Lake Emory (Little Tennessee River), on the east by residential property and a Macon County government transit facility, and on the south by a drainage feature, undeveloped landfill property, and Macon County government facilities (**Figure 3**).

The only observed rock outcrop in the Phase 3 area is located near the southern edge of the proposed cell footprint (west of BLE-16) and consists of feldspar-quartz-biotite gneiss.

Topographically, the ground surface elevation in the Phase 3 area drops off to the north, west, and south from a centrally located ridgeline. The highest elevation in the Phase 3 footprint is approximately 2159 feet above mean sea level (msl) located at the center of the Phase 3 area, and the lowest elevation is approximately 2015 feet msl located north of the proposed Phase 3 cell footprint. The relief across the Phase 3 area is approximately 144 feet.

Groundwater in the Phase 3 area generally flows from the ridgeline towards the north into Lake Emory, and to the south and west into drainage features and a retention pond. The drainage features south and west of Phase 3 drain northward into Lake Emory north of the Phase 3 area.

3.4 STUDY AREA SUBSURFACE CONDITIONS

Twenty-nine (29) borings have been performed in, and adjacent to, Phase 3 at the locations shown on **Figure 3**. The cell footprint is underlain by residual soils, partially weathered rock (PWR), and bedrock at depth. Subsurface geology of the Phase 3 area is shown on two cross-sections designated A-A', B-B', and C-C' on **Figure 4**. A description of the subsurface materials encountered is provided below.

3.4.1 Geologic Unit Description

3.4.1.1 Residual Soil

Residual soils are the result of in-place weathering of the gneiss bedrock. The residual soil profile below the topsoil consists of two identifiable components based on the USCS.

The upper soil component consists of reddish-brown, pinkish-brown, and brown, slightly micaceous, sandy silty clay and sandy clayey silt, with lesser amounts of clayey sand. Where encountered, the thickness of this component ranges from 1.5 to 12 feet below ground surface with an average thickness of 5.1 feet. USCS classifications of these soils are typically ML, CL, and SC. N-values ranged from 3 to 33 with an average value of 11, indicating a stiff average consistency.

The upper soil component grades with depth into a coarser grained, less plastic, brown, red-brown, and light brown micaceous sandy silt and silty sand which extends to the depth of the partially weathered rock and/or auger refusal. Where encountered, the thickness of this component ranged from 5.0 to 82 feet, with an average thickness of 33.6 feet. USCS classifications of these soils are ML and SM. N-values range from 4 to 100 with an average of 26.4, indicating a very firm average consistency.

3.4.1.2 Partially Weathered Rock (PWR)

The transition between soil and rock at the site is irregular and consists of partially weathered rock (PWR) overlying the parent bedrock. The PWR consists primarily of brown, light brown, and gray, micaceous to very micaceous, silty, fine to coarse sand with varying amounts of gravel size rock fragments. USCS classifications of these soils are typically SM. Where encountered, this zone was found to range in thickness from 2.5 to 30.0 feet, with an average thickness of 10.3 feet. This zone also includes various float rock and boulders indicative of the varying weathering patterns.

3.4.1.3 Fractured Bedrock

The upper bedrock profile is fractured, severely to slightly weathered, feldspar-quartz-biotite gneiss. Alternating rock seams and partially weathered rock zones were commonly encountered in the rock core samples. The metamorphic foliation is shallow to moderately dipping and the bedrock fractures (joints) are shallow to moderately dipping.

Bedrock coring was performed at eleven different locations for a total of 275.5 feet. The bedrock core had generally “poor” recovery (range of 0 to 100 percent; average of 50 percent) and “very poor” rock quality designation (RQD; range of 0 to 100 percent; average of 24 percent). In general, the bedrock becomes more competent with depth.

A map of the approximate bedrock surface (auger refusal) is shown as **Figure 5**. Auger refusal depths may represent competent bedrock or possibly boulders of hard rock within the residual soil and partially weathered rock units. The depth to auger refusal can vary even over short horizontal distances due to boulders, fractures, joints, and the presence of less resistant rock types. Therefore, the actual depth to continuous bedrock may vary somewhat from that presented on **Figure 5**.

3.4.2 Fracture Trace Analysis

A fracture trace analysis was performed for this phase of work. The data plots for the fracture trace analysis are in **Appendix H** and a summary of the fracture trace analysis is provided below.

The trend of 50 topographic fracture traces and lineaments within 1.5 miles of the site were measured and plotted on a Rose diagram utilizing a 10° interval. Two primary fracture trace trends were observed: N11°-50°E; N31°-70°W.

Bedrock outcrops are not common in the Phase 3 area. The orientation of one joint orientation was measured near boring BLE-16, which measured N40°W, dipping 65°NE. This orientation correlates with the N31°-70°W topographic lineament trend.

3.4.3 Laboratory Testing Results

Thirty (30) split-spoon samples, 12 undisturbed Shelby Tube samples, and 7 bulk bag samples were collected and tested in the laboratory to measure natural soil conditions in the Phase 3 area. The laboratory test results are summarized in **Table 5**. Laboratory data sheets are in **Appendix G**.

Testing results of the 10 samples collected from the upper residual soil component consisted of:
- Natural moisture content values ranging from 17.2 to 45.5 percent;
- Liquid Limit (LL) values ranging from 33 to 55;
- Plasticity Index (PI) values ranging from 10 to 22;
- Average gravel, sand, silt, and clay contents of 2.0, 43.9, 22.3, and 31.8 percent, respectively;
- In-situ hydraulic conductivity values ranging from 1.3×10^{-5} to 5.2×10^{-4} cm/sec;
- Remolded hydraulic conductivity values ranging from 2.1×10^{-7} to 2.1×10^{-6} cm/sec;
- Total porosity values ranging from 45.5 to 49.9 percent; and
- Effective porosity values ranging from 3.7 to 5.5 percent.

Testing results of the 31 samples collected from the deeper residual soil component consisted of:
- Natural moisture content values ranging from 10.4 to 33.8 percent;
- LL values ranging from 26 to 55;
- PI values ranging from non-plastic (NP) to 12;
- Average gravel, sand, silt, and clay contents of 2.5, 62.5, 27.3, and 7.7 percent, respectively;
- In-situ hydraulic conductivity values ranging from 3.0×10^{-6} to 4.2×10^{-4} cm/sec;
- Remolded hydraulic conductivity values ranging from 1.0×10^{-6} to 7.9×10^{-6} cm/sec;
- Triaxial testing of two in-situ samples indicated total cohesive strength (C) values of 0.0 and 0.65 kips per square foot (ksf) and effective C values of 0.0 and 0.0 ksf, respectively; the samples also indicated total Phi (ϕ) angles of 29.20 and 21.06 degrees and effective ϕ angles of 42.25 and 38.75 degrees, respectively;
- Consolidation testing of one in-situ sample indicated a preconsolidation pressure of 7.21 ksf;
- Total porosity values ranging from 40.1 to 57.5 percent; and
- Effective porosity values ranging from 15.0 to 32.5 percent.

Testing results of the 8 samples collected from the partially weathered rock component consisted of:
- Natural moisture content values ranging from 3.7 to 24.1 percent;
- LL values ranging from 22 to 37;
- PI values ranging from NP to 3;
- Average gravel, sand, silt, and clay contents of 3.9, 68.5, 25.1, and 2.5 percent, respectively;
- Total porosity values ranging from 47.0 to 50.0 percent; and
- Effective porosity values ranging from 27.5 to 31.0 percent.

3.5 STUDY AREA HYDROGEOLOGY

Twenty-four (24) new piezometers were installed in, or adjacent to, the Phase 3 area at the locations shown on **Figure 3**. Groundwater is present both above and below the bedrock surface in the Phase 3 area. The water-table aquifer in the Phase 3 area consists of the residual saprolitic soil,

partially weathered rock, and fractured gneiss bedrock. These units are hydraulically connected and thus comprise a single unconfined aquifer, although recharge rates, flow rates and storativity differ between the units based on the unique geologic conditions of each zone. The configuration of the water table surface is a subdued replica of the ground surface (**Figure 6**). The hydrogeologic conditions encountered in the Phase 3 area are consistent with the conditions encountered during previous phases of work at the landfill. A description of the hydrogeologic conditions in the study area is provided below.

3.5.1 Piezometer Construction and Nomenclature

Twenty-one (21) new piezometers drilled during the current site investigation in locations where no piezometers had been installed were labeled with the identifier "BLE". Three (3) new piezometers drilled in locations where piezometers had been previously drilled and abandoned during the previous site investigation conducted by Westinghouse (1990) were labeled with the identifier "B" and the suffix "R" to indicate the piezometer's status as a replacement. **Table 2** summarizes the piezometer depths and units screened.

3.5.1.1 Deep Residual Soil Piezometers

Seven new piezometers were installed with screened intervals in the deep residual soils. These piezometers were: BLE-3, BLE-9, BLE-16, BLE-18, BLE-21, BLE-22, and B-6R.

3.5.1.2 Partially Weathered Rock Piezometers

Six new piezometers were installed with screened intervals in the partially weathered rock. These piezometers were: BLE-7, BLE-11, BLE-13, BLE-14, BLE-15, and B-18R.

3.5.1.3 Bedrock Piezometers

Eleven new piezometers were installed with screened intervals in the bedrock. These piezometers were: BLE-1, BLE-2, BLE-4, BLE-5, BLE-6, BLE-8 BLE-12, BLE-17, BLE-19, BLE-20 and B-16R.

3.5.2 Seasonal High Groundwater Elevations

The relationship between precipitation and groundwater level trends at the site was evaluated from 2000 to 2014. The following sources of data were used to evaluate the seasonal high water level at the site:

1. Historical National Oceanic and Atmospheric Administration (NOAA) precipitation data were obtained to establish seasonal trends for the Macon County area (*http://www.ncdc.noaa.gov/oa/climate/climatedata.html*);
2. Historical water level measurements from monitoring wells between December 2004 and April 2013; and
3. Recent monthly water level measurements from the piezometers and monitoring wells at the facility between September 2013 and September 2014.

Historical NOAA monthly precipitation data were obtained from Division 1, North Carolina for the period of January 2000 through December 2014. The data are summarized seasonally in **Appendix D** such that January-March represents *winter*, April-June represents *spring*, July-September represents *summer*, and October-December represents *fall*.

Historically in the Macon County area, the spring and summer months will experience relatively more amounts of precipitation, with slightly less precipitation in the winter and fall months. The effects of evapotranspiration during the summer months offset the contribution of this precipitation to recharge of the aquifer. The winter and spring months will experience maximum water infiltration efficiency to recharge the uppermost aquifer because the effects of evapotranspiration are limited (i.e., cooler weather and less plant uptake). Because of these natural trends, the amount of groundwater recharge and subsequent increase in the water table level is typically greatest during the months of March through July.

The region surrounding the site received normal amounts of precipitation during the period of water level measurements from September 2013 to September 2014. Also during this time period, the region was not in drought conditions (see precipitation and Palmer Drought Severity Index data in **Appendix D**). During the period of monthly water level measurements, most piezometers and wells monitored experienced their highest water levels during the summer months of 2013 and the spring months of 2014 (**Table 3**).

Figure 7 is the seasonal high groundwater elevation contour map for the water levels collected between September 2013 and September 2014. The groundwater elevations in the piezometers, and the groundwater elevation contours on **Figure 7** should be used for landfill subgrade design, along with the bedrock (auger refusal) elevations shown on **Figure 5**.

3.5.3 Estimated Long-Term Seasonal High Groundwater Elevations

Groundwater levels were recorded monthly for a year in the new piezometers and existing monitoring wells at the site between September 2013 and September 2014. Additionally, semi-annual groundwater level data was available from the existing monitoring wells during the period between December 2004 and April 2013. Historical groundwater level data is provided on **Table 3**. The historical groundwater levels in the existing monitoring wells have varied on the average of 4.5 feet from December 2004 to September 2014. As a conservative approach using this natural water level trend, an estimated long-term seasonal high groundwater elevation contour map was prepared (**Figure 8**). This map was prepared by adding 4.5 feet (typical seasonal variation in the existing monitoring wells from December 2004 to September 2014) to the *maximum* observed water level (from September 2013 to September 2014) in each piezometer in the Phase 3 area. These water level calculations are included on **Table 3**.

3.5.4 Groundwater Flow Direction

An east-west to northwest trending topographic ridge exists in the Phase 3 footprint from which groundwater flows to the north discharging into Lake Emory, and to the west and southwest discharging into an unnamed drainage feature and a retention pond (**Figure 3**). The groundwater table surface has a configuration similar to the site topography (**Figures 6, 7, and 8**). Recharge to the unconfined aquifer occurs at the higher elevations of Phase 3 and in the areas east of Phase 3.

3.5.5 Man-made Influences to Groundwater Levels

Man-made features on the landfill property that could influence groundwater levels in the Phase 3 area include the proposed lined waste cell footprint, ditches next to access roads, existing and proposed retention ponds. The retention ponds will have the effect of raising or mounding the groundwater level in their vicinity. The proposed lined cell footprint will have the effect of lowering the groundwater level in its vicinity by reducing the recharge area to the aquifer. Currently, there is one existing retention pond northwest of the Phase 3 area (**Figure 3**).

There are no groundwater receptors located between the Phase 3 area and the Lake Emory north of Phase 3, which is the downgradient groundwater discharge area from Phase 3.

3.5.6 Hydraulic Coefficients and Groundwater Flow Velocity

The velocity of groundwater flow is derived from the equation:

$$V = \frac{Ki}{n_e}$$

Where

V is the flow velocity;
K is the hydraulic conductivity;
i is the hydraulic gradient; and
$\boldsymbol{n_e}$ is the effective porosity.

Estimated values for each of these parameters were developed based on site-specific subsurface data and are provided below. The parameters are summarized on attached **Tables 4, 5, 6,** and **7**.

3.5.6.1 Hydraulic Conductivity

Hydraulic conductivity is defined as the ability of the aquifer material to conduct water under a hydraulic gradient. Ten slug tests were performed by BLE in the Phase 3 area to measure the *in situ* hydraulic conductivity of the different zones of the water-table aquifer. The slug test results were evaluated using the *Bouwer and Rice Method (1976)* for partially-penetrating wells in an unconfined aquifer (**Table 4** and **Appendix E**). The slug tests performed at the site include:

- Four tests in a piezometer set in the deep residual soil unit (BLE-3, BLE-9, BLE-18 and BLE - 21);
- Three tests in piezometers set in the partially weathered rock unit (BLE-7, BLE-13, BLE-15; and
- Three tests in piezometers set in the bedrock unit (BLE-4, BLE-8, and BLE-17).

Based on the slug tests conducted in the Phase 3 area, the range of hydraulic conductivity values is as follows:

- 2.8×10^{-4} cm/sec (BLE-9) to 4.5×10^{-4} cm/sec (BLE-3) in the deep residual soil unit (geometric mean 3.7×10^{-4} cm/sec);

- 1.7 x 10^{-4} cm/sec (BLE-15) to 2.0 x 10^{-3} cm/sec (BLE-7) in partially weathered rock unit (geometric mean 4.0 x 10^{-4} cm/sec); and
- 6.8 x 10^{-5} cm/sec (BLE-4) to 3.9 x 10^{-4} cm/sec (BLE-8) in the bedrock unit (geometric mean 1.9 x 10^{-4} cm/sec).

3.5.6.2 Hydraulic Gradient

The hydraulic gradient is determined by dividing the difference in groundwater elevations at two locations by the horizontal distance between those locations along the direction of groundwater flow. Hydraulic gradients were measured from the September 26, 2014 water table elevation contour map (**Figure 6**). In the Phase 3 area, the approximate range of hydraulic gradient is as follows:

- 0.041 ft/ft (measured between the 2060 and 2080-ft msl groundwater contours near boring BLE-18).
- 0.150 ft/ft (measured between the 2020 and 2070-ft msl groundwater contours north of boring BLE-9).

3.5.6.3 Effective Porosity and Specific Yield

Effective porosity is the volume of void spaces through which water or other fluids can travel in soil divided by the total volume of the soil. Effective porosity can be assumed to be approximately equal to specific yield. Specific yield is defined as the ratio of the volume of water that drains from saturated sediment owing to the attraction of gravity to the total volume of soil. The laboratory grain size analyses were used to derive values for specific yield and effective porosity (**Table 5** and **Appendix G**).

Based on soil laboratory data and published geologic literature, effective porosity measurements in the Phase 3 area range from approximately:

- 3.7% to 5.5% (average = 4.9%) in the shallow residual soil unit;
- 15.0% to 32.5% (average = 25.0%) in the deep residual soil unit
- 27.5% to 31.0% (average = 29.3%) in the partially weathered rock unit; and
- the effective porosity can be expected to range from about 5% to 10% for fractured crystalline bedrock unit (average = 7.5%) according (*Kruseman and deRidder, 1989*).

3.5.6.4 Groundwater Flow Velocity

Based on these parameters and the data provided above, the horizontal movement of groundwater across the Phase 3 area is approximately:

- 0.16 to 0.79 (average 0.40) feet/day in the deep residual soil unit;
- 0.26 to 1.86 (average 0.37) feet/day in the partially weathered rock unit; and
- 0.50 to 1.40 (average 0.70) feet/day in the bedrock unit.

The maximum and minimum values for each unit represent a range of values using available data. The *average* values are more representative of site-wide conditions. **Table 6** summarizes the groundwater seepage velocity calculations.

3.6 LOCATION RESTRICTIONS

An evaluation of the potential impact from Holocene faults, seismic impact zones and unstable areas, as required by 15A NCAC13B.1622, is provided below in Sections 3.6.1, 3.6.2, and 3.6.3. Other location restrictions are being addressed by other consultants working for Macon County.

3.6.1 Fault Areas

The location restrictions related to fault areas are specified in Title 15A Section 13B .1622 (4)(a), which states "*New MSWLF units and lateral expansions shall not be located within 200 feet (60 meters) of a fault that has had displacement in Holocene time unless the owner or operator demonstrates to the Division that an alternative setback distance of less than 200 feet (60 meters) will prevent damage to the structural integrity of the MSWLF unit and will be protective of human health and the environment.*"

BLE performed a literature review and property walkover to determine if Holocene faults exist on the subject tracts. The geologic literature does not indicate the presence of known Holocene faults on the proposed expansion area, or the surrounding vicinity (*Horton and Zullo 1991; Howard et al. 1978*). A BLE staff geologist conducted a site walkover on January 5, 2015. No surface indications of faults were visually observed. In conclusion, there are no Holocene-age faults documented in the literature or observed visually within 200 feet of the Phase 3 area.

3.6.2 Seismic Impact Zones

The location restrictions related to seismic impact zones are specified in Title 15A Section 13B .1622 (5)(a), which states "*New MSWLF units and lateral expansions shall not be located in seismic impact zones, unless the owner or operator demonstrates to the Division that all containment structures, including liners, leachate collection systems, and surface water control systems, are designed to resist the maximum horizontal acceleration in lithified earth material for the site.*"

BLE conducted a literature review and the most recent United States Geological Survey data available for our use indicate that the maximum horizontal acceleration at the proposed expansion area, expressed as a percentage of the earth's gravity (g), in rock is approximately 0.23g with a 2% probability of being exceeded in 50 years (*Petersen et al. 2014*); approximately equal to 10% probability in 250 years. Therefore, the site is located in a seismic impact zone. However, this seismic standard is a design criterion and does not preclude landfill development. The landfill should be designed to resist the maximum horizontal acceleration in lithified earth material at the site.

3.6.3 Unstable Areas

The location restrictions related to unstable areas are specified in Title 15A Section 13B .1622 (6)(a), which states "*Owners or operators of new MSWLF units, existing MSWLF units, and lateral expansions located in an unstable area shall demonstrate that engineering measures have been incorporated into the MSWLF unit's design to ensure that the integrity of the structural components of the MSWLF unit will not be disrupted.*" According to the Rule, an unstable area is defined as a location that is susceptible to natural or human induced events or forces capable of impairing the integrity of some or all of the landfill structural components responsible for preventing releases from a landfill. Unstable areas could include poor foundation conditions, areas susceptible to mass movements, and karst terrains.

Surface and subsurface data obtained were evaluated to determine if unstable site areas exist in the Phase 3 area. The site is located in the Blue Ridge Geologic Belt. The site subsurface conditions consist of residual soils overlying partially weathered rock, with gneiss bedrock at depth, which are not susceptible to karst conditions. Topographic expressions of karst features, such as sinkholes and disappearing streams, are not apparent from the site topography and were not observed on site during our reconnaissance. Limited deposits of alluvial sediments are present within the narrow drainage features on site. These soils are susceptible to settlement upon loading; however, they are limited in extent and can be removed if needed in areas of structural fill. No unstable areas were noted in our literature review. Our field reconnaissance of the site did not identify any other potential unstable areas.

3.7 GEOTECHNICAL CONSIDERATIONS

Excavation and engineered fill placement considerations for the proposed landfill development are provided in the following sections. A geotechnical evaluation of slope stability and subgrade settlement by BLE based on the landfill design by McGill is also included.

3.7.1 Excavation

Excavations of the existing residual soils are anticipated to achieve the design grades. An estimated top of rock (auger refusal) contour map was developed as **Figure 5** which is based on auger refusal depths in the soil borings drilled at this site. Materials sufficiently hard to cause refusal to the mechanical drill augers may result from continuous bedrock, boulders, lenses, ledges, or layers of relatively hard rock within the overburden residual soil. Bedrock coring was performed at eleven locations where refusal to augering occurred. Continuous rock was found with varying recovery and Rock Quality Designation (RQD) as discussed above in **Section 3.4.1.3**. Due to its typically varying surface, the actual occurrence of hard rock during site grading may vary somewhat from that presented in **Figure 5**.

Very dense soil and partially weathered rock such as that encountered in the borings may present some difficulty in excavating during construction. There is usually no sharp distinction between soil and rock in residual soil areas. Typically, the degree of weathering simply decreases with greater depth until solid rock is eventually reached. The partially weathered rock, as well as the soil above, may also contain boulders, lenses or ledges of hard rock. The mechanical auger used in this exploration could penetrate some of the partially weathered rock of the transitional zone. The

ease of excavation depends on the geologic structure of the material itself, such as the direction of bedding, planes or weakness and spacing between discontinuities. Weathered rock or rock that cannot be penetrated by the mechanical drill auger or that has a standard penetration resistance (N) of less than or equal to 3-inches of penetration with 50 hammer blows will likely require heavy excavating equipment with ripping tools or other methods for removal, if required.

3.7.2 Engineered Fill

The residual soils without organic material that will be excavated from the cell areas to achieve the design subgrade elevations are suitable for use as structural fill. Some moisture modification (wetting or drying) may be required depending on the particular area of excavation, as well as the rainfall prior to and during excavation. Conventional compaction equipment and methods should be appropriate.

Prior to placement of engineered fill, the stripped ground surface should be proofrolled with a loaded dump truck or similar weight rubber tired vehicle. Areas which undergo excessive deflection under the proofrolling should be over excavated to firm soils.

Fill soil used for raising site grades or for replacement of material that is over-excavated as a result of poor proofrolling performance should be uniformly compacted to at least 95 percent of the standard Proctor maximum dry density (ASTM D 698) within 4% of the Standard Proctor optimum moisture content.

Partially weathered rock may be mixed with the soil borrow materials provided it can be broken down by the excavation and compaction equipment into particles with a maximum dimension of 6 inches. Larger boulders or rock pieces may be used in the lower portions of the deeper fills if the boulders are placed individually and soil compacted around and over each boulder. Sufficient quantities of soil should be mixed with the partially weathered rock so that voids do not result between the pieces of partially weathered rock and the fill meets the compaction requirements. Fill soils containing rock should not be placed within 5 vertical feet of any potential or proposed utility locations.

Before filling operations begin, representative samples of each proposed fill material should be collected and tested to determine the compaction and classification characteristics. The maximum dry density and optimum moisture content should be determined. Once compaction begins, a sufficient number of density tests should be performed to measure the degree of compaction being obtained.

Earthwork cut or fill slopes outside of the cell area can be constructed as steep as 2H:1V (horizontal:vertical). Structural fill slopes at the 2H:1V inclination should initially be constructed at two to three feet beyond the design slope due to difficulty of compacting the edge of slopes, and then trimmed to final grade leaving the exposed face well compacted. Relatively flat slopes, on the order of 3H:1V or flatter, can be compacted in place without overfilling. Cut and fill slope surfaces outside the cell area should be protected from erosion by grassing or other means. Where the cell embankment is to be constructed on natural or existing fill slopes steeper than 4H:1V, we recommend that the new fill soils be keyed into the slopes using horizontal benches to facilitate

placement and compaction of structural fill and to prevent formation of a potential slip surface. Temporary excavation slopes should conform to OSHA regulations.

The surface of compacted subgrade soils can deteriorate and lose its support capabilities when exposed to environmental changes and construction activity. Deterioration can occur in the form of freezing, formation of erosion gullies, extreme drying, exposure for a long period of time, or rutting by construction traffic. We recommend that if the fill soils within the cell become deteriorated or softened, they be proofrolled, scarified and recompacted (and additional fill placed, if necessary) prior to construction of the compacted cell subgrade. Additionally, any excavations through the cell embankments should be properly backfilled in compacted lifts. Recompaction of subgrade surfaces and compaction of backfill should be checked with a sufficient number of density tests to determine if adequate compaction is being achieved.

3.7.3 Settlement Analysis

Site grading plans prepared by McGill (dated April 2, 2015) for construction of the proposed landfill cell indicate primarily earthwork cut with minimal fill will be made to establish the cell subgrade. Foundation support conditions for the landfill cell will consist of loose to dense residual soils with typical thicknesses of 20 feet or less but extending to as much as approximately 60 feet above bedrock in some locations, or by engineered fill overlying residual soils.

Moderate landfill subgrade settlements will be realized from compression of the residual soils and the anticipated structural fill. The compressibility parameters for the soil and partially weathered rock were estimated based on published correlations (*Martin, R. E. 1987*) with standard penetration resistance (N-value) and our experience with similar conditions. The bedrock underlying the site is relatively incompressible and will not realize appreciable settlements under the anticipated landfill loading. The settlement at a given location will be a function of the waste and soil thicknesses at a given point and the corresponding thickness and consistency of the foundation soils. Larger settlements would be expected when placing greater heights of waste over greater thicknesses of structural fill and residual soil. Settlement near the edge of the landfill should be minimal. The subgrade of Cell 1 will incur additional settlement from the construction of future adjacent waste cells that provide for greater height of waste. The proposed load conditions from the potential future cells are included in the settlement analysis presented in **Appendix I**. Settlement of the landfill base liner system should occur relatively quickly from the compression of the residual sandy soils as the cells are filled.

The results of the settlement analysis of areas overlying residual soil and structural fill conditions are presented in **Appendix I**. Based on the proposed design grades, the estimated settlement at the clay liner subgrade will vary from negligible to ½-foot. The anticipated settlements are well within the tolerances of the planned HDPE geomembrane liner and liner system. The post-settlement vertical separation between the proposed clay liner subgrade and seasonal high groundwater and bedrock are also presented in **Appendix I**. The post-settlement vertical separation will be greater than the minimum required 4 feet.

3.7.4 Stability Analysis

The soil test borings and laboratory test results indicate that the on-site residual soils may be used for landfill subgrade and for construction of earthwork cut and engineered fills and slopes to form new cells or other required site features.

Shear strength parameters for structural fill, residual soils and the waste were developed based on the subsurface data reported in the Design Hydrogeologic Report, our experience with similar subsurface and site conditions and published correlations. The Macon County MSW Landfill is in a seismic impact zone. The bedrock acceleration for the site is 0.23g based on the 2014 USGS seismic hazard maps for a maximum horizontal acceleration with a 10 % chance of being exceeded in 250 years. Based on the site subsurface conditions and the seismic bedrock acceleration of 0.23g, the resulting seismic coefficient within the waste mound used in the pseudo-static stability analysis is 0.17 (*RCRA Subtitle D (258) Seismic Design Guidance for MSW Landfill Facilities, April 1995*).

Static and pseudo-static (seismic) slope stability analyses were performed including both circular and sliding block potential failure modes of the capped landfill, using the computer program Slope/W by Geo-Slope International. The results of the analyses are presented in **Appendix I**. The analysis indicates that the planned 3H:1V waste final slopes have a factor of safety of approximately 2.3 for static conditions and 1.35 for seismic conditions. The analysis of interface sliding failure along the base liner has factors of safety of 1.74 for static conditions and 1.02 for seismic conditions. The interface sliding factor of safety is contingent upon the use of textured geomembrane. The factors of safety were greater than 1.5 for all of the configurations under static loads and greater than, or equal to 1.0 for seismic conditions. A safety factor of 1.5 or more is considered acceptable for long term (steady state) static conditions. A factor of safety of 1.0 or more is considered acceptable for seismic conditions. The analysis indicates that the planned slopes are stable.

4.0 CONCLUSIONS

The proposed Phase 3 cell area is located on the western portion of the Macon County landfill facility, and is not contiguous to the existing waste cell areas (Phases 1 and 2). Initial Phase 3 development will be an approximate 7.6-area area designated as Phase 3 (Cell No. 1). The Phase 3 area's subsurface geology and hydrogeology are typical of Blue Ridge terrain in North Carolina. No unusual or unexpected geologic features were observed in the Phase 3 area.

The groundwater table surface has a configuration similar to the site topography. Groundwater flow in the Phase 3 area includes an east-west to northwest trending topographic ridge from which groundwater flows to the north discharging into Lake Emory, and to the west and southwest discharging into an unnamed drainage feature and retention pond. Other than these features, there are no groundwater receptors to this landfill phase.

The landfill subgrade design should maintain a minimum four-foot post-settlement vertical separation between the bottom elevation of the base liner system and the elevations of the bedrock (**Figure 5**) and the 2013-2014 seasonal high groundwater (**Figure 7**). If bedrock is removed by mechanical means during cell construction to levels below that shown on **Figure 5**, then any

resulting redesign of the subgrade elevations should maintain the minimum required post-settlement vertical separation with the final bedrock level. Likewise, if bedrock is encountered during cell construction above the levels shown on **Figure 5**, then the minimum required post-settlement vertical separation with the bedrock level should be established by raising the cell grades as needed, unless the bedrock is removed.

This Design Hydrogeologic Report was prepared to satisfy the requirements specified in the North Carolina Title 15A NCAC 13B .1623 (b). Based on the results of field and laboratory testing, it is our opinion that the study area is geologically and hydrogeologically suitable for municipal solid waste landfill cell development.

A comprehensive *Environmental Monitoring Plan* will be provided at a later date after the proposed Phase 3 area has been designed by McGill. The *Environmental Monitoring Plan* will include procedures and locations for groundwater, underdrain, surface water, and landfill gas monitoring for landfill Phases 1, 2, and 3 in accordance with North Carolina Title 15A NCAC 13B Rules .0601 and .1630 through .1637 (groundwater), 15A NCAC 13B Rule .0602 (surface water), and 15A NCAC 13B Rule .1624(4) (landfill gas). This Plan will also include new proposed monitoring locations for Phase 3.

5.0 ANNOTATED BIBLIOGRAPHY

Bouwer, H. and Rice, R.C., 1976, *A slug test method for determining hydraulic conductivity of unconfined aquifers with completely or partially penetrating wells*, Water Resources Research, Vol. 12, No. 3, pp. 423-428.
- Slug testing data reduction procedures.

Brown, M.B., and others (compilers), 1985, *Geologic Map of North Carolina*: NCDNRCD, scale 1:500,000.
- General geologic setting, fault locations, and diabase dike locations.

Fetter, C.W., 1988, *Applied Hydrogeology*: Merrill Publishing Company, Columbus, Ohio.
- Basic hydrogeologic principles and estimates of effective porosity in soils.

Horton, J.W. and Zullo, V.A., 1991, *The Geology of the Carolinas: Carolina Geological Society fifteenth anniversary volume*: The University of Tennessee Press, Knoxville, TN.
- General geologic setting.

Hatcher, R.D., Jr., December 1979, *The Coweeta Group and Coweeta Syncline: Major Features of the North Carolina – Georgia Blue Ridge*: Southeastern Geology, Volume 21, No. 1.

Howard, K.A., Aaron, J.M., Brabb, ,E.E., Borck, M.R., Gower, H.D., Hunt, S.J., Milton, D.J., Muehlberger, W.R., Nakata, J.K., Plafker, G., Prowell, D.C., Wallace, R.E., and Witkind, I.J., 1978, *Preliminary Map of Young Faults in the United States as a Guide to Possible Fault Activity*, United States Geological Survey Miscellaneous field Studies Map MF-916, scale 1:5,000,000.
- Holocene faults in the United States.

Kruseman, G.P., and deRidder, N.A., 1989, *Analysis and Evaluation of Pumping Test Data*: *Publication 47*, International Institute for Land Reclamation and Improvement, Wageningen, The Netherlands.
- Estimates of effective porosity in fractured bedrock.

Martin, R. E., *Settlement of Residual Soils*, Foundations and Excavations in Decomposed Rock of the Piedmont Province, ASCE Geotechnical Special Publication No. 9, April 28, 1987, pp. 1-13.
- Foundation settlement.

Petersen, M.D., Moschetti, M.P., Powers, P.M., Mueller, C.S., Haller, K.M., Frankel, A.D., Zeng, Yuehua, Rezaeian, Sanaz, Harmsen, S.C., Boyd, O.S., Field, Ned, Chen, Rui, Rukstales, K.S., Luco, Nico, Wheeler, R.L., Williams, R.A., and Olsen, A.H., 2014, *Documentation for the 2014 update of the United States national seismic hazard maps*: U.S. Geological Survey Open-File Report 2014-1091, 243 p., http://dx.doi.org/10.3133/ofr20141091.
- Seismic impact zones.

Richardson, G. N., Kavazanjian Edward, Jr., and Matasovic Neven, RCRA Subtitle D (258) Seismic Design Guidance for MSW Landfill Facilities, April 1995.
- Seismic coefficient.

Rhodes, Thomas S., and Conrad, Stephen G., 1985, *Geologic Map of North Carolina*: Department of Natural Resources and Community Development, Division of Land Resources, and the NC Geological Survey, 1:500,000-scale, compiled by Brown, Philip M., et al, and Parker, John M. III, and in association with the State Geologic Map Advisory Committee.
- General geologic setting.

TABLES

TABLE 1

MONITORING WELL, PIEZOMETER, AND BORING SURVEY INFORMATION

Macon County MSW Landfill - Phase 3 DHR
Franklin, North Carolina
BLE Project Number J13-1101-06

Soil Test Boring	Piezometer	Ground Elevation	TOC Elevation	Northing	Easting	Status of Well/Piezometer
---	**BLE-1**	**2078.09**	**2081.10**	**557,993.41**	**693,239.72**	**Present**
---	**BLE-2**	**2094.54**	**2097.47**	**557,870.28**	**693,607.21**	**Present**
---	**BLE-3**	**2081.47**	**2084.33**	**557,666.48**	**693,782.19**	**Present**
---	**BLE-4**	**2096.93**	**2099.80**	**557,238.47**	**693,782.94**	**Present**
---	**BLE-5**	**2103.10**	**2106.17**	**557,841.09**	**693,407.97**	**Present**
---	**BLE-6**	**2122.41**	**2125.43**	**557,674.55**	**693,571.99**	**Present**
---	**BLE-7**	**2128.01**	**2131.11**	**557,464.27**	**693,888.05**	**Present**
---	**BLE-8**	**2083.89**	**2086.97**	**557,233.65**	**693,541.51**	**Present**
---	**BLE-9**	**2065.65**	**2068.76**	**557,376.37**	**693,411.58**	**Present**
BLE-10	**---**	**2125.43**	**NA**	**557,247.94**	**694,053.25**	**Abandoned**
---	**BLE-11**	**2158.69**	**2161.80**	**557,575.33**	**694,139.17**	**Present**
---	**BLE-12**	**2109.23**	**2112.25**	**557,377.54**	**694,294.85**	**Present**
---	**BLE-13**	**2116.38**	**2119.50**	**557,652.86**	**694,424.14**	**Present**
---	**BLE-14**	**2146.02**	**2148.59**	**557,393.99**	**694,599.83**	**Present**
---	**BLE-15**	**2100.28**	**2103.52**	**557,095.96**	**694,432.06**	**Present**
---	**BLE-16**	**2091.57**	**2094.67**	**556,836.77**	**694,273.66**	**Present**
---	**BLE-17**	**2057.62**	**2060.75**	**557,024.62**	**693,860.66**	**Present**
---	**BLE-18**	**2110.36**	**2113.57**	**557,702.85**	**694,721.10**	**Present**
---	**BLE-19**	**2093.04**	**2096.48**	**557,865.75**	**694,291.14**	**Present**
---	**BLE-20**	**2027.39**	**2030.26**	**558,225.18**	**693,574.71**	**Present**
---	**BLE-21**	**2042.71**	**2045.86**	**558,126.50**	**693,339.53**	**Present**
---	**BLE-22**	**2042.22**	**2044.57**	**558,174.37**	**693,064.36**	**Present**
B-4	**---**	**2097.30**	**NA**	**NA**	**NA**	**Abandoned**
B-5	**---**	**2120.30**	**NA**	**NA**	**NA**	**Abandoned**
B-5R	**---**	**2121.32**	**NA**	**557,425.78**	**693,688.63**	**Abandoned**
B-6	**---**	**2147.00**	**NA**	**NA**	**NA**	**Abandoned**
---	**B-6R**	**2146.27**	**2149.49**	**557,583.84**	**694,576.67**	**Present**
---	**B-16**	**2084.20**	**NA**	**NA**	**NA**	**Abandoned**
---	**B-16R**	**2079.74**	**2082.89**	**557,575.73**	**693,335.21**	**Present**
---	**B-17**	**2061.50**	**NA**	**NA**	**NA**	**Abandoned**
---	**B-18**	**2082.00**	**NA**	**NA**	**NA**	**Abandoned**
---	**B-18R**	**2083.18**	**2086.28**	**557,088.88**	**694,199.23**	**Present**
B-19	**---**	**2156.90**	**NA**	**NA**	**NA**	**Abandoned**
---	MW-1A	NA	2012.25	NA	NA	Present
---	MW-1B	NA	2012.19	NA	NA	Present
---	MW-1D	NA	2013.65	NA	NA	Present
---	MW-2	NA	2014.78	NA	NA	Present
---	MW-3A	NA	2070.55	NA	NA	Present
---	MW-5D	NA	2075.67	NA	NA	Present
---	MW-10	NA	2115.08	NA	NA	Present
---	MW-12	2056.01	2059.56	NA	NA	Present
---	MW-14	NA	2049.54	NA	NA	Present
---	MW-15	NA	2029.19	NA	NA	Present
---	MW-17	NA	2133.30	NA	NA	Present
---	MW-18	NA	2115.40	NA	NA	Present
---	MW-19	NA	2021.00	NA	NA	Present
---	MW-19A	NA	2020.80	NA	NA	Present
---	MW-20	NA	2015.40	NA	NA	Present
---	MW-21	NA	2020.90	NA	NA	Present
---	MW-22	NA	2020.92	NA	NA	Present
---	MW-22A	NA	2017.94	NA	NA	Present
---	MW-23	NA	2007.08	NA	NA	Present

NOTES:

1. **Bold** borings represent those in the **Phase 3 Area**.
2. TOC = *Top Of Casing*
3. NA = *Not Available* . Information was not provided in previous SHR & DHR reports performed by others.
4. Elevations are in relative to an arbitrary site datum that is approxiamtely 0.86 FEET above mean sea level (MSL).
5. Horizontal coordinates are in feet relative to the North Carolina state plane grid NAD83(1986).
6. Surveying for locations BLE-1 through BLE-22 and B-5R through B-18R was performed by McGill Associates of Asheville, NC.
7. Surveying for locations B-4 through B-19 was provded in the Site Suitability Study for Macon County Landfill, Franklin, North Carolina (Westinghouse Job No. 1351-89-369), dated January 17, 1990.

TABLE 2

SOIL TEST BORING AND PIEZOMETER CONSTRUCTION DETAILS - PHASE 3

Macon County MSW Landfill - Phase 3 DHR
Franklin, North Carolina
BLE Project Number J13-1101-06

Soil Test Boring	Piezometers & Monitoring Wells	Ground Elev.	TOC Elev.	Unit Screened	Auger Refusal Depth	Auger Refusal Elev.	Bedrock Drilling Depth	Screened Interval Depth	Screened Interval Elevation
---	**BLE-1**	2078.09	2081.10	Bedrock	43.0	2035.1	43.0 - 65.0	54.7 - 64.7	2023.4 - 2013.4
---	**BLE-2**	2094.54	2097.47	Bedrock	34.0	2060.5	34.0 - 55.0	43.7 - 53.7	2050.8 - 2040.8
---	**BLE-3**	2081.47	2084.33	Deep Residuum	24.0	2057.5	---	13.8 - 23.8	2067.7 - 2057.7
---	**BLE-4**	2096.93	2099.80	Bedrock	36.5	2060.4	36.5 - 50.5	39.7 - 49.7	2057.2 - 2047.2
---	**BLE-5**	2103.10	2106.17	Bedrock	41.0	2062.1	41.0 - 71.0	57.0 - 67.0	2046.1 - 2036.1
---	**BLE-6**	2122.41	2125.43	Bedrock	31.0	2091.4	31.0 - 66.0	55.3 - 65.3	2067.1 - 2057.1
---	**BLE-7**	2128.01	2131.11	Partially Weathered Rock	59.0	2069.0	---	48.7 - 58.7	2079.3 - 2069.3
---	**BLE-8**	2083.89	2086.97	Bedrock	33.0	2050.9	33.0 - 56.0	42.3 - 52.3	2041.6 - 2031.6
---	**BLE-9**	2065.65	2068.76	Deep Residuum	29.5	2036.2	---	19.0 - 29.0	2046.7 - 2036.7
BLE-10	---	2125.43	NA	---	45.5	2079.9	---	---	---
---	**BLE-11**	2158.69	2161.80	Partially Weathered Rock	77.5	2081.2	---	66.7 - 76.7	2092.0 - 2082.0
---	**BLE-12**	2109.23	2112.25	Bedrock	26.5	2082.7	26.5 - 51.5	39.3 - 49.3	2069.9 - 2059.9
---	**BLE-13**	2116.38	2119.50	Partially Weathered Rock/Residuum	55.0	2061.4	---	44.7 - 54.7	2071.7 - 2061.7
---	**BLE-14**	2146.02	2148.59	Partially Weathered Rock/Residuum	>90.0	<2056.0	---	77.0 - 87.0	2069.0 - 2059.0
---	**BLE-15**	2100.28	2103.52	Partially Weathered Rock	36.5	2063.8	---	25.3 - 35.3	2075.0 - 2065.0
---	**BLE-16**	2091.57	2094.67	Deep Residuum	36.0	2055.6	---	25.4 - 35.4	2066.2 - 2056.2
---	**BLE-17**	2057.62	2060.75	Bedrock	22.0	2035.6	22.0 - 46.0	34.0 - 44.0	2023.6 - 2013.6
---	**BLE-18**	2110.36	2113.57	Deep Residuum	46.0	2064.4	---	35.0 - 45.0	2075.4 - 2065.4
---	**BLE-19**	2093.04	2096.48	Bedrock	31.5	2061.5	31.5 - 55.5	36.5 - 46.5	2056.5 - 2046.5
---	**BLE-20**	2027.39	2030.26	Bedrock	7.0	2020.4	7.0 - 39.5	24.2 - 34.2	2003.2 - 1993.2
---	**BLE-21**	2042.71	2045.86	Deep Residuum	45.5	1997.2	---	35.2 - 45.2	2007.5 - 1997.5
---	**BLE-22**	2042.22	2044.57	Deep Residuum	38.0	2004.2	---	27.6 - 37.6	2014.6 - 2004.6
B-4	---	2097.30	NA	---	36.5	2060.8	---	---	---
B-5	---	2120.30	NA	---	43.0	2077.3	---	---	---
B-5R	---	2121.32	NA	---	51.5	2069.8	---	---	---
B-6	---	2147.00	NA	---	>50.0	<2097.0	---	---	---
---	**B-6R**	2146.27	2149.49	Deep Residuum	>80.0	<2066.3	---	69.3 - 79.3	2077.0 - 2067.0
---	**B-16**	2084.20	NA	Bedrock	33.0	2051.2	33.0 - 39.3	34.3 - 39.3	2049.9 - 2044.9
---	**B-16R**	2079.74	2082.89	Bedrock	31.0	2048.7	31.0 - 56.0	44.3 - 54.3	2035.4 - 2025.4
---	**B-17**	2061.50	NA	Partially Weathered Rock	54.5	2007.0	---	52.5 - 57.5	2009.0 - 2004.0
---	**B-18**	2082.00	NA	Partially Weathered Rock	40.0	2042.0	---	35.0 - 40.0	2047.0 - 2042.0
---	**B-18R**	2083.18	2086.28	Partially Weathered Rock	39.0	2044.2	---	28.7 - 38.7	2054.5 - 2044.5
B-19	---	2156.90	NA	---	76.0	2080.9	---	---	---

NOTES:

1. Measurements are in FEET
2. Elevations are in relative to an arbitrary site datum that is approxiamtely 0.86 FEET above mean sea level (MSL).
3. TOC = *Top Of Casing*
4. NA = *Not Available*
5. "B" indicates piezometers or soil borings drilled by Westinghouse Environmental and Geotechnical Services Inc.
   Information is from Site Suitability Study for Macon County Landfill Franklin, North Carolina Westinghouse Job No. 1351-89-369 January 1990
6. Surveying for locations BLE-1 through BLE-22 and B-5R through B-18R was performed by McGill Associates of Asheville, NC.
7. Surveying for locations B-4 through B-19 Site Suitability Study for Macon County Landfill Franklin, North Carolina Westinghouse Job No. 1351-89-369 January 1990

TABLE 3

GROUNDWATER ELEVATION MEASUREMENTS

Macon County MSW Landfill - Phase 3 DHR
Franklin, North Carolina
BLE Project Number J13-1101-06

			Groundwater Elevation Data																																		Data from 2004 40 2014				
Piezometer/ Well	**Ground Elevation**	**TOC Elevation**			**2004**	**2005**		**2006**		**2007**		**2008**		**2009**		**2010**		**2011**		**2012**		**2013**					**2014**									**2013-2014 Seasonal High Groundwater**	**Maximum Elevation**	**Minimum Elevation**	**Head Difference**	**Estimated Long-Term Seasonal High Groundwater**	**Piezometer/ Well**
			TOB	**24-hr**	**12/14/04**	**4/19/05**	**10/11/05**	**4/19/06**	**10/19/06**	**4/18/07**	**10/16/07**	**4/15/08**	**10/14/08**	**4/22/09**	**10/13/09**	**4/13/10**	**10/13/10**	**4/14/11**	**10/12/11**	**4/19/12**	**10/17/12**	**4/18/13**	**9/26/13**	**10/21/13**	**11/15/13**	**12/16/13**	**1/16/14**	**2/20/14**	**3/20/14**	**4/25/14**	**5/22/14**	**6/17/14**	**7/24/14**	**8/28/14**	**9/26/14**						
BLE-1	2078.09	2081.10	NS	2022.69	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	**2021.80**	2020.25	2018.93	2017.84	2018.06	2018.35	2018.76	2019.35	2019.74	2019.65	2019.00	2017.90	2017.02	2021.80	2021.80	2017.02	4.78	2026.3	BLE-1
BLE-2	2094.54	2097.47	NS	2048.74	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	2050.45	2050.39	2050.35	2050.36	2050.36	2050.44	2050.42	2050.42	**2050.47**	2050.45	2050.37	2050.37	2050.37	2050.47	2050.47	2050.35	0.12	2055.0	BLE-2
BLE-3	2081.47	2084.33	2068.92	2067.87	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	2066.63	2065.75	2064.84	2065.22	**2068.17**	2066.73	2066.31	2066.57	2067.10	2065.98	2065.69	2063.78	2063.02	2068.17	2068.17	2063.02	5.15	2072.7	BLE-3
BLE-4	2096.93	2099.80	NS	2059.73	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	**2059.63**	2058.81	2058.35	2057.80	2058.66	2058.69	2058.89	2058.92	2059.32	2059.16	2058.64	2057.95	2057.48	2059.63	2059.63	2057.48	2.15	2064.1	BLE-4
BLE-5	2103.10	2106.17	NS	2045.70	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	**2044.90**	2044.42	2044.10	2043.77	2043.61	2043.56	2043.67	2044.01	2044.12	2044.13	2044.17	2043.77	2043.57	2044.90	2044.90	2043.56	1.34	2049.4	BLE-5
BLE-6	2122.41	2125.43	NS	2067.11	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	2067.27	**2067.28**	2067.22	2067.10	2067.14	2067.09	2067.07	2067.11	2067.10	2067.13	2067.13	2067.08	2067.02	2067.28	2067.28	2067.02	0.26	2071.8	BLE-6
BLE-7	2128.01	2131.11	2075.71	2077.06	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	**2076.99**	2076.40	2075.86	2075.20	2075.36	2075.27	2075.35	2075.70	2075.87	2075.79	2075.64	2075.06	2074.50	2076.99	2076.99	2074.50	2.49	2081.5	BLE-7
BLE-8	2083.89	2086.97	NS	2048.29	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	2047.95	2046.34	2046.19	2046.06	**2048.61**	2048.47	2048.36	2048.05	2048.49	2048.04	2046.26	2045.97	2045.85	2048.61	2048.61	2045.85	2.76	2053.1	BLE-8
BLE-9	2065.65	2068.76	2037.85	2043.38	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	2042.36	2041.61	2040.99	2040.28	2042.21	2041.99	2042.06	2041.85	**2042.56**	2042.06	2041.20	2040.42	2039.91	2042.56	2042.56	2039.91	2.65	2047.1	BLE-9
BLE-11	2158.69	2161.80	2085.09	2085.29	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	2085.51	**2085.58**	2085.42	2085.12	2084.90	2084.59	2084.59	2084.85	2085.03	2085.15	2085.44	2085.40	2085.19	2085.58	2085.58	2084.59	0.99	2090.1	BLE-11
BLE-12	2109.23	2112.25	NS	2067.73	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	2066.80	2066.11	2065.57	2065.12	2066.48	2066.37	2066.26	2066.33	**2066.89**	2066.51	2065.84	2065.20	2064.65	2066.89	2066.89	2064.65	2.24	2071.4	BLE-12
BLE-13	2116.38	2119.50	2070.33	2072.98	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	**2072.30**	2071.60	2071.00	2070.27	2070.48	2071.18	2071.30	2071.38	2071.58	2071.54	2070.98	2070.13	2069.50	2072.30	2072.30	2069.50	2.80	2076.8	BLE-13
BLE-14	2146.02	2148.59	2079.32	2084.62	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	**2084.59**	2084.29	2083.85	2083.05	2083.04	2082.90	2082.91	2083.25	2083.38	2083.19	2083.04	2082.47	2081.95	2084.59	2084.59	2081.95	2.64	2089.1	BLE-14
BLE-15	2100.28	2103.52	2071.28	2077.33	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	2076.25	2075.60	2075.07	2074.68	2076.22	2076.07	2076.02	2076.26	**2076.75**	2076.17	2075.47	2074.71	2074.16	2076.75	2076.75	2074.16	2.59	2081.3	BLE-15
BLE-16	2091.57	2094.67	2061.47	2060.17	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	2059.77	2059.25	2058.79	2058.70	2059.94	2059.89	2059.83	2059.83	**2060.20**	2059.87	2059.17	2058.56	2058.12	2060.20	2060.20	2058.12	2.08	2064.7	BLE-16
BLE-17	2057.62	2060.75	NS	2034.52	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	2034.78	2034.05	2033.69	2034.36	2034.72	**2034.83**	2034.67	2034.75	2034.78	2034.44	2034.20	2033.55	2033.13	2034.83	2034.83	2033.13	1.70	2039.3	BLE-17
BLE-18	2110.36	2113.57	2078.34	2082.35	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	2080.95	2080.53	2079.57	2079.96	**2081.37**	2080.46	2080.13	2080.65	2081.07	2080.16	2079.72	2078.67	2077.81	2081.37	2081.37	2077.81	3.56	2085.9	BLE-18
BLE-19	2093.04	2096.48	NS	2058.74	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	2058.64	2058.20	2057.79	2057.48	2058.42	2058.38	2058.46	2058.49	**2058.73**	2058.43	2057.93	2057.40	2057.07	2058.73	2058.73	2057.07	1.66	2063.2	BLE-19
BLE-20	2027.39	2030.26	NS	2014.04	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	**2013.89**	2013.33	2012.91	2013.09	2013.75	2013.66	2013.53	2013.62	2013.75	2013.36	2012.94	2012.26	2011.96	2013.89	2013.89	2011.96	1.93	2018.4	BLE-20
BLE-21	2042.71	2045.86	2019.81	2019.89	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	**2018.78**	2017.63	2016.52	2015.73	2016.67	2016.82	2016.94	2017.26	2017.67	2017.30	2016.46	2015.40	2014.57	2018.78	2018.78	2014.57	4.21	2023.3	BLE-21
BLE-22	2042.22	2044.57	2013.62	2012.62	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	**2012.37**	2012.14	2011.95	2011.95	2012.06	2012.08	2012.05	2012.07	2012.07	2011.97	2011.87	2011.76	2011.65	2012.37	2012.37	2011.65	0.72	2016.9	BLE-22
B-6R	2146.27	2149.49	2074.97	2081.02	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	**2081.29**	2080.90	2080.31	2079.45	2079.85	2079.47	2079.44	2079.78	2080.05	2079.83	2079.59	2078.83	2078.14	2081.29	2081.29	2078.14	3.15	2085.8	B-6R
B-16R	2079.74	2082.89	NS	2041.34	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	2041.31	2040.15	2039.15	2038.30	2041.04	2040.56	2040.47	2040.43	**2041.39**	2040.52	2039.23	2038.03	2037.19	2041.39	2041.39	2037.19	4.20	2045.9	B-16R
B-18R	2083.18	2086.28	2064.73	2064.08	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	2064.22	2063.82	2063.45	2063.24	2064.40	2064.26	2064.17	2064.23	**2064.57**	2064.23	2063.74	2063.23	2062.88	2064.57	2064.57	2062.88	1.69	2069.1	B-18R
MW-1A	NA	2012.25	NA	NA	**2008.13**	2007.27	2004.68	2004.84	2005.74	2005.25	2002.67	2006.39	2002.68	2006.17	2005.82	2005.75	2002.52	2007.46	2002.25	2007.60	2002.80	2007.60	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	-	2008.13	2002.25	5.88	2012.6	MW-1A
MW-1B	NA	2012.19	NA	NA	**2008.08**	2007.21	2004.60	2004.80	2005.70	2005.25	2002.65	2006.34	2002.59	2006.11	2005.82	2005.71	2002.49	2007.39	2002.19	2007.58	2002.79	2007.59	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	-	2008.08	2002.19	5.89	2012.6	MW-1B
MW-1D	NA	2013.65	NA	NA	NP	NP	NP	NP	NP	NP	NS	2004.25	2003.21	2003.24	2008.65	2009.34	2007.15	2010.82	2007.20	2009.97	2007.89	**2012.05**	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	-	2012.05	2003.21	8.84	2016.6	MW-1D
MW-2	NA	2014.78	NA	NA	2002.58	**2002.88**	2002.31	2002.11	2001.88	2002.23	2000.96	2002.53	2000.82	2001.65	2002.07	2002.12	2000.33	2002.28	2000.55	2002.15	2000.99	2002.43	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	-	2002.88	2000.33	2.55	2007.4	MW-2
MW-3A	NA	2070.55	NA	NA	2010.90	2011.33	2010.85	2010.63	2010.04	2010.63	2009.90	2010.64	2009.76	2010.30	2010.53	**2011.36**	2010.18	2010.74	2009.80	2010.29	2009.72	2010.64	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	-	2011.36	2009.72	1.64	2015.9	MW-3A
MW-5D	NA	2075.67	NA	NA	NP	NP	NP	NP	NP	NP	2015.17	2016.19	2012.87	2015.12	2014.53	2015.18	2012.31	2016.64	2011.50	2015.77	2011.27	**2017.13**	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	-	2017.13	2011.27	5.86	2021.6	MW-5D
MW-10	NA	2115.08	NA	NA	2057.64	2059.06	**2060.58**	2059.04	2057.76	2056.90	2056.10	2055.02	2055.01	2054.01	2055.41	2059.06	2059.24	2057.61	2058.53	2057.80	2057.65	2058.37	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	-	2060.58	2054.01	6.57	2065.1	MW-10
MW-12	2056.01	2059.56	NA	NA	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	2043.30	2044.01	**2044.08**	2042.96	2043.03	2043.30	2042.68	2042.53	2041.94	2041.52	2044.08	2044.08	2041.52	2.56	2048.6	MW-12
MW-14	NA	2049.54	NA	NA	2015.01	2015.14	2014.83	2014.64	2014.39	2014.70	2014.15	2014.09	2013.70	2014.63	2014.86	**2015.59**	2014.51	2015.21	2014.64	2015.03	2014.63	2015.42	NM	NM	NM	2015.14	2015.44	2015.37	2015.29	2015.39	2015.44	2015.22	2015.07	2014.79	2014.49	2015.44	2015.59	2013.70	1.89	2020.1	MW-14
MW-15	NA	2029.19	NA	NA	2015.95	2015.84	2015.69	2015.46	2015.96	2015.46	2015.28	2014.64	2014.83	2015.74	**2016.69**	2015.97	2015.54	2016.13	2015.84	2016.38	2015.79	2016.14	NM	NM	NM	2016.26	2016.34	2016.51	2016.03	2016.07	2015.97	2015.79	2015.81	2015.58	2015.29	2016.51	2016.69	2014.64	2.05	2021.2	MW-15
MW-17	NA	2133.30	NA	NA	2064.55	2066.23	2067.52	2066.38	2064.37	2063.19	2061.83	2059.56	2059.90	2058.58	2061.04	2065.48	2066.33	2063.68	2064.80	2063.52	2063.50	2063.49	NM	NM	NM	2068.80	2068.63	2068.56	2068.74	2069.23	2069.25	2069.15	**2069.28**	2068.96	2068.32	2069.28	2069.28	2058.58	10.70	2073.8	MW-17
MW-18	NA	2115.40	NA	NA	2063.07	2064.41	2065.65	2064.59	2063.54	2062.76	2061.96	2060.59	2061.00	2059.89	2061.88	2064.12	2065.36	2063.60	2064.80	2063.93	2064.30	2064.32	NM	NM	NM	2067.19	2067.20	2067.30	2067.40	**2067.74**	2067.70	2067.60	2067.64	2067.17	2066.90	2067.74	2067.74	2059.89	7.85	2072.2	MW-18
MW-19	NA	2021.00	NA	NA	2000.85	2000.90	2000.82	2000.70	2000.85	2000.70	2000.80	**2001.18**	2000.98	2000.65	2000.74	2000.77	2000.25	2000.48	2000.15	2000.60	2000.28	2000.50	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	-	2001.18	2000.15	1.03	2005.7	MW-19
MW-19A	NA	2020.80	NA	NA	2001.39	2001.44	2001.35	2001.17	2001.27	2001.15	2001.18	**2001.58**	2001.33	2001.05	2001.12	2001.29	2000.70	2000.96	2000.58	2000.95	2000.69	2000.61	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	-	2001.58	2000.58	1.00	2006.1	MW-19A
MW-20	NA	2015.40	NA	NA	2003.85	2003.26	2002.78	2002.43	2003.91	2002.90	2001.76	2003.15	2002.20	2003.80	2004.97	2003.29	2002.30	2004.61	2001.85	**2005.38**	2003.05	2004.49	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	-	2005.38	2001.76	3.62	2009.9	MW-20
MW-21	NA	2020.90	NA	NA	2006.35	2006.11	2004.73	2004.13	2006.41	2005.30	2002.69	2005.15	2002.67	2005.80	2006.24	2005.70	2002.88	2006.10	2002.39	2006.64	2003.50	**2006.85**	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	-	2006.85	2002.39	4.46	2011.4	MW-21
MW-22	NA	2020.92	NA	NA	**2007.97**	2006.92	2004.52	2004.67	2004.02	2004.97	2002.44	2005.90	2002.42	2005.54	2005.53	2005.48	2002.36	2006.55	2001.92	2006.28	2002.55	2006.55	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	-	2007.97	2001.92	6.05	2012.5	MW-22
MW-22A	NA	2017.94	NA	NA	**2007.28**	2006.77	2004.58	2004.68	2005.10	2005.04	2002.79	2005.89	2002.86	2005.51	2005.59	2005.55	2002.67	2006.44	2002.29	2006.28	2002.82	2006.43	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	-	2007.28	2002.29	4.99	2011.8	MW-22A
MW-23	NA	2007.08	NA	NA	NP	NP	NP	NP	NP	NP	2000.88	**2001.98**	2001.20	2001.65	2001.58	2001.46	2000.37	2001.57	2000.28	2001.95	2000.53	2001.43	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	-	2001.98	2000.28	1.70	2006.5	MW-23
																																					(11) Average Fluctuation =		**4.5**		

NOTES:

1. Elevations are in relative to an arbitrary site datum that is approxiamtely 0.86 FEET above mean sea level (MSL).
2. TOC = *Top Of Casing*
3. NM = *Not Measured*
4. NP = *Not Present*
5. NA = *Not Available*
6. NS = *Not Stable* at time of measurement
7. **Bold water elevations** represent the **highest water level measurement** in each well/piezometer.
8. TOB = *Time Of Boring* water level
9. 24-hr = water level collected *24-Hours* after drilling
10. Only the piezometers and wells for which water levels have been measured at least ten times and have been at the site longer than one year were used to calculate the *Average Fluctuation*
11. As a conservative approach, the *Estimated Long-Term Seasonal High Groundwater Elevation* was calculated by adding the Average Fluctuation (maximum level minus the minimum level from 2004 to 2014 in the monitoring wells) to the historical highest measured groundwater water elevation in each piezometer or well.

TABLE 4

SUMMARY OF IN-SITU HYDRAULIC CONDUCTIVITY TESTING - SLUG TEST RESULTS

Macon County MSW Landfill - Phase 3 DHR
Franklin, North Carolina
BLE Project Number J13-1101-06

Piezometer	Method	Data Type	Aquifer Unit	K(ft/min)	K(cm/sec)	K(ft/day)
BLE-3	Bouwer-Rice	Falling Head	Deep Residuum	8.9E-04	4.5E-04	1.28
BLE-4	Bouwer-Rice	Falling Head	Bedrock	1.3E-04	6.8E-05	0.19
BLE-7	Bouwer-Rice	Rising Head	Partially Weathered Rock	4.0E-03	2.0E-03	5.698
BLE-8	Bouwer-Rice	Falling Head	Bedrock	7.6E-04	3.9E-04	1.094
BLE-9	Bouwer-Rice	Rising Head	Deep Residuum	5.5E-04	2.8E-04	0.792
BLE-13	Bouwer-Rice	Falling Head	Partially Weathered Rock	3.7E-04	1.9E-04	0.54
BLE-15	Bouwer-Rice	Falling Head	Partially Weathered Rock	3.3E-04	1.7E-04	0.48
BLE-17	Bouwer-Rice	Falling Head	Bedrock	5.2E-04	2.6E-04	0.74
BLE-18	Bouwer-Rice	Falling Head	Deep Residuum	7.9E-04	4.0E-04	1.13
BLE-21	Bouwer-Rice	Falling Head	Deep Residuum	7.2E-04	3.6E-04	1.03
Deep Residuum Only	Maximum Hydraulic Conductivity			8.9E-04	4.5E-04	1.28
	Geometric Mean Hydraulic Conductivity			7.2E-04	3.7E-04	1.04
	Minimum Hydraulic Conductivity			5.5E-04	2.8E-04	0.792
PWR Only	Maximum Hydraulic Conductivity			4.0E-03	2.0E-03	5.70
	Geometric Mean Hydraulic Conductivity			7.9E-04	4.0E-04	1.13
	Minimum Hydraulic Conductivity			3.3E-04	1.7E-04	0.476
Rock Only	Maximum Hydraulic Conductivity			7.6E-04	3.9E-04	1.09
	Geometric Mean Hydraulic Conductivity			3.7E-04	1.9E-04	0.54
	Minimum Hydraulic Conductivity			1.3E-04	6.8E-05	0.193
All Units	Maximum Hydraulic Conductivity			4.0E-03	2.0E-03	5.70
	Geometric Mean Hydraulic Conductivity			6.1E-04	3.1E-04	0.88
	Minimum Hydraulic Conductivity			1.3E-04	6.8E-05	0.193

NOTES:
1. K = *Hydraulic Conductivity*

TABLE 5

SUMMARY OF SOIL LABORATORY RESULTS
Macon County MSW Landfill - Phase 3 DHR
Franklin, North Carolina
BLE Project Number J13-1101-06

						Standard Proctor		Remolded Permeability Conditions						Consolidation			Triaxial Shear									Atterberg Limits			Grain Size (% by wt)					
	Split-Spoon	Shelby Tube	Bag Sample	Nat. Moisture	Hydraulic Cond.	Opt. Moisture	Max. Dry	Pressure	Moisture Content		Dry Density		Hydraulic	Precon. Press.	Virgin Slope	Void Ratio	C (ksf)		ϕ (deg)		Specific	Wet Unit	Dry Unit	Effective	Total								% Pass	
Boring	Depth (ft)	Depth (ft)	Depth (ft)	Content (%)	(cm/sec)	Content (%)	Density (pcf)	Gradient (PSI)	%	% Wet of Opt.	pcf	% of MDD	Cond. (cm/sec)	Pc (ksf)	C_c	(e_o)	total	effective	total	effective	Gravity	Weight (pcf)	Weight (pcf)	Porosity (%)	Porosity (%)	LL	PL	PI	Gravel	Sand	Silt	Clay	200 Sieve	USCS
BLE-1	1.0 - 2.5	-	-	23.6%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.6%	-	43	23	20	0.0%	49.6%	19.6%	30.8%	50.4%	CL
BLE-2	18.5 - 20.0	-	-	8.0%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	31.0%	*47.0%*	28	26	2	12.8%	65.0%	19.8%	2.4%	22.2%	SM
BLE-2	28.5 - 30.0	-	-	3.7%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	22	22	NP	28.8%	57.9%	13.3%		13.3%	SM
BLE-3	3.5 - 5.0	-	-	22.6%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.5%	-	45	28	17	5.6%	42.1%	24.5%	27.8%	52.3%	ML
BLE-4	-	-	5.0 - 10.0	19.3%	-	17.3%	108.2	10	19.3%	2.0%	102.9	95.1%	1.0E-06	-	-	-	-	-	-	-	2.70	122.8	102.9	-	-	39	30	9	0.0%	52.6%	26.3%	21.1%	47.4%	SM
BLE-4	-	14.0 - 16.0	-	20.5%	2.4E-04	-	-	-	-	-	-	-	-	-	-	-	0	0	29.20	42.25	2.74	113.5	94.2	29.5%	44.9%	42	39	3	2.7%	71.9%	22.4%	3.0%	25.4%	SM
BLE-4	-	18.0 - 20.0	-	24.7%	1.4E-05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.76	121.9	97.7	24.0%	43.4%	38	35	3	0.0%	57.4%	36.4%	6.2%	42.6%	SM
BLE-6	-	6.0 - 8.0	-	28.7%	4.2E-04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.78	95.2	74.0	25.5%	57.5%	43	32	11	1.1%	68.5%	22.8%	7.6%	30.4%	SM
BLE-6	18.5 - 20.0	-	-	25.2%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	27.0%	-	34	32	2	0.7%	64.6%	31.1%	3.6%	34.7%	SM
BLE-6	28.5 - 30.0	-	-	17.0%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	28.0%	*48.5%*	30	30	NP	0.0%	70.6%	25.6%	3.8%	29.4%	SM
BLE-7	1.0 - 2.5	-	-	13.0%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17.0%	-	33	26	7	1.3%	62.9%	21.6%	14.2%	35.8%	SM
BLE-7	28.5 - 30.0	-	-	17.7%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	28.0%	-	42	40	2	0.0%	67.8%	29.6%	2.6%	32.2%	SM
BLE-7	48.5 - 50.0	-	-	24.1%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	30.0%	*47.5%*	33	NP	NP	8.3%	65.8%	23.5%	2.4%	25.9%	SM
BLE-11	-	1.0 - 3.0	-	26.3%	1.3E-05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.76	113.0	89.5	-	47.9%	44	24	20	0.0%	35.2%	19.9%	44.9%	64.8%	CL
BLE-11	-	5.0 - 7.0	-	21.0%	1.5E-04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.79	110.1	91.0	21.0%	47.8%	40	31	9	0.0%	54.8%	37.9%	7.3%	45.2%	SM
BLE-11	-	-	15.0 - 20.0	17.9%	-	15.9%	112.7	10	17.9%	2.0%	107.3	95.2%	1.7E-06	-	-	-	0.650	0	21.06	38.76	2.79	126.5	107.3	-	-	36	28	8	0.0%	58.3%	25.5%	16.2%	41.7%	SM
BLE-11	63.5 - 65.0	-	-	21.1%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	27.5%	*49.0%*	37	34	3	0.0%	68.4%	27.7%	3.9%	31.6%	SM
BLE-13	38.5 - 40.0	-	-	21.0%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	27.0%	-	37	35	2	0.0%	66.6%	30.3%	3.1%	33.4%	SM
BLE-13	53.5 - 55.0	-	-	14.9%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	29.0%	*50.0%*	28	26	2	0.0%	68.9%	29.0%	2.1%	31.1%	SM
BLE-14	-	28.0 - 30.0	-	33.8%	1.9E-05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.79	112.0	83.7	22.5%	52.0%	53	41	12	0.0%	54.8%	38.6%	6.6%	45.2%	SM
BLE-15	1.0 - 2.5	-	-	22.5%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.0%	-	41	25	16	0.0%	48.8%	22.2%	29.0%	51.2%	CL
BLE-15	-	2.0 - 4.0	-	17.2%	4.5E-04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.77	110.6	94.4	5.5%	45.5%	41	22	19	7.5%	45.2%	19.7%	27.6%	47.3%	SC
BLE-15	-	-	0.0 - 5.0	20.1%	-	18.1%	107.7	10	20.1%	2.0%	102.3	95.0%	1.9E-06	-	-	-	-	-	-	-	2.79	122.9	102.3	-	-	43	28	15	0.6%	48.3%	24.6%	26.5%	51.1%	ML
BLE-15	13.5 - 15.0	-	-	16.1%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25.5%	-	29	28	1	7.5%	59.3%	28.1%	5.1%	33.2%	SM
BLE-15	23.5 - 25.0	-	-	18.0%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	30.5%	*49.0%*	36	36	NP	0.0%	71.2%	27.3%	1.5%	28.8%	SM
BLE-17	18.5 - 20.0	-	-	8.6%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	31.0%	*47.5%*	29	28	1	6.3%	69.6%	23.1%	1.0%	24.1%	SM
BLE-18	-	18.0 - 20.0	-	14.6%	8.1E-05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.77	113.4	98.9	30.5%	42.8%	31	30	1	0.0%	77.2%	20.3%	2.5%	22.8%	SM
BLE-21	-	1.0 - 3.0	-	21.0%	2.1E-04	-	-	-	-	-	-	-	-	7.21	0.18	0.78	-	-	-	-	2.76	121.5	100.3	15.0%	41.8%	43	32	11	6.5%	54.4%	23.2%	15.9%	39.1%	SM
BLE-21	-	8.0 - 10.0	-	18.7%	3.2E-05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.77	120.6	101.7	32.5%	41.2%	37	34	3	1.9%	78.8%	18.9%	0.4%	19.3%	SM
BLE-22	-	3.0 - 5.0	-	28.4%	5.2E-04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.77	110.9	86.4	3.7%	49.9%	55	33	22	0.0%	38.0%	25.9%	36.1%	62.0%	MH
BLE-22	-	6.0 - 8.0	-	20.3%	3.0E-06	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.77	124.3	103.3	25.0%	40.1%	31	27	4	19.0%	49.7%	24.1%	7.2%	31.3%	SM
B-4	28.5 - 30.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	31	30	1	-	-	-	-	31.0%	-
B-16	-	-	1.0 - 2.5	28.2%	-	21.9%	101.4	unknown	22.4%	0.5%	97.3	96.0%	2.1E-06	-	-	-	-	-	-	-	2.74	-	-	-	-	39	29	10	-	-	-	-	57.0%	ML
B-16	6.0 - 7.5	-	-	20.3%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33.5%	-
B-16	8.5 - 10.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	35	-	NP	-	-	-	-	-	SM
B-17	-	-	1.0 - 5.0	21.1%	-	17.7%	108.8	unknown	18.5%	0.8%	103.6	95.2%	7.9E-06	-	-	-	-	-	-	-	2.76	-	-	-	-	35	27	8	-	-	-	-	44.0%	ML
B-17	6.0 - 7.5	-	-	10.4%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	37	-	NP	-	-	-	-	-	SM
B-17	8.5 - 10.0	-	-	16.6%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	29.0%	SM
B-18	-	-	1.0 - 3.0	18.2%	-	18.5%	108.4	unknown	18.5%	0.0%	104.4	96.3%	2.1E-07	-	-	-	-	-	-	-	2.76	-	-	-	-	33	20	13	-	-	-	-	56.0%	CL
B-18	3.5 - 5.0	-	-	13.9%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	38.0%	SM
B-18	6.0 - 7.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	26	-	NP	-	-	-	-	-	SM
B-18	23.5 - 25.0	-	-	25.8%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	40.0%	SM
B-18	28.5 - 30.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	26	-	NP	-	-	-	-	-	-
B-19	-	-	1.0 - 3.0	45.5%	-	26.0%	94.8	unknown	24.8%	-1.2%	91.4	96.4%	5.8E-07	-	-	-	-	-	-	-	2.77	-	-	-	-	51	33	18	-	-	-	-	65.0%	MH
B-19	8.5 - 10.0	-	-	22.3%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	46.5%	SM
B-19	13.5 - 15.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	44	-	NP	-	-	-	-	-	SM
B-19	28.5 - 30.0	-	-	13.5%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B-19	53.0 - 55.0	-	-	13.8%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	34	-	NP	-	-	-	-	-	SM
B-19	58.5 - 60.0	-	-	27.7%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	29.0%	SM

NOTES:
1. Effective Porosity (Specific Yield) is based on grain size analyses and Figure 4.11 (Fetter, 1994).
2. Total Porosity values in *italic case* are based on grain size analyses (Rawls and Brankensiek, 1989). Other values are based on laboratory tests.
3. USCS = *Unified Soil Classification System*. Refer to **Appendix B** for a description of the abbreviations.
4. NP = *Not Plastic*
5. NV = *Not Viscous*
6. Refer to **Appendix G** for lab data sheets.

TABLE 6

INTERSTITIAL GROUNDWATER FLOW VELOCITY CALCULATIONS - PHASE 3

Macon County MSW Landfill - Phase 3 DHR
Franklin, North Carolina
BLE Project Number J13-1101-06

Geologic Unit	Part of Water Table Aquifer	Velocity Calculation	Hydraulic Conductivity (K) (feet per day)	Hydraulic Gradient (i) (unitless)	Effective Porosity (n_e) (unitless)	Groundwater Flow Velocity (V) (feet per day)
Deep Residuum	Yes	Max K, Max n_e, & Min i	1.28	0.041	0.325	**0.16**
		Geometric Mean K, and Average n_e & i	1.04	0.095	0.250	**0.40**
		Max K, and Average n_e & i	1.28	0.095	0.250	**0.49**
		Min K, Min n_e, & Max i	0.79	0.150	0.150	**0.79**
Partially Weathered Rock	Yes	Max K, Max n_e, & Min i	5.70	0.041	0.310	**0.76**
		Geometric Mean K, and Average n_e & i	1.13	0.095	0.293	**0.37**
		Max K, and Average n_e & i	5.70	0.095	0.293	**1.86**
		Min K, Min n_e, & Max i	0.48	0.150	0.275	**0.26**
Bedrock	Yes	Max K, Max n_e, & Min i	1.09	0.041	0.100	**0.50**
		Geometric Mean K, and Average n_e & i	0.54	0.095	0.075	**0.70**
		Max K, and Average n_e & i	1.09	0.095	0.075	**1.40**
		Min K, Min n_e, & Max i	0.19	0.150	0.050	**0.57**

Notes:

1. Groundwater Flow Velocity is derived from $\mathbf{V = Ki/n_e}$ where:
   V = Groundwater Flow Velocity, K = Hydraulic Conductivity, i = Hydraulic Gradient, and n_e = Effective Porosity.
2. The hydraulic conductivity values in the Residuum, Partially Weathered Rock, and Bedrock are from slug tests (**Table 4**).
3. Effective porosity values in the Residuum and Partially Weathered Rock are from soil laboratory tests (**Table 5**).
   Effective porosity values in the Bedrock are from published values (5 to 10 percent) (Kruseman & deRidder, 1989).
4. Hydraulic gradient information is from the September 26, 2014 Water Table Elevation Contour Map (**Figure 6**).
   The minimum hydraulic gradient measured in the Phase 3 area was measured between the 2060 and 2080-ft MSL groundwater contours near BLE-18 (approximately 0.041 ft/ft).
   The maximum hydraulic gradient measured in the Phase 3 area was measured between the 2020 and 2070-ft MSL groundwater contours north of BLE-9 (approximately 0.150 ft/ft).

TABLE 7

SUMMARY OF GEOLOGIC AND HYDROGEOLOGIC CHARACTERISTICS OF GEOLOGIC UNITS - PHASE 3

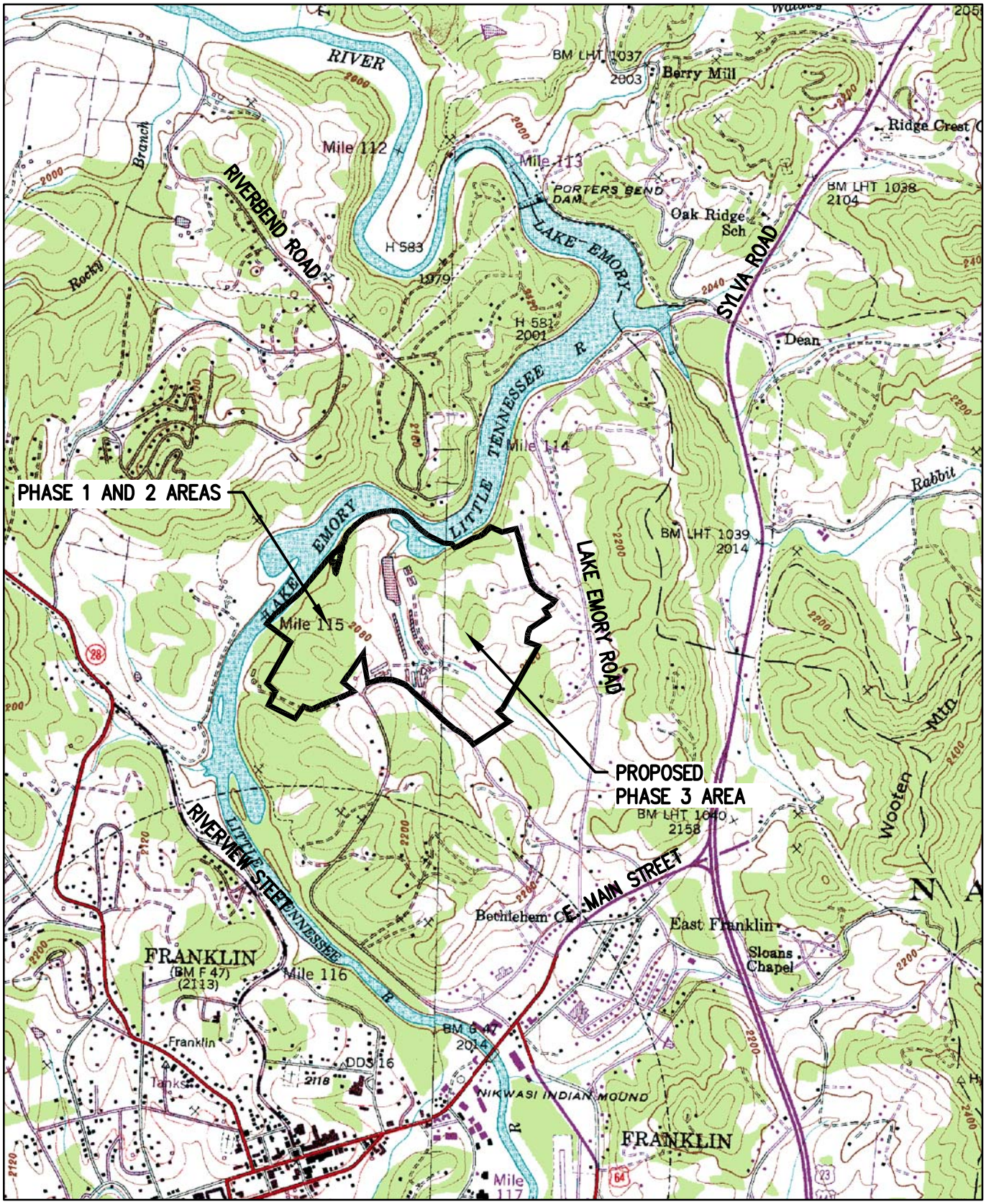
Macon County MSW Landfill - Phase 3 DHR
Franklin, North Carolina
BLE Project Number J13-1101-06

Geologic Unit	USCS	Grain Size				Total Porosity			Effective Porosity			K (cm/sec) via Slug Tests			K (cm/sec) via Lab Tests		
		gravel	sand	silt	clay	max	min	geomean	max	min	geomean	max	min	geomean	max	min	geomean
Shallow Residuum	ML & CL	2.0%	43.9%	22.3%	31.8%	49.9%	45.5%	47.7%	5.5%	3.7%	4.9%	-	-	-	5.2E-04	1.3E-05	1.4E-04
Deep Residuum	ML & SM	2.5%	62.5%	27.3%	7.7%	57.5%	40.1%	45.4%	32.5%	15.0%	24.5%	4.5E-04	2.8E-04	3.7E-04	4.2E-04	3.0E-06	5.7E-05
Partially Weathered Rock	SM	3.9%	68.5%	25.1%	2.5%	50.0%	47.0%	48.3%	31.0%	27.5%	29.3%	2.0E-03	1.7E-04	4.0E-04	-	-	-
Bedrock	Gneiss & Schist	-	-	-	-	10.0%	5.0%	7.1%	10.0%	5.0%	7.1%	3.9E-04	6.8E-05	1.9E-04	-	-	-

Notes:

1. Values are summarized from **Table 4** (Summary of Slug Test Results) and **Table 5** (Summary of Soil Laboratory Results).
2. Grain size values are averages
3. geomean = G*eometric Mean*
4. K = *Hydraulic Conductivity*
5. Values of porosity in Bedrock are from published values (Kruseman & deRidder, 1989).

FIGURES



2000 1000 0 2000 4000

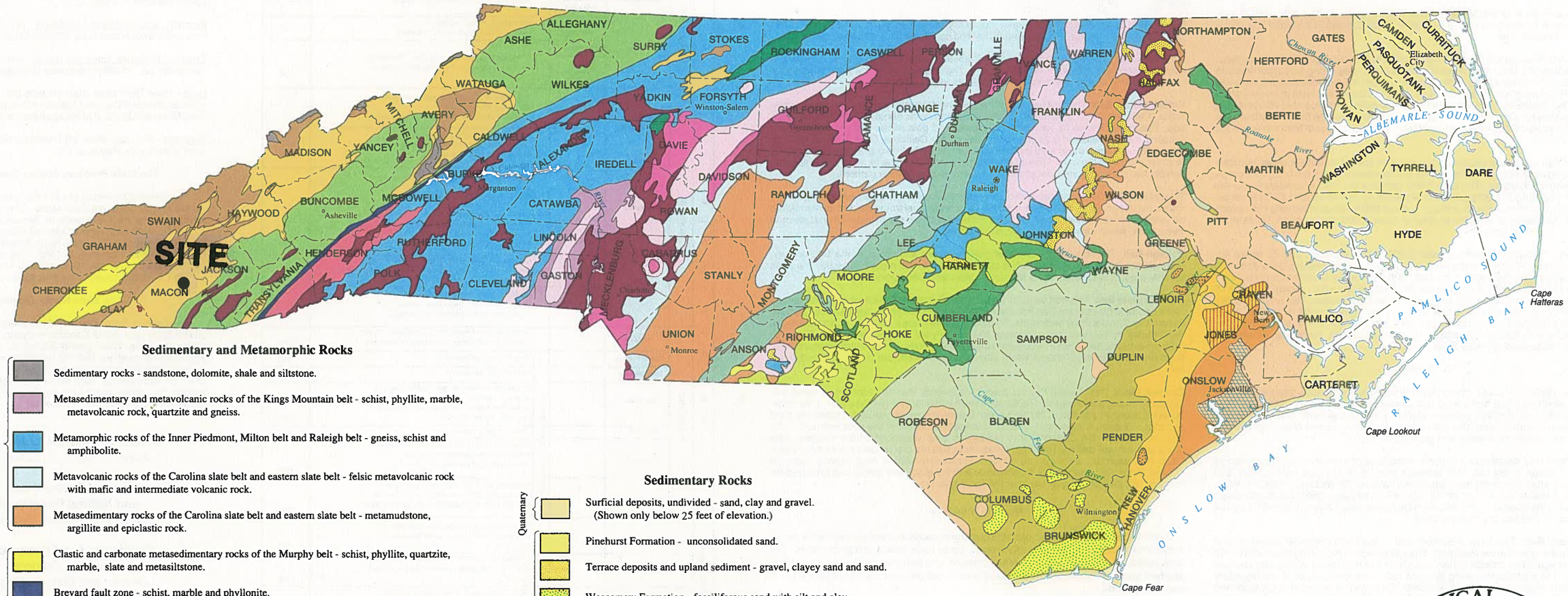
APPROXIMATE SCALE IN FEET

NOTE:
ALL BOUNDARIES ARE APPROXIMATE.

REFERENCE:
USGS TOPOGRAPHIC MAP, 7.5 MINUTE SERIES, CORBIN KNOB AND FRANKLIN, N.C. QUADRANGLES, PHOTOREVISED 1978.

DRAWN: ACE	DATE: 05-27-15	BLE INC. BUNNELL-LAMMONS ENGINEERING, INC. 6004 PONDERS COURT GREENVILLE, SOUTH CAROLINA 29615 PHONE: (864)288-1265 FAX: (864)288-4430	SITE LOCATION MAP MACON COUNTY MSW LANDFILL FRANKLIN, NORTH CAROLINA	FIGURE 1
CHECKED: AWA	CAD: MACONCOLF06-SLM			
APPROVED: AWA	JOB NO: J13-1101-06			

GENERALIZED GEOLOGIC MAP OF NORTH CAROLINA



Sedimentary and Metamorphic Rocks

Late Proterozoic to Early Paleozoic

- Sedimentary rocks - sandstone, dolomite, shale and siltstone.
- Metasedimentary and metavolcanic rocks of the Kings Mountain belt - schist, phyllite, marble, metavolcanic rock, quartzite and gneiss.
- Metamorphic rocks of the Inner Piedmont, Milton belt and Raleigh belt - gneiss, schist and amphibolite.
- Metavolcanic rocks of the Carolina slate belt and eastern slate belt - felsic metavolcanic rock with mafic and intermediate volcanic rock.
- Metasedimentary rocks of the Carolina slate belt and eastern slate belt - metamudstone, argillite and epiclastic rock.

Late Proterozoic

- Clastic and carbonate metasedimentary rocks of the Murphy belt - schist, phyllite, quartzite, marble, slate and metasiltstone.
- Brevard fault zone - schist, marble and phyllonite.
- Clastic metasedimentary and metavolcanic rocks of the Ocoee Supergroup, Grandfather Mountain Formation, Mount Rogers Formation and quartzite of the Sauratown Mountains anticlinorium - slate, metasiltstone, schist, metagraywacke, calc-silicate granofels, quartzite and felsic metavolcanic rock.
- Clastic metasedimentary rock and mafic and felsic metavolcanic rock of the Ashe Metamorphic Suite, Tallulah Falls Formation and Alligator Back Formation - gneiss, schist, metagraywacke, amphibolite and calc-silicate granofels.

Middle Proterozoic

- Felsic gneiss derived from sedimentary and igneous rocks in the northern outcrop area; biotite gneiss in the southern outcrop area; locally migmatitic and mylonitic. Locally and variably interlayered with amphibolite, calc-silicate granofels and rare marble. Intruded by Late Proterozoic mafic and felsic plutons.

Intrusive Rocks

Middle Paleozoic to Late Paleozoic

- Granitic rocks - unfoliated to weakly foliated.
- Syenite - Concord ring dike.

Late Proterozoic to Middle Paleozoic

- Metamorphosed gabbro and diorite - foliated to weakly foliated.
- Metamorphosed granitic rocks - foliated to weakly foliated; locally migmatitic.
- Henderson Gneiss - uneven-grained monzonitic to granodioritic.
- Meta-ultramafic rocks.

Sedimentary Rocks

Quaternary

- Surficial deposits, undivided - sand, clay and gravel. (Shown only below 25 feet of elevation.)

