U.S. Army Corps of Engineers
New England Division

SITE INVESTIGATION REPORT

AREA OF CONTAMINATION (AOC) 63BD

DEVENS, MASSACHUSETTS

Prepared for:
U.S. Army Corps of Engineers
New England Division
Waltham, Massachusetts

DECEMBER 1996

ABB Environmental Services, Inc.

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Fort Devens was placed on the National Priority List (NPL) on December 21, 1989, under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, Superfund) as amended by the Superfund Amendments and Reauthorization Act (SARA). Subsequently, under Public Law 101-510, the Defense Base Realignment and Closure (BRAC) Act of 1990, Fort Devens was selected for cessation of operations and closure. Fort Devens was officially closed in September 1996 and a majority of the property was transferred to the Devens Commerce Center. AOC 63BD is located in the area transferred to the Devens Commerce Center.

In conjunction with the U.S. Army's Installation Restoration Program, Fort Devens and the U.S. Army Environmental Center (USAEC) developed a Master Environmental Plan (MEP) in 1988. The MEP consisted of assessments of the environmental status of study areas, specified necessary investigations, and provided recommendations for response actions with the objective of identifying priorities for environmental restoration at Fort Devens. Areas Requiring Environmental Evaluation (AREEs) were identified and investigations were conducted in order to determine where removal actions were necessary.

Based on the results and findings of an underground storage tank removal and subsequent site evaluations at AREE 63BD, it was recommended that further investigation of groundwater contamination be conducted. In compliance with the Federal Facility Agreement (Interagency Agreement), the AREE was transferred into the Remedial Investigation/Feasibility Study (RI/FS) process and redesignated as Area of Contamination (AOC) 63BD.

ABB Environmental Services, Inc. (ABB-ES) was tasked by the USAEC in 1996, to conduct the RI/FS at AOC 63BD to further assess the nature and distribution of contaminants detected in groundwater during the previous investigations. The field program for the RI was completed in the summer of 1996.

Concurrent with the field investigation at AOC 63BD, the Devens Commerce Center took control of the land associated with AOC 63BD. In an effort to appropriately remediate the site, and to facilitate the land transfer, the RI/FS process at AOC 63BD was stopped and the site was administratively transferred back to the site investigation process. A consensus statement between the U.S. Army, U.S. Environmental Protection Agency, Massachusetts Environmental Protection Agency, and the Devens Commerce Center has been prepared to

document this transfer. The soil contamination detected below the former heating oil underground storage tank was removed by the U.S. Army Corp of Engineers - New England Division (USACE-NED) in November 1996 and subsequent groundwater monitoring will be conducted by the Devens Commerce Center using the Massachusetts Department of Environmental Protection's guidance.

Area of Contamination (AOC) 63BD is the site of a previously removed 1,000 gallon underground storage tank (UST) used to store No. 2 fuel oil at Building 1666 located on the northeast side of the former Main Post at Fort Devens. Building 1666, now abandoned, is one of a group of former enlisted men's barracks located near Antietam, Carey, and Buena Vista streets. The UST, identified as UST 26, was located on the northwest side of Building 1666.

UST 26 was removed by ATEC Environmental Consultants in January 1992 as part of the Fort Devens UST Removal program, and soil samples were collected from the sidewalls and bottom of the shallow (8 feet below ground surface [bgs]) excavation to assess whether residual fuel contamination existed. Analytical results showed total petroleum hydrocarbon (TPHC) concentrations up to 375 micrograms per gram (μg/g) in soil and indicated that contamination may have reached groundwater. Additional soil was removed to a depth of 14 feet bgs in July 1992, and additional samples were collected to assess whether residual fuel contamination still remained. These new soil samples from the excavation bottom and sidewall showed TPHC concentrations of up to 3,630 μg/g.

As a result, an extensive soil TerraProbe^{SM} survey was conducted by ABB Environmental Services, Inc. (ABB-ES) in 1992 as part of a Preliminary Site Investigation (PSI) at AOC 63BD. Samples from the TerraProbe^{SM} survey showed field analytical TPHC concentrations of up to 2,900 parts per million (ppm) in soil. No target volatile organic compounds (VOCs) (benzene, toluene, ethylbenzene, or xylene) were detected.

In 1994, a Supplemental Site Evaluation (SSE) was conducted by ABB-ES to further assess the distribution of soil contamination and determine if groundwater had been adversely impacted. A second TerraProbe^{SM} survey, groundwater monitoring well, and soil boring program were completed. The results of the TerraProbe^{SM} sampling and field analysis showed TPHC concentration as high as 2,800 ppm. The results of the soil boring program showed TPHC concentrations up to 1,770 μg/g. Results of the groundwater sampling indicated that VOCs, semivolatile organic compounds (SVOCs), and TPHC were present in the groundwater at AOC 63BD.

A Preliminary Risk Evaluation (PRE) for soil and groundwater was completed and presented in the SSE report. The PRE concluded that residual subsurface soil contamination in the vicinity of Building 1666 does not present unacceptable

human health risks; however, it was considered as a continuing source of groundwater contamination. The concentrations of VOCs, SVOCs, and TPHC detected in groundwater exceeded drinking water and groundwater standards (ABB-ES, 1994).

Based on these investigation findings, it was recommended that further investigation of groundwater contamination at AOC 63BD be conducted. In compliance with the Interagency Agreement (IAG), the site was transferred into the Remedial Investigation/Feasibility Study (RI/FS) process under CERCLA and Area Requiring Environmental Evaluation (AREE) 63BD was redesignated AOC 63BD.

ABB-ES conducted RI/FS activities at AOC 63BD in accordance with the plans and rationale presented in the Task Order Work Plan (ABB-ES, 1996) and in conformance to the methods, procedures, and requirements set forth in the Final Project Operations Plan (POP) prepared by ABB-ES for activities conducted at Fort Devens (ABB-ES, 1995).

As proposed in the Task Order Work Plan, activities were performed to establish the nature and distribution of contamination at the site and to evaluate potential risks to human health presented by the contaminants. The following specific activities were completed at AOC 63BD as part of the RI:

- Background Historical Research - as a means to further understand and better characterize the contaminant release scenarios at AOC 63BD;

- Installation of five Groundwater Monitoring Wells - as a means to gather information on the distribution of dissolved phases of contaminants, monitoring possible free-phase product thicknesses, and characterize aquifer hydraulic properties; and

- Collection and Analysis of Soil and Groundwater Samples - including both field and off-site laboratory analysis, to provide information necessary to evaluate contaminant distribution and assess potential risks to human health and the environment.

The results of the RI field investigation indicated that residual petroleum contamination appears to be limited to the soil from directly below the former heating oil UST to approximately 20 feet downgradient. The results of the field analysis and off-site laboratory analyses indicated that site-related contaminants were present in groundwater directly below the former heating oil UST but had not migrated downgradient at concentrations above federal or state drinking water standards.

Based on the results of the RI field work, it is recommended that a soil removal be conducted to eliminate the existing soil contamination between 14 feet bgs and the water table (approximately 27 feet bgs). In addition, groundwater monitoring should be conducted at the site to evaluate potential future risks to human health.

1.0 INTRODUCTION

This Site Investigation (SI) Report (Data Item A013) for Area of Contamination (AOC) 63BD at the Devens Reserve Forces Training Area (Devens RFTA), was prepared by ABB Environmental Services, Inc. (ABB-ES) as a component of Task Order 0007 of Contract DACA31-94-D-0061 with the U.S Army Environmental Center (USAEC). This report details the results of the Remedial Investigation (RI) program at AOC 63BD, which was completed in accordance with relevant USAEC and U.S. Environmental Protection Agency (USEPA) guidance. Prior to the beginning of the field effort associated with this AOC, this Task Order No. 0007 was administratively transferred from the USAEC to the U.S. Army Corps of Engineers-New England Division (USACE-NED). Therefore, this report has been issued as a USACE-NED document. In addition, prior to the end of the RI field investigation AOC 63BD was administratively moved from the RI/feasibility study (FS) program under CERCLA, to the SI program in order to appropriately remediate the soil and groundwater contamination detected at the AOC, and to expedite the transfer of the property to the Devens Commerce Center (DCC).

1.1 PURPOSE AND SCOPE

The scope of work for the RI field investigation at AOC 63BD was specified by the USAEC based on previous studies and investigations and USEPA and Massachusetts Department of Environmental Protection (MADEP) comments on prior investigations conducted by ABB-ES at this AOC. The purpose of the RI field investigation was to fully evaluate the nature and distribution of site-related contamination.

Prior investigations included an underground storage tank (UST) removal, preliminary SI activities, and Supplemental Site Evaluation (SSE) activities. These activities, directed by USAEC and USACE-NED, were undertaken to establish the presence or absence of site-related contaminants in groundwater and subsurface soil at AOC 63BD. Data were collected in order to provide a basis for evaluating and recommending remedial alternatives for potential site remediation, if necessary. The following activities were included in the preliminary SI, SSE, and RI:

- soil borings and subsurface soil sampling for field and off-site laboratory analysis;
- installation of groundwater monitoring wells and the sampling of groundwater for off-site laboratory analyses;
- aquifer testing;
- geophysical survey; and
- vertical and horizontal location surveys.

1.2 REPORT ORGANIZATION

Preparation of this SI Report consisted of characterizing the geologic and hydrogeologic conditions and assessing the distribution and migration of contaminants receptors, and evaluating potential effects of identified chemicals on human receptors. The content and presentation of the report relies heavily upon figures and tables that present the data in the context of exploration locations on site maps. The text within the report supports the figures, and provides detail, interpretation, and analysis that cannot be presented in figures.

After acquiring and evaluating the field and off-site laboratory data, ABB-ES has prepared this SI Report for AOC 63BD in accordance with USEPA, USACE-NED, and USAEC guidance. The report describes the field methods employed and summarizes and evaluates the relevant background information, results, and conclusions from previous investigations, presents the RI field and off-site laboratory data, assesses the potential human health risks, and includes conclusions and recommendations.

Section 1.0 is the introduction to the report, Section 2.0 of this report describes the site background, previous investigations, RI field activities, and the field and off-site laboratory analytical program used during the RI. Section 3.0 presents the geologic and hydrogeologic conditions, summarizes the RI data, source evaluation and contaminant migration potential, presents the human health preliminary risk evaluation (PRE), and outlines the recommendations and conclusions. Figures and tables associated with each section are presented at the end of each section.

1.3 REMEDIAL INVESTIGATION OBJECTIVES

The objective of the RI at AOC 63BD was to perform field program in accordance with relevant USEPA guidance and in compliance with USAEC-approved field methods and procedures. The purpose of the RI field program at AOC 63BD was to further define the site contaminants detected in soil and groundwater during the previous UST removal and investigations, and to determine whether remediation of the identified site contaminants was warranted.

1.4 PROJECT APPROACH

To meet the RI objectives, a significant effort was focused on the production of RI planning documents. The planning documents were developed in compliance with the appropriate regulatory guidance for remedial investigations, and considered regulatory and Army comments and results of previous investigations.

The project plans were designed to answer data gaps identified from the previous investigations and gather additional data on the physical conditions of the AOC, the nature and distribution of site-related contaminants, and determine the potential impact of site-related contaminants on human receptors.

1.4.1 Project Operations Plan

The principal planning document was the ABB-ES Fort Devens Project Operations Plan (POP) (ABB-ES, 1995), which provides detailed descriptions and discussions of the elements essential to conducting field investigation activities. The POP was revised between the 1994 and 1995 field investigations to include new sampling techniques. The purpose of the POP is to define responsibilities and authorities for data quality, and to define requirements for assuring that the field investigation activities undertaken by ABB-ES at Fort Devens are planned and executed in a manner consistent with USAEC quality assurance (QA) program objectives. The POP includes the specified elements of a Sampling and Analysis Plan (SAP) and Health and Safety Plan (HASP). The SAP includes the essential elements of the Quality Assurance Project Plan (QAPP) and the Field Sampling Plan (FSP). USEPA has prepared guidance on the preparation of a

POP in "Guidance for Preparation of Combined Work/Quality Assurance Project Plans for Environmental Monitoring" (OWRS QA-1: May 1984). The guidance was designed to eliminate the necessity for preparation of multiple, redundant documents.

Requirements of the POP were applied to ABB-ES and subcontractor activities related to the collection of environmental data at Fort Devens. The POP adheres to the requirements and guidelines contained in the "USAEC QA Program, January 1990" for collection and analysis of samples, and the USAEC "Geotechnical Requirements for Drilling, Monitoring Wells, Data Acquisition, and Reports, March 1987" for the installation of borings and monitoring wells, and for land survey location. In addition, the POP meets guidelines of USAEC chain-of-custody (COC) procedures.

The POP provides guidance and specifications to ensure that samples are obtained under controlled conditions using appropriate, documented procedures; and that samples are identified uniquely and controlled through sample tracking systems and COC protocols. The POP also includes specifications to ensure that field determinations and off-site laboratory analytical results are of known quality and are valid, consistent, and compatible with the USAEC chemical data base through the use of certified methods, preventive maintenance, calibration and analytical protocols, quality control (QC) measurements, review, correction of out-of-control situations, and audits. The POP also specifies the methods and procedures to be used to ensure that calculations and evaluations are accurate, appropriate, and consistent throughout the projects; generated data are validated and their use in calculations is documented; and records are retained as documentary evidence of the quality of samples, applied processes, equipment, and results.

The HASP was prepared as an integral element of the POP in accordance with the same schedule and review requirements (ABB-ES, 1995, Appendix A). The HASP complies with EM 385-1-1, AMC-R-385-100, and Fort Devens safety requirements, as well as Occupational Safety and Health Administration (OSHA) Regulations 29 CFR 1910.120. The HASP development was based on appropriate information contained in previous investigation documents from Fort Devens. The HASP portion of the POP ensures that health and safety procedures are maintained by requiring inclusion of the health and safety staff function in the project organization.

1.4.2 Task Order Work Plan

The background, rationale, and specific scope for the RI are set forth in another planning document, the Task Order Work Plan. The Final Task Order Work Plan for AOC 63BD was prepared under contract DACA31-94-D-0061 Task Order No. 0007 (ABB-ES, 1996b). The Final Task Order Work Plan was developed to comply with the Massachusetts Contingency Plan (MCP) (310 Code of Massachusetts Regulations [CMR] 40.000); the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986; the corrective action provisions of the Hazardous and Solid Waste Amendments; and the Toxic Substances Control Act. Work conducted under the Final Task Order Work Plan was performed in accordance with the provisions of the Federal Facility Agreement (FFA) (USEPA and Army, 1991), and USAEC guidelines.

The background information provided in the Final Task Order Work Plan for AOC 63BD was based largely on information in the Master Environmental Plan (MEP), review of installation documents, observations made during site visits, interviews with installation personnel, and previous investigations. Summaries of each of these activities and discussions of specific field activities to be conducted under Task Order No. 0007 were included in the Final Task Order Work Plan. The discussions focused specifically on the objectives and scope of proposed RI activities.

2.0 AOC 63BD REMEDIAL INVESTIGATION

2.1 INSTALLATION BACKGROUND

Devens (formerly Fort Devens) is located in the towns of Ayer and Shirley (Middlesex County) and Harvard and Lancaster (Worcester County), approximately 35 miles northwest of Boston, Massachusetts. It lies within the Ayer, Shirley, and Clinton map quadrangles (7½-minute series). The installation previously occupied approximately 9,260 acres and was divided into the North Post, the Main Post, and the South Post (Figure 2-1). Presently, Devens RFTA occupies approximately 6,000 acres and includes a small portion of the former North Post and Main Post, and the entire South Post.

Formerly, over 6,000 acres at Fort Devens was used for training and military maneuvers, and over 3,000 acres were developed for housing, buildings, and other facilities; the installation was reported as the largest undeveloped land holding under a single owner in north-central Massachusetts (U.S. Fish and Wildlife Service [USFWS], 1992c).

The South Post is located south of Massachusetts Route 2 and is largely undeveloped. The Main Post and North Post primarily contained developed lands, including recreational areas (e.g., a golf course and Mirror Lake), training areas, and an airfield. AOC 63BD is located on the northern side of the former Main Post, but outside the existing Devens RFTA (see Figure 2-1).

A complete summary of Devens history is presented in Section 2.0 of the Groups 3, 5, and 6. Revised Final SI Report (ABB-ES, 1996a).

2.2 SITE BACKGROUND

2.2.1 AOC 63BD Background

AOC 63BD is the site of a previously removed 1,000 gallon UST used to store No. 2. fuel oil at Building 1666 located on the northeast side of the former Main Post at Fort Devens (see Figure 2-1). Presently, the property is a lease parcel to the DCC. Building 1666, now removed, was one of a group of former enlisted

men's barracks located near Antietam, Carey, and Buena Vista Streets. The UST, identified as UST 26, was located on the northwest side of Building 1666 (Figure 2-2). All of the figures associated with this SI Report depict the AOC prior to the demolition of the barracks in November 1996.

2.2.2 UST Removal Program

UST 26 was excavated and removed from the site on January 9 and 13, 1992 by ATEC Environmental Consultants, Inc. (ATEC).

The excavation at closure measured 7.5 feet by 15.5 feet and was 5.5 feet below ground surface (bgs). Groundwater was not encountered in the excavation. Confirmatory soil samples were collected by ATEC from the sidewalls and floor of the excavation and were field-screened for volatile organic compounds (VOCs) in soil-jar headspace using a photoionization detector (PID) and for TPHC using infrared spectroscopy (IR). Two of the soil samples were analyzed in an off-site laboratory for TPHC using USEPA Method 418.1. Field screening detected TPHC concentrations ranging from 6.5 micrograms per gram (μg/g) to 932 μg/g, and the off-site laboratory results indicated TPHC concentrations of 94 μg/g (southwest sidewall [RS-1]) and 375 μg/g (bottom [RS-2]) (ATEC, 1992 and 1993) (Table 2-1).

On July 21, 1992, additional contaminated soil was removed by ATEC from the floor and sidewalls at the direction of the Fort Devens Contracting Officer in conjunction with the MADEP. The excavation was enlarged to an area 14 by 19 feet and initially to a depth of 8 feet bgs (Figure 2-3). Four confirmatory soil samples were collected from the sidewalls, and one from the floor. The samples were field-screened for headspace VOCs using a PID. Total VOC concentrations in the sidewall samples were all at or below 5 parts per million (ppm). The bottom sample (at a depth of 8 feet bgs) had total VOCs of 60 ppm. Additional lifts of soil were removed from the bottom of the excavation, and total VOCs in the successive bottom soil samples were 70 ppm (at a depth of 10 feet bgs), 80 ppm (at a depth of 12 feet bgs), and 95 ppm (at a depth of 14 feet bgs) (see Table 2-1).

The final depth of the excavation was 14 feet bgs. ATEC collected two soil samples from the excavation for off-site laboratory analysis. TPHC was detected in the southeast sidewall (depth 12 feet bgs [RSS-2]) at 3,630 μg/g and in the

northeast sidewall (depth 12 feet [RSS-1]) at 514 μg/g (ATEC, 1993f) (see Table 2-1).

ATEC lined the tank excavation with polyethylene sheeting and backfilled it with uncontaminated fill material (ATEC, 1993f).

2.2.3 Preliminary Site Investigation Program

In September 1992, at the request of the USAEC, ABB-ES conducted a TerraProbe℠ survey around the former UST excavation to determine the distribution of petroleum contamination in subsurface soil. A preliminary site investigation (PSI) was completed, and a total of 21 soil samples was collected from ten TerraProbe℠ points (66001 through 66010) (Figure 2-4). The samples were screened in the field for TPHC by IR and for benzene, toluene, ethylbenzene, and xylenes (BTEX) by gas chromatograph (GC). Field screening results are presented in Table 2-2. BTEX was not detected in any of the samples. TPHC was detected in only four of the samples. The highest concentration (2,900 μg/g) was in the 9-foot bgs sample from TerraProbe℠ 66010, in the center of the excavation (see Table 2-2 and Figure 2-4). The reason for such a high concentration of TPHC within the reported depth of clean fill was not determined.

Based on the PSI data and the UST removal findings, this site was designated as an area requiring environmental evaluation (AREE) and designated as 63BD. A soil removal was recommended for this AREE, and it was administratively transferred to the USACE-NED to have the soil removal completed.

2.2.4 Supplemental Site Evaluation Program

An SSE was completed by ABB-ES in 1994 under contract to USACE-NED to estimate the volume of soil, and potential groundwater contamination, to aid in the design of soil removal action. The first phase of the SSE field program was developed and executed based on the reported distribution of contaminants in the UST removal excavation and PSI.

The program began with a ground-penetrating radar (GPR) survey to clear locations for subsurface sampling. The survey also helped delineate the extent of the former excavation.

An SSE TerraProbe[SM] survey was conducted in December, 1993 with a total of 9 soil samples collected at five locations (see Figure 2-4). The soil samples were for field analysis by IR for TPHC and by PID for total VOCs in soil-jar headspace.

A soil boring (1666B-01X) was drilled based on the TerraProbe[SM] screening results within the excavation (see Figure 2-4). Four soil samples were collected and screened for TPHC and VOCs. The two soil samples with the highest TPHC concentrations were selected for off-site laboratory analysis for VOCs, semi-volatile organic compounds (SVOCs), and TPHC (Table 2-4).

To assess groundwater conditions below AOC 63BD, a monitoring well (1666W-01X) was installed at a location interpreted to be downgradient from the excavation (see Figure 2-4), based on the Main Post computer groundwater flow model developed by Engineering Technologies Associates, Inc. (ETA, 1995). The well was developed, and a groundwater sample was collected and analyzed in the off-site laboratory for VOCs, SVOCs, and TPHC. At the request of the MADEP, a second phase of the SSE was undertaken consisting of an additional round of sampling in monitoring well 1666W-01X and the installation, development, and sampling of monitoring well 1666W-02X (see Figure 2-4). The additional groundwater samples were analyzed for VOCs, SVOCs, and TPHC (ABB-ES, 1994). Soil boring logs, monitoring well installation diagrams, and field data sheets from the SSE are included in Appendices A, B, and C of this report. Off-site laboratory data is presented in Appendix D.

2.2.4.1 Soil Sample Results. The highest field analytical TPHC concentration (2,800 μg/g) was detected in the 14-foot bgs TerraProbe[SM] sample (1666T-04X) from between Building 1666 and the excavation, and a fuel odor was observed in that sample. TPHC was detected at 78 μg/g in the 10-foot bgs sample from TerraProbe[SM] 1666T-02X, and that sample also had a fuel odor. The highest VOC concentrations were in TerraProbes[SM] 1666T-03X and 1666T-04X (see Table 2-2 and Figure 2-4).

Soil boring 1666B-01X was drilled between TerraProbes[SM] 1666T-03X and 1666T-04X (see Figure 2-4). Field screening results showed that total VOC concentrations were 142 ppm in the 15-foot bgs sample, 121 ppm in the 20-foot bgs sample, 175 ppm in the 25-foot bgs sample, and 36 ppm in the 30-foot bgs sample. TPHC concentrations were 3,040 ppm in the 15-foot bgs sample,

3,500 ppm in the 20-foot bgs sample, 2,300 ppm in the 25-foot bgs sample, and 76 ppm in the 30-foot bgs sample (see Table 2-3).

Based on these field screening results the 15- and 20-foot bgs samples were submitted for off-site laboratory analysis. The 25-foot bgs soil sample was collected from just above the water table. TPHC was detected at 1,360 μg/g in the 15-foot bgs sample and at 1,770 μg/g in the 20-foot bgs sample. Methylene chloride and acetone were detected in both samples, but were also detected in the associated method blanks and were attributed to off-site laboratory contaminants. Toluene and ethylbenzene were detected at concentrations below the sample quantitation limits in the 15-foot bgs sample, and total xylene concentrations were 0.3 μg/g and 0.21 μg/g in the 15- and 20-foot bgs samples, respectively. SVOCs were detected in both soil boring samples (Table 2-4) (ABB-ES, 1994).

2.2.4.2 Groundwater Results. A groundwater sample was collected in February 1994 from monitoring well 1666W-01X, and was analyzed at an off-site laboratory for VOCs, SVOCs, and TPHC. TPHC was not detected in the sample. Methylene chloride, toluene, and ethylbenzene were present at concentrations below the sample quantitation limit, and the concentration of total xylenes was 21 micrograms per liter (μg/L). Bis(2-ethylhexyl)phthalate and di-n-butylphthalate were detected at concentrations below the sample quantitation limits, and di-n-butylphthalate was also detected in the associated method blank. Both of these phthalate compounds were attributed to off-site laboratory contamination (Table 2-5).

An additional round of groundwater samples were collected in January 1995 from monitoring wells 1666W-01X and 1666W-02X. Contaminant concentrations were higher in both wells in January 1995 than in the February 1994 sample collected from well 1666W-01X. Toluene, ethylbenzene, and xylenes were detected in both wells in January 1995 with higher concentrations (toluene 53 μg/L, ethylbenzene 36 μg/L, xylenes 280 μg/L) in the sample from monitoring well 1666W-02X. Naphthalene was detected only in monitoring well 1666W-01X, at 46 μg/L. The SVOCs 2-methylnaphthalene (maximum concentration 20 μg/L in well 1666W-01X) and 1-methylnaphthalene (maximum concentration 58 μg/L in well 1666W-02X) were also detected. Fluorene and di-n-butylphthalate were detected below the sample quantitation limits in well 1666W-02X. Di-n-butylphthalate was also detected in the associated method blank, and appears to be attributable to off-site laboratory contamination. Bis(2-ethylhexyl)phthalate was detected below

the sample quantitation limit in well 1666W-01X and at 60 μg/L in well 1666W-02X. TPHC was detected in both monitoring wells (maximum concentration 3,610 μg/L in well 1666W-02X) (see Table 2-5).

2.2.4.3 SSE Preliminary Risk Evaluation Summary. A PRE was completed for soil and groundwater as part of the SSE. Although the maximum detected concentration of TPHC in subsurface soil was above the MCP S-2 soil standard for TPHC, it is below ABB-ES' calculated commercial/industrial soil concentration for No. 2 fuel oil (Table 2-6). Furthermore, the average TPHC soil concentration was well below both screening guidelines.

The detected concentrations of VOC, SVOC, and TPHC in groundwater exceeded their respective drinking water and/or groundwater standards (Table 2-7).

Based on the findings of this SSE PRE, residual soil contamination in the vicinity of AOC 63BD did not appear to present unacceptable human health risks. However, the contaminants detected in groundwater would pose an unacceptable human health risk as a drinking water source.

A complete presentation of the human health PRE findings can be found in the Final SSE Report (ABB-ES, 1994).

Upon completion of the SSE, it was recommended that an RI/FS be completed to further assess the distribution of groundwater contamination at this site, assess associated human health risks, and develop appropriate remedial alternatives. The site designation was changed from AREE 63BD to AOC 63BD at this time.

2.3 REMEDIAL INVESTIGATION FIELD ACTIVITY SUMMARY

The RI field investigation was conducted in conformance with the RI/FS Task Order Work Plan (ABB-ES, 1996b) and the Final Fort Devens POP (ABB-ES, 1995).

The RI field program for AOC 63BD consisted of:

- performing a geophysical surveys for clearing utilities;

- drilling and installation of two piezometers and one monitoring well;
- drilling of four soil borings for monitoring well installation;
- installing of four monitoring wells;
- subsurface soil sampling for field and off-site laboratory analysis;
- field analysis of environmental samples using a field gas chromatograph (GC);
- well development;
- one round of groundwater sampling for off-site laboratory analysis;
- aquifer conductivity testing; and
- horizontal and vertical survey of explorations.

ABB-ES established a project field office in Building 88 on Pine Street at Devens' RFTA. The field office was used for equipment storage and maintenance, sample management, shipping and receiving, staff meetings, and communications. A radio base-station and telephone were maintained in the field office; each field crew was issued a hand-held radio. An equipment decontamination pad was constructed at Building 202 located approximately one-half mile from AOC 63BD. ABB-ES and subcontractor staff were briefed about the nature of the site, health and safety information, Devens traffic regulations, and key technical requirements.

ABB-ES began implementation of the RI field program in June 1996, with geophysical surveys to identify buried utilities. The soil boring and monitoring well and piezometer installation program was begun and completed in July 1996. The new monitoring wells were developed and sampled in July 1996. A second round of sampling was proposed in the Task Order Work Plan, but due to the administrative changes at the AOC, it was not collected.

The subcontractors used by ABB-ES in conducting the RI program were as follows:

- New Hampshire Boring, Derry, NH - Drilling and monitoring well installation.
- ESE, Gainesville, FL - Chemical analysis of environmental samples.
- Groundwater Analytical, Needham, MA - Chemical analysis of environmental samples.
- L.J. Ducharme Associates, Bolton, MA - Surveying of site explorations.

2.4 REMEDIAL INVESTIGATION ANALYTICAL PROGRAM

The analytical program for the RI was designed to identify contaminants that were expected, based on previous investigation, to be encountered at AOC 63BD. The program included an extensive range of organic and inorganic analytes. The specific analyses performed on soil samples collected from AOC 63BD included MADEP's volatile petroleum hydrocarbon (VPH) and extractable petroleum hydrocarbon (EPH) method, USEPA's total petroleum hydrocarbon (TPHC) analysis (Method 418.1), grain size distribution analysis, and total organic carbon (TOC). Groundwater samples were also analyzed for VPH/EPH, TPHC, and water quality and bioremediation parameters (alkalinity, chloride, sulfate, sulfide, nitrate/nitrite, phosphorus, TOC, hardness, total iron, dissolved iron, methane, and total aerobic heterotrophs).

The results of the VPH and EPH analyses will be presented with the appropriate adjusted toxicity values in accordance with MADEP guidelines (MADEP, 1994).

2.4.1 Field Laboratory Analyses

To develop screening information to aid in the placement and selection of boring, monitoring well, and sample locations, selected soil samples were analyzed in the field to evaluate the extent of contamination. Field analyses were conducted in accordance with ABB-ES guidelines outlined in Section 4.6 of the POP (ABB-ES, 1995). A field laboratory was used on-site for the analysis of total VPH (TVPH) and total EPH (TEPH) using a field GC. Results of soil field analyses were reported in micrograms per kilogram ($\mu g/g$) dry weight. The TVPH/TEPH field

analytical method was not included in the 1995 POP revision. However, the procedure followed during the RI field program is attached as Appendix E to this SI Report.

2.4.2 Quality Assurance/Quality Control

Off-site laboratories performing the analytical work for all parameters, except for MADEP VPH/EPH analysis and grain size distribution, during the AOC 63BD RI were required to implement the USAEC 1990 QA Program (USAEC, 1990). Sections 7.0 through 14.0 of the POP describe the procedure followed during the RI program at AOC 63BD (ABB-ES, 1995).

Soil and groundwater samples analyzed for MADEP's VPH/EPH method were not analyzed by a USAEC-performance demonstrated laboratory. Instead these samples were analyzed by a commercial laboratory (Groundwater Analytical, Inc.), and the data will be entered into the USAEC's data management system as non-certified methods.

2.4.2.1 Data Quality Assessment. On-site and off-site laboratory data collected during the RI field investigation were evaluated for laboratory and/or sampling-related contamination. The soil and groundwater sample results for VPH/EPH were assessed using the duplicate results and the off-site laboratory QA sample results (i.e., method blanks, laboratory control samples, surrogates). A review of the QA sample results showed that no laboratory contaminants were present in the sample results for AOC 63BD. Laboratory control sample and surrogate recoveries were within the QC limits set by the laboratory.

One soil sample duplicate (BDM-96-03X) was collected during the RI. The results of the off-site laboratory analysis were consistent with the results of the regular soil sample. In addition, one groundwater sample duplicate (BDM-96-01X) was collected. The results from the off-site laboratory analyses were also consistent with the regular groundwater sample collected from this location.

2.5 SITE INVESTIGATION REPORT PRELIMINARY RISK EVALUATION METHODOLOGY

This section discusses the approach used for the human health PRE for AOC 63BD. The groundwater PRE from the Final SSE Report (ABB-ES, 1994) has been updated with data collected during the RI field effort. The soil PRE has not been updated because the soil data collected during the RI was obtained from upgradient and downgradient locations, and because no unacceptable human health risks were found in the SSE PRE. Therefore, the soil PRE completed during the SSE provides a better representation of the risks associated with source area soil contamination (ABB-ES, 1994). The PRE results are presented in Section 3.0 of this SI Report. The RI PRE was updated to help establish whether environmental contamination at this AOC will require one of the following actions:

- Nomination for no further action (NFA)
- Removal Action (with subsequent NFA nomination)

As presented in the Final SSE Report (ABB-ES, 1994), environmental sampling conducted during previous field programs at AOC 63BD revealed the presence of organic contaminants in the following environmental media:

- Subsurface soil (defined as soil below 3 feet bgs), and
- Groundwater

The SSE human health PRE was previously conducted at AOC 63BD to evaluate contamination in subsurface soil. For the purposes of selecting soil CPCs, only TPHC was evaluated. Other organic compounds and inorganic analytes in soil were not evaluated. The PRE was also conducted to evaluate contamination in groundwater. VOCs, SVOCs, and TPHC detected in groundwater were evaluated as CPCs.

The updated human health PRE presented in this SI Report for AOC 63BD, only evaluates groundwater and was conducted in accordance with the procedures and guidelines outlined in the Groups 3, 5, and 6 Revised Final SI Report (ABB-ES, 1996a). In addition, it compares the previous groundwater data for VOCs and SVOCs, and the RI groundwater data for VPH/EPH, to USEPA and MADEP MCP drinking water standards.

2.5.1 General PRE Uncertainties

The evaluation of human health risks at AOC 63BD involves numerous uncertainties and assumptions. Although many of the assumptions and uncertainties at Devens are inherent in the human health assessment process (i.e., in development and formulation of the conceptual model), others are related to data limitations and natural environmental stochasticity (USEPA, 1992b).

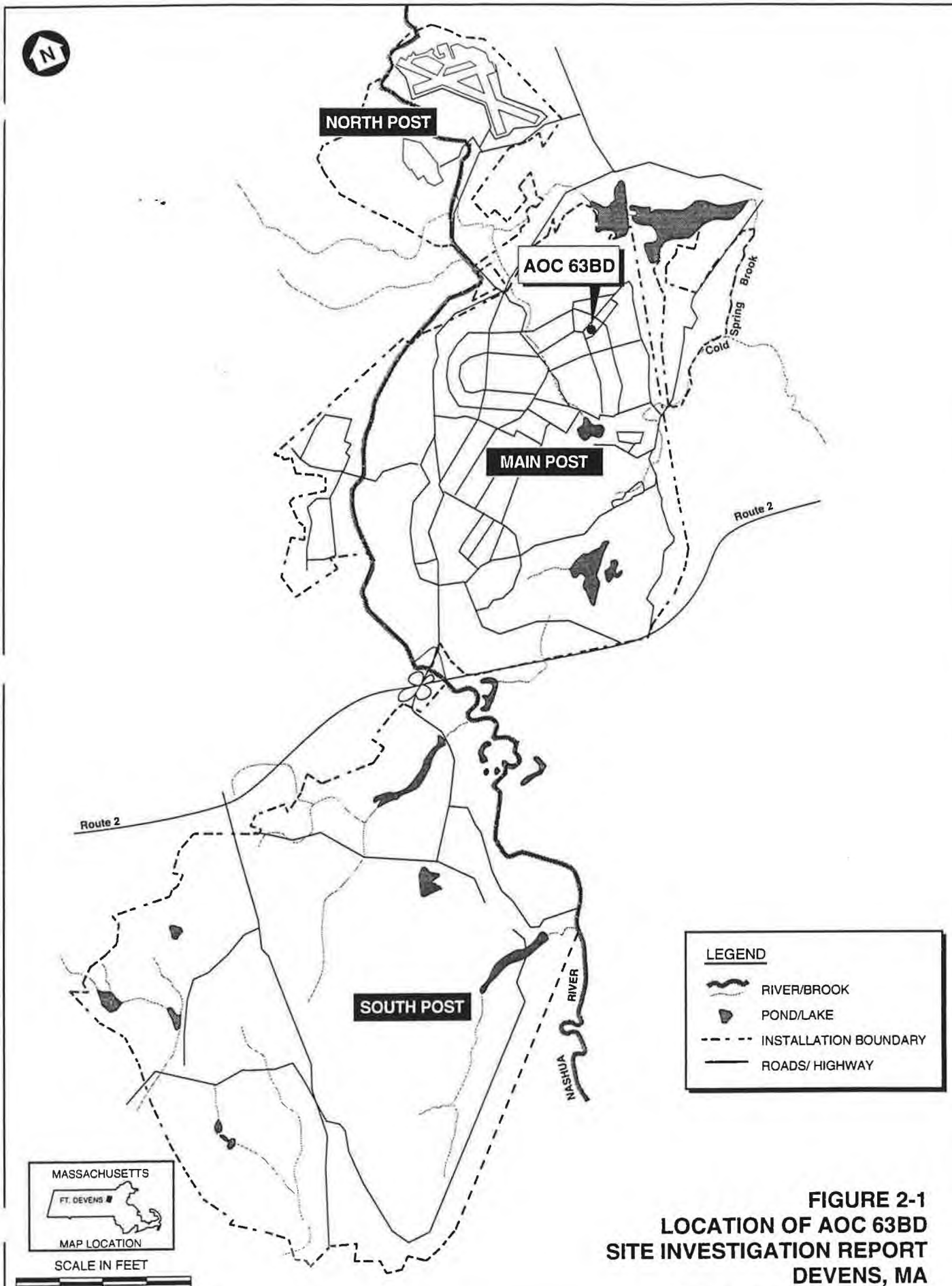

FIGURE 2-1
LOCATION OF AOC 63BD
SITE INVESTIGATION REPORT
DEVENS, MA

ABB Environmental Services, Inc.

9601005D 5

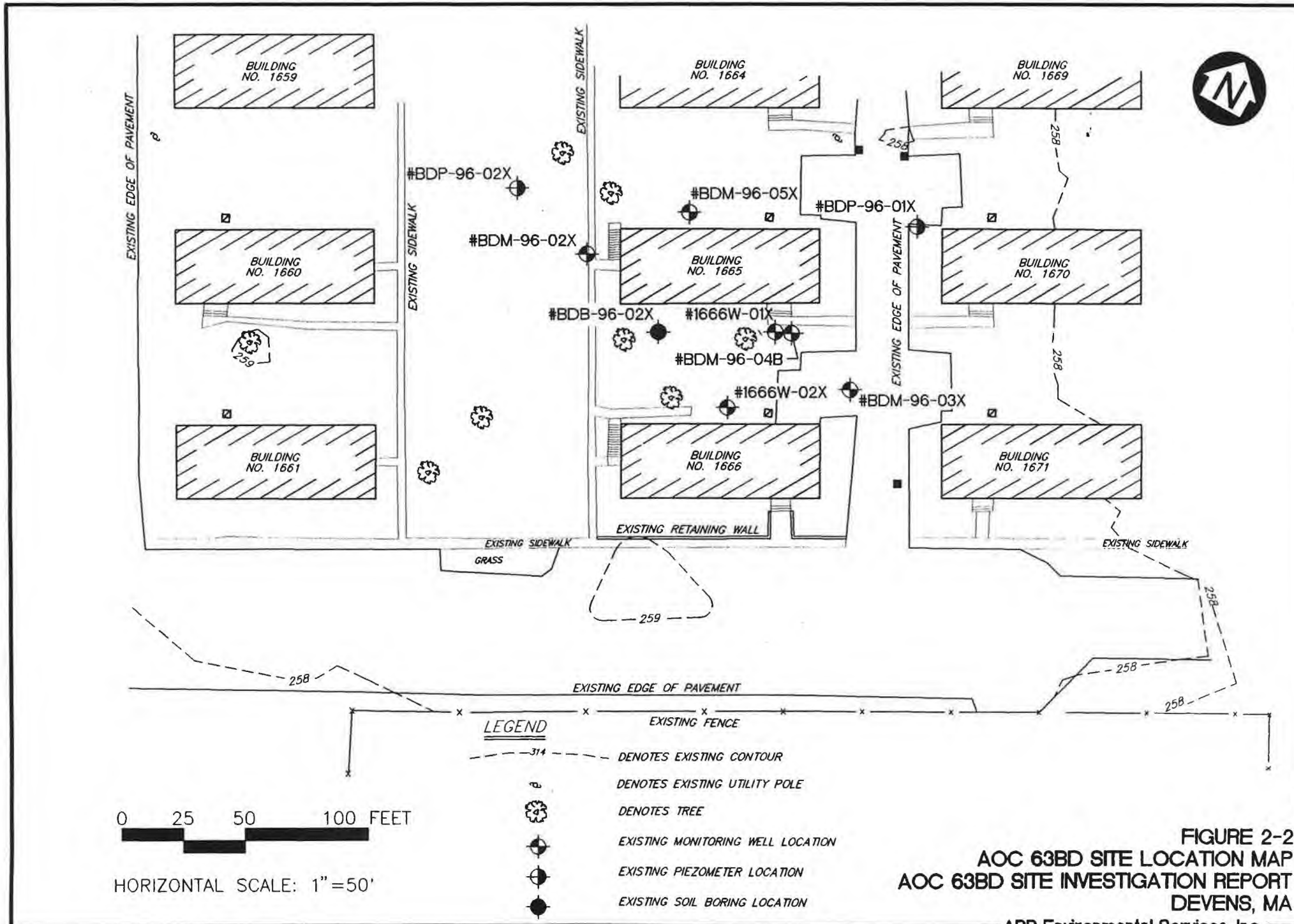

FIGURE 2-2
AOC 63BD SITE LOCATION MAP
AOC 63BD SITE INVESTIGATION REPORT
DEVENS, MA

ABB Environmental Services, Inc.

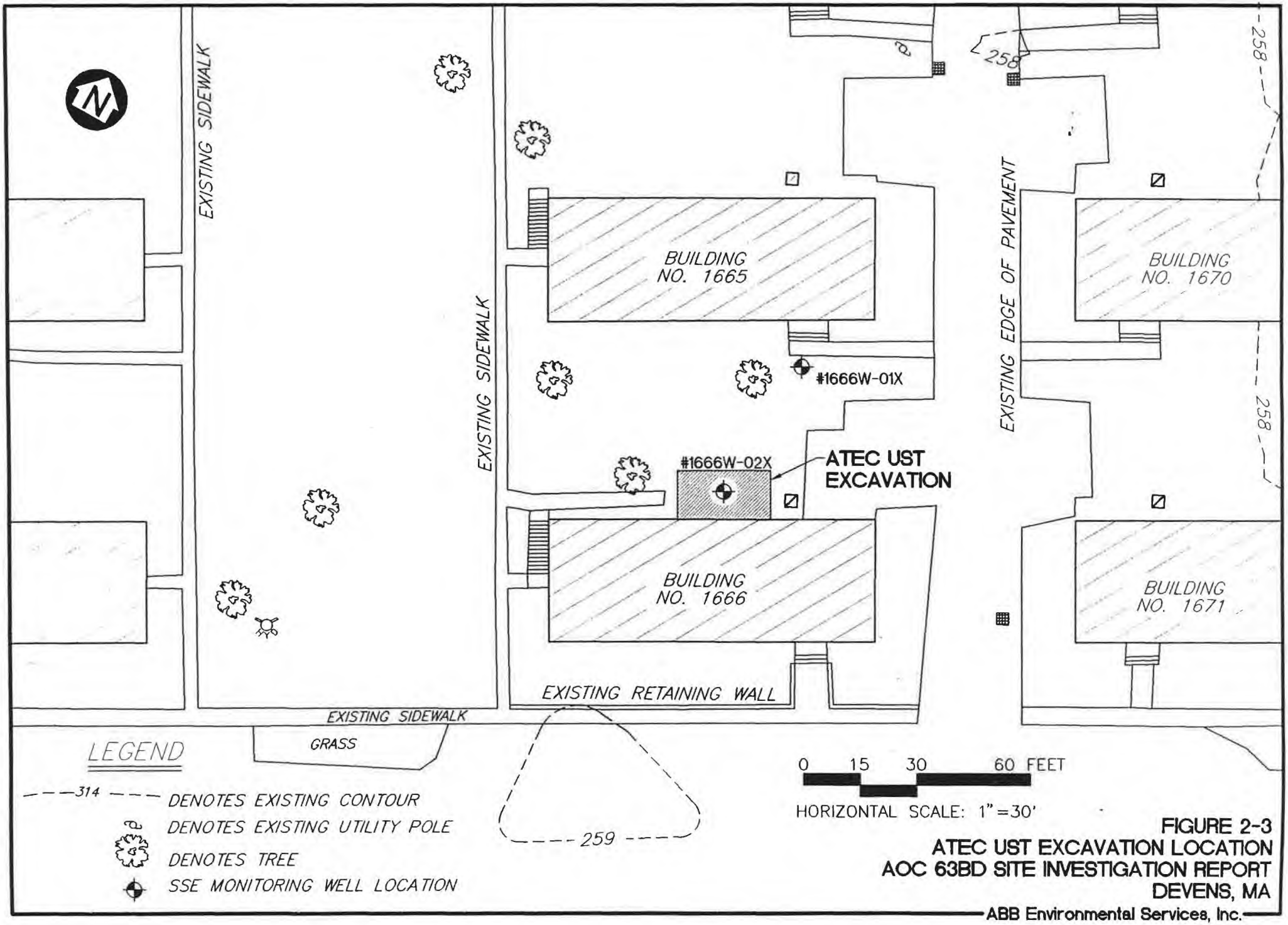

FIGURE 2-3
ATEC UST EXCAVATION LOCATION
AOC 63BD SITE INVESTIGATION REPORT
DEVENS, MA

ABB Environmental Services, Inc.

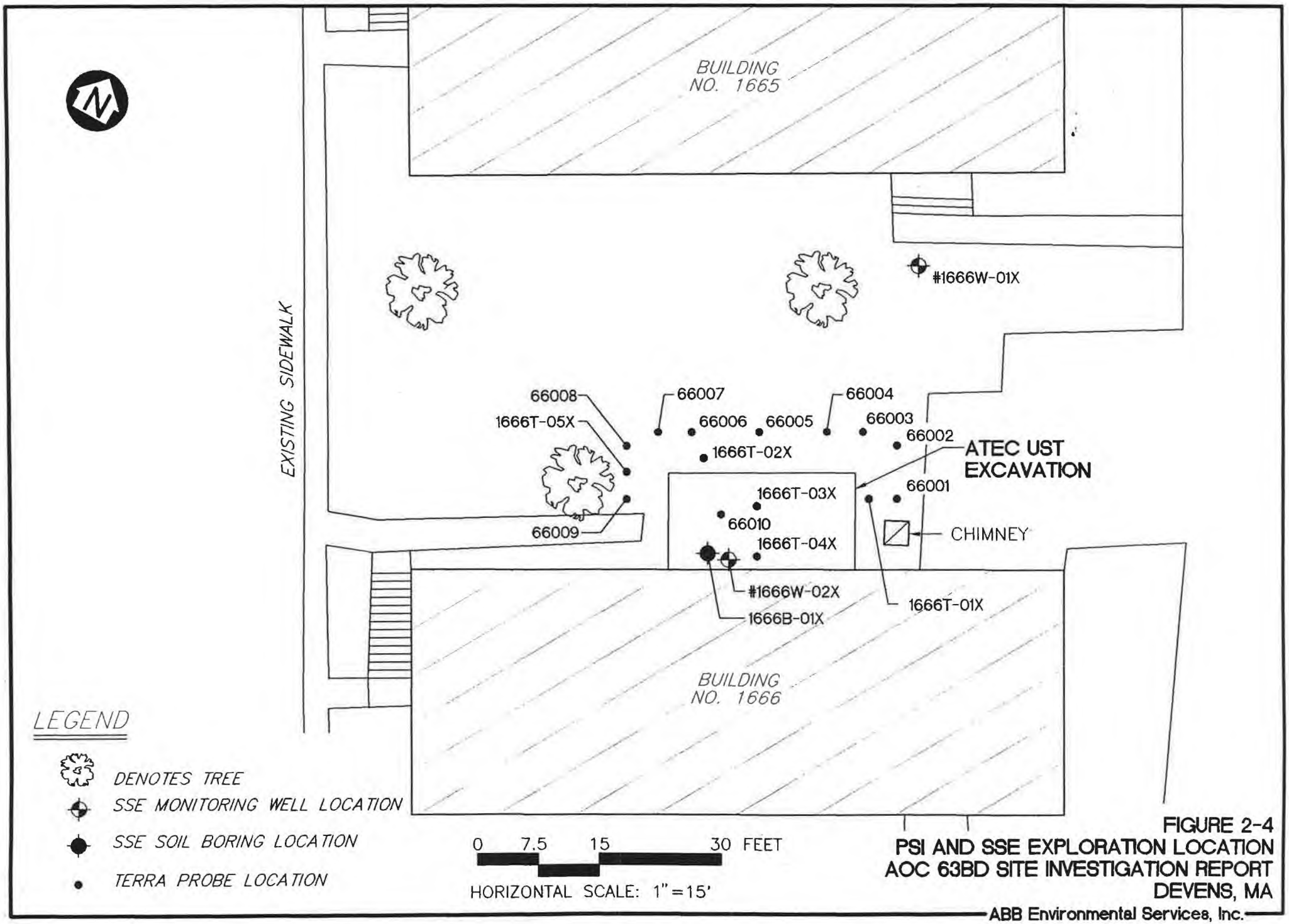

FIGURE 2-4
PSI AND SSE EXPLORATION LOCATION
AOC 63BD SITE INVESTIGATION REPORT
DEVENS, MA

ABB Environmental Services, Inc.

TABLE 2–1
SUMMARY OF ATEC LABORATORY RESULTS[1,2]
AOC 63BD

SITE INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

SOIL			
SAMPLE NUMBER	VOLATILES ug/g	TPH ug/g	SAMPLE LOCATION
RS–1	NA	94	Southwest
RS–2	NA	375	Bottom
RSS–1	NA	514	Northeast sidewall (12 feet deep)
RSS–2	NA	3,630	Southeast sidewall (12 feet deep)
WATER			
SAMPLE NUMBER	VOLATILES ug/L	TPH ug/L	SAMPLE LOCATION
–– None ––			

NOTES: 1. Source: ATEC, 1993f.

2. Analyses performed by Environmental Science Services

NA = Not analyzed.

TPHC = Total petroleum hydrocarbons

TABLE 2-2
PSI AND SSE TERRAPROBE SURVEY FIELD SCREENING RESULTS
AOC 63BD

SITE INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

TANK SITE	PROBE NO.	SAMPLE NO.	SAMPLE DATE	SAMPLE MEDIUM	SAMPLE DEPTH (feet)	FIELD SCREENING		COMMENTS
						TPHC[1] (ug/g)	TVO[2] (ppm)	
		T16660214	12/14/93	SOIL	14-15	<50	11.9	
	1666T-03X	T16660314	12/14/93	SOIL	14-15	<50	113.8	
	1666T-04X	T16660410	12/14/93	SOIL	10-11	<50	12.2	
		T16660414	12/14/93	SOIL	14-15	2,800	192.9	fuel odor
	1666T-05X	T16660510	12/14/93	SOIL	10-11	64	18.5	
		T16660514	12/14/93	SOIL	14-15	<50	24.5	

NOTES:

1. Total petroleum hydrocarbons.
2. Total volatile organic compounds in soil-jar headspace, as measured by photoionization detector.
3. ND= Non-detect.

TABLE 2-3
SSE SOIL BORING FIELD SCREENING RESULTS
AOC 63BD

SITE INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

TANK SITE	BORING NO.	WATER TABLE DEPTH (feet)	SAMPLE NO.	SAMPLE DATE	SAMPLE MEDIUM	SAMPLE DEPTH (feet)	FIELD SCREENING TPH[1] (ug/g)	FIELD SCREENING TVO[2] (ppm)	SENT TO LAB	COMMENTS
Bldg 1666 (UST 26)	1666B-01X	27.5	BX16660115	01/03/94	SOIL	15-17	3,040	142.4	YES	
			BX16660120	01/03/94	SOIL	20-22	3,500	121.4	YES	oily sheen on rinse water
			BX16660125	01/03/94	SOIL	25-27	2,300	175.1	NO	
			BX16660130	01/03/94	SOIL	30-32	76	36.9	NO	petroleum odor
	1666W-01X	-- No soil samples --								

NOTES:
1. Total petroleum hydrocarbons.
2. Total volatile organic compounds in soil-jar headspace, as measured by photoionization detector.

TABLE 2-4
SSE OFF-SITE LABORATORY SOIL RESULTS[1]
AOC 63BD

SITE INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

ANALYTE	BORING NO. / DEPTH	1666B-01X 15-17 ft	1666B-01X 20-22 ft
VOLATILES (ug/g)			
Methylene chloride		0.009 B,J	0.081 B
Acetone		<0.010	0.16 B
Toluene		0.004 J	<0.026
Ethylbenzene		0.002 J	<0.026
Total xylenes		0.3	0.21
SEMIVOLATILES (ug/g)			
Naphthalene		0.56	4.3
2-Methylnaphthalene		3.7	18
Acenaphthene		0.21 J	<1.7
Dibenzofuran		0.39	0.73 J
Fluorene		0.43	1.2 J
Phenanthrene		0.9	1.6 J
Anthracene		0.14 J	0.3 J
Di-n-butylphthalate		0.13 B,J	0.24 B,J
Pyrene		0.041 J	<1.7
Butylbenzylphthalate		0.053 J	<1.7
bis(2-Ethylhexyl)phthalate		0.083 J	1 J
PETROLEUM HYDROCARBONS (ug/g)			
Total Petroleum Hydrocarbons		1,360	1,770
INORGANICS (ug/g)		NA	NA

NOTES:
1. Data as reported by CompuChem Environmental Corporation; data have not been "blank-corrected."

B (organics) = Also found in associated method blank.

J = Estimated value, below sample quantitation limit.

NA = Not analyzed.

TABLE 2-5
SSE OFF-SITE LABORATORY GROUNDWATER RESULTS[1]
AOC 63BD

SITE INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

ANALYTE	WELL NO.	1666W-01X	1666W-01X	1666W-01X	1666W-02X	1666W-02X
	SAMPLE DATE	February 1994	February 1994	January 1995	January 1995	January 1995
	SAMPLE NO.	MX166611	MD166611 (Dup)	MX166612	MX166621	MD166621 (Dup)
VOLATILES (ug/L)						
Methylene Chloride		1 J	3 J	<10	<10	<10
Toluene		1 J	1 J	12	53	78
Ethylbenzene		1 J	1 J	4 J	36	47
Total xylenes		21	21	32	280	420 E
SEMIVOLATILES (ug/L)						
Naphthalene		<5	<5	46	<5	<5
2-Methylnaphthalene		<10	<10	20	10	<10
1-Methylnaphthalene		<15	<15	26	58	12 J
Diethylphthalate		<15	<15	<15	<15	6 J
Fluorene		<10	<10	<10	5 J	<10
Pentachlorophenol		<55	<55	<55	<55	2 J
Phenanthrene		<15	<15	<15	<15	2 J
Di-n-butylphthalate		1 B,J	1 B,J	<15	3 B,J	<15
bis(2-ethylhexyl)phthalate		3 J	4 J	3 J	60	32
TOTAL PETROLEUM HYDROCARBONS (ug/L)		<250	<250	1,350	3,610	3,000
INORGANICS (ug/L)		NA	NA	NA	NA	NA

NOTES: 1. Data as reported by CompuChem Environmental Corporation; data have not been "blank corrected."

B = Also found in blank.

E = Exceeds upper level of calibration range of instrument.

J = Estimated value, below sample quantitation limit.

NA = Not analyzed.

TABLE 2-6
SSE HUMAN HEALTH PRELIMINARY RISK EVALUATION OF SUBSURFACE SOIL
AOC 63BD

SITE INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

ANALYTE	CONCENTRATION [a]		FREQUENCY OF DETECTION	USEPA REGION III COMMERCIAL/INDUSTRIAL SOIL CONCENTRATION (ug/g)	MCP STANDARD (ug/g)		MAXIMUM EXCEEDS GUIDELINE CONCENTRATION?
	AVERAGE (ug/g)	MAXIMUM (ug/g)			S-2 [d]	S-3 [e]	
VOLATILES (ug/g)							
Not analyzed [b]	--	--	--	--	--	--	--
SEMIVOLATILES (ug/g)							
Not analyzed [b]	--	--	--	--	--	--	--
PETROLEUM HYDROCARBONS (ug/g)							
Total Petroleum Hydrocarbons (TPH) Depth <15 ft	503	3,630	7/21	16,360 [c]	2,500	--	Yes
Total Petroleum Hydrocarbons (TPH) Depth > 15 ft	628	3,500	6/15	16,360 [c]	--	5,000	No
INORGANICS (ug/g)							
Not analyzed [b]	--	--	--	--	--		--

Notes:

[a] TPH data at depths of 15 feet or less include field screening results from five Terraprobe locations (1666T-01X through 1666T-05X, at 10 to 15 foot depths) sampled in December 1993; field-screening results from ten TerraProbe locations (66001 through 66010, at 9 to 10 foot depths) sampled in September 1992; and ATEC samples RSS-1 and RSS-2, at 12 foot depths. TPH data at 15 feet or greater include field screening results for samples from ten TerraProbe locations (66001 through 66004, at 16 to 22 foot depths) sampled in September 1992, and field-screening results from samples from boring 1666B-01X at 15 to 32 foot depths.

[b] For samples collected at 15 foot depths or less, only TPH was analyzed for in the December 1993 Terraprobe survey.
BTEX compounds were not detected in the September 1992 preliminary Terraprobe survey.

[c] Calculated commercial/industrial soil concentration for No. 2 fuel oil (using diesel oil as a surrogate); see Section 2.4 for discussion.
Shaded line indicates an exceedance of a screening guideline.

[d] The lowest of the S-2/GW-1, S-2/GW-2 or S-2/GW-3 soil standards.

[e] The lowest of the S-3/GW-1, S-3/GW-2, or S-3/GW-3 soil standards.

ug/g = micrograms per gram

TABLE 2–7
SSE HUMAN HEALTH PRELIMINARY RISK EVALUATION OF GROUNDWATER
AOC 63BD

SITE INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

ANALYTE	CONCENTRATION [a]		FREQUENCY OF DETECTION	DRINKING WATER STANDARD/GUIDELINE [b] (ug/L)	MCP GROUNDWATER STANDARD [c] (ug/L)	MAXIMUM EXCEEDS STANDARD/GUIDELINE?
	AVERAGE (ug/L)	MAXIMUM (ug/L)				
VOLATILES (ug/L)						
Methylene chloride	3	3	1/3	5	5	No
Toluene	26.1	79	3/3	1000	1,000	No
Ethylbenzene	15.5	47	3/3	700	700	No
Total xylenes	134	420	3/3	10,000	6,000	No
SEMIVOLATILES (ug/L)						
Naphthalene	17	46	1/3	20	20	Yes
2–Methylnaphthalene	10.8	20	2/3	NA	10	Yes
1–Methylnaphthalene	23	58	2/3	NA	NA	--
Diethylphthalate	6	6	1/3	5,000	30	No
Fluorene	5	5	1/3	NA	300	No
Pentachlorophenol	2	2	1/3	1	1	Yes
Phenanthrene	2	2	1/3	NA	50	No
Di–n–butylphthalate	3	3	2/3	3,700	NA	No
Bis(2–ethylhexyl)phthalate	17.5	60	3/3	6	6	Yes
PETROLEUM HYDROCARBONS (ug/L)						
Total Petroleum Hydrocarbons (TPH)	1,593	3,610	2/3	--	1,000	Yes
INORGANICS (ug/L)						
Not analyzed	--	--	--	--		--

Notes:

[a] Based on analytical data from Well No. 1666W–01X and 1666W–02x (and their duplicates).

