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State of North Carolina
Department of Environment,
Health and Natural Resources
Division of Waste Management

James B. Hunt, Jr., Governor
Jonathan B. Howes, Secretary
William L. Meyer, Director

DEHNR

January 29, 1997

Carmen Johnson
Fac/Perm/Co ID # 42-04 | Date ~~3/26/12~~ 4/4/12 (cj) | Doc ID#

Mr. Richard Garner, Manager
Halifax County
P.O. Box 38
Halifax, North Carolina 27839

Re: Notification of Site Suitability
Proposed Halifax County Landfill Expansion
Permit No. 42-04

The Division of Solid Waste Management, Solid Waste Section, has completed its review of the site study for the proposed Halifax County Municipal Solid Waste Landfill. Pursuant to North Carolina Solid Waste Management Rule .1618(a)(1), the Division hereby notifies Halifax County that the site is suitable and the applicant is authorized to prepare an application for a Permit to Construct a Municipal Solid Waste Management Facility.

The Permit to Construct Application shall be prepared in accordance with 15A NCAC 13B .1617(a)(1) and shall include a comprehensive development plan for the facility in accordance with Rule .1619. The facility plan shall be in general accordance with the conceptual plan shown in the site study. Final approval of the facility plan is dependent upon Division review of the Permit to Construct application.

Solid Waste Management Rule .0201 requires the Division to issue a solid waste permit in two parts. The first part is a Permit to Construct and the second part is a Permit to Operate. This letter is not a permit. This letter only informs the applicant that they may proceed with a permit application. The final action the Division may take on a permit application is the issuance or denial of a permit.

G.N. RICHARDSON & ASSOCIATES
Engineering and Geological Services

April 10, 1997

RECEIVED
Solid Waste
APR 10 1997
MANAGEMENT DIV.

Mr. Bobby Lutfy
NC DEHNR
Division of Waste Management
P.O. Box 27687
Raleigh, North Carolina 27611-7687

RE: Supplemental Response to Hydrogeologic Review
Halifax County MSW Landfill Transition Plan
Permit No. 42-04

Dear Mr. Lutfy:

G.N. Richardson & Associates (GNRA) hereby makes the following additional response to your letter dated March 12, 1997, on behalf of our client, Halifax County. Our initial response dated March 18, 1997 provided revised drawings pertaining to the local area study for the facility. An error was noted in that submittal, in that an underground telephone line existing near the facility entrance was omitted from Drawing G-4.

This letter serves as transmittal for the corrected drawing. Please accept our apology if this causes any inconvenience. As always, please contact us at your earliest convenience if there are any questions or additional comments.

Sincerely,
G.N. Richardson & Associates

G. David Garrett, P.G.
Principal, Senior Geologist

Fac/Perm/Co ID# 42-04 Date 3/26/12 Doc ID# Carmen Johnson

Attachment

cc: Mr. Richard Garner, Director
Halifax County Solid Waste Department

417 N. BOYLAN AVENUE • RALEIGH, NORTH CAROLINA 27603 • TEL. 919-828-0577 • FAX. 919-828-3899

Drawing "Under Seperate Cover"

42-04

Carmen Johnson
Fac/Perm/Co ID #
42-04
Date
~~3/26/12~~
4/4/12 cg
Doc ID#

Part 1 Site Application Report
Hydrogeology and Facility Plan

Lined MSW Landfill Site
Halifax County, North Carolina

Prepared for
Halifax County
Department of Solid Waste Management

APPROVED
DIVISION OF SOLID WASTE MANAGEMENT
DATE ____________ BY ____________

Original May 1996
Revised October 1996

G.N. Richardson & Associates
Engineering and Geological Services
417 N. Boylan Avenue
Raleigh, North Carolina 27603

APPROVED
DIVISION OF SOLID WASTE MANAGEMENT
DATE ____________ BY ____________

Part 1 Site Application Report
Hydrogeology and Facility Design Report

Lined MSW Landfill Site
Halifax County, North Carolina

OCT 1996
Received
Solid Waste
Section

Prepared for:

Halifax County
Department of Solid Waste Management
P.O. Box 327
Halifax, NC 27839

To the Attention of:

Mr. Richard Garner
Director

GNRA Project No. Halifax-5

NORTH CAROLINA LICENSED SEAL 983 GEOLOGIST G. DAVID GARRETT
10/24/96

G. David Garrett, P.G.
Principal, Senior Geologist

Gregory N. Richardson, PhD., P.E.
President

NORTH CAROLINA PROFESSIONAL SEAL 8895 ENGINEER GREGORY N. RICHARDSON
10/31/96

Original May 1996
Revised October 1996

G.N. Richardson & Associates
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Part 1 Site Application Report
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Lined MSW Landfill Site
Halifax County, North Carolina

Table of Contents

A guide to specific NC DSWM rules addressed in this volume is shown in italics after each entry, and are referenced throughout the text.

Tables

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Appendices

1.0 EXECUTIVE SUMMARY

The planned facility is a new composite-lined landfill that will replace an existing unlined MSWLF unit (Permit #42-04). The footprint of the planned MSWLF unit is located on a 45± acre site, entirely within an existing ±200 acre permitted facility boundary. The planned facility is located within the areal limits of an unlined MSWLF unit that was approved in 1981 but not constructed. For permitting purposes, the new landfill is being treated as a new facility, subject to all current siting criteria promulgated by NC DEHNR, Division of Solid Waste Management - Solid Waste Section (NC DSWM).

The 45 acre study area for the planned MSWLF unit is located southwest of a lined ash Monofill and across a creek from (north of) the unlined MSWLF unit. The new MSWLF unit will be constructed in two phases, each providing approximately 5 years of capacity, with future expansion potential on the north side of the creek pending additional land purchase. The current MSWLF unit has a targeted closure date of December 1997, unless an extension is granted by NC DSWM. Construction of the new lined landfill will need to commence in early 1997 to meet the scheduled closure of the existing landfill.

Permitting of the planned MSWLF unit must comply with the application requirements of solid waste regulation 15A NCAC 13B .1603 (a) (1) (C). Under these provisions, a two-part site application has been initiated in accordance with paragraph (a) of Rule .1617. The application for Part 1, the permit to construct, has been addressed by a two-volume site characterization and design report. This document is Volume 1 of 2, which contains Regional/Local Siting Studies, Site/Design Geological Investigations, a Facility Plan and a Water Quality Monitoring Plan. Volume 2 contains an Engineering Plan, a Construction Quality Assurance (CQA) Plan, a Closure/Post Closure Plan and an Operations Plan. Part 2 of the site application will be the permit to operate, which includes construction documentation.

The planned facility site meets all applicable location requirements of Rule .1622 (1) through (6). The site vicinity is sparsely populated, with virtually no development down gradient of the site. Geological and geotechnical conditions at the planned MSWLF site are typical of the North Carolina piedmont, with on-site soils consisting of moderately stiff sandy silts and silty clays, weathered from the underlying bedrock. These soils make excellent structural fill and provide adequate foundation support conditions to assure long-term stability of the landfill. An on-site borrow source with sufficient quantities of low permeability clay for base liner construction has been identified within a 30-acre tract recently purchased by Halifax County. Two jurisdictional wetland areas exist within the planned MSWLF footprint, with a combined area of 0.34 acres.

Ground water characteristics at the site are sufficiently well understood to design an effective ground water monitoring network. Ground water generally occurs within the deeper residual soils and the relatively thin partially weathered rock interface existing just above the top of bedrock. The site contains a permanent stream that serves as an on-site ground water discharge feature. There are no potable wells located between the landfill and the ground water discharge feature. Based on 15 years of nearby monitoring well records and regional weather data, ground water levels appear to have attained a maximum seasonal high elevations soon after the investigation was completed earlier this year. Depths to bedrock and/or ground water are such that the current grading plan will meet NC DSWM vertical separation requirements.

This report includes a site characterization study for the addition of a 30 acre parcel of property, purchased by the County in 1995, to the permitted facility boundary. This property was purchased by the County in 1995 for the purposes of monitoring and buffers for the unlined MSW landfill. The tract will also serve as a soil borrow site. The County may wish to develop a C&D disposal facility on that tract at some future time. However, it is not anticipated that a MSWLF unit will be developed within this portion of the property.

2.0 SITE AND FACILITY CHARACTERIZATION

2.1 Regional Characterization Study - *.1618(c)(1)(A-F)*

Figure 1A shows the site vicinity and 2-mile radius on the USGS topographic map (Thelma and Aurelian Springs quadrangles, 1 inch = 2000 feet). The facility is located twelve miles south of Roanoke Rapids, one mile north of the intersection of NC 48 and SR 1001 at Aurelian Springs, in the Butterwood township (see inset on Figure 1A).

The study area for the planned MSWLF unit is situated between two north-south oriented ridge lines. The ridges are separated by a shallow drainage swale that bisects the study area and drains the site to the south. The swale intersects a southwesterly permanent stream (unnamed tributary) at the south end of the study area. Ground surfaces within the study area vary from El. 322 (feet) within the northeast corner to El. 235 where the tributary exits at the southwest corner.

Area land use is primarily undeveloped or agricultural. Scattered houses and businesses exist along NC 48 and the other paved roads in the vicinity. The permitted site is bounded on the north by SR 1417 and to all other directions by private property. Access to the site is from SR 1417, which connects to S.R. 1418 to the north and S.R. 1001 to the south. Both these roads connect to NC 48 and serve as the primary waste transportation routes. All access roads are paved. Current public road transportation routes, shown in Figure 1A, will not be modified.

Public water supply wells in the vicinity are identified on Figure 1A. No surface water intakes or residential subdivisions are known to exist within two miles of the site. The nearest known public water service area is Roanoke Rapids. Municipal water is not available in the vicinity of the landfill. Based on the current aeronautical chart for the area (Appendix B), there are no public airports within 5 miles of the site.

2.2 Local Characterization Study - .1618(c)(2)(A-G)

Figure 1B shows the site with a 2000 foot radius on regional mapping (1 inch = equal 400 feet). A current aerial photograph is presented in Figure 1C of this volume, also showing the 2000 foot radius. The aerial photo has been field verified that no significant new development has occurred within the 2000 foot radius since the aerial was taken. On-site easements include an overhead electric power line (North Carolina Power Company), located along S.R. 1417 at the north end of the site, within the 300 foot buffer. No other utilities or easements are known within the site boundary.

The planned MSWLF site has been previously timbered (estimated forest age is 20 to 30 years), and portions of the site had previously been farmed. The County's white goods, tires and composting operations now occupy portions of the site, along with other site uses associated with the current landfill. The zoning of the subject site is Agricultural. There are no known historical sites within the subject property boundary.

Significant ground water users within two miles of the site include two schools: a high school located northeast at a distance of 1.5 miles, and an elementary school located south at a distance of 0.8 miles from the planned MSWLF unit boundary. Neither facility is down gradient of the site, nor are these facilities expected to be influenced by the planned MSWLF unit.

Potential contaminant sources near the planned MSWLF unit include the unlined MSW landfill, located across the creek from the planned MSWLF site. This facility has been investigated and is monitored separately. An old C&D facility is located on the same side of the creek, down gradient from the planned MSWLF. Other potential contaminant sources in the planning area (outside the 2000 foot radius) include a junkyard (automobiles, construction/farm machinery, and other debris) located 0.75 miles northeast at the intersection of SR 1417 and SR 1418, a chicken farm located south on SR 1001 and two gas stations at the NC 48 - SR1001 intersection. These facilities are neither up gradient nor down gradient of the site. Non of these facilities has been investigated with regard to ground water contamination.

The local map and photo show 24 residences within a 2000 foot radius of the site boundary. A potable well survey conducted in conjunction with the transition plan for the current MSWLF unit identified 24 potable water wells within 2000 feet of the site boundary, excluding two wells at the nearer school located outside the 2000 foot radius to the south. None of the area water wells are considered to be down gradient of the landfill site.

The unnamed tributary and Brewer's Creek, shown in Figure 1A, are the primary water courses on the site. No portion of the site under consideration for development exists within a 100-year floodplain, based on FIRM mapping (presented in Appendix C). Two shallow swales serve as runoff conveyances within the study area. Two relatively small wetlands areas have been identified, one in each of the drainage swales. No springs or intermittent streams have been identified in the study area for the planned MSWLF unit.

2.3 Previous Site Studies - *.1618(c)(3) ≠ .1623*

Excerpts of the following studies have been used to augment the site investigation recently completed by G.N. Richardson & Associates. A site characterization study was completed in 1981 by McDavid & Associates (Farmville, NC), supplemented by a geotechnical investigation conducted by Law Engineering. The earlier work addressed "site suitability" characteristics of the property, as required at the time, including the planned MSWLF site. A site permitting study and design for the ash monofil were completed by GNRA in 1991. Another geotechnical investigation of the planned MSWLF site, including several test borings and ground water piezometers, was performed in 1992 by GNRA staff, while employed by another consulting firm (Hazen and Sawyer). A written report was not prepared from that work. A Transition Plan study of the current MSWLF unit was performed by Hazen and Sawyer in 1994. This document was amended by GNRA in October 1996.

Based on the earlier studies, the overall site characteristics appeared sufficiently suitable to proceed with a detailed investigation, in the interest of time. Aspects of the hydrogeology pertaining to "site suitability" are addressed separately from the detailed site investigation in

Section 3.0 of this volume. This report covers a site investigation performed in November-December 1995, with an original submittal presented for NC DSWM review in May 1996. Revisions to the text of this volume were made based on NC DSWM preliminary comments.

2.4 Location Restrictions - *.1618(c)(4) ⇉ .1622(1-10)*

2.4.1 Airport Safety - Based on current aeronautical mapping (Appendix B), the landfill is not located within 5,000 feet of an airport used by piston-powered aircraft, nor is the landfill located within 10,000 feet of an airport used by turbine-powered aircraft. The nearest airport is Halifax County Airport, located 6.8± miles to the northeast.

2.4.2 Floodplain - The main drainage feature on the site is an unnamed tributary that roughly bisects the permitted property and drains westward to Brewer's Creek and Bear Swamp. The banks of the unnamed tributary form a narrow floodplain extending no more than 20 feet to either side of the channel within the site boundary. No development is proposed within 50 feet of the stream channel to the north of the tributary. An inspection of FIRM national flood mapping for Halifax County [1] indicates that no areas of the site exist within the 100 year flood limits. A reprint of the FIRM map is presented in Appendix C. Design grades will be set such that no restriction to the flow of the unnamed tributary will occur and the risk of exposure of the waste due to flooding or scouring will be minimal.

2.4.3 Wetlands - Two isolated areas of wetlands were identified in earlier site studies. The wetlands determination was made by a qualified soil scientist on the basis of soil types and vegetation and certified by the US Army Corps of Engineers (COE) as jurisdictional. A US COE certified map is presented in Appendix D of this volume. These areas, shown on Figure 3 as Area "A" and "B", have jurisdictional areas of 0.12 and 0.22 acres, respectively. One area falls within each of the proposed phases of the planned MSWLF unit.

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1 Flood Insurance Rate Map, Panel 370327 0060 B, National Flood Insurance Program, 1991.

The locations of the delineated wetlands areas are such that no practical site development alternative exists. Since the combined area is less than one acre, these features fall under NC DEHNR - Division of Water Quality (DWQ) jurisdiction. A permit from NC DWQ to fill the areas will be acquired. Appropriate waste containment design and sedimentation/erosion control measures will be implemented to prevent degradation of other wetlands areas known to exist downstream of the site (outside the facility boundary).

2.4.4 Fault Areas - There are no Holocene age fault zones mapped within 200 feet of the site based on published geologic mapping [2 and 3]. There are no active fault zones within the North Carolina piedmont [4]. The nearest mapped fault area is a zone of subparallel normal faults, identified as the Graingers wrench zone, buried beneath the coastal plain in the Kinston-Graingers area of Lenoir County. The northward extension of this fault system passes about 50 miles east of the site. These faults are believed to date to Triassic time (approximately 200 m.y. before present), when the eastern margin of North America was an active tectonic zone.

Movement on the Graingers wrench zone may have occurred as recently as the Pleistocene, but movement in Holocene time is not clearly evident. Recent EPA guidance for seismic design guidance for municipal solid waste landfills [5] clearly indicates that only two faults east of the

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2 North Carolina Geological Map, Scale 1:62,500, NC Geological Survey, 1985.

3 Brown, P.M., et al., Wrench-style Deformation in Rocks of the Cretaceous and Paleocene Age, North Carolina Coastal Plain, NC Geological Survey, Special Publication 5, 1979.

4 Goldberg, Steven A., University of North Carolina, Chapel Hill, personal comm., 1995.

5 Richardson, G.N., E. Kavazanjian, Jr., and N. Matasovic, RCRA Subtitle D (258) Seismic Design Guidance for Municipal Solid Waste Landfill Facilities, US EPA Risk Reduction Engineering Laboratory, (EPA/600/R-95/051), April 1995.

Rocky Mountains have been shown to be tectonically active. The region of capable faults shown on Figure 6 extends eastward to the Meers fault in Oklahoma. While seismicity within the south eastern US is not unknown, the region is generally considered to be tectonically inactive.

2.4.5 Seismic Impact - The peak bedrock acceleration at the Halifax County site is obtained from USGS MF-2120 which is partially reproduced on Figure 7. This indicates that a peak bedrock acceleration of 0.10 g can be assigned to the Halifax County site. The peak acceleration represents a 90% probability of not being exceeded in 250 years, which corresponds to a site earthquake having a return period exceeding 2400 years. This indicates that the site is marginally located within a seismic impact zone, as defined by Rule .1622. However, the peak bedrock acceleration must be modified for site conditions to predict the peak ground surface acceleration at the site. The site amplification or attenuation of the peak bedrock acceleration can be evaluated using one-dimensional wave propagation analysis, either specifically performed for the site or based on parametric studies.

Since the Halifax County site is only marginally associated with a seismic impact zone, the site amplification or attenuation is estimated using the parametric relationships shown on Figure 8. Soil borings indicate that much of the Halifax County site is underlain by medium stiff, cohesive residual silt and clays (ML and CL). Based on these soil conditions, the ground surface acceleration is taken from Figure 8 as equal to the peak bedrock acceleration of 0.10 g. A seismic impact evaluation was performed for the site due to its proximity to the seismic impact zone. Seismic design loads were considered in the slope stability calculations presented in Volume 2 (Engineering and Design Report).

2.4.6 Unstable Ground - Subsurface investigations performed at the site and geotechnical laboratory test results indicate no unstable areas, either naturally occurring or man-made, within the site boundary, with respect to foundation conditions, slope stability and settlement potential. Detailed stability and settlement analyses are discussed in Volume 2 of this report.

2.4.7 Cultural Resources - A Phase 1 Cultural Resource Study was performed in 1991 for the adjacent ash monofil, permitted and constructed in 1992. That study, performed by a reputable archaeologist, identified no significant historical or cultural artifacts within the site boundary. A reprint of the study is presented in Appendix E of this volume.

2.4.8 State Nature and Historic Preserve - Refer to Section 2.4.7 above. In addition, a letter presented in Appendix E from the NC Natural Heritage Program (NC DEHNR Division of Parks and Recreation), pertaining to the ash monofil site, indicates no state park/recreation areas or endangered species habitats known in the vicinity of Halifax County landfill.

2.4.9 Water Supply Watersheds - The central unnamed tributary serves as the main drainage basin for the permitted site. The tributary merges with Brewer's Creek (so named on the site boundary map) at the southwest corner of the study area. Brewer's Creek makes the southern boundary of the permitted site. Both the unnamed tributary and Brewer's Creek originate on undeveloped land located northeast and southeast of the permitted site, respectively. Regional drainage near the site is toward the southwest via the Brewer's Creek, which merges with Bear Swamp approximately 0.75 miles to the southwest of the study area.

The local dendritic drainage pattern, including the landfill site, is located entirely within the Tar River regional drainage basin. The nearest public surface water intake belongs to the Town of Roanoke Rapids, located on the Roanoke River some 14 miles from the site. The nearest down stream municipality is Rocky Mount, located approximately 40 miles from the site along surface water courses. Leachate shall <u>not</u> be discharged to any waters of the State from this facility.

2.4.10 Endangered and Threatened Species - Refer to Section 2.4.8 above. The subject site has been cleared in the past for agricultural use, and portions of the site are currently utilized for support operations to the existing landfill.

2.5 Local Government Approval - *.1618(c)(5)*

The County of Halifax makes this site permit application in their own behalf. A resolution by the County Commissioners has not been finalized as of this writing. However, due to the anticipated closure of the existing landfill, currently scheduled for the end of calendar year 1997, this application has been initiated without this documentation in the interest of time. Documentation of local government approvals will be submitted by the County when available.

2.6 Facility Plan - *.1618(c)(6) ⇉ .1619(d)(1-4)*

The following provides an overview of the conceptual plan for the new lined MSWLF unit in accordance with applicable solid waste rules. More detailed descriptions of each aspect of the landfill design and operation are presented in Volume 2 of the report.

2.6.1 Site Development Plan - Figure 2A presents a facility plan showing the planned MSWLF unit study area, relative to the locations of other planned and existing disposal units and facility infrastructure. Test boring locations are shown in Figure 2B. Topographic contours presented on Figure 2 were prepared in March 1996 based on a recent aerial survey. A property boundary survey prepared by a North Carolina registered land surveyor is presented in Appendix A to this volume. Current aerial photography is presented in Figure 1C.

The planned MSWLF unit is located north of an unnamed tributary that bisects the permitted area and provides drainage toward the southwest. The unlined landfill is located south of the unnamed tributary. A lined ash Monofill opened in 1992 north of the unnamed tributary, to the east (upstream) of the planned MSWLF unit. An old construction and demolition debris (C&D) disposal area exists outside the study area to the southwest, down gradient from the planned MSWLF unit. Current plans are to consolidate a portion of the C&D waste into a smaller footprint, prior to the development of Phase 2 of the planned MSWLF unit. The old C&D site may be reutilized for white goods storage or as a yard waste composting area. A new borrow site and a possible C&D disposal facility are being planned east of the current MSWLF unit.

2.6.2 Landfill Construction - Figures 3A and 3B (discussed in Section 3.0) present ground water potentiometric contours determined during the recent site investigation and top of bedrock contours, respectively. These maps were used to define the footprint and cell bottoms for the planned MSWLF unit presented in Figure 4. The planned base grading plan will meet the 4-foot minimum vertical buffer requirements between the bottom of the compacted clay liner and the top of bedrock and/or the estimated maximum seasonal high ground water elevation.

The currently planned MSWLF unit will incorporate two phases, each divided into three or more storm water and leachate separation cells. Each phase is anticipated to provide approximately 5 years of disposal capacity, based on current waste stream projections. Horizontal buffers of 300 feet to the property boundary and a minimum of 500 feet to any dwellings will be observed. Proposed bottom grades will have a minimum 2.5 percent slope toward a future sump in the southwest corner. All leachate removal from the waste cell will be accomplished by gravity flow. Leachate management facilities, i.e., storage area and pipelines, are shown in Figure 4. Detail descriptions of these features are presented in Volume 2.

Earthwork for the base grading plan is balanced within the footprint of the planned MSWLF unit. The low permeability liner clay will be brought from the on-site borrow site located about 0.25 miles from the footprint. Proposed grades will require fill within the central and southern portions of the footprint. Fill depths varying to a maximum of 6 feet will be required within the southern portion of the site. Cuts depths will vary up to 12 feet in the east and south-central portion of the footprint.

Figure 5 presents proposed final cover contours for the planned MSWLF unit. Final contours will consist of 4H:1V side slopes with erosion control benches placed every 20 vertical feet and a 5 percent final cap. Maximum waste thicknesses will be 80± feet, with a crest at El. 364. The final cover will be designed to limit surface water infiltration. Details of the proposed final cover are presented in Volume 2 of this report.

2.6.3 Landfill Operation - The facility will be operated as an area fill, using on-site soil for periodic cover. Fill sequencing in Phase 1 of the planned MSWLF unit will begin in the eastern cell (Figure 4), working from the north end of the phase toward the south. The phase will be divided into multiple cells with temporary soil berms to promote separation of leachate from storm water. Interim soil covers and temporary diversion berms will be used to maintain separation of storm water and leachate during placement of the waste lifts. Soil covers will be seeded in all subcells which will not receive additional waste for a period of at least 30 days to minimize erosion.

Surface runoff from both phases will be diverted to a storm water/sedimentation basin located near the southern site boundary. Working faces and interim slopes within the phase will utilize 4H:1V side slopes. Each cell will initially receive a single lift of waste with a lift thickness of 20 feet. The last cell to receive waste will include the leachate sump, located in the southwest corner of the footprint. Once waste has been placed across the entire bottom of the phase, a second lift will be placed across the entire phase in a similar sequence. An interim soil cover will be utilized on all working faces. Side slopes will be filled to design grades and closed incrementally as the individual cells and lifts are completed. Interim side slope cover only will be utilized on the slope between Phases 1 and 2.

2.7 Facility Report - *.1618(c)(6) ⇸ .1619(e)(1-5)*

2.7.1 Waste Stream - The lined MSWLF unit will replace the existing unlined landfill, opened in 1981, that serves the general population of Halifax County. The waste stream volume is currently 180 tons per day, consisting primarily of residential and commercial wastes. Some local non-hazardous industrial wastes are disposed in the facility. Tires, white goods, yard waste and construction/demolition (C&D) debris are excluded from the MSWLF per State statute. These wastes are now handled separately, with tentative plans to develop new disposal areas for these wastes within the facility boundary. The County currently does not have an active recycling program.

The list of equipment currently used and required for operation of the planned MSWLF unit follows (excluding private contractor equipment occasionally used):

Equipment Type	Model, Purchase Date	Designated Function
Landfill Compactor	Rex 355B, 7/8/92	Waste placement and compaction
Track Loader	Fiat FL-10E, 8/29/94	Stripping soil and grading
Track Loader	Fiat FL-175, 8/29/94	Wet weather excavation, general maint.
Scraper Excavator	Dresser 412, 11/1/91	Daily cover excavation, cover placement
Lawn Tractor	Long 2510, 5/10/94	Grounds maintenance

2.7.2 Landfill Capacity - Preliminary estimates of the available airspace for waste in the planned MSWLF unit is based on the conceptual plans shown in Figures 4 and 5. The estimated operational life of the lined facility is based on an assumed waste density of 0.6 tons per cubic yard, an estimated soil volume of 20 percent and a projected monthly tonnage of 4,200 tons. The projected waste volume (excluding cover soil) and life expectancy for both phases follows:

Phase 1	Phase 2	Total
431,000 cubic yards	444,100 cubic yards	875,100 cubic yards
258,600 tons	266,400 tons	525,000 tons
5.1 years	5.3 years	10.4 years

Assuming that facility permitting and construction stays on schedule for an opening date of January 1, 1998, the projected operational life of the facility (both phases) extends through April 2008. Projected soil requirements for construction (including liner), operation, and closure (estimated in Volume 2) are summarized in the table at the end of this section.

2.7.3 Containment Systems - The base liner will include a composite 60-mil HDPE geomembrane overlying a compacted clay liner (permeability of 1.0 x 10^{-7} cm/sec) and a leachate collection system. The final cover will include, as a minimum, a low permeability composite barrier with an infiltration recovery system on the final cap and erosion control benches. Side slopes will receive a compacted soil barrier or an alternative cover design. Details of these components are presented in Volume 2 of this report.

2.7.4 Leachate Management - Leachate from the new phase will be collected in a tank to be located at the south end of the study area. Leachate production in the active phase is expected to diminish once the final cover is installed. The leachate tank will be designed with adequate capacity for the additional leachate production generated by the second phase. Leachate treatment is currently not available at the landfill. A pump and haul operation will be utilized to the nearest public-owned treatment works (POTW) access, located 12 miles north of the site.

2.7.5 Special Engineering Features - A more comprehensive discussion of the various engineering design features is presented in Volume 2 of this report, including storm water management facilities, slope stability, geosynthetic components of the liner and final cover, leachate management systems and the final cover.

ESTIMATED SOIL QUANTITIES FOR PLANNED MSWLF UNIT

Required Soil Quantity	**Phase 1 - 14.7 ac. (c.y.)**	**Phase 2 - 6.42 ac. (c.y.)**	**Planned Source**
Excavation	120,500	25,700	Within Footprint
Compacted Embankment [1]	50,000	43,800	From Excavation
Compacted Clay Liner (CCL) [2]	60,000	24,900	On-site Borrow Area
Leachate Collection System (LCS)	20,500	10,400	Manufactured Sand or Gravel (Off-site)
Operational Cover	30,000	15,200	On-site Borrow Area
Daily and Intermediate Cover	131,000	110,800	On-site Borrow Area
Final Cover - Barrier [3]	7,300	3,100	On-site Borrow Area
Final Cover - Agr.	48,400	15,500	On-site Borrow Area
Total Soil Borrow [4]	216,700	162,700	

Notes to the table above:

1. Surplus from Excavation in Phase 1 will be stockpiled for use as cover or used for general grading and drainage improvements outside the footprint.

2. Consists of low permeability (10^{-7} cm/sec) clay for Phase 1, possibly an alternative liner design for Phase 2. An estimated 145,200 c.y. of potentially suitable clay exists within the on-site borrow site, using a conservatively assumed clay thickness of 3 feet over the 30 acre site. Actual clay thicknesses in the borrow site vary.

3. Assumes 20% final contour coverage.

4. Excludes quantities for Excavation, CCL and LCS. The 30 acre borrow site is estimated to contain between 484,000 and 726,000 c.y. of soil (avg. 10 or 15 foot cut, respectively). Shading indicates quantities used in determining borrow soil requirement (balance of compacted embankment minus excavation used for Phase 2)

3.0 GEOLOGY AND HYDROGEOLOGY

3.1 Site Hydrogeologic Report - *.1623 (a)(1-13)*

3.1.1 Local and Regional Geology - A review of historical literature [6] and available geologic mapping [7] indicates that the proposed landfill site is situated on the eastern edge of the Eastern Piedmont Physiographic Province, just west of the Coastal Plain overlap. Western Halifax County is underlain by an assemblage of felsic to intermediate crystalline igneous and metamorphic rocks of early to late Paleozoic age. The rocks of the eastern piedmont exhibit a northeast strike and locally dip gently eastward as a result of regional metamorphism and folding which 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 rocks of the Piedmont plunge beneath non-indurated fluvial and deep-marine sedimentary deposits of the Coastal Plain. During late Tertiary times, portions of the eastern Piedmont were over washed by deltaic streams and shallow seas. This resulted in the deposition of a thin veneer of clayey sands and rounded quartz gravel, which is still visible along the uplands near the site.

Primary lineaments observed in the area topographic mapping (Figures 1A, 1B) are defined by the northeast-southwest orientation of Bear Swamp and the main ridge occupied by SR 1417. The leg of the unnamed tributary at the south end of the 45-acre study area parallels this orientation. This northwest-southeast orientation aligns with the regional strike of mapped geologic formations.

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6 Mundorff, M.J., Ground Water in the Halifax Area, North Carolina, NC Department of Conservation and Development, Division of Mineral Resources, Bulletin No. 51, 1946.

7 North Carolina Geologic Map, NC Geological Survey, 1985.

Secondary topographic lineaments noted throughout the region include subparallel ridges and drainage features oriented north-south (Figure 1A). These secondary features align with the prominent topographic features within the study area. The north-south orientation is believed to reflect a regional joint alignment. The unnamed tributary and Brewer's Creek follow an east-west orientation on either side of the study area. Brewer's Creek approaches the confluence with the unnamed tributary from the southeast. These short-segmented linear features suggest additional bedrock fracture orientations. An summary evaluation of structurally controlled topographic features identified in available mapping is presented as a rose diagram in Figure 9.

3.1.2 Site Reconnaissance - Site topography consists of gently sloping, subparallel ridges flanked by relatively shallow drainage swales. These generally dry swales drain the site to the south and lead to a permanent stream, identified as the "unnamed tributary" in the site mapping. A relatively thin deposit of sandy alluvium exists immediately near the unnamed tributary, outside the limits of the proposed footprint. No alluvial deposits were noted elsewhere in the study area, except for the isolated wetlands features located in two of the swales (see Section 2.4.3). The unnamed tributary exhibits year-round base flow and serves as a ground water discharge feature for the uppermost aquifer on the site.

Surface drainage within the study area originates along S.R. 1417. There is no development along this portion of the road. An old C&D disposal facility exists to the southwest of the planned MSWLF footprint. The facility plan (Figure 2A) indicates a minimum separation of 300 feet between the planned MSWLF unit and the old C&D disposal facility. There are no other natural or man-made features present which are likely to affect the ability to monitor the site.

The on-site soils are chiefly in-situ weathering products of granitic origin. Weathering and erosion along the widely spaced bedrock jointing produced large rounded boulders and irregular outcrops exposed along the creek bottom east of the study area (south of the ash Monofill site). Granite outcrops observed during area reconnaissance (and core run recoveries examined during the test drilling) exhibit a coarse porphyritic texture, with 1 to 2 inch diameter potassic feldspar crystals embedded in a fine matrix of feldspar, quartz, mica and minor accessory minerals.

The granite outcrops located east of the planned MSWLF study area exhibit a highly differential weathering pattern along two widely spaced, steeply dipping joint sets that appear to align with the principal orientation of vicinity lineaments. The outcrops exhibit surficial exfoliation (near horizontal convex fracturing) that results in rounded surface exposures. These outcrops are generally too weathered to obtain reliable strike and dip measurements on the joint surfaces.

A relatively small exposure of bedrock observed along the eastern ridge of the study area appears to be an isolated "ridge cap" or rock pinnacle, based on five test borings and auger probes near this feature (G-3, et al). Similar isolated ridge caps and rounded boulders have been observed within the site vicinity, but no other rock outcrops were noted within the study area. Such isolated surface exposures of bedrock surrounded by deeply weathered soils indicate a highly differential weathering pattern, which is typical of the piedmont and especially common in granitic terranes.

3.1.3 Site Investigation - The recently completed geotechnical investigation augments data from earlier site investigations and boring records for the previously existing monitoring wells. This investigation includes test borings, piezometer installation and laboratory testing, described below. This site investigation report is intended to meet the requirements for both site suitability and design hydrogeologic investigations. These requirements are discussed in separate sections.

Figure 2B shows the locations of test borings and piezometers installed during the recent site investigations. Ground water potentiometric surfaces and top of rock contours (based on auger refusal elevations) are presented in Figures 3A and 3B, respectively. Tables 1A and 1B present a summary of the depths to rock, partially weathered rock (100+ bpf material), and ground water data upon completion and after 24 hours. Table 1C presents a summary of the hydrogeologic properties of the various lithologic units encountered on the site. Table 1D presents a summary of long-term ground water levels. Test boring and monitoring well installation records for the recently installed borings are presented in Appendix F. Geotechnical laboratory data are presented in Appendix G. Data from earlier site investigations are presented in Appendix H.

Test Borings - The 45 acre study area for the planned MSWLF unit was investigated with 58 test borings, 37 of which fall within the 27-acre footprint. Thirty five (35) recent test borings, identified as the "B" and "G" series, and H-1d, were advanced to depths which encountered rock and/or ground water, 21 of which were completed as grouted standpipe piezometers. The others were backfilled with auger cuttings. The recent borings are supplemented by 23 earlier borings located in and around the study area , 20 of which were finished as ground water piezometers, identified as the "H" and "MW"series, and L-1 (a remnant 1981 piezometer). 14

Test boring locations were selected based on topographic features within the site, including drainage swales, ridges and intermediate side slopes. The test borings were drilled with a CME 450 drill rig mounted on an all-terrain vehicle carrier, turning 5¼ inch hollow stem augers. Five (5) of these borings were advanced at least 15 feet below auger refusal depths using rotary rock coring techniques. Test borings were sampled by the standard penetration test (ASTM D-1586). Representative split spoon samples and Shelby tube samples and bulk soil samples from the auger cuttings were procured for laboratory testing. All field work for the "H", "G" and "B" series borings was supervised by a North Carolina licensed geologist.

Table 1A and 1B show relative soil thicknesses, depths of partially weathered rock and auger refusal at the various test boring locations. Partially weathered rock is defined in this context as dense soils which can be penetrated by a machine-turned hollow stem auger and yield standard penetration resistance values in excess of 100 blows per foot (bpf). Auger refusal defines the top of bedrock that cannot be penetrated and sampled using conventional soil sampling techniques. In general, auger refusal denotes materials which required pre-loosening and heavy excavation equipment for removal. Auger refusal was encountered in nine of the borings within the study area at depths ranging from 17.5 feet to 36 feet.

The five rock cores performed within the study area each encountered granitic bedrock with varying degrees of weathering. In general, the granite is relatively weathered to depths of 10 to 15 feet below auger refusal. The rock at G-13d and H-1d located in drainage ways, for example, is sufficiently dense to produce auger refusal but not dense enough to yield a solid core run recovery. The rock at these locations was classified from cuttings retrieved with the core water return. Within the higher elevations, the upper bedrock is less weathered and more intact.

Piezometers - Each test boring which encountered ground water was converted to a 2 inch diameter PVC standpipe piezometer to allow long-term ground water observation and aquifer properties testing. Piezometer screens completed above auger refusal levels were constructed with sand packs. Screens installed within cored borings were isolated in the fractured bedrock. All piezometer screen intervals were isolated with bentonite seals, then the annular space above the seal was grouted to the surface with a bentonite-cement grout. Each of the piezometers and monitoring wells were surveyed for location and elevation by a registered land surveyor.

Each piezometer was developed using a downhole pump or bailer until clear water was retrieved. After development, a rising head slug test was performed on each piezometer. This test consisted of placing a pressure transducer at the bottom of the piezometer, and removing the volume of two bailers from the piezometer. A Hermit 1000 C data logger was used to record the rate of water influx until equilibrium was re-established. These data were used to calculate ground water velocities across the site. The slug test data and calculations are presented in Appendix I.

The on-site piezometers provide a total of 41 ground water observation points within the proposed MSWLF study area. Monitoring well "nests" were installed at G-5s/5d, G-13s/13d, H-1s/1d within the study area, supplemented by MW-6s/6d and MW-7s/7d located near the study area across the unnamed tributary. Monthly water level measurements have been collected since the installation of the piezometers and will continue through the permit review period. All piezometers within the MSWLF footprint will be properly abandoned prior to new construction.

Laboratory Testing - Laboratory test results are summarized in Table 2. Full lab reports are presented in Appendix G. All laboratory testing was performed in accordance with appropriate ASTM test procedures. Representative bulk soil samples were acquired at borings in the higher elevations of the study area (G-5, G-7 and G-9) and the proposed borrow area (BP-3 and BP-6). Relatively undisturbed samples were acquired from the study area (B-4, B-8, G-2 and G-6).

Samples were analyzed for grain size and Atterberg limits to verify soil classifications. Other testing performed to determine the engineering and hydrological properties of the on-site soils includes standard Proctor compaction, triaxial shear strength, consolidation, and flexible wall permeability (hydraulic conductivity) testing. Selected split spoon samples were also tested.

A majority of the soils within the MSWLF study area are silty and sandy clays and clayey silts, i.e., Unified Soil Classification System (USCS) classifications of CL, ML and SC. A minority of the soils classified as CH. Typical permeability values for the silts and clays within the footprint are on the order of 10^{-5} to 10^{-6} cm/sec. These soils have remolded shear strength values sufficient for construction of stable structural fills.

The proposed borrow soils are classified as CL and ML. Flexible wall permeability tests performed on remolded bulk samples indicate that permeability values of 1.0×10^{-7} cm/sec, or lower, can be achieved with the near-surface soils existing within the proposed borrow site. The lower permeability soils exist in sufficient quantities to construct the soil liner with a required thickness of 24 inches. These soils are generally limited to the uppermost 3 to 5 feet within the 30-acre site existing east of the current MSWLF unit but may be found deeper in isolated "pockets". Based on grain size distribution tests (summarized in Table 2), the available soils will not require screening prior to base grading or liner construction.

3.1.4 Hydrogeologic and Lithologic Units - Table 1C presents a summary of the hydrologic properties of each lithologic unit. The hydrogeologic cross-sections (Figure 10), based on the test boring records (Appendix F), indicate that the uppermost hydrogeologic unit consists of the saturated zone within the deeper saprolite and partially weathered rock (100+ bpf). The upper unit exhibits a transitional boundary with the underlying bedrock, becoming gradually denser with increasing depth. Two hydrogeologic units have been identified on the site:

Unit 1 - Granular Saprolite - Partially Weathered Rock (uppermost aquifer)

Unit 2 - Fractured Bedrock (variable density within the upper few feet).

The upper hydrogeologic unit can be subdivided into two lithological units based on density:

> **Unit 1a -** Residual soils (saprolite), unconsolidated in-situ weathering products of underlying granite, chiefly sandy silt (ML), sandy clay (CL) and silty or clayey sand (SM or SC). These soils exhibit a distinct rock-like texture with standard penetration resistance values less than 100 blows per foot (bpf).
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> **Unit 1b -** Partially weathered rock, dense residual soils exhibiting standard penetration resistance values of 100+ bpf. These soils can be penetrated with a hollow stem auger and generally consist of silty sands (SM) with relict rock-like textures. This material represents a transition between the residual soil and the deeper bedrock. It occurs as a relatively thin, discontinuous "mantle" above the less weathered rock, not present in every boring that encountered rock.

Unit 1 exhibits porous flow media characteristics due to the granular nature of the soils and partially weathered rock. The position of water levels in the piezometers relative to completed screen intervals (Tables 1A and 1B) supports a conclusion that the lithologic subunits of Unit 1 can be interpreted as a single, porous medium aquifer. Stabilized water levels fall within the depths of the near surface residual soils, although many of the borings were dry until the deeper, more granular saprolite was encountered. No distinct confining layers were identified, but the near surface, non-saturated clayey soils provide partial confinement. The deeper saprolite exhibits a distinctly rock-like texture.

A transitional boundary between Unit 1 and Unit 2 is reflected by differential weathering just below auger refusal within Unit 2. The transitional weathering profile is typified by G-5d, where core recoveries in the upper 7 feet below auger refusal were low and rock quality determination (RQD) values were less than 40%. Samples of the highly weathered bedrock exhibit heavy iron-oxide and/or manganese staining, indicating ground water movement. Core recoveries and RQD values increased to near 100% within 12 to 15 feet below the top of the unit. Two borings, H-1d and G-13d, yielded no recovery in core runs penetrating the rock by 10 and 23 feet, respectively.

Within Unit 2, rock core recoveries at B-4d and G-3s were over 90% for 10 foot core runs, with RQD values of 60% to 86%, respectively. Some of the more weathered portions of the bedrock, i.e., H-1d and G-13d, may exhibit hydraulic characteristics similar to Unit 1. However, slug test data for piezometers in the deeper, less weathered bedrock of Unit 2 indicate lower hydraulic conductivities, as expected with discreet fracture flow. Thus, the fractured bedrock is considered to be a separate hydrogeologic unit. Based on the consistency of water levels in piezometers completed in Unit 1 and Unit 2 , there appears to be an intimate connection between the uppermost porous media aquifer and the fractured bedrock aquifer.

The highly differential weathering pattern of the granitic bedrock is very apparent in Figure 10. The granite outcrop along the east side of the 45 acre study area was investigated with test boring G-3s, which yielded fairly competent rock from depths of 1 to 11 feet. The borings, G-3d, G-3A and G-3B, encountered relatively deep soils, indicating the isolated "pinnacle" nature of the outcrop. The relatively shallow rock at G-3, et. al appears to follow the topographic ridge toward G-5. Based on the similarity with the deeper core run at G-5d, the rock core at G-3s may be considered indicative of the deeper, unweathered granite of Unit 2.

3.1.5 Water Table Information - Table 1A presents a tabulation of Time of Boring (TOB) and 24-hour water level observations at the on-site piezometers. Table 1D presents on-going water level observations for the piezometers. Table 3 presents a summary of historical ground water records for the earlier test borings and nearby monitoring well network, including ground water records for the period from April 1988 to April 1996 at MW-1, 5, 6s and MW-7s.

Ground water elevations in the study area are monitored by 44 piezometers or monitoring wells, all of which have hydraulically isolated screen intervals. Monitoring well "nests" were installed at G-5s/5d, G-13s/13d, H-1s/1d within the study area, supplemented by MW-6s/6d and MW-7s/7d located near the study area across the unnamed tributary. The permanent unnamed tributary serves as an on-site ground water discharge feature for the site and provides additional ground water elevation data within the southern portion of the study area. Ground water levels are generally shallower than the bedrock at this site.

Table 4A presents a comparison of rainfall data for the on-site rain gauge and the nearest weather station (Roanoke Rapids, ID #317319) from August 1994 to March 1996. Cumulative monthly rainfall data for the period of January 1981 through December 1995 from the Roanoke Rapids weather station are presented on Table 4B. A comparison of ground water and climatological hydrographs (see Tables) has been used to determine seasonal ground water trends at the site.

Ground water recharge occurs through a balance of rainfall, evapotranspiration, surface run-off and infiltration. Historical rainfall data indicate that highest cumulative rainfall amounts at the site typically occur during March and during May through August. The 15-year average precipitation during these months is 4 to 5 inches per month. Average precipitation in the cooler autumn and winter months is typically 3 to 4 inches. However, the warmer summer months are also periods of higher evapotranspiration. Assuming surface conditions which influence direct runoff have changed little within the period of record, it can be assumed that surface water infiltration to the soils (e.g., ground water recharge) is higher during the cooler months with elevated precipitation, less during the warmer portions of the year. The closed-loop, porous media aquifer is expected to reflect longer term seasonal climatic trends, rather than short duration responses.

The ground water hydrographic data (Table 3) shows an apparent trend toward a record high water level during the months of April to June 1996. A water level of El. 295.72 was observed at MW-1 in late June 1996. Based on the plotted ground water hydrograph for MW-1, water levels this high have not been observed since high water level of El. 298.8 was observed in June 1990. Reliable records for MW-1 date back to April 1988. The boring was drilled in 1981, but the readings are semi-annual until recent years. The range of seasonal fluctuation at MW-1 since 1981 has been about 8 feet (including the June 1990 reading), with a minimum water level of El. 290.4. This magnitude of fluctuation is not unusual within a ground water recharge zone.

Elsewhere around the site, ground water levels have apparently not fluctuated more than 1 to 2 feet at MW-5, 6s, 7s, and 9. MW- 5 is similar in age to MW-1, but the data are discontinuous between December 1993 and March 1996. The apparent peak in the data at MW-1 in June 1990 is not reflected in the MW-5 data. The other monitoring wells show fairly consistent water levels throughout the period of record, with slightly higher water levels observed during March - April 1996 at MW-6s and February - May 1996 at MW-7s. MW-9 is not as old as the other monitoring wells, but its water level apparently peaked during the period of record in April 1996.

Measured precipitation at the landfill and at the Roanoke Rapids weather station (Table 4A) indicate that rainfall during the latter portion of 1995 and early 1996 did not set records, but cumulative precipitation was higher than normal during this period. Records show that much of the precipitation during this period was frozen. Precipitation for the 6 months prior to the investigation (May through November 1995) is substantially higher than the 15-year monthly averages (Table 4B). The relatively high precipitation coupled with unusually cool temperatures within the region evidently lowered evapotranspiration rates, resulting in higher than normal surface water infiltration, thus, higher ground water elevations.

Table 4B shows that 1989 received record rainfall (63.91 inches) for the 14 year period of record (46.42 inches, average), with June of that year (9.72 inches) receiving well above the 14-year average rainfall for that month (4.39 inches). This could account for the anomalously high ground water observations at MW-1, although the data at other wells present at that time did not peak near June 1989.

Estimated Seasonal High Ground Water - Ground water levels over most of the site appear to have attained the highest elevations since record keeping began during the months of April - June 1996. On-going monthly ground water levels observed since then support this conclusion. Ground water observation will be conducted throughout the remainder of the permit application review period to confirm the seasonal trend of ground water levels within this portion of the facility. These data have been used to estimate the maximum seasonal high ground water levels, from which phase bottom grades were determined to meet NC DSWM vertical separation requirements (see Figure 5). The estimated seasonal high ground water levels shown on Figure 3A were based on the April 1996 potentiometric map, modified accordingly with the hydrographic data of Table 3.

How were water levels modified?

Except for a relatively minor amount of paving and/or structures associated with the landfill offices and maintenance building, there appear to be no significant natural or man-made activities which would cause unusual ground water level fluctuations near the site. The ground water is believed to be adequately characterized in the study area to develop an effective early detection ground water monitoring plan for the planned MSWLF site. A Ground Water Quality Monitoring Plan (Appendix J) has been developed based on these data.

3.1.6 Ground Water Flow Characteristics - The shallowest on-site aquifer has been characterized based on topographic relationships and test boring data as a closed-loop, partially confined, porous flow medium, with a relatively short separation between the recharge and discharge zones. A conceptual model of ground water flow within the shallowest aquifer consists of the following:

- recharge occurring over most of the site from the non-saturated uppermost soils,
- partially confined flow within a saturated zone coinciding with the top of bedrock (with some downward recharge into the deeper, widely spaced bedrock fractures), and
- discharge along the perennial stream existing at the south side of the site.

These conditions are considered typical of piedmont terranes. Based on the test borings, primary ground water flow occurs within a relatively thin, saturated layer of highly weathered, porous saprolite existing between the near surface soil horizon and the underlying competent bedrock. The uppermost aquifer, identified as Unit 1, varies from 25 to 40 feet in thickness, as measured between the upper point of saturation (water table) and the estimated depth of competent bedrock. The uppermost aquifer generally follows surface contours, as shown on Figure 10. There are no obvious confining layers above the uppermost aquifer, except for partial confinement effects caused by the non-saturated near surface soils.

Based on stabilized ground water observations (Table 1D), the depth of the zone of saturation (i.e., water table) typically occurs between 10 to 20 feet below existing ground surfaces at most piezometer locations, varying from 3 feet within the lower drainage swales to 40 feet within the higher elevations along the west side of the study area. Test borings were advanced a few feet beyond the depth where ground water was first encountered, then a piezometer screen was installed across the saturated interval encountered by the test boring. Hydrostatic pressures due to partial confinement within the aquifer cause water levels to exist above the screened interval.

Probably not a correct statement

The deeper bedrock aquifer(s), identified as Unit 2, occur as discreet fractures in competent (less weathered) bedrock, which are differentiated from the uppermost aquifer based on flow characteristics. The discreet fractures offer more restricted flow pathways and provide partial to complete confinement for the base of the uppermost aquifer. There appears to be an intimate connection between the upper and lower units, based on similarities in observed ground water levels (hydraulic head) among piezometers completed in Units 1 and 2.

Vertical Ground Water Flow Characteristics - A summary of vertical hydraulic gradients calculated for several dates of ground water observation is presented in Table 5A. Vertical gradients were calculated by the elevation difference in observed ground water levels relative to the difference in the midpoint of the screened intervals at nested pairs of piezometers. A typical downward vertical gradient of 0.05 ft/ft is indicated by the nested pair of piezometers, H-1s and H-1d, located within a recharge area at the north end of the planned MSWLF footprint. An upward vertical gradient of 0.01 ft/ft is apparent at nested piezometers, G-13s and G-13d, located near the discharge feature for the uppermost aquifer, i.e., the unnamed tributary. Ground water levels recorded at G-13, G-15, MW-6s/6d and MW-7s/7d are close to water levels in the shallow tributary. The variation in the vertical gradients on Table 5A is slight.

Due to the non-homogenous, partially confined nature and limited thickness of the aquifer(s) at the site, a flow net is not considered to be an appropriate demonstration of flow characteristics. However, the hydrogeological cross sections (Figure 10) have been constructed to indicate the relative position of the ground water recharge and discharge areas and approximated vertical flow dimensions for the uppermost aquifer.

Horizontal Ground Water Gradients and Velocities - A summary of measured hydraulic conductivities measured at selected piezometers, along with apparent horizontal hydraulic gradients and velocities, is presented on Table 5B. Horizontal hydraulic gradients were estimated using vertical and horizontal distances between potentiometric contours scaled from Figure 3A. Ground water velocities were calculated using apparent horizontal hydraulic gradients, hydraulic conductivity values calculated from slug tests at each piezometer, and empirical effective porosity values according to 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).

Horizontal ground water gradients estimated from Figure 3A (units are ft/ft) vary from 0.0026 at B-4s to 0.046 at G-6. Hydraulic conductivity values measured in the soil and bedrock aquifers vary on the order of 0.34 to 7.49 ft/day (10^{-5} to 10^{-3} cm/sec), respectively. Apparent ground water velocities at the site range from 0.099 ft/day at G-6 to 0.829 ft/day at G-7. It is common practice to use conservative estimates of effective porosity based on published values in hydrological calculations. Effective porosities reported for a given soil type are typically lower than the porosity values calculated from laboratory tests. Laboratory porosity values are based on the *total* percentage of pore space in a soil, where *effective* porosity values reflect the degree of interconnectivity of the pore spaces. Laboratory porosity values can be adversely affected by sample disturbance. Published effective porosity values used in the calculations on Table 5 are based on field tests and more closely reflect probable in-situ conditions [8]. Thus, the calculated ground water velocities are conservative, i.e., overestimated.

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[8] Driscoll, F.G., Groundwater and Wells, 2nd ed., Johnson Division, St. Paul, MN, 1986.

Ground Water Potentiometric Surfaces - A ground water potentiometric surface map prepared from the available piezometric and monitoring well data is presented as Figure 3A. The potentiometric surface represents the hydraulic heads measured at the various ground water observation points on the site, modified with the historical ground water elevation data to reflect the estimated maximum seasonal high water table. The potentiometric surface shown in Figure 3A is a subdued reflection of the surface topography. This trend is characteristic of porous flow media and typical of aquifers throughout the piedmont. The potentiometric surface indicates ground water flow to the south within the study area.

Summary of Hydrogeological Evaluation - The uppermost aquifer within the study area is confined within a closed-loop ground water basin, coinciding with a relatively small surface drainage area which aligns with primary and/or secondary bedrock lineaments. The uppermost aquifer coincides with the weathered upper bedrock surface and roughly conforms to surface topography. Ground water recharge occurs over much of the site, while discharge occurs along the permanent stream located along the southern boundary of the study area.

The lined MSWLF unit will be situated over a portion of the recharge area, effecting a minor reduction in ground water recharge within the property boundary. The area in which ground water recharge will be reduced is relatively small compared to the drainage basin feeding the permanent stream (unnamed tributary). Thus, the reduction in base flow along the ground water discharge feature is expected to be minimal. No ground water receptors (water wells) are located between the planned MSWLF unit and the ground water discharge feature. Ground water users in the vicinity of the site are not down gradient of the planned MSWLF unit.

Based on the recent investigation of the study area and previous ground water investigations for the ash Monofill and the old MSW disposal site, geologic and hydrogeologic conditions are consistent throughout the 200± acre permitted site boundary. Based on this characterization, the 45 acre study area appears to be well suited to development of a new lined MSWLF unit. No other areas within the permitted site boundary are suitable for development of the planned MSWLF unit, considering available buffer space and long-term site development potential.

Wells located between the planned MSWLF unit and the unnamed tributary will provide effective monitoring to ensure early detection of hazardous constituents in the uppermost aquifer.

3.2 Design Hydrogeologic Report - .1623 (b)(1-3)

3.2.1 Site Hydrogeologic Investigation - This site characterization was developed to meet the requirements of both the *Site Suitability* and *Design Hydrogeologic* investigations. An earlier site study (1992) determined the basic hydrogeological characteristics of the site, which were found to be similar to those of the adjacent ash Monofill site (permitted in 1991). A report was not completed for the earlier investigation of this site. Since that time, regulatory requirements for site permitting became more stringent, with the implementation of Subtitle D rules in 1993.

The 45 acre MSWLF study area contains a 27 acre footprint (Phases 1 and 2), which has now been characterized with a total of 58 test borings, including rock cores at 6 locations. A total 44 piezometers, with 5 piezometers completed in bedrock and 5 piezometer "nests", are located within the study area. Other aspects of the site investigation intended to meet the requirements for the Design Hydrogeologic Report are rock cores (described in the next section) and hydraulic conductivity testing (slug tests) performed at each piezometers within the study area. These data are summarized in Table 1C, with full data presented in Appendix I. Laboratory testing (Appendix G) provides hydrogeological and engineering properties for the on-site soils within the MSWLF study area and proposed borrow site, i.e., grain size, classification, permeability, shear strength and consolidation data.

Based on the estimated seasonal high water table surfaces presented in Figure 3A, the density of data described in Section 3.1 are considered adequate to determine design grades to meet vertical separation requirements. Design grades shown in Figure 4 meet the vertical separation requirements of Rule .1624 (b)(4). Geotechnical laboratory data described in Section 3.1.3 and presented in Appendix G of this report have been used to determine post-settlement vertical separation and evaluate foundation subgrade conditions within the footprint, as required by Rule .1624(b)(7). The foundation stability and settlement calculations based on available geotechnical data are presented in Appendices C and D, respectively. The requirements of .1680(e), which pertain to surface leachate impoundments, do not apply to this facility. Leachate will be stored in above ground tanks, described in Rule .1680(c).

3.2.2 Site Specific Data - Section 3.1 of this report describes an investigation performed for the proposed MSWLF unit which meets the requirements of Solid Waste Rule .1623 (a)(4 - 12). The data density are considered adequate to design an effective water quality monitoring system for the planned disposal facility in accordance with Rule .1631(c). The following addresses the specific requirements of Rule .1623(b)(2), providing supplemental discussion as required.

Rock cores at selected test boring are described in Section 3.1.3 and in the test boring records (Appendix F). Rock cores were performed at G-3S, G-5D, G-13D, H-1D, B-4D AND B-4a. The rock type encountered by all borings was described as coarse, porphyritic granite. Varying degrees of weathering within the upper portions of the granite result in variable core recoveries and RQD values. Saturated hydraulic conductivity values measured at piezometers installed within the bedrock are presented in Table 1C. The rock outcrops and core run recoveries are described in Section 3.1.2.

A ground water contour map showing the estimated seasonal high water levels (April 1996) is presented as Figure 3A to this report. This map has been prepared from ground water observations made during and since completion of the site investigation, supplemented with historical ground water records obtained for the earlier piezometers and monitoring wells. A bedrock contour map prepared from the test boring data and surface outcrops is presented as Figure 3B. Hydrogeologic cross sections based on available test boring and piezometric data within the planned MSWLF unit study area are presented in Figure 10. The ground water flow regime is described in Section 3.1 of this report.

By way of the seal on the cover of this document by a North Carolina licensed geologist, this certifies that all borings on the site will be properly abandoned in accordance with 15A NCAC 2C .0113(a)(2) prior to construction of the planned MSWLF unit. Those borings which were converted to permanent piezometers will also be properly abandoned prior to new construction.

Relevant Point of Compliance - Based on the discussion of ground water characteristics presented in Section 3.1, a relevant point of compliance can be determined in accordance with Rule .1631(a)(2) as described in the following. The hydrogeologic characteristics of the site and surrounding land consist of partially confined porous media aquifers occurring within the saprolite and upper weathered bedrock, underlain by bedrock with a relatively low fracture density. The uppermost aquifers coincide with surface drainage features, with relatively short recharge-discharge cycles. Ground water elevations (potentiometric surfaces) at the site generally conform to a subdued reflection of the surface topography. The site contains a permanent stream (unnamed tributary) which serves as an on-site ground water discharge feature, located south of the planned MSWLF unit.

No down gradient ground water users exist between the disposal facility and the nearest discharge feature. Area water well users are several hundred feet from the site boundary and none are considered to be down gradient of the planned MSWLF unit. As the surrounding land is generally undeveloped and contains a relatively low density of non-porous surfaces (pavements, structures, etc.), the withdrawal of ground water by area users is not expected to influence (or be influenced by) the planned MSWLF unit. The planned MSWLF unit is a lined facility with leachate collection and off-site leachate disposal. The facility should not affect the quality or quantity of ground water at the points of withdrawal in the vicinity. In other words, there should be no reasonably expected impact on local drinking water supplies and no apparent public health, safety or welfare effects due to the planned MSWLF unit.

The proximity of older disposal facilities within the site boundary (outside the study area) are the only potential sources of impact to ground water quality immediately near the site. These facilities have been investigated and are monitored separately. Ground water conditions at these facilities are not expected to affect the ability to monitor the planned MSWLF unit. There is a ground water discharge feature located between the planned MSWLF unit and the old MSW site, and adequate separation (minimum 300 feet) will exist between the planned MSWLF unit and the old C&D disposal unit on the north side of the unnamed tributary.

Based on these considerations, the relevant point of this compliance for the planned MSWLF unit should be set at 250 feet from the waste boundary, pursuant to Rule .1631(a)(2)(A). Initially, new monitoring wells should be installed approximately half this distance, 125 to 150 feet from waste boundary, in keeping with prior NC DSWM policy. The facility plan (Figure 2A) shows proposed monitoring well locations, selected based on preferential lineaments shown in Figure 9, the future locations of critical structures and an understanding of ground water flow characteristics determined in this study. Additional monitoring requirements for the planned MSWLF unit are addressed in the following section of this report.

3.2.3 Water Quality Monitoring Plan - A ground water Sampling and Analysis Plan (SAP) has been prepared for the planned MSWLF unit and is presented in Appendix J of this report. The SAP discusses the location of specific monitoring wells and surface sampling points, along with field and laboratory protocol, a sampling schedule and analytical parameters. The SAP is a stand alone report which meets the requirements of Rule .1630 through .1637 and bears the seal and certification of a North Carolina licensed geologist.

Figures

Refer to the rolled set of Figures, submitted separately, containing:

1A	Regional Characterization Map (2 mile radius, 1" = 2000')
1B	Local Area Map (2000 foot radius, 1" = 400')
1C	Local Area Photo (2000 foot radius, 1" = 400')
2A	Overall Facility Plan
2B	Site Boundary and Test Boring Locations
3A	Ground Water Potentiometric Surfaces
3B	Bedrock Contours
4	Proposed Grading Plan
5	Proposed Final Contours

and

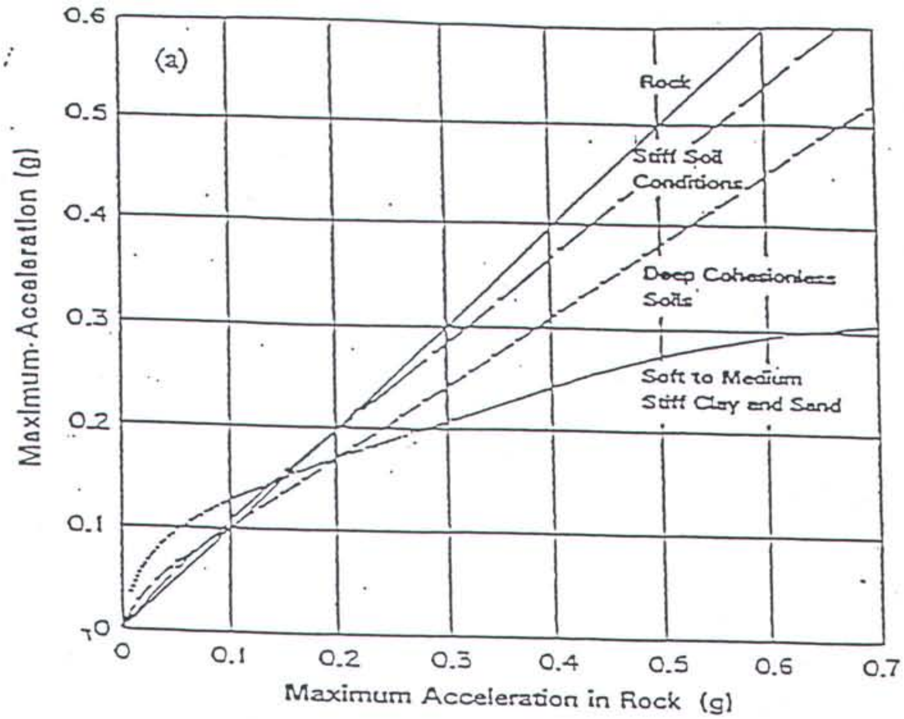
10	Hydrogeological Cross Sections

SITE AMPLIFICATION/ ATTENUATION RELATIONSHIPS

G.N. RICHARDSON & ASSOCIATES, INC.
Engineering and Geological Services

417 N. Boylan Avenue Raleigh, North Carolina
(919) 828-0577 Fax 828-3899

SCALE:	DRAWN BY:	CHECKED BY:	DATE:	PROJECT NO.	FIGURE NO.
N.T.S.	A.W.H.	G.D.G.	APRIL, 1996	HALFAX-5	7

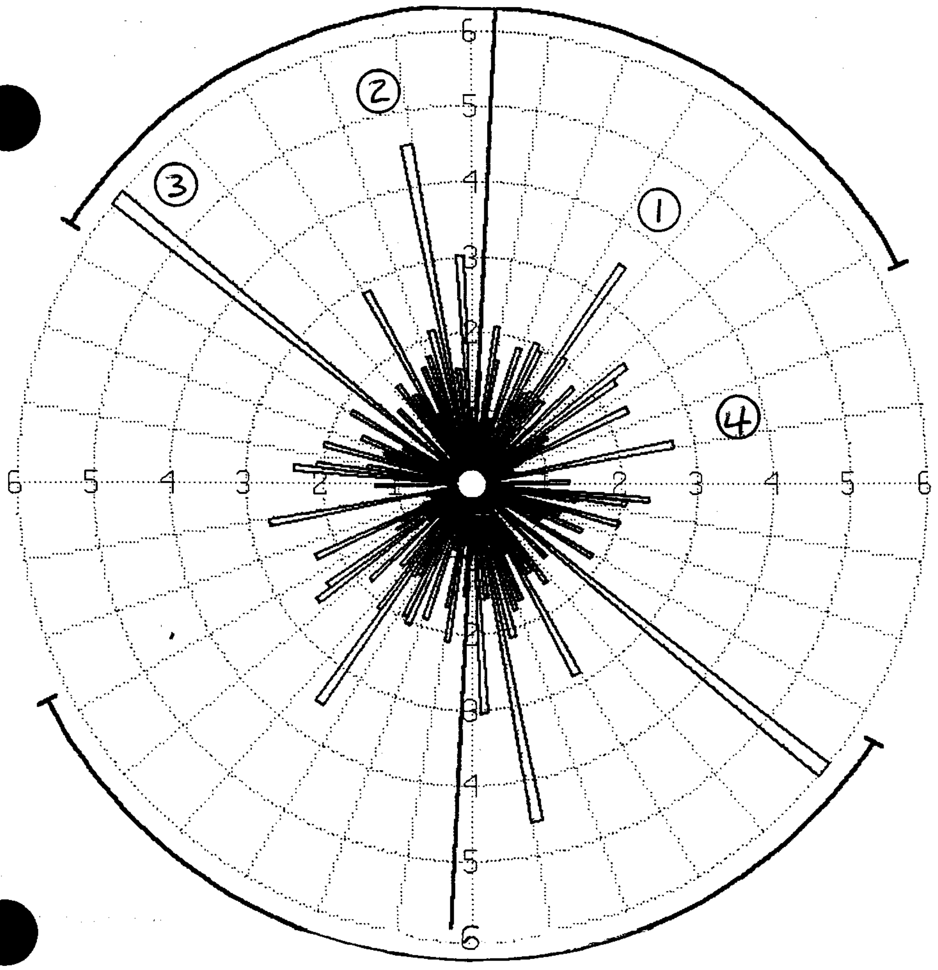


PEAK BEDROCK
ACCELERATIONS MAP

G.N. RICHARDSON & ASSOCIATES, INC.
Engineering and Geological Services

417 N. Boylan Avenue Raleigh, North Carolina
(919) 828-0577 Fax 828-3899

SCALE:	DRAWN BY:	CHECKED BY:	DATE:	PROJECT NO.	FIGURE NO.
N.T.S.	A.W.H.	G.D.G.	APRIL, 1996	HALFAX-5	8



Calculation Method	Frequency
Class Interval	2 Degrees
Filtering	Activated
Minimum Azimuth	0 Degrees
Maximum Azimuth	180 Degrees
Data Type	Bidirectional
Rotation Amount	0 Degrees
Population	139
Maximum Percentage	6 Percent
Mean Percentage	1.4 Percent
Standard Deviation	1.01 Percent
Vector Mean	2.82 Degrees
Confidence Interval	60.03 Degrees
R-mag	0.11

Preferential Lineaments	Orientation (From Map)	Example from Topographic Map
1	N35°E	Unnamed tributary southeast of study area Dry run southeast of old MSW site Unnamed tributary southeast of ash Monofill Bear Swamp (See Figure 1A, not included in numerical analysis)
2	N10-12°W	Numerous drainage swales (no well defined creeks) including 45 acre study area
3	N50°W	Brewer's Creek south of permitted facility boundary Drainage swales located northeast of ash Monofill
4	N70°E	Unnamed tributary due south of ash Monofill Brewer's Creek west of permitted facility boundary

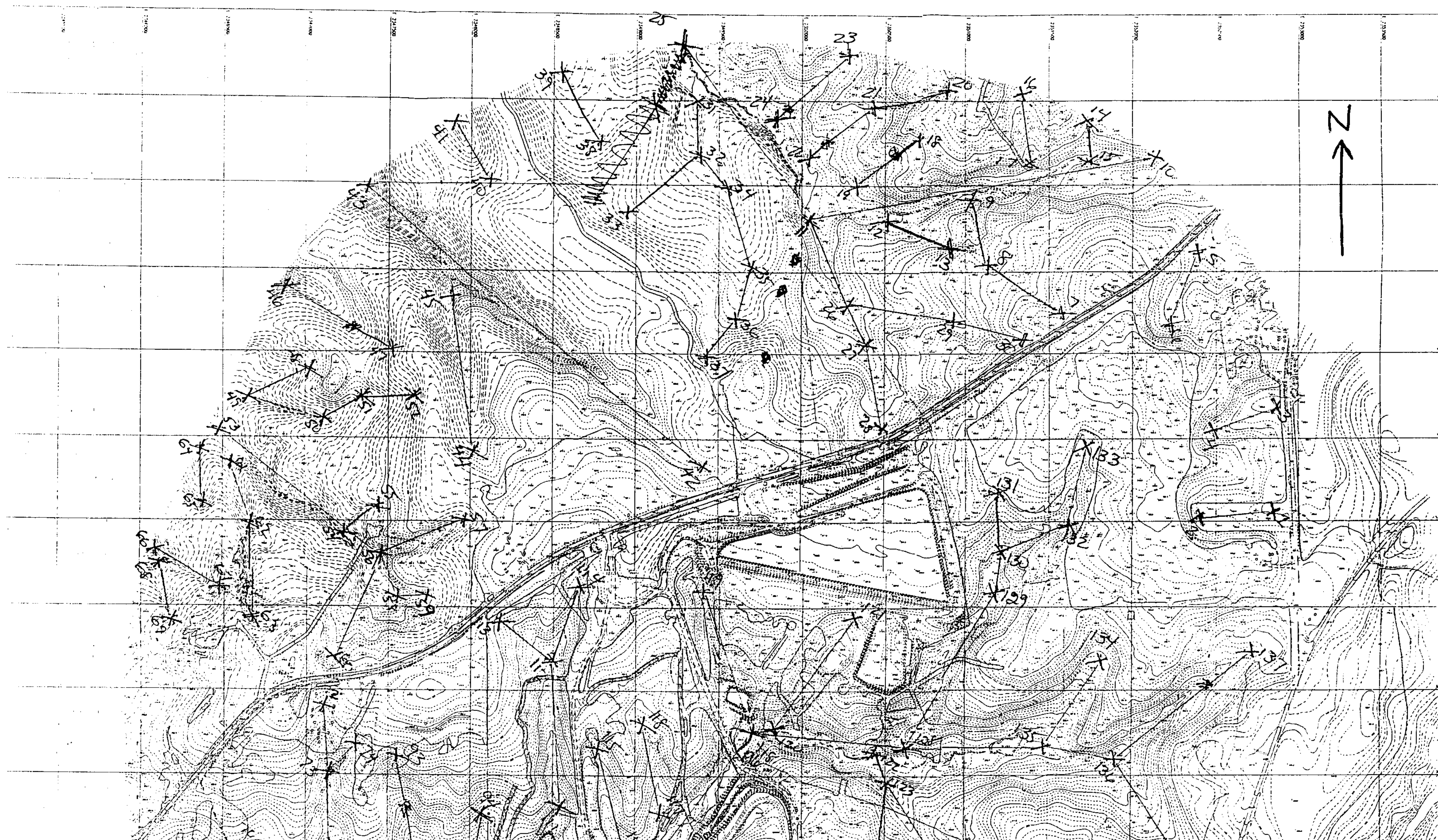
Miscellaneous orientations on short segmented intervals, resulting in high degree of data dispersivity reflected in low R-mag value, is possibly due to random erosion patterns or subparallel structural lineaments.

PROJECT **Figure 9**

HALIFAX COUNTY LANDFILL
Rose Diagram of Sructurally Controlled Topographic Features

Numerical analysis of topographic features performed using Rockworks™Version 7 Software
Rockworks is copyrighted by Rockware, Inc.

G.N. Richardson & Associates
Engineering and Geological Services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Tables

Table 1 A
Test Boring Data

Borings Completed November - December 1995

				Geotechnical Data					Piezometer Construction Data					Piezometer Monitoring Data			
Boring Number	Boring Date	Ground Elev. (1)	PVC Pipe Elev.	Boring Depth, ft.	PWR Depth, ft.	PWR Elev.	Refusal Depth, ft.	Refusal Elev.	Top of Piez. Screen Depth, ft.	Top of Piez. Screen Elev. (4)	Bot. of Piez. Screen Depth, ft.	Bot. of Piez. Screen Elev.	Stickup ft.	TOB Depth to Water*	TOB Water Table elev.	24-hr. Depth to Water*	24-hr. Water Table elev.
G-1	11/29/95	304.7	309.93	39.4	26.8	277.9	--	--	29.4	275.3	39.4	265.3	5.2	19.06	285.64	19.47	285.23
G-2	12/7/95	292.4	295.21	30.0	--	--	--	--	20.0	272.4	30.0	262.4	2.8	20.81	271.59	20.59	271.81
G-3D	12/12/95	293.4	294.95	53.5	--	--	--	--	43.5	249.9	53.5	239.9	1.6	24.21	269.19	23.72	269.68
G-3S (Core)	12/26/95	293.5	296.07	11.0	1.0	292.5	1.0	292.5	2.0	291.5	11.0	282.5	2.6	DRY	--	DRY	--
G-3a	12/12/95	293.4	--	25.0	--	--	--	--	--	--	--	--	--	--	--	--	--
G-3b	12/12/95	293.5	--	25.0	--	--	--	--	--	--	--	--	--	--	--	--	--
G-3c	12/13/95	294.1	--	3.5	3.5	290.6	3.5	290.6	--	--	--	--	--	--	--	--	--
G-4	12/7/95	283.7	286.04	30.0	--	--	--	--	20.0	263.7	30.0	253.7	2.3	20.74	262.96	21.88	261.82
G-5D (Core)	12/13/95	283.7	286.26	46.2	28.6	255.1	28.6	255.1	36.0	247.7	46.0	237.7	2.6	28.82	254.88	28.8	254.9
G-5S	12/21/95	283.5	286.10	22.5	22.5	261.0	22.5	261.0	12.5	271.0	22.5	261.0	2.6	DRY	--	DRY	--
G-6	12/4/95	284.1	286.26	25.0	--	--	--	--	15.0	269.1	25.0	259.1	2.2	23.55	260.55	23.42	260.68
G-7	12/7/95	291.8	293.90	35.0	--	--	--	--	25.0	266.8	35.0	256.8	2.1	20.1	271.7	19.6	272.2
G-8	11/27/95	307.0	312.31	40.0	--	--	--	--	30.0	277.0	40.0	267.0	5.3	32	275	31.86	275.14
G-9	12/15/95	307.0	310.35	40.0	--	--	--	--	29.0	278.0	39.0	268.0	3.4	30.25	276.75	29	278
G-10	12/8/95	308.8	310.84	50.0	--	--	--	--	38.0	270.8	48.0	260.8	2.0	40.15	268.65	40.74	268.06
G-11	12/1/95	281.4	286.38	30.0	--	--	--	--	20.0	261.4	30.0	251.4	5.0	19.34	262.06	19.24	262.16
G-12	12/11/95	277.3	279.88	35.0	--	--	--	--	25.0	252.3	35.0	242.3	2.6	26.4	250.9	22.6	254.7
G-13D (Core)	12/27/95	250.1	252.12	54.5	30.5	219.6	30.5	219.6	44.5	205.6	54.5	195.6	2.0	24.21	225.89	23.72	226.38
G-13S	11/30/95	249.9	252.34	20.0	--	--	--	--	10.0	239.9	20.0	229.9	2.4	8.91	240.99	8.8	241.1
G-14	12/1/95	263.3	265.89	22.0	--	--	--	--	12.0	251.3	22.0	241.3	2.6	10.49	252.81	10.34	252.96
G-15	12/14/95	257.0	259.37	40.0	--	--	--	--	30.0	227.0	40.0	217.0	2.4	9.7	247.3	9.58	247.42
G-16	12/11/95	268.1	270.48	30.0	--	--	--	--	20.0	248.1	30.0	238.1	2.4	17.01	251.09	16.66	251.44
H-1D (Core)	12/28/96	293.9	296.54	42.0	32.0	261.9	32.0	261.9	33.0	260.9	42.0	251.9	2.6	--	--	--	--
B-1	11/28/95	297.7	--	20.0	--	--	--	--	No Piezometer		--	--	--	--	--	--	--
B-2	11/28/95	302.0	--	15.0	--	--	--	--	No Piezometer		--	--	--	--	--	--	--
B-3	11/28/95	310.0	--	20.0	--	--	--	--	No Piezometer		--	--	--	--	--	--	--
B-4D (Core)	12/20/95	272.6	274.69	28.0	18.0	254.6	18.0	254.6	18.0	254.6	28.0	244.6	2.1	--	--	--	--
B-4a (Core)	12/15/96	273.0	--	27.0	24.0	249.0	24.0	249.0	No Piezometer		--	--	--	--	--	--	--
B-4S	12/27/95	272.8	277.16	17.5	17.5	255.3	17.5	255.3	6.0	266.8	11.0	261.8	4.4	--	--	--	--
B-5	11/30/95	277.9	--	17.5	17.5	260.4	17.5	260.4	No Piezometer		--	--	--	--	--	--	--
B-6	11/28/95	290.1	--	20.0	--	--	--	--	No Piezometer		--	--	--	--	--	--	--
B-7	11/30/95	268.0	--	20.0	--	--	--	--	No Piezometer		--	--	--	--	--	--	--
B-8	11/28/95	287.6	--	15.0	--	--	--	--	No Piezometer		--	--	--	--	--	--	--
B-9	11/28/95	269.2	--	15.0	--	--	--	--	No Piezometer		--	--	--	--	--	--	--
B-10	11/28/95	283.2	--	20.0	--	--	--	--	No Piezometer		--	--	--	--	--	--	--

Notes: -- = Piezometer not measured
* = Depth to Water measurements collected from ground surface

– under footprint
– immediately next to foot print

Table 1 B
Supplemental Test Boring Data

Borings Completed prior to December 1995

				Geotechnical Data					Piezometer Construction Data					Piezometer Monitoring Data			
									Top of Piez. Screen		Bot. of Piez. Screen			Time of Boring		24-hour readings	
Boring Number	Boring Date	Ground Elev. (1)	PVC Pipe Elev.	Boring Depth, ft.	PWR Depth, ft.	PWR Elev.	Refusal Depth, ft.	Refusal Elev.	Depth, ft.	Elev. (4)	Depth, ft.	Elev.	Stickup ft.	Depth, ft.	Elev.	Depth, ft.	Elev.
H-1	3/4/92	294.4	295.96	18	--	--	--	--	13	281.4	18	276.4	1.6	7.5	288.46	17.83	285.48
H-2	3/4/92	301.0	303.31	15	--	--	--	--	10	291.0	15	286.0	2.3	DRY	-	-	-
H-3	3/4/92	*297.0*	Lost	15	--	--	--	--	10	287.0	15	282.0	3.0	DRY	-	-	-
H-4	3/3/92	292.3	295.15	25	--	--	--	--	20	272.3	25	267.3	2.8	DRY	-	-	-
H-5	3/3/92	279.1	281.11	20	--	--	--	--	15	264.1	20	259.1	2.0	DRY	-	-	-
H-6	3/3/92	255.9	258.95	15	--	--	--	--	10	245.9	15	240.9	3.0	7.75	251.20	-	-
H-7	3/4/92	268.9	271.93	22.5	--	--	--	--	17.5	251.4	22.5	246.4	3.0	16	255.93	10.67	261.26
H-8	3/4/92	*288.0*	Lost	20	--	--	--	--	15	273.0	20	268.0	1.6	DRY	-	-	-
H-9	3/4/92	285.1	287.02	20	--	--	--	--	15	270.1	20	265.1	1.9	DRY	-	-	-
H-10	3/4/92	259.5	262.74	15	--	--	--	--	10	249.5	15	244.5	3.2	7.42	255.32	-	-
H-11	3/5/92	*284.0*	NA	16	11	273	16	268	No Piezometer		--	--	--	No Piezometer		No Piezometer	
H-12	3/5/92	282.4	285.32	20	--	--	--	--	15	267.4	20	262.4	2.9	16.33	269.0	-	-
H-13	3/4/92	272.7	275.23	15	--	--	--	--	10	262.7	15	257.7	2.5	DRY	-	-	-
H-14	3/4/92	267.9	270.78	15	--	--	--	--	10	257.9	15	252.9	2.9	11.83	259.0	-	-
H-15	3/5/92	*302.0*	Lost	20	--	--	--	--	15	287.0	20	282.0	2.1	DRY	-	-	-
L-1	1/27/81	301.8	303.51	35	--	--	--	--	Unknown		35	266.8	1.7	Unknown		Unknown	
MW-1	7/7/81	322.3	324.60	40	--	--	--	--	30	292.3	40	282.3	2.3	-	-	-	-
MW-5	7/7/81	235.5	236.83	15	--	--	--	--	5	230.5	15	220.5	1.3	-	-	-	-
MW-6s	1/6/92	251.3	253.30	23	--	--	--	--	8	243.3	23	228.3	2.0	11.33	240.0	-	-
MW-6d	10/30/91	250.8	253.20	40	--	--	--	--	25	225.8	40	210.8	2.4	11.58	239.2	-	-
MW-7s	1/7/92	248.4	250.40	17.5	--	--	--	--	2.5	245.9	17.5	230.9	2.0	3.17	245.2	-	-
MW-7d	10/31/91	247.9	249.10	40	--	--	--	--	25	222.9	40	207.9	1.2	3.92	244.0	-	-
MW-9	01/05/94	275.4	277.16	25	--	--	--	--	10	265.4	25	250.4	1.8	17	260.2	-	-
MW-10	01/10/94	~260.4	258.63	16.5	--	--	--	--	5	~255.4	15	~245.4	~1.8	4	254.6	3.75	254.9
Borrow Pit Area Borings																	
BP-3	12/6/95	313.7	315.39	50	--	--	--	--	38	277.39	48	267.39	1.69	45.51	269.88	45.22	270.17
BP-4	12/6/95	310.8	313.16	48	--	--	--	--	38	275.16	48	265.16	2.36	41.07	272.09	38.89	274.27
BP-6	12/5/95	315	317.28	25	--	--	--	--	15	302.28	25	292.28	2.28	16.64	300.64	15.94	301.34
GY-1	-	291.2	292.51	30	--	--	--	--	--	--	--	--	1.31	--	--	--	--
GY-2	-	297.9	299.99	20	--	--	--	--	--	--	--	--	2.09	--	--	--	--
GY-3	-	304.2	304.2	50	--	--	--	--	--	--	--	--	0	--	--	--	--

Notes:
1. Ground and piezometer elevations based on survey performed 2/25/96, except as noted in italics
2. Auger refusal depths and elevations (denoted by bold numbers) indicate top of bedrock
3. All depths referenced from ground surface except water levels
4. Piezometers consist of 2" diameter PVC
5. A potable well exists behind the office/shop building; no records can be found for its construction.

-- immediately next to footprint

Table 1c
Summary of Hydrogeological Properties
Halifax County Landfill

Hydrological Unit	Well	Lithological Unit	Aquifer Thickness (feet)	Effective Porosity	Total Porosity	Hydraulic Conductivity (feet/day)	Grain Size Distribution % Gravel	% Sand	% Silt	% Clay
1a	B-4s	Saprolite Zone	10.00	0.15		3.64 1.29×10^{-3}				
	G-2	Saprolite Zone	33.00	0.15		0.34	0	56	37	7
	G-4	Saprolite Zone	25.00	0.15		0.42 1.48×10^{-4}				
	G-6	Saprolite Zone	31.00	0.15	0.47	0.34 1.2×10^{-4}	0	48	32	20
	G-7	Saprolite Zone	40.00	0.15	0.39	7.51 2.65×10^{-3}	2	43	27	28
	G-8	Saprolite Zone	35.00	0.15		0.50				
	G-9	Saprolite Zone	35.00	0.15	0.46	0.20	0	42	13	45
	G-15	Saprolite Zone	35.00	0.15		1.93				
1b	G-1	P.W.R. (100+ bpf)	39.0	0.20		0.44 1.55×10^{-4}				
	G-3d	P.W.R. (100+ bpf)	37.00	0.20		5.75				
2	G-5d	Weathered Rock	40.0	0.20		1.29 4.56×10^{-4}				
	H-1d	Weathered Rock	40.00	0.20		6.06 2.14×10^{-3}				
	B-4d	Weathered Rock	25.00	0.20	0.36	1.81 6.37×10^{-4}	0	87	8	5

Notes: Effective porosities based upon published values (see Hydrogeologic Report)
Hydraulic Conductivities calculated from slug tests (see Appendix B) in feet/day
Total porosity and grain size distribution determined in laboratory tests.
Aquifer thickness calculated from high water table measurements to bottom of weathered rock zone.

Ta[illegible]
Gr[illegible] Water Measurements
Hal[illegible] County Landfill

Well	TOC Elev.	02/26/96 GW Depth	Elev.	03/20/96 GW Depth	Elev.	04/23/96 GW Depth	Elev.	05/22/96 GW Depth	Elev.	06/25/96 GW Depth	Elev.	07/31/96 GW Depth	Elev.	08/27/96 GW Depth	Elev.	10/2/96 GW Depth	Elev.
MW-1	324.6	--	--	30.39	294.21	29.63	294.97	29.2	295.4	28.88	295.72	29.01	295.59	29.11	295.49	29.16	295.44
MW-5	236.83	--	--	5.7	231.13	5.8	231.03	6.35	230.48	7.27	229.56	7.85	228.98	7.55	229.28	--	--
MW-6s	253.26	--	--	12.21	241.05	12.17	241.09	12.46	240.8	13.04	240.22	17.71	235.55	12.93	240.33	12.31	240.95
MW-7s	250.44	--	--	5.57	244.87	5.67	244.77	5.82	244.62	6.22	244.22	6.07	244.37	6.18	244.26	5.71	244.73
MW-7d	249.09	--	--	3.82	245.27	3.95	245.14	4.14	244.95	4.61	244.48	4.48	244.61	4.56	244.53	4.05	245.04
MW-9	277.16	--	--	7.78	269.38	7.54	269.62	8.04	269.12	9.94	267.22	10.13	267.03	10.31	266.85	9.45	267.71
MW-15	309.09	--	--	42.56	266.53	42.63	266.46	42.14	266.95	42.03	267.06	41.77	267.32	41.62	267.47	41.96	267.13
MW-16	280.99	--	--	--	--	30.39	250.6	30.5	250.49	30.56	250.43	31.01	249.98	30.81	250.18	30.43	250.56
G-1	309.93	23.26	286.67	22.9	287.03	22.39	287.54	22.21	287.72	22.79	287.14	22.75	287.18	22.88	287.05	22.47	287.46
G-2	295.21	18.8	276.41	18.52	276.69	18.29	276.92	18.15	277.06	19.55	275.66	20.84	274.37	20.8	274.41	20.31	274.9
G-3d	294.95	22.52	272.43	22	272.95	21.73	273.22	21.81	273.14	23.55	271.4	24.97	269.98	24.96	269.99	24.41	270.54
G-3s core	296.07	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
G-4	286.04	20.84	265.2	20.53	265.51	20.49	265.55	20.67	265.37	22.25	263.79	23.57	262.47	23.5	262.54	23.01	263.03
G-5d core	286.26	29.34	256.92	29.23	257.03	29.12	257.14	29.19	257.07	30.91	255.35	32.11	254.15	32.03	254.23	31.62	254.64
G-5s	286.1	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
G-6	286.26	22.56	263.7	22.25	264.01	22.06	264.2	22.1	264.16	24.15	262.11	25.65	260.61	25.6	260.66	24.84	261.42
G-7	293.9	18.66	275.24	18.22	275.68	17.97	275.93	17.71	276.19	19.09	274.81	20.39	273.51	20.4	273.5	19.89	274.01
G-8	312.31	34.43	277.88	33.5	278.81	32.48	279.83	31.99	280.32	33.17	279.14	34.22	278.09	34.31	278	34.03	278.28
G-9	310.35	29.55	280.8	28.5	281.85	27.14	283.21	26.78	283.57	27.83	282.52	29.29	281.06	29.28	281.07	29.05	281.3
G-10	310.84	40.64	270.2	39.79	271.05	38.71	272.13	38.14	272.7	38.22	272.62	39.03	271.81	39.34	271.5	39.41	271.43
G-11	286.38	21.43	264.95	21.13	265.25	20.97	265.41	21.03	265.35	22.98	263.4	24.26	262.12	24.34	262.04	23.36	263.02
G-12	279.88	22.86	257.02	22.63	257.25	22.37	257.51	22.5	257.38	24.26	255.62	25.51	254.37	25.52	254.36	24.5	255.38
G-13	252.34	10.98	241.36	11	241.34	10.98	241.36	11.24	241.1	12.03	240.31	11.8	240.54	11.97	240.37	11.37	240.97
G-13d core	252.12	10.56	241.56	10.55	241.57	10.53	241.59	10.78	241.34	11.56	240.56	11.27	240.85	11.51	240.61	10.88	241.24
G-14	265.89	10.75	255.14	10.58	255.31	10.69	255.2	11.05	254.84	13.17	252.72	13.88	252.01	14.2	251.69	12.85	253.04
G-15	259.37	11.12	248.25	11.16	248.21	11.4	247.97	11.78	247.59	12.37	247	12.28	247.09	12.33	247.04	11.7	247.67
G-16	270.48	16.98	253.5	17.05	253.43	17.18	253.3	17.57	252.91	19.61	250.87	20.23	250.25	20.15	250.33	19.13	251.35
B-4d core	274.69	11.26	263.43	11.25	263.44	11.04	263.65	11.33	263.36	13.76	260.93	19.15	255.54	15.08	259.61	13.93	260.76
B-4s	277.16	6.67	270.49	7.48	269.68	7.58	269.58	8.59	268.57	11.99	265.17	11.66	265.5	12.74	264.42	9.01	268.15
H-1	295.96	12.16	283.8	11.86	284.1	10.7	285.26	10.74	285.22	14.12	281.84	13.22	282.74	14.51	281.45	12.51	283.45
H-1d core	296.54	14.96	281.58	13.59	282.95	12.46	284.08	12.48	284.06	15.41	281.13	15.07	281.47	15.93	280.61	14.45	282.09
H-2	303.31	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
H-4	295.15	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
H-5	281.11	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
H-6	258.95	5.84	253.11	5.61	253.34	6.59	252.36	5.81	253.14	5.28	253.67	5.92	253.03	7.4	251.55	7.52	251.43
H-7	271.93	4.71	267.22	4	267.93	4.97	266.96	5.79	266.14	--	--	--	--	8.65	263.28	6.79	265.14
H-9	287.02	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
H-10	262.74	4.3	258.44	13.56	249.18	4.51	258.23	5.09	257.65	7.1	255.64	7.78	254.96	7.78	254.96	6.73	256.01
H-12	285.32	11.93	273.39	11.83	273.49	11.55	273.77	11.8	273.52	DRY	DRY	15.12	270.2	15.24	270.08	14.16	271.16
H-13	275.23	13.18	262.05	11.92	263.31	11.77	263.46	11.95	263.28	14.23	261	15.53	259.7	15.5	259.73	14.53	260.7
H-14	270.78	12.66	258.12	12.9	257.88	8.41	262.37	8.7	262.08	--	--	9.27	261.51	11.97	258.81	10.76	260.02
L-1	303.51	28.46	275.05	27.44	276.07	26.64	276.87	26.07	277.44	26.77	276.74	28.24	275.27	28.35	275.16	28.35	275.16
GY-1	292.51	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
GY-2	299.99	21.64	278.35	21.64	278.35	21.65	278.34	21.67	278.32	DRY	DRY	21.67	278.32	21.66	278.33	21.67	278.32
GY-3	304.2	39.1	265.1	38.68	265.52	38.39	265.81	38.1	266.1	38.02	266.18	37.87	266.33	37.8	266.4	37.8	266.4
BP-3	315.39	46.11	269.28	45.45	269.94	45.25	270.14	44.91	270.48	44.98	270.41	44.88	270.51	44.84	270.55	44.89	270.5
BP-4	313.16	38.23	274.93	37.9	275.26	37.49	275.67	37.28	275.88	37.95	275.21	38.61	274.55	38.48	274.68	37.98	275.18
BP-6	317.28	13.31	303.97	13.8	303.48	13.61	303.67	14.39	302.89	18.35	298.93	18.48	298.8	18.36	298.92	18.42	298.86

Table 2 A
Geotechnical Laboratory Data

Soil Classifications for Samples Collected Nov-Dec 1995

Sample Number	Sample Depth, ft.	Sample Type	Grain Size Distributuion 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.	
G-5	1.0 - 1.7	Bulk	0	1	21	17	61	76	29	MH	32.2
G-7	5.0 - 8.0	Bulk	0	2	43	19	36	42	13	ML	24.0
G-9	15 - 20	Bulk	0	0	42	15	43	62	25	MH	35.3
BP-3	3 - 5	Bulk	0	0	59	40*	--	37	10	SM	13.8
BP-6	15-20	Bulk	0	0	48	52*	--	49	15	ML	34.2
B-5 (1)	0-1.5	Jar	--	--	--	--	--	38	14	ML	19.4
B-7 (1)	0-1.5	Jar	--	--	--	--	--	41	10	ML	22.6
B-7 (2)	3.5-5.0	Jar	--	--	--	--	--	46	12	ML	23.4
G-7 (1)	0-1.5	Jar	--	--	--	--	--	66	26	MH	22.6
G-7 (2)	3.5-5.0	Jar	--	--	--	--	--	46	4	ML	23.9
G-11 (4)	13.5-15.0	Jar	--	--	--	--	--	42	6	ML	23.3
G-14 (2)	3.5-5.0	Jar	--	--	--	--	--	42	6	ML	23.0
BP-1 (1)	0-1.5	Jar	0	0	29	18	53	59	27	MH	--
BP-2 (1)	0-1.5	Jar	0	0	30	20	50	57	29	CH	--
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	--
B-4	1 - 3	U.D.	0	0	86	9	5	31	14	CL	17.3
B-8	5 - 7	U.D.	0	0	51	34	15	50	28	CL/CH	23.8
G-2	1.5 - 3.5	U.D.	0	0	56	38	6	68	37	CH	22.3
G-6	1 - 3	U.D.	0	0	56	26	18	71	43	CH	30.8

*Represents Silt and Clay Fractions Combined

Table 2 B
Geotechnical Laboratory Data

Bulk Samples Collected during Nov-Dec 1995

Sample Number	Sample Depth, ft.	Remolded Moisture-Density Data: Max. Dry Density, pcf	Optimum Moisture, %	Natural Moisture, %	Total* Porosity, %	Shear Strength Data: Total Strength c, ksf	phi, deg.	Effective Strength c', ksf	phi', deg.	Hydraulic Conductivity Data: Remolded Dry Density, pcf	Remolded Moisture, %	5 psi cm/sec
G-5	1.0 - 1.7	82.5	37.1	32.2	54.0					79.0	40.5	8.78E-08
G-7	5.0 - 8.0	108.3	18.0	24.0	39.0					104.6	21.7	9.08E-08
G-9	15 - 20	97.2	23.5	35.3	45.6					93.4	27.0	4.76E-07
BP-3	3 - 5	107.5	19.0	13.8	40.3					102.5	22.0	3.97E-08
BP-6	15-20	102.6	21.5	34.2	43.2					97.6	24.5	1.45E-07

*As Tested for Conductivity

Undisturbed Samples Collected during Nov-Dec 1995

Sample Number	Sample Depth, ft.	In-Situ Moisture-Density and Hydraulic Conductivity Data: Dry Density, pcf	Wet Density, pcf	Natural Moisture, %	Total Porosity,%	Conductivity cm/sec**	Shear Strength Data: Total Strength c, ksf	phi, deg.	Effective Strength c', ksf	phi', deg.	Pc ksf	CR	Consolida RR
B-4	1 - 3	110.6	129.8	17.3	35.6	4.66E-06	0.33	27.8	0.19	32.4	0.6	0.119	0.033
B-8	5 - 7	99.5	123.2	23.8	42.0	1.62E-05	0.40	24.4	0.11	28.3	0.9	0.063	0.006
G-2	1.5 - 3.5										1.5	0.1	0.016
G-6	1 - 3	90.3	118.2	30.8	47.4	3.01E-07							

** 5 psi effective confining stress

Notes to Tables 2A and 2B: Moisture Contents are Dry Unit Weight Based

Pc = Past consolidation pressure
CR = Compression ratio
RR = Recompression ratio
Cv = Consolidation coefficient

Total Porosity values are backcalculated from Void Ratios

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

Borings marked "BP" are from a proposed borrow site

Samples tested by Geotechnologies, Inc.

Table 3
Ground Water Hydrograph

Piezometric Levels Observed at Current MSWLF Monitoring Wells

Boring Number	Boring Date	Ground Elev.	PVC Pipe Elev.	T.O.B. Elev.	4/28/88 Elev.	06/30/89 Elev.	6/14/90 Elev.	6/13/91 Elev.	6/11/92 Elev.	6/8/93 Elev.	12/13/93 Elev.	01/11/94 Elev.	6/14/94 Elev.
MW-1	7/07/81	322.3	324.6	288.3	293.5	295.4	298.8*		291	294.4	290.5		293.6
MW-2	07/07/81	244.2	246.36	240.69	239.60	NS	238.89	238.19	239.68	239.44	239.81		238.79
MW-2A	07/26/95	243.2	246.43										
MW-3	07/07/81	250.9	252.65	238.87	243.09	236.05	245.94	241.09	242.82	243.90			
MW-3A	07/25/95	252.7	252.68										
MW-5	07/07/81	235.5	236.95	232.20	230.87	230.62	230.54	228.79	230.14	230.37			
MW-6s	01/06/92	251.3	253.26	240.00					240.66				
MW-6d	10/30/91	250.8	253.22	239.20									
MW-7s	01/07/92	248.4	250.44	245.30					244.64		237.29		236.34
MW-7d	10/31/91	247.9	249.09	244.00									
MW-9	01/05/94	275.4	277.16	266.09								266.09	
MW-10	01/10/94	260.4	258.63	256.65								NA	
MW-15	09/21/94	307.1	309.09										
MW-16	09/22/94	278.8	280.99										
MW-16A	07/26/95	268.6	271.46										

Boring Number	9/26/94 Elev.	10/31/94 Elev.	01/09/95 Elev.	08/08/95 Elev.	10/19/95 Elev.	12/04/95 Elev.	1/22/96 Elev.	2/25/96 Elev.	3/20/96 Elev.	4/23/96 Elev.	5/22/96 Elev.	6/25/96 Elev.	7/31/96 Elev.	8/27/96 Elev.
MW-1	292.5	291.8	290.4	291.3	291.3	292		293.3	294.2	294.97	295.4	295.72	295.59	295.49
MW-2	239.76	239.87	240.83	240.55	240.47	240.47		240.76		241.54	241.31	240.84	241.10	241.07
MW-2A											240.76	240.43	240.66	NA
MW-3	242.93	243.39	243.55	243.90	241.68	241.68		242.80		243.38	244.05	243.54	244.11	244.24
MW-3A											243.06	242.40	243.09	243.25
MW-5									231.25	231.15	230.60	229.68	229.10	229.40
MW-6s	239.12	239.36	239.94	239.93	240.57	240.57		241.05	241.05	241.09	240.80	240.22	235.55	240.33
MW-6d				239.95					241.23	241.21	241.00	240.33	240.61	240.41
MW-7s	236.30	244.26	244.33	244.06	244.49	244.49		244.90	244.87	244.77	244.62	244.22	244.37	244.26
MW-7d				244.25					245.27	245.14	244.95	244.48	244.61	244.53
MW-9							268.79		269.38	269.62	269.12	267.22	267.03	266.85
MW-10							255.51							
MW-15	265.07	264.93	263.36	263.66	264.40	264.40		265.51	266.53	266.46	266.95	267.06	267.32	267.47
MW-16	248.30	248.12	246.78							250.60	250.49	250.43	249.98	250.18
MW-16A				264.65	264.65	265.57		266.85						

Notes:
1. Data acquired from ground water monitoring records on file with Halifax County
2. Wells MW-1, MW-5, MW-6, MW-7, MW-9 and MW-10 are close to the planned new MSWLF unit
3. MW-5 not routinely sampled after 6/8/93
4. Refer to Monitoring Well Hydrograph Plot
5. * - This water level measurement is suspect
6. Ground water level was not measured at MW-2A on 8/27/96

Summary of Highest Water Elevations

Well	Highest Water elev	Date	Difference between 4/96 elev. and highest elevation, ft.
MW-1	295.72	6/96	0.75
MW-2	241.54	4/96	0.00
MW-3	244.24	8/96	0.86
MW-5	231.25	3/96	0.10
MW-6s	241.09	4/96	0.00
MW-6d	241.23	3/96	0.02
MW-7s	244.90	2/96	0.13
MW-7d	245.27	3/96	0.13
MW-9	269.62	4/96	0.00
MW-15	267.47	8/96	1.01
MW-16	250.60	4/96	0.00

used for seasonal high

Table 3
Ground Water Hydrograph

Piezometric Levels Observed at Current MSWLF Monitoring Wells

Boring Number	Boring Date	Ground Elev.	PVC Pipe Elev.	T.O.B. Elev.	4/28/88 Elev.	06/30/89 Elev.	6/14/90 Elev.	6/13/91 Elev.	6/11/92 Elev.	6/8/93 Elev.	12/13/93 Elev.	01/11/94 Elev.	6/14/94 Elev.
MW-1	7/07/81	322.3	324.6	288.3	293.5	295.4	298.8*		291	294.4	290.5		293.6
MW-2	07/07/81	244.2	246.36	240.69	239.60	NS	238.89	238.19	239.68	239.44	239.81		238.79
MW-2A	07/26/95	243.2	246.43										
MW-3	07/07/81	250.9	252.65	238.87	243.09	236.05	245.94	241.09	242.82	243.90			
MW-3A	07/25/95	252.7	252.68										
MW-5	07/07/81	235.5	236.95	232.20	230.87	230.62	230.54	228.79	230.14	230.37			
MW-6s	01/06/92	251.3	253.26	240.00					240.66				
MW-6d	10/30/91	250.8	253.22	239.20									
MW-7s	01/07/92	248.4	250.44	245.30					244.64		237.29		236.34
MW-7d	10/31/91	247.9	249.09	244.00									
MW-9	01/05/94	275.4	277.16	266.09								266.09	
MW-10	01/10/94	260.4	258.63	256.65								NA	
MW-15	09/21/94	307.1	309.09										
MW-16	09/22/94	278.8	280.99										
MW-16A	07/26/95	268.6	271.46										

Boring Number	9/26/94 Elev.	10/31/94 Elev.	01/09/95 Elev.	08/08/95 Elev.	10/19/95 Elev.	12/04/95 Elev.	1/22/96 Elev.	2/25/96 Elev.	3/20/96 Elev.	4/23/96 Elev.	5/22/96 Elev.	6/25/96 Elev.	7/31/96 Elev.	8/27/96 Elev.
MW-1	292.5	291.8	290.4	291.3	291.3	292		293.3	294.2	294.97	295.4	295.72	295.59	295.49
MW-2	239.76	239.87	240.83	240.55	240.47	240.47		240.76		241.54	241.31	240.84	241.10	241.07
MW-2A											240.76	240.43	240.66	246.43
MW-3	242.93	243.39	243.55	243.90	241.68	241.68		242.80		243.38	244.05	243.54	244.11	244.24
MW-3A											243.06	242.40	243.09	243.25
MW-5									231.25	231.15	230.60	229.68	229.10	229.40
MW-6s	239.12	239.36	239.94	239.93	240.57	240.57		241.05	241.05	241.09	240.80	240.22	235.55	240.33
MW-6d				239.95					241.23	241.21	241.00	240.33	240.61	240.41
MW-7s	236.30	244.26	244.33	244.06	244.49	244.49		244.90	244.87	244.77	244.62	244.22	244.37	244.26
MW-7d				244.25					245.27	245.14	244.95	244.48	244.61	244.53
MW-9							268.79		269.38	269.62	269.12	267.22	267.03	266.85
MW-10							255.51							
MW-15	265.07	264.93	263.36	263.66	264.40	264.40		265.51	266.53	266.46	266.95	267.06	267.32	267.47
MW-16	248.30	248.12	246.78							250.60	250.49	250.43	249.98	250.18
MW-16A				264.65	264.65	265.57		266.85						

Notes:
1. Data acquired from ground water monitoring records on file with Halifax County
2. Wells MW-1, MW-5, MW-6, MW-7, MW-9 and MW-10 are close to the planned new MSWLF unit
3. MW-5 not routinely sampled after 6/8/93
4. Refer to Monitoring Well Hydrograph Plot
5. * - This water level measurement is suspect

Summary of Highest Water Elevations

Well	Highest Water elev	Date	Difference between '4/96 elev. and highest elevation
MW-1	295.72	6/96	0.75
MW-2	241.54	4/96	0.00
MW-3	244.24	8/96	0.86
MW-5	231.25	3/96	0.10
MW-6s	241.09	4/96	0.00
MW-6d	241.23	3/96	0.02
MW-7s	244.77	4/96	0.00
MW-7d	245.27	3/96	0.13
MW-9	269.62	4/96	0.00
MW-15	267.47	8/96	1.01
MW-16	250.6	4/96	0.00

should be 244.90

wrong elev. - same as TOB

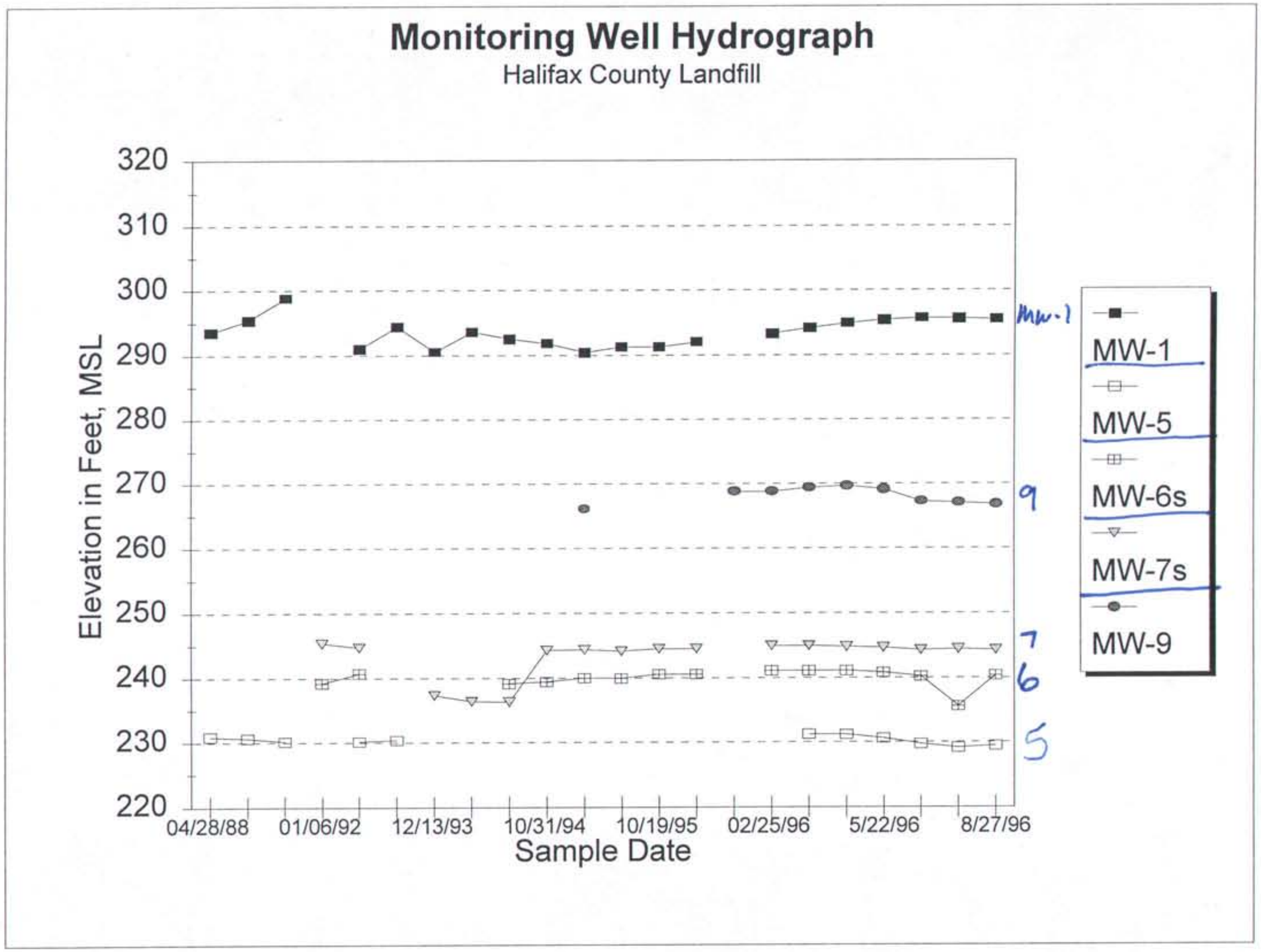

Monitoring Well Hydrograph
Halifax County Landfill
Elevation in Feet, MSL
320
310
300
290
280
270
260
250
240
230
220
04/28/88
01/06/92
12/13/93
10/31/94
10/19/95
02/25/96
5/22/96
8/27/96
Sample Date
MW-1
MW-5
MW-6s
MW-7s
MW-9
MW-1
9
7
6
5

Table 4 A
Historical Rainfall Data

Cumulative On-Site Monthly Rainfall Data
for August 1994 through March 1996

All Values in Inches

Year	Month	Rainfall	
1994	Aug	2.15	
	Sep	2.31	
	Oct	2.22	
	Nov	2.44	
	Dec	1.00	
1995	Jan	3.35	
	Feb	5.10	
	Mar	4.76	
	Apr	1.35	
	May	2.93	
	Jun	9.97	
	Jul	5.77	
	Aug	4.90	
	Sep	4.70	
	Oct	8.87	
	Nov	3.60	
	Dec	2.25	
1996	Jan	7.80	(4 Days Snow)
	Feb	2.76	(2 Days Snow)
	Mar	2.50	Allow 1 inch per Snow Day
	Apr	3.45	
	May	4.65	
	Jun	2.70	
	Jul	7.55	
	Aug	1.75	
	Sep	9.50	
	Oct		

Cumulative Monthly Rainfall Data
At Roanoke Rapids Weather Station

Year	Month	Rainfall
1994	Aug	3.88
	Sep	3.74
	Oct	1.65
	Nov	3.22
	Dec	0.74
1995	Jan	3.31
	Feb	3.18
	Mar	5.47
	Apr	1.17
	May	4.63
	Jun	5.91
	Jul	6.08
	Aug	3.86
	Sep	2.55
	Oct	6.51
	Nov	3.93
	Dec	1.93
1996	Jan	5.35
	Feb	3.43
	Mar	3.38
	Apr	
	May	
	Jun	
	Jul	
	Aug	
	Sep	
	Oct	

State Climatological
Records Unavailable
During Sept-Oct 1996
Due to Office Relocation

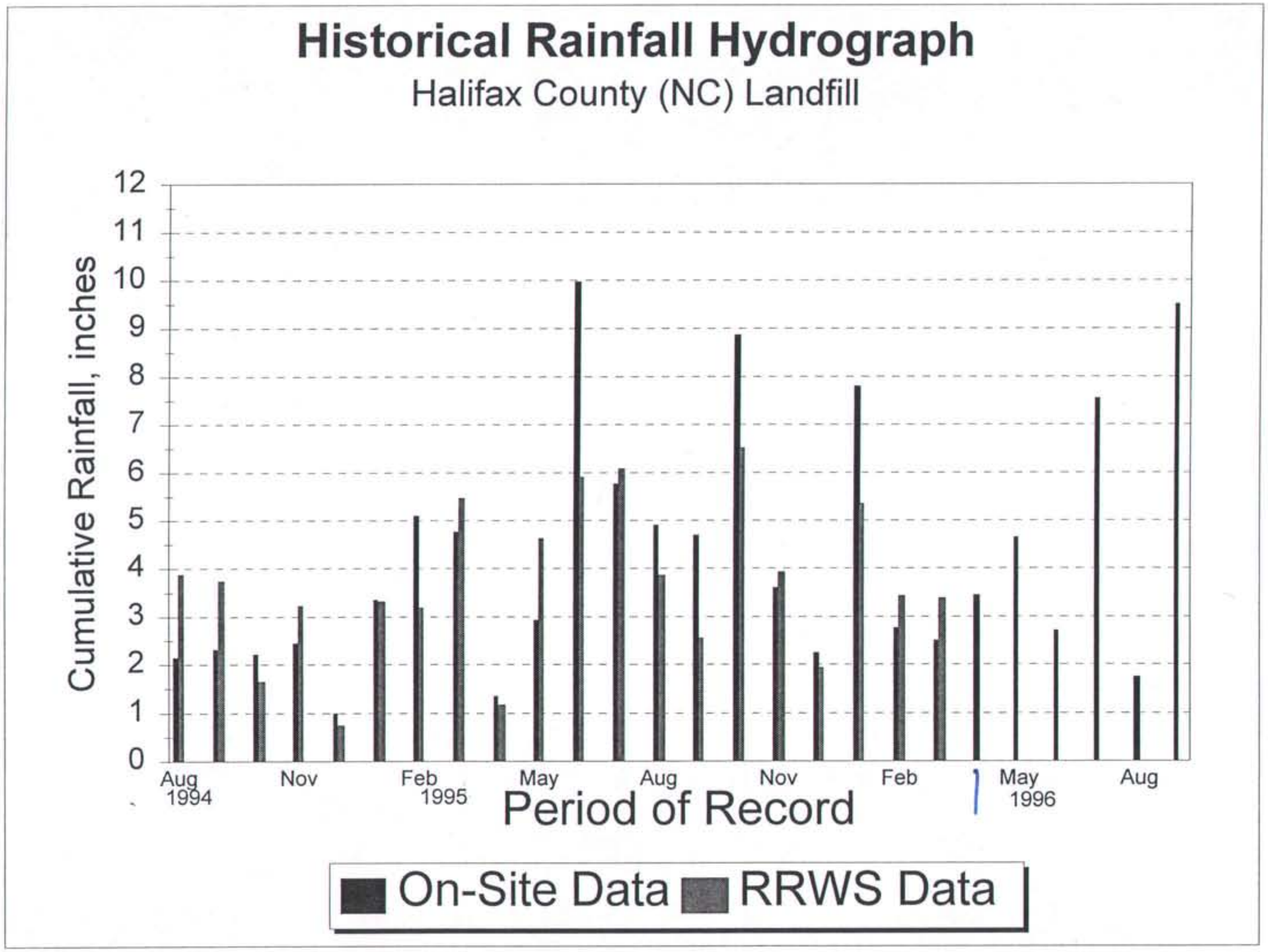

Historical Rainfall Hydrograph
Halifax County (NC) Landfill
Cumulative Rainfall, inches
12
11
10
9
8
7
6
5
4
3
2
1
0
Aug 1994
Nov
Feb 1995
May
Aug
Nov
Feb
May 1996
Aug
Period of Record
On-Site Data
RRWS Data

Table 5a
Summary of Horizontal Flow Ground Water Calculations for Upper Aquifer

Well	Hydraulic Conductivity (K)	Hydraulic Gradient (I)	Effective Porosity (n)	Ground Water Velocity (V)
G-2	0.34	0.016	0.15	0.04
G-4	0.42	0.037	0.15	0.10
G-6	0.34	0.048	0.15	0.11
G-7	7.5	0.016	0.15	0.80
G-8	0.5	0.029	0.15	0.10
G-9	0.19	0.015	0.15	0.02
G-15	1.9	0.034	0.15	0.43

Notes: Horizontal Conductivity calculated from slug tests
Hydraulic Gradient calculated from 4/96 Hydraulic Gradient Map
Effective Porosity from published sources (see Hydrogeological Report)
Ground Water Velocity calculated from V = (K I) / n

Table 5b
Vertical Gradient Calculations
Halifax County Landfill

Vertical Gradient Calculations

Nested Pair: G-13s - Shallow Well
G-13d - Deep Well

Vertical Gradient (VG) = $\frac{\text{Deep WTE - Shallow WTE}}{\text{Deep MOS - Shallow MOS}}$

Well	Water Table Elev. (WTE) 4/23/96	Water Table Elev. (WTE) 6/25/96	Water Table Elev. (WTE) 8/27/96	Middle of Screened Interval (MOS)
G-13s	241.36	240.31	240.37	234.9
G-13d	241.59	240.56	240.61	200.6
	VG for 4/23/96 = -0.01 Upward	**VG for 6/25/96 = -0.01 Upward**	**VG for 8/27/96 = -0.01 Upward**	

Nested Pair: B-4s - Shallow Well
B-4d - Deep Well

Well	Water Table Elev. (WTE) 4/23/96	Water Table Elev. (WTE) 6/25/96	Water Table Elev. (WTE) 8/27/96	Middle of Screened Interval (MOS)
B-4s	269.58	265.17	264.42	264.3
B-4d	263.65	260.93	259.61	249.6
	VG for 4/23/96 = 0.40 Downward	**VG for 6/25/96 = 0.29 Downward**	**VG for 8/27/96 = 0.33 Downward**	

MW-6s - Shallow Well
MW-6d - Deep Well

Well	Water Table Elev. (WTE) 4/23/96	Water Table Elev. (WTE) 6/25/96	Water Table Elev. (WTE) 8/27/96	Middle of Screened Interval (MOS)
MW-6s	241.09	240.22	240.33	235.8
MW-6d	241.21	240.33	240.41	218.3
	VG for 4/23/96 = -0.01 Upward	**VG for 6/25/96 = -0.01 Upward**	**VG for 8/27/96 = -0.00 Upward**	

MW-7s - Shallow Well
MW-7d - Deep Well

Well	Water Table Elev. (WTE) 4/23/96	Water Table Elev. (WTE) 6/25/96	Water Table Elev. (WTE) 8/27/96	Middle of Screened Interval (MOS)
MW-7s	244.77	244.22	244.26	238.9
MW-7d	245.14	244.48	244.53	215.4
	VG for 4/23/96 = -0.02 Upward	**VG for 6/25/96 = -0.01 Upward**	**VG for 8/27/96 = -0.01 Upward**	

H-1 - Shallow Well
H-1d - Deep Well

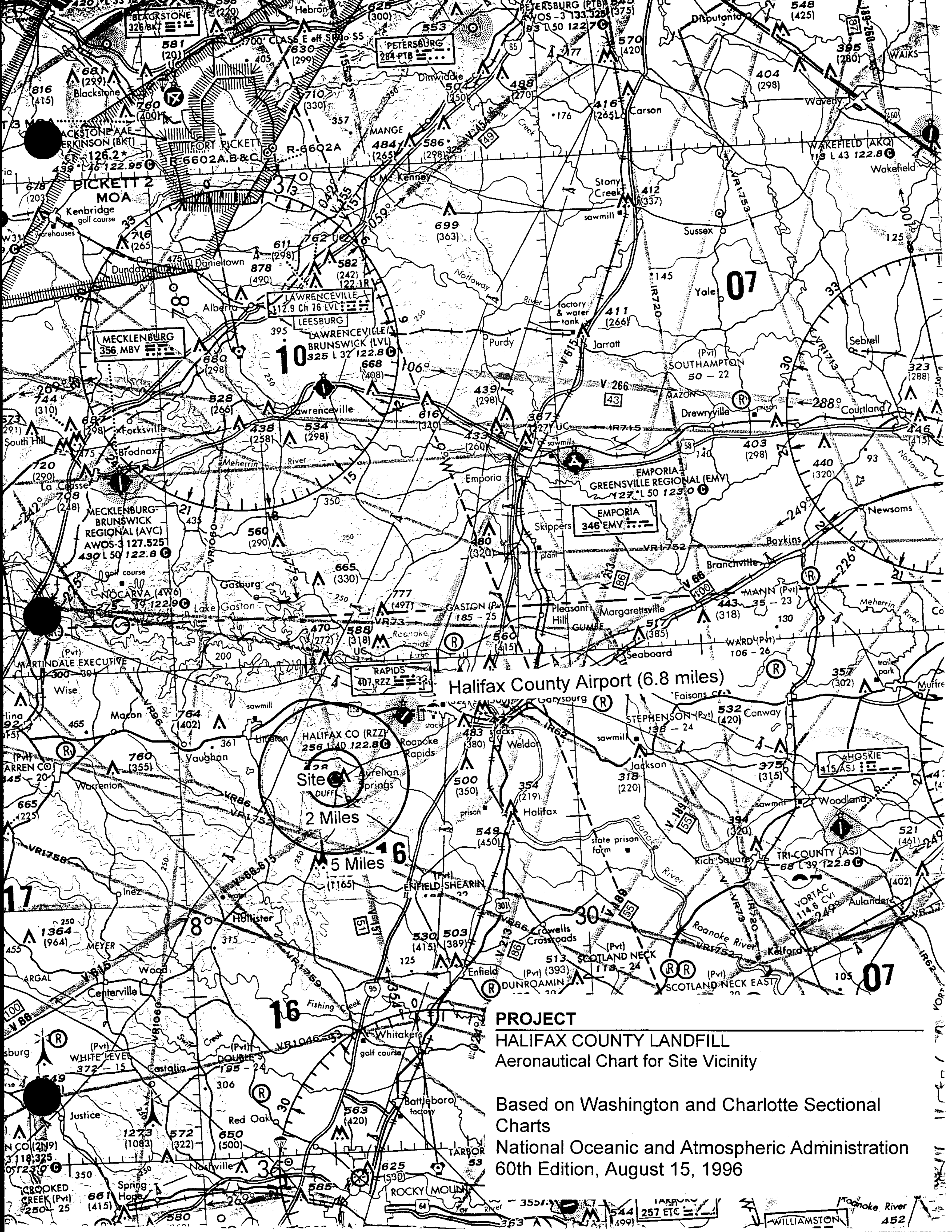
Well	Water Table Elev. (WTE) 4/23/96	Water Table Elev. (WTE) 6/25/96	Water Table Elev. (WTE) 8/27/96	Middle of Screened Interval (MOS)
H-1	285.26	281.84	281.45	278.9
H-1d	284.08	281.13	280.61	256.4
	VG for 4/23/96 = 0.05 Upward	**VG for 6/25/96 = 0.03 Upward**	**VG for 8/27/96 = 0.04 Upward**	

Monitoring Wells G-3s and G-5s have been dry, and therefore a vertical gradient cannot be calculated

Appendix A

Drawing "Under Seperate Cover"

Appendix B

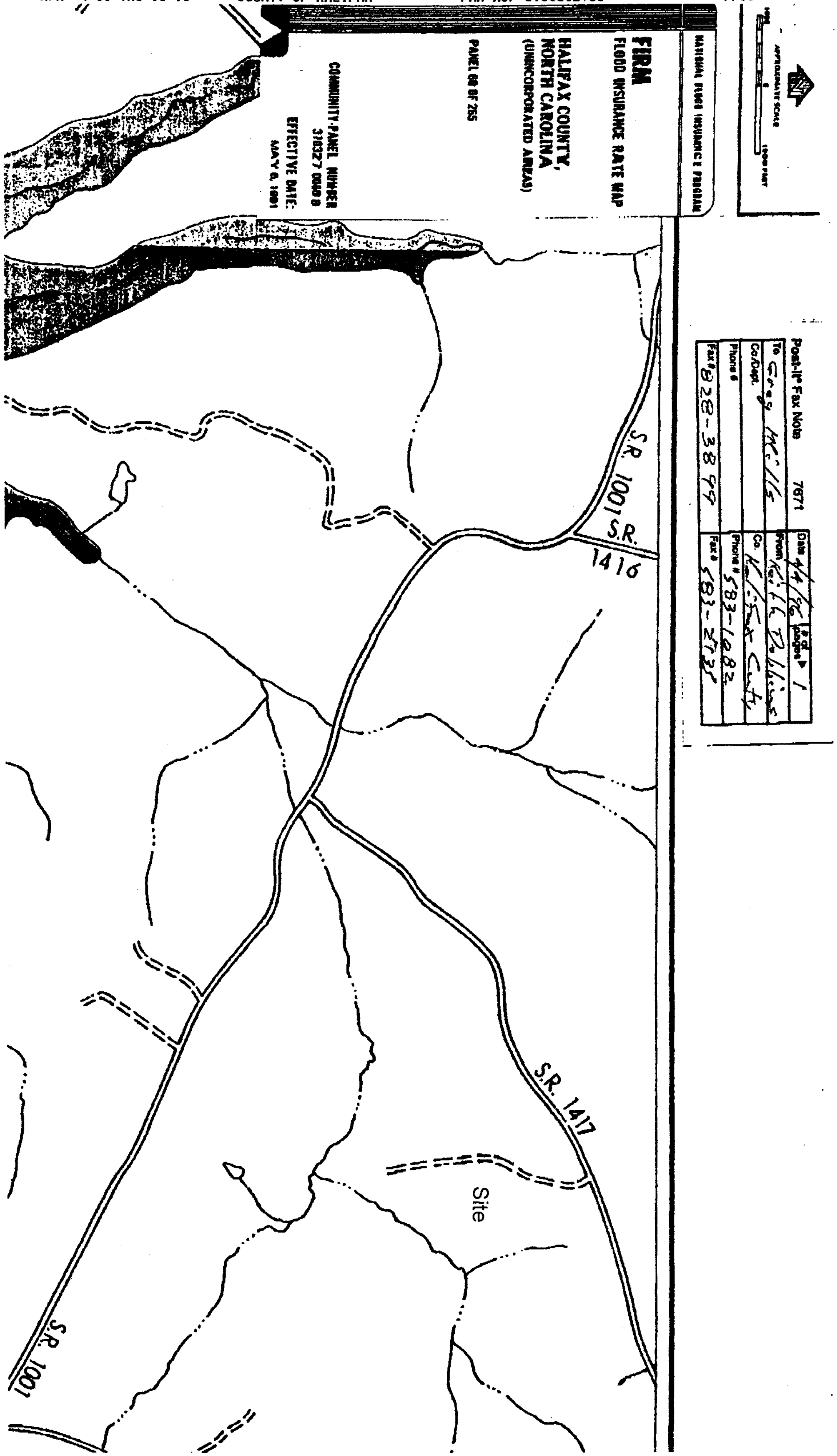


PROJECT

HALIFAX COUNTY LANDFILL
Aeronautical Chart for Site Vicinity

Based on Washington and Charlotte Sectional Charts
National Oceanic and Atmospheric Administration
60th Edition, August 15, 1996

Appendix C



Post-it® Fax Note 7671

To Greg McGills	Date 4/4/96 # of pages ▶ 1
Co./Dept.	From Keith Pollins
	Co. Halifax County
Phone #	Phone # 583-1082
Fax # 828-3899	Fax # 583-2735

Appendix D

HAZEN AND SAWYER
Environmental Engineers & Scientists

Hazen and Sawyer, P.C.
4011 WestChase Blvd.
Raleigh, NC 27607
919 833-7152
Fax: 919 833-1828

April 12, 1995

Mr. Hazen Blodgett III
Assistant County Manager
Halifax County
Historic Courthouse
P.O. Box 38 - King St.
Halifax, NC 27839

Re: Halifax Co. Landfill
Wetlands Study

Dear Mr. Blodgett:

As you may be aware, we conducted a wetlands study in 1993 for the proposed new MSW landfill. Hazen and Sawyer had given the County copies of the wetlands survey soon after it was completed, but we have no record of ever formally submitting the delineation report which first established those limits. Since the Corps of Engineers has visited the site and confirmed the presence of the wetlands, we thought that you should get a copy of all the background information regarding the wetlands. This information will be required for your new permit application.