Tertiary

- Pinehurst Formation - unconsolidated sand.
- Terrace deposits and upland sediment - gravel, clayey sand and sand.
- Waccamaw Formation - fossiliferous sand with silt and clay.
- Yorktown Formation and Duplin Formation, undivided -
  Yorktown Formation- fossiliferous clay and sand.
  Duplin Formation- shelly sand, sandy marl and limestone.
- Belgrade Formation, undivided -
  Pollocksville Member- oyster-shell mounds in sand matrix.
  Haywood Landing Member- fossiliferous clayey sand.
- River Bend Formation - sandy, molluscan-mold limestone.
- Castle Hayne Formation -
  Spring Garden Member- molluscan-mold limestone.
- Comfort Member and New Hanover Member, undivided -
  Comfort Member - limestone with bryozoan and echinoid skeletons.
  New Hanover Member - phosphate-pebble conglomerate.
- Beaufort Formation, undivided -
  Unnamed upper member - glauconitic, fossiliferous sand and silty clay.
  Jericho Run Member - siliceous mudstone with sandstone lenses.

Cretaceous

- Peedee Formation - marine sand, clayey sand and clay.
- Black Creek Formation - lignitic sand and clay.
- Middendorf Formation - sand, sandstone and clay.
- Cape Fear Formation - sandstone and sandy mudstone.

Triassic

- Dan River Group, undivided -
  Stoneville Formation - conglomerate, sandstone and mudstone.
  Cow Branch Formation - mudstone.
  Pine Hall Formation - sandstone, mudstone and conglomerate.
- Chatham Group, undivided -
  Sanford Formation - conglomerate, sandstone and mudstone.
  Cumnock Formation - sandstone and mudstone.
  Pekin Formation - conglomerate, sandstone and mudstone.

50 Miles

GEOLOGICAL SURVEY N.C. 1823

1991

Reprinted, 1996

FIGURE 2

Physiography

North Carolina can be divided into three physiographic provinces, the Coastal Plain, the Piedmont and the Blue Ridge. Each province is characterized by particular types of landforms.

The Coastal Plain is characterized by flat land to gently rolling hills and valleys. Elevations range from sea level near the coast to about 600 feet in the Sand Hills of the southern Inner Coastal Plain.

The Piedmont Province lies between the Coastal Plain and the Blue Ridge Mountains. The Piedmont occupies about 45 percent of the area of the state. Along the border between the Piedmont and the Coastal Plain, elevations range from 300 to 600 feet above sea level. To the west, elevations gradually rise to about 1,500 feet above sea level at the foot of the Blue Ridge. The Piedmont is characterized by gently rolling, well rounded hills and long low ridges with a few hundred feet of elevation difference between the hills and valleys. The Piedmont includes some relatively low mountains including the South Mountains and the Uwharrie Mountains.

The Blue Ridge is a deeply dissected mountainous area of numerous steep mountain ridges, intermontane basins and trench valleys that intersect at all angles and give the area its rugged mountain character. The Blue Ridge contains the highest elevations and the most rugged topography in the Appalachian Mountain system of eastern North America. The North Carolina portion of the Blue Ridge is about 200 hundred miles long and ranges from 15 to 55 miles wide. It contains an area of about 6,000 square miles, or about 10 percent of the area of the state.

Within North Carolina, 43 peaks exceed 6,000 feet in elevation and 82 peaks are between 5,000 and 6,000 feet. On the west, the Great Smoky Mountains is the dominant range with several peaks that reach more than 6000 feet. On the eastern side of the North Carolina Blue Ridge, the highest range is the Black Mountains which extend for some 15 miles and contain a dozen peaks that exceed 6,000 feet in elevation. This group includes Mount Mitchell. At an elevation of 6,684 feet, it is the highest peak of eastern North America. Other prominent ranges from northeast to southwest are the Pisgah Mountains, Newfound Mountains, Balsam Mountains, Cowee Mountains, Nantahala Mountains, Snowbird Mountains and the Valley River Mountains.

Geology

Three major classes of rocks common to North Carolina are igneous, metamorphic and sedimentary. North Carolina has a long and complex geologic history. Although much remains to be learned, detailed geologic studies provide a general understanding of regional geological relationships. The state is best described in terms of geological belts; that is, areas with similar rock types and geologic history.

Blue Ridge Belt: This mountainous region is composed of rocks from over one billion to about one-half billion years old. This complex mixture of igneous, sedimentary and metamorphic rock has repeatedly been squeezed, fractured, faulted and twisted into folds. The Blue Ridge belt is well known for its deposits of feldspar, mica and quartz–basic materials used in the ceramic, paint and electronic industries. Olivine is mined for use as refractory material and foundry molding sand.

Inner Piedmont Belt: The Inner Piedmont belt is the most intensely deformed and metamorphosed segment of the Piedmont. The metamorphic rocks range from 500 to 750 million years in age. They include gneiss and schist that have been intruded by younger granitic rocks. The northeast-trending Brevard fault zone forms much of the boundary between the Blue Ridge and Inner Piedmont belts. Although this zone of strongly deformed rocks is one of the major structural features in the southern Appalachians, its origin is poorly understood. Crushed stone for road aggregate and building construction is the principal commodity produced.

Kings Mountain Belt: The belt consists of moderately deformed and metamorphosed volcanic and sedimentary rocks. The rocks are about 400-500 million yearls old. Lithium deposits here provide raw materials for chemical compounds, ceramics, glass, greases, batteries and TV glass.

Milton Belt: This belt consists of gneiss, schist and metamorphosed intrusive rocks. The principal mineral resource is crushed stone for road aggregate and for building construction.

Charlotte Belt: The belt consists mostly of igneous rocks such as granite, diorite and gabbro. These are 300-500 million years old. The igneous rocks are good sources for crushed and dimension stone for road aggregate and buildings.

Carolina Slate Belt: This belt consists of heated and deformed volcanic and sedimentary rocks. It was the site of a series of oceanic volcanic islands about 550-650 million years ago. This belt is known for its numerous abandoned gold mines and prospects. North Carolina led the nation in gold production before the California Gold Rush of 1849. In recent decades, only minor gold mining has taken place, but mining companies continue to show interest in the area. Mineral production is crushed stone for road aggregate and pyrophyllite for refractories, ceramics, filler, paint and insecticide carriers.

Triassic Basins: The basins are filled with sedimentary rocks that formed about 200-190 million years ago. Streams carried mud, silt, sand and gravel from adjacent highlands into rift valleys similar to those of Africa today. The mudstones are mined and processed to make brick, sewer pipe, structural tile and drain tile.

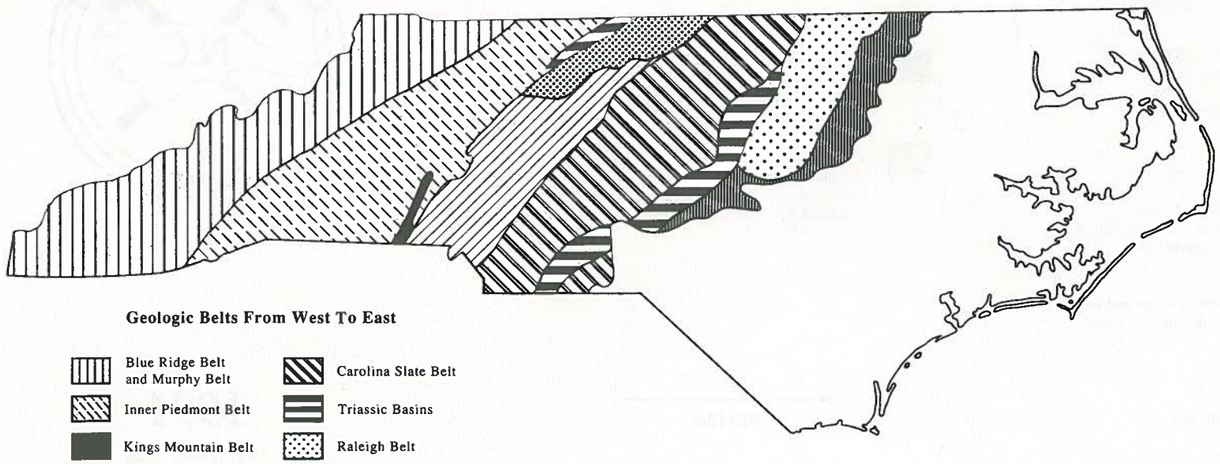
Raleigh Belt: The Raleigh belt contains granite, gneiss and schist. In the 19th century, there were a number of small building stone quarries in this region, but today the main mineral product is crushed stone for construction and road aggregate.

Eastern Slate Belt: This belt contains slightly metamorphosed volcanic and sedimentary rocks similar to those of the Carolina slate belt. The rocks are poorly exposed and partially covered by Coastal Plain sediments. The metamorphic rocks, 500-600 million years old, are intruded by younger, approximately 300 million year old, granitic bodies. Gold was once mined in the belt, and small occurrences of molybdenite, an ore of molybdenum, have been prospected here. Crushed stone, clay, sand and gravel are currently mined in this belt.

Coastal Plain: The Coastal Plain is a wedge of mostly marine sedimentary rocks that gradually thickens to the east. The Coastal Plain is the largest geologic belt in the state, covering about 45 percent of the land area. The most common sediment types are sand and clay, although a significant amount of limestone occurs in the southern part of the Coastal Plain. In the Coastal Plain, geology is best understood from studying data gathered from well drilling. The state's most important mineral resource in terms of dollar value is phosphate, an important fertilizer component, mined near Aurora, Beaufort County. Industrial sand for making container and flat glass and ferrosilicon and used for filtration and sandblasting is mined in the Sand Hills area.

Mineral Industry

North Carolina has important deposits of many minerals and annually leads the nation in the production of feldspar, lithium minerals, scrap mica, olivine and pyrophyllite. The state ranks second in phosphate rock production and ranks in the top five in clay and crushed granite production. North Carolina does not produce significant quantities of metallic minerals.



GEOLOGIC TIME SCALE FOR NORTH CAROLINA

EON	ERA	PERIOD	EPOCH	GEOLOGIC EVENTS IN NORTH CAROLINA	AGE*
PHANEROZOIC	CENOZOIC	Quaternary	Recent	Deposition of sediments in Coastal Plain. Erosion of Piedmont and Appalachian Mountains to their present rugged features.	
			Pleistocene		1.7
		Tertiary	Pliocene		5
			Miocene	Phosphate deposited in eastern North Carolina (Beaufort and Pamlico Counties).	24
			Oligocene	Limestone deposited in Coastal Plain. Weathering and erosion continue in Piedmont and Mountains.	
			Eocene		
			Paleocene		66
	MESOZOIC	Cretaceous	Late	Deposition of estuarine and marine sediments in the Coastal Plain. Continued erosion of the Piedmont and Mountains.	
			Early	Sediments deposited in northern half of the Coastal Plain. Cape Fear Arch begins to develop. Piedmont and Mountains eroded.	138
		Jurassic	Late	Marine sediments deposited on outer continental shelf. Piedmont and mountains eroded.	
			Middle	Weathering and erosion of the Blue Ridge and the Piedmont areas. Emplacement of diabase dikes and sheets.	
			Early		205
		Triassic	Late	Faulting and rifting create Deep River, Dan River, and Davie County basins. Basins fill with continental clastic sediments known as "red beds".	
			Middle	Formation of the Atlantic Ocean as North America and Africa drifted apart. Weathering and erosion of Piedmont and Mountains.	
			Early		240
	PALEOZOIC	Permian		Final collision of North America and Africa. Thrust faulting in west; deformation in eastern Piedmont.	290
		Pennsylvanian		Emplacement of igneous intrusions: Time of uplift and erosion.	330
		Mississippian		Time of uplift and erosion.	360
		Devonian		Emplacement of lithium, mica, and feldspar-rich pegmatites, primarily in the Kings Mountain and Spruce Pine districts. Metamorphism of Carolina slate belt. Period of erosion.	410
		Silurian		Period of uplift and erosion.	435
		Ordovician		Continental collision and beginning of mountain building process--faulting, folding, and metamorphism of pre-existing rocks.	500
		Cambrian		Sandstone, shale, and limestone deposited in the mountain area. Continued deposition of Carolina slate belt rocks. Gold deposits of the slate belt form.	570
PROTEROZOIC		Late		Sedimentary and volcanic rocks deposited in the mountains and Piedmont. Local intrusions of igneous rocks.	900
		Middle		Sedimentary, volcanic, and igneous rocks formed in the Blue Ridge and metamorphosed to gneisses and schists.	1600
		Early		Oldest dated rock in North Carolina is 1,800 million years old.	2500

* Estimated age in millions of years.

Oldest known rock in U.S.- 3,600 million years old.
Oldest known rocks in world- 3,850 million years old.
Formation of the Earth- about 4,500 million years ago.

Commercial Gem- and Mineral-Collecting Sites

Garnet, moonstone, ruby and sapphire - Cowee Valley mines; 8 miles north of Franklin, Macon Co., on NC 28. Panners Creek Gem Lines; southwest of Raleigh off Old Apex Road (gems are from western N.C.)

Emerald, aquamarine and amethyst - mines in the Spruce Pine-Little Switzerland area, Mitchell County.

Emerald, hiddenite, rutile and quartz - mines at Hiddenite, Alexander Co., 15 miles northwest of Statesville off NC 90.

Gold - Reed Gold Mine State Historic Site; off NC 200, 6 miles southeast of Concord, Cabarrus County. Cotton Patch Gold Mine; off US 52, 2 miles southeast of New London.

Sapphire - Pressley Mine; off Interstate 40, near Canton, west of Asheville, Haywood Co.

The State Precious Stone - Emerald

The General Assembly of 1973 designated the emerald as the official State precious stone. Emerald is found in North Carolina near Hiddenite in Alexander County and southwest of Spruce Pine in Mitchell County. The largest single emerald crystal found in North America was found at the Rist Mine at Hiddenite in 1969. This crystal weighed 1,438 carats. The *Carolina Emerald*, a 13.14 carat, emerald-cut gem, was also found at the Rist Mine.

The State Rock - Granite

The General Assembly of 1979 designated granite as the official State rock. North Carolina is blessed with an abundance of granite. When granite is crushed, it is used as an aggregate for road and building construction. If granite has the right physical properties, it can be cut into blocks and used for monuments, curb stone and stone for building facings. The largest open-face granite quarry in the world is located at Mount Airy, North Carolina.

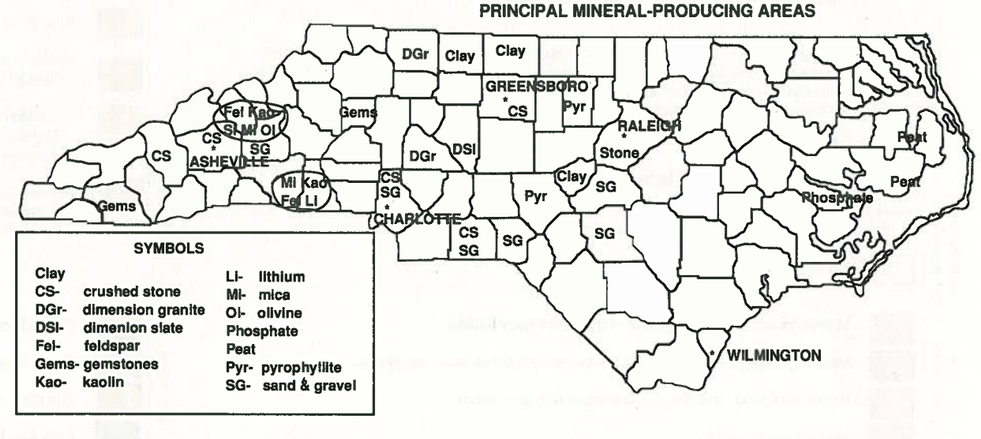
STATE OF NORTH CAROLINA
James B. Hunt, Jr., Governor

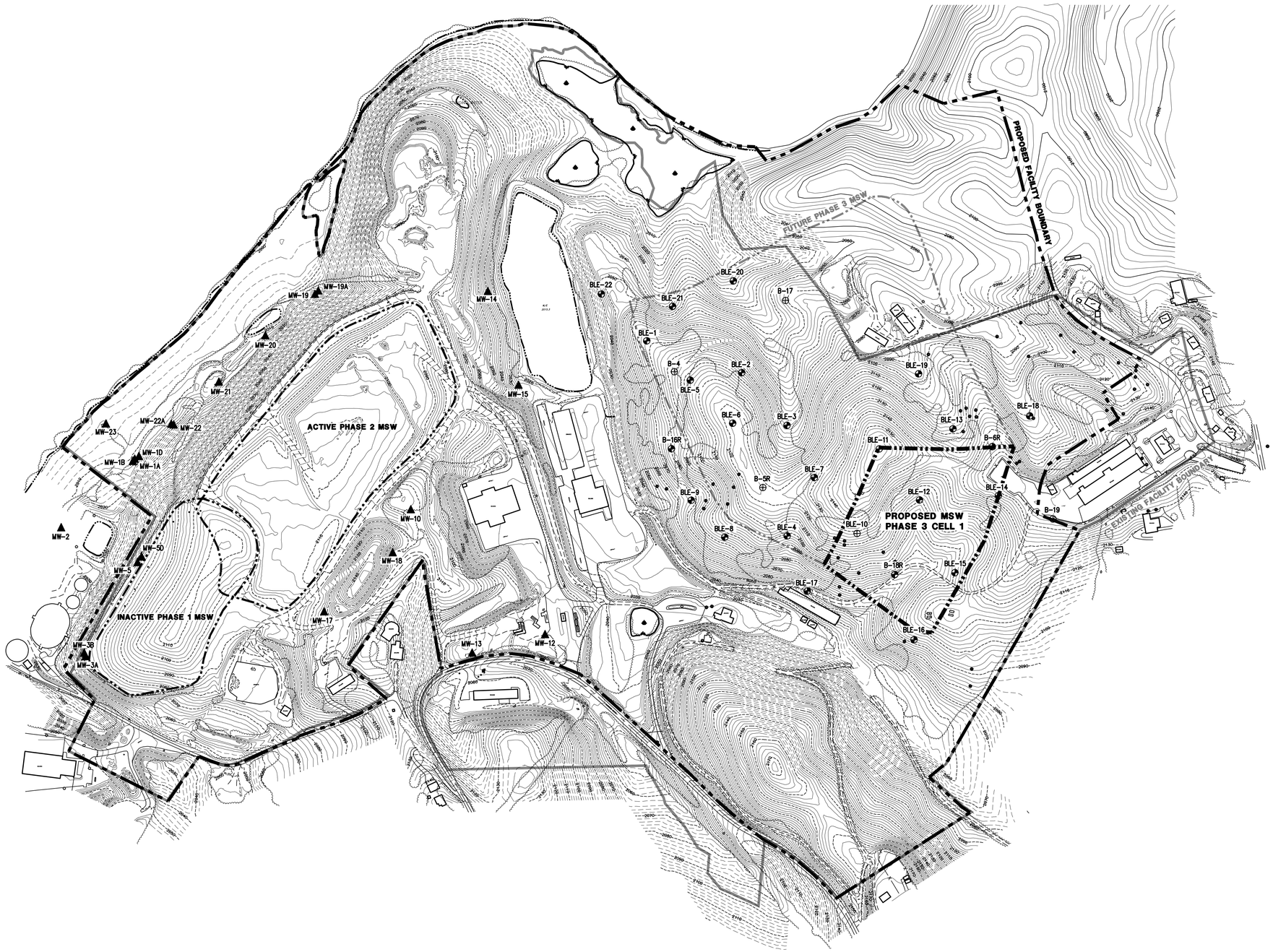
Department of Environment, Health and Natural Resources
Jonathan B. Howes, Secretary

Division of Land Resources
Charles H. Gardner
Director and State Geologist

North Carolina Geological Survey
P.O. Box 27687, Raleigh, N.C. 27611-7687
Telephone (919)733-2423; FAX (919)733-0900
e-mail: jeff_reid@mail.ehnr.state.nc.us
http://www.ehnr.state.nc.us/EHNR/DLR/JEFF/rock1.htm

PRINCIPAL MINERAL-PRODUCING AREAS





MONITORING LOCATION LEGEND

BLE-1	⊕	SURVEYED LOCATION OF PIEZOMETERS
B-5	⊕	SURVEYED LOCATION OF SOIL TEST BORINGS
MW-9	▲	SURVEYED LOCATION OF GROUNDWATER MONITORING WELL

TOPOGRAPHIC & GEOLOGIC LEGEND

- 2060 — TOPOGRAPHIC SURFACE CONTOUR (FEET ABOVE MSL) CONTOUR INTERVAL = 2 FEET
- STREAM OR CREEK
- ROAD
- EXISTING FACILITY BOUNDARY
- PROPOSED FACILITY BOUNDARY
- PHASE 3 (CELL 1) PROPOSED WASTE LIMITS
- EXISTING PHASE 1 & 2 BOUNDARIES
- FUTURE PHASE 3 BOUNDARY

NOTES:

1. ELEVATIONS ARE RELATIVE TO AN ARBITRARY SITE DATUM THAT IS WITHIN APPROXIMATELY 0.86 FEET OF MEAN SEA LEVEL.
2. THE LOCATIONS OF HISTORICAL BORINGS B-4, B-17, AND B-19 ARE APPROXIMATE BASED ON INFORMATION IN THE ORGINAL SHR PERFORMED BY WESTINGHOUSE (1990).

GENERAL MAP REFERENCE

200 100 0 200 400

APPROXIMATE SCALE IN FEET

REFERENCES:

1. DRAWING PROVIDED BY McGILL ASSOCIATES VIA EMAIL ON 11-19-13.

REVISIONS		
No.	DESCRIPTION	BY

DRAWN:	ACE
CHECKED:	MSP
APPROVED:	

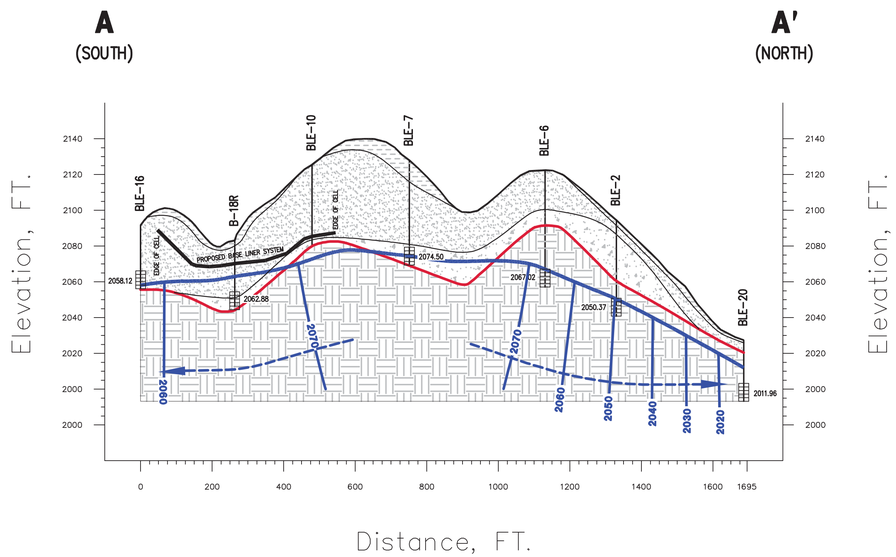
DATE:	05-27-15
CAD FILE:	MACONCOLF06-BLP
JOB NO:	J13-1101-06

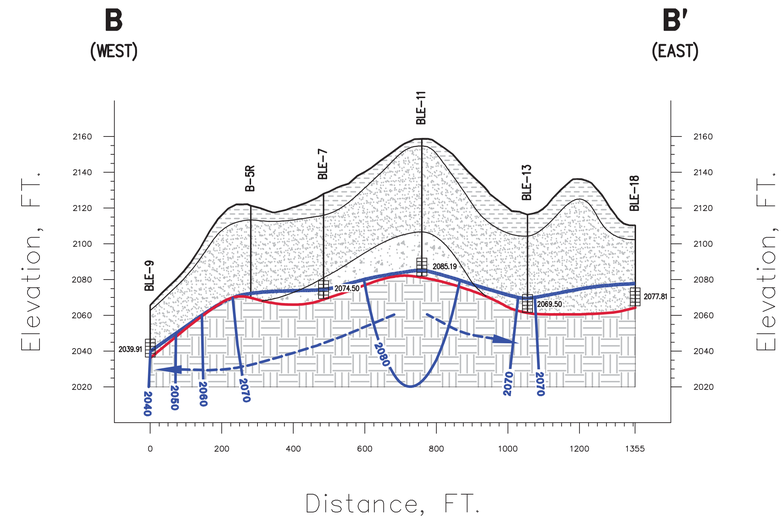
BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.
8004 PONDERS COURT
GREENVILLE, SOUTH CAROLINA 29615
PHONE: (864)288-1258 FAX: (864)288-4430

SITE TOPOGRAPHY AND BORING LOCATION PLAN
MACON COUNTY MSW LANDFILL - PHASE 3 DHR
FRANKLIN, NORTH CAROLINA

FIGURE NO. 3





LEGEND

- WATER TABLE SURFACE – SEPTEMBER 26, 2014
- 2070 — EQUIPOTENTIAL LINES (FEET MSL)
- GROUNDWATER FLOW DIRECTION
- TOP OF BEDROCK SURFACE
- SCREENED INTERVAL OF PIEZOMETER OR WELL
- 2011.96 — GROUNDWATER ELEVATION (FEET MSL)
- SHALLOW RESIDUUM
- DEEP RESIDUUM
- PARTIALLY WEATHERED ROCK
- BEDROCK
- PROPOSED BASE LINER SYSTEM FOR PHASE 3 (CELL 1) AS DESIGNED BY MCGILL ASSOCIATES.
- APPROXIMATE FORMATION BOUNDARY. ALL GEOLOGIC FORMATION BOUNDARIES ARE APPROXIMATE AND ARE SUBJECT TO GEOLOGIC INTERPRETATION. GEOLOGIC BOUNDARIES WERE INFERRED BASED ON BORING DESCRIPTIONS, AERIAL PHOTOGRAPHS, AND FIELD OBSERVATIONS.

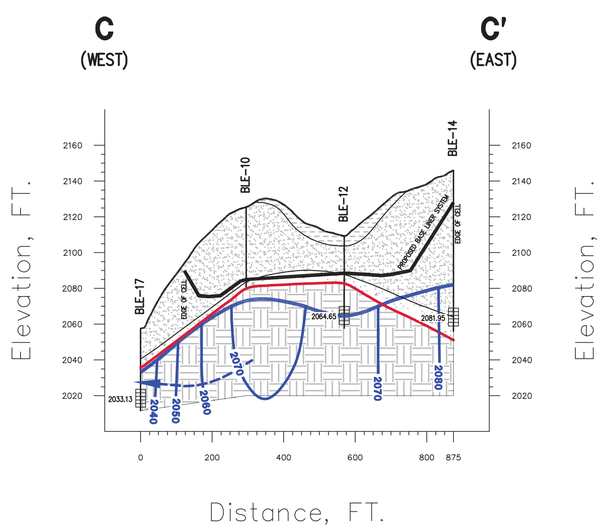
20 Feet
1 Inch

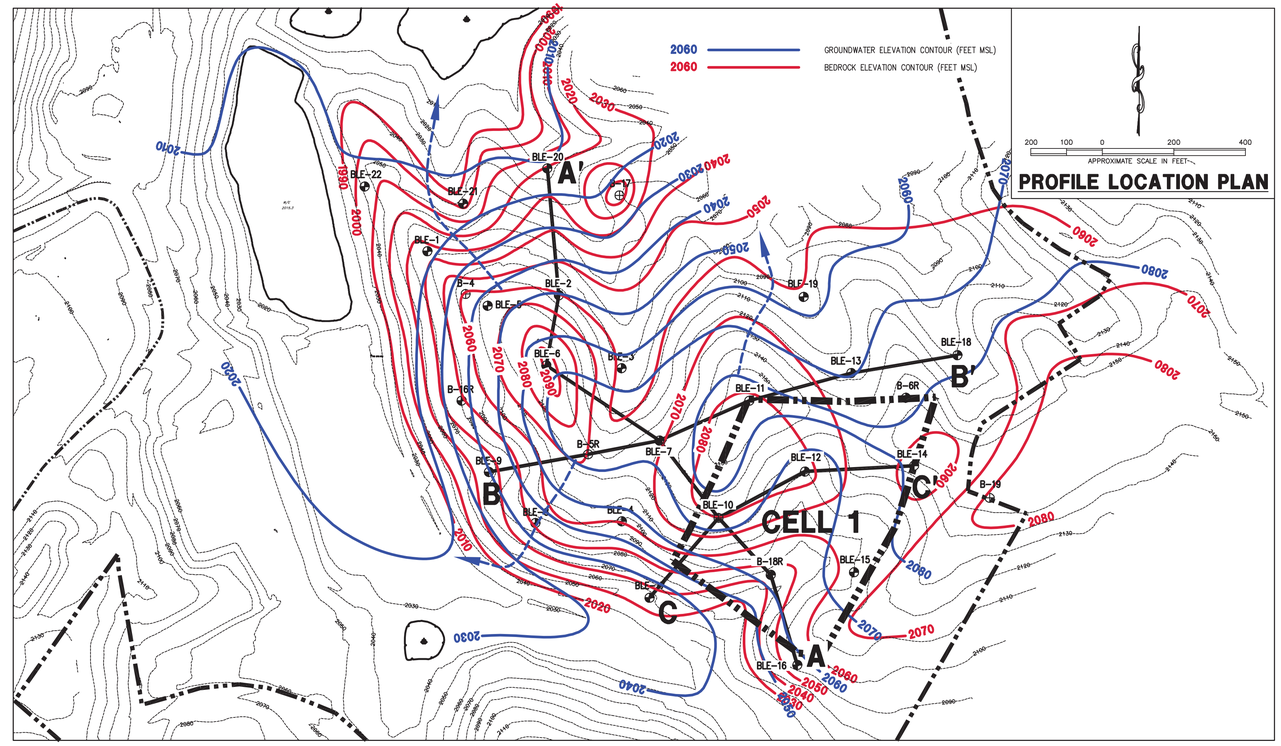
1 Inch
200 Feet

SCALE

VERTICAL EXAGGERATION = 10X

NORTH CAROLINA LICENSED SEAL 1043 GEOLOGIST MARK S. PREDDY
5/27/15





REVISIONS		
No.	DESCRIPTION	BY

DRAWN:	MSP
CHECKED:	
APPROVED:	

DATE:	05-27-15
CAD FILE:	MACONCOLF06-PROFILES
JOB NO:	J13-1101-06

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.
6004 PONDERS COURT
GREENVILLE, SOUTH CAROLINA 29615
PHONE: (864)288-1265 FAX: (864)288-4430

GEOLOGIC PROFILES: CROSS-SECTION A-A', B-B', AND C-C'
MACON COUNTY MSW LANDFILL - PHASE 3 (CELL 1) DHR
FRANKLIN, NORTH CAROLINA

FIGURE NO. 4

MONITORING LOCATION LEGEND

BLE-1	⊕	SURVEYED LOCATION OF PIEZOMETERS
B-5	⊕	SURVEYED LOCATION OF SOIL TEST BORINGS
MW-9	▲	SURVEYED LOCATION OF GROUNDWATER MONITORING WELL

TOPOGRAPHIC & GEOLOGIC LEGEND

2060	TOPOGRAPHIC SURFACE CONTOUR (FEET ABOVE MSL) CONTOUR INTERVAL = 2 FEET
	STREAM OR CREEK
	ROAD
	EXISTING FACILITY BOUNDARY
	PROPOSED FACILITY BOUNDARY
	PHASE 3 (CELL 1) PROPOSED WASTE LIMITS
	EXISTING PHASE 1 & 2 BOUNDARIES
	FUTURE PHASE 3 BOUNDARY
2000	TOP OF BEDROCK ELEVATION CONTOUR (FEET ABOVE MSL) CONTOUR INTERVAL = 10 FEET
2061.4	TOP OF BEDROCK ELEVATION (FEET ABOVE MSL)

NOTES:

1. THIS MAP REPRESENTS THE APPROXIMATE BEDROCK SURFACE (AUGER REFUSAL OR >50% ROCK CORE RECOVERY). THE TOP OF ROCK DEPTHS MAY REPRESENT COMPETENT BEDROCK OR POSSIBLY BOULDERS OF HARD ROCK WITHIN THE RESIDUAL SOIL AND PARTIALLY WEATHERED ROCK UNITS. THE DEPTH TO THE TOP OF ROCK CAN VARY EVEN OVER SHORT HORIZONTAL DISTANCES DUE TO FRACTURES, JOINTS AND THE PRESENCE OF LESS RESISTANT ROCK TYPES. THEREFORE, THE ACTUAL DEPTH TO CONTINUOUS BEDROCK WILL VARY SOMEWHAT FROM THAT PRESENTED ON THIS FIGURE.
2. PARTIALLY WEATHERED ROCK WITH BLOW-COUNT VALUES OF 50 BPF ≤ 3-INCHES OF PENETRATION MAY EXIST ABOVE THIS LEVEL THAT WILL RESULT IN DIFFICULT EXCAVATION.
3. ELEVATIONS ARE RELATIVE TO AN ARBITRARY SITE DATUM THAT IS WITHIN APPROXIMATELY 0.86 FEET OF MEAN SEA LEVEL.
4. THE LOCATIONS OF HISTORICAL BORINGS B-4, B-17, AND B-19 ARE APPROXIMATE BASED ON INFORMATION IN THE ORGINAL SHR PERFORMED BY WESTINGHOUSE (1990).

GENERAL MAP REFERENCE

NORTH CAROLINA LICENSED SEAL 1043 GEOLOGIST MARK S. PRESNOT
5/27/15

200 100 0 200 400
APPROXIMATE SCALE IN FEET

REFERENCES:

1. DRAWING PROVIDED BY McGILL ASSOCIATES VIA EMAIL ON 11-19-13.

REVISIONS		
No.	DESCRIPTION	BY

DRAWN:	PJVH
CHECKED:	MSP/TWM
APPROVED:	MSP

DATE:	05-27-15
CAD FILE:	MACONCOLF06-BEDROCK
JOB NO:	J13-1101-06

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.
6004 PONDERS COURT
GREENVILLE, SOUTH CAROLINA 29615
PHONE: (864)288-1255 FAX: (864)288-4430

TOP OF BEDROCK (AUGER REFUSAL) ELEVATION CONTOUR MAP
MACON COUNTY MSW LANDFILL - PHASE 3 (CELL 1) DHR
FRANKLIN, NORTH CAROLINA

FIGURE NO.
5

MONITORING LOCATION LEGEND

BLE-1	◐	SURVEYED LOCATION OF PIEZOMETERS
B-5	⊕	SURVEYED LOCATION OF SOIL TEST BORINGS
MW-9	▲	SURVEYED LOCATION OF GROUNDWATER MONITORING WELL

TOPOGRAPHIC & GEOLOGIC LEGEND

2060	TOPOGRAPHIC SURFACE CONTOUR (FEET ABOVE MSL) CONTOUR INTERVAL = 2 FEET
	STREAM OR CREEK
	ROAD
	EXISTING FACILITY BOUNDARY
	PROPOSED FACILITY BOUNDARY
	PHASE 3 (CELL 1) PROPOSED WASTE LIMITS
	EXISTING PHASE 1 & 2 BOUNDARIES
	FUTURE PHASE 3 BOUNDARY
2000	GROUNDWATER ELEVATION CONTOUR (FEET ABOVE MSL) CONTOUR INTERVAL = 10 FEET
	GROUNDWATER FLOW DIRECTION
2061.4	GROUNDWATER ELEVATION CONTOUR (FEET ABOVE MSL)

NOTES:

1. ELEVATIONS ARE RELATIVE TO AN ARBITRARY SITE DATUM THAT IS WITHIN APPROXIMATELY 0.86 FEET OF MEAN SEA LEVEL.
2. THE LOCATIONS OF HISTORICAL BORINGS B-4, B-17, AND B-19 ARE APPROXIMATE BASED ON INFORMATION IN THE ORGINAL SHR PERFORMED BY WESTINGHOUSE (1990).

GENERAL MAP REFERENCE

NORTH CAROLINA LICENSED SEAL 1043 GEOLOGIST MARK S. PREDDY
5/27/15

200 100 0 200 400
APPROXIMATE SCALE IN FEET

REFERENCES:

1. DRAWING PROVIDED BY McGILL ASSOCIATES VIA EMAIL ON 11-19-13.

REVISIONS		
No.	DESCRIPTION	BY

DRAWN:	MSP
CHECKED:	TWM/MSP
APPROVED:	

DATE:	05-27-15
CAD FILE:	MACONCOLF06-POTMAP 9-26-14
JOB NO:	J13-1101-06

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.
6004 PONDERS COURT
GREENVILLE, SOUTH CAROLINA 29615
PHONE: (864)288-1265 FAX: (864)288-4430

GROUNDWATER ELEVATION CONTOUR MAP - SEPTEMBER 26, 2014
MACON COUNTY MSW LANDFILL - PHASE 3 (CELL 1) DHR
FRANKLIN, NORTH CAROLINA

FIGURE NO.
6

MONITORING LOCATION LEGEND

BLE-1	⊕	SURVEYED LOCATION OF PIEZOMETERS
B-5	⊕	SURVEYED LOCATION OF SOIL TEST BORINGS
MW-9	▲	SURVEYED LOCATION OF GROUNDWATER MONITORING WELL

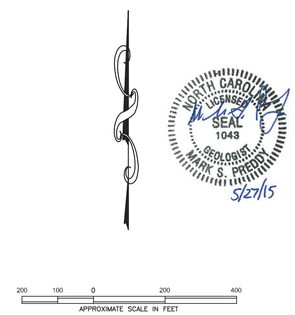
TOPOGRAPHIC & GEOLOGIC LEGEND

2060	TOPOGRAPHIC SURFACE CONTOUR (FEET ABOVE MSL) CONTOUR INTERVAL = 2 FEET
	STREAM OR CREEK
	ROAD
	EXISTING FACILITY BOUNDARY
	PROPOSED FACILITY BOUNDARY
	PHASE 3 (CELL 1) PROPOSED WASTE LIMITS
	EXISTING PHASE 1 & 2 BOUNDARIES
	FUTURE PHASE 3 BOUNDARY
2000	SEASONAL HIGH GROUNDWATER ELEVATION CONTOUR (FEET ABOVE MSL) CONTOUR INTERVAL = 10 FEET
2061.4	SEASONAL HIGH GROUNDWATER ELEVATION CONTOUR (FEET ABOVE MSL)

NOTES:

1. THIS MAP REPRESENTS THE HIGHEST OBSERVED GROUNDWATER ELEVATION AT EACH PIEZOMETER OR MONITORING WELL BETWEEN SEPTEMBER 2013 AND SEPTEMBER 2014 (TABLE 3 OF THE PHASE 3 DHR).
2. ELEVATIONS ARE RELATIVE TO AN ARBITRARY SITE DATUM THAT IS WITHIN APPROXIMATELY 0.86 FEET OF MEAN SEA LEVEL.
3. THE LOCATIONS OF HISTORICAL BORINGS B-4, B-17, AND B-19 ARE APPROXIMATE BASED ON INFORMATION IN THE ORGINAL SHR PERFORMED BY WESTINGHOUSE (1990).

GENERAL MAP REFERENCE



REFERENCES:

1. DRAWING PROVIDED BY McGILL ASSOCIATES VIA EMAIL ON 11-19-13.

REVISIONS		
No.	DESCRIPTION	BY

DRAWN:	PJVH
CHECKED:	MSP/TWM
APPROVED:	MSP

DATE:	05-27-15
CAD FILE:	MACONCOLF06-SHWTM
JOB NO:	J13-1101-06

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.
6004 PONDERS COURT
GREENVILLE, SOUTH CAROLINA 29615
PHONE: (864)255-1265 FAX: (864)255-4430

SEASONAL HIGH GROUNDWATER ELEVATION CONTOUR MAP - SEPTEMBER 2013 TO SEPTEMBER 2014
MACON COUNTY MSW LANDFILL - PHASE 3 (CELL 1) DHR
FRANKLIN, NORTH CAROLINA

FIGURE NO.
7

MONITORING LOCATION LEGEND

BLE-1	◐	SURVEYED LOCATION OF PIEZOMETERS
B-5	⊕	SURVEYED LOCATION OF SOIL TEST BORINGS
MW-9	▲	SURVEYED LOCATION OF GROUNDWATER MONITORING WELL

TOPOGRAPHIC & GEOLOGIC LEGEND

2060	TOPOGRAPHIC SURFACE CONTOUR (FEET ABOVE MSL) CONTOUR INTERVAL = 2 FEET
	STREAM OR CREEK
	ROAD
	EXISTING FACILITY BOUNDARY
	PROPOSED FACILITY BOUNDARY
	PHASE 3 (CELL 1) PROPOSED WASTE LIMITS
	EXISTING PHASE 1 & 2 BOUNDARIES
	FUTURE PHASE 3 BOUNDARY
2000	GROUNDWATER ELEVATION CONTOUR (FEET ABOVE MSL) CONTOUR INTERVAL = 10 FEET
2061.4	GROUNDWATER ELEVATION CONTOUR (FEET ABOVE MSL)

NOTES:

1. THE ESTIMATED LONG-TERM SEASONAL HIGH VALUES PRESENTED ON THIS FIGURE WERE GENERATED BY TAKING THE HIGHEST WATER LEVEL MEASURED FROM EACH PIEZOMETER AND ADDING 4.5 FEET (REFER TO TABLE 3 OF THE PHASE 3 DHR). 4.5 FEET REPRESENTS THE AVERAGE WATER LEVEL FLUCTUATION IN THE MONITORING WELLS FROM 2004 TO 2014.
2. ELEVATIONS ARE RELATIVE TO AN ARBITRARY SITE DATUM THAT IS WITHIN APPROXIMATELY 0.86 FEET OF MEAN SEA LEVEL.
3. THE LOCATIONS OF HISTORICAL BORINGS B-4, B-17, AND B-19 ARE APPROXIMATE BASED ON INFORMATION IN THE ORGINAL SHR PERFORMED BY WESTINGHOUSE (1990).

GENERAL MAP REFERENCE

NORTH CAROLINA LICENSED SEAL 1043 GEOLOGIST MARK S. PREDDY
5/27/15

200 100 0 200 400
APPROXIMATE SCALE IN FEET

REFERENCES:

1. DRAWING PROVIDED BY McGILL ASSOCIATES VIA EMAIL ON 11-19-13.

REVISIONS		
No.	DESCRIPTION	BY

DRAWN: MSP
CHECKED: TWM/MSP
APPROVED:

DATE: 05-27-15
CAD FILE: MACONCOLF06-ELSHWTM
JOB NO: J13-1101-06

BLE INC.
BUNNELL-LAMMONS ENGINEERING, INC.
6004 PONDERS COURT
GREENVILLE, SOUTH CAROLINA 29615
PHONE: (864)288-1265 FAX: (864)288-4430

ESTIMATED LONG-TERM SEASONAL HIGH GROUNDWATER ELEVATION CONTOUR MAP
MACON COUNTY MSW LANDFILL - PHASE 3 (CELL 1) DHR
FRANKLIN, NORTH CAROLINA

FIGURE NO. 8

APPENDICES

APPENDIX A

DRILLING AND SAMPLING PROCEDURES

APPENDIX A

DRILLING AND SAMPLING PROCEDURES

SOIL TEST BORINGS

Soil test borings were advanced by mechanically twisting a continuous flight steel auger into the soil. Soil sampling and penetration testing were performed in general accordance with ASTM D 1586. At regular intervals, soil samples were obtained with a standard 1.4-inch ID, 2-inch OD, split-tube sampler. The sampler was first seated 6 inches to penetrate any loose cuttings, and then driven an additional 12 inches with blows of a 140-pound hammer falling 30 inches. The number of hammer blows required to drive the sampler the final 12 inches was recorded and designated the "penetration resistance."

CORE DRILLING

Core drilling procedures were required to determine the character and vertical continuity of refusal materials. Refusal to soil drilling equipment may result from hard cemented soil, soft weathered rock, coarse gravel or boulders, thin rock seams, or the upper surface of solid continuous rock.

Prior to coring, a 4-inch diameter PVC pipe was seated in the refusal material and grouted into place with a cement-bentonite mixture. Refusal materials were then cored according to the ASTM D 2113 using a diamond-studded bit fastened to the end of a hollow, double-tube core barrel. The NQ and HQ sizes designate bits that obtain rock cores 1-7/8 and 2-1/2 inches in diameter. Upon completion of each drill run, the core inner barrel was brought to the surface, the core recovered was measured, and the core samples were removed and placed in boxes for storage.

The core samples were returned to our laboratory where the refusal material was identified and the percent core recovery and rock quality designation (RQD) was determined by a geologist. The percent core recovery is the ratio of the core length obtained to the length cored, expressed as a percent. The RQD is obtained by summing only those pieces of recovered core which are 4 inches or longer and are at least moderately hard, and dividing by the total length cored. The percent core recovery and the RQD are related to soundness and continuity of the refusal material. Refusal-material descriptions, recoveries and the bit size are shown on a Test Boring Record (see **Appendix B**).

APPENDIX B

SOIL AND ROCK BORING RECORDS AND WELL DIAGRAMS

KEY TO SOIL CLASSIFICATIONS AND CONSISTENCY DESCRIPTIONS

BUNNELL-LAMMONS ENGINEERING, INC.
GREENVILLE, SOUTH CAROLINA

Penetration Resistance* Blows per Foot	Relative Density
SANDS	
0 to 4	Very Loose
5 to 10	Loose
11 to 20	Firm
21 to 30	Very Firm
31 to 50	Dense
over 50	Very Dense

Penetration Resistance* Blows per Foot	Consistency
SILTS and CLAYS	
0 to 2	Very Soft
3 to 4	Soft
5 to 8	Firm
9 to 15	Stiff
16 to 30	Very Stiff
31 to 50	Hard
over 50	Very Hard

*ASTM D 1586

Particle Size Identification

Boulder: Greater than 300 mm
Cobble: 75 to 300 mm
Gravel:
Coarse - 19 to 75 mm
Fine - 4.75 to 19 mm
Sand:
Coarse - 2 to 4.75 mm
Medium - 0.425 to 2 mm
Fine - 0.075 to 0.425 mm
Silt & Clay: Less than 0.075 mm

KEY TO DRILLING SYMBOLS

Grab Sample

Split Spoon Sample

Undisturbed Sample

NR = No reaction to HCL

NA = Not applicable

NS = No sample

Groundwater Table at Time of Drilling

Groundwater Table 24 Hours after Completion of Drilling

KEY TO SOIL CLASSIFICATIONS

Well-graded Gravel
GW

Low Plasticity Clay
CL

Clayey Silt
MH

Silty Sand
SM

Poorly-graded Gravel
GP

Sandy Clay
CLS

Sandy Silt
MLS

Topsoil
TOPSOIL

Partially Weathered Rock
BLDRCBBL

Silty Clay
CL-ML

Sand
SW

Liquid Sludge
SLUDGE

High Plasticity Clay
CH

Silt
ML

Clayey Sand
SC

Fill
FILL

Poorly Graded Sand
SP

Bedrock
BEDROCK

Waste
WOOD

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

PIEZOMETER NO. BLE-1

PROJECT: Macon County MSW Landfill - Phase 3 | PROJECT NO.: J13-1101-06

CLIENT: Macon County SWM Department | START: 8-27-13 END: 9-12-13

LOCATION: Franklin, North Carolina | ELEVATION: 2078.09

DRILLER: Landprobe, R. Banks | LOGGED BY: B. Nisbeth

DRILLING METHOD: CME 750 ATV; 8.25-inch hollow stem auger and 3-inch NQ rock coring

DEPTH TO - WATER> INITIAL: NS AFTER 24 HOURS: 55.4 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SAMPLES (BLOWS/FOOT)
	6-inches of TOPSOIL	
	Firm, reddish-brown, slightly moist, slightly micaceous, fine to medium sandy CLAY - (residuum)	3, 3, 4
2075	Firm, reddish-brown, slightly moist, micaceous, silty, fine to medium SAND	4, 5, 7
5		4, 6, 7
2070		5, 5, 7
10		
2065		9, 10, 10
15		
2060	Very stiff, reddish-brown, slightly moist, micaceous, fine to medium sandy SILT	5, 7, 9
20		
2055		8, 9, 11
25		
2050	Firm to very firm, brown, slightly moist, micaceous, silty, fine to medium SAND	9, 9, 6
30		
2045		7, 12, 14
35		
2040	PARTIALLY WEATHERED ROCK which sampled as brown, slightly moist, micaceous, silty, fine to medium SAND	50/5"

STANDARD PENETRATION RESULTS BLOWS/FOOT: 2 5 10 20 30 40 50 70 90

PIEZOMETER INSTALLATION DETAILS:

Grout, 0 to 4.6 feet

Bentonite seal, 4.6 to 42.3 feet

PIEZOMETER 1101-06.GPJ 2/9/15

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

PIEZOMETER NO. BLE-1

PROJECT: Macon County MSW Landfill - Phase 3 | PROJECT NO.: J13-1101-06

CLIENT: Macon County SWM Department | START: 8-27-13 END: 9-12-13

LOCATION: Franklin, North Carolina | ELEVATION: 2078.09

DRILLER: Landprobe, R. Banks | LOGGED BY: B. Nisbeth

DRILLING METHOD: CME 750 ATV; 8.25-inch hollow stem auger and 3-inch NQ rock coring

DEPTH TO - WATER> INITIAL: NS AFTER 24 HOURS: 55.4 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE / SAMPLES	STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90)	PIEZOMETER INSTALLATION DETAILS
	PARTIALLY WEATHERED ROCK which sampled as brown, slightly moist, micaceous, silty, fine to medium SAND			Bentonite seal, 4.6 to 42.3 feet
2035	Auger refusal at 43.0 feet. Began rock coring.	R-1		Filter pack, sand 42.3 to 65.0 feet
45	Moderately hard to soft, moderate to moderately severely weathered, gray, medium to coarse grained feldspar, quartz, biotite, GNEISS with closely spaced fractures and thinly spaced shallow dipping foliation	R-2		
2030	R-1 recovery = 95%, RQD = 0% R-2 recovery = 16%, RQD = 0% R-3 recovery = 10%, RQD = 0%			
50		R-3		
2025				
55	Moderately hard, moderately weathered, gray, medium grained, feldspar, quartz, biotite GNEISS with closely spaced fractures and thinly spaced shallow dipping foliation	R-4		
2020	R-4 recovery = 35%, RQD = 0%			2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 54.7 to 64.7 feet
60	Moderately hard to very soft, moderate to completely weathered, gray, medium grained feldspar, quartz, biotite GNEISS with closely spaced fractures and thinly spaced, shallow dipping foliation	R-5		
2015	R-5 recovery = 72%, RQD = 30%			
65	Boring terminated at 65.0 feet. Groundwater level not stable at time of drilling, but was encountered at 55.4 feet after 24 hours.			Pipe cap
2010				Total well depth, 64.90 feet SURFACE COMPLETION 3.01-foot PVC stick-up Top of PVC casing elev. = 2,081.10 feet
70				Ground surface elev. = 2,078.09 feet
2005				Northing = 557,993.41' Easting = 693,239.72'
75				
2000				

PIEZOMETER 1101-06.GPJ 2/9/15

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

PIEZOMETER NO. BLE-2

PROJECT: Macon County MSW Landfill - Phase 3 | PROJECT NO.: J13-1101-06

CLIENT: Macon County SWM Department | START: 8-28-13 END: 8-29-13

LOCATION: Franklin, North Carolina | ELEVATION: 2094.54

DRILLER: Landprobe, R. Banks | LOGGED BY: B. Nisbeth

DRILLING METHOD: CME 750 ATV; 8.25-inch hollow stem auger and 3-inch NQ rock coring

DEPTH TO - WATER> INITIAL: NS AFTER 24 HOURS: 45.8 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SAMPLES	STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90)
	6-inches of TOPSOIL		
	Firm, reddish-brown, slightly moist, slightly micaceous, clayey, fine to medium sandy SILT - (residuum)	3 4 4	
	Firm, brown, slightly moist, micaceous, silty, fine to medium SAND	UD	
2090 / 5		5 7 8	
	PARTIALLY WEATHERED ROCK which sampled as gray, slightly moist, micaceous, silty, fine to coarse SAND with some gravel	50/5"	50/5"
2085 / 10			
		50/3"	50/3"
2080 / 15			
		23 50/4"	50/4"
2075 / 20			
	Dense, reddish-brown, micaceous, silty, fine to medium SAND with partially weathered rock fragments	14 20 25	
2070 / 25			
	PARTIALLY WEATHERED ROCK which sampled as gray, slightly moist, micaceous, silty, fine to coarse SAND with some gravel	50/5"	50/5"
2065 / 30			
	Auger refusal at 34.0 feet. Began rock coring.	R-1	
2060 / 35	Moderately hard, moderately weathered, gray, medium grained, feldspar, quartz, biotite GNIESS with moderately closely spaced fractures and thinly spaced shallow dipping foliation R-1 recovery = 40%, RQD = 40% R-2 recovery = 85%, RQD = 40%	R-2	
2055			

PIEZOMETER INSTALLATION DETAILS

Grout, 0 to 4.6 feet

Bentonite seal, 4.6 to 37.6 feet

Filter pack, sand 37.6 to 55.0 feet

PIEZOMETER 1101-06.GPJ 2/9/15

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

PIEZOMETER NO. BLE-2

PROJECT: Macon County MSW Landfill - Phase 3 | PROJECT NO.: J13-1101-06

CLIENT: Macon County SWM Department | START: 8-28-13 END: 8-29-13

LOCATION: Franklin, North Carolina | ELEVATION: 2094.54

DRILLER: Landprobe, R. Banks | LOGGED BY: B. Nisbeth

DRILLING METHOD: CME 750 ATV; 8.25-inch hollow stem auger and 3-inch NQ rock coring

DEPTH TO - WATER> INITIAL: NS AFTER 24 HOURS: 45.8 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90)	PIEZOMETER INSTALLATION DETAILS
	Brown PARTIALLY WEATHERED ROCK		R-3		Filter pack, sand 37.6 to 55.0 feet
2050 / 45	Moderately hard, moderately severely weathered, gray and brown, medium grained, feldspar, quartz, biotite GNEISS with closely spaced fractures and thinly spaced moderately dipping foliation R-3 recovery = 82%, RQD = 30%		R-4		
2045 / 50	Moderately hard, moderately weathered, gray and brown, medium grained, feldspar, quartz, biotite GNEISS with closely spaced fractures and thinly spaced moderately dipping foliation R-4 recovery = 85%, RQD = 85% R-5 recovery = 100%. RQD = 100%		R-5		2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 43.7 to 53.7 feet Pipe cap
2040 / 55	Boring terminated at 55.0 feet. Groundwater level was not stable at time of drilling, but was encountered at 45.8 feet after 24 hours.				Total well depth, 53.9 feet
2035 / 60					SURFACE COMPLETION 2.93-foot PVC stick-up Top of PVC casing elev. = 2,097.47 feet Ground surface elev. = 2,094.54 feet Northing = 557,870.28' Easting = 693,607.21'
2030 / 65					
2025 / 70					
2020 / 75					
2015					

PIEZOMETER 1101-06.GPJ 2/9/15

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

PIEZOMETER NO. BLE-3

PROJECT: Macon County MSW Landfill - Phase 3 | PROJECT NO.: J13-1101-06

CLIENT: Macon County SWM Department | START: 8-27-13 END: 8-27-13

LOCATION: Franklin, North Carolina | ELEVATION: 2,081.47

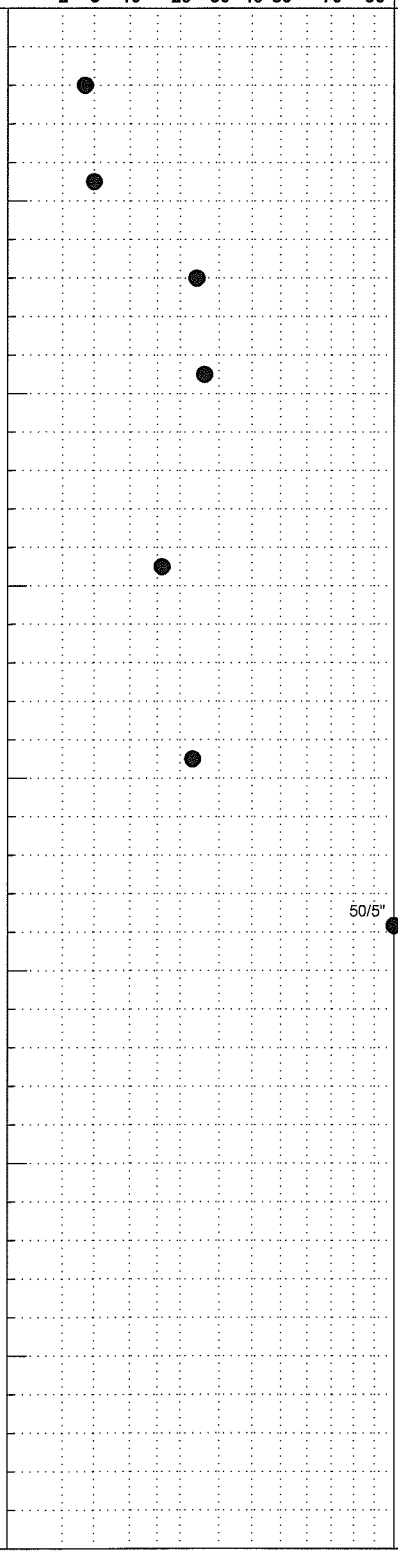
DRILLER: Landprobe, R. Banks | LOGGED BY: B. Nisbeth

DRILLING METHOD: CME 750 ATV; 8.25-inch hollow stem auger

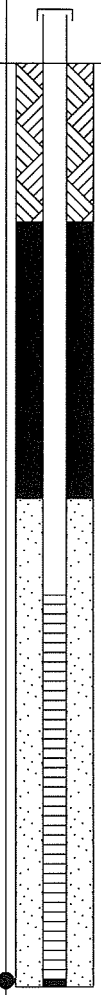
DEPTH TO - WATER> INITIAL: 12.55 AFTER 24 HOURS: 13.60 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SAMPLES (BLOWS/FOOT)
	6-inches of TOPSOIL	
2080	Soft to firm, brownish-red, slightly moist, slightly micaceous, fine to medium sandy SILT - (residuum)	2, 2, 2 / 2, 2, 3
5		
2075	Very firm, dark brown, slightly moist, very micaceous, silty, fine to medium SAND	9, 9, 15 / 8, 12, 14
10		
2070	Firm, brown, slightly moist, very micaceous, silty, fine to medium SAND	3, 6, 10
15		
2065	Very firm to very dense, brown, slightly moist, micaceous, silty, fine to medium SAND	10, 11, 12
20		
2060	PARTIALLY WEATHERED ROCK which sampled as brown, moist, micaceous, silty, fine to medium SAND	50/5"
25	Auger refusal at 24.0 feet. Groundwater encountered at 12.55 feet at time of drilling and at 13.60 feet after 24 hours.	
2055		
30		
2050		
35		
2045		

STANDARD PENETRATION RESULTS BLOWS/FOOT



PIEZOMETER INSTALLATION DETAILS



Grout, 0 to 4.1 feet

Bentonite seal, 4.1 to 11.3 feet

Filter pack, sand 11.3 to 24.0 feet

2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 13.8 to 23.8 feet

Pipe cap

Total well depth, 24.00 feet

SURFACE COMPLETION
2.86-foot PVC stick-up

Top of PVC casing elev. = 2,084.33 feet

Ground surface elev. = 2,081.47 feet

Northing = 557,666.48'

Easting = 693,782.19'

PIEZOMETER 1101-06.GPJ 2/9/15

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

PIEZOMETER NO. BLE-4

PROJECT: Macon County MSW Landfill - Phase 3 | PROJECT NO.: J13-1101-06

CLIENT: Macon County SWM Department | START: 8-29-13 END: 9-16-13

LOCATION: Franklin, North Carolina | ELEVATION: 2096.93

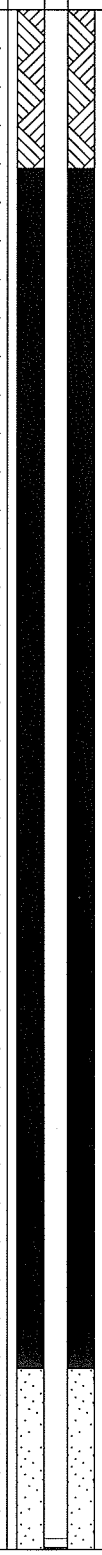
DRILLER: Landprobe, R. Banks | LOGGED BY: B. Nisbeth

DRILLING METHOD: CME 750 ATV; 8.25-inch hollow stem auger and 3-inch NQ rock coring

DEPTH TO - WATER> INITIAL: NS AFTER 24 HOURS: 37.2 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SAMPLES	STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90)
	6-inches of TOPSOIL		
2095	Stiff, reddish-brown, slightly moist, micaceous, fine to medium sandy SILT - (residuum)		4 5 4
	Firm, reddish-brown, slightly moist, micaceous, silty, fine to medium SAND		9 9 10
5			
2090			4 5 6
	Stiff, reddish-brown, slightly moist, micaceous, fine to medium sandy SILT		4 4 5
10			
2085	Firm to dense, reddish-brown, slightly moist, micaceous, silty, fine to medium SAND		
			UD
15			
2080			
			UD
20			
2075			
			4 7 9
25			
2070			
			12 15 17
30			
2065			
			9 14 18
35			
2060	Auger refusal at 36.5 feet, began rock coring.		R-1
	Medium to very soft, moderately severely weathered, gray and brown, medium grained feldspar, quartz, biotite GNEISS with very		

PIEZOMETER INSTALLATION DETAILS



Grout, 0 to 4.1 feet

Bentonite seal, 4.1 to 35.3 feet

Filter pack, sand 35.3 to 50.5 feet

PIEZOMETER 1101-06.GPJ 2/9/15

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

PIEZOMETER NO. BLE-4

PROJECT: Macon County MSW Landfill - Phase 3 | PROJECT NO.: J13-1101-06

CLIENT: Macon County SWM Department | START: 8-29-13 END: 9-16-13

LOCATION: Franklin, North Carolina | ELEVATION: 2096.93

DRILLER: Landprobe, R. Banks | LOGGED BY: B. Nisbeth

DRILLING METHOD: CME 750 ATV; 8.25-inch hollow stem auger and 3-inch NQ rock coring

DEPTH TO - WATER> INITIAL: NS AFTER 24 HOURS: 37.2 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90)	PIEZOMETER INSTALLATION DETAILS
2055	closely spaced fractures and thinly spaced, moderately dipping foliation R-1 recovery = 65%, RQD = 13% R-2 recovery = 48%, RQD = 7%		R-2		Filter pack, sand 35.3 to 50.5 feet
45					
2050	Moderately hard, moderately weathered, gray and brown, medium grained feldspar, quartz, biotite GNEISS with closely spaced fractures and thinly spaced, moderately dipping fractures R-3 recovery = 68%, RQD = 27%		R-3		2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 39.7 to 49.7 feet
50					Pipe cap
2045	Boring terminated at 50.5 feet. Groundwater level not stable at time of drilling, but was encountered at 37.2 feet after 24 hours.				Total well depth, 49.9 feet
					SURFACE COMPLETION 2.87-foot PVC stick-up
					Top of PVC casing elev. = 2,099.80 feet
55					
2040					Ground surface elev. = 2,096.93 feet
					Northing = 557,238.47'
					Easting = 693,782.94'
60					
2035					
65					
2030					
70					
2025					
75					
2020					

PIEZOMETER 1101-06.GPJ 2/9/15

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

PIEZOMETER NO. BLE-5

PROJECT: Macon County MSW Landfill - Phase 3 | PROJECT NO.: J13-1101-06

CLIENT: Macon County SWM Department | START: 8-26-13 END: 9-11-13

LOCATION: Franklin, North Carolina | ELEVATION: 2103.10

DRILLER: Landprobe, R. Banks | LOGGED BY: P. VanHeest

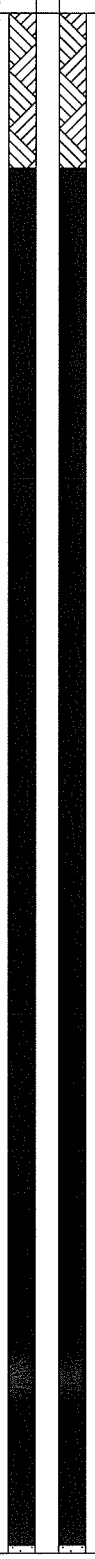
DRILLING METHOD: CME 750 ATV; 8.25-inch hollow stem auger and 3-inch NQ rock coring

DEPTH TO - WATER> INITIAL: NS AFTER 24 HOURS: 57.4 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SAMPLES (BLOWS/FOOT)
	0.5-inches of TOPSOIL	
	Loose, reddish-brown, slightly moist, slightly micaceous, silty, fine to medium SAND - (residuum)	6, 5, 4
2100	Firm, brown, slightly moist, micaceous, silty, fine to medium SAND	6, 7, 7
5		7, 7, 9
2095		5, 8, 10
10		
2090		4, 5, 7
15		
2085		4, 9, 8
20		
2080	Very firm, light brown, slightly moist, micaceous, silty, fine to medium SAND	11, 11, 12
25		
2075		12, 11, 16
30		
2070	Dense, brown, slightly moist, micaceous, silty, fine to medium SAND	14, 21, 27
35		
2065		12, 18, 26

STANDARD PENETRATION RESULTS BLOWS/FOOT: 2 5 10 20 30 40 50 70 90

PIEZOMETER INSTALLATION DETAILS



Grout, 0 to 4.0 feet

Bentonite seal, 4.0 to 39.8 feet

PIEZOMETER 1101-06.GPJ 2/9/15

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

PIEZOMETER NO. BLE-5

PROJECT: Macon County MSW Landfill - Phase 3 | PROJECT NO.: J13-1101-06

CLIENT: Macon County SWM Department | START: 8-26-13 END: 9-11-13

LOCATION: Franklin, North Carolina | ELEVATION: 2103.10

DRILLER: Landprobe, R. Banks | LOGGED BY: P. VanHeest

DRILLING METHOD: CME 750 ATV; 8.25-inch hollow stem auger and 3-inch NQ rock coring

DEPTH TO - WATER> INITIAL: NS AFTER 24 HOURS: 57.4 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE / SAMPLES	STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90)	PIEZOMETER INSTALLATION DETAILS
	Auger refusal at 41.0 feet. Began rock coring.		R-1	
2060 / 45	Medium to soft, moderately severely weathered, gray and brown, medium grained feldspar, quartz, biotite GNEISS with close to very closely spaced fractures and shallow dipping, thinly spaced foliation R-1 recovery = 10%, RQD = 0% R-2 recovery = 24%, RQD = 8%		R-2	
2055 / 50				Filter pack, sand 39.8 to 71.0 feet
	No recovery R-3 recovery = 0%, RQD = 0%		R-3	
2050 / 55				
	Brown, micaceous, sandy SILT and silty SAND with fragments of partially weathered rock R-4 recovery = 26%, RQD = 0%		R-4	
2045 / 60				
	Medium hardness, moderately severely weathered, gray and brown, medium to coarse grained, feldspar, quartz, biotite GNEISS with very closely spaced fractures and thinly spaced shallow, dipping foliation R-5 recovery = 80%, RQD = 0%		R-5	2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 57.0 to 67.0 feet
2040 / 65				
	Moderately hard, slight weathering, gray, medium grained, feldspar, quartz, biotite GNEISS with moderately closely spaced fractures and thinly spaced shallow dipping foliation R-6 recovery = 60%, RQD = 50%		R-6	Pipe cap
2035 / 70				Total well depth, 67.2 feet SURFACE COMPLETION 3.07-foot PVC stick-up
	Boring terminated at 71.0 feet. Groundwater level was not stable at time of drilling, but was encountered at 57.4 feet after 24 hours.			Top of PVC casing elev. = 2,106.17 feet
2030 / 75				Ground surface elev. = 2,103.10 feet Northing = 557,841.09' Easting = 693,407.97'
2025				

PIEZOMETER 1101-06.GPJ 2/9/15

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

PIEZOMETER NO. BLE-6

PROJECT: Macon County MSW Landfill - Phase 3 | PROJECT NO.: J13-1101-06

CLIENT: Macon County SWM Department | START: 8-26-13 END: 9-11-13

LOCATION: Franklin, North Carolina | ELEVATION: 2122.41

DRILLER: Landprobe, R. Banks | LOGGED BY: P. VanHeest

DRILLING METHOD: CME 750 ATV; 8.25-inch hollow stem auger and 3-inch NQ rock coring

DEPTH TO - WATER> INITIAL: NS AFTER 24 HOURS: 55.3 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90)	PIEZOMETER INSTALLATION DETAILS
	6-inches of TOPSOIL				
2120	Firm, brown, slightly moist, micaceous, clayey, silty, fine to medium SAND - (residuum)		4 6 10		Grout, 0 to 4.1 feet
5	Stiff, brown, slightly moist, slightly micaceous, fine to medium sandy SILT		3 5 4		
2115	Loose, brown, slightly moist, micaceous, slightly clayey, silty, fine to medium SAND		UD		
10			4 4 3		
2110	Firm, reddish-brown, slightly moist, micaceous, silty, fine to medium SAND		7 8 7		Bentonite seal, 4.1 to 29.3 feet
15					
2105	Firm, brown, slightly moist, slightly micaceous, silty, fine to medium SAND		8 6 5		
20					
2100	PARTIALLY WEATHERED ROCK which sampled as brown, dry, micaceous, silty, fine to coarse SAND with some gravel		13 18 50/3"	50/3"	
25					
2095	PARTIALLY WEATHERED ROCK which sampled as gray, slightly moist, micaceous, silty, fine to medium SAND		13 50/5"	50/5"	Filter pack, sand 29.3 to 66.0 feet
30					
	Auger refusal at 31.0 feet. Began rock coring.		R-1		
2090	Moderately hard to soft, moderately to very severely weathered, gray and brown, medium grained, feldspar, quartz, biotite GNEISS with very closely spaced fractures and shallow dipping, thinly spaced foliation R-1 recovery = 15%, RQD = 0% R-2 recovery = 10%, RQD = 0%				
35			R-2		
2085					

PIEZOMETER 1101-06.GPJ 2/9/15

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

PIEZOMETER NO. BLE-6

PROJECT: Macon County MSW Landfill - Phase 3 | PROJECT NO.: J13-1101-06

CLIENT: Macon County SWM Department | START: 8-26-13 END: 9-11-13

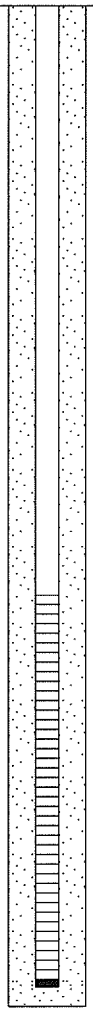
LOCATION: Franklin, North Carolina | ELEVATION: 2122.41

DRILLER: Landprobe, R. Banks | LOGGED BY: P. VanHeest

DRILLING METHOD: CME 750 ATV; 8.25-inch hollow stem auger and 3-inch NQ rock coring

DEPTH TO - WATER> INITIAL: NS AFTER 24 HOURS: 55.3 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90)	PIEZOMETER INSTALLATION DETAILS
2080 / 45	PARTIALLY WEATHERED ROCK - No recovery R-3 recovery = 0%, RQD = 0%		R-3		Filter pack, sand 29.3 to 66.0 feet
2075 / 50	Moderately hard to very soft, moderately to completely weathered, gray and brown, medium grained, feldspar, quartz, biotite GNEISS with closely spaced fractures and shallow dipping thinly spaced foliation R-4 recovery = 30%, RQD = 8%		R-4		
2070 / 55	Moderately hard to medium hard, slight to moderately severely weathered, gray and brown, medium to coarse grained, feldspar, quartz, biotite GNEISS with close to very closely spaced fractures and thinly spaced shallow dipping foliation R-5 recovery = 100%, RQD = 62%		R-5		
2065 / 60	Moderately hard, slightly to moderately severely weathered, gray and brown, medium to coarse grained, feldspar, quartz, biotite, muscovite GNEISS with closely to very closely spaced fractures and thinly spaced shallow to steeply dipping foliation. Weathered zones 60-61 feet and 65 to 66 feet. R-6 recovery = 100%, RQD = 92% R-7 recovery = 48%, RQD = 28%		R-6 R-7		2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 55.3 to 65.3 feet
2060 / 65					Pipe cap
2055 / 70	Boring terminated at 66.0 feet. Groundwater was not stable at time of drilling, but was encountered at 55.3 feet after 24 hours.				Total well depth, 65.5 feet
2050 / 75					SURFACE COMPLETION 3.02-foot PVC stick-up Top of PVC casing elev. = 2,125.43 feet Ground surface elev. = 2,122.41 feet Northing = 557,674.55' Easting = 693,571.99'
2045					



PIEZOMETER 1101-06.GPJ 2/9/15

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

PIEZOMETER NO. BLE-7

PROJECT: Macon County MSW Landfill - Phase 3 | PROJECT NO.: J13-1101-06

CLIENT: Macon County SWM Department | START: 8-23-13 END: 8-23-13

LOCATION: Franklin, North Carolina | ELEVATION: 2128.01

DRILLER: Landprobe, R. Banks | LOGGED BY: P. VanHeest

DRILLING METHOD: CME 750 ATV; 8.25-inch hollow stem auger

DEPTH TO - WATER> INITIAL: 52.3 AFTER 24 HOURS: 50.95 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SAMPLES (BLOWS/FOOT)
	6-inches of TOPSOIL	
	Firm, reddish-brown, slightly moist, slightly micaceous, clayey, silty, fine to medium SAND - (residuum)	4 5 6
2125		
	Stiff, reddish-brown, slightly moist, micaceous, clayey, fine to medium sandy SILT	5 5 6
5		
	Loose, brown, slightly moist, slightly micaceous, clayey, silty, fine to medium SAND	2 3 6
2120		
	Stiff, brown, slightly moist, micaceous, clayey, fine to medium sandy SILT	3 4 5
10		
	Firm, brown, slightly moist, micaceous, silty, fine to medium SAND	
2115		7 8 9
15		
2110		8 7 11
20		
	Firm, purplish-brown, slightly moist, micaceous, silty, fine to medium SAND	
2105		7 9 9
25		
	Very firm, brown, dry, micaceous, silty, fine to medium SAND	
2100		7 10 11
30		
2095		5 9 12
35		
	Dense, brown, slightly moist, very micaceous, silty, fine to medium SAND	
2090		9 16 23

STANDARD PENETRATION RESULTS BLOWS/FOOT: 2 5 10 20 30 40 50 70 90

PIEZOMETER INSTALLATION DETAILS:

Grout, 0 to 3.9 feet

Bentonite seal, 3.9 to 44.3 feet

PIEZOMETER 1101-06.GPJ 2/9/15

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

PIEZOMETER NO. BLE-7

PROJECT: Macon County MSW Landfill - Phase 3 | PROJECT NO.: J13-1101-06

CLIENT: Macon County SWM Department | START: 8-23-13 END: 8-23-13

LOCATION: Franklin, North Carolina | ELEVATION: 2128.01

DRILLER: Landprobe, R. Banks | LOGGED BY: P. VanHeest

DRILLING METHOD: CME 750 ATV; 8.25-inch hollow stem auger

DEPTH TO - WATER> INITIAL: 52.3 AFTER 24 HOURS: 50.95 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90)	PIEZOMETER INSTALLATION DETAILS
2085 / 45	Dense, brown, slightly moist, very micaceous, silty, fine to medium SAND		20 21 19		Bentonite seal, 3.9 to 44.3 feet Filter pack, sand 44.3 to 59.0 feet
2080 / 50	PARTIALLY WEATHERED ROCK which sampled as reddish-brown, slightly moist, slightly micaceous, silty, fine to coarse SAND with black, angular gravel		8 7 50/4"	50/4"	
2075 / 55	PARTIALLY WEATHERED ROCK which sampled as reddish-brown, slightly moist, slightly micaceous, silty, fine SAND transitioning to dark gray, moist, very micaceous, silty, fine to coarse SAND		18 50/5"	50/5"	2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 48.7 to 58.7 feet
2070 / 60	Auger refusal at 59.0 feet. Groundwater encountered at 52.3 feet at time of drilling and at 50.95 feet after 24 hours.				Pipe cap Total well depth, 58.9 feet
2065 / 65					SURFACE COMPLETION 3.10-foot PVC stick-up Top of PVC casing elev. = 2,131.11 feet Ground surface elev. = 2,128.01 feet Northing = 557,464.27' Easting = 693,888.05'
2060 / 70					
2055 / 75					
2050					

PIEZOMETER 1101-06.GPJ 2/9/15

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

PIEZOMETER NO. BLE-8

PROJECT: Macon County MSW Landfill - Phase 3 | PROJECT NO.: J13-1101-06

CLIENT: Macon County SWM Department | START: 8-28-13 END: 9-13-13

LOCATION: Franklin, North Carolina | ELEVATION: 2083.89

DRILLER: Landprobe, R. Banks | LOGGED BY: B. Nisbeth

DRILLING METHOD: CME 750 ATV; 8.25-inch hollow stem auger and 3-inch NQ rock coring

DEPTH TO - WATER> INITIAL: NS AFTER 24 HOURS: 35.6 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90)	PIEZOMETER INSTALLATION DETAILS
	6-inches of TOPSOIL				
	Hard, dark brown, slightly moist, micaceous, clayey, fine to medium sandy SILT with rock fragments - (residuum)		7 15 18		Grout, 0 to 4.4 feet
2080 / 5	Very firm to dense, reddish-brown, slightly moist, micaceous, silty, fine to medium SAND		10 10 17		
			12 12 21		
2075 / 10			9 14 15		
2070 / 15	PARTIALLY WEATHERED ROCK which sampled as light brown, slightly moist, slightly micaceous, silty, fine to medium SAND with angular gravel		50/4"	50/4"	Bentonite seal, 4.4 to 32.1 feet
2065 / 20	Dense, reddish-brown, micaceous, silty, fine to medium SAND with some rock fragments		15 23 25		
2060 / 25	Dense, brown, slightly moist, micaceous, silty, fine to medium SAND with some angular gravel		18 17 26		
2055 / 30			21 19 12		
2050 / 35	Auger refusal at 33.0 feet. Began rock coring.		R-1		Filter pack, sand 32.1 to 56.0 feet
	Medium hardness, moderately weathered, brown, medium grained, feldspar, quartz, biotite GNEISS with closely spaced fractures and thinly spaced shallow dipping foliation R-1 recovery = 75%, RQD = 20%		R-2		
2045	Moderately hard, slightly weathered, gray, medium to				

PIEZOMETER 1101-06.GPJ 2/9/15

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

PIEZOMETER NO. BLE-8

PROJECT: Macon County MSW Landfill - Phase 3 | PROJECT NO.: J13-1101-06

CLIENT: Macon County SWM Department | START: 8-28-13 END: 9-13-13

LOCATION: Franklin, North Carolina | ELEVATION: 2083.89

DRILLER: Landprobe, R. Banks | LOGGED BY: B. Nisbeth

DRILLING METHOD: CME 750 ATV; 8.25-inch hollow stem auger and 3-inch NQ rock coring

DEPTH TO - WATER> INITIAL: NS AFTER 24 HOURS: 35.6 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90)	PIEZOMETER INSTALLATION DETAILS
2040 / 45	coarse grained, feldspar, quartz, biotite GNEISS with closely spaced fractures and thinly spaced shallow dipping foliation R-2 recovery = 90%, RQD = 70% R-3 recovery = 90%, RQD = 90% R-4 recovery = 100%, RQD = 80% R-5 recovery = 70%, RQD = 70%		R-3		Filter pack, sand 32.1 to 56.0 feet
2035 / 50			R-4		2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 42.3 to 52.3 feet
2030 / 55			R-5		Pipe cap Total well depth, 52.50 feet SURFACE COMPLETION 3.08-foot PVC stick-up Top of PVC casing elev. = 2,086.97 feet
2025 / 60	Boring terminated at 56.0 feet. Groundwater level was not stable at time of drilling, but was encountered at 35.6 feet after 24 hours.				Ground surface elev. = 2,083.89 feet Northing = 557,233.65' Easting = 693,541.51'
2020 / 65					
2015 / 70					
2010 / 75					
2005					

PIEZOMETER 1101-06.GPJ 2/9/15

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

PIEZOMETER NO. BLE-9

PROJECT: Macon County MSW Landfill - Phase 3 | PROJECT NO.: J13-1101-06

CLIENT: Macon County SWM Department | START: 8-28-13 END: 8-28-13

LOCATION: Franklin, North Carolina | ELEVATION: 2065.65

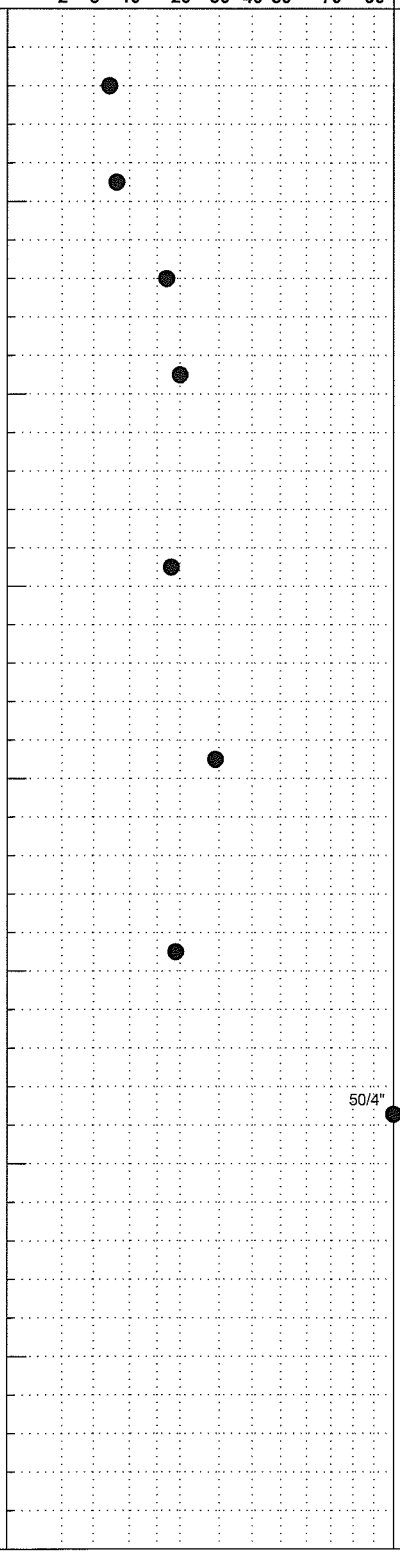
DRILLER: Landprobe, R. Banks | LOGGED BY: B. Nisbeth

DRILLING METHOD: CME 750 ATV; 8.25-inch hollow stem auger

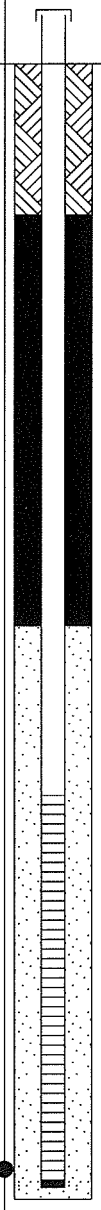
DEPTH TO - WATER> INITIAL: 27.8 AFTER 24 HOURS: 22.27 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SAMPLES (BLOWS/FOOT)
2065	6-inches of TOPSOIL	
	Firm, dark brown, slightly moist, slightly micaceous, clayey, fine to medium sandy SILT - (residuum)	3, 3, 4
	Loose, reddish-brown, slightly moist, micaceous, silty, fine to medium SAND	3, 4, 4
2060 (5)	Firm, brown, slightly moist, micaceous, silty, fine to medium SAND	6, 7, 10
		6, 9, 11
2055 (10)		
		4, 6, 12
2050 (15)		
	Very firm, brown, slightly moist, micaceous, silty, fine SAND	9, 13, 16
2045 (20)		
	Very stiff, reddish-brown, slightly moist, micaceous, fine to medium sandy SILT	7, 7, 12
2040 (25)		
	PARTIALLY WEATHERED ROCK which sampled as grayish-brown, slightly moist, micaceous, silty, fine to medium SAND with some gravel	50/4"
2035 (30)	Auger refusal at 29.5 feet. Groundwater encountered at 27.8 feet at time of drilling and at 22.27 feet after 24 hours.	
2030 (35)		

STANDARD PENETRATION RESULTS BLOWS/FOOT



PIEZOMETER INSTALLATION DETAILS



Grout, 0 to 3.9 feet

Bentonite seal, 3.9 to 14.6 feet

Filter pack, sand 14.6 to 29.5 feet

2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 19.0 to 29.0 feet

Pipe cap

Total well depth, 29.2 feet

SURFACE COMPLETION
3.11-foot PVC stick-up

Top of PVC casing elev. = 2,068.76 feet

Ground surface elev. = 2,065.65 feet

Northing = 557,376.37'

Easting = 693,411.58'

PIEZOMETER 1101-06.GPJ 2/9/15

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

SOIL TEST BORING NO. BLE-10

PROJECT: Macon County MSW Landfill - Phase 3 | PROJECT NO.: J13-1101-06

CLIENT: Macon County SWM Department | START: 9-4-13 END: 9-4-13

LOCATION: Franklin, North Carolina | ELEVATION: 2125.43

DRILLER: Landprobe, R. Banks | LOGGED BY: P. VanHeest

DRILLING METHOD: CME 750 ATV; 8.25-inch hollow stem auger

DEPTH TO - WATER> INITIAL: dry AFTER 24 HOURS: dry CAVING>

ELEVATION/ DEPTH (FT)	SOIL DESCRIPTION	SAMPLES	STANDARD PENETRATION RESULTS BLOWS/FOOT
2125	6-inches of TOPSOIL		
	Loose, brown, slightly moist, micaceous, silty, fine to medium SAND - (residuum)	4, 4, 5	
	Firm, brown, slightly moist, micaceous, silty, fine to medium SAND	7, 6, 5	
2120 (5)		9, 9, 11	
		9, 8, 9	
2115 (10)			
	PARTIALLY WEATHERED ROCK which sampled as light brown, slightly moist, micaceous, fine to coarse SAND	16, 23, 50/4"	50/4"
2110 (15)			
	Very firm, brown, slightly moist, very micaceous, silty, fine to medium SAND	12, 12, 12	
2105 (20)			
	Very firm to firm, light brown, slightly moist, micaceous, silty, fine to medium SAND	9, 14, 15	
2100 (25)			
		10, 11, 9	
2095 (30)			
	Dense, light brown, slightly moist, micaceous, silty, fine to medium SAND	12, 18, 27	
2090 (35)			
	Very firm, brown, slightly moist, micaceous, silty, fine to medium SAND	10, 10, 12	

GEOT_NOWELL 1101-06.GPJ 2/9/15

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

SOIL TEST BORING NO. BLE-10

PROJECT: Macon County MSW Landfill - Phase 3 | PROJECT NO.: J13-1101-06

CLIENT: Macon County SWM Department | START: 9-4-13 END: 9-4-13

LOCATION: Franklin, North Carolina | ELEVATION: 2125.43

DRILLER: Landprobe, R. Banks | LOGGED BY: P. VanHeest

DRILLING METHOD: CME 750 ATV; 8.25-inch hollow stem auger

DEPTH TO - WATER> INITIAL: dry AFTER 24 HOURS: dry CAVING>

ELEVATION/ DEPTH (FT)	SOIL DESCRIPTION	SOIL TYPE	SAMPLES	STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90)
2085	Very firm, brown, slightly moist, micaceous, silty, fine to medium SAND			
	PARTIALLY WEATHERED ROCK		50/1"	50/1"
2080 / 45				
	Auger refusal at 45.5 feet. No groundwater encountered at time of drilling. Ground surface elev. = 2,125.43 feet, Northing = 557,247.94', Easting = 694,053.25'.			
2075 / 50				
2070 / 55				
2065 / 60				
2060 / 65				
2055 / 70				
2050 / 75				

GEOT_NOWELL 1101-06.GPJ 2/9/15

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

PIEZOMETER NO. BLE-11

PROJECT: Macon County MSW Landfill - Phase 3 | PROJECT NO.: J13-1101-06

CLIENT: Macon County SWM Department | START: 8-22-13 END: 8-22-13

LOCATION: Franklin, North Carolina | ELEVATION: 2158.69

DRILLER: Landprobe, R. Banks | LOGGED BY: P. VanHeest

DRILLING METHOD: CME 750 ATV; 8.25-inch hollow stem auger

DEPTH TO - WATER> INITIAL: 73.60 AFTER 24 HOURS: 73.4 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90)
	6-inches of TOPSOIL			
	Stiff, pinkish-brown, slightly moist, micaceous, silty, fine to medium sandy CLAY - (residuum)		UD	
2155 / 5	Firm, pinkish-brown, slightly moist, micaceous, silty, fine to medium SAND		6 7 7	
			UD	
2150 / 10			6 6 7	
2145 / 15			7 5 6	
	Dense, brown, slightly moist, micaceous, silty, fine to medium SAND			
2140 / 20			15 17 19	
2135 / 25			13 21 23	
	Firm, brown, slightly moist, micaceous, silty, fine to medium SAND			
2130 / 30			6 7 9	
2125 / 35			7 7 10	
	Very firm, brown, slightly moist, micaceous, silty, fine to medium SAND			
2120			12 16 10	

