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Direct Push Monitoring Point Assessment

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13. ABSTRACT *(Maximum 200 words)*
Beginning late in 1996, the Air Force Research Laboratory undertook the first phase of a long-term program to compare the performance of direct push monitoring wells with that of conventionally-installed wells for long-term groundwater monitoring of corrective action sites. The goals of the project reported here were to (a) emplace 40 or more direct push wells in proximity to, and paired with, conventional auger-drilled wells at an Air Force corrective action site, matching well construction details as closely as practicable, (b) to collect and analyze samples from both well types in the matched pairs on two separate occasions for laboratory analysis of volatile organic chemicals (VOCs) in groundwater, and (c) to determine whether any statistically significant difference in the outcome of the VOC analyses resulted from the difference in installation method of the wells. Two rounds of sampling and analysis were successfully completed between March 1997 and April 1999, adhering strictly to a low-flow sampling protocol and evaluating a suite of ten volatile organic analytes. Paired data statistical tests were used to compare the performance of the two well types because of their ability to neutralize the influence of extraneous factors which may vary from pair to pair but are assumed to have the same influence within each pair. The findings provide support for the use of direct push monitoring wells for long-term monitoring of corrective action. However, the support is limited to the selected volatile organic analytes, water quality parameters, and physical well configurations included in the study, as well as to the range of hydrogeologic conditions encountered at the study field site.

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PREFACE

This report was prepared by Applied Research Associates, Inc. New England Division, 415 Waterman Road, South Royalton, Vermont for the United States Air Force Research Laboratory, Air Expeditionary Forces Technologies Division, AFRL/MLQL, 139 Barnes Drive, Suite 2, Tyndall Air Force Base, FL 32403-5323 for contract numbers F08635-93-C0020, SSG Subtask 8.05 and F08637-98-C6002 SSG Subtask 32.03S.

This final report describes a project to compare the performance of direct push monitoring wells with that of conventionally-installed wells for long-term groundwater monitoring of corrective action sites.

The authors wish to acknowledge the technical and logistical support of Tom Best of Hanscom AFB, USAF 66 SPTG/CEVR and of the technical support of the Environmental Protection Agency Region 1 and the Air Force Center for Environmental Excellence.

The work was performed between August 1996 and February 2000. The AFRL/MLQL project officers were Mr. Bruce Nielsen, 1Lt Debbie Davis, and 1Lt Gina Graziano.

EXECUTIVE SUMMARY

Beginning late in 1996, the Air Force Research Laboratory undertook the first phase of a long-term program to compare the performance of direct push monitoring wells with that of conventionally-installed wells for long-term groundwater monitoring of corrective action sites. On average, long term monitoring accounts for nearly a third of the life cycle cost of corrective action. Wells emplaced using direct push technology have been shown to be less costly to install than conventional, auger-drilled wells. However, their use for long-term monitoring does not yet enjoy widespread regulatory acceptance.

The goals of the project reported here were to (a) emplace 40 or more direct push wells in proximity to, and paired with, conventional auger-drilled wells at an Air Force corrective action site, matching well construction details as closely as practical, (b) to collect and analyze samples from both well types in the matched pairs on two separate occasions for laboratory analysis of volatile organic chemicals (VOCs) in groundwater, and (c) to determine whether any statistically significant difference in the outcome of the VOC analyses resulted from the difference in installation method of the wells.

Sites at Hanscom Air Force Base (AFB) and Hanscom Field were selected as the locations at which to conduct the study. A comprehensive Work Plan was prepared and received the approval of the Air Force Center for Engineering Excellence (AFCEE) and state (Massachusetts) and federal (US Environmental Protection Agency, Region 1) regulators. The Work Plan included protocols for well installation, sampling, chemical analysis, and statistical comparisons, as well as a site specific Health and Safety Plan (HASP) and Quality Assurance Project Plan (QAPP).

Sixty-four existing conventional monitoring wells were selected as candidates with which to compare the performance of direct pushed wells. Direct pushed wells were successfully installed adjacent to 43 of these existing wells, creating the same number of matched pairs. Screen lengths and elevations of screened intervals, as well as well diameter, were matched as closely as possible in all pairs. However, screen slot sizes were allowed to vary in some cases, as was the schedule (or duty) of PVC riser used, due to the unique demands of direct push installation. Wells were installed to depths as shallow as 13 feet and as great as 65 feet.

Two rounds of sampling and analysis were successfully completed between March 1997 and April 1999, adhering strictly to a low-flow sampling protocol and evaluating a suite of ten volatile organic analytes. Paired data statistical tests were used to compare the performance of the two well types because of their ability to neutralize the influence of extraneous factors (e.g., location of the well pair within the contaminant plume, location with regard to local variation in the hydrogeology, length and depth of the screened interval, etc.) which may vary from pair to pair but are assumed to have the same influence within each pair.

Statistical testing was conducted on the differences of paired observations of analyte concentration, as well as on differences in water quality parameters measured during purging of the wells for sample collection. In the cases where the distribution of differences (or differences of log values) was found to be normally distributed by application of the Shapiro-Wilk W test, the Student's t test was applied to the data set to test the null hypothesis that the mean of

differences was equal to zero. For cases in which the paired difference data were found to be non-normally distributed, the Sign Test and Wilcoxen Signed Rank Test, non-parametric equivalents to the paired data Student's t test, were applied.

Volatile organic analytes included in the comparison consisted of trichloroethene, cis-1,2-dichloroethene, trans-1,2-dichloroethene, vinyl chloride, 1,1-dichloroethane, benzene, toluene, o-xylene, and 1,4-dichlorobenzene. Water quality parameters consisted of temperature, specific conductivity, dissolved oxygen, pH, and turbidity.

With only one exception among all analytes and water quality parameters for which results were compared, the results showed that no statistically significant difference between the performance of the two well types could be discerned. The exception applied to the analytical results for toluene obtained from the first round of sampling. This finding for toluene was not reproduced in the second round results.

The findings provide support for the use of direct push monitoring wells for long-term monitoring of corrective action. However, the support is limited to the selected volatile organic analytes, water quality parameters, and physical well configurations included in the study, as well as to the range of hydrogeologic conditions encountered at the study field site. It is hoped that a subsequent phase of the program will be undertaken, allowing an expanded set of analytes, additional direct-push well styles, and more hydrogeologic conditions to be examined and evaluated based on additional sampling rounds.

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SECTION I

INTRODUCTION

A. OBJECTIVES

In an effort to reduce the cost of characterization and long term monitoring at hazardous waste sites, cone penetrometer testing (CPT) methods and other direct push technologies (DPT) are increasingly being used to install groundwater monitoring wells faster and less expensively than by conventional methods. A long-term program is envisioned to validate the long-term performance of direct push installed wells (DPWs) so that they may become fully accepted for long-term monitoring by EPA, other regulators, and groundwater professionals. The project reported here, entitled Direct Push Monitoring Point Assessment, undertook the first phase of the long-term program.

The specific objectives of the project were to: (1) use CPT, a direct push technology, to install wells alongside conventional monitoring wells (CMWs), (2) collect and analyze groundwater samples from the conventional and direct push installed well pairs as a means to begin the validation of direct push installed wells for long term regulatory monitoring, and (3) conduct a statistical comparison of the results obtained to evaluate the performance of direct-pushed wells against the accepted baseline of auger-drilled wells for long-term monitoring.

One caveat in the study is notable. Comparing contaminant analytical results of groundwater sampling from direct push installed wells (DPWs) to those from conventionally installed auger drilled wells (CMWs) with the intent to determine their validity implies that the CMWs produce empirically, or absolutely accurate monitoring results. In reality, there is no universally accepted standard monitoring well or sampling method that produces absolutely accurate representation of the groundwater. This is important because in this study we are not measuring the accuracy with which samples from DPWs are representative of the groundwater, we are only determining whether DPWs produce the same results, statistically, as CMWs.

B. BACKGROUND

1. Rationale

Installing monitoring wells by conventional methods is typically a time consuming and costly component of site characterization and monitoring. It is becoming widely recognized that direct push installation technologies are less costly than conventional approaches to well installation. Direct push technologies have been used for several years for installing monitoring points, which have mainly been used for water level determinations or to collect one-time samples during initial site characterization. However, due to a lack of validation data, direct push installation techniques have not been widely used and are not yet widely accepted for use in long-term monitoring programs. This project reported here was conducted to evaluate the performance of DPT-installed wells for long-term monitoring of volatile organic compounds (VOCs) in groundwater. It was not conducted as a cost comparison study.

2. Cone Penetration Testing

Among the most developed of direct push technologies is cone penetrometer testing (CPT). CPT originated in the Netherlands about 1934 for geotechnical site investigations. The first cones were used to perform mechanical measurements of the penetration resistance on a conical tip at the end of a series of hollow, cylindrical rods (a "rod string") that were quasi-statically "pushed" into the subsurface using the weight of a truck. A friction sleeve was added to the cone in 1965 (Begemann, 1965). Electronic measurements replaced mechanical measurements in 1948 and were further improved in 1971 (de Reister, 1971). Pore pressure probes were introduced in 1975 (Torstensson, 1975 and Wissa et al., 1975), initially as independent sensors, but were soon incorporated as part of "standard" CPT instrumentation. The modern electronic CPT probe contains the primary geotechnical sensors for tip stress, sleeve friction, and pore pressure along with a wide range of options such as an inclinometer to measure the tilt of the probe, resistivity, soil moisture, pH as well as other physical and chemical parameters. The standard cone is used widely in Europe for geotechnical investigations due to the soft nature of many of the European soils. In the United States, significant efforts have been made to develop larger, more robust CPT probes suitable for use in the stiffer United States soils (especially in the western states). Major components of a complete CPT system are the instrumented probe and rod string, the data acquisition and control unit, the hydraulic push apparatus, and the vehicle on which the system is mounted. The common configuration provides the reaction mass for a hydraulic push force of about 20 tons (18,000 kg). Standard procedures for geotechnical application of the cone penetration test were established by the American Society of Testing and Materials in 1986. This standard applies to probes of 1.44 in or 1.75 in (3.658 cm or 4.445 cm) diameter.

3. CPT for Site Characterization

Using the cone penetrometer for environmental site characterization represents a relatively recent application of the technology. Due primarily to the high cost of drilling at their contaminant sites, both the Department of Defense (DOD) and Department of Energy (DOE) have supported programs to develop advanced chemical sensors and sampling methods for CPT (Bratton, et al., 1993; Gildea, et al., 1995; Montgomery, et al., 1996; Farrington and Bratton, 1997) as a means to reduce site characterization expenses. Significant advantages of CPT for site characterization include:

- Eliminating drilling wastes and the need for treatment and disposal of drill spoils as hazardous material;
- Providing continuous data on the subsurface stratigraphy in real time;
- Identifying thin layers of significantly different hydraulic conductivity;
- Eliminating the possibility of the crew being exposed to the potentially hazardous material;

- Reducing the possibility of cross-contamination (by pressure grouting the hole as the probe is withdrawn); and
- Speed, when compared to conventional drilling and sampling.

CPT is an excellent platform for making continuous measurements through the depths of contaminated soils. In addition, CPT is useful for pushing monitoring sensors into the subsurface, for installing monitoring wells and points, and for taking gas, water, or soil samples for environmental testing.

As mentioned previously, direct push technologies have been used to reduce the cost of monitoring well installation. The wells used in this study differ from conventionally installed wells in that they don't have a sand pack around the screen area.

C. APPROACH

The Direct Push Monitoring Point Assessment project was devised to meet the objective of assessing and validating the performance of direct push installed wells (DPWs) for long-term monitoring of groundwater. This experimental program has been designed to determine if DPWs provide groundwater samples comparable to those provided by wells installed by conventional methods.

D. PROJECT SCOPE

The first step under the program was to use CPT to install a series of monitoring wells adjacent to well-characterized, conventionally installed wells. This approach allows data collected from each direct push well (e.g., chemical contaminant concentrations and water quality parameters) to be directly compared against data collected at the same time from its proximate conventional "paired" well with minimal impact from environmental variables (seasonal factors, hydraulic gradient, bioactivity, etc.). Another important element of our approach is to match the CPT-installed monitoring well physical characteristics (e.g., casing diameter, screen depth and length, number of screen slots, casing material, etc.) as closely as possible to those of the conventionally-installed wells, thereby limiting the comparison to the installation technique and not the well configuration.

The second major element in the program is a long-term sampling and chemical analysis program. The program is designed to be conducted over a minimum of 5 years in a series of "rounds" where both the CPT-installed wells and their corresponding conventional wells are sampled and analyzed for select VOCs using EPA-accepted procedures. Each round of chemical constituent concentration data is analyzed statistically against the hypothesis that there is no difference between the analytical results of samples obtained from CPT-installed well and those obtained from conventionally installed monitoring wells. The statistical analysis is performed on proximate well pairs and, if the hypothesis holds true over the duration of the program, will serve to validate the performance of CPT installed wells.

The project reported here was to undertake the first phase of the overall Direct Push Monitoring Point Assessment program. Under this project, we have initiated the Direct Push Monitoring Assessment program at Hanscom Air Force Base and Hanscom Field near Boston, MA. CPT monitoring wells have been installed adjacent to conventionally-installed groundwater monitoring wells at the sites and the first two rounds of sampling and analysis have been completed. The remainder of this report describes the procedures developed under the program and presents results for the initial two rounds of validation sampling and analysis. The report concludes with our recommendations for further rounds of validation testing.

SECTION II

TEST DESCRIPTION

A. PROJECT PLANNING

The first phase of the experiment consisted of developing a Work Plan. The Work Plan outlined the purpose of the experiment, field conditions, field methods, analytical methods, QA/QC procedures and safety. A copy of the Work Plan is included with this report as Appendix A. To avoid duplication, the elements of the Work Plan are included herein by reference only.

B. SITE DESCRIPTION

1. Background

The Direct Push Monitoring Point Assessment Program took place at two operable units, OU-1 and OU-3, of Hanscom Field and Hanscom AFB. Hanscom AFB and Hanscom Field are situated approximately 14 miles northwest of Boston, Massachusetts, in the towns of Bedford, Concord and Lincoln. Hanscom Field is a civilian airport currently operated by the Massachusetts Port Authority (Massport). Hanscom AFB is a military installation located adjacent to and southeast of the airfield.

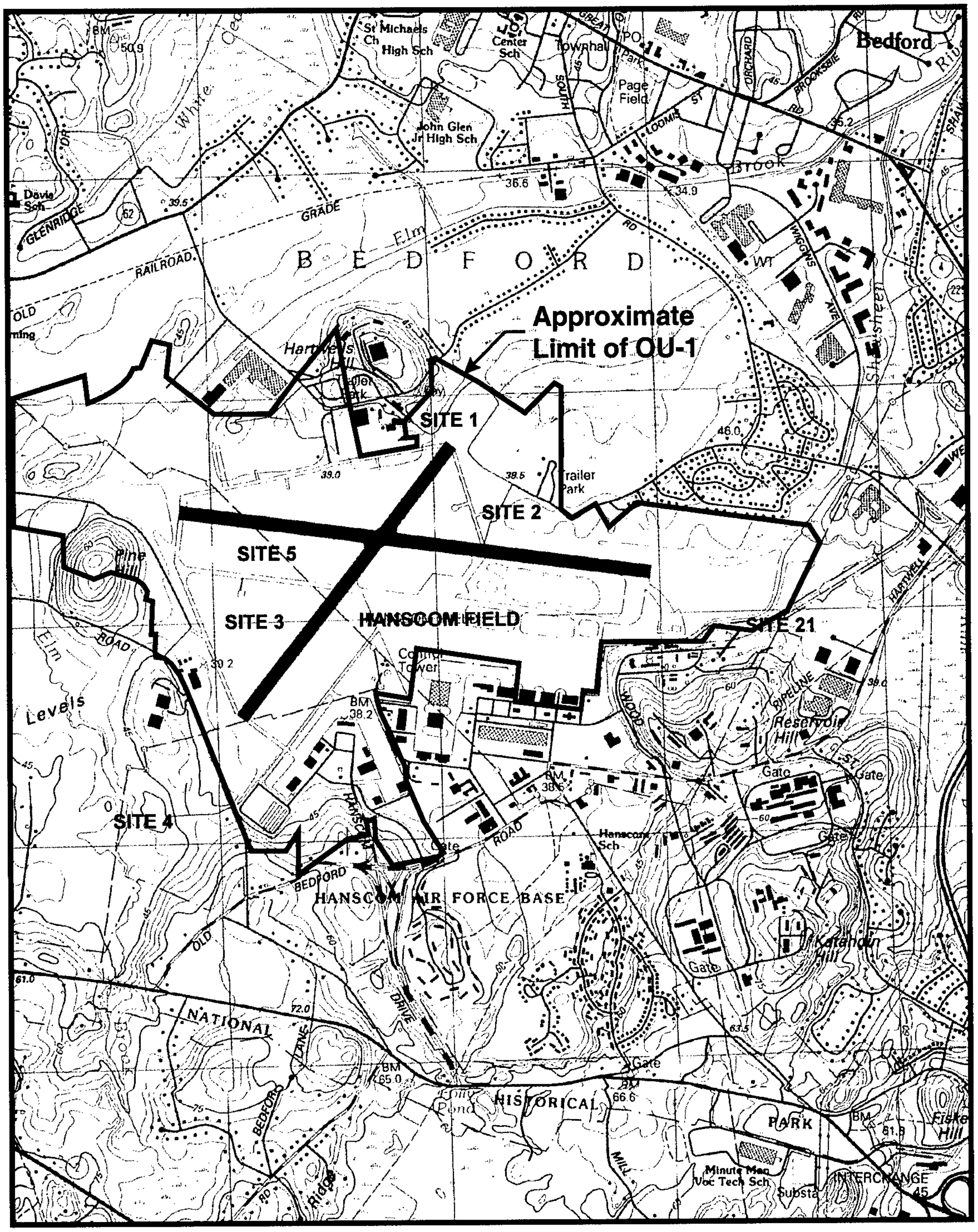
Prior to 1974, Hanscom Field was used as a military airport by the Air Force. During this time, hazardous substances were generated by support operations and disposed of at different sites on the airfield. In addition, flammable materials were ignited and extinguished during fire training exercises performed at selected sites on the airfield. These sites, contained in OU-1, are as follows:

Site 1: Fire Training Area II
Site 2: Paint Waste Disposal Area
Site 3: Jet Fuel Residue/Tank Sludge Disposal Area
Site 5: Fire Training Area I.

To assess potential soil and groundwater contamination associated with these previous activities, Haley and Aldrich, Inc. (H&A) completed a remedial investigation culminating in a report ("Installation Restoration Program, Phase IV-A, Remedial Investigation Report for Sites 1-5 of Area 1") dated May 1988. This assessment detected volatile organic compounds in groundwater in three separate aquifers. In response to these findings, a groundwater treatment facility was installed at the airfield. The treatment facility consists of three collection trenches located at Sites 1,2, and 3, and four bedrock interceptor wells located along the northern Hanscom Field property boundary. Collected groundwater is pumped to an air stripping tower, treated, and then routed to a drainage ditch, which discharges into the wetlands to the north, and/or routed to recharge basins at Sites 2 and 3, where it is reintroduced to the groundwater.

Currently, groundwater is being collected from each of the installed trenches and bedrock interceptor wells.

Figure 1. Hanscom AFB and Hanscom Field test site locations.



2. Hydrogeologic Setting

Hanscom Field is located on a flat-lying plain with a general relief of less than 10 ft. over a distance of approximately 3 miles. This feature is an ancient lake basin that was formed and subsequently filled in by sediment during the last phase of glaciation in New England. The plain extends beyond OU-1 to the north and west. To the south and east, this plain is bounded near the limit of OU-1 by low-lying hills of glacial till and gravel. Other topographic features include Hartswell Hill and Pine Hill. These are till-covered, isolated hills located at the northern and western boundaries of OU-1, respectively. The hills provide a relief of approximately 100-ft above the surrounding plain.

The principal drainage features in the vicinity of OU-1 are the Shawsheen River, which originates in the east end of the air field and flows toward the northeast, and Elm Brook, which is located west of the airfield and ultimately flows northwest and into the Shawsheen River. Surface runoff at Hanscom Field is controlled by a storm drain system that includes drainage ditches, culverts, and subdrains. This system drains into Elm Brook, the Shawsheen River and the wetlands northeast of OU-1.

Test borings completed during an Installation Restoration Program have identified three principal soil deposits underlying OU-1. From upper to lower, these soils are an outwash section, a lacustrine section, and a till section. The till section is deposited above bedrock, consisting primarily of granite, with lesser amounts of quartz diorite and gneiss.

The upper most outwash section measures 0 ft to 33 ft in thickness and consists primarily of fine sand. Locally this unit is composed of medium to coarse sand with lesser amounts of gravel. The underlying lacustrine section consists of interbedded silt, clay, and fine sand. The unit varies in thickness from 0 ft to 60 ft. Beneath the lacustrine section is a till deposit which locally grades into a lower outwash unit. This unit measures from 0 ft to 88 ft in thickness.

These geological units define three separate aquifers. The outwash section comprises the area's near-surface unconfined aquifer. The till section, positioned beneath a thick sequence of lacustrine clay, silt and fine sand, forms a lower, semi-confined aquifer. A third aquifer has been encountered by monitoring wells installed into bedrock.

C. SITE SELECTION

Before individual wells were selected for the study, each of the contaminated sites at Hanscom AFB and Hanscom Field were evaluated against the data quality objectives. Sites 1, 2 and 21 were selected based on the range of contaminants present at the sites, distribution of existing wells and ease of access to these sites. Obtaining access to each of these sites did not impact operations on the AFB or at the air field.

Site 21, also known as the Fuels Site for this study, is located on Hanscom AFB, southeast of the airfield (Figure 1). Site 21 was formerly used for fuel and gasoline storage and distribution. Between 1945 and 1973 the site was used for jet fuel and aviation gasoline and during the 1970s the site was only used for heating and fuel oils. During this period, several spills were identified in the vicinity of former buildings and areas of this site. In 1990 the storage tanks were removed and the land is now in use as a general storage area. In September of 1995, a soil vapor extraction and passive groundwater collection system began operation to remove subsurface contamination.

1. Conventional Well Selection

From a list of all of the wells at sites 1, 2, and 21, a total of 64 possible locations were selected to cover the range of interest of concentration values and to include wells in both the upper and lower aquifer. The study focused on wells bearing lower concentrations because these levels were presumed to be of greatest interest for regulatory monitoring, and thus most appropriate to the study. The principal benchmarks of regulatory concern are action limits and cleanup targets, both being defined by characteristically low concentrations. The goal was to install paired wells at approximately 40 of the 64 candidate locations identified. As discussed in the results section, a total of 43 functioning direct-pushed wells were successfully installed for use in the study.

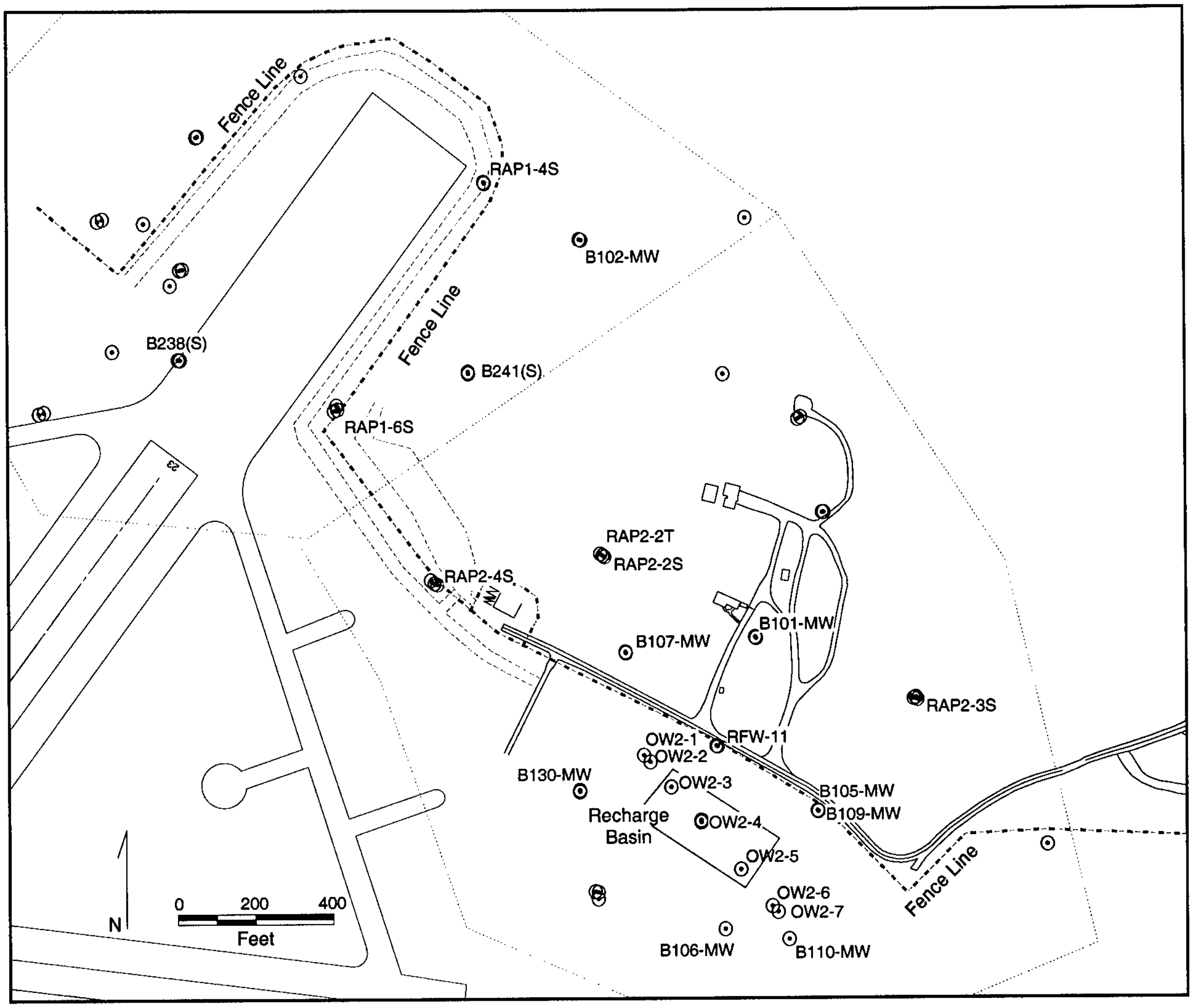


Figure 2. Map of Sites 1 & 2 showing the locations of conventionally installed monitoring wells. Direct push installed monitoring wells were installed within 5 to 10 feet of the conventionally installed wells.

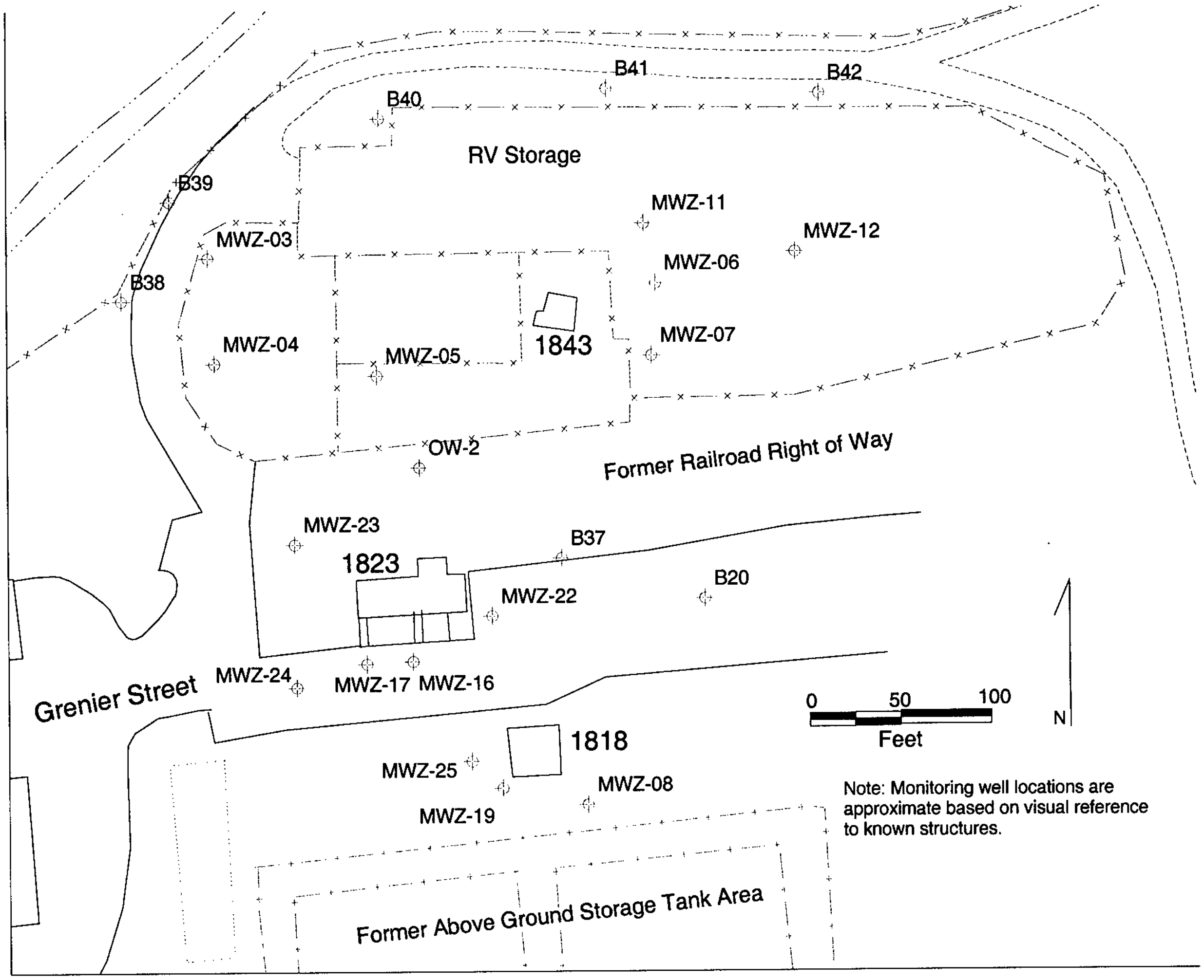


Figure 3. Map of Site 21 showing the locations of conventionally installed monitoring wells. Direct push installed monitoring wells were installed within 5 to 10 feet of the conventionally installed wells.

D. DIRECT PUSH MONITORING WELLS

1. Location and Placement

In order to isolate the effects of the well installation technique as the only significant comparative variable in the validation study, we sought to minimize all other potential influences on the results obtained from the CPT-installed versus conventionally installed monitoring wells. Perhaps the most obvious potential source of variability is the distribution of wells in relation to the distribution of contaminants in the heterogeneous subsurface environment. To minimize these spatial variances, the CPT-installed wells were located as closely as practical to the existing auger-drilled wells. In addition, screened intervals were matched as closely as possible in the vertical dimension so that sampling from consistent depths was maintained within well pairs.

2. Construction Details

The physical configuration of wells can also have a significant impact on sampling, and the subsequent analytical results. For example, at a fixed flow rate, the time required to effectively purge a 4-inch diameter well would be significantly longer than the time required to purge a 2-inch diameter well in the same formation. Therefore, identical purge times or volumes would likely result in non-identical samples.

Variability in the physical parameters of well construction (i.e., materials and dimensions) between the two well populations was allowed only to the extent that it was necessary to permit establishment of functional direct pushed monitoring points. Wells were constructed of 2-inch diameter schedule 80 PVC with flush threaded joints. Although some of the conventional wells were constructed of schedule 40 PVC, schedule 80 was used in the direct-pushed wells because the heavier duty material is necessary to resist the additional stress that direct-pushed wells receive upon installation. This difference results in a slight reduction of the inside diameter of the well. Each riser section was one meter (3.28 feet) long with an outside diameter of 2.375 inches.

Another important construction parameter is the slot size, due to its effect on bulk permeability of the screened well interval. Differences in permeability will result in different time scales for reaching dynamic equilibrium, including both chemical (partitioning) and physical (flow) equilibrium between the water outside the well, the water inside the well, and the headspace above the well water. Also, because direct push installation displaces material into the surrounding formation rather than removing it, and since conventional wells are surrounded by a high permeability non-native sand pack, lower permeability may result around the direct push wells. Although slot sizes were matched to the maximum extent practical, some variation was allowed as discussed below.

While the existing conventional wells utilized both 0.010-inch and 0.020-inch screen slot sizes, all direct push well screens were constructed of 0.020-inch slots. The larger slot size enables more effective well development, and compensates for the potentially lower permeability of the formation in contact with direct push wells, which can be due to differences in installation technique, including the exclusion of an annular sand pack. Since a CPT-installed well does not have a non-native sand pack around it, aggressive well development is performed to remove the fines from the immediate formation material, effectively creating a natural sand pack. We have found that with the larger, 0.020-inch slot size we can more effectively mobilize and remove these fines during well development. The screen sections were configured to match as closely as possible the existing conventionally installed wells in terms of their top and bottom elevations.

In most cases, a silt trap was installed on the CPT-installed wells even when not present on the conventionally installed well. Inclusion of a silt trap is common practice which helps maintain the effective screen area on CPT-installed wells. On the conventionally installed wells, a silt trap is usually not needed because the annular sand pack installed around drilled well screens provides a place for mobile fines to settle before entering the well. CPT-installed wells do not have a sand pack around the screen to reduce silt infiltration so even low silt content material will produce silt infiltration. The inclusion of a silt trap allows the silt to collect below the screen interval away from the sampling zone. In the present study, a circumstance in which a silt trap would not have been included on the CPT-installed wells would be when the bottom of the screen of the conventionally installed well extended to the top of the bedrock. In this situation the bottom of the screen of the CPT-installed well would also be installed as close to the bedrock as possible, leaving no room for inclusion of a silt trap.

3. Installation Procedure

New CPT-installed monitoring wells were installed according to standard installation procedures developed by ARA. A schematic of this well installation procedure is presented in Figure 4.

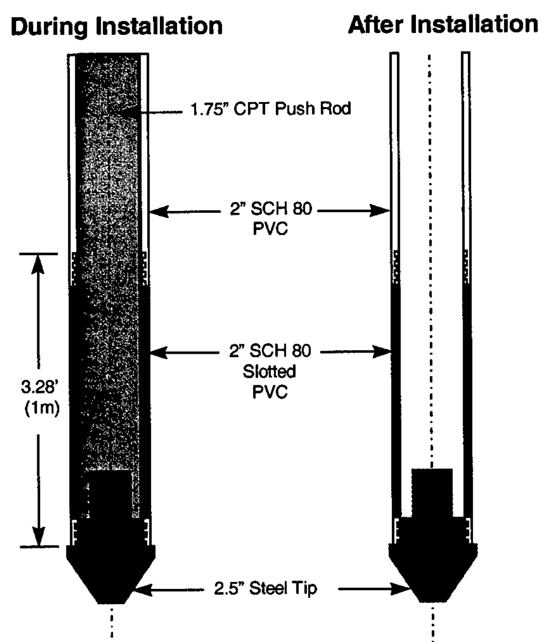


Figure 4. Schematic of 2-inch diameter PVC well installation with Cone Penetration Technique (CPT).

Before each new well was installed, a 1.75-inch standard CPT cone was advanced to the design well completion depth. This first penetration measured the geologic conditions at the well location and provided a guide hole for the larger diameter well. During each pilot penetration, CPT data were acquired and recorded, and used to generate a field plot upon completion of the hole. CPT profiles are contained in Appendix B.

Most of the DPT-installed wells included a one-meter section of solid riser beneath the screened interval to serve as a silt trap, or sump. Installation of each well began by threading a sacrificial stainless steel or high-strength plastic tip, which acted as the drive point, into one end of the bottom section of well casing, either solid (sump) or slotted (screen). The remainder of the screen sections and solid riser were then threaded onto the other end as the drive point was lowered to the ground. Once the sacrificial tip reached ground surface (beneath the truck), the steel push rods, with a blunt tip attached, were lowered inside the well material until the blunt end rested behind the sacrificial tip. Enough rods were added so that the end of the rods extended beyond the top of the well material and the CPT head clamp on the CPT rig could clamp the rods and not the well material. Installation began as the CPT rods, in compression, drove the sacrificial tip into the ground, pulling the trailing well material in with it. Additional screen and riser sections were added as necessary until the desired installation depth was achieved.

Upon reaching the planned well completion depth, the CPT rods were removed from within the well casing and a depth indicator was lowered down the well to verify the total depth of the well. This information was recorded on the well installation reports. During removal, the rods were decontaminated using the CPT rig's steam cleaner. Water generated during the rod decontamination process was containerized in a 55-gallon drum and delivered to the on-site groundwater treatment facility for disposal.

A flush-mounted manhole cover was installed and set in an eighteen (18) inch square concrete cap. The well riser was cut approximately 2 to 3 inches below the top of the cap before the manhole cover and cap were installed. Due to the winter conditions the well locations were marked with wood stakes which had been spray painted with fluorescent marking paint. The man hole covers and concrete caps were installed in the spring.

4. Well Development

Development of CPT-installed monitoring wells was conducted with the Aardvark well development system. This system is a combination of a mechanical surge block and a venturi airlift silt and water pump. The Aardvark system was cleaned in a liquinox water bath before each use to avoid cross-contamination. Development was achieved by raising and lowering the Aardvark development head in the well repeatedly over a two-foot section of the well screen. During this process field readings were taken of the purge water's temperature, pH, and turbidity at a rate of 1 reading per removed well volume. Field parameters were measured with a YSI Model 6820 field water quality tester. Instrument specifications and calibration procedures are included in Appendix D. The Aardvark process continued until these parameters stabilized (less than 0.2 pH units or a 10 percent change for the other parameters among four consecutive readings) and the water was clear and free of fines.

The existing, conventionally-installed monitoring wells were not developed under this study, since these wells were previously developed and are part of a separate, on-going water quality study. Well development logs for the DPW are contained in Appendix D.

E. SAMPLING AND ANALYSIS

The objectives of this sampling program were to collect water samples from two-inch diameter wells using a sampling method that is suitable for collection of water contaminated with volatile organic compounds (VOCs) and is generally accepted by regulatory agencies such as the EPA. Other requirements were that the groundwater table varies from 2 feet to 20 feet below the ground surface. The primary concentration range is near the action MCL level.

A decision was required as to what sampling techniques and analytical methodology should be used to compare the populations of monitoring results from the two well types. We determined that this methodology should be chosen to maximize relevance to the intended purpose of the study results (i.e. to promote regulatory acceptance). For this reason, only sampling and analysis procedures considered standard within the framework of the long-term monitoring requirements of major regulatory programs, such as the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (also known as Superfund), and the Resource Conservation and Recovery Act (RCRA) were considered for use. Accordingly, we required the data quality of the study to meet or exceed the typical data quality objectives of these programs. Thus, all samples were collected and analyzed according to typical (RCRA and CERCLA) requirements and EPA technical guidance directives to ensure that the results of the experiment are valid in the context of regulatory required long-term monitoring.

1. Groundwater Sampling

For this study, we selected a relatively new technique published by the EPA Region I in July, 1996. In this document, titled "Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells," the EPA "provides a general framework for collecting groundwater samples that are indicative of mobile organic and inorganic loads at ambient flow conditions." This document is included in the Work Plan (Appendix A) for reference.

The first round of sampling was conducted during April and May of 1997, and the second round in September of 1998. However, re-sampling of the second round in March and April of 1999, was required due to uncorrectable errors in laboratory analyses.

a. Equipment

During the first round, samples were collected using a stainless steel Grundfos Redi-flow™ submersible pump which was shared among the wells. Since the pump and tubing were shared, they were decontaminated before each sampling round and after each well was sampled according to the procedures described below.