Very truly yours,

HAZEN AND SAWYER, P.C.

John A. Bove

John A. Bove, P.E.
Senior Principal Engineer

cc: Jerry Williams, Solid Waste Director

.SOIL SCIENCE SERVICES, INC. . P.O. BOX 5064 . RALEIGH, NC 27650.
. (919) 828-1074 .

June 7, 1993

Mr. John D. Barnard
Assistant Engineer
Hazen and Sawyer, P.C.
4011 WestChase Boulevard
Raleigh, NC 27607

Project: Halifax County Landfill - Wetland Related Consulting

Dear Mr. Barnard:

We met the Corps-on-site at the Halifax County Landfill to approve our wetland delineation on 5/18/93. In fact, we were able to reduce the jurisdictional area to somewhat smaller than originally flagged on the eastern drainageway (see enclosed mylar of signed delineation "wetland area A").

As previously discussed, our flag numbers 200 thru 203 were not located in "wetlands area B" (see attached sketch map) and therefore the approved map shows more jurisdictional area than actually exists between flags 104 and 5. The Corps signed the map anyway but agreed to sign a revision if your client chooses to located flags 200 thru 203.

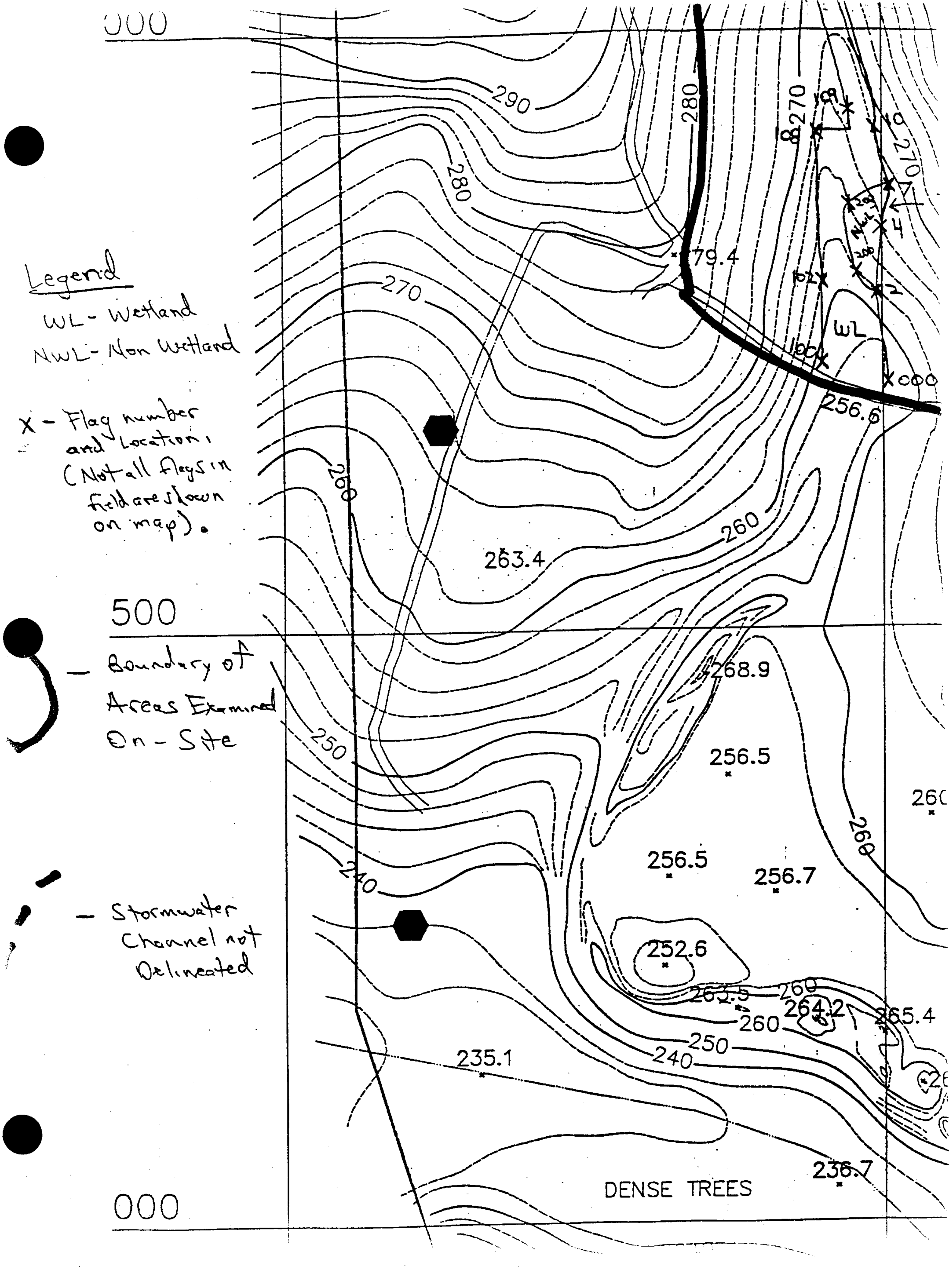
Please call if you have questions or need assistance with Corps and/or DEM permitting. We have also enclosed copies of the Corps required delineation forms that were completed on-site.

Sincerely,

Dennis J. Osborne, Ph.D.
Certified Professional
Soil Scientist #329

/mp

Enclosures



000
290
280
280
270
280
270
270
19
18
19
4
2
102
100
WL
NWL
000
79.4
256.6
270
260
260
263.4
500
268.9
256.5
256.5
256.7
260
260
250
240
252.6
263.5
260
264.2
265.4
260
250
240
235.1
236.7
DENSE TREES
000
Legend
WL - Wetland
NWL - Non Wetland
X - Flag number and Location. (Not all flags in field are shown on map).
- Boundary of Areas Examined On-Site
- Stormwater Channel not Delineated

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: Halifax Co Landfill
Date: 3/22/93 County: Halifax State: NC
Applicant/Owner: Neal Phillips, County Manager
P.O. Box 38
Halifax NC 27839
Investigator: Soil and Environmental Consultants, Inc.
3818 Bland Road, Raleigh, NC 27609
Phone: 919-790-9117 Fax: 919-790-1728
Do normal conditions exist on site? Yes Community ID: ____
Is the site significantly disturbed? No Transect ID: ____
Is the area a potential problem area? No Plot ID: ____

Flags 000 and 100

Wetland

VEGETATION

Dominant Plant Species	Stratum	%	Indicator
1. Betula nigra	subcanopy	5%	FACW
2. Liquidambar styraciflua	"	5%	FAC
3. Liriodendron tulipifera	"	5%	FAC
4. Arundinaria gigantea	groundcover	30%	FACW
5. Smilax rotundifolia	"	10%	FAC
6. Lonicera japonica	"	10%	FAC
7. Carex sp.	"	5%	—
8.			
9.			
10.			
11.			

Percent of Dominant Species that are OBL, FACW, or FAC: 7̶5̶0̶%
Remarks:

HYDROLOGY

_ Recorded Data (Describe in Remarks)
  _ Stream, Lake, or Tide Gauge
  _ Aerial Photographs
  _ Other
_ No Recorded Data Available

Field Observations
  Depth of Surface Water: 0"
  Depth to Free Water in Pit: 10"
  Depth to Saturated Soil: 10"

Wetland Hydrology Indicators
  Primary Indicators:
  _ Inundated
  X Saturated in Upper 12 Inches
  _ Water Marks
  _ Drift Lines
  _ Sediment Deposits
  X Drainage Patterns in Wetlands
Secondary Indicators (2 or more required):
  X Oxidized Root Channels in Upper 12 Inches
  _ Water-Stained Leaves
  _ Local Soil Survey Data
  X FAC-Neutral Test
  _ Other (Explain in Remarks)

Remarks:

SOILS
Map Unit Name (Series and Phase): Wadadkee
Drainage Class: Poorly
Taxonomy (Subgroup):
Confirm Mapped Type? Yes/No

PROFILE

Depth/Horizon/Matrix	Color/Mottle	Mottle Color/Abundance/Structure	Texture,
1. 10"	2.5 Y 5/2	5 YR 5/8	
2.			
3.			
4.			
5.			
6.			

WL

Hydric Soil Indicators:
- _ Histosol
- _ Histic Epipedon
- _ Sulfide Odor
- ✓ Aquic Moisture Regime
- ✓ Reducing Conditions
- ✓ Gleyed or Low-Chroma Colors
- _ Concretions
- _ High Organic Content in Surface Layer in Sandy Soils
- _ Organic Streaking in Sandy Soils
- ✓ Listed on Local Hydric Soils List
- ✓ Listed on National Hydric Soils List
- _ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION
Hydrophytic Vegetation Present? Yes/No
Wetland Hydrology Present? Yes/No
Hydric Soils Present? Yes/No
Is this Sampling Point Within a Wetland? Yes/No
Remarks:

Above flag
1-1

non wetland

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: Halifax Co Landfill
Date: 3/22/93 County: Halifax State: NC
Applicant/Owner: Neal Phillips, County Manager
P.O. Box 38
Halifax NC 27839
Investigator: Soil and Environmental Consultants, Inc.
3818 Bland Road, Raleigh, NC 27609
Phone: 919-790-9117 Fax: 919-790-1728
Do normal conditions exist on site? Yes Community ID: ____
Is the site significantly disturbed? No Transect ID: ____
Is the area a potential problem area? No Plot ID: ____

VEGETATION

Dominant Plant Species	Stratum	%	Indicator
1. Liquidambar styraciflua	canopy	5%	FAC
2. Liriodendron tulipifera	"	5%	FAC
3. Pinus taeda	subcanopy	5%	FAC
4. Cornus florida	"	2%	FACU
5. Acer rubrum	"	2%	FAC
6. Carpinus caroliniana	"	2%	FAC
7. Arundinaria gigantea	groundcover	10%	FACW
8. Smilax sp.	"	5%	—
9. Lonicera japonica	"	5%	FAC
10. Smilax rotundifolia	"	5%	FAC
11.			

Percent of Dominant Species that are OBL, FACW, or FAC: 750%
Remarks:

HYDROLOGY

_ Recorded Data (Describe in Remarks)
  _ Stream, Lake, or Tide Gauge
  _ Aerial Photographs
  _ Other
_ No Recorded Data Available

Field Observations
  Depth of Surface Water: 0"
  Depth to Free Water in Pit: >30"
  Depth to Saturated Soil: >30"

Wetland Hydrology Indicators
  Primary Indicators:
  _ Inundated
  _ Saturated in Upper 12 Inches
  _ Water Marks
  _ Drift Lines
  _ Sediment Deposits
  _ Drainage Patterns in Wetlands
Secondary Indicators (2 or more required):
  _ Oxidized Root Channels in Upper 12 Inches
  _ Water-Stained Leaves
  _ Local Soil Survey Data
  _ FAC-Neutral Test
  _ Other (Explain in Remarks)

Remarks:

SOILS
Map Unit Name (Series and Phase): Altavista
Drainage Class: Moderately Well
Taxonomy (Subgroup):
Confirm Mapped Type? Yes/No

PROFILE

Depth/Horizon/Matrix	Color/Mottle	Mottle Color/Abundance/Structure	Texture,
1. 10"	10YR 6/6	7.5YR 5/8 and 2.5YR 4/8	
2.			
3.			
4.			
5.			
6.			

NWL

Hydric Soil Indicators:
- _ Histosol
- _ Histic Epipedon
- _ Sulfide Odor
- _ Aquic Moisture Regime
- _ Reducing Conditions
- _ Gleyed or Low-Chroma Colors
- _ Concretions
- _ High Organic Content in Surface Layer in Sandy Soils
- _ Organic Streaking in Sandy Soils
- _ Listed on Local Hydric Soils List
- _ Listed on National Hydric Soils List
- _ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION
Hydrophytic Vegetation Present? Yes/No
Wetland Hydrology Present? Yes/No
Hydric Soils Present? Yes/No
Is this Sampling Point Within a Wetland? Yes/No
Remarks:

S&
EC

Soil & Environmental Consultants, Inc.

3818 Bland Road ■ Raleigh, North Carolina 27609 ■ (919) 790-9117 ■ Fax (919) 790-1728

June 2, 1993

Mr. Dennis Osborne
PO Box 5064
Raleigh, NC 27650

Dear Mr. Osborne:

We met the Corps on-site at the Halifax County Landfill to approve our wetland delineation on 5/18/93. In fact, we were able to reduce the jurisdictional area to somewhat smaller than originally flagged on the eastern drainageway (see enclosed mylar of signed delineation "wetland area A").

As previously discussed our flag numbers 200 thru 203 were not located in "wetlands area B" (see attached sketch map) and therefore the approved map shows more jurisdictional area than actually exists between flags 105 and 5. The Corps signed the map anyway but agreed to sign a revision if your client chooses to located flags 200 thru 203.

Please call if you have questions or need assistance with Corps and/or DEM permitting. We have also enclosed copies of the Corps required delineation forms that were completed on-site.

Sincerely,

Kevin C. Martin

Kevin C. Martin,
President

March 25, 1993

Re: Wetland Situation - Parts of Undeveloped Section of Halifax County Landfill

Parts of the property was traversed on foot and the soils, vegetation and hydrology evaluated and wetland areas examined by current procedures described in the 1987 Corps Manual for Identifying and Delineating Wetlands. (See enclosed sketch map).

A new manual is currently out for public comment and several bills are in Congress which would change the way wetlands are delineated. We performed this preliminary evaluation utilizing current 1987 "rules".

We have determined that the only jurisdictional areas on the property are along "intermittent" streams (see Attached Map). No wetlands or Waters of the U.S. were found anywhere else on the parts of the tract examined. Ironically even <u>non</u> vegetated channels meet the definition of an intermittent stream in the Clean Water Act and therefore are subject to similar regulations as vegetated wetlands. Therefore these areas were delineated as well. One marginal channel (shown as dashed lines on map) was also observed which we did not flag. We do not propose locating this area since its jurisdiction is questionable and its square footage is so small and quality so low that it would not have any significant effect on permitting.

<u>Findings</u>

Almost the entire area consists of upland soils. The drainageways on the site were closely evaluated for evidence of hydrology and vegetation. In this area, the hydrologic proof would be in the existence hydric soils, of oxidized root channels in the upper 12 inches of the "A" horizon, water borne deposits, drift lines, scour marks, regional indicators of soil saturation, etc.

After close examination of the soil borings, we found no hydric soils, no oxidized root channels or any of the other hydrology indicators present to indicate hydrology exists for wetlands except in the areas approximately shown on the attached map. The enclosed map shows the rough location and shape of wetlands flagged on-site. It is for use by surveyors in locating our numbered flags and should not be relied for area determinations.

If a Corps written approval is desired a survey of the flags indicating their location, number and meets and bounds or NC coordinate grid will be required.

Recommendations

We recommend that we arrange a site meeting with the Corps to obtain approval of the delineation. The Corps will then prepare a letter referencing our meeting and approval of the delineation. This letter will be useful if any questions arise at a later date.

Once contacted, it normally takes two to four weeks before the Corps can meet on-site to approve delineations. If we are less than an acre we do not need Corps written verification to begin work but for your records we can obtain it in 2-4 weeks after the site meeting. If we are less then 1/3 acre we do not need a written verification from DEM but we can obtain it for your files in 2-4 weeks.

We can meet the Corps on-site to review our delineations for $600. Since a site almost always looks "wetter" after it is cleared, I strongly recommended we follow thru with the Corps site meeting before any clearing or grading commences if you choose to have such a meeting. By proceeding in this fashion, we will be able to confirm our work as well as avoid any potential "hang ups" during construction.

Please call if you need more information or have questions. If you wish for us to proceed, we should arrange a site meeting with the Corps as soon as possible. We will make every attempt to minimize your costs. Once we have seen a survey of our work and your proposed plans we can prepare a proposal for making permit applications on your behalf if you wish.

Sincerely,

Kevin C. Martin,
President

Drawing "Under Seperate Cover"

Appendix E

North Carolina Department of Cultural Resources

James G. Martin, Governor
Patric Dorsey, Secretary

Division of Archives and History
William S. Price, Jr., Director

January 31, 1991

John D. Barnard, Staff Engineer
ENSCI corporation
1108 Old Thomasville Road
High Point, N.C. 27260

Re: Proposed solid waste landfill,
Halifax County, GS 91-0055

Dear Mr. Barnard:

Thank you for your letter of January 8, 1991, concerning the above project.

There are no known recorded archaeological sites within the project boundaries. However, the project area has never been systematically surveyed to determine the location or significance of archaeological resources. Based on the hydrologic and topographic characteristics of the proposed landfill area, it is likely that small specialized activity campsites dating from the Archaic and Woodland prehistoric periods are located within this vicinity.

We recommend that a comprehensive survey be conducted by an experienced archaeologist to identify the presence and significance of archaeological remains that may be damaged or destroyed by the proposed project. Potential effects on unknown resources should be assessed prior to the initiation of construction activities.

Enclosed is a list of archaeological consultants who have conducted or expressed an interest in conducting contract work in North Carolina. Individual files providing additional information on the consultants may be examined at the State Historic Preservation Office's Office of State Archaeology, 421 North Blount Street, Raleigh. If additional names are desired, you may consult the current listing of the members of the Society of Professional Archeologists, or contact the society's current secretary/treasurer, J. Barto Arnold, III, P.O. Box 13265, Austin, Texas 78711-3265. Any of the above persons, or any other experienced archaeologist, may be contacted to conduct the recommended investigation.

State of North Carolina
Department of Environment, Health, and Natural Resources
Division of Parks and Recreation
512 North Salisbury Street • Raleigh, North Carolina 27611

James G. Martin, Governor
William W. Cobey, Jr., Secretary

Dr. Philip K. McKnelly
Director

December 11, 1990

John D. Barnard
ENSCI Corporation
1108 Old Thomasville Rd.
High Point, NC 27260

Dear Mr. Barnard:

The Natural Heritage Program has reviewed its topographic maps and database for locations of 1) endangered or threatened species and 2) locations of State Parks or State Recreation Areas in the vicinity of two projects of concern to ENSCI Corporation. Neither the proposed landfill site near Bilboa in Durham County nor the proposed landfill site near Aurelian Springs in Halifax County lies within 2-3 miles of such rare species or State Park/Recreation Areas. The proposed site in Durham County lies 5 to 10 river miles above Jordan Lake, which is a State Recreation Area. No impact to the recreation area would be expected from a properly-maintained landfill this far upstream from the lake.

If you have further questions about this response, please let me know.

Sincerely,

Harry E. LeGrand, Jr.

Harry E. LeGrand, Jr.
Zoologist, N.C. Natural Heritage Program

John D. Barnard
January 31, 1991, Page Two

We have conducted a search of our files and are aware of no structures of historical or architectural importance located within the planning area.

These comments are made in accord with G.S. 121-12(a) and Executive Order XVI. If you have any questions regarding them, please contact Ms. Renee Gledhill-Earley, environmental review coordinator, at 733-4763.

Sincerely,

David Brook

David Brook
Deputy State Historic Preservation Officer

DB:slw

Enclosures

A PHASE-I CULTURAL RESOURCE STUDY OF THE PROPOSED 55-ACRE HALIFAX COUNTY LANDFILL EXTENSION

by:

David M. Van Horn, Ph.D.

ARCHAEOLOGICAL ASSOCIATES, LTD.
P.O. Box 180
Sun City, CA 92381

(714) 244-1783
FAX 244-0084

March 9, 1991

TABLE OF CONTENTS

MANAGEMENT SUMMARY

The Halifax County landfill extension project will add a 55-acre area to the eastern side of the existing County landfill facility. Plans call for the additional space to be used for ash disposal. The ash will be generated by the Hadson-Westmoreland cogenerating plant to be built in Weldon. The purpose of the study described in this report was to determine whether the addition to the landfill could adversely affect potentially significant archaeological or historical resources. The study has no clearinghouse number at this time.

Fieldwork for the project was conducted by Dr. David M. Van Horn and Ruth Ann Van Horn. It consisted of two parts: (1) a walk-over survey of the entire parcel and (2) shovel-testing of those areas regarded as having a relatively high probability of containing cultural resources. The walk-over survey, which was conducted in parallel transects at 15-20 m. intervals where practicable, resulted in an inspection of the remains of a burned down farmhouse with accompanying corrugated metal service building and privy. The remainder of the property, which lacks historical features of any kind, was divided into the following areas:

Area A: Northerly field which is in an undrained swale.

Area B: Southerly field which comprises a ridgetop; this is the principal highland portion of the parcel.

Area C: A wooded area on the eastern edge of the property. A small ridge and drainage are situated in Area C.

Area D: The riparian zone along the creek which runs parallel to the southern property boundary. Two areas thought to be of possible interest along the creek include its confluence with the Area C drainage and its passage through a small granite boulder outcrop.

Area E: This is a small "panhandle" which provides access from the existing landfill on the west to the study area. Area E is in a drainage swale and the topography is irregular.

Area F: Area F comprises wooded south-facing slopes between the ridgetop and riparian zone.

Surface visibility was good in some areas of the fields but poor in others due to weeds. Visibility was generally nil in wooded areas where fallen leaves blanketed the ground. Therefore, shovel-testing of high probability portions of these areas was conducted. Generally, shovel-testing was performed by excavating small pits 18-24 inches in diameter to the substratum. All backdirt was successfully passed through a shaker screen fitted with 1/4-inch mesh. Shovel test pits were dug at 30, 50, and 100 ft. intervals (depending upon location--see report for specific details). Five locations were shovel tested:

(1) Small north-south trending ridge in Area C (pits A1 - A4).
(2) Ungraded area in front of the farmhouse (B1 - B3).
(3) Area B, the property's central highland ridge (B4 - B9).
(4) Small terrace at the confluence of two drainages in Area D (C1 - C3).
(5) Small granite boulder outcrop along southerly stream (D1 - D2).

Insofar as prehistoric material is concerned, the results of the field investigation were entirely negative, not so much as a flake being found anywhere on the parcel. We were not surprised by this result since the streams on the property are small and since the area is topographically obscure (i.e. it lacks any kind of distinction relative to the surrounding rolling hills in the region).

Interviews of local individuals were conducted in order to identify the age and occupants of the burned down farmhouse. Mr. Edward Butts, whose family has resided in Aurelian Springs for many generations, told us that the farm had been occupied by a Mr. Ray Stansbury whose family has also lived in the community since sometime in the 19th century. However, the farmhouse in question had not been built until the 1930's or 1940's. Inspection of the materials around the house seemed to confirm the information acquired from Mr. Butts. A dilapidated corrugated metal service building still stands south of the house. The privy building may be found southwest of the house where it lies on its side. In the opinion of the author, it is not even remotely possible that any of these structures or their location might be eligible for the National Register of Historic Places. This statement is based upon the relatively recent age of the farm as well as its lack of historical significance or association with prominent historical persons.

A reasonably thorough field study in conjunction with interviews and a literature review have failed to show that the planned landfill extension will affect potentially significant archaeological or historical resources. Therefore, it is recommended that the project be permitted to proceed without additional measures in connection with cultural resources.

I. INTRODUCTION

This report describes the results of a cultural resources investigation of the proposed Hadson-Westmoreland cogenerating plant ash disposal site near Aurelian Springs in Halifax County, North Carolina (figs. 1-3). The planned disposal site will comprise a 55-acre extension to the existing Halifax County solid waste disposal landfill which is situated adjacent to the study area on the west. The additional landfill area is needed as a location for disposal of ash which will be generated by a new cogenerating plant to be built in Weldon. North Carolina Solid Waste Management Rules require that a solid waste disposal site ..."shall not damage or destroy an archaeological or historical site ..." (Section .0503 (b) (iii).

The existing land fill and the proposed extension are situated on the south side of Highway 1417 about 1 mile northeast of the small community of Aurelian Springs (fig. 3). Technically, the irregularly shaped 55-acre extension consists of parcel 10 as shown on Map No. 233, Butterwood Township, Halifax County. The northern boundary of the parcel fronts on the southern side of Highway 1417 while the western boundary is contiguous with the existing County landfill. The southern boundary more or less follows the alignment of a creek while fields and wooded areas lie to the east.

The survey of the subject property was conducted by Archaeological Associates, Ltd. at the verbal request of the Westmoreland-Hadson partners Charlottesville and Fairfax, Virginia. Work was conducted for the sole purpose of determining whether development of the landfill extension would adversely affect significant archaeological or historical resources. The project was directed and conducted by the author who was assisted by Ruth Ann Van Horn. Fieldwork was performed during two separate days. On February 12, 1991, the author spent the entire day conducting a walk-over survey of the property. Shovel testing of high probability areas with poor surface visibility was conducted on February 14, 1991. The reader is referred to the discussion of methods presented below for full details. Specific test locations are shown in Figure 5.

II. PHYSICAL ENVIRONMENT

The study area is situated in a region of rolling hills which is typical of North Carolina's Piedmont physiographic province. Slopes vary from gentle to moderately

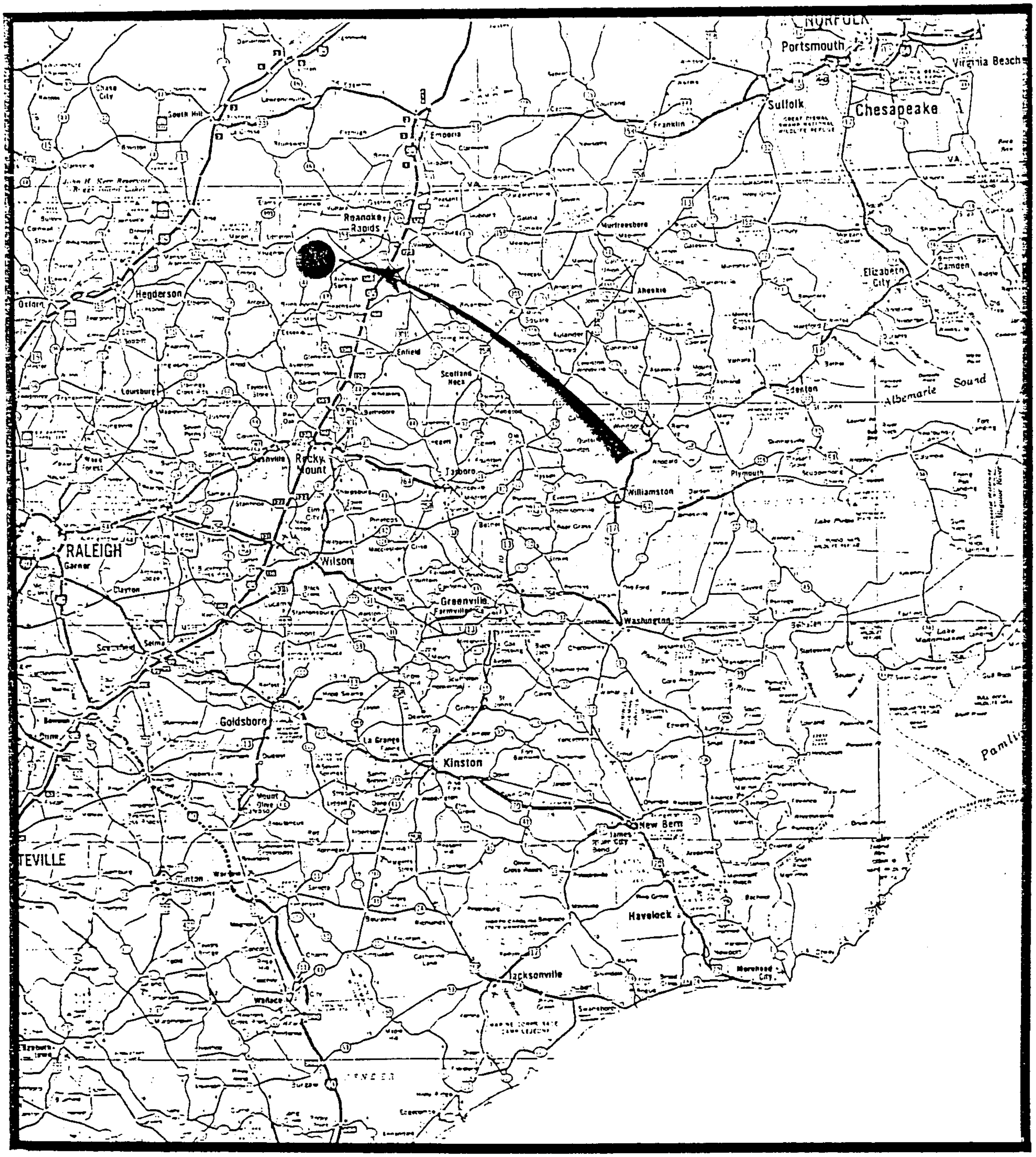


Figure 1. General location of study area shown on map of a portion of eastern North Carolina.

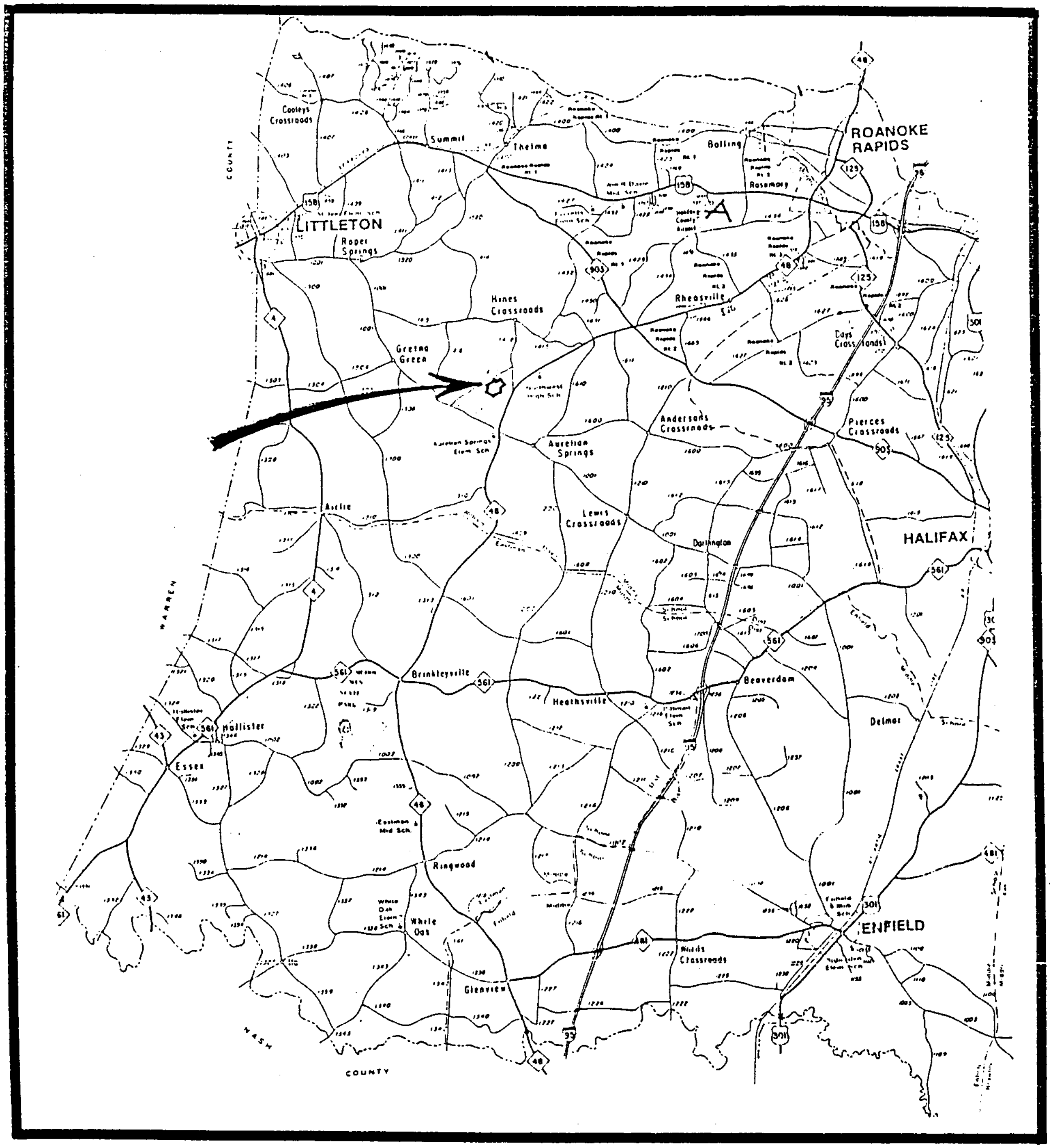


Figure 2. Location of study area shown on a map of Halifax County.

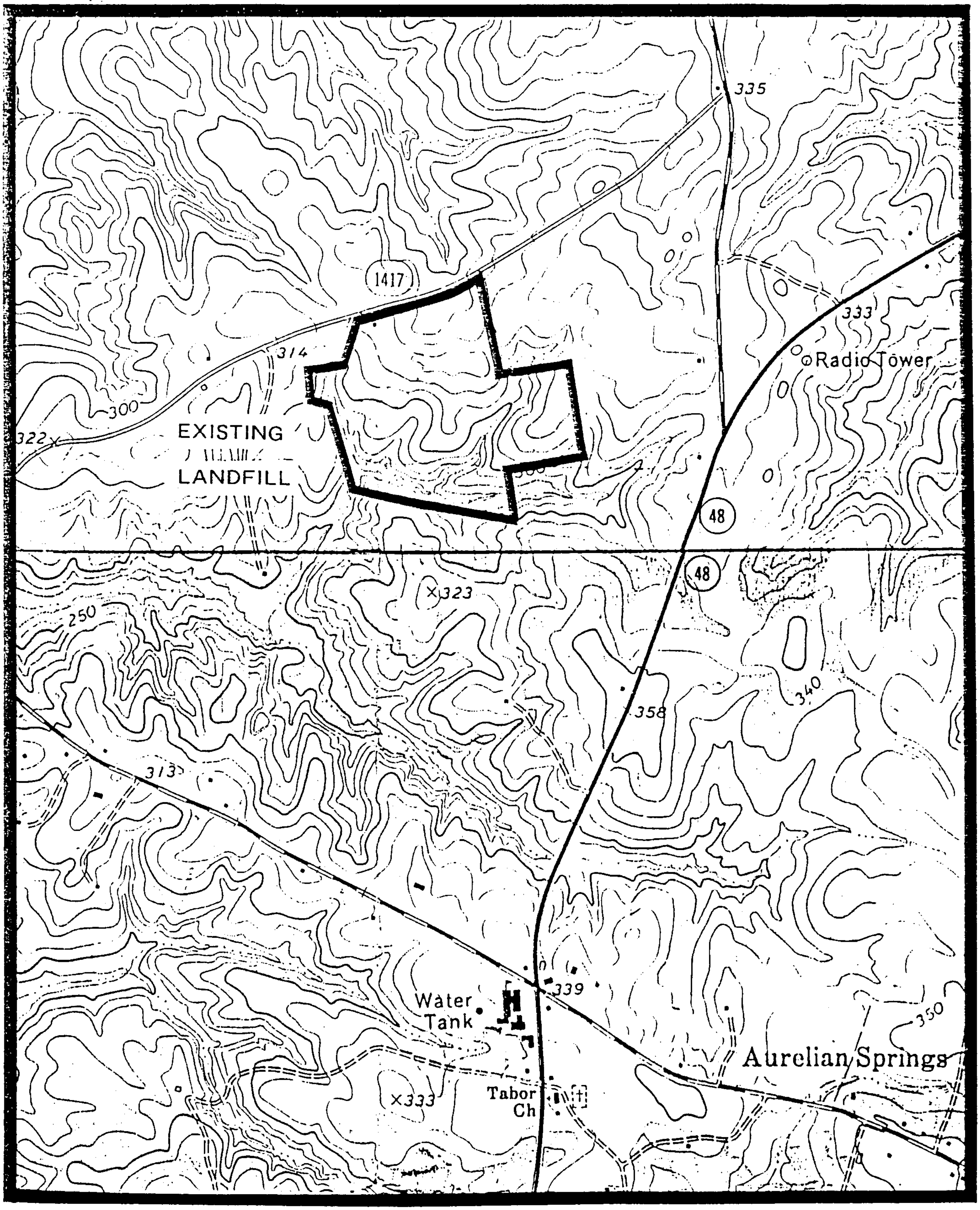


Figure 3. Study area plotted on a portion of the USGS 7.5' Thelma Topographic Quadrangle. The topograpy below the central horizontal line is a portion of the Aurelian Springs Quadrangle.

steep in the Piedmont topography. The bedrock geology of the region has been described as follows:

> Geologically, the vicinity of the site consists of an eroded peneplain which exhibits numerous broad flat-topped ridges dissected by a dendritic drainage pattern of streams and dry swales. This portion of Halifax County is underlain by a late Paleozoic-age coarse grained granite formation, which is part of a large complex of crystalline igneous rocks which comprises the so-called Eastern Piedmont geologic province. This formation forms large rounded outcrops and boulders within the lower lying portions of the site...(Ensci Corp 1991:n.p.).

The principal topographic feature of the subject property is a northwest trending ridge which transects the north-central portion of the parcel. The property generally drains to the north and south of this ridge which has an elevation of about 360' above msl. The area to the north drains into a swale which probably collects a good deal of water during rainy periods. The slope to the south, which can become moderately steep (10% - 15% grade), drains into a small creek which generally follows the southern boundary of the parcel. However, the southern slope also includes a second small

Figure 4. Granite boulders in area of dense young trees along southern Creek. Area of shovel-test D1 (see fig. 10 for location).

drainage which empties into the first. A second small ridge is located east of this secondary drainage (fig. 3).

Bedrock outcrops are absent over most of the parcel. However, several large, rounded granite boulders are situated along the southern creek in the southwestern quadrant of the study area (fig. 4). These boulders may be found to either side of the creek but their distribution is quite restricted so that they seem to represent a discrete area.

Most of the study area is covered with Wedowee soil which is characterized as a yellow clay. However, we found that most of the A-horizon soil on the property could be more accurately characterized as a red sandy clay overlying a B-horizon consisting of yellow or beige sandy clay. The local soils are said to be poor for agricultural purposes although much of the region, including parts of the study area, is farmed.

Doubtless during late prehistoric time the study area was entirely covered with mixed forest vegetation. Dominant species on uncleared portions of the higher elevations include white oak and American elm while river birch, soft rush, and various sedges are found along the drainages. Dense thickets of briar occupy much of the

Figure 5. A bulldozer cut through Area F (see fig. 9). Cuts such as this provided access for soil testing equipment but also facilitated our survey.

disturbed margins around the fields. Deer inhabit the property today as they were observed during our survey.

As noted above, most of the northern half of the property has been farmed for many years. The entire length of the major ridge has been cleared in addition to the swale to the north. The ruins of a burned farmhouse stand near Hwy. 1417 at the northeastern corner of the property (fig. 6). A badly deteriorated shed and turned over privy are located south of the house (figs. 7-8).

The small ridge on the east and the south-facing slopes below the major ridge are generally wooded and relatively undisturbed. However, a series of bulldozer cuts now connect the ridge with the southerly creek at several locations (fig. 5). These cuts, which were apparently made to facilitate soil testing, provided access to areas which could otherwise be visited only with difficulty.

III. ARCHAEOLOGICAL & HISTORICAL BACKGROUND

A. ARCHAEOLOGICAL BACKGROUND

(1) Culture History: Paleo-Indian to Early Archaic

Most culture histories for reports such as this begin with the observation that prehistoric man is generally believed to have entered North America via the "Bering Land Bridge." The hypothetical land bridge was a strip of land which connected present-day Alaska with Siberia. For some inscrutable reason, students of the subject have tended to assume that the people of the last ice age, generally referred to as the Pleistocene epoch, lacked the technical skill to construct a boat. However, recent, evidence from San Clemente Island off of the coast of California all but proves that the prehistoric inhabitants of that island built water craft capable of deep water ocean navigation almost 10,000 years ago:

> Geologic evidence indicates that San Clemente Island has never had a land connection with the mainland or its nearest neighbor, Santa Catalina Island. A very deep channel exists between the two islands and between Santa Catalina Island and the mainland. Watercraft, therefore, had to have been present on San Clemente Island at least 9,775 years ago.
>
> The watercraft technology of these early mariners appears to have been much more advanced than has been previously believed. The marine basins between the southern Channel Islands are dangerous and unpredictable and require extremely seaworthy watercraft for their

navigation. It is speculated that the channels were probably first crossed in reed boats as these craft ..., are probably among the most the most seaworthy ships ever devised by man...(Salls 1990:71).

Since the Pleistocene is generally regarded as having ended circa 12,000-10,000 B.P. on the west coast, the recent data from San Clemente Island suggest that the earliest inhabitants of North America arrived by boat.

In any event, there is reason to believe that these early people were nomadic hunters who spread across the North American continent following game. Archaeologically, they are recognized by a particular long spear point with parallel sides, a slightly concave base, and a narrow channel or "flute" extending from the base up toward the mid-section of the point. The points, and, by implication, the people, have come to be known as "Clovis" after the City of Clovis, New Mexico, where one of the earliest discoveries of fluted points occurred.

No Clovis sites have ever been found in North Carolina although there are reports of fluted points having been found on the surface in Carburrus County near Rimer (east of Kannapolis), near Union Grove and Lookout Shoals Dam in Iredell County, and near Lake Norman in Mecklenburg County (Perkinson 1973:38, 40, 42). The oldest archaeological deposit investigated in North Carolina appears to be the Hardaway site on the Yadkin River in Stanley County. It is the finds from this Piedmont site which provided most of the data used to develop the North Carolina Paleo-Indian and Early Archaic cultural phases (Coe 1964). However, no Clovis points were uncovered at the Hardaway site and the Paleo-Indian phase in North Carolina remains sketchy to say the least.

Equally sketchy are the reasons for the termination of the Paleo-Indian phase. However, it is generally held that climatic changes (end of the ice age) caused floral and faunal changes which, in turn, necessitated changes in the lifestyle of the early big game hunters. In North Carolina, it is believed that nut-producing or deciduous trees became dominant over the formerly prevalent conifers (evergreens), thereby eliminating the habitat of certain Pleistocene fauna such as mammoth:

> When many large game animals disappeared, native Americans turned to smaller animals, shellfish, and wild plants for subsistence. Other changes accompanying the shift are significant enough to distinguish this new culture from that of the Paleo-Indians. Archaeologists call the more recent cultural tradition Archaic. Archaic peoples were far more confined to particular regions than Paleo-Indians had been... (Perdue 1964:6).

The archaic cultures were aceramic (i.e., they did not know pottery) but are well-known for their groundstone vessels and axes. These people also used the atlatl (spear thrower) although the bow and arrow remained unknown. The frequency of fire-cracked rock at Archaic sites suggests that Archaic people may have dropped heated stones into water for cooking purposes. The early Archaic Period in North Carolina has been divided into the Palmer and Kirk Periods (ca. 8,000 B.C. and 7-6,000 B.C. respectively), both of which are characterized by corner notched points (Ward and Coe 1976:11-12).

Insofar as we are aware, no evidence of the presence of either the Paleo-Indian or Early Archaic peoples has ever been found in the immediate vicinity of our study area. However, most of the remaining cultural phases are locally known.

2. Culture History: The Gaston Site & Middle Archaic to Woodland Cultural Phases in Halifax County

A records check was conducted at the Office of State Archaeology, Raleigh, with the kind assistance of Dolores A. Hall, state archaeologist. The results showed that a series of prehistoric archaeological sites have been recorded along the Roanoke River about eight miles to the north of the subject property. Most of these sites were recorded in connection with the Roanoke Rapids Dam project which took place during the 1950's. Since the impending formation of Roanoke Rapids Lake would result in inundation of some of these sites, the University of North Carolina petitioned the Virginia Electric and Power Company for permission to conduct investigations. Permission was received and excavations ensued. The most important of these excavations took place on a small (3 acre) alluvial plain next to the river at a location called Eaton's Falls. The site is situated near the entrance to the old Roanoke River Navigation where the old town of Gaston was once located (Coe 1964; this and most of the information which follows is based upon Coe 1964). Hence the name "Gaston site" for the archaeological deposit.

The Gaston site, which comprised alluvial sediments nearing nine feet in depth, was found to contain cultural material in the upper 5 1/2 feet (with the exception of an isolated hammerstone uncovered at a depth of about 6 feet). The earliest cultural phase identified at the Gaston site is known as the Guilford (after the type site in Guilford County) and is believed to date circa 4500-3500 B.C. based upon radiocarbon assays for the succeeding Halifax cultural phase. Prominent Guilford phase artifact types include long lanceolate points and chipped stone axes.

The next phase in the sequence represented at the Gaston site is called "Halifax." The Halifax people manufactured points with slender blades and shallow side notches which are often formed by grinding as opposed to chipping. Most Halifax points are made from quartz as opposed to Carolina slate which was favored for point manufacture by many other groups. Coe (1964) believed that the Halifax people may have come from the north. In any event, they are thought to have been nomadic hunters who came to the area periodically.

At the Gaston site, the Halifax people were followed by the Savannah River culture (3,000 - 1,000 B.C.). The Savannah River people, who represent the end of the Archaic Period, left a greater variety and quantity of artifacts behind than any of their predecessors. Consequently, it is thought that they may have occupied the site in greater numbers than did the earlier peoples. These Savannah River artifacts include Carolina slate points, hammerstones, ground stone vessels and grooved stone axes.

The Gaston site was apparently abandoned for about 1500 years following the departure of the Savannah River people. Then, about 500 A.D., a new people appear on the scene. Known as the Vincent Culture, the new population had technology not seen before including pottery and the bow and arrow. These introductions are the harbingers of the outset of the Woodland Period which lasted throughout the remainder of the region's prehistory. The local early pottery, called Vincent ware, is typically sand tempered and decorated by paddling with a cord-wrapped paddle or impression with a wicker type fabric (Coe 1964). Clay pipes found at the Gaston site seem to indicate that smoking of tobacco had begun.

By about 1200 A.D., sufficient changes in the material culture had occurred to justify the desingation of a new phase -- the Clements Culture. These changes include variations in pottery style, an increase in the frequency of smoking pipes, apparent complete abandonment of the atlatl in favor of the bow and arrow, and manufacture of bone points and other tools. The regional Woodland or latest prehistoric era ends with the termination of the Clements culture.

The final Indian occupation of the Gaston site commenced at circa 1600 A.D., or at about the same time as the Jamestown settlement. Known as the "Gaston Occupation," it consisted of a compact village with a stockade. The people of the Gaston Occupation may have been the historically known Tuscarora who are said to have controlled all of the land and smaller tribes between the Roanoke and Neuse River Valleys.

3. The Ethnographic Period: The Tuscarora War

European trade with the Indians began as early as the 16th century when explorers discovered that large profits were waiting to be made (most of the information which follows is from Perdue 1964).

> The first group of Englishmen whom Raleigh dispatched to Carolina in 1584 discovered that a handsome profit could be made in the Indian trade. Arthur Barlowe, captain of one of the ships sent on the expedition, reported to Raleigh: 'We exchanged our tin dish for twenty skins, worth twenty crowns or twenty nobles, and a copper kettle for fifty skins worth fifty crowns. They offered us good exchange for our hatchets and axes and for knives, and would have given anything for swords, but we would not depart with any.' (Perdue 1964:26).

The second most important Indian trade item was slaves taken as war captives. The white plantation owners purchased Indian slaves to work alongside their black slaves. The Tuscarora tribe, which was the most important in northeastern North Carolina, was among the groups active in these forms of trade. In fact, the upper Tuscarora, those living north of the Pamlico River, enjoyed the comfortable position of being middlemen in the trade taking place between the North Carolina Indian traders and the Virginia merchants operating out of the port cities.

By the early 18th century, the southern Tuscarora, living between the Roanoke and Neuse Rivers, began to feel the pressure from developing white settlements. This caused the normally independant Tuscarora villages to confederate together with some of the small displaced coastal tribes. The confederation, which I shall refer to collectively as the southern Tuscarora, was led by Chief Hancock while the upper Tuscarora were under the leadership of Chief Tom Blunt.

In 1710, a group of Swiss and German colonists built the town of New Bern near the southern Tuscarora. Convinced that hostilities were the only way to preserve the Indian domain, Chief Hancock planned an attack on New Bern for September, 1711. Just prior to the attack, the southern Tuscarora captured and executed John Lawson, an early explorer who provided some of the earliest descriptions of Piedmont cultures. The attack took place on September 22, 1711 and resulted in the deaths of some 120 colonists. Other colonists were taken captive, houses and barns were burned, and cattle and crops were seized.

The colonists retaliated and hostilities continued until finally, in 1712, Colonel John Barnwell was dispatched from South Carolina to subdue the southern Tuscarora.

Although he was able to take Fort Narhantes, a major Tuscarora fortification, Barnwell was unable to take Fort Hancock. Nonetheless, the Indians agreed to a truce.

> During a subsequent conference, however, Barnwell's troops killed 50 Tuscarora men and seized about 200 women and children as slaves. This act of treachery led to renewed hostilities which raged throughout the summer. The desparate Carolina colonists promised Tom Blunt of the northern Tuscarora control over the entire tribe in exchange for his collaboration. Blunt accepted the offer and captured Hancock, whom the colonists executed. In the spring of 1713 Colonel James Moore of South Carolina captured more than 900 Tuscarora ... the surviving southern Tuscarora were forced onto a reservation near Lake Mattamuskeet in Hyde County, but throughout the eighteenth century, groups of Tuscarora moved north to join the Iroquois, a powerful confederacy of related tribes in New York and southern Canada. (Ibid. 30).

Those Tuscarora who remained in North Carolina continued to feel the pressure of colonial expansion. Even worse, they were hated and despised as a result of the former hostilities. Finally, in 1803, the Tuscarora abandoned all land in North Carolina and followed their predecessors to reservations in New York and Canada.

4. Modern Indians: The Haliwa Tribe

The Haliwa are the only Indian tribe which exists in Halifax County today. The name "Haliwa" is not traditional--rather, it is a synthesis of the words "Halifax" and "Warren," the two counties where the tribal members reside. The tribe, which is made up of some 3,000 - 4,000 individuals, was officially recognized by the State of North Carolina on April 15, 1965. The Tuscarora, Saponi, and Cherokee are all represented among the Haliwa. W.R. Richardson is currently chief of the Haliwa, most of whom live in the towns of Hollister and Essex in Halifax County, and in Warren County (Richardson as told to Wheeler and Elias 1976:66).

B. HISTORICAL BACKGROUND

1. Halifax County

Most of the early English settlers in Halifax County were farmers from Virginia. The plantation system gradually developed as a result of their agrarian activities. The plantation owners used slave labor to grow various crops including wheat, corn, peas, and tobacco for out-of-state markets (Dept. of Cult. Resources n.d.:1). Completion of the Dismal Swamp Canal and the Roanoke River Navigation in the early 1800's provided a practical means of transporting agricultural goods to Virginia port cities.

The town of Halifax was founded on the bank of Roanoke River in 1760. It served as the seat of Halifax County as well as comprising an important trade center:

> The new town was ... at the intersection of major north-south and east-west roads. Falls and rapids were just upriver, making Halifax the head of river navigation. With these advantages, the small town quickly became a trading center and river port for goods moving between the backcountry, the plantations, and Virginia. (Ibid.).

Halifax is probably best known for its "Resolves" whereby North Carolina became the first American colony to formerly advocate overthrow of English control. This event occurred in April of 1776 when the Fourth Provincial Congress met at Halifax. The representatives at the congress were so unhappy with recent events that they authorized assembling four new Continental regiments and approved issuance of 500,000 pounds in currency to finance the war effort. They then turned to the matter of the resolves:

> The most significant action of the congress came on April 12, 1776, when a committee reported on the state of conflict with the resolution. Prefaced with a statement on the British destruction of property and lives in the colonies, the resolve firmly declared that the delegates from North Carolina to the Continental Congress 'be impowered to concur with the delegates of the other Colonies in declaring Independency, and forming foreign alliances.' (Butler 1976:65).

Halifax continued to prosper after the revolution as its agricultural-based economy flourished. But by 1835, certain changes in the State Constitution eliminated some of the County's political authority. A second blow was dealt to the City's prominence when the railroads arrived in 1839. They not only by-passed Halifax but provided a new means of transportation which soon rendered river navigation obsolete. The final blow to the area's economy resulted from the emancipation of slaves during the Civil War. Without slaves to do the work, the plantation system broke down completely.

2. Notes on Aurelian Springs

Research at the Halifax and Roanoke Rapids libraries failed to produce any documentary history of the community of Aurelian Springs. Interviews of several individuals who are familiar with Halifax County and its history also failed to produce any information (Akers 1991:pers. comm.). Consequently, we were compelled to depend upon the recollections of local residents. One such resident, Mr. Edward Butts Jr., is a student of the local genealogy and provided most of the useful information which we were able to acquire.

The small community of Aurelian Springs has its roots in colonial times era when it comprised an area of small plantations (Butts 1991:pers. comm.). The earliest name for the area, if indeed there was a name, is not known. At some time prior to the latter part of the 19th century, a teacher named Webb ran a boarding school at the intersection west of the springs. At that time, the area was known as "Webb's Crossroads."

Sometime about 1880, a man named Brinkley moved to the area. He decided to develop the springs as a health resort and it was he who named them "Aurelian Springs" or golden springs -- the name being intended to suggest the health benefits of the springwater. Local residents also came to believe that the springs conferred health benefits and it was said that they were "magical" because they moved around alot (i.e. the exact spring locations were ephemeral; Jones 1991:pers. comm.). Mr. Brinkley eventually moved away, selling the springs to a Mr. Walter Harris. Mr. Harris discontinued the resort business and returned the land to its former agrarian use. However, the community has retained the name Aurelian Springs ever since the late 19th century resort era.

3. Comments on Anticipated Cultural Resources Based upon Background Research

Aside from the well-known sites along the Roanoke River, virtually no prehistoric archaeological sites have been recorded within many miles of the subject property. Thus, there is little basis for speculation with regard to what types of prehistoric sites might be anticipated within the study area. In fact, the generalities presented in the culture history are about the only available basis for prediction.

Given these constraints, I might comment that I would not anticipate finding a Woodland era occupation site on the property since its soils are regarded as poor for agricultural purposes (Kelly 1991:pers. comm.) and the drainage channels are too narrow to accomodate fields. The prominent ridge in the north-central area of the property might seem to offer some potential for an earlier site, however.

With regard to historical sites, a prominent old farmhouse would seem to be about the only possibility. The Aurelian Springs community is very small and obscure and, with the exception of the late 19th century resort around the springs themselves, has always had an agricultural economic base. Since industry, transportation routes, and political importance are all lacking, it would be surprising to encounter an important historical site on the subject property.

IV. METHODS

The subject property was surveyed using two methods: (1) systematic walk-over inspection and (2) shovel testing. The entire property was covered by the author using the walk-over method on February 12, 1991. Each procedure is described in detail below.

1. Systematic Walk-Over Inspection

The survey began in the area of the former farmhouse (fig. 4) which was intensively reconnoitered by moving from one feature to the next. First, the area of the burned down farmhouse was examined followed by the metal shed and finally the fallen down privy. These are the only historical features visible within the study area.

Figure 6. Ruins of the Ray Stansbury farmhouse believed to have been built in the 1930's or 1940's.

The field in the swale north of the ridge was then inspected by walking in parallel transects spaced 20-30 meters apart (Area "A" in fig. 9). Although tall weeds

Figure 7. Wood and corrugated metal service building located south of farmhouse (see fig. 10 for location). Looking west.

Figure 8. Fallen down privy structure (see fig. 10 for location). Looking west.

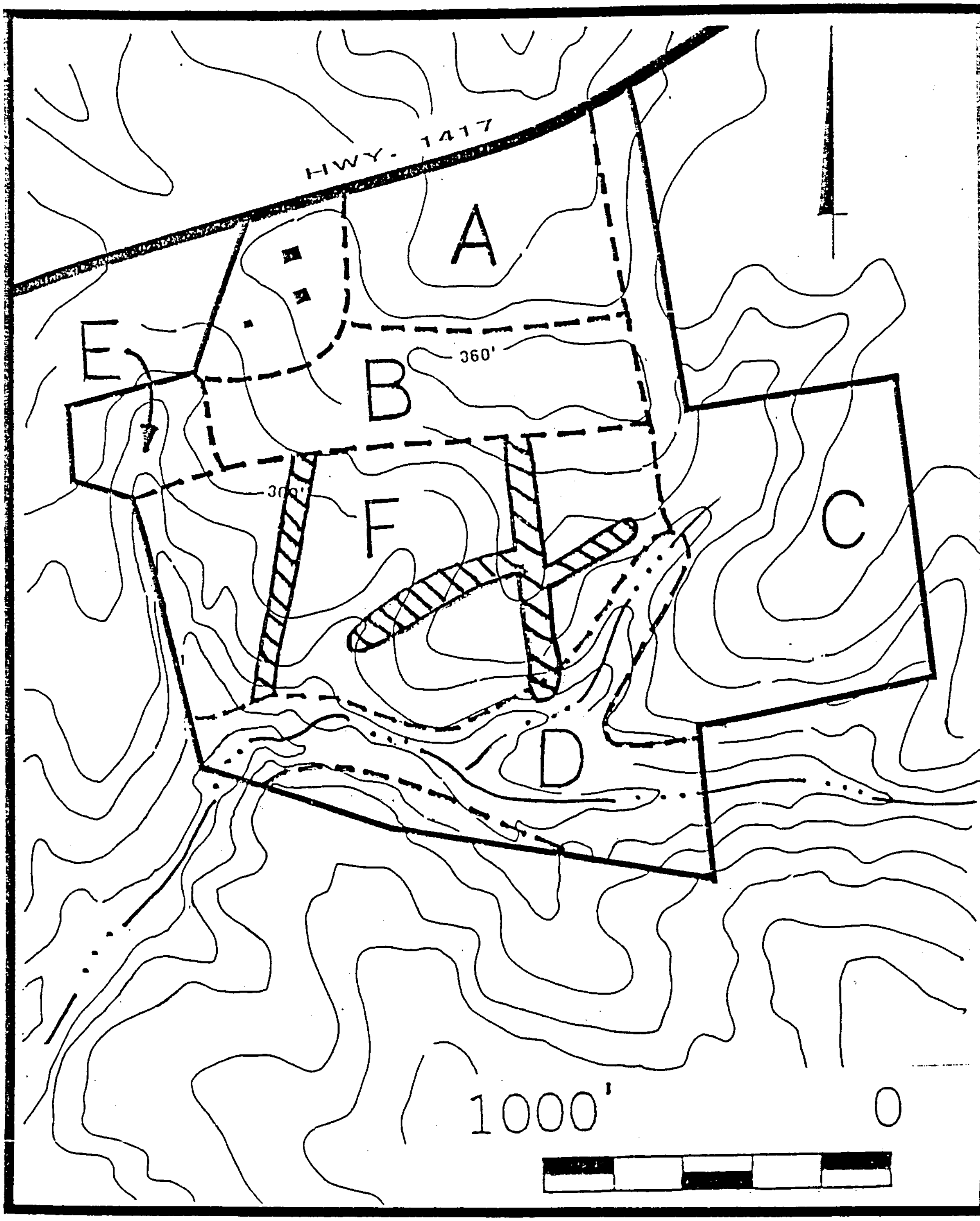


Figure 9. Study area divided into zones A through F. The hatched areas represent bulldoze cuts through wooded Area F. The farmhouse, service building, and privy are at upper left.

populate the abandoned field, it had been disced with sufficient frequency to afford some surface visibility. Soils consist of red sandy clay mixed with abundant small stream-rolled pebbles. The swale in which this northern field is situated is very poorly drained and was regarded as a low-probability location for that reason.

The ridgetop fields to the south were then inspected using a similar transect pattern (Area "B" in fig. 9). Some parts of the southern field had been recently disced affording excellent surface visibility. Other areas, particularly the highest elevations, were covered with weeds and surface visibility was poor. Since the ridgetop was regarded as a relatively high probability area, it was determined that it should be shovel-tested.

The next area to be surveyed consisted of the woods on the eastern flank of the property (Area "C" in fig. 9). This included a narrow strip of trees along the eastern edges of the two fields as well as the woods on a small ridge in the easternmost sector of the subject property. The trees on the small ridge are mature by comparison to those on the southerly slopes (Area "F," see below) and the understory is thin (excepting only the row of briars that separate the fields from the rigdes). However, surface visibility was so poor due to fallen leaves that walking the ridge was an all but perfunctory excercise. Consequently, it was decided that it too should be shovel-tested.

The survey then moved into the riparian zone ("D" in fig. 9) which consists mainly of a narrow creek which runs along the southern study area boundary and a small tributary drainage which runs down from Area C. The trees in the riparian area are mostly young, apparently due to the mature timber having been strip cut in 1978-1979 (Kelly 1991:pers. comm.). The trees are so dense and interconnected with viney understory that passage anywhere was hampered. However, access to the riparian zone was greatly facilitated by several bulldozer cuts which extended to the southerly creek from the fields in Area B. These cuts, which had apparently been made to provide access for soil sampling equipment, provided access to the southerly creek in the eastern and western areas of the property (fig. 5). Several established hunter's trails wind along both sides of the creek and these were followed.

In most places, the creek channel was quite narrow. However, small terraces were found near its confluence with the above-mentioned tributary on the west where several large granite boulder outcrops were observed. The latter were inspected with considerable care but no indications of prehistoric activity were observed. It was determined that additional shovel-testing should be performed at this location.

The next region examined comprised the wooded area on the south-facing slope (fig. 9, Area "F"). These woods had also been lumbered in 1978-1979 and consist of small trees often accompanied by dense understory growth. Surface visibility in this area was found to be very poor due to fallen leaves. However, the afore-mentioned bulldozer cuts provided a network of cleared area and these were carefully inspected. Area F was regarded as a low-probability area due to the sloping terrain and absence of attractive features.

The final area to be examined is a small panhandle shown as Area E in Figure 9. This area currently provides access to and from the existing landfill. The terrain here is irregular due to the fact that it actually comprises the upper reaches of a drainage. Much of the surface is covered with grass but a dirt road passes down the center of the panhandle. The irregularity of the ground surface and location within a drainage area led me to regard the chances of an archaeological deposit being situated in location as very low.

2. Shovel-Testing Program

The shovel testing was conducted at areas of moderate to high probability as distinguished during the walk-over inspection. Five such areas were distinguished:

(1) The small ridge in the eastern part of the study area. This area was regarded as having a relatively high probability of containing artifacts due to its elevation and the fact that it represents a discrete topographic entity. Four holes were dug on the ridge. Three, A1, A3, and A4 were placed at 50 ft. intervals in a line down the main axis of the ridge (fig. 5). The fourth, A2, was excavated northwest of A1 in a relatively flat area. The soil on the ridge was found to be quite thin. Stratigraphy consisted of about 3" of dark sandy humus overlying 4" of brown topsoil. Yellow subsoil was encountered at a depth of about 7"-8" and each hole was excavated to about 16".

(2) Non-graded area along the road in front of the farmhouse ruins. The farmhouse had been built in a flat cut which had been graded to accomodate the house. Thus there was little or no chance of encountering prehistoric material around the house itself (which we regarded as insignificant based upon our own observations as well as information obtained from interviewing Mr. Butts).

The area along the road in front (east) of the house and service building had apparently not been graded. Surface visibility here was poor due to tall grass. Therefore, a series of three shovel-test pits was dug in a curve parallel and west of the

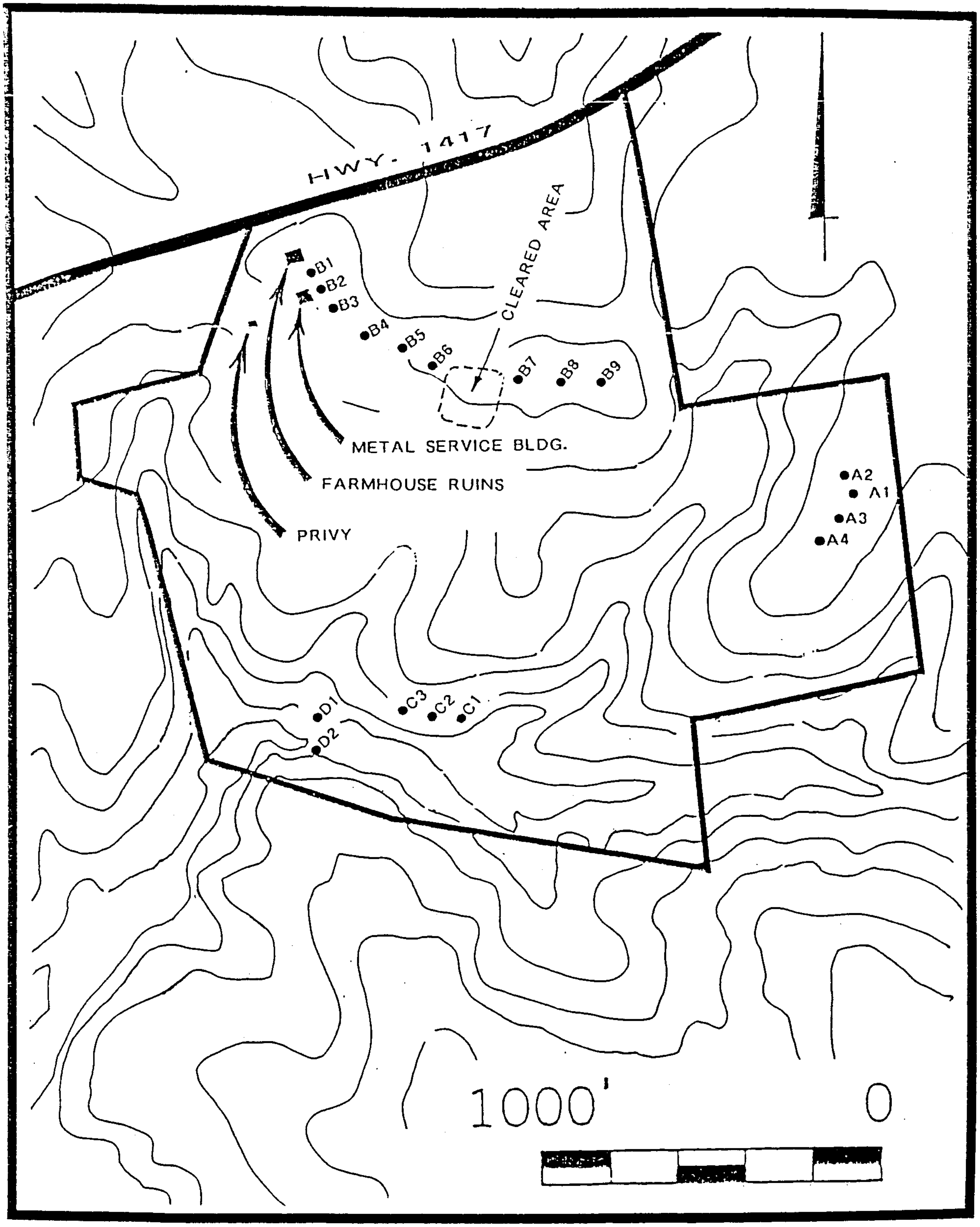


Figure 10. Shovel-Test pit locations and identifications of farm structures.

dirt road alignment. These holes, which were placed 50 ft. apart, were labeled B1 - B3 (fig. 5). The first, B1, proved to have been in a graded location as it consisted exclusively of red clay substratum. Holes B2 and B3, which were also placed at 50' intervals, were in ungraded locations. B2 yielded 10"-12" of brown topsoil overlying a red and yellow mottled substratum which contains plentiful stream pebbles. The historic finds from B2 are listed in the following section. The topsoil in B3 seemed to lack humus altogether as it consisted of about 12" of brownish yellow sand. The substratum in B3 consisted of pale yellow sandy clay mixed with pebbles.

(3) The main ridge across the northern portion of the study area. In my opinion, the main east-west trending ridge in the north-central area of the property had the highest probability of including prehistoric archaeological material of any location within the study area. Therefore, its entire length was checked with shovel-test pits spaced 100 ft. apart (B4 - B9; holes B6 and B7 were space 200' apart due to an area of near perfect surface visibility; see fig. 5). The topsoil in B4 consisted of 10" of orange clay overlying a bright brick red and yellow mottled clay substratum. The stratigraphy along the remainder of the ridge consisted of only 6"-7" of light brownish red loam overlying a substratum of solid brick red clay.

Figure 11. Location of Shovel-test pit C-1 on creek terrace.

(4) The small terrace next to the confluence of two drainages in the south-central area. Three holes placed at 30' intervals were excavated in the terrace (C1 - C3; fig. 5). Not surprisingly, soils in the terrace were found to consist of dark brown moist pure sandy alluvium. Pebbles were completely absent. We estimated, based upon the elevation of the terrace above the water level in the creek, that the terrace comprised some 4' - 5' of such alluvial sediment. However, the shovel test extended to 26".

(5) The boulder outcrop area along the southerly stream in the southwestern part of the property (fig. 4). Several boulders are situated on either side of the stream at this location. One shovel-test pit was excavated on the north side of the creek next to the most prominent boulder. This pit, D1, exposed 3"-4" of humus overlying sterile looking red sand. Once again, the depth of this alluvial deposit was probably considerable. We dug the shovel-test pit to 24". D2 was placed above the two highest boulders on the north side of the creek. Here we encountered bedrock after excavating to a depth of 12".

V. RESULTS

No prehistoric finds of any type were observed during our field investigation. Consequently, we conclude that no prehistoric archaeological material is present within the boundaries of the study area.

Shovel-test pit B2, which was placed on the west site of the road slightly south of the corrugated metal service building was the only unit which yielded finds of any kind. These consisted of series of historic items, all of which are believed to relate to the farmhouse and to be relatively late in time (no earlier than the 1930's). These finds are listed in Table 1.

TABLE 1

Finds from shovel-test pit B2, Halifax County landfill extension study.

Quantity	Description
10	nail fragments; too corroded to identify.
1	fragment of a sheet metal address letter or number.
1	white crockery ware sherd.
7	clear bottle glass fragments.
12	small brick fragments.

A great deal of debris from the burned down farmhouse is also lying about on the surface (fig. 6). This is dominated by burned wood, fallen brick from chimney, composition flooring, cement block pillars (which upon which the structure stood) and corrugated metal roofing. Other objects include the metal from a mattress and a wringer washer. Judging by this debris, we supposed that the house probably dated no earlier than the 1940's.

Fortunately, we were able to glean some confirmation of this surmisal from Mr. Edward Butts, Jr., a life-long resident of Aurelian Springs whose family has lived in the community for generations. Mr. Butts told us that Mr. Ray Stansbury had farmed the property and lived in the house. Although he could not recall precisely when the house was built, Mr. Butts did not think that it dated earlier than the 1930's. The Stansbury family, however, has resided in the Aurelian Springs area since sometime before the Civil War and may have owned the property since well before the farmhouse was built.

The "1914-1915 Map of Halifax, North Carolina" (Hughes 1914-1915) shows two Stansburys residing in Aurelian Springs: J.B Stansbury (no. 8) and (T.W. Stansbury (no. 15). However, aside from the fact that they are an old local family, we were unable to discover any other history relating to the Stansburys. The farmhouse is said to have been burned down by a vandal who was subsequently apprehended.

VI. SIGNIFICANCE EVALUATIONS

The results of our fieldwork indicate that no prehistoric archaeological material is present within the boundaries of our study area. Only the burned rubble of the Stansbury farmhouse remains. The wood and corrugated metal service building is about to fall down and the privy has been turned over. However none of these structures are regarded as significant since they are relatively recent (perhaps too recent to be eligible for the National Register of Historic Places) and, in any event, they lack the historical significance in terms of connections with either prominent historical persons or events. Consequently, the farm buildings are not regarded as significant within the meaning of state or federal historical preservation statutes.

VII. RECOMMENDATIONS

A reasonably thorough study in conjuction with interviews and a literature review has failed to show that the planned landfill extension will affect potentially significant archaeological or historical resources. Therefore, it is recommended that the project be permitted to proceed without additional measures in connection with such resources.

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Appendix F

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)	-	-
Time	-	-
Date:	-	-

DEPTH	BLOW COUNTS	SAMPLING METHOD	SAMPLE NUMBER	MOISTURE	CONSISTANCY	SAMPLE RECOVERY	DRILL METHOD
0.0	3 5 7	Ss	S1			18"	
3.0	8 16 15	Ss	S2			18"	
8.0	5 6 9	Ss	S3			18"	
13.0	5 6 7	Ss	S4			18"	
18.0	4 5 6	Ss	S5			18"	
23.0	5 10 9	Ss	S6			12"	
28.0	10 50/4	Ss	S7			8"	
33.0	50/5	Ss	S8			3"	

DEPTH	LITHOLOGY DESCRIPTION
0.0	SANDY CLAY: Orange brown sandy clay and topsoil; took a jar sample from 0 to 1.5 feet.
3.0	CLAYEY SANDY SILT: Yellow-orange clayey sandy silt; abundant feldspar; trace mica.
12.5	SILTY SAND: Yellow tan fine silty sand; powdery; felsic; trace mica.
23.0	SILTY SAND: Slightly clayey silty sand; micaceous; coarse sand; gravel at 25'.
29.0	SILTY SAND: Relict granite; very felsic; iron stained; quartz sand and mica; auger refusal at 36'.

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)	-	-
Time	-	-
Date:	-	-

DEPTH	BLOW COUNTS	SAMPLING METHOD	SAMPLE NUMBER	MOISTURE	CONSISTANCY	SAMPLE RECOVERY	DRILL METHOD	LITHOLOGY DESCRIPTION
0.0–1.5	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.
3.5–5.0	7 8 9	Ss	S2	D		16"		SANDY CLAYEY SILT: Orange brown sandy clayey silt; slightly plastic.
8.5–10.0	5 8 11	Ss	S3	D		14"		
13.5–15.0	4 5 8	Ss	S4	M		16"		SANDY SILT: Pink to white to tan sandy silt; relict granite structure visible; sample contains feldspar, mica and quartz; wet at 28.5'.
18.5–20.0	5 11 11	Ss	S5	M		18"		

DEPTH | LITHOLOGY | WELL INSTALLATION

Depth scale: 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, 19.0, 20.0

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

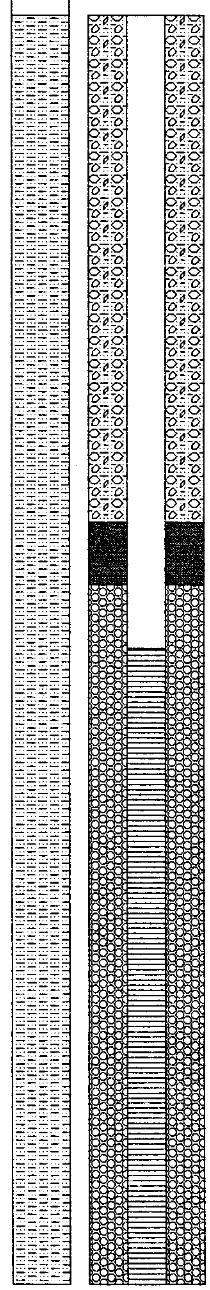
TOP OF CASING ELEVATION: -
TOTAL DEPTH: 40.0 FT
GROUND SURFACE ELEVATION: -
SHEET: 2 OF: 2

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'.
23.0	7 10 14	Ss	S6	M		16"		
28.0	8 12 16	Ss	S7	W		16"		
33.0	5 8 12	Ss	S8	W		14"		
38.0	5 9 14	Ss	S9	W				
40.0								

DEPTH: 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, 37.0, 38.0, 39.0, 40.0

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

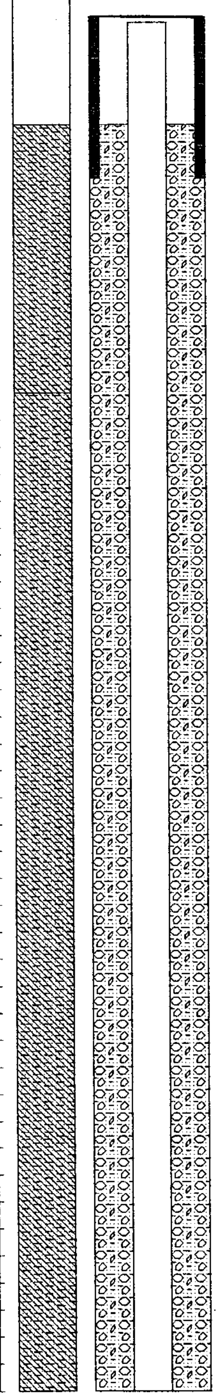
TOP OF CASING ELEVATION: 315.39
TOTAL DEPTH: 50.0 FT
GROUND SURFACE ELEVATION: 313.70
SHEET: 1   OF: 2

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	4 8 12	Ss	S1			18"		SANDY SILTY CLAY: Red-orange-brown with some yellow; took a bulk sample from 3 to 5 feet.
3.5	10 11 9	Ss	S2			18"		
5.0								CLAYEY SANDY SILT: Orange yellow brown; abundant feldspar and mica; four pieces of quartz gravel at 19 ft.
8.5	4 7 8	Ss	S3			16"		
13.5	4 5 6	Ss	S4			18"		
18.5	6 9 13	Ss	S5			16"		
23.5	6	Ss	S6					

DEPTH scale: 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, 19.0, 20.0, 21.0, 22.0, 23.0

LITHOLOGY | WELL INSTALLATION



FIELD BOREHOLE LOG

BOREHOLE NUMBER: BP-3

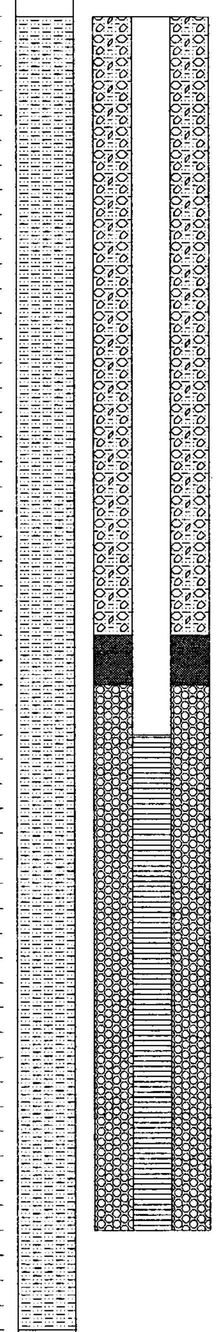
PROJECT NUMBER: HALIFAX-5
PROJECT NAME: HALIFAX COUNTY
LOCATION: HALIFAX, NORTH CAROLINA
DRILLING COMPANY: BORE AND CORE
RIG TYPE & NUMBER: CME 450
DRILLING METHOD: HOLLOW STEM AUGER
WEATHER: CLOUDY, 45 DEGREES
FIELD PARTY: L. FOSKEY
GEOLOGIST: G. MILLS
DATE BEGUN: 12/5/95 DATE COMPLETED: 12/6/95

TOP OF CASING ELEVATION: 315.39
TOTAL DEPTH: 50.0 FT
GROUND SURFACE ELEVATION: 313.70
SHEET: 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	LITHOLOGY DESCRIPTION
23.5–24.5	6 12 13	Ss	S6					SANDY SILT: White-orange relict granite with abundant feldspar; more k-spar and coarse quartz sand at 33.5 ft.
28.5–29.5	10 16 18	Ss	S7					
33.5–34.5	7 12 16	Ss	S8			12"		
38.5–39.5	9 13 17	Ss	S9			8"		
43.5–44.5	7 12 17	Ss	S10			10"		
48.5–49.5	10 17 21	Ss	S11					
50.0								Boring Terminated at 50 feet.

Depth scale: 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, 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, 51.0, 52.0



FIELD BOREHOLE LOG

BOREHOLE NUMBER: BP-6

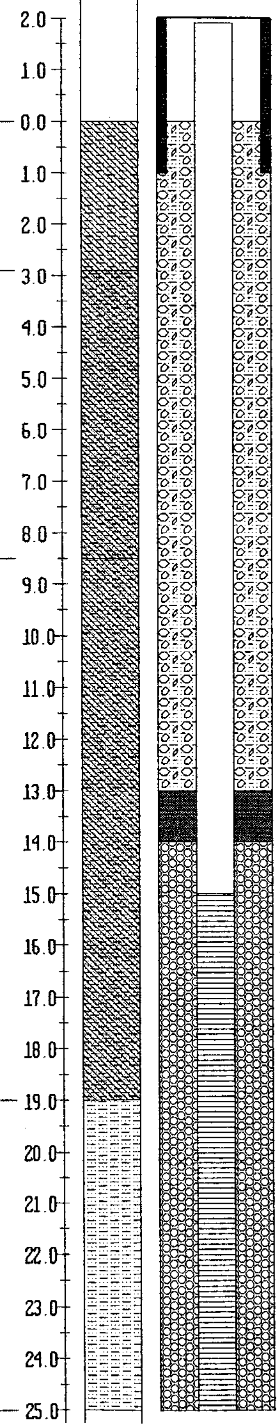
PROJECT NUMBER: HALIFAX-5
PROJECT NAME: HALIFAX COUNTY
LOCATION: HALIFAX, NORTH CAROLINA
DRILLING COMPANY: BORE AND CORE
RIG TYPE & NUMBER: CME 450
DRILLING METHOD: HOLLOW STEM AUGER
WEATHER: CLOUDY, 45 DEGREES
FIELD PARTY: L. FOSKEY
GEOLOGIST: G. MILLS
DATE BEGUN: 12/5/95 DATE COMPLETED: 12/5/95

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
2.0								
1.0								
0.0	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.
1.0								
2.0								
3.0	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.
4.0								
5.0								
6.0								
7.0								
8.0	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.
9.0								
10.0								
11.0								
12.0								
13.0	3 4 6	Ss	S4	D				
14.0								
15.0								
16.0								
17.0								
18.0	3 6 9	Ss	S5	W				
19.0								SANDY SILT: Tan, slightly clayey sandy silt; wet at 19'; very wet at 23.5'.
20.0								
21.0								
22.0								
23.0	3 6 9	Ss	S6	VW				
24.0								
25.0								

DEPTH | LITHOLOGY | WELL INSTALLATION



FIELD BOREHOLE LOG

BOREHOLE NUMBER: B-1

PROJECT NUMBER: HALIFAX-5
PROJECT NAME: HALIFAX COUNTY
LOCATION: HALIFAX, NORTH CAROLINA
DRILLING COMPANY: BORE AND CORE
RIG TYPE & NUMBER: MOBILE B-53
DRILLING METHOD: HOLLOW STEM AUGER
WEATHER: CLOUDY, 45 DEGREES
FIELD PARTY: L. FOSKEY
GEOLOGIST: J. FINKBEINER
DATE BEGUN: 11/28/95 DATE COMPLETED: 11/28/95

TOP OF CASING ELEVATION: -
TOTAL DEPTH: 20.0 FT
GROUND SURFACE ELEVATION: 297.7
SHEET: 1 OF: 1

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	DEPTH	LITHOLOGY	WELL INSTALLATION
0.0	7 14 20	Ss	S1			14"		SILTY CLAY: Red-brown silty clay with some large quartz crystals; dry.	0.0		
3.0	11 17 22	Ss	S2	D		13"		CLAYEY SILTY SAND: Red brown; some quartz and mica; dry.	3.0		
8.0	5 7 10	Ss	S3	D		10"		SILTY CLAY: Brown silty clay mica schist grading up into a k-spar rich silty clay; dry.	8.0		
13.0	7 12 14	Ss	S4	D		9"		SILTY CLAYEY SAND: Light pink silty clayey fine sand with greenish mica veins and some this clayey feldspar layers; dry.	13.0		
18.0	11 14 15	Ss	S5	D		13"			18.0		
20.0								Boring Terminated at 20'.	20.0		

Depth scale: 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

FIELD BOREHOLE LOG

BOREHOLE NUMBER: B-2

PROJECT NUMBER: HALIFAX-5
PROJECT NAME: HALIFAX COUNTY
LOCATION: HALIFAX, NORTH CAROLINA
DRILLING COMPANY: BORE AND CORE
RIG TYPE & NUMBER: MOBILE B-53
DRILLING METHOD: HOLLOW STEM AUGER
WEATHER: CLOUDY, 45 DEGREES
FIELD PARTY: L. FOSKEY
GEOLOGIST: J. FINKBEINER
DATE BEGUN: 11/28/95 DATE COMPLETED: 11/28/95

TOP OF CASING ELEVATION: -
TOTAL DEPTH: 15.0 FT
GROUND SURFACE ELEVATION: 302
SHEET: 1 OF: 1

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	LITHOLOGY	WELL INSTALLATION
0.0	3, 6, 9	Ss	S1			13"		SILTY CLAY: Red brown silty clay with quartz; dry.		
3.0	9, 12, 15	Ss	S2	D		15"		CLAYEY SILT: Red brown clayey silt with some sand; dry.		
8.0	5, 6, 7	Ss	S3	D		8"		SANDY SILT: Pink k-spar rich sandy silt with green micaceous layers; trace clay; some feldspar; dry.		
13.0	4, 7, 8	Ss	S4	D		9"				
15.0								Boring Terminated at 15'.		

DEPTH scale: 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

FIELD BOREHOLE LOG

BOREHOLE NUMBER: B-3

PROJECT NUMBER: HALIFAX-5
PROJECT NAME: HALIFAX COUNTY
LOCATION: HALIFAX, NORTH CAROLINA
DRILLING COMPANY: BORE AND CORE
RIG TYPE & NUMBER: MOBILE B-53
DRILLING METHOD: HOLLOW STEM AUGER
WEATHER: CLOUDY, 45 DEGREES
FIELD PARTY: L. FOSKEY
GEOLOGIST: J. FINKBEINER
DATE BEGUN: 11/28/95 DATE COMPLETED: 11/28/95

TOP OF CASING ELEVATION: -
TOTAL DEPTH: 20.0 FT
GROUND SURFACE ELEVATION: 310
SHEET: 1 OF: 1

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
0.0	2 4 4	Ss	S1			11"		SILTY CLAY: Red-brown silty clay with some pink and white siltier layers; fill; dry.
3.5	5 6 6	Ss	S2	D		14"		CLAYEY SILT: Light reddish tan clayey silt; possible fill; dry.
8.5	11 17 20	Ss	S3	D		13"		SILTY CLAY: Red-brown silty clay with quartz crystals; very cohesive; trace white mottling; dry.
13.5	6 8 9	Ss	S4	D		6"		SILT: Banded light pink and light greenish silt to clayey silt; greenish layers are micaceous; some quartz; relict granite structure; k-spar abundant; dry.
18.5	6 8 10	Ss	S5	D		8"		
20.0								Boring Terminated at 20 Feet.

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

LITHOLOGY | WELL INSTALLATION

FIELD BOREHOLE LOG

BOREHOLE NUMBER: B-4D

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, NO CORE
WEATHER: SUNNY, 30 DEGREES
FIELD PARTY: L. FOSKEY
GEOLOGIST: G. MILLS
DATE BEGUN: 12/20/95 DATE COMPLETED: 12/21/95

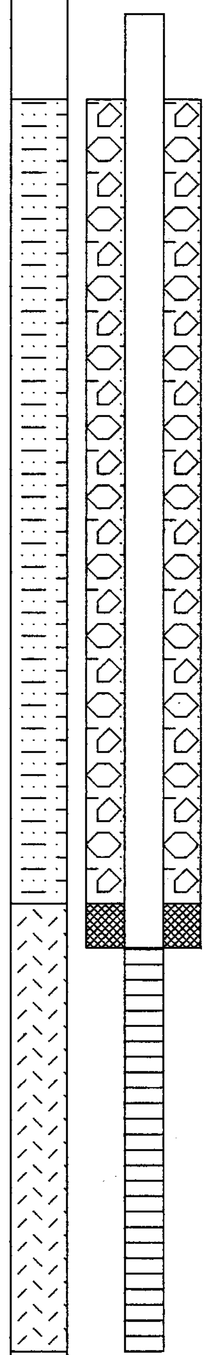
TOP OF CASING ELEVATION: 274.69
TOTAL DEPTH: 28 FT
GROUND SURFACE ELEVATION: 272.6
SHEET: 1 OF: 1

STATIC WATER LEVEL (BLS)		
WD=While Drilling AB=After Boring		
Depth(Ft)	2.47	1.27
Time	-	-
Date:	12-27-95	1-24-95

DEPTH	BLOW COUNTS	SAMPLING METHOD	SAMPLE NUMBER	MOISTURE	CONSISTANCY	SAMPLE RECOVERY	DRILL METHOD	LITHOLOGY DESCRIPTION	DEPTH
0.0 – 18.0								SANDY SILT: Probed to auger refusal without sampling and cored 10 feet; lithology should be the same as B-4A, drilled 10 feet south; took a U.D. sample from 1 to 3 feet.	0.0 – 18.0
18.0 – 28.0								GRANITE: Cored through granite for 10 feet. REC=84% RQD=60%	18.0 – 28.0
28.0								Boring Terminated at 28 feet.	28.0

Depth scale (both sides): 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, 19.0, 20.0, 21.0, 22.0, 23.0, 24.0, 25.0, 26.0, 27.0, 28.0, 29.0, 30.0

LITHOLOGY / WELL INSTALLATION



FIELD BOREHOLE LOG

BOREHOLE NUMBER: B-4A

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/MUD ROTARY/NQ CORE
WEATHER: SUNNY, 55 DEGREES
FIELD PARTY: L. FOSKEY
GEOLOGIST: G. MILLS
DATE BEGUN: 12/15/95 DATE COMPLETED: 12/15/95

TOP OF CASING ELEVATION: -
TOTAL DEPTH: 24.0 FT
GROUND SURFACE ELEVATION: 273
SHEET: 1 OF: 1

STATIC WATER LEVEL (BLS)		
WD=While Drilling AB=After Boring		
Depth(Ft)	4.3	-
Time	WD	-
Date:	12/15/95	-

DEPTH	BLOW COUNTS	SAMPLING METHOD	SAMPLE NUMBER	MOISTURE	CONSISTANCY	SAMPLE RECOVERY	DRILL METHOD	LITHOLOGY DESCRIPTION
1.0		St						SANDY CLAY: Brown; quite sandy; micaceous coarse quartz sand; shelby tube samples collected at 1.0' and 5.0'; rock ledge at 8.5' to 9.0'.
3.0–4.0	3 6 5	Ss	S1	D		12"		
5.0		St						
7.0–8.0	15 17 19	Ss	S2	W		14"		
8.5								SANDY SILT: Sandy silt to silty sand; even mix of sand and silt; brown orange in color; abundant mica; felsic quartz and gravel; drilled with tri-cone mud rotary.
13.0–14.0	5 5 7	Ss	S3	W		14"		
16.0								SAND: Partially weathered rock; coarse sand; very iron stained; orange with white, gray and tan; abundant mica;
18.0–19.0	35 35 21	Ss				12"		
23.0	50/0.5	Ss	S4			0"		tri-cone refusal at 24.0 feet.
24.0								GRANITE: NQ core run through granite; 3 ft run with 2 ft recovery; casing lost its seal; abandoned hole; offset 5 feet to redrill.
27.0								Boring Terminated at 27 feet.

DEPTH scale: 2.0, 1.0, 0.0, 1.0 … 30.0

FIELD BOREHOLE LOG

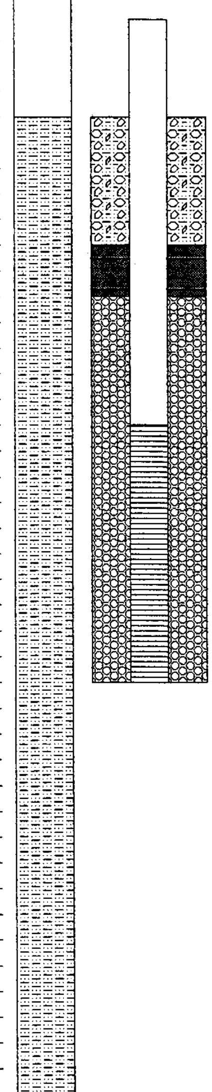
BOREHOLE NUMBER: B-4S

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, NO CORE
WEATHER: SUNNY, 30 DEGREES
FIELD PARTY: L. FOSKEY
GEOLOGIST: G. MILLS
DATE BEGUN: 12/19/95 DATE COMPLETED: 12/20/95

TOP OF CASING ELEVATION: 277.16
TOTAL DEPTH: 19 FT
GROUND SURFACE ELEVATION: 272.18
SHEET: 1 OF: 1

STATIC WATER LEVEL (BLS)		
WD=While Drilling AB=After Boring		
Depth(ft)	2.47	1.27
Time	-	-
Date:	12-27-95	1-24-95

DEPTH	BLOW COUNTS	SAMPLING METHOD	SAMPLE NUMBER	MOISTURE	CONSISTANCY	SAMPLE RECOVERY	DRILL METHOD	LITHOLOGY DESCRIPTION	DEPTH	LITHOLOGY	WELL INSTALLATION
0.0								SANDY SILT: Probed to auger refusal without sampling; lithology should be same as B-4A, drilled 5 feet south; when we attempted to core this hole, the core bit came off and was lost in the hole. The piezometer was installed in the open bore hole on 12/27/95. The hole had caved at 11 feet.	0.0		
19.0								Auger Refusal at 19 feet.	19.0		



FIELD BOREHOLE LOG

BOREHOLE NUMBER: B-5

PROJECT NUMBER: HALIFAX-5
PROJECT NAME: HALIFAX COUNTY
LOCATION: HALIFAX, NORTH CAROLINA
DRILLING COMPANY: BORE AND CORE
RIG TYPE & NUMBER: MOBILE B-53
DRILLING METHOD: HOLLOW STEM AUGER
WEATHER: CLOUDY, 45 DEGREES
FIELD PARTY: L. FOSKEY
GEOLOGIST: G. MILLS
DATE BEGUN: 11/30/95 DATE COMPLETED: 11/30/95

TOP OF CASING ELEVATION: -
TOTAL DEPTH: 17.5 FT
GROUND SURFACE ELEVATION: 277.9
SHEET: 1 OF: 1

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	DEPTH	LITHOLOGY	WELL INSTALLATION
1.0									1.0		
0.0	5 5 7	Ss	S1			12"		SANDY SILTY CLAY: ML; Brown to orange-brown; some organics; some mica; dry; took a jar sample from 0 too 1.5 feet.	0.0		
1.0									1.0		
2.0									2.0		
3.0	7 11 15	Ss	S2	D		10"		SANDY SILT: Brown-orange sandy silt; relict granite structure; abundant mica; some coarse quartz.	3.0		
4.0									4.0		
5.0									5.0		
6.0									6.0		
7.0									7.0		
8.0	7 8 8	Ss	S3	D		10"		SILTY SAND: Relict granite; abundant k-spar and mica; some Mn staining; some quartz; dry.	8.0		
9.0									9.0		
10.0									10.0		
11.0									11.0		
12.0									12.0		
13.0	25 29 13	Ss	S4	D		8"			13.0		
14.0									14.0		
15.0									15.0		
16.0									16.0		
17.0								Auger Refusal at 17.5 feet.	17.0		
18.0									18.0		
19.0									19.0		
20.0									20.0		

FIELD BOREHOLE LOG

BOREHOLE NUMBER: B-6

PROJECT NUMBER: HALIFAX-5
PROJECT NAME: HALIFAX COUNTY
LOCATION: HALIFAX, NORTH CAROLINA
DRILLING COMPANY: BORE AND CORE
RIG TYPE & NUMBER: MOBILE B-53
DRILLING METHOD: HOLLOW STEM AUGER
WEATHER: CLOUDY, 45 DEGREES
FIELD PARTY: L. FOSKEY
GEOLOGIST: J. FINKBEINER
DATE BEGUN: 11/28/95 DATE COMPLETED: 11/28/95

TOP OF CASING ELEVATION: -
TOTAL DEPTH: 20.0 FT
GROUND SURFACE ELEVATION: 290.1
SHEET: 1 OF: 1

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	DEPTH	LITHOLOGY	WELL INSTALLATION
0.0	5 7 11	Ss	S1			11"		CLAYEY SAND: brown clayey fine sand; abundant quartz crystals in bottom of sample; dry.	0.0		
3.0	5 8 9	Ss	S2	D		15"		CLAYEY SILTY SAND: Brown clayey silty fine sand; abundant quartz in 1/2" thick layers; dry.	3.0		
8.0	3 4 4	Ss	S3	D		6"		SILTY CLAY: Maroon and yellow brown mottled silty clay; trace sand; some quartz; dry.	8.0		
13.0	2 4 5	Ss	S4	M		12"		SILTY CLAY: Mottled red brown to pinkish white silty clay some quartz and mica; moist.	13.0		
18.0	4 6 10	Ss	S5	M		14"		CLAYEY SANDY SILT: Pinkish green; green mica layers; moist.	18.0		
20.0								Boring Terminated at 20'.	20.0		

Depth scale: 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

FIELD BOREHOLE LOG

BOREHOLE NUMBER: B-7

PROJECT NUMBER: HALIFAX-5
PROJECT NAME: HALIFAX COUNTY
LOCATION: HALIFAX, NORTH CAROLINA
DRILLING COMPANY: BORE AND CORE
RIG TYPE & NUMBER: MOBILE B-53
DRILLING METHOD: HOLLOW STEM AUGER
WEATHER: CLOUDY, 45 DEGREES
FIELD PARTY: L. FOSKEY
GEOLOGIST: G. MILLS
DATE BEGUN: 11/30/95 DATE COMPLETED: 11/30/95

TOP OF CASING ELEVATION: -
TOTAL DEPTH: 20.0 FT
GROUND SURFACE ELEVATION: 268
SHEET: 1 OF: 1

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	DEPTH	LITHOLOGY	WELL INSTALLATION
1.0									1.0		
0.0	5 9 11	Ss	S1			14"		CLAYEY SANDY SILT: Orange brown clayey sandy silt with abundant feldspar, mica, and some quartz gravel; took a jar sample from 0 to 1.5 feet Lab USC: ML	0.0		
3.0	7 11 14	Ss	S2	D		18"		SANDY SILT: Relict Granite; orange-white-pink slightly plastic fine sandy silt; feldspar, k-feldspar, mica, fine quartz gravel, iron stains; took a jar sample from 3.5 to 5 feet. Lab USC: ML	3.0		
8.0	6 10 12	Ss	S3	D		10"		a plane of iron stains runs at a 45 degree angle through sample at 9 feet;	8.0		
13.0	6 8 9	Ss	S4	M		15"		moist at 14 feet;	13.0		
18.0	7 8 11	Ss	S5	M		12"		quite damp at 20 feet.	18.0		
20.0								Boring Terminated at 20 feet.	20.0		

Depth scale: 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

FIELD BOREHOLE LOG

BOREHOLE NUMBER: B-8

PROJECT NUMBER: HALIFAX-5
PROJECT NAME: HALIFAX COUNTY
LOCATION: HALIFAX, NORTH CAROLINA
DRILLING COMPANY: BORE AND CORE
RIG TYPE & NUMBER: MOBILE B-53
DRILLING METHOD: HOLLOW STEM AUGER
WEATHER: CLOUDY, 45 DEGREES
FIELD PARTY: L. FOSKEY
GEOLOGIST: J. FINKBEINER
DATE BEGUN: 11/28/95 DATE COMPLETED: 11/28/95

TOP OF CASING ELEVATION: -
TOTAL DEPTH: 15.0 FT
GROUND SURFACE ELEVATION: 287.6
SHEET: 1 OF: 1

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	DEPTH	LITHOLOGY	WELL INSTALLATION
0.0	4 4 4	Ss	S1			11"		SILTY CLAY: Red brown silty clay; trace quartz; dry.	0.0		
3.0	4 6 12	Ss	S2	D		12"		SANDY CLAYEY SILT: Red brown soft fine sandy clayey silt; dry; Shelby Tube taken from 5' to 7'.	3.0		
8.0	6 6 5	Ss	S3	D		9"		SANDY SILT: Yellow brown fine sandy silt with trace clay; quartz and mica in bottom 3"; dry.	8.0		
12.0	5 8 12	Ss	S4	D		10"		SANDY SILT: Light pink k-spar rich fine sandy silt; abundant quartz; some white feldspar layers; dry.	12.0		
15.0								Boring Terminated at 15 feet.	15.0		

Depth scale: 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

FIELD BOREHOLE LOG

BOREHOLE NUMBER: B-9

PROJECT NUMBER: HALIFAX-5
PROJECT NAME: HALIFAX COUNTY
LOCATION: HALIFAX, NORTH CAROLINA
DRILLING COMPANY: BORE AND CORE
RIG TYPE & NUMBER: MOBILE B-53
DRILLING METHOD: HOLLOW STEM AUGER
WEATHER: CLOUDY, 45 DEGREES
FIELD PARTY: L. FOSKEY
GEOLOGIST: J. FINKBEINER
DATE BEGUN: 11/28/95 DATE COMPLETED: 11/28/95

TOP OF CASING ELEVATION: -
TOTAL DEPTH: 15.0 FT
GROUND SURFACE ELEVATION: 269.2
SHEET: 1 OF: 1

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	DEPTH	LITHOLOGY	WELL INSTALLATION
0.0	7 7 6	Ss	S1			6"		SILT: Dark brown silty organic soil; dry.	0.0		
3.0	6 8 12	Ss	S2	D		15"		CLAYEY SILT: Dark reddish brown clayey silt; quartz crystals throughout; uniform; dry.	3.0		
8.0	13 18 22	Ss	S3	D		14"		SANDY CLAYEY SILT: Reddish brown with white layers (1/8" to 1/4") throughout; trace mica; some quartz; dry.	8.0		
12.0								SANDY SILTY CLAY: Reddish brown with large quartz grains; some k-spar; trace mica.	12.0		
13.0	8 15 17	Ss	S4	D		6"			13.0		
15.0								Boring Terminated at 15 Ft.	15.0		

Depth scale: 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

FIELD BOREHOLE LOG

BOREHOLE NUMBER: B-10

PROJECT NUMBER: HALIFAX-5
PROJECT NAME: HALIFAX COUNTY
LOCATION: HALIFAX, NORTH CAROLINA
DRILLING COMPANY: BORE AND CORE
RIG TYPE & NUMBER: MOBILE B-53
DRILLING METHOD: HOLLOW STEM AUGER
WEATHER: CLOUDY, 45 DEGREES
FIELD PARTY: L. FOSKEY
GEOLOGIST: J. FINKBEINER
DATE BEGUN: 11/28/95 DATE COMPLETED: 11/28/95

TOP OF CASING ELEVATION: -
TOTAL DEPTH: 20.0 FT
GROUND SURFACE ELEVATION: 283.2
SHEET: 1 OF: 1

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	DEPTH	LITHOLOGY	WELL INSTALLATION
0.0	7 9 10	Ss	S1			14"		CLAYEY SAND: Reddish brown clayey sand to sandy clay; some quartz; trace mica; dry.	0.0		
3.0	5 7 7	Ss	S2	D		13"		CLAYEY SILT: Light pink k-spar rich clayey silt; micaceous veins; some Mn staining; some quartz; dry.	3.0		
8.0	7 9 10	Ss	S3	D		11"		CLAYEY SAND: Light pink k-spar rich clayey sand saprolite; abundant quartz crystals; some greenish micaceous veins; slightly moist at 18.5'; L: -20.0 -30.0 -20.0 Boring Terminated at 20 feet.	8.0		
13.0	6 9 11	Ss	S4	D		13"			13.0		
18.0	7 9 10	Ss	S5	M		11"			18.0		

FIELD BOREHOLE LOG

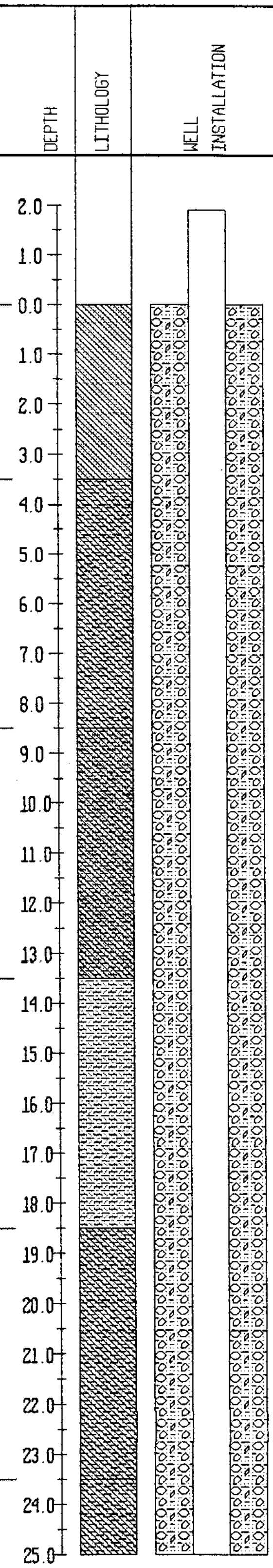
BOREHOLE NUMBER: G-1

PROJECT NUMBER: HALIFAX-5
PROJECT NAME: HALIFAX COUNTY
LOCATION: HALIFAX, NORTH CAROLINA
DRILLING COMPANY: BORE AND CORE
RIG TYPE & NUMBER: MOBILE B-53
DRILLING METHOD: HOLLOW STEM AUGER
WEATHER: CLOUDY, 45 DEGREES
FIELD PARTY: L. FOSKEY
GEOLOGIST: J. FINKBEINER
DATE BEGUN: 11/29/95 DATE COMPLETED: 11/30/95

TOP OF CASING ELEVATION: 309.93
TOTAL DEPTH: 40.0 FT
GROUND SURFACE ELEVATION: 304.7
SHEET: 1 OF: 2

STATIC WATER LEVEL (BLS)		
WD=While Drilling AB=After Boring		
Depth(ft)	19.06	19.47
Time	5 pm	9 am
Date	11/30/95	12/01/95

DEPTH	BLOW COUNTS	SAMPLING METHOD	SAMPLE NUMBER	MOISTURE	CONSISTANCY	SAMPLE RECOVERY	DRILL METHOD	LITHOLOGY DESCRIPTION
0.0	2 1 3	Ss	S1			9"		SANDY CLAY: Brown sandy clay fill; organics.
3.0	6 11 14	Ss	S2	D		13"		SILTY CLAY: Reddish yellowish brown silty clay with quartz; fill.
8.0	4 5 7	Ss	S3	D		14"		CLAYEY SILTY SAND: Yellow brown clayey silty fine sand; dry.
13.0	4 6 6	Ss	S4	D		13"		SILTY SAND: Yellow brown silty fine sand; very uniform; dry.
18.0	3 3 5	Ss	S5	M		8"		CLAYEY SILT: Moist yellow brown to tan clayey silt; Mn stained.
23.0	2 4 4	Ss	S6	M		10"		CLAYEY SILT: Gray and brown banded clayey silt; moist.



FIELD BOREHOLE LOG

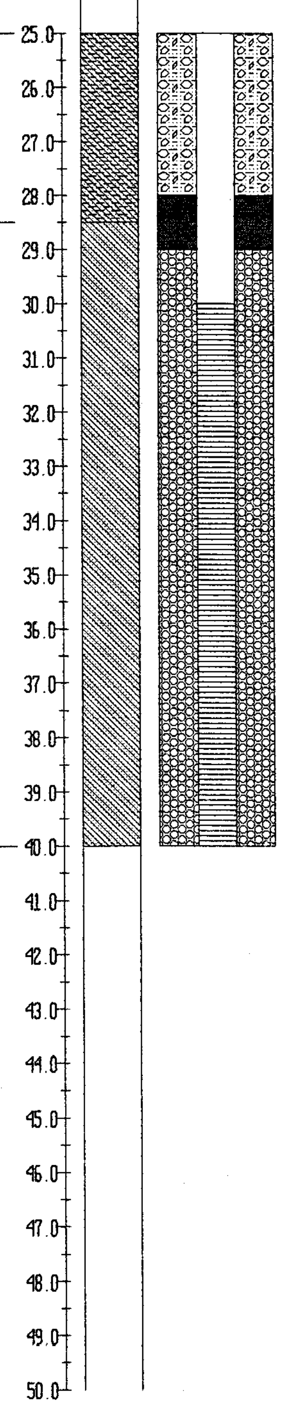
BOREHOLE NUMBER: G-1

PROJECT NUMBER: HALIFAX-5
PROJECT NAME: HALIFAX COUNTY
LOCATION: HALIFAX, NORTH CAROLINA
DRILLING COMPANY: BORE AND CORE
RIG TYPE & NUMBER: MOBILE B-53
DRILLING METHOD: HOLLOW STEM AUGER
WEATHER: CLOUDY, 45 DEGREES
FIELD PARTY: L. FOSKEY
GEOLOGIST: J. FINKBEINER
DATE BEGUN: 11/29/95 DATE COMPLETED: 11/30/95

TOP OF CASING ELEVATION: 309.93
TOTAL DEPTH: 40.0 FT
GROUND SURFACE ELEVATION: 304.7
SHEET: 2 OF: 2

STATIC WATER LEVEL (BLS)		
WD-While Drilling AB-After Boring		
Depth(ft)	19.06	19.47
Time	5 pm	9 am
Date	11/30/95	12/01/95

DEPTH	BLOW COUNTS	SAMPLING METHOD	SAMPLE NUMBER	MOISTURE	CONSISTANCY	SAMPLE RECOVERY	DRILL METHOD	LITHOLOGY DESCRIPTION
25.0								CLAYEY SILT: Gray and brown banded clayey silt; moist.
28.0	8 13 15	Ss	S7	M		14"		CLAYEY SAND: relict feldspathic granite with abundant k-spar crystals; some iron staining; micaceous; moist.
33.0	17 20 30	Ss	S8	M		8"		
38.0	31 50/4	Ss	S9	M		11"		
40.0								Boring Terminated at 40 feet.



FIELD BOREHOLE LOG

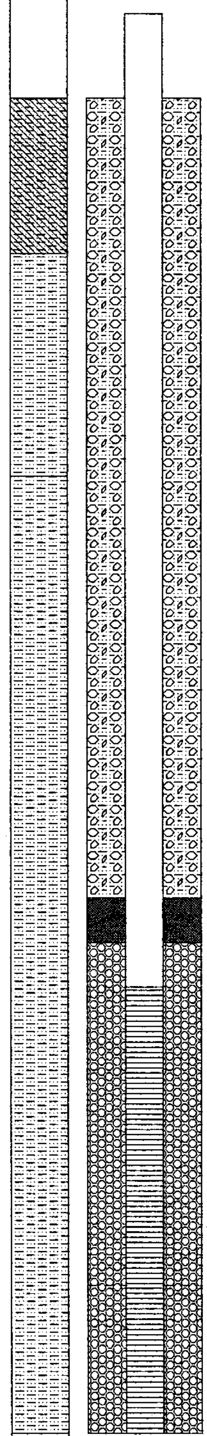
BOREHOLE NUMBER: G-2

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: SUNNY, 60 DEGREES
FIELD PARTY: L. FOSKEY
GEOLOGIST: G. MILLS
DATE BEGUN: 12/7/95
DATE COMPLETED: 12/7/95

TOP OF CASING ELEVATION: 295.21
TOTAL DEPTH: 30.0 FT
GROUND SURFACE ELEVATION: 292.4
SHEET: 1 OF: 1

STATIC WATER LEVEL (BLS)		
WD=While Drilling AB=After Boring		
Depth (Ft)	19.40	20.59
Time	2 pm	3:40 pm
Date:	12/07/95	12/08/95

DEPTH	BLOW COUNTS	SAMPLING METHOD	SAMPLE NUMBER	MOISTURE	CONSISTANCY	SAMPLE RECOVERY	DRILL METHOD	LITHOLOGY DESCRIPTION
0.0	2 5 5	Ss	S1			18"		SANDY SILTY CLAY: Red-yellow-orange sandy silty clay; took a U.D. sample from 1.5 to 3.5 feet.
3.0	5 7 10	Ss	S2	D		18"		SANDY SILT: Yellow orange.
8.0	6 7 10	Ss	S3	D		8"		SANDY SILT: Relict granite; pink, white, black and tan; wet at 23.5'.
13.0	7 11 13	Ss	S4	D		10"		
18.0	6 8 10	Ss	S5	D		10"		
23.0	8 12 20	Ss	S6	W		14"		
28.0	7 11 15	Ss	S7	W				
30.0								Boring Terminated at 30 feet.



FIELD BOREHOLE LOG

BOREHOLE NUMBER: G-3D

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, ROLLER CONE
WEATHER: SOME CLOUDS, 34 DEGREES
FIELD PARTY: L. FOSKEY
GEOLOGIST: G. MILLS
DATE BEGUN: 12/12/95 DATE COMPLETED: 12/12/95

TOP OF CASING ELEVATION: 295.0
TOTAL DEPTH: 53.5 FT
GROUND SURFACE ELEVATION: 293.4
SHEET: 1 OF: 2

STATIC WATER LEVEL (BLS)		
WD=While Drilling AB=After Boring		
Depth (Ft)	24.21	23.72
Time	3:00 pm	5:00 pm
Date:	12-12-95	12-13-95

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, 19.0, 20.0, 21.0, 22.0, 23.0, 24.0, 25.0, 26.0, 27.0, 28.0, 29.0, 30.0

BLOW COUNTS	SAMPLING METHOD	SAMPLE NUMBER	MOISTURE	CONSISTANCY	SAMPLE RECOVERY	DRILL METHOD
7 9 10	Ss	S1			18"	
12	Ss	S2	D		14"	
7 9 9	Ss	S3	M		12"	
11 12 15	Ss	S4	D		14"	
8 13 13	Ss	S5	D		15"	
7 7 10	Ss	S6	W		12"	
4 6 8	Ss	S7	W		12"	

LITHOLOGY DESCRIPTION

CLAYEY SANDY SILT: ML; Tan orange brown micaceous silt with quartz sand. Spoon hit a rock at 4 feet.

WEATHERED GRANITE: Hard rock ledge, light gray cuttings.