[b] Includes the lowest of either the EPA or MA drinking water standards or guidelines, or if no federal or state standard or guideline is available, the USEPA Region III tap water concentration.

[c] Includes the lowest of the GW–1, GW–2, or GW–3 standards.

3.0 REMEDIAL INVESTIGATION DATA SUMMARY

The following subsections present the findings of the RI field investigation conducted at AOC 63BD during the summer of 1996. The tables associated with this section also include the data collected during previous investigation so that a complete assessment of the AOC may be presented.

3.1 REMEDIAL INVESTIGATION PROGRAM SUMMARY

The first phase of the RI field program was developed and executed based on of contaminants from the previous investigations which could have interfered with the exploration program.

A GPR survey was completed at proposed exploration locations to identify subsurface obstructions which could have interfered with the exploration program.

Two water table piezometer (BDP-96-01X and BDP-96-02X) and one monitoring well (BDM-96-01X) were installed at the AOC to better define the groundwater flow direction prior to the monitoring well installations (Figure 3-1). The locations were used for piezometric surface elevations only. Table 3-1 summarizes the depths of the soil borings and the soil types encountered.

A total of five soil borings (BDM-96-02X, BDM-96-03X, BDM-96-04B, BDM-96-05X, and BDB-96-02X) were drilled crossgradient and downgradient of the former UST excavation for the installation of monitoring wells (see Figure 3-1). Up to four soil samples per boring were collected and field screened for VPH/EPH. One soil sample per boring was submitted and off-site laboratory analysis for VPH/EPH and TPHC based on field PID measurements and one soil sample from the well screen interval was analyzed for TOC.

To assess the nature and distribution of groundwater contamination associated with petroleum contamination from the former heating oil UST, four monitoring wells (BDM-96-02X, BDM-96-03X, BDM-96-04B, and BDM-96-05X) were installed upgradient, crossgradient, and downgradient in the borings mentioned above (see Figure 3-1). Table 3-2 summarizes the monitoring well construction details. The groundwater flow direction used to determine the location for the

monitoring wells was based on the piezometric elevation data collected from piezometers BDP-96-01X and BDP-96-02X, and BDM-96-01X, installed at the beginning of the field program (see Figure 3-1). The monitoring wells were developed, and one round of groundwater samples was collected from each of the five new and two existing monitoring wells and submitted to the off-site laboratories for VPH/EPH, TPHC, and water quality parameters analyses.

Each of the new monitoring wells, piezometers, and the soil boring were surveyed to establish the vertical and horizontal location of each exploration.

3.2 Field Investigation Results and Observations

3.2.1 Physical Setting

The following subsections describe the physical setting of AOC 63BD.

3.2.1.1 Soil. Soils encountered in the TerraProbe℠ and soil borings graded fine-to-coarse sand and gravelly sand within an area mapped by Jahns (1953) as kame terrace deposits. Boring BDM-96-04B was advanced by hollow stem auger to refusal at 53.5 feet bgs (see Figure 3-1). The soil encountered in this boring were similar to soil encountered in the previous investigations. The soil at each of the soil borings consisted of fine to medium sand with gravel (approximately 30%) and trace silt. Table 3-1 summarizes the soils encountered at AOC 63BD.

3.2.1.2 Bedrock. Hollow stem auger refusal was reached at 53.5 feet bgs in boring BDM-96-04B (see Figure 3-1). Rock core samples were not collected to characterize or confirm that the top of bedrock had been reached. However, based on regional bedrock maps, it appears that the bedrock in this portion of the installation is part of the Oakdale Formation, which consists of metasiltstone and phyllite. Subsection 2.2.7 of the Groups 3, 5 and 6 Revised Final SI Report presents a detailed discussion of the bedrock geology for Devens (ABB-ES, 1996a).

3.2.1.3 Hydrogeologic Conditions. Locally, the site was drained by a stormwater drainage ditch that runs along the eastern and southern borders of the site.

ABB-ES measured water levels in each of the new and existing monitoring wells in October 14, 1996 using an interface probe. Floating product was not encountered, however, a fuel odor was detected in monitoring well 1666W-02X. The depths to groundwater ranged from 27.95 feet at BDM-96-03X to 28.34 feet bgs at BDM-96-05X. Based on piezometric surface elevation data, the horizontal groundwater flow gradient is 0.0005 feet per foot (ft/ft). This same piezometric surface elevation data indicated that the groundwater flow direction was from the southwest to the northeast (Figure 3-2). This manual horizontal gradient may indicate that seasonal variations in the groundwater flow direction could occur. This could impact the lateral distribution of site-related contaminants. Table 3-3 summarizes the water level data collected on October 14, 1996.

Monitoring well BDM-96-04B was installed adjacent to the existing monitoring well 1666W-01 to assess vertical groundwater gradients at AOC 63BD (see Figure 3-1). Monitoring well 1666W-01 was installed with a 10-foot well screen extending from 25 to 35 feet bgs. Monitoring well BDM-96-04B was also installed with a 10-foot well screen extending from 43.5 to 53.5 feet bgs (see Table 3-2). Piezometric surface elevations collected on October 14, 1996 show an elevation at 1666W-01 of 232.97 feet mean sea level (MSL), and an elevation at BDM-96-04B of 232.99 feet MSL. Based on this data there appears to be a slight upward gradient (see Table 3-3). The upward vertical gradient of 0.02 feet would appear to indicate that contaminant migration deeper into the aquifer is unlikely at AOC 63BD.

Rising head hydraulic conductivity tests were completed at all but one (1666W-02X) of the new and existing monitoring wells installed at AOC 63BD. Results of the tests ranged from $1x10^{-1}$ centimeters per second (cm/sec) at BDM-96-01X to $3x10^{-4}$ cm/sec at BDM-96-04B. The results of the hydraulic conductivity tests are presented in Table 3-3.

3.3.3 Nature and Distribution of Contaminants

The objective of the RI sampling program at AOC 63BD was to investigate the nature and distribution of contamination in subsurface soil and groundwater. The primary concern at AOC 63BD was that fuel-related compounds had leaked from, or been spilled near, the former heating oil UST, and had migrated downward to the water table via infiltration and percolation of surface water through the overburden soils to the water table. The distribution of residual fuel-related

compounds in the soil (to a depth of 27 feet bgs) below the former heating oil UST had been determined during the SSE. Therefore, the RI concentrated on the distribution of fuel-related compounds in soil at the water table and in groundwater downgradient of the AOC. One upgradient well (BDM-96-01X) and three downgradient or crossgradient monitoring wells (BDM-96-02X, BDM-96-03X, and BDM-96-05X) were installed to assess the groundwater quality. An additional deep monitoring well (BDM-96-04B) was installed adjacent to the existing water table monitoring well 1666W-01X, to assess the groundwater quality deeper in the aquifer and evaluate vertical gradients (see Figure 3-1).

3.3.3.1 Soil. Field screening results of soil samples collected from each boring are presented in Table 3-4. The samples were analyzed for TVPH/TEPH using a field GC. The results of the field analysis indicate that fuel-related compounds were not present in the soil at the water table at any of the monitoring well locations. However, field screening results from the 25- to 27-foot bgs soil sample collected from BDB-96-02X, indicate that fuel-related compounds were present in soil just above the water table at this location. A concentration of 1,111 μg/g of TEPH was detected (see Table 3-4).

Off-site laboratory results for soil samples collected during the RI are presented in Table 3-5. The VPH/EPH results presented in this section include unadjusted data for each analyte range, and equivalent TPHC data adjusted with the appropriate toxicity value. The results of the off-site laboratory VPH/EPH analysis indicate that low concentrations of fuel-related compounds were present in the soil at the AOC. An unadjusted concentration of 280 μg/g in the n-C9 to n-C 12 aliphatic range, and an equivalent TPHC concentration of 14 μg/g, was detected in the 23-foot soil sample collected from the upgradient monitoring well boring BDM-96-01X (see Table 3-5). Concentrations in the other subsurface soil samples were below the reporting limit (BRL) for both VPH and EPH analysis. The results for the subsurface soil samples submitted for TPHC analysis via USEPA Method 418.1, indicated that residual TPHC was present in the sample collected from 25 feet bgs at BDM-96-01X (1,160 μg/g), and the sample collected from 29 feet bgs at BDM-96-02X (1,230 μg/g) (see Table 3-5). TPHC was not detected in the other soil samples. The TOC analysis results showed TOC at 879 μg/g in the 50-foot soil sample collected from BDM-96-04B. The TOC results for the other soil samples indicated that TOC was not present above the detection limit of 360 μg/g (see Table 3-5). See Appendix D for off-site laboratory results.

3.3.3.2 Groundwater. The results of the RI groundwater sampling round are presented in Table 3-6. The VPH/EPH results presented in this section include both adjusted (using toxicity value multipliers) and unadjust concentration. The results of the VPH/EPH analyses indicated that residual fuel-related compounds were present only in the groundwater sample collected from monitoring 1666W-02X, which is located within the former heating oil UST grave. Concentrations in the VPH analysis included 1,900 μg/L in the n-C 9 to n-C 12 aliphatic range, and 5,400 μg/L in the n-C 9 to n-C 10 aromatic range, this totaled to an equivalent TPHC concentration of 6,400 μg/L for the VPH analysis. No individual compounds were detected, however, the reporting limits were increased up to 1,250 μg/L due to contaminant levels.

The EPH analysis results for 1666W-02X included 75,000 μg/L in the n-C 9 to n-C 18 aliphatic range, 9,100 μg/L in the n-C 19 to n-C 36 aliphatic range, and 10,000 μg/L in the n-C 10 to n-C 22 aromatic range. These concentrations totaled to 14,000 μg/L for an equivalent TPHC value in the EPH analysis. In addition, five individual SVOCs were detected: naphthalene at 100 μg/L, 2-methylnaphthalene at 460 μg/L, acenaphthalene at 110 μg/L, fluorene at 62 μg/L, and phenanthrene at 64 μg/L (see Table 3-6). Additional n-C5 to n-C18 and n-C19 to n-C36 aliphatic concentrations were detected in the groundwater samples collected from BDM-96-02X, BDM-96-03X, and BDM-96-05X (see Table 3-6 and Figure 3-1).

By totaling the equivalent TPHC for VPH and EPH analyses, a combined TPHC value was determined. The combined values ranged from 7.8 μg/L at BDM-96-05X to 20,400 μg/L at 1666W-02X (see Table 3-6).

The RI groundwater samples were also analyzed by an off-site laboratory (ESE) for TPHC using USEPA Method 418.1. The results of this analysis indicated that TPHC was present in the samples collected from 1666W-02X at 3,960 μg/L, BDM-96-01X at 4,000 μg/L, BDM-96-02X at 5,200 μg/L, BDM-96-03X at 1,000 μg/L, and BDM-96-05X at 490 μg/L (see Table 3-6).

The RI groundwater samples collected from AOC 63BD were also analyzed for several water quality and bioremediation assessment parameters. The list of parameters and the results for each analysis are presented in Table 3-6.

3.3.4 Source Evaluation and Migration Potential

Most of the fuel-contaminated soil was removed from the site by ATEC during the UST removal program; however, some residual contamination extends to 25 feet bgs near the south corner of the excavation. Screening results from the PSI TerraProbe℠ survey indicate that some contaminated soil may have been mixed with clean fill at the time the remedial excavation was closed. The results of the SSE soil sampling indicate that residual fuel-related compounds are present in the soil from approximately 14 feet bgs to the water table (approximately 27 feet bgs). The results of the RI soil sampling and analysis indicates that no significant soil contamination is present downgradient or crossgradient of the AOC.

Monitoring well 1666W-02X is located in the area of highest soil contamination encountered at the site. The results of the SSE and RI groundwater sampling indicate that fuel-related compounds (i.e., ethylbenzene, xylenes, polynuclear aromatic hydrocarbons [PAHs], and TPHC [via VPH/EPH]) are highest in the groundwater samples collected from 1666W-02X (see Table 3-6). However, the results of the RI groundwater sampling indicate that the distribution of fuel-related compounds appears to be limited to the areas directly adjacent to the former heating oil UST; and that downgradient migration appears limited based on the small horizontal gradient and the type of contaminants encountered.

3.3.5 Preliminary Human Health Risk Evaluation

A preliminary human health risk evaluation was prepared for AOC 63BD to determine if contaminants detected at this AOC pose a risk to human receptors. For this PRE, the future use of AOC is assumed to be commercial/industrial. The soil PRE completed in the Final SSE Report (ABB-ES, 1994) will not be modified for this SI Report. Tables 3-6 present summary statistics and human health groundwater standards and guidelines used in the PRE for AOC 63BD.

3.3.5.1 Groundwater. Groundwater samples were collected during the SSE and RI from monitoring wells 1666W-01X, 1666W-02X, BDM-96-01X through BDM-96-05X and analyzed at an off-site laboratory. As shown in Table 3-6, four VOCs were detected (during the SSE): methylene chloride, toluene, ethylbenzene, and xylenes. The maximum detected concentration of each compound was below its respective drinking water standard. Ten SVOCs were also detected. Of these 10 SVOCs, the maximum detected concentrations of six

compounds exceeded their respective drinking water or groundwater standard. Naphthalene was detected in three of 10 samples; while its maximum detected concentration (100 μg/L in VPH analysis) exceeds the USEPA lifetime health advisory and the MCP GW-1 standard of 20 μg/L, its average concentration (15 μg/L) is below both screening values. Both the maximum detected concentration of 2-methylnaphthalene (450 μg/L) exceed the MCP GW-1 standard of 10 μg/L, however, its average concentration (4.9 μg/L) does not exceed the standard. Pentachlorophenol was detected in one of 10 samples at 2 μg/L; the federal MCL and MCP GW-1 standard for pentachlorophenol are 1 μg/L. Bis(2-ethylhexyl)phthalate was detected in three samples at average (10 μg/L) and maximum (60 μg/L) concentrations above the federal and state drinking water standard of 6 μg/L. This compound is a common laboratory contaminant and this concentration may not represent existing site conditions. Equivalent VPH and EPH concentrations were assessed as part of this groundwater PRE rather then the TPHC data which had previously been assessed. This change was a result of the need for more specific data than provided by TPHC (Method 418.1) results. TPHC analysis was part of the RI parameter list, but the data will not be assessed in this groundwater PRE. TPHC, via total equivalent VPH/EPH, was detected in five of 10 samples at average (2,560 μg/L) and maximum (20,400 μg/L) concentrations above the MCP GW-1 standard for TPHC of 1,000 μg/L. The average concentration was increased significantly due to the maximum concentration detected in monitoring well 1666W-02X. Without this result, the average concentration would be well below drinking water standards.

Based on the findings of this PRE, groundwater below the former UST excavation associated with AOC 63BD would be unacceptable as drinking water.

3.3.6 Conclusions and Recommendations

Contaminants detected in groundwater samples collected from AOC 63BD, exceed drinking water standards. Although residual soil contamination does not appear to present at unacceptable health risks, it is likely a continuing source for groundwater contamination.

It is recommended that a soil removal action be conducted to eliminate the residual soil contamination detected from approximately 14 feet begs to the water table (approximately 27 feet bgs). In addition, groundwater monitoring should be

conducted at the site to evaluate potential risks to human health. Future groundwater monitoring should be conducted in accordance with MADEP MCP guidelines.

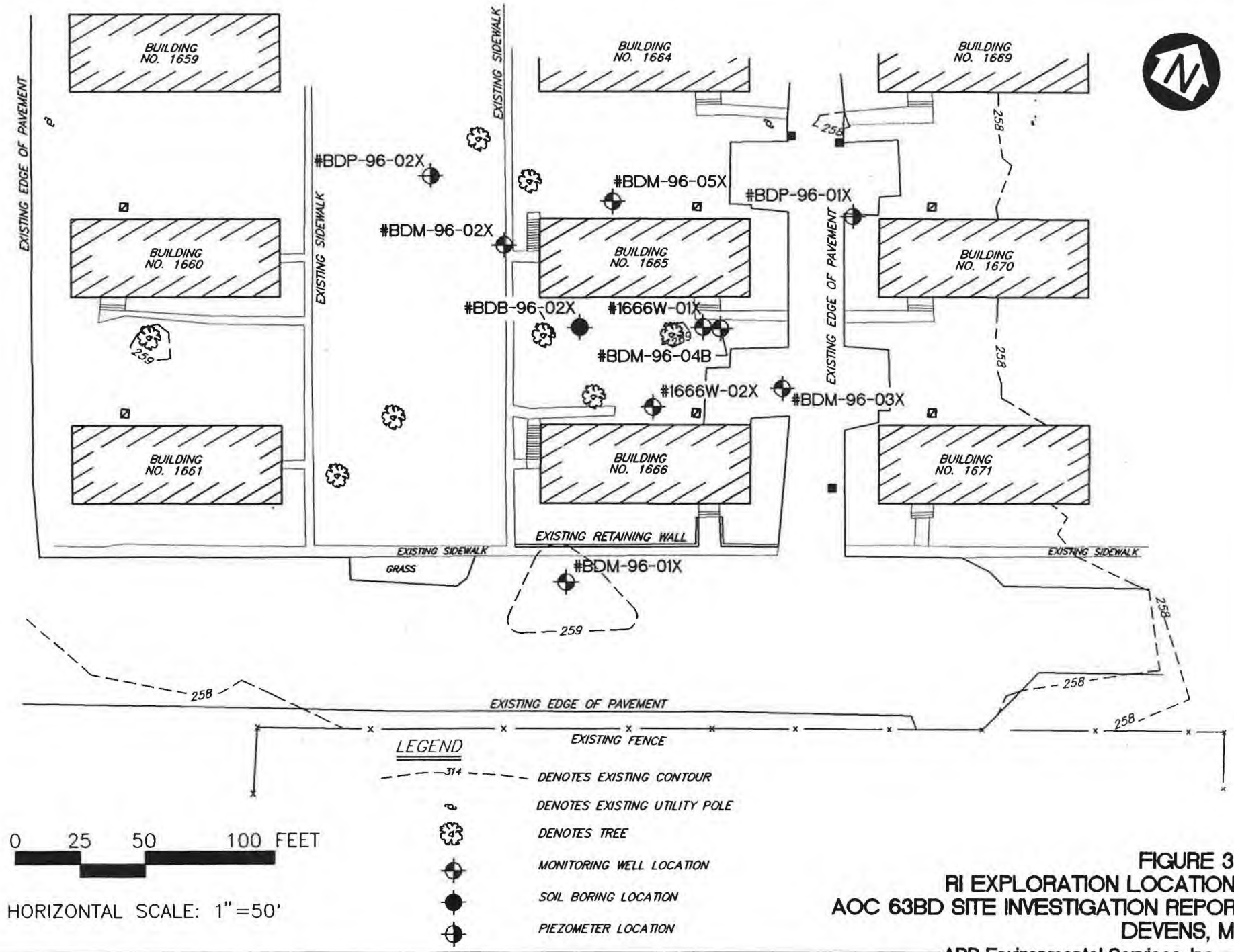

FIGURE 3-1
RI EXPLORATION LOCATIONS
AOC 63BD SITE INVESTIGATION REPORT
DEVENS, MA

ABB Environmental Services, Inc.

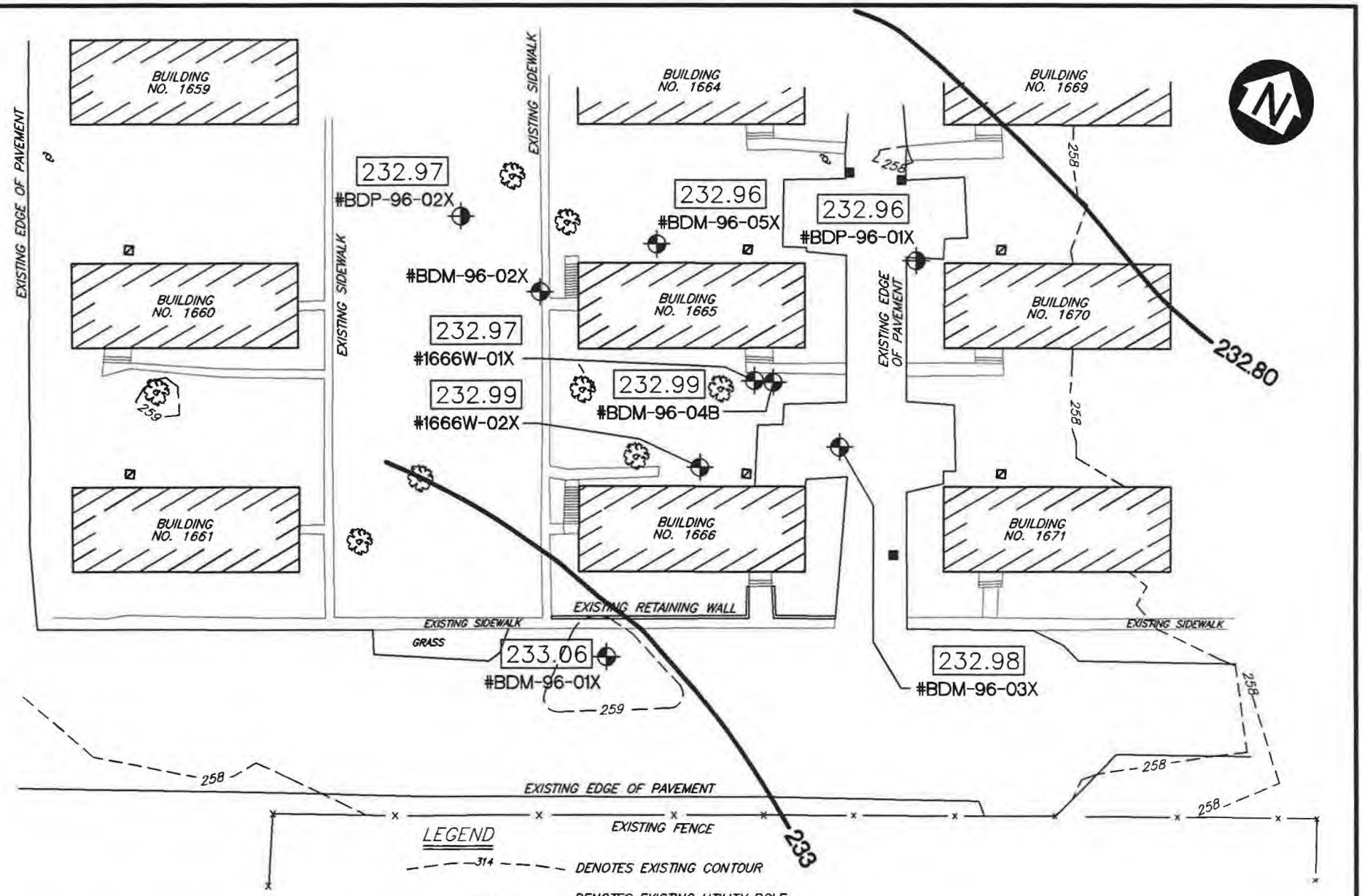

FIGURE 3-2
INTERPRETED GROUNDWATER FLOW MAP 10/14/96
AOC 63BD SITE INVESTIGATION REPORT
DEVENS, MA

ABB Environmental Services, Inc.

J:\8740-02\8740F005.DWG 1=50 12-03-96

TABLE 3-1
SUMMARY OF RI SOIL BORINGS
AOC 63BD

SITE INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

EXPLORATION ID	COMPLETION DEPTH (Feet bgs)	REFERENCE SAMPLE INTERVALS (Feet bgs)	ANALYTICAL SAMPLES COLLECTED	SOIL TYPE (USCS)	TOTAL VOCs BY PID (ppm)
BDM-96-01X	32	0-2		SM	BKG
		5-7		SW	BKG
		10-12		SW	BKG
		15-17		SW	BKG
		17-19		SW	BKG
		19-21		SW-SM	BKG
		21-23		SW-SM	BKG
		23-25	23-25	SW-SM	BKG
		25-27	25-27	SW-SM	BKG
		27-29	27-29	SW	BKG
		29-32			BKG
BDM-96-02X	33	0-2		SM	BKG
		5-7		SP	BKG
		10-12		SP	BKG
		15-17		SW	BKG
		17-19		SW	BKG
		19-21		SW	BKG
		21-23		SW	BKG
		23-25		SW	BKG
		25-27		SP	BKG
		27-29	27-29	SP	BKG
		29-31		SP	BKG
		31-33		SP	BKG
BDM-96-03X	33	0-2		SM	BKG
		5-7		SW	BKG
		10-12		SW	BKG
		15-17		SW	BKG
		17-19		SW	BKG
		19-21		SW	BKG
		21-23		SW	BKG
		23-25		SW	BKG
		25-27		SW	BKG
		27-29	27-29	SW	BKG
		29-31		SW	BKG
		31-33			BKG
BDM-96-04B	53	0-2		ML-SP	BKG
		2-4		SP	BKG
		4-6		SP	BKG
		6-8		SM	BKG
		10-12		SM	BKG
		12-14		SM	BKG
		14-16		SM	BKG
		16-18		SM	BKG
		18-20		SM	BKG
		20-22		SM	BKG
		22-24		SM	BKG

TABLE 3-1
SUMMARY OF RI SOIL BORINGS
AOC 63BD

SITE INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

EXPLORATION ID	COMPLETION DEPTH (Feet bgs)	REFERENCE SAMPLE INTERVALS (Feet bgs)	ANALYTICAL SAMPLES COLLECTED	SOIL TYPE (USCS)	TOTAL VOCs BY PID (ppm)
		24-26		SM	BKG
		26-28		SP	BKG
		28-30	28-30	SM	BKG
		30-32		SM	BKG
		32-34		SM	BKG
		34-36		SM	BKG
		36-38		SM	BKG
		38-40		SP	BKG
		40-42		SM	BKG
		42-44		NS	BKG
		44-46		SM	BKG
		46-48		SM	BKG
		48-50		SM	BKG
		50-52		SM	BKG
		52-53		Refusal	BKG
BDM-96-05X	33	0-2		ML-SM	BKG
		5-7		SW	BKG
		10-12		SM	BKG
		15-17		SW	BKG
		17-19		SW	BKG
		19-21		SW	BKG
		21-23		SW	BKG
		23-25		SW	BKG
		25-27	25-27	SW	BKG
		27-29		SW	BKG
		29-31		SW	BKG
		31-33		SW	BKG

TABLE 3–2
RI MONITORING WELL COMPLETION DETAILS
AOC 63BD

SITE INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

WELL IDENTIFICATION	SOIL DRILLING METHOD	BEDROCK DRILLING MEHTOD	MEDIA SCREENED	WELL SCREEN DEPTH (Feet bgs)	WELL SCREEN ELEVATION (Feet NGVD)	COMPLETION DEPTH (Feet bgs)	CONSTRUCTION MATERIAL
BDM–96–01X	HOLLOW STEM AUGER	NA	SOIL	22–32	236.9 – 226.9	33	2" ID PVC
BDM–96–02X	HOLLOW STEM AUGER	NA	SOIL	22.8–32.8	235.7 – 225.7	33	2" ID PVC
BDM–96–03X	HOLLOW STEM AUGER	NA	SOIL	22.8–32.8	235.4 – 225.4	33	2" ID PVC
BDM–96–04B	HOLLOW STEM AUGER	NA	SOIL	43.3–53.3	215.3 – 205.3	53.5	2" ID PVC
BDM–96–05X	HOLLOW STEM AUGER	NA	SOIL	23–33	235.5–225.5	33	2" ID PVC

Notes: bgs = below ground surface
NGVD = National geodetic vertical datum

TABLE 3-3
WATER LEVELS AND
ESTIMATES OF HYDRAULIC CONDUCTIVITY
AOC 63BD

SITE INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

EXPLORATION	SCREENED INTERVAL (FT BGS)	ELEV TOP OF PVC (FT MSL)	DEPTH TO WATER (FEET)	ELEV OF WATER (FT MSL)	HYDRAULIC CONDUCTIVITY (CM/SEC) VIA:			GEOLOGY OF SCREENED INTERVAL (USCS)
					HVORSLEV	HAZEN	MASCH AND DENNY	
1666W-1	35-25	258.41	25.44	232.97	4E-2	NA[1]	NA[1]	SW
1666W-2	35-25	261.80	28.81	232.99	NA[2]	NA[1]	NA[1]	SW
BDM-96-01X	32.5-22.5	261.42	28.36	233.06	4E-2	5E-2	2E-2	SW-SM
BDM-96-02X	33-23	260.96	27.99	232.97	NA[3]	5E-2	5E-3	SW-SP
BDM-96-03X	33-23	260.93	27.95	232.98	NA[3]	6E-2	2E-2	SW
BDM-96-04B	53.3-43.3	261.05	28.06	232.99	3E-4	1E-3	NA[4]	SP-GP
BDM-96-05X	33-23	261.30	28.34	232.96	1E-1	1E-1	NA[4]	SW
BDP-96-01X	30.5-20.5	260.87	27.91	232.96	NA[2]	NA[1]	NA[1]	SW
BDP-96-02X	31-21	261.31	28.34	232.97	NA[2]	NA[1]	NA[1]	SM-SW

NOTES: WATER LEVEL MEASUREMENTS COLLECTED ON 10/14/96

REFER TO APPENDIX F FOR CALCULATIONS

NA[1] = GRAIN SIZE ANALYSIS NOT PERFORMED ON 1666W-1, 1666W-2, BDP-96-01X, AND BDP-96-02X

NA[2] = PERMEABILITY TESTING NOT PERFORMED ON 1666W-2, BDP-96-01X, AND BDP-96-02X

NA[3] = PERMEABILITY TEST DATA NOT COMPATIBLE WITH HVORSLEV METHOD

NA[4] = CALCULATED INCLUSIVE STANDARD DEVIATIONS TOO LARGE FOR GRAPHICAL ESTIMATION

USCS = UNIFIED SOIL CLASSIFICATION SYSTEM

CM/SEC = CENTIMETER PER SECOND

FT BGS = FEET BELOW GROUND SURFACE

FT MSL = FEET MEAN SEA LEVEL

PVC = POLYVINYL CHLORIDE

TABLE 3-4
RI FIELD SCREENING RESULTS
AOC 63BD

SITE INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

BORING NO.	SAMPLE NO.	SAMPLE DATE	SAMPLE MEDIUM	SAMPLE DEPTH (feet)	FIELD SCREENING VPH[1] (ug/g)	FIELD SCREENING EPH[2] (ug/g)	COMMENTS
BDM-96-01X	MXBD0115XF	7/18/96	SOIL	15-17	BRL	BRL	
	MXBD0119XF	7/18/96	SOIL	19-21	BRL	BRL	
	MXBD0123XF	7/18/96	SOIL	23-25	BRL	BRL	
	MXBD0127XF	7/18/96	SOIL	27-29	BRL	BRL	
BDM-96-02X	MXBD0217XF	7/18/96	SOIL	17-19	BRL	BRL	
	MXBD0221XF	7/18/96	SOIL	21-23	BRL	BRL	
	MXBD0225XF	7/18/96	SOIL	25-27	BRL	BRL	
	MXBD0229XF	7/18/96	SOIL	29-31	BRL	BRL	
BDB-96-02X	BXBD0215XF	7/19/96	SOIL	15-17	BRL	BRL	
	BXBD0219XF	7/19/96	SOIL	19-21	BRL	BRL	
	BXBD0223XF	7/19/96	SOIL	23-25	BRL	BRL	
	BXBD0225XF	7/19/96	SOIL	25-27	BRL	1,111	
	BXBD0229XF	7/19/96	SOIL	29-31	BRL	BRL	
BDM-96-03X	MXBD0315XF	7/19/96	SOIL	15-17	BRL	BRL	
	MXBD0319XF	7/19/96	SOIL	19-21	BRL	BRL	
	MXBD0323XF	7/19/96	SOIL	23-25	BRL	BRL	
	MDBD0323XF	7/19/96	SOIL	23-25	BRL	BRL	Duplicate
	MXBD0327XF	7/19/96	SOIL	27-29	BRL	BRL	
	MXBD0329XF	7/19/96	SOIL	29-31	BRL	BRL	
BDM-96-04B	MXBD4B18XF	7/17/96	SOIL	18-20	BRL	BRL	
	MXBD4B22XF	7/17/96	SOIL	22-24	BRL	BRL	
	MXBD4B26XF	7/17/96	SOIL	26-28	BRL	BRL	
	MXBD4B30XF	7/17/96	SOIL	30-32	BRL	BRL	
	MXBD4B34XF	7/17/96	SOIL	34-36	BRL	BRL	

TABLE 3–4
RI FIELD SCREENING RESULTS
AOC 63BD

SITE INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

BORING NO.	SAMPLE NO.	SAMPLE DATE	SAMPLE MEDIUM	SAMPLE DEPTH (feet)	FIELD SCREENING VPH[1] (ug/g)	FIELD SCREENING EPH[2] (ug/g)	COMMENTS
BDM–96–05X	MXBD0515XF	7/17/96	SOIL	15–17	BRL	BRL	
	MXBD0519XF	7/17/96	SOIL	19–21	BRL	BRL	
	MXBD0523XF	7/17/96	SOIL	23–25	BRL	BRL	
	MXBD0525XF	7/17/96	SOIL	25–27	BRL	BRL	
	MXBD0527XF	7/17/96	SOIL	27–29	BRL	BRL	

Notes:

1. VPH = volatile petroluem hydrocarbons
2. EPH = extractable petroluem hydrocarbons
3. BRL = Below reporting limit

TABLE 3-5
RI OFF-SITE LABORATORY SOIL RESULTS
AOC 63BD

SITE INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

ANALYTE	BORING NO. / DEPTH	BDM-96-01X 23-25 ft	BDM-96-02X 29-31 ft	BDM-96-03X 27-29 ft	BDM-96-03X 27-29 ft dup	BDM-96-04B 28-30 ft	BDM-96-05X 29-31 ft
VOLATILES (ug/g)							
Methylene chloride		NA	NA	NA	NA	NA	NA
Acetone		NA	NA	NA	NA	NA	NA
Toluene		NA	NA	NA	NA	NA	NA
Ethylbenzene		NA	NA	NA	NA	NA	NA
Total xylenes		NA	NA	NA	NA	NA	NA
n-C 5 to n-C 8 Aliphatics		BRL	BRL	BRL	BRL	BRL	BRL
n-C 9 to n-C 12 Aliphatics		14	BRL	BRL	BRL	BRL	BRL
n-C 9 to n-C 10 Aliphatics		BRL	BRL	BRL	BRL	BRL	BRL
TOTAL VPH (ug/g)		14	BRL	BRL	BRL	BRL	BRL
SEMIVOLATILES (ug/g)							
Naphthalene		NA	NA	NA	NA	NA	NA
2-Methylnaphthalene		NA	NA	NA	NA	NA	NA
Acenaphthene		NA	NA	NA	NA	NA	NA
Dibenzofuran		NA	NA	NA	NA	NA	NA
Fluorene		NA	NA	NA	NA	NA	NA
Phenanthrene		NA	NA	NA	NA	NA	NA
Anthracene		NA	NA	NA	NA	NA	NA
Di-n-butylphthalate		NA	NA	NA	NA	NA	NA
Pyrene		NA	NA	NA	NA	NA	NA
Butylbenzylphthalate		NA	NA	NA	NA	NA	NA
bis(2-Ethylhexyl)phthalate		NA	NA	NA	NA	NA	NA
n-C 5 to n-C 18 Aliphatics		BRL	BRL	BRL	BRL	BRL	BRL
n-C 19 to n-C 36 Aliphatics		BRL	BRL	BRL	BRL	BRL	BRL
n-C 10 to n-C 22 Aliphatics		BRL	BRL	BRL	BRL	BRL	BRL
TOTAL EPH (ug/g)		BRL	BRL	BRL	BRL	BRL	BRL
PETROLEUM HYDROCARBONS (ug/g)							
Total Petroleum Hydrocarbons (418.1)		1160	1230	<28.5	<28.5	<28.5	<28.5
VPH/EPH Total Petroleum Hydrocarbons		BRL	BRL	BRL	BRL	BRL	BRL
OTHER (ug/g)							
Total Organic Carbon		<360	<360	<360	<360	879	<360

NOTES: 1. Data as reported by CompuChem Environmental Corporation; data have not been "blank-corrected."

B (organics) = Also found in associated method blank.

J = Estimated value, below sample quantitation limit.

NA = Not analyzed.

VPH= MADEP's volatile petroleum hydrocarbon method.

EPH= MADEP's extractable petroleum hydrocarbon method.

ug/g= micrograms per gram.

TABLE 3-6
RI OFF-SITE LABORATORY GROUNDWATER RESULTS
AOC 63BD

SITE INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

ANALYTE	WELL NO.	1666W-01X	1666W-02X	BDM-96-01X	BDM-96-01X	BDM-96-02X	BDM-96-03X	BDM-96-04B	BDM-96-05X
	SAMPLE DATE	JULY 1996	JULY 1996	JULY 1996	JULY 1996	JULY 1996	JULY 1996	JULY 1996	JULY 1996
	SAMPLE NO.	MX166613	MX166623	MXBD01X1	MDBD01X1dup	MXBD02X1	MXBD03X1	MXBD04B1	MXBD05X1
VOLATILES (ug/L)									
n-C 5 to n-C 8 Aliphatics		BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL
n-C 9 to n-C 12 Aliphatics		BRL	19000	BRL	BRL	BRL	BRL	BRL	BRL
n-C 9 to n-C 10 Aromatics		BRL	5400	BRL	BRL	BRL	BRL	BRL	BRL
EQUALENT VPH (ug/L) *		BRL	6400	BRL	BRL	BRL	BRL	BRL	BRL
SEMIVOLATILES (ug/L)									
n-C 9 to n-C 18 Aliphatics		BRL	75000	BRL	BRL	BRL	890	BRL	BRL
n-C 19 to n-C 36 Aliphatics		BRL	9100	BRL	BRL	1700	2900	BRL	1600
n-C 10 to n-C 22 Aromatics		BRL	10000	BRL	BRL	BRL	BRL	BRL	BRL
EQUIVALENT EPH (ug/L) *		BRL	14000	BRL	BRL	8.3	58	BRL	7.8
Naphthalene		BRL	100	BRL	BRL	BRL	BRL	BRL	BRL
2-Methylnaphthalene		BRL	460	BRL	BRL	BRL	BRL	BRL	BRL
Acenaphthalene		BRL	110	BRL	BRL	BRL	BRL	BRL	BRL
Fluorene		BRL	62	BRL	BRL	BRL	BRL	BRL	BRL
Phenanthrene		BRL	64	BRL	BRL	BRL	BRL	BRL	BRL
TOTAL PETROLEUM HYDROCARBONS (ug/L)									
TPHC (418.1)		<185	3,960	4,000	<174	5,200	1,000	<172	490
TOTAL EQUIVALENT VPH/EPH *		BRL	20400	BRL	BRL	8.3	58	BRL	7.8
OTHER (ug/L)									
Total Hardness		23400	14400	51600	45200	41200	24800	20400	26800
Alkalinity		115000	12000	13000	10000	8000	12000	76000	7000
Total Iron		<36.8	123	<36.8	<36.8	5050	333	905	<36.8
Nitrate/Nitrite-Non Specific		75.9	79	30.8	69.2	37.7	144	135	93.5
Nitrogen by Kjeldahl Method		<183	<183	<183	<183	<183	<183	<183	<183
Total Phosphate		<13.3	<13.3	<13.3	<13.3	252	<13.3	82.4	<13.3

TABLE 5-6
RI OFF-SITE LABORATORY GROUNDWATER RESULTS
AOC 63BD

SITE INVESTIGATION REPORT
DEVENS, MASSACHUSETTS

	WELL NO.	1666W-01X	1666W-02X	BDM-96-01X	BDM-96-01X	BDM-96-02X	BDM-96-03X	BDM-96-04B	BDM-96-05X
	SAMPLE DATE	JULY 1996	JULY 1996	JULY 1996	JULY 1996	JULY 1996	JULY 1996	JULY 1996	JULY 1996
ANALYTE	SAMPLE NO.	MX166613	MX166623	MXBD01X1	MDBD01X1dup	MXBD02X1	MXBD03X1	MXBD04B1	MXBD05X1
Chloride		23000	9900	18000	18000	13000	15000	18000	20000
Sulfate		16000	18000	13000	13000	130000	<10000	30000	14000
Sulfide		<50	<50	<50	<50	409	<50	<50	<50

NOTES: 1. SSE data as reported by CompuChem Environmental Corporation; data have not been "blank corrected." RI data as reported by ESE Laboratory and Groundwater Analytical.

NA = Not analyzed.

* = Concentrations have been adjusted with MADEP toxicity values.

VPH = MADEP's volatile petroleum hydrocarbons

EPH = MADEP's extractable petroleum hydrocarbons

TABLE 3–7
RI HUMAN HEALTH PRELIMINARY RISK EVALUATION OF GROUNDWATER

SITE INVESTIGATION REPORT
AOC 63BD
DEVENS, MASSACHUSETTS

ANALYTE	CONCENTRATION [a]		FREQUENCY OF DETECTION	DRINKING WATER STANDARD/GUIDELINE [b] (ug/L)	MCP GROUNDWATER STANDARD [c] (ug/L)	MAXIMUM EXCEEDS STANDARD/GUIDELINE?
	AVERAGE (ug/L)	MAXIMUM (ug/L)				
VOLATILES (ug/L)						
Methylene chloride	3	3	1/3	5	5	No
Toluene	26.1	79	3/3	1000	1,000	No
Ethylbenzene	15.5	47	3/3	700	700	No
Total xylenes	134	420	3/3	10,000	6,000	No
SEMIVOLATILES (ug/L)						
Naphthalene	15	100	3/10	20	20	Yes
2–Methylnaphthalene	49	460	3/10	NA	10	Yes
1–Methylnaphthalene	10	58	2/10	NA	NA	--
Diethylphthalate	0.6	6	1/10	5,000	30	No
Acenaphthalene	110	110	1/10	NA	20	Yes
Fluorene	6	62	3/10	NA	300	No
Pentachlorophenol	0.2	2	1/10	1	1	Yes
Phenanthrene	22	64	3/3	NA	50	Yes
Di–n–butylphthalate	0.5	3	3/10	3,700	NA	No
Bis(2–ethylhexyl)phthalate	10	60	3/10	6	6	Yes
PETROLEUM HYDROCARBONS (ug/L)						
Total Equivalent TPHC *	2,560	20,400	4/8	--	1,000	Yes

Notes:

[a] Based on analytical data from Well No. 1666W–01X and 1666W–02x (and their duplicates).

[b] Includes the lowest of either the EPA or MA drinking water standards or guidelines, or if no federal or state standard or guideline is available, the USEPA Region III tap water concentration.

[c] Includes the lowest of the GW–1, GW–2, or GW–3 standards.

* = Toatl equivalent TPHC concentrations are calculated through the addition of the equivalent VPH and the equivalent EPH concentrations.

AREE	Area Requiring Environmental Evaluation
ABB-ES	ABB Environmental Services, Inc.
AOC	Area of Contamination
ATEC	ATEC Environmental Consultants
BRAC	Base Realignment and Closure
BRL	below reporting limit
BTEX	benzene, toluene, ethylbenzene, and xylenes
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cm/sec	centimeters per second
CMR	Code of Massachusetts Regulations
COC	chain-of-custody
COPC	chemical of potential concern
DCC	Devens Commerce Center
DQO	Data Quality Objective
EPH	extractable petroleum hydrocarbons
ETA	Engineering Technologies Associates, Inc.
FFA	Federal Facilities Agreement
FS	feasibility study
FSP	Field Sampling Plan
ft/ft	feet per foot
GC	gas chromatograph
GPR	ground-penetrating radar
HASP	Health and Safety Plan
HSA	hollow stem auger
IAG	interagency agreement
IR	infrared
KGS	Kansas Geological Survey

MADEP	Massachusetts Department of Environmental Protection
MCL	Maximum Contaminant Level
MCP	Massachusetts Contingency Plan
MEP	Master Environmental Plan
mg/L	milligrams per liter
msl	mean sea level
µg/g	micrograms per gram
µg/L	micrograms per liter
NCP	National Contingency Plan
NFA	no further action
NGVD	National Geodetic Vertical Datum
NPL	National Priority List
OSHA	Occupational Safety and Health Administration
PAHs	polynuclear aromatic hydrocarbons
PAL	Project Analyte List
PID	photoionization detector
POP	Project Operations Plan
ppb	parts per billion
ppm	parts per million
PRE	preliminary risk evaluation
PSI	Preliminary Site Investigation
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RFTA	Reserved Forces Training Area
RI	remedial investigation
SARA	Superfund Amendments and Reauthorization Act
SAP	Sampling Analysis Plan
SI	Site Investigation
SSE	Supplemental Site Evaluation
SSI	Supplemental Site Investigation

SVOC	semivolatile organic compounds
TEPH	total extractable petroleum hydrocarbons
TOC	total organic carbon
TPHC	total petroleum hydrocarbon compounds
TSS	total suspended solids
TVPH	total volatile petroleum hydrocarbons
USACE-NED	U.S. Army Corps of Engineers, New England Division
USAEC	U.S. Army Environmental Center
USATHAMA	U.S. Army Toxic and Hazardous Materials Agency
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
UST	underground storage tank
VOC	volatile organic compound
VPH	volatile petroleum hydrocarbons

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APPENDIX A

SOIL BORING LOGS

1666D-01A

SOIL BORING LOG

Client: USATHAMA	Project No. 7137-00		Study Area: [check mark] Boring No.: ~~RX 1666:01~~
			Protection: D
Contractor: NH Boring	Date Started: 3 JAN 94		Completed: 5 JAN 94
Method: SPT w/ HSA	Casing Size: 4.25" ID HSA		PI Meter: #3398 OVM
Ground Elev.:	Soil Drilled: 32 FT		Total Depth: 32 FT
Logged by: R Gillespie	Checked by: D. Pierce		∇ Below Ground: 27.5'
Screen: (ft.) Riser: (ft.)	Diam: (ID)	Material:	Page 1 of: 2

DEPTH (FT)	SAMPLE NUMBER	SAMPLE DEPTH	CLP/SCREENING	RECOVERY	PID (ppm)	SOIL/ROCK DESCRIPTION	BLOWS/6-IN.	COMMENTS
5						FILL NO SAMPLES TO 15 FT.		
10								
15	1	15-17		16"	4.2	GRAVELLY SAND, 15-20% SUB-ROUND GRAVEL TO 1/2", COARSE TO FINE SAND, <5% FINES DRY, LT. YELLOW-BROWN (2.5Y 6/4)	12-14-19-22	(SW)
20		20-22		12"	1.5	GRAVELLY SAND 25-35% GRAVEL TO 3/4" COARSE TO FINE SAND, <5% FINES, DRY, VERY PALE BROWN (10 YR 7/4) OILY SHEEN ON RINSE WATER	8-11-15-16	(SW)

ABB Environmental Services, Inc.

9205007D

16665-01X

SOIL BORING LOG

Study Area: X			
Boring No.: ~~BX16666~~			
Client: USATHAMA	Project No. 7137-CO	Protection: D	
Contractor: NH BORING	Date Started: 3 JAN 93	Completed: 5 JAN 94	
Method: SPT W/ HSA	Casing Size: 4.25" HSA	PI Meter: # 3378 OVM	
Ground Elev.:	Soil Drilled: 32'	Total Depth: 32'	
Logged by: R GILLESPIE	Checked by:	▽ Below Ground:	
Screen: (ft.)	Riser: (ft.) Diam: (ID) Material:	Page 2 of: 2	

DEPTH (FT)	SAMPLE NUMBER	SAMPLE DEPTH	CLP/SCREENING	RECOVERY	PID (ppm)	SOIL/ROCK DESCRIPTION	BLOWS/6-IN.	COMMENTS
25		25-27		18"	3.9	GRAVELLY SAND 10-20% GRAVEL TO 3/8", C-F SAND, <5% FINES DRY, BROWN (7.5 YR 4/2)	11-13-15-9	(SW)
30		30-32		2"	0.4	GRAVELLY SAND 10-15% GRAVEL TO 1/2" C-F SAND, <5% FINES SATURATED, LT. YELLOW-BROWN (10YR 6/4) PETROLEUM ODOR END OF BORING @ 32'	7-11-14-16	(SW)

ABB Environmental Services, Inc.

9205007D

SOIL BORING LOG

Study Area: Bldg 1666			
Boring No.: 1666W-02X			
Client: USATHAMA	Project No. 07137.00	Protection: D	
Contractor: NHB	Date Started: 12/20/94	Completed: 12/20/94	
Method: 6.25" HSA	Casing Size: N/A	PI Meter: 580A OVM TE	
Ground Elev.:	Soil Drilled: 35'	Total Depth: 35'	
Logged by: Jim Kenny	Checked by: D. Pierce	Below Ground: 27.8'	
Screen: (ft.)	Riser: (ft.) Diam: (ID) Material:	Page 1 of: 1	

DEPTH (FT)	SAMPLE NUMBER	SAMPLE DEPTH	CLP/SCREENING	RECOVERY	PID (ppm)	SOIL/ROCK DESCRIPTION	BLOWS/6-IN.	COMMENTS
5'						Fill: M-C sand, gravel 5-10%, very lt bn loose, damp		SPT not conducted
10'								
13'								
14'						Same as above, dk bn, odor		
	1666W-02X 14-16	14-16' bgs		1'	63	Top 0.9': Gravelly C sand, gravel 10%, fines < 5%, C sand 50% m sand 30%, mod graded, loose, wet petrol odor, lt gray (SW) Bottom 0.1' Silty f sand, fines 15-25% gravel 0%, f sand 60%, med dense, lt gray, poorly graded, low plastic (ML)	3 4 6 5	SPT conducted with 2" spoon and 300lb hammer
16'					8-100	cuttings appear to be fill-like		
25'				1.4'		sand, well graded, gravel 5-10%, fines < 5%; m sand 60%, damp, lt bn (SW)	5 6 7 6	SPT conducted with
27'						cuttings off augers appear to be fill-like: C sand, f gravel 10-20%, < 5% fines strong, petrol odor, wet		
35'						BOE = 35' bgs		

ABB Environmental Services, Inc.

9205007D

SOIL BORING LOG - FORT DEVENS, MA.		PROJECT NO.: 8740.02		BORING NO.: BDP-96-01X		
CLIENT: COE CONTRACTOR: NHB METHOD: HSA 4.25" GROUND ELEV.: LOGGED BY : JCR		DATE STARTED: 6/18/96 DATE COMPLETED: 6/18/96 BORING DIAMETER: 6" REFERENCE PT. ELEV.: CHECKED BY: JCR		STUDY AREA: AOC 63BD PROTECTION: D (Mod.) PID METER: OVM 580B TOTAL DEPTH: 31' WATER TABLE BGS: 21'		
Logged from cuttings. SAMPLE NO.	DEPTH	PEN./REC. (ft./ft.)	PID OF SPOON	SOIL/ROCK DESCRIPTION AND PHYSICAL CONDITIONS	BLOWS/6 IN.	USCS SOIL CLASS.	ONSITE SCREENING
S1	0-5'		0.2	Silty sand, well graded fine to medium sand, 20% silt, loose, dry, non plastic, dark brown.		SM	
S2	5-10'		0.2	Same as above.		SW	
S3	10-15'		0.2	Well graded sands, fine to medium, rounded to subrounded, 10% silt, 10 yr 5/4 yellowish brown.		SW	
S4	15-20'		0	Well graded fine to medium sand, same as above, <5% well rounded gravel, .5 - 1" diameter.		SW	
S5	20-24'		0	Same as above.			
S6	24-26'		0	Well graded medium to coarse sand, angular to subrounded, flakes of mica, <5% rounded gravel, saturated, light brown.	10,14,12,11		Split spoon sample. BDBX0124
S7	26-30'			Cuttings same as 20-24'			Collected water sample MXBD01P1
S8	30-31'			End of boring at 31'.			

SOIL BORING LOG - FORT DEVENS, MA.		PROJECT NO.: 8740.02		BORING NO.: BDP-96-02X			
CLIENT: COE		DATE STARTED:	6/18/96	STUDY AREA:	AOC 63BD		
CONTRACTOR: NHB		DATE COMPLETED:	6/18/96	PROTECTION:	D (Mod.)		
METHOD: HSA 4.25"		BORING DIAMETER:	6"	PID METER:	OVM 580B		
GROUND ELEV.:		REFERENCE PT. ELEV.:		TOTAL DEPTH:	31'		
LOGGED BY : JCR		CHECKED BY:	JCR	WATER TABLE BGS:	24'		

Logged from cuttings. SAMPLE NO.	DEPTH	PEN./REC. (ft./ft.)	PID OF SPOON	SOIL/ROCK DESCRIPTION AND PHYSICAL CONDITIONS	BLOWS/6 IN.	USCS SOIL CLASS.	ONSITE SCREENING
S1	0-5'		0	Silty fine sands, 20-30% silts, loose, dry, 10 yr 5/3 brown.		SM	
S2	5-10'		0	Same as above.		SM	
S3	10-15'		0	Silty sand, medium - subrounded sand, 5% subang. to subrounded gravel, color and moisture same as above.		SM	
S4	15-20'		0	Same as above, gravel increasing a few %.		SM	
S5	20-24'		0	Same as above.		SM	
S6	24-26'		0	Well graded fine to medium sand, 5-10% silt, gravel subang - subrounded, saturated, 10 yr 5/2 grayish brown	9,13,13,19	SW	PXBD0224
S7	26-30'			Same as above.			MXBD02P1 Collected water sample.
				End of boring at 31'.			

SOIL BORING LOG - FORT DEVENS, MA. | PROJECT NO.: **8740.02** | BORING NO.: **BDB-96-02X**

CLIENT: **COE**
CONTRACTOR: NHB
METHOD: HSA 4.25"
GROUND ELEV.: 259
LOGGED BY : JCR

DATE STARTED: 6/24/96
DATE COMPLETED: 6/24/96
BORING DIAMETER: 6"
REFERENCE PT. ELEV.:
CHECKED BY: JCR

STUDY AREA: AOC 63BD
PROTECTION: D (Mod.)
PID METER: OVM 580B
TOTAL DEPTH: 29'
WATER TABLE BGS: 25'

SAMPLE NO.	SAMPLE DEPTH	PEN./REC. (ft./ft.)	PID OF SPOON	SOIL/ROCK DESCRIPTION AND PHYSICAL CONDITIONS	BLOWS/6 IN.	USCS SOIL CLASS.	ON-SITE SCREENING
S1	0-5'	1.2	0	Top 0.4': Sandy silt, 20% fine-medium sand, loose to dense, dry, dark brown. 0.4-0.6': quartz frag. 0.6-1.2': silty sand, 20% silt, fine-med. sand, loose, dry, 10yr 5/6 yellow brown.	3,8,12,8	ML	
S2	5-7'	1	0	Well graded fine sand, ang. - subang. medium dense, dry, 10yr 7/2, light gray.	6,10,12,9	SM	
S3	10-12'	1.4	0	Well graded fine sand, ang. - subang., med. dense, dry, 10yr 7/2 light gray.	7,9,11,11	SW	
S4	15-17'	1	0	0-0.7': same as above. 0.7-1.0': Gravelly sand, subrounded sand, similar to above.	7,9,22,20	SW	BXBD0215XF
S5	17-19'	1.2	0	Well graded gravelly sand, 20% med. - coarse gravel (sunang. - rounded) fine to medium sand, dense, dry, 10yr 5/2 grayish brown.	29,23,18,16	SW-GP	
S6	19-21'	1.2	0	Well graded medium sand, subang. med. dense, damp, 10yr 5/2 grayish brown.	10,7,10,12	SW	BXBD0219XF
S7	21-23'	1.3	5.1	Gravelly sand, 15% gravel, subang., dense, damp, 10yr 5/2.	30,30,27,22	SW	
S8	23-25'		0	Well sorted sand, same as 21-23 without gravel, wet.	19,18,21,21	SW	BXBD0223XF
S9	25-27'		0	Same as above, 10% gavel, saturated.	25,39,51,31	SW	BXBD0225XF
S10	27-29'	1.8	1.2	Same as above, odor, saturated.	13,16,19,21	SW	BXBD0227XF
S11	29-31'	1.8	49.8	Top 0.4': well graded medium sand, same as above. Middle 1.0' well graded coarse sand, same as above. Bottom 0.4': well graded medium sand, same as above. End of boring.	12,14,20,37	SW	BXBD0229XF

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SOIL BORING LOG - FORT DEVENS, MA. | PROJECT NO.: **8740.02** | BORING NO.: **BDM-96-01X**

CLIENT: **COE**
CONTRACTOR: NHB
METHOD: HSA 6.25"
GROUND ELEV.:
LOGGED BY : R. M.

DATE STARTED: 6/18/96
DATE COMPLETED: 6/19/96
BORING DIAMETER: 9"
REFERENCE PT. ELEV.:
CHECKED BY: JCR

STUDY AREA: AOC 63BD
PROTECTION: D (Mod.)
PID METER: OVM 580B
TOTAL DEPTH: 33'
WATER TABLE BGS: ~25'

SAMPLE NO.	SAMPLE DEPTH	REC (ft.)	PID OF SPOON	SOIL/ROCK DESCRIPTION AND PHYSICAL CONDITIONS	BLOWS/6 IN.	USCS SOIL CLASS.	ONSITE SCREENING
S1	0-2'	1.5	0	Silty sand, 25% fines, fine sands, nonplastic, loose, dry, 10yr 5/6.	4,6,7,7	SM	
S2	5-7'	1.4	0	Well graded fine to medium sand, <10% silt, 5% rounded gravel, loose, dry, 10yr 5/3 brown.	4,7,12,12	SW	
S3	10-12'	1.5	0	Same as above, 10% silts.	8,10,9,10	SW	
S4	15-17'	1.6	0	Same as above, moist.	4,9,11,12	SW	BXBD0115
S5	17-19'	1.5	0	Well graded sand, similar to above, moist.	44,20,26,23	SW	
S6	19-21'	1.6	0	Same as above, 10-20% gravel, rounded - subrounded 1.5-2" diam., 10-15% silt.	11,15,19,13	SW-SM	BXBD0119
S7	21-23'	1	0	Similar to above, no gravel.	12,18,12,15	SW-SM	
S8	23-25'	1.5	0	Same as above, bottom 1.0' wet - saturated.	8,8,13,14	SW-SM	BXBD0123 MATPH
S9	25-27'	1.6	0	Same as above, saturated.	5,8,9,9	SW-SM	BXBD0125 MATPH
S10	27-29'	2	0	Fine-med. well graded sands, rounded - subrounded, 10% fines, saturated, brown.	8,17,16,13	SW	BXBD0127 GRAIN SIZE
				Augered to 32' w/o split spooning. End of boring.			