During the second round, samples were collected using a stainless steel non-dedicated submersible bladder pump with dedicated tubing. During this round, only the pump was decontaminated before each sampling round and after each well was sampled. The tubing was not decontaminated since each well had its own dedicated segment which was not re-used.

All sampling equipment was decontaminated before the beginning of each sampling round and after each well was sampled. If dedicated tubing was not used, the outside of the sampling tubing was decontaminated during retraction of the sampling pump. After the pump had been removed from the well it was placed in a water and Liquinox™ bath. Three pump volumes were pumped through the pump and sampling tubing (if non dedicated). This process was repeated for two baths of tap water rinse and again in a bath of reagent free water.

b. Well Purging

Prior to collecting groundwater samples from each well, water was purged from the well until the field measurements of turbidity, conductivity, temperature, dissolved oxygen, and pH stabilized. Purged water was pumped through the flow through cell of a YSI Model 6820 sonde to measure water quality parameters during purging. Field parameters were recorded at regular intervals (at least once per well volume), typically of five to ten minutes. In slight deviation from the sampling protocol, oxidation-reduction potential (ORP) was not monitored, as equipment for measuring this parameter was not available.

Also, before and during purging, water levels were measured using a Solinst water level meter calibrated to 0.01 feet. The probe portion of the water level meter was decontaminated before each measurement by soaking with a Liquinox™ solution and rinsing with tap water and again with distilled water. Purge water generated during the groundwater sampling and decontamination water was containerized in 55-gallon drums and delivered to the on-site groundwater treatment facility for disposal. Purge procedures and stabilization guidelines are covered in the Work Plan (Appendix A).

c. Sample Collection

For each well the pump was positioned at the mid-point of the screened interval. If this location is less than 2 ft above the bottom of the well, then the pump was positioned at 2 ft above the bottom of the well. Each sample was collected in a 40-ml glass vial with a Teflon-backed septum. Purchased sample vials were pre-cleaned and suitable for purgeable volatile organic analysis (PVOA). The vials were preserved with hydrochloric acid (HCl). Groundwater from the site was tested before hand to determine how many drops were required to increase the acidity to a pH of 2.

Sample containers were filled such that no air was retained within the sample vial. The absence of headspace was verified by turning the capped vial upside down and tapping the lid while watching for bubbles. Sample labels with requisite identification data were affixed to each vial. Vials were labeled with the date and time of collection, sampling personnel's initials, well ID and depth, and a unique sequence number. The same information was recorded in the field sampling logbook.

d. Sample Handling and Chain-of-Custody

Each sample set of more than one vial was placed in a single, sealed plastic bag. Filled sample vials were stored at four degrees centigrade in a refrigerator or ice-containing insulated cooler until delivery to the analytical laboratory.

Samples to be analyzed by the CLP laboratory were packed into a separate cooler at the end of the sampling day. This cooler was packed with a bottom layer surrounding the sample containers. A Chain-of-Custody Form was signed and placed in a resealable plastic bag within the cooler and the cooler was sealed with tape and a Chain-of-Custody Seal, such that the seal must be destroyed before accessing the cooler. The cooler was shipped to the laboratory by overnight express (or equivalent) mail from the field.

Chain-of-Custody Forms accompanied all samples delivered to each laboratory. The forms listed the number of vials of each size contained in each cooler. They were signed and dated by field personnel at the time of packing for shipment from the field, and by laboratory personnel at the time of receipt in the laboratory.

2. Analytical Chemistry

a. Analytes

The analytes of interest for the study, all volatile organic compounds (VOCs), were chosen on the basis of two criteria:

- Significance to the Hanscom base Installation Restoration Program (IRP) in terms of relevance to their regulatory obligations, and
- documentation of prior occurrence in the groundwater at the demonstration site.

While the second criterion is obvious, the first criterion was a function of the ultimate objective of the study, which is to validate the use of direct push monitoring points versus the baseline monitoring technology for use in regulatory monitoring programs. These criteria resulted in the selection of the following nine VOC for inclusion in the study: benzene, toluene, xylene, trichloroethene, cis-1,2-dichloroethene, trans-1,2-dichloroethene, vinyl chloride, 1,1-dichloroethane, and 1,4-dichlorobenzene.

b. Methods

Chemical analyses of field samples were performed for selected compounds using EPA SW-846 methods. The first round samples were analyzed by ARA's New England Division laboratory using EPA Method 5021 static head space sample concentration and modified EPA method 8021 for the analysis of volatile organic compounds in water. Modifications to method 8021 included: the use of a capillary column in place of a packed column; the use of a flame ionization detector (FID) in parallel with an electron capture detector (ECD) instead of a photo-ionization detector (PID) and electrolytic conductivity detector (ELCD); and truncation of the standard analyte list. The truncated target analyte list included only the purgeable halocarbons and aromatics presented above.

c. Equipment

The instrument configuration at ARA's laboratory consisted of Tekmar 7000 Static Headspace sampler connected directly via a heated transfer line to the split/splitless capillary injection port of a Hewlett-Packard 5890 series II gas chromatograph equipped with electronic pressure control (EPC). The injection port was run in splitless mode to optimize the detection of trace analytes.

Split samples for laboratory Quality Assurance/Quality Control (QA/QC) were sent to Inchcape Testing Services (ITS) Environmental Laboratories (Colchester, VT). Analysis of splits was performed using Gas Chromatography/Mass Spectrometry (GC/MS) following EPA Method 8260. All of the second round samples were sent to Severn-Trent Laboratories (formerly ITS) where they were analyzed by Gas Chromatography/Mass Spectrometry (GC/MS) method 8260.

d. Laboratory Procedures

The Gas Chromatography (GC) equipment used by ARA was calibrated according to the procedures specified in EPA method 8021. For each analyte of interest, a five-point calibration was developed including one at a concentration near, but above the method detection limit. The other concentrations correspond to the expected range of concentrations found in the actual samples or defined the working range of the detector. A linear calibration curve was derived for each analyte by a least squares best fit through the five calibration points plus the origin. The calibration curve was considered acceptable if the correlation coefficient is greater than or equal to 0.995. Retention time windows included plus or minus three standard deviations of the mean retention times for each analyte measured over a 72-hour period. The instrument was re-calibrated under two conditions: before analyzing the samples from each sampling round, and upon failure of a quality control check as discussed in the Quality Assurance Project Plan (QAPP).

Calibration standards used by ARA's Laboratory were prepared according to the procedures specified by EPA method 8021B. Stock standards were prepared from pure (neat) standards, prepared as specified in the method, or purchased as certified solutions. Any required dilution of the purchased standards was performed using Level A precision glassware and reagent-free water that had been analytically demonstrated to be free of target analytes, at least down to the analytical method detection limits. Retention time windows for all of the individual peaks were identified by analyzing a 10-ppm dilute standard of each of the individual target analytes in accordance with the procedures outlined in SW-846 method 8000. Calibration check standards were run at a rate of one every ten samples and included each of the target analytes at a concentration of 20 ppb. These standards were made up independently from the dilutions used to make the calibration standards. All calibration standards were purchased from Supelco, Inc. (Bellefont, PA). The normal level of certification that accompanies all Supelco standards was considered acceptable for the purpose of the project.

Method 8021 specifies method performance criteria which assume a photo-ionization detector (PID) and a Hall electrolytic conductivity detector (HECD) are used in series. Since we used different detectors as a modification of Method 8021 it was necessary to conduct an instrument-specific method detection limit (MDL) study for the analysis of samples from the first round.

e. Quality Assurance/Quality Control

A comprehensive Quality Assurance Project Plan (QAPP) to assure quality in both sampling and analysis was developed for this project. The QAPP addresses quality assurance associated with all aspects of sampling and analysis of samples. All laboratory work associated with this project adhered to the QA/QC procedures contained in the QAPP. A copy of the QAPP is included in the Work Plan contained in Appendix A.

SECTION IV

TEST RESULTS

A. WELL INSTALLATION AND DEVELOPMENT

One of the goals of this study was to install approximately 40 wells with direct push technology, adjacent to conventionally installed auger drilled wells, forming well pairs from which to obtain samples for comparison. We completed the well installation and development tasks during February and March of 1997. Of the 64 candidate locations identified, we succeeded at installing functioning wells at 43. Forty-one of these were installed to depths ranging from 17 to 35 feet, and two wells were installed to an approximate depth of 65 feet. Twenty-five of the wells installed were at sites 1 & 2 and 18 were at site 21. At the other 21 candidate locations, wells were either not installed or not used due to the following reasons:

- At 9 locations, refusal was encountered, where we were unable to obtain the desired depth of penetration.
- Nine wells were skipped because either (a) confidence was low, based on boring logs and previous attempts, that the desired depth would be achievable, or (b) we had already succeeded in installing enough wells for the study.
- At one well, casing damage was discovered following installation.
- At the final two wells, both wells in the pair were pumped dry due to nearby Pump and Treat remediation operations.

An installation summary of the wells used in this study is presented in the following tables. Complete field records of the installation and development activities, including CPT sounding profiles, well construction logs, and well development logs appear in Appendices B, C, and D, respectively.

Table 1 Well installation summary showing all candidate locations and which locations were selected for well installation.

Monitoring Wells		Well and Screen Construction		
Well No.	Direct Push Installation Status	Total Depth (feet B.G.S.)	Top Depth (feet B.G.S.)	Bottom Depth (feet B.G.S.)
Site No. 1				
B102-MW	✓	14.0	3.0	14.0
B103-MW	✓	15.0	5.0	15.0
B104-MW	✓	13.0	3.0	13.0
B238(S)	✓	12.0	5.0	10.0
B239(T)	x	30.0	23.0	28.0
CW-4	x	25.0	15.0	25.0
P01-4SA	-	13.1	3.0	13.1
RAP1-1T	-	23.8	18.7	23.8
RAP1-3S	-	17.5	0.0	17.5
RAP1-4S	✓	14.7	0.0	14.7
RAP1-5S	✓	13.5	0.0	13.5
RAP1-6S	✓	14.5	0.0	14.5
RAP1-6T	-	44.7	29.6	44.7
RFW-15	-	15.6	5.8	15.6
Site No. 2				
B101-MW	✓	18.5	3.5	18.5
B105-MW	✓	15.0	5.0	15.0
B106-MW	✓	14.0	4.0	14.0
B107-MW	✓	14.0	4.0	14.0
B108-MW	x	78.0	68.0	78.0
B109-MW	✓	69.0	59.0	69.0
B115-MW	x	59.0	52.0	59.0
B126-MW	x	61.7	51.7	61.7
B130-MW	✓	14.0	4.0	14.0
B241(S)	✓	17.0	3.0	16.0
B242(T)	x	49.0	43.0	48.0
OW2-1	✓	15.0	10.0	15.0
OW2-2	✓	20.0	15.0	20.0
OW2-3	-	25.0	20	25
OW2-4	✓	30.0	25.0	30.0
OW2-5	-	25.0	20	25
OW2-6	✓	20.0	15.0	20.0
OW2-7	✓	20.0	15.0	20.0
P02-1S	-	18.0	5.5	18.0
RAP2-2S	✓	19.9	0.0	19.9
RAP2-2T	✓	75.3	60.1	75.3
RAP2-3S	✓	23.6	0.0	23.6
RAP2-4S	✓	25.0	0.0	25.0
RAP2-4T	x	41.4	31.4	41.4
RAP2-5S	✓	14.6	0.0	14.6
RAP2-5T	-	32.9	17.7	32.9
RFW-11	✓	17.2	7.2	17.2

Monitoring Wells		Well and Screen Construction		
Well No.	Direct Push Installation Status	Total Depth (feet B.G.S.)	Top Depth (feet B.G.S.)	Bottom Depth (feet B.G.S.)
Site No. 21				
MWZ-3	✓	20.0	10.0	20.0
MWZ-4	+	20.0	10.0	20.0
MWZ-5	✓	20.0	10.0	20.0
MWZ-6	✓	18.5	8.5	18.5
MWZ-7	✓	19.0	9.0	19.0
MWZ-8	✓	20.0	10.0	20.0
MWZ-11	✓	22.0	12.0	22.0
MWZ-12	✓	20.0	10.0	20.0
MWZ-16	x	20.0	10.0	20.0
MWZ-17	✓	20.0	10.0	20.0
MWZ-19	+	20.0	10.0	20.0
MWZ-22	✓	19.5	9.5	19.5
MWZ-23	✓	19.0	9.0	19.0
MWZ-24	x	18.0	8.0	18.0
MWZ-25	+	19.5	9.5	19.5
OW-2	✓	20.0	7.0	20.0
B20	✓	17.0	7.0	17.0
B37	✓	17.0	7.0	17.0
B38	✓	20.0	10.0	20.0
B39	✓	20.0	10.0	20.0
B40	✓	17.0	7.0	17.0
B41	✓	15.0	5.0	15.0
B42	✓	15.0	5.0	15.0

Site	Success ✓	Refusal x	Skipped -	Problem +
Sites 1&2	25	7	9	0
Site 21	18	2	0	3
Total	43	9	9	3

Table 2 Well Construction Details

Well No.	Site	Sampled Round 1	Sampled Round 2	Direct Push Wells: Total Depth (feet B.G.S)	Direct Push Wells: Screen Top Depth (feet B.G.S)	Direct Push Wells: Screen Bottom Depth (feet B.G.S)	Direct Push Wells: Silt Trap (feet)	Conventional Wells: Total Depth (feet B.G.S.)	Conventional Wells: Screen Top Depth (feet B.G.S.)	Conventional Wells: Screen Bottom Depth (feet B.G.S.)	Conventional Wells: Slot Size (inches)
Site No. 1 & 2											
B101-MW	2	✓		21.83	2.15	18.55	3.28	18.50	3.50	18.50	0.01
B102-MW	1	✓		17.23	4.35	14.19	3.28	14.00	3.00	14.00	0.01
B103-MW	1			15.00	5.47	15.31	no	15.00	5.00	15.00	0.01
B104-MW	1			8.74	2.50	9.06	no	13.00	3.00	13.00	0.01
B105-MW	2	✓		18.13	11.57	14.85	3.28	15.00	5.00	15.00	0.01
B106-MW	2			17.10	0.70	13.82	3.28	14.00	4.00	14.00	0.01
B107-MW	2	✓		17.21	4.09	13.93	3.28	14.00	4.00	14.00	0.01
B109-MW	2	✓	✓	62.61	59.33	62.61	no	69.00	59.00	69.00	0.01
B130-MW	2	✓		17.15	4.03	13.87	3.28	14.00	4.00	14.00	0.01
B238-MW	1	✓		10.27	4.09	10.65	no	12.00	5.00	10.00	0.01
B241(S)	2	✓	✓	18.25	5.13	14.97	3.28	17.00	3.00	16.00	0.01
RAP1-4S	1	✓		14.63	1.87	14.99	no	14.70	0.00	14.70	0.02
RAP1-5S	1			10.19	0.66	10.50	no	13.50	0.00	13.50	0.02
RAP1-6S	1	✓	✓	17.88	1.83	14.95	3.28	14.50	0.00	14.50	0.02
RAP2-2S	2	✓	✓	22.84	3.16	19.56	3.28	19.90	0.00	19.90	0.02
RAP2-2T	2	✓	✓	62.19	55.63	62.19	no	75.30	60.10	75.30	0.02
RAP2-3S	2	✓		27.00	0.76	23.72	3.28	23.60	0.00	23.60	0.02
RAP2-4S	2	✓	✓	24.52	4.84	24.52	no	25.00	0.00	25.00	0.02
RAP2-5S	2			14.49	1.37	14.49	no	14.60	0.00	14.60	0.02
OW2-1	2			18.18	11.62	14.90	3.28	15.00	10.00	15.00	NA
OW2-2	2	✓		23.39	16.83	20.11	3.28	20.00	15.00	20.00	NA
OW2-4	2	✓		33.35	23.51	30.07	3.28	30.00	25.00	30.00	NA
OW2-6	2	✓	✓	23.10	13.26	19.82	3.28	20.00	15.00	20.00	NA
OW2-7	2	✓		23.49	13.65	20.21	3.28	20.00	15.00	20.00	NA
RFW-11	2	✓		20.34	7.22	17.06	3.28	17.20	7.20	17.20	0.02
Site No. 21											
B20	21			17.04	7.20	17.04	no	17.00	7.00	17.00	NA
B37	21	✓		16.77	7.33	17.17	no	17.00	7.00	17.00	NA
B38	21			17.95	8.11	17.95	no	20.00	10.00	20.00	NA
B39	21	✓		17.54	7.70	17.54	no	20.00	10.00	20.00	NA
B40	21	✓		16.70	7.31	17.15	no	17.00	7.00	17.00	NA
B41	21	✓		14.84	5.37	15.21	no	15.00	5.00	15.00	NA
B42	21	✓		15.28	5.94	15.78	no	15.00	5.00	15.00	NA
MWZ-3	21			15.50	9.27	15.83	no	20.00	10.00	20.00	NA
MWZ-4	21			17.90	8.06	17.90	no	20.00	10.00	20.00	NA
MWZ-5	21	✓		20.41	10.57	20.41	no	20.00	10.00	20.00	NA
MWZ-6	21	✓	✓	18.78	8.94	18.78	no	18.50	8.50	18.50	NA
MWZ-7	21	✓	✓	14.03	7.47	14.03	no	19.00	9.00	19.00	NA
MWZ-8	21			19.88	10.38	20.22	no	20.00	10.00	20.00	NA
MWZ-11	21	✓	✓	19.93	10.09	19.93	no	22.00	12.00	22.00	NA
MWZ-12	21	✓		20.08	10.24	20.08	no	20.00	10.00	20.00	NA
MWZ-17	21	✓		18.94	9.10	18.94	no	20.00	10.00	20.00	NA
MWZ-19	21			14.45	8.24	14.80	no	20.00	10.00	20.00	NA
MWZ-22	21			19.54	9.70	19.54	no	19.50	9.50	19.50	NA
MWZ-23	21			17.78	8.23	18.07	no	19.00	9.00	19.00	NA
MWZ-25	21			15.81	6.32	16.16	no	19.50	9.50	19.50	NA
OW-2	21	✓		16.37	6.89	16.73	no	20.00	7.00	20.00	NA

Notes: ✓ Checked wells were sampled during indicated round.
Slot Size: All direct push wells have a slot size of 0.020 inches.

B. SAMPLING AND ANALYSIS

Two separate sampling tasks were completed during April-May of 1997 and in March-April of 1999. From the first round of sampling, thirty-one (31) samples were collected and analyzed from each well pair resulting in a total of 62 samples. Fourteen quality control replicate samples were sent to a contract laboratory for verification. During the second round of sampling, 20 samples (2 from each of 10 pairs) were collected and sent to Severn-Trent Laboratory (Colchester, VT) for analysis. The analytical results form part of the basis for the statistical comparisons presented in section C below. The results from monitoring water quality parameters during well purging for two sample collection rounds (one for which the VOC analyses were conducted incorrectly, and a re-sampling of that round) formed the rest of the data set used in the statistical comparisons.

During each event, all sampling adhered to the low-flow sampling procedure detailed in the attached Work Plan. This procedure requires the monitoring of several water quality parameters used to indicate when purging has resulted in dynamic steady-state conditions within the well and surrounding formation. These parameters included: temperature, specific conductivity, dissolved oxygen, pH, and turbidity. The monitoring of oxidation-reduction potential (ORP) is also recommended in the protocol, but was not performed due to unavailability of appropriate equipment. This monitoring, performed using a handheld analyzer, resulted in field sampling logs which contained records of observations of all the monitored parameters. With the exception of Round 1 water quality monitoring data, these parameters were also subjected in the statistical analyses presented below. The Round 1 data were omitted because the sampling apparatus used in Round 1 included a relatively long hose with a correspondingly high residence time. This configuration may have resulted in values that, while sufficiently indicative of the attainment of steady state conditions for sampling, may not have been representative of actual conditions within the well, due to atmospheric influence on the hose. The field sampling logs are presented in Appendix E.

Results of analyses for volatile organic compounds (VOCs) from samples collected during the study are summarized in the tables below. Well sampling logs appear in Appendix E, and complete analytical results are presented in Appendix F.

Table 3. Summary of results of VOC analyses from the first sampling round.

Analyte	n	Direct Push Wells Results Mean	Min	Max	Std. Dev.	Conventional Wells Results Mean	Min	Max	Std. Dev.
Vinyl chloride	31	6.9	0.5	101.7	23.4	5.9	0.5	89.8	17.4
1,1-Dichloroethane	31	4.9	0.5	98.4	18.7	5.8	0.5	121.6	22.6
Benzene	31	41.4	0.3	786.4	145.6	14.2	0.5	194.2	39.1
Toluene	31	5.2	0.5	49.4	11.0	2.2	0.5	40.4	7.1
o-Xylene	31	1.1	0.5	6.8	1.5	1.5	0.5	15.3	3.0
trans-1,2-Dichloroethene	31	26.5	0.1	768.4	137.7	1.4	0.3	12.5	2.3
cis-1,2-Dichloroethene	31	114.7	0.5	2488.1	457.1	89.5	0.5	2009.6	373.3
Trichloroethene	31	77.4	0.5	1477.1	268.3	80.6	0.5	1944.2	349.3
1,4-Dichlorobenzene	31	104.7	0.5	2628.2	469.6	25.7	0.5	104.8	37.7

Analyte	n	Log(Direct Push Wells Results) Mean	Min	Max	Std. Dev.	Log(Conventional Wells Results) Mean	Min	Max	Std. Dev.
Vinyl chloride	31	-0.083	-0.301	2.007	0.614	0.017	-0.301	1.953	0.643
1,1-Dichloroethane	31	-0.166	-0.301	1.993	0.526	-0.135	-0.301	2.085	0.553
Benzene	31	0.205	-0.600	2.896	0.948	0.163	-0.301	2.288	0.814
Toluene	31	0.200	-0.301	1.694	0.599	-0.086	-0.301	1.606	0.409
o-Xylene	31	-0.126	-0.301	0.832	0.345	-0.112	-0.301	1.184	0.400
trans-1,2-Dichloroethene	31	0.007	-1.235	2.886	0.715	-0.094	-0.570	1.097	0.380
cis-1,2-Dichloroethene	31	0.358	-0.301	3.396	1.030	0.359	-0.301	3.303	0.958
Trichloroethene	31	0.713	-0.301	3.169	0.913	0.624	-0.301	3.289	0.857
1,4-Dichlorobenzene	31	0.597	-0.301	3.420	0.997	0.615	-0.301	2.020	0.931

Table 4. Summary of results of VOC analyses from the second sampling round.

Analyte	n	Direct Push Wells Results Mean	Min	Max	Std. Dev.	Conventional Wells Results Mean	Min	Max	Std. Dev.
Vinyl chloride	10	31.5	0.5	290.0	91.0	41.5	0.5	310.0	99.4
1,1-Dichloroethane	10	17.1	0.5	120.0	39.0	26.4	0.5	140.0	54.8
Benzene	8	0.8	0.5	1.8	0.5	0.5	0.2	1.1	0.2
Toluene	8	1.0	0.3	4.2	1.3	0.5	0.3	0.5	0.1
o-Xylene	8	0.5	0.5	0.5	0.0	0.5	0.5	0.5	0.0
trans-1,2-Dichloroethene	8	0.5	0.5	0.5	0.0	0.5	0.5	0.5	0.0
cis-1,2-Dichloroethene	10	392.8	0.4	2600.0	861.0	682.0	0.5	4100.0	1470.0
Trichloroethene	10	120.1	0.5	750.0	258.9	91.9	0.5	800.0	250.7
1,4-Dichlorobenzene	8	0.5	0.5	0.5	0.0	0.5	0.5	0.5	0.0

Analyte	n	Log(Direct Push Wells Results) Mean	Min	Max	Std. Dev.	Log(Conventional Wells Results) Mean	Min	Max	Std. Dev.
Vinyl chloride	10	0.154	-0.301	2.462	0.956	0.264	-0.301	2.491	1.065
1,1-dichloroethane	10	0.134	-0.301	2.079	0.923	0.182	-0.301	2.146	1.018
Benzene	8	-0.168	-0.301	0.255	0.238	-0.303	-0.658	0.041	0.187
Toluene	8	-0.159	-0.538	0.623	0.368	-0.329	-0.523	-0.301	0.078
o-Xylene	8	-0.301	-0.301	-0.301	0.000	-0.301	-0.301	-0.301	0.000
trans-1,2-Dichloroethene	8	-0.301	-0.301	-0.301	0.000	-0.301	-0.301	-0.301	0.000
cis-1,2-Dichloroethene	10	0.772	-0.420	3.415	1.509	0.813	-0.301	3.613	1.497
Trichloroethene	10	0.571	-0.301	2.875	1.259	0.578	-0.301	2.903	1.099
1,4-Dichlorobenzene	8	-0.301	-0.301	-0.301	0.000	-0.301	-0.301	-0.301	0.000

C. STATISTICAL ANALYSIS

A statistical analysis of the analytical and purge monitoring results was conducted to compare the wells installed with direct push technology to the conventional well installation method. The statistical analysis compared the VOC analytical results of groundwater samples collected from the direct push installed wells (DPWs) to the results of samples collected from the conventionally installed wells (CMWs). Water quality parameters, measured and recorded while purging the wells for sampling, were also compared. In accordance with the sampling protocol, these parameters were measured regularly (every five to ten minutes) during purging and recorded on the groundwater sampling logs. For the statistical analysis, the last measurement of each parameter recorded in each log prior to sample collection was used. Only data from the second round of sampling were compared in this fashion due to influences discussed in section B above. Parametric and non-parametric statistical tests were applied, depending of the distribution of the underlying data.

Paired data tests are preferred for comparing the influence of a single factor (well installation method) on two populations of samples that are also subject to the influence of extraneous factors (e.g., the location of the wells within the contaminant plume and with regard to variation in the local hydrogeology, the length and depth of the screened interval, etc.). Taking the observations in pairs, where the external influence may vary from pair to pair but is assumed to be the same within each pair neutralizes the influence of these factors.

The work plan called for application of the Student's t test on paired data to evaluate the null hypothesis that the mean of differences between measurements from two adjacent wells of different types was equal to zero (e.g., that both types of wells produced the same results). The paired Student's t test is used to determine if two sample populations are statistically different. That is, it tests whether the population of differences of paired measurements from the two types of wells has a mean of some value, in this case zero. In our case, one population is the analytical results and water quality measurements from the DPWs and the other is the results from the CMWs. The Student t test is only applicable to a population of means that is normally distributed, or can be transformed to a normal distribution. The assumption of normality (and of log-normality) of the paired differences was tested by application of the Shapiro-Wilk W test.

In cases where the population of differences between paired well measurements was found to violate the assumption of normality, and the data could not be log-transformed to a normal distribution of differences, the Sign Test and Wilcoxen Signed Rank Test were applied. These parametric tests were also used where the number of non-detect analytical results precluded the test for normality.

1. Parametric Tests

The Student's paired t test called for in the work plan is only applicable to normally distributed differences of observations. The assumption of normality was checked by applying the Shapiro-Wilk W test (Shapiro & Wilk, pp.591-611) to both the differences of paired well observations and to the differences of log-transformed observations from each sampling round. None of the sets of differences on un-transformed data were found to be normally distributed for either round of sampling. Only the differences of the log-transformed analytical results for toluene and TCE were found to be normally distributed, and only from the second round of sampling. The Student t test was performed on these results. All other sets of differences were subjected to the non-parametric Sign Test and Wilcoxen Signed Rank Test. Details are discussed below.

a. Shapiro-Wilk W test for normality

The differences of paired observations from the two well types, as well as the differences of log-transformed observations, were subjected to the Shapiro-Wilk W test for normality. At a 90% confidence the two-tailed Shapiro-Wilk test will reject the null hypothesis that the data are normally distributed when the p-value associated with the W is less than 0.05. That is, the probability (for each tail) is less than 5 in 100 that the observed deviation from normal is due solely to a chance occurrence in sampling a normal population.

As the results shown in Table 5 below indicate, for the first round of sampling, neither the paired differences of the analytical data nor the paired differences of the log-transformed analytical data were normally distributed. For the second round of sampling, only the paired differences of the logs of TCE and toluene were normally distributed. Thus only these data were compared by the paired Student t test.

Table 5. Results of Shapiro-Wilk W test of normality applied to differences of paired observations of VOC results from the two well types.

	Round 1				Round 2			
	Difference of Values		Difference of Logs		Difference of Values		Difference of Logs	
Analyte	W	p-value	W	p-value	W	p-value	W	p-value
Vinyl chloride	0.308	0.000	0.465	0.000	0.482	0.000	0.557	0.000
1,1-Dichloroethane	0.215	0.000	0.206	0.000	0.366	0.000	0.366	0.000
Benzene	0.290	0.000	0.764	0.000	0.395	0.000	0.734	0.002
Toluene	0.505	0.000	0.905	0.009	0.415	0.000	0.849	***0.056***
o-Xylene	0.443	0.000	0.678	0.000	0.381	0.000	0.386	0.000
trans-1,2-Dichloroethene	0.183	0.000	0.724	0.000	0.381	0.000	0.386	0.000
cis-1,2-Dichloroethene	0.365	0.000	0.813	0.000	0.411	0.000	0.736	0.002
Trichloroethene	0.560	0.000	0.852	0.001	0.371	0.000	0.900	***0.217***
1,4-Dichlorobenzene	0.196	0.000	0.764	0.000	0.381	0.000	0.386	0.000
	n = 31				n = 10			

The Shapiro-Wilk test was also applied to the water quality monitoring data obtained during purging of the wells. As the results summarized in Table 6 below indicate, the hypothesis of normality was rejected (p-value<0.05) for all of these parameters.

Table 6. Results of Shapiro-Wilk W test of normality applied to differences of paired observations of water quality parameters from the two well types

	Difference of Values		Difference of Logs	
Parameter	W	p-value	W	p-value
Temperature	0.871	0.003	0.908	0.021
Specific Conductivity	0.611	0.000	0.674	0.000
Dissolved Oxygen	0.787	0.000	0.908	0.021
pH	0.884	0.006	0.871	0.003
	n = 10			

b. Student's paired t test

The Student t test was conducted on the paired data that were found to pass the assumption of normality. The *t* test determines the probability with which a normally distributed underlying population of some sampled data set has a mean equal to some value, in this case zero. Although the number of non-detects and ties in the results of VOC analyses performed made statistical comparison of the results difficult, the results of toluene and trichloroethene from Round 2 were amenable to using the Student's paired t test.

The paired t test is well suited to situations where there are external influences on the measurement, but where variation due to external factors can be controlled by taking the data in pairs. The experiment is designed such that external influences (e.g. contaminant concentration, geochemistry, hydrologic regime, screened interval, well construction details, etc.) may vary from pair to pair but are presumed to be the same within each pair. A complete discussion of the statistical methodology is presented in the work plan, however, the basic application is to test the null hypothesis that the mean of differences between paired measurements from two samples is equal to some value, in this case zero.

The null hypothesis is expressed as:

$$H_0 : \mu_D = \delta_0$$

The value of the test statistic is:

$$t = \frac{\bar{d} - \delta_0}{s_d / \sqrt{n}}$$

where $\bar{d}$ is the mean of differences between pairs of measurements, δ_0 in this case is zero, s_d is the standard deviation, and n is the degrees of freedom in the data set. The null hypothesis is that the mean of the differences is zero. We reject the null hypothesis H_0 when:

$t \le t_{\alpha/2, n-1}$ or when $t \ge t_{1-\alpha/2, n-1}$

Table 7 presents the t statistic and it's corresponding p-value for the analytes Toluene and TCE.

Table 7. Results of Student's t test on paired differences of analytical results for toluene and trichloroethene from Round 2.

Analyte	95% Conf. Interval		t	p-value	
Toluene	-0.386	0.275	-0.380	0.713	Accept
Trichloroethene	-0.294	0.674	0.890	0.397	Accept

At 95% confidence we cannot reject the null hypothesis that the mean difference between measurements of toluene and trichloroethene produced by the two well types in Round 2 is zero. In fact, we can not reject this hypothesis with any confidence above approximately 71% for toluene, and 40% for TCE. In other words, any differences that were observed between paired measurements from the two well types are too insignificant to suggest that they were not due to chance alone.

2. Non-Parametric Statistics

Since most of the analytical data were neither normally distributed, nor could be log-transformed to a normal distribution, and multiple non-detects were present, a non-parametric test was needed to compare the monitoring results. Two such tests which are appropriate to the study are the Sign Test and the Wilcoxen Signed Rank Test. They are the non-parametric equivalents to the Student's t procedure for paired data.

a. Sign Test

The Sign Test is performed on paired data, does not require the underlying distribution to be normal or symmetric, and allows ties and non-detects. The Sign Test tests the null hypothesis that the median of the population of all possible differences is zero. That is, that one population is as likely to be larger than the other, as the other is likely to be larger than the first. The inputs to the sign test are the number of pairs, the signs of the differences between the paired data, and the number of ties. The difference of a detected concentration minus a non-detect is considered positive, assuming the same detection limits. The degrees of freedom n are reduced by the number of ties; and the test statistic B which is the sum of positive differences, is compared to lower and upper limits, l and u, for the chosen confidence interval.

The test was applied to the results for each analyte from Rounds 1 and 2 and to each water quality parameter from Round 2. The outcome of the testing is summarized in the tables below. As shown, in all cases except the toluene results from the first sampling round, the p-value associated with the Sign Test is greater than 0.05, signifying (for the two-tailed test) that the null hypothesis cannot be rejected at or above the 90% confidence interval. In other words, with the one exception noted, the Sign Test shows no statistically significant difference between the VOC analytical results produced by the direct push well and those produced by the conventional wells.

Table 8. Results of Sign Test performed on VOC analyses from first round of sampling.

Analyte	n	Below	Equal	Above	p-value	Median
Vinyl Chloride	31	6	24	1	0.125	0.000
1,1-Dichloroethane	31	3	28	0	0.250	0.000
Benzene	31	5	18	8	0.581	0.000
Toluene	31	5	10	16	0.027	0.175
Xylene (o)	31	6	22	3	0.508	0.000
trans-1,2-Dichloroethene	31	9	8	14	0.405	0.000
cis-1,2-Dichloroethene	31	8	14	9	1.000	0.000
Trichloroethene	31	13	4	14	1.000	0.000
1,4-Dichlorobenzene	31	14	7	10	0.541	0.000

Table 9. Results of Sign Test performed on VOC analyses from second round of sampling.

Analyte	n	Below	Equal	Above	p-value	Median
Vinyl Chloride	10	3	7	0	0.250	0.000
1,1-Dichloroethane	10	1	9	0	1.000	0.000
Benzene	10	2	5	3	1.000	0.000
Toluene	10	3	5	2	1.000	0.000
Xylene (o)	10	2	8	0	0.500	0.000
trans-1,2-Dichloroethene	10	2	8	0	0.500	0.000
cis-1,2-Dichloroethene	10	6	3	1	0.125	-0.610
Trichloroethene	10	6	1	3	0.508	-1.450
1,4-Dichlorobenzene	10	2	8	0	0.500	0.000

Table 10. Results of Sign Test performed on water quality parameters from second round(s) of sampling.

Parameter	n	Below	Equal	Above	p-value	Median
Temperature	27	13	0	14	1.000	0.590
Specific Conductivity	27	11	6	10	1.000	0.000
Disolved Oxygen	27	16	0	11	0.442	-0.130
pH	27	14	0	13	1.000	-0.010
Turbidity	22	10	1	11	1.000	0.800

b. Wilcoxen Signed Rank Test

The Wilcoxen Rank Sum Test is used also to test for a shift a central tendency (mean) between two paired populations. Like the Sign Test, the Wilcoxen Rank Sum Test does not require the underlying distribution to be normal or symmetric, and allows ties and non-detects. However, the Wilcoxen test is more powerful than the Sign Test because it also considers the magnitude of the paired differences, whereas the Sign Test does not. To apply the signed rank test for each analyte, the differences between paired results from the two well types are ranked by the magnitude of the differences without regard to their sign. The ranks, however, are assigned the sign of the differences, and the test statistic T is calculated as the sum of the positive ranks. Absolute ties, such as a pair of analytical non-detects, are dropped from the set, reducing the degrees of freedom *n* by one for each tie discarded. The results of the test on differences of VOC analytical results from each round of sampling are summarized in the tables below.

In all cases except the toluene results from the first sampling round, the p-value associated with the test statistic T is greater than 0.05, signifying (for the two-tailed test) that the null hypothesis cannot be rejected at or above the 90% confidence interval. In other words, with the one exception noted, there is no statistically significant difference between the VOC analytical results produced by the two types of wells. These results of the Wilcoxen Signed Rank Test agree with those of the Sign Test discussed above.

Table 11. Results of Wilcoxen Signed Rank Test performed on results of VOC analyses from first round of sampling.

Analyte	n	n for Test	T	p-value	Estimated Median
Vinyl Chloride	31	7	7	0.272	0.000
1,1-Dichloroethane	31	3	0	0.181	0.000
Benzene	31	13	62	0.263	0.000
Toluene	31	21	184	0.018	0.562
Xylene (o)	31	9	18	0.636	0.000
trans-1,2-Dichloroethene	31	23	186	0.149	0.117
cis-1,2-Dichloroethene	31	17	79	0.925	0.000
Trichloroethene	31	27	180	0.838	-0.015
1,4-Dichlorobenzene	31	24	124	0.466	-0.188

Table 12. Results of Wilcoxen Signed Rank Test performed on results of VOC analyses from second round of sampling.

Analyte	n	n for Test	T	p-value	Estimated Median
Vinyl Chloride	10	3	0	0.181	0.000
1,1-Dichloroethane	10	1	0	1.000	0.000
Benzene	10	5	6	0.787	0.000
Toluene	10	5	6	0.787	0.000
Xylene (o)	10	2	0	0.371	0.000
trans-1,2-Dichloroethene	10	2	0	0.371	0.000
cis-1,2-Dichloroethene	10	7	6	0.205	-1.100
Trichloroethene	10	9	10	0.155	-1.450
1,4-Dichlorobenzene	10	2	0	0.371	0.000

The toluene results from round 1 indicate a p-value of 0.018, or that the null hypothesis can be rejected at the 96% confidence interval. The Sign Test yielded a similar result. Possible reasons for this finding, not reproduced in the second round, are discussed in the conclusions section.

Table 13. Results of Wilcoxen Signed Rank Test performed on water quality parameters from second round(s) of sampling.

Parameter	n	n for Test	T	p-value	Estimated Median
Temperature	27	27	208	0.665	0.075
Specific Conductivity	27	21	122	0.848	0.000
Disolved Oxygen	27	27	171	0.665	-0.088
pH	27	27	167	0.605	-0.035
Turbidity	22	21	103	0.664	-0.870

SECTION V

CONCLUSIONS & RECOMENDATIONS

A. WELL COMPARISON

The direct push wells (DPWs) were found to produce the same results as the conventionally installed wells (CMWs), in terms of both VOC analytical samples and water quality monitoring during well purging. With one non-reproducible exception as noted, no statistically significant difference was found in the performance of DPWs as compared to CMWs for the two monitoring rounds conducted. This conclusion is demonstrated in the p-value of the statistical results presented in the previous section. The p-value of a test statistic indicates how often by chance alone we would expect to produce the observations that we did if the null hypothesis about the underlying distribution from which we sampled is true. In this study, for instance, a p-value of 0.007 would mean that if the choice of well type truly does not produce a difference in analytical results, then by chance alone we would observe the differences that we did see 7 out of 1000 times that we sampled. The actual finding was that, except in one instance, the p-value for each of the tests comparing the DPW monitoring results to those of CMWs never fell below 0.05. This indicates that at the 90% confidence level, we can not reject the null hypothesis that the two well types perform equally.

The exception noted was for the analytical results of toluene observed in the first round of sampling, and was not re-produced in the second round. Therefore, we can not conclude that the results are consistently different for toluene.

