Design Hydrogeologic Report

Halifax County C&D Landfill – Area 2
Halifax County, North Carolina

Prepared for:

Halifax County, Department of Public Utilities
Halifax, North Carolina

December 2012
REVISED - July 2013

NC LIC. NO. C-0828 (ENGINEERING)

SMITH+GARDNER

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Halifax County, North Carolina

Prepared For:
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S+G Project No. Halifax 12-1

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Executive Summary

This *Design Hydrogeological Study* was performed to assess the local and regional geologic, hydrogeologic and hydrologic characteristics of the uppermost aquifer regime at the proposed Area 2 expansion of the Halifax County Construction and Demolition (C&D) Debris Landfill. Requirements for the Design Hydrogeologic Study are described in Rule 15A NCAC 13B .0538 (b).

The Halifax C&D Landfill is located at 921 Liles Road in Littleton, North Carolina, approximately twelve miles south of Roanoke Rapids, NC and one mile north of the intersection of NC 48 and SR 1001 at Aurelian Springs, in the Butterwood Township. The land area for the proposed Area 2 is currently undeveloped. The surrounding area is undeveloped property and agricultural. There is no residential or commercial/industrial development in the vicinity. The site is located in the Eastern Piedmont Province of North Carolina in the Tar-Pamlico drainage basin.

The approximately ±6 acre Area 2 area was investigated utilizing 16 historic soil borings, advanced to depths of up to 50 feet below ground surface (bgs). The site stratigraphy is based more on the in-situ weathering pattern than actual depositional units. The upper soils are stiff, reddish-orange clayey silt and silty clay, extending to depths of 10 to 15 feet bgs. The borings generally did not encounter bedrock or partially weathered rock; however, test boring BP-1 encountered partially weathered rock and auger refusal on bedrock at 36 feet bgs.

Ground water conditions have been characterized using 16 piezometers and permanent wells located in and around the C&D Area 2 footprint. The uppermost, unconfined aquifer is located at an approximate elevation of 210 feet to 275 feet amsl; determined using the approximate bedrock depth and average groundwater elevation as the upper and lower boundaries. Generally, groundwater flows through the unconsolidated sediments in a northwesterly direction toward the local discharge feature, an unnamed tributary of Brewers Creek. These fine-grained sediments yield moderate hydraulic conductivities and groundwater flow rates.

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1.0 INTRODUCTION

1.1 Study Purpose and Scope

This *Design Hydrogeological Study* was performed to assess the local and regional geologic, hydrogeologic and hydrologic characteristics of the uppermost aquifer regime at the proposed Area 2 expansion of the Halifax Construction and Demolition (C&D) Landfill. Collected field information was used to determine subsurface hydrogeologic and engineering properties, to evaluate hydrogeologic and geologic conditions, to identify base grade elevations for compliance with vertical separation requirements and to design effective monitoring plans for early detection of a potential release into groundwater and potential landfill gas migration. Data, conclusions and recommendations for hydrologic and geologic conditions are provided to fulfill the requirements for the Design Hydrogeologic Study described in Rule 15A NCAC 13B, .0538 (b).

1.2 Site Background

The proposed Area 2 expansion will operate under NC Solid Waste Permit 42-04. The Halifax landfill facility includes a municipal solid waste (MSW) unit closed December 31, 1997, the existing C&D landfill (Phase 1), an Ash Monofill unit, woodwaste processing, animal waste and white goods disposal. The planned Area 2 C&D landfill area covers approximately 6 acres within the existing permitted boundary and will be located east of the closed MSW landfill and Phase 1 C&D landfill. Historically, the land has been forest and was most recently used as a soil borrow area.

The facility meets the applicable location requirements of 15A NCAC 13B .0503. This document and its attachments meet the hydrogeological report requirements outlined in Rule.0538 (a) and (b). Design submittal requirements of .0535, including a Facility Plan, Engineering Plan, Construction Quality Assurance (CQA) Plan, Closure/Post Closure Plan, and Operations Plan, are addressed elsewhere in the permit application. This document also includes a certified Water Quality Monitoring Plan (WQMP) and Landfill Gas Monitoring Plan in accordance with Rule .0544. Current development plans for the site will observe the buffer requirements in accordance with 15A NCAC13B .0540.

A regional topographic map showing the 2-mile radius around the facility is provided as **Figure 1**. **Figure 2** presents the local conditions with a 2000 foot radius.

1.3 Site and facility description

1.3.1 Location and Area Use

The Halifax C&D Landfill is located at 921 Liles Road in Littleton, North Carolina, approximately twelve miles south of Roanoke Rapids, NC and one mile north of

the intersection of NC 48 and SR 1001 at Aurelian Springs, in the Butterwood Township. The permitted facility is bound on the north by SR 1417 and in all other directions by private property. The surrounding land is currently mixed forest and agricultural. The closest residence is approximately 1800 feet from the proposed C&D landfill (Area 2). The site topography for the northern portion of the site is on the Thelma U.S.G.S topographic map and the southern portion of the site is on the Aurelian Springs U.S.G.S topographic map. **Figure 3** shows an aerial photograph of the site and surrounding area. An Area 2 site map is included as **Figure 4**.

The land area for the proposed Area 2 is currently undeveloped. The surrounding area is undeveloped property and agricultural. There is no residential or commercial/industrial development in the vicinity. Most development is located along the main roads. Public road haul routes are shown on **Figure 1**.

An on-site easement for a North Carolina Power Company overhead power line runs along SR 1417 at the north end of the site. No other utilities or easements are known within the property boundary.

2.0 GEOLOGY AND GROUNDWATER CHARACTERISTICS

2.1 Surface Topography and Drainage

The site is located in the Eastern Piedmont Province of North Carolina in the Tar-Pamlico drainage basin. The existing topography, including the closed MSW and active C&D landfills, ranges from 220 to 360 feet above mean sea level (amsl).

The uppermost aquifer is clayey silt and silty clay. Groundwater occurs from approximately 10 to 40 feet bgs. Brewers Creek runs along the western property boundary, with one of its tributaries bisecting the facility. Locally, groundwater from the C&D Area 1 and proposed Area 2, flows northwest toward an unnamed tributary of Brewers Creek.

2.2 Site Investigation Methodology

The approximately ±6 acre Area 2 area was investigated utilizing 16 historic soil borings, advanced to depths up to 50 feet bgs. Investigation locations were based on topographical and geologic features, access and existing site knowledge. BP-1 through BP-6 were advanced December 1995. BP-7 through BP-14 were advanced in April 1997. GY-1, GY-2, GY-3, MW-15 and MW-15R were installed 1994. Field work was performed under the supervision of a North Carolina licensed geologist. To provide a comprehensive subsurface representation, boring logs and information from past investigations are included in **Appendix A**. **Figure 4** illustrates boring locations.

Most borings were sampled using the standard penetration test (ASTM D1586). Representative split spoon samples, undisturbed (Shelby tube) samples and bulk soil samples from the auger cuttings were procured for laboratory testing. Laboratory testing was performed in accordance with appropriate ASTM test procedures. Geotechnical laboratory data is included in **Appendix B**.

Groundwater levels were measured in select piezometers from January 1996 until January 1998, from September 2005 until August 2009 and in February 2011 and September 2012.

2.3 Soil Characteristics

According to the USDA web soil survey[1], soils within Area 2 are generally classified as Wedowee Sandy Loam with some Loamy Udorthents and Pacolte Sandy Loam. The Wedowee Sandy Loam is a well drained soil with a very moderately high to high capacity to transmit water; slopes range from two to ten percent. The Pacolet Sandy Loam and

[1] Web Soil Survey, US Dept. of Agriculture, Natural Resource Conservation Service. http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm

Loamy Udorthents are also well drained soils with capacity to transmit water that ranges from moderately high to high; slopes range from zero to six percent.

The site stratigraphy is based more on the in-situ weathering patterns than actual depositional units. The upper soils are stiff, reddish-orange clayey silt and silty clay, extending to depths of 10 to 15 feet bgs. These soils are moist and often exhibit mottling. Occasional dark brown iron and/or manganese staining along joint surfaces, noted in the boring logs, provide evidence of water movement through the soils.

The upper soils are underlain by a pink-white and gray sandy silt that exhibits relic texture derived from the parent bedrock (saprolite), resembling the nearby granite outcrops. These soils grade with depth to a coarse-grained silty sand, often containing angular quartz or feldspar gravel and mica. Weathered soil and saprolite eventually transition into weathered rock and bedrock. The test borings and piezometers used for this design study were constructed in upper soils with SPT values less than 100 blows per foot (bpf).

2.4 Regional and Site Geology

2.4.1 Regional Geologic Characteristics

Geologic mapping[2] indicate that the proposed C&D landfill site situated on the eastern edge of the Eastern Piedmont Physiographic Province, just west of the Coastal Plain overlap. Western Halifax County is underlain by early to late Paleozoic age, felsic to intermediate crystalline igneous and metamorphic rocks.

Eastern Piedmont[3] rocks exhibit a northeast strike and gently dip eastward resulting from regional metamorphism and folding that produced a broad plunging anticline. The area was simultaneously intruded by a number of felsic (granite) plutons. The rock formation underlying the subject site is a granitic pluton, identified as the Butterwood Creek intrusive.

A few miles east of the site, the crystalline Piedmont rocks plunge beneath unconsolidated fluvial and deep-marine Coastal Plain[4] deposits. During the late Tertiary, portions of the eastern Piedmont were over washed by deltaic streams and shallow seas, resulting in a thin clayey sand and rounded quartz gravel veneer still visible along the site uplands. The deeper soils are chiefly in-situ weathering products of granitic origin.

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[2] Generalized Geologic Map of North Carolina, 1991.

[3] Maher, Harmon D. Jr,, Sacks, Paul E, and Secor, Donald T. Jr. The Eastern Piedmont in North Carolina, Geology of the Carolinas, Horton and Zullo, University of Tennessee Press, p79.

[4] Sohl, Norman F, and Owens, James P. Cretaceous Stratigraphy of the Coastal Plain, The Geology of the Carolinas, Horton and Zullo, University of Tennessee Press, 1991, p191.

Primary lineaments observed in area topographic mapping are defined by the northeast-southwest orientation of Bear Swamp and the main ridge occupied by SR 1417. This northwest-southeast orientation aligns with the regional strike of mapped geologic formations. Secondary topographic lineaments noted throughout the region include sub-parallel ridges and north-south oriented drainage features. These secondary features align with prominent topographic features within the study area and are believed to reflect regional jointing.

Granite outcrops were observed along the creek bottom north of the study area, south of the ash monofill site. The granite exhibits a coarse porphyritic texture, with one- to two-inch diameter potassic feldspar crystals embedded in a fine matrix of feldspar, quartz, mica and accessory minerals. The outcrops exhibit surficial exfoliation (near horizontal convex fracturing) and differential weathering along widely spaced, steeply dipping joint sets, resulting in rounded surface exposures. The joint surfaces are generally too weathered to obtain reliable strike and dip measurements. No rock outcrops were observed in the planned C&D landfill Area 2 footprint; nor was bedrock encountered during drilling which extended to a maximum depth of 50 feet bgs.

2.4.2 Site Geologic Characteristics

A test boring investigation for the C&D Area 2 site was performed. Test borings BP-1 through BP-6 were installed in December 1995. Test borings BP-7 through BP-14 extending to depths of 6 to 50 feet, were installed in April-May 1997. Test boring elevations and construction details are summarized on **Table 1**. **Figure 4** illustrates test borings and ground water level observation point locations.

All but three BP- series borings (BP-1, BP-2 and BP-5) were converted to piezometers for long-term ground water level observation. Three earlier piezometers, GY-1 through GY-3, and three ground water monitoring wells, MW-11, MW-15 and MW-15A provide supplemental hydrogeologic data. There are 16 ground water piezometers within and near the proposed C&D Area 2 footprint.

The soils in the upper 10 feet are generally classified as low to medium plasticity clayey and/or sandy silt (ML) and high plasticity silt (MH) with occasional silty sand (SM). The borings generally did not encounter bedrock or partially weathered rock. The deeper soils are more granular and exhibit a relic rock-like texture, generally classified as coarse silty sand (SM). Test boring BP-1 encountered partially weathered rock and auger refusal on bedrock at 36 feet bgs.

2.4.3 Laboratory Analyses

The soil test borings were sampled with standard penetration test techniques (ASTM D-1586). Soil samples were visually classified by an experienced soils

technician and laboratory testing was performed on representative samples to confirm the field classifications.

Shelby tube samples were obtained from within the facility boundary during the site study for the lined MSWLF unit. The samples were tested for triaxial permeability. Permeability values ranged from 10^{-5} to 10^{-6} cm/sec. Visual observation and laboratory classification indicate these samples are representative of the soils within the planned Area 2 C&D site. Density, moisture and porosity were also analyzed.

Representative bulk samples were procured from the upper 20 feet of soils in the C&D Phase 2 study area. Remolded samples were subjected to laboratory triaxial permeability tests and had values in the range of 10^{-7} to 10^{-8} cm/sec. These bulk samples are considered representative of shallower site soils.

Laboratory testing results are presented on **Table 2**. Test boring logs are presented in **Appendix A** with geotechnical laboratory data in **Appendix B**.

2.5 Site Hydrogeology

2.5.1 General

Ground water conditions have been characterized using 16 temporary and permanent wells located in and around the C&D Area 2 footprint. The uppermost, unconfined aquifer is located at an approximate elevation of 210 feet to 275 feet amsl; determined using the approximate bedrock depth[5] and the average water level as the upper and lower boundaries. The resulting aquifer thickness for Phase 2 ranges between 60 to 90 feet. **Table 3** presents groundwater elevation data over time.

Generally, groundwater flows through the unconsolidated sediments northwest toward an unnamed tributary of Brewers Creek. These fine-grained sediments yield moderate hydraulic conductivities and groundwater flow rates.

2.5.2 Aquifer Slug Testing and Analysis

Aquifer slug tests have been performed on piezometers in and around Area 2. Data from these aquifer tests were analyzed using the Bouwer and Rice (1976) method. The Bouwer and Rice (1976) method (as modified by Bouwer, 1989) was developed for partially penetrating wells in an unconfined (or semi-confined) aquifer. Hydraulic conductivity (**K**) is determined using the following equation:

[5] Corrective Action Plan, March 29, 2009, Richardson Smith Gardner and Associates, Inc. Figure 4.

$$K = \frac{r_c^2 \ \ln \frac{r_e}{r_w} \ln \frac{Y_o}{Y_t}}{2\ L\ t}$$

Where:

L = the screened interval length
Y_o = the initial rise in water level from the introduction of the slug
r_e = the effective radius through which **Y_o** is dissipated
r_w = the horizontal distance from the well center to the aquifer
r_c = the well casing radius of the well casing and **t** is time.

The variable, **Y_o,** is determined from semi-logarithmic plots of drawdown versus time. The variable, **Y_t**, is the drawdown (recovery) at any specific time **t**. The variable, **$\ln(r_e/r_w)$**, is determined using the following equation:

$$\ln \frac{r_e}{r_w} = \frac{1}{\frac{1.1}{\ln\left(\frac{H}{r_w}\right)} + \frac{A + B \ln \frac{D-H}{r_w}}{\frac{L}{r_w}}}$$

Where:

D = total aquifer thickness
H = the portion of the aquifer tapped by the well
A and **B** = constants derived from curves relating coefficients
A and **B** to **L/r_w** (Bouwer and Rice, 1976).

A total aquifer thickness (**D**) for the water-table aquifer was estimated to be between 60 and 90 feet based on historic groundwater measurements and varying bedrock depths and weathering characteristics.

The aquifer slug test data and calculated hydraulic conductivities are included in **Appendix C**.

Hydraulic conductivities for the study area ranged from 3.56 x 10^{-4} cm/sec to 6.76 x 10^{-4} cm/sec and averaged 4.62 x 10^{-4}. Conductivity and groundwater velocity data is summarized in **Table 4**.

2.5.3 Potentiometric Surface and Ground Water Gradients

The potentiometric surface reflects a subdued expression of the surface topography, which is typical of the Piedmont, and indicates a generally northwest ground water flow pattern, toward the unnamed tributary. Based on test boring data, the uppermost aquifer varies from 60 to 90 feet in thickness, measured between the historic upper saturation point (water table) and the estimated competent bedrock depth below ground surface (bgs). There are no obvious

confining layers and PWR or bedrock were not encountered in the test borings. Bedrock depth was estimated from the Corrective Action Plan cross-sections created for the C&D over closed MSW. Observed composite high water levels (**Table 3**) vary from depths of 1 foot bgs within the low lying drainage features to 45 feet (or more) bgs at the higher study area elevations.

Based on groundwater data, high ground water levels primarily occur in April or May. Low ground water levels have generally occurred in September or November but have been reported throughout the year at various well locations. A ground water potentiometric surface map prepared from September 2012 piezometer and monitoring well data is presented as **Figure 5**.

The potentiometric data (**Table 3**) and aquifer "slug" testing data (**Appendix C**) are suitable to identify recharge and discharge zones, determine flow directions and gradients, and estimate ground water flow velocities. Calculated horizontal ground water gradients for Area 2 (units are ft/ft) vary from 0.023 in BP-1 to 1.12 in BP-7 with an average of 0.059.

Ground water velocities were calculated using slug test data by the equation:

$$V = Ki/n$$

Where:
V = Ground Water Velocity
K = Hydraulic Conductivity (from rising head tests)
i = Hydraulic Gradient (from water table elevations)
n = Porosity (based on referenced values).

A calculated ground water velocity and gradient summary is provided as **Table 4**. Ground water velocities range from 0.03 ft/day in BP-1 to 12.70 ft/day in BP-7 with an average of 3.58 ft/day.

2.5.4 Ground Water Recharge/Discharge

Site conditions are typical of a piedmont terrane with recharge occurring over most of the site from the non-saturated surface soils with some downward recharge into the deeper, bedrock fractures. Discharge occurs to the north/northwest along the perennial unnamed tributary of Brewers Creek.

In general, groundwater recharge occurs outside the C&D Area 2 footprint, in the southeastern portion of the facility. Groundwater discharge occurs in the unnamed tributary north and northwest of the landfill units.

The uppermost aquifer for Area 2 appears to exhibit lateral flow with potentiometric surfaces that reflect a subdued expression of the surface topography.

2.5.5 Potential Natural or Man-Made Influences on Ground Water Levels

Potential natural influences on long-term water table fluctuations include existing low-yield sediments and rocks located within the Area 2 footprint. The landfill facility would constitute a man-made influence on water table fluctuation; and the reduced stormwater infiltration in the landfill footprint will potentially reduce water table elevations over time.

2.5.6 Long Term and Short Term Seasonal High Ground Water Trends

Ground water is influenced through rainfall, evapotranspiration, surface run-off and infiltration. Historical rainfall data from 1972 - 2012 indicate that highest cumulative rainfall amounts typically occur in July through September. Peak rainfall amounts typically occur during the summer months; however, these are also times of elevated evapotranspiration. **Table 4** and the associated hydrograph, present a precipitation study for the area.

Table 3 indicates ground water elevations across the site are relatively stable. Select piezometers were monitored from January 1996 until January 1998, from September 2005 until August 2009 and in February 2011 and September 2012. Piezometer data indicates the highest water levels were generally found in the spring, from March to May.

Using composite high water level measurements from the historic piezometers, a long term-seasonal high water level map was constructed (**Figure 6**). The potentiometric surface, water level data and flow directions are consistent over the course of this investigation.

2.5.7 Aquifer Characteristic Summary

Stratigraphy shown on the hydrogeologic cross-sections (**Figures 7A and 7B**) and described in the test boring records (**Appendix A**) indicates the uppermost aquifer for Area 2 is generally unconfined, stiff, unconsolidated clayey silt and silty clays.

The single-day potentiometric map (**Figure 5**) and the Long-Term Composite High Potentiometric Surface Map (**Figure 6**) indicate groundwater flows generally to the west and northwest. The upgradient portion of the site is located to the southeast of proposed Area 2. Groundwater discharges to the perennial unnamed tributaries of Bear Swamp Creek.

The information presented in this section has been used to prepare both the Water Quality Monitoring Plan (**Attachment I**) and the Landfill Gas Monitoring Plan (**Attachment J**) for the site.

3.0 WATER QUALITY MONITORING PLAN

The water quality monitoring system is designed to effectively detect a hazardous constituent release into the uppermost aquifer. The Water Quality Monitoring Plan (WQMP) is included as **Attachment I** to this report. This section summarizes that proposed plan.

Three groundwater monitoring wells (CDMW-1, CDMW-2 and CDMW-3) and two surface water monitoring locations (CDSW-1and CDSW-2) are proposed. Monitoring network details incorporated into the Water Quality Monitoring Plan are presented in **Attachment I**.

In summary, the following actions are proposed for the Area 2 C&D water quality monitoring plan.

1. Properly abandon piezometers in the C&D Area 2 footprint. (BP-8, BP-9, BP-10, BP-11, BP-12 & GY-2).
2. Utilize BP-7 as up-gradient monitoring well CDMW-1
3. Advance two new monitoring locations, CDMW-2 and CDMW-3 into the monitoring plan.
4. Maintain MW-11, BP-3, BP-4, BP-6 and BP-13 for water level monitoring only.
5. Properly abandon GY-1, GY-3 and BP-14 due to dry or invalid water level data.
6. Monitor C&D Phase 2 monitoring wells semi-annually in conjunction with other Halifax County Water Quality Monitoring.
7. Add surface water monitoring location CDSW-1.

4.0 LANDFILL GAS MONITORING PLAN

The landfill gas monitoring system is designed to effectively detect potential landfill gas migration in the subsurface. The Landfill Gas Monitoring Plan is included as **Attachment J** to this report. This section summarizes that proposed plan.

The existing landfill gas network monitors the closed MSW and active Phase 1 C&D landfill. Two landfill gas monitoring wells GM-6 and GM-7 will be installed to monitor for landfill gas from the Phase 2 C&D landfill. The Landfill Gas Monitoring Plan showing existing and proposed landfill gas monitoring wells is presented in **Attachment J**.

The following actions are proposed for landfill gas monitoring at the site:

1. Continue monitoring the existing system around the closed MSW and Phase 1 C&D.
2. Install landfill gas monitoring wells near the property line east and south of the Phase 2 C&D unit.
3. Perform quarterly monitoring.

Due to the stream located north of the landfill, as well as the animal waste and borrow areas between the two landfill units, additional landfill gas wells are not deemed necessary in these areas. Further discussion regarding the rationale for the landfill gas monitoring network is included in the landfill gas plan. This plan meets the requirements of the November 2010 NCDENR Landfill Gas Monitoring Guidance Document and 15A NCAC 13B .0544 (d).

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FIGURES

Design Hydrogeologic Report
Halifax County C&D Landfill – Area 2
Halifax County, North Carolina

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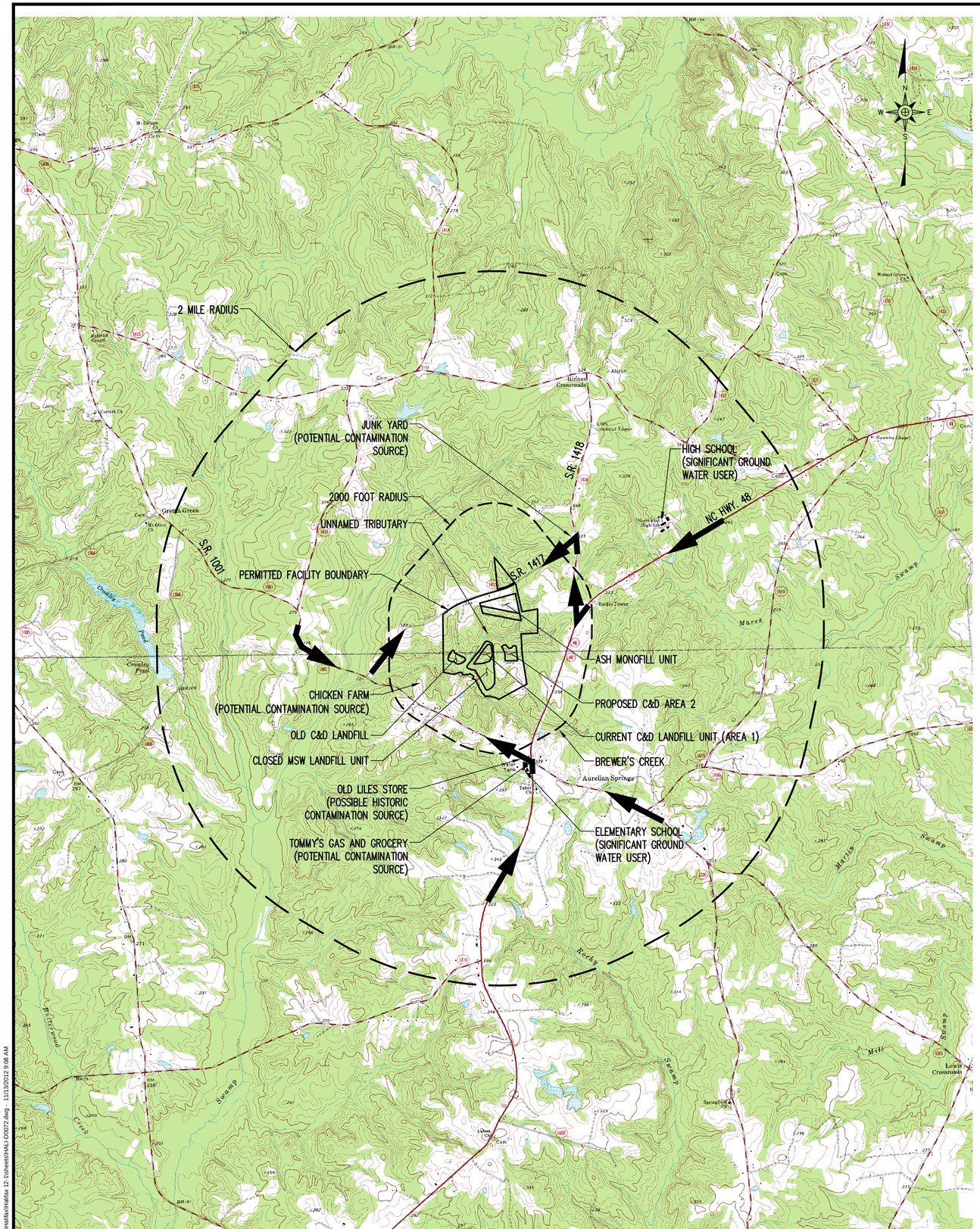

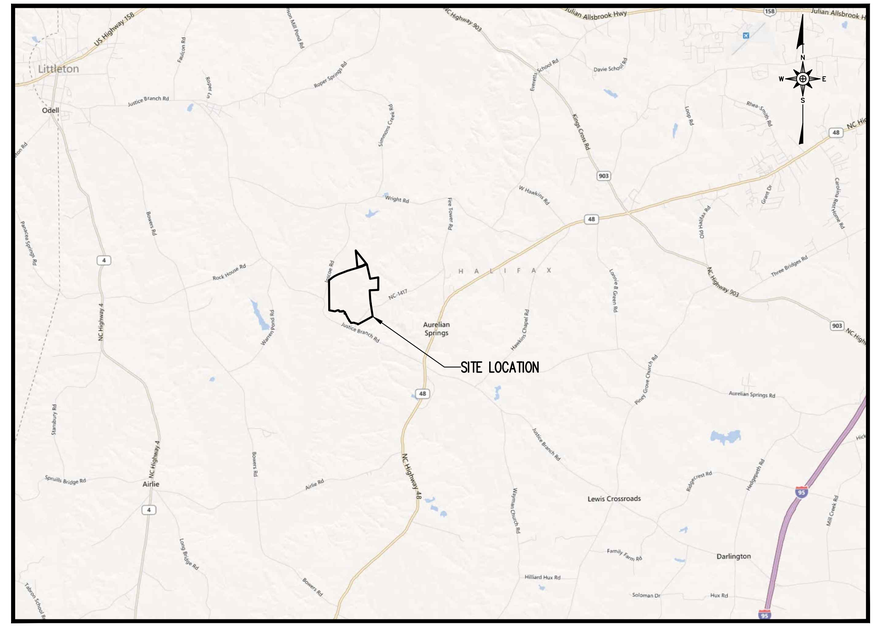

SITE LOCATION MAP
NOT TO SCALE

LEGEND

- 2 MILE RADIUS
- 2000 FOOT RADIUS
- PROPERTY LINE
- WASTE TRANSPORTATION ROUTE (TYP.)

NOTES

1. NO PUBLIC WATER SUPPLY WELLS OR SURFACE WATER INTAKES EXIST WITHIN 2 MILES OF THE PERMITTED FACILITY BOUNDARY.
2. NO RESIDENTIAL SUBDIVISIONS EXIST WITHIN 2 MILES OF THE PERMITTED FACILITY BOUNDARY.
3. NO PUBLIC USE AIRPORTS EXIST WITHIN 2 MILES OF THE PERMITTED FACILITY BOUNDARY.
4. DISTANCES IN STATUTE MILES.

REFERENCES

1. TOPOGRAPHY REFERENCES U.S.G.S. 7.5 MIN. QUADRANGLES "THELMA, NC", DATED 1973, AND "AURELIAN SPRINGS, NC", DATED 1973.

0 2000' 4000' 6000'

PREPARED FOR:

DEPARTMENT OF PUBLIC WORKS

PREPARED BY:

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PROJECT TITLE:

HALIFAX COUNTY, NORTH CAROLINA
C&D LANDFILL - AREA 2
DESIGN HYDROGEOLOGIC REPORT

DRAWING TITLE:

REGIONAL CHARECTERIZATION MAP WITH 2-MILE RADIUS

DESIGNED: JAS	PROJECT NO: HALIFAX 12-1
DRAWN: JAL	SCALE: AS SHOWN
APPROVED:	DATE: OCT. 2012
FILENAME: HALI-D0072	
SHEET NUMBER:	DRAWING NUMBER: FIG 1

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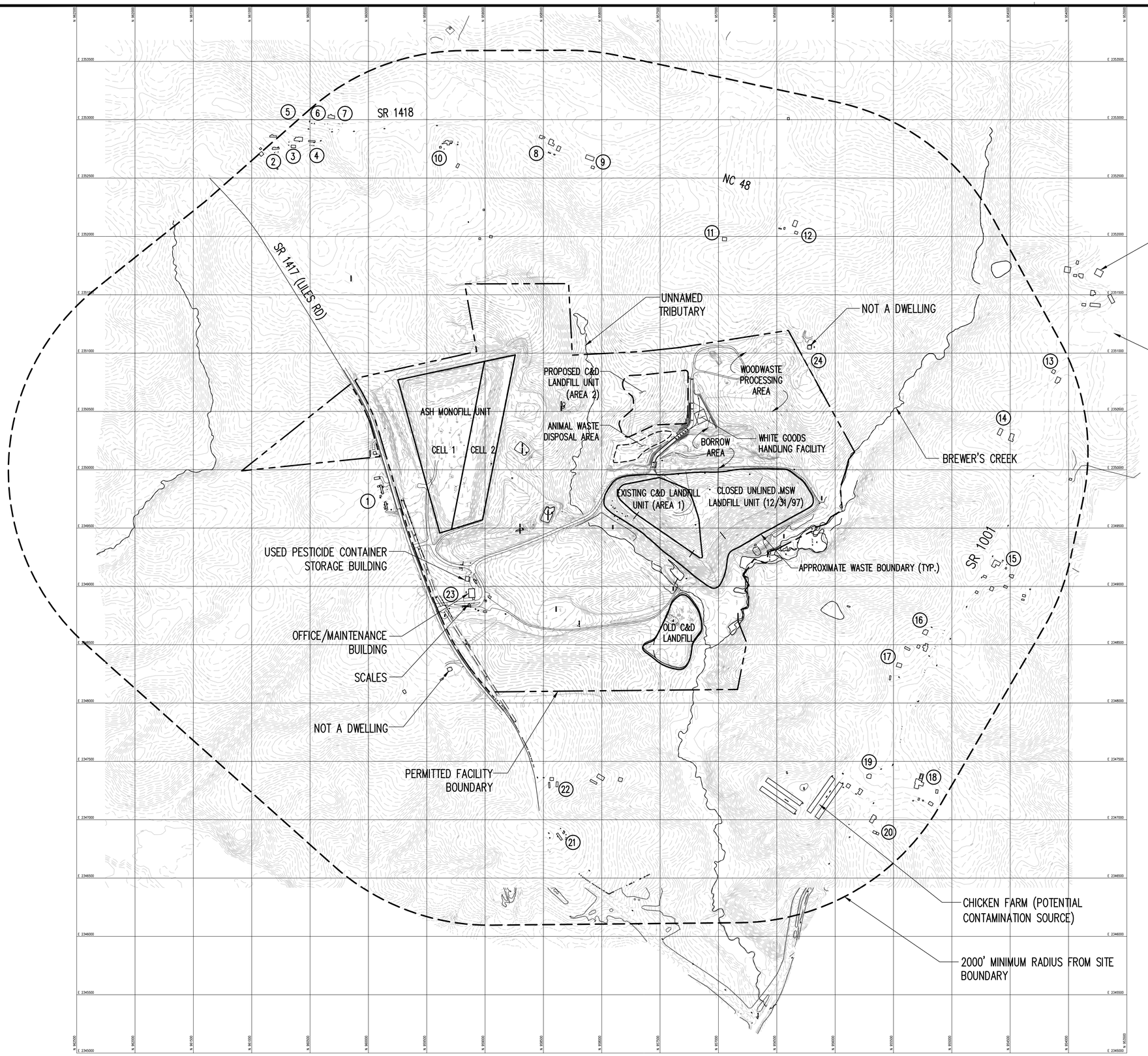

POTABLE WELL SURVEY		
REF. NO.	OWNER NAME	STRUCTURAL TYPE
1	LUG, LEONARD	RESIDENCE
2	ALSTON, JR.	RESIDENCE
3	JONES, TOMMY	RESIDENCE
4	ALSTON, MARCHELL	RESIDENCE
5	HAWKINS, RONALD	RESIDENCE
6	DAVIS, ODELIA	RESIDENCE
7	DAVIS, JIMMY	RESIDENCE
8	WARREN, HARRY	RESIDENCE
9	JOHNSTON, MICHAEL	RESIDENCE
10	BUTTS, ALLEN	RESIDENCE
11	WARREN, CHRIS	RESIDENCE
12	UNKNOWN	RESIDENCE
13	DUKE, FRED, JR.	RESIDENCE
14	DUKE, FRED, SR.	RESIDENCE
15	MAYO, BILLY	RESIDENCE
16	LANCASTER, SANKEY	RESIDENCE
17	UNKNOWN	RESIDENCE
18	UNKNOWN	RESIDENCE
19	BUTTS, JESSIE	RESIDENCE
20	UNKNOWN	RESIDENCE
21	UNKNOWN	RESIDENCE
22	UNKNOWN	RESIDENCE
23	HALIFAX COUNTY	LANDFILL
24	HAWKINS	FORMER RESIDENCE

BASED ON WATER WELL SURVEYS CONDUCTED IN 1991 & 1994

LEGEND

- 200 — EXISTING 10' CONTOUR
- EXISTING 2' CONTOUR
- 2000 FOOT RADIUS
- PROPERTY LINE
- (18) POTABLE WELL (APPROXIMATE)

NOTES

1. THE PROPERTY IS ZONED AGRICULTURAL/RESIDENTIAL.
2. NO COMMERCIAL/INDUSTRIAL BUILDINGS OR HISTORIC SITES EXIST WITHIN A 2000 FOOT RADIUS OF THE SITE.
3. NO PORTIONS OF THE SITE EXIST WITHIN A 100 YEAR FLOODPLAIN, PER FIRM MAPPING.
4. THERE ARE NO UNDERGROUND UTILITIES WITHIN THE FACILITY.
5. THERE ARE NO PUBLIC WATER SUPPLY SURFACE INTAKES WITHIN 2000 FEET OF THE SITE.

REFERENCES

1. OVERALL SITE TOPOGRAPHY PROVIDED BY GEODATA CORPORATION, ZEBULON, NC, BASED ON MAY 25, 2012 AERIAL PHOTOGRAPHY. AND NCDOT GIS DEPARTMENT DATA RELEASE MARCH 2005. TOPOGRAPHY IN OUTLYING AREAS PROVIDED BY PIEDMONT AERIAL SERVICES BASED ON FEBRUARY 1994 AERIAL PHOTOGRAPHY.

0 400' 800' 1200'

PREPARED FOR:

DEPARTMENT OF PUBLIC WORKS

PREPARED BY:

NC LIC. NO. C-0828 (ENGINEERING)

SMITH+ GARDNER
ENGINEERS
14 N. Boylan Avenue, Raleigh NC 27603 | 919.828.0577

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PROJECT TITLE:

HALIFAX COUNTY, NORTH CAROLINA C&D LANDFILL - AREA 2 DESIGN HYDROGEOLOGIC REPORT

DRAWING TITLE:

LOCAL AREA MAP WITH 2000 FOOT RADIUS

DESIGNED: JAS	PROJECT NO: HALIFAX 12-1
DRAWN: JAL	SCALE: AS SHOWN
APPROVED:	DATE: OCT. 2012
FILENAME: HALI-D0212	
SHEET NUMBER:	DRAWING NUMBER: FIG. 2

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LEGEND

- 2000 FOOT RADIUS
- PROPERTY LINE
- HOUSE NOT SHOWN IN PHOTO

NOTE

1. AREA LAND USE WITHIN RADIUS SURROUNDING THE LANDFILL FACILITY ZONED AS RURAL/AGRICULTURE.

REFERENCES

1. AERIAL PHOTOGRAPH PROVIDED BY BING MAPS, MICROSOFT CORP, DATE UNSPECIFIED.

0 400' 800' 1200'

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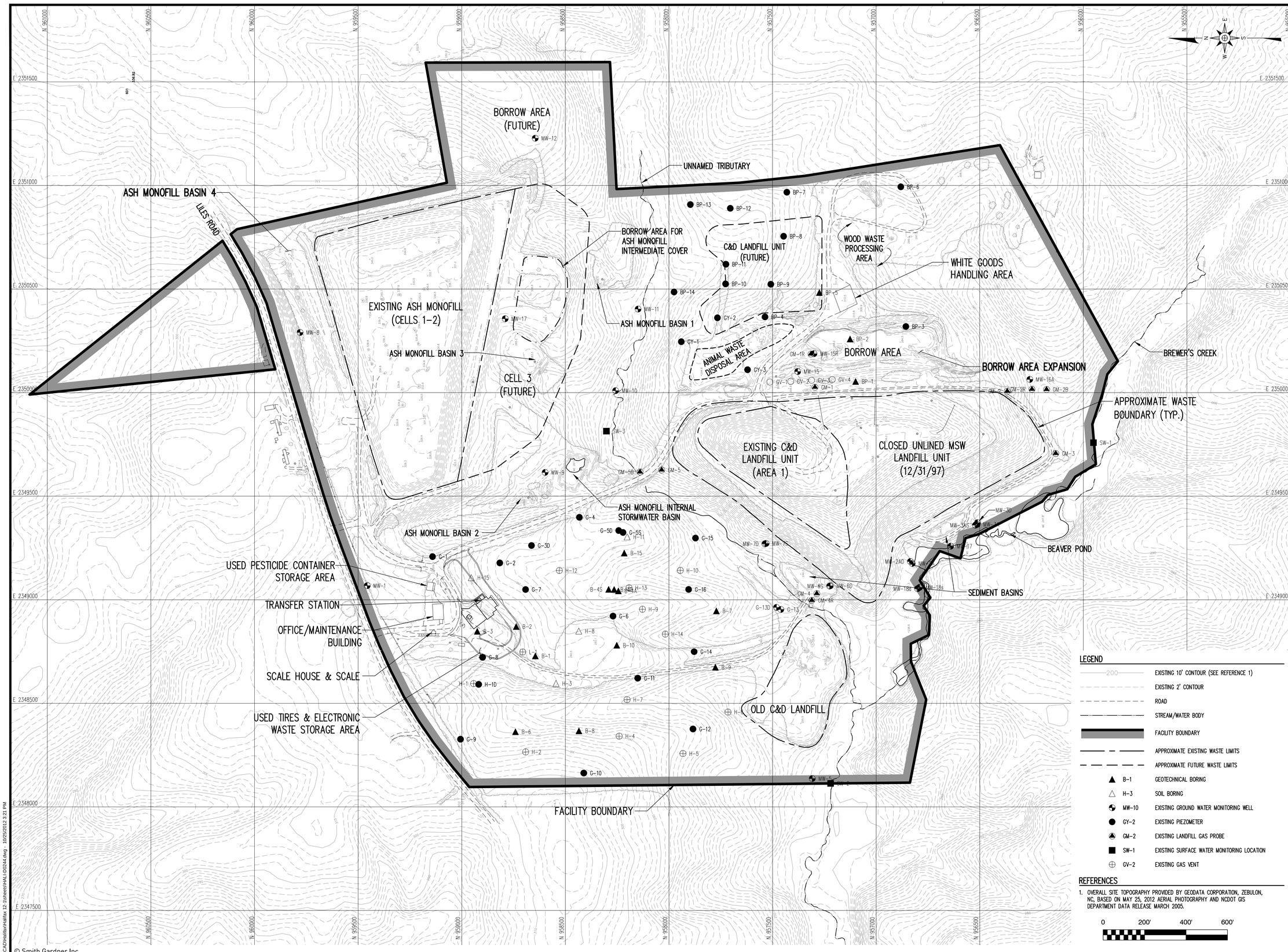
PROJECT TITLE:

HALIFAX COUNTY, NORTH CAROLINA C&D LANDFILL - AREA 2 DESIGN HYDROGEOLOGIC REPORT

DRAWING TITLE:

LOCAL AREA PHOTO

DESIGNED: JAS	PROJECT NO: HALIFAX 12-1
DRAWN: JAL	SCALE: AS SHOWN
APPROVED:	DATE: OCT. 2012
FILENAME: HALI-D0075	
SHEET NUMBER:	DRAWING NUMBER: FIG. 3



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HALIFAX COUNTY
NORTH CAROLINA
DEPARTMENT OF
PUBLIC UTILITIES

PREPARED BY:

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LEGEND

- 200 — EXISTING 10' CONTOUR (SEE REFERENCE 1)
- EXISTING 2' CONTOUR
- ROAD
- STREAM/WATER BODY
- FACILITY BOUNDARY
- APPROXIMATE EXISTING WASTE LIMITS
- APPROXIMATE FUTURE WASTE LIMITS
- B-1 — GEOTECHNICAL BORING
- H-3 — SOIL BORING
- MW-10 — EXISTING GROUND WATER MONITORING WELL
- GY-2 — EXISTING PIEZOMETER
- GM-2 — EXISTING LANDFILL GAS PROBE
- SW-1 — EXISTING SURFACE WATER MONITORING LOCATION
- GV-2 — EXISTING GAS VENT

REFERENCES

1. OVERALL SITE TOPOGRAPHY PROVIDED BY GEODATA CORPORATION, ZEBULON, NC, BASED ON MAY 25, 2012 AERIAL PHOTOGRAPHY AND NCDOT GIS DEPARTMENT DATA RELEASE MARCH 2005.