ABB Environmental Services, Inc.

SOIL BORING LOG - FORT DEVENS, MA.		PROJECT NO.: 8740.02		BORING NO.: BDM-96-02X	
CLIENT: COE	DATE STARTED:	6/25/96		STUDY AREA:	AOC 63BD
CONTRACTOR: NHB	DATE COMPLETED:	6/25/96		PROTECTION:	D (Mod.)
METHOD: HSA 4.25"	BORING DIAMETER:	6"		PID METER:	OVM 580B
GROUND ELEV.:	REFERENCE PT. ELEV.:			TOTAL DEPTH:	33.0'
LOGGED BY : HKW	CHECKED BY:	JCR		WATER TABLE BGS:	~24.5'

SAMPLE NO.	SAMPLE DEPTH	PEN./REC. (ft./ft.)	PID OF SPOON	SOIL/ROCK DESCRIPTION AND PHYSICAL CONDITIONS	BLOWS/6 IN.	USCS SOIL CLASS.	ONSITE SCREENING
S1	0-2'	8"	0.5	Silty sand, well graded, loose, dry color 10yr 3/3 dark brown top soil with roots, ~10% gravel <1/2 inch.	4,5,5,8	SM	
S2	5-7'	1.3	0	Sand, poorly graded, mostly fine sand, occassional <5% gravel clasts, <5% fines, loose, 10yr 6/2 light brownish gray.	5,9,11,18	SP	
S3	10-12'	1.1	0	Top 0.6': Fine sand, same as 5-7'. Bottom 0.5': Very fine sand, poorly graded,loose, damp, 10yr 6/2 light brownish gray, horizontal thin brown seams - sand.	6,8,10,12	SP	
S4	15-17'	0.1	0	Too little to classify.	15,24,18,18		
S5	17-19'	1.3	0	Well graded c-f sand, 10-15% coarse gravel up to 1" diam. medium dense, damp, 10yr 6/2 light brownish gray.	15,13,24,30	SW	
S6	19-21'	1.1	0	Well graded c-f sand, same as 17-19', high blows are reflective of siltstone rock - 1-1.5" thick, <5% fines.	41,27,23,23	SW	
S7	21-23'	1.4	0	Well graded c-f sand, same as above.	42,32,40,25	SW	
S8	23-25'	1.6	0	Well graded f-c sand, ~10% gravel, coarse up to 1 inch, <5% fines, saturated at tip, 10yr 5/2 grayish brown.	9,14,15,22	SW	
S9	25-27'	1.2	0	Well graded f-c sand, same as 23-25'.	11,12,14,8	SW	
S10	27-29'	1.7	0	Poorly graded medium sand, ~5% coarse gravel up to 1/2" <5% fines, saturated, 10yr 5/3 brown.	4,8,10,10	SP	
S11	29-31'	1.7	0	Poorly graded mostly medium sand, same as 27-29'.	26,19,19,30	SP	MXBDO229XF
S12	31-33'	1.7	0	Top 1.1': poorly graded, mostly med. sand, same as 29-31'. Bottom 0.5': Poorly graded mostly fine sand, occassional gravel <5% up to 1/2 inch, 10yr 6/3 pale brown, saturated.	12,40,22,18	SP	
				B.O.B. at 33' bgs.			

SOIL BORING LOG - FORT DEVENS, MA. | PROJECT NO.: **8740.02** | BORING NO.: **BDM-96-03X**

CLIENT: **COE**
CONTRACTOR: NHB
METHOD: HSA 4.25"
GROUND ELEV.:
LOGGED BY : JCR

DATE STARTED: 6/25/96
DATE COMPLETED: 6/25/96
BORING DIAMETER: 6"
REFERENCE PT. ELEV.:
CHECKED BY: JCR

STUDY AREA: AOC 63BD
PROTECTION: D (Mod.)
PID METER: OVM 580B
TOTAL DEPTH: 33'
WATER TABLE BGS: ~25'

SAMPLE NO.	SAMPLE DEPTH	REC (ft.)	PID OF SPOON	SOIL/ROCK DESCRIPTION AND PHYSICAL CONDITIONS	BLOWS/6 IN.	USCS SOIL CLASS.	ONSITE SCREENING
S1	1-3'	1.8	0	Silty sand, 20% silt, fine to medium sand, loose, dry, top 0.5 dark brown 10yr 3/1, bottom 10yr 6/8 brownish yellow increasing sand with depth.	4,7,9,8	SM	
S2	5-7'	1.2	1.1	Top 0.4': Same as above. Mid. 0.6': Gravelly , well graded medium sand, 10-20% small gravel, ang. - subang., loose. Bottom 0.2': Poorly graded fine sand, unifiform, medium dense, dry, 10yr 6/3, pale brown.	8,14,15,20	SM SW SP	
S3	10-12'	1	0	Top 0.5': Well ggraded medium sands, loose, dry, 10yr 7/2. Bottom 0.5': Poorly graded fine sand, very uniform, laminations same color, dry.	4,6,11,12	SW SP	
S4	15-17'	1.2	0	Well graded medium - coarse sand, 5% rounded gravel, loose, damp, 10yr 5/3 brown	6,13,12,15	SW	MXBD0315XF
S5	17-19'	1	0	Same as above.	11,14,18,19	SW	
S6	19-21'	1.6	5.5	Well graded coarse sand, subang. - subrounded, same as above.	5,8,13,19	SW	MXBD0319XF
S7	21-23'	1.2	3.6	Top 0.8': Well graded gravelly sand, 15% 1/4"-1/2" subrounded gravel, dense, damp, 10yr 6/2 light brown - gray. Bottom 0.4': Coarse sand, same as 19-21'.	32,14,11,14	SW	
S8	23-25'	1	1.6	Same as above, wet coarse sand.	7,12,12,16	SW	MXBD0323XF MBD0323XF
S9	25-27'	1.2	0	Gravelly sand, 15% 1/4" gravel, saturated.	7,10,10,9	SW	
S10	27-29'	2	0	Coarse sand, 10% gravel as in 25-27'.	14,20,22,19	SW	MXBD0329 MDBD0329 MXBD0329XF
S11	29-31'	1.8	0	Coarse sand as above.	6,15,17	SW	
				Augered to 33' to set well. End of boring.			

ABB Environmental Services, Inc.

SOIL BORING LOG - FORT DEVENS, MA.	PROJECT NO.: 8740.02	BORING NO.: BDM-96-04B

CLIENT: **COE**	DATE STARTED:	6/26/96	STUDY AREA: AOC 63BD
CONTRACTOR: NHB	DATE COMPLETED:	6/26/96	PROTECTION: D (Mod.)
METHOD: HSA 4.25"	BORING DIAMETER:	6"	PID METER: OVM 580B
GROUND ELEV.:			TOTAL DEPTH: 53.5'
LOGGED BY : R.M.	REFERENCE PT. ELEV.:	JCR	WATER TABLE BGS: ~25'
	CHECKED BY:		PAGE 1 OF 2

SAMPLE NO.	SAMPLE DEPTH	REC. (FT)	PID OF SPOON	SOIL/ROCK DESCRIPTION AND PHYSICAL CONDITIONS	BLOWS/6 IN.	USCS SOIL CLASS.	ONSITE SCREENING
S1	0-2'	1.4	0	Top 0.4': Dark brown 10yr 4/2 silt with some sand, roots, little gravel, dry to damp, loose. Bottom 1.0': 10yr 6/3 medium sand, trace silt and gravel, dry, loose	2,12,15,13	ML-SP	
S2	2-4'	1.2	0	Same as above, little coarse gravel.	11,8,8,10	SP	
S3	4-6'	1.3	0	(10yr 5/2) brown coarse sand and gravel (30%), poorly graded, dry, loose.	8,13,13,16	SP	
S4	6-8'	1.3	0	(10yr 6/2) brown medium to coarse sand, poorly graded, dry, loose.	10,22,22,17	SM	
S5	8-10'	1.5	0	(10yr 6/3) light brown medium sand, trace silt and gravel, very poorly graded, slightly damp, mod. dense.	6,7,13,15	SM	
S6	10-12'	1.5	0	Same as above, some fine sand.	8,12,12,12	SM	
S7	12-14'	1.3	0	Top 0.6':(10yr 6/3) same as above. Bottom 0.7': Coarse sand, trace silt and gravel, dry, loose.	13,12,15,15	SM	
S8	14-16'	1.3	0	Same as above.	12,15,17,16	SM	MXBD04B14XF
S9	16-18'	1.4	0.8	(10yr 6/3) CMF sand (20% fines), trace gravel, dry to slightly damp, loose to mod. loose.	7,11,13,19	SM	
S10	18-20'	1.3	0	Same as above.	13,16,24,26	SM	MXBD04B18XF
S11	20-22'	1.2	1.9	(10yr 6/3) Brown cmf sand, trace gravel, slightly damp, mod. dense.	12,16,18,20	SM	MXBD04B22XF
S12	22-24'	1.2	3	Brown (10yr 5/3 cmf sand, trace fines and gravel, slightly damp to dry.	23,18,20,20	SM	
S13	24-26'	1.3	0	Grayish brown (10yr 5/3) cmf sand, and little gravel, trace silt, saturated, mod. dense.	14,14,16,18	SP	
S14	26-28'	1.5	0	(10yr 5/3) coarse sand, trace silt and gravel, saturated, dense.	19,19,22,23	SM	MXBD04B26XF
S15	28-30'	1.7	0	Same as above.	22,21,31,33	SM	MXBD04B28 MATPH TPHC
S16	30-32'	1.5	0	Same as above.	4,7,7,10	SM	
S17	32-34'	1.1	0	Same as above.	5,6,7,10	SM	
S18	34-36'	0.9	0	Grayish brown (10yr 5/2) med. sand, trace silt, no gravel, saturated, mod. dense.	4,8,17,50/.4	SM	MXBD04B34XF
S19	36-38'	1.1	0	Same as above.	11,10,15,18	SM	

SOIL BORING LOG - FORT DEVENS, MA.		PROJECT NO.: 8740.02		BORING NO.: BDM-96-04B	
CLIENT: COE		DATE STARTED:	6/26/96	STUDY AREA:	AOC 63BD
CONTRACTOR: NHB		DATE COMPLETED:	6/26/96	PROTECTION:	D (Mod.)
METHOD: HSA 4.25"		BORING DIAMETER:	6"	PID METER:	OVM 580B
GROUND ELEV.:		REFERENCE PT. ELEV.:		TOTAL DEPTH:	53.5'
LOGGED BY : R.M.		CHECKED BY:	JCR	WATER TABLE BGS:	~25'
				PAGE 2 OF 2	

SAMPLE NO.	SAMPLE DEPTH	PEN./REC. (ft./ft.)	PID OF SPOON	SOIL/ROCK DESCRIPTION AND PHYSICAL CONDITIONS	BLOWS/6 IN.	USCS SOIL CLASS.	COMMENTS
S20	38-40'	1.9	0	(10yr 5/2) medium to coarse sand, little silt, no gravel, saturated, dense.	5,7,11,19	SP	
S21	40-42'	1.8	0	Same as above.	10,12,15,21	SM	
S22	44-46'	NA	0	Fine to medium sand, trace silt and gravel, saturated dense.	NA	SM	
S23	50-52'	1.2	0	Light brown (10yr 6/2) gravel with cmf sand, some silt, saturated, well graded, dense.	33,33,35,24	GP	
				B.O.B. -53.5 bgs. (auger refusal)			

SOIL BORING LOG - FORT DEVENS, MA.	PROJECT NO.: 8740.02	BORING NO.: BDM-96-05X

CLIENT: **COE**	DATE STARTED:	6/26/96	STUDY AREA: AOC 63BD
CONTRACTOR: NHB	DATE COMPLETED:	6/26/96	PROTECTION: D (Mod.)
METHOD: HSA 4.25"	BORING DIAMETER:	6"	PID METER: OVM 580B
GROUND ELEV.:	REFERENCE PT. ELEV.:		TOTAL DEPTH: 33.0'
LOGGED BY : R.M.	CHECKED BY:	JCR	WATER TABLE BGS: ~24'

SAMPLE NO.	SAMPLE DEPTH	PEN./REC. (ft./ft.)	PID OF SPOON	SOIL/ROCK DESCRIPTION AND PHYSICAL CONDITIONS	BLOWS/6 IN.	USCS SOIL CLASS.	ONSITE SCREENING
S1	0-2'	1.7	0	Top 0.3': (10yr 6/2) silt with some sand, roots, dry, loose. 0.3 silty sand, brown to dark brown, angular. 0.5 gravel, reddish brown fm sand, trace silt.	3,5,7,7	ML - SM	
S2	5-7'	1.2	0	Light brown (10yr 6/2) cmf sand. little silt and gravel, dry, loose.	5,9,22,26	SW	
S3	10-12'	1.8	0	(10yr 6/2 to 6/3) fine to med. sand, trace silt and gravel, very poorly graded, dry, loose.	4,4,17,12	SM	
S4	15-17'	1.7	0	Brown (10yr 6/4) cmf sand, little silt and gravel, well graded, dry, loose.	8,4,7,12	SW	MXBD0515XF
S5	17-19'	1.9	0	Same as above.	14,15,20,20	SW	
S6	19-21'	1.8	0	(10yr 6/2) cmf sand, little gravel, dry, loose.		SW	MXBD0519XF
S7	21-23'	1.6	0	Same as above.	23,20,16,15	SW	
S8	23-25'	1.1	0	Same as above.	14,14,19,21		MXBD0523XF
S9	25-27'	1.4	0	Cmf sand, with some to littl gravel, little silt, saturated dense.	12,14,21,23	SW	MXBD0526 MATPH TPHC
S10	27-29'	1.7	0	Same as above.	21,13,12,21	SW	MXBD0527XF
S11	29-31'	0.3	0	(10yr 6/2) med to coarse sand, little subrounded gravel, trace silt, mod. dense.	14,22,20,14	SW	
				B.O.B. - 33.0' bgs, not auger refusal.			

APPENDIX B

MONITORING WELL COMPLETION DIAGRAMS

ABB ENVIRONMENTAL SERVICES, INC.

MONITORING WELL DIAGRAM

PROJECT: FORT DEVENS	**CONTRACTOR:** NH BORING
PROJECT No.: 7137-00	**DRILLER:** TWOMBLY
BORING No.: 1666W-01X	**DRILLING METHOD:** 6.25" HSA
GEOLOGIST: R. P. GILLESPIE	**DATE INSTALLED:** 1/5/94

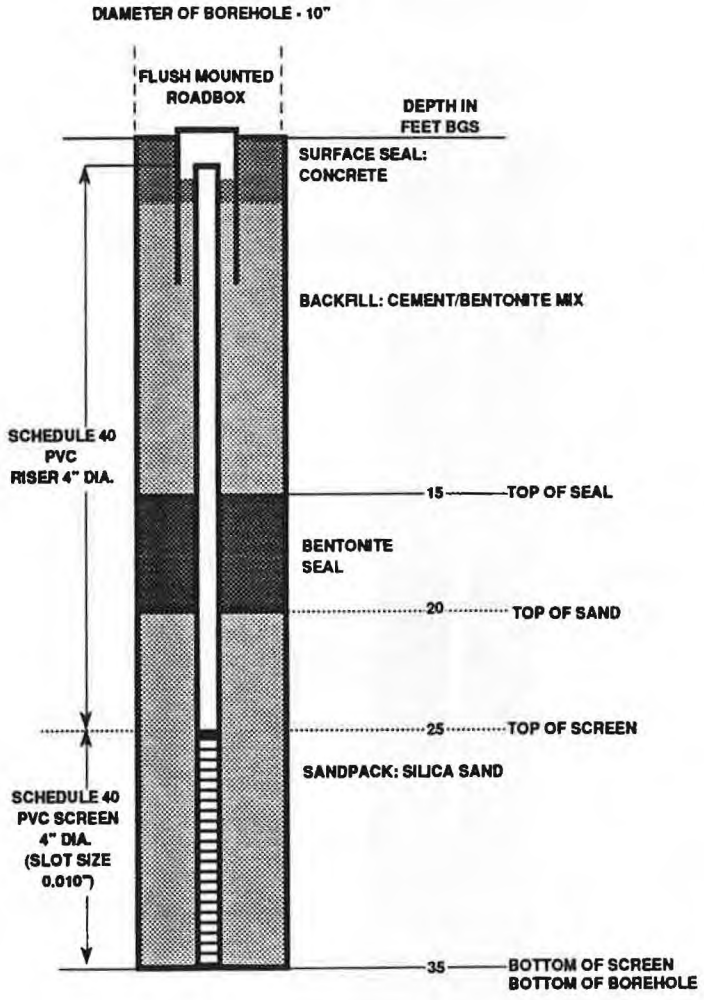


ABB ENVIRONMENTAL SERVICES, INC.

MONITORING WELL DIAGRAM

PROJECT: FORT DEVENS	**CONTRACTOR:** NH BORING
PROJECT No.: 7137-00	**DRILLER:** JOHN GARSIDE
BORING No.: 1666W-02X	**DRILLING METHOD:** 6.25" HSA
GEOLOGIST: JIM KENNY	**DATE INSTALLED:** 12/20/94

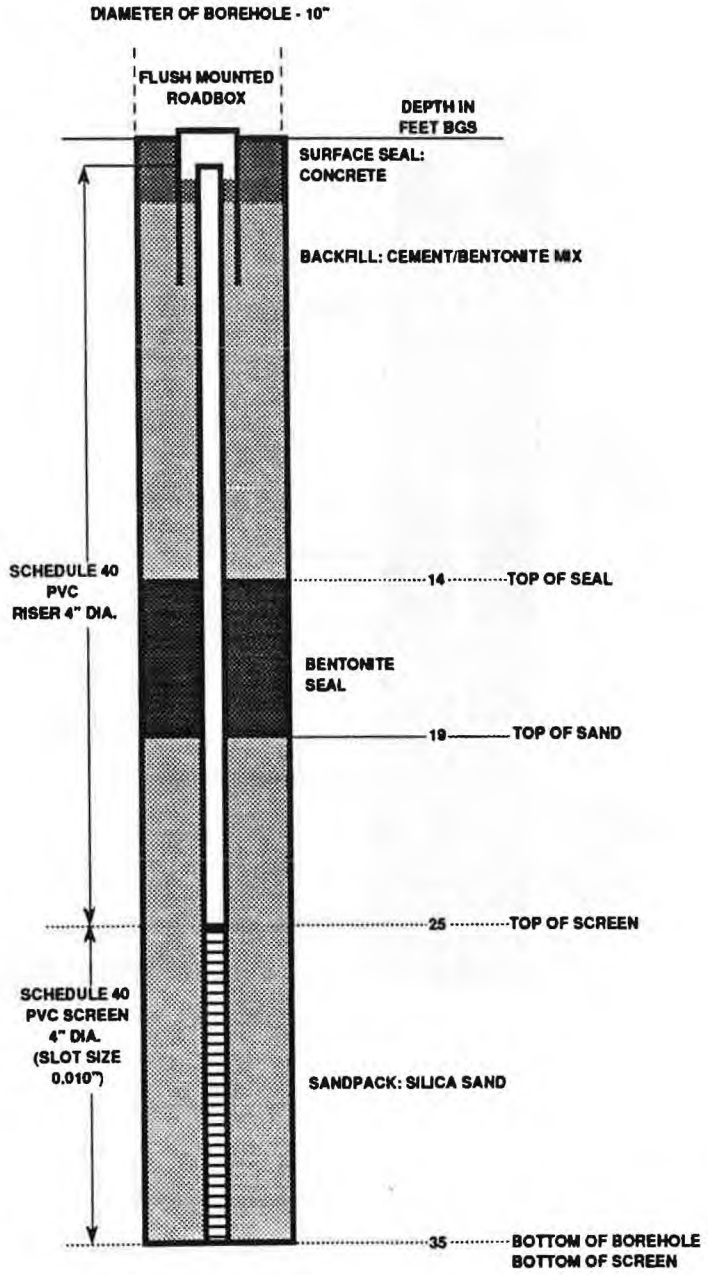


ABB Environmental Services, Inc.

MONITORING WELL DIAGRAM

PROJECT:	FORT DEVENS
PROJECT NO.:	8740-02
STUDY AREA:	AOC 63BD
BORING NO.:	BDM-96-01X
GEOLOGIST:	J. ROWLAND
DRILLER:	NHB
DRILLING METHOD:	HSA 6.25"
DATE INSTALLED	6/19/96
DEVELOPMENT:	SURGE & PUMP

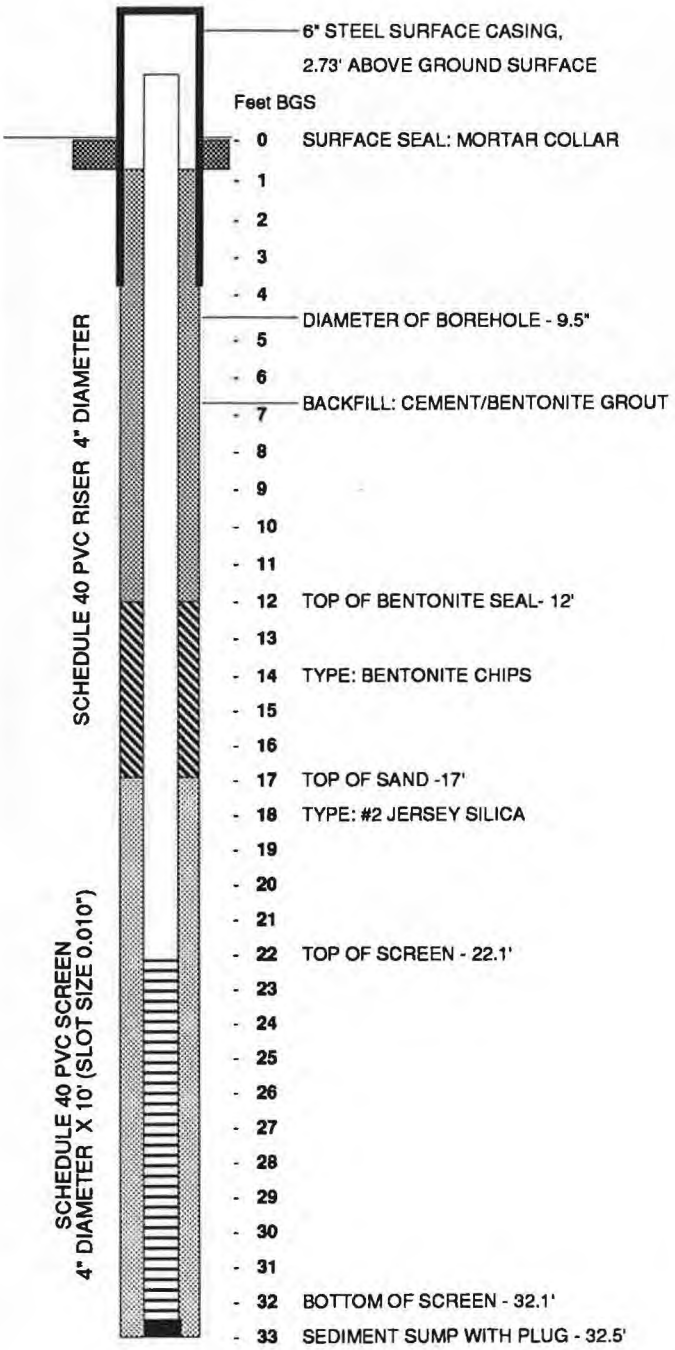


ABB Environmental Services, Inc.

MONITORING WELL DIAGRAM

PROJECT:	FORT DEVENS
PROJECT NO.:	8740-02
STUDY AREA:	AOC 63BD
BORING NO.:	BDM-96-02X
GEOLOGIST:	HKW
DRILLER:	NHB
DRILLING METHOD:	HSA 4.25"
DATE INSTALLED	6/25/96
DEVELOPMENT:	SURGE & PUMP

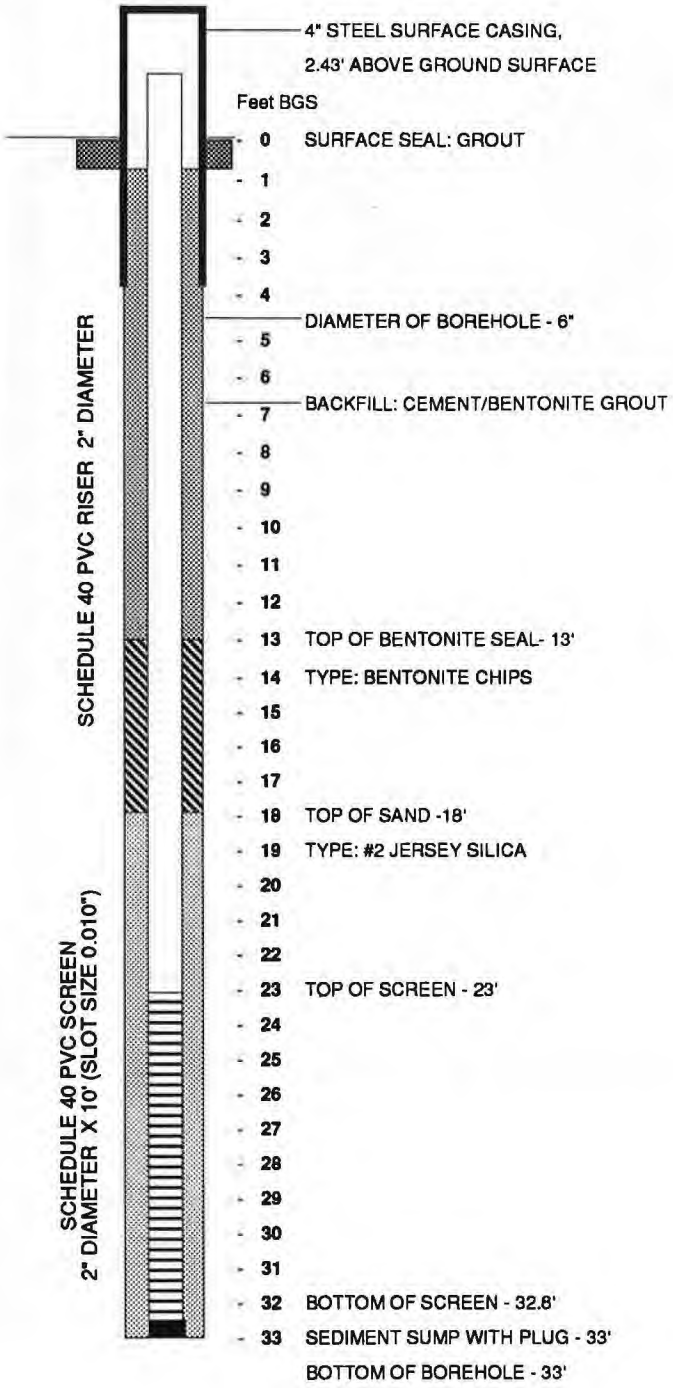


ABB Environmental Services, Inc.

MONITORING WELL DIAGRAM

PROJECT:	FORT DEVENS
PROJECT NO.:	8740-02
STUDY AREA:	AOC 63BD
BORING NO.:	BDM-96-03X
GEOLOGIST:	J. ROWLAND
DRILLER:	NHB
DRILLING METHOD:	HSA 4.25"
DATE INSTALLED	6/25/96
DEVELOPMENT:	SURGE & PUMP

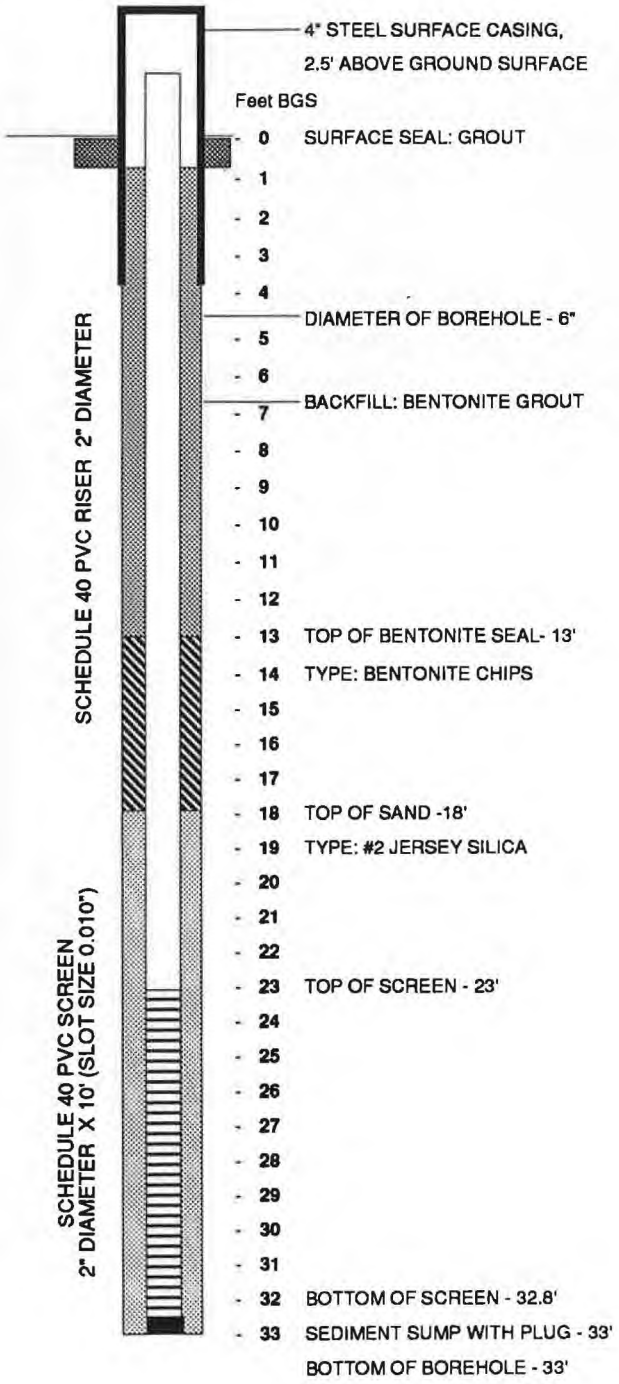


ABB Environmental Services, Inc.

MONITORING WELL DIAGRAM

PROJECT:	FORT DEVENS
PROJECT NO.:	8740-02
STUDY AREA:	AOC 63BD
BORING NO.:	BDM-96-04B
GEOLOGIST:	R. McCOY
DRILLER:	NHB
DRILLING METHOD:	HSA 4.25"
DATE INSTALLED	6/26/96
DEVELOPMENT:	SURGE & PUMP

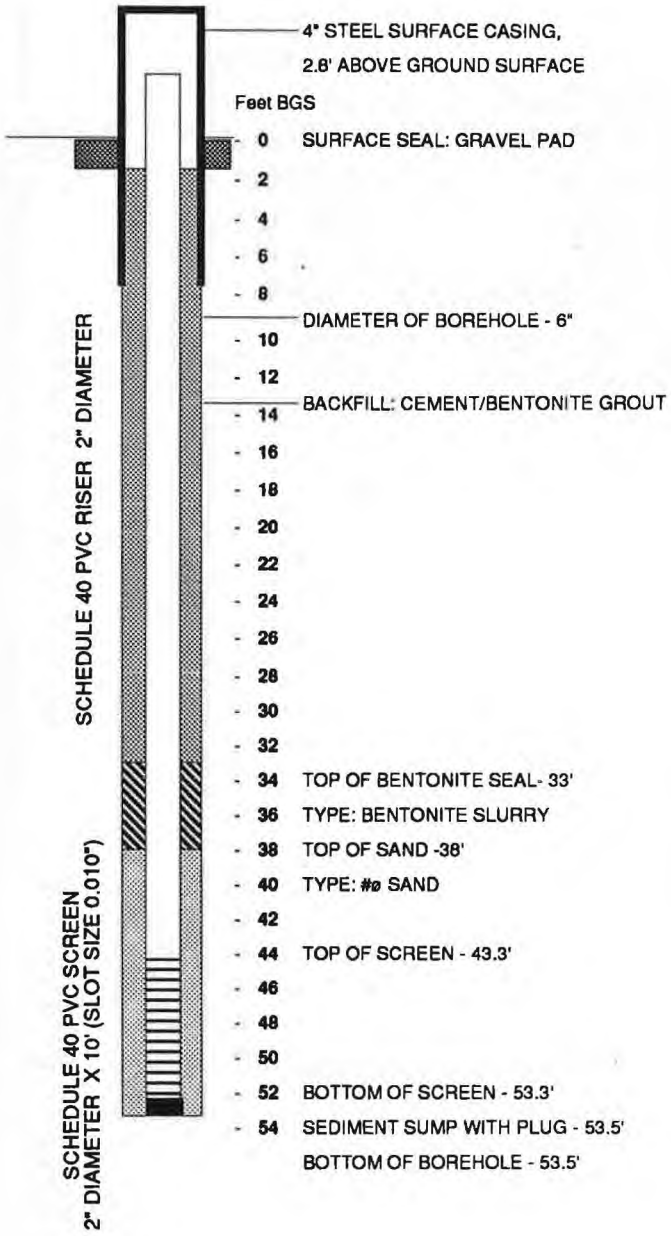


ABB Environmental Services, Inc.

MONITORING WELL DIAGRAM

PROJECT:	FORT DEVENS
PROJECT NO.:	8740-02
STUDY AREA:	AOC 63BD
BORING NO.:	BDM-96-05X
GEOLOGIST:	R. McCOY
DRILLER:	NHB
DRILLING METHOD:	HSA 4.25"
DATE INSTALLED	6/27/96
DEVELOPMENT:	SURGE & PUMP

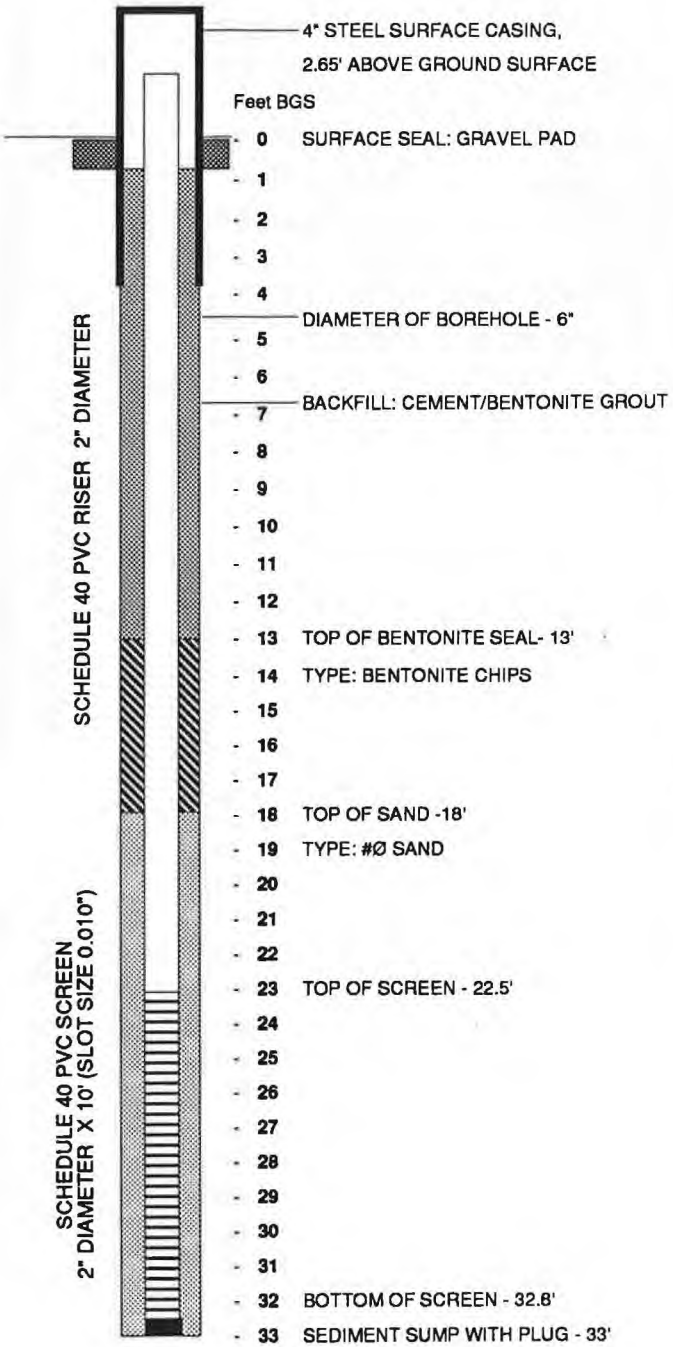


ABB Environmental Services, Inc.

MONITORING WELL DIAGRAM

PROJECT:	FORT DEVENS
PROJECT NO.:	8740-02
STUDY AREA:	AOC 63BD
BORING NO.:	BDP-96-01X
GEOLOGIST:	J. ROWLAND
DRILLER:	NHB
DRILLING METHOD:	HSA 4.25"
DATE INSTALLED	6/18/96

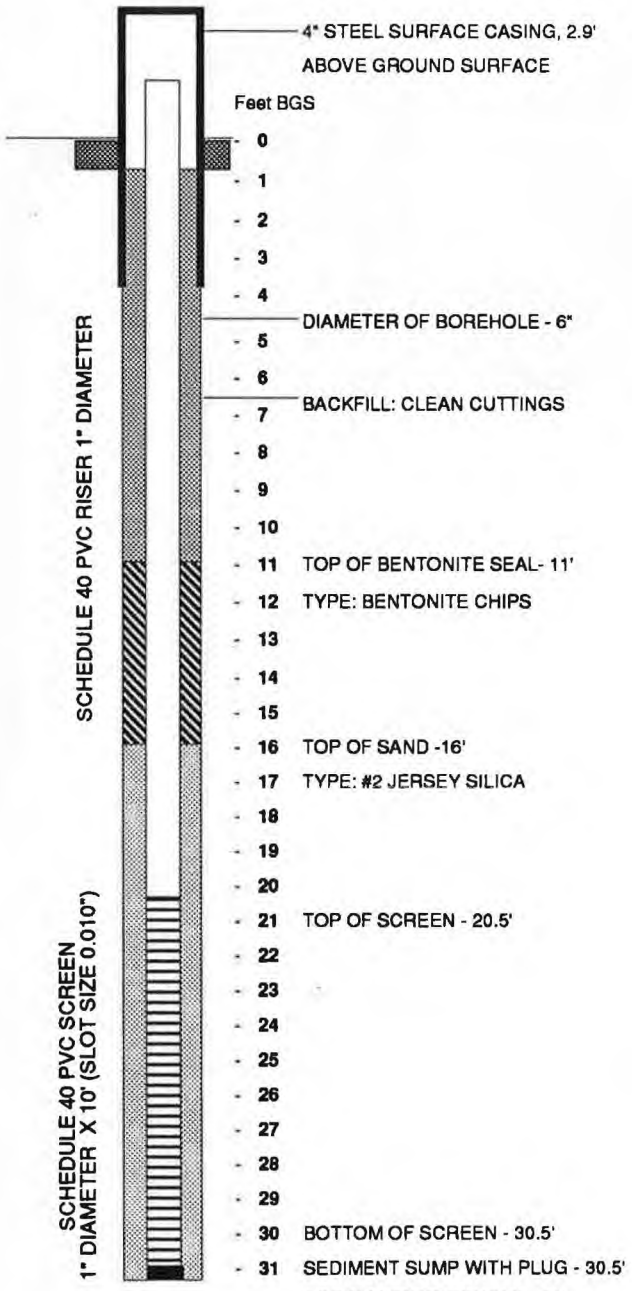
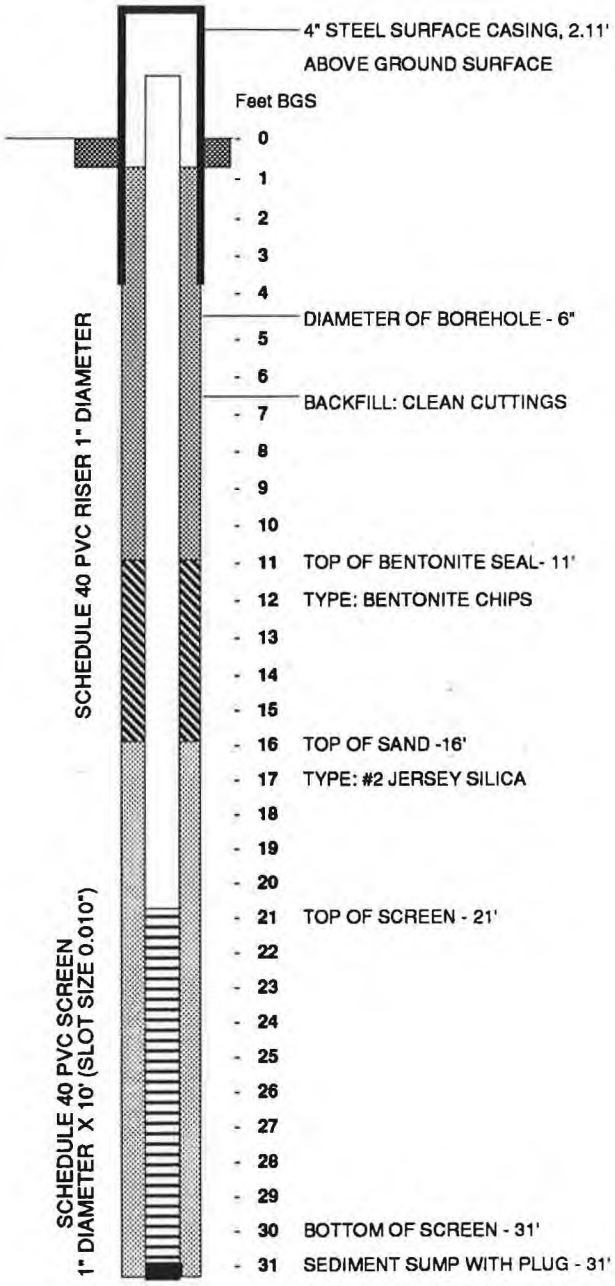


ABB Environmental Services, Inc.

MONITORING WELL DIAGRAM

PROJECT:	FORT DEVENS
PROJECT NO.:	8740-02
STUDY AREA:	AOC 63BD
BORING NO.:	BDP-96-02X
GEOLOGIST:	J. ROWLAND
DRILLER:	NHB
DRILLING METHOD:	HSA 4.25"
DATE INSTALLED	6/18/96



APPENDIX C

SSE AND RI FIELD DATA SHEETS

ABB ENVIRONMENTAL SERVICES, INC.

SOIL BORING DATA SHEET

PROJECT: USATHAMA-FT. DEVENS | DATE SAMPLED: 1/3/94 - 93

FILE NAME: CSO | SITE TYPE: BORE | SITE ID: 1666B-01X | JOB NUMBER: 07137.00

FIELD SAMPLING NUMBER: BX16660115 | SAMPLE DEPTH: 0 1 5 | PROGRAM: C | TQ:

ANALYSIS	METHOD NUMBER	FRACTION CODE	CONTAINER	PRESERVATION	SAMPLE COLLECTED	BOTTLE NUMBERS
☒ VOC	LM19	SV	(2) 2 OZ AG	4 DEG C	☒	/
☒ SVOC	LM18	SS	(1) 16 OZ AG		☒	/
☐ PEST/PCB	LM16 LM10	SS			☐	/
☐ PAL INORG.	See Below	SS			☐	/
☐ EXPLOSIVES	LW12	SS			☐	/
☒ TPHC	418.1	SS			☒	/
☐ LEAD ONLY	JD17	SS			☐	/
☐ TOC	415.1	SS			☐	/
☐ TCLP	1311	SS	(1) 16 OZ AG	4 DEG C	☐	/

PAL INORGANICS: ICP METALS (JS16); AS (JD19); SE (JD15); TL (JD24); SB (JD25); PB (JD17); HG (JB10).

FIELD ANALYSIS DATA:

SPLIT-SPOON 4.2 PPM | HEAD SPACE 142 PPM | TPH 3040 PPM

NOTES:

SOIL CLASSIFICATION:

(SW)

SIGNATURE: R.P. Gillespie

RECEIVED BY: _____

ABB ENVIRONMENTAL SERVICES, INC.

SOIL BORING DATA SHEET

PROJECT: USATHAMA-FT. DEVENS | DATE SAMPLED: 1/3/94

FILE NAME: CSO | SITE TYPE: BORE | SITE ID: 1666B-01X | JOB NUMBER: 07137.00

FIELD SAMPLING NUMBER: BX166601 20 | SAMPLE DEPTH: 0 2 0 | PROGRAM: C | TO:

ANALYSIS	METHOD NUMBER	FRACTION CODE	CONTAINER	PRESERVATION	SAMPLE COLLECTED	BOTTLE NUMBERS
☒ VOC	LM19	SV	(2) 2 OZ AG	4 DEG C	☒	
☒ SVOC	LM18	SS	(1) 16 OZ AG		☒	
☐ PEST/PCB	LM16 / LM10	SS				
☐ PAL INORG.	See Below	SS				
☐ EXPLOSIVES	LW12	SS				
☒ TPHC	418.1	SS			☒	
☐ LEAD ONLY	JD17	SS				
☐ TOC	415.1	SS				
☐ TCLP	1311	SS	(1) 16 OZ AG	4 DEG C		

PAL INORGANICS: ICP METALS (JS16); AS (JD19); SE (JD15); TL (JD24); SB (JD25); PB (JD17); HG (JB10).

FIELD ANALYSIS DATA:

SPLIT-SPOON 1.5 PPM | HEAD SPACE 121. PPM | TPH 3,500 ppm

NOTES:

OIL SHOW ON RINSE WATER

SOIL CLASSIFICATION:

(SW)

SIGNATURE: A P Gillespie

RECEIVED BY: _____

WELL DEVELOPMENT RECORD

Project:	Well Installation Date:		Project No.
FT Dens	6/4/96		08740
Client: USACE	**Well Development Date:** 7/9/96	**Developed by:** CH	**Checked by:** JW
Well/Site I.D.: BOm-96-01X	**Weather:** Partly cloudy	**Start Date:** 7/9/96	**Finish Date:** 7/9/96
Well Construction Record Data:		**Start Time:** 1312	**Finish Time:** 1820

Well Diameter: 4 in.

Bottom of Screen: 32.1 ft.
Sediment Sump/Plug: 32.5 ft.
Screen Length: 10 ft.
☑ From Ground Surface ☐ From top of Riser

Fluids Lost During Drilling: 60 gal.

Protective Casing Stick-up: 2.73 ft. Protective Casing/Well Diff.: 0.25 ft.

PID Readings: Ambient Air 0.0 ppm; Well Mouth 0.0 ppm

Water Levels:
Initial: 27.1 ft.
End of Development: 27.15 ft.
24 Hrs. After Development: 27.19 ft.

Sediment:
Well Depth Before Development: 34.5 ft. (from top of PVC)
Well Depth After Development: 34.5 ft.
Sediment Depth Removed: 0 ft.

HT of Water Column: 7.37 ft. x ☑ 1.68* ☐ ____ 12.4 = gal./vol. 12.4
*For 4" HSA installed wells

Equipment:
☑ Dedicated Submersible Pump
☐ Surge Block
☐ Bailer ☐ 2" ☐ _____
☐ Grundfos Pump 2"___ 4"___

Approximate Recharge Rate: ____ gpm
Total Gallons Removed: 365 gal.

Well Development Criteria Met:

	yes	no
• Well water clear to unaided eye	☑	☐
• Sediment thickness remaing in well is <1.0% of screen length	☑	☐
• Total water removed = a minimum of 5x calculated well volume plus 5x drilling fluid lost	☑	☐

Notes: _____

End of Well Development Sample (1 pint) Collected? yes ☑ no ☐

Water Parameter Measurments

Record at the start, twice during and at the end of development (minimum):

Time	Volume	Total Gallons	pH	Temp.	Conductivity	Turbidity	Pumping Rate
1312	Init	1	7.17	15.3	138	453	—
1329	2	15	6.50	13.2	114	10	1.5
1342	3	30	6.11	12.8	109	1	1.5
1409	4	45	6.00	12.3	112	0	1.5
1427	5	60	6.06	12.7	113	5	1.5
1445	6	75	6.03	12.8	116	60	1.5
1820		365	6.11	13.3	122	16	2 gpm

Well Developer's Signature: Robert Jones

ABB Environmental Services, Inc.

9312005S L 6

WELL DEVELOPMENT RECORD

Project: Ft. Devens	Well Installation Date: 6/18/96		Project No. 08740
Client: USACE	Well Development Date: 7/9/98	Developed by: GH	Checked by:
Well/Site I.D.: BPM-96-02X	Weather: Partly Cloudy	Start Date: 7/9/98	Finish Date: 7/9/98
		Start Time: 0913	Finish Time: 1050

Well Construction Record Data:

Bottom of Screen: 32+ ft. 33 — From Ground Surface

Sediment Sump/Plug: 32.5 ft. 33

Screen Length: 10 ft.

Well Diameter: 2 in.

From top of Riser

Fluids Lost During Drilling: 10 gal.

Protective Casing Stick-up: 2.43 ft. Protective Casing/Well Diff. .32 ft. PID Readings: Ambient Air 0.0 ppm; Well Mouth 5.8 ppm

Water Levels:
- Initial: 26.63 ft.
- End of Development: 26.63 ft.
- 24 Hrs. After Development: 26.67 ft.

Sediment (from top of PVC):
- Well Depth Before Development: 34.69 ft.
- Well Depth After Development: 34.82 ft.
- Sediment Depth Removed: .13 ft.

HT of Water Column 8.06 ft. x ☐ 1.68* ☐ .55 4.4 = 4.4 gal./vol. *For 4" HSA installed wells

Equipment:
- ☑ Dedicated Submersible Pump
- ☐ Surge Block
- ☐ Bailer ☐ 2" ☐ ______
- ☐ Grundfos Pump 2" ___ 4" ___

Approximate Recharge Rate: 1 gpm

Total Gallons Removed: 80 gal.

Well Development Criteria Met:

	yes	no
• Well water clear to unaided eye	☑	☐
• Sediment thickness remaing in well is <1.0% of screen length	☑	☐
• Total water removed = a minimum of 5x calculated well volume plus 5x drilling fluid lost	☑	☐

Notes: ______

End of Well Development Sample (1 pint) Collected? yes ☑ no ☐

Water Parameter Measurments

Record at the start, twice during and at the end of development (minimum):

Time	Volume	Total Gallons	pH	Temp.	Conductivity	Turbidity	Pumping Rate
0913	First	1	7.28	13.7	298	999	—
0918	1	5	6.54	11.8	164	58	1 gal/min
0923	2	10	5.86	11.4	160	40	1
0929	3	15	5.82	11.3	161	41	1
0935	4	20	5.75	11.4	166	12	1
0944	5	25	5.76	11.1	162	8	1

0951 - 30 Removed; 0955 35 Removed; 1000 40 Removed; 1005 45

1012 - 50 Removed; 1020 - 55 Removed; 1026 - 60 gal Removed

1032 - 65 gal Removed; 1038 - 70 gal Removed; 1045 - 75; 1050 - 80 Temp = 12.8, pH = 5.91, Cond = 167, Turb = 17

Well Developer's Signature: [signature]

ABB Environmental Services, Inc.

9312005S L6

WELL DEVELOPMENT RECORD

Project: Devens	Well Installation Date: 62596		Project No. 8742.02
Client: US AEC	Well Development Date: 7996	Developed by: GH/BF	Checked by:
Well/Site I.D.: BDM-96-03X	Weather: Humid. Storms likely	Start Date: 7/9/96	Finish Date: 7996
		Start Time: 11:31	Finish Time: 12:15

Well Construction Record Data:

Bottom of Screen: 32.8 ft.
Sediment Sump/Plug: 33-2 ft.
Screen Length: 10 ft.
From Ground Surface ☐ From top of Riser ☐

Well Diameter: 2 in.
Fluids Lost During Drilling: 10 gal.

Protective Casing Stick-up: 2.4 ft.
Protective Casing/Well Diff.: -.2c ft.

PID Readings: Ambient Air 0.0 ppm; Well Mouth 7.0 ppm

Water Levels:

Initial	~~32.8~~ ft.	26.66
End of Development	26.65 ft.	
24 Hrs. After Development	26.70 ft.	

HT of Water Column: 8.28 ft. x ☐ 1.68* ☑ .55 = gal./vol. 4.5 *For 4" HSA installed wells

Sediment:

Well Depth Before Development	34.94 ft.	(from top of PVC)
Well Depth After Development	34.95 ft.	
Sediment Depth Removed	.01 ft.	

Equipment:

☑ Dedicated Submersible Pump
☐ Surge Block
☐ Bailer ☐ 2" ☐ _____
☐ Grundfos Pump 2"___ 4"___

Approximate Recharge Rate: gpm
Total Gallons Removed: 73 gal.

Well Development Criteria Met:

	yes	no
• Well water clear to unaided eye	☑	☐
• Sediment thickness remaing in well is <1.0% of screen length	☑	☐
• Total water removed = a minimum of 5x calculated well volume plus 5x drilling fluid lost	☑	☐

Notes: _____

End of Well Development Sample (1 pint) Collected? yes ☑ no ☐

Water Parameter Measurments

Record at the start, twice during and at the end of development (minimum):

Time	Volume	Total Gallons	pH	Temp.	Conductivity	Turbidity	Pumping Rate
1131	1	1	6.06	13.2	123	999	2 gal/min
1140	20	21	5.74	11.4	145	6	2 gal/min
1150	20	41	5.63	11.3	146	0	2 gal/m
1200	20	61	5.61	11.1	146	2	2 gal/m
1208	12	73	5.60	11.1	146	2	2 gal/m

PID 0

Well Developer's Signature: Robert Frank

ABB Environmental Services, Inc.

9312005S L 6

WELL DEVELOPMENT RECORD

Project: Devens	Well Installation Date: 62696		Project No. 8740.02
Client: USAEC	Well Development Date: 7996	Developed by: RF	Checked by: TH
Well/Site I.D.: BDM-96-04B	Weather: Hot Humid. Cummulus 85	Start Date: 7/9/96	Finish Date: 7996
		Start Time: 15:00	Finish Time: 17:00

Well Construction Record Data:

Bottom of Screen: 53.3 ft. — From Ground Surface ☐ — From top of Riser ☒

Sediment Sump/Plug: 53.5 ft.

Screen Length: 10 ft.

Well Diameter: 2 in.

Fluids Lost During Drilling: 20 gal.

Protective Casing Stick-up: 2.2' ft. Protective Casing/Well Diff.: -.17 ft.

PID Readings: Ambient Air 0 ppm; Well Mouth 3 ppm

Water Levels: From TOR

Initial: 26.76 ft.

End of Development: 26.86 ft.

24 Hrs. After Development: 26.86 ft.

Sediment: From TOR

Well Depth Before Development: 55.13 ft. (from top of PVC)

Well Depth After Development: 55.18 ft.

Sediment Depth Removed: .05 ft.

HT of Water Column: 28.37 ft. x ☐ 1.68" ☑ .55 = gal./vol. 15.7 "For 4" HSA installed wells

Equipment:

☑ Dedicated Submersible Pump

☐ Surge Block

☐ Bailer ☐ 2" ☐ _____

☐ Grundfos Pump 2"___ 4"___

Approximate Recharge Rate: ____ gpm

Total Gallons Removed: 178 gal.

Well Development Criteria Met:

	yes	no
• Well water clear to unaided eye	☑	☐
• Sediment thickness remaing in well is <1.0% of screen length	☑	☐
• Total water removed = a minimum of 5x calculated well volume plus 5x drilling fluid lost	☑	☐

Notes: 15.7 x 5 = 78

20 x 5 = 100

178 gal

Drummed waste & read w/PID, No hits all zero

End of Well Development Sample (1 pint) Collected? yes ☑ no ☐

Water Parameter Measurments

Record at the start, twice during and at the end of development (minimum):

Time	Volume	Total Gallons	pH	Temp.	Conductivity	Turbidity	Pumping Rate
1500	1	1	10.05	13.4	375	999	1½ gm
1510	15	16	8.03	12.1	418	270	1½ gm
1535	40	56	7.17	12.2	411	164	1½ gm
1600	40	96	7.10	12.8	414	35	1½ gm
1630	45	141	7.04	13.1	417	86	1½ gm
1650	37	178	7.02	12.3	420	199 141 37	PID = 0

weather may have been a factor

PID 0 ↓

Well Developer's Signature: Robert Doust

ABB Environmental Services, Inc.

WELL DEVELOPMENT RECORD

Project:	Well Installation Date:		Project No.
Devens	6 LTS		8740.02
Client:	**Well Development Date:**	**Developed by:**	**Checked by:**
USACE	7 10 96	RC	JC
Well/Site I.D.:	**Weather:**	**Start Date:**	**Finish Date:**
BDM-96-5X	Clear Sunny 70° Breezy	7/10/96	7/10/96

Well Construction Record Data:

Bottom of Screen	32.8 ft.	From Ground Surface ☑	Well Diameter	2 in.	Start Time: 0845
Sediment Sump/Plug	33.0 ft.	From top of Riser ☐			Finish Time: 1015
Screen Length	10 ft.	Fluids Lost During Drilling	10 gal.		

Protective Casing Stick-up: 2.65 ft. Protective Casing/Well Diff.: -.27 ft. PID Readings: Ambient Air 0 ppm; Well Mouth 0 ppm

Water Levels:

Initial	27.04 ft.
End of Development	27.05 ft.
24 Hrs. After Development	27.05 ft.

Sediment:

Well Depth Before Development	35.10 ft.	(from top of PVC)
Well Depth After Development	35.10 ft.	
Sediment Depth Removed	— ft.	

HT of Water Column: 8.06 ft. x ☐ 1.68 ☑ .55 = gal./vol. 4.4 "For 4" HSA installed wells

Equipment:

☑ Dedicated Submersible Pump
☐ Surge Block
☐ Bailer ☐ 2" ☐ _____
☐ Grundfos Pump 2"___ 4"___

Approximate Recharge Rate: gpm
Total Gallons Removed: 75 gal. 75 gal

Well Development Criteria Met:

	yes	no
• Well water clear to unaided eye	☑	☐
• Sediment thickness remaing in well is <1.0% of screen length	☑	☐
• Total water removed = a minimum of 5x calculated well volume plus 5x drilling fluid lost	☑	☐

Notes: _____

End of Well Development Sample (1 pint) Collected? yes ☑ no ☐

Water Parameter Measurments

Record at the start, twice during and at the end of development (minimum):

Time	Volume	Total Gallons	pH	Temp.	Conductivity	Turbidity	Pumping Rate
0845	1	1	6.22	13.0	182	999	1½ gpm
0850	9	10	5.98	11.1	136	118	↓
0900	15	25	5.80	10.6	138	11	1 gpm
0915	10	35	5.80	10.5	141	1	↓
0950	20	55	5.84	10.5	142	-3	2 gpm
	20	75					

PID 0

Well Developer's Signature: Robert Town

ABB Environmental Services, Inc.