SILTY SAND: SM; Relict granite; pink, tan, orange and gray; K-feldspar and quartz sand; mica; Mn and Iron stains wet at 23.5'.

SAND: SW; Relict granite; dry powdery micaceous sand with some coarse quartz sand, becoming coarser with depth; pink, tan, gray-green; horizontal Mn stain and Iron stain at 19 feet.

SAND: SW; Relict granite, wet, coarse and fine sand; but sand at 23 feet is not as coarse as sand at 18 feet;

LITHOLOGY | WELL INSTALLATION

FIELD BOREHOLE LOG

BOREHOLE NUMBER: G-3D

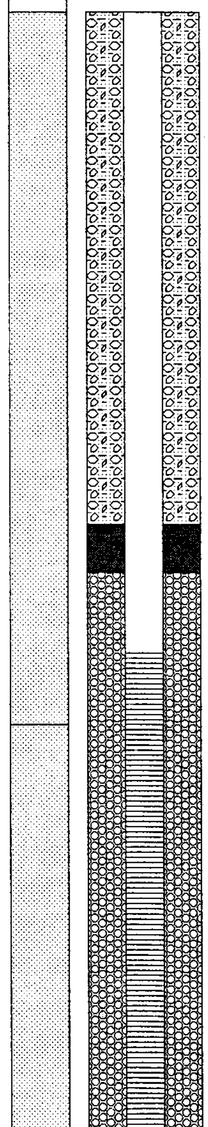
PROJECT NUMBER: HALIFAX-5
PROJECT NAME: HALIFAX COUNTY
LOCATION: HALIFAX, NORTH CAROLINA
DRILLING COMPANY: BORE AND CORE
RIG TYPE & NUMBER: CME 450
DRILLING METHOD: HOLLOW STEM AUGER, ROLLER CONE
WEATHER: SOME CLOUDS, 34 DEGREES
FIELD PARTY: L. FOSKEY
GEOLOGIST: G. MILLS
DATE BEGUN: 12/12/95 DATE COMPLETED: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

TOP OF CASING ELEVATION: 295.0
TOTAL DEPTH: 53.5 FT
GROUND SURFACE ELEVATION: 293.4
SHEET: 2 OF: 2

STATIC WATER LEVEL (BLS)		
WD=While Drilling AB=After Boring		
Depth(Ft)	24.21	23.72
Time	3:00 pm	5:00 pm
Date	12-12-95	12-13-95

DEPTH	BLOW COUNTS	SAMPLING METHOD	SAMPLE NUMBER	MOISTURE	CONSISTANCY	SAMPLE RECOVERY	DRILL METHOD	LITHOLOGY DESCRIPTION
31.0								at 39 feet, some small gravel sized pieces of quartz;
33.0	9 12 16	Ss	S8	W		10"		
37.0								at 44 feet, recovered an oblong piece of K-felsic gravel, 1.5" by 0.5".
38.0	9 11 17	Ss	S9	W		10"		
43.0	9 13 18	Ss	S10	W		11"		
45.0								SAND: SW, relict granite, fine to coarse sand; gravelly sand; at 45 feet switched to roller cone bit with the intention of probing to rock and then coring. At 53.5 feet, while still in weathered granite, the hole was abandoned.
48.0	18 21 26	Ss	S11	W		9"		
54.0								Boring Terminated at 53.5 feet.

DEPTH / LITHOLOGY / WELL INSTALLATION



FIELD BOREHOLE LOG

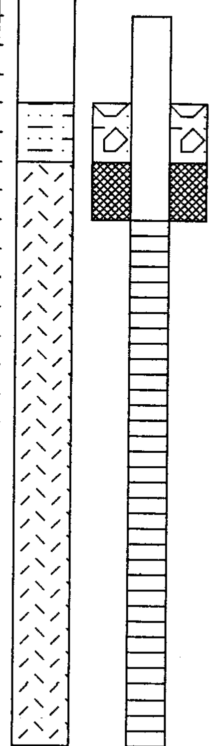
BOREHOLE NUMBER: G-3S

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, NO CORE
WEATHER: SOME CLOUDS, 34 DEGREES
FIELD PARTY: L. FOSKEY
GEOLOGIST: G. MILLS
DATE BEGUN: 12/26/95 DATE COMPLETED: 12/27/95

TOP OF CASING ELEVATION: 296.1
TOTAL DEPTH: 11.0 FT
GROUND SURFACE ELEVATION: 293.5
SHEET: 1 OF: 1

STATIC WATER LEVEL (BLS)		
WD=While Drilling AB=After Boring		
Depth(Ft)	dry	dry
Time	-	-
Date:	12/27/95	01/24/96

DEPTH	BLOW COUNTS	SAMPLING METHOD	SAMPLE NUMBER	MOISTURE	CONSISTANCY	SAMPLE RECOVERY	DRILL METHOD	LITHOLOGY DESCRIPTION	DEPTH	LITHOLOGY	WELL INSTALLATION
0.0–1.0								SANDY SILT: Auger Refusal at 1 foot.	0.0–1.0		
1.0–11.0								GRANITE: Cored 10 of granite; gray. REC=87% RQD=86%	1.0–11.0		
11.0								Boring Terminated at 11 feet.	11.0		



FIELD BOREHOLE LOG

BOREHOLE NUMBER: G-3A

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, ROLLER CONE
WEATHER: SOME CLOUDS, 34 DEGREES
FIELD PARTY: L. FOSKEY
GEOLOGIST: G. MILLS
DATE BEGUN: 12/12/95 DATE COMPLETED: 12/12/95

TOP OF CASING ELEVATION: -
TOTAL DEPTH: 25.0 FT
GROUND SURFACE ELEVATION: 293.4
SHEET: 1 OF: 1

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	DEPTH
0.0–1.5								CLAYEY SANDY SILT: not sampled.	0.0–1.5
1.5–3.5								WEATHERED GRANITE: Hard rock ledge, light gray cuttings.	1.5–3.5
3.5–13.5								SILTY SAND: brown tan silty sandy cuttings; dry; not sampled.	3.5–13.5
13.5–15.0								WEATHERED GRANITE: Hard rock ledge, light gray cuttings.	13.5–15.0
15.0–25.0								SAND: SW; Relict granite, coarse and fine sand; micaceous; water in open hole at 22 feet.	15.0–25.0
23.0	12 17 18	Ss	S1	W		12"			
25.0								Boring Terminated at 25 feet.	25.0

LITHOLOGY | WELL INSTALLATION

FIELD BOREHOLE LOG

BOREHOLE NUMBER: G-3b

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, ROLLER CONE
WEATHER: SOME CLOUDS, 39 DEGREES
FIELD PARTY: L. FOSKEY
GEOLOGIST: G. MILLS
DATE BEGUN: 12/12/95 DATE COMPLETED: 12/12/95

TOP OF CASING ELEVATION: -
TOTAL DEPTH: 25 FT
GROUND SURFACE ELEVATION: 293.5
SHEET: 1 OF: 1

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	DEPTH	LITHOLOGY	WELL INSTALLATION
0.0–4.0								CLAYEY SANDY SILT: not sampled.	0.0–4.0		
4.0–6.0								WEATHERED GRANITE: Hard rock ledge, light gray cuttings.	4.0–6.0		
6.0–14.0								SILTY SAND: brown tan silty sandy cuttings; dry; not sampled.	6.0–14.0		
14.0–16.0								WEATHERED GRANITE: Hard rock ledge, light gray cuttings.	14.0–16.0		
16.0–25.0								SAND: SW; Relict granite, coarse and fine sand; micaceous; K-feldspar crystals, felsic powder; quartz sand; Mn nodules; water in open hole at 23 feet.	16.0–25.0		
23.0–25.0	11 13 19 -	Ss	S1	W		12"					
25.0								Boring Terminated at 25 feet.	25.0		

Depth scale: 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, 19.0, 20.0, 21.0, 22.0, 23.0, 24.0, 25.0, 26.0, 27.0, 28.0, 29.0, 30.0

FIELD BOREHOLE LOG

BOREHOLE NUMBER:
G-3c

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, NO CORE
WEATHER: SOME CLOUDS, 34 DEGREES
FIELD PARTY: L. FOSKEY
GEOLOGIST: G. MILLS
DATE BEGUN: 12/26/95 DATE COMPLETED: 12/27/95

TOP OF CASING ELEVATION: -
TOTAL DEPTH: 3.5
GROUND SURFACE ELEVATION: 294.1
SHEET: 1 OF: 1

STATIC WATER LEVEL (BLS)		
WD=While Drilling AB=After Boring		
Depth(ft)	dry	dry
Time	-	-
Date:	12/27/95	01/24/96

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								Granite outcrop 6 feet from boring.	1.0		
0.0									0.0		
1.0									1.0		
2.0									2.0		
3.0								Hard drilling.	3.0		
4.0								Auger refusal at 3.5 feet.	4.0		
5.0									5.0		
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		

FIELD BOREHOLE LOG

BOREHOLE NUMBER: G-4

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: SUNNY, 60 DEGREES
FIELD PARTY: L. FOSKEY
GEOLOGIST: G. MILLS
DATE BEGUN: 12/7/95 DATE COMPLETED: 12/7/95

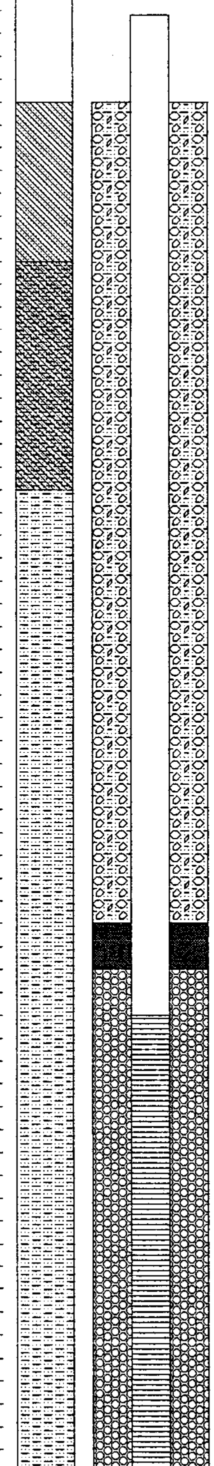
TOP OF CASING ELEVATION: 286.04
TOTAL DEPTH: 30.0 FT
GROUND SURFACE ELEVATION: 283.7
SHEET: 1 OF: 1

STATIC WATER LEVEL (BLS)		
WD=While Drilling AB=After Boring		
Depth (Ft)	20.74	21.88
Time	4 pm	4 pm
Date	12/07/95	12/08/95

DEPTH	BLOW COUNTS	SAMPLING METHOD	SAMPLE NUMBER	MOISTURE	CONSISTANCY	SAMPLE RECOVERY	DRILL METHOD	LITHOLOGY DESCRIPTION
2.0								
1.0								
0.0	5 8 10	Ss	S1			18"		SANDY CLAY: Brown orange sandy clay; dry.
3.0		Ss	S2	D				SANDY CLAYEY SILT: brown with white, orange, and tan; very felsic; some quartz sand; micaceous; dry.
8.0	5 6 9	Ss	S3	D		10"		SANDY SILT: Relict granite; pink, with veins of mica; vein of quartz at 13.5 feet; moist at 13.5 feet; k-spar is abundant below 18.5 feet, in layers running at angles of 25 to 45 degrees; wet at 23.5 feet.
13.0	7 11 12	Ss	S4	M		6"		
18.0	9 10 12	Ss	S5	M		16"		
23.0	6 9 10	Ss	S6	W		14"		
28.0	9 13 15	Ss	S7	W		14"		
30.0								

DEPTH scale: 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, 19.0, 20.0, 21.0, 22.0, 23.0, 24.0, 25.0, 26.0, 27.0, 28.0, 29.0, 30.0

LITHOLOGY / WELL INSTALLATION



FIELD BOREHOLE LOG

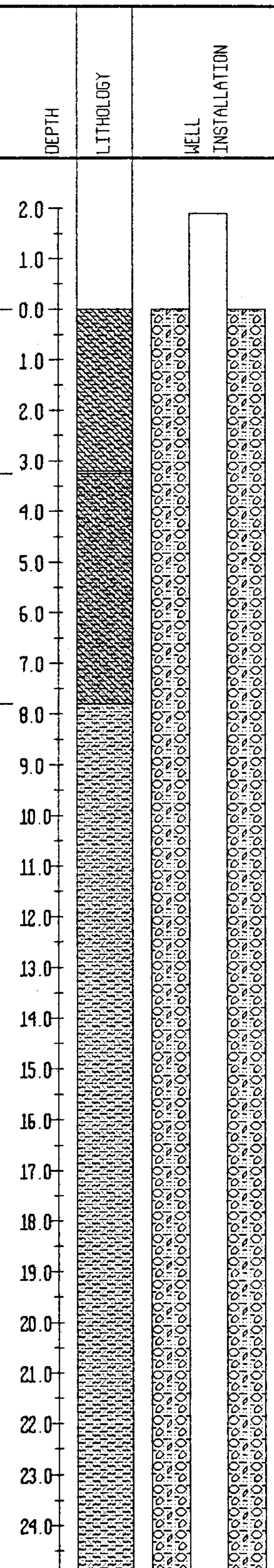
BOREHOLE NUMBER: G-5D

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, NO CORE
WEATHER: CLOUDY, 42 DEGREES
FIELD PARTY: L. FOSKEY
GEOLOGIST: G. MILLS
DATE BEGUN: 12/13/95 DATE COMPLETED: 12/13/95

TOP OF CASING ELEVATION: 286.26
TOTAL DEPTH: 46.2 FT
GROUND SURFACE ELEVATION: 283.7
SHEET: 1 OF: 2

STATIC WATER LEVEL (BLS)		
WD=While Drilling AB=After Boring		
Depth (ft)	28.82	28.80
Time	5:30 pm	3:00 pm
Date	12-13-95	12-14-95

DEPTH	BLOW COUNTS	SAMPLING METHOD	SAMPLE NUMBER	MOISTURE	CONSISTANCY	SAMPLE RECOVERY	DRILL METHOD	LITHOLOGY DESCRIPTION
0.0	5 9 15	Ss	S1			18"		SILTY CLAY: Red-orange-brown silty clay, with mica; took a bulk sample from 1 to 2 feet; dry. Lab USC: MH.
3.0		Ss	S2	D				SANDY CLAYEY SILT: Orange-white micaceous sandy clayey silt; mica, feldspar, some quartz; dry.
8.0	6 8 9	Ss	S3	M		12"		SILT with SAND: Relict Granite; pink, white, tan micaceous silt with sand; quartz, feldspar; damp;
13.0	6 8 11	Ss	S4	M		8"		
18.0	8 13 16	Ss	S5	M		12"		coarse quartz sand at 19', weathered iron stains, and four 1/4"-wide Mn stains at 45 degree angle between 19.5 and 20 feet.
23.0	11 18 20	Ss	S6	M		12"		



FIELD BOREHOLE LOG

BOREHOLE NUMBER: G-5D

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, NO CORE
WEATHER: CLOUDY, 42 DEGREES
FIELD PARTY: L. FOSKEY
GEOLOGIST: G. MILLS
DATE BEGUN: 12/13/95 DATE COMPLETED: 12/13/95

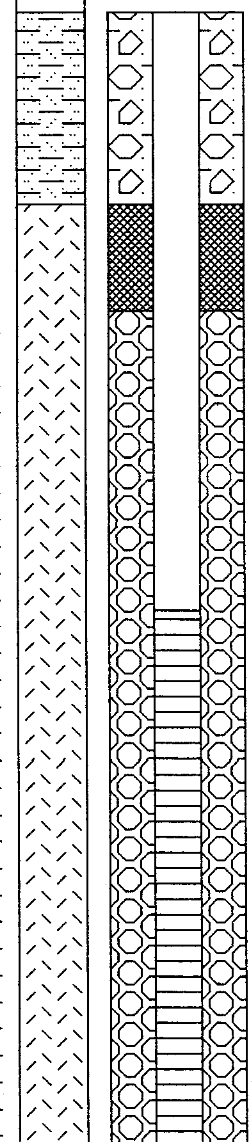
TOP OF CASING ELEVATION: 286.26
TOTAL DEPTH: 46.2 FT
GROUND SURFACE ELEVATION: 283.7
SHEET: 2 OF: 2

STATIC WATER LEVEL (BLS)		
WD=While Drilling AB=After Boring		
Depth(Ft)	28.82	28.80
Time	5:30 pm	3:00 pm
Date:	12-13-95	12-14-95

DEPTH	BLOW COUNTS	SAMPLING METHOD	SAMPLE NUMBER	MOISTURE	CONSISTANCY	SAMPLE RECOVERY	DRILL METHOD	LITHOLOGY DESCRIPTION
28.0	50/0	SS	S7	D		1"		
28.6–46.2								GRANITE: NO coring through pink, gray, white granite. Auger Refusal at 28.6 feet; Run 1 28.6 - 31.2' (2.6') REC=67% RQD=33% Run 2 31.2 - 36.2' (5.0') REC=37% RQD=24% Run 3 36.2 - 41.2' (5.0') REC=95% RQD=70% Run 4 41.2 - 46.2' (5.0') REC=100% RQD=99%
46.2								Boring terminated at 46.2 feet.

DEPTH: 25.0 26.0 27.0 28.0 29.0 30.0 31.0 32.0 33.0 34.0 35.0 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

LITHOLOGY / WELL INSTALLATION



FIELD BOREHOLE LOG

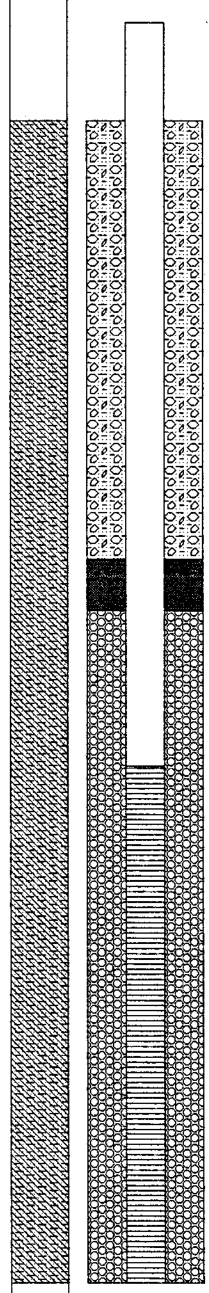
BOREHOLE NUMBER
G-5S

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: SUNNY, 30 DEGREES
FIELD PARTY: L. FOSKEY
GEOLOGIST: G. MILLS
DATE BEGUN: 12/21/95 DATE COMPLETED: 12/21/95

TOP OF CASING ELEVATION: 286.10
TOTAL DEPTH: 22.5 FT
GROUND SURFACE ELEVATION: 283.5
SHEET: 1 OF: 1

STATIC WATER LEVEL (BLS)		
WD=While Drilling AB=After Boring		
Depth(ft)	dry	dry
Time	-	-
Date:	12-27-95	1-24-95

DEPTH	BLOW COUNTS	SAMPLING METHOD	SAMPLE NUMBER	MOISTURE	CONSISTANCY	SAMPLE RECOVERY	DRILL METHOD	LITHOLOGY DESCRIPTION	DEPTH	LITHOLOGY	WELL INSTALLATION
0.0								CLAYEY SANDY SILT: Probed to auger refusal without sampling; lithology should be same as G-5, drilled 5 feet north.	0.0		
22.5								Auger Refusal at 22.5 feet.	22.5		



FIELD BOREHOLE LOG

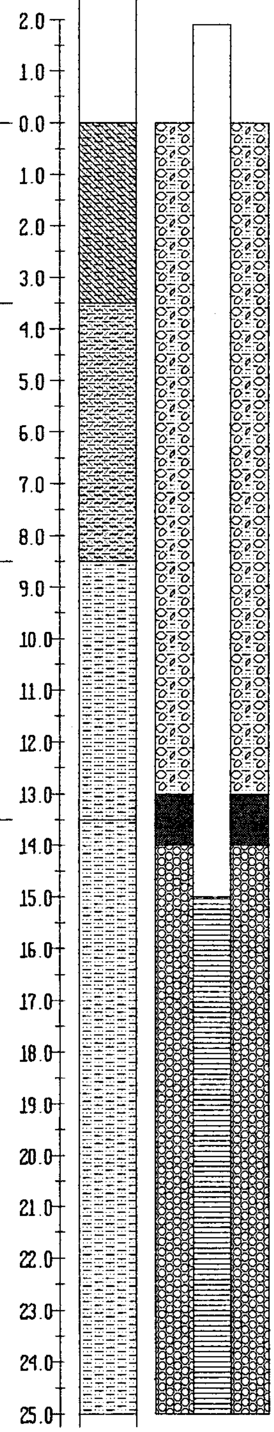
BOREHOLE NUMBER: G-6

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: SUNNY, 60 DEGREES
FIELD PARTY: L. FOSKEY
GEOLOGIST: G. MILLS
DATE BEGUN: 12/4/95 DATE COMPLETED: 12/4/95

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

STATIC WATER LEVEL (BLS)		
WD=While Drilling AB=After Boring		
Depth(ft)	23.42	23.23
Time	-	-
Date:	12/5/95	12/27/95

DEPTH	BLOW COUNTS	SAMPLING METHOD	SAMPLE NUMBER	MOISTURE	CONSISTANCY	SAMPLE RECOVERY	DRILL METHOD	LITHOLOGY DESCRIPTION
0.0–3.5	6 9 10	Ss	S1					SANDY SILTY CLAY: Orange brown sandy silty clay; dry; took a U.D. sample from 1 to 3 feet.
3.5–8.5	6 9 30	Ss	S2	D				SILTY SAND: Gray silty sand partially weathered rock at 5'.
8.5–13.5	32 16 8	Ss	S3	D				SANDY SILT: Relict granite; very hard partially weathered rock; moist.
13.5–25.0	5 7 7	Ss	S4	M				SANDY SILT: Relict granite; micaceous; moist to wet; some coarse quartz sand. boring terminated at 25'.'
	4 5 9	Ss	S5	M				
	11 10 10	Ss	S6	M				



FIELD BOREHOLE LOG

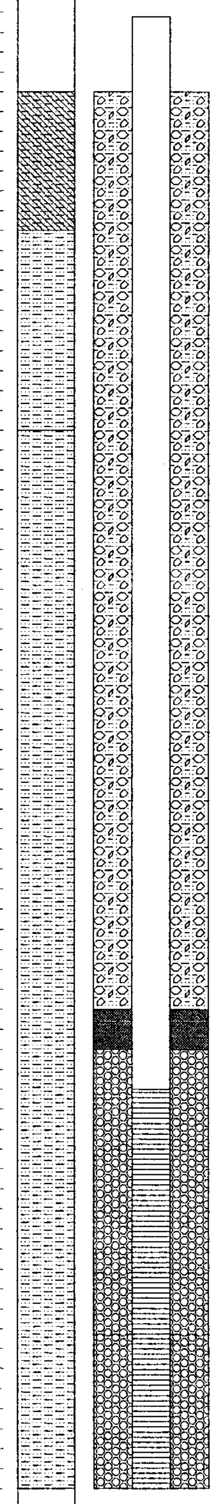
BOREHOLE NUMBER: G-7

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: SUNNY, 60 DEGREES
FIELD PARTY: L. FOSKEY
GEOLOGIST: G. MILLS
DATE BEGUN: 12/7/95 DATE COMPLETED: 12/7/95

TOP OF CASING ELEVATION: 293.9
TOTAL DEPTH: 35.0 FT
GROUND SURFACE ELEVATION: 291.8
SHEET: 1 OF: 1

STATIC WATER LEVEL (BLS)		
WD=While Drilling AB=After Boring		
Depth(ft)	20.10	20.59
Time	10:30 am	4 pm
Date:	12/07/95	12/08/95

DEPTH	BLOW COUNTS	SAMPLING METHOD	SAMPLE NUMBER	MOISTURE	CONSISTANCY	SAMPLE RECOVERY	DRILL METHOD	LITHOLOGY DESCRIPTION
0.0	3 4 6	Ss	S1					SANDY SILTY CLAY: Orange sandy silty clay; with feldspar and mica; dry; took a jar sample from 0 to 1.5 feet. Lab USC: MH
3.0	5 6 10	Ss	S2	D				SANDY SILT: Slightly clayey; dry; took a jar sample from 3.5 to 5 feet; took a bulk sample from 5 to 8 feet. Lab USC: ML.
8.0	5 8 10	Ss	S3	D				SANDY SILT: Relict granite; feldspar; micaceous; coarse quartz sand; k-spar; some iron staining; moist at 23.5'; wet at 28.5'.
13.0	5 8 12	Ss	S4	D				
18.0	7 11 13	Ss	S5	D				
23.0	4 7 11	Ss	S6	M				
28.0	7 10 18	Ss	S7	W				
33.0	9 15 17	Ss	S8	W				
35.0								Boring terminated at 35 feet.



FIELD BOREHOLE LOG

BOREHOLE NUMBER: G-8

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: J. FINKBEINER
DATE BEGUN: 11/27/95 DATE COMPLETED: 11/27/95

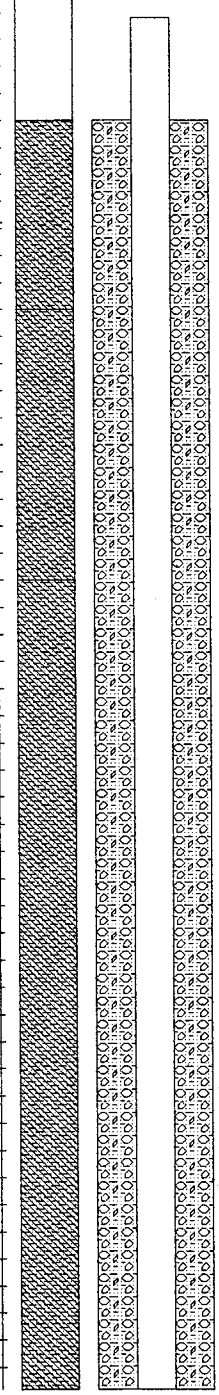
TOP OF CASING ELEVATION: 312.31
TOTAL DEPTH: 40.0 FT
GROUND SURFACE ELEVATION: 307.0
SHEET: 1 OF: 2

STATIC WATER LEVEL (BLS)		
WD=While Drilling AB=After Boring		
Depth(ft)	32.00	31.80
Time	7 AM	7 AM
Date	11/28/95	11/30/95

DEPTH	BLOW COUNTS	SAMPLING METHOD	SAMPLE NUMBER	MOISTURE	CONSISTANCY	SAMPLE RECOVERY	DRILL METHOD	LITHOLOGY DESCRIPTION
0.0	4 6 10	Ss	S1			14"		SILTY CLAY: Red-brown silty clay with thin white layers and some quartz crystals.
3.5	6 8 9	Ss	S2	D		13"		CLAYEY SILT: Red-brown clayey micaceous silt with relict granite texture and some feldspar layers.
8.5	7 11 12	Ss	S3	D		12"		CLAYEY SILT: Light pink to cream colored clayey silt; k-spar rich with relict granite texture and mica; some iron staining and quartz crystals.
13.5	6 10 12	Ss	S4	D		10"		
18.5	8 13 16	Ss	S5	D		9"		

DEPTH (scale): 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, 19.0, 20.0, 21.0, 22.0, 23.0

LITHOLOGY / WELL INSTALLATION



FIELD BOREHOLE LOG

BOREHOLE NUMBER: G-8

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: J. FINKBEINER
DATE BEGUN: 11/27/95 DATE COMPLETED: 11/27/95

TOP OF CASING ELEVATION: 312.31
TOTAL DEPTH: 40.0 FT
GROUND SURFACE ELEVATION: 307.0
SHEET: 2 OF: 2

STATIC WATER LEVEL (BLS)		
WD=While Drilling AB=After Boring		
Depth(Ft)	32.00	31.80
Time	7 AM	7 AM
Date:	11/28/95	11/30/95

DEPTH	BLOW COUNTS	SAMPLING METHOD	SAMPLE NUMBER	MOISTURE	CONSISTANCY	SAMPLE RECOVERY	DRILL METHOD	LITHOLOGY DESCRIPTION
23.5–24.5	9 13 15	Ss	S6	D		12"		CLAYEY SILT: Light pink to cream colored clayey silt; k-spar rich with relict granite texture and mica; some iron staining and quartz crystals; moist at 33.5' and wet at 38.5'.
28.5–29.5	9 13 17	Ss	S7	D		16"		
33.5–34.5	13 20 28	Ss	S8	M		15"		
38.5–39.5	16 24 32	Ss	S9	W		16"		
40.0								Boring Terminated at 40'.

Depth scale: 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, 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, 51.0, 52.0, 53.0, 54.0, 55.0

LITHOLOGY | WELL INSTALLATION

FIELD BOREHOLE LOG

BOREHOLE NUMBER: G-9

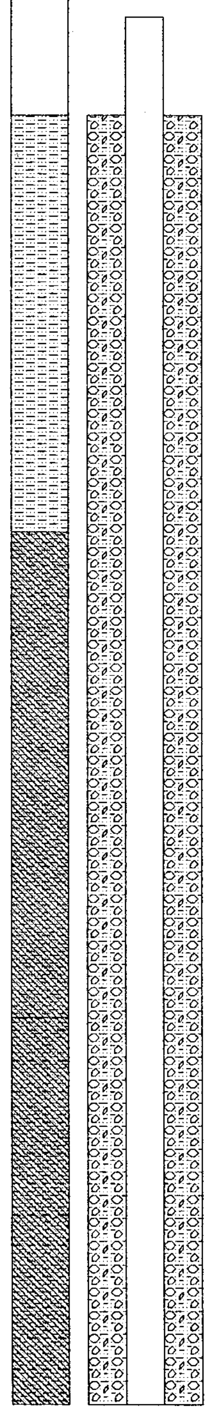
PROJECT NUMBER: HALIFAX-5
PROJECT NAME: HALIFAX COUNTY
LOCATION: HALIFAX, NORTH CAROLINA
DRILLING COMPANY: BORE AND CORE
RIG TYPE & NUMBER: CME 450
DRILLING METHOD: HOLLOW STEM AUGER
WEATHER: SUNNY, 40 DEGREES
FIELD PARTY: L. FOSKEY
GEOLOGIST: G. MILLS
DATE BEGUN: 12/14/95 DATE COMPLETED: 12/15/95

TOP OF CASING ELEVATION: 310.35
TOTAL DEPTH: 40.0 FT
GROUND SURFACE ELEVATION: 307.0
SHEET: 1 OF: 2

STATIC WATER LEVEL (BLS)		
WD=While Drilling AB=After Boring		
Depth (Ft)	30.25	29.00
Time	8:30 AM	7:30 PM
Date	12/15/95	12/19/95

DEPTH	BLOW COUNTS	SAMPLING METHOD	SAMPLE NUMBER	MOISTURE	CONSISTANCY	SAMPLE RECOVERY	DRILL METHOD	LITHOLOGY DESCRIPTION
0.0–2.0	5 8 11	Ss	S1			18"		SANDY SILT: Bright yellow orange with one 2" long piece of gravel at 2" up the sample. Some quartz sand seen at 3.5"; slightly plastic; dry.
3.0–4.5	5 7 10	Ss	S2	D		16"		
8.0–9.5	5 8 10	Ss	S3	M		14"		SANDY CLAYEY SILT: pink and white with some quartz sand; slightly plastic; moist; Mn nodules; took a bulk sample from 15 to 20 feet. Lab USC: MH.
13.0–14.5	4 7 7	Ss	S4	M		14"		
18.0–19.5	4 5 5	Ss	S5	M		16"		SANDY CLAYEY SILT: pink, white and orange quartz sand; Mn nodules throughout sample; more plastic; moist.
23.0–24.5	3 4 5	Ss	S6	M		15"		

LITHOLOGY | WELL INSTALLATION



FIELD BOREHOLE LOG

BOREHOLE NUMBER: G-9

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: SUNNY, 40 DEGREES
FIELD PARTY: L. FOSKEY
GEOLOGIST: G. MILLS
DATE BEGUN: 12/14/95 DATE COMPLETED: 12/15/95

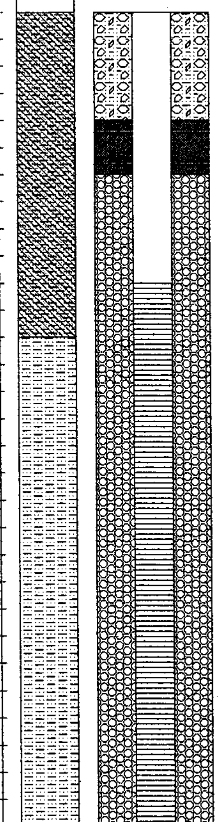
TOP OF CASING ELEVATION: 310.35
TOTAL DEPTH: 40.0 FT
GROUND SURFACE ELEVATION: 307.0
SHEET: 2 OF: 2

STATIC WATER LEVEL (BLS)		
WD=While Drilling AB=After Boring		
Depth(Ft)	30.25	29.00
Time	8:30 AM	7:30 PM
Date	12/15/95	12/19/95

DEPTH	BLOW COUNTS	SAMPLING METHOD	SAMPLE NUMBER	MOISTURE	CONSISTANCY	SAMPLE RECOVERY	DRILL METHOD	LITHOLOGY DESCRIPTION
25.0–31.0	3 5 6	Ss	S7	W		15"		SANDY CLAYEY SILT: pink, white and orange quartz sand; Mn nodules throughout sample; more plastic; wet.
31.0–40.0	4 8 10	Ss	S8	W		16"		SANDY SILT: tan, white, mostly orange and pink coarse to fine sandy silt; some fine mica and coarse quartz sand; feldspar and k-spar very distinct; very weathered rock at 38.5'.
	10 18 23	Ss	S9	W		10"		
40.0								Boring Terminated at 40 feet.

DEPTH: 25.0 26.0 27.0 28.0 29.0 30.0 31.0 32.0 33.0 34.0 35.0 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

LITHOLOGY / WELL INSTALLATION



FIELD BOREHOLE LOG

BOREHOLE NUMBER
G-10

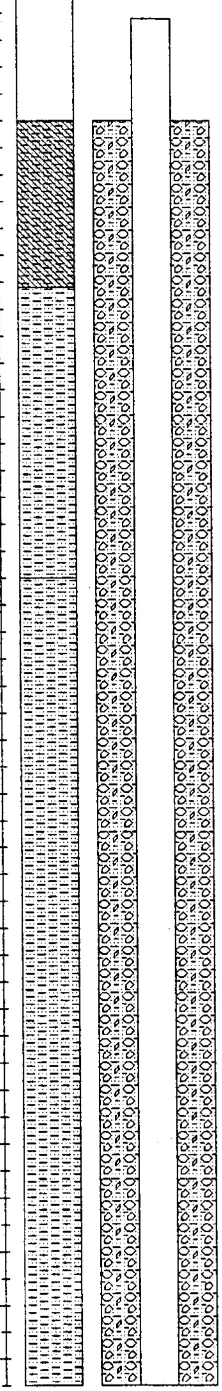
PROJECT NUMBER: HALIFAX-5
PROJECT NAME: HALIFAX COUNTY
LOCATION: HALIFAX, NORTH CAROLINA
DRILLING COMPANY: BORE AND CORE
RIG TYPE & NUMBER: CME 450
DRILLING METHOD: HOLLOW STEM AUGER
WEATHER: CLOUDY, 45 DEGREES
FIELD PARTY: L. FOSKEY
GEOLOGIST: G. MILLS
DATE BEGUN: 12/8/95 DATE COMPLETED: 12/8/95

TOP OF CASING ELEVATION: 310.84
TOTAL DEPTH: 50.0 FT
GROUND SURFACE ELEVATION: 308.8
SHEET: 1 OF 2

STATIC WATER LEVEL (BLS)		
WD=While Drilling AB=After Boring		
Depth(ft)	44.50	40.74
Time	1:15 PM	3:00 PM
Date:	12/8/95	12/11/95

DEPTH	BLOW COUNTS	SAMPLING METHOD	SAMPLE NUMBER	MOISTURE	CONSISTANCY	SAMPLE RECOVERY	DRILL METHOD	LITHOLOGY DESCRIPTION	DEPTH
2.0									2.0
1.0									1.0
0.0	5 8 9	Ss	S1					CLAYEY SANDY SILT: with quartz sand and mica; only slightly clayey; dry.	0.0
3.0	6 7 9	Ss	S2	D				SANDY SILT: Distinct felsic silt bands - horizontal to 10 degree angle; abundant mica in veins; dry.	3.0
8.0	4 6 8	Ss	S3	D				SANDY SILT: Relict granite; powdery very felsic silt with mica veins; coarse quartz sand, moist at 23.5'.	8.0
13.0	5 7 10	Ss	S4	D					13.0
18.0	6 10 12	Ss	S5	D					18.0
23.0	6	Ss	S6	D					23.0

LITHOLOGY / WELL INSTALLATION



FIELD BOREHOLE LOG

BOREHOLE NUMBER: G-10

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: 12/8/95 DATE COMPLETED: 12/8/95

TOP OF CASING ELEVATION: 310.84
TOTAL DEPTH: 50.0 FT
GROUND SURFACE ELEVATION: 308.8
SHEET: 2 OF: 2

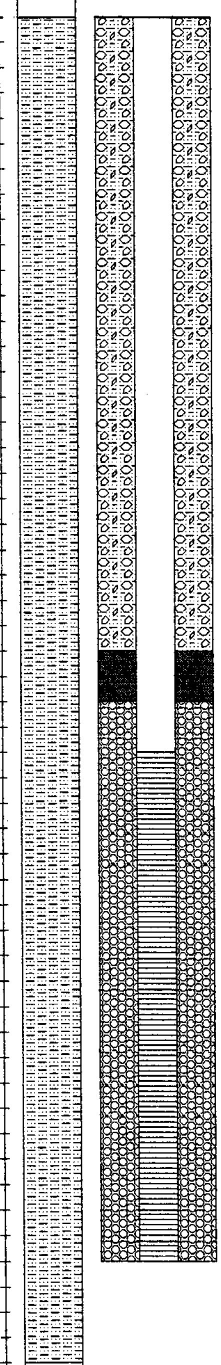
STATIC WATER LEVEL (BLS)		
WD=While Drilling AB=After Boring		
Depth(ft)	44.50	40.74
Time	1:15 PM	3:00 PM
Date	12/8/95	12/11/95

DEPTH	BLOW COUNTS	SAMPLING METHOD	SAMPLE NUMBER	MOISTURE	CONSISTANCY	SAMPLE RECOVERY	DRILL METHOD
23.5	6 10 13	Ss	S6	D			
28.5	6 10 15	Ss	S7	M			
33.5	8 12 15	Ss	S8	M			
38.5	10 12 15	Ss	S9	W			
43.5	5 8 13	Ss	S10	W			
48.5	8 14 18	Ss	S11	W			

LITHOLOGY DESCRIPTION

SANDY SILT: Relict granite; powdery very felsic silt with mica veins; moist at 23.5'; at 33.5' k-spar is more abundant; wet at 43.5'.

Boring Terminated at 50 feet.



FIELD BOREHOLE LOG

BOREHOLE NUMBER: G-11

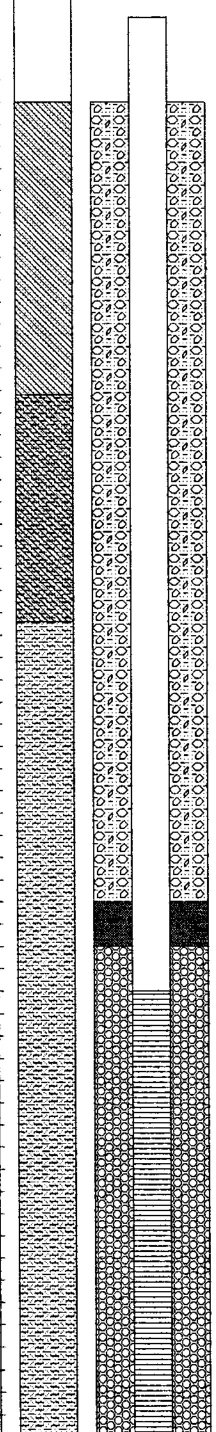
PROJECT NUMBER: HALIFAX-5
PROJECT NAME: HALIFAX COUNTY
LOCATION: HALIFAX, NORTH CAROLINA
DRILLING COMPANY: BORE AND CORE
RIG TYPE & NUMBER: MOBILE DRILL CME 450
DRILLING METHOD: HOLLOW STEM AUGER
WEATHER: CLOUDY, 45 DEGREES
FIELD PARTY: L. FOSKEY
GEOLOGIST: G. MILLS
DATE BEGUN: 12/1/95 DATE COMPLETED: 12/1/95

TOP OF CASING ELEVATION: 286.38
TOTAL DEPTH: 30.0 FT
GROUND SURFACE ELEVATION: 281.4
SHEET: 1 OF: 1

STATIC WATER LEVEL (BLS)		
WD=While Drilling AB=After Boring		
Depth(ft)	19.34	19.24
Time	3:30 PM	4:00 PM
Date:	12/1/95	12/4/95

DEPTH	BLOW COUNTS	SAMPLING METHOD	SAMPLE NUMBER	MOISTURE	CONSISTANCY	SAMPLE RECOVERY	DRILL METHOD	LITHOLOGY DESCRIPTION
0.0	4 5 7	Ss	S1			14"		SANDY CLAY: Red brown sandy clay with quartz and organics; trace mica; dry.
3.0	6 10 14	Ss	S2	D		18"		
7.0								CLAYEY SILTY SAND: Red-brown-orange clayey silty sand; weathered granite; feldspar and quartz present; trace mica; iron stains; dry.
8.0	9 14 16	Ss	S3	M		12"		
12.0								SILTY SAND: Relict granite; non-plastic; abundant feldspar and k-spar; quartz sand and gravel; some iron staining; moist to wet; some mica; quartz and k-feldspar sand becoming increasingly coarse with depth; took a jar sample from 13.5 to 15 feet. Lab USC: ML
13.0	5 10 11	Ss	S4	M		12"		
18.0	6 9 13	Ss	S5	M		16"		
23.0	6 9 14	Ss	S6	M		12"		
28.0	10 13 17	Ss	S7	W		14"		
30.0								Boring Terminated at 30'.

LITHOLOGY / WELL INSTALLATION



FIELD BOREHOLE LOG

BOREHOLE NUMBER: G-12

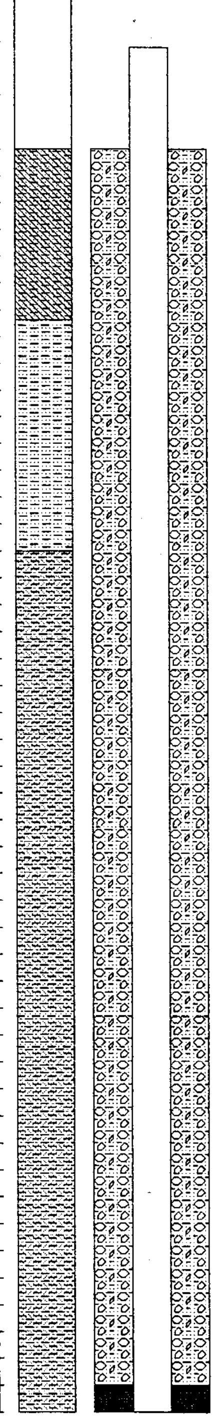
PROJECT NUMBER: HALIFAX-5
PROJECT NAME: HALIFAX COUNTY
LOCATION: HALIFAX, NORTH CAROLINA
DRILLING COMPANY: BORE AND CORE
RIG TYPE & NUMBER: CME 450
DRILLING METHOD: HOLLOW STEM AUGER
WEATHER: PARTYLY CLOUDY, 40 DEGREES
FIELD PARTY: L. FOSKEY
GEOLOGIST: G. MILLS
DATE BEGUN: 12/11/95 DATE COMPLETED: 12/11/95

TOP OF CASING ELEVATION: 279.88
TOTAL DEPTH: 35.0 FT
GROUND SURFACE ELEVATION: 277.3
SHEET: 1 OF 2

STATIC WATER LEVEL (BLS)		
WD=While Drilling AB=After Boring		
Depth(Ft)	26.4	22.85
Time	2:00 PM	5:30 PM
Date	12/11/95	12/12/95

DEPTH	BLOW COUNTS	SAMPLING METHOD	SAMPLE NUMBER	MOISTURE	CONSISTANCY	SAMPLE RECOVERY	DRILL METHOD	LITHOLOGY DESCRIPTION	DEPTH
2.0									2.0
1.0									1.0
0.0	4 5 7	Ss	S1					SANDY SILTY CLAY: Reddish brown sandy silty clay with some mica.	0.0
1.0									1.0
2.0									2.0
3.0	7 11 12	Ss	S2	D				SANDY SILT: Tan, well graded sand and silt, dry.	3.0
4.0									4.0
5.0									5.0
6.0									6.0
7.0									7.0
8.0	6 6 7	Ss	S3	D				SILTY SAND: Pink, tan and gray silty sand; trace of manganese; some mica; damp at 23.5 feet.	8.0
9.0									9.0
10.0									10.0
11.0									11.0
12.0									12.0
13.0	5 7 9	Ss	S4	D					13.0
14.0									14.0
15.0									15.0
16.0									16.0
17.0									17.0
18.0	4 7 8	Ss	S5	D					18.0
19.0									19.0
20.0									20.0
21.0									21.0
22.0									22.0
23.0	5	Ss	S6	M					23.0

LITHOLOGY / WELL INSTALLATION



FIELD BOREHOLE LOG

BOREHOLE NUMBER: G-12

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: PARTYLY CLOUDY, 40 DEGREES
FIELD PARTY: L. FOSKEY
GEOLOGIST: G. MILLS
DATE BEGUN: 12/11/95 DATE COMPLETED: 12/11/95

TOP OF CASING ELEVATION: 279.88
TOTAL DEPTH: 35.0 FT
GROUND SURFACE ELEVATION: 277.3
SHEET: 2 OF: 2

STATIC WATER LEVEL (BLS)		
WD=While Drilling AB=After Boring		
Depth(Ft)	26.4	22.85
Time	2:00 PM	5:30 PM
Date	12/11/95	12/12/95

DEPTH	BLOW COUNTS	SAMPLING METHOD	SAMPLE NUMBER	MOISTURE	CONSISTANCY	SAMPLE RECOVERY	DRILL METHOD	LITHOLOGY DESCRIPTION
24.0	5 6 8	Ss	S6	M				
25.0–35.0								SILTY SAND: Pink, tan and gray silty sand; trace of manganese; some mica; wet at 28.5 feet.
28.0	6 7 9	Ss	S7	W				
33.0	5 7 9	Ss	S8	W				
35.0								Boring Terminated at 35 feet.

Depth scale: 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, 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

DEPTH | LITHOLOGY | WELL INSTALLATION

FIELD BOREHOLE LOG

BOREHOLE NUMBER: G-13S

PROJECT NUMBER: HALIFAX-5
PROJECT NAME: HALIFAX COUNTY
LOCATION: HALIFAX, NORTH CAROLINA
DRILLING COMPANY: BORE AND CORE
RIG TYPE & NUMBER: MOBILE B-53
DRILLING METHOD: HOLLOW STEM AUGER
WEATHER: CLOUDY, 45 DEGREES
FIELD PARTY: L. FOSKEY
GEOLOGIST: G. MILLS
DATE BEGUN: 11/30/95 DATE COMPLETED: 11/30/95

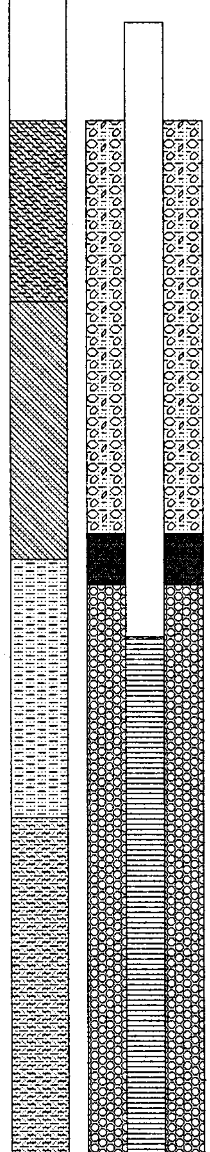
TOP OF CASING ELEVATION: 252.34
TOTAL DEPTH: 20.0 FT
GROUND SURFACE ELEVATION: 249.9
SHEET: 1 OF: 1

STATIC WATER LEVEL (BLS)		
WD=While Drilling AB=After Boring		
Depth(ft)	8.9	8.8
Time	5:00 PM	9:05 AM
Date:	11/30/95	12/1/95

DEPTH	BLOW COUNTS	SAMPLING METHOD	SAMPLE NUMBER	MOISTURE	CONSISTANCY	SAMPLE RECOVERY	DRILL METHOD	LITHOLOGY DESCRIPTION
0.0	4 7 4	Ss	S1					SILTY CLAY: Dark brown silty clay with some sand and organics; fill.
3.5	6 9 6	Ss	S2	D		10"		SANDY CLAY: Orange brown sandy clay; some mica and feldspar and quartz; dry.
8.5	7 10 13	Ss	S3	M		16"		SANDY SILT: Brown-orange slightly plastic sandy silt; some mica; iron stained; moist.
13.5	13 16 18	Ss	S4	M		16"		SILTY SAND: Brown-orange silty sand; iron stained; abundant mica; very moist; relict granite;aceous; some quartz; relict granite structure; k-spar abundant from 18.5' to 20'.
18.5	16 23 30	Ss	S5	W				
20.0								Boring Terminated at 20 feet.

Depth scale: 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, 19.0, 20.0, 21.0, 22.0, 23.0, 24.0, 25.0

LITHOLOGY | WELL INSTALLATION



FIELD BOREHOLE LOG

BOREHOLE NUMBER: G-13D

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, NQ CORE, ROLLER CONE
WEATHER: CLOUDY, 45 DEGREES
FIELD PARTY: L. FOSKEY
GEOLOGIST: G. MILLS
DATE BEGUN: 12/27/95 DATE COMPLETED: 12/28/95

TOP OF CASING ELEVATION: 252.12
TOTAL DEPTH: 54.5 FT
GROUND SURFACE ELEVATION: 250.1
SHEET: 1 OF: 1

STATIC WATER LEVEL (BLS)		
WD=While Drilling AB=After Boring		
Depth(ft)	8.60	8.50
Time	-	-
Date	1-23-95	1-24-95

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								CLAYEY SANDY SILT: Probed to auger refusal without sampling; lithology shlould be same as G-13, drilled 5 feet south.	0.0		
1.0									1.0		
2.0									2.0		
3.0									3.0		
4.0									4.0		
5.0									5.0		
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								Auger Refusal at 30.5 feet; boring continued with NQ core.	25.0		
26.0									26.0		
27.0									27.0		
28.0									28.0		
29.0									29.0		
30.0									30.0		
31.0									31.0		

FIELD BOREHOLE LOG

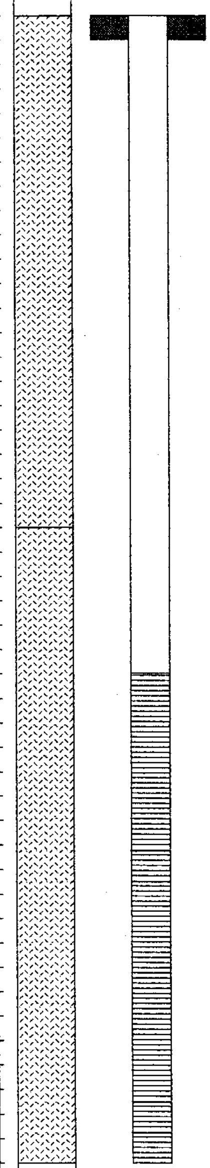
BOREHOLE NUMBER: G-13D

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, NO CORE, ROLLER CONE
WEATHER: CLOUDY, 45 DEGREES
FIELD PARTY: L. FOSKEY
GEOLOGIST: G. MILLS
DATE BEGUN: 12/27/95 DATE COMPLETED: 12/28/95

TOP OF CASING ELEVATION: 252.12
TOTAL DEPTH: 54.5 FT
GROUND SURFACE ELEVATION: 250.1
SHEET: 1 OF: 1

STATIC WATER LEVEL (BLS)		
WD=While Drilling AB=After Boring		
Depth(Ft)	8.60	8.50
Time	-	-
Date:	1-23-95	1-24-95

DEPTH	BLOW COUNTS	SAMPLING METHOD	SAMPLE NUMBER	MOISTURE	CONSISTANCY	SAMPLE RECOVERY	DRILL METHOD	LITHOLOGY DESCRIPTION	DEPTH
31.0								WEATHERED GRANITE: 11 feet of NO core with no recovery.	31.0
42.0								WEATHERED GRANITE: Tri-cone roller with 2-15/16 inch bit through weathered rock until refusal.	42.0
55.0								Roller refusal at 54.5 feet.	55.0



FIELD BOREHOLE LOG

BOREHOLE NUMBER: G-14

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: 12/1/95　DATE COMPLETED: 12/1/95

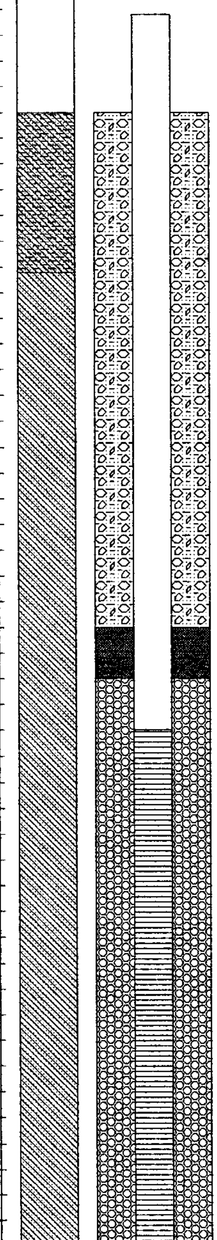
TOP OF CASING ELEVATION: 265.9
TOTAL DEPTH: 22.0 FT
GROUND SURFACE ELEVATION: 263.3
SHEET: 1 OF: 1

STATIC WATER LEVEL (BLS) WD=While Drilling AB=After Boring		
Depth(ft)	10.49	10.34
Time	11:40 AM	4:00 PM
Date:	12/1/95	12/4/95

DEPTH	BLOW COUNTS	SAMPLING METHOD	SAMPLE NUMBER	MOISTURE	CONSISTANCY	SAMPLE RECOVERY	DRILL METHOD	LITHOLOGY DESCRIPTION
0.0	5 8 10	Ss	S1			12"		SANDY CLAYEY SILT: Red brown fine sandy clayey silt with mica; some organics; some quartz; Mn staining.
3.0	7 9 11	Ss	S2	D		12"		CLAYEY SAND: Relict granite; Pink, white, gray, black slightly clayey sand; abundant k-spar and feldspar; rock texture; mica; some quartz sand, becoming coarser with depth; moist horizontal iron stain at 10'; wet at 18.5'; took a jar sample from 3.5 to 5 feet. Lab USC: ML.
8.0	8 11 15	Ss	S3	M		18"		
13.0	8 10 12	Ss	S4	M		18"		
18.0	8 12 17	Ss	S5	W		14"		
22.0								Boring Terminated at 22.0'.

DEPTH scale: 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, 19.0, 20.0, 21.0, 22.0, 23.0, 24.0, 25.0

LITHOLOGY　WELL INSTALLATION



FIELD BOREHOLE LOG

BOREHOLE NUMBER: G-15

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: SUNNY, 40 DEGREES
FIELD PARTY: L. FOSKEY
GEOLOGIST: G. MILLS
DATE BEGUN: 12/14/95 DATE COMPLETED: 12/14/95

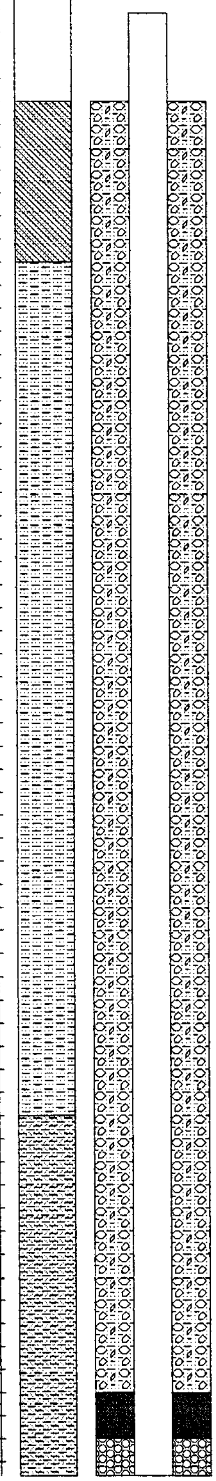
TOP OF CASING ELEVATION: 259.37
TOTAL DEPTH: 40.0 FT
GROUND SURFACE ELEVATION: 257.0
SHEET: 1 OF: 2

STATIC WATER LEVEL (BLS)		
WD=While Drilling AB=After Boring		
Depth(Ft)	9.70	9.58
Time	3:00 PM	2:00 PM
Date	12/14/95	12/15/95

DEPTH	BLOW COUNTS	SAMPLING METHOD	SAMPLE NUMBER	MOISTURE	CONSISTANCY	SAMPLE RECOVERY	DRILL METHOD	LITHOLOGY DESCRIPTION
0.0	7 12 26	Ss	S1			16"		SANDY CLAY: Tan-gray with orange coarse sandy clay with quartz gravel; dry.
3.5	6 9 10	Ss	S2	D		15"		SANDY SILT: White with yellow sandy silt; mostly feldspar, some iron staining; some coarse quartz sand and mica; wet at 13 feet.
8.5	4 4 5	Ss	S3	D				
13.5	3 4 5	Ss	S4	W				
18.5	4 5 9	Ss	S5	W				
22.0								SILTY SAND: Tan-gray with pink; black and white; micaceous; coarse k-spar and quartz; wet.
23.5	5 7 9	Ss	S6	W				
28.5	5 8 15	Ss	S7	W				

DEPTH scale: 2.0, 1.0, 0.0, 1.0 … 29.0

LITHOLOGY | WELL INSTALLATION



FIELD BOREHOLE LOG

BOREHOLE NUMBER: G-15

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: SUNNY, 40 DEGREES
FIELD PARTY: L. FOSKEY
GEOLOGIST: G. MILLS
DATE BEGUN: 12/14/95 DATE COMPLETED: 12/14/95

TOP OF CASING ELEVATION: 259.37
TOTAL DEPTH: 40.0 FT
GROUND SURFACE ELEVATION: 257.0
SHEET: 2 OF: 2

STATIC WATER LEVEL (BLS)		
WD=While Drilling AB=After Boring		
Depth(ft)	9.70	9.58
Time	3:00 PM	2:00 PM
Date	12/14/95	12/15/95

DEPTH	BLOW COUNTS	SAMPLING METHOD	SAMPLE NUMBER	MOISTURE	CONSISTANCY	SAMPLE RECOVERY	DRILL METHOD	LITHOLOGY DESCRIPTION	DEPTH	LITHOLOGY	WELL INSTALLATION
30.0								SILTY SAND: Tan-gray with pink; black and white; micaceous; coarse k-spar and quartz; wet.	30.0		
33.0	2 9 14	Ss	S8	W					33.0		
38.0	13 14 18	Ss	S9	W					38.0		
40.0								Boring Terminated at 40 feet.	40.0		

Depth scale: 30.0 31.0 32.0 33.0 34.0 35.0 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 51.0 52.0 53.0 54.0 55.0 56.0 57.0 58.0 59.0 60.0

FIELD BOREHOLE LOG

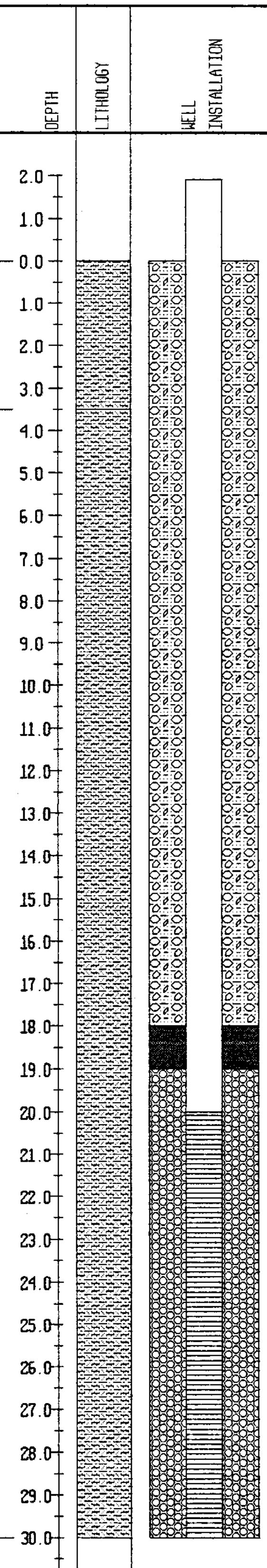
BOREHOLE NUMBER: G-16

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: PARTLY CLOUDY, 34 DEGREES
FIELD PARTY: L. FOSKEY
GEOLOGIST: G. MILLS
DATE BEGUN: 12/11/95 DATE COMPLETED: 12/11/95

TOP OF CASING ELEVATION: 270.48
TOTAL DEPTH: 30.0 FT
GROUND SURFACE ELEVATION: 268.1
SHEET: 1 OF: 1

STATIC WATER LEVEL (BLS)		
WD=While Drilling AB=After Boring		
Depth(ft)	17.01	16.66
Time	5:00 PM	3:15 PM
Date:	12/11/95	12/12/95

DEPTH	BLOW COUNTS	SAMPLING METHOD	SAMPLE NUMBER	MOISTURE	CONSISTANCY	SAMPLE RECOVERY	DRILL METHOD	LITHOLOGY DESCRIPTION
0.0	4 7 7	Ss	S1			18"		SILTY SAND: orange-brown; micaceous; dry.
3.0	5 6 7	Ss	S2	D		18"		SILTY SAND: Fine silty sand with relict granite structure; orange, pink, white, green, dark gray in color; moist at 8.5';
8.0	4 7 10	Ss	S3	D		12"		
13.0	4 6 8	Ss	S4	M		12"		
17.0								at 18.5' coarse quartz and coarse k-spar sand bedded at 45 degree angle; iron staining at 45 degree angle through felsic powdery sandy silt bands;
18.0	4 5 7	Ss	S5	M		14"		
22.0								wet at 23.5'; at 28.5' is gray quartz sand; this alternates with bands of feldspar and mica.
23.0	8 10 13	Ss	S6	W		11"		
28.0	9 15 20	Ss	S7	W		10"		
30.0								Boring Terminated at 30 feet.



FIELD BOREHOLE LOG

BOREHOLE NUMBER
H-1D

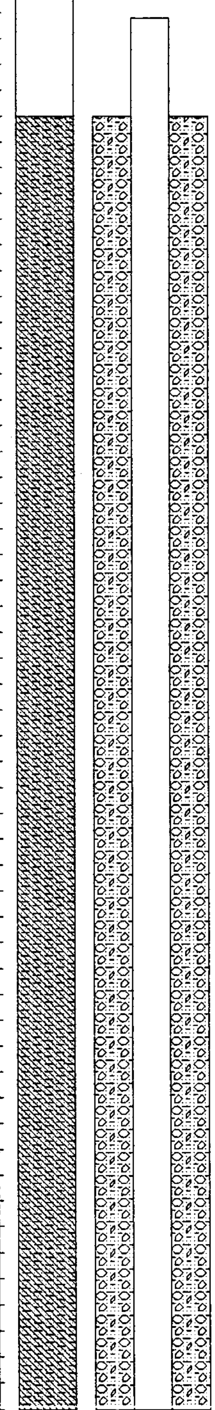
PROJECT NUMBER: HALIFAX-5
PROJECT NAME: HALIFAX COUNTY
LOCATION: HALIFAX, NORTH CAROLINA
DRILLING COMPANY: BORE AND CORE
RIG TYPE & NUMBER: CME 450
DRILLING METHOD: HOLLOW STEM AUGER, NO CORER
WEATHER: SUNNY, 30 DEGREES
FIELD PARTY: L. FOSKEY
GEOLOGIST: G. MILLS
DATE BEGUN: 12/28/95 DATE COMPLETED: 12/28/95

TOP OF CASING ELEVATION: 296.54
TOTAL DEPTH: 42.0 FT
GROUND SURFACE ELEVATION: 293.9
SHEET: 1 OF: 2

STATIC WATER LEVEL (BLS)		
WD=While Drilling AB=After Boring		
Depth(ft)	14.34	14.18
Time	-	-
Date:	01-24-96	01-25-96

DEPTH	BLOW COUNTS	SAMPLING METHOD	SAMPLE NUMBER	MOISTURE	CONSISTANCY	SAMPLE RECOVERY	DRILL METHOD	LITHOLOGY DESCRIPTION	DEPTH
2.0									2.0
1.0									1.0
0.0								CLAYEY SANDY SILT: Probed to auger refusal without sampling.	0.0
1.0									1.0
2.0									2.0
3.0									3.0
4.0									4.0
5.0									5.0
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

LITHOLOGY | WELL INSTALLATION



FIELD BOREHOLE LOG

BOREHOLE NUMBER: H-10

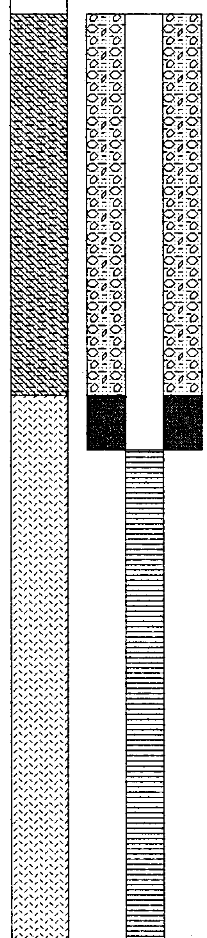
PROJECT NUMBER: HALIFAX-5
PROJECT NAME: HALIFAX COUNTY
LOCATION: HALIFAX, NORTH CAROLINA
DRILLING COMPANY: BORE AND CORE
RIG TYPE & NUMBER: CME 450
DRILLING METHOD: HOLLOW STEM AUGER, NQ CORER
WEATHER: SUNNY, 30 DEGREES
FIELD PARTY: L. FOSKEY
GEOLOGIST: G. MILLS
DATE BEGUN: 12/28/95 DATE COMPLETED: 12/28/95

TOP OF CASING ELEVATION: 296.54
TOTAL DEPTH: 42.0 FT
GROUND SURFACE ELEVATION: 293.9
SHEET: 2 OF: 2

STATIC WATER LEVEL (BLS)		
WD=While Drilling AB=After Boring		
Depth(ft)	14.34	14.18
Time	-	-
Date:	01-24-96	01-25-96

DEPTH	BLOW COUNTS	SAMPLING METHOD	SAMPLE NUMBER	MOISTURE	CONSISTANCY	SAMPLE RECOVERY	DRILL METHOD	LITHOLOGY DESCRIPTION	DEPTH
32.0								GRANITE: NQ core run from 32 to 42 feet; no recovery.	32.0
42.0								Boring Terminated at 42 feet.	42.0

Depth scale: 25.0 – 50.0



FIELD DRILLING RECORD

HAZEN AND SAWYER
Environmental Engineers & Scientists

BORING NO. H-1 DATE STARTED 3/4/92 DATE COMPLETED ______
LOCATION Halifax Co MSW DIAMETER OF BORING ______ DRILL MACHINE ______
METHOD OF DRILLING AND SAMPLING HSA, no sampling
DRILLER B&C GEOLOGIST DG GROUND ELEVATION ______
WATER LEVEL ______ (TERMINATION OF BORING) WATER LEVEL ______ (AT 24 HRS.)
DEPTH OF CASING ______ WATER LOSSES ______ THICKNESS OF TOPSOIL <6"
CASING DIAMETER ______ TYPE ______ TERMINATION OF BORING DEPTH ______ FEET
INDICATE IF AUGER REFUSAL/TRICONE REFUSAL

DEPTH FROM	DEPTH TO	SOIL DESCRIPTION HARDNESS	COLOR	MOIST.	TYPE MATERIAL	PENETRATION TEST RESULTS NO	DEPTH	6"	12"	18"
0	2	(loose)	tan-br	wet	sli cly v. si fine sand SM					
2			lt tan	v. moist-wet	fi sa si clay (CL)					
			sli drier, more silty below 3'							
	7.5		v. wet below 7.5', w/ c. sa + fi grav							
7.5		soft	tan	wet	f-c sa si clay w/ tr fi grav CL-CH					
	18'		consistent to 18'							
			set screen 13-18'							

FOR MONITORING WELL INSTALLATION ONLY:
STANDPIPE DIAMETER 1¼ INCHES
PVC / S.S. (CIRCLE ONE)
LENGTH OF SCREEN 5 FEET
SCREEN SLOT OPENING SIZE .010 INCHES

DEPTH TO TOP OF SAND 12'
DEPTH TO TOP OF SEAL 11'
STICKUP LENGTH 1'8"
TYPE BACKFILL cuttings
SURFACE SEAL THICKNESS NA
SAND USED 1½ (BAGS)
CEMENT USED NA (BAGS)
PELLETS ½ (PAILS)

Depth 19'6" Water 17'10" (18 hrs)

FIELD DRILLING RECORD

HAZEN AND SAWYER
Environmental Engineers & Scientists

BORING NO. H-2 DATE STARTED 3-4-92 DATE COMPLETED 3-4-92
LOCATION ______ DIAMETER OF BORING 6" DRILL MACHINE CME 45C
METHOD OF DRILLING AND SAMPLING HSA w/ no SPT
DRILLER B&C (Tony) GEOLOGIST ______ GROUND ELEVATION ______
WATER LEVEL Dry (TERMINATION OF BORING) WATER LEVEL ______ (AT 24 HRS.)
THICKNESS OF TOPSOIL ~2"
DEPTH OF CASING NA WATER LOSSES NA TERMINATION OF BORING DEPTH 15 FEET
CASING DIAMETER NA TYPE NA
INDICATE IF AUGER REFUSAL/TRICONE REFUSAL

DEPTH		SOIL DESCRIPTION				PENETRATION TEST RESULTS				
FROM	TO	HARDNESS	COLOR	MOIST.	TYPE MATERIAL	NO	DEPTH	6"	12"	18"
0	5	firm	tan org.	moist	v. sli. sa si clay (CL)					
					tr. f. gr., mod. plasticity					
5	12½	firm	lt. tan org.	moist	v. sli. sa si clay (CL)					
					sli. less clay, lighter color					
12½	15	firm	tan	moist	v. sli. sa si clay (CL)					
					less clay, lighter color, tr. f. gr.					
					cuttings v. moist					
					c. sandy plastic SILT					
					CL-ML-MH					
					topsoil ~2"					
					well complete @ 9:00					

FOR MONITORING WELL INSTALLATION ONLY:
STANDPIPE DIAMETER 1.25 INCHES
PVC / S.S. (CIRCLE ONE)
LENGTH OF SCREEN 5 FEET
SCREEN SLOT OPENING SIZE 0.010 INCHES

DEPTH TO TOP OF SAND 8'
DEPTH TO TOP OF SEAL 7'
STICKUP LENGTH ±3' 2'2"
TYPE BACKFILL cuttings
SURFACE SEAL THICKNESS N/A
SAND USED 1½ (BAGS)
CEMENT USED NA (BAGS)
PELLETS ½ (PAILS)

Depth 17'2" Dry 3/4/92

FIELD DRILLING RECORD

HAZEN AND SAWYER
Environmental Engineers & Scientists

BORING NO. H-3 DATE STARTED 3-4-92 DATE COMPLETED 3-4-92
LOCATION ______ DIAMETER OF BORING 6" DRILL MACHINE CME 450
METHOD OF DRILLING AND SAMPLING HSA w/no SPT
DRILLER B&C (TONY) GEOLOGIST ______ GROUND ELEVATION ______
WATER LEVEL Dry (TERMINATION OF BORING) WATER LEVEL ______ (AT 24 HRS.)
DEPTH OF CASING N/A WATER LOSSES N/A THICKNESS OF TOPSOIL ~4"
CASING DIAMETER N/A TYPE N/A TERMINATION OF BORING DEPTH 15 FEET
INDICATE IF AUGER REFUSAL/TRICONE REFUSAL

DEPTH		SOIL DESCRIPTION				PENETRATION TEST RESULTS				
FROM	TO	HARDNESS	COLOR	MOIST.	TYPE MATERIAL	NO	DEPTH	6"	12"	18"
0	13	FIRM	TAN-ORG	V.MOIST	~~RSCH~~ Si Cly SILT CLAY ML (CL)					
					TRACE fine SAND					
13	15	FIRM	TAN	V.MOIST	Si CLAY (CL)					
					TRACE fine SAND					
					TOPSOIL < 4" THICK					
					WELL COMPLETED @ 10:10					

FOR MONITORING WELL INSTALLATION ONLY:
STANDPIPE DIAMETER 1 1/4 INCHES
PVC / S.S. (CIRCLE ONE)
LENGTH OF SCREEN 5 FEET
SCREEN SLOT OPENING SIZE 0.010 INCHES

DEPTH TO TOP OF SAND 8'
DEPTH TO TOP OF SEAL 7'
STICKUP LENGTH ±3' 3'0"
TYPE BACKFILL CUTTINGS
SURFACE SEAL THICKNESS N/A
SAND USED 1 1/2 (BAGS)
CEMENT USED N/A (BAGS)
PELLETS 1/2 (PAILS)

Depth 18.0" Dry 3/4/92

FIELD DRILLING RECORD

HAZEN AND SAWYER
Environmental Engineers & Scientists

BORING NO. H-4 DATE STARTED 3-3-92 DATE COMPLETED 3-3-92
LOCATION ______ DIAMETER OF BORING 6" DRILL MACHINE CME 450
METHOD OF DRILLING AND SAMPLING HSA w/no SPT
DRILLER B&C (Tony) GEOLOGIST ______ GROUND ELEVATION ______
WATER LEVEL Dry (TERMINATION OF BORING) WATER LEVEL ______ (AT 24 HRS.)
DEPTH OF CASING N/A WATER LOSSES N/A THICKNESS OF TOPSOIL ~1'
CASING DIAMETER N/A TYPE N/A TERMINATION OF BORING DEPTH 25' FEET
INDICATE IF AUGER REFUSAL/TRICONE REFUSAL

DEPTH FROM	DEPTH TO	HARDNESS	COLOR	MOIST.	TYPE MATERIAL	NO	DEPTH	6"	12"	18"
0	8	firm	tan-org.	moist	v. sli. sa si clay (CL)					
					mod. plastic; tr. fi. gravel					
8	18	firm	lt. tan-orange	moist	v. sli sa si clay (CL) ML-CL					
					mod plastic (more					
					granular than 0-8, lighter					
					in color, less plasticity)					
18	.	firm	lt tan	moist	v. sli. sa si clay (CL)					
					(less plastic, more fi.					
					gravel, slightly more moist					
					than 8-18')					
					~1' topsoil					
					well complete @ 4:45					

FOR MONITORING WELL INSTALLATION ONLY:
STANDPIPE DIAMETER 1 1/4 INCHES
PVC / S.S. (CIRCLE ONE)
LENGTH OF SCREEN 5 FEET
SCREEN SLOT OPENING SIZE 0.010 INCHES

DEPTH TO TOP OF SAND 18'
DEPTH TO TOP OF SEAL 17'
STICKUP LENGTH ± 3' 2'11"
TYPE BACKFILL CUTTINGS
SURFACE SEAL THICKNESS N/A
SAND USED 1 1/2 (BAGS)
CEMENT USED N/A (BAGS)
PELLETS 1/2 (PAILS)

Depth 28'11" Dry 3/4/92

FIELD DRILLING RECORD

HAZEN AND SAWYER
Environmental Engineers & Scientists

BORING NO. H-5 DATE STARTED 3-3-92 DATE COMPLETED 3-3-92
LOCATION ______ DIAMETER OF BORING 6" DRILL MACHINE CME 45C
METHOD OF DRILLING AND SAMPLING HSA w/ no SPT
DRILLER B & C (Tony) GEOLOGIST ______ GROUND ELEVATION ______
WATER LEVEL ______ (TERMINATION OF BORING) WATER LEVEL ______ (AT 24 HRS.)
DEPTH OF CASING N/A WATER LOSSES N/A THICKNESS OF TOPSOIL 6"
CASING DIAMETER N/A TYPE N/A TERMINATION OF BORING DEPTH 20 FEET
INDICATE IF AUGER REFUSAL/TRICONE REFUSAL

DEPTH FROM	DEPTH TO	HARDNESS	COLOR	MOIST.	TYPE MATERIAL	PENETRATION TEST RESULTS NO	DEPTH	6"	12"	18"
0	7 1/2	firm	tan-orange		sli moist - clayey silt, (CL) ML-CL					
					some coarse sand fragments (mod plastic)					
7 1/2	10 1/2	firm	tan-org.	lo-moist	drier, sli. lower plasticity (CL)					
					→ denser mat'l ML					
10 1/2	20		lt brown	mod moist	~~sandy~~ silty clay - low plasticity; slightly wetter ML					
					denser mat'l					
					6" topsoil					
					well complete @ 3:40					

FOR MONITORING WELL INSTALLATION ONLY:
STANDPIPE DIAMETER 1 1/4 INCHES
PVC / S.S. (CIRCLE ONE)
LENGTH OF SCREEN 5 FEET
SCREEN SLOT OPENING SIZE 0.010 INCHES

DEPTH TO TOP OF SAND 13'
DEPTH TO TOP OF SEAL 12'
STICKUP LENGTH 1'10"
TYPE BACKFILL cuttings
SURFACE SEAL THICKNESS N/A
SAND USED 1 1/2 (BAGS)
CEMENT USED N/A (BAGS)
PELLETS 1/2 (PAILS)

Depth 22'1" (Below Ref Mark), Dry

FIELD DRILLING RECORD

HAZEN AND SAWYER
Environmental Engineers & Scientists

BORING NO. H-6 DATE STARTED 3-3-92 DATE COMPLETED 3-3-92
LOCATION Halifax Co. MSW site DIAMETER OF BORING 6" DRILL MACHINE CME 450
METHOD OF DRILLING AND SAMPLING HSA w/ No SPT
DRILLER B & C (TONY) GEOLOGIST BK GROUND ELEVATION
WATER LEVEL (TERMINATION OF BORING) WATER LEVEL ~~7'9"~~ (AT 24 HRS.) 3/4/9
DEPTH OF CASING N/A WATER LOSSES N/A THICKNESS OF TOPSOIL 1'
CASING DIAMETER NA TYPE NA TERMINATION OF BORING DEPTH FEET 15'
INDICATE IF AUGER REFUSAL/TRICONE REFUSAL

DEPTH		SOIL DESCRIPTION				PENETRATION TEST RESULTS				
FROM	TO	HARDNESS	COLOR	MOIST.	TYPE MATERIAL	NO	DEPTH	6"	12"	18"
0	7	(FIRM)	TAN-ORG.	MOIST	V. SLI SA SI CL (CL)					
					MOD. PLASTIC - TR FI GRAV.					
7	12	(FIRM)	TAN	V. MOIST	V. SLI SA SI CL (CL)					
					LOW PLAST. TR FI GRAV.					
12	15	SAME	-	V MOIST	WET					
					TOPSOIL ≈ 1 ft THICK					
					CONSISTENT MAT'L IN BOTH STRATA					
					WELL COMPLETE @ 2:30					

FOR MONITORING WELL INSTALLATION ONLY:
STANDPIPE DIAMETER 1 1/4 INCHES
PVC / S.S. (CIRCLE ONE)
LENGTH OF SCREEN 5' FEET
SCREEN SLOT OPENING SIZE 0.010 INCHES

DEPTH TO TOP OF SAND 8'
DEPTH TO TOP OF SEAL 7'
STICKUP LENGTH ± 3' 2'11"
TYPE BACKFILL CUTTINGS
SURFACE SEAL THICKNESS N/A
SAND USED 1 1/2 (BAGS)
CEMENT USED N/A (BAGS)
PELLETS 1/2 (PAILS)

Depth 18'4" Water 7'9"

FIELD DRILLING RECORD

HAZEN AND SAWYER
Environmental Engineers & Scientists

BORING NO. H-7 DATE STARTED 3/3/92 DATE COMPLETED 3/3/92
LOCATION Halifax Co. MSW Site DIAMETER OF BORING 6" DRILL MACHINE CME 450
METHOD OF DRILLING AND SAMPLING HSA w/ NO SPT
DRILLER B.E.C (Tony) GEOLOGIST DG GROUND ELEVATION
WATER LEVEL 16' (TERMINATION OF BORING) WATER LEVEL ~~DG~~ (AT 24 HRS.) 3/4/92
DEPTH OF CASING NA WATER LOSSES NA THICKNESS OF TOPSOIL 4"
CASING DIAMETER NA TYPE NA TERMINATION OF BORING DEPTH 22.5 FEET
INDICATE IF AUGER REFUSAL/TRICONE REFUSAL

DEPTH		SOIL DESCRIPTION				PENETRATION TEST RESULTS				
FROM	TO	HARDNESS	COLOR	MOIST.	TYPE MATERIAL	NO	DEPTH	6"	12"	18"
0	8	(FIRM)	TAN-ORG	V. MOIST	V. SLI. SA SI CLAY (CL)					
					(MOD PLAST.), TR. FI. GRAV.					
8	22.5	SAME -- V. MOIST - WET, INCR. GRAV. CONTENT								
		THIN LEDGE OF DENSER MAT'L @ 15								
		TOPSOIL < 4" THICK								
		V. CONSISTENT MATERIAL W/ DEPTH								
		11:40	1:00	HOLE SET OPEN W/ AUGERS						

FOR MONITORING WELL INSTALLATION ONLY:
STANDPIPE DIAMETER 1¼ INCHES
PVC / S.S. (CIRCLE ONE)
LENGTH OF SCREEN 5' FEET
SCREEN SLOT OPENING SIZE .010 INCHES

DEPTH TO TOP OF SAND 12.5
DEPTH TO TOP OF SEAL 11.5
STICKUP LENGTH ~~3~~ ±3 2'11"
TYPE BACKFILL CUTTINGS
SURFACE SEAL THICKNESS NA
SAND USED 2 (BAGS)
CEMENT USED NA (BAGS)
PELLETS 1/2 (PAILS)

Below Top of Standpipe
Depth Bottom 22'10" Water 10'8"

Bentonite

FIELD DRILLING RECORD

HAZEN AND SAWYER
Environmental Engineers & Scientists

BORING NO. H-8 DATE STARTED 3/4/92 DATE COMPLETED ______
LOCATION Halifax Co. MSW DIAMETER OF BORING 6" DRILL MACHINE CME450
METHOD OF DRILLING AND SAMPLING Hollow Stem Auger (no SPT)
DRILLER Bore & Core GEOLOGIST DG GROUND ELEVATION ______
WATER LEVEL Dry (TERMINATION OF BORING) WATER LEVEL ______ (AT 24 HRS.)
DEPTH OF CASING / WATER LOSSES / THICKNESS OF TOPSOIL (filled)
CASING DIAMETER / TYPE / TERMINATION OF BORING DEPTH ____ FEET
INDICATE IF AUGER REFUSAL/TRICONE REFUSAL

DEPTH		SOIL DESCRIPTION				PENETRATION TEST RESULTS				
FROM	TO	HARDNESS	COLOR	MOIST.	TYPE MATERIAL	NO	DEPTH	6"	12"	18"
0	1				filled topsoil w/ fi gravel					
1	2.5	(soft)	br.org	wet	si clay, mottled, poss. filled					
2.5	5.0	(soft)	org	moist	sli fi sa, v. clay silt (ML-CL)					
5	20	(firm)	tan	sli. moist	sli cly fi sa silt (ML)					
					stiffer @ 10', cuttings moist					
					v. consistent below 5'					
					set screen 15-20'					

FOR MONITORING WELL INSTALLATION ONLY:
STANDPIPE DIAMETER 1 1/4 INCHES
PVC / S.S. (CIRCLE ONE)
LENGTH OF SCREEN 5 FEET
SCREEN SLOT OPENING SIZE .010 INCHES

DEPTH TO TOP OF SAND 14
DEPTH TO TOP OF SEAL 13
STICKUP LENGTH ± 2' 16"
TYPE BACKFILL cuttings
SURFACE SEAL THICKNESS NA
SAND USED 1 1/2 (BAGS)
CEMENT USED NA (BAGS)
PELLETS 1/3 (PAILS)

Depth 21'4" below top

FIELD DRILLING RECORD

HAZEN AND SAWYER
Environmental Engineers & Scientists

BORING NO. H-9 DATE STARTED 3/4/92 DATE COMPLETED ______
LOCATION Halifax Co. MSW site DIAMETER OF BORING 6" DRILL MACHINE CME450
METHOD OF DRILLING AND SAMPLING HSA no sampling
DRILLER B & C (Tony) GEOLOGIST DG GROUND ELEVATION ______
WATER LEVEL ______ (TERMINATION OF BORING) WATER LEVEL ______ (AT 24 HRS.)
DEPTH OF CASING / WATER LOSSES / THICKNESS OF TOPSOIL ______
CASING DIAMETER / TYPE / TERMINATION OF BORING DEPTH ____ FEET
INDICATE IF AUGER REFUSAL/TRICONE REFUSAL

DEPTH FROM	DEPTH TO	SOIL DESCRIPTION HARDNESS	COLOR	MOIST.	TYPE MATERIAL	PENETRATION TEST RESULTS NO	DEPTH	6"	12"	18"
0	6		Rd-Org	sli. moist	sli fi sa cly silt ~~w/ fi gr.~~	ML				
					w/ tr fi gr., occ. clay					
6			Tan-Org	v. sli moist	cly silt w/ more fi grav.					
	17				noticeable incr. in moisture content @ 9'					
					(darker color @ 9', 12')					
17		(stiff)	Tan	sli moist	fi sa cly silt (ML)					
					(v. little cse sa - fi grav.)					
					set screen 15-20'					

FOR MONITORING WELL INSTALLATION ONLY:
STANDPIPE DIAMETER 1 1/4 INCHES
PVC / S.S. (CIRCLE ONE)
LENGTH OF SCREEN 5 FEET
SCREEN SLOT OPENING SIZE .010 INCHES

DEPTH TO TOP OF SAND 14
DEPTH TO TOP OF SEAL 13
STICKUP LENGTH 1' 11"
TYPE BACKFILL cuttings
SURFACE SEAL THICKNESS NA
SAND USED 1 1/2 (BAGS)
CEMENT USED — (BAGS)
PELLETS 1/2 (PAILS)

Depth 22' 2" Dry

FIELD DRILLING RECORD

HAZEN AND SAWYER
Environmental Engineers & Scientists

BORING NO. H-10 DATE STARTED 3-4-92 DATE COMPLETED 3-4-92
LOCATION ______ DIAMETER OF BORING 6" DRILL MACHINE CME 450
METHOD OF DRILLING AND SAMPLING HSA w/no SPT
DRILLER B&C Tony GEOLOGIST ______ GROUND ELEVATION ______
WATER LEVEL ~~Dry~~ (TERMINATION OF BORING) WATER LEVEL ______ (AT 24 HRS.)
DEPTH OF CASING NA WATER LOSSES NA THICKNESS OF TOPSOIL ~1'
CASING DIAMETER NA TYPE NA TERMINATION OF BORING DEPTH 15 FEET
INDICATE IF AUGER REFUSAL/TRICONE REFUSAL

DEPTH		SOIL DESCRIPTION				PENETRATION TEST RESULTS				
FROM	TO	HARDNESS	COLOR	MOIST.	TYPE MATERIAL	NO	DEPTH	6"	12"	18"
0	5	firm	tan-org.	v. moist	sli. sa si clay CL w/ mod. plasticity; tr. f. gr.					
5	~~8~~ 12		gray-brwn	wet	sli. sa si clay CL wet, > gr.					
12	15		tan	v. wet	sli. sa si clay CL > wet, not as gray, tr. f. gr. (saturated)					
					topsoil ~1' thick					
					water to surface @ completion					
					well complete @ 11:15					

FOR MONITORING WELL INSTALLATION ONLY:
STANDPIPE DIAMETER 1 1/4 INCHES
PVC / S.S. (CIRCLE ONE)
LENGTH OF SCREEN 5 FEET
SCREEN SLOT OPENING SIZE 0.010 INCHES

DEPTH TO TOP OF SAND 8'
DEPTH TO TOP OF SEAL 7
STICKUP LENGTH 3'1"
TYPE BACKFILL cuttings
SURFACE SEAL THICKNESS N/A
SAND USED 1 1/2 (BAGS)
CEMENT USED N/A (BAGS)
PELLETS 1/3-1/2 (PAILS)

below standpipe
Depth 18'5" Water 7'5" 3/4/92

FIELD DRILLING RECORD

HAZEN AND SAWYER
Environmental Engineers & Scientists

BORING NO. H-11 DATE STARTED 3/5/92 DATE COMPLETED 3/5/92
LOCATION Halifax MSW DIAMETER OF BORING 6" DRILL MACHINE CME 450
METHOD OF DRILLING AND SAMPLING HSA, no spt
DRILLER Bore & Core (Tony) GEOLOGIST OG GROUND ELEVATION ______
WATER LEVEL Dry (TERMINATION OF BORING) WATER LEVEL ______ (AT 24 HRS.)
DEPTH OF CASING / WATER LOSSES / THICKNESS OF TOPSOIL ______
CASING DIAMETER / TYPE / TERMINATION OF BORING DEPTH 16 FEET
INDICATE IF AUGER REFUSAL/TRICONE REFUSAL

DEPTH		SOIL DESCRIPTION				PENETRATION TEST RESULTS				
FROM	TO	HARDNESS	COLOR	MOIST.	TYPE MATERIAL	NO	DEPTH	6"	12"	18"
0		(Firm)	Rd-Org	sli moist to moist	fi sa si clay w/ tr. m-c SG *					
	6				drier below 3', more silty CL					
6		(Stiff)	Tan-Org	sli moist	fi sa sl. cly silt ML					
					w/ fi gravel (trace), dry below 10', sm. chunks in cuttings					
	15				v. stiff below 11', material dry					
15		Hard-V. Hard	Rd-Brn	Dry	fi sa SILT ML					
		Augers chattering 14.5', cuttings powder dry								
		Fi Gravel in cuttings — appear to be derived fr. granite								
14.5	16	PWR – Augers scratching & chattering								
16		Refusal								

No piezometer set in hole – powder dry below 11 feet

* bulk sample procured 0-4'

Similar Red soil exposed length of trail, some fragments of dark gray metavolcanic rock along trail – not sure if in-situ, but o/c 200' uphill is granite-gran. could be a sill or dike – seems isolated to narrow zone thru site & beyond

FOR MONITORING WELL INSTALLATION ONLY:
STANDPIPE DIAMETER ____ INCHES
PVC / S.S. (CIRCLE ONE)
LENGTH OF SCREEN ____ FEET
SCREEN SLOT OPENING SIZE ____ INCHES

DEPTH TO TOP OF SAND ______
DEPTH TO TOP OF SEAL ______
STICKUP LENGTH ______
TYPE BACKFILL ______
SURFACE SEAL THICKNESS ______
SAND USED ______ (BAGS)
CEMENT USED ______ (BAGS)
PELLETS ______ (PAILS)

FIELD DRILLING RECORD

HAZEN AND SAWYER
Environmental Engineers & Scientists

BORING NO. H-12 DATE STARTED 3/5/92 DATE COMPLETED ______
LOCATION Halifax MSW site DIAMETER OF BORING 6" DRILL MACHINE CME 450
METHOD OF DRILLING AND SAMPLING HSA, no spt
DRILLER Bore & Core (Tony) GEOLOGIST DL GROUND ELEVATION ______
WATER LEVEL ______ (TERMINATION OF BORING) WATER LEVEL ______ (AT 24 HRS.)
DEPTH OF CASING ______ WATER LOSSES ______ THICKNESS OF TOPSOIL ______
CASING DIAMETER ______ TYPE ______ TERMINATION OF BORING DEPTH 20 FEET
INDICATE IF AUGER REFUSAL/TRICONE REFUSAL

DEPTH		SOIL DESCRIPTION				PENETRATION TEST RESULTS				
FROM	TO	HARDNESS	COLOR	MOIST.	TYPE MATERIAL	NO	DEPTH	6"	12"	18"
0	3	(Firm)	Brn	Moist	Si CLAY or Cly SILT (ML-CL)					
			sli organic stain, minimal topsoil, few sm. roots							
3	7	(Firm)	Tan	Moist	sli m-c Sa cly SILT (ML)					
7		(Firm)	Lt. Tan	moist-v. moist	fi sa si clay w/ c sa, fi gravel					CL
			v. moist @ 13' - lg clumps in cuttings*, more silty							
17	20		slightly stiffer, same material							
					*v. sticky mat'l hanging on augers when pulled					
					set screen 15-20'					

FOR MONITORING WELL INSTALLATION ONLY:
STANDPIPE DIAMETER 1¼ INCHES
PVC / S.S. (CIRCLE ONE)
LENGTH OF SCREEN 5 FEET
SCREEN SLOT OPENING SIZE .010 INCHES

Below top of standpipe
Depth 22'7" Water 16'4"

DEPTH TO TOP OF SAND 13'
DEPTH TO TOP OF SEAL 12
STICKUP LENGTH 2'9"
TYPE BACKFILL cuttings
SURFACE SEAL THICKNESS ______
SAND USED 2 (BAGS)
CEMENT USED NA (BAGS)
PELLETS ½ (PAILS)

FIELD DRILLING RECORD

HAZEN AND SAWYER
Environmental Engineers & Scientists

BORING NO. H-13 DATE STARTED 3-4-92 DATE COMPLETED 3-4-92
LOCATION ______ DIAMETER OF BORING 6" DRILL MACHINE CME 450
METHOD OF DRILLING AND SAMPLING HSA w/ NO SPT
DRILLER B&C TONY GEOLOGIST ______ GROUND ELEVATION ______
WATER LEVEL Dry (TERMINATION OF BORING) WATER LEVEL ______ (AT 24 HRS.)
DEPTH OF CASING NA WATER LOSSES NA THICKNESS OF TOPSOIL <4"
CASING DIAMETER NA TYPE NA TERMINATION OF BORING DEPTH 15 FEET
INDICATE IF AUGER REFUSAL/TRICONE REFUSAL

DEPTH FROM	DEPTH TO	HARDNESS	COLOR	MOIST.	TYPE MATERIAL	PENETRATION TEST RESULTS NO	DEPTH	6"	12"	18"
0	3	FIRM	TAN	V. MOIST	SA SI CLAY					
					LOW PLASTICITY W/ FINE GRAV.					
3	10	FIRM	TAN-ORG.	MOIST	SA SI CLAY CL-ML					
					LOW PLASTICITY TR FINE GRAV					
					THIN LAYER OF DENSER MAT'L @ 5'					
10	15	FIRM	TAN-ORG	V MOIST	SAME AS ABOVE BUT V. MOIST					
					TOPSOIL < 4"					
					WELL COMPLETED @ 11:55					

FOR MONITORING WELL INSTALLATION ONLY:
STANDPIPE DIAMETER 1¼ INCHES
PVC / S.S. (CIRCLE ONE)
LENGTH OF SCREEN 5 FEET
SCREEN SLOT OPENING SIZE 0.010 INCHES

DEPTH TO TOP OF SAND 8'
DEPTH TO TOP OF SEAL 7'
STICKUP LENGTH ±3' 2'4"
TYPE BACKFILL CUTTINGS
SURFACE SEAL THICKNESS N/A
SAND USED 2 (BAGS)
CEMENT USED NA (BAGS)
PELLETS ½ (PAILS)

Depth 18'1" Dry

FIELD DRILLING RECORD

HAZEN AND SAWYER
Environmental Engineers & Scientists

BORING NO. H-14 DATE STARTED 3-4-92 DATE COMPLETED
LOCATION Halifax Co. MSW Site DIAMETER OF BORING 6" DRILL MACHINE CME 450
METHOD OF DRILLING AND SAMPLING HSA no sampling GROUND ELEVATION
DRILLER B & C (Tony) GEOLOGIST
WATER LEVEL ~~14'8"~~ 11'10" (TERMINATION OF BORING) WATER LEVEL (AT 24 HRS.)
DEPTH OF CASING / WATER LOSSES / THICKNESS OF TOPSOIL ~1'
CASING DIAMETER / TYPE / TERMINATION OF BORING DEPTH 15 FEET
INDICATE IF AUGER REFUSAL/TRICONE REFUSAL

DEPTH		SOIL DESCRIPTION				PENETRATION TEST RESULTS				
FROM	TO	HARDNESS	COLOR	MOIST.	TYPE MATERIAL	NO	DEPTH	6"	12"	18"
0	8		Red-org.	moist	sa si clay CL					
8			tan	v. moist	silt, mod. plast. ML					
					set screen 10-15'					

FOR MONITORING WELL INSTALLATION ONLY:
STANDPIPE DIAMETER 1 1/4 INCHES
PVC / S.S. (CIRCLE ONE)
LENGTH OF SCREEN 5 FEET
SCREEN SLOT OPENING SIZE .010 INCHES

DEPTH TO TOP OF SAND 9'
DEPTH TO TOP OF SEAL 8'
STICKUP LENGTH 2'10"
TYPE BACKFILL cuttings
SURFACE SEAL THICKNESS
SAND USED 1 1/2 (BAGS)
CEMENT USED / (BAGS)
PELLETS 1/2 (PAILS)

2'10
14'8"
2'10"
/ 22 10

FIELD DRILLING RECORD

HAZEN AND SAWYER
Environmental Engineers & Scientists

BORING NO. H-15 DATE STARTED 3/5/92 DATE COMPLETED ______
LOCATION Halifax MSW site DIAMETER OF BORING 6" DRILL MACHINE CME 450
METHOD OF DRILLING AND SAMPLING HSA, no samples
DRILLER Bore & Core (Tony) GEOLOGIST DG GROUND ELEVATION ______
WATER LEVEL Dry (TERMINATION OF BORING) WATER LEVEL ______ (AT 24 HRS.)
DEPTH OF CASING ______ WATER LOSSES ______ THICKNESS OF TOPSOIL ≤ 6"
CASING DIAMETER ______ TYPE ______ TERMINATION OF BORING DEPTH 20 FEET
INDICATE IF AUGER REFUSAL/TRICONE REFUSAL

DEPTH FROM	DEPTH TO	SOIL DESCRIPTION HARDNESS	COLOR	MOIST.	TYPE MATERIAL	PENETRATION TEST RESULTS NO	DEPTH	6"	12"	18"
0	8	-	Org	Sl. Moist	sli fi sa cly silt, ML-CL					
					sli incr. moist. content @ 5'					
8	20	Soft	Org	V. moist	si cly w/ tr. m-c sand CH-MH					
					v. consistent mat'l to bottom of boring					
					wetter toward bottom of hole					
		set	piezometer @ 15-20'							

FOR MONITORING WELL INSTALLATION ONLY:
STANDPIPE DIAMETER 1¼ INCHES
PVC / S.S. (CIRCLE ONE)
LENGTH OF SCREEN 5 FEET
SCREEN SLOT OPENING SIZE .010 INCHES

DEPTH TO TOP OF SAND 13
DEPTH TO TOP OF SEAL ~~[illegible]~~ 12
STICKUP LENGTH 2'1"
TYPE BACKFILL cuttings
SURFACE SEAL THICKNESS NA
SAND USED 2 (BAGS)
CEMENT USED NA (BAGS)
PELLETS ______ (PAILS)

Depth = 22'2" Dry

N. C. Department of Human Resources
Division of Health Services

MW 6S

WELL COMPLETION RECORD

[...]MPLETE ALL INFORMATION REQUESTED BELOW FOR EACH WELL INSTALLED, AND RETURN FORM TO THE N.C. DEPARTMENT OF HUMAN RESOURCES, SOLID AND HAZARDOUS WASTE MANAGEMENT BRANCH, P. O. BOX 2091, RALEIGH, N.C. 27602

SOLID WASTE SECTION
JAN 27 [...]

NAME OF SITE: Halifax County Landfill	PERMIT NO.: 41-0176-WM-0033
ADDRESS: S.R. 1417 Aurelian Springs, N.C.	OWNER (print): Halifax County
DRILLING CONTRACTOR: Bore and Core, Inc.	REGISTRATION NO.: 763

Casing Type: PVC dia. 2 in.
Casing Depth: from 3'2 to -9'8 ft. - dia. 2 in.
Screen Type: .010 slotted PVC dia. 2 in.
Screen Depth: from -9'8 to -23' ft. - dia. 2 in.

Grout Depth: from 0 to -6' ft. - dia. 7 in.
Bentonite Seal: from -6 to -7' ft. - dia. 7 in.
Sand/Gravel PK: from -7 to -23 ft. - dia. 7 in.
Total Well Depth: from 3 to -23' ft. - dia. 7 in.

Static Water Level: 11'4" below ground surface ~~feet from top of casing~~ Date Measured 1 / 6 / 92

Yield (gpm): ______ Method of Testing: ______ Casing is ______ feet above land surface

DRILLING LOG

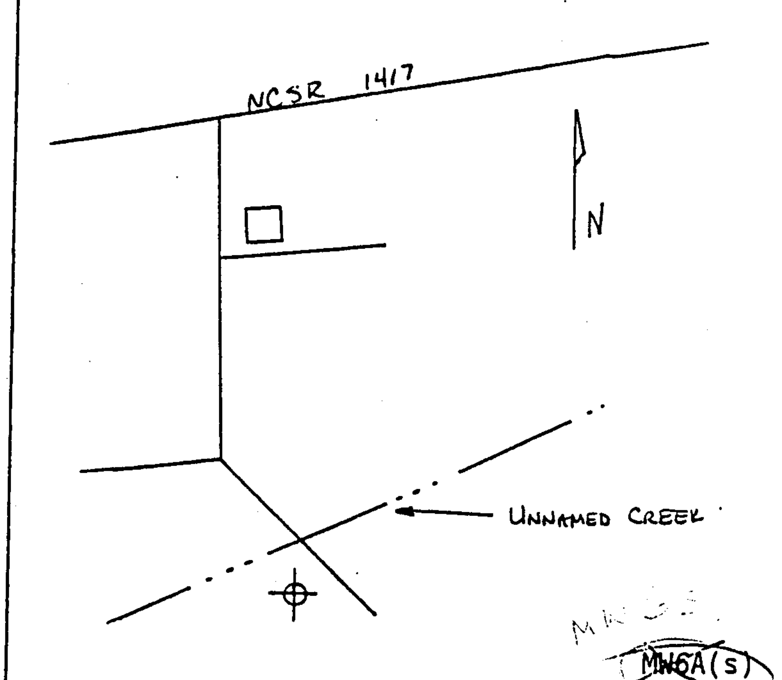
DEPTH FROM	TO	FORMATION DESCRIPTION
0.0	8.4	Brown fine sandy silt
8.4	23.0	Wet, brown, silty fine
		to medium sand

Well numbering scheme changed on 12-13-93 to match scheme used during past sampling episodes.

LK

LOCATION SKETCH

(show distance to numbered roads, or other map reference points)



REMA[...]

DATE: 1/6/92 SIGNATURE: John D Barnard

S 3342 (6/85)
Solid & Hazardous Waste Management Branch

MW 6S
MW 6S

TEST BORING FIELD REPORT

Name Halifax County Landfill Aurelian Springs, N.C. Job No. MW-7 3720

Field Supervisor Tony Crew Ken Hrs. Drilling ____ Hrs. Moving ____ Boring # ~~MW6A(S)~~

Date 1/6/92 Weather Cool Ground Surface Elevation ____

Soil Strata			Sampling/Blows per Ft				
From	To	Soil Description and Remarks	No.	Depth	1st6"	2nd6"	3rd
.0	8.4	Brown fine sandy silt					
.4	23.0	Wet brown silty fine to medium sand/gravel B.T. 23.0'					
		Set 2"x 15' screen at 23.0 with 10' riser 4 bags sand					
		½ bucket bentonite, grout to top, 1 2" locking cap 1 4"x 5'					
		protective casing					

Water Level 11'4" at TOB

Water Level ____ at ____

Water Level ____ at 24 Hours

Water Losses ____

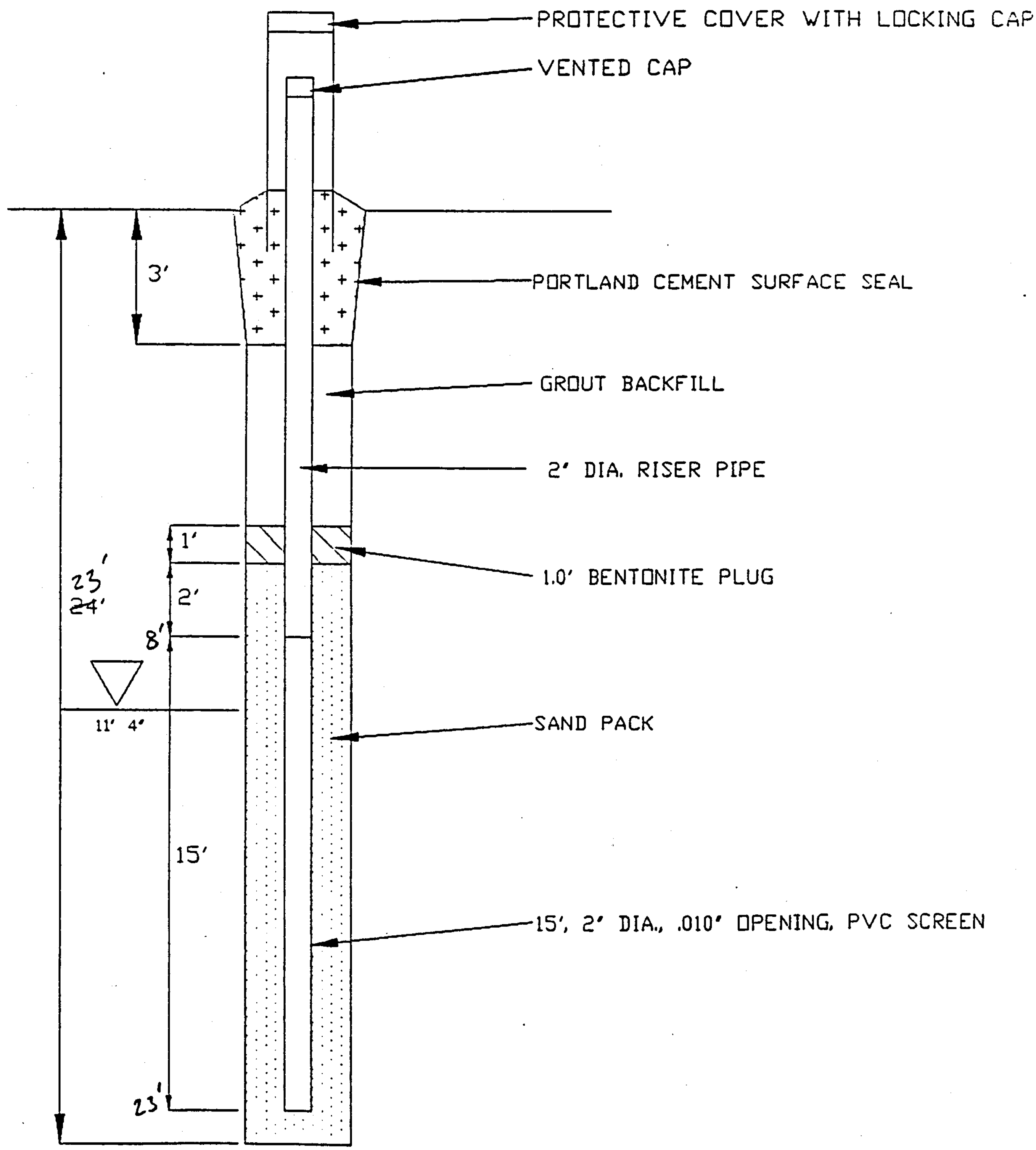
Casing, Size ____ Length ____

Note: (Record Methods of Drilling & Depths)

CME 450 ATV
4¼" I.D. H.S.A.
0.0' - 23.0'

TYPICAL MONITORING WELL SCHEMATIC

PROJECT HALIFAX COUNTY LANDFILL VERTICAL EXPANSION
WELL NUMBER MW-6a(s)



Division of Health Services

WELL COMPLETION RECORD

MW-6A MW-6d

PLETE ALL INFORMATION REQUESTED BELOW FOR EACH WELL INSTALLED, AND RETURN FORM TO THE N.C.
ARTMENT OF HUMAN RESOURCES, SOLID AND HAZARDOUS WASTE MANAGEMENT BRANCH,
BO 2091, RALEIGH, N.C. 27602

E OF SITE: alifax County Sanitary Landfill	PERMIT NO.: 41-0176-WM-0033
RESS: .R. 1417 Aurelian Springs, N.C.	OWNER (print): Halifax County
LING CONTRACTOR: ore & Core, Inc.	REGISTRATION NO.: 763

; Type: PVC dia. 2 in.
; Depth: from 2' to -25 ft. - dia. 2 in.
ı Type: slotted .010 dia. 2 in.
ı Depth: from -25 to -40 ft. - dia. 2 in.

Grout Depth: from 0' to -21' ft. - dia. 4 in.
Bentonite Seal: from -21' to -23 ft. - dia. 4 in.
Sand/Gravel PK: from -23 to -40 ft. - dia. 4 in.
Total Well Depth: from 2' to -41 ft. - dia. 4 in.

Water Level: 11' 7" Below ground surface ~~feet from top of casing~~ Date Measured 11 / 26 / 91

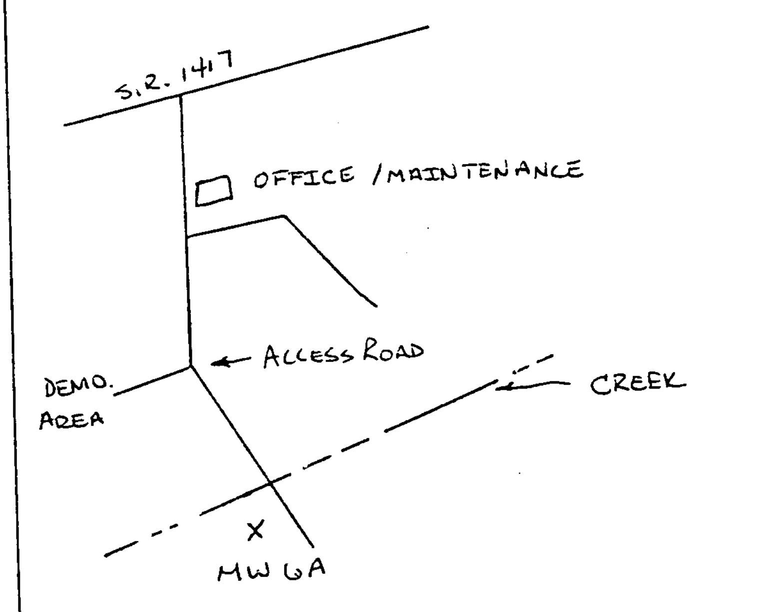
(gpm): ______ Method of Testing: ______ Casing is ______ feet above land surface

DRILLING LOG

DEPTH OM	TO	FORMATION DESCRIPTION
.0	2.8	Brown fine sandy silt
2.	10.6	Brown medium to fine silt
.0.6	22.4	Damp DrkBr.Med. sandy silt
2.4	40.0	Wet Br. fine sandy silt

LOCATION SKETCH

(show distance to numbered roads, or other map reference points)



MARKS: Well screened too deep.
Static water level is above the screen.

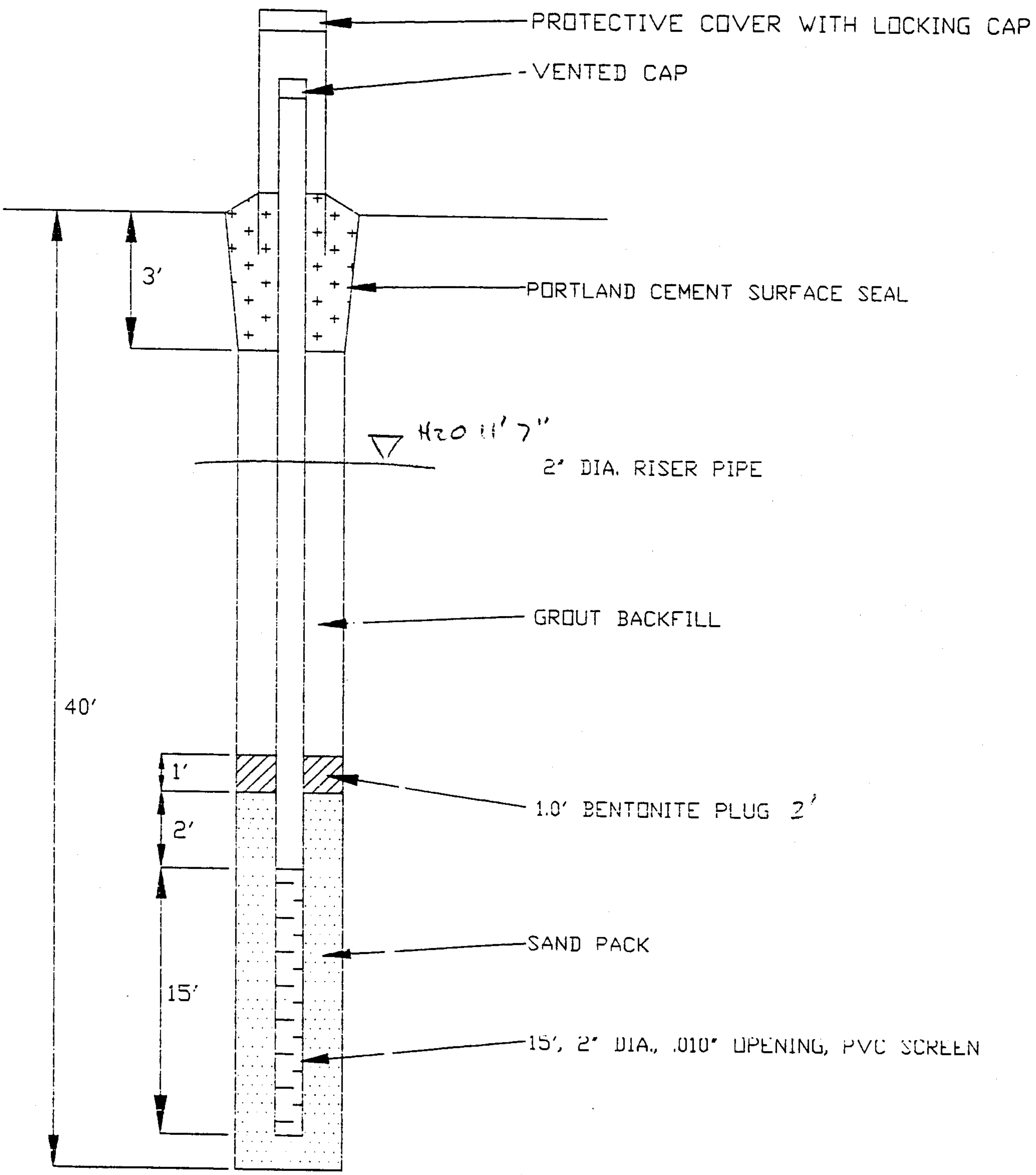
T______ SIGNATURE: ______

3342 (6/85)
& Hazardous Waste Management Branch

TYPICAL MONITORING WELL SCHEMATIC

PROJECT HALIFAX COUNTY LANDFILL VERTICAL EXPANSION
WELL NUMBER MW-6A

6d



TEST BORING FIELD REPORT

MW 6d

, Name Halifax County Landfill Vertical Expansion Job No. ______

i Supervisor Tony Crew Ben Hrs. Drilling ____ Hrs. Moving ____ Boring # MW6

ate 10/30/91 Weather ______________ Ground Surface Elevation ______

		Soil Strata	Sampling/Blows per Ft.				
om	To	Soil Description and Remarks	No.	Depth	1st6"	2nd6"	3rd6
.0	2.8	Brown fine sandy silt w/rocks					
.8	10.6	Brown medium to fine sandy silt					
.6	22.4	Damp dark brown medium sandy silt					
.4	40.0	Wet brown fine sandy silt					
		B.T. 40.0					
		Set 2"x15' PVC screen at 40.0 with 30' PVC riser 4 bags					
		sand, ½ bucket bentonite 1 2" locking cap, 1 4"x5'					
		protective casing					

ter Level ______ at TOB

ter Level ______ at ______

ter Level ______ at 24 Hours

t Losses ______

sing, Size ______ Length ______

Note: (Record Methods of Drilling & Depths)

CME 450 ATV

$4\frac{1}{4}$" ID hollow stem auger

0.0 - 40.0

N. C. Department of Human Resources
Division of Health Services

MW 7s

WELL COMPLETION RECORD

(CO)MPLETE ALL INFORMATION REQUESTED BELOW FOR EACH WELL INSTALLED, AND RETURN FORM TO THE N.C DEPARTMENT OF HUMAN RESOURCES, SOLID AND HAZARDOUS WASTE MANAGEMENT BRANCH P. O. BOX 2091, RALEIGH, N.C. 27602

NAME OF SITE: Halifax County Landfill	PERMIT NO.: 41-0176-WW-0033
ADDRESS: S.R. 141/ Aurelian Springs, NC	OWNER (print): Halifax County
DRILLING CONTRACTOR: Bore and Core, Inc.	REGISTRATION NO.: 763

Casing Type: PVC dia. 2 in.
Casing Depth: from 2.5 to -2.5 ft. - dia. 2 in.
Screen Type: .010 slotted PVC dia. 2 in.
Screen Depth: from -2.5 to -17.5' ft. - dia. 2 in.

Grout Depth: from 0 to -1 ft. - dia. 7 in.
Bentonite Seal: from -1 to -2 ft. - dia. 7 in.
Sand/Gravel PK: from -2 to -17 ft. - dia. 7 in.
Total Well Depth: from 2.5 to -17.5 ft. - dia. 7 in

Static Water Level: 3'2" below ground surface ~~feet from top of casing~~

Thin sand pack between bentonite + screen.