0 200' 400' 600'

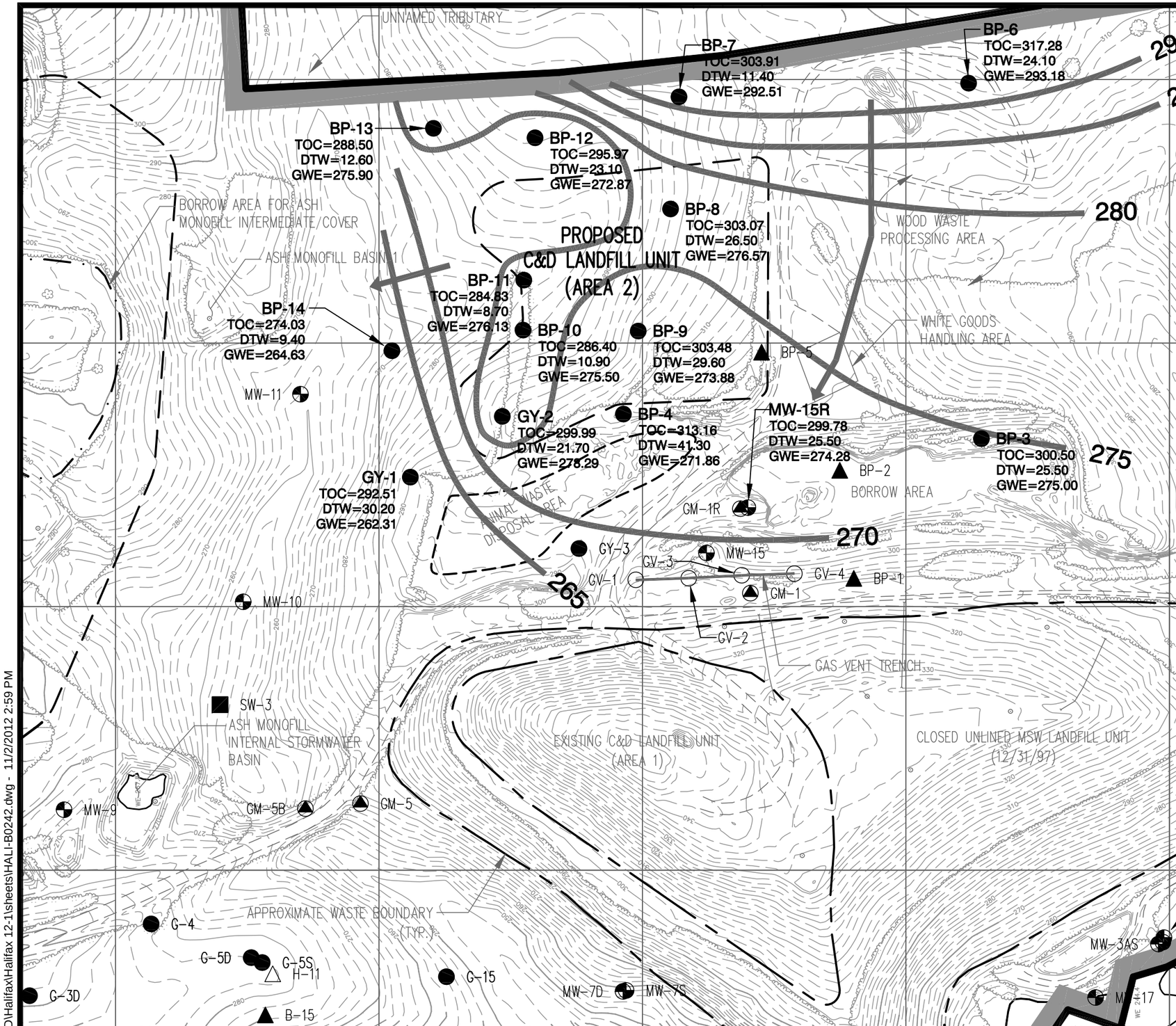
PROJECT TITLE:

HALIFAX COUNTY
C&D LANDFILL
AREA 2
DESIGN HYDROGEOLOGIC REPORT

DRAWING TITLE:

SITE MAP

DESIGNED: JAS	PROJECT NO: HALIFAX 12-1
DRAWN: JAL	SCALE:
APPROVED:	DATE: OCT. 2012
FILENAME: HALI-D0244	
SHEET NUMBER:	DRAWING NUMBER: FIG 4



LEGEND

200	EXISTING 10' CONTOUR (SEE REFERENCE 1)
	EXISTING 2' CONTOUR
	ROAD
	STREAM/WATER BODY
	FACILITY BOUNDARY
	APPROXIMATE EXISTING WASTE LIMITS
	APPROXIMATE FUTURE WASTE LIMITS
	GROUNDWATER CONTOUR
B-1	GEOTECHNICAL BORING
H-3	SOIL BORING
MW-10	EXISTING GROUND WATER MONITORING WELL
GY-2 TOC=299.99 DTW=21.70 GWE=278.29	EXISTING PIEZOMETER TOC=TOP OF CASING DWT=DEPTH TO WATER (BELOW TOC) GWE=GROUND WATER ELEVATION
GM-2	EXISTING LANDFILL GAS PROBE
SW-1	EXISTING SURFACE WATER MONITORING LOCATION
GV-2	EXISTING GAS VENT
	GROUND WATER FLOW DIRECTION

REFERENCES

1. OVERALL SITE TOPOGRAPHY PROVIDED BY GEODATA CORPORATION, ZEBULON, NC, BASED ON MAY 25, 2012 AERIAL PHOTOGRAPHY.

0 200' 400'

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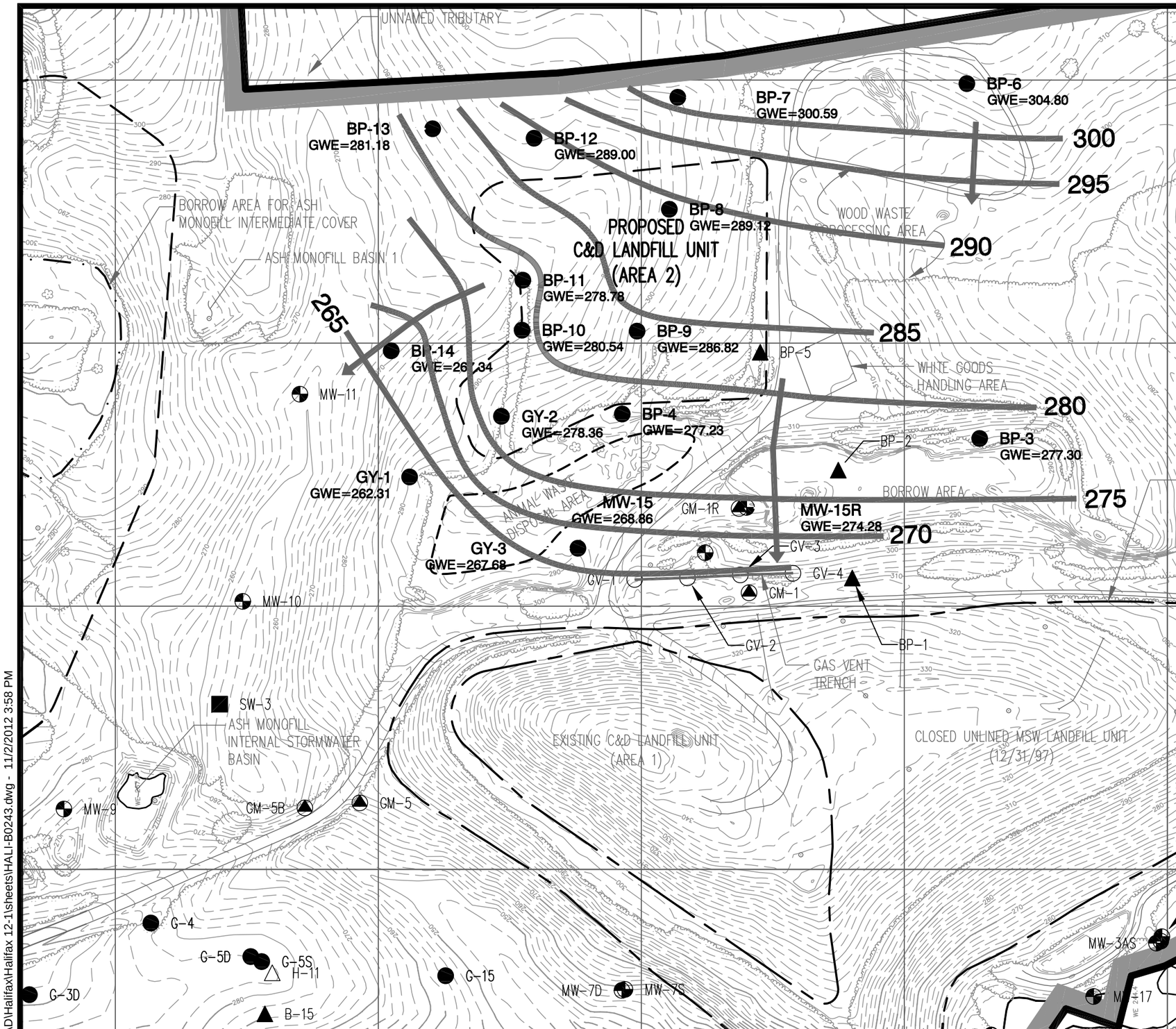
PREPARED BY:

FIGURE NO.	5
FILENAME:	HALI-B0242
SCALE:	AS SHOWN
PROJECT NO.	HALIFAX 12-1
APPROVED:	JAS
DRAWN:	JAL
DATE:	Nov 2012

PREPARED FOR:

HALIFAX COUNTY C&D LANDFILL AREA 2
DESIGN HYDROGEOLOGIC REPORT
POTENTIOMETRIC MAP
SEPTEMBER 2012



LEGEND

200	EXISTING 10' CONTOUR (SEE REFERENCE 1)
	EXISTING 2' CONTOUR
	ROAD
	STREAM/WATER BODY
	FACILITY BOUNDARY
	APPROXIMATE EXISTING WASTE LIMITS
	APPROXIMATE FUTURE WASTE LIMITS
	GROUNDWATER CONTOUR
▲ B-1	GEOTECHNICAL BORING
△ H-3	SOIL BORING
MW-10	EXISTING GROUND WATER MONITORING WELL
● GY-2 GWE=278.36	EXISTING PIEZOMETER GWE=GROUND WATER ELEVATION
GM-2	EXISTING LANDFILL GAS PROBE
■ SW-1	EXISTING SURFACE WATER MONITORING LOCATION
○ GV-2	EXISTING GAS VENT
	GROUND WATER FLOW DIRECTION

REFERENCES

1. OVERALL SITE TOPOGRAPHY PROVIDED BY GEODATA CORPORATION, ZEBULON, NC, BASED ON MAY 25, 2012 AERIAL PHOTOGRAPHY.

0 200' 400'

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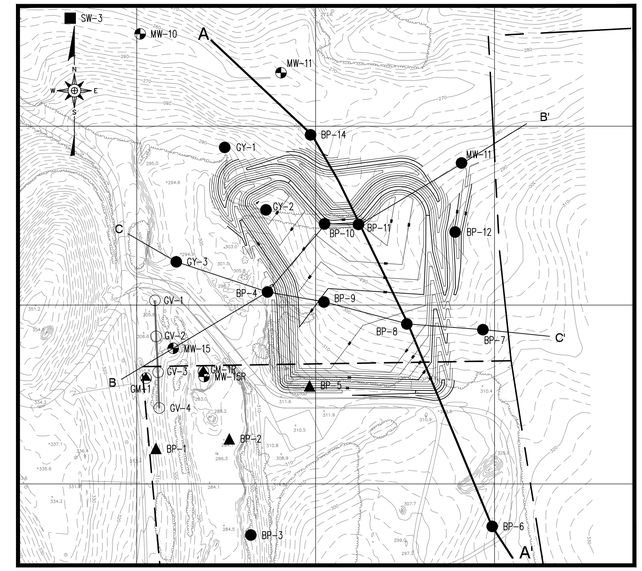
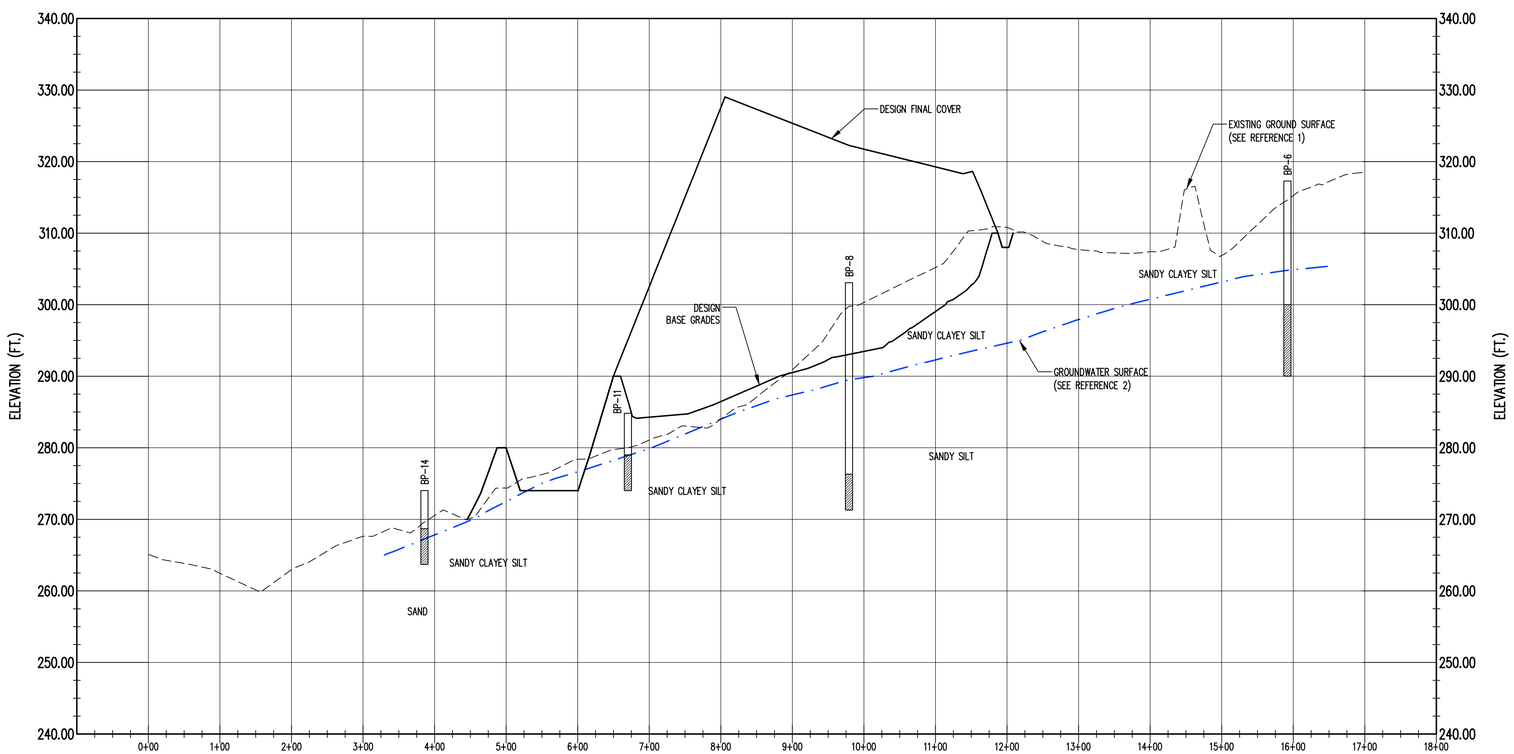
FIGURE NO.	6
SCALE:	AS SHOWN
FILENAME:	HALI-B0243
DRAWN:	JAL
APPROVED:	JAS
PROJECT NO.	HALIFAX 12-1
DATE:	Nov 2012

PREPARED FOR:

HALIFAX COUNTY C&D LANDFILL AREA 2
DESIGN HYDROGEOLOGIC REPORT
COMPOSITE HIGH
POTENTIOMETRIC SURFACE MAP



SECTION LOCATION MAP
NOT TO SCALE



SECTION A–A'
AS SHOWN
FIG7A

LEGEND

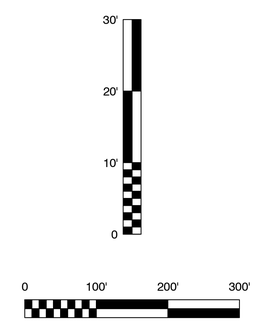
	EXISTING CONTOUR 10' INTERVAL (SEE REFERENCE 1)
	EXISTING CONTOUR 2' INTERVAL (SEE REFERENCE 1)
	PROPOSED 10' CONTOUR
	PROPOSED 2' CONTOUR
	FACILITY BOUNDARY
B-1	GEOTECHNICAL BORING
MW-10	EXISTING GROUND WATER MONITORING WELL
GY-2	EXISTING PIEZOMETER
GM-2	EXISTING LANDFILL GAS PROBE
SW-1	EXISTING SURFACE WATER MONITORING LOCATION
GV-2	EXISTING GAS VENT

SECTION LEGEND

	EXISTING GROUND SURFACE (SEE REFERENCE 1)
	DESIGN GRADES
	GROUNDWATER SURFACE (SEE REFERENCE 2)

REFERENCES

1. OVERALL SITE TOPOGRAPHY PROVIDED BY GEODATA CORPORATION, ZEBULON, NC, BASED ON MAY 25, 2012.
2. GROUNDWATER SURFACE FROM COMPOSITE HIGH POTENTIOMETRIC MAP (FIGURE 6).



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PREPARED BY:

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PROJECT TITLE:

HALIFAX COUNTY, NORTH CAROLINA
C&D LANDFILL - AREA 2
DESIGN HYDROGEOLOGIC REPORT

DRAWING TITLE:

CROSS SECTIONS
(SHEET 1 OF 2)

DESIGNED: JAS	PROJECT NO: HALIFAX 12-1
DRAWN: JAL	SCALE: AS SHOWN
APPROVED:	DATE: OCT. 2012
FILENAME: HALI-D0247	
SHEET NUMBER:	DRAWING NUMBER: FIG. 7A

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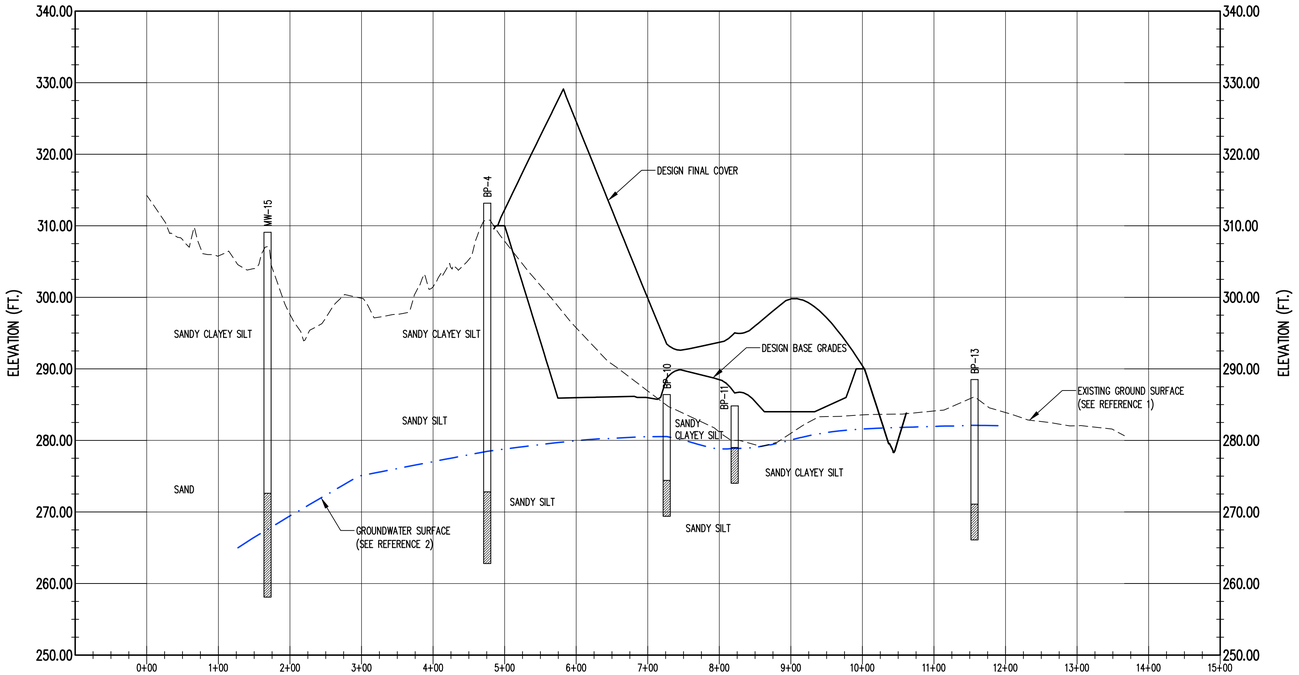
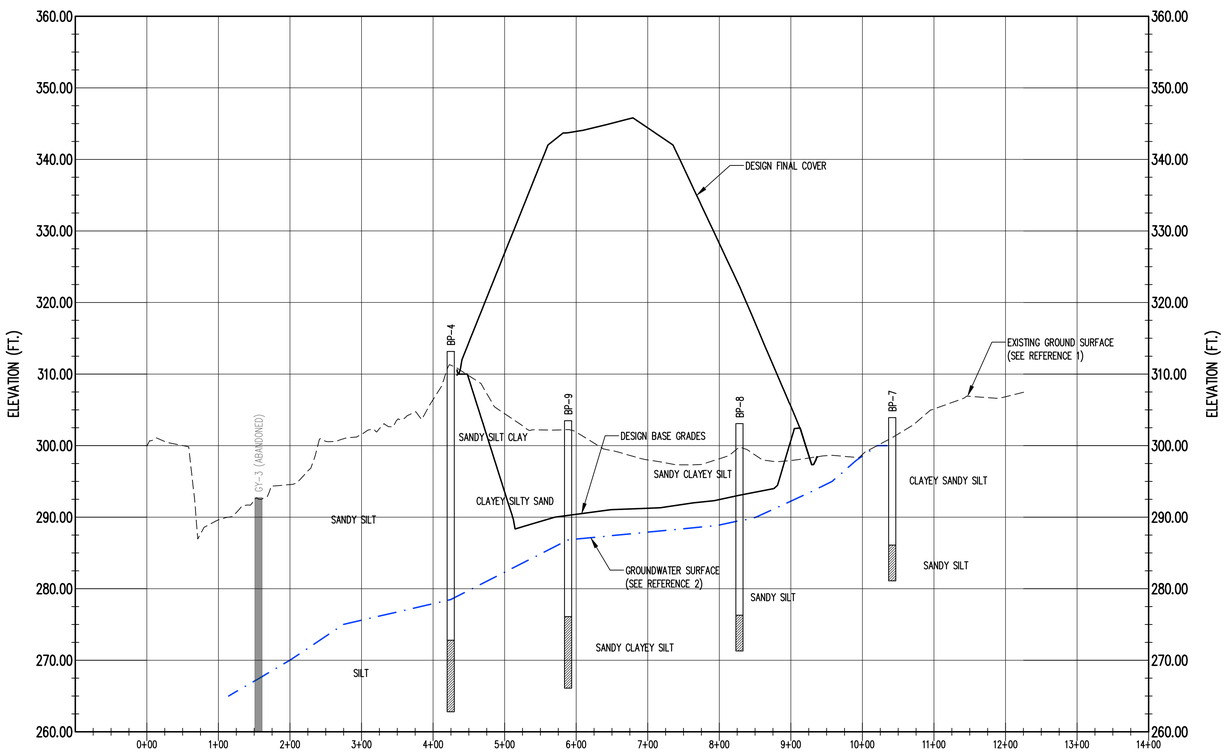
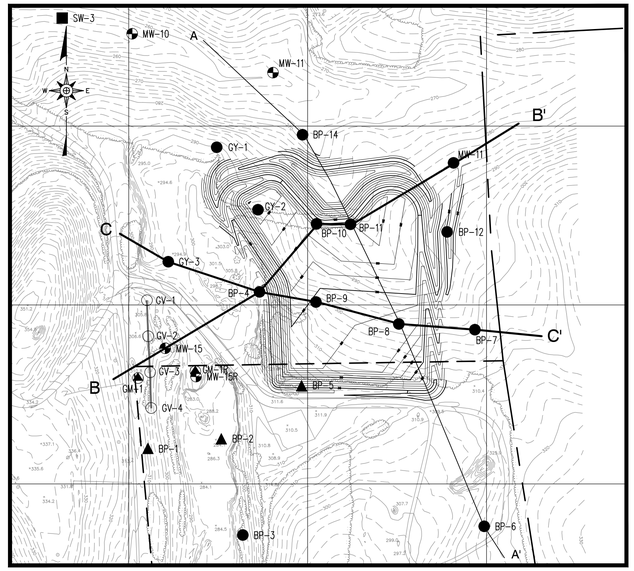


SECTION B-B' FIG7B
AS SHOWN



SECTION C-C' FIG7B
AS SHOWN



SECTION LOCATION MAP
NOT TO SCALE

LEGEND

	EXISTING CONTOUR 10' INTERVAL (SEE REFERENCE 1)
	EXISTING CONTOUR 2' INTERVAL (SEE REFERENCE 1)
	PROPOSED 10' CONTOUR
	PROPOSED 2' CONTOUR
	FACILITY BOUNDARY
B-1	GEOTECHNICAL BORING
MW-10	EXISTING GROUND WATER MONITORING WELL
GY-2	EXISTING PIEZOMETER
GM-2	EXISTING LANDFILL GAS PROBE
SW-1	EXISTING SURFACE WATER MONITORING LOCATION
GV-2	EXISTING GAS VENT

SECTION LEGEND

	EXISTING GROUND SURFACE (SEE REFERENCE 1)
	DESIGN GRADES
	GROUNDWATER SURFACE (SEE REFERENCE 2)

REFERENCES

1. OVERALL SITE TOPOGRAPHY PROVIDED BY GEODATA CORPORATION, ZEBULON, NC, BASED ON MAY 25, 2012.
2. GROUNDWATER SURFACE FROM COMPOSITE HIGH POTENTIOMETRIC MAP (FIGURE 6).

30' 20' 10' 0

0 100' 200' 300'

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PREPARED BY:

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SMITH+ GARDNER ENGINEERS

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PROJECT TITLE:

HALIFAX COUNTY, NORTH CAROLINA
C&D LANDFILL - AREA 2
DESIGN HYDROGEOLOGIC REPORT

DRAWING TITLE:

CROSS SECTIONS (SHEET 2 OF 2)

DESIGNED: JAS	PROJECT NO: HALIFAX 12-1
DRAWN: JAL	SCALE: AS SHOWN
APPROVED:	DATE: OCT. 2012
FILENAME: HALI-D0248	
SHEET NUMBER:	DRAWING NUMBER: FIG. 7B

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TABLES

Design Hydrogeologic Report
Halifax County C&D Landfill – Area 2
Halifax County, North Carolina

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Table 1
Test Boring Data and Piezometer Construction Details
Halifax County C&D Landfill - Phase 2

By: JAS
Date: 8/19/1997

Elevation Data				Geotechnical Data			Piezometer Construction Data			
Boring Number	Install Date	Ground Elevation	PVC Pipe Elevation	Boring Depth, ft	PWR Depth, ft.	Refusal Depth, ft.	Top of Sceen Depth, ft.	Top of Screen Elevation	Bot. of Screen Depth, ft.	Bottom of Screen Elevation
BP-3*	12/6/95	313.7	300.5	50	NE	NE	38	275.7	48	265.7
BP-4	12/6/95	310.8	313.16	48	NE	NE	38	272.8	48	262.8
BP-6	12/5/95	315	317.28	25	NE	NE	15	300.0	25	290.0
BP-7	4/29/97	301.1	303.91	20	NE	NE	15	286.1	20	281.1
BP-8	4/29/97	299.8	303.07	30	NE	NE	24	276.3	28.5	271.3
BP-9	4/28/97	302.1	303.48	36	NE	NE	26	276.1	36	266.1
BP-10	4/30/97	284.4	286.4	15	NE	NE	10	274.4	15	269.4
BP-11	5/1/97	280	284.83	6	NE	NE	1	279.0	6	274.0
BP-12	4/30/97	294.4	295.97	26	NE	NE	21	273.4	26	268.4
BP-13	4/30/97	286.1	288.5	20	NE	NE	15	271.1	20	266.1
BP-14	5/1/97	269.7	274.03	6	NE	NE	1	268.7	6	263.7
GY-1	--	291.2	292.51	30	NE	NE	--	--	--	--
GY-2	--	297.9	299.99	20	NE	NE	--	--	--	--
GY-3	--	304.2	304.2	50	NE	NE	--	--	--	--
MW-11	--	--	265.96	--	NE	NE	--	--	--	--
MW-15	9/21/94	307.1	309.09	20	NE	NE	35	272.6	49	258.1

Notes: 1. No data exists for GY series borings, advanced by others ca. 1994.

2. Boring record not located for MW-11, advanced by others ca. 1994.

3. No 7-day ground water levels were obtained

4. Piezometer BP-3 is located in an area where the ground has been excavated and the piezometer lowered. Hence the TOC elevation is currently lower than the original grade elevation.

5. NE= Not Encountered

SMITH+GARDNER

Table 2
Geotechincal Laboratory Data
Halifax County C&D Landfill - Phase 2

By: JAS
Date:8/19/1997

Sample Number	Sample Depth, ft.	Sample Type	Grain Size Distribution and Soil Classification								Natural Moisture %
			% > 3" >75 mm	% Gravel 75 mm>	% Sand 4.5 mm>	% Silt 0.075 mm>	% Clay 0.005 mm>	Liquid Limit	Plasticity Index	USCS Class.	
BP-1	0-1.5	Jar	0	0	29	18	53	59	27	MH	--
BP-3	0-1.5	jar	0	0	30	20	50	57	29	CH	--
BP-3	3.0-5.0	Bulk	0	0	59	40*	--	37	10	SM	13.8
BP-6 (1)	0-1.5	Jar	0	0	20	35	45	58	12	MH	--
BP-6(2)	3.5-5.0	jar	0	0	47	32	21	59	7	MH	--
BP-6	15-20	Bulk	0	0	48	52*	--	49	15	ML	34.2
BP-7	1.0-10.1	Jar	0	0	39	39	22	43	15	ML	36.7
BP-8	1.0-10.0	Bulk	0	0	37	10	53	49	15	ML	25.1
BP-9	15-20	Bulk	0	0	48	34	18	45	6	ML	31.8
BP-12	0-1.5	Jar	0	0	18	65	17	72	13	MH	72
BP-13	0-1.5	Jar	0	0	20	62	18	70	16	MH	57.8

Sample Number	Sample Depth, ft.	Sample Type	Remolded Moisture-Density Data				Hydraulic Coductivity Data		
			Max. Dry Densiyt, pcf	Optimum Moisture, %	Natural Moisture, %	Total** Porosity, %	Rem. Dry Density, pcf	Remolded Moisture, %	Ksat @ 5 psi cm/sec
BP-3	3.0-5.0	Bulk	107.5	19	13.8	40.3	102.5	22	3.97E-08
BP-6	15.0-20.2	Bulk	102.6	21.5	34.2	43.2	97.6	24.5	1.45E-07
BP-8	1.0-10.0	Bulk	98.1	24	25.1	45.9	92.9	24.4	2.96E-07

Thr following Undisturbed Samples were collected during Nov-Dec 1995 for MSW permiting report and considered representative:

Sample Number	Sample Depth, ft.	Sample Type	In-Situ Moisture-Density and Hydraulic Conductivity Data				
			Dry Density, pcf	Wet Density, pcf	Natural Moisture, %	Total Porosity, %	Ksat @ 5 psi cm/sec
B-4	1.0-3.0	Tube	110.6	129.8	17.3	35.6	4.66E-06
B-8	5.0-7.0	Tube	99.5	123.2	23.8	42	1.62E-05

Note to Above : Moisture Contents are Dry Unit Weight Based

* Represents silt and clay fractions combined (<200 sieve wash)

** Total Porosity values are backcalculated from Void Ratios

Falling head triaxial permeability tests were run with 1 to 2 psi
with differential pressure across sample, hydraulic gradient of 12

Samples tested by Geotechnologies, Inc.

SMITH+GARDNER

Table 3
Halifax County C&D Landfill - Phase 2
Long-Term Water Level Summary

By: MG
Date:9/18/2012

Piezometer	Date Installed	Ground Elevation	Stick-Up Height	Top of Casing Elevation	Previous TOC	Time of Boring	24-hour readings	1/24/1996	1/26/1996	2/26/1996	3/20/1996	4/23/1996
BP-3	12/6/1995	-----	-----	300.50	315.39	268.19	268.48	--	268.33	269.28	269.94	270.14
BP-4	12/6/1995	310.8	2.36	313.16	313.16	272.5	274.55	--	273.72	274.93	275.26	275.67
BP-6	12/5/1995	315.0	2.28	317.28	317.28	298.36	299.06	--	299.39	303.97	303.48	303.67
BP-7	4/29/1997	301.1	2.81	303.91	303.91	300.1	297.84	--	--	--	--	--
BP-8	4/29/1997	299.8	3.27	303.07	303.07	278.1	285.37	--	--	--	--	--
BP-9	4/28/1997	302.1	1.38	303.48	305.48	283.7	283.22	--	--	--	--	--
BP-10	4/30/1997	284.4	2.00	286.40	286.40	279.6	278.54	--	--	--	--	--
BP-11	5/1/1997	280.0	4.83	284.83	284.83	279.5	277.95	--	--	--	--	--
BP-12	4/30/1997	294.4	1.57	295.97	295.97	273.1	287.43	--	--	--	--	--
BP-13	4/30/1997	286.1	2.40	288.50	288.50	270.3	278.78	--	--	--	--	--
BP-14	5/1/1997	269.7	4.33	274.03	274.03	267.2	267.1	--	--	--	--	--
GY-1	**	291.2	1.31	292.51	292.51	--	--	-----	--	-----	-----	-----
GY-2	**	297.9	2.09	299.99	299.99	--	--	278.36	--	278.35	278.35	278.34
GY-3	**	--	--	304.2	304.20	--	--	265.07	--	265.10	265.52	265.81
MW-15	**	--	--	309.09	309.09	--	--	--	--		266.53	266.46
MW-15R	**	--	--	299.78		265.6	264.95	--	--	--	--	--

NOTE:
** Test boring data not available. Borings performed ca. 1994.
--Test Results (Water Depth & Ground water elevation) are not available
----Test Results shows no water i.e. dry piezometer.
For date before 9/30/05,ground water elevation is measured with previous TOC data.

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Table 3
Halifax County C&D Landfill - Phase 2
Long-Term Water Level Summary

By: MG
Date:9/18/2012

Piezometer	5/22/1996	6/25/1996	7/31/1996	8/27/1996	10/2/1996	10/29/1996	11/27/1996	12/31/1996	1/31/1997	2/25/1997	3/28/1997	5/1/1997
BP-3	270.48	270.41	270.51	270.55	270.50	270.89	270.79	271.10	272.02	271.93	272.26	272.24
BP-4	275.88	275.21	274.55	274.68	275.18	275.87	275.64	276.66	277.05	277.23	277.19	276.77
BP-6	302.89	298.93	298.80	298.92	298.86	302.03	301.34	301.50	299.79	304.80	304.21	303.08
BP-7	--	--	--	--	--	--	--	--	--	--	--	300.59
BP-8	--	--	--	--	--	--	--	--	--	--	--	289.12
BP-9	--	--	--	--	--	--	--	--	--	--	--	286.82
BP-10	--	--	--	--	--	--	--	--	--	--	--	280.54
BP-11	--	--	--	--	--	--	--	--	--	--	--	278.78
BP-12	--	--	--	--	--	--	--	--	--	--	--	289.00
BP-13	--	--	--	--	--	--	--	--	--	--	--	281.18
BP-14	--	--	--	--	--	--	--	--	--	--	--	267.34
GY-1	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
GY-2	278.32	-----	278.32	278.33	278.32	278.27	278.25	278.24	278.28	-----	-----	-----
GY-3	266.10	266.18	266.33	266.40	266.40	266.61	266.48	267.00	267.29	267.35	267.68	267.64
MW-15	266.95	267.06	267.32	267.47	267.13	267.53	267.39	268.19	268.52	268.48	268.79	268.86
MW-15R	--	--	--	--	--	--	--	--	--	--	--	--

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Table 3
Halifax County C&D Landfill - Phase 2
Long-Term Water Level Summary

By: MG
Date:9/18/2012

Piezometer	6/30/1997	7/17/1997	8/28/1997	9/30/1997	11/4/1997	1/2/1998	9/30/2005	10/25/2005	11/28/2005	12/28/2005	1/26/2006	2/23/2006	5/19/2006
BP-3	271.48	271.12	270.35	269.72	268.85	268.43	268.71	268.28	267.90	268.95	269.89	268.00	269.13
BP-4	275.39	274.71	273.63	272.71	271.78	271.89	271.15	270.41	270.00	271.14	272.36	272.94	271.38
BP-6	298.26	296.40	294.77	293.72	293.02	295.93	293.85	294.33	294.03	297.79	299.03	298.50	294.80
BP-7	294.61	293.27	291.59	290.33	289.33	292.61	289.89	286.96	285.61	285.39	285.35	295.99	293.15
BP-8	285.49	284.25	282.24	280.78	--	281.81	280.94	275.98	275.98	276.07	283.35	281.04	281.42
BP-9	283.93	282.92	281.50	280.30	279.50	280.38	276.26	275.55	275.28	273.70	274.68	274.56	277.10
BP-10	276.58	276.03	275.54	275.73	275.53	277.49	272.99	-----	-----	-----	-----	-----	275.60
BP-11	275.62	-----	-----	-----	-----	276.75	-----	-----	-----	-----	-----	-----	-
BP-12	280.26	277.77	276.11	275.74	275.88	279.80	273.50	-----	-----	-----	-----	-----	279.60
BP-13	274.94	273.26	272.47	266.39	273.15	276.87	270.83	272.20	273.15	267.28	269.91	269.98	275.48
BP-14	265.86	264.97	264.78	265.37	265.68	266.88	264.51	264.49	264.50	264.43	264.48	264.45	265.81
GY-1	-----	-----	-----	-----	-----	--	261.99	261.99	262.01	262.01	262.03	261.99	261.96
GY-2	-----	-----	-----	-----	-----	--	278.27	278.28	278.27	278.27	278.27	278.26	278.24
GY-3	267.17	--	--	--	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed
MW-15	268.16	267.92	267.34	266.87	266.02	replaced	replaced	replaced	replaced	replaced	replaced	replaced	replaced
MW-15R	--	--	--	--	--	--	267.30	266.83	266.58	267.29	268.20	268.57	267.06

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Table 3
Halifax County C&D Landfill - Phase 2
Long-Term Water Level Summary

By: MG
Date:9/18/2012

Piezometer	8/7/2006	9/17/2006	10/16/2006	11/29/2006	12/19/2006	2/20/2007	3/14/2007	8/10/2007	10/11/2007	12/12/2007	1/18/2008	5/9/2008	6/27/2008
BP-3	272.15	273.25	274.05	276.50	275.00	274.85	274.20	272.30	268.92	267.60	270.00	277.30	272.13
BP-4	272.36	271.86	272.43	274.48	275.01	276.16	275.98	272.01	269.46	268.16	268.26	272.91	273.61
BP-6	297.05	296.63	297.00	300.48	299.43	300.56	300.53	293.28	290.13	-----	-----	296.18	295.23
BP-7	293.51	292.61	292.73	298.91	297.56	298.81	298.03	289.96	286.41	284.99	285.36	294.36	292.76
BP-8	281.67	280.02	280.57	280.57	284.92	286.27	275.95	279.47	276.52	-----	-----	282.42	281.92
BP-9	277.16	276.26	276.53	279.23	279.38	281.08	273.38	275.93	273.03	271.88	271.98	275.23	278.03
BP-10	275.40	275.70	276.20	278.95	277.90	279.00	-	273.20	270.30	271.15	272.35	277.05	275.05
BP-11	-	-	275.56	278.38	275.83	-----	-	-----	-----	-----	-----	277.08	-----
BP-12	279.59	278.42	278.87	285.72	284.62	-----	-	274.77	271.47	272.57	273.47	283.97	278.07
BP-13	275.30	275.00	275.62	279.55	278.50	279.75	265.70	271.25	268.40	270.15	270.65	278.10	273.65
BP-14	265.23	265.85	266.05	266.08	266.58	267.23	264.38	264.63	-----	-----	264.53	266.38	265.03
GY-1	261.99	262.01	262.01	261.96	261.96	262.01	262.01	262.01	260.96	261.99	261.96	262.01	262.01
GY-2	278.24	278.24	278.24	278.24	278.24	278.26	278.26	278.24	278.24	278.24	278.24	278.24	278.24
GY-3	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed
MW-15	replaced	replaced	replaced	replaced	replaced	replaced	replaced	replaced	replaced	replaced	replaced	replaced	replaced
MW-15R	269.58	270.40	271.63	273.68	273.18	272.95	272.48	270.28	267.83	266.43	267.38	272.98	270.48

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Table 3

Halifax County C&D Landfill - Phase 2

Long-Term Water Level Summary

By: MG
Date:9/18/2012

Piezometer	8/22/2008	10/6/2008	11/20/2008	2/13/2009	5/18/2009	8/17/2009	2/16/2011	9/21/2012	Maximum	Minimum	Difference
BP-3	273.80	272.55	270.55	271.30	270.50	267.90	268.25	275.00	277.30	267.60	9.70
BP-4	271.46	270.16	268.96	269.61	271.41	268.56	267.66	271.86	277.23	267.66	9.57
BP-6	291.88	289.98	-----	290.48	294.53	289.78	-----	293.18	304.80	289.78	15.02
BP-7	288.01	285.81	284.51	285.81	292.61	286.01	285.66	292.51	300.59	284.51	16.08
BP-8	277.72	275.87	275.67	275.87	280.27	275.27	-----	276.57	289.12	275.27	13.85
BP-9	273.73	272.18	271.28	272.18	275.68	272.08	271.63	273.88	286.82	271.28	15.54
BP-10	271.40	-----	271.15	272.60	275.10	269.80	272.55	275.50	280.54	269.80	10.74
BP-11	-----	-----	-----	-----	275.38	-----	-----	276.13	278.78	275.38	3.40
BP-12	273.67	272.27	272.17	275.97	280.42	271.97	274.97	272.87	289.00	271.47	17.53
BP-13	270.50	269.70	270.00	273.35	275.50	269.25	272.65	275.90	281.18	265.70	15.48
BP-14	264.53	264.53	264.53	264.53	266.13	264.53	264.78	264.63	267.34	264.38	2.96
GY-1	262.01	262.01	262.06	262.01	262.06	262.01	261.06	262.31	262.31	260.96	1.35
GY-2	278.24	278.24	278.24	278.24	278.24	278.29	278.19	278.29	278.36	278.19	0.17
GY-3	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	267.68	265.07	2.61
MW-15	replaced	replaced	replaced	replaced	replaced	replaced	replaced	replaced	268.86	266.02	2.84
MW-15R	272.13	270.78	268.98	269.78	269.23	266.88	265.95	274.28	274.28	265.95	8.33

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Table 4
Horizontal Gradient and Velocity Calculations
Halifax County C&D Landfill - Phase 2

By: JAS
Date: 8/19/1997

Well No.	Hydraulic Conductivity (k)	Hydraulic Gradient (i)	Effective Porosity (n)	Ground Water Velocity (V)
BP-3	0.29	0.023	0.2	0.03
BP-4	2.21	0.040	0.2	0.44
BP-6	10.8	0.070	0.2	3.78
BP-7	22.84	0.112	0.2	12.70
BP-8	3.2	0.050	0.2	0.80
BP-9	3.45	0.030	0.2	0.52
BP-10	27.92	0.060	0.2	8.38
BP-12	4.74	0.050	0.2	1.19
BP-13	9.46	0.093	0.2	4.40

Notes: Ground Water Velocity Calculated from Equation:

$$V=Ki/n$$

Hydraulic Coductivity in ft/day
Hydraulic Gradient in ft/ft
Effective Porosity in ft/ft
Ground Water Velocity in ft/day

Effective Porosity values from published lieterature.
Hydralic Conductivity values form aquifer slug testing
Hyraulic Gradient values calculated from hydraulic gradient map

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Table 5
Historical Precipitation Data (1972-2012)
Halifax C12/14/2012 Landfill, Phase 2

By: MG
Date: 3/13/2012

1972	
Month	Value (in)
1	1.94
2	4.89
3	3.3
4	2.38
5	5.37
6	5.36
7	3.25
8	1.37
9	5.51
10	7.01
11	5.48
12	4.83
Total	**50.69**

1973	
Month	Value (in)
1	2.15
2	3.63
3	3.74
4	3.80
5	3.48
6	8.76
7	5.18
8	8.55
9	1.24
10	1.64
11	1.45
12	6.81
Total	**50.43**

1974	
Month	Value (in)
1	4.21
2	2.67
3	3.67
4	0.98
5	6.87
6	3.09
7	2.43
8	7.75
9	4.13
10	1.54
11	1.19
12	3.84
Total	**42.37**

1975	
Month	Value (in)
1	5.74
2	4.60
3	7.21
4	1.28
5	2.35
6	1.32
7	12.22
8	0.87
9	11.31
10	1.31
11	3.64
12	3.39
Total	**55.24**

1976	
Month	Value (in)
1	4.29
2	1.91
3	2.2
4	0.77
5	3.15
6	3.61
7	4.34
8	4.55
9	4.98
10	5.58
11	1.85
12	3.35
Total	**40.58**

1977	
Month	Value (in)
1	2.99
2	2.86
3	4.94
4	2.11
5	4.79
6	3.05
7	2.67
8	5.99
9	4.64
10	9.53
11	6.67
12	3.43
Total	**53.67**

1978	
Month	Value (in)
1	6.21
2	0.83
3	4.47
4	5.49
5	4.00
6	3.51
7	4.74
8	4.05
9	1.72
10	1.35
11	5.24
12	3.28
Total	**44.89**

1979	
Month	Value (in)
1	6.38
2	3.24
3	3.52
4	4.43
5	6.35
6	2.31
7	2.19
8	1.21
9	10.04
10	1.85
11	5.87
12	1.11
Total	**48.5**

1980	
Month	Value (in)
1	4.96
2	1.42
3	4
4	2.37
5	2.88
6	1.4
7	1.87
8	0.4
9	2.43
10	5.98
11	2.05
12	1.8
Total	**31.56**

1981	
Month	Value (in)
1	0.66
2	2.89
3	2.48
4	1.14
5	4.62
6	1.96
7	1.83
8	5.75
9	2.71
10	2.31
11	1.75
12	4.74
Total	**32.84**