PROJECT: FT. DEVENS | FIELD SAMPLE NUMBER: WX1601X1 | STUDY AREA/AOC: BOM

SITE ID: 1666W-01 | SITE TYPE: WELL | SAMPLING DATE: 7/29/96 7/30/96

LOCATION ACTIVITY: START 1200 END | JOB NUMBER: J8740.02 | FILE TYPE: CGW | WEATHER: Sunny

WATER LEVEL / WELL DATA

WELL DEPTH: 34.7 FT | MEASURED / HISTORICAL | TOP OF WELL / TOP OF CASING | PROTECTIVE CASING STICK-UP (FROM GROUND): 0.0 Flush FT | PROTECTIVE CASING/WELL DIFF.: 0.57 FT

WATER DEPTH: 24.0 FT

17 GAL/VOL

HEIGHT OF WATER COLUMN: 10.7 FT | 102 TOTAL GAL PURGED

1.68 gal/ft (4") ___ gal/ft

PID READINGS: AMBIENT AIR 0 PPM | WELL MOUTH 0 PPM

WELL INTEGRITY:

	YES	NO	N/A
PROT. CASING SECURE	X		
CONCRETE COLLAR INTACT	X		
WELL LOCKED			
PVC WELL CAP			

WELL DIAMETER: 2 INCH / 4 INCH / ___ INCH

PURGE DATA

VOLUME #	1	2	3	4	5				7/30/96 G
GALLONS	17	34	51	68	85				102
PUMPING RATE (GPM)	1	1	1	1	1				1
TEMP, DEG C	11.3	11.9	12.2	12.1	11.9				11.6
pH, UNITS ☐ pH PAPER	5.72	5.74	5.74	5.74	5.73				5.81
SPECIFIC CONDUCTIVITY, mS mmhos/cm	.083	.100	.111	.106	.114				.096
TURBIDITY, ntu	0	0	0	0	0				0

SAMPLE OBSERVATIONS: ☒ CLEAR ☐ CLOUDY ☐ COLORED ___ ☐ TURBID ☐ ODOR ☐ OTHER (SEE NOTES)

REDOX (@ COMPLETION OF PURGING): 312.2 +/- mv 324 7/30/96

EQUIPMENT DOCUMENTATION

BAILING: ☐

SAMPLING: ☒ PERISTALTIC PUMP ☐ DEDICATED SUBMERSIBLE PUMP ☐ BAILER ☒ PVC/SILICON TUBING ☐ IN-LINE/DISPOSABLE FILTER ___ ☐ OTHER ___

EQUIPMENT ID: ISCO # ___ ☐ 2" ☐ 4" # ___

DECON FLUIDS USED: ☐ POTABLE WATER ☐ LIQUINOX ☐ STEAM CLEANING — None - dedicated equipment

NUMBER OF FILTERS USED: 1

WATER LEVEL EQUIP. USED: ☒ ELECTRIC COND. PROBE ☐ PRESSURE TRANSDUCER

ANALYTICAL PARAMETERS	METHOD NUMBER	FRACTION CODE	PRESERVATION METHOD	VOLUME REQUIRED	SAMPLE COLLECTED	SAMPLE BOTTLE ID NUMBERS	BOTTLE
☐ VOC	UM20	VP	HCL, 4 DEG C	(4) 60 ML	☐		
☐ SVOC	UM18	MS	4 DEG C	(2) 1 L AG	☐		
☐ PEST/PCBs	UH02	EC	4 DEG C	(3) 1 L AG			
	UH13						
☐ PAL INORGANICS (see notes)		M	HNO3 TO pH<2	1 L P-CUBE	☐		
☐ LEAD ONLY	SD20	M	HNO3 TO pH<2		☐		
☐ EXPLOSIVES	UM19	LC	4 DEG C	(3) 1 L AG			
	UM32						
☐ TPHC	418.1	O	H2SO4 TO pH<2	1 L AG	☐		
☐ TOC	415.1	O	H2SO4 TO pH<2	1 L AG	☐		
☐ ANIONS	TF22	S	H2SO4 TO pH<2	1 L P-CUBE	☐		
	TT10	C	4 DEG C	1 L P-CUBE	☐		
	310.1	N	HNO3 TO pH<2	1 L P-CUBE	☐		
☐ TSS ONLY	160.2	C	4 DEG C	1 L P-CUBE	☐		
☐ H20 QUALITY (see notes)		S	H2SO4 TO pH<2	1 L P-CUBE	☐		
		C	4 DEG C	1 L P-CUBE	☐		
		N	HNO3 TO pH<2	1 L P-CUBE	☐		
☐ COLIFORM	303, 909		4 DEG C	(1) 4 OZ STERILE	☐		

NOTES (1) PURGING COMPLETE WHEN 5 WELL VOLUMES HAVE BEEN PURGED AND WHEN WATER PARAMETERS VARY BY LESS THAN APPROXIMATELY 10%.
(2) PAL INORGANICS: ICP METALS (SS10); AS (SD22); SE (SD21); TL (SD09); SB (SD28); PB (SD20); HG (SB01).
H20 QUALITY: PO4 (TF27); TKN (TF26); NIT (TF22); CL/SO4 (TT10); TSS (160.2); ALK (301.0); HARDNESS.
ALL PARAMETERS COLLECTED AS TOTALS, IE: NON-FILTERED

SAMPLED BY: Heather Hawke

RECEIVED BY: ___

Note - electrical tape on tubing used in Purging

GROUNDWATER SAMPLE DATA RECORD
PROJECT OPERATIONS PLAN
FORT DEVENS, MASSACHUSETTS
ABB Environmental Services, Inc.

2.3

PROJECT: FT. DEVENS
SITE ID: 1666W-02
FIELD SAMPLE NUMBER: MW160201
SITE TYPE: WELL
JOB NUMBER: 08740-02
STUDY AREA/AOC: BDM
SAMPLING DATE: 7/29/96 (7/30/96)
FILE TYPE: CGW
WEATHER: Sunny 75°
LOCATION ACTIVITY: START 1015 END 1130

WATER LEVEL / WELL DATA
WATER DEPTH: 27.42 FT
WELL DEPTH: 37.50 FT
MEASURED / HISTORICAL
TOP OF WELL / TOP OF CASING
PROTECTIVE CASING STICK-UP (FROM GROUND): 2.3 FT
PROTECTIVE CASING/WELL DIFF.: 0.49 FT
16.9 GAL/VOL
102 TOTAL GAL PURGED
HEIGHT OF WATER COLUMN: 10.18 FT
1.68 gal/ft (4")
___ gal/ft
PID READINGS: AMBIENT AIR 0.0 PPM; WELL MOUTH 2.3 PPM

WELL INTEGRITY:

	YES	NO	N/A
PROT. CASING SECURE	X		
CONCRETE COLLAR INTACT	X		
WELL LOCKED			
PVC WELL CAP	X		

WELL DIAMETER: 2 INCH; X 4 INCH; ___ INCH

PURGE DATA — VOLUME #	1	2	3	4	5				6 7/30/96
GALLONS	17	34	51	68	85				lab
PUMPING RATE (GPM)	≈1	1	1	1	1				
TEMP, DEG C	11.2	11.5	11.2	11.6	11.1				11.5
pH, UNITS ☐ pH PAPER	5.71	5.84	5.83	5.82	5.84				5.93
SPECIFIC CONDUCTIVITY, mS/cm	.080	.076	.078	.080	.079				.081
TURBIDITY, ntu	4	0	0	0	0				2

SAMPLE OBSERVATIONS: X CLEAR; ☐ CLOUDY; ☐ COLORED ___; ☐ TURBID; X ODOR – Petroleum; X OTHER (SEE NOTES) Sheen

REDOX (@ COMPLETION OF PURGING): 280.7 +/- mv 7/30/96 291.8

EQUIPMENT DOCUMENTATION
PURGING: X PERISTALTIC PUMP; ☐ DEDICATED SUBMERSIBLE PUMP; X BAILER; X PVC/SILICON TUBING; X IN-LINE/DISPOSABLE FILTER; ☐ OTHER
SAMPLING: X PERISTALTIC PUMP; ☐ DEDICATED SUBMERSIBLE PUMP; ☐ BAILER; X PVC/SILICON TUBING; ☐ IN-LINE/DISPOSABLE FILTER; ☐ OTHER
EQUIPMENT ID: ISCO # ___; ☐ 2" ☐ 4" #___
DECON FLUIDS USED: ☐ POTABLE WATER; ☐ LIQUINOX; X STEAM CLEANING; NONE - Dedicated equipment
NUMBER OF FILTERS USED: 1
WATER LEVEL EQUIP. USED: X ELECTRIC COND. PROBE; ☐ PRESSURE TRANSDUCER

ANALYTICAL PARAMETERS	METHOD NUMBER	FRACTION CODE	PRESERVATION METHOD	VOLUME REQUIRED	SAMPLE COLLECTED	SAMPLE BOTTLE ID NUMBERS — BOTTLE
☐ VOC	UM20	VP	HCL, 4 DEG C	(4) 60 ML	☐	
☐ SVOC	UM18	NS	4 DEG C	(2) 1 L AG	☐	
☐ PEST/PCBs	UM02	EC	4 DEG C	(3) 1 L AG		
	UM13					
☐ PAL INORGANICS (see notes)		M	HNO3 TO pH<2	1 L P-CUBE	☐	
☐ LEAD ONLY	SD20	M	HNO3 TO pH<2		☐	
☐ EXPLOSIVES	UM19	LC	4 DEG C	(3) 1 L AG	☐	
	UM32					
☐ TPHC	418.1	O	H2SO4 TO pH<2	1 L AG	☐	
☐ TOC	415.1	O	H2SO4 TO pH<2	1 L AG	☐	
☐ ANIONS	TF22	S	H2SO4 TO pH<2	1 L P-CUBE	☐	
	TT10	C	4 DEG C	1 L P-CUBE	☐	
	310.1	N	HNO3 TO pH<2	1 L P-CUBE	☐	
☐ TSS ONLY	160.2	C	4 DEG C	1 L P-CUBE	☐	
☐ H2O QUALITY (see notes)		S	H2SO4 TO pH<2	1 L P-CUBE	☐	
		C	4 DEG C	1 L P-CUBE	☐	
		N	HNO3 TO pH<2	1 L P-CUBE	☐	
☐ COLIFORM	303, 909		4 DEG C	(1) 4 OZ STERILE	☐	

NOTES (1) PURGING COMPLETE WHEN 5 WELL VOLUMES HAVE BEEN PURGED AND WHEN WATER PARAMETERS VARY BY LESS THAN APPROXIMATELY 10%.
(2) PAL INORGANICS: ICP METALS (SS10); AS (SD22); SE (SD21); TL (SD09); SB (SD28); PB (SD20); HG (SB01).
H2O QUALITY: PO4 (TF27); TKN (TF26); NIT (TF22); CL/SO4 (TT10); TSS (160.2); ALK (301.0); HARDNESS.
ALL PARAMETERS COLLECTED AS TOTALS, IE: NON-FILTERED

SAMPLED BY: Gordon Knowles
RECEIVED BY: ___

GROUNDWATER SAMPLE DATA RECORD
PROJECT OPERATIONS PLAN
FORT DEVENS, MASSACHUSETTS
ABB Environmental Services, Inc.

PROJECT: FT. DEVENS
SITE ID: BDM-9G-01X
FIELD SAMPLE NUMBER: MXBDDHX1
SITE TYPE: WELL
JOB NUMBER: 087402
STUDY AREA/AOC: BDM
SAMPLING DATE: 7/30/96
FILE TYPE: CGW
WEATHER: M. Cloudy

LOCATION ACTIVITY: 7/29/96 - Purged. START 1405 END 1440

Dup

WATER LEVEL / WELL DATA

WELL DEPTH: 34.24 FT
WATER DEPTH: 27.01 FT
HEIGHT OF WATER COLUMN: 7.03 FT
1.68 gal/ft (4")
___ gal/ft
MEASURED
HISTORICAL
TOP OF WELL
TOP OF CASING
PROTECTIVE CASING STICK-UP (FROM GROUND): 2.7 FT
PROTECTIVE CASING/WELL DIFF.: -0.24 FT
11.1 GAL/VOL
55.5 TOTAL GAL PURGED
PID READINGS: AMBIENT AIR 0.0 PPM; WELL MOUTH 0.0 PPM

WELL INTEGRITY:

	YES	NO	N/A
PROT. CASING SECURE			
CONCRETE COLLAR INTACT			
WELL LOCKED			
PVC WELL CAP			

WELL DIAMETER: 2 INCH; 4 INCH; ___ INCH

PURGE DATA — VOLUME #	1	2	3	4	5	7/30/96	6	
GALLONS	11.1	22.2	33.3	44.4	55.5		66.6	
PUMPING RATE (GPM)	2	2	2	2	2		2	
TEMP, DEG C	12.1	12.0	13.0	12.1	12.3		12.4	
pH, UNITS ☐ pH PAPER	5.80	5.85	5.80	5.79	5.80		5.62	
SPECIFIC CONDUCTIVITY, umhos/cm	.232	.241	.238	244	.243		.245	
TURBIDITY, ntu	0	0	0	0	0		50	

SAMPLE OBSERVATIONS: ☑ CLEAR; ☐ CLOUDY; ☐ COLORED ___; ☐ TURBID; ☐ ODOR; ☐ OTHER (SEE NOTES)

REDOX (@ COMPLETION OF PURGING): 279.6 +/- mv 274.0 (7/30/96)

EQUIPMENT DOCUMENTATION

PURGING	SAMPLING	
☐	☑	PERISTALTIC PUMP
☐	☐	DEDICATED SUBMERSIBLE PUMP
☐	☑	BAILER
☐	☑	PVC/SILICON TUBING
☐	☐	IN-LINE/DISPOSABLE FILTER ___
☐	☑	OTHER ___

EQUIPMENT ID: ISCO # ___; ☑ 2" ☐ 4" # ___

DECON FLUIDS USED: ☑ POTABLE WATER; ☐ LIQUINOX; ☐ STEAM CLEANING; ___

WATER LEVEL EQUIP. USED: ☑ ELECTRIC COND. PROBE; ☐ PRESSURE TRANSDUCER ___

NUMBER OF FILTERS USED: 1

ANALYTICAL PARAMETERS	METHOD NUMBER	FRACTION CODE	PRESERVATION METHOD	VOLUME REQUIRED	SAMPLE COLLECTED	SAMPLE BOTTLE ID NUMBERS — BOTTLE
☐ VOC	UM20	VP	HCL, 4 DEG C	(4) 60 ML	☑	
☐ SVOC	UM18	MS	4 DEG C	(2) 1 L AG	☑	
☐ PEST/PCBs	UH02	EC	4 DEG C	(3) 1 L AG	☑	
	UH13					
☐ PAL INORGANICS (see notes)		M	HNO3 TO pH<2	1 L P-CUBE	☑	
☐ LEAD ONLY	SD20	M	HNO3 TO pH<2		☑	
☐ EXPLOSIVES	UM19	LC	4 DEG C	(3) 1 L AG	☑	
	UM32					
☐ TPHC	418.1	O	H2SO4 TO pH<2	1 L AG	☑	
☐ TOC	415.1	O	H2SO4 TO pH<2	1 L AG	☑	
☐ ANIONS	TF22	S	H2SO4 TO pH<2	1 L P-CUBE	☑	
	TT10	C	4 DEG C	1 L P-CUBE	☑	
	310.1	M	HNO3 TO pH<2	1 L P-CUBE	☑	
☐ TSS ONLY	160.2	C	4 DEG C	1 L P-CUBE	☑	
☐ H20 QUALITY (see notes)		S	H2SO4 TO pH<2	1 L P-CUBE	☑	
		C	4 DEG C	1 L P-CUBE	☑	
		N	HNO3 TO pH<2	1 L P-CUBE	☑	
☐ COLIFORM	303, 909		4 DEG C	(1) 4 OZ STERILE	☑	

NOTES (1) PURGING COMPLETE WHEN 5 WELL VOLUMES HAVE BEEN PURGED AND WHEN WATER PARAMETERS VARY BY LESS THAN APPROXIMATELY 10%.
(2) PAL INORGANICS: ICP METALS (SS10); AS (SD22); SE (SD21); TL (SD09); SB (SD28); PB (SD20); HG (S801).
H20 QUALITY: PO4 (TF27); TKN (TF26); NIT (TF22); CL/SO4 (TT10); TSS (160.2); ALK (301.0); HARDNESS.
ALL PARAMETERS COLLECTED AS TOTALS, IE: NON-FILTERED

SAMPLED BY: Gordon Hamilton
RECEIVED BY: ___

Dup collected

PROJECT: FT. DEVENS
SITE ID: BDM-96-02R
FIELD SAMPLE NUMBER: MXBD02R1
SITE TYPE: WELL
JOB NUMBER: 08702
STUDY AREA/AOC: BDM
SAMPLING DATE: 7/30/96
FILE TYPE: CGW
WEATHER: Sunny
LOCATION ACTIVITY: START END 1200

WATER LEVEL / WELL DATA
WELL DEPTH: 34.85 FT
WATER DEPTH: 26.59 FT
HEIGHT OF WATER COLUMN: 7.26 FT
☐ 1.68 gal/ft (4")
☐ .55 gal/ft
☒ MEASURED ☐ HISTORICAL
☒ TOP OF WELL ☐ TOP OF CASING
PROTECTIVE CASING STICK-UP (FROM GROUND): 2.5 FT
PROTECTIVE CASING/WELL DIFF.: -0.58 FT
4.1 GAL/VOL
20 TOTAL GAL PURGED
WELL INTEGRITY: PROT. CASING SECURE — YES; CONCRETE COLLAR INTACT — YES; WELL LOCKED — NO; PVC WELL CAP — N/A
WELL DIAMETER: ☐ 2 INCH ☒ 4 INCH ☐ ___ INCH
PID READINGS: AMBIENT AIR 0.0 PPM; WELL MOUTH 0.0 PPM

PURGE DATA	VOLUME #	1	2	3	4	5				6 7/30/96
	GALLONS	4	8	12	16	20				24
	PUMPING RATE (GPM)	1	1	1	1	1				1
TEMP, DEG C		11.3	11.0	10.8	11.0	11.1				11.9
pH, UNITS ☐ pH PAPER		5.76	5.73	5.72	5.72	5.73				5.86
SPECIFIC CONDUCTIVITY, mS/cm		.161	.166	.168	.168	.168				.164
TURBIDITY, ntu		2	0	0	0	0				144

SAMPLE OBSERVATIONS: ☒ CLEAR ☐ CLOUDY ☐ COLORED ___ ☐ TURBID ☐ ODOR ☐ OTHER (SEE NOTES)

REDOX (@ COMPLETION OF PURGING): 3432 +/- mv 7/30/96 362.0

EQUIPMENT DOCUMENTATION
RGING: ☒ PERISTALTIC PUMP ☐ DEDICATED SUBMERSIBLE PUMP ☐ BAILER ☐ PVC/SILICON TUBING ☐ IN-LINE/DISPOSABLE FILTER ☐ OTHER
SAMPLING: ☒ PERISTALTIC PUMP ☒ DEDICATED SUBMERSIBLE PUMP ☐ BAILER ☒ PVC/SILICON TUBING ☐ IN-LINE/DISPOSABLE FILTER ☐ OTHER
EQUIPMENT ID: ISCO # ___ ☒ 2" ☐ 4" # ___
DECON FLUIDS USED: ☐ POTABLE WATER ☐ LIQUINOX ☐ STEAM CLEANING — None dedicated equipment
NUMBER OF FILTERS USED: 1
WATER LEVEL EQUIP. USED: ☒ ELECTRIC COND. PROBE ☐ PRESSURE TRANSDUCER

ANALYTICAL PARAMETERS	METHOD NUMBER	FRACTION CODE	PRESERVATION METHOD	VOLUME REQUIRED	SAMPLE COLLECTED	SAMPLE BOTTLE ID NUMBERS	BOTTLE
☐ VOC	UM20	VP	HCL, 4 DEG C	(4) 60 ML	☐		
☐ SVOC	UM18	MS	4 DEG C	(2) 1 L AG			
☐ PEST/PCBs	UM02	EC	4 DEG C	(3) 1 L AG			
	UM13						
☐ PAL INORGANICS (see notes)		M	HNO3 TO pH<2	1 L P-CUBE	☐		
☐ LEAD ONLY	SD20	M	HNO3 TO pH<2				
☐ EXPLOSIVES	UM19	LC	4 DEG C	(3) 1 L AG			
	UM32						
☐ TPHC	418.1	O	H2SO4 TO pH<2	1 L AG	☐		
☐ TOC	415.1	O	H2SO4 TO pH<2	1 L AG			
☐ ANIONS	TF22	S	H2SO4 TO pH<2	1 L P-CUBE			
	TT10	C	4 DEG C	1 L P-CUBE			
	310.1	N	HNO3 TO pH<2	1 L P-CUBE			
☐ TSS ONLY	160.2	C	4 DEG C	1 L P-CUBE			
☐ H2O QUALITY (see notes)		S	H2SO4 TO pH<2	1 L P-CUBE			
		C	4 DEG C	1 L P-CUBE			
		N	HNO3 TO pH<2	1 L P-CUBE			
☐ COLIFORM	303, 909		4 DEG C	(1) 4 OZ STERILE	☐		

NOTES (1) PURGING COMPLETE WHEN 5 WELL VOLUMES HAVE BEEN PURGED AND WHEN WATER PARAMETERS VARY BY LESS THAN APPROXIMATELY 10%.
(2) PAL INORGANICS: ICP METALS (SS10); AS (SD22); SE (SD21); TL (SD09); SB (SD28); PB (SD20); HG (SB01).
H2O QUALITY: PO4 (TF27); TKN (TF26); NIT (TF22); CL/SO4 (TT10); TSS (160.2); ALK (301.0); HARDNESS.
ALL PARAMETERS COLLECTED AS TOTALS, IE: NON-FILTERED

SAMPLED BY: Gordon Hamlin
RECEIVED BY:

MS/MSD collected

GROUNDWATER SAMPLE DATA RECORD
PROJECT OPERATIONS PLAN
FORT DEVENS, MASSACHUSETTS
ABB Environmental Services, Inc.

PROJECT: FT. DEVENS
SITE ID: BDM-96-03X
FIELD SAMPLE NUMBER: MXBD@3X1
SITE TYPE: WELL
JOB NUMBER: 08240.02
STUDY AREA/AOC: BDM
SAMPLING DATE: 7/30/96
FILE TYPE: CGW
WEATHER: Rain
LOCATION ACTIVITY: START ' END 1300

WATER LEVEL / WELL DATA
WELL DEPTH: 34.95 FT
WATER DEPTH: 26.06 FT
HEIGHT OF WATER COLUMN: 8.89 FT
☐ 1.68 gal/ft (4") ___ gal/ft
☑ MEASURED ☐ HISTORICAL
☐ TOP OF WELL ☐ TOP OF CASING
PROTECTIVE CASING STICK-UP (FROM GROUND): 2.4 FT
PROTECTIVE CASING/WELL DIFF.: -0.2C FT
4.9 GAL/VOL
25 (+5) (30) TOTAL GAL PURGED
PID READINGS: AMBIENT AIR 0.0 PPM; WELL MOUTH 0.4 PPM

WELL INTEGRITY:

	YES	NO	N/A
PROT. CASING SECURE	☑	☐	☐
CONCRETE COLLAR INTACT	☑	☐	☐
WELL LOCKED		☐	☐
PVC WELL CAP		☐	☐

WELL DIAMETER: ☑ 2 INCH ☐ 4 INCH ___ INCH

PURGE DATA — VOLUME #	1	2	3	4	5	7/30/96	6	
GALLONS	5	10	15	20	25		30	
PUMPING RATE (GPM)	—	2	2	2	2		2	
TEMP, DEG C	11.5	~~11.9~~ 11.4 (11.9)	11.0	10.8	10.6		11.4	
pH, UNITS ☐ pH PAPER	5.81	5.74	5.71	5.71	5.70		5.73	
SPECIFIC CONDUCTIVITY, umhos/cm	.116	.118	.117	.117	.117		.114	
TURBIDITY, ntu	0	0	0	0	0		96	

SAMPLE OBSERVATIONS: ☑ CLEAR ☐ CLOUDY ☐ COLORED ___ ☐ TURBID ☐ ODOR ☐ OTHER (SEE NOTES)

REDOX (@ COMPLETION OF PURGING): 298.7 +/- mv 7/30/96 317.4

EQUIPMENT DOCUMENTATION
PURGING: ☐ PERISTALTIC PUMP ☐ DEDICATED SUBMERSIBLE PUMP ☐ BAILER ☐ PVC/SILICON TUBING ☐ IN-LINE/DISPOSABLE FILTER ___ ☐ OTHER ___
SAMPLING: ☑ PERISTALTIC PUMP ☐ DEDICATED SUBMERSIBLE PUMP ☐ BAILER ☑ PVC/SILICON TUBING ☐ IN-LINE/DISPOSABLE FILTER ___ ☐ OTHER ___
EQUIPMENT ID: ISCO # ___ ☐ 2" ☐ 4" # ___
DECON FLUIDS USED: ☐ POTABLE WATER ☐ LIQUINOX ☐ STEAM CLEANING ___
WATER LEVEL EQUIP. USED: ☑ ELECTRIC COND. PROBE ☐ PRESSURE TRANSDUCER ___
NUMBER OF FILTERS USED: 1

ANALYTICAL PARAMETERS	METHOD NUMBER	FRACTION CODE	PRESERVATION METHOD	VOLUME REQUIRED	SAMPLE COLLECTED	SAMPLE BOTTLE ID NUMBERS — BOTTLE
☐ VOC	UM20	VP	HCL, 4 DEG C	(4) 60 ML	☐	
☐ SVOC	UM18	MS	4 DEG C	(2) 1 L AG	☐	
☐ PEST/PCBs	UM02	EC	4 DEG C	(3) 1 L AG	☐	
	UM13					
☐ PAL INORGANICS (see notes)		N	HNO3 TO pH<2	1 L P-CUBE	☐	
☐ LEAD ONLY	SD20	N	HNO3 TO pH<2		☐	
☐ EXPLOSIVES	UM19	LC	4 DEG C	(3) 1 L AG	☐	
	UM32					
☐ TPHC	418.1	O	H2SO4 TO pH<2	1 L AG	☐	
☐ TOC	415.1	O	H2SO4 TO pH<2	1 L AG	☐	
☐ ANIONS	TF22	S	H2SO4 TO pH<2	1 L P-CUBE	☐	
	TT10	C	4 DEG C	1 L P-CUBE	☐	
	310.1	N	HNO3 TO pH<2	1 L P-CUBE	☐	
☐ TSS ONLY	160.2	C	4 DEG C	1 L P-CUBE	☐	
☐ H2O QUALITY (see notes)		S	H2SO4 TO pH<2	1 L P-CUBE	☐	
		C	4 DEG C	1 L P-CUBE	☐	
		N	HNO3 TO pH<2	1 L P-CUBE	☐	
☐ COLIFORM	303, 909		4 DEG C	(1) 4 OZ STERILE	☐	

NOTES (1) PURGING COMPLETE WHEN 5 WELL VOLUMES HAVE BEEN PURGED AND WHEN WATER PARAMETERS VARY BY LESS THAN APPROXIMATELY 10%.
(2) PAL INORGANICS: ICP METALS (SS10); AS (SD22); SE (SD21); TL (SD09); SB (SD28); PB (SD20); HG (SB01).
H2O QUALITY: PO4 (TF27); TKN (TF26); NIT (TF22); CL/SO4 (TT10); TSS (160.2); ALK (301.0); HARDNESS.
ALL PARAMETERS COLLECTED AS TOTALS, IE: NON-FILTERED

SAMPLED BY: Gordon Howitt
RECEIVED BY: ___

GROUNDWATER SAMPLE DATA RECORD
PROJECT OPERATIONS PLAN
FORT DEVENS, MASSACHUSETTS
ABB Environmental Services, Inc.

PROJECT: FT. DEVENS
SITE ID: BDM-96-04B
FIELD SAMPLE NUMBER: MXBD4B+1 (04, 15)
SITE TYPE: WELL
JOB NUMBER: 08740.02
STUDY AREA/AOC: BDM
SAMPLING DATE: 7/30/96
FILE TYPE: CGW
WEATHER: Pt. Cloudy

LOCATION ACTIVITY: START ___ END 16:30

WATER LEVEL / WELL DATA

WELL DEPTH: 55.2 FT — ☒ MEASURED ☐ HISTORICAL
WATER DEPTH: 26.72 FT
HEIGHT OF WATER COLUMN: 28.5 FT
15.6 GAL/VOL
75 TOTAL GAL PURGED
☐ 1.68 gal/ft (4")
☒ .55 gal/ft

☐ TOP OF WELL ☐ TOP OF CASING

PROTECTIVE CASING STICK-UP (FROM GROUND): 2.3 FT
PROTECTIVE CASING/WELL DIFF.: 0.17 FT

WELL INTEGRITY:	YES	NO	N/A
PROT. CASING SECURE	☒	☐	☐
CONCRETE COLLAR INTACT	☒	☐	☐
WELL LOCKED	☒	☐	☐
PVC WELL CAP	☒	☐	☐

WELL DIAMETER: ☒ 2 INCH ☐ 4 INCH ☐ ___ INCH

PID READINGS: AMBIENT AIR 0.0 PPM   WELL MOUTH 0.0 PPM

PURGE DATA

VOLUME #	1	2	3	4	5			
GALLONS	15	30	45	60	75			
PUMPING RATE (GPM)	.75	.75	.75	1.0	1.0			
TEMP, DEG C	12.5	12.2	12.2	11.9	11.9			
pH, UNITS ☐ pH PAPER	7.60	7.13	7.19	7.08	7.02			
SPECIFIC CONDUCTIVITY, mS/cm	.379	.380	.384	.379	.380			
TURBIDITY, ntu	26	3	451	14	12			

SAMPLE OBSERVATIONS
☒ CLEAR
☐ CLOUDY
☐ COLORED ___
☐ TURBID
☐ ODOR
☐ OTHER (SEE NOTES)

REDOX (@ COMPLETION OF PURGING): 316.7 +/- mv

EQUIPMENT DOCUMENTATION

PURGING / SAMPLING
☒ ☐ PERISTALTIC PUMP — EQUIPMENT ID: ISCO # ___
☐ ☒ DEDICATED SUBMERSIBLE PUMP ☐ 2" ☐ 4" # ___
☐ ☒ BAILER
☐ ☒ PVC/SILICON TUBING
☐ ☒ IN-LINE/DISPOSABLE FILTER ___
☐ ☐ OTHER ___

DECON FLUIDS USED
☐ POTABLE WATER
☐ LIQUINOX
☐ STEAM CLEANING
☐ ___

WATER LEVEL EQUIP. USED
☒ ELECTRIC COND. PROBE
☐ PRESSURE TRANSDUCER
___

NUMBER OF FILTERS USED: 1

ANALYTICAL PARAMETERS	METHOD NUMBER	FRACTION CODE	PRESERVATION METHOD	VOLUME REQUIRED	SAMPLE COLLECTED	SAMPLE BOTTLE ID NUMBERS	BOTTLE
☐ VOC	UM20	VP	HCL, 4 DEG C	(4) 60 ML	☐	___/___/___/___	
☐ SVOC	UM18	MS	4 DEG C	(2) 1 L AG	☐	___/___/___/___	
☐ PEST/PCBs	UH02	EC	4 DEG C	(3) 1 L AG	☐	___/___/___/___	
	UH13					___/___/___/___	
☐ PAL INORGANICS (see notes)		N	HNO3 TO pH<2	1 L P-CUBE	☐	___/___/___/___	
☐ LEAD ONLY	SD20	N	HNO3 TO pH<2		☐	___/___/___/___	
☐ EXPLOSIVES	UW19	LC	4 DEG C	(3) 1 L AG	☐	___/___/___/___	
	UW32					___/___/___/___	
☐ TPHC	418.1	O	H2SO4 TO pH<2	1 L AG	☐	___/___/___/___	
☐ TOC	415.1	O	H2SO4 TO pH<2	1 L AG	☐	___/___/___/___	
☐ ANIONS	TF22	S	H2SO4 TO pH<2	1 L P-CUBE	☐	___/___/___/___	
	TT10	C	4 DEG C	1 L P-CUBE	☐	___/___/___/___	
	310.1	N	HNO3 TO pH<2	1 L P-CUBE	☐	___/___/___/___	
☐ TSS ONLY	160.2	C	4 DEG C	1 L P-CUBE	☐	___/___/___/___	
☐ H2O QUALITY (see notes)		S	H2SO4 TO pH<2	1 L P-CUBE	☐	___/___/___/___	
		C	4 DEG C	1 L P-CUBE	☐	___/___/___/___	
		N	HNO3 TO pH<2	1 L P-CUBE	☐	___/___/___/___	
☐ COLIFORM	303, 909		4 DEG C	(1) 4 OZ STERILE	☐	___/___/___/___	

NOTES (1) PURGING COMPLETE WHEN 5 WELL VOLUMES HAVE BEEN PURGED AND WHEN WATER PARAMETERS VARY BY LESS THAN APPROXIMATELY 10%.
(2) PAL INORGANICS: ICP METALS (SS10); AS (SD22); SE (SD21); TL (SD09); SB (SD28); PB (SD20); HG (SB01).
H2O QUALITY: PO4 (TF27); TKN (TF26); NIT (TF22); CL/SO4 (TT10); TSS (160.2); ALK (301.0); HARDNESS.
ALL PARAMETERS COLLECTED AS TOTALS, IE: NON-FILTERED

SAMPLED BY: Gordon Pfander
RECEIVED BY: ___

GROUNDWATER SAMPLE DATA RECORD
PROJECT OPERATIONS PLAN
FORT DEVENS, MASSACHUSETTS

ABB Environmental Services, Inc.

PROJECT: FT. DEVENS
SITE ID: BDM-96-05X
FIELD SAMPLE NUMBER: MXBDW5HX1
SITE TYPE: WELL
JOB NUMBER: 02740.02
STUDY AREA/AOC: BDM
SAMPLING DATE: 7/30/96
FILE TYPE: CGW
LOCATION ACTIVITY: START 1640 END 1700
WEATHER: Partly cloudy

WATER LEVEL / WELL DATA
WELL DEPTH: 35.05 FT
WATER DEPTH: 26.95 FT
[X] MEASURED [ ] HISTORICAL
[X] TOP OF WELL [ ] TOP OF CASING
PROTECTIVE CASING STICK-UP (FROM GROUND): 2.7 FT
PROTECTIVE CASING/WELL DIFF.: -0.28 FT
4.4 GAL/VOL
20 TOTAL GAL PURGED
HEIGHT OF WATER COLUMN: 8.0 FT
[ ] 1.68 gal/ft (4") [X] .65 gal/ft
PID READINGS: AMBIENT AIR 0.0 PPM; WELL MOUTH 0.0 PPM

WELL INTEGRITY:

	YES	NO	N/A
PROT. CASING SECURE	X		
CONCRETE COLLAR INTACT	X		
WELL LOCKED			
PVC WELL CAP			

WELL DIAMETER: [ ] 2 INCH [X] 4 INCH [ ] ___ INCH

PURGE DATA	VOLUME #	1	2	3	4	5			
	GALLONS	4	8	12	16	20			
	PUMPING RATE (GPM)	1	1	1	1	1			
TEMP, DEG C		10.9	10.3	10.6	10.3	10.3			
pH, UNITS [ ] pH PAPER		6.01	5.99	5.91	5.88	5.87			
SPECIFIC CONDUCTIVITY, mS/cm		.087	.093	.095	.100	.097			
TURBIDITY, ntu		20	0	0	0	0			

SAMPLE OBSERVATIONS
[X] CLEAR
[ ] CLOUDY
[ ] COLORED ____
[ ] TURBID
[ ] ODOR
[ ] OTHER (SEE NOTES)

REDOX (@ COMPLETION OF PURGING): [361.7] +/- mv

EQUIPMENT DOCUMENTATION
PURGING: [ ]
SAMPLING: [X]
EQUIPMENT ID
PERISTALTIC PUMP
ISCO #____
DEDICATED SUBMERSIBLE PUMP [X] 2" [ ] 4" #__
BAILER
PVC/SILICON TUBING
IN-LINE/DISPOSABLE FILTER____
OTHER____

DECON FLUIDS USED
[ ] POTABLE WATER
[ ] LIQUINOX
[ ] STEAM CLEANING
None - Disposal equipment
NUMBER OF FILTERS USED: 1

WATER LEVEL EQUIP. USED
[X] ELECTRIC COND. PROBE
[ ] PRESSURE TRANSDUCER
____

ANALYTICAL PARAMETERS	METHOD NUMBER	FRACTION CODE	PRESERVATION METHOD	VOLUME REQUIRED	SAMPLE COLLECTED	SAMPLE BOTTLE ID NUMBERS	BOTTLE
[ ] VOC	UM20	VP	HCL, 4 DEG C	(4) 60 ML	[ ]		
[ ] SVOC	UM18	MS	4 DEG C	(2) 1 L AG	[ ]		
[ ] PEST/PCBs	UM02	EC	4 DEG C	(3) 1 L AG	[ ]		
	UM13						
[ ] PAL INORGANICS (see notes)		N	HNO3 TO pH<2	1 L P-CUBE	[ ]		
[ ] LEAD ONLY	SD20	N	HNO3 TO pH<2		[ ]		
[ ] EXPLOSIVES	UM19	LC	4 DEG C	(3) 1 L AG	[ ]		
	UM32						
[ ] TPHC	418.1	O	H2SO4 TO pH<2	1 L AG	[ ]		
[ ] TOC	415.1	O	H2SO4 TO pH<2	1 L AG	[ ]		
[ ] ANIONS	TF22	S	H2SO4 TO pH<2	1 L P-CUBE	[ ]		
	TT10	C	4 DEG C	1 L P-CUBE	[ ]		
	310.1	N	HNO3 TO pH<2	1 L P-CUBE	[ ]		
[ ] TSS ONLY	160.2	C	4 DEG C	1 L P-CUBE	[ ]		
[ ] H2O QUALITY (see notes)		S	H2SO4 TO pH<2	1 L P-CUBE	[ ]		
		C	4 DEG C	1 L P-CUBE	[ ]		
		N	HNO3 TO pH<2	1 L P-CUBE	[ ]		
[ ] COLIFORM	303, 909		4 DEG C	(1) 4 OZ STERILE	[ ]		

NOTES (1) PURGING COMPLETE WHEN 5 WELL VOLUMES HAVE BEEN PURGED AND WHEN WATER PARAMETERS VARY BY LESS THAN APPROXIMATELY 10%.
(2) PAL INORGANICS: ICP METALS (SS10); AS (SD22); SE (SD21); TL (SD09); SB (SD28); PB (SD20); HG (SB01).
H2O QUALITY: PO4 (TF27); TKN (TF26); NIT (TF22); CL/SO4 (TT10); TSS (160.2); ALK (301.0); HARDNESS.
ALL PARAMETERS COLLECTED AS TOTALS, IE: NON-FILTERED

SAMPLED BY: Gordon Hanson
RECEIVED BY: ____

GROUNDWATER SAMPLE DATA RECORD
PROJECT OPERATIONS PLAN
FORT DEVENS, MASSACHUSETTS
ABB Environmental Services, Inc.

APPENDIX D

OFF-SITE LABORATORY DATA

COMPUCHEM
ENVIRONMENTAL
CORPORATION

3306 Chapel Hill/Nelson Highway P.O. Box 14998
Research Triangle Park, NC 27709-4998
(919) 406-1600

February 15, 1995

ABB Environmental Services
107 Audubon Rd.
Wakefield, MA 01880

ATTN: Doug Pierce

RE: IMPORTANT NOTICE - SAMPLE ANALYSIS ACKNOWLEDGMENT
LETTER OF RECEIPT

Thank you for selecting CompuChem Environmental Corporation for your analytical service needs. Would you please take a few moments to review the important documentation attached?

Enclosed is information pertaining to sample(s) just received from your firm. The attached listing provides a cross-reference between your sample I.D. and CompuChem's laboratory number. The listing also indicates the analysis that has been scheduled to be performed on your sample(s).

Please! If the attached listing does not completely or accurately reflect the analyses you want CompuChem to perform, it is essential that you contact one of the Project Management representatives immediately so we may correct your order.

Any discrepancy noted should be made known to CompuChem by FAX'ed transmission without delay! This will allow your order to be reviewed and corrected, thereby ensuring timely receipt of the analytical reports you require. Your original Chain-of-Custody document(s) will be mailed under a separate cover within a week of the date of this correspondence.

Your time and assistance in helping us to ensure the accuracy and completeness of your order is much appreciated!

FAX number for Inquiries or Corrective Actions

(919) 406-1686

Sincerely,

Marlene Swift (919) 406-1626
Cathy Dover (919) 406-1627
Mickey Cartagena (919) 406-1628

Project Management Representatives
CompuChem Environmental Corporation
(800) 833-5097

ABB Environmental Services
ATTN: Doug Pierce
107 Audubon Rd.
Wakefield, MA 01880

PAGE 1

RECEIVE DATE: 2/14/95
QUOTE NUMBER: 94-00053400000500580
ORDER NUMBER: 29987

SAMPLE ID	TURNAROUND** TIME	ANALYSIS	COMPUCHEM NUMBER
MD061911	30	Metals SW-846 3rd Ed Water	684387
MD166621	30	TCL Voa+LS Method 8240 Water	684375
		TCL Semivoa+LibSearch Method 8270 Water	684379
		TPH Method 503 Water	684383

** Please note that turnarcund time and sample due dates will be, whenever applicable, calculated and determined by the last sample received in a Sample Delivery Group.

COMPUCHEM
ENVIRONMENTAL
CORPORATION

January 27, 1995

ABB Environmental Services
107 Audubon Rd.
Wakefield, MA 01880

ATTN: Doug Pierce

RE: IMPORTANT NOTICE - SAMPLE ANALYSIS ACKNOWLEDGMENT
LETTER OF RECEIPT

Thank you for selecting CompuChem Environmental Corporation for your analytical service needs. Would you please take a few moments to review the important documentation attached?

Enclosed is information pertaining to sample(s) just received from your firm. The attached listing provides a cross-reference between your sample I.D. and CompuChem's laboratory number. The listing also indicates the analysis that has been scheduled to be performed on your sample(s).

Please! If the attached listing does not completely or accurately reflect the analyses you want CompuChem to perform, it is essential that you contact one of the Project Management representatives immediately so we may correct your order.

Any discrepancy noted should be made known to CompuChem by FAX'ed transmission without delay! This will allow your order to be reviewed and corrected, thereby ensuring timely receipt of the analytical reports you require. Your original Chain-of-Custody document(s) will be mailed under a separate cover within a week of the date of this correspondence.

Your time and assistance in helping us to ensure the accuracy and completeness of your order is much appreciated!

FAX number for Inquiries or Corrective Actions

(919) 406-1686

Sincerely,

Marlene Swift (919) 406-1626
Cathy Dover (919) 406-1627
Mickey Cartagena (919) 406-1628

Project Management Representatives
CompuChem Environmental Corporation
(800) 833-5097

COMPUCHEM
ENVIRONMENTAL
CORPORATION

ABB Environmental Services
ATTN: Doug Pierce
107 Audubon Rd.
Wakefield, MA 01880

RECEIVE DATE: 1/26/95
QUOTE NUMBER: 94-00053400000500580
ORDER NUMBER: 29987

SAMPLE ID	TURNAROUND** TIME	ANALYSIS	COMPUCHEM NUMBER
MX061421	30	TCL Voa+LS Method 8240 Water	680057
		TCL Semivoa+LibSearch Method 8270 Water	680059
		TPH Method 503 Water	680060
MX061431	30	TCL Voa+LS Method 8240 Water	680061
		TCL Semivoa+LibSearch Method 8270 Water	680062
		TPH Method 503 Water	680063
MX061441	30	TCL Voa+LS Method 8240 Water	680064
		TCL Semivoa+LibSearch Method 8270 Water	680066
		TPH Method 503 Water	680067
MX061911	30	TCL Voa+LS Method 8240 Water	680068
		TCL Semivoa+LibSearch Method 8270 Water	680069
		TPH Method 503 Water	680070
		Metals SW-846 3rd Ed Water	680072
MX166612	30	TCL Voa+LS Method 8240 Water	680044
		TCL Semivoa+LibSearch Method 8270 Water	680045
		TPH Method 503 Water	680047
MX166621	30	TCL Voa+LS Method 8240 Water	680041
		TCL Semivoa+LibSearch Method 8270 Water	680042
		TPH Method 503 Water	680043
MX362252	30	TCL Voa+LS Method 8240 Water	680029
		TCL Semivoa+LibSearch Method 8270 Water	680033
		TPH Method 503 Water	680037
SBK-25	30	TCL Voa+LS Method 8240 Water	680048
		TCL Semivoa+LibSearch Method 8270 Water	680049
		TPH Method 503 Water	680050
		Metals SW-846 3rd Ed Water	680052
TBK-25	30	TCL Voa+LS Method 8240 Water	680073

** Please note that turnaround time and sample due dates will be, whenever applicable, calculated and determined by the last sample received in a Sample Delivery Group.

GROUNDWATER ANALYTICAL

EPA METHOD 8015 (MA DEP Modified)
Volatile Petroleum Hydrocarbons (GC/PID/FID)

Field ID:	**BXBD0123**	Lab ID:	**13627-04**
Project:	**Devens/ESPS Task 7 (DV5)**	Batch ID:	**VG1-0037-E**
Client:	**ABB**	Sampled:	**06-19-96**
Cont/Prsv:	**125mL VOA Vial/Methanol Cool**	Received:	**06-20-96**
Matrix:	**Soil** Percent Moisture **11 %**	Analyzed:	**07-02-96**

Volatile Petroleum Hydrocarbons

PARAMETER	CONCENTRATION (ug/Kg)	TOXICITY MULTIPLIER	EQUIVALENT CONCENTRATION (ug/Kg)	ADJUSTED REPORTING LIMIT (ug/Kg)
n-C 5 to n-C 8 Aliphatics *	BRL	0.5	BRL	130
n-C 9 to n-C 12 Aliphatics	280	0.05	14	13
n-C 9 to n-C 10 Aromatics	BRL	1.0	BRL	250
Volatile Petroleum Hydrocarbons (VPH)			**14**	**13**

Targeted Volatile Organic Analytes

PARAMETER	CONCENTRATION (ug/Kg)	REPORTING LIMIT (ug/Kg)
Methyl *tert*-butyl Ether	BRL	250
Benzene	BRL	50
Toluene	BRL	50
Ethylbenzene	BRL	50
meta- and *para*-Xylene	BRL	50
ortho-Xylene	BRL	50
Naphthalene	BRL	250

QC SURROGATE COMPOUND	SPIKED	MEASURED	RECOVERY	QC LIMITS
2,5-Dibromotoluene	2,500	2,400	95 %	60 - 140 %

BRL = Below Reporting Limit. * = Reported concentration excludes targeted Volatile Organic analytes. Calculations based on dry sample weight. Method Reference: Method 8015 (Modified) - Nonhalogenated Volatile Organics by Gas Chromatography, Test Methods for Evaluating Solid Waste, US EPA SW-846, Third Edition (1986). Modified in accordance with the Method for the Determination of Volatile Petroleum Hydrocarbons, MA DEP, Public Comment Draft 1.0 (1995).

GROUNDWATER ANALYTICAL

EPA METHOD 8100 (MA DEP Modified)
Extractable Petroleum Hydrocarbons (GC/FID)

Field ID:	**BXBD0123**	Lab ID:	**13627-03**
Project:	**Devens/ESPS Task 7 (DV5)**	Batch ID:	**EP-0139-M**
Client:	**ABB**	Sampled:	**06-18-96**
Cont/Prsv:	**250mL Glass/Cool**	Received:	**06-20-96**
Matrix:	**Soil** Percent Moisture: **11 %**	Extracted:	**06-25-96**
		Analyzed:	**07-02-96**

Extractable Petroleum Hydrocarbons

PARAMETER	CONCENTRATION (mg/Kg)	TOXICITY MULTIPLIER	EQUIVALENT CONCENTRATION (mg/Kg)	ADJUSTED REPORTING LIMIT (mg/Kg)
n-C 9 to n-C 18 Aliphatics	BRL	0.05	BRL	1.7
n-C 19 to n-C 36 Aliphatics	BRL	0.005	BRL	0.17
n-C 10 to n-C 22 Aromatics *	BRL	1.0	BRL	33
Extractable Petroleum Hydrocarbons (EPH)			**BRL**	**0.17**

Targeted Polynuclear Aromatic Hydrocarbon Analytes

PARAMETER	CONCENTRATION (mg/Kg)	REPORTING LIMIT (mg/Kg)
Naphthalene	BRL	0.56
2-Methylnaphthalene	BRL	0.56
Acenaphthylene	BRL	0.56
Acenaphthene	BRL	0.56
Fluorene	BRL	0.56
Phenanthrene	BRL	0.56
Anthracene	BRL	0.56
Fluoranthene	BRL	0.56
Pyrene	BRL	0.56
Benzo(a)anthracene	BRL	0.56
Chrysene	BRL	0.56
Benzo(b)fluoranthene	BRL	0.56
Benzo(k)fluoranthene	BRL	0.56
Benzo(a)pyrene	BRL	0.56
Indeno(1,2,3-c,d)pyrene	BRL	0.56
Dibenzo(a,h)anthracene	BRL	0.56
Benzo(g,h,i)perylene	BRL	0.56

QC SURROGATE COMPOUND	SPIKED	MEASURED	RECOVERY	QC LIMITS
Chloro-octadecane	2.2	1.8	80 %	60 - 140 %
o-Terphenyl	2.2	1.9	87 %	60 - 140 %

BRL = Below Reporting Limit. * = Reported concentration excludes targeted Polynuclear Aromatic Hydrocarbon analytes. Calculations based on dry sample weight. Method Reference: Method 8100 (Modified) - Polynuclear Aromatic Hydrocarbons, Test Methods for Evaluating Solid Waste, US EPA SW-846, Third Edition (1986). Modified in accordance with the Method for the Determination of Extractable Petroleum Hydrocarbons, MA DEP, Public Comment Draft 1.0 (1995).

GROUNDWATER ANALYTICAL

EPA METHOD 8100 (MA DEP Modified)
Extractable Petroleum Hydrocarbons (GC/FID)

Field ID:	**MXBD0229**	Lab ID:	**13655-05**
Project:	**Devens/ESPS Task 7 (DV5)**	Batch ID:	**EP-0141-M**
Client:	**ABB**	Sampled:	**06-25-96**
Cont/Prsv:	**250mL Glass/Cool**	Received:	**06-25-96**
Matrix:	**Soil** Percent Moisture: **15 %**	Extracted:	**06-29-96**
		Analyzed:	**07-10-96**

Extractable Petroleum Hydrocarbons

PARAMETER	CONCENTRATION (mg/Kg)	TOXICITY MULTIPLIER	EQUIVALENT CONCENTRATION (mg/Kg)	ADJUSTED REPORTING LIMIT (mg/Kg)
n-C 9 to n-C 18 Aliphatics	BRL	0.05	BRL	1.8
n-C 19 to n-C 36 Aliphatics	BRL	0.005	BRL	0.18
n-C 10 to n-C 22 Aromatics *	BRL	1.0	BRL	35
Extractable Petroleum Hydrocarbons (EPH)			**BRL**	**0.18**

Targeted Polynuclear Aromatic Hydrocarbon Analytes

PARAMETER	CONCENTRATION (mg/Kg)	REPORTING LIMIT (mg/Kg)
Naphthalene	BRL	0.59
2-Methylnaphthalene	BRL	0.59
Acenaphthylene	BRL	0.59
Acenaphthene	BRL	0.59
Fluorene	BRL	0.59
Phenanthrene	BRL	0.59
Anthracene	BRL	0.59
Fluoranthene	BRL	0.59
Pyrene	BRL	0.59
Benzo(a)anthracene	BRL	0.59
Chrysene	BRL	0.59
Benzo(b)fluoranthene	BRL	0.59
Benzo(k)fluoranthene	BRL	0.59
Benzo(a)pyrene	BRL	0.59
Indeno(1,2,3-c,d)pyrene	BRL	0.59
Dibenzo(a,h)anthracene	BRL	0.59
Benzo(g,h,i)perylene	BRL	0.59

QC SURROGATE COMPOUND	SPIKED	MEASURED	RECOVERY	QC LIMITS
Chloro-octadecane	2.3	2.0	87 %	60 - 140 %
o-Terphenyl	2.3	1.9	81 %	60 - 140 %

BRL = Below Reporting Limit. * = Reported concentration excludes targeted Polynuclear Aromatic Hydrocarbon analytes. Calculations based on dry sample weight. Method Reference: Method 8100 (Modified) - Polynuclear Aromatic Hydrocarbons, Test Methods for Evaluating Solid Waste, US EPA SW-846, Third Edition (1986). Modified in accordance with the Method for the Determination of Extractable Petroleum Hydrocarbons, MA DEP, Public Comment Draft 1.0 (1995).

GROUNDWATER ANALYTICAL

EPA METHOD 8015 (MA DEP Modified)
Volatile Petroleum Hydrocarbons (GC/PID/FID)

Field ID:	**MXBD0229**	Lab ID:	**13655-06**
Project:	**Devens/ESPS Task 7 (DV5)**	Batch ID:	**VG1-0039-E**
Client:	**ABB**	Sampled:	**06-25-96**
Cont/Prsv:	**125mL VOA Vial/Methanol Cool**	Received:	**06-25-96**
Matrix:	**Soil** Percent Moisture **15 %**	Analyzed:	**07-02-96**

Volatile Petroleum Hydrocarbons

PARAMETER	CONCENTRATION (ug/Kg)	TOXICITY MULTIPLIER	EQUIVALENT CONCENTRATION (ug/Kg)	ADJUSTED REPORTING LIMIT (ug/Kg)
n-C 5 to n-C 8 Aliphatics *	BRL	0.5	BRL	130
n-C 9 to n-C 12 Aliphatics	BRL	0.05	BRL	25
n-C 9 to n-C 10 Aromatics	BRL	1.0	BRL	250
Volatile Petroleum Hydrocarbons (VPH)			**BRL**	**25**

Targeted Volatile Organic Analytes

PARAMETER	CONCENTRATION (ug/Kg)	REPORTING LIMIT (ug/Kg)
Methyl *tert*-butyl Ether	BRL	250
Benzene	BRL	50
Toluene	BRL	50
Ethylbenzene	BRL	50
meta- and *para*-Xylene	BRL	50
ortho-Xylene	BRL	50
Naphthalene	BRL	250

QC SURROGATE COMPOUND	SPIKED	MEASURED	RECOVERY	QC LIMITS
2,5-Dibromotoluene	2,500	2,400	95 %	60 - 140 %

BRL = Below Reporting Limit. * = Reported concentration excludes targeted Volatile Organic analytes. Calculations based on dry sample weight. Method Reference: Method 8015 (Modified) - Nonhalogenated Volatile Organics by Gas Chromatography, Test Methods for Evaluating Solid Waste, US EPA SW-846, Third Edition (1986). Modified in accordance with the Method for the Determination of Volatile Petroleum Hydrocarbons, MA DEP, Public Comment Draft 1.0 (1995).

GROUNDWATER ANALYTICAL

EPA METHOD 8100 (MA DEP Modified)
Extractable Petroleum Hydrocarbons (GC/FID)

Field ID:	**MDBD0327**	Lab ID:	**13655-03**
Project:	**Devens/ESPS Task 7 (DV5)**	Batch ID:	**EP-0141-M**
Client:	**ABB**	Sampled:	**06-25-96**
Cont/Prsv:	**250mL Glass/Cool**	Received:	**06-25-96**
Matrix:	**Soil** Percent Moisture: **12 %**	Extracted:	**06-29-96**
		Analyzed:	**07-09-96**

Extractable Petroleum Hydrocarbons

PARAMETER	CONCENTRATION (mg/Kg)	TOXICITY MULTIPLIER	EQUIVALENT CONCENTRATION (mg/Kg)	ADJUSTED REPORTING LIMIT (mg/Kg)
n-C 9 to n-C 18 Aliphatics	BRL	0.05	BRL	1.6
n-C 19 to n-C 36 Aliphatics	BRL	0.005	BRL	0.16
n-C 10 to n-C 22 Aromatics *	BRL	1.0	BRL	32
Extractable Petroleum Hydrocarbons (EPH)			**BRL**	**0.16**

Targeted Polynuclear Aromatic Hydrocarbon Analytes

PARAMETER	CONCENTRATION (mg/Kg)	REPORTING LIMIT (mg/Kg)
Naphthalene	BRL	0.54
2-Methylnaphthalene	BRL	0.54
Acenaphthylene	BRL	0.54
Acenaphthene	BRL	0.54
Fluorene	BRL	0.54
Phenanthrene	BRL	0.54
Anthracene	BRL	0.54
Fluoranthene	BRL	0.54
Pyrene	BRL	0.54
Benzo(a)anthracene	BRL	0.54
Chrysene	BRL	0.54
Benzo(b)fluoranthene	BRL	0.54
Benzo(k)fluoranthene	BRL	0.54
Benzo(a)pyrene	BRL	0.54
Indeno(1,2,3-c,d)pyrene	BRL	0.54
Dibenzo(a,h)anthracene	BRL	0.54
Benzo(g,h,i)perylene	BRL	0.54

QC SURROGATE COMPOUND	SPIKED	MEASURED	RECOVERY	QC LIMITS
Chloro-octadecane	2.2	1.8	82 %	60 - 140 %
o-Terphenyl	2.2	1.8	82 %	60 - 140 %

BRL = Below Reporting Limit. * = Reported concentration excludes targeted Polynuclear Aromatic Hydrocarbon analytes. Calculations based on dry sample weight. Method Reference: Method 8100 (Modified) - Polynuclear Aromatic Hydrocarbons, Test Methods for Evaluating Solid Waste, US EPA SW-846, Third Edition (1986). Modified in accordance with the Method for the Determination of Extractable Petroleum Hydrocarbons, MA DEP, Public Comment Draft 1.0 (1995).