PIEZOMETER INSTALLATION DETAILS

SURFACE COMPLETION

Grout, 0 to 4.1 feet

Bentonite seal, 4.1 to 62.3 feet

PIEZOMETER 1101-06.GPJ 2/9/15

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

PIEZOMETER NO. BLE-11

PROJECT: Macon County MSW Landfill - Phase 3 | PROJECT NO.: J13-1101-06

CLIENT: Macon County SWM Department | START: 8-22-13 END: 8-22-13

LOCATION: Franklin, North Carolina | ELEVATION: 2158.69

DRILLER: Landprobe, R. Banks | LOGGED BY: P. VanHeest

DRILLING METHOD: CME 750 ATV; 8.25-inch hollow stem auger

DEPTH TO - WATER> INITIAL: 73.60 AFTER 24 HOURS: 73.4 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SAMPLES	STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90)
	Very firm, brown, slightly moist, micaceous, silty, fine to medium SAND		
2115 / 45	Dense, light brown, slightly moist, micaceous, silty, fine to medium SAND		14 16 20
2110 / 50	PARTIALLY WEATHERED ROCK which sampled as brown, slightly moist, micaceous, silty, fine to medium SAND		30 50/3"
2105 / 55	Very dense, brown, slightly moist, micaceous, silty, fine to medium SAND		22 26 33
2100 / 60	PARTIALLY WEATHERED ROCK which sampled as brown, slightly moist, micaceous, silty, fine to medium SAND		50/3"
2095 / 65	PARTIALLY WEATHERED ROCK which sampled as brown, slightly moist, micaceous, silty, fine to medium SAND transitioning to dark gray, very micaceous, silty, fine to medium SAND		20 50/3"
2090 / 70	PARTIALLY WEATHERED ROCK which sampled as light brown, slightly moist, micaceous, silty, fine to medium SAND		50/3"
2085 / 75			50/1"
2080	Auger refusal at 77.5 feet. Groundwater encountered at 73.60 feet at time of drilling and at		

PIEZOMETER INSTALLATION DETAILS

- Bentonite seal, 4.1 to 62.3 feet
- Filter pack, sand 62.3 to 77.5 feet
- 2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 66.7 to 76.7 feet
- Pipe cap
- Total well depth, 76.90 feet

PIEZOMETER 1101-06.GPJ 2/9/15

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

PIEZOMETER NO. BLE-11

PROJECT: Macon County MSW Landfill - Phase 3 | PROJECT NO.: J13-1101-06

CLIENT: Macon County SWM Department | START: 8-22-13 END: 8-22-13

LOCATION: Franklin, North Carolina | ELEVATION: 2158.69

DRILLER: Landprobe, R. Banks | LOGGED BY: P. VanHeest

DRILLING METHOD: CME 750 ATV; 8.25-inch hollow stem auger

DEPTH TO - WATER> INITIAL: 73.60 AFTER 24 HOURS: 73.4 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90)	PIEZOMETER INSTALLATION DETAILS
	73.4 feet after 24 hours.				SURFACE COMPLETION 3.11-foot PVC stick-up Top of PVC casing elev. = 2,161.80 feet Ground surface elev. = 2,158.69 feet Northing = 557,575.33' Easting = 694,139.17'
2075 / 85					
2070 / 90					
2065 / 95					
2060 / 100					
2055 / 105					
2050 / 110					
2045 / 115					
2040					

PIEZOMETER 1101-06.GPJ 2/9/15

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

PIEZOMETER NO. BLE-12

PROJECT: Macon County MSW Landfill - Phase 3 | PROJECT NO.: J13-1101-06

CLIENT: Macon County SWM Department | START: 8-29-13 END: 9-19-13

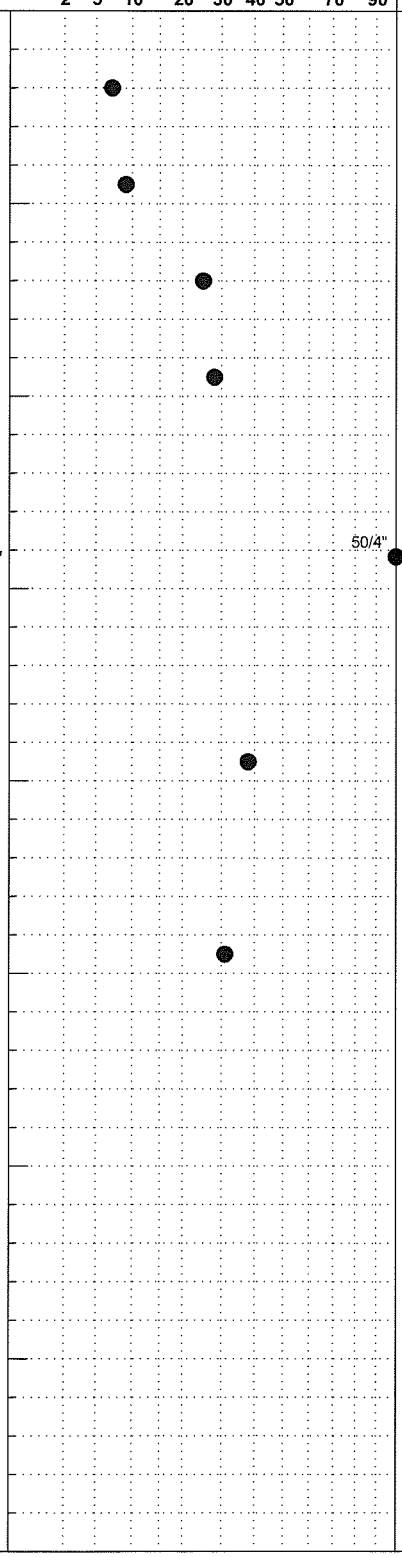
LOCATION: Franklin, North Carolina | ELEVATION: 2109.23

DRILLER: Landprobe, R. Banks | LOGGED BY: B. Nisbeth

DRILLING METHOD: CME 750 ATV; 8.25-inch hollow stem auger and 3-inch NQ rock coring

DEPTH TO - WATER> INITIAL: NS AFTER 24 HOURS: 41.5 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SAMPLES	STANDARD PENETRATION RESULTS BLOWS/FOOT
	6-inches of TOPSOIL		
	Firm to stiff, reddish-brown, slightly moist, micaceous, clayey, fine to medium sandy SILT - (residuum)		3, 3, 4
2105 / 5			4, 4, 5
	Very firm, light brown, slightly moist, micaceous, silty, fine to medium SAND		12, 12, 13
2100 / 10			11, 13, 15
2095 / 15	PARTIALLY WEATHERED ROCK which sampled as light brown, slightly moist, slightly micaceous, silty, fine to coarse SAND and some gravel		20, 50/4"
	Dense, brown, slightly moist, micaceous, silty, fine to medium SAND		12, 20, 18
2090 / 20			
2085 / 25			11, 14, 17
	Auger refusal at 26.5 feet. Began rock coring.		R-1
2080 / 30	Gray, moderately hard, slightly weathered, medium grained, feldspar, quartz, biotite GNEISS with closely spaced fractures and thinly spaced shallow dipping foliation R-1 recovery = 80%, RQD = 26% R-2 recovery = 30%, RQD = 8% R-3 recovery = 60%, RQD = 36% R-4 recovery = 80%, RQD = 60% R-5 recovery = 100%, RQD = 50%		R-2
2075 / 35			R-3
2070			



PIEZOMETER INSTALLATION DETAILS

Grout, 0 to 4.5 feet

Bentonite seal, 4.5 to 34.4 feet

Filter pack, sand 34.4 to 51.5 feet

PIEZOMETER 1101-06.GPJ 2/9/15

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

PIEZOMETER NO. BLE-12

PROJECT: Macon County MSW Landfill - Phase 3 | PROJECT NO.: J13-1101-06

CLIENT: Macon County SWM Department | START: 8-29-13 END: 9-19-13

LOCATION: Franklin, North Carolina | ELEVATION: 2109.23

DRILLER: Landprobe, R. Banks | LOGGED BY: B. Nisbeth

DRILLING METHOD: CME 750 ATV; 8.25-inch hollow stem auger and 3-inch NQ rock coring

DEPTH TO - WATER> INITIAL: NS AFTER 24 HOURS: 41.5 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90)	PIEZOMETER INSTALLATION DETAILS
2065 / 45	Gray, moderately hard, slightly weathered, medium grained, feldspar, quartz, biotite GNEISS with closely spaced fractures and thinly spaced shallow dipping foliation R-1 recovery = 80%, RQD = 26% R-2 recovery = 30%, RQD = 8% R-3 recovery = 60%, RQD = 36% R-4 recovery = 80%, RQD = 60% R-5 recovery = 100%, RQD = 50%		R-4		2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 39.3 to 49.3 feet
2060 / 50			R-5		Pipe cap Total well depth, 49.5 feet SURFACE COMPLETION 3.02-foot PVC stick-up
2055 / 55	Boring terminated at 51.5 feet. Groundwater level was not stable at time of drilling, but was encountered at 41.5 feet after 24 hours.				Top of PVC casing elev. = 2,112.25 feet Ground surface elev. = 2,109.23 feet Northing = 557,377.54' Easting = 694,294.85'
2050 / 60					
2045 / 65					
2040 / 70					
2035 / 75					
2030					

PIEZOMETER 1101-06.GPJ 2/9/15

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

PIEZOMETER NO. BLE-13

PROJECT: Macon County MSW Landfill - Phase 3 | PROJECT NO.: J13-1101-06

CLIENT: Macon County SWM Department | START: 8-20-13 END: 8-20-13

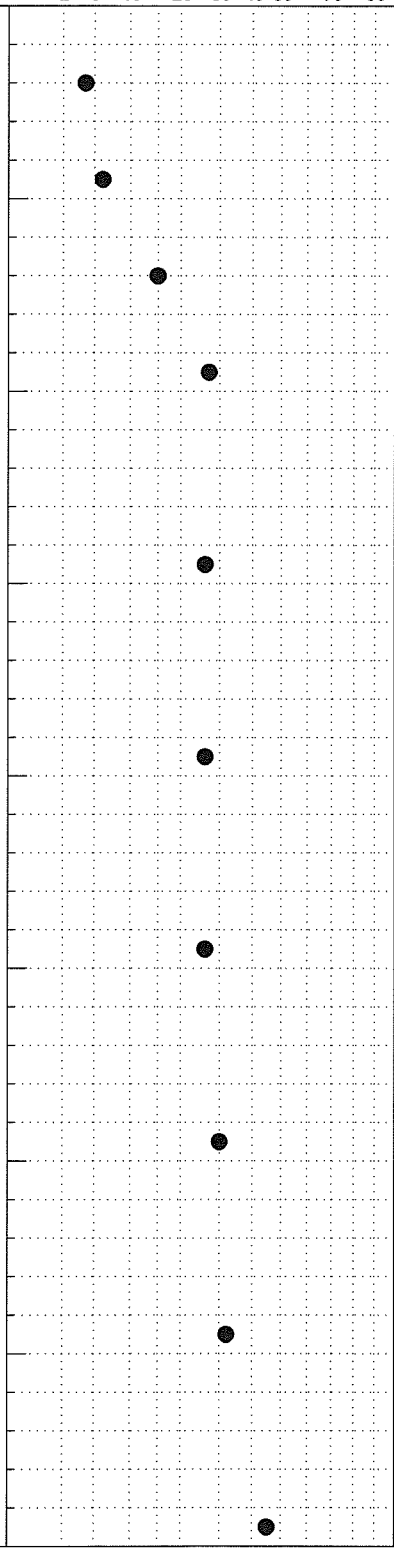
LOCATION: Franklin, North Carolina | ELEVATION: 2116.38

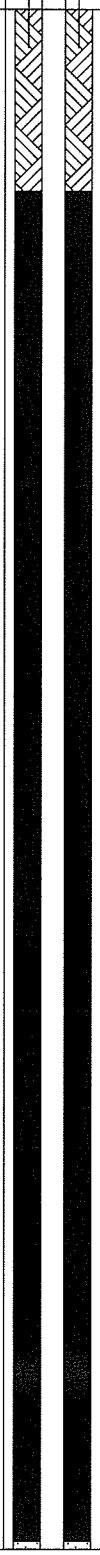
DRILLER: Landprobe, R. Banks | LOGGED BY: P. VanHeest

DRILLING METHOD: CME 750 ATV; 8.25-inch hollow stem auger

DEPTH TO - WATER> INITIAL: 46.05 AFTER 24 HOURS: 43.4 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SAMPLES (STANDARD PENETRATION RESULTS BLOWS/FOOT)
	6-inches of TOPSOIL	
2115	Soft, brown, slightly moist, slightly micaceous, sandy, clayey SILT - (residuum)	2, 2, 2
	Firm, brown, slightly moist, slightly micaceuos, sandy, clayey SILT	2, 3, 3
5		
2110	Stiff, brown, slightly moist, slightly micaceous, fine to coarse sandy, clayey SILT	3, 7, 8
	Very stiff, brown, slightly moist, micaceous, fine to medium sandy SILT	6, 9, 18
10		
2105	Very firm, light brown, slightly moist, micaceous, silty, fine to medium SAND	12, 12, 14
15		
2100	Very firm, light brown, moist, micaceous, silty, fine to medium SAND	9, 14, 12
20		
2095	Very firm to dense, brown, moist, micaceous, silty, fine to medium SAND	11, 11, 15
25		
2090		12, 11, 19
30		
2085	Dense, brown, slightly moist, very micaceous, silty, fine to medium SAND	10, 14, 18
35		
2080	Dense, brown, moist, very micaceous, silty, fine to medium SAND	20, 23, 22





PIEZOMETER INSTALLATION DETAILS

Grout, 0 to 4.7 feet

Bentonite seal, 4.7 to 39.8 feet

PIEZOMETER 1101-06.GPJ 2/9/15

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

PIEZOMETER NO. BLE-13

PROJECT: Macon County MSW Landfill - Phase 3 | PROJECT NO.: J13-1101-06

CLIENT: Macon County SWM Department | START: 8-20-13 END: 8-20-13

LOCATION: Franklin, North Carolina | ELEVATION: 2116.38

DRILLER: Landprobe, R. Banks | LOGGED BY: P. VanHeest

DRILLING METHOD: CME 750 ATV; 8.25-inch hollow stem auger

DEPTH TO - WATER> INITIAL: 46.05 AFTER 24 HOURS: 43.4 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90)	PIEZOMETER INSTALLATION DETAILS
2075	Dense, brown, moist, very micaceous, silty, fine to medium SAND				Filter pack, sand 39.8 to 55.0 feet
			9 14 25		
45					
2070	PARTIALLY WEATHERED ROCK which sampled as brown, slightly moist, very micaceous, silty, fine to medium SAND				2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 44.7 to 54.7 feet
			16 15 50/4"	50/4"	
50					
2065			50/5"	50/5"	
55					Pipe cap
2060	Auger refusal at 55.0 feet. Groundwater encountered at 46.05 feet at time of drilling and at 43.40 feet after 24 hours.				Total well depth, 54.9 feet
					SURFACE COMPLETION 3.12-foot PVC stick-up
					Top of PVC casing elev. = 2,119.50 feet
60					
2055					Ground surface elev. = 2,116.38 feet
					Northing = 557,652.86'
					Easting = 694,424.14'
65					
2050					
70					
2045					
75					
2040					

PIEZOMETER 1101-06.GPJ 2/9/15

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

PIEZOMETER NO. BLE-14

PROJECT: Macon County MSW Landfill - Phase 3 | PROJECT NO.: J13-1101-06

CLIENT: Macon County SWM Department | START: 9-4-13 END: 9-4-13

LOCATION: Franklin, North Carolina | ELEVATION: 2146.02

DRILLER: Landprobe, R. Banks | LOGGED BY: P. VanHeest

DRILLING METHOD: CME 750 ATV; 8.25-inch hollow stem auger

DEPTH TO - WATER> INITIAL: 66.7 AFTER 24 HOURS: 61.4 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90)
	6-inches of TOPSOIL			
2145	Loose, light brown, slightly moist, slightly micaceous, silty, fine to medium SAND - (residuum)			3 3 5
				4 4 4
5				
2140				3 4 5
				5 4 5
10				
2135	Stiff, reddish-brown, slightly moist, slightly micaceous, clayey, fine sandy SILT			3 3 7
15				
2130	Very stiff, reddish-brown, slightly moist, micaceous, clayey, fine sandy SILT			4 7 9
20				
2125	Loose, brown, slightly moist, micaceous, slightly clayey, silty, fine to medium SAND			4 4 6
25				
2120				UD
30				
2115				3 3 6
35				
2110				4 5 5

PIEZOMETER INSTALLATION DETAILS

Grout, 0 to 4.3 feet

Bentonite seal, 4.3 to 72.6 feet

PIEZOMETER 1101-06.GPJ 2/9/15

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

PIEZOMETER NO. BLE-14

PROJECT: Macon County MSW Landfill - Phase 3 | PROJECT NO.: J13-1101-06

CLIENT: Macon County SWM Department | START: 9-4-13 END: 9-4-13

LOCATION: Franklin, North Carolina | ELEVATION: 2146.02

DRILLER: Landprobe, R. Banks | LOGGED BY: P. VanHeest

DRILLING METHOD: CME 750 ATV; 8.25-inch hollow stem auger

DEPTH TO - WATER> INITIAL: 66.7 AFTER 24 HOURS: 61.4 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SAMPLES	STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90)
2105	Loose, brown, slightly moist, micaceous, slightly clayey, silty, fine to medium SAND		
	Very firm, brown, slightly moist, slightly micaceous, clayey, silty, fine SAND		
			9 11 13
45			
2100			
			15 12 10
50			
2095			
			6 10 13
55			
2090			
	Very firm, brown, slightly moist, micaceous, silty, fine to medium SAND		
			8 11 17
60			
2085			
	Hard, brown, slightly moist, micaceous, fine sandy SILT		
			14 16 24
65			
2080			
	PARTIALLY WEATHERED ROCK which sampled as brown, slightly moist, micaceous, silty, fine to medium SAND		
			20 23 50/5" (50/5")
70			
2075			
	Dense to very dense, brown, slightly moist, micaceous, silty, fine to medium SAND		
			19 24 26
75			
2070			
			14 27 25

PIEZOMETER INSTALLATION DETAILS

Bentonite seal, 4.3 to 72.6 feet

Filter pack, sand 72.6 to 90.0 feet

PIEZOMETER 1101-06.GPJ 2/9/15

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

PIEZOMETER NO. BLE-14

PROJECT: Macon County MSW Landfill - Phase 3 | PROJECT NO.: J13-1101-06

CLIENT: Macon County SWM Department | START: 9-4-13 END: 9-4-13

LOCATION: Franklin, North Carolina | ELEVATION: 2146.02

DRILLER: Landprobe, R. Banks | LOGGED BY: P. VanHeest

DRILLING METHOD: CME 750 ATV; 8.25-inch hollow stem auger

DEPTH TO - WATER> INITIAL: 66.7 AFTER 24 HOURS: 61.4 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90)	PIEZOMETER INSTALLATION DETAILS
2065					Filter pack, sand 72.6 to 90.0 feet
	PARTIALLY WEATHERED ROCK which sampled as grayish-brown, micaceous, moist, silty, fine to medium SAND		22 50/4"	50/4"	2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 77.0 to 87.0 feet
85					
2060					Pipe cap
			50/5"	50/5"	Total well depth, 87.2 feet
90					SURFACE COMPLETION 2.57-foot PVC stick-up
2055	Boring terminated at 90.0 feet. Groundwater encountered at 66.7 feet at time of drilling and at 61.4 feet after 24 hours.				Top of PVC casing elev. = 2,148.59 feet
					Ground surface elev. = 2,146.02 feet
95					Northing = 557,393.99'
2050					Easting = 694,599.83'
100					
2045					
105					
2040					
110					
2035					
115					
2030					

PIEZOMETER 1101-06.GPJ 2/9/15

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

PIEZOMETER NO. BLE-15

PROJECT: Macon County MSW Landfill - Phase 3 | PROJECT NO.: J13-1101-06

CLIENT: Macon County SWM Department | START: 8-19-13 END: 8-19-13

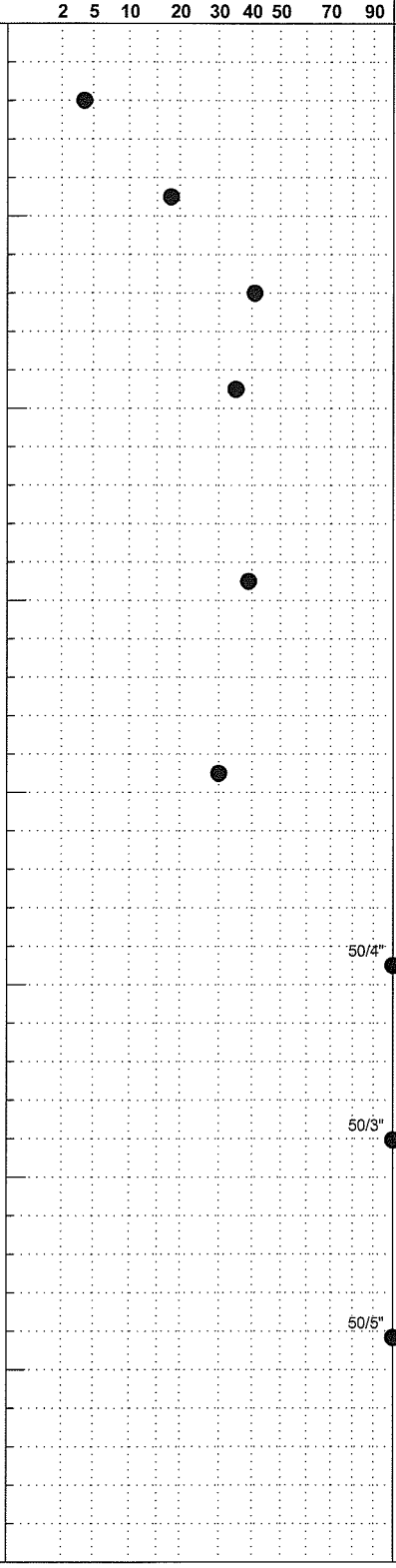
LOCATION: Franklin, North Carolina | ELEVATION: 2100.28

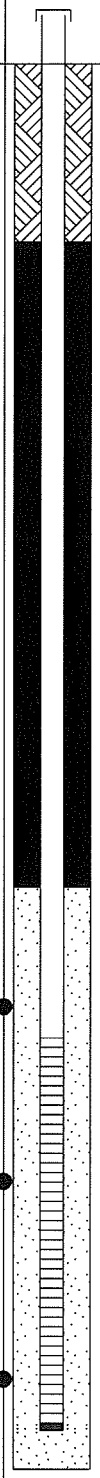
DRILLER: Landprobe, R. Banks | LOGGED BY: P. VanHeest

DRILLING METHOD: CME 750 ATV; 8.25-inch hollow stem auger

DEPTH TO - WATER> INITIAL: 29.00 AFTER 24 HOURS: 22.95 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SAMPLES (BLOWS/FOOT)
2100	6-inches of TOPSOIL	
	Soft, brown, slightly moist, slightly micaceous, fine to medium sandy, silty CLAY - (residuum)	2, 2, 2, UD
	Firm, brown, slightly moist, slightly micaceous, silty, clayey, fine to medium SAND	5, 8, 10
2095 (5)	Dense, brown, slightly moist, slightly micaceous, clayey, silty, fine to medium SAND	11, 20, 21
	Dense, brown, slightly moist, micaceous, silty, fine to coarse SAND	14, 16, 19
2090 (10)	Dense, brown, slightly moist, slightly micaceous, silty, fine to medium SAND with some gravel	15, 18, 21
2085 (15)	Very firm, gray, slightly moist, micaceous, silty, fine to coarse SAND	9, 15, 15
2080 (20)	PARTIALLY WEATHERED ROCK which sampled as brown, slightly moist, micaceous, silty, fine to medium SAND	24, 25, 50/4"
2075 (25)	PARTIALLY WEATHERED ROCK which sampled as brown, wet, micaceous, clayey, silty, fine to coarse SAND	16, 50/3"
2070 (30)		17, 50/5"
2065 (35)	Auger refusal at 36.5 feet. Groundwater encountered at 29.0 feet at time of drilling and at 22.95 feet after 24 hours. UD sample	





PIEZOMETER INSTALLATION DETAILS

Grout, 0 to 4.6 feet

Bentonite seal, 4.6 to 21.4 feet

Filter pack, sand 21.4 to 36.5 feet

2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 25.3 to 35.3 feet

Pipe cap

Total well depth, 35.5 feet

SURFACE COMPLETION
3.24-foot PVC stick-up

PIEZOMETER 1101-06.GPJ 2/9/15

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

PIEZOMETER NO. BLE-15

PROJECT: Macon County MSW Landfill - Phase 3 | PROJECT NO.: J13-1101-06

CLIENT: Macon County SWM Department | START: 8-19-13 END: 8-19-13

LOCATION: Franklin, North Carolina | ELEVATION: 2100.28

DRILLER: Landprobe, R. Banks | LOGGED BY: P. VanHeest

DRILLING METHOD: CME 750 ATV; 8.25-inch hollow stem auger

DEPTH TO - WATER> INITIAL: 29.00 AFTER 24 HOURS: 22.95 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90)	PIEZOMETER INSTALLATION DETAILS
2060	collected from 2 to 4 feet depth in offset boring.				Top of PVC casing elev. = 2,103.52 feet Ground surface elev. = 2,100.28 feet Northing = 557,095.96' Easting = 694,432.06'
2055 (45)					
2050 (50)					
2045 (55)					
2040 (60)					
2035 (65)					
2030 (70)					
2025 (75)					

PIEZOMETER 1101-06.GPJ 2/9/15

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

PIEZOMETER NO. BLE-16

PROJECT: Macon County MSW Landfill - Phase 3 | PROJECT NO.: J13-1101-06

CLIENT: Macon County SWM Department | START: 9-4-13 END: 9-4-13

LOCATION: Franklin, North Carolina | ELEVATION: 2091.57

DRILLER: Landprobe, R. Banks | LOGGED BY: P. VanHeest

DRILLING METHOD: CME 750 ATV; 8.25-inch hollow stem auger

DEPTH TO - WATER> INITIAL: 30.1 AFTER 24 HOURS: 31.4 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SAMPLES (BLOWS/FOOT)
	6-inches of TOPSOIL	
2090	Firm, brown, slightly moist, slightly micaceous, silty, fine to medium SAND - (residuum)	7, 9, 11
	Very firm, brown, slightly moist, micaceous, clayey, silty, fine to medium SAND	9, 10, 12
5		
2085	Firm, light brown, slightly moist, micaceous, silty, fine to medium SAND	3, 5, 7
	Firm, brown, slightly moist, micaceous, silty, fine to coarse SAND	5, 5, 6
10		
2080	Very firm, brown, slightly moist, micaceous, silty, fine to medium SAND	12, 13, 16
15		
2075	Very firm, brown, slightly moist, very micaceous, silty, fine to medium SAND	9, 8, 13
20		
2070	Firm to very firm, brown, slightly moist, micaceous, silty, fine to medium SAND	7, 9, 9
25		
2065		9, 13, 15
30		
2060	Very dense, brown, moist, very micaceous, silty, fine to medium SAND	9, 24, 27
35		
2055	Auger refusal at 36.0 feet. Groundwater encountered at 30.1 feet at time of drilling and at 31.4 feet after 24 hours.	

STANDARD PENETRATION RESULTS BLOWS/FOOT: 2 5 10 20 30 40 50 70 90

PIEZOMETER INSTALLATION DETAILS

- Grout, 0 to 4.2 feet
- Bentonite seal, 4.2 to 20.8 feet
- Filter pack, sand 20.8 to 36.0 feet
- 2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 25.35 to 35.35 feet
- Pipe cap

Total well depth, 35.55 feet

SURFACE COMPLETION

3.10-foot PVC stick-up

PIEZOMETER 1101-06.GPJ 2/9/15

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

PIEZOMETER NO. BLE-16

PROJECT: Macon County MSW Landfill - Phase 3 | PROJECT NO.: J13-1101-06

CLIENT: Macon County SWM Department | START: 9-4-13 END: 9-4-13

LOCATION: Franklin, North Carolina | ELEVATION: 2091.57

DRILLER: Landprobe, R. Banks | LOGGED BY: P. VanHeest

DRILLING METHOD: CME 750 ATV; 8.25-inch hollow stem auger

DEPTH TO - WATER> INITIAL: 30.1 AFTER 24 HOURS: 31.4 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90)	PIEZOMETER INSTALLATION DETAILS
2050					Top of PVC casing elev. = 2,094.67 feet Ground surface elev. = 2,091.57 feet Northing = 556,836.77' Easting = 694,273.66'
45					
2045					
50					
2040					
55					
2035					
60					
2030					
65					
2025					
70					
2020					
75					
2015					

PIEZOMETER 1101-06.GPJ 2/9/15

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

PIEZOMETER NO. BLE-17

PROJECT: Macon County MSW Landfill - Phase 3 | PROJECT NO.: J13-1101-06

CLIENT: Macon County SWM Department | START: 9-5-13 END: 9-17-13

LOCATION: Franklin, North Carolina | ELEVATION: 2057.62

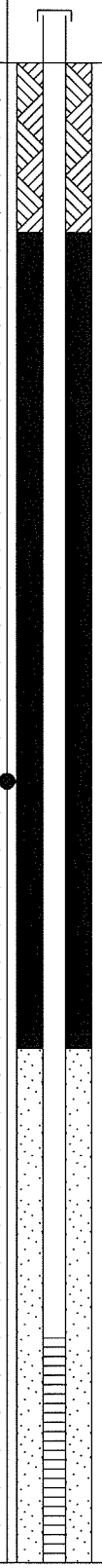
DRILLER: Landprobe, R. Banks | LOGGED BY: P. VanHeest

DRILLING METHOD: CME 750 ATV; 8.25-inch hollow stem auger and 3-inch NQ rock coring

DEPTH TO - WATER> INITIAL: NS AFTER 24 HOURS: 23.1 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SAMPLES	STANDARD PENETRATION RESULTS BLOWS/FOOT
	6-inches of TOPSOIL		
2055	Very loose, brown, slightly moist, micaceous, silty, fine to medium SAND - (residuum)		3 3 1
	Loose, reddish-brown, slightly moist, slightly micaceous, silty, fine to medium SAND		5 5 5
5			
2050	Stiff, brown, slightly moist, slightly micaceous, fine sandy SILT		5 5 5
			5 8 7
10			
2045	Firm, brown, slightly moist, very micaceous, silty, fine to coarse SAND		5 7 7
15			
2040	PARTIALLY WEATHERED ROCK which sampled as brown, slightly moist, very micaceous, silty, fine to coarse SAND		30 50/4" (50/4")
20			
2035	Auger refusal at 22 feet. Began rock coring.		R-1
25	Medium hardness, moderate to moderately severely weathered, light brownish-gray, medium to coarse grained, feldspar, quartz, biotite GNEISS with closely spaced fractures and moderately dipping, thinly spaced foliation R-1 recovery = 62.5%, RQD = 12.5%		R-2
2030			
30	Medium hardness, moderately severely weathered, brown, medium grained, feldspar, quartz, biotite GNEISS with closely spaced fractures an moderately dipping, thinly spaced foliation R-2 recovery = 20%, RQD = 16%		R-3
2025			
35	Moderately hard to medium hardness, moderately to moderately severely weathered, grayish-brown, medium grained feldspar, quartz, biotite GNEISS with closely spaced fractures and moderately dipping, closely spaced foliation R-3 recovery = 50%, RQD = 20% R-4 recovery = 10%, RQD = 0%		R-4
2020			

STANDARD PENETRATION RESULTS BLOWS/FOOT: 2 5 10 20 30 40 50 70 90



PIEZOMETER INSTALLATION DETAILS

- Grout, 0 to 4.5 feet
- Bentonite seal, 4.5 to 26.3 feet
- Filter pack, sand 26.3 to 46.0 feet
- 2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 34.0 to 44.0 feet

PIEZOMETER 1101-06.GPJ 2/9/15

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

PIEZOMETER NO. BLE-17

PROJECT: Macon County MSW Landfill - Phase 3 | PROJECT NO.: J13-1101-06

CLIENT: Macon County SWM Department | START: 9-5-13 END: 9-17-13

LOCATION: Franklin, North Carolina | ELEVATION: 2057.62

DRILLER: Landprobe, R. Banks | LOGGED BY: P. VanHeest

DRILLING METHOD: CME 750 ATV; 8.25-inch hollow stem auger and 3-inch NQ rock coring

DEPTH TO - WATER> INITIAL: NS AFTER 24 HOURS: 23.1 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90)	PIEZOMETER INSTALLATION DETAILS
2015	R-5 recovery = 70%, RQD = 20%		R-5		2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 34.0 to 44.0 feet
45					Pipe cap
					Total well depth, 44.2 feet
2010	Boring terminated at 46.0 feet. Groundwater level was not stable at time of drilling, but was encountered at 23.1 feet after 24 hours.				SURFACE COMPLETION 3.13-foot PVC stick-up
					Top of PVC casing elev. = 2,060.75 feet
50					Ground surface elev. = 2,057.62 feet
2005					Northing = 557,024.62'
					Easting = 693,860.66'
55					
2000					
60					
1995					
65					
1990					
70					
1985					
75					
1980					

PIEZOMETER 1101-06.GPJ 2/9/15

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

PIEZOMETER NO. BLE-18

PROJECT: Macon County MSW Landfill - Phase 3 | PROJECT NO.: J13-1101-06

CLIENT: Macon County SWM Department | START: 8-21-13 END: 8-21-13

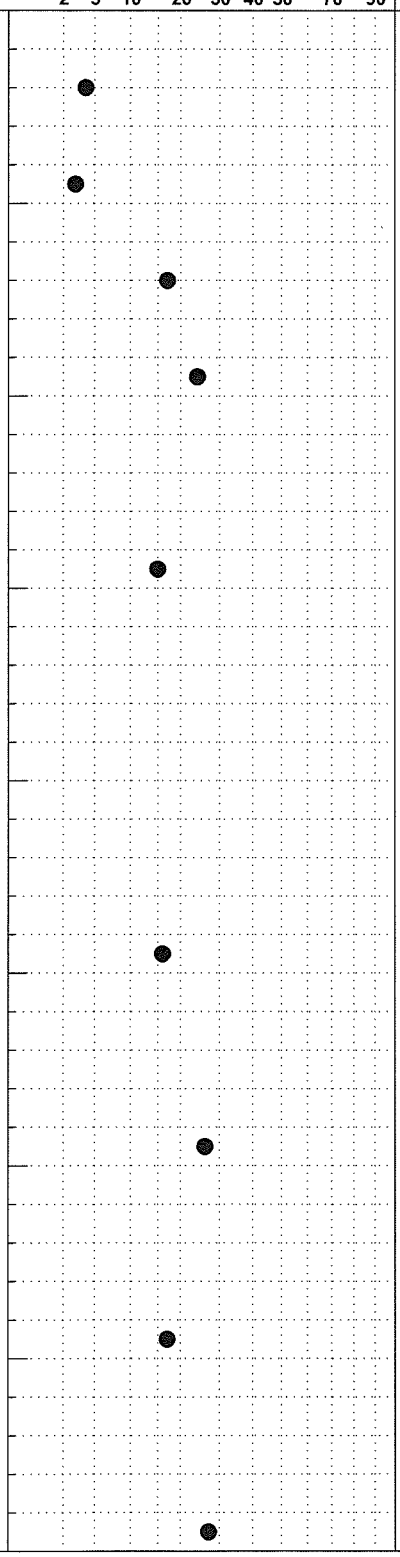
LOCATION: Franklin, North Carolina | ELEVATION: 2110.36

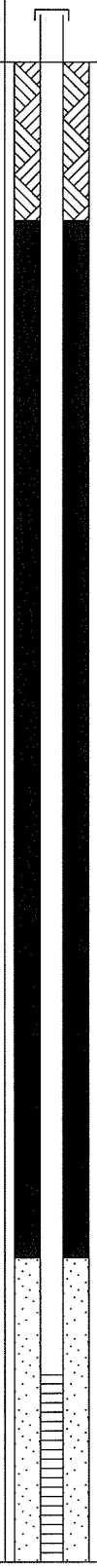
DRILLER: Landprobe, R. Banks | LOGGED BY: P. VanHeest

DRILLING METHOD: CME 750 ATV; 8.25-inch hollow stem auger

DEPTH TO - WATER> INITIAL: 32.02 AFTER 24 HOURS: 28.01 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SAMPLES	STANDARD PENETRATION RESULTS BLOWS/FOOT
2110	6-inches of TOPSOIL		
	Soft, brown, moist, micaceous, fine sandy, silty CLAY - (residuum)		1 2 2
	Soft, brown, moist, micaceous, fine sandy, clayey SILT		2 1 2
2105 (5)	Very stiff, brown, slightly moist, slightly micaceous, sandy, clayey SILT		7 9 8
	Very firm, brown, slightly moist, micaceous, silty, fine to medium SAND		8 11 13
2100 (10)			
	Firm, brown, slightly moist, very micaceous, silty, fine to medium SAND		6 7 8
2095 (15)			
		UD	
2090 (20)			
			6 7 9
2085 (25)			
	Very firm, light brown, slightly moist, micaceous, silty, fine to medium SAND		11 16 10
2080 (30)			
	Firm, light brown, slightly moist, micaceous, silty, fine to medium SAND		7 9 8
2075 (35)			
	Very firm, brown, moist, micaceous, silty, fine to medium SAND		6 15 12





PIEZOMETER INSTALLATION DETAILS

- Grout, 0 to 4.2 feet
- Bentonite seal, 4.2 to 31.9 feet
- Filter pack, sand 31.9 to 46.0 feet
- 2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 35.0 to 45.0 feet

PIEZOMETER 1101-06.GPJ 2/9/15

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

PIEZOMETER NO. BLE-18

PROJECT: Macon County MSW Landfill - Phase 3 | PROJECT NO.: J13-1101-06

CLIENT: Macon County SWM Department | START: 8-21-13 END: 8-21-13

LOCATION: Franklin, North Carolina | ELEVATION: 2110.36

DRILLER: Landprobe, R. Banks | LOGGED BY: P. VanHeest

DRILLING METHOD: CME 750 ATV; 8.25-inch hollow stem auger

DEPTH TO - WATER> INITIAL: 32.02 AFTER 24 HOURS: 28.01 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90)	PIEZOMETER INSTALLATION DETAILS
2070	Very firm, brown, moist, micaceous, silty, fine to medium SAND				2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 35.0 to 45.0 feet
	Dense, brown, wet, very micaceous, silty, fine to coarse SAND		9 14 21		
2065 – 45					Pipe cap
	Auger refusal at 46.0 feet. Groundwater encountered at 32.02 feet at time of drilling and at 28.01 feet after 24 hours.				Total well depth, 45.2 feet
					SURFACE COMPLETION 3.21-foot PVC stick-up
2060 – 50					Top of PVC casing elev. = 2,113.57 feet
					Ground surface elev. = 2,110.36 feet
					Northing = 557,702.85'
					Easting = 694,721.10'
2055 – 55					
2050 – 60					
2045 – 65					
2040 – 70					
2035 – 75					

PIEZOMETER 1101-06.GPJ 2/9/15

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

PIEZOMETER NO. BLE-19

PROJECT: Macon County MSW Landfill - Phase 3 | PROJECT NO.: J13-1101-06

CLIENT: Macon County SWM Department | START: 8-21-13 END: 9-18-13

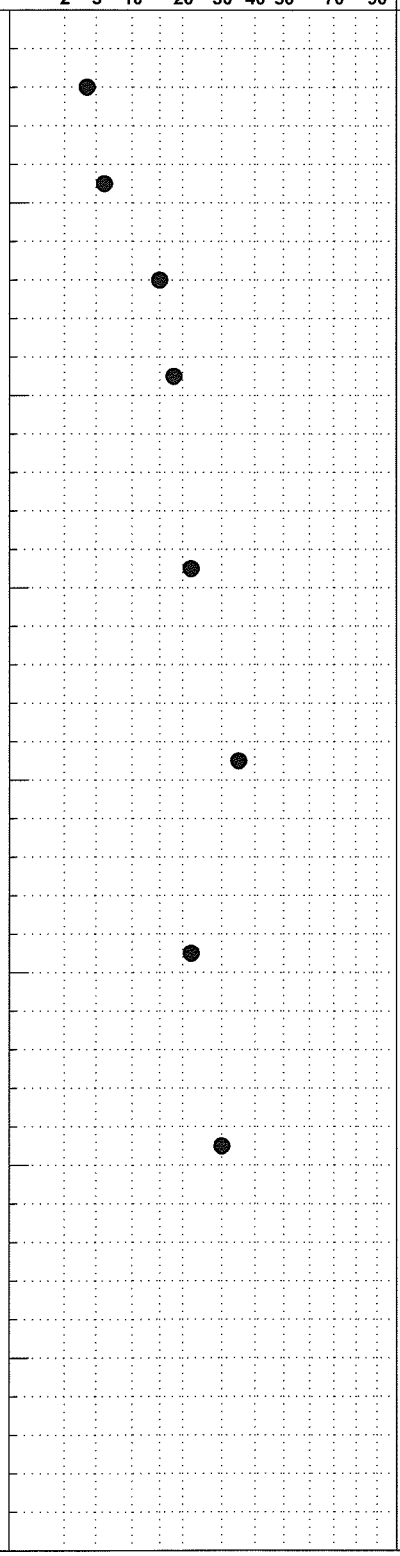
LOCATION: Franklin, North Carolina | ELEVATION: 2093.04

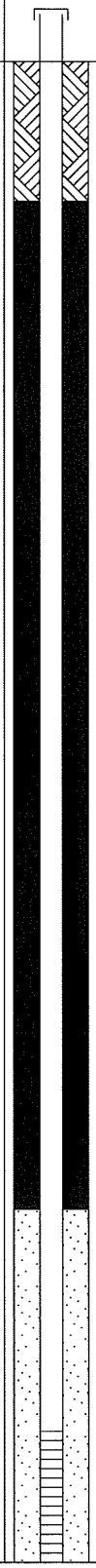
DRILLER: Landprobe, R. Banks | LOGGED BY: P. VanHeest

DRILLING METHOD: CME 750 ATV; 8.25-inch hollow stem auger and 3-inch NQ rock coring

DEPTH TO - WATER> INITIAL: NS AFTER 24 HOURS: 34.3 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SAMPLES	STANDARD PENETRATION RESULTS BLOWS/FOOT
	6-inches of TOPSOIL		
	Soft, brown, slightly moist, slightly micaceous, sandy, clayey SILT - (residuum)		2 2 2
2090	Firm, brown, slightly moist, slightly micaceous, sandy, clayey SILT		2 3 3
5	Stiff, brown, slightly moist, slightly micaceous, clayey, fine to coarse sandy SILT with angular gravel		6 6 9
2085	Firm, brown, slightly moist, micaceous, clayey, silty, fine to medium SAND		7 8 10
10			
2080	Very firm, light brown, slightly moist, micaceous, silty, fine to medium SAND		8 10 12
15			
2075	Dense, brown, slightly moist, micaceous, silty, fine to medium SAND		14 20 15
20			
2070	Very firm, brown, micaceous, slightly moist, silty, fine to medium SAND		12 11 11
25			
2065	Very firm, brown, moist, micaceous, silty, fine to medium SAND		10 11 19
30			
	Auger refusal at 31.5 feet. Began rock coring.		R-1
2060	Moderately hard to medium hard, slight to moderately severely weathered, medium grained feldspar, quartz, biotite GNEISS with closely spaced fractures and thinly spaced medium dipping foliation R-1 recovery = 50%, RQD = 20% R-2 recovery = 50%, RQD = 10%		
35			R-2
2055			





PIEZOMETER INSTALLATION DETAILS

Grout, 0 to 3.7 feet

Bentonite seal, 3.7 to 30.6 feet

Filter pack, sand 30.6 to 55.5 feet

2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 36.5 to 46.5 feet

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

PIEZOMETER NO. BLE-19

PROJECT: Macon County MSW Landfill - Phase 3 | PROJECT NO.: J13-1101-06

CLIENT: Macon County SWM Department | START: 8-21-13 END: 9-18-13

LOCATION: Franklin, North Carolina | ELEVATION: 2093.04

DRILLER: Landprobe, R. Banks | LOGGED BY: P. VanHeest

DRILLING METHOD: CME 750 ATV; 8.25-inch hollow stem auger and 3-inch NQ rock coring

DEPTH TO - WATER> INITIAL: NS AFTER 24 HOURS: 34.3 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90)	PIEZOMETER INSTALLATION DETAILS
2050, 45, 2045, 50, 2040, 55	Soft to moderately hard, moderately severely weathered, brown, medium grained, feldspar, quartz, biotite GNEISS with closely spaced fractures and thinly spaced shallow dipping foliation R-3 recovery = 5%, RQD = 0% R-4 recovery = 40%, RQD = 10% R-5 recovery = 70%, RQD = 20%		R-3 R-4 R-5		2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 36.5 to 46.5 feet Filter pack, sand 30.6 to 55.5 feet Pipe cap Total well depth, 46.7 feet SURFACE COMPLETION 3.44-foot PVC stick-up Top of PVC casing elev. = 2,096.48 feet Ground surface elev. = 2,093.04 feet Northing = 557,865.75' Easting = 694,291.14'
2035, 60, 2030, 65, 2025, 70, 2020, 75, 2015	Boring terminated at 55.5 feet. Groundwater level was not stable at time of drilling, but was encountered at 34.3 feet after 24 hours.				

PIEZOMETER 1101-06.GPJ 2/9/15

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

PIEZOMETER NO. BLE-20

PROJECT: Macon County MSW Landfill - Phase 3 | PROJECT NO.: J13-1101-06

CLIENT: Macon County SWM Department | START: 8-27-13 END: 9-19-13

LOCATION: Franklin, North Carolina | ELEVATION: 2027.39

DRILLER: Landprobe, R. Banks | LOGGED BY: B. Nisbeth

DRILLING METHOD: CME 750 ATV; 8.25-inch hollow stem auger and 3-inch NQ rock coring

DEPTH TO - WATER> INITIAL: NS AFTER 24 HOURS: 13.35 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90)	PIEZOMETER INSTALLATION DETAILS
	6-inches of TOPSOIL				
2025	Very stiff, brown to reddish-brown, slightly moist, slightly micaceous, clayey, fine to medium sandy SILT - (residuum)		7 9 16		Grout, 0 to 4.5 feet
5	Very firm, light brown, slightly moist, slightly micaceous, silty, fine to medium SAND		7 14 16		
2020	Auger refusal at 7.0 feet. Began rock coring.		R-1		
10	Medium hardness, moderately weathered, grayish-brown, medium grained, feldspar, quartz, biotite GNEISS with closely spaced fractures an thinly spaced shallow dipping foliation		R-2		Bentonite seal, 4.5 to 20.3 feet
2015	R-1 recovery = 30%, RQD = 0% R-2 recovery = 60%, RQD = 10% R-3 recovery = 15%, RQD = 0% R-4 recovery = 4%, RQD = 0%				
15			R-3		
2010					
20			R-4		Filter pack, sand 20.3 to 34.4 feet
2005					
25	PARTIALLY WEATHERED ROCK, no recovery R-5 recovery = 0%, RQD = 0% R-6 recovery = 0%, RQD = 0% R-7 recovery = 0%, RQD = 0%		R-5		2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 24.2 to 34.2 feet
2000					
30			R-6		
1995					
35			R-7		Pipe cap Borehole caved, 34.4 to 39.5 feet Total well depth, 34.40 feet
1990					

PIEZOMETER 1101-06.GPJ 2/9/15

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

PIEZOMETER NO. BLE-20

PROJECT: Macon County MSW Landfill - Phase 3 | PROJECT NO.: J13-1101-06

CLIENT: Macon County SWM Department | START: 8-27-13 END: 9-19-13

LOCATION: Franklin, North Carolina | ELEVATION: 2027.39

DRILLER: Landprobe, R. Banks | LOGGED BY: B. Nisbeth

DRILLING METHOD: CME 750 ATV; 8.25-inch hollow stem auger and 3-inch NQ rock coring

DEPTH TO - WATER> INITIAL: NS AFTER 24 HOURS: 13.35 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90)	PIEZOMETER INSTALLATION DETAILS
1985, 45, 1980, 50, 1975, 55, 1970, 60, 1965, 65, 1960, 70, 1955, 75, 1950	Boring terminated at 39.5 feet. Groundwater level was not stable at time of drilling, but was encountered at 13.35 feet after 24 hours.				SURFACE COMPLETION 2.87-foot PVC stick-up Top of PVC casing elev. = 2,030.26 feet Ground surface elev. = 2,027.39 feet Northing = 558,225.18' Easting = 693,574.71'

PIEZOMETER 1101-06.GPJ 2/9/15

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

PIEZOMETER NO. BLE-21

PROJECT: Macon County MSW Landfill - Phase 3 | PROJECT NO.: J13-1101-06

CLIENT: Macon County SWM Department | START: 8-27-13 END: 8-27-13

LOCATION: Franklin, North Carolina | ELEVATION: 2042.71

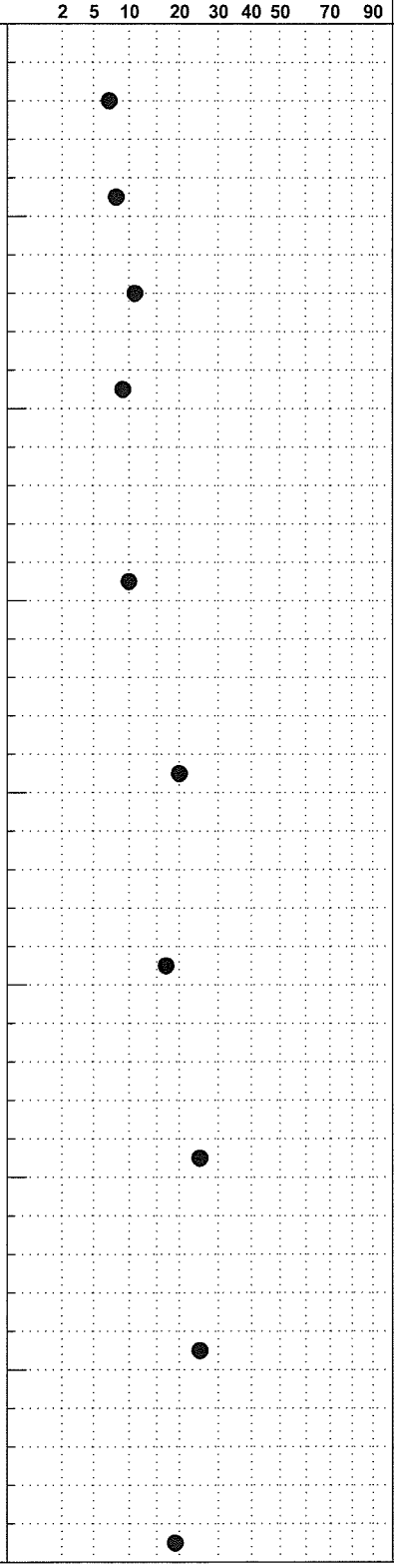
DRILLER: Landprobe, R. Banks | LOGGED BY: B. Nisbeth

DRILLING METHOD: CME 750 ATV; 8.25-inch hollow stem auger

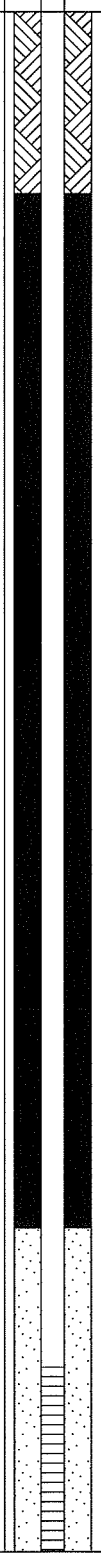
DEPTH TO - WATER> INITIAL: 22.9 AFTER 24 HOURS: 22.82 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SAMPLES (BLOWS/FOOT)
	6-inches of TOPSOIL	
2040	Loose, reddish-brown, slightly moist, slightly micaceous, silty, clayey, fine to coarse SAND - (residuum)	2, 3, 4, UD
	Loose to firm, brown, slightly moist, micaceous, silty, fine to coarse SAND	3, 4, 4
5		4, 5, 6
2035		UD, 4, 4, 5
10		
2030		3, 4, 6
15		
2025	Very stiff, brown, slightly moist, micaceous, fine to medium sandy SILT	7, 9, 11
20		
2020	Very stiff, reddish-brown, micaceous, fine to medium sandy SILT	3, 5, 12
25		
2015	Very firm to firm, brown, wet, micaceous, silty, fine to medium SAND	8, 10, 15
30		
2010		9, 9, 16
35		
2005		6, 9, 10

STANDARD PENETRATION RESULTS BLOWS/FOOT



PIEZOMETER INSTALLATION DETAILS



Grout, 0 to 4.7 feet

Bentonite seal, 4.7 to 31.6 feet

Filter pack, sand 31.6 to 45.5 feet

2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 35.2 to 45.2 feet

PIEZOMETER 1101-06.GPJ 2/9/15

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

PIEZOMETER NO. BLE-21

PROJECT: Macon County MSW Landfill - Phase 3 | PROJECT NO.: J13-1101-06

CLIENT: Macon County SWM Department | START: 8-27-13 END: 8-27-13

LOCATION: Franklin, North Carolina | ELEVATION: 2042.71

DRILLER: Landprobe, R. Banks | LOGGED BY: B. Nisbeth

DRILLING METHOD: CME 750 ATV; 8.25-inch hollow stem auger

DEPTH TO - WATER> INITIAL: 22.9 AFTER 24 HOURS: 22.82 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90)	PIEZOMETER INSTALLATION DETAILS
2000	Very firm to firm, brown, wet, micaceous, silty, fine to medium SAND		7 8 12		2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 35.2 to 45.2 feet
45					Pipe cap
1995	Auger refusal at 45.5 feet. Groundwater encountered at 22.90 feet at time of drilling and at 22.82 feet after 24 hours. UD samples collected from 1 to 3 feet, 8 to 10 feet, and 13 to 15 feet depths in offset boring.				Total well depth, 45.4 feet
50					SURFACE COMPLETION 3.15-foot PVC stick-up
1990					Top of PVC casing elev. = 2,045.86 feet
					Ground surface elev. = 2,042.71 feet
					Northing = 558,126.50'
					Easting = 693,339.53'
55					
1985					
60					
1980					
65					
1975					
70					
1970					
75					
1965					

PIEZOMETER 1101-06.GPJ 2/9/15

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

PIEZOMETER NO. BLE-22

PROJECT: Macon County MSW Landfill - Phase 3 | PROJECT NO.: J13-1101-06

CLIENT: Macon County SWM Department | START: 8-28-13 END: 8-28-13

LOCATION: Franklin, North Carolina | ELEVATION: 2042.22

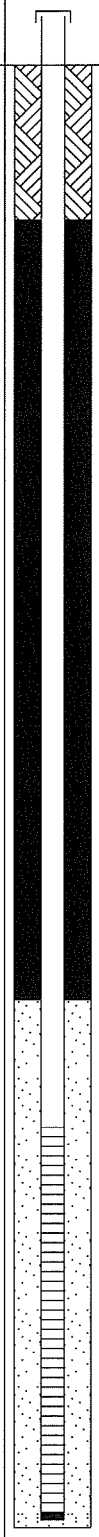
DRILLER: Landprobe, R. Banks | LOGGED BY: B. Nisbeth

DRILLING METHOD: CME 750 ATV; 8.25-inch hollow stem auger

DEPTH TO - WATER> INITIAL: 28.6 AFTER 24 HOURS: 29.60 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SAMPLES	STANDARD PENETRATION RESULTS BLOWS/FOOT
	6-inches of TOPSOIL		
2040	Firm, reddish-brown, slightly moist, micaceous, fine to medium sandy, clayey SILT - (residuum)		3 3 4
	Very stiff, brown, fine to medium sandy, clayey SILT		UD 4 6 10
5			
2035	Brown and gray, micaceous, slightly clayey, gravelly, silty, fine to coarse SAND		UD
10			
2030	Loose, brown, slightly moist, slightly micaceous, silty, fine to medium SAND		3 4 6
15			
2025	Stiff, reddish-brown, slightly moist, micaceous, fine to medium sandy SILT		4 6 8
20			
2020	Very firm, brown, slightly moist, micaceous, silty, fine to medium SAND		9 9 14
25			
2015			7 8 20
30			
2010	Very firm, brown, moist, very micaceous, silty, fine to medium SAND		11 12 14
35			
2005			
	Auger refusal at 38.0 feet. Groundwater encountered at 28.6		

STANDARD PENETRATION RESULTS BLOWS/FOOT: 2 5 10 20 30 40 50 70 90



PIEZOMETER INSTALLATION DETAILS

SURFACE COMPLETION

Grout, 0 to 4.0 feet

Bentonite seal, 4.0 to 24.3 feet

Filter pack, sand 24.3 to 38.0 feet

2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 27.6 to 37.6 feet

Pipe cap

Total well depth, 37.8 feet

PIEZOMETER 1101-06.GPJ 2/9/15

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

PIEZOMETER NO. BLE-22

PROJECT: Macon County MSW Landfill - Phase 3 | PROJECT NO.: J13-1101-06

CLIENT: Macon County SWM Department | START: 8-28-13 END: 8-28-13

LOCATION: Franklin, North Carolina | ELEVATION: 2042.22

DRILLER: Landprobe, R. Banks | LOGGED BY: B. Nisbeth

DRILLING METHOD: CME 750 ATV; 8.25-inch hollow stem auger

DEPTH TO - WATER> INITIAL: 28.6 AFTER 24 HOURS: 29.60 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90)	PIEZOMETER INSTALLATION DETAILS
2000, 45, 1995, 50, 1990, 55, 1985, 60, 1980, 65, 1975, 70, 1970, 75, 1965	feet at time of drilling and at 29.60 feet after 24 hours. UD sampled collected from 3 to 5 feet depth and 6 to 8 foot depth in offset boring.				SURFACE COMPLETION 2.35-foot PVC stick-up Top of PVC casing elev. = 2,044.57 feet Ground surface elev. = 2,042.22 feet Northing = 558,174.37' Easting = 693,064.36'

PIEZOMETER 1101-06.GPJ 2/9/15

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

SOIL TEST BORING NO. B-5R

PROJECT: Macon County MSW Landfill - Phase 3 | PROJECT NO.: J13-1101-06

CLIENT: Macon County SWM Department | START: 8-26-13 END: 8-26-13

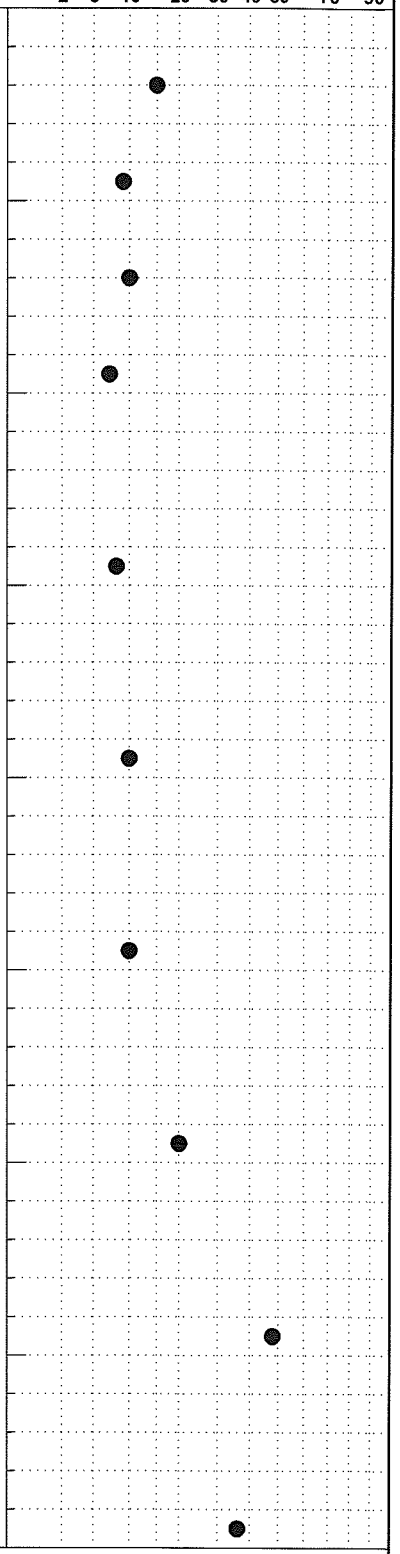
LOCATION: Franklin, North Carolina | ELEVATION: 2121.32

DRILLER: Landprobe, R. Banks | LOGGED BY: P. VanHeest

DRILLING METHOD: CME 750 ATV; 8.25-inch hollow stem auger

DEPTH TO - WATER> INITIAL: dry AFTER 24 HOURS: dry CAVING>

ELEVATION/ DEPTH (FT)	SOIL DESCRIPTION	SOIL TYPE	SAMPLES	STANDARD PENETRATION RESULTS BLOWS/FOOT
2120	Stiff, reddish-brown, slightly micaceous, fine to coarse sandy, clayey to slightly clayey SILT - (residuum)			3 7 8
				4 5 4
5				
2115				5 4 6
	Loose, reddish-brown, tan to brown, micaceous, silty, fine to coarse SAND with occasional fine gravel			3 3 4
10				
2110				
				4 4 4
15				
2105				
				6 6 4
20				
2100				
				4 4 6
25				
2095				
	Firm to dense, reddish-brown, tannish-brown, micaceous, silty, fine to coarse SAND with occasional fine gravel			20
30				
2090				
				48
35				
2085				
				36



GEOT_NOWELL 1101-06.GPJ 2/9/15

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

SOIL TEST BORING NO. B-5R

PROJECT: Macon County MSW Landfill - Phase 3 | PROJECT NO.: J13-1101-06

CLIENT: Macon County SWM Department | START: 8-26-13 END: 8-26-13

LOCATION: Franklin, North Carolina | ELEVATION: 2121.32

DRILLER: Landprobe, R. Banks | LOGGED BY: P. VanHeest

DRILLING METHOD: CME 750 ATV; 8.25-inch hollow stem auger

DEPTH TO - WATER> INITIAL: dry AFTER 24 HOURS: dry CAVING>

ELEVATION/ DEPTH (FT)	SOIL DESCRIPTION	SOIL TYPE	SAMPLES	STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90)
2080	Firm to dense, reddish-brown, tannish-brown, micaceous, silty, fine to coarse SAND with occasional fine gravel			
45				
2075				
50				
2070	Auger refusal at 51.50 feet. Groundwater level was not encountered at time of drilling or after 24 hours. No piezometer installed. Soil descriptions from Westinghouse Environmental & Geotechnical Services, Inc. Site suitability study for Macon County Landfill, Franklin, North Carolina. Westinghouse job number 1351-89-369 dated January 17, 1990. Ground surface elev. = 2,121.32 feet. Northing = 557,425.78' Easting = 693,688.63'.			
55				
2065				
60				
2060				
65				
2055				
70				
2050				
75				
2045				

GEOT_NOWELL 1101-06.GPJ 2/9/15

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

PIEZOMETER NO. B-6R

PROJECT: Macon County MSW Landfill - Phase 3 | PROJECT NO.: J13-1101-06

CLIENT: Macon County SWM Department | START: 8-20-13 END: 8-28-13

LOCATION: Franklin, North Carolina | ELEVATION: 2146.27

DRILLER: Landprobe, R. Banks | LOGGED BY: P. VanHeest

DRILLING METHOD: CME 750 ATV; 8.25-inch hollow stem auger

DEPTH TO - WATER> INITIAL: 71.3 AFTER 24 HOURS: 65.25 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SAMPLES	STANDARD PENETRATION RESULTS BLOWS/FOOT
	6-inches of TOPSOIL		
2145	Stiff, brown, slightly moist, slightly micaceous, sandy, silty CLAY - (residuum)		3 5 5
	Loose, brown, slightly moist, slightly micaceous, silty, fine to medium SAND		4 5 5
5			
2140			3 4 5
	Firm, light brown, slightly moist, micaceous, silty, fine to coarse SAND and some gravel		4 8 6
10			
2135			
	Firm, light brown, slightly moist, micaceous, clayey, silty, fine to medium SAND		5 6 8
15			
2130			
	Very firm, brown, slightly moist, micaceous, clayey, silty, fine to medium SAND		6 11 11
20			
2125			
	Firm, brown, slightly moist, micaceous, clayey, silty, fine to medium SAND		4 6 9
25			
2120			
	Very firm, brown, slightly moist, micaceous, clayey, silty, fine to medium SAND		10 11 11
30			
2115			
			8 11 18
35			
2110			
	Dense, brown, slightly moist, micaceous, clayey, silty, fine to medium SAND		8 12 19

STANDARD PENETRATION RESULTS BLOWS/FOOT: 2 5 10 20 30 40 50 70 90

PIEZOMETER INSTALLATION DETAILS

Grout, 0 to 3.0 feet

Bentonite seal, 3.0 to 64.8 feet

PIEZOMETER 1101-06.GPJ 2/9/15

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

PIEZOMETER NO. B-6R

PROJECT: Macon County MSW Landfill - Phase 3 | PROJECT NO.: J13-1101-06

CLIENT: Macon County SWM Department | START: 8-20-13 END: 8-28-13

LOCATION: Franklin, North Carolina | ELEVATION: 2146.27

DRILLER: Landprobe, R. Banks | LOGGED BY: P. VanHeest

DRILLING METHOD: CME 750 ATV; 8.25-inch hollow stem auger

DEPTH TO - WATER> INITIAL: 71.3 AFTER 24 HOURS: 65.25 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SAMPLES	STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90)
2105	Dense, brown, slightly moist, micaceous, clayey, silty, fine to medium SAND		
	Dense, light brown, slightly moist, slightly micaceous, silty, fine to coarse SAND		15 18 23
45			
2100			
	Dense, brown, slightly moist, micaceous, silty, fine to medium SAND		16 21 23
50			
2095			
	Very firm, light brown, slightly moist, slightly micaceous, silty, fine to medium SAND		8 10 17
55			
2090			
	PARTIALLY WEATHERED ROCK which sampled as light brown, slightly moist, micaceous, silty, fine to medium SAND		16 25 50/5" (50/5")
60			
2085			
	Dense, light brown, slightly moist, micaceous, silty, fine to medium SAND		13 17 23
65			
2080			
			8 12 19
70			
2075			
	Dense, brown, moist, micaceous, silty, fine to medium SAND		18 24 23
75			
2070			
			9 21 29

PIEZOMETER INSTALLATION DETAILS

Bentonite seal, 3.0 to 64.8 feet

Filter pack, sand 64.8 to 80.0 feet

2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 69.3 to 79.3 feet

Pipe cap

PIEZOMETER 1101-06.GPJ 2/9/15

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

PIEZOMETER NO. B-6R

PROJECT: Macon County MSW Landfill - Phase 3 | PROJECT NO.: J13-1101-06

CLIENT: Macon County SWM Department | START: 8-20-13 END: 8-28-13

LOCATION: Franklin, North Carolina | ELEVATION: 2146.27

DRILLER: Landprobe, R. Banks | LOGGED BY: P. VanHeest

DRILLING METHOD: CME 750 ATV; 8.25-inch hollow stem auger

DEPTH TO - WATER> INITIAL: 71.3 AFTER 24 HOURS: 65.25 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90)	PIEZOMETER INSTALLATION DETAILS
2065	Boring terminated at 80.0 feet. Groundwater encountered at 71.3 feet at time of drilling and at 65.25 feet after 24 hours.				Total well depth, 79.5 feet SURFACE COMPLETION 3.22-foot PVC stick-up Top of PVC casing elev. = 2,149.49 feet Ground surface elev. = 2,146.27 feet Northing = 557,583.84' Easting = 694,576.67'
85					
2060					
90					
2055					
95					
2050					
100					
2045					
105					
2040					
110					
2035					
115					
2030					

PIEZOMETER 1101-06.GPJ 2/9/15

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

PIEZOMETER NO. B-16R

PROJECT: Macon County MSW Landfill - Phase 3 | PROJECT NO.: J13-1101-06

CLIENT: Macon County SWM Department | START: 8-28-13 END: 8-29-13

LOCATION: Franklin, North Carolina | ELEVATION: 2079.74

DRILLER: Landprobe, R. Banks | LOGGED BY: B. Nisbeth

DRILLING METHOD: CME 750 ATV; 8.25-inch hollow stem auger and 3-inch NQ rock coring

DEPTH TO - WATER> INITIAL: NS AFTER 24 HOURS: 38.4 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SAMPLES	STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90)
	6-inches of TOPSOIL		
	Stiff, reddish-brown, micaceous, clayey, fine to medium sandy SILT - (residuum)	9	
	Loose to firm, reddish-brown, slightly silty, clayey, fine to coarse SAND	9	
2075 – 5		16	
	Loose, reddish-brown, slightly micaceous, silty, fine to medium SAND	8	
2070 – 10			
	PARTIALLY WEATHERED ROCK which sampled as yellowish-tannish-black, silty, fine to medium SAND with rock fragments	50/5"	
2065 – 15			
	Stiff to very stiff, yellowish-orangish-brown and white, micaceous, fine sandy SILT with coarse sand and veins	17	
2060 – 20			
		15	
2055 – 25			
	PARTIALLY WEATHERED ROCK which sampled as tan and brown	50/1"	
2050 – 30			
	Auger refusal at 31.0 feet. Began rock coring.	R-1	
	Medium to moderately hard, moderately severely to moderately weathered, light gray, medium grained, feldspar, quartz, biotite GNEISS with closely spaced fractures and thinly spaced shallow dipping foliation R-1 recovery = 64%, RQD = 27% R-2 recovery = 57%, RQD = 23% R-3 recovery = 95%, RQD = 28% R-4 recovery = 48%, RQD = 40%	R-2	
2045 – 35			
2040			

PIEZOMETER INSTALLATION DETAILS

Grout, 0 to 4.7 feet

Bentonite seal, 4.7 to 36.8 feet

Filter pack, sand 36.8 to 56.0 feet

PIEZOMETER 1101-06.GPJ 2/9/15

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

PIEZOMETER NO. B-16R

PROJECT: Macon County MSW Landfill - Phase 3 | PROJECT NO.: J13-1101-06

CLIENT: Macon County SWM Department | START: 8-28-13 END: 8-29-13

LOCATION: Franklin, North Carolina | ELEVATION: 2079.74

DRILLER: Landprobe, R. Banks | LOGGED BY: B. Nisbeth

DRILLING METHOD: CME 750 ATV; 8.25-inch hollow stem auger and 3-inch NQ rock coring

DEPTH TO - WATER> INITIAL: NS AFTER 24 HOURS: 38.4 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90)	PIEZOMETER INSTALLATION DETAILS
2035 – 45 2030 – 50	Medium to moderately hard, moderately severely to moderately weathered, light gray, medium grained, feldspar, quartz, biotite GNEISS with closely spaced fractures and thinly spaced shallow dipping foliation R-1 recovery = 64%, RQD = 27% R-2 recovery = 57%, RQD = 23% R-3 recovery = 95%, RQD = 28% R-4 recovery = 48%, RQD = 40%		R-3 R-4		Filter pack, sand 36.8 to 56.0 feet 2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 44.3 to 54.3 feet
2025 – 55	Medium hard, moderately severely weathered, brown, medium grained, feldspar, quartz, biotite GNEISS with very closely spaced fractures and thinly spaced shallow dipping foliation R-5 recovery = 16%, RQD = 0%		R-5		Pipe cap Total well depth, 54.50 feet
2020 – 60 2015 – 65 2010 – 70 2005 – 75 2000	Boring terminated at 56.0 feet. Groundwater level was not stable at time of drilling, but was encountered at 38.4 feet after 24 hours. Soil descriptions from Westinghouse Environmental & Geotechnical Services, Inc. Site suitability study for Macon County Landfill, Franklin, North Carolina. Westinghouse job number 1351-89-369 dated January 17, 1990.				SURFACE COMPLETION 3.15-foot PVC stick-up Top of PVC casing elev. = 2,082.89 feet Ground surface elev. = 2,079.74 feet Northing = 557,575.73' Easting = 693,335.21'

PIEZOMETER 1101-06.GPJ 2/9/15

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

PIEZOMETER NO. B-18R

PROJECT: Macon County MSW Landfill - Phase 3 | PROJECT NO.: J13-1101-06

CLIENT: Macon County SWM Department | START: 9-5-13 END: 9-5-13

LOCATION: Franklin, North Carolina | ELEVATION: 2083.18

DRILLER: Landprobe, R. Banks | LOGGED BY: P. VanHeest

DRILLING METHOD: CME 750 ATV; 8.25-inch hollow stem auger

DEPTH TO - WATER> INITIAL: 18.45 AFTER 24 HOURS: 22.06 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SAMPLES (BLOWS/FOOT)
	6-inches of TOPSOIL	
	Firm, reddish-brown, slightly micaceous, fine to coarse sandy, silty CLAY	8
2080 / 5	Firm to very firm, tannish-brown to orangish-brown, micaceous, silty, fine to coarse SAND	15, 23, 30
2075 / 10		
2070 / 15	Hard, black and white to reddish-brown, slightly micaceous, fine to medium sandy SILT	48
2065 / 20		40
2060 / 25	Very dense, silty, fine to medium SAND	63
2055 / 30	Very dense, yellowish-black, silty, fine to medium SAND with maganese stains	57
2050 / 35	PARTIALLY WEATHERED ROCK which sampled as black, white and tan, silty, fine to medium SAND	50/5"
2045		

STANDARD PENETRATION RESULTS BLOWS/FOOT: 2 5 10 20 30 40 50 70 90

PIEZOMETER INSTALLATION DETAILS:

- Grout, 0 to 4.8 feet
- Bentonite seal, 4.8 to 24.7 feet
- Filter pack, sand 24.7 to 39.0 feet
- 2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 28.7 to 38.7 feet
- Pipe cap
- Total well depth, 38.9 feet

PIEZOMETER 1101-06.GPJ 2/9/15

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

PIEZOMETER NO. B-18R

PROJECT: Macon County MSW Landfill - Phase 3 | PROJECT NO.: J13-1101-06

CLIENT: Macon County SWM Department | START: 9-5-13 END: 9-5-13

LOCATION: Franklin, North Carolina | ELEVATION: 2083.18

DRILLER: Landprobe, R. Banks | LOGGED BY: P. VanHeest

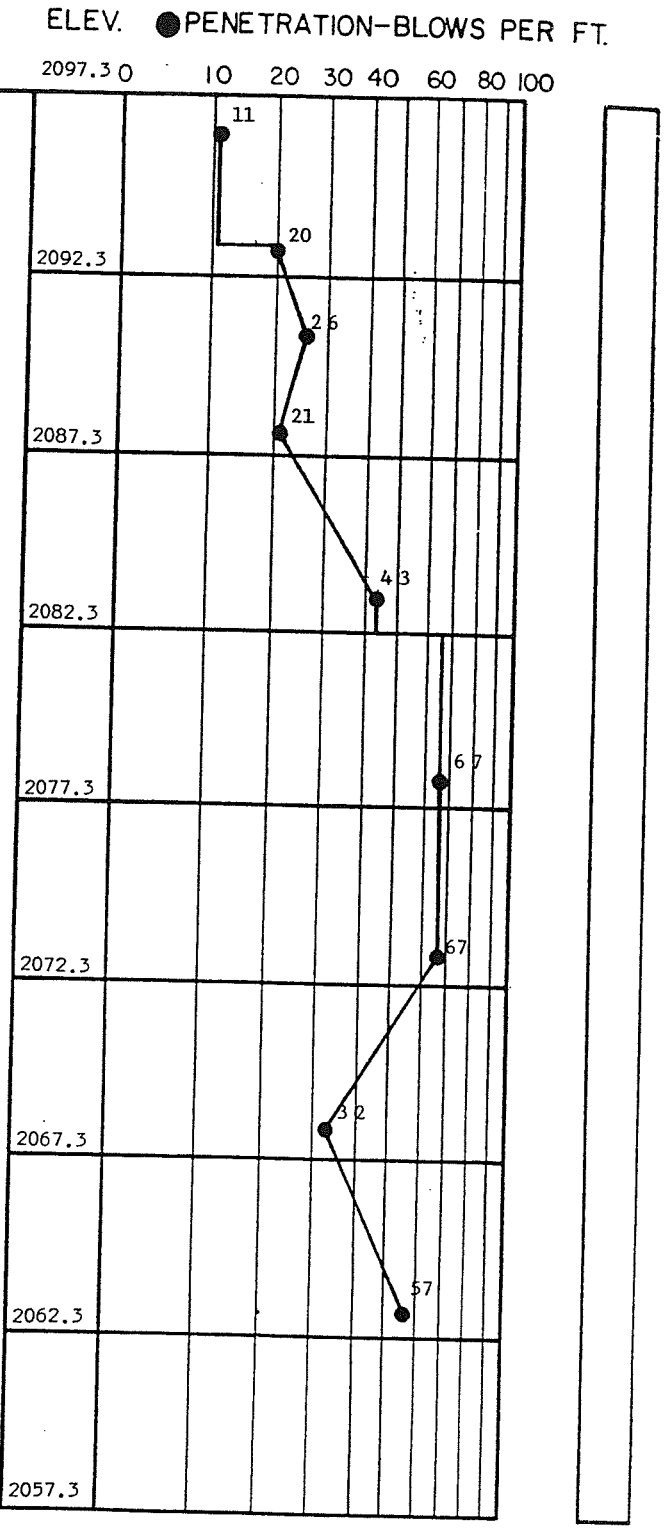
DRILLING METHOD: CME 750 ATV; 8.25-inch hollow stem auger

DEPTH TO - WATER> INITIAL: 18.45 AFTER 24 HOURS: 22.06 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90)	PIEZOMETER INSTALLATION DETAILS
2040, 45, 2035, 50, 2030, 55, 2025, 60, 2020, 65, 2015, 70, 2010, 75, 2005	Auger refusal at 39.0 feet. Groundwater was encountered at 18.45 feet at time of drilling and at 22.06 feet after 24 hours. Soil descriptions from Westinghouse Environmental & Geotechnical Services, Inc. Site suitability study for Macon County Landfill, Franklin, North Carolina. Westinghouse job number 1351-89-369 dated January 17, 1990.				SURFACE COMPLETION 3.10-foot PVC stick-up Top of PVC casing elev. = 2086.28 feet Ground surface elev. = 2083.18 feet Northing = 557,088.88' Easting = 694,199.23'

PIEZOMETER 1101-06.GPJ 2/9/15

DEPTH FT.	DESCRIPTION
0.0	
0.3	Top Soil
	Firm, Red-Brown, Medium to Fine Sandy, Clayey, Silt with Quartz Stringers Residuum
4.0	Medium Dense, Red-Brown, Micaceous, Slightly Clayey, Silty, Coarse to Fine Sand
15.0	Dense to Very Dense, Brown, Tan-Brown, Silty Coarse to Fine Sand with Occasional Gravel
36.5	Auger Refusal No Groundwater Encountered @ 24-hr.



Macon County Landfill

BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113

PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER. FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

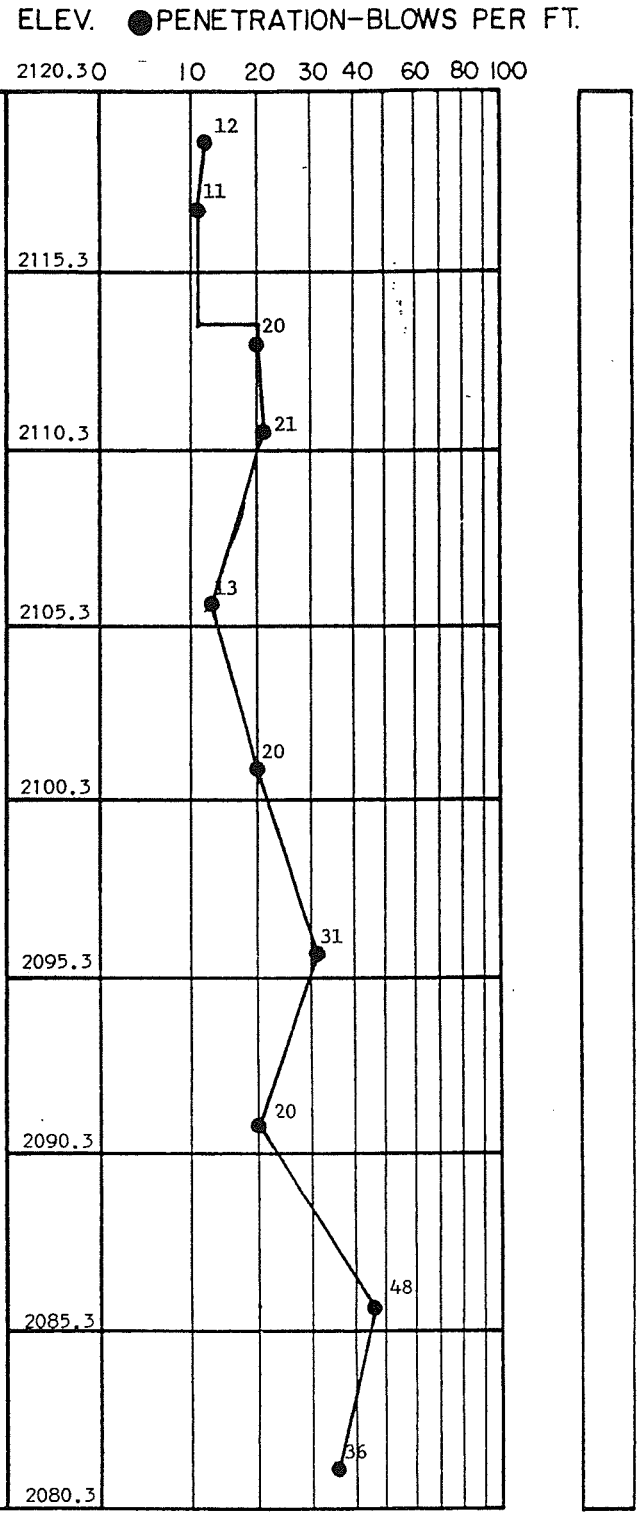
UNDISTURBED SAMPLE
50 % ROCK CORE RECOVERY
LOSS OF DRILLING WATER
WATER TABLE-24 HR.
WATER TABLE-1 HR.

TEST BORING RECORD

BORING NO. B-4
DATE DRILLED 6/2/89
JOB NO. 1351-89-369

Westinghouse

DEPTH FT.	DESCRIPTION
0.0	Top Soil
0.3	Stiff Red-Brown, Slightly Micaceous Coarse to Fine, Sandy Clayey to Slightly Clayey Silt - Residuum
6.5	Medium Dense to Dense, Red-Brown, Tan-Brown Micaceous Silty, Coarse to Fine Sand with Occasional Fine Gravel



Macon County Landfill

TEST BORING RECORD

BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113

PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER, FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

BORING NO. B-5
DATE DRILLED 6/1/89
JOB NO. 1351-89-369

UNDISTURBED SAMPLE
50 % ROCK CORE RECOVERY
LOSS OF DRILLING WATER
WATER TABLE-24 HR.
WATER TABLE-1 HR.

Westinghouse

DEPTH FT.	DESCRIPTION	ELEV.	●PENETRATION-BLOWS PER FT. 0 10 20 30 40 60 80 100
	Continued from page 1	2080.3	
43.0	Auger Refusal No Groundwater Encountered @ 24-Hr.	2075.3	

Macon County Landfill

TEST BORING RECORD

BORING NO. B-5
DATE DRILLED 6/1/89
JOB NO. 1351-89-369

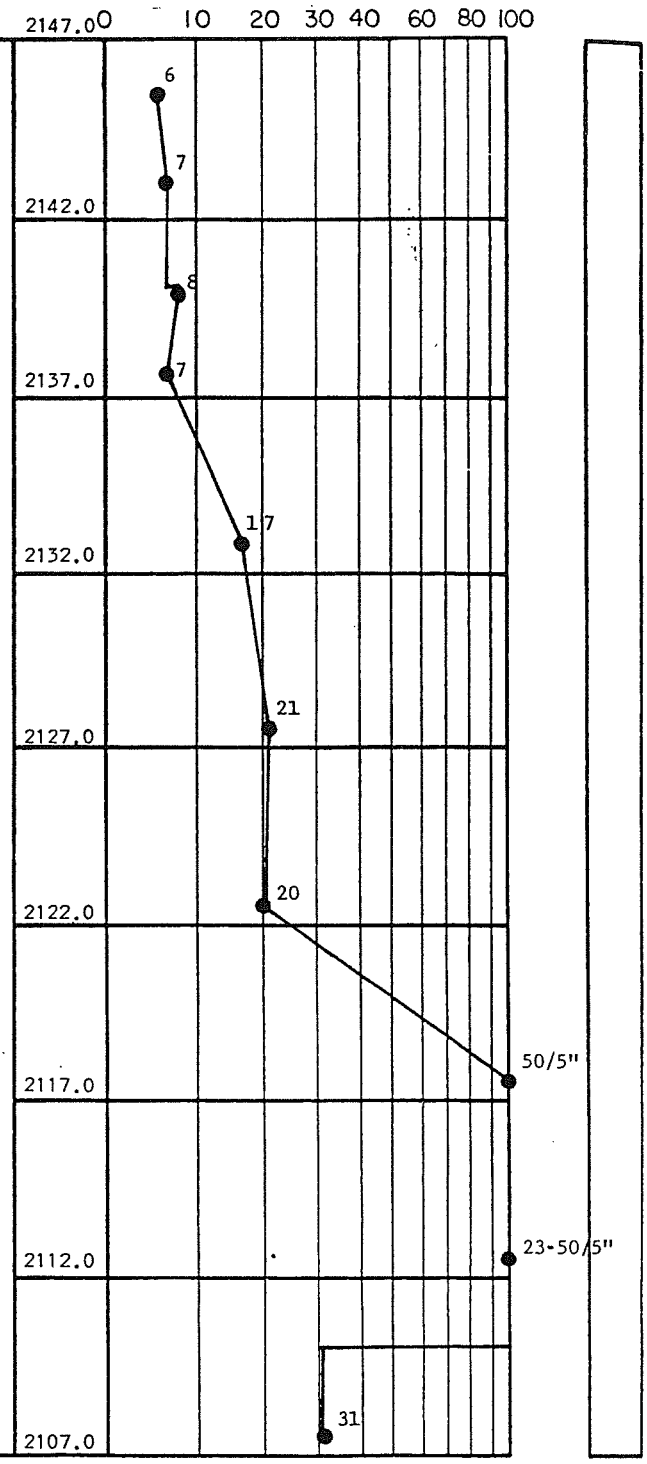
BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113

PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER. FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

UNDISTURBED SAMPLE
50 % ROCK CORE RECOVERY
LOSS OF DRILLING WATER
WATER TABLE-24HR.
WATER TABLE-1HR.

Westinghouse

DEPTH FT.	DESCRIPTION
0.0	Top Soil
0.2	Firm, Red-Brown, White Micaceous Medium to Fine, Sandy, Clayey Silt-Residuum
7.0	Loose to Medium Dense Red-Brown, Black Slightly Micaceous, Silty Coarse to Fine Sand
22.0	Partially Weathered Rock Sampled as Brown, Black Silty, Coarse to Fine Sand with Rock Fragments
37.0	Hard Brown, Micaceous, Medium to Fine Sandy Silt



Macon County Landfill

BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113

PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER. FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

UNDISTURBED SAMPLE
50 % ROCK CORE RECOVERY
LOSS OF DRILLING WATER
WATER TABLE-24 HR.
WATER TABLE-1 HR.

TEST BORING RECORD

BORING NO. B-6
DATE DRILLED 5/31/89
JOB NO. 1351-89-369

Westinghouse

SM-

DEPTH FT.	DESCRIPTION	ELEV.	●PENETRATION-BLOWS PER FT. 10 20 30 40 60 80 100
	Continued from Page 1	2107.00	
		2102.0	37
47.0	Partially Weathered Rock Sampled as Brown, Micaceous, Medium to Fine Sandy Silt	2097.0	50/3"
50.0	Boring Terminated No Groundwater Encountered @ 24-hr.		

Macon County Landfill

TEST BORING RECORD

BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113

PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER, FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

UNDISTURBED SAMPLE
50 % ROCK CORE RECOVERY
◀ LOSS OF DRILLING WATER
WATER TABLE-24HR.
WATER TABLE-1HR.