1982	
Month	Value (in)
1	4.98
2	5.67
3	2.64
4	2.86
5	3.52
6	4.63
7	3.19
8	2.23
9	2.39
10	4.88
11	2.41
12	3.54
Total	**42.94**

1983	
Month	Value (in)
1	2.26
2	5.50
3	5.08
4	6.64
5	5.15
6	1.97
7	0.88
8	2.03
9	6.87
10	3.60
11	3.93
12	6.07
Total	**49.98**

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Table 5
Historical Precipitation Data (1972-2012)
Halifax C12/14/2012 Landfill, Phase 2

By: MG
Date: 3/13/2012

1984	
Month	Value (in)
1	3.89
2	5.99
3	3.96
4	5.89
5	6.93
6	1.16
7	7.67
8	3.86
9	2.06
10	1.35
11	2.43
12	2.52
Total	**47.71**

1985	
Month	Value (in)
1	4.24
2	4.41
3	1.17
4	0.55
5	3.98
6	4.17
7	6.65
8	5.26
9	3.78
10	3.19
11	10.31
12	1.65
Total	**49.36**

1986	
Month	Value (in)
1	2.03
2	1.82
3	2.81
4	1.29
5	1.97
6	0.1
7	1.9
8	12.92
9	0.91
10	1.8
11	2.07
12	4.97
Total	**34.59**

1987	
Month	Value (in)
1	7.40
2	3.74
3	5.33
4	7.54
5	1.80
6	2.60
7	3.91
8	2.57
9	6.19
10	2.13
11	2.52
12	3.82
Total	**49.55**

1988	
Month	Value (in)
1	2.97
2	3.48
3	1.55
4	4.42
5	3.26
6	4.95
7	3.67
8	3.10
9	1.86
10	3.01
11	4.31
12	0.77
Total	**37.35**

1989	
Month	Value (in)
1	2.05
2	5.53
3	8.21
4	7.87
5	4.69
6	7.78
7	2.18
8	4.85
9	2.36
10	4.84
11	3.69
12	3.24
Total	**57.29**

1990	
Month	Value (in)
1	4.16
2	4.15
3	3.70
4	3.80
5	6.49
6	1.01
7	2.92
8	6.49
9	0.43
10	3.14
11	1.35
12	2.78
Total	**40.42**

1991	
Month	Value (in)
1	4.60
2	0.88
3	4.86
4	2.85
5	1.35
6	3.84
7	6.81
8	6.64
9	3.97
10	2.96
11	1.23
12	2.78
Total	**42.77**

1992	
Month	Value (in)
1	4.29
2	2.14
3	3.68
4	2.72
5	3.94
6	6.63
7	3.02
8	6.69
9	1.89
10	3.41
11	4.47
12	2.54
Total	**45.42**

1993	
Month	Value (in)
1	5.05
2	1.77
3	7.53
4	3.35
5	3.03
6	3.22
7	1.64
8	0.81
9	4.84
10	3.40
11	3.27
12	4.10
Total	**42.01**

1994	
Month	Value (in)
1	3.39
2	3.66
3	7.27
4	1.49
5	7.03
6	7.26
7	3.88
8	3.74
9	1.65
10	3.22
11	0.74
12	1.27
Total	**44.6**

1995	
Month	Value (in)
1	3.31
2	3.18
3	5.47
4	1.17
5	4.63
6	5.91
7	6.08
8	3.86
9	2.55
10	6.51
11	3.93
12	1.93
Total	**48.53**

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Table 5
Historical Precipitation Data (1972-2012)
Halifax C12/14/2012 Landfill, Phase 2

By: MG
Date: 3/13/2012

1996	
Month	Value (in)
1	5.85
2	3.44
3	3.04
4	3.76
5	5.29
6	NR
7	NR
8	6.19
9	7.88
10	4.87
11	3.58
12	4.27
Total	**48.17**

1997	
Month	Value (in)
1	2.88
2	2.8
3	3.17
4	4.62
5	0.73
6	2.49
7	7.35
8	1.06
9	3.66
10	2.17
11	3.8
12	3.54
Total	**38.27**

1998	
Month	Value (in)
1	6.30
2	4.79
3	6.67
4	3.17
5	NR
6	4.13
7	5.40
8	3.08
9	3.31
10	1.56
11	1.74
12	5.33
Total	**45.48**

1999	
Month	Value (in)
1	6.17
2	1.58
3	3.42
4	3.64
5	1.00
6	2.61
7	6.73
8	3.54
9	21.57
10	4.63
11	1.99
12	2.09
Total	**58.97**

2000	
Month	Value (in)
1	4.46
2	1.08
3	2.31
4	4.25
5	4.73
6	4.14
7	9.71
8	7.07
9	6.43
10	0.00
11	2.20
12	1.33
Total	**47.71**

2001	
Month	Value (in)
1	1.44
2	2.64
3	4.39
4	2.15
5	2.67
6	12.48
7	3.04
8	4.09
9	2.21
10	1.11
11	1.22
12	1.76
Total	**39.2**

2002	
Month	Value (in)
1	4.96
2	1.15
3	4.15
4	2.98
5	2.59
6	1.63
7	2.67
8	7.72
9	2.17
10	5.8
11	4.18
12	4.05
Total	**44.05**

2003	
Month	Value (in)
1	2.26
2	4.80
3	4.83
4	6.41
5	6.22
6	5.80
7	5.17
8	5.03
9	9.48
10	2.74
11	2.50
12	4.54
Total	**59.78**

2004	
Month	Value (in)
1	1.75
2	3
3	1.62
4	4.1
5	3.1
6	4.43
7	7.71
8	12.4
9	3.95
10	3.21
11	4.62
12	3.02
Total	**52.91**

2005	
Month	Value (in)
1	2.88
2	2.27
3	4.20
4	2.30
5	3.68
6	1.64
7	5.16
8	2.14
9	1.60
10	5.32
11	4.01
12	5.82
Total	**41.02**

2006	
Month	Value (in)
1	2.28
2	1.33
3	0.64
4	2.91
5	2.96
6	8.85
7	8.88
8	2.13
9	9.09
10	6.01
11	6.88
12	2.61
Total	**54.57**

2007	
Month	Value (in)
1	2.50
2	2.07
3	1.89
4	3.23
5	1.49
6	2.65
7	3.52
8	4.23
9	0.91
10	4.75
11	0.61
12	4.22
Total	**32.07**

SMITH+GARDNER

Table 5
Historical Precipitation Data (1972-2012)
Halifax C12/14/2012 Landfill, Phase 2

By: MG
Date: 3/13/2012

2008	
Month	Value (in)
1	0.85
2	3.3
3	4.05
4	8.28
5	2.77
6	2.91
7	5.49
8	1.42
9	5
10	0.94
11	3.01
12	3.62
Total	**41.64**

2009	
Month	Value (in)
1	2.61
2	0.84
3	9.07
4	0.61
5	3.89
6	3.50
7	3.78
8	4.99
9	2.83
10	1.14
11	7.90
12	5.58
Total	**46.74**

2010	
Month	Value (in)
1	4.59
2	2.94
3	4.66
4	1.27
5	6.41
6	0.58
7	2.90
8	4.46
9	5.22
10	3.37
11	0.94
12	2.32
Total	**39.66**

2011	
Month	Value (in)
1	2.19
2	1.16
3	5.4
4	2.63
5	1.49
6	4.09
7	6.33
8	13.67
9	5.33
10	2.52
11	4.04
12	1.21
Total	**50.06**

2012	
Month	Value (in)
1	1.69
2	8.97
3	2.84
4	3.44
5	5.85
6	4.61
7	4.57
8	18.92
9	5.91
10*	2.63
11	
12	
Total*	**59.43**

NOTE:
NR = Not Reported
* = incomplete data
DATA from station COOP 317319

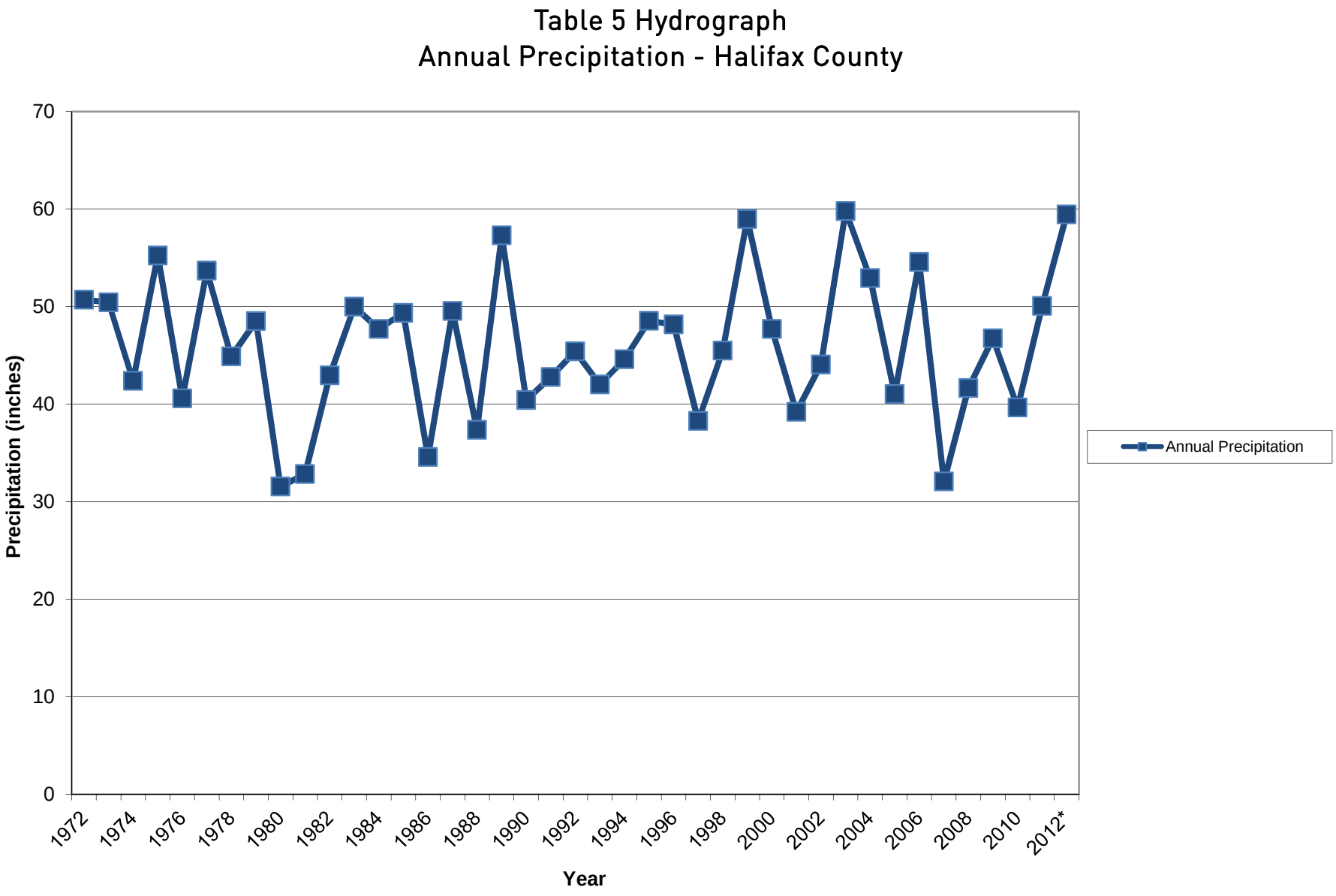
Table 5 Hydrograph
Annual Precipitation - Halifax County
Precipitation (inches)
70
60
50
40
30
20
10
0
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012*
Year
Annual Precipitation

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Appendix A

Boring Logs

Design Hydrogeologic Report
Halifax County C&D Landfill – Area 2
Halifax County, North Carolina

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FIELD BOREHOLE LOG

BOREHOLE NUMBER: BP-1

PROJECT NUMBER: HALIFAX-5
PROJECT NAME: HALIFAX COUNTY
LOCATION: HALIFAX, NORTH CAROLINA
DRILLING COMPANY: BORE AND CORE
RIG TYPE & NUMBER: CME 450
DRILLING METHOD: HOLLOW STEM AUGER
WEATHER: CLOUDY, 45 DEGREES
FIELD PARTY: L. FOSKEY
GEOLOGIST: G. MILLS
DATE BEGUN: 12/6/95 DATE COMPLETED: 12/6/95

TOP OF CASING ELEVATION: -
TOTAL DEPTH: 36.0 FT
GROUND SURFACE ELEVATION: -
SHEET: 1 OF: 1

STATIC WATER LEVEL (BLS)		
WD=While Drilling AB=After Boring		
Depth(ft)	Dry	-
Time	-	-
Date:	-	-

DEPTH	BLOW COUNTS	SAMPLING METHOD	SAMPLE NUMBER	MOISTURE	CONSISTANCY	SAMPLE RECOVERY	DRILL METHOD	LITHOLOGY DESCRIPTION
0.0	3 5 7	SS	S1			18"		SANDY CLAY: Orange brown sandy clay and topsoil; took a jar sample from 0 to 1.5 feet.
3.0	8 16 15	SS	S2			18"		CLAYEY SANDY SILT: Yellow-orange clayey sandy silt; abundant feldspar; trace mica.
8.0	5 6 9	SS	S3			18"		
13.0	5 6 7	SS	S4			18"		SILTY SAND: Yellow tan fine silty sand; powdery; felsic; trace mica.
18.0	4 5 6	SS	S5			18"		
23.0	5 10 9	SS	S6			12"		SILTY SAND: Slightly clayey silty sand; micaceous; coarse sand; gravel at 25'.
28.0	10 50/ 4	SS	S7			8"		SILTY SAND: Relict granite; very felsic; iron stained; quartz sand and mica; auger refusal at 36'.
33.0	50/ 3	SS	S8			3"		

DEPTH: 1.0, 0.0, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 11.0, 12.0, 13.0, 14.0, 15.0, 16.0, 17.0, 18.0, 19.0, 20.0, 21.0, 22.0, 23.0, 24.0, 25.0, 26.0, 27.0, 28.0, 29.0, 30.0, 31.0, 32.0, 33.0, 34.0, 35.0, 36.0

LITHOLOGY

WELL INSTALLATION

FIELD BOREHOLE LOG

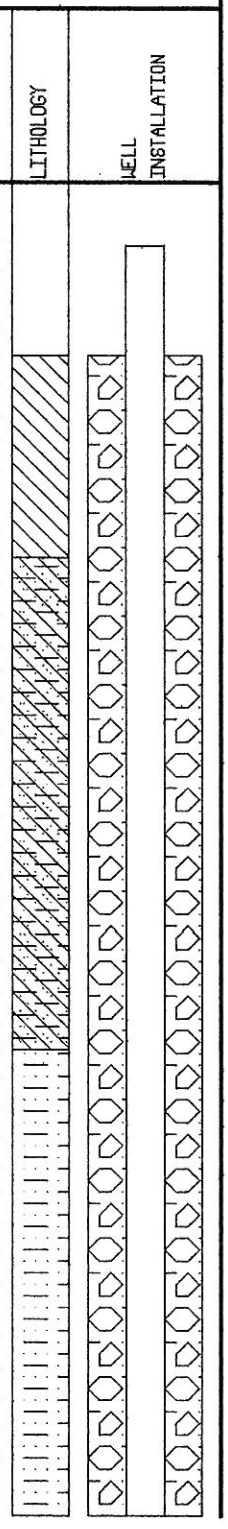
BOREHOLE NUMBER: BP-2

PROJECT NUMBER: **HALIFAX-5**
PROJECT NAME: **HALIFAX COUNTY**
LOCATION: **HALIFAX, NORTH CAROLINA**
DRILLING COMPANY: **BORE AND CORE**
RIG TYPE & NUMBER: **MOBILE DRILL CME 450**
DRILLING METHOD: **HOLLOW STEM AUGER**
WEATHER: **CLOUDY, 45 DEGREES**
FIELD PARTY: **L. FOSKEY**
GEOLOGIST: **G. MILLS**
DATE BEGUN: **12/5/95** DATE COMPLETED: **12/5/95**

TOP OF CASING ELEVATION: -
TOTAL DEPTH: **40.0 FT**
GROUND SURFACE ELEVATION: -
SHEET: **1** OF: **2**

STATIC WATER LEVEL (BLS)		
WD=While Drilling AB=After Boring		
Depth(ft)	27	-
Time	13:30	-
Date:	12/5/95	-

DEPTH	BLOW COUNTS	SAMPLING METHOD	SAMPLE NUMBER	MOISTURE	CONSISTANCY	SAMPLE RECOVERY	DRILL METHOD	LITHOLOGY DESCRIPTION
0.0	2 4 6	Ss	S1			12"		CLAY: Orange brown clay with a 3" layer of topsoil above it; took a jar sample from 0 to 1.5 feet.
3.0	7 8 9	Ss	S2	D		15"		SANDY CLAYEY SILT: Orange brown sandy clayey silt; slightly plastic.
8.0	5 8 11	Ss	S3	D		14"		
12.0								SANDY SILT: Pink to white to tan sandy silt; relict granite structure visible; sample contains feldspar, mica and quartz; wet at 28.5'.
13.0	4 5 8	Ss	S4	M		16"		
18.0	5 11 11	Ss	S5	M		18"		



FIELD BOREHOLE LOG

BOREHOLE NUMBER: BP-2

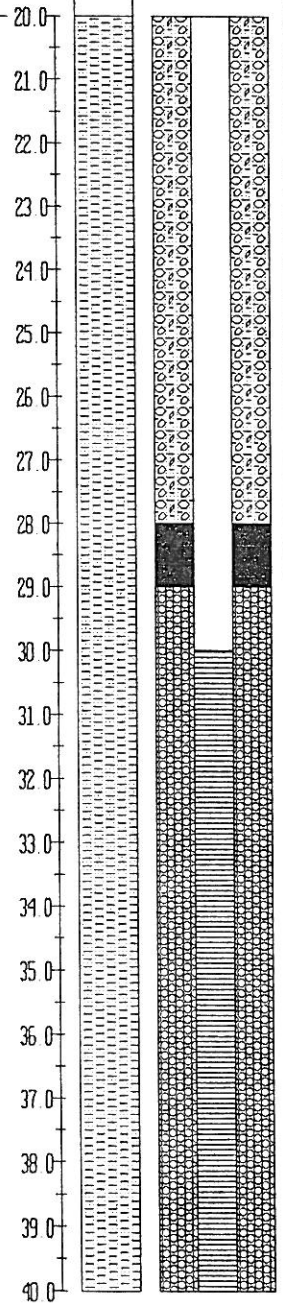
PROJECT NUMBER: HALIFAX-5
PROJECT NAME: HALIFAX COUNTY
LOCATION: HALIFAX, NORTH CAROLINA
DRILLING COMPANY: BORE AND CORE
RIG TYPE & NUMBER: MOBILE DRILL CME 450
DRILLING METHOD: HOLLOW STEM AUGER
WEATHER: CLOUDY, 45 DEGREES
FIELD PARTY: L. FOSKEY
GEOLOGIST: G. MILLS
DATE BEGUN: 12/5/95 DATE COMPLETED: 12/5/95

TOP OF CASING ELEVATION: -
TOTAL DEPTH: 40.0 FT
GROUND SURFACE ELEVATION: -
SHEET: 2 OF: 2

STATIC WATER LEVEL (BLS)		
WD=While Drilling AB=After Boring		
Depth(ft)	-	-
Time	-	-
Date	-	-

DEPTH	BLOW COUNTS	SAMPLING METHOD	SAMPLE NUMBER	MOISTURE	CONSISTANCY	SAMPLE RECOVERY	DRILL METHOD	LITHOLOGY DESCRIPTION
20.0								SANDY SILT: Pink to white to tan sandy silt; relict granite structure visible; samples contain feldspar, mica and quartz; wet at 28.5'.
21.0								
22.0								
23.0	7	Ss	S6	M		16"		
24.0	10							
	14							
25.0								
26.0								
27.0								
28.0	8	Ss	S7	W		16"		
29.0	12							
	16							
30.0								
31.0								
32.0								
33.0	5	Ss	S8	W		14"		
34.0	8							
	12							
35.0								
36.0								
37.0								
38.0	5	Ss	S9	W				
39.0	9							
	14							
40.0								

DEPTH | LITHOLOGY | WELL INSTALLATION



FIELD BOREHOLE LOG

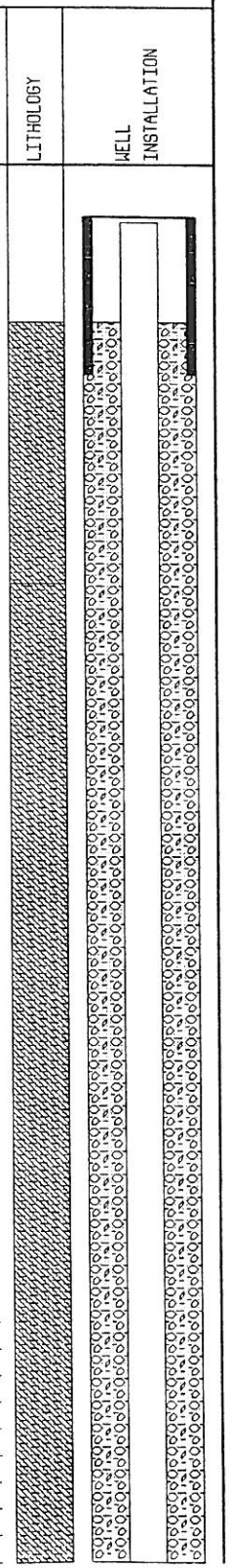
BOREHOLE NUMBER: BP-3

PROJECT NUMBER: HALIFAX-5
PROJECT NAME: HALIFAX COUNTY
LOCATION: HALIFAX, NORTH CAROLINA
DRILLING COMPANY: BORE AND CORE
RIG TYPE & NUMBER: CME 450
DRILLING METHOD: HOLLOW STEM AUGER
WEATHER: CLOUDY, 45 DEGREES
FIELD PARTY: L. FOSKEY
GEOLOGIST: G. MILLS
DATE BEGUN: 12/5/95 DATE COMPLETED: 12/6/95

TOP OF CASING ELEVATION: 315.39
TOTAL DEPTH: 50.0 FT
GROUND SURFACE ELEVATION: 313.70
SHEET: 1 OF 2

STATIC WATER LEVEL (BLS)		
WD=While Drilling AB=After Boring		
Depth(ft)	45.51	45.22
Time	8:45 AM	4 PM
Date	12/6/95	12/7//95

DEPTH	BLOW COUNTS	SAMPLING METHOD	SAMPLE NUMBER	MOISTURE	CONSISTANCY	SAMPLE RECOVERY	DRILL METHOD	LITHOLOGY DESCRIPTION
0.0–1.0	4, 8, 12	Ss	S1			18"		SANDY SILTY CLAY: Red-orange-brown with some yellow; took a bulk sample from 3 to 5 feet.
3.0–4.0	10, 11, 9	Ss	S2			18"		
5.0–8.0								CLAYEY SANDY SILT: Orange yellow brown; abundant feldspar and mica; four pieces of quartz gravel at 19 ft.
8.0–9.0	4, 7, 8	Ss	S3			16"		
13.0–14.0	4, 5, 6	Ss	S4			18"		
18.0–19.0	6, 9, 13	Ss	S5			16"		
23.0	6	Ss	S6					



FIELD BOREHOLE LOG

BOREHOLE NUMBER
BP-3

PROJECT NUMBER HALIFAX-5
PROJECT NAME HALIFAX COUNTY
LOCATION HALIFAX, NORTH CAROLINA
DRILLING COMPANY BORE AND CORE
RIG TYPE & NUMBER CME 450
DRILLING METHOD HOLLOW STEM AUGER
WEATHER CLOUDY, 45 DEGREES
FIELD PARTY L. FOSKEY
GEOLOGIST G. MILLS
DATE BEGUN 12/5/95 DATE COMPLETED 12/6/95

TOP OF CASING ELEVATION 315.39
TOTAL DEPTH 50.0 FT
GROUND SURFACE ELEVATION 313.70
SHEET 2 OF 2

STATIC WATER LEVEL (BLS)		
WD=While Drilling AB=After Boring		
Depth(ft)	45.51	45.22
Time	8:45 AM	4 PM
Date	12/6/95	12/7//95

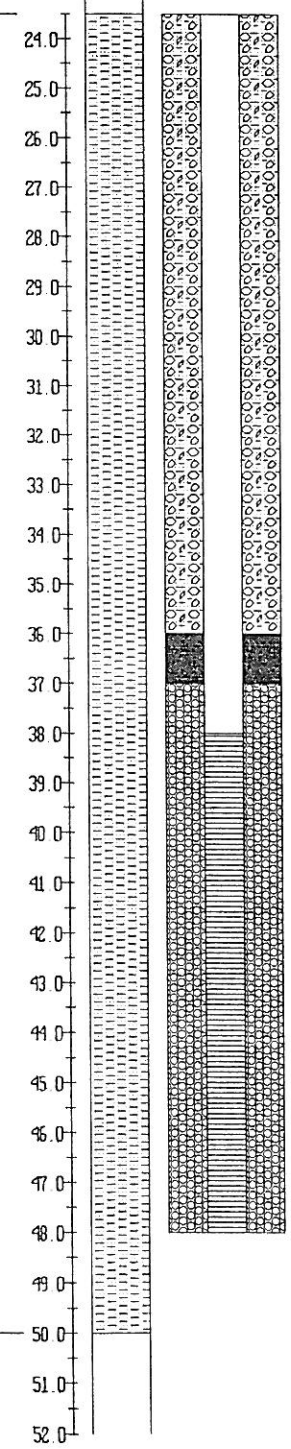
DEPTH	BLOW COUNTS	SAMPLING METHOD	SAMPLE NUMBER	MOISTURE	CONSISTANCY	SAMPLE RECOVERY	DRILL METHOD
24.0	6 12 13	Ss	S6				
28.0	10 16 18	Ss	S7				
33.0	7 12 16	Ss	S8			12"	
38.0	9 13 17	Ss	S9			8"	
43.0	7 12 17	Ss	S10			10"	
48.0	10 17 21	Ss	S11				

LITHOLOGY DESCRIPTION

SANDY SILT: White-orange relict granite with abundant feldspar; more k-spar and coarse quartz sand at 33.5 ft.

Boring Terminated at 50 feet.

DEPTH | LITHOLOGY | WELL INSTALLATION



FIELD BOREHOLE LOG

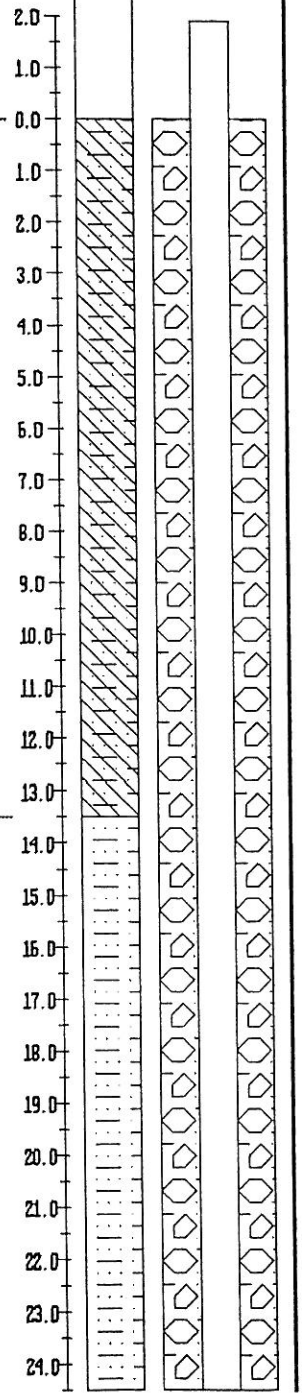
BOREHOLE NUMBER: BP-4

PROJECT NUMBER: HALIFAX-5
PROJECT NAME: HALIFAX COUNTY
LOCATION: HALIFAX, NORTH CAROLINA
DRILLING COMPANY: BORE AND CORE
RIG TYPE & NUMBER: CME 45D
DRILLING METHOD: HOLLOW STEM AUGER
WEATHER: SOME CLOUDS, 34 DEGREES
FIELD PARTY: L. FOSKEY
GEOLOGIST: G. MILLS
DATE BEGUN: 12/6/95 DATE COMPLETED: 12/6/95

TOP OF CASING ELEVATION: 313.16
TOTAL DEPTH: 48.0 FT
GROUND SURFACE ELEVATION: 310.8
SHEET: 1 OF: 2

STATIC WATER LEVEL (BLS)		
WD=While Drilling AB=After Boring		
Depth(ft)	38.30	36.25
Time	4:00 pm	4:00 pm
Date:	12-6-95	12-7-95

DEPTH	BLOW COUNTS	SAMPLING METHOD	SAMPLE NUMBER	MOISTURE	CONSISTANCY	SAMPLE RECOVERY	DRILL METHOD	LITHOLOGY DESCRIPTION
0.0	2 3 6	Ss	S1			18"		SANDY SILTY CLAY: Orange brown; slightly plastic.
3.0	6 7 8	Ss	S2	D		18"		
8.0	4 5 8	Ss	S3	M		18"		
13.0	4 8 10	Ss	S4	D		17"		SANDY SILT: Relict Granite; moist, pink to gray micaceous sandy silt with quartz and abundant feldspar.
18.0	8 11 14	Ss	S5	D		18"		
23.0	7 10 13	Ss	S6	M		18"		



FIELD BOREHOLE LOG

BOREHOLE NUMBER: BP-4

PROJECT NUMBER: HALIFAX-5
PROJECT NAME: HALIFAX COUNTY
LOCATION: HALIFAX, NORTH CAROLINA
DRILLING COMPANY: BORE AND CORE
RIG TYPE & NUMBER: CME 450
DRILLING METHOD: HOLLOW STEM AUGER
WEATHER: SOME CLOUDS, 34 DEGREES
FIELD PARTY: L. FOSKEY
GEOLOGIST: G. MILLS
DATE BEGUN: 12/6/95 DATE COMPLETED: 12/6/95

TOP OF CASING ELEVATION: 313.16
TOTAL DEPTH: 48.0 FT
GROUND SURFACE ELEVATION: 310.8
SHEET: 2 OF: 2

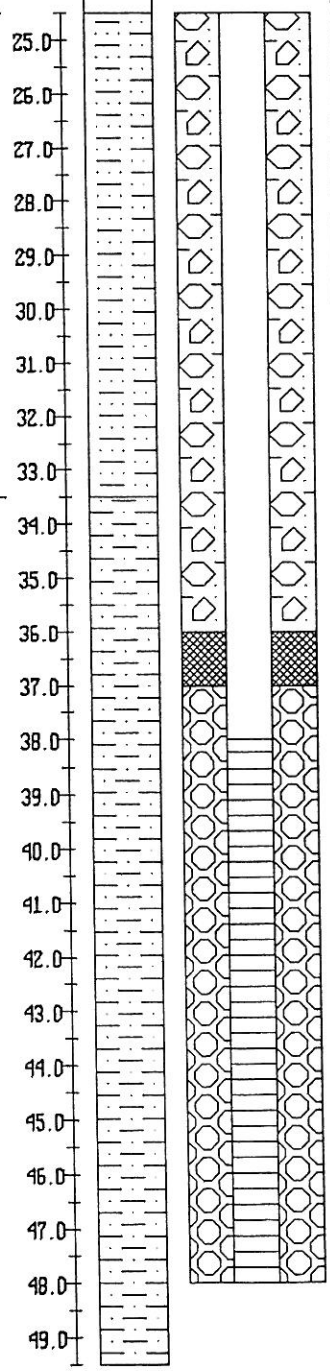
STATIC WATER LEVEL (BLS)		
WD=While Drilling AB=After Boring		
Depth(ft)	38.30	36.25
Time	4:00 pm	4:00 pm
Date:	12-6-95	12-7-95

DEPTH	BLOW COUNTS	SAMPLING METHOD	SAMPLE NUMBER	MOISTURE	CONSISTANCY	SAMPLE RECOVERY	DRILL METHOD
25.0	13						
26.0							
27.0							
28.0	11	Ss	S7	M		14"	
29.0	10						
30.0	14						
31.0							
32.0							
33.0	3	Ss	S8	M			
34.0	4						
35.0	6						
36.0							
37.0							
38.0	6	Ss	S9	W			
39.0	11						
40.0	14						
41.0							
42.0							
43.0	13	Ss	S10	W			
44.0	16						
45.0	25						
46.0							
47.0							
48.0	10	Ss	S11	W			
49.0	16						
	16						

LITHOLOGY DESCRIPTION

SANDY SILT: Relict Granite; moist, pink to gray micaceous sandy silt with quartz and abundant feldspar.

SILT: Thin 1/8" layers of gray and tan with an interface of orange - iron staining and black Mn staining in a vertical direction; relict granite texture more pronounced at bottom of boring.



FIELD BOREHOLE LOG

BOREHOLE NUMBER: BP-5

PROJECT NUMBER: HALIFAX-5
PROJECT NAME: HALIFAX COUNTY
LOCATION: HALIFAX, NORTH CAROLINA
DRILLING COMPANY: BORE AND CORE
RIG TYPE & NUMBER: CME 450
DRILLING METHOD: HOLLOW STEM AUGER
WEATHER: CLOUDY, 45 DEGREES
FIELD PARTY: L. FOSKEY
GEOLOGIST: G. MILLS
DATE BEGUN: 12/5/95 DATE COMPLETED: 12/5/95

TOP OF CASING ELEVATION: -
TOTAL DEPTH: 40.0 FT
GROUND SURFACE ELEVATION: -
SHEET: 1 OF: 2

STATIC WATER LEVEL (BLS)		
WD=While Drilling AB=After Boring		
Depth(ft)	27	-
Time	-	-
Date:	12/5/95	-

DEPTH	BLOW COUNTS	SAMPLING METHOD	SAMPLE NUMBER	MOISTURE	CONSISTANCY	SAMPLE RECOVERY	DRILL METHOD	LITHOLOGY DESCRIPTION
0.0	4 3 8	Ss	S1			18"		SILTY CLAY: Red-brown.
3.0	7 10 12	Ss	S2			14"		SANDY CLAYEY SILT: White gray, brown and pink; abundant feldspar and mica; slightly plastic; trace quartz; relict granite structure at 13'.
8.0	5 9 12	Ss	S3			12"		
13.0	7 11 14	Ss	S4			12"		

DEPTH: 2.0, 1.0, 0.0, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 11.0, 12.0, 13.0, 14.0, 15.0, 16.0, 17.0, 18.0

LITHOLOGY

WELL INSTALLATION

FIELD BOREHOLE LOG

BOREHOLE NUMBER: BP-5

ROJECT NUMBER: HALIFAX-5
PROJECT NAME: HALIFAX COUNTY
LOCATION: HALIFAX, NORTH CAROLINA
DRILLING COMPANY: BORE AND CORE
RIG TYPE & NUMBER: CME 450
DRILLING METHOD: HOLLOW STEM AUGER
WEATHER: SOME CLOUDS, 34 DEGREES
FIELD PARTY: L. FOSKEY
GEOLOGIST: G. MILLS
DATE BEGUN: 12/5/95 DATE COMPLETED: 12/5/95

TOP OF CASING ELEVATION: --
TOTAL DEPTH: 40.0 FT
GROUND SURFACE ELEVATION: --
SHEET: 2 OF: 2

STATIC WATER LEVEL (BLS)		
WD=While Drilling AB=After Boring		
Depth(ft)	--	--
Time	--	--
Date:	--	--

DEPTH	BLOW COUNTS	SAMPLING METHOD	SAMPLE NUMBER	MOISTURE	CONSISTANCY	SAMPLE RECOVERY	DRILL METHOD	LITHOLOGY DESCRIPTION
19.0	5 8 11	Ss	S5	M		14"		SANDY SILT: Relict Granite; moist to wet, pink to gray with weathered iron and Mn staining.
20.0								
21.0								
22.0								
23.0	5 7 11	Ss	S6	M		16"		
24.0								
25.0								
26.0								
27.0								
28.0	6 9 12	Ss	S7	W		12"		
29.0								
30.0								
31.0								
32.0								
33.0	5 9 15	Ss	S8	W		12"		
34.0								
35.0								
36.0								
37.0								
38.0	7 11 15	Ss	S9	W		10"		
39.0								
40.0								Boring Terminated at 40.0 feet.
41.0								

DEPTH | LITHOLOGY | WELL INSTALLATION

FIELD BOREHOLE LOG

BOREHOLE NUMBER: BP-6

PROJECT NUMBER: HALIFAX-5
PROJECT NAME: HALIFAX COUNTY
LOCATION: HALIFAX, NORTH CAROLINA
DRILLING COMPANY: BORE AND CORE
RIG TYPE & NUMBER: CME 450
DRILLING METHOD: HOLLOW STEM AUGER
WEATHER: CLOUDY, 45 DEGREES
FIELD PARTY: L. FOSKEY
GEOLOGIST: G. MILLS
DATE BEGUN: 12/5/95 DATE COMPLETED: 12/5/95

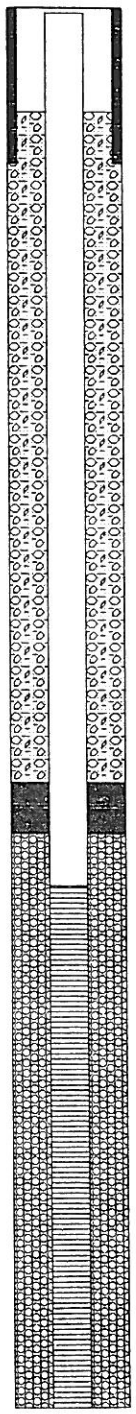
TOP OF CASING ELEVATION: 317.28
TOTAL DEPTH: 25.0 FT
GROUND SURFACE ELEVATION: 315.0
SHEET: 1 OF 1

STATIC WATER LEVEL (BLS)		
WD=While Drilling AB=After Boring		
Depth(ft)	16.64	15.94
Time	9:45 am	7:45 am
Date	12/5/95	12/6/95

DEPTH	BLOW COUNTS	SAMPLING METHOD	SAMPLE NUMBER	MOISTURE	CONSISTANCY	SAMPLE RECOVERY	DRILL METHOD	LITHOLOGY DESCRIPTION
0.0–1.5	4 5 7	Ss	S1					SANDY SILTY CLAY: 6" of topsoil underlain by sandy silty clay; took a jar sample from 0 to 1.5 feet.
3.0–5.0	6 7 9	Ss	S2	D				SANDY CLAYEY SILT: Red-brown fine sandy clayey silt; took a jar sample from 3.5 to 5 feet.
8.0–13.0	8 5 10	Ss	S3	D				SANDY CLAYEY SILT: Red-brown fine sandy clayey silt; relict rock structure is evident at 8.5 feet; color becomes pink, texture is sandier at 13.5 feet; bulk sample taken between 13.5 and 19 feet.
13.0–18.0	3 4 6	Ss	S4	D				
18.0–19.0	3 6 9	Ss	S5	W				
19.0–25.0								SANDY SILT: Tan, slightly clayey sandy silt; wet at 19'; very wet at 23.5'.
23.0–24.0	3 6 9	Ss	S6	VW				

LITHOLOGY

WELL INSTALLATION



FIELD BOREHOLE LOG

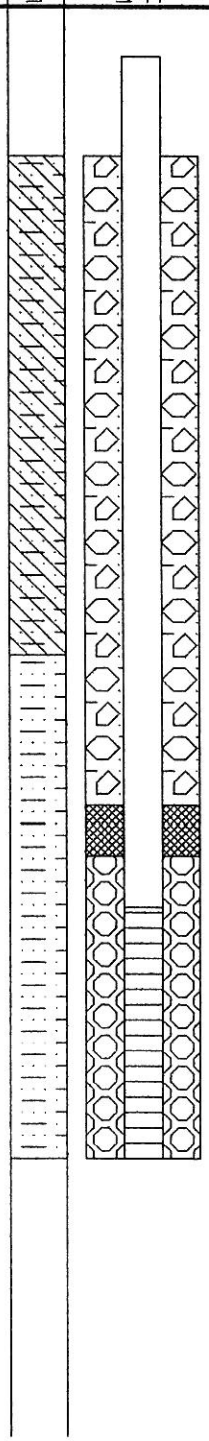
BOREHOLE NUMBER: BP-7

PROJECT NUMBER: **HALIFAX-8**
PROJECT NAME: **HALIFAX COUNTY**
LOCATION: **HALIFAX, NORTH CAROLINA**
DRILLING COMPANY: **BORE AND CORE**
RIG TYPE & NUMBER: **CME 450**
DRILLING METHOD: **HOLLOW STEM AUGER**
WEATHER: **CLOUDY, RAIN 60 DEGREES**
FIELD PARTY: **L. FOSKEY**
GEOLOGIST: **P. MAY**
DATE BEGUN: **4/29/97** DATE COMPLETED: **4/29/97**

TOP OF CASING ELEVATION: **NA**
TOTAL DEPTH: **20.0 FT**
GROUND SURFACE ELEVATION: **NA**
SHEET: **1** OF: **1**

STATIC WATER LEVEL (BLS)		
WD=While Drilling AB=After Boring		
Depth(Ft)	1.0	3.26
Time	5:00 pm	2:00 pm
Date:	4/29/97	4/30/97

DEPTH	BLOW COUNTS	SAMPLING METHOD	SAMPLE NUMBER	MOISTURE	CONSISTANCY	SAMPLE RECOVERY	DRILL METHOD	LITHOLOGY DESCRIPTION
0.0	3 3 6	Ss	S1	M		16"		CLAYEY SANDY SILT: 6" of topsoil underlain by tan soft clayey sandy silt; bulk sample 1-10';
3.0	4 5 6	Ss	S2	M		18"		ML; iron banding from 3.5-5.0';
8.0	3 2 4	Ss	S3	W		14"		manganese bands from 8.5-10.0'.
10.0								SANDY SILT: Tan fine sandy silt with white feldspar; micaceous;
13.0	4 6 8	Ss	S4	W		16"		MH;
18.0	8 9 11	Ss	S5	W		16"		
20.0								Boring terminated at 20.0'.



FIELD BOREHOLE LOG

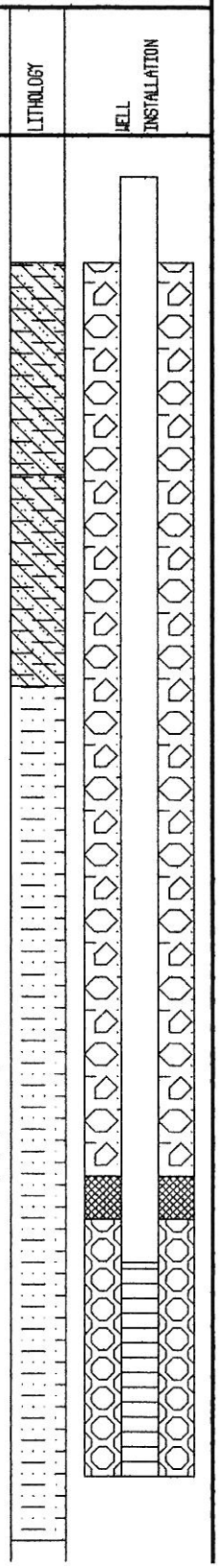
BOREHOLE NUMBER: BP-8

PROJECT NUMBER: HALIFAX-8
PROJECT NAME: HALIFAX COUNTY
LOCATION: HALIFAX, NORTH CAROLINA
DRILLING COMPANY: BORE AND CORE
RIG TYPE & NUMBER: CME 450
DRILLING METHOD: HOLLOW STEM AUGER
WEATHER: CLOUDY, RAIN 60 DEGREES
FIELD PARTY: L. FOSKEY
GEOLOGIST: P. MAY
DATE BEGUN: 4/29/97 DATE COMPLETED: 4/29/97

TOP OF CASING ELEVATION: NA
TOTAL DEPTH: 30.0 FT
GROUND SURFACE ELEVATION: NA
SHEET: 1 OF: 1

STATIC WATER LEVEL (BLS)		
WD=While Drilling AB=After Boring		
Depth(ft)	21.7	14.43
Time	2:00 pm	2:00 pm
Date:	4/29/97	4/30/97

DEPTH	BLOW COUNTS	SAMPLING METHOD	SAMPLE NUMBER	MOISTURE	CONSISTANCY	SAMPLE RECOVERY	DRILL METHOD	LITHOLOGY DESCRIPTION
0.0	2 6 10	Ss	s1	D		16"		SILTY SANDY CLAY: 6" of topsoil underlain by firm red-brown dry silty sandy clay; bulk sample 1-10'; MH-CL.
3.0	10 12 18	Ss	s2	D		18"		
5.0								SANDY CLAYEY SILT: Tan fine dry sandy clayey silt; ML.
8.0	10 13 18	Ss	s3	D		14"		
10.0								SANDY SILT: Red-purple moist fine sandy silt; trace clay; micoceous; MH;
13.0	4 7 11	Ss	s4	M		16"		
17.0								water at 18 feet; bands of white feldspar at 19-20 feet; manganese striations starting at 18-20 feet.
18.0	6 7 12	Ss	s5	M		18"		
23.0	5 8 13	Ss	s6	VM		16"		
28.0	5 8 14	Ss	s7	VM		14"		
30.0								Boring terminated at 30.0 feet.