GROUNDWATER ANALYTICAL

EPA METHOD 8015 (MA DEP Modified)
Volatile Petroleum Hydrocarbons (GC/PID/FID)

Field ID:	**MDBD0327**	Lab ID:	**13655-04**
Project:	**Devens/ESPS Task 7 (DV5)**	Batch ID:	**VG1-0039-E**
Client:	**ABB**	Sampled:	**06-25-96**
Cont/Prsv:	**125mL VOA Vial/Methanol Cool**	Received:	**06-25-96**
Matrix:	**Soil** Percent Moisture **12 %**	Analyzed:	**07-02-96**

Volatile Petroleum Hydrocarbons

PARAMETER	CONCENTRATION (ug/Kg)	TOXICITY MULTIPLIER	EQUIVALENT CONCENTRATION (ug/Kg)	ADJUSTED REPORTING LIMIT (ug/Kg)
n-C 5 to n-C 8 Aliphatics *	BRL	0.5	BRL	130
n-C 9 to n-C 12 Aliphatics	BRL	0.05	BRL	25
n-C 9 to n-C 10 Aromatics	BRL	1.0	BRL	250
Volatile Petroleum Hydrocarbons (VPH)			**BRL**	**25**

Targeted Volatile Organic Analytes

PARAMETER	CONCENTRATION (ug/Kg)	REPORTING LIMIT (ug/Kg)
Methyl *tert*-butyl Ether	BRL	250
Benzene	BRL	50
Toluene	BRL	50
Ethylbenzene	BRL	50
meta- and *para*-Xylene	BRL	50
ortho-Xylene	BRL	50
Naphthalene	BRL	250

QC SURROGATE COMPOUND	SPIKED	MEASURED	RECOVERY	QC LIMITS
2,5-Dibromotoluene	2,500	2,800	111 %	60 - 140 %

BRL = Below Reporting Limit. * = Reported concentration excludes targeted Volatile Organic analytes. Calculations based on dry sample weight. Method Reference: Method 8015 (Modified) - Nonhalogenated Volatile Organics by Gas Chromatography, Test Methods for Evaluating Solid Waste, US EPA SW-846, Third Edition (1986). Modified in accordance with the Method for the Determination of Volatile Petroleum Hydrocarbons, MA DEP, Public Comment Draft 1.0 (1995).

GROUNDWATER ANALYTICAL

EPA METHOD 8100 (MA DEP Modified)
Extractable Petroleum Hydrocarbons (GC/FID)

Field ID:	**MXBD0327**	Lab ID:	**13655-07**
Project:	**Devens/ESPS Task 7 (DV5)**	Batch ID:	**EP-0141-M**
Client:	**ABB**	Sampled:	**06-25-96**
Cont/Prsv:	**250mL Glass/Cool**	Received:	**06-25-96**
Matrix:	**Soil** Percent Moisture: **12 %**	Extracted:	**06-29-96**
		Analyzed:	**07-09-96**

Extractable Petroleum Hydrocarbons

PARAMETER	CONCENTRATION (mg/Kg)	TOXICITY MULTIPLIER	EQUIVALENT CONCENTRATION (mg/Kg)	ADJUSTED REPORTING LIMIT (mg/Kg)
n-C 9 to n-C 18 Aliphatics	BRL	0.05	BRL	1.6
n-C 19 to n-C 36 Aliphatics	BRL	0.005	BRL	0.16
n-C 10 to n-C 22 Aromatics *	BRL	1.0	BRL	32
Extractable Petroleum Hydrocarbons (EPH)			**BRL**	**0.16**

Targeted Polynuclear Aromatic Hydrocarbon Analytes

PARAMETER	CONCENTRATION (mg/Kg)	REPORTING LIMIT (mg/Kg)
Naphthalene	BRL	0.54
2-Methylnaphthalene	BRL	0.54
Acenaphthylene	BRL	0.54
Acenaphthene	BRL	0.54
Fluorene	BRL	0.54
Phenanthrene	BRL	0.54
Anthracene	BRL	0.54
Fluoranthene	BRL	0.54
Pyrene	BRL	0.54
Benzo(a)anthracene	BRL	0.54
Chrysene	BRL	0.54
Benzo(b)fluoranthene	BRL	0.54
Benzo(k)fluoranthene	BRL	0.54
Benzo(a)pyrene	BRL	0.54
Indeno(1,2,3-c,d)pyrene	BRL	0.54
Dibenzo(a,h)anthracene	BRL	0.54
Benzo(g,h,i)perylene	BRL	0.54

QC SURROGATE COMPOUND	SPIKED	MEASURED	RECOVERY	QC LIMITS
Chloro-octadecane	2.1	1.8	87 %	60 - 140 %
o-Terphenyl	2.1	1.9	89 %	60 - 140 %

BRL = Below Reporting Limit. * = Reported concentration excludes targeted Polynuclear Aromatic Hydrocarbon analytes. Calculations based on dry sample weight. Method Reference: Method 8100 (Modified) - Polynuclear Aromatic Hydrocarbons, Test Methods for Evaluating Solid Waste, US EPA SW-846, Third Edition (1986). Modified in accordance with the Method for the Determination of Extractable Petroleum Hydrocarbons, MA DEP, Public Comment Draft 1.0 (1995).

GROUNDWATER ANALYTICAL

EPA METHOD 8015 (MA DEP Modified)
Volatile Petroleum Hydrocarbons (GC/PID/FID)

Field ID:	**MXBD0327**	Lab ID:	**13655-08**
Project:	**Devens/ESPS Task 7 (DV5)**	Batch ID:	**VG1-0039-E**
Client:	**ABB**	Sampled:	**06-25-96**
Cont/Prsv:	**125mL VOA Vial/Methanol Cool**	Received:	**06-25-96**
Matrix:	**Soil** Percent Moisture **12 %**	Analyzed:	**07-02-96**

Volatile Petroleum Hydrocarbons

PARAMETER	CONCENTRATION (ug/Kg)	TOXICITY MULTIPLIER	EQUIVALENT CONCENTRATION (ug/Kg)	ADJUSTED REPORTING LIMIT (ug/Kg)
n-C 5 to n-C 8 Aliphatics *	BRL	0.5	BRL	130
n-C 9 to n-C 12 Aliphatics	BRL	0.05	BRL	25
n-C 9 to n-C 10 Aromatics	BRL	1.0	BRL	250
Volatile Petroleum Hydrocarbons (VPH)			**BRL**	**25**

Targeted Volatile Organic Analytes

PARAMETER	CONCENTRATION (ug/Kg)	REPORTING LIMIT (ug/Kg)
Methyl *tert*-butyl Ether	BRL	250
Benzene	BRL	50
Toluene	BRL	50
Ethylbenzene	BRL	50
meta- and *para*-Xylene	BRL	50
ortho-Xylene	BRL	50
Naphthalene	BRL	250

QC SURROGATE COMPOUND	SPIKED	MEASURED	RECOVERY	QC LIMITS
2,5-Dibromotoluene	2,500	2,700	106 %	60 - 140 %

BRL = Below Reporting Limit. * = Reported concentration excludes targeted Volatile Organic analytes. Calculations based on dry sample weight. Method Reference: Method 8015 (Modified) - Nonhalogenated Volatile Organics by Gas Chromatography, Test Methods for Evaluating Solid Waste, US EPA SW-846, Third Edition (1986). Modified in accordance with the Method for the Determination of Volatile Petroleum Hydrocarbons, MA DEP, Public Comment Draft 1.0 (1995).

GROUNDWATER ANALYTICAL

EPA METHOD 8100 (MA DEP Modified)
Extractable Petroleum Hydrocarbons (GC/FID)

Field ID:	**MXBD4B28**	Lab ID:	**13685-03**
Project:	**Devens/ESPS Task 7 (DV5)**	Batch ID:	**EP-0142-M**
Client:	**ABB**	Sampled:	**06-26-96**
Cont/Prsv:	**250mL Glass/Cool**	Received:	**06-27-96**
Matrix:	**Soil** Percent Moisture: **12 %**	Extracted:	**07-03-96**
		Analyzed:	**07-12-96**

Extractable Petroleum Hydrocarbons

PARAMETER	CONCENTRATION (mg/Kg)	TOXICITY MULTIPLIER	EQUIVALENT CONCENTRATION (mg/Kg)	ADJUSTED REPORTING LIMIT (mg/Kg)
n-C 9 to n-C 18 Aliphatics	BRL	0.05	BRL	1.6
n-C 19 to n-C 36 Aliphatics	BRL	0.005	BRL	0.16
n-C 10 to n-C 22 Aromatics *	BRL	1.0	BRL	33
Extractable Petroleum Hydrocarbons (EPH)			**BRL**	**0.16**

Targeted Polynuclear Aromatic Hydrocarbon Analytes

PARAMETER	CONCENTRATION (mg/Kg)	REPORTING LIMIT (mg/Kg)
Naphthalene	BRL	0.54
2-Methylnaphthalene	BRL	0.54
Acenaphthylene	BRL	0.54
Acenaphthene	BRL	0.54
Fluorene	BRL	0.54
Phenanthrene	BRL	0.54
Anthracene	BRL	0.54
Fluoranthene	BRL	0.54
Pyrene	BRL	0.54
Benzo(a)anthracene	BRL	0.54
Chrysene	BRL	0.54
Benzo(b)fluoranthene	BRL	0.54
Benzo(k)fluoranthene	BRL	0.54
Benzo(a)pyrene	BRL	0.54
Indeno(1,2,3-c,d)pyrene	BRL	0.54
Dibenzo(a,h)anthracene	BRL	0.54
Benzo(g,h,i)perylene	BRL	0.54

QC SURROGATE COMPOUND	SPIKED	MEASURED	RECOVERY	QC LIMITS
Chloro-octadecane	2.2	2.0	91 %	60 - 140 %
o-Terphenyl	2.2	1.2	54 % m	60 - 140 %

m = Surrogate recovery outside recommended limits due to sample matrix interference. BRL = Below Reporting Limit. * = Reported concentration excludes targeted Polynuclear Aromatic Hydrocarbon analytes. Calculations based on dry sample weight. Method Reference: Method 8100 (Modified) - Polynuclear Aromatic Hydrocarbons, Test Methods for Evaluating Solid Waste, US EPA SW-846, Third Edition (1986). Modified in accordance with the Method for the Determination of Extractable Petroleum Hydrocarbons, MA DEP, Public Comment Draft 1.0 (1995).

GROUNDWATER ANALYTICAL

EPA METHOD 8015 (MA DEP Modified)
Volatile Petroleum Hydrocarbons (GC/PID/FID)

Field ID:	**MXBD4B28**	Lab ID:	**13685-04**
Project:	**Devens/ESPS Task 7 (DV5)**	Batch ID:	**VG1-0039-E**
Client:	**ABB**	Sampled:	**06-27-96**
Cont/Prsv:	**125mL VOA Vial/Methanol Cool**	Received:	**06-27-96**
Matrix:	**Soil** Percent Moisture **12 %**	Analyzed:	**07-02-96**

Volatile Petroleum Hydrocarbons

PARAMETER	CONCENTRATION (ug/Kg)	TOXICITY MULTIPLIER	EQUIVALENT CONCENTRATION (ug/Kg)	ADJUSTED REPORTING LIMIT (ug/Kg)
n-C 5 to n-C 8 Aliphatics *	BRL	0.5	BRL	130
n-C 9 to n-C 12 Aliphatics	BRL	0.05	BRL	13
n-C 9 to n-C 10 Aromatics	BRL	1.0	BRL	250
Volatile Petroleum Hydrocarbons (VPH)			**BRL**	**13**

Targeted Volatile Organic Analytes

PARAMETER	CONCENTRATION (ug/Kg)	REPORTING LIMIT (ug/Kg)
Methyl *tert*-butyl Ether	BRL	250
Benzene	BRL	50
Toluene	BRL	50
Ethylbenzene	BRL	50
meta- and *para*-Xylene	BRL	50
ortho-Xylene	BRL	50
Naphthalene	BRL	250

QC SURROGATE COMPOUND	SPIKED	MEASURED	RECOVERY	QC LIMITS
2,5-Dibromotoluene	2,500	2,500	99 %	60 - 140 %

BRL = Below Reporting Limit. * = Reported concentration excludes targeted Volatile Organic analytes. Calculations based on dry sample weight. Method Reference: Method 8015 (Modified) - Nonhalogenated Volatile Organics by Gas Chromatography, Test Methods for Evaluating Solid Waste, US EPA SW-846, Third Edition (1986). Modified in accordance with the Method for the Determination of Volatile Petroleum Hydrocarbons, MA DEP, Public Comment Draft 1.0 (1995).

GROUNDWATER ANALYTICAL

EPA METHOD 8100 (MA DEP Modified)
Extractable Petroleum Hydrocarbons (GC/FID)

Field ID:	**MXBD0525**	Lab ID:	**13685-01**
Project:	**Devens/ESPS Task 7 (DV5)**	Batch ID:	**EP-0142-M**
Client:	**ABB**	Sampled:	**06-27-96**
Cont/Prsv:	**250mL Glass/Cool**	Received:	**06-27-96**
Matrix:	**Soil** Percent Moisture: **9 %**	Extracted:	**07-03-96**
		Analyzed:	**07-12-96**

Extractable Petroleum Hydrocarbons

PARAMETER	CONCENTRATION (mg/Kg)	TOXICITY MULTIPLIER	EQUIVALENT CONCENTRATION (mg/Kg)	ADJUSTED REPORTING LIMIT (mg/Kg)
n-C 9 to n-C 18 Aliphatics	BRL	0.05	BRL	1.6
n-C 19 to n-C 36 Aliphatics	BRL	0.005	BRL	0.16
n-C 10 to n-C 22 Aromatics *	BRL	1.0	BRL	31
Extractable Petroleum Hydrocarbons (EPH)			**BRL**	**0.16**

Targeted Polynuclear Aromatic Hydrocarbon Analytes

PARAMETER	CONCENTRATION (mg/Kg)	REPORTING LIMIT (mg/Kg)
Naphthalene	BRL	0.52
2-Methylnaphthalene	BRL	0.52
Acenaphthylene	BRL	0.52
Acenaphthene	BRL	0.52
Fluorene	BRL	0.52
Phenanthrene	BRL	0.52
Anthracene	BRL	0.52
Fluoranthene	BRL	0.52
Pyrene	BRL	0.52
Benzo(a)anthracene	BRL	0.52
Chrysene	BRL	0.52
Benzo(b)fluoranthene	BRL	0.52
Benzo(k)fluoranthene	BRL	0.52
Benzo(a)pyrene	BRL	0.52
Indeno(1,2,3-c,d)pyrene	BRL	0.52
Dibenzo(a,h)anthracene	BRL	0.52
Benzo(g,h,i)perylene	BRL	0.52

QC SURROGATE COMPOUND	SPIKED	MEASURED	RECOVERY	QC LIMITS
Chloro-octadecane	2.1	1.8	85 %	60 - 140 %
o-Terphenyl	2.1	1.2	58 % m	60 - 140 %

m = Surrogate recovery outside recommended limits due to sample matrix interference. BRL = Below Reporting Limit. * = Reported concentration excludes targeted Polynuclear Aromatic Hydrocarbon analytes. Calculations based on dry sample weight. Method Reference: Method 8100 (Modified) - Polynuclear Aromatic Hydrocarbons, Test Methods for Evaluating Solid Waste, US EPA SW-846, Third Edition (1986). Modified in accordance with the Method for the Determination of Extractable Petroleum Hydrocarbons, MA DEP, Public Comment Draft 1.0 (1995).

GROUNDWATER ANALYTICAL

EPA METHOD 8015 (MA DEP Modified)
Volatile Petroleum Hydrocarbons (GC/PID/FID)

Field ID:	**MXBD0525**	Lab ID:	**13685-02**
Project:	**Devens/ESPS Task 7 (DV5)**	Batch ID:	**VG1-0039-E**
Client:	**ABB**	Sampled:	**06-27-96**
Cont/Prsv:	**125mL VOA Vial/Methanol Cool**	Received:	**06-27-96**
Matrix:	**Soil** Percent Moisture **9 %**	Analyzed:	**07-02-96**

Volatile Petroleum Hydrocarbons

PARAMETER	CONCENTRATION (ug/Kg)	TOXICITY MULTIPLIER	EQUIVALENT CONCENTRATION (ug/Kg)	ADJUSTED REPORTING LIMIT (ug/Kg)
n-C 5 to n-C 8 Aliphatics *	BRL	0.5	BRL	130
n-C 9 to n-C 12 Aliphatics	BRL	0.05	BRL	13
n-C 9 to n-C 10 Aromatics	BRL	1.0	BRL	250
Volatile Petroleum Hydrocarbons (VPH)			**BRL**	**13**

Targeted Volatile Organic Analytes

PARAMETER	CONCENTRATION (ug/Kg)	REPORTING LIMIT (ug/Kg)
Methyl *tert*-butyl Ether	BRL	250
Benzene	BRL	50
Toluene	BRL	50
Ethylbenzene	BRL	50
meta- and *para*-Xylene	BRL	50
ortho-Xylene	BRL	50
Naphthalene	BRL	250

QC SURROGATE COMPOUND	SPIKED	MEASURED	RECOVERY	QC LIMITS
2,5-Dibromotoluene	2,500	2,500	99 %	60 - 140 %

BRL = Below Reporting Limit. * = Reported concentration excludes targeted Volatile Organic analytes. Calculations based on dry sample weight. Method Reference: Method 8015 (Modified) - Nonhalogenated Volatile Organics by Gas Chromatography, Test Methods for Evaluating Solid Waste, US EPA SW-846, Third Edition (1986). Modified in accordance with the Method for the Determination of Volatile Petroleum Hydrocarbons, MA DEP, Public Comment Draft 1.0 (1995).

GROUNDWATER ANALYTICAL

EPA METHOD 8100 (MA DEP Modified)
Extractable Petroleum Hydrocarbons (GC/FID)

Field ID:	**MX1601X1**	Lab ID:	**13960-02**
Project:	**Devens/ESPS Task 7 (DV5)**	Batch ID:	**EP-0123-F**
Client:	**ABB**	Sampled:	**07-30-96**
Cont/Prsv:	**1L Glass/Cool H2SO4**	Received:	**07-30-96**
Matrix:	**Aqueous**	Extracted:	**08-06-96**
		Analyzed:	**08-09-96**

Extractable Petroleum Hydrocarbons

PARAMETER	CONCENTRATION (ug/L)	TOXICITY MULTIPLIER	EQUIVALENT CONCENTRATION (ug/L)	ADJUSTED REPORTING LIMIT (ug/L)
n-C 9 to n-C 18 Aliphatics	BRL	0.05	BRL	25
n-C 19 to n-C 36 Aliphatics	BRL	0.005	BRL	2.5
n-C 10 to n-C 22 Aromatics *	BRL	1.0	BRL	500
Extractable Petroleum Hydrocarbons (EPH)			**BRL**	**2.5**

Targeted Polynuclear Aromatic Hydrocarbon Analytes

PARAMETER	CONCENTRATION (ug/L)	REPORTING LIMIT (ug/L)
Naphthalene	BRL	10
2-Methylnaphthalene	BRL	10
Acenaphthylene	BRL	10
Acenaphthene	BRL	10
Fluorene	BRL	10
Phenanthrene	BRL	10
Anthracene	BRL	10
Fluoranthene	BRL	10
Pyrene	BRL	10
Benzo(a)anthracene	BRL	10
Chrysene	BRL	10
Benzo(b)fluoranthene	BRL	10
Benzo(k)fluoranthene	BRL	10
Benzo(a)pyrene	BRL	10
Indeno(1,2,3-c,d)pyrene	BRL	10
Dibenzo(a,h)anthracene	BRL	10
Benzo(g,h,i)perylene	BRL	10

QC SURROGATE COMPOUND	SPIKED	MEASURED	RECOVERY	QC LIMITS
Chloro-octadecane	20	16	82 %	60 - 140 %
o-Terphenyl	20	17	84 %	60 - 140 %

BRL = Below Reporting Limit. * = Reported concentration excludes targeted Polynuclear Aromatic Hydrocarbon analytes. Method Reference: Method 8100 (Modified) - Polynuclear Aromatic Hydrocarbons, Test Methods for Evaluating Solid Waste, US EPA SW-846, Third Edition (1986). Modified in accordance with the Method for the Determination of Extractable Petroleum Hydrocarbons, MA DEP, Public Comment Draft 1.0 (1995).

GROUNDWATER ANALYTICAL

EPA METHOD 8015 (MA DEP Modified)
Volatile Petroleum Hydrocarbons (GC/PID/FID)

Field ID:	**MX1601X1**	Lab ID:	**13960-08**
Project:	**Devens/ESPS Task 7 (DV5)**	Batch ID:	**VG1-0049-W**
Client:	**ABB**	Sampled:	**07-30-96**
Cont/Prsv:	**40mL VOA Vial/Cool HCl**	Received:	**07-30-96**
Matrix:	**Aqueous**	Analyzed:	**08-05-96**

Volatile Petroleum Hydrocarbons

PARAMETER	CONCENTRATION (ug/L)	TOXICITY MULTIPLIER	EQUIVALENT CONCENTRATION (ug/L)	ADJUSTED REPORTING LIMIT (ug/L)
n-C 5 to n-C 8 Aliphatics *	BRL	0.5	BRL	2.5
n-C 9 to n-C 12 Aliphatics	BRL	0.05	BRL	0.25
n-C 9 to n-C 10 Aromatics	BRL	1.0	BRL	5.0
Volatile Petroleum Hydrocarbons (VPH)			**BRL**	**0.25**

Targeted Volatile Organic Analytes

PARAMETER	CONCENTRATION (ug/L)	REPORTING LIMIT (ug/L)
Methyl *tert*-butyl Ether	BRL	25
Benzene	BRL	5
Toluene	BRL	5
Ethylbenzene	BRL	5
meta- and *para*-Xylene	BRL	5
ortho-Xylene	BRL	5
Naphthalene	BRL	10

QC SURROGATE COMPOUND	SPIKED	MEASURED	RECOVERY	QC LIMITS
2,5-Dibromotoluene	50	41	82 %	60 - 140 %

BRL = Below Reporting Limit. * = Reported concentration excludes targeted Volatile Organic analytes. Method Reference: Method 8015 (Modified) - Nonhalogenated Volatile Organics by Gas Chromatography, Test Methods for Evaluating Solid Waste, US EPA SW-846, Third Edition (1986). Modified in accordance with the Method for the Determination of Volatile Petroleum Hydrocarbons, MA DEP, Public Comment Draft 1.0 (1995).

GROUNDWATER ANALYTICAL

EPA METHOD 8015 (MA DEP Modified)
Volatile Petroleum Hydrocarbons (GC/PID/FID)

Field ID:	**MX1602X1**	Lab ID:	**13960-09**
Project:	**Devens/ESPS Task 7 (DV5)**	Batch ID:	**VG1-0053-W**
Client:	**ABB**	Sampled:	**07-30-96**
Cont/Prsv:	**40mL VOA Vial/Cool HCl**	Received:	**07-30-96**
Matrix:	**Aqueous**	Analyzed:	**08-07-96**

Volatile Petroleum Hydrocarbons

PARAMETER	CONCENTRATION (ug/L)	TOXICITY MULTIPLIER	EQUIVALENT CONCENTRATION (ug/L)	ADJUSTED REPORTING LIMIT (ug/L)
n-C 5 to n-C 8 Aliphatics *	BRL	0.5	BRL	130
n-C 9 to n-C 12 Aliphatics	19,000	0.05	950	13
n-C 9 to n-C 10 Aromatics	5,400	1.0	5,400	250
Volatile Petroleum Hydrocarbons (VPH)			**6,400**	**13**

Targeted Volatile Organic Analytes

PARAMETER	CONCENTRATION (ug/L)	REPORTING LIMIT (ug/L)
Methyl *tert*-butyl Ether	BRL	1,250
Benzene	BRL	250
Toluene	BRL	250
Ethylbenzene	BRL	250
meta- and *para*-Xylene	BRL	250
ortho-Xylene	BRL	250
Naphthalene	BRL	500

QC SURROGATE COMPOUND	SPIKED	MEASURED	RECOVERY	QC LIMITS
2,5-Dibromotoluene	2,500	2,600	104 %	60 - 140 %

Elevated reporting limit due to required sample dilution. BRL = Below Reporting Limit. * = Reported concentration excludes targeted Volatile Organic analytes. Method Reference: Method 8015 (Modified) - Nonhalogenated Volatile Organics by Gas Chromatography, Test Methods for Evaluating Solid Waste, US EPA SW-846, Third Edition (1986). Modified in accordance with the Method for the Determination of Volatile Petroleum Hydrocarbons, MA DEP, Public Comment Draft 1.0 (1995).

GROUNDWATER ANALYTICAL

EPA METHOD 8100 (MA DEP Modified)
Extractable Petroleum Hydrocarbons (GC/FID)

Field ID:	**MX1602X1**	Lab ID:	**13960-03**
Project:	**Devens/ESPS Task 7 (DV5)**	Batch ID:	**EP-0123-F**
Client:	**ABB**	Sampled:	**07-30-96**
Cont/Prsv:	**1L Glass/Cool H2SO4**	Received:	**07-30-96**
Matrix:	**Aqueous**	Extracted:	**08-06-96**
		Analyzed:	**08-09-96**

Extractable Petroleum Hydrocarbons

PARAMETER	CONCENTRATION (ug/L)	TOXICITY MULTIPLIER	EQUIVALENT CONCENTRATION (ug/L)	ADJUSTED REPORTING LIMIT (ug/L)
n-C 9 to n-C 18 Aliphatics	75,000	0.05	3,800	250
n-C 19 to n-C 36 Aliphatics	9,100	0.005	45	25
n-C 10 to n-C 22 Aromatics *	10,000	1.0	10,000	2,500
Extractable Petroleum Hydrocarbons (EPH)			**14,000**	**25**

Targeted Polynuclear Aromatic Hydrocarbon Analytes

PARAMETER	CONCENTRATION (ug/L)	REPORTING LIMIT (ug/L)
Naphthalene	100	50
2-Methylnaphthalene	460	50
Acenaphthylene	BRL	50
Acenaphthene	110	50
Fluorene	62	50
Phenanthrene	64	50
Anthracene	BRL	50
Fluoranthene	BRL	50
Pyrene	BRL	50
Benzo(a)anthracene	BRL	50
Chrysene	BRL	50
Benzo(b)fluoranthene	BRL	50
Benzo(k)fluoranthene	BRL	50
Benzo(a)pyrene	BRL	50
Indeno(1,2,3-c,d)pyrene	BRL	50
Dibenzo(a,h)anthracene	BRL	50
Benzo(g,h,i)perylene	BRL	50

QC SURROGATE COMPOUND	SPIKED	MEASURED	RECOVERY	QC LIMITS
Chloro-octadecane	20	d	N/A	60 - 140 %
o-Terphenyl	20	25	125 %	60 - 140 %

d = Surrogate recovery outside recommended limits due to required sample dilution. Elevated reporting limit due to required sample dilution. BRL = Below Reporting Limit. * = Reported concentration excludes targeted Polynuclear Aromatic Hydrocarbon analytes. Method Reference: Method 8100 (Modified) - Polynuclear Aromatic Hydrocarbons, Test Methods for Evaluating Solid Waste, US EPA SW-846, Third Edition (1986). Modified in accordance with the Method for the Determination of Extractable Petroleum Hydrocarbons, MA DEP, Public Comment Draft 1.0 (1995).

GROUNDWATER ANALYTICAL

EPA METHOD 8100 (MA DEP Modified)
Extractable Petroleum Hydrocarbons (GC/FID)

Field ID:	**MXBD01X1**	Lab ID:	**13960-04**
Project:	**Devens/ESPS Task 7 (DV5)**	Batch ID:	**EP-0123-F**
Client:	**ABB**	Sampled:	**07-30-96**
Cont/Prsv:	**1L Glass/Cool H2SO4**	Received:	**07-30-96**
Matrix:	**Aqueous**	Extracted:	**08-06-96**
		Analyzed:	**08-09-96**

Extractable Petroleum Hydrocarbons

PARAMETER	CONCENTRATION (ug/L)	TOXICITY MULTIPLIER	EQUIVALENT CONCENTRATION (ug/L)	ADJUSTED REPORTING LIMIT (ug/L)
n-C 9 to n-C 18 Aliphatics	BRL	0.05	BRL	25
n-C 19 to n-C 36 Aliphatics	BRL	0.005	BRL	2.5
n-C 10 to n-C 22 Aromatics *	BRL	1.0	BRL	500
Extractable Petroleum Hydrocarbons (EPH)			**BRL**	**2.5**

Targeted Polynuclear Aromatic Hydrocarbon Analytes

PARAMETER	CONCENTRATION (ug/L)	REPORTING LIMIT (ug/L)
Naphthalene	BRL	10
2-Methylnaphthalene	BRL	10
Acenaphthylene	BRL	10
Acenaphthene	BRL	10
Fluorene	BRL	10
Phenanthrene	BRL	10
Anthracene	BRL	10
Fluoranthene	BRL	10
Pyrene	BRL	10
Benzo(a)anthracene	BRL	10
Chrysene	BRL	10
Benzo(b)fluoranthene	BRL	10
Benzo(k)fluoranthene	BRL	10
Benzo(a)pyrene	BRL	10
Indeno(1,2,3-c,d)pyrene	BRL	10
Dibenzo(a,h)anthracene	BRL	10
Benzo(g,h,i)perylene	BRL	10

QC SURROGATE COMPOUND	SPIKED	MEASURED	RECOVERY	QC LIMITS
Chloro-octadecane	20	17	83 %	60 - 140 %
o-Terphenyl	20	19	95 %	60 - 140 %

BRL = Below Reporting Limit. * = Reported concentration excludes targeted Polynuclear Aromatic Hydrocarbon analytes. Method Reference: Method 8100 (Modified) - Polynuclear Aromatic Hydrocarbons, Test Methods for Evaluating Solid Waste, US EPA SW-846, Third Edition (1986). Modified in accordance with the Method for the Determination of Extractable Petroleum Hydrocarbons, MA DEP, Public Comment Draft 1.0 (1995).

GROUNDWATER ANALYTICAL

EPA METHOD 8015 (MA DEP Modified)
Volatile Petroleum Hydrocarbons (GC/PID/FID)

Field ID:	**MXBD01X1**	Lab ID:	**13960-10**
Project:	**Devens/ESPS Task 7 (DV5)**	Batch ID:	**VG1-0049-W**
Client:	**ABB**	Sampled:	**07-30-96**
Cont/Prsv:	**40mL VOA Vial/Cool HCl**	Received:	**07-30-96**
Matrix:	**Aqueous**	Analyzed:	**08-05-96**

Volatile Petroleum Hydrocarbons

PARAMETER	CONCENTRATION (ug/L)	TOXICITY MULTIPLIER	EQUIVALENT CONCENTRATION (ug/L)	ADJUSTED REPORTING LIMIT (ug/L)
n-C 5 to n-C 8 Aliphatics *	BRL	0.5	BRL	2.5
n-C 9 to n-C 12 Aliphatics	BRL	0.05	BRL	0.25
n-C 9 to n-C 10 Aromatics	BRL	1.0	BRL	5
Volatile Petroleum Hydrocarbons (VPH)			**BRL**	**0.25**

Targeted Volatile Organic Analytes

PARAMETER	CONCENTRATION (ug/L)	REPORTING LIMIT (ug/L)
Methyl *tert*-butyl Ether	BRL	25
Benzene	BRL	5
Toluene	BRL	5
Ethylbenzene	BRL	5
meta- and *para*-Xylene	BRL	5
ortho-Xylene	BRL	5
Naphthalene	BRL	10

QC SURROGATE COMPOUND	SPIKED	MEASURED	RECOVERY	QC LIMITS
2,5-Dibromotoluene	50	48	97 %	60 - 140 %

BRL = Below Reporting Limit. * = Reported concentration excludes targeted Volatile Organic analytes. Method Reference: Method 8015 (Modified) - Nonhalogenated Volatile Organics by Gas Chromatography, Test Methods for Evaluating Solid Waste, US EPA SW-846, Third Edition (1986). Modified in accordance with the Method for the Determination of Volatile Petroleum Hydrocarbons, MA DEP, Public Comment Draft 1.0 (1995).

GROUNDWATER ANALYTICAL

EPA METHOD 8100 (MA DEP Modified)
Extractable Petroleum Hydrocarbons (GC/FID)

Field ID:	**MDBD01X1**	Lab ID:	**13960-01**
Project:	**Devens/ESPS Task 7 (DV5)**	Batch ID:	**EP-0123-F**
Client:	**ABB**	Sampled:	**07-30-96**
Cont/Prsv:	**1L Glass/Cool H2SO4**	Received:	**07-30-96**
Matrix:	**Aqueous**	Extracted:	**08-06-96**
		Analyzed:	**08-09-96**

Extractable Petroleum Hydrocarbons

PARAMETER	CONCENTRATION (ug/L)	TOXICITY MULTIPLIER	EQUIVALENT CONCENTRATION (ug/L)	ADJUSTED REPORTING LIMIT (ug/L)
n-C 9 to n-C 18 Aliphatics	BRL	0.05	BRL	25
n-C 19 to n-C 36 Aliphatics	BRL	0.005	BRL	2.5
n-C 10 to n-C 22 Aromatics *	BRL	1.0	BRL	500
Extractable Petroleum Hydrocarbons (EPH)			**BRL**	**2.5**

Targeted Polynuclear Aromatic Hydrocarbon Analytes

PARAMETER	CONCENTRATION (ug/L)	REPORTING LIMIT (ug/L)
Naphthalene	BRL	10
2-Methylnaphthalene	BRL	10
Acenaphthylene	BRL	10
Acenaphthene	BRL	10
Fluorene	BRL	10
Phenanthrene	BRL	10
Anthracene	BRL	10
Fluoranthene	BRL	10
Pyrene	BRL	10
Benzo(a)anthracene	BRL	10
Chrysene	BRL	10
Benzo(b)fluoranthene	BRL	10
Benzo(k)fluoranthene	BRL	10
Benzo(a)pyrene	BRL	10
Indeno(1,2,3-c,d)pyrene	BRL	10
Dibenzo(a,h)anthracene	BRL	10
Benzo(g,h,i)perylene	BRL	10

QC SURROGATE COMPOUND	SPIKED	MEASURED	RECOVERY	QC LIMITS
Chloro-octadecane	20	16	80 %	60 - 140 %
o-Terphenyl	20	17	84 %	60 - 140 %

BRL = Below Reporting Limit. * = Reported concentration excludes targeted Polynuclear Aromatic Hydrocarbon analytes. Method Reference: Method 8100 (Modified) - Polynuclear Aromatic Hydrocarbons, Test Methods for Evaluating Solid Waste, US EPA SW-846, Third Edition (1986). Modified in accordance with the Method for the Determination of Extractable Petroleum Hydrocarbons, MA DEP, Public Comment Draft 1.0 (1995).

GROUNDWATER ANALYTICAL

EPA METHOD 8015 (MA DEP Modified)
Volatile Petroleum Hydrocarbons (GC/PID/FID)

Field ID:	**MDBD01X1**	Lab ID:	**13960-07**
Project:	**Devens/ESPS Task 7 (DV5)**	Batch ID:	**VG1-0049-W**
Client:	**ABB**	Sampled:	**07-30-96**
Cont/Prsv:	**40mL VOA Vial/Cool HCl**	Received:	**07-30-96**
Matrix:	**Aqueous**	Analyzed:	**08-05-96**

Volatile Petroleum Hydrocarbons

PARAMETER	CONCENTRATION (ug/L)	TOXICITY MULTIPLIER	EQUIVALENT CONCENTRATION (ug/L)	ADJUSTED REPORTING LIMIT (ug/L)
n-C 5 to n-C 8 Aliphatics *	BRL	0.5	BRL	2.5
n-C 9 to n-C 12 Aliphatics	BRL	0.05	BRL	0.25
n-C 9 to n-C 10 Aromatics	BRL	1.0	BRL	5.0
Volatile Petroleum Hydrocarbons (VPH)			**BRL**	**0.25**

Targeted Volatile Organic Analytes

PARAMETER	CONCENTRATION (ug/L)	REPORTING LIMIT (ug/L)
Methyl *tert*-butyl Ether	BRL	25
Benzene	BRL	5
Toluene	BRL	5
Ethylbenzene	BRL	5
meta- and *para*-Xylene	BRL	5
ortho-Xylene	BRL	5
Naphthalene	BRL	10

QC SURROGATE COMPOUND	SPIKED	MEASURED	RECOVERY	QC LIMITS
2,5-Dibromotoluene	50	41	83 %	60 - 140 %

BRL = Below Reporting Limit. * = Reported concentration excludes targeted Volatile Organic analytes. Method Reference: Method 8015 (Modified) - Nonhalogenated Volatile Organics by Gas Chromatography, Test Methods for Evaluating Solid Waste, US EPA SW-846, Third Edition (1986). Modified in accordance with the Method for the Determination of Volatile Petroleum Hydrocarbons, MA DEP, Public Comment Draft 1.0 (1995).

GROUNDWATER ANALYTICAL

EPA METHOD 8015 (MA DEP Modified)
Volatile Petroleum Hydrocarbons (GC/PID/FID)

Field ID:	**MXBD02X1**	Lab ID:	**13960-11**
Project:	**Devens/ESPS Task 7 (DV5)**	Batch ID:	**VG1-0049-W**
Client:	**ABB**	Sampled:	**07-30-96**
Cont/Prsv:	**40mL VOA Vial/Cool HCl**	Received:	**07-30-96**
Matrix:	**Aqueous**	Analyzed:	**08-05-96**

Volatile Petroleum Hydrocarbons

PARAMETER	CONCENTRATION (ug/L)	TOXICITY MULTIPLIER	EQUIVALENT CONCENTRATION (ug/L)	ADJUSTED REPORTING LIMIT (ug/L)
n-C 5 to n-C 8 Aliphatics *	BRL	0.5	BRL	2.5
n-C 9 to n-C 12 Aliphatics	BRL	0.05	BRL	0.25
n-C 9 to n-C 10 Aromatics	BRL	1.0	BRL	5
Volatile Petroleum Hydrocarbons (VPH)			**BRL**	**0.25**

Targeted Volatile Organic Analytes

PARAMETER	CONCENTRATION (ug/L)	REPORTING LIMIT (ug/L)
Methyl *tert*-butyl Ether	BRL	25
Benzene	BRL	5
Toluene	BRL	5
Ethylbenzene	BRL	5
meta- and *para*-Xylene	BRL	5
ortho-Xylene	BRL	5
Naphthalene	BRL	10

QC SURROGATE COMPOUND	SPIKED	MEASURED	RECOVERY	QC LIMITS
2,5-Dibromotoluene	50	50	99 %	60 - 140 %

BRL = Below Reporting Limit. * = Reported concentration excludes targeted Volatile Organic analytes. Method Reference: Method 8015 (Modified) - Nonhalogenated Volatile Organics by Gas Chromatography, Test Methods for Evaluating Solid Waste, US EPA SW-846, Third Edition (1986). Modified in accordance with the Method for the Determination of Volatile Petroleum Hydrocarbons, MA DEP, Public Comment Draft 1.0 (1995).

GROUNDWATER ANALYTICAL

EPA METHOD 8100 (MA DEP Modified)
Extractable Petroleum Hydrocarbons (GC/FID)

Field ID:	**MXBD02X1**	Lab ID:	**13960-05**
Project:	**Devens/ESPS Task 7 (DV5)**	Batch ID:	**EP-0123-F**
Client:	**ABB**	Sampled:	**07-30-96**
Cont/Prsv:	**1L Glass/Cool H2SO4**	Received:	**07-30-96**
Matrix:	**Aqueous**	Extracted:	**08-06-96**
		Analyzed:	**08-09-96**

Extractable Petroleum Hydrocarbons

PARAMETER	CONCENTRATION (ug/L)	TOXICITY MULTIPLIER	EQUIVALENT CONCENTRATION (ug/L)	ADJUSTED REPORTING LIMIT (ug/L)
n-C 9 to n-C 18 Aliphatics	BRL	0.05	BRL	25
n-C 19 to n-C 36 Aliphatics	1,700	0.005	8.3	2.5
n-C 10 to n-C 22 Aromatics *	BRL	1.0	BRL	500
Extractable Petroleum Hydrocarbons (EPH)			**8.3**	**2.5**

Targeted Polynuclear Aromatic Hydrocarbon Analytes

PARAMETER	CONCENTRATION (ug/L)	REPORTING LIMIT (ug/L)
Naphthalene	BRL	10
2-Methylnaphthalene	BRL	10
Acenaphthylene	BRL	10
Acenaphthene	BRL	10
Fluorene	BRL	10
Phenanthrene	BRL	10
Anthracene	BRL	10
Fluoranthene	BRL	10
Pyrene	BRL	10
Benzo(a)anthracene	BRL	10
Chrysene	BRL	10
Benzo(b)fluoranthene	BRL	10
Benzo(k)fluoranthene	BRL	10
Benzo(a)pyrene	BRL	10
Indeno(1,2,3-c,d)pyrene	BRL	10
Dibenzo(a,h)anthracene	BRL	10
Benzo(g,h,i)perylene	BRL	10

QC SURROGATE COMPOUND	SPIKED	MEASURED	RECOVERY	QC LIMITS
Chloro-octadecane	20	17	86 %	60 - 140 %
o-Terphenyl	20	18	90 %	60 - 140 %

BRL = Below Reporting Limit. * = Reported concentration excludes targeted Polynuclear Aromatic Hydrocarbon analytes. Method Reference: Method 8100 (Modified) - Polynuclear Aromatic Hydrocarbons, Test Methods for Evaluating Solid Waste, US EPA SW-846, Third Edition (1986). Modified in accordance with the Method for the Determination of Extractable Petroleum Hydrocarbons, MA DEP, Public Comment Draft 1.0 (1995).

GROUNDWATER ANALYTICAL

EPA METHOD 8015 (MA DEP Modified)
Volatile Petroleum Hydrocarbons (GC/PID/FID)

Field ID:	**MXBD03X1**	Lab ID:	**13960-12**
Project:	**Devens/ESPS Task 7 (DV5)**	Batch ID:	**VG1-0050-W**
Client:	**ABB**	Sampled:	**07-30-96**
Cont/Prsv:	**40mL VOA Vial/Cool HCl**	Received:	**07-30-96**
Matrix:	**Aqueous**	Analyzed:	**08-06-96**

Volatile Petroleum Hydrocarbons

PARAMETER	CONCENTRATION (ug/L)	TOXICITY MULTIPLIER	EQUIVALENT CONCENTRATION (ug/L)	ADJUSTED REPORTING LIMIT (ug/L)
n-C 5 to n-C 8 Aliphatics *	BRL	0.5	BRL	2.5
n-C 9 to n-C 12 Aliphatics	BRL	0.05	BRL	0.25
n-C 9 to n-C 10 Aromatics	BRL	1.0	BRL	5
Volatile Petroleum Hydrocarbons (VPH)			**BRL**	**0.25**

Targeted Volatile Organic Analytes

PARAMETER	CONCENTRATION (ug/L)	REPORTING LIMIT (ug/L)
Methyl *tert*-butyl Ether	BRL	25
Benzene	BRL	5
Toluene	BRL	5
Ethylbenzene	BRL	5
meta- and *para*-Xylene	BRL	5
ortho-Xylene	BRL	5
Naphthalene	BRL	10

QC SURROGATE COMPOUND	SPIKED	MEASURED	RECOVERY	QC LIMITS
2,5-Dibromotoluene	50	55	111 %	60 - 140 %

BRL = Below Reporting Limit. * = Reported concentration excludes targeted Volatile Organic analytes. Method Reference: Method 8015 (Modified) - Nonhalogenated Volatile Organics by Gas Chromatography, Test Methods for Evaluating Solid Waste, US EPA SW-846, Third Edition (1986). Modified in accordance with the Method for the Determination of Volatile Petroleum Hydrocarbons, MA DEP, Public Comment Draft 1.0 (1995).

GROUNDWATER ANALYTICAL

EPA METHOD 8100 (MA DEP Modified)
Extractable Petroleum Hydrocarbons (GC/FID)

Field ID:	**MXBD03X1**	Lab ID:	**13960-06**
Project:	**Devens/ESPS Task 7 (DV5)**	Batch ID:	**EP-0123-F**
Client:	**ABB**	Sampled:	**07-30-96**
Cont/Prsv:	**1L Glass/Cool H2SO4**	Received:	**07-30-96**
Matrix:	**Aqueous**	Extracted:	**08-06-96**
		Analyzed:	**08-09-96**

Extractable Petroleum Hydrocarbons

PARAMETER	CONCENTRATION (ug/L)	TOXICITY MULTIPLIER	EQUIVALENT CONCENTRATION (ug/L)	ADJUSTED REPORTING LIMIT (ug/L)
n-C 9 to n-C 18 Aliphatics	890	0.05	44	25
n-C 19 to n-C 36 Aliphatics	2,900	0.005	14	2.5
n-C 10 to n-C 22 Aromatics *	BRL	1.0	BRL	500
Extractable Petroleum Hydrocarbons (EPH)			**58**	**2.5**

Targeted Polynuclear Aromatic Hydrocarbon Analytes

PARAMETER	CONCENTRATION (ug/L)	REPORTING LIMIT (ug/L)
Naphthalene	BRL	10
2-Methylnaphthalene	BRL	10
Acenaphthylene	BRL	10
Acenaphthene	BRL	10
Fluorene	BRL	10
Phenanthrene	BRL	10
Anthracene	BRL	10
Fluoranthene	BRL	10
Pyrene	BRL	10
Benzo(a)anthracene	BRL	10
Chrysene	BRL	10
Benzo(b)fluoranthene	BRL	10
Benzo(k)fluoranthene	BRL	10
Benzo(a)pyrene	BRL	10
Indeno(1,2,3-c,d)pyrene	BRL	10
Dibenzo(a,h)anthracene	BRL	10
Benzo(g,h,i)perylene	BRL	10

QC SURROGATE COMPOUND	SPIKED	MEASURED	RECOVERY	QC LIMITS
Chloro-octadecane	20	18	88 %	60 - 140 %
o-Terphenyl	20	17	83 %	60 - 140 %

BRL = Below Reporting Limit. * = Reported concentration excludes targeted Polynuclear Aromatic Hydrocarbon analytes. Method Reference: Method 8100 (Modified) - Polynuclear Aromatic Hydrocarbons, Test Methods for Evaluating Solid Waste, US EPA SW-846, Third Edition (1986). Modified in accordance with the Method for the Determination of Extractable Petroleum Hydrocarbons, MA DEP, Public Comment Draft 1.0 (1995).

GROUNDWATER ANALYTICAL

EPA METHOD 8100 (MA DEP Modified)
Extractable Petroleum Hydrocarbons (GC/FID)

Field ID:	**MXBD04B1**	Lab ID:	**13967-06**
Project:	**Devens/ESPS Task 7 (DV5)**	Batch ID:	**EP-0123-F**
Client:	**ABB**	Sampled:	**07-30-96**
Cont/Prsv:	**1L Glass/H2SO4 Cool**	Received:	**07-31-96**
Matrix:	**Aqueous**	Extracted:	**08-06-96**
		Analyzed:	**08-12-96**

Extractable Petroleum Hydrocarbons

PARAMETER	CONCENTRATION (ug/L)	TOXICITY MULTIPLIER	EQUIVALENT CONCENTRATION (ug/L)	ADJUSTED REPORTING LIMIT (ug/L)
n-C 9 to n-C 18 Aliphatics	BRL	0.05	BRL	25
n-C 19 to n-C 36 Aliphatics	BRL	0.005	BRL	2.5
n-C 10 to n-C 22 Aromatics *	BRL	1.0	BRL	500
Extractable Petroleum Hydrocarbons (EPH)			**BRL**	**2.5**

Targeted Polynuclear Aromatic Hydrocarbon Analytes

PARAMETER	CONCENTRATION (ug/L)	REPORTING LIMIT (ug/L)
Naphthalene	BRL	10
2-Methylnaphthalene	BRL	10
Acenaphthylene	BRL	10
Acenaphthene	BRL	10
Fluorene	BRL	10
Phenanthrene	BRL	10
Anthracene	BRL	10
Fluoranthene	BRL	10
Pyrene	BRL	10
Benzo(a)anthracene	BRL	10
Chrysene	BRL	10
Benzo(b)fluoranthene	BRL	10
Benzo(k)fluoranthene	BRL	10
Benzo(a)pyrene	BRL	10
Indeno(1,2,3-c,d)pyrene	BRL	10
Dibenzo(a,h)anthracene	BRL	10
Benzo(g,h,i)perylene	BRL	10

QC SURROGATE COMPOUND	SPIKED	MEASURED	RECOVERY	QC LIMITS
Chloro-octadecane	20	18	90 %	60 - 140 %
o-Terphenyl	20	19	94 %	60 - 140 %

BRL = Below Reporting Limit. * = Reported concentration excludes targeted Polynuclear Aromatic Hydrocarbon analytes. Method Reference: Method 8100 (Modified) - Polynuclear Aromatic Hydrocarbons, Test Methods for Evaluating Solid Waste, US EPA SW-846, Third Edition (1986). Modified in accordance with the Method for the Determination of Extractable Petroleum Hydrocarbons, MA DEP, Public Comment Draft 1.0 (1995).

GROUNDWATER ANALYTICAL

EPA METHOD 8015 (MA DEP Modified)
Volatile Petroleum Hydrocarbons (GC/PID/FID)

Field ID:	**MXBD04B1**	Lab ID:	**13967-14**
Project:	**Devens/ESPS Task 7 (DV5)**	Batch ID:	**VG1-0049-W**
Client:	**ABB**	Sampled:	**07-30-96**
Cont/Prsv:	**40mL VOA Vial/Cool HCl**	Received:	**07-31-96**
Matrix:	**Aqueous**	Analyzed:	**08-05-96**

Volatile Petroleum Hydrocarbons

PARAMETER	CONCENTRATION (ug/L)	TOXICITY MULTIPLIER	EQUIVALENT CONCENTRATION (ug/L)	ADJUSTED REPORTING LIMIT (ug/L)
n-C 5 to n-C 8 Aliphatics *	BRL	0.5	BRL	2.5
n-C 9 to n-C 12 Aliphatics	BRL	0.05	BRL	0.25
n-C 9 to n-C 10 Aromatics	BRL	1.0	BRL	5.0
Volatile Petroleum Hydrocarbons (VPH)			**BRL**	**0.25**

Targeted Volatile Organic Analytes

PARAMETER	CONCENTRATION (ug/L)	REPORTING LIMIT (ug/L)
Methyl *tert*-butyl Ether	BRL	25
Benzene	BRL	5
Toluene	BRL	5
Ethylbenzene	BRL	5
meta- and *para*-Xylene	BRL	5
ortho-Xylene	BRL	5
Naphthalene	BRL	10

QC SURROGATE COMPOUND	SPIKED	MEASURED	RECOVERY	QC LIMITS
2,5-Dibromotoluene	50	53	106 %	60 - 140 %

BRL = Below Reporting Limit. * = Reported concentration excludes targeted Volatile Organic analytes. Method Reference: Method 8015 (Modified) - Nonhalogenated Volatile Organics by Gas Chromatography, Test Methods for Evaluating Solid Waste, US EPA SW-846, Third Edition (1986). Modified in accordance with the Method for the Determination of Volatile Petroleum Hydrocarbons, MA DEP, Public Comment Draft 1.0 (1995).

GROUNDWATER ANALYTICAL

EPA METHOD 8100 (MA DEP Modified)
Extractable Petroleum Hydrocarbons (GC/FID)

Field ID:	**MXBD05X1**	Lab ID:	**13967-07**
Project:	**Devens/ESPS Task 7 (DV5)**	Batch ID:	**EP-0123-F**
Client:	**ABB**	Sampled:	**07-30-96**
Cont/Prsv:	**1L Glass/H2S04 Cool**	Received:	**07-31-96**
Matrix:	**Aqueous**	Extracted:	**08-06-96**
		Analyzed:	**08-12-96**

Extractable Petroleum Hydrocarbons

PARAMETER	CONCENTRATION (ug/L)	TOXICITY MULTIPLIER	EQUIVALENT CONCENTRATION (ug/L)	ADJUSTED REPORTING LIMIT (ug/L)
n-C 9 to n-C 18 Aliphatics	BRL	0.05	BRL	25
n-C 19 to n-C 36 Aliphatics	1,600	0.005	7.8	2.5
n-C 10 to n-C 22 Aromatics *	BRL	1.0	BRL	500
Extractable Petroleum Hydrocarbons (EPH)			**7.8**	**2.5**

Targeted Polynuclear Aromatic Hydrocarbon Analytes

PARAMETER	CONCENTRATION (ug/L)	REPORTING LIMIT (ug/L)
Naphthalene	BRL	10
2-Methylnaphthalene	BRL	10
Acenaphthylene	BRL	10
Acenaphthene	BRL	10
Fluorene	BRL	10
Phenanthrene	BRL	10
Anthracene	BRL	10
Fluoranthene	BRL	10
Pyrene	BRL	10
Benzo(a)anthracene	BRL	10
Chrysene	BRL	10
Benzo(b)fluoranthene	BRL	10
Benzo(k)fluoranthene	BRL	10
Benzo(a)pyrene	BRL	10
Indeno(1,2,3-c,d)pyrene	BRL	10
Dibenzo(a,h)anthracene	BRL	10
Benzo(g,h,i)perylene	BRL	10

QC SURROGATE COMPOUND	SPIKED	MEASURED	RECOVERY	QC LIMITS
Chloro-octadecane	20	12	60 %	60 - 140 %
o-Terphenyl	20	14	71 %	60 - 140 %

BRL = Below Reporting Limit. * = Reported concentration excludes targeted Polynuclear Aromatic Hydrocarbon analytes. Method Reference: Method 8100 (Modified) - Polynuclear Aromatic Hydrocarbons, Test Methods for Evaluating Solid Waste, US EPA SW-846, Third Edition (1986). Modified in accordance with the Method for the Determination of Extractable Petroleum Hydrocarbons, MA DEP, Public Comment Draft 1.0 (1995).

GROUNDWATER ANALYTICAL

EPA METHOD 8015 (MA DEP Modified)
Volatile Petroleum Hydrocarbons (GC/PID/FID)

Field ID:	**MXBDO5X1**	Lab ID:	**13967-15**
Project:	**Devens/ESPS Task 7 (DV5)**	Batch ID:	**VG1-0049-W**
Client:	**ABB**	Sampled:	**07-30-96**
Cont/Prsv:	**40mL VOA Vial/Cool HCl**	Received:	**07-31-96**
Matrix:	**Aqueous**	Analyzed:	**08-05-96**

Volatile Petroleum Hydrocarbons

PARAMETER	CONCENTRATION (ug/L)	TOXICITY MULTIPLIER	EQUIVALENT CONCENTRATION (ug/L)	ADJUSTED REPORTING LIMIT (ug/L)
n-C 5 to n-C 8 Aliphatics *	BRL	0.5	BRL	2.5
n-C 9 to n-C 12 Aliphatics	BRL	0.05	BRL	0.25
n-C 9 to n-C 10 Aromatics	BRL	1.0	BRL	5.0
Volatile Petroleum Hydrocarbons (VPH)			**BRL**	**0.25**

Targeted Volatile Organic Analytes

PARAMETER	CONCENTRATION (ug/L)	REPORTING LIMIT (ug/L)
Methyl *tert*-butyl Ether	BRL	25
Benzene	BRL	5
Toluene	BRL	5
Ethylbenzene	BRL	5
meta- and *para*-Xylene	BRL	5
ortho-Xylene	BRL	5
Naphthalene	BRL	10

QC SURROGATE COMPOUND	SPIKED	MEASURED	RECOVERY	QC LIMITS
2,5-Dibromotoluene	50	54	108 %	60 - 140 %

BRL = Below Reporting Limit. * = Reported concentration excludes targeted Volatile Organic analytes. Method Reference: Method 8015 (Modified) - Nonhalogenated Volatile Organics by Gas Chromatography, Test Methods for Evaluating Solid Waste, US EPA SW-846, Third Edition (1986). Modified in accordance with the Method for the Determination of Volatile Petroleum Hydrocarbons, MA DEP, Public Comment Draft 1.0 (1995).

APPENDIX E

VPH/EPH FIELD ANALYTICAL METHOD

PROJECT OPERATION PLAN ADDENDUM
1996 FIELD SCREENING METHODOLOGY
TARGET VOLATILE ORGANIC COMPOUNDS(VOCS)
ESTIMATION OF TOTAL VOLATILE PETROLEUM HYDROCARBONS(TVPH)
AND TOTAL EXTRACTABLE PETROLEUM HYDROCARBONS(TEPH)

1.0 Introduction

Field screening procedures for Fort Devens remedial investigations are described in Section 4.6 of the Fort Devens Project Operation Plan (POP) (ABB-ES, 1995). Modifications to some of these field screening procedures have been made for the 1996 field investigations. The purpose of this addendum is to outline modifications to field screening procedures that will be incorporated into the 1996 field program. Field screening gas chromatography (GC) procedures have been developed to provide on-site results for target volatile organics (VOCs) and estimates of total volatile petroleum hydrocarbons (TVPH) and extractable petroleum hydrocarbons (TEPH). The TVPH and TEPH measurements will provide an estimate of total hydrocarbons present in each fraction that are comparable to results generated using analytical methods developed by the Massachusetts Department of Environmental Protection (MADEP), however, TVPH and TEPH will be reported as a total concentration and not broken down into aliphatic and aromatic fractions as outlined in the MADEP methodology (MADEP, 1995). The purpose of the field analyses is to provide quick turnaround of analytical results for real time decision making during the field investigation.

A summary of the field methodologies instrumentation, sample preparation, instrument calibration, target compounds and detection limits, sample quantitation, and analytical quality control analyses are presented below.

2.0 Field Instrumentation and Analytical Methods

Investigations at AOC 50 are driven by the potential presence of fuel hydrocarbons including benzene, toluene, ethylbenzene, and xylene (BTEX), and solvents including tetrachloroethene (PCE) and the de-chlorination degradation products trichloroethene (TCE), cis-1,2-dichloroethene, trans-1,2-dichloroethene, and vinyl chloride in groundwater. Groundwater samples collected at AOC 50 will be analyzed using purge and trap Method 5030A and modified USEPA Method 8021A and modified USEPA Method 8015A (USEPA, 1995). As outlined in Method 8021A, BTEX compounds will be identified and quantified with a photoionization detector (PID) and the chlorinated solvents will be identified and quantified using an electrolytic conductivity detector (ELCD). As outlined in Method 8015, TVPH will be quantified using a Flame ionization detector (FID). Target compounds and reporting limits for AOC 50 groundwater samples are summarized in Table 1. For target compound analyses, analytical procedures for instrument calibration, sample identification, quality control blank analyses, and sample preparation will be

consistent with those outlined in the POP. TVPH procedures are described below in Subsection 2.2.

Investigations at AOCs 61Z and 63BD are driven by the potential presence of fuel hydrocarbons as a result of fuel oil and waste oil products releases to soil. Soil samples collected at AOCs 61Z and 63BD will be analyzed for BTEX, TVPH, and TEPH using a modified USEPA Method 8020A for BTEX, and modified USEPA Method 8015A for TVPH and TEPH. Soil samples analyzed for BTEX, and TVPH will be prepared using a methanol extraction as outlined in USEPA Method 5030A and the POP. Methanol extracts will be analyzed using purge and trap and GC/PID for BTEX, and purge and trap GC/FID for the TVPH. Soil samples analyzed for TEPH will be prepared using a methylene chloride micro-extraction technique and direct injection by GC/FID. A summary of target compounds and reporting limits for the soil analyses is presented in Table 1.

Laboratory techniques used for sample preparation for the TEPH method, and calibration and sample quantitation procedures for the TVPH and TEPH methods are outlined in the following sections.

2.1 TEPH Sample Preparation:

Sample analysis and preparation techniques have been adapted from protocols outlined in SW-846 3rd ed. USEPA Methods 3550A (USEPA 1995).