BORING NO. B-6
DATE DRILLED 5/31/89
JOB NO. 1351-89-369

Westinghouse

SM-14

DEPTH FT.	DESCRIPTION	ELEV.	PENETRATION-BLOWS PER FT. (0 10 20 30 40 60 80 100)
0		2084.2	
0.2	Stiff Red Brown Micaceous Sandy Clayey Medium to Fine Sandy SILT		9
2.5	Loose to Medium Dense Red Brown Slightly Silty Clayey Coarse to Fine SAND	2079.2	9
			16
8.0	Loose Red Brown Slightly Micaceous Silty Medium to Fine SAND	2074.2	8
0.0	Partially Weathered Rock When Sampled Becomes Yellow Tan to Black Silty Medium to Fine SAND - with rock fragments		
4.5	Stiff Yellow to Orange Brown and White Micaceous Fine Sandy SILT - with coarse sand and veins	2069.2	50/5"
		2064.2	17
		2059.2	15
5.0	Partially Weathered Rock When Sampled Becomes Tan Brown		
		2054.2	50/1" SET; 50/2" SET
		2051.2	
3.0	GARNETIFEROUS GRANITIC GNIESS: Light colored, medium grained, moderately **		RUN #1 From 33.0 feet to 38.0 feet REC = 85% RQD = 40%
5.5	***		
.25	GRANITIC GNIESS: White, medium grained slightly foliated, quartz-feldspar ****	2046.2	
8.0	Boring terminated at 38.0 feet Groundwater level at 24.6 feet at *** **		

24.6 ' 10-24-89

28.9 ' 10-26-89

Continue on Page 2

Macon County Landfill

TEST BORING RECORD

BORING NO. B-16
DATE DRILLED 9-26-89
JOB NO. 1351-89-369

BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113

PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

UNDISTURBED SAMPLE
50 % ROCK CORE RECOVERY
LOSS OF DRILLING WATER
WATER TABLE-24HR.
WATER TABLE-1HR.
HOLE CAVE

Westinghouse Environmental and Geotechnical Services, Inc.

WE-8

DEPTH FT.	DESCRIPTION	ELEV.	●PENETRATION-BLOWS PER FT. 0 10 20 30 40 60 80 100
	Continued from Page 1		
	* TOPSOIL ** foliated, garnet-quartz-feldspar rich, highly fractured. Iron stain on fractures. *** BIOTITE GRANITIC SCHIST: Light colored, medium grained, moderately foliated, biotite-quartz-feldspar rich, abundant irregular, near vertical, iron stained fractures, abundant dissolution of biotite. **** rich with minor biotite and traces of garnet ***** termination of boring and at 28.9 feet after 24 hours Note: Installed pipe (2 inch PVC pipe) to depth of 39.3 feet		

Macon County Landfill

TEST BORING RECORD

BORING NO. B-16
DATE DRILLED 9-26-89
JOB NO. 1351-89-369

BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113

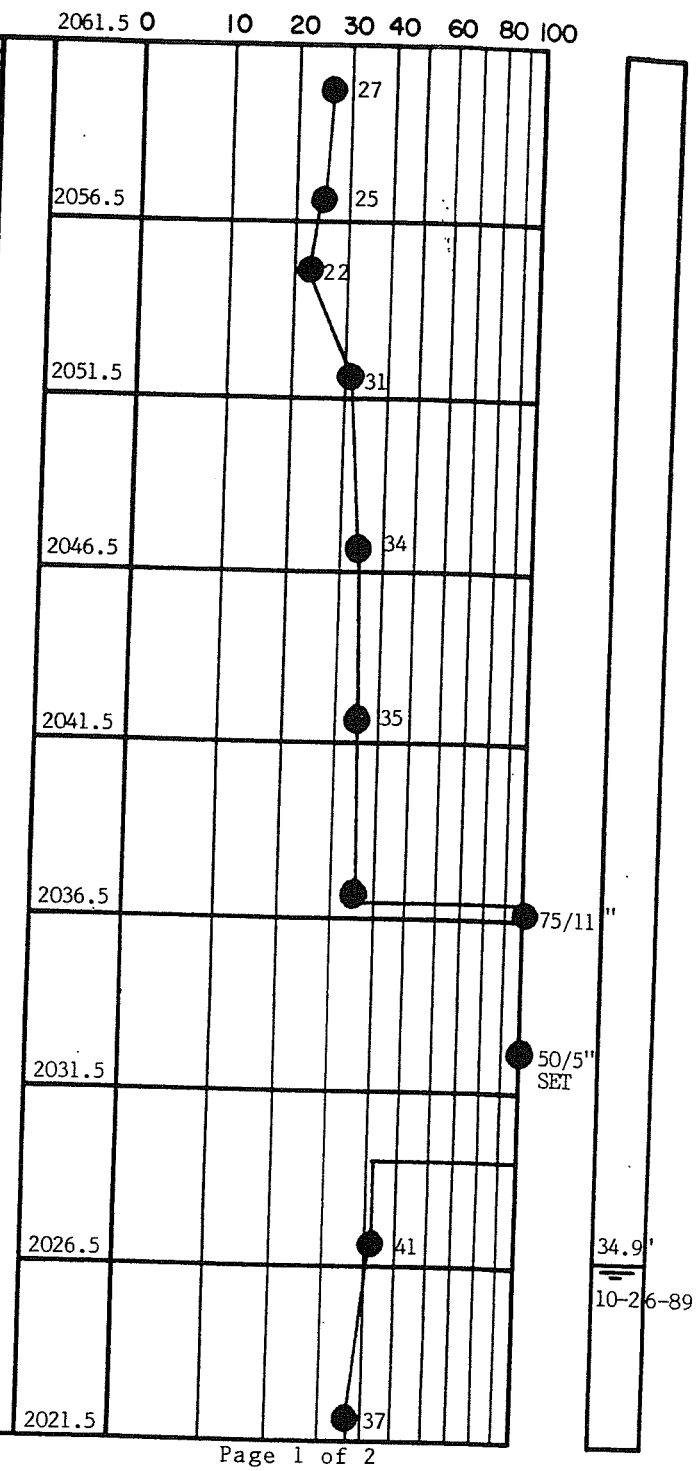
PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

UNDISTURBED SAMPLE
50 % ROCK CORE RECOVERY
LOSS OF DRILLING WATER
WATER TABLE-24HR.
WATER TABLE-1HR.
HOLE CAVE

Westinghouse Environmental and Geotechnical Services, Inc.

WE-8

DEPTH FT.	DESCRIPTION
0	
0.2	Residuum: Medium Dense Red to Orange Brown Slightly Micaceous Clayey Silty Coarse to Fine SAND
5.0	Medium Dense to Dense Brown Micaceous Silty Medium to Fine SAND - with manganese stains
24.5	Partially Weathered Rock When Sampled Becomes Orange Tan Brown Black Silty Medium to Fine SAND
32.0	Hard Tan to Black and White Slightly Micaceous Fine Sandy SILT
40.0	



Continue of Page 2

BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113

PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

UNDISTURBED SAMPLE
50 % ROCK CORE RECOVERY
LOSS OF DRILLING WATER
WATER TABLE-24 HR.
WATER TABLE-1 HR.
HOLE CAVE

WE-8

TEST BORING RECORD

BORING NO. B-17
DATE DRILLED 9-26-89
JOB NO. 1351-89-369

Westinghouse Environmental and Geotechnical Services, Inc.

DEPTH FT.	DESCRIPTION	ELEV.	PENETRATION-BLOWS PER FT. 0 10 20 30 40 60 80 100
	Continued from Page 1	2021.5	
40.0	Partially Weathered Rock When Sampled Becomes Black and Tan Brown Silty Medium to Fine SAND - with rock fragments	2016.5	50/4" SET
45.0	Very Dense Black to Tan Brown Silty Coarse to Fine SAND	2011.5	37
51.0	Partially Weathered Rock (No Recovery)	2006.5	50/0" SET
54.5	Boring terminated at auger refusal at 54.5 feet Groundwater level at 49.5 at termination of boring and 34.9 feet after 31 days * TOPSOIL Note: Installed pipe (2" PVC pipe) to depth of 57.5 feet		

49.0'
9-26-89

Macon County Landfill

BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113

PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

UNDISTURBED SAMPLE
50 % ROCK CORE RECOVERY
LOSS OF DRILLING WATER
WATER TABLE-24 HR.
WATER TABLE-1 HR.
HOLE CAVE

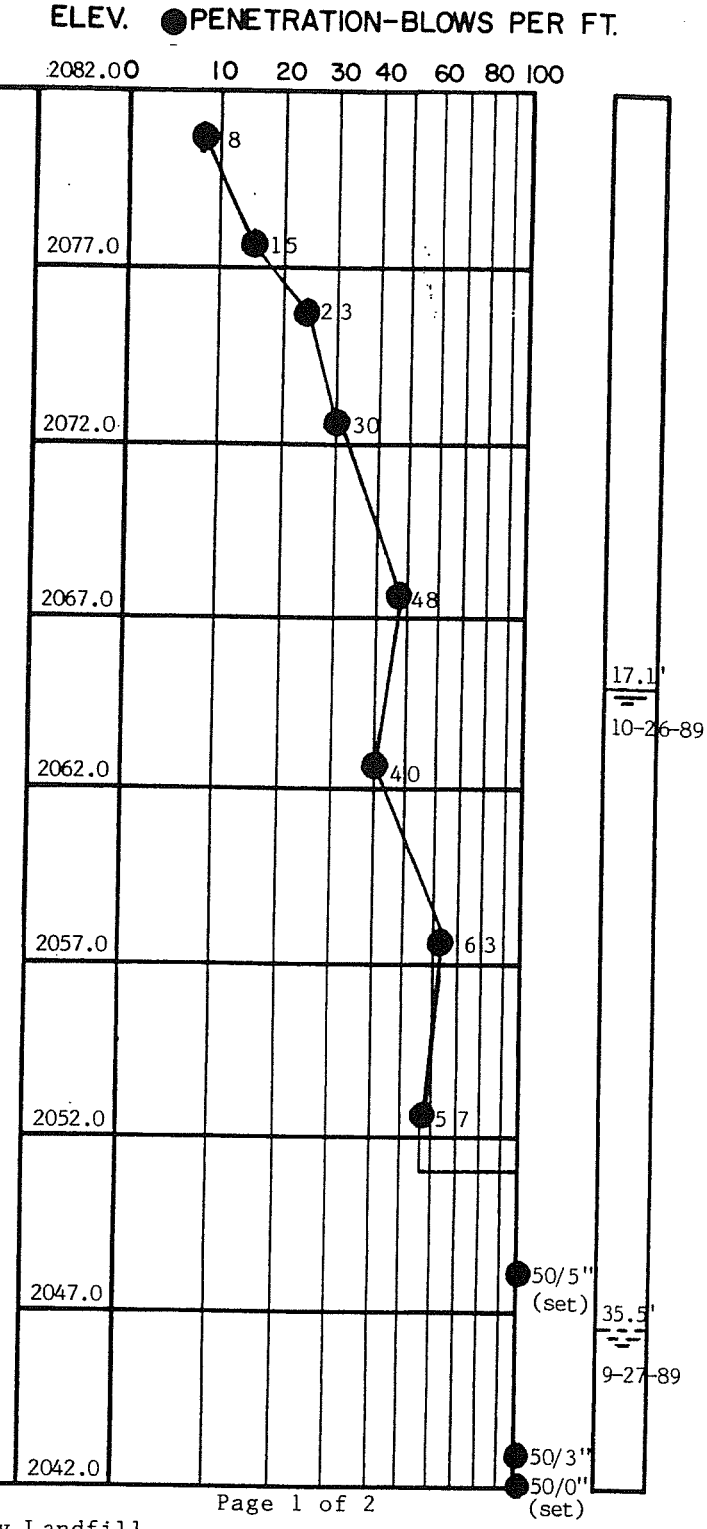
WE-8

TEST BORING RECORD

BORING NO. B-17
DATE DRILLED 9-26-89
JOB NO. 1351-89-369

Westinghouse Environmental and Geotechnical Services, Inc.

DEPTH FT.	DESCRIPTION
0	
0.2	* Residuum: Medium Stiff Red Brown Slightly Micaceous Coarse to Fine **
3.0	Medium Dense Tan Brown to Orange Brown Micaceous Silty Coarse to Fine SAND
12.0	Hard to Hard Black White to Red Brown Slightly Micaceous Medium to Fine Sandy SILT
23.5	Very Dense Silty Medium to Fine SAND
27.0	Very Dense Yellow Black Silty Medium to Fine SAND - with manganese stains
31.0	Partially Weathered Rock When Sampled Becomes Black White Tan Silty Medium to Fine SAND
40.0	



Continue on Page 2

Macon County Landfill

TEST BORING RECORD

BORING NO. B-18
DATE DRILLED 9-27-89
JOB NO. 1351-89-369

BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113

PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

UNDISTURBED SAMPLE
50 % ROCK CORE RECOVERY
LOSS OF DRILLING WATER
WATER TABLE-24HR.
WATER TABLE-1HR.
HOLE CAVE

WE-8

Westinghouse Environmental and Geotechnical Services, Inc.

DEPTH FT.	DESCRIPTION	ELEV.	●PENETRATION-BLOWS PER FT. 0 10 20 30 40 60 80 100
40.0	Continued from page 1	2042.0	
	Boring terminated at auger refusal at 40.0 feet Groundwater level at 35.5 feet at termination of boring and at 17.1 feet after 30 days * TOPSOIL ** Sandy SILT Note: Installed pipe (2" PVC pipe) to depth of 43.0 feet		

Macon County Landfill

TEST BORING RECORD

BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113

PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

BORING NO. B-18
DATE DRILLED 9-27-89
JOB NO. 1351-89-369

UNDISTURBED SAMPLE
50 % ROCK CORE RECOVERY
LOSS OF DRILLING WATER
WATER TABLE-24 HR.
WATER TABLE-1 HR.
HOLE CAVE

Westinghouse Environmental and Geotechnical Services, Inc.

WE-8

DEPTH FT.	DESCRIPTION	ELEV.	PENETRATION-BLOWS PER FT. (0 10 20 30 40 60 80 100)
0		2156.9	
0.2	Residuum: Stiff Red Brown Slightly Micaceous Silty Medium to Fine Sandy**		14
2.5	Medium Dense Red Brown Slightly Clayey Silty Medium to Fine SAND	2151.9	14
			14
		2146.9	13
		2141.9	14
		2136.9	12
		2131.9	14
25.0	Medium Dense Yellow Brown Silty Medium to Fine SAND	2126.9	29
			31.0' 10-27-89
35.0	Hard Violet Slightly Fine Sandy SILT	2121.9	26
40.0		2116.9	40

Continue on Page 2

Macon County Landfill

TEST BORING RECORD

BORING NO. B-19
DATE DRILLED 9-27-89
JOB NO. 1351-89-369

BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113

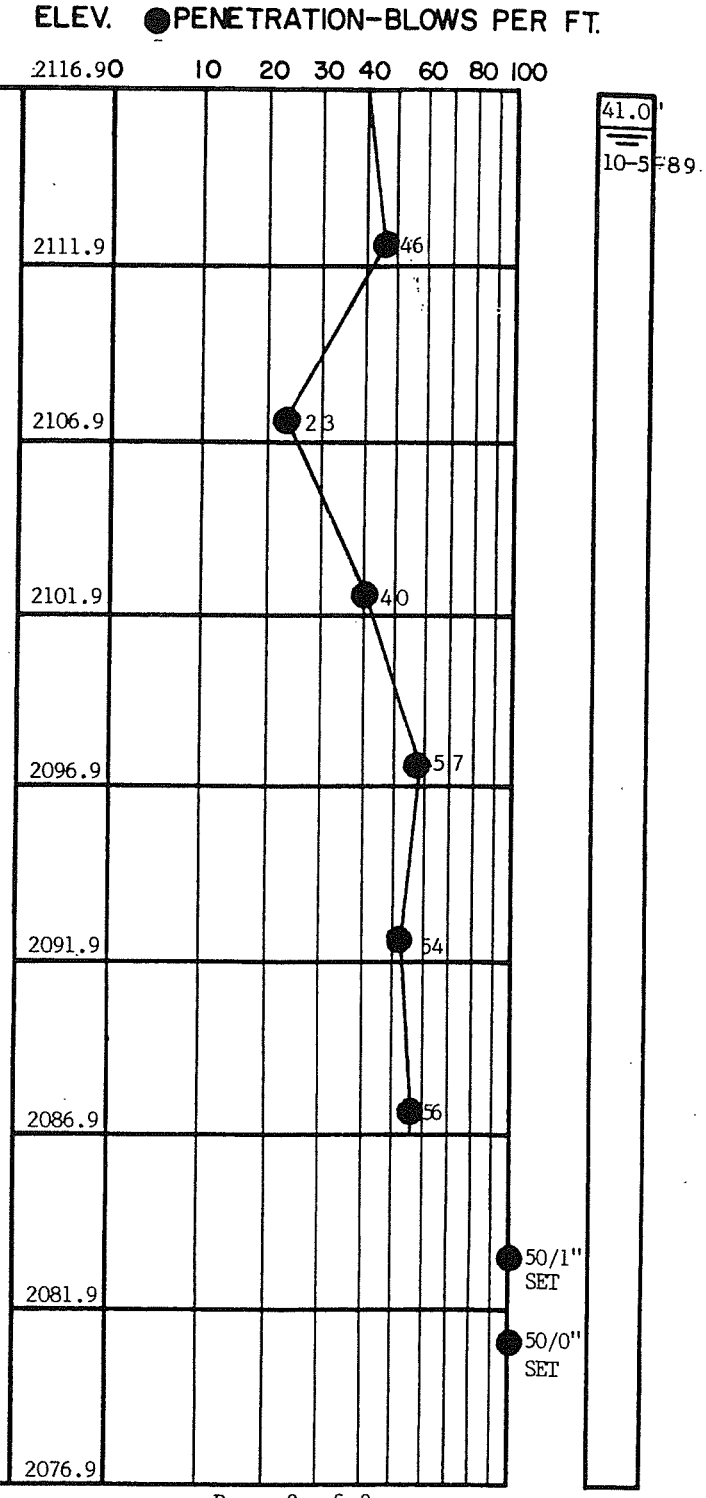
PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

UNDISTURBED SAMPLE
50% ROCK CORE RECOVERY
LOSS OF DRILLING WATER
WATER TABLE-24 HR.
WATER TABLE-1 HR.
HOLE CAVE

Westinghouse Environmental and Geotechnical Services, Inc.

WE-8

DEPTH FT.	DESCRIPTION	ELEV.
40.0	Continued from Page 1	2116.9
47.0	Very Stiff Tan Brown Medium to Fine Sandy SILT - with manganese stain	
53.0	Dense to Very Dense Tan Silty Coarse to Fine SAND	
70.0	Partially Weathered Rock When Sampled Becomes Medium to Fine Silty SAND	
76.0	Boring terminated at auger refusal at 76.0 feet Groundwater level at 31.0 feet at termination of boring and 41.0 feet after 2 hours	



* TOPSOIL
** CLAY - with root traces

Macon County Landfill

BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113

PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

UNDISTURBED SAMPLE
50 % ROCK CORE RECOVERY
LOSS OF DRILLING WATER
WATER TABLE-24HR.
WATER TABLE-1HR.
HOLE CAVE

WE-8

TEST BORING RECORD

BORING NO. B-19
DATE DRILLED 9-27-89
JOB NO. 1351-89-369

Westinghouse Environmental and Geotechnical Services, Inc.

Macon County Landfill - Cell No. 3 Piezometer Table				
Description	Northing	Easting	Elevation	Point No.
BLE 1 TOC	557993.4123	693239.7173	2081.10	10047
1 CPNL	557993.5900	693240.2381	2078.09	10046
BLE 2 TOC	557870.2755	693607.2131	2097.47	10055
2 CPNL	557870.3748	693606.7174	2094.54	10053
BLE 3 TOC	557666.4750	693782.1931	2084.33	10063
3 CPNL	557666.2328	693783.0221	2081.47	10061
BLE 4 TOC	557238.4730	693782.9383	2099.80	10204
4 CPNL	557237.7877	693783.2425	2096.93	10203
BLE 5 TOC	557841.0910	693407.9687	2106.17	10051
5 CPNL	557841.9024	693408.1476	2103.10	10048
Stake - BLE 5R2 - NO WELL	557425.7804	693688.6330	2121.32	10026
BLE 6 TOC	557674.5536	693571.9895	2125.43	10030
6 CPNL	557673.9250	693572.4675	2122.41	10029
B-6R TOC	557583.8367	694576.6711	2149.49	10087
6R CPNL	557584.3626	694577.2685	2146.27	10086
BLE 7 TOC	557464.2712	693888.0486	2131.11	10024
7 CPNL	557464.6489	693887.5204	2128.01	10021
BLE 8 TOC	557233.6541	693541.5133	2086.97	10038
8 CPNL	557233.1844	693540.9162	2083.89	10035
BLE 9 TOC	557376.3672	693411.5764	2068.76	10041
9 CPNL	557375.3080	693411.6151	2065.65	10040
Stake - BLE 10 - NO WELL	557247.9358	694053.2472	2125.43	10078
BLE 11 TOC	557575.3270	694139.1726	2161.80	10020
11 CPNL	557575.9445	694139.1262	2158.69	10017
BLE 12 TOC	557377.5440	694294.8514	2112.25	10016
12 CPNL	557378.1164	694294.7478	2109.23	10014
BLE 13 TOC	557652.8644	694424.1419	2119.50	10083
13 CPNL	557653.4937	694423.6793	2116.38	10082
BLE 14 TOC	557393.9918	694599.8306	2148.59	10095
14 CPNL	557394.8768	694599.0908	2146.02	10094
BLE 15 TOC	557095.9608	694432.0585	2103.52	10103
15 CPNL	557095.8201	694431.4321	2100.28	10102
BLE 16 TOC	556836.7733	694273.6572	2094.67	10099
16 CPNL	556836.1418	694274.5478	2091.57	10098
BLE 16R TOC	557575.7250	693335.2115	2082.89	10034
16R CPNL	557576.5099	693335.7661	2079.74	10032
BLE 17 TOC	557024.6239	693860.6557	2060.75	10011
17 CPNL	557025.0027	693861.2359	2057.62	10010
BLE 18 TOC	557702.8464	694721.0996	2113.57	10091
18 CPNL	557703.4025	694720.8453	2110.36	10090
BLE 18R TOC	557088.8820	694199.2259	2086.28	10007
18R CPNL	557090.0765	694199.5009	2083.18	10005
BLE 19 TOC	557865.7488	694291.1442	2096.48	10074
19 CPNL	557866.7829	694290.8621	2093.04	10073

Macon County Landfill - Cell No. 3 Piezometer Table				
BLE 20 TOC	558225.1797	693574.7092	2030.26	10066
20 CPNL	558224.3514	693574.3760	2027.39	10065
BLE 21 TOC	558126.4971	693339.5281	2045.86	10059
21 CPNL	558125.7645	693339.7093	2042.71	10057
BLE 22 TOC	558174.3678	693064.3614	2044.57	10071
22 CPNL	558175.9405	693064.5608	2042.22	10069

Horizontal coordinates are reported on the North Carolina state plane grid NAD83(1986).

The elevations listed are orthometric heights based upon NAVD88 (GEOID09) and adjusted +0.39 feet to match the localized vertical datum provided by the County, established by Brian T. Moore, PLS.

The average combined scale factor for this site is 0.999777814.

See GPS report by J. Dallas Gordon, PLS NC L-4626 dated May 5, 2012.

APPENDIX C

PIEZOMETER INSTALLATION PROCEDURES

APPENDIX C

PIEZOMETER INSTALLATION PROCEDURES

Groundwater piezometers were installed in the boreholes resulting from the drilling process. Approximate well locations are shown on the attached Piezometer/Boring Location Plan (**Figure 3**).

The piezometer consists of 2-inch diameter PVC pipe (Schedule 40 with flush-threaded joints) inserted into 4.0 to 8.25-inch nominal diameter boreholes. The bottom 10 to 15-foot section of each piezometer was a manufactured screen with 0.010-inch slots. Washed sand backfill was placed around the outside of the pipe to at least 2 feet above the top of the well screen.

A bentonite seal (minimum 2-foot thick) was installed on top of the sand backfill up to within 5 feet of the ground surface. The upper 5 feet was filled cement-bentonite grout mixture. A PVC cap was placed over the PVC well stickup on each piezometer. Piezometer construction records are attached in **Appendix B**.

APPENDIX D

PRECIPITATION DATA

MONTHLY PRECIPITATION DATA - 2000 TO 2014

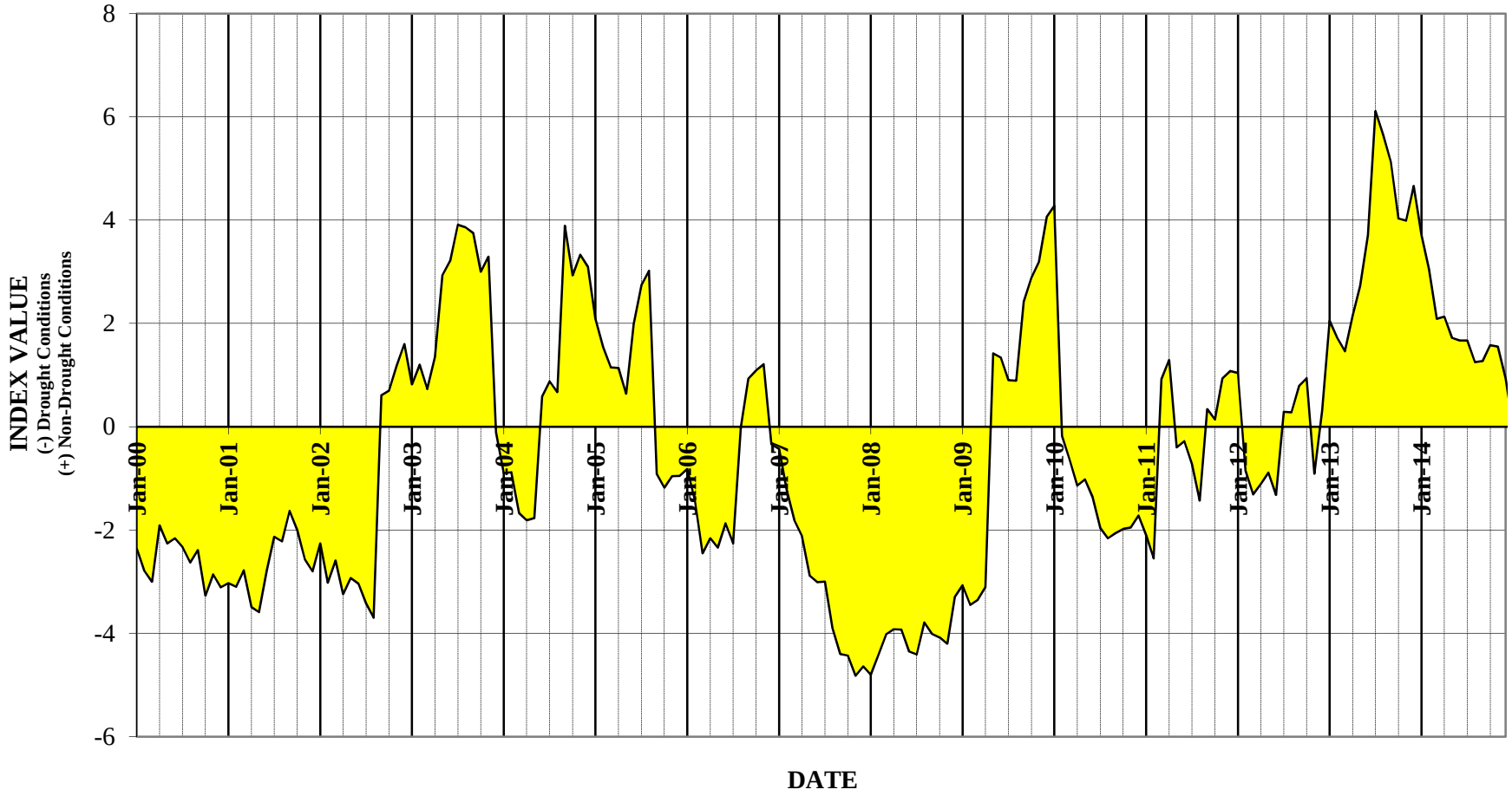
North Carolina Division 01
Macon County MSW Landfill
Franklin, North Carolina
BLE Job Number J13-1101-06

	Year															
MONTH	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**Monthly Avg.**
January	4.85	3.91	5.7	2.65	2.14	2.83	5.32	4.56	2.67	4.38	6.67	2.83	5.22	10.83	3.12	4.51
February	2.85	3.92	1.6	6.45	4.59	3.87	2.44	1.86	4.69	2.51	3.98	2.86	2.29	4.44	4.01	3.49
March	4.47	5.39	6.15	4.99	3.17	4.77	1.99	4.03	5.5	5.01	3.9	8.89	5	4.82	3.38	4.76
April	6.53	1.82	2.24	6.54	3.53	4.68	5.11	2.76	3.61	4.08	3.18	6.21	5	6.89	5.32	4.50
May	3.19	3.48	4.48	9.73	4.53	2.9	3	1.58	3.03	8.87	4.87	3.37	5.3	6.69	4.02	4.60
June	4.3	5.71	3.37	5.83	6.17	8.48	5.08	3.83	2.4	4.88	3.76	5.07	2.86	8.15	5.03	4.99
July	4.2	6.19	3.68	8.21	6.24	8.3	3.56	4.73	4.26	3.89	3.79	4.28	6.95	13.57	5.39	5.82
August	3.4	3.97	3.63	6.17	4.17	6.96	5.55	2.18	6.11	5.34	4.74	2.78	4.87	5.25	3.91	4.60
September	4.24	4.69	7.03	4.34	14.01	0.88	6.6	2.64	2.17	8.71	4.54	5.75	5.23	3.77	4.43	5.27
October	0.07	1.7	4.93	2.53	2.34	3.17	4.75	3.27	2.34	6.54	3.75	3.26	4.76	1.94	5.71	3.40
November	4.86	1.88	5.37	6.22	6.4	4.79	4.66	2.29	2.51	6.03	3.53	6.58	0.91	4.88	3.91	4.32
December	2.57	3.38	6.5	4.2	5.05	4.26	3.84	4.61	6.56	8.64	4.52	5.81	6.1	8.56	3.51	5.21
SEASON																**Seasonal Avg.**
Winter	12.17	13.22	13.45	14.09	9.9	11.47	9.75	10.45	12.86	11.9	14.55	14.58	12.51	**20.09**	10.51	12.77
Spring	14.02	11.01	10.09	**22.1**	14.23	16.06	13.19	8.17	9.04	17.83	11.81	14.65	13.16	21.73	14.37	14.10
Summer	11.84	14.85	14.34	18.72	**24.42**	16.14	15.71	9.55	12.54	17.94	13.07	12.81	17.05	22.59	13.73	15.69
Fall	7.5	6.96	16.8	12.95	13.79	12.22	13.25	10.17	11.41	**21.21**	11.8	15.65	11.77	15.38	13.13	12.93
Yearly Totals	45.53	46.04	54.68	67.86	62.34	55.89	51.90	38.34	45.85	68.88	51.23	57.69	54.49	79.79	51.74	**Yearly Avg.** 55.48

Notes:

1. Data Source: NOAA, public information - Updated through December 2014.
2. Monthly water levels were collected from September 2013 to Septamber 2014.

PALMER DROUGHT SEVERITY INDEX
North Carolina Division 1
Macon County MSW Landfill
Franklin, North Carolina
BLE Project Number J13-1101-06



APPENDIX E

SLUG TEST PROCEDURES AND RESULTS

APPENDIX E

SLUG TEST PROCEDURES AND RESULTS

Slug tests were performed in the field to estimate the average hydraulic conductivity of the upper formation material. Hydraulic conductivity is a constant of proportionality relating to the ease with which a fluid passes through a porous medium. These data were used to estimate the groundwater flow velocities of groundwater beneath the site. The field procedure was as follows:

- Measure the static groundwater elevation in the well to be tested.
- Affect an instantaneous change to the static water level in the well by removing a known volume of water.
- Measure the rate at which shown on the attached sheets the water level recovers to its original level.

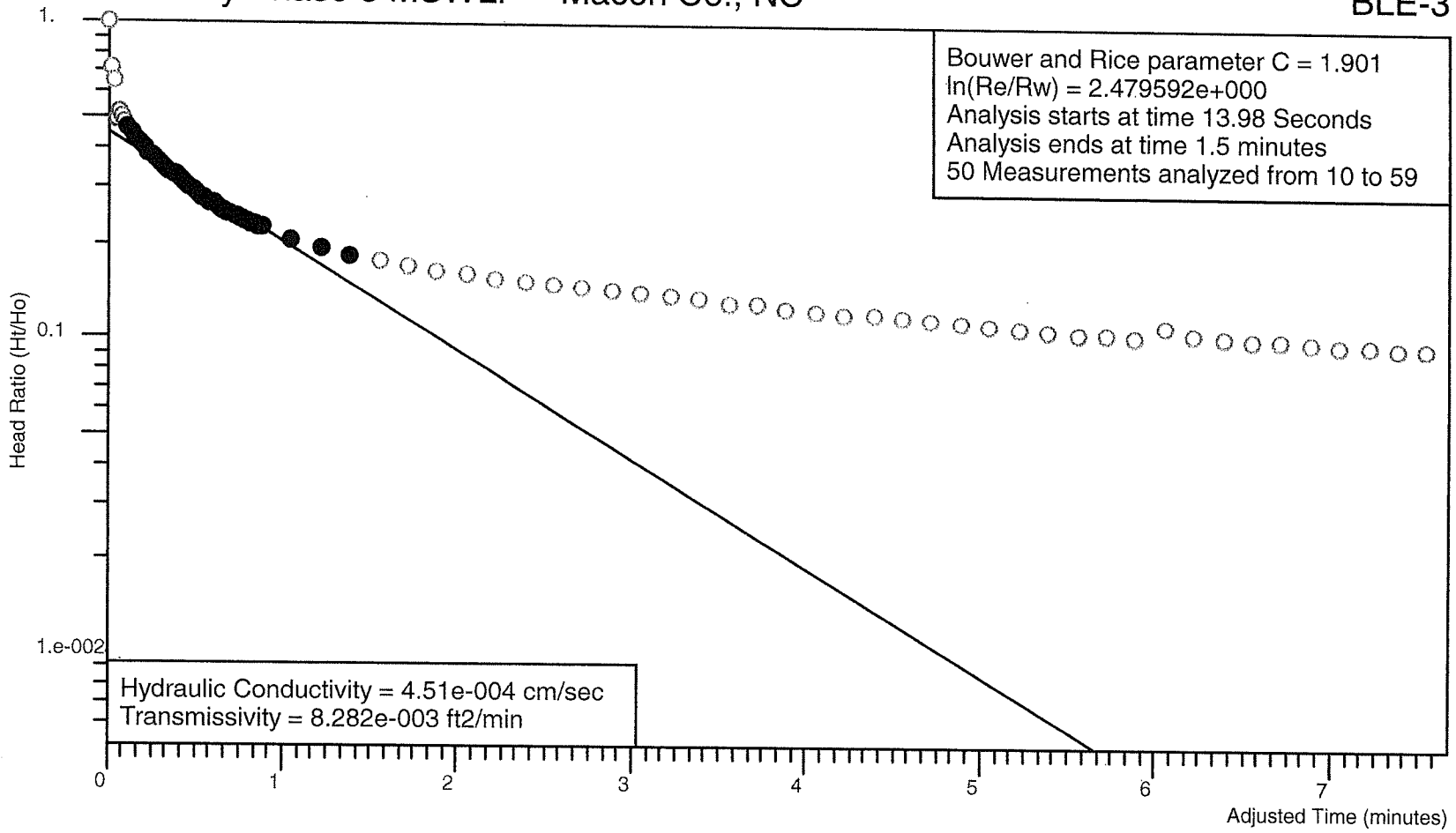
The resulting slug test data (time versus water level) was reduced and hydraulic conductivity values were calculated using the *Bouwer and Rice (1976)* Method for partially-penetrating wells in an unconfined aquifer.

Falling Head Slug Test - September 6, 2013

Macon County Phase 3 MSWLF - Macon Co., NC

Bouwer and Rice Graph

BLE-3



Ho is 5.696 feet at 7.02 Seconds

Project Number: J13-1101-06

Analysis by BLE

Falling Head Slug Test -

Site Name:	Macon County Phase 3 MSWLF -
Location:	Macon Co., NC
Test Date:	September 6, 2013
Project Number:	J13-1101-06
Import File:	C:\Public PC113\Projects\1101-06 Macon County Phase 3 DHR\Slug test\FINAL\

Well Label:	BLE-3
Aquifer Thickness:	9.33 feet
Screen Length:	9.33 feet
Casing Radius:	8.333e-002 feet
Effective Radius:	0.3438 feet
Static Water Level:	0. feet
Water Table to Screen Bottom:	9.33 feet
Anisotropy Ratio:	1.
Time Adjustment:	7.02 Seconds

Test starts with trial 2
There are 96 time and drawdown measurements
Maximum head is 5.696 feet
Minimum head is 0. feet

Trial	Time (minutes)	Adjusted Time (minutes)	Drawdown (feet)	Head (feet)	Head Ratio
1	8.3e-002	-3.4e-002	1.5e-002	1.5e-002	2.633e-003
2	0.1	-1.7e-002	0.532	0.532	9.34e-002
3	0.117	0.	5.696	5.696	1.
4	0.133	1.6e-002	4.114	4.114	0.7223
5	0.15	3.3e-002	3.717	3.717	0.6526
6	0.167	5.e-002	2.784	2.784	0.4888
7	0.183	6.6e-002	2.955	2.955	0.5188
8	0.2	8.3e-002	2.842	2.842	0.4989
9	0.217	0.1	2.737	2.737	0.4805
10	0.233	0.116	2.64	2.64	0.4635
11	0.25	0.133	2.554	2.554	0.4484
12	0.267	0.15	2.473	2.473	0.4342
13	0.283	0.166	2.426	2.426	0.4259
14	0.3	0.183	2.368	2.368	0.4157
15	0.317	0.2	2.309	2.309	0.4054
16	0.333	0.216	2.255	2.255	0.3959
17	0.35	0.233	2.204	2.204	0.3869
18	0.367	0.25	2.154	2.154	0.3782
19	0.383	0.266	2.107	2.107	0.3699
20	0.4	0.283	2.068	2.068	0.3631
21	0.417	0.3	2.029	2.029	0.3562
22	0.433	0.316	2.002	2.002	0.3515
23	0.45	0.333	1.967	1.967	0.3453
24	0.467	0.35	1.928	1.928	0.3385
25	0.483	0.366	1.897	1.897	0.333
26	0.5	0.383	1.87	1.87	0.3283
27	0.517	0.4	1.835	1.835	0.3222
28	0.533	0.416	1.8	1.8	0.316
29	0.55	0.433	1.765	1.765	0.3099
30	0.567	0.45	1.734	1.734	0.3044
31	0.583	0.466	1.703	1.703	0.299
32	0.6	0.483	1.687	1.687	0.2962
33	0.617	0.5	1.66	1.66	0.2914
34	0.633	0.516	1.633	1.633	0.2867

35	0.65	0.533	1.602	1.602	0.2813
36	0.667	0.55	1.578	1.578	0.277
37	0.683	0.566	1.559	1.559	0.2737
38	0.7	0.583	1.535	1.535	0.2695
39	0.717	0.6	1.516	1.516	0.2662
40	0.733	0.616	1.497	1.497	0.2628
41	0.75	0.633	1.477	1.477	0.2593
42	0.767	0.65	1.458	1.458	0.256
43	0.783	0.666	1.446	1.446	0.2539
44	0.8	0.683	1.43	1.43	0.2511
45	0.817	0.7	1.407	1.407	0.247
46	0.833	0.716	1.392	1.392	0.2444
47	0.85	0.733	1.38	1.38	0.2423
48	0.867	0.75	1.372	1.372	0.2409
49	0.883	0.766	1.361	1.361	0.2389
50	0.9	0.783	1.349	1.349	0.2368
51	0.917	0.8	1.333	1.333	0.234
52	0.933	0.816	1.325	1.325	0.2326
53	0.95	0.833	1.314	1.314	0.2307
54	0.967	0.85	1.298	1.298	0.2279
55	0.983	0.866	1.291	1.291	0.2267
56	1.	0.883	1.279	1.279	0.2245
57	1.167	1.05	1.174	1.174	0.2061
58	1.333	1.216	1.104	1.104	0.1938
59	1.5	1.383	1.053	1.053	0.1849
60	1.667	1.55	1.01	1.01	0.1773
61	1.833	1.716	0.971	0.971	0.1705
62	2.	1.883	0.936	0.936	0.1643
63	2.167	2.05	0.909	0.909	0.1596
64	2.333	2.216	0.882	0.882	0.1548
65	2.5	2.383	0.874	0.874	0.1534
66	2.667	2.55	0.854	0.854	0.1499
67	2.833	2.716	0.835	0.835	0.1466
68	3.	2.883	0.815	0.815	0.1431
69	3.167	3.05	0.804	0.804	0.1412
70	3.333	3.216	0.784	0.784	0.1376
71	3.5	3.383	0.769	0.769	0.135
72	3.667	3.55	0.749	0.749	0.1315
73	3.833	3.716	0.741	0.741	0.1301
74	4.	3.883	0.722	0.722	0.1268
75	4.167	4.05	0.706	0.706	0.1239
76	4.333	4.216	0.695	0.695	0.122
77	4.5	4.383	0.687	0.687	0.1206
78	4.667	4.55	0.679	0.679	0.1192
79	4.833	4.716	0.664	0.664	0.1166
80	5.	4.883	0.652	0.652	0.1145
81	5.167	5.05	0.64	0.64	0.1124
82	5.333	5.216	0.628	0.628	0.1103
83	5.5	5.383	0.621	0.621	0.109
84	5.667	5.55	0.609	0.609	0.1069
85	5.833	5.716	0.601	0.601	0.1055
86	6.	5.883	0.593	0.593	0.1041
87	6.167	6.05	0.636	0.636	0.1117
88	6.333	6.216	0.609	0.609	0.1069
89	6.5	6.383	0.593	0.593	0.1041
90	6.667	6.55	0.586	0.586	0.1029
91	6.833	6.716	0.582	0.582	0.1022

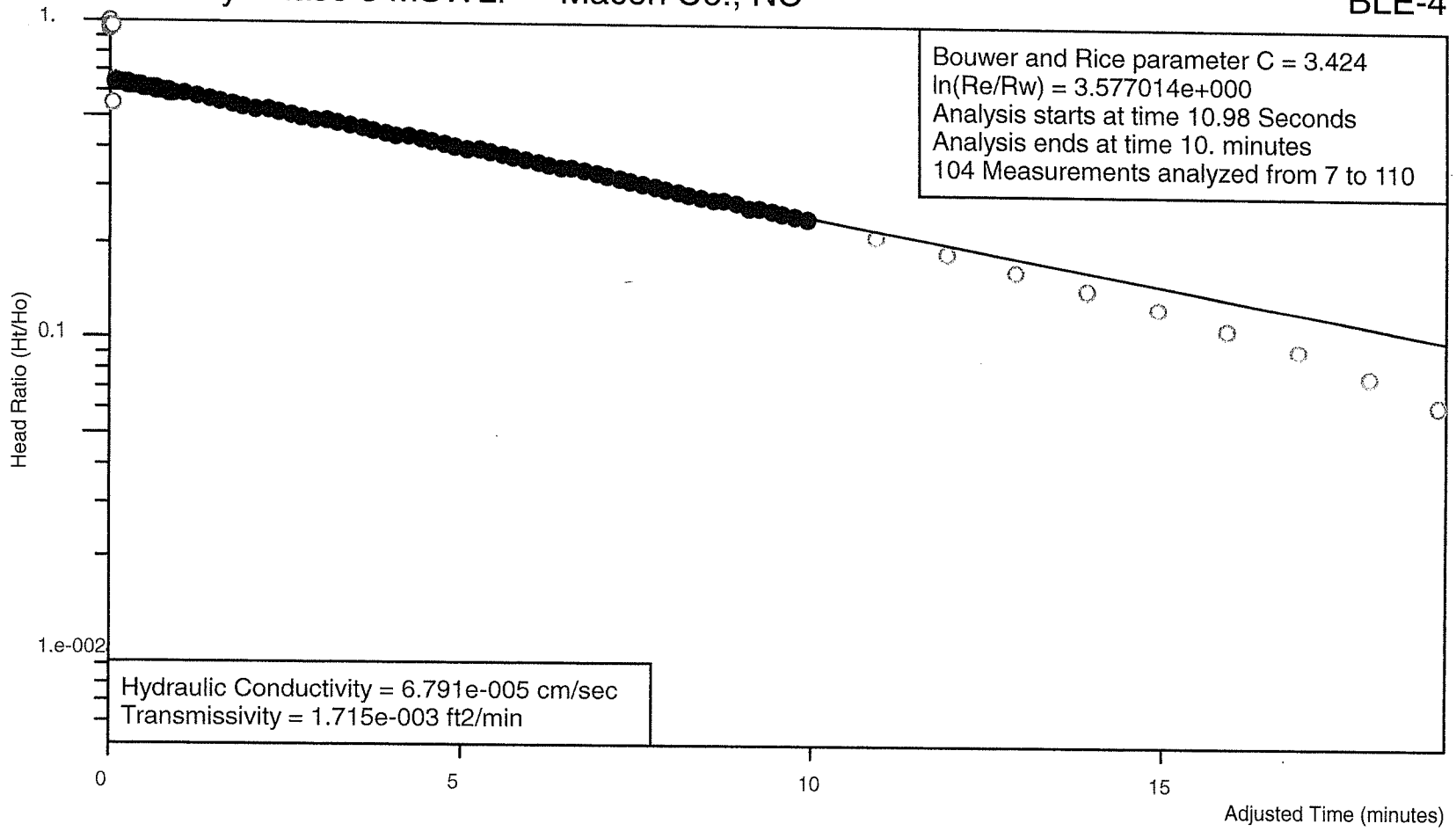
92	7.	6.883	0.57	0.57	0.1001
93	7.167	7.05	0.566	0.566	9.937e-002
94	7.333	7.216	0.558	0.558	9.796e-002
95	7.5	7.383	0.551	0.551	9.673e-002
96	7.667	7.55	0.547	0.547	9.603e-002

Falling Head Slug Test - September 26, 2013

Macon County Phase 3 MSWLF - Macon Co., NC

Bouwer and Rice Graph

BLE-4



Ho is 5.609 feet at 4.98 Seconds

Project Number: J13-1101-06

Analysis by BLE

Falling Head Slug Test -

Site Name:	Macon County Phase 3 MSWLF -
Location:	Macon Co., NC
Test Date:	September 26, 2013
Project Number:	J13-1101-06
Import File:	C:\Public PC113\Projects\1101-06 Macon County Phase 3 DHR\Slug test\FINAL\I

Well Label:	BLE-4
Aquifer Thickness:	12.83 feet
Screen Length:	10. feet
Casing Radius:	8.333e-002 feet
Effective Radius:	0.124 feet
Static Water Level:	0. feet
Water Table to Screen Bottom:	12.83 feet
Anisotropy Ratio:	1.
Time Adjustment:	4.98 Seconds

Test starts with trial 0
There are 119 time and drawdown measurements
Maximum head is 5.609 feet
Minimum head is 0. feet

Trial	Time (minutes)	Adjusted Time (minutes)	Drawdown (feet)	Head (feet)	Head Ratio
1	8.3e-002	0.	5.609	5.609	1.
2	0.1	1.7e-002	5.379	5.379	0.959
3	0.117	3.4e-002	5.488	5.488	0.9784
4	0.133	5.e-002	5.426	5.426	0.9674
5	0.15	6.7e-002	3.077	3.077	0.5486
6	0.167	8.4e-002	3.63	3.63	0.6472
7	0.183	1.e-001	3.626	3.626	0.6465
8	0.2	0.117	3.622	3.622	0.6457
9	0.217	0.134	3.614	3.614	0.6443
10	0.233	0.15	3.61	3.61	0.6436
11	0.25	0.167	3.602	3.602	0.6422
12	0.267	0.184	3.598	3.598	0.6415
13	0.283	0.2	3.591	3.591	0.6402
14	0.3	0.217	3.587	3.587	0.6395
15	0.317	0.234	3.583	3.583	0.6388
16	0.333	0.25	3.571	3.571	0.6367
17	0.35	0.267	3.567	3.567	0.6359
18	0.367	0.284	3.56	3.56	0.6347
19	0.383	0.3	3.556	3.556	0.634
20	0.4	0.317	3.552	3.552	0.6333
21	0.417	0.334	3.544	3.544	0.6318
22	0.433	0.35	3.54	3.54	0.6311
23	0.45	0.367	3.532	3.532	0.6297
24	0.467	0.384	3.525	3.525	0.6285
25	0.483	0.4	3.521	3.521	0.6277
26	0.5	0.417	3.517	3.517	0.627
27	0.517	0.434	3.513	3.513	0.6263
28	0.533	0.45	3.505	3.505	0.6249
29	0.55	0.467	3.497	3.497	0.6235
30	0.567	0.484	3.494	3.494	0.6229
31	0.583	0.5	3.49	3.49	0.6222
32	0.6	0.517	3.482	3.482	0.6208
33	0.617	0.534	3.478	3.478	0.6201
34	0.633	0.55	3.47	3.47	0.6186

35	0.65	0.567	3.462	3.462	0.6172
36	0.667	0.584	3.459	3.459	0.6167
37	0.683	0.6	3.459	3.459	0.6167
38	0.7	0.617	3.447	3.447	0.6145
39	0.717	0.634	3.443	3.443	0.6138
40	0.733	0.65	3.435	3.435	0.6124
41	0.75	0.667	3.431	3.431	0.6117
42	0.767	0.684	3.428	3.428	0.6112
43	0.783	0.7	3.424	3.424	0.6104
44	0.8	0.717	3.416	3.416	0.609
45	0.817	0.734	3.408	3.408	0.6076
46	0.833	0.75	3.404	3.404	0.6069
47	0.85	0.767	3.396	3.396	0.6055
48	0.867	0.784	3.392	3.392	0.6047
49	0.883	0.8	3.389	3.389	0.6042
50	0.9	0.817	3.381	3.381	0.6028
51	0.917	0.834	3.377	3.377	0.6021
52	0.933	0.85	3.369	3.369	0.6006
53	0.95	0.867	3.365	3.365	0.5999
54	0.967	0.884	3.361	3.361	0.5992
55	0.983	0.9	3.358	3.358	0.5987
56	1.	0.917	3.35	3.35	0.5973
57	1.167	1.084	3.303	3.303	0.5889
58	1.333	1.25	3.241	3.241	0.5778
59	1.5	1.417	3.194	3.194	0.5694
60	1.667	1.584	3.147	3.147	0.5611
61	1.833	1.75	3.097	3.097	0.5521
62	2.	1.917	3.046	3.046	0.5431
63	2.167	2.084	2.999	2.999	0.5347
64	2.333	2.25	2.957	2.957	0.5272
65	2.5	2.417	2.914	2.914	0.5195
66	2.667	2.584	2.867	2.867	0.5111
67	2.833	2.75	2.821	2.821	0.5029
68	3.	2.917	2.778	2.778	0.4953
69	3.167	3.084	2.735	2.735	0.4876
70	3.333	3.25	2.692	2.692	0.4799
71	3.5	3.417	2.649	2.649	0.4723
72	3.667	3.584	2.611	2.611	0.4655
73	3.833	3.75	2.568	2.568	0.4578
74	4.	3.917	2.529	2.529	0.4509
75	4.167	4.084	2.486	2.486	0.4432
76	4.333	4.25	2.447	2.447	0.4363
77	4.5	4.417	2.412	2.412	0.43
78	4.667	4.584	2.37	2.37	0.4225
79	4.833	4.75	2.335	2.335	0.4163
80	5.	4.917	2.296	2.296	0.4093
81	5.167	5.084	2.257	2.257	0.4024
82	5.333	5.25	2.222	2.222	0.3961
83	5.5	5.417	2.187	2.187	0.3899
84	5.667	5.584	2.152	2.152	0.3837
85	5.833	5.75	2.117	2.117	0.3774
86	6.	5.917	2.082	2.082	0.3712
87	6.167	6.084	2.051	2.051	0.3657
88	6.333	6.25	2.016	2.016	0.3594
89	6.5	6.417	1.981	1.981	0.3532
90	6.667	6.584	1.946	1.946	0.3469
91	6.833	6.75	1.915	1.915	0.3414

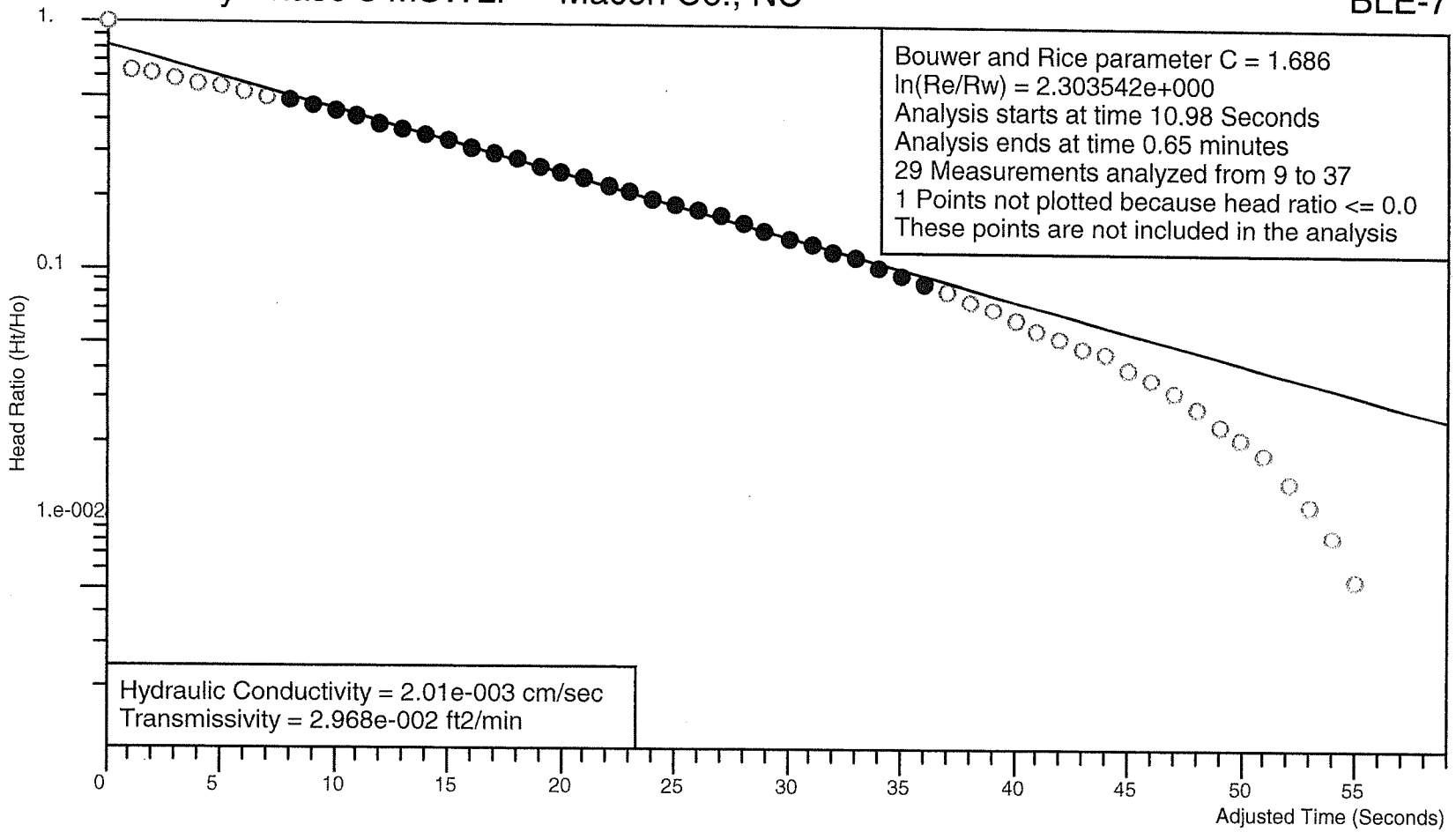
92	7.	6.917	1.88	1.88	0.3352
93	7.167	7.084	1.849	1.849	0.3296
94	7.333	7.25	1.818	1.818	0.3241
95	7.5	7.417	1.787	1.787	0.3186
96	7.667	7.584	1.756	1.756	0.3131
97	7.833	7.75	1.725	1.725	0.3075
98	8.	7.917	1.693	1.693	0.3018
99	8.167	8.084	1.666	1.666	0.297
100	8.333	8.25	1.635	1.635	0.2915
101	8.5	8.417	1.608	1.608	0.2867
102	8.667	8.584	1.577	1.577	0.2812
103	8.833	8.75	1.55	1.55	0.2763
104	9.	8.917	1.522	1.522	0.2713
105	9.167	9.084	1.491	1.491	0.2658
106	9.333	9.25	1.464	1.464	0.261
107	9.5	9.417	1.437	1.437	0.2562
108	9.667	9.584	1.414	1.414	0.2521
109	9.833	9.75	1.386	1.386	0.2471
110	10.	9.917	1.359	1.359	0.2423
111	11.	10.92	1.211	1.211	0.2159
112	12.	11.92	1.072	1.072	0.1911
113	13.	12.92	0.943	0.943	0.1681
114	14.	13.92	0.827	0.827	0.1474
115	15.	14.92	0.714	0.714	0.1273
116	16.	15.92	0.613	0.613	0.1093
117	17.	16.92	0.527	0.527	9.396e-002
118	18.	17.92	0.442	0.442	7.88e-002
119	19.	18.92	0.36	0.36	6.418e-002

Rising Head Slug Test - September 6, 2013

Bouwer and Rice Graph

Macon County Phase 3 MSWLF - Macon Co., NC

BLE-7



Project Number: J13-1101-06

Analysis by BLE

Ho is 2.753 feet at 3. Seconds

Rising Head Slug Test -

Site Name:	Macon County Phase 3 MSWLF -
Location:	Macon Co., NC
Test Date:	September 6, 2013
Project Number:	J13-1101-06
Import File:	C:\Public PC113\Projects\1101-06 Macon County Phase 3 DHR\Slug test\FINAL\I

Well Label:	BLE-7
Aquifer Thickness:	7.5 feet
Screen Length:	7.5 feet
Casing Radius:	8.333e-002 feet
Effective Radius:	0.3438 feet
Static Water Level:	0. feet
Water Table to Screen Bottom:	7.5 feet
Anisotropy Ratio:	1.
Time Adjustment:	3. Seconds

Test starts with trial 0
There are 57 time and drawdown measurements
Maximum head is 2.753 feet
Minimum head is 0. feet

Trial	Time (minutes)	Adjusted Time (minutes)	Drawdown (feet)	Head (feet)	Head Ratio
1	5.e-002	0.	-2.753	2.753	1.
2	6.7e-002	1.7e-002	-1.761	1.761	0.6397
3	8.3e-002	3.3e-002	-1.695	1.695	0.6157
4	0.1	5.e-002	-1.637	1.637	0.5946
5	0.117	6.7e-002	-1.547	1.547	0.5619
6	0.133	8.3e-002	-1.501	1.501	0.5452
7	0.15	1.e-001	-1.446	1.446	0.5252
8	0.167	0.117	-1.388	1.388	0.5042
9	0.183	0.133	-1.326	1.326	0.4817
10	0.2	0.15	-1.271	1.271	0.4617
11	0.217	0.167	-1.209	1.209	0.4392
12	0.233	0.183	-1.147	1.147	0.4166
13	0.25	0.2	-1.089	1.089	0.3956
14	0.267	0.217	-1.034	1.034	0.3756
15	0.283	0.233	-0.976	0.976	0.3545
16	0.3	0.25	-0.921	0.921	0.3345
17	0.317	0.267	-0.875	0.875	0.3178
18	0.333	0.283	-0.824	0.824	0.2993
19	0.35	0.3	-0.777	0.777	0.2822
20	0.367	0.317	-0.735	0.735	0.267
21	0.383	0.333	-0.692	0.692	0.2514
22	0.4	0.35	-0.657	0.657	0.2386
23	0.417	0.367	-0.618	0.618	0.2245
24	0.433	0.383	-0.583	0.583	0.2118
25	0.45	0.4	-0.548	0.548	0.1991
26	0.467	0.417	-0.521	0.521	0.1892
27	0.483	0.433	-0.49	0.49	0.178
28	0.5	0.45	-0.466	0.466	0.1693
29	0.517	0.467	-0.435	0.435	0.158
30	0.533	0.483	-0.408	0.408	0.1482
31	0.55	0.5	-0.381	0.381	0.1384
32	0.567	0.517	-0.357	0.357	0.1297
33	0.583	0.533	-0.334	0.334	0.1213
34	0.6	0.55	-0.315	0.315	0.1144

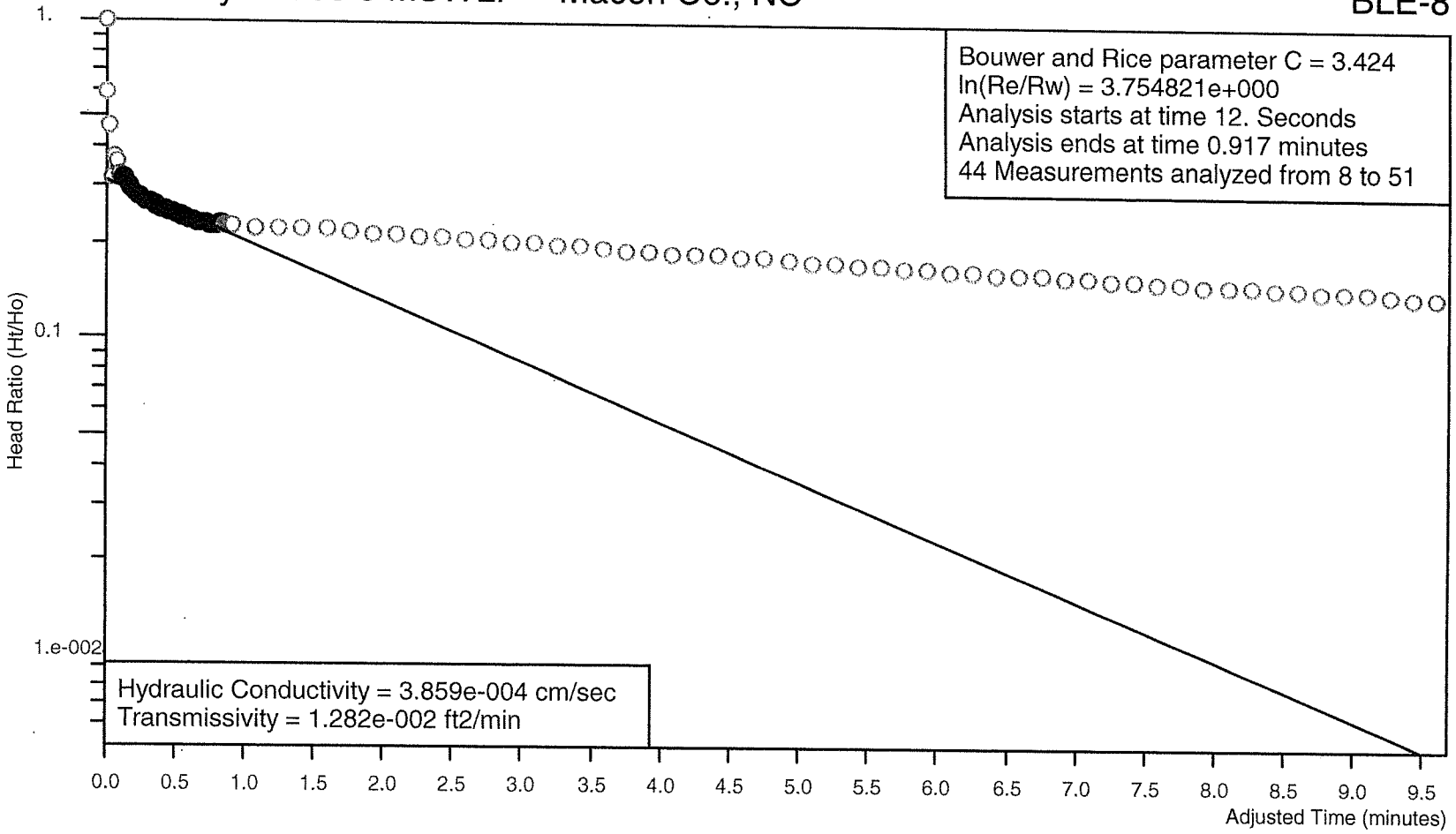
35	0.617	0.567	-0.291	0.291	0.1057
36	0.633	0.583	-0.272	0.272	9.88e-002
37	0.65	0.6	-0.252	0.252	9.154e-002
38	0.667	0.617	-0.233	0.233	8.463e-002
39	0.683	0.633	-0.213	0.213	7.737e-002
40	0.7	0.65	-0.198	0.198	7.192e-002
41	0.717	0.667	-0.178	0.178	6.466e-002
42	0.733	0.683	-0.163	0.163	5.921e-002
43	0.75	0.7	-0.151	0.151	5.485e-002
44	0.767	0.717	-0.136	0.136	4.94e-002
45	0.783	0.733	-0.128	0.128	4.649e-002
46	0.8	0.75	-0.112	0.112	4.068e-002
47	0.817	0.767	-0.101	0.101	3.669e-002
48	0.833	0.783	-8.9e-002	8.9e-002	3.233e-002
49	0.85	0.8	-7.7e-002	7.7e-002	2.797e-002
50	0.867	0.817	-6.6e-002	6.6e-002	2.397e-002
51	0.883	0.833	-5.8e-002	5.8e-002	2.107e-002
52	0.9	0.85	-5.e-002	5.e-002	1.816e-002
53	0.917	0.867	-3.8e-002	3.8e-002	1.38e-002
54	0.933	0.883	-3.1e-002	3.1e-002	1.126e-002
55	0.95	0.9	-2.3e-002	2.3e-002	8.355e-003
56	0.967	0.917	-1.5e-002	1.5e-002	5.449e-003
57	0.983	0.933	-3.e-003	3.e-003	1.09e-003

Falling Head Slug Test - September 26, 2013

Macon County Phase 3 MSWLF - Macon Co., NC

Bouwer and Rice Graph

BLE-8



Project Number: J13-1101-06

Analysis by BLE

Ho is 3.376 feet at 4.98 Seconds

Falling Head Slug Test -

Site Name:	Macon County Phase 3 MSWLF -
Location:	Macon Co., NC
Test Date:	September 26, 2013
Project Number:	J13-1101-06
Import File:	C:\Public PC113\Projects\1101-06 Macon County Phase 3 DHR\Slug test\FINAL\

Well Label:	BLE-8
Aquifer Thickness:	16.88 feet
Screen Length:	10. feet
Casing Radius:	8.333e-002 feet
Effective Radius:	0.124 feet
Static Water Level:	0. feet
Water Table to Screen Bottom:	16.88 feet
Anisotropy Ratio:	1.
Time Adjustment:	4.98 Seconds

Test starts with trial 0
There are 108 time and drawdown measurements
Maximum head is 3.376 feet
Minimum head is 0. feet

Trial	Time (minutes)	Adjusted Time (minutes)	Drawdown (feet)	Head (feet)	Head Ratio
1	8.3e-002	0.	3.376	3.376	1.
2	0.1	1.7e-002	2.011	2.011	0.5957
3	0.117	3.4e-002	1.556	1.556	0.4609
4	0.133	5.e-002	1.078	1.078	0.3193
5	0.15	6.7e-002	1.257	1.257	0.3723
6	0.167	8.4e-002	1.214	1.214	0.3596
7	0.183	1.e-001	1.101	1.101	0.3261
8	0.2	0.117	1.082	1.082	0.3205
9	0.217	0.134	1.074	1.074	0.3181
10	0.233	0.15	1.035	1.035	0.3066
11	0.25	0.167	1.008	1.008	0.2986
12	0.267	0.184	0.988	0.988	0.2927
13	0.283	0.2	0.973	0.973	0.2882
14	0.3	0.217	0.957	0.957	0.2835
15	0.317	0.234	0.945	0.945	0.2799
16	0.333	0.25	0.934	0.934	0.2767
17	0.35	0.267	0.93	0.93	0.2755
18	0.367	0.284	0.914	0.914	0.2707
19	0.383	0.3	0.902	0.902	0.2672
20	0.4	0.317	0.898	0.898	0.266
21	0.417	0.334	0.891	0.891	0.2639
22	0.433	0.35	0.883	0.883	0.2616
23	0.45	0.367	0.875	0.875	0.2592
24	0.467	0.384	0.867	0.867	0.2568
25	0.483	0.4	0.863	0.863	0.2556
26	0.5	0.417	0.859	0.859	0.2544
27	0.517	0.434	0.855	0.855	0.2533
28	0.533	0.45	0.848	0.848	0.2512
29	0.55	0.467	0.84	0.84	0.2488
30	0.567	0.484	0.836	0.836	0.2476
31	0.583	0.5	0.832	0.832	0.2464
32	0.6	0.517	0.828	0.828	0.2453
33	0.617	0.534	0.82	0.82	0.2429
34	0.633	0.55	0.816	0.816	0.2417

35	0.65	0.567	0.809	0.809	0.2396
36	0.667	0.584	0.809	0.809	0.2396
37	0.683	0.6	0.801	0.801	0.2373
38	0.7	0.617	0.797	0.797	0.2361
39	0.717	0.634	0.793	0.793	0.2349
40	0.733	0.65	0.785	0.785	0.2325
41	0.75	0.667	0.785	0.785	0.2325
42	0.767	0.684	0.777	0.777	0.2302
43	0.783	0.7	0.777	0.777	0.2302
44	0.8	0.717	0.773	0.773	0.229
45	0.817	0.734	0.773	0.773	0.229
46	0.833	0.75	0.769	0.769	0.2278
47	0.85	0.767	0.769	0.769	0.2278
48	0.867	0.784	0.769	0.769	0.2278
49	0.883	0.8	0.769	0.769	0.2278
50	0.9	0.817	0.773	0.773	0.229
51	0.917	0.834	0.773	0.773	0.229
52	0.933	0.85	0.769	0.769	0.2278
53	0.95	0.867	0.769	0.769	0.2278
54	0.967	0.884	0.765	0.765	0.2266
55	0.983	0.9	0.769	0.769	0.2278
56	1.	0.917	0.769	0.769	0.2278
57	1.167	1.084	0.753	0.753	0.223
58	1.333	1.25	0.746	0.746	0.221
59	1.5	1.417	0.745	0.745	0.2207
60	1.667	1.584	0.745	0.745	0.2207
61	1.833	1.75	0.733	0.733	0.2171
62	2.	1.917	0.729	0.729	0.2159
63	2.167	2.084	0.721	0.721	0.2136
64	2.333	2.25	0.709	0.709	0.21
65	2.5	2.417	0.705	0.705	0.2088
66	2.667	2.584	0.697	0.697	0.2065
67	2.833	2.75	0.693	0.693	0.2053
68	3.	2.917	0.685	0.685	0.2029
69	3.167	3.084	0.678	0.678	0.2008
70	3.333	3.25	0.67	0.67	0.1985
71	3.5	3.417	0.666	0.666	0.1973
72	3.667	3.584	0.658	0.658	0.1949
73	3.833	3.75	0.65	0.65	0.1925
74	4.	3.917	0.646	0.646	0.1914
75	4.167	4.084	0.638	0.638	0.189
76	4.333	4.25	0.634	0.634	0.1878
77	4.5	4.417	0.627	0.627	0.1857
78	4.667	4.584	0.619	0.619	0.1834
79	4.833	4.75	0.615	0.615	0.1822
80	5.	4.917	0.611	0.611	0.181
81	5.167	5.084	0.603	0.603	0.1786
82	5.333	5.25	0.595	0.595	0.1762
83	5.5	5.417	0.592	0.592	0.1754
84	5.667	5.584	0.584	0.584	0.173
85	5.833	5.75	0.576	0.576	0.1706
86	6.	5.917	0.576	0.576	0.1706
87	6.167	6.084	0.568	0.568	0.1682
88	6.333	6.25	0.564	0.564	0.1671
89	6.5	6.417	0.556	0.556	0.1647
90	6.667	6.584	0.553	0.553	0.1638
91	6.833	6.75	0.549	0.549	0.1626

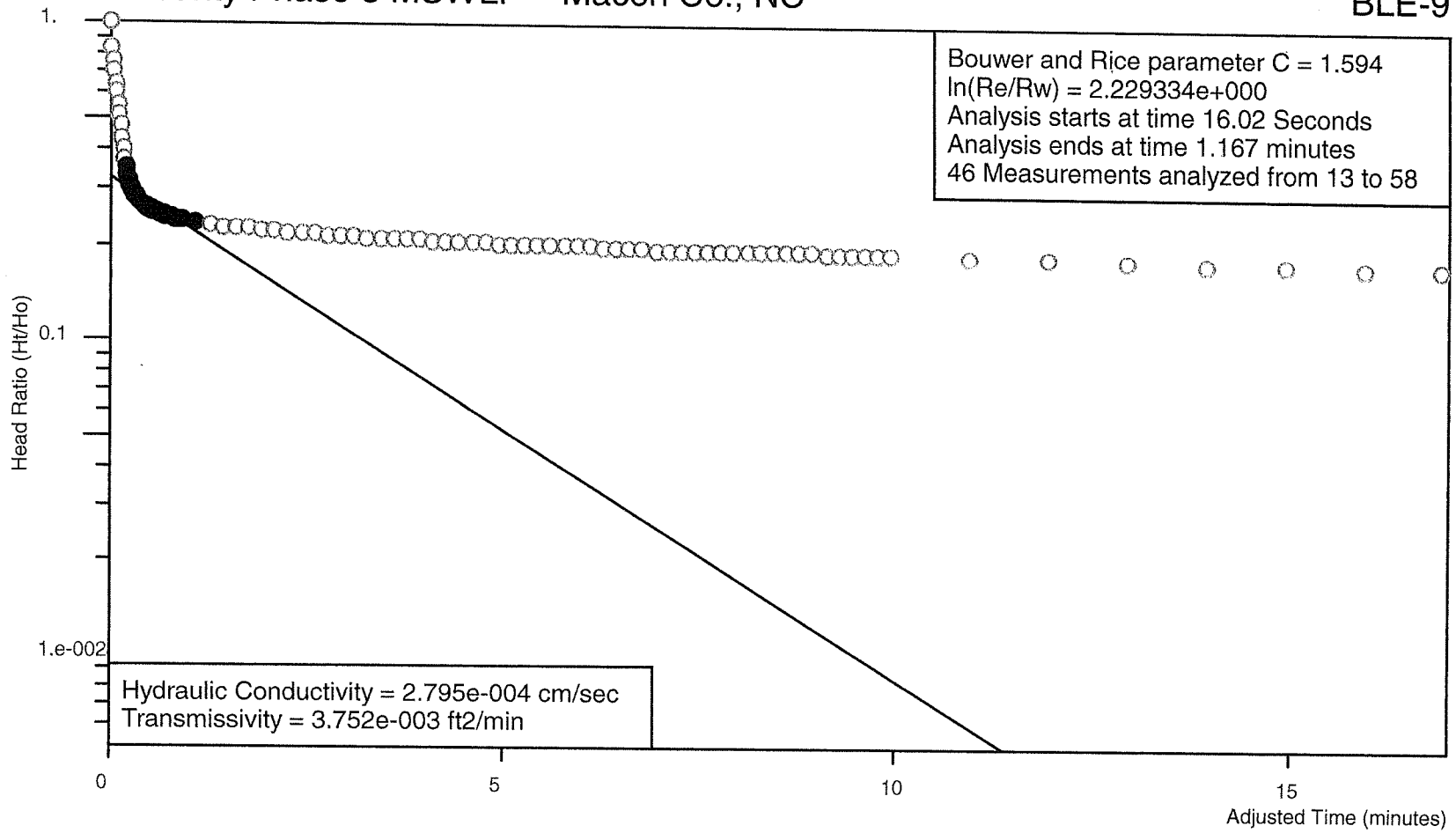
92	7.	6.917	0.545	0.545	0.1614
93	7.167	7.084	0.541	0.541	0.1602
94	7.333	7.25	0.537	0.537	0.1591
95	7.5	7.417	0.529	0.529	0.1567
96	7.667	7.584	0.525	0.525	0.1555
97	7.833	7.75	0.525	0.525	0.1555
98	8.	7.917	0.518	0.518	0.1534
99	8.167	8.084	0.514	0.514	0.1523
100	8.333	8.25	0.51	0.51	0.1511
101	8.5	8.417	0.506	0.506	0.1499
102	8.667	8.584	0.502	0.502	0.1487
103	8.833	8.75	0.494	0.494	0.1463
104	9.	8.917	0.49	0.49	0.1451
105	9.167	9.084	0.49	0.49	0.1451
106	9.333	9.25	0.486	0.486	0.144
107	9.5	9.417	0.479	0.479	0.1419
108	9.667	9.584	0.475	0.475	0.1407

Rising Head Slug Test - September 6, 2013

Macon County Phase 3 MSWLF - Macon Co., NC

Bouwer and Rice Graph

BLE-9



Ho is 3.285 feet at 4.02 Seconds

Project Number: J13-1101-06

Analysis by BLE

Rising Head Slug Test -

Site Name:	Macon County Phase 3 MSWLF -
Location:	Macon Co., NC
Test Date:	September 6, 2013
Project Number:	J13-1101-06
Import File:	C:\Public PC113\Projects\1101-06 Macon County Phase 3 DHR\Slug test\FINAL\I

Well Label:	BLE-9
Aquifer Thickness:	6.82 feet
Screen Length:	6.82 feet
Casing Radius:	8.333e-002 feet
Effective Radius:	0.3438 feet
Static Water Level:	0. feet
Water Table to Screen Bottom:	6.82 feet
Anisotropy Ratio:	1.
Time Adjustment:	4.02 Seconds

Test starts with trial 0
There are 118 time and drawdown measurements
Maximum head is 3.285 feet
Minimum head is 0. feet

Trial	Time (minutes)	Adjusted Time (minutes)	Drawdown (feet)	Head (feet)	Head Ratio
1	6.7e-002	0.	-3.285	3.285	1.
2	8.3e-002	1.6e-002	-2.722	2.722	0.8286
3	0.1	3.3e-002	-2.492	2.492	0.7586
4	0.117	5.e-002	-2.298	2.298	0.6995
5	0.133	6.6e-002	-2.123	2.123	0.6463
6	0.15	8.3e-002	-1.99	1.99	0.6058
7	0.167	0.1	-1.823	1.823	0.5549
8	0.183	0.116	-1.672	1.672	0.509
9	0.2	0.133	-1.543	1.543	0.4697
10	0.217	0.15	-1.423	1.423	0.4332
11	0.233	0.166	-1.314	1.314	0.4
12	0.25	0.183	-1.221	1.221	0.3717
13	0.267	0.2	-1.15	1.15	0.3501
14	0.283	0.216	-1.092	1.092	0.3324
15	0.3	0.233	-1.049	1.049	0.3193
16	0.317	0.25	-1.014	1.014	0.3087
17	0.333	0.266	-0.991	0.991	0.3017
18	0.35	0.283	-0.972	0.972	0.2959
19	0.367	0.3	-0.952	0.952	0.2898
20	0.383	0.316	-0.937	0.937	0.2852
21	0.4	0.333	-0.925	0.925	0.2816
22	0.417	0.35	-0.913	0.913	0.2779
23	0.433	0.366	-0.898	0.898	0.2734
24	0.45	0.383	-0.894	0.894	0.2721
25	0.467	0.4	-0.882	0.882	0.2685
26	0.483	0.416	-0.878	0.878	0.2673
27	0.5	0.433	-0.871	0.871	0.2651
28	0.517	0.45	-0.863	0.863	0.2627
29	0.533	0.466	-0.859	0.859	0.2615
30	0.55	0.483	-0.855	0.855	0.2603
31	0.567	0.5	-0.847	0.847	0.2578
32	0.583	0.516	-0.843	0.843	0.2566
33	0.6	0.533	-0.839	0.839	0.2554
34	0.617	0.55	-0.843	0.843	0.2566

35	0.633	0.566	-0.832	0.832	0.2533
36	0.65	0.583	-0.828	0.828	0.2521
37	0.667	0.6	-0.828	0.828	0.2521
38	0.683	0.616	-0.82	0.82	0.2496
39	0.7	0.633	-0.816	0.816	0.2484
40	0.717	0.65	-0.816	0.816	0.2484
41	0.733	0.666	-0.816	0.816	0.2484
42	0.75	0.683	-0.812	0.812	0.2472
43	0.767	0.7	-0.808	0.808	0.246
44	0.783	0.716	-0.808	0.808	0.246
45	0.8	0.733	-0.804	0.804	0.2447
46	0.817	0.75	-0.804	0.804	0.2447
47	0.833	0.766	-0.8	0.8	0.2435
48	0.85	0.783	-0.797	0.797	0.2426
49	0.867	0.8	-0.797	0.797	0.2426
50	0.883	0.816	-0.793	0.793	0.2414
51	0.9	0.833	-0.793	0.793	0.2414
52	0.917	0.85	-0.793	0.793	0.2414
53	0.933	0.866	-0.789	0.789	0.2402
54	0.95	0.883	-0.785	0.785	0.239
55	0.967	0.9	-0.785	0.785	0.239
56	0.983	0.916	-0.785	0.785	0.239
57	1.	0.933	-0.785	0.785	0.239
58	1.167	1.1	-0.77	0.77	0.2344
59	1.333	1.266	-0.754	0.754	0.2295
60	1.5	1.433	-0.75	0.75	0.2283
61	1.667	1.6	-0.742	0.742	0.2259
62	1.833	1.766	-0.738	0.738	0.2247
63	2.	1.933	-0.727	0.727	0.2213
64	2.167	2.1	-0.723	0.723	0.2201
65	2.333	2.266	-0.719	0.719	0.2189
66	2.5	2.433	-0.715	0.715	0.2177
67	2.667	2.6	-0.711	0.711	0.2164
68	2.833	2.766	-0.704	0.704	0.2143
69	3.	2.933	-0.7	0.7	0.2131
70	3.167	3.1	-0.7	0.7	0.2131
71	3.333	3.266	-0.696	0.696	0.2119
72	3.5	3.433	-0.696	0.696	0.2119
73	3.667	3.6	-0.688	0.688	0.2094
74	3.833	3.766	-0.688	0.688	0.2094
75	4.	3.933	-0.684	0.684	0.2082
76	4.167	4.1	-0.68	0.68	0.207
77	4.333	4.266	-0.68	0.68	0.207
78	4.5	4.433	-0.676	0.676	0.2058
79	4.667	4.6	-0.676	0.676	0.2058
80	4.833	4.766	-0.672	0.672	0.2046
81	5.	4.933	-0.669	0.669	0.2037
82	5.167	5.1	-0.669	0.669	0.2037
83	5.333	5.266	-0.669	0.669	0.2037
84	5.5	5.433	-0.665	0.665	0.2024
85	5.667	5.6	-0.661	0.661	0.2012
86	5.833	5.766	-0.661	0.661	0.2012
87	6.	5.933	-0.661	0.661	0.2012
88	6.167	6.1	-0.661	0.661	0.2012
89	6.333	6.266	-0.653	0.653	0.1988
90	6.5	6.433	-0.653	0.653	0.1988
91	6.667	6.6	-0.653	0.653	0.1988

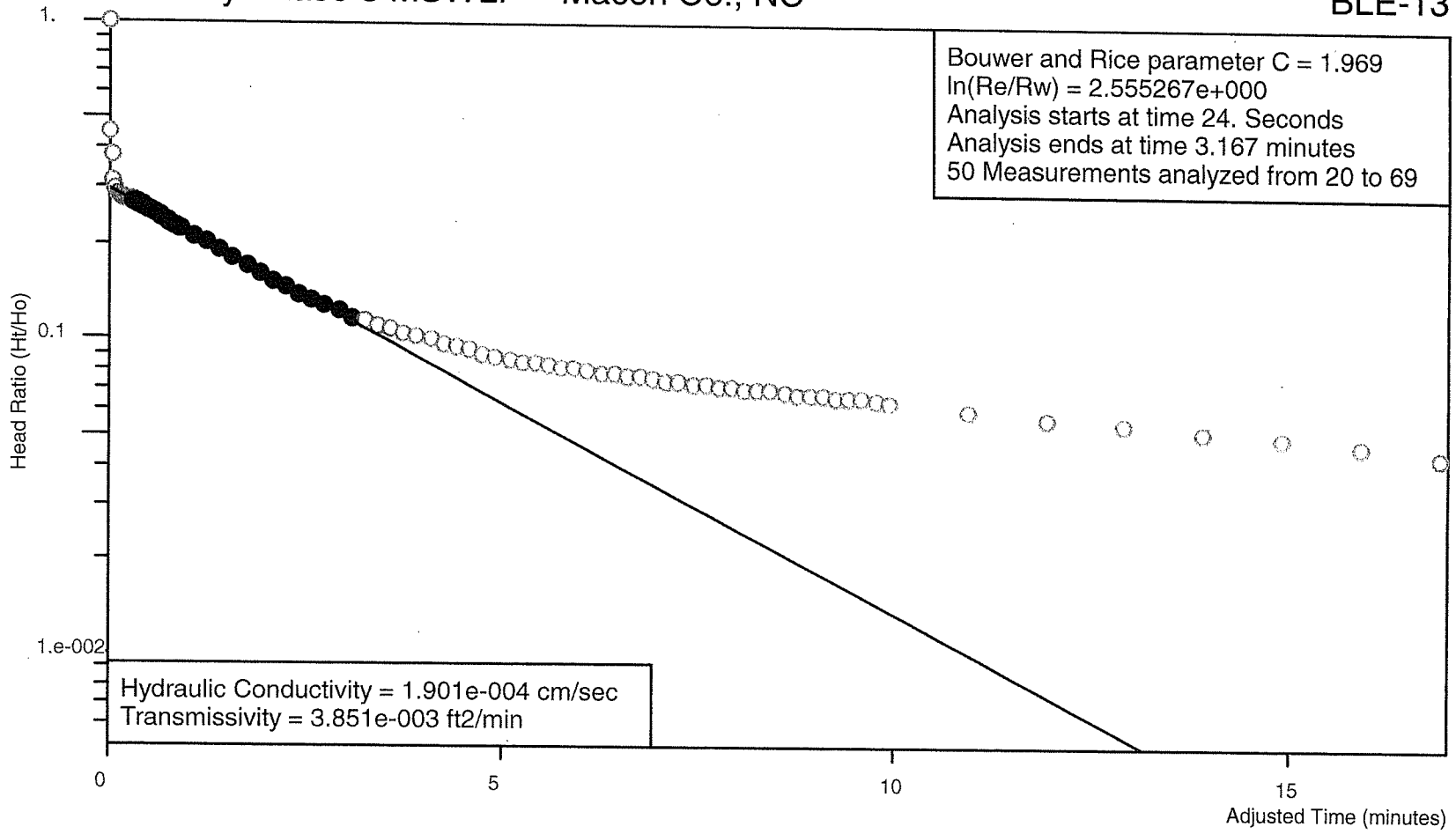
92	6.833	6.766	-0.649	0.649	0.1976
93	7.	6.933	-0.645	0.645	0.1963
94	7.167	7.1	-0.645	0.645	0.1963
95	7.333	7.266	-0.645	0.645	0.1963
96	7.5	7.433	-0.641	0.641	0.1951
97	7.667	7.6	-0.641	0.641	0.1951
98	7.833	7.766	-0.641	0.641	0.1951
99	8.	7.933	-0.641	0.641	0.1951
100	8.167	8.1	-0.637	0.637	0.1939
101	8.333	8.266	-0.637	0.637	0.1939
102	8.5	8.433	-0.637	0.637	0.1939
103	8.667	8.6	-0.634	0.634	0.193
104	8.833	8.766	-0.634	0.634	0.193
105	9.	8.933	-0.634	0.634	0.193
106	9.167	9.1	-0.63	0.63	0.1918
107	9.333	9.266	-0.63	0.63	0.1918
108	9.5	9.433	-0.626	0.626	0.1906
109	9.667	9.6	-0.626	0.626	0.1906
110	9.833	9.766	-0.626	0.626	0.1906
111	10.	9.933	-0.622	0.622	0.1893
112	11.	10.93	-0.618	0.618	0.1881
113	12.	11.93	-0.61	0.61	0.1857
114	13.	12.93	-0.603	0.603	0.1836
115	14.	13.93	-0.595	0.595	0.1811
116	15.	14.93	-0.591	0.591	0.1799
117	16.	15.93	-0.583	0.583	0.1775
118	17.	16.93	-0.579	0.579	0.1763

Falling Head Slug Test - September 6, 2013

Macon County Phase 3 MSWLF - Macon Co., NC

Bouwer and Rice Graph

BLE-13



Ho is 8.402 feet at 4.98 Seconds

Project Number: J13-1101-06

Analysis by BLE

Falling Head Slug Test -

Site Name:	Macon County Phase 3 MSWLF -
Location:	Macon Co., NC
Test Date:	September 6, 2013
Project Number:	J13-1101-06
Import File:	C:\Public PC113\Projects\1101-06 Macon County Phase 3 DHR\Slug test\FINAL\I

Well Label:	BLE-13
Aquifer Thickness:	10.29 feet
Screen Length:	10. feet
Casing Radius:	8.333e-002 feet
Effective Radius:	0.3438 feet
Static Water Level:	0. feet
Water Table to Screen Bottom:	10.29 feet
Anisotropy Ratio:	1.
Time Adjustment:	4.98 Seconds