Date Measured 1 / 7 / 92

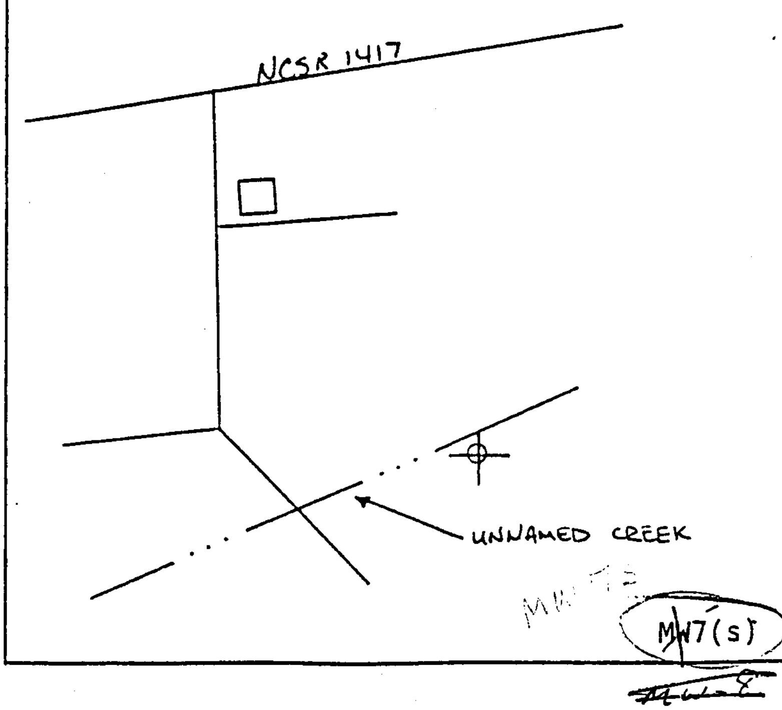
Yield (gpm): ______ Method of Testing: ______ Casing is ______ feet above land surface

DRILLING LOG

DEPTH FROM	TO	FORMATION DESCRIPTION
0.0	3.4	Brown fine to medium sandy silt
3.4	17.0	Damp brown fine to medium sand/gravel

LOCATION SKETCH

(show distance to numbered roads, or other map reference points)



REMARKS: ______

DATE: 1-7-92 SIGNATURE: John D Barnard

HS 3342 (6/85)

MW 7S

TEST BORING FIELD REPORT

Name Halifax County Landfill - Aurelian Springs, N.C. Job No. ~~MW7~~ 3720

Field Supervisor Tony Crew Ken Hrs. Drilling ____ Hrs. Moving ____ Boring # MW7-S

Date 1-7-92 Weather Cool Ground Surface Elevation ____

Soil Strata			Sampling/Blows per F				
rom	To	Soil Description and Remarks	No.	Depth	1st6"	2nd6"	3r
0.0	3.4	Brown fine to medium sandy silt					
3.4	17.0	Damp brown fine to medium sand/gravel B.T. 17.0					
		Set 2"x 15' screen at 17.~~0~~5' with 5.0' riser 4 bags					
		sand, ½ bucket bentonite, grout to top. 1, 2" locking cap					
		1, 4"x 5' protective casing.					

ter Level 3'2" at TOB

t Level ____ at ____

t Level ____ at 24 Hours

ter Losses ____

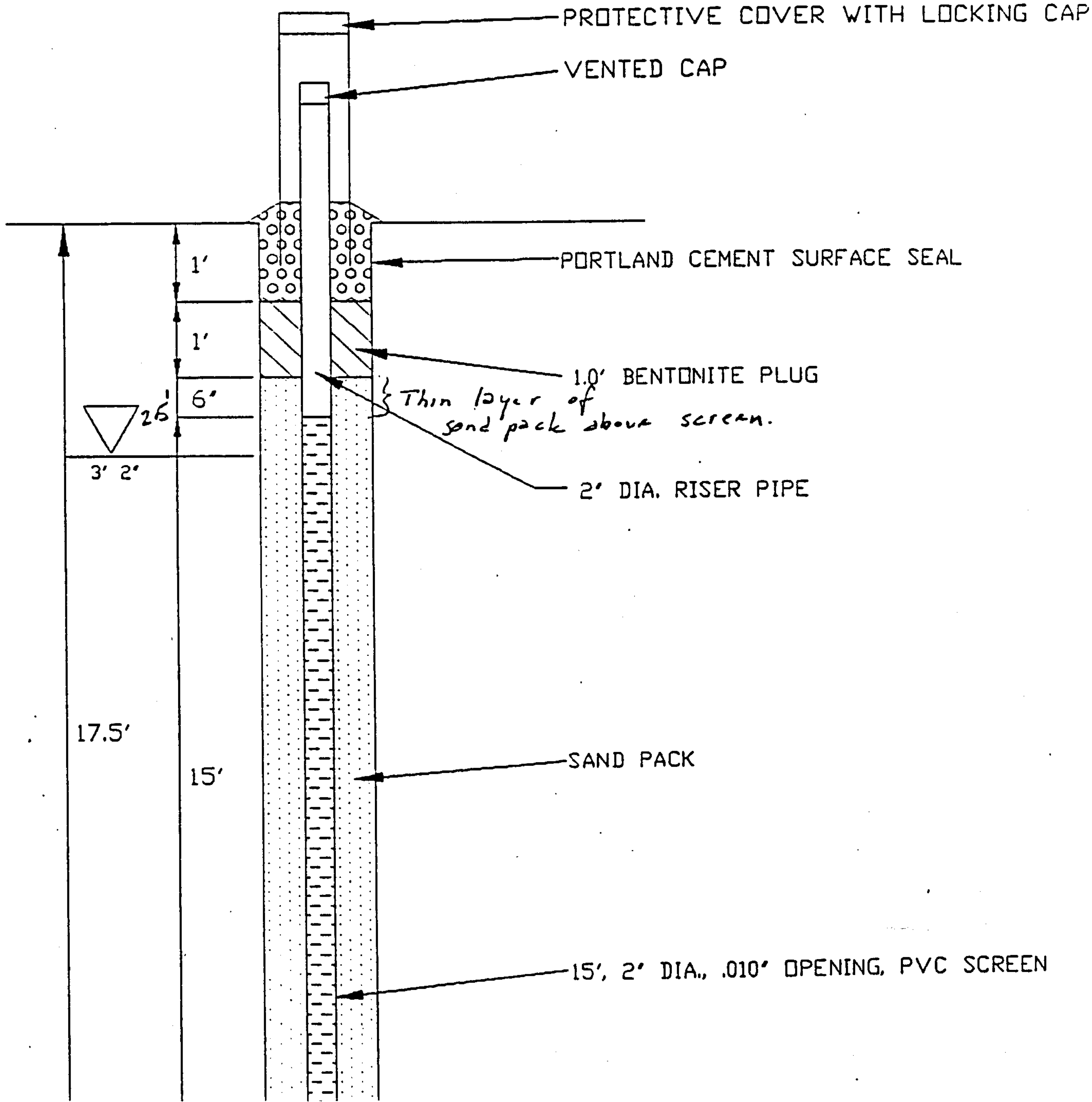
sing, Size ____ Length ____

Note: (Record Methods of Drilling & Depths)

CME 450 ATV
4¼" I.D. H.S.A.
0.0' - 17.0'

TYPICAL MONITORING WELL SCHEMATIC

PROJECT HALIFAX COUNTY LANDFILL VERTICAL EXPANSION
WELL NUMBER MW-7(s) ✓



Division of Health Services

WELL COMPLETION RECORD

MW-7 MW-7d

PLETE ALL INFORMATION REQUESTED BELOW FOR EACH WELL INSTALLED, AND RETURN FORM TO THE N.C. ARTMENT OF HUMAN RESOURCES, SOLID AND HAZARDOUS WASTE MANAGEMENT BRANCH, BO 2091, RALEIGH, N.C. 27602

E OF SITE: lifax County Sanitary Landfill	PERMIT NO.: 41-0176-WM-0033
RESS: R. 1417 Aurelian Springs, N.C.	OWNER (print): Halifax County
LING CONTRACTOR: re & Core, Inc.	REGISTRATION NO.: 763

g Type:	PVC dia. 2 in.	Grout Depth:	from 0 to -21' ft. - dia. 4" in.
g Depth:	from 2 to -25 ft. - dia. 2 in.	Bentonite Seal:	from -21' to -23' ft. - dia. 4" in.
n Type:	slotted PVC .010 dia. 2 in.	Sand/Gravel PK:	from -23' to 40' ft. - dia. 4" in.
n Depth:	from -25 to -40 ft. - dia. 2 in.	Total Well Depth:	from 2' to -40' ft. - dia. 4" in.

Water Level: 3' 11" Below ground surface feet from top of casing

Date Measured 11 / 26 / 91

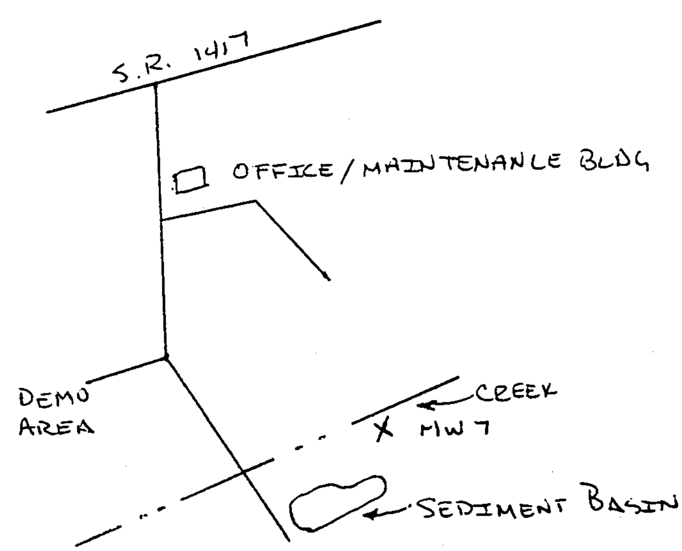
(gpm): ______ Method of Testing: ______ Casing is ______ feet above land surface

DRILLING LOG

DEPTH FROM	TO	FORMATION DESCRIPTION
	1.4	Brown fine sandy silt
.4	6.7	Brown fine sandy silt
.7	14.3	Damp DrkBr. fine very sandy silt.
4.3	40.0	Wet Brown medium sandy silt/gravel

LOCATION SKETCH

(show distance to numbered roads, or other map reference points)



MARKS: Well screened too deep.
Static water table is above the screen.

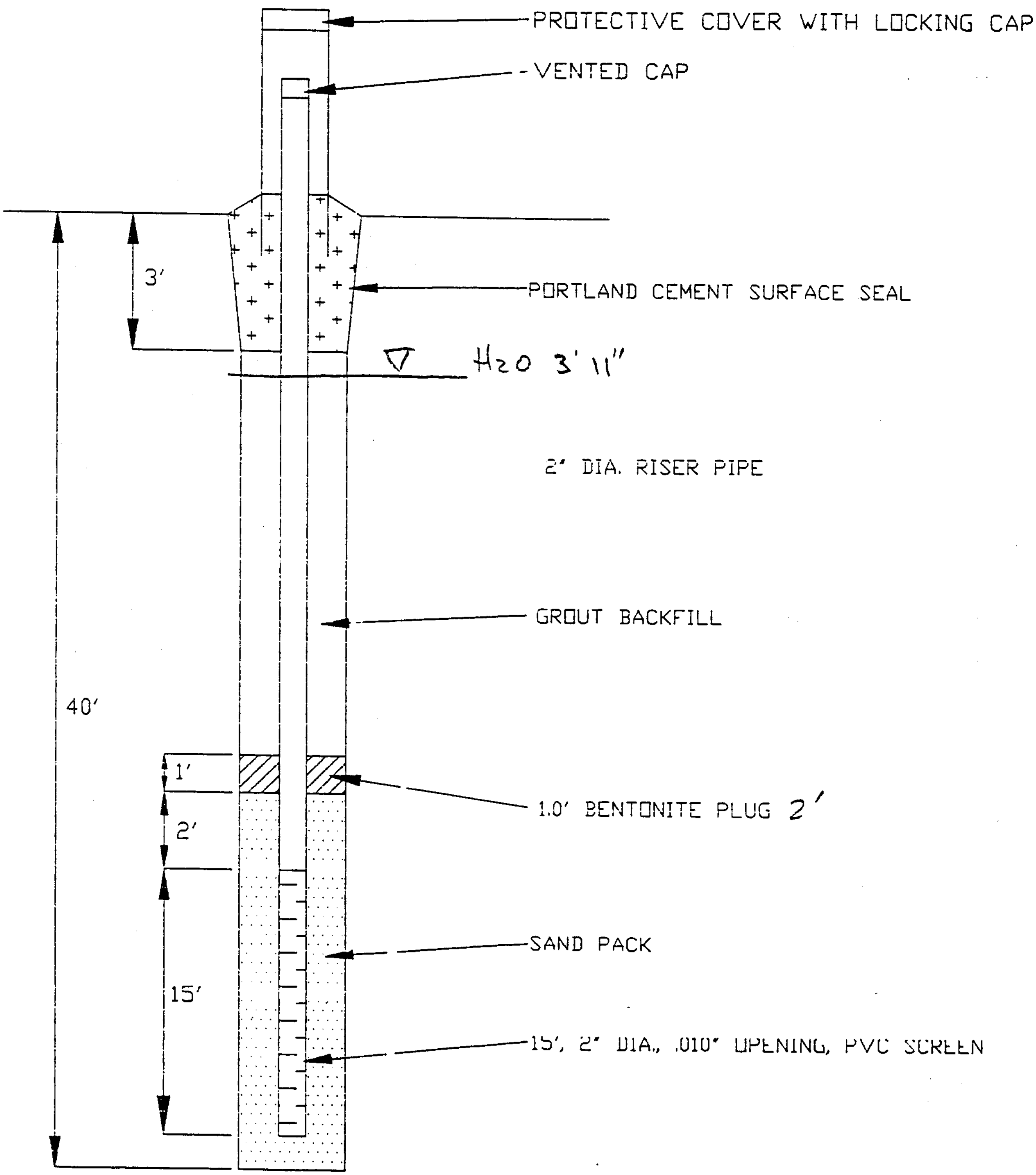
T ______ SIGNATURE: ______

3342 (6/85)
& Hazardous Waste Management Branch

TYPICAL MONITORING WELL SCHEMATIC

PROJECT HALIFAX COUNTY LANDFILL VERTICAL EXPANSION
WELL NUMBER MW-7

7d



TEST BORING FIELD REPORT

MW7d

ɟ Name Halifax County Landfill Vertical Expansion Job No. ______

d Supervisor Tony Crew Ben Hrs. Drilling ____ Hrs. Moving ____ Boring # MW7

Date 10/31/91 Weather ______ Ground Surface Elevation ______

Soil Strata			Sampling/Blows per Ft				
rom	To	Soil Description and Remarks	No.	Depth	1st6"	2nd6"	3rd6
).0	1.4	Brown fine sandy silt with roots					
.4	6.7	Brown fine sandy silt					
.7	14.3	Damp dark brown fine very sandy silt					
.3	40.0	Wet brown medium sandy silt with gravel B.T. 40.0					
		Set 2" PVC screen (15') at 40.0 with 30' PVC riser 4 bags					
		sand, ½ bucket Bentonite 1 2" locking cap, 1 4"x5'					
		protective casing					

ater Level ______ at TOB

ater Level ______ at ______

ater Level ______ at 24 Hours

a Losses ______

asing, Size ______ Length ______

Note: (Record Methods of Drilling & Depths)

CME 450 ATV
4¼" ID hollow stem auger
0.0 - 40.0

parratt wolff inc

TEST BORING LOG

ONE COPLEY PARKWAY
RALEIGH, NC 27623

PROJECT Coal Ash Monofill
LOCATION Halifax County, North Carolina
DATE STARTED 1/5/94 DATE COMPLETED 1/5/94

HOLE NO. MW-9
SURF. EL.
JOB NO. 94009NC

GROUND WATER DEPTH
WHILE DRILLING 17.0'
BEFORE CASING REMOVED 16.3'
AFTER CASING REMOVED Installed Well

N — NO. OF BLOWS TO DRIVE SAMPLER 12" W/140# HAMMER FALLING 30" — ASTM D-1586, STANDARD PENETRATION TEST

C — NO. OF BLOWS TO DRIVE CASING 12" W/ # HAMMER FALLING "/OR — % CORE RECOVERY

CASING TYPE - HOLLOW STEM AUGER
DRILLER'S FIELD LOG

SHEET 1 OF 1

DEPTH	SAMPLE DEPTH	SAMPLE NUMBER	C	SAMPLE DRIVE RECORD PER 6"	N	DESCRIPTION OF MATERIAL	STRATA CHANGE DEPTH
	0.0'-	1		5/7		Red-brown-white moist very stiff CLAY, some silt, trace fine gravel, trace fine to coarse sand, trace roots	
	1.5'			18	25		
5.0							5.0'
	5.0'-	2		7/10		Red-brown-white moist very stiff CLAY, little silt, little fine to medium gravel, trace fine to coarse sand	
	6.5'			8	18		
10.0							
	10.0'-	3		5/7			
	11.5'			9	16		
15.0							
	15.0'-	4		6/8			
WL ▼	16.5'			11	19		
20.0							20.0'
	20.0'-	5		9/16		Red-white wet very stiff CLAY, little silt, little fine to medium gravel, little fine to coarse sand	
	21.5'			11	27		
25.0							
						Bottom of Boring	25.0'
						Note: Installed 2" PVC 10 slot screen 25.0' to 10.0', 2" PVC riser to surface with standpipe protective casing.	

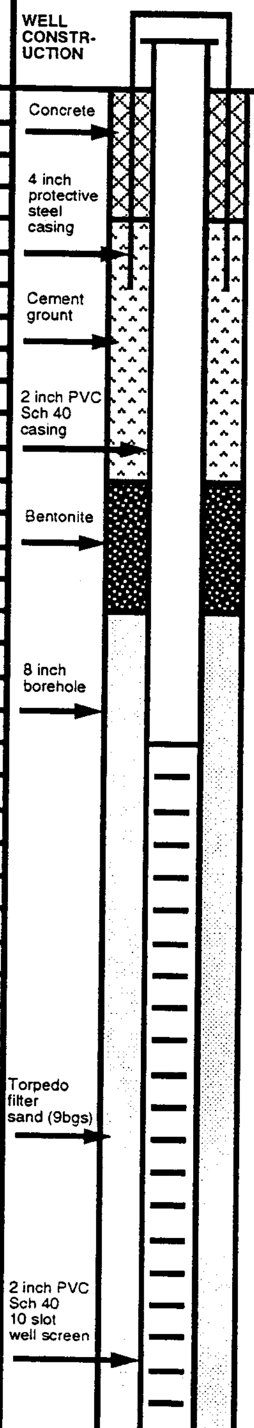
TEST BORING - WELL CONSTRUCTION LOG

PROJECT	Halifax County Ash Landfill	WELL NO.	MW-9
CLIENT	Halifax County	SHEET 1 OF 2	
DRILLING CONTRACTOR	Parratt Wolff, Inc.	JOB NO.	931210
PURPOSE	Monitoring Well for Ash Landfill	ELEV.	MP / GR

GROUND WATER					CASING	SAMPLE	CORE	WELL	DATUM	
DATE	TIME	DEPTH	CASING	TYPE					STARTED	1/5/94
1-10-94	1015	9.31'		DIAMETER					COMPLETED	1/6/94
				WEIGHT					DRILLER	Dave Stratton
				FALL					GEOLOGIST	Mac Armstrong

DEPTH FEET	SAMPLE NUMBER	BLOWS PER 6"	IDENTIFICATION	REMARKS
0	S-1	5, 7, 18	Red brown sandy clayey silt (ML) dry	CME 55 rig drilled borehole using 8 inch outside diameter 4 1/4 inch inside diameter hollow stem augers
				Well casing and screen installed through augers
5	S-2	7, 10, 8	Red brown sandy silt to sandy silty clay with pieces of rock (ML to CL) dry	
				Water at 9.31 feet after 5 days
10	S-3	5, 7, 9	Red brown silty clayey sand to sandy clay (SM to CL) moist (partially weathered rock)	
15	S-4	6, 8, 11	Tan to brown silty clayey sand (SM) moist (partially weathered rock)	Water at 16 feet after one hour
20				

WELL CONSTRUCTION



TEST BORING - WELL CONSTRUCTION LOG

PROJECT	Halifax County Ash Landfill	WELL NO.	MW-9
CLIENT	Halifax County	JOB NO. 931210	SHEET 2 OF 2

DEPTH FEET	SAMPLE NUMBER	BLOWS PER 6"	WELL CONSTRUCTION	IDENTIFICATION	REMARKS
	S-5	9 16 11		Tan, brown, pink weathered rock	
25				Total depth at 25 feet	
30					
35					
40					
45					

parratt wolff inc

TEST BORING LOG

ONE COPLEY PARKWAY
RALEIGH, NC 27623

PROJECT Coal Ash Monofill
LOCATION Halifax County, North Carolina
DATE STARTED 1/10/94 DATE COMPLETED 1/10/94

HOLE NO. MW-10
SURF. EL.
JOB NO. 94009NC

GROUND WATER DEPTH
WHILE DRILLING 4.0'
BEFORE CASING REMOVED 5.3'
AFTER CASING REMOVED Installed Well

N — NO. OF BLOWS TO DRIVE SAMPLER 12" W/140# HAMMER FALLING 30" — ASTM D-1586, STANDARD PENETRATION TEST

C — NO. OF BLOWS TO DRIVE CASING 12" W/ # HAMMER FALLING "/OR — % CORE RECOVERY

CASING TYPE - HOLLOW STEM AUGER
DRILLER'S FIELD LOG

SHEET 1 OF 1

DEPTH	SAMPLE DEPTH	SAMPLE NUMBER	C	SAMPLE DRIVE RECORD PER 6"	N	DESCRIPTION OF MATERIAL	STRATA CHANGE DEPTH
	0.0'-	1		1/1		Red-brown moist very soft SILT, little clay	
	1.5'			1	2		
WL ▼ 5.0							4.0'
	5.0'-	2		2/3		Brown wet loose fine to coarse SAND, some fine to medium gravel, trace silt	
	6.5'			2	5		
10.0							10.0'
	10.0'-	3		2/3		Brown moist loose to medium dense fine to coarse SAND, some weathered granite	
	11.5'			4	7		
15.0							
	15.0'-	4		4/6			
	16.5'			7	13	Bottom of Boring	16.5'
20.0						Note: Installed 2" PVC 10 slot screen 15.0' to 5.0', 2" PVC riser to surface with standpipe protective casing.	

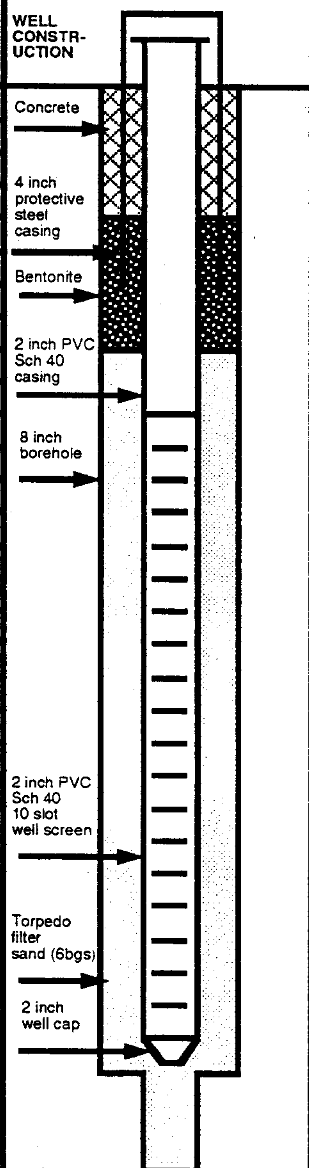
TEST BORING - WELL CONSTRUCTION LOG

PROJECT	Halifax County Ash Landfill	**WELL NO.**	MW-10
CLIENT	Halifax County	**SHEET 1 OF**	1
DRILLING CONTRACTOR	Parratt Wolff, Inc.	**JOB NO.**	931210
PURPOSE	Monitoring Well for Ash Landfill	**ELEV.**	MP / GR

GROUND WATER					CASING	SAMPLE	CORE	WELL	DATUM	
DATE	TIME	DEPTH	CASING	TYPE					STARTED	1/10/94
1-11-94	1315	3.75'		DIAMETER					COMPLETED	1/10/94
				WEIGHT					DRILLER	Dave Stratton
				FALL					GEOLOGIST	Mac Armstrong

DEPTH FEET	SAMPLE NUMBER	BLOWS PER 6"	IDENTIFICATION	REMARKS
0–1.5	S-1	1, 1, 11	Brown sandy clayey silt (ML) wet	CME 55 rig drilled borehole using 8 inch outside diameter 4 1/4 inch inside diameter hollow stem augers Water at 3.75 feet after 26 hours Well casing and screen installed through augers
5	S-2	2, 3, 2	Brown silty sand with pieces of rock (SM) wet	
10	S-3	2, 3, 4	Brown to pink silty sand (SM) wet (partially weathered rock)	
15	S-4	4, 6, 7	Partially weathered rock	
			Total depth at 16.5 feet	
20				

WELL CONSTRUCTION



Appendix G

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

R. Sherwood Core, CET
Construction Services Manager

Edward B. Hearn, P.E.
President

RSC/fgo
Attachments

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

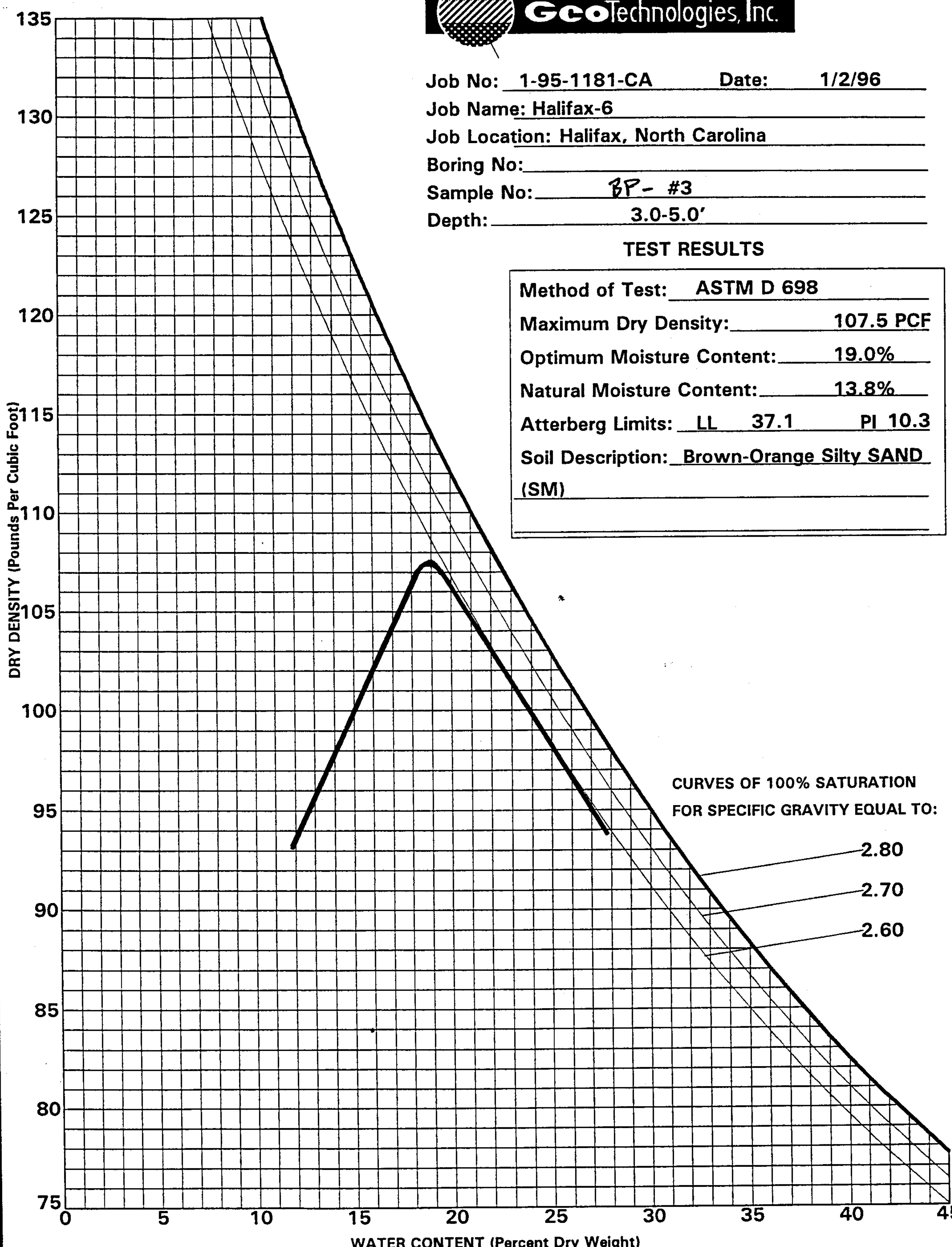
Maximum Dry Density: 107.5 PCF

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

GeoTechnologies, Inc.

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

Job Name: Halifax-6

Job Location: Halifax, North Carolina

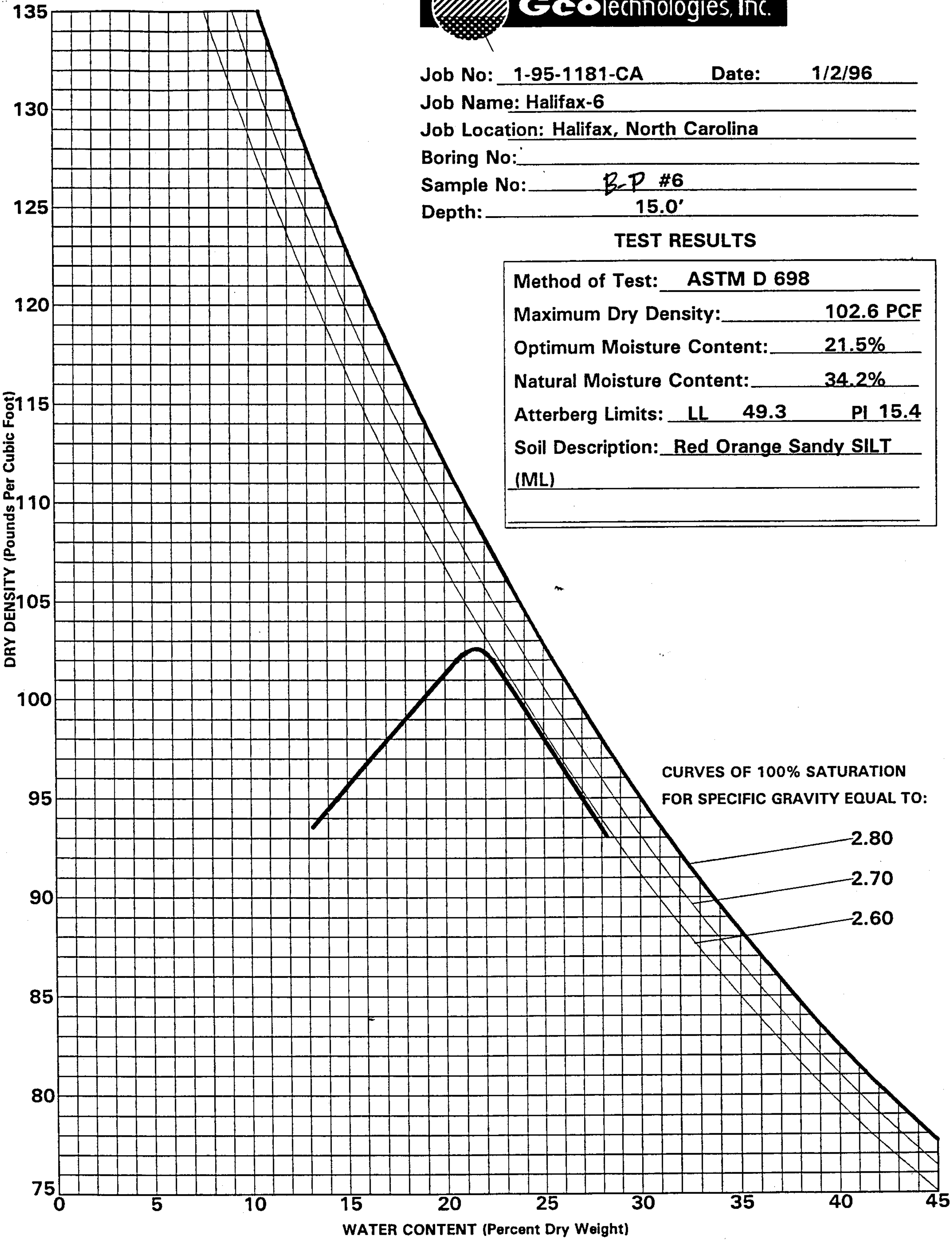
Boring No:

Sample No: B-P #6

Depth: 15.0'

TEST RESULTS

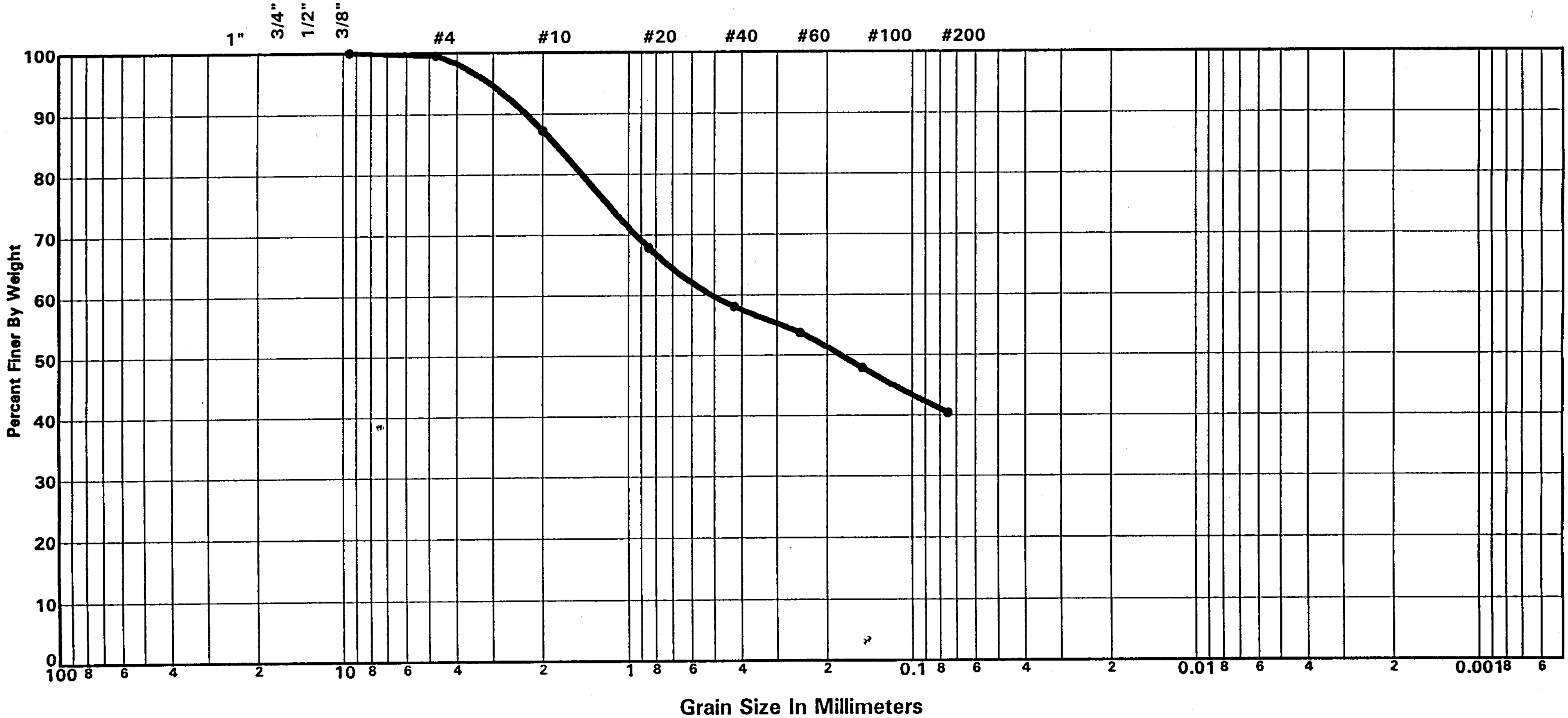
Method of Test:	ASTM D 698
Maximum Dry Density:	102.6 PCF
Optimum Moisture Content:	21.5%
Natural Moisture Content:	34.2%
Atterberg Limits:	LL 49.3 PI 15.4
Soil Description:	Red Orange Sandy SILT (ML)



MOISTURE-DENSITY RELATIONSHIP

Geotechnologies, Inc.

Raleigh, North Carolina



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)

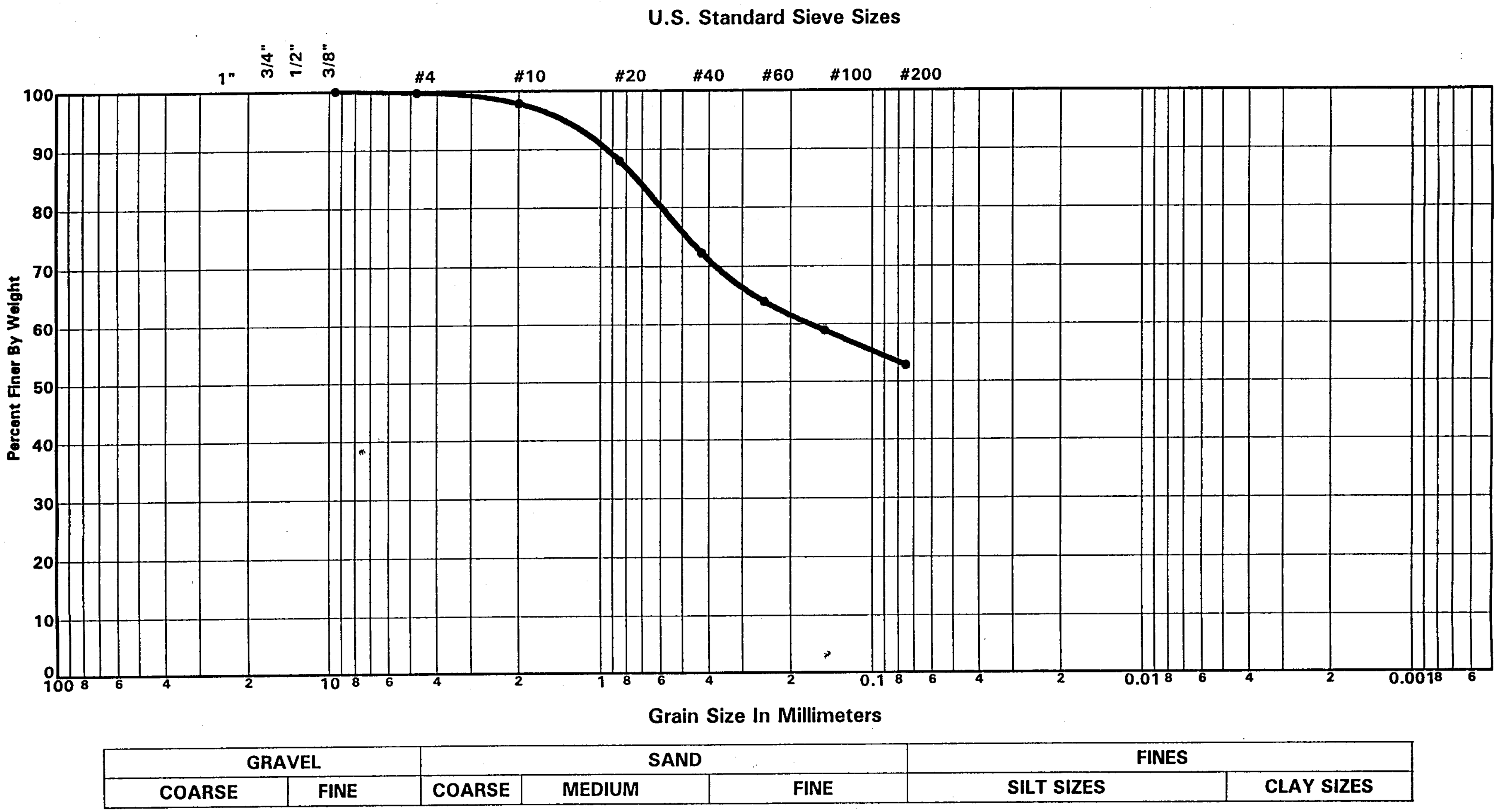
Project:
Halifax-6
Halifax, North Carolina

Job No.: 1-95-1181-CA

Date: 1/2/96

GRAIN SIZE DISTRIBUTION

GeoTechnologies, Inc.



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)

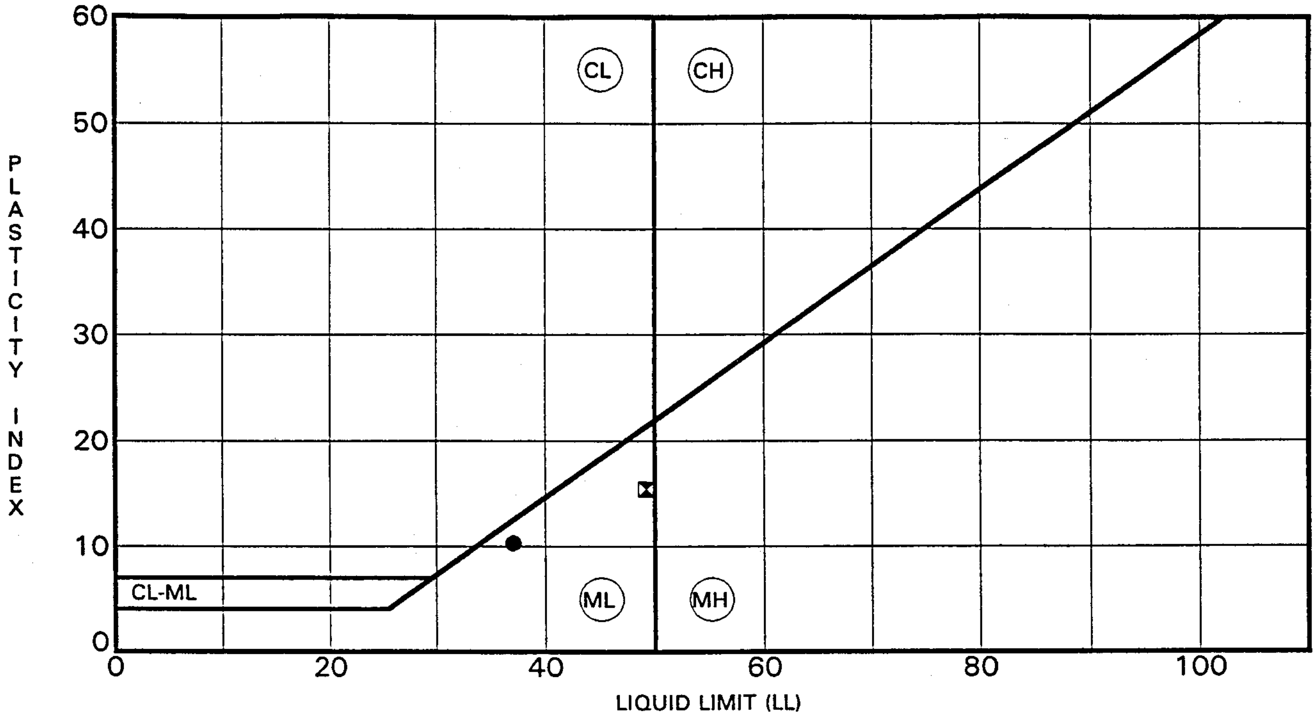
Project:
Halifax-6
Halifax, North Carolina

Job No.: 1-95-1181-CA

Date: 1/2/96

GRAIN SIZE DISTRIBUTION

GeoTechnologies, Inc.



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

GeoTechnologies, Inc.

PERMEABILITY TEST

Job Number:	1-95-1181 CA	Job Name:	HALIFAX - 6		
Date:	12/23/95	Sample I.D.	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.				
				Moisture Content	**22**	%
				Wet Density	**125.1**	lbs./cu.ft.
Length	**2.861**	**7.267**		Dry Density	**102.5**	lbs./cu.ft.
Diameter	**2.852**	**7.244**		Initial Saturation	**89.7**	%
Area	**6.388**	**41.214**		Final Saturation	**100.0**	%
Volume	**18.277**	**299.504**		Initial Void Ratio	**0.7**	
Wet Mass	**1.323**	**600.16**	grams	Porosity	**40.3**	%
Dry Mass	**1.0845**	**491.9**	grams	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.	6	**Depth:**	15'

Soil Description: RED ORANGE SANDY SILT

SAMPLE DATA

type		standard proctor	
remolded	( )	Max. Dry Density	102.6 lbs/cu.ft.
undisturbed	(X)	Moisture Content	21.5 %
		Compaction	95.1 %

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

TEST DATA

	L =	7.46 cm.	length of sample
hi = inflow burette	A =	41.534 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	

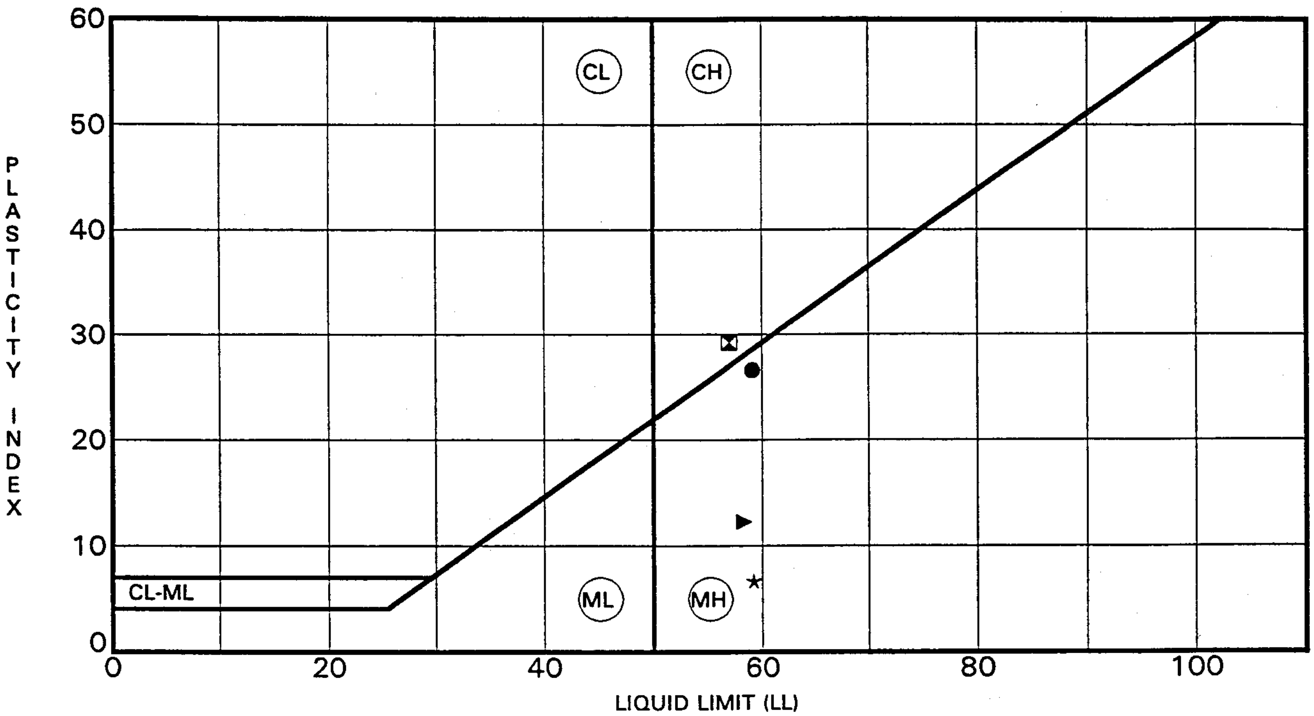
t1	t2	ho1	hi1	h1	ho2	hi2	h2
0	**5700**	93.9	0.9	**93**	93.4	1.4	**92**
0	**3900**	93.4	1.4	**92**	93.1	1.8	**91.3**
0	**4500**	93.1	1.8	**91.3**	92.7	2.1	**90.6**
	74400	92.7	2.1	**90.6**	86.5	8.5	**78**

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



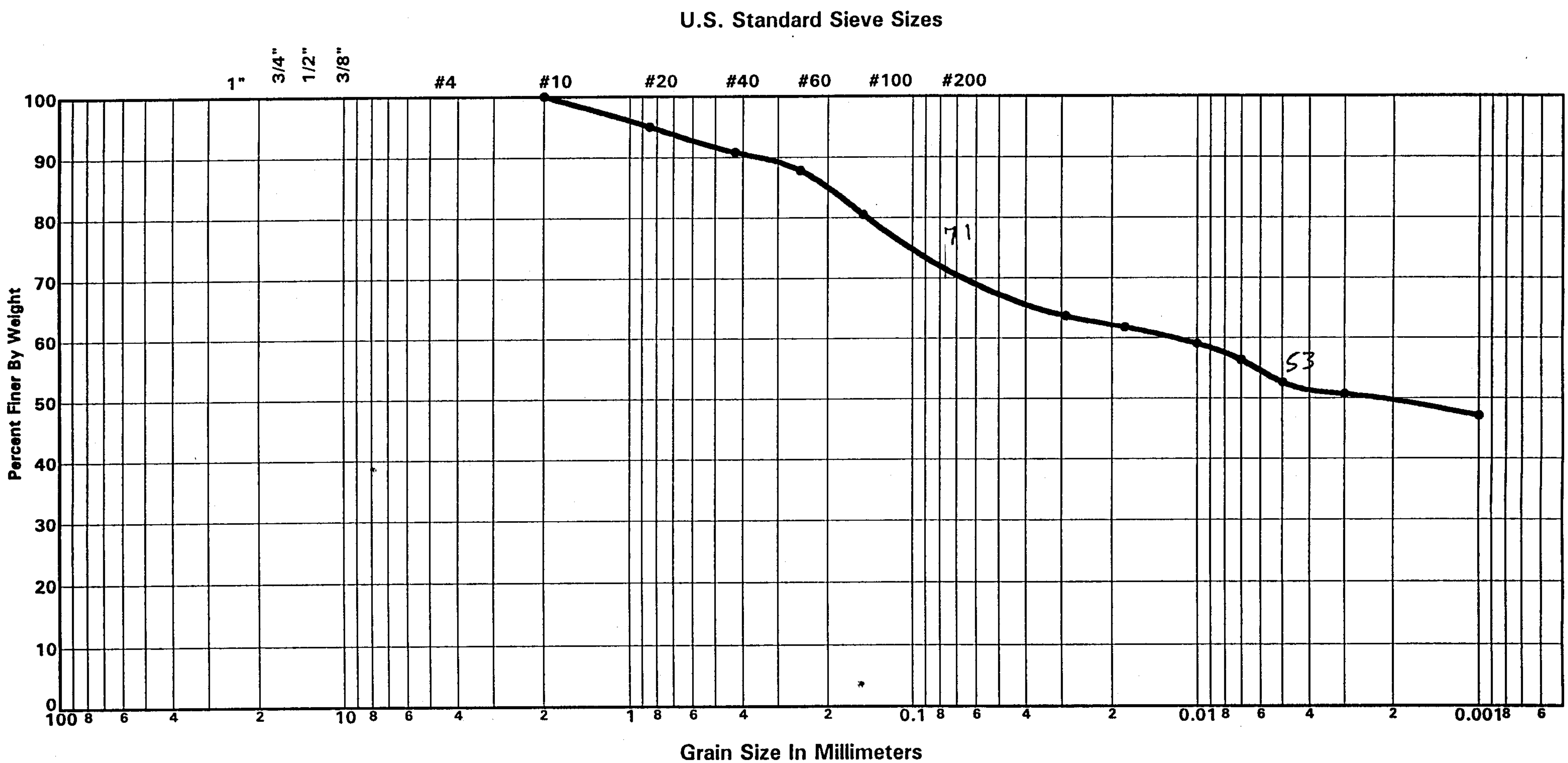
	Specimen Identification		LL	PL	PI	Fines	Classification
●	BP #1 - 1	0-1.5'	59	33	27		Tan Slightly Sandy CLAY (MH)
⊠	BP #2 - 1	0-1.5'	57	28	29		Tan-Orange Slightly Sandy CLAY (CH)
▶	BP #6-1	0-1.5'	58	46	12		Brown Orange Slightly Fine Sandy SILT (MH)
★	BP #6-2	3.5-5.0'	59	53	7		Brown Micaceous Slightly 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
#1	0-1.5'		59.1	32.5	26.6	Tan Slightly Sandy CLAY (MH)

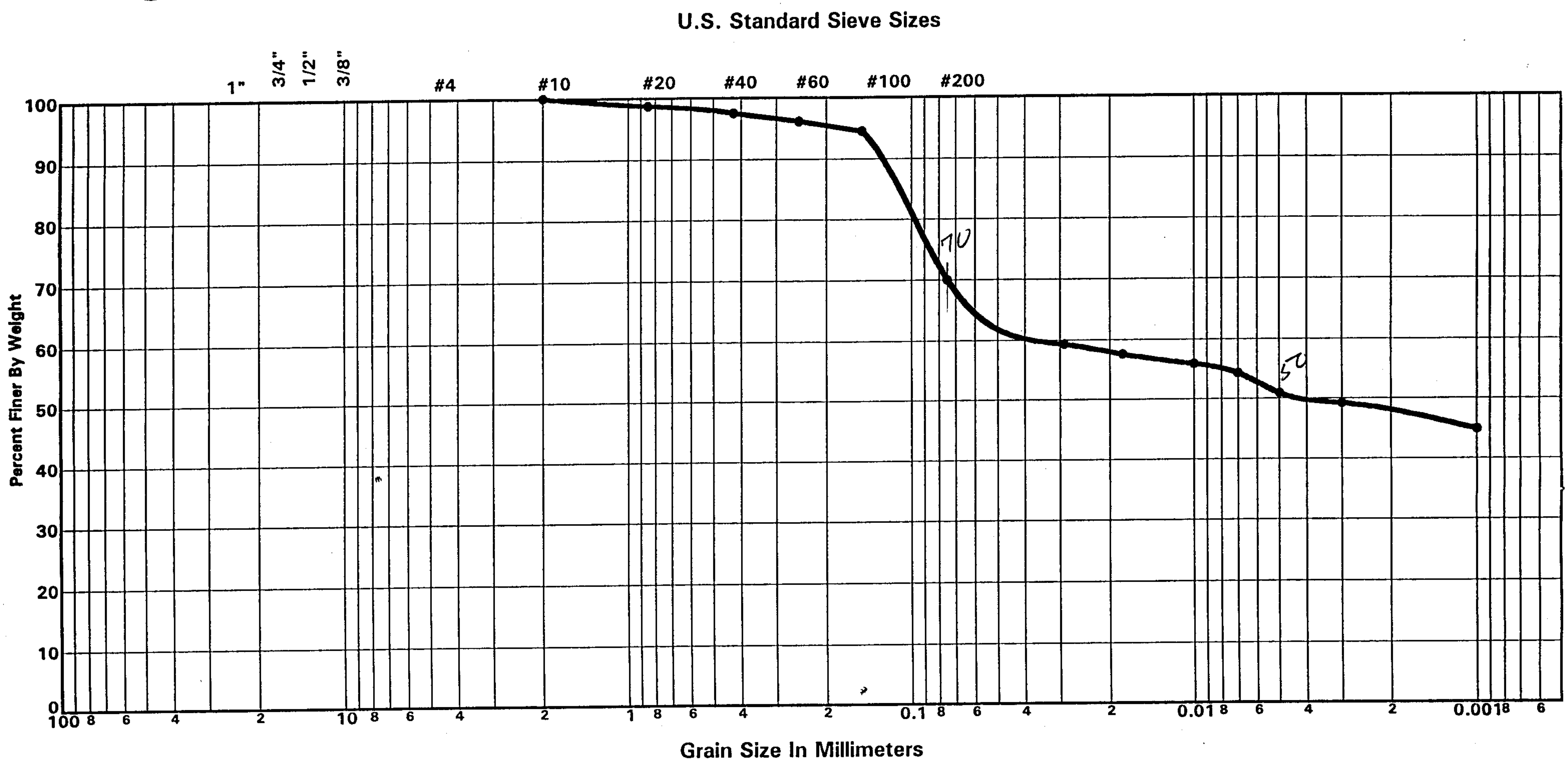
Project:
Halifax-6
Halifax, North Carolina

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
#2	0-1.5′		57.0	27.8	29.2	Tan-Orange Slightly Sandy CLAY (CH)

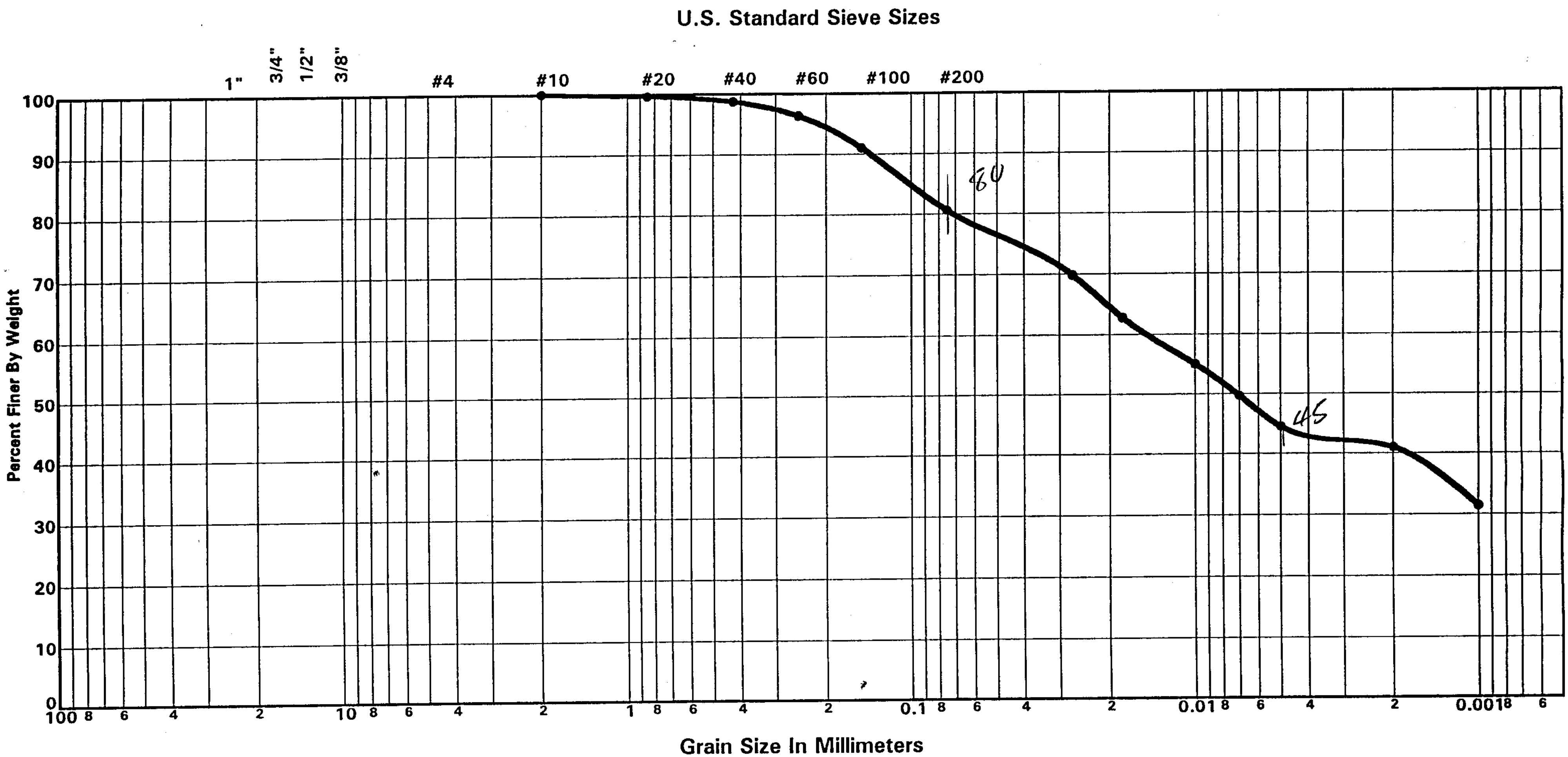
Project:
Halifax-6
Halifax, North Carolina

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
#6-1	0-1.5'		58.3	46.0	12.3	Brown Orange Slightly Fine Sandy SILT (MH)

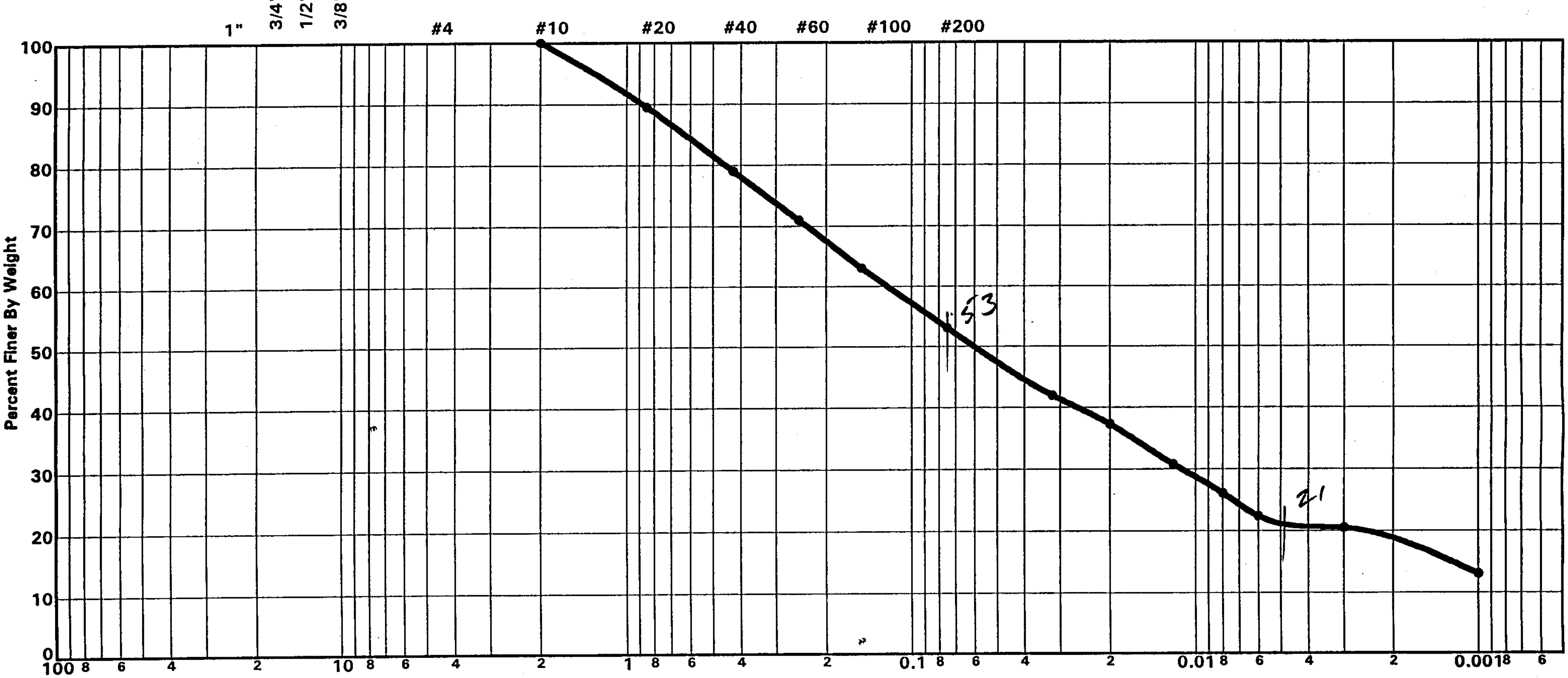
Project:
Halifax-6
Halifax, North Carolina

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
#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., P.A.

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

2/2/96

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

Attention: David Garrett

Attached for your review are the results of construction material testing performed on the Halifax - 5 project which is located in Halifax County, North Carolina.

Very truly yours,

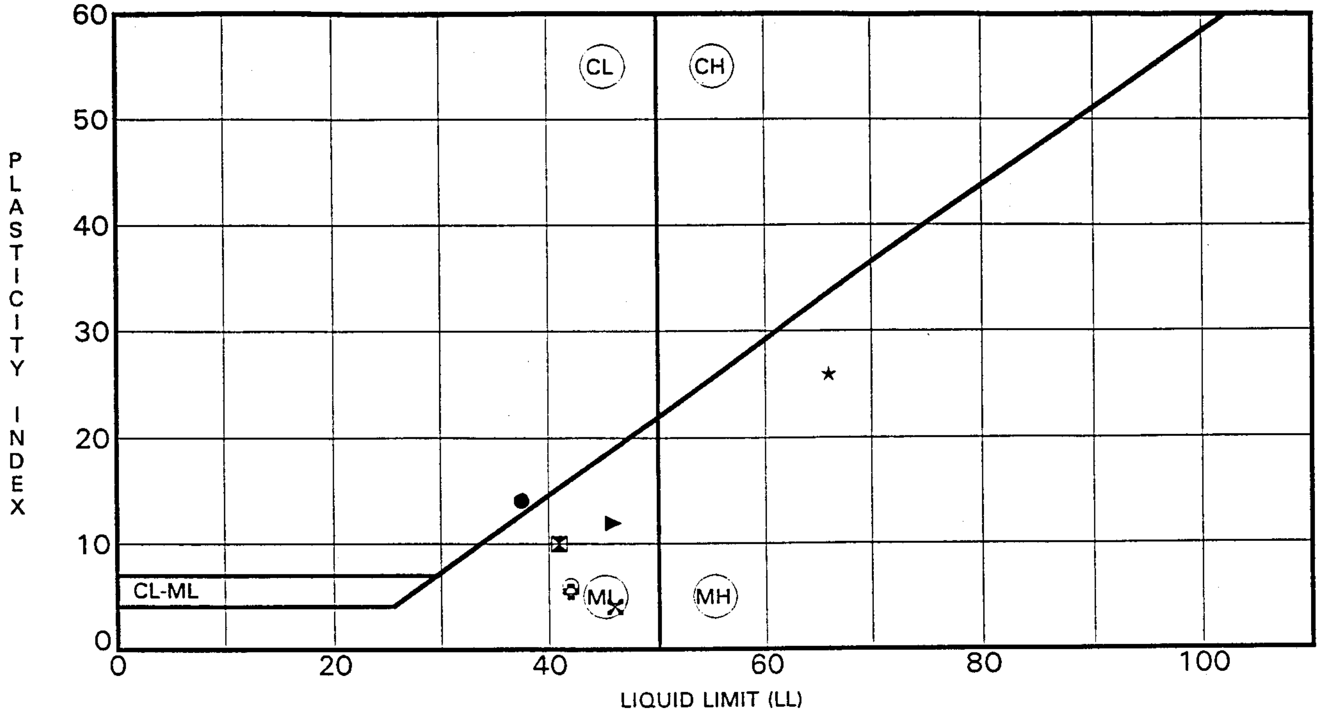
GeoTechnologies, Inc.

R. Sherwood Core, CET
Construction Services Manager

Edward B. Hearn, P.E.
President

Project No. 1-95-1181-CB
RSC-EBH/fgo
Enclosures

c:



	Specimen Identification		LL	PL	PI	Moisture	Classification
●	B5-1	0-1.5'	38	23	14	19.4	Tan Slightly Sandy SILT (ML)
⧗	B7-1	0-1.5'	41	31	10	22.6	Brown Micaceous SILT (ML)
▶	B7-2	3.5-5.0'	46	34	12	23.4	Tan Slightly Sandy SILT (ML)
★	G7-1	0-1.5'	66	40	26	22.6	Orange Brown Medium Sandy Clayey SILT (MH)
✕	G7-2	3.5-5.0'	46	42	4	23.9	Tan/Orange Sandy SILT (ML)
✪	G11-4	13.5-15.0'	42	37	6	23.3	Brown Micaceous SILT (ML)
○	G14-2	3.5-5.0'	42	36	6	23.0	Tan Slightly Sandy SILT (ML)

PROJECT Halifax-5 - Halifax, North Carolina

JOB NO. 1-95-1181-CB
DATE 1/11/96

ATTERBERG LIMITS' RESULTS

Geotechnologies, Inc.
Raleigh, North Carolina

GeoTechnologies, Inc., P.A.

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

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1/15/96

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

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GeoTechnologies, Inc.

R. Sherwood Core, CET
Construction Services Manager

Edward B. Hearn, P.E.
President

Project No. 1-95-1181-CB
RSC-EBH/fgo
Enclosures

c:

GeoTechnologies, Inc.

PERMEABILITY TEST

Job Number:	1-95-1181 CB	Job Name:	HALIFAX - 5		
Date:	1/5/96	Sample I.D.	G - 5	Depth:	

Soil Description: ORANGE RED SILTY CLAY

SAMPLE DATA

type	standard proctor	
remolded (X)	Max. Dry Density	82.5 lbs/cu.ft.
undisturbed ()	Moisture Content	37.1 %
	Compaction	95.7 %

	inches	cm.		
			Moisture Content	**40.5** %
			Wet Density	**110.9** lbs./cu.ft.
Length	**2.937**	**7.460**	Dry Density	**79.0** lbs./cu.ft.
Diameter	**2.888**	**7.336**	Initial Saturation	**94.8** %
Area	**6.551**	**42.262**	Final Saturation	**100.0** %
Volume	**19.239**	**315.275**	Initial Void Ratio	**1.2**
Wet Mass	**1.235**	**560.22** grams	Porosity	**54.0** %
Dry Mass	**0.8790**	**398.7** grams	Specific Gravity	**2.75** apparent

TEST DATA

hi = inflow burette
ho = outflow burette
t = time

L = 7.46 cm. length of sample
A = 42.262 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	**4440**	93.8	1	**92.8**	93.5	1.3	**92.2**
0	**5400**	93.5	1.3	**92.2**	93.3	1.5	**91.8**
0	**3960**	93.3	1.5	**91.8**	93.1	1.8	**91.3**
0	**7560**	93.1	1.8	**90.6**	92.8	2.9	**89.9**

ASTM D 5084

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

1	k =	1.10E-07
2	k =	6.05E-08
3	k =	1.04E-07
4	k =	7.71E-08

Average k= 8.78E-08 cm/sec

GeoTechnologies, Inc.

PERMEABILITY TEST

Job Number: 1-95-1181 CB **Job Name:** HALIFAX - 5

Date: 1/5/96 **Sample I.D.** G - 7 **Depth:**

Soil Description: TAN BROWN SLIGHTLY CLAYEY SANDY SILT

SAMPLE DATA

type

remolded (X)

undisturbed ()

standard proctor

Max. Dry Density	108.3	lbs/cu.ft.
Moisture Content	18	%
Compaction	96.6	%

	inches	cm.	
Length	**3.008**	**7.640**	
Diameter	**2.875**	**7.303**	
Area	**6.492**	**41.883**	
Volume	**19.527**	**319.996**	
Wet Mass	**1.439**	**652.8**	grams
Dry Mass	**1.1825**	**536.4**	grams

Moisture Content	**21.7**	%
Wet Density	**127.4**	lbs./cu.ft.
Dry Density	**104.6**	lbs./cu.ft.
Initial Saturation	**93.2**	%
Final Saturation	**100.0**	%
Initial Void Ratio	**0.6**	
Porosity	**39.0**	%
Specific Gravity	**2.75**	apparent

TEST DATA

hi = inflow burette

ho = outflow burette

t = time

L = 7.64 cm. length of sample

A = 41.883 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	**4500**	94	1.3	**92.7**	93.7	1.5	**92.2**
0	**5400**	93.7	1.5	**92.2**	93.3	1.9	**91.4**
0	**3900**	93.3	1.9	**91.4**	93.1	2.1	**91**
	7560	93.1	2.1	**90.6**	92.6	2.5	**90.1**

ASTM D 5084

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

1	k =	9.34E-08
2	k =	1.25E-07
3	k =	8.74E-08
4	k =	5.69E-08

Average k= **9.08E-08** cm/sec

GeoTechnologies, Inc.

PERMEABILITY TEST

Job Number:	1-95-1181 CB	Job Name:	HALIFAX - 5		
Date:	1/5/96	Sample I.D.	G - 9	Depth:	

Soil Description: PINK SLIGHTLY SANDY CLAYEY SILT

SAMPLE DATA

type

remolded (X)

undisturbed ()

standard proctor

Max. Dry Density	97.2	lbs/cu.ft.
Moisture Content	23.5	%
Compaction	96.1	%

	inches	cm.				
				Moisture Content	**27**	%
				Wet Density	**118.6**	lbs./cu.ft.
Length	**3.045**	**7.734**		Dry Density	**93.4**	lbs./cu.ft.
Diameter	**2.867**	**7.282**		Initial Saturation	**88.6**	%
Area	**6.456**	**41.650**		Final Saturation	**100.0**	%
Volume	**19.658**	**322.132**		Initial Void Ratio	**0.8**	
Wet Mass	**1.349**	**612**	grams	Porosity	**45.6**	%
Dry Mass	**1.0624**	**481.9**	grams	Specific Gravity	**2.75**	apparent

TEST DATA

hi = inflow burette

ho = outflow burette

t = time

L = 7.73 cm. length of sample

A = 41.650 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

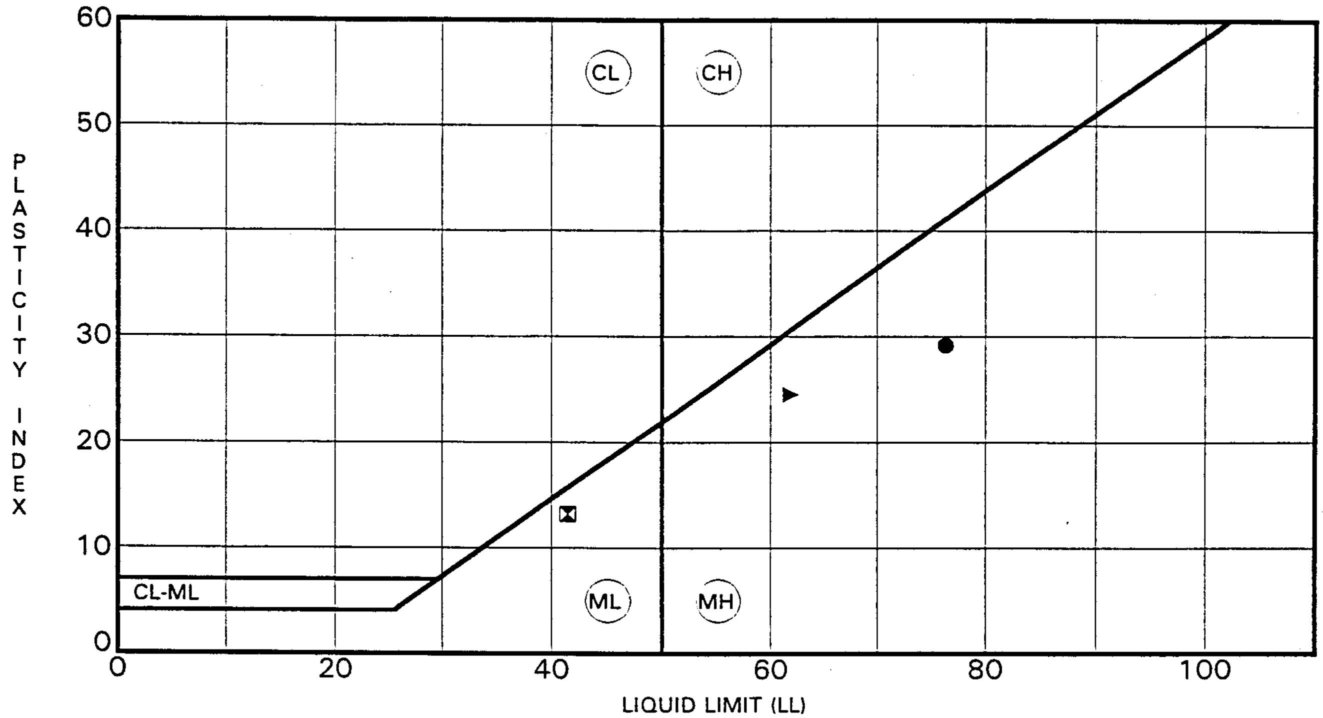
t1	t2	ho1	hi1	h1	ho2	hi2	h2
0	**4440**	93.3	2	**91.3**	92.4	2.7	**89.7**
0	**5400**	92.4	2.7	**89.7**	91.3	3.8	**87.5**
0	**3960**	91.3	3.8	**87.5**	90.6	4.5	**86.1**
0	**7560**	90.6	4.5	**90.6**	89.1	6	**83.1**

ASTM D 5084

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

1	k =	3.15E-07
2	k =	3.64E-07
3	k =	3.22E-07
4	k =	9.04E-07

Average k= 4.76E-07 cm/sec



	Specimen Identification		LL	PL	PI	Fines	Classification
●	G-5	1.0-1.7'	76	47	29		Orange Red Silty CLAY (MH)
⊠	G-7	5.0-8.0'	42	28	13		Tan Brown Slightly Clayey Sandy SILT (ML)
▶	G-9	15.0-20.0'	62	37	25		Pink Slightly Coarse Sandy Clayey SILT (MH)

PROJECT Halifax-5 - Halifax, North Carolina

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

ATTERBERG LIMITS' RESULTS

Geotechnologies, Inc.
Raleigh, North Carolina

GeoTechnologies, Inc.

Job No: 1-95-1181-CB Date: 1/10/96

Job Name: Halifax-5

Job Location: Halifax, North Carolina

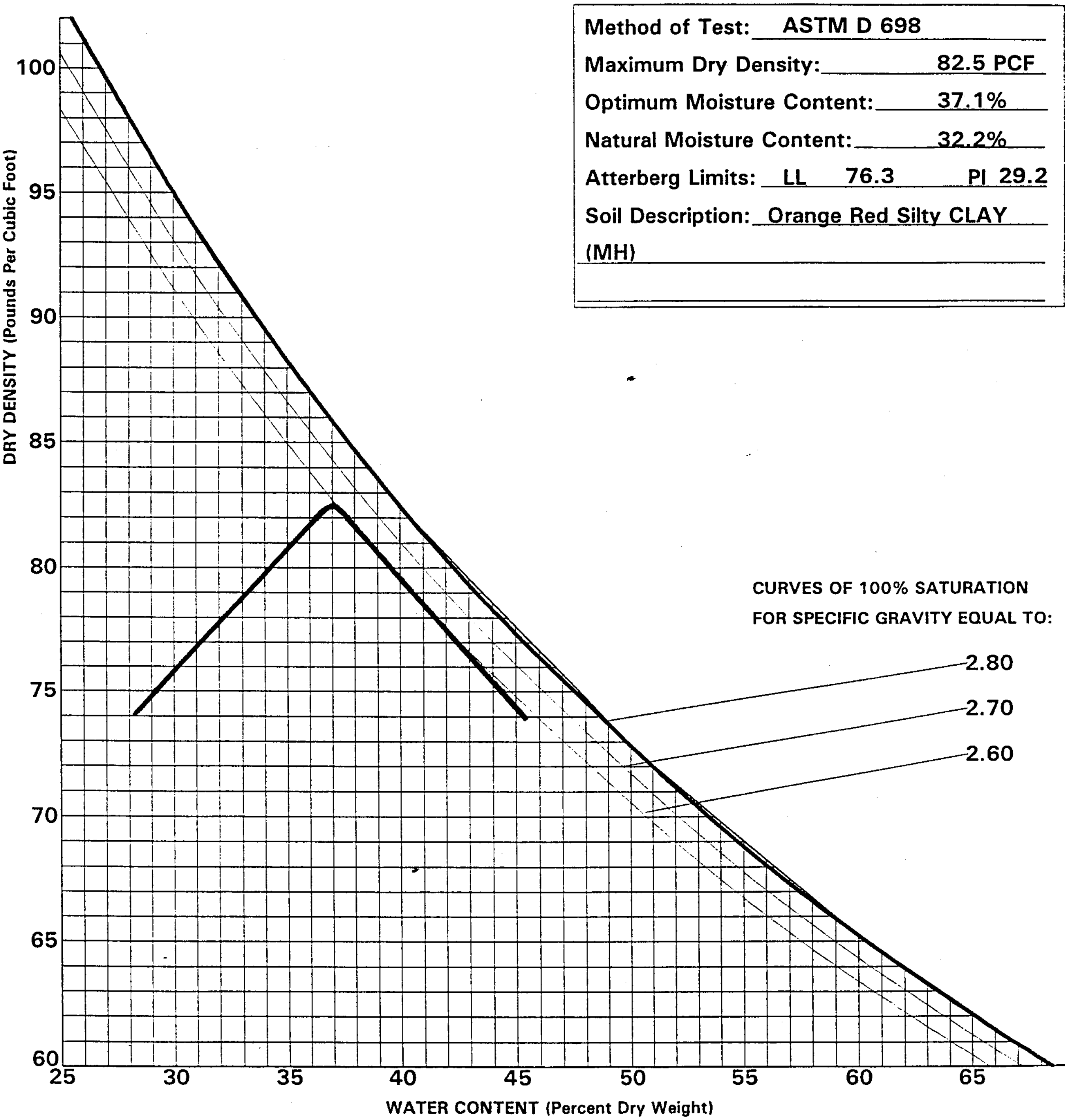
Boring No:

Sample No: G-5

Depth: 1.0-1.7'

TEST RESULTS

Method of Test:	ASTM D 698
Maximum Dry Density:	82.5 PCF
Optimum Moisture Content:	37.1%
Natural Moisture Content:	32.2%
Atterberg Limits:	LL 76.3 PI 29.2
Soil Description:	Orange Red Silty CLAY (MH)



MOISTURE-DENSITY RELATIONSHIP

Geotechnologies, Inc.

Raleigh, North Carolina

GeoTechnologies, Inc.

Job No: 1-95-1181-CB Date: 1/10/96

Job Name: Halifax-5

Job Location: Halifax, North Carolina

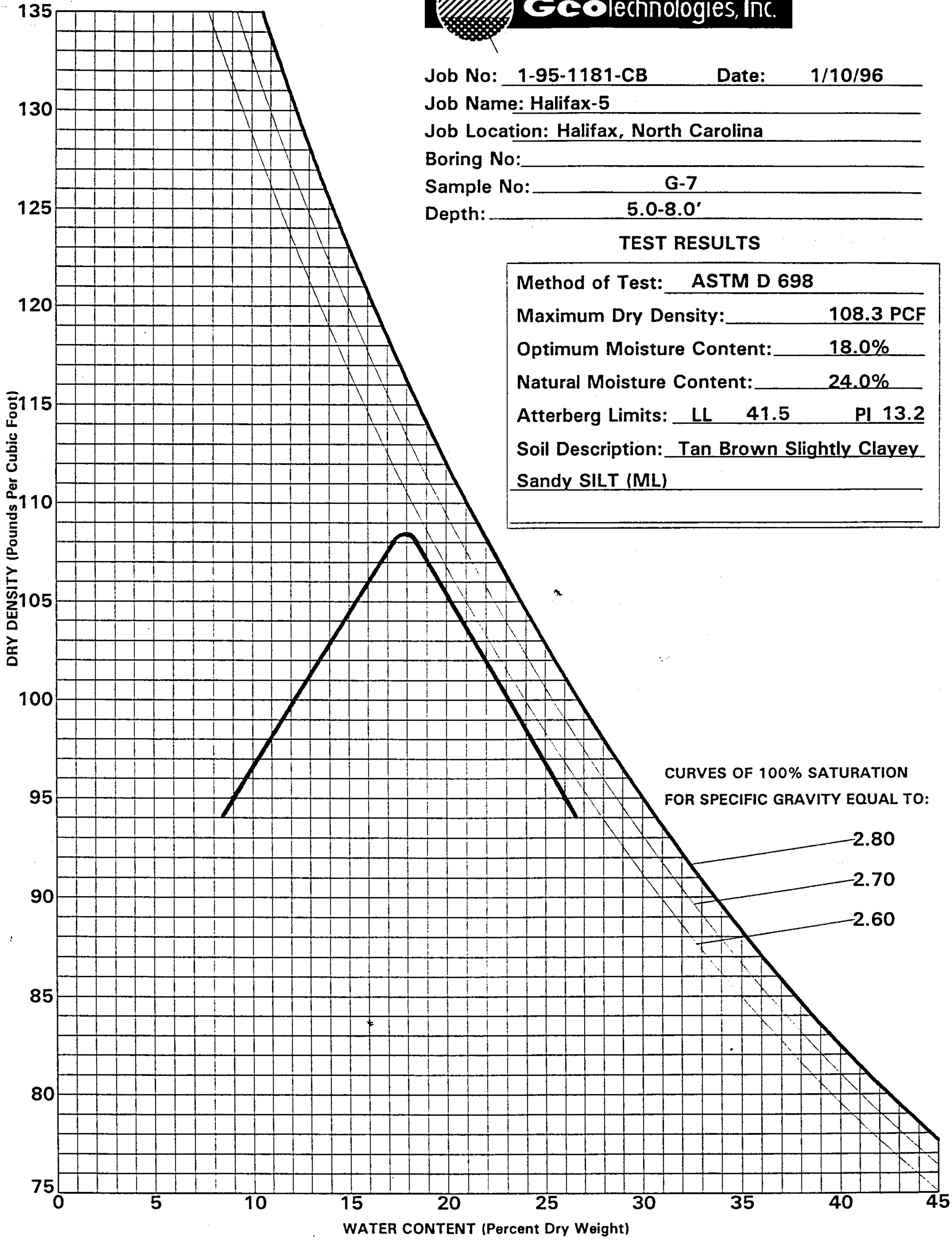
Boring No:

Sample No: G-7

Depth: 5.0-8.0'

TEST RESULTS

Method of Test:	ASTM D 698
Maximum Dry Density:	108.3 PCF
Optimum Moisture Content:	18.0%
Natural Moisture Content:	24.0%
Atterberg Limits:	LL 41.5 PI 13.2
Soil Description:	Tan Brown Slightly Clayey Sandy SILT (ML)



MOISTURE-DENSITY RELATIONSHIP

Geotechnologies, Inc.
Raleigh, North Carolina

GeoTechnologies, Inc.

Job No: 1-95-1181-CB Date: 1/10/96

Job Name: Halifax-5

Job Location: Halifax, North Carolina

Boring No:

Sample No: G-9

Depth: 15.0-20.0'

TEST RESULTS

Method of Test: ASTM D 698

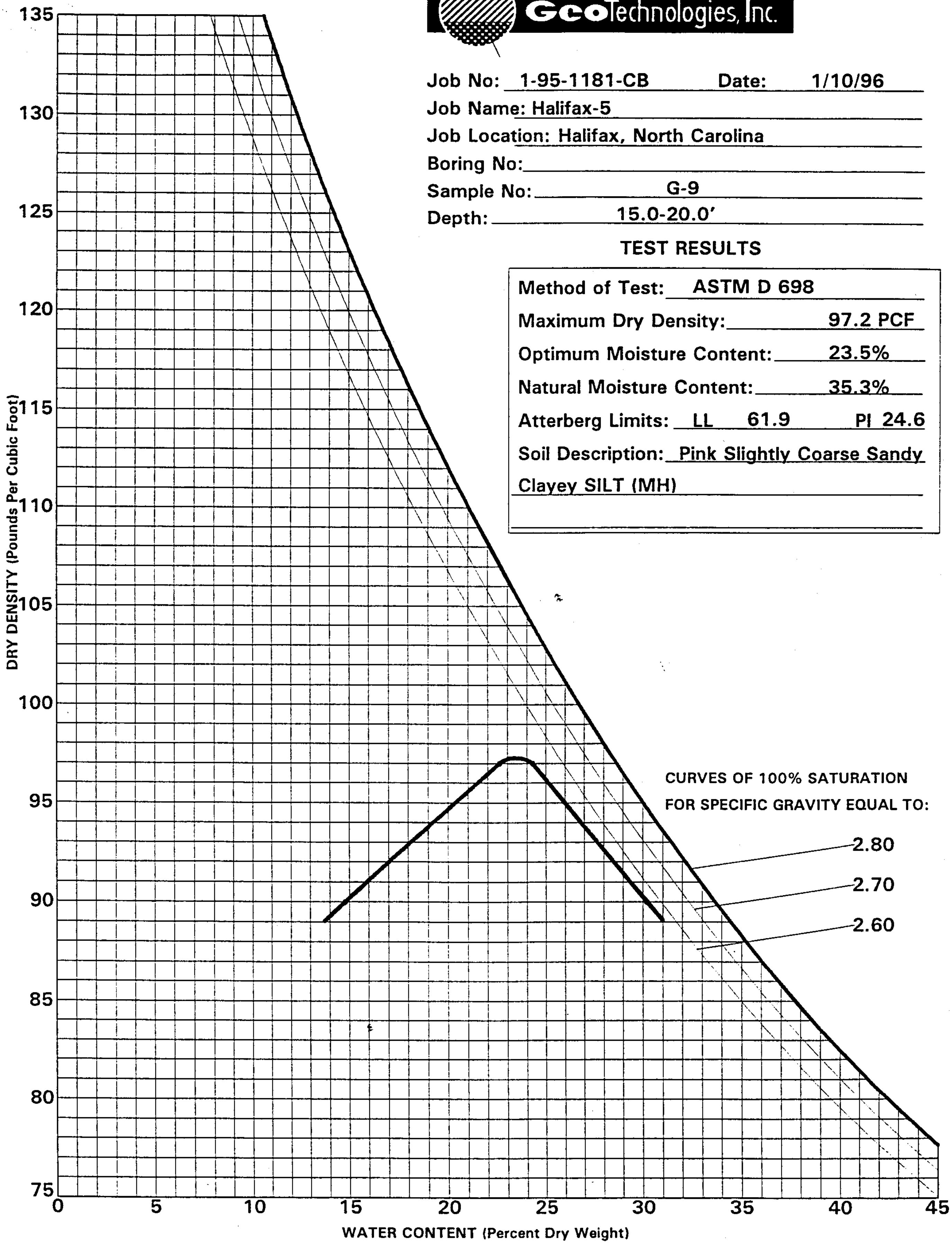
Maximum Dry Density: 97.2 PCF

Optimum Moisture Content: 23.5%

Natural Moisture Content: 35.3%

Atterberg Limits: LL 61.9 PI 24.6

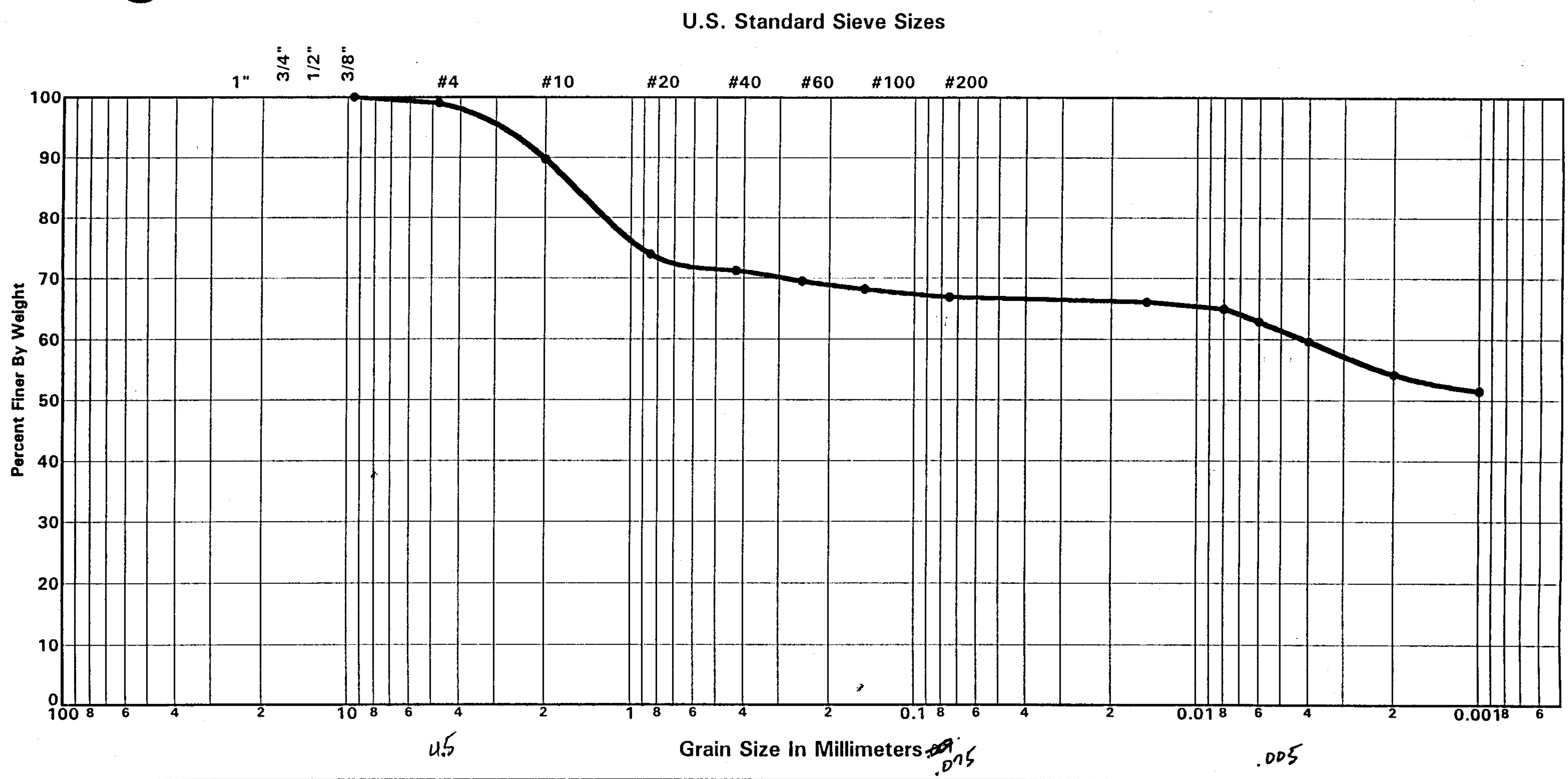
Soil Description: Pink Slightly Coarse Sandy Clayey SILT (MH)



MOISTURE-DENSITY RELATIONSHIP

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
G-5	1.0-1.7′	32.2	76.3	47.1	29.2	Orange Red Silty CLAY (MH)

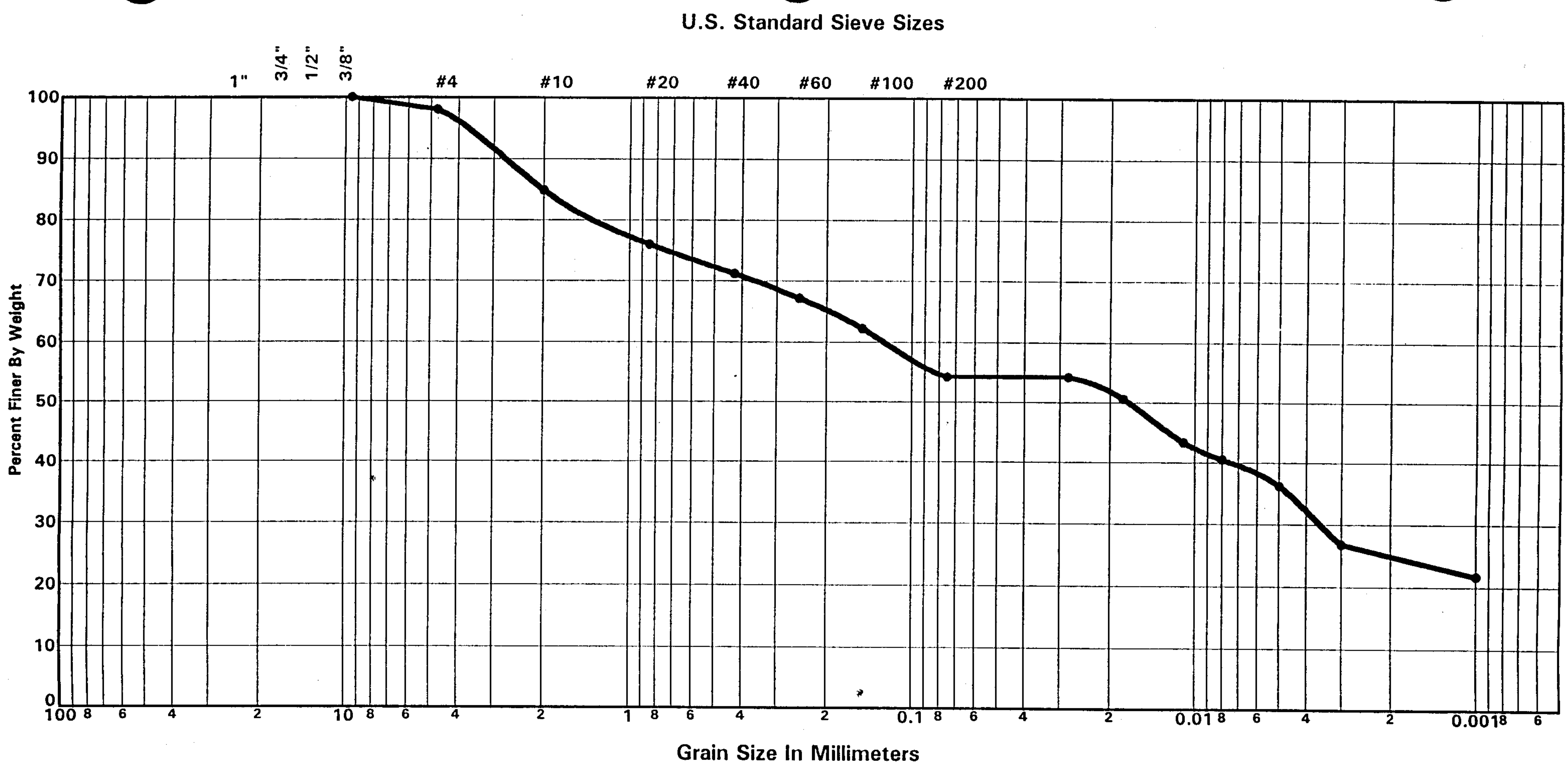
Project:
Halifax-5
Halifax, North Carolina

Job No.: 1-95-1181-CB

Date: 1/10/96

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
G-7	5.0-8.0'	24.0	41.5	28.3	13.2	Tan Brown Slightly Clayey Sandy SILT (ML)

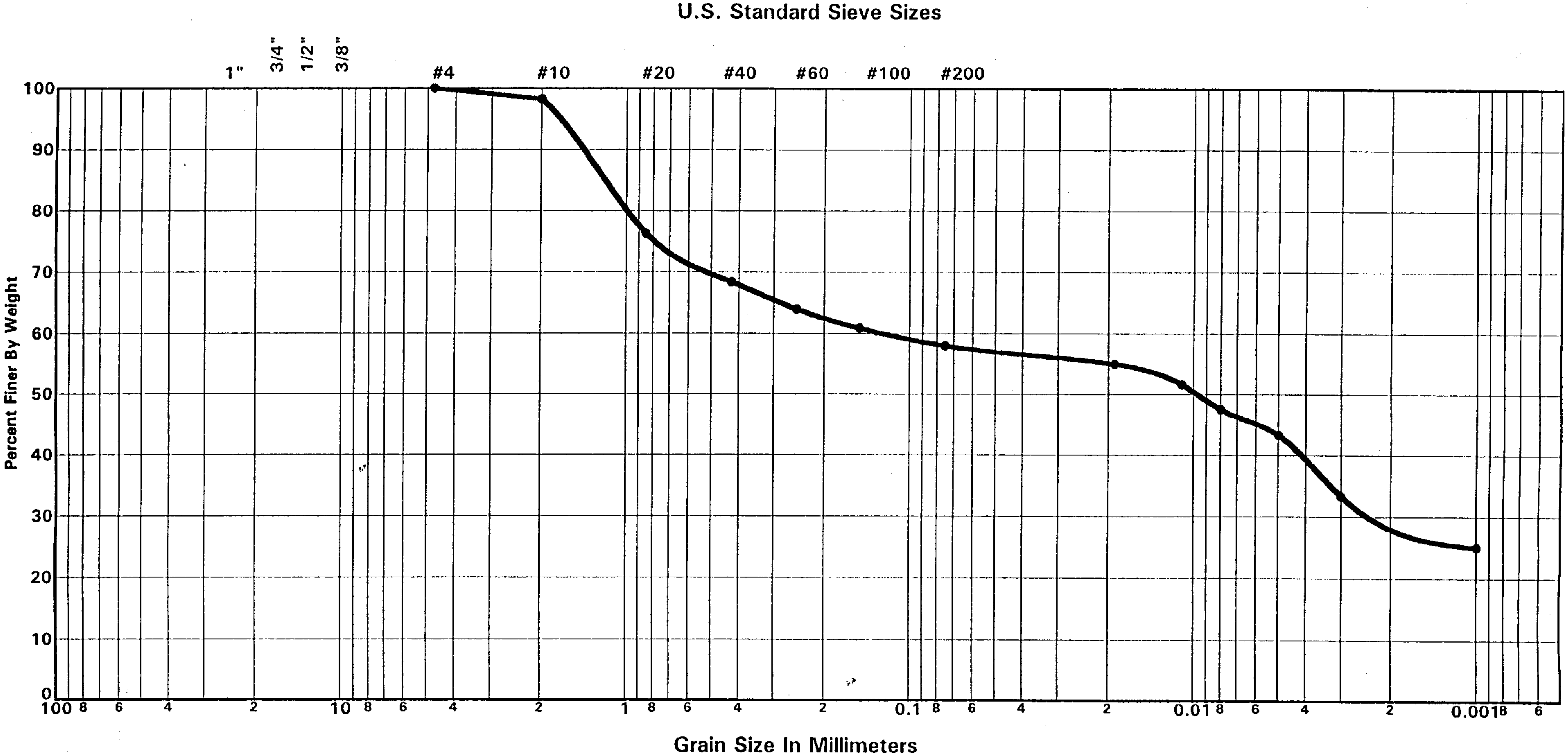
Project:
Halifax-5
Halifax, North Carolina

Job No.: 1-95-1181-CB

Date: 1/10/96

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
G-9	15.0-20.0'	35.3	61.9	37.3	24.6	Pink Slightly Coarse Sandy Clayey SILT (MH)

Project:
Halifax-5
Halifax, North Carolina

Job No.: 1-95-1181-CB

Date: 1/10/96

GRAIN SIZE DISTRIBUTION

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Phone: (919) 954-1514 Fax: (919) 954-1428

4/22/96

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APR 23 1996

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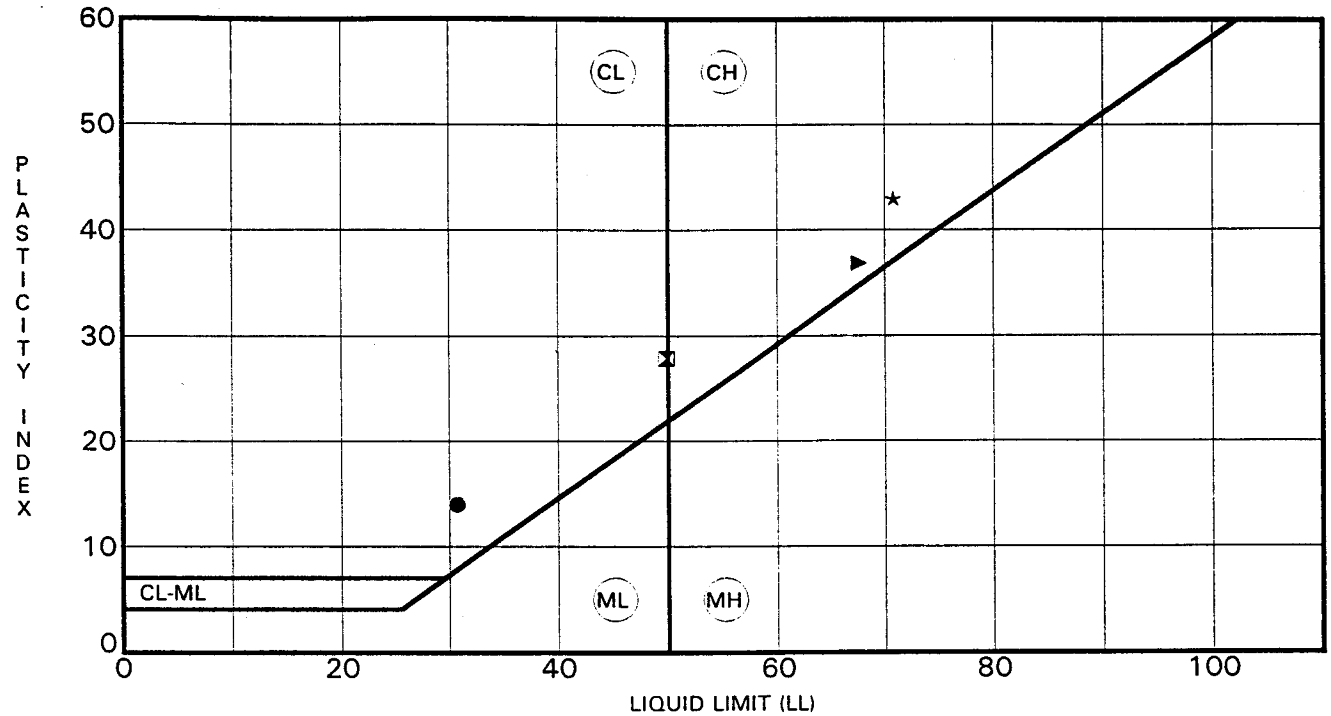
President

Project No. 1-95-1181-CB
RSC-EBH/fgo
Enclosures

c:



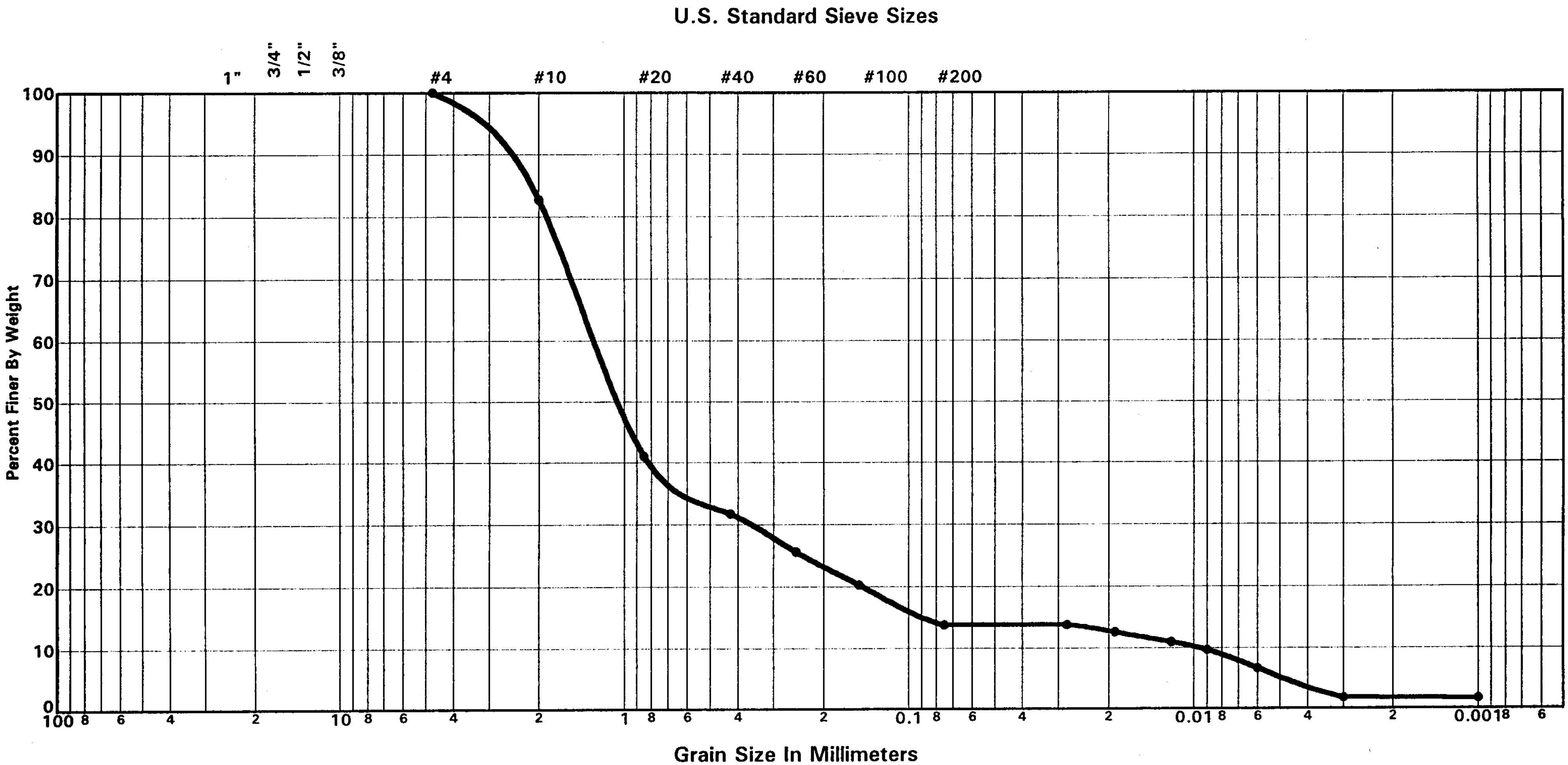
	Specimen Identification	LL	PL	PI	Fines	Classification
●	B-4	31	17	14	13.8	Red Orange Clayey SILT (CL)
⧗	B-8-1	50	22	28	48.8	Red Orange Clayey SILT (CL/CH)
▶	G-2-A	68	31	37	43.8	Very Gravelly Reddish Brown Silty CLAY (CH)
★	G-6-A	71	28	43	43.2	Orange Slightly Sandy Silty CLAY (CH)

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 Clayey SILT (CL)

GRAIN SIZE DISTRIBUTION

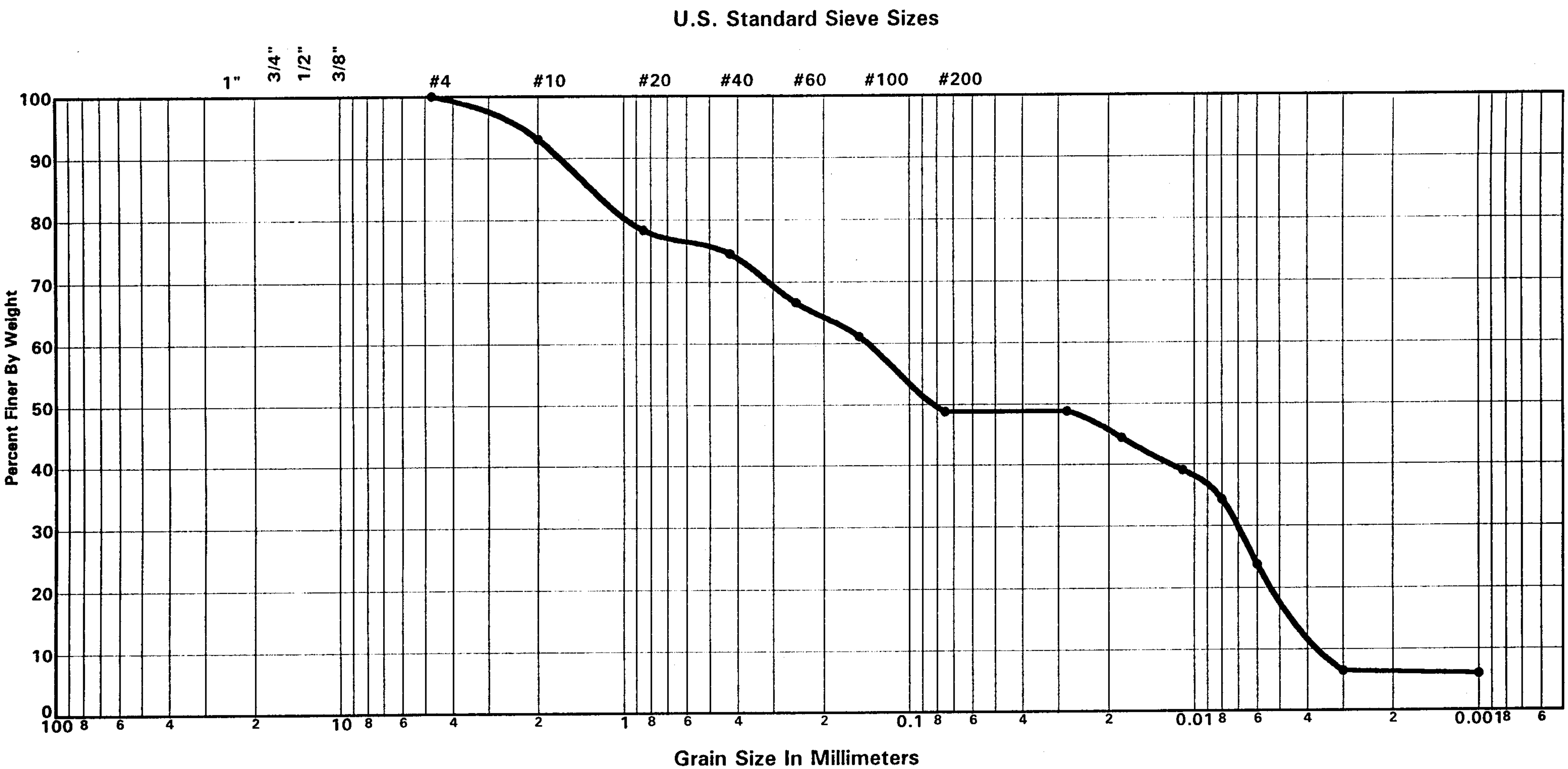
GeoTechnologies, Inc.

Project:

Halifax-5
Halifax, North Carolina

Job No.: 1-95-1181-CB

Date: 4/16/96



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)

GRAIN SIZE DISTRIBUTION

GeoTechnologies, Inc.

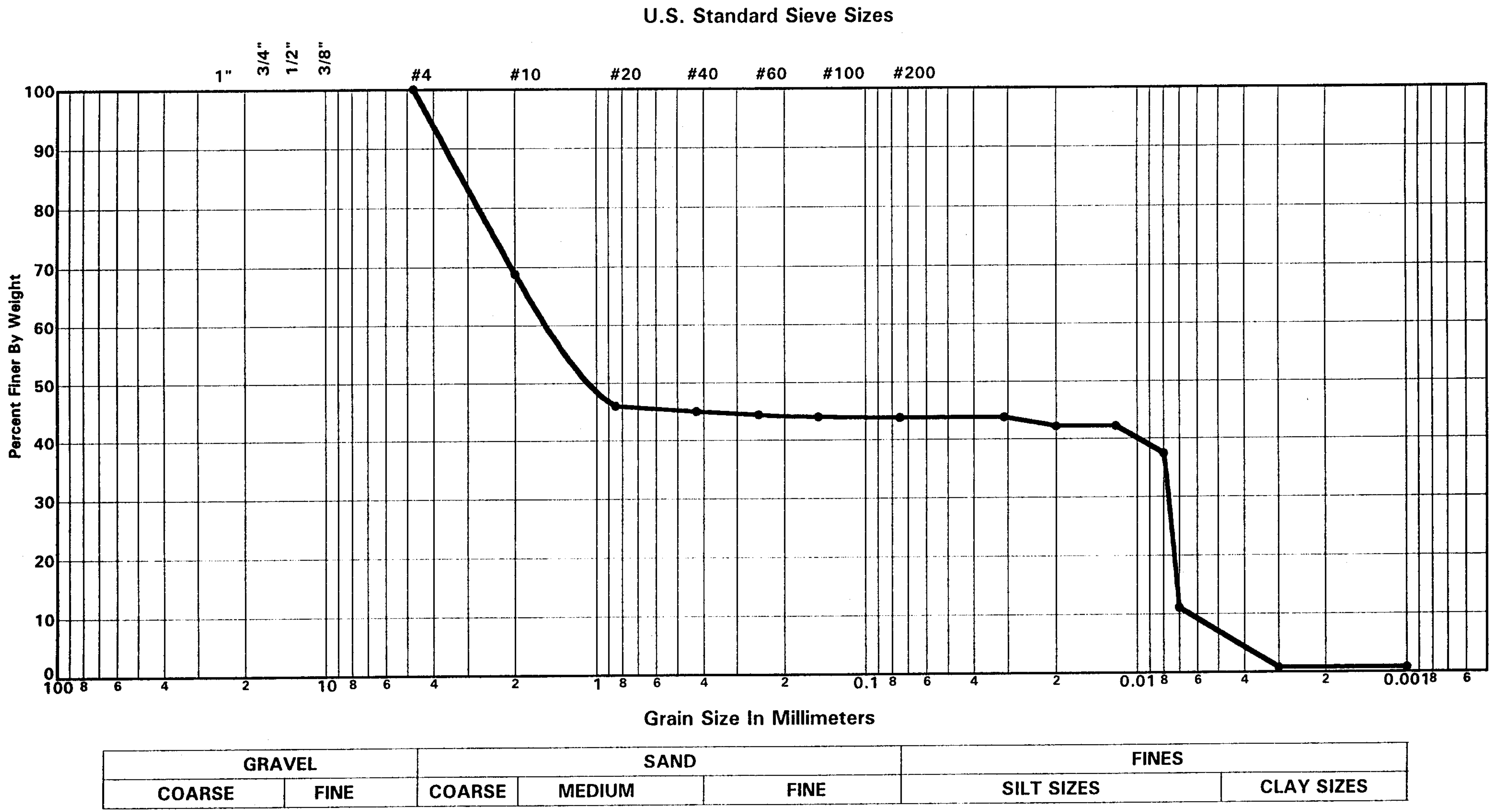
Project:

Halifax-5
Halifax, North Carolina

Job No.: 1-95-1181-CB

Date: 4/16/96

GRAIN SIZE DISTRIBUTION



Boring No.	Elev./Depth	Nat. W.C.	L.L.	P.L.	P.I.	Soil Description or Classification
G-2-A			67.6	30.7	36.9	Very Gravelly Reddish Brown Silty CLAY (CH)

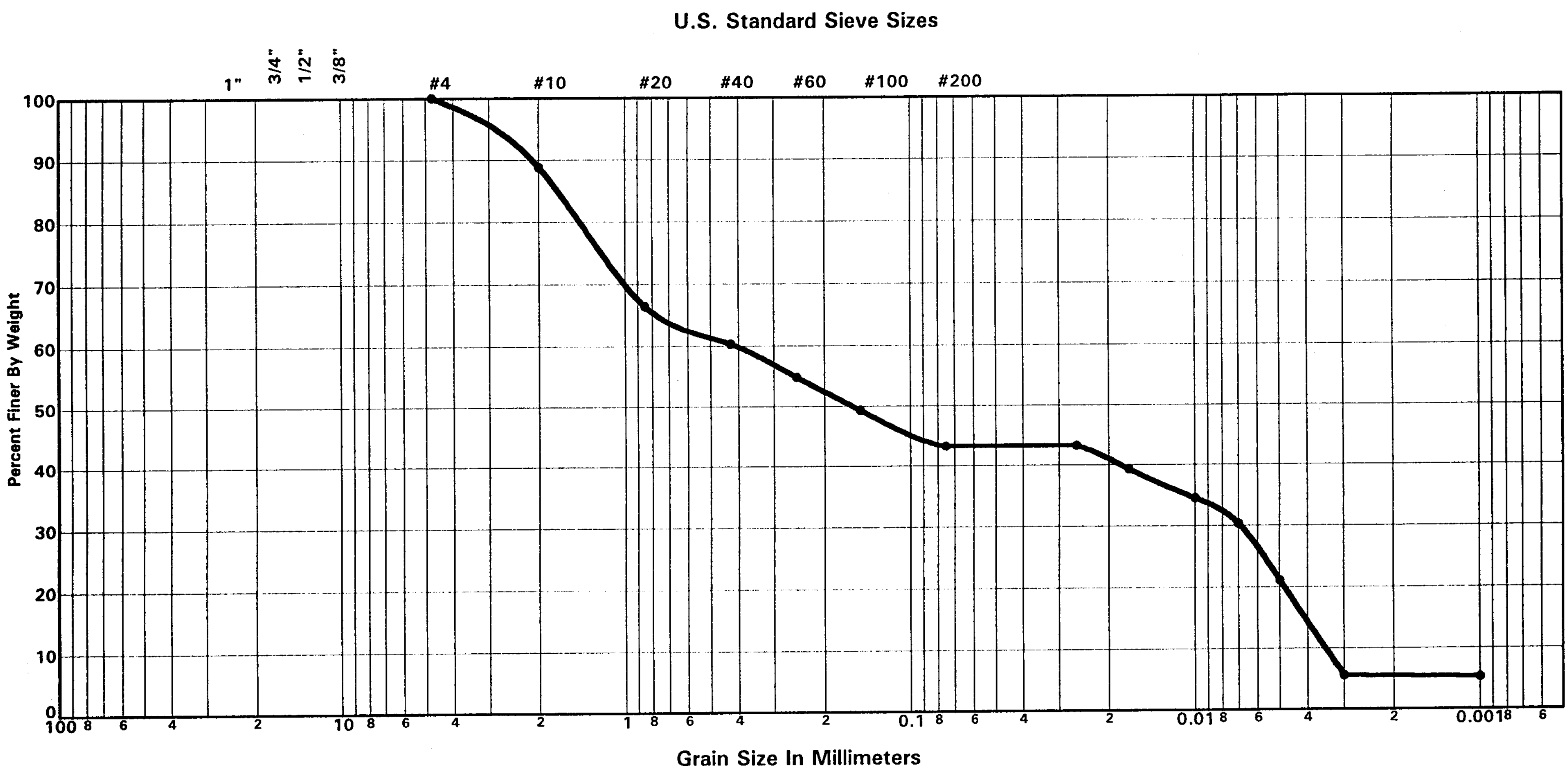
Project:

Halifax-5
Halifax, North Carolina

Job No.: 1-95-1181-CB

Date: 4/16/96

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
G-6-A			70.8	27.8	43.0	Orange Slightly Sandy Silty CLAY (CH)

GRAIN SIZE DISTRIBUTION

GeoTechnologies, Inc.

Project:

Halifax-5
Halifax, North Carolina

Job No.: 1-95-1181-CB

Date: 4/16/96

GeoTechnologies, Inc.