FIELD BOREHOLE LOG

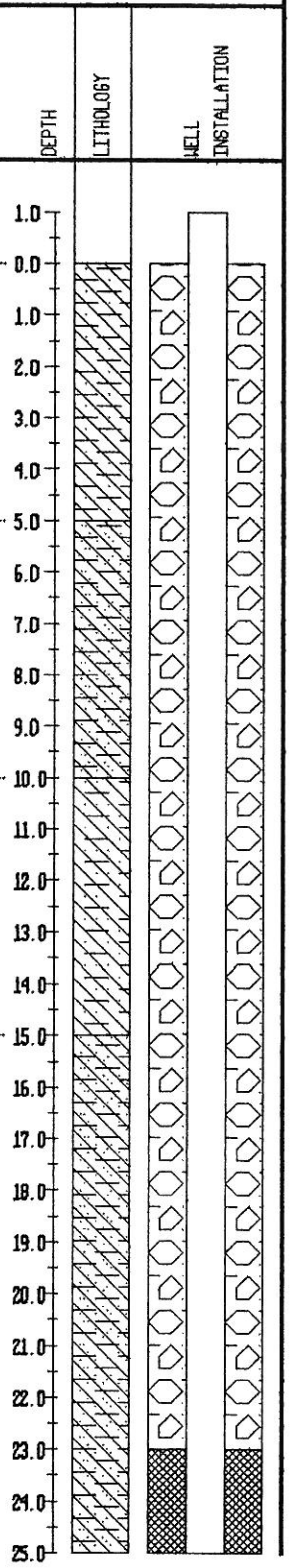
BOREHOLE NUMBER: BP-9

PROJECT NUMBER: HALIFAX-B
PROJECT NAME: HALIFAX COUNTY
LOCATION: HALIFAX, NORTH CAROLINA
DRILLING COMPANY: BORE AND CORE
RIG TYPE & NUMBER: CME 450
DRILLING METHOD: HOLLOW STEM AUGER
WEATHER: CLOUDY, RAIN 60 DEGREES
FIELD PARTY: L. FOSKEY
GEOLOGIST: P. MAY
DATE BEGUN: 4/28/97 DATE COMPLETED: 4/28/97

TOP OF CASING ELEVATION: NA
TOTAL DEPTH: 35.0 FT
GROUND SURFACE ELEVATION: NA
SHEET: 1 OF: 2

STATIC WATER LEVEL (BLS)		
WD=While Drilling AB=After Boring		
Depth(ft)	18.4	18.88
Time	2:00 pm	12:30 pm
Date:	4/28/97	4/30/97

DEPTH	BLOW COUNTS	SAMPLING METHOD	SAMPLE NUMBER	MOISTURE	CONSISTANCY	SAMPLE RECOVERY	DRILL METHOD	LITHOLOGY DESCRIPTION
0.0	2 4 7	Ss	S1	D		16"		CLAYEY SILT: 6" of topsoil underlain by red-brown dry clayey silt; moderately plastic; MH-CL.
3.0	6 10 14	Ss	S2	D		18"		
5.0								CLAYEY SILTY SAND: Tan moist F-M clayey silty sand; mottled with pink & white feldspar; quartz granules; SM-SC.
8.0	5 8 9	Ss	S3	M		14"		
10.0								CLAYEY SANDY SILT: Mottled tan & pink & white moist M-C clayey sandy silt; some quartz; MH-CL.
13.0	5 7 10	Ss	S4	M		16"		
15.0								SILTY CLAYEY SAND: Mottled tan moist silty clayey sand with pink & white feldspar; some quartz; manganese banding starts at 19.0'; SM-SC;
18.0	7 7 11	Ss	S5	M		16"		
20.0								water at 20.0';
23.0	7 12 17	Ss	S6	M		12"		mostly lateral manganese bands; micaceous; mostly pink feldspar;



FIELD BOREHOLE LOG

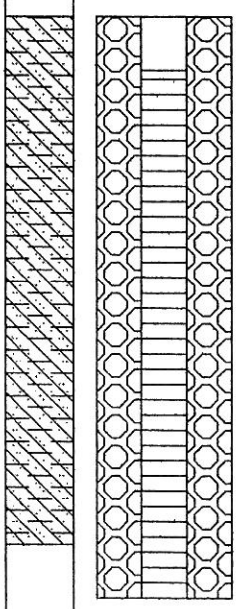
BOREHOLE NUMBER: BP-9

PROJECT NUMBER: HALIFAX-8
PROJECT NAME: HALIFAX COUNTY
LOCATION: HALIFAX, NORTH CAROLINA
DRILLING COMPANY: BORE AND CORE
RIG TYPE & NUMBER: CME 450
DRILLING METHOD: HOLLOW STEM AUGER
WEATHER: CLOUDY, RAIN 60 DEGREES
FIELD PARTY: L. FOSKEY
GEOLOGIST: P. MAY
DATE BEGUN: 4/28/97 DATE COMPLETED: 4/28/97

TOP OF CASING ELEVATION: NA
TOTAL DEPTH: 35.0 FT
GROUND SURFACE ELEVATION: NA
SHEET: 2 OF: 2

STATIC WATER LEVEL (BLS)		
WD=While Drilling AB=After Boring		
Depth(ft)	18.4	18.88
Time	2:00 pm	12:30 pm
Date:	4/28/97	4/30/97

DEPTH	BLOW COUNTS	SAMPLING METHOD	SAMPLE NUMBER	MOISTURE	CONSISTANCY	SAMPLE RECOVERY	DRILL METHOD	LITHOLOGY DESCRIPTION
25.0								
26.0								
27.0								
28.0	7	Ss	S7	M		16"		
29.0	10							white feldspar bands more evident.
	14							
30.0								
31.0								
32.0								
33.0	10	Ss	S8	M		14"		
34.0	13							
	14							
35.0								Boring terminated at 36.0'.
36.0								
37.0								
38.0								
39.0								
40.0								
41.0								
42.0								
43.0								
44.0								
45.0								
46.0								
47.0								
48.0								
49.0								
50.0								



FIELD BOREHOLE LOG

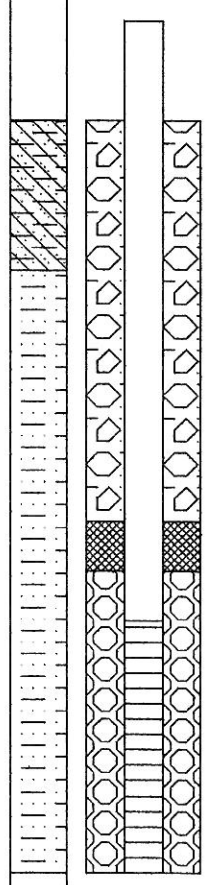
BOREHOLE NUMBER: BP-10

PROJECT NUMBER: HALIFAX-8
PROJECT NAME: HALIFAX COUNTY
LOCATION: HALIFAX, NORTH CAROLINA
DRILLING COMPANY: BORE AND CORE
RIG TYPE & NUMBER: CME 450
DRILLING METHOD: HOLLOW STEM AUGER
WEATHER: CLOUDY, RAIN 60 DEGREES
FIELD PARTY: L. FOSKEY
GEOLOGIST: P. MAY
DATE BEGUN: 4/30/97 DATE COMPLETED: 4/30/97

TOP OF CASING ELEVATION: NA
TOTAL DEPTH: 15.0 FT
GROUND SURFACE ELEVATION: NA
SHEET: 1 OF: 1

STATIC WATER LEVEL (BLS)		
WD=While Drilling AB=After Boring		
Depth(ft)	4.8	5.86
Time	2:00 pm	1:45 pm
Date:	4/30/97	5/1/97

DEPTH	BLOW COUNTS	SAMPLING METHOD	SAMPLE NUMBER	MOISTURE	CONSISTANCY	SAMPLE RECOVERY	DRILL METHOD	LITHOLOGY DESCRIPTION
0.0	4 5 6	Ss	S1	D		14"		SANDY CLAYEY SILT: 6" of topsoil underlain by tan dry C sandy clayey silt; some quartz; ML.
3.0	3 4 5	Ss	S2	D		16"		SANDY SILT: Tan-grey moist F-M sandy silt; iron banding; MH;
8.0	2 3 4	Ss	S3	M		18"		less sand at 8-10'; some manganese in vertical bands; mottled with white & gray granite; water at 10';
13.0	3 3 5	Ss	S4	W		10"		turns brown-grey at 13'; more sand and mica; white feldspar striations.
15.0								Boring terminated at 15.0'.



FIELD BOREHOLE LOG

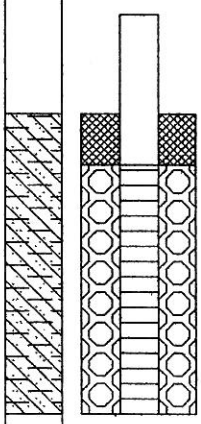
BOREHOLE NUMBER: BP-11

PROJECT NUMBER: HALIFAX-B
PROJECT NAME: HALIFAX COUNTY
LOCATION: HALIFAX, NORTH CAROLINA
DRILLING COMPANY: GNRA
RIG TYPE & NUMBER: NA
DRILLING METHOD: HAND AUGER
WEATHER: BUNNY 70 DEGREES
FIELD PARTY: P. MAY
GEOLOGIST: P. MAY
DATE BEGUN: 5/1/97 DATE COMPLETED: 5/1/97

TOP OF CASING ELEVATION: NA
TOTAL DEPTH: 6.0 FT
GROUND SURFACE ELEVATION: NA
SHEET: 1 OF: 1

STATIC WATER LEVEL (BLS)		
WD=While Drilling AB=After Boring		
Depth(ft)	0.5	2.05
Time	10:30 am	1:00 pm
Date:	5/1/97	5/1/97

DEPTH	BLOW COUNTS	SAMPLING METHOD	SAMPLE NUMBER	MOISTURE	CONSISTANCY	SAMPLE RECOVERY	DRILL METHOD	LITHOLOGY DESCRIPTION	DEPTH	LITHOLOGY	WELL INSTALLATION
2.0									2.0		
1.0									1.0		
0.0								SANDY CLAYEY SILT: 2" of topsoil underlain by tan wet F-M sandy clayey silt; some quartz; some white-gray striations (granite); quartz at 4-5'; ML.	0.0		
1.0									1.0		
2.0									2.0		
3.0									3.0		
4.0									4.0		
5.0									5.0		
6.0								Boring terminated at 6.0'.	6.0		
7.0									7.0		
8.0									8.0		
9.0									9.0		
10.0									10.0		
11.0									11.0		
12.0									12.0		
13.0									13.0		
14.0									14.0		
15.0									15.0		
16.0									16.0		
17.0									17.0		
18.0									18.0		
19.0									19.0		
20.0									20.0		
21.0									21.0		
22.0									22.0		
23.0									23.0		
24.0									24.0		
25.0									25.0		



FIELD BOREHOLE LOG

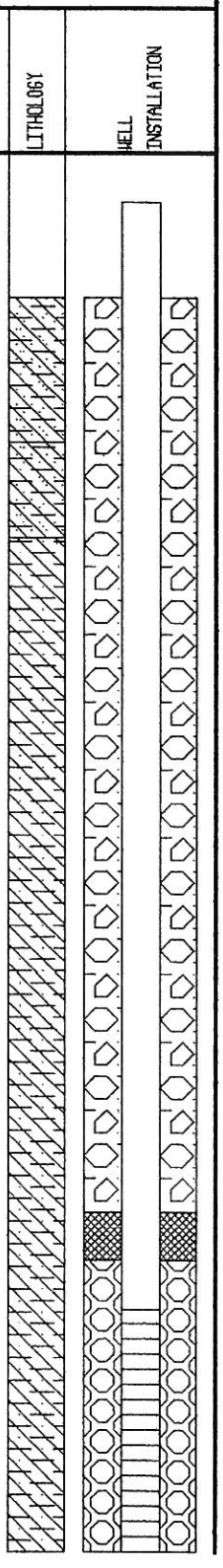
BOREHOLE NUMBER: BP-12

PROJECT NUMBER: HALIFAX-8
PROJECT NAME: HALIFAX COUNTY
LOCATION: HALIFAX, NORTH CAROLINA
DRILLING COMPANY: BORE AND CORE
RIG TYPE & NUMBER: CME 450
DRILLING METHOD: HOLLOW STEM AUGER
WEATHER: PARTLY SUNNY, 70 DEGREES
FIELD PARTY: L. FOSKEY
GEOLOGIST: P. MAY
DATE BEGUN: 4/30/97 DATE COMPLETED: 4/30/97

TOP OF CASING ELEVATION: NA
TOTAL DEPTH: 25.0 FT
GROUND SURFACE ELEVATION: NA
SHEET: 1 OF: 1

STATIC WATER LEVEL (BLS)		
WD=While Drilling AB=After Boring		
Depth(ft)	21.3	5.97
Time	9:00 Am	2:00 pm
Date:	4/30/97	5/1/97

DEPTH	BLOW COUNTS	SAMPLING METHOD	SAMPLE NUMBER	MOISTURE	CONSISTANCY	SAMPLE RECOVERY	DRILL METHOD	LITHOLOGY DESCRIPTION
0.0	3 7 13	Ss	S1	D		14"		SILTY SANDY CLAY: 6" of topsoil underlain by tan dry F silty sandy clay; MH-CL.
3.0	8 10 13	Ss	S2	D		16"		SANDY CLAYEY SILT: Tan dry F sandy clayey silt; ML.
5.0								CLAYEY SILT: Dark purple dry clayey silt; fractures of white feldspar;
8.0	5 5 7	Ss	S3	D		16"		MH-CL;
11.0								turns red with tan bands; grey/white granite striations;
13.0	5 5 5	Ss	S4	M		18"		water at 15.0';
16.0								tan colored; manganese striations; moist;
18.0	3 5 7	Ss	S5	M		16"		
19.0								some relict rock texture.
23.0	4 4 6	Ss	S6	M		16"		
25.0								Boring terminated at 26.0'.



FIELD BOREHOLE LOG

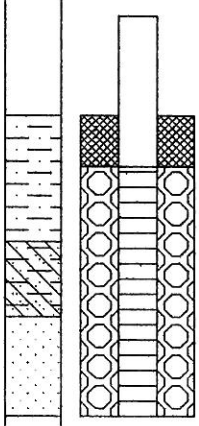
BOREHOLE NUMBER: BP-14

PROJECT NUMBER: HALIFAX-B
PROJECT NAME: HALIFAX COUNTY
LOCATION: HALIFAX, NORTH CAROLINA
DRILLING COMPANY: GNRA
RIG TYPE & NUMBER: NA
DRILLING METHOD: HAND AUGER
WEATHER: BUNNY, 70 DEGREES
FIELD PARTY: P. MAY
GEOLOGIST: P. MAY
DATE BEGUN: 5/1/97 DATE COMPLETED: 5/1/97

TOP OF CASING ELEVATION: NA
TOTAL DEPTH: 6.0 FT
GROUND SURFACE ELEVATION: NA
SHEET: 1 OF: 1

STATIC WATER LEVEL (BLS)		
WD=While Drilling AB=After Boring		
Depth(ft)	2.5	2.60
Time	11:00 am	1:30 pm
Date:	5/1/97	5/1/97

DEPTH	BLOW COUNTS	SAMPLING METHOD	SAMPLE NUMBER	MOISTURE	CONSISTANCY	SAMPLE RECOVERY	DRILL METHOD	LITHOLOGY DESCRIPTION
0.0–1.0								SILT: 6" of topsoil underlain by dark brown slightly moist silt; MH-ML.
1.0–3.0								SANDY CLAYEY SILT: Tan-grey moist F-M sandy clayey silt; ML.
3.0–4.0								SAND: Grey wet F-M sand; tan bands; SW.
4.0–6.0								Boring terminated at 6.0'.

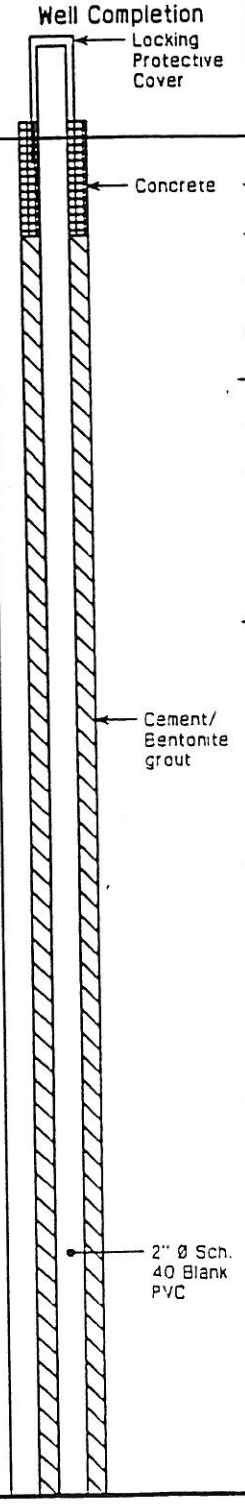


Civil & Environmental Consultants, Inc.	Hazen & Sawyer	JOB NO.: 94521
Cincinnati, OH (513) 469-0200 • (800) 759-5614 / Pittsburgh, PA (412) 921-4302 • (800) 365-2324	Hallfax County Landfill	LOG OF MW-15
	Hallfax, NC	Sheet 1 of 2

LOGGED BY: J. Barnard	GROUND SURFACE ELEVATION: 307.1 FT. MSL
DRILLER: Parratt-Wolff	TOP OF CASING ELEVATION: 309.10 FT. MSL
DATE DRILLED: 9/21/94	INITIAL WATER LEVEL: 41.5 ' BGS DATE: 9/21/94
DRILL METHOD: 4 1/4" ID Hollow Stem Auger	STATIC WATER LEVEL: 42.15 ' BGS DATE: 9/28/94

HNu (ppm)	Recovery (in.)	Blow Counts	Elevation MSL	Depth (ft.)	Graphic Log	Materials Description
	NA	NA	305			Orangish-brown, SILT, trace fine to coarse sand, trace clay, sl. moist.
	22	6 8 12 14	300	5		Reddish-brown silty CLAY, trace fine sand, dry to sl. moist.
	17	4 6 7 8	295	10		Reddish-brown clayey SILT.
						Orangish-brown, trace pink, clayey fine SAND to fine GRAVEL, sl. moist.
	23	4 5 6 7	290	15		Orangish-brown, trace gray, clayey SILT, some fine sand to fine gravel, sl. moist.
	22	7 8 11 19	285	20		Pink, orangish-tan, and white, silty fine to coarse SAND, trace fine gravel, micaceous (Granite Saprolite), sl. moist.
						Hard drilling beginning at approx. 22'.
	23	24 25 28 25	280	25		Same as above, dry to sl. moist.

Well Completion



Civil & Environmental Consultants, Inc.
Cincinnati, OH (513) 469-0200 • (800) 759-6814
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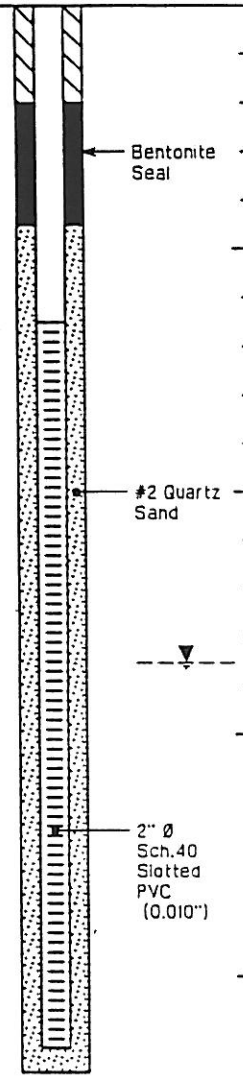
Hazen & Sawyer
Halifax County Landfill
Halifax, NC

JOB NO.: 94521
LOG OF MW-15
Sheet 2 of 2

HNu (ppm)	Recovery (in.)	Blow Counts	Elevation MSL	Depth (ft.)	Graphic Log	Materials Description
	22	14 18 19 24				Same, dry.
			275	33		
	13	14 16 18 19				Pink, orangish-tan, and white, silty fine to coarse SAND, high % of pink feldspar crystals, sl. moist.
			270	38		
	21	9 10 7 8				Same, with increasing clay content, moist.
			265	43		
			260	48		
						Bottom of boring at 50.0' BGS.
			255	53		
			250	58		

Well Completion



Appendix B

Geotechnical Laboratory Data

Design Hydrogeologic Report
Halifax County C&D Landfill – Area 2
Halifax County, North Carolina

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GeoTechnologies, Inc., P.A.

3200 Wellington Court, Suite G
Raleigh, North Carolina 27615
Phone: (919) 954-1514 Fax: (919) 954-1428

5/20/97

G.N. Richardson & Associates
417 North Boylan Avenue
Raleigh, NC 27603

Attention: Project Manager

Attached for your review are the results of construction material testing performed on the G.N. Richardson & Assoc. Lab Services project which is located in Raleigh, North Carolina.

Very truly yours,

GeoTechnologies, Inc.

R. Sherwood Core, CET
Construction Services Manager

Edward B. Hearn, P.E.
President

Project No. 1-95-0084-CA
RSC-EBH/fgo
Enclosures

c:

GeoTechnologies, Inc.

PERMEABILITY TEST

Job Number:	1-96-0084 CA	**Job Name:**	G N RICHARDSON		
Date:	5/19/97	**Sample I.D.**	BP - 8	**Depth:**	

Soil Description: TAN SANDY SILT

SAMPLE DATA

type		standard proctor	
remolded	(X)	Max. Dry Density	98.1 lbs/cu.ft.
undisturbed	()	Moisture Content	24 %
		Compaction	94.7 %

	inches	cm.			
Length	**3.013**	**7.653**		Moisture Content	**24.4** %
Diameter	**2.869**	**7.287**		Wet Density	**115.5** lbs./cu.ft.
Area	**6.465**	**41.708**		Dry Density	**92.9** lbs./cu.ft.
Volume	**19.478**	**319.191**		Initial Saturation	**79.1** %
Wet Mass	**1.302**	**590.64**	grams	Final Saturation	**100.0** %
Dry Mass	**1.0467**	**474.8**	grams	Initial Void Ratio	**0.8**
				Porosity	**45.9**
				Specific Gravity	**2.75** apparent

TEST DATA

	L =	7.65 cm.	length of sample
hi = inflow burette	A =	41.708 sq.cm.	area of sample
ho = outflow burette	a =	0.852 sq.cm.	area of burettes
t = time	h1 =	head loss across specimen at t1	
	h2 =	head loss across specimen at t2	

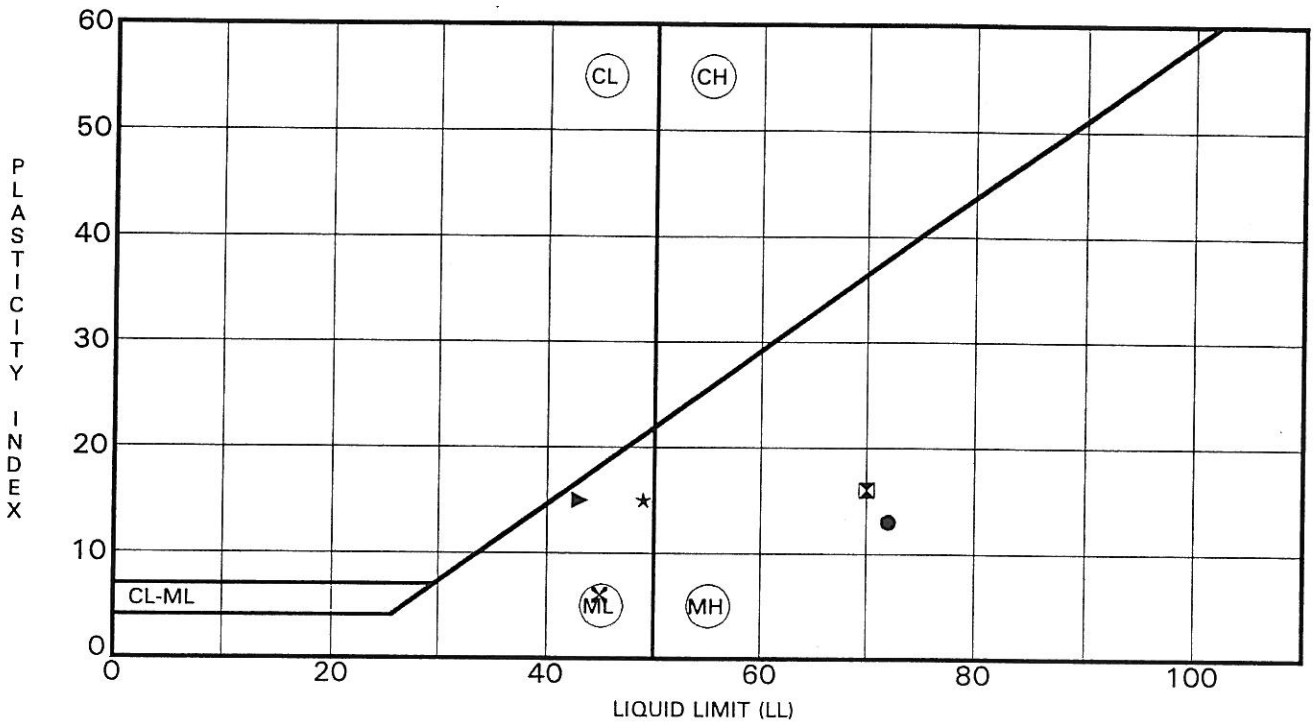
t1	t2	ho1	hi1	h1	ho2	hi2	h2
0	**2400**	94	0.7	**93.3**	93.6	1.2	**92.4**
0	**3120**	93.6	1.2	**92.4**	93	1.6	**91.4**
0	**2580**	93	1.6	**91.4**	92.5	2.1	**90.4**
0	**4320**	92.5	2.1	**90.4**	91.8	2.7	**89.1**

ASTM D 5084

$$k = ((aaL/(At(a+a)))*\ln(h1/h2)$$

1	k =	3.16E-07
2	k =	2.73E-07
3	k =	3.33E-07
4	k =	2.62E-07

Average **k=** **2.96E-07** cm/sec



	Specimen Identification	LL	PL	PI	Fines	Classification
●	BP-12	72	59	13		Orange Brown Clayey SILT (MH)
⊠	BP-13	70	54	16		Light Green Yellow Sandy SILT (MH)
▶	BP-7	43	28	15		Light Brown Fine Sandy Slightly Clayey SILT (ML)
★	BP-8	49	34	15		Orange Brown Slightly Clayey SILT (ML)
✕	BP-9	45	39	6		Tan Brown Sandy SILT (ML)

PROJECT G.N. Richardson & Associates Lab Services - Raleigh, North Carolina

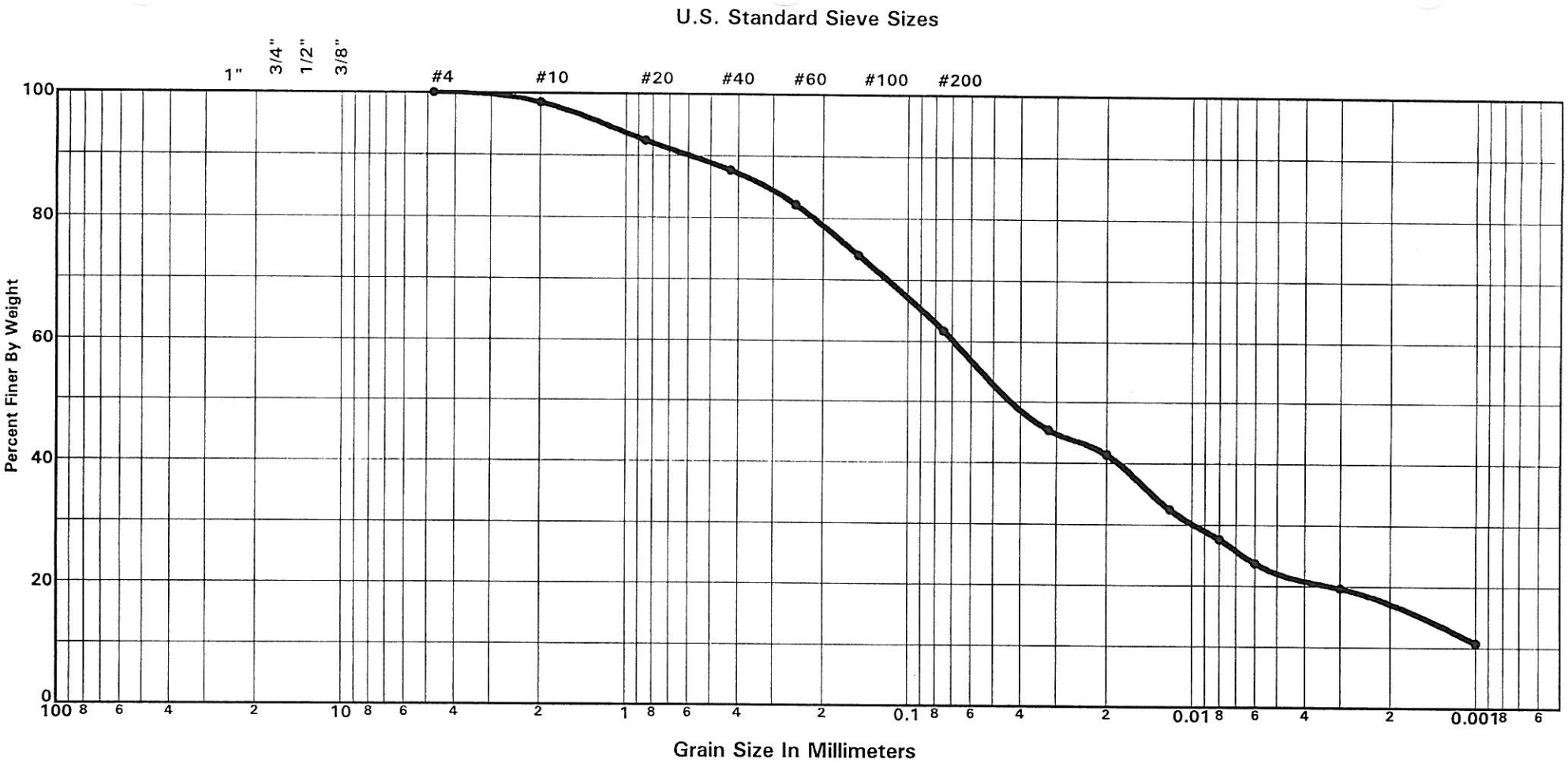
JOB NO. 1-95-0084 CA

DATE 5/19/97

ATTERBERG LIMITS' RESULTS

GeoTechnologies, Inc.

Raleigh, North Carolina



GRAVEL		SAND			FINES	
COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

Boring No.	Elev./Depth	Nat. W.C.	L.L.	P.L.	P.I.	Soil Description or Classification
BP-7						Mustard Yellow Slightly Sandy SILT

Project:

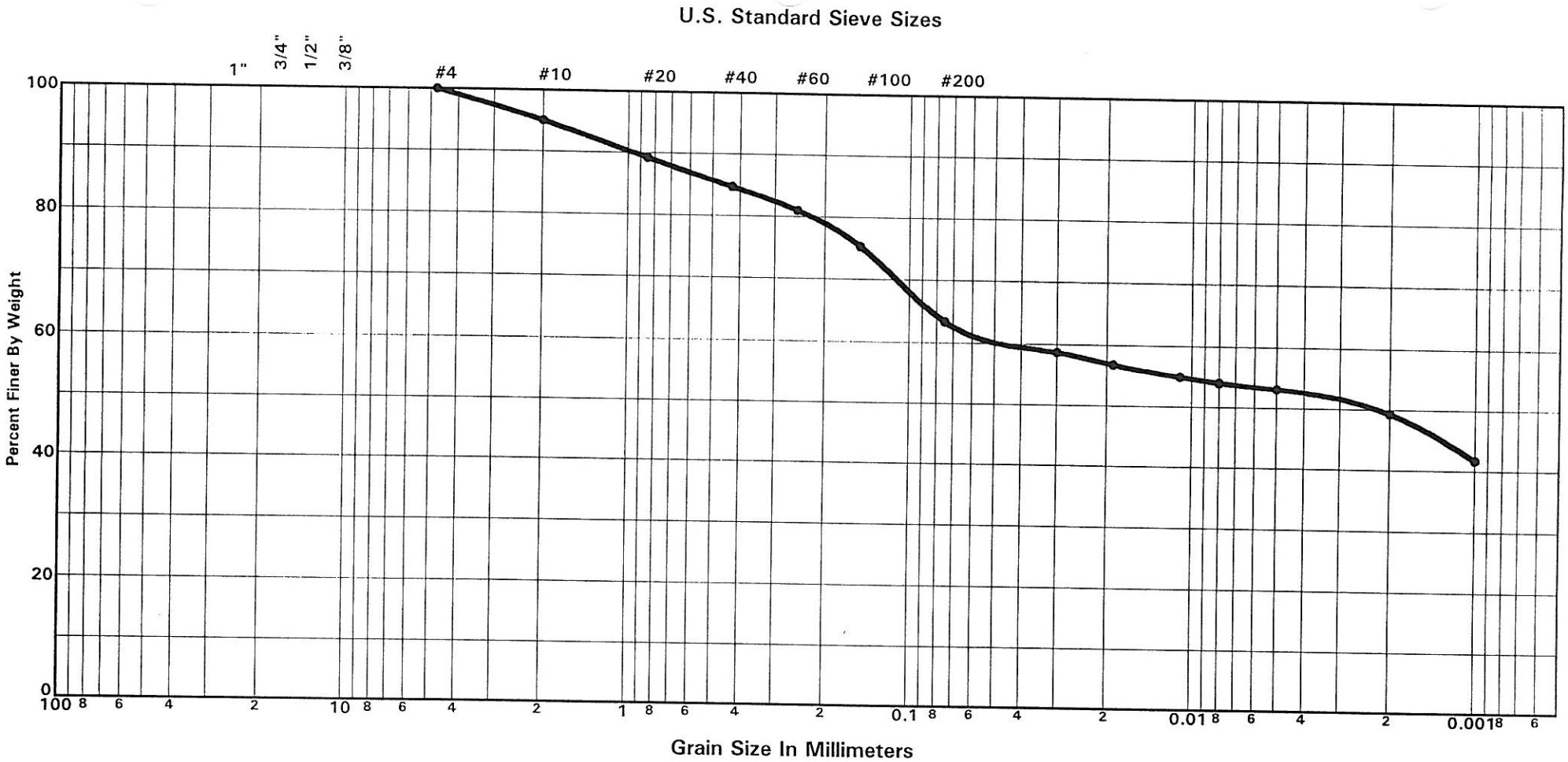
G.N. Richardson & Associates Lab Services
Raleigh, North Carolina

Job No.: 1-95-0084 CA

Date: 5/19/97

GRAIN SIZE DISTRIBUTION

GeoTechnologies, Inc.



GRAVEL		SAND			FINES	
COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

Boring No.	Elev./Depth	Nat. W.C.	L.L.	P.L.	P.I.	Soil Description or Classification
BP-8						Tan Sandy SILT

Project:

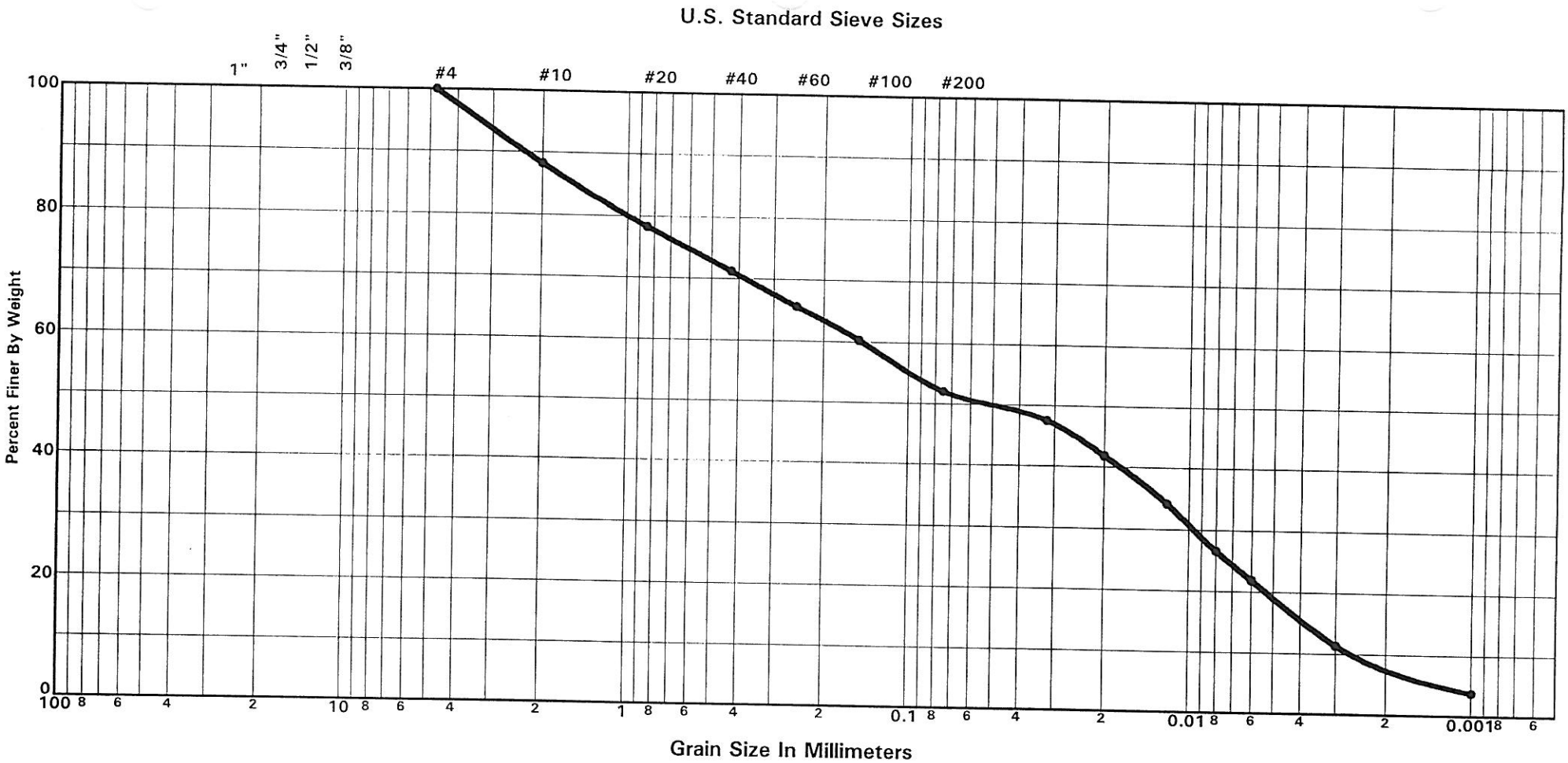
G.N. Richardson & Associates Lab Services
Raleigh, North Carolina

Job No.: 1-95-0084 CA

Date: 5/19/97

GRAIN SIZE DISTRIBUTION

GeoTechnologies, Inc.



GRAVEL		SAND			FINES	
COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

Boring No.	Elev./Depth	Nat. W.C.	L.L.	P.L.	P.I.	Soil Description or Classification
BP-9						Micaceous Sandy SILT

Project:

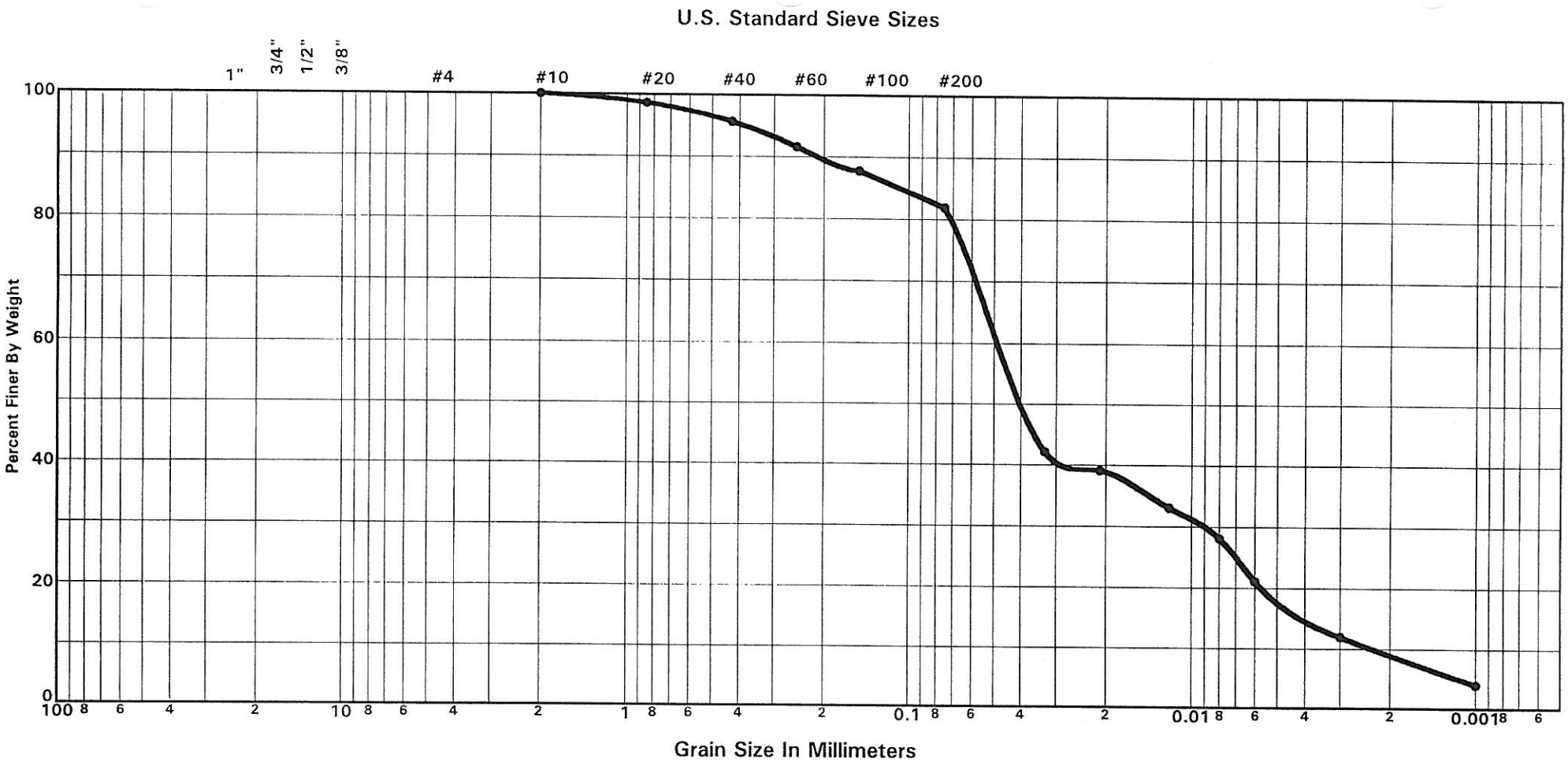
G.N. Richardson & Associates Lab Services
Raleigh, North Carolina

Job No.: 1-95-0084 CA

Date: 5/19/97

GRAIN SIZE DISTRIBUTION

GeoTechnologies, Inc.