Test starts with trial 0
There are 117 time and drawdown measurements
Maximum head is 8.402 feet
Minimum head is 0. feet

Trial	Time (minutes)	Adjusted Time (minutes)	Drawdown (feet)	Head (feet)	Head Ratio
1	8.3e-002	0.	8.402	8.402	1.
2	0.1	1.7e-002	3.771	3.771	0.4488
3	0.117	3.4e-002	3.184	3.184	0.379
4	0.133	5.e-002	2.605	2.605	0.31
5	0.15	6.7e-002	2.492	2.492	0.2966
6	0.167	8.4e-002	2.457	2.457	0.2924
7	0.183	1.e-001	2.379	2.379	0.2831
8	0.2	0.117	2.376	2.376	0.2828
9	0.217	0.134	2.329	2.329	0.2772
10	0.233	0.15	2.329	2.329	0.2772
11	0.25	0.167	2.337	2.337	0.2781
12	0.267	0.184	2.341	2.341	0.2786
13	0.283	0.2	2.306	2.306	0.2745
14	0.3	0.217	2.286	2.286	0.2721
15	0.317	0.234	2.302	2.302	0.274
16	0.333	0.25	2.302	2.302	0.274
17	0.35	0.267	2.298	2.298	0.2735
18	0.367	0.284	2.286	2.286	0.2721
19	0.383	0.3	2.282	2.282	0.2716
20	0.4	0.317	2.271	2.271	0.2703
21	0.417	0.334	2.263	2.263	0.2693
22	0.433	0.35	2.255	2.255	0.2684
23	0.45	0.367	2.243	2.243	0.267
24	0.467	0.384	2.232	2.232	0.2657
25	0.483	0.4	2.22	2.22	0.2642
26	0.5	0.417	2.208	2.208	0.2628
27	0.517	0.434	2.197	2.197	0.2615
28	0.533	0.45	2.185	2.185	0.2601
29	0.55	0.467	2.17	2.17	0.2583
30	0.567	0.484	2.158	2.158	0.2568
31	0.583	0.5	2.142	2.142	0.2549
32	0.6	0.517	2.135	2.135	0.2541
33	0.617	0.534	2.127	2.127	0.2532
34	0.633	0.55	2.111	2.111	0.2512

35	0.65	0.567	2.096	2.096	0.2495
36	0.667	0.584	2.084	2.084	0.248
37	0.683	0.6	2.076	2.076	0.2471
38	0.7	0.617	2.061	2.061	0.2453
39	0.717	0.634	2.049	2.049	0.2439
40	0.733	0.65	2.034	2.034	0.2421
41	0.75	0.667	2.022	2.022	0.2407
42	0.767	0.684	2.01	2.01	0.2392
43	0.783	0.7	1.999	1.999	0.2379
44	0.8	0.717	1.983	1.983	0.236
45	0.817	0.734	1.971	1.971	0.2346
46	0.833	0.75	1.96	1.96	0.2333
47	0.85	0.767	1.948	1.948	0.2318
48	0.867	0.784	1.936	1.936	0.2304
49	0.883	0.8	1.925	1.925	0.2291
50	0.9	0.817	1.917	1.917	0.2282
51	0.917	0.834	1.905	1.905	0.2267
52	0.933	0.85	1.894	1.894	0.2254
53	0.95	0.867	1.886	1.886	0.2245
54	0.967	0.884	1.878	1.878	0.2235
55	0.983	0.9	1.866	1.866	0.2221
56	1.	0.917	1.859	1.859	0.2213
57	1.167	1.084	1.777	1.777	0.2115
58	1.333	1.25	1.683	1.683	0.2003
59	1.5	1.417	1.602	1.602	0.1907
60	1.667	1.584	1.512	1.512	0.18
61	1.833	1.75	1.431	1.431	0.1703
62	2.	1.917	1.353	1.353	0.161
63	2.167	2.084	1.287	1.287	0.1532
64	2.333	2.25	1.224	1.224	0.1457
65	2.5	2.417	1.17	1.17	0.1393
66	2.667	2.584	1.112	1.112	0.1323
67	2.833	2.75	1.069	1.069	0.1272
68	3.	2.917	1.03	1.03	0.1226
69	3.167	3.084	0.987	0.987	0.1175
70	3.333	3.25	0.96	0.96	0.1143
71	3.5	3.417	0.921	0.921	0.1096
72	3.667	3.584	0.901	0.901	0.1072
73	3.833	3.75	0.874	0.874	0.104
74	4.	3.917	0.855	0.855	0.1018
75	4.167	4.084	0.839	0.839	9.986e-002
76	4.333	4.25	0.812	0.812	9.664e-002
77	4.5	4.417	0.793	0.793	9.438e-002
78	4.667	4.584	0.777	0.777	9.248e-002
79	4.833	4.75	0.758	0.758	9.022e-002
80	5.	4.917	0.738	0.738	8.784e-002
81	5.167	5.084	0.73	0.73	8.688e-002
82	5.333	5.25	0.715	0.715	8.51e-002
83	5.5	5.417	0.711	0.711	8.462e-002
84	5.667	5.584	0.699	0.699	8.319e-002
85	5.833	5.75	0.688	0.688	8.189e-002
86	6.	5.917	0.68	0.68	8.093e-002
87	6.167	6.084	0.672	0.672	7.998e-002
88	6.333	6.25	0.66	0.66	7.855e-002
89	6.5	6.417	0.657	0.657	7.82e-002
90	6.667	6.584	0.649	0.649	7.724e-002
91	6.833	6.75	0.645	0.645	7.677e-002

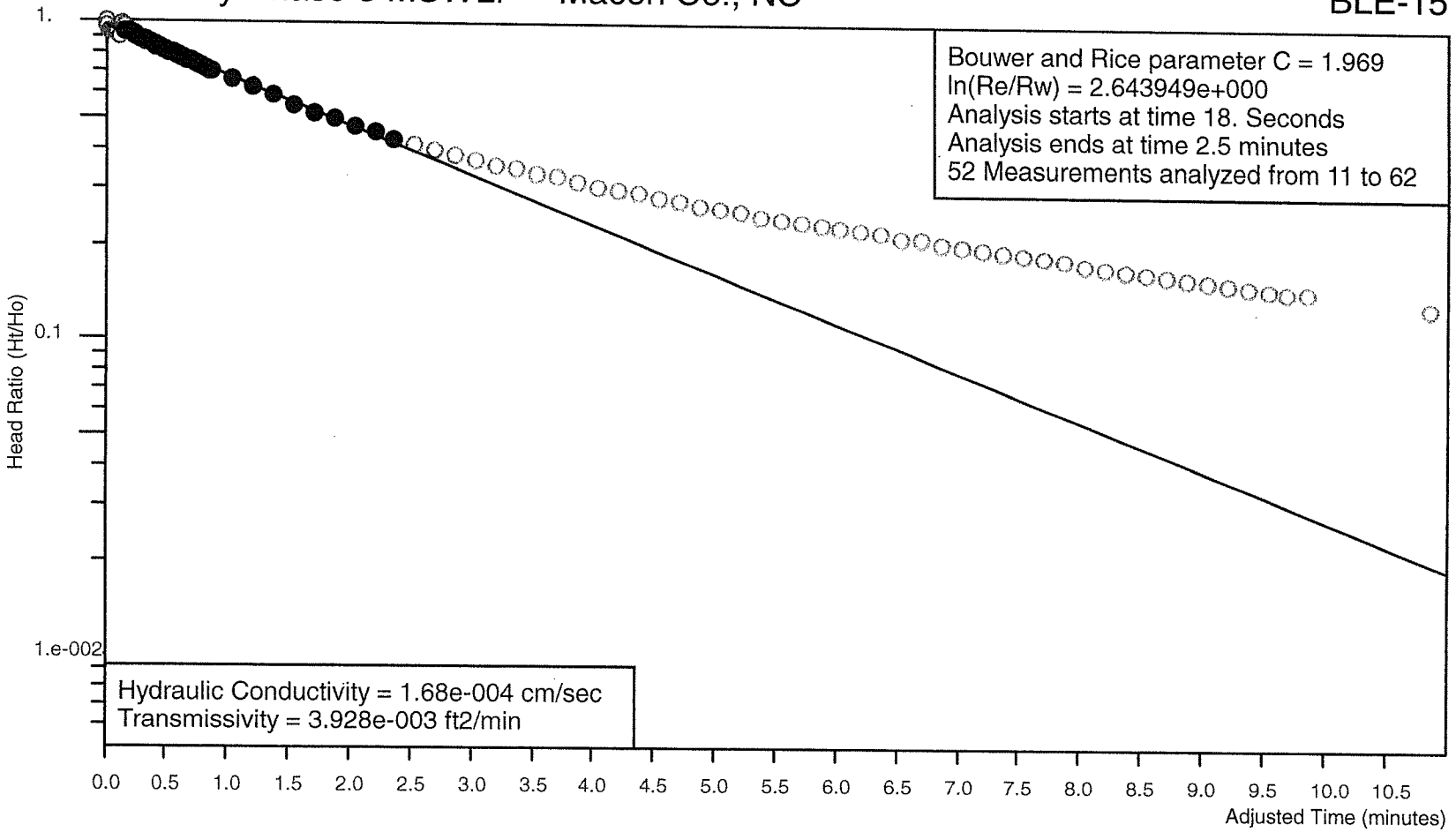
92	7.	6.917	0.637	0.637	7.582e-002
93	7.167	7.084	0.625	0.625	7.439e-002
94	7.333	7.25	0.621	0.621	7.391e-002
95	7.5	7.417	0.614	0.614	7.308e-002
96	7.667	7.584	0.61	0.61	7.26e-002
97	7.833	7.75	0.602	0.602	7.165e-002
98	8.	7.917	0.602	0.602	7.165e-002
99	8.167	8.084	0.594	0.594	7.07e-002
100	8.333	8.25	0.59	0.59	7.022e-002
101	8.5	8.417	0.587	0.587	6.986e-002
102	8.667	8.584	0.579	0.579	6.891e-002
103	8.833	8.75	0.571	0.571	6.796e-002
104	9.	8.917	0.567	0.567	6.748e-002
105	9.167	9.084	0.563	0.563	6.701e-002
106	9.333	9.25	0.555	0.555	6.606e-002
107	9.5	9.417	0.555	0.555	6.606e-002
108	9.667	9.584	0.552	0.552	6.57e-002
109	9.833	9.75	0.544	0.544	6.475e-002
110	10.	9.917	0.536	0.536	6.379e-002
111	11.	10.92	0.509	0.509	6.058e-002
112	12.	11.92	0.482	0.482	5.737e-002
113	13.	12.92	0.462	0.462	5.499e-002
114	14.	13.92	0.435	0.435	5.177e-002
115	15.	14.92	0.415	0.415	4.939e-002
116	16.	15.92	0.392	0.392	4.666e-002
117	17.	16.92	0.369	0.369	4.392e-002

Falling Head Slug Test - September 6, 2013

Macon County Phase 3 MSWLF - Macon Co., NC

Bouwer and Rice Graph

BLE-15



Project Number: J13-1101-06

Analysis by BLE

Ho is 2.251 feet at 7.98 Seconds

Falling Head Slug Test -

Site Name:	Macon County Phase 3 MSWLF -
Location:	Macon Co., NC
Test Date:	September 6, 2013
Project Number:	J13-1101-06
Import File:	C:\Public PC113\Projects\1101-06 Macon County Phase 3 DHR\Slug test\FINAL\

Well Label:	BLE-15
Aquifer Thickness:	11.88 feet
Screen Length:	10. feet
Casing Radius:	8.333e-002 feet
Effective Radius:	0.3438 feet
Static Water Level:	0. feet
Water Table to Screen Bottom:	11.88 feet
Anisotropy Ratio:	1.
Time Adjustment:	7.98 Seconds

Test starts with trial 0
There are 108 time and drawdown measurements
Maximum head is 2.251 feet
Minimum head is 0. feet

Trial	Time (minutes)	Adjusted Time (minutes)	Drawdown (feet)	Head (feet)	Head Ratio
1	0.133	0.	2.251	2.251	1.
2	0.15	1.7e-002	2.185	2.185	0.9707
3	0.167	3.4e-002	2.1	2.1	0.9329
4	0.183	5.e-002	2.088	2.088	0.9276
5	0.2	6.7e-002	2.104	2.104	0.9347
6	0.217	8.4e-002	2.112	2.112	0.9382
7	0.233	1.e-001	2.115	2.115	0.9396
8	0.25	0.117	2.045	2.045	0.9085
9	0.267	0.134	2.236	2.236	0.9933
10	0.283	0.15	2.189	2.189	0.9725
11	0.3	0.167	2.096	2.096	0.9311
12	0.317	0.184	2.088	2.088	0.9276
13	0.333	0.2	2.088	2.088	0.9276
14	0.35	0.217	2.065	2.065	0.9174
15	0.367	0.234	2.049	2.049	0.9103
16	0.383	0.25	2.026	2.026	0.9
17	0.4	0.267	2.01	2.01	0.8929
18	0.417	0.284	2.003	2.003	0.8898
19	0.433	0.3	1.991	1.991	0.8845
20	0.45	0.317	1.979	1.979	0.8792
21	0.467	0.334	1.964	1.964	0.8725
22	0.483	0.35	1.952	1.952	0.8672
23	0.5	0.367	1.937	1.937	0.8605
24	0.517	0.384	1.925	1.925	0.8552
25	0.533	0.4	1.909	1.909	0.8481
26	0.55	0.417	1.89	1.89	0.8396
27	0.567	0.434	1.882	1.882	0.8361
28	0.583	0.45	1.871	1.871	0.8312
29	0.6	0.467	1.859	1.859	0.8259
30	0.617	0.484	1.843	1.843	0.8187
31	0.633	0.5	1.832	1.832	0.8139
32	0.65	0.517	1.824	1.824	0.8103
33	0.667	0.534	1.808	1.808	0.8032
34	0.683	0.55	1.797	1.797	0.7983

35	0.7	0.567	1.785	1.785	0.793
36	0.717	0.584	1.773	1.773	0.7876
37	0.733	0.6	1.762	1.762	0.7828
38	0.75	0.617	1.75	1.75	0.7774
39	0.767	0.634	1.738	1.738	0.7721
40	0.783	0.65	1.727	1.727	0.7672
41	0.8	0.667	1.715	1.715	0.7619
42	0.817	0.684	1.707	1.707	0.7583
43	0.833	0.7	1.696	1.696	0.7534
44	0.85	0.717	1.684	1.684	0.7481
45	0.867	0.734	1.668	1.668	0.741
46	0.883	0.75	1.664	1.664	0.7392
47	0.9	0.767	1.657	1.657	0.7361
48	0.917	0.784	1.641	1.641	0.729
49	0.933	0.8	1.629	1.629	0.7237
50	0.95	0.817	1.622	1.622	0.7206
51	0.967	0.834	1.614	1.614	0.717
52	0.983	0.85	1.598	1.598	0.7099
53	1.	0.867	1.591	1.591	0.7068
54	1.167	1.034	1.497	1.497	0.665
55	1.333	1.2	1.407	1.407	0.6251
56	1.5	1.367	1.326	1.326	0.5891
57	1.667	1.534	1.252	1.252	0.5562
58	1.833	1.7	1.182	1.182	0.5251
59	2.	1.867	1.123	1.123	0.4989
60	2.167	2.034	1.073	1.073	0.4767
61	2.333	2.2	1.022	1.022	0.454
62	2.5	2.367	0.979	0.979	0.4349
63	2.667	2.534	0.937	0.937	0.4163
64	2.833	2.7	0.902	0.902	0.4007
65	3.	2.867	0.867	0.867	0.3852
66	3.167	3.034	0.835	0.835	0.3709
67	3.333	3.2	0.808	0.808	0.359
68	3.5	3.367	0.781	0.781	0.347
69	3.667	3.534	0.762	0.762	0.3385
70	3.833	3.7	0.738	0.738	0.3279
71	4.	3.867	0.715	0.715	0.3176
72	4.167	4.034	0.695	0.695	0.3088
73	4.333	4.2	0.676	0.676	0.3003
74	4.5	4.367	0.661	0.661	0.2936
75	4.667	4.534	0.645	0.645	0.2865
76	4.833	4.7	0.629	0.629	0.2794
77	5.	4.867	0.606	0.606	0.2692
78	5.167	5.034	0.594	0.594	0.2639
79	5.333	5.2	0.579	0.579	0.2572
80	5.5	5.367	0.564	0.564	0.2506
81	5.667	5.534	0.552	0.552	0.2452
82	5.833	5.7	0.544	0.544	0.2417
83	6.	5.867	0.532	0.532	0.2363
84	6.167	6.034	0.517	0.517	0.2297
85	6.333	6.2	0.505	0.505	0.2243
86	6.5	6.367	0.502	0.502	0.223
87	6.667	6.534	0.486	0.486	0.2159
88	6.833	6.7	0.478	0.478	0.2124
89	7.	6.867	0.467	0.467	0.2075
90	7.167	7.034	0.455	0.455	0.2021
91	7.333	7.2	0.447	0.447	0.1986

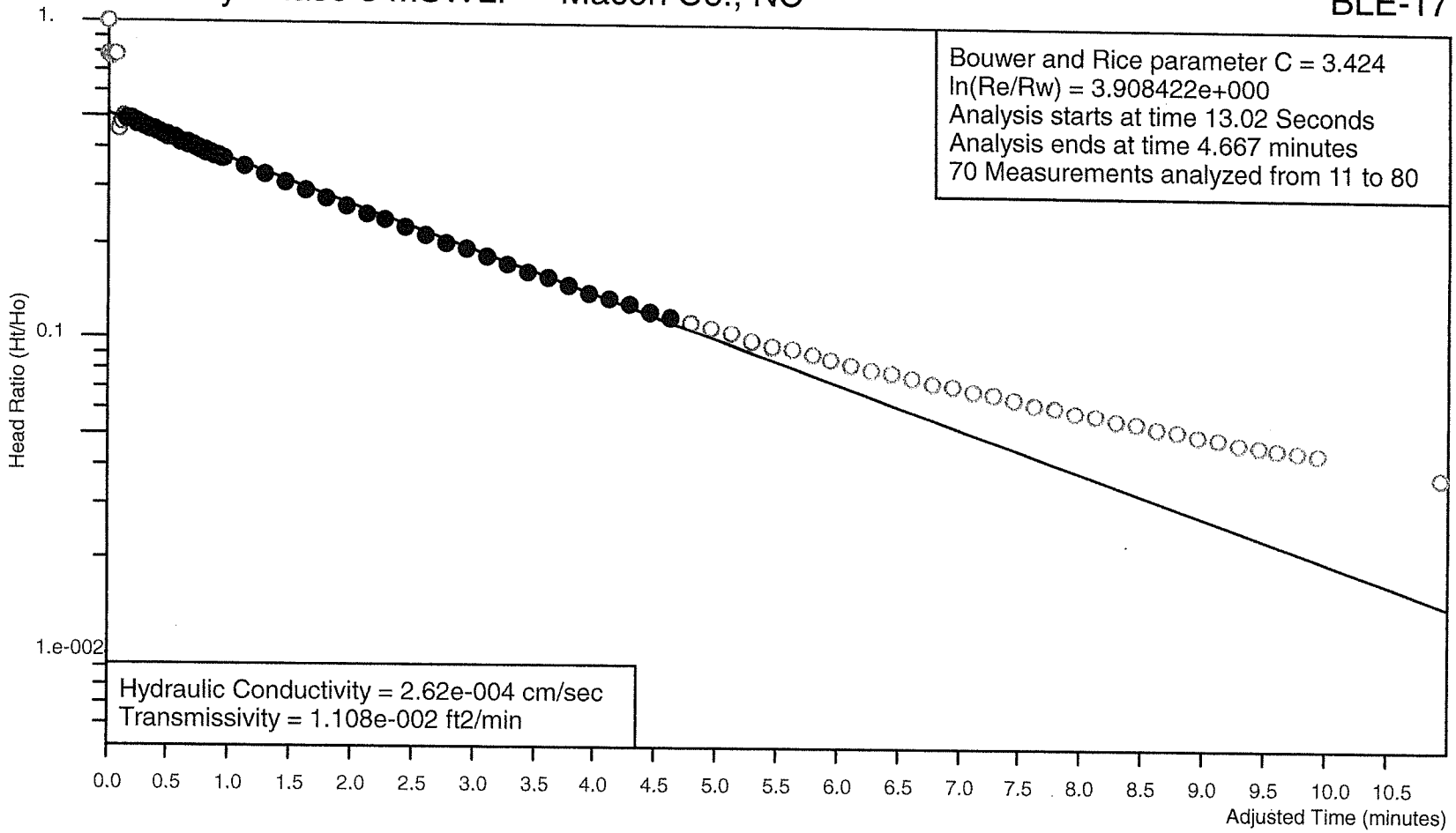
92	7.5	7.367	0.439	0.439	0.195
93	7.667	7.534	0.428	0.428	0.1901
94	7.833	7.7	0.42	0.42	0.1866
95	8.	7.867	0.412	0.412	0.183
96	8.167	8.034	0.4	0.4	0.1777
97	8.333	8.2	0.393	0.393	0.1746
98	8.5	8.367	0.385	0.385	0.171
99	8.667	8.534	0.377	0.377	0.1675
100	8.833	8.7	0.37	0.37	0.1644
101	9.	8.867	0.362	0.362	0.1608
102	9.167	9.034	0.354	0.354	0.1573
103	9.333	9.2	0.35	0.35	0.1555
104	9.5	9.367	0.342	0.342	0.1519
105	9.667	9.534	0.334	0.334	0.1484
106	9.833	9.7	0.327	0.327	0.1453
107	10.	9.867	0.327	0.327	0.1453
108	11.	10.87	0.296	0.296	0.1315

Falling Head Slug Test - September 26, 2013

Macon County Phase 3 MSWLF - Macon Co., NC

Bouwer and Rice Graph

BLE-17



Project Number: J13-1101-06

Analysis by BLE

Ho is 6.833 feet at 3. Seconds

Falling Head Slug Test -

Site Name:	Macon County Phase 3 MSWLF -
Location:	Macon Co., NC
Test Date:	September 26, 2013
Project Number:	J13-1101-06
Import File:	C:\Public PC113\Projects\1101-06 Macon County Phase 3 DHR\Slug test\FINAL\I

Well Label:	BLE-17
Aquifer Thickness:	21.48 feet
Screen Length:	10. feet
Casing Radius:	8.333e-002 feet
Effective Radius:	0.124 feet
Static Water Level:	0. feet
Water Table to Screen Bottom:	21.48 feet
Anisotropy Ratio:	1.
Time Adjustment:	3. Seconds

Test starts with trial 0
There are 113 time and drawdown measurements
Maximum head is 6.833 feet
Minimum head is 0. feet

Trial	Time (minutes)	Adjusted Time (minutes)	Drawdown (feet)	Head (feet)	Head Ratio
1	5.e-002	0.	6.833	6.833	1.
2	6.7e-002	1.7e-002	5.363	5.363	0.7849
3	8.3e-002	3.3e-002	5.324	5.324	0.7792
4	0.1	5.e-002	5.383	5.383	0.7878
5	0.117	6.7e-002	5.348	5.348	0.7827
6	0.133	8.3e-002	5.429	5.429	0.7945
7	0.15	1.e-001	3.1	3.1	0.4537
8	0.167	0.117	3.302	3.302	0.4832
9	0.183	0.133	3.396	3.396	0.497
10	0.2	0.15	3.388	3.388	0.4958
11	0.217	0.167	3.364	3.364	0.4923
12	0.233	0.183	3.333	3.333	0.4878
13	0.25	0.2	3.333	3.333	0.4878
14	0.267	0.217	3.298	3.298	0.4827
15	0.283	0.233	3.279	3.279	0.4799
16	0.3	0.25	3.259	3.259	0.477
17	0.317	0.267	3.236	3.236	0.4736
18	0.333	0.283	3.217	3.217	0.4708
19	0.35	0.3	3.197	3.197	0.4679
20	0.367	0.317	3.178	3.178	0.4651
21	0.383	0.333	3.158	3.158	0.4622
22	0.4	0.35	3.135	3.135	0.4588
23	0.417	0.367	3.116	3.116	0.456
24	0.433	0.383	3.096	3.096	0.4531
25	0.45	0.4	3.077	3.077	0.4503
26	0.467	0.417	3.061	3.061	0.448
27	0.483	0.433	3.042	3.042	0.4452
28	0.5	0.45	3.026	3.026	0.4429
29	0.517	0.467	3.003	3.003	0.4395
30	0.533	0.483	2.987	2.987	0.4371
31	0.55	0.5	2.964	2.964	0.4338
32	0.567	0.517	2.952	2.952	0.432
33	0.583	0.533	2.929	2.929	0.4287
34	0.6	0.55	2.917	2.917	0.4269

35	0.617	0.567	2.898	2.898	0.4241
36	0.633	0.583	2.879	2.879	0.4213
37	0.65	0.6	2.859	2.859	0.4184
38	0.667	0.617	2.844	2.844	0.4162
39	0.683	0.633	2.824	2.824	0.4133
40	0.7	0.65	2.812	2.812	0.4115
41	0.717	0.667	2.797	2.797	0.4093
42	0.733	0.683	2.777	2.777	0.4064
43	0.75	0.7	2.758	2.758	0.4036
44	0.767	0.717	2.746	2.746	0.4019
45	0.783	0.733	2.727	2.727	0.3991
46	0.8	0.75	2.711	2.711	0.3968
47	0.817	0.767	2.696	2.696	0.3946
48	0.833	0.783	2.68	2.68	0.3922
49	0.85	0.8	2.665	2.665	0.39
50	0.867	0.817	2.649	2.649	0.3877
51	0.883	0.833	2.634	2.634	0.3855
52	0.9	0.85	2.618	2.618	0.3831
53	0.917	0.867	2.602	2.602	0.3808
54	0.933	0.883	2.587	2.587	0.3786
55	0.95	0.9	2.575	2.575	0.3768
56	0.967	0.917	2.556	2.556	0.3741
57	0.983	0.933	2.544	2.544	0.3723
58	1.	0.95	2.525	2.525	0.3695
59	1.167	1.117	2.388	2.388	0.3495
60	1.333	1.283	2.252	2.252	0.3296
61	1.5	1.45	2.131	2.131	0.3119
62	1.667	1.617	2.011	2.011	0.2943
63	1.833	1.783	1.906	1.906	0.2789
64	2.	1.95	1.805	1.805	0.2642
65	2.167	2.117	1.711	1.711	0.2504
66	2.333	2.283	1.622	1.622	0.2374
67	2.5	2.45	1.54	1.54	0.2254
68	2.667	2.617	1.459	1.459	0.2135
69	2.833	2.783	1.385	1.385	0.2027
70	3.	2.95	1.319	1.319	0.193
71	3.167	3.117	1.252	1.252	0.1832
72	3.333	3.283	1.186	1.186	0.1736
73	3.5	3.45	1.132	1.132	0.1657
74	3.667	3.617	1.077	1.077	0.1576
75	3.833	3.783	1.027	1.027	0.1503
76	4.	3.95	0.972	0.972	0.1423
77	4.167	4.117	0.93	0.93	0.1361
78	4.333	4.283	0.887	0.887	0.1298
79	4.5	4.45	0.852	0.852	0.1247
80	4.667	4.617	0.813	0.813	0.119
81	4.833	4.783	0.778	0.778	0.1139
82	5.	4.95	0.747	0.747	0.1093
83	5.167	5.117	0.719	0.719	0.1052
84	5.333	5.283	0.692	0.692	0.1013
85	5.5	5.45	0.665	0.665	9.732e-002
86	5.667	5.617	0.646	0.646	9.454e-002
87	5.833	5.783	0.622	0.622	9.103e-002
88	6.	5.95	0.599	0.599	8.766e-002
89	6.167	6.117	0.579	0.579	8.474e-002
90	6.333	6.283	0.56	0.56	8.196e-002
91	6.5	6.45	0.548	0.548	8.02e-002

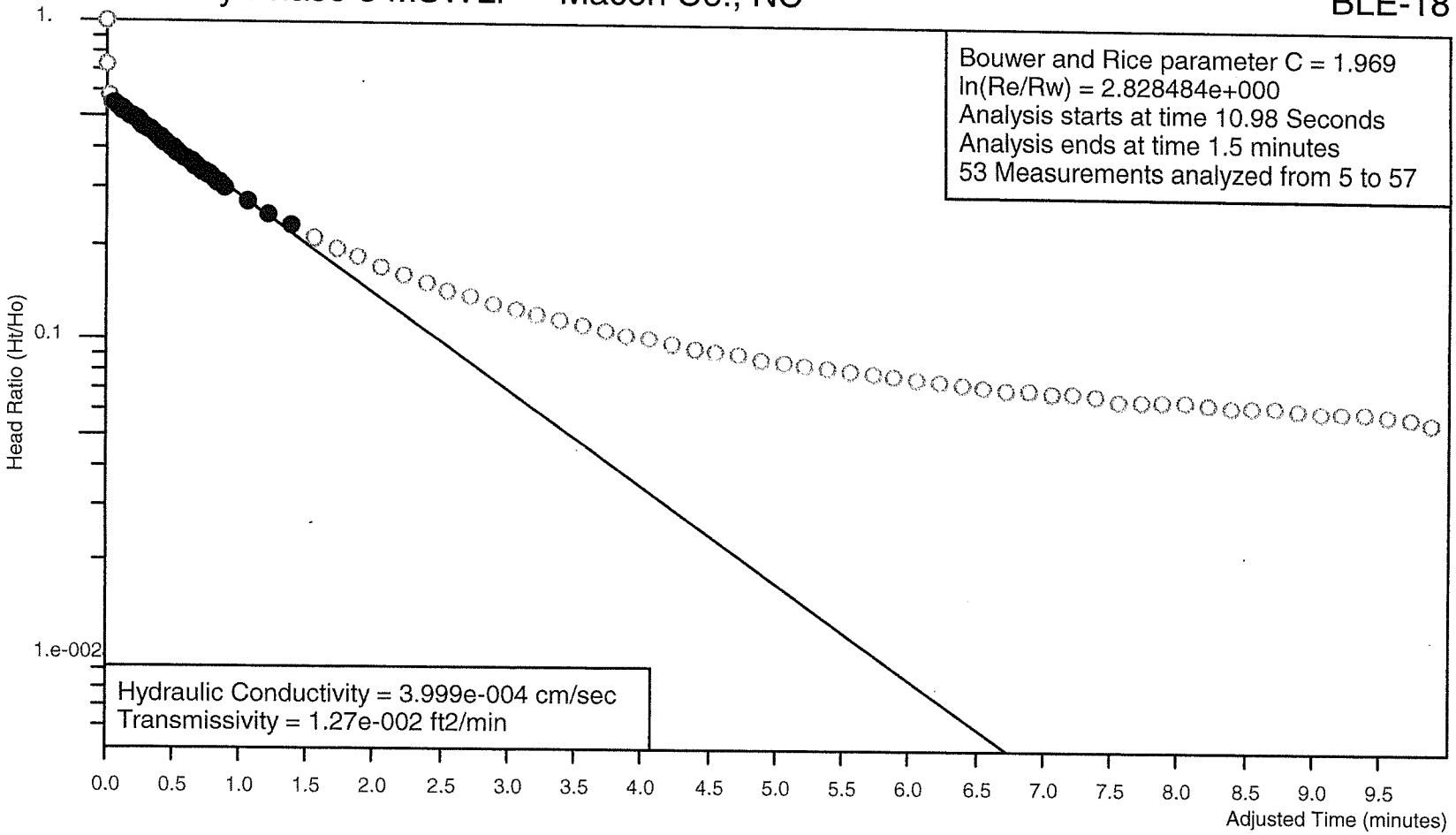
92	6.667	6.617	0.529	0.529	7.742e-002
93	6.833	6.783	0.509	0.509	7.449e-002
94	7.	6.95	0.494	0.494	7.23e-002
95	7.167	7.117	0.482	0.482	7.054e-002
96	7.333	7.283	0.467	0.467	6.834e-002
97	7.5	7.45	0.451	0.451	6.6e-002
98	7.667	7.617	0.436	0.436	6.381e-002
99	7.833	7.783	0.428	0.428	6.264e-002
100	8.	7.95	0.412	0.412	6.03e-002
101	8.167	8.117	0.401	0.401	5.869e-002
102	8.333	8.283	0.389	0.389	5.693e-002
103	8.5	8.45	0.381	0.381	5.576e-002
104	8.667	8.617	0.37	0.37	5.415e-002
105	8.833	8.783	0.358	0.358	5.239e-002
106	9.	8.95	0.35	0.35	5.122e-002
107	9.167	9.117	0.342	0.342	5.005e-002
108	9.333	9.283	0.327	0.327	4.786e-002
109	9.5	9.45	0.323	0.323	4.727e-002
110	9.667	9.617	0.315	0.315	4.61e-002
111	9.833	9.783	0.307	0.307	4.493e-002
112	10.	9.95	0.303	0.303	4.434e-002
113	11.	10.95	0.257	0.257	3.761e-002

Falling Head Slug Test - September 26, 2013

Macon County Phase 3 MSWLF - Macon Co., NC

Bouwer and Rice Graph

BLE-18



Project Number: J13-1101-06

Analysis by BLE

Ho is 4.18 feet at 7.02 Seconds

Falling Head Slug Test -

Site Name:	Macon County Phase 3 MSWLF -
Location:	Macon Co., NC
Test Date:	September 26, 2013
Project Number:	J13-1101-06
Import File:	C:\Public PC113\Projects\1101-06 Macon County Phase 3 DHR\Slug test\FINAL\I

Well Label:	BLE-18
Aquifer Thickness:	16.13 feet
Screen Length:	10. feet
Casing Radius:	8.333e-002 feet
Effective Radius:	0.3438 feet
Static Water Level:	0. feet
Water Table to Screen Bottom:	16.13 feet
Anisotropy Ratio:	1.
Time Adjustment:	7.02 Seconds

Test starts with trial 0
There are 108 time and drawdown measurements
Maximum head is 4.18 feet
Minimum head is 0. feet

Trial	Time (minutes)	Adjusted Time (minutes)	Drawdown (feet)	Head (feet)	Head Ratio
1	0.117	0.	4.18	4.18	1.
2	0.133	1.6e-002	3.033	3.033	0.7256
3	0.15	3.3e-002	2.434	2.434	0.5823
4	0.167	5.e-002	2.298	2.298	0.5498
5	0.183	6.6e-002	2.282	2.282	0.5459
6	0.2	8.3e-002	2.255	2.255	0.5395
7	0.217	0.1	2.232	2.232	0.534
8	0.233	0.116	2.224	2.224	0.5321
9	0.25	0.133	2.181	2.181	0.5218
10	0.267	0.15	2.162	2.162	0.5172
11	0.283	0.166	2.131	2.131	0.5098
12	0.3	0.183	2.107	2.107	0.5041
13	0.317	0.2	2.088	2.088	0.4995
14	0.333	0.216	2.061	2.061	0.4931
15	0.35	0.233	2.037	2.037	0.4873
16	0.367	0.25	2.01	2.01	0.4809
17	0.383	0.266	1.987	1.987	0.4754
18	0.4	0.283	1.96	1.96	0.4689
19	0.417	0.3	1.94	1.94	0.4641
20	0.433	0.316	1.905	1.905	0.4557
21	0.45	0.333	1.89	1.89	0.4522
22	0.467	0.35	1.862	1.862	0.4455
23	0.483	0.366	1.843	1.843	0.4409
24	0.5	0.383	1.816	1.816	0.4344
25	0.517	0.4	1.792	1.792	0.4287
26	0.533	0.416	1.769	1.769	0.4232
27	0.55	0.433	1.75	1.75	0.4187
28	0.567	0.45	1.726	1.726	0.4129
29	0.583	0.466	1.703	1.703	0.4074
30	0.6	0.483	1.68	1.68	0.4019
31	0.617	0.5	1.66	1.66	0.3971
32	0.633	0.516	1.637	1.637	0.3916
33	0.65	0.533	1.617	1.617	0.3868
34	0.667	0.55	1.594	1.594	0.3813

35	0.683	0.566	1.579	1.579	0.3778
36	0.7	0.583	1.559	1.559	0.373
37	0.717	0.6	1.54	1.54	0.3684
38	0.733	0.616	1.52	1.52	0.3636
39	0.75	0.633	1.505	1.505	0.36
40	0.767	0.65	1.485	1.485	0.3553
41	0.783	0.666	1.47	1.47	0.3517
42	0.8	0.683	1.45	1.45	0.3469
43	0.817	0.7	1.439	1.439	0.3443
44	0.833	0.716	1.419	1.419	0.3395
45	0.85	0.733	1.404	1.404	0.3359
46	0.867	0.75	1.388	1.388	0.3321
47	0.883	0.766	1.384	1.384	0.3311
48	0.9	0.783	1.357	1.357	0.3246
49	0.917	0.8	1.341	1.341	0.3208
50	0.933	0.816	1.322	1.322	0.3163
51	0.95	0.833	1.314	1.314	0.3144
52	0.967	0.85	1.299	1.299	0.3108
53	0.983	0.866	1.283	1.283	0.3069
54	1.	0.883	1.267	1.267	0.3031
55	1.167	1.05	1.147	1.147	0.2744
56	1.333	1.216	1.042	1.042	0.2493
57	1.5	1.383	0.96	0.96	0.2297
58	1.667	1.55	0.882	0.882	0.211
59	1.833	1.716	0.82	0.82	0.1962
60	2.	1.883	0.765	0.765	0.183
61	2.167	2.05	0.715	0.715	0.1711
62	2.333	2.216	0.676	0.676	0.1617
63	2.5	2.383	0.641	0.641	0.1533
64	2.667	2.55	0.606	0.606	0.145
65	2.833	2.716	0.579	0.579	0.1385
66	3.	2.883	0.551	0.551	0.1318
67	3.167	3.05	0.528	0.528	0.1263
68	3.333	3.216	0.505	0.505	0.1208
69	3.5	3.383	0.485	0.485	0.116
70	3.667	3.55	0.47	0.47	0.1124
71	3.833	3.716	0.454	0.454	0.1086
72	4.	3.883	0.438	0.438	0.1048
73	4.167	4.05	0.427	0.427	0.1022
74	4.333	4.216	0.411	0.411	9.833e-002
75	4.5	4.383	0.399	0.399	9.545e-002
76	4.667	4.55	0.388	0.388	9.282e-002
77	4.833	4.716	0.38	0.38	9.091e-002
78	5.	4.883	0.368	0.368	8.804e-002
79	5.167	5.05	0.361	0.361	8.636e-002
80	5.333	5.216	0.353	0.353	8.445e-002
81	5.5	5.383	0.349	0.349	8.349e-002
82	5.667	5.55	0.341	0.341	8.158e-002
83	5.833	5.716	0.333	0.333	7.967e-002
84	6.	5.883	0.326	0.326	7.799e-002
85	6.167	6.05	0.322	0.322	7.703e-002
86	6.333	6.216	0.318	0.318	7.608e-002
87	6.5	6.383	0.31	0.31	7.416e-002
88	6.667	6.55	0.306	0.306	7.321e-002
89	6.833	6.716	0.298	0.298	7.129e-002
90	7.	6.883	0.298	0.298	7.129e-002
91	7.167	7.05	0.294	0.294	7.033e-002

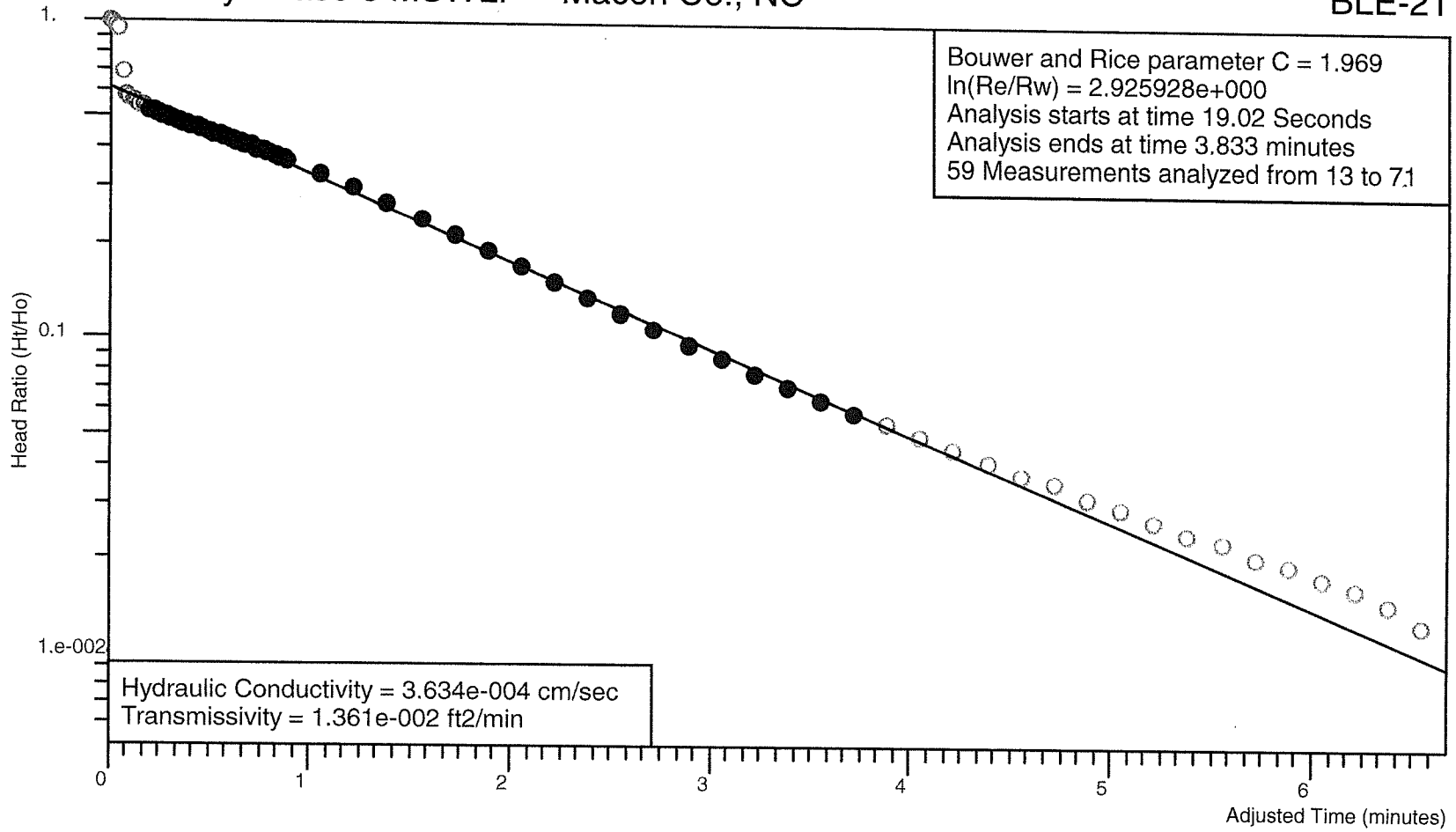
92	7.333	7.216	0.291	0.291	6.962e-002
93	7.5	7.383	0.287	0.287	6.866e-002
94	7.667	7.55	0.279	0.279	6.675e-002
95	7.833	7.716	0.279	0.279	6.675e-002
96	8.	7.883	0.275	0.275	6.579e-002
97	8.167	8.05	0.275	0.275	6.579e-002
98	8.333	8.216	0.271	0.271	6.483e-002
99	8.5	8.383	0.267	0.267	6.388e-002
100	8.667	8.55	0.267	0.267	6.388e-002
101	8.833	8.716	0.267	0.267	6.388e-002
102	9.	8.883	0.259	0.259	6.196e-002
103	9.167	9.05	0.256	0.256	6.124e-002
104	9.333	9.216	0.256	0.256	6.124e-002
105	9.5	9.383	0.256	0.256	6.124e-002
106	9.667	9.55	0.252	0.252	6.029e-002
107	9.833	9.716	0.248	0.248	5.933e-002
108	10.	9.883	0.24	0.24	5.742e-002

Falling Head Slug Test - September 6, 2013

Macon County Phase 3 MSWLF - Macon Co., NC

Bouwer and Rice Graph

BLE-21



Project Number: J13-1101-06

Analysis by BLE

Ho is 5.245 feet at 7.02 Seconds

Falling Head Slug Test -

Site Name:	Macon County Phase 3 MSWLF -
Location:	Macon Co., NC
Test Date:	September 6, 2013
Project Number:	J13-1101-06
Import File:	C:\Public PC113\Projects\1101-06 Macon County Phase 3 DHR\Slug test\FINAL\

Well Label:	BLE-21
Aquifer Thickness:	19.03 feet
Screen Length:	10. feet
Casing Radius:	8.333e-002 feet
Effective Radius:	0.3438 feet
Static Water Level:	0. feet
Water Table to Screen Bottom:	19.03 feet
Anisotropy Ratio:	1.
Time Adjustment:	7.02 Seconds

Test starts with trial 0
There are 88 time and drawdown measurements
Maximum head is 5.245 feet
Minimum head is 0. feet

Trial	Time (minutes)	Adjusted Time (minutes)	Drawdown (feet)	Head (feet)	Head Ratio
1	0.117	0.	5.245	5.245	1.
2	0.133	1.6e-002	5.183	5.183	0.9882
3	0.15	3.3e-002	5.144	5.144	0.9807
4	0.167	5.e-002	5.028	5.028	0.9586
5	0.183	6.6e-002	3.608	3.608	0.6879
6	0.2	8.3e-002	3.06	3.06	0.5834
7	0.217	0.1	2.979	2.979	0.568
8	0.233	0.116	2.932	2.932	0.559
9	0.25	0.133	2.889	2.889	0.5508
10	0.267	0.15	2.85	2.85	0.5434
11	0.283	0.166	2.811	2.811	0.5359
12	0.3	0.183	2.776	2.776	0.5293
13	0.317	0.2	2.745	2.745	0.5234
14	0.333	0.216	2.718	2.718	0.5182
15	0.35	0.233	2.687	2.687	0.5123
16	0.367	0.25	2.664	2.664	0.5079
17	0.383	0.266	2.632	2.632	0.5018
18	0.4	0.283	2.613	2.613	0.4982
19	0.417	0.3	2.586	2.586	0.493
20	0.433	0.316	2.562	2.562	0.4885
21	0.45	0.333	2.543	2.543	0.4848
22	0.467	0.35	2.524	2.524	0.4812
23	0.483	0.366	2.5	2.5	0.4766
24	0.5	0.383	2.477	2.477	0.4723
25	0.517	0.4	2.458	2.458	0.4686
26	0.533	0.416	2.438	2.438	0.4648
27	0.55	0.433	2.419	2.419	0.4612
28	0.567	0.45	2.399	2.399	0.4574
29	0.583	0.466	2.38	2.38	0.4538
30	0.6	0.483	2.356	2.356	0.4492
31	0.617	0.5	2.341	2.341	0.4463
32	0.633	0.516	2.321	2.321	0.4425
33	0.65	0.533	2.302	2.302	0.4389
34	0.667	0.55	2.283	2.283	0.4353

35	0.683	0.566	2.267	2.267	0.4322
36	0.7	0.583	2.248	2.248	0.4286
37	0.717	0.6	2.228	2.228	0.4248
38	0.733	0.616	2.205	2.205	0.4204
39	0.75	0.633	2.185	2.185	0.4166
40	0.767	0.65	2.17	2.17	0.4137
41	0.783	0.666	2.15	2.15	0.4099
42	0.8	0.683	2.131	2.131	0.4063
43	0.817	0.7	2.115	2.115	0.4032
44	0.833	0.716	2.092	2.092	0.3989
45	0.85	0.733	2.073	2.073	0.3952
46	0.867	0.75	2.057	2.057	0.3922
47	0.883	0.766	2.038	2.038	0.3886
48	0.9	0.783	2.022	2.022	0.3855
49	0.917	0.8	2.003	2.003	0.3819
50	0.933	0.816	1.983	1.983	0.3781
51	0.95	0.833	1.968	1.968	0.3752
52	0.967	0.85	1.948	1.948	0.3714
53	0.983	0.866	1.933	1.933	0.3685
54	1.	0.883	1.913	1.913	0.3647
55	1.167	1.05	1.738	1.738	0.3314
56	1.333	1.216	1.571	1.571	0.2995
57	1.5	1.383	1.415	1.415	0.2698
58	1.667	1.55	1.263	1.263	0.2408
59	1.833	1.716	1.131	1.131	0.2156
60	2.	1.883	1.011	1.011	0.1928
61	2.167	2.05	0.898	0.898	0.1712
62	2.333	2.216	0.801	0.801	0.1527
63	2.5	2.383	0.711	0.711	0.1356
64	2.667	2.55	0.633	0.633	0.1207
65	2.833	2.716	0.567	0.567	0.1081
66	3.	2.883	0.509	0.509	9.704e-002
67	3.167	3.05	0.459	0.459	8.751e-002
68	3.333	3.216	0.412	0.412	7.855e-002
69	3.5	3.383	0.377	0.377	7.188e-002
70	3.667	3.55	0.342	0.342	6.52e-002
71	3.833	3.716	0.311	0.311	5.929e-002
72	4.	3.883	0.287	0.287	5.472e-002
73	4.167	4.05	0.26	0.26	4.957e-002
74	4.333	4.216	0.237	0.237	4.519e-002
75	4.5	4.383	0.217	0.217	4.137e-002
76	4.667	4.55	0.198	0.198	3.775e-002
77	4.833	4.716	0.186	0.186	3.546e-002
78	5.	4.883	0.167	0.167	3.184e-002
79	5.167	5.05	0.155	0.155	2.955e-002
80	5.333	5.216	0.139	0.139	2.65e-002
81	5.5	5.383	0.128	0.128	2.44e-002
82	5.667	5.55	0.12	0.12	2.288e-002
83	5.833	5.716	0.108	0.108	2.059e-002
84	6.	5.883	0.101	0.101	1.926e-002
85	6.167	6.05	9.3e-002	9.3e-002	1.773e-002
86	6.333	6.216	8.5e-002	8.5e-002	1.621e-002
87	6.5	6.383	7.7e-002	7.7e-002	1.468e-002
88	6.667	6.55	6.6e-002	6.6e-002	1.258e-002

APPENDIX F

SOIL LABORATORY TEST PROCEDURES

APPENDIX F

SOIL LABORATORY TEST PROCEDURES

MOISTURE CONTENT AND UNIT WEIGHT

An undisturbed sample is trimmed in the laboratory into a right circular cylinder approximately three to six inches long. The dimensions and weight of the specimen are determined and the total unit weight calculated. Moisture contents are determined from representative portions of the specimen. The soil is dried to a constant weight in an oven at 100 degrees C and the loss of moisture during the drying process is measured. From this data, the moisture content and dry unit weight are computed.

ATTERBERG LIMITS

The Atterberg Limits Tests, Liquid Limit (LL), and Plastic Limit (PL), are performed to aid in the classification of soils and to determine the plasticity and volume change characteristics of the materials. The Liquid Limit is the minimum moisture content at which a soil will flow as a heavy viscous fluid. The Plastic Limit is the minimum moisture content at which the solid behaves as a plastic material. The Plasticity Index (PI) is the numeric difference of Liquid Limit and the Plastic Limit and indicated the range of moisture content over which a soil remains plastic. These tests are performed in accordance with ASTM D 4318.

PARTICLE SIZE DISTRIBUTION

The distribution of soils coarser than the No. 200 (75-um) sieve is determined by passing a representative specimen through a standard set of nested sieves. The weight of material retained on each sieve is determined and the percentage retained (or passing) is calculated. A specimen may be washed through only the No. 200 sieve, if the full range of particle sizes is not required. The percentage of material passing the No. 200 sieve is reported. The distribution of materials finer than No. 200 sieve is determined by use of the hydrometer. The particle sizes and distribution are computed from the time rate of settlement of the different size particles while suspended in water. These tests are performed in accordance with ASTM D 421, D 422, and D 1140.

HYDRAULIC CONDUCTIVITY

The ease with which water flows through a soil is characterized by its hydraulic conductivity. Two general test methods are employed depending on the soil type.

The **Constant Head** method is used for coarse-grained materials (sands and gravels). The sample is confined in permeameter chamber while water is allowed to flow through it from a constant head level. The quantity of water flowing through the specimen in a given time period is used to calculate the hydraulic conductivity. See ASTM D 2434 for a complete description of this test.

Fine-grained materials (silts and clays) require the use of a **Flexible Wall Permeameter**. The sample is prepared in a similar manner as in the triaxial compression test. It is encased in a rubber membrane and place inside a permeameter chamber. The specimen is back-pressure saturated and allowed to consolidate under a specified effective stress. Water is then forced through the

specimen under a controlled hydraulic gradient. The quantity of water flowing into the sample in a given time period is used to calculate the hydraulic conductivity. This test is performed in general accordance wit ASTM D 5084.

APPENDIX G

SOIL LABORATORY TEST RESULTS

Total Porosity from Percent Saturation, Specific Gravity, and Moisture Content

Macon County MSW Landfill - Phase 3 DHR
Franklin, North Carolina
BLE Project Number J13-1101-06

boring	depth	S	Gs	w	e	Vs	Vv	V	n
BLE-4	**14.0 - 16.0**	69.0%	2.74	20.5%	0.814058	1	0.814058	1.814058	**44.9%**
BLE-4	**18.0 - 20.0**	89.0%	2.76	24.7%	0.765978	1	0.765978	1.765978	**43.4%**
BLE-6	**6.0 - 8.0**	59.0%	2.78	28.7%	1.352305	1	1.352305	2.352305	**57.5%**
BLE-11	**1.0 - 3.0**	79.0%	2.76	26.3%	0.918835	1	0.918835	1.918835	**47.9%**
BLE-11	**5.0 - 7.0**	64.0%	2.79	21.0%	0.915469	1	0.915469	1.915469	**47.8%**
BLE-14	**28.0 - 30.0**	87.0%	2.79	33.8%	1.083931	1	1.083931	2.083931	**52.0%**
BLE-15	**2.0 - 4.0**	57.0%	2.77	17.2%	0.83586	1	0.83586	1.83586	**45.5%**
BLE-18	**18.0 - 20.0**	54.0%	2.77	14.6%	0.748926	1	0.748926	1.748926	**42.8%**
BLE-21	**1.0 - 3.0**	81.0%	2.76	21.1%	0.718963	1	0.718963	1.718963	**41.8%**
BLE-21	**8.0 - 10.0**	74.0%	2.77	18.7%	0.699986	1	0.699986	1.699986	**41.2%**
BLE-22	**3.0 - 5.0**	79.0%	2.77	28.4%	0.995797	1	0.995797	1.995797	**49.9%**
BLE-22	**6.0 - 8.0**	84.0%	2.77	20.3%	0.669417	1	0.669417	1.669417	**40.1%**

Notes:

1. S = percent Saturation
2. Gs = Specific Gravity
3. w = percent Moisture Content
4. e = Void Ratio (Vv/Vs); (Gs*w/S)
5. Vs = Volume of the Solids
6. Vv = Volume of the Voids
7. V = Total Volume (Vv+Vs)
8. n = Total Porosity

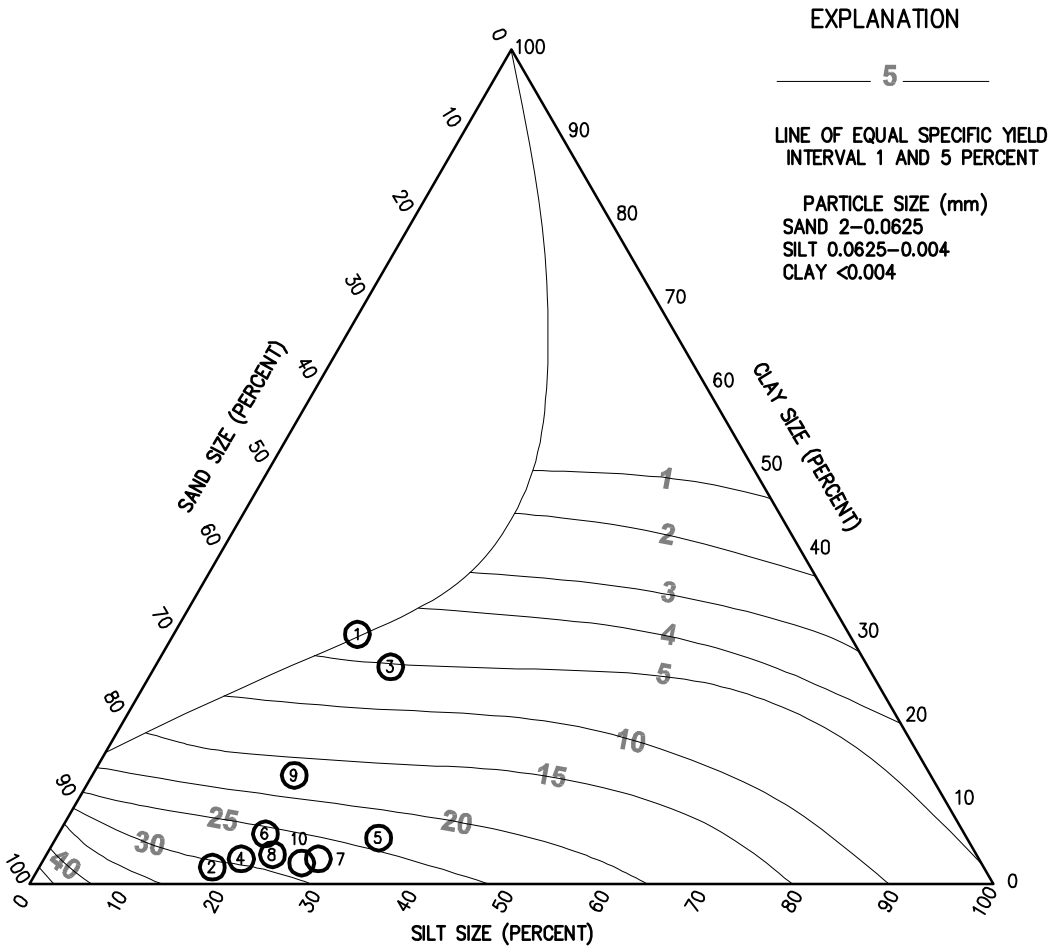


FIGURE 4.11 FROM FETTER, C.W., 1994, APPLIED HYDROGEOLOGY
TEXTURAL CLASSIFICATION TRIANGLE FOR UNCONSOLIDATED MATERIALS SHOWING THE RELATION BETWEEN PARTICAL SIZE AND SPECIFIC YIELD. SOURCE: A.I. JOHNSON, U.S. GEOLOGICAL SURVEY WATER-SUPPLY PAPER 1662-D, 1967.

ID#	BORING	DEPTH (FT)
1	BLE-1	1.0 – 2.0
2	BLE-2	18.5 – 20.0
3	BLE-3	3.5 – 5.0
4	BLE-4	14.0 – 16.0
5	BLE-4	18.0 – 20.0
6	BLE-6	6.0 – 8.0
7	BLE-6	18.5 – 20.0
8	BLE-6	28.5 – 30.0
9	BLE-7	1.0 – 2.5
10	BLE-7	28.5 – 30.0

DRAWN: MSP	DATE: 02-06-15	BLE INC. BUNNELL-LAMMONS ENGINEERING, INC. 6004 PONDERS COURT GREENVILLE, SOUTH CAROLINA 29615 PHONE: (864)288-1265 FAX: (864)288-4430	EFFECTIVE POROSITY ESTIMATION MACON COUNTY MSW LANDFILL MACON COUNTY, NORTH CAROLINA	FIGURE
CHECKED:	CAD: MCLF 1101-06 EFF POROS-1			G-1
APPROVED:	JOB NO: J13-1101-06			

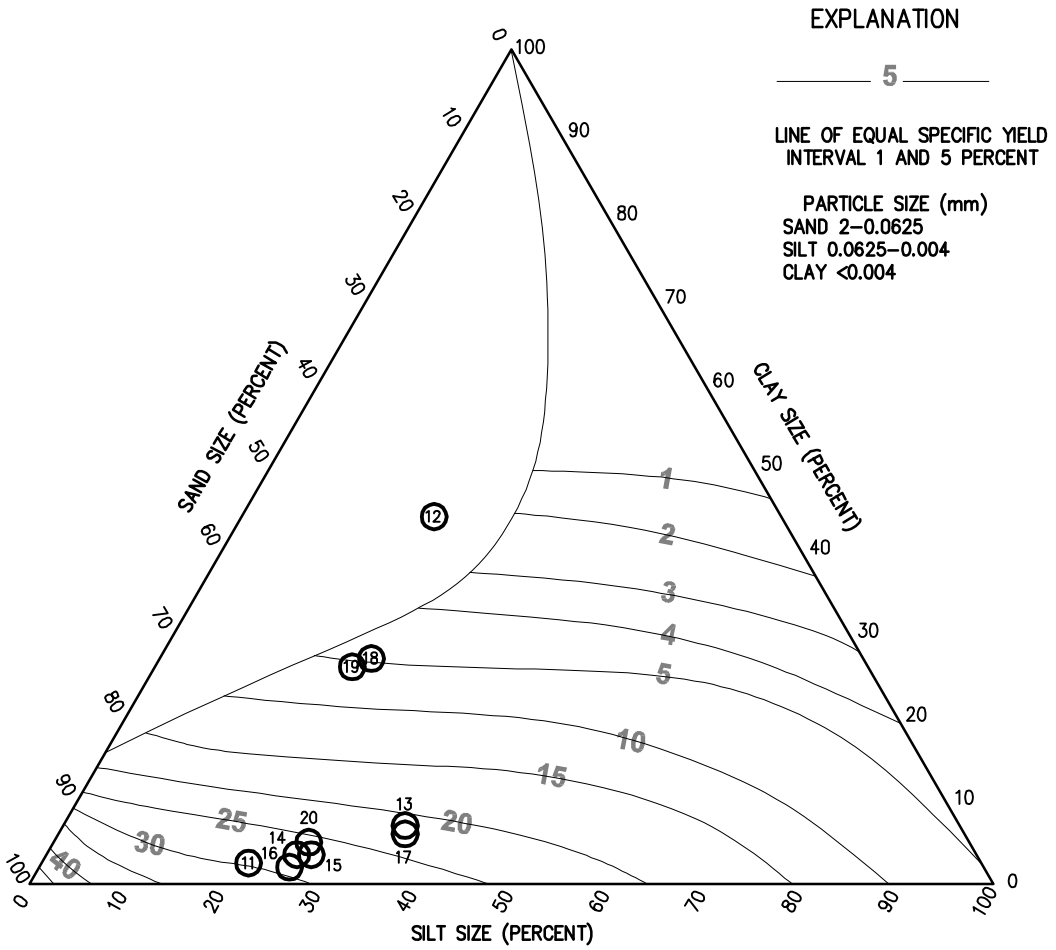


FIGURE 4.11 FROM FETTER, C.W., 1994, APPLIED HYDROGEOLOGY
TEXTURAL CLASSIFICATION TRIANGLE FOR UNCONSOLIDATED MATERIALS SHOWING THE RELATION BETWEEN PARTICAL SIZE AND SPECIFIC YIELD. SOURCE: A.I. JOHNSON, U.S. GEOLOGICAL SURVEY WATER-SUPPLY PAPER 1662-D, 1967.

ID#	BORING	DEPTH (FT)
11	BLE-7	48.5 – 50.0
12	BLE-11	1.0 – 3.0
13	BLE-11	5.0 – 7.0
14	BLE-11	63.5 – 65.0
15	BLE-13	38.5 – 40.0
16	BLE-13	53.5 – 55.0
17	BLE-14	28.0 – 30.0
18	BLE-15	1.0 – 2.5
19	BLE-15	2.0 – 4.0
20	BLE-15	13.5 – 15.0

DRAWN: MSP	DATE: 02-06-15	BLE INC. BUNNELL-LAMMONS ENGINEERING, INC. 6004 PONDERS COURT GREENVILLE, SOUTH CAROLINA 29615 PHONE: (864)288-1265 FAX: (864)288-4430	EFFECTIVE POROSITY ESTIMATION MACON COUNTY MSW LANDFILL MACON COUNTY, NORTH CAROLINA	FIGURE
CHECKED:	CAD: MCLF 1101-06 EFF POROS-2			G-2
APPROVED:	JOB NO: J13-1101-06			

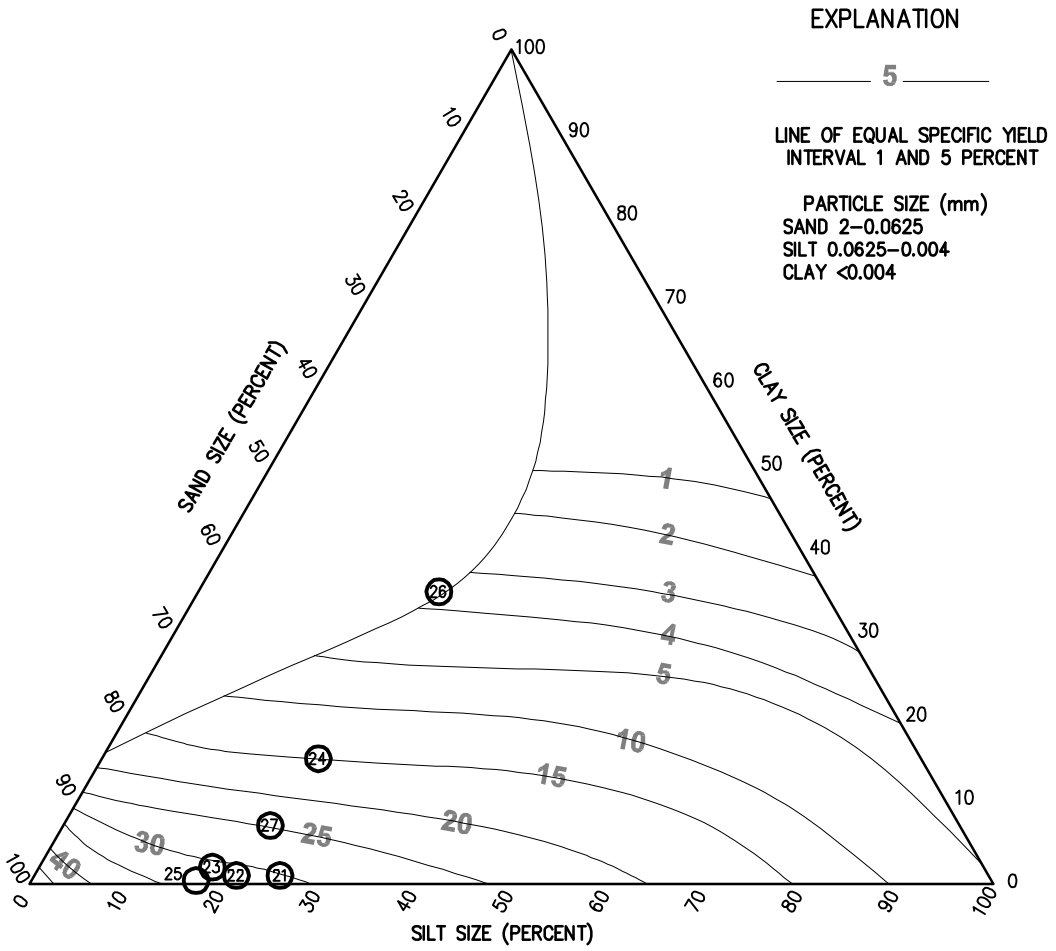
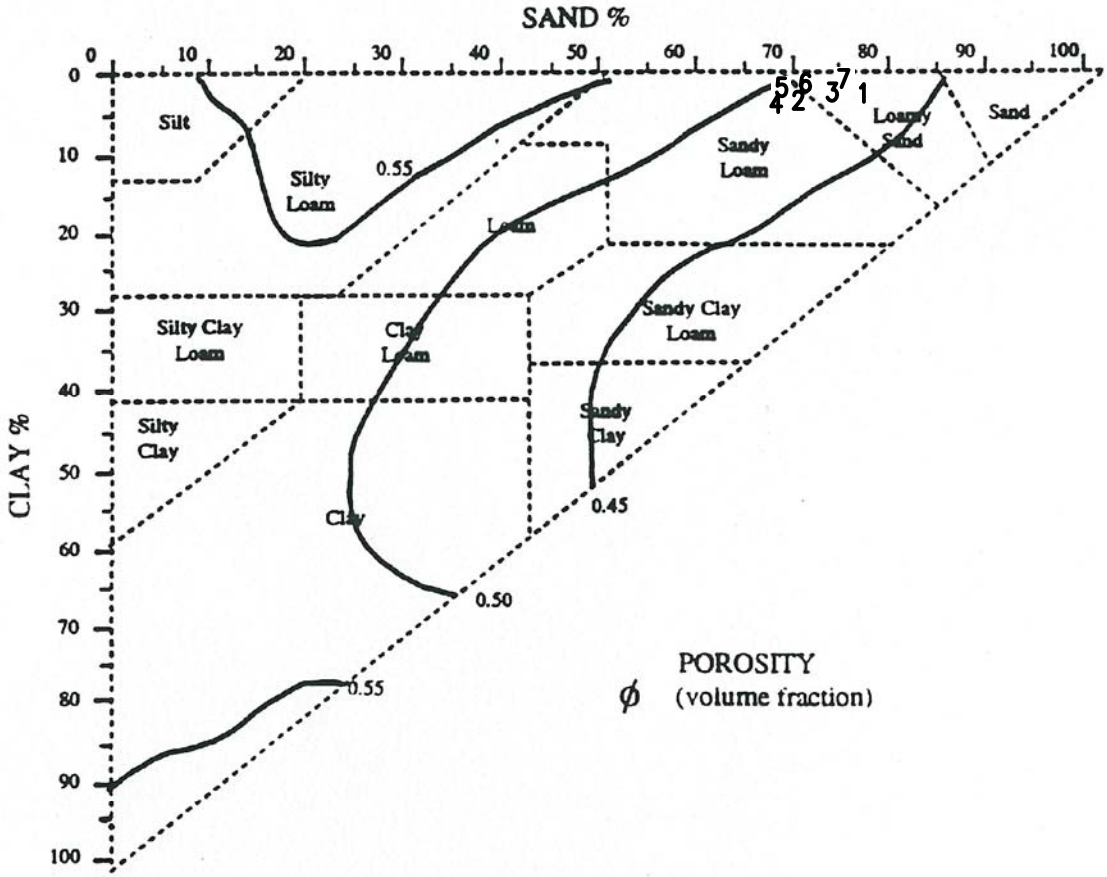


FIGURE 4.11 FROM FETTER, C.W., 1994, APPLIED HYDROGEOLOGY
TEXTURAL CLASSIFICATION TRIANGLE FOR UNCONSOLIDATED MATERIALS SHOWING THE RELATION BETWEEN PARTICAL SIZE AND SPECIFIC YIELD. SOURCE: A.I. JOHNSON, U.S. GEOLOGICAL SURVEY WATER-SUPPLY PAPER 1662-D, 1967.

ID#	BORING	DEPTH (FT)
21	BLE-15	23.5 – 25.0
22	BLE-17	18.5 – 20.0
23	BLE-18	18.0 – 20.0
24	BLE-21	1.0 – 3.0
25	BLE-21	8.0 – 10.0
26	BLE-22	3.0 – 5.0
27	BLE-22	6.0 – 8.0

DRAWN: MSP	DATE: 02-06-15	BLE INC. BUNNELL-LAMMONS ENGINEERING, INC. 6004 PONDERS COURT GREENVILLE, SOUTH CAROLINA 29615 PHONE: (864)288-1265 FAX: (864)288-4430	EFFECTIVE POROSITY ESTIMATION MACON COUNTY MSW LANDFILL MACON COUNTY, NORTH CAROLINA	FIGURE
CHECKED:	CAD: MCLF 1101-06 EFF POROS-3			G-3
APPROVED:	JOB NO: J13-1101-06			

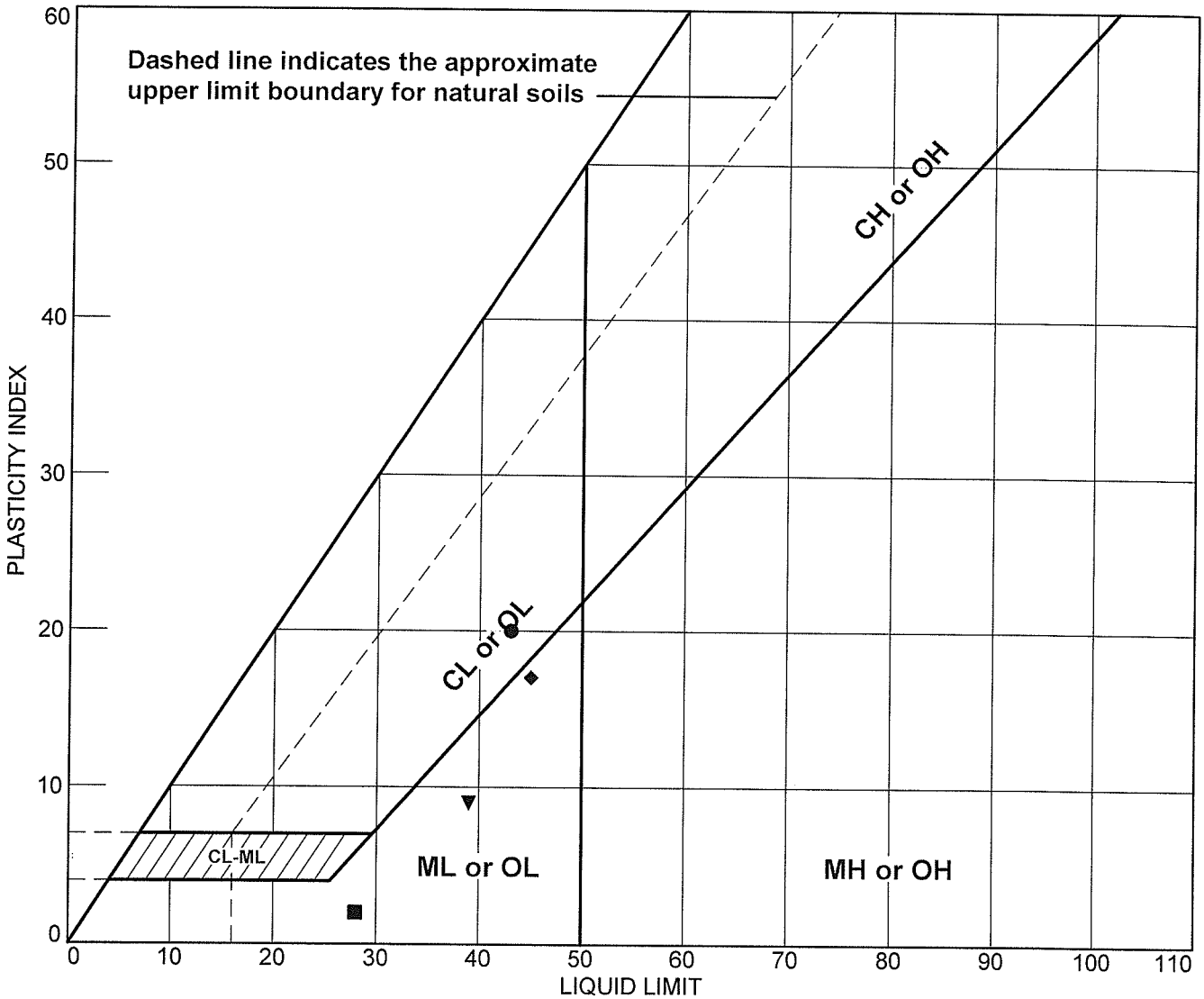


(Modified from Rawls and Brankensiek, 1989)

ID#	BORING	DEPTH (FT)
1	BLE-2	18.5 – 20.0
2	BLE-6	28.5 – 30.0
3	BLE-7	48.5 – 50.0
4	BLE-11	63.5 – 65.0
5	BLE-13	53.5 – 55.0
6	BLE-15	23.5 – 25.0
7	BLE-17	18.5 – 20.0

DRAWN: MSP	DATE: 02-06-15	BLE INC. BUNNELL-LAMMONS ENGINEERING, INC. 6004 PONDERS COURT GREENVILLE, SOUTH CAROLINA 29615 PHONE: (864)288-1265 FAX: (864)288-4430	TOTAL POROSITY ESTIMATION MACON COUNTY MSW LANDFILL MACON COUNTY, NORTH CAROLINA	FIGURE
CHECKED:	CAD: MCLF 1101-06 TOTAL POROS			G-4
APPROVED:	JOB NO: J13-1101-06			

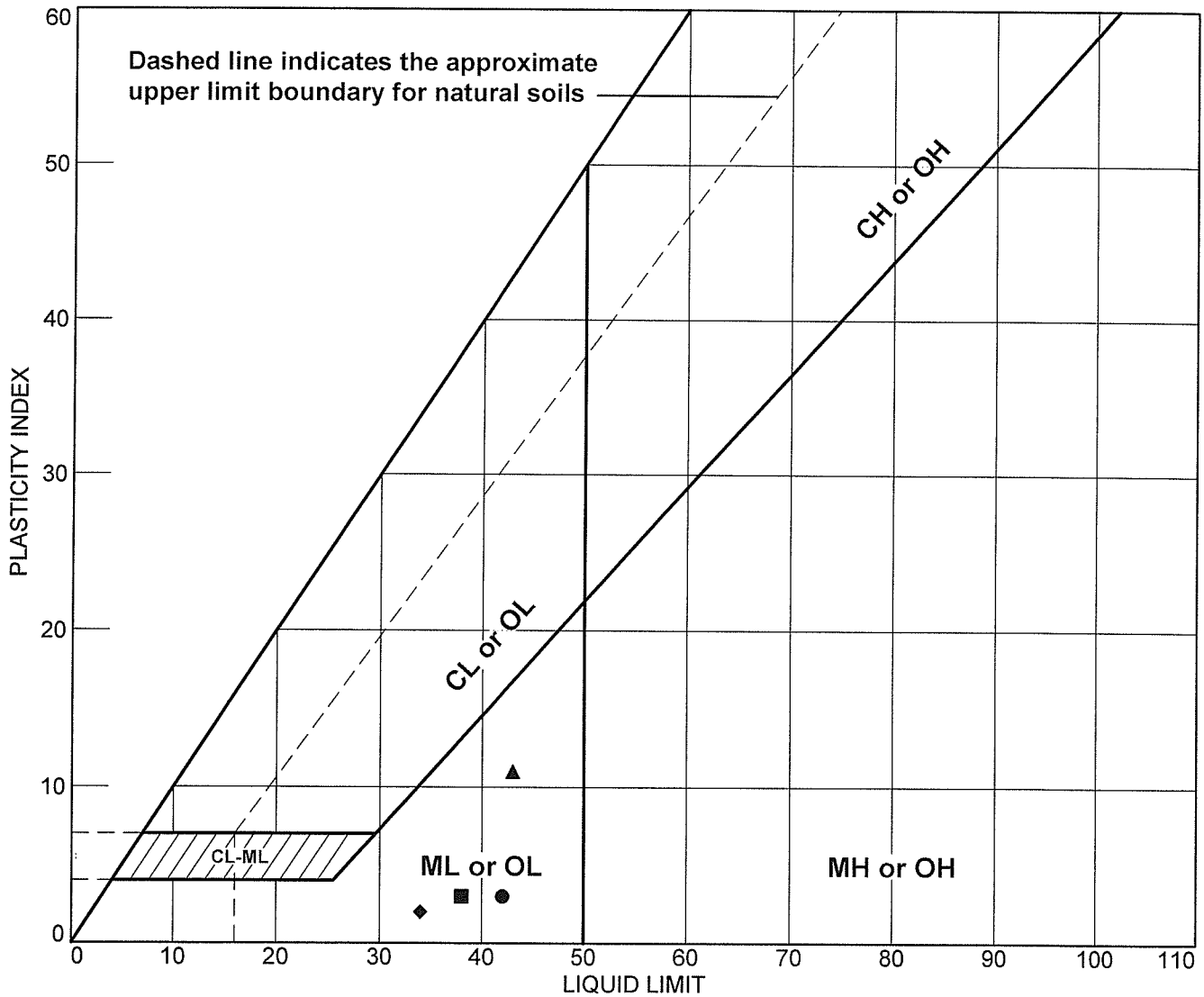
LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA								
SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	Boring	BLE-1	1.0-2.0	23.6	23	43	20	CL
■	Boring	BLE-2	18.5-20.0	8.0	26	28	2	SM
▲	Boring	BLE-2	28.5-30.0	3.7	22	22	NP	SM
◆	Boring	BLE-3	3.5-5.0	22.6	28	45	17	ML
▼	Boring	BLE-4	5.0-10.0		30	39	9	SM

Bunnell Lammons Engineering, Inc. **Greenville, SC**	**Client:** Macon County - Chris Stahl **Project:** Macon County, NC MSW Landfill Phase III DHR **Project No.:** J13-1101-06 **Figure**

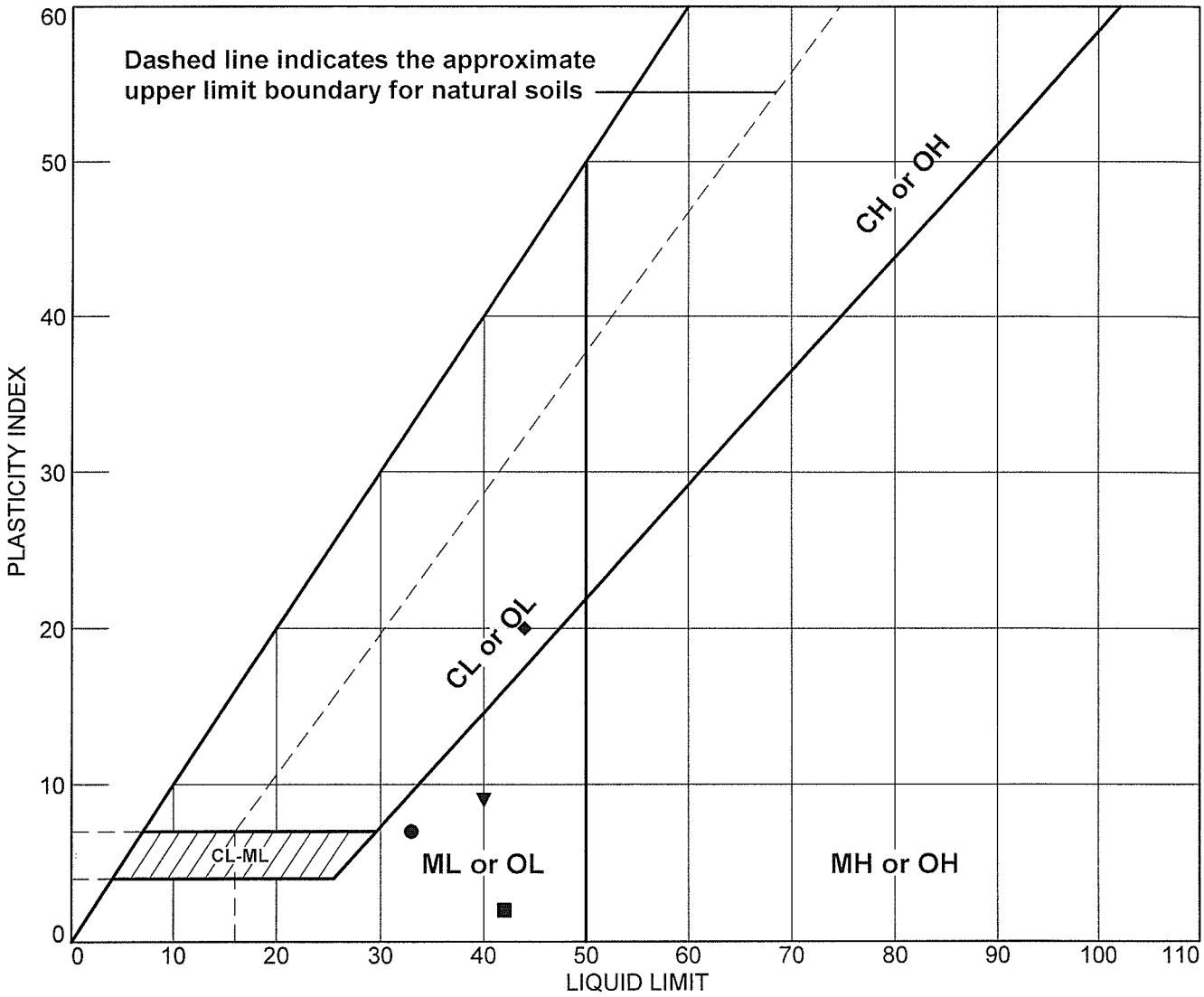
LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA								
SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	Boring	BLE-4	14.0-16.0	20.5	39	42	3	SM
■	Boring	BLE-4	18.0-20.0	24.7	35	38	3	SM
▲	Boring	BLE-6	6.0-8.0	28.7	32	43	11	SM
◆	Boring	BLE-6	18.5-20.0	25.2	32	34	2	SM
▼	Boring	BLE-6	28.5-30.0	17.0	30	30	NP	SM

Bunnell Lammons Engineering, Inc. **Greenville, SC**	**Client:** Macon County - Chris Stahl **Project:** Macon County, NC MSW Landfill Phase III DHR **Project No.:** J13-1101-06 **Figure**

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA								
SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	Boring	BLE-7	1.0-2.5	13.0	26	33	7	SM
■	Boring	BLE-7	28.5-30.0	17.7	40	42	2	SM
▲	Boring	BLE-7	48.5-50.0	24.1	NP	33	NP	SM
◆	Boring	BLE-11	1.0-3.0	26.3	24	44	20	CL
▼	Boring	BLE-11	5.0-7.0	21.0	31	40	9	SM

Bunnell Lammons Engineering, Inc.

Greenville, SC

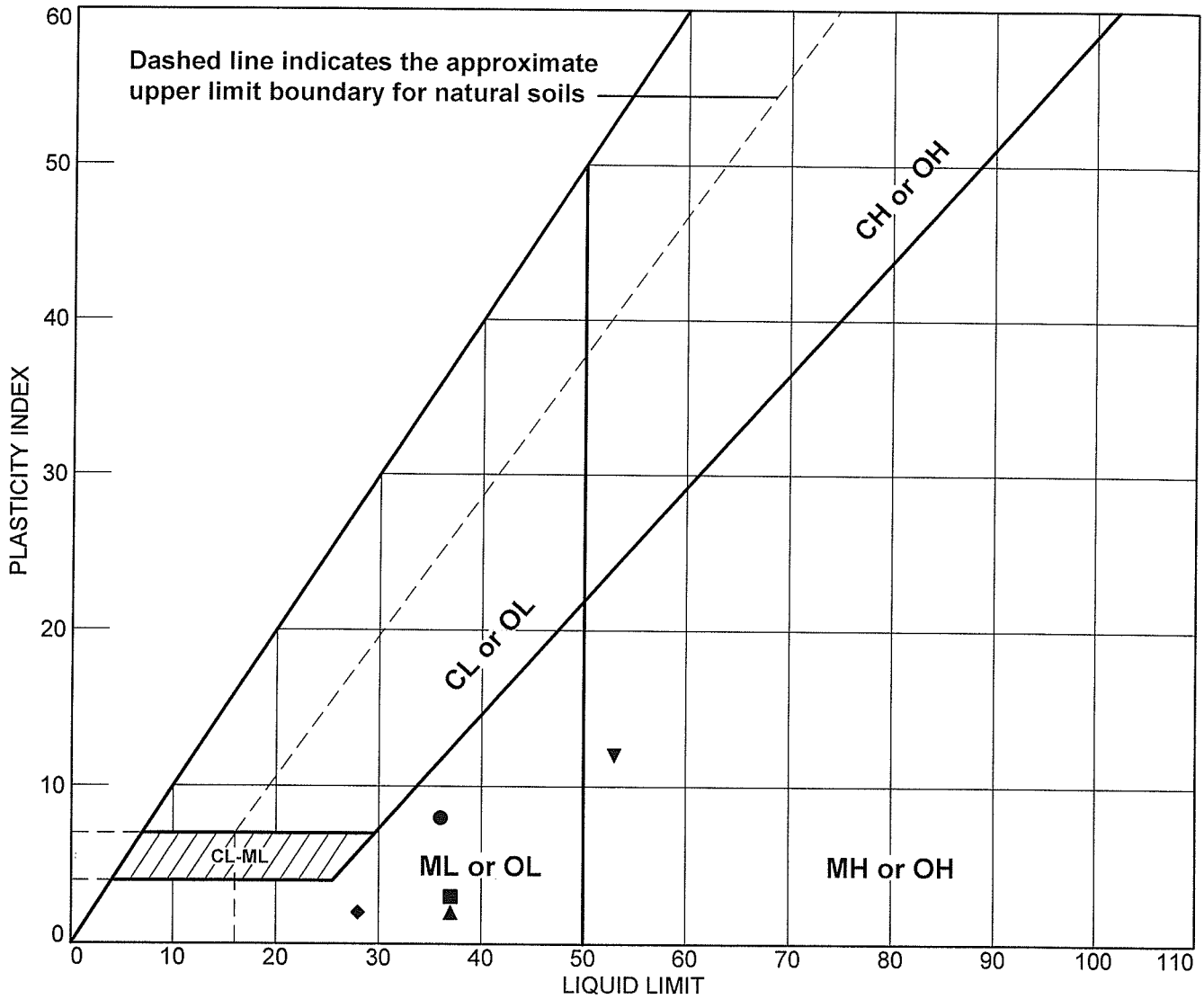
Client: Macon County - Chris Stahl

Project: Macon County, NC
MSW Landfill Phase III DHR

Project No.: J13-1101-06

Figure

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA								
SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	Boring	BLE-11	15.0-20.0		28	36	8	SM
■	Boring	BLE-11	63.5-65.0	21.1	34	37	3	SM
▲	Boring	BLE-13	38.5-40.0	21.0	35	37	2	SM
◆	Boring	BLE-13	53.5-55.0	14.9	26	28	2	SM
▼	Boring	BLE-14	28.0-30.0	33.8	41	53	12	SM

Bunnell Lammons Engineering, Inc.