PERMEABILITY TEST

Job Number:	1-95-1181 CB	Job Name:	HALIFAX - 5		
Date:	3/8/96	Sample I.D.	G - 6	Depth:	1' - 3'

Soil Description: ORANGE SLIGHTLY SANDY SILTY CLAY

SAMPLE DATA

type		standard proctor			
remolded	( )	Max. Dry Density		lbs/cu.ft.	
undisturbed	(X)	Moisture Content		%	
		Compaction	#DIV/0!	%	

	inches	cm.				
				Moisture Content	30.8	%
				Wet Density	118.2	lbs./cu.ft.
Length	3.488	8.860		Dry Density	90.3	lbs./cu.ft.
Diameter	2.863	7.272		Initial Saturation	94.1	%
Area	6.438	41.534		Final Saturation	100.0	%
Volume	22.455	367.968		Initial Void Ratio	0.9	
Wet Mass	1.536	696.55	grams	Porosity	47.4	
Dry Mass	1.1740	532.5	grams	Specific Gravity	2.75	apparent

TEST DATA

	L =	8.86 cm.	length of sample
hi = inflow burette	A =	41.534 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	4200	93.3	1.4	91.9	92.7	2.1	90.6
0	5280	92.7	2.1	90.6	91.9	2.8	89.1
0	4620	91.9	2.8	89.1	91.3	3.4	87.9
0	35880	91.3	3.4	87.9	85.7	8.9	76.8

ASTM D 5084

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

1	k =	3.08E-07
2	k =	2.87E-07
3	k =	2.67E-07
4	k =	3.42E-07

Average **k =** **3.01E-07** cm/sec

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

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.				
				Moisture Content	23.8	%
				Wet Density	123.2	lbs./cu.ft.
Length	5.949	15.110		Dry Density	99.5	lbs./cu.ft.
Diameter	2.869	7.287		Initial Saturation	90.3	%
Area	6.465	41.708		Final Saturation	100.0	%
Volume	38.459	630.226		Initial Void Ratio	0.7	
Wet Mass	2.743	1244.07	grams	Porosity	42.0	
Dry Mass	2.2154	1004.9	grams	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

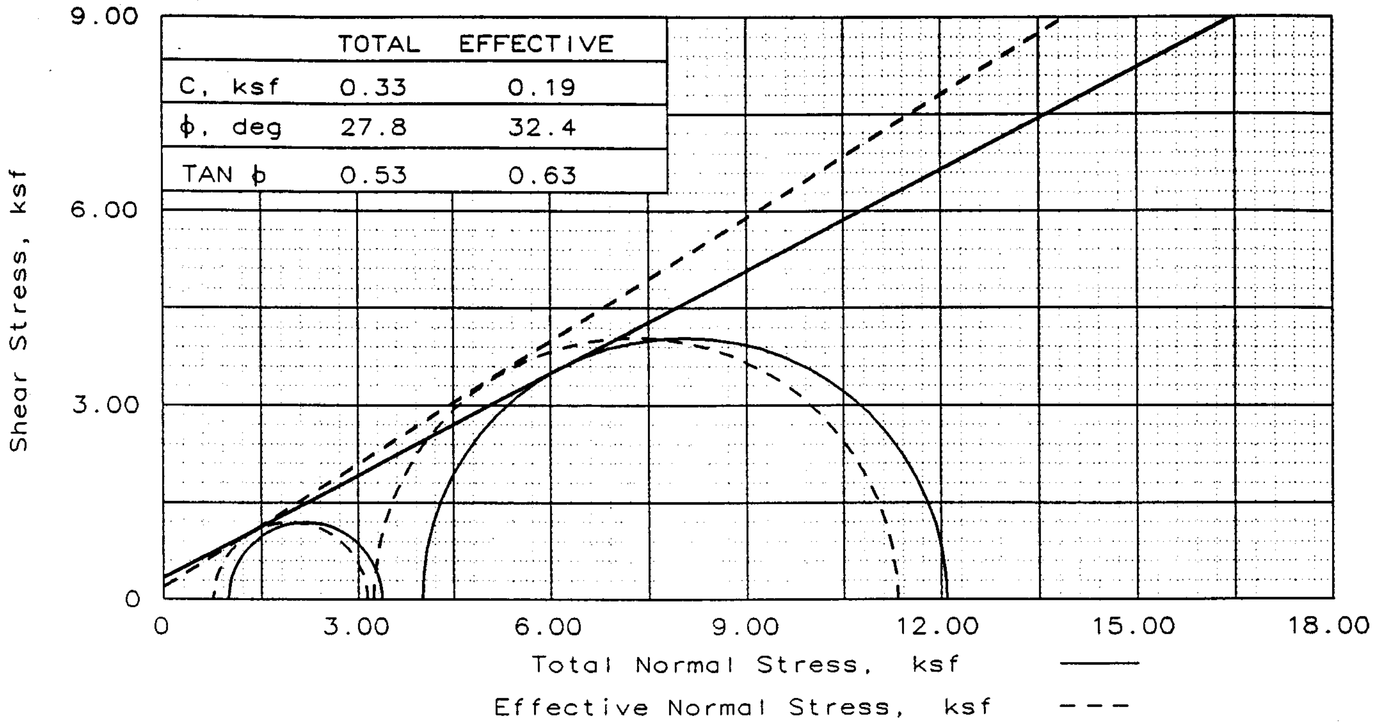
t1	t2	ho1	hi1	h1	ho2	hi2	h2
0	1800	94.5	0.5	94	87.1	7.6	79.5
0	1440	87.1	7.6	79.5	81.5	13.2	68.3
0	2700	81.5	13.2	68.3	71.9	23	48.9
0	2700	94.5	0.8	93.7	83.7	11.5	72.2

ASTM D 5084

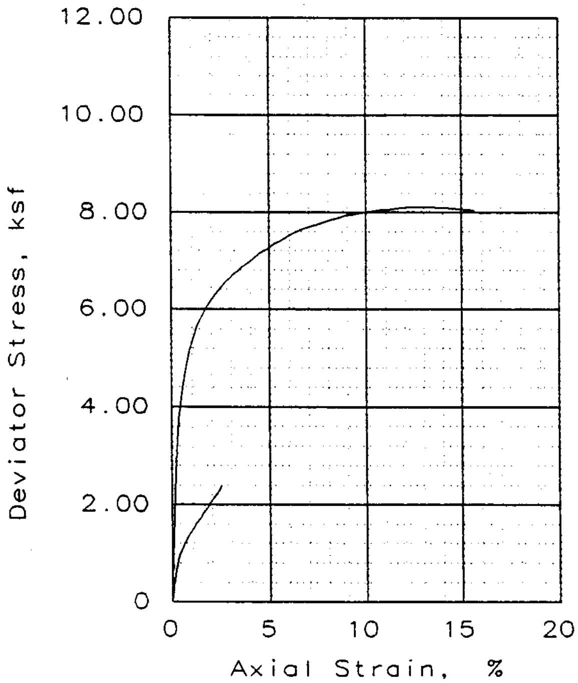
k = ((aaL/(At(a+a)))*ln(h1/h2)

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



	TOTAL	EFFECTIVE
C, ksf	0.33	0.19
ϕ, deg	27.8	32.4
TAN ϕ	0.53	0.63



	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:

FIG. NO.

CLIENT: RICHARDSON AND ASSOCIATES

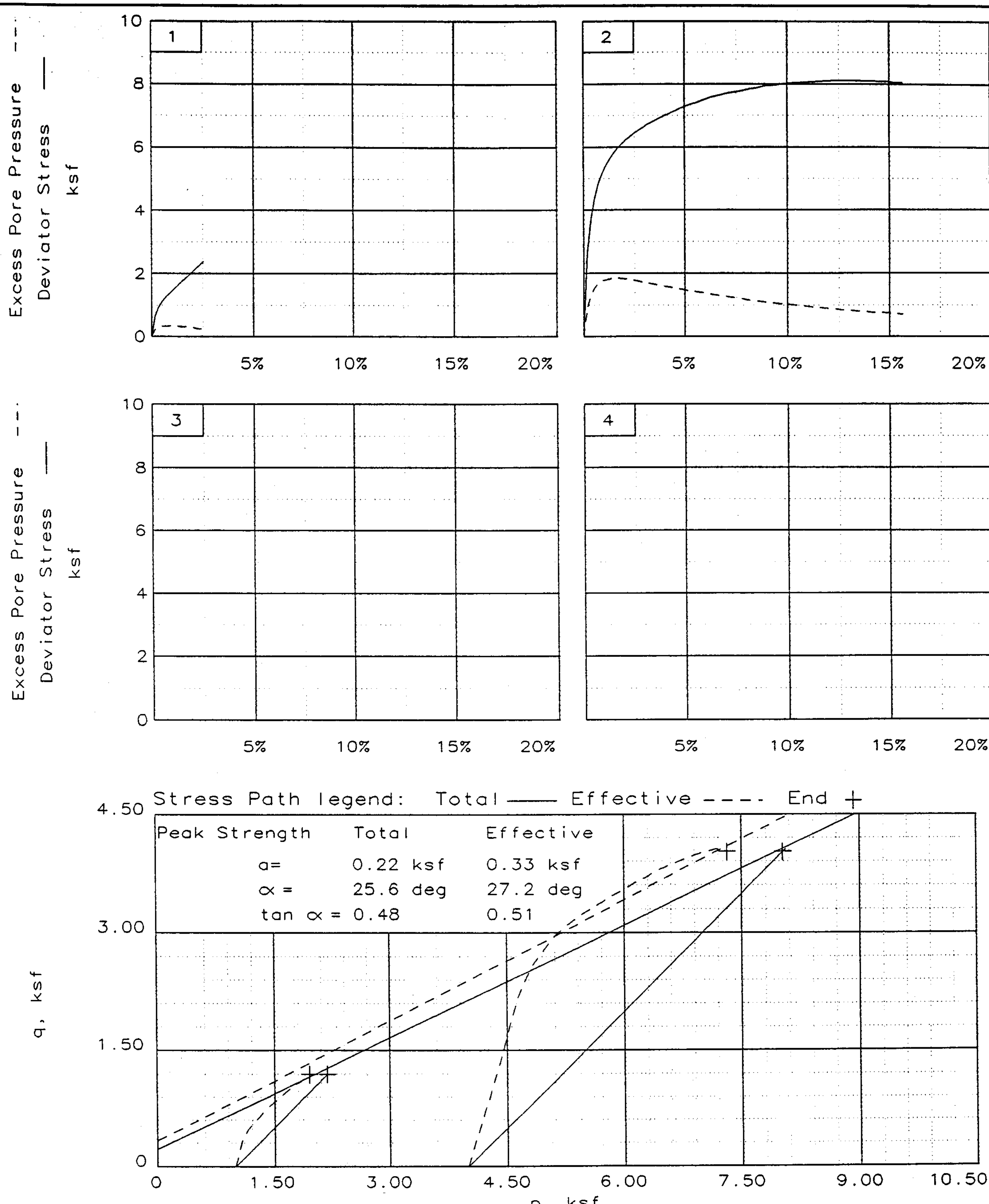
PROJECT: HALIFAX - 5

SAMPLE LOCATION: B - 4

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

TRIAXIAL SHEAR TEST REPORT

GEOTECHNOLOGIES, INC., P.A.

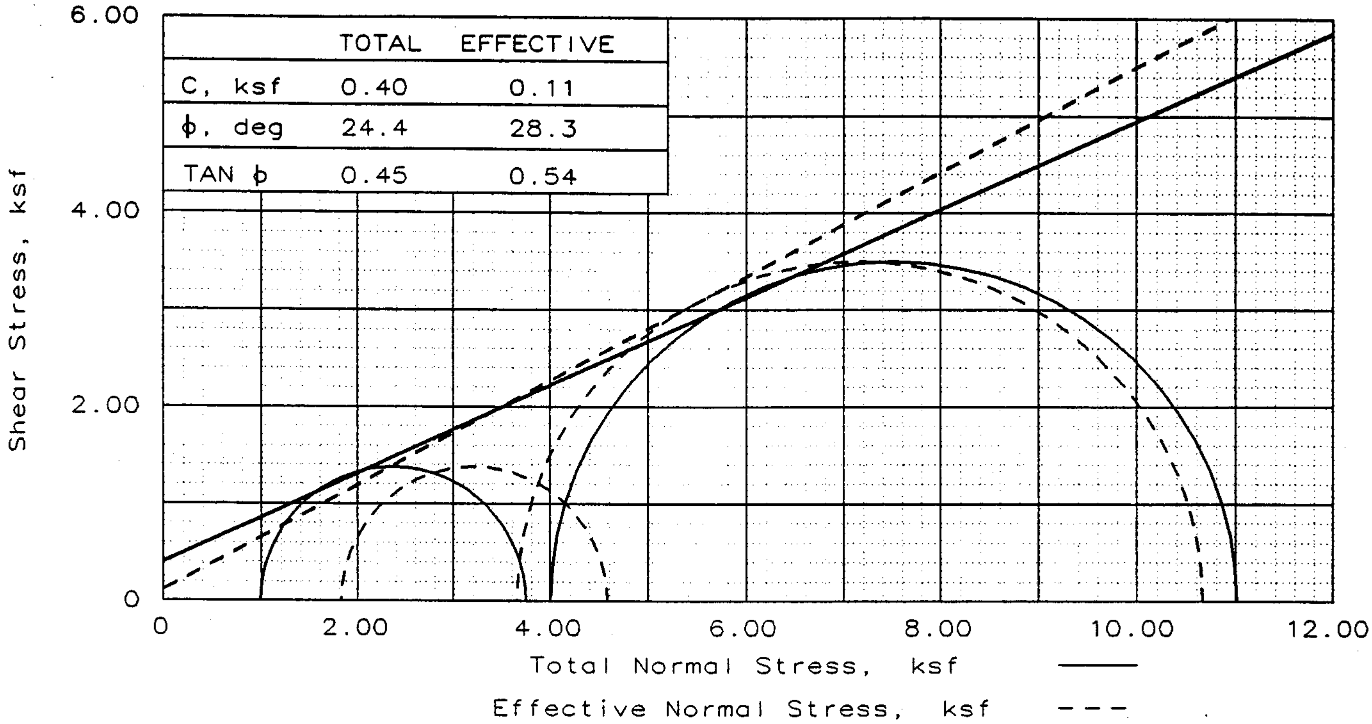


Client: RICHARDSON AND ASSOCIATES

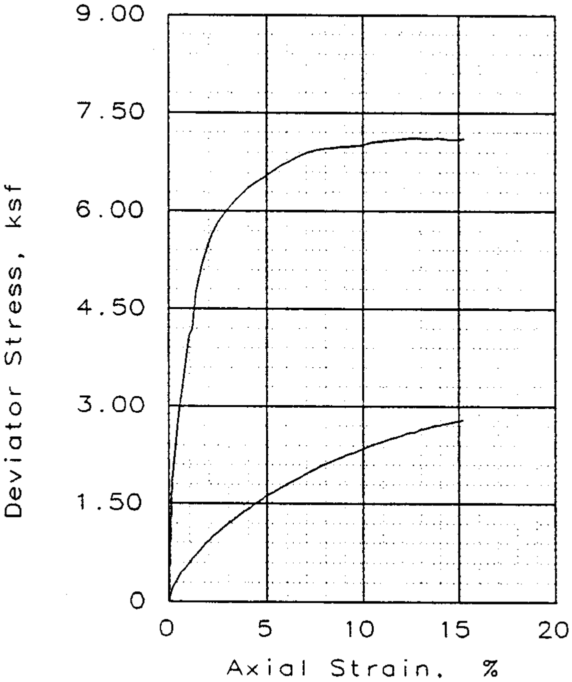
Project: HALIFAX - 5

Location: B - 4

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



	TOTAL	EFFECTIVE
C, ksf	0.40	0.11
ϕ, deg	24.4	28.3
TAN ϕ	0.45	0.54



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:

FIG. NO.

CLIENT: G.N. RICHARDSON & ASSOC

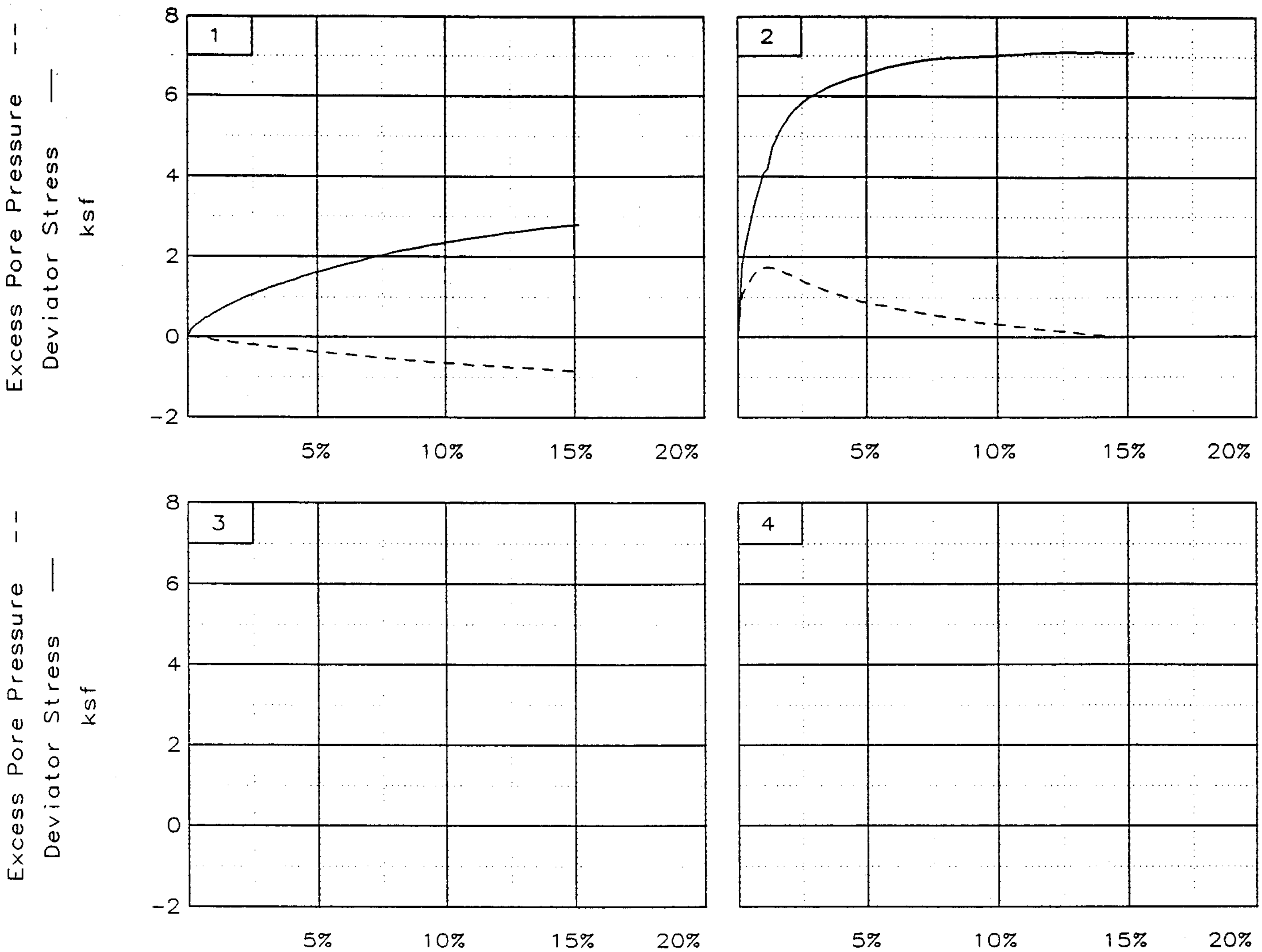
PROJECT: HALIFAX 5

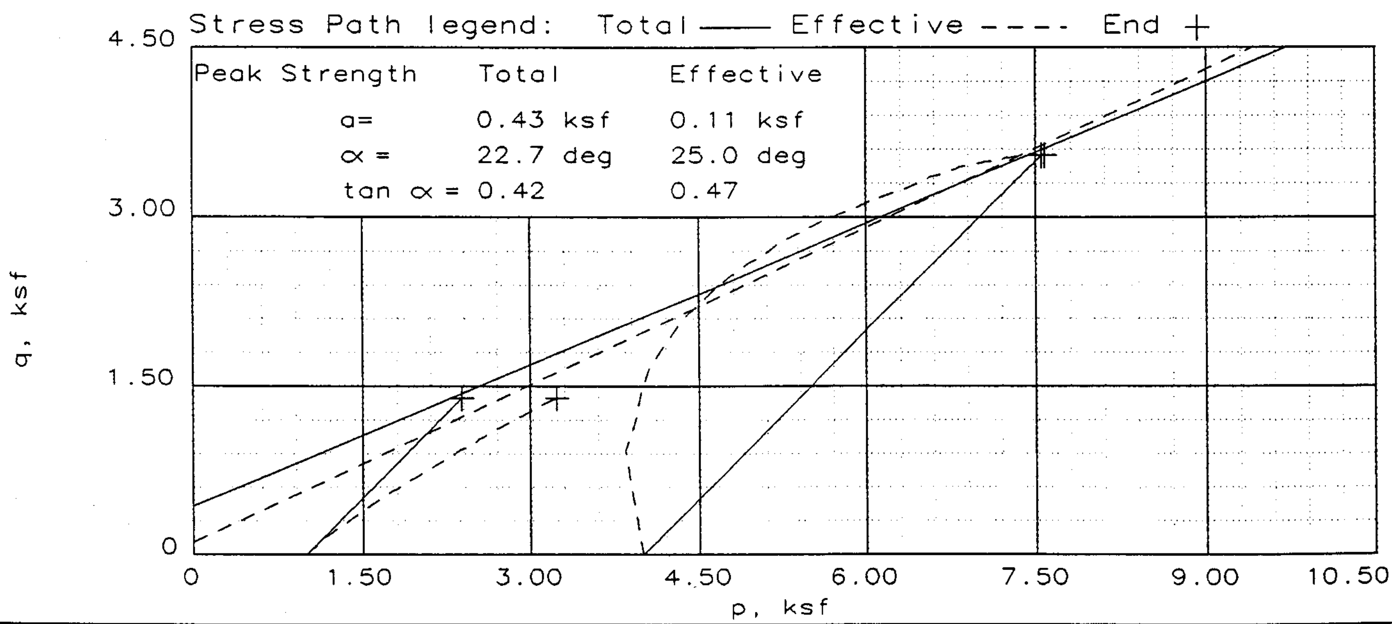
SAMPLE LOCATION: B - 8

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

TRIAXIAL SHEAR TEST REPORT

GEOTECHNOLOGIES, INC., P.A.





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

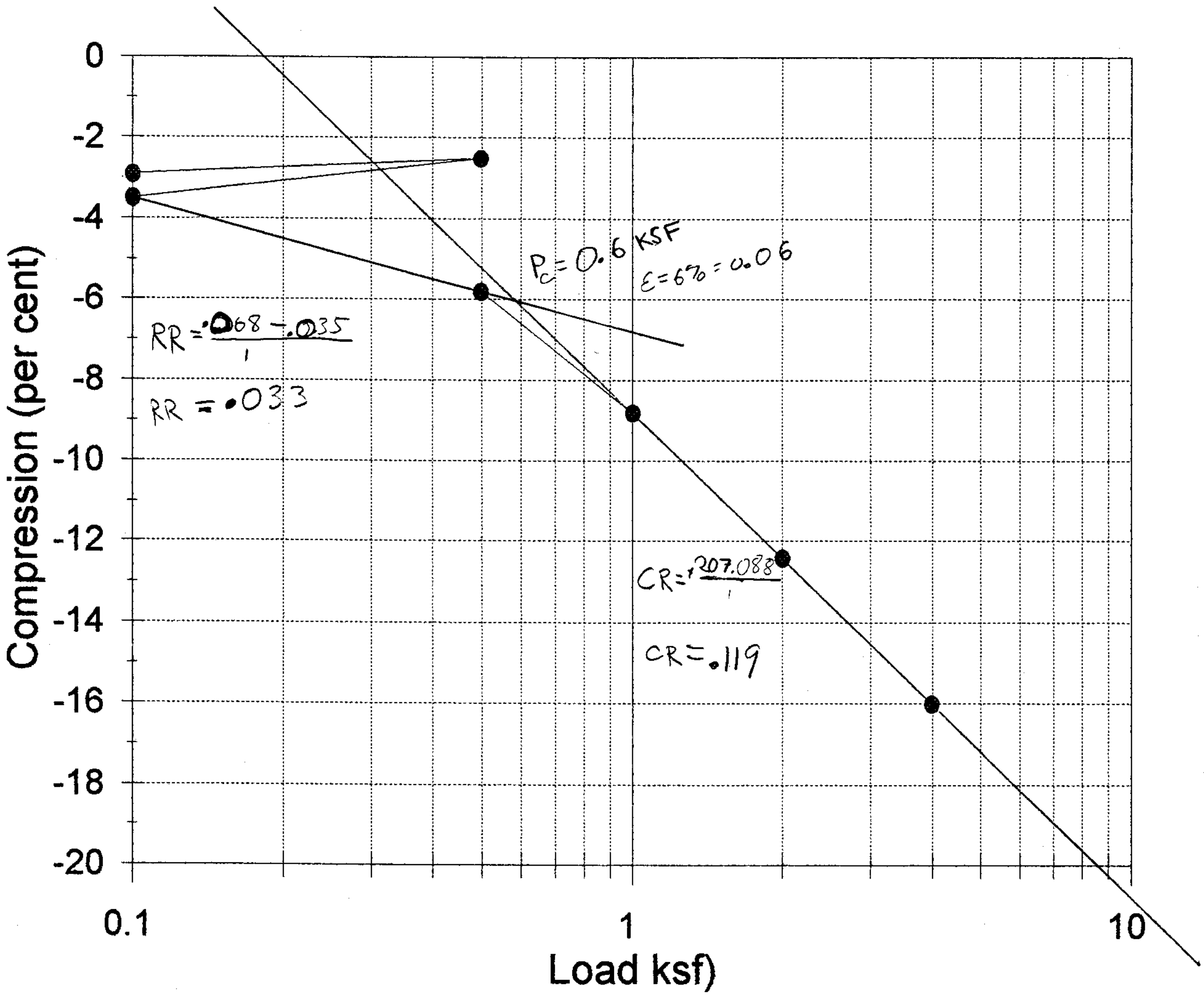
LOAD / psf	%E	Con. Coef.	%IC
100	0.4		90.0
500	2.9		93.3
100	2.5		80.0
500	3.5		77.4
1000	5.8	4.979	87.8
2000	8.8	3.136	91.2
4000	12.4	8.743	92.7
8000	16.0	5.371	86.0
16000			

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

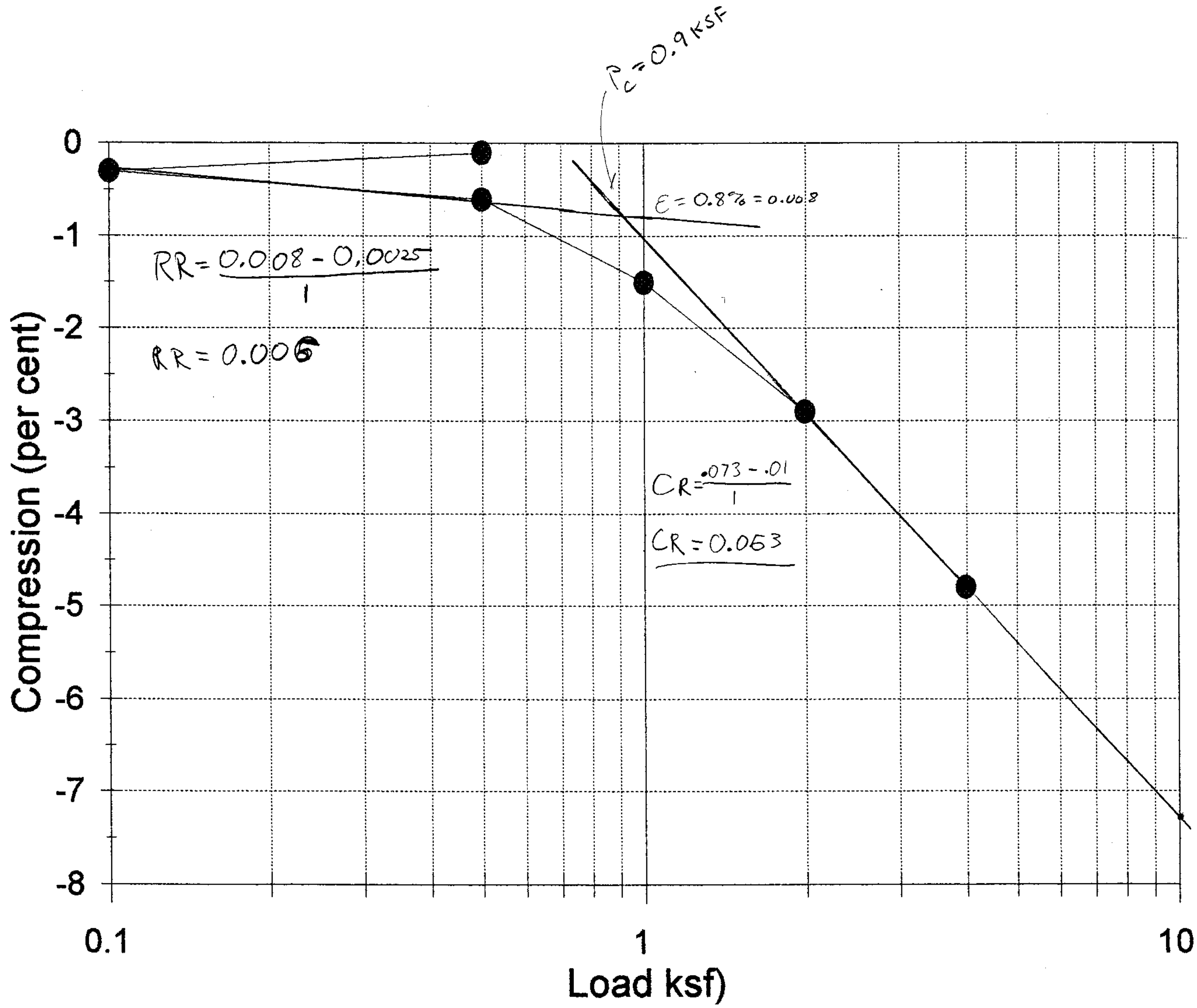
LOAD / psf	%E	Con. Coef.	%IC
100	0.1		80.0
500	0.3		92.6
100	0.1		92.3
500	0.3		95.8
1000	0.6	5.421	88.2
2000	1.5	10.710	89.7
4000	2.9	5.236	88.1
8000	4.8	10.124	88.7
16000			

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'



GeoTechnologies, Inc.

CONSOLIDATION TEST

Job Name: HALIFAX 5 — Date: 4/16/96

Job Number: 1-95-1181 CB

Sample I.D. G-2-A — Depth: 1.5-3.5'

Soil Description: Red Brown Silty Fine 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	254.02	grams

SOIL PROPERTIES		
Init. Moisture	22.3	%
Soil Weight.	143.5	grams
Wet Density	111.4	lbs./cu.ft.
Dry Density	91.1	lbs./cu.ft.
Specific Gravity	2.68	Apparent
Final Moisture	22.2	%

Initial Reading	.0000
Preload Rebound Reading	.0129

LOAD / psf	R0	R6	R100	T50	R50
100	.0000	.0016	.0199		
500	.0199	.0120	.0129		
100	.0129	.0100	.0086		
500	.0086	.0161	.0175		
1000	.0175	.0276	.0297	0.9	0.0236
2000	.0297	.0459	.0483	0.45	0.039
4000	.0483	.0722	.0758	0.9	0.0621
8000	.0758	.1080	.1117	0.9	0.0938

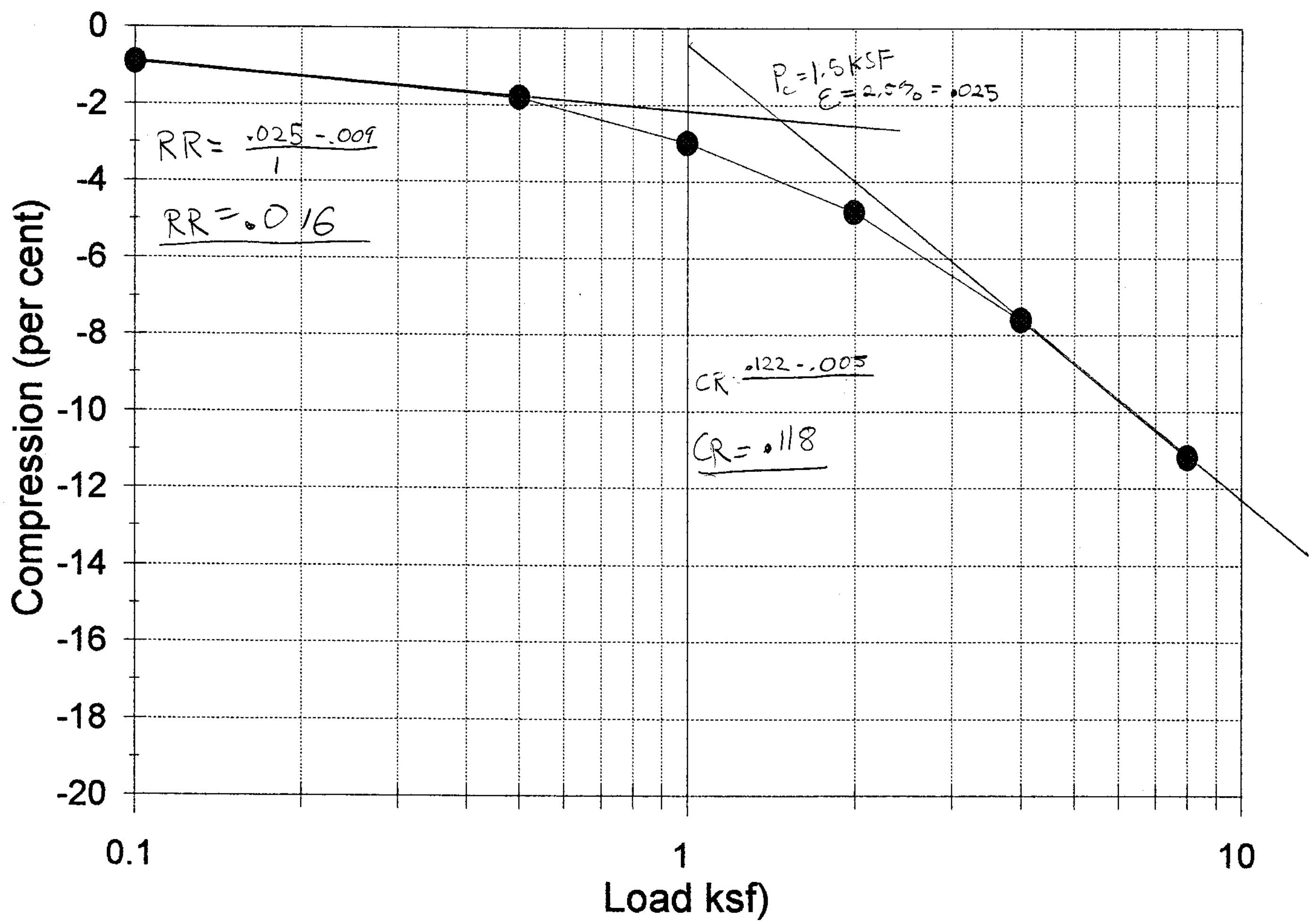
LOAD / psf	%E	Con. Coef.	%IC
100	2.0		8.0
500	1.3		112.9
100	0.9		68.1
500	1.8		84.3
1000	3.0	5.217	82.8
2000	4.8	10.107	87.1
4000	7.6	4.814	86.9
8000	11.2	4.494	89.7
16000			

NOTE: Consolidation Coefficient in Square Feet Per Day

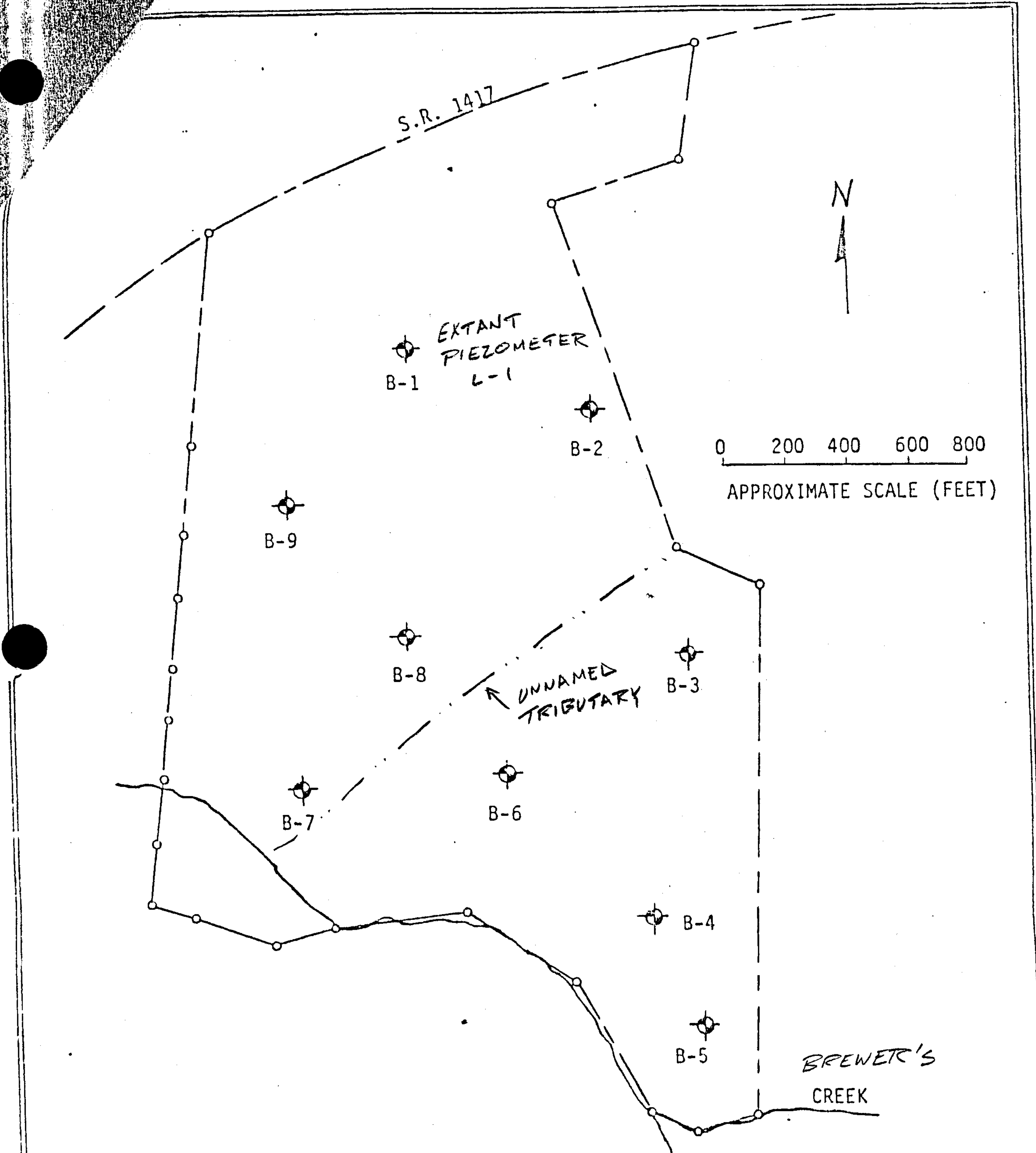
Initial Void Ratio	0.837
Final Void Ratio	0.632
Initial Saturation, %	71.4
Final Saturation, %	94.4

Consolidation Test

G-2, 1.5' - 3.5'



Appendix H



BORING LOCATION PLAN

HALIFAX COUNTY LANDFILL 42-04

HALIFAX COUNTY, NORTH CAROLINA

LAW ENGINEERING TESTING CO.
RALEIGH, NORTH CAROLINA

SCALE	Drawn: JRR	Job No. RA-1673
AS SHOWN	Checked: JAT	
	Date: 2/3/81	Dwg. No. 2

Sec # 2

LAW ENGINEERING TESTING COMPANY
geotechnical, environmental & construction materials consultants
3301 WINTON ROAD
P.O. BOX 18288 • RALEIGH, NORTH CAROLINA 27619
(919) 876-0416

RECORD OF AUGER BORING

JOB NO. RA-1673 BORING NO. B-1

DEPTH - FT. FROM	TO	SOIL DESCRIPTION AND REMARKS	BAG AND JAR SAMPLES NO.	FROM	TO
0.0	0.3	Topsoil with grass roots	1	0	2'
0.3	5½	Red-tan silty sandy CLAY (CL)	2	2	3'
5½	16	Light tan fine to coarse very sandy SILT (ML)	3	3	5½'
16	35	Light tan fine sandy SILT, trace coarse sand (ML)	4	5½	7'
		(Wet below 25± ft.)	5	7	11'
		Boring terminated @ 35.0 ft.	6	11	13'
			7	13	16½'
		Piezometer set @ 35± ft.	8	16½	23'
		Water level @ 26 ft. after 24 hours (1/28/81)	9	23	30'
			10	30	35'

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RECORD OF AUGER BORING

JOB NO. RA-1673 BORING NO. B-2

DEPTH - FT. FROM	TO	SOIL DESCRIPTION AND REMARKS	BAG AND JAR SAMPLES NO.	FROM	TO
0.0	0.4	Topsoil with organics	1	0	4'
0.4	4	Red silty sandy CLAY (CL/ML)	2	4'	6'
4	7½	Red-tan slightly clayey sandy SILT (ML)	3	6'	7½'
7½	12½	Weathered rock fragments and silty SAND	4	7½'	9'
12½	29	Light tan sandy SILT (ML)	5	9'	12½'
		(Wet below 22± ft.)	6	12½'	17'
		Boring terminated @ 29.0 ft.	7	17	22½'
		Water level @ 21 ft. after 24 hours (1/28/81)	8	22½'	29'

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RECORD OF AUGER BORING

JOB NO. RA-1673

BORING NO. B-8

DEPTH - FT. FROM	TO	SOIL DESCRIPTION AND REMARKS	BAG AND JAR SAMPLES NO.	FROM	TO
0.0	0.6	Topsoil - Brown SAND with some gravel	1	0	4'
0.6	4	Red-tan fine to coarse sandy silty CLAY, trace mica	2	4'	10'
		some coarse rounded gravel (CL)	3	10'	15'
4	20	Light tan and gray coarse sandy SILT, trace mica (ML)	4	15'	20'
		(Wet below 10 ± ft.)			
		Boring terminated @ 20.0 ft.			
		Water level @ 11± ft. after 24 hours (1/28/81)			

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RECORD OF AUGER BORING

JOB NO. RA-1673 BORING NO. B-9

DEPTH - FT. FROM	TO	SOIL DESCRIPTION AND REMARKS	BAG AND JAR SAMPLES NO.	FROM	TO
0.0	0.8	Topsoil with heavy root matter	1	0	4½'
0.8	4½	Red-tan sandy very silty CLAY (CL)	2	4½'	7'
4½	15	Light tan micaceous fine to coarse sandy SILT (ML)	3	7'	12'
		Boring terminated @ 15.0 ft.	4	12'	15'
		Piezometer set @ 10 ft.			
		Water level @ 6± ft. after 24 hours (1/28/81)			

LAW ENGINEERING TESTING COMPANY
3301 WINTON ROAD
RALEIGH, NORTH CAROLINA
SOIL DATA SUMMARY-JOB NO. RA-1673

BORING NO.	DEPTH, FEET	SAMPLE TYPE	CLASSIFICATION	UNIT WEIGHT, pcf		% FINER NO. 200 SIEVE	SPECIFIC GRAVITY	VOID RATIO	NATURAL MOISTURE	ATTERBERG LIMITS		
				WET	DRY					LL	PL	PI
B-3	0-4.5	1	MH						30.8	77	42	35
B-3	7.0-10.5	3	SM			46.8			25.8	43	35	8
B-4	5.0-7.0	2	MH						26.9	69	38	31

SS- SPLIT SPOON
UD- UNDISTURBED SAMPLE

472-05

The following data were collected in 1991 pertaining to the installation of the original monitoring well network at the site. Two of the original wells are extant, MW-1 and MW-5, with only MW-1 remaining in active service. Both these wells provide supplemental ground water elevation data for the site permit application. However, no other well construction data or boring logs are available.

G·N·Richardson & Associates
CONSULTING ENGINEERING

May 2, 1991

North Carolina Department of Environment,
Health, and Natural Resources
Post Office Box 27687
Raleigh, North Carolina 27611-7687

Atention: Mr. Bobby Lufty
Hydrogeologist
Solid Waste Section

Reference: Halifax County Ash Monofill
Site Suitability Application Corrections
GNRA Project Number 90-001

Dear Bobby;

I am enclosing copies of corrections to two Tables and two Well Construction Records from the Site Suitability Application for the Halifax County Ash Monofill that we submitted to your office on March 22, 1991. The Tables that were corrected are "Table 5 - Summary of Groundwater Level Data" located in the Table section of the Appendix, and an unnumbered table entitled "Summary of Groundwater Level Data" located in "Appendix A - Field Investigation". The two Well Construction Records are for Piezometers MW-8 and MW-9 and are located in Appendix A. Since four copies of the report were forwarded to your office, I have enclosed four full sets of the corrections. Please direct these corrections to those individuals holding copies of the report so that they can be inserted into the appropriate sections.

Additionally, I have enclosed a copy of the report from Law Engineering from July 1981, detailing the construction of the monitoring wells from the current sanitary landfill. The numbering system of the wells that Law used in their report was different than that used in the permit. A copy of the sketch used in the permit is enclosed to show you the locations and numbers of the wells as presented in the permit. Additionally, we have made a table to correlate the well number from the permit (shown on the sketch) to the well number shown in the Law report.

12600 SHOOTING CLUB ROAD • RALEIGH, NORTH CAROLINA 27613 • TEL. 919-848-2371 • FAX 919-676-1425

Halifax County Ash Monofill
Site Application Corrections
May 2, 1991

The following table equates the well numbers used in the permit to those used in the Law report:

Permit Well Number	Law Well Number
MW-1	MW-1
MW-2	MW-4
MW-3	MW-5
MW-4	MW-6
MW-5	MW-2
MW-6	MW-3

If you have any questions please contact at us.

Very Truely Yours,
G.N. Richardson and Associates

John C. Robins, PE
Associate

Enclosures
CC: 1- File GNRA 91-001
2- Sherri Hoyt, Engineer
Solid Waste Section

July 17, 1981

McDavid Associates, Inc.
Post Office Drawer 49
Farmville, North Carolina 27828

Attention: Mr. Mike Barnette, Jr.

Subject: Installation of Groundwater Monitoring Wells
Halifax County Landfill
Halifax County, North Carolina
LETCO JOB No. RA-1673A

Gentlemen:

Law Engineering has completed the installation of six groundwater monitoring wells at the subject site. This work was accomplished in accordance with our proposal PRS-1-071 dated June 17, 1981.

Six groundwater monitoring wells were installed generally according to the requirements of the North Carolina Department of Human Resources, Division of Health Services. Locations of the wells were staked by McDavid Associates, Inc. The actual placement of the wells was as close as practical to the stakes and within the tolerances allowed to us.

Details of the monitoring wells, including depths of the particular well components and water levels recorded are shown on Drawing No. 1. After completing the well installations, each well was developed by bailing and a lock placed on each standpipe. The keys have been sent to Mr. John Kelly at the landfill.

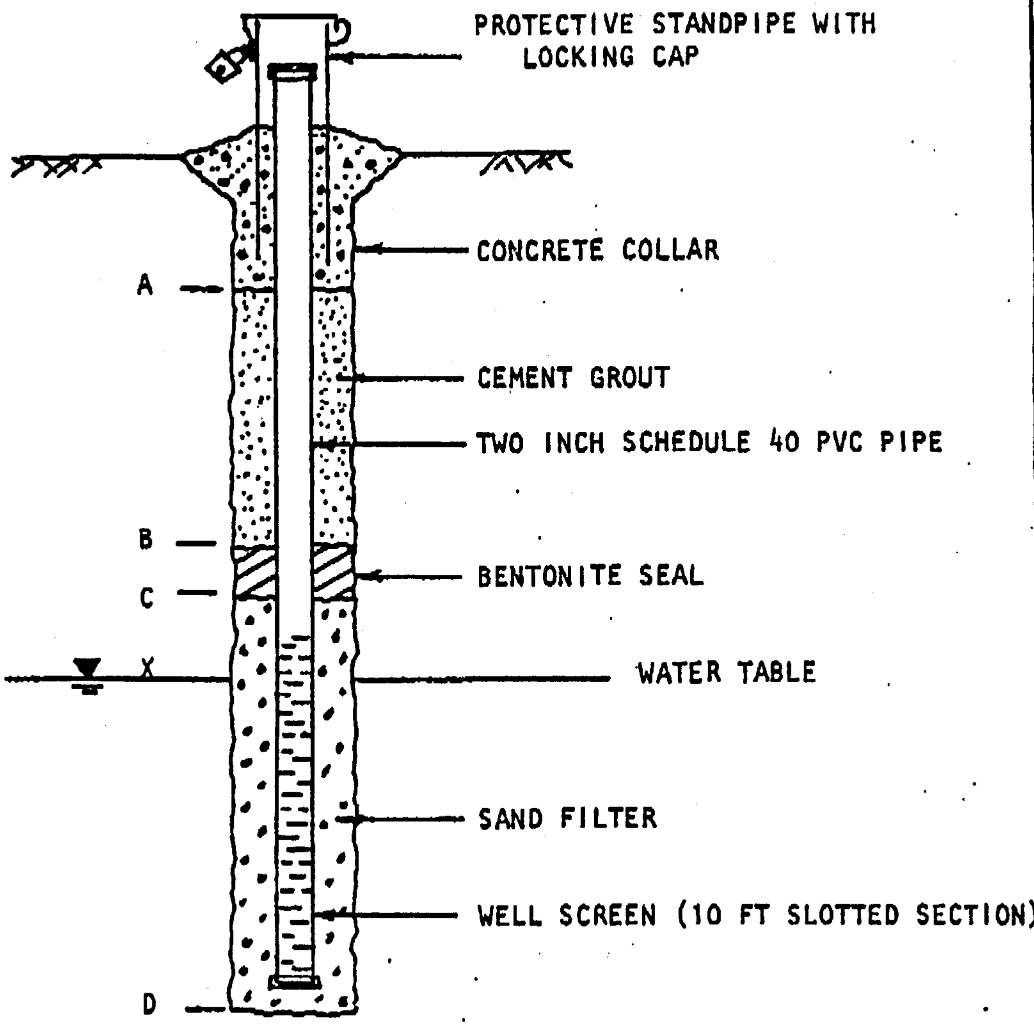
We appreciate the opportunity to be of continued service on the project. If you have any questions, don't hesitate to call on our office.

Very truly yours,

LAW ENGINEERING TESTING COMPANY

J. Richard Rhudy, P.E.
Staff Geotechnical Engineer

Peter Fleming, P.E.
Senior Engineer
Geotechnical Department Manager

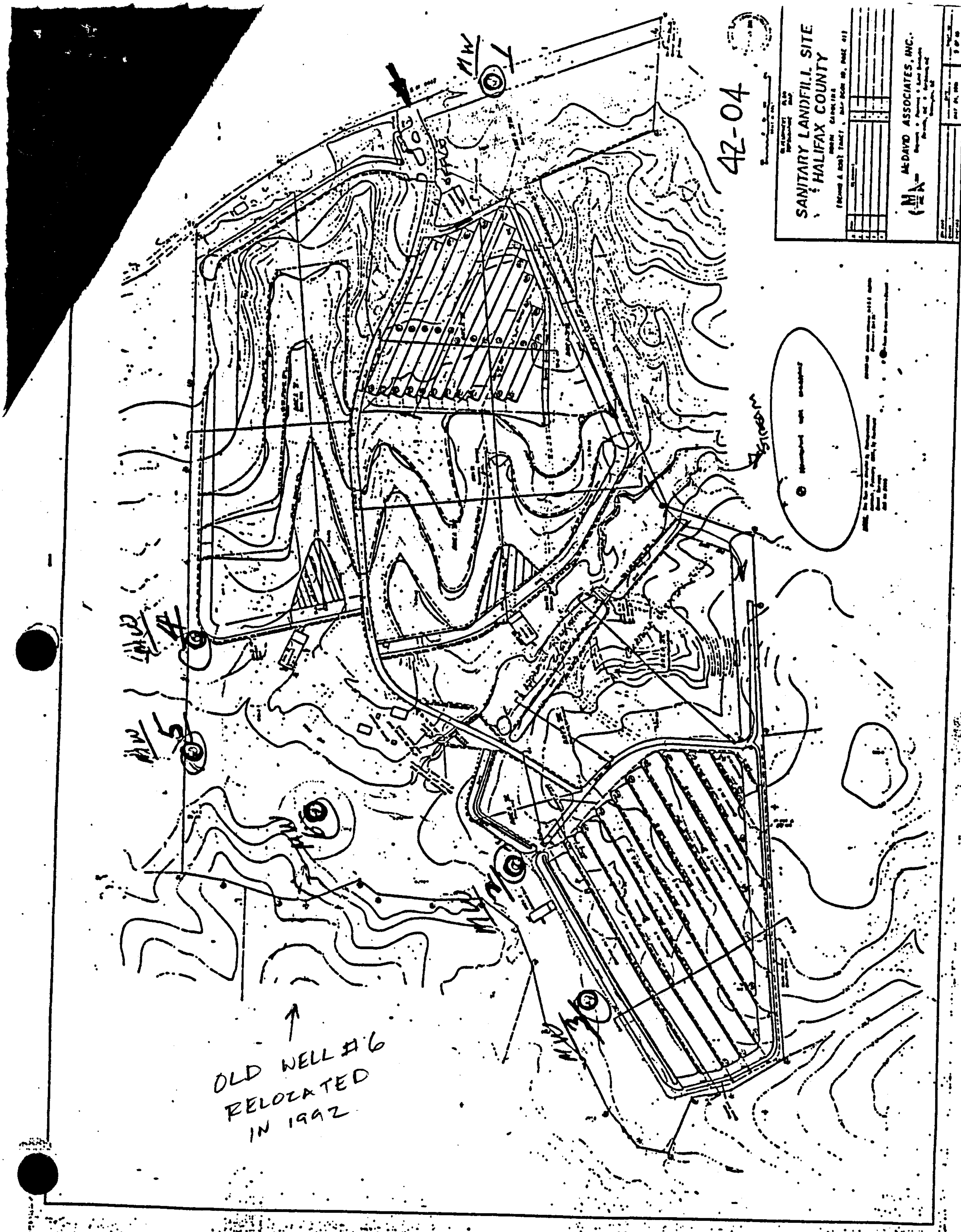


DEPTHS BELOW GROUND SURFACE, FEET

WELL NO	Permt	A	B	C	D	X	(DATE)
W-1	mw-1	3.0	25	27	40	34	7/7/81
W-2	mw-5	2.0	2.0	3.0	15	3.3	7/7/81
W-3	mw-6	2.0	2.3	3.7	16	3.0	7/7/81
W-4	mw-2	2.0	2.0	3.0	15	3.5	7/1/81
W-5	mw-3	2.5	3.0	4.0	15	12	7/1/81
W-6	mw-4	3.0	4.0	5.0	20	15	7/7/81

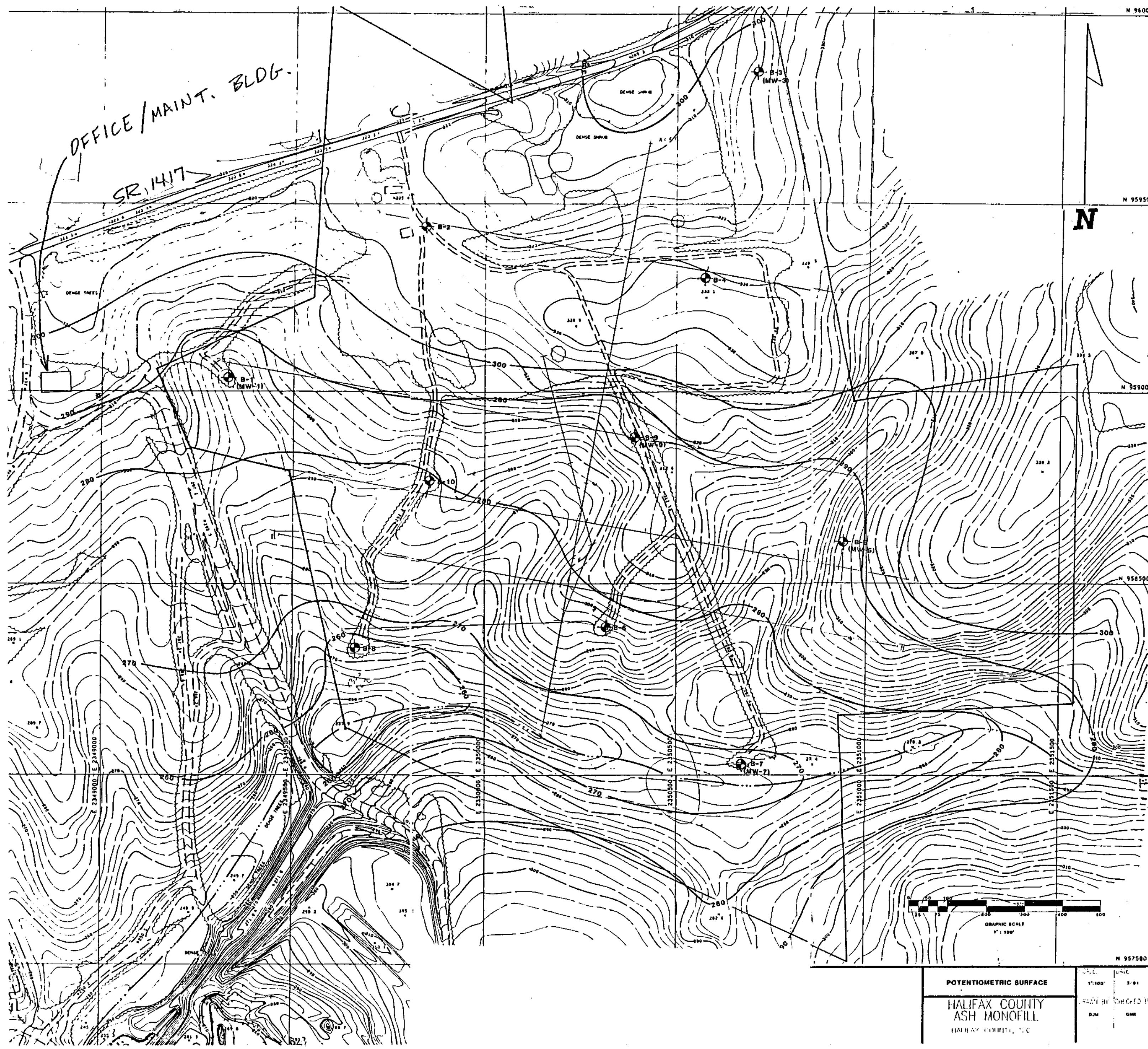
may or may not be the same B-6 as currently w-cl OLD.
3/5

GROUNDWATER MONITORING WELLS	LAW ENGINEERING TESTING CO. RALEIGH, NORTH CAROLINA		
HALIFAX COUNTY LANDFILL	SCALE N.T.S.	Drawn: JRR Checked: PF Date: 7/16/81	Job No. RA-1673A
HALIFAX COUNTY, NORTH CAROLINA			Dwg. No. 1



SANITARY LANDFILL SITE
HALIFAX COUNTY
McDAVID ASSOCIATES, INC.
42-04
MW 1
MW 4
MW 5
MW 2
MW 3
STREAM
OLD WELL #6
RELOCATED
IN 1992

The following data were collected in 1991 during the site permitting investigation for the ash monofil, shown here for demonstration of continuity with site conditions with the study area.


OFFICE/MAINT. BLDG.
SR 1417
N
N 960000
N 959500
N 959000
N 958500
N 957580
E 2349000
E 2349500
E 2350000
E 2350500
E 2351000
E 2351500
B-1 (MW-1)
B-2
B-3 (MW-3)
B-4
B-5 (MW-5)
B-6
B-7 (MW-7)
B-8
B-9 (MW-9)
B-10
DENSE TREES
DENSE SHRUB
GRAPHIC SCALE
1" : 100'
POTENTIOMETRIC SURFACE
HALIFAX COUNTY
ASH MONOFILL
HALIFAX COUNTY, N.C.
1"=100'
3/91
DJM
GMB

SUMMARY OF LABORATORY TESTS

BORING NUMBER	SAMPLE	DEPTH	NATURAL MOIST CONT	ATTERBURG LIMITS LL	PL	PI	AMOUNT OF SOIL (%) COARSE SAND	MEDIUM SAND	FINE SAND	SILT	CLAY	USCS CLASS
B-1	BULK-A	0-3.5	19.1	37	29	8	0	6.9	46	15.1	32	SM-ML
B-1	BULK-B	0-3.5	24.3	50	47	3	---	---	---	---	---	ML-MH
B-1	S-2	3.5-5	32.8	50	27	23	0	7.7	17	35.4	39.9	CL-CH
B-1	S-5	18.5-20	28									
B-1	S-7	28.5-30	20.3									
B-1	S-9	38.5-40	9.5									
B-2	S-2	3.5-5	23	61	25	36	0	2.2	39.4	14.3	44.1	CH
B-2	S-5	18.5-20	26.6									
B-2	S-7	28.5-30	39.2									
B-2	S-9	38.5-40	34.1									
B-3	S-2	3.5-5	26.6	47	37	10	0	2.2	30	48.8	19	ML
B-3	S-5	18.5-20	44.3	54	45	9	0	7.1	29.3	50.6	13	MH
B-3	S-7	28.5-30	34.7									
B-3	S-9	38.5-40	38.9									
B-4	S-2	3.5-5	19									
B-4	S-5	18.5-20	25.6									
B-4	S-7	28.5-30	68.6	99	68	31	0	0	4.3	67.7	28	MH
B-4	S-8	33.5-35	35.9									
B-5	S-2	3.5-5	34.6	69	44	25	0	1.1	24.1	40.8	34	MH
B-5	S-5	18.5-20	34.2	NP	NP	NP	0	19.1	31.7	42.2	7	SM-ML
B-5	S-7	28.5-30	22									
B-5	S-9	38.5-40	36.6									
B-6	S-2	3.5-5	37.6									
B-6	S-4	13.5-15	31.9	NP	NP	NP	0	3.1	44.1	44.8	8	ML-SM
B-6	S-6	23.5-25	29									
B-6	S-9	38.5-40	35.6									
B-7	S-11	48.5-50	12									
B-7	S-2	3.5-5	23.7									
B-7	S-5	18.5-20	26.5									
B-7	S-9	38.5-40	15.5									

SUMMARY OF LABORATORY TESTS

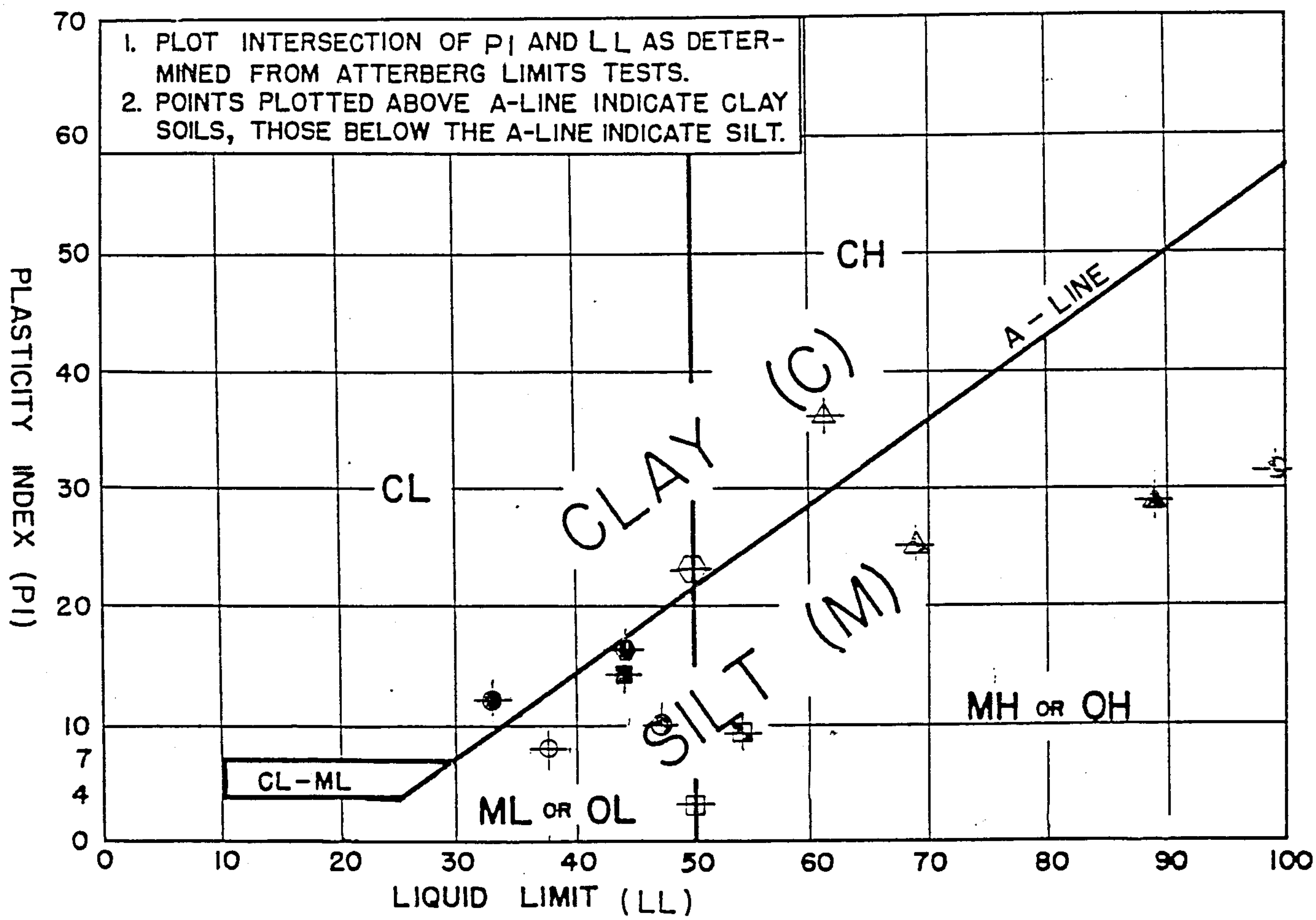
BORING NUMBER	SAMPLE	DEPTH	NATURAL MOIST CONT	ATTERBURG LIMITS LL	PL	PI	AMOUNT OF SOIL (%) COARSE SAND	MEDIUM SAND	FINE SAND	SILT	CLAY	USCS CLASS
B-8	BULK-A	0-5	9.8	NP	NP	NP	20.4	23.3	21.8	22.3	*	SM
B-8	BULK-B	5-10.0	16.1	33	21	12	---	---	---	---	---	ML
B-8	S-2	3.5-5	26.1									
B-8	S-5	18.5-20	11.4									
B-8	S-6	23.5-25	43.8									
B-9	BULK	0-10	---	44	30	14	0.6	14.8	28.1	56.5	*	ML
B-9	BULK	10-20	20	44	28	16	2	14.4	30.1	22.5	31	ML
B-9	S-2	3.5-5	20.2									
B-9	S-5	18.5-20	23									
B-9	S-7	28.5-30	59.8	89	60	29	0	0.3	6.5	70.2	23	MH
B-9	S-9	38.5-40	24									
B-10	S-10	43.5-45	18.2									
B-10	S-2	3.5-5	15.7									
B-10	S-5	18.5-20	29.2									
B-10	S-8	33.5-35	21.6									

* Total percentage of soil passing the #200 sieve.

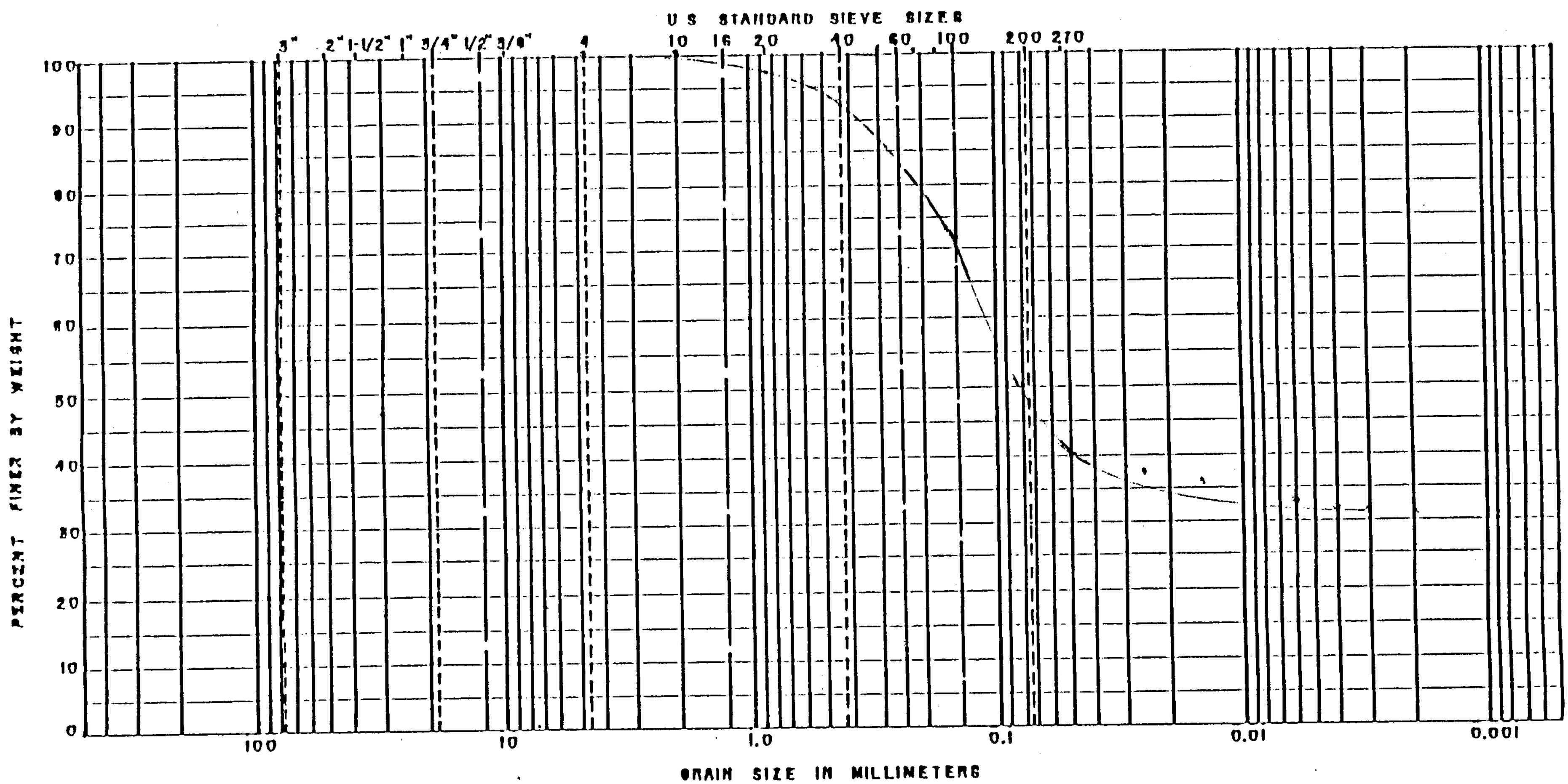
SUMMARY OF PERMEABILITY TEST RESULTS

			ASTM D 698 PROCTOR DATA		ACTUAL SPECIMEN COMPACTION DATA					
SAMPLE NO.	DEPTH (FEET)	SPECIFIC GRAVITY	MAX. DRY DENSITY (pcf)	OPT. MOISTURE CONTENT (%)	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	PERCENT COMPACTION	PERCENT MOISTURE CONTENT ABOVE OPTIMUM	HYDRAULIC CONDUCTIVITY k (cm/sec)	USCS CLASSIFICATION
B-1	3.5 - 5.0	2.65	102.4	21.0	100.7	23.0	98	2	2×10^{-8}	CL-CH
B-1	0 - 3.5	2.69	107.4	18.2	102.7	18.6	96	0.1	3.1×10^{-6}	SM-ML
B-8	5 - 10	2.65	117.0	12.7	111.1	12.8	95	0.1	1.7×10^{-5}	SM
B-9	0 - 10	2.71	106.4	18.8	105.5	19.2	99	0.4	1.6×10^{-7}	ML

ATTERBERG LIMITS TEST RESULTS



SYMBOL	BORING	DEPTH	USCS CLASSIFICATION
	B-1A	0-3.5'	ML-SM
	B-1B	0-3.5'	ML-MH
	B-1	3.5-5.0'	CL-CH
	B-2	3.5-5.0'	CH
	B-3	3.5-5.0'	ML
	B-3	18.5-20.0'	MH
	B-4	28.5-30.0'	MH
	B-5	3.5-5.0'	MH
	B-8	5.0-10.0'	ML
	B-9	0-10.0'	ML
	B-9	10.0-20.0'	ML
	B-9	28.5-30.0'	MH

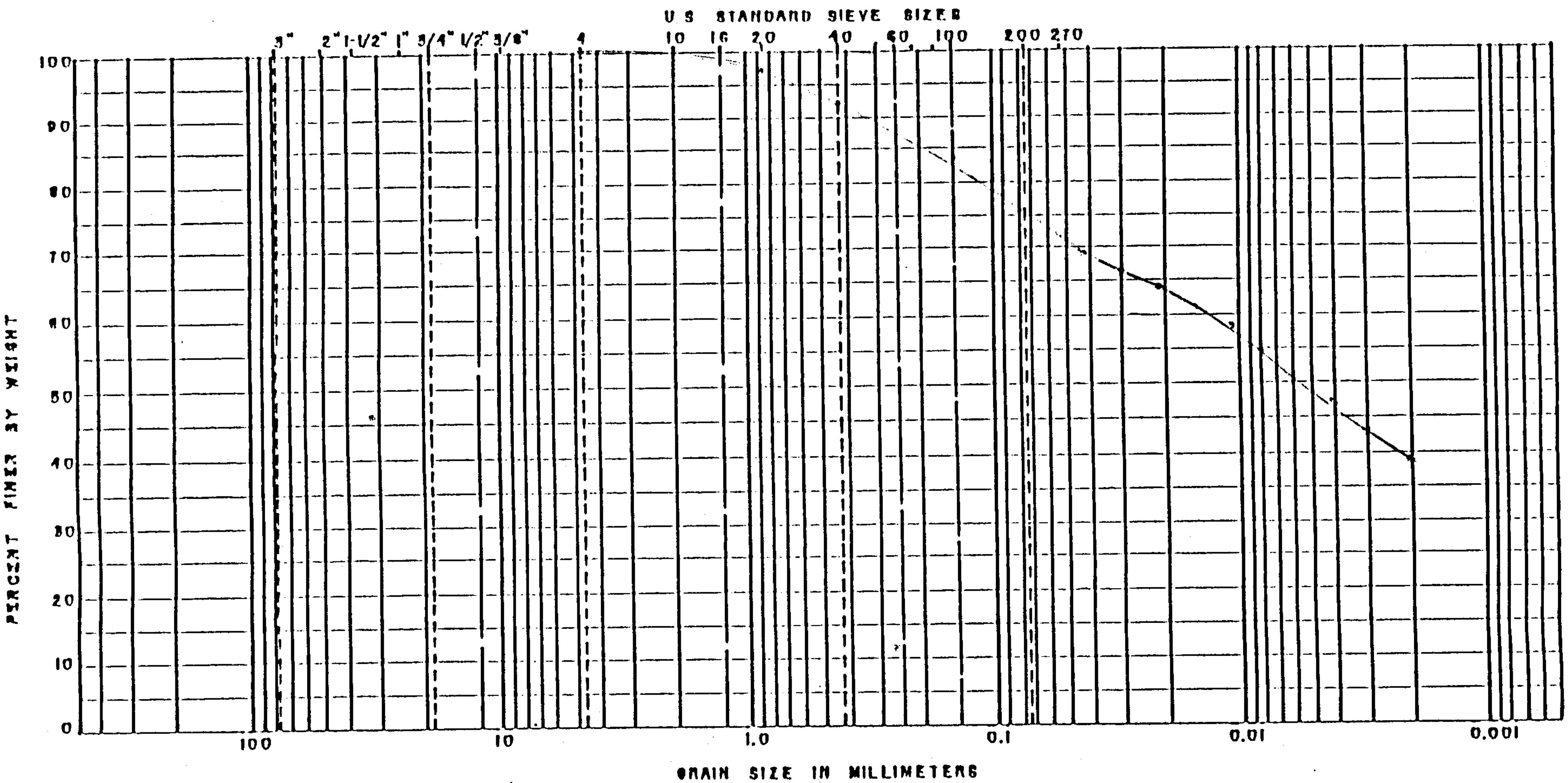


BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

BORING NO	ELEV. OR DEPTH	NAT WC	LL	PL	PI	DESCRIPTION OR CLASSIFICATION
B-1	0-3.5	19.1	37	29	8	Tannish Brown Fine Sandy Silt

GRAIN SIZE DISTRIBUTION

ENSCI CORPORATION

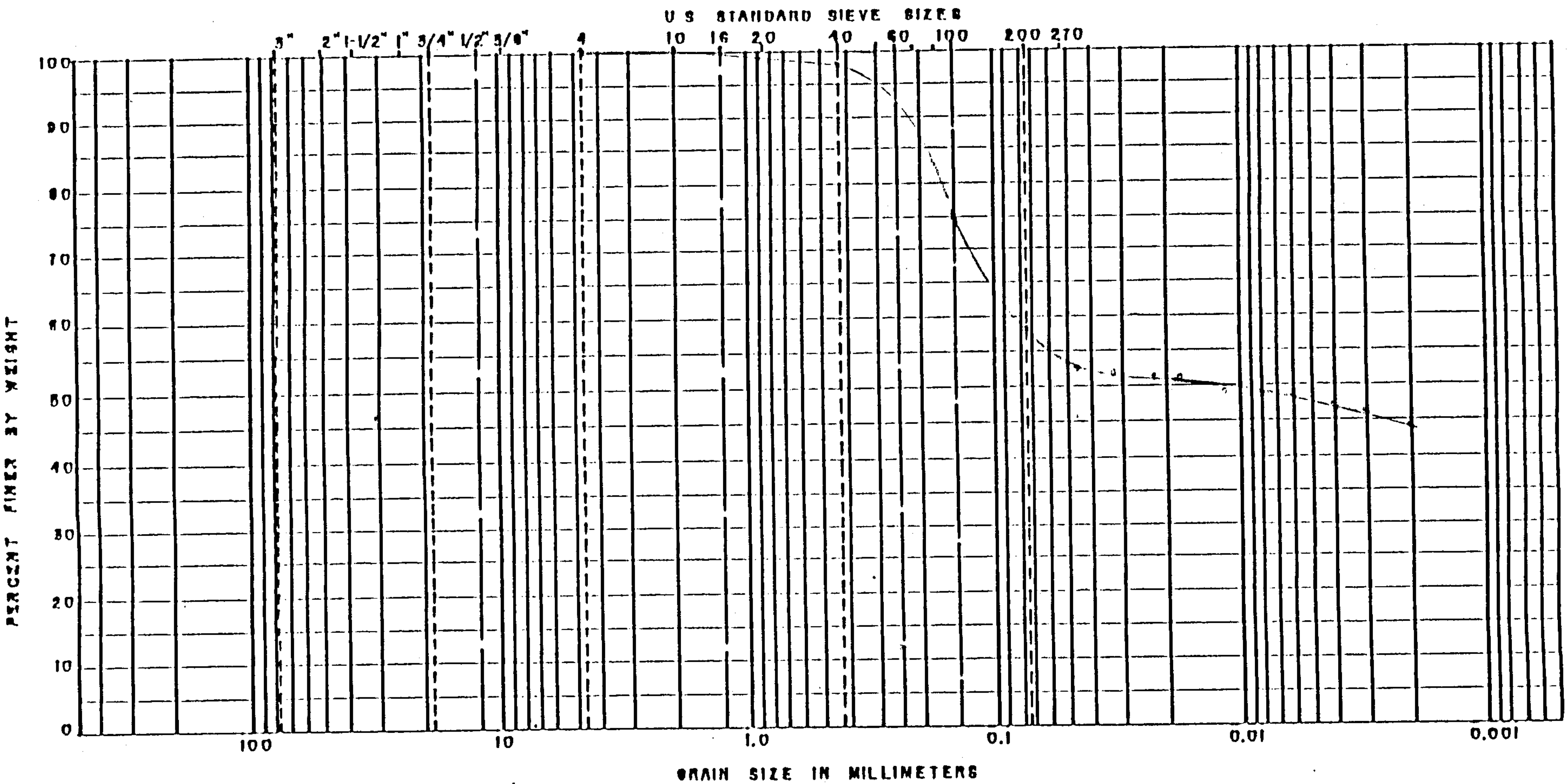


BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

BORING NO	ELEV. OR DEPTH	NAT WC	LL	PL	PI	DESCRIPTION OR CLASSIFICATION
B-1	3.5-5.0	32.8	50	27	23	Brownish Grey Fine Sandy Clay

GRAIN SIZE DISTRIBUTION

ENSCI CORPORATION

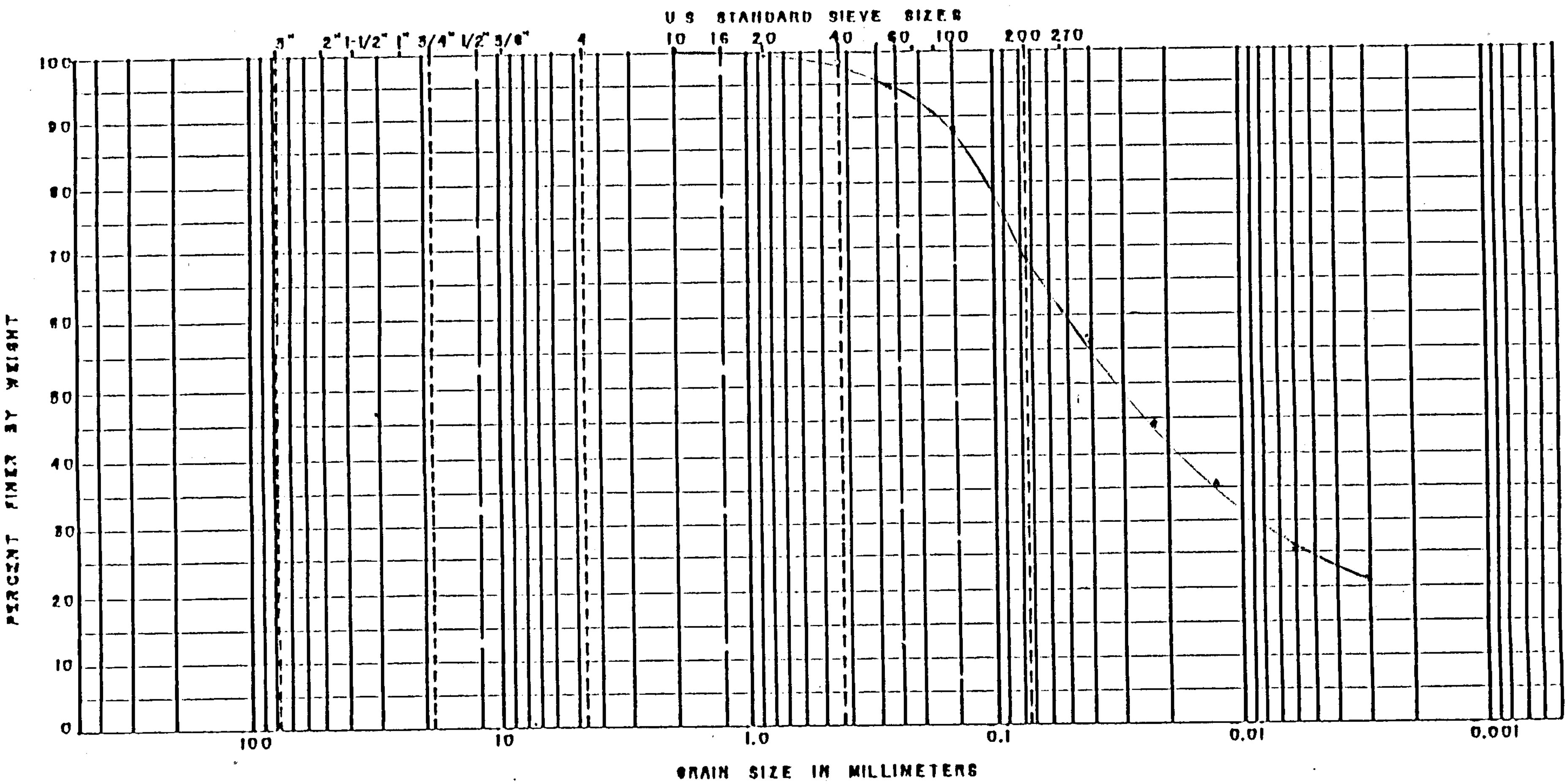


BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

BORING NO	ELEV. OR DEPTH	NAT WC	LL	PL	PI	DESCRIPTION OR CLASSIFICATION
B-2	3.5-5.0	23	61	25	36	Brown Silty Clay

GRAIN SIZE DISTRIBUTION

ENSCI CORPORATION

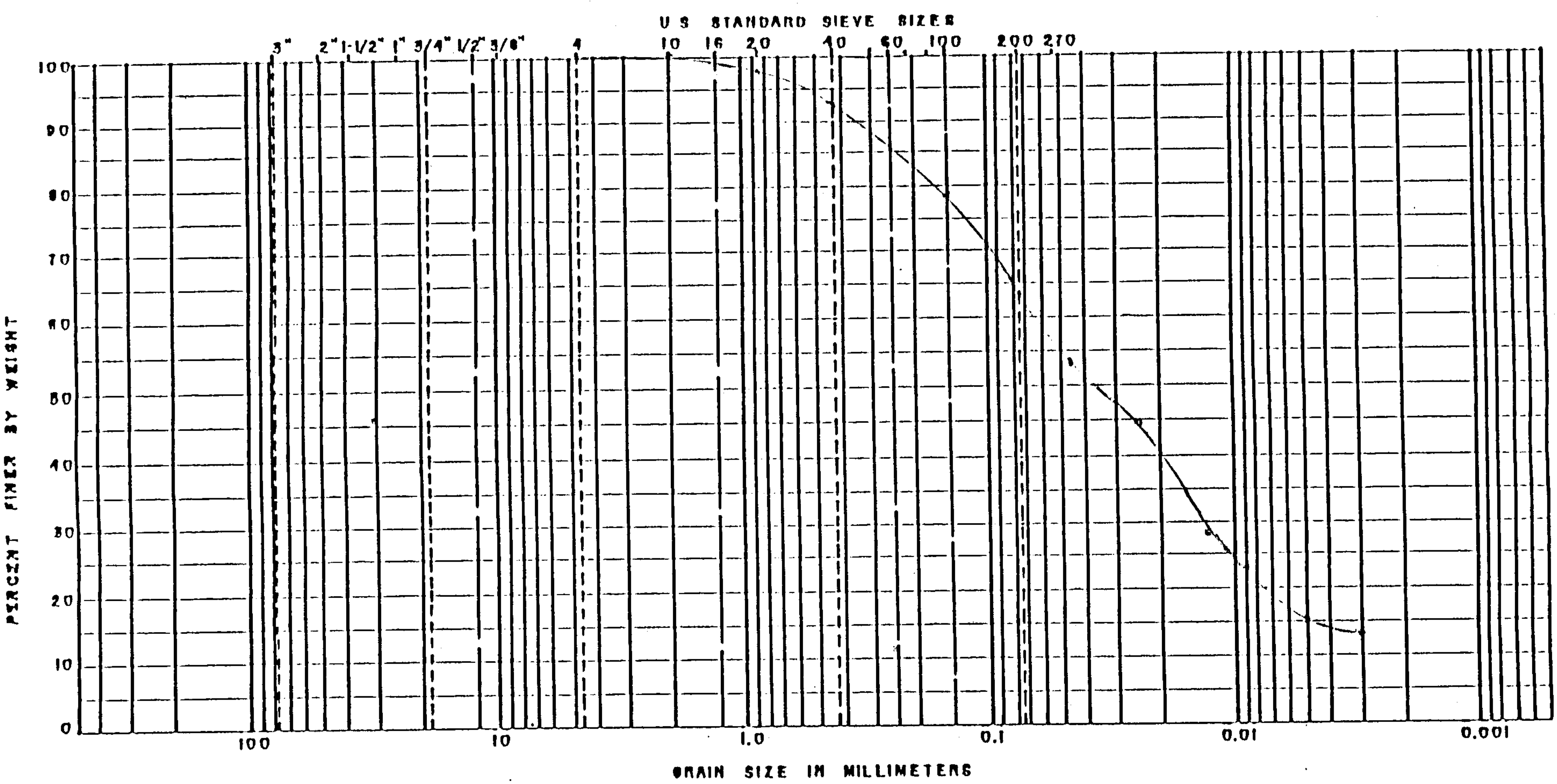


BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

BORING NO	ELEV. OR DEPTH	NAT WC	LL	PL	PI	DESCRIPTION OR CLASSIFICATION
B-3	3.5-5.0	26.6	47	37	10	Reddish Brown Fine Sandy Silt

GRAIN SIZE DISTRIBUTION

ENSCI CORPORATION

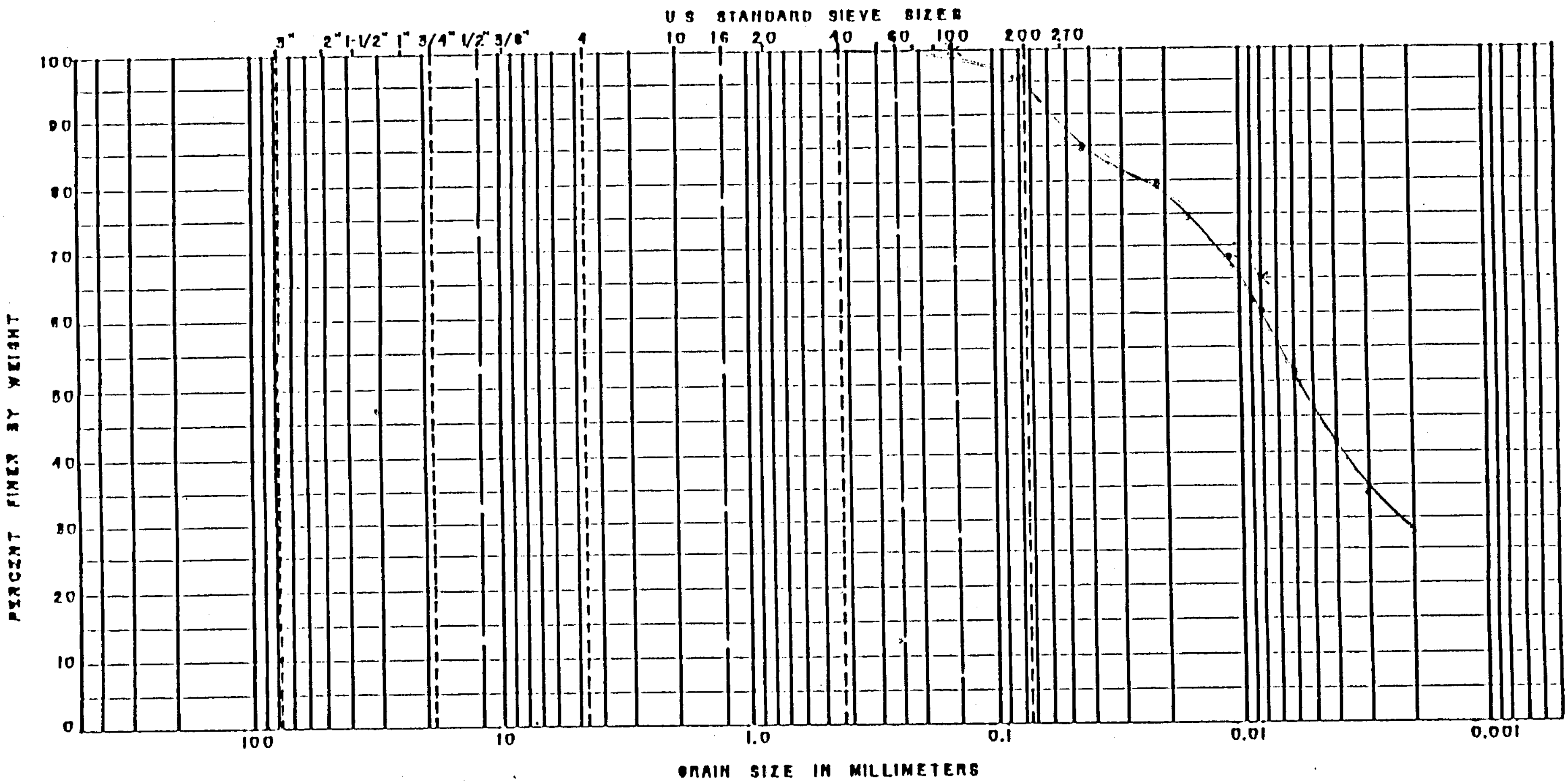


BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

BORING NO	ELEV. OR DEPTH	NAT WC	LL	PL	PI	DESCRIPTION OR CLASSIFICATION
B-3	18.5- 20	44.3	54	45	9	Reddish Tan Medium Clayey Silt

GRAIN SIZE DISTRIBUTION

ENSCI CORPORATION

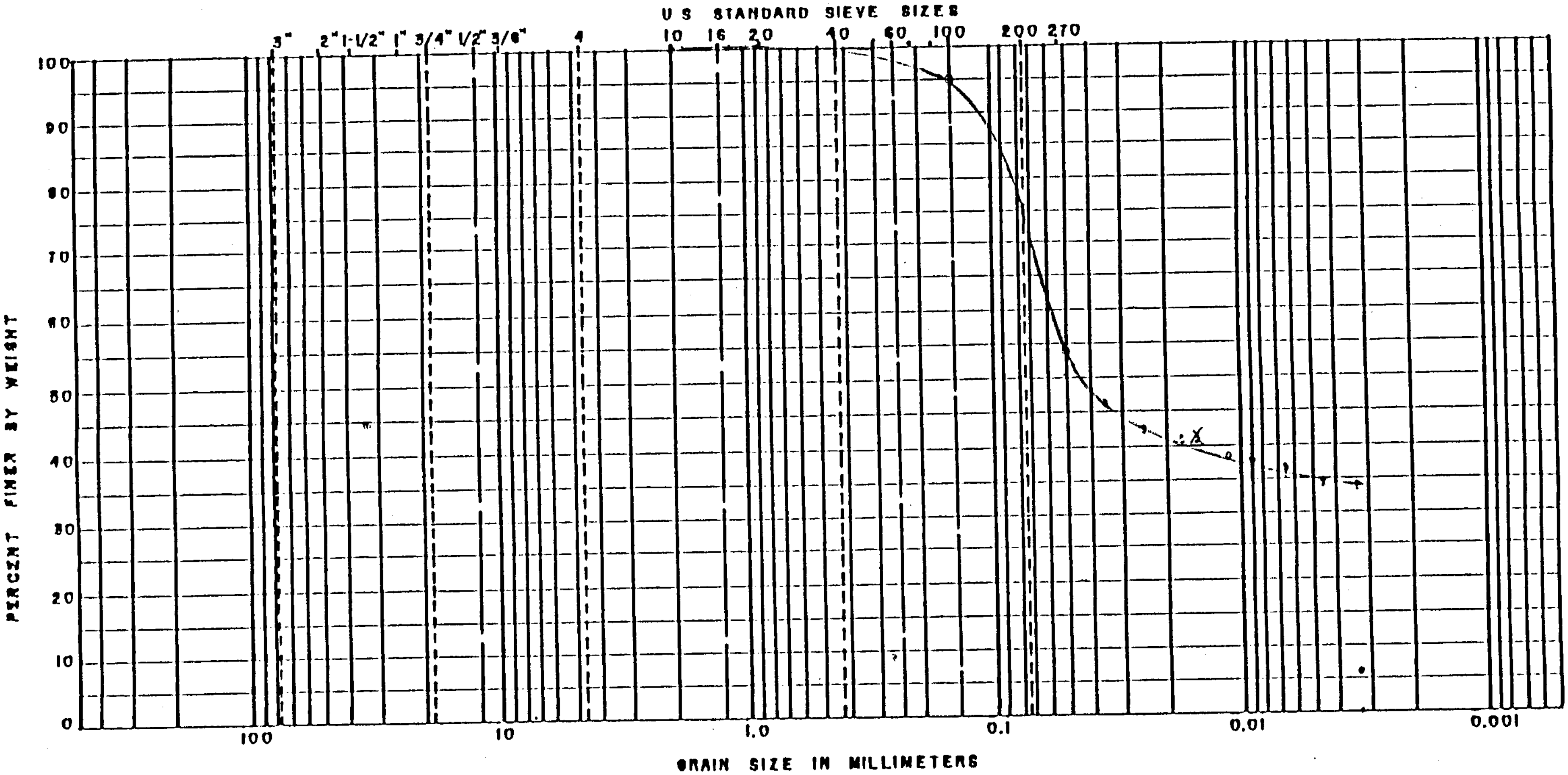


BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

BORING NO	ELEV. OR DEPTH	NAT WC	LL	PL	PI	DESCRIPTION OR CLASSIFICATION
B-4	28.5-30.0	68.6	99	68	31	Reddish Grey Tan Clayey Silt

GRAIN SIZE DISTRIBUTION

ENSCI CORPORATION

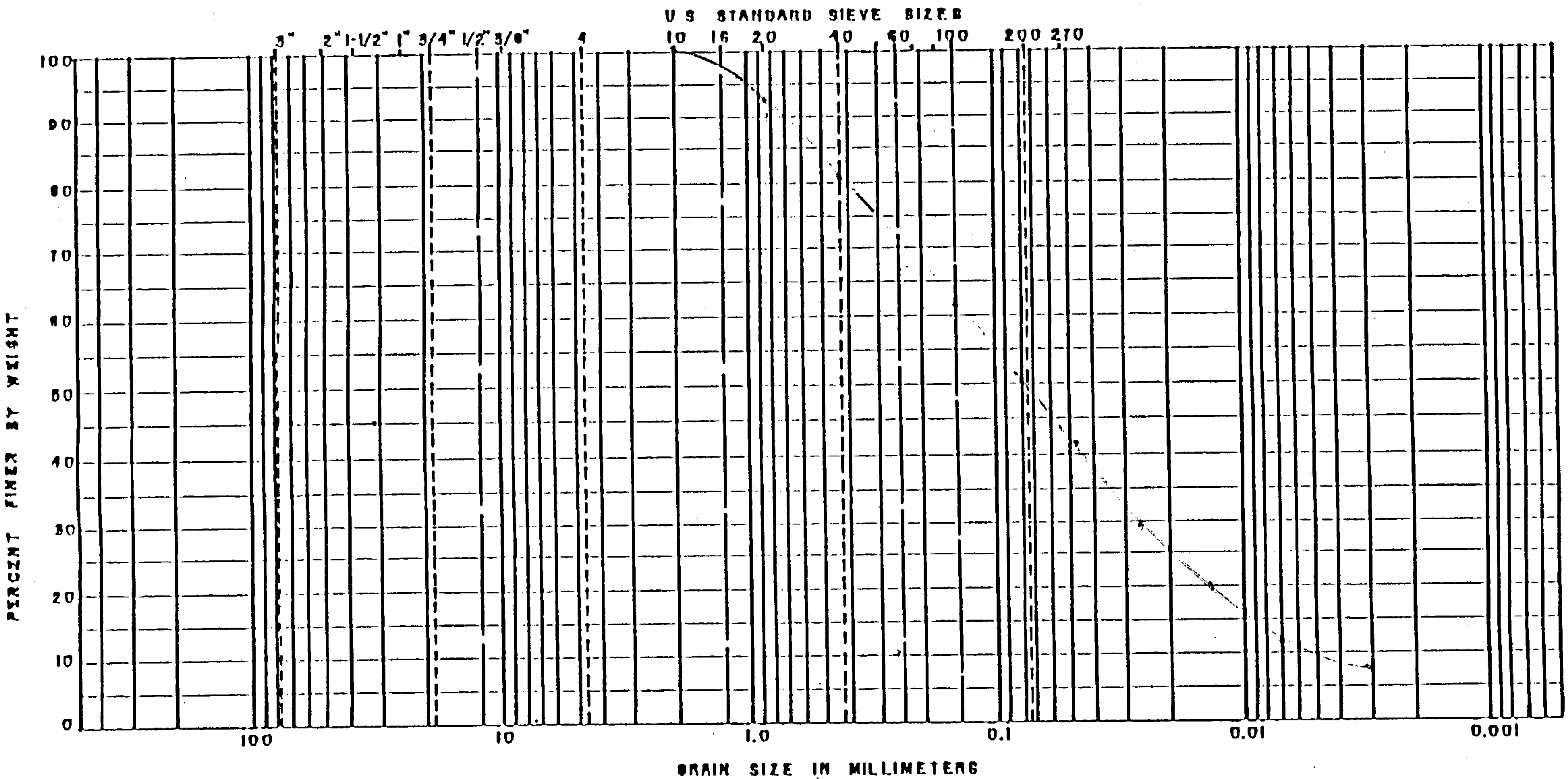


BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

BORING NO	ELEV. OR DEPTH	NAT WC	LL	PL	PI	DESCRIPTION OR CLASSIFICATION
B-5	3.5-5	34.6	69	44	25	Reddish Brown Fine Sandy Silt

GRAIN SIZE DISTRIBUTION

ENSCI CORPORATION

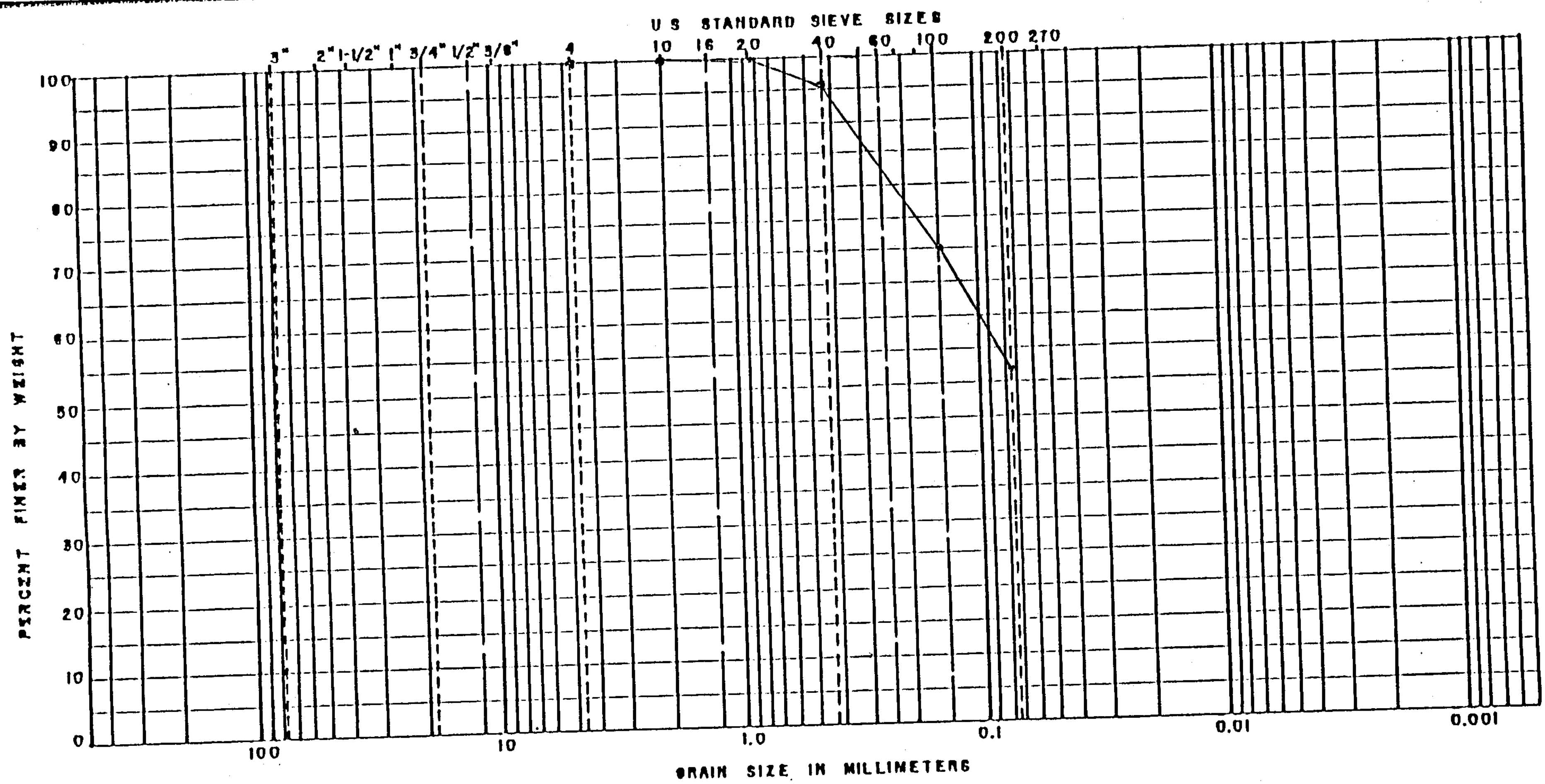


BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

BORING NO	ELEV. OR DEPTH	NAT WC	LL	PL	PI	DESCRIPTION OR CLASSIFICATION
B-5	18.5-20.0	34.2	NP	NP	NP	Greyish Brown Medium Sandy Silt

GRAIN SIZE DISTRIBUTION

ENSCI CORPORATION



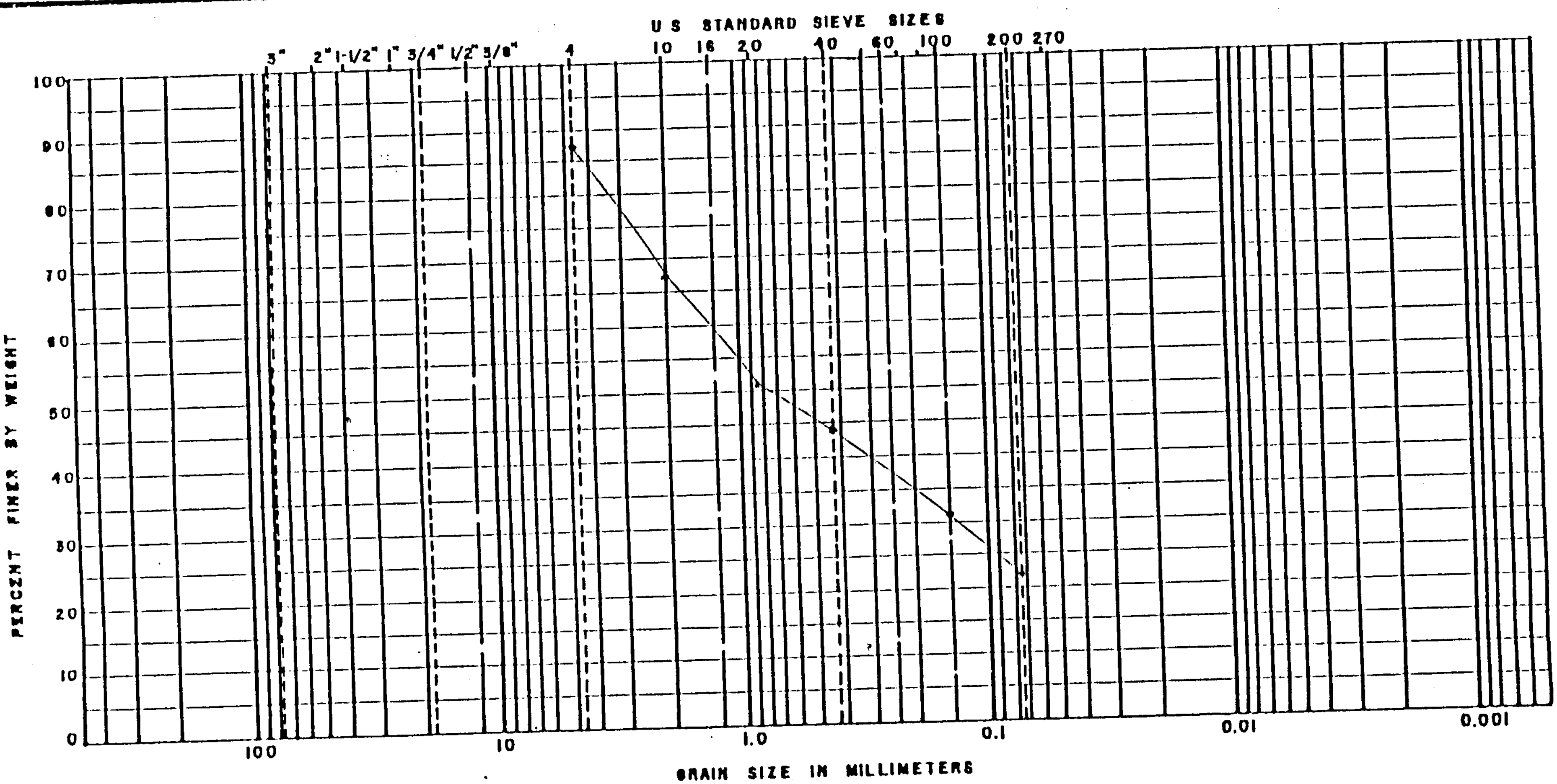
BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

BORING NO	ELEV. OR DEPTH	NAT WC	LL	PL	PI	DESCRIPTION OR CLASSIFICATION
B-6	13.5-15.0	31.9	NP	NP	NP	Reddish Brown Sandy Clayey Silt

GRAIN SIZE DISTRIBUTION

JOB NO. ES90-001

ENSCI



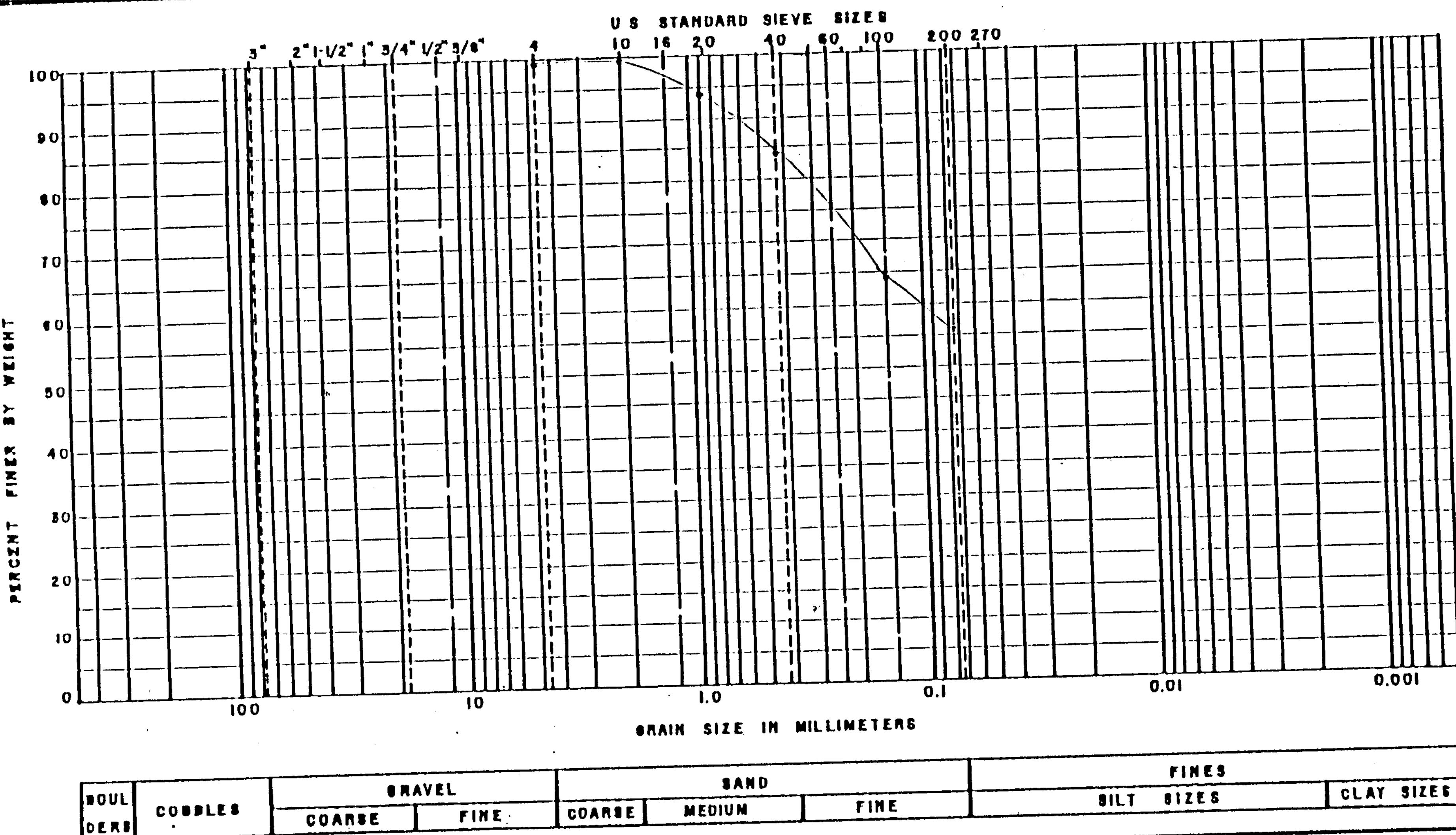
BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

BORING NO	ELEV. OR DEPTH	NAT WC	LL	PL	PI	DESCRIPTION OR CLASSIFICATION
B-8	0-5	9.8	NP	NP	NP	Tannish Brown Sandy Clayey Silt

GRAIN SIZE DISTRIBUTION

JOB NO. ______

ENSCI

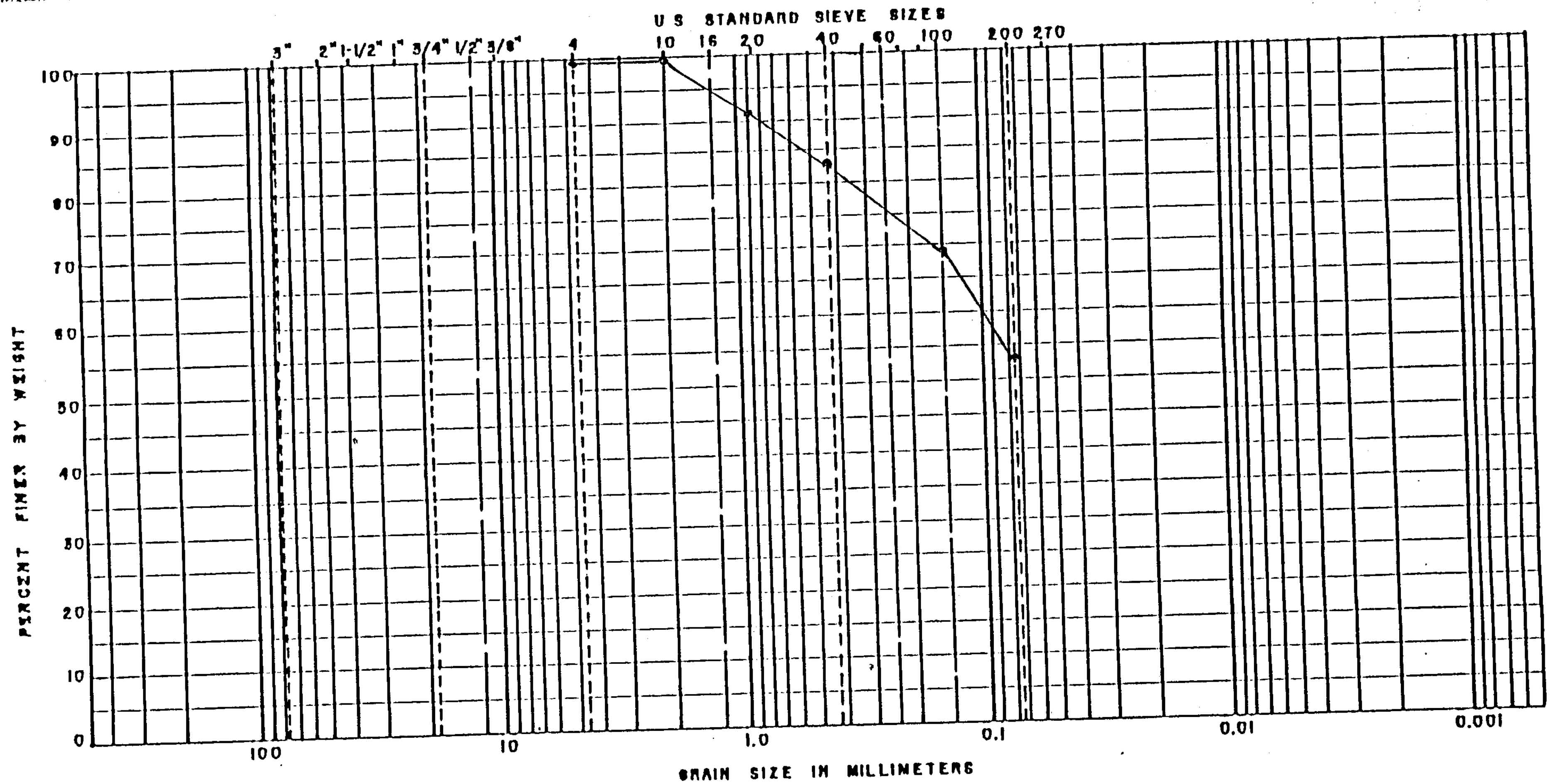


BORING NO	ELEV. OR DEPTH	NAT WC	LL	PL	PI	DESCRIPTION OR CLASSIFICATION
B-9	0-10.0	--	44	30	14	Reddish Brown Fine to Medium Sandy Clayey Silt

GRAIN SIZE DISTRIBUTION

JOB NO. ES90-001

ENSCI



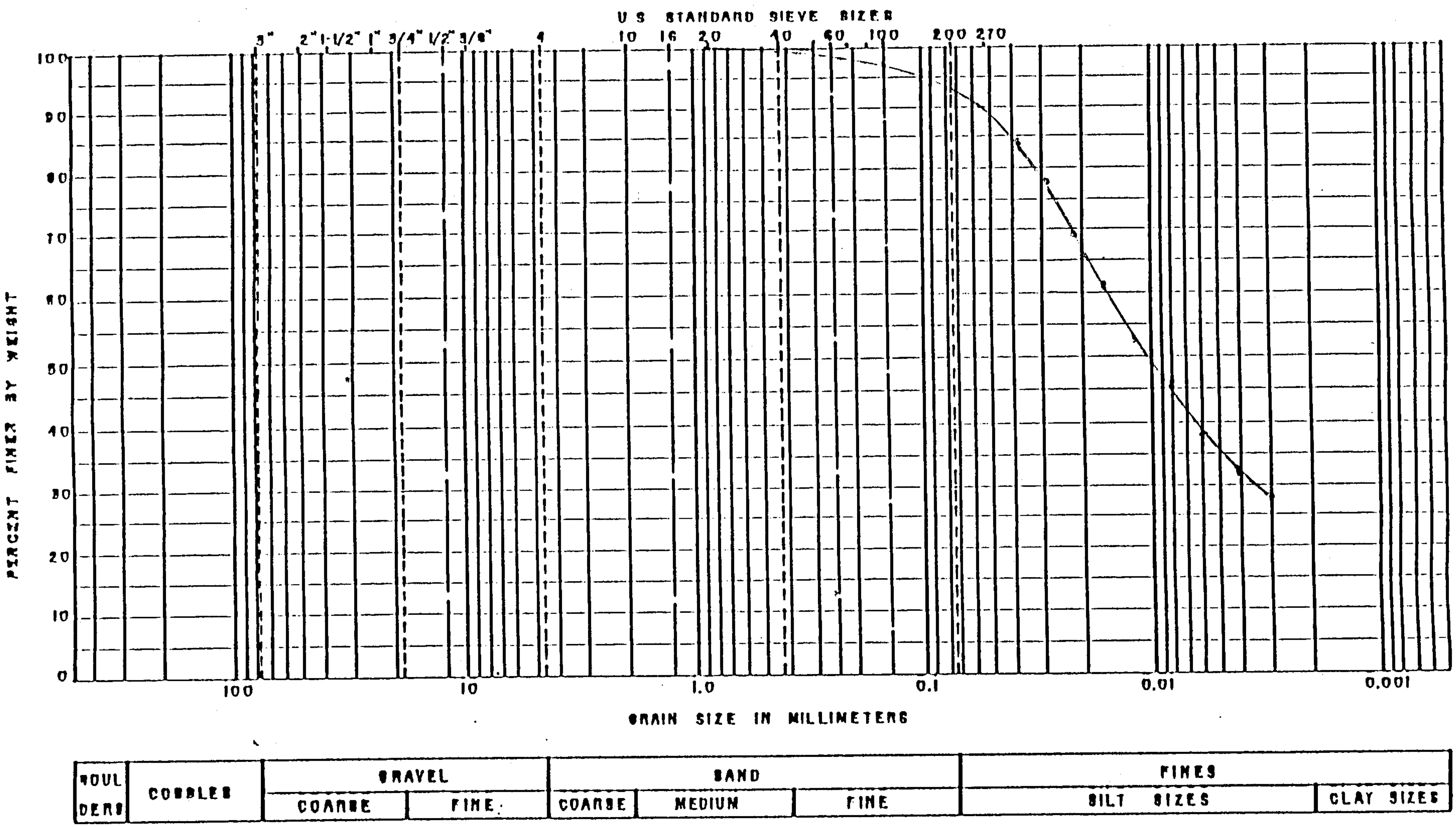
BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

BORING NO	ELEV. OR DEPTH	NAT WC	LL	PL	PI	DESCRIPTION OR CLASSIFICATION
B-9	10-20	20	44	28	16	Reddish Brown Clayey Silt

GRAIN SIZE DISTRIBUTION

JOB NO. ES90-001

ENSCI



BORING NO	ELEV. OR DEPTH	NAT WC	LL	PL	PI	DESCRIPTION OR CLASSIFICATION
B-9	28.5-30.0	59.8	89	60	29	Dark Purple Clayey Silt

GRAIN SIZE DISTRIBUTION

ENSCI CORPORATION

MOISTURE-DENSITY RELATIONS OF SOIL

JOB NUMBER ES90-001A

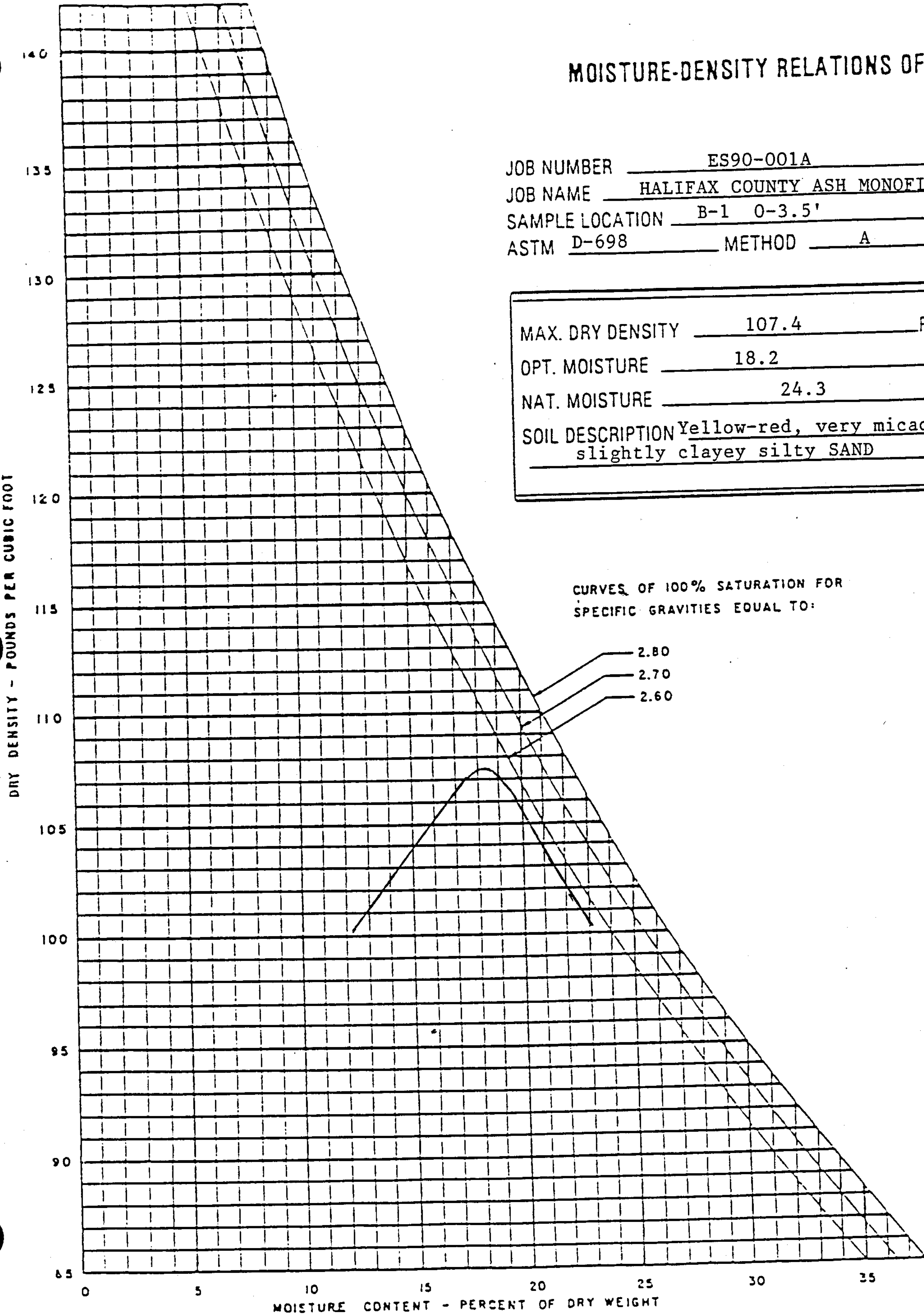
JOB NAME HALIFAX COUNTY ASH MONOFILL

SAMPLE LOCATION B-1 0-3.5'

ASTM D-698 METHOD A

MAX. DRY DENSITY	107.4	PCF
OPT. MOISTURE	18.2	%
NAT. MOISTURE	24.3	%

SOIL DESCRIPTION Yellow-red, very micacious slightly clayey silty SAND



Westinghouse Environmental and Geotechnical Services, Inc.