GRAVEL		SAND			FINES	
COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

Boring No.	Elev./Depth	Nat. W.C.	L.L.	P.L.	P.I.	Soil Description or Classification
BP-12						Light Yellow Slightly Sandy SILT

Project:

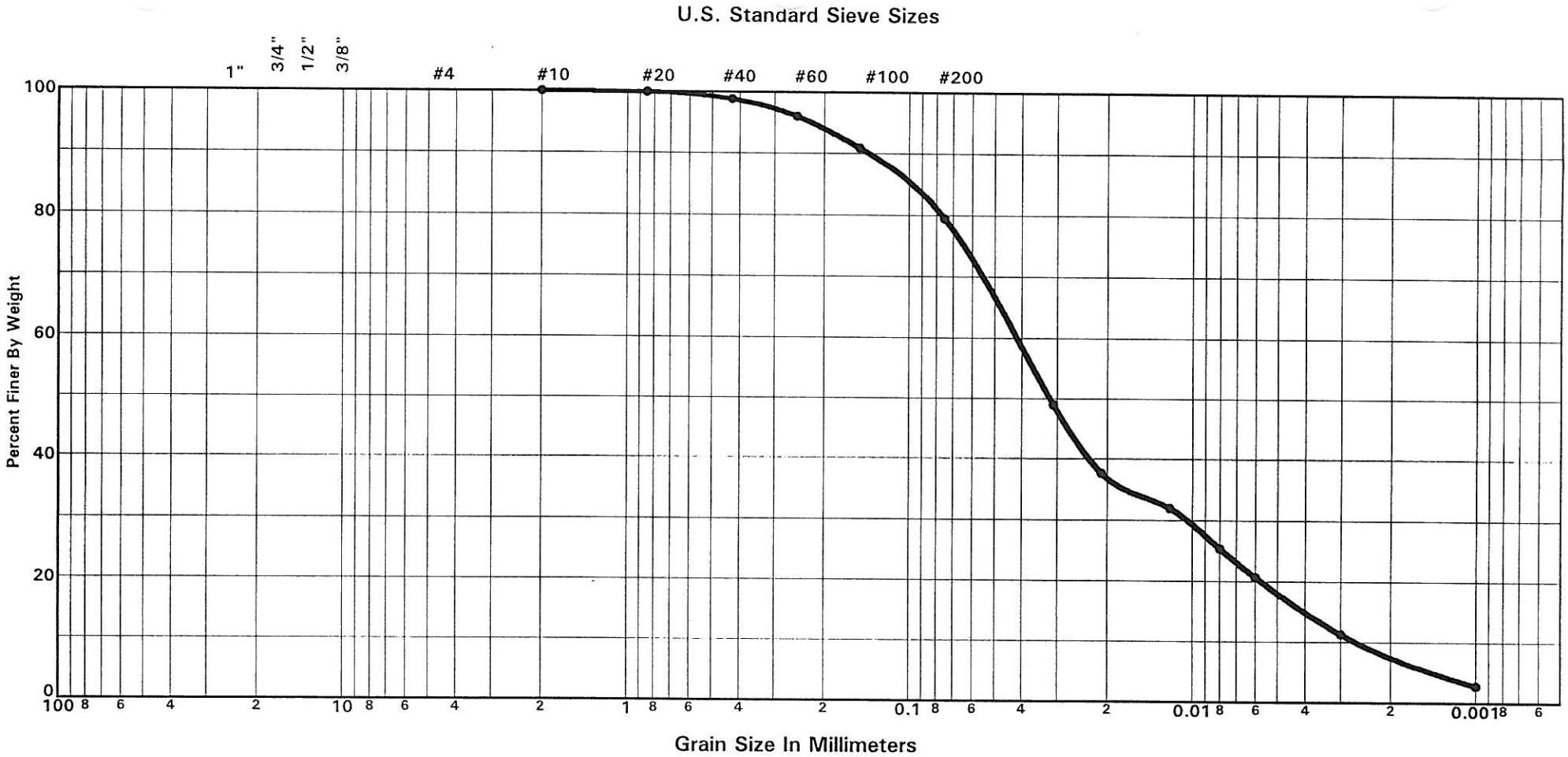
G.N. Richardson & Associates Lab Services
Raleigh, North Carolina

Job No.: 1-95-0084 CA

Date: 5/19/97

GRAIN SIZE DISTRIBUTION

GeoTechnologies, Inc.



GRAVEL		SAND			FINES	
COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

Boring No.	Elev./Depth	Nat. W.C.	L.L.	P.L.	P.I.	Soil Description or Classification
BP-13						Yellow Slightly Sandy SILT

Project:

G.N. Richardson & Associates Lab Services
Raleigh, North Carolina

Job No.: 1-95-0084 CA

Date: 5/19/97

GRAIN SIZE DISTRIBUTION

GeoTechnologies, Inc.

GeoTechnologies, Inc.

Job No: 1-95-0084 CA Date: 5/19/97

Job Name: G.N. Richardson & Associates Lab Services

Job Location: Raleigh, North Carolina

Boring No:

Sample No: BP-8

Depth:

TEST RESULTS

Method of Test: ASTM D 698

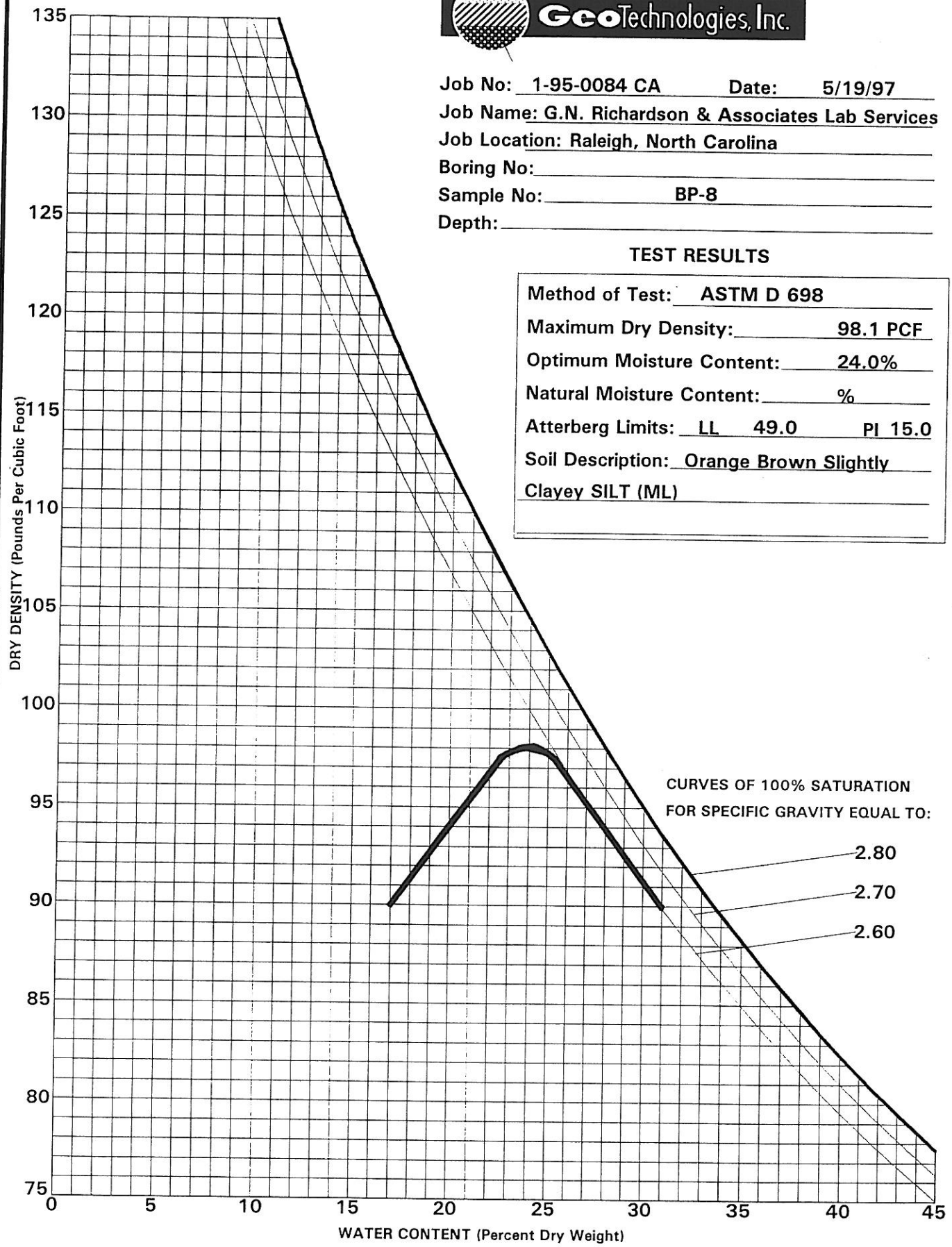
Maximum Dry Density: 98.1 PCF

Optimum Moisture Content: 24.0%

Natural Moisture Content: %

Atterberg Limits: LL 49.0 PI 15.0

Soil Description: Orange Brown Slightly Clayey SILT (ML)



MOISTURE-DENSITY RELATIONSHIP

GeoTechnologies, Inc.

Raleigh, North Carolina

[redacted]logies, Inc.

MOISTURE CONTENT DATA SHEET

[redacted] #: 1-95-0084 CA Job Name: G.N. Richardson

Date: _____

	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	Content [redacted]
1	BP-7	TRI	100.71	326.97	266.23	60.74	165.52	36.7
2	BP-12	I-6	106.53	260.53	196.05	64.48	89.52	72.0
3	BP-9	URG	100.83	332.78	276.84	55.94	176.01	31.8
4	BP-13	PET	100.58	263.80	204.04	59.76	103.46	57.8
5	BP-8	SAR	97.86	369.74	315.20	54.54	217.34	25.1
6								
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GeoTechnologies, Inc.

3200 Wellington Court, Suite G
Raleigh, North Carolina 27615
919-954-1514
Fax 919-954-1428

January 3, 1996

RECEIVED
JAN 10 1996

G.N. Richardson & Associates
317 North Boylan Avenue
Raleigh, NC 27603

Attention: Mr. Gregg Richardson

Reference: Natural Moisture, Atterberg Limits, & Permeability Test Results
Halifax - 6
Halifax, North Carolina
GeoTechnologies Project No. 1-95-1181-CA

Gentlemen:

GeoTechnologies, Inc. has completed laboratory testing on the two samples received in our laboratory on December 14, 1995. As requested, natural moisture, Atterberg limits, sieve analysis, and permeability (remolded) tests were performed. Presented in the following attachment are results of the tests.

GeoTechnologies, Inc. appreciates the opportunity to have provided you with our services on this phase of the project. Please contact us if you should have questions regarding this information or if we may be of any further assistance.

Very truly yours,

GeoTechnologies, Inc.

R. Sherwood Core, CET
Construction Services Manager

Edward B. Hearn, P.E.
President

RSC/fgo
Attachments

GeoTechnologies, Inc.

PERMEABILITY TEST

Job Number:	1-95-1181 CA	**Job Name:**	HALIFAX - 6		
Date:	12/23/95	**Sample I.D.**	BP 3	**Depth:**	3-5'

Soil Description: ORANGE BROWN SILTY SAND

SAMPLE DATA

type
remolded ( )
undisturbed (X)

standard proctor

Max. Dry Density	107.5	lbs/cu.ft.
Moisture Content	19	%
Compaction	95.4	%

	inches	cm.				
Length	**2.861**	**7.267**		Moisture Content	**22**	%
Diameter	**2.852**	**7.244**		Wet Density	**125.1**	lbs./cu.ft.
Area	**6.388**	**41.214**		Dry Density	**102.5**	lbs./cu.ft.
Volume	**18.277**	**299.504**		Initial Saturation	**89.7**	%
Wet Mass	**1.323**	**600.16**	grams	Final Saturation	**100.0**	%
Dry Mass	**1.0845**	**491.9**	grams	Initial Void Ratio	**0.7**	
				Porosity	**40.3**	%
				Specific Gravity	**2.75**	apparent

TEST DATA

hi = inflow burette
ho = outflow burette
t = time

L =	7.27	cm.	length of sample
A =	41.214	sq.cm.	area of sample
a =	0.852	sq.cm.	area of burettes

h1 = head loss across specimen at t1
h2 = head loss across specimen at t2

t1	t2	ho1	hi1	h1	ho2	hi2	h2
0	**5460**	94.3	1.5	**92.8**	94.1	1.6	**92.5**
0	**3900**	94.1	1.6	**92.5**	94	1.7	**92.3**
0	**4440**	94	1.7	**92.3**	93.9	1.8	**92.1**
	74400	93.9	1.8	**92.1**	92.3	3.4	**88.9**

ASTM D 5084

k = ((aaL/(At(a+a)))*ln(h1/h2)

1	k =	4.45E-08
2	k =	4.17E-08
3	k =	3.67E-08
4	k =	3.57E-08

Average k= 3.97E-08 cm/sec

GeoTechnologies, Inc.

PERMEABILITY TEST

Job Number:	1-95-1181 CA	**Job Name:**	HALIFAX - 6		
Date:	12/23/95	**Sample I.D.**	BF 6	**Depth:**	15'

Soil Description: RED ORANGE SANDY SILT

SAMPLE DATA

type
remolded ( )
undisturbed (X)

standard proctor

Max. Dry Density	102.6	lbs/cu.ft.
Moisture Content	21.5	%
Compaction	95.1	%

	inches	cm.				
Length	**2.936**	**7.457**		Moisture Content	**24.5**	%
Diameter	**2.863**	**7.272**		Wet Density	**121.5**	lbs./cu.ft.
Area	**6.438**	**41.534**		Dry Density	**97.6**	lbs./cu.ft.
Volume	**18.901**	**309.735**		Initial Saturation	**88.8**	%
Wet Mass	**1.329**	**602.85**	grams	Final Saturation	**100.0**	%
Dry Mass	**1.0675**	**484.2**	grams	Initial Void Ratio	**0.8**	
				Porosity	**43.2**	%
				Specific Gravity	**2.75**	apparent

TEST DATA

hi = inflow burette
ho = outflow burette
t = time

L =	7.46	cm.	length of sample
A =	41.534	sq.cm.	area of sample
a =	0.852	sq.cm.	area of burettes

h1 = head loss across specimen at t1
h2 = head loss across specimen at t2

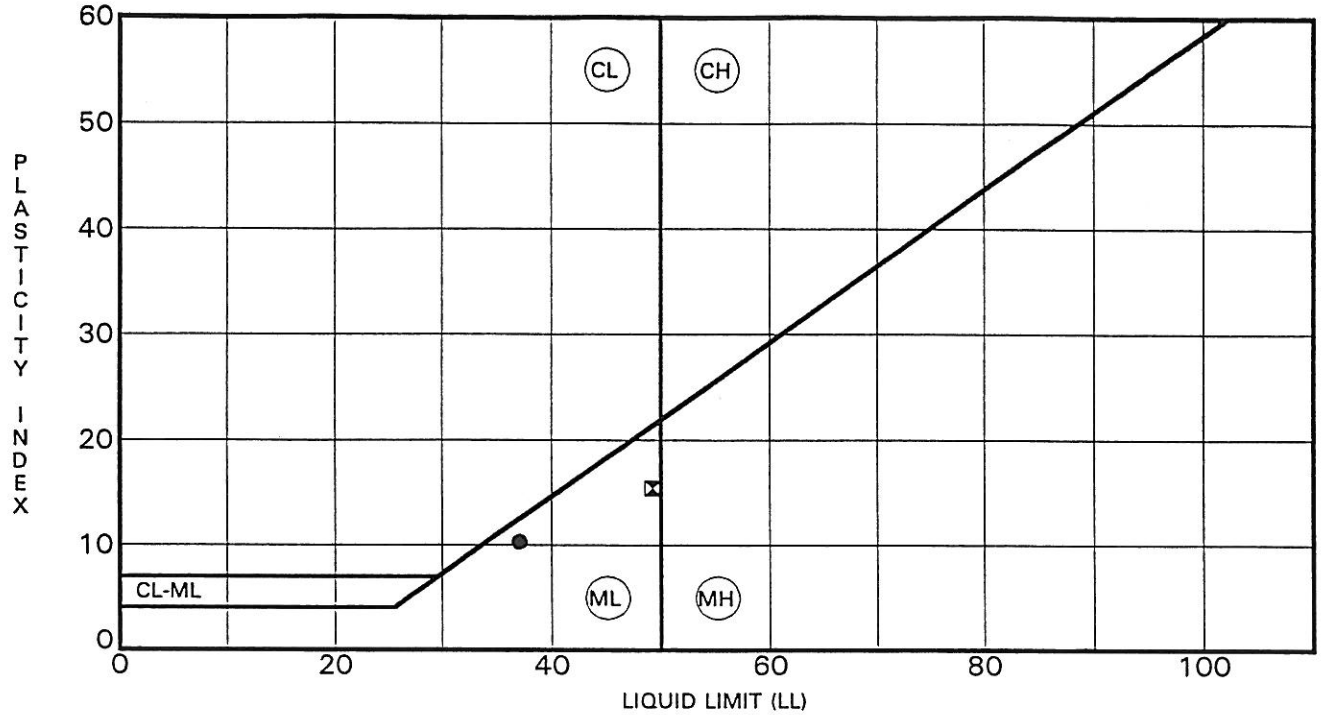
t1	t2	ho1	hi1	h1	ho2	hi2	h2
0	**5700**	93.9	0.9	**93**	93.4	1.4	**92**
0	**3900**	93.4	1.4	**92**	93.1	1.8	**91.3**
0	**4500**	93.1	1.8	**91.3**	92.7	2.1	**90.6**
	74400	92.7	2.1	**90.6**	86.5	8.5	**78**

ASTM D 5084

k = ((aaL/(At(a+a)))*ln(h1/h2)

1	k =	1.45E-07
2	k =	1.50E-07
3	k =	1.31E-07
4	k =	1.54E-07

Average k= 1.45E-07 cm/sec



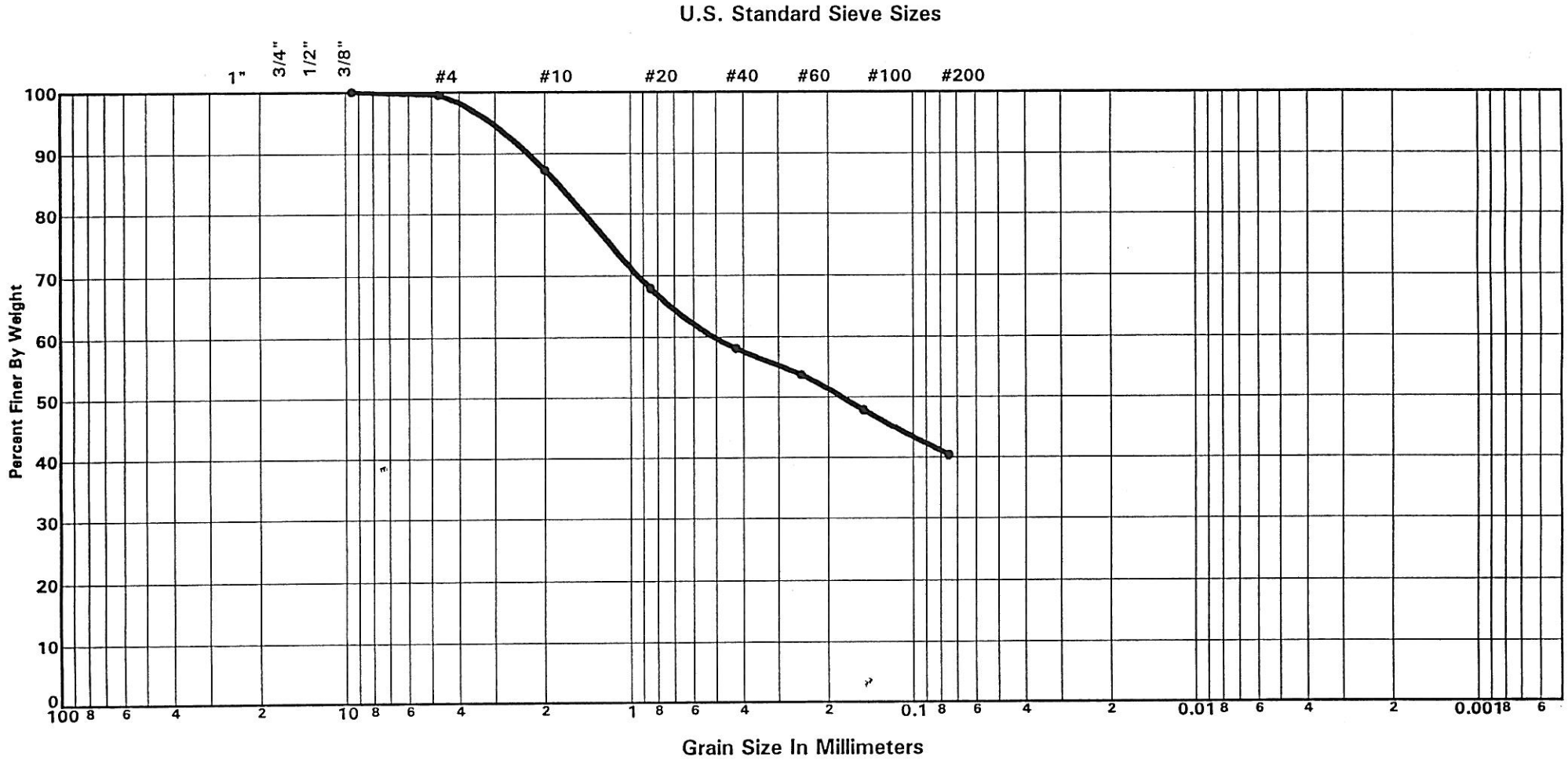
	Specimen Identification		LL	PL	PI	Fines	Classification
●	BP #3	3.0-5.0'	37	27	10	40.4	Brown-Orange Silty SAND (SM)
⊠	BP #6	15.0'	49	34	15	52.8	Red Orange Sandy SILT (ML)

PROJECT Halifax-6 - Halifax, North Carolina

JOB NO. 1-95-1181-CA
DATE 1/2/96

ATTERBERG LIMITS' RESULTS

Geotechnologies, Inc.
Raleigh, North Carolina



GRAVEL		SAND			FINES	
COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

Boring No.	Elev./Depth	Nat. W.C.	L.L.	P.L.	P.I.	Soil Description or Classification
BP #3	3.0-5.0'	13.8	37.1	26.8	10.3	Brown-Orange Silty SAND (SM)

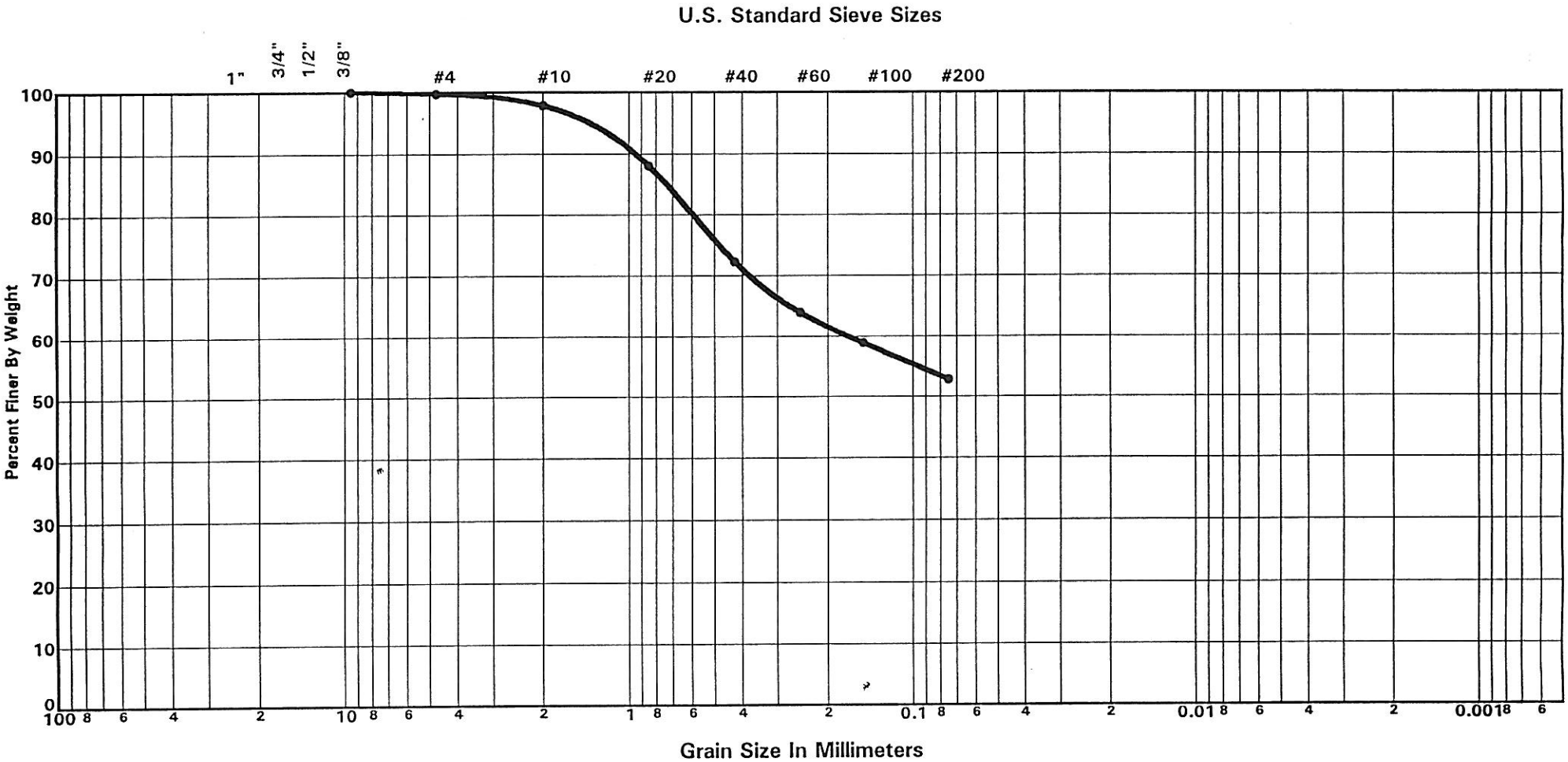
Project:
Halifax-6
Halifax, North Carolina

Job No.: 1-95-1181-CA

Date: 1/2/96

GRAIN SIZE DISTRIBUTION

GeoTechnologies, Inc.



GRAVEL		SAND			FINES	
COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

Boring No.	Elev./Depth	Nat. W.C.	L.L.	P.L.	P.I.	Soil Description or Classification
BP #6	15.0'	34.2	49.3	33.9	15.4	Red Orange Sandy SILT (ML)

Project:
Halifax-6
Halifax, North Carolina

Job No.: 1-95-1181-CA

Date: 1/2/96

GRAIN SIZE DISTRIBUTION

GeoTechnologies, Inc.

GeoTechnologies, Inc.

Job No: 1-95-1181-CA Date: 1/2/96

Job Name: Halifax-6

Job Location: Halifax, North Carolina

Boring No:

Sample No: B-P #6

Depth: 15.0'

TEST RESULTS

Method of Test: ASTM D 698

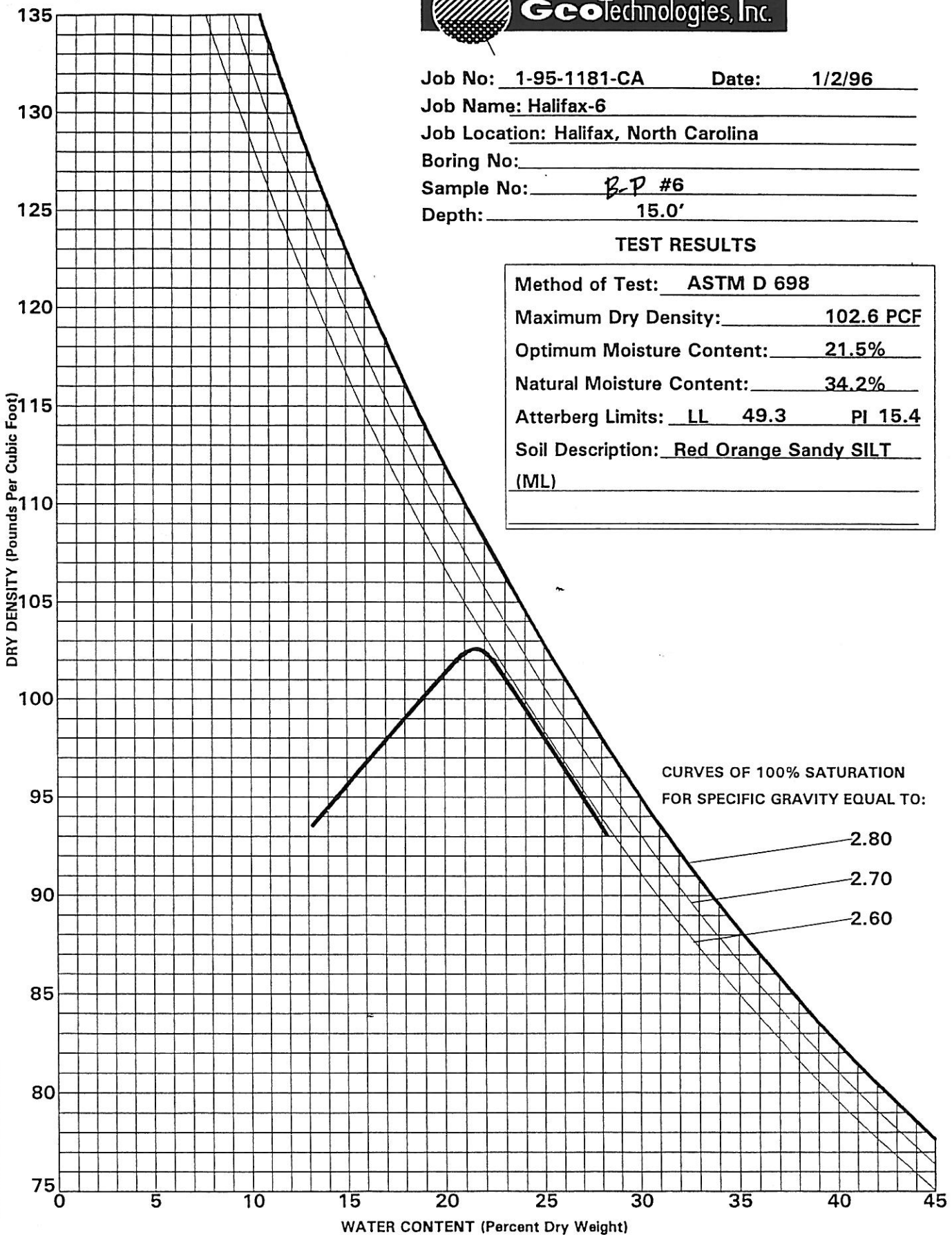
Maximum Dry Density: 102.6 PCF

Optimum Moisture Content: 21.5%

Natural Moisture Content: 34.2%

Atterberg Limits: LL 49.3 PI 15.4

Soil Description: Red Orange Sandy SILT (ML)



MOISTURE-DENSITY RELATIONSHIP

Geotechnologies, Inc.

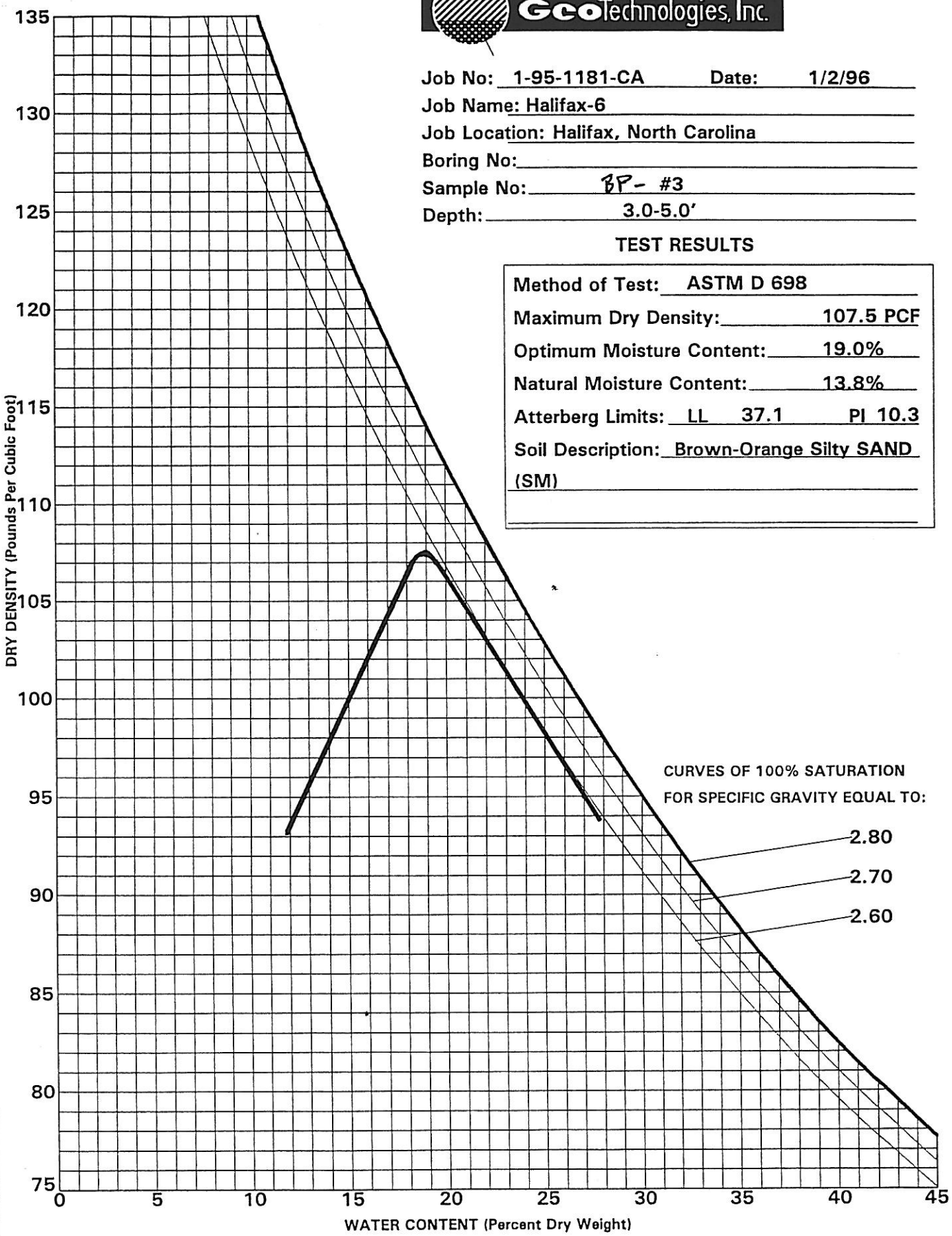
Raleigh, North Carolina

GeoTechnologies, Inc.

Job No: 1-95-1181-CA Date: 1/2/96
Job Name: Halifax-6
Job Location: Halifax, North Carolina
Boring No:
Sample No: BP- #3
Depth: 3.0-5.0'

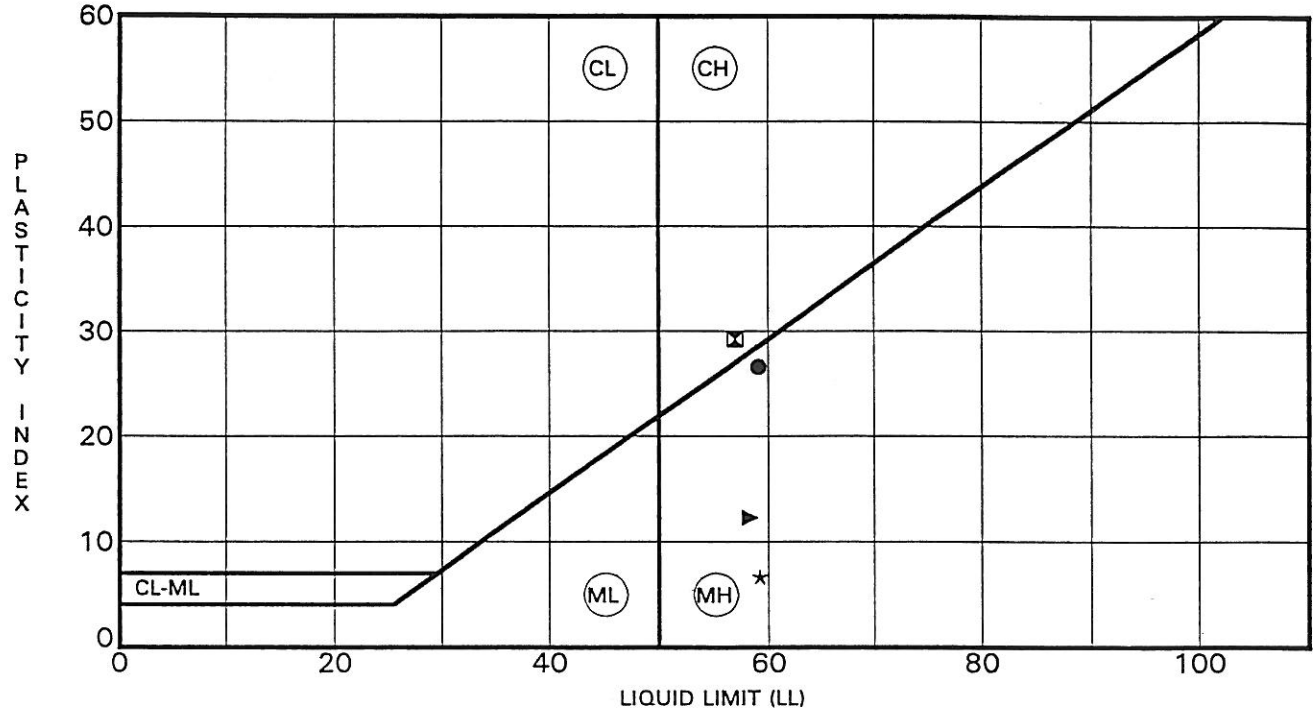
TEST RESULTS

Method of Test: ASTM D 698
Maximum Dry Density: 107.5 PCF
Optimum Moisture Content: 19.0%
Natural Moisture Content: 13.8%
Atterberg Limits: LL 37.1 PI 10.3
Soil Description: Brown-Orange Silty SAND (SM)



MOISTURE-DENSITY RELATIONSHIP

Geotechnologies, Inc.
Raleigh, North Carolina



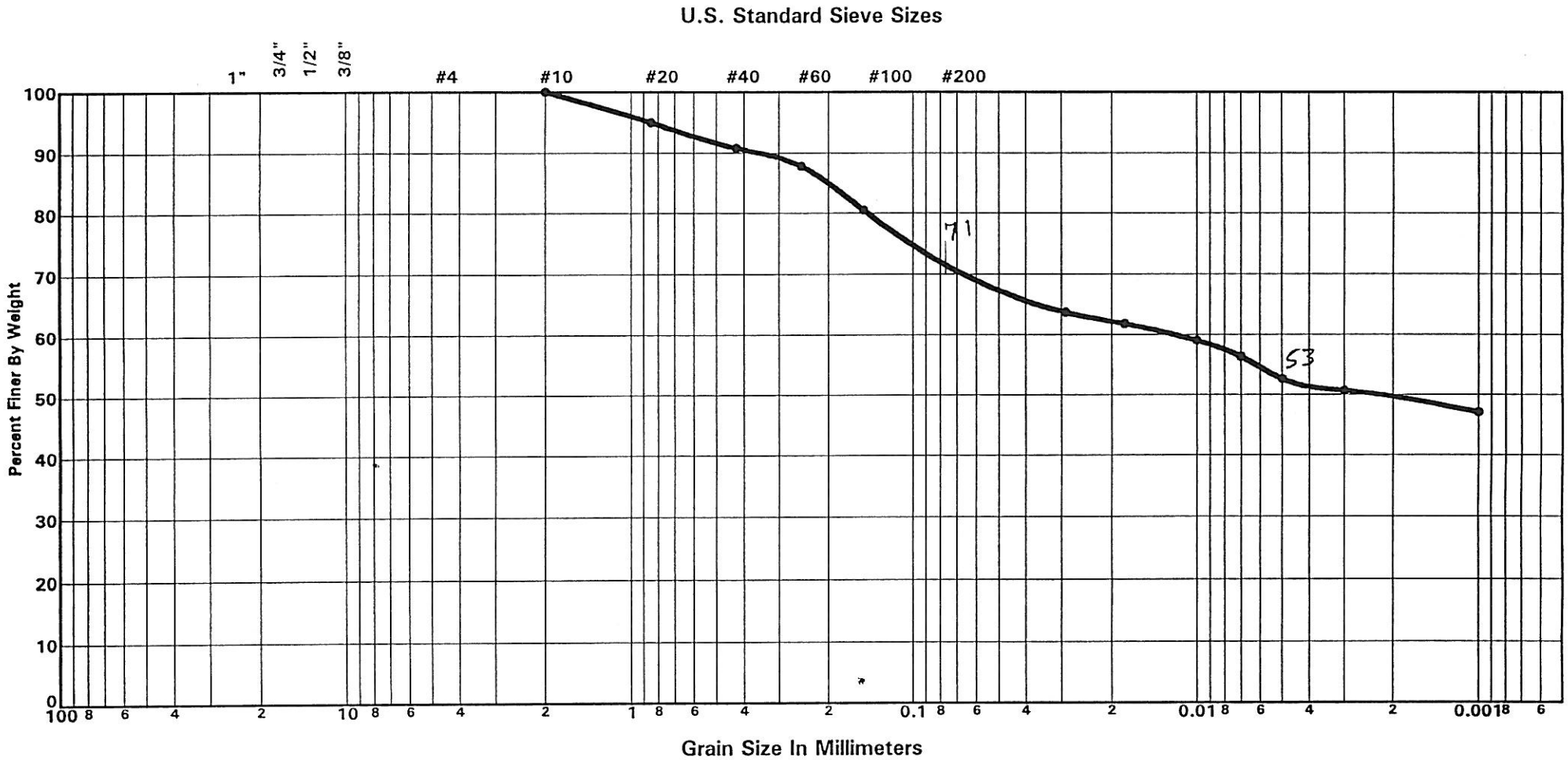
	Specimen Identification		LL	PL	PI	Fines	Classification
●	BP #1 - 1	0-1.5'	59	33	27		Tan Slightly Sandy CLAY (MH)
⊠	BP #2 - 1	0-1.5'	57	28	29		Tan-Orange Slightly Sandy CLAY (CH)
▶	BP #6-1	0-1.5'	58	46	12		Brown Orange Slightly Fine Sandy SILT (MH)
★	BP #6-2	3.5-5.0'	59	53	7		Brown Micaceous Slightly Clayey SILT (MH)

PROJECT Halifax-6 - Halifax, North Carolina

JOB NO. 1-95-1181-CA
DATE 1/2/96

ATTERBERG LIMITS' RESULTS

Geotechnologies, Inc.
Raleigh, North Carolina



GRAVEL		SAND			FINES	
COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

Boring No.	Elev./Depth	Nat. W.C.	L.L.	P.L.	P.I.	Soil Description or Classification
BP #1	0-1.5'		59.1	32.5	26.6	Tan Slightly Sandy CLAY (MH)

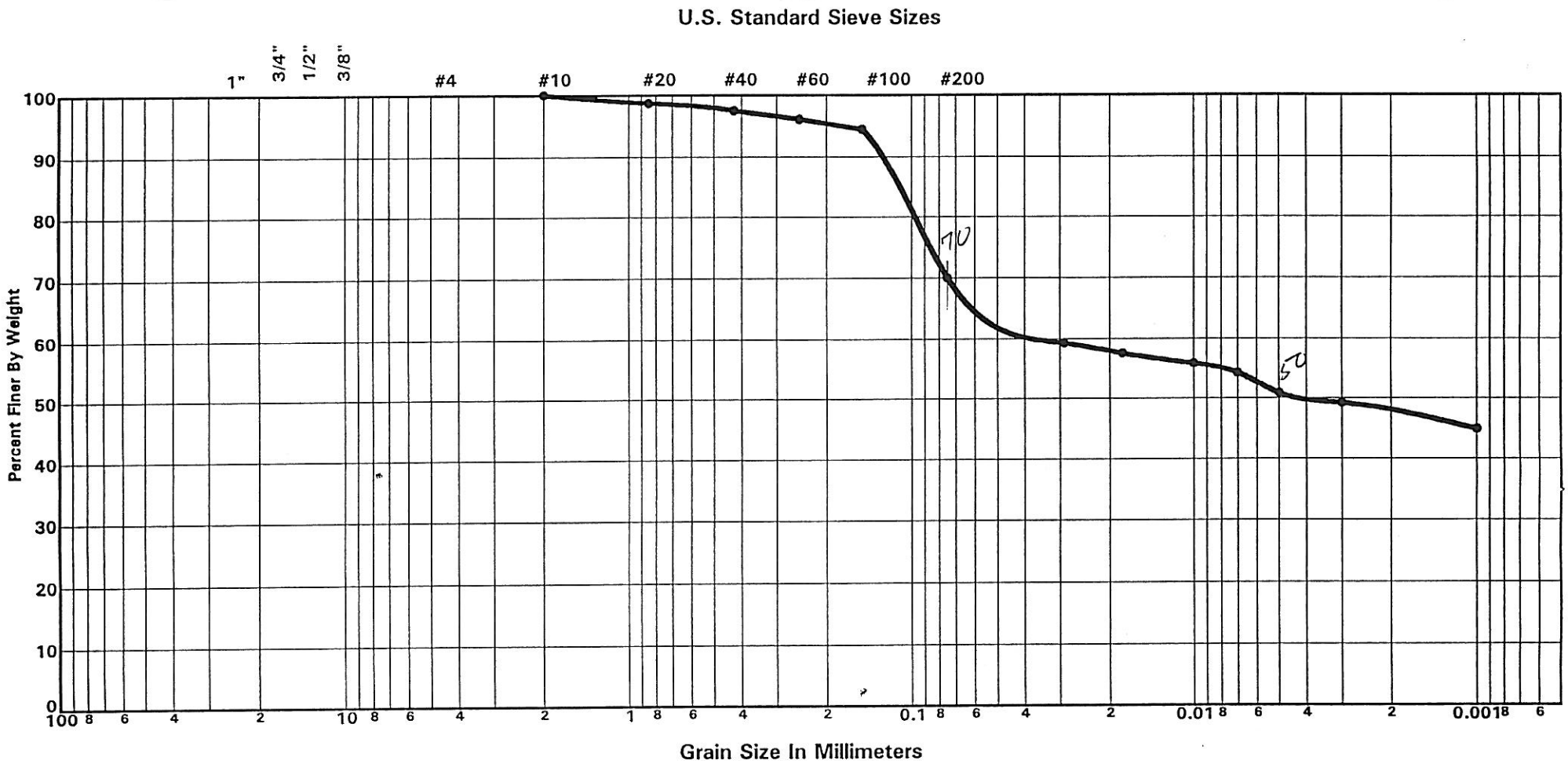
Project:
Halifax-6
Halifax, North Carolina

Job No.: 1-95-1181-CA

Date: 1/4/96

GRAIN SIZE DISTRIBUTION

GeoTechnologies, Inc.