Greenville, SC

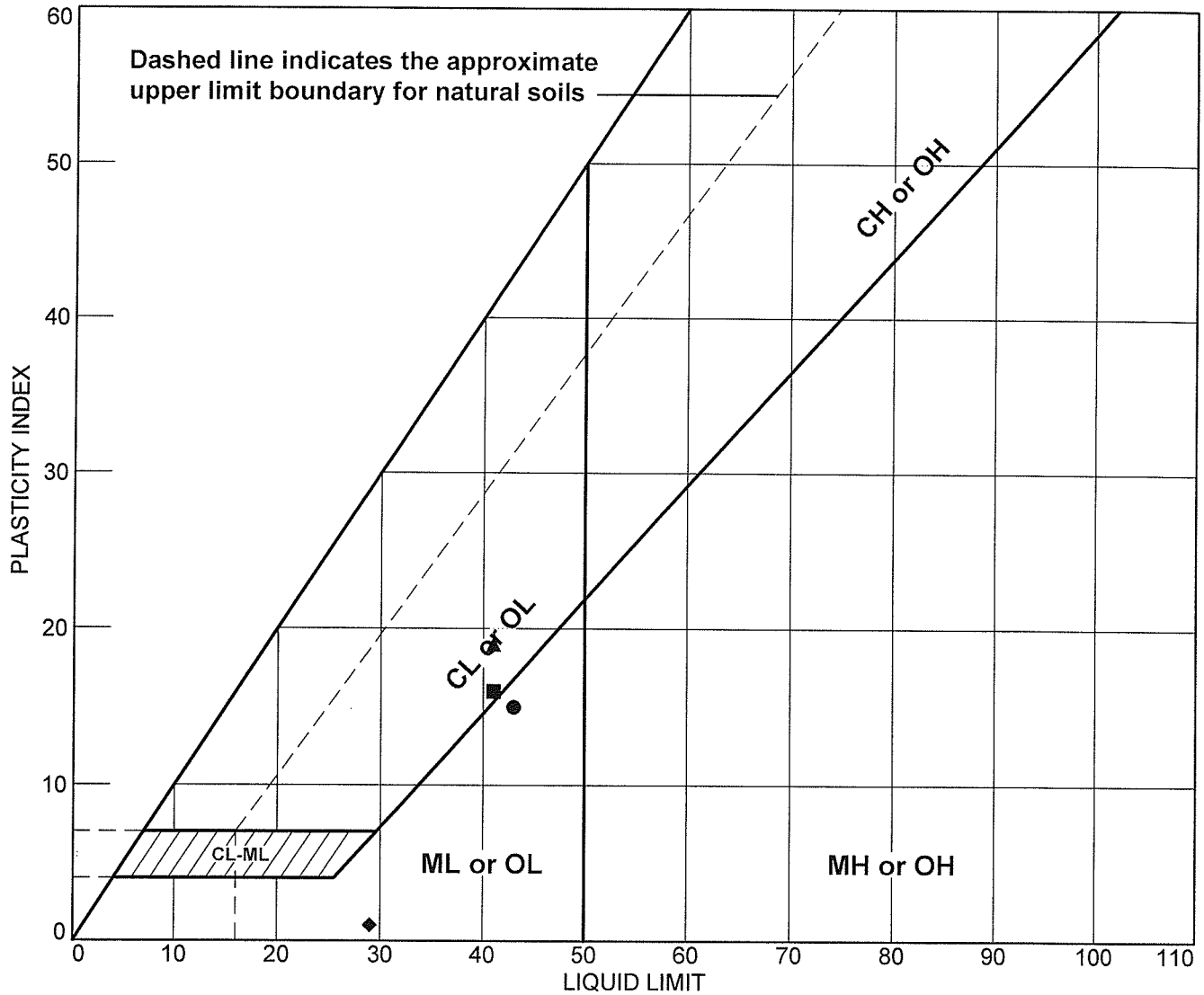
Client: Macon County - Chris Stahl

Project: Macon County, NC
MSW Landfill Phase III DHR

Project No.: J13-1101-06

Figure

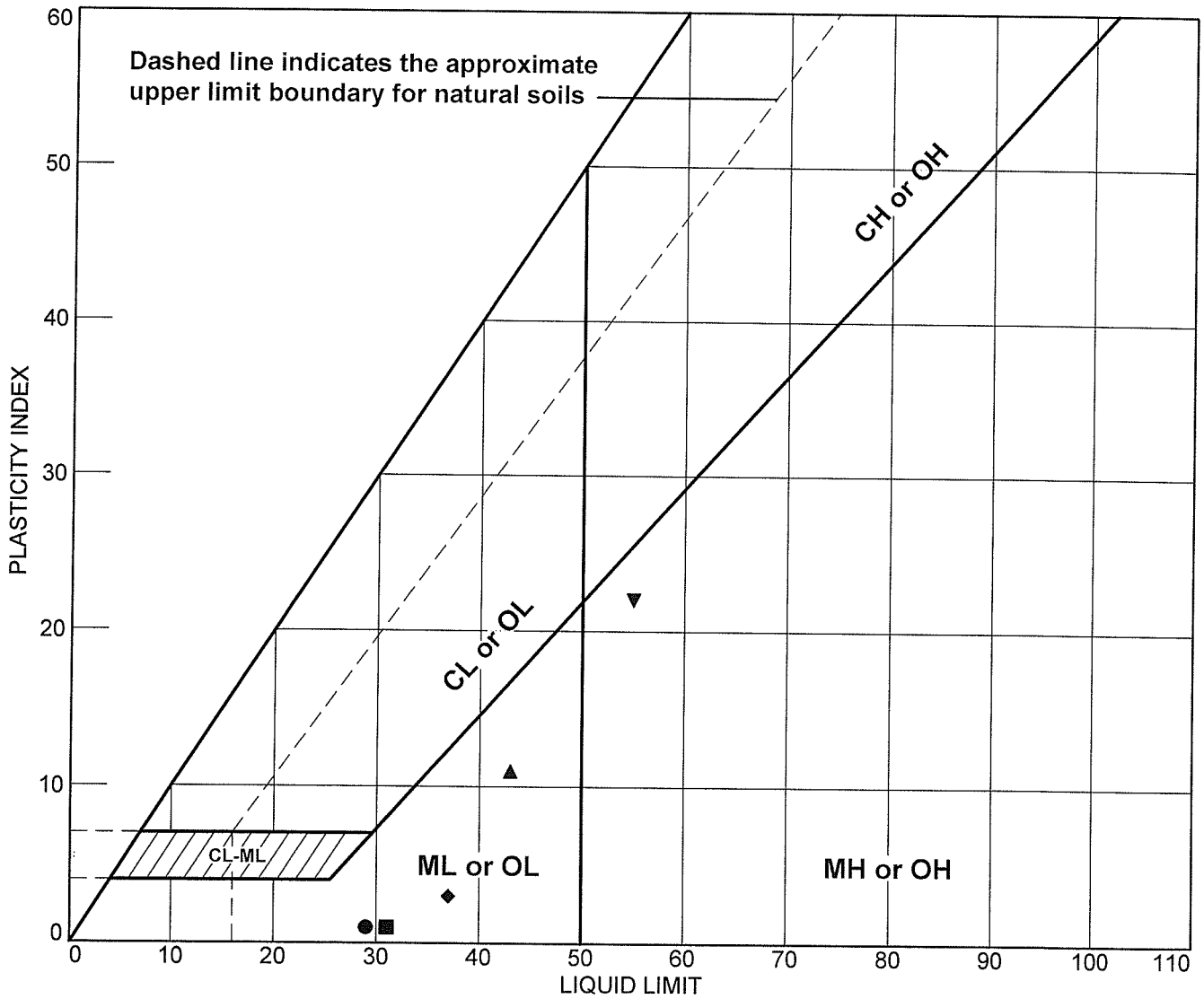
LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA								
SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	Boring	BLE-15	0.0-5.0		28	43	15	ML
■	Boring	BLE-15	1.0-2.5	22.5	25	41	16	CL
▲	Boring	BLE-15	2.0-4.0	17.2	22	41	19	SC
◆	Boring	BLE-15	13.5-15.0	16.1	28	29	1	SM
▼	Boring	BLE-15	23.5-25.0	18.0	36	36	NP	SM

Bunnell Lammons Engineering, Inc. **Greenville, SC**	**Client:** Macon County - Chris Stahl **Project:** Macon County, NC MSW Landfill Phase III DHR **Project No.:** J13-1101-06 **Figure**

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA								
SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	Boring	BLE-17	18.5-20.0	8.6	28	29	1	SM
■	Boring	BLE-18	18.0-20.0	14.6	30	31	1	SM
▲	Boring	BLE-21	1.0-3.0	21.0	32	43	11	SM
◆	Boring	BLE-21	8.0-10.0	18.7	34	37	3	SM
▼	Boring	BLE-22	3.0-5.0	28.4	33	55	22	MH

Bunnell Lammons Engineering, Inc.

Greenville, SC

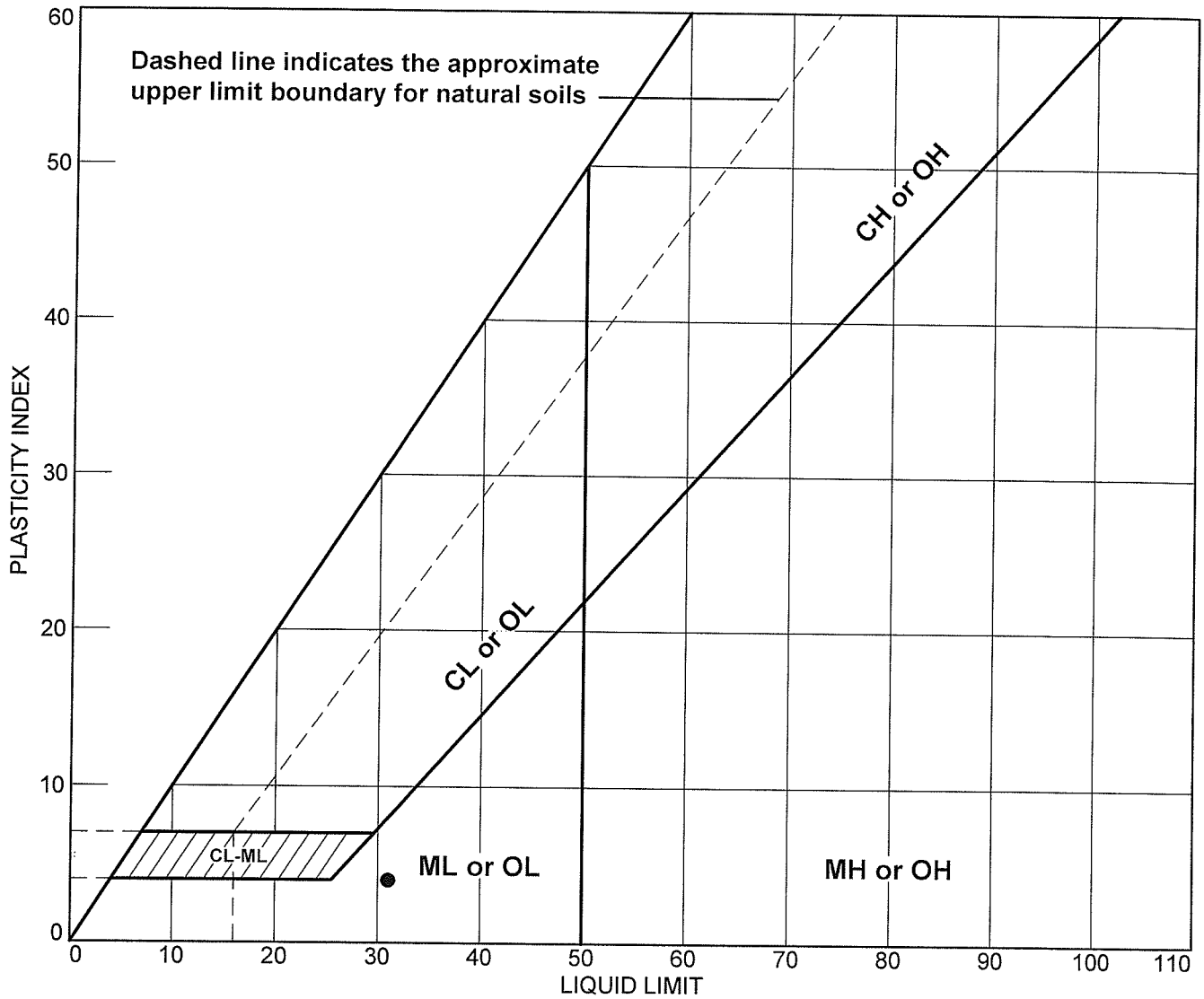
Client: Macon County - Chris Stahl

Project: Macon County, NC
MSW Landfill Phase III DHR

Project No.: J13-1101-06

Figure

LIQUID AND PLASTIC LIMITS TEST REPORT

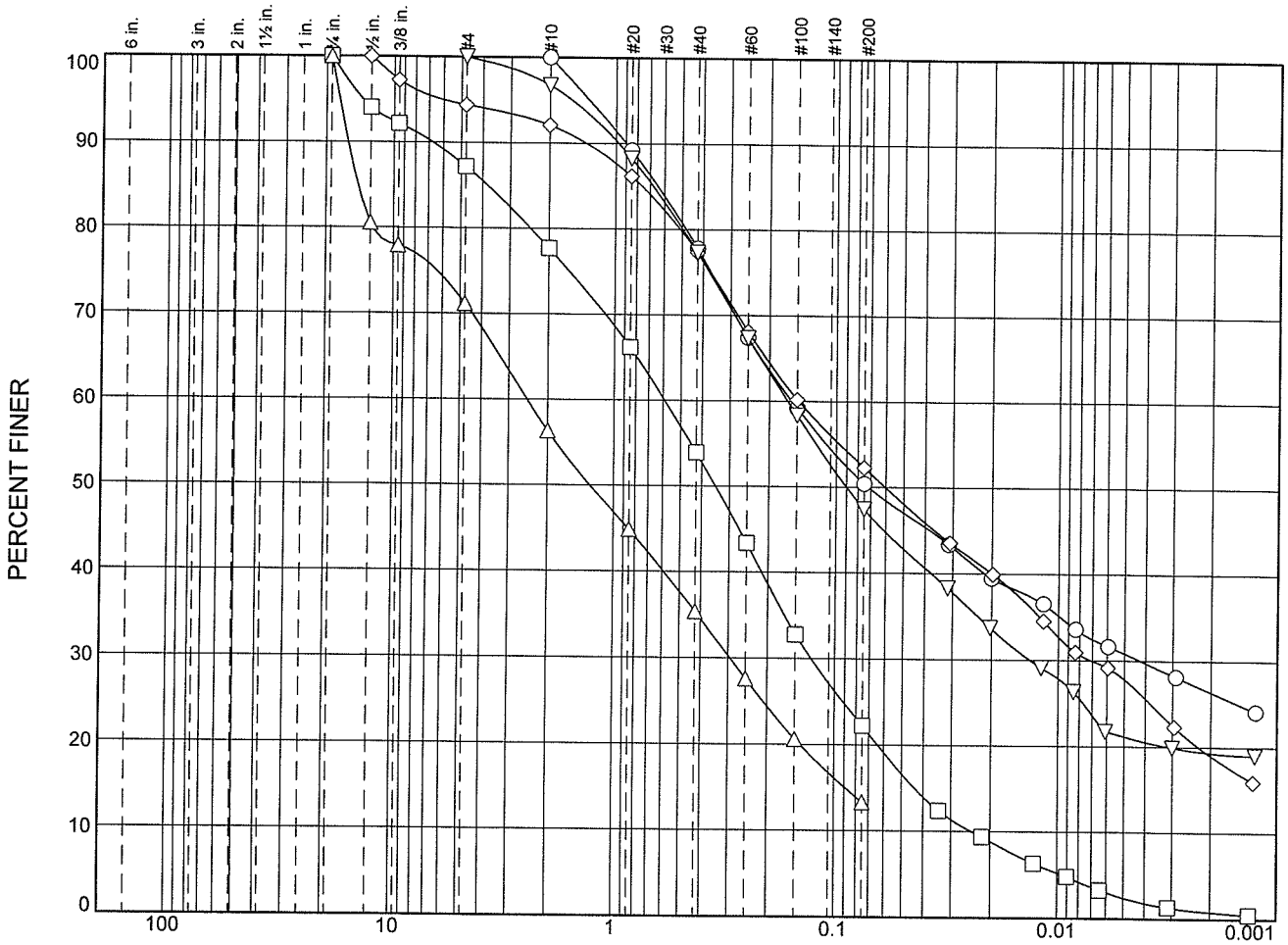


SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	Boring	BLE-22	6.0-8.0	20.3	27	31	4	SM

Bunnell Lammons Engineering, Inc. **Greenville, SC**	**Client:** Macon County - Chris Stahl **Project:** Macon County, NC MSW Landfill Phase III DHR **Project No.:** J13-1101-06 **Figure**

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.0	22.2	27.4	19.6	30.8
□	0.0	0.0	12.8	9.5	23.8	31.7	19.8	2.4
△	0.0	0.0	28.8	14.9	20.9	22.1	13.3	
◇	0.0	0.0	5.6	2.3	14.8	25.0	24.5	27.8
▽	0.0	0.0	0.0	3.3	19.3	30.0	26.3	21.1

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	Boring	BLE-1	1.0-2.0	Reddish brown fi.-med. sandy CLAY	CL
□	Boring	BLE-2	18.5-20.0	Grey silty fi.-co. SAND w/gravel	SM
△	Boring	BLE-2	28.5-30.0	Grey silty fi.-co. SAND w/gravel	SM
◇	Boring	BLE-3	3.5-5.0	Reddish brown fi.-med. sandy SILT	ML
▽	Boring	BLE-4	5.0-10.0	Brown silty fi.-med. SAND	SM

Bunnell Lammons Engineering, Inc.

Greenville, SC

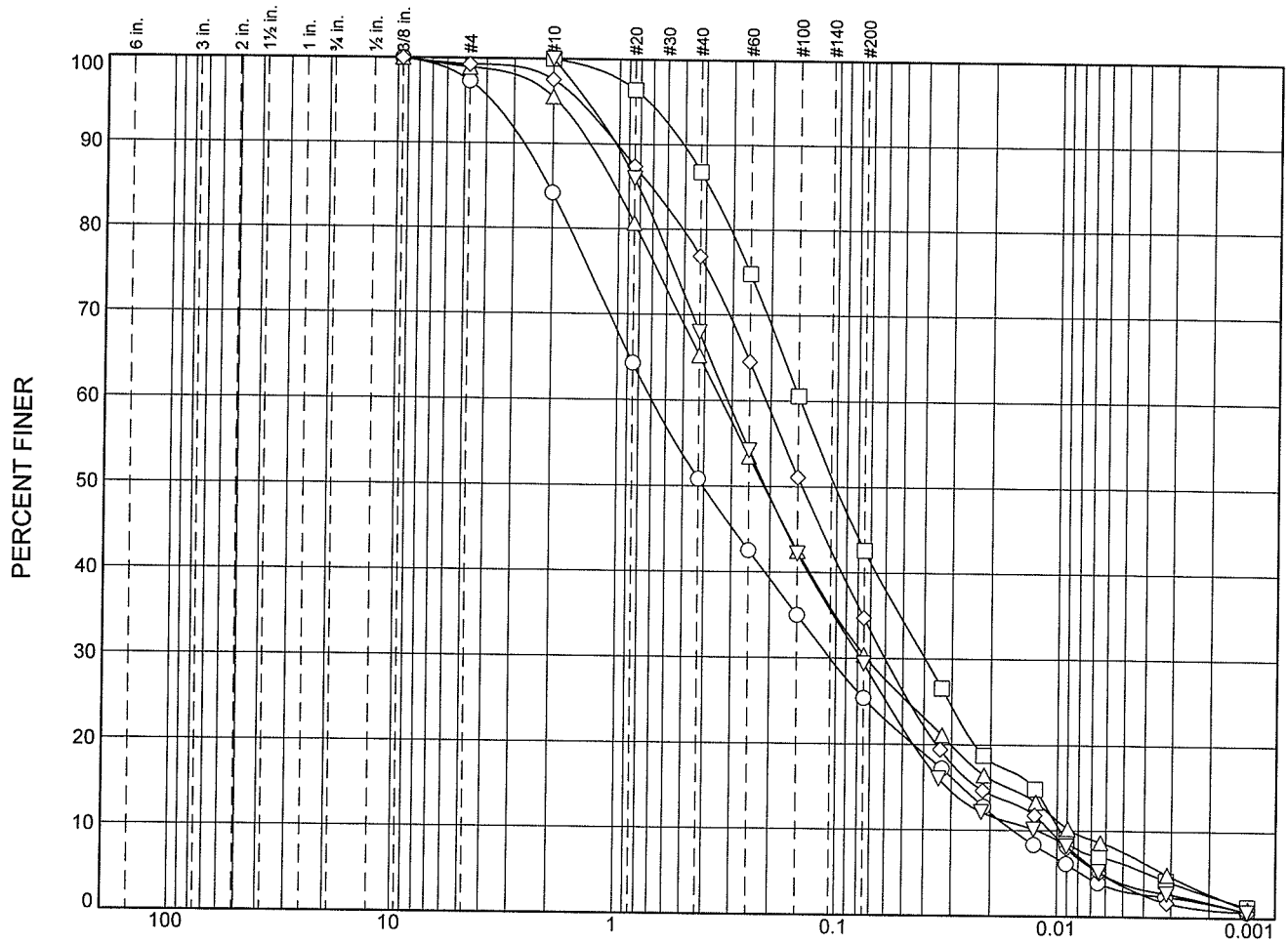
Client: Macon County - Chris Stahl

Project: Macon County, NC
MSW Landfill Phase III DHR

Project No.: J13-1101-06

Figure

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	2.7	13.1	33.4	25.4	22.4	3.0
□	0.0	0.0	0.0	0.0	13.2	44.2	36.4	6.2
△	0.0	0.0	1.1	3.4	30.2	34.9	22.8	7.6
◇	0.0	0.0	0.7	1.8	20.6	42.2	31.1	3.6
▽	0.0	0.0	0.0	0.0	32.0	38.6	25.6	3.8

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	Boring	BLE-4	14.0-16.0	Brown silty fi.-co. SAND	SM
□	Boring	BLE-4	18.0-20.0	Brown silty fi.-med. SAND	SM
△	Boring	BLE-6	6.0-8.0	Brown silty fi.-med. SAND	SM
◇	Boring	BLE-6	18.5-20.0	Light brown silty fi.-med. SAND	SM
▽	Boring	BLE-6	28.5-30.0	Grey silty fi.-med. SAND	SM

Bunnell Lammons Engineering, Inc.

Greenville, SC

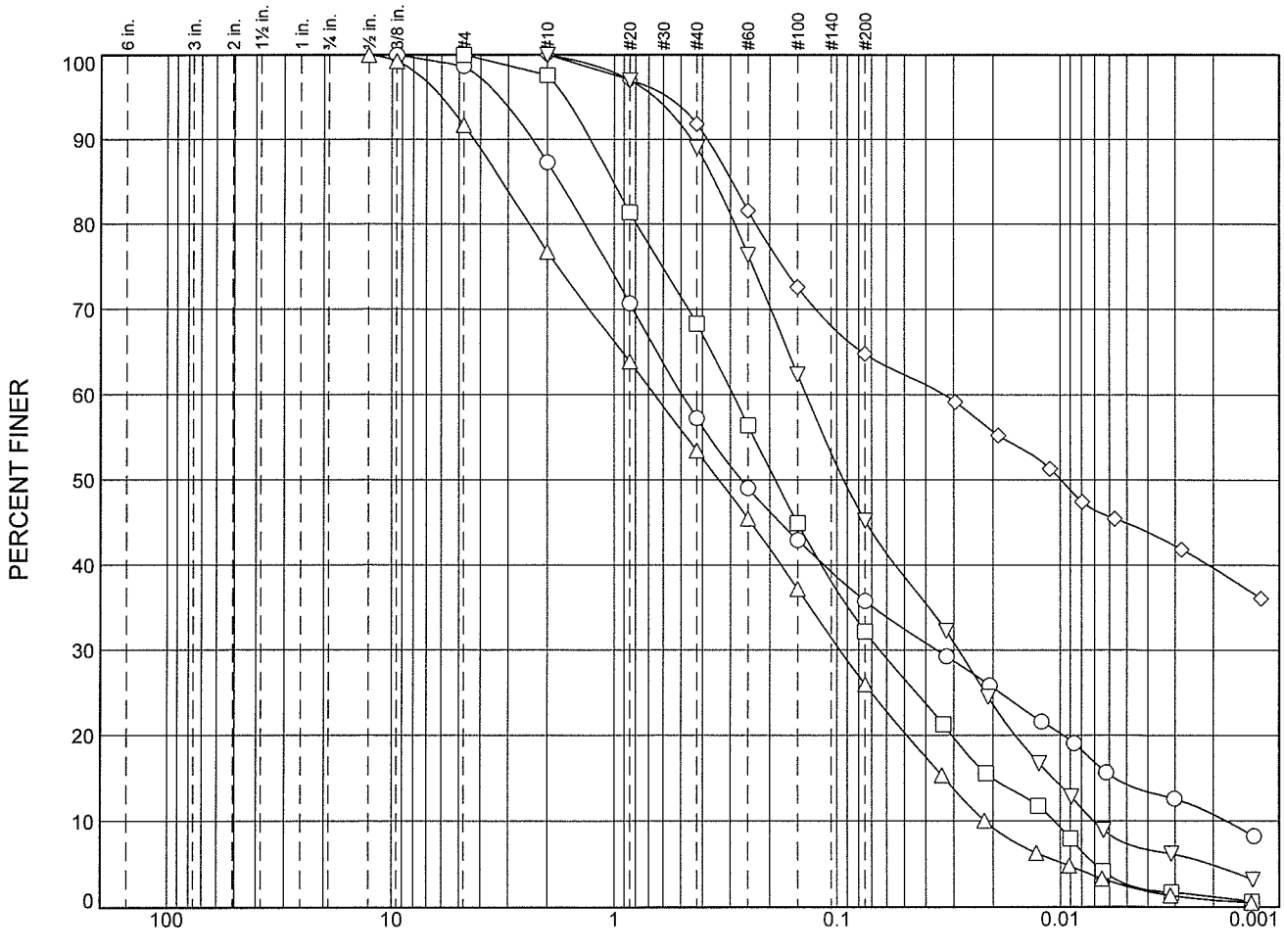
Client: Macon County - Chris Stahl

Project: Macon County, NC
MSW Landfill Phase III DHR

Project No.: J13-1101-06

Figure

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	1.3	11.4	30.0	21.5	21.6	14.2
□	0.0	0.0	0.0	2.4	29.3	36.1	29.6	2.6
△	0.0	0.0	8.3	14.9	23.4	27.5	23.5	2.4
◇	0.0	0.0	0.0	0.0	8.2	27.0	19.9	44.9
▽	0.0	0.0	0.0	0.0	11.0	43.8	37.9	7.3

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	Boring	BLE-7	1.0-2.5	Red silty fi.-med. SAND	SM
□	Boring	BLE-7	28.5-30.0	Brown silty fi.-med. SAND	SM
△	Boring	BLE-7	48.5-50.0	Reddish brown silty fi.-co. SAND	SM
◇	Boring	BLE-11	1.0-3.0	Red fi. sandy CLAY	CL
▽	Boring	BLE-11	5.0-7.0	Brown silty fi.-med. SAND	SM

Bunnell Lammons Engineering, Inc.

Greenville, SC

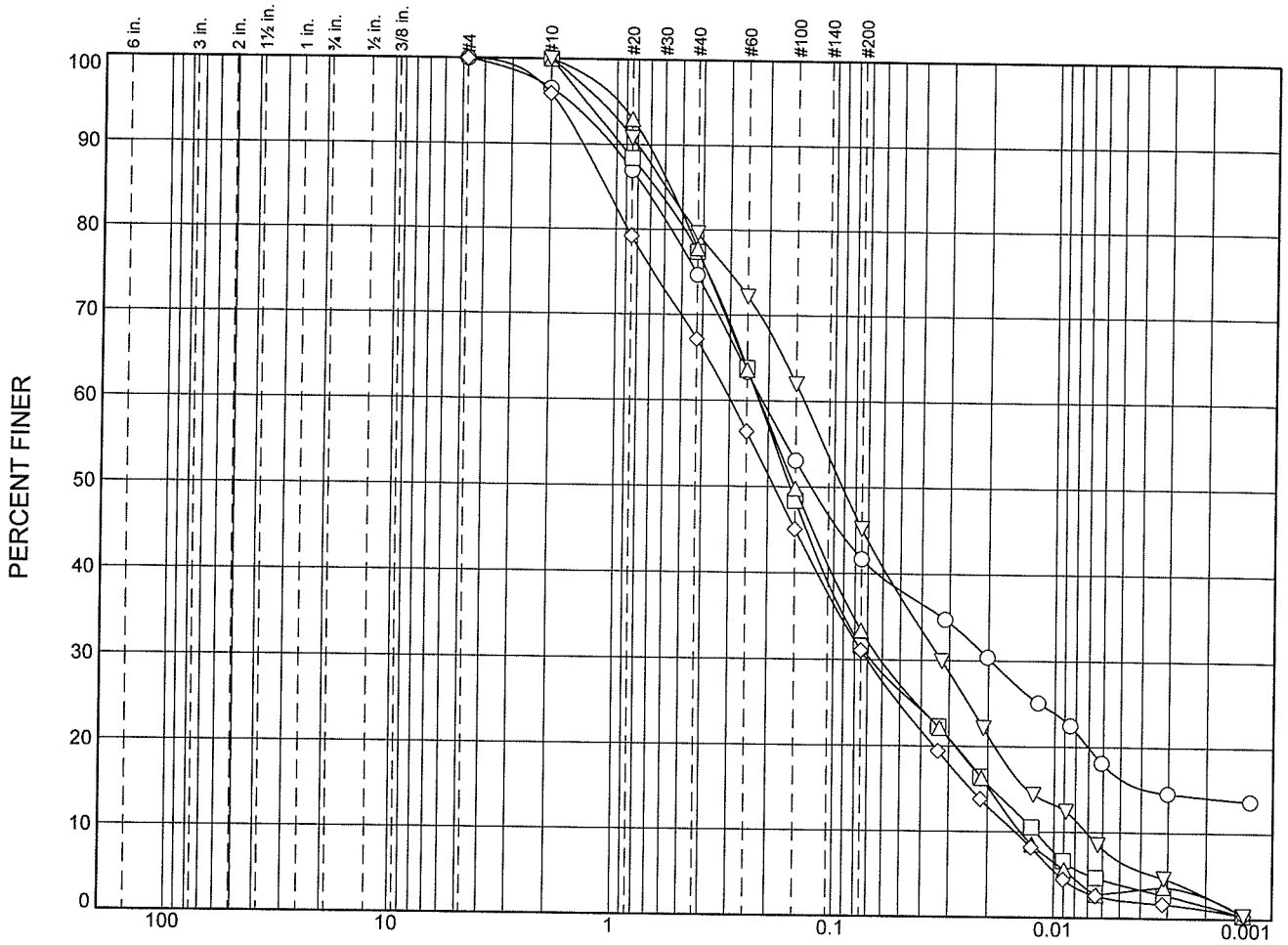
Client: Macon County - Chris Stahl

Project: Macon County, NC
MSW Landfill Phase III DHR

Project No.: J13-1101-06

Figure

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	3.4	21.9	33.0	25.5	16.2
□	0.0	0.0	0.0	0.0	22.6	45.8	27.7	3.9
△	0.0	0.0	0.0	0.0	22.2	44.4	30.3	3.1
◇	0.0	0.0	0.0	4.1	28.8	36.0	29.0	2.1
▽	0.0	0.0	0.0	0.0	20.4	34.4	38.6	6.6

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	Boring	BLE-11	15.0-20.0	Dark brown silty fi.-med. SAND	SM
□	Boring	BLE-11	63.5-65.0	Dark brown silty fi.-med. SAND	SM
△	Boring	BLE-13	38.5-40.0	Dark brown silty fi.-med. SAND	SM
◇	Boring	BLE-13	53.5-55.0	Dark brown silty fi.-med. SAND	SM
▽	Boring	BLE-14	28.0-30.0	Light brown & black silty fi.-med. SAND	SM

Bunnell Lammons Engineering, Inc.

Greenville, SC

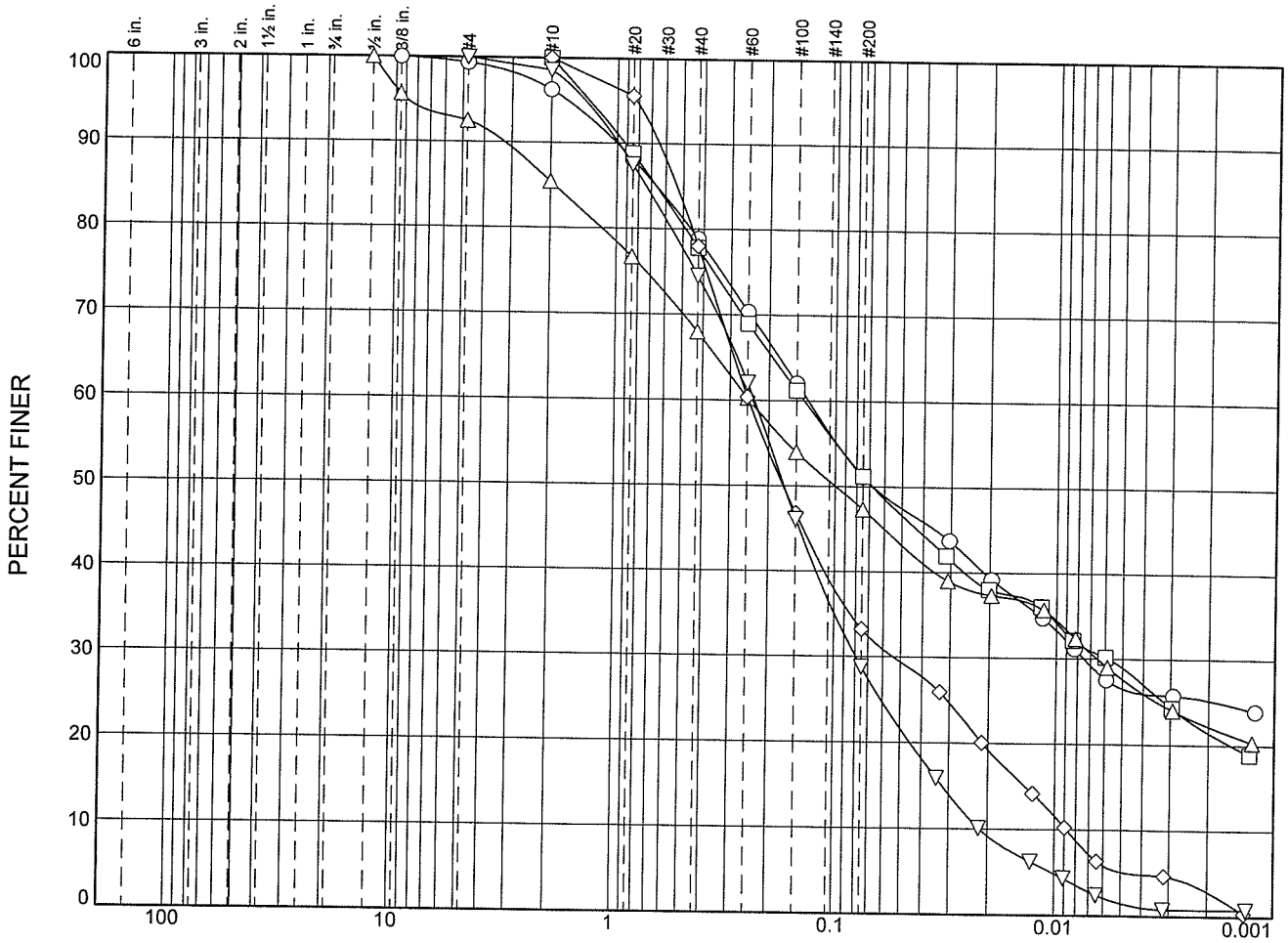
Client: Macon County - Chris Stahl

Project: Macon County, NC
MSW Landfill Phase III DHR

Project No.: J13-1101-06

Figure

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.6	3.2	17.3	27.8	24.6	26.5
□	0.0	0.0	0.0	0.0	22.2	26.6	22.2	29.0
△	0.0	0.0	7.5	7.1	17.4	20.7	19.7	27.6
◇	0.0	0.0	0.0	0.0	22.0	44.8	28.1	5.1
▽	0.0	0.0	0.0	1.4	24.1	45.7	27.3	1.5

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	Boring	BLE-15	0.0-5.0	Dark brown fi.-med. sandy SILT	ML
□	Boring	BLE-15	1.0-2.5	Brown fi.-med. sandy CLAY	CL
△	Boring	BLE-15	2.0-4.0	Red brown clayey fi.-co. SAND	SC
◇	Boring	BLE-15	13.5-15.0	Light brown silty fi.-med. SAND	SM
▽	Boring	BLE-15	23.5-25.0	White & dark brown silty fi.-med. SAND	SM

Bunnell Lammons Engineering, Inc.

Greenville, SC

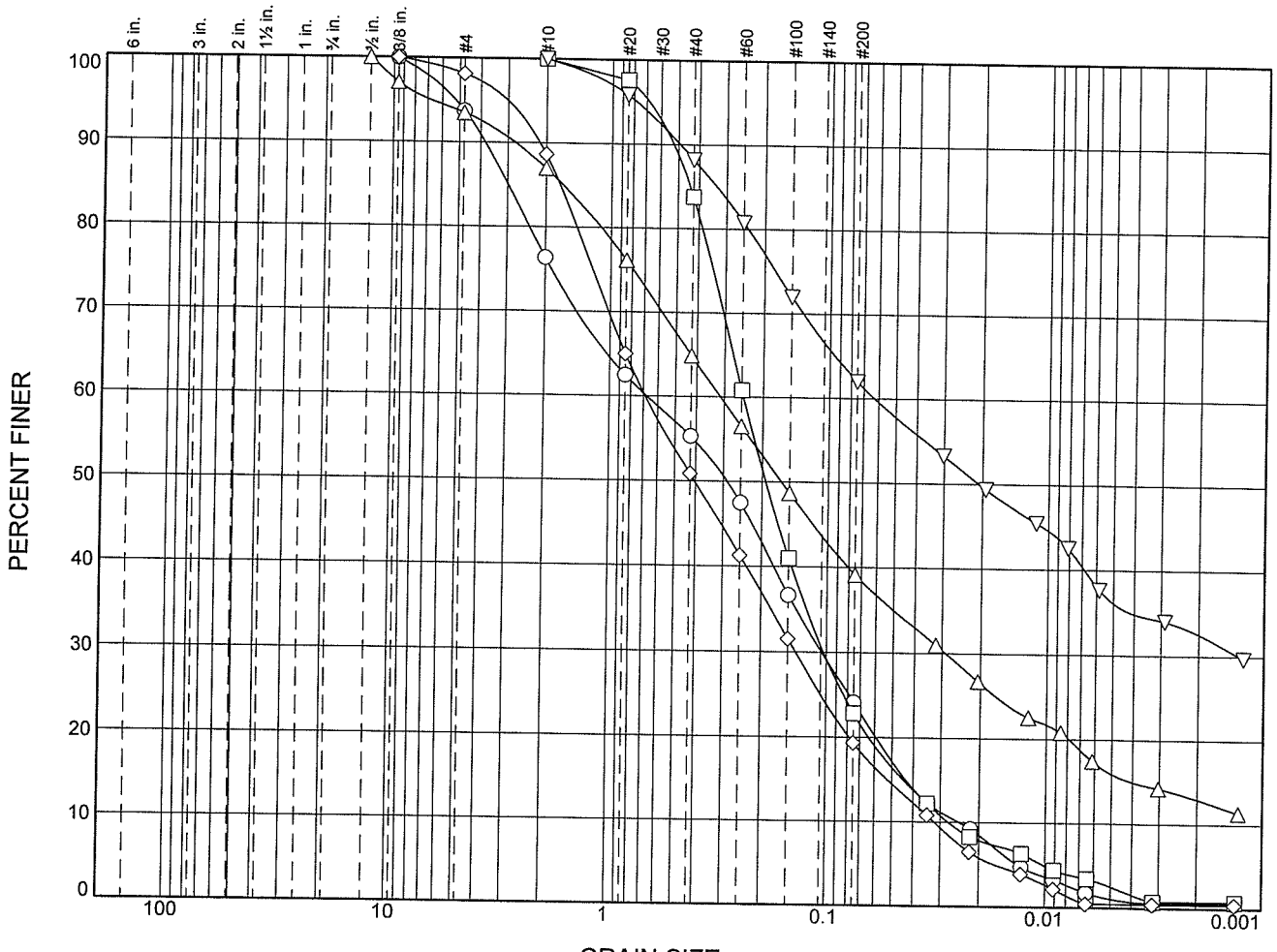
Client: Macon County - Chris Stahl

Project: Macon County, NC
MSW Landfill Phase III DHR

Project No.: J13-1101-06

Figure

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	6.3	17.3	21.1	31.2	23.1	1.0
□	0.0	0.0	0.0	0.0	16.2	61.0	20.3	2.5
△	0.0	0.0	6.5	6.5	22.1	25.8	23.2	15.9
◇	0.0	0.0	1.9	9.5	37.7	31.6	18.9	0.4
▽	0.0	0.0	0.0	0.0	11.8	26.2	25.9	36.1

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	Boring	BLE-17	18.5-20.0	Dark brown silty fi.-co. SAND	SM
□	Boring	BLE-18	18.0-20.0	Brown silty fi.-med. SAND	SM
△	Boring	BLE-21	1.0-3.0	Brown silty fi.-co. SAND	SM
◇	Boring	BLE-21	8.0-10.0	Brown silty fi.-co. SAND	SM
▽	Boring	BLE-22	3.0-5.0	Brown fi.-med. sandy SILT	MH

Bunnell Lammons Engineering, Inc.

Greenville, SC

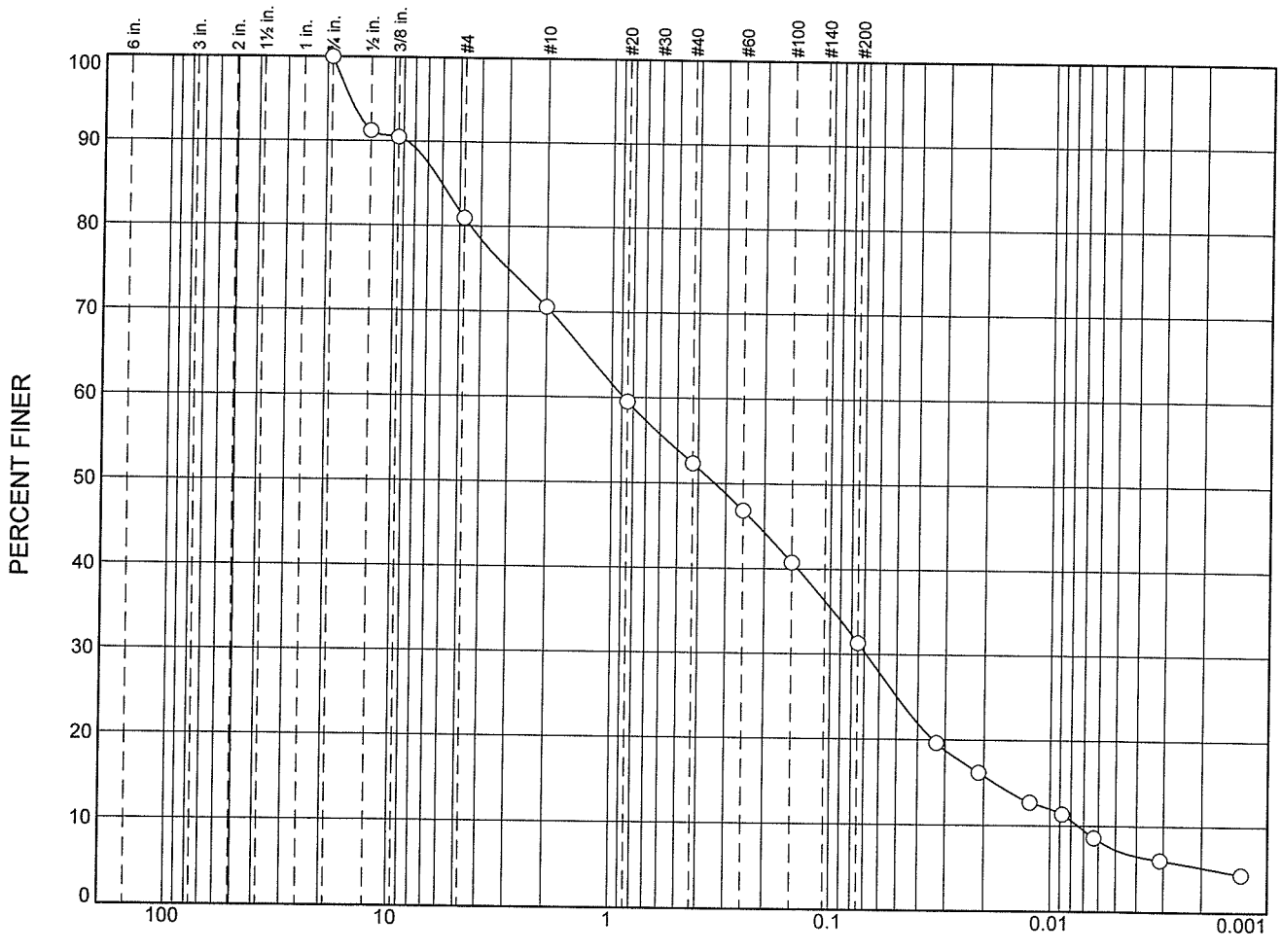
Client: Macon County - Chris Stahl

Project: Macon County, NC
MSW Landfill Phase III DHR

Project No.: J13-1101-06

Figure

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	19.0	10.5	18.2	21.0	24.1	7.2

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	Boring	BLE-22	6.0-8.0	Brown & grey sitly fi.-co. SAND w/gravel	SM

Bunnell Lammons Engineering, Inc.

Greenville, SC

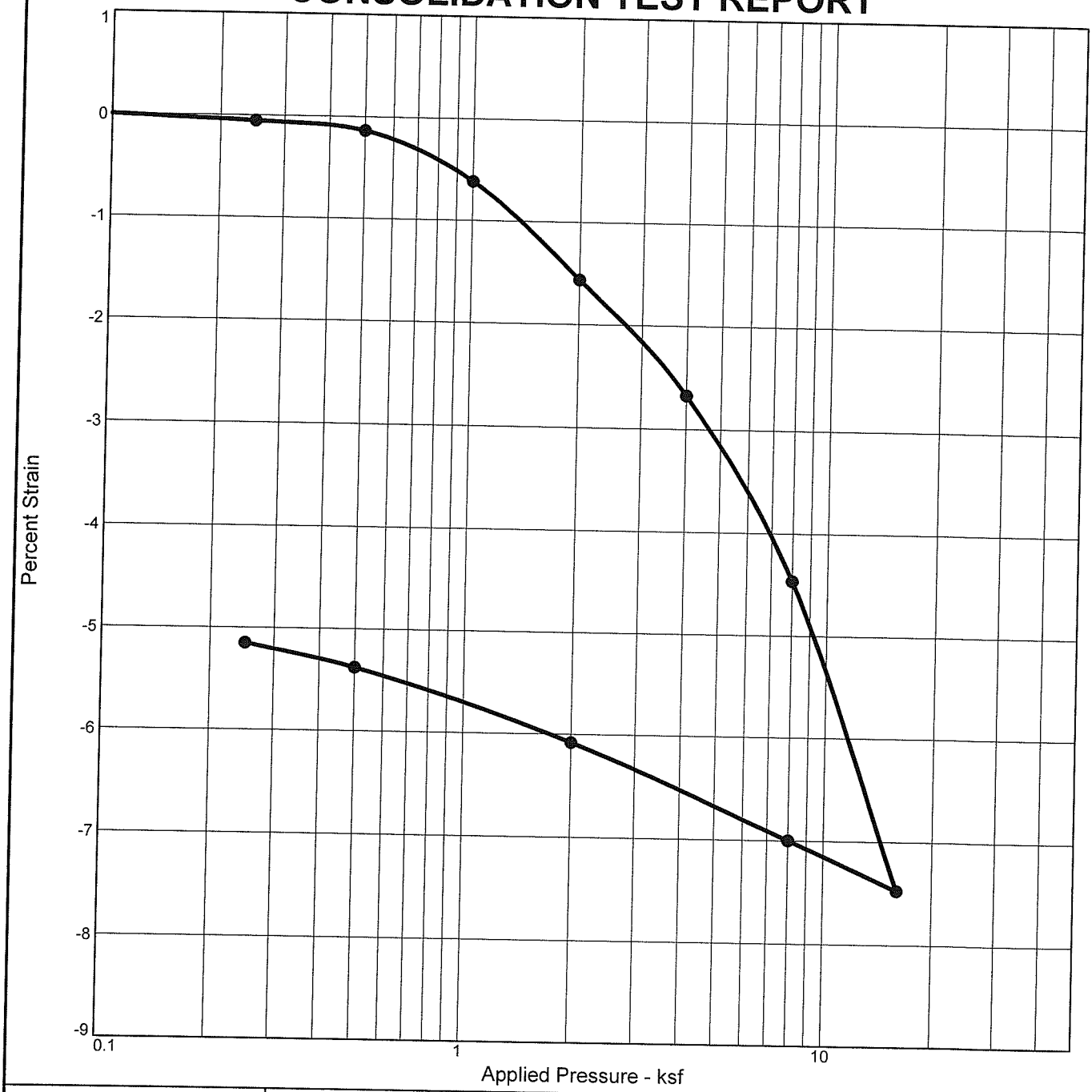
Client: Macon County - Chris Stahl

Project: Macon County, NC
MSW Landfill Phase III DHR

Project No.: J13-1101-06

Figure

CONSOLIDATION TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	P_c (ksf)	C_c	Initial Void Ratio
Saturation	Moisture							
74.6 %	21.0 %	97.1	43	11	2.77	7.21	0.18	0.780

MATERIAL DESCRIPTION	USCS	AASHTO
Brown silty fi.-co. SAND	SM	

Project No. J13-1101-06 **Client:** Macon County - Chris Stahl

Project: Macon County NC
MSW Landfill Phase III DHR

Source of Sample: Boring **Depth:** 1.0-3.0 **Sample Number:** BLE-21

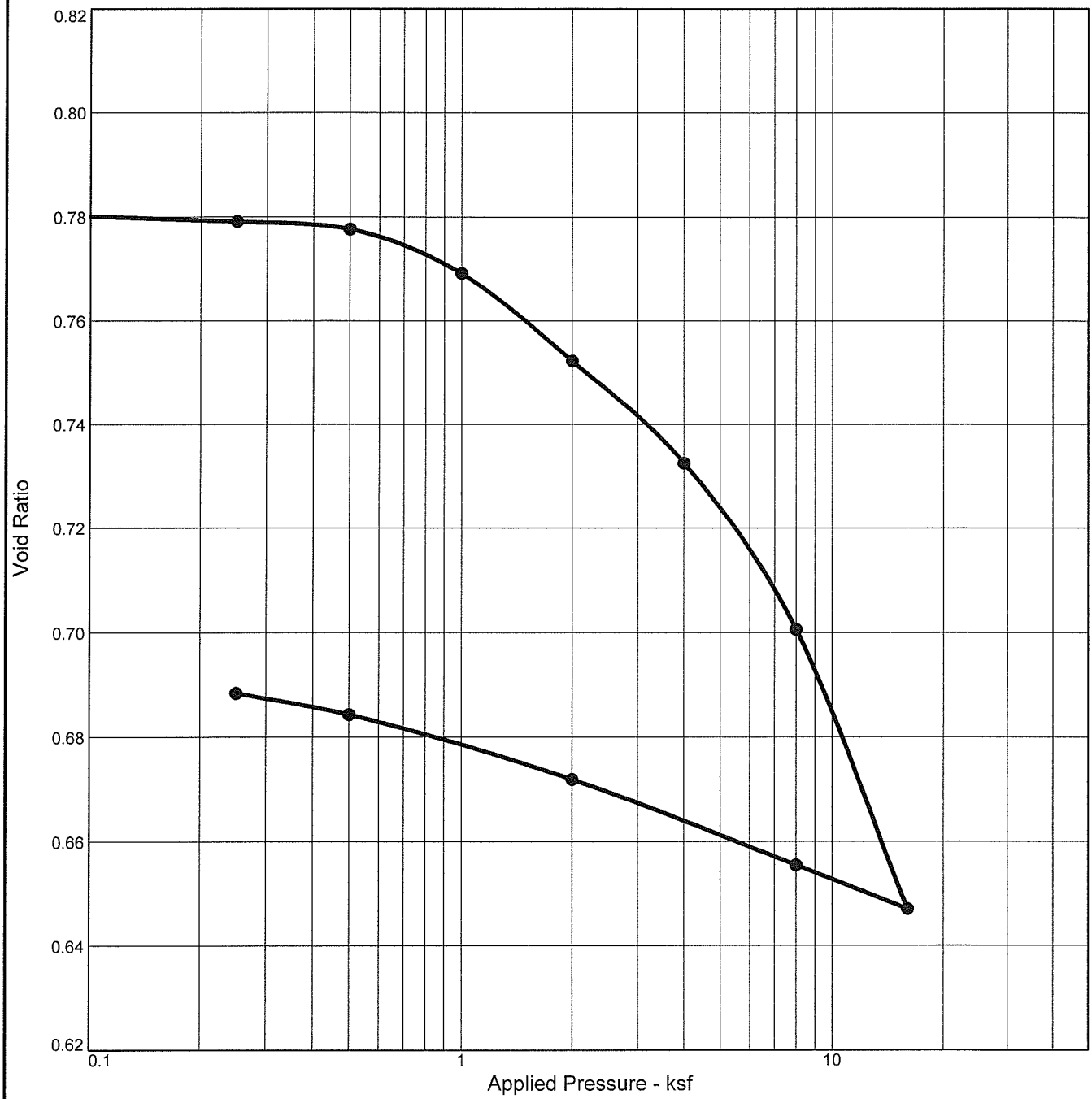
Bunnell Lammons Engineering, Inc.

Greenville, SC

Remarks:

Figure

CONSOLIDATION TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	P_c (ksf)	C_c	Initial Void Ratio
Saturation	Moisture							
74.6 %	21.0 %	97.1	43	11	2.77	7.21	0.18	0.780

MATERIAL DESCRIPTION	USCS	AASHTO
Brown silty fi.-co. SAND	SM	

Project No. J13-1101-06 **Client:** Macon County - Chris Stahl

Project: Macon County NC
MSW Landfill Phase III DHR

Source of Sample: Boring **Depth:** 1.0-3.0 **Sample Number:** BLE-21

Remarks:

Bunnell Lammons Engineering, Inc.

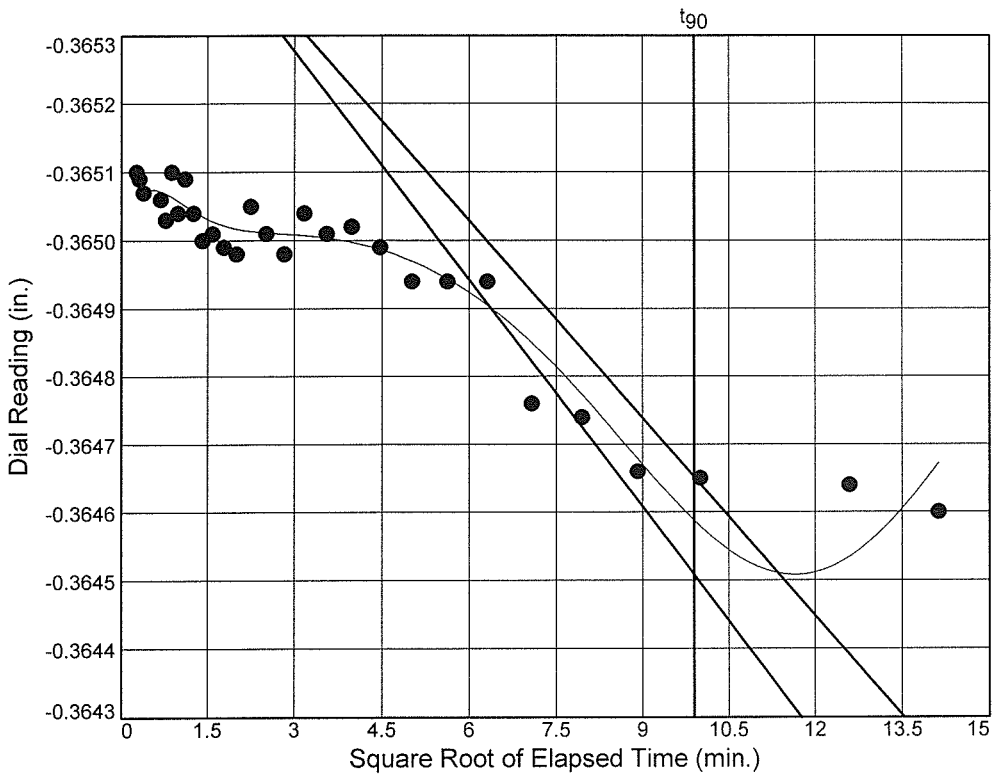
Greenville, SC

Figure

Dial Reading vs. Time

Project No.: J13-1101-06
Project: Macon County NC

Source of Sample: Boring Depth: 1.0-3.0 Sample Number: BLE-21



Load No.= 1

Load= 0.25 ksf

D_0 = -0.3656

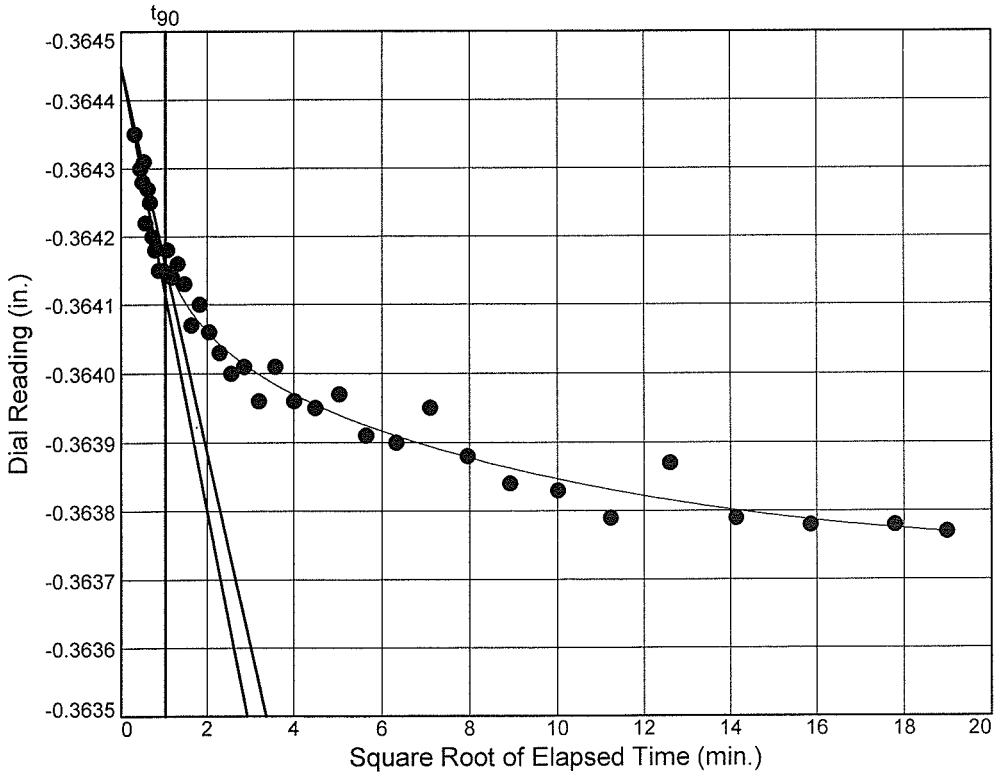
D_{90} = -0.3646

D_{100} = -0.3645

T_{90} = 97.97 min.

C_v @ T_{90}

0.002 in.^{2}/min.



Load No.= 2

Load= 0.50 ksf

D_0 = -0.3644

D_{90} = -0.3642

D_{100} = -0.3641

T_{90} = 1.06 min.

C_v @ T_{90}

0.199 in.^{2}/min.

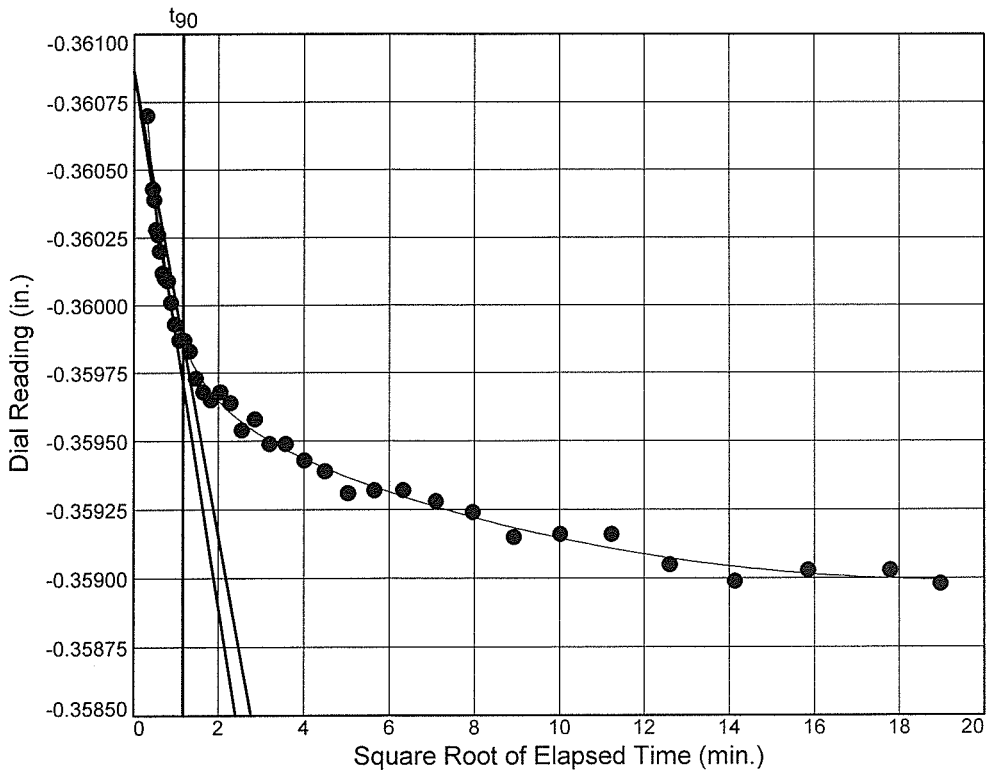
Figure

Bunnell Lammons Engineering, Inc.

Dial Reading vs. Time

Project No.: J13-1101-06
Project: Macon County NC

Source of Sample: Boring Depth: 1.0-3.0 Sample Number: BLE-21



Load No.= 3

Load= 1.00 ksf

D_0 = -0.3609

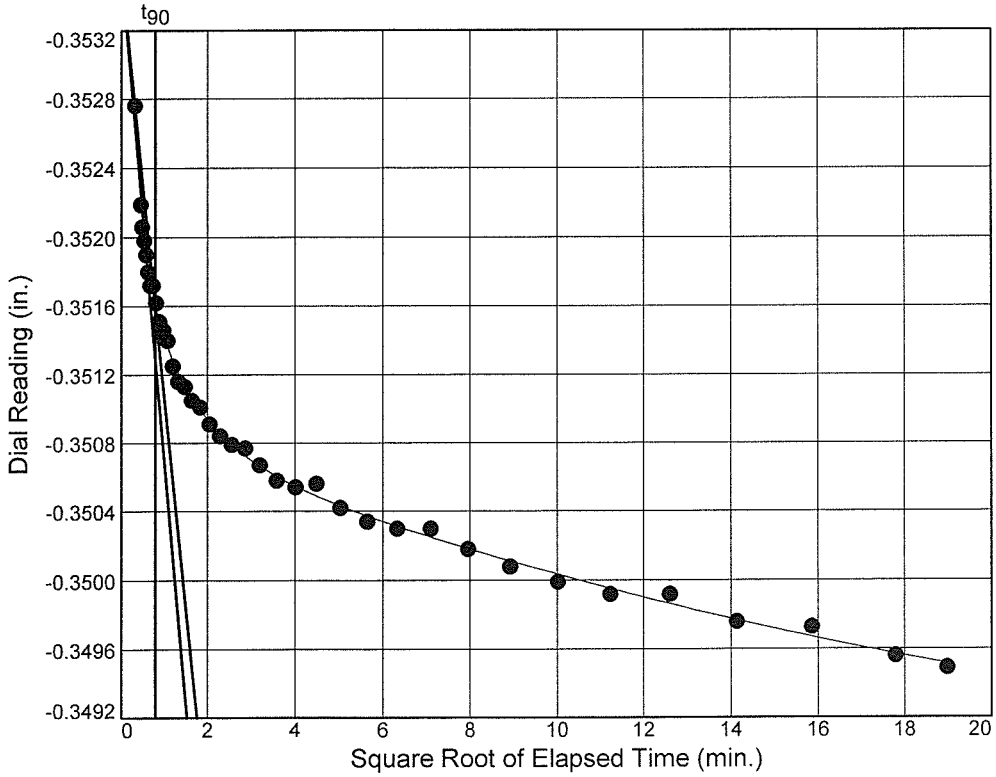
D_{90} = -0.3599

D_{100} = -0.3597

T_{90} = 1.38 min.

C_v @ T_{90}

0.153 in.^{2}/min.



Load No.= 4

Load= 2.00 ksf

D_0 = -0.3535

D_{90} = -0.3516

D_{100} = -0.3514

T_{90} = 0.63 min.

C_v @ T_{90}

0.332 in.^{2}/min.

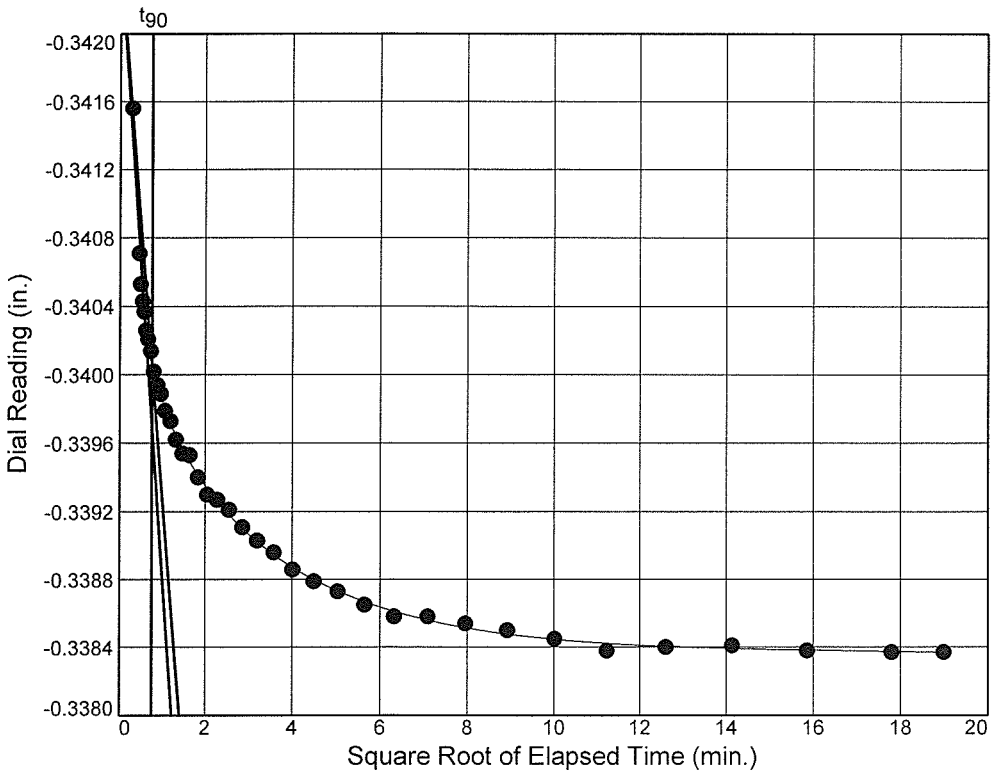
Figure

Bunnell Lammons Engineering, Inc.

Dial Reading vs. Time

Project No.: J13-1101-06
Project: Macon County NC

Source of Sample: Boring Depth: 1.0-3.0 Sample Number: BLE-21



Load No.= 5

Load= 4.00 ksf

D_0 = -0.3424

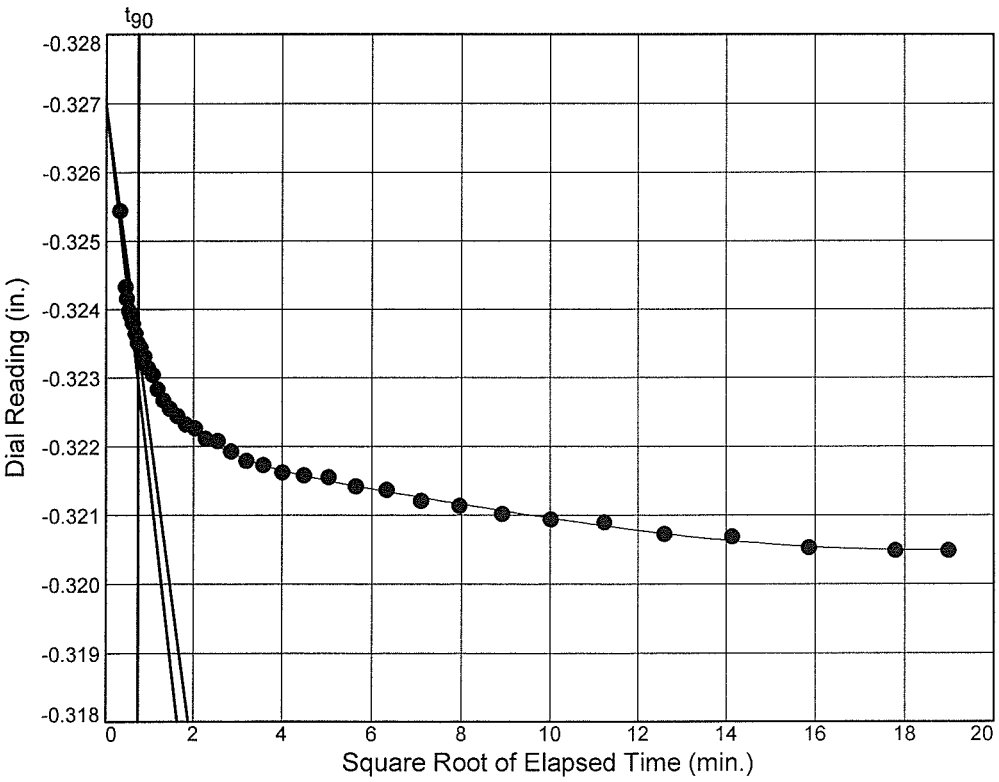
D_{90} = -0.3401

D_{100} = -0.3398

T_{90} = 0.57 min.

C_v @ T_{90}

0.354 in.^{2}/min.



Load No.= 6

Load= 8.00 ksf

D_0 = -0.3270

D_{90} = -0.3235

D_{100} = -0.3231

T_{90} = 0.54 min.

C_v @ T_{90}

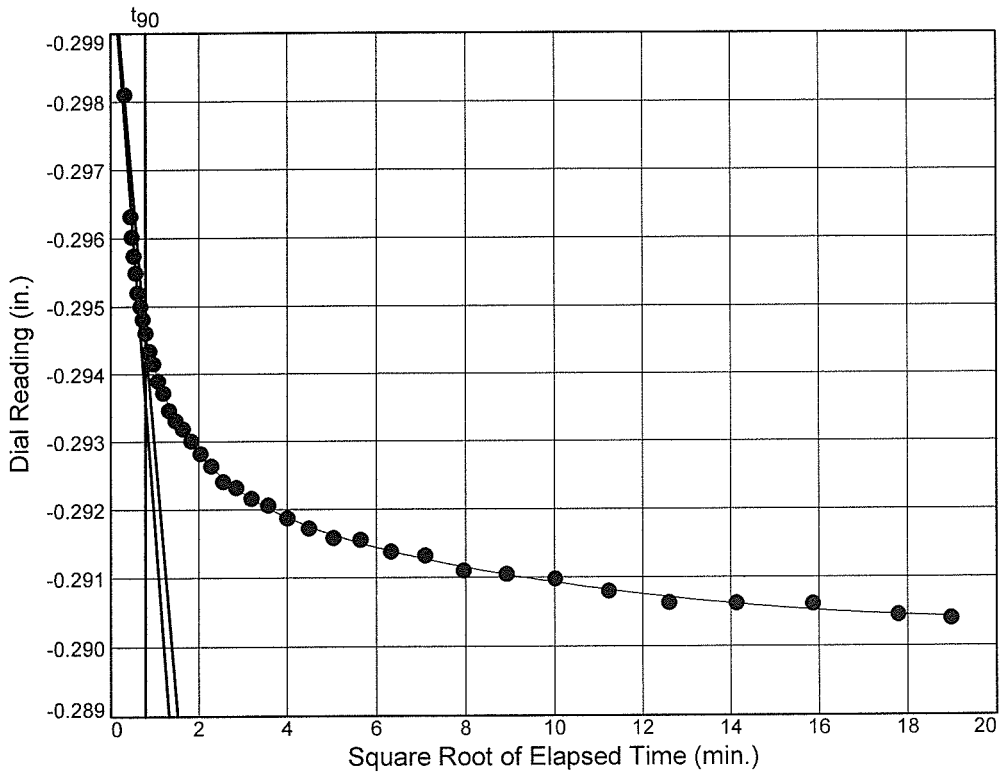
0.364 in.^{2}/min.

Figure

Dial Reading vs. Time

Project No.: J13-1101-06
Project: Macon County NC

Source of Sample: Boring Depth: 1.0-3.0 Sample Number: BLE-21



Load No.= 7

Load= 16.00 ksf

D_0 = -0.3004

D_{90} = -0.2946

D_{100} = -0.2939

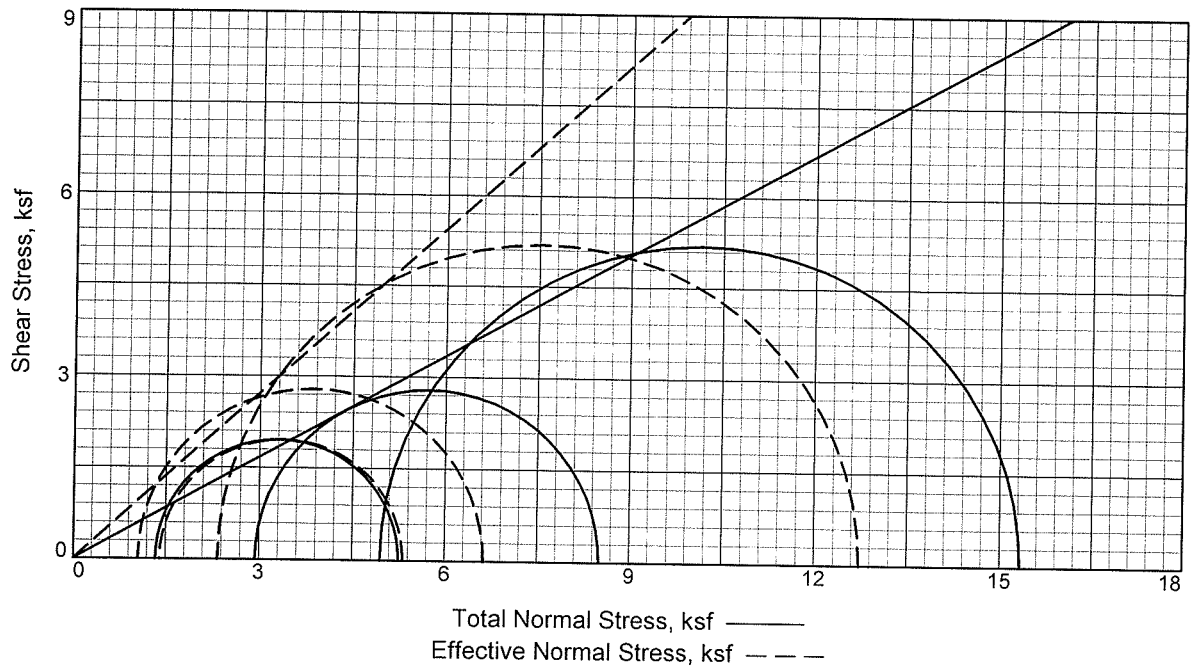
T_{90} = 0.62 min.

C_v @ T_{90}
0.302 in.^{2}/min.

Figure

Bunnell Lammons Engineering, Inc.

TRIAXIAL SHEAR TEST REPORT



Type of Test: CU with Pore Pressures **Sample Type:** Undisturbed

No.	Fluid Press. psi		Fail. Stress, ksf		Ult. Stress, ksf		Principal Stresses at Failure ksf	
	Cell	Back	Deviator	Total Pore Pressure	Deviator	Total Pore Pressure	$\bar{\sigma}_1$	$\bar{\sigma}_3$
1	70.000	60.714	3.912	8.675	3.859	8.644	5.317	1.405
2	80.800	60.400	5.574	10.579	5.555	10.572	6.630	1.056
3	95.000	60.626	10.384	11.338	9.063	11.135	12.726	2.342

No.	Consolidated Sample Parameters						
	% Water Content	Dry Dens. pcf	Satur-ation	Void Ratio	Diameter in.	Height in.	Strain Rate in/min.
1	32.4	90.6	100.0%	0.8848	2.922	5.824	0.015
2	34.3	88.0	100.0%	0.9391	2.905	5.904	0.015
3	34.3	88.0	100.0%	0.9391	2.975	5.629	0.015

Mohr-Coulomb Strength Parameters	Total	Effective
Strength intercept, c=	0 ksf	0 ksf
Friction angle, ϕ =	29.20 deg	42.25 deg
Tangent, ϕ =	0.56	0.91

Material Description

Brown silty fi.-co. SAND

LL= 42 **PL=** 39 **PI=** 3

Client: Macon County - Chris Stahl

Project: Macon County, NC
MSW Landfill Phase III DHR

Source of Sample: Boring **Depth:** 14.0-16.0

Sample Number: BLE-4

Date Sampled:

File: MACON CO. MSW LF 1101.06

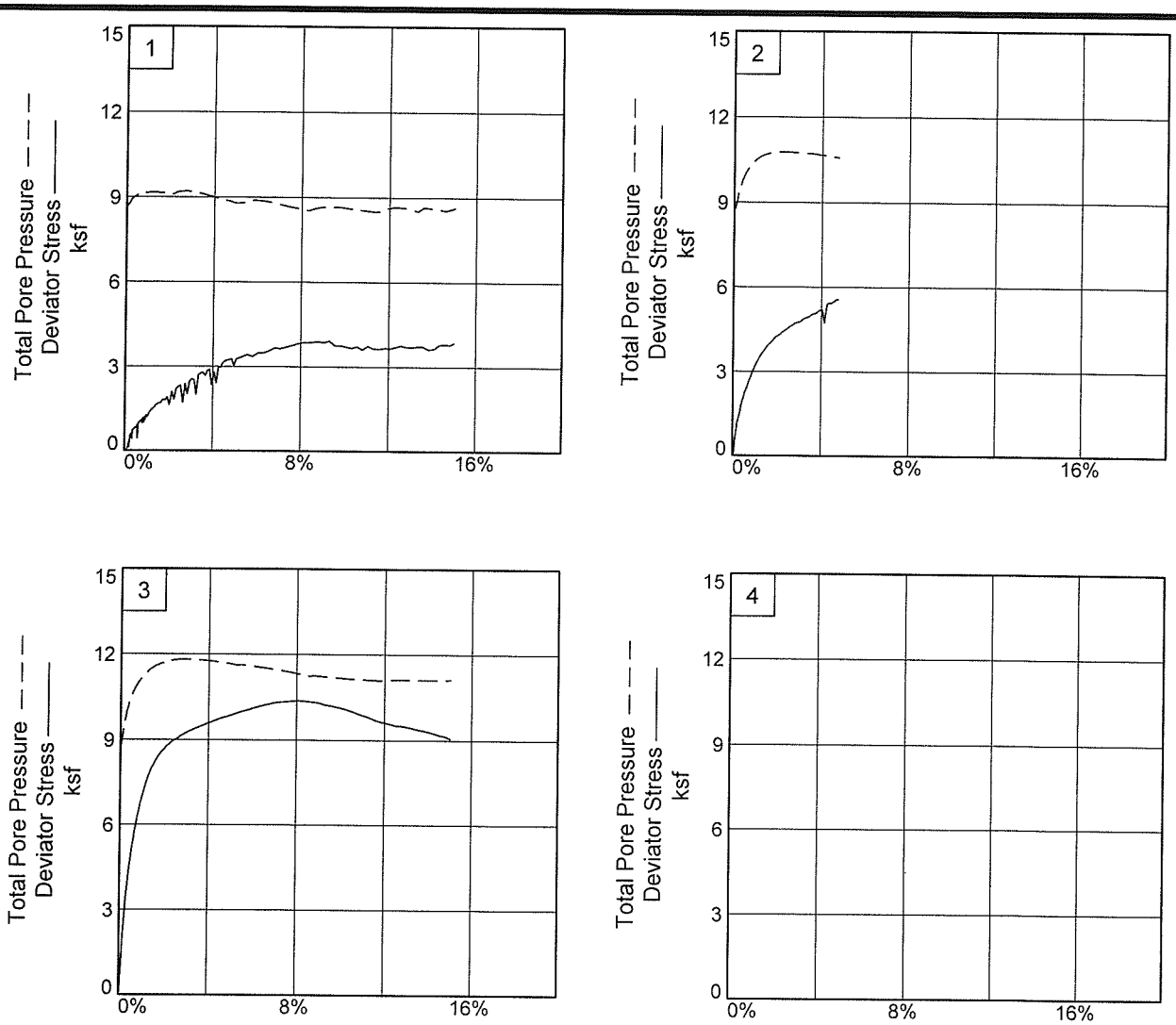
Remarks:

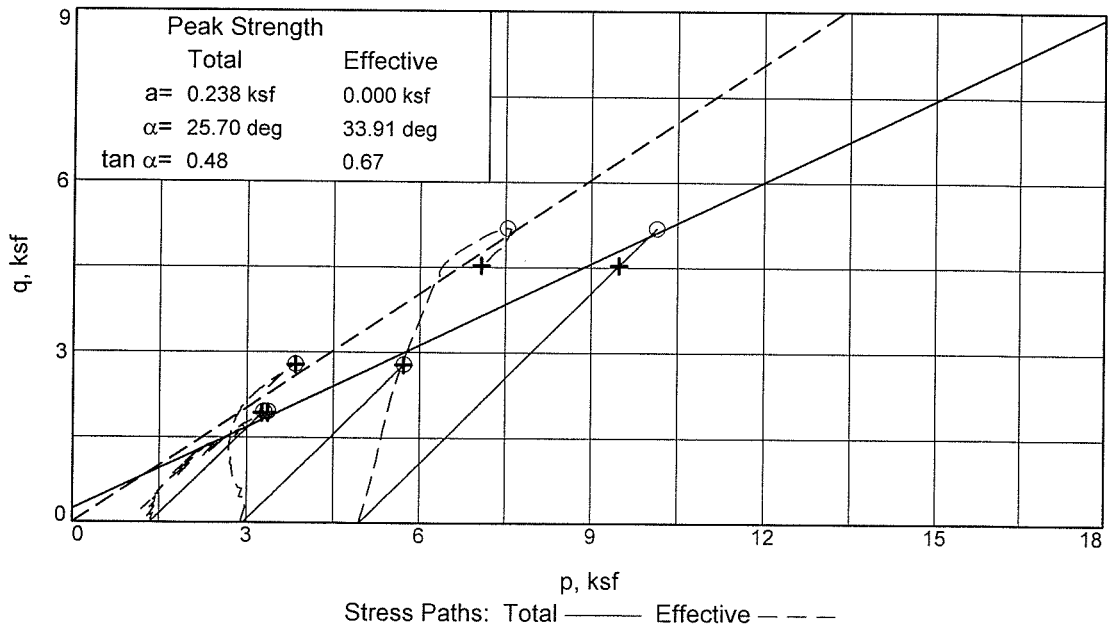
TRIAXIAL SHEAR TEST REPORT

Bunnell Lammons Engineering, Inc.
Greenville, SC

Proj. No.: J13-1101-06

Figure _____





Client: Macon County - Chris Stahl

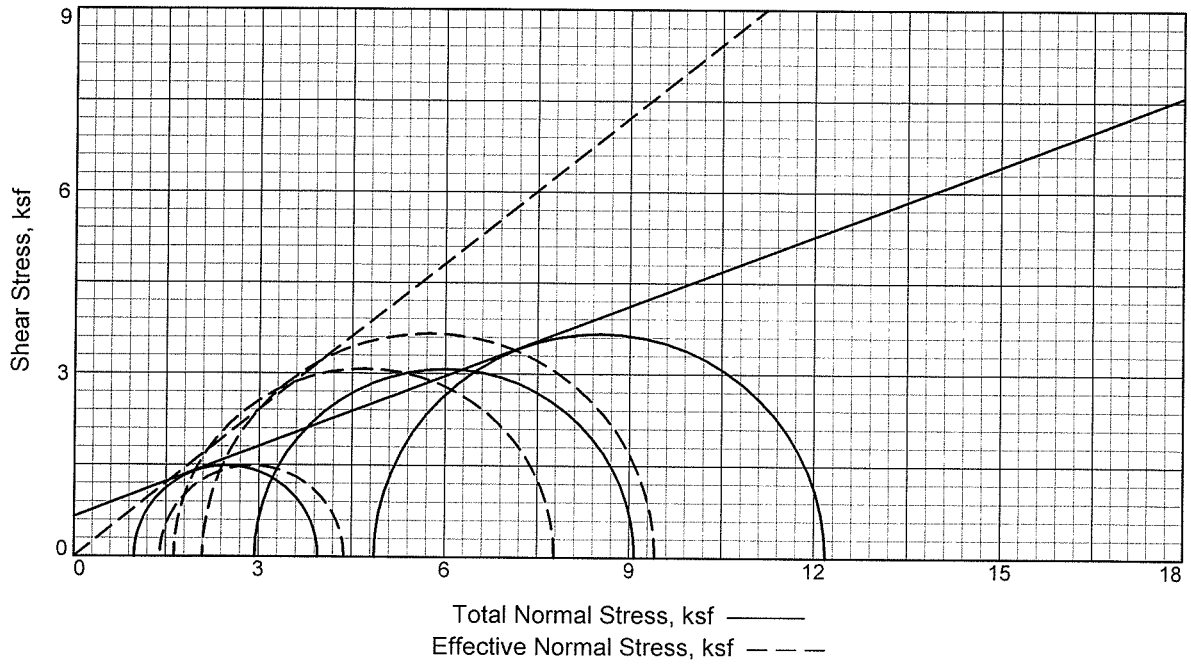
Project: Macon County, NC

Source of Sample: Boring **Depth:** 14.0-16.0 **Sample Number:** BLE-4

Project No.: J13-1101-06 **Figure** _____

Bunnell Lammons Engineering, Inc.