The results from this phase of the study provide significant evidence that performance of direct push monitoring wells is at least as good as conventionally auger-drilled wells. However this study was limited in the extent of geologic conditions, duration (number of sampling rounds), well materials, well configuration, and chemical constituents. To provide the necessary supporting data to continue the validation of direct push wells, future studies should be conducted to account for these limiting factors.

Additionally, due to cost constraints, the low number of degrees of freedom provided by the sample sets limited the power of the statistical tests applied, especially where non-detects were prevalent in the analytical data. With fewer degrees of freedom, the variability in the sample sets diminishes the ability to discern statistically significant differences. For instance, the second round of sampling provided only ten degrees of freedom, which is the minimum recommended for use of either the Student's t test or the Wilcoxen Signed Rank Test. Any future study or continuation of this study should be designed to provide more independent samples of paired data with fewer analytical non-detects.

For analytes present at close to or below detection limits, the correlation between well types tended to be less than for analytes present at higher concentrations. This is likely due to the influence of extraneous or uncontrolled factors on the data, (such as analytical precision, geologic variation, and unintended minor discrepancies in screening intervals), being more dominant at lower concentrations than at higher concentrations.

Natural variability in contaminant concentrations observed at any given well is also an influence on the correlation between wells in a pair. For instance, the Hanscom AFB Environmental Engineer noted that at well OW2-6, significant variation has been observed in the same well over time. Considerable differences were observed in the analytical results of samples collected from this well pair during the second sampling event where as little discernable difference was observed from the first sampling event. For this reason, it would be advantageous to obtain samples from each well in a pair over a large number of sampling events, and compare the distribution of analytical results over time from one well to that of the other. In this way, the variability (or consistency) of results from the two well types can be compared, as well as their central tendency.

A wider range of geologic conditions and chemical constituents can be incorporated into future studies by expanding the initiated program to include multiple sites with differing geology and chemical constituent conditions. Other DOD/DOE/EPA contamination concerns include metals, special fuels and additives (MTBE), nitroaromatics, and explosives. Additionally, future studies should be conducted that include more sampling rounds over a longer period of time. This will allow the comparability of well types to be evaluated in the context of long-term performance to potentially provide additional support for the use of direct-push wells in long-term monitoring.

Future studies should consider additional direct push well configurations, such as micro wells. Micro-wells better exploit the advantages of direct push methods because they can be installed to greater depths and can provide assessment of groundwater conditions with higher spatial precision than can large diameter conventional wells with long screen intervals. Additionally, micro-wells can include a sand pack around the wells and mud block above the screened interval to address potential end-user concern for inclusion of this feature.

The work conducted on this study provides valuable experience for installing wells for the purpose of long term monitoring. This report and the attached Work Plan (Appendix A) are suitable for use in developing an ASTM standard for direct push technology well installation.

B. WELL COST

In general direct push technology has been shown to reduce site characterization costs including costs associated with monitoring well and monitoring point installation. However, a detailed cost comparison is often difficult to accomplish due to the differences in data products produced during well installation, (CPT profiles vs. blow counts and/or geologist boring logs), and the scarcity of precise cost information for existing conventionally installed wells. Although a cost analysis was not a component of this study, future studies should include a planned cost comparison component. If conducted where detailed cost information is available for existing conventionally installed wells, it should provide the data necessary to conduct a cost comparison.

REFERENCES

Begemann, H.K.S., "The Friction Jacket Cone as an Aid in Determining the Soil Profile," *Proc. 6th ICSMFE*, Montreal, Canada, Vol. I, pp. 17-20, 1965.

Bratton, W.L., J.D. Shinn, S.M. Timian, G.D. Gillispie, R. St. Germain, "The Air Force Site Characterization and Analysis Penetrometer System (AFSCAPS); Laser Induced Fluorescence Cone Penetrometer," Under Contract No. F08635-88-C-0067, SETA Subtask 8.00, Report to Air Force Armstrong Laboratory, Tyndall AFB, FL, February 1993.

de Reister, J., "Electric Penetrometer for Site Investigations," *Journal of SMFE Division*, ASCE, Vol. 97, SM-2, pp. 457-472, February 1971.

Farrington, S.P., and W.L. Bratton, "Measuring Fuel Contamination Using Cone Penetration Testing and High Speed Gas Chromatography," Final Report to U.S. Department of Energy, Morgantown Technology Center, Morgantown, WV, February 1997.

Gildea, M.L., W.L. Bratton, J.D. Shinn, "Demonstration and Evaluation of the Air Force Site Characterization and Analysis Penetrometer System in Support of Natural Attenuation Initiatives," Under Contract F08635-93-C-0020, SETA Subtask 8.01.1, Report to Air Force Armstrong Laboratory, Tyndall AFB, FL, February 1995.

Montgomery, R.L., J.C. Bianchi, J.D. Shinn, R.M. Morey, R.E. Walker, S.P. Farrington, W.C. Dickerson, S.M. Conklin, "Groundwater Remediation Field Laboratory - GRFL: Hydrogeology Characterization and Site Development," Report to Air Force Armstrong Laboratory AL/EQW-OL, Tyndall AFB, FL, June 1996.

Shapiro and Wilk, "An Analysis of Variance Test for Normality (complete samples)," Biometrika 52, 1965.

Torstensson, B.A., "Pore Pressure Sounding Instrument," *Proc. ASCE Spec. Conf. on In Situ Measurement of Soil Properties*, Raleigh, NC, Vol. II, pp. 48-54, 1975.

APPENDIX A

WORK PLAN

WORK PLAN
DIRECT PUSH MONITORING POINT ASSESSMENT

HANSCOM AIR FORCE BASE
MASSACHUSETTS

Contract No. F08037-98-C6002
SSG Subtask 32.03S

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INTRODUCTION

BACKGROUND

This Work Plan is presented in response to Contract Number F08037-98-C6002 SSG Sub-task 32.03S issued to Applied Research Associates, Inc., by the United States Air Force Armstrong Laboratory (AL/EQA). Presented in this Work Plan are the procedures and information required for groundwater sampling and analysis in support of the assessment of CPT-installed monitoring wells, and statistical methods to compare water samples obtained from conventional monitoring wells and direct push wells. Also included in this work plan are the procedures for monitoring well installation using Cone Penetration Technology (CPT). Although this phase of work was completed during the initial project it is included for reference on how the wells were installed. The Work Plan is designed to generate field and analytical results that are reliable and achieve the quality control requirements. The Work Plan is composed of an experimental design, a field program and an analytical program. Quality Assurance/Quality Control (QA/QC) is addressed in the Quality Assurance Project Plan (QAPP) presented in Appendix E. The field program defines the methods necessary for installation of monitoring wells and proper collection of groundwater samples and associated field data. The analytical program designates the chemical analytical laboratory to perform the analyses and identifies the samples to be collected and the type of chemical analyses to be performed. The QA/QC program defines measures for maintaining criteria of data quality. The Work Plan also provides a required list of submittals and a schedule to complete the work.

PROJECT OBJECTIVES AND PURPOSE

There are almost 4,300 Air Force hazardous waste sites with anticipated cleanup and monitoring costing billions of dollars. In hazardous waste site assessments it is necessary to detect, delineate, and identify contaminants and to further characterize subsurface conditions. Current practice often requires multiphase efforts with many visits, using geophysical methods as well as soil borings and monitoring well installations. Site characterization and monitoring contributes to one-third or more of the total remediation costs. The objective of this effort is to validate the use of CPT-installed monitoring wells for monitoring groundwater quality.

CPT-installed monitoring point assessment will involve a rigorous sampling effort to establish a database of water quality chemical analytical results comparing samples from conventionally installed monitoring wells with CPT-installed monitoring points. There has been one sampling round conducted during May and June of 1997. The goal is to obtain funding each year to continue sample for seven sampling rounds. A statistical model has be developed to determine if enough wells have been used in the study, if enough samples have been collected, and to determine with statistical confidence if groundwater samples from CPT-installed monitoring points yield analytical results comparable to those obtained from conventional monitoring wells. All samples will be collected and analyzed according to regulatory requirements to ensure the results of the experiment are valid. A major goal of this effort is to validate the use of CPT-installed monitoring points for regulatory monitoring. Although CPT-installed monitoring points have been accepted by the EPA for characterization of a groundwater contamination plume, there is little data on the long term performance of these wells (EPA 1996). Additionally, there is little data to support the use of CPT-installed monitoring points for characterization or long term monitoring. The results of this study will provide this needed information, ultimately leading to widespread acceptance of the use of CPT-installed monitoring points by groundwater professionals.

SITE DESCRIPTION

The Direct Push Monitoring Point Assessment Program is to take place at two operable units (OU), OU-1 and OU-3 of Hanscom Field and Hanscom Air Force Base (AFB) (Figure 1). Hanscom AFB and Hanscom Field are situated approximately 14 miles northwest of Boston, Massachusetts, in the towns of Bedford, Concord and Lincoln. Hanscom Field is a civilian airport currently operated by the Massachusetts Port Authority (Massport). Hanscom AFB is a military installation located adjacent to and southeast of the airfield.

Prior to 1974, Hanscom Field was used as a military airport by the Air Force. During this time, hazardous substances were generated by support operations and disposed of at different sites on the airfield. In addition, flammable materials were ignited and extinguished during fire

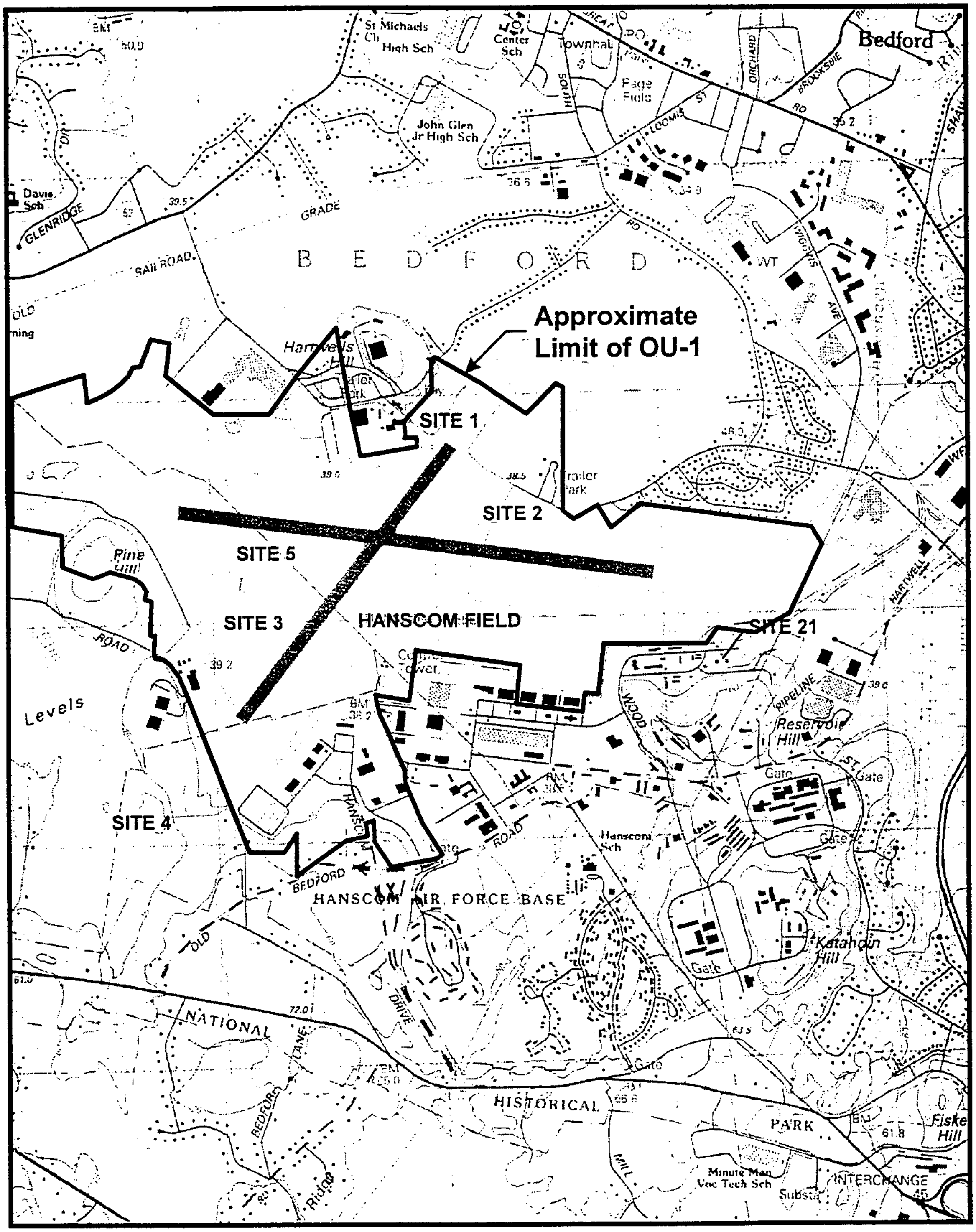

Figure 1. Hanscom AFB and Hanscom Field test site locations. Hydrogeologic Setting.

training exercises performed at selected sites on the airfield. These sites, contained in OU-1, are as follows:

Site 1: Fire Training Area II
Site 2: Paint Waste Disposal Area
Site 3: Jet Fuel Residue/Tank Sludge Disposal Area
Site 5: Fire Training Area I.

To assess potential soil and groundwater contamination associated with these previous activities, Haley and Aldrich, Inc. (H&A) completed a remedial investigation culminating in a report ("Installation Restoration Program, Phase IV-A, Remedial Investigation Report for Sites 1-5 of Area 1") dated May 1988. This assessment detected volatile organic compounds in groundwater in three separate aquifers. In response to these findings, a groundwater treatment facility was installed at the airfield. The treatment facility consists of three collection trenches located at Sites 1,2, and 3, and four bedrock interceptor wells located along the northern Hanscom Field property boundary. Collected groundwater is pumped to an air stripping tower, treated, and then routed to a drainage ditch, which discharges into the wetlands to the north, and/or routed to recharge basins at Sites 2 and 3, where it is reintroduced to the groundwater. Currently, groundwater is being collected from each of the installed trenches and bedrock interceptor wells.

Conventional wells will be selected from Sites 1 & 2 of OU-1 listed above and from Site 21 of OU-3. Site 21, also known as the Fuels Site for this study, is located on Hanscom AFB, southeast of the airfield (Figure 1). Site 21 was formerly used for fuel and gasoline storage and distribution. Between 1945 and 1973 the site was used for jet fuel and aviation gasoline, and during the 1970s the site was only used for heating and fuel oils. During this period, several spills were identified in the vicinity of former buildings and areas of this site. In 1990 the storage tanks were removed and the land is now in use as a general storage area. In September of 1995, a soil vapor extraction and passive groundwater collection system began operation to remove subsurface contamination.

HYDROGEOLOGIC SETTING

Hanscom Field is located on a flat-lying plain with a general relief of less than 10 ft over a distance of approximately 3 miles. This feature is an ancient lake basin that was formed and subsequently filled in by sediment during the last phase of glaciation in New England. The plain extends beyond OU-1 to the north and west. To the south and east, this plain is bounded near the limit of OU-1 by low lying hills of glacial till and gravel. Other topographic features include Hartswell Hill and Pine Hill. These are till-covered, isolated hills located at the northern and western boundaries of OU-1, respectively. The hills provide a relief of approximately 100 ft above the surrounding plain.

The principal drainage features in the vicinity of OU-1 are the Shawsheen River, which originates in the east end of the air field and flows toward the northeast, and Elm Brook, which is located west of the airfield and ultimately flows northwest and into the Shawsheen River (Figure 1). Surface runoff at Hanscom Field is controlled by a storm drain system that includes drainage ditches, culverts, and subdrains. This system drains into Elm Brook, the Shawsheen River and the wetlands northeast of OU-1.

Test borings completed during an Installation Restoration Program have identified three principle soil deposits underlying OU-1. From upper to lower, these soils are an outwash section, a lacustrine section, and a till section. The till section is deposited above bedrock, consisting primarily of granite, with lesser amounts of quartz diorite and gneiss.

The upper most outwash section measures 0 ft to 33 ft in thickness and consists primarily of fine sand. Locally this unit is composed of medium to coarse sand with lesser amounts of gravel. The underlying lacustrine section consists of interbedded silt, clay, and fine sand. The unit varies in thickness from 0 ft to 60 ft. Beneath the lacustrine section is a till deposit which locally grades into a lower outwash unit. This unit measures from 0 ft to 88 ft in thickness.

These geological units define three separate aquifers. The outwash section comprises the area's near-surface unconfined aquifer. The till section, positioned beneath a thick sequence of lacustrine clay, silt and fine sand, forms a lower, semi confined aquifer. A third aquifer has been encountered by monitoring wells installed into bedrock.

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CPT TECHNOLOGY DESCRIPTION

The Cone Penetrometer Test (CPT) was originally developed in the Netherlands in about 1934 for geotechnical site investigations. The original cones involved mechanical measurements of the penetration resistance on a conical tip. A friction sleeve was added in 1965 (Begemann, 1965). Electronic measurements were added in 1948 and improved in 1971 (de Reister,1971). Pore pressure probes were introduced in 1975 (Torstensson, 1975 and Wissa et al., 1975), initially as independent sensors, but were soon incorporated with the cone penetrometer instrumentation. The modern CPT probe contains the primary geotechnical sensors for tip stress, sleeve friction, pore pressure along with options of an inclinometer to measure the tilt of the probe, resistivity, soil moisture, soil pH, and redox potential. The standard $10cm^2$ cone is used widely in Europe for geotechnical investigations due to the soft nature of many of the European soils. In the United States, significant efforts have been made to develop more robust CPT probes, suitable for use in the stiffer United States soils (especially in the western states). Due to the high cost of drilling at their contaminant sites, both the Departments of Defense and Energy have aggressive programs to develop chemical sensors and sampling methods for the minimally intrusive CPT (Bratton, et al., 1993; Gildea, et al., 1995; Montgomery, et al., 1996; Farrington and Bratton, 1997).

Major components of the modern cone penetrometer system are the instrumented probe, the instrumentation conditioning and recording system, the hydraulic push system, and the vehicle on which the system is mounted. The common configuration provides the reaction mass for a hydraulic push force of about 20 tons (18,000 Kg). Standardization for geotechnical applications of the cone penetration test was established by the American Society of Testing and Materials in 1986. This standard allows for a probe diameter of 1.44 or 1.75 inches (3.658 cm or 4.445 cm).

Using the cone penetrometer for environmental site characterization represents a relatively recent application of the technology. Significant advantages of the CPT include: eliminating drilling wastes and the need for treatment and disposal of drill spoils as hazardous material; providing continuous data on the subsurface stratigraphy in real time; identifying thin layers of significantly different hydraulic conductivity; eliminating the possibility of the crew being exposed to the potentially hazardous material; reducing the possibility of cross-contamination (by pressure grouting the hole as the probe is withdrawn); and speed, when compared to conventional drilling and sampling. CPT is an excellent platform for making continuous measurements of contaminant information with depth, is useful for pushing monitoring sensors into the subsurface, for installing monitoring wells and points, and for taking gas, water, or soil samples for environmental testing.

EXPERIMENTAL DESIGN

INTRODUCTION

The Direct Push Monitoring Point Assessment is an experiment to determine whether or not groundwater samples collected from CPT-installed wells produce the same analytical results as groundwater samples collected from conventionally installed wells. This section discusses the design of that experiment. An experimental design was completed to ensure that the data obtained during this experiment can be used to support any conclusions drawn from this experiment. This section explains the reasoning behind the chosen types of wells, analytical methods, sample collection methods and statistical analysis. It does not describe the procedural details associated with conducting the tasks of well installation, groundwater sampling or laboratory analysis. These procedures are discussed in the Field and Analytical Program sections.

EXPERIMENT HYPOTHESIS

The basic experiment is the comparison of a set of parameters found in groundwater samples collected from two separate wells installed by different methods. The hypothesis is that there will be no difference or that there is a systematic difference and that the results between the two wells can be correlated. By collecting a large number of samples and analyzing the samples for various parameters, statistics can be used to determine within a certain confidence interval whether or not the hypothesis is valid.

MONITORING WELLS

Since this experiment is comparing conventionally installed monitoring wells to CPT-installed monitoring wells, a description of the two types of wells is warranted. Conventional monitoring wells are installed by first drilling a bore hole and removing the soil from the ground. The bore hole is held open by the hollow stem augers that are used to bore the hole. The well casing is typically constructed of schedule 40 PVC (Polyvinyl Chloride) but may also be constructed of steel or stainless steel. Well casings are typically 2 or 4 inches in diameter but may vary from one-half inch to 8 inches or larger. The well casing is lowered down inside the hollow stem auger to the design depth and a sand backfill is packed around the screen section. Above the screen section a seal is typically installed to prevent migration from geologic units above the screen down along the well casing. This seal is typically two to four feet in thickness and constructed of bentonite. The remainder of the hole is back filled with a cement grout and a concrete cap is installed at the surface.

CPT-installed wells are pulled into the ground with the CPT rods and the weight of the CPT truck as reaction mass. The details of the installation procedure are discussed in the field program. With CPT-installed wells the choices for casing size are limited as compared to conventional wells, since the well material has to either fit inside the push rods or fit closely around the outside of the rods. Casing sizes are typically ¾-inch, 1½-inch or 2-inch nominal diameter. CPT-installed wells, which are 1½ inches or larger do not have any type of sand pack back fill. The ¾-inch wells may have a sand pack since the well is carried into place on the inside of the rods. The sand pack would take the place of the rods as the rods are extracted.

The well screen section on both wells varies in length depending on the requirements of the well. Openings in the screen, typically called slots, allow the water to pass into or out of the well. The slots are designated by the width of the slot, typically 0.010 inch or 0.020 inch (10-Slot or 20-Slot respectively).

In designing the experiment, the number of variables influencing the groundwater samples was minimized to limit the comparison to the installation technique and the not the well configuration. For that reason, the geometry of the CPT-installed wells was matched as closely as possible to that of the conventionally installed wells existing at the sites. The conventionally installed monitoring wells at Hanscom AFB and Hanscom Field are typically 2-inch diameter schedule 40 PVC wells with a 10-slot (.010-inch) or 20-slot (0.020-inch) screen size; the screen length varies. Table 1 contains a list of wells installed at Sites 1 and 2 of OU-1 and Site 21 of OU-3 showing the well and screen construction.

Table 1. List of Potential Wells for Sites 1, 2 and 21 with Well Properties.

			Total Meas. VOC			Direct Push Wells				Conventional Wells			
							Screen				Screen		
Well No.	Site		DPW ARA (ug/l)	CMW ARA (ug/l)	CMW H&A (ug/l)	Total Depth (feet B.G.S)	Top Depth (feet B.G.S)	Bottom Depth (feet B.G.S)	Silt Trap (feet)	Total Depth (feet B.G.S.)	Top Depth (feet B.G.S.)	Bottom Depth (feet B.G.S.)	Slot Size (inches)
Site No. 1 & 2													
B101-MW	2		3.2	3.7		21.83	2.15	18.55	3.28	18.50	3.50	18.50	0.01
B102-MW	1-2		21.3	3.9	u	17.23	4.35	14.19	3.28	14.00	3.00	14.00	0.01
B105-MW	2		86.6	94.8	5.0	18.13	11.57	14.85	3.28	15.00	5.00	15.00	0.01
B107-MW	2		1.7	4.9	2.8	17.21	4.09	13.93	3.28	14.00	4.00	14.00	0.01
B109-MW	2		38.2	41.0	26.2	62.61	59.33	62.61	no	69.00	59.00	69.00	0.01
B130-MW	2		73.4	110.6	u - 7/96	17.15	4.03	13.87	3.28	14.00	4.00	14.00	0.01
B238-MW	1	H	7.0	5.7	u	10.27	4.09	10.65	no	12.00	5.00	10.00	0.01
B241(S)	1-2		3.7	12.2	u	18.25	5.13	14.97	3.28	17.00	3.00	16.00	0.01
RAP1-4S	1		5.2	7.6	2.1j - 7/96	14.63	1.87	14.99	no	14.70	0.00	14.70	0.02
RAP1-6S	1	H	4.9	61.1	27.0	17.88	1.83	14.95	3.28	14.50	0.00	14.50	0.02
RAP2-2S	2	H	662.5	105.5	1.3 - 7/96	22.84	3.16	19.56	3.28	19.90	0.00	19.90	0.02
RAP2-2T	2	H	948.9	1039.7	1400.0	62.19	55.63	62.19	no	75.30	60.10	75.30	0.02
RAP2-3S	2	H	3.1	54.7	u - 7/96	27.00	0.76	23.72	3.28	23.60	0.00	23.60	0.02
RAP2-4S	2		76.7	68.0		24.52	4.84	24.52	no	25.00	0.00	25.00	0.02
OW2-1	2		127.5	107.2		18.18	11.62	14.90	3.28	15.00	10.00	15.00	NA
OW2-4	2		3623.7	25.2		33.35	23.51	30.07	3.28	30.00	25.00	30.00	NA
OW2-6	2		4288.9	4224.1		23.10	13.26	19.82	3.28	20.00	15.00	20.00	NA
OW2-7	2		32.9	213.0		23.49	13.65	20.21	3.28	20.00	15.00	20.00	NA
RFW-11	2		319.0	135.7	21.0	20.34	7.22	17.06	3.28	17.20	7.20	17.20	0.02
Site No. 21													
B39	21	M	9.4	92		17.54	7.70	17.54	no	20.00	10.00	20.00	NA
B42	21	M	4.1	3.9		15.28	5.94	15.78	no	15.00	5.00	15.00	NA
MWZ-5	21	L	3.6	1.9		20.41	10.57	20.41	no	20.00	10.00	20.00	NA
MWZ-6	21	H	862.4	226.1		18.78	8.94	18.78	no	18.50	8.50	18.50	NA
MWZ-7	21	H	258.2	57.1		14.03	7.47	14.03	no	19.00	9.00	19.00	NA
MWZ-11	21	H	171.3	119		19.93	10.09	19.93	no	22.00	12.00	22.00	NA
MWZ-12	21	H	98.9	95.3		20.08	10.24	20.08	no	20.00	10.00	20.00	NA
MWZ-17	21	M	29.9	25.7		18.94	9.10	18.94	no	20.00	10.00	20.00	NA
OW-2	21	L	0.9	0.9		16.37	6.89	16.73	no	20.00	7.00	20.00	NA

There are some minor differences between the CPT-installed wells and the conventionally installed wells. During CPT well installation the stresses on the PVC well material are great, so typically schedule 80 PVC is used instead of schedule 40 PVC. This results in a small difference in well inner diameter. All of the CPT-installed wells have a slot size of 0.020 inches. We have found that with the larger slot size we can more efficiently remove the fines from the geologic material during the well development stage. Since a CPT-installed well does not have a sand pack around the well, aggressive well development was performed to remove the fines from the material effectively creating a natural sand pack around the well. Also, in some cases a silt trap will be installed on the CPT-installed wells even when one does not exist on the conventionally installed well. Installing a silt trap is common practice and particularly helps maintain the effective screen area in CPT-installed wells. On the conventionally installed wells a silt trap may not have been installed if the geologic material has a low silt content. In this case a silt trap would not be needed because of the clean sand pack installed around drilled well screens. CPT-installed wells do not have a sand pack around the screen to reduce silt infiltration so even low silt content material will have silt infiltration and the silt trap allows the silt to collect below the screen interval away from the sampling zone. A circumstance in which a silt trap will not be installed on the CPT-installed wells would be when the bottom of the screen of the existing well was installed at the bedrock elevation. In this situation the bottom of the screen of the CPT-installed well would also be installed as close to the bedrock as possible, leaving no room for a silt trap.

SAMPLE PARAMETERS

During groundwater sampling programs several water quality parameters can be measured, depending on the objectives of the program. These parameters include chemical constituent concentrations and general water quality measures such as temperature, pH, dissolved oxygen, and turbidity. Chemical constituent concentrations are determined in the laboratory, typically by Gas Chromatography (GC) analysis. General water quality measures are typically measured in the field with portable equipment.

There are two classes of volatile organic compounds present in the groundwater at Hanscom AFB. Previous sampling rounds have identified primarily halogenated hydrocarbons at Sites 1 and 2 from chlorinated solvent contamination, and aromatic hydrocarbons at site 21 from jet and diesel fuel contamination. From a review of the previous sampling round results, we have selected a list of analytes, presented in Table 2, that encompasses both the halogenated and aromatic hydrocarbons. We have chosen this list because we know that these analytes are present at the sites in varying concentration levels from non-detect up to as high as 21,000 ppb. Also presented in Table 2 are the Maximum Contaminant Limits (MCL) and the estimated quantitation limits (EQL) that will be reported by ARA's laboratory during this study. The MCLs are reported in the "Drinking Water Regulations and Health Advisories" (USEPA 1996) publication and the EQLs are determined from the method detection limit (MDL) study performed by ARA's laboratory. The Method Detection Limit study is discussed later in the Laboratory Program section.

In addition to the contaminant concentration of the target analytes (presented in Table 2), the water quality parameters measured during the sampling process will also be included in the statistical comparison of the two wells. These parameters, which include temperature, conductivity, dissolved oxygen, pH, and turbidity, are measured periodically during purging before the actual sample is collected. According to the sampling procedure, the well is purged until these parameters stabilize, and then the sample is collected. The last set of general water quality values measured before the sample is collected will be used in the statistical study.

Samples will be collected in pairs from selected CPT-installed wells and their corresponding conventional wells at OU-1 (solvent site, sites 1 & 2) and at site 21 (the fuels site).

Table 2. Truncated Target Analyte List.

Analyte	MCL ug/l	Estimated Quantitation Limit ug/l
1, 1-Dichloroethane	5.0	2.5
trans 1, 2-Dichloroethene	70.0	10.0
cis 1, 2-Dichloroethene	70.0	10.0
Trichloroethene	5.0	2.5
1,4-Dichlorobenzene	75.0	10.0
Benzene	5.0	6.7
Toluene	1000.0	10.0
o-Xylene	10000.0	10.0
Vinyl chloride	2.0	18.4

GROUNDWATER SAMPLING METHOD

There are many different sampling procedures currently in practice for sampling programs. The needs and objectives of the program often dictate the type of sampling method. The objectives of this sampling program are to collect water samples from wells that have a two-inch diameter. The groundwater table varies from 2 feet to 20 feet below the ground surface. The contaminants of concern are all volatile organic compounds, and the primary concentration range is near the action MCL level. Additionally, since the study is an experiment to support and validate the use of CPT-installed wells, the sampling procedure should be supported by the scientific community. For this study, we have selected the relatively new technique published by the EPA Region I in July, 1996. This technique, titled, "Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells," is included in Appendix B of this document. EPA publication, "Low-Flow (Minimal Drawdown) Ground-water Sampling Procedures", which is referenced in the EPA Region I publication, has also been included in Appendix C for reference purposes.

LABORATORY ANALYSIS

ARA will use a modified EPA Method 8021 for sample detection with EPA Static Headspace Method 5021 for sample introduction to analyze the groundwater samples for the truncated analyte list presented in Table 2. Method 8021 was selected because it includes both the halogenated and aromatic hydrocarbons allowing all of the samples to be analyzed with one GC method.

Split samples will be collected for Quality Assurance/Quality Control (QA/QC) and sent to Inchcape Testing Services, Environmental Laboratories in Colchester, Vermont for analysis by EPA Method 8260 (GC/MS). The QA/QC samples and procedures for groundwater sampling and analysis are described in the Quality Assurance Project Plan included in Appendix E.

STATISTICAL DATA ANALYSIS

Analysis of the chemical and field sampling results will consist of a statistical analysis of the difference between the samples collected from the CPT-installed wells and the samples collected from the conventionally installed wells. This section describes the formulation of the statistical analysis.

Statistical Hypothesis

The primary hypothesis of interest is that there is no difference between CPT-installed monitoring well (*cw*) and conventionally installed monitoring well (*mw*) samples of groundwater chemical constituent (GWCC) data. Because of spatial variability in GWCC data, the test on measurement differences ($D=cw-mw$) between *cw* and *mw* pairs will be based on pairs that are immediately adjacent in the field. This approach removes the variance inflating effect of an expected positive covariance between the measurements and improves the precision of the test.

The variance of the differences is that is the sum of the two variances minus twice the covariance (Steel & Torrie, p. 78).

$$S_d^2 = S_{cw}^2 + S_{mw}^2 - 2\frac{\sum(cw \text{ x } mw)}{n-1} \tag{1}$$

Where S_d^2, S_{cw}^2 and S_{mw}^2 are the standard deviation of the difference, the *cw* samples and the *mw* samples respectively. The usual form for the hypothesis of no difference is $H_0{:}\mu(D)=0$. That is, the expected mean difference is zero, with test statistic:

$$T = \frac{\sum D}{\sqrt{n} \text{ x } S_d} \tag{2}$$

A *t* statistic with n-1 degrees of freedom and S_d is computed as:

$$S_d = \frac{n\sum D^2 - \left(\sum D\right)^2}{n(n-1)} \tag{3}$$

(Walpole & Myers, p. 252).

The difference, *D*, is usually taken to be the simple difference (*cw-mw* in this case), and is assumed to be normally distributed, but "Since the data will generally be concentrations and since concentration data are often found to follow the log-normal distribution, the log transformation is suggested if substantial violations of the assumptions are found in the analysis of the original data" (USEPA, 1989). The *cw* and *mw* measurements of concentrations should be bounded below by zero, not normally distributed, and producing no guarantee that their difference is normally distributed, which it would be if *cw* and *mw* were each normally distributed. The problem of non-normality is much less likely to occur by taking *D*, the difference, to be *ln(cw)-ln(mw)* and constructing *T* and S_d from that. The null hypothesis, H_0, now concerns a difference in log space and translates into original space as $H_0{:}median(cw)/median(mw)=1$. To show this to be true, consider how H_0, in its original form, "$H_0{:}\mu(D)=0$", is now equivalent to "$\mu(ln(cw))-\mu(ln(mw))=0$", since saying "the mean difference is 0" is the same as saying "the difference of the means is 0." This follows from standard probability theorems concerning expectation (means) (Feller, p. 222):

$$\mu(a * Y) = a * \mu(Y), \text{ a constant, and} \tag{4}$$

$$\mu(X + Y) = \mu(X) + \mu(Y) \tag{5}$$

To apply them here, let $a = -1$ and X and Y be $ln(cw)$ and $ln(mw)$, respectively. What this easily tested hypothesis in the log space implies for the original measurements is not so straightforward. Since $ln(cw)$ and $ln(mw)$ are assumed to be normalized transformations of *cw* and *mw*, they should be centrally mounded and more or less symmetric, which is to say the mean, median, and mode (the three measures of the distributions' "centers") should coincide, within each of the two normalized distributions.

For normal distributions, one can replace hypotheses about means with ones about modes or medians, since they are all the same numbers. This is not true when we leave the log space, chosen for the convenience of doing a "paired t-test," exponentiate the test results and try to come to a conclusion about the original measures of interest, *cw* and *mw*. The likely distribution of the *cw* and *mw* measurements is log-normal, that is, bounded below by zero, mounded to the left, asymmetric (skewed) and unbounded (at least in theory) to the right. Under the t-test assumptions, they would be log-normal: X is log-normal $\Leftrightarrow X=exp(Y)$ where Y is normal and $Y=ln(X)$. As with any such skewed distribution, the three measures of the "center" are separated with the mode to the left, mean to the right, and median between them. That exponentiating H_0 should leave us with $H_0: f(cw)/f(mw)=1$, an hypothesis that the ratio of functions of *cw* and *mw* is 1, should be clear, but what is function, *f*? The mean and mode of a log-normal are functions of both the mean and variance of the underlying normal and, so, are independent of H_0; only the median is not. In fact, for X a log-normal, median(X)=$exp(\mu(ln(X))$ (Hald, p. 161).

Test Method

On the expectation that the number of pairs of wells to be tested exceeds 15, an estimate of how many pairs are required can be obtained by computing:

$$N = \frac{4 \text{ x } S_d^2}{Bound^2} \tag{6}$$

where Bound is the desired 95% error on the estimate of the mean expected difference, (i.e., $P(\mu(D)$ is contained in $[\overline{D} \pm Bound]) = .95$, where $\overline{D} = \sum \frac{D}{n}$ and is the estimator of $\mu(D)$, the expected difference of the logs, or, the log of the expected ratio of the medians). Choice of Bound affects N and represents minimally acceptable median ratios:

$$Bound = ln(2) = .6931472 <=> Reject\ H_0 \tag{7}$$

if the ratio of the medians < 0.5 or > 2.0,

$$Bound = ln(10) = 2.3025851 <=> Reject\ H_0 \tag{8}$$

if the ratio of the medians < 0.1 or > 10.

Choosing N appropriately guarantees a 5% or less chance of being wrong about the validity of H_0, since, if it is true, 95% of ln(ratios) fall within $\pm Bound$. The estimate of S_d also affects N and must be computed from an initial group of pairs of wells that were planned as a minimal experiment from the outset. A (1-alpha)100% confidence interval for the true variance is estimated by:

$$\left[\frac{(n-1)S_d^2}{\chi^2\left(\frac{\alpha}{2}\right)}, \frac{(n-1)S_d^2}{\chi^2\left(\frac{1-\alpha}{2}\right)}\right] \tag{9}$$

where χ^2 are tabled values of the Chi-Squared distribution (Walpole & Myers, p. 217). Multiplying both upper and lower bounds by $\frac{4}{Bound^2}$ gives a similar confidence interval for N. After N pairs of log differences are obtained they will be tested for normality, using the Shapiro-Wilk test (Shapiro & Wilk, pp.591-611, Royston, pp.115-124). If they are normal, the test statistic T, above, will be computed and t test performed. If not normal, a nonparametric test, such as Wilcoxon's signed rank test can be used to test H_0 (Conover, Iman, pp.795-806). If the log differences are not symmetrically distributed, as would be the case if median(D) were not contained in $[\overline{D} \pm Bound]$, then a less powerful nonparametric test like the sign test must be used, since "The assumption (for Wilcoxon's test) is that each difference is from some symmetric distribution" (Steel & Torrie, p. 403). Tests will be performed using SAS (SAS Institute, pp.625-628).

If H_0 is rejected, an analysis of variance-driven model selection procedure could be employed to find a transformation to reliably estimate *mw* readings from *cw* and cone penetrometer data. To do so would probably require more data pairs to be collected as well as data on any exogenous variables thought to be affecting the readings. The mean squared error for such a transformation model ought to be very small and would be roughly the $\frac{\sum errors^2}{n-p}$, where n = the number of data pairs and p = the number of parameters in the model estimated from the same data.

FIELD PROGRAM

SITE RECONNAISSANCE

During the site reconnaissance approximately 20 monitoring well pairs will be selected based on the chemical and geological data from the existing conventionally installed wells.

MONITORING WELL INSTALLATION

Field Documentation

Field documentation was maintained during the installation of monitoring wells. Associated standard CPT data included a Daily Log Sheet Form. This form was filled out by the crew chief. The standard example of this form is provided in Appendix A. A monitoring well installation report was completed for each well installed. The report form shown in Appendix A was filled in during the installation of the well.

Depths and Locations

Approximately 20 locations will be selected from the Wells listed in Table 1. The pump will be placed at depth which is the higher of the midpoint of the screen or two feet above the bottom of the well and two feet below the water table elevation.

Well Installation Method

CPT-installed monitoring wells were installed according to standard installation procedures developed by ARA. A schematic of this well installation procedure is presented in Figure 2.

Before new wells were installed a 1.75-inch standard CPT cone was pushed to the designed well completion depth. This first push measured the geologic conditions at that location and provided a guide hole for the larger diameter well. During the first push the CPT data was acquired and stored during penetration and a field plot was generated at the completion of the penetration.