GRAVEL		SAND			FINES	
COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

Boring No.	Elev./Depth	Nat. W.C.	L.L.	P.L.	P.I.	Soil Description or Classification
BP #2	0-1.5'		57.0	27.8	29.2	Tan-Orange Slightly Sandy CLAY (CH)

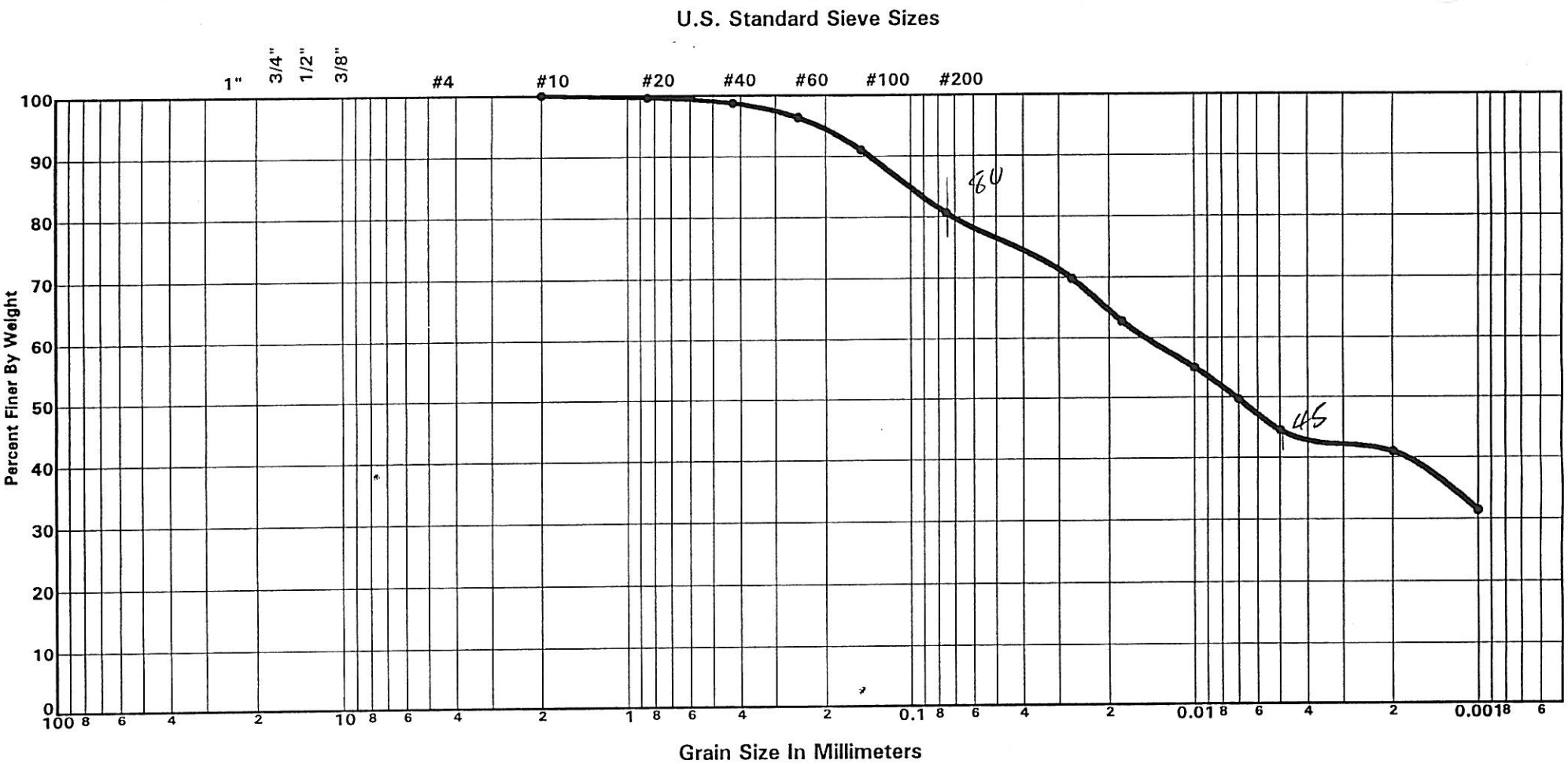
Project:
Halifax-6
Halifax, North Carolina

Job No.: 1-95-1181-CA

Date: 1/2/96

GRAIN SIZE DISTRIBUTION

GeoTechnologies, Inc.



GRAVEL		SAND			FINES	
COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

Boring No.	Elev./Depth	Nat. W.C.	L.L.	P.L.	P.I.	Soil Description or Classification
BP #6-1	0-1.5'		58.3	46.0	12.3	Brown Orange Slightly Fine Sandy SILT (MH)

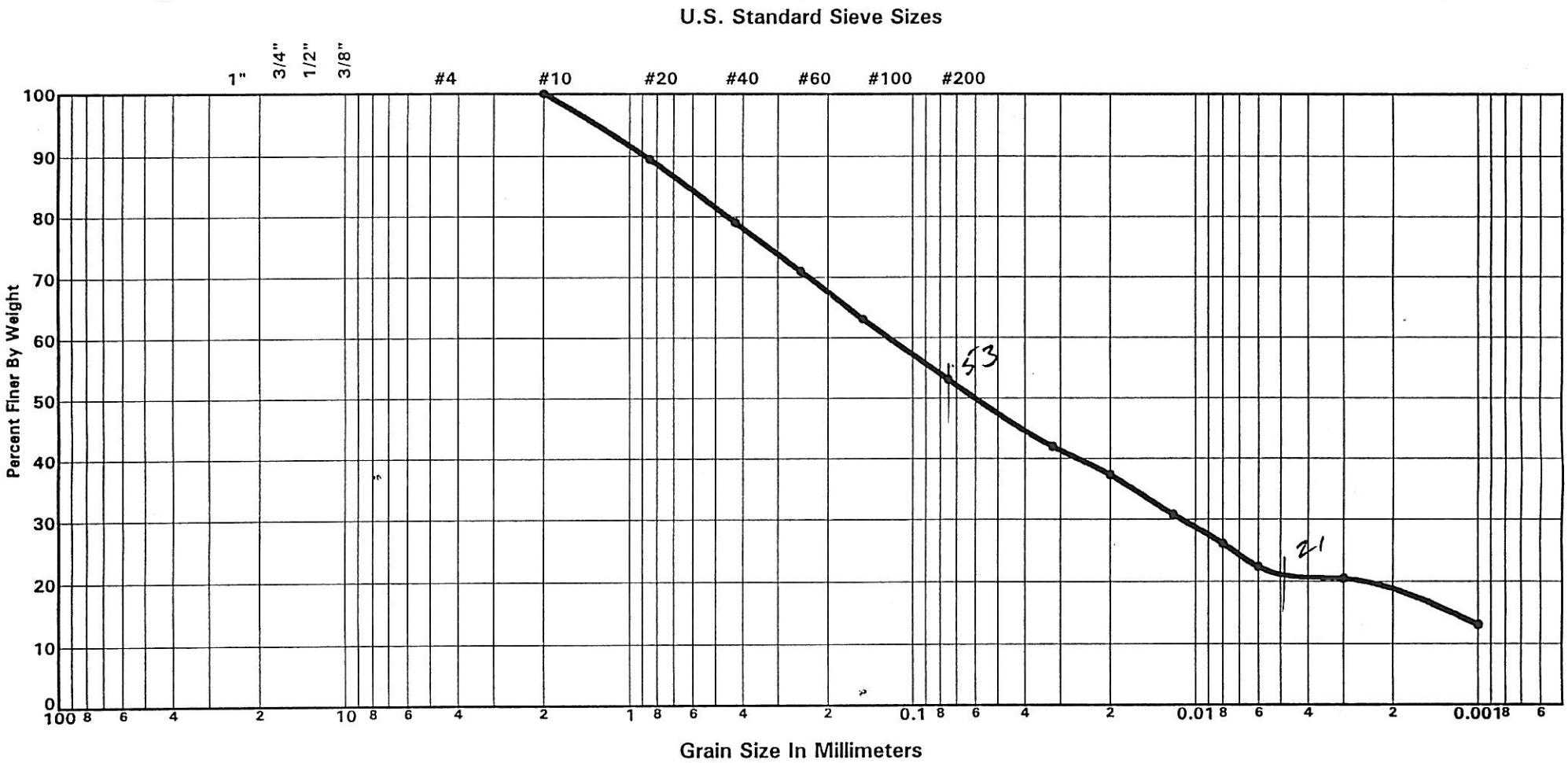
Project:
Halifax-6
Halifax, North Carolina

Job No.: 1-95-1181-CA

Date: 1/2/96

GRAIN SIZE DISTRIBUTION

GeoTechnologies, Inc.



GRAVEL		SAND			FINES	
COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

Boring No.	Elev./Depth	Nat. W.C.	L.L.	P.L.	P.I.	Soil Description or Classification
BP #6-2	3.5-5.0'		59.2	52.5	6.7	Brown Micaceous Slightly Clayey SILT (MH)

Project:
Halifax-6
Halifax, North Carolina

Job No.: 1-95-1181-CA

Date: 1/2/96

GRAIN SIZE DISTRIBUTION

GeoTechnologies, Inc.

GeoTechnologies, Inc.

PERMEABILITY TEST

Job Number:	1-95-1181 CB	**Job Name:**	HALIFAX - 5		
Date:	3/25/96	**Sample I.D.**	B - 4	**Depth:**	

Soil Description: RED ORANGE CLAYEY SILT

SAMPLE DATA

type
remolded ( )
undisturbed (X)

standard proctor

Max. Dry Density		lbs/cu.ft.
Moisture Content		%
Compaction	#DIV/0!	%

	inches	cm.	
Length	6.007	15.258	
Diameter	2.896	7.356	
Area	6.587	42.497	
Volume	39.568	648.404	
Wet Mass	2.971	1347.69	grams
Dry Mass	2.5329	1148.9	grams

Moisture Content	17.3	%
Wet Density	129.8	lbs./cu.ft.
Dry Density	110.6	lbs./cu.ft.
Initial Saturation	86.2	%
Final Saturation	100.0	%
Initial Void Ratio	0.6	
Porosity	35.6	
Specific Gravity	2.75	apparent

TEST DATA

hi = inflow burette
ho = outflow burette
t = time

L = 15.26 cm. length of sample
A = 42.497 sq.cm. area of sample
a = 0.852 sq.cm. area of burettes
h1 = head loss across specimen at t1
h2 = head loss across specimen at t2

t1	t2	ho1	hi1	h1	ho2	hi2	h2
0	1860	91.3	3.3	88	86.7	7.9	78.8
0	1440	86.7	7.9	78.8	85.5	9	76.5
0	2760	85.5	9	76.5	83.3	11.1	72.2
0	2640	83.3	11.1	72.2	81.4	13.1	68.3

ASTM D 5084

$$k = ((aaL/(At(a+a)))*\ln(h1/h2)$$

1	k =	9.08E-06
2	k =	3.15E-06
3	k =	3.21E-06
4	k =	3.22E-06

AVG. = 3.19×10^{-6}

Average k = **4.66E-06** cm/sec

GeoTechnologies, Inc.

PERMEABILITY TEST

Job Number:	1-95-1181 CB	**Job Name:**	HALIFAX - 5		
Date:	3/25/96	**Sample I.D.**	B - 8	**Depth:**	

Soil Description: RED ORANGE CLAYEY SILT

SAMPLE DATA

type
remolded ( )
undisturbed (X)

standard proctor

Max. Dry Density		lbs/cu.ft.
Moisture Content		%
Compaction	#DIV/0!	%

	inches	cm.	
Length	**5.949**	**15.110**	
Diameter	**2.869**	**7.287**	
Area	**6.465**	**41.708**	
Volume	**38.459**	**630.226**	
Wet Mass	**2.743**	**1244.07**	grams
Dry Mass	**2.2154**	**1004.9**	grams

Moisture Content	**23.8**	%
Wet Density	**123.2**	lbs./cu.ft.
Dry Density	**99.5**	lbs./cu.ft.
Initial Saturation	**90.3**	%
Final Saturation	**100.0**	%
Initial Void Ratio	**0.7**	
Porosity	**42.0**	
Specific Gravity	**2.75**	apparent

TEST DATA

hi = inflow burette
ho = outflow burette
t = time

L =	15.11 cm.	length of sample
A =	41.708 sq.cm.	area of sample
a =	0.852 sq.cm.	area of burettes

h1 = head loss across specimen at t1
h2 = head loss across specimen at t2

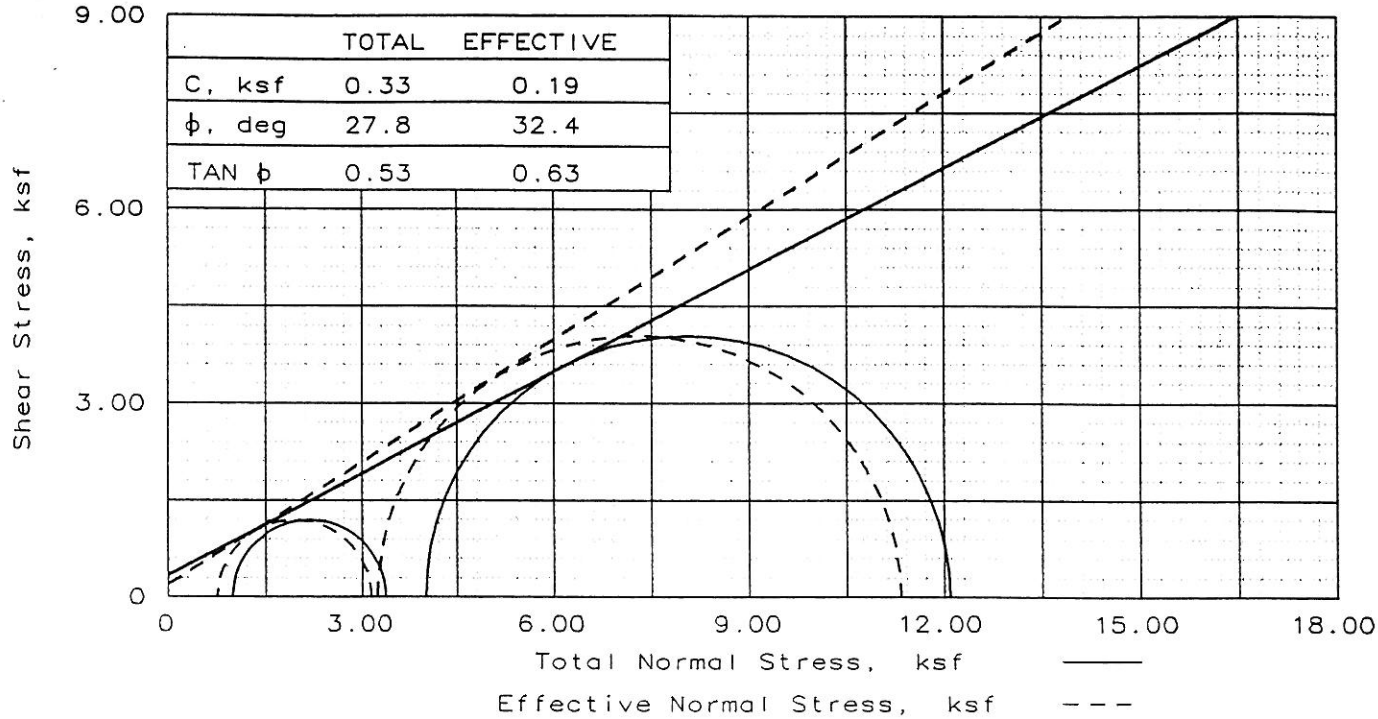
t1	t2	ho1	hi1	h1	ho2	hi2	h2
0	**1800**	94.5	0.5	**94**	87.1	7.6	**79.5**
0	**1440**	87.1	7.6	**79.5**	81.5	13.2	**68.3**
0	**2700**	81.5	13.2	**68.3**	71.9	23	**48.9**
0	**2700**	94.5	0.8	**93.7**	83.7	11.5	**72.2**

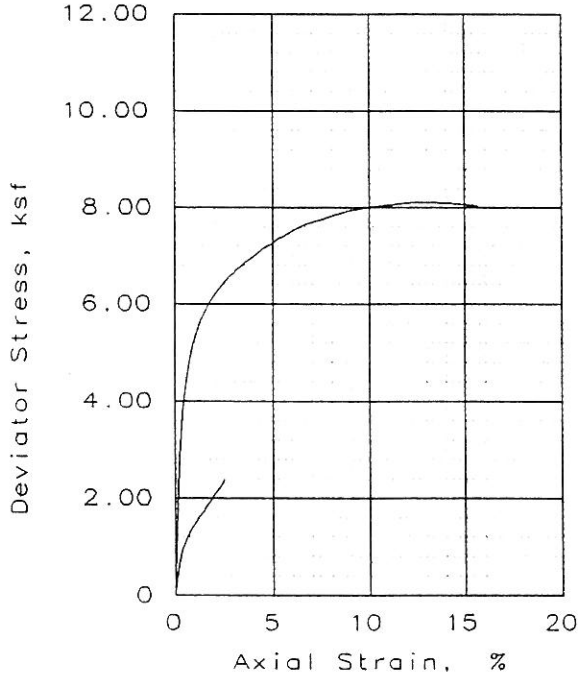
ASTM D 5084

$$k = ((aaL/(At(a+a)))*\ln(h1/h2)$$

1	k =	1.44E-05
2	k =	1.63E-05
3	k =	1.91E-05
4	k =	1.49E-05

Average **k=** **1.62E-05** cm/sec





SAMPLE NO.		1	2
INITIAL	WATER CONTENT, %	14.3	14.3
	DRY DENSITY, pcf	115.8	119.7
	SATURATION, %	88.3	99.2
	VOID RATIO	0.429	0.382
	DIAMETER, in	2.79	2.79
	HEIGHT, in	5.55	5.37
AT TEST	WATER CONTENT, %	14.9	14.5
	DRY DENSITY, pcf	118.5	119.7
	SATURATION, %	99.9	100.5
	VOID RATIO	0.396	0.382
	DIAMETER, in	2.77	2.79
	HEIGHT, in	5.51	5.37
Strain rate, %/min		0.120	0.120
BACK PRESSURE, ksf		10.48	10.47
CELL PRESSURE, ksf		11.48	14.47
FAILURE STRESS, ksf		2.38	8.08
PORE PRESSURE, ksf		10.71	11.23
ULTIMATE STRESS, ksf		2.38	8.08
PORE PRESSURE, ksf		10.71	11.23
$\bar{\sigma}_1$ FAILURE, ksf		3.14	11.32
$\bar{\sigma}_3$ FAILURE, ksf		0.76	3.24

TYPE OF TEST:
CU with pore pressures
SAMPLE TYPE: UNDISTURBED TUBE
DESCRIPTION: RED ORANGE CLAYEY SILT
LL= 31.0 PL= 17.0 PI= 14.0
SPECIFIC GRAVITY= 2.65
REMARKS:

CLIENT: RICHARDSON AND ASSOCIATES

PROJECT: HALIFAX - 5

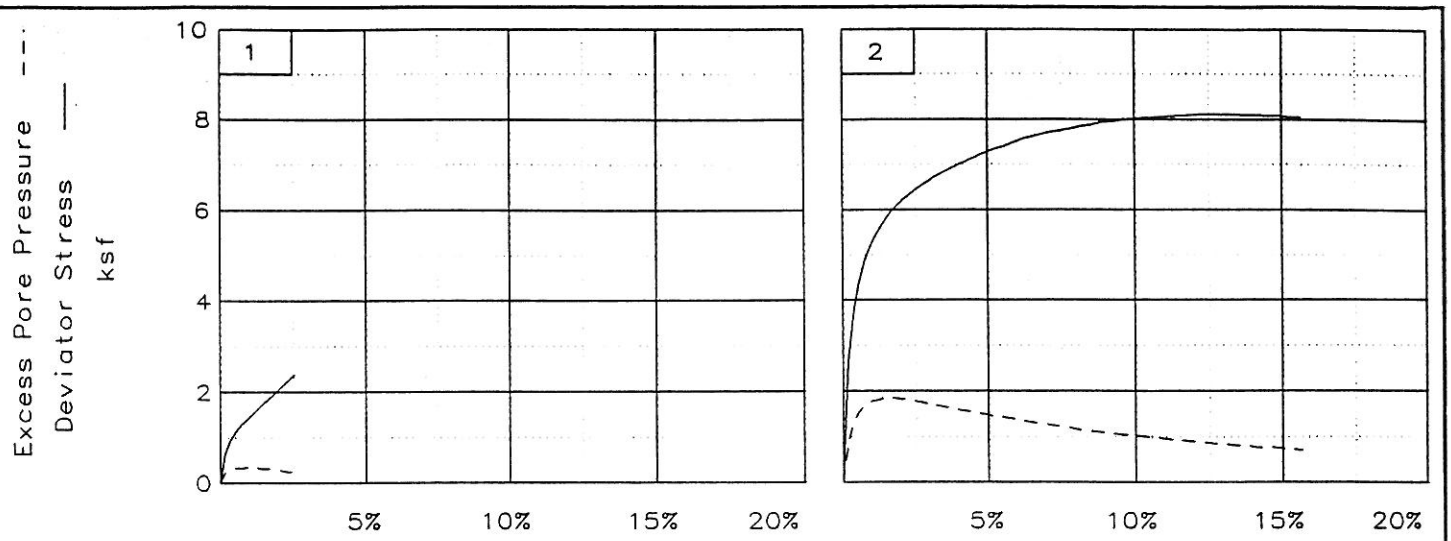
SAMPLE LOCATION: B - 4

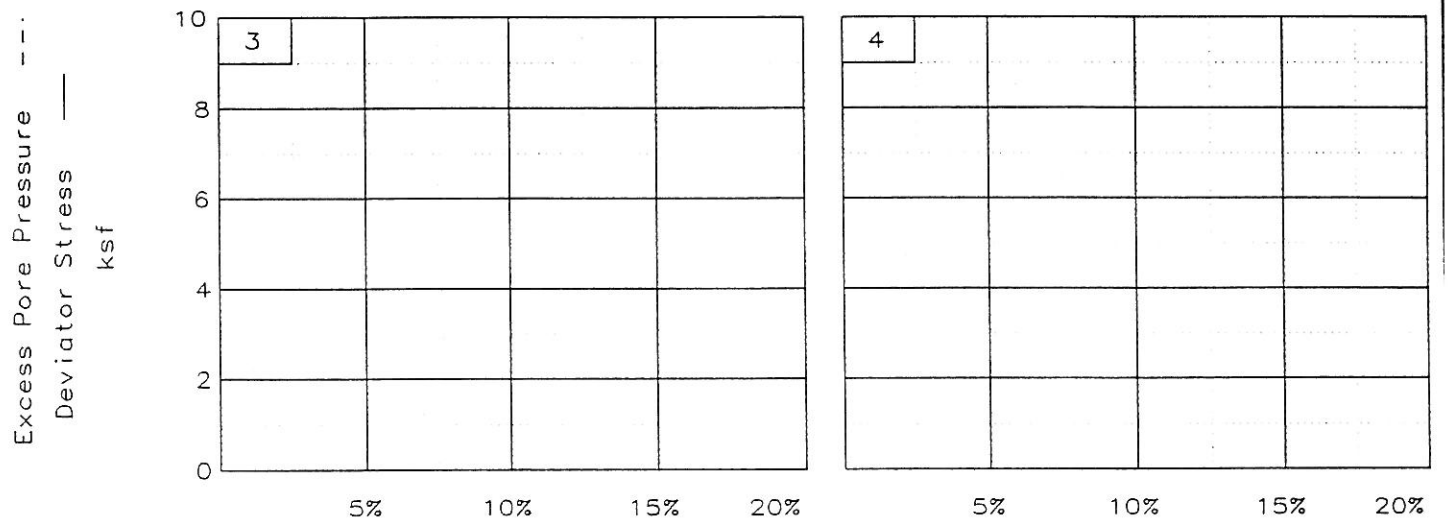
PROJ. NO.: 1-95-1181CB DATE: 4-4-96

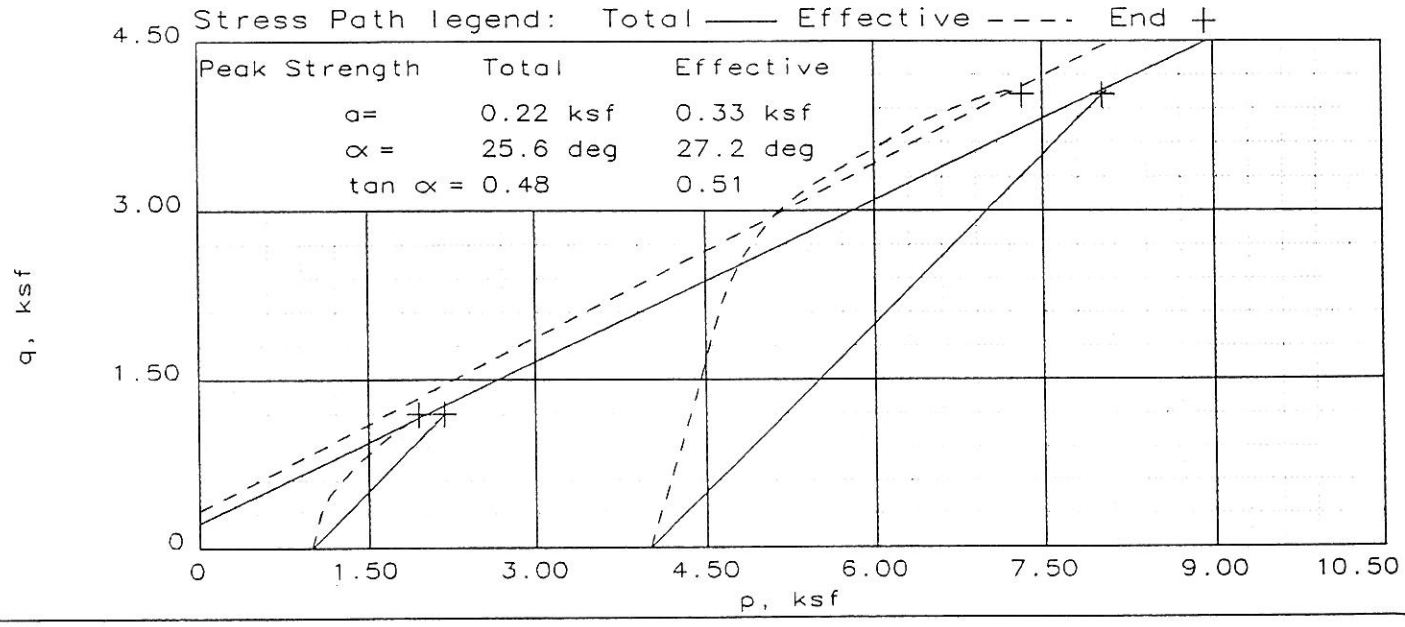
TRIAXIAL SHEAR TEST REPORT

FIG. NO.

GEOTECHNOLOGIES, INC., P.A.





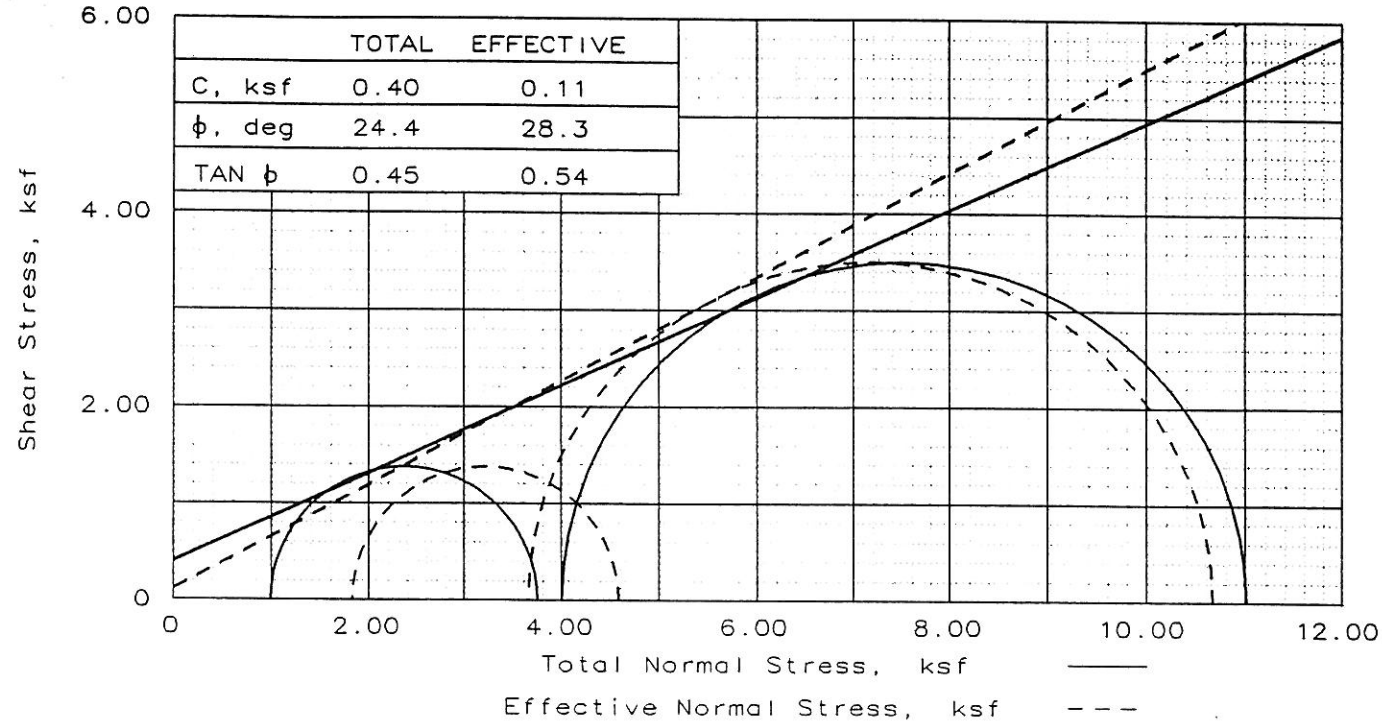


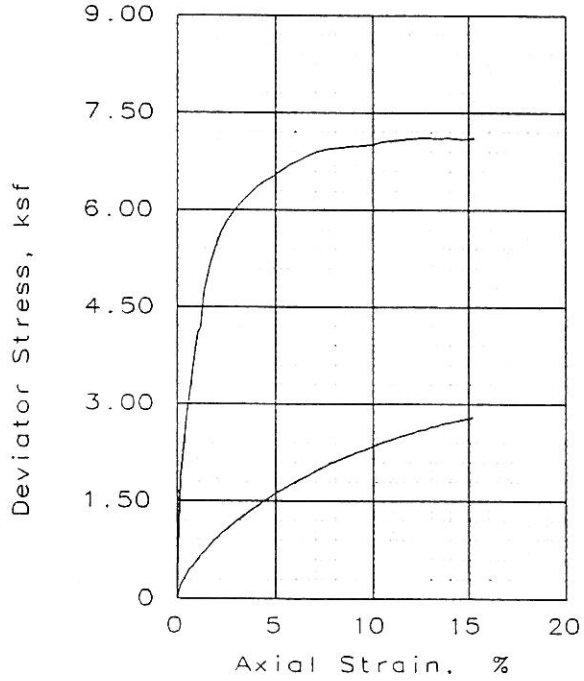
Client: RICHARDSON AND ASSOCIATES

Project: HALIFAX - 5

Location: B - 4

File: HPL Project No.: 1-95-1181CB Page 2/2 Fig. No. ——





SAMPLE NO.		1	2
INITIAL	WATER CONTENT, %	23.7	23.7
	DRY DENSITY, pcf	88.3	99.7
	SATURATION, %	71.7	95.0
	VOID RATIO	0.874	0.660
	DIAMETER, in	2.88	2.87
	HEIGHT, in	6.41	5.95
AT TEST	WATER CONTENT, %	30.3	23.5
	DRY DENSITY, pcf	91.9	102.1
	SATURATION, %	100.4	100.2
	VOID RATIO	0.799	0.620
	DIAMETER, in	2.84	2.85
	HEIGHT, in	6.32	5.90
Strain rate, %/min		0.120	0.120
BACK PRESSURE, ksf		9.99	11.06
CELL PRESSURE, ksf		10.99	15.06
FAILURE STRESS, ksf		2.76	7.01
PORE PRESSURE, ksf		9.16	11.40
ULTIMATE STRESS, ksf		2.76	7.01
PORE PRESSURE, ksf		9.16	11.40
$\bar{\sigma}_1$ FAILURE, ksf		4.58	10.66
$\bar{\sigma}_3$ FAILURE, ksf		1.83	3.66

TYPE OF TEST:
CU with pore pressures
SAMPLE TYPE: UNDISTURBED TUBE
DESCRIPTION: RED ORANGE CLAYEY SILT
LL= 50.0 PL= 22.0 PI= 28.0
SPECIFIC GRAVITY= 2.65
REMARKS:

CLIENT: G.N. RICHARDSON & ASSOC

PROJECT: HALIFAX 5

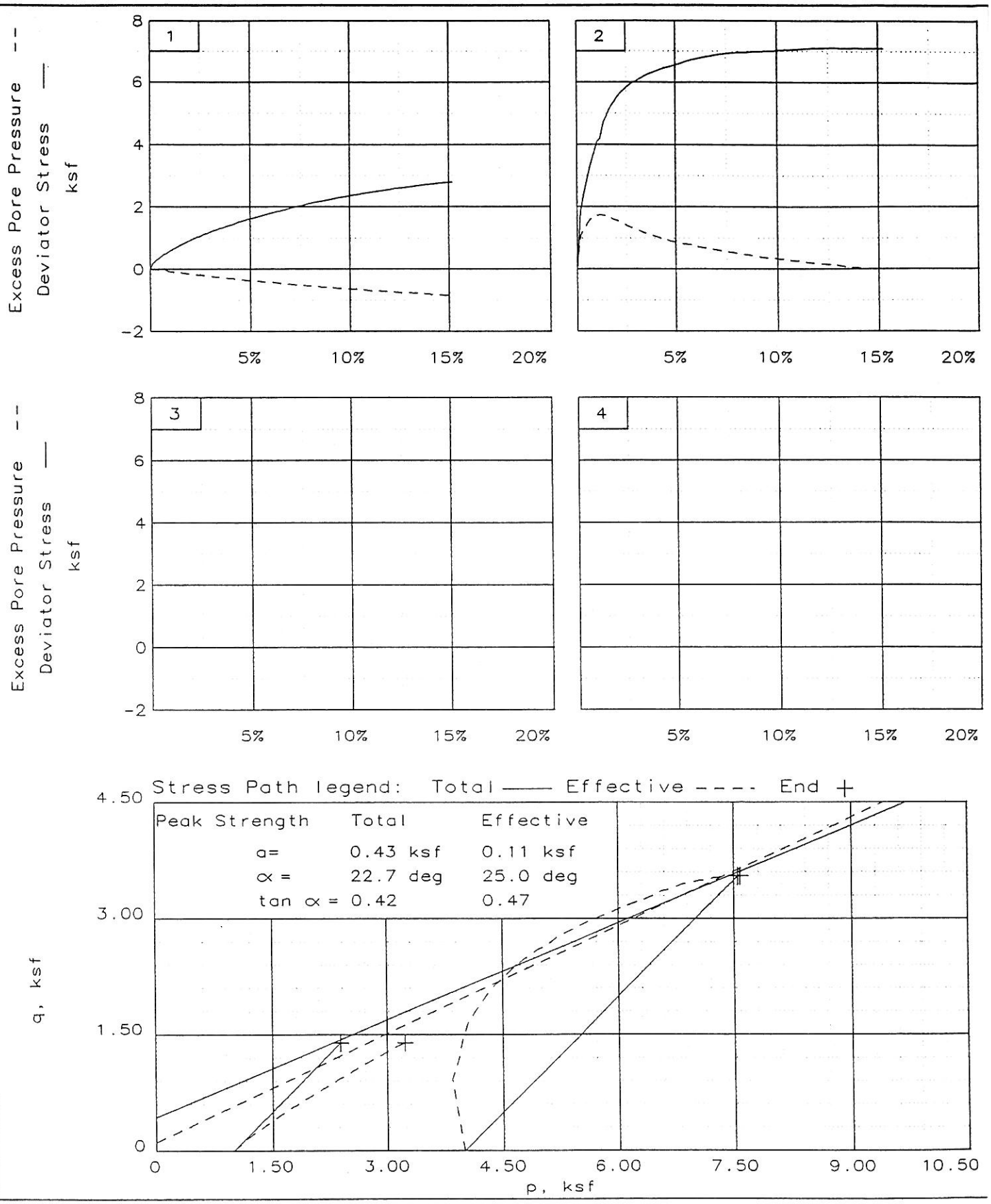
SAMPLE LOCATION: B - 8

PROJ. NO.: 1-95-1181CB DATE: 4-4-96

TRIAXIAL SHEAR TEST REPORT

GEOTECHNOLOGIES, INC., P.A.

FIG. NO.



Client: G.N. RICHARDSON & ASSOC

Project: HALIFAX 5

Location: B - 8

File: HAL4 Project No.: 1-95-1181CB Page 2/2 Fig. No. ——

GeoTechnologies, Inc.

CONSOLIDATION TEST

Job Name: HALIFAX 5 Date: 4/16/96

Job Number: 1-95-1181 CB

Sample I.D. B - 4 Depth: 1 - 3'

Soil Description: RED ORANGE CLAYEY SILT

Notes: PRELOAD 500 \ SATURATED \ UNDISTURBED

RING PROPERTIES		
Diameter	2.5	inches
Height	1	inches
Volume	0.00284	cu.ft.
Weight	110.48	grams
Ring + Soil	257.63	grams

SOIL PROPERTIES		
Init. Moisture	17.4	%
Soil Weight.	147.2	grams
Wet Density	114.2	lbs./cu.ft.
Dry Density	97.3	lbs./cu.ft.
Specific Gravity	2.68	Apparent
Final Moisture	19.1	%

Initial Reading	.0000
Preload Rebound Reading	.0294

LOAD / psf	R0	R6	R100	T50	R50
100	.0000	.0036	.0040		
500	.0040	.0277	.0294		
100	.0294	.0262	.0254		
500	.0254	.0326	.0347		
1000	.0347	.0548	.0576	0.9	0.0461
2000	.0576	.0856	.0883	1.35	0.0729
4000	.0883	.1215	.1241	0.45	0.1062
8000	.1241	.1549	.1599	0.675	0.142

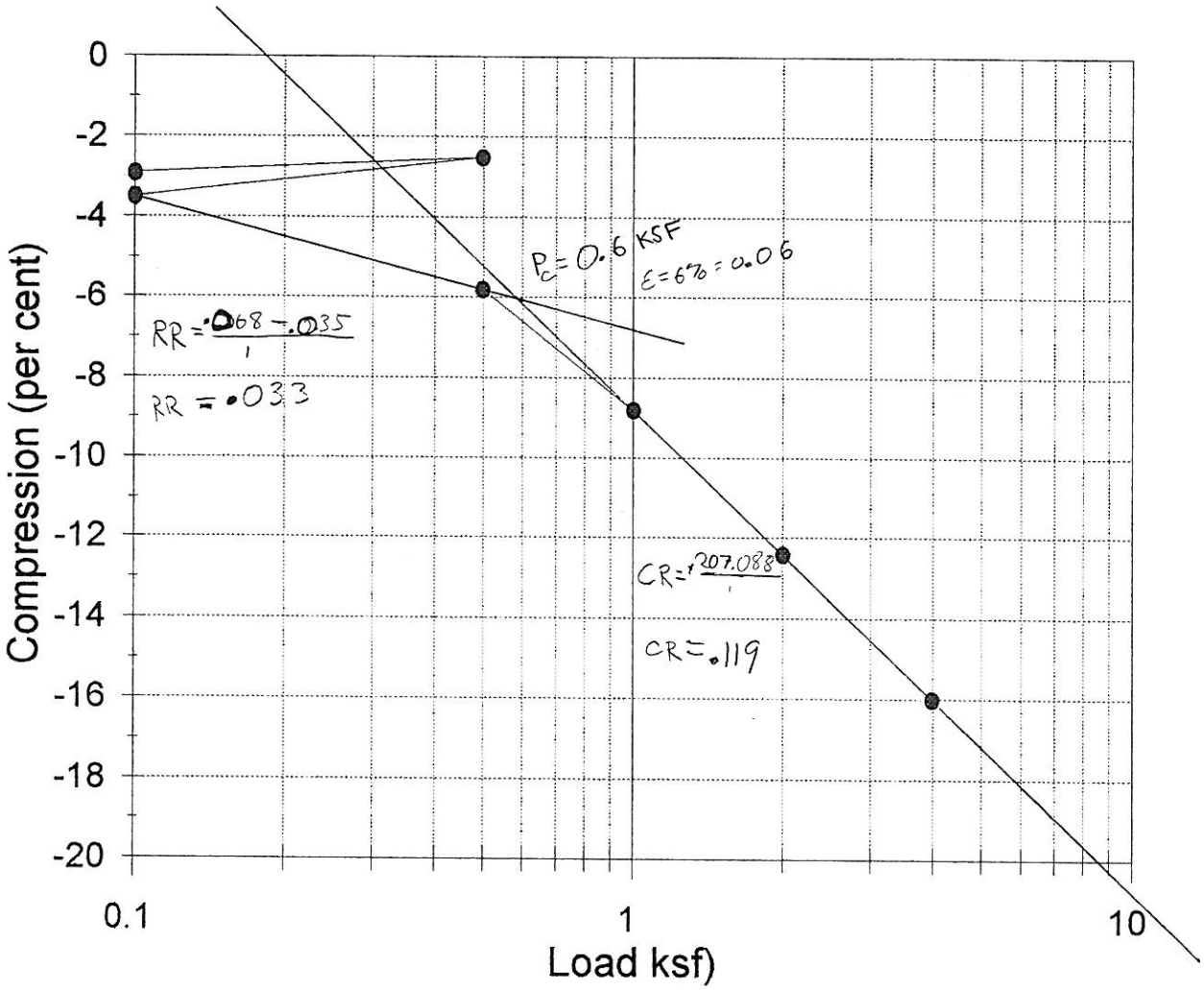
LOAD / psf	%E	Con. Coef.	%IC
100	0.4		90.0
500	2.9		93.3
100	2.5		80.0
500	3.5		77.4
1000	5.8	4.979	87.8
2000	8.8	3.136	91.2
4000	12.4	8.743	92.7
8000	16.0	5.371	86.0
16000			

NOTE: Consolidation Coefficient in Square Feet Per Day

Initial Void Ratio	0.720
Final Void Ratio	0.445
Initial Saturation, %	64.8
Final Saturation, %	109.9

Consolidation Test

B-4, 1'-3'



GeoTechnologies, Inc.