TRIAXIAL SHEAR TEST REPORT



Type of Test: CU with Pore Pressures **Sample Type:** Remolded

No.	Fluid Press. psi		Fail. Stress, ksf		Ult. Stress, ksf		Principal Stresses at Failure ksf	
	Cell	Back	Deviator	Total Pore Pressure	Deviator	Total Pore Pressure	$\bar{\sigma}_1$	$\bar{\sigma}_3$
1	67.000	60.145	2.970	8.243	2.936	8.224	4.375	1.405
2	80.800	60.411	6.149	10.005	6.127	9.985	7.779	1.630
3	94.700	60.950	7.320	11.543	7.320	11.543	9.414	2.094

No.	Consolidated Sample Parameters						
	% Water Content	Dry Dens. pcf	Satur-ation	Void Ratio	Diameter in.	Height in.	Strain Rate in/min.
1	23.5	105.1	100.0%	0.6543	2.886	5.975	0.015
2	22.6	106.7	100.0%	0.6292	2.871	5.945	0.015
3	22.0	107.7	100.0%	0.6137	2.859	5.940	0.015

Mohr-Coulomb Strength Parameters	Total	Effective
Strength intercept, c=	0.650 ksf	0 ksf
Friction angle, ϕ =	21.06 deg	38.76 deg
Tangent, ϕ =	0.39	0.80

Material Description

Dark brown silty fi.-med. SAND

LL= 36 **PL=** 28 **PI=** 8

Client: Macon County - Chris Stahl

Project: Macon County, NC
MSW Landfill Phase III DHR

Source of Sample: Boring **Depth:** 15.0-20.0

Sample Number: BLE-11

Date Sampled:

File: MACON CO. MSW LF 1101.06

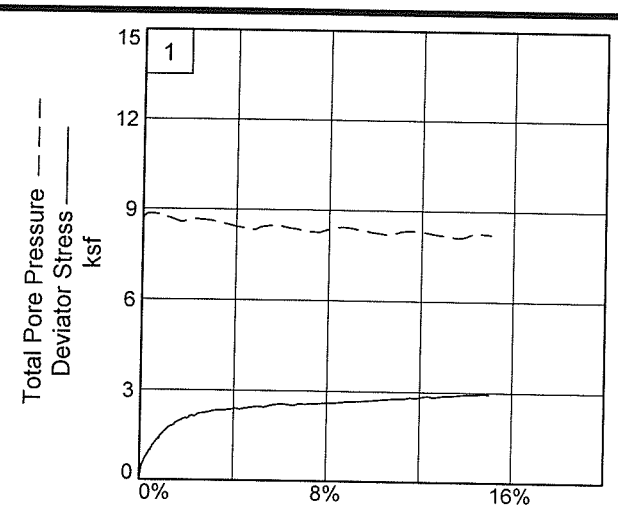
Remarks:

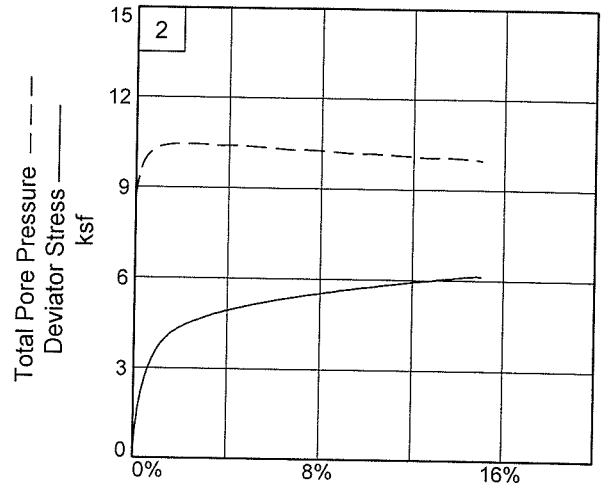
TRIAXIAL SHEAR TEST REPORT

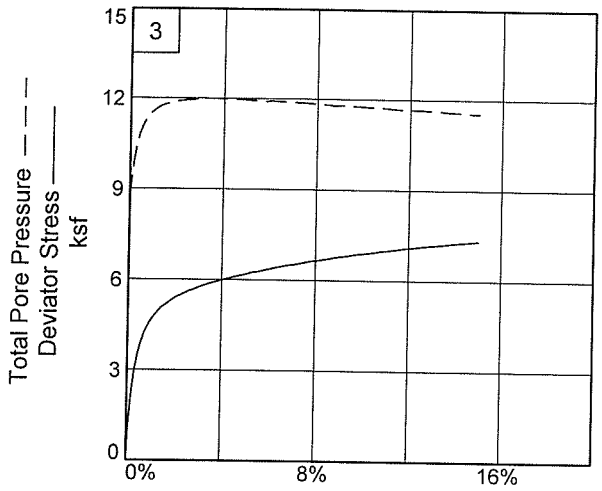
Bunnell Lammons Engineering, Inc.
Greenville, SC

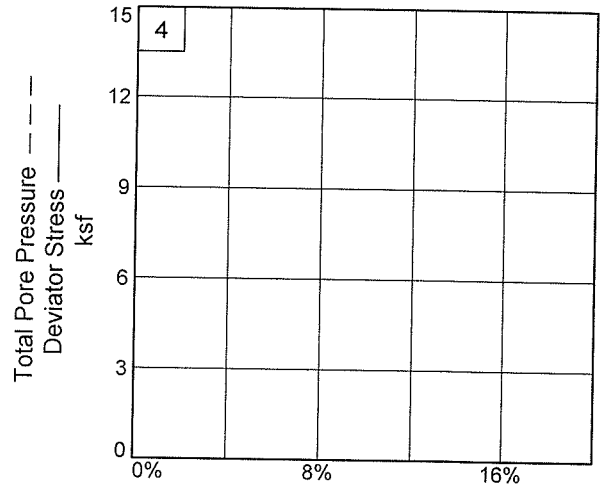
Proj. No.: J13-1101-06

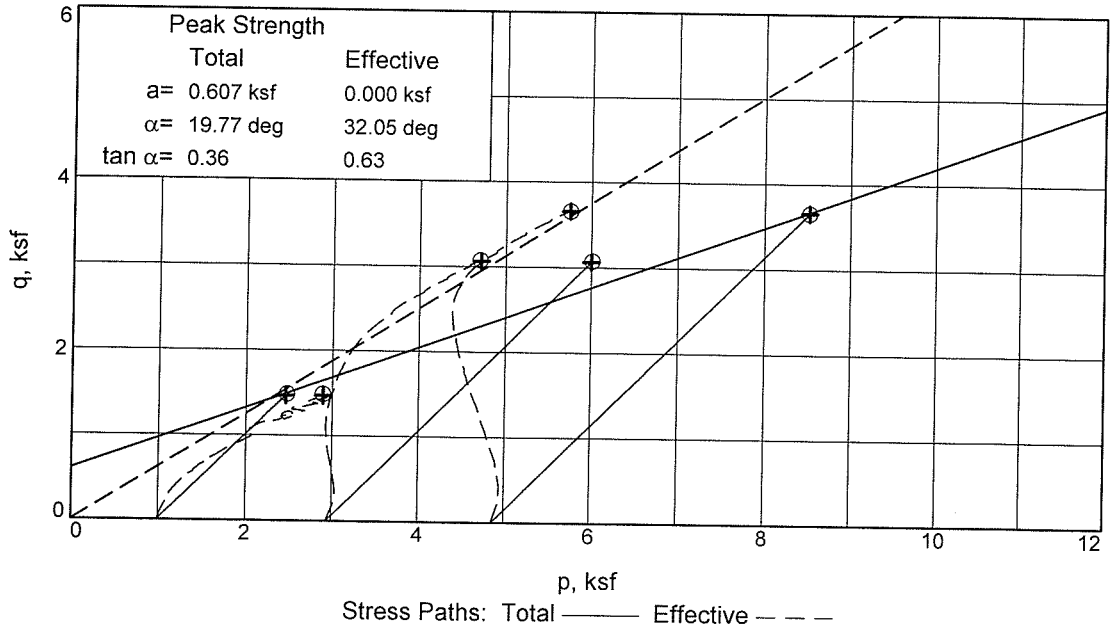
Figure _____







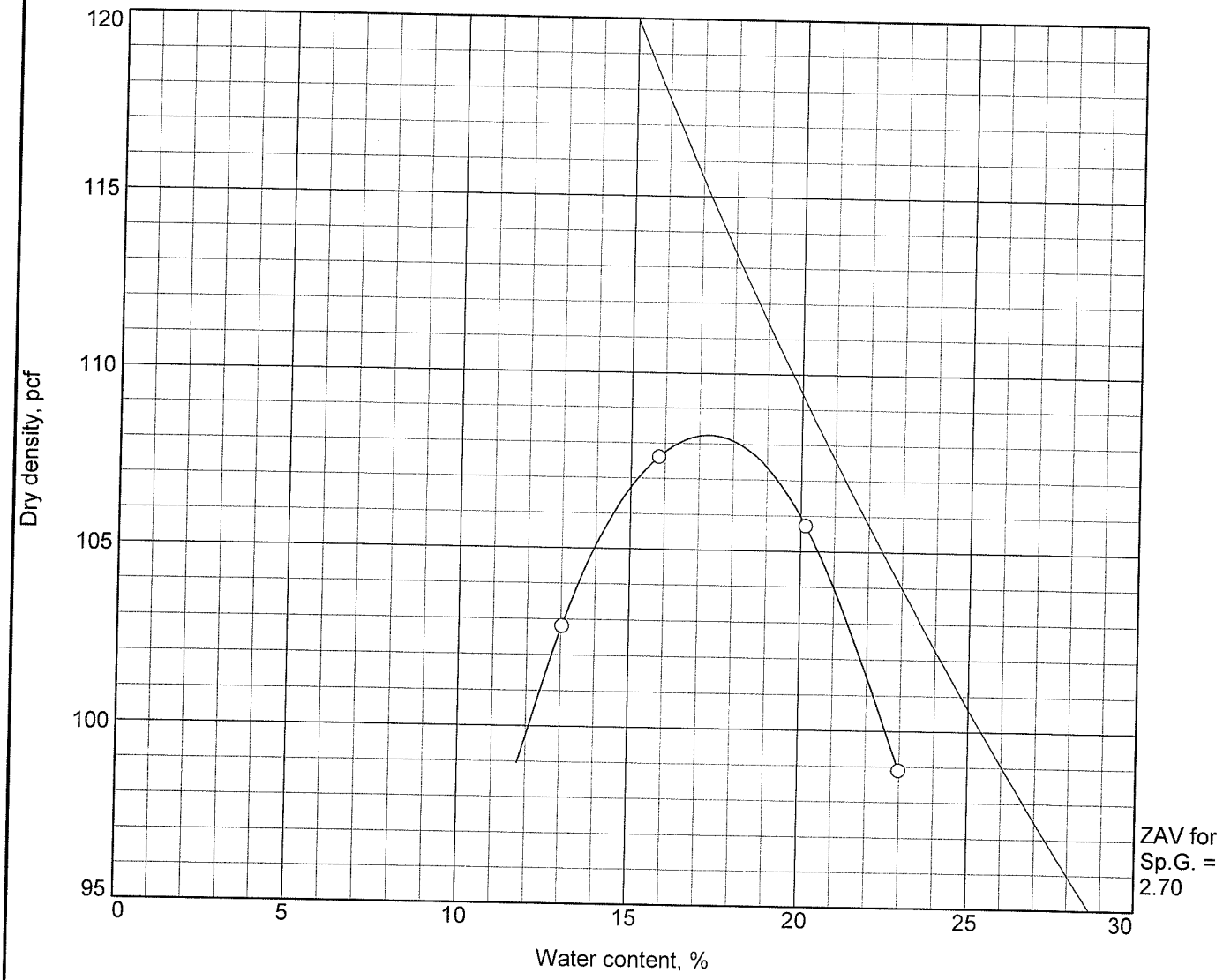




Client: Macon County - Chris Stahl
Project: Macon County, NC
Source of Sample: Boring **Depth:** 15.0-20.0 **Sample Number:** BLE-11
Project No.: J13-1101-06 **Figure** _____

Bunnell Lammons Engineering, Inc.

MOISTURE DENSITY RELATIONSHIP



Test specification: ASTM D 698-07 Method A Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > #4	% < No.200
	USCS	AASHTO						
5.0-10.0	SM	A-4(2)			39	9	0.0	47.4

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 108.2 pcf Optimum moisture = 17.3 %	Brown silty fi.-med. SAND

Project No. J13-1101-06 **Client:** Macon County - Chris Stahl
Project: Macon County, NC
MSW Landfill Phase III DHR
○ **Source of Sample:** Boring **Sample Number:** BLE-4

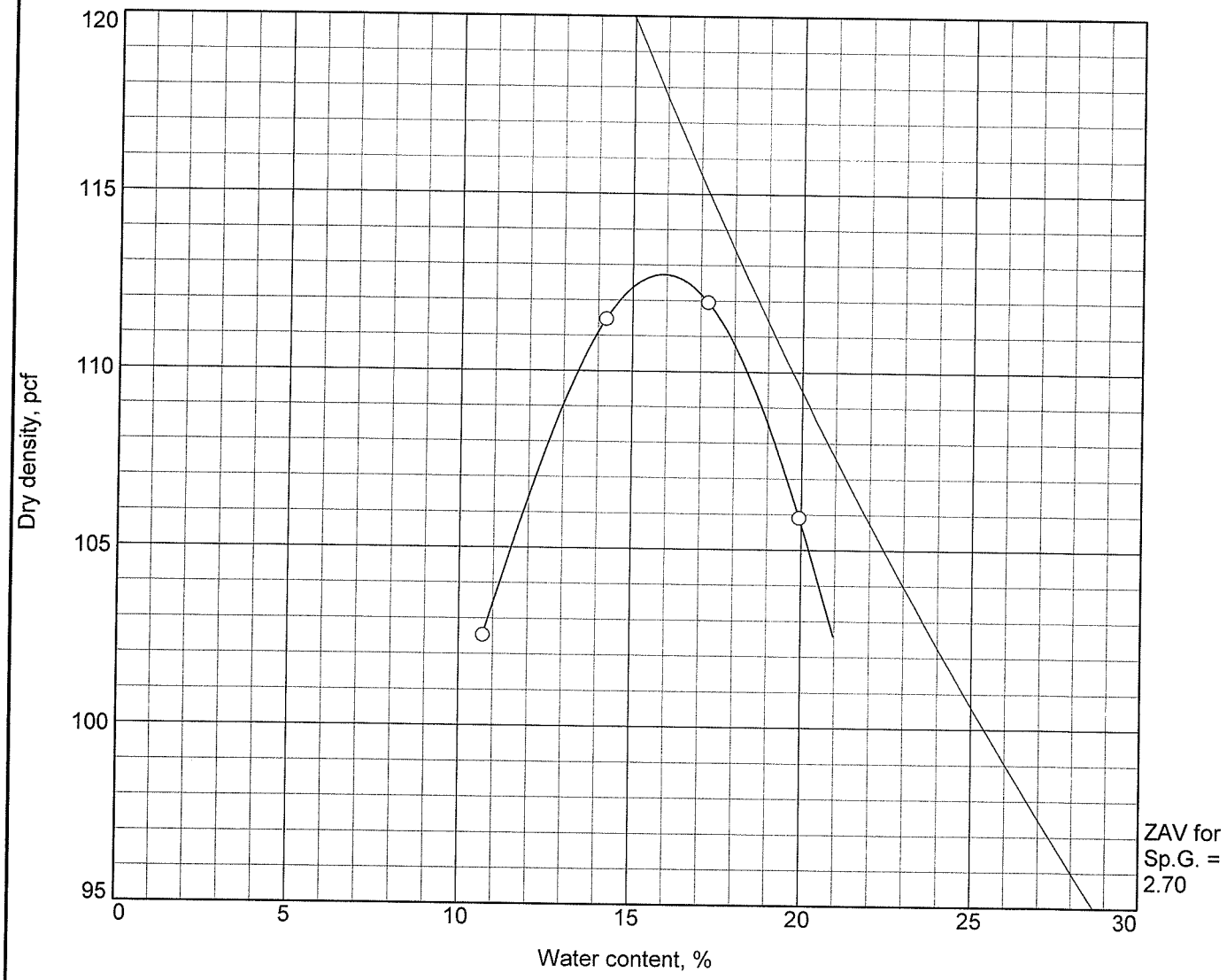
Remarks:

Bunnell Lammons Engineering, Inc.

Greenville, SC

Figure

MOISTURE DENSITY RELATIONSHIP



Test specification: ASTM D 698-07 Method A Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > #4	% < No.200
	USCS	AASHTO						
15.0-20.0	SM				36	8	0.0	41.7

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 112.7 pcf Optimum moisture = 15.9 %	Dark brown silty fi.-med. SAND

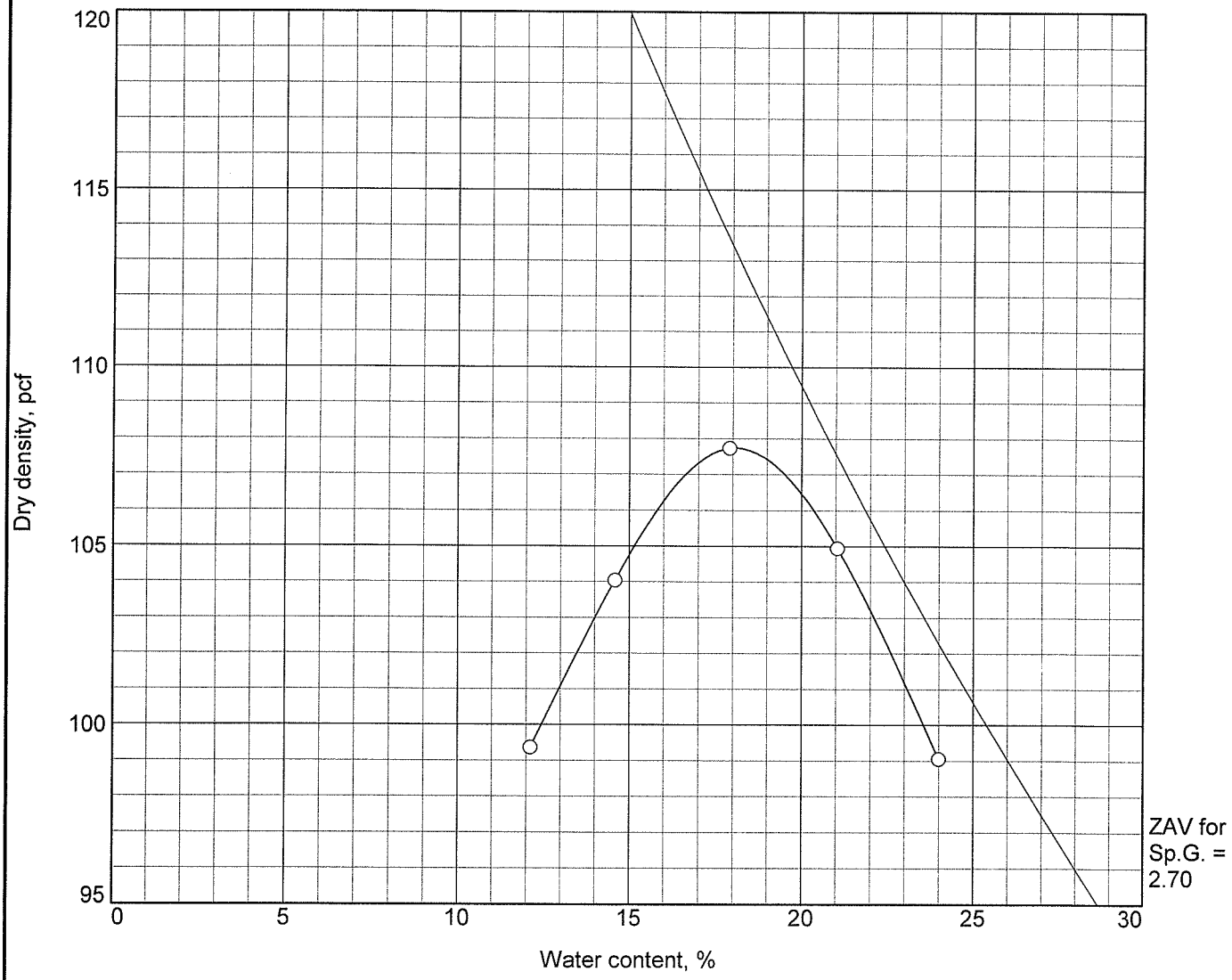
Project No. J13-1101-06 **Client:** Macon County - Chris Stahl
Project: Macon County, NC
MSW Landfill Phase III DHR
○ **Source of Sample:** Boring **Sample Number:** BLE-11

Remarks:

Bunnell Lammons Engineering, Inc.

Greenville, SC

Figure



Test specification: ASTM D 698-07 Method A Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > #4	% < No.200
	USCS	AASHTO						
0.0-5.0	ML				43	15	0.6	51.1

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 107.7 pcf Optimum moisture = 18.1 %	Dark brown fi.-med. sandy SILT

Project No. J13-1101-06 **Client:** Macon County - Chris Stahl

Project: Macon County, NC

MSW Landfill Phase III DHR **Date:**

○ **Source of Sample:** Boring **Sample Number:** BLE-15

Remarks:

Bunnell Lammons Engineering, Inc.

Greenville, SC

Figure

BLE INC.

HYDRAULIC CONDUCTIVITY TEST REPORT

CONSTANT VOLUME APPARATUS (ASTM D 5084)

PROJECT: **MACON CO. LANDFILL**
PROJECT NO.: **J13-1101-06**
DATE RECEIVED: **12-28-13**

TESTED BY: **JOHN MATHEW**
CHECKED BY: **PAUL YARBER**

SAMPLE NO. **BLE-4**
TYPE **REMOLDED**
SAMPLE LOCATION: **5.0-10.0'**
SAMPLE DESCRIPTION: **BROWN SILTY FI.-MED. SAND**

SAMPLE DIMENSIONS AND PROPERTIES

ITEM	INITIAL		FINAL	
	inches	centimeters	inches	centimeters
Sample Length	3.000	7.620	2.982	7.574
Sample Diameter	2.850	7.239	2.859	7.262
Length/Diameter Ratio		1.05		
Moisture Content (%)	WW= 165.7 DW= 138.9	19.3	WW= 255.1 DW= 206.6	23.5
Sample Wet Weight (grams)	616.9		637.2	
Wet Density (pcf)	122.8		126.8	
Dry Density (pcf)	102.9		102.7	
Saturation (%) TESTED SG= 2.7	82		99	

HYDRAULIC CONDUCTIVITY TESTING MEASUREMENT

(PERMOMETER)

Confining Pressure (psi) 70 | Influent Pressure (psi) 60 | Effluent Pressure (psi) 60 | B-Value 0.95

Reset (Y/N)	Date	Clock Time	Elapsed Time	HA_{OUT} (cm)	HA_{IN} (cm)	Temp °C	Gradient	K (cm/sec)	Temp Correction	$K_{20°C}$ (cm/sec)
Y	12-11-13	2:03:35		7.4	1.57	22.3	10			
	12-11-13	2:06:01	0:02:26	5.7	1.64	22.3	7	1.1E-06	0.947	1.0E-06
	12-11-13	2:06:15	0:02:40	5.6	1.64	22.3	7	1.1E-06	0.947	1.0E-06
	12-11-13	2:06:29	0:02:54	5.5	1.65	22.3	7	1.0E-06	0.947	9.9E-07
	12-11-13	2:06:42	0:03:07	5.4	1.65	22.3	7	1.0E-06	0.947	9.8E-07

HYDRAULIC CONDUCTIVITY ($K_{20°C}$) 1.0E-06 cm/sec

% COMPACTION OF STD. PROCTOR MAX. DRY DENSITY (ASTM D 698): 95.1
% WETTER THAN OPTIMUM MOISTURE CONTENT (ASTM D 698): +2.0

BLE INC.

HYDRAULIC CONDUCTIVITY TEST REPORT

CONSTANT VOLUME APPARATUS (ASTM D 5084)

PROJECT: **MACON CO. LANDFILL**
PROJECT NO.: **J13-1101-06**
DATE RECEIVED: **10-28-13**

TESTED BY: **JOHN MATHEW**
CHECKED BY: **PAUL YARBER**

SAMPLE NO. **BLE-4** SAMPLE LOCATION: **14.0-16.0'**
TYPE **UNDISTURBED** SAMPLE DESCRIPTION: **BROWN SILTY FI.-CO. SAND**

SAMPLE DIMENSIONS AND PROPERTIES

ITEM	INITIAL		FINAL	
	inches	centimeters	inches	centimeters
Sample Length	2.992	7.600	2.914	7.402
Sample Diameter	2.852	7.244	2.846	7.229
Length/Diameter Ratio		1.05		
Moisture Content (%)	WW= 228.5 DW= 189.6	20.5	WW= 274.5 DW= 219.0	25.3
Sample Wet Weight (grams)	569.4		600.7	
Wet Density (pcf)	113.5		123.4	
Dry Density (pcf)	94.2		98.5	
Saturation (%) TESTED SG= 2.74	69		94	

HYDRAULIC CONDUCTIVITY TESTING MEASUREMENT

FALLING HEAD TEST

Confining Pressure (psi) 72.8 | Influent Pressure (psi) 70.2 | Effluent Pressure (psi) 70 | B-Value 0.95

Date	Clock Time		Elapsed Time	Pipet Readings				Head		Temp	Gradient	K	Temp	$K_{20°C}$
				Initial		Final		Initial	Final					
	Start	End	seconds	in	out	in	out	cm	cm	°C		(cm/sec)	Correction	(cm/sec)
11-19-13	1:51:10	1:51:28	18	1.0	23.0	2.0	22.0	40.092	37.726	21.0	5	2.6E-04	0.976	2.5E-04
11-19-13	1:51:28	1:51:48	20	2.0	22.0	3.0	21.0	37.726	35.361	21.0	5	2.5E-04	0.976	2.4E-04
11-19-13	1:51:48	1:52:09	21	3.0	21.0	4.0	20.0	35.361	32.995	21.0	5	2.5E-04	0.976	2.5E-04
11-19-13	1:52:09	1:52:32	23	4.0	20.0	5.0	19.0	32.995	30.629	21.0	5	2.5E-04	0.976	2.4E-04
		Pipet Length, cm		28.390	28.390									
		Pipet Volume, cc		24	24									
		Cross-sectional Area of Pipet, cm^2		0.8454	0.8454									

HYDRAULIC CONDUCTIVITY ($K_{20°C}$) 2.4E-04 cm/sec

BLE INC.

HYDRAULIC CONDUCTIVITY TEST REPORT

CONSTANT VOLUME APPARATUS (ASTM D 5084)

PROJECT: **MACON CO. LANDFILL**
PROJECT NO.: **J13-1101-06**
DATE RECEIVED: **10-28-13**

TESTED BY: **JOHN MATHEW**
CHECKED BY: **PAUL YARBER**

SAMPLE NO. **BLE-4** SAMPLE LOCATION: **18.0-20.0'**
TYPE **UNDISTURBED** SAMPLE DESCRIPTION: **BROWN SILTY FI.-MED. SAND**

SAMPLE DIMENSIONS AND PROPERTIES

ITEM	INITIAL		FINAL	
	inches	centimeters	inches	centimeters
Sample Length	2.932	7.447	2.920	7.417
Sample Diameter	2.863	7.272	2.882	7.320
Length/Diameter Ratio		1.02		
Moisture Content (%)	WW= 189.4 DW= 151.9	24.7	WW= 222.8 DW= 179.3	24.3
Sample Wet Weight (grams)	603.8		617.8	
Wet Density (pcf)	121.9		123.6	
Dry Density (pcf)	97.7		99.4	
Saturation (%) TESTED SG= 2.76	89		91	

HYDRAULIC CONDUCTIVITY TESTING MEASUREMENT

FALLING HEAD TEST

Confining Pressure (psi) 87.1 | Influent Pressure (psi) 70.2 | Effluent Pressure (psi) 70 | B-Value 0.95

Date	Clock Time		Elapsed Time	Pipet Readings				Head		Temp	Gradient	K	Temp	$K_{20°C}$
				Initial		Final		Initial	Final					
	Start	End	seconds	in	out	in	out	cm	cm	°C		(cm/sec)	Correction	(cm/sec)
11-19-13	2:10:15	2:15:20	305	1.0	23.0	2.0	22.0	40.092	37.726	21.0	5	1.5E-05	0.976	1.4E-05
11-19-13	2:15:20	2:20:45	325	2.0	22.0	3.0	21.0	37.726	35.361	21.0	5	1.5E-05	0.976	1.4E-05
11-19-13	2:20:45	2:26:43	358	3.0	21.0	4.0	20.0	35.361	32.995	21.0	5	1.4E-05	0.976	1.4E-05
11-19-13	2:26:43	2:33:18	395	4.0	20.0	5.0	19.0	32.995	30.629	21.0	5	1.4E-05	0.976	1.4E-05
		Pipet Length, cm		28.390	28.390									
		Pipet Volume, cc		24	24									
		Cross-sectional Area of Pipet, cm^2		0.8454	0.8454									

HYDRAULIC CONDUCTIVITY ($K_{20°C}$) 1.4E-05 cm/sec

BLE INC.

HYDRAULIC CONDUCTIVITY TEST REPORT

CONSTANT VOLUME APPARATUS (ASTM D 5084)

PROJECT: MACON CO. LANDFILL
PROJECT NO.: J13-1101-06
DATE RECEIVED: 10-28-13

TESTED BY: JOHN MATHEW
CHECKED BY: PAUL YARBER

SAMPLE NO. BLE-6
TYPE UNDISTURBED
SAMPLE LOCATION: 6.0-8.0'
SAMPLE DESCRIPTION: BROWN SILTY FI.-MED. SAND

SAMPLE DIMENSIONS AND PROPERTIES

ITEM	INITIAL		FINAL	
	inches	centimeters	inches	centimeters
Sample Length	2.853	7.247	2.820	7.163
Sample Diameter	2.850	7.239	2.843	7.221
Length/Diameter Ratio		1.00		
Moisture Content (%)	WW= 180.5 DW= 140.3	28.7	WW= 201.9 DW= 142.8	41.4
Sample Wet Weight (grams)	454.7		509.0	
Wet Density (pcf)	95.2		108.3	
Dry Density (pcf)	74.0		76.6	
Saturation (%) TESTED SG= 2.78	59		91	

HYDRAULIC CONDUCTIVITY TESTING MEASUREMENT

FALLING HEAD TEST

Confining Pressure (psi) 80.2 | Influent Pressure (psi) 70.2 | Effluent Pressure (psi) 70 | B-Value 0.95

Date	Clock Time		Elapsed Time	Pipet Readings				Head		Temp	Gradient	K	Temp	$K_{20°C}$
				Initial		Final		Initial	Final					
	Start	End	seconds	in	out	in	out	cm	cm	°C		(cm/sec)	Correction	(cm/sec)
11-19-13	1:33:00	1:33:10	10	1.0	23.0	2.0	22.0	40.092	37.726	21.0	5	4.5E-04	0.976	4.4E-04
11-19-13	1:33:10	1:33:21	11	2.0	22.0	3.0	21.0	37.726	35.361	21.0	5	4.4E-04	0.976	4.2E-04
11-19-13	1:33:21	1:33:33	12	3.0	21.0	4.0	20.0	35.361	32.995	21.0	5	4.3E-04	0.976	4.2E-04
11-19-13	1:33:33	1:33:46	13	4.0	20.0	5.0	19.0	32.995	30.629	21.0	5	4.2E-04	0.976	4.1E-04
		Pipet Length, cm		28.390	28.390									
		Pipet Volume, cc		24	24									
		Cross-sectional Area of Pipet, cm^2		0.8454	0.8454									

HYDRAULIC CONDUCTIVITY ($K_{20°C}$) 4.2E-04 cm/sec

BLE INC.

HYDRAULIC CONDUCTIVITY TEST REPORT

CONSTANT VOLUME APPARATUS (ASTM D 5084)

PROJECT: MACON CO. LANDFILL
PROJECT NO.: J13-1101-06
DATE RECEIVED: 12-28-13

TESTED BY: JOHN MATHEW
CHECKED BY: PAUL YARBER

SAMPLE NO. BLE-11
TYPE UNDISTURBED
SAMPLE LOCATION: 1.0-3.0'
SAMPLE DESCRIPTION: RED FI. SANDY CLAY

SAMPLE DIMENSIONS AND PROPERTIES

ITEM	INITIAL		FINAL	
	inches	centimeters	inches	centimeters
Sample Length	2.901	7.369	2.912	7.396
Sample Diameter	2.849	7.236	2.853	7.247
Length/Diameter Ratio		1.02		
Moisture Content (%)	WW= 166.0 DW= 131.4	26.3	WW= 199.2 DW= 152.4	30.7
Sample Wet Weight (grams)	548.6		564.6	
Wet Density (pcf)	113.0		115.5	
Dry Density (pcf)	89.5		88.4	
Saturation (%) TESTED SG= 2.76	79		89	

HYDRAULIC CONDUCTIVITY TESTING MEASUREMENT

(PERMOMETER)

Confining Pressure (psi) 70 | Influent Pressure (psi) 60 | Effluent Pressure (psi) 60 | B-Value 0.95

Reset (Y/N)	Date	Clock Time	Elapsed Time	HA_{OUT} (cm)	HA_{IN} (cm)	Temp °C	Gradient	K (cm/sec)	Temp Correction	$K_{20°C}$ (cm/sec)
Y	12-12-13	2:13:32		4.5	1.79	21.3	5			
	12-12-13	2:13:48	0:00:16	3.5	1.83	21.3	3	1.3E-05	0.969	1.3E-05
	12-12-13	2:14:00	0:00:28	3.0	1.85	21.3	2	1.3E-05	0.969	1.3E-05
	12-12-13	2:14:10	0:00:38	2.7	1.87	21.3	2	1.3E-05	0.969	1.3E-05
	12-12-13	2:14:20	0:00:48	2.5	1.88	21.3	1	1.3E-05	0.969	1.3E-05

HYDRAULIC CONDUCTIVITY ($K_{20°C}$) 1.3E-05 cm/sec

BLE INC.

HYDRAULIC CONDUCTIVITY TEST REPORT

CONSTANT VOLUME APPARATUS (ASTM D 5084)

PROJECT: MACON CO. LANDFILL
PROJECT NO.: J13-1101-06
DATE RECEIVED: 10-28-13

TESTED BY: JOHN MATHEW
CHECKED BY: PAUL YARBER

SAMPLE NO. BLE-11
TYPE UNDISTURBED
SAMPLE LOCATION: 5.0-7.0'
SAMPLE DESCRIPTION: BROWN SILTY FI.-MED. SAND

SAMPLE DIMENSIONS AND PROPERTIES

ITEM	INITIAL		FINAL	
	inches	centimeters	inches	centimeters
Sample Length	2.942	7.473	2.942	7.473
Sample Diameter	2.851	7.242	2.877	7.308
Length/Diameter Ratio		1.03		
Moisture Content (%)	WW= 160.9 DW= 133.0	21.0	WW= 162.1 DW= 123.5	31.3
Sample Wet Weight (grams)	542.6		588.1	
Wet Density (pcf)	110.1		117.1	
Dry Density (pcf)	91.0		89.2	
Saturation (%) TESTED SG= 2.79	64		92	

HYDRAULIC CONDUCTIVITY TESTING MEASUREMENT

FALLING HEAD TEST

Confining Pressure (psi) 80.2 | Influent Pressure (psi) 70.2 | Effluent Pressure (psi) 70 | B-Value 0.95

Date	Clock Time		Elapsed Time	Pipet Readings				Head		Temp	Gradient	K	Temp	$K_{20°C}$
				Initial		Final		Initial	Final					
	Start	End	seconds	in	out	in	out	cm	cm	°C		(cm/sec)	Correction	(cm/sec)
11-19-13	1:12:30	1:13:01	31	1.0	23.0	2.0	22.0	40.092	37.726	21.0	5	1.5E-04	0.976	1.4E-04
11-19-13	1:13:01	1:13:34	33	2.0	22.0	3.0	21.0	37.726	35.361	21.0	5	1.5E-04	0.976	1.4E-04
11-19-13	1:13:34	1:14:06	32	3.0	21.0	4.0	20.0	35.361	32.995	21.0	5	1.6E-04	0.976	1.6E-04
11-19-13	1:14:06	1:14:44	38	4.0	20.0	5.0	19.0	32.995	30.629	21.0	5	1.5E-04	0.976	1.4E-04
		Pipet Length, cm		28.390	28.390									
		Pipet Volume, cc		24	24									
		Cross-sectional Area of Pipet, cm^2		0.8454	0.8454									

HYDRAULIC CONDUCTIVITY ($K_{20°C}$) 1.5E-04 cm/sec

BLE INC.

HYDRAULIC CONDUCTIVITY TEST REPORT

CONSTANT VOLUME APPARATUS (ASTM D 5084)

PROJECT: **MACON CO. LANDFILL**
PROJECT NO.: **J13-1101-06**
DATE RECEIVED: **12-28-13**

TESTED BY: **JOHN MATHEW**
CHECKED BY: **PAUL YARBER**

SAMPLE NO. **BLE-11** SAMPLE LOCATION: **15.0-20.0'**
TYPE **REMOLDED** SAMPLE DESCRIPTION: **DARK BROWN SILTY FI.-MED. SAND**

SAMPLE DIMENSIONS AND PROPERTIES

ITEM	INITIAL		FINAL	
	inches	centimeters	inches	centimeters
Sample Length	3.000	7.620	2.992	7.600
Sample Diameter	2.850	7.239	2.860	7.264
Length/Diameter Ratio		1.05		
Moisture Content (%)	WW= 150.0 DW= 127.2	17.9	WW= 213.3 DW= 175.3	21.7
Sample Wet Weight (grams)	635.5		651.7	
Wet Density (pcf)	126.5		129.2	
Dry Density (pcf)	107.3		106.2	
Saturation (%) TESTED SG= 2.79	80		94	

HYDRAULIC CONDUCTIVITY TESTING MEASUREMENT

(PERMOMETER)

Confining Pressure (psi) 70 | Influent Pressure (psi) 60 | Effluent Pressure (psi) 60 | B-Value 0.95

Reset (Y/N)	Date	Clock Time	Elapsed Time	HA_{OUT} (cm)	HA_{IN} (cm)	Temp °C	Gradient	K (cm/sec)	Temp Correction	$K_{20°C}$ (cm/sec)
Y	12-11-13	2:18:12		7.4	1.57	22.3	10			
	12-11-13	2:20:29	0:02:17	5.0	1.67	22.3	6	1.8E-06	0.947	1.7E-06
	12-11-13	2:20:46	0:02:34	4.8	1.68	22.3	6	1.8E-06	0.947	1.7E-06
	12-11-13	2:21:02	0:02:50	4.6	1.69	22.3	5	1.8E-06	0.947	1.7E-06
	12-11-13	2:21:21	0:03:09	4.4	1.69	22.3	5	1.8E-06	0.947	1.7E-06

HYDRAULIC CONDUCTIVITY ($K_{20°C}$) 1.7E-06 cm/sec

% COMPACTION OF STD. PROCTOR MAX. DRY DENSITY (ASTM D 698): 95.2
% WETTER THAN OPTIMUM MOISTURE CONTENT (ASTM D 698): +2.0

BLE INC.

HYDRAULIC CONDUCTIVITY TEST REPORT

CONSTANT VOLUME APPARATUS (ASTM D 5084)

PROJECT: MACON CO. LANDFILL
PROJECT NO.: J13-1101-06
DATE RECEIVED: 12-28-13

TESTED BY: JOHN MATHEW
CHECKED BY: PAUL YARBER

SAMPLE NO. BLE-14
TYPE UNDISTURBED
SAMPLE LOCATION: 28.0-30.0'
SAMPLE DESCRIPTION: LIGHT BROWN & BLACK SILTY FI.-MED. SAND

SAMPLE DIMENSIONS AND PROPERTIES

ITEM	INITIAL		FINAL	
	inches	centimeters	inches	centimeters
Sample Length	2.914	7.402	2.947	7.485
Sample Diameter	2.865	7.277	2.848	7.234
Length/Diameter Ratio		1.02		
Moisture Content (%)	WW= 152.4 DW= 113.9	33.8	WW= 224.3 DW= 160.2	40.0
Sample Wet Weight (grams)	552.4		572.0	
Wet Density (pcf)	112.0		116.1	
Dry Density (pcf)	83.7		82.9	
Saturation (%) TESTED SG= 2.79	87		101	

HYDRAULIC CONDUCTIVITY TESTING MEASUREMENT

(PERMOMETER)

Confining Pressure (psi) 83.3 | Influent Pressure (psi) 70 | Effluent Pressure (psi) 70 | B-Value 0.95

Reset (Y/N)	Date	Clock Time	Elapsed Time	HA_{OUT} (cm)	HA_{IN} (cm)	Temp °C	Gradient	K (cm/sec)	Temp Correction	$K_{20°C}$ (cm/sec)
Y	12-11-13	4:03:19		4.6	1.79	23.2	5			
	12-11-13	4:03:30	0:00:11	3.5	1.83	23.2	3	2.1E-05	0.927	1.9E-05
	12-11-13	4:03:38	0:00:19	3.0	1.85	23.2	2	2.1E-05	0.927	1.9E-05
	12-11-13	4:03:50	0:00:31	2.5	1.88	23.2	1	2.1E-05	0.927	2.0E-05
	12-11-13	4:04:05	0:00:46	2.2	1.89	23.2	1	2.1E-05	0.927	1.9E-05

HYDRAULIC CONDUCTIVITY ($K_{20°C}$) 1.9E-05 cm/sec

BLE INC.

HYDRAULIC CONDUCTIVITY TEST REPORT

CONSTANT VOLUME APPARATUS (ASTM D 5084)

PROJECT: **MACON CO. LANDFILL**
PROJECT NO.: **J13-1101-06**
DATE RECEIVED: **12-28-13**

TESTED BY: **JOHN MATHEW**
CHECKED BY: **PAUL YARBER**

SAMPLE NO. **BLE-15** SAMPLE LOCATION: **0.0-5.0'**
TYPE **REMOLDED** SAMPLE DESCRIPTION: **DARK BROWN FI.-MED. SANDY SILT**

SAMPLE DIMENSIONS AND PROPERTIES

ITEM	INITIAL		FINAL	
	inches	centimeters	inches	centimeters
Sample Length	3.000	7.620	2.990	7.595
Sample Diameter	2.850	7.239	2.864	7.275
Length/Diameter Ratio		1.05		
Moisture Content (%)	WW= 203.4 DW= 169.3	20.1	WW= 238.9 DW= 191.6	24.7
Sample Wet Weight (grams)	617.5		635.6	
Wet Density (pcf)	122.9		125.7	
Dry Density (pcf)	102.3		100.8	
Saturation (%) TESTED SG= 2.79	80		95	

HYDRAULIC CONDUCTIVITY TESTING MEASUREMENT

(PERMOMETER)

Confining Pressure (psi) 70 | Influent Pressure (psi) 60 | Effluent Pressure (psi) 60 | B-Value 0.95

Reset (Y/N)	Date	Clock Time	Elapsed Time	HA_{OUT} (cm)	HA_{IN} (cm)	Temp °C	Gradient	K (cm/sec)	Temp Correction	$K_{20°C}$ (cm/sec)
Y	12-11-13	1:53:10		7.4	1.57	22.3	10			
	12-11-13	1:54:55	0:01:45	5.3	1.66	22.3	6	2.0E-06	0.947	1.9E-06
	12-11-13	1:55:08	0:01:58	5.1	1.66	22.3	6	2.0E-06	0.947	1.9E-06
	12-11-13	1:55:23	0:02:13	4.9	1.67	22.3	6	2.0E-06	0.947	1.8E-06
	12-11-13	1:55:38	0:02:28	4.7	1.68	22.3	5	2.0E-06	0.947	1.8E-06

HYDRAULIC CONDUCTIVITY ($K_{20°C}$) 1.9E-06 cm/sec

% COMPACTION OF STD. PROCTOR MAX. DRY DENSITY (ASTM D 698): 95.0
% WETTER THAN OPTIMUM MOISTURE CONTENT (ASTM D 698): +2.0

BLE INC.

HYDRAULIC CONDUCTIVITY TEST REPORT

CONSTANT VOLUME APPARATUS (ASTM D 5084)

PROJECT: MACON CO. LANDFILL
PROJECT NO.: J13-1101-06
DATE RECEIVED: 10-28-13

TESTED BY: JOHN MATHEW
CHECKED BY: PAUL YARBER

SAMPLE NO. BLE-15
TYPE UNDISTURBED
SAMPLE LOCATION: 2.0-4.0'
SAMPLE DESCRIPTION: RED BROWN CLAYE FI.-CO. SAND

SAMPLE DIMENSIONS AND PROPERTIES

ITEM	INITIAL		FINAL	
	inches	centimeters	inches	centimeters
Sample Length	2.924	7.427	2.925	7.430
Sample Diameter	2.853	7.247	2.810	7.137
Length/Diameter Ratio		1.02		
Moisture Content (%)	WW= 144.7 DW= 123.5	17.2	WW= 140.6 DW= 110.7	27.0
Sample Wet Weight (grams)	542.8		588.3	
Wet Density (pcf)	110.6		123.5	
Dry Density (pcf)	94.4		97.3	
Saturation (%) TESTED SG= 2.77	57		96	

HYDRAULIC CONDUCTIVITY TESTING MEASUREMENT

FALLING HEAD TEST

Confining Pressure (psi) 90.2 | Influent Pressure (psi) 80.2 | Effluent Pressure (psi) 80 | B-Value 0.95

Date	Clock Time		Elapsed Time	Pipet Readings				Head		Temp	Gradient	K	Temp	$K_{20°C}$
				Initial		Final		Initial	Final					
	Start	End	seconds	in	out	in	out	cm	cm	°C		(cm/sec)	Correction	(cm/sec)
12-9-13	10:16:20	10:16:30	10	1.0	23.0	2.0	22.0	40.092	37.726	21.3	5	4.8E-04	0.969	4.6E-04
12-9-13	10:16:30	10:16:41	11	2.0	22.0	3.0	21.0	37.726	35.360	21.3	5	4.6E-04	0.969	4.5E-04
12-9-13	10:16:41	10:16:53	12	3.0	21.0	4.0	20.0	35.360	32.995	21.3	5	4.5E-04	0.969	4.4E-04
12-9-13	10:16:53	10:17:06	13	4.0	20.0	5.0	19.0	32.995	30.629	21.3	5	4.5E-04	0.969	4.4E-04
		Pipet Length, cm		28.390	28.390									
		Pipet Volume, cc		24	24									
		Cross-sectional Area of Pipet, cm^2		0.8454	0.8454									

HYDRAULIC CONDUCTIVITY ($K_{20°C}$) 4.5E-04 cm/sec

BLE INC.

HYDRAULIC CONDUCTIVITY TEST REPORT

CONSTANT VOLUME APPARATUS (ASTM D 5084)

PROJECT: MACON CO. LANDFILL
PROJECT NO.: J13-1101-06
DATE RECEIVED: 10-28-13

TESTED BY: JOHN MATHEW
CHECKED BY: PAUL YARBER

SAMPLE NO. BLE-18
TYPE UNDISTURBED
SAMPLE LOCATION: 18.0-20.0'
SAMPLE DESCRIPTION: BROWN SILTY FI.-MED. SAND

SAMPLE DIMENSIONS AND PROPERTIES

ITEM	INITIAL		FINAL	
	inches	centimeters	inches	centimeters
Sample Length	2.993	7.602	2.940	7.468
Sample Diameter	2.850	7.239	2.860	7.264
Length/Diameter Ratio		1.05		
Moisture Content (%)	WW= 204.6 DW= 178.5	14.6	WW= 172.5 DW= 137.8	25.2
Sample Wet Weight (grams)	568.4		616.4	
Wet Density (pcf)	113.4		124.3	
Dry Density (pcf)	98.9		99.3	
Saturation (%) TESTED SG= 2.77	54		94	

HYDRAULIC CONDUCTIVITY TESTING MEASUREMENT

FALLING HEAD TEST

Confining Pressure (psi) 96 | Influent Pressure (psi) 80.2 | Effluent Pressure (psi) 80 | B-Value 0.95

Date	Clock Time		Elapsed Time	Pipet Readings				Head		Temp	Gradient	K	Temp	$K_{20°C}$
				Initial		Final		Initial	Final					
	Start	End	seconds	in	out	in	out	cm	cm	°C		(cm/sec)	Correction	(cm/sec)
12-9-13	10:51:20	10:52:15	55	1.0	23.0	2.0	22.0	40.092	37.726	21.3	5	8.4E-05	0.969	8.2E-05
12-9-13	10:52:15	10:53:14	59	2.0	22.0	3.0	21.0	37.726	35.360	21.3	5	8.4E-05	0.969	8.1E-05
12-9-13	10:53:14	10:54:17	63	3.0	21.0	4.0	20.0	35.360	32.995	21.3	5	8.4E-05	0.969	8.1E-05
12-9-13	10:54:17	10:55:26	69	4.0	20.0	5.0	19.0	32.995	30.629	21.3	5	8.2E-05	0.969	8.0E-05
		Pipet Length, cm		28.390	28.390									
		Pipet Volume, cc		24	24									
		Cross-sectional Area of Pipet, cm^2		0.8454	0.8454									

HYDRAULIC CONDUCTIVITY ($K_{20°C}$) 8.1E-05 cm/sec

BLE INC.

HYDRAULIC CONDUCTIVITY TEST REPORT

CONSTANT VOLUME APPARATUS (ASTM D 5084)

PROJECT: MACON CO. LANDFILL
PROJECT NO.: J13-1101-06
DATE RECEIVED: 10-28-13

TESTED BY: JOHN MATHEW
CHECKED BY: PAUL YARBER

SAMPLE NO. BLE-21
TYPE UNDISTURBED
SAMPLE LOCATION: 1.0-3.0'
SAMPLE DESCRIPTION: BROWN SILTY FI.-CO. SAND

SAMPLE DIMENSIONS AND PROPERTIES

ITEM	INITIAL		FINAL	
	inches	centimeters	inches	centimeters
Sample Length	2.960	7.518	2.948	7.488
Sample Diameter	2.859	7.262	2.859	7.262
Length/Diameter Ratio		1.04		
Moisture Content (%)	WW= 115.2 DW= 95.1	21.1	WW= 145.1 DW= 113.3	28.1
Sample Wet Weight (grams)	605.9		629.8	
Wet Density (pcf)	121.5		126.8	
Dry Density (pcf)	100.3		99.0	
Saturation (%) TESTED SG= 2.76	81		105	

HYDRAULIC CONDUCTIVITY TESTING MEASUREMENT

FALLING HEAD TEST

Confining Pressure (psi) 80.2 | Influent Pressure (psi) 70.2 | Effluent Pressure (psi) 70 | B-Value 0.95

Date	Clock Time		Elapsed Time	Pipet Readings				Head		Temp	Gradient	K	Temp	$K_{20°C}$
				Initial		Final		Initial	Final					
	Start	End	seconds	in	out	in	out	cm	cm	°C		(cm/sec)	Correction	(cm/sec)
12-11-13	3:40:10	3:40:30	20	1.0	23.0	2.0	22.0	40.092	37.726	23.2	5	2.3E-04	0.927	2.2E-04
12-11-13	3:40:30	3:40:52	22	2.0	22.0	3.0	21.0	37.726	35.361	23.2	5	2.2E-04	0.927	2.1E-04
12-11-13	3:40:52	3:41:15	23	3.0	21.0	4.0	20.0	35.361	32.995	23.2	5	2.3E-04	0.927	2.1E-04
12-11-13	3:41:15	3:41:40	25	4.0	20.0	5.0	19.0	32.995	30.629	23.2	5	2.3E-04	0.927	2.1E-04
		Pipet Length, cm		28.390	28.390									
		Pipet Volume, cc		24	24									
		Cross-sectional Area of Pipet, cm^2		0.8454	0.8454									

HYDRAULIC CONDUCTIVITY ($K_{20°C}$) 2.1E-04 cm/sec

BLE INC.

HYDRAULIC CONDUCTIVITY TEST REPORT

CONSTANT VOLUME APPARATUS (ASTM D 5084)

PROJECT: MACON CO. LANDFILL
PROJECT NO.: J13-1101-06
DATE RECEIVED: 10-28-13

TESTED BY: JOHN MATHEW
CHECKED BY: PAUL YARBER

SAMPLE NO. BLE-21
TYPE UNDISTURBED
SAMPLE LOCATION: 8.0-10.0'
SAMPLE DESCRIPTION: BROWN SILTY FI.-CO. SAND

SAMPLE DIMENSIONS AND PROPERTIES

ITEM	INITIAL		FINAL	
	inches	centimeters	inches	centimeters
Sample Length	2.996	7.610	3.001	7.623
Sample Diameter	2.858	7.259	2.852	7.244
Length/Diameter Ratio		1.05		
Moisture Content (%)	WW= 181.3 DW= 152.8	18.7	WW= 240.6 DW= 192.0	25.3
Sample Wet Weight (grams)	608.6		643.1	
Wet Density (pcf)	120.6		127.8	
Dry Density (pcf)	101.7		102.0	
Saturation (%) TESTED SG= 2.77	74		101	

HYDRAULIC CONDUCTIVITY TESTING MEASUREMENT

FALLING HEAD TEST

Confining Pressure (psi) 90.2 | Influent Pressure (psi) 80.2 | Effluent Pressure (psi) 80 | B-Value 0.95

Date	Clock Time		Elapsed Time	Pipet Readings				Head		Temp	Gradient	K	Temp	$K_{20°C}$
				Initial		Final		Initial	Final					
	Start	End	seconds	in	out	in	out	cm	cm	°C		(cm/sec)	Correction	(cm/sec)
12-9-13	10:29:00	10:31:22	142	1.0	23.0	2.0	22.0	40.092	37.726	21.3	5	3.3E-05	0.969	3.2E-05
12-9-13	10:31:22	10:33:55	153	2.0	22.0	3.0	21.0	37.726	35.360	21.3	5	3.3E-05	0.969	3.2E-05
12-9-13	10:33:55	10:36:40	165	3.0	21.0	4.0	20.0	35.360	32.995	21.3	5	3.3E-05	0.969	3.2E-05
12-9-13	10:36:40	10:39:37	177	4.0	20.0	5.0	19.0	32.995	30.629	21.3	5	3.3E-05	0.969	3.2E-05
		Pipet Length, cm		28.390	28.390									
		Pipet Volume, cc		24	24									
		Cross-sectional Area of Pipet, cm^2		0.8454	0.8454									

HYDRAULIC CONDUCTIVITY ($K_{20°C}$) 3.2E-05 cm/sec

BLE INC.

HYDRAULIC CONDUCTIVITY TEST REPORT

CONSTANT VOLUME APPARATUS (ASTM D 5084)

PROJECT: MACON CO. LANDFILL
PROJECT NO.: J13-1101-06
DATE RECEIVED: 10-28-13

TESTED BY: JOHN MATHEW
CHECKED BY: PAUL YARBER

SAMPLE NO. BLE-22
TYPE UNDISTURBED
SAMPLE LOCATION: 3.0-5.0'
SAMPLE DESCRIPTION: BROWN FI.-MED. SANDY SILT

SAMPLE DIMENSIONS AND PROPERTIES

ITEM	INITIAL		FINAL	
	inches	centimeters	inches	centimeters
Sample Length	2.914	7.402	2.885	7.328
Sample Diameter	2.865	7.277	2.853	7.247
Length/Diameter Ratio		1.02		
Moisture Content (%)	WW= 132.3 DW= 103.0	28.4	WW= 164.9 DW= 121.8	35.4
Sample Wet Weight (grams)	547.0		571.7	
Wet Density (pcf)	110.9		118.1	
Dry Density (pcf)	86.4		87.2	
Saturation (%) TESTED SG= 2.77	79		100	

HYDRAULIC CONDUCTIVITY TESTING MEASUREMENT

FALLING HEAD TEST

Confining Pressure (psi) 80.2 | Influent Pressure (psi) 70.2 | Effluent Pressure (psi) 70 | B-Value 0.95

Date	Clock Time		Elapsed Time	Pipet Readings				Head		Temp	Gradient	K	Temp	$K_{20°C}$
				Initial		Final		Initial	Final					
	Start	End	seconds	in	out	in	out	cm	cm	°C		(cm/sec)	Correction	(cm/sec)
12-10-13	3:35:30	3:35:38	8	1.0	23.0	2.0	22.0	40.092	37.726	23.2	5	5.7E-04	0.927	5.3E-04
12-10-13	3:35:37	3:35:46	9	2.0	22.0	3.0	21.0	37.726	35.361	23.2	5	5.4E-04	0.927	5.0E-04
12-10-13	3:35:46	3:35:55	9	3.0	21.0	4.0	20.0	35.361	32.995	23.2	5	5.8E-04	0.927	5.4E-04
12-10-13	3:35:55	3:36:05	10	4.0	20.0	5.0	19.0	32.995	30.629	23.2	5	5.6E-04	0.927	5.2E-04
		Pipet Length, cm		28.390	28.390									
		Pipet Volume, cc		24	24									
		Cross-sectional Area of Pipet, cm^2		0.8454	0.8454									

HYDRAULIC CONDUCTIVITY ($K_{20°C}$) 5.2E-04 cm/sec

BLE INC.

HYDRAULIC CONDUCTIVITY TEST REPORT

CONSTANT VOLUME APPARATUS (ASTM D 5084)

PROJECT: **MACON CO. LANDFILL**
PROJECT NO.: **J13-1101-06**
DATE RECEIVED: **12-28-13**

TESTED BY: **JOHN MATHEW**
CHECKED BY: **PAUL YARBER**

SAMPLE NO. **BLE-22**
TYPE **UNDISTURBED**
SAMPLE LOCATION: **6.0-8.0'**
SAMPLE DESCRIPTION: **BROWN & GREY SILTY FI.-CO. SAND w/gravel**

SAMPLE DIMENSIONS AND PROPERTIES

ITEM	INITIAL		FINAL	
	inches	centimeters	inches	centimeters
Sample Length	2.955	7.506	2.936	7.457
Sample Diameter	2.849	7.236	2.850	7.239
Length/Diameter Ratio		1.04		
Moisture Content (%)	WW= 236.9 DW= 196.9	20.3	WW= 133.4 DW= 106.6	25.1
Sample Wet Weight (grams)	614.5		625.4	
Wet Density (pcf)	124.3		127.2	
Dry Density (pcf)	103.3		101.6	
Saturation (%) TESTED SG= 2.77	84		99	

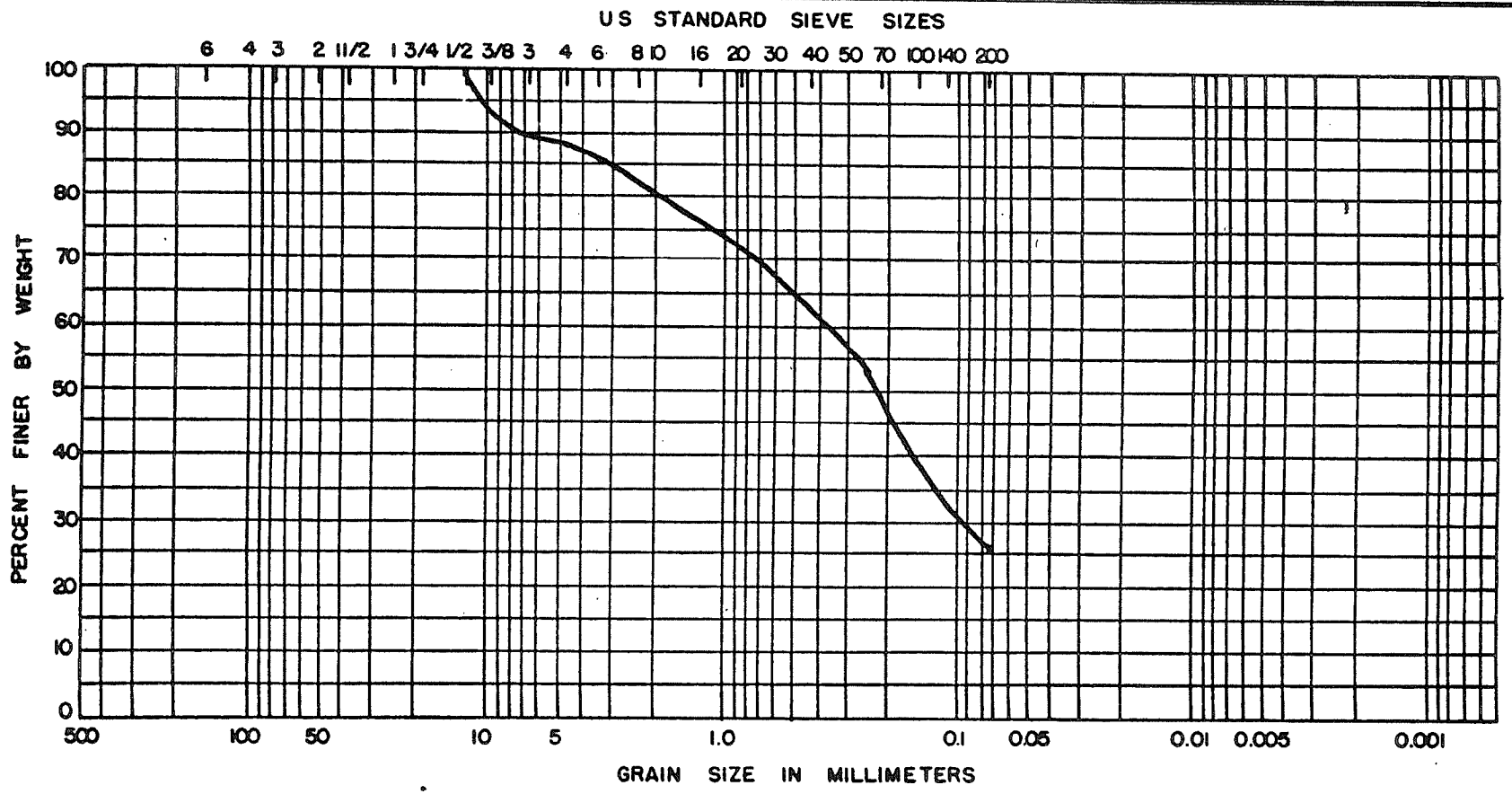
HYDRAULIC CONDUCTIVITY TESTING MEASUREMENT

(PERMOMETER)

Confining Pressure (psi) 80 | Influent Pressure (psi) 70 | Effluent Pressure (psi) 70 | B-Value 0.95

Reset (Y/N)	Date	Clock Time	Elapsed Time	HA_{OUT} (cm)	HA_{IN} (cm)	Temp °C	Gradient	K (cm/sec)	Temp Correction	$K_{20°C}$ (cm/sec)
Y	12-9-13	3:28:16		4.6	1.79	21.9	5			
	12-9-13	3:28:50	0:00:34	4.0	1.81	21.9	4	3.2E-06	0.956	3.1E-06
	12-9-13	3:29:12	0:00:56	3.7	1.83	21.9	4	3.2E-06	0.956	3.0E-06
	12-9-13	3:29:28	0:01:12	3.5	1.83	21.9	3	3.2E-06	0.956	3.0E-06
	12-9-13	3:29:47	0:01:31	3.3	1.84	21.9	3	3.1E-06	0.956	3.0E-06

HYDRAULIC CONDUCTIVITY ($K_{20°C}$) 3.0E-06 cm/sec



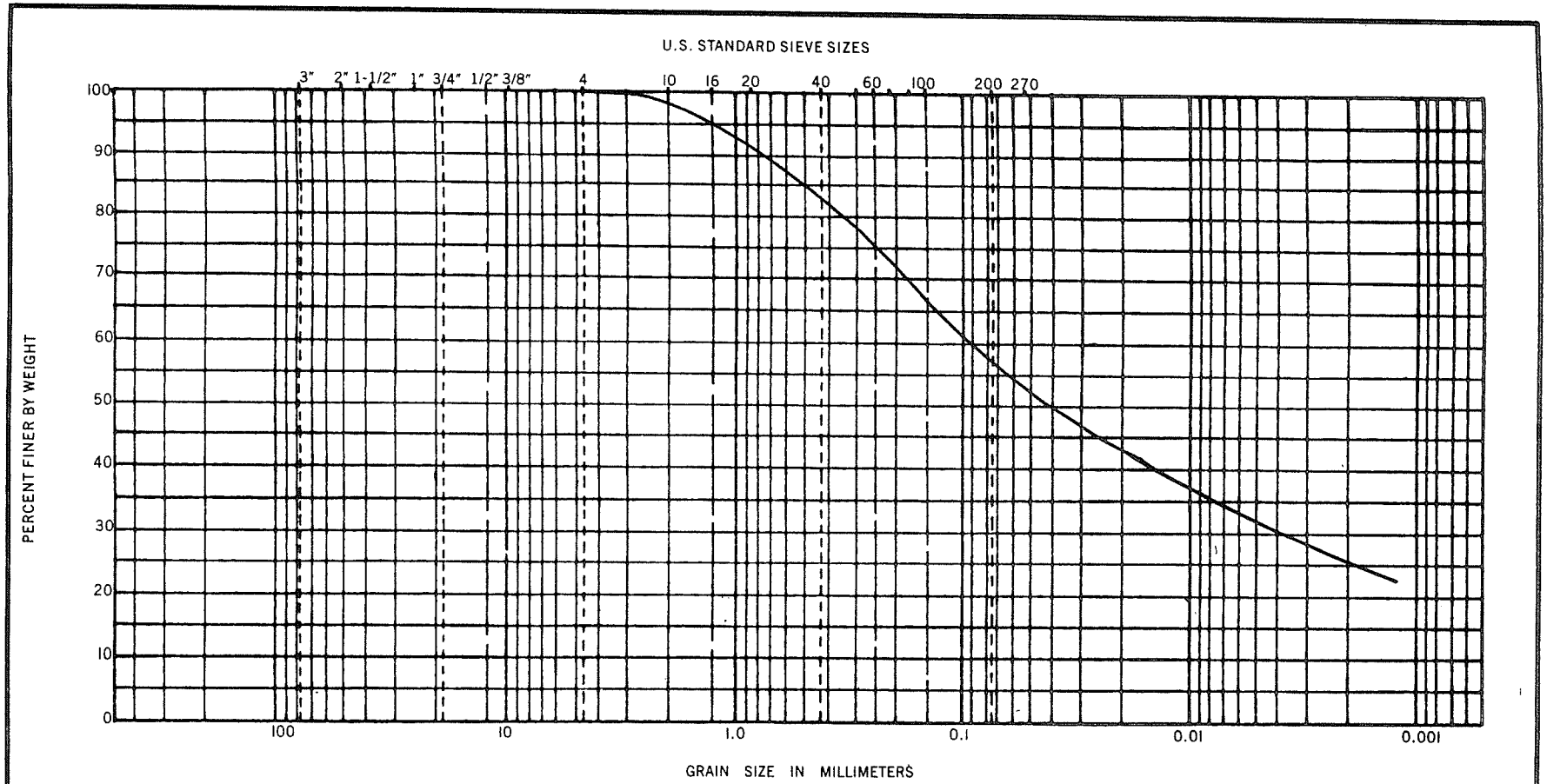
BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

BORING NO.	ELEV. OR DEPTH	NAT WC	LL	PL	PI	CLASSIFICATION
B-4	28.5'-30'		31	30	1	Brown Micaceous Silty Fine SAND

JOB NO. 1351-89-369

GRAIN SIZE DISTRIBUTION

Westinghouse Environmental and Geotechnical Services, Inc.



BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

BORING NO	ELEV. OR DEPTH	NAT WC	LL	PL	PI	DESCRIPTION OR CLASSIFICATION
B-16	1' - 2.5'	28.2	39	29	10	Orange-Brown Micaceous Clayey Sandy SILT

GRAIN SIZE DISTRIBUTION

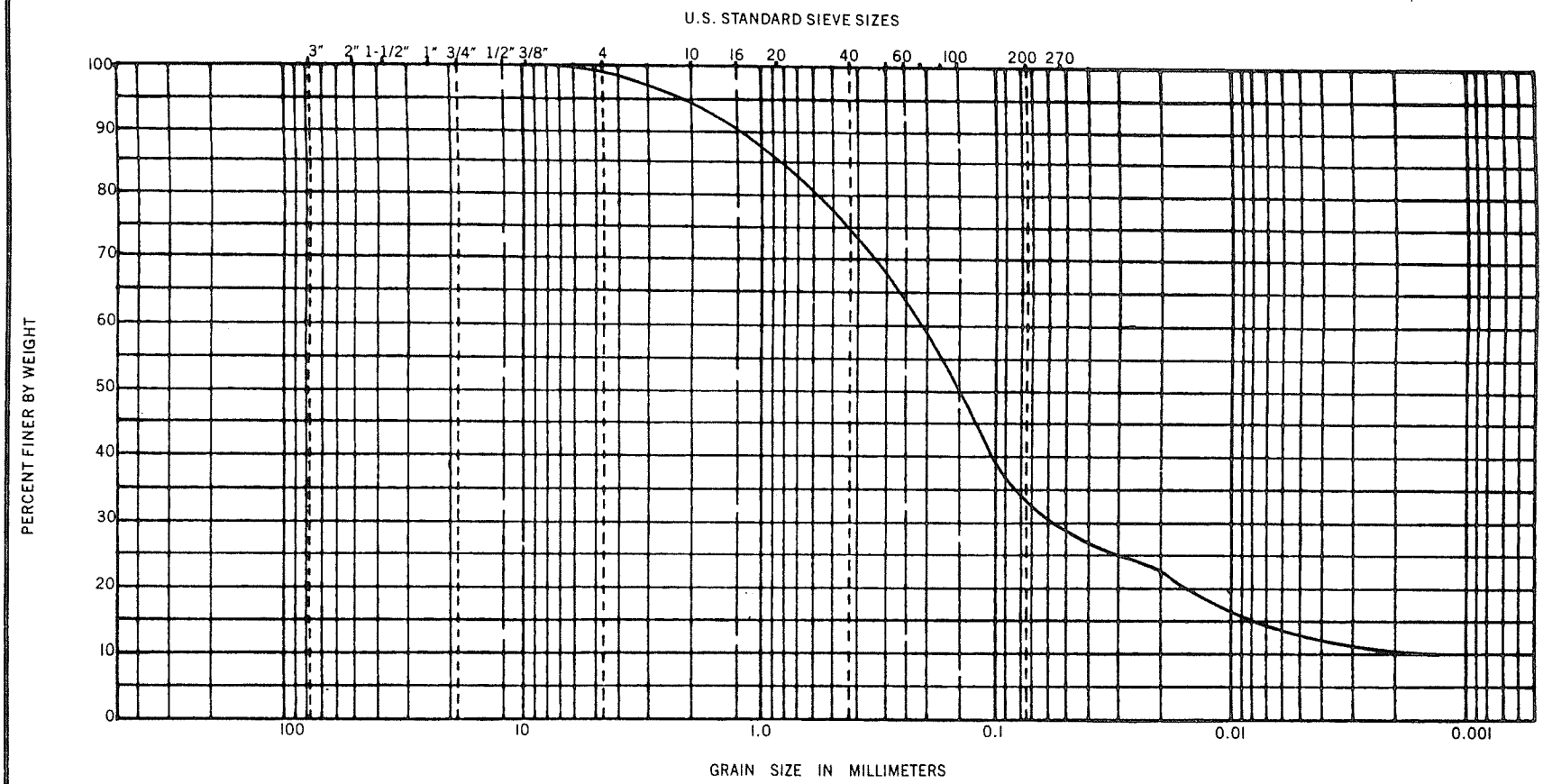
Macon County Landfill

JOB NO. 1351-89-369

Westinghouse Environmental and Geotechnical Services, Inc.

THE SHARPE CO. 065547

WE-9



BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

BORING NO	ELEV. OR DEPTH	NAT WC	LL	PL	PI	DESCRIPTION OR CLASSIFICATION
B-16	6.0'-7.5'	20.3	--	--	--	Reddish Brown Slightly Silty Clayey Coarse to Fine SAND

GRAIN SIZE DISTRIBUTION

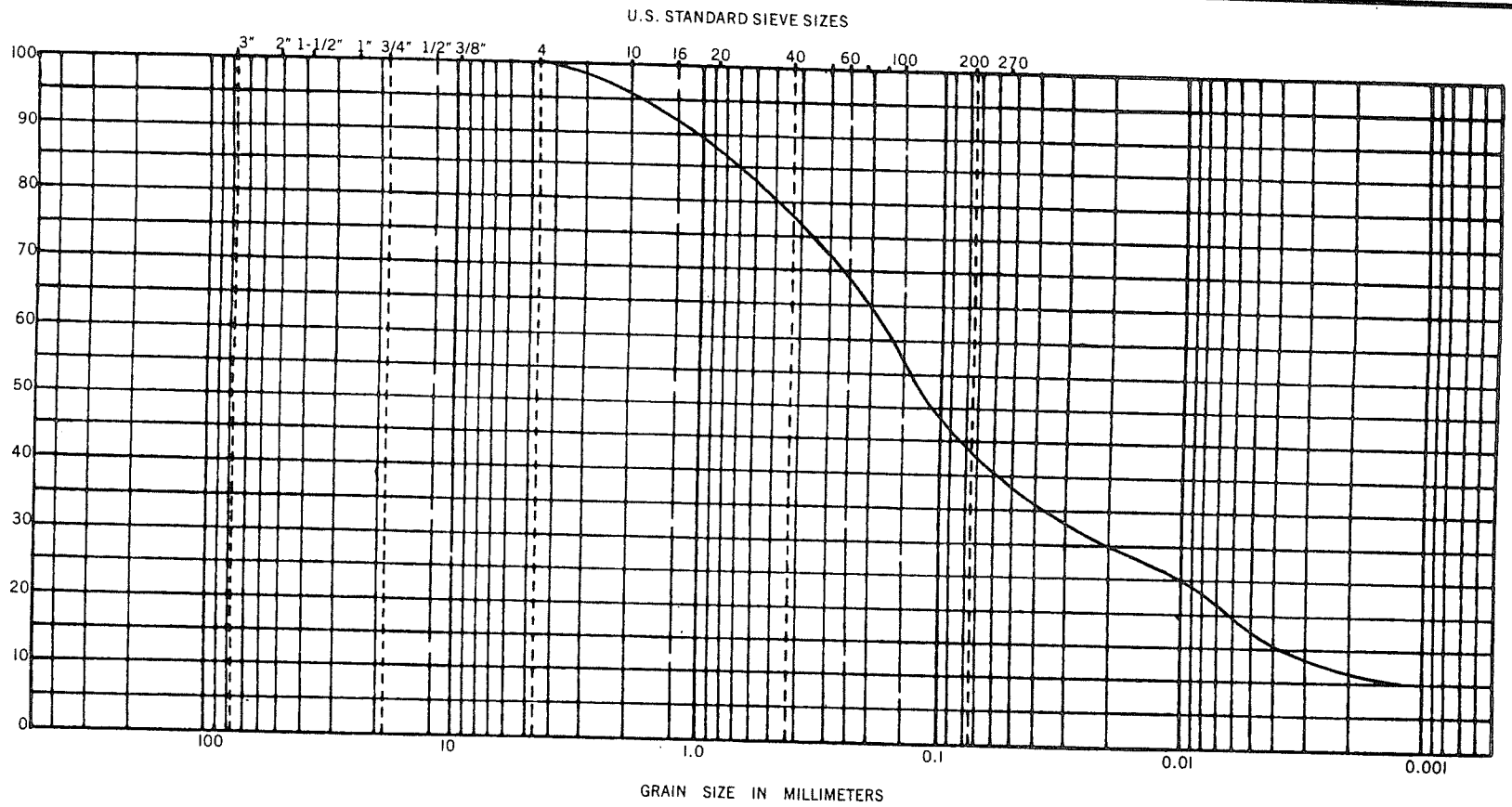
Macon County Landfill

JOB NO. 1351-89-369

Westinghouse Environmental and Geotechnical Services, Inc.

THE SHARPE CO. 065547

WE-9



BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

BORING NO	ELEV. OR DEPTH	NAT WC	LL	PL	PI	DESCRIPTION OR CLASSIFICATION
B-17	1' - 5'	21.1	35	27	8	Orange-Brown Micaceous Slightly Clayey Silty Coarse to Medium to Fine SAND

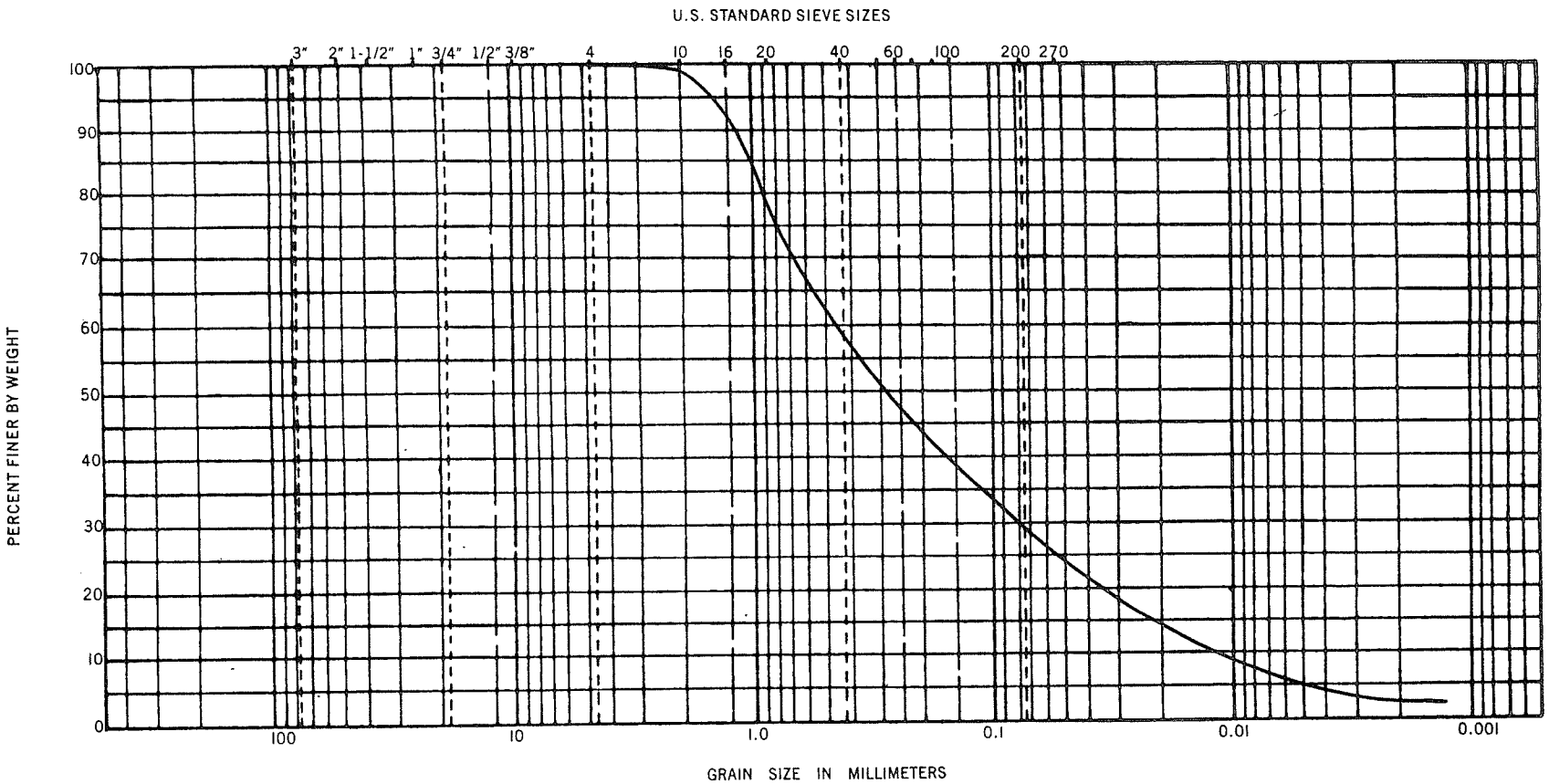
GRAIN SIZE DISTRIBUTION

Macon County Landfill

JOB NO. 1351-89-369

Westinghouse Environmental and Geotechnical Services, Inc.

THE SHARPE CO. 0655147



BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

BORING NO	ELEV. OR DEPTH	NAT WC	LL	PL	PI	DESCRIPTION OR CLASSIFICATION
B-17	8.5'-10.0'	16.6	--	--	--	Brown Micaceous Silty Medium to Fine SAND

GRAIN SIZE DISTRIBUTION

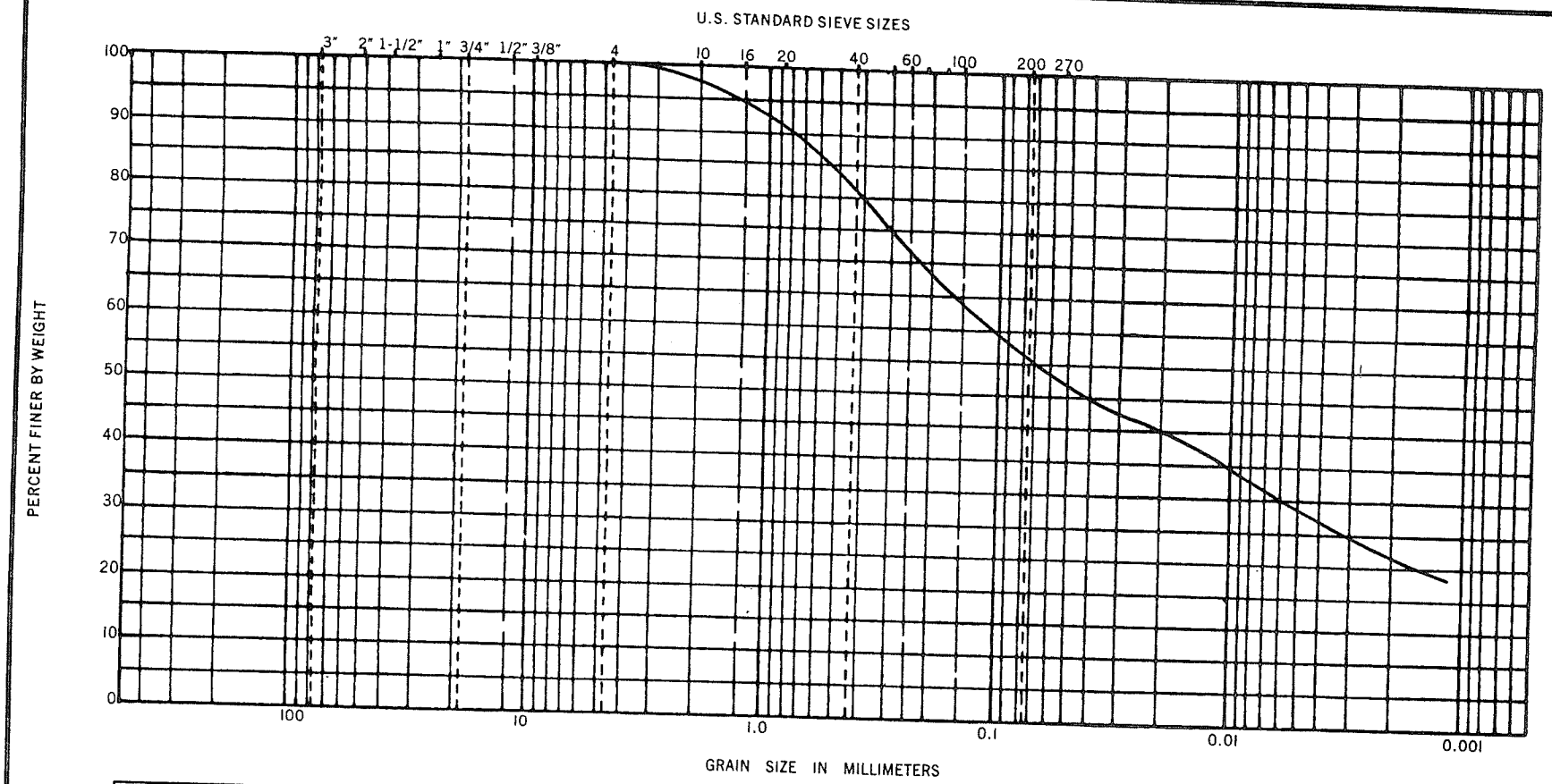
Macon County Landfill

JOB NO. 1351-89-369

Westinghouse Environmental and Geotechnical Services, Inc.

THE SHARPE CO. 065547

WE-9



BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

BORING NO	ELEV. OR DEPTH	NAT WC	LL	PL	PI	DESCRIPTION OR CLASSIFICATION
B-18	1' - 3'	18.2	33	20	13	Brown Micaceous Clayey Coarse to Fine Sandy SILT

GRAIN SIZE DISTRIBUTION

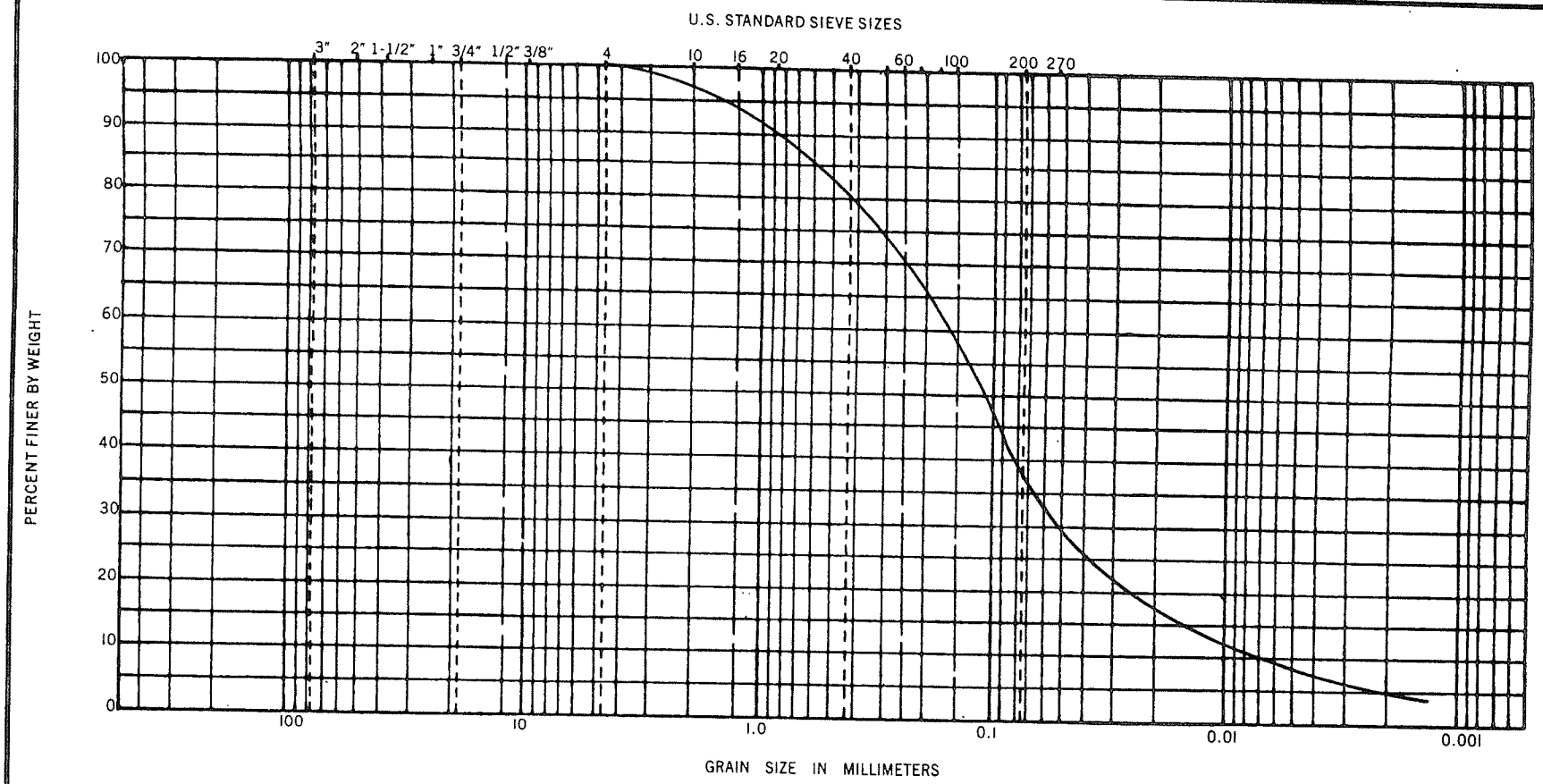
Macon County Landfill

JOB NO. 1351-89-369

Westinghouse Environmental and Geotechnical Services, Inc.