Soil Samples. Weigh 2 grams ($\pm$ 0.1 g) wet soil into a 12 ml screw cap test tube. Spike the sample mixture with appropriate concentration of surrogate solution. For MS/MSD samples the appropriate aliquot of spike solution is added to the sample. Add approximately 2 grams of anhydrous sodium sulfate, Na_2SO_4 (a drying agent) to the sample. With a Teflon spatula thoroughly mix the sample and sodium sulfate (break the sample up to form a uniform free flowing mixture). Add 10 mL of methylene chloride to the sample.

Shake or vortex vigorously for 3 minutes to mix and extract the sample. The field chemist will pay close attention to the sample extraction to ensure that the soil and solvent are actively mixing during the 3 minute extraction. Allow the sample to stand and separate or centrifuge the sample to separate the solvent phase. Withdraw a the extract solvent and transfer the sample extract to a sample vial and cap, sample in now ready for analysis.

Dilutions. If high concentrations of fuels are suspected, then samples should be analyzed prior to concentration, otherwise the extract can be diluted with methylene chloride to bring the target compound concentrations within the instrument calibration range. To dilute the sample, remove a measured quantity of extract and add to an appropriate volume of extraction solvent. The results of diluted samples will be adjusted for by the dilution factor.

2.2 TVPH and TEPH Instrument Calibration

Initial and continuing calibration will be established for TVPH and TEPH. A commercial gasoline standard will be used for TVPH calibration. A commercial Fuel Oil #2 or diesel standard will be used for TEPH calibration. The retention time markers identified in the MADEP methods to determine the retention times of the TVPH and TEPH determination will be used to define the hydrocarbon molecular weight range of the TVPH and TEPH analyses. The hydrocarbon range quantified in the TVPH analysis will extend from 0.1 minutes before the marker compound pentane to 0.1 minute after naphthalene. The TEPH hydrocarbon range quantified will extend from 0.1 minute before naphthalene to 0.1 minute after hexatriacontane. The concentration of hydrocarbons in standards and samples will be determined based on the total baseline to baseline area response of the standards within the designated retention time widows. A three point initial calibration and continuing calibration will be conducted as outlined in the POP. The concentrations of TVPH and TEPH will be added together to determine the total concentration of petroleum hydrocarbons present at a given sample location.

3.0 Quality Control:

Quality control steps outlined below will be conducted during the field analyses including an MDL study for target compounds, initial and continuing calibrations, method blank extraction and analysis with each sample batch, matrix spikes and field duplicate sample analyses, and evaluation of accuracy using a surrogate standard.

- holding times: Soil: 14 days
  Water: 7 days
- Surrogate %R goal of 50% (<30% re-analysis limit)
- MDL study (Appendix B part 136, CFR 40)
- Initial calibration by linear regression (.95) or average response factor (RSD 25%) with low standard at or near reporting limit
- Continuing calibration each day and after 20 samples (30% difference)
- Extraction blank (method blank) with each extraction batch prepared or daily with each purge and trap analytical sequence
- Matrix spike/Matrix spike duplicates will be prepared by spiking 5 percent of samples with target compounds, a commercial gasoline standard, or a commercial diesel fuel standard, as appropriate for each analysis, at approximately the mid-range of the calibration curve. Percent recoveries (%R) and relative percent difference (RPD) will be used to evaluate the accuracy and precision of measurements and to qualify results. Percent recovery goals: 60% to 140%; RPD < 20
- Field duplicates will be submitted to the field laboratory routinely during the program. Relative percent difference of the duplicate results will be used to evaluate the precision of field measurements and qualify results. RPD goals are 30% for aqueous samples and 50% for soil samples.

4.0 Data Review and Reporting:

The field chemist will review results based on project data quality control goal outlined above. Sample results not meeting data quality control goals will be qualified as outlined below:

Qualification flags for data evaluation

(J) The J flag is used to indicate estimated data. This can occur when a compound does not meet calibration criteria for initial calibration, continuing calibration, or both.

(B) The B flag is used when a target compound is detected in an associated method blank. All values within five times of the method blank result are flagged.

(E) The E flag is used to indicate estimated data. The flag is used when a compound is detected at a concentration that is above the highest calibration standard.

(S) The S flag is used when the associated surrogate recovery is less than 50%. For soils the surrogate recovery must be greater than 50 percent for results to go unqualified, however, re-analysis will only occur if recoveries are less than 30%.

Matrix spike and field duplicate results will be tabulated and summarized on an ongoing basis during the field program. Results will be used by the field chemist, FOL, and project manager on an ongoing basis to evaluate the usability of results. Associated field sample results presented in the final data reports may be qualified based on the judgement of the field and project chemist.

References:

Massachusetts Department of Environmental Protection (MADEP), 1995. "Method for the Determination of Extractable Petroleum Hydrocarbons (TEPH); Division of Environmental Analysis; Office of Research and Standards; Bureau of Waste Site Cleanup; August 1995.

Massachusetts Department of Environmental Protection (MADEP), 1995. "Method for the Determination of Volatile Petroleum Hydrocarbons (TVPH); Division of Environmental Analysis; Office of Research and Standards; Bureau of Waste Site Cleanup; August 1995.

U.S. Environmental Protection Agency (USEPA), 1995. "Test Methods for Evaluating Solid Waste"; Laboratory Manual Physical/Chemical Methods; Office of Solid Waste and Remedial Response; Washington, DC; SW-846; November 1986; Revised January 1995.

TABLE 1
SUMMARY OF TARGET COMPOUNDS AND REPORTING LIMITS
1996 FIELD SCREENING PROGRAM
FORT DEVENS REMEDIAL INVESTIGATION

Target Analyte	Soil µg/g	Water µg/L
Benzene	0.25	2
Toluene	0.25	2
Ethylbenzene	0.25	2
m/p-xylene	0.5	4
o-xylene	0.25	2
Tetrachloroethene	0.25	2
Trichloroethene	0.25	2
cis-1,2-dichloroethene	0.25	2
trans-1,2-dicholorethene	0.25	2
Vinyl chloride	0.25	2
TVPH	6.25	50
TEPH	100	NA

Notes:
NA = soil not analyzed
µg/g = microgram per gram
µg/L = microgram per liter

TABLE 1
SUMMARY OF TARGET COMPOUNDS AND REPORTING LIMITS
1996 FIELD SCREENING PROGRAM
FORT DEVENS REMEDIAL INVESTIGATION

Target Analyte	Soil µg/g	Water µg/L
Benzene	0.25	2
Toluene	0.25	2
Ethylbenzene	0.25	2
m/p-xylene	0.5	4
o-xylene	0.25	2
Tetrachloroethene	0.25	2
Trichloroethene	0.25	2
cis-1,2-dichloroethene	0.25	2
trans-1,2-dicholorethene	0.25	2
Vinyl chloride	0.25	2
TVPH	6.25	50
TEPH	100	NA

Notes:
NA = soil not analyzed
µg/g = microgram per gram
µg/L = microgram per liter

APPENDIX F

HYDRAULIC CONDUCTIVITY TEST RESULTS

AQUIFER TESTING COMPLETION CHECKLIST

AQUIFER TEST NO. _____

SETUP	DATE	BY WHOM JRK
MONITORING WELL ID	1666W-1	1666W-1
DATE OF TEST	10/15/96	10/15/96
TYPE OF TEST	RISING	RISING
HERMIT TYPE/SERIAL#	IKB-480 →	
TEST #	SEL #6 →	SEL #7
DATA COLLECTION RATE	LOG →	T
TRANSDUCER		
SERIAL #	204604 →	
PSIG	10 →	
SCALE FACTOR	10.068 →	
OFFSET	-0.205 →	
INPUT CHANNEL	1	1
TEST DATA		
INPUT MODE (TOC/SUR)	SUR	
STATIC WATER LEVEL (FT./TOC)	25.80	
WELL DEPTH (FT./TOC)	34.7	
XD DEPTH (FT.TOC)	33.7	
INITIAL XD REFERENCE	8.18	8.17
SLUG DEPTH (FT./TOC)	25 BTOR	27 BTOR
TIME OF SLUG PLACEMENT	~~1600~~ 1618	1633
TIME OF WL EQUILIBRATION	~~1602~~ 1619	1634
NEW XD REFERENCE	0	0
START TIME OF TEST	~~1603~~ 1620	1637
END TIME OF TEST	1630	1640
NOTES: LIN. = 0.0134		

NOTE TEST ID 04 FOR SEL #6
ID 661 FOR SEL #7

AQUIFER TESTING COMPLETION CHECKLIST

AQUIFER TEST NO. ______

SETUP	DATE	BY WHOM JGR
MONITORING WELL ID	BDM-96-01X	BDM-96-01X
DATE OF TEST	10/15/96	10/15/96
TYPE OF TEST	RISING	RISING
HERMIT TYPE/SERIAL#	1KB-490	
TEST #	SEC #14 /	SEC #15
DATA COLLECTION RATE	LOG	
TRANSDUCER		
SERIAL #	204604	
PSIG	10	
SCALE FACTOR	10.0683	
OFFSET	-0.205	
INPUT CHANNEL	1	
TEST DATA		
INPUT MODE (TOC/SUR)	SUR	
STATIC WATER LEVEL (FT./TOC)	23.39	
WELL DEPTH (FT./TOC)	34.45	
XD DEPTH (FT.TOC)	33.5	
INITIAL XD REFERENCE	5.07	5.08
SLUG DEPTH (FT./TOC)	28' BTOR	28' BTOR
TIME OF SLUG PLACEMENT	1831	1843
TIME OF WL EQUILIBRATION	1836	1844
NEW XD REFERENCE	0.01	0
START TIME OF TEST	~~1800~~ 1836	1845
END TIME OF TEST	1841	~~BY~~ 1848
NOTES: LW - 0.0434		

1D-01

Post-it® Fax Note 7671

To: Rod Rustad	Date	# of pages ▸ 3
Co./Dept.	From: J. Rowland	
Phone #	Co.	
Fax #	Phone #	
	Fax #	

BB Environmental Services, Inc.

AQUIFER TESTING COMPLETION CHECKLIST

AQUIFER TEST NO. _____

SETUP	DATE	BY WHOM JR
MONITORING WELL ID	BOM-96 ext	→
DATE OF TEST	10/15/96	→
TYPE OF TEST	RISING HEAD	→
HERMIT TYPE/SERIAL#	IKB-480	→
TEST #	SEL #10	SEL #11
DATA COLLECTION RATE	LOG	→
TRANSDUCER		
SERIAL #	204604	→
PSIG	10	→
SCALE FACTOR	10.0683	→
OFFSET	-0.205	→
INPUT CHANNEL	1	→
TEST DATA		
INPUT MODE (TOC/SUR)	SUR	→
STATIC WATER LEVEL (FT./TOC)	28.00 BTOR	→
WELL DEPTH (FT./TOC)	34.85	→
XD DEPTH (FT.TOC)	33.85	→
INITIAL XD REFERENCE	5.98	5.99
SLUG DEPTH (FT./TOC)	29' BTOR	29' BTOR
TIME OF SLUG PLACEMENT	1729	1737
TIME OF WL EQUILIBRATION	1730	1738
NEW XD REFERENCE	0.01	0.01
START TIME OF TEST	1731	1740
END TIME OF TEST	1735	1743
NOTES: LIN - 0.0434		

10 02

AQUIFER TESTING COMPLETION CHECKLIST

AQUIFER TEST NO. 0

SETUP	DATE	BY WHOM JCR
MONITORING WELL ID	BDM-96-03X	BDM-96-03X
DATE OF TEST	10/14/96	10/15
TYPE OF TEST	RISING HEAD →	
HERMIT TYPE/SERIAL#	In Situ - Level IKB-490	
TEST #	SEC 0	SEC #3 (SEC #9.)
DATA COLLECTION RATE	LOG	LOG
TRANSDUCER		
SERIAL #	204604 →	
PSIG	10 →	
SCALE FACTOR	11.0683 →	
OFFSET	-0.205 →	
INPUT CHANNEL	1 →	
TEST DATA		
INPUT MODE (TOC/SUR)	SUR	SUR
STATIC WATER LEVEL (FT./TOC)	27.95 BTOR	28.0 BTOR →
WELL DEPTH (FT./TOC)	34.95	34.95 →
XD DEPTH (FT.TOC)	33.85	33.85 →
INITIAL XD REFERENCE	5.88	5.83 (5.84)
SLUG DEPTH (FT./TOC)	28.33 'BTOR	28-33'
TIME OF SLUG PLACEMENT	1615	1655 (1704)
TIME OF WL EQUILIBRATION	1615	1656 (1705)
NEW XD REFERENCE	0	0 (0.01)
START TIME OF TEST	1615	1657 (1706)
END TIME OF TEST	1627	1700 (1709)
NOTES: CINGARITY, 0434		

10 03

AQUIFER TESTING COMPLETION CHECKLIST

AQUIFER TEST NO. _____

SETUP	DATE	BY WHOM
MONITORING WELL ID	BDM-96-04B	
DATE OF TEST	10/14/96	
TYPE OF TEST	RISING	
HERMIT TYPE/SERIAL#	IN STN 1000 IKB-480	
TEST #	SBL #5	
DATA COLLECTION RATE	LOG	
TRANSDUCER		
SERIAL #	204604	
PSIG	10	
SCALE FACTOR	10.693	
OFFSET	-0.205	
INPUT CHANNEL	1	
TEST DATA		
INPUT MODE (TOC/SUR)	SUR	
STATIC WATER LEVEL (FT./TOC)	28.06	
WELL DEPTH (FT./TOC)	55.2 BTOR	
XD DEPTH (FT.TOC)	40 BTOR	
INITIAL XD REFERENCE	11.50	
SLUG DEPTH (FT./TOC)	28' BTOR	
TIME OF SLUG PLACEMENT	1401	
TIME OF WL EQUILIBRATION	1803	
NEW XD REFERENCE	0	
START TIME OF TEST	1808	
END TIME OF TEST	1814	
NOTES: LINEARITY -0.0434		

10 04

AQUIFER TESTING COMPLETION CHECKLIST

AQUIFER TEST NO. _____

SETUP	DATE 10/14/96	BY WHOM JJL
MONITORING WELL ID	BAM-96-04B	
DATE OF TEST	10/14/96	
TYPE OF TEST	RISING	FALLING
HERMIT TYPE/SERIAL#	IN STN 1000 IKB-440	
TEST #	SEQ 3 ✓	SEQ 4 ✓
DATA COLLECTION RATE	LOG	
TRANSDUCER		
SERIAL #	204604	
PSIG	10	
SCALE FACTOR	10.683	
OFFSET	-0.205	
INPUT CHANNEL	1	
TEST DATA		
INPUT MODE (TOC/SUR)	SUR	
STATIC WATER LEVEL (FT./TOC)	28.06	
WELL DEPTH (FT./TOC)	55.2 BTOR	
XD DEPTH (FT.TOC)	~~SUR 11.52~~ ~~SUR 28~~ 40	
INITIAL XD REFERENCE	11.50	11.49
SLUG DEPTH (FT./TOC)	28'	
TIME OF SLUG PLACEMENT	~~1752~~ 1735	1801
TIME OF WL EQUILIBRATION	1738	
NEW XD REFERENCE	0	0
START TIME OF TEST	1752	1801
END TIME OF TEST	1758	1806
NOTES: LINEARITY = .0434		

10 04

AQUIFER TESTING COMPLETION CHECKLIST

AQUIFER TEST NO. 1

SETUP	DATE	BY WHOM
MONITORING WELL ID	BDM-96-04B	
DATE OF TEST	10/14/96	
TYPE OF TEST	RISING HEAD	FALLING HEAD
HERMIT TYPE/SERIAL#	IN SITU 1000C IKB-480	
TEST #	SEC 1	SEC 2
DATA COLLECTION RATE	LOG	
TRANSDUCER		
SERIAL #	204604	
PSIG	10	
SCALE FACTOR	10.0685	
OFFSET	-0.205	
INPUT CHANNEL	1	
TEST DATA		
INPUT MODE (TOC/SUR)	FM SUR	
STATIC WATER LEVEL (FT./TOC)	28.06	28.06
WELL DEPTH (FT./TOC)	55.2 EST	
XD DEPTH (FT.TOC)	38	
INITIAL XD REFERENCE	11.49	11.49
SLUG DEPTH (FT./TOC)	28-35'	
TIME OF SLUG PLACEMENT	~~1718~~ 1715	1735
TIME OF WL EQUILIBRATION	1720	1735
NEW XD REFERENCE	0	0
START TIME OF TEST	1720	1735
END TIME OF TEST	1731	1746
NOTES: LINEARITY, 0434		

WORK 10-04

AQUIFER TESTING COMPLETION CHECKLIST

AQUIFER TEST NO. _____

SETUP	DATE	BY WHOM RJC
MONITORING WELL ID	BDM-96-05X →	
DATE OF TEST	10/15/96	10/15/96
TYPE OF TEST	Rising Head →	
HERMIT TYPE/SERIAL#	KB-480 →	
TEST #	SBC #12	SBC #13
DATA COLLECTION RATE	LOG →	
TRANSDUCER		
SERIAL #	204604 →	
PSIG	10 →	
SCALE FACTOR	10.0683 →	
OFFSET	-0.205 →	
INPUT CHANNEL	1 →	
TEST DATA		
INPUT MODE (TOC/SUR)	SUR →	
STATIC WATER LEVEL (FT./TOC)	28.35 BTOR →	
WELL DEPTH (FT./TOC)	35.12 BTOR →	
XD DEPTH (FT.TOC)	34	34
INITIAL XD REFERENCE	5.59	5.59
SLUG DEPTH (FT./TOC)	33	33
TIME OF SLUG PLACEMENT	1758	1805
TIME OF WL EQUILIBRATION	1759	1806
NEW XD REFERENCE	0	0.01
START TIME OF TEST	1759	1808
END TIME OF TEST	1803	1810
NOTES: AUTO LIN -0.0434		

10 - 05

CALCULATION OF HYDRAULIC CONDUCTIVITIES USING THE HVORSLEV EQUATION
AOC 63BD REMEDIAL INVESTIGATION
DEVENS, MASSACHUSETTS

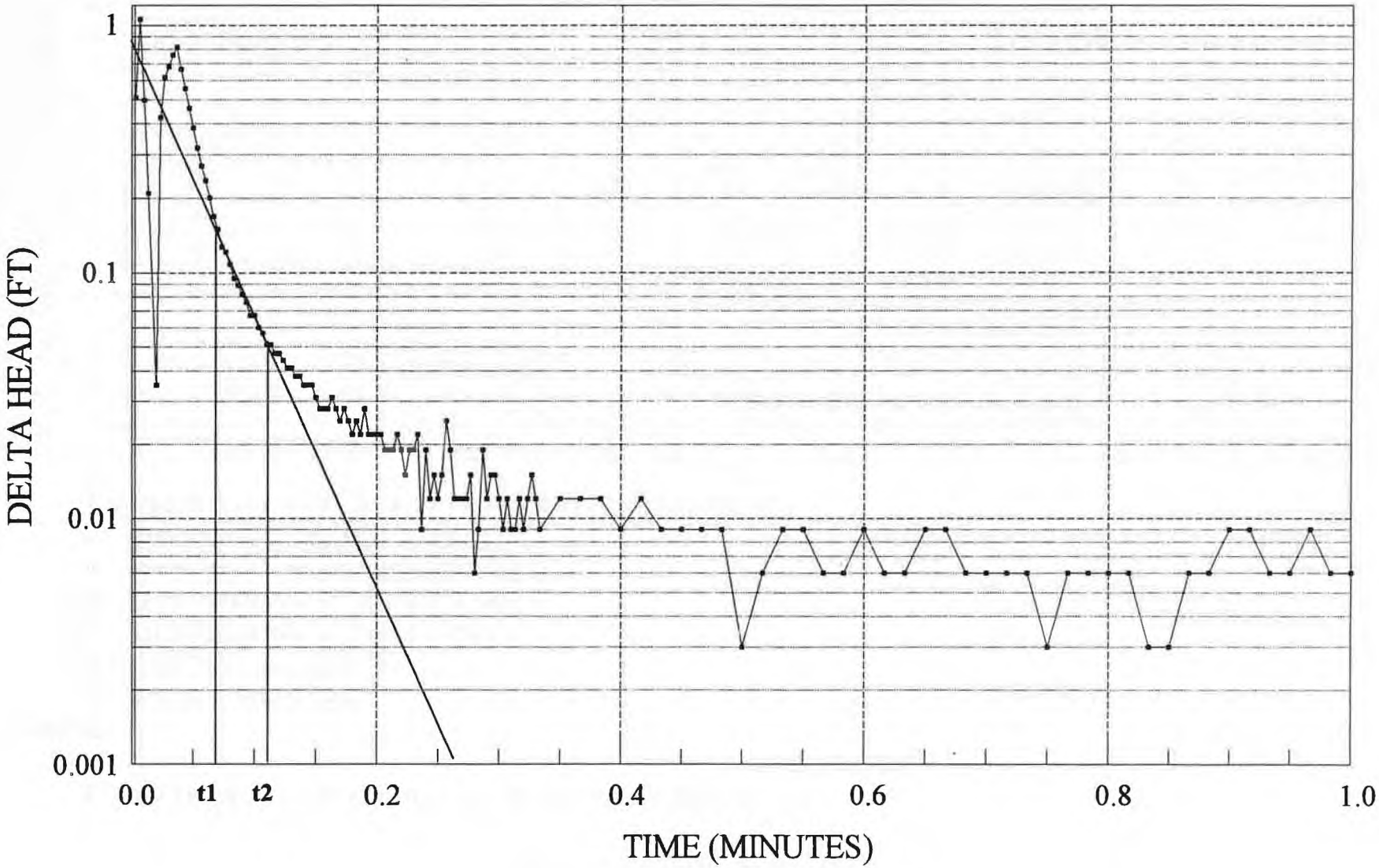
$$K = -[(\log Ht1 - \log Ht2)/(t1 - t2)]\{[(r)^2 \log (L/R)]/2L\}$$

WHERE:

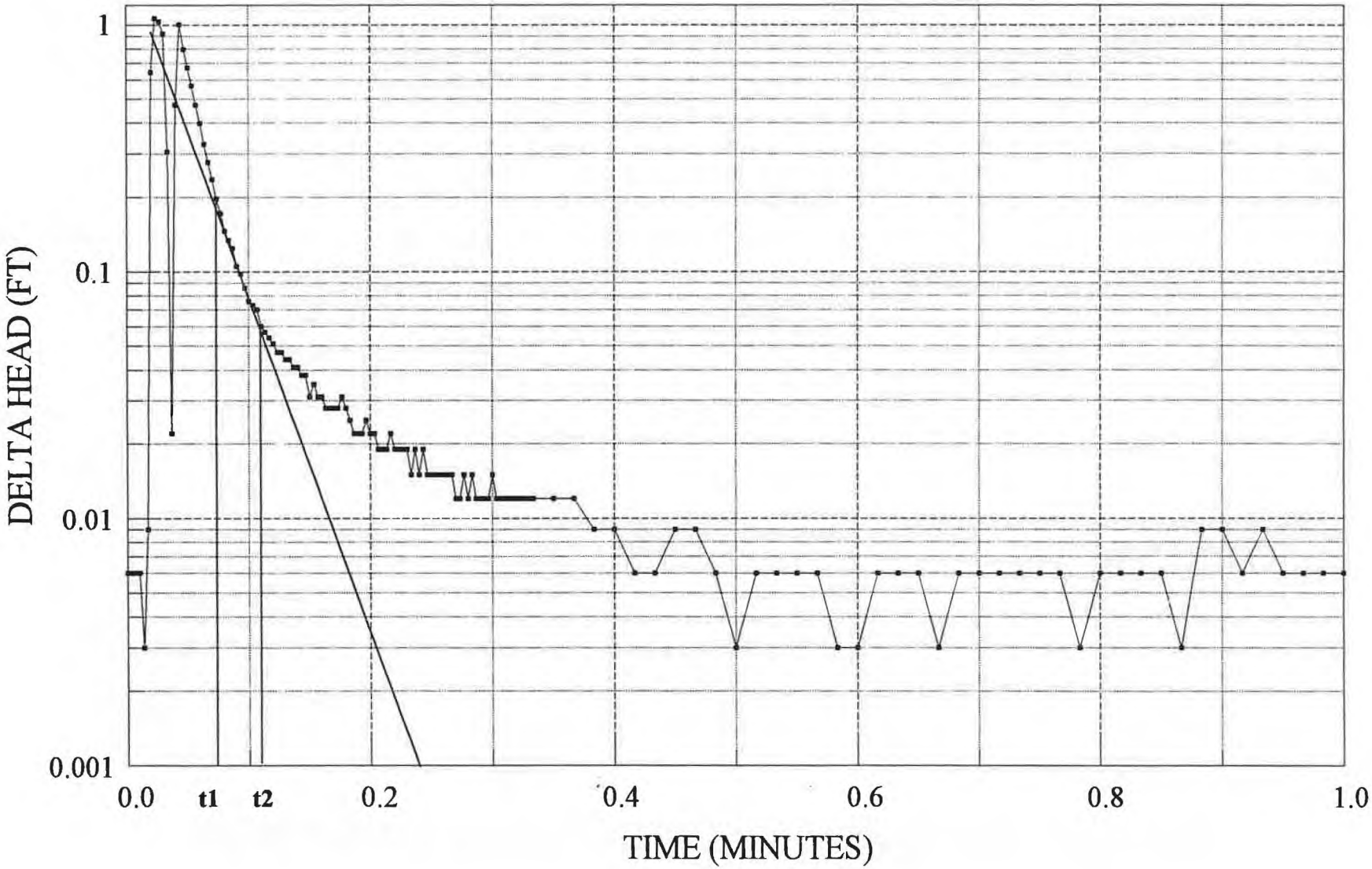
t1 = TIME 1 (MINUTES)
t2 = TIME 2 (MINUTES)
Ht1 = HEAD STRESS AT TIME 1 (FEET)
Ht2 = HEAD STRESS AT TIME 2 (FEET)
r = RADIUS OF WELL CASING (FEET)
R = RADUS OF BOREHOLE (FEET)
L = EFFECTIVE SATURATED LENGTH OF SCREEN (FEET)

WELL	t1	t2	Ht1	Ht2	r	R	L	TYPE	K (FT/MIN)	K (CM/SEC)
1666W-1	0.07	0.11	0.15	0.051	0.29	0.46	9.2	RISING	7.0E-02	3.5E-02
1666W-1	0.0766	0.11	0.172	0.06	0.29	0.46	9.2	RISING	8.1E-02	4.1E-02
BDM-96-01X	0.0933	0.1533	0.137	0.031	0.29	0.46	6.06	RISING	8.4E-02	4.2E-02
BDM-96-01X	0.1	0.1666	0.13	0.028	0.29	0.46	6.06	RISING	7.8E-02	4.0E-02
BDM-96-02X	NA	NA	NA	NA	NA	NA	NA	RISING	NA	NA
BDM-96-02X	NA	NA	NA	NA	NA	NA	NA	RISING	NA	NA
BDM-96-03X	NA	NA	NA	NA	NA	NA	NA	RISING	NA	NA
BDM-96-03X	NA	NA	NA	NA	NA	NA	NA	RISING	NA	NA
BDM-96-03X	NA	NA	NA	NA	NA	NA	NA	RISING	NA	NA
BDM-96-04B	0.0833	1	1.98	0.064	0.08	0.29	15.5	RISING	5.8E-04	2.9E-04
BDM-96-04B	0.5	1	0.367	0.038	0.08	0.29	15.5	RISING	7.0E-04	3.6E-04
BDM-96-04B	0.5	1	0.52	0.079	0.08	0.29	15.5	RISING	5.8E-04	3.0E-04
BDM-96-04B	0.5	1	0.44	0.099	0.08	0.29	15.5	FALLING	4.6E-04	2.3E-04
BDM-96-04B	0.5	1	0.578	0.13	0.08	0.29	15.5	FALLING	4.6E-04	2.3E-04
BDM-96-05X	0.04	0.05	0.27	0.031	0.174	0.29	6.77	RISING	2.9E-01	1.5E-01
BDM-96-05X	0.03	0.0466	0.475	0.028	0.174	0.29	6.77	RISING	2.3E-01	1.2E-01

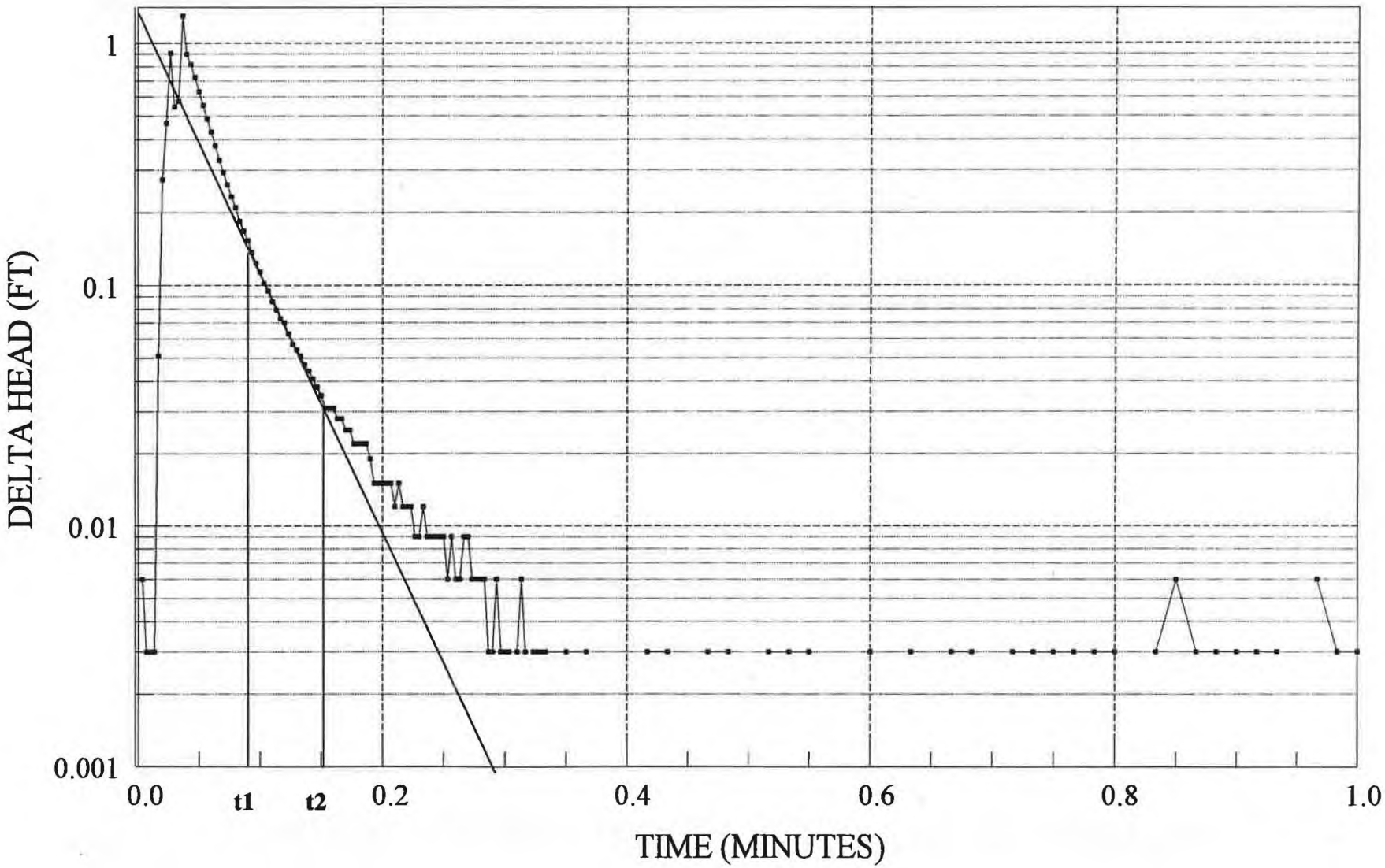
1666W-1 RISING HEAD PERMEABILITY TEST No. 1



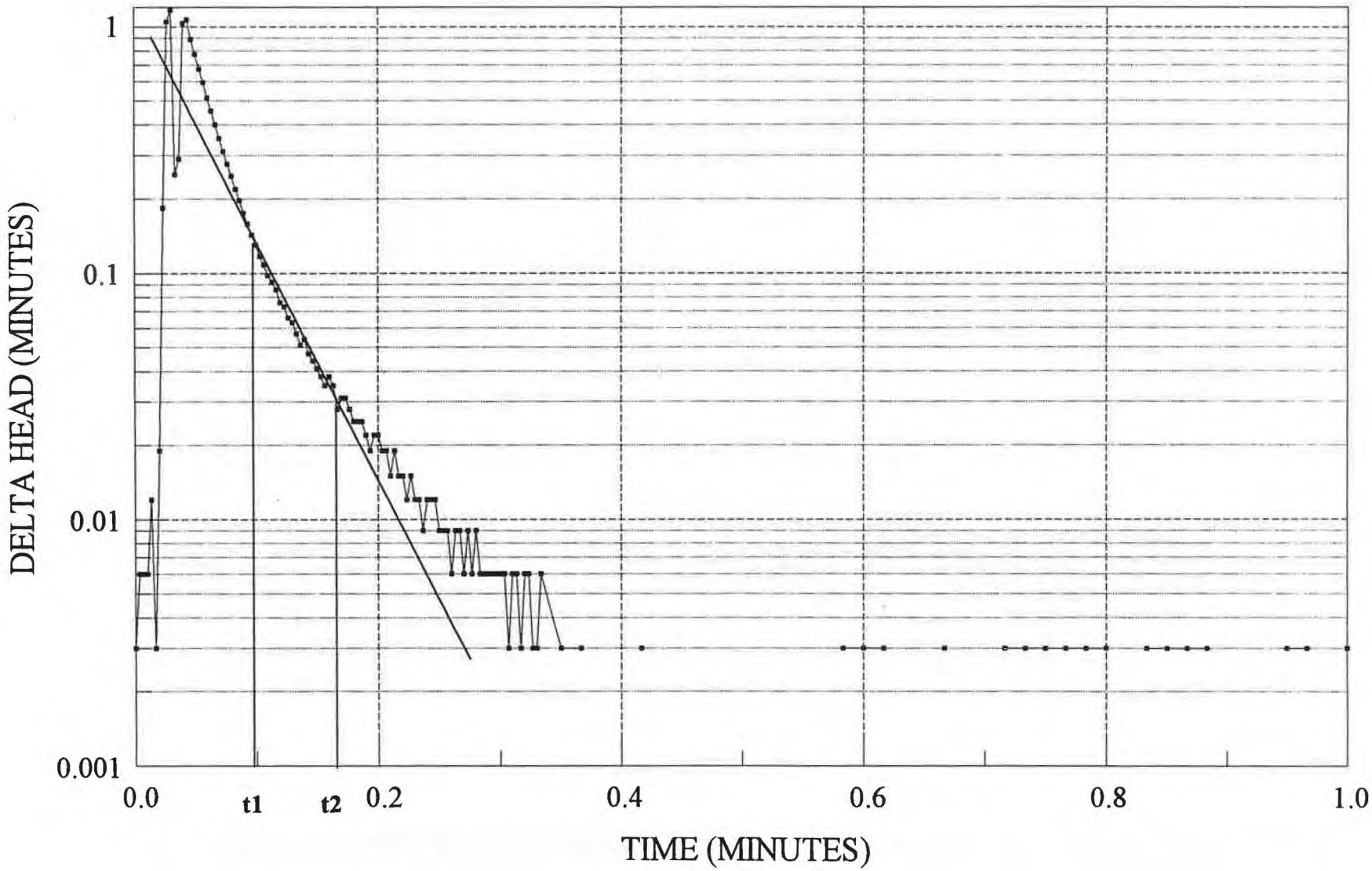
1666W-1 RISING HEAD PERMEABILITY TEST No.2



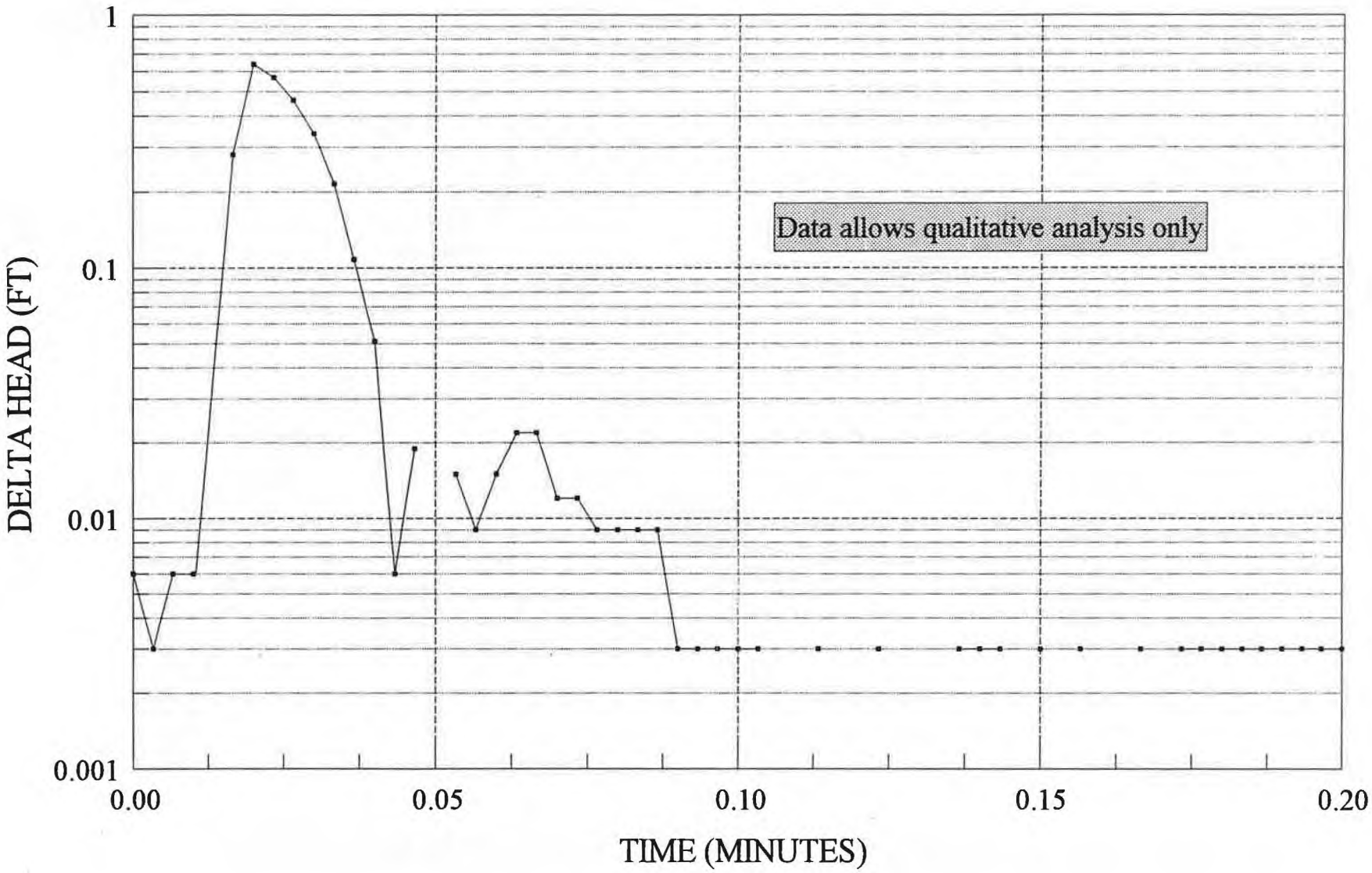
BDM-96-01X RISING HEAD PERMEABILITY TEST No. 1



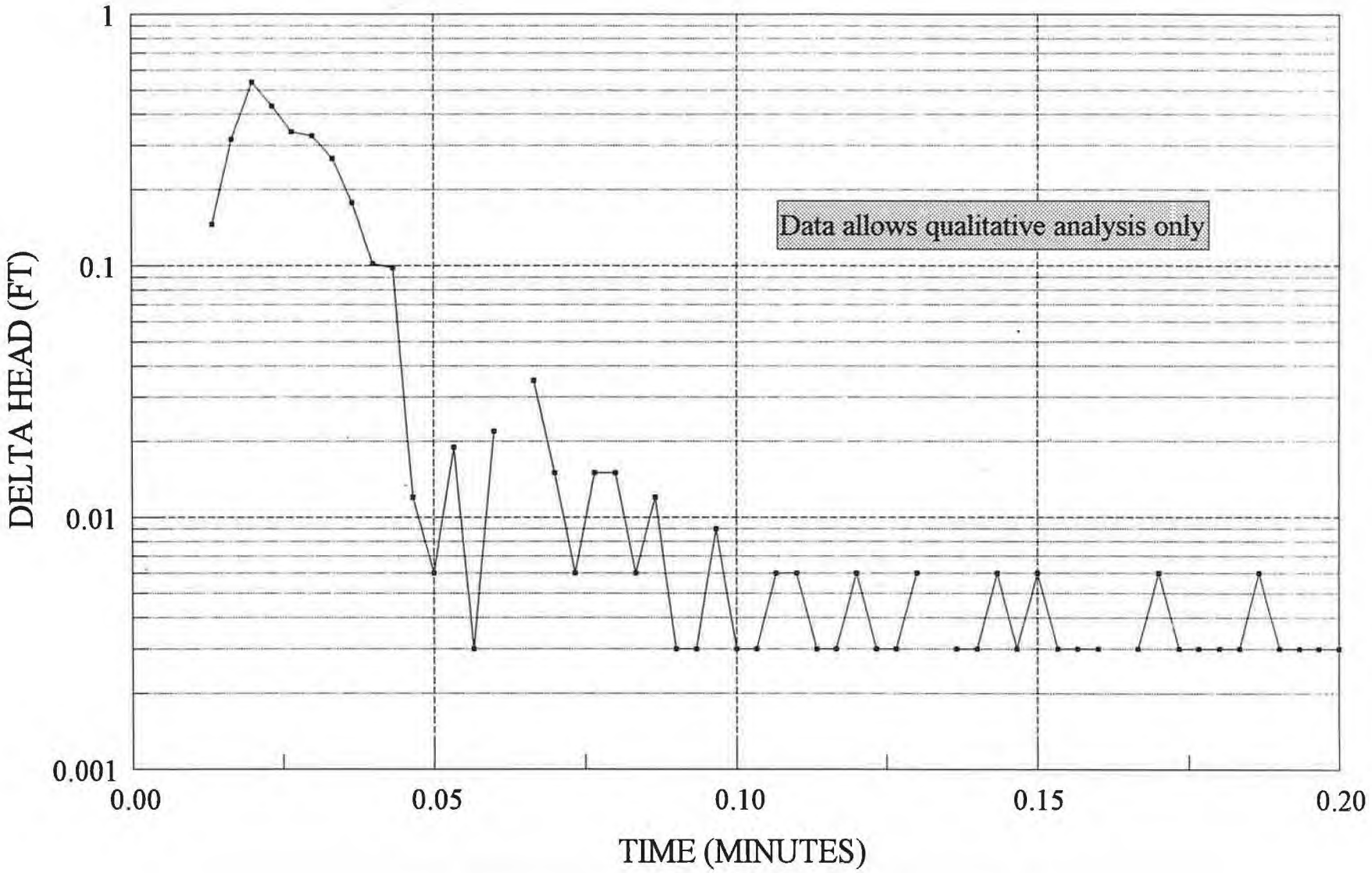
BDM-96-01X RISING HEAD PERMEABILITY TEST No. 2



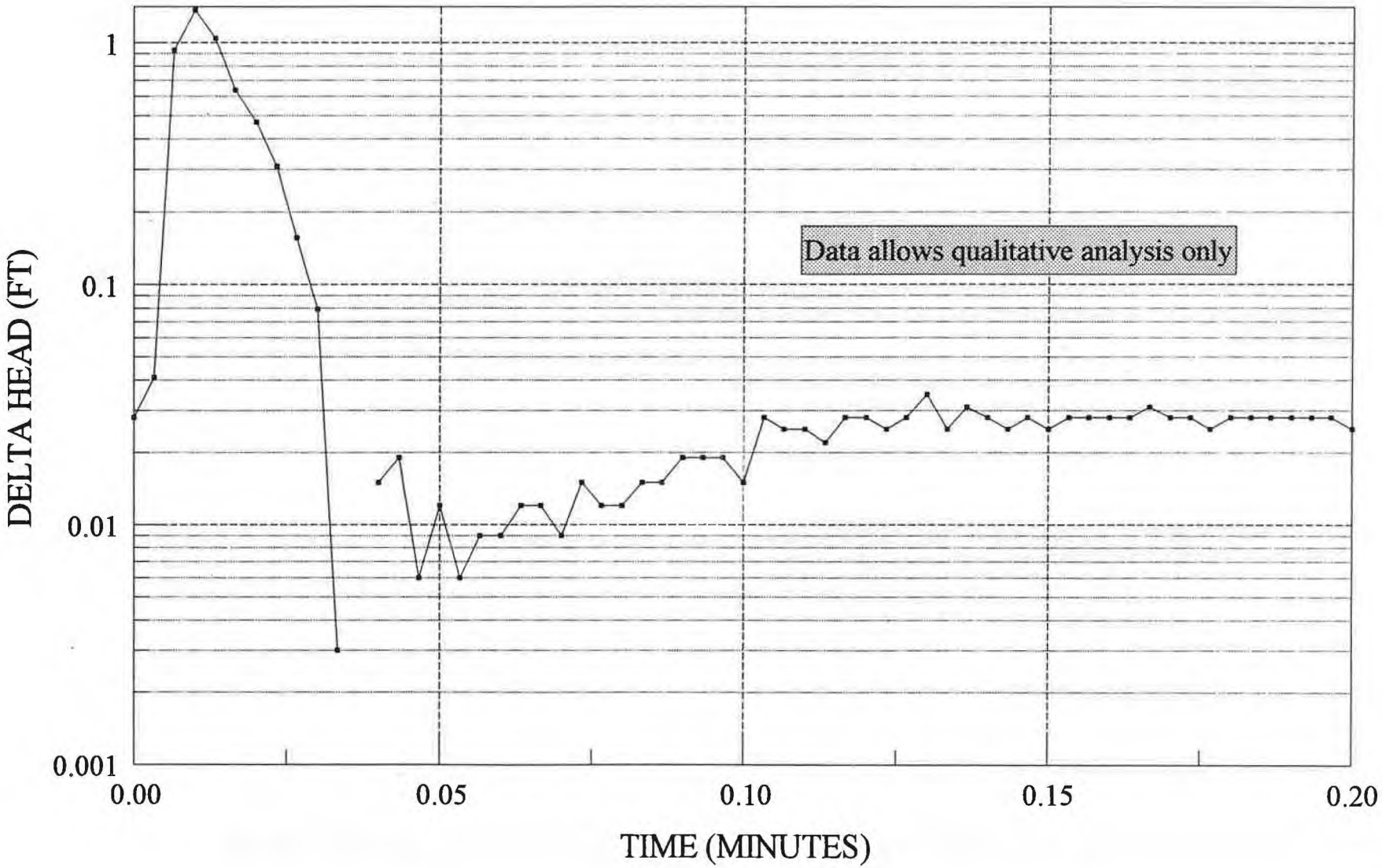
BDM-96-02X RISING HEAD PERMEABILITY TEST No. 1



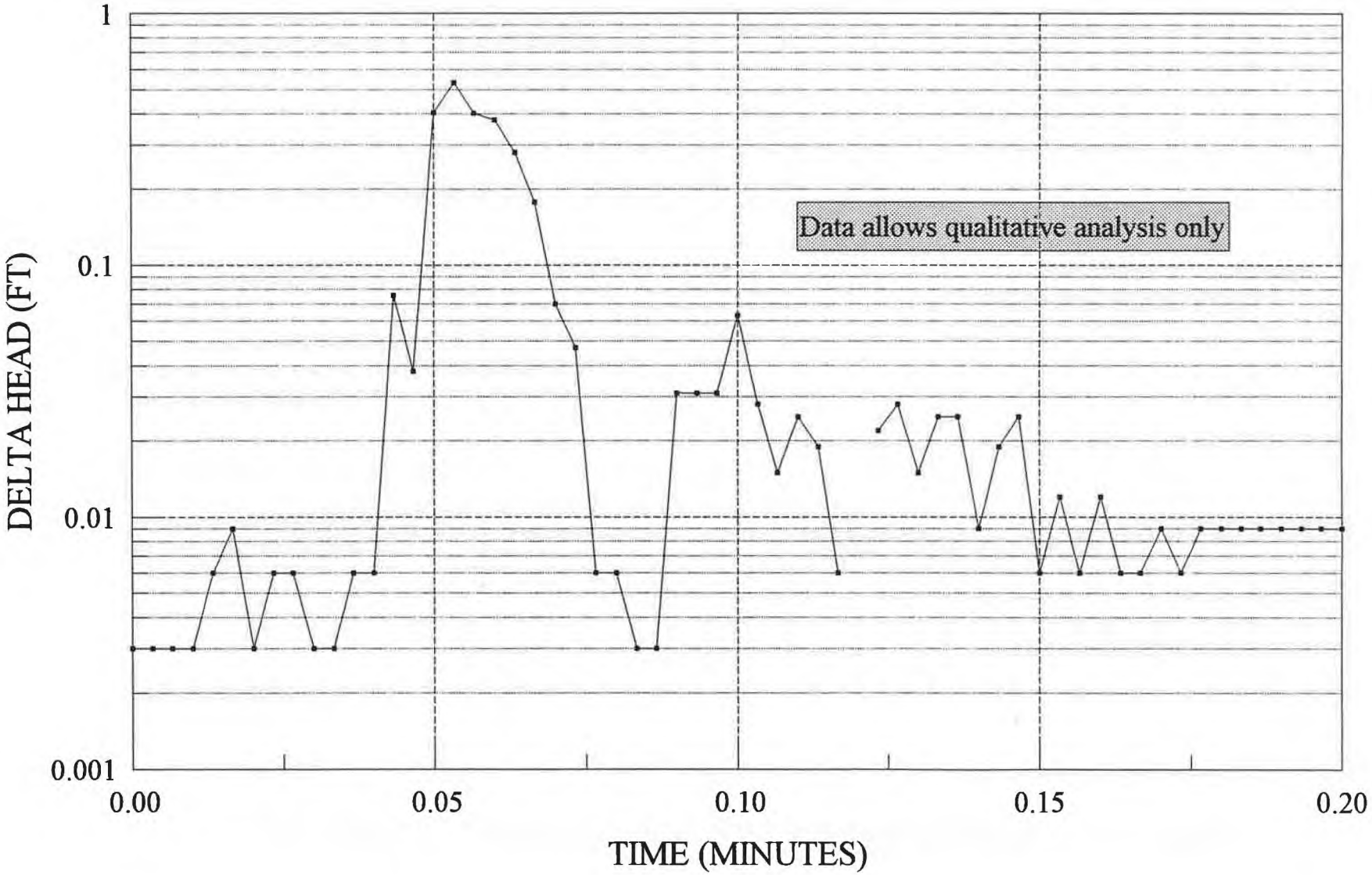
BDM-96-02X RISING HEAD PERMEABILITY TEST No. 2



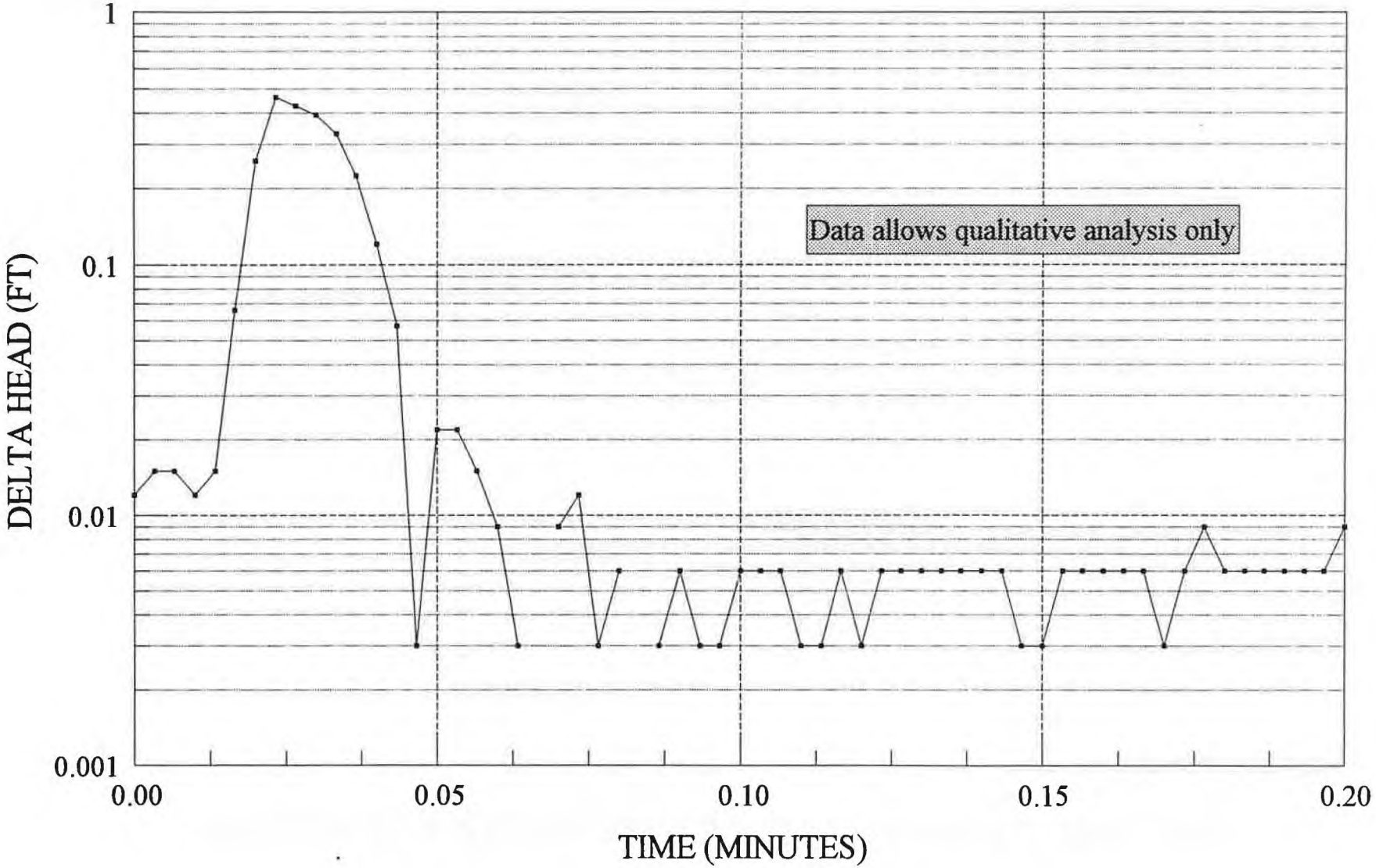
BDM-96-03X RISING HEAD PERMEABILITY TEST No. 1



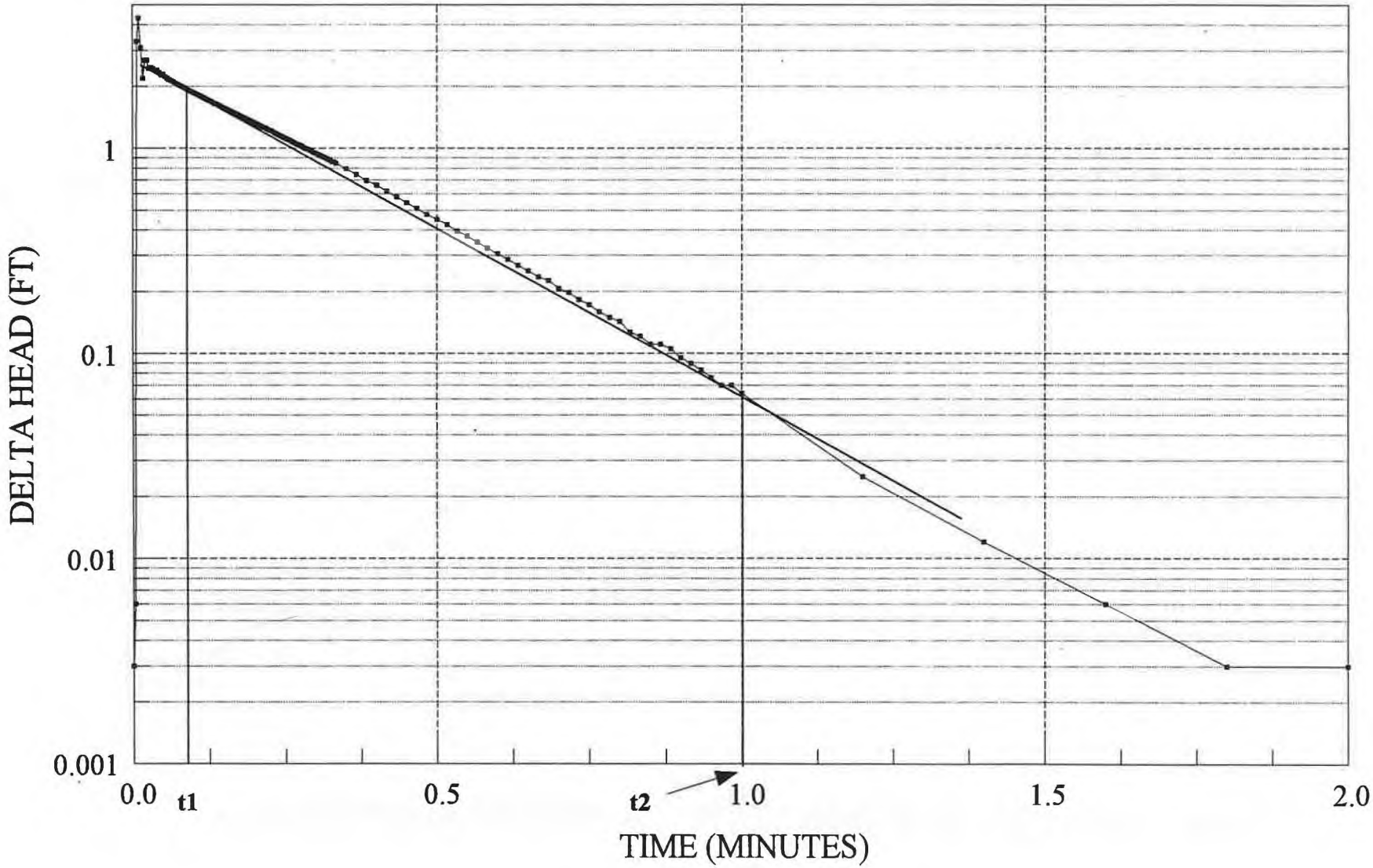
BDM-96-03X RISING HEAD PERMEABILITY TEST No. 2