CONSOLIDATION TEST

Job Name: HALIFAX 5 Date: 4/16/96

Job Number: 1-95-1181 CB

Sample I.D. B - 8 - 1 Depth: 5 - 7'

Soil Description: RED ORANGE CLAYEY SAND

Notes: PRELOAD 500 \ SATURATED \ UNDISTURBED

RING PROPERTIES		
Diameter	2.5	inches
Height	1	inches
Volume	0.00284	cu.ft.
Weight	110.48	grams
Ring + Soil	262.34	grams

SOIL PROPERTIES		
Init. Moisture	23.0	%
Soil Weight.	151.9	grams
Wet Density	117.9	lbs./cu.ft.
Dry Density	95.8	lbs./cu.ft.
Specific Gravity	2.68	Apparent
Final Moisture	24.9	%

Initial Reading	.0000
Preload Rebound Reading	.0032

LOAD / psf	R0	R6	R100	T50	R50
100	.0000	.0004	.0005		
500	.0005	.0030	.0032		
100	.0032	.0008	.0006		
500	.0006	.0029	.0030		
1000	.0030	.0060	.0064	0.9	0.0047
2000	.0064	.0142	.0151	0.45	0.01075
4000	.0151	.0269	.0285	0.9	0.0218
8000	.0285	.0457	.0479	0.45	0.0382

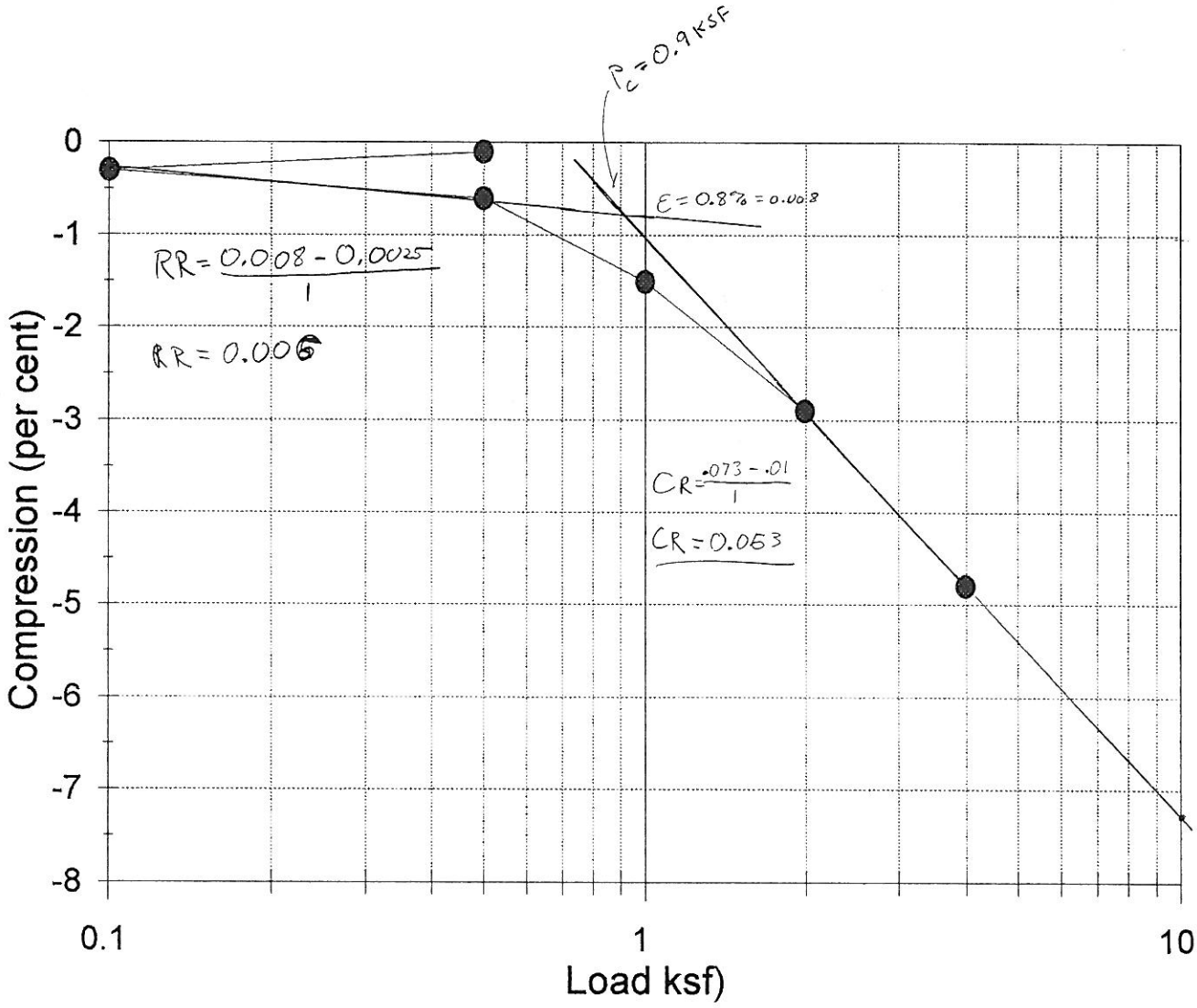
LOAD / psf	%E	Con. Coef.	%IC
100	0.1		80.0
500	0.3		92.6
100	0.1		92.3
500	0.3		95.8
1000	0.6	5.421	88.2
2000	1.5	10.710	89.7
4000	2.9	5.236	88.1
8000	4.8	10.124	88.7
16000			

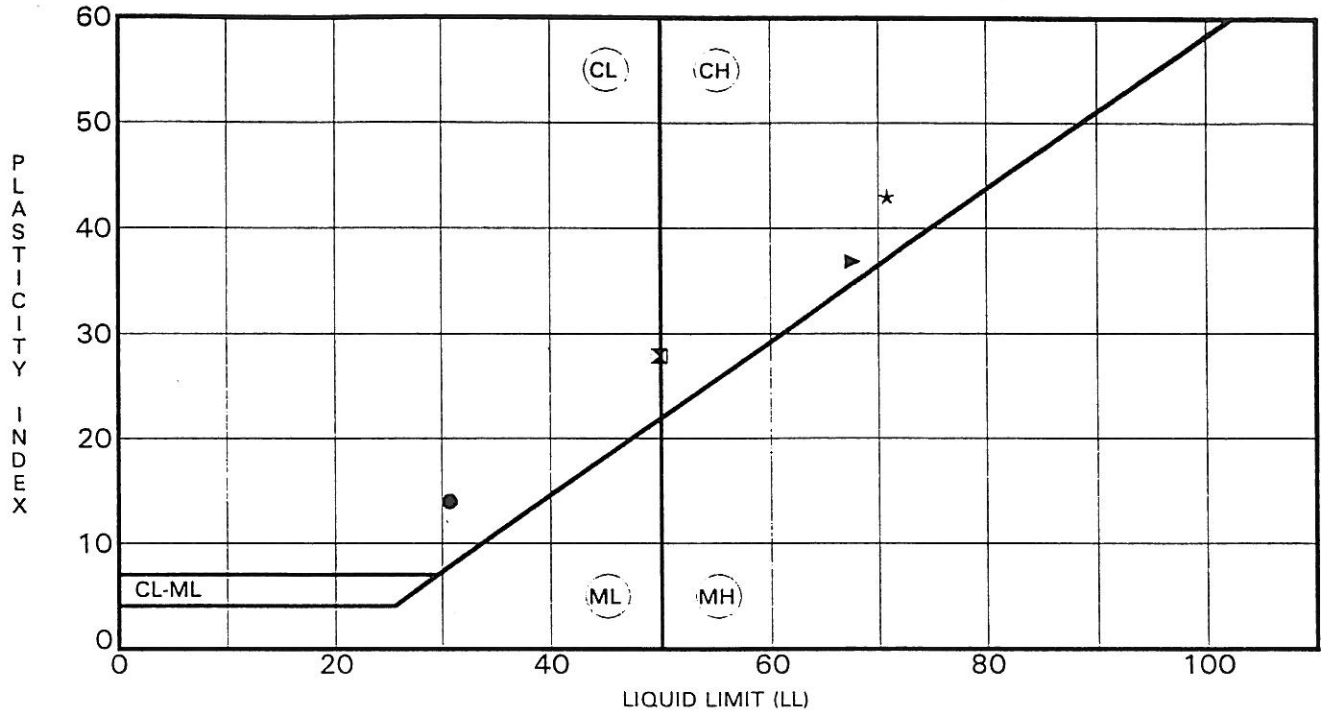
NOTE: Consolidation Coefficient in Square Feet Per Day

Initial Void Ratio	0.746
Final Void Ratio	0.662
Initial Saturation, %	82.6
Final Saturation, %	97.0

Consolidation Test

B-8, 5'-7'





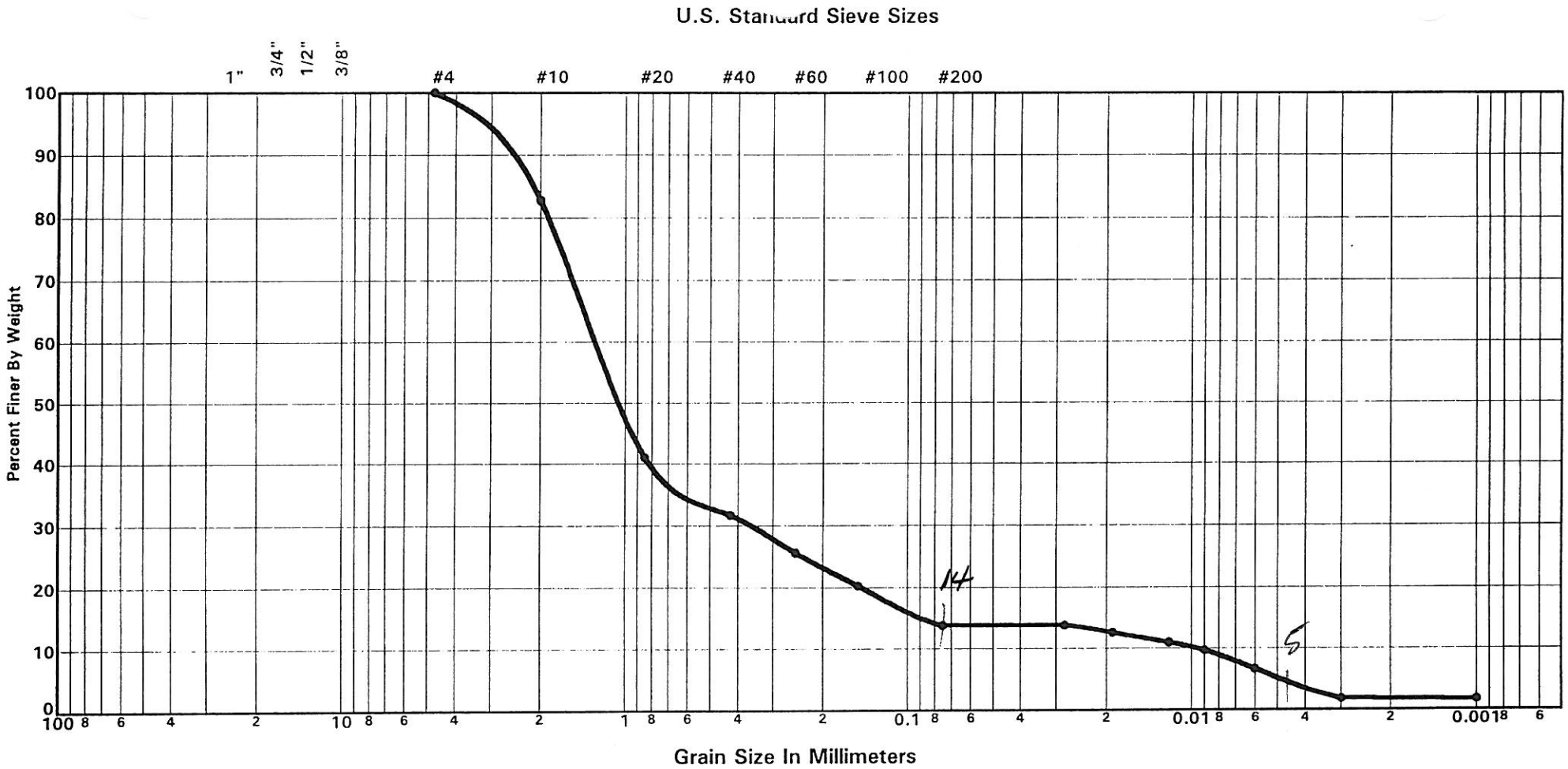
	Specimen Identification	LL	PL	PI	Fines	Classification
●	B-4	31	17	14	13.8	Red Orange Clayey FINE SANDY SILT ~~(CL)~~ (SM/ML)
⧗	B-8-1	50	22	28	48.8	Red Orange Clayey SILTY FINE SAND ~~SILT (CL/CH)~~ (SM/CL)
▶	G-2-A	68	31	37	43.8	Very Gravelly Reddish Brown Silty CLAY (CH)
★	G-6-A	71	28	43	43.2	Orange Slightly Sandy Silty CLAY (CH)

PROJECT Halifax-5 - Halifax, North Carolina

JOB NO. 1-95-1181-CB
DATE 4/16/96

ATTERBERG LIMITS' RESULTS

Raleigh, North Carolina



GRAVEL		SAND			FINES	
COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

Boring No.	Elev./Depth	Nat. W.C.	L.L.	P.L.	P.I.	Soil Description or Classification
B-4			30.7	16.7	14.0	Red Orange FINE SANDY Clayey SILT ~~(CL)~~ SM/ML

Project:

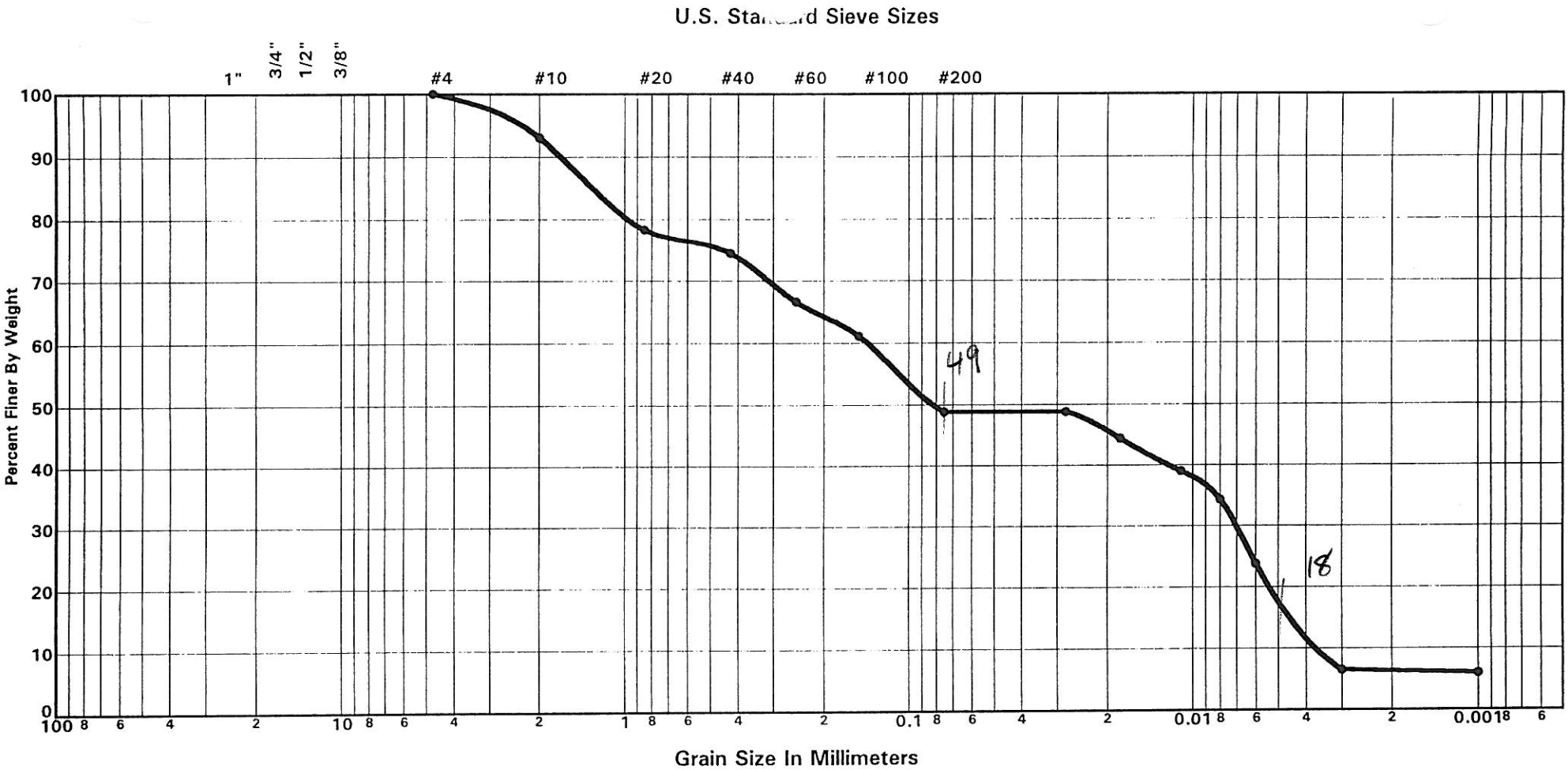
Halifax-5
Halifax, North Carolina

Job No.: 1-95-1181-CB

Date: 4/16/96

GRAIN SIZE DISTRIBUTION

GeoTechnologies, Inc.



GRAVEL		SAND			FINES	
COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

Boring No.	Elev./Depth	Nat. W.C.	L.L.	P.L.	P.I.	Soil Description or Classification
B-8-1			49.9	22.0	27.9	Red Orange Clayey ~~SILT (CL/CH)~~ SILTY FINE SAND SM/CL

Project:

Halifax-5
Halifax, North Carolina

Job No.: 1-95-1181-CB

Date: 4/16/96

GRAIN SIZE DISTRIBUTION

GeoTechnologies, Inc.

Appendix C

Aquifer Slug Test Data

Design Hydrogeologic Report
Halifax County C&D Landfill – Area 2
Halifax County, North Carolina

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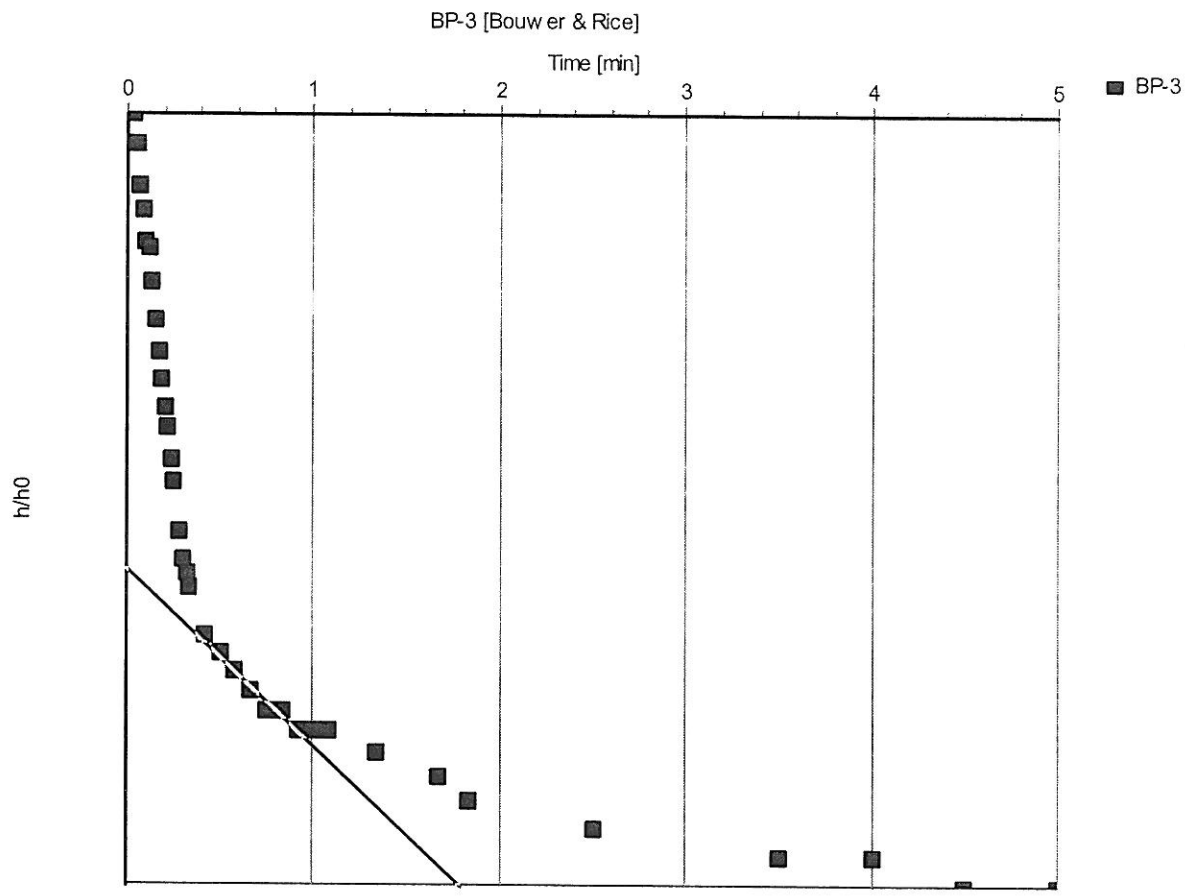
G. N. Richardson & Assoc., Inc.
14 N. Boylan Avenue
Raleigh, North Carolina
919-828-0577

Slug Test Analysis Report

Project: Halifax
Number:
Client:



Slug Test: **BP-3**

Analysis Method: **Bouwer & Rice**

Analysis Results:

Conductivity: 6.48E-4 [ft/min]

Test parameters:

Test Well:	BP-3	Aquifer Thickness:	80 [ft]
Casing radius:	0.083 [ft]	Gravel Pack Porosity (%)	25
Screen length:	4.7 [ft]		
Boring radius:	0.167 [ft]		
r(eff):	0.110 [ft]		

Comments:

Evaluated by: JAS
Evaluation Date: 1/18/2006

G. N. Richardson & Assoc., Inc.
14 N. Boylan Avenue
Raleigh, North Carolina
919-828-0577

Slug Test Data Report

Project: Halifax

Number:

Client:

Test Well:	**BP-3**	**Slug Test:**	**BP-3**
		Test Well:	BP-3
Depth to Static WL:	43.3 [ft]	Casing radius:	0.083 [ft]
Location:	C&D Landfill	Boring radius:	0.167 [ft]
Recorded by:		Screen length:	4.7 [ft]
Date:	1/18/2006	Aquifer Thickness:	80 [ft]

	Time [min]	Depth to WL [ft]	Drawdown [ft]
32	3.5	43.44	0.14
33	4	43.44	0.14
34	4.5	43.43	0.13
35	5	43.43	0.13

G. N. Richardson & Assoc., Inc.
14 N. Boylan Avenue
Raleigh, North Carolina
919-828-0577

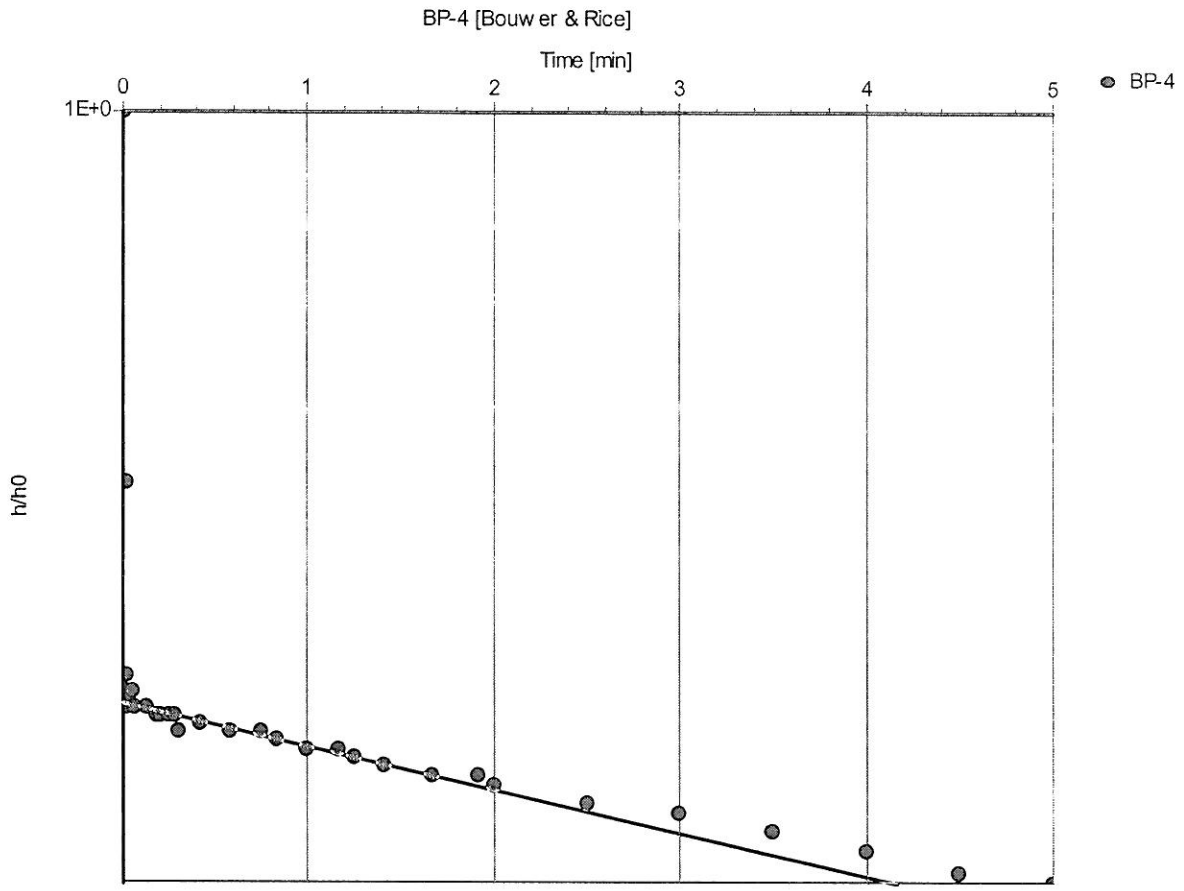
Slug Test Data Report

Project: Halifax
Number:
Client:

Test Well:	**BP-3**	**Slug Test:**	**BP-3**
		Test Well:	BP-3
Depth to Static WL:	43.3 [ft]	Casing radius:	0.083 [ft]
Location:	C&D Landfill	Boring radius:	0.167 [ft]
Recorded by:		Screen length:	4.7 [ft]
Date:	1/18/2006	Aquifer Thickness:	80 [ft]

	Time [min]	Depth to WL [ft]	Drawdown [ft]
1	0.033	44.16	0.86
2	0.05	44.10	0.80
3	0.067	44.02	0.72
4	0.083	43.98	0.68
5	0.1	43.93	0.63
6	0.117	43.92	0.62
7	0.133	43.87	0.57
8	0.15	43.82	0.52
9	0.167	43.78	0.48
10	0.183	43.75	0.45
11	0.2	43.72	0.42
12	0.217	43.70	0.40
13	0.233	43.67	0.37
14	0.25	43.65	0.35
15	0.283	43.61	0.31
16	0.3	43.59	0.29
17	0.317	43.58	0.28
18	0.333	43.57	0.27
19	0.417	43.54	0.24
20	0.5	43.53	0.23
21	0.583	43.52	0.22
22	0.667	43.51	0.21
23	0.75	43.50	0.20
24	0.833	43.50	0.20
25	0.917	43.49	0.19
26	1	43.49	0.19
27	1.083	43.49	0.19
28	1.333	43.48	0.18
29	1.667	43.47	0.17
30	1.833	43.46	0.16
31	2.5	43.45	0.15

G. N. Richardson & Assoc., Inc. 14 N. Boylan Avenue Raleigh, North Carolina 919-828-0577	**Slug Test Analysis Report**
	Project: Halifax
	Number:
	Client:



Slug Test: **BP-4**

Analysis Method: **Bouwer & Rice**

Analysis Results:

Conductivity: 6.24E-5 [ft/min]

Test parameters:

Test Well:	BP-4	Aquifer Thickness:	80 [ft]
Casing radius:	0.083 [ft]	Gravel Pack Porosity (%)	25
Screen length:	10 [ft]		
Boring radius:	0.1667 [ft]		
r(eff):	0.110 [ft]		

Comments:

Evaluated by:

Evaluation Date: 1/18/2006

G. N. Richardson & Assoc., Inc.
14 N. Boylan Avenue
Raleigh, North Carolina
919-828-0577

Slug Test Data Report

Project: Halifax

Number:

Client:

Test Well:	**BP-4**	**Slug Test:**	**BP-4**
		Test Well:	BP-4
Depth to Static WL:	35.93 [ft]	Casing radius:	0.083 [ft]
Location:	C&D Landfill	Boring radius:	0.1667 [ft]
Recorded by:		Screen length:	10 [ft]
Date:	1/18/2006	Aquifer Thickness:	80 [ft]

	Time [min]	Depth to WL [ft]	Drawdown [ft]
1	0.013	37.93	2.00
2	0.017	37.06	1.13
3	0.02	36.73	0.80
4	0.023	36.77	0.84
5	0.027	36.75	0.82
6	0.03	36.74	0.81
7	0.033	36.74	0.81
8	0.05	36.75	0.82
9	0.067	36.73	0.80
10	0.133	36.73	0.80
11	0.183	36.72	0.79
12	0.2	36.72	0.79
13	0.25	36.72	0.79
14	0.283	36.72	0.79
15	0.3	36.70	0.77
16	0.417	36.71	0.78
17	0.583	36.70	0.77
18	0.75	36.70	0.77
19	0.833	36.69	0.76
20	1	36.68	0.75
21	1.167	36.68	0.75
22	1.25	36.67	0.74
23	1.417	36.66	0.73
24	1.667	36.65	0.72
25	1.917	36.65	0.72
26	2	36.64	0.71
27	2.5	36.62	0.69
28	3	36.61	0.68
29	3.5	36.59	0.66
30	4	36.57	0.64
31	4.5	36.55	0.62

G. N. Richardson & Assoc., Inc. 14 N. Boylan Avenue Raleigh, North Carolina 919-828-0577	**Slug Test Data Report** Project: Halifax Number: Client:	Page 2

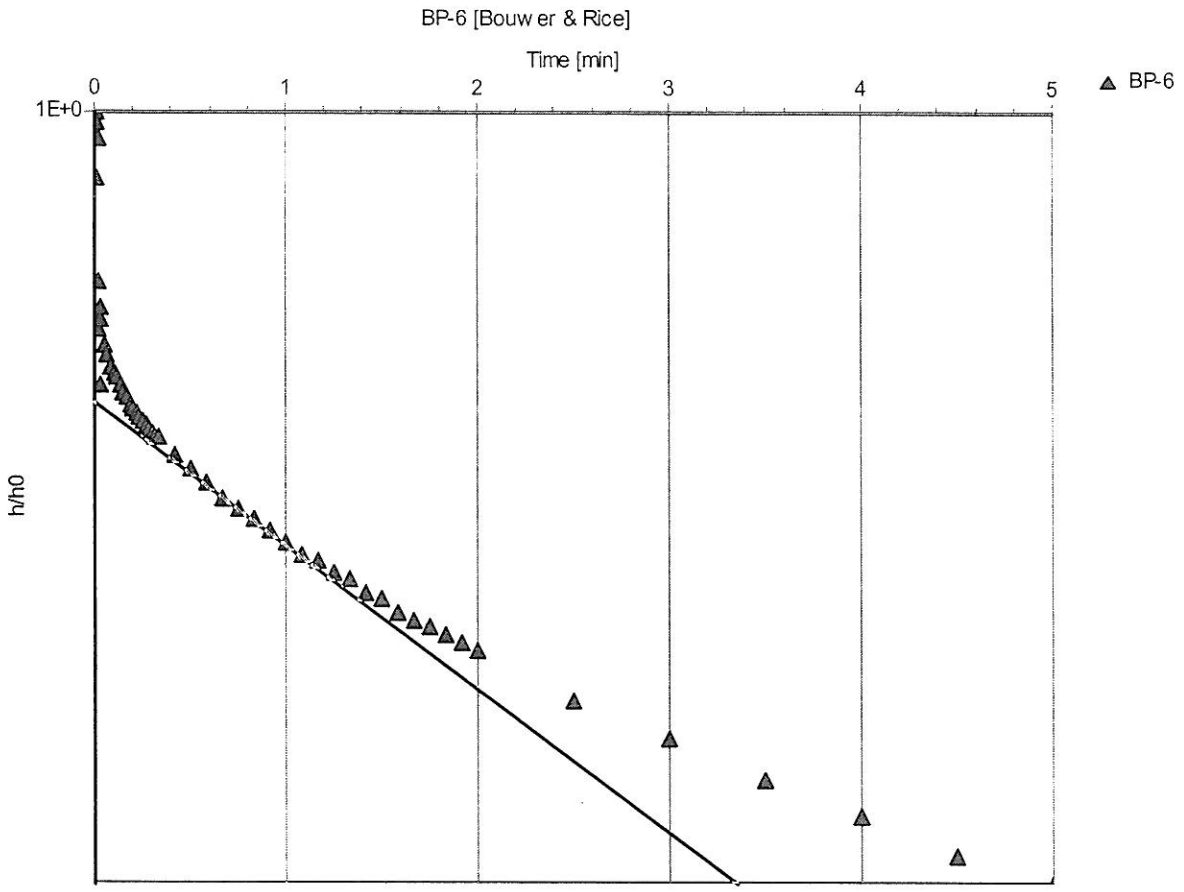
Test Well:	**BP-4**	**Slug Test:**	**BP-4**
		Test Well:	BP-4
Depth to Static WL:	35.93 [ft]	Casing radius:	0.083 [ft]
Location:	C&D Landfill	Boring radius:	0.1667 [ft]
Recorded by:		Screen length:	10 [ft]
Date:	1/18/2006	Aquifer Thickness:	80 [ft]

	Time [min]	Depth to WL [ft]	Drawdown [ft]
32	5	36.54	0.61

G. N. Richardson & Assoc., Inc.
14 N. Boylan Avenue
Raleigh, North Carolina
919-828-0577

Slug Test Analysis Report

Project: Halifax
Number:
Client:



Slug Test: **BP-6**

Analysis Method: **Bouwer & Rice**

Analysis Results:

Conductivity: 4.40E-4 [ft/min]

Test parameters:

Test Well:	BP-6	Aquifer Thickness:	80 [ft]
Casing radius:	0.083 [ft]	Gravel Pack Porosity (%)	25
Screen length:	10 [ft]		
Boring radius:	0.1667 [ft]		
r(eff):	0.110 [ft]		

Comments:

Evaluated by:

Evaluation Date: 1/18/2006

G. N. Richardson & Assoc., Inc.	Slug Test Data Report	
14 N. Boylan Avenue	Project: Halifax	
Raleigh, North Carolina	Number:	
919-828-0577	Client:	Page 1

Test Well:	**BP-6**	**Slug Test:**	**BP-6**
		Test Well:	BP-6
Depth to Static WL:	14.47 [ft]	Casing radius:	0.083 [ft]
Location:	C&D Landfill	Boring radius:	0.1667 [ft]
Recorded by:		Screen length:	10 [ft]
Date:	1/18/2006	Aquifer Thickness:	80 [ft]

	Time [min]	Depth to WL [ft]	Drawdown [ft]
1	0.007	16.52	2.05
2	0.01	16.46	1.99
3	0.013	16.18	1.71
4	0.017	15.75	1.28
5	0.02	15.59	1.12
6	0.023	16.38	1.91
7	0.027	15.43	0.96
8	0.03	15.62	1.15
9	0.033	15.66	1.19
10	0.05	15.54	1.07
11	0.067	15.51	1.04
12	0.083	15.48	1.01
13	0.1	15.46	0.99
14	0.117	15.45	0.98
15	0.133	15.43	0.96
16	0.15	15.41	0.94
17	0.167	15.40	0.93
18	0.183	15.38	0.91
19	0.2	15.37	0.90
20	0.217	15.36	0.89
21	0.233	15.35	0.88
22	0.25	15.34	0.87
23	0.267	15.33	0.86
24	0.283	15.32	0.85
25	0.3	15.31	0.84
26	0.317	15.30	0.83
27	0.333	15.30	0.83
28	0.417	15.26	0.79
29	0.5	15.23	0.76
30	0.583	15.20	0.73
31	0.667	15.17	0.70

G. N. Richardson & Assoc., Inc.	Slug Test Data Report	
14 N. Boylan Avenue	Project: Halifax	
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Test Well:	**BP-6**	**Slug Test:**	**BP-6**
		Test Well:	BP-6
Depth to Static WL:	14.47 [ft]	Casing radius:	0.083 [ft]
Location:	C&D Landfill	Boring radius:	0.1667 [ft]
Recorded by:		Screen length:	10 [ft]
Date:	1/18/2006	Aquifer Thickness:	80 [ft]

	Time [min]	Depth to WL [ft]	Drawdown [ft]
32	0.75	15.15	0.68
33	0.833	15.13	0.66
34	0.917	15.11	0.64
35	1	15.09	0.62
36	1.083	15.07	0.60
37	1.167	15.06	0.59
38	1.25	15.04	0.57
39	1.333	15.03	0.56
40	1.417	15.01	0.54
41	1.5	15.00	0.53
42	1.583	14.98	0.51
43	1.667	14.97	0.50
44	1.75	14.96	0.49
45	1.833	14.95	0.48
46	1.917	14.94	0.47
47	2	14.93	0.46
48	2.5	14.87	0.40
49	3	14.83	0.36
50	3.5	14.79	0.32
51	4	14.76	0.29
52	4.5	14.73	0.26
53	5	14.71	0.24

G. N. Richardson & Assoc., Inc.
14 N. Boylan Avenue
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Slug Test Analysis Report

Project: Halifax
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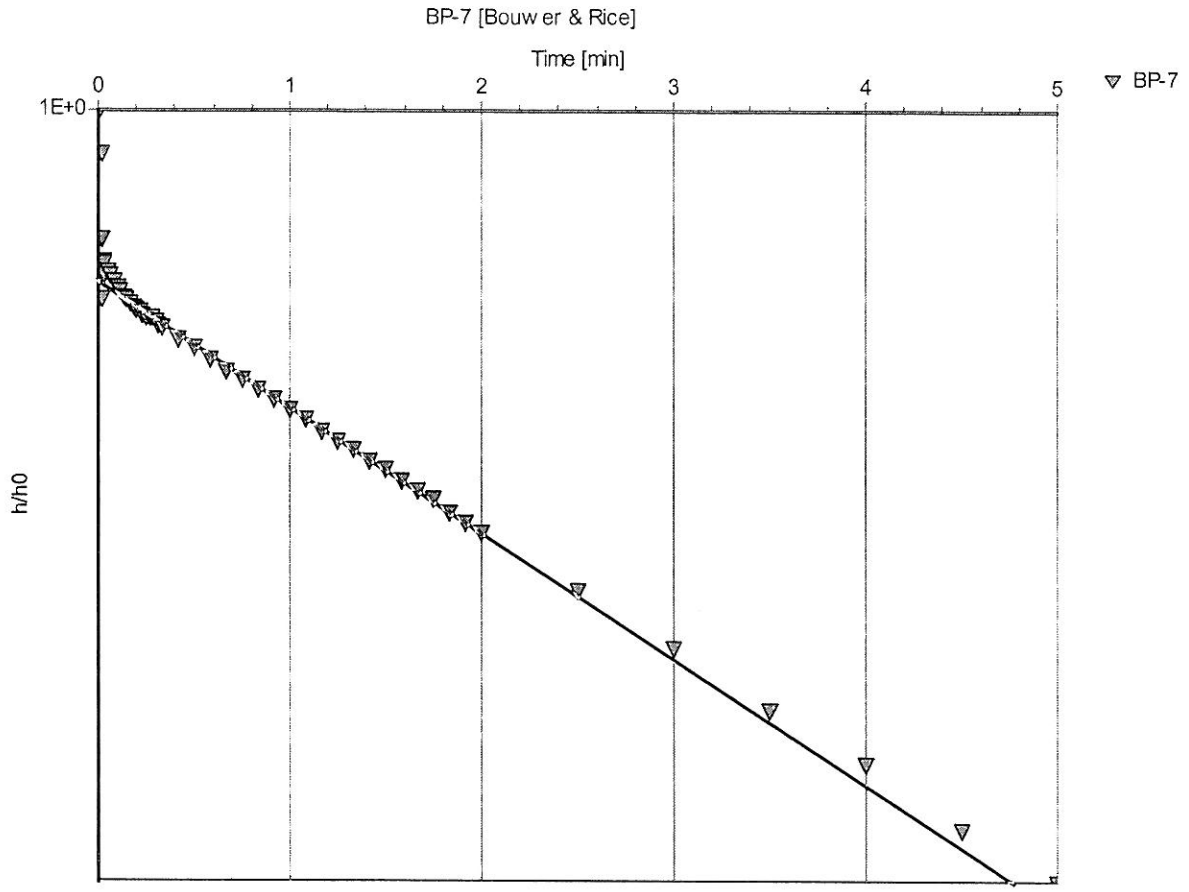

Slug Test: **BP-7**

Analysis Method: **Bouwer & Rice**

Analysis Results:

Conductivity: 6.46E-4 [ft/min]

Test parameters:

Test Well:	BP-7	Aquifer Thickness:	80 [ft]
Casing radius:	0.083 [ft]	Gravel Pack Porosity (%)	25
Screen length:	5 [ft]		
Boring radius:	0.1667 [ft]		
r(eff):	0.110 [ft]		

Comments:

Evaluated by:

Evaluation Date: 1/18/2006

G. N. Richardson & Assoc., Inc.
14 N. Boylan Avenue
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Slug Test Data Report

Project: Halifax
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Test Well:	**BP-7**	**Slug Test:**	**BP-7**
		Test Well:	BP-7
Depth to Static WL:	5.64 [ft]	Casing radius:	0.083 [ft]
Location:	C&D Landfill	Boring radius:	0.1667 [ft]
Recorded by:		Screen length:	5 [ft]
Date:	1/18/2006	Aquifer Thickness:	80 [ft]

	Time [min]	Depth to WL [ft]	Drawdown [ft]
1	0.013	8.03	2.39
2	0.017	7.26	1.62
3	0.02	7.74	2.10
4	0.023	7.00	1.36
5	0.027	7.10	1.46
6	0.03	7.16	1.52
7	0.033	7.15	1.51
8	0.05	7.12	1.48
9	0.067	7.10	1.46
10	0.083	7.07	1.43
11	0.1	7.05	1.41
12	0.117	7.03	1.39
13	0.133	7.01	1.37
14	0.15	7.00	1.36
15	0.167	6.98	1.34
16	0.183	6.97	1.33
17	0.2	6.96	1.32
18	0.217	6.95	1.31
19	0.233	6.94	1.30
20	0.25	6.93	1.29
21	0.267	6.93	1.29
22	0.283	6.93	1.29
23	0.3	6.91	1.27
24	0.317	6.90	1.26
25	0.333	6.89	1.25
26	0.417	6.85	1.21
27	0.5	6.82	1.18
28	0.583	6.78	1.14
29	0.667	6.74	1.10
30	0.75	6.71	1.07
31	0.833	6.68	1.04

G. N. Richardson & Assoc., Inc. 14 N. Boylan Avenue Raleigh, North Carolina 919-828-0577	**Slug Test Data Report** Project: Halifax Number: Client:	Page 2

Test Well:	**BP-7**	**Slug Test:**	**BP-7**
		Test Well:	BP-7
Depth to Static WL:	5.64 [ft]	Casing radius:	0.083 [ft]
Location:	C&D Landfill	Boring radius:	0.1667 [ft]
Recorded by:		Screen length:	5 [ft]
Date:	1/18/2006	Aquifer Thickness:	80 [ft]

	Time [min]	Depth to WL [ft]	Drawdown [ft]
32	0.917	6.65	1.01
33	1	6.62	0.98
34	1.083	6.59	0.95
35	1.167	6.56	0.92
36	1.25	6.53	0.89
37	1.333	6.51	0.87
38	1.417	6.48	0.84
39	1.5	6.46	0.82
40	1.583	6.43	0.79
41	1.667	6.41	0.77
42	1.75	6.39	0.75
43	1.833	6.36	0.72
44	1.917	6.34	0.70
45	2	6.32	0.68
46	2.5	6.21	0.57
47	3	6.12	0.48
48	3.5	6.04	0.40
49	4	5.98	0.34
50	4.5	5.92	0.28
51	5	5.88	0.24