MOISTURE-DENSITY RELATIONSHIP

JOB NUMBER CHW B008

JOB NAME ENSCI - Lab Testing

JOB LOCATION High Point, NC

BORING NO. B-1A

SAMPLE NO. Bulk

DEPTH 4'-8'

METHOD OF TEST ASTM D 698A

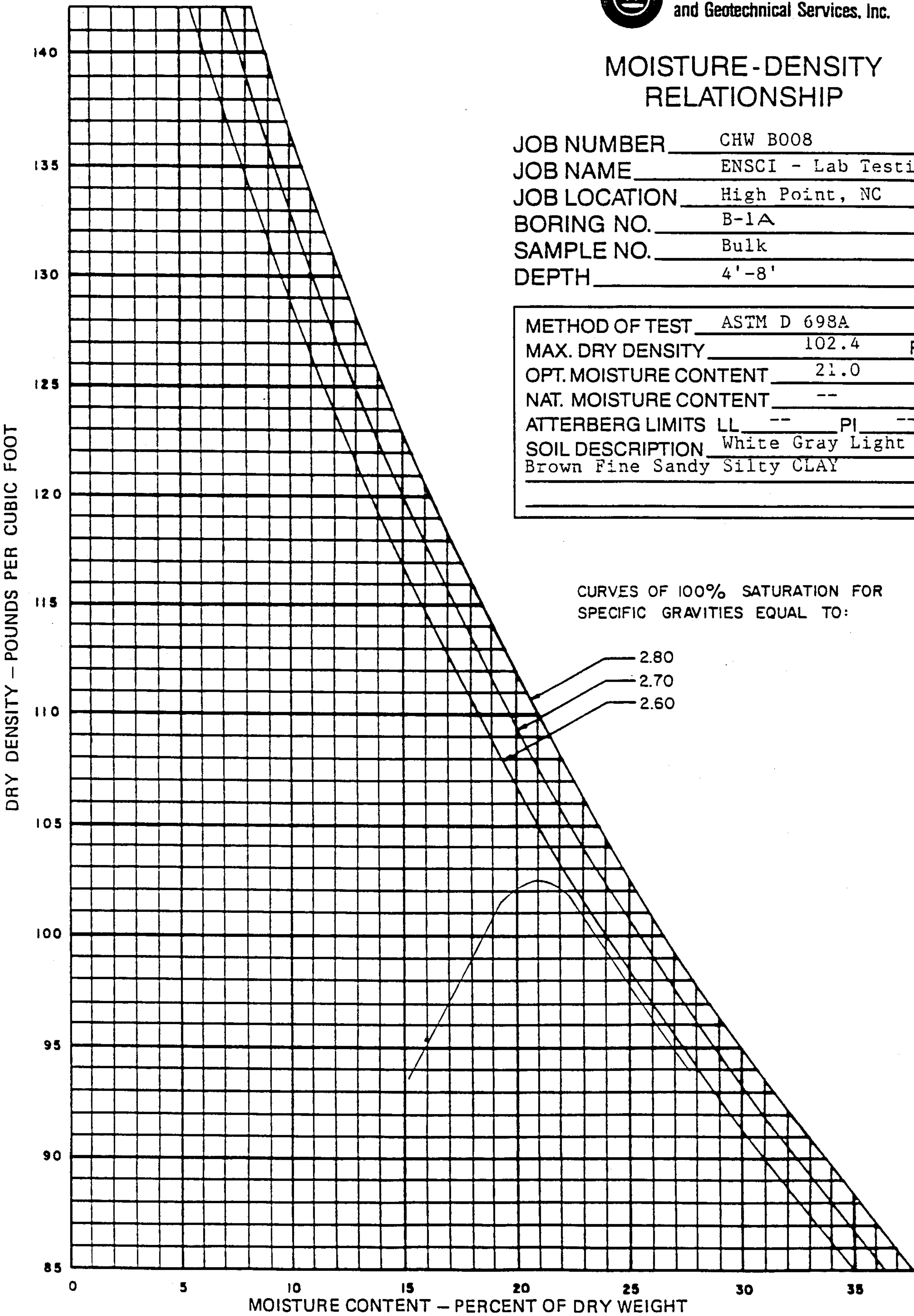
MAX. DRY DENSITY 102.4 PCF

OPT. MOISTURE CONTENT 21.0 %

NAT. MOISTURE CONTENT -- %

ATTERBERG LIMITS LL -- PI --

SOIL DESCRIPTION White Gray Light Brown Fine Sandy Silty CLAY



THE SHARPE 065542

WE-3

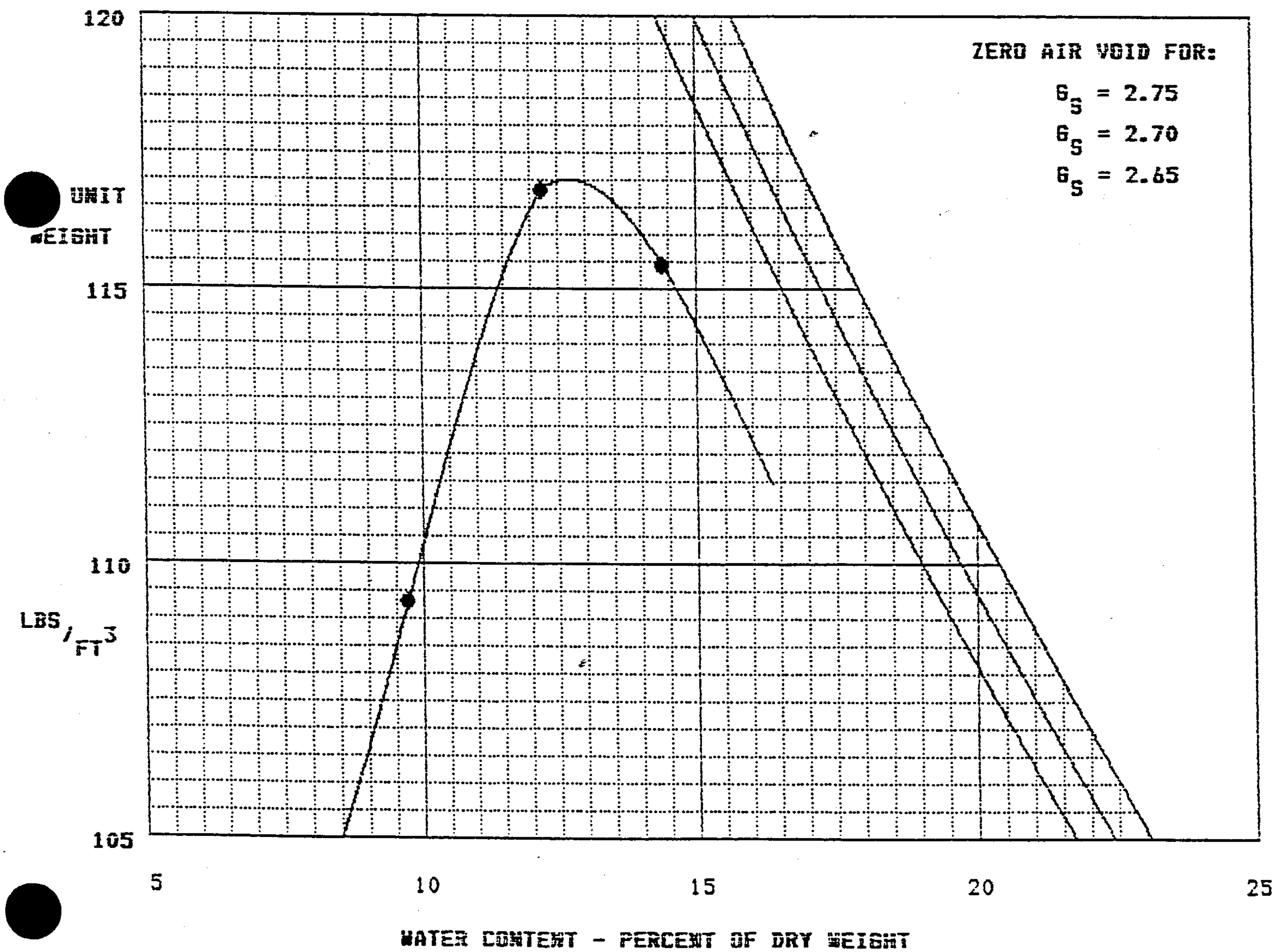
LAW ENGINEERING

STANDARD PROCTOR REPORT
ASTM D698 C

DATE: MARCH 7, 1991
PROJECT NUMBER: J-6479
PROJECT NAME: ENSCI
CLIENT: ENSCI
SAMPLE NUMBER: #1
FIELD MOISTURE: 16.1%

SOIL DESCRIPTION:
(VISUAL) YELLOW BROWN GRAVELLY SAND AND CLAY
PROPOSED USE:
FILL MATERIAL
SOURCE LOCATION:
ON SITE: B-8, 5'-10'

MOISTURE - DENSITY RELATIONSHIP



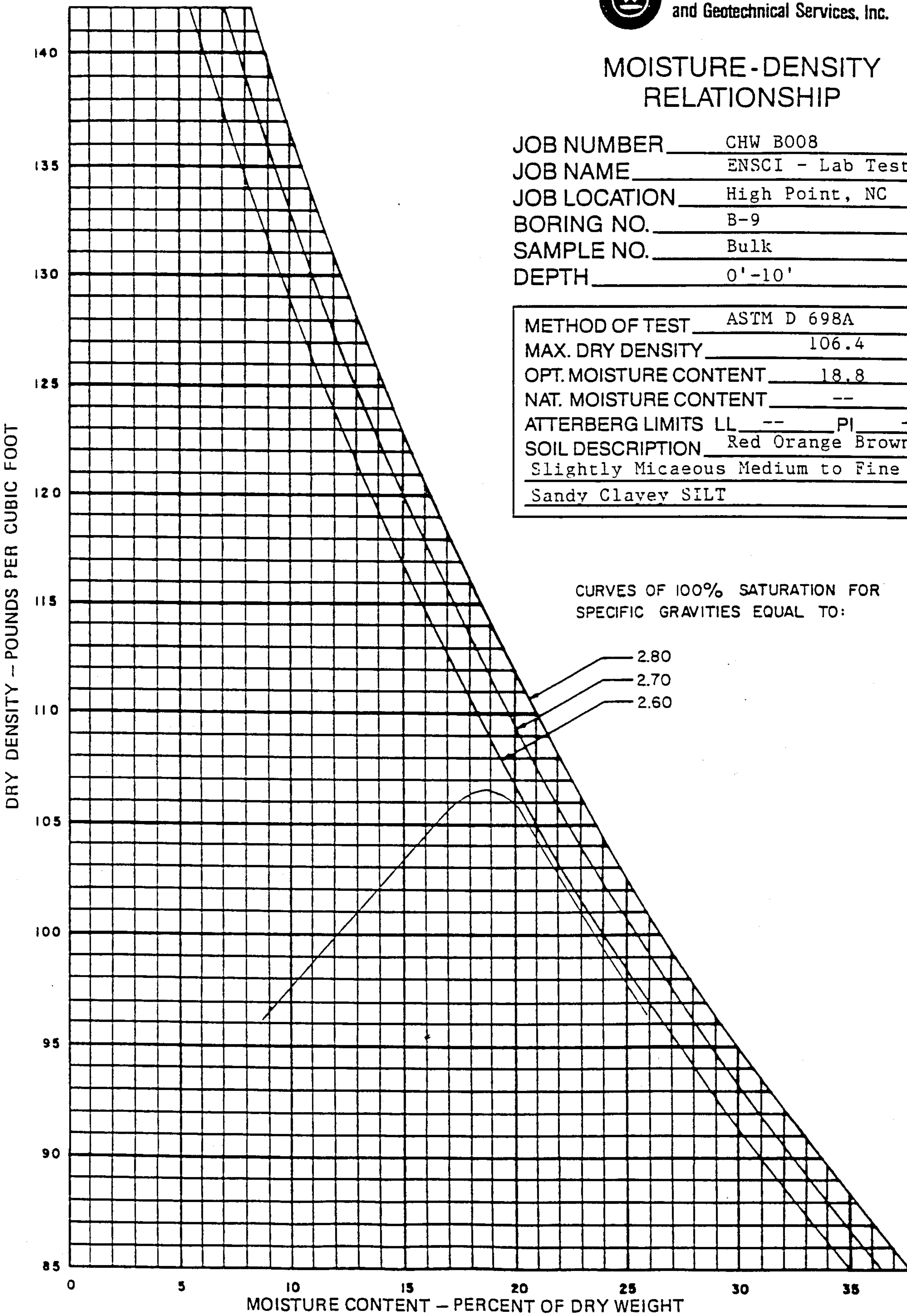
OPTIMUM MOISTURE CONTENT 12.7 MAXIMUM DRY DENSITY 117.0

Westinghouse Environmental and Geotechnical Services, Inc.

MOISTURE-DENSITY RELATIONSHIP

JOB NUMBER CHW B008
JOB NAME ENSCI - Lab Testing
JOB LOCATION High Point, NC
BORING NO. B-9
SAMPLE NO. Bulk
DEPTH 0'-10'

METHOD OF TEST ASTM D 698A
MAX. DRY DENSITY 106.4 PCF
OPT. MOISTURE CONTENT 18.8 %
NAT. MOISTURE CONTENT -- %
ATTERBERG LIMITS LL -- PI --
SOIL DESCRIPTION Red Orange Brown
Slightly Micaeous Medium to Fine
Sandy Clayey SILT



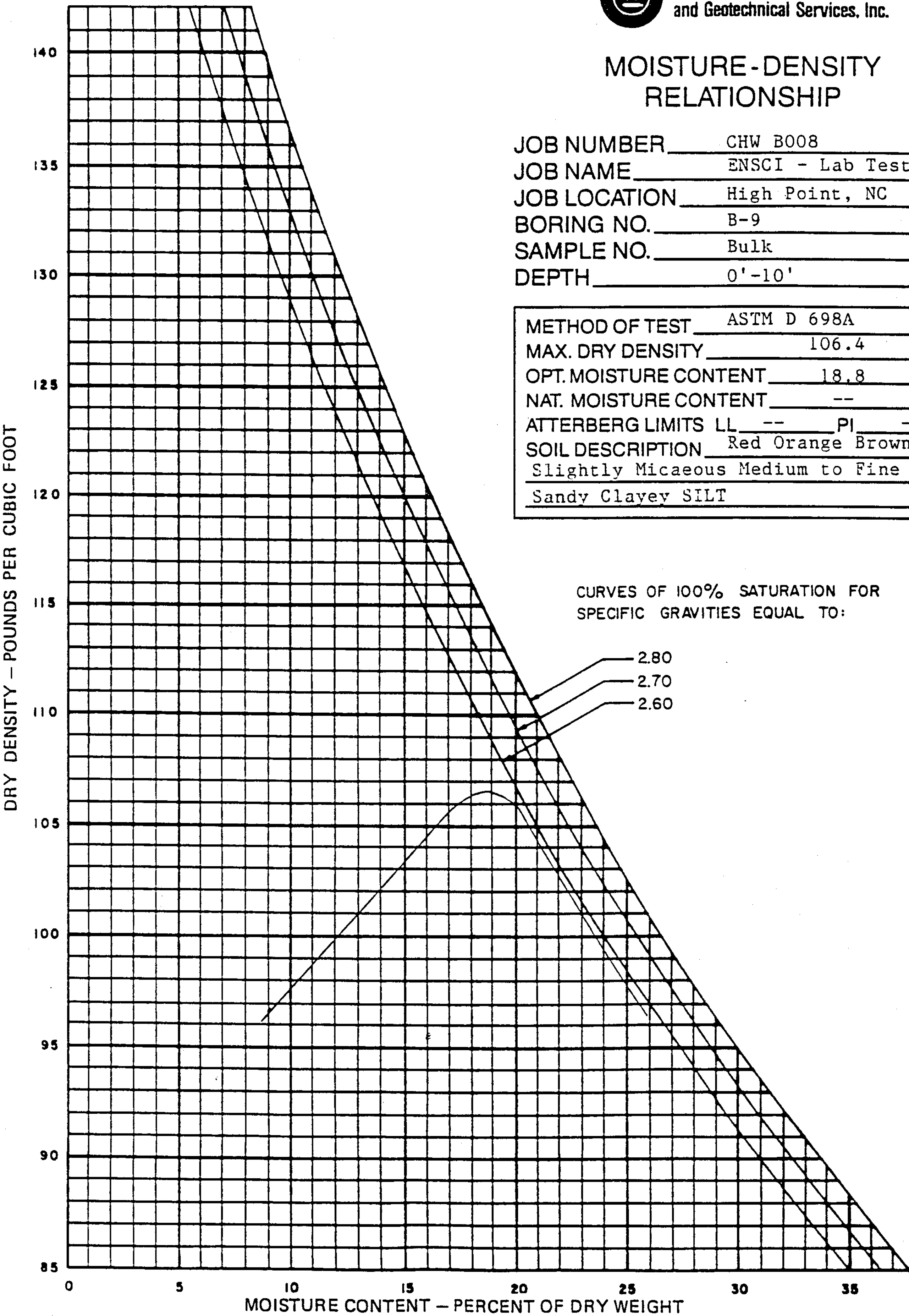
THE SHARPE 065542

Westinghouse Environmental and Geotechnical Services, Inc.

MOISTURE-DENSITY RELATIONSHIP

JOB NUMBER: CHW B008
JOB NAME: ENSCI - Lab Testing
JOB LOCATION: High Point, NC
BORING NO.: B-9
SAMPLE NO.: Bulk
DEPTH: 0'-10'

METHOD OF TEST: ASTM D 698A
MAX. DRY DENSITY: 106.4 PCF
OPT. MOISTURE CONTENT: 18.8 %
NAT. MOISTURE CONTENT: -- %
ATTERBERG LIMITS LL: -- PI: --
SOIL DESCRIPTION: Red Orange Brown Slightly Micaeous Medium to Fine Sandy Clayey SILT



Appendix I

G. N. Richardson and Associates

Client:	Halifax County	**Proj. No.**	Halifax-4
		Sheet:	1/1
Project:	Halifax County Landfill	**Date:**	1/96
		Well:	B-4s
		Reference:	Bouwer, 1989

ln[Re/Rw] = [1.1/ln(Lw/Rw) + A + Bln[(H-Lw)/Rw]/Le/Rw] exp -1

Where:	Lw = Height of Water Column in Well =	9.78
	Le = Screened Interval Open to Aquifer =	5
	Rw = Radius of Well Including Sand Pack =	0.43
	Rc = Radius of Well Casing =	0.083
	H = Aquifer Thickness to First Aquitard =	10
	Yo = Relative Height of Water at Time Zero	1.5
	Yt = Relative Height of Water at Time t =	1
	n = Porosity =	0.15
	Time Tt (in minutes) =	7
	H - Lw =	0.22
	Yo/Yt =	1.5
	Lw/Rw =	22.744186
	ln(H-Lw)/Rw =	-0.6701577

Correction for Sandpack:

Req = [Rc exp2 + n(Rw exp2 + Rc exp2)] exp1/2

Req = 1

Req = 1

Evaluation of A and B:

Le/Rw = 11.62791

From Attached Graph of A and B:

A =	1.95
B =	0.25

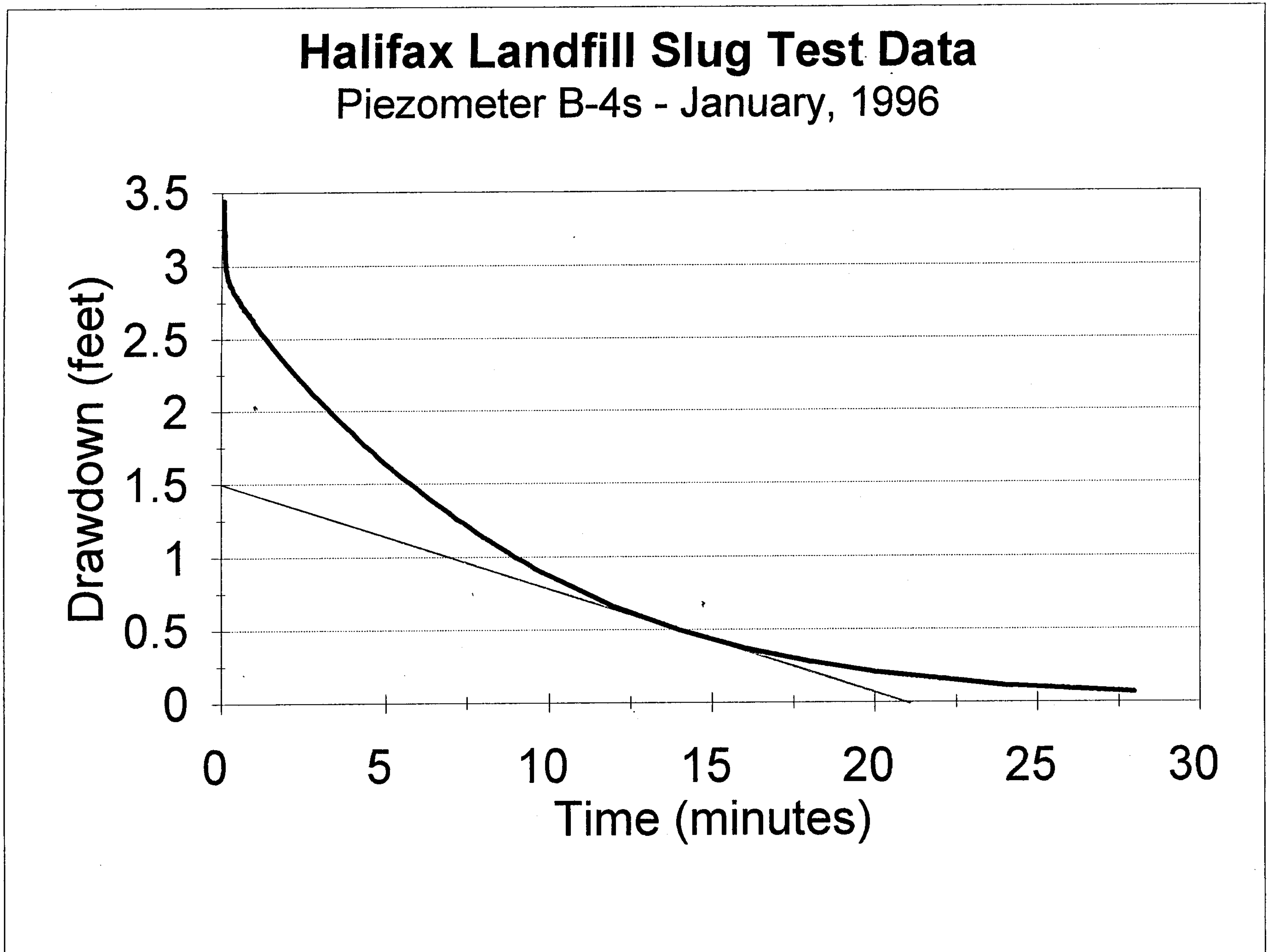
ln Re/Rw = [1.1/ln Lw/Rw + A + B ln[(H-Lw)/Rw] / Le/Rw] exp-1

ln Re/Rw= 2.2876694 exp-1

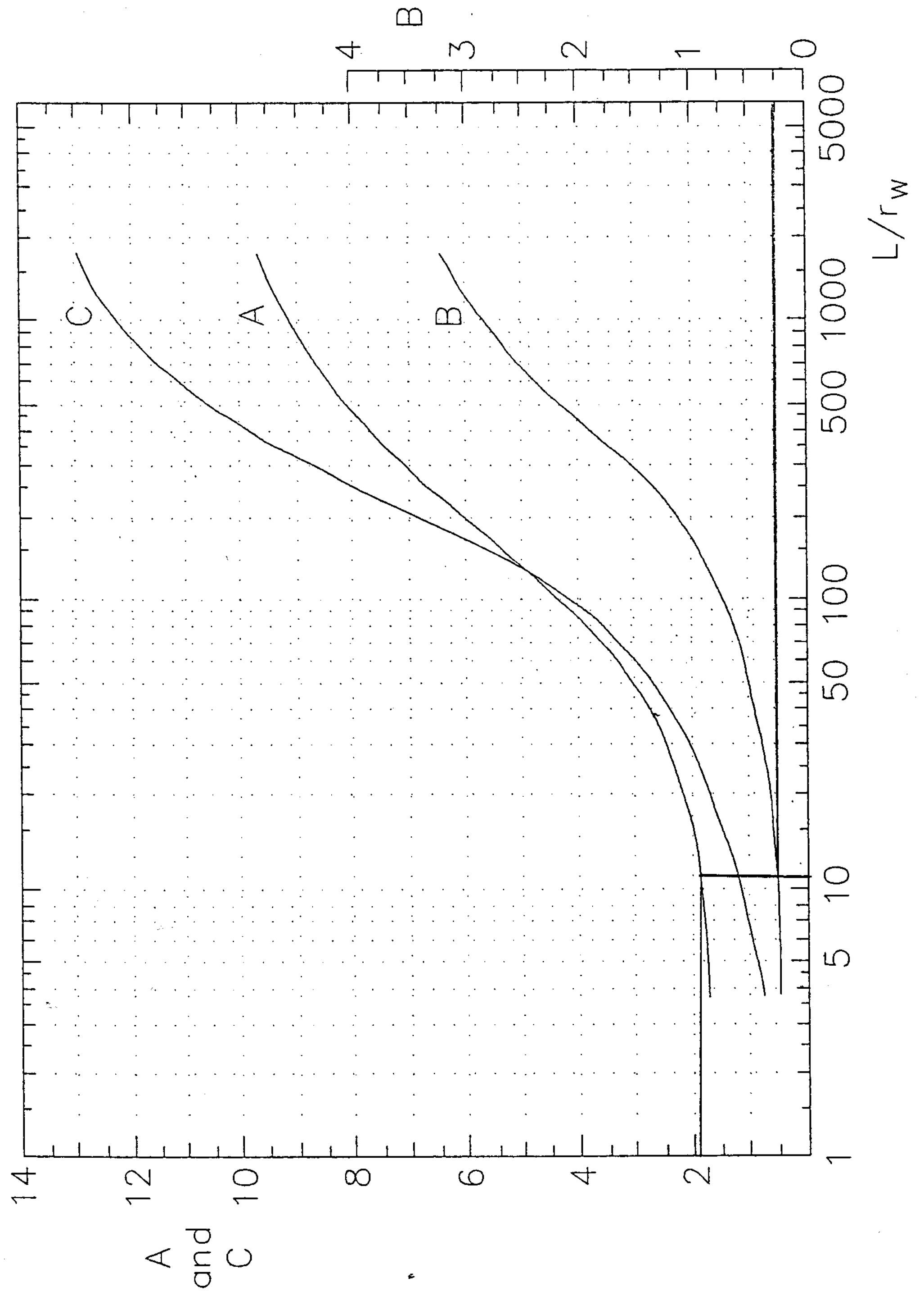
ln Re/Rw= 0.4371261

K = (Req) exp2 ln(Re/Rw)1/Tt ln(Yo/Yt) /2Le

K =	0.002532 Ft/Min	or	0.001286 CM/Sec
K =	3.646067 Ft/Day		



1.28×10^{-3}
3.64 ft/day



Curves relating coefficients A, B, and C to L/r_w

FROM: BOUWER, H. AND RICE, R.C., 1976: A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS.

G.N. RICHARDSON & ASSOC.
417 N. BOYLAN AVENUE
RALEIGH N.C. 27603
919-828-0577

COEFFICIENT CURVE MATCHPOINT
RISING HEAD AQUIFER TEST
Halifax Landfill
B-4s

Haliifax B-4s Data - slug test 1/24/96
SE1000C
Environmental Logger
01/24 20:47

Unit# 00069 Test 2

Setups: INPUT 1

Setups:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	00001

Reference	0.000
Linearity	0.120
Scale factor	20.020
Offset	-0.020
Delay mSEC	50.000

Step 0 01/24 11:59:03

Elapsed Time	INPUT 1
0.0000	0.031
0.0033	0.025
0.0066	0.025
0.0100	0.025
0.0133	0.012
0.0166	0.195
0.0200	-0.056
0.0233	-0.069
0.0266	-0.025
0.0300	0.613
0.0333	-0.145
0.0366	0.233
0.0400	0.524
0.0433	-0.107
0.0466	0.347
0.0500	1.446
0.0533	2.861
0.0566	3.474
0.0600	2.697
0.0633	1.889
0.0666	1.478
0.0700	3.613
0.0733	1.946
0.0766	2.899
0.0800	3.209
0.0833	3.442
0.0866	3.322
0.0900	3.284

Halifax B-4s Slug Test Data Page 2

Elapsed Time	INPUT 1
0.0933	3.259
0.0966	3.209
0.1000	3.183
0.1033	3.165
0.1066	3.139
0.1100	3.127
0.1133	3.095
0.1166	3.089
0.1200	3.070
0.1233	3.051
0.1266	3.044
0.1300	3.032
0.1333	3.019
0.1366	3.013
0.1400	3.000
0.1433	2.988
0.1466	2.988
0.1500	2.988
0.1533	2.975
0.1566	2.969
0.1600	2.962
0.1633	2.956
0.1666	2.956
0.1700	2.950
0.1733	2.950
0.1766	2.943
0.1800	2.937
0.1833	2.937
0.1866	2.931
0.1900	2.931
0.1933	2.918
0.1966	2.925
0.2000	2.912
0.2033	2.918
0.2066	2.912
0.2100	2.906
0.2133	2.906
0.2166	2.906
0.2200	2.906
0.2233	2.899
0.2266	2.899
0.2300	2.893
0.2333	2.893
0.2366	2.893
0.2400	2.893
0.2433	2.887
0.2466	2.887
0.2500	2.887

Halifax B-4s Slug Test Data Page 3

Elapsed Time	INPUT 1
0.2533	2.887
0.2566	2.880
0.2600	2.880
0.2633	2.880
0.2666	2.874
0.2700	2.874
0.2733	2.874
0.2766	2.874
0.2800	2.874
0.2833	2.868
0.2866	2.868
0.2900	2.868
0.2933	2.868
0.2966	2.861
0.3000	2.861
0.3033	2.861
0.3066	2.861
0.3100	2.861
0.3133	2.855
0.3166	2.855
0.3200	2.855
0.3233	2.855
0.3266	2.855
0.3300	2.849
0.3333	2.849
0.3500	2.842
0.3666	2.836
0.3833	2.823
0.4000	2.817
0.4166	2.811
0.4333	2.805
0.4500	2.798
0.4666	2.792
0.4833	2.792
0.5000	2.779
0.5166	2.779
0.5333	2.773
0.5500	2.767
0.5666	2.760
0.5833	2.754
0.6000	2.748
0.6166	2.741
0.6333	2.741
0.6500	2.729
0.6666	2.729
0.6833	2.722
0.7000	2.716
0.7166	2.710
0.7333	2.703
0.7500	2.697
0.7666	2.697
0.7833	2.691

Halifax B-4s Slug Test Data Page 4

Elapsed Time	INPUT 1
0.8000	2.685
0.8166	2.678
0.8333	2.672
0.8500	2.672
0.8666	2.666
0.8833	2.659
0.9000	2.653
0.9166	2.647
0.9333	2.647
0.9500	2.640
0.9666	2.634
0.9833	2.628
1.0000	2.621
1.2000	2.552
1.4000	2.495
1.6000	2.438
1.8000	2.381
2.0000	2.331
2.2000	2.274
2.4000	2.224
2.6000	2.173
2.8000	2.122
3.0000	2.078
3.2000	2.034
3.4000	1.983
3.6000	1.939
3.8000	1.895
4.0000	1.851
4.2000	1.807
4.4000	1.762
4.6000	1.724
4.8000	1.680
5.0000	1.642
5.2000	1.604
5.4000	1.567
5.6000	1.529
5.8000	1.497

Halifax B-4s Slug Test Data Page 5

Elapsed Time	INPUT 1
6.0000	1.465
6.2000	1.428
6.4000	1.390
6.6000	1.358
6.8000	1.326
7.0000	1.295
7.2000	1.257
7.4000	1.232
7.6000	1.200
7.8000	1.169
8.0000	1.137
8.2000	1.112
8.4000	1.080
8.6000	1.055
8.8000	1.029
9.0000	0.998
9.2000	0.973
9.4000	0.947
9.6000	0.922
9.8000	0.897
10.0000	0.878
12.0000	0.663
14.0000	0.499
16.0000	0.372
18.0000	0.278
20.0000	0.208
22.0000	0.157
24.0000	0.113
26.0000	0.088
28.0000	0.063
30.0000	0.044
32.0000	0.025
34.0000	0.012
36.0000	0.006
38.0000	-0.006
40.0000	-0.018
42.0000	-0.031
44.0000	-0.044
46.0000	-0.044
48.0000	-0.050
50.0000	-0.056
52.0000	-0.063
54.0000	-0.069
56.0000	-0.069
58.0000	-0.069
60.0000	-0.069
62.0000	-0.069
64.0000	-0.069

G. N. Richardson and Associates

Client:	Halifax County	**Proj. No.**	Halifax-4
		Sheet:	1/1
Project:	Halifax County Landfill	**Date:**	1/96
		Well:	B-4
		Reference:	Bouwer, 1989

ln[Re/Rw] = [1.1/ln(Lw/Rw) + A + Bln[(H-Lw)/Rw]/Le/Rw] exp -1

Where:	Lw = Height of Water Column in Well =	17.29
	Le = Screened Interval Open to Aquifer =	10
	Rw = Radius of Well Including Sand Pack =	0.43
	Rc = Radius of Well Casing =	0.083
	H = Aquifer Thickness to First Aquitard =	40
	Yo = Relative Height of Water at Time Zero	1.5
	Yt = Relative Height of Water at Time t =	0.75
	n = Porosity =	0.2
	Time Tt (in minutes) =	10
	H - Lw =	22.71
	Yo/Yt =	2
	Lw/Rw =	40.2093023
	ln(H-Lw)/Rw =	3.96677543

Correction for Sandpack:

Req = [Rc exp2 + n(Rw exp2 + Rc exp2)] exp1/2

Req = 1

Req = 1

Evaluation of A and B:

Le/Rw = 23.25581

From Attached Graph of A and B:

A = 2.4

B = 0.4

ln Re/Rw = [1.1/ln Lw/Rw + A + B ln[(H-Lw)/Rw] / Le/Rw] exp-1

ln Re/Rw= 2.7660008 exp-1

ln Re/Rw= 0.3615328

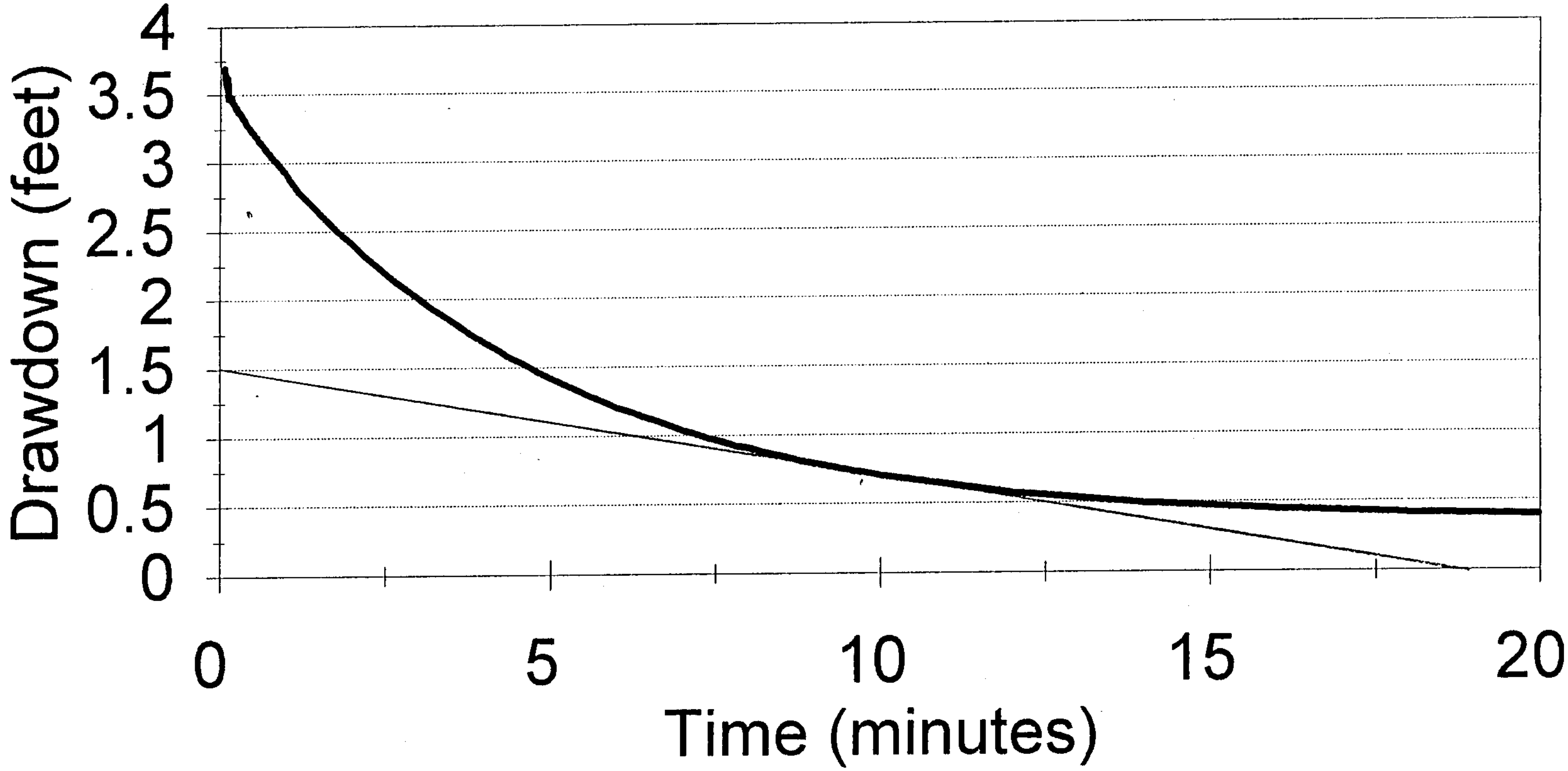
K = (Req) exp2 ln(Re/Rw)1/Tt ln(Yo/Yt) /2Le

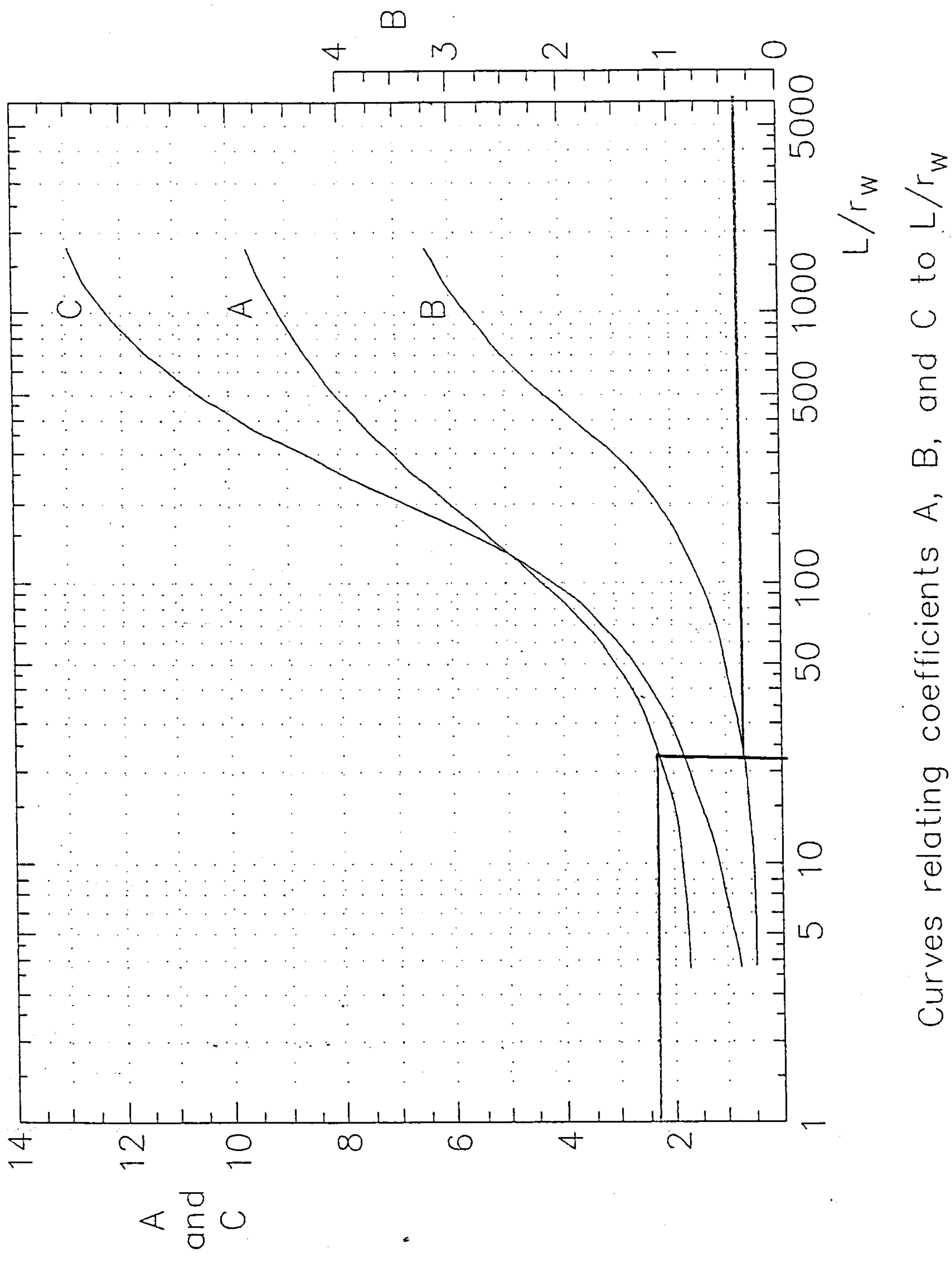
K = 0.001253 Ft/Min or 0.000637 CM/Sec

K = 1.804287 Ft/Day

6.32x10^-4
1.8 ft/day

Halifax Landfill Slug Test Data
Piezometer B-4 - January, 1996





Curves relating coefficients A, B, and C to L/r_w

FROM: BOUWER, H. AND RICE, R.C., 1976: A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS.

G.N. RICHARDSON & ASSOC.
417 N. BOYLAN AVENUE
RALEIGH N.C. 27603
919-828-0577

COEFFICIENT CURVE MATCHPOINT
RISING HEAD AQUIFER TEST
Halifax Landfill
B-4

Halifax B-4 data - Slug Test 1/24/96

SE1000C

Environmental Logger

01/24 20:50

Unit# 00069 Test 1

Setups:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	00001

Reference	0.000
Linearity	0.120
Scale factor	20.020
Offset	-0.020
Delay mSEC	50.000

Step 0 01/24 10:41:55

Elapsed Time	INPUT 1
0.0000	0.012
0.0033	0.012
0.0066	0.012
0.0100	0.012
0.0133	0.012
0.0166	0.012
0.0200	0.019
0.0233	0.436
0.0266	1.328
0.0300	2.486
0.0333	3.112
0.0366	3.903
0.0400	3.915
0.0433	4.592
0.0466	4.958
0.0500	5.363
0.0533	3.106
0.0566	2.429
0.0600	3.100
0.0633	2.429
0.0666	3.277
0.0700	3.694
0.0733	3.694
0.0766	3.675
0.0800	3.656
0.0833	3.637
0.0866	3.631
0.0900	3.612
0.0933	3.593

Halifax B-4 Slug Test Data Page 2

Elapsed Time	INPUT 1
0.0966	3.587
0.1000	3.580
0.1033	3.580
0.1066	3.599
0.1100	3.555
0.1133	3.555
0.1166	3.549
0.1200	3.542
0.1233	3.536
0.1266	3.624
0.1300	3.593
0.1333	3.587
0.1366	3.473
0.1400	3.498
0.1433	3.504
0.1466	3.498
0.1500	3.498
0.1533	3.492
0.1566	3.492
0.1600	3.485
0.1633	3.485
0.1666	3.485
0.1700	3.485
0.1733	3.473
0.1766	3.454
0.1800	3.466
0.1833	3.466
0.1866	3.460
0.1900	3.454
0.1933	3.454
0.1966	3.447
0.2000	3.447
0.2033	3.441
0.2066	3.441
0.2100	3.435
0.2133	3.435
0.2166	3.428
0.2200	3.428
0.2233	3.428
0.2266	3.422
0.2300	3.416
0.2333	3.416
0.2366	3.416
0.2400	3.409
0.2433	3.409
0.2466	3.403
0.2500	3.409
0.2533	3.403
0.2566	3.397
0.2600	3.397

Halifax B-4 Slug Test Data Page 3

Elapsed Time	INPUT 1
0.2633	3.390
0.2666	3.390
0.2700	3.390
0.2733	3.384
0.2766	3.384
0.2800	3.378
0.2833	3.378
0.2866	3.372
0.2900	3.372
0.2933	3.372
0.2966	3.372
0.3000	3.365
0.3033	3.365
0.3066	3.359
0.3100	3.359
0.3133	3.359
0.3166	3.353
0.3200	3.353
0.3233	3.346
0.3266	3.346
0.3300	3.340
0.3333	3.340
0.3500	3.327
0.3666	3.315
0.3833	3.302
0.4000	3.289
0.4166	3.277
0.4333	3.264
0.4500	3.251
0.4666	3.245
0.4833	3.232
0.5000	3.220
0.5166	3.213
0.5333	3.201
0.5500	3.188
0.5666	3.182
0.5833	3.169
0.6000	3.157
0.6166	3.150
0.6333	3.138
0.6500	3.125
0.6666	3.112
0.6833	3.106
0.7000	3.093
0.7166	3.087

Halifax B-4 Slug Test Data Page 4

Elapsed Time	INPUT 1
0.7333	3.074
0.7500	3.068
0.7666	3.055
0.7833	3.043
0.8000	3.036
0.8166	3.024
0.8333	3.017
0.8500	3.005
0.8666	2.998
0.8833	2.986
0.9000	2.979
0.9166	2.967
0.9333	2.960
0.9500	2.948
0.9666	2.941
0.9833	2.935
1.0000	2.922
1.2000	2.790
1.4000	2.689
1.6000	2.594
1.8000	2.499
2.0000	2.410
2.2000	2.322
2.4000	2.239
2.6000	2.157
2.8000	2.081
3.0000	2.012
3.2000	1.942
3.4000	1.872
3.6000	1.809
3.8000	1.746
4.0000	1.683
4.2000	1.632
4.4000	1.575
4.6000	1.525
4.8000	1.468
5.0000	1.423
5.2000	1.379
5.4000	1.335
5.6000	1.290
5.8000	1.252
6.0000	1.208
6.2000	1.177
6.4000	1.139
6.6000	1.107

Halifax B-4 Slug Test Data Page 5

Elapsed Time	INPUT 1
6.8000	1.075
7.0000	1.037
7.2000	1.012
7.4000	0.980
7.6000	0.955
7.8000	0.923
8.0000	0.905
8.2000	0.879
8.4000	0.854
8.6000	0.835
8.8000	0.810
9.0000	0.791
9.2000	0.772
9.4000	0.753
9.6000	0.734
9.8000	0.721
10.0000	0.702
12.0000	0.575
14.0000	0.493
16.0000	0.449
18.0000	0.417
20.0000	0.398
22.0000	0.386
24.0000	0.379
26.0000	0.373
28.0000	0.367
30.0000	0.367
32.0000	0.367
34.0000	0.367
36.0000	0.379
38.0000	0.367
40.0000	0.367
42.0000	0.373
44.0000	0.373
46.0000	0.367
48.0000	0.367
50.0000	0.367
52.0000	0.367
54.0000	0.367
56.0000	0.367
58.0000	0.367
60.0000	0.373

G. N. Richardson and Associates

Client:	Halifax County	**Proj. No.**	Halifax-4
		Sheet:	1/1
Project:	Halifax County Landfill	**Date:**	1/96
		Well:	BP-3
		Reference:	Bouwer, 1989

ln[Re/Rw] = [1.1/ln(Lw/Rw) + A + Bln[(H-Lw)/Rw]/Le/Rw] exp -1

Where:

Lw = Height of Water Column in Well =	2.83
Le = Screened Interval Open to Aquifer =	2.83
Rw = Radius of Well Including Sand Pack =	0.43
Rc = Radius of Well Casing =	0.083
H = Aquifer Thickness to First Aquitard =	35
Yo = Relative Height of Water at Time Zero =	0.43
Yt = Relative Height of Water at Time t =	0.23
n = Porosity =	0.15
Time Tt (in minutes) =	3
H - Lw =	32.17
Yo/Yt =	1.86956522
Lw/Rw =	6.58139535
ln(H-Lw)/Rw =	4.31500441

Correction for Sandpack:

Req = [Rc exp2 + n(Rw exp2 + Rc exp2)] exp1/2

Req = 0.035657

Req = 0.188832

Evaluation of A and B:

Le/Rw = 6.581395

From Attached Graph of A and B:

A =	1.75
B =	0.3

ln Re/Rw = [1.1/ln Lw/Rw + A + B ln[(H-Lw)/Rw] / Le/Rw] exp-1

ln Re/Rw= 2.53047866 exp-1

ln Re/Rw= 0.39518215

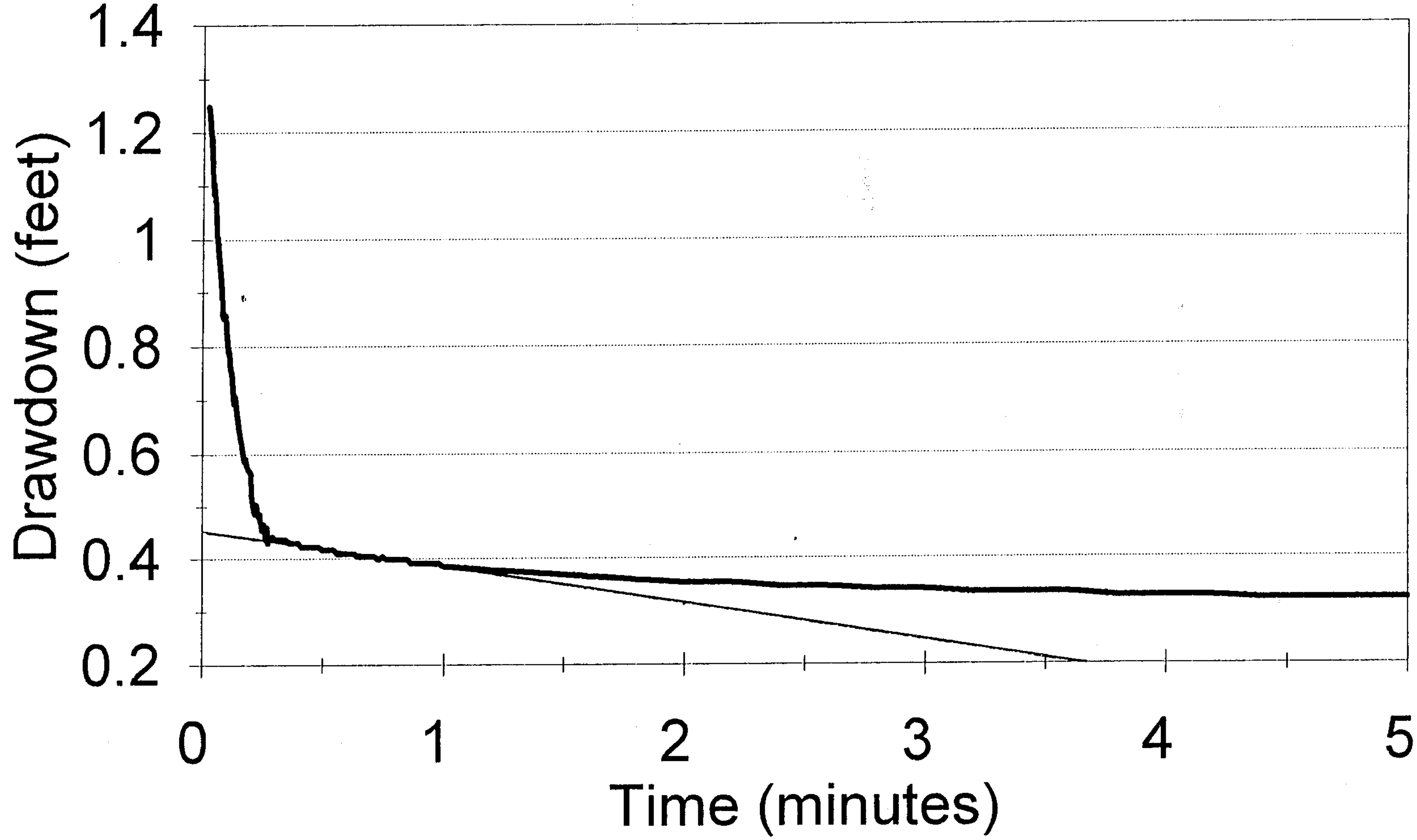
K = (Req) exp2 ln(Re/Rw)1/Tt ln(Yo/Yt) /2Le

K = 0.000519 Ft/Min or 0.000264 CM/Sec

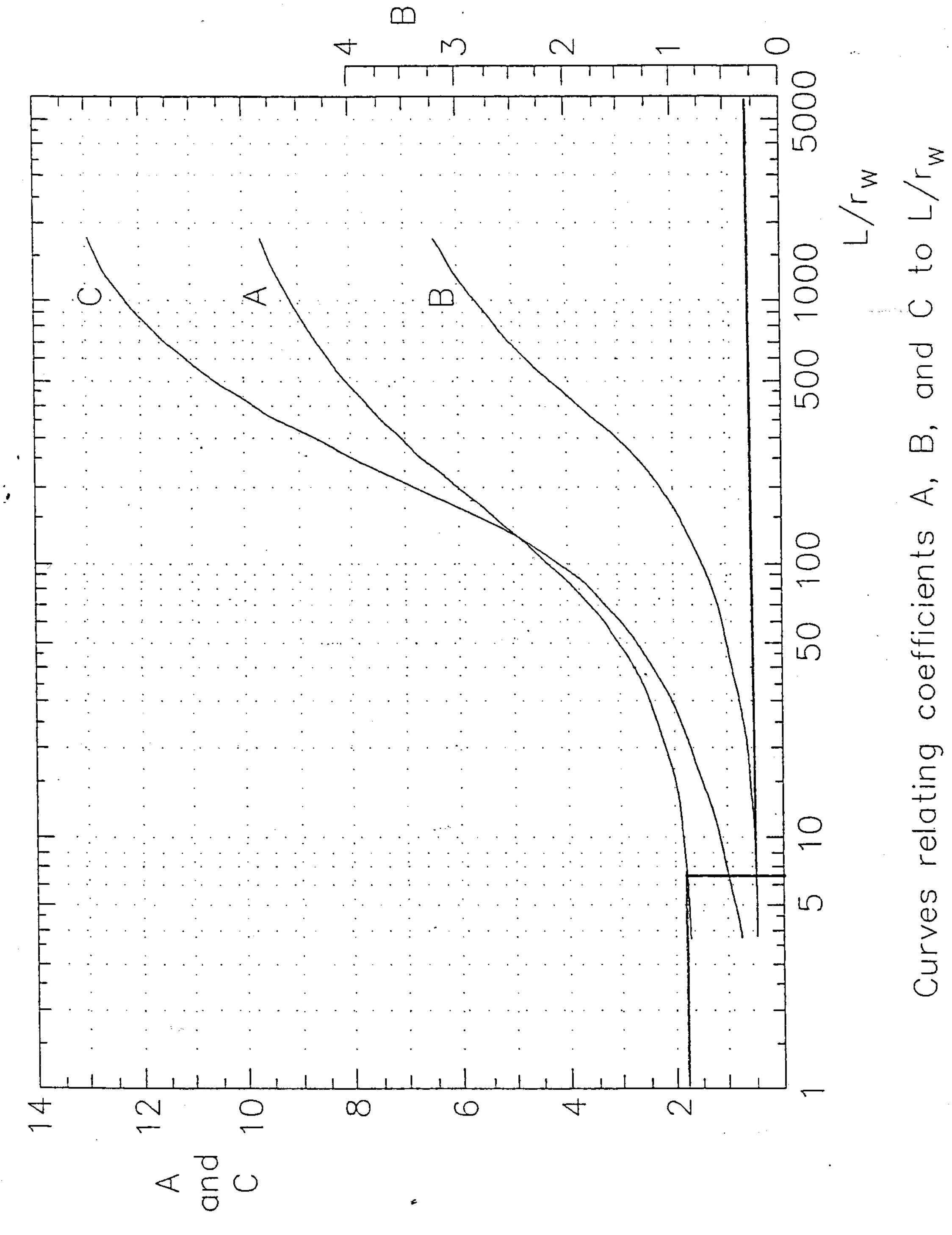
K = 0.747724 Ft/Day

Halifax Landfill Slug Test Data

Piezometer BP-3 - January, 1996



2.6 × 10⁻⁴ cm/sec
.75 ft/day



FROM: BOUWER, H. AND RICE, R.C., 1976: A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS.

G.N. RICHARDSON & ASSOC.
417 N. BOYLAN AVENUE
RALEIGH N.C. 27603
919-828-0577

COEFFICIENT CURVE MATCHPOINT
RISING HEAD AQUIFER TEST
Halifax Landfill
BP-3

Halifax BP-3 Slug Test Data
SE1000C
Environmental Logger
01/26 09:10

Unit# 00069 Test 7

Setups:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	00001

Reference	0.000
Linearity	0.120
Scale factor	20.020
Offset	-0.020
Delay mSEC	50.000

Step 0 01/25 16:53:56

Elapsed Time	INPUT 1
0.0000	6.738
0.0033	6.738
0.0066	6.738
0.0100	7.716
0.0133	7.704
0.0166	7.861
0.0200	8.000
0.0233	7.987
0.0266	7.975
0.0300	7.950
0.0333	7.937
0.0366	7.924
0.0400	7.899
0.0433	7.874
0.0466	7.823
0.0500	7.842
0.0533	7.811
0.0566	7.805
0.0600	7.773
0.0633	7.741
0.0666	7.741
0.0700	7.723
0.0733	7.697
0.0766	7.685
0.0800	7.659
0.0833	7.640
0.0866	7.609
0.0900	7.590
0.0933	7.590

Halifax BP-3 Slug Test Data
Page 2

Elapsed Time	INPUT 1
0.0966	7.596
0.1000	7.577
0.1033	7.565
0.1066	7.546
0.1100	7.527
0.1133	7.527
0.1166	7.508
0.1200	7.495
0.1233	7.489
0.1266	7.476
0.1300	7.458
0.1333	7.432
0.1366	7.439
0.1400	7.445
0.1433	7.426
0.1466	7.413
0.1500	7.401
0.1533	7.388
0.1566	7.382
0.1600	7.369
0.1633	7.363
0.1666	7.357
0.1700	7.344
0.1733	7.338
0.1766	7.325
0.1800	7.331
0.1833	7.331
0.1866	7.319
0.1900	7.312
0.1933	7.306
0.1966	7.306
0.2000	7.306
0.2033	7.300
0.2066	7.262
0.2100	7.243
0.2133	7.237
0.2166	7.230
0.2200	7.224
0.2233	7.237
0.2266	7.243
0.2300	7.230
0.2333	7.224
0.2366	7.218
0.2400	7.224
0.2433	7.211
0.2466	7.205
0.2500	7.193

Halifax BP-3 Slug Test Data
Page 3

Elapsed Time	INPUT 1
0.2533	7.199
0.2566	7.205
0.2600	7.193
0.2633	7.193
0.2666	7.174
0.2700	7.199
0.2733	7.199
0.2766	7.167
0.2800	7.180
0.2833	7.180
0.2866	7.180
0.2900	7.180
0.2933	7.174
0.2966	7.180
0.3000	7.174
0.3033	7.174
0.3066	7.174
0.3100	7.174
0.3133	7.174
0.3166	7.174
0.3200	7.174
0.3233	7.174
0.3266	7.174
0.3300	7.174
0.3333	7.174
0.3500	7.174
0.3666	7.167
0.3833	7.167
0.4000	7.167
0.4166	7.161
0.4333	7.161
0.4500	7.161
0.4666	7.161
0.4833	7.161
0.5000	7.155
0.5166	7.155
0.5333	7.155
0.5500	7.155
0.5666	7.148
0.5833	7.148
0.6000	7.148
0.6166	7.148
0.6333	7.148
0.6500	7.142
0.6666	7.142
0.6833	7.142

Halifax BP-3 Slug Test Data
Page 4

Elapsed Time	INPUT 1
0.7000	7.142
0.7166	7.142
0.7333	7.136
0.7500	7.142
0.7666	7.136
0.7833	7.136
0.8000	7.136
0.8166	7.136
0.8333	7.136
0.8500	7.136
0.8666	7.129
0.8833	7.129
0.9000	7.129
0.9166	7.129
0.9333	7.129
0.9500	7.129
0.9666	7.129
0.9833	7.129
1.0000	7.123
1.2000	7.117
1.4000	7.111
1.6000	7.104
1.8000	7.098
2.0000	7.092
2.2000	7.092
2.4000	7.085
2.6000	7.085
2.8000	7.079
3.0000	7.079
3.2000	7.073
3.4000	7.073
3.6000	7.073
3.8000	7.066
4.0000	7.066
4.2000	7.066
4.4000	7.060
4.6000	7.060
4.8000	7.060
5.0000	7.060
5.2000	7.060
5.4000	7.054
5.6000	7.054
5.8000	7.054

Halifax BP-3 Slug Test Data
Page 5

Elapsed Time	INPUT 1
6.0000	7.054
6.2000	7.054
6.4000	7.054
6.6000	7.047
6.8000	7.047
7.0000	7.047
7.2000	7.047
7.4000	7.047
7.6000	7.041
7.8000	7.041
8.0000	7.041
8.2000	7.041
8.4000	7.041
8.6000	7.041
8.8000	7.041
9.0000	7.041
9.2000	7.041
9.4000	7.035
9.6000	7.035
9.8000	7.035
10.0000	7.035
12.0000	7.041
14.0000	7.035
16.0000	7.029
18.0000	7.022
20.0000	7.022
22.0000	7.016
24.0000	7.016
26.0000	7.010
28.0000	6.997
30.0000	6.978
32.0000	6.991

G. N. Richardson and Associates

Client: Halifax County

Project: Halifax County Landfill

Proj. No. Halifax-4
Sheet: 1/1
Date: 1/96
Well: H-1d
Reference: Bouwer, 1989

ln[Re/Rw] = [1.1/ln(Lw/Rw) + A + Bln[(H-Lw)/Rw]/Le/Rw] exp -1

Where:

Lw = Height of Water Column in Well =	27.76
Le = Screened Interval Open to Aquifer =	10
Rw = Radius of Well Including Sand Pack =	0.43
Rc = Radius of Well Casing =	0.083
H = Aquifer Thickness to First Aquitard =	40
Yo = Relative Height of Water at Time Zero =	1.25
Yt = Relative Height of Water at Time t =	0.5
n = Porosity =	0.2
Time Tt (in minutes) =	4
H - Lw =	12.24
Yo/Yt =	2.5
Lw/Rw =	64.5581395
ln(H-Lw)/Rw =	3.34867935

Correction for Sandpack:

Req = [Rc exp2 + n(Rw exp2 + Rc exp2)] exp1/2

Req = 1

Req = 1

Evaluation of A and B:

Le/Rw = 23.25581

From Attached Graph of A and B:

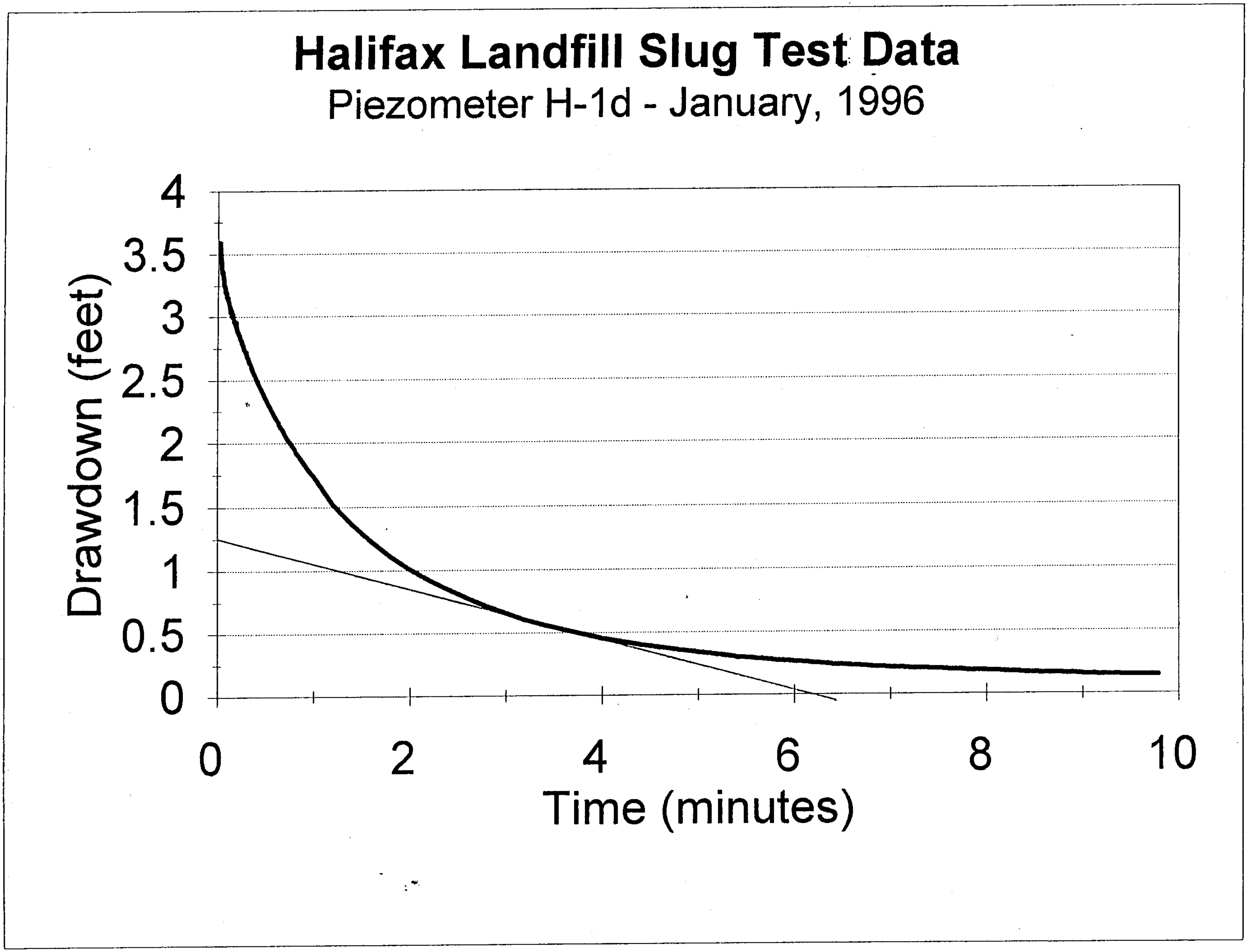
A =	2.4
B =	0.4

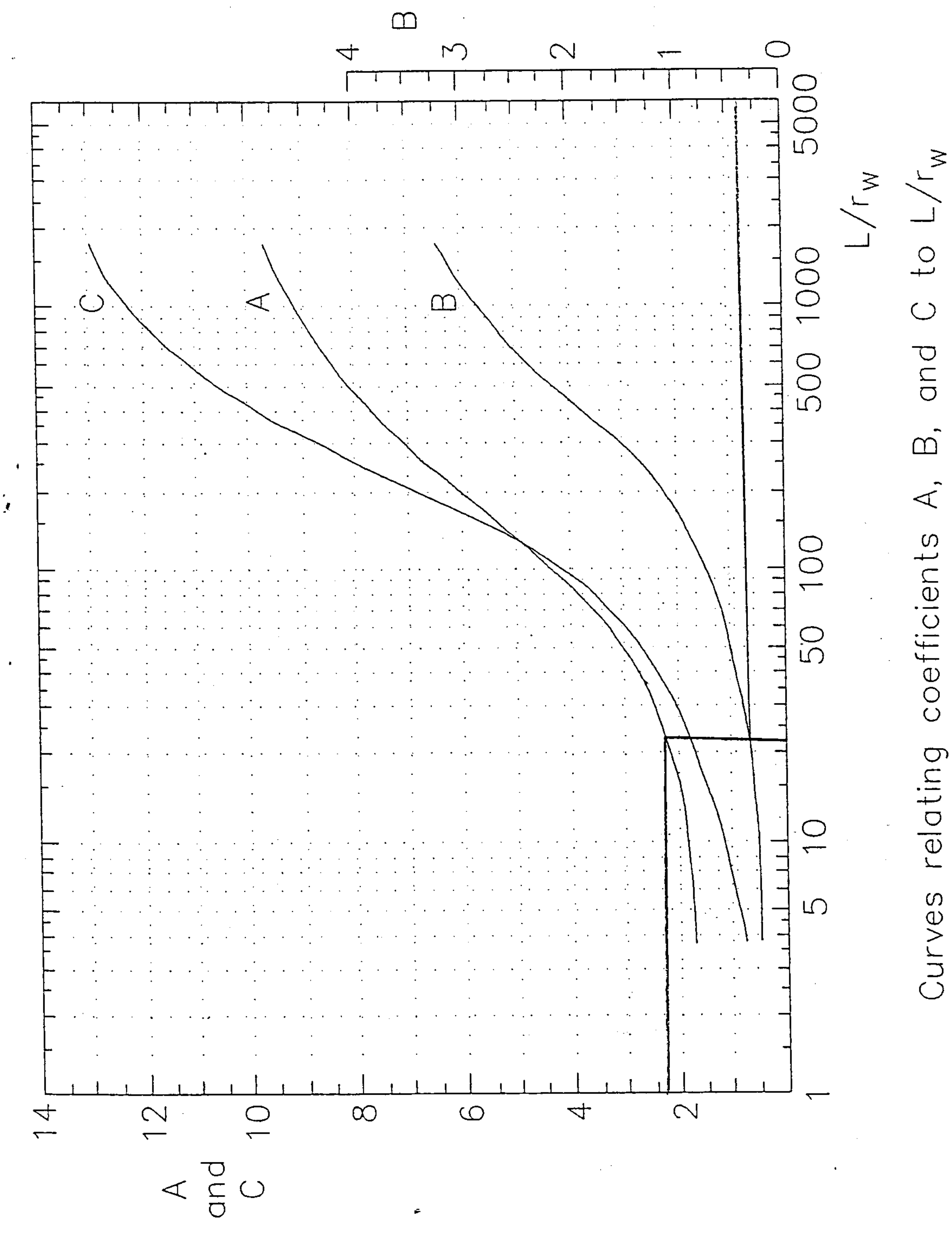
ln Re/Rw = [1.1/ln Lw/Rw + A + B ln[(H-Lw)/Rw] / Le/Rw] exp-1

ln Re/Rw= 2.7215403 exp-1
ln Re/Rw= 0.36743898

K = (Req) exp2 ln(Re/Rw)1/Tt ln(Yo/Yt) /2Le

K = 0.004209 Ft/Min or 0.002138 CM/Sec
K = 6.060257 Ft/Day


Halifax Landfill Slug Test Data
Piezometer H-1d - January, 1996
Drawdown (feet)
4
3.5
3
2.5
2
1.5
1
0.5
0
0
2
4
6
8
10
Time (minutes)



Curves relating coefficients A, B, and C to L/r_w

FROM: BOUWER, H. AND RICE, R.C., 1976: A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS.

G.N. RICHARDSON & ASSOC.
417 N. BOYLAN AVENUE
RALEIGH N.C. 27603
919-828-0577

COEFFICIENT CURVE MATCHPOINT
RISING HEAD AQUIFER TEST
Halifax Landfill
H-1d

Halifax H-1d Slug Test Data

SE1000C

Environmental Logger

01/26 09:05

Unit# 00069 Test 5

Setups:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	00001

Reference	0.000
Linearity	0.120
Scale factor	20.020
Offset	-0.020
Delay mSEC	50.000

Step 0 01/25 14:47:12

Elapsed Time	INPUT 1
0.0000	0.000
0.0033	0.000
0.0066	0.000
0.0100	0.126
0.0133	2.102
0.0166	2.754
0.0200	2.975
0.0233	3.190
0.0266	2.747
0.0300	3.589
0.0333	3.437
0.0366	3.443
0.0400	3.424
0.0433	3.393
0.0466	3.368
0.0500	3.349
0.0533	3.361
0.0566	3.342
0.0600	3.323
0.0633	3.298
0.0666	3.304
0.0700	3.266
0.0733	3.247
0.0766	3.241
0.0800	3.235
0.0833	3.222
0.0866	3.216
0.0900	3.197
0.0933	3.190

Halifax H-1d Slug Test Data
Page 2

Elapsed Time	INPUT 1
0.0966	3.178
0.1000	3.159
0.1033	3.152
0.1066	3.140
0.1100	3.152
0.1133	3.133
0.1166	3.127
0.1200	3.121
0.1233	3.102
0.1266	3.095
0.1300	3.089
0.1333	3.076
0.1366	3.070
0.1400	3.038
0.1433	3.051
0.1466	3.051
0.1500	3.032
0.1533	3.007
0.1566	3.019
0.1600	3.007
0.1633	3.000
0.1666	2.988
0.1700	2.981
0.1733	2.975
0.1766	2.956
0.1800	2.956
0.1833	2.956
0.1866	2.950
0.1900	2.937
0.1933	2.956
0.1966	2.925
0.2000	2.912
0.2033	2.906
0.2066	2.899
0.2100	2.887
0.2133	2.880
0.2166	2.874
0.2200	2.868
0.2233	2.861
0.2266	2.855
0.2300	2.849
0.2333	2.842
0.2366	2.836
0.2400	2.830
0.2433	2.823
0.2466	2.817
0.2500	2.811

Halifax G-1 Slug Test Data
Page 3

Elapsed Time	INPUT 1
0.2533	2.804
0.2566	2.792
0.2600	2.792
0.2633	2.785
0.2666	2.779
0.2700	2.773
0.2733	2.760
0.2766	2.754
0.2800	2.747
0.2833	2.741
0.2866	2.735
0.2900	2.728
0.2933	2.722
0.2966	2.722
0.3000	2.709
0.3033	2.703
0.3066	2.697
0.3100	2.690
0.3133	2.684
0.3166	2.678
0.3200	2.671
0.3233	2.665
0.3266	2.659
0.3300	2.652
0.3333	2.646
0.3500	2.614
0.3666	2.583
0.3833	2.551
0.4000	2.519
0.4166	2.494
0.4333	2.462
0.4500	2.437
0.4666	2.406
0.4833	2.380
0.5000	2.355
0.5166	2.330
0.5333	2.304
0.5500	2.279
0.5666	2.254
0.5833	2.228
0.6000	2.209
0.6166	2.184
0.6333	2.165
0.6500	2.140
0.6666	2.121
0.6833	2.095

Halifax G-1 Slug Test Data
Page 4

Elapsed Time	INPUT 1
0.7000	2.076
0.7166	2.051
0.7333	2.032
0.7500	2.013
0.7666	1.994
0.7833	1.975
0.8000	1.956
0.8166	1.937
0.8333	1.918
0.8500	1.899
0.8666	1.880
0.8833	1.861
0.9000	1.842
0.9166	1.823
0.9333	1.810
0.9500	1.791
0.9666	1.772
0.9833	1.760
1.0000	1.741
1.2000	1.519
1.4000	1.367
1.6000	1.234
1.8000	1.114
2.0000	1.013
2.2000	0.924
2.4000	0.848
2.6000	0.778
2.8000	0.715
3.0000	0.658
3.2000	0.607
3.4000	0.563
3.6000	0.525
3.8000	0.487
4.0000	0.455
4.2000	0.430
4.4000	0.405
4.6000	0.380
4.8000	0.360
5.0000	0.341
5.2000	0.323
5.4000	0.303
5.6000	0.291
5.8000	0.278
6.0000	0.266
6.2000	0.253

Halifax G-1 Slug Test Data
Page 5

Elapsed Time	INPUT 1
6.4000	0.240
6.6000	0.234
6.8000	0.221
7.0000	0.215
7.2000	0.208
7.4000	0.202
7.6000	0.196
7.8000	0.189
8.0000	0.183
8.2000	0.177
8.4000	0.170
8.6000	0.164
8.8000	0.164
9.0000	0.158
9.2000	0.151
9.4000	0.151
9.6000	0.145
9.8000	0.145
10.0000	0.145
12.0000	0.120
14.0000	0.107
16.0000	0.101
18.0000	0.088
20.0000	0.082
22.0000	0.082
24.0000	0.075
26.0000	0.075
28.0000	0.069
30.0000	0.069
32.0000	0.069
34.0000	0.063
36.0000	0.063

G. N. Richardson and Associates

Client:	Halifax County	**Proj. No.**	Halifax-4
		Sheet:	1/1
Project:	Halifax County Landfill	**Date:**	1/96
		Well:	G-1
		Reference:	Bouwer, 1989

ln[Re/Rw] = [1.1/ln(Lw/Rw) + A + Bln[(H-Lw)/Rw]/Le/Rw] exp -1

Where:

Lw = Height of Water Column in Well =	20.95
Le = Screened Interval Open to Aquifer =	10
Rw = Radius of Well Including Sand Pack =	0.43
Rc = Radius of Well Casing =	0.083
H = Aquifer Thickness to First Aquitard =	39
Yo = Relative Height of Water at Time Zero	3.23
Yt = Relative Height of Water at Time t =	2.5
n = Porosity =	0.2
Time Tt (in minutes) =	16
H - Lw =	18.05
Yo/Yt =	1.292
Lw/Rw =	48.7209302
ln(H-Lw)/Rw =	3.73711576

Correction for Sandpack:

Req = [Rc exp2 + n(Rw exp2 + Rc exp2)] exp1/2

Req = 1

Req = 1

Evaluation of A and B:

Le/Rw = 23.25581

From Attached Graph of A and B:

A = 2.3

B = 0.3

ln Re/Rw = [1.1/ln Lw/Rw + A + B ln[(H-Lw)/Rw] / Le/Rw] exp-1

ln Re/Rw= 2.6312683 exp-1

ln Re/Rw= 0.3800449

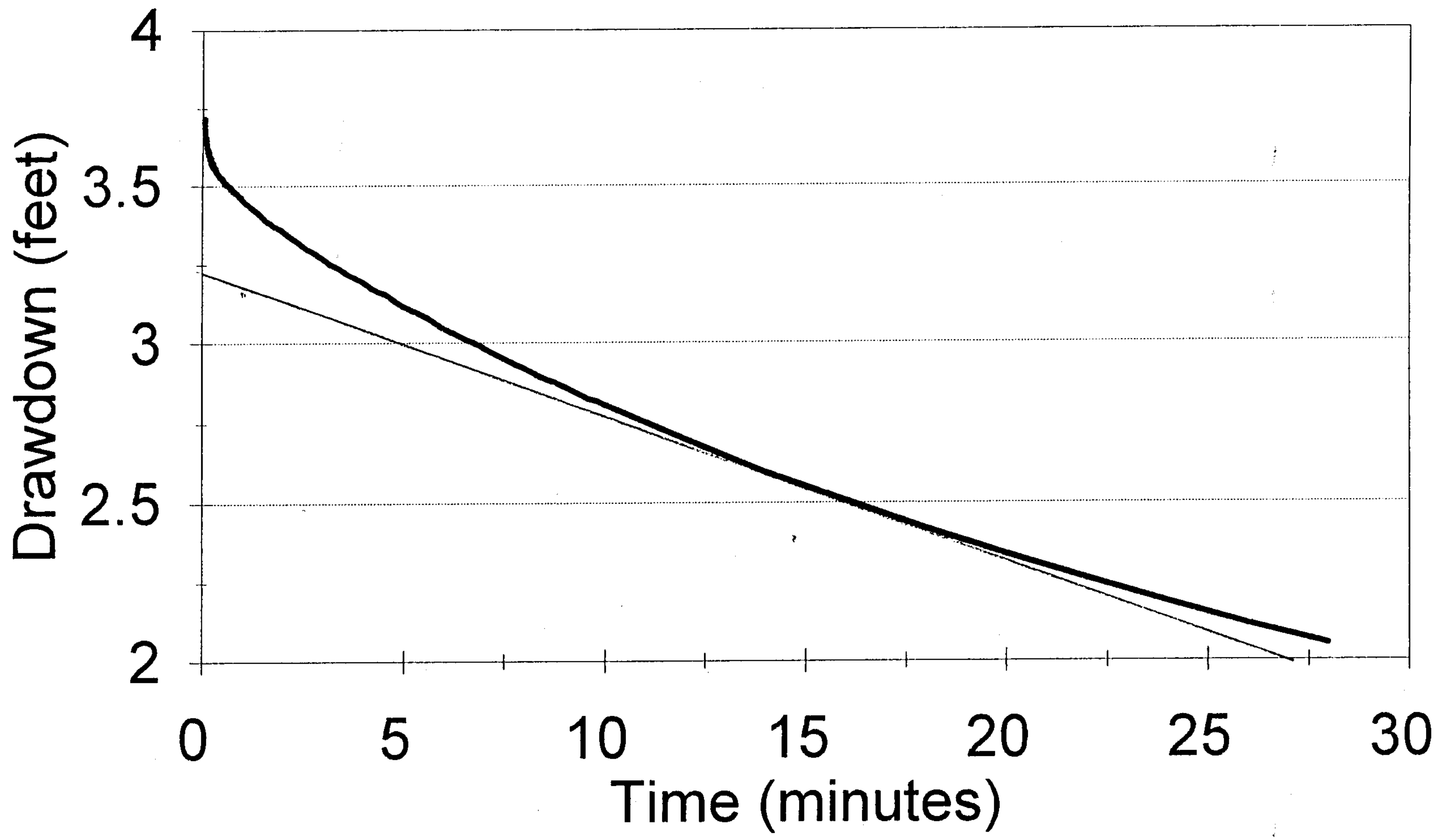
K = (Req) exp2 ln(Re/Rw)1/Tt ln(Yo/Yt) /2Le

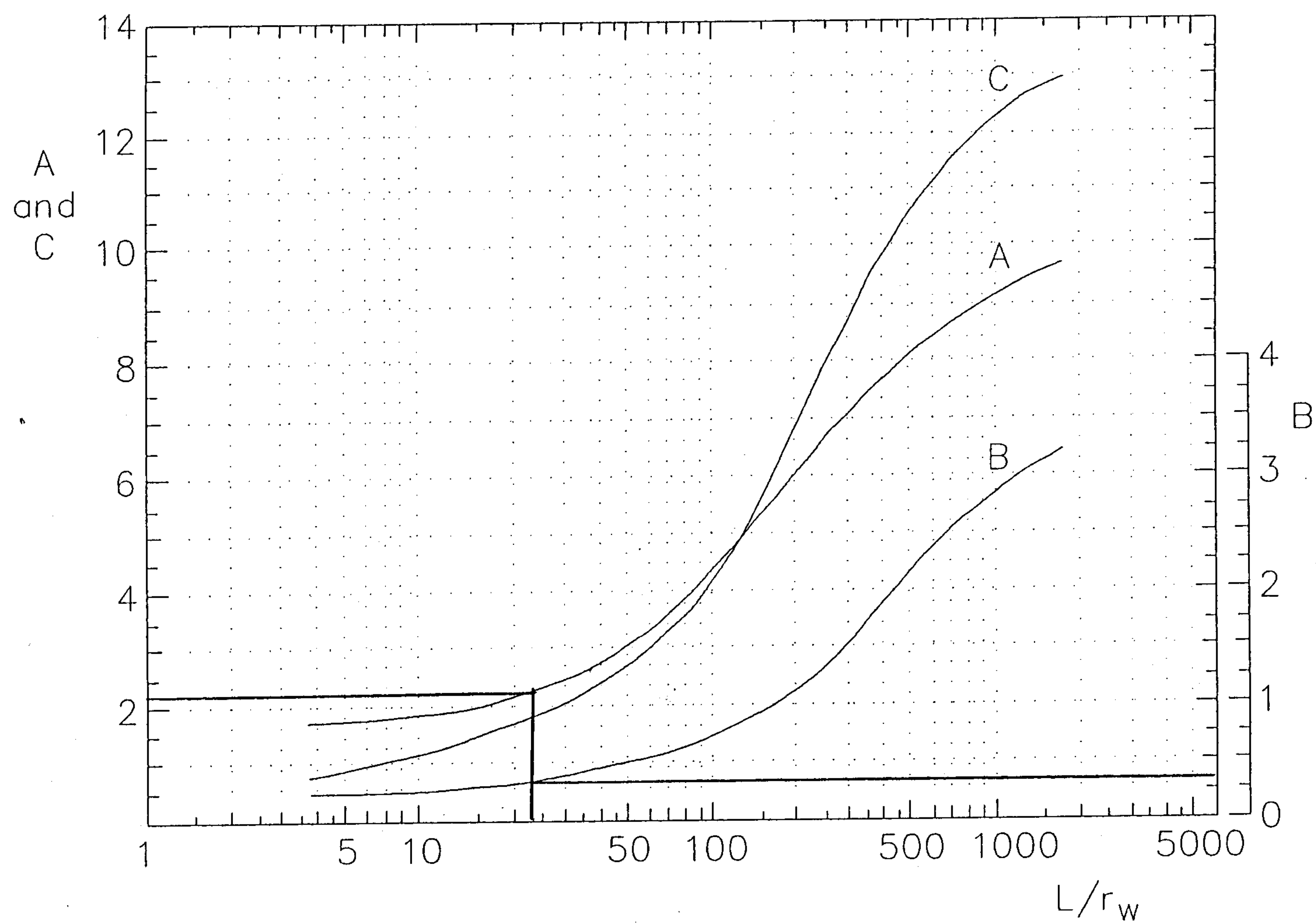
K = 0.000304 Ft/Min or 0.000155 CM/Sec

K = 0.438139 Ft/Day

Halifax Landfill Slug Test Data

Piezometer G-1 - January, 1996





Curves relating coefficients A, B, and C to L/r_w

FROM: BOUWER, H. AND RICE, R.C., 1976: A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS.

G.N. RICHARDSON & ASSOC.
417 N. BOYLAN AVENUE
RALEIGH N.C. 27603
919-828-0577

COEFFICIENT CURVE MATCHPOINT
RISING HEAD AQUIFER TEST
Halifax Landfill
G-1

Halifax G-1 Slug Test Data
SE1000C
Environmental Logger
01/26 09:02

Unit# 00069 Test 4

Setups:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	00001

Reference	0.000
Linearity	0.120
Scale factor	20.020
Offset	-0.020
Delay mSEC	50.000

Step 0 01/25 12:31:07

Elapsed Time	INPUT 1
0.0000	0.006
0.0033	0.006
0.0066	0.076
0.0100	0.728
0.0133	1.204
0.0166	2.040
0.0200	1.711
0.0233	1.913
0.0266	2.179
0.0300	2.673
0.0333	3.022
0.0366	2.686
0.0400	2.490
0.0433	3.402
0.0466	2.610
0.0500	3.117
0.0533	3.681
0.0566	3.681
0.0600	3.788
0.0633	3.668
0.0666	3.719
0.0700	3.700
0.0733	3.687
0.0766	3.693
0.0800	3.674
0.0833	3.681
0.0866	3.674
0.0900	3.662
0.0933	3.655

Halifax G-1 Slug Test Data
Page 2

Elapsed Time	INPUT 1
0.0966	3.655
0.1000	3.655
0.1033	3.649
0.1066	3.642
0.1100	3.642
0.1133	3.636
0.1166	3.636
0.1200	3.636
0.1233	3.630
0.1266	3.630
0.1300	3.624
0.1333	3.624
0.1366	3.624
0.1400	3.624
0.1433	3.624
0.1466	3.624
0.1500	3.624
0.1533	3.611
0.1566	3.617
0.1600	3.605
0.1633	3.617
0.1666	3.605
0.1700	3.611
0.1733	3.598
0.1766	3.611
0.1800	3.598
0.1833	3.605
0.1866	3.598
0.1900	3.598
0.1933	3.592
0.1966	3.586
0.2000	3.592
0.2033	3.586
0.2066	3.592
0.2100	3.586
0.2133	3.592
0.2166	3.573
0.2200	3.592
0.2233	3.592
0.2266	3.579
0.2300	3.592
0.2333	3.579
0.2366	3.579
0.2400	3.573
0.2433	3.579

Halifax G-1 Slug Test Data
Page 3

Elapsed Time	INPUT 1
0.2466	3.579
0.2500	3.579
0.2533	3.573
0.2566	3.579
0.2600	3.573
0.2633	3.573
0.2666	3.567
0.2700	3.567
0.2733	3.567
0.2766	3.567
0.2800	3.567
0.2833	3.560
0.2866	3.567
0.2900	3.560
0.2933	3.560
0.2966	3.560
0.3000	3.573
0.3033	3.560
0.3066	3.560
0.3100	3.560
0.3133	3.560
0.3166	3.554
0.3200	3.554
0.3233	3.560
0.3266	3.560
0.3300	3.554
0.3333	3.560
0.3500	3.554
0.3666	3.548
0.3833	3.548
0.4000	3.541
0.4166	3.541
0.4333	3.535
0.4500	3.529
0.4666	3.529
0.4833	3.529
0.5000	3.529
0.5166	3.522
0.5333	3.522
0.5500	3.516
0.5666	3.510
0.5833	3.510
0.6000	3.510
0.6166	3.510
0.6333	3.503

Halifax G-1 Slug Test Data
Page 4

Elapsed Time	INPUT 1
0.6500	3.503
0.6666	3.503
0.6833	3.497
0.7000	3.497
0.7166	3.497
0.7333	3.491
0.7500	3.491
0.7666	3.491
0.7833	3.484
0.8000	3.484
0.8166	3.484
0.8333	3.478
0.8500	3.478
0.8666	3.478
0.8833	3.478
0.9000	3.472
0.9166	3.472
0.9333	3.465
0.9500	3.465
0.9666	3.465
0.9833	3.465
1.0000	3.459
1.2000	3.434
1.4000	3.415
1.6000	3.389
1.8000	3.370
2.0000	3.358
2.2000	3.339
2.4000	3.320
2.6000	3.301
2.8000	3.288
3.0000	3.269
3.2000	3.250
3.4000	3.237
3.6000	3.218
3.8000	3.206
4.0000	3.193
4.2000	3.174
4.4000	3.161
4.6000	3.149
4.8000	3.130
5.0000	3.117
5.2000	3.104
5.4000	3.092
5.6000	3.079
5.8000	3.060
6.0000	3.047
6.2000	3.035

Halifax G-1 Slug Test Data
Page 5

Elapsed Time	INPUT 1
6.4000	3.022
6.6000	3.009
6.8000	2.997
7.0000	2.984
7.2000	2.971
7.4000	2.959
7.6000	2.946
7.8000	2.933
8.0000	2.921
8.2000	2.908
8.4000	2.895
8.6000	2.883
8.8000	2.876
9.0000	2.864
9.2000	2.851
9.4000	2.838
9.6000	2.826
9.8000	2.819
10.0000	2.807
12.0000	2.699
14.0000	2.598
16.0000	2.509
18.0000	2.420
20.0000	2.338
22.0000	2.262
24.0000	2.186
26.0000	2.116
28.0000	2.053
30.0000	1.989
32.0000	1.932
34.0000	1.875
36.0000	1.825
38.0000	1.774
40.0000	1.730
42.0000	1.685
44.0000	1.641
46.0000	1.603
48.0000	1.565
50.0000	1.527
52.0000	1.489
54.0000	1.457
56.0000	1.425
58.0000	1.394
60.0000	1.368
62.0000	1.337
64.0000	1.311
66.0000	1.286
68.0000	1.267
70.0000	1.242
72.0000	1.216
74.0000	1.197
76.0000	1.178

G. N. Richardson and Associates

Client:	Halifax County	**Proj. No.**	Halifax-4
		Sheet:	1/1
Project:	Halifax County Landfill	**Date:**	1/96
		Well:	G-2
		Reference:	Bouwer, 1989

ln[Re/Rw] = [1.1/ln(Lw/Rw) + A + Bln[(H-Lw)/Rw]/Le/Rw] exp -1

Where:	Lw = Height of Water Column in Well =	9.84
	Le = Screened Interval Open to Aquifer =	9.84
	Rw = Radius of Well Including Sand Pack =	0.43
	Rc = Radius of Well Casing =	0.083
	H = Aquifer Thickness to First Aquitard =	33
	Yo = Relative Height of Water at Time Zero	0.3
	Yt = Relative Height of Water at Time t =	0.15
	n = Porosity =	0.15
	Time Tt (in minutes) =	2
	H - Lw =	23.16
	Yo/Yt =	2
	Lw/Rw =	22.8837209
	ln(H-Lw)/Rw =	3.98639672

Correction for Sandpack:

Req = [Rc exp2 + n(Rw exp2 + Rc exp2)] exp1/2

Req = 0.035657

Req = 0.188832

Evaluation of A and B:

Le/Rw = 22.88372

From Attached Graph of A and B:

A = 2.25

B = 0.3

ln Re/Rw = [1.1/ln Lw/Rw + A + B ln[(H-Lw)/Rw] / Le/Rw] exp-1

ln Re/Rw= 2.6536506 exp-1

ln Re/Rw= 0.3768394

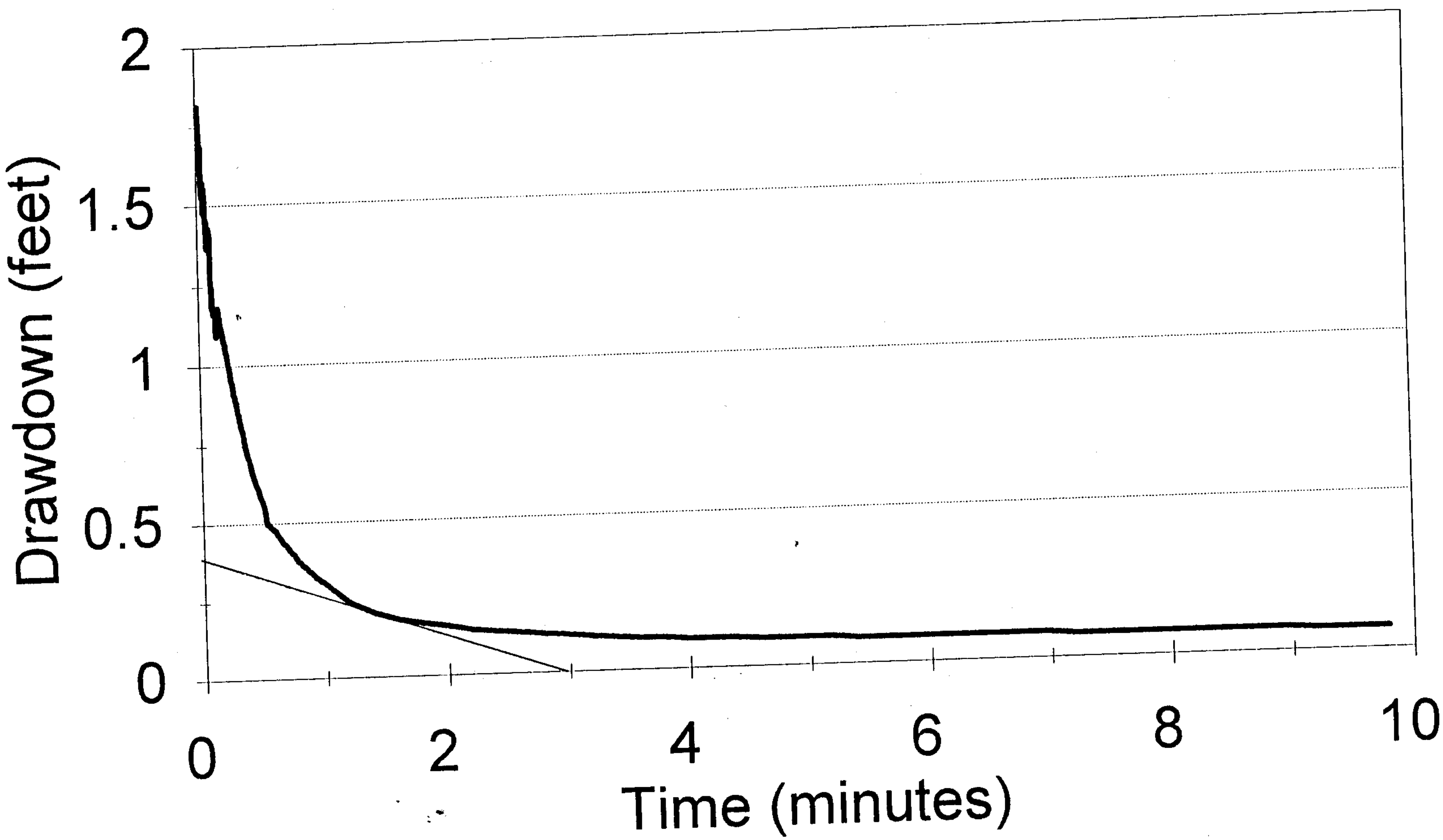
K = (Req) exp2 ln(Re/Rw)1/Tt ln(Yo/Yt) /2Le

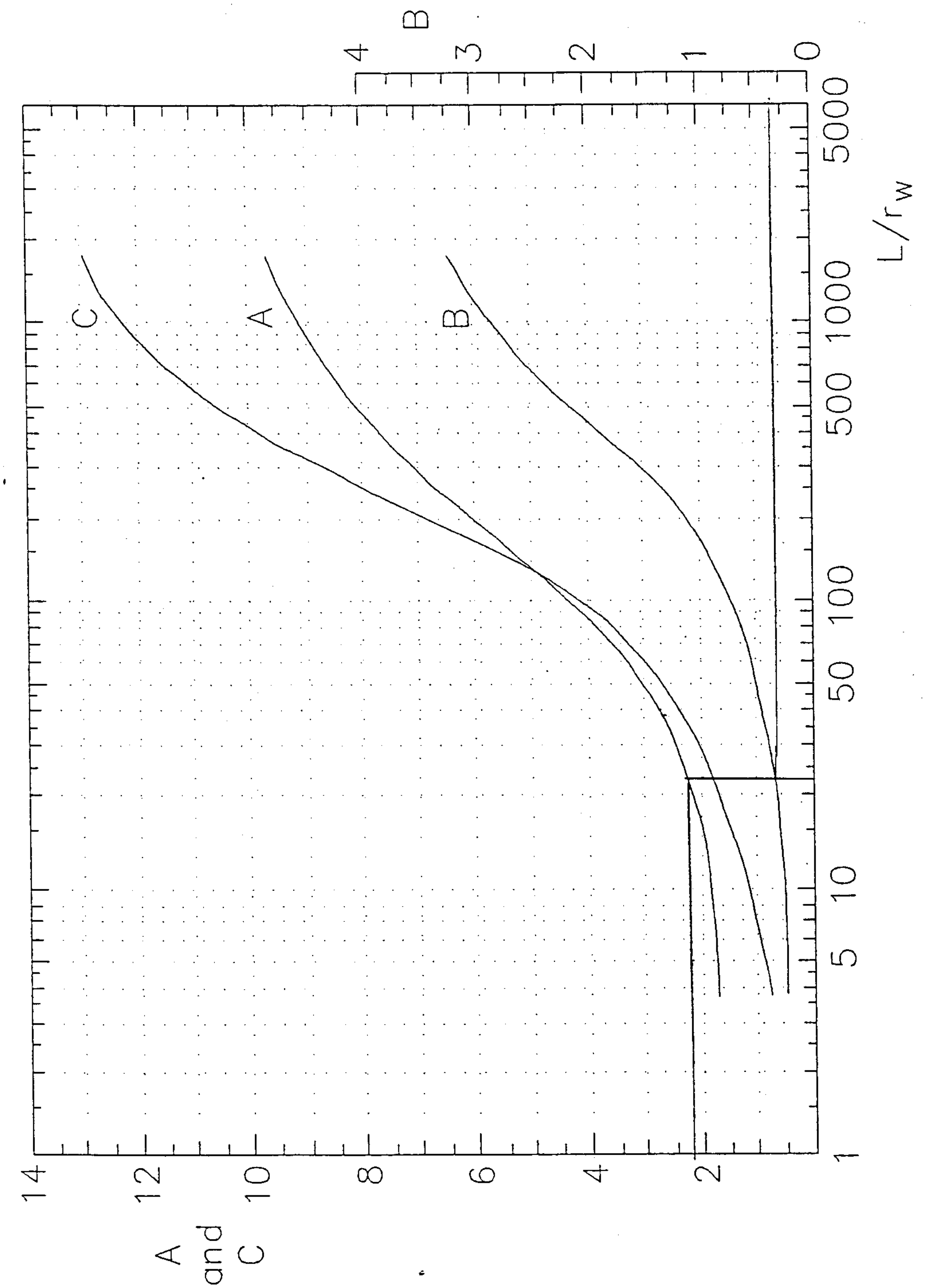
K = 0.000237 Ft/Min or 0.00012 CM/Sec

K = 0.340752 Ft/Day

Halifax Landfill Slug Test Data

Piezometer G-2 - January, 1996





Curves relating coefficients A, B, and C to L/r_w

FROM: BOUWER, H. AND RICE, R.C., 1976: A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS.

G.N. RICHARDSON & ASSOC.
417 N. BOYLAN AVENUE
RALEIGH N.C. 27603
919-828-0577

COEFFICIENT CURVE MATCHPOINT
RISING HEAD AQUIFER TEST
Halifax Landfill
G-2

Halifax G-2 Slug Test Data
SE1000C
Environmental Logger
01/26 08:56

Unit# 00069 Test 2

Setups:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	00001

Reference	0.000
Linearity	0.120
Scale factor	20.020
Offset	-0.020
Delay mSEC	50.000

Step 0 01/25 10:03:41

Elapsed Time	INPUT 1
0.0000	-0.063
0.0033	-0.044
0.0066	1.131
0.0100	1.574
0.0133	1.504
0.0166	1.466
0.0200	1.264
0.0233	1.814
0.0266	1.713
0.0300	1.757
0.0333	1.637
0.0366	1.605
0.0400	1.687
0.0433	1.593
0.0466	1.529
0.0500	1.542
0.0533	1.574
0.0566	1.479
0.0600	1.498
0.0633	1.517
0.0666	1.485
0.0700	1.555
0.0733	1.416
0.0766	1.428
0.0800	1.453
0.0833	1.371
0.0866	1.428
0.0900	1.365
0.0933	1.409

Halifax G-2 Slug Test Data
Page 2

Elapsed Time	INPUT 1
0.0966	1.409
0.1000	1.428
0.1033	1.403
0.1066	1.327
0.1100	1.182
0.1133	1.239
0.1166	1.245
0.1200	1.213
0.1233	1.207
0.1266	1.163
0.1300	1.163
0.1333	1.175
0.1366	1.175
0.1400	1.175
0.1433	1.156
0.1466	1.100
0.1500	1.175
0.1533	1.093
0.1566	1.112
0.1600	1.144
0.1633	1.182
0.1666	1.182
0.1700	1.163
0.1733	1.156
0.1766	1.150
0.1800	1.137
0.1833	1.131
0.1866	1.125
0.1900	1.118
0.1933	1.106
0.1966	1.100
0.2000	1.093
0.2033	1.087
0.2066	1.081
0.2100	1.074
0.2133	1.068
0.2166	1.055
0.2200	1.049
0.2233	1.043
0.2266	1.036
0.2300	1.030
0.2333	1.024
0.2366	1.017
0.2400	1.005
0.2433	1.005
0.2466	0.992
0.2500	0.986
0.2533	0.979
0.2566	0.973
0.2600	0.967

Halifax G-2 Slug Test Data
Page 3

Elapsed Time	INPUT 1
0.2633	0.954
0.2666	0.948
0.2700	0.941
0.2733	0.935
0.2766	0.929
0.2800	0.922
0.2833	0.910
0.2866	0.904
0.2900	0.897
0.2933	0.891
0.2966	0.885
0.3000	0.878
0.3033	0.872
0.3066	0.866
0.3100	0.859
0.3133	0.853
0.3166	0.847
0.3200	0.840
0.3233	0.828
0.3266	0.828
0.3300	0.821
0.3333	0.815
0.3500	0.783
0.3666	0.752
0.3833	0.720
0.4000	0.695
0.4166	0.670
0.4333	0.644
0.4500	0.625
0.4666	0.606
0.4833	0.581
0.5000	0.569
0.5166	0.543
0.5333	0.499
0.5500	0.493
0.5666	0.486
0.5833	0.480
0.6000	0.474
0.6166	0.461
0.6333	0.455
0.6500	0.448
0.6666	0.436
0.6833	0.429
0.7000	0.423
0.7166	0.411
0.7333	0.404

Halifax G-2 Slug Test Data
Page 4

Elapsed Time	INPUT 1
0.7500	0.398
0.7666	0.385
0.7833	0.379
0.8000	0.373
0.8166	0.366
0.8333	0.360
0.8500	0.354
0.8666	0.347
0.8833	0.341
0.9000	0.335
0.9166	0.328
0.9333	0.322
0.9500	0.316
0.9666	0.309
0.9833	0.309
1.0000	0.303
1.2000	0.240
1.4000	0.208
1.6000	0.183
1.8000	0.170
2.0000	0.158
2.2000	0.145
2.4000	0.139
2.6000	0.132
2.8000	0.126
3.0000	0.120
3.2000	0.113
3.4000	0.107
3.6000	0.101
3.8000	0.101
4.0000	0.094
4.2000	0.094
4.4000	0.094
4.6000	0.088
4.8000	0.088
5.0000	0.088
5.2000	0.088
5.4000	0.082
5.6000	0.082
5.8000	0.082
6.0000	0.082
6.2000	0.082
6.4000	0.082
6.6000	0.082
6.8000	0.082

Halifax G-2 Slug Test Data
Page 5

Elapsed Time	INPUT 1
7.0000	0.082
7.2000	0.075
7.4000	0.075
7.6000	0.075
7.8000	0.075
8.0000	0.075
8.2000	0.075
8.4000	0.075
8.6000	0.075
8.8000	0.075
9.0000	0.075
9.2000	0.069
9.4000	0.069
9.6000	0.069
9.8000	0.069
10.0000	0.069
12.0000	0.069
14.0000	0.069
16.0000	0.063
18.0000	0.063
20.0000	0.069
22.0000	0.069
24.0000	0.069
26.0000	0.069
28.0000	0.069
30.0000	0.075
32.0000	0.075
34.0000	0.075
36.0000	0.075
38.0000	0.075
40.0000	0.075
42.0000	0.075
44.0000	0.075
46.0000	0.075
48.0000	0.075
50.0000	0.075
52.0000	0.075
54.0000	0.075
56.0000	0.075
58.0000	0.075
60.0000	0.075
62.0000	0.075
64.0000	0.075
66.0000	0.075
68.0000	0.075
70.0000	0.075
72.0000	0.075
74.0000	0.075
76.0000	0.075
78.0000	0.075
80.0000	0.075
82.0000	0.075

G. N. Richardson and Associates

Client:	Halifax County	**Proj. No.**	Halifax-4
		Sheet:	1/1
Project:	Halifax County Landfill	**Date:**	1/96
		Well:	G-3d
		Reference:	Bouwer, 1989

ln[Re/Rw] = [1.1/ln(Lw/Rw) + A + Bln[(H-Lw)/Rw]/Le/Rw] exp -1

Where:

Lw = Height of Water Column in Well =	28.97
Le = Screened Interval Open to Aquifer =	10
Rw = Radius of Well Including Sand Pack =	0.43
Rc = Radius of Well Casing =	0.083
H = Aquifer Thickness to First Aquitard =	37
Yo = Relative Height of Water at Time Zero	1
Yt = Relative Height of Water at Time t =	0.5
n = Porosity =	0.2
Time Tt (in minutes) =	3.2
H - Lw =	8.03
Yo/Yt =	2
Lw/Rw =	67.372093
ln(H-Lw)/Rw =	2.9271546

Correction for Sandpack:

Req = [Rc exp2 + n(Rw exp2 + Rc exp2)] exp1/2

Req = 1

Req = 1

Evaluation of A and B:

Le/Rw = 23.25581

From Attached Graph of A and B:

A = 2.4

B = 0.4

ln Re/Rw = [1.1/ln Lw/Rw + A + B ln[(H-Lw)/Rw] / Le/Rw] exp-1

ln Re/Rw= 2.7116154 exp-1

ln Re/Rw= 0.3687839

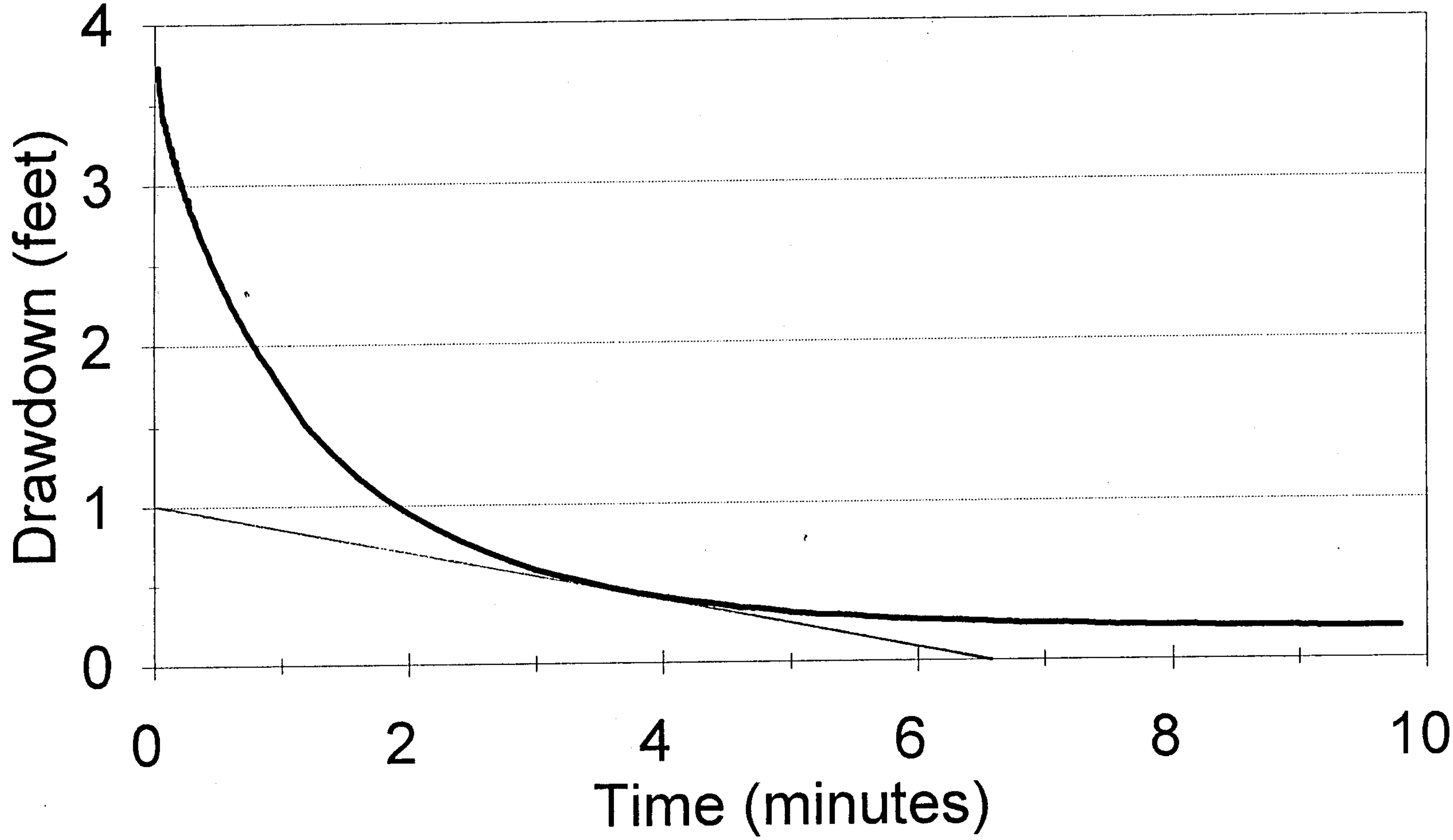
K = (Req) exp2 ln(Re/Rw)1/Tt ln(Yo/Yt) /2Le

K = 0.003994 Ft/Min or 0.002029 CM/Sec

K = 5.751484 Ft/Day

Halifax Landfill Slug Test Data

Piezometer G-3d - January, 1996



Halifax G-3d data - slug Test 1/24/96
SE1000C
Environmental Logger
01/24 20:34

Unit# 00069 Test 6

Setups:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	00001

Reference	0.000
Linearity	0.120
Scale factor	20.020
Offset	-0.020
Delay mSEC	50.000

Step 0 01/24 16:24:51

Elapsed Time	INPUT 1
0.0000	0.424
0.0033	2.229
0.0066	3.089
0.0100	2.906
0.0133	2.893
0.0166	2.292
0.0200	2.450
0.0233	2.855
0.0266	3.279
0.0300	2.735
0.0333	2.931
0.0366	3.735
0.0400	3.627
0.0433	3.615
0.0466	3.577
0.0500	3.558
0.0533	3.532
0.0566	3.514
0.0600	3.501
0.0633	3.488
0.0666	3.463
0.0700	3.431
0.0733	3.406
0.0766	3.419
0.0800	3.406
0.0833	3.393
0.0866	3.387
0.0900	3.381
0.0933	3.368

Halifax G-3d Slug Test Data Page 2

Elapsed Time	INPUT 1
0.0966	3.349
0.1000	3.324
0.1033	3.324
0.1066	3.324
0.1100	3.311
0.1133	3.292
0.1166	3.279
0.1200	3.273
0.1233	3.260
0.1266	3.248
0.1300	3.229
0.1333	3.229
0.1366	3.229
0.1400	3.241
0.1433	3.203
0.1466	3.184
0.1500	3.191
0.1533	3.178
0.1566	3.165
0.1600	3.146
0.1633	3.140
0.1666	3.134
0.1700	3.134
0.1733	3.153
0.1766	3.134
0.1800	3.102
0.1833	3.089
0.1866	3.083
0.1900	3.077
0.1933	3.070
0.1966	3.064
0.2000	3.051
0.2033	3.045
0.2066	3.039
0.2100	3.026
0.2133	3.020
0.2166	3.014
0.2200	2.995
0.2233	3.001
0.2266	2.988
0.2300	2.976
0.2333	2.976
0.2366	2.963
0.2400	2.957
0.2433	2.950
0.2466	2.938
0.2500	2.931

Halifax G-3d Slug Test Data Page 3

Elapsed Time	INPUT 1
0.2533	2.925
0.2566	2.912
0.2600	2.906
0.2633	2.906
0.2666	2.900
0.2700	2.887
0.2733	2.868
0.2766	2.912
0.2800	2.849
0.2833	2.849
0.2866	2.855
0.2900	2.843
0.2933	2.836
0.2966	2.830
0.3000	2.824
0.3033	2.817
0.3066	2.811
0.3100	2.805
0.3133	2.798
0.3166	2.792
0.3200	2.786
0.3233	2.779
0.3266	2.773
0.3300	2.767
0.3333	2.754
0.3500	2.722
0.3666	2.684
0.3833	2.653
0.4000	2.621
0.4166	2.589
0.4333	2.558
0.4500	2.526
0.4666	2.494
0.4833	2.463
0.5000	2.438
0.5166	2.406
0.5333	2.381
0.5500	2.349
0.5666	2.324
0.5833	2.298
0.6000	2.267
0.6166	2.241
0.6333	2.216
0.6500	2.191
0.6666	2.165
0.6833	2.146

Halifax G-3d Slug Test Data Page 4

Elapsed Time	INPUT 1
0.7000	2.121
0.7166	2.096
0.7333	2.077
0.7500	2.051
0.7666	2.032
0.7833	2.007
0.8000	1.988
0.8166	1.963
0.8333	1.944
0.8500	1.925
0.8666	1.906
0.8833	1.887
0.9000	1.868
0.9166	1.849
0.9333	1.830
0.9500	1.804
0.9666	1.785
0.9833	1.766
1.0000	1.747
1.2000	1.507
1.4000	1.336
1.6000	1.184
1.8000	1.057
2.0000	0.950
2.2000	0.861
2.4000	0.779
2.6000	0.709
2.8000	0.646
3.0000	0.589
3.2000	0.544
3.4000	0.506
3.6000	0.468
3.8000	0.437
4.0000	0.411
4.2000	0.386
4.4000	0.367
4.6000	0.342
4.8000	0.329
5.0000	0.310
5.2000	0.297
5.4000	0.291
5.6000	0.278
5.8000	0.266

Halifax G-3d Slug Test Data Page 5

Elapsed Time	INPUT 1
6.0000	0.259
6.2000	0.253
6.4000	0.247
6.6000	0.240
6.8000	0.234
7.0000	0.228
7.2000	0.228
7.4000	0.221
7.6000	0.215
7.8000	0.215
8.0000	0.209
8.2000	0.209
8.4000	0.202
8.6000	0.202
8.8000	0.202
9.0000	0.202
9.2000	0.196
9.4000	0.196
9.6000	0.196
9.8000	0.196
10.0000	0.196
12.0000	0.190
14.0000	0.183
16.0000	0.190
18.0000	0.183
20.0000	0.183
22.0000	0.190
24.0000	0.183
26.0000	0.183
28.0000	0.183
30.0000	0.183
32.0000	0.183
34.0000	0.183
36.0000	0.183
38.0000	0.190
40.0000	0.183
42.0000	0.183
44.0000	0.190
46.0000	0.190
48.0000	0.190
50.0000	0.190
52.0000	0.190
54.0000	0.183
56.0000	0.190
58.0000	0.190
60.0000	0.183
62.0000	0.190
64.0000	0.190

G. N. Richardson and Associates

Client:	Halifax County	**Proj. No.**	Halifax-4
		Sheet:	1/1
Project:	Halifax County Landfill	**Date:**	1/96
		Well:	G-4
		Reference:	Bouwer, 1989

ln[Re/Rw] = [1.1/ln(Lw/Rw) + A + Bln[(H-Lw)/Rw]/Le/Rw] exp -1

Where:

Lw = Height of Water Column in Well =	9.72
Le = Screened Interval Open to Aquifer =	9.72
Rw = Radius of Well Including Sand Pack =	0.43
Rc = Radius of Well Casing =	0.083
H = Aquifer Thickness to First Aquitard =	25
Yo = Relative Height of Water at Time Zero	0.75
Yt = Relative Height of Water at Time t =	0.125
n = Porosity =	0.15
Time Tt (in minutes) =	4
H - Lw =	15.28
Yo/Yt =	6
Lw/Rw =	22.6046512
ln(H-Lw)/Rw =	3.57051485

Correction for Sandpack:

Req = [Rc exp2 + n(Rw exp2 + Rc exp2)] exp1/2

Req = 0.035657

Req = 0.188832

Evaluation of A and B:

Le/Rw = 22.60465

From Attached Graph of A and B:

A =	2.4
B =	0.4

ln Re/Rw = [1.1/ln Lw/Rw + A + B ln[(H-Lw)/Rw] / Le/Rw] exp-1

ln Re/Rw= 2.8159546 exp-1

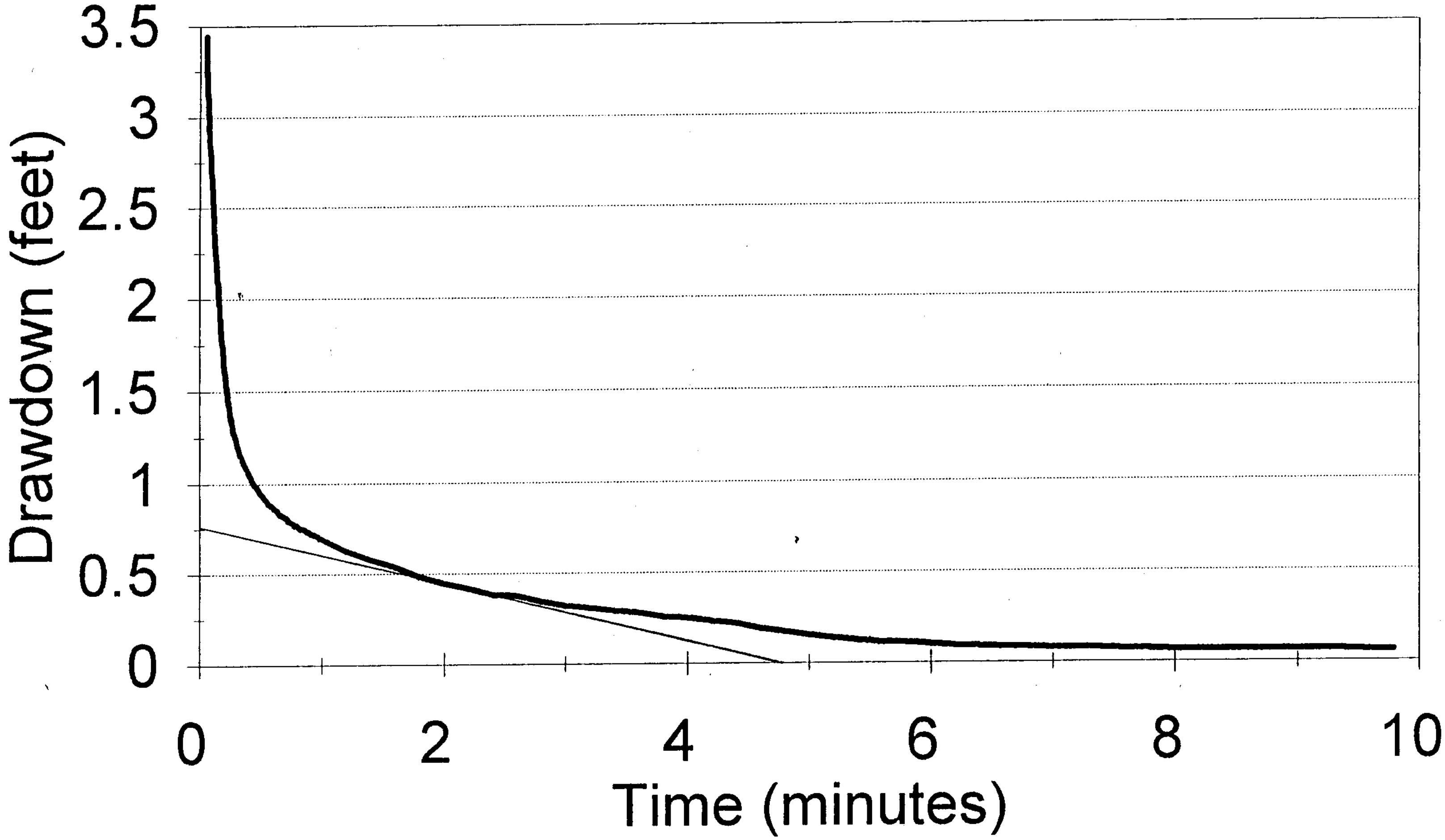
ln Re/Rw= 0.3551194

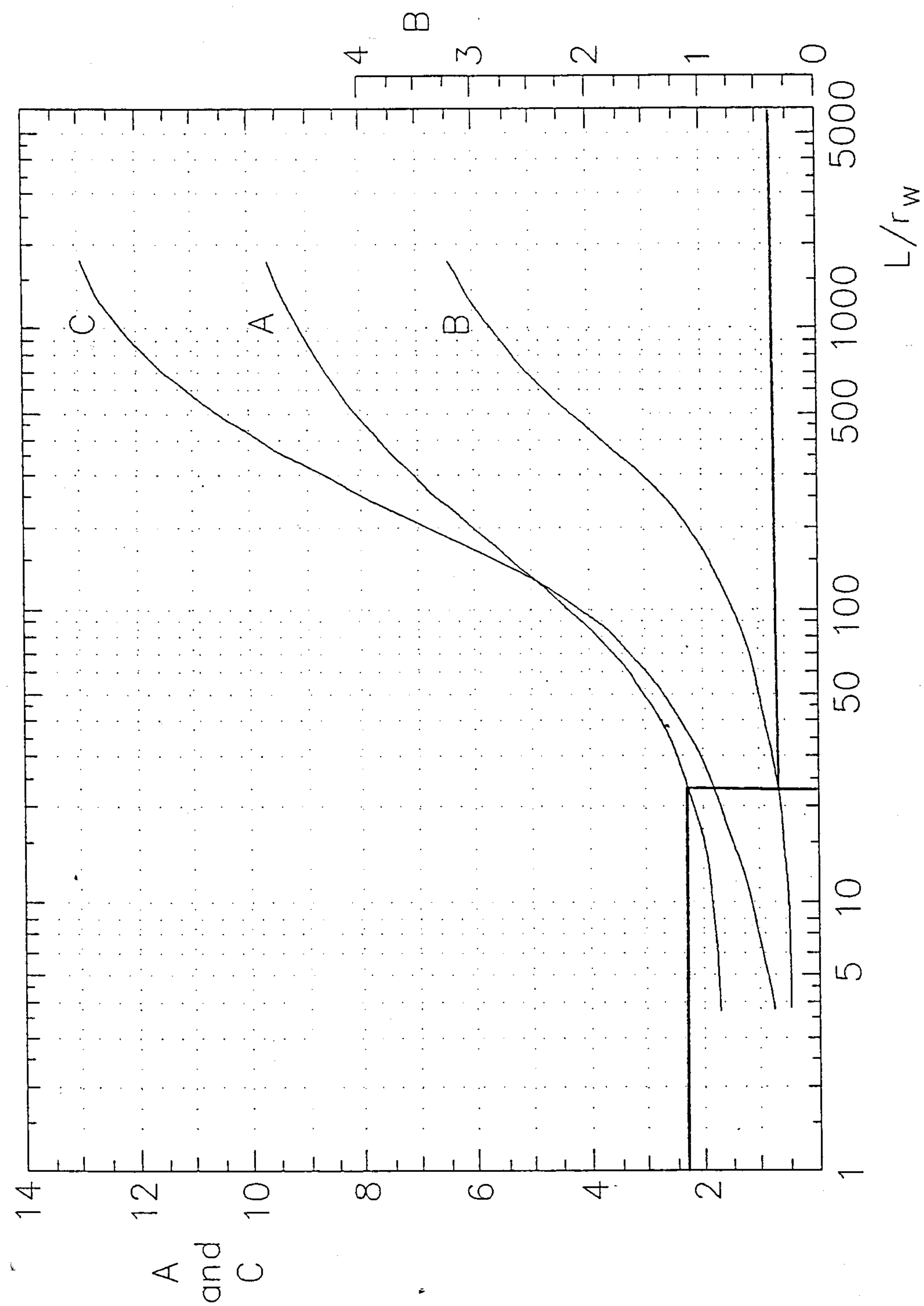
K = (Req) exp2 ln(Re/Rw)1/Tt ln(Yo/Yt) /2Le

K = 0.000292 Ft/Min or 0.000148 CM/Sec

K = 0.420155 Ft/Day

Halifax Landfill Slug Test Data
Piezometer G-4 - January, 1996





Curves relating coefficients A, B, and C to L/r_w

FROM: BOUWER, H. AND RICE, R.C., 1976: A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS.