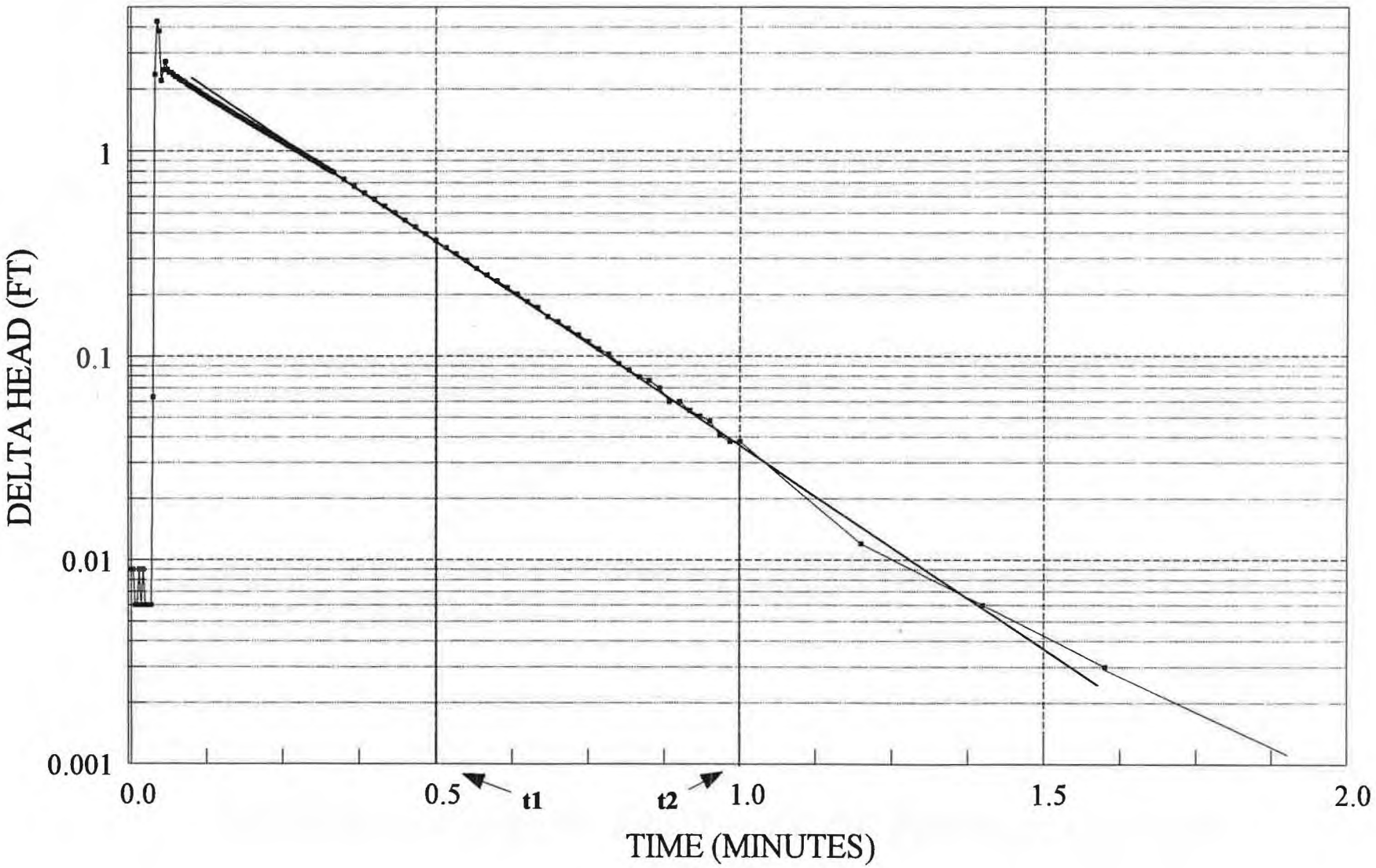
BDM-96-03X RISING HEAD PERMEABILITY TEST No. 3



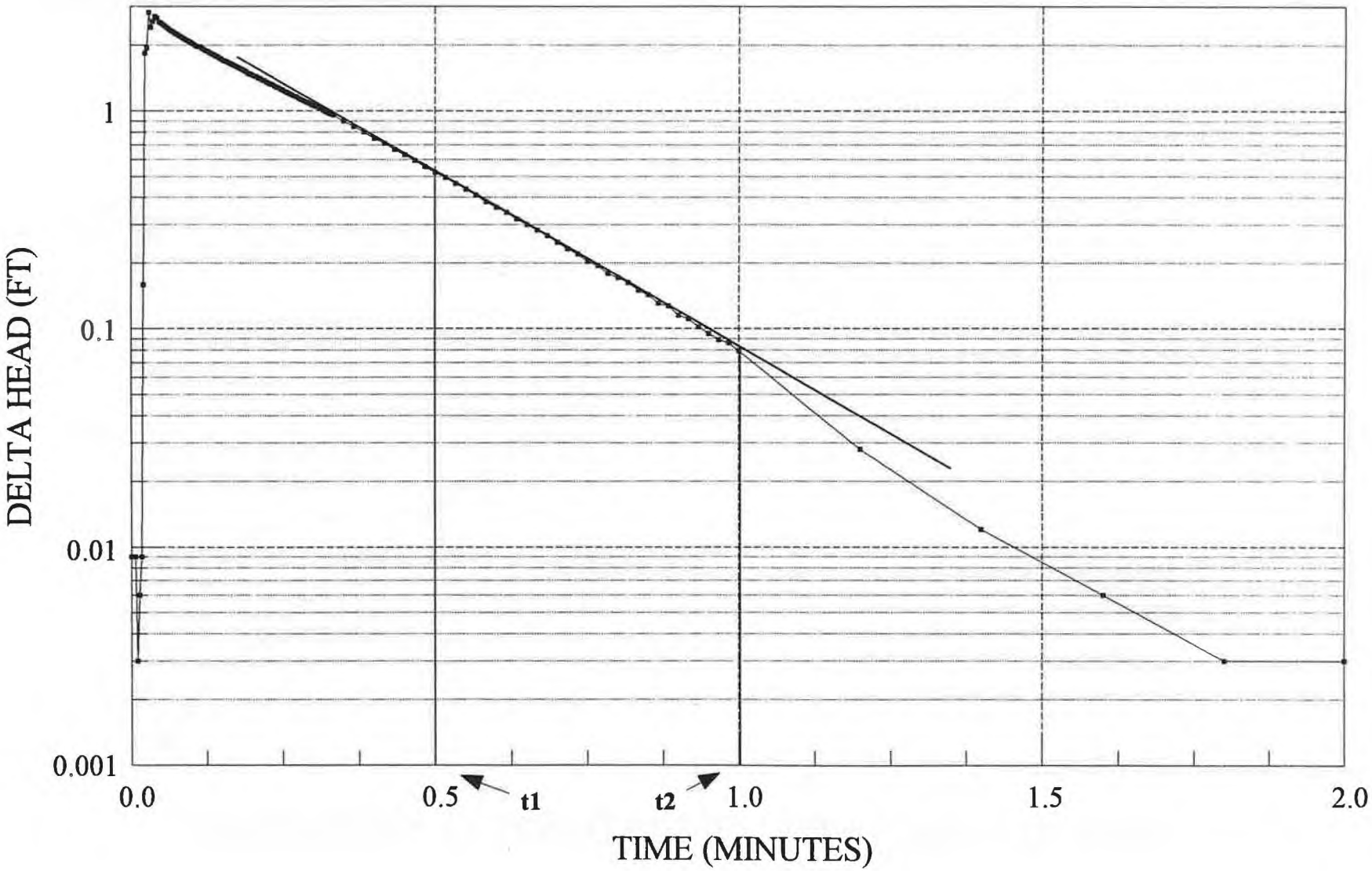
BDM-96-04B RISING HEAD PERMEABILITY TEST No. 1



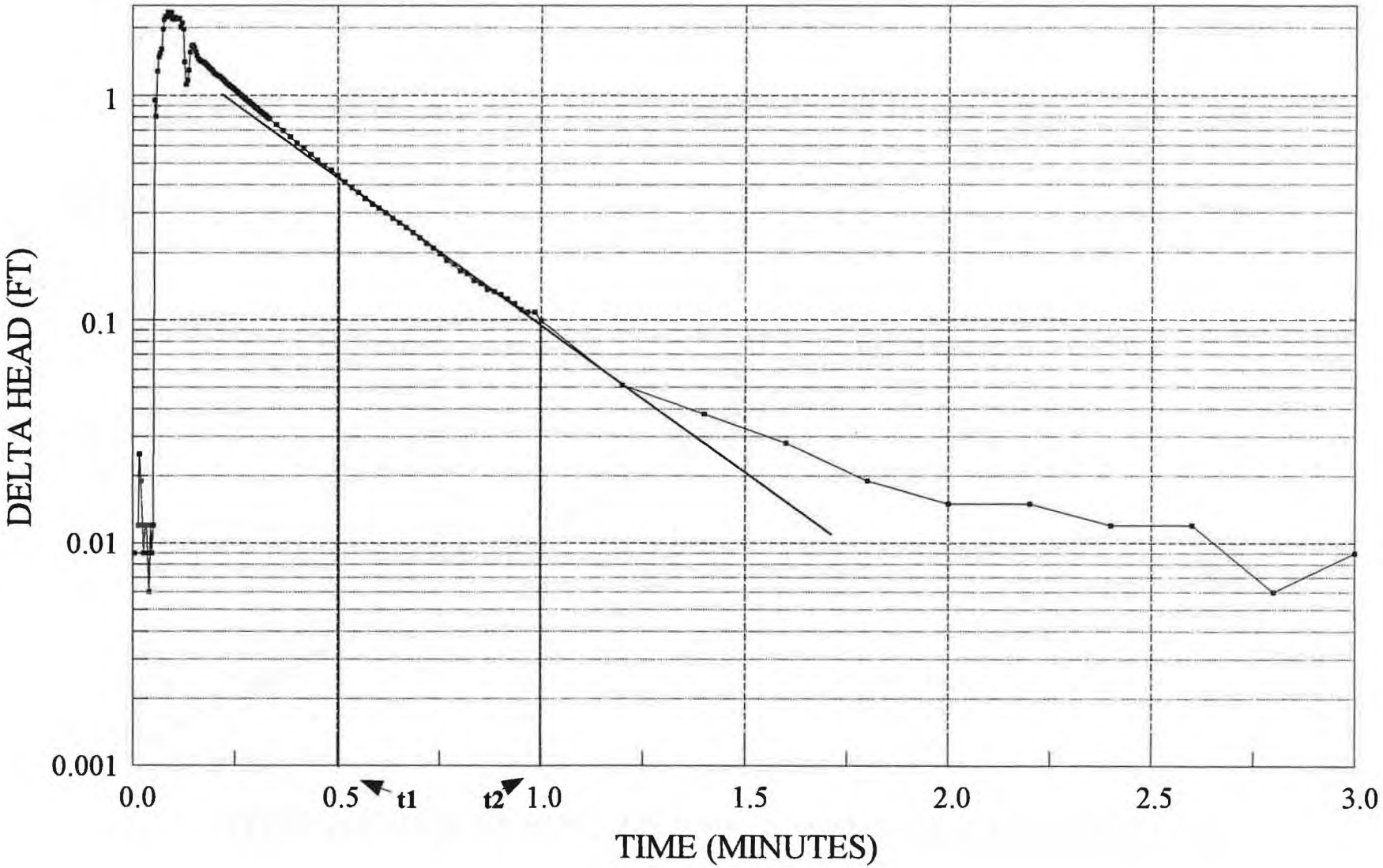
BDM-96-04B RISING HEAD PERMEABILITY TEST No. 2



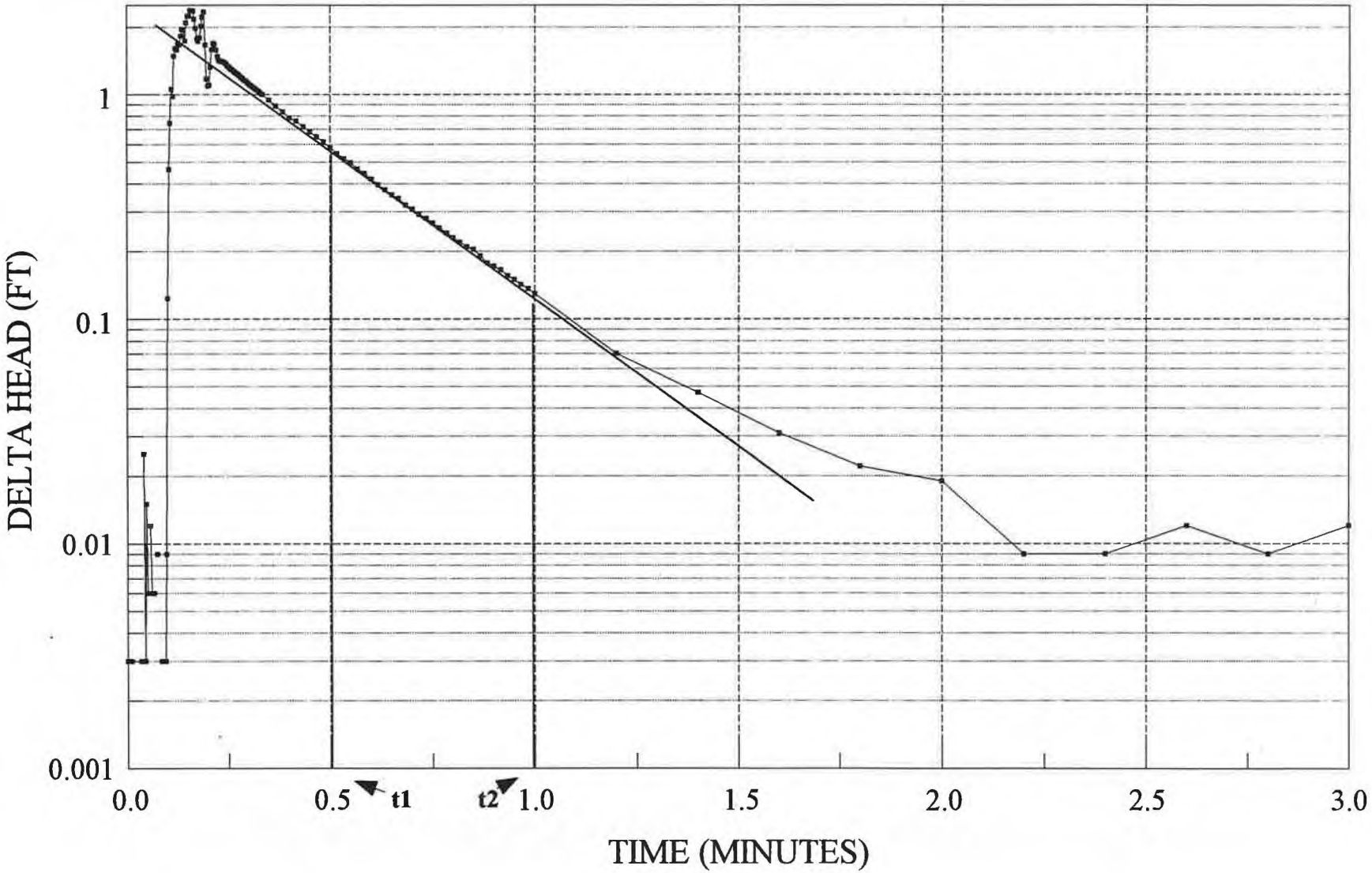
BDM-96-04B RISING HEAD PERMEABILITY TEST No. 3



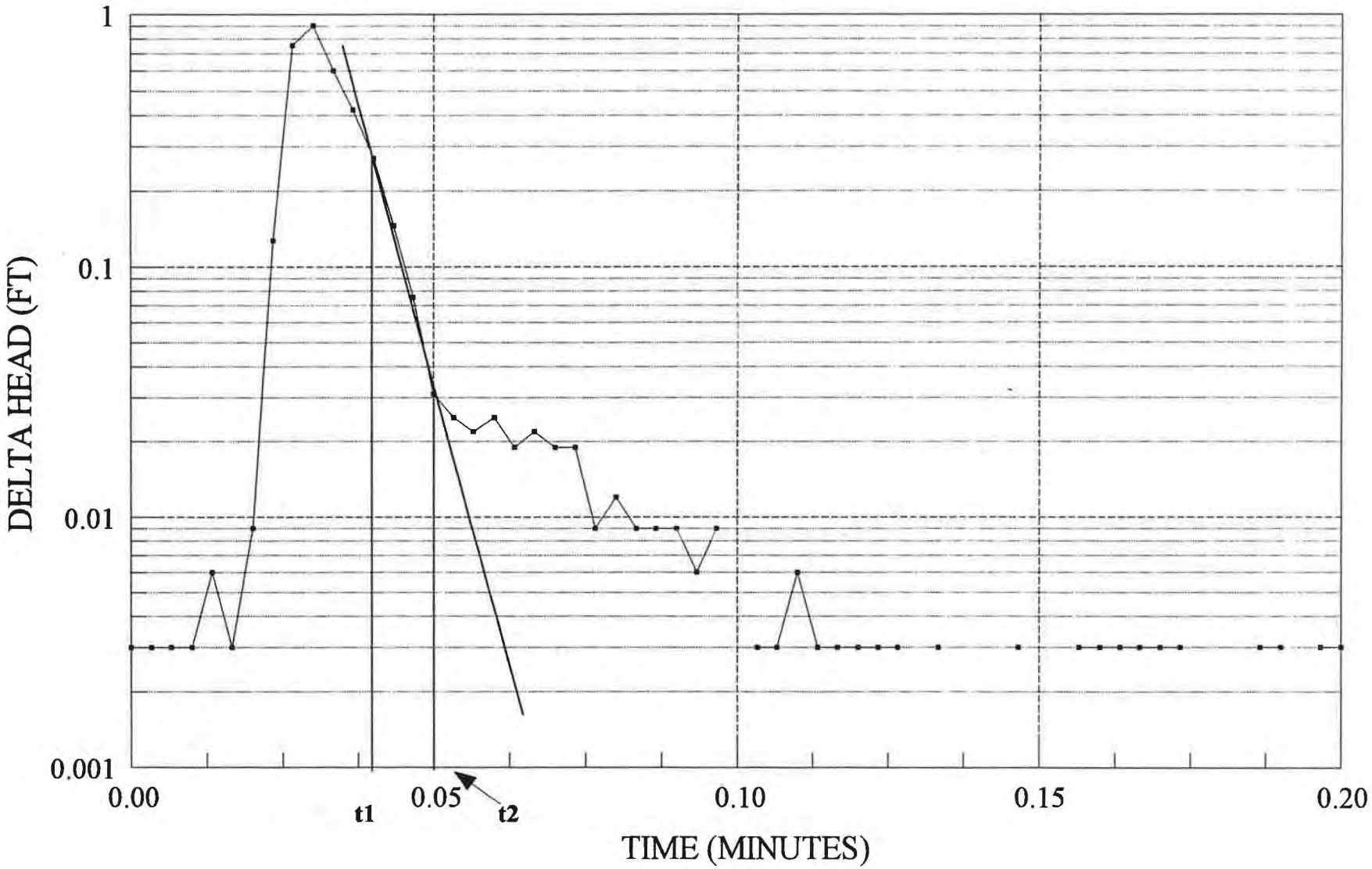
BDM-96-04B FALLING HEAD PERMEABILITY TEST No. 1



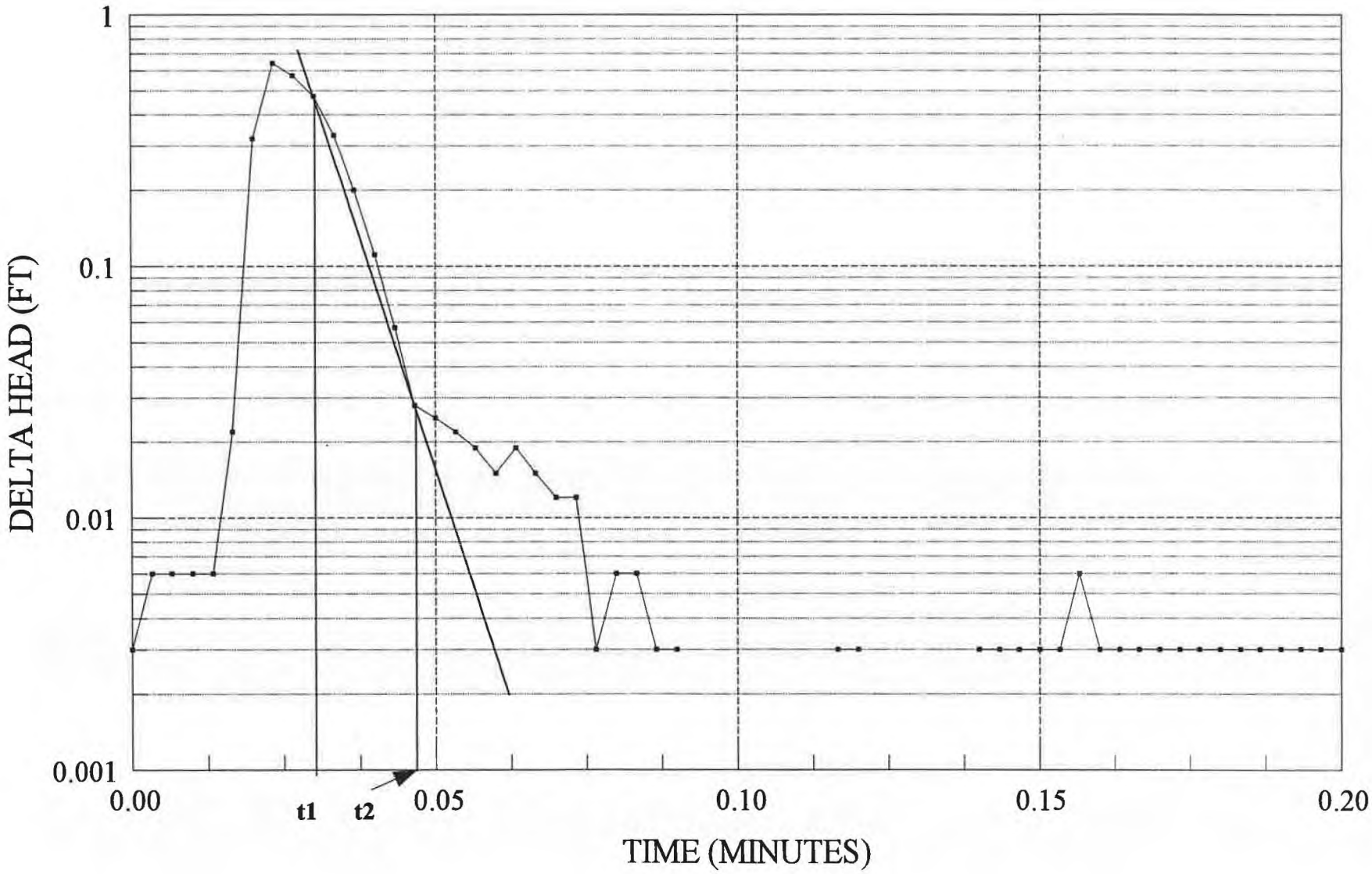
BDM-96-04B FALLING HEAD PERMEABILITY TEST No. 2



BDM-96-05X RISING HEAD PERMEABILITY TEST No. 1



BDM-96-05X RISING HEAD PERMEABILITY TEST No. 2



1666W-1 Rising Head Permeability Test No. 1		
Time (min)	Delta H (ft)	Absolute Value H (ft)
0	0	0
0.0033	-0.51	0.51
0.0066	-1.056	1.056
0.01	-0.497	0.497
0.0133	-0.21	0.21
0.0166	0.255	0.255
0.02	-0.035	0.035
0.0233	-0.424	0.424
0.0266	-0.615	0.615
0.03	-0.679	0.679
0.0333	-0.759	0.759
0.0366	-0.813	0.813
0.04	-0.666	0.666
0.0433	-0.555	0.555
0.0466	-0.462	0.462
0.05	-0.386	0.386
0.0533	-0.319	0.319
0.0566	-0.271	0.271
0.06	-0.236	0.236
0.0633	-0.201	0.201
0.0666	-0.169	0.169
0.07	-0.15	0.15
0.0733	-0.127	0.127
0.0766	-0.121	0.121
0.08	-0.108	0.108
0.0833	-0.095	0.095
0.0866	-0.089	0.089
0.09	-0.082	0.082
0.0933	-0.076	0.076
0.0966	-0.067	0.067
0.1	-0.067	0.067
0.1033	-0.06	0.06
0.1066	-0.057	0.057
0.11	-0.051	0.051
0.1133	-0.051	0.051
0.1166	-0.047	0.047
0.12	-0.047	0.047
0.1233	-0.044	0.044
0.1266	-0.041	0.041
0.13	-0.041	0.041
0.1333	-0.038	0.038
0.1366	-0.038	0.038
0.14	-0.035	0.035
0.1433	-0.035	0.035
0.1466	-0.035	0.035
0.15	-0.031	0.031
0.1533	-0.028	0.028

1666W-1 Rising Head Permeability Test No. 1		
Time (min)	Delta H (ft)	Absolute Value H (ft)
0.1566	-0.028	0.028
0.16	-0.028	0.028
0.1633	-0.031	0.031
0.1666	-0.028	0.028
0.17	-0.025	0.025
0.1733	-0.028	0.028
0.1766	-0.025	0.025
0.18	-0.022	0.022
0.1833	-0.025	0.025
0.1866	-0.022	0.022
0.19	-0.028	0.028
0.1933	-0.022	0.022
0.1966	-0.022	0.022
0.2	-0.022	0.022
0.2033	-0.022	0.022
0.2066	-0.019	0.019
0.21	-0.019	0.019
0.2133	-0.019	0.019
0.2166	-0.022	0.022
0.22	-0.019	0.019
0.2233	-0.015	0.015
0.2266	-0.019	0.019
0.23	-0.019	0.019
0.2333	-0.022	0.022
0.2366	-0.009	0.009
0.24	-0.019	0.019
0.2433	-0.012	0.012
0.2466	-0.015	0.015
0.25	-0.012	0.012
0.2533	-0.015	0.015
0.2566	-0.025	0.025
0.26	-0.019	0.019
0.2633	-0.012	0.012
0.2666	-0.012	0.012
0.27	-0.012	0.012
0.2733	-0.012	0.012
0.2766	-0.015	0.015
0.28	-0.006	0.006
0.2833	-0.009	0.009
0.2866	-0.019	0.019
0.29	-0.012	0.012
0.2933	-0.015	0.015
0.2966	-0.015	0.015
0.3	-0.012	0.012
0.3033	-0.009	0.009
0.3066	-0.012	0.012
0.31	-0.009	0.009

1666W-1 Rising Head Permeability Test No. 1		
Time (min)	Delta H (ft)	Absolute Value H (ft)
0.3133	-0.009	0.009
0.3166	-0.012	0.012
0.32	-0.009	0.009
0.3233	-0.012	0.012
0.3266	-0.015	0.015
0.33	-0.012	0.012
0.3333	-0.009	0.009
0.35	-0.012	0.012
0.3666	-0.012	0.012
0.3833	-0.012	0.012
0.4	-0.009	0.009
0.4166	-0.012	0.012
0.4333	-0.009	0.009
0.45	-0.009	0.009
0.4666	-0.009	0.009
0.4833	-0.009	0.009
0.5	-0.003	0.003
0.5166	-0.006	0.006
0.5333	-0.009	0.009
0.55	-0.009	0.009
0.5666	-0.006	0.006
0.5833	-0.006	0.006
0.6	-0.009	0.009
0.6166	-0.006	0.006
0.6333	-0.006	0.006
0.65	-0.009	0.009
0.6666	-0.009	0.009
0.6833	-0.006	0.006
0.7	-0.006	0.006
0.7166	-0.006	0.006
0.7333	-0.006	0.006
0.75	-0.003	0.003
0.7666	-0.006	0.006
0.7833	-0.006	0.006
0.8	-0.006	0.006
0.8166	-0.006	0.006
0.8333	-0.003	0.003
0.85	-0.003	0.003
0.8666	-0.006	0.006
0.8833	-0.006	0.006
0.9	-0.009	0.009
0.9166	-0.009	0.009
0.9333	-0.006	0.006
0.95	-0.006	0.006
0.9666	-0.009	0.009
0.9833	-0.006	0.006
1	-0.006	0.006

1666W-1 Rising Head Permeability Test No. 1		
Time (min)	Delta H (ft)	Absolute Value H (ft)
1.2	-0.006	0.006
1.4	-0.006	0.006
1.6	-0.006	0.006
1.8	-0.009	0.009
2	-0.006	0.006
2.2	-0.006	0.006
2.4	-0.003	0.003
2.6	-0.003	0.003
2.8	-0.003	0.003
3	-0.003	0.003
3.2	-0.006	0.006
3.4	-0.006	0.006
3.6	-0.006	0.006
3.8	-0.006	0.006
4	-0.003	0.003
4.2	-0.006	0.006
4.4	-0.003	0.003
4.6	-0.006	0.006
4.8	-0.006	0.006
5	-0.006	0.006
5.2	-0.006	0.006
5.4	-0.009	0.009
5.6	-0.006	0.006
5.8	-0.006	0.006
6	-0.003	0.003
6.2	-0.006	0.006
6.4	-0.006	0.006
6.6	-0.003	0.003
6.8	-0.006	0.006
7	-0.003	0.003
7.2	-0.003	0.003
7.4	-0.006	0.006
7.6	-0.003	0.003
7.8	-0.006	0.006
8	-0.003	0.003
8.2	-0.006	0.006
8.4	-0.006	0.006
8.6	-0.006	0.006
8.8	-0.006	0.006
9	-0.006	0.006
9.2	-0.003	0.003
9.4	-0.006	0.006
9.6	-0.006	0.006
9.8	-0.009	0.009
10	-0.009	0.009

1666W-1 Rising Head Permeability Test No. 2		
Time (min)	Delta H (ft)	Absolute Value H (ft)
0	-0.006	0.006
0.0033	-0.006	0.006
0.0066	-0.006	0.006
0.01	-0.006	0.006
0.0133	-0.003	0.003
0.0166	-0.009	0.009
0.02	-0.644	0.644
0.0233	-1.059	1.059
0.0266	-1.033	1.033
0.03	-0.922	0.922
0.0333	-0.306	0.306
0.0366	0.022	0.022
0.04	-0.472	0.472
0.0433	-1.001	1.001
0.0466	-0.797	0.797
0.05	-0.67	0.67
0.0533	-0.567	0.567
0.0566	-0.472	0.472
0.06	-0.398	0.398
0.0633	-0.328	0.328
0.0666	-0.277	0.277
0.07	-0.236	0.236
0.0733	-0.197	0.197
0.0766	-0.172	0.172
0.08	-0.146	0.146
0.0833	-0.134	0.134
0.0866	-0.124	0.124
0.09	-0.105	0.105
0.0933	-0.098	0.098
0.0966	-0.086	0.086
0.1	-0.076	0.076
0.1033	-0.073	0.073
0.1066	-0.07	0.07
0.11	-0.06	0.06
0.1133	-0.057	0.057
0.1166	-0.054	0.054
0.12	-0.051	0.051
0.1233	-0.047	0.047
0.1266	-0.047	0.047
0.13	-0.044	0.044
0.1333	-0.044	0.044
0.1366	-0.041	0.041
0.14	-0.041	0.041
0.1433	-0.038	0.038
0.1466	-0.038	0.038
0.15	-0.031	0.031
0.1533	-0.035	0.035

1666W-1 Rising Head Permeability Test No. 2		
Time (min)	Delta H (ft)	Absolute Value H (ft)
0.1566	-0.031	0.031
0.16	-0.031	0.031
0.1633	-0.028	0.028
0.1666	-0.028	0.028
0.17	-0.028	0.028
0.1733	-0.028	0.028
0.1766	-0.031	0.031
0.18	-0.028	0.028
0.1833	-0.025	0.025
0.1866	-0.022	0.022
0.19	-0.022	0.022
0.1933	-0.022	0.022
0.1966	-0.025	0.025
0.2	-0.022	0.022
0.2033	-0.022	0.022
0.2066	-0.019	0.019
0.21	-0.019	0.019
0.2133	-0.019	0.019
0.2166	-0.022	0.022
0.22	-0.019	0.019
0.2233	-0.019	0.019
0.2266	-0.019	0.019
0.23	-0.019	0.019
0.2333	-0.015	0.015
0.2366	-0.019	0.019
0.24	-0.015	0.015
0.2433	-0.019	0.019
0.2466	-0.015	0.015
0.25	-0.015	0.015
0.2533	-0.015	0.015
0.2566	-0.015	0.015
0.26	-0.015	0.015
0.2633	-0.015	0.015
0.2666	-0.015	0.015
0.27	-0.012	0.012
0.2733	-0.012	0.012
0.2766	-0.015	0.015
0.28	-0.012	0.012
0.2833	-0.015	0.015
0.2866	-0.012	0.012
0.29	-0.012	0.012
0.2933	-0.012	0.012
0.2966	-0.012	0.012
0.3	-0.015	0.015
0.3033	-0.012	0.012
0.3066	-0.012	0.012
0.31	-0.012	0.012

1666W-1 Rising Head Permeability Test No. 2		
Time (min)	Delta H (ft)	Absolute Value H (ft)
0.3133	-0.012	0.012
0.3166	-0.012	0.012
0.32	-0.012	0.012
0.3233	-0.012	0.012
0.3266	-0.012	0.012
0.33	-0.012	0.012
0.3333	-0.012	0.012
0.35	-0.012	0.012
0.3666	-0.012	0.012
0.3833	-0.009	0.009
0.4	-0.009	0.009
0.4166	-0.006	0.006
0.4333	-0.006	0.006
0.45	-0.009	0.009
0.4666	-0.009	0.009
0.4833	-0.006	0.006
0.5	-0.003	0.003
0.5166	-0.006	0.006
0.5333	-0.006	0.006
0.55	-0.006	0.006
0.5666	-0.006	0.006
0.5833	-0.003	0.003
0.6	-0.003	0.003
0.6166	-0.006	0.006
0.6333	-0.006	0.006
0.65	-0.006	0.006
0.6666	-0.003	0.003
0.6833	-0.006	0.006
0.7	-0.006	0.006
0.7166	-0.006	0.006
0.7333	-0.006	0.006
0.75	-0.006	0.006
0.7666	-0.006	0.006
0.7833	-0.003	0.003
0.8	-0.006	0.006
0.8166	-0.006	0.006
0.8333	-0.006	0.006
0.85	-0.006	0.006
0.8666	-0.003	0.003
0.8833	-0.009	0.009
0.9	-0.009	0.009
0.9166	-0.006	0.006
0.9333	-0.009	0.009
0.95	-0.006	0.006
0.9666	-0.006	0.006
0.9833	-0.006	0.006
1	-0.006	0.006

1666W-1 Rising Head Permeability Test No. 2		
Time (min)	Delta H (ft)	Absolute Value H (ft)
1.2	-0.003	0.003
1.4	-0.006	0.006
1.6	-0.006	0.006
1.8	-0.006	0.006
2	-0.003	0.003
2.2	-0.003	0.003
2.4	-0.006	0.006
2.6	-0.006	0.006
2.8	-0.006	0.006
3	-0.006	0.006
3.2	-0.006	0.006
3.4	-0.006	0.006
3.6	-0.006	0.006

BDM-96-01X Rising Head Permeability Test No. 1		
Time (min)	Delta H (ft)	Absolute Value H (ft)
0	0.003	0.003
0.0033	0.006	0.006
0.0066	0.003	0.003
0.01	0.003	0.003
0.0133	0.003	0.003
0.0166	-0.051	0.051
0.02	-0.274	0.274
0.0233	-0.468	0.468
0.0266	-0.905	0.905
0.03	-0.545	0.545
0.0333	-0.577	0.577
0.0366	-1.29	1.29
0.04	-0.898	0.898
0.0433	-0.816	0.816
0.0466	-0.723	0.723
0.05	-0.631	0.631
0.0533	-0.554	0.554
0.0566	-0.487	0.487
0.06	-0.43	0.43
0.0633	-0.379	0.379
0.0666	-0.328	0.328
0.07	-0.293	0.293
0.0733	-0.261	0.261
0.0766	-0.232	0.232
0.08	-0.21	0.21
0.0833	-0.184	0.184
0.0866	-0.168	0.168
0.09	-0.153	0.153
0.0933	-0.137	0.137
0.0966	-0.124	0.124
0.1	-0.114	0.114
0.1033	-0.102	0.102
0.1066	-0.095	0.095
0.11	-0.086	0.086
0.1133	-0.079	0.079
0.1166	-0.073	0.073
0.12	-0.07	0.07
0.1233	-0.063	0.063
0.1266	-0.057	0.057
0.13	-0.054	0.054
0.1333	-0.051	0.051
0.1366	-0.047	0.047
0.14	-0.044	0.044
0.1433	-0.041	0.041
0.1466	-0.038	0.038
0.15	-0.035	0.035
0.1533	-0.031	0.031

BDM-96-01X Rising Head Permeability Test No. 1		
Time (min)	Delta H (ft)	Absolute Value H (ft)
0.1566	-0.031	0.031
0.16	-0.031	0.031
0.1633	-0.028	0.028
0.1666	-0.028	0.028
0.17	-0.025	0.025
0.1733	-0.025	0.025
0.1766	-0.022	0.022
0.18	-0.022	0.022
0.1833	-0.022	0.022
0.1866	-0.022	0.022
0.19	-0.019	0.019
0.1933	-0.015	0.015
0.1966	-0.015	0.015
0.2	-0.015	0.015
0.2033	-0.015	0.015
0.2066	-0.015	0.015
0.21	-0.012	0.012
0.2133	-0.015	0.015
0.2166	-0.012	0.012
0.22	-0.012	0.012
0.2233	-0.012	0.012
0.2266	-0.009	0.009
0.23	-0.009	0.009
0.2333	-0.012	0.012
0.2366	-0.009	0.009
0.24	-0.009	0.009
0.2433	-0.009	0.009
0.2466	-0.009	0.009
0.25	-0.009	0.009
0.2533	-0.006	0.006
0.2566	-0.009	0.009
0.26	-0.006	0.006
0.2633	-0.006	0.006
0.2666	-0.009	0.009
0.27	-0.009	0.009
0.2733	-0.006	0.006
0.2766	-0.006	0.006
0.28	-0.006	0.006
0.2833	-0.006	0.006
0.2866	-0.003	0.003
0.29	-0.003	0.003
0.2933	-0.006	0.006
0.2966	-0.003	0.003
0.3	-0.003	0.003
0.3033	-0.003	0.003
0.3066	0	0
0.31	-0.003	0.003

BDM-96-01X Rising Head Permeability Test No. 1		
Time (min)	Delta H (ft)	Absolute Value H (ft)
0.3133	-0.006	0.006
0.3166	-0.003	0.003
0.32	0	0
0.3233	-0.003	0.003
0.3266	-0.003	0.003
0.33	-0.003	0.003
0.3333	-0.003	0.003
0.35	-0.003	0.003
0.3666	-0.003	0.003
0.3833	0	0
0.4	0	0
0.4166	-0.003	0.003
0.4333	0.003	0.003
0.45	0	0
0.4666	-0.003	0.003
0.4833	0.003	0.003
0.5	0	0
0.5166	0.003	0.003
0.5333	0.003	0.003
0.55	0.003	0.003
0.5666	0	0
0.5833	0	0
0.6	0.003	0.003
0.6166	0	0
0.6333	0.003	0.003
0.65	0	0
0.6666	0.003	0.003
0.6833	0.003	0.003
0.7	0	0
0.7166	0.003	0.003
0.7333	0.003	0.003
0.75	0.003	0.003
0.7666	0.003	0.003
0.7833	0.003	0.003
0.8	0.003	0.003
0.8166	0	0
0.8333	0.003	0.003
0.85	0.006	0.006
0.8666	0.003	0.003
0.8833	0.003	0.003
0.9	0.003	0.003
0.9166	0.003	0.003
0.9333	0.003	0.003
0.95	0	0
0.9666	0.006	0.006
0.9833	0.003	0.003
1	0.003	0.003

BDM-96-01X Rising Head Permeability Test No. 1		
Time (min)	Delta H (ft)	Absolute Value H (ft)
1.2	0.003	0.003
1.4	0	0
1.6	0	0
1.8	0.003	0.003
2	0.003	0.003
2.2	0.003	0.003
2.4	0	0
2.6	0	0
2.8	0.003	0.003
3	0.003	0.003
3.2	0.003	0.003
3.4	0	0
3.6	0.003	0.003
3.8	0	0
4	0.003	0.003
4.2	0.003	0.003
4.4	0.003	0.003
4.6	0	0
4.8	0.003	0.003
5	0.003	0.003
5.2	0.003	0.003
5.4	0.003	0.003

BDM-96-01X Rising Head Permeability Test No. 2		
Time (min)	Delta H (ft)	Absolute Value H (ft)
0	0.003	0.003
0.0033	0.006	0.006
0.0066	0.006	0.006
0.01	0.006	0.006
0.0133	0.012	0.012
0.0166	0.003	0.003
0.02	0.019	0.019
0.0233	-0.184	0.184
0.0266	-1.045	1.045
0.03	-1.166	1.166
0.0333	-0.251	0.251
0.0366	-0.29	0.29
0.04	-1.032	1.032
0.0433	-1.067	1.067
0.0466	-0.886	0.886
0.05	-0.774	0.774
0.0533	-0.675	0.675
0.0566	-0.592	0.592
0.06	-0.516	0.516
0.0633	-0.455	0.455
0.0666	-0.401	0.401
0.07	-0.353	0.353
0.0733	-0.312	0.312
0.0766	-0.277	0.277
0.08	-0.248	0.248
0.0833	-0.219	0.219
0.0866	-0.197	0.197
0.09	-0.175	0.175
0.0933	-0.159	0.159
0.0966	-0.143	0.143
0.1	-0.13	0.13
0.1033	-0.117	0.117
0.1066	-0.108	0.108
0.11	-0.098	0.098
0.1133	-0.092	0.092
0.1166	-0.086	0.086
0.12	-0.076	0.076
0.1233	-0.073	0.073
0.1266	-0.066	0.066
0.13	-0.063	0.063
0.1333	-0.057	0.057
0.1366	-0.051	0.051
0.14	-0.054	0.054
0.1433	-0.047	0.047
0.1466	-0.044	0.044
0.15	-0.041	0.041
0.1533	-0.038	0.038

BDM-96-01X Rising Head Permeability Test No. 2		
Time (min)	Delta H (ft)	Absolute Value H (ft)
0.1566	-0.035	0.035
0.16	-0.038	0.038
0.1633	-0.035	0.035
0.1666	-0.028	0.028
0.17	-0.031	0.031
0.1733	-0.031	0.031
0.1766	-0.028	0.028
0.18	-0.025	0.025
0.1833	-0.025	0.025
0.1866	-0.025	0.025
0.19	-0.022	0.022
0.1933	-0.019	0.019
0.1966	-0.022	0.022
0.2	-0.022	0.022
0.2033	-0.019	0.019
0.2066	-0.019	0.019
0.21	-0.015	0.015
0.2133	-0.019	0.019
0.2166	-0.015	0.015
0.22	-0.015	0.015
0.2233	-0.012	0.012
0.2266	-0.015	0.015
0.23	-0.012	0.012
0.2333	-0.012	0.012
0.2366	-0.009	0.009
0.24	-0.012	0.012
0.2433	-0.012	0.012
0.2466	-0.012	0.012
0.25	-0.009	0.009
0.2533	-0.009	0.009
0.2566	-0.009	0.009
0.26	-0.006	0.006
0.2633	-0.009	0.009
0.2666	-0.009	0.009
0.27	-0.006	0.006
0.2733	-0.009	0.009
0.2766	-0.006	0.006
0.28	-0.009	0.009
0.2833	-0.006	0.006
0.2866	-0.006	0.006
0.29	-0.006	0.006
0.2933	-0.006	0.006
0.2966	-0.006	0.006
0.3	-0.006	0.006
0.3033	-0.006	0.006
0.3066	-0.003	0.003
0.31	-0.006	0.006

BDM-96-01X Rising Head Permeability Test No. 2		
Time (min)	Delta H (ft)	Absolute Value H (ft)
0.3133	-0.006	0.006
0.3166	-0.003	0.003
0.32	-0.006	0.006
0.3233	-0.006	0.006
0.3266	-0.003	0.003
0.33	-0.003	0.003
0.3333	-0.006	0.006
0.35	-0.003	0.003
0.3666	-0.003	0.003
0.3833	0	0
0.4	0	0
0.4166	-0.003	0.003
0.4333	0	0
0.45	0	0
0.4666	0	0
0.4833	0	0
0.5	0	0
0.5166	0	0
0.5333	0	0
0.55	0	0
0.5666	0	0
0.5833	0.003	0.003
0.6	0.003	0.003
0.6166	0.003	0.003
0.6333	0	0
0.65	0	0
0.6666	0.003	0.003
0.6833	0	0
0.7	0	0
0.7166	0.003	0.003
0.7333	0.003	0.003
0.75	0.003	0.003
0.7666	0.003	0.003
0.7833	0.003	0.003
0.8	0.003	0.003
0.8166	0	0
0.8333	0.003	0.003
0.85	0.003	0.003
0.8666	0.003	0.003
0.8833	0.003	0.003
0.9	0	0
0.9166	0	0
0.9333	0	0
0.95	0.003	0.003
0.9666	0.003	0.003
0.9833	0	0
1	0.003	0.003

BDM-96-01X Rising Head Permeability Test No. 2		
Time (min)	Delta H (ft)	Absolute Value H (ft)
1.2	0.003	0.003
1.4	0.003	0.003
1.6	0	0
1.8	0.003	0.003
2	0.003	0.003
2.2	0.003	0.003
2.4	0.003	0.003
2.6	0.003	0.003
2.8	0.003	0.003
3	0.003	0.003
3.2	0.003	0.003
3.4	0.003	0.003

BDM-96-02X Rising Head Permeability Test No. 1		
Time (min)	Delta H (ft)	Absolute Value H (ft)
0	0.006	0.006
0.0033	0.003	0.003
0.0066	0.006	0.006
0.01	0.006	0.006
0.0133	0	0
0.0166	-0.28	0.28
0.02	-0.64	0.64
0.0233	-0.567	0.567
0.0266	-0.462	0.462
0.03	-0.341	0.341
0.0333	-0.216	0.216
0.0366	-0.108	0.108
0.04	-0.051	0.051
0.0433	-0.006	0.006
0.0466	-0.019	0.019
0.05	0	0
0.0533	-0.015	0.015
0.0566	-0.009	0.009
0.06	-0.015	0.015
0.0633	-0.022	0.022
0.0666	-0.022	0.022
0.07	-0.012	0.012
0.0733	-0.012	0.012
0.0766	-0.009	0.009
0.08	-0.009	0.009
0.0833	-0.009	0.009
0.0866	-0.009	0.009
0.09	-0.003	0.003
0.0933	-0.003	0.003
0.0966	-0.003	0.003
0.1	-0.003	0.003
0.1033	-0.003	0.003
0.1066	0	0
0.11	0	0
0.1133	-0.003	0.003
0.1166	0	0
0.12	0	0
0.1233	-0.003	0.003
0.1266	0	0
0.13	0	0
0.1333	0	0
0.1366	-0.003	0.003
0.14	0.003	0.003
0.1433	-0.003	0.003
0.1466	0	0
0.15	0.003	0.003
0.1533	0	0

BDM-96-02X Rising Head Permeability Test No. 1		
Time (min)	Delta H (ft)	Absolute Value H (ft)
0.1566	0.003	0.003
0.16	0	0
0.1633	0	0
0.1666	0.003	0.003
0.17	0	0
0.1733	0.003	0.003
0.1766	0.003	0.003
0.18	0.003	0.003
0.1833	0.003	0.003
0.1866	0.003	0.003
0.19	0.003	0.003
0.1933	0.003	0.003
0.1966	0.003	0.003
0.2	0.003	0.003
0.2033	0.003	0.003
0.2066	0.003	0.003
0.21	0.003	0.003
0.2133	0.003	0.003
0.2166	0.006	0.006
0.22	0.003	0.003
0.2233	0.003	0.003
0.2266	0.003	0.003
0.23	0.003	0.003
0.2333	0.003	0.003
0.2366	0.003	0.003
0.24	0.003	0.003
0.2433	0.003	0.003
0.2466	0.003	0.003
0.25	0.003	0.003
0.2533	0.003	0.003
0.2566	0.003	0.003
0.26	0.006	0.006
0.2633	0.003	0.003
0.2666	0.003	0.003
0.27	0.003	0.003
0.2733	0.003	0.003
0.2766	0.003	0.003
0.28	0	0
0.2833	0.003	0.003
0.2866	0.003	0.003
0.29	0	0
0.2933	0.003	0.003
0.2966	0.006	0.006
0.3	0.003	0.003
0.3033	0.003	0.003
0.3066	0.003	0.003
0.31	0.003	0.003

BDM-96-02X Rising Head Permeability Test No. 1		
Time (min)	Delta H (ft)	Absolute Value H (ft)
0.3133	0	0
0.3166	0.003	0.003
0.32	0.003	0.003
0.3233	0.003	0.003
0.3266	0.003	0.003
0.33	0.003	0.003
0.3333	0.003	0.003
0.35	0.003	0.003
0.3666	0.003	0.003
0.3833	0.006	0.006
0.4	0.003	0.003
0.4166	0.003	0.003
0.4333	0	0
0.45	0.003	0.003
0.4666	0.003	0.003
0.4833	0.006	0.006
0.5	0.003	0.003
0.5166	0.003	0.003
0.5333	0.003	0.003
0.55	0.006	0.006
0.5666	0.003	0.003
0.5833	0.003	0.003
0.6	0.003	0.003
0.6166	0.006	0.006
0.6333	0.003	0.003
0.65	0.003	0.003
0.6666	0.003	0.003
0.6833	0.006	0.006
0.7	0.006	0.006
0.7166	0.003	0.003
0.7333	0.003	0.003
0.75	0.003	0.003
0.7666	0.003	0.003
0.7833	0.003	0.003
0.8	0.003	0.003
0.8166	0.003	0.003
0.8333	0.003	0.003
0.85	0.003	0.003
0.8666	0.003	0.003
0.8833	0.003	0.003
0.9	0.003	0.003
0.9166	0.003	0.003
0.9333	0.003	0.003
0.95	0.003	0.003
0.9666	0.003	0.003
0.9833	0	0
1	0.003	0.003

BDM-96-02X Rising Head Permeability Test No. 1		
Time (min)	Delta H (ft)	Absolute Value H (ft)
1.2	0.006	0.006
1.4	0.006	0.006
1.6	0.006	0.006
1.8	0.003	0.003
2	0.006	0.006
2.2	0.003	0.003
2.4	0.003	0.003
2.6	0.006	0.006
2.8	0.006	0.006
3	0.003	0.003
3.2	0.003	0.003
3.4	0.006	0.006
3.6	0.006	0.006
3.8	0.003	0.003
4	0.006	0.006
4.2	0.006	0.006
4.4	0.006	0.006
4.6	0.003	0.003

BDM-96-02X Rising Head Permeability Test No. 2		
Time (min)	Delta H (ft)	Absolute Value H (ft)
0	0.009	0.009
0.0033	0.009	0.009
0.0066	0.028	0.028
0.01	0.006	0.006
0.0133	-0.146	0.146
0.0166	-0.318	0.318
0.02	-0.538	0.538
0.0233	-0.43	0.43
0.0266	-0.341	0.341
0.03	-0.328	0.328
0.0333	-0.267	0.267
0.0366	-0.178	0.178
0.04	-0.102	0.102
0.0433	-0.098	0.098
0.0466	-0.012	0.012
0.05	-0.006	0.006
0.0533	-0.019	0.019
0.0566	0.003	0.003
0.06	-0.022	0.022
0.0633	0	0
0.0666	-0.035	0.035
0.07	-0.015	0.015
0.0733	-0.006	0.006
0.0766	-0.015	0.015
0.08	-0.015	0.015
0.0833	-0.006	0.006
0.0866	-0.012	0.012
0.09	-0.003	0.003
0.0933	-0.003	0.003
0.0966	-0.009	0.009
0.1	-0.003	0.003
0.1033	-0.003	0.003
0.1066	-0.006	0.006
0.11	-0.006	0.006
0.1133	-0.003	0.003
0.1166	-0.003	0.003
0.12	-0.006	0.006
0.1233	-0.003	0.003
0.1266	-0.003	0.003
0.13	-0.006	0.006
0.1333	0	0
0.1366	-0.003	0.003
0.14	-0.003	0.003
0.1433	-0.006	0.006
0.1466	-0.003	0.003
0.15	-0.006	0.006
0.1533	-0.003	0.003

BDM-96-02X Rising Head Permeability Test No. 2		
Time (min)	Delta H (ft)	Absolute Value H (ft)
0.1566	-0.003	0.003
0.16	-0.003	0.003
0.1633	0	0
0.1666	-0.003	0.003
0.17	-0.006	0.006
0.1733	0.003	0.003
0.1766	0.003	0.003
0.18	0.003	0.003
0.1833	0.003	0.003
0.1866	0.006	0.006
0.19	0.003	0.003
0.1933	0.003	0.003
0.1966	0.003	0.003
0.2	0.003	0.003
0.2033	0.003	0.003
0.2066	0.006	0.006
0.21	0.006	0.006
0.2133	0.006	0.006
0.2166	0.003	0.003
0.22	0.003	0.003
0.2233	0.006	0.006
0.2266	0.006	0.006
0.23	0.003	0.003
0.2333	0.006	0.006
0.2366	0.003	0.003
0.24	0	0
0.2433	0.006	0.006
0.2466	0.006	0.006
0.25	0.006	0.006
0.2533	0.006	0.006
0.2566	0.006	0.006
0.26	0.003	0.003
0.2633	0.006	0.006
0.2666	0.006	0.006
0.27	0.006	0.006
0.2733	0.006	0.006
0.2766	0.006	0.006
0.28	0.006	0.006
0.2833	0.003	0.003
0.2866	0.006	0.006
0.29	0.006	0.006
0.2933	0.006	0.006
0.2966	0.006	0.006
0.3	0.006	0.006
0.3033	0.006	0.006
0.3066	0.003	0.003
0.31	0.006	0.006

BDM-96-02X Rising Head Permeability Test No. 2		
Time (min)	Delta H (ft)	Absolute Value H (ft)
0.3133	0.006	0.006
0.3166	0.003	0.003
0.32	0.006	0.006
0.3233	0.006	0.006
0.3266	0.006	0.006
0.33	0.006	0.006
0.3333	0.006	0.006
0.35	0.003	0.003
0.3666	0.003	0.003
0.3833	0.006	0.006
0.4	0.006	0.006
0.4166	0.006	0.006
0.4333	0.006	0.006
0.45	0.006	0.006
0.4666	0.003	0.003
0.4833	0.006	0.006
0.5	0.006	0.006
0.5166	0.006	0.006
0.5333	0.006	0.006
0.55	0.006	0.006
0.5666	0.006	0.006
0.5833	0.003	0.003
0.6	0.006	0.006
0.6166	0.006	0.006
0.6333	0.006	0.006
0.65	0.006	0.006
0.6666	0.006	0.006
0.6833	0.006	0.006
0.7	0.006	0.006
0.7166	0.006	0.006
0.7333	0.006	0.006
0.75	0.006	0.006
0.7666	0.006	0.006
0.7833	0.006	0.006
0.8	0.006	0.006
0.8166	0.006	0.006
0.8333	0.006	0.006
0.85	0.006	0.006
0.8666	0.006	0.006
0.8833	0.003	0.003
0.9	0.003	0.003
0.9166	0.006	0.006
0.9333	0.006	0.006
0.95	0.006	0.006
0.9666	0.006	0.006
0.9833	0.003	0.003
1	0.003	0.003

BDM-96-02X Rising Head Permeability Test No. 2		
Time (min)	Delta H (ft)	Absolute Value H (ft)
1.2	0.006	0.006
1.4	0.003	0.003
1.6	0.003	0.003
1.8	0.006	0.006
2	0.006	0.006
2.2	0.006	0.006
2.4	0.006	0.006
2.6	0.006	0.006
2.8	0.006	0.006

BDM-96-03X Rising Head Permeability Test No. 1		
Time (min)	Delta H (ft)	Absolute Value H (ft)
0	0.028	0.028
0.0033	0.041	0.041
0.0066	-0.927	0.927
0.01	-1.354	1.354
0.0133	-1.039	1.039
0.0166	-0.637	0.637
0.02	-0.471	0.471
0.0233	-0.309	0.309
0.0266	-0.156	0.156
0.03	-0.079	0.079
0.0333	-0.003	0.003
0.0366	0	0
0.04	0.015	0.015
0.0433	0.019	0.019
0.0466	0.006	0.006
0.05	0.012	0.012
0.0533	0.006	0.006
0.0566	0.009	0.009
0.06	0.009	0.009
0.0633	0.012	0.012
0.0666	0.012	0.012
0.07	0.009	0.009
0.0733	0.015	0.015
0.0766	0.012	0.012
0.08	0.012	0.012
0.0833	0.015	0.015
0.0866	0.015	0.015
0.09	0.019	0.019
0.0933	0.019	0.019
0.0966	0.019	0.019
0.1	0.015	0.015
0.1033	0.028	0.028
0.1066	0.025	0.025
0.11	0.025	0.025
0.1133	0.022	0.022
0.1166	0.028	0.028
0.12	0.028	0.028
0.1233	0.025	0.025
0.1266	0.028	0.028
0.13	0.035	0.035
0.1333	0.025	0.025
0.1366	0.031	0.031
0.14	0.028	0.028
0.1433	0.025	0.025
0.1466	0.028	0.028
0.15	0.025	0.025
0.1533	0.028	0.028

BDM-96-03X Rising Head Permeability Test No. 1		
Time (min)	Delta H (ft)	Absolute Value H (ft)
0.1566	0.028	0.028
0.16	0.028	0.028
0.1633	0.028	0.028
0.1666	0.031	0.031
0.17	0.028	0.028
0.1733	0.028	0.028
0.1766	0.025	0.025
0.18	0.028	0.028
0.1833	0.028	0.028
0.1866	0.028	0.028
0.19	0.028	0.028
0.1933	0.028	0.028
0.1966	0.028	0.028
0.2	0.025	0.025
0.2033	0.025	0.025
0.2066	0.025	0.025
0.21	0.025	0.025
0.2133	0.028	0.028
0.2166	0.028	0.028
0.22	0.028	0.028
0.2233	0.028	0.028
0.2266	0.028	0.028
0.23	0.028	0.028
0.2333	0.028	0.028
0.2366	0.028	0.028
0.24	0.028	0.028
0.2433	0.028	0.028
0.2466	0.028	0.028
0.25	0.028	0.028
0.2533	0.031	0.031
0.2566	0.028	0.028
0.26	0.028	0.028
0.2633	0.028	0.028
0.2666	0.028	0.028
0.27	0.031	0.031
0.2733	0.028	0.028
0.2766	0.028	0.028
0.28	0.028	0.028
0.2833	0.028	0.028
0.2866	0.028	0.028
0.29	0.028	0.028
0.2933	0.028	0.028
0.2966	0.028	0.028
0.3	0.025	0.025
0.3033	0.028	0.028
0.3066	0.031	0.031
0.31	0.031	0.031