G. N. Richardson & Assoc., Inc.
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Slug Test Analysis Report

Project: Halifax
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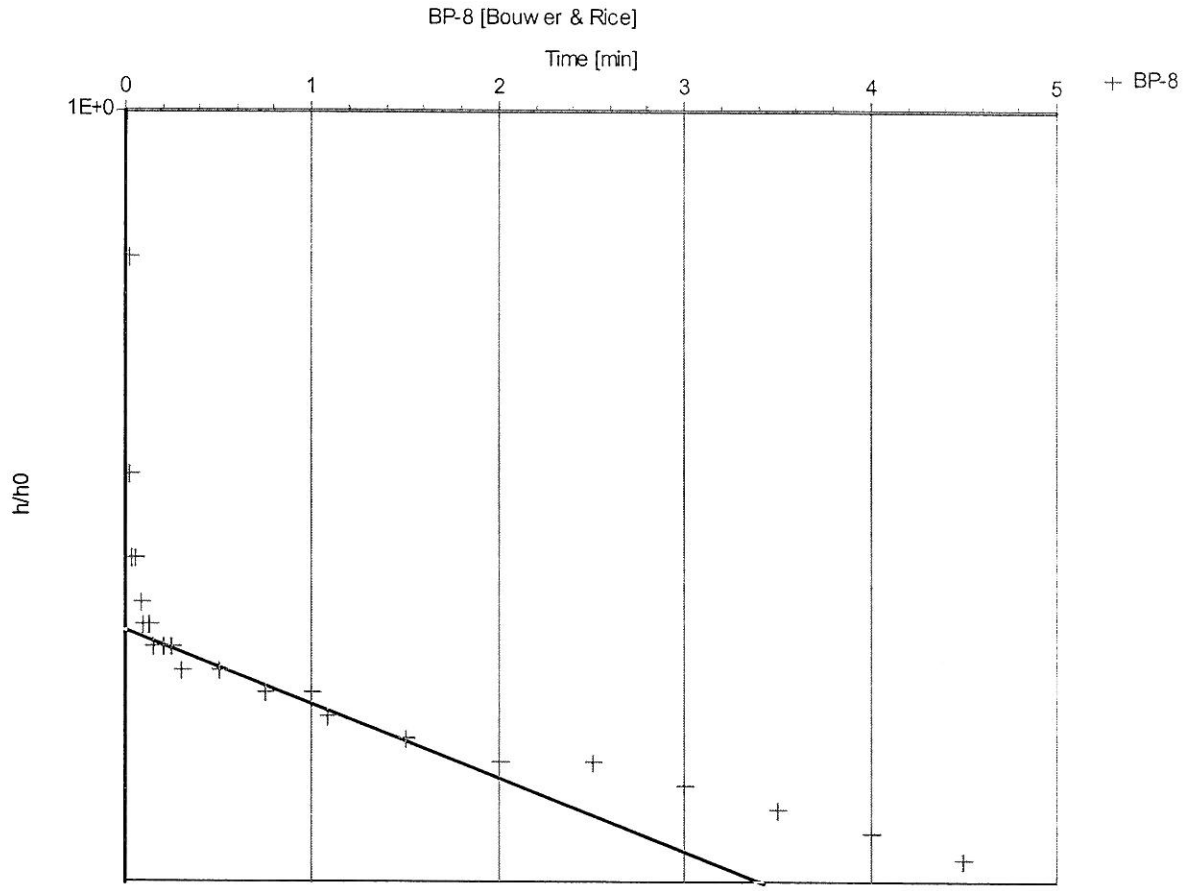

Slug Test: **BP-8**

Analysis Method: **Bouwer & Rice**

Analysis Results:

Conductivity: 5.57E-5 [ft/min]

Test parameters:

Test Well:	BP-8	Aquifer Thickness:	80 [ft]
Casing radius:	0.083 [ft]	Gravel Pack Porosity (%)	25
Screen length:	5 [ft]		
Boring radius:	0.1667 [ft]		
r(eff):	0.110 [ft]		

Comments:

Evaluated by:

Evaluation Date: 2/2/2006

G. N. Richardson & Assoc., Inc.
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Raleigh, North Carolina
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Slug Test Data Report

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Client:

Test Well:	**BP-8**	**Slug Test:**	**BP-8**
		Test Well:	BP-8
Depth to Static WL:	16.68 [ft]	Casing radius:	0.083 [ft]
Location:	C&D Landfill	Boring radius:	0.1667 [ft]
Recorded by:		Screen length:	5 [ft]
Date:	1/18/2006	Aquifer Thickness:	80 [ft]

	Time [min]	Depth to WL [ft]	Drawdown [ft]
1	0.007	17.94	1.26
2	0.02	17.86	1.18
3	0.027	17.75	1.07
4	0.03	17.71	1.03
5	0.05	17.71	1.03
6	0.083	17.69	1.01
7	0.1	17.68	1.00
8	0.133	17.68	1.00
9	0.15	17.67	0.99
10	0.2	17.67	0.99
11	0.25	17.67	0.99
12	0.3	17.66	0.98
13	0.5	17.66	0.98
14	0.75	17.65	0.97
15	1	17.65	0.97
16	1.083	17.64	0.96
17	1.5	17.63	0.95
18	2	17.62	0.94
19	2.5	17.62	0.94
20	3	17.61	0.93
21	3.5	17.60	0.92
22	4	17.59	0.91
23	4.5	17.58	0.90
24	5	17.57	0.89

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	Project: Halifax
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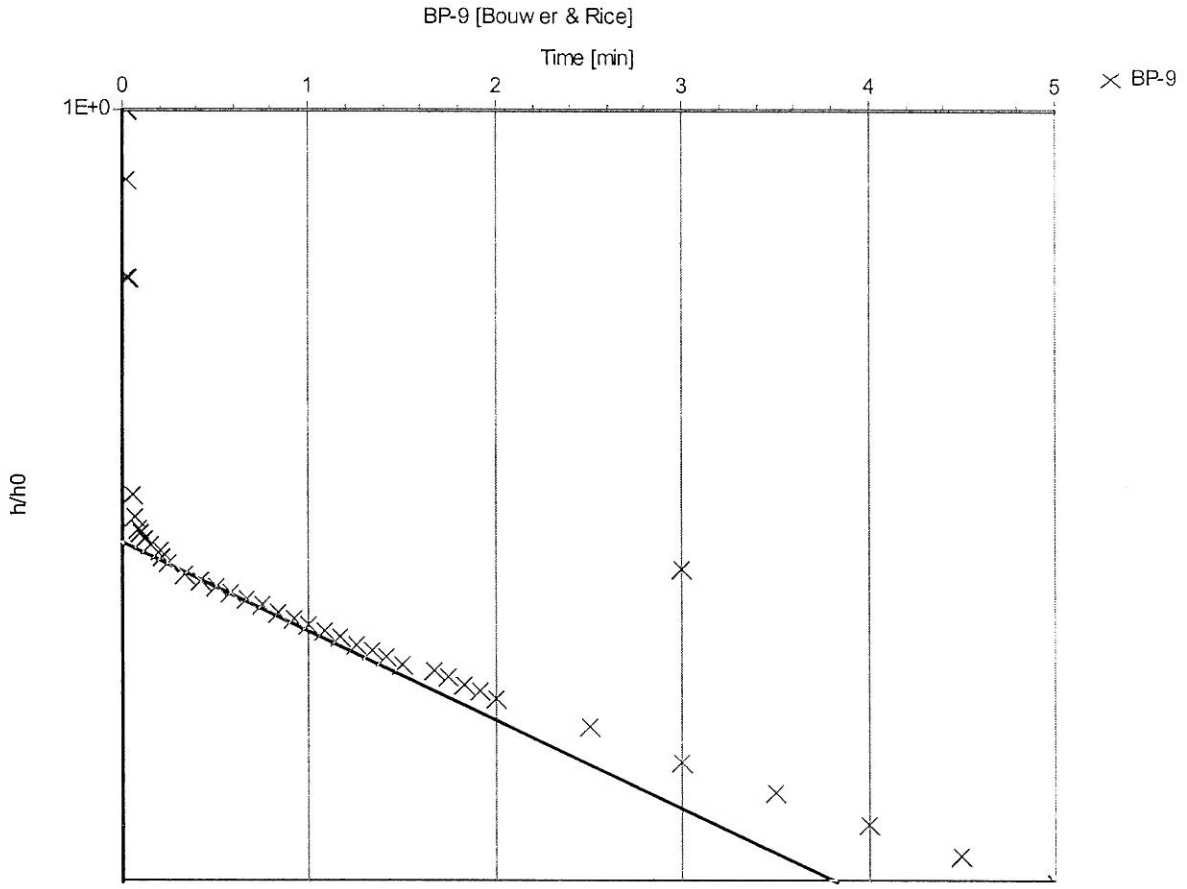
	Client:



Slug Test: **BP-9**

Analysis Method: **Bouwer & Rice**

Analysis Results:

Conductivity: 1.04E-4 [ft/min]

Test parameters:

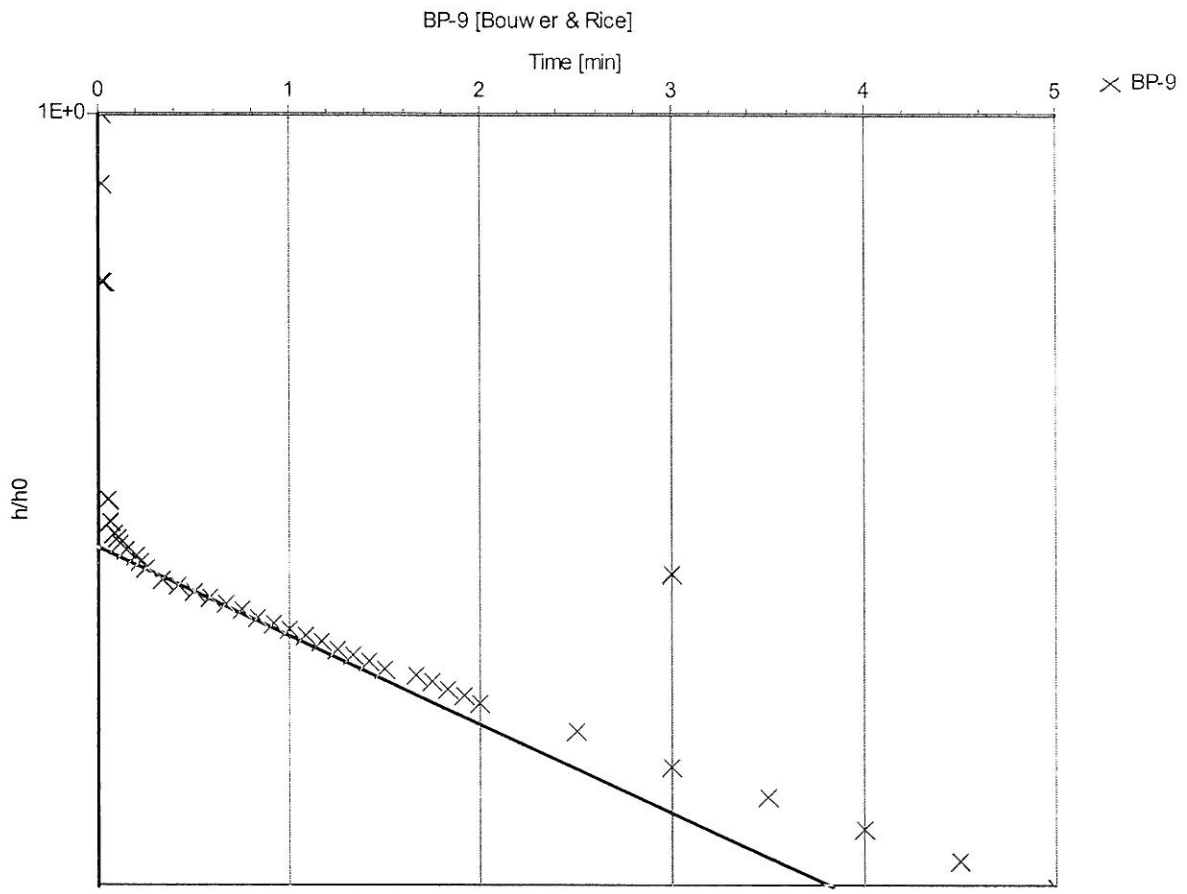
Test Well:	BP-9	Aquifer Thickness:	80 [ft]
Casing radius:	0.083 [ft]	Gravel Pack Porosity (%)	25
Screen length:	10 [ft]		
Boring radius:	0.1667 [ft]		
r(eff):	0.110 [ft]		

Comments:

Evaluated by:

Evaluation Date: 2/2/2006

G. N. Richardson & Assoc., Inc. 14 N. Boylan Avenue Raleigh, North Carolina 919-828-0577	Slug Test Analysis Report
	Project: Halifax
	Number:
	Client:



Slug Test: **BP-9**

Analysis Method: **Bouwer & Rice**

Analysis Results:

Conductivity: 1.04E-4 [ft/min]

Test parameters:				
	Test Well:	BP-9	Aquifer Thickness:	80 [ft]
	Casing radius:	0.083 [ft]	Gravel Pack Porosity (%)	25
	Screen length:	10 [ft]		
	Boring radius:	0.1667 [ft]		
	r(eff):	0.110 [ft]		

Comments:

Evaluated by:

Evaluation Date: 2/2/2006

G. N. Richardson & Assoc., Inc.
14 N. Boylan Avenue
Raleigh, North Carolina
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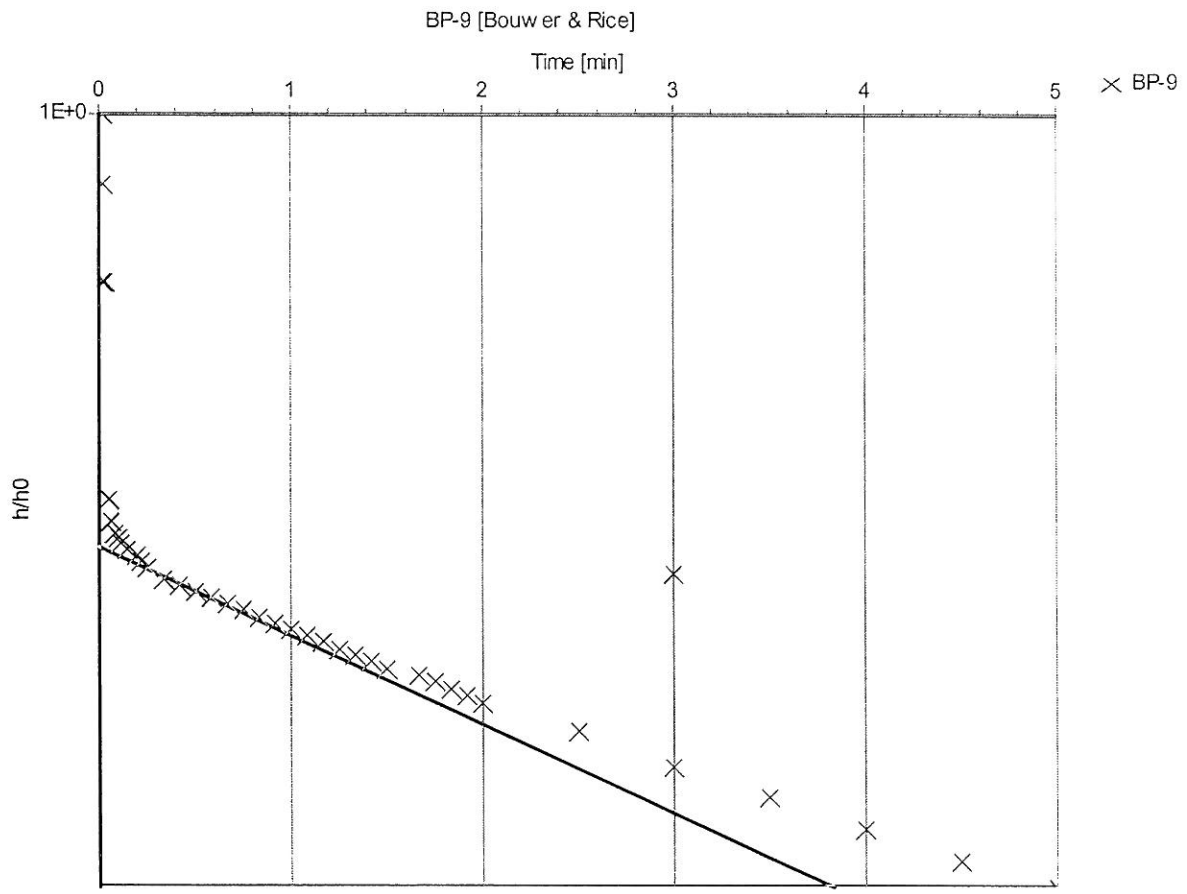
Slug Test Analysis Report

Project: Halifax
Number:
Client:



Slug Test: **BP-9**

Analysis Method: **Bouwer & Rice**

Analysis Results:

Conductivity: 1.04E-4 [ft/min]

Test parameters:

Test Well:	BP-9	Aquifer Thickness:	80 [ft]
Casing radius:	0.083 [ft]	Gravel Pack Porosity (%)	25
Screen length:	10 [ft]		
Boring radius:	0.1667 [ft]		
r(eff):	0.110 [ft]		

Comments:

Evaluated by:

Evaluation Date: 2/2/2006

G. N. Richardson & Assoc., Inc. 14 N. Boylan Avenue Raleigh, North Carolina 919-828-0577	**Slug Test Data Report** Project: Halifax Number: Client:	Page 1

Test Well:	**BP-9**	**Slug Test:**	**BP-9**
		Test Well:	BP-9
Depth to Static WL:	18.98 [ft]	Casing radius:	0.083 [ft]
Location:	C&D Landfill	Boring radius:	0.1667 [ft]
Recorded by:		Screen length:	10 [ft]
Date:	2/2/2006	Aquifer Thickness:	80 [ft]

	Time [min]	Depth to WL [ft]	Drawdown [ft]
1	0.017	21.45	2.47
2	0.02	21.26	2.28
3	0.023	21.02	2.04
4	0.03	21.02	2.04
5	0.05	20.57	1.59
6	0.067	20.53	1.55
7	0.083	20.51	1.53
8	0.1	20.50	1.52
9	0.117	20.49	1.51
10	0.15	20.48	1.50
11	0.2	20.47	1.49
12	0.217	20.46	1.48
13	0.25	20.45	1.47
14	0.333	20.43	1.45
15	0.417	20.42	1.44
16	0.5	20.41	1.43
17	0.583	20.40	1.42
18	0.667	20.39	1.41
19	0.75	20.38	1.40
20	0.833	20.37	1.39
21	0.917	20.36	1.38
22	1	20.35	1.37
23	1.083	20.34	1.36
24	1.167	20.33	1.35
25	1.25	20.32	1.34
26	1.333	20.31	1.33
27	1.417	20.30	1.32
28	1.5	20.29	1.31
29	1.667	20.28	1.30
30	1.75	20.27	1.29
31	1.833	20.26	1.28

G. N. Richardson & Assoc., Inc.
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Slug Test Data Report

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Test Well:	**BP-9**	**Slug Test:**	**BP-9**
		Test Well:	BP-9
Depth to Static WL:	18.98 [ft]	Casing radius:	0.083 [ft]
Location:	C&D Landfill	Boring radius:	0.1667 [ft]
Recorded by:		Screen length:	10 [ft]
Date:	2/2/2006	Aquifer Thickness:	80 [ft]

	Time [min]	Depth to WL [ft]	Drawdown [ft]
32	1.917	20.25	1.27
33	2	20.24	1.26
34	2.5	20.20	1.22
35	3	20.44	1.46
36	3	20.15	1.17
37	3.5	20.11	1.13
38	4	20.07	1.09
39	4.5	20.03	1.05
40	5	20.00	1.02

G. N. Richardson & Assoc., Inc.
14 N. Boylan Avenue
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Slug Test Analysis Report

Project: Halifax
Number:
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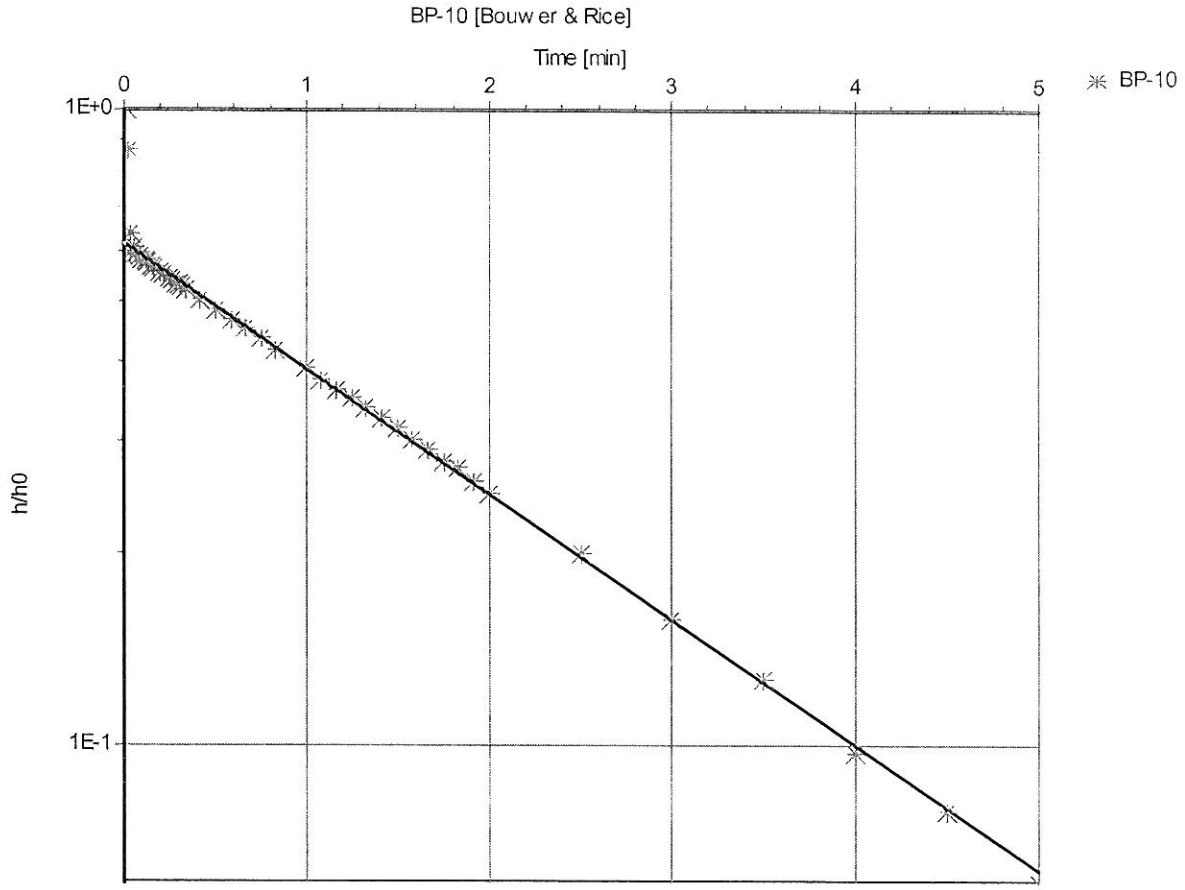


Slug Test: **BP-10**

Analysis Method: **Bouwer & Rice**

Analysis Results:

Conductivity: 7.56E-4 [ft/min]

Test parameters:

Test Well:	BP-10	Aquifer Thickness:	80 [ft]
Casing radius:	0.083 [ft]	Gravel Pack Porosity (%)	25
Screen length:	5 [ft]		
Boring radius:	0.1667 [ft]		
r(eff):	0.110 [ft]		

Comments:

Evaluated by:

Evaluation Date: 2/2/2006

G. N. Richardson & Assoc., Inc. 14 N. Boylan Avenue Raleigh, North Carolina 919-828-0577	**Slug Test Data Report** Project: Halifax Number: Client:	Page 1

Test Well:	**BP-10**	**Slug Test:**	**BP-10**
		Test Well:	BP-10
Depth to Static WL:	8.1 [ft]	Casing radius:	0.083 [ft]
Location:	C&D Landfill	Boring radius:	0.1667 [ft]
Recorded by:		Screen length:	5 [ft]
Date:	2/2/2006	Aquifer Thickness:	80 [ft]

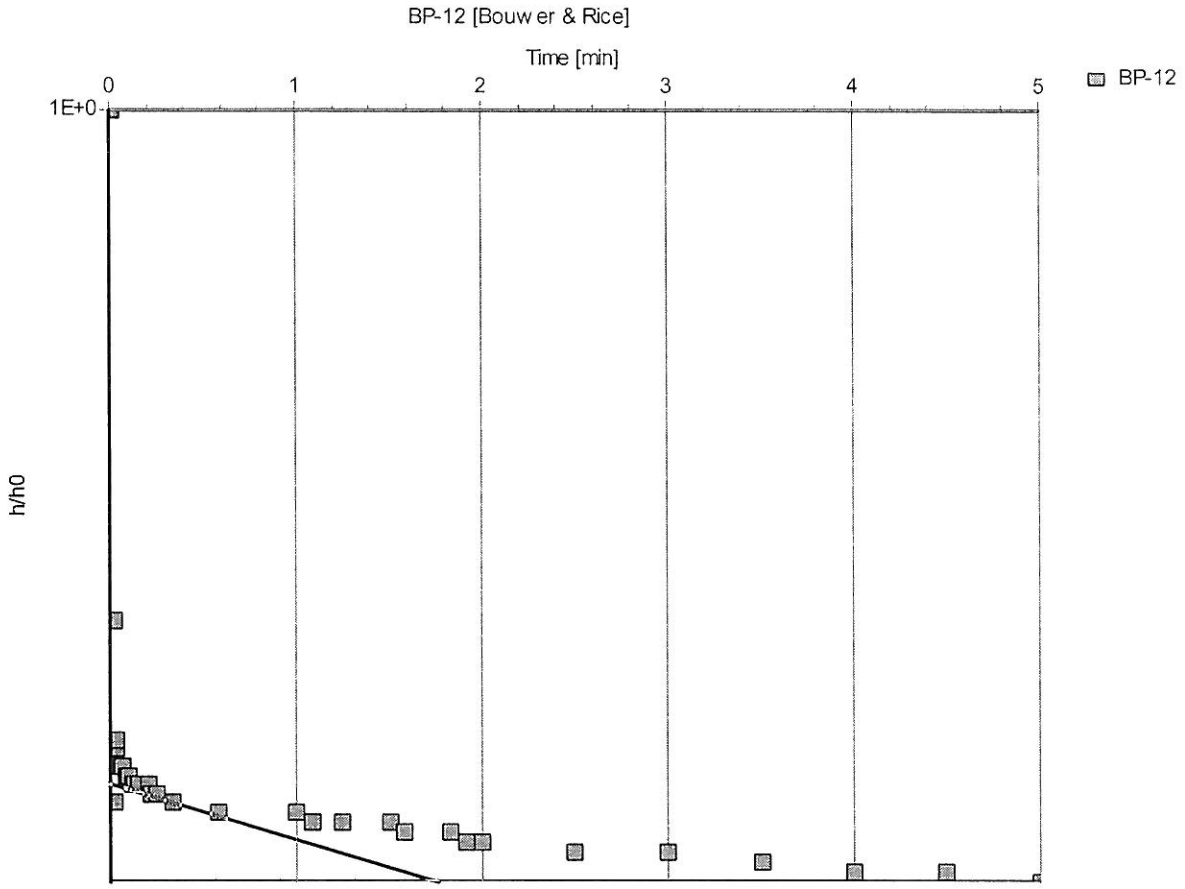
	Time [min]	Depth to WL [ft]	Drawdown [ft]
1	0.013	9.75	1.65
2	0.027	9.53	1.43
3	0.03	9.15	1.05
4	0.033	9.08	0.98
5	0.05	9.10	1.00
6	0.067	9.08	0.98
7	0.083	9.07	0.97
8	0.1	9.06	0.96
9	0.117	9.06	0.96
10	0.133	9.05	0.95
11	0.15	9.04	0.94
12	0.167	9.03	0.93
13	0.2	9.02	0.92
14	0.217	9.01	0.91
15	0.25	9.00	0.90
16	0.267	8.99	0.89
17	0.283	8.98	0.88
18	0.3	8.98	0.88
19	0.317	8.97	0.87
20	0.333	8.96	0.86
21	0.417	8.93	0.83
22	0.5	8.90	0.80
23	0.583	8.87	0.77
24	0.667	8.85	0.75
25	0.75	8.82	0.72
26	0.833	8.79	0.69
27	1	8.75	0.65
28	1.083	8.72	0.62
29	1.167	8.70	0.60
30	1.25	8.68	0.58
31	1.333	8.66	0.56

G. N. Richardson & Assoc., Inc. 14 N. Boylan Avenue Raleigh, North Carolina 919-828-0577	**Slug Test Data Report** Project: Halifax Number: Client:	Page 2

Test Well:	**BP-10**	**Slug Test:**	**BP-10**
		Test Well:	BP-10
Depth to Static WL:	8.1 [ft]	Casing radius:	0.083 [ft]
Location:	C&D Landfill	Boring radius:	0.1667 [ft]
Recorded by:		Screen length:	5 [ft]
Date:	2/2/2006	Aquifer Thickness:	80 [ft]

	Time [min]	Depth to WL [ft]	Drawdown [ft]
32	1.417	8.64	0.54
33	1.5	8.62	0.52
34	1.583	8.60	0.50
35	1.667	8.58	0.48
36	1.75	8.56	0.46
37	1.833	8.55	0.45
38	1.917	8.53	0.43
39	2	8.51	0.41
40	2.5	8.43	0.33
41	3	8.36	0.26
42	3.5	8.31	0.21
43	4	8.26	0.16
44	4.5	8.23	0.13
45	5	8.20	0.10

G. N. Richardson & Assoc., Inc.	Slug Test Analysis Report
14 N. Boylan Avenue	Project: Halifax
Raleigh, North Carolina	Number:
919-828-0577	Client:



Slug Test: **BP-12**

Analysis Method: **Bouwer & Rice**

Analysis Results: Conductivity: 1.32E-4 [ft/min]

Test parameters:				
	Test Well:	BP-12	Aquifer Thickness:	80 [ft]
	Casing radius:	0.083 [ft]	Gravel Pack Porosity (%)	25
	Screen length:	5 [ft]		
	Boring radius:	0.1667 [ft]		
	r(eff):	0.110 [ft]		

Comments:

Evaluated by:

Evaluation Date: 2/2/2006

G. N. Richardson & Assoc., Inc. 14 N. Boylan Avenue Raleigh, North Carolina 919-828-0577	**Slug Test Data Report** Project: Halifax Number: Client:	Page 1

Test Well:	**BP-12**	**Slug Test:**	**BP-12**
		Test Well:	BP-12
Depth to Static WL:	12.02 [ft]	Casing radius:	0.083 [ft]
Location:	C&D Landfill	Boring radius:	0.1667 [ft]
Recorded by:		Screen length:	5 [ft]
Date:	2/2/2006	Aquifer Thickness:	80 [ft]

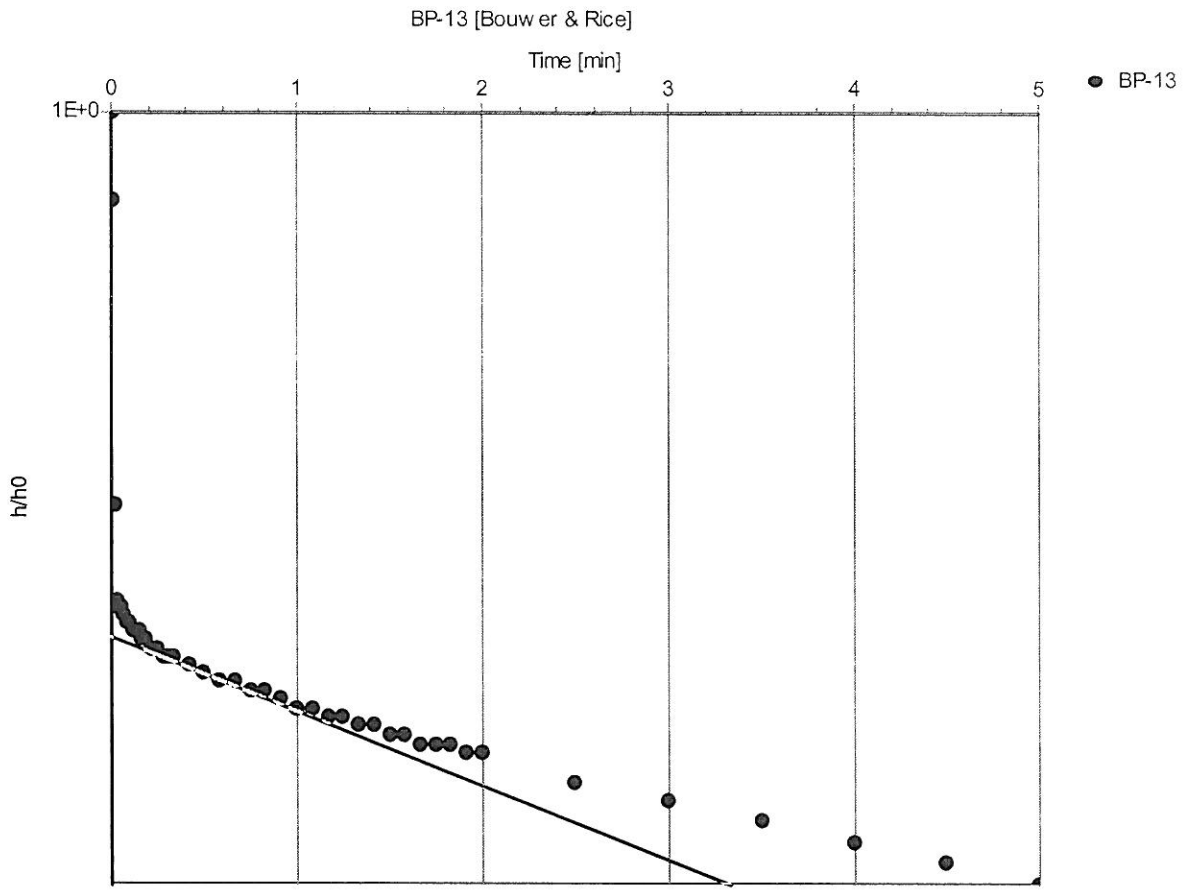
	Time [min]	Depth to WL [ft]	Drawdown [ft]
1	0.013	14.04	2.02
2	0.02	12.83	0.81
3	0.023	13.05	1.03
4	0.027	12.89	0.87
5	0.03	12.89	0.87
6	0.033	12.90	0.88
7	0.05	12.87	0.85
8	0.067	12.87	0.85
9	0.083	12.86	0.84
10	0.1	12.86	0.84
11	0.117	12.85	0.83
12	0.133	12.85	0.83
13	0.15	12.85	0.83
14	0.2	12.85	0.83
15	0.217	12.84	0.82
16	0.25	12.84	0.82
17	0.333	12.83	0.81
18	0.583	12.82	0.80
19	1	12.82	0.80
20	1.083	12.81	0.79
21	1.25	12.81	0.79
22	1.5	12.81	0.79
23	1.583	12.80	0.78
24	1.833	12.80	0.78
25	1.917	12.79	0.77
26	2	12.79	0.77
27	2.5	12.78	0.76
28	3	12.78	0.76
29	3.5	12.77	0.75
30	4	12.76	0.74
31	4.5	12.76	0.74

G. N. Richardson & Assoc., Inc. 14 N. Boylan Avenue Raleigh, North Carolina 919-828-0577	**Slug Test Data Report** Project: Halifax Number: Client:	Page 2

Test Well:	**BP-12**	**Slug Test:**	**BP-12**
		Test Well:	BP-12
Depth to Static WL:	12.02 [ft]	Casing radius:	0.083 [ft]
Location:	C&D Landfill	Boring radius:	0.1667 [ft]
Recorded by:		Screen length:	5 [ft]
Date:	2/2/2006	Aquifer Thickness:	80 [ft]

	Time [min]	Depth to WL [ft]	Drawdown [ft]
32	5	12.75	0.73

G. N. Richardson & Assoc., Inc.	Slug Test Analysis Report
14 N. Boylan Avenue	Project: Halifax
Raleigh, North Carolina	Number:
919-828-0577	Client:



Slug Test: **BP-13**

Analysis Method: **Bouwer & Rice**

Analysis Results:

Conductivity: 1.55E-4 [ft/min]

Test parameters:				
	Test Well:	BP-13	Aquifer Thickness:	80 [ft]
	Casing radius:	0.083 [ft]	Gravel Pack Porosity (%)	25
	Screen length:	5 [ft]		
	Boring radius:	0.1667 [ft]		
	r(eff):	0.110 [ft]		

Comments:

Evaluated by:

Evaluation Date: 2/2/2006

G. N. Richardson & Assoc., Inc. 14 N. Boylan Avenue Raleigh, North Carolina 919-828-0577	**Slug Test Data Report** Project: Halifax Number: Client:	Page 1

Test Well:	**BP-13**	**Slug Test:**	**BP-13**
		Test Well:	BP-13
Depth to Static WL:	11 [ft]	Casing radius:	0.083 [ft]
Location:	C&D Landfill	Boring radius:	0.1667 [ft]
Recorded by:		Screen length:	5 [ft]
Date:	2/2/2006	Aquifer Thickness:	80 [ft]

	Time [min]	Depth to WL [ft]	Drawdown [ft]
1	0.01	12.93	1.93
2	0.013	12.74	1.74
3	0.027	12.21	1.21
4	0.03	12.08	1.08
5	0.033	12.07	1.07
6	0.05	12.07	1.07
7	0.067	12.06	1.06
8	0.083	12.05	1.05
9	0.1	12.05	1.05
10	0.117	12.04	1.04
11	0.133	12.04	1.04
12	0.15	12.04	1.04
13	0.167	12.03	1.03
14	0.183	12.03	1.03
15	0.217	12.02	1.02
16	0.25	12.02	1.02
17	0.283	12.01	1.01
18	0.3	12.01	1.01
19	0.333	12.01	1.01
20	0.417	12.00	1.00
21	0.5	11.99	0.99
22	0.583	11.98	0.98
23	0.667	11.98	0.98
24	0.75	11.97	0.97
25	0.833	11.97	0.97
26	0.917	11.96	0.96
27	1	11.95	0.95
28	1.083	11.95	0.95
29	1.167	11.94	0.94
30	1.25	11.94	0.94
31	1.333	11.93	0.93

G. N. Richardson & Assoc., Inc. 14 N. Boylan Avenue Raleigh, North Carolina 919-828-0577	**Slug Test Data Report** Project: Halifax Number: Client:	Page 2

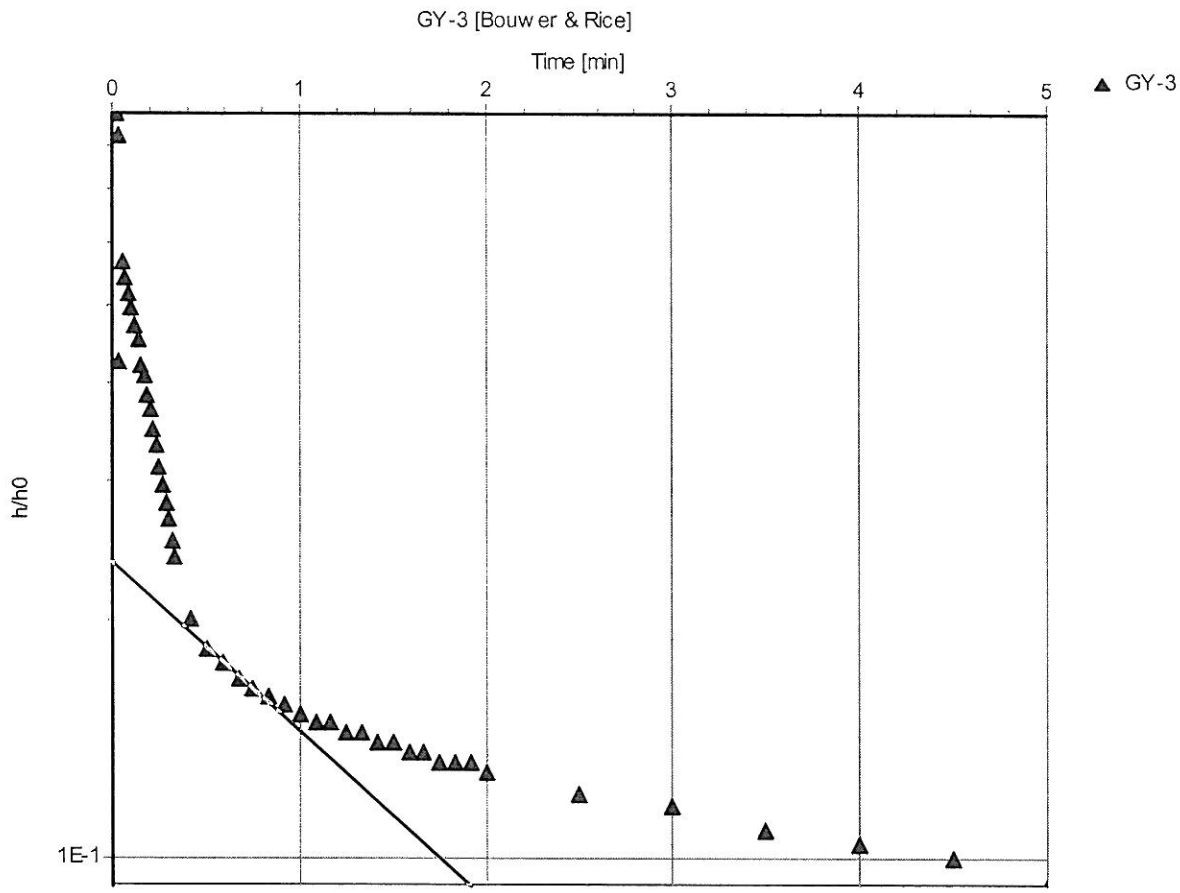
Test Well:	**BP-13**	**Slug Test:**	**BP-13**
		Test Well:	BP-13
Depth to Static WL:	11 [ft]	Casing radius:	0.083 [ft]
Location:	C&D Landfill	Boring radius:	0.1667 [ft]
Recorded by:		Screen length:	5 [ft]
Date:	2/2/2006	Aquifer Thickness:	80 [ft]

	Time [min]	Depth to WL [ft]	Drawdown [ft]
32	1.417	11.93	0.93
33	1.5	11.92	0.92
34	1.583	11.92	0.92
35	1.667	11.91	0.91
36	1.75	11.91	0.91
37	1.833	11.91	0.91
38	1.917	11.90	0.90
39	2	11.90	0.90
40	2.5	11.87	0.87
41	3	11.85	0.85
42	3.5	11.83	0.83
43	4	11.81	0.81
44	4.5	11.79	0.79
45	5	11.77	0.77

G. N. Richardson & Assoc., Inc.
14 N. Boylan Avenue
Raleigh, North Carolina
919-828-0577

Slug Test Analysis Report

Project: Halifax
Number:
Client:



Slug Test: **GY-3**

Analysis Method: **Bouwer & Rice**

Analysis Results:

Conductivity: 8.52E-4 [ft/min]

Test parameters:

Test Well:	GY-3	Aquifer Thickness:	40 [ft]
Casing radius:	0.083 [ft]	Gravel Pack Porosity (%)	25
Screen length:	5 [ft]		
Boring radius:	0.167 [ft]		
r(eff):	0.110 [ft]		

Comments:

Evaluated by:

Evaluation Date: 3/9/2006

G. N. Richardson & Assoc., Inc. 14 N. Boylan Avenue Raleigh, North Carolina 919-828-0577	**Slug Test Data Report** Project: Halifax Number: Client:	Page 1

Test Well:	**GY-3**	**Slug Test:**	**GY-3**
		Test Well:	GY-3
Depth to Static WL:	36.38 [ft]	Casing radius:	0.083 [ft]
Location:	C&D Landfill	Boring radius:	0.167 [ft]
Recorded by:		Screen length:	5 [ft]
Date:	3/9/2006	Aquifer Thickness:	40 [ft]

	Time [min]	Depth to WL [ft]	Drawdown [ft]
1	0	38.87	2.49
2	0.027	38.56	2.18
3	0.03	37.44	1.06
4	0.033	38.42	2.04
5	0.05	37.80	1.42
6	0.067	37.73	1.35
7	0.083	37.67	1.29
8	0.1	37.62	1.24
9	0.117	37.56	1.18
10	0.133	37.51	1.13
11	0.15	37.43	1.05
12	0.167	37.40	1.02
13	0.183	37.34	0.96
14	0.2	37.30	0.92
15	0.217	37.25	0.87
16	0.233	37.21	0.83
17	0.25	37.16	0.78
18	0.267	37.12	0.74
19	0.283	37.08	0.70
20	0.3	37.05	0.67
21	0.317	37.01	0.63
22	0.333	36.98	0.60
23	0.417	36.88	0.50
24	0.5	36.84	0.46
25	0.583	36.82	0.44
26	0.667	36.80	0.42
27	0.75	36.79	0.41
28	0.833	36.78	0.40
29	0.917	36.77	0.39
30	1	36.76	0.38
31	1.083	36.75	0.37

G. N. Richardson & Assoc., Inc. 14 N. Boylan Avenue Raleigh, North Carolina 919-828-0577	**Slug Test Data Report** Project: Halifax Number: Client:	Page 2

Test Well:	**GY-3**	**Slug Test:**	**GY-3**
		Test Well:	GY-3
Depth to Static WL:	36.38 [ft]	Casing radius:	0.083 [ft]
Location:	C&D Landfill	Boring radius:	0.167 [ft]
Recorded by:		Screen length:	5 [ft]
Date:	3/9/2006	Aquifer Thickness:	40 [ft]

	Time [min]	Depth to WL [ft]	Drawdown [ft]
32	1.167	36.75	0.37
33	1.25	36.74	0.36
34	1.333	36.74	0.36
35	1.417	36.73	0.35
36	1.5	36.73	0.35
37	1.583	36.72	0.34
38	1.667	36.72	0.34
39	1.75	36.71	0.33
40	1.833	36.71	0.33
41	1.917	36.71	0.33
42	2	36.70	0.32
43	2.5	36.68	0.30
44	3	36.67	0.29
45	3.5	36.65	0.27
46	4	36.64	0.26
47	4.5	36.63	0.25
48	5	36.61	0.23

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