G.N. RICHARDSON & ASSOC. 417 N. BOYLAN AVENUE RALEIGH N.C. 27603 919-828-0577	COEFFICIENT CURVE MATCHPOINT RISING HEAD AQUIFER TEST Halifax Landfill G-4

Halifax G-4 data - Slug Test 1/24/96
SE1000C
Environmental Logger
01/24 20:38

Unit# 00069 Test 5

Setups:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	00001

Reference	0.000
Linearity	0.120
Scale factor	20.020
Offset	-0.020
Delay mSEC	50.000

Step 0 01/24 15:24:59

Elapsed Time	INPUT 1
0.0000	0.012
0.0033	0.006
0.0066	0.012
0.0100	0.006
0.0133	0.006
0.0166	0.006
0.0200	0.006
0.0233	0.012
0.0266	0.006
0.0300	0.417
0.0333	3.000
0.0366	3.278
0.0400	4.067
0.0433	3.979
0.0466	2.609
0.0500	1.933
0.0533	3.158
0.0566	2.988
0.0600	3.442
0.0633	3.228
0.0666	3.246
0.0700	3.145
0.0733	3.095
0.0766	3.032
0.0800	3.000
0.0833	2.956
0.0866	2.893
0.0900	2.855
0.0933	2.811
0.0966	2.767

Halifax G-4 - Slug Test Data Page 2

Elapsed Time	INPUT 1
0.1000	2.703
0.1033	2.659
0.1066	2.628
0.1100	2.590
0.1133	2.552
0.1166	2.501
0.1200	2.470
0.1233	2.438
0.1266	2.388
0.1300	2.331
0.1333	2.299
0.1366	2.280
0.1400	2.255
0.1433	2.204
0.1466	2.167
0.1500	2.141
0.1533	2.103
0.1566	2.078
0.1600	2.028
0.1633	1.983
0.1666	1.990
0.1700	1.939
0.1733	1.901
0.1766	1.882
0.1800	1.838
0.1833	1.819
0.1866	1.794
0.1900	1.762
0.1933	1.737
0.1966	1.712
0.2000	1.686
0.2033	1.642
0.2066	1.630
0.2100	1.617
0.2133	1.585
0.2166	1.573
0.2200	1.554
0.2233	1.535
0.2266	1.510
0.2300	1.491
0.2333	1.478
0.2366	1.459
0.2400	1.440
0.2433	1.428
0.2466	1.415
0.2500	1.396
0.2533	1.383

Halifax G-4 - Slug Test Data Page 3

Elapsed Time	INPUT 1
0.2566	1.371
0.2600	1.358
0.2633	1.345
0.2666	1.345
0.2700	1.326
0.2733	1.314
0.2766	1.289
0.2800	1.289
0.2833	1.276
0.2866	1.270
0.2900	1.257
0.2933	1.251
0.2966	1.244
0.3000	1.232
0.3033	1.225
0.3066	1.219
0.3100	1.206
0.3133	1.200
0.3166	1.194
0.3200	1.187
0.3233	1.181
0.3266	1.175
0.3300	1.168
0.3333	1.162
0.3500	1.137
0.3666	1.112
0.3833	1.086
0.4000	1.061
0.4166	1.042
0.4333	1.017
0.4500	0.998
0.4666	0.985
0.4833	0.966
0.5000	0.947
0.5166	0.935
0.5333	0.922
0.5500	0.909
0.5666	0.891
0.5833	0.884
0.6000	0.872
0.6166	0.859
0.6333	0.853
0.6500	0.840
0.6666	0.827
0.6833	0.821
0.7000	0.815
0.7166	0.808

Halifax G-4 - Slug Test Data Page 4

Elapsed Time	INPUT 1
0.7333	0.796
0.7500	0.789
0.7666	0.783
0.7833	0.770
0.8000	0.770
0.8166	0.758
0.8333	0.751
0.8500	0.751
0.8666	0.745
0.8833	0.733
0.9000	0.733
0.9166	0.720
0.9333	0.720
0.9500	0.714
0.9666	0.707
0.9833	0.701
1.0000	0.695
1.2000	0.631
1.4000	0.581
1.6000	0.537
1.8000	0.486
2.0000	0.448
2.2000	0.417
2.4000	0.385
2.6000	0.379
2.8000	0.347
3.0000	0.322
3.2000	0.309
3.4000	0.290
3.6000	0.278
3.8000	0.259
4.0000	0.252
4.2000	0.233
4.4000	0.221
4.6000	0.189
4.8000	0.170
5.0000	0.151
5.2000	0.139
5.4000	0.126
5.6000	0.113
5.8000	0.113

Halifax G-4 - Slug Test Data Page 5

Elapsed Time	INPUT 1
6.0000	0.101
6.2000	0.094
6.4000	0.088
6.6000	0.082
6.8000	0.082
7.0000	0.075
7.2000	0.075
7.4000	0.075
7.6000	0.069
7.8000	0.069
8.0000	0.063
8.2000	0.063
8.4000	0.063
8.6000	0.063
8.8000	0.063
9.0000	0.063
9.2000	0.063
9.4000	0.063
9.6000	0.056
9.8000	0.056
10.0000	0.056
12.0000	0.056
14.0000	0.050
16.0000	0.050
18.0000	0.050
20.0000	0.056
22.0000	0.050
24.0000	0.044
26.0000	0.050
28.0000	0.050
30.0000	0.056
32.0000	0.056
34.0000	0.056
36.0000	0.056
38.0000	0.056
40.0000	0.056
42.0000	0.056
44.0000	0.056
46.0000	0.063
48.0000	0.063
50.0000	0.056

G. N. Richardson and Associates

Client:	Halifax County	**Proj. No.**	Halifax-4
		Sheet:	1/1
Project:	Halifax County Landfill	**Date:**	1/96
		Well:	G-5d
		Reference:	Bouwer, 1989

ln[Re/Rw] = [1.1/ln(Lw/Rw) + A + Bln[(H-Lw)/Rw]/Le/Rw] exp -1

Where:

Lw = Height of Water Column in Well =	18.74
Le = Screened Interval Open to Aquifer =	10
Rw = Radius of Well Including Sand Pack =	0.43
Rc = Radius of Well Casing =	0.083
H = Aquifer Thickness to First Aquitard =	40
Yo = Relative Height of Water at Time Zero	1
Yt = Relative Height of Water at Time t =	0.5
n = Porosity =	0.2
Time Tt (in minutes) =	14
H - Lw =	21.26
Yo/Yt =	2
Lw/Rw =	43.5813953
ln(H-Lw)/Rw =	3.90079744

Correction for Sandpack:

Req = [Rc exp2 + n(Rw exp2 + Rc exp2)] exp1/2

Req = 1

Req = 1

Evaluation of A and B:

Le/Rw = 23.25581

From Attached Graph of A and B:

A =	2.4
B =	0.4

ln Re/Rw = [1.1/ln Lw/Rw + A + B ln[(H-Lw)/Rw] / Le/Rw] exp-1

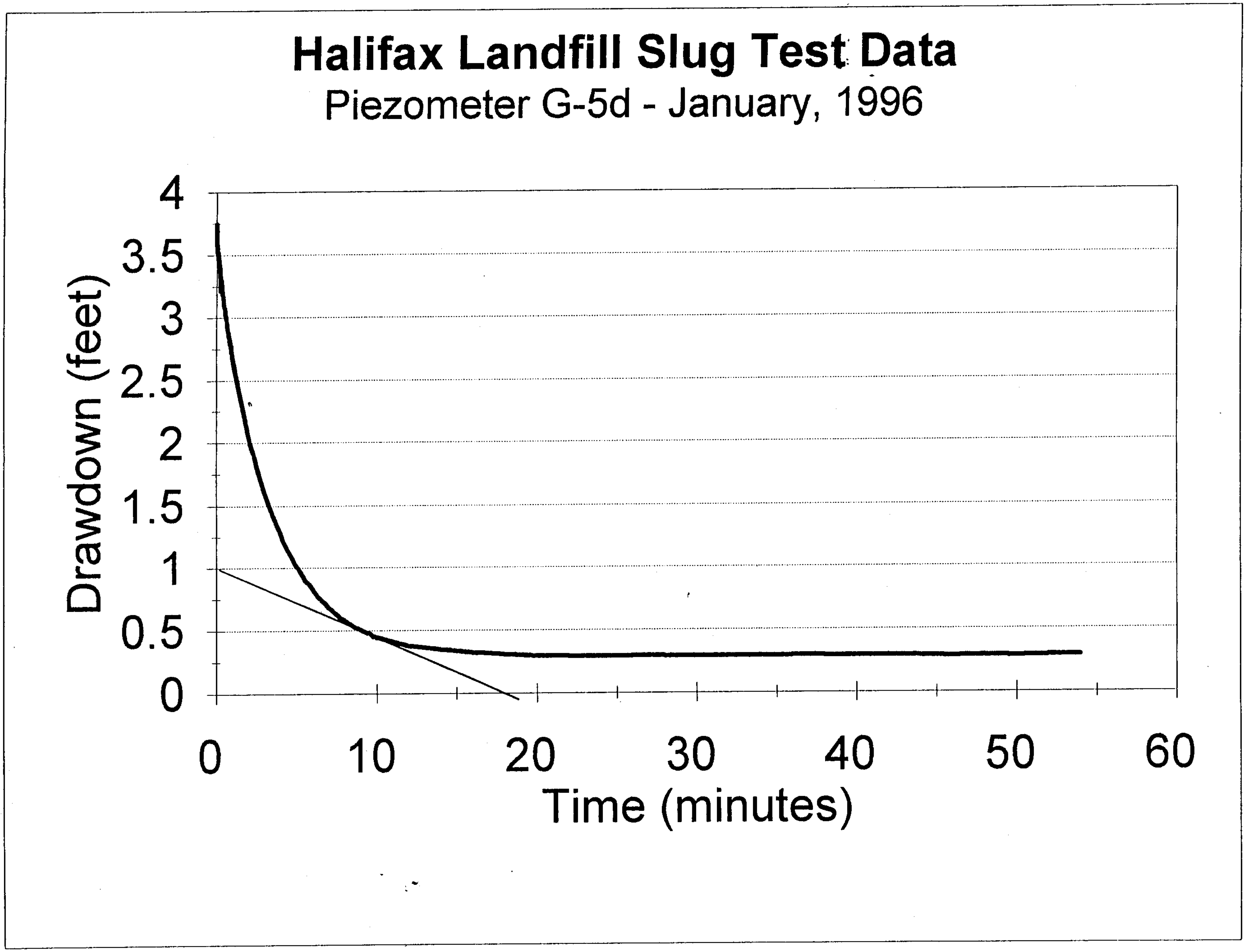
ln Re/Rw= 2.758513 exp-1

ln Re/Rw= 0.3625142

K = (Req) exp2 ln(Re/Rw)1/Tt ln(Yo/Yt) /2Le

K = 0.000897 Ft/Min or 0.000456 CM/Sec

K = 1.292275 Ft/Day


Halifax Landfill Slug Test Data
Piezometer G-5d - January, 1996
Drawdown (feet)
4
3.5
3
2.5
2
1.5
1
0.5
0
0
10
20
30
40
50
60
Time (minutes)

Halifax G-5d - slug test 1/24/96

SE1000C

Environmental Logger

01/24 20:41

Unit# 00069 Test 4

Setups:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	00001

Reference	0.000
Linearity	0.120
Scale factor	20.020
Offset	-0.020
Delay mSEC	50.000

Step 0 01/24 14:23:44

Elapsed Time	INPUT 1
0.0000	-0.075
0.0033	0.132
0.0066	1.822
0.0100	2.043
0.0133	2.562
0.0166	2.638
0.0200	3.043
0.0233	3.567
0.0266	3.182
0.0300	3.637
0.0333	3.662
0.0366	2.979
0.0400	3.681
0.0433	3.744
0.0466	3.662
0.0500	3.669
0.0533	3.656
0.0566	3.656
0.0600	3.624
0.0633	3.612
0.0666	3.599
0.0700	3.631
0.0733	3.599
0.0766	3.586
0.0800	3.567
0.0833	3.555
0.0866	3.536
0.0900	3.555
0.0933	3.555
0.0966	3.555

Halifax G-5d Slug Test Data Page 2

Elapsed Time	INPUT 1
0.1000	3.542
0.1033	3.529
0.1066	3.517
0.1100	3.529
0.1133	3.523
0.1166	3.517
0.1200	3.510
0.1233	3.491
0.1266	3.479
0.1300	3.498
0.1333	3.498
0.1366	3.498
0.1400	3.485
0.1433	3.473
0.1466	3.479
0.1500	3.473
0.1533	3.466
0.1566	3.454
0.1600	3.460
0.1633	3.441
0.1666	3.460
0.1700	3.447
0.1733	3.460
0.1766	3.447
0.1800	3.428
0.1833	3.435
0.1866	3.428
0.1900	3.479
0.1933	3.409
0.1966	3.409
0.2000	3.409
0.2033	3.397
0.2066	3.403
0.2100	3.397
0.2133	3.390
0.2166	3.390
0.2200	3.384
0.2233	3.384
0.2266	3.371
0.2300	3.365
0.2333	3.371
0.2366	3.397
0.2400	3.359
0.2433	3.346
0.2466	3.371
0.2500	3.359
0.2533	3.365

Halifax G-5d Slug Test Data Page 3

Elapsed Time	INPUT 1
0.2566	3.352
0.2600	3.340
0.2633	3.333
0.2666	3.340
0.2700	3.327
0.2733	3.327
0.2766	3.314
0.2800	3.213
0.2833	3.321
0.2866	3.321
0.2900	3.314
0.2933	3.308
0.2966	3.308
0.3000	3.308
0.3033	3.289
0.3066	3.295
0.3100	3.295
0.3133	3.289
0.3166	3.289
0.3200	3.289
0.3233	3.283
0.3266	3.276
0.3300	3.276
0.3333	3.270
0.3500	3.258
0.3666	3.239
0.3833	3.226
0.4000	3.207
0.4166	3.188
0.4333	3.169
0.4500	3.156
0.4666	3.144
0.4833	3.131
0.5000	3.112
0.5166	3.099
0.5333	3.087
0.5500	3.080
0.5666	3.068
0.5833	3.049
0.6000	3.036
0.6166	3.024
0.6333	3.005
0.6500	2.992
0.6666	2.979
0.6833	2.967
0.7000	2.954
0.7166	2.941
0.7333	2.929

Halifax G-5d Slug Test Data Page 4

Elapsed Time	INPUT 1
0.7500	2.910
0.7666	2.897
0.7833	2.884
0.8000	2.872
0.8166	2.859
0.8333	2.846
0.8500	2.834
0.8666	2.821
0.8833	2.815
0.9000	2.802
0.9166	2.790
0.9333	2.777
0.9500	2.764
0.9666	2.752
0.9833	2.739
1.0000	2.726
1.2000	2.562
1.4000	2.429
1.6000	2.309
1.8000	2.195
2.0000	2.087
2.2000	1.980
2.4000	1.885
2.6000	1.790
2.8000	1.702
3.0000	1.619
3.2000	1.543
3.4000	1.468
3.6000	1.398
3.8000	1.335
4.0000	1.290
4.2000	1.214
4.4000	1.164
4.6000	1.113
4.8000	1.063
5.0000	1.018
5.2000	0.980
5.4000	0.936
5.6000	0.898
5.8000	0.867
6.0000	0.829
6.2000	0.797
6.4000	0.765
6.6000	0.740
6.8000	0.715

Halifax G-5d Slug Test Data Page 5

Elapsed Time	INPUT 1
7.0000	0.683
7.2000	0.664
7.4000	0.639
7.6000	0.620
7.8000	0.601
8.0000	0.582
8.2000	0.563
8.4000	0.550
8.6000	0.531
8.8000	0.518
9.0000	0.506
9.2000	0.493
9.4000	0.480
9.6000	0.474
9.8000	0.455
10.0000	0.449
12.0000	0.379
14.0000	0.348
16.0000	0.322
18.0000	0.310
20.0000	0.297
22.0000	0.297
24.0000	0.291
26.0000	0.297
28.0000	0.297
30.0000	0.291
32.0000	0.291
34.0000	0.291
36.0000	0.297
38.0000	0.297
40.0000	0.291
42.0000	0.297
44.0000	0.291
46.0000	0.284
48.0000	0.291
50.0000	0.284
52.0000	0.291
54.0000	0.291

G. N. Richardson and Associates

Client:	Halifax County	**Proj. No.**	Halifax-4
		Sheet:	1/1
Project:	Halifax County Landfill	**Date:**	1/96
		Well:	G-6
		Reference:	Bouwer, 1989

ln[Re/Rw] = [1.1/ln(Lw/Rw) + A + Bln[(H-Lw)/Rw]/Le/Rw] exp -1

Where:

Lw = Height of Water Column in Well =	3.13
Le = Screened Interval Open to Aquifer =	3.13
Rw = Radius of Well Including Sand Pack =	0.43
Rc = Radius of Well Casing =	0.083
H = Aquifer Thickness to First Aquitard =	31
Yo = Relative Height of Water at Time Zero	0.15
Yt = Relative Height of Water at Time t =	0.05
n = Porosity =	0.15
Time Tt (in minutes) =	7.5
H - Lw =	27.87
Yo/Yt =	3
Lw/Rw =	7.27906977
ln(H-Lw)/Rw =	4.17152091

Correction for Sandpack:

Req = [Rc exp2 + n(Rw exp2 + Rc exp2)] exp1/2

Req = 0.035657

Req = 0.188832

Evaluation of A and B:

Le/Rw = 7.27907

From Attached Graph of A and B:

A = 2.7

B = 0.45

ln Re/Rw = [1.1/ln Lw/Rw + A + B ln[(H-Lw)/Rw] / Le/Rw] exp-1

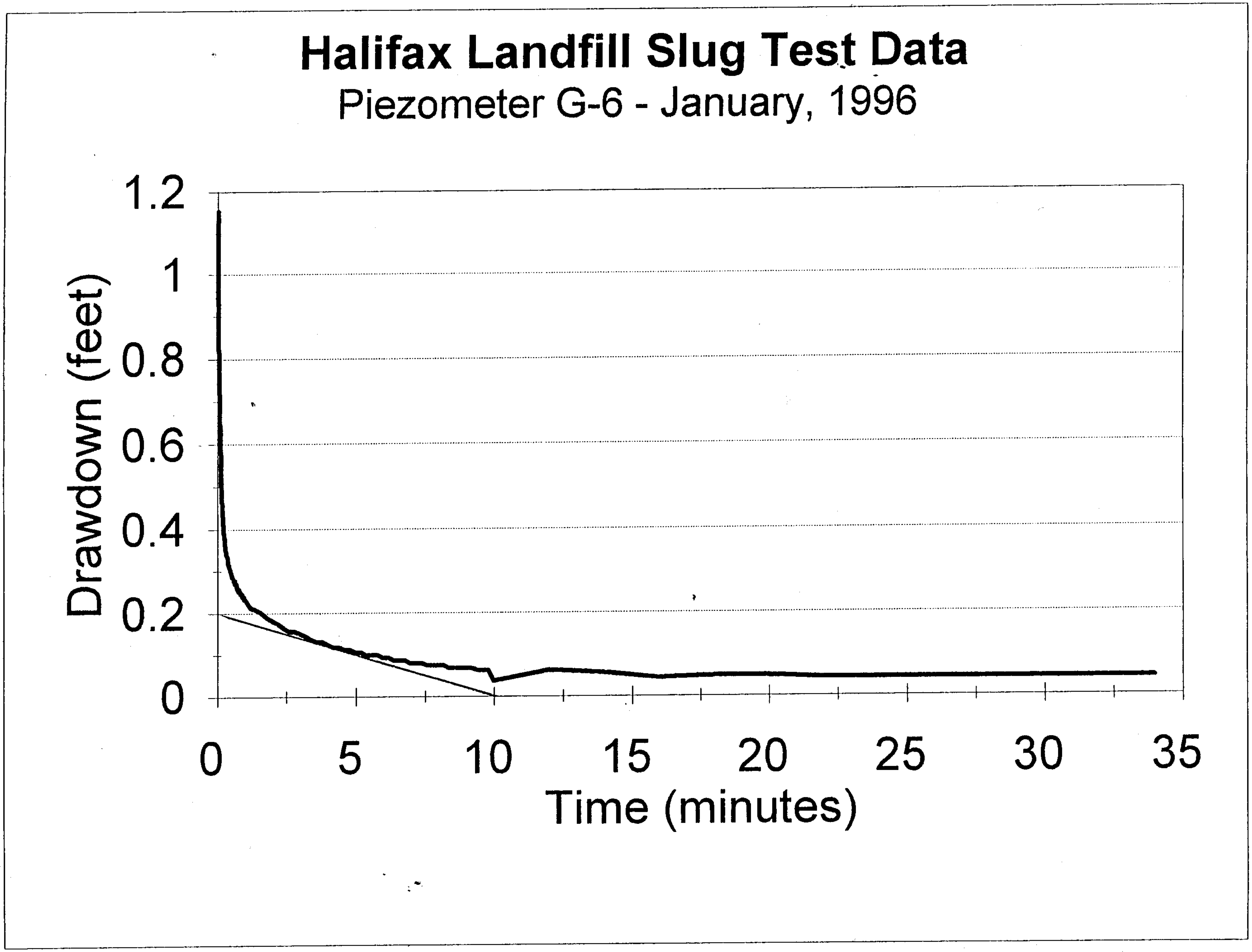
ln Re/Rw= 3.5120433 exp-1

ln Re/Rw= 0.2847345

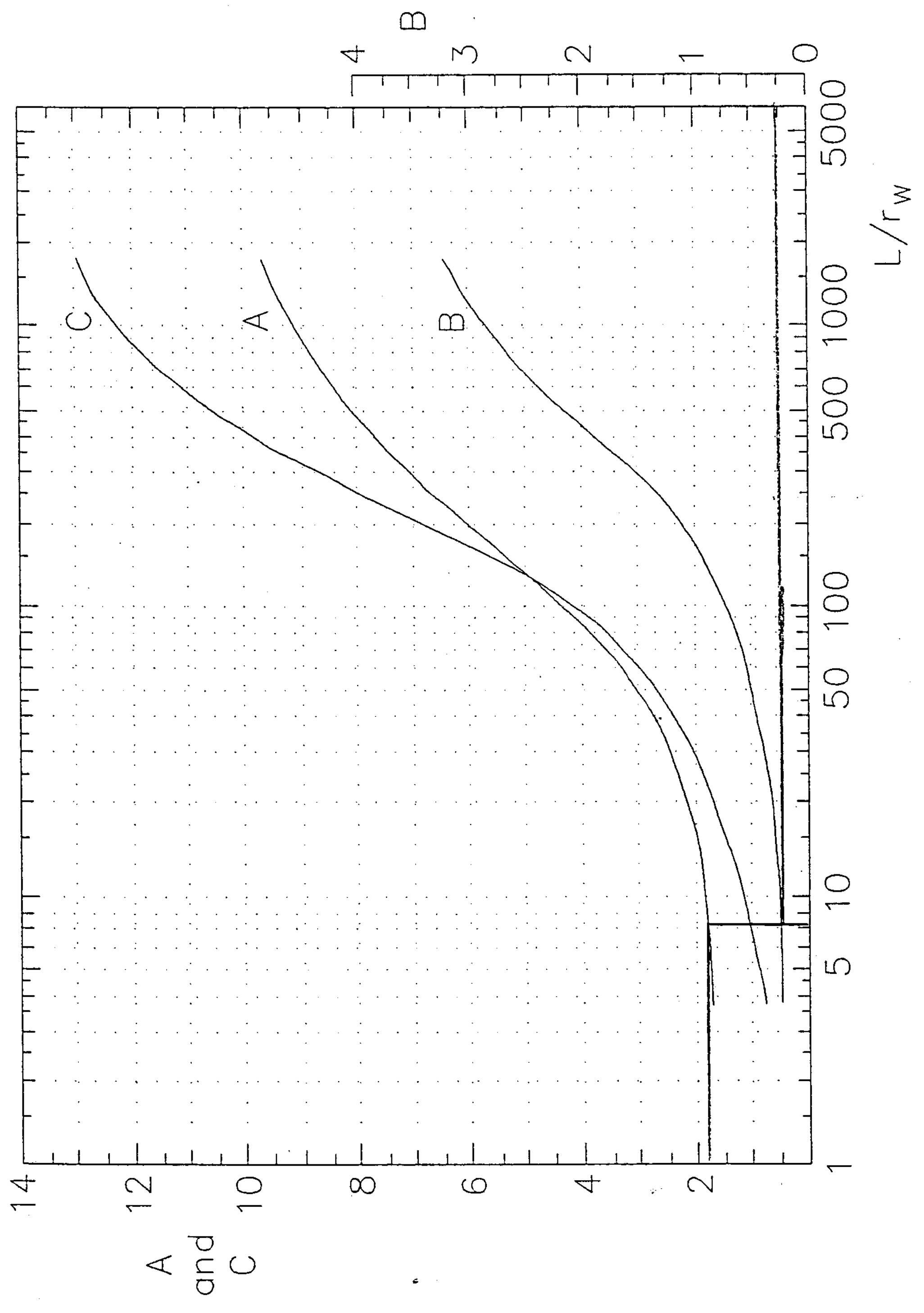
K = (Req) exp2 ln(Re/Rw)1/Tt ln(Yo/Yt) /2Le

K = 0.000238 Ft/Min or 0.000121 CM/Sec

K = 0.342106 Ft/Day



Halifax Landfill Slug Test Data
Piezometer G-6 - January, 1996
Drawdown (feet)
1.2
1
0.8
0.6
0.4
0.2
0
0
5
10
15
20
25
30
35
Time (minutes)



Curves relating coefficients A, B, and C to L/r_w

FROM: BOUWER, H. AND RICE, R.C., 1976: A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS.

G.N. RICHARDSON & ASSOC.
417 N. BOYLAN AVENUE
RALEIGH N.C. 27603
919-828-0577

COEFFICIENT CURVE MATCHPOINT
RISING HEAD AQUIFER TEST
Halifax Landfill
G-6

SE1000C
Environmental Logger
01/24 20:52

Halifax G-6 Slug Test

Setups:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	00001

Reference	0.000
Linearity	0.120
Scale factor	20.020
Offset	-0.020
Delay mSEC	50.000

Step 0 01/24 09:42:51

Elapsed Time	INPUT 1
0.0000	0.012
0.0033	0.012
0.0066	0.006
0.0100	0.006
0.0133	0.063
0.0166	1.741
0.0200	0.025
0.0233	1.154
0.0266	1.103
0.0300	1.003
0.0333	0.996
0.0366	0.996
0.0400	0.996
0.0433	0.952
0.0466	0.933
0.0500	0.921
0.0533	0.883
0.0566	0.902
0.0600	0.870
0.0633	0.851
0.0666	0.826
0.0700	0.813
0.0733	0.801
0.0766	0.794
0.0800	0.782
0.0833	0.750
0.0866	0.738
0.0900	0.725
0.0933	0.712
0.0966	0.706
0.1000	0.687
0.1033	0.681

0.1066	0.656
0.1100	0.649
0.1133	0.643
0.1166	0.624
0.1200	0.624
0.1233	0.611
0.1266	0.599
0.1300	0.586
0.1333	0.586
0.1366	0.567
0.1400	0.561
0.1433	0.542
0.1466	0.529
0.1500	0.517
0.1533	0.517
0.1566	0.504
0.1600	0.517
0.1633	0.492
0.1666	0.504
0.1700	0.485
0.1733	0.479
0.1766	0.473
0.1800	0.466
0.1833	0.460
0.1866	0.460
0.1900	0.447
0.1933	0.447
0.1966	0.435
0.2000	0.435
0.2033	0.428
0.2066	0.428
0.2100	0.422
0.2133	0.422
0.2166	0.416
0.2200	0.416
0.2233	0.410
0.2266	0.410
0.2300	0.403
0.2333	0.403
0.2366	0.403
0.2400	0.403
0.2433	0.403
0.2466	0.391
0.2500	0.391
0.2533	0.391
0.2566	0.391
0.2600	0.384
0.2633	0.384
0.2666	0.384
0.2700	0.378

Halifax G-6 Slug Test Data Page 3

0.2733	0.378
0.2766	0.372
0.2800	0.372
0.2833	0.372
0.2866	0.365
0.2900	0.365
0.2933	0.359
0.2966	0.359
0.3000	0.359
0.3033	0.359
0.3066	0.353
0.3100	0.353
0.3133	0.353
0.3166	0.346
0.3200	0.346
0.3233	0.346
0.3266	0.346
0.3300	0.346
0.3333	0.340
0.3500	0.340
0.3666	0.334
0.3833	0.328
0.4000	0.321
0.4166	0.315
0.4333	0.315
0.4500	0.309
0.4666	0.309
0.4833	0.302
0.5000	0.296
0.5166	0.296
0.5333	0.290
0.5500	0.283
0.5666	0.283
0.5833	0.283
0.6000	0.277
0.6166	0.277
0.6333	0.277
0.6500	0.271
0.6666	0.271
0.6833	0.271
0.7000	0.264
0.7166	0.264
0.7333	0.258
0.7500	0.258
0.7666	0.258
0.7833	0.252
0.8000	0.252
0.8166	0.252
0.8333	0.252
0.8500	0.246
0.8666	0.246

Halifax G-6 Slug Test Data Page 4

0.8833	0.246
0.9000	0.246
0.9166	0.239
0.9333	0.239
0.9500	0.239
0.9666	0.239
0.9833	0.233
1.0000	0.233
1.2000	0.214
1.4000	0.208
1.6000	0.201
1.8000	0.189
2.0000	0.182
2.2000	0.176
2.4000	0.164
2.6000	0.157
2.8000	0.157
3.0000	0.151
3.2000	0.145
3.4000	0.138
3.6000	0.132
3.8000	0.132
4.0000	0.126
4.2000	0.119
4.4000	0.119
4.6000	0.113
4.8000	0.113
5.0000	0.107
5.2000	0.107
5.4000	0.100
5.6000	0.100
5.8000	0.100
6.0000	0.094
6.2000	0.094
6.4000	0.088
6.6000	0.088
6.8000	0.088
7.0000	0.081
7.2000	0.081

Halifax G-6 Slug Test Data Page 5

7.4000	0.081
7.6000	0.075
7.8000	0.075
8.0000	0.075
8.2000	0.075
8.4000	0.069
8.6000	0.069
8.8000	0.069
9.0000	0.069
9.2000	0.069
9.4000	0.063
9.6000	0.063
9.8000	0.063
10.0000	0.037
12.0000	0.063
14.0000	0.056
16.0000	0.044
18.0000	0.050
20.0000	0.050
22.0000	0.044
24.0000	0.044
26.0000	0.044
28.0000	0.044
30.0000	0.044
32.0000	0.044
34.0000	0.044

G. N. Richardson and Associates

Client:	Halifax County	**Proj. No.**	Halifax-4
		Sheet:	1/1
Project:	Halifax County Landfill	**Date:**	1/96
		Well:	G-7
		Reference:	Bouwer, 1989

ln[Re/Rw] = [1.1/ln(Lw/Rw) + A + Bln[(H-Lw)/Rw]/Le/Rw] exp -1

Where:		
	Lw = Height of Water Column in Well =	14.6
	Le = Screened Interval Open to Aquifer =	10
	Rw = Radius of Well Including Sand Pack =	0.43
	Rc = Radius of Well Casing =	0.083
	H = Aquifer Thickness to First Aquitard =	30
	Yo = Relative Height of Water at Time Zero	1
	Yt = Relative Height of Water at Time t =	0.5
	n = Porosity =	0.15
	Time Tt (in minutes) =	2.5
	H - Lw =	15.4
	Yo/Yt =	2
	Lw/Rw =	33.9534884
	ln(H-Lw)/Rw =	3.57833758

Correction for Sandpack:

Req = [Rc exp2 + n(Rw exp2 + Rc exp2)] exp1/2

Req = 1

Req = 1

Evaluation of A and B:

Le/Rw = 23.25581

From Attached Graph of A and B:

A =	2.3
B =	0.3

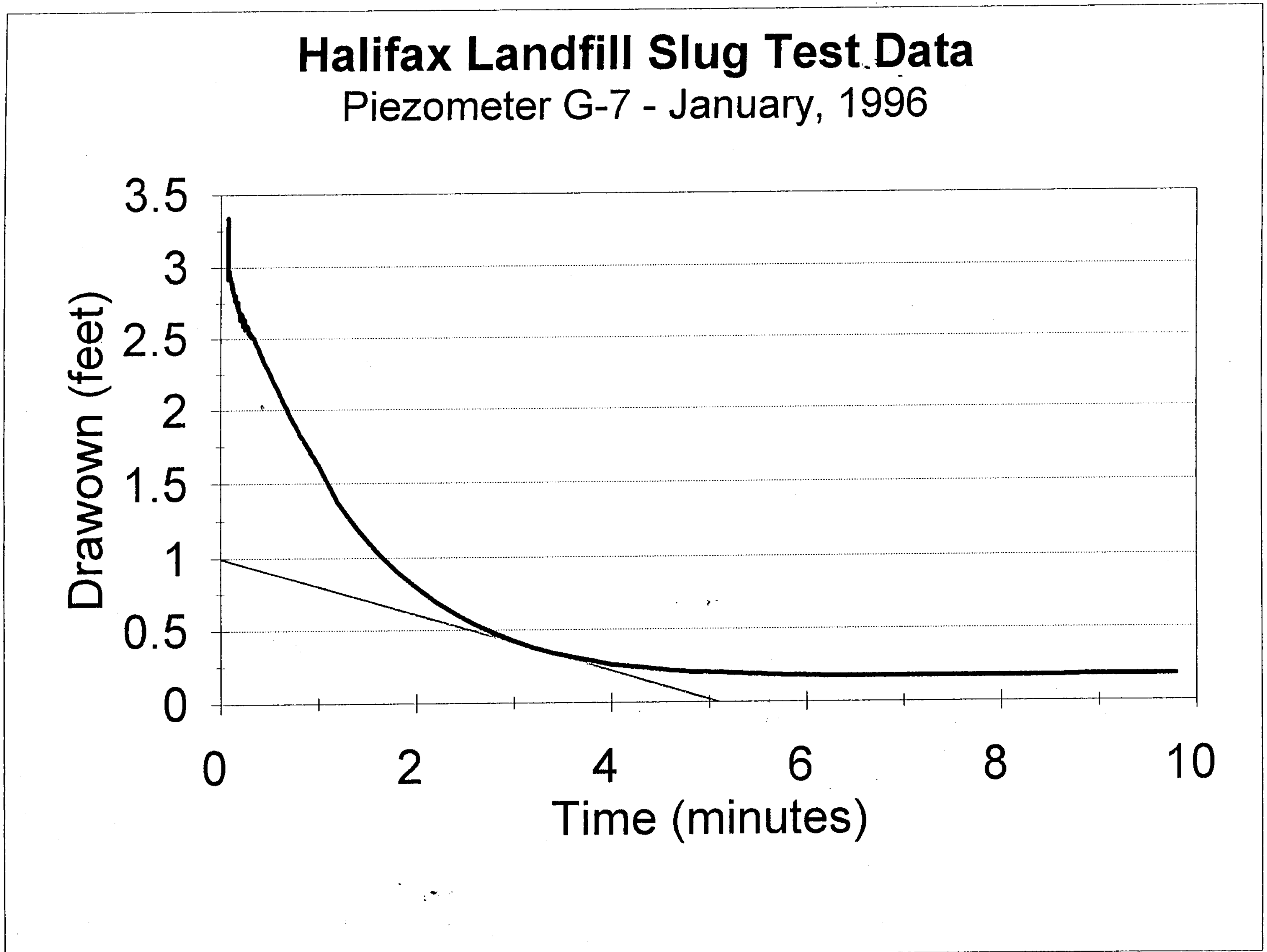
ln Re/Rw = [1.1/ln Lw/Rw + A + B ln[(H-Lw)/Rw] / Le/Rw] exp-1

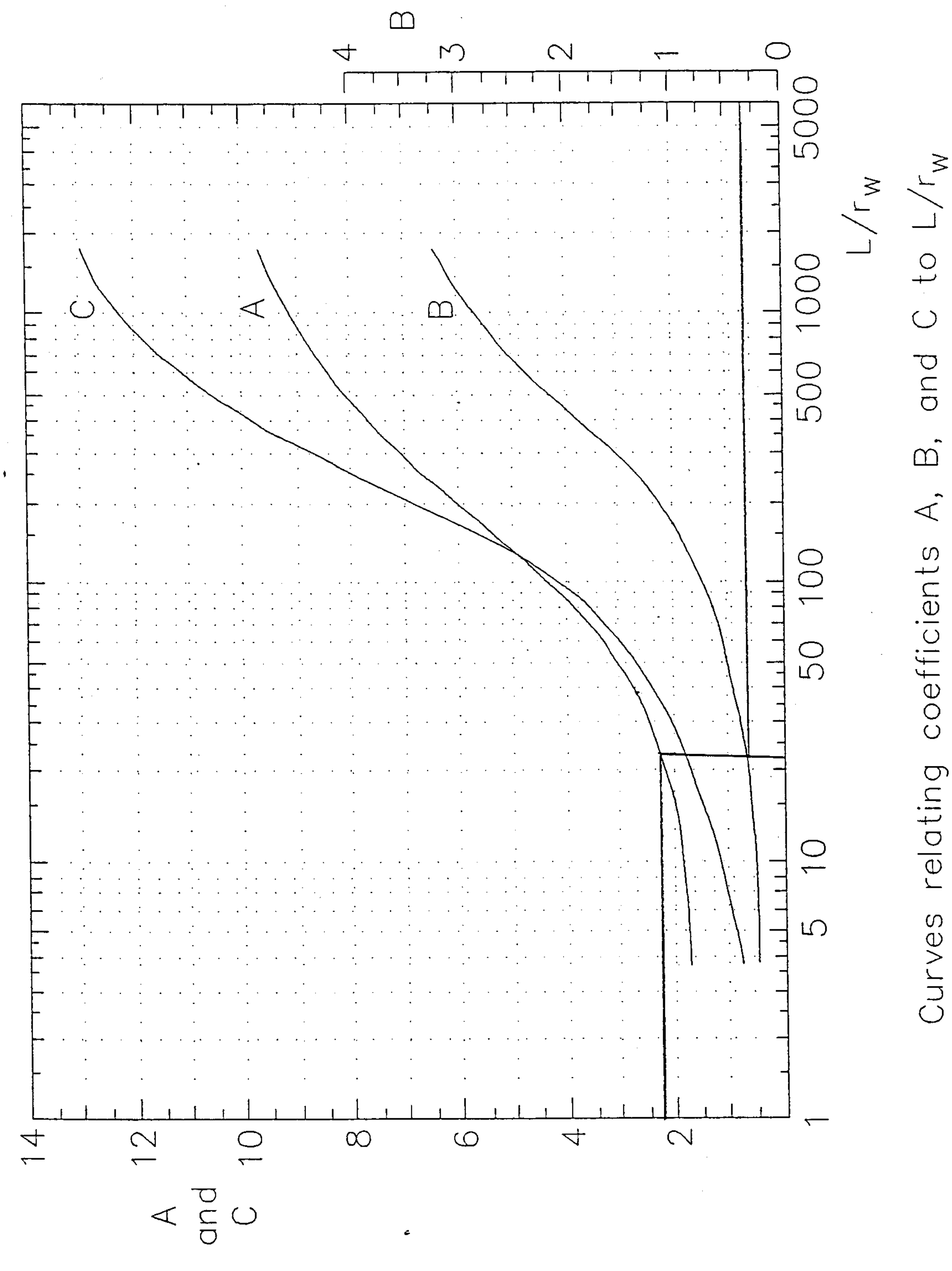
ln Re/Rw= 2.658218 exp-1

ln Re/Rw= 0.3761919

K = (Req) exp2 ln(Re/Rw)1/Tt ln(Yo/Yt) /2Le

K =	0.005215 Ft/Min	or	0.002649	CM/Sec
K =	7.509782 Ft/Day			


Halifax Landfill Slug Test Data
Piezometer G-7 - January, 1996
Drawown (feet)
3.5
3
2.5
2
1.5
1
0.5
0
0
2
4
6
8
10
Time (minutes)



Curves relating coefficients A, B, and C to L/r_w

FROM: BOUWER, H. AND RICE, R.C., 1976: A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS.

G.N. RICHARDSON & ASSOC.
417 N. BOYLAN AVENUE
RALEIGH N.C. 27603
919-828-0577

COEFFICIENT CURVE MATCHPOINT
RISING HEAD AQUIFER TEST
Halifax Landfill
G-7

Halifax G-7 Slug Test Data
SE1000C
Environmental Logger
01/26 08:59

Unit# 00069 Test 3

Setups:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	00001

Reference	0.000
Linearity	0.120
Scale factor	20.020
Offset	-0.020
Delay mSEC	50.000

Step 0 01/25 11:43:03

Elapsed Time	INPUT 1
0.0000	0.063
0.0033	0.063
0.0066	0.063
0.0100	0.063
0.0133	0.063
0.0166	0.063
0.0200	0.063
0.0233	0.031
0.0266	0.202
0.0300	0.949
0.0333	0.968
0.0366	1.430
0.0400	3.081
0.0433	3.643
0.0466	3.953
0.0500	2.866
0.0533	2.916
0.0566	2.189
0.0600	0.031
0.0633	0.879
0.0666	0.904
0.0700	5.205
0.0733	3.757
0.0766	2.024
0.0800	3.340
0.0833	2.916
0.0866	2.967
0.0900	2.954
0.0933	2.973

Halifax G-7 Slug Test Data
Page 2

Elapsed Time	INPUT 1
0.0966	2.929
0.1000	2.916
0.1033	2.910
0.1066	2.903
0.1100	2.897
0.1133	2.891
0.1166	2.878
0.1200	2.859
0.1233	2.853
0.1266	2.885
0.1300	2.828
0.1333	2.828
0.1366	2.821
0.1400	2.821
0.1433	2.809
0.1466	2.802
0.1500	2.790
0.1533	2.771
0.1566	2.802
0.1600	2.758
0.1633	2.758
0.1666	2.758
0.1700	2.752
0.1733	2.745
0.1766	2.739
0.1800	2.720
0.1833	2.758
0.1866	2.745
0.1900	2.701
0.1933	2.695
0.1966	2.695
0.2000	2.688
0.2033	2.670
0.2066	2.638
0.2100	2.632
0.2133	2.663
0.2166	2.638
0.2200	2.663
0.2233	2.676
0.2266	2.657
0.2300	2.644
0.2333	2.594
0.2366	2.606
0.2400	2.644
0.2433	2.625
0.2466	2.619
0.2500	2.625

Halifax G-7 Slug Test Data
Page 3

Elapsed Time	INPUT 1
------------	---------
0.2533	2.632
0.2566	2.600
0.2600	2.581
0.2633	2.568
0.2666	2.575
0.2700	2.575
0.2733	2.575
0.2766	2.587
0.2800	2.594
0.2833	2.587
0.2866	2.581
0.2900	2.543
0.2933	2.543
0.2966	2.543
0.3000	2.537
0.3033	2.537
0.3066	2.543
0.3100	2.543
0.3133	2.524
0.3166	2.518
0.3200	2.524
0.3233	2.524
0.3266	2.518
0.3300	2.511
0.3333	2.511
0.3500	2.499
0.3666	2.473
0.3833	2.448
0.4000	2.423
0.4166	2.391
0.4333	2.366
0.4500	2.341
0.4666	2.315
0.4833	2.290
0.5000	2.271
0.5166	2.246
0.5333	2.220
0.5500	2.195
0.5666	2.176
0.5833	2.151
0.6000	2.125
0.6166	2.100
0.6333	2.075
0.6500	2.056
0.6666	2.031
0.6833	2.005

Halifax G-7 Slug Test Data
Page 4

Elapsed Time	INPUT 1
0.7000	1.986
0.7166	1.961
0.7333	1.942
0.7500	1.917
0.7666	1.898
0.7833	1.879
0.8000	1.853
0.8166	1.835
0.8333	1.816
0.8500	1.797
0.8666	1.778
0.8833	1.759
0.9000	1.740
0.9166	1.721
0.9333	1.702
0.9500	1.683
0.9666	1.664
0.9833	1.645
1.0000	1.626
1.2000	1.373
1.4000	1.196
1.6000	1.044
1.8000	0.911
2.0000	0.797
2.2000	0.696
2.4000	0.613
2.6000	0.537
2.8000	0.480
3.0000	0.423
3.2000	0.379
3.4000	0.341
3.6000	0.310
3.8000	0.284
4.0000	0.259
4.2000	0.246
4.4000	0.234
4.6000	0.215
4.8000	0.208
5.0000	0.202
5.2000	0.196
5.4000	0.189
5.6000	0.183
5.8000	0.177
6.0000	0.177
6.2000	0.170

Halifax G-7 Slug Test Data
Page 5

Elapsed Time	INPUT 1
6.4000	0.170
6.6000	0.170
6.8000	0.170
7.0000	0.170
7.2000	0.170
7.4000	0.170
7.6000	0.170
7.8000	0.170
8.0000	0.170
8.2000	0.170
8.4000	0.170
8.6000	0.170
8.8000	0.177
9.0000	0.177
9.2000	0.177
9.4000	0.177
9.6000	0.177
9.8000	0.177
10.0000	0.177
12.0000	0.189
14.0000	0.196
16.0000	0.202
18.0000	0.202
20.0000	0.202
22.0000	0.202
24.0000	0.208
26.0000	0.208
28.0000	0.208
30.0000	0.208
32.0000	0.208
34.0000	0.215
36.0000	0.215
38.0000	0.208

G. N. Richardson and Associates

Client: Halifax County

Project: Halifax County Landfill

Proj. No. Halifax-4
Sheet: 1/1
Date: 1/96
Well: G-8
Reference: Bouwer, 1989

ln[Re/Rw] = [1.1/ln(Lw/Rw) + A + Bln[(H-Lw)/Rw]/Le/Rw] exp -1

Where:

Lw = Height of Water Column in Well =	8.18
Le = Screened Interval Open to Aquifer =	8.18
Rw = Radius of Well Including Sand Pack =	0.43
Rc = Radius of Well Casing =	0.083
H = Aquifer Thickness to First Aquitard =	35
Yo = Relative Height of Water at Time Zero	1.25
Yt = Relative Height of Water at Time t =	0.65
n = Porosity =	0.15
Time Tt (in minutes) =	0.5
H - Lw =	26.82
Yo/Yt =	1.9230769
Lw/Rw =	19.023256
ln(H-Lw)/Rw =	4.1331179

Correction for Sandpack:

Req = [Rc exp2 + n(Rw exp2 + Rc exp2)] exp1/2

Req = 0.035657

Req = 0.188832

Evaluation of A and B:

Le/Rw = 19.02326

From Attached Graph of A and B:

A =	2.1
B =	0.3

ln Re/Rw = [1.1/ln Lw/Rw + A + B ln[(H-Lw)/Rw] / Le/Rw] exp-1

ln Re/Rw= 2.5386104 exp-1

ln Re/Rw= 0.3939163

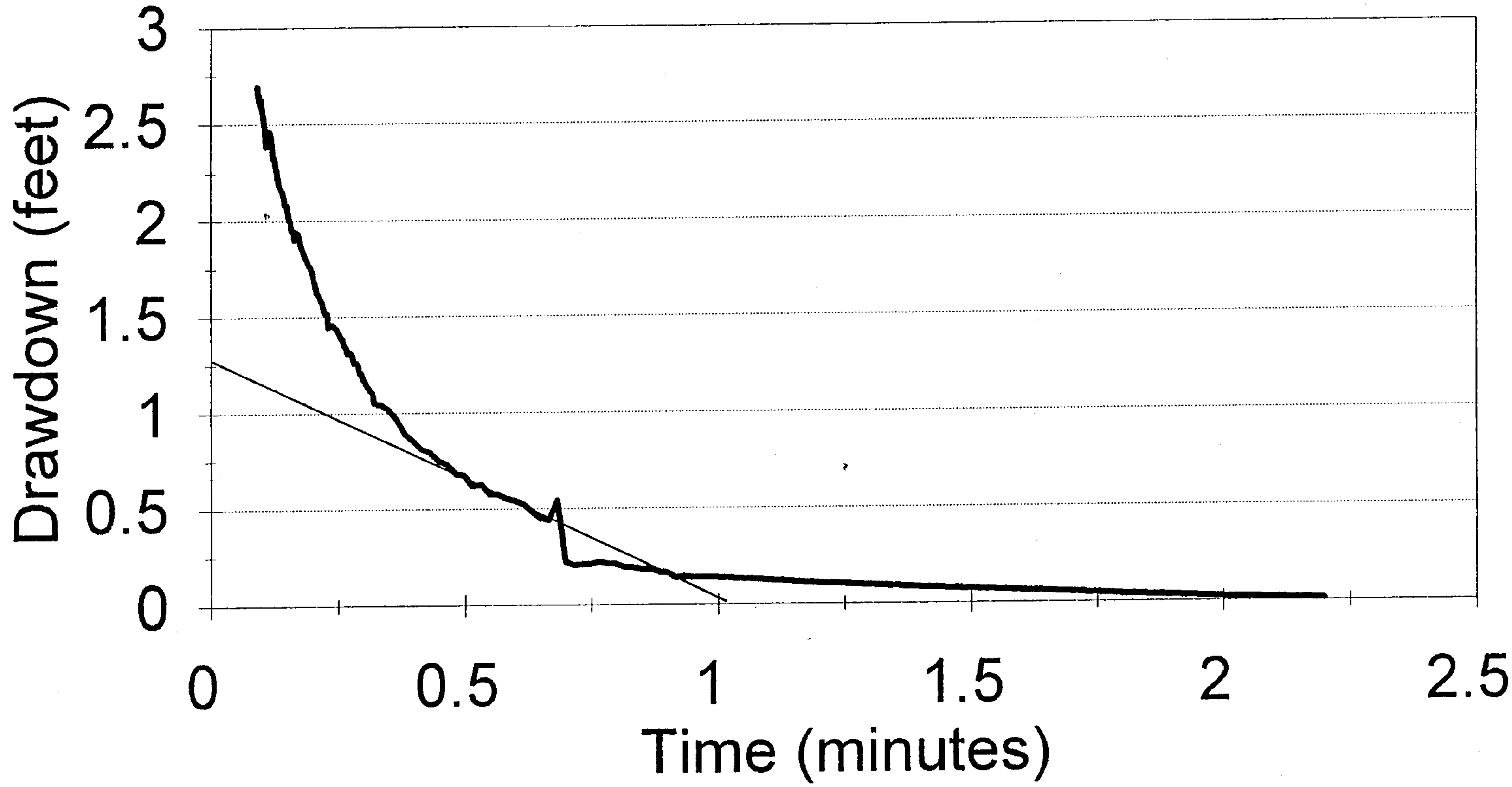
K = (Req) exp2 ln(Re/Rw)1/Tt ln(Yo/Yt) /2Le

K = 0.001123 Ft/Min or 0.00057 CM/Sec

K = 1.61693 Ft/Day

Halifax Landfill Slug Test Data

Piezometer G-8- January, 1996



Halifax G-8 Slug Test Data - 1st Test

SE1000C

Environmental Logger

01/26 08:51

Unit# 00069 Test 0

Setups:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	00001

Reference	0.000
Linearity	0.120
Scale factor	20.020
Offset	-0.020
Delay mSEC	50.000

Step 0 01/25 08:42:19

Elapsed Time	INPUT 1
0.0000	0.006
0.0033	0.006
0.0066	0.006
0.0100	0.006
0.0133	0.006
0.0166	0.006
0.0200	0.006
0.0233	0.006
0.0266	-0.050
0.0300	-0.044
0.0333	-0.037
0.0366	0.037
0.0400	0.454
0.0433	0.859
0.0466	1.250
0.0500	1.193
0.0533	2.305
0.0566	1.932
0.0600	2.046
0.0633	1.774
0.0666	1.515
0.0700	1.313
0.0733	1.345
0.0766	2.027
0.0800	1.964
0.0833	2.292
0.0866	2.848
0.0900	2.671
0.0933	2.696

Halifax G-8 Slug Test Data - 1st Test
Page 2

Elapsed Time	INPUT 1
0.0966	2.608
0.1000	2.627
0.1033	2.551
0.1066	2.488
0.1100	2.387
0.1133	2.450
0.1166	2.463
0.1200	2.425
0.1233	2.330
0.1266	2.330
0.1300	2.279
0.1333	2.223
0.1366	2.185
0.1400	2.166
0.1433	2.141
0.1466	2.084
0.1500	2.084
0.1533	2.021
0.1566	2.002
0.1600	1.951
0.1633	1.945
0.1666	1.901
0.1700	1.939
0.1733	1.932
0.1766	1.888
0.1800	1.863
0.1833	1.844
0.1866	1.812
0.1900	1.787
0.1933	1.768
0.1966	1.762
0.2000	1.730
0.2033	1.692
0.2066	1.654
0.2100	1.623
0.2133	1.610
0.2166	1.591
0.2200	1.572
0.2233	1.541
0.2266	1.515
0.2300	1.522
0.2333	1.446
0.2366	1.459
0.2400	1.459
0.2433	1.446
0.2466	1.440
0.2500	1.421
0.2533	1.414
0.2566	1.389

Halifax G-8 Slug Test Data - 1st Test
Page 3

Elapsed Time	INPUT 1
0.2600	1.383
0.2633	1.351
0.2666	1.345
0.2700	1.313
0.2733	1.320
0.2766	1.313
0.2800	1.301
0.2833	1.263
0.2866	1.263
0.2900	1.250
0.2933	1.212
0.2966	1.212
0.3000	1.174
0.3033	1.168
0.3066	1.149
0.3100	1.136
0.3133	1.118
0.3166	1.111
0.3200	1.105
0.3233	1.054
0.3266	1.054
0.3300	1.048
0.3333	1.048
0.3500	1.023
0.3666	0.966
0.3833	0.890
0.4000	0.852
0.4166	0.814
0.4333	0.795
0.4500	0.751
0.4666	0.732
0.4833	0.682
0.5000	0.675
0.5166	0.619
0.5333	0.625
0.5500	0.574
0.5666	0.574
0.5833	0.555
0.6000	0.543
0.6166	0.524
0.6333	0.486
0.6500	0.448
0.6666	0.442
0.6833	0.543
0.7000	0.221
0.7166	0.202
0.7333	0.208

Halifax G-8 Slug Test Data - 1st Test
Page 4

Elapsed Time	INPUT 1
0.7500	0.208
0.7666	0.221
0.7833	0.208
0.8000	0.208
0.8166	0.189
0.8333	0.189
0.8500	0.183
0.8666	0.183
0.8833	0.170
0.9000	0.164
0.9166	0.139
0.9333	0.145
0.9500	0.139
0.9666	0.139
0.9833	0.139
1.0000	0.139
1.2000	0.107
1.4000	0.082
1.6000	0.063
1.8000	0.044
2.0000	0.025
2.2000	0.012
2.4000	-0.006
2.6000	-0.018
2.8000	-0.025
3.0000	-0.037
3.2000	-0.050
3.4000	-0.056
3.6000	-0.063
3.8000	-0.069
4.0000	-0.075
4.2000	-0.082
4.4000	-0.082
4.6000	-0.088
4.8000	-0.088
5.0000	-0.088
5.2000	-0.094
5.4000	-0.094

Halifax G-8 Slug Test Data - 1st Test
Page 5

Elapsed Time	INPUT 1
------------	---------
5.6000	-0.094
5.8000	-0.094
6.0000	-0.094
6.2000	-0.094
6.4000	-0.094
6.6000	-0.094
6.8000	-0.094
7.0000	-0.094
7.2000	-0.088
7.4000	-0.088
7.6000	-0.088
7.8000	-0.088
8.0000	-0.082
8.2000	-0.082
8.4000	-0.082
8.6000	-0.082
8.8000	-0.082
9.0000	-0.075
9.2000	-0.075
9.4000	-0.075
9.6000	-0.075
9.8000	-0.075
10.0000	-0.075
12.0000	-0.063

G. N. Richardson and Associates

Client:	Halifax County	**Proj. No.**	Halifax-4
		Sheet:	1/1
Project:	Halifax County Landfill	**Date:**	1/96
		Well:	G-8 2nd test
		Reference:	Bouwer, 1989

ln[Re/Rw] = [1.1/ln(Lw/Rw) + A + Bln[(H-Lw)/Rw]/Le/Rw] exp -1

Where:

Lw = Height of Water Column in Well =	8.18
Le = Screened Interval Open to Aquifer =	8.18
Rw = Radius of Well Including Sand Pack =	0.43
Rc = Radius of Well Casing =	0.083
H = Aquifer Thickness to First Aquitard =	35
Yo = Relative Height of Water at Time Zero	0.45
Yt = Relative Height of Water at Time t =	0.2
n = Porosity =	0.15
Time Tt (in minutes) =	2
H - Lw =	26.82
Yo/Yt =	2.25
Lw/Rw =	19.0232558
ln(H-Lw)/Rw =	4.13311795

Correction for Sandpack:

Req = [Rc exp2 + n(Rw exp2 + Rc exp2)] exp1/2

Req = 0.035657

Req = 0.188832

Evaluation of A and B:

Le/Rw = 19.02326

From Attached Graph of A and B:

A = 2.1

B = 0.3

ln Re/Rw = [1.1/ln Lw/Rw + A + B ln[(H-Lw)/Rw] / Le/Rw] exp-1

ln Re/Rw= 2.5386104 exp-1

ln Re/Rw= 0.3939163

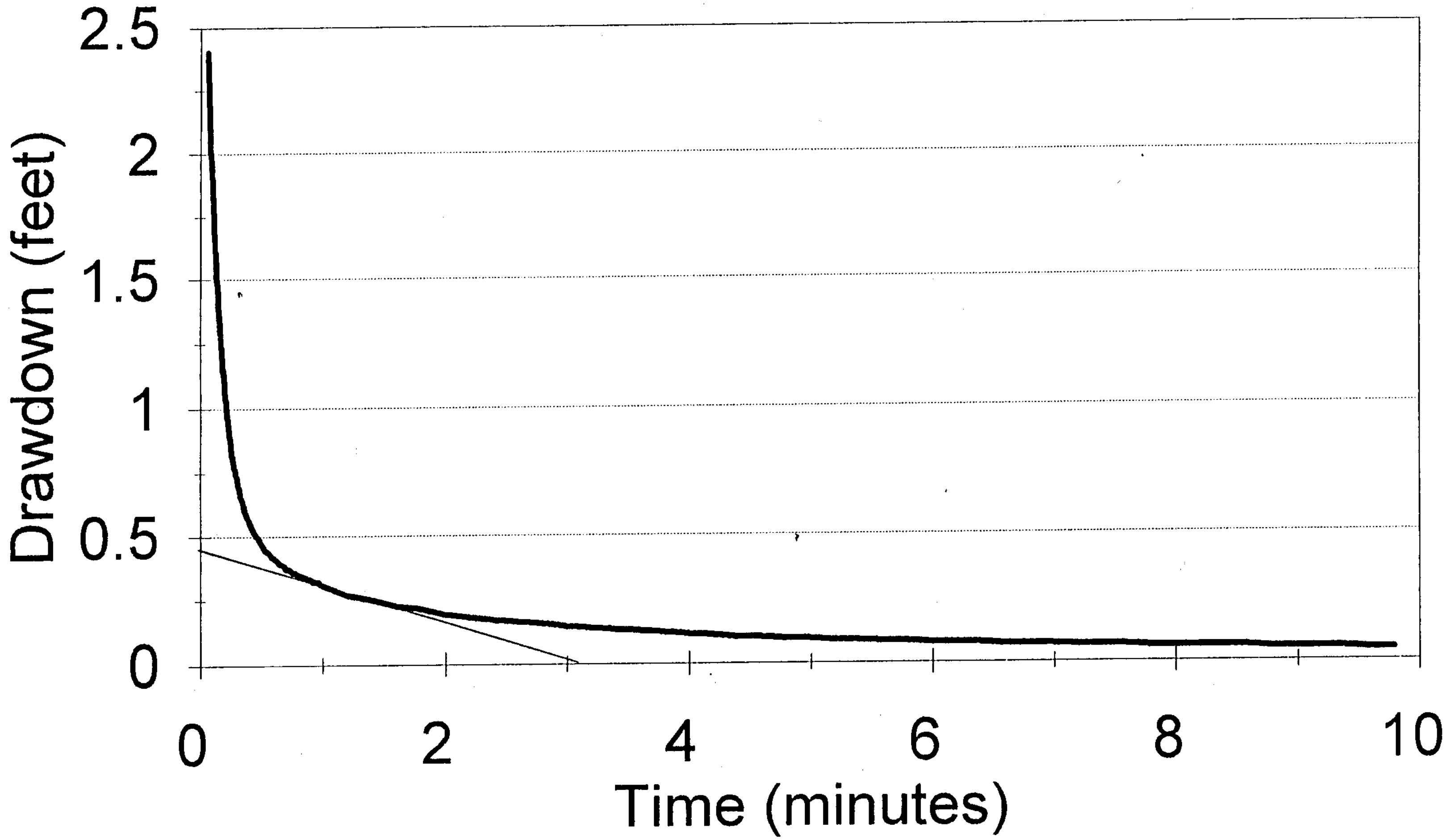
K = (Req) exp2 ln(Re/Rw)1/Tt ln(Yo/Yt) /2Le

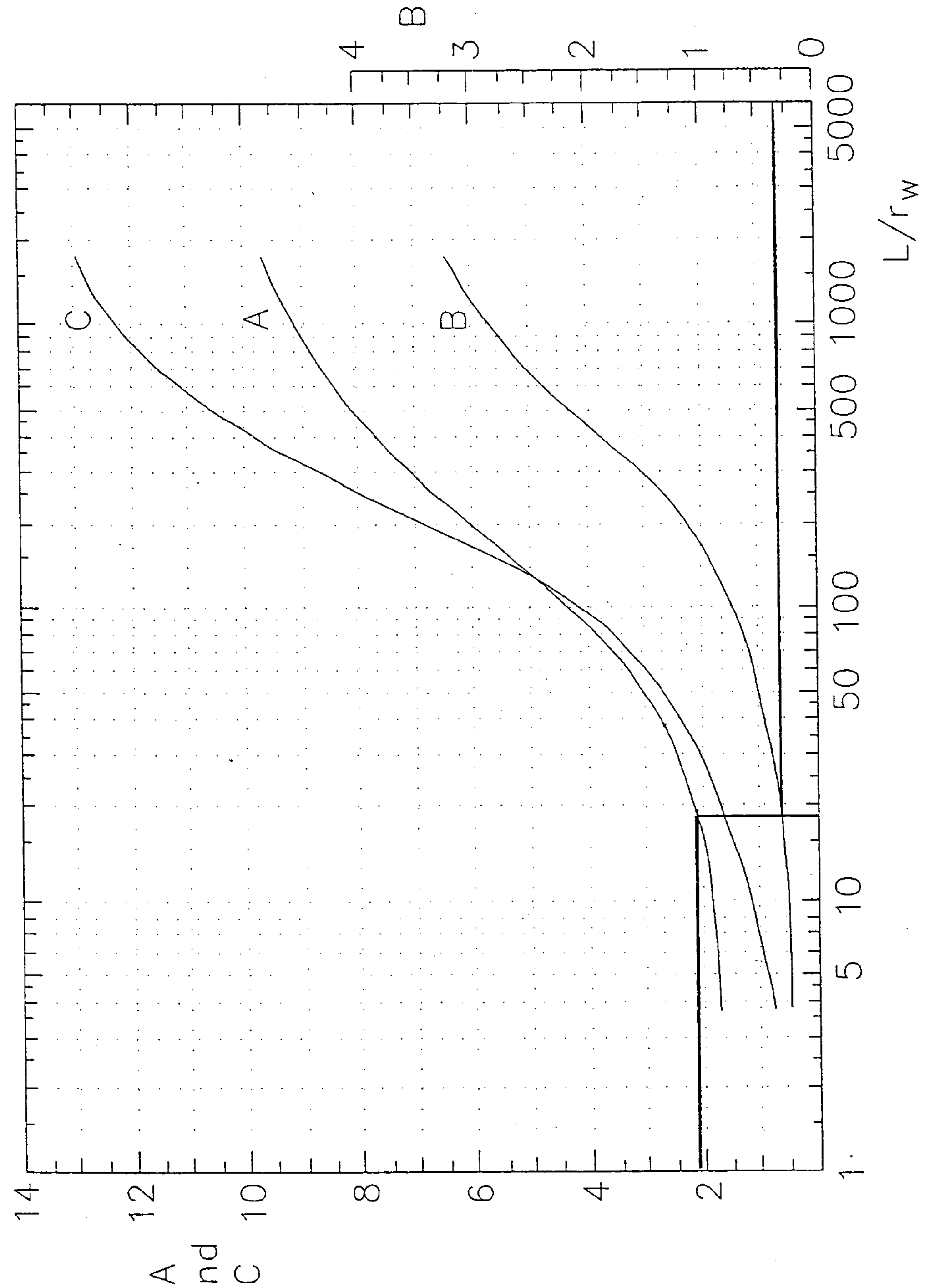
K = 0.000348 Ft/Min or 0.000177 CM/Sec

K = 0.501286 Ft/Day

Halifax Landfill Slug Test Data

Piezometer G-8, 2nd test - Jan., 1996





Curves relating coefficients A, B, and C to L/r_w

FROM: BOUWER, H. AND RICE, R.C., 1976: A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS.

G.N. RICHARDSON & ASSOC.
417 N. BOYLAN AVENUE
RALEIGH N.C. 27603
919-828-0577

COEFFICIENT CURVE MATCHPOINT
RISING HEAD AQUIFER TEST
Halifax Landfill
G-8 (2nd test)

Halifax G-8 Slug Test Data - 2nd Test

SE1000C

Environmental Logger

01/26 08:54

Unit# 00069 Test 1

Setups:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	00001

Reference	0.000
Linearity	0.120
Scale factor	20.020
Offset	-0.020
Delay mSEC	50.000

Step 0 01/25 09:06:12

Elapsed Time	INPUT 1
0.0000	0.006
0.0033	0.006
0.0066	0.000
0.0100	0.006
0.0133	0.006
0.0166	0.006
0.0200	0.006
0.0233	0.006
0.0266	0.006
0.0300	0.006
0.0333	0.006
0.0366	0.006
0.0400	0.006
0.0433	0.006
0.0466	0.006
0.0500	0.012
0.0533	1.584
0.0566	2.587
0.0600	2.448
0.0633	0.751
0.0666	2.032
0.0700	2.404
0.0733	2.246
0.0766	2.221
0.0800	2.164
0.0833	2.127
0.0866	2.076
0.0900	2.019
0.0933	1.975

Halifax G-8 Slug Test Data - 2nd Test
Page 2

Elapsed Time	INPUT 1
0.0966	1.956
0.1000	1.918
0.1033	1.887
0.1066	1.849
0.1100	1.779
0.1133	1.779
0.1166	1.748
0.1200	1.697
0.1233	1.647
0.1266	1.622
0.1300	1.603
0.1333	1.590
0.1366	1.559
0.1400	1.502
0.1433	1.477
0.1466	1.464
0.1500	1.445
0.1533	1.401
0.1566	1.350
0.1600	1.338
0.1633	1.344
0.1666	1.306
0.1700	1.275
0.1733	1.243
0.1766	1.237
0.1800	1.212
0.1833	1.186
0.1866	1.148
0.1900	1.155
0.1933	1.129
0.1966	1.123
0.2000	1.098
0.2033	1.066
0.2066	1.047
0.2100	1.041
0.2133	1.022
0.2166	0.997
0.2200	0.984
0.2233	0.965
0.2266	0.953
0.2300	0.940
0.2333	0.934
0.2366	0.921
0.2400	0.909
0.2433	0.896
0.2466	0.877
0.2500	0.871

Halifax G-8 Slug Test Data - 2nd Test
Page 3

Elapsed Time	INPUT 1
0.2533	0.858
0.2566	0.845
0.2600	0.833
0.2633	0.820
0.2666	0.814
0.2700	0.801
0.2733	0.795
0.2766	0.789
0.2800	0.782
0.2833	0.770
0.2866	0.763
0.2900	0.751
0.2933	0.744
0.2966	0.738
0.3000	0.738
0.3033	0.725
0.3066	0.719
0.3100	0.713
0.3133	0.700
0.3166	0.694
0.3200	0.694
0.3233	0.681
0.3266	0.675
0.3300	0.669
0.3333	0.662
0.3500	0.631
0.3666	0.606
0.3833	0.580
0.4000	0.561
0.4166	0.542
0.4333	0.524
0.4500	0.511
0.4666	0.498
0.4833	0.486
0.5000	0.473
0.5166	0.460
0.5333	0.448
0.5500	0.441
0.5666	0.435
0.5833	0.422
0.6000	0.416
0.6166	0.410
0.6333	0.404
0.6500	0.397
0.6666	0.391
0.6833	0.385

Halifax G-8 Slug Test Data - 2nd Test
Page 4

Elapsed Time	INPUT 1
0.7000	0.378
0.7166	0.372
0.7333	0.372
0.7500	0.366
0.7666	0.359
0.7833	0.359
0.8000	0.353
0.8166	0.347
0.8333	0.347
0.8500	0.340
0.8666	0.340
0.8833	0.334
0.9000	0.334
0.9166	0.328
0.9333	0.321
0.9500	0.321
0.9666	0.321
0.9833	0.315
1.0000	0.309
1.2000	0.271
1.4000	0.252
1.6000	0.227
1.8000	0.214
2.0000	0.195
2.2000	0.183
2.4000	0.170
2.6000	0.164
2.8000	0.157
3.0000	0.145
3.2000	0.138
3.4000	0.132
3.6000	0.126
3.8000	0.119
4.0000	0.113
4.2000	0.107
4.4000	0.101
4.6000	0.101
4.8000	0.094
5.0000	0.094
5.2000	0.088
5.4000	0.088
5.6000	0.082
5.8000	0.082

Halifax G-8 Slug Test Data - 2nd Test
Page 5

Elapsed Time	INPUT 1
6.0000	0.075
6.2000	0.075
6.4000	0.075
6.6000	0.069
6.8000	0.069
7.0000	0.069
7.2000	0.063
7.4000	0.063
7.6000	0.063
7.8000	0.056
8.0000	0.056
8.2000	0.056
8.4000	0.056
8.6000	0.056
8.8000	0.050
9.0000	0.050
9.2000	0.050
9.4000	0.050
9.6000	0.044
9.8000	0.044
10.0000	0.044
12.0000	0.031
14.0000	0.031
16.0000	0.025
18.0000	0.018
20.0000	0.012
22.0000	0.012
24.0000	0.006
26.0000	0.006
28.0000	0.000
30.0000	-0.006

G. N. Richardson and Associates

Client:	Halifax County	**Proj. No.**	Halifax-4
		Sheet:	1/1
Project:	Halifax County Landfill	**Date:**	1/96
		Well:	G-9
		Reference:	Bouwer, 1989

ln[Re/Rw] = [1.1/ln(Lw/Rw) + A + Bln[(H-Lw)/Rw]/Le/Rw] exp -1

Where:

Lw = Height of Water Column in Well =	11.34
Le = Screened Interval Open to Aquifer =	10
Rw = Radius of Well Including Sand Pack =	0.43
Rc = Radius of Well Casing =	0.083
H = Aquifer Thickness to First Aquitard =	35
Yo = Relative Height of Water at Time Zero	1.75
Yt = Relative Height of Water at Time t =	0.5
n = Porosity =	0.15
Time Tt (in minutes) =	6
H - Lw =	23.66
Yo/Yt =	3.5
Lw/Rw =	26.372093
ln(H-Lw)/Rw =	4.00775593

Correction for Sandpack:

Req = [Rc exp2 + n(Rw exp2 + Rc exp2)] exp1/2

Req = 0.035657

Req = 0.188832

Evaluation of A and B:

Le/Rw = 23.25581

From Attached Graph of A and B:

A =	2.3
B =	0.3

ln Re/Rw = [1.1/ln Lw/Rw + A + B ln[(H-Lw)/Rw] / Le/Rw] exp-1

ln Re/Rw= 2.6878544 exp-1

ln Re/Rw= 0.372044

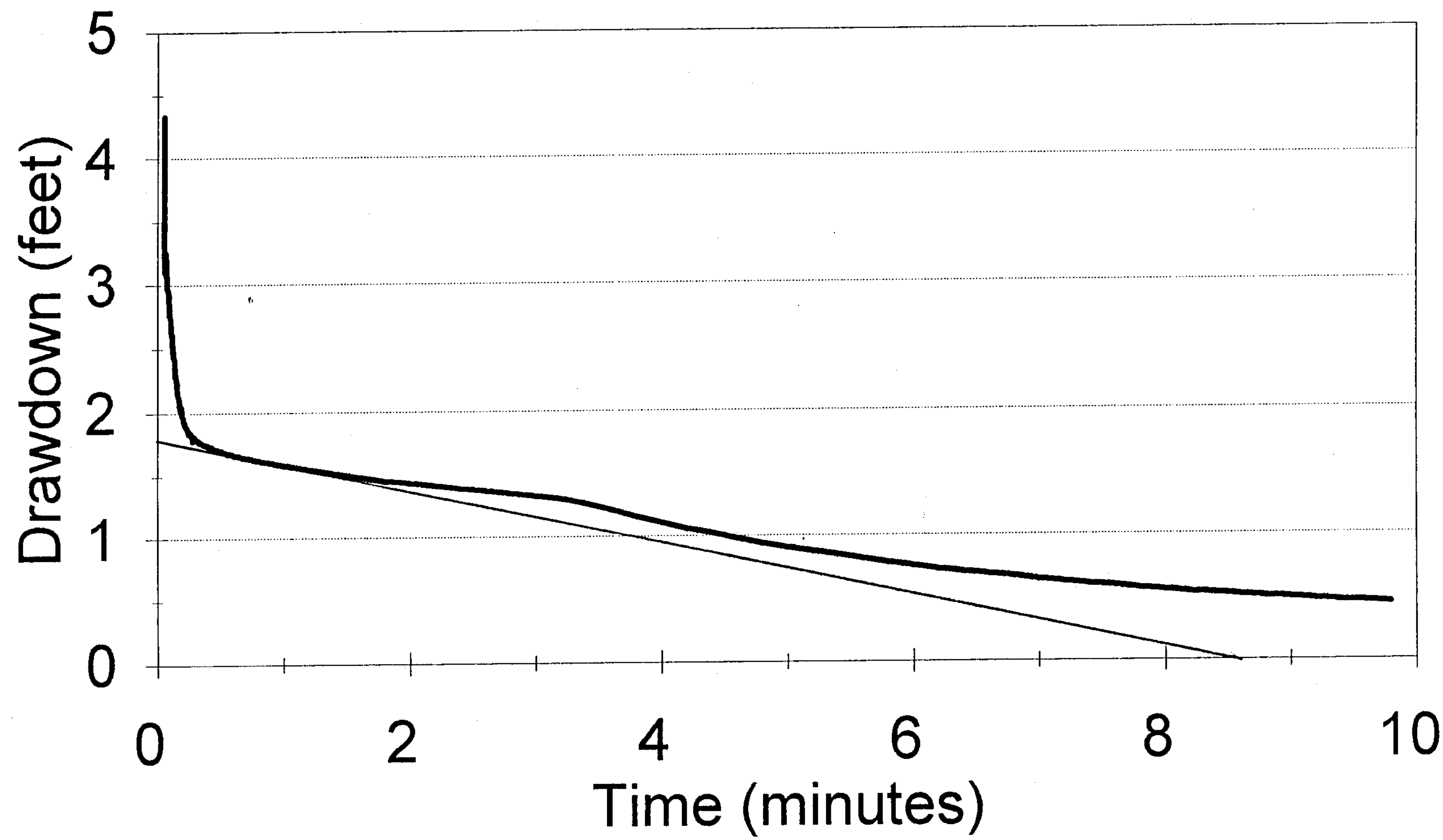
K = (Req) exp2 ln(Re/Rw)1/Tt ln(Yo/Yt) /2Le

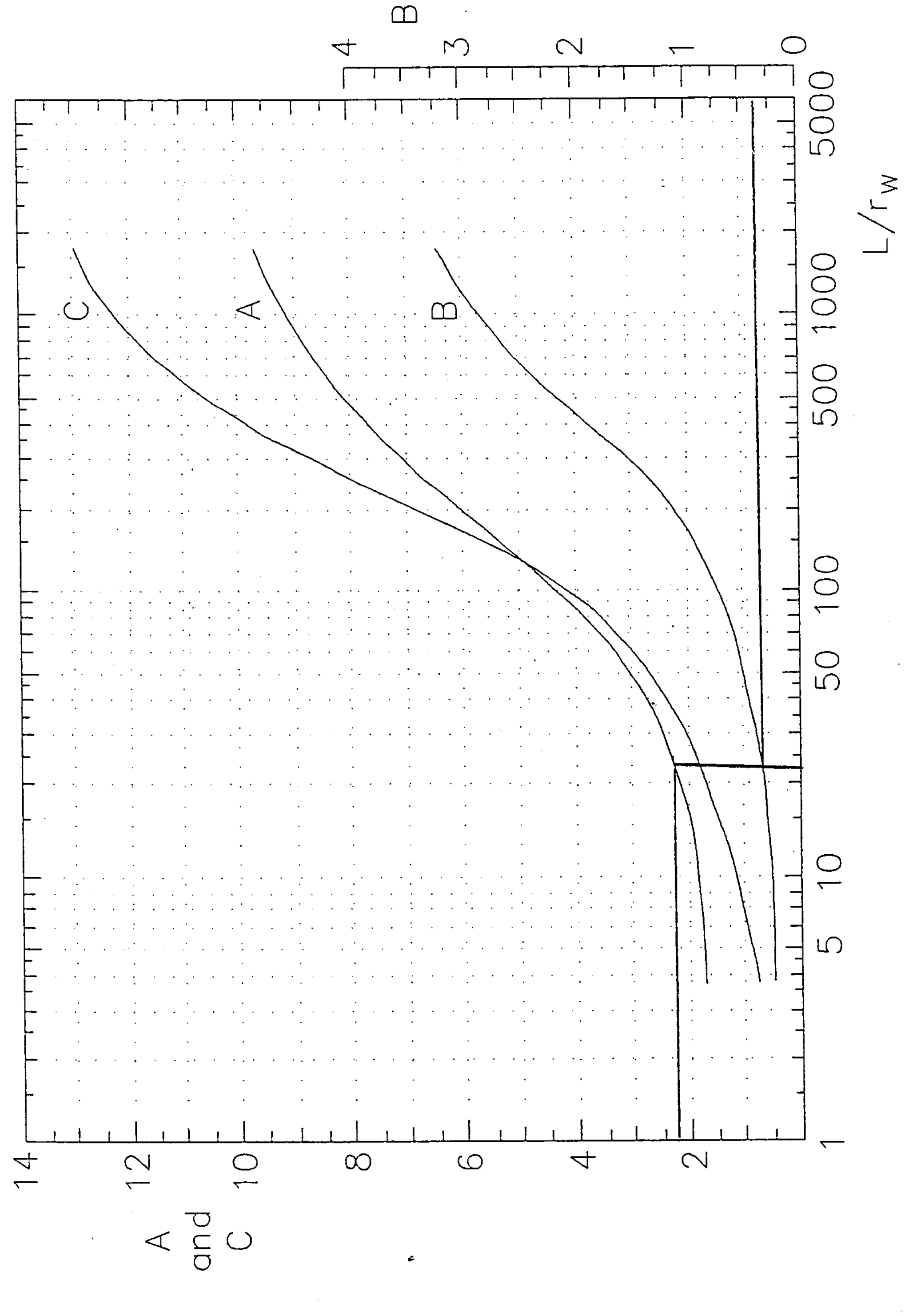
K = 0.000138 Ft/Min or 7.04E-05 CM/Sec

K = 0.199431 Ft/Day

Halifax Landfill Slug Test Data

Piezometer G-9 - January, 1996





Curves relating coefficients A, B, and C to L/r_w

FROM: BOUWER, H. AND RICE, R.C., 1976: A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS.

G.N. RICHARDSON & ASSOC.
417 N. BOYLAN AVENUE
RALEIGH N.C. 27603
919-828-0577

COEFFICIENT CURVE MATCHPOINT
RISING HEAD AQUIFER TEST
Halifax Landfill
G-9

Halifax G-9 Slug Test Data
SE1000C
Environmental Logger
01/26 09:07

Unit# 00069 Test 6

Setups:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	00001

Reference	0.000
Linearity	0.120
Scale factor	20.020
Offset	-0.020
Delay mSEC	50.000

Step 0 01/25 15:32:15

Elapsed Time	INPUT 1
0.0000	0.012
0.0033	0.006
0.0066	0.006
0.0100	0.012
0.0133	0.012
0.0166	0.012
0.0200	0.012
0.0233	0.012
0.0266	0.012
0.0300	0.543
0.0333	2.799
0.0366	3.437
0.0400	4.371
0.0433	3.380
0.0466	3.190
0.0500	2.824
0.0533	3.140
0.0566	4.333
0.0600	3.329
0.0633	3.102
0.0666	3.235
0.0700	3.216
0.0733	3.254
0.0766	3.171
0.0800	3.102
0.0833	3.032
0.0866	2.982
0.0900	2.950
0.0933	2.912
0.0966	2.868

Halifax G-9 Slug Test Data
Page 2

Elapsed Time	INPUT 1
0.1000	2.830
0.1033	2.773
0.1066	2.723
0.1100	2.698
0.1133	2.672
0.1166	2.616
0.1200	2.609
0.1233	2.552
0.1266	2.470
0.1300	2.470
0.1333	2.439
0.1366	2.413
0.1400	2.363
0.1433	2.312
0.1466	2.281
0.1500	2.274
0.1533	2.268
0.1566	2.230
0.1600	2.180
0.1633	2.161
0.1666	2.136
0.1700	2.117
0.1733	2.098
0.1766	2.066
0.1800	2.034
0.1833	2.028
0.1866	2.047
0.1900	2.041
0.1933	2.009
0.1966	1.984
0.2000	1.971
0.2033	1.971
0.2066	1.959
0.2100	1.933
0.2133	1.927
0.2166	1.921
0.2200	1.902
0.2233	1.895
0.2266	1.889
0.2300	1.889
0.2333	1.883
0.2366	1.876
0.2400	1.870
0.2433	1.864
0.2466	1.857
0.2500	1.839

Halifax G-9 Slug Test Data
Page 3

Elapsed Time	INPUT 1
0.2533	1.845
0.2566	1.839
0.2600	1.845
0.2633	1.832
0.2666	1.832
0.2700	1.832
0.2733	1.820
0.2766	1.826
0.2800	1.782
0.2833	1.826
0.2866	1.820
0.2900	1.807
0.2933	1.813
0.2966	1.788
0.3000	1.801
0.3033	1.794
0.3066	1.794
0.3100	1.788
0.3133	1.788
0.3166	1.788
0.3200	1.782
0.3233	1.782
0.3266	1.782
0.3300	1.782
0.3333	1.775
0.3500	1.769
0.3666	1.756
0.3833	1.750
0.4000	1.744
0.4166	1.731
0.4333	1.731
0.4500	1.719
0.4666	1.712
0.4833	1.706
0.5000	1.700
0.5166	1.700
0.5333	1.693
0.5500	1.687
0.5666	1.681
0.5833	1.681
0.6000	1.674
0.6166	1.668
0.6333	1.662
0.6500	1.662
0.6666	1.655
0.6833	1.649

Halifax G-9 Slug Test Data
Page 4

Elapsed Time	INPUT 1
0.7000	1.649
0.7166	1.643
0.7333	1.643
0.7500	1.636
0.7666	1.630
0.7833	1.630
0.8000	1.624
0.8166	1.624
0.8333	1.617
0.8500	1.617
0.8666	1.611
0.8833	1.611
0.9000	1.605
0.9166	1.605
0.9333	1.598
0.9500	1.598
0.9666	1.592
0.9833	1.592
1.0000	1.586
1.2000	1.548
1.4000	1.516
1.6000	1.491
1.8000	1.459
2.0000	1.440
2.2000	1.415
2.4000	1.390
2.6000	1.371
2.8000	1.352
3.0000	1.327
3.2000	1.308
3.4000	1.264
3.6000	1.213
3.8000	1.156
4.0000	1.112
4.2000	1.061
4.4000	1.023
4.6000	0.979
4.8000	0.941
5.0000	0.910
5.2000	0.878
5.4000	0.846

Halifax G-9 Slug Test Data
Page 5

Elapsed Time	INPUT 1
5.6000	0.815
5.8000	0.783
6.0000	0.758
6.2000	0.733
6.4000	0.707
6.6000	0.688
6.8000	0.670
7.0000	0.644
7.2000	0.625
7.4000	0.606
7.6000	0.594
7.8000	0.575
8.0000	0.562
8.2000	0.543
8.4000	0.530
8.6000	0.518
8.8000	0.505
9.0000	0.493
9.2000	0.480
9.4000	0.467
9.6000	0.461
9.8000	0.448
10.0000	0.436
12.0000	0.366
14.0000	0.322
16.0000	0.284
18.0000	0.265
20.0000	0.246
22.0000	0.233
24.0000	0.227
26.0000	0.214
28.0000	0.214
30.0000	0.214
32.0000	0.208
34.0000	0.208
36.0000	0.202

G. N. Richardson and Associates

Client:	Halifax County	**Proj. No.**	Halifax-4
		Sheet:	1/1
Project:	Halifax County Landfill	**Date:**	1/96
		Well:	G-10
		Referenc	Bouwer, 1989

ln[Re/Rw] = [1.1/ln(Lw/Rw) + A + Bln[(H-Lw)/Rw]/Le/Rw] exp -1

Where:		
	Lw = Height of Water Column in Well =	9.29
	Le = Screened Interval Open to Aquifer =	9.29
	Rw = Radius of Well Including Sand Pack	0.167
	Rc = Radius of Well Casing =	0.083
	H = Aquifer Thickness to First Aquitard =	22
	Yo = Relative Height of Water at Time Zer	0.7
	Yt = Relative Height of Water at Time t =	0.25
	n = Porosity =	0.2
	Time Tt (in minutes) =	3.5
	H - Lw =	12.71
	Yo/Yt =	2.8
	Lw/Rw =	55.62874
	ln(H-Lw)/Rw =	4.332151

Correction for Sandpack:

Req = [Rc exp2 + n(Rw exp2 + Rc exp2)] exp1/2

Req = 0.013845

Req = 0.117663

Evaluation of A and B:

Le/Rw = 55.62874

From Attached Graph of A and B:

A =	3.3
B =	0.5

ln Re/Rw = [1.1/ln Lw/Rw + A + B ln[(H-Lw)/Rw] / Le/Rw] exp-1

ln Re/Rw= 3.612658 exp-1

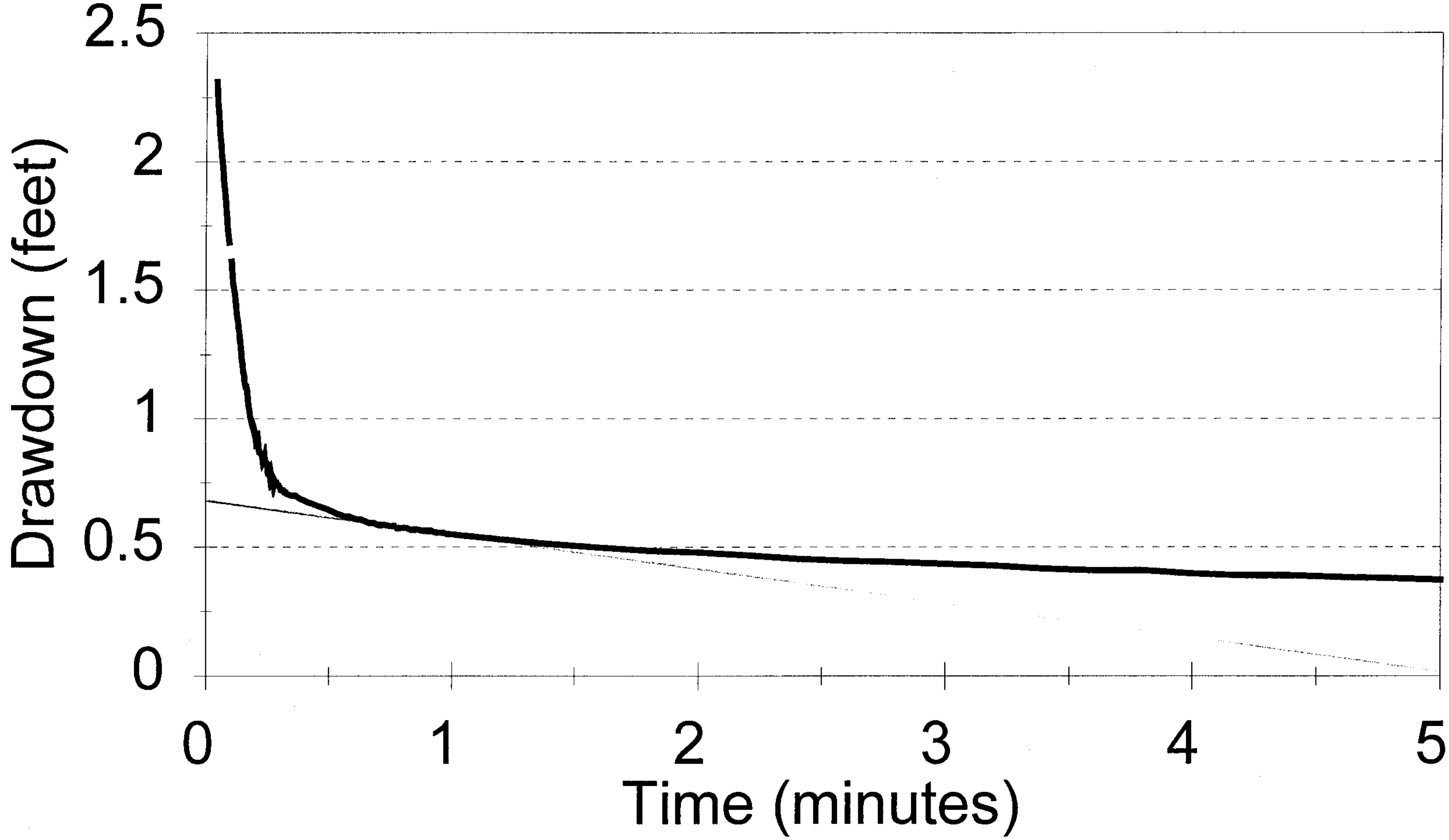
ln Re/Rw= 0.276804

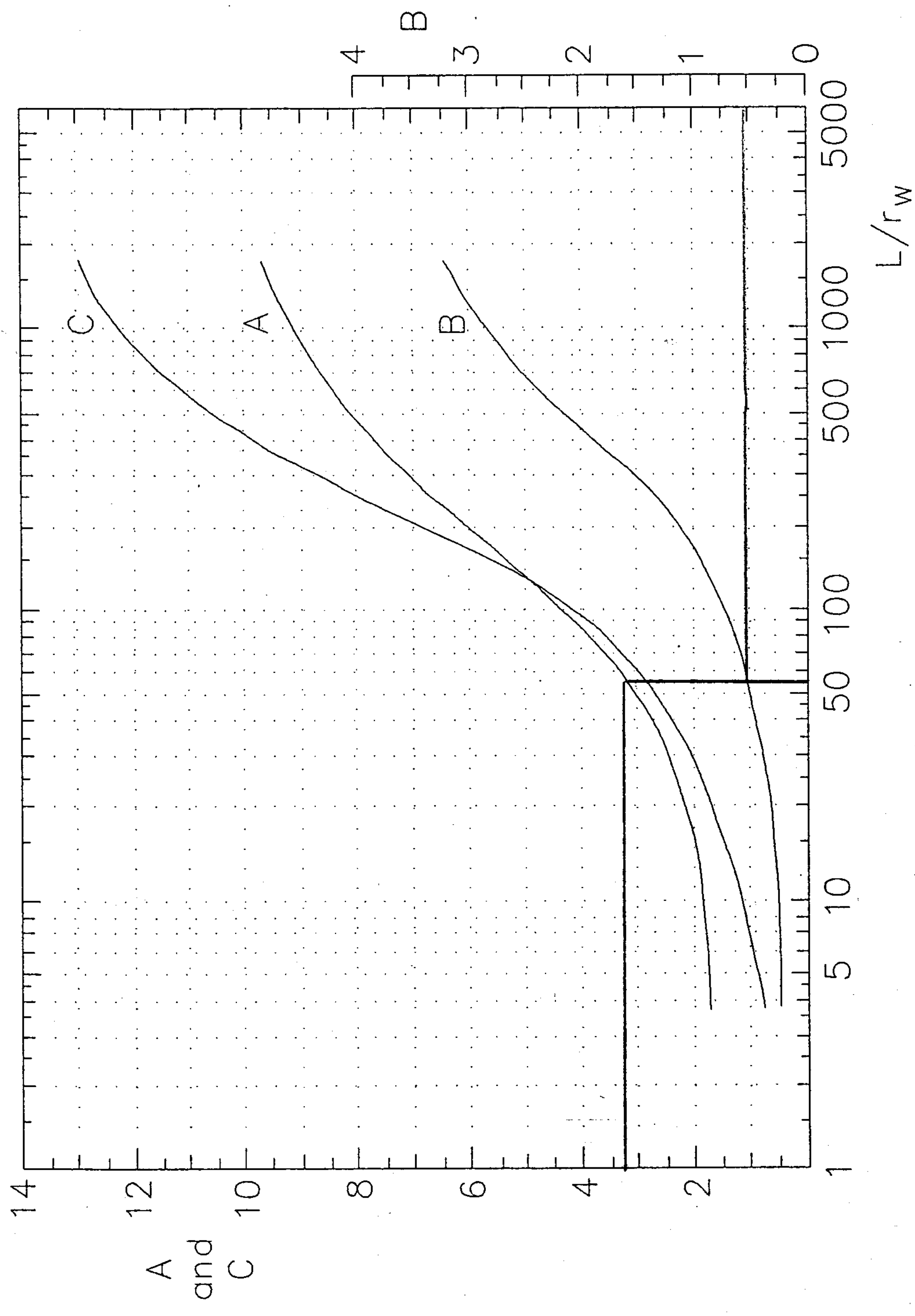
K = (Req) exp2 ln(Re/Rw)1/Tt ln(Yo/Yt) /2Le

K =	6.07E-05 Ft/Min	or	3.08E-05 CM/Sec
K =	0.087373 Ft/Day		

Halifax Landfill Slug Test Data

Piezometer G-10 - January, 1996





Curves relating coefficients A, B, and C to L/r_w

FROM: BOUWER, H. AND RICE, R.C., 1976: A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS.

G.N. RICHARDSON & ASSOC.
417 N. BOYLAN AVENUE
RALEIGH N.C. 27603
919-828-0577

COEFFICIENT CURVE MATCHPOINT
RISING HEAD AQUIFER TEST

G-10

Halifax County Landfill

Halifax G-10 Slug Test Data
SE1000C
Environmental Logger
01/26 09:10

Unit# 00069 Test 7

Setups:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	00001

Reference	0.000
Linearity	0.120
Scale factor	20.020
Offset	-0.020
Delay mSEC	50.000

Step 0 01/25 16:53:56

Elapsed Time	INPUT 1
0	6.643
0.0033	6.643
0.0066	6.643
0.01	6.643
0.0133	6.643
0.0166	6.643
0.02	6.643
0.0233	6.649
0.0266	7.615
0.03	8.531
0.0333	8.467
0.0366	8.531
0.04	8.373
0.0433	8.953
0.0466	8.871
0.05	8.852
0.0533	8.789
0.0566	8.745
0.06	8.714
0.0633	8.676
0.0666	8.644
0.07	8.606
0.0733	8.549
0.0766	8.543
0.08	8.505
0.0833	8.467
0.0866	8.417
0.09	8.385
0.0933	8.354
0.0966	8.329

Halifax G-10 Slug Test Data
Page 2

Elapsed Time	INPUT 1
0.1066	8.253
0.11	8.202
0.1133	8.171
0.1166	8.133
0.12	8.101
0.1233	8.082
0.1266	8.044
0.13	8.026
0.1333	7.994
0.1366	7.981
0.14	7.943
0.1433	7.912
0.1466	7.88
0.15	7.861
0.1533	7.824
0.1566	7.817
0.16	7.786
0.1633	7.767
0.1666	7.767
0.17	7.748
0.1733	7.716
0.1766	7.691
0.18	7.672
0.1833	7.653
0.1866	7.64
0.19	7.622
0.1933	7.609
0.1966	7.615
0.2	7.603
0.2033	7.577
0.2066	7.558
0.21	7.539
0.2133	7.539
0.2166	7.552
0.22	7.514
0.2233	7.514
0.2266	7.508
0.23	7.501
0.2333	7.476
0.2366	7.483
0.24	7.495
0.2433	7.476
0.2466	7.476
0.25	7.47
0.2533	7.432
0.2566	7.432
0.26	7.438
0.2633	7.413
0.2666	7.426
0.27	7.413

Halifax G-10 Slug Test Data
Page 3

Elapsed Time	INPUT 1
0.2733	7.413
0.2766	7.407
0.28	7.388
0.2833	7.4
0.2866	7.394
0.29	7.394
0.2933	7.388
0.2966	7.382
0.3	7.382
0.3033	7.375
0.3066	7.369
0.31	7.369
0.3133	7.363
0.3166	7.363
0.32	7.363
0.3233	7.356
0.3266	7.356
0.33	7.356
0.3333	7.35
0.35	7.344
0.3666	7.344
0.3833	7.331
0.4	7.325
0.4166	7.318
0.4333	7.312
0.45	7.306
0.4666	7.299
0.4833	7.293
0.5	7.287
0.5166	7.281
0.5333	7.274
0.55	7.268
0.5666	7.262
0.5833	7.262
0.6	7.255
0.6166	7.249
0.6333	7.249
0.65	7.243
0.6666	7.236
0.6833	7.236
0.7	7.23
0.7166	7.23
0.7333	7.23
0.75	7.224
0.7666	7.224

Halifax G-10 Slug Test Data
Page 4

Elapsed Time	INPUT 1
0.7833	7.217
0.8	7.217
0.8166	7.217
0.8333	7.211
0.85	7.211
0.8666	7.211
0.8833	7.205
0.9	7.205
0.9166	7.205
0.9333	7.198
0.95	7.198
0.9666	7.198
0.9833	7.192
1	7.192
1.2	7.173
1.4	7.154
1.6	7.142
1.8	7.129
2	7.123
2.2	7.11
2.4	7.097
2.6	7.091
2.8	7.085
3	7.078
3.2	7.072
3.4	7.06
3.6	7.053
3.8	7.053
4	7.041
4.2	7.034
4.4	7.034
4.6	7.028
4.8	7.022
5	7.015
5.2	7.009
5.4	7.003
5.6	6.996
5.8	6.996
6	6.99
6.2	6.984
6.4	6.977
6.6	6.977
6.8	6.971
7	6.965
7.2	6.958
7.4	6.958
7.6	6.952
7.8	6.946
8	6.946

Halifax G-10 Slug Test Data
Page 5

Elapsed Time	INPUT 1
8.2	6.94
8.4	6.94
8.6	6.933
8.8	6.927
9	6.927
9.2	6.921
9.4	6.921
9.6	6.914
9.8	6.908
10	6.908
12	6.876
14	6.851
16	6.826
18	6.807
20	6.788
22	6.769
24	6.756
26	6.744
28	6.731
30	6.718
32	6.712
34	6.706
36	6.693
38	6.687
40	6.681
42	6.674
44	6.668
46	6.662
48	6.655
50	6.649
52	6.643
54	6.643
56	6.636
58	6.636
60	6.63
62	6.63
64	6.617
66	6.617

G. N. Richardson and Associates

Client:	Halifax County	**Proj. No.**	Halifax-4
		Sheet:	1/1
Project:	Halifax County Landfill	**Date:**	1/96
		Well:	G-11
		Referenc	Bouwer, 1989

ln[Re/Rw] = [1.1/ln(Lw/Rw) + A + Bln[(H-Lw)/Rw]/Le/Rw] exp -1

Where:

Lw = Height of Water Column in Well =	9.03
Le = Screened Interval Open to Aquifer =	9.03
Rw = Radius of Well Including Sand Pack	0.167
Rc = Radius of Well Casing =	0.083
H = Aquifer Thickness to First Aquitard =	22
Yo = Relative Height of Water at Time Zer	1.5
Yt = Relative Height of Water at Time t =	0.6
n = Porosity =	0.2
Time Tt (in minutes) =	3
H - Lw =	12.97
Yo/Yt =	2.5
Lw/Rw =	54.07186
ln(H-Lw)/Rw =	4.3524

Correction for Sandpack:

Req = [Rc exp2 + n(Rw exp2 + Rc exp2)] exp1/2

Req = 0.013845

Req = 0.117663

Evaluation of A and B:

Le/Rw = 54.07186

From Attached Graph of A and B:

A = 3.2

B = 0.5

ln Re/Rw = [1.1/ln Lw/Rw + A + B ln[(H-Lw)/Rw] / Le/Rw] exp-1

ln Re/Rw= 3.515914 exp-1

ln Re/Rw= 0.284421

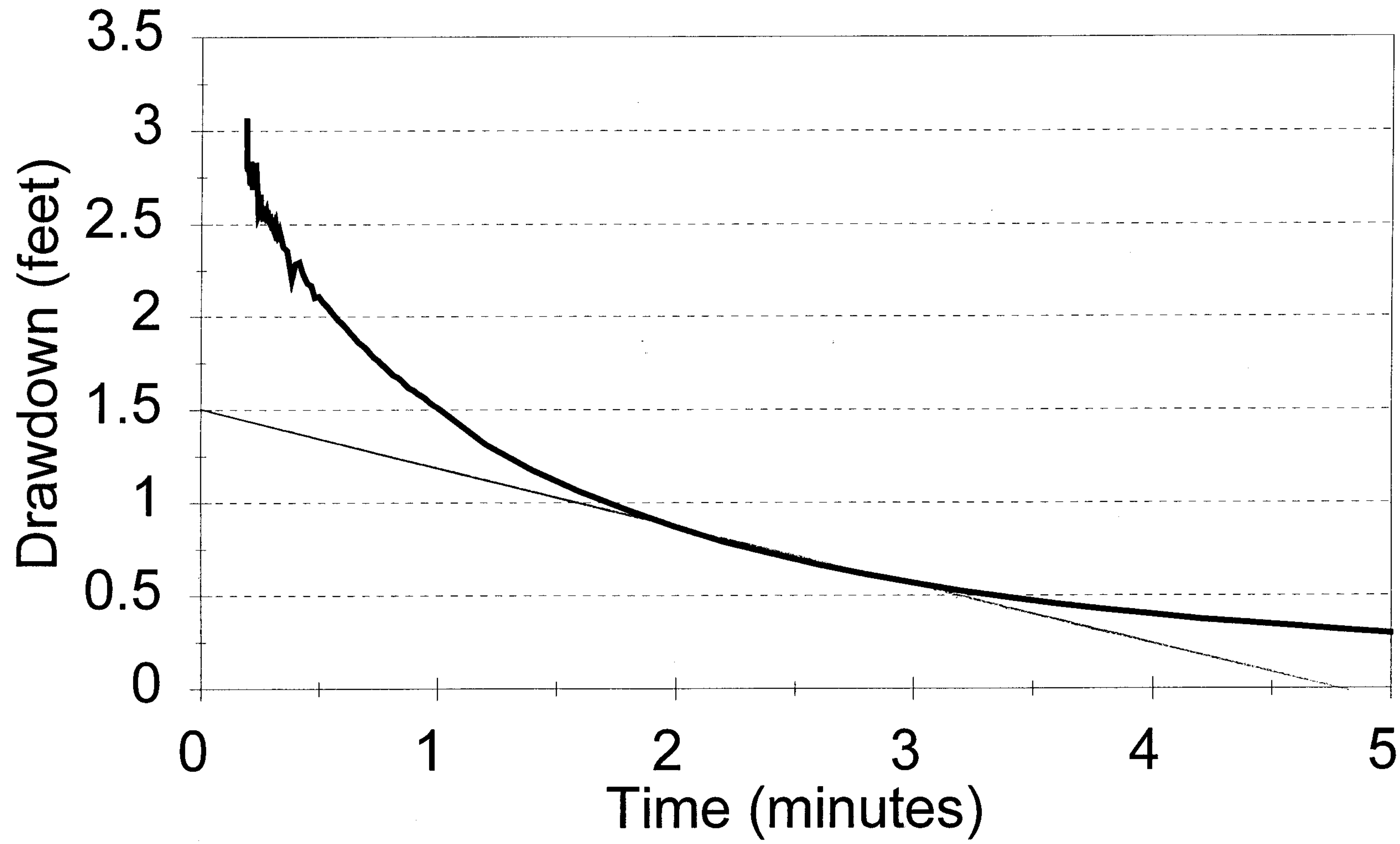
K = (Req) exp2 ln(Re/Rw)1/Tt ln(Yo/Yt) /2Le

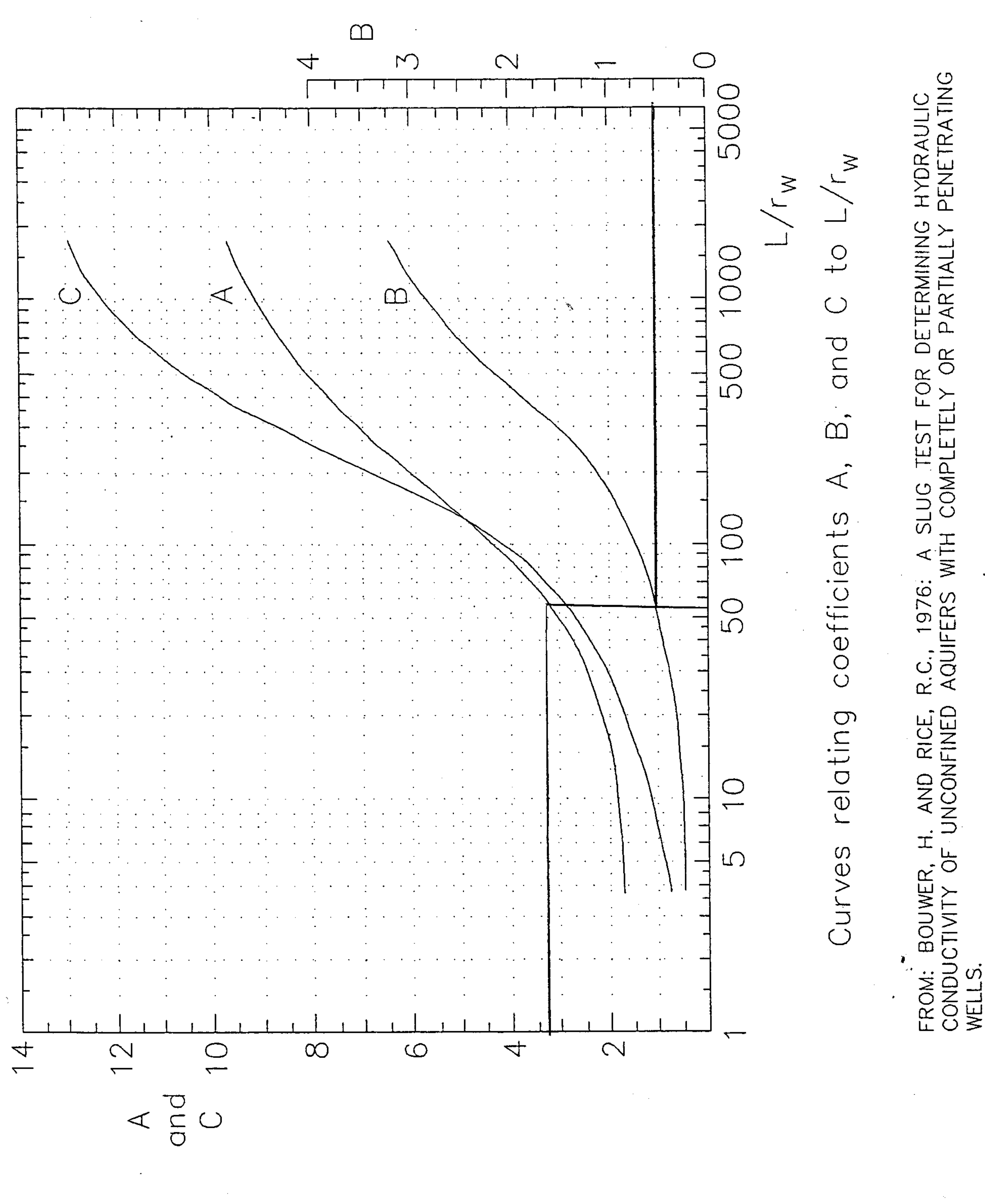
K = 6.66E-05 Ft/Min or 3.38E-05 CM/Sec

K = 0.095896 Ft/Day

Halifax Landfill Slug Test Data

Piezometer G-11, January, 1996





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RALEIGH N.C. 27603
919-828-0577

COEFFICIENT CURVE MATCHPOINT
RISING HEAD AQUIFER TEST
G-11
Halifax County Landfill

Halifax G-11 Slug Test Data
SE1000C
Environmental Logger
01/26 09:10

Unit# 00069 Test 7

Setups:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	00001

Reference	0.000
Linearity	0.120
Scale factor	20.020
Offset	-0.020
Delay mSEC	50.000

Step 0 01/25 16:53:56

Elapsed Time	INPUT 1
0	0.006
0.0033	0.006
0.0066	0.006
0.01	0.006
0.0133	0.006
0.0166	0.006
0.02	0.006
0.0233	0.006
0.0266	0.006
0.03	0.006
0.0333	0.012
0.0366	0.006
0.04	0.006
0.0433	0.012
0.0466	0.006
0.05	0.006
0.0533	0.012
0.0566	0.006
0.06	0.012
0.0633	0.012
0.0666	0.012
0.07	0.012
0.0733	0.012
0.0766	0.012
0.08	0.012
0.0833	0.012
0.0866	0.012
0.09	0.012
0.0933	0.012
0.0966	0.012

Halifax G-11 Slug Test Data
Page 2

Elapsed Time	INPUT 1
0.1	0.012
0.1033	0.012
0.1066	0.012
0.11	0.012
0.1133	0.012
0.1166	0.012
0.12	0.012
0.1233	0.012
0.1266	0.012
0.13	0.012
0.1333	0.012
0.1366	0.069
0.14	1.491
0.1433	1.959
0.1466	2.256
0.15	1.555
0.1533	1.359
0.1566	2.307
0.16	2.736
0.1633	1.953
0.1666	2.174
0.17	2.926
0.1733	2.957
0.1766	2.964
0.18	2.863
0.1833	2.401
0.1866	2.673
0.19	2.844
0.1933	3.065
0.1966	2.812
0.2	2.806
0.2033	2.837
0.2066	2.787
0.21	2.724
0.2133	2.85
0.2166	2.781
0.22	2.717
0.2233	2.717
0.2266	2.724
0.23	2.844
0.2333	2.793
0.2366	2.711
0.24	2.66
0.2433	2.566
0.2466	2.578
0.25	2.673
0.2533	2.648
0.2566	2.547
0.26	2.578
0.2633	2.547

Halifax G-11 Slug Test Data
Page 3

Elapsed Time	INPUT 1
0.2666	2.566
0.27	2.559
0.2733	2.572
0.2766	2.585
0.28	2.566
0.2833	2.54
0.2866	2.534
0.29	2.547
0.2933	2.534
0.2966	2.54
0.3	2.496
0.3033	2.496
0.3066	2.484
0.31	2.503
0.3133	2.49
0.3166	2.509
0.32	2.484
0.3233	2.458
0.3266	2.446
0.33	2.452
0.3333	2.471
0.35	2.389
0.3666	2.37
0.3833	2.218
0.4	2.3
0.4166	2.307
0.4333	2.243
0.45	2.193
0.4666	2.18
0.4833	2.117
0.5	2.123
0.5166	2.092
0.5333	2.067
0.55	2.041
0.5666	2.016
0.5833	1.991
0.6	1.972
0.6166	1.947
0.6333	1.921
0.65	1.902
0.6666	1.877
0.6833	1.858
0.7	1.839
0.7166	1.814
0.7333	1.795
0.75	1.776
0.7666	1.757

Halifax G-11 Slug Test Data
Page 4

Elapsed Time	INPUT 1
0.7833	1.738
0.8	1.719
0.8166	1.7
0.8333	1.687
0.85	1.668
0.8666	1.649
0.8833	1.63
0.9	1.618
0.9166	1.599
0.9333	1.586
0.95	1.574
0.9666	1.555
0.9833	1.536
1	1.523
1.2	1.327
1.4	1.188
1.6	1.074
1.8	0.973
2	0.885
2.2	0.803
2.4	0.739
2.6	0.676
2.8	0.626
3	0.581
3.2	0.537
3.4	0.499
3.6	0.468
3.8	0.436
4	0.411
4.2	0.385
4.4	0.366
4.6	0.347
4.8	0.328
5	0.309
5.2	0.297
5.4	0.284
5.6	0.271
5.8	0.259
6	0.246
6.2	0.24
6.4	0.234
6.6	0.221
6.8	0.215

Halifax G-11 Slug Test Data
Page 5

Elapsed Time	INPUT 1
7	0.208
7.2	0.202
7.4	0.196
7.6	0.189
7.8	0.183
8	0.183
8.2	0.177
8.4	0.17
8.6	0.17
8.8	0.17
9	0.158
9.2	0.158
9.4	0.158
9.6	0.151
9.8	0.151
10	0.145
12	0.132
14	0.126
16	0.12
18	0.113
20	0.107
22	0.107
24	0.107
26	0.107
28	0.107
30	0.107
32	0.107
34	0.107
36	0.107
38	0.107
40	0.101
42	0.107
44	0.107
46	0.107

G. N. Richardson and Associates

Client:	Halifax County	**Proj. No.**	Halifax-4
		Sheet:	1/1
Project:	Halifax County Landfill	**Date:**	1/96
		Well:	G-12
		Referenc	Bouwer, 1989

ln[Re/Rw] = [1.1/ln(Lw/Rw) + A + Bln[(H-Lw)/Rw]/Le/Rw] exp -1

Where:		
	Lw = Height of Water Column in Well =	12.63
	Le = Screened Interval Open to Aquifer =	10
	Rw = Radius of Well Including Sand Pack	0.167
	Rc = Radius of Well Casing =	0.083
	H = Aquifer Thickness to First Aquitard =	27
	Yo = Relative Height of Water at Time Zer	2
	Yt = Relative Height of Water at Time t =	0.6
	n = Porosity =	0.2
	Time Tt (in minutes) =	2
	H - Lw =	14.37
	Yo/Yt =	3.333333
	Lw/Rw =	75.62874
	ln(H-Lw)/Rw =	4.454904

Correction for Sandpack:

Req = [Rc exp2 + n(Rw exp2 + Rc exp2)] exp1/2

Req = 1

Req = 1

Evaluation of A and B:

Le/Rw = 59.88024

From Attached Graph of A and B:

A =	3.3
B =	0.65

ln Re/Rw = [1.1/ln Lw/Rw + A + B ln[(H-Lw)/Rw] / Le/Rw] exp-1

ln Re/Rw= 3.602644 exp-1

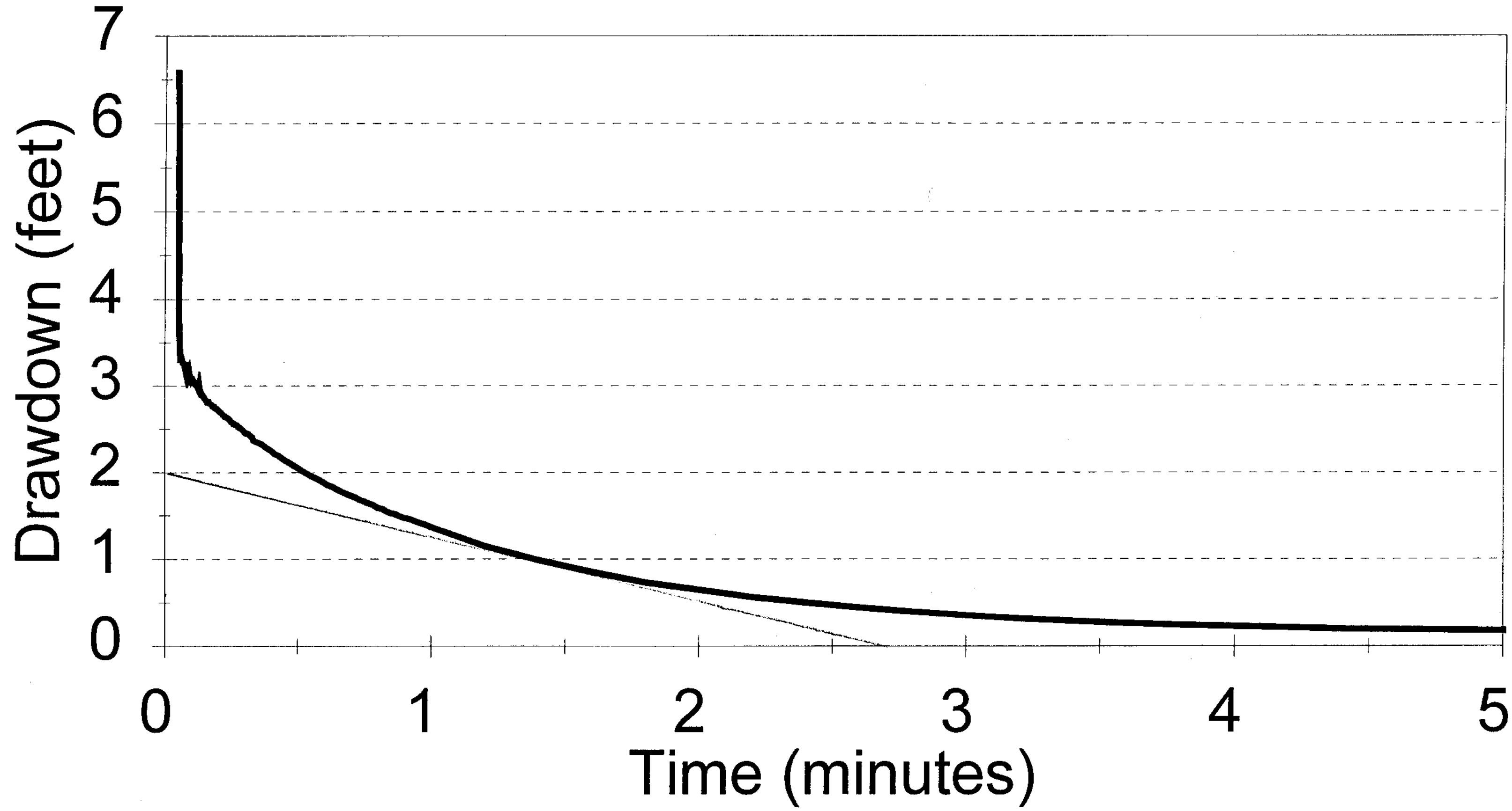
ln Re/Rw= 0.277574

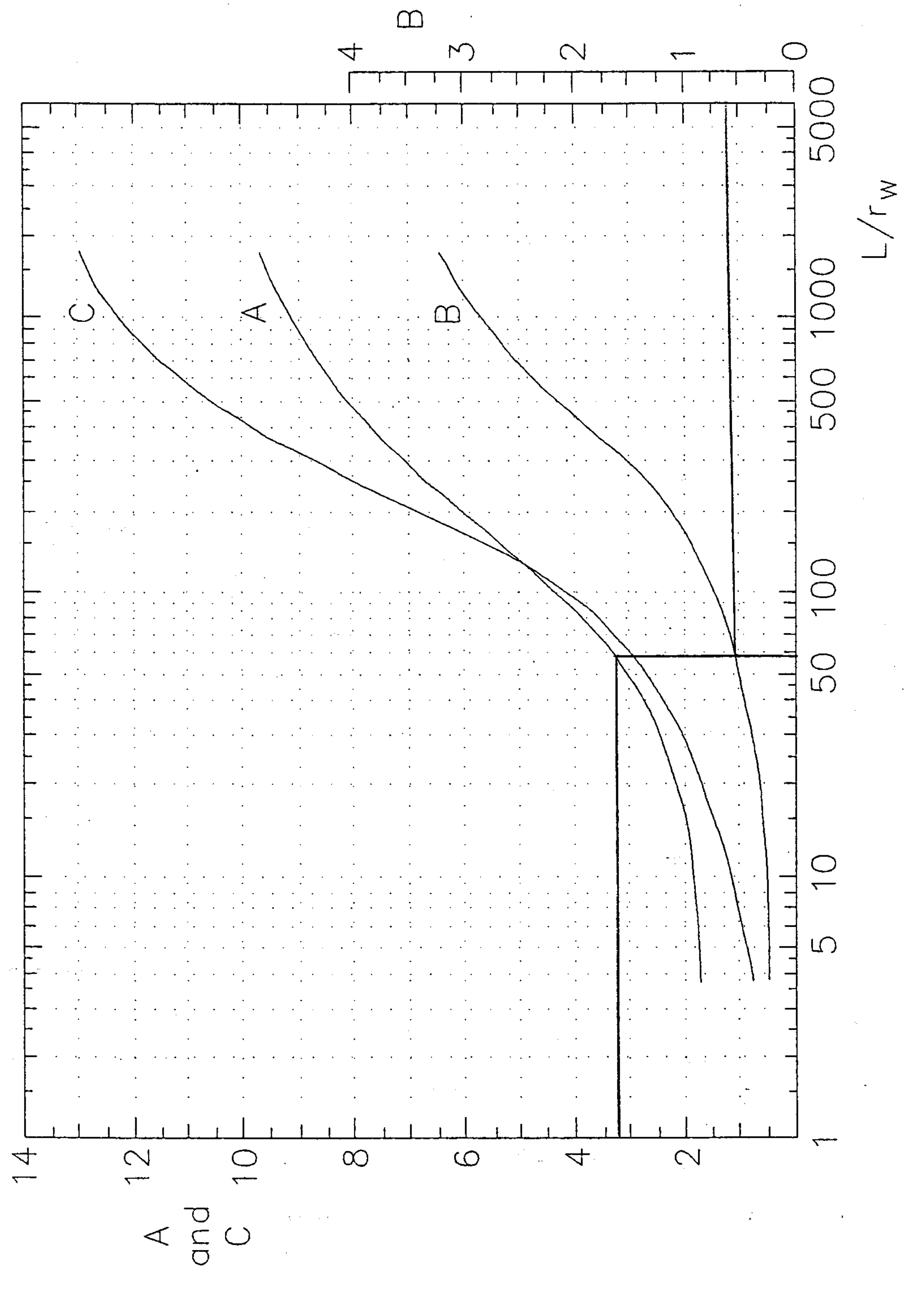
K = (Req) exp2 ln(Re/Rw)1/Tt ln(Yo/Yt) /2Le

K =	0.008355 Ft/Min	or	0.004244	CM/Sec
K =	12.03089 Ft/Day			

Halifax Landfill Slug Test Data

Piezometer G-12 - January, 1996





Curves relating coefficients A, B, and C to L/r_w

FROM: BOUWER, H. AND RICE, R.C., 1976: A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS.