BDM-96-03X Rising Head Permeability Test No. 1		
Time (min)	Delta H (ft)	Absolute Value H (ft)
0.3133	0.028	0.028
0.3166	0.028	0.028
0.32	0.028	0.028
0.3233	0.028	0.028
0.3266	0.028	0.028
0.33	0.028	0.028
0.3333	0.028	0.028
0.35	0.028	0.028
0.3666	0.028	0.028
0.3833	0.028	0.028
0.4	0.028	0.028
0.4166	0.028	0.028
0.4333	0.031	0.031
0.45	0.028	0.028
0.4666	0.031	0.031
0.4833	0.028	0.028
0.5	0.025	0.025
0.5166	0.028	0.028
0.5333	0.028	0.028
0.55	0.028	0.028
0.5666	0.028	0.028
0.5833	0.031	0.031
0.6	0.031	0.031
0.6166	0.028	0.028
0.6333	0.028	0.028
0.65	0.028	0.028
0.6666	0.028	0.028
0.6833	0.028	0.028
0.7	0.028	0.028
0.7166	0.031	0.031
0.7333	0.031	0.031
0.75	0.028	0.028
0.7666	0.031	0.031
0.7833	0.031	0.031
0.8	0.028	0.028
0.8166	0.031	0.031
0.8333	0.031	0.031
0.85	0.028	0.028
0.8666	0.031	0.031
0.8833	0.031	0.031
0.9	0.028	0.028
0.9166	0.028	0.028
0.9333	0.028	0.028
0.95	0.031	0.031
0.9666	0.028	0.028
0.9833	0.031	0.031
1	0.031	0.031

BDM-96-03X Rising Head Permeability Test No. 1		
Time (min)	Delta H (ft)	Absolute Value H (ft)
1.2	0.031	0.031
1.4	0.031	0.031
1.6	0.035	0.035
1.8	0.028	0.028
2	0.031	0.031
2.2	0.031	0.031
2.4	0.031	0.031
2.6	0.028	0.028
2.8	0.035	0.035
3	0.031	0.031
3.2	0.028	0.028
3.4	0.031	0.031
3.6	0.031	0.031
3.8	0.028	0.028
4	0.031	0.031
4.2	0.031	0.031
4.4	0.028	0.028
4.6	0.031	0.031
4.8	0.031	0.031
5	0.031	0.031
5.2	0.031	0.031
5.4	0.031	0.031
5.6	0.028	0.028
5.8	0.025	0.025
6	0.031	0.031
6.2	0.025	0.025
6.4	0.028	0.028
6.6	0.028	0.028
6.8	0.028	0.028
7	0.028	0.028
7.2	0.031	0.031
7.4	0.028	0.028
7.6	0.028	0.028
7.8	0.031	0.031
8	0.028	0.028
8.2	0.031	0.031
8.4	0.028	0.028
8.6	0.028	0.028
8.8	0.028	0.028
9	0.022	0.022
9.2	0.028	0.028
9.4	0.028	0.028
9.6	0.031	0.031
9.8	0.022	0.022
10	0.028	0.028
12	0.025	0.025

BDM-96-03X Rising Head Permeability Test No. 2		
Time (min)	Delta H (ft)	Absolute Value H (ft)
0	0.003	0.003
0.0033	0.003	0.003
0.0066	0.003	0.003
0.01	0.003	0.003
0.0133	0.006	0.006
0.0166	0.009	0.009
0.02	0.003	0.003
0.0233	0.006	0.006
0.0266	0.006	0.006
0.03	0.003	0.003
0.0333	0.003	0.003
0.0366	0.006	0.006
0.04	0.006	0.006
0.0433	0.076	0.076
0.0466	0.038	0.038
0.05	-0.404	0.404
0.0533	-0.532	0.532
0.0566	-0.401	0.401
0.06	-0.379	0.379
0.0633	-0.28	0.28
0.0666	-0.178	0.178
0.07	-0.07	0.07
0.0733	-0.047	0.047
0.0766	-0.006	0.006
0.08	0.006	0.006
0.0833	-0.003	0.003
0.0866	-0.003	0.003
0.09	-0.031	0.031
0.0933	-0.031	0.031
0.0966	-0.031	0.031
0.1	-0.063	0.063
0.1033	-0.028	0.028
0.1066	-0.015	0.015
0.11	-0.025	0.025
0.1133	-0.019	0.019
0.1166	-0.006	0.006
0.12	0	0
0.1233	-0.022	0.022
0.1266	-0.028	0.028
0.13	-0.015	0.015
0.1333	-0.025	0.025
0.1366	-0.025	0.025
0.14	-0.009	0.009
0.1433	-0.019	0.019
0.1466	-0.025	0.025
0.15	0.006	0.006
0.1533	-0.012	0.012

BDM-96-03X Rising Head Permeability Test No. 2		
Time (min)	Delta H (ft)	Absolute Value H (ft)
0.1566	-0.006	0.006
0.16	-0.012	0.012
0.1633	-0.006	0.006
0.1666	-0.006	0.006
0.17	-0.009	0.009
0.1733	-0.006	0.006
0.1766	-0.009	0.009
0.18	-0.009	0.009
0.1833	-0.009	0.009
0.1866	-0.009	0.009
0.19	-0.009	0.009
0.1933	-0.009	0.009
0.1966	-0.009	0.009
0.2	-0.009	0.009
0.2033	-0.009	0.009
0.2066	-0.006	0.006
0.21	-0.009	0.009
0.2133	-0.006	0.006
0.2166	-0.006	0.006
0.22	-0.009	0.009
0.2233	-0.009	0.009
0.2266	-0.009	0.009
0.23	-0.006	0.006
0.2333	-0.006	0.006
0.2366	-0.009	0.009
0.24	-0.006	0.006
0.2433	-0.006	0.006
0.2466	-0.006	0.006
0.25	-0.006	0.006
0.2533	-0.006	0.006
0.2566	-0.006	0.006
0.26	-0.006	0.006
0.2633	-0.006	0.006
0.2666	-0.009	0.009
0.27	-0.006	0.006
0.2733	-0.006	0.006
0.2766	-0.006	0.006
0.28	-0.003	0.003
0.2833	-0.006	0.006
0.2866	0	0
0.29	-0.003	0.003
0.2933	-0.003	0.003
0.2966	-0.003	0.003
0.3	-0.003	0.003
0.3033	-0.003	0.003
0.3066	0.003	0.003
0.31	0	0

BDM-96-03X Rising Head Permeability Test No. 2		
Time (min)	Delta H (ft)	Absolute Value H (ft)
0.3133	0	0
0.3166	0	0
0.32	-0.003	0.003
0.3233	0	0
0.3266	-0.003	0.003
0.33	0	0
0.3333	0	0
0.35	0	0
0.3666	0	0
0.3833	0	0
0.4	0	0
0.4166	-0.003	0.003
0.4333	-0.003	0.003
0.45	-0.003	0.003
0.4666	0	0
0.4833	0	0
0.5	0	0
0.5166	0	0
0.5333	-0.003	0.003
0.55	0	0
0.5666	0	0
0.5833	-0.003	0.003
0.6	0	0
0.6166	0	0
0.6333	0	0
0.65	0	0
0.6666	0.003	0.003
0.6833	-0.003	0.003
0.7	0	0
0.7166	-0.003	0.003
0.7333	0	0
0.75	0	0
0.7666	0	0
0.7833	0	0
0.8	0	0
0.8166	0	0
0.8333	0	0
0.85	0	0
0.8666	0	0
0.8833	-0.003	0.003
0.9	-0.003	0.003
0.9166	0	0
0.9333	0	0
0.95	0	0
0.9666	0	0
0.9833	0	0
1	-0.003	0.003

BDM-96-03X Rising Head Permeability Test No. 2		
Time (min)	Delta H (ft)	Absolute Value H (ft)
1.2	0	0
1.4	0	0
1.6	0	0
1.8	0	0
2	0	0
2.2	0	0
2.4	0	0
2.6	-0.003	0.003
2.8	0.003	0.003
3	0.003	0.003

BDM-96-03X Rising Head Permeability Test No. 3		
Time (min)	Delta H (ft)	Absolute Value H (ft)
0	0.012	0.012
0.0033	0.015	0.015
0.0066	0.015	0.015
0.01	0.012	0.012
0.0133	0.015	0.015
0.0166	0.066	0.066
0.02	-0.258	0.258
0.0233	-0.462	0.462
0.0266	-0.427	0.427
0.03	-0.392	0.392
0.0333	-0.331	0.331
0.0366	-0.226	0.226
0.04	-0.121	0.121
0.0433	-0.057	0.057
0.0466	-0.003	0.003
0.05	0.022	0.022
0.0533	0.022	0.022
0.0566	0.015	0.015
0.06	0.009	0.009
0.0633	-0.003	0.003
0.0666	0	0
0.07	-0.009	0.009
0.0733	0.012	0.012
0.0766	-0.003	0.003
0.08	0.006	0.006
0.0833	0	0
0.0866	0.003	0.003
0.09	0.006	0.006
0.0933	0.003	0.003
0.0966	0.003	0.003
0.1	0.006	0.006
0.1033	0.006	0.006
0.1066	0.006	0.006
0.11	0.003	0.003
0.1133	0.003	0.003
0.1166	0.006	0.006
0.12	0.003	0.003
0.1233	0.006	0.006
0.1266	0.006	0.006
0.13	0.006	0.006
0.1333	0.006	0.006
0.1366	0.006	0.006
0.14	0.006	0.006
0.1433	0.006	0.006
0.1466	0.003	0.003
0.15	0.003	0.003
0.1533	0.006	0.006

BDM-96-03X Rising Head Permeability Test No. 3		
Time (min)	Delta H (ft)	Absolute Value H (ft)
0.1566	0.006	0.006
0.16	0.006	0.006
0.1633	0.006	0.006
0.1666	0.006	0.006
0.17	0.003	0.003
0.1733	0.006	0.006
0.1766	0.009	0.009
0.18	0.006	0.006
0.1833	0.006	0.006
0.1866	0.006	0.006
0.19	0.006	0.006
0.1933	0.006	0.006
0.1966	0.006	0.006
0.2	0.009	0.009
0.2033	0.006	0.006
0.2066	0.009	0.009
0.21	0.009	0.009
0.2133	0.006	0.006
0.2166	0.006	0.006
0.22	0.006	0.006
0.2233	0.006	0.006
0.2266	0.003	0.003
0.23	0.009	0.009
0.2333	0.006	0.006
0.2366	0.006	0.006
0.24	0.006	0.006
0.2433	0.009	0.009
0.2466	0.006	0.006
0.25	0.009	0.009
0.2533	0.006	0.006
0.2566	0.009	0.009
0.26	0.012	0.012
0.2633	0.006	0.006
0.2666	0.009	0.009
0.27	0.006	0.006
0.2733	0.006	0.006
0.2766	0.006	0.006
0.28	0.009	0.009
0.2833	0.006	0.006
0.2866	0.009	0.009
0.29	0.006	0.006
0.2933	0.009	0.009
0.2966	0.009	0.009
0.3	0.009	0.009
0.3033	0.009	0.009
0.3066	0.009	0.009
0.31	0.006	0.006

BDM-96-03X Rising Head Permeability Test No. 3		
Time (min)	Delta H (ft)	Absolute Value H (ft)
0.3133	0.006	0.006
0.3166	0.009	0.009
0.32	0.006	0.006
0.3233	0.009	0.009
0.3266	0.006	0.006
0.33	0.006	0.006
0.3333	0.006	0.006
0.35	0.006	0.006
0.3666	0.006	0.006
0.3833	0.006	0.006
0.4	0.006	0.006
0.4166	0.009	0.009
0.4333	0.006	0.006
0.45	0.009	0.009
0.4666	0.009	0.009
0.4833	0.006	0.006
0.5	0.009	0.009
0.5166	0.006	0.006
0.5333	0.009	0.009
0.55	0.009	0.009
0.5666	0.009	0.009
0.5833	0.012	0.012
0.6	0.009	0.009
0.6166	0.009	0.009
0.6333	0.009	0.009
0.65	0.006	0.006
0.6666	0.009	0.009
0.6833	0.009	0.009
0.7	0.006	0.006
0.7166	0.006	0.006
0.7333	0.009	0.009
0.75	0.009	0.009
0.7666	0.009	0.009
0.7833	0.009	0.009
0.8	0.006	0.006
0.8166	0.009	0.009
0.8333	0.009	0.009
0.85	0.009	0.009
0.8666	0.009	0.009
0.8833	0.009	0.009
0.9	0.006	0.006
0.9166	0.009	0.009
0.9333	0.009	0.009
0.95	0.009	0.009
0.9666	0.006	0.006
0.9833	0.009	0.009
1	0.009	0.009

BDM-96-03X Rising Head Permeability Test No. 3		
Time (min)	Delta H (ft)	Absolute Value H (ft)
1.2	0.009	0.009
1.4	0.009	0.009
1.6	0.006	0.006
1.8	0.009	0.009
2	0.006	0.006
2.2	0.006	0.006
2.4	0.009	0.009
2.6	0.009	0.009
2.8	0.006	0.006
3	0.006	0.006
3.2	0.009	0.009
3.4	0.006	0.006
3.6	0.009	0.009

BDM-96-04B Rising Head Permeability Test No. 1		
Time (min)	Delta H (ft)	Absolute Value H (ft)
0	0.003	0.003
0.0033	0.006	0.006
0.0066	-3.33	3.33
0.01	-4.303	4.303
0.0133	-3.11	3.11
0.0166	-2.194	2.194
0.02	-2.688	2.688
0.0233	-2.692	2.692
0.0266	-2.452	2.452
0.03	-2.487	2.487
0.0333	-2.439	2.439
0.0366	-2.401	2.401
0.04	-2.398	2.398
0.0433	-2.331	2.331
0.0466	-2.289	2.289
0.05	-2.296	2.296
0.0533	-2.235	2.235
0.0566	-2.19	2.19
0.06	-2.159	2.159
0.0633	-2.13	2.13
0.0666	-2.111	2.111
0.07	-2.079	2.079
0.0733	-2.05	2.05
0.0766	-2.028	2.028
0.08	-2.002	2.002
0.0833	-1.98	1.98
0.0866	-1.954	1.954
0.09	-1.929	1.929
0.0933	-1.909	1.909
0.0966	-1.884	1.884
0.1	-1.862	1.862
0.1033	-1.842	1.842
0.1066	-1.817	1.817
0.11	-1.801	1.801
0.1133	-1.779	1.779
0.1166	-1.756	1.756
0.12	-1.737	1.737
0.1233	-1.718	1.718
0.1266	-1.696	1.696
0.13	-1.68	1.68
0.1333	-1.657	1.657
0.1366	-1.641	1.641
0.14	-1.622	1.622
0.1433	-1.606	1.606
0.1466	-1.587	1.587
0.15	-1.568	1.568
0.1533	-1.552	1.552

BDM-96-04B Rising Head Permeability Test No. 1		
Time (min)	Delta H (ft)	Absolute Value H (ft)
0.1566	-1.533	1.533
0.16	-1.517	1.517
0.1633	-1.498	1.498
0.1666	-1.482	1.482
0.17	-1.466	1.466
0.1733	-1.45	1.45
0.1766	-1.434	1.434
0.18	-1.415	1.415
0.1833	-1.405	1.405
0.1866	-1.386	1.386
0.19	-1.37	1.37
0.1933	-1.354	1.354
0.1966	-1.341	1.341
0.2	-1.325	1.325
0.2033	-1.309	1.309
0.2066	-1.293	1.293
0.21	-1.28	1.28
0.2133	-1.268	1.268
0.2166	-1.255	1.255
0.22	-1.236	1.236
0.2233	-1.223	1.223
0.2266	-1.213	1.213
0.23	-1.194	1.194
0.2333	-1.185	1.185
0.2366	-1.169	1.169
0.24	-1.156	1.156
0.2433	-1.143	1.143
0.2466	-1.13	1.13
0.25	-1.118	1.118
0.2533	-1.105	1.105
0.2566	-1.095	1.095
0.26	-1.082	1.082
0.2633	-1.07	1.07
0.2666	-1.057	1.057
0.27	-1.044	1.044
0.2733	-1.038	1.038
0.2766	-1.025	1.025
0.28	-1.009	1.009
0.2833	-0.999	0.999
0.2866	-0.99	0.99
0.29	-0.98	0.98
0.2933	-0.968	0.968
0.2966	-0.955	0.955
0.3	-0.948	0.948
0.3033	-0.936	0.936
0.3066	-0.926	0.926
0.31	-0.913	0.913

BDM-96-04B Rising Head Permeability Test No. 1		
Time (min)	Delta H (ft)	Absolute Value H (ft)
0.3133	-0.904	0.904
0.3166	-0.897	0.897
0.32	-0.884	0.884
0.3233	-0.875	0.875
0.3266	-0.862	0.862
0.33	-0.859	0.859
0.3333	-0.846	0.846
0.35	-0.795	0.795
0.3666	-0.747	0.747
0.3833	-0.699	0.699
0.4	-0.661	0.661
0.4166	-0.619	0.619
0.4333	-0.581	0.581
0.45	-0.543	0.543
0.4666	-0.511	0.511
0.4833	-0.476	0.476
0.5	-0.45	0.45
0.5166	-0.425	0.425
0.5333	-0.396	0.396
0.55	-0.373	0.373
0.5666	-0.348	0.348
0.5833	-0.325	0.325
0.6	-0.306	0.306
0.6166	-0.287	0.287
0.6333	-0.268	0.268
0.65	-0.252	0.252
0.6666	-0.236	0.236
0.6833	-0.226	0.226
0.7	-0.207	0.207
0.7166	-0.198	0.198
0.7333	-0.182	0.182
0.75	-0.172	0.172
0.7666	-0.159	0.159
0.7833	-0.15	0.15
0.8	-0.143	0.143
0.8166	-0.127	0.127
0.8333	-0.121	0.121
0.85	-0.111	0.111
0.8666	-0.111	0.111
0.8833	-0.105	0.105
0.9	-0.095	0.095
0.9166	-0.089	0.089
0.9333	-0.083	0.083
0.95	-0.076	0.076
0.9666	-0.07	0.07
0.9833	-0.07	0.07
1	-0.064	0.064

BDM-96-04B Rising Head Permeability Test No. 1		
Time (min)	Delta H (ft)	Absolute Value H (ft)
1.2	-0.025	0.025
1.4	-0.012	0.012
1.6	-0.006	0.006
1.8	-0.003	0.003
2	-0.003	0.003
2.2	-0.003	0.003
2.4	-0.003	0.003
2.6	0	0
2.8	0	0
3	0	0
3.2	0	0
3.4	0	0
3.6	0	0
3.8	0	0
4	0	0
4.2	0	0
4.4	0.003	0.003
4.6	0.006	0.006
4.8	0	0
5	0.003	0.003
5.2	0	0
5.4	0.003	0.003
5.6	-0.003	0.003
5.8	0	0
6	0.003	0.003
6.2	0.003	0.003
6.4	0	0
6.6	0	0
6.8	0	0
7	0.003	0.003
7.2	0.003	0.003
7.4	0.003	0.003
7.6	0	0
7.8	0.003	0.003
8	0.003	0.003
8.2	0.003	0.003
8.4	0	0
8.6	0.003	0.003
8.8	0.003	0.003
9	0.003	0.003
9.2	0	0
9.4	0	0
9.6	0	0
9.8	0	0
10	0.003	0.003

BDM-96-04B Rising Head Permeability Test No. 2		
Time (min)	Delta H (ft)	Absolute Value H (ft)
0	0.009	0.009
0.0033	0.009	0.009
0.0066	0.006	0.006
0.01	0.006	0.006
0.0133	0.009	0.009
0.0166	0.006	0.006
0.02	0.009	0.009
0.0233	0.006	0.006
0.0266	0.006	0.006
0.03	0.006	0.006
0.0333	0.006	0.006
0.0366	0.063	0.063
0.04	-2.363	2.363
0.0433	-4.265	4.265
0.0466	-3.831	3.831
0.05	-2.21	2.21
0.0533	-2.481	2.481
0.0566	-2.72	2.72
0.06	-2.497	2.497
0.0633	-2.423	2.423
0.0666	-2.414	2.414
0.07	-2.36	2.36
0.0733	-2.315	2.315
0.0766	-2.293	2.293
0.08	-2.251	2.251
0.0833	-2.21	2.21
0.0866	-2.19	2.19
0.09	-2.152	2.152
0.0933	-2.107	2.107
0.0966	-2.085	2.085
0.1	-2.06	2.06
0.1033	-2.031	2.031
0.1066	-1.999	1.999
0.11	-1.973	1.973
0.1133	-1.938	1.938
0.1166	-1.9	1.9
0.12	-1.881	1.881
0.1233	-1.862	1.862
0.1266	-1.83	1.83
0.13	-1.804	1.804
0.1333	-1.779	1.779
0.1366	-1.753	1.753
0.14	-1.728	1.728
0.1433	-1.705	1.705
0.1466	-1.68	1.68
0.15	-1.664	1.664
0.1533	-1.635	1.635

BDM-96-04B Rising Head Permeability Test No. 2		
Time (min)	Delta H (ft)	Absolute Value H (ft)
0.1566	-1.616	1.616
0.16	-1.59	1.59
0.1633	-1.571	1.571
0.1666	-1.552	1.552
0.17	-1.53	1.53
0.1733	-1.504	1.504
0.1766	-1.485	1.485
0.18	-1.466	1.466
0.1833	-1.447	1.447
0.1866	-1.427	1.427
0.19	-1.408	1.408
0.1933	-1.389	1.389
0.1966	-1.37	1.37
0.2	-1.351	1.351
0.2033	-1.335	1.335
0.2066	-1.319	1.319
0.21	-1.296	1.296
0.2133	-1.28	1.28
0.2166	-1.265	1.265
0.22	-1.245	1.245
0.2233	-1.229	1.229
0.2266	-1.213	1.213
0.23	-1.197	1.197
0.2333	-1.181	1.181
0.2366	-1.166	1.166
0.24	-1.15	1.15
0.2433	-1.137	1.137
0.2466	-1.124	1.124
0.25	-1.105	1.105
0.2533	-1.092	1.092
0.2566	-1.076	1.076
0.26	-1.06	1.06
0.2633	-1.047	1.047
0.2666	-1.035	1.035
0.27	-1.022	1.022
0.2733	-1.006	1.006
0.2766	-0.996	0.996
0.28	-0.98	0.98
0.2833	-0.968	0.968
0.2866	-0.952	0.952
0.29	-0.942	0.942
0.2933	-0.926	0.926
0.2966	-0.916	0.916
0.3	-0.904	0.904
0.3033	-0.894	0.894
0.3066	-0.878	0.878
0.31	-0.868	0.868

BDM-96-04B Rising Head Permeability Test No. 2		
Time (min)	Delta H (ft)	Absolute Value H (ft)
0.3133	-0.856	0.856
0.3166	-0.843	0.843
0.32	-0.833	0.833
0.3233	-0.824	0.824
0.3266	-0.808	0.808
0.33	-0.798	0.798
0.3333	-0.789	0.789
0.35	-0.731	0.731
0.3666	-0.674	0.674
0.3833	-0.626	0.626
0.4	-0.581	0.581
0.4166	-0.539	0.539
0.4333	-0.501	0.501
0.45	-0.46	0.46
0.4666	-0.428	0.428
0.4833	-0.396	0.396
0.5	-0.367	0.367
0.5166	-0.338	0.338
0.5333	-0.316	0.316
0.55	-0.294	0.294
0.5666	-0.268	0.268
0.5833	-0.249	0.249
0.6	-0.233	0.233
0.6166	-0.217	0.217
0.6333	-0.201	0.201
0.65	-0.185	0.185
0.6666	-0.172	0.172
0.6833	-0.156	0.156
0.7	-0.147	0.147
0.7166	-0.137	0.137
0.7333	-0.127	0.127
0.75	-0.118	0.118
0.7666	-0.108	0.108
0.7833	-0.102	0.102
0.8	-0.092	0.092
0.8166	-0.086	0.086
0.8333	-0.079	0.079
0.85	-0.076	0.076
0.8666	-0.07	0.07
0.8833	-0.06	0.06
0.9	-0.06	0.06
0.9166	-0.054	0.054
0.9333	-0.051	0.051
0.95	-0.048	0.048
0.9666	-0.041	0.041
0.9833	-0.038	0.038
1	-0.038	0.038

BDM-96-04B Rising Head Permeability Test No. 2		
Time (min)	Delta H (ft)	Absolute Value H (ft)
1.2	-0.012	0.012
1.4	-0.006	0.006
1.6	-0.003	0.003
1.8	0	0
2	0	0
2.2	-0.003	0.003
2.4	0	0
2.6	0	0
2.8	0	0
3	0.003	0.003
3.2	0	0
3.4	0.003	0.003
3.6	0	0
3.8	0	0
4	0	0
4.2	-0.003	0.003
4.4	0	0
4.6	0.003	0.003
4.8	0	0
5	0	0
5.2	0.003	0.003
5.4	0	0
5.6	0	0
5.8	0	0
6	0.003	0.003
6.2	0.003	0.003
6.4	0	0
6.6	0.003	0.003

BDM-96-04B Rising Head Permeability Test No. 3		
Time (min)	Delta H (ft)	Absolute Value H (ft)
0	0.009	0.009
0.0033	0.009	0.009
0.0066	0.009	0.009
0.01	0.003	0.003
0.0133	0.006	0.006
0.0166	0.009	0.009
0.02	-0.159	0.159
0.0233	-1.833	1.833
0.0266	-1.938	1.938
0.03	-2.81	2.81
0.0333	-2.404	2.404
0.0366	-2.551	2.551
0.04	-2.701	2.701
0.0433	-2.647	2.647
0.0466	-2.545	2.545
0.05	-2.51	2.51
0.0533	-2.481	2.481
0.0566	-2.439	2.439
0.06	-2.395	2.395
0.0633	-2.36	2.36
0.0666	-2.318	2.318
0.07	-2.296	2.296
0.0733	-2.258	2.258
0.0766	-2.238	2.238
0.08	-2.2	2.2
0.0833	-2.174	2.174
0.0866	-2.149	2.149
0.09	-2.123	2.123
0.0933	-2.101	2.101
0.0966	-2.072	2.072
0.1	-2.05	2.05
0.1033	-2.024	2.024
0.1066	-1.989	1.989
0.11	-1.97	1.97
0.1133	-1.964	1.964
0.1166	-1.938	1.938
0.12	-1.913	1.913
0.1233	-1.884	1.884
0.1266	-1.871	1.871
0.13	-1.849	1.849
0.1333	-1.826	1.826
0.1366	-1.807	1.807
0.14	-1.782	1.782
0.1433	-1.769	1.769
0.1466	-1.743	1.743
0.15	-1.724	1.724
0.1533	-1.692	1.692

BDM-96-04B Rising Head Permeability Test No. 3		
Time (min)	Delta H (ft)	Absolute Value H (ft)
0.1566	-1.689	1.689
0.16	-1.667	1.667
0.1633	-1.648	1.648
0.1666	-1.632	1.632
0.17	-1.613	1.613
0.1733	-1.597	1.597
0.1766	-1.581	1.581
0.18	-1.565	1.565
0.1833	-1.546	1.546
0.1866	-1.53	1.53
0.19	-1.514	1.514
0.1933	-1.482	1.482
0.1966	-1.478	1.478
0.2	-1.463	1.463
0.2033	-1.447	1.447
0.2066	-1.434	1.434
0.21	-1.415	1.415
0.2133	-1.405	1.405
0.2166	-1.386	1.386
0.22	-1.373	1.373
0.2233	-1.357	1.357
0.2266	-1.341	1.341
0.23	-1.328	1.328
0.2333	-1.316	1.316
0.2366	-1.3	1.3
0.24	-1.287	1.287
0.2433	-1.274	1.274
0.2466	-1.258	1.258
0.25	-1.249	1.249
0.2533	-1.233	1.233
0.2566	-1.22	1.22
0.26	-1.204	1.204
0.2633	-1.194	1.194
0.2666	-1.181	1.181
0.27	-1.166	1.166
0.2733	-1.159	1.159
0.2766	-1.143	1.143
0.28	-1.13	1.13
0.2833	-1.118	1.118
0.2866	-1.105	1.105
0.29	-1.095	1.095
0.2933	-1.082	1.082
0.2966	-1.073	1.073
0.3	-1.06	1.06
0.3033	-1.051	1.051
0.3066	-1.041	1.041
0.31	-1.028	1.028

BDM-96-04B Rising Head Permeability Test No. 3		
Time (min)	Delta H (ft)	Absolute Value H (ft)
0.3133	-1.019	1.019
0.3166	-1.006	1.006
0.32	-0.996	0.996
0.3233	-0.983	0.983
0.3266	-0.974	0.974
0.33	-0.968	0.968
0.3333	-0.955	0.955
0.35	-0.9	0.9
0.3666	-0.846	0.846
0.3833	-0.798	0.798
0.4	-0.75	0.75
0.4166	-0.709	0.709
0.4333	-0.667	0.667
0.45	-0.629	0.629
0.4666	-0.591	0.591
0.4833	-0.555	0.555
0.5	-0.52	0.52
0.5166	-0.495	0.495
0.5333	-0.463	0.463
0.55	-0.437	0.437
0.5666	-0.409	0.409
0.5833	-0.383	0.383
0.6	-0.361	0.361
0.6166	-0.341	0.341
0.6333	-0.319	0.319
0.65	-0.3	0.3
0.6666	-0.284	0.284
0.6833	-0.268	0.268
0.7	-0.249	0.249
0.7166	-0.233	0.233
0.7333	-0.22	0.22
0.75	-0.204	0.204
0.7666	-0.195	0.195
0.7833	-0.179	0.179
0.8	-0.172	0.172
0.8166	-0.163	0.163
0.8333	-0.15	0.15
0.85	-0.143	0.143
0.8666	-0.131	0.131
0.8833	-0.127	0.127
0.9	-0.115	0.115
0.9166	-0.111	0.111
0.9333	-0.102	0.102
0.95	-0.095	0.095
0.9666	-0.089	0.089
0.9833	-0.086	0.086
1	-0.079	0.079

BDM-96-04B Rising Head Permeability Test No. 3		
Time (min)	Delta H (ft)	Absolute Value H (ft)
1.2	-0.028	0.028
1.4	-0.012	0.012
1.6	-0.006	0.006
1.8	-0.003	0.003
2	-0.003	0.003
2.2	0	0
2.4	0	0
2.6	0	0
2.8	0	0
3	0	0
3.2	0.003	0.003
3.4	0	0
3.6	0	0
3.8	0	0
4	0	0
4.2	0	0
4.4	0	0
4.6	0	0
4.8	0	0
5	-0.003	0.003
5.2	0	0
5.4	0.003	0.003
5.6	0	0
5.8	0	0

BDM-96-04B Falling Head Permeability Test No. 1		
Time (min)	Delta H (ft)	Absolute Value H (ft)
0	0	0
0.0033	0.009	0.009
0.0066	-0.006	0.006
0.01	0	0
0.0133	0.012	0.012
0.0166	0.025	0.025
0.02	0.019	0.019
0.0233	0.012	0.012
0.0266	0.009	0.009
0.03	0.012	0.012
0.0333	0.012	0.012
0.0366	0.009	0.009
0.04	0.006	0.006
0.0433	0.012	0.012
0.0466	0.009	0.009
0.05	0.012	0.012
0.0533	0.952	0.952
0.0566	0.808	0.808
0.06	1.281	1.281
0.0633	1.482	1.482
0.0666	1.543	1.543
0.07	1.601	1.601
0.0733	1.971	1.971
0.0766	2.176	2.176
0.08	2.237	2.237
0.0833	2.23	2.23
0.0866	2.333	2.333
0.09	2.259	2.259
0.0933	2.32	2.32
0.0966	2.179	2.179
0.1	2.166	2.166
0.1033	2.214	2.214
0.1066	2.179	2.179
0.11	2.186	2.186
0.1133	2.192	2.192
0.1166	2.013	2.013
0.12	2.093	2.093
0.1233	1.965	1.965
0.1266	1.412	1.412
0.13	1.121	1.121
0.1333	1.166	1.166
0.1366	1.294	1.294
0.14	1.559	1.559
0.1433	1.652	1.652
0.1466	1.671	1.671
0.15	1.633	1.633
0.1533	1.565	1.565

BDM-96-04B Falling Head Permeability Test No. 1		
Time (min)	Delta H (ft)	Absolute Value H (ft)
0.1566	1.498	1.498
0.16	1.457	1.457
0.1633	1.428	1.428
0.1666	1.418	1.418
0.17	1.412	1.412
0.1733	1.402	1.402
0.1766	1.386	1.386
0.18	1.364	1.364
0.1833	1.342	1.342
0.1866	1.322	1.322
0.19	1.31	1.31
0.1933	1.294	1.294
0.1966	1.271	1.271
0.2	1.252	1.252
0.2033	1.239	1.239
0.2066	1.233	1.233
0.21	1.22	1.22
0.2133	1.214	1.214
0.2166	1.195	1.195
0.22	1.179	1.179
0.2233	1.163	1.163
0.2266	1.143	1.143
0.23	1.127	1.127
0.2333	1.115	1.115
0.2366	1.105	1.105
0.24	1.089	1.089
0.2433	1.08	1.08
0.2466	1.067	1.067
0.25	1.054	1.054
0.2533	1.041	1.041
0.2566	1.028	1.028
0.26	1.016	1.016
0.2633	1.003	1.003
0.2666	0.993	0.993
0.27	0.98	0.98
0.2733	0.968	0.968
0.2766	0.955	0.955
0.28	0.945	0.945
0.2833	0.936	0.936
0.2866	0.923	0.923
0.29	0.913	0.913
0.2933	0.904	0.904
0.2966	0.891	0.891
0.3	0.881	0.881
0.3033	0.872	0.872
0.3066	0.862	0.862
0.31	0.849	0.849

BDM-96-04B Falling Head Permeability Test No. 1		
Time (min)	Delta H (ft)	Absolute Value H (ft)
0.3133	0.84	0.84
0.3166	0.83	0.83
0.32	0.824	0.824
0.3233	0.814	0.814
0.3266	0.805	0.805
0.33	0.795	0.795
0.3333	0.786	0.786
0.35	0.741	0.741
0.3666	0.696	0.696
0.3833	0.655	0.655
0.4	0.616	0.616
0.4166	0.584	0.584
0.4333	0.549	0.549
0.45	0.517	0.517
0.4666	0.488	0.488
0.4833	0.466	0.466
0.5	0.44	0.44
0.5166	0.412	0.412
0.5333	0.389	0.389
0.55	0.37	0.37
0.5666	0.348	0.348
0.5833	0.329	0.329
0.6	0.316	0.316
0.6166	0.3	0.3
0.6333	0.284	0.284
0.65	0.271	0.271
0.6666	0.258	0.258
0.6833	0.246	0.246
0.7	0.233	0.233
0.7166	0.22	0.22
0.7333	0.21	0.21
0.75	0.198	0.198
0.7666	0.185	0.185
0.7833	0.178	0.178
0.8	0.166	0.166
0.8166	0.162	0.162
0.8333	0.15	0.15
0.85	0.146	0.146
0.8666	0.137	0.137
0.8833	0.134	0.134
0.9	0.13	0.13
0.9166	0.124	0.124
0.9333	0.118	0.118
0.95	0.111	0.111
0.9666	0.108	0.108
0.9833	0.108	0.108
1	0.099	0.099

BDM-96-04B Falling Head Permeability Test No. 1		
Time (min)	Delta H (ft)	Absolute Value H (ft)
1.2	0.051	0.051
1.4	0.038	0.038
1.6	0.028	0.028
1.8	0.019	0.019
2	0.015	0.015
2.2	0.015	0.015
2.4	0.012	0.012
2.6	0.012	0.012
2.8	0.006	0.006
3	0.009	0.009
3.2	0.009	0.009
3.4	0.012	0.012
3.6	0.009	0.009
3.8	0.009	0.009
4	0.009	0.009
4.2	0.009	0.009
4.4	0.003	0.003
4.6	0.006	0.006
4.8	0.006	0.006
5	0.009	0.009
5.2	0.009	0.009
5.4	0.006	0.006
5.6	0.006	0.006
5.8	0.006	0.006
6	0.009	0.009
6.2	0.009	0.009
6.4	0.009	0.009
6.6	0.009	0.009
6.8	0.006	0.006
7	0.006	0.006
7.2	0.009	0.009
7.4	0.009	0.009
7.6	0.006	0.006
7.8	0.006	0.006
8	0.009	0.009
8.2	0.009	0.009
8.4	0.006	0.006
8.6	0.006	0.006
8.8	0.006	0.006
9	0.009	0.009
9.2	0.009	0.009
9.4	0.009	0.009
9.6	0.006	0.006
9.8	0.009	0.009
10	0.009	0.009

BDM-96-04B Falling Head Permeability Test No. 2		
Time (min)	Delta H (ft)	Absolute Value H (ft)
0	0.003	0.003
0.0033	0	0
0.0066	0.003	0.003
0.01	0.003	0.003
0.0133	0	0
0.0166	0	0
0.02	0	0
0.0233	0	0
0.0266	0	0
0.03	0	0
0.0333	0.003	0.003
0.0366	-0.019	0.019
0.04	0.025	0.025
0.0433	0.003	0.003
0.0466	0.015	0.015
0.05	0.006	0.006
0.0533	0	0
0.0566	0.012	0.012
0.06	0.006	0.006
0.0633	0.006	0.006
0.0666	0.006	0.006
0.07	0	0
0.0733	0.009	0.009
0.0766	-0.003	0.003
0.08	-0.006	0.006
0.0833	0.003	0.003
0.0866	0	0
0.09	0	0
0.0933	0.003	0.003
0.0966	0.009	0.009
0.1	0.124	0.124
0.1033	0.463	0.463
0.1066	0.747	0.747
0.11	1.057	1.057
0.1133	0.977	0.977
0.1166	1.482	1.482
0.12	1.604	1.604
0.1233	1.581	1.581
0.1266	1.69	1.69
0.13	1.661	1.661
0.1333	1.824	1.824
0.1366	1.959	1.959
0.14	1.946	1.946
0.1433	1.738	1.738
0.1466	2.099	2.099
0.15	2.246	2.246
0.1533	2.246	2.246

BDM-96-04B Falling Head Permeability Test No. 2		
Time (min)	Delta H (ft)	Absolute Value H (ft)
0.1566	2.377	2.377
0.16	2.374	2.374
0.1633	2.362	2.362
0.1666	2.173	2.173
0.17	1.978	1.978
0.1733	1.77	1.77
0.1766	1.722	1.722
0.18	1.786	1.786
0.1833	2.019	2.019
0.1866	2.214	2.214
0.19	2.336	2.336
0.1933	1.668	1.668
0.1966	1.175	1.175
0.2	1.092	1.092
0.2033	1.105	1.105
0.2066	1.326	1.326
0.21	1.585	1.585
0.2133	1.69	1.69
0.2166	1.674	1.674
0.22	1.578	1.578
0.2233	1.479	1.479
0.2266	1.425	1.425
0.23	1.402	1.402
0.2333	1.406	1.406
0.2366	1.399	1.399
0.24	1.39	1.39
0.2433	1.37	1.37
0.2466	1.351	1.351
0.25	1.332	1.332
0.2533	1.316	1.316
0.2566	1.297	1.297
0.26	1.287	1.287
0.2633	1.271	1.271
0.2666	1.259	1.259
0.27	1.243	1.243
0.2733	1.227	1.227
0.2766	1.214	1.214
0.28	1.201	1.201
0.2833	1.185	1.185
0.2866	1.172	1.172
0.29	1.156	1.156
0.2933	1.147	1.147
0.2966	1.131	1.131
0.3	1.121	1.121
0.3033	1.105	1.105
0.3066	1.096	1.096
0.31	1.08	1.08

BDM-96-04B Falling Head Permeability Test No. 2		
Time (min)	Delta H (ft)	Absolute Value H (ft)
0.3133	1.07	1.07
0.3166	1.057	1.057
0.32	1.048	1.048
0.3233	1.035	1.035
0.3266	1.025	1.025
0.33	1.009	1.009
0.3333	1	1
0.35	0.942	0.942
0.3666	0.885	0.885
0.3833	0.837	0.837
0.4	0.786	0.786
0.4166	0.76	0.76
0.4333	0.718	0.718
0.45	0.683	0.683
0.4666	0.648	0.648
0.4833	0.613	0.613
0.5	0.578	0.578
0.5166	0.546	0.546
0.5333	0.517	0.517
0.55	0.495	0.495
0.5666	0.466	0.466
0.5833	0.444	0.444
0.6	0.421	0.421
0.6166	0.396	0.396
0.6333	0.377	0.377
0.65	0.357	0.357
0.6666	0.345	0.345
0.6833	0.322	0.322
0.7	0.309	0.309
0.7166	0.293	0.293
0.7333	0.281	0.281
0.75	0.268	0.268
0.7666	0.255	0.255
0.7833	0.242	0.242
0.8	0.23	0.23
0.8166	0.22	0.22
0.8333	0.21	0.21
0.85	0.204	0.204
0.8666	0.191	0.191
0.8833	0.178	0.178
0.9	0.172	0.172
0.9166	0.166	0.166
0.9333	0.156	0.156
0.95	0.15	0.15
0.9666	0.143	0.143
0.9833	0.137	0.137
1	0.13	0.13

BDM-96-04B Falling Head Permeability Test No. 2		
Time (min)	Delta H (ft)	Absolute Value H (ft)
1.2	0.07	0.07
1.4	0.047	0.047
1.6	0.031	0.031
1.8	0.022	0.022
2	0.019	0.019
2.2	0.009	0.009
2.4	0.009	0.009
2.6	0.012	0.012
2.8	0.009	0.009
3	0.012	0.012
3.2	0.009	0.009
3.4	0.012	0.012
3.6	0.009	0.009
3.8	0.012	0.012
4	0.006	0.006
4.2	0.006	0.006
4.4	0.012	0.012
4.6	0.009	0.009
4.8	0.009	0.009
5	0.009	0.009
5.2	0.009	0.009
5.4	0.009	0.009

BDM-96-05X Rising Head Permeability Test No. 1		
Time (min)	Delta H (ft)	Absolute Value H (ft)
0	0.003	0.003
0.0033	0.003	0.003
0.0066	0.003	0.003
0.01	0.003	0.003
0.0133	0.006	0.006
0.0166	0.003	0.003
0.02	0.009	0.009
0.0233	-0.127	0.127
0.0266	-0.755	0.755
0.03	-0.902	0.902
0.0333	-0.599	0.599
0.0366	-0.42	0.42
0.04	-0.27	0.27
0.0433	-0.146	0.146
0.0466	-0.076	0.076
0.05	-0.031	0.031
0.0533	-0.025	0.025
0.0566	-0.022	0.022
0.06	-0.025	0.025
0.0633	-0.019	0.019
0.0666	-0.022	0.022
0.07	-0.019	0.019
0.0733	-0.019	0.019
0.0766	-0.009	0.009
0.08	-0.012	0.012
0.0833	-0.009	0.009
0.0866	-0.009	0.009
0.09	-0.009	0.009
0.0933	-0.006	0.006
0.0966	-0.009	0.009
0.1	0	0
0.1033	-0.003	0.003
0.1066	-0.003	0.003
0.11	-0.006	0.006
0.1133	-0.003	0.003
0.1166	-0.003	0.003
0.12	-0.003	0.003
0.1233	-0.003	0.003
0.1266	-0.003	0.003
0.13	0	0
0.1333	-0.003	0.003
0.1366	0	0
0.14	0	0
0.1433	0	0
0.1466	-0.003	0.003
0.15	0	0
0.1533	0	0

BDM-96-05X Rising Head Permeability Test No. 1		
Time (min)	Delta H (ft)	Absolute Value H (ft)
0.1566	-0.003	0.003
0.16	-0.003	0.003
0.1633	-0.003	0.003
0.1666	-0.003	0.003
0.17	-0.003	0.003
0.1733	-0.003	0.003
0.1766	0	0
0.18	0	0
0.1833	0	0
0.1866	-0.003	0.003
0.19	-0.003	0.003
0.1933	0	0
0.1966	0.003	0.003
0.2	0.003	0.003
0.2033	0	0
0.2066	-0.003	0.003
0.21	0	0
0.2133	0.003	0.003
0.2166	0	0
0.22	0	0
0.2233	0	0
0.2266	0.003	0.003
0.23	0	0
0.2333	0	0
0.2366	0	0
0.24	0	0
0.2433	0	0
0.2466	0	0
0.25	0.003	0.003
0.2533	0	0
0.2566	0.003	0.003
0.26	0	0
0.2633	0	0
0.2666	0	0
0.27	0	0
0.2733	0.003	0.003
0.2766	0	0
0.28	0	0
0.2833	0	0
0.2866	0	0
0.29	0.003	0.003
0.2933	0	0
0.2966	0	0
0.3	0	0
0.3033	0	0
0.3066	0	0
0.31	0.003	0.003

BDM-96-05X Rising Head Permeability Test No. 1		
Time (min)	Delta H (ft)	Absolute Value H (ft)
0.3133	0	0
0.3166	0	0
0.32	0	0
0.3233	0	0
0.3266	0	0
0.33	0	0
0.3333	0	0
0.35	0	0
0.3666	0	0
0.3833	0	0
0.4	0	0
0.4166	0	0
0.4333	0.003	0.003
0.45	0.003	0.003
0.4666	0	0
0.4833	0.003	0.003
0.5	0	0
0.5166	0.003	0.003
0.5333	0	0
0.55	0.003	0.003
0.5666	0.003	0.003
0.5833	0.003	0.003
0.6	0.003	0.003
0.6166	0.003	0.003
0.6333	0.003	0.003
0.65	0.003	0.003
0.6666	0.003	0.003
0.6833	0	0
0.7	0.003	0.003
0.7166	0	0
0.7333	0.003	0.003
0.75	0	0
0.7666	0.003	0.003
0.7833	0.003	0.003
0.8	0.003	0.003
0.8166	0.003	0.003
0.8333	0	0
0.85	0.003	0.003
0.8666	0.003	0.003
0.8833	0	0
0.9	0	0
0.9166	0.003	0.003
0.9333	0	0
0.95	0	0
0.9666	0.003	0.003
0.9833	0	0
1	0.003	0.003

BDM-96-05X Rising Head Permeability Test No. 1		
Time (min)	Delta H (ft)	Absolute Value H (ft)
1.2	0.003	0.003
1.4	0	0
1.6	0.003	0.003
1.8	0	0
2	0.003	0.003
2.2	0.003	0.003
2.4	0.003	0.003
2.6	0.003	0.003
2.8	0.006	0.006
3	0.003	0.003
3.2	0.003	0.003
3.4	0.003	0.003
3.6	0.003	0.003
3.8	0	0
4	0	0
4.2	0.003	0.003
4.4	0.003	0.003
4.6	0.003	0.003
4.8	0.006	0.006

BDM-96-05X Rising Head Permeability Test No. 2		
Time (min)	Delta H (ft)	Absolute Value H (ft)
0	0.003	0.003
0.0033	0.006	0.006
0.0066	0.006	0.006
0.01	0.006	0.006
0.0133	0.006	0.006
0.0166	-0.022	0.022
0.02	-0.321	0.321
0.0233	-0.643	0.643
0.0266	-0.573	0.573
0.03	-0.475	0.475
0.0333	-0.331	0.331
0.0366	-0.2	0.2
0.04	-0.111	0.111
0.0433	-0.057	0.057
0.0466	-0.028	0.028
0.05	-0.025	0.025
0.0533	-0.022	0.022
0.0566	-0.019	0.019
0.06	-0.015	0.015
0.0633	-0.019	0.019
0.0666	-0.015	0.015
0.07	-0.012	0.012
0.0733	-0.012	0.012
0.0766	-0.003	0.003
0.08	-0.006	0.006
0.0833	-0.006	0.006
0.0866	-0.003	0.003
0.09	-0.003	0.003
0.0933	0	0
0.0966	0	0
0.1	0	0
0.1033	0	0
0.1066	0	0
0.11	0	0
0.1133	0	0
0.1166	0.003	0.003
0.12	0.003	0.003
0.1233	0	0
0.1266	0	0
0.13	0	0
0.1333	0	0
0.1366	0	0
0.14	0.003	0.003
0.1433	0.003	0.003
0.1466	0.003	0.003
0.15	0.003	0.003
0.1533	0.003	0.003

BDM-96-05X Rising Head Permeability Test No. 2		
Time (min)	Delta H (ft)	Absolute Value H (ft)
0.1566	0.006	0.006
0.16	0.003	0.003
0.1633	0.003	0.003
0.1666	0.003	0.003
0.17	0.003	0.003
0.1733	0.003	0.003
0.1766	0.003	0.003
0.18	0.003	0.003
0.1833	0.003	0.003
0.1866	0.003	0.003
0.19	0.003	0.003
0.1933	0.003	0.003
0.1966	0.003	0.003
0.2	0.003	0.003
0.2033	0.003	0.003
0.2066	0	0
0.21	0.003	0.003
0.2133	0.003	0.003
0.2166	0.006	0.006
0.22	0.003	0.003
0.2233	0.003	0.003
0.2266	0.003	0.003
0.23	0.003	0.003
0.2333	0.003	0.003
0.2366	0.003	0.003
0.24	0.006	0.006
0.2433	0.003	0.003
0.2466	0.003	0.003
0.25	0	0
0.2533	0.003	0.003
0.2566	0.006	0.006
0.26	0.003	0.003
0.2633	0	0
0.2666	0.003	0.003
0.27	0.003	0.003
0.2733	0.003	0.003
0.2766	0.003	0.003
0.28	0.003	0.003
0.2833	0.003	0.003
0.2866	0.003	0.003
0.29	0.003	0.003
0.2933	0.003	0.003
0.2966	0.003	0.003
0.3	0.003	0.003
0.3033	0.003	0.003
0.3066	0.003	0.003
0.31	0.003	0.003

BDM-96-05X Rising Head Permeability Test No. 2		
Time (min)	Delta H (ft)	Absolute Value H (ft)
0.3133	0.003	0.003
0.3166	0.006	0.006
0.32	0.003	0.003
0.3233	0.003	0.003
0.3266	0.003	0.003
0.33	0.003	0.003
0.3333	0.003	0.003
0.35	0.006	0.006
0.3666	0.006	0.006
0.3833	0.003	0.003
0.4	0.006	0.006
0.4166	0.006	0.006
0.4333	0.006	0.006
0.45	0.003	0.003
0.4666	0.006	0.006
0.4833	0.006	0.006
0.5	0.006	0.006
0.5166	0.006	0.006
0.5333	0.003	0.003
0.55	0.003	0.003
0.5666	0.006	0.006
0.5833	0.006	0.006
0.6	0.003	0.003
0.6166	0.006	0.006
0.6333	0.006	0.006
0.65	0.006	0.006
0.6666	0.003	0.003
0.6833	0.006	0.006
0.7	0.006	0.006
0.7166	0.006	0.006
0.7333	0.003	0.003
0.75	0.003	0.003
0.7666	0.006	0.006
0.7833	0.006	0.006
0.8	0.006	0.006
0.8166	0.003	0.003
0.8333	0.006	0.006
0.85	0.006	0.006
0.8666	0.006	0.006
0.8833	0.006	0.006
0.9	0.006	0.006
0.9166	0.006	0.006
0.9333	0.006	0.006
0.95	0.003	0.003
0.9666	0.006	0.006
0.9833	0.006	0.006
1	0.006	0.006

BDM-96-05X Rising Head Permeability Test No. 2		
Time (min)	Delta H (ft)	Absolute Value H (ft)
1.2	0.006	0.006
1.4	0.003	0.003
1.6	0.006	0.006
1.8	0.003	0.003
2	0.006	0.006
2.2	0.006	0.006
2.4	0.006	0.006

ESTIMATES OF HYDRAULIC CONDUCTIVITY
BASED UPON GRAIN SIZE DISTRIBUTION
AOC 63BD
DEVENS, MASSACHUSETTS

Hazen Method: $K=d_{10}^2$

Where: K = hydraulic conductivity expressed as cm/sec

d_{10} = grain size diameter (in mm) at which 10% by wieght of the soil particles are finer

Masch and Denny:

Graphical method employing the inclusive standard deviation (σ) and the median grain size (d50)

See attached plot

Exploration	Sample Depth (ft bgs)	d_{10} (mm)	d_5 (mm)	d_{16} (mm)	d_{50} (mm)	d_{84} (mm)	d_{95} (mm)	incl. std. dev (σ) (phi units)	$K=d_{10}^2$, Hazen (cm/sec)	K via Masch and Denny (cm/sec)
BDM-96-01X	27	0.23	0.11	0.27	0.5	0.9	2.2	1.09	5E-2	2E-2
BDM-96-02X	29	0.215	0.1	0.3	0.83	5.62	2.1	1.72	5E-2	5E-3
BDM-96-03X	29	0.254	0.14	0.3	0.61	1.37	2.2	1.15	6E-2	2E-2
BDM-96-04B	50	0.033	0.017	0.0058	2.04	24	35	4.67	1E-3	NA
BDM-96-05X	29	0.327	0.1	0.48	1.6	10.7	21	2.29	1E-1	NA

PROJECT	COMP. BY	JOB NO.
USACE - DEVENS		8740-03
AOC 63BD GRAIN SIZE / K ANALYSES	CHK. BY	DATE 11.12.96

HAZEN METHOD:

$K = d_{10}^2$ (FOR K IN cm/s AND d IN mm)

d_{10} = GRAIN SIZE DIAMETER AT WHICH 10% BY WEIGHT OF THE SOIL PARTICLES ARE FINER

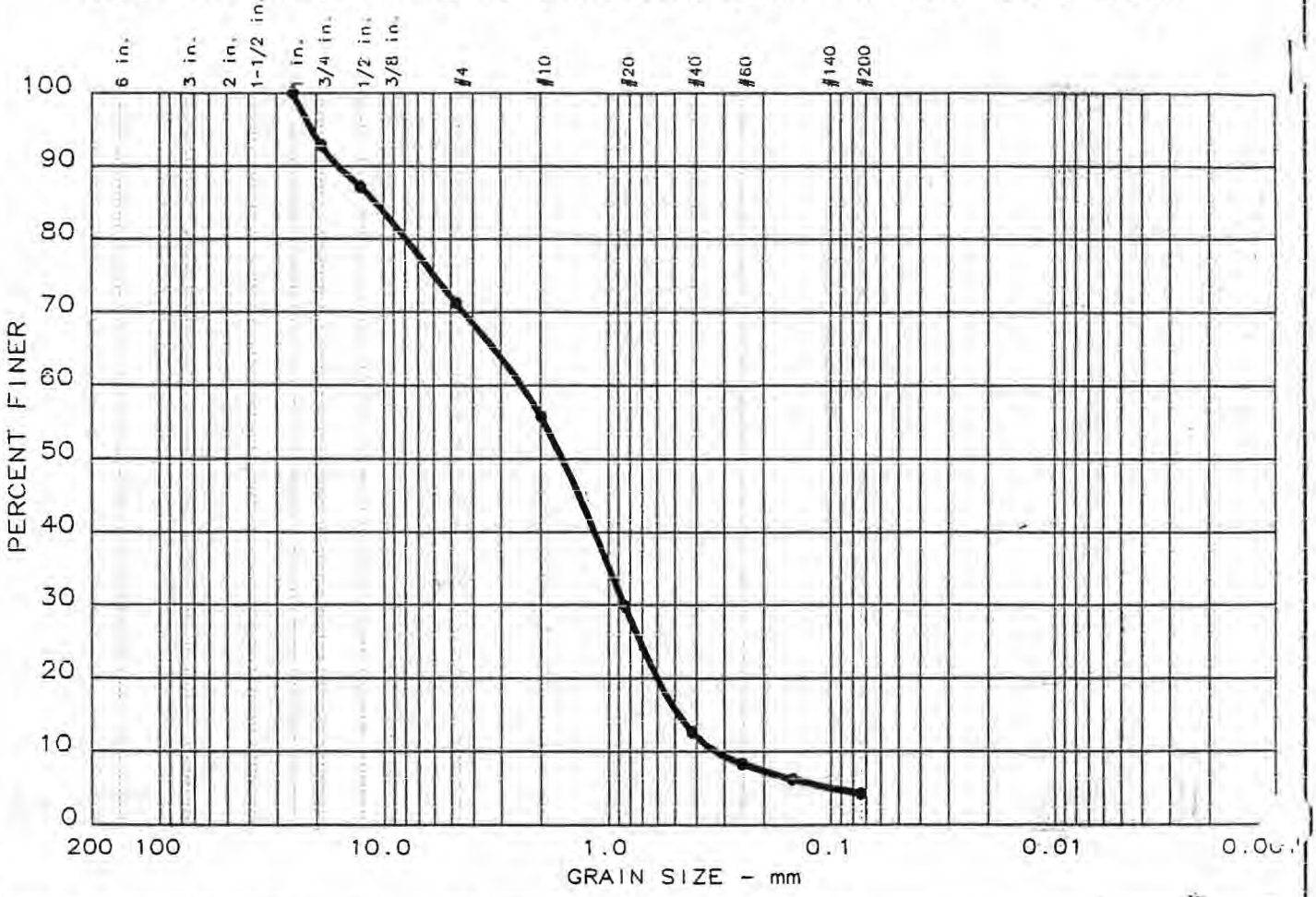
WELL	d_{10} (mm)	K (cm/s)	
BDM.96-01X (27')	0.23	5×10^{-2}	
BDM.96-02X (29')	0.215	4.6×10^{-2}	
BDM.96-03X (29')	0.254	6.5×10^{-2}	(6.45×10^{-2})
BDM.96-04B (50')	0.033	1.1×10^{-3}	
BDM.96-05X (29')	0.327	1.06×10^{-1}	

MASCH & DENNY:

$$\sigma_I = \frac{d_{16} - d_{84}}{4} + \frac{d_5 - d_{95}}{6.6}$$: (EXPRESSED IN Ø UNITS)

	d_{16}	d_{84}	d_5	d_{95}	: (EXPRESSED AS D IN MM)
BDM.96.01X	0.27	.9	.11	2.2	
BDM.96.02X	~~3.1~~ 0.3	5.62	.1	~~20~~ 21 (RV)	
BDM.96.03X	~~3.1~~ 0.3	1.37	~~3.1~~ .14 (RE)	2.2	
BDM.96.04B	0.058	24	.017	35	
BDM.96.05X	0.48	10.7	0.1	21	

GRAIN SIZE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% FINES
●	0.0	28.7	67.1	4.2

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	-- --	-- --	10.72	2.42	1.60	0.840	0.4781	0.3270	0.89	7.4

MATERIAL DESCRIPTION	USCS	AASHTO
● Poorly Graded SAND with Gravel	SP	-- --

Project No.: 8740.02
Project: Fort Devens - Task 7
● Location: Ayer, MA

Date: August 5, 1996

Remarks:
Sample No. MXBD0529

As rec'd w% = 10.9

GRAIN SIZE DISTRIBUTION TEST REPORT
THE GEOTECHNICAL GROUP, INC.

SL - 017