Wells were installed by threading into one end of the one-meter silt trap section a sacrificial stainless steel or high-strength plastic tip, which acted as the drive point. When the sump was not used the sacrificial tip was threaded onto the first screen section. The screen sections were threaded onto the other end of the silt trap section and to each other as the drive point was lowered to the ground. Once on the ground, the steel push rods, with a blunt tip attached, were lowered inside the well material until the blunt end rests behind the sacrificial tip. Enough rods were added so that the end of the rods extend beyond the top of the well material and the head clamp could clamp the rods and not the well material. Installation began as the rods drove the sacrificial tip into the ground, pulling the well material into the ground with it. Additional screen and riser sections were added as necessary until the screen section was at the designed depth.

At the completion of advancement the rods were removed from the well and a depth indicator was lowered down the well to determine the total depth of the well. This information was recorded on the well installation report. During removal of the rods, the rods were decontaminated using the CPT rig's steam cleaner. Water generated during the rod decontamination process was containerized in 55-gallon drums and delivered to the on-site groundwater treatment facility for disposal.

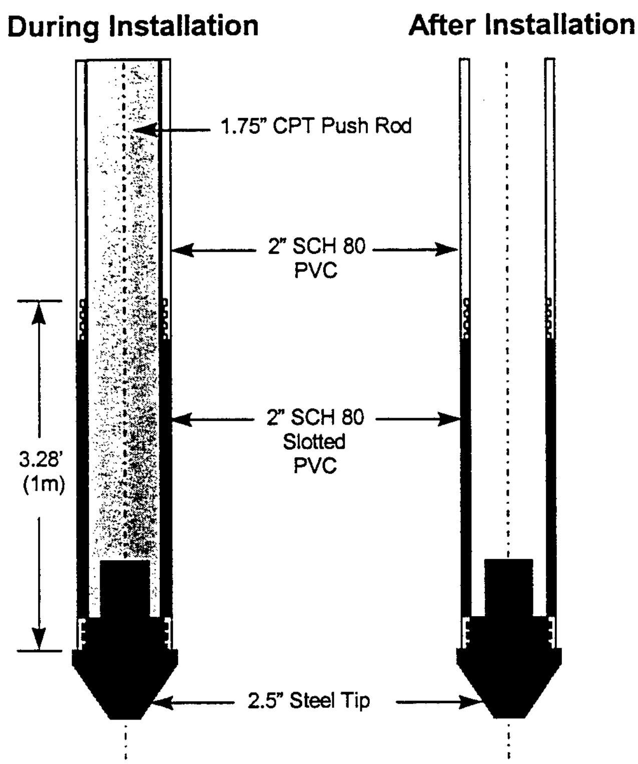


Figure 2. Schematic of 2-inch diameter PVC well installation with Cone Penetration Technique (CPT).

Well Screen and Riser

Wells are constructed of 2-inch diameter schedule 80 PVC with flush threaded joints. Each section is one meter (3.28 feet) long, has an outside diameter of 2.375 inches. As discussed in the Experimental Design section the well screen were constructed of 0.020-inch slot schedule 80 PVC and are configured to match as closely as possible the existing conventionally installed well screen top and bottom elevations. There are some minor differences in the construction of two wells, which have been noted in the experimental design section.

Surface Seal

After the well is installed a flush mounted manhole cover was installed and set in an eighteen (18) inch square concrete cap. The well riser was cut approximately 2 to 3 inches below the top of the cap before the manhole cover and cap were installed.

DEVELOPMENT OF MONITORING WELLS

Objectives

Newly installed monitoring wells were developed following their completed installation. Well development is designed to promote the free movement of groundwater through the well screen so that representative groundwater samples can be obtained.

Development Procedures

Development of CPT-installed monitoring wells was conducted with the Aardvark well development system. This system is a combination of a mechanical surge block and a venturi air lift silt and water pump. The Aardvark system was cleaned in a liquinox water bath before each use to avoid cross-contamination. Development was achieved by raising and lowering the Aardvark development head in the well repeatedly over a two-foot section of the well screen. During this process field readings were taken of the purge water's temperature, pH, and turbidity at a rate of 1 reading per removed well volume. Field parameters were measured with a YSI Model 6820 field water quality tester. Instrument specifications and calibration procedures are included in Appendix D. The Aardvark process continued until these parameters stabilized (less than 0.2 pH units or a 10 percent change for the other parameters among four consecutive readings) and the water was clear and free of fines.

Well Development Records

Well development records were maintained by completing the Well Development Log, found in Appendix A, for each well.

Management of Purge Water

Purge water generated during the well development process was containerized in 55-gallon drums and delivered to the on-site groundwater treatment facility for disposal.

GROUNDWATER SAMPLING

Sample Collection

Groundwater samples will be collected from monitoring wells using the EPA Region I Low Flow Groundwater Sampling Procedures as described in the publication included in Appendix B. The EPA document "provides a general framework for collecting groundwater samples that are indicative of mobile organic and inorganic loads at ambient flow conditions" (EPA 1996). This document will serve as the procedural guide for sampling unless superseded by procedures outlined in this section.

Samples will be collected using a stainless steel non-dedicated Grundfos Redi-flow™ submersible pump or other pump accepted by the method. Since the pump is non-dedicated, it will be decontaminated before each sampling round and after each well is sampled according to the procedures outlined below. Water levels will be measured using a Solinst (or other acceptable) water level meter calibrated to 0.01 feet. The instrument probe will be decontaminated before each measurement by soaking with a Liquinox™ solution and rinsing with tap water and again with distilled water. Field water quality parameters will be measured using a YSI Model 6820 sonde with a flow-through cell. Instrument specifications and calibration procedures for the 6820 are included in Appendix D.

Each sampling round will be initiated by collecting one set of piezometric data from each well included in the study. Piezometric data will be collected in one site-wide survey, before groundwater purging and sampling begins. Piezometric data will be recorded in bound field log books. The example format for recording piezometric data is provided in Appendix A.

Prior to collection of groundwater samples, water will be purged from the well until field measurements of turbidity, conductivity, temperature, dissolved oxygen, and pH stabilize. Purge procedures and stabilization guidelines are also covered in Appendix B. Field parameters will be recorded at regular intervals (at least once per well volume) with the specified water quality tester using a flow-through cell. This instrument will be calibrated at the start of each sampling day and after extended periods of non-use. Field data collected during purging shall be recorded on the Groundwater Sampling Log, provided in Appendix A.

For each well the Redi-flow pump will be positioned, as described in Appendix B, at the mid-point of the screened interval. If this location is less than 2 ft above the bottom of the well, then the pump will be positioned at 2 ft above the bottom of the well.

Purge water generated during the groundwater sampling and decontamination water will be containerized in 55-gallon drums or polyethylene equivalent and delivered to the on-site groundwater treatment facility for disposal.

Sampling Equipment Decontamination

All sampling equipment will be decontaminated before the beginning of each sampling round and after each well is sampled. Decontamination of the equipment reduces the risk of worker exposure, reduces the risk of cross contamination and insures collection of representative samples. The procedure summarized below is Procedure Number 2 in Appendix B.

If dedicated tubing is not use, the outside of the sampling tubing will be decontaminated during retraction of the sampling pump. When the pump has been removed from the well it will be placed in a water and liquinox bath. Three pump volumes will be pumped through the pump and sampling tubing (if non dedicated). This process will be repeated for two baths of tap water rinse and again in a bath of reagent free water.

Sample Containers

Each sample will be collected in a 40-ml glass vial with Teflon-backed septum. Purchased sample vials will be pre-cleaned and suitable for purgeable volatile organic analysis (PVOA).

Sample containers will be filled such that no air is retained within the sample vial. The absence of headspace will be verified by turning the capped vial upside down and tapping the lid while watching for bubbles. Sample labels with requisite identification data will be affixed to each vial. Each sample set of more than one vial will be placed in a single plastic bag. The plastic bag will be of the re-sealable type or will be sealed with clear tape. Filled sample vials will be stored at four degrees centigrade in a refrigerator or ice-containing insulated cooler until delivery to the analytical laboratory.

Sample Identification

Field samples and associated QA/QC samples will be labeled with the date and time of collection, sampling personnel's initials, well ID and depth, and a unique sequence number. The same information will be recorded in the field sampling logbook.

Sample Preservation

Samples will be preserved with hydrochloric acid (HCl). Water at the site will be tested to determine how many drops are required to increase the acidity to 2 pH units.

Samples to be analyzed by the certified laboratory will be packed into a separate cooler at the end of the sampling day. This cooler will be packed with a bottom layer surrounding the sample containers. A Chain-of-Custody Form will be signed and placed in a resealable plastic bag within the cooler and the cooler will be sealed with tape and a Chain-of-Custody Seal, such that the seal must be destroyed before accessing the cooler. The cooler shall be shipped to the laboratory by overnight express (or equivalent) mail from the field.

Holding times for samples sent to both ARA's laboratory or the QA/QC laboratory will not exceed 14 days.

Chain-of-Custody Records

Chain-of-Custody Forms will accompany all samples delivered to each laboratory. The forms will list the number of vials of each size contained in each cooler. They will be signed and dated by field personnel at the time of packing for shipment from the field, and by laboratory personnel at the time of receipt in the laboratory. An example Chain-of-Custody Form is provided in Appendix A.

FIELD QUALITY ASSURANCE/ QUALITY CONTROL

Quality assurance procedures will be implemented to evaluate if quantitative and qualitative information is accurately represented. These procedures are outlined in detail in the Quality Assurance Project Plan (QAPP) in Appendix E and include QA/QC samples to be collected and analyzed in addition to the samples collected for the study. These samples are briefly described below and are summarized in Table 3.

Table 3. Field QA/QC Sampling Schedule.

Sample Description	Frequency	Number of Samples/Event		
		Solvent (Sites 1&2)	Fuel (Site 21)	Total
Experiment Samples		30	10	40
QA/QC Field Samples				
Trip Blanks	1 /event/cooler	2	1	3
Field Equipment Blanks	1 /event/cooler	2	1	3
Field Duplicates	5%	2	1	3
Ambient Background Samples	1 /event/site	1	1	2
Field Replicates (for independent lab)	20%	6	2	8
Total Samples collected/Event		43	16	59

Field Duplicates

Field duplicate samples will be collected for five percent (5%) of the total number of samples collected. Duplicates will be collected by discharging from the same pump volume, first into the original sample container and then into the duplicate container. They will be identified as field duplicates on the Chain-of-Custody Forms. They will be analyzed by ARA in the same manner as all other samples. The results of analyses of the field duplicate samples will provide a measure of the precision (repeatability) of the field sampling methods and ARA's laboratory analytical methods.

Field Replicates (Split Samples)

Split samples will be collected from twenty percent (20%) of the total number of samples. Split samples will be collected from both the CPT installed well and the conventionally installed well. Splits will be sent to a certified laboratory for analysis by EPA Method 8260 to evaluate the analytical performance of ARA's laboratory. Splits will be collected in the same manner as field duplicate groundwater samples. The results of analyses of split samples will provide a measure of the precision (repeatability) of the field sampling methods and the accuracy of the laboratory analytical methods.

Trip Blanks and Field Equipment Blanks

One trip blank and at least one field equipment blank will be prepared for each sample cooler returned from each sampling event at the site. Trip blanks will be prepared in ARA's laboratory using the same analyte-free reagent water as used in the preparation of check standards and instrument blanks. Equipment blanks will be prepared in the field by passing analyte-free water through all decontaminated sampling equipment in the same manner that a groundwater sample must pass. Water will be provided by the laboratory. The use of equipment blanks validates the effectiveness of equipment decontamination procedures.

Trip blanks and equipment blanks must be handled, transported, and analyzed using identical procedures as those used for regular groundwater samples. One trip blank must accompany each sample cooler, including split sample coolers shipped to a level III certified laboratory.

Matrix Spike and Matrix Spike Duplicate Samples

As mentioned above Field duplicates will be collected for five percent (5%) of the total number of samples collected in the field to provide analytical quality control samples to the ARA laboratory. These field duplicates will be used to prepare Matrix Spike and Matrix Spike Duplicate (MS/MSD) samples in the laboratory and will be identified as field duplicates on the Chain-of-Custody Forms. These samples will help identify matrix effects on spiked analytes of known quantity, as well as the laboratory's precision in recognizing matrix effects.

Ambient Background Samples

Two background samples will be collected during each sampling event. These samples will be collected from a well independent of the study wells and known to be up gradient of the contaminate plume. These samples will be used to establish the background environment for the study.

EQUIPMENT AND MATERIALS

Well Installation:

- CPT Truck with Support Truck
- Standard 1.75 Piezo Cone and Acquisition System
- One-meter long 2-inch diameter schedule 80 PVC, 20 slot screen sections, 4 TPI (M/F)
- One-meter long 2-inch diameter schedule 80 PVC, 20 slot riser sections, 4 TPI (M/F)
- CPT well installation disposable drive points

Well Development:

- Support Truck
- Aardvark well development system
- 55 gallon drum or polyethylene tank for purged water disposal
- Water quality tester, and water level meter
- PID

Sampling

- Grundfos Redi-flow pump and controller, or other acceptable pump
- Water quality tester
- Sample Shipping Coolers
- Plastic Bags
- Ice Packs
- Sample Vials
- Photo Ionization Detector

LABORATORY PROGRAM

ANALYTICAL METHODS

Chemical analysis of field samples will be performed for selected compounds using EPA method 5021 static head space sample concentration and modified EPA method 8021 for the analysis of volatile organic compounds in water. Modifications to method 8021 will include the use of a capillary column in place of a packed column, truncation of the standard analyte list, and substitution of a flame ionization detector (FID) in place of a photo-ionization detector (PID) in parallel with an electron capture detector (ECD) in place of a electrolytic conductivity detector. The truncated target analyte list will include only the purgeable halocarbons and aromatics presented in Table 2.

Split samples for laboratory Quality Assurance/Quality Control (QA/QC) will be sent to Inchcape Testing Services Environmental Laboratories in Colchester Vermont. Analysis of splits will be performed using Gas Chromatography/Mass Spectrometry (GC/MS) following EPA Method 8260 with the same modified analyte list presented in Table 2.

As specified by the analytical methods sample holding times for samples sent to both ARA's laboratory and the QA/QC laboratory will not exceed 14 days. Sample vials will be pre-preserved with hydrochloric acid (HCl). A sufficient amount of acid will be added to the vials to reduce the pH of each sample to less then 2 pH units.

INSTRUMENT CALIBRATION

The Gas Chromatography (GC) equipment used by ARA will be calibrated according to the procedures specified in EPA method 8021. For each analyte of interest, a five point calibration will be developed including one at a concentration near, but above the method detection limit. The other concentrations will correspond to the expected range of concentrations found in the actual samples or will define the working range of the detector. A linear calibration curve will be derived for each analyte by a least squares best fit through the five calibration points plus the origin. The calibration curve is considered acceptable if the correlation coefficient is greater than or equal to 0.995. Retention time windows will include plus or minus three standard deviations of the mean retention times for each analyte measured over a 72 hour period. The instrument will be re-calibrated under two conditions: before analyzing the samples from each sampling round, and upon failure of a quality control check as discussed in the Quality Assurance Project Plan (QAPP) presented in Appendix E.

CALIBRATION STANDARDS

Calibration standards will be prepared according to the procedures specified by EPA method 8021B. Stock standards will be prepared from pure (neat) standards, prepared as specified in the method, or purchased as certified solutions. Dilution's of any of the purchased standards will be performed using Level A precision glassware and reagent-free water that has been analytically demonstrated to be free of target analytes within the minimum detection limits for the method. Retention time windows for all of the individual peaks will be identified by analyzing 10-ppm dilution's of each of the individual target analytes in accordance with the procedures outlined in SW846 method 8000. Calibration check standards will be run at a rate of one every ten samples and will include each of the target analytes at a concentration of 20-ppb. These standards will be made up independently from the dilution's used to make the calibration standards. All calibration standards will be purchased from Supelco, Inc., a commercial chromatography supplies vendor located in Bellefont, PA. The normal level of certification that accompanies all of Supelco's standards is acceptable for the purpose of this project.

METHOD PERFORMACE

Method Detection Limits

EPA Method 8021 specifies method performance criteria assuming a photo-ionization detector (PID) and a Hall electrolytic conductivity detector (HECD) are used in series. Since we are using different detectors (e.g., flame ionization detector (FID) and an electronic capture detector (ECD)) in parallel as a modification of Method 8021 it was necessary to conduct an instrument specific method detection limit (MDL) study.

The MDL study was conducted in ARA, New England Division's Environmental Laboratory. The instrument configuration consisted of Tekmar 7000 Static Headspace sampler connected directly via a heated transfer line to the split/splitless capillary injection port of an Hewlett-Packard 5890 series II gas chromatograph equipped with electronic pressure control

(EPC). The injection port was run in splitless mode to optimize the detection of trace analytes. The MDL study results are presented in Appendix F of this Work Plan.

Estimated Quantitation Limits

EPA Method 8021 states that the estimated quantitation limit (EQL), which is the minimum concentration that can be reported with reasonable accuracy, is determined as the MDL for each analyte times a response factor. The response factor (which is dependent on the sample matrix) for groundwater and this method is 10. These EQLs are reported in Table 3 in the Experimental Design section.

LABORATORY QUALITY ASSURANCE/QUALITY CONTROL

A comprehensive Quality Assurance Project Plan (QAPP) to assure quality in both sampling and analysis has been developed and is presented in Appendix E. The QAPP addresses quality assurance associated with all aspects of sampling and analysis of samples. As addressed in the QAPP, the criteria of completeness, representativeness, precision, and accuracy are used to assess the quality assurance measures of the project.

Completeness is a measure of the amount of valid data obtained from a measurement system compared with the amount that was expected under normalized conditions.

Representativeness (a sample exhibiting average properties of the whole) is determined by the sampling procedures and proper selection of sampling points. Representative samples will be maintained by collecting all samples following specific procedures provided in the Field Program.

Precision for this sampling program will be assessed by analyzing field duplicate samples submitted to ARA's laboratory. These samples will be analyzed using the same procedures as the rest of the samples. This will provide assurance of both the repeatability of sampling procedures and the precision of the analytical effort.

Accuracy is a quantitative measure of the bias of a method or the level of agreement between a measurement and a known true value. Laboratory accuracy will be evaluated using the results of matrix spike and matrix spike duplicate (MS/MSD) sample analysis. Additionally accuracy will be addressed by sending splits from 20% of the samples to an independent laboratory. Laboratory accuracy will be maintained in accordance with the EPA standard methods used, as provided in the EPA Solid Waste Manual SW846.

Laboratory analytical quality will be assured through the performance of specific QC checks and procedures described in the QAPP. These procedures include the use of method blanks, laboratory control samples, and matrix spike samples. A summary of all samples to be analyzed by ARA's laboratory is presented in Table 4.

Table 4. QA/QC Analysis Schedule for Groundwater Samples.

Sample Description	Frequency	Number of Samples/Event		
		Solvent (Sites 1&2)	Fuel (Site 21)	Total
Experiment Samples		30	10	40
ARA Internal QA/QC Field Samples				
Trip Blanks	1 /event/cooler	2	1	3
Field Equipment Blanks	1 /event/cooler	2	1	3
Field Duplicates	5%	2	1	3
Ambient Background Samples	1 /event/site	1	1	2
ARA Internal QA/QC Lab Samples				
Method Blanks	5%	2	1	3
Laboratory Control Samples	5%	2	1	3
Matrix Spike (MS) Samples	5%	2	1	3
Matrix Spike Duplicate (MSD) Samples	5%	2	1	3
Total Samples for ARA Lab per Event		45	18	63
Total Samples for ARA Lab Modified EPA Method 8021, Static Headspace Method 5021		**45**	**18**	**63**
Independent QA/QC Lab				
Field Replicates (Splits)	20%	6	2	8
Trip Blanks	1 /event/cooler	1	1	2
Total Samples sent to QA/QC Lab per Event		7	3	10
Total Samples sent to QA/QC Lab EPA Method 8260, EPA Method 5030 Purge and Trap		**7**	**3**	**10**
TOTAL SAMPLES		**52**	**21**	**73**

Method blanks will be made from the same reagent free water used in the preparation of calibration standards. Laboratory control samples will be prepared in the same manner as calibration standards, but using standards purchased from a separate vendor, or prepared in the laboratory from neat analyte stock. One method blank, one mid-level laboratory control sample, and one matrix spike/matrix spike duplicate (MS/MSD) pair will be analyzed for every twenty groundwater samples (5%). If any analytes are found in a method blank above the method detection limit, or if the recovery of any laboratory control sample deviates by greater than fifteen percent from complete recovery (i.e. less than 85% or greater than 115%) the given QC sample will be re-analyzed. If a second analysis fails this quality control check, the instrument must be re-calibrated and the last twenty samples re-analyzed.

The matrix spike samples will be prepared from the field duplicates collected for this purpose, as indicated by field personnel on the Chain-of-Custody Forms. These samples will be spiked with the same standard (i.e., same vendor and lot number) as used for instrument calibrations. Control charts will be prepared from the results of MS and MSD analyses and used to track instrument precision. The control charts will be developed from parametric statistics on a moving twenty-point window of MS/MSD results, assuming a normal distribution of relative percent differences in spike recoveries. If the relative percent difference for any pair of MS/MSDs falls outside the established control limits (i.e., plus or minus three standard deviations of the mean of the twenty previous spiked pairs), then the instrument will be re-calibrated and new control limits established.

QA/QC EVALUATION OF ANALYTICAL DATA

Chemical analytical data reported by the ARA laboratory will be evaluated by the laboratory manager following the analysis of each round of samples. Through this evaluation, the laboratory manager will decide to reject, or to flag reported analytical results based on the results of the analyses of trip blanks, equipment blanks, method blanks, split samples, matrix spikes, and based on holding times and other information obtained through field audits.

Criteria used in this evaluation will be based on those included in the EPA Region I Laboratory Data Validation Functional Guidelines for Evaluating Organics Analyses (1988).

Results of this evaluation will be included in the Quality Control Summary Report to be prepared at the conclusion of each sampling round.

HEALTH AND SAFETY

A separate Health and Safety Plan (HASP) has been prepared for this project. This HASP addresses the issues associated with working at Hanscom AFB or Hanscom Field conducting direct push monitoring well installation, typical cone penetrometer operations or groundwater sampling. This document must be read by every participant working on this project for ARA or its subcontractors. Copies of the HASP will be available on the CPT rig, the sampling support rig and with the Project Manager at ARA in South Royalton, Vermont. Addition copies will be provided to the Air Force Subtask Monitor at AFRL/MLQ at Tyndall, AFB and the Base Civil Engineer at Hanscom AFB.

SCHEDULE

Table 5. Technical Milestones.

	Milestone	Planned Date
6.1	Project Start	July 98
6.2	Monthly Progress Reports	Monthly
6.3	Perform Sampling/Analysis	Aug 98
6.4	Final Report	Dec 99
6.5	Final Presentation	Dec 99
6.6	Final Technical Report (Camera Ready): Due 30 days after receipt of government's comments to the draft report.	

REPORTING

Documentation for this project will consists of monthly status reports (MSR), a draft technical report and a camera ready final technical report. The MSRs will be provided to the ARA Tyndall office and directly to the Air Force Project Officer according to SSG MSR schedule established by AFRL/MLQ. The draft technical report will be provided to AFRL/MLQ within 30 days of the completion of the tasks. The final technical report will be provided to AFRL/MLQ within 30 days of receiving the government's comments on the draft technical report.

REFERENCES

Begemann, H.K.S., "The Friction Jacket Cone as an Aid in Determining the Soil Profile," *Proc. 6th ICSMFE*, Montreal, Canada, Vol. I, pp. 17-20, 1965.

Bratton, W.L., J.D. Shinn, S.M. Timian, G.D. Gillispie, R. St. Germain, "The Air Force Site Characterization and Analysis Penetrometer System (AFSCAPS); Laser Induced Fluorescence Cone Penetrometer," Under Contract No. F08635-88-C-0067, SETA Subtask 8.00, Report to Air Force Armstrong Laboratory, Tyndall AFB, FL, February 1993.

Conover, *Practical Nonparametric Statistics*, John Wiley & Sons, NY 1980.

de Reister, J., "Electric Penetrometer for Site Investigations," *Journal of SMFE Division*, ASCE, Vol. 97, SM-2, pp. 457-472, February 1971.

Farrington, S.P., and W.L. Bratton, "Measuring Fuel Contamination Using Cone Penetration Testing and High Speed Gas Chromatography," Final Report to U.S. Department of Energy, Morgantown Technology Center, Morgantown, WV, February 1997.

Feller, *An Introduction to Probability Theory and Its Applications, Volume I*, John Wiley & Sons, NY 1968.

Gildea, M.L., W.L. Bratton, J.D. Shinn, "Demonstration and Evaluation of the Air Force Site Characterization and Analysis Penetrometer System in Support of Natural Attenuation Initiatives," Under Contract F08635-93-C-0020, SETA Subtask 8.01.1, Report to Air Force Armstrong Laboratory, Tyndall AFB, FL, February 1995.

Hald, *Statistical Theory with Engineering Applications*, John Wiley & Sons, NY 1952.

Iman, "Use of a t-statistic as an Approximation to the Exact Distribution of the Wilcoxon Signed Ranks Test Statistic," Communications in Statistics 3, 1974.

Montgomery, R.L., J.C. Bianchi, J.D. Shinn, R.M. Morey, R.E. Walker, S.P. Farrington, W.C. Dickerson, S.M. Conklin, "Groundwater Remediation Field Laboratory - GRFL: Hydrogeology Characterization and Site Development," Report to Air Force Armstrong Laboratory AL/EQW-OL, Tyndall AFB, FL, June 1996.

Royston, "An Extension of Shapiro and Wilk's W Test for Normality to Large Samples," Applied Statistics 31, 1982.

SAS Institute Inc., *SAS Procedures Guide, Version 6, 3rd Ed.*, Cary NC 1990.

Shapiro and Wilk, "An Analysis of Variance Test for Normality (complete samples)," Biometrika 52, 1965.

Steel and Torrie, *Principles and Procedures of STATISTICS*, McGraw-Hill, NY 1960. Walpole and Myers, *Probability and Statistics for Engineers and Scientists*, Macmillan, NY 1978.

Torstensson, B.A., "Pore Pressure Sounding Instrument," *Proc. ASCE Spec. Conf. on In Situ Measurement of Soil Properties*, Raleigh, NC, Vol. II, pp. 48-54, 1975.

US Environmental Protection Agency, "Drinking Water Regulations and Health Advisories," Office of Water, Washington, DC, February 1996.

US Environmental Protection Agency, "Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities," Office of Solid Waste Management Division, Washington, DC, February 1989.

US Environmental Protection Agency, Correspondence between R. Lim and R. Spelfogel, December 6, 1996.

Wissa, A.E.Z., Martin, R.T., and Garlanger, J.E., "The Piezometer Probe," *Proc. ASCE Spec. Conf. on In Situ Measurement of Soil Properties*, Raleigh, NC, Vol. I, pp. 536-545, 1975.

APPENDIX A

DOCUMENTATION

- CPT Daily Log Sheet
- CPT Well Installation Report
- Well Development Log
- Piezo
- Groundwater Sampling Log
- Chain-of-Custody Form

CPT DAILY LOG SHEET

CPT WELL INSTALLATION REPORT

Project: ______________________ Observation Well: ____________

City/State: ______________________ CPT ID: ____________

Client: ______________________ Installation Date: ____________

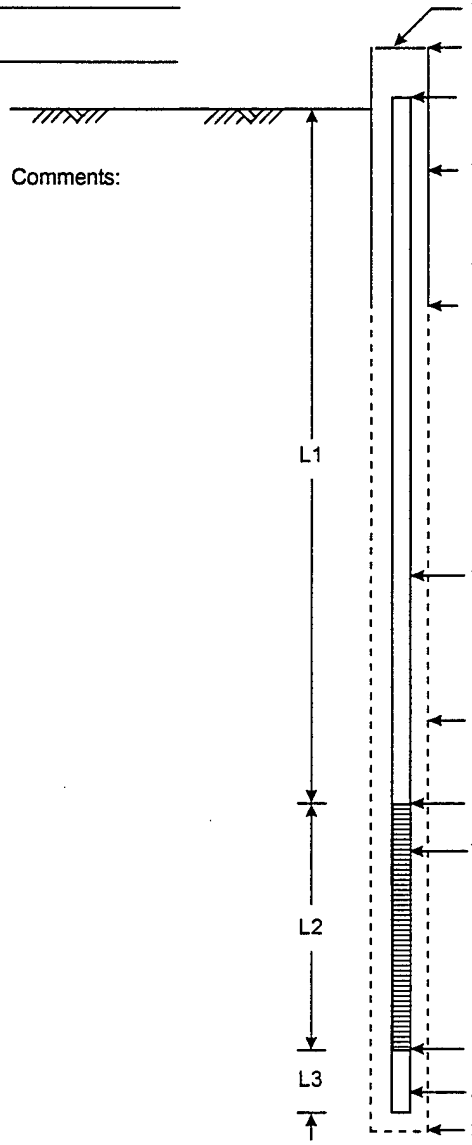
Crew Chief: ______________________ Location: ____________

ARA File No.: ____________

Ground El. ____________

El. Datum ____________

Comments:



Type of Protective Cover/Lock

Depth of Top of Roadway Box below Ground Surface ________ ft

Depth of Top of Riser Pipe below Ground Surface ________ ft

Type of Protective Casing:

Length ________ ft

Inside Diameter ________ in

Depth of Bottom of Roadway Box ________ ft

Seals:

Type	Depth to Top (ft)	Thickness (ft)

Type of Riser Pipe:

Inside Diameter of Riser Pipe ________ in

Type of Backfill around Riser

Diameter of Largest CPT Expander ________ in

Depth of Top of Wellpoint ________ ft

Type of Point or Manufacturer:

Screen Gauge or Size of Openings ________ in

Diameter of Wellpoint ________ in

Depth of Bottom of Wellpoint ________ ft

Silt Trap

Depth of Bottom of Borehole ________ ft

(Depths refer to ground surface)

________ ft	+	________ ft	+	________ ft	=	________ ft
Riser length (L1)		Screen length (L2)		Length of silt trap (L3)		Total length

WELL DEVELOPMENT LOG

PROJECT:	SITE:	WELL ID:	DATE:
WELL DEPTH:	WATER LEVEL:	WEATHER INFORMATION:	
METHOD & EQUIPMENT:			
SURGING TIME BEGIN: END:	PUMPING TIME BEGIN: END:	VOLUME BAILED DURING SURGING:	

TIME	MEASUREMENTS			OBSERVATIONS				
	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	CLARITY	COLOR	ODOR	PARTICULATES
T_0 :								
END:								

Comments: ______________________________

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

PIEZOMETRIC DATA RECORDING FORMAT

1. NAME OF PROJECT:
2. DATE:
3. WEATHER INFORMATION:
4. WORK PERFORMED:
5. FIELD PERSONNEL:
6. FIELD INSTRUMENTATION USED WITH CALIBRATION INFORMATION:
7. DECONTAMINATION PROCEDURES:
8. WATER LEVEL DEPTH MEASUREMENTS TAKEN FROM TOP OF CASING IN MONITORING WELLS. MEASUREMENTS IN COLLECTION TRENCH CLEANOUTS TAKEN FROM TOP OF CLEANOUT STRUCTURE. MEASUREMENTS IN PUMP STATION WET WELLS TAKEN FROM SURVEYED DATUM.
9. PID READINGS TAKEN OF WELL HEADSPACE IMMEDIATELY UPON OPENING WELL. PID READINGS LISTED WITH WELL READING/BACKGROUND READING.
10. PIEZOMETRIC MEASUREMENTS:

LOCATION	PID READING	DEPTH	TIME

11. GENERAL REMARKS:
12. SIGNATURE AND JOB TITLE OF PREPARER:

GROUNDWATER SAMPLING LOG

PROJECT:	SITE:	WELL ID:	DATE:
WELL DEPTH:	SCREEN LENGTH:	WELL DIAMETER:	CASING TYPE:
MEASUREMENT POINT:	WATER LEVEL:	WEATHER INFORMATION:	
METHOD & EQUIPMENT:			
SAMPLING PERSONNEL:			

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY			COMMENTS:
T_0 :							
END:							

Samples Collected:____________________________________

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

PROJECT NO.: ________

CHAIN OF CUSTODY RECORD/LAB WORK REQUEST

Chain of Custody No.: ________
Cooler No.: ________
Page ______ of ______
Air Bill No.: ________

LABORATORY: ________

APPLIED RESEARCH ASSOCIATES, INC
Phone (802) 763-8348 FAX (802) 763-8283

ARA Contact: ________
Project: ________
Date Due: ________
Samplers Signature: ________
AF ID: ________ **Log Code:** ________

Lab ID No. Lab Only	Location ID	Sample ID	Depth Interval	Date Collected	Time Collected	Matrix[a]	Sampling Tech.[b]	Container Type	Preservatives	Analyses Requested: Mod EPA 8260					Lab Control ID

[a] **Matrix:**
SO - Soil
SE - Sediment
WS - Surface Water
WG - Groundwater
LF - Product
AA - Air
SW - Wipe
EP/TCLP - Leachate
WQ- Trip Blank, Equipment Blanks
WW -Wastewater

[b] **Sampling Technique:**
Composite = C
Grab = G
Hand Auger = HA
MLS = MLS Sampling System
Cone Penetrometer = CN
Bladder Pump = BP
Submersible Pump = SP
Bailer = B
PP = Peristaltic Pump

Relinquished by/Affiliation	Received by Affiliation	Date	Time

Relinquished by/Affiliation	Received by Affiliation	Date	Time

LABORATORY USE ONLY

SAMPLES WERE:

1 Shipped or hand delivered
Notes:

2 Ambient or Chilled
Notes:

3 Temperature

4 Received Broken/Leaking (Improperly Sealed)
Y **N**
Notes:

5 Properly Preserved
Y **N**
Notes:

6 Received Within Holding Times
Y **N**
Notes:

COC Tape Was:

1 Present on Outer Package
Y **N** **NA**

2 Unbroken on Outer Package
Y **N** **NA**

3 Present on Sample
Y **N** **NA**

4 Unbroken on Sample
Y **N** **NA**
Notes:

Discrepancies Between Sample Labels and COC Record?
Y **N**
Notes:

APPENDIX B

Low Stress (low flow) Purging and Sampling Procedure for the Collection of Ground Water Samples from Monitoring Wells

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION I

LOW STRESS (low flow) PURGING AND SAMPLING PROCEDURE FOR THE COLLECTION OF GROUND WATER SAMPLES FROM MONITORING WELLS

I. SCOPE & APPLICATION

This standard operating procedure (SOP) provides a general framework for collecting ground water samples that are indicative of mobile organic and inorganic loads at ambient flow conditions (both the dissolved fraction and the fraction associated with mobile particulates). The SOP emphasizes the need to minimize stress by low water-level drawdowns, and low pumping rates (usually less than 1 liter/min) in order to collect samples with minimal alterations to water chemistry. This SOP is aimed primarily at sampling monitoring wells that can accept a submersible pump and have a screen, or open interval length of 10 feet or less (this is the most common situation). However, this procedure is flexible and can be used in a variety of well construction and ground-water yield situations. Samples thus obtained are suitable for analyses of ground water contaminants (volatile and semi-volatile organic analytes, pesticides, PCBs, metals and other inorganics), or other naturally occurring analytes.

This procedure does not address the collection of samples from wells containing light or dense non-aqueous phase liquids (LNAPLs and DNAPLs). For this the reader may wish to check: Cohen, R.M. and J.W. Mercer, 1993, DNAPL Site Evaluation; C.K. Smoley (CRC Press), Boca Raton, Florida and U.S. Environmental Protection Agency, 1992, RCRA Ground-Water Monitoring: Draft Technical Guidance; Washington, DC (EPA/530-R-93-001).

The screen, or open interval of the monitoring well should be optimally located (both laterally and vertically) to intercept existing contaminant plume(s) or along flowpaths of potential contaminant releases. It is presumed that the analytes of interest move (or potentially move) primarily through the more permeable zones within the screen, or open interval.

Proper well construction and development cannot be overemphasized, since the use of installation techniques that are appropriate to the hydrogeologic setting often prevents "problem well" situations from occurring. It is also recommended that as part of development or redevelopment the well should be tested to determine the appropriate pumping rate to obtain stabilization of field indicator parameters with minimal drawdown in shortest amount of time. With this information field crews can then conduct purging and sampling in a more expeditious manner.

The mid-point of the saturated screen length (which should not exceed 10 feet) is used by convention as the location of the pump intake. However, significant chemical or permeability contrast(s) within the screen may require additional field work to determine the optimum vertical location(s) for the intake, and appropriate pumping rate(s) for purging and sampling more localized target zone(s). Primary flow zones (high(er) permeability and/or high(er) chemical concentrations) should be identified in wells with screen lengths longer than 10 feet, or in wells with open boreholes in bedrock. Targeting these zones for water sampling will help insure that the low stress procedure will not underestimate contaminant concentrations. The Sampling and Analysis Plan must provide clear instructions on how the pump intake depth(s) will be selected, and reason(s) for the depth(s) selected.

Stabilization of indicator field parameters is used to indicate that conditions are suitable for sampling to begin. Achievement of turbidity levels of less than 5 NTU and stable drawdowns of less than 0.3 feet, while desirable, are not mandatory. Sample collection may still take place provided the remaining criteria in this procedure are met. If after 4 hours of purging indicator field parameters have not stabilized, one of 3 optional courses of action may be taken: a) continue purging until stabilization is achieved, b) discontinue purging, do not collect any samples, and record in log book that stabilization could not be achieved (documentation must describe attempts to achieve stabilization) c) discontinue purging, collect samples and provide full explanation of attempts to achieve stabilization (note: there is a risk that the analytical data obtained, especially metals and strongly hydrophobic organic analytes, may not meet the sampling objectives).

Changes to this SOP should be proposed and discussed when the site Sampling and Analysis Plan is submitted for approval. Subsequent requests for modifications of an approved plan must include adequate technical justification for proposed changes. All changes and modifications must be approved before implementation in field.

II. EQUIPMENT

A. Extraction device

Adjustable rate, submersible pumps are preferred (for example, centrifugal or bladder pump constructed of stainless steel or Teflon).

Adjustable rate, peristaltic pumps (suction) may be used with caution. Note that EPA guidance states: "Suction pumps are not recommended because they may cause degassing, pH modification, and loss of volatile compounds" (EPA/540/P-87/001, 1987, page 8.5-11).

The use of inertial pumps is discouraged. These devices frequently cause greater disturbance during purging and sampling and are less easily controlled than the pumps listed above. This can lead to sampling results that are adversely affected by purging and sampling operations, and a higher degree of data variability.

B. Tubing

Teflon or Teflon lined polyethylene tubing are preferred when sampling is to include VOCs, SVOCs, pesticides, PCBs and inorganics.

PVC, polypropylene or polyethylene tubing may be used when collecting samples for inorganics analyses. However, these materials should be used with caution when sampling for organics. If these materials are used, the equipment blank (which includes the tubing) data must show that these materials do not add contaminants to the sample.

Stainless steel tubing may be used when sampling for VOCs, SVOCs, pesticides, and PCBs. However, it should be used with caution when sampling for metals.

The use of 1/4 inch or 3/8 inch (inner diameter) tubing is preferred. This will help ensure the tubing remains liquid filled when operating at very low pumping rates.

Pharmaceutical grade (Pharmed) tubing should be used for the section around the rotor head of a peristaltic pump, to minimize gaseous diffusion.

C. Water level measuring device(s), capable of measuring to 0.01 foot accuracy (electronic "tape", pressure transducer). Recording pressure transducers, mounted above the pump, are especially helpful in tracking water levels during pumping operations, but their use must include check measurements with a water level "tape" at the start and end of each record.