THE SHARPE CO. 065547

WE-9



BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

BORING NO	ELEV. OR DEPTH	NAT WC	LL	PL	PI	DESCRIPTION OR CLASSIFICATION
B-18	3.5'-5.0'	13.9	--	--	--	Red Brown Silty Medium to Fine SAND

GRAIN SIZE DISTRIBUTION

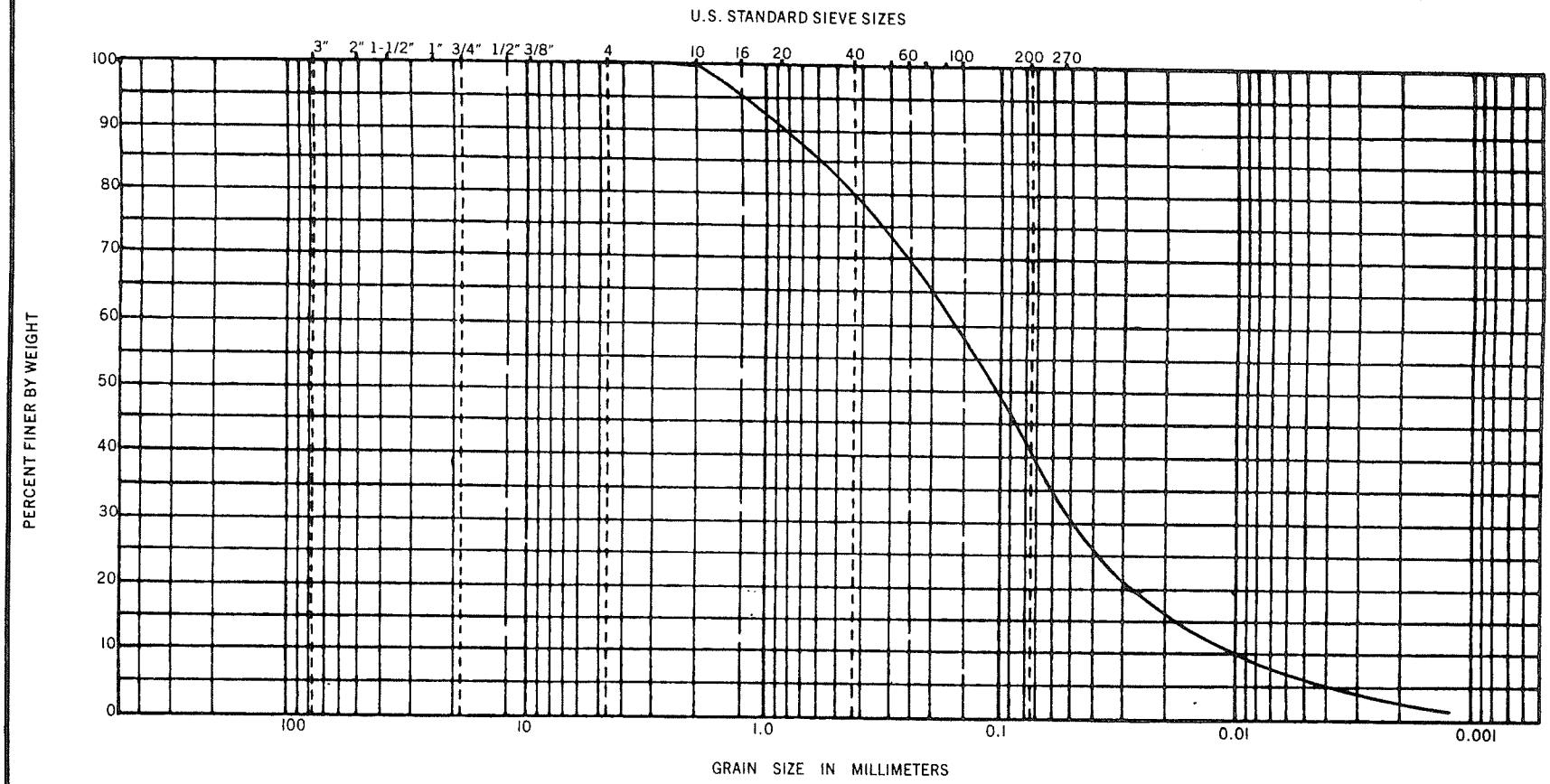
Macon County Landfill

JOB NO. 1351-89-369

Westinghouse Environmental and Geotechnical Services, Inc.

THE SHARPE CO. 065547

WE-9



BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

BORING NO	ELEV. OR DEPTH	NAT WC	LL	PL	PI	DESCRIPTION OR CLASSIFICATION
B-18	23.5'-25'	25.8	--	--	--	Brown Micaceous Silty Medium to Fine SAND

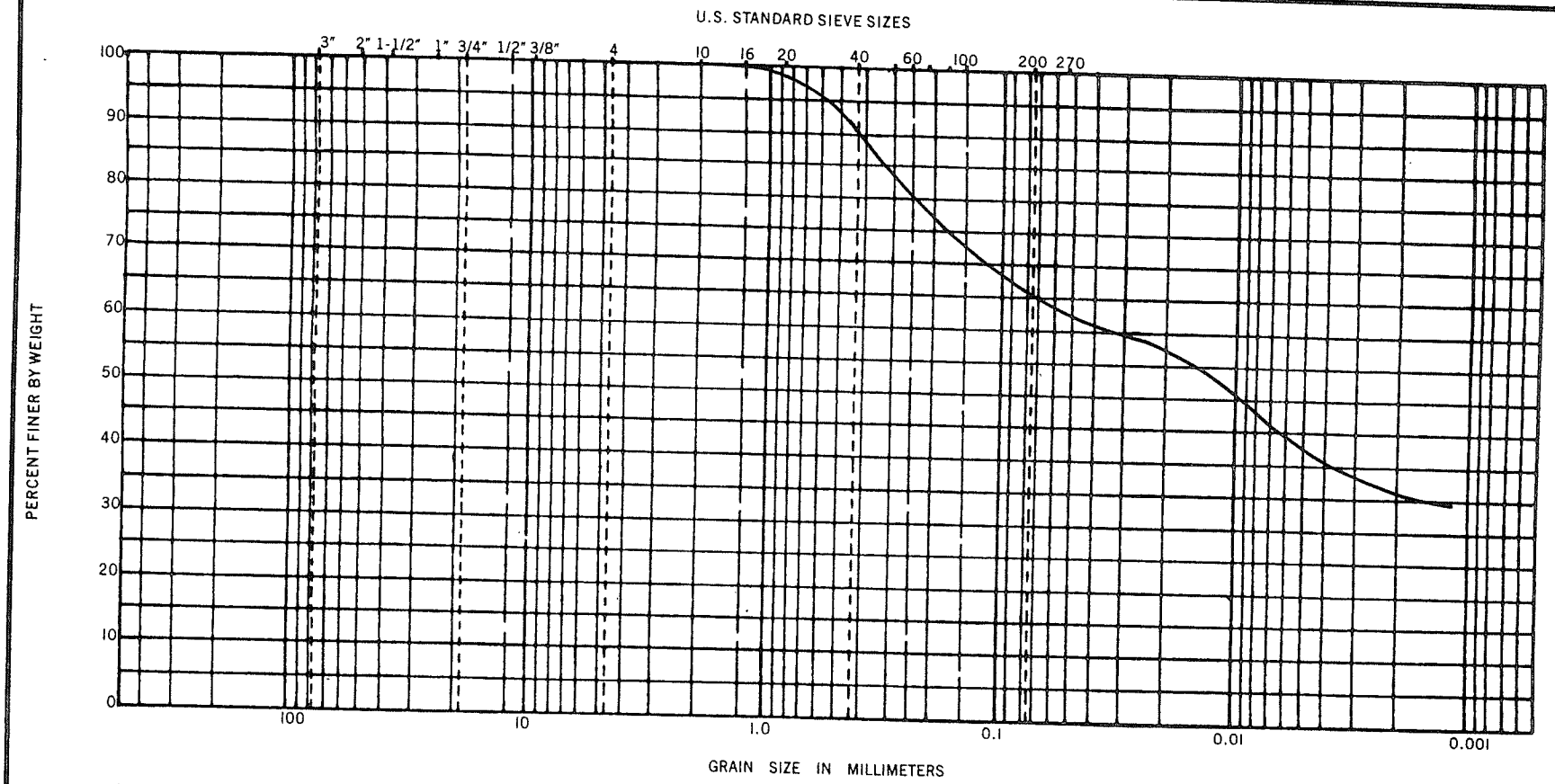
GRAIN SIZE DISTRIBUTION

Macon County Landfill

JOB NO. 1351-89-369

Westinghouse Environmental and Geotechnical Services, Inc.

THE SHARPE CO. 065547



BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

BORING NO	ELEV. OR DEPTH	NAT WC	LL	PL	PI	DESCRIPTION OR CLASSIFICATION
B-19	1' - 3'	45.5	51	33	18	Orange-Brown Micaceous Silty Medium to Fine Sandy CLAY

GRAIN SIZE DISTRIBUTION

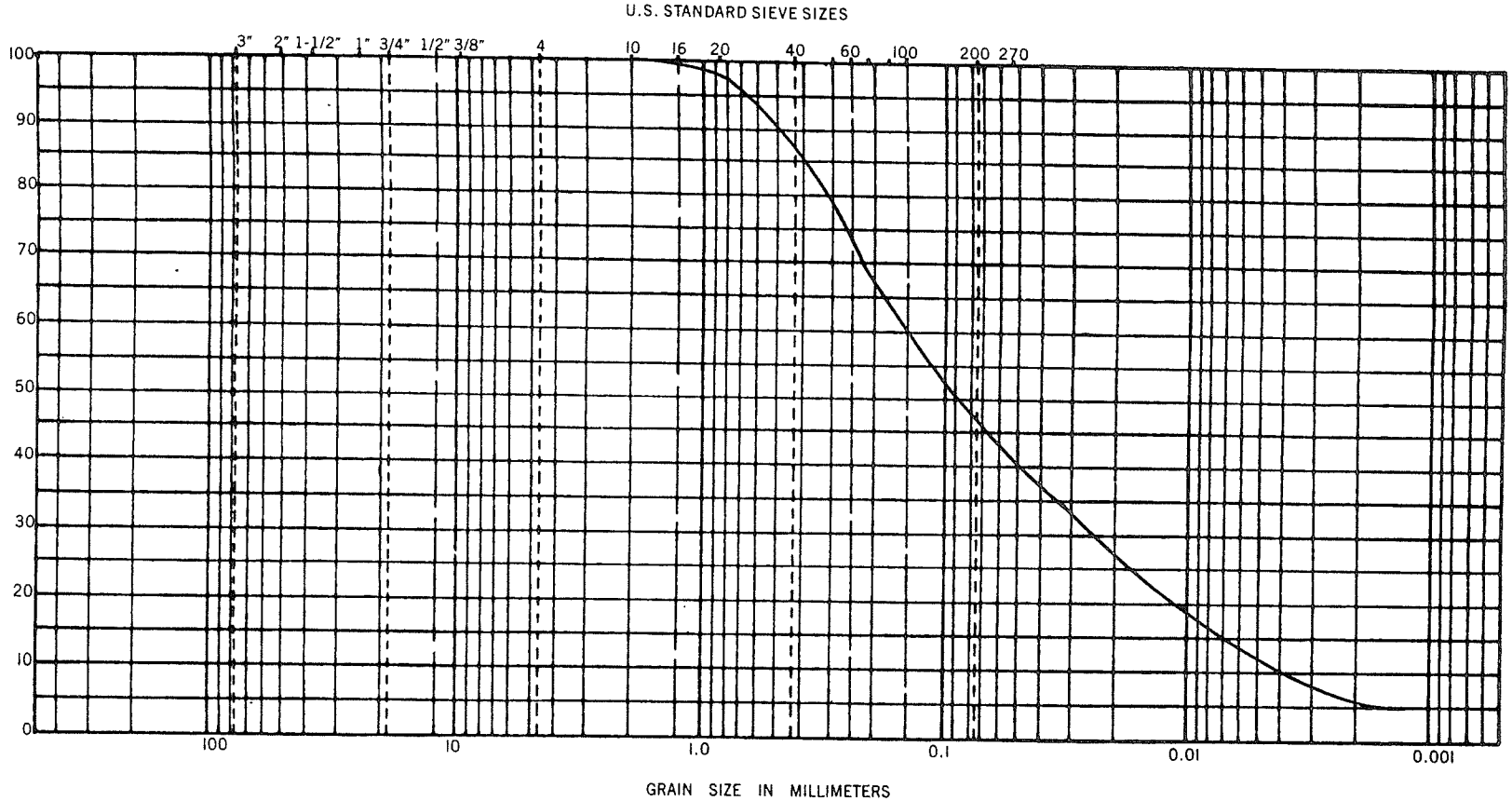
Macon County Landfill

JOB NO. 1351-89-369

Westinghouse Environmental and Geotechnical Services, Inc.

THE SHARPE CO. 065547

WE-9



BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

BORING NO	ELEV. OR DEPTH	NAT WC	LL	PL	PI	DESCRIPTION OR CLASSIFICATION
B-19	8.5'-10.0'	22.3	--	--	--	Reddish Brown Slightly Clayey Silty Medium to Fine SAND

GRAIN SIZE DISTRIBUTION

Macon County Landfill

JOB NO. 1351-89-369

Westinghouse Environmental and Geotechnical Services, Inc.

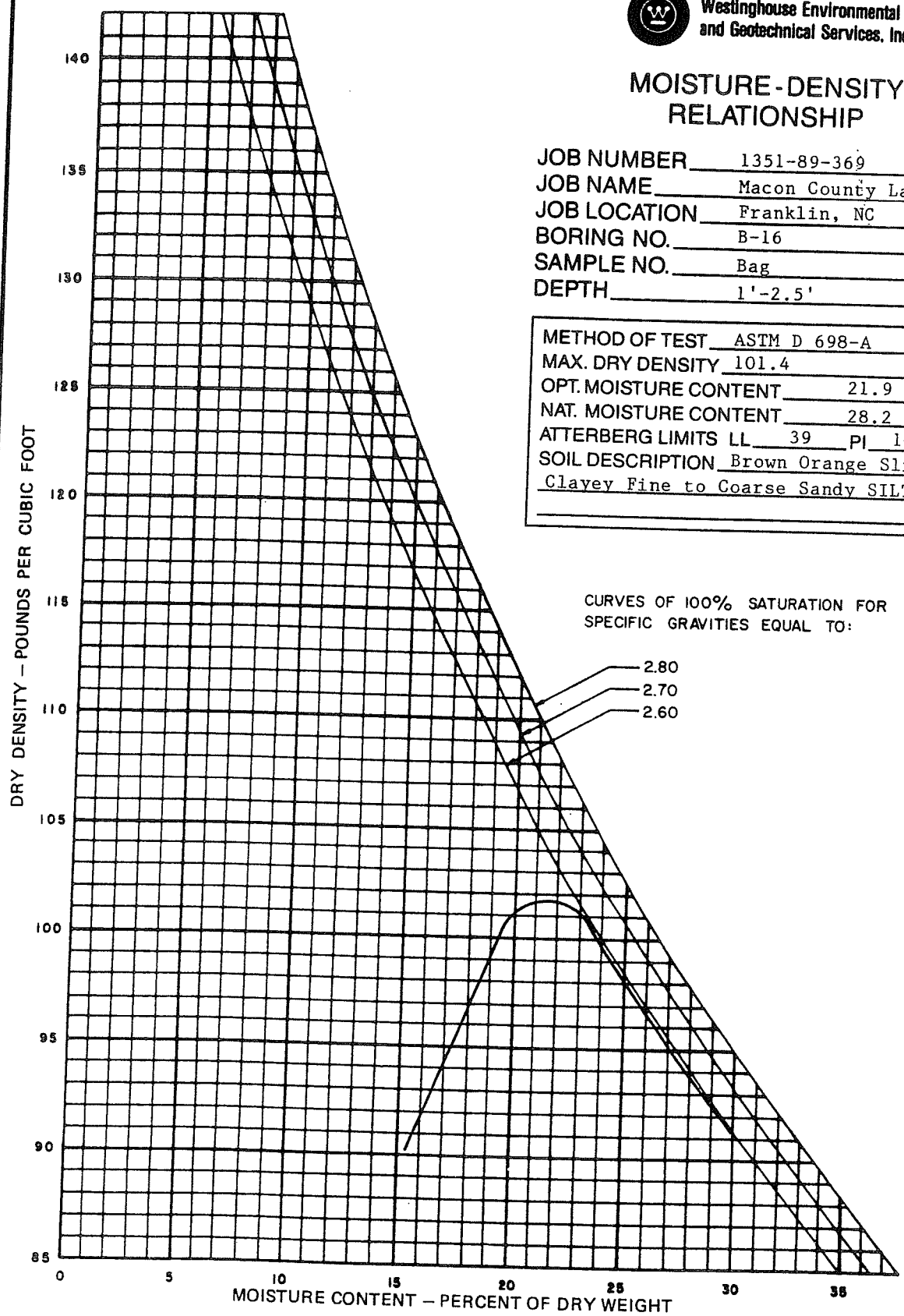
THE SHARPE CO. 065547

Westinghouse Environmental and Geotechnical Services, Inc.

MOISTURE-DENSITY RELATIONSHIP

JOB NUMBER 1351-89-369
JOB NAME Macon County Landfill
JOB LOCATION Franklin, NC
BORING NO. B-16
SAMPLE NO. Bag
DEPTH 1'-2.5'

METHOD OF TEST ASTM D 698-A
MAX. DRY DENSITY 101.4 PCF
OPT. MOISTURE CONTENT 21.9 %
NAT. MOISTURE CONTENT 28.2 %
ATTERBERG LIMITS LL 39 PI 10
SOIL DESCRIPTION Brown Orange Slightly Clayey Fine to Coarse Sandy SILT

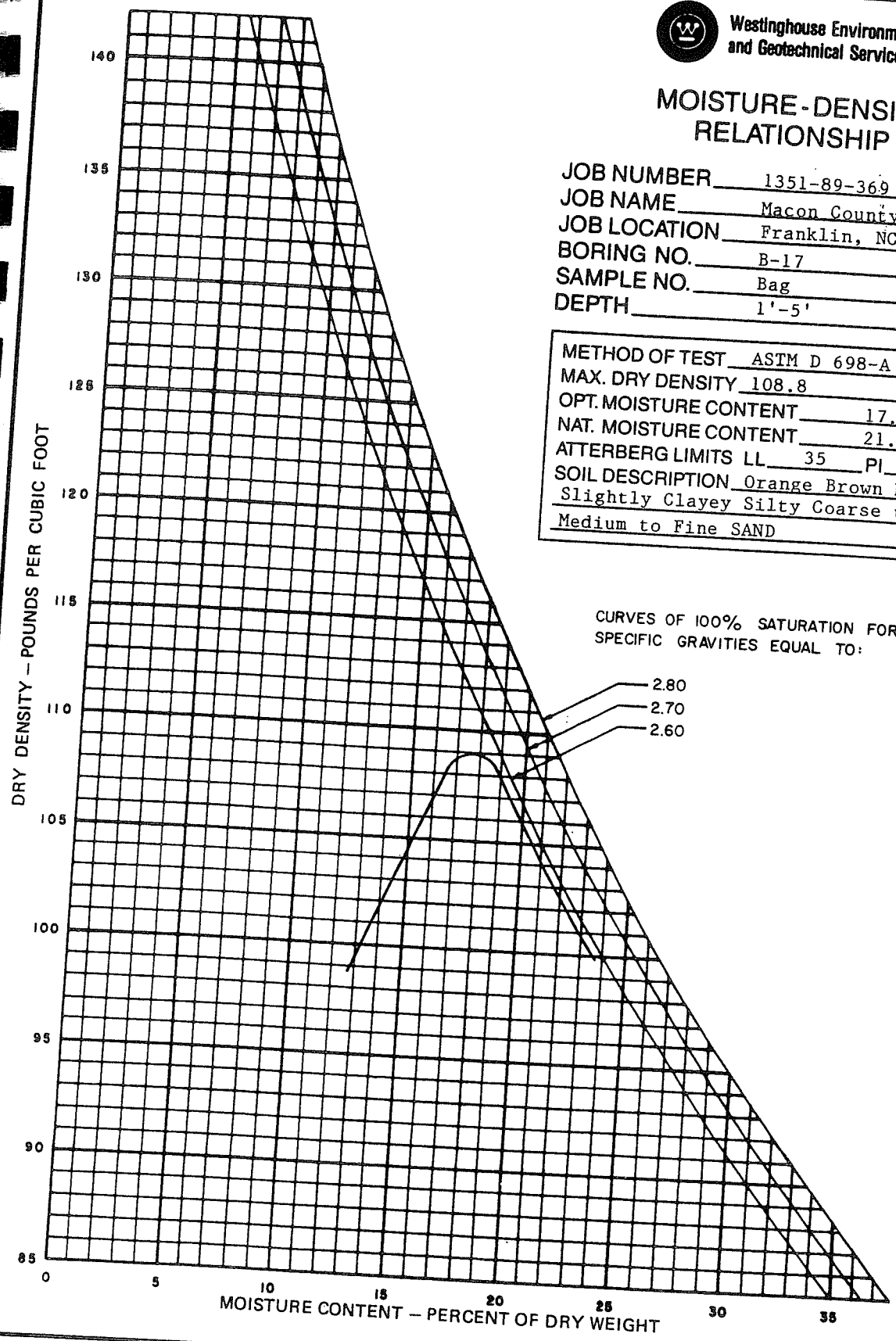


Westinghouse Environmental and Geotechnical Services, Inc.

MOISTURE-DENSITY RELATIONSHIP

JOB NUMBER 1351-89-369
JOB NAME Macon County Landfill
JOB LOCATION Franklin, NC
BORING NO. B-17
SAMPLE NO. Bag
DEPTH 1'-5'

METHOD OF TEST ASTM D 698-A
MAX. DRY DENSITY 108.8 PCF
OPT. MOISTURE CONTENT 17.7 %
NAT. MOISTURE CONTENT 21.1 %
ATTERBERG LIMITS LL 35 PI 8
SOIL DESCRIPTION Orange Brown Micaceous Slightly Clayey Silty Coarse to Medium to Fine SAND



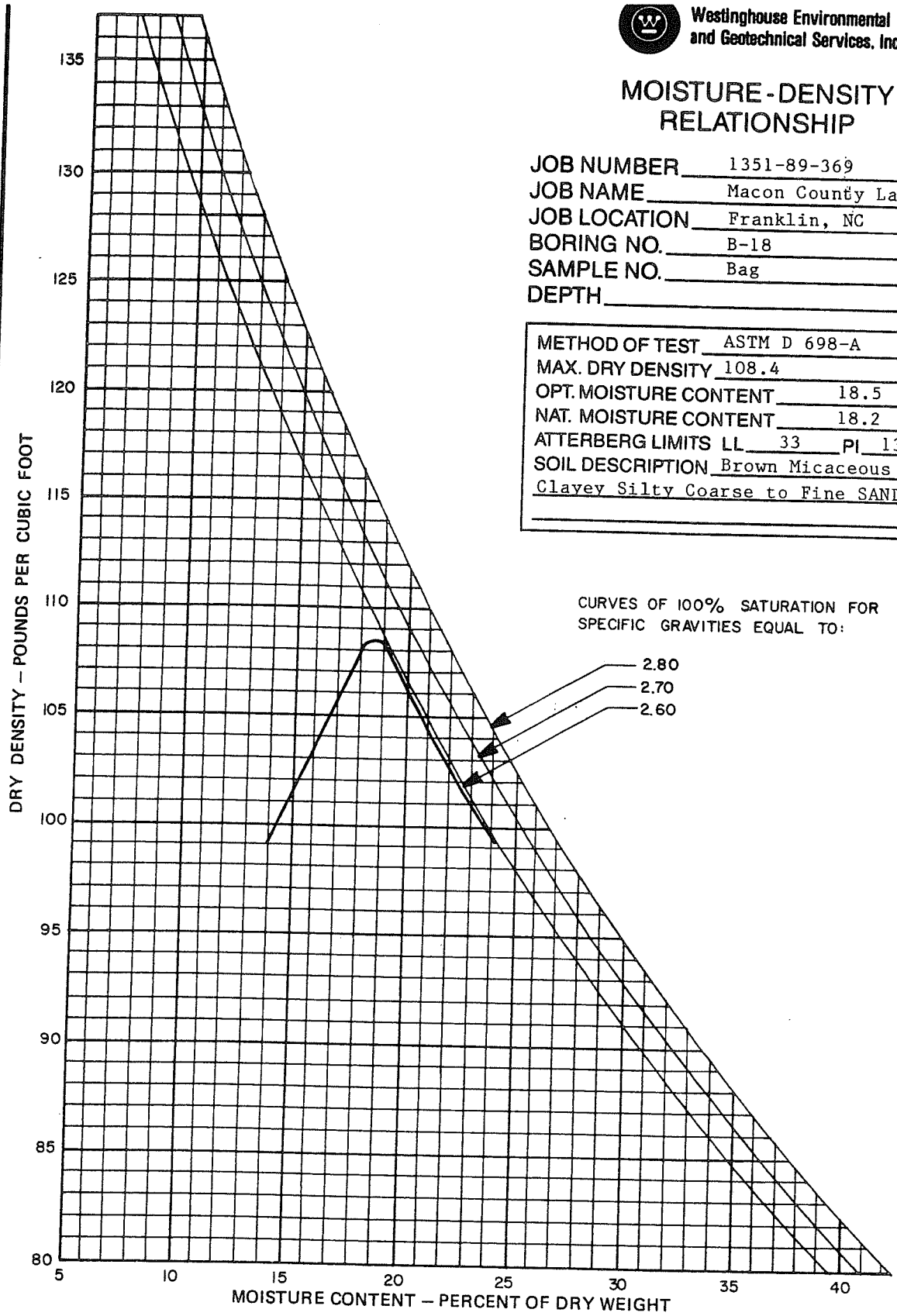
WE-3

Westinghouse Environmental and Geotechnical Services, Inc.

MOISTURE-DENSITY RELATIONSHIP

JOB NUMBER 1351-89-369
JOB NAME Macon County Landfill
JOB LOCATION Franklin, NC
BORING NO. B-18
SAMPLE NO. Bag
DEPTH

METHOD OF TEST ASTM D 698-A
MAX. DRY DENSITY 108.4 PCF
OPT. MOISTURE CONTENT 18.5 %
NAT. MOISTURE CONTENT 18.2 %
ATTERBERG LIMITS LL 33 PI 13
SOIL DESCRIPTION Brown Micaceous Clayey Silty Coarse to Fine SAND

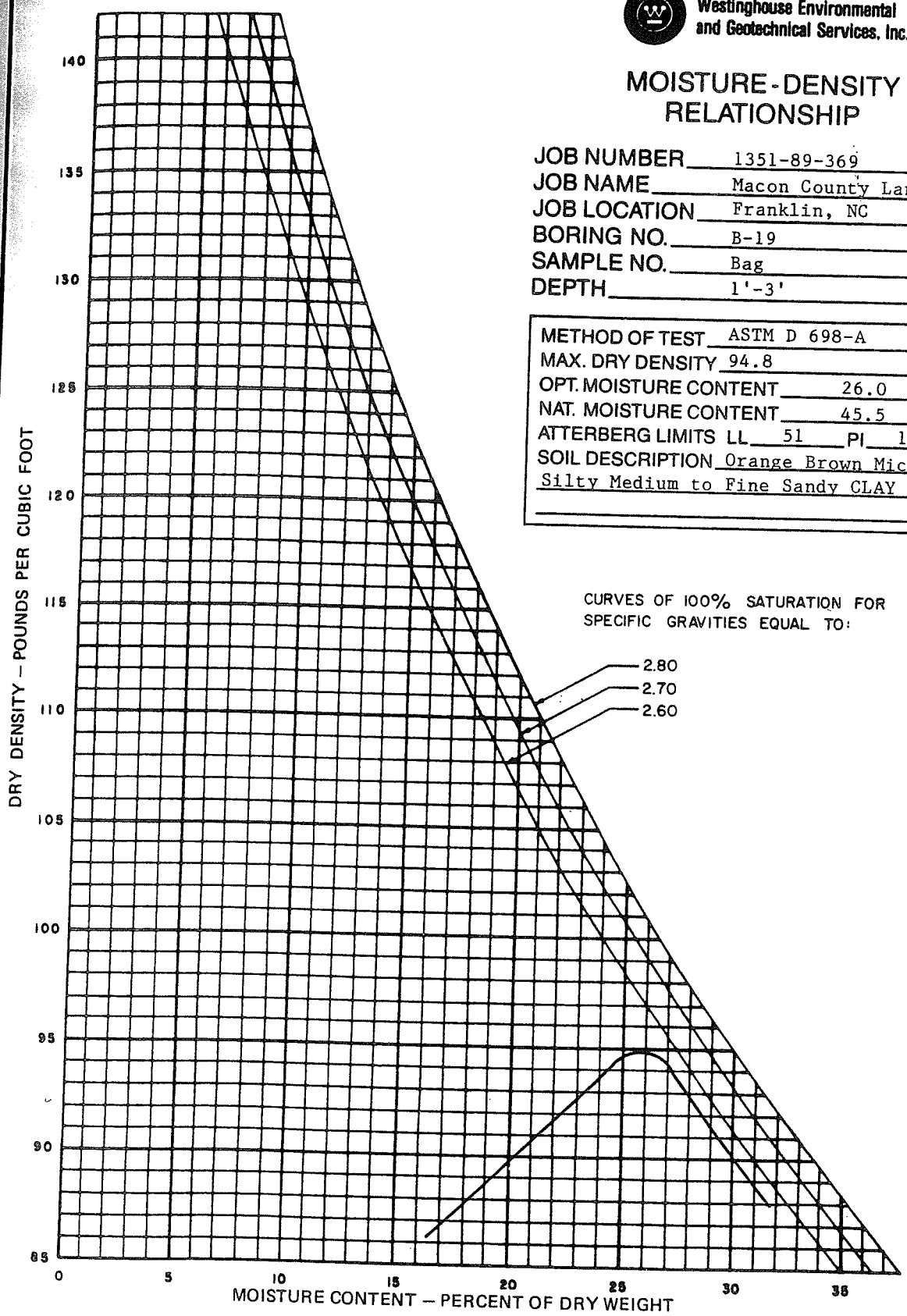


Westinghouse Environmental and Geotechnical Services, Inc.

MOISTURE-DENSITY RELATIONSHIP

JOB NUMBER 1351-89-369
JOB NAME Macon County Landfill
JOB LOCATION Franklin, NC
BORING NO. B-19
SAMPLE NO. Bag
DEPTH 1'-3'

METHOD OF TEST ASTM D 698-A
MAX. DRY DENSITY 94.8 PCF
OPT. MOISTURE CONTENT 26.0 %
NAT. MOISTURE CONTENT 45.5 %
ATTERBERG LIMITS LL 51 PI 18
SOIL DESCRIPTION Orange Brown Micaceous Silty Medium to Fine Sandy CLAY



SUMMARY OF LABORATORY TEST DATA

Boring No.	Sample Depth (Feet)	Sample Type ●●	USCS Classification	Natural Moisture Content	% Finer No. 200	Atterberg Limits		Proctor Data		Specific Gravity	Constant Head Coefficient of Permeability		
											Molding Conditions		
						L.L	P.I.	Max. Dry Density (Pcf)	Opt. Moisture Content (%)		Dry Density (PCF)	Moisture Content (%)	k, cm/sec
B-10	3 - 10	Bag	MH	22.3	57.5	55.0	12.0	95.0	24.8	2.74	90.8	25.7	4.6×10^{-6}
B-11	1 - 3	Bag	MH	29.8	74.8	54.0	19.0	92.0	26.5	2.70	88.8	27.0	5.1×10^{-6}
B-12	2 - 4	Bag	ML	28.5	65.0	44.0	11.0	90.2	30.0	2.70	86.4	30.5	3.0×10^{-8}
B-13	1 - 3	Bag	MH	32.1	82.5	64.0	22.0	82.2	33.5	2.75	78.9	33.4	1.6×10^{-7}
B-14	3 - 10	Bag	ML	24.2	57.5	47.0	11.0	101.0	19.5	2.72	96.5	20.5	1.6×10^{-6}
B-15	1 - 3	Bag	CL	12.4	54.0	34.0	13.0	107.3	18.6	2.79	102.6	18.6	1.7×10^{-6}
B-16	1 - 2.5	Bag	ML	28.2	57.0	39.0	10.0	101.4	21.9	2.74	97.3	22.4	2.1×10^{-6}
B-17	1 - 5	Bag	ML	21.1	44.0	35.0	8.0	108.8	17.7	2.76	103.6	18.5	7.9×10^{-6}
B-18	1 - 3	Bag	CL	18.2	56.0	33.0	13.0	108.4	18.5	2.76	104.4	18.5	2.1×10^{-7}
B-19	1 - 3	Bag	MH	45.5	65.0	51.0	18.0	94.8	26.0	2.77	91.4	24.8	5.8×10^{-7}
B-8	3.5-5.0	SS	ML	13.4		29.0	8.0						
B-8	13.5-15.0	SS		20.5		30.0	NP						
B-9	3.5-5.0	SS	SM	13.8		28.5	NP						
B-9	8.5-10.0	SS		13.4		30.0	NP						

● - Graphic Presentations of Results of Triaxial, Consolidation, CBR, Proctor, Grain Size, and other test follow this summary

●● - SS = Split Spoon Sample (ASTM D-1586)
UD = Undisturbed Sample (ASTM D-1587)

Bag = Bulk Sample

Westinghouse Environmental and Geotechnical Services, Inc.

JOB NAME Macon County Landfill
LOCATION Franklin, North Carolina
JOB NUMBER 1351-89-369 PAGE 1 OF 5

Continued from page 1

SUMMARY OF LABORATORY TEST DATA

Boring No.	Sample Depth (Feet)	Sample Type ●●	USCS Classification	Natural Moisture Content	% Finer No. 200	Atterberg Limits		Proctor Data		Specific Gravity	Constant Head Coefficient of Permeability		
											Molding Conditions		
						L.L	P.I.	Max. Dry Density (Pcf)	Opt. Moisture Content (%)		Dry Density (PCF)	Moisture Content (%)	k, cm/sec
B-10	3.5-5.0	SS	SM	14.4		47.0	NP						
B-10	13.5-15.0	SS	SM			43.0	NP						
B-11	0.5-2.0	SS	MH	11.9		51.0	16.0						
B-11	8.5-10.0	SS		23.4		54.0	NP						
B-12	3.5-5.0	SS		18.1		52.0	23.0						
B-12	8.5-10.0	SS		15.4		31.0	NP						
B-13	13.5-15.0	SS		28.6		56.0	NP						
B-13	33.5-35.0	SS		13.0		43.0	NP						
B-14	.5-1.5	SS	SM	12.2		28.0	NP						
B-14	13.5-15.0	SS	SM	31.0		44.0	NP						
B-15	6-7.5	SS		12.9		32.0	NP						
B-16	8.5-10.0	SS				35.0	NP						
B-17	6-7.5	SS	SM	10.4		37.0	NP						
B-18	6-7.5	SS	SM			26.0	NP						

● - Graphic Presentations of Results of Triaxial, Consolidation, CBR, Proctor, Grain Size, and other test follow this summary

●● - SS = Split Spoon Sample (ASTM D-1586)

UD = Undisturbed Sample (ASTM D-1587)

Bag = Bulk Sample

Westinghouse Environmental and Geotechnical Services, Inc.

JOB NAME Macon County Landfill

LOCATION Franklin, North Carolina

JOB NUMBER 1351-89-369

Continued from page 2

SUMMARY OF LABORATORY TEST DATA

Boring No.	Sample Depth (Feet)	Sample Type **	USCS Classification	Natural Moisture Content	% Finer No. 200	Atterberg Limits		Proctor Data		Specific Gravity	Constant Head Coefficient of Permeability		
						L.L	P.I.	Max. Dry Density (Pcf)	Opt. Moisture Content (%)		Molding Conditions: Dry Density (PCF)	Molding Conditions: Moisture Content (%)	k, cm/sec
B-18	28.5-30.	SS				26.0	NP						
B-19	13.5-15	SS	SM			44.0	NP						
B-19	53-55	SS		13.8		34.0	NP						
B-8	6-7.5	SS		13.4	43.8								
B-8	18.5-20	SS	SM	20.5	34.3								
B-9	6-7.5	SS		19.9	58.0								
B-9	13.5-15	SS		26.0	31.0								
B-9	18-20.0	SS		40.9									
B-10	.5-2	SS		36.1	72.0								
B-10	8.5-10	SS		22.7	51.0								
B-11	6-7.5	SS	SM	27.9	54.0								
B-11	13.5-15.0	SS		20.0	31.0								
B-12	6-7.5	SS		25.7	62.0								
B-12	13.5-15.0	SS		20.3	39.0								

* - Graphic Presentations of Results of Triaxial, Consolidation, CBR, Proctor, Grain Size, and other test follow this summary

** - SS = Split Spoon Sample (ASTM D-1586)

UD = Undisturbed Sample (ASTM D-1587)

Bag = Bulk Sample

Westinghouse Environmental and Geotechnical Services, Inc.

JOB NAME: Macon County Landfill

LOCATION: Franklin, North Carolina

JOB NUMBER 1351-89-369

Continued from page 3

SUMMARY OF LABORATORY TEST DATA

Boring No.	Sample Depth (Feet)	Sample Type ••	USCS Classification	Natural Moisture Content	% Finer No. 200	Atterberg Limits		Proctor Data		Specific Gravity	Constant Head Coefficient of Permea		
						L.L	P.I.	Max. Dry Density (Pcf)	Opt. Moisture Content (%)		Molding Conditions		
											Dry Density (PCF)	Moisture Content (%)	k,
B-14	6-7.5	SS	SM	32.5	55.0								
B-14	18.5-20	SS	SM	40.6	53.2								
B-14	25-26	SS		25.2									
B-15	8.5-10	SS		21.8	34.0								
B-15	13.5-15	SS		14.8									
B-16	6-7.5	SS		20.3	33.5								
B-17	8.5-10	SS	SM	16.6	29.0								
B-18	3.5-5	SS	SM	13.9	38.0								
B-18	23.5-25	SS	SM	25.8	40.0								
B-19	8.5-10	SS	SM	22.3	46.5								
B-19	28.5-30	SS		13.5									
B-19	58.5-60	SS	SM	27.7	29.0								
B-13	6-7.5	SS		40.2									
B-13	18.5-20	SS	SM	36.2	71.0								

• - Graphic Presentations of Results of Triaxial, Consolidation, CBR, Proctor, Grain Size, and other test follow this summary

•• - SS = Split Spoon Sample (ASTM D-1586)

UD = Undisturbed Sample (ASTM D-1587)

Bag = Bulk Sample

Westinghouse Environmental and Geotechnical Services, Inc.

JOB NAME Macon County Landfill

LOCATION Franklin, North Carolina

JOB NUMBER 1351-89-369

Continued from page 4

SUMMARY OF LABORATORY TEST DATA

Boring No.	Sample Depth (Feet)	Sample Type **	USCS Classification	Natural Moisture Content	% Finer No. 200	Atterberg Limits		Proctor Data		Specific Gravity	Constant Head Coefficient of Permeabi		
						L.L	P.I.	Max. Dry Density (Pcf)	Opt. Moisture Content (%)		Molding Conditions		
											Dry Density (PCF)	Moisture Content (%)	k, cm
B-13	38-40	SS	SM	26.6	63.0								
B-1	23.5-25	SS			24.5	42.0	1.0						
B-2	6.5-8	SS			34.0	52.0	2.0						
B-3	.5-2	SS			39.5	33.0	1.0						
B-4	28.5-30	SS			25.5	31.0	1.0						
B-7	33.5-35	SS			37.0	40.0	1.0						
B-1	3.5-5	SS			24.5	30.0	2.0						

* - Graphic Presentations of Results of Triaxial, Consolidation, CBR, Proctor, Grain Size, and other test follow this summary

** - SS = Split Spoon Sample (ASTM D-1586)

UD = Undisturbed Sample (ASTM D-1587)

Bag = Bulk Sample

Westinghouse Environmental and Geotechnical Services, Inc.

JOB NAME Macon County Landfill

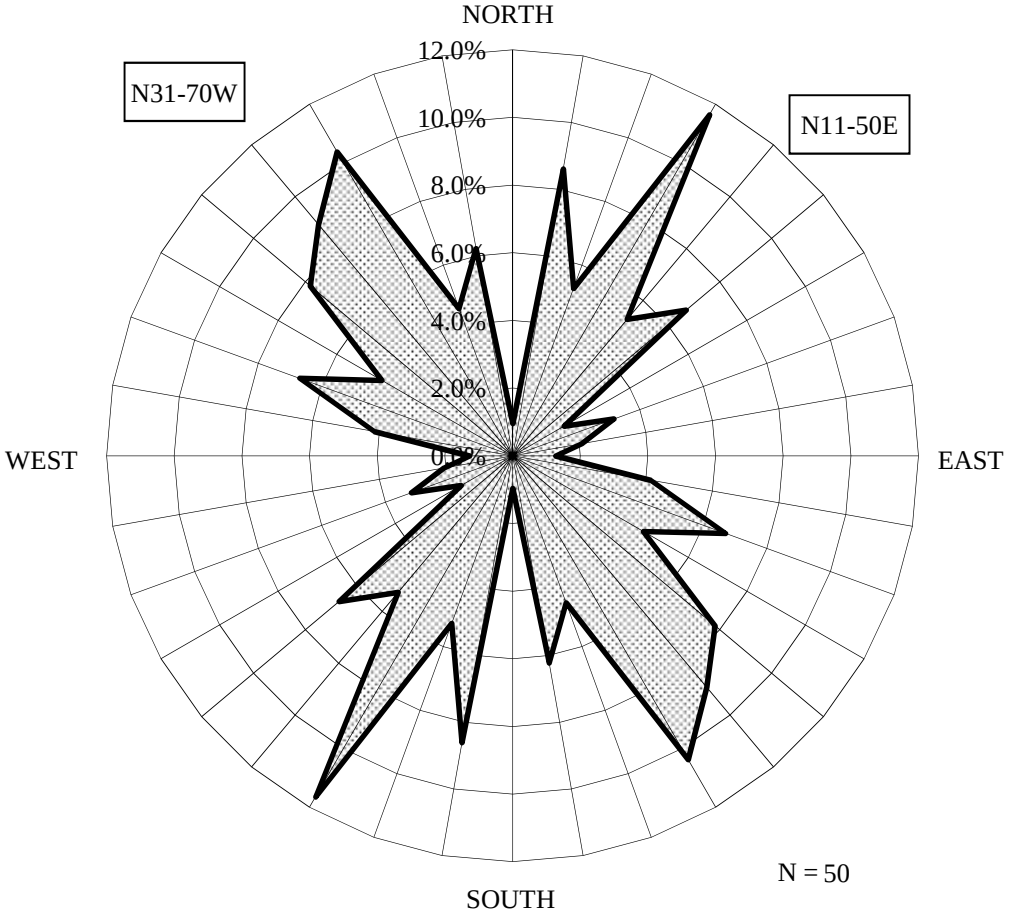
LOCATION Franklin, North Carolina

JOB NUMBER 1351-89-369

APPENDIX H

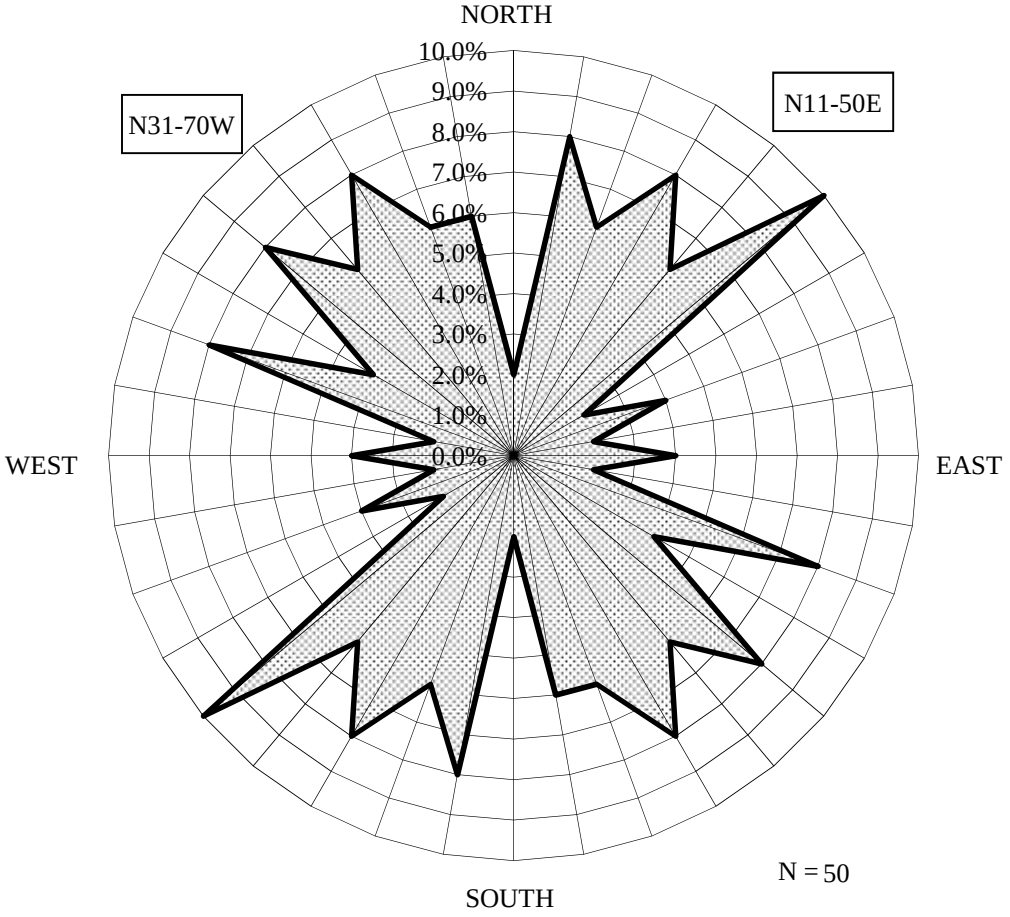
FRACTURE TRACE ANALYSIS DATA

ROSE DIAGRAM OF FRACTURE TRACE AND LINEAMENT TRENDS
Percentage Expressed as Length of Fracture Traces/Lineaments
Data Collected within 1.5-Mile Radius of the Macon County MSW Landfill
Franklin, NC
BLE Job Number J13-1101-06



1101-06 Macon Co LF FTA.xls
Rose Diagram (Lineament Length)

ROSE DIAGRAM OF FRACTURE TRACE AND LINEAMENT TRENDS
Percentage Expressed as Number of Fracture Traces/Lineaments
Data Collected within 1.5-Mile Radius of the Macon County MSW Landfill
Franklin, NC
BLE Job Number J13-1101-06



APPENDIX I

GEOTECHNICAL CALCULATIONS

APPENDIX I
GEOTECHNICAL CALCULATIONS

ANALYSES DOCUMENTATION
GLOBAL SLOPE STABILITY AND
SUBGRADE SETTLEMENT

DESIGN HYDROGEOLOGIC REPORT - PHASE 3 CELL 1
MACON COUNTY MSW LANDFILL
MACON COUNTY, NORTH CAROLINA

BLE Project No. J13-1101-06

Prepared By: _____

Gary L. Weekley, P.E. May 27, 2015
Registered, NC #8251

Reviewed By: _____

Daniel B. Bunnell, P.E. May 27, 2015
Registered, NC #13814

Bunnell-Lammons Engineering, Inc.
Greenville, South Carolina
864-288-1265 (Voice)
864-288-4430 (Fax)

PURPOSE

1. Analyze the stability of the tallest planned final waste slope for the proposed Phase 3 expansion under static and pseudo-static (seismic) conditions.
2. Calculate the estimated foundation settlement caused by the proposed future waste mound for Phase 3 and confirm that the post-settlement subgrade separation with the seasonal high groundwater level and bedrock will be the required minimum of 4 feet.

CONDITIONS

1. Geotechnical Soil Parameter information was obtained from boring logs and laboratory test data presented in the Design Hydrogeologic Report. Compressibility of residual foundation soils was conservatively estimated using a correlation between standard penetration (N) values and soil modulus developed by Martin.
2. Shear strength and unit weight of municipal solid waste was estimated from published literature and our experience with similar materials. (Bray, Zekkos, & Merry, 2008) (Zekkos, et al., 2006)
3. Plan and slope configurations obtained from drawing prepared by McGill Associates.
4. Base liner grades and existing ground surface contours obtained from drawing prepared by McGill Associates.
5. Bedrock elevations obtained from Top of Bedrock (Auger Refusal) Elevation Contour Map (Figure 5) presented in the Design Hydrogeologic Report for Phase 3 Cell No. 1 by BLE dated May 27, 2015.
6. Groundwater elevations obtained from the Seasonal High Groundwater Contour Map September 2013 – September 2014 (Figure 7) presented in the Design Hydrogeologic Report for Phase 3 Cell No. 1 by BLE dated May 27, 2015.
7. According the USGS Seismic Hazard Map, updated 2014, the landfill is located within a seismic impact zone which is defined as a landfill with a 10% probability in 250 years of having a peak bedrock acceleration greater than or equal to 0.10g. The bedrock acceleration for the site is 0.23g. The seismic coefficient used in the stability analysis considering allowable limited displacement was 0.17 using the methods recommended in the *Seismic Design Guidance for MSW Landfill Facilities*, April 1995.
8. Base liner and protective cover soil will consist of textured HDPE geomembrane and sandy protective cover.
9. Block sliding failure analysis along the base liner interface was performed with an interface friction angle of 18 degrees which yielded a factor of safety of 1.5. The interface friction angle of 18 degrees was selected as a typical value between textured geomembrane and cover soil from Koerner, et al. 1986 and Dixon et al. 2006, as well as our experience.

ASSUMPTIONS

1. Assumed the waste stream is characterized as "typical" municipal waste with less than approximately 10% sludge and no sludge present within 50 lateral feet of the temporary or final landfill slopes.
2. Assumed sufficient drainage within the leachate collection and removal system so that no more than 1-foot of liquid head is present on the base liner system.
3. Assumed subsurface profile is consistent with that found in the soil test borings.

SUMMARY OF RESULTS

The results of the analysis are summarized in the following table along with the computer printouts of the analysis results. From the analysis the minimum calculated factors of safety were greater than or equal to the minimum recommended factors of safety of 1.5 for static, long-term conditions (effective stress) and 1.0 for seismic conditions. The factor of safety values shown below for sliding along the base liner interface were calculated using a conservative estimation of the weakest interface estimated interface shear strength of the base liner of 18 degrees and zero cohesion. This is a conservative estimate of the expected minimum interface shear strength for a textured geomembrane against a clay liner.

Minimum Calculated Factors of Safety – MSW Unit Weight of 85 pcf

Effective Stress Analysis (static long term)	2.29
Total Stress Analysis (pseudo-static, seismic)	1.35
Effective Stress Analysis, failure along base liner interface (static)	1.74
Total Stress Analysis, failure along base liner interface (pseudo-static, seismic)	1.02

With Interface Friction of Base Liner Ø = 18°

CONCLUSION

Based on the results of the slope stability analysis, the factor of safety for the proposed 3:1 (H:V) waste slope is greater than the minimum recommended factors of safety of 1.5 for long term static conditions and 1.0 for pseudo-static (seismic) conditions. These factors of safety are contingent upon the conditions included in this analysis and presented in the attached Design Hydrogeologic Report.

Based on the analysis of subgrade settlement caused by the landfill loading, the estimated settlement calculated at the borings is approximately 0.1 foot or less. The settlement is relatively low due to the significant planned removal of overburden soil to obtain the design subgrade

elevations. Based on the design top of clay liner grades and a liner thickness of 1.5 feet, the post-settlement vertical separation between the clay liner subgrade and the seasonal high groundwater and bedrock is a minimum of 4 feet.

REFERENCES

Bunnell-Lammons Engineering, Inc., May 27, 2015, *Design Hydrogeologic Report - Phase 3 Cell No. 1, BLE Project No. J13-1101-06.*

Bray, J., Zekkos, D., & Merry, S. (2008). Shear Strength of Municipal Solid Waste. In D. (. Zekkos, *Geotechnical Characterization, Field Measurement, and Laboratory Testing of Municipal Solid Waste - Geotechnical Special Publication No 209* (pp. 44-75). Reston, Virginia: ASCE.

Dixon, N., Jones, D., & Fowmes, G. (2006). Interface shear strength variability and its use in reliability-based landfill stability analysis. *Geosynthetics International*, 1-14.

Koerner, R., Martin, J., & Koerner, G. (1986). Shear Strength Parameters between Geomembranes and Cohesive Soils. *Geotextiles and Geomembranes*, 21-30.

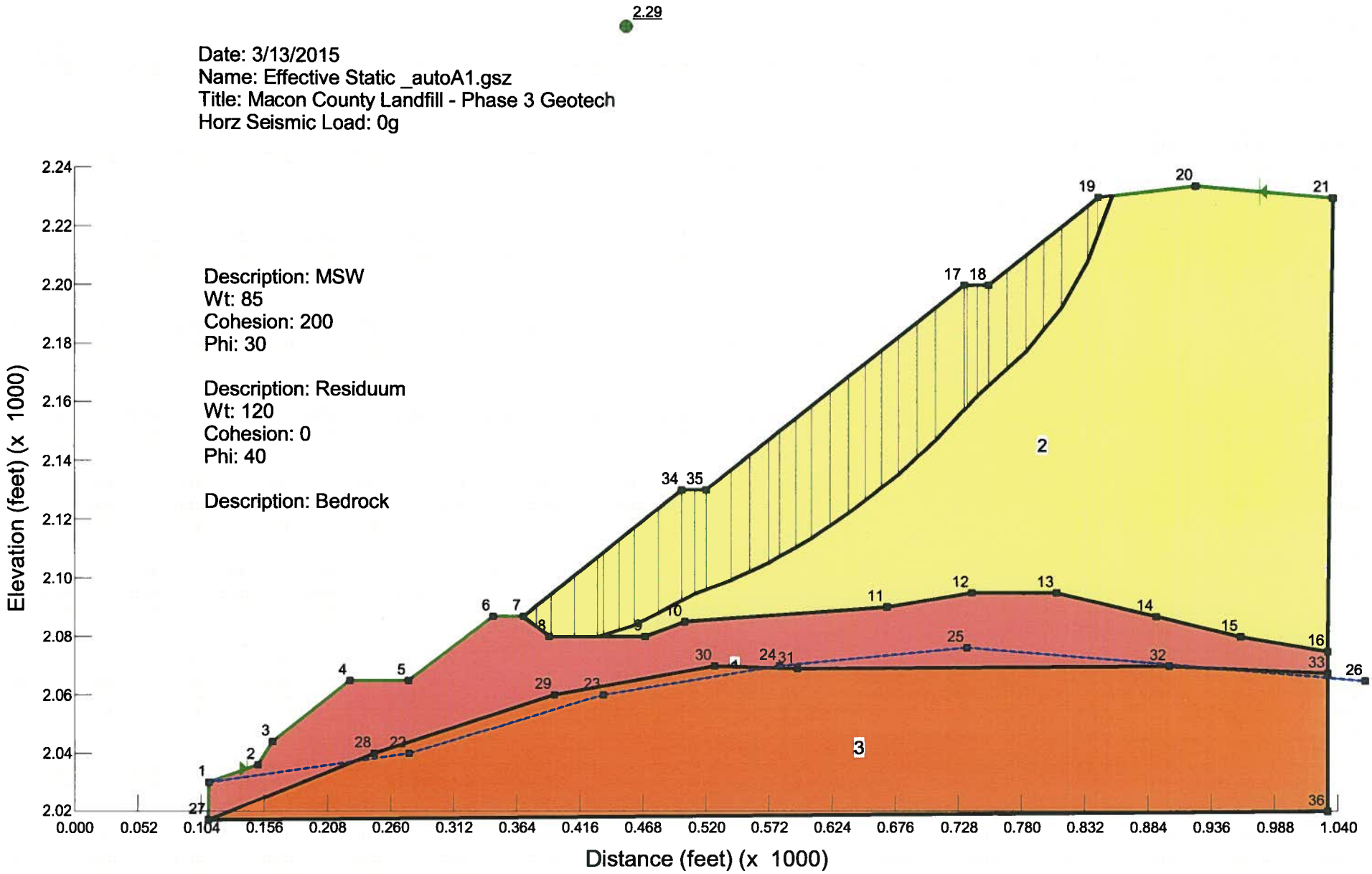
Martin, Ray E., 1987. Settlement in Residual Soils, *Foundation and Excavations in Decomposed Rock of the Piedmont Province, Geotechnical Special Publication No. 9*, ASCE.

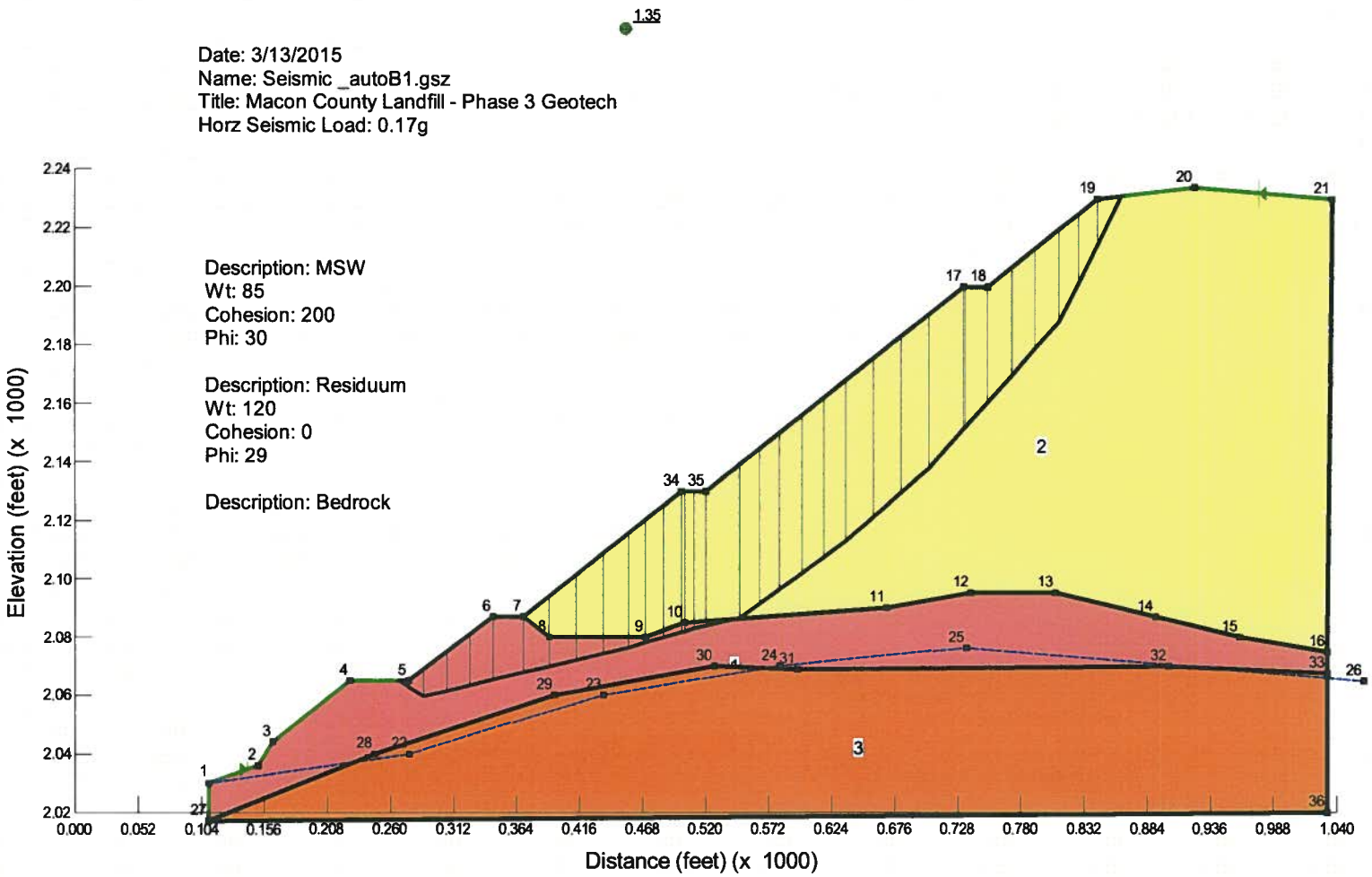
McGill Associates, April 2015, *Macon County MSW Phase 3 Cell 1 Grading Plans.*

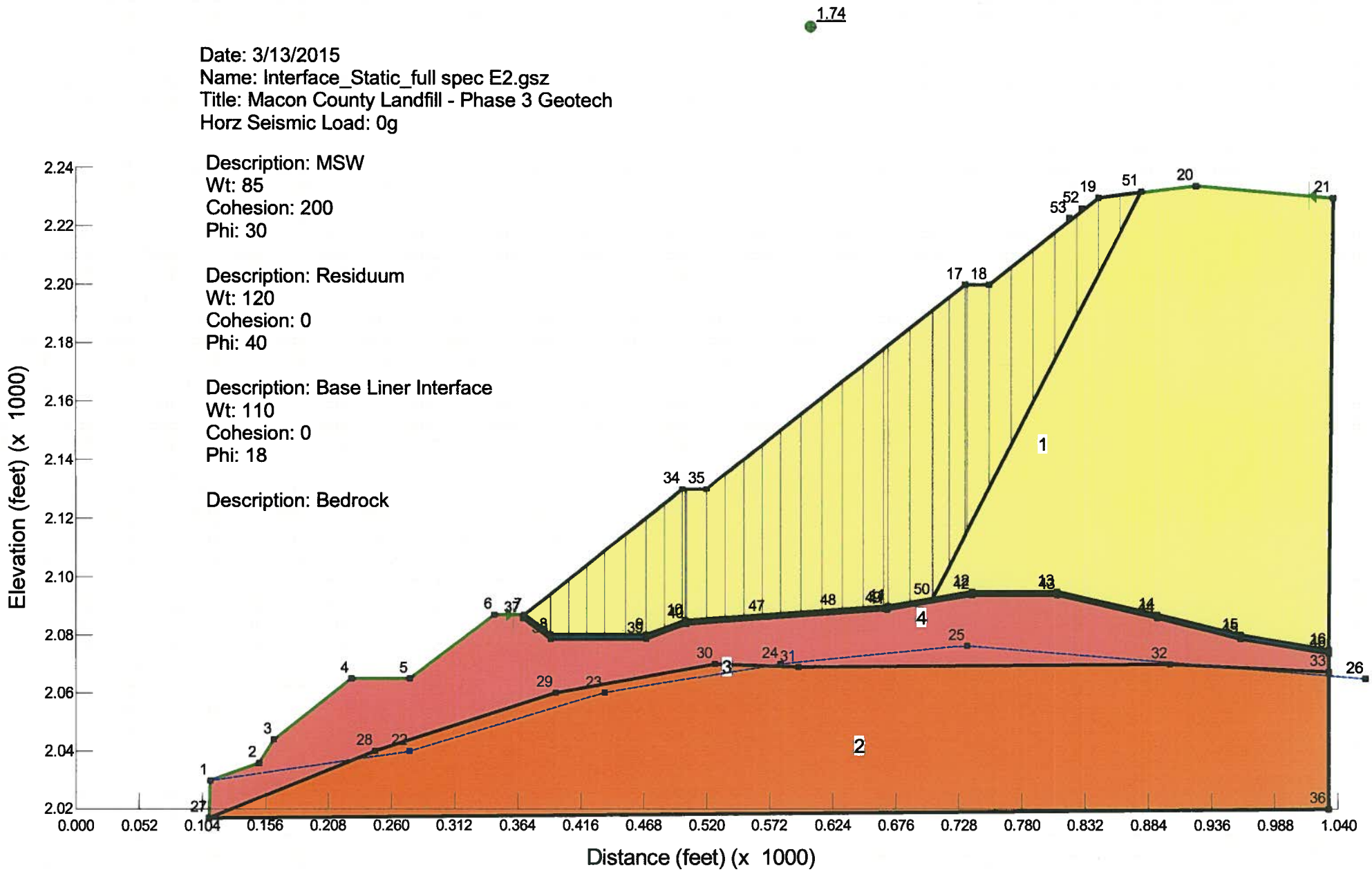
Petersen, M. E. (2014). *Documentation for the 2014 update of the United States national seismic hazard maps: U.S. Geological Survey Open-File Report 2014–1091.* Reston, Virginia: USGS.

RCRA, April 1995. *Seismic Design Guidance for Municipal Solid Waste Landfill Facilities.*

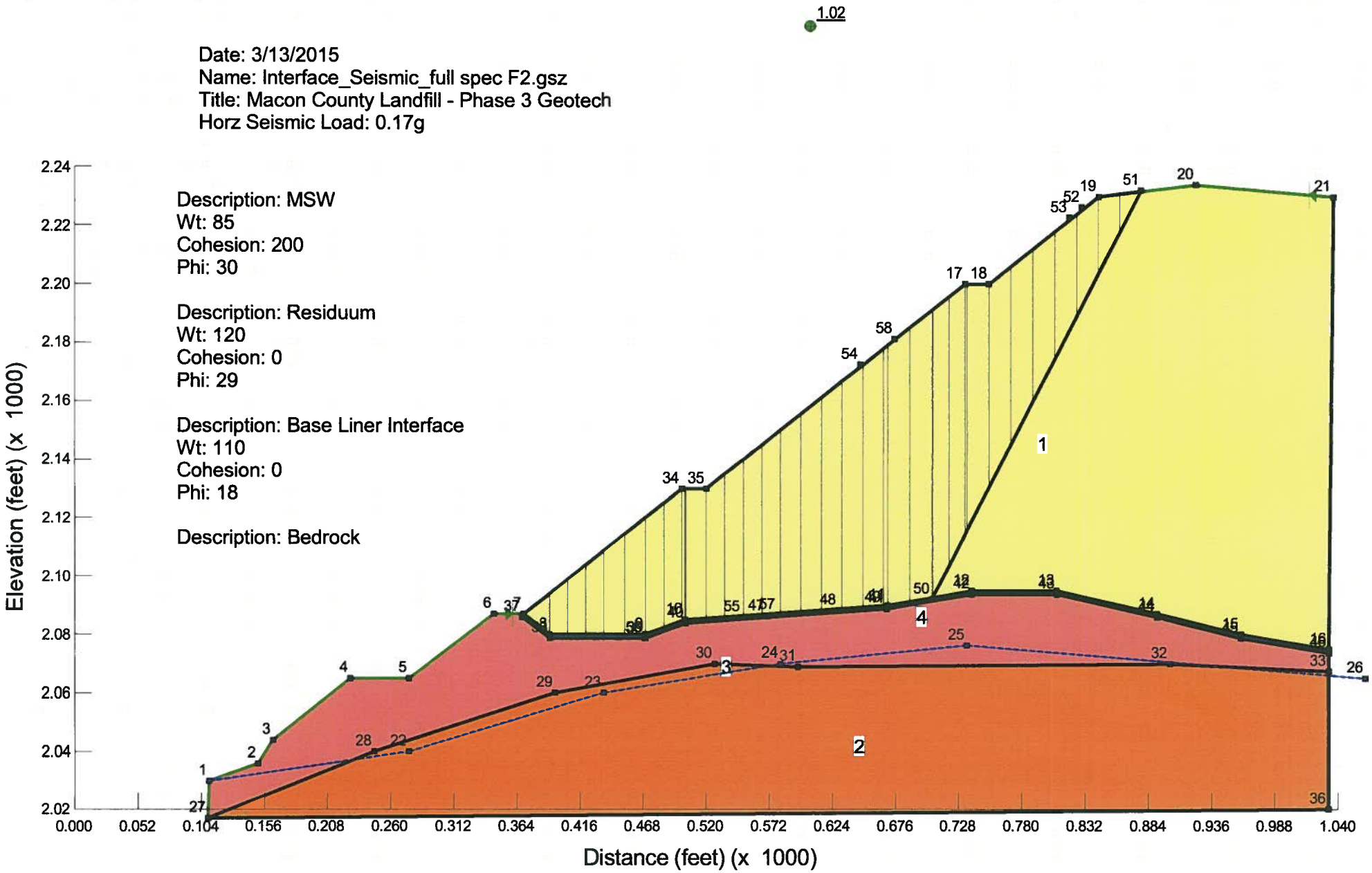
Zekkos, D., Bray, J., Kavazanjian, E., Matasovic, N., Rathje, E., Riemer, M., & Stukoe, K. (2006). Unit weight of municipal solid waste. *Journal of Geotechnical and Geoenvironmental Engineering*, 1250.


2.29
Date: 3/13/2015
Name: Effective Static _autoA1.gsz
Title: Macon County Landfill - Phase 3 Geotech
Horz Seismic Load: 0g
Description: MSW
Wt: 85
Cohesion: 200
Phi: 30
Description: Residuum
Wt: 120
Cohesion: 0
Phi: 40
Description: Bedrock
Elevation (feet) (x 1000)
Distance (feet) (x 1000)
2.24
2.22
2.20
2.18
2.16
2.14
2.12
2.10
2.08
2.06
2.04
2.02
0.000
0.052
0.104
0.156
0.208
0.260
0.312
0.364
0.416
0.468
0.520
0.572
0.624
0.676
0.728
0.780
0.832
0.884
0.936
0.988
1.040
2
3
4


1.35
Date: 3/13/2015
Name: Seismic _autoB1.gsz
Title: Macon County Landfill - Phase 3 Geotech
Horz Seismic Load: 0.17g
Description: MSW
Wt: 85
Cohesion: 200
Phi: 30
Description: Residuum
Wt: 120
Cohesion: 0
Phi: 29
Description: Bedrock
Elevation (feet) (x 1000)
Distance (feet) (x 1000)
2.24
2.22
2.20
2.18
2.16
2.14
2.12
2.10
2.08
2.06
2.04
2.02
0.000
0.052
0.104
0.156
0.208
0.260
0.312
0.364
0.416
0.468
0.520
0.572
0.624
0.676
0.728
0.780
0.832
0.884
0.936
0.988
1.040
2
3


1.74
Date: 3/13/2015
Name: Interface_Static_full spec E2.gsz
Title: Macon County Landfill - Phase 3 Geotech
Horz Seismic Load: 0g
Description: MSW
Wt: 85
Cohesion: 200
Phi: 30
Description: Residuum
Wt: 120
Cohesion: 0
Phi: 40
Description: Base Liner Interface
Wt: 110
Cohesion: 0
Phi: 18
Description: Bedrock
Elevation (feet) (x 1000)
Distance (feet) (x 1000)
2.24
2.22
2.20
2.18
2.16
2.14
2.12
2.10
2.08
2.06
2.04
2.02
0.000
0.052
0.104
0.156
0.208
0.260
0.312
0.364
0.416
0.468
0.520
0.572
0.624
0.676
0.728
0.780
0.832
0.884
0.936
0.988
1.040

Date: 3/13/2015
Name: Interface_Seismic_full spec F2.gsz
Title: Macon County Landfill - Phase 3 Geotech
Horz Seismic Load: 0.17g



RCRA SUBTITLE D (258)
SEISMIC DESIGN GUIDANCE
FOR
MUNICIPAL SOLID WASTE LANDFILL FACILITIES

Prepared By:

Gregory N. Richardson
G.N. Richardson & Associates
Raleigh, North Carolina 27603

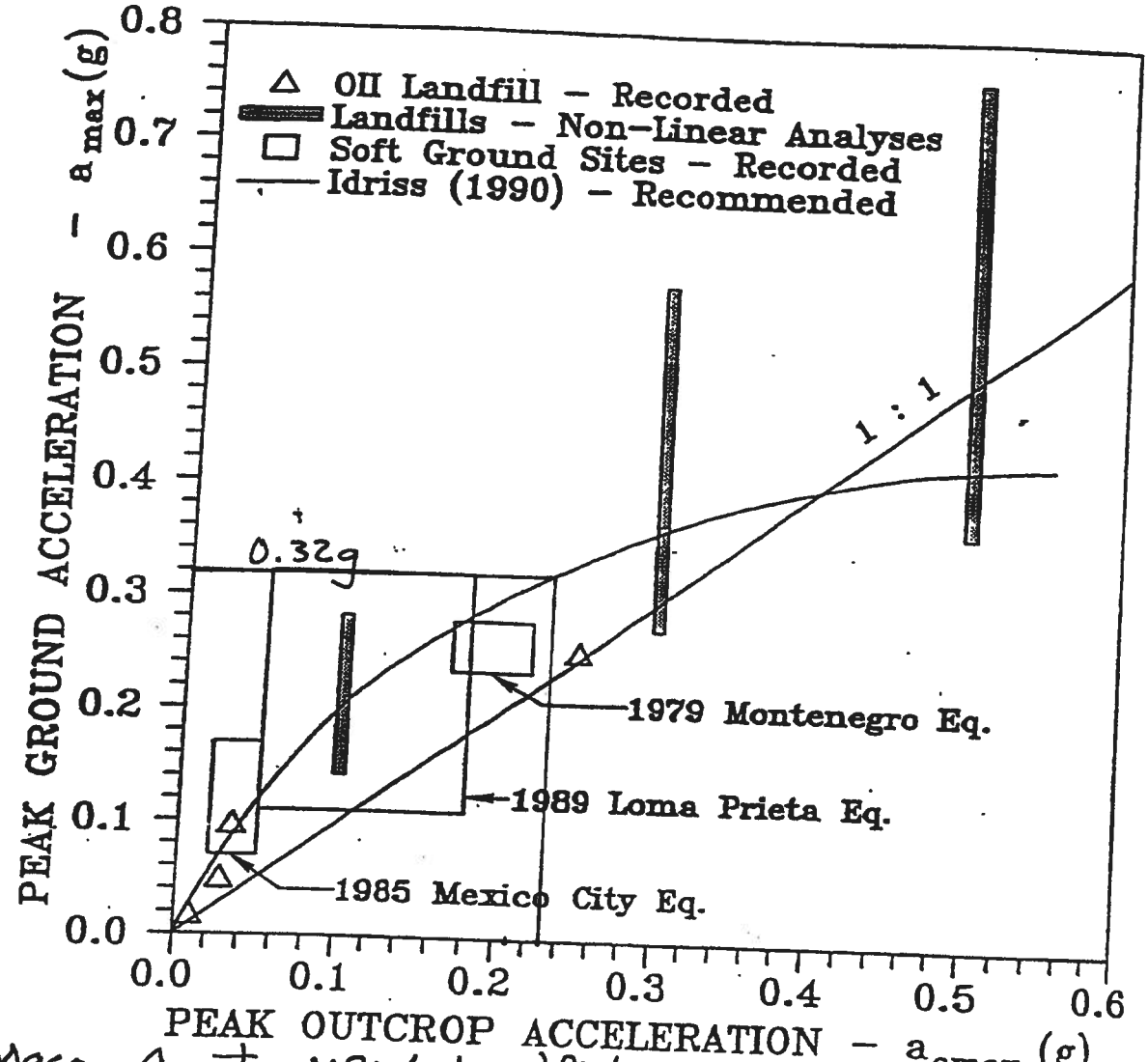
and

Edward Kavazanjian, Jr.
and
Neven Matasović
GeoSyntec Consultants
Huntington Beach, California 92647

PROJECT MANAGER

Robert Landreth
Waste Minimization, Destruction and
Disposal Research Division
Risk Reduction Engineering Laboratory
Cincinnati, Ohio 45268

Risk Reduction Engineering Laboratory
Office of Research and Development
U.S. Environmental Protection Agency
Cincinnati, Ohio 45268



Macon County MSW Landfill BLE J13-1101-06

$a_{omax} = 0.23g$

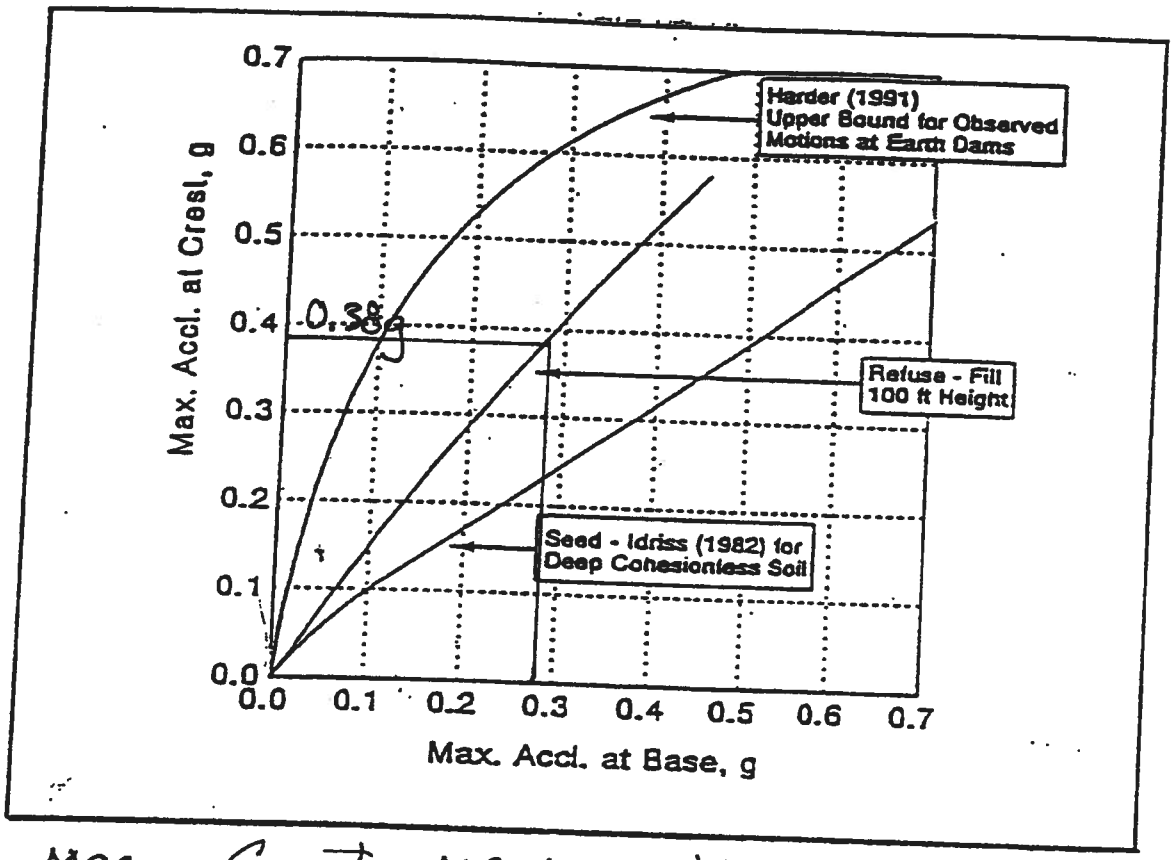
$a_{max} = 0.32g$ for soft soils

For medium stiff soils

$a_{max} = \frac{0.23g + 0.32g}{2}$

$a_{max} = 0.28g$ at base ✓

Figure 4.5 Observed Variations of Peak Horizontal Accelerations on Soft Soil and MSW Sites in Comparison to Rock Sites (Kavazanjian and Matasović, 1994).



Macon County MSW Landfill J13-1101-06

$a_{max} = 0.38g$ at crest

$$a_{max} = \frac{0.28g + 0.38g}{2} = 0.33g \text{ for waste mass}$$

Figure 4.6 Approximate Relationship Between Maximum Accelerations at the Base and Crest for Various Ground Conditions (Singh and Sun, 1995)

Following Hynes & Franklin method that allows limited displacement:

(CONCLUSION)

$$\therefore K_s = \frac{0.33g}{g} \times 0.5 = 0.17 \text{ seismic coefficient}$$

SURCHARGE DETERMINATION FOR ULTIMATE BUILD
PHASE 3 CELL 1

MACON COUNTY MSW LANDFILL
MACON COUNTY, NORTH CAROLINA

BLE Project No. J13-1101-06
May 27, 2015

Analysis Point Location	Ground Elevation at Point Feet	Elevation Finished Cap 3H : 1V Feet	Elevation of Geomembrane (Top of Clay Liner) Feet	Height of Cap Above Top of Clay Liner Feet	Cut Depth to Clay Liner Subgrade Cut (-) Fill (+) Feet	Net Surcharge Pressure at Clay Liner Subgrade Elevation psf
Cell 1						
BLE-6R	2146.27	2153.94	2132.37	22	-15	328
BLE-10	2125.43	2128.03	2086.76	41	-40	-970
BLE-11	2158.69	2200.00	2102.00	98	-58	1,690
BLE-12	2109.23	2184.55	2089.85	95	-21	5,887
BLE-14	2146.02	2129.53	2127.83	2	-20	-1,876
BLE-15	2100.28	2115.98	2093.67	22	-8	1,265
BLE-18R	2083.18	2117.58	2070.17	47	-15	2,631

Net Surcharge = cap weight + weight of waste down to protective cover + protective cover weight+ clay liner weight - net stress relief between original ground and clay liner subgrade.

Cap and geomembrane elevations from McGill Drawing Macon County MSW Phase 3 Cell 1 for PTC 4-29-15

Borings BLE-10 and BLE-14 have negative net surcharge pressures, therefore no expected settlement.

Assumed unit weight of materials:	Solid Waste	85 pcf
	Residual Soil and Clay Liner	120 pcf
	Cap Soil and Protective Cover	110 pcf

SETTLEMENT CALCULATIONS
DESIGN HYDROGEOLOGIC REPORT - PHASE 3 CELL 1

MACON COUNTY MSW LANDFILL
MACON COUNTY, NORTH CAROLINA

Bunnell-Lammons Engineering, Inc. Project No. J13-1101-06

April 30, 2015

Subsurface Layer Elevation	Soil Type	Standard Penetration Resistance (N-Value) (bpf)	Layer Thickness (feet)	Total Soil Unit Weight (pcf)	Effective Soil Unit Weight (pcf)	Surcharge Pressure[1] (psf)	Soil Modulus (ksf)	Layer Settlement (inches)
Cell 1 Boring BLE-6R								
2131-2114	Firm clayey silty SAND	18	17	120	120	328	280	0.2
2114-2089	Dense silty SAND	34	25	130	130	328	420	0.2
2089-2084	PWR	120	5	140	140	328	970	0.0
2084-2074	Dense silty SAND	35	10	130	130	328	430	0.1
2074-2066	Dense silty SAND	48	8	130	68	328	530	0.1
Total Thickness of Compressible Material			65	Feet				
							TOTAL ESTIMATED SETTLEMENT (inches)	**0.6**
							TOTAL ESTIMATED SETTLEMENT (feet)	**0.05**
Cell 1 Boring BLE-10								
	No Net Loading					***No Net Load***		
Total Thickness of Compressible Material				Feet				
							TOTAL ESTIMATED SETTLEMENT (inches)	**0.0**
							TOTAL ESTIMATED SETTLEMENT (feet)	**0.00**

[1] Surcharge pressure assumes weight of solid waste of 85 pcf

Prepared By: Gary L. Weekley, PE *Checked By:* Larry A. Simonson, EIT

SETTLEMENT CALCULATIONS
DESIGN HYDROGEOLOGIC REPORT - PHASE 3 CELL 1

MACON COUNTY MSW LANDFILL
MACON COUNTY, NORTH CAROLINA

Bunnell-Lammons Engineering, Inc. Project No. J13-1101-06

April 30, 2015

Subsurface Layer Elevation	Soil Type	Standard Penetration Resistance (N-Value) (bpf)	Layer Thickness (feet)	Total Soil Unit Weight (pcf)	Effective Soil Unit Weight (pcf)	Surcharge Pressure[1] (psf)	Soil Modulus (ksf)	Layer Settlement (inches)
Cell 1 Boring BLE-11								
2100-2081	PWR	200	19	140	140	1,690	1,350	0.3
Total Thickness of Compressible Material			19	Feet				
			TOTAL ESTIMATED SETTLEMENT (inches)					**0.3**
			TOTAL ESTIMATED SETTLEMENT (feet)					**0.03**
Cell 1 Boring BLE-12								
2088-2082	Dense silty SAND	31	6	130	130	5,887	400	1.1
Total Thickness of Compressible Material			6	Feet				
			TOTAL ESTIMATED SETTLEMENT (inches)					**1.1**
			TOTAL ESTIMATED SETTLEMENT (feet)					**0.09**

[1] Surcharge pressure assumes weight of solid waste of 85 pcf

Prepared By: Gary L. Weekley, PE *Checked By:* Larry A. Simonson, EIT

SETTLEMENT CALCULATIONS
DESIGN HYDROGEOLOGIC REPORT - PHASE 3 CELL 1

MACON COUNTY MSW LANDFILL
MACON COUNTY, NORTH CAROLINA

Bunnell-Lammons Engineering, Inc. Project No. J13-1101-06

April 30, 2015

Subsurface Layer Elevation	Soil Type	Standard Penetration Resistance (N-Value) (bpf)	Layer Thickness (feet)	Total Soil Unit Weight (pcf)	Effective Soil Unit Weight (pcf)	Surcharge Pressure[1] (psf)	Soil Modulus (ksf)	Layer Settlement (inches)
Cell 1 Boring BLE-14								
	No Net Loading					***No Net Load***		
Total Thickness of Compressible Material				Feet				
			TOTAL ESTIMATED SETTLEMENT (inches)					**0.0**
			TOTAL ESTIMATED SETTLEMENT (feet)					**0.00**
Cell 1 Boring BLE-15								
2092-2078	Dense silty SAND	34	14	130	130	1,265	420	0.5
2078-2064	PWR	150	14	140	78	1,265	1,120	0.2
Total Thickness of Compressible Material			28	Feet				
			TOTAL ESTIMATED SETTLEMENT (inches)					**0.7**
			TOTAL ESTIMATED SETTLEMENT (feet)					**0.06**

[1] Surcharge pressure assumes weight of solid waste of 85 pcf

Prepared By: Gary L. Weekley, PE *Checked By:* Larry A. Simonson, EIT

SETTLEMENT CALCULATIONS
DESIGN HYDROGEOLOGIC REPORT - PHASE 3 CELL 1

MACON COUNTY MSW LANDFILL
MACON COUNTY, NORTH CAROLINA

Bunnell-Lammons Engineering, Inc. Project No. J13-1101-06

April 30, 2015

Subsurface Layer Elevation	Soil Type	Standard Penetration Resistance (N-Value) (bpf)	Layer Thickness (feet)	Total Soil Unit Weight (pcf)	Effective Soil Unit Weight (pcf)	Surcharge Pressure[1] (psf)	Soil Modulus (ksf)	Layer Settlement (inches)
Cell 1 Boring BLE-18R								
2069-2051	Very Dense silty SAND	53	18	130	68	2,631	560	1.0
2051-2044	PWR	120	7	140	78	2,631	970	0.2
Total Thickness of Compressible Material			25	Feet				
			TOTAL ESTIMATED SETTLEMENT (inches)					**1.2**
			TOTAL ESTIMATED SETTLEMENT (feet)					**0.10**
Total Thickness of Compressible Material				Feet				
			TOTAL ESTIMATED SETTLEMENT (inches)					
			TOTAL ESTIMATED SETTLEMENT (feet)					

[1] Surcharge pressure assumes weight of solid waste of 85 pcf

Prepared By: Gary L. Weekley, PE *Checked By:* Larry A. Simonson, EIT

POST-SETTLEMENT VERTICAL SEPARATION BETWEEN CLAY LINER SUBGRADE & SEASONAL HIGH GROUNDWATER

GEOTECHNICAL ANALYSIS - PHASE 3
MACON COUNTY MSW LANDFILL
MACON COUNTY, NORTH CAROLINA
BLE Project No. J13-1101-06
May 27, 2015

Boring Number	Geomembrane (FML) Elevation Feet	Estimated Settlement at Clay Subgrade Feet	Clay Liner Subgrade Elevation (FML-1.5 Ft) Feet	Groundwater Elevation (Seasonal High[1]) Feet	Groundwater Separation with Clay Liner Subgrade Feet
Cell No. 1					
BLE-6R	2132.37	0.05	2130.87	2081.29	49.5
BLE-10[2]	2086.76	0.00	2085.26	2073.17	12.1
BLE-11	2102.00	0.03	2100.50	2085.58	14.9
BLE-12	2089.85	0.09	2088.35	2066.89	21.4
BLE-14	2127.83	0.00	2126.33	2084.59	41.7
BLE-15	2093.67	0.06	2092.17	2076.75	15.4
BLE-18R	2070.17	0.10	2068.67	2064.57	4.0

1 Data from Figure 7 of Design Hydrogeologic Report BLE Project No. J13-1101-06, report dated May 27, 2015.
2 Seasonal high groundwater at boring BLE-10 is an interpolated value from Figure 7 of Design Hydrogeologic Report

Prepared By: Gary L. Weekley, PE
Checked By: Larry A. Simonson, EIT
Reviewed By: Daniel B. Bunnell, PE

POST-SETTLEMENT VERTICAL SEPARATION BETWEEN CLAY LINER SUBGRADE & BEDROCK

GEOTECHNICAL ANALYSIS - PHASE 3
MACON COUNTY MSW LANDFILL
MACON COUNTY, NORTH CAROLINA
BLE Project No. J13-1101-06
May 27, 2015

Boring Number	Geomembrane (FML) Elevation Feet	Estimated Settlement at Clay Subgrade Feet	Clay Liner Subgrade Elevation (FML-1.5 Ft) Feet	Top of Bedrock[1] Elevation Feet	Bedrock Separation with Clay Liner Subgrade Feet
Cell No. 1					
BLE-6R	2132.37	0.05	2130.87	<2066.3	>64.1
BLE-10	2086.76	0.00	2085.26	2079.93	5.3
BLE-11	2102.00	0.03	2100.50	2081.19	19.3
BLE-12	2089.85	0.09	2088.35	2082.73	5.5
BLE-14	2127.83	0.00	2126.33	<2056.0	>70.5
BLE-15	2093.67	0.06	2092.17	2063.78	28.3
BLE-18R	2070.17	0.10	2068.67	2044.18	24.4

1 Data from Figure 5 of Design Hydrogeologic Report
BLE Project No. J13-1101-06, report dated May 27, 2015.

Prepared By: Gary L. Weekley, PE
Checked By: Larry A. Simonson, EIT
Reviewed By: Daniel B. Bunnell, PE