G.N. RICHARDSON & ASSOC.
417 N. BOYLAN AVENUE
RALEIGH N.C. 27603
919-828-0577

COEFFICIENT CURVE MATCHPOINT
RISING HEAD AQUIFER TEST
G-12
Halifax County Landfill

Halifax G-12 Slug test data
SE1000C
Environmental Logger
01/23 21:54

Unit# 00069 Test 0

Setups:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	00001

Reference	0.000
Linearity	0.120
Scale factor	20.020
Offset	-0.020
Delay mSEC	50.000

Step 0 01/23 09:19:39

Elapsed Time	INPUT 1
0	0.056
0.0033	0.056
0.0066	0.056
0.01	0.056
0.0133	0.056
0.0166	0.056
0.02	3.724
0.0233	6.359
0.0266	6.984
0.03	7.47
0.0333	5.291
0.0366	5.601
0.04	5.348
0.0433	3.155
0.0466	6.58
0.05	6.024
0.0533	3.699
0.0566	3.515
0.06	3.275
0.0633	3.338
0.0666	3.3
0.07	3.269
0.0733	3.26
0.0766	3.231
0.08	3.155
0.0833	3.18
0.0866	3.243
0.09	3.123
0.0933	3.161

Halifax G-12 Slug Test Data
Page 2

Elapsed Time	INPUT 1
0.0966	3.098
0.1	3.073
0.1033	3.085
0.1066	3.085
0.11	3.06
0.1133	3.041
0.1166	3.029
0.12	3.01
0.1233	2.991
0.1266	2.972
0.13	3.022
0.1333	2.94
0.1366	2.946
0.14	2.921
0.1433	2.896
0.1466	2.89
0.15	2.883
0.1533	2.858
0.1566	2.833
0.16	2.814
0.1633	2.814
0.1666	2.814
0.17	2.801
0.1733	2.795
0.1766	2.788
0.18	2.782
0.1833	2.769
0.1866	2.763
0.19	2.757
0.1933	2.744
0.1966	2.738
0.2	2.732
0.2033	2.719
0.2066	2.713
0.21	2.7
0.2133	2.694
0.2166	2.687
0.22	2.675
0.2233	2.668
0.2266	2.662
0.23	2.649
0.2333	2.643
0.2366	2.63

Halifax G-12 Slug Test Data
Page 3

Elapsed Time	INPUT 1
0.24	2.624
0.2433	2.618
0.2466	2.611
0.25	2.599
0.2533	2.592
0.2566	2.586
0.26	2.573
0.2633	2.567
0.2666	2.561
0.27	2.554
0.2733	2.548
0.2766	2.536
0.28	2.529
0.2833	2.523
0.2866	2.517
0.29	2.504
0.2933	2.498
0.2966	2.491
0.3	2.485
0.3033	2.472
0.3066	2.466
0.31	2.46
0.3133	2.453
0.3166	2.447
0.32	2.441
0.3233	2.428
0.3266	2.422
0.33	2.415
0.3333	2.409
0.3366	2.371
0.3666	2.333
0.3833	2.295
0.4	2.257
0.4166	2.219
0.4333	2.188
0.45	2.156
0.4666	2.118
0.4833	2.093
0.5	2.061
0.5166	2.03
0.5333	1.998
0.55	1.966
0.5666	1.941
0.5833	1.916
0.6	1.884

Halifax G-12 Slug Test Data
Page 4

Elapsed Time	INPUT 1
0.6166	1.859
0.6333	1.834
0.65	1.808
0.6666	1.783
0.6833	1.758
0.7	1.739
0.7166	1.714
0.7333	1.688
0.75	1.669
0.7666	1.644
0.7833	1.625
0.8	1.6
0.8166	1.581
0.8333	1.555
0.85	1.536
0.8666	1.518
0.8833	1.499
0.9	1.48
0.9166	1.467
0.9333	1.448
0.95	1.429
0.9666	1.41
0.9833	1.391
1	1.372
1.2	1.151
1.4	0.993
1.6	0.86
1.8	0.74
2	0.651
2.2	0.569
2.4	0.506
2.6	0.449
2.8	0.398
3	0.354
3.2	0.322
3.4	0.291
3.6	0.265
3.8	0.246
4	0.227
4.2	0.215
4.4	0.202
4.6	0.196
4.8	0.189
5	0.183
5.2	0.177
5.4	0.17
5.6	0.17

Halifax G-12 Slug Test Data
Page 5

Elapsed Time	INPUT 1
5.8	0.164
6	0.164
6.2	0.164
6.4	0.164
6.6	0.164
6.8	0.158
7	0.158
7.2	0.158
7.4	0.158
7.6	0.158
7.8	0.158
8	0.158
8.2	0.158
8.4	0.158
8.6	0.158
8.8	0.158
9	0.158
9.2	0.164
9.4	0.164
9.6	0.164
9.8	0.164
10	0.164
12	0.17
14	0.177
16	0.183
18	0.189
20	0.196
22	0.202
24	0.202
26	0.208
28	0.215
30	0.221
32	0.221
34	0.234
36	0.234
38	0.234
40	0.24
42	0.24
44	0.246
46	0.246
48	0.253
50	0.253
52	0.259
54	0.265
56	0.272

G. N. Richardson and Associates

Client:	Halifax County	**Proj. No.**	Halifax-4
		Sheet:	1/1
Project:	Halifax County Landfill	**Date:**	1/96
		Well:	G-13
		Referenc	Bouwer, 1989

ln[Re/Rw] = [1.1/ln(Lw/Rw) + A + Bln[(H-Lw)/Rw]/Le/Rw] exp -1

Where:	Lw = Height of Water Column in Well =	9.02
	Le = Screened Interval Open to Aquifer =	9.02
	Rw = Radius of Well Including Sand Pack	0.167
	Rc = Radius of Well Casing =	0.083
	H = Aquifer Thickness to First Aquitard =	27
	Yo = Relative Height of Water at Time Zer	9
	Yt = Relative Height of Water at Time t =	6.5
	n = Porosity =	0.2
	Time Tt (in minutes) =	3.8
	H - Lw =	17.98
	Yo/Yt =	1.384615
	Lw/Rw =	54.01198
	ln(H-Lw)/Rw =	4.679021

Correction for Sandpack:

Req = [Rc exp2 + n(Rw exp2 + Rc exp2)] exp1/2

Req = 0.013845

Req = 0.117663

Evaluation of A and B:

Le/Rw = 54.01198

From Attached Graph of A and B:

A = 3.2

B = 0.6

ln Re/Rw = [1.1/ln Lw/Rw + A + B ln[(H-Lw)/Rw] / Le/Rw] exp-1

ln Re/Rw= 3.527722 exp-1

ln Re/Rw= 0.283469

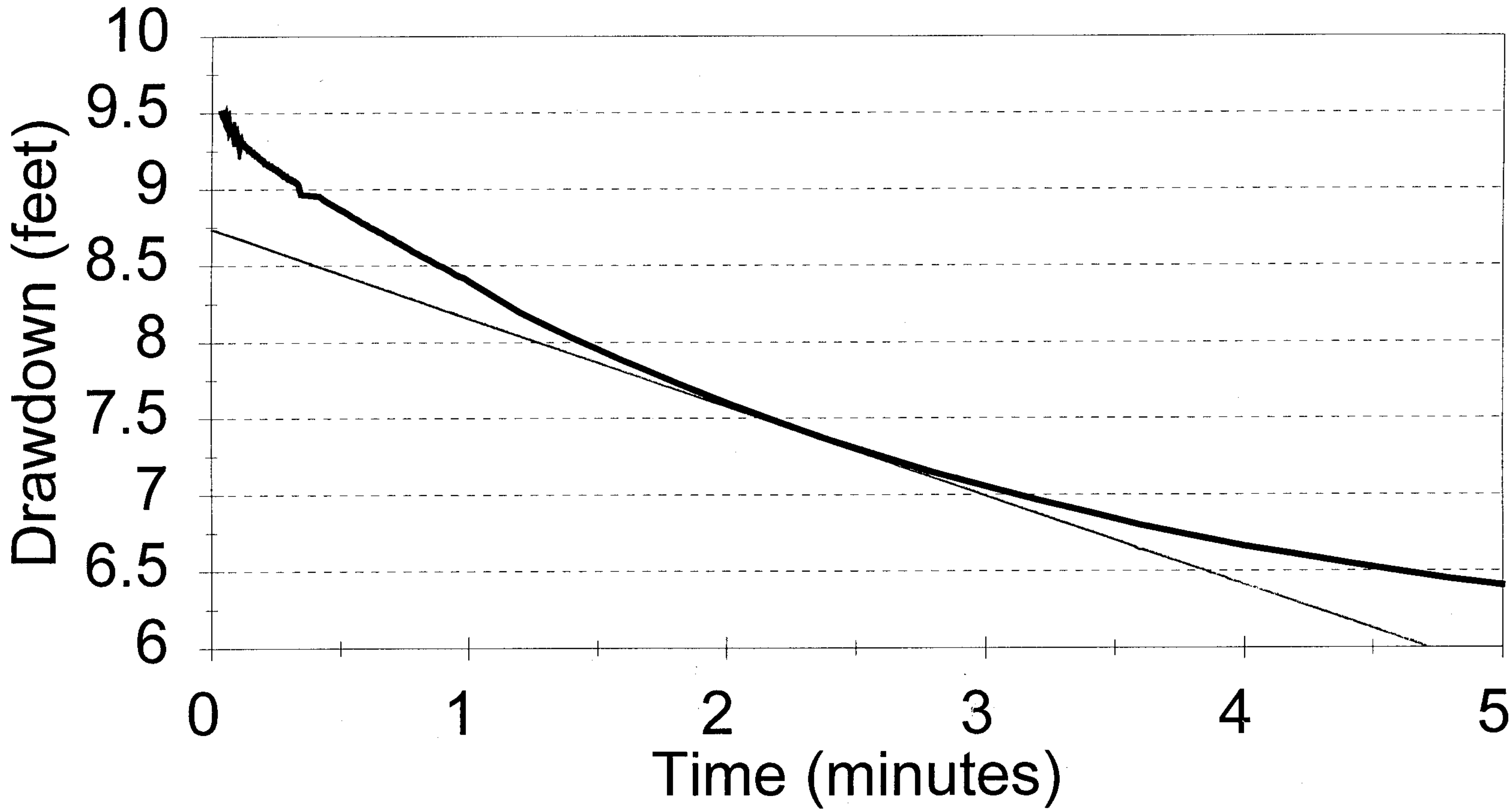
K = (Req) exp2 ln(Re/Rw)1/Tt ln(Yo/Yt) /2Le

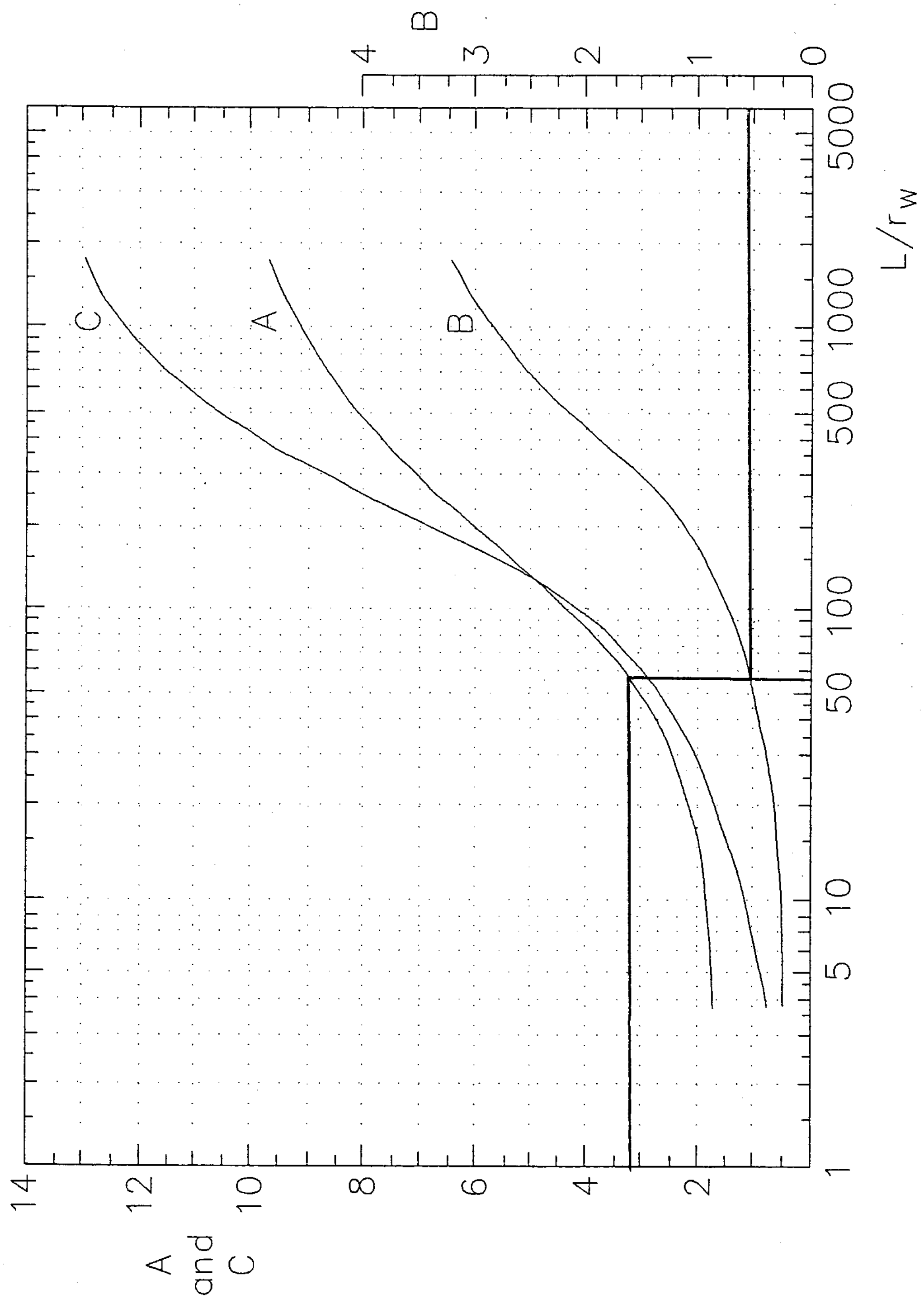
K = 1.86E-05 Ft/Min or 9.46E-06 CM/Sec

K = 0.026827 Ft/Day

Halifax Landfill Slug Test Data

Peizometer G-13 - January, 1996





Curves relating coefficients A, B, and C to L/r_w

FROM: BOUWER, H. AND RICE, R.C., 1976: A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS.

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919-828-0577

COEFFICIENT CURVE MATCHPOINT
RISING HEAD AQUIFER TEST
G-13
Halifax County Landfill

Halifax G-13 Slug Test Data

SE1000C
Environmental Logger
01/23 21:59

Unit# 00069 Test 2

Setups:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	00001
Reference	0.000
Linearity	0.120
Scale factor	20.020
Offset	-0.020
Delay mSEC	50.000

Step 0 01/23 12:17:51

Elapsed Time	INPUT 1
0	
0.0033	
0.0066	
0.01	
0.0133	
0.0166	
0.02	
0.0233	
0.0266	
0.03	
0.0333	
0.0366	
0.04	9.503
0.0433	9.477
0.0466	9.471
0.05	9.458
0.0533	9.471
0.0566	9.427
0.06	9.414
0.0633	9.42
0.0666	9.439
0.07	9.389
0.0733	9.402
0.0766	9.402
0.08	9.383
0.0833	9.345
0.0866	9.376
0.09	9.345
0.0933	9.332

Halifax G-13 Slug Test Data
Page 2

Elapsed Time	INPUT 1
------------	---------
0.0966	9.351
0.1	9.332
0.1033	9.32
0.1066	9.282
0.11	9.313
0.1133	9.32
0.1166	9.301
0.12	9.301
0.1233	9.301
0.1266	9.288
0.13	9.282
0.1333	9.282
0.1366	9.275
0.14	9.263
0.1433	9.269
0.1466	9.263
0.15	9.25
0.1533	9.244
0.1566	9.244
0.16	9.237
0.1633	9.237
0.1666	9.231
0.17	9.225
0.1733	9.225
0.1766	9.219
0.18	9.212
0.1833	9.206
0.1866	9.2
0.19	9.2
0.1933	9.193
0.1966	9.187
0.2	9.187
0.2033	9.181
0.2066	9.174
0.21	9.174
0.2133	9.168
0.2166	9.168
0.22	9.162
0.2233	9.155
0.2266	9.155
0.23	9.149
0.2333	9.149
0.2366	9.143
0.24	9.137
0.2433	9.137
0.2466	9.13
0.25	9.13
0.2533	9.124
0.2566	9.118

Halifax G-13 Slug Test Data
Page 3

Elapsed Time	INPUT 1
0.26	9.118
0.2633	9.111
0.2666	9.111
0.27	9.105
0.2733	9.099
0.2766	9.099
0.28	9.092
0.2833	9.092
0.2866	9.086
0.29	9.086
0.2933	9.08
0.2966	9.073
0.3	9.073
0.3033	9.067
0.3066	9.067
0.31	9.061
0.3133	9.061
0.3166	9.054
0.32	9.054
0.3233	9.048
0.3266	9.048
0.33	9.042
0.3333	9.036
0.3366	9.023
0.34	9.004
0.3433	8.985
0.3466	8.966
0.4166	8.953
0.4333	8.935
0.45	8.916
0.4666	8.897
0.4833	8.884
0.5	8.865
0.5166	8.852
0.5333	8.834
0.55	8.815
0.5666	8.802
0.5833	8.783
0.6	8.77
0.6166	8.751
0.6333	8.739
0.65	8.72
0.6666	8.707
0.6833	8.688
0.7	8.676
0.7166	8.657
0.7333	8.644
0.75	8.625
0.7666	8.613
0.7833	8.594

Halifax G-13 Slug Test Data
Page 4

Elapsed Time	INPUT 1
0.8	8.581
0.8166	8.562
0.8333	8.549
0.85	8.537
0.8666	8.518
0.8833	8.505
0.9	8.493
0.9166	8.474
0.9333	8.461
0.95	8.442
0.9666	8.43
0.9833	8.417
1	8.398
1.2	8.196
1.4	8.032
1.6	7.88
1.8	7.735
2	7.603
2.2	7.476
2.4	7.356
2.6	7.249
2.8	7.148
3	7.053
3.2	6.965
3.4	6.883
3.6	6.801
3.8	6.731
4	6.662
4.2	6.605
4.4	6.548
4.6	6.497
4.8	6.447
5	6.403
5.2	6.365
5.4	6.327
5.6	6.295
5.8	6.257
6	6.232
6.2	6.207
6.4	6.182
6.6	6.163
6.8	6.144
7	6.125
7.2	6.106
7.4	6.093

Halifax G-13 Slug Test Data
Page 5

Elapsed Time	INPUT 1
7.6	6.081
7.8	6.068
8	6.055
8.2	6.049
8.4	6.036
8.6	6.03
8.8	6.024
9	6.017
9.2	6.011
9.4	6.005
9.6	5.998
9.8	5.998
10	5.992
12	5.973
14	5.967
16	5.961
18	5.961
20	5.954
22	5.954
24	5.954
26	5.954
28	5.954
30	5.954
32	5.954
34	5.954
36	5.954
38	5.954
40	5.961
42	5.954
44	5.954
46	5.954
48	5.954
50	5.961
52	5.961
54	5.954
56	5.954
58	5.954
60	5.954

G. N. Richardson and Associates

Client:	Halifax County	**Proj. No.**	Halifax-4
		Sheet:	1/1
Project:	Halifax County Landfill	**Date:**	1/96
		Well:	G-14
		Referenc	Bouwer, 1989

ln[Re/Rw] = [1.1/ln(Lw/Rw) + A + Bln[(H-Lw)/Rw]/Le/Rw] exp -1

Where:

Lw = Height of Water Column in Well =	11.31
Le = Screened Interval Open to Aquifer =	10
Rw = Radius of Well Including Sand Pack	0.167
Rc = Radius of Well Casing =	0.083
H = Aquifer Thickness to First Aquitard =	25
Yo = Relative Height of Water at Time Zer	1.5
Yt = Relative Height of Water at Time t =	0.6
n = Porosity =	0.2
Time Tt (in minutes) =	2
H - Lw =	13.69
Yo/Yt =	2.5
Lw/Rw =	67.72455
ln(H-Lw)/Rw =	4.406427

Correction for Sandpack:

Req = [Rc exp2 + n(Rw exp2 + Rc exp2)] exp1/2

Req = 1

Req = 1

Evaluation of A and B:

Le/Rw = 59.88024

From Attached Graph of A and B:

A =	3.5
B =	0.6

ln Re/Rw = [1.1/ln Lw/Rw + A + B ln[(H-Lw)/Rw] / Le/Rw] exp-1

ln Re/Rw= 3.805097 exp-1

ln Re/Rw= 0.262805

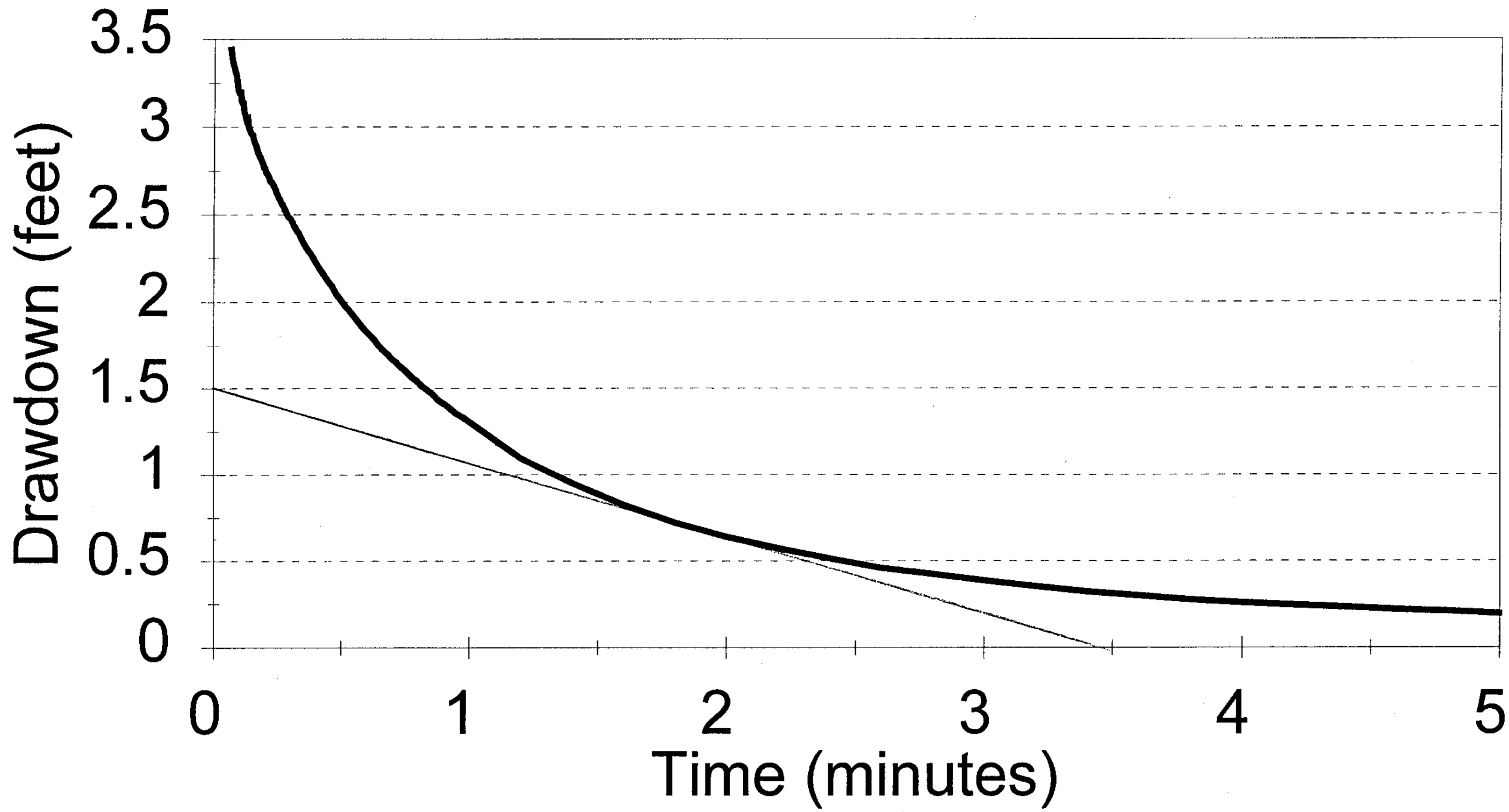
K = (Req) exp2 ln(Re/Rw)1/Tt ln(Yo/Yt) /2Le

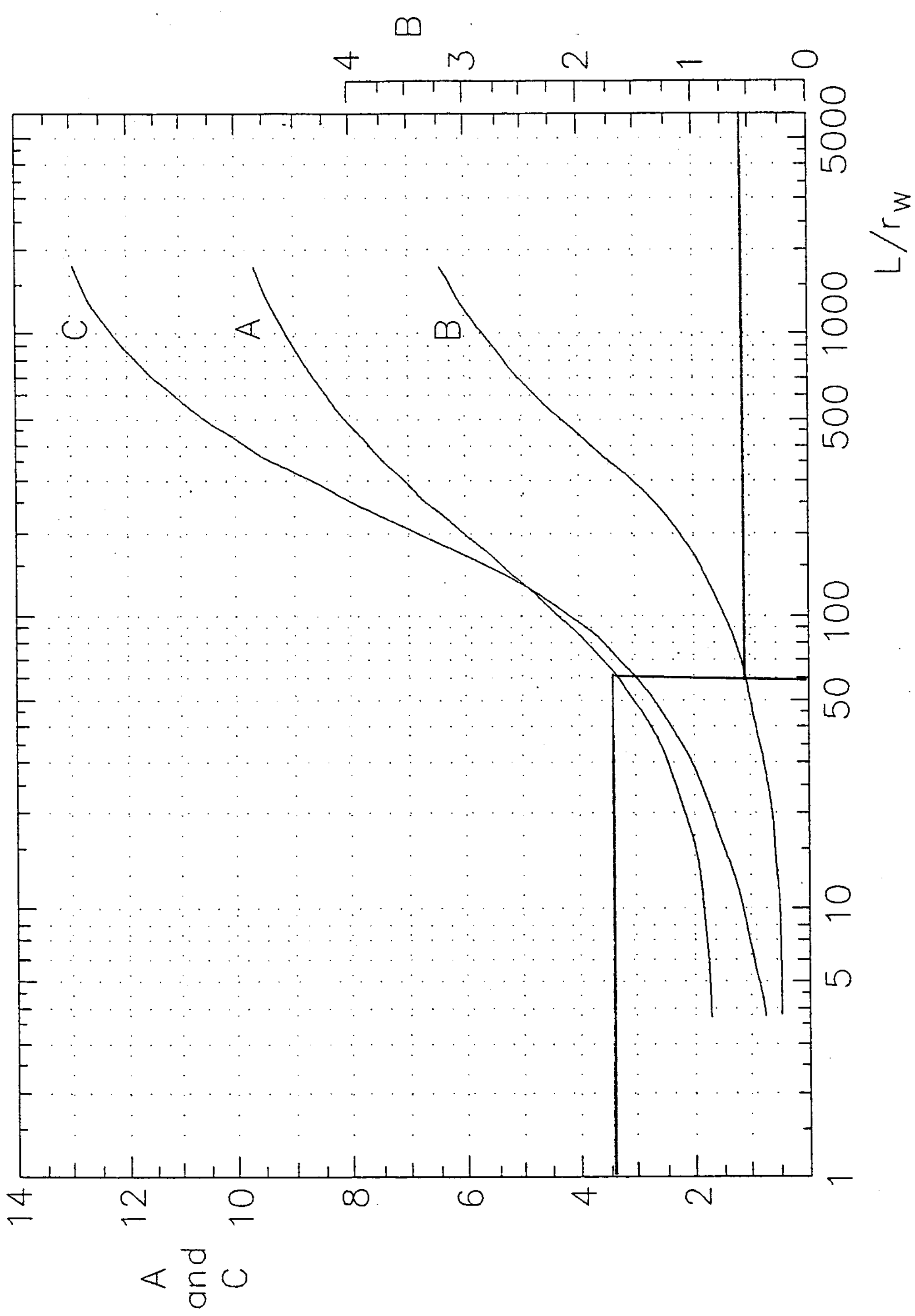
K = 0.00602 Ft/Min or 0.003058 CM/Sec

K = 8.66902 Ft/Day

Halifax Landfill Slug Test Data

Piezometer G-14 - January, 1996





Curves relating coefficients A, B, and C to L/r_w

FROM: BOUWER, H. AND RICE, R.C., 1976: A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS.

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417 N. BOYLAN AVENUE
RALEIGH N.C. 27603
919-828-0577

COEFFICIENT CURVE MATCHPOINT
RISING HEAD AQUIFER TEST
G-14
Halifax County Landfill

Halifax G-14 Slug test data

SE1000C

Environmental Logger

01/23 21:59

Unit# 00069 Test 2

Setups: INPUT 1

Setups:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	00001
Reference	0.000
Linearity	0.120
Scale factor	20.020
Offset	-0.020
Delay mSEC	50.000

Step 0 01/23 12:17:51

Elapsed Time	INPUT 1
0	0.012
0.0033	0.012
0.0066	0.012
0.01	0.012
0.0133	0.012
0.0166	0.012
0.02	0.012
0.0233	0.012
0.0266	0.012
0.03	0.012
0.0333	0.012
0.0366	0.044
0.04	1.971
0.0433	3.468
0.0466	2.767
0.05	2.957
0.0533	3.613
0.0566	2.881
0.06	3.632
0.0633	3.392
0.0666	3.443
0.07	3.405
0.0733	3.373
0.0766	3.342
0.08	3.323
0.0833	3.304
0.0866	3.285
0.09	3.247
0.0933	3.209

Halifax G-14 Slug Test Data
Page 2

Elapsed Time	INPUT 1
0.0966	3.197
0.1	3.197
0.1033	3.197
0.1066	3.146
0.11	3.14
0.1133	3.14
0.1166	3.096
0.12	3.077
0.1233	3.064
0.1266	3.039
0.13	3.026
0.1333	3.032
0.1366	3.001
0.14	2.988
0.1433	2.976
0.1466	2.963
0.15	2.957
0.1533	2.931
0.1566	2.912
0.16	2.906
0.1633	2.9
0.1666	2.874
0.17	2.868
0.1733	2.849
0.1766	2.843
0.18	2.83
0.1833	2.824
0.1866	2.811
0.19	2.799
0.1933	2.786
0.1966	2.773
0.2	2.767
0.2033	2.754
0.2066	2.742
0.21	2.736
0.2133	2.723
0.2166	2.717
0.22	2.704
0.2233	2.691
0.2266	2.685
0.23	2.672
0.2333	2.666
0.2366	2.653
0.24	2.647
0.2433	2.634
0.2466	2.622

Halifax G-14 Slug Test Data
Page 3

Elapsed Time	INPUT 1
0.25	2.609
0.2533	2.603
0.2566	2.59
0.26	2.584
0.2633	2.571
0.2666	2.565
0.27	2.559
0.2733	2.546
0.2766	2.54
0.28	2.527
0.2833	2.521
0.2866	2.508
0.29	2.502
0.2933	2.489
0.2966	2.483
0.3	2.477
0.3033	2.47
0.3066	2.458
0.31	2.451
0.3133	2.439
0.3166	2.432
0.32	2.426
0.3233	2.413
0.3266	2.407
0.33	2.401
0.3333	2.394
0.35	2.35
0.3666	2.306
0.3833	2.268
0.4	2.23
0.4166	2.192
0.4333	2.154
0.45	2.116
0.4666	2.085
0.4833	2.047
0.5	2.015
0.5166	1.984
0.5333	1.952
0.55	1.921
0.5666	1.895
0.5833	1.864
0.6	1.832
0.6166	1.807
0.6333	1.782
0.65	1.75
0.6666	1.725
0.6833	1.699
0.7	1.674
0.7166	1.655
0.7333	1.63

Halifax G-14 Slug Test Data
Page 4

Elapsed Time	INPUT 1
0.75	1.605
0.7666	1.586
0.7833	1.56
0.8	1.542
0.8166	1.516
0.8333	1.497
0.85	1.478
0.8666	1.459
0.8833	1.434
0.9	1.415
0.9166	1.396
0.9333	1.377
0.95	1.358
0.9666	1.346
0.9833	1.327
1	1.308
1.2	1.099
1.4	0.954
1.6	0.827
1.8	0.726
2	0.644
2.2	0.575
2.4	0.518
2.6	0.461
2.8	0.423
3	0.385
3.2	0.353
3.4	0.322
3.6	0.303
3.8	0.278
4	0.259
4.2	0.246
4.4	0.233
4.6	0.221
4.8	0.208
5	0.195
5.2	0.189
5.4	0.183
5.6	0.176
5.8	0.17
6	0.164
6.2	0.158
6.4	0.151
6.6	0.151
6.8	0.145
7	0.139
7.2	0.139
7.4	0.132
7.6	0.132
7.8	0.126

Halifax G-14 Slug Test Data
Page 5

Elapsed Time	INPUT 1
8	0.126
8.2	0.12
8.4	0.12
8.6	0.12
8.8	0.12
9	0.113
9.2	0.113
9.4	0.113
9.6	0.113
9.8	0.107
10	0.107
12	0.107
14	0.094
16	0.088
18	0.094
20	0.094
22	0.088
24	0.088
26	0.088
28	0.082
30	0.075
32	0.082
34	0.082
36	0.082
38	0.082
40	0.082
42	0.082
44	0.088
46	0.088
48	0.088
50	0.088
52	0.094

G. N. Richardson and Associates

Client:	Halifax County	**Proj. No.**	Halifax-4
		Sheet:	1/1
Project:	Halifax County Landfill	**Date:**	1/96
		Well:	G-15
		Reference:	Bouwer, 1989

ln[Re/Rw] = [1.1/ln(Lw/Rw) + A + Bln[(H-Lw)/Rw]/Le/Rw] exp -1

Where:

Lw = Height of Water Column in Well =	31.33
Le = Screened Interval Open to Aquifer =	10
Rw = Radius of Well Including Sand Pack =	0.43
Rc = Radius of Well Casing =	0.083
H = Aquifer Thickness to First Aquitard =	35
Yo = Relative Height of Water at Time Zero	1
Yt = Relative Height of Water at Time t =	0.5
n = Porosity =	0.15
Time Tt (in minutes) =	10
H - Lw =	3.67
Yo/Yt =	2
Lw/Rw =	72.8604651
ln(H-Lw)/Rw =	2.14416173

Correction for Sandpack:

Req = [Rc exp2 + n(Rw exp2 + Rc exp2)] exp1/2

Req = 1

Req = 1

Evaluation of A and B:

Le/Rw = 23.25581

From Attached Graph of A and B:

A =	2.3
B =	0.3

ln Re/Rw = [1.1/ln Lw/Rw + A + B ln[(H-Lw)/Rw] / Le/Rw] exp-1

ln Re/Rw= 2.5841569 exp-1

ln Re/Rw= 0.3869734

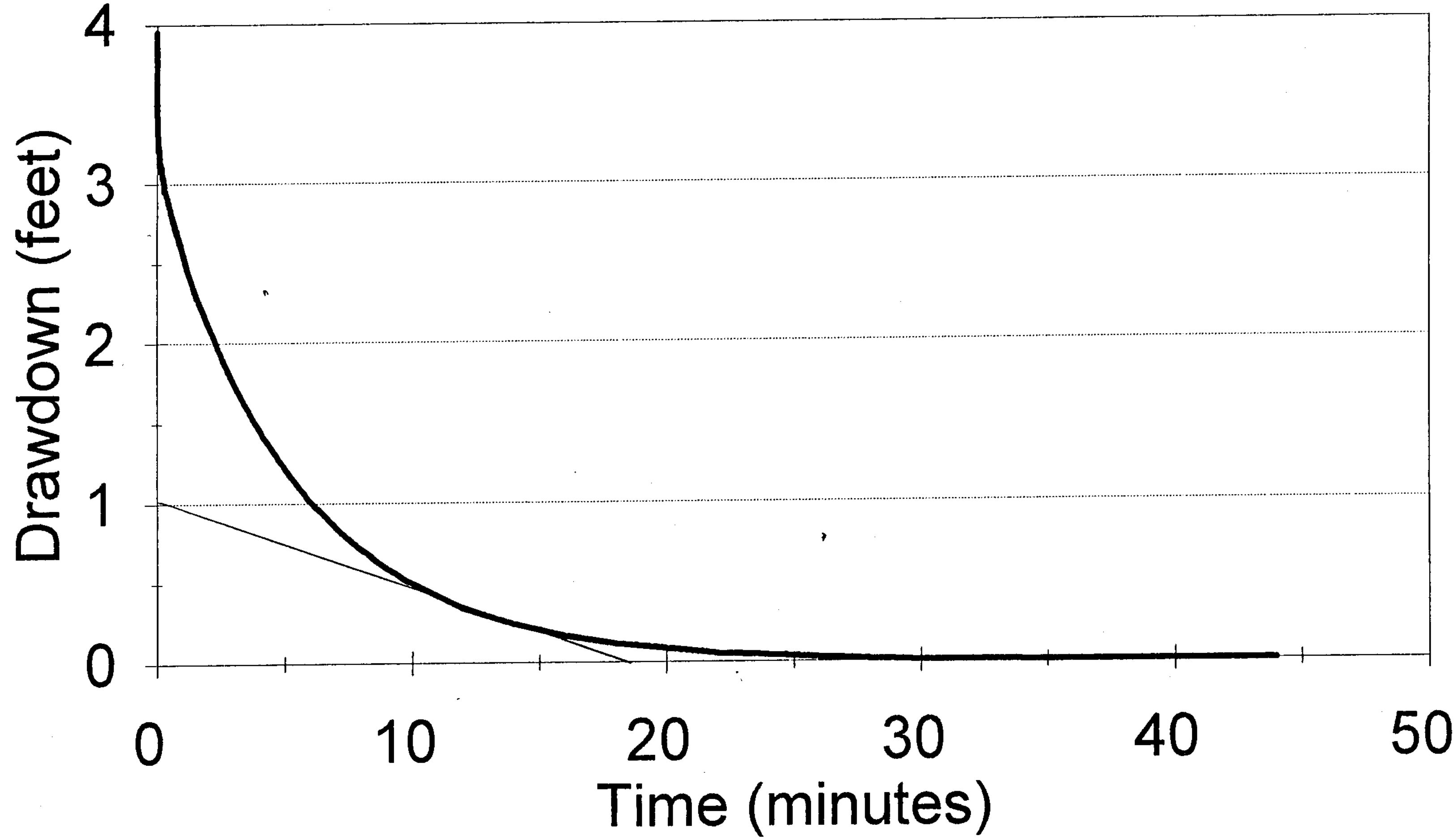
K = (Req) exp2 ln(Re/Rw)1/Tt ln(Yo/Yt) /2Le

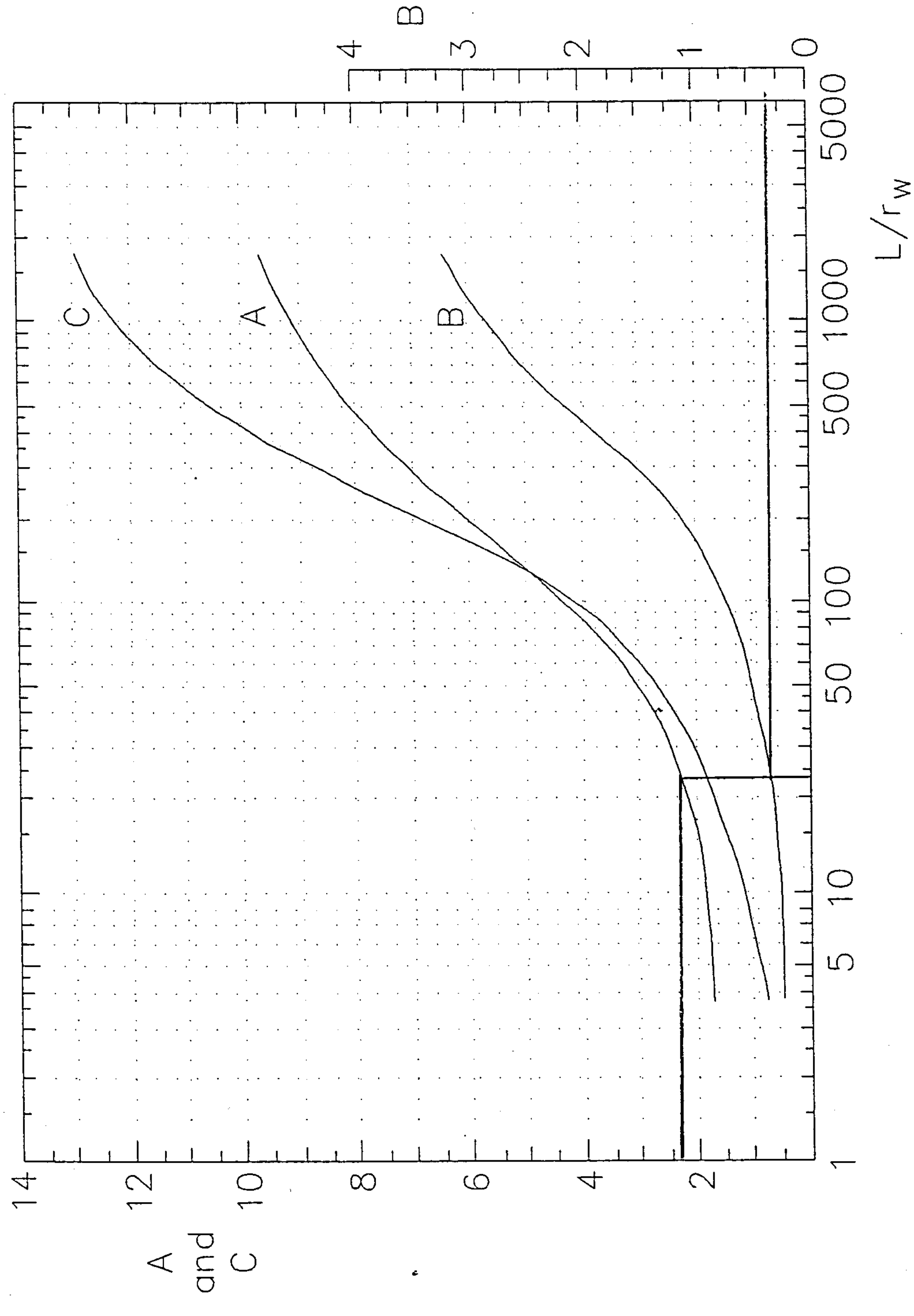
K = 0.001341 Ft/Min or 0.000681 CM/Sec

K = 1.931253 Ft/Day

Halifax Landfill Slug Test Data

Piezometer G-15 - January, 1996





Curves relating coefficients A, B, and C to L/r_w

FROM: BOUWER, H. AND RICE, R.C., 1976: A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS.

G.N. RICHARDSON & ASSOC.
417 N. BOYLAN AVENUE
RALEIGH N.C. 27603
919-828-0577

COEFFICIENT CURVE MATCHPOINT
RISING HEAD AQUIFER TEST

Halifax Landfill

G-15

Halifax G-15 Data - Slug Test 1/24/96
SE1000C
Environmental Logger
01/24 20:44

Unit# 00069 Test 3

Setups:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	00001

Reference	0.000
Linearity	0.120
Scale factor	20.020
Offset	-0.020
Delay mSEC	50.000

Step 0 01/24 13:27:13

Elapsed Time	INPUT 1
0.0000	0.126
0.0033	0.101
0.0066	1.447
0.0100	4.886
0.0133	4.607
0.0166	4.067
0.0200	2.405
0.0233	3.953
0.0266	3.427
0.0300	3.439
0.0333	3.427
0.0366	3.414
0.0400	3.382
0.0433	3.389
0.0466	3.370
0.0500	3.363
0.0533	3.344
0.0566	3.351
0.0600	3.313
0.0633	3.294
0.0666	3.294
0.0700	3.275
0.0733	3.275
0.0766	3.300
0.0800	3.256
0.0833	3.249
0.0866	3.211
0.0900	3.256
0.0933	3.218
0.0966	3.160

Halifax G-15 Slug Test Data Page 2

Elapsed Time	INPUT 1
0.1000	3.211
0.1033	3.192
0.1066	3.135
0.1100	3.180
0.1133	3.198
0.1166	3.160
0.1200	3.192
0.1233	3.122
0.1266	3.148
0.1300	3.167
0.1333	3.160
0.1366	3.122
0.1400	3.160
0.1433	3.148
0.1466	3.122
0.1500	3.110
0.1533	3.129
0.1566	3.110
0.1600	3.097
0.1633	3.135
0.1666	3.116
0.1700	3.084
0.1733	3.090
0.1766	3.116
0.1800	3.097
0.1833	3.084
0.1866	3.078
0.1900	3.110
0.1933	3.090
0.1966	3.084
0.2000	3.078
0.2033	3.097
0.2066	3.078
0.2100	3.072
0.2133	3.103
0.2166	3.065
0.2200	3.072
0.2233	3.078
0.2266	3.097
0.2300	3.065
0.2333	3.052
0.2366	3.059
0.2400	3.052
0.2433	3.046
0.2466	3.040
0.2500	3.040
0.2533	3.027

Halifax G-15 Slug Test Data Page 3

Elapsed Time	INPUT 1
0.2566	3.034
0.2600	3.034
0.2633	3.027
0.2666	3.027
0.2700	3.027
0.2733	3.021
0.2766	3.021
0.2800	3.002
0.2833	3.008
0.2866	3.008
0.2900	2.995
0.2933	2.989
0.2966	2.957
0.3000	2.995
0.3033	3.008
0.3066	2.995
0.3100	2.964
0.3133	2.995
0.3166	2.964
0.3200	2.989
0.3233	2.989
0.3266	2.976
0.3300	2.983
0.3333	2.976
0.3500	2.957
0.3666	2.951
0.3833	2.938
0.4000	2.944
0.4166	2.919
0.4333	2.906
0.4500	2.894
0.4666	2.881
0.4833	2.875
0.5000	2.862
0.5166	2.856
0.5333	2.843
0.5500	2.830
0.5666	2.818
0.5833	2.811
0.6000	2.799
0.6166	2.792
0.6333	2.780
0.6500	2.773
0.6666	2.761
0.6833	2.754
0.7000	2.742
0.7166	2.735

Halifax G-15 Slug Test Data Page 4

Elapsed Time	INPUT 1
0.7333	2.723
0.7500	2.716
0.7666	2.710
0.7833	2.704
0.8000	2.691
0.8166	2.685
0.8333	2.678
0.8500	2.666
0.8666	2.653
0.8833	2.646
0.9000	2.640
0.9166	2.628
0.9333	2.621
0.9500	2.615
0.9666	2.602
0.9833	2.596
1.0000	2.589
1.2000	2.462
1.4000	2.367
1.6000	2.278
1.8000	2.196
2.0000	2.120
2.2000	2.044
2.4000	1.967
2.6000	1.897
2.8000	1.828
3.0000	1.764
3.2000	1.701
3.4000	1.638
3.6000	1.580
3.8000	1.523
4.0000	1.472
4.2000	1.415
4.4000	1.364
4.6000	1.320
4.8000	1.269
5.0000	1.225
5.2000	1.181
5.4000	1.142
5.6000	1.098
5.8000	1.060
6.0000	1.022
6.2000	0.984
6.4000	0.958
6.6000	0.920
6.8000	0.889
7.0000	0.857
7.2000	0.825
7.4000	0.793

Halifax G-15 Slug Test Data Page 5

Elapsed Time	INPUT 1
7.6000	0.768
7.8000	0.742
8.0000	0.717
8.2000	0.692
8.4000	0.666
8.6000	0.641
8.8000	0.616
9.0000	0.596
9.2000	0.577
9.4000	0.558
9.6000	0.533
9.8000	0.514
10.0000	0.501
12.0000	0.342
14.0000	0.241
16.0000	0.165
18.0000	0.114
20.0000	0.082
22.0000	0.050
24.0000	0.038
26.0000	0.025
28.0000	0.018
30.0000	0.006
32.0000	0.006
34.0000	0.006
36.0000	0.000
38.0000	0.000
40.0000	0.000
42.0000	0.000
44.0000	0.000

G. N. Richardson and Associates

Client:	Halifax County	**Proj. No.**	Halifax-4
		Sheet:	1/1
Project:	Halifax County Landfill	**Date:**	1/96
		Well:	G-16
		Referenc	Bouwer, 1989

ln[Re/Rw] = [1.1/ln(Lw/Rw) + A + Bln[(H-Lw)/Rw]/Le/Rw] exp -1

Where:	Lw = Height of Water Column in Well =	12.82
	Le = Screened Interval Open to Aquifer =	10
	Rw = Radius of Well Including Sand Pack	0.167
	Rc = Radius of Well Casing =	0.083
	H = Aquifer Thickness to First Aquitard =	25
	Yo = Relative Height of Water at Time Zer	1.5
	Yt = Relative Height of Water at Time t =	0.5
	n = Porosity =	0.2
	Time Tt (in minutes) =	2
	H - Lw =	12.18
	Yo/Yt =	3
	Lw/Rw =	76.76647
	ln(H-Lw)/Rw =	4.289557

Correction for Sandpack:

Req = [Rc exp2 + n(Rw exp2 + Rc exp2)] exp1/2

Req = 1

Req = 1

Evaluation of A and B:

Le/Rw = 59.88024

From Attached Graph of A and B:

A =	3.5
B =	0.6

ln Re/Rw = [1.1/ln Lw/Rw + A + B ln[(H-Lw)/Rw] / Le/Rw] exp-1

ln Re/Rw= 3.796393 exp-1

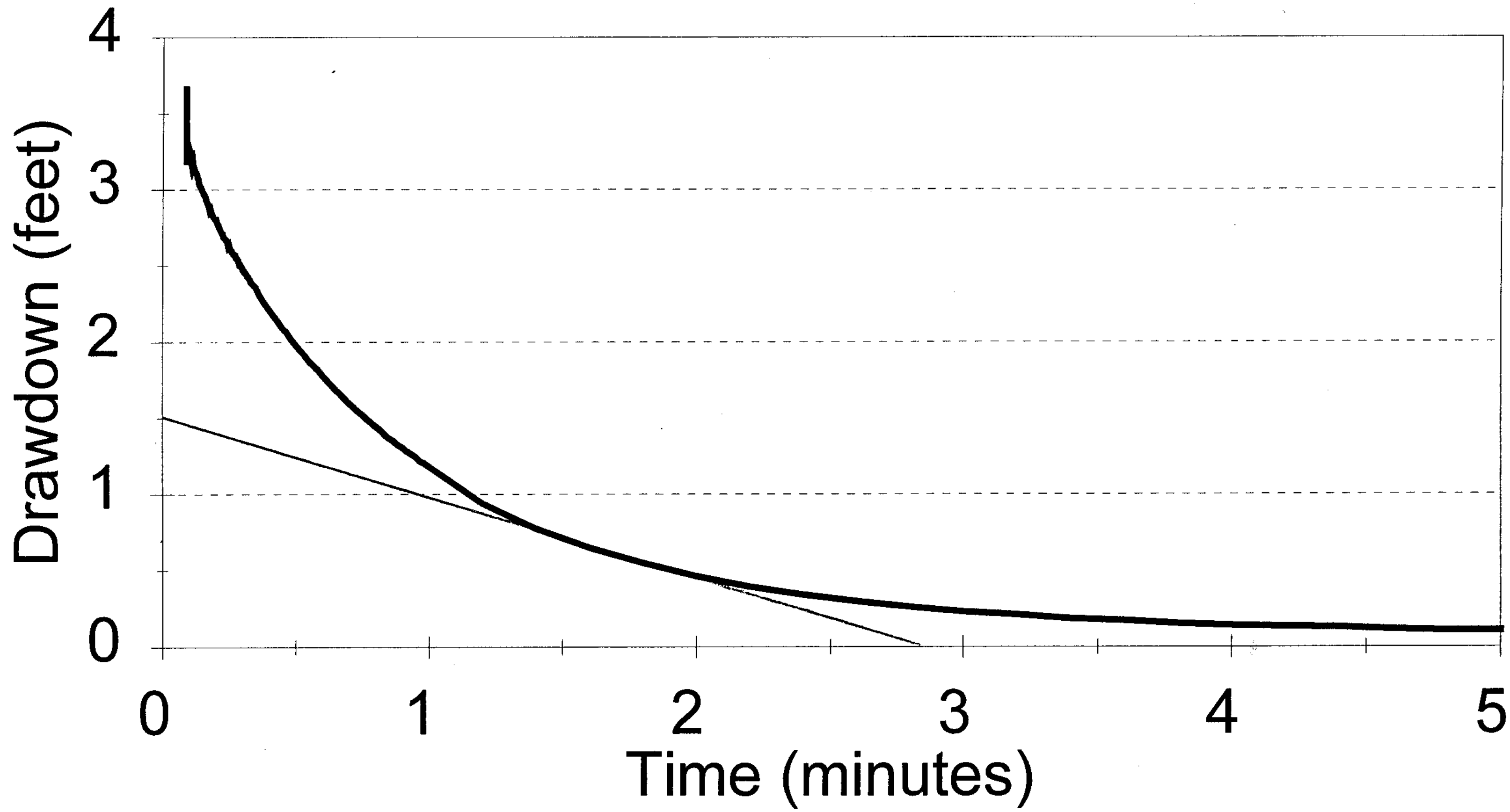
ln Re/Rw= 0.263408

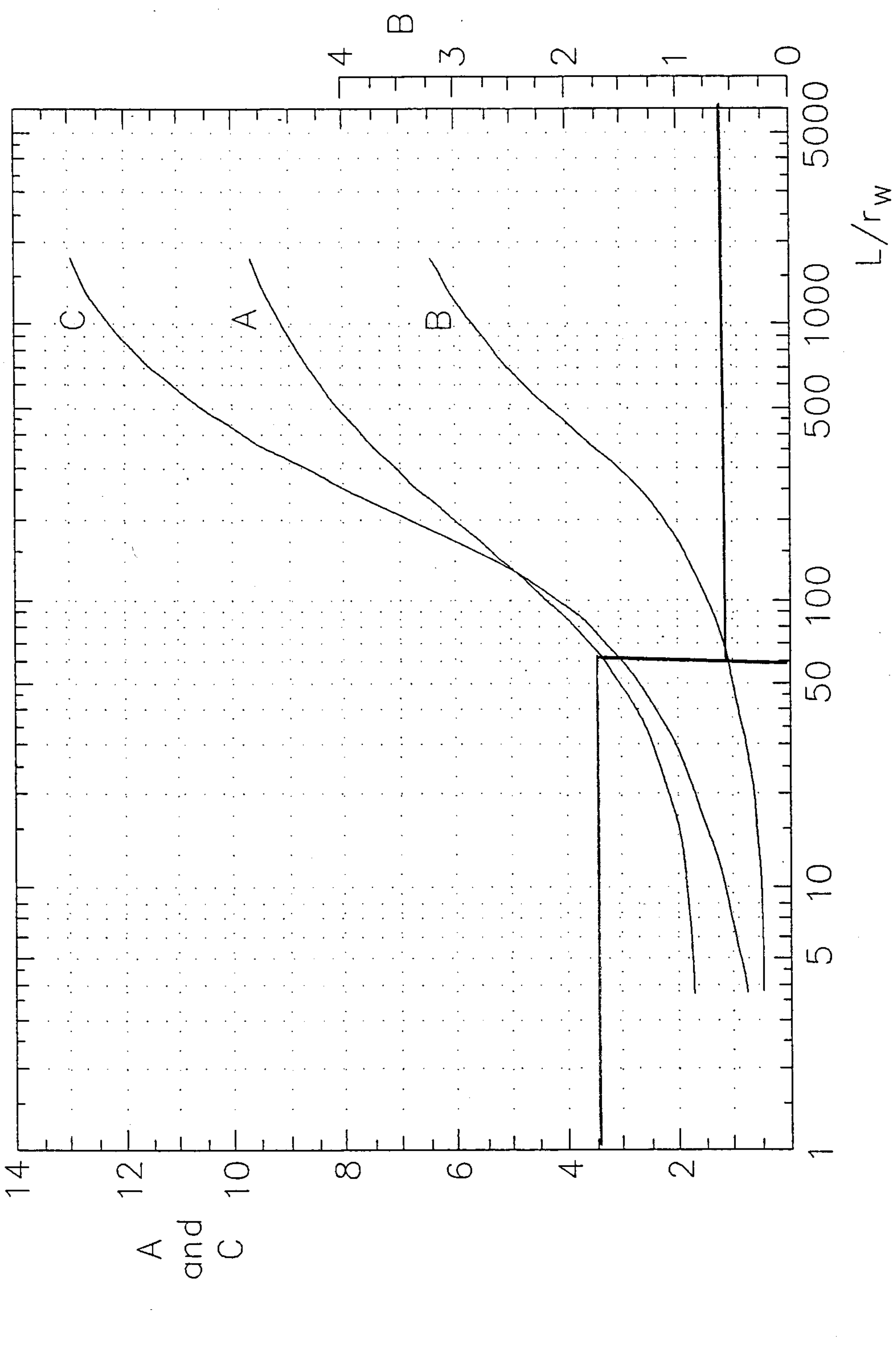
K = (Req) exp2 ln(Re/Rw)1/Tt ln(Yo/Yt) /2Le

K =	0.007235 Ft/Min	or	0.003675	CM/Sec
K =	10.4178 Ft/Day			

Halifax Landfill Slug Test Data

Piezometer G-16 - January, 1996





Curves relating coefficients A, B, and C to L/r_w

FROM: BOUWER, H. AND RICE, R.C., 1976: A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS.

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417 N. BOYLAN AVENUE
RALEIGH N.C. 27603
919-828-0577

COEFFICIENT CURVE MATCHPOINT
RISING HEAD AQUIFER TEST
G-16
Halifax County Landfill

Halifax G-16 Slug test data

SE1000C

Environmental Logger

01/23 21:59

Unit# 00069 Test 2

Setups:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	00001
Reference	0.000
Linearity	0.120
Scale factor	20.020
Offset	-0.020
Delay mSEC	50.000

Step 0 01/23 12:17:51

Elapsed Time	INPUT 1
0	0.006
0.0033	0
0.0066	0
0.01	0
0.0133	0
0.0166	0
0.02	0
0.0233	0
0.0266	0
0.03	0.006
0.0333	0.474
0.0366	1.144
0.04	1.694
0.0433	2.502
0.0466	2.167
0.05	3.317
0.0533	3.633
0.0566	4.41
0.06	2.648
0.0633	3.532
0.0666	3.64
0.07	2.193
0.0733	2.136
0.0766	2.193
0.08	2.995
0.0833	3.659
0.0866	3.665
0.09	3.172
0.0933	3.305

Halifax G-16 Slug Test Data
Page 2

Elapsed Time	INPUT 1
0.0966	3.286
0.1	3.261
0.1033	3.229
0.1066	3.197
0.11	3.166
0.1133	3.191
0.1166	3.159
0.12	3.122
0.1233	3.115
0.1266	3.109
0.13	3.084
0.1333	3.071
0.1366	3.039
0.14	3.027
0.1433	3.02
0.1466	3.008
0.15	2.995
0.1533	2.983
0.1566	2.957
0.16	2.951
0.1633	2.932
0.1666	2.913
0.17	2.907
0.1733	2.888
0.1766	2.863
0.18	2.869
0.1833	2.856
0.1866	2.837
0.19	2.831
0.1933	2.818
0.1966	2.806
0.2	2.806
0.2033	2.787
0.2066	2.774
0.21	2.768
0.2133	2.749
0.2166	2.742
0.22	2.73
0.2233	2.717
0.2266	2.711
0.23	2.692
0.2333	2.679
0.2366	2.673
0.24	2.667
0.2433	2.654
0.2466	2.629

Halifax G-16 Slug Test Data
Page 3

Elapsed Time	INPUT 1
0.25	2.635
0.2533	2.622
0.2566	2.61
0.26	2.603
0.2633	2.591
0.2666	2.584
0.27	2.578
0.2733	2.572
0.2766	2.553
0.28	2.547
0.2833	2.54
0.2866	2.528
0.29	2.509
0.2933	2.509
0.2966	2.496
0.3	2.49
0.3033	2.477
0.3066	2.471
0.31	2.458
0.3133	2.452
0.3166	2.439
0.32	2.433
0.3233	2.427
0.3266	2.414
0.33	2.408
0.3333	2.395
0.35	2.357
0.3666	2.306
0.3833	2.262
0.4	2.218
0.4166	2.18
0.4333	2.136
0.45	2.098
0.4666	2.06
0.4833	2.022
0.5	1.984
0.5166	1.946
0.5333	1.915
0.55	1.877
0.5666	1.845
0.5833	1.814
0.6	1.782
0.6166	1.75
0.6333	1.719
0.65	1.687
0.6666	1.656
0.6833	1.63
0.7	1.599
0.7166	1.573
0.7333	1.548

Halifax G-16 Slug Test Data
Page 4

Elapsed Time	INPUT 1
0.75	1.523
0.7666	1.498
0.7833	1.472
0.8	1.447
0.8166	1.422
0.8333	1.396
0.85	1.371
0.8666	1.352
0.8833	1.327
0.9	1.308
0.9166	1.283
0.9333	1.264
0.95	1.245
0.9666	1.22
0.9833	1.201
1	1.182
1.2	0.941
1.4	0.777
1.6	0.651
1.8	0.55
2	0.461
2.2	0.392
2.4	0.341
2.6	0.297
2.8	0.259
3	0.227
3.2	0.208
3.4	0.183
3.6	0.17
3.8	0.151
4	0.139
4.2	0.132
4.4	0.126
4.6	0.113
4.8	0.107
5	0.107
5.2	0.101
5.4	0.094
5.6	0.094
5.8	0.088
6	0.088
6.2	0.082
6.4	0.082
6.6	0.082
6.8	0.082
7	0.075
7.2	0.075
7.4	0.075
7.6	0.075
7.8	0.069

Halifax G-16 Slug Test Data
Page 5

Elapsed Time	INPUT 1
8	0.069
8.2	0.069
8.4	0.069
8.6	0.069
8.8	0.069
9	0.069
9.2	0.069
9.4	0.063
9.6	0.069
9.8	0.063
10	0.063
12	0.063
14	0.063
16	0.063
18	0.063
20	0.063
22	0.063
24	0.056
26	0.063
28	0.056
30	0.056
32	0.056
34	0.056
36	0.056
38	0.056
40	0.056
42	0.056
44	0.056
46	0.056
48	0.056
50	0.05

Appendix J

Sampling and Analysis Plan
Halifax County Lined Landfill Expansion (Phase I Cell)

Halifax, North Carolina

Prepared for:
Halifax County
Department of Public Works
Halifax, North Carolina

The water quality monitoring plan for this facility has been prepared by a qualified geologist who is licensed to practice in the state of North Carolina. The plan has been prepared based on knowledge of site conditions and familiarity with North Carolina solid waste rules and industry standard protocol. The water quality monitoring plan described herein should provide reasonably effective early detection of a chronic release of hazardous constituents into the ground or surface waters of the state, due to or caused by activities at the landfill. No other warranties, expressed or implied, are made.

Joan A. Finkbeiner, ~~P.G.~~
Project Hydrogeologist

G. David Garrett, P.G.
Principal, Senior Geologist

NORTH CAROLINA LICENSED SEAL 983 GEOLOGIST G. DAVID GARRETT
10/14/96

October, 1996

G.N. Richardson & Associates
Engineering and Geological Services
417 N. Boylan Avenue
Raleigh, North Carolina 27603

TABLE OF CONTENTS

1.0 Introduction

1.1 Background

The North Carolina Solid Waste Rules, Section 13B.1631 and Section 258.53 of Subtitle D, Subpart E specifies that the owner/operator must provide, as part of the ground water monitoring program, a ground water and surface water sampling and analysis plan (S.A.P.). The S.A.P. should be designed to provide accurate results of groundwater quality at the upgradient and downgradient sampling locations. The S.A.P. will address the following subjects:

- Groundwater sample collection
- Sample preservation and shipment
- Analytical procedures
- Chain-of-custody
- Quality assurance/quality control (QA/QC).

The methods and procedures described in the following sections are intended to gather true and representative samples and test data. Field procedures are presented in their general order of implementation. Equipment requirements are presented in each section, and quality assurance and record keeping requirements are presented in the latter sections. Strict adherence to these procedures is required.

2.0 Ground and Surface Water Sample Collection

Table 1 presents a summary description of ground water monitoring well (total of 7) and surface water sampling point (total of 4) locations for Phase 1. A map depicting the monitoring well locations is included as Figure 1. Ground water samples will be collected from each of the monitor wells and from the surface water sampling locations. The proposed frequency of sampling events will be at least semi-annually in accordance with existing State regulations and is based on the landfill design and site hydrogeologic conditions. Four baseline sampling events will occur in the first semi-annual period. Three of the ground water monitoring wells have previously been installed, and the remaining four will be installed during Phase 1 construction.

2.1 Static Water Level Measurements

Static water level elevations will be measured prior to any purging or sampling activities. Static water level data will be used to monitor changes in site hydrogeologic conditions. The following measurements will be recorded in a dedicated field book prior to sample collection:

- Elevation of water level (to the nearest 0.01 foot)
- Total depth of well
- Height of water column in the riser
- Changes in condition of well and surroundings.

An electronic water level indicator will be used to accurately measure water elevations to within 0.01 foot. Each well will have a permanent, easily identified reference point from which all water level measurements will be taken. The reference point will be marked and the elevation surveyed by a Registered Land Surveyor. The static water level and total depth will be used to calculate the volume of water in the well.

The static water measuring device will be constructed of inert materials such as stainless steel and Teflon. Between well measurements the device will be thoroughly decontaminated by washing with non-phosphate soap and triple rinsing with deionized water to prevent cross contamination from one well to another.

2.2 Detection of Immiscible Layers

The screened portion of the well will intersect the water table, which will allow for the detection of light nonaqueous phase liquids (LNAPLS) prior to sampling. Since this is a new facility, and immiscible layers should not be present, only upon detection of impacted ground water will the following procedures be used to detect immiscible layers.

Should impacted ground water be detected, an interface probe will be used to detect the existence of any light or dense phase immiscible fluids. The probe will be lowered into the well and will identify the presence of an immiscible layer. The depth of the light phase immiscible layer, if present, will then be recorded in a dedicated field logbook. The interface probe will continue to be lowered until it intersects the water table. The depth of the organic/water interface will also be recorded. From these two measurements, the thickness of the light phase immiscible layer can be determined. Dense phase immiscible layer will be detected by lowering the interface probe to the bottom of the well where it will indicate the presences of any dense organic liquid compounds. All immiscible phase liquids will be removed prior to sampling

The procedure for collecting light phase immiscibles will be dependent on the depth to the surface of the floating layer and the thickness of that layer. If the thickness of the light phase is two (2) feet or greater, a bottom valve bailer will be lowered slowly until contact is made with the surface of the immiscible/water interface depth as determined by preliminary measurements with the interface probe.

If the thickness of the light phase is less than two (2) feet, a bottom valve bailer will be modified to allow the sample to enter from the top. The bottom check valve will be disassembled and a piece of 2-inch diameter fluorocarbon resin sheet will be inserted between the ball and ball seat to seal off the bottom valve and the ball from the top check valve will be removed to allow the sample to enter from the top. The buoyancy that occurs when the bailer is lowered into the light immiscible phase will be overcome by placing a length of stainless steel pipe on the retrieval line above the bailer. The bailer will be lowered, carefully measuring the depth to the surface of the light immiscible phase, until the top of the bailer is level with the top of the light immiscible phase. The bailer will be lowered and additional one-half thickness of the light immiscible phase and the sample collected.

The procedure to collecting dense phase immiscibles will be to use a double check valve bailer. The bailer will be lowered in a controlled manner, then slowly retrieved to retain the dense phase immiscible. The presence of immiscible layers at the proposed facility are not anticipated. Upon completion of one year of immiscible layer testing, initiated by the detection of impacted ground water, monitoring data will be reviewed, and the frequency and need of subsequent immiscible layer tests will be re-evaluated.

2.3 Monitor Well Evacuation

Following measurement of the static water elevation in all of the wells, individual wells will be purged of all stagnant water. The stagnant water, which is not representative of true aquifer conditions, must be removed to insure that fresh formation water can be sampled. A minimum of three well volumes will be removed prior to sampling the well. The well volume for 2-inch diameter wells will be calculated using the following equation:

$$V = (TD - SWL) \times C$$

Where:

V = One well volume

TD = Total depth of the well (in feet)

SWL = Static water level (in feet)

C = Volume constant for given well diameter (gallons/foot)

C = 0.163 gal/ft for two-inch wells.

Well completion depth data are included in Table 2. Determining the well volume in gallons will allow the sampler to determine the amount of ground water to purge in order to remove a minimum of three to five well volumes (or until the well is purged dry). Wells will be purged at a rate which will not cause recharge water to be excessively agitated. Dry and low recharge rates, and the total purged volume will be noted in field observations. Should impacted ground water be detected purge water will be managed as to prevent possible soil contamination (either through containment, or treatment on-site).

Prior to purging, new latex or nitrile surgical gloves will be donned. Each well will be purged in such a way that water is removed from the bottom of the screened interval. During the well purging process, field measurements (i.e., pH, temperature, and specific conductance) will be collected at regular intervals, and reported in a tabular format. The well will be purged until field measurements stabilize (to within 10% of each other) or until the well is dry. Stabilization of these measurements will indicate that fresh formation water is present in the well. Field measurements of pH, temperature, and conductivity will be obtained by using a combination water quality meter. Data collected will be recorded in a field log book.

A new, disposable fluorocarbon resin (Teflon) or inert plastic bailer with bottom check valve will be used to evacuate each well. A new Teflon-coated stainless steel, inert monofilament line or new nylon rope will be used to retrieve the bailer. Clean, disposable latex or nitrile surgical gloves will be used at each well, and appropriate measures will be taken to prevent surface soils and other contaminant sources from contacting the purging equipment. Non-dedicated field equipment (such as field measuring devices) will be thoroughly decontaminated between wells by disassembling and washing with (non-phosphate) soapy, de-ionized water and triple rinsed using de-ionized water.

Should dedicated pumps be used, a minimum of three to five well volumes (or until the well is purged dry) will be purged from the well utilizing a dedicated pump. If the Micro-Purge and/or Purge Saver systems are used, less water may be purged based upon these field parameters analyzed by these systems. Pumping will be completed at a flowrate the aquifer can maintain, and so as to not agitate sediments. Only stainless steel and teflon pumps will be used.

2.4 Ground Water Sample Collection

After purging activities are complete, groundwater samples will be collected for laboratory analysis. Samples will only be collected after new latex or nitrile surgical gloves have been donned. The wells will be sampled using either disposable Teflon bailers with bottom check valve, bottom emptying devices and Teflon coated wire, inert monofilament line or new nylon rope, or by the use of dedicated pumps. Sampling will occur as soon after well recovery as possible. Wells which fail to produce an adequate sample volume within 24 hours of purging will not be sampled.

Temperature, pH, and specific conductance will be taken at the start and ending of sampling as a measure of purging efficiency and as a check on the stability of the water samples over time. Measurements of temperature, pH, and specific conductivity will be recorded for all water samples. The calibration of the pH, temperature, and conductivity meter will be completed at the beginning of each sampling event, according to the manufacturers' specifications and consistent with Test Methods for Evaluating Solid Waste - Physical/Chemical Methods (SW-846).

Ground water samples will be collected and contained in the order of volatilization sensitivity of the parameters as follows:

- Initial measurements of pH, temperature and conductivity
- Volatile Organics
- Total Metals
- Turbidity
- Final measurements of pH, temperature, and conductivity

All detection monitoring samples will be collected unfiltered. Samples for dissolved metal analysis, if subsequently required, will be prepared by field filtration using a decontaminated Nalgene hand-operated filtering pump, (or equivalent), or peristaltic pump and a disposable 0.45 micron filter cartridge specifically manufactured for this purpose.

All reusable sampling equipment including meter probes, and filtering pump (if used), which might contact aquifer water or samples, will be thoroughly decontaminated between wells by washing with non-phosphate soapy, de-ionized water and triple rinsing with deionized water.

Samples will be transferred directly from the Teflon bailer into a container that has been specifically prepared for the preservation and storage of compatible parameters. A bottom

emptying device provided with the bailer will be used to transfer samples from bailer to sample container to assure minimum agitation.

Blanks and duplicate samples will be taken and analyzed for the same parameters as ground water samples to insure cross-contamination has not occurred. One set of trip blanks, as described later in this document, will be collected before leaving the laboratory to insure that the sample containers or handling processes have not affected the quality of the samples. One set of field (equipment) blanks will be collected in the field at the time of sampling to insure that the field conditions, equipment used, and handling during sampling collection have not affected the quality of the samples. A duplicate ground water sample may be collected from a single well as a check of laboratory accuracy. Blanks and duplicate containers, preservatives, handling, and transport procedures for surface water samples will be identical to those noted for ground water samples.

Sample containers shall be provided by the laboratory for each sampling event. Containers shall be cleaned by the laboratory based on the analyte of interest. Metal containers shall be thoroughly washed with non-phosphate detergent and tap water, and rinsed with (1:1) nitric acid, tap water, (1:1) hydrochloric acid, tap water, and deionized water, in that order. Organic sample containers shall be thoroughly washed with non-phosphate detergent in hot water and rinsed with tap water, distilled water, acetone, and pesticide quality hexane, in that order. Other sample containers shall be thoroughly washed with non-phosphate detergent and tap water, rinsed with tap water, and rinsed with deionized water. The laboratory shall provide proper preservatives in the sample containers prior to shipment.

2.5 Surface Water Sample Collection

Surface water samples will be obtained from areas of minimal turbulence and aeration. The following procedure will be implemented regarding sampling of surface waters:

1. Put on new latex or nitrile surgical gloves.
2. Hold the bottle in the bottom with one hand, and with the other, remove the cap.
3. Push the sample container slowly into the water and tilt up towards the current to fill. A depth of about 6 inches is satisfactory. Avoid breaching the surface while filling the container.
4. If there is little current movement, the container should be moved slowly, in a lateral direction.

2.6 Equipment Decontamination

All non-dedicated equipment that will come in contact with the well casing and water, i.e. water level indicator, will be decontaminated. The procedure for decontaminating non-dedicated equipment as follows:

1. Clean item with tap water and phosphate-free laboratory detergent (Liquinox or equivalent), using a brush if necessary to remove particulate matter and surface films.
2. Rinse thoroughly with tap water
3. Rinse thoroughly with deionized or distilled water and allow to air dry
4. Rinse thoroughly with high grade isopropanol and allow to air dry
5. Wrap with aluminum foil, if necessary, to prevent contamination of equipment during storage or transport.

3.0 Field QA/QC Program

Field Quality Assurance/Quality Control (QA/QC) requires the routine collection and analysis of two types of QC blanks, trip blanks and field blanks, to verify that the sample collection and handling process has not affected the quality of the samples. The laboratory and field crew will prepare the following sampling blanks and analyze them for all of the required monitoring parameters:

Trip Blank - Fill one of each type of sample bottle with distilled or deionized water, transport to the site, handle like a sample, and return to the laboratory for analysis. One set of trip blanks will be analyzed per sampling event. Trip blanks should be prepared by the laboratory and transported with the sample glassware prior to sampling.

Field blank - To insure that any non-dedicated sampling device has been effectively cleaned, fill the device with distilled or deionized water, while wearing clean latex or nitrile surgical gloves, transfer to sample bottles(s), and return to the laboratory for analysis. If the samples are collected with bailers, a minimum of one field blank for each day that samples are collected is required. If dedicated pumps are used for sample collection, field blank samples are not necessary.

Sampling blanks will be placed in bottles of the specific type required for the analyzed parameters and taken from a bottle pack specifically assembled by the laboratory for each ground water sampling event. Trip blanks will be taken prior to the sampling event and transported with the empty bottle packs. Field blanks will be placed in contact with field sampling equipment and returned to the laboratory in a manner identical to the handling procedure used for the samples. The blanks will be subjected to the same analyses as the ground water. Any contaminants found in the trip blanks could be attributed to: (1) interaction between the sample and the container, (2) contaminated source water, or (3) a handling procedure that alters the sample. Additionally, field blank contamination could be attributed to: (4) interaction with the sampling device, and (5) a field handling procedure which taints the retrieved sample.

The concentration levels of any contaminants found in the trip blank will be reported but will not be used to correct the ground water data. In the event that elevated parameter concentrations are found in any blank, the analysis will be flagged for future evaluation and possible resampling.

All field instruments utilized in the field to measure ground water characteristics will be calibrated prior to entering the field, and recalibrated in the field as required, to insure accurate measurement for each sample. The specific conductivity and pH meter shall be recalibrated utilizing two prepared solutions of known concentration in the range of anticipated values (between 4 and 10). A permanent thermometer, calibrated against a National Bureau of Standards Certified thermometer, will be used for temperature meter calibration.

4.0 Sample Preservation and Shipment

In order to insure sample integrity, preservation and shipment procedures will be carefully monitored. Generally, ice and chemical ice packs will be used as sample preservatives, as recommended by the commercial laboratory. Dry ice is not to be used. Proper storage and transport conditions must be maintained in order to preserve the integrity of the sample. For VOC analysis, hydrochloric acid will be used for sample preservation as well as by maintaining the samples at a temperature of 4°C. Nitric acid will be used as the preservative for samples needing metals analysis. Samples shall be delivered to the analytical laboratory within a 24-hour period using an overnight delivery service, if needed, to insure holding times are not exceeded. Shipment and receipt of samples will be coordinated with the laboratory.

Once collected, samples will be placed on ice and cooled to a temperature of 4°C. Samples are to be packed in high impact polystyrene coolers so as to inhibit breakage or accidental spills. Custody seals shall be placed on the outside of the cooler, in a manner to detect tampering of the samples. Chain-of-Custody control for all samples will consist of the following:

1. Labels will be placed on individual sample containers in the field, indicating the site, time of sampling, date of sampling, well number, and preservation method used for the sample.

2. Sample containers will be individually secured or placed in a secured area in iced coolers and will remain in the continuous possession of the field technician until transferral as provided by the Chain-of-Custody form has occurred.

3. Upon delivery to the laboratory, samples are given laboratory sample numbers and recorded into a logbook indicating client, well number, and date and time of delivery. The laboratory director or his designatee will sign the Chain-of-Custody control forms and formally receive the samples. The field technician, project manager and the laboratory director will work together to insure that proper refrigeration of the samples is maintained.

5.0 Field Logbook

The field technician will keep an up-to-date logbook documenting important information pertaining to the technician's field activities. The field logbook will document the following:

- Site Name and Location
- Date and Time of Sampling
- Climatic Conditions Immediately Before and After Sampling Event
- Well Identification Number
- Presence of Immiscible Layers and Detection Method
- Well Static Water Level
- Well Depth
- Height of Water Column in Well
- Volume of Three (3) Well Volumes
- Volume of Five (5) Well Volumes
- Purged Water Volume and Well Yield (High or Low)
- Pumping or Bailing Rate
- Time Well Purged
- Observations on Purging and Sampling Event
- Time of Sample Collection
- Temperature, pH, Turbidity, and Conductivity Readings (4x)
- Signature of Field Technician.

6.0 Laboratory Analysis

The ground water parameters to be analyzed will be those specified in the sanitary landfill permit, and/or North Carolina Solid Waste Management Rules. These will include field indicators of ground water quality (pH, conductivity, and temperature) and selected volatile organic and total metal constituents as listed in Appendix I of 40 CFR.258. All analytical methods are taken from Test Methods For Evaluating Solid Waste - Physical/Chemical Methods (SW-846) or Methods For the Chemical Analysis of Water and Wastes. Analysis will be performed by a laboratory certified by the North Carolina DEHNR for the analyzed parameters.

Quality Assurance/Quality Control (QA/QC) procedures are to be utilized at all times. The

Table 2

Estimated Monitoring Well Completion Data

Halifax County Lined Landfill (Phase 1)

June 1996

Monitoring Well	Top of Casing Elevation	Est. Depth to Bottom, ft.	Screened Interval, ft.
MW-1	324.6	40	25.0 - 40.0
MW-17 (G-9)	310.35	40	30.0 - 40.0
MW-18	TBD	25*	10.0 - 25.0*
MW-19	TBD	20*	5.0 - 20.0*
MW-20	252.84	20	10.0 - 20.0
MW-21s	TBD	20*	5.0 - 20.0*
MW-21d	TBD	40*	25.0 - 40.0*

Notes: *Estimated based on nearest available piezometer data presented in May 1996 Hydrogeology Report. Actual completed values to be determined based on actual field conditions. This table will be amended with actual values once the well installation is complete.

TBD = To Be Determined

Table 1

Ground Water and Surface Water Monitoring Plan
Monitoring Well and Stream Sampling Locations

Halifax County Lined Landfill (Phase 1)

June 1996

Monitoring Wells for Phase 1 Lined Landfill	Location and Justification of Placement	Proposed Installation
MW-1	Existing Up-gradient Well	Previously Installed
MW-17	New Up-gradient Well	Convert Existing Piez. G-9
MW-18	Cross-gradient of Phase 1	New Well near Piez. H-3
MW-19	Cross-gradient of Phase 1	New Well near Piez. H-6
MW-20	Below Leachate Tank	Convert Existing Piez. G-13
MW-21s	Down-gradient of Phase 1	New Well near Piez. G-15
MW-21d	Down-gradient of Phase 1	New Well near Piez. G-15
Stream Sampling Point (Entire Facility)	**Location and Justification of Placement**	**Proposed Placement**
SW-1A	Up-gradient of Unlined MSWLF Unit	Replaces SW-1 (Moves Further Upstream)
SW-2	Down-gradient of Facility along Property Line	Exising Sampling Location (Already Monitored)
SW-3A	Up-gradient of Lined and Unlined MSWLF Units	Replaces SW-3 (Moves Further Uptream)
SW-4	Down-gradient of Unlined MSWLF Unit	New Sampling Location (Near Current SW-1)
SW-5	Down-gradient of Lined and Unlined MSWLF Units	New Sampling Location

Other monitoring wells exist within the facility boundary for the ash monfil and the unlined MSWLF unit. As these units are presently monitored separately, monitoring well descriptions are not provided here.

All monitoring wells shall be installed under the supervision of a geologist or engineer who is registered in North Carolina and who will certify to the NCDSWM that the installation complies with the North Carolina Regulations. Upon installation of future wells the documentation for the construction of each well will be submitted by the registered geologist or engineer within 30 days after well construction.

8.4 Implementation Schedule

The Ground Water Monitoring Program and sampling and analysis will be implemented upon approval of the Ground Water Monitoring Program and construction of site wells. Analyses have been performed four times during the first semi-annual event, and will be performed once semi-annually throughout the active life and post-closure monitoring period of the landfill, unless an alternate sampling schedule is accepted by the DSWM.

8.0 Record Keeping and Reporting

8.1 Notifications

Should a statistically significant increase in ground water concentrations as defined in North Carolina Solid Waste Rules be detected during monitoring, the owner/operator of the landfill shall notify the North Carolina DEHNR within 14 days and will place a notice in the operating record as to which constituents increased. At this point the owner/operator and the North Carolina DEHNR may negotiate assessment requirements.

8.2 Well Abandonment/Rehabilitation

Should wells become irreversibly damaged or require rehabilitation, the North Carolina DEHNR shall be notified. If monitoring wells and/or piezometers are damaged irreversibly they shall be abandoned under the direction of the North Carolina DEHNR. The abandonment will consist of plugging the well with a chemically inert sealant which is impermeable, such as neat cement and/or bentonite clay. Where possible, it is preferred to overdrill and remove well casing, screen and filter pack prior to grouting.

8.3 Additional Well Installations

The static ground water surface elevation shall be used to create potentiometric maps to determine exact locations for future monitoring wells and verify the correct placement of existing wells. If the potentiometric maps reveal that the depths, location, or number of wells is insufficient to monitor potential releases of solid waste constituents from the solid waste management area, new well locations and depths will be submitted to the NCDSWM for approval.

Methods to evaluate the data are taken from North Carolina Solid Waste Rules, 40 CFR 258.53g and the EPA RCRA Ground Water Monitoring Draft Technical Guidance Document. The North Carolina Solid Waste Rules requires that the owner or operator of the landfill specify a statistical method outlined in these rules to evaluate ground water monitoring data. The goal of the statistical analysis is to determine whether statistically significant evidence of contamination exists and to identify the point of contamination. Upon receipt of each monitoring event's data, the statistical database of analyses will be updated. The North Carolina Solid Waste Rules provide several methods for statistical analysis of ground water data. These methods are:

1. Parametric analysis of variance (ANOVA)
2. Rank-based (non-parametric) ANOVA with multiple comparisons
3. Tolerance prediction interval
4. Control chart
5. Test of Proportions
6. An alternative statistical test method that meets the performance standards of 40 CFR 258.53 (h)

Statistical evaluation of monitoring data will be performed for the duration of the monitoring program, including the post-closure care period. The choice of an appropriate statistical test depends on the type of monitoring, the nature of the data, and the proportion of values in the data set that are below detection limits. The statistical analysis will be conducted separately for each detected constituent in each well. The statistical method is based on the EPA's Statistical Analysis of Ground Water Monitoring Data at RCRA Facilities, Interim Final Guidance Document (1989). All statistical analysis will be performed in accordance with North Carolina State Regulations 15A NCAC 13B.1632.

owner/operator of the landfill is responsible for selecting a laboratory and insuring that they are utilizing proper QA/QC procedures. The laboratory must have a QA/QC program based upon specific routine procedures outlined in a written laboratory Quality Assurance/Quality Control Manual. The QA/QC procedures listed in the manual provide the lab with the necessary assurances and documentation for accuracy and precision of analytical determinations. Internal quality control checks shall be undertaken, regularly by the lab, to assess the precision and accuracy of analytical procedures.

The internal quality control checks include the use of calibration standards, standard references, duplicate samples and spiked or fortified samples. Calibration standards shall be verified against a standard reference obtained from an outside source. Calibration curves shall be developed using at least one blank and three standards. Samples shall be diluted if necessary to insure that analytical measurements fall on the linear portion of the calibration curve. Duplicate samples shall be processed at an average frequency of 10 percent to assess the precision of testing methods, and standard references shall be processed monthly to assess accuracy of analytical procedures. Spiked or fortified samples shall be carried through all stages of sample preparation and measurement to validate the accuracy of the analysis.

During the course of the analyses, quality control data and sample data shall be reviewed by the laboratory manager to identify questionable data and determine if the necessary QA/QC requirements are being followed. If a portion of the lab work is subcontracted, it is the responsibility of the contracted laboratory to verify that all subcontracted work is completed by certified laboratories, using identical QA/QC procedures.

7.0 Statistical Evaluation

Copies of all laboratory results and water quality reports will be kept at the Halifax County Landfill office. Reports summarizing all ground water and statistical evaluation will be submitted to the DSWM for each sampling event following the baseline monitoring period.

Methods to evaluate the data are taken from North Carolina Solid Waste Rules, 40 CFR 258.53g and the EPA RCRA Ground Water Monitoring Draft Technical Guidance Document. The North Carolina Solid Waste Rules requires that the owner or operator of the landfill specify a statistical method outlined in these rules to evaluate ground water monitoring data. The goal of the statistical analysis is to determine whether statistically significant evidence of contamination exists and to identify the point of contamination. Upon receipt of each monitoring event's data, the statistical database of analyses will be updated. The North Carolina Solid Waste Rules provide several methods for statistical analysis of ground water data. These methods are:

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All monitoring wells shall be installed under the supervision of a geologist or engineer who is registered in North Carolina and who will certify to the NCDSWM that the installation complies with the North Carolina Regulations. Upon installation of future wells the documentation for the construction of each well will be submitted by the registered geologist or engineer within 30 days after well construction.

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The Ground Water Monitoring Program and sampling and analysis will be implemented upon approval of the Ground Water Monitoring Program and construction of site wells. Analyses have been performed four times during the first semi-annual event, and will be performed once semi-annually throughout the active life and post-closure monitoring period of the landfill, unless an alternate sampling schedule is accepted by the DSWM.

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Stream Sampling Point (Entire Facility)	**Location and Justification of Placement**	**Proposed Placement**
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SW-3A	Up-gradient of Lined and Unlined MSWLF Units	Replaces SW-3 (Moves Further Uptream)
SW-4	Down-gradient of Unlined MSWLF Unit	New Sampling Location (Near Current SW-1)
SW-5	Down-gradient of Lined and Unlined MSWLF Units	New Sampling Location

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TBD = To Be Determined

Appendix K

APPENDIX K

Characterization of 30 Acre Tract

1.0 Introduction

This report describes a site characterization study for a 30 acre tract located adjacent to (east of) the Halifax County MSW landfill. This tract, identified in site boundary mapping (Appendix A) as Hawkins Tract A, is owned by the County but is outside the permitted facility boundary. The County endeavors to add this property to the permitted facility boundary to provide additional buffer space around the unlined MSW landfill. Current development plans for the 30 acre site include a soil borrow site and possibly a future construction and demolition debris (C&D) disposal facility. No plans exist at present to develop a new MSWLF unit on the 30 acre tract. Plans for a future C&D facility have not been developed at present.

The addition of the 30 acre tract to the permitted facility is part of a facility plan modification (see Figure 2A), in conjunction with the site permit application for a planned MSWLF unit located north of the existing MSW landfill. A site characterization study of the 30 acre tract was performed in conjunction with site studies performed in late 1995 for the planned MSWLF unit. Five test borings and three piezometers were installed during the investigation, supplemented by five nearby piezometers and/or monitoring wells located within the permitted facility boundary.

2.0 Site Characterization

This report is an Appendix which augments the site application report for the planned MSWLF unit, presented in the main body of the report. Throughout this text, reference is made to specific sections of the report with relevant data for the 30 acre tract. Regional and local characterization studies relevant to the permitted facility, including the 30 acre tract, are presented in Section 2.0 of this report. Local and regional geology are discussed in Section 3.1.1.

2.1 Site Reconnaissance - Site topography consists of two subparallel ridges, separated by a relatively shallow central drainage swale that opens toward the south. The orientation of the central swale generally aligns with the unnamed tributary on the opposite side of the unlined MSW landfill. A drainage divide exists along the fence line at the north tract boundary. The divide splits surface drainage between swales which lead to either Brewer's Creek or the unnamed tributary. All drainage from the 30 acre tract leads to Brewer's Creek via the central swale. The central swale serves as a conveyance of surface runoff and is normally dry. There are no permanent streams on the 30 acre tract.

Ground elevations within the 30 acre tract vary from a high of El. 322, located on a knoll within the northwest corner of the tract, to a low of El. 268 where the central drainage swale leaves the tract. This location is near MW-16A on Figure K1. Ground elevations vary from about El. 309 to El. 313 along the north drainage divide and along the eastern ridge. The 30 acre tract was clear-cut in 1995 of nearly all vegetation except for grass and underbrush. A majority of the tract was recently in pasture, visible in recent aerial photography (Figure 1C), while a stand of trees (estimated age at 20 to 30 years) previously existed within the central swale and along the southern margin of the site.

Based on site reconnaissance and soil samples recovered from test borings, on-site soils are similar to soils observed elsewhere within the permitted facility boundary. A small isolated granite outcrop and surface float exists in the southeast corner of the tract. Test borings (discussed below) indicate soil depths exceeding 15 to 20 feet at the investigated locations.

3.0 Site Investigation

A site plan showing topography, site boundaries and test boring locations is presented in Figure K1 (within this Appendix). Relevant test boring and piezometer construction data are presented on Table 1A and this Appendix. Ground water potentiometric surfaces showing flow directions are presented in Figure K2. A hydrogeologic cross section is presented as Figure K3. Laboratory data associated with the "BP" series of test borings is presented in Table 2 and Appendix G.

3.1 Test Borings - Six test borings were performed, identified as BP-1 through BP-6, five of which fall within the 30 acre tract. This provides an average density of 1 boring per 6 acres. One boring (BP-4) was performed just north of the 30 acre tract boundary within the permitted facility area. These borings were intended for preliminary site characterization and borrow site evaluation. The borings were extended to depths of 25 to 50 feet below existing ground surfaces. No rock cores were taken from the borings on the 30 acre tract.

Table K (this Appendix) presents a summary of the test boring data within the 30 acre tract. Topsoil thicknesses are approximately 6 to 9 inches at the investigated locations. The near surface soils consist of stiff orange clay exhibiting standard penetration resistance values of 12 to 20 blows per foot (bpf). These soils extend to nominal depths of at least 3 to 4 feet. The clayey soils appear to be thicker at BP-4, indicating the possible presence of deeper isolated "pockets" of clay. The near surface clayey soils are somewhat plastic and appear suitable for compacted soil liner construction at the planned MSWLF unit.

Beneath the near surface clayey horizon exist more granular clayey silt and fine sandy silt that grades with depth to a granitic saprolite. The deeper soils encountered from about 9 to 13 feet below the surface exhibit a distinct rock texture, relict of the parent bedrock. These soils exhibit standard penetration resistance values varying from 15 to 30 bpf. The saprolite becomes gradually denser with increasing depth, as seen in the test boring log for BP-3, where standard penetration resistance values of 28 to 48 bpf were encountered between depths of 40 to 50 feet.

Only BP-1 encountered auger refusal on bedrock, at a depth of 36 feet. Soils exhibiting standard penetration resistance values in excess of 100 bpf, classified as "partially weathered rock," were encountered at BP-1 at a depth of 29 feet. The other borings exhibited saprolitic soils extending to termination without encountering rock or partially weathered rock.

Ground water was encountered at the test boring locations at depths generally in excess of 21 feet. Boring BP-5 caved at a depth of 6 feet within a period of 48 hours after the boring was completed. The depth at which an open bore hole caves is sometimes (but not necessarily) an indication of saturated soils. Ground water was first noted at a depth of 27 feet during drilling at boring BP-5. The caved depth may indicate the presence of perched water in the soils at BP-5. No ground water was encountered at BP-1, located closest to the existing landfill. Short term ground water information for the other borings is presented on Table 1B.

3.2 Piezometers - Three borings, BP-3, BP-4 and BP-6, were converted to temporary standpipe piezometers for long-term ground water level observation. Piezometer construction was similar to that described in Section 3.1.3 of this report. These data are supplemented by ground water level observations at nearby monitoring wells MW-15 and MW-16A, and three earlier piezometers located within the permitted facility, GY-1, GY-2 and GY-3. Test boring and piezometer installation records for the BP series borings are presented in Appendix F. Long-term ground water level observations for these borings are presented on Table 1D.

3.3 Laboratory Testing - Laboratory test results summarized on Table 2 and presented in Appendix G include data from the BP series borings performed in the 30 acre tract. Bulk samples were subjected to standard Proctor compaction, permeability and tests for classification (No. 200 sieve wash and Atterberg limits) and natural moisture content. Test results for these soils appear similar to those sampled within the 45 acre study area for the planned MSWLF unit.

Near surface soils within the 30 acre tract appear suitable for construction of a compacted clay liner for Phase 1 of the planned MSWLF unit. Laboratory classification of recovered jar samples indicates the near surface soils within the 30 acre tract exhibit USCS classifications of MH and CH. Remolded permeability values reported in Table 2B are on the order of 10^{-7} to 10^{-8} cm/sec.

3.4 Hydrogeologic and Lithologic Units - Test borings within the 30 acre tract encountered similar lithologies to those described in Section 3.1.4 of this report. The saprolite described as Units 1a and 1b are represented by all borings on this tract. Auger refusal at BP-1 (depth of 36 feet) may indicate the top of Unit 2 (fractured bedrock). BP-1 was dry upon completion and not fitted with a piezometer. The other borings encountered water but did not extend to auger refusal.

Stabilized piezometer levels provide an indicatation of the upper limits of saturation within the soils near the boring. Based on long-term piezometer observation (discussed below) and the estimated average depth of auger refusal based on BP-1 and BP-3, the average thickness of hydrogeologic Unit 1 (uppermost aquifer) within the 30 acre tract appears to vary in the range of 25 to 40 feet. These values are based in part on unit thicknesses presented on Table 1C. Figure K3 is a cross section of the borings in the 30 acre tract showing the hydrogeologic units.

3.5 Water Table Information - Monthly water level observations at piezometers with and near the 30 acre tract are presented on Table 1D, beginning with January 1996. Water levels at BP-3 generally vary from 45 to 47 feet. Water levels vary from 37 to 39 feet at BP-4 and 23 to 18 feet at BP-6. Using supplemental data for the GY-series of piezometers, MW-15 and MW-16A, a potentiometric surface map (Figure K2) was constructed for the April to June 1996 ground water levels. The data for piezometers within the 30 acre tract reflect a similar trend to that discussed in Section 3.1.5, regarding the estimate of seasonal high water level during that time period. Figure K2 is based on the current estimate of the seasonal high ground water elevation.

3.6 Ground Water Flow Characteristics - Section 3.1.6 presents a conceptual ground water model for the shallowest aquifer at the 45 acre study area for the planned MSWLF unit. Based on the similar test boring data, this model applies to the 30 acre tract, as well. Recharge is expected to occur over most of the 30 acre tract. The porous sapprolite is expected to exhibit partially confined flow within a zone of saturation, with recharge to the deeper fractured bedrock aquifer. Discharge from the upper most aquifer occurs along Brewer's Creek or the unnamed tributary, as shown in Figure K2.

Vertical Ground Water Flow - Vertical gradients and velocities at the 30 acre site are resonably expected to be similar to those discussed in Section 3.1.6, except that mounding effects within the waste may affect flow patterns immediately east of the landfill. Some cross gradient flow is evident along the east side of the landfill, based on recent ground water monitoring trends. These effects are expected to diminish with time, after the unlined landfill is closed. At present, no nested piezometers exist within the 30 acre tract.

Horizontal Ground Water Flow - Based on stabilized water level measurements shown on Table 1D, the upper most zone of saturation varies between El. 298 and 303 feet along the east side of the 30 acre tract (BP-6). The top of the saturated zone (water table) gradually slopes westward beneath the 30 acre tract to El. 274 to 275 at BP-4, decreasing to values around El. 270 at BP-3. Figure K2 clearly indicates that ground water flow within the upper most aquifer in the vicinity of the existing MSW landfill, including the 30 acre tract, is to the west, or *toward* the existing MSW landfill. Horizontal ground water flow beneath and adjacent to the unlined landfill is toward the permanent streams that serve as ground water discharge features.

As this site characterization is not intended to site a new MSWLF unit on the 30 acre tract, slug tests (usually performed during the detail investigation for design) were not performed on the BP-series piezometers. Thus ground water velocities, have not been calculated. Slug tests performed at MW-15 and MW-16A indicate similar hydraulic conductivities a those measured within the 45 acre study.

Summary - Ground water piezometers and monitoring wells present within and near the 30 acre site provide seasonal water table data, which may be used for future permitting of a C&D disposal facility. Based on observed soil types, field conductivity testing, laboratory data and ground water levels, hydrogeologic conditions appear consistent throughout the permitted facility boundary. Ground water flow beneath the 30 acre tract is directed generally toward the unlined MSW unit (not away from it) or toward the ground water discharge features. Based on the present understanding of site conditions, the site appears suitable for the intended uses. Addition of the 30 acre tract to the permitted facility boundary should not adversely affect local ground water condition or constitute an impact to public health and welfare.

Table K-1

Test Boring Summary - 30 Acre Tract

Boring	Depth, ft.	Stratigraphic Description
BP-1	0 - 3.3	Orange-Brown Sandy CLAY, N = 12 bpf
	3.3 - 12.5	Yellow-Orange Clayey Fine Sandy SILT, N = 15 bpf
	12.5 - 29	Yellow-Tan Silty Fine SAND w/ mica (Dry), N = 11
	29 - 36	Dense Silty Fine to Coarse SAND, N = 100 bpf
		Auger Refusal at 36 feet
		No Ground Water Encountered
		**Bulk Sample Taken from Auger Cuttings at 0 - 5 feet
BP-2	0 - 3.2	Orange-Brown CLAY, N = 10 bpf
	3.2 - 12	Orange-Brown Sandy Clayey SILT, Slightly Plastic, N = 17
	12 - 40	Tan-Pink-White Sandy SILT, granitic sapprolite, increasing moisture content with depth, N = 20 to 30 bpf
		Boring Terminated at 40 feet
		Ground Water Encountered at 27 feet TOB
		(Boring caved at 34.4 feet after 48 hours)
BP-3*	0 - 5	Red-Orange Mottled Fine Silty CLAY, N = 20 bpf
	5 - 23	Orange-Yellow Clayey Fine Sandy SILT w/mica, N= 15 to 21 bpf
	23 - 50	Orange-White Sandy SILT, granitic sapprolite with quartz sand, feldspar sand and mica, N = 25 to 30 bpf
		Boring Terminated at 50 feet
		Ground Water Encountered at 45.3 feet
		*Piezometer Screen set at 38 to 48 feet

BP-4*	0 - 4	Orange-Brown Sandy Silty CLAY, N = 9 bpf
	4 - 13	Orange-Brown Fine Sandy Silty Clay, N = 14 bpf
	13 - 47	Pink-Tan-Gray Fine Sandy SILT, granitic sapprolite w/coarse sand, N = 24 bpf, increasing moisture below 21 feet
	47 - 50	Brown-Tan-Gray Silty Fine to Coarse SAND, N = 30 - 40
		Boring Terminated at 50 feet
		Ground Water Encountered at 38.3 feet TOB
		*Piezometer Screen set at 37.5 to 47.5 feet
BP-5	0 - 3.2	Red-Brown Fine Sandy Silty CLAY, N = 16 bpf
	3.2 - 40	White-Gray-Brown Fine Sandy SILT w/mica, N = 18 to 24, increasing moisture content, heavy iron-manganese staining below 21 feet
		Boring Terminated at 40 feet
		Ground water Encountered at 27 feet TOB
		(Boring Caved at 5.8 feet in 48 hours)
BP-6*	0 - 2.9	Red-Brown Silty CLAY, N = 12
	2.9 - 19	Red-Brown Fine Sandy Clayey SILT, N = 15 bpf
	19 - 25	Tan Slightly Clayey Fine Sandy SILT (Wet), N = 15 bpf
		Boring terminated at 25 feet
		Ground Water Encountered at 16 feet TOB
		*Piezometer Screen set at 15 to 25 feet
		**Bulk Sample Taken from Auger Cutting at 0 - 3 feet

Piezometers were constructed of 2" diameter PVC (Such. 40) with 10 foot screen length (0.010" slot size), filter sand extending 12 " above screen interval, 12 " thick hydrated bentonite seal, backfilled to surface with Portland cement-bentonite grout, finished with locking steel cover embedded in 12"x 24"x 24" concrete surface pad (stick up length approximately 3 feet).

Refer to the rolled set of Figures, submitted separately, containing:

K1 Site Map of 30 Acre Tract

K2 Ground Water Potentiomentric Surfaces (30 Acre Tract)

K3 Hydrogeologic Cross Sections (30 Acre Tract)

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

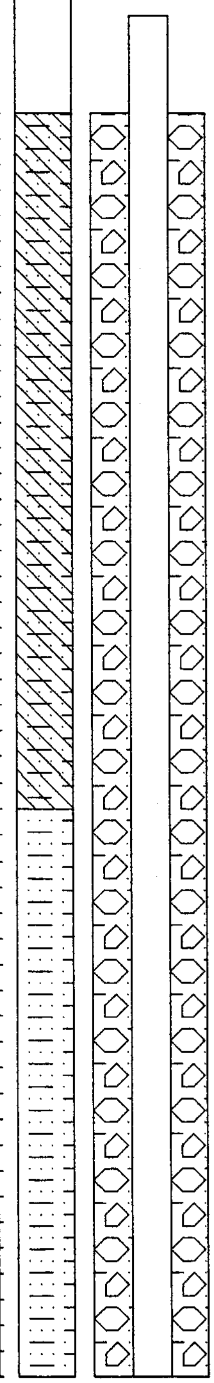
TOP OF CASING ELEVATION: 313.16
TOTAL DEPTH: 48.0 FT
GROUND SURFACE ELEVATION: 310.8
SHEET: 1 OF: 2

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
	2 3 6	Ss	S1			18"		SANDY SILTY CLAY: Orange brown; slightly plastic.
	6 7 8	Ss	S2	D		18"		
	4 5 8	Ss	S3	M		18"		
	4 8 10	Ss	S4	D		17"		SANDY SILT: Relict Granite; moist, pink to gray micaceous sandy silt with quartz and abundant feldspar.
	8 11 14	Ss	S5	D		18"		
	7 10 13	Ss	S6	M		18"		

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, 19.0, 20.0, 21.0, 22.0, 23.0, 24.0

LITHOLOGY | WELL INSTALLATION



FIELD BOREHOLE LOG

BOREHOLE NUMBER: BP-4

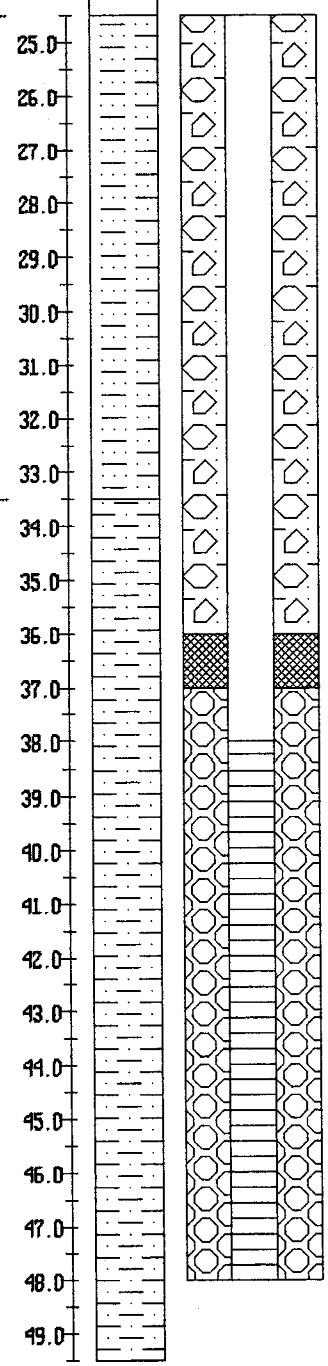
PROJECT NUMBER: HALIFAX-5
PROJECT NAME: HALIFAX COUNTY
LOCATION: HALIFAX, NORTH CAROLINA
DRILLING COMPANY: BORE AND CORE
RIG TYPE & NUMBER: CME 450
DRILLING METHOD: HOLLOW STEM AUGER
WEATHER: SOME CLOUDS, 34 DEGREES
FIELD PARTY: L. FOSKEY
GEOLOGIST: G. MILLS
DATE BEGUN: 12/6/95 DATE COMPLETED: 12/6/95

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	LITHOLOGY DESCRIPTION
	13							
25.0								SANDY SILT: Relict Granite; moist, pink to gray micaceous sandy silt with quartz and abundant feldspar.
26.0								
27.0								
28.0	11 10 14	Ss	S7	M		14"		
29.0								
30.0								
31.0								
32.0								
33.0	3 4 6	Ss	S8	M				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.
34.0								
35.0								
36.0								
37.0								
38.0	6 11 14	Ss	S9	W				
39.0								
40.0								
41.0								
42.0								
43.0	13 16 25	Ss	S10	W				
44.0								
45.0								
46.0								
47.0								
48.0	10 16 16	Ss	S11	W				
49.0								

DEPTH | LITHOLOGY | WELL INSTALLATION



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: **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: **1** 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	DEPTH	LITHOLOGY	WELL INSTALLATION
2.0'									2.0		
1.0									1.0		
0.0	4 8 8	Ss	S1			18"		SILTY CLAY: Red brown.	0.0		
1.0									1.0		
2.0									2.0		
3.0	7 10 12	Ss	S2	D		14"		SANDY CLAYEY SILT: Slightly plastic with abundant feldspar and mica; trace quartz; relict granitic structure at depth.	3.0		
4.0									4.0		
5.0									5.0		
6.0									6.0		
7.0									7.0		
8.0	5 9 12	Ss	S3	D		12"			8.0		
9.0									9.0		
10.0									10.0		
11.0									11.0		
12.0									12.0		
13.0	7 11 14	Ss	S4	M		12"			13.0		
14.0									14.0		
15.0									15.0		
16.0									16.0		
17.0									17.0		
18.0									18.0		

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: 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
18.5–20.0	5 8 11	Ss	S5	M		14"		SANDY SILT: Relict Granite; moist to wet, pink to gray with weathered iron and Mn staining.
23.5–25.0	5 7 11	Ss	S6	M		16"		
28.5–30.0	6 9 12	Ss	S7	W		12"		
33.5–35.0	5 9 15	Ss	S8	W		12"		
38.5–40.0	7 11 15	Ss	S9	W		10"		

Boring Terminated at 40.0 feet.