D. Flow measurement supplies (e.g., graduated cylinder and stop watch).

E. Interface probe, if needed.

F. Power source (generator, nitrogen tank, etc.). If a gasoline generator is used, it must be located downwind and at least 30 feet from the well so that the exhaust fumes do not contaminate the samples.

G. Indicator field parameter monitoring instruments - pH, Eh, dissolved oxygen (DO), turbidity, specific conductance, and temperature. Use of a flow-through-cell is required when measuring all listed parameters, except turbidity. Standards to perform field calibration of instruments. Analytical methods are listed in 40 CFR 136, 40 CFR 141, and SW-846. For Eh measurements, follow manufacturer's instructions.

H. Decontamination supplies (for example, non-phosphate detergent, distilled/deionized water, isopropyl alcohol, etc.).

I. Logbook(s), and other forms (for example, well purging forms).

J. Sample Bottles.

K. Sample preservation supplies (as required by the analytical methods).

L. Sample tags or labels.

M. Well construction data, location map, field data from last sampling event.

N. Well keys.

O. Site specific Sample and Analysis Plan/Quality Assurance Project Plan.

P. PID or FID instrument (if appropriate) to detect VOCs for health and safety purposes, and provide qualitative field evaluations.

III. PRELIMINARY SITE ACTIVITIES

Check well for security damage or evidence of tampering, record pertinent observations.

Lay out sheet of clean polyethylene for monitoring and sampling equipment.

Remove well cap and immediately measure VOCs at the rim of the well with a PID or FID instrument and record the reading in the field logbook.

If the well casing does not have a reference point (usually a V-cut or indelible mark in the well casing), make one. Describe its location and record the date of the mark in the logbook.

A synoptic water level measurement round should be performed (in the shortest possible time) before any purging and sampling activities begin. It is recommended that water level depth (to 0.01 ft.) and total well depth (to 0.1 ft.) be measured the day before, in order to allow for re-settlement of any particulates in the water column. If measurement of total well depth is not made the day before, it should not be measured until after sampling of the well is complete. All measurements must be taken from the established referenced point. Care should be taken to minimize water column disturbance.

Check newly constructed wells for the presence of LNAPLs or DNAPLs before the initial sampling round. If none are encountered, subsequent check measurements with an interface probe are usually not needed unless analytical data or field head space information signal a worsening situation. Note: procedures for collection of LNAPL and DNAPL samples are not addressed in this SOP.

IV. PURGING AND SAMPLING PROCEDURE

Sampling wells in order of increasing chemical concentrations (known or anticipated) is preferred.

1. Install Pump

Lower pump, safety cable, tubing and electrical lines slowly (to minimize disturbance) into the well to the midpoint of the zone to be sampled. The Sampling and Analysis Plan should specify the sampling depth, or provide criteria for selection of intake depth for each well (see Section I). If possible keep the pump intake at least two feet above the bottom of the well, to minimize mobilization of particulates present in the bottom of the well. Collection of turbid free water samples may be especially difficult if there is two feet or less of standing water in the well.

2. Measure Water Level

Before starting pump, measure water level. If recording pressure transducer is used-initialize starting condition.

3. Purge Well

3a. Initial Low Stress Sampling Event

Start the pump at its lowest speed setting and slowly increase the speed until discharge occurs. Check water level. Adjust pump speed until there is little or no water level drawdown (less than 0.3 feet). If the minimal drawdown that can be achieved exceeds 0.3 feet but remains stable, continue purging until indicator field parameters stabilize.

Monitor and record water level and pumping rate every three to five minutes (or as appropriate) during purging. Record any pumping rate adjustments (both time and flow rate). Pumping rates should, as needed, be reduced to the minimum capabilities of the pump (for example, 0.1 - 0.4 l/min) to ensure stabilization of indicator parameters. Adjustments are best made in the first fifteen minutes of pumping in order to help minimize purging time. During pump start-up, drawdown may exceed the 0.3 feet target and then "recover" as pump flow adjustments are made. Purge volume calculations should utilize stabilized drawdown value, not the initial drawdown. Do not allow the water level to fall to the intake level (if the static water level is above the well screen, avoid lowering the water level into the screen). The final purge volume must be greater than the stabilized drawdown volume plus the extraction tubing volume.

Wells with low recharge rates may require the use of special pumps capable of attaining very low pumping rates (bladder, peristaltic), and/or the use of dedicated equipment. If the recharge rate of the well is lower than extraction rate capabilities of currently manufactured pumps and the well is essentially dewatered during purging, then the well should be sampled as soon as the water level has recovered sufficiently to collect the appropriate volume needed for all anticipated samples (ideally the intake should not be moved during this recovery period). Samples may then be collected even though the indicator field parameters have not stabilized.

3b. Subsequent Low Stress Sampling Events

After synoptic water level measurement round, check intake depth and drawdown information from previous sampling event(s) for each well. Duplicate, to the extent practicable, the intake depth and extraction rate (use final pump dial setting information) from previous event(s). Perform purging operations as above.

4. Monitor Indicator Field Parameters

During well purging, monitor indicator field parameters (turbidity, temperature, specific conductance, pH, Eh, DO) every three to five minutes (or less frequently, if appropriate). Note: during the early phase of purging emphasis should be put on minimizing and stabilizing pumping stress, and recording those adjustments. Purging is considered complete and sampling may begin when all the above indicator field parameters have stabilized. Stabilization is considered to be achieved when three consecutive readings, taken at three (3) to five (5) minute intervals, are within the following limits:

turbidity (10% for values greater than 1 NTU),
DO (10%),
specific conductance (3%),
temperature (3%),
pH (± 0.1 unit),
ORP/Eh (± 10 millivolts).

All measurements, except turbidity, must be obtained using a flow-through-cell. Transparent flow-through-cells are preferred, because they allow field personnel to watch for particulate build-up within the cell. This build-up may affect indicator field parameter values measured within the cell and may also cause an underestimation of turbidity values measured after the cell. If the cell needs to be cleaned during purging operations, continue pumping and disconnect cell for cleaning, then reconnect after cleaning and continue monitoring activities.

The flow-through-cell must be designed in a way that prevents air bubble entrapment in the cell. When the pump is turned off or cycling on/off (when using a bladder pump), water in the cell must not drain out. Monitoring probes must be submerged in water at all times. If two flow-through-cells are used in series, the one containing the dissolved oxygen probe should come first (this parameter is most susceptible to error if air leaks into the system).

5. Collect Water Samples

Water samples for laboratory analyses must be collected before water has passed through the flow-through-cell (use a by-pass assembly or disconnect cell to obtain sample).

VOC samples should be collected first and directly into pre-preserved sample containers. Fill all sample containers by allowing the pump discharge to flow gently down the inside of the container with minimal turbulence.

During purging and sampling, the tubing should remain filled with water so as to minimize possible changes in water chemistry upon contact with the atmosphere. It is recommended that 1/4 inch or 3/8 inch (inside diameter) tubing be used to help insure that the sample tubing remains water filled. If the pump tubing is not completely filled to the sampling point, use one of the following procedures to collect samples: (1) add clamp, connector (Teflon or stainless steel) or valve to constrict sampling end of tubing; (2) insert small diameter Teflon tubing into water filled portion of pump tubing allowing the end to protrude beyond the end of the pump tubing, collect sample from small diameter tubing; (3) collect non-VOC samples first, then increase flow rate slightly until the water completely fills the tubing, collect sample and record new drawdown, flow rate and new indicator field parameter values.

Add preservative, as required by analytical methods, to samples immediately after they are collected if the sample containers are not pre-preserved. Check analytical methods (e.g. EPA SW-846, water supply, etc.) for additional information on preservation. Check pH for all samples requiring pH adjustment to assure proper pH value. For VOC samples, this will require that a test sample be collected during purging to determine the amount of preservative that needs to be added to the sample containers prior to sampling.

If determination of filtered metal concentrations is a sampling objective, collect filtered water samples using the same low flow procedures. The use of an in-line filter is required, and the filter size (0.45 um is commonly used) should be based on the sampling objective. Pre-rinse the filter with approximately 25 - 50 ml of ground water prior to sample collection. Preserve filtered water sample immediately. Note: filtered water samples are not an acceptable substitute for unfiltered samples when the monitoring objective is to obtain chemical concentrations of total mobile contaminants in ground water for human health risk calculations.

Label each sample as collected. Samples requiring cooling (volatile organics, cyanide, etc.) will be placed into a cooler with ice or refrigerant for delivery to the laboratory. Metal samples after acidification to a pH less than 2 do not need to be cooled.

6. Post Sampling Activities

If recording pressure transducer is used, remeasure water level with tape.

After collection of the samples, the pump tubing may either be dedicated to the well for resampling (by hanging the tubing inside the well), decontaminated, or properly discarded.

Before securing the well, measure and record the well depth (to 0.1 ft.), if not measured the day before purging began. Note: measurement of total well depth is optional after the initial low stress sampling event. However, it is recommended if the well has a "silting" problem or if confirmation of well identity is needed.

Secure the well.

V. DECONTAMINATION

Decontaminate sampling equipment prior to use in the first well and following sampling of each subsequent well. Pumps will not be removed between purging and sampling operations. The pump and tubing (including support cable and electrical wires which are in contact with the well) will be decontaminated by one of the procedures listed below.

Procedure 1

The decontaminating solutions can be pumped from either buckets or short PVC casing sections through the pump or the pump can be disassembled and flushed with the decontaminating solutions. It is recommended that detergent and isopropyl alcohol be used sparingly in the decontamination process and water flushing steps be extended to ensure that any sediment trapped in the pump is removed. The pump exterior and electrical wires must be rinsed with the decontaminating solutions, as well. The procedure is as follows:

Flush the equipment/pump with potable water.

Flush with non-phosphate detergent solution. If the solution is recycled, the solution must be changed periodically.

Flush with potable or distilled/deionized water to remove all of the detergent solution. If the water is recycled, the water must be changed periodically.

Flush with isopropyl alcohol (pesticide grade). If equipment blank data from the previous sampling event show that the level of contaminants is insignificant, then this step may be skipped.

Flush with distilled/deionized water. The final water rinse must not be recycled.

Procedure 2

Steam clean the outside of the submersible pump.

Pump hot potable water from the steam cleaner through the inside of the pump. This can be accomplished by placing the pump inside a three or four inch diameter PVC pipe with end cap. Hot water from the steam cleaner jet will be directed inside the PVC pipe and the pump exterior will be cleaned. The hot water from the steam cleaner will then be pumped from the PVC pipe through the pump and collected into another container. Note: additives or solutions should not be added to the steam cleaner.

Pump non-phosphate detergent solution through the inside of the pump. If the solution is recycled, the solution must be changed periodically.

Pump potable water through the inside of the pump to remove all of the detergent solution. If the solution is recycled, the solution must be changed periodically.

Pump distilled/deionized water through the pump. The final water rinse must not be recycled.

VI. FIELD QUALITY CONTROL

Quality control samples are required to verify that the sample collection and handling process has not compromised the quality of the ground water samples. All field quality control samples must be prepared the same as regular investigation samples with regard to sample volume, containers, and preservation. The following quality control samples shall be collected for each batch of samples (a batch may not exceed 20 samples). Trip blanks are required for the VOC samples at a frequency of one set per VOC sample cooler.

Field duplicate.

Matrix spike.

Matrix spike duplicate.

Equipment blank.

Trip blank (VOCs).

Temperature blank (one per sample cooler).

Equipment blank shall include the pump and the pump's tubing. If tubing is dedicated to the well, the equipment blank will only include the pump in subsequent sampling rounds.

Collect samples in order from wells with lowest contaminant concentration to highest concentration. Collect equipment blanks after sampling from contaminated wells and not after background wells.

Field duplicates are collected to determine precision of sampling procedure. For this procedure, collect duplicate for each analyte group in consecutive order (VOC original, VOC duplicate, SVOC original, SVOC duplicate, etc.).

If split samples are to be collected, collect split for each analyte group in consecutive order (VOC original, VOC split, etc.). Split sample should be as identical as possible to original sample.

All monitoring instrumentation shall be operated in accordance with EPA analytical methods and manufacturer's operating instructions. EPA analytical methods are listed in 40 CFR 136, 40 CFR 141, and SW-846 with exception of Eh, for which the manufacturer's instructions are to be followed. Instruments shall be calibrated at the beginning of each day. If a measurement falls outside the calibration range, the instrument should be re-calibrated so that all measurements fall within the calibration range. At the end of each day, check calibration to verify that instruments remained in calibration. Temperature measuring equipment, thermometers and thermistors, need not be calibrated to the above frequency. They should be checked for accuracy prior to field use according to EPA Methods and the manufacturer's instructions.

VII. FIELD LOGBOOK

A field log shall be kept to document all ground water field monitoring activities (see attached example matrix), and record all of the following:

Well identification.

Well depth, and measurement technique.

Static water level depth, date, time and measurement technique.

Presence and thickness of immiscible liquid (NAPL) layers and detection method.

Pumping rate, drawdown, indicator parameters values, and clock time, at the appropriate time intervals; calculated or measured total volume pumped.

Well sampling sequence and time of each sample collection.

Types of sample bottles used and sample identification numbers.

Preservatives used.

Parameters requested for analysis.

Field observations during sampling event.

Name of sample collector(s).

Weather conditions.

QA/QC data for field instruments.

Any problems encountered should be highlighted.

Description of all sampling equipment used, including trade names, model number, diameters, material composition, etc.

VIII. DATA REPORT

Data reports are to include laboratory analytical results, QA/QC information, and whatever field logbook information is needed to allow for a full evaluation of data usability.

EXAMPLE (Minimum Requirements)
Well PURGING-FIELD WATER QUALITY MEASUREMENTS FORM

Location (Site/Facility Name)____________________
Well Number__________Date____________________
Field Personnel____________________
Sampling Organization____________________
Identify MP____________________

Depth to (below MP) ______ top / ______ bottom of screen
Pump Intake at (ft. below MP)__________
Purging Device; (pump type)__________

Clock Time	Water Depth below MP	Pump Dial[1]	Purge Rate	Cum. Volume Purged	Temp.	Spec. Cond.[2]	pH	ORP/ Eh[3]	DO	Turb-idity	Comments
24 HR	ft		ml/min	liters	°C	mS/cm		mv	mg/L	NTU	

1. Pump dial setting (for example: hertz, cycles/min, etc.).
2. mSiemens per cm(same as mmhos/cm)at 25°C.
3. Oxidation reduction potential (stand in for Eh).

APPENDIX C

Low-Flow (Minimal Drawdown) Groundwater Sampling Procedures®

United States Environmental Protection Agency | Office of Research and Development | Office of Solid Waste and Emergency Response | EPA/540/S-95/504 April 1996

EPA Ground Water Issue

LOW-FLOW (MINIMAL DRAWDOWN) GROUND-WATER SAMPLING PROCEDURES

by Robert W. Puls[1] and Michael J. Barcelona[2]

Background

The Regional Superfund Ground Water Forum is a group of ground-water scientists, representing EPA's Regional Superfund Offices, organized to exchange information related to ground-water remediation at Superfund sites. One of the major concerns of the Forum is the sampling of ground water to support site assessment and remedial performance monitoring objectives. This paper is intended to provide background information on the development of low-flow sampling procedures and its application under a variety of hydrogeologic settings. It is hoped that the paper will support the production of standard operating procedures for use by EPA Regional personnel and other environmental professionals engaged in ground-water sampling.

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I. Introduction

The methods and objectives of ground-water sampling to assess water quality have evolved over time. Initially the emphasis was on the assessment of water quality of aquifers as sources of drinking water. Large water-bearing units were identified and sampled in keeping with that objective. These were highly productive aquifers that supplied drinking water via private wells or through public water supply systems. Gradually, with the increasing awareness of subsurface pollution of these water resources, the understanding of complex hydrogeochemical processes which govern the fate and transport of contaminants in the subsurface increased. This increase in understanding was also due to advances in a number of scientific disciplines and improvements in tools used for site characterization and ground-water sampling. Ground-water quality investigations where pollution was detected initially borrowed ideas, methods, and materials for site characterization from the water supply field and water analysis from public health practices. This included the materials and manner in which monitoring wells were installed and the way in which water was brought to the surface, treated, preserved and analyzed. The prevailing conceptual ideas included convenient generalizations of ground-water resources in terms of large and relatively homogeneous hydrologic *units*. With time it became apparent that conventional water supply generalizations of *homogeneity* did not adequately represent field data regarding pollution of these subsurface resources. The important role of *heterogeneity* became increasingly clear not only in geologic terms, but also in terms of complex physical,

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chemical and biological subsurface processes. With greater appreciation of the role of heterogeneity, it became evident that subsurface pollution was ubiquitous and encompassed the unsaturated zone to the deep subsurface and included unconsolidated sediments, fractured rock, and *aquitards* or low-yielding or impermeable formations. Small-scale processes and heterogeneities were shown to be important in identifying contaminant distributions and in controlling water and contaminant flow paths.

It is beyond the scope of this paper to summarize all the advances in the field of ground-water quality investigations and remediation, but two particular issues have bearing on ground-water sampling today: aquifer heterogeneity and colloidal transport. Aquifer heterogeneities affect contaminant flow paths and include variations in geology, geochemistry, hydrology and microbiology. As methods and the tools available for subsurface investigations have become increasingly sophisticated and understanding of the subsurface environment has advanced, there is an awareness that in most cases a primary concern for site investigations is characterization of contaminant flow paths rather than entire aquifers. In fact, in many cases, plume thickness can be less than well screen lengths (e.g., 3-6 m) typically installed at hazardous waste sites to detect and monitor plume movement over time. Small-scale differences have increasingly been shown to be important and there is a general trend toward smaller diameter wells and shorter screens.

The hydrogeochemical significance of colloidal-size particles in subsurface systems has been realized during the past several years (Gschwend and Reynolds, 1987; McCarthy and Zachara, 1989; Puls, 1990; Ryan and Gschwend, 1990). This realization resulted from both field and laboratory studies that showed faster contaminant migration over greater distances and at higher concentrations than flow and transport model predictions would suggest (Buddemeier and Hunt, 1988; Enfield and Bengtsson, 1988; Penrose et al., 1990). Such models typically account for interaction between the mobile aqueous and immobile solid phases, but do not allow for a mobile, reactive solid phase. It is recognition of this third *phase* as a possible means of contaminant transport that has brought increasing attention to the manner in which samples are collected and processed for analysis (Puls et al., 1990; McCarthy and Degueldre, 1993; Backhus et al., 1993; U. S. EPA, 1995). If such a phase is present in sufficient mass, possesses high sorption reactivity, large surface area, and remains stable in suspension, it can serve as an important mechanism to facilitate contaminant transport in many types of subsurface systems.

Colloids are particles that are sufficiently small so that the surface free energy of the particle dominates the bulk free energy. Typically, in ground water, this includes particles with diameters between 1 and 1000 nm. The most commonly observed mobile particles include: secondary clay minerals; hydrous iron, aluminum, and manganese oxides; dissolved and particulate organic materials, and viruses and bacteria. These reactive particles have been shown to be mobile under a variety of conditions in both field studies and laboratory column experiments, and as such need to be included in monitoring programs where identification of the *total* mobile contaminant loading (dissolved + naturally suspended particles) at a site is an objective. To that end, sampling methodologies must be used which do not artificially bias *naturally* suspended particle concentrations.

Currently the most common ground-water purging and sampling methodology is to purge a well using bailers or high speed pumps to remove 3 to 5 casing volumes followed by sample collection. This method can cause adverse impacts on sample quality through collection of samples with high levels of turbidity. This results in the inclusion of otherwise immobile artifactual particles which produce an overestimation of certain analytes of interest (e.g., metals or hydrophobic organic compounds). Numerous documented problems associated with filtration (Danielsson, 1982; Laxen and Chandler, 1982; Horowitz et al., 1992) make this an undesirable method of rectifying the turbidity problem, and include the removal of potentially mobile (contaminant-associated) particles during filtration, thus artificially biasing contaminant concentrations low. Sampling-induced turbidity problems can often be mitigated by using low-flow purging and sampling techniques.

Current subsurface conceptual models have undergone considerable refinement due to the recent development and increased use of field screening tools. So-called hydraulic *push* technologies (e.g., cone penetrometer, Geoprobe®, QED HydroPunch®) enable relatively fast screening site characterization which can then be used to design and install a monitoring well network. Indeed, alternatives to conventional monitoring wells are now being considered for some hydrogeologic settings. The ultimate design of any monitoring system should however be based upon adequate site characterization and be consistent with established monitoring objectives.

If the sampling program objectives include accurate assessment of the magnitude and extent of subsurface contamination over time and/or accurate assessment of subsequent remedial performance, then some information regarding plume delineation in three-dimensional space is necessary prior to monitoring well network design and installation. This can be accomplished with a variety of different tools and equipment ranging from hand-operated augers to screening tools mentioned above and large drilling rigs. Detailed information on ground-water flow velocity, direction, and horizontal and vertical variability are essential baseline data requirements. Detailed soil and geologic data are required prior to and during the installation of sampling points. This includes historical as well as detailed soil and geologic logs which accumulate during the site investigation. The use of borehole geophysical techniques is also recommended. With this information (together with other site characterization data) and a clear understanding of sampling objectives, then appropriate location, screen length, well diameter, slot size, etc. for the monitoring well network can be decided. This is especially critical for new in situ remedial approaches or natural attenuation assessments at hazardous waste sites.

In general, the overall goal of any ground-water sampling program is to collect water samples with no alteration in water chemistry; analytical data thus obtained may be used for a variety of specific monitoring programs depending on the regulatory requirements. The sampling methodology described in this paper assumes that the monitoring goal is to sample monitoring wells for the presence of contaminants and it is applicable whether mobile colloids are a concern or not and whether the analytes of concern are metals (and metalloids) or organic compounds.

II. Monitoring Objectives and Design Considerations

The following issues are important to consider prior to the design and implementation of any ground-water monitoring program, including those which anticipate using low-flow purging and sampling procedures.

A. Data Quality Objectives (DQOs)

Monitoring objectives include four main types: detection, assessment, corrective-action evaluation and resource evaluation, along with *hybrid* variations such as site-assessments for property transfers and water availability investigations. Monitoring objectives may change as contamination or water quality problems are discovered. However, there are a number of common components of monitoring programs which should be recognized as important regardless of initial objectives. These components include:

1) Development of a conceptual model that incorporates elements of the regional geology to the local geologic framework. The conceptual model development also includes initial site characterization efforts to identify hydrostratigraphic units and likely flow-paths using a minimum number of borings and well completions;

2) Cost-effective and well documented collection of high quality data utilizing simple, accurate, and reproducible techniques; and

3) Refinement of the conceptual model based on supplementary data collection and analysis.

These fundamental components serve many types of monitoring programs and provide a basis for future efforts that evolve in complexity and level of spatial detail as purposes and objectives expand. High quality, reproducible data collection is a common goal regardless of program objectives.

High quality data collection implies data of sufficient accuracy, precision, and completeness (i.e., ratio of valid analytical results to the minimum sample number called for by the program design) to meet the program objectives. Accuracy depends on the correct choice of monitoring tools and procedures to minimize sample and subsurface disturbance from collection to analysis. Precision depends on the repeatability of sampling and analytical protocols. It can be assured or improved by replication of sample analyses including blanks, field/lab standards and reference standards.

B. Sample Representativeness

An important goal of any monitoring program is collection of data that is truly representative of conditions at the site. The term *representativeness* applies to chemical and hydrogeologic data collected via wells, borings, piezometers, geophysical and soil gas measurements, lysimeters, and temporary sampling points. It involves a recognition of the statistical variability of individual subsurface physical properties, and contaminant or major ion concentration levels, while explaining extreme values. Subsurface temporal and spatial variability are facts. Good professional practice seeks to maximize representativeness by using proven accurate and reproducible techniques to define limits on the distribution of measurements collected at a site. However, measures of representativeness are dynamic and are controlled by evolving site characterization and monitoring objectives. An evolutionary site characterization model, as shown in Figure 1, provides a systematic approach to the goal of consistent data collection.

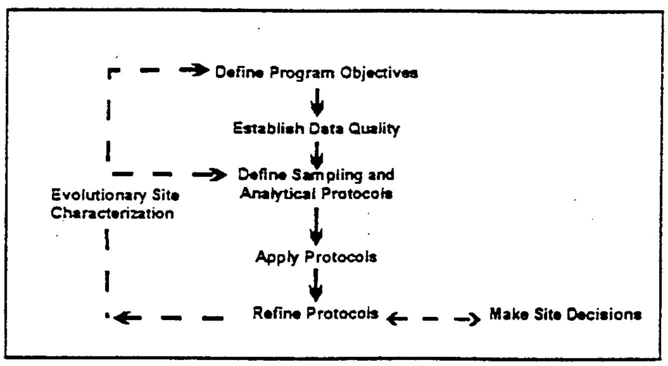

Figure 1. Evolutionary Site Characterization Model

The model emphasizes a recognition of the causes of the variability (e.g., use of inappropriate technology such as using bailers to purge wells; imprecise or operator-dependent methods) and the need to control avoidable errors.

1) Questions of Scale

A sampling plan designed to collect representative samples must take into account the potential scale of changes in site conditions through space and time as well as the chemical associations and behavior of the parameters that are targeted for investigation. In subsurface systems, physical (i.e., aquifer) and chemical properties over time or space are not statistically independent. In fact, samples taken in close proximity (i.e., within distances of a few meters) or within short time periods (i.e., more frequently than monthly) are highly auto-correlated. This means that designs employing high-sampling frequency (e.g., monthly) or dense spatial monitoring designs run the risk of redundant data collection and misleading inferences regarding trends in values that aren't statistically valid. In practice, contaminant detection and assessment monitoring programs rarely suffer these *over-sampling* concerns. In corrective-action evaluation programs, it is also possible that too little data may be collected over space or time. In these cases, false interpretation of the spatial extent of contamination or underestimation of temporal concentration variability may result.

2) Target Parameters

Parameter selection in monitoring program design is most often dictated by the regulatory status of the site. However, background water quality constituents, purging indicator parameters, and contaminants, all represent targets for data collection programs. The tools and procedures used in these programs should be equally rigorous and applicable to all categories of data, since all may be needed to determine or support regulatory action.

C. Sampling Point Design and Construction

Detailed site characterization is central to all decision-making purposes and the basis for this characterization resides in identification of the geologic framework and major hydro-stratigraphic units. Fundamental data for sample point location include: subsurface lithology, head-differences and background geochemical conditions. Each sampling point has a proper use or uses which should be documented at a level which is appropriate for the program's data quality objectives. Individual sampling points may not always be able to fulfill multiple monitoring objectives (e.g., detection, assessment, corrective action).

1) Compatibility with Monitoring Program and Data Quality Objectives

Specifics of sampling point location and design will be dictated by the complexity of subsurface lithology and variability in contaminant and/or geochemical conditions. It should be noted that, regardless of the ground-water sampling approach, few sampling points (e.g., wells, drive-points, screened augers) have zones of influence in excess of a few feet. Therefore, the spatial frequency of sampling points should be carefully selected and designed.

2) Flexibility of Sampling Point Design

In most cases *well-point* diameters in excess of 1 7/8 inches will permit the use of most types of submersible pumping devices for low-flow (minimal drawdown) sampling. It is suggested that *short* (e.g., less than 1.6 m) screens be incorporated into the monitoring design where possible so that comparable results from one device to another might be expected. *Short*, of course, is relative to the degree of vertical water quality variability expected at a site.

3) Equilibration of Sampling Point

Time should be allowed for equilibration of the well or sampling point with the formation after installation. Placement of well or sampling points in the subsurface produces some disturbance of ambient conditions. Drilling techniques (e.g., auger, rotary, etc.) are generally considered to cause more disturbance than *direct-push* technologies. In either case, there may be a period (i.e., days to months) during which water quality near the point may be distinctly different from that in the formation. Proper development of the sampling point and adjacent formation to remove fines created during emplacement will shorten this water quality *recovery* period.

III. Definition of Low-Flow Purging and Sampling

It is generally accepted that water in the well casing is non-representative of the formation water and needs to be purged prior to collection of ground-water samples. However, the water in the screened interval may indeed be representative of the formation, depending upon well construction and site hydrogeology. Wells are purged to some extent for the following reasons: the presence of the air interface at the top of the water column resulting in an oxygen concentration gradient with depth, loss of volatiles up the water column, leaching from or sorption to the casing or filter pack, chemical changes due to clay seals or backfill, and surface infiltration.

Low-flow purging, whether using portable or dedicated systems, should be done using pump-intake located in the middle or slightly above the middle of the screened interval. Placement of the pump too close to the bottom of the well will cause increased entrainment of solids which have collected in the well over time. These particles are present as a result of well development, prior purging and sampling events, and natural colloidal transport and deposition. Therefore, placement of the pump in the middle or toward the top of the screened interval is suggested. Placement of the pump at the top of the water column for sampling is only recommended in unconfined aquifers, screened across the water table, where this is the desired sampling point. Low-flow purging has the advantage of minimizing mixing between the overlying stagnant casing water and water within the screened interval.

A. Low-Flow Purging and Sampling

Low-flow refers to the velocity with which water enters the pump intake and that is imparted to the formation pore water in the immediate vicinity of the well screen. It does not necessarily refer to the flow rate of water discharged at the surface which can be affected by flow regulators or restrictions. Water level drawdown provides the best indication of the stress imparted by a given flow-rate for a given hydrological situation. The objective is to pump in a manner that minimizes stress (drawdown) to the system to the extent practical taking into account established site sampling objectives. Typically, flow rates on the order of 0.1 - 0.5 L/min are used, however this is dependent on site-specific hydrogeology. Some extremely coarse-textured formations have been successfully sampled in this manner at flow rates to 1 L/min. The effectiveness of using low-flow purging is intimately linked with proper screen location, screen length, and well construction and development techniques. The reestablishment of natural flow paths in both the vertical and horizontal directions is important for correct interpretation of the data. For high resolution sampling needs, screens less than 1 m should be used. Most of the need for purging has been found to be due to passing the sampling device through the overlying casing water which causes mixing of these stagnant waters and the dynamic waters within the screened interval. Additionally, there is disturbance to suspended sediment collected in the bottom of the casing and the displacement of water out into the formation immediately adjacent to the well screen. These disturbances and impacts can be avoided using dedicated sampling equipment, which precludes the need to insert the sampling device prior to purging and sampling.

Isolation of the screened interval water from the overlying stagnant casing water may be accomplished using low-flow minimal drawdown techniques. If the pump intake is located within the screened interval, most of the water pumped will be drawn in directly from the formation with little mixing of casing water or disturbance to the sampling zone. However, if the wells are not constructed and developed properly, zones other than those intended may be sampled. At some sites where geologic heterogeneities are sufficiently different within the screened interval, higher conductivity zones may be preferentially sampled. This is another reason to use shorter screened intervals, especially where high spatial resolution is a sampling objective.

B. Water Quality Indicator Parameters

It is recommended that water quality indicator parameters be used to determine purging needs prior to sample collection in each well. Stabilization of parameters such as pH, specific conductance, dissolved oxygen, oxidation-reduction potential, temperature and turbidity should be used to determine when formation water is accessed during purging. In general, the order of stabilization is pH, temperature, and specific conductance, followed by oxidation-reduction potential, dissolved oxygen and turbidity. Temperature and pH, while commonly used as purging indicators, are actually quite insensitive in distinguishing between formation water and stagnant casing water; nevertheless, these are important parameters for data interpretation purposes and should also be measured. Performance criteria for determination of stabilization should be based on water-level drawdown, pumping rate and equipment specifications for measuring indicator parameters. Instruments are available which utilize in-line flow cells to continuously measure the above parameters.

It is important to establish specific well stabilization criteria and then consistently follow the same methods thereafter, particularly with respect to drawdown, flow rate and sampling device. Generally, the time or purge volume required for parameter stabilization is independent of well depth or well volumes. Dependent variables are well diameter, sampling device, hydrogeochemistry, pump flow rate, and whether the devices are used in a portable or dedicated manner. If the sampling device is already in place (i.e., dedicated sampling systems), then the time and purge volume needed for stabilization is much shorter. Other advantages of dedicated equipment include less purge water for waste disposal, much less decontamination of equipment, less time spent in preparation of sampling as well as time in the field, and more consistency in the sampling approach which probably will translate into less variability in sampling results. The use of dedicated equipment is strongly recommended at wells which will undergo routine sampling over time.

If parameter stabilization criteria are too stringent, then minor oscillations in indicator parameters may cause purging operations to become unnecessarily protracted. It should also be noted that turbidity is a very conservative parameter in terms of stabilization. Turbidity is always the last parameter to stabilize. Excessive purge times are invariably related to the establishment of too stringent turbidity stabilization criteria. It should be noted that natural turbidity levels in ground water may exceed 10 nephelometric turbidity units (NTU).

C. Advantages and Disadvantages of Low-Flow (Minimum Drawdown) Purging

In general, the advantages of low-flow purging include:

- samples which are representative of the *mobile* load of contaminants present (dissolved and colloid-associated);
- minimal disturbance of the sampling point thereby minimizing sampling artifacts;
- less operator variability, greater operator control;

- reduced stress on the formation (minimal drawdown);
- less mixing of stagnant casing water with formation water;
- reduced need for filtration and, therefore, less time required for sampling;
- smaller purging volume which decreases waste disposal costs and sampling time;
- better sample consistency; reduced artificial sample variability.

Some disadvantages of low-flow purging are:
- higher initial capital costs,
- greater set-up time in the field,
- need to transport additional equipment to and from the site,
- increased training needs,
- resistance to change on the part of sampling practitioners,
- concern that new data will indicate a *change in conditions* and trigger an *action.*

IV. Low-Flow (Minimal Drawdown) Sampling Protocols

The following ground-water sampling procedure has evolved over many years of experience in ground-water sampling for organic and inorganic compound determinations and as such summarizes the authors' (and others) experiences to date (Barcelona et al., 1984, 1994; Barcelona and Helfrich, 1986; Puls and Barcelona, 1989; Puls et. al. 1990, 1992; Puls and Powell, 1992; Puls and Paul, 1995). High-quality chemical data collection is essential in ground-water monitoring and site characterization. The primary limitations to the collection of *representative* ground-water samples include: mixing of the stagnant casing and *fresh* screen waters during insertion of the sampling device or ground-water level measurement device; disturbance and resuspension of settled solids at the bottom of the well when using high pumping rates or raising and lowering a pump or bailer; introduction of atmospheric gases or degassing from the water during sample handling and transfer, or inappropriate use of vacuum sampling device, etc.

A. Sampling Recommendations

Water samples should not be taken immediately following well development. Sufficient time should be allowed for the ground-water flow regime in the vicinity of the monitoring well to stabilize and to approach chemical equilibrium with the well construction materials. This lag time will depend on site conditions and methods of installation but often exceeds one week.

Well purging is nearly always necessary to obtain samples of water flowing through the geologic formations in the screened interval. Rather than using a general but arbitrary guideline of purging three casing volumes prior to sampling, it is recommended that an in-line water quality measurement device (e.g., flow-through cell) be used to establish the stabilization time for several parameters (e.g., pH, specific conductance, redox, dissolved oxygen, turbidity) on a well-specific basis. Data on pumping rate, drawdown, and volume required for parameter stabilization can be used as a guide for conducting subsequent sampling activities.

The following are recommendations to be considered before, during and after sampling:
- use low-flow rates (<0.5 L/min), during both purging and sampling to maintain minimal drawdown in the well;
- maximize tubing wall thickness, minimize tubing length;
- place the sampling device intake at the desired sampling point;
- minimize disturbances of the stagnant water column above the screened interval during water level measurement and sampling device insertion;
- make proper adjustments to stabilize the flow rate as soon as possible;
- monitor water quality indicators during purging;
- collect unfiltered samples to estimate contaminant loading and transport potential in the subsurface system.

B. Equipment Calibration

Prior to sampling, all sampling device and monitoring equipment should be calibrated according to manufacturer's recommendations and the site Quality Assurance Project Plan (QAPP) and Field Sampling Plan (FSP). Calibration of pH should be performed with at least two buffers which bracket the expected range. Dissolved oxygen calibration must be corrected for local barometric pressure readings and elevation.

C. Water Level Measurement and Monitoring

It is recommended that a device be used which will least disturb the water surface in the casing. Well depth should be obtained from the well logs. Measuring to the bottom of the well casing will only cause resuspension of settled solids from the formation and require longer purging times for turbidity equilibration. Measure well depth after sampling is completed. The water level measurement should be taken from a permanent reference point which is surveyed relative to ground elevation.

D. Pump Type

The use of low-flow (e.g., 0.1-0.5 L/min) pumps is suggested for purging and sampling all types of analytes. All pumps have some limitation and these should be investigated with respect to application at a particular site. Bailers are inappropriate devices for low-flow sampling.

1) General Considerations

There are no unusual requirements for ground-water sampling devices when using low-flow, minimal drawdown techniques. The major concern is that the device give consistent results and minimal disturbance of the sample across a range of *low* flow rates (i.e., < 0.5 L/min). Clearly, pumping rates that cause minimal to no drawdown in one well could easily cause *significant* drawdown in another well finished in a less transmissive formation. In this sense, the pump should not cause undue pressure or temperature changes or physical disturbance on the water sample over a reasonable sampling range. Consistency in operation is critical to meet accuracy and precision goals.

2) Advantages and Disadvantages of Sampling Devices

A variety of sampling devices are available for low-flow (minimal drawdown) purging and sampling and include peristaltic pumps, bladder pumps, electrical submersible pumps, and gas-driven pumps. Devices which lend themselves to both dedication and consistent operation at definable low-flow rates are preferred. It is desirable that the pump be easily adjustable and operate reliably at these lower flow rates. The peristaltic pump is limited to shallow applications and can cause degassing resulting in alteration of pH, alkalinity, and some volatiles loss. Gas-driven pumps should be of a type that does not allow the gas to be in direct contact with the sampled fluid.

Clearly, bailers and other *grab* type samplers are ill-suited for low-flow sampling since they will cause repeated disturbance and mixing of *stagnant* water in the casing and the *dynamic* water in the screened interval. Similarly, the use of inertial lift foot-valve type samplers may cause too much disturbance at the point of sampling. Use of these devices also tends to introduce uncontrolled and unacceptable operator variability.

Summaries of advantages and disadvantages of various sampling devices are listed in Herzog et al. (1991), U. S. EPA (1992), Parker (1994) and Thurnblad (1994).

E. Pump Installation

Dedicated sampling devices (left in the well) capable of pumping and sampling are preferred over <u>any</u> other type of device. Any portable sampling device should be slowly and carefully lowered to the middle of the screened interval or slightly above the middle (e.g., 1-1.5 m below the top of a 3 m screen). This is to minimize excessive mixing of the stagnant water in the casing above the screen with the screened interval zone water, and to minimize resuspension of solids which will have collected at the bottom of the well. These two disturbance effects have been shown to directly affect the time required for purging. There also appears to be a direct correlation between size of portable sampling devices relative to the well bore and resulting purge volumes and times. The key is to minimize disturbance of water and solids in the well casing.

F. Filtration

Decisions to filter samples should be dictated by sampling objectives rather than as a *fix* for poor sampling practices, and field-filtering of certain constituents should not be the default. Consideration should be given as to what the application of field-filtration is trying to accomplish. For assessment of truly dissolved (as opposed to operationally *dissolved* [i.e., samples filtered with 0.45 μm filters]) concentrations of major ions and trace metals, 0.1 μm filters are recommended although 0.45 μm filters are normally used for most regulatory programs. Alkalinity samples must also be filtered if significant particulate calcium carbonate is suspected, since this material is likely to impact alkalinity titration results (although filtration itself may alter the CO_2 composition of the sample and, therefore, affect the results).

Although filtration may be appropriate, filtration of a sample may cause a number of unintended changes to occur (e.g. oxidation, aeration) possibly leading to filtration-induced artifacts during sample analysis and uncertainty in the results. Some of these unintended changes may be unavoidable but the factors leading to them must be recognized. Deleterious effects can be minimized by consistent application of certain filtration guidelines. Guidelines should address selection of filter type, media, pore size, etc. in order to identify and minimize potential sources of uncertainty when filtering samples.

In-line filtration is recommended because it provides better consistency through less sample handling, and minimizes sample exposure to the atmosphere. In-line filters are available in both disposable (barrel filters) and non-disposable (in-line filter holder, flat membrane filters) formats and various filter pore sizes (0.1-5.0 μm). Disposable filter cartridges have the advantage of greater sediment handling capacity when compared to traditional membrane filters. Filters must be pre-rinsed following manufacturer's recommendations. If there are no recommendations for rinsing, pass through a minimum of 1 L of ground water following purging and prior to sampling. Once filtration has begun, a filter cake may develop as particles larger than the pore size accumulate on the filter membrane. The result is that the effective pore diameter of the membrane is reduced and particles smaller than the stated pore size are excluded from the filtrate. Possible corrective measures include prefiltering (with larger pore size filters), minimizing particle loads to begin with, and reducing sample volume.

G. Monitoring of Water Level and Water Quality Indicator Parameters

Check water level periodically to monitor drawdown in the well as a guide to flow rate adjustment. The goal is minimal drawdown (<0.1 m) during purging. This goal may be difficult to achieve under some circumstances due to geologic heterogeneities within the screened interval, and may require adjustment based on site-specific conditions and personal experience. In-line water quality indicator parameters should be continuously monitored during purging. The water quality indicator parameters monitored can include pH, redox potential, conductivity, dissolved oxygen (DO) and turbidity. The last three parameters are often most sensitive. Pumping rate, drawdown, and the time or volume required to obtain stabilization of parameter readings can be used as a future guide to purge the well. Measurements should be taken every three to five minutes if the above suggested rates are used. Stabilization is achieved after all parameters have stabilized for three successive readings. In lieu of measuring all five parameters, a minimum subset would include pH, conductivity, and turbidity or DO. Three successive readings should be within ± 0.1 for pH, ± 3% for conductivity, ± 10 mv for redox potential, and ± 10% for turbidity and DO. Stabilized purge indicator parameter trends are generally obvious and follow either an exponential or asymptotic change to stable values during purging. Dissolved oxygen and turbidity usually require the longest time for stabilization. The above stabilization guidelines are provided for rough estimates based on experience.

H. Sampling, Sample Containers, Preservation and Decontamination

Upon parameter stabilization, sampling can be initiated. If an in-line device is used to monitor water quality parameters, it should be disconnected or bypassed during sample collection. Sampling flow rate may remain at established purge rate or may be adjusted slightly to minimize aeration, bubble formation, turbulent filling of sample bottles, or loss of volatiles due to extended residence time in tubing. Typically, flow rates less than 0.5 L/min are appropriate. The same device should be used for sampling as was used for purging. Sampling should occur in a progression from least to most contaminated well, if this is known. Generally, volatile (e.g., solvents and fuel constituents) and gas sensitive (e.g., Fe^{2+}, CH_4, H_2S/HS^-, alkalinity) parameters should be sampled first. The sequence in which samples for most inorganic parameters are collected is immaterial unless filtered (dissolved) samples are desired. Filtering should be done last and in-line filters should be used as discussed above. During both well purging and sampling, proper protective clothing and equipment must be used based upon the type and level of contaminants present.

The appropriate sample container will be prepared in advance of actual sample collection for the analytes of interest and include sample preservative where necessary. Water samples should be collected directly into this container from the pump tubing.

Immediately after a sample bottle has been filled, it must be preserved as specified in the site (QAPP). Sample preservation requirements are based on the analyses being performed (use site QAPP, FSP, RCRA guidance document [U. S. EPA, 1992] or EPA SW-846 [U. S. EPA, 1982]). It may be advisable to add preservatives to sample bottles in a controlled setting prior to entering the field in order to reduce the chances of improperly preserving sample bottles or introducing field contaminants into a sample bottle while adding the preservatives.

The preservatives should be transferred from the chemical bottle to the sample container using a disposable polyethylene pipet and the disposable pipet should be used only once and then discarded.

After a sample container has been filled with ground water, a Teflon™ (or tin)-lined cap is screwed on tightly to prevent the container from leaking. A sample label is filled out as specified in the FSP. The samples should be stored inverted at 4°C.

Specific decontamination protocols for sampling devices are dependent to some extent on the type of device used and the type of contaminants encountered. Refer to the site QAPP and FSP for specific requirements.

I. Blanks

The following blanks should be collected:

(1) field blank: one field blank should be collected from each source water (distilled/deionized water) used for sampling equipment decontamination or for assisting well development procedures.

(2) equipment blank: one equipment blank should be taken prior to the commencement of field work, from each set of sampling equipment to be used for that day. Refer to site QAPP or FSP for specific requirements.

(3) trip blank: a trip blank is required to accompany each volatile sample shipment. These blanks are prepared in the laboratory by filling a 40-mL volatile organic analysis (VOA) bottle with distilled/deionized water.

V. Low-Permeability Formations and Fractured Rock

The overall sampling program goals or sampling objectives will drive how the sampling points are located, installed, and choice of sampling device. Likewise, site-specific hydrogeologic factors will affect these decisions. Sites with very low permeability formations or fractures causing discrete flow channels may require a unique monitoring approach. Unlike water supply wells, wells installed for ground-water quality assessment and restoration programs are often installed in low water-yielding settings (e.g., clays, silts). Alternative types of sampling points and sampling methods are often needed in these types of environments, because low-permeability settings may require extremely low-flow purging (<0.1 L/min) and may be technology-limited. Where devices are not readily available to pump at such low flow rates, the primary consideration is to avoid dewatering of the well screen. This may require repeated recovery of the water during purging while leaving the pump in place within the well screen.

Use of low-flow techniques may be impractical in these settings, depending upon the water recharge rates. The sampler and the end-user of data collected from such wells need to understand the limitations of the data collected; i.e., a strong potential for underestimation of actual contaminant concentrations for volatile organics, potential false negatives for filtered metals and potential false positives for unfiltered metals. It is suggested that comparisons be made between samples recovered using low-flow purging techniques and samples recovered using passive sampling techniques (i.e., two sets of samples). Passive sample collection would essentially entail acquisition of the sample with no or very little purging using a dedicated sampling system installed within the screened interval or a passive sample collection device.

A. Low-Permeability Formations (<0.1 L/min recharge)

1. Low-Flow Purging and Sampling with Pumps

   a. "portable or non-dedicated mode" - Lower the pump (one capable of pumping at <0.1 L/min) to mid-screen or slightly above and set in place for minimum of 48 hours (to lessen purge volume requirements). After 48 hours, use procedures listed in Part IV above regarding monitoring water quality parameters for stabilization, etc., but do not dewater the screen. If excessive drawdown and slow recovery is a problem, then alternate approaches such as those listed below may be better.

   b. "dedicated mode" - Set the pump as above at least a week prior to sampling; that is, operate in a dedicated pump mode. With this approach significant reductions in purge volume should be realized. Water quality parameters should stabilize quite rapidly due to less disturbance of the sampling zone.

2. Passive Sample Collection

Passive sampling collection requires insertion of the device into the screened interval for a sufficient time period to allow flow and sample equilibration before extraction for analysis. Conceptually, the extraction of water from low yielding formations seems more akin to the collection of water from the unsaturated zone and passive sampling techniques may be more appropriate in terms of obtaining "representative" samples. Satisfying usual sample volume requirements is typically a problem with this approach and some latitude will be needed on the part of regulatory entities to achieve sampling objectives.

B. Fractured Rock

In fractured rock formations, a low-flow to zero purging approach using pumps in conjunction with packers to isolate the sampling zone in the borehole is suggested. Passive multi-layer sampling devices may also provide the most "representative" samples. It is imperative in these settings to identify flow paths or water-producing fractures prior to sampling using tools such as borehole flowmeters and/or other geophysical tools.

After identification of water-bearing fractures, install packer(s) and pump assembly for sample collection using low-flow sampling in "dedicated mode" or use a passive sampling device which can isolate the identified water-bearing fractures.

VI. Documentation

The usual practices for documenting the sampling event should be used for low-flow purging and sampling techniques. This should include, at a minimum: information on the conduct of purging operations (flow-rate, drawdown, water-quality parameter values, volumes extracted and times for measurements), field instrument calibration data, water sampling forms and chain of custody forms. See Figures 2 and 3 and "Ground Water Sampling Workshop -- A Workshop Summary" (U. S. EPA, 1995) for example forms and other documentation suggestions and information. This information coupled with laboratory analytical data and validation data are needed to judge the "useability" of the sampling data.

VII. Notice

The U.S. Environmental Protection Agency through its Office of Research and Development funded and managed the research described herein as part of its in-house research program and under Contract No. 68-C4-0031 to Dynamac Corporation. It has been subjected to the Agency's peer and administrative review and has been approved for publication as an EPA document. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

VIII. References

Backhus, D.A., J.N. Ryan, D.M. Groher, J.K. McFarlane, and P.M. Gschwend. 1993. Sampling Colloids and Colloid-Associated Contaminants in Ground Water. *Ground Water*, 31(3):466-479.

Barcelona, M.J., J.A. Helfrich, E.E. Garske, and J.P. Gibb. 1984. A laboratory evaluation of groundwater sampling mechanisms. *Ground Water Monitoring Review*, 4(2):32-41.

Barcelona, M.J. and J.A. Helfrich. 1986. Well construction and purging effects on ground-water samples. *Environ. Sci. Technol.*, 20(11):1179-1184.

Barcelona, M.J., H.A. Wehrmann, and M.D. Varljen. 1994. Reproducible well purging procedures and VOC stabilization criteria for ground-water sampling. *Ground Water*, 32(1):12-22.

Buddemeier, R.W. and J.R. Hunt. 1988. Transport of Colloidal Contaminants in Ground Water: Radionuclide Migration at the Nevada Test Site. *Applied Geochemistry*, 3: 535-548.

Danielsson, L.G. 1982. On the Use of Filters for Distinguishing Between Dissolved and Particulate Fractions in Natural Waters. *Water Research*, 16:179.

Enfield, C.G. and G. Bengtsson. 1988. Macromolecular Transport of Hydrophobic Contaminants in Aqueous Environments. *Ground Water*, 26(1): 64-70.

Gschwend, P.M. and M.D. Reynolds. 1987. Monodisperse Ferrous Phosphate Colloids in an Anoxic Groundwater Plume, *J. of Contaminant Hydrol.*, 1: 309-327.

Herzog, B., J. Pennino, and G. Nielsen. 1991. Ground-Water Sampling. In **Practical Handbook of Ground-Water Monitoring** (D.M. Nielsen, ed.). Lewis Publ., Chelsea, MI, pp. 449-499.

Horowitz, A.J., K.A. Elrick, and M.R. Colberg. 1992. The effect of membrane filtration artifacts on dissolved trace element concentrations. *Water Res.*, 26(6):753-763.

Laxen, D.P.H. and I.M. Chandler. 1982. Comparison of Filtration Techniques for Size Distribution in Freshwaters. *Analytical Chemistry*, 54(8):1350.

McCarthy, J.F. and J.M. Zachara. 1989. Subsurface Transport of Contaminants, *Environ. Sci. Technol.*, 5(23):496-502.

McCarthy, J.F. and C. Degueldre. 1993. Sampling and Characterization of Colloids and Ground Water for Studying Their Role in Contaminant Transport. In: Environmental Particles (J. Buffle and H.P. van Leeuwen, eds.), Lewis Publ., Chelsea, MI, pp. 247-315.

Parker, L.V. 1994. The Effects of Ground Water Sampling Devices on Water Quality: A Literature Review. *Ground Water Monitoring and Remediation*, 14(2):130-141.

Penrose, W.R., W.L. Polzer, E.H. Essington, D.M. Nelson, and K.A. Orlandini. 1990. Mobility of Plutonium and Americium through a Shallow Aquifer in a Semiarid Region, *Environ. Sci. Technol.*, 24:228-234.

Puls, R.W. and M.J. Barcelona. 1989. Filtration of Ground Water Samples for Metals Analyses. *Hazardous Waste and Hazardous Materials*, 6(4):385-393.

Puls, R.W., J.H. Eychaner, and R.M. Powell. 1990. Colloidal-Facilitated Transport of Inorganic Contaminants in Ground Water: Part I. Sampling Considerations. EPA/600/M-90/023, NTIS PB 91-168419.

Puls, R.W. 1990. Colloidal Considerations in Groundwater Sampling and Contaminant Transport Predictions. *Nuclear Safety*, 31(1):58-65.

Puls, R.W. and R.M. Powell. 1992. Acquisition of Representative Ground Water Quality Samples for Metals. *Ground Water Monitoring Review*, 12(3):167-176.

Puls, R.W., D.A. Clark, B.Bledsoe, R.M. Powell, and C.J. Paul. 1992. Metals in Ground Water: Sampling Artifacts and Reproducibility. *Hazardous Waste and Hazardous Materials*, 9(2): 149-162.

Puls, R.W. and C.J. Paul. 1995. Low-Flow Purging and Sampling of Ground-Water Monitoring Wells with Dedicated Systems. *Ground Water Monitoring and Remediation*, 15(1):116-123.

Ryan, J.N. and P.M. Gschwend. 1990. Colloid Mobilization in Two Atlantic Coastal Plain Aquifers. *Water Resour. Res.*, 26: 307-322.

Thurnblad, T. 1994. Ground Water Sampling Guidance: Development of Sampling Plans, Sampling Protocols, and Sampling Reports. Minnesota Pollution Control Agency.

U. S. EPA. 1992. RCRA Ground-Water Monitoring: Draft Technical Guidance. Office of Solid Waste, Washington, DC EPA/530/R-93/001, NTIS PB 93-139350.

U. S. EPA. 1995. Ground Water Sampling Workshop -- A Workshop Summary, Dallas, TX, November 30 - December 2, 1993. EPA/600/R-94/205, NTIS PB 95-193249, 126 pp.

U. S. EPA. 1982. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, EPA SW-846. Office of Solid Waste and Emergency Response, Washington, D.C.

Figure 2. **Ground Water Sampling Log**

Project ______________ **Site** ______________ **Well No.** ____________ **Date** ______________________

Well Depth ___________ **Screen Length** _________ **Well Diameter** ________ **Casing Type** ___________

Sampling Device ______________ **Tubing type** _________________ **Water Level** _______________

Measuring Point _________________ **Other Infor** ______________________________________

____

Sampling Personnel ____

Time	pH	Temp	Cond.	Dis.O_2	Turb.	[ ]Conc.			Notes

Type of Samples Collected

____

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft: $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi\ r^3$

Figure 3. **Ground Water Sampling Log** (with automatic data logging for most water quality parameters)

Project ______________ **Site** ______________ **Well No.** ____________ **Date** ______________
Well Depth ____________ **Screen Length** __________ **Well Diameter** _________ **Casing Type** ____________
Sampling Device ______________ **Tubing type** ____________________ **Water Level** ____________
Measuring Point ________________ **Other Infor** ________________________________

Sampling Personnel ____

Time	Pump Rate	Turbidity	Alkalinity	[ ] Conc	Notes

Type of Samples Collected

____

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft: $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

APPENDIX D

YSI Model 6820 Water Quality Tester
Specifications and Calibration Procedures

6. Sonde Setup

6.1 Description

All menus described in this chapter adjust the operation of the connected sonde. Absolutely **no** information about any sonde is maintained inside the 610. When you first enter **any** of these menus, the 610 displays a "please wait" message while it reads information out of the sonde. It is easiest to think of these menus as directly manipulating variables inside the attached sonde.

6.2 Sensors and Parameters

In the YSI product line, "sensor" refers to a physical piece of sensing hardware, and "parameter" refers to a calculation which can be derived from one or more sensors. Thus temperature is a physical sensor, but salinity is a calculated parameter derived from a temperature sensor and conductivity sensor. More subtly, temperature in Celsius is a parameter derived from a physical temperature sensor. As a rule, sensors never have units attached, and parameters always have units attached.

The Sensors and Parameters menus of the 610 allow you to display or change the active sensors and parameters in the sonde. You will rarely find yourself in the Sensors menu (except when you first purchase a sonde). And you will only occasionally use the Parameters menu.

The Sensors and Parameters menus are each entered through the Main menu. They have a similar format to each other. To select or deselect an item, just highlight it and press Enter.

Warning: The Sensors menu tells a sonde what hardware it is equipped with. Be careful, the 610 and sonde will believe whatever you tell them here. This is not a danger in the Parameters menu, whose list only includes items which can be derived from the sensors you already selected.

6.3 Calibration

Most real-world physical sensors need to be calibrated occasionally. When you calibrate a sensor, you are telling the sonde that you know the exact value for what it is measuring. For example you may know the exact pH of a solution the probe is immersed in, or its exact conductivity.

When you tell a sonde to calibrate to a certain exact value, the sonde takes several measurements of the selected sensor until it obtains a stable reading. It then records this stable reading, and uses it to compute all future results.

When you enter the Calibration menu (accessed from the Main menu), you are presented a list of sensors which can be calibrated. Some sensors (like pH or nitrate) can be calibrated using 1, 2, or 3 points. These options are either shown separately on the list, or offered right after you select a sensor. Select the sensor (and number of points) you wish and press Enter. The 610 asks for the exact value to calibrate to, and performs the calibration. The 610 will step you through multi-point calibrations if applicable.

YSI Sondes calibrate slightly different from each other. The 600 shows you data until you are satisfied it is stable. The 6000 performs this stabilization process internally, and notifies you when it is finished. Note if you are using a 600 with auto-sleep enabled, the calibration is auto-stabilized by the 600.

Errors can occur during calibration. The number you enter may be out of range, the sensor may be installed incorrectly, the sensor may be drifting. If an error occurs, the sonde rejects the calibration and an error message is displayed on the 610. Some types of errors can be overridden; you will be offered this option if applicable.

If you have a turbidity probe attached to your sonde, it is equipped with a wiper to clean its optics. If your sonde is a 6000, the 610 automatically activates the wiper prior to each solution you calibrate turbidity in. If your sonde is a 600, you can activate the wiper manually by pressing T, at any time while you wait for stabilization.

When your calibration is successful, and you have seen the Successful message, the 610 displays new data from the sonde. This allows you to see the improvement in the data. Press Esc to get out of data display and return to more calibration.

Press Esc to abort a calibration before it is completed.

1. INTRODUCTION

1.1 DESCRIPTION

The 6820 Environmental Monitoring System is a multiparameter, water quality measurement, and data collection system. It is intended for use in research, assessment, and regulatory compliance applications.

Measurement parameters include:

- [x] Dissolved Oxygen
- [x] Conductivity
- [ ] Specific Conductance
- [ ] Salinity
- [ ] Total Dissolved Solids
- [ ] Resistivity
- [x] Temperature
- [x] pH
- [ ] ORP
- [ ] Depth
- [x] Turbidity
- [ ] Nitrate-N
- [ ] Ammonia-N
- [ ] Ammonium-N

The Model 6820 is ideal for profiling and monitoring water conditions in industrial and waste water effluents, lakes, rivers, wetlands, estuaries, coastal waters, and monitoring wells. It can be left unattended for weeks at a time with measurement parameters sampled at your setup interval and data transmitted to your computer or logging device. The Model 6820 can be used 200 feet (61 meters) below the water's surface or in as little as a few inches (centimeters) of water. The fast sensor responses of the Model 6820 make it ideal for vertical profiling. Its small size makes it convenient to carry from site to site, and allows it to fit down many standard monitoring wells.

The Model 6820 is designed to house 8 field-replaceable sensors and the option to add a depth sensor module to the sonde body. The 6820 does not have internal battery capability and therefore must be operated from an external power source. YSI offers an AC adapter, battery pack and a terminal device, all of which can power the sonde.

The Model 6820 is equipped with YSI's patented Rapid Pulse Dissolved Oxygen Sensor which exhibits low stirring dependence, and therefore provides accurate dissolved oxygen results without an expensive and bulky stirrer. Because stirring is not required, external battery life is extended. In addition, because of the nature of the technology, sensor drift caused by passive fouling is minimized.

The Model 6820 communicates with an ASCII terminal or a computer with a terminal emulation program. The 6820 has no internal logging capability, and therefore must be used with a terminal, data logger, data collection platform or computer. Use of the 6820 with our 610-D or 610-DM display/logger provides an ideal system for profiling or spot sampling.

Every Model 6820 comes with IBM-compatible PC-based software for simple and convenient setup and data handling. Reports and plots are automatically generated and their presentation easily customized. Data is easily exported to any spreadsheet program for more sophisticated data processing.

The RS-232C and SDI-12 interfaces provide maximum versatility for system networking and real-time data collection. Several Model 6820 units may be installed as a network, providing valuable water quality data at a variety of locations. For real-time results, the Model 6820 can interface to radio telemetry systems, satellite, modem and cellular phone data collection platforms.

The Model 6820 is available with an economical built-in cable (various lengths), or with a sonde-mounted connector. Optional interface cables in several lengths are available for interfacing with a computer, terminal or data collection platform. These cables are waterproof at the sonde end and can be used in the lab or field.

See Appendix D for a complete list of accessories and calibration reagents.

1.2 GENERAL SPECIFICATIONS

Operating Environment
Medium: fresh, sea, or polluted water
Temperature: -5 to +45 °C (23°F TO 113°F)
Depth: 0 to 200 feet (61 meters)

Storage Temperature: -40 to +60 °C (-40°F TO 140°F)

Material: PVC, Stainless Steel

Dimensions and weight, sonde without cable and with 6036 turbidity sensor.
Maximum Diameter: 2.9 inches (7.4 cm)
Maximum Length: 13.6 inches (34.5 cm)
Maximum Weight: 3.4 pounds (1.5 kg)

Computer Interface
RS-232C
SDI-12

Software

PC6000

IBM PC compatible computer, 3 1/2 or 5 1/4 inch, high or low density disk drive.
Minimum RAM requirement: 256 K bytes
Optional graphic adapter for plotting

Ecowatch for Windows (optional)

IBM PC compatible computer with 3 1/2 inch disk drive and with a 386 processor (or better) running Windows version 3.1 (or later).

Minimum RAM requirement: 4 megabytes

Power

External 12 VDC (8 to 13.8 VDC)

1.3 SENSOR SPECIFICATIONS

The following are typical performance specifications for each sensor.

Depth - Medium

Sensor Type...........Stainless steel strain gauge
Range......................0 to 200 ft (61 m)
Accuracy................+/- 0.4 ft (0.12 m)
Resolution..............0.001 ft (0.001 m)

Depth - Shallow

Sensor Type..............Stainless steel strain gauge
Range.........................0 to 30 ft (9.1 m)
Accuracy .... +/- 0.06 ft (0.018 m)
Resolution.................0.001 ft (0.001 m)

✓ **Temperature**

Sensor Type...........Thermistor
Range......................-5 to 45 °C (23°F TO 113°F)
Accuracy................+/- 0.15 °C (optional configuration at +/- 0.05 °C)
Resolution..............0.01 °C

✓ **Dissolved Oxygen, % saturation**

Sensor Type...........Rapid Pulse - Clark type, polarographic
Range......................0 to 200 % air saturation
Accuracy................+/- 2 % air saturation
Resolution..............0.1 % air saturation

Dissolved Oxygen, mg/L (Calculated from % air saturation, temperature and salinity)

Sensor Type........... Rapid Pulse - Clark type polarographic
Range......................0 to 20 mg/L
Accuracy................+/- 0.2 mg/L
Resolution..............0.01 mg/L

Conductivity*
Sensor Type...........4 electrode cell with autoranging
Range.....................0 to 100 mS/cm
Accuracy................+/- 0.5% of reading + 0.001 mS/cm
Resolution.............0.001 mS/cm to 0.1 mS/cm (range dependent)

Salinity
Sensor Type...........Calculated from conductivity and temperature
Range.....................0 to 70 ppt
Accuracy................+/- 1.0% of reading or 0.1 ppt, whichever is greater
Resolution..............0:01 ppt

pH
Sensor Type...........Glass combination electrode
Range.....................0 to 14 units
Accuracy................+/- 0.2 units
Resolution.............0.01 units

pH - Low Ionic Strength
Sensor Type...........Glass combination electrode with low impedance glass
Range.....................2 to 12 units
Accuracy................+/- 0.2 units
Resolution.............0.01 units

ORP
Sensor type............ Platinum ring
Range.....................-999 to +999 mV
Accuracy................+/-20 mV
Resolution..............0.1 mV

Turbidity ND
Sensor type............ Optical, 90 ° Scatter, mechanical cleaning option
Range.....................0 to 1000 NTU
Accuracy................+/- 5% reading or 2 NTU (whichever is greater)
Resolution..............0.1 NTU

Nitrate-Nitrogen
Sensor Type...........Ion-selective electrode
Range.....................0-200 mg/L-N
Accuracy................+/- 10% of reading or 2 mg/L (whichever is greater)
Resolution.............0.001 mg/L-N to 1 mg/L-N (range dependent)

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* Report outputs of specific conductance (conductivity corrected to 25 C), resistivity, and total dissolved solids are also provided. These values are automatically calculated from conductivity according to algorithms found in *Standard Methods for the Examination of Water and Wastewater* (Ed 1989).

Ammonium-Nitrogen
Sensor Type...........Ion-selective electrode
Range.....................0-200 mg/L-N
Accuracy................+/- 10% of reading or 2 mg/L (whichever is greater)
Resolution..............0.001 mg/L-N to 1 mg/L-N (range dependent)

Ammonia-Nitrogen
Sensor Type...........Calculated from ammonium, pH and temperature
Range.....................0-200 mg/L-N
Accuracy................+/- 10% of reading or 2 mg/L (whichever is greater)
Resolution..............0.001 mg/L-N to 1 mg/L-N (range dependent)

1.4 HOW TO USE THIS MANUAL

The manual is organized to let you quickly understand and operate the 6820 system. However, it cannot be stressed too strongly that informed and safe operation is more than just knowing which buttons to push. An understanding of the principles of operation, calibration techniques, and system setup is necessary to obtain accurate and meaningful results.

Sections 2 and 3 help you get started, providing initial setup information as well as calibration and basic operating instructions. Sections 4 and 5 provide detailed information on the Sonde software structure and YSI PC6000 software, respectively. PC6000 is PC-based software designed to help the user to easily generate reports and plots from the data collected by the sonde. Sections 6-8 address principles of operation, sonde and sensor maintenance, and system troubleshooting. Section 9 provides more detailed information on communications protocols. Section 10 provides service and repair information. The appendices (A-H) provide information on safety, warranty, accessories, options, storage recommendations, and more.

NOTE: Because of the many features, configurations and applications of this versatile product, some sections of this manual may not apply to the specific system you have purchased.

The Model 6820 can be purchased with external battery or power supply capability. Additionally, all probes, cables and accessories can be ordered either as options or ordered together as a system.

If you have any questions about this product or its application, please contact our customer service department or authorized dealer for assistance. See Appendix C for contact information.

APPENDIX E

Quality Assurance Project Plan (QAPP)

TABLE OF CONTENTS

I. PURPOSE OF THE QUALITY ASSURANCE PROJECT PLAN

This Quality Assurance Project Plan (QAPP) has been prepared to document the quality assurance protocols for execution of the Direct Push Monitoring Point Assessment Study. The purpose of this QAPP is to define the field and laboratory data requirements for the experiment as specified in the Work Plan and to ensure that the data are of sufficient quality to support the end use of the data. The QAPP defines the policy, organization, functional activities, and quality assurance (QA) and quality control (QC) protocols that will be used to meet the objectives of this investigation. Descriptions of the procedures associated with the field programs, including sample collection, sample custody, laboratory analysis, and QA/QC for this project are described in this document. Adherence to the procedures described in this QAPP should generate data that are scientifically sound, valid, defensible, and of known, acceptable, and documented quality.

The QAPP is organized as follows:

- Section I Purpose Of The Quality Assurance Project Plan
- Section II Quality Assurance Objectives
- Section III Sampling Procedures
- Section IV Sample Custody, Handling, and Shipping Procedures
- Section V Calibration Procedures
- Section VI Analytical Procedures and Detection Limits
- Section VII Data Reduction, Validation and Reporting
- Section VIII Internal Quality Control
- Section IX Performance Systems Audits
- Section X Preventative Maintenance
- Section XI Data Assessment Procedures
- Section XII Corrective Actions
- Section XIII Quality Assurance Reports

II. QUALITY ASSURANCE OBJECTIVES

A. DATA QUALITY OBJECTIVES

The overall quality assurance objective for this study is to develop and implement sampling, sample handling, and analytical procedures that will provide data that can be used to fulfill the data quality objectives (DQOs) as stated in the Work Plan. DQOs are qualitative and quantitative statements developed by data users to specify the quality of data from field and laboratory data collection activities that is needed to support specific decisions or regulatory actions. The DQOs describe which data are needed, why the data are needed, and how the data will be used to meet the needs of the project. DQOs also establish numeric limits for the data to allow the data user (or reviewers) to determine whether the data collected are of sufficient quality for their intended use.

DQO development as described in USEPA guidance is based on:

- Identifying project objectives
- Specifying the data necessary to meet project objectives
- Describing the methods that will yield data of acceptable quality and quantity to support the required decisions.

The project objectives and data specifications are described in the Work Plan. Analytical and testing methods are described in this QAPP.

B. ANALYTICAL QUALITY CONTROL LEVELS

Five levels of analytical quality control are identified by CERCLA and are described in *Data Quality Objectives for Remedial Response Activities Development Process* (USEPA, 1987). These levels are based on the type of site under investigation, the required precision and accuracy, the end use of the analytical data, and the level of documentation. Two levels of analytical data will be collected during this investigation. The analytical levels include the following:

- **Level II.** Level II data are quantitative and are generally collected by field instruments designed for in situ measurements and that do not require laboratory support. Examples of Level II data include topographical survey data, pH data, and data collected using a field gas chromatograph (GC). Level II data are used for site characterization, evaluation of alternatives, engineering design, and monitoring during sampling.

- **Level III.** Level III data are quantitative, have known precision and accuracy, and are produced under controlled conditions using laboratory-grade instrumentation. USEPA-accepted methods, such as SW-846, National Pollution Discharge Elimination System, and the Contract Laboratory Program (CLP) are used under Level III. Data uses include risk assessment, site characterization, evaluation of alternatives, and engineering design. Level III is the highest QC level to be collected during this project.

Practical quantitation limits (PQLs) are based on the extent to which the equipment, laboratory or field, or analytical process can provide accurate measurements of a reliable quality for specific constituents in field samples. The PQL for a given analysis will vary depending on instrument sensitivity and matrix effects. PQLs are discussed in Section V on Analytical Procedures and Detection Limits.

C. DATA QUALITY DEFINITION AND MEASUREMENT

The effectiveness of a QA program is measured by the quality of data generated in the field and by the laboratory. Data quality is judged in terms of its precision accuracy, representativeness, completeness, and comparability. These terms are described in the following sections.

1. Accuracy

Accuracy is the degree of agreement of a measurement or an average of measurements with an accepted reference or "true" value, and is a measure of bias in the system. The accuracy of a measurement system is impacted by errors introduced through the sampling process, field contamination, preservation, handling, sample matrix, sample preparation, and analytical techniques.

Accuracy is evaluated by the following equation:

$$\text{Precent Recovery} = \frac{A - B}{C} \times 100$$

where: A is the concentration of analyte in a spiked sample

B is the concentration of analyte in an unspiked sample

C is the concentration of spike added.

For this project, accuracy will be assessed and controlled by the results of the following QC samples, which contain known concentrations of specific analytes (spiked):

- Matrix spike (MS) and matrix spike duplicates (MSD)
- Laboratory control samples (LCS) and LCS duplicates (LCSD)

As these samples are analyzed, spike recoveries will be calculated and compared to pre-established acceptance limits, as listed in Attachment A. Acceptance limits are based on previously established laboratory performance or specified by the analytical methods. The control limits reflect the minimum and maximum recoveries expected for individual measurements for an in-control system. Recoveries outside the established limits indicate error in addition to normal measurement error, and the possible need for corrective action. Corrective action may include re-calibrating the instrument, reanalyzing the QC samples, re-analyzing the sample batch, re-preparation of the sample batch, or flagging the data (if problems can not be resolved). For contaminated samples, matrix spike recoveries may be dependent upon sample homogeneity, matrix interference, and dilution requirements.

2. Precision

Precision is the reproducibility of measurements under a given set of conditions. For large data sets, precision is expressed as the variability of a group of measurements compared to their average value (i.e., standard deviation). For duplicate measurements, precision is expressed as the relative percent difference (RPD) of a data pair and is calculated using the following equation:

$$\text{RPD} = \frac{[\text{A} - \text{B}]}{([\text{A} + \text{B}]/2)} \times 100$$

where: A and B are the reported concentrations for sample duplicate analyses.

For this project, precision will be assessed by calculating the RPD of the MS/MSD sample pairs and the duplicate and replicate sample pairs and comparing the results to laboratory-established RPD control limits, which are listed in Attachment A. Precision of duplicate samples is dependent upon sample homogeneity.

The analyst, group leader, or technical advisor is responsible for investigating data outside the QC limits. Corrective action may include re-calibrating the instrument, re-analyzing QC samples, re-analyzing samples, or flagging the data.

3. Representativeness

Representativeness is a qualitative expression of the degree to which sample data accurately and precisely represents a characteristic of a population, a sampling point, or an environmental condition. Representativeness is maximized by ensuring that, for a given project, the number and location of sampling points and sample collection and analysis techniques are appropriate for the specific investigation, and that the sampling and analysis program will provide information that reflects "true" site conditions. Results for duplicate sample analysis are also used to evaluate representativeness.

4. Comparability

Comparability is a qualitative parameter that expresses the confidence that one data set may be compared to another. Comparability of data is achieved through the use of standardized methods for sample collection and analysis, and the use of standardized units of measure.

5. Completeness

Completeness is defined as the percentage of valid data relative to the total number of analytes and is evaluated using precision, accuracy, and holding time criteria. Completeness will be calculated using the following equation:

$$\text{Completeness} = \frac{\text{Valid Data}}{\text{TotalData}} \times 100$$

Project completeness is determined at the conclusion of the data validation and is calculated by dividing the number of valid sample results by the total number of samples analyzed. The completeness objective for this project is 90 percent for all data and is based on USEPA guidelines (USEPA, 1988a).

III. SAMPLING PROCEDURES

All of the sampling locations and procedures to be used for environmental sample collection are presented in the Work Plan. The Work Plan describes in detail the procedures that will be followed during sampling to ensure that the data are representative of environmental conditions. The remainder of this section describes the sampling procedures that will be used to collect QC samples in the field.

A. SAMPLE CONTAINERS

The types of sample containers and preservation required for each matrix and analysis are outlined in the Work Plan for the sampling program.

B. QC SAMPLE COLLECTION

As discussed above, the sampling procedures for all of the environmental samples are described in the Work Plan. The following sections outline the procedures to be used to collect QC samples in the field.

1. Equipment Blanks

Equipment blanks will be collected at a rate of one per day when non-dedicated or non-disposable equipment is used for sampling. Equipment blanks will be collected for each analytical parameter for which the associated environmental sample was collected. Equipment blanks will be collected immediately after decontaminating sampling equipment by pouring reagent free water over the sampling equipment, then collecting it in the appropriate sample containers. The samples will be labeled, handled, and shipped following the procedures outlined in the next section of this QAPP.

2. Duplicates

During this sampling program, duplicate samples will be collected for 5 percent of the total number of groundwater samples. A duplicate sample pair is a single grab sample that is split into two samples during collection. Duplicate groundwater samples will be collected by discharging a pump-volume of water into the original and duplicate sample containers. One of the samples from the duplicate sample set will be labeled with the correct sample identification, and the other sample will be labeled with the same correct sample identification with the suffix "DUP." Both samples will be sent to the same laboratory for analysis. The samples will be labeled, handled, and shipped following the procedures outlined in the next section of this QAPP.

3. Field Replicates (Split Samples)

Split samples will be collected from twenty percent of all designated sampling points. Splits will be sent to a certified laboratory for analysis by EPA Method 8260 to evaluate the analytical performance of ARA's laboratory. Splits will be collected in the same manner as duplicate groundwater samples. The results of analyses of split samples will provide a measure of the precision (repeatability) of the field sampling methods and the accuracy of the laboratory analytical methods.

4. Matrix Spike and Matrix Spike Duplicate Samples

Samples for MS/MSD analysis will be collected for five percent of the total number of samples collected. The ARA Project Manager or designee will identify samples to be used for MS/MSD analysis. The same procedures used to collect duplicate samples during sampling will be used to collect samples for MS/MSD analysis.

5. Trip Blanks

Trip blanks will be prepared by the laboratory prior to sampling and will consist of one 40-milliliter amber glass bottle filled with preserved reagent grade water for each sample cooler. The bottles will be filled so that there is no head space and will be capped with a Teflon® septum. Trip blanks will accompany all samples scheduled for VOC analysis.

6. Temperature Blanks

A water temperature blank will accompany each cooler of samples shipped to the laboratory. A temperature blank consists of a 40-milliliter amber glass bottle filled with reagent-grade water. The temperature of the blank will be measured upon arrival at the laboratory If the temperature of the blank is outside the 2° to 6° Centigrade (C) temperature criterion, both the laboratory and ARA project managers will be notified and the appropriate corrective actions will be taken.

IV. SAMPLE CUSTODY, HANDLING, AND SHIPPING PROCEDURES

A. SAMPLE CUSTODY

To ensure that samples are identified correctly and remain representative of the environment, the documentation and sample custody procedures specified in this section will be followed during sample collection and analysis. Standard sample documentation and custody procedures, as outlined below, will be used during each sampling program to maintain and document sample integrity during collection, transportation, storage, and analysis. The Field Team Leader, to be designated at the time of the investigation, will be responsible for ensuring proper documentation and custody procedures are initiated at the time of sample collection, and that individual samples can be tracked from the time of sample collection until the samples are relinquished to the laboratory. The laboratory will be responsible for maintaining sample custody and documentation from the time the samples are relinquished to the lab until final sample disposition.

1. Chain of Custody

Chain of Custody (COC) procedures provide an accurate written record of the possession of each sample from the time of collection in the field through laboratory analysis. A sample is considered in custody if one of the following applies:

- It is in an authorized person's immediate possession
- It is in view of an authorized person after being in physical possession
- It is in a secure area after having been in physical possession of an authorized person
- It is in a designated secure area, restricted to authorized personnel only.

2. Field Procedures

The sample custody and documentation procedures will be initiated at the time of sample collection. Sample collection details will be documented on the groundwater sampling forms in the field Program of the Work Plan. Samples will be labeled and the appropriate information will be recorded on the COC form using indelible ink. Any errors will be corrected by drawing a single line through the incorrect entry, entering the correct information, and then initialing and dating the change.

3. Sample Labels

Sample labels will be completed and attached to sample containers at the time of sample collection. The following information will be included on the sample label:

- Project name/location
- Sample location
- Date and time of sample collection
- Unique sample identification sequential number
- Sampler's initials

4. Chain of Custody Record

Properly completed COC forms will ensure that sample custody is documented, appropriate sample fractions have been collected, and scheduled analyses are properly assigned. An example of the type of COC record that will be used is shown in Appendix A of the Work Plan.

Unused portions of the COC form will be crossed out and initialed. A completed COC record will be included with each sample cooler. The sampler will retain a copy of the COC. When shipping the sample cooler to the laboratory by a commercial carrier, the COC will be signed, placed in a plastic bag, and taped to the inside of the shipping container used for sample transport. Signed shipping bills will serve as evidence of custody transfer between the field sampler and courier and courier and laboratory. The sampler will retain and file copies of the COC record and the shipping bill after the samples are shipped. The samples are relinquished to the laboratory upon arrival and the laboratory personnel then will complete the COC.

5. Custody Seals

Custody seals will be placed in two locations across the cooler closure to ensure that any tampering is detected. The date and initials of the sampler will be written on the custody seal.

6. Laboratory Custody Procedures

Upon receipt in the laboratory, the integrity of the shipping container will be checked by verifying that the custody seal is not broken. The cooler will be opened and the temperature blank will be measured to determine the temperature inside the cooler. The sample containers will then be checked for breakage, leakage, and damage, and the contents of the shipping container will be verified against the COC. Custody seal integrity, cooler temperature, and sample preservation will be documented on the sample control worksheet.

A permanent log book will be maintained in the sample control area to document the following:

- Date of sample receipt
- Sample accession number
- Number of samples
- Source of samples

All insufficiencies and/or discrepancies will be immediately reported to the Laboratory Project Manager and documented. The Laboratory Project Manager will either resolve the problem internally or contact the ARA Project Manager for resolution. If the samples and documentation are acceptable, each sample container's unique identification number will be recorded. Other information that will be recorded includes date and time of sampling, sample description, due dates, and required analytical tests.

After samples have been received by the laboratory, the samples will be transferred to a refrigerator. The sample refrigerator will be kept at 4°C±2°C and their temperatures will be recorded regularly with thermometers calibrated against NIST thermometers. The cleanliness of refrigerators storing samples for VOC analyses will be monitored using refrigerator blanks.

Samples will be distributed for analysis from Sample Control by either a sample custodian or laboratory chemist. Sample tracking will be documented on the Sample Control Form. After all samples and documentation have been reviewed and appropriately annotated, the Sample Custodian will sign the log sheet and submit it to the Information Services Department for processing. Any marks or notes made on the chain of custody document by the Sample Custodian will be clearly distinguishable from original field notations.

Shipping receipts will be stapled on chain of custody log sheets and stored in the project file. The Laboratory Manager or designee will be notified that the samples have arrived through the distribution of arrival notices. The samples are to be stored in a refrigerator or cold room with the temperature maintained at 4°C±2°C.

B. SAMPLE HANDLING AND SHIPPING

After each water sample is collected, it will be placed in a cooler containing ice, and the cooler will be shipped by overnight courier to the laboratory. The samples will be placed upright in the cooler, and secured with inert cushioning material to prevent breakage. A completed COC form will accompany all samples. Complete packaging and shipping procedures are as follows:

- The samples will be placed upright in a waterproof metal (or equivalent strength plastic) ice chest or cooler.
- Bags of ice will be placed around, among, and on top of the sample bottles. Enough ice will be used so that the samples will be maintained at 4°C±2°C.
- To prevent the sample containers from sliding around the cooler, the cooler will be filled with inert cushioning material, such shipping peanuts, additional bubble pack, or cardboard dividers.
- The completed COC form will be placed in a waterproof plastic bag and taped to the inside of the cooler lid.
- The lid will be secured with strapping tape by wrapping it completely around the cooler.
- The completed shipping label will be attached to the top of the cooler and "This Side Up" and "Fragile" labels will be placed on the sides of the cooler.
- Signed and dated custody seals will be placed on the cooler in two locations across the opening of the cooler lid.

C. SAMPLE DISPOSAL

Thirty days after a laboratory report has been generated and submitted to the Project Manager the samples are transferred to the sample disposal area. This transfer is also documented on the Sample Control Form. Samples will be disposed according to each laboratory's SOP, which is based on both State and Federal guidelines.

V. CALIBRATION PROCEDURES

This section discusses general requirements for field equipment and laboratory instrument calibration and standards preparation. Instrument calibration is necessary for accurate sample quantitation, and establishes the dynamic range of an instrument. Criteria for calibration are specific to each method and instrument manufacturer. The following paragraphs outline the calibration procedures for the field equipment and laboratory instrumentation.

A. FIELD EQUIPMENT

The field equipment to be used during the groundwater sampling program includes a water-level sounder, a pH, specific conductance, dissolved oxygen, temperature, and turbidity meter, and an organic vapor meter. The meters will be calibrated according to the procedures outlined below.

1. Water-Level Sounder

Electric water-level sounders will be checked before the beginning of the field activities by comparing the scale on the water-level tape against an engineering measurement tape.

2. pH, Turbidity, Dissolved Oxygen, Temperature, and Specific Conductivity Meter

A YSI Model 6820 Water Quality Instrument or equivalent will be used for pH, salinity, turbidity, dissolved oxygen, temperature and specific conductivity measurement. The instrument will be calibrated daily prior to use according to the manufacturer's instructions provided in Appendix C of the Work Plan. The meter follows an automatic calibration routine in which independent reference solutions are used to calibrate the meter for pH, specific conductivity, salinity, turbidity, and dissolved oxygen.

3. Organic Vapor Meter

Any organic vapor detectors including flame ionization detectors (FIDs) and photoionization detectors (PIDs) will be calibrated daily prior to use and any time that instrument drift is suspected. In addition, calibration will be checked at the conclusion of each day of use in order to evaluate instrument performance. Instruments will not be adjusted before the final calibration check has been performed and recorded. Calibration procedures will be documented in the log book or on the appropriate field form. Calibration gases that have a shelf life will not be used past the expiration date.

4. Laboratory Instruments

The following paragraphs describe procedures for standard preparation and instrument calibration for SW-846 methods. ARA's laboratory will provide analytical services for all Level III data, while an independent contract laboratory will provide analytical services for replicates of 20% of all samples using Level III procedures.

5. Standard/Reagent Preparation

Data accuracy is dependent upon the accuracy of the standards used for instrument calibration. To ensure the highest quality standard, primary reference standards used by ARA and the contract laboratory are obtained from the National Institute of Standards Technology (NIST), EPA CRADA vendors, or other reliable commercial sources. When standards are received at the laboratory, the date received, supplier, lot number, purity, concentration, and expiration date are recorded in a standards log book. Vendor certification for the standards are retained in the files.

Standards are obtained either in their pure form, or in stock or working standard solutions. Dilutions are made from vendor standards. All standards are given a standard identification number and the following information is recorded in the standards log book: 1) source of the standard, 2) the initial concentration of the standard, 3) the final concentration of the standard, 4) the volume of the standard that was diluted, the volume of the final solution, 5) the solvent and the source and lot number of the solvent used for standard preparation, and 6) the preparer's initials. All standards are validated prior to use.

Validation procedures for standards include a check for chromatographic purity and verification of the standard's concentration by comparing its response to a standard of the same analyte prepared at a different time or obtained from a different source. Reagents also are analyzed for purity; for example, every lot of dichloromethane (used for organic extraction) is analyzed for contaminants prior to use in the laboratory. Standards are checked routinely for signs of deterioration (e.g., discoloration, formation of precipitates, and changes in concentration) and are discarded if deterioration is suspected or the expiration date has passed. Expiration dates are based on vendor recommendation, the analytical method, or internal research. Stock solutions for VOCs are not to be held for more than 30 days. Fresh working calibration standards shall be prepared every week. Stock solutions for semi-volatile organic compounds shall not be held for more than 90 days. Dilutions below 1 ppm shall not be held more than 30 days.

6. Calibration of Organic Methods

Calibration of instrumentation is required to ensure that the analytical system is operating correctly and functioning at the sensitivity necessary to meet established reporting limits (i.e., PQLs). Each instrument will be calibrated with standard solutions appropriate to the type of instrument and the linear range established for the analytical method.

Analytical instruments will be calibrated using standards in accordance with the specified analytical methods and manufacturer's procedures. At a minimum, written calibration procedures include the equipment to be calibrated, the reference standards used for calibration, the calibration techniques, actions, acceptable performance tolerances, frequency of calibration, and calibration documentation format. Records of standard preparation and instrument calibration will be maintained. Instrument calibration will include daily checks using standards prepared independently of the calibration standards and instrument response will be evaluated against established criteria. The analysis log book, maintained for each analytical instrument, will include at a minimum: the date and time of calibration, the initials of the person performing the calibration, the calibrator reference number and concentration. Attachment B contains the methods to be used in this study that detail the calibration procedures. Instrument calibration procedures for specific instruments used for organic analyses are discussed in the following paragraphs.

a) Gas Chromatography

Initial calibration consists of determining the linear range, establishing detection limits, and establishing retention time windows. The calibration will then be checked daily to ensure that the system calibration remains within specifications. If the daily calibration check does not meet established criteria, the system will be recalibrated.

Calibration standards will be prepared according to the standard operating procedure for the method. For the SW 846 8000 series methods, a calibration standard will be prepared for each analyte of interest at five concentration levels. One of these standards will be slightly above the method detection limit. The other standards will bracket the concentration range expected in the environmental samples, but not exceed the working range of the detector.

A reagent water blank will be run prior to calibration to show the absence of interferences. The calibration standards then will be introduced into the system and a calibration curve will be generated for each analyte. The response factor for each analyte at each concentration will be calculated as follows:

$$\text{Response Factor (RF)} = \frac{\text{Total Area of Peak}^{(a)}}{\text{Mass Injected (in nanograms)}}$$

[a] For multiresponse analytes, the area from at least five major peaks shall be used for quantitation.

Acceptance criteria for instrument response linearity checks are based upon the correlation coefficient (r) of the best fit line for the calibration data points, or on the percent relative standard deviation (% RSD) for response factors calculated for each analyte at each level over the working range. The correlation coefficient is calculated as:

$$r = \frac{n\sum(xy) - \left(\sum x\right)\left(\sum y\right)}{\sqrt{\left[n\left(\sum x^2\right)-\left(\sum x^2\right)\right]\left[n\left(\sum y^2\right)-\left(\sum y^2\right)\right]}}$$

where: x = calibration concentrations

y = instrument response (peak area)

n = number of calibration points (x,y data pairs).

The percent RSD is calculated as:

$$\%RSD = \frac{SD}{\bar{c}} \times 100$$

where: %RSD = relative standard deviation

$\bar{c}$ = means of 5 initial RFs for a compound

SD = standard deviation of the RFs for a compound

$$SD = s\sqrt{\frac{\sum_{i=1}^{n} x_i^2 - \left[\sum_{i=1}^{n} x_i\right]^2 / n}{n-1}}$$

If the coefficient of correlation, *r*, is greater than or equal to 0.995, or the %RSD is less than or equal to 20 percent, the calibration is considered valid. The use of r or %RSD is instrument specific, and only one of these criteria will be used on each instrument.

The calibration curve and response factors will be checked daily by injecting at least one calibration standard, usually the mid-range standard. The percent difference between initial and continuing response factors will be calculated using the following equation:

$$\%\ \text{Difference} = \frac{\left(RF_1 - RF_c\right)}{RF_1} \times 100$$

where: RF_1 = average relative response factor from initial calibration

RF_2 = response factor from continuing calibration

An acceptable percent difference will be within plus or minus 15 percent.

Retention time windows must be established for each analyte during initial calibration per SW 846, Method 8000. The retention time window must be checked prior to sample analysis using the calibration check standard. A warning limit specific to the method will be used. If the standard fails to meet the retention time window, the instrument will be recalibrated.

b) Gas Chromatography/Mass Spectrometry (GC/MS)

Each day prior to analysis of samples for VOCs, the instrument will be tuned with bromofluorobenzene (BFB) (according to the tuning criteria specified in the USEPA Contract Laboratory Program [CLP]). No samples will be analyzed until the instrument has met tuning criteria.

After the instrument has met tuning criteria, it will then be calibrated for all target compounds. An initial calibration curve will be produced, and certain compounds referred to as System Performance Calibration Compounds (SPCC) and Continuing Calibration Compounds (CCC) will be evaluated to ensure that the system is within calibration. If the daily SPCCs and CCCs do not meet the established criteria, the system will be recalibrated.

Calibration standards at a minimum of five concentrations will be prepared by secondary dilution of stock standards. All or a subset of the compounds listed in EPA Methods 8260 can be used as calibration standards.

Each calibration solution including internal standards and surrogates will be introduced according to EPA Method 5030 for volatile compounds. A relative response factor (RF) will be calculated for each compound relative to the internal standard whose retention time is closest to the compound being measured. The RF is calculated as follows:

$$RF = \frac{\left(A_x C_{is}\right)}{\left(A_{is} C_x\right)}$$

where: A_x = Area of characteristic ion for the compound being measured

A_{is} = Area of characteristic ion for the specific internal standard

C_{is} = Concentration of the specific internal standard

C_x = Concentration of the compound being measured.

The average relative response factor (RF_1) will be calculated for each compound using the values from the five-point calibration. A system performance check must be made before the calibration is accepted as valid. The SPCCs are checked for a minimum average relative response factor. The five volatile SPCCs are chloromethane, 1,1-dichloroethane, bromoform, 1,1,2,2-tetrachloroethane, and chlorobenzene. The minimum acceptable average relative response factor for volatile compounds is 0.300 (0.250 for bromoform).

The percent relative standard deviation (% RSD) for the CCCs will be calculated from the RFs in the initial calibration and must meet specified criteria. The volatile CCCs are 1,1-dichloroethane, 1,2-dichloropropane, toluene, ethylbenzene, and vinyl chloride. The formula used to calculate % RSD is:

$$\% \, RSD = \frac{SD}{\bar{c}} \times 100 \quad \% \, RSD = D \times 100$$

where: RSD = Relative Standard Deviation

$\bar{c}$ = Mean of 5 initial RFs for a compound

SD = Standard deviation of the RFs for a compound

$$SD = s\sqrt{\frac{\sum_{i=1}^{n} x_i^2 - \left[\sum_{i=1}^{n} x_i\right]^2 / n}{n-1}}$$

Every 12-hour shift, each GC/MS must be tuned by purging or injecting 4-bromofluorobenzene (BFB) for volatile compounds. Also, initial calibration of the GC/MS will be checked by analyzing a calibration standard (usually the mid level standard) and checking the SPCC and CCC performance. If the minimum relative response factors for SPCCs are not met, corrective action must be taken before samples are analyzed. The percent difference of relative response factor compared to the average relative response factor from the initial calibration is calculated as follows:

$$\% \text{ Difference } = \frac{\left(\mathrm{RF}_1 - \mathrm{RF}_c\right)}{\mathrm{RF}_1} \times 100$$

where: RF_1 = Average relative response factor from initial calibration

RF_c = Relative response factor from current calibration check standard.

If the percent difference criterion for each CCC compound is met, the initial calibration is assumed to be valid. If the criterion is not met for any CCC, corrective action must be taken. A new five-point calibration must be generated if the source of the problem cannot be found and corrected.

The internal standard responses and retention times in the CCC must be evaluated. If any internal standard retention time changes by more than 30 seconds from the last calibration check (12 hours), the system must be checked for malfunctions and corrected as necessary. If the extracted ion current profile (EICP) area for any of the internal standards changes by a factor of two from the last daily calibration standard check, the system must be checked for malfunctions and corrections made as necessary. All samples analyzed during the time the system was malfunctioning must be re-analyzed.

VI. ANALYTICAL PROCEDURES AND DETECTION LIMITS

All samples will be prepared and analyzed using the *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, 3rd Edition* (USEPA, 1996). The units of measure and typical practical quantitation limits for each analyte are listed in the Work Plan. These are laboratory-specific target reporting limits that can be met in the absence of matrix interferences or high contaminant concentrations, and are at least as stringent as the reporting limits specified for the individual analytical methods.

VII. DATA REDUCTION, VALIDATION AND REPORTING

A. FIELD MEASUREMENTS

Raw data from field measurements and sample collection activities will be documented in the field log book and on the appropriate forms, as described in the Work Plan. The field measurements and data collected during sampling will be presented in the report scheduled for this project. All field data generated during this investigation will be evaluated under the direction of ARA Quality Control (QC) Coordinator before it is incorporated in the report.

B. LABORATORY MEASUREMENTS

1. Data Reduction Calculations

Data will be reduced as specified by the analytical methods. These calculations are specific to the analytical instruments that are used for the analysis, the level of automation, and the type of software used to reduce the data. The procedures used for data reduction for each analytical method are described in the laboratory's SOPs.

2. Data Validation

The laboratory will perform in-house analytical data reduction and review under the direction of the Laboratory Project Manager and the ARA Quality Control Coordinator before the data are released to EL/EQA. The Laboratory Project Manager and Quality Control Coordinator are also responsible for assessing the data quality and qualifying any data that may be unreliable. The laboratory will prepare and retain full analytical and QC documentation. The data reduction and review will be conducted as follows:

- The bench analyst will convert the raw data into the reportable data, and conduct the initial data review. The analyst will review preliminary data entries, calculations, holding times and precision, accuracy and calibration check standards. The analyst will also provide explanation and/or corrective action summaries for any method control parameters that are outside the control criteria.
- The QC Coordinator or designee will review the analytical control documentation associated with each batch, as well as any corrective action explanations provided by the analyst. If the QC Coordinator is not satisfied with all corrective action explanations and analytical control results, additional explanation will be required for the batch. The QC Coordinator is responsible for determining if the analytical data meet quality control criteria established by the analytical methods and by this QAPP. The QC Coordinator will sign the analytical batch control form when satisfied with the data quality and review all final data reports for proper format prior to releasing data.

The laboratory review of the data includes assessing compliance with the control limits in QAPP. Accuracy and precision are the primary data parameters that can be used to calculate control limits. Data to evaluate accuracy are obtained primarily from separately prepared laboratory QC samples or from spiked field samples. Data used to evaluate precision are QC sample analyses or the replicate analysis of field samples. The calculations that are used to evaluate precision and accuracy are defined in the laboratory's SOP and/or QA/QC manual. Precision and accuracy quality control limits are generated from the statistical analysis of QC sample results. The quality control limits that will be used to evaluate the data are listed in Attachment A.

3. Data Reporting

The analytical data will be reported in a format organized to facilitate data evaluation. All of the data, including QC data will be reported in the chronological order in which they were produced. The following information will be included in each data package:

- A cover sheet that identifies the samples contained in the report, including QC samples, and that identifies any data that do not meet QA/QC criteria.
- A list of diluted samples including their dilution factors.
- A report for each completed environmental and QC sample analysis (equipment blanks, source-water blanks, MS/MSD samples, laboratory control samples, surrogate spike samples, and method blanks) that includes the following information: the field sample ID number (if applicable), the date the sample was collected, the date the sample was received by the laboratory, the date and method of sample extraction (if applicable), the date and method of sample analysis, tabulated results for each sample, surrogate spike recoveries (if applicable), internal standard recoveries (if applicable), associated method blank results, and the detection limit for each analyte. The initial concentration of the surrogate spikes, matrix spikes, and laboratory control sample spikes, as well as the percent recovery and acceptance limits of each spiked analyte also should be reported. The samples analyzed in association with each QC sample also should be identified on the report. All questionable data should be flagged according to USEPA guidelines.
- A corrective action summary that identifies all analytical irregularities (i.e., missed holding times, poor analytical recoveries), and the corrective action taken by the laboratory for the affected samples.

VIII. INTERNAL QUALITY CONTROL

A. FIELD PROGRAM

Internal quality control evaluates whether a method is performing within acceptable limits of precision and accuracy. On the sampling level, quality control samples used to assess field sampling techniques and environmental conditions during sample collection and transportation include duplicates, trip blanks, and equipment blanks.

1. Duplicates

Duplicate or replicate samples will be used to assess variability in the sample matrix and to assess sampling precision. The sampling procedures will be evaluated by comparing the analytical results of duplicate or replicate sample pairs. If the reported values for the sample pair are similar, the samples are considered to be representative of the environment. A large difference (greater than 40 percent) between the reported values for the sample pair indicates that there may have been a problem during sampling or analysis. Duplicate analyses will be used to evaluate precision by calculating the RPD between a duplicate sample and its associated environmental sample. The RPD will be compared to the MS/MSD QC limits for precision. Relative percent difference values within the QC guidelines indicate that good sampling and analytical procedures were followed. Relative percent difference values outside the QC limits indicate that sample may be heterogeneous, or that there may have been a problem during sampling and/or analysis.

2. Trip Blanks

Trip blanks will be used to evaluate representativeness by assessing whether VOCs were introduced into samples during handling, shipping, or storage at the laboratory. Trip blanks prepared by the laboratory will be included with each sample shipment that contains groundwater samples for VOC analysis.

3. Equipment Blanks

Equipment blanks will be used to assess the equipment decontamination procedures and evaluate whether the samples are representative of the environment. The results of each equipment blank analysis will be reviewed for the presence of target analytes. If target analytes are found, the data from the associated environmental samples will be evaluated to determine if they are representative of environmental conditions or the result of incomplete equipment decontamination.

B. LABORATORY ANALYSIS

The general objectives of a laboratory QC program are to:

- Ensure that all procedures are documented, including any changes in administrative and/or technical procedures.
- Ensure that all analytical procedures are validated and conducted according to method guidelines.
- Monitor the performance of the laboratory using a systematic inspection program.
- Ensure that all data are properly archived.

Internal quality control for analytical services will be conducted by the laboratory in accordance to their standard operating procedures, the individual method requirements, and this QAPP. Before making significant changes to the QAPP or analytical methodology, the laboratory will notify AL/EQA in writing.

Laboratory quality control consists of two distinct components: a laboratory and matrix component. The laboratory component measures the performance of the laboratory analytical process during the sample analyses, while the matrix component measures the effects on the method performance of a specific matrix. Method blanks and laboratory control samples uniquely measure the laboratory component of method performance, while matrix spikes, matrix spike duplicates, laboratory sample duplicates, and surrogate spikes measure the matrix component of method performance, but also reflect laboratory performance. The following paragraphs discuss the QC samples and parameters to be evaluated to assess the overall laboratory data quality.

1. Holding Time

Holding time reflects the length of time that a sample or sample extract remains representative of the environmental conditions. Holding time for method EPA 8021 is 14 days.

Analytical results of samples whose holding times are exceeded are considered quantitatively questionable and may be biased low.

2. Duplicate and Replicate Samples

Like the field procedures, the analytical procedures will be evaluated by comparing the analytical results of duplicate or replicate sample pairs. If the reported values for the sample pair are similar, the samples are considered to be *representative* of the environment. A large difference (greater than 40 percent) between the reported values for the sample pair indicates that there may have been a problem during the sampling or analysis. Duplicate analyses will be used to evaluate *precision* by calculating the RPD between a duplicate sample and its associated environment sample. The RPD will be compared to the MS/MSD QC limits for precision. Relative percent difference values within the QC guidelines indicate that good sampling and analytical procedures were followed. Relative percent difference values outside the QC limits indicate that sample may be heterogeneous, or that there may have been a problem during sampling and/or analysis.

3. Method Blanks

Method blanks will be used to evaluate representativeness by identifying any contaminants that have been introduced during analysis. Method blanks are generated in the laboratory and consist of ultra-pure water. Method blanks are carried through each processing step necessary for an analytical procedure and are analyzed at frequency of one per 20 samples or daily, whichever is more frequent. These blanks measure contamination originating from the laboratory (i.e., water, air, reagents, equipment, and instruments used for analysis), and help in distinguishing low-level field contamination from laboratory contamination. If analytes of interest are found in both the method blank and associated environmental samples, the environmental data will be qualified as per USEPA guidelines (USEPA, 1988b). The data from the associated samples may be considered quantitatively questionable depending on the relative concentrations of contaminants in the method blank and the environmental sample.

4. Laboratory Control Samples

Laboratory control samples (LCS) will be used to evaluate accuracy. These samples are carried through the same analytical procedures as the environmental samples and are used to evaluate method and analytical procedure performance in the absence of matrix interference. Laboratory control samples are prepared in the laboratory and consist of ultra-pure water that is spiked with specific compounds as outlined in the analytical methods. An LCS sample will be prepared and analyzed at a frequency of one per 20 samples, or daily, whichever is more frequent. Accuracy will be evaluated by calculating the percent recovery for each spiked compound and comparing it to the QC limits established by the individual methods. Values within the established QC limits indicate acceptable analytical accuracy. Values outside the QC limits indicate that the data may be questionable.

5. Matrix Spike and Matrix Spike Duplicate Samples

Results of MS/MSD sample analysis will be used to evaluate accuracy and precision. Unlike LCSs, MS/MSD samples are used to assess the influence of the sample matrix (matrix interference) on the analysis. Each MS/MSD sample will be spiked with the compounds specified by the analytical method. To evaluate accuracy, the percent recovery for each spiked compound will be calculated and compared to the QC limits established by the method. Precision will be evaluated by calculating the RPD between the MS and MSD samples for each spiked analyte. These RPDs will be compared to the QC limits established by laboratory performance. Percent recovery and RPD values within the QC limits indicate acceptable precision and accuracy values outside the QC limits indicate that there may have been a matrix interference during analysis. The laboratory data validation protocol will be based on precision and accuracy measurements from MS/MSDs. Individual compound recoveries will be compared with acceptance limits. If a matrix spike analyte fails acceptance criteria, the MS/MSD will be reanalyzed and a LCS also will be analyzed. For the method to be considered in control, those compounds that failed the matrix spike criteria must be within acceptance limits in the LCS. If, after re-analysis, analytes that failed acceptance criteria in the MS and MSD pass acceptance criteria in the LCS, these analytes may be considered biased due to sample matrix effects.

All samples analyzed or prepared in a process batch without an MS and MSD will, at a minimum, have a method blank and LCS. The environmental samples in this batch will be considered in control if more than 80 percent of the target compounds in the LCS are within acceptance limits.

IX. PERFORMANCE SYSTEMS AUDITS

A. FIELD PROGRAMS

Oversight of ARA field procedures will be the direct responsibility of the ARA Project Manager, who will review all elements of the QAPP to ensure that the objectives of the Work Plan are met. In addition to an initial review, the sampling procedures will be reviewed as the field work progresses so that any necessary modifications can be made.

Internal audits of ARA field activities (sampling and measurements) will be conducted by the ARA QC coordinator or the coordinator's designee. The audits will include examining field measurement records, field equipment calibration records, field sampling records, field instrument operation records, sample collection procedures, sample handling and shipping procedures, and chain of custody procedures. Field activities will be audited early in the project to verify that all of the procedures outlined in the Work Plan and QAPP are being followed. Follow-up audits will be conducted to correct deficiencies, and to verify that QA procedures are maintained throughout the project.

1. Laboratory Audits

In-house and regulatory agency audits of laboratory systems and performance are a regular part of a laboratory QC program and are outlined in the subcontract laboratory's QA/QC plan. The audits consist of a review of the entire laboratory system and at a minimum include: examination of sample receiving, log-in storage, and chain of custody documentation procedures; sample preparation and analysis; and instrumentation procedures. An external audit may be performed by AL/EQA or its designee prior to or during the field work, to verify proper implementation of laboratory procedures and adherence to this QAPP.

X. PREVENTATIVE MAINTENANCE

A. FIELD EQUIPMENT

The field equipment that will be used during this investigation includes an electronic water-level sounder, a PID and/or FID, and a pH, specific conductivity, salinity, turbidity, temperature, and dissolved oxygen meter. All meters and instruments will be maintained and used according to the manufacturers' directions. Each piece of equipment will be inspected on a regular basis to ensure that the equipment is operational. Any preventative maintenance or repair conducted in the field will be recorded in the field log book.

B. LABORATORY EQUIPMENT

1. Documentation

All maintenance performed on an instrument is documented; the name of the analyst performing the maintenance and the type of maintenance are recorded in the log book. Receipts from routine maintenance performed by the manufacturer's representative are kept in folders and filed in the department's file cabinets.

2. Contingency Plan

In the event of instrument failure, every effort will be made to analyze samples by alternate means within holding times. If the redundancy in equivalent instrumentation is insufficient to handle the affected samples, efforts will be made to secure the same or equivalent analyses at another location. Lt. Kevin Judd, AL/EQA, will be advised of any proposed changes in methodology or location.

XI. DATE ASSESSMENT PROCEDURES

The quality of the field and analytical data will be evaluated using precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters, which are quantitative and qualitative statements that describe data quality. The PARCC parameters will be used to determine whether the data quality objectives of this investigation have been met by comparing QC sample results and standard procedures with acceptance criteria established for this project. The PARCC parameters that will be used for data evaluation are defined in Section II, Quality Assurance Objectives.

A. FIELD DATA

Field measurement data will be assessed by the ARA QC coordinator or designee. The data quality evaluation, in terms of the PARCC parameters, will focus primarily on the laboratory data. However, the field data will be evaluated qualitatively in terms of the PARCC parameters. The following sections discuss how the PARCC parameters will be used to evaluate the field data and field sampling procedures.

1. Precision

Sampling precision is affected by the procedures used for sample collection, handling, and transportation. To reduce the variability that may be introduced during sampling, the Work Plan outlines the standard sampling, handling, and shipping procedures that will be used for each sampling program. The use of these procedures should minimize variability in the sampling process.

In addition, the results of duplicate and replicate sample analyses also will be used to evaluate sampling precision. The RPD will be calculated for each duplicate sample pair. Although the results of duplicate sample analyses also reflect the variability associated with analytical procedures, low RPD values are an indication that consistent sampling techniques were used for sample collection.

2. Accuracy

Although there is no way to quantitatively measure the accuracy of the field program using percent recovery, some aspects of accuracy can be assessed, such as comparing the length of the water-level probe to another measuring tape of known length and proper calibration of the field instruments.

3. Representativeness

The representativeness of the field data is determined by the design of the data collection procedures. The sampling and field measurement procedures to be used are based on the needs of the study, the existing analytical data, hydrogeology, the physical setting of the field sites, and the past land use history. Representativeness of the field sampling procedures and the field measurements will be evaluated by comparing the sampling and measurement procedures used in the field to the procedures outlined in the Work Plan and this QAPP. In addition, the results of equipment blank samples will be used to evaluate the representativeness of field sampling procedures. Contaminants detected in equipment blanks are indications that the decontamination procedures are not completely effective, and that contaminants detected at specific sites may be attributable to cross-contamination rather than the environment.

4. Comparability

The comparability of the field sampling procedures and field measurement data will be evaluated by comparing them to previous sampling rounds.

5. Completeness

Completeness of the field program will be evaluated to ensure that the appropriate number of samples were collected for analysis, and that field data of the type and quantity outlined in the Work Plan were collected. Completeness of the field investigations will be evaluated by comparing the actual number of samples and the actual quantity of data that were collected to the requirements outlined in the Work Plan.

B. LABORATORY DATA

The laboratory data will be assessed by the ARA QC coordinator or designee, and based on the assumption that the sample was collected, handled, and analyzed according to the Work Plan and this QAPP. The data reviewer will conduct a systematic review of the data for compliance with the QC criteria established in the QAPP, and will identify any data omissions or data that do not meet the quality control criteria. The reviewer also will interact with the laboratory to correct any data deficiencies. Decisions to repeat sample collection or analyses will be made by the ARA Project Manager based on the extent of the data deficiencies and their importance in the overall context of the project. Results of the data assessment will be presented in an appendix of the report scheduled to summarize the results of the investigation.

C. LABORATORY DATA ASSESSMENT PROCEDURES

As discussed above, PARCC parameters will be used to evaluate the quality of analytical data and determine whether the data quality objectives of the project have been met. To asses the quality of the analytical data, the results of the QC sample analyses will be evaluated using quality control limits established by the analytical methods used for the analysis, or by past laboratory performance. Results of the quality control sample evaluation then will be expressed in terms of the PARCC parameters and used to assess the quality of the analytical data.

The quality control samples that will be used to evaluate the analytical data for this program include trip blanks, equipment blanks, duplicate samples, replicate samples, method blanks, surrogate spikes (when applicable), laboratory control samples, and matrix spike/matrix spike duplicates samples. The specific types and descriptions of the QC samples that will be collected in the field are presented in Section III of this QAPP. The total number of each type of QC sample that will be collected during each sampling program is listed in Table 4 of the Work Plan. The quality control samples that are prepared in the laboratory and the rate at which these samples are analyzed are method-specific (see Section III. B). The acceptance limits for MS/MSD, surrogate spikes and LCS are updated periodically. The laboratory shall inform the Project Manager before new limits are implemented. The following sections describe the criteria that will be used to evaluate the laboratory data.

1. Precision

Analytical precision is determined by analyzing field duplicates or replicates submitted to the laboratory, and MS/MSD samples. Relative percent difference is calculated between the sample pairs and compared with control limit acceptance criteria. The data quality objectives for precision during this program are based on laboratory established control limits, which are specific to each analyte.

2. Accuracy

Accuracy is a quantitative measure of the bias of a method or the level of agreement between a measurement and a known true value. Laboratory accuracy will be evaluated using the results for MS/MSD, and LCS/LCSD sample analyses. As with precision, the accuracy objectives for the data are based on laboratory established limits, and vary with the specific analyte.

3. Representativeness

Representativeness is a qualitative parameter that evaluates whether or not the data represent the actual environmental conditions. Representativeness will be evaluated by analysis of laboratory method and equipment blanks, and duplicate or replicate samples. Laboratory method and equipment blanks will be used with duplicates or replicates to evaluate laboratory performance.

Representativeness is also evaluated using holding-time criteria, which reflect the length of time that a sample or extract remains representative of the environmental conditions after sample collection. Holding time are compared to standard method-specific holding times accepted by the EPA. All holding times within the acceptance criteria are considered representative. Those holding times outside of EPA acceptance criteria are qualitatively evaluated to determine the effect on sample representativeness.

4. Comparability

Comparability is a qualitative expression of the confidence with which one data set can be compared to another. Comparability is maximized through the use of standard analytical methods and units of measurement.

5. Completeness

Completeness also will be used to assess the data. Completeness is expressed as a percentage and is defined as the number of valid samples relative to the total number of samples gathered during the sampling programs. Completeness will be calculated using the following equation:

$$\text{Completeness} = (\text{Number of Valid Samples}) / (\text{Total Number of Samples}) \times 100$$

XII. CORRECTIVE ACTIONS

A. FIELD PROGRAMS

The field staff will be responsible for documenting and reporting all suspected technical and QA non-conformances, and suspected deficiencies during any field activity. The non-conformances and/or deficiencies will be documented in the field log book and reported to the ARA Project Manager. If the problem is associated with field measurements or sampling equipment, the field staff will take the appropriate steps to correct the problem. Typical field procedures to correct problems include the following:

- Repeating the measurement to check for error
- Making sure the meters or instruments are adjusted properly for the ambient conditions, such as temperature
- Checking or replacing batteries
- Recharging batteries
- Recalibrating the instruments
- Replacing the meters or instruments used to measure field parameters
- Stopping work until the problem is corrected (if necessary).

If a non-conformance or problem requires a major adjustment to the field procedures as outlined in the Work Plan (e.g., changing sampling methodology), the Project Manager, in conjunction with the QC Coordinator, will be responsible for initiating corrective actions. The Project Manager will be responsible for the following:

- Evaluating the reported non-conformance
- Controlling additional work on non-conforming items
- Determining the appropriate corrective actions
- Maintaining a log of all non-conformances and corrective actions
- Ensuring that explanation of non-conformances and corrective actions is included in an appendix of the report scheduled for this investigation.

The ARA Project Manager will ensure that no additional work that is dependent on the non-conforming activity is performed until the appropriate corrective actions are completed.

B. LABORATORY ANALYSIS

Corrective actions are required whenever unreliable analytical results prevent the quality control criteria as specified by the method or this QAPP from being met. The corrective action that is taken depends on the analysis and the non-conformance.

Corrective actions will be undertaken if one of the following occurs:

- QC data are outside the acceptance windows for precision and accuracy
- Blanks contain contaminants above acceptance levels
- Undesirable trends are detected for spike recoveries (or spike recoveries are outside the QC limits) or RPDs between duplicate analyses are consistently outside QC limits
- There are unusual changes of detection limits during analysis
- Deficiencies are detected during QA audits
- Inquiries concerning data quality are received from AL/EQA

Corrective actions are primarily handled at the bench level by the analyst who reviews the sample preparation or extraction procedures, and performs the instrument calibration and analysis. If the problem persists or its cause cannot be identified, the matter will be referred to the Laboratory Manager or QC Coordinator for further investigation. Once resolved, full documentation of the corrective action procedure will be filed with the QC Coordinator. A summary of the corrective actions will be included in the report submitted to AL/EQA.

XIII. QUALITY ASSURANCE REPORTS

All of the analytical data collected during the investigation will be presented in an appendix to the Report scheduled for this investigation. The following information will be included in the report:

- Sampling procedures (planned and implemented, problems, and corrective actions)
- Analytical procedures and detection limits
- Analytical data (environmental and QC sample results)
- Results of the data quality evaluation
- Conclusions and recommendations.

XIV. REFERENCES

US Environmental Protection Agency (USEPA), 1983; "Methods for Chemical Analysis of Water and Wastes," EPA Manual, 600/4-79-020.

US Environmental Protection Agency (USEPA), 1986; "Test Methods for Evaluating Solid Waste," Physical/Chemical Methods, SW-846, 3rd Edition.

US Environmental Protection Agency (USEPA), 1987; "Data Quality Objectives for Remedial Response Activities Development."

US Environmental Protection Agency (USEPA), 1988a; "Guidance for Conducting Remedial Investigations/Feasibility Studies Under CERCLA."

US Environmental Protection Agency (USEPA), 1988b; "Laboratory Data Validation Functional Guidelines for Evaluating Organic Analyses," Hazardous Waste Site Evaluation Division, Washington, DC.

Appendix E

Attachment A

VOLATILE ORGANIC COMPOUND ANALYSIS
QUALITY CONTROL CRITERIA FOR LABORATORY DATA EVALUATION

Analytical Method	Spiking Compounds	Spike Concentration in Water (μg/l)	Laboratory-Established Control Limits: Accuracy Percent Recovery (%)	Laboratory-Established Control Limits: Precision (RPD %)
Matrix Spike/Matrix Spke Duplicates				
VOCs, SW8260	Matrix			
	1, 1-Dichloroethane	10	75-124	12
	1, 2-Dichloroethene (total)	10	66-134	25
	Trichloroethene	5	78-131	14
	1, 4-Dichlorobenzene	10	84-117	12
	Benzene	5	75-125	16
	Toluene	10	79-129	13
	o-Xylene	10	83-115	11
	Vinyl chloride	2	10-145	29
Laboratory Control Samples				
VOCs, SW8260	Matrix			
	1, 1-Dichloroethane	10	76-119	#N/A
	1, 2-Dichloroethene (total)	10	70-126	#N/A
	Trichloroethene	5	80-121	#N/A
	1, 4-Dichlorobenzene	10	81-119	#N/A
	Benzene	5	78-116	#N/A
	Toluene	10	80-114	#N/A
	o-Xylene	10	81-115	#N/A
	Vinyl chloride	2	14-135	#N/A

ATTACHMENT B

US EPA METHODS
8000A
8021
5021

METHOD 8000A

GAS CHROMATOGRAPHY

METHOD 8000A

GAS CHROMATOGRAPHY

1.0 SCOPE AND APPLICATION

1.1 Gas chromatography is a quantitative analytical technique useful for organic compounds capable of being volatilized without being decomposed or chemically rearranged. Gas chromatography (GC), also known as vapor phase chromatography (VPC), has two subcategories distinguished by: gas-solid chromatography (GSC), and gas-liquid chromatography (GLC) or gas-liquid partition chromatography (GLPC). This last group is the most commonly used, distinguished by type of column adsorbent or packing.

1.2 The chromatographic methods are recommended for use only by, or under the close supervision of, experienced residue analysts.

2.0 SUMMARY OF METHOD

2.1 Each organic analytical method that follows provides a recommended technique for extraction, cleanup, and occasionally, derivatization of the samples to be analyzed. Before the prepared sample is introduced into the GC, a procedure for standardization must be followed to determine the recovery and the limits of detection for the analytes of interest. Following sample introduction into the GC, analysis proceeds with a comparison of sample values with standard values. Quantitative analysis is achieved through integration of peak area or measurement of peak height.

3.0 INTERFERENCES

3.1 Contamination by carryover can occur whenever high-concentration and low-concentration samples are sequentially analyzed. To reduce carryover, the sample syringe or purging device must be rinsed out between samples with water or solvent. Whenever an unusually concentrated sample is encountered, it should be followed by an analysis of a solvent blank or of water to check for cross contamination. For volatile samples containing large amounts of water-soluble materials, suspended solids, high boiling compounds or high organohalide concentrations, it may be necessary to wash out the syringe or purging device with a detergent solution, rinse it with distilled water, and then dry it in a 105°C oven between analyses.

4.0 APPARATUS AND MATERIALS

4.1 Gas chromatograph - Analytical system complete with gas chromatograph suitable for on-column injections and all required accessories, including detectors, column supplies, recorder, gases, and syringes. A data system for measuring peak height and/or peak areas is recommended.

4.2 Gas chromatographic columns - See the specific determinative method. Other packed or capillary (open-tubular) columns may be used if the requirements of Section 8.4 are met.

5.0 REAGENTS

5.1 See the specific determinative method for the reagents needed.

6.0 SAMPLE COLLECTION, PRESERVATION, AND HANDLING

6.1 See the introductory material to this chapter, Organic Analytes, Section 4.1.

7.0 PROCEDURE

7.1 Extraction - Adhere to those procedures specified in the referring determinative method.

7.2 Cleanup and separation - Adhere to those procedures specified in the referring determinative method.

7.3 The recommended gas chromatographic columns and operating conditions for the instrument are specified in the referring determinative method.

7.4 Calibration

7.4.1 Establish gas chromatographic operating parameters equivalent to those indicated in Section 7.0 of the determinative method of interest. Prepare calibration standards using the procedures indicated in Section 5.0 of the determinative method of interest. Calibrate the chromatographic system using either the external standard technique (Section 7.4.2) or the internal standard technique (Section 7.4.3).

7.4.2 External standard calibration procedure

7.4.2.1 For each analyte of interest, prepare calibration standards at a minimum of five concentrations by adding volumes of one or more stock standards to a volumetric flask and diluting to volume with an appropriate solvent. One of the external standards should be at a concentration near, but above, the method detection limit. The other concentrations should correspond to the expected range of concentrations found in real samples or should define the working range of the detector.

7.4.2.2 Inject each calibration standard using the technique that will be used to introduce the actual samples into the gas chromatograph (e.g. 2-5 μL injections, purge-and-trap, etc.). Tabulate peak height or area responses against the mass injected. The results can be used to prepare a calibration curve for each analyte. Alternatively, for samples that are introduced into the gas chromatograph using a syringe, the ratio of the response to the amount injected, defined as the calibration factor (CF), can be calculated for each analyte at each standard concentration. If the percent relative standard deviation (%RSD) of the calibration factor is less than 20% over the working range, linearity through the origin can be assumed, and the average calibration factor can be used in place of a calibration curve.

$$\text{Calibration factor} = \frac{\text{Total Area of Peak}^{*}}{\text{Mass injected (in nanograms)}}$$

* For multiresponse pesticides/PCBs, use the total area of all peaks used for quantitation.

7.4.2.3 The working calibration curve or calibration factor must be verified on each working day by the injection of one or more calibration standards. The frequency of verification is dependent on the detector. Detectors, such as the electron capture detector, that operate in the sub-nanogram range are more susceptible to changes in detector response caused by GC column and sample effects. Therefore, more frequent verification of calibration is necessary. The flame ionization detector is much less sensitive and requires less frequent verification. If the response for any analyte varies from the predicted response by more than $\pm$ 15%, a new calibration curve must be prepared for that analyte.

$$\text{Percent Difference} = \frac{R_1 - R_2}{R_1} \times 100$$

where:

R_1 = Calibration Factor from first analysis.

R_2 = Calibration Factor from succeeding analyses.

7.4.3 Internal standard calibration procedure

7.4.3.1 To use this approach, the analyst must select one or more internal standards that are similar in analytical behavior to the compounds of interest. The analyst must further demonstrate that the measurement of the internal standard is not affected by method or matrix interferences. Due to these limitations, no internal standard applicable to all samples can be suggested.

7.4.3.2 Prepare calibration standards at a minimum of five concentrations for each analyte of interest by adding volumes of one or more stock standards to a volumetric flask. To each calibration standard, add a known constant amount of one or more internal standards and dilute to volume with an appropriate solvent. One of the standards should be at a concentration near, but above, the method detection limit. The other concentrations should correspond to the expected range of concentrations found in real samples or should define the working range of the detector.

7.4.3.3 Inject each calibration standard using the sa... introduction technique that will be applied to the actual samples (e.g. 2 to 5 µL injection, purge-and-trap, etc.). Tabulate the peak height or area responses against the concentration of each compound and internal standard. Calculate response factors (RF) for each compound as follows:

$$RF = (A_s C_{is})/(A_{is} C_s)$$

where:

A_s = Response for the analyte to be measured.

A_{is}= Response for the internal standard.

C_{is}= Concentration of the internal standard, µg/L.

C_s = Concentration of the analyte to be measured, µg/L.

If the RF value over the working range is constant (< 20% RSD), the RF can be assumed to be invariant, and the average RF can be used for calculations. Alternatively, the results can be used to plot a calibration curve of response ratios, A_s/A_{is} versus RF.

7.4.3.4 The working calibration curve or RF must be verified on each working day by the measurement of one or more calibration standards. The frequency of verification is dependent on the detector. Detectors, such as the electron capture detector, that operate in the sub-nanogram range are more susceptible to changes in detector response caused by GC column and sample effects. Therefore, more frequent verification of calibration is necessary. The flame ionization detector is much less sensitive and requires less frequent verification. If the response for any analyte varies from the predicted response by more than ± 15%, a new calibration curve must be prepared for that compound. For methods 8010, 8020, and 8030, see Table 3 in each method for calibration and quality control acceptance criteria.

7.5 Retention time windows

7.5.1 Before establishing windows, make sure the GC system is within optimum operating conditions. Make three injections of all single component standard mixtures and multiresponse products (i.e. PCBs) throughout the course of a 72 hour period. Serial injections over less than a 72 hour period result in retention time windows that are too tight.

7.5.2 Calculate the standard deviation of the three absolute retention times for each single component standard. For multiresponse products, choose one major peak from the envelope and calculate the standard deviation of the three retention times for that peak. The peak chosen should be fairly immune to losses due to degradation and weathering in samples.

7.5.2.1 Plus or minus three times the standard deviation of the absolute retention times for each standard will be used to define the retention time window; however, the experience of the analyst should weigh heavily in the interpretation of chromatograms. For multiresponse analytes (i.e. PCBs), the analyst should use the retention time window, but should primarily rely on pattern recognition.

7.5.2.2 In those cases where the standard deviation for a particular standard is zero, the laboratory must substitute the standard deviation of a close eluting, similar compound to develop a valid retention time window.

7.5.3 The laboratory must calculate retention time windows for each standard on each GC column and whenever a new GC column is installed. The data must be retained by the laboratory.

7.6 Gas chromatographic analysis

7.6.1 Introduction of organic compounds into the gas chromatograph varies depending on the volatility of the compound. Volatile organics are primarily introduced by purge-and-trap (Method 5030). However, there are limited applications (in Method 5030) where direct injection is acceptable. Use of Method 3810 or 3820 as a screening technique for volatile organic analysis may be valuable with some sample matrices to prevent overloading and contamination of the GC systems. Semivolatile organics are introduced by direct injection.

7.6.2 The appropriate detector(s) is given in the specific method.

7.6.3 Samples are analyzed in a set referred to as an analysis sequence. The sequence begins with instrument calibration followed by sample extracts interspersed with multi-concentration calibration standards. The sequence ends when the set of samples has been injected or when qualitative and/or quantitative QC criteria are exceeded.

7.6.4 Direct Injection - Inject 2-5 μL of the sample extract using the solvent flush technique, if the extract is manually injected. Smaller volumes (1.0 μL) can be injected, and the solvent flush technique is not required, if automatic devices are employed. Record the volume injected to the nearest 0.05 μL and the resulting peak size in area units or peak height.

7.6.5 If the responses exceed the linear range of the system, dilute the extract and reanalyze. It is recommended that extracts be diluted so that all peaks are on scale. Overlapping peaks are not always evident when peaks are off scale. Computer reproduction of chromatograms, manipulated to ensure all peaks are on scale over a 100-fold range, are acceptable if linearity is demonstrated. Peak height measurements are recommended over peak area integration when overlapping peaks cause errors in area integration.

7.6.6 If peak detection is prevented by the presence of interferences, further cleanup is required.

7.6.7 Examples of chromatograms for the compounds of interest are frequently available in the referring analytical method.

7.6.8 Calibrate the system immediately prior to conducting any analyses (see Section 7.4). A mid-concentration standard must also be injected at intervals specified in the method and at the end of the analysis sequence. The calibration factor for each analyte to be quantitated, must not exceed a 15% difference when compared to the initial standard of the analysis sequence. When this criteria is exceeded, inspect the GC system to determine the cause and perform whatever maintenance is necessary (see Section 7.7) before recalibrating and proceeding with sample analysis. All samples that were injected after the standard exceeding the criteria must be reinjected, if the initial analysis indicated the presence of the specific target analytes that exceeded the criteria.

7.6.9 Establish daily retention time windows for each analyte. Use the absolute retention time for each analyte from Section 7.6.8 as the midpoint of the window for that day. The daily retention time window equals the midpoint $\pm$ three times the standard deviation determined in Section 7.5.

7.6.9.1 Tentative identification of an analyte occurs when a peak from a sample extract falls within the daily retention time window. Normally, confirmation is required: on a second GC column, by GC/MS if concentration permits, or by other recognized confirmation techniques. Confirmation may not be necessary if the composition of the sample matrix is well established by prior analyses.

7.6.9.2 Validation of GC system qualitative performance: Use the mid-concentration standards interspersed throughout the analysis sequence (Section 7.6.8) to evaluate this criterion. If any of the standards fall outside their daily retention time window, the system is out of control. Determine the cause of the problem and correct it (see Section 7.7).

7.7 Suggested chromatography system maintenance - Corrective measures may require any one or more of the following remedial actions.

7.7.1 Packed columns - For instruments with injection port traps, replace the demister trap, clean, and deactivate the glass injection port insert or replace with a cleaned and deactivated insert. Inspect the injection end of the column and remove any foreign material (broken glass from the rim of the column or pieces of septa). Replace the glass wool with fresh deactivated glass wool. Also, it may be necessary to remove the first few millimeters of the packing material if any discoloration is noted, also swab out the inside walls of the column if any residue is noted. If these procedures fail to eliminate the degradation problem, it may be necessary to deactivate the metal injector body (described in Section 7.7.3) and/or repack/replace the column.

7.7.2 Capillary columns - Clean and deactivate the glass injection port insert or replace with a cleaned and deactivated insert. Break off the first few inches, up to one foot, of the injection port side of the column. Remove the column and solvent backflush according to the manufacturer's instructions. If these procedures fail to eliminate the degradation problem, it may be necessary to deactivate the metal injector body and/or replace the column.

7.7.3 Metal injector body - Turn off the oven and remove the analytical column when the oven has cooled. Remove the glass injection port insert (instruments with off-column injection or Grob). Lower the injection port temperature to room temperature. Inspect the injection port and remove any noticeable foreign material.

7.7.3.1 Place a beaker beneath the injector port inside the GC oven. Using a wash bottle, serially rinse the entire inside of the injector port with acetone and then toluene; catching the rinsate in the beaker.

7.7.3.2 Prepare a solution of deactivating agent (Sylon-CT or equivalent) following manufacturer's directions. After all metal surfaces inside the injector body have been thoroughly coated with the deactivation solution, serially rinse the injector body with toluene, methanol, acetone, and hexane. Reassemble the injector and replace the GC column.

7.8 Calculations

7.8.1 External standard calibration - The concentration of each analyte in the sample may be determined by calculating the amount of standard purged or injected, from the peak response, using the calibration curve or the calibration factor determined in Section 7.4.2. The concentration of a specific analyte is calculated as follows:

<u>Aqueous samples</u>

$$\text{Concentration } (\mu g/L) = [(A_x)(A)(V_t)(D)]/[(A_s)(V_i)(V_s)]$$

where:

A_x = Response for the analyte in the sample, units may be in area counts or peak height.

A = Amount of standard injected or purged, ng.

A_s = Response for the external standard, units same as for A_x.

V_i = Volume of extract injected, μL. For purge-and-trap analysis, V_i is not applicable and therefore = 1.

D = Dilution factor, if dilution was made on the sample prior to analysis. If no dilution was made, D = 1, dimensionless.

V_t = Volume of total extract, μL. For purge-and-trap analysis, V_t is not applicable and therefore = 1.

V_s = Volume of sample extracted or purged, mL.

<u>Nonaqueous samples</u>

Concentration (μg/Kg) = $[(A_x)(A)(V_t)(D)]/[(A_s)(V_i)(W)]$

where:

W = Weight of sample extracted or purged, g. The wet weight or dry weight may be used, depending upon the specific applications of the data.

A_x, A_s, A, V_t, D, and V_i have the same definition as for aqueous samples.

7.8.2 Internal standard calibration - For each analyte of interest, the concentration of that analyte in the sample is calculated as follows:

<u>Aqueous samples</u>

Concentration (μg/L) = $[(A_x)(C_{is})(D)]/[(A_{is})(RF)(V_s)]$

where:

A_x = Response of the analyte being measured, units may be in area counts or peak height.

C_{is} = Amount of internal standard added to extract or volume purged, ng.

D = Dilution factor, if a dilution was made on the sample prior to analysis. If no dilution was made, D = 1, dimensionless.

A_{is} = Response of the internal standard, units same as A_x.

RF = Response factor for analyte, as determined in Section 7.4.3.3.

V_s = Volume of water extracted or purged, mL.

<u>Nonaqueous samples</u>

Concentration (μg/Kg) = $[(A_s)(C_{is})(D)]/[(A_{is})(RF)(W_s)]$

where:

W_s = Weight of sample extracted, g. Either a dry weight or wet weight may be used, depending upon the specific application of the data.

A_s, C_{is}, D, A_{is}, and RF have the same definition as for aqueous samples.

8.0 QUALITY CONTROL

8.1 Refer to Chapter One for specific quality control procedures.

8.2 The experience of the analyst in performing gas chromatography is invaluable to the success of the methods.

8.2.1 Each day that analysis is performed, the daily calibration sample should be evaluated to determine if the chromatographic system is operating properly. Questions that should be asked are: Do the peaks look normal?; Is the response obtained comparable to the response from previous calibrations? Careful examination of the standard chromatogram can indicate whether the column is still good, the injector is leaking, the injector septum needs replacing, etc. If any changes are made to the system (e.g. column changed), recalibration of the system must take place.

8.2.2 The performance of the entire analytical system should be checked daily, using data gathered from analyses of blanks, standards, and replicate samples. Significant peak tailing must be corrected. Tailing problems are generally traceable to active sites on the GC column or to the detector operation.

8.2.3 The precision between replicate analyses of standards and check samples should be evaluated. A properly operating system should perform with an average relative standard deviation of less than 10%. Poor precision is generally traceable to pneumatic leaks, especially at the injection port.

8.3 Required instrument QC

8.3.1 Section 7.4 requires that the %RSD vary by < 20% when comparing calibration factors to determine if a five point calibration curve is linear.

8.3.2 Section 7.4 sets a limit of ± 15% difference when comparing daily response of a given analyte versus the initial response. If the limit is exceeded, a new standard curve must be prepared.

8.3.3 Section 7.5 requires the establishment of retention time windows.

8.3.4 Section 7.6.8 sets a limit of ± 15% difference when comparing the initial response of a given analyte versus any succeeding standards analyzed during an analysis sequence.

8.3.5 Section 7.6.9.2 requires that all succeeding standards in an analysis sequence must fall within the daily retention time window established by the first standard of the sequence.

8.4 To establish the ability to generate data of acceptable bias and precision, the analyst must perform the following operations:

8.4.1 A quality control (QC) check sample concentrate is required containing each analyte of interest. The QC check sample concentrate may be prepared from pure standard materials, or purchased as certified solutions. If prepared by the laboratory, the QC check sample concentrate must be made using stock standards prepared independently from those used for calibration.

8.4.1.1 The concentration of the QC check sample concentrate is highly dependent upon the analytes being investigated. Therefore, refer to Method 3500, Section 8.0 for the required concentration of the QC check sample concentrate.

8.4.2 Preparation of QC check samples

8.4.2.1 Volatile organic analytes - Prepare the QC check sample by adding 200 μL of the QC check sample concentrate (Section 8.4.1) to 100 mL of water.

8.4.2.2 Semivolatile organic analytes - Prepare the QC check sample by adding 1.0 mL of the QC check sample concentrate (Section 8.4.1) to each of four 1 L aliquots of water.

8.4.3 Analyze replicate aliquots (at least four) of the well mixed QC check sample by the same procedures used to analyze actual samples (Section 7.0 of each of the methods). For volatile organics, the preparation/analysis process is purge-and-trap/gas chromatography, or direct injection/gas chromatography. For semivolatile organics, the QC check samples must undergo solvent extraction (see Method 3500) prior to chromatographic analysis.

8.4.4 Calculate the average recovery ($\bar{x}$) in μg/L, and the standard deviation of the recovery (s) in μg/L, for each analyte of interest using the four results.

8.4.5 For each analyte compare s and $\bar{x}$ with the corresponding acceptance criteria for precision and accuracy, respectively, given in the QC Acceptance Criteria Table at the end of each of the determinative methods. If s and $\bar{x}$ for all analytes of interest meet the acceptance criteria, the system performance is acceptable and analysis of actual samples can begin. If any individual s exceeds the precision limit or any individual $\bar{x}$ falls outside the range for accuracy, then the system performance is unacceptable for that analyte.

NOTE: The large number of analytes in each of the QC Acceptance Criteria Tables present a substantial probability that one or more will fail at least one of the acceptance criteria when all analytes of a given method are determined.

8.4.6 When one or more of the analytes tested fail at least one of the acceptance criteria, the analyst must proceed according to Section 8.4.6.1 or 8.4.6.2.

8.4.6.1 Locate and correct the source of the problem and repeat the test for all analytes of interest beginning with Section 8.4.2.

8.4.6.2 Beginning with Section 8.4.2, repeat the test only for those analytes that failed to meet criteria. Repeated failure, however, will confirm a general problem with the measurement system. If this occurs, locate and correct the source of the problem and repeat the test for all compounds of interest beginning with Section 8.4.2.

8.5 The laboratory must have procedures for documenting the effect of the matrix on method performance, including the analysis of at least one matrix spike and either one matrix duplicate or one matrix spike duplicate per analytical batch.

8.5.1 The concentration of the spike in the sample should be determined as follows:

8.5.1.1 If, as in compliance monitoring, the concentration of a specific analyte in the sample is being checked against a regulatory concentration limit, the spike should be at that limit, or 1 to 5 times higher than the background concentration determined in Section 8.5.2, whichever concentration would be larger.

8.5.1.2 If the concentration of a specific analyte in a water sample is not being checked against a limit specific to that analyte, the spike should be at the same concentration as the QC reference sample (Section 8.4.2) or 1 to 5 times higher than the background concentration determined in Section 8.5.2, whichever concentration would be larger. For other matrices, the recommended spiking concentration is 20 times the estimated quantitation limit (EQL).

8.5.1.3 For semivolatile organics, it may not be possible to determine the background concentrations prior to spiking (e.g. maximum holding times will be exceeded). If this is the case, the spike concentration should be (1) the regulatory concentration limit, if any; or, if none (2) the larger of either 5 times higher than the expected background concentration or the QC reference sample concentration (Section 8.4.2). For other matrices, the recommended spiking concentration is 20 times the EQL.

8.5.2 Analyze one unspiked and one spiked sample aliquot to determine percent recovery of each of the spiked compounds.

8.5.2.1 Volatile organics - Analyze one 5 mL sample aliquot to determine the background concentration of each analyte. If necessary, prepare a new QC reference sample concentrate (Section 8.4.1) appropriate for the background concentration in the sample. Spike a second 5 mL sample aliquot with 10 μL of the QC reference sample concentrate and analyze it to determine the concentration after spiking of each analyte. Calculate each percent recovery (%R) as:

$$\%R = 100\ (x_s - x_u)/\ K,$$

where: x_s = measured value for spiked sample,
x_u = measured value for unspiked sample, and
K = known value of the spike in the sample.

8.5.2.2 Semivolatile organics - Analyze one sample aliquot (extract of 1 L sample) to determine the background concentration of each analyte. If necessary, prepare a new QC reference sample concentrate (Section 8.4.1) appropriate for the background concentration in the sample. Spike a second 1 L sample aliquot with 1.0 mL of the QC reference sample concentrate and analyze it to determine the concentration after spiking of each analyte. Calculate each percent recovery according to the calculation in Section 8.5.2.1.

8.5.3 Compare the percent recovery (%R) for each analyte in a water sample with the corresponding criteria presented in the QC Acceptance Criteria Table found at the end of each of the determinative methods. These acceptance criteria were calculated to include an allowance for error in measurement of both the background and spike concentrations, assuming a spike to background ratio of 5:1. This error will be accounted for to the extent that the analyst's spike to background ratio approaches 5:1. If spiking was performed at a concentration lower than the QC reference sample concentration (Section 8.4.2), the analyst must use either the QC acceptance criteria presented in the Tables, or optional QC acceptance criteria calculated for the specific spike concentration. To calculate optional acceptance criteria for the recovery of an analyte: (1) Calculate accuracy (x') using the equation found in the Method Accuracy and Precision as a Function of Concentration Table (appears at the end of each determinative method), substituting the spike concentration (T) for C; (2) calculate overall precision (S') using the equation in the same Table, substituting x' for $\bar{x}$; (3) calculate the range for recovery at the spike concentration as $(100x'/T) \pm 2.44(100S'/T)\%$.

8.5.4 If any individual %R falls outside the designated range for recovery, that analyte has failed the acceptance criteria. A check standard containing each analyte that failed the criteria must be analyzed as described in Section 8.6.

8.6 If any analyte in a water sample fails the acceptance criteria for recovery in Section 8.5, a QC reference standard containing each analyte that failed must be prepared and analyzed.

<u>NOTE</u>: The frequency for the required analysis of a QC reference standard will depend upon the number of analytes being simultaneously tested, the

complexity of the sample matrix, and the performance of the laboratory. If the entire list of analytes given in a method must be measured in the sample in Section 8.5, the probability that the analysis of a QC check standard will be required is high. In this case, the QC check standard should be routinely analyzed with the spiked sample.

8.6.1 Preparation of the QC check sample - For volatile organics, add 10 µL of the QC check sample concentrate (Section 8.4.1) to 5 mL of water. For semivolatile organics, add 1.0 mL of the QC check sample concentrate (Section 8.4.1) to 1 L of water. The QC check sample needs only to contain the analytes that failed criteria in the test in Section 8.5. Prepare the QC check sample for analysis following the guidelines given in Method 3500 (e.g. purge-and-trap, extraction, etc.).

8.6.2 Analyze the QC check sample to determine the concentration measured of each analyte. Calculate each percent recovery (%R) as

$$\%R = 100\ (x_t/T),$$

where: x_t = measured value for reference value,
T = true value of the standard concentration.

8.6.3 Compare the percent recovery (%R) for each analyte with the corresponding QC acceptance criteria found in the appropriate Table in each of the methods. Only analytes that failed the test in Section 8.5 need to be compared with these criteria. If the recovery of any such analyte falls outside the designated range, the laboratory performance for that analyte is judged to be out of control, and the problem must be immediately identified and corrected.

8.7 Procedures for determination of acceptable bias and precision

8.7.1 For aqueous and soil matrices, these laboratory established surrogate control limits should, if applicable, be compared with the control limits presented in Methods 8240 and 8270. The limits given in these methods are multi-laboratory performance based limits for soil and aqueous samples, and therefore, the established single-laboratory limits must fall within those given for these matrices.

8.7.2 If recovery is not within limits, the following are required.

8.7.2.1 Check to be sure that there are no errors in the calculations, surrogate solutions or internal standards. If errors are found, recalculate the data accordingly.

8.7.2.2 Check instrument performance. If an instrument performance problem is identified, correct the problem and re-analyze the extract.

8.7.2.3 If no problem is found, re-extract and re-analyze the sample.

8.7.2.4 If, upon re-analysis, the recovery is again not within limits, flag the data as "estimated concentration".

8.8 It is recommended that the laboratory adopt additional quality assurance practices for use with this method. The specific practices that are most productive depend upon the needs of the laboratory, the nature of the samples, and project-specific requirements. Field duplicates may be analyzed to assess the precision of the environmental measurements. When doubt exists over the identification of a peak on the chromatogram, confirmatory techniques such as gas chromatography with a dissimilar column, specific element detector, or mass spectrometer must be used. Whenever possible, the laboratory should analyze standard reference materials and participate in relevant performance evaluation studies.

9.0 METHOD PERFORMANCE

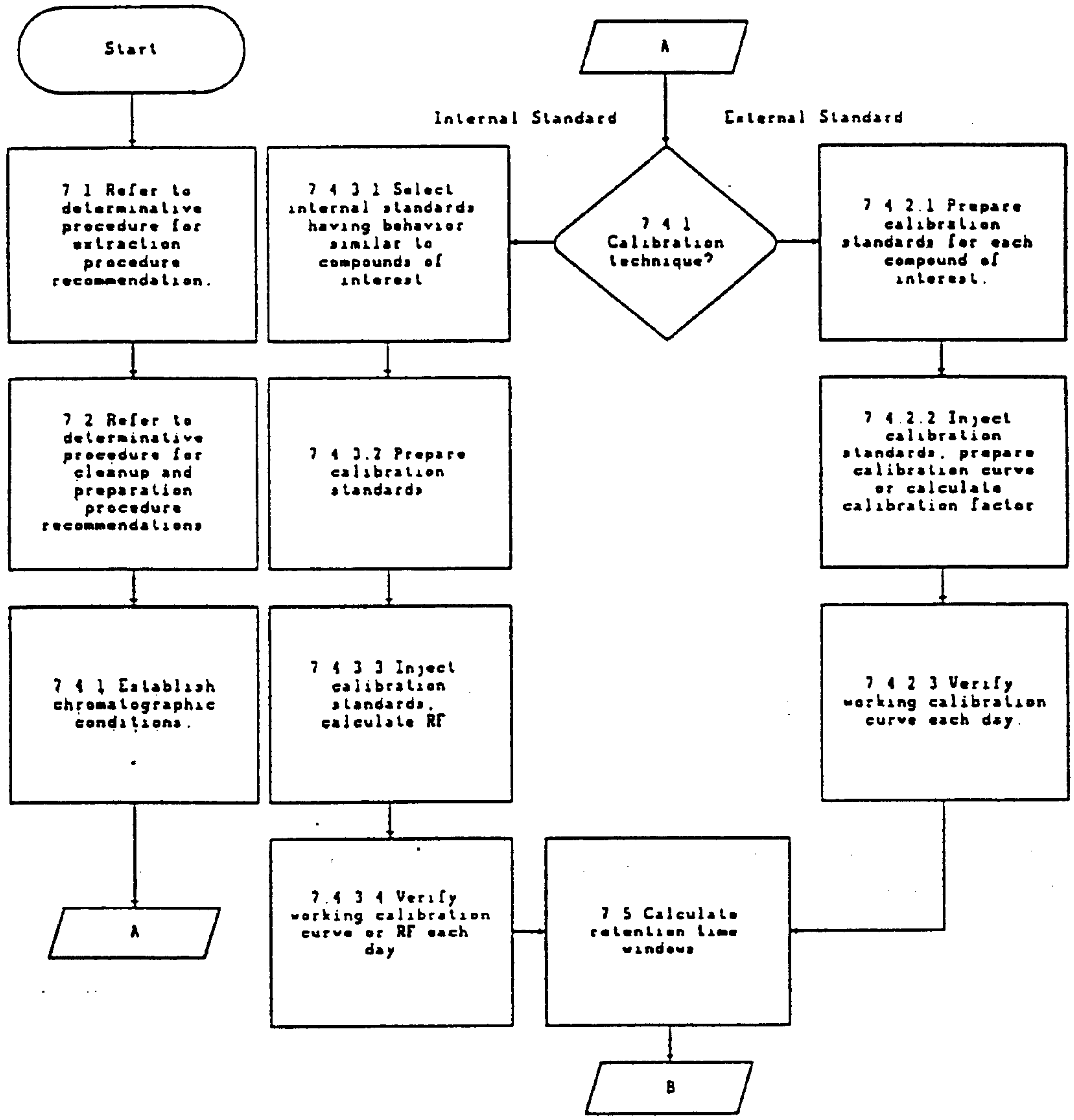
9.1 The method detection limit (MDL) is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the value is above zero. The MDL concentrations listed in the referring analytical methods were obtained using water. Similar results were achieved using representative wastewaters. The MDL actually achieved in a given analysis will vary depending on instrument sensitivity and matrix effects.

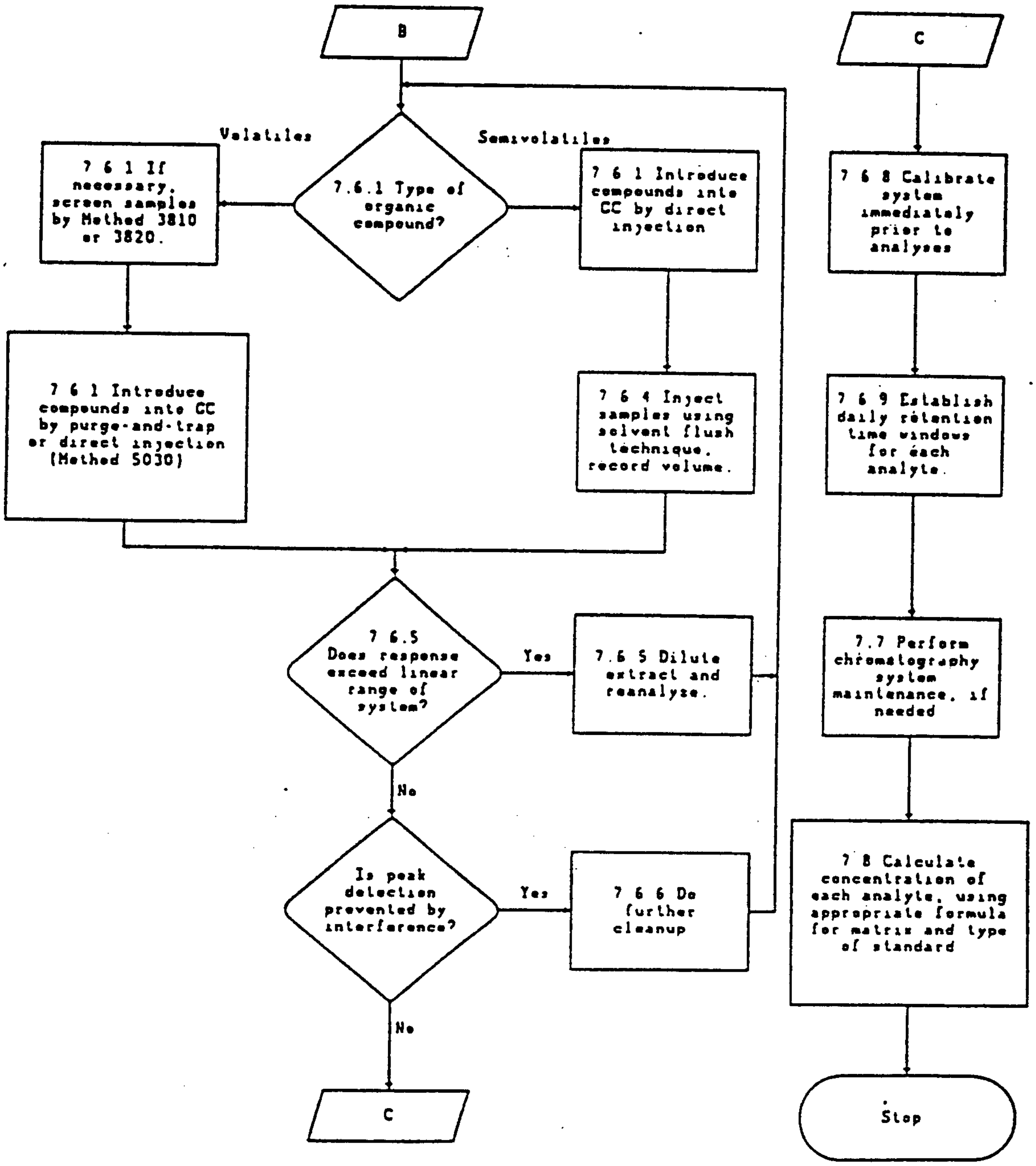
9.2 Refer to the determinative method for specific method performance information.

10.0 REFERENCES

1. U.S. EPA 40 CFR Part 136, "Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act; Final Rule and Interim Final Rule and Proposed Rule," October 26, 1984.

2. U.S. EPA Contract Laboratory Program, Statement of Work for Organic Analysis, July 1985, Revision.


Start
7 1 Refer to determinative procedure for extraction procedure recommendation.
7 2 Refer to determinative procedure for cleanup and preparation procedure recommendations
7 4 1 Establish chromatographic conditions.
A
7 4 3 1 Select internal standards having behavior similar to compounds of interest
7 4 3.2 Prepare calibration standards
7 4 3 3 Inject calibration standards, calculate RF
7.4 3 4 Verify working calibration curve or RF each day
A
Internal Standard
External Standard
7 4 1 Calibration technique?
7 4 2.1 Prepare calibration standards for each compound of interest.
7 4.2.2 Inject calibration standards, prepare calibration curve or calculate calibration factor
7 4 2 3 Verify working calibration curve each day.
7 5 Calculate retention time windows
B


B
Volatiles
Semivolatiles
7.6.1 Type of organic compound?
7 6 1 If necessary, screen samples by Method 3810 or 3820.
7 6 1 Introduce compounds into GC by direct injection
7 6 1 Introduce compounds into GC by purge-and-trap or direct injection (Method 5030)
7 6 4 Inject samples using solvent flush technique, record volume.
7 6.5 Does response exceed linear range of system?
Yes
7.6 5 Dilute extract and reanalyze.
No
Is peak detection prevented by interference?
Yes
7 6 6 Do further cleanup
No
C
C
7 6 8 Calibrate system immediately prior to analyses
7 6 9 Establish daily retention time windows for each analyte.
7.7 Perform chromatography system maintenance, if needed
7 8 Calculate concentration of each analyte, using appropriate formula for matrix and type of standard
Stop

METHOD 8021

HALOGENATED AND AROMATIC VOLATILES BY GAS CHROMATOGRAPHY USING ELECTROLYTIC CONDUCTIVITY AND PHOTOIONIZATION DETECTORS IN SERIES: CAPILLARY TECHNIQUE

METHOD 8021

HALOGENATED AND AROMATIC VOLATILES BY GAS CHROMATOGRAPHY USING ELECTROLYTIC CONDUCTIVITY AND PHOTOIONIZATION DETECTORS IN SERIES: CAPILLARY TECHNIQUE

1.0 SCOPE AND APPLICATION

1.1 Method 8021 is used to determine volatile organic compounds in a variety of solid waste matrices. This method is applicable to nearly all types of samples, regardless of water content, including ground water, aqueous sludges, caustic liquors, acid liquors, waste solvents, oily wastes, mousses, tars, fibrous wastes, polymeric emulsions, filter cakes, spent carbons, spent catalysts, soils, and sediments. The following compounds can be determined by this method:

		Appropriate Technique	
Analyte	CAS No.[a]	Purge-and-Trap	Direct Injection
Benzene	71-43-2	b	b
Bromobenzene	108-86-1	b	b
Bromochloromethane	74-97-5	b	b
Bromodichloromethane	75-27-4	b	b
Bromoform	75-25-2	b	b
Bromomethane	74-83-9	b	b
n-Butylbenzene	104-51-8	b	b
sec-Butylbenzene	135-98-8	b	b
tert-Butylbenzene	98-06-6	b	b
Carbon tetrachloride	56-23-5	b	b
Chlorobenzene	108-90-7	b	b
Chlorodibromomethane	124-48-1	b	b
Chloroethane	75-00-3	b	b
Chloroform	67-66-3	b	b
Chloromethane	74-87-3	b	b
2-Chlorotoluene	95-49-8	b	b
4-Chlorotoluene	106-43-4	b	b
1,2-Dibromo-3-chloropropane	96-12-8	pp	b
1,2-Dibromoethane	106-93-4	b	b
Dibromomethane	74-95-3	b	b
1,2-Dichlorobenzene	95-50-1	b	b
1,3-Dichlorobenzene	541-73-1	b	b
1,4-Dichlorobenzene	106-46-7	b	b
Dichlorodifluoromethane	75-71-8	b	b
1,1-Dichloroethane	75-34-3	b	b
1,2-Dichloroethane	107-06-2	b	b
1,1-Dichloroethene	75-35-4	b	b
cis-1,2-Dichloroethene	156-59-4	b	b
trans-1,2-Dichloroethene	156-60-5	b	b

Analyte	CAS No.[a]	Appropriate Technique Purge-and-Trap	Appropriate Technique Direct Injection
1,2-Dichloropropane	78-87-5	b	b
1,3-Dichloropropane	142-28-9	b	b
2,2-Dichloropropane	590-20-7	b	b
1,1-Dichloropropene	563-58-6	b	b
cis-1,3-dichloropropene	10061-01-5	b	b
trans-1,3-dichloropropene	10061-02-6	b	b
Ethylbenzene	100-41-4	b	b
Hexachlorobutadiene	87-68-3	b	b
Isopropylbenzene	98-82-8	b	b
p-Isopropyltoluene	99-87-6	b	b
Methylene chloride	75-09-2	b	b
Naphthalene	91-20-3	b	b
n-Propylbenzene	103-65-1	b	b
Styrene	100-42-5	b	b
1,1,1,2-Tetrachloroethane	630-20-6	b	b
1,1,2,2-Tetrachloroethane	79-34-5	b	b
Tetrachloroethene	127-18-4	b	b
Toluene	108-88-3	b	b
1,2,3-Trichlorobenzene	87-61-6	b	b
1,2,4-Trichlorobenzene	120-82-1	b	b
1,1,1-Trichloroethane	71-55-6	b	b
1,1,2-Trichloroethane	79-00-5	b	b
Trichloroethene	79-01-6	b	b
Trichlorofluoromethane	75-69-4	b	b
1,2,3-Trichloropropane	96-18-4	b	b
1,2,4-Trimethylbenzene	95-63-6	b	b
1,3,5-Trimethylbenzene	108-67-8	b	b
Vinyl chloride	75-01-4	b	b
o-Xylene	95-47-6	b	b
m-Xylene	108-38-3	b	b
p-Xylene	106-42-3	b	b

a Chemical Abstract Services Registry Number.
b Adequate response by this technique.
pp Poor purging efficiency resulting in high EQLs.
i Inappropriate technique for this analyte.
pc Poor chromatographic behavior.

1.2 Method detection limits (MDLs) are compound dependent and vary with purging efficiency and concentration. The MDLs for selected analytes are presented in Table 1. The applicable concentration range of this method is compound and instrument dependent but is approximately 0.1 to 200 μg/L. Analytes that are inefficiently purged from water will not be detected when present at low concentrations, but they can be measured with acceptable accuracy and precision when present in sufficient amounts. Determination of some structural isomers (i.e. xylenes) may be hampered by coelution.

1.3 The estimated quantitation limit (EQL) of Method 8021 for an individual compound is approximately 1 µg/Kg (wet weight) for soil/sediment samples, 0.1 mg/Kg (wet weight) for wastes, and 1 µg/L for ground water (see Table 3). EQLs will be proportionately higher for sample extracts and samples that require dilution or reduced sample size to avoid saturation of the detector.

1.4 This method is recommended for use only by analysts experienced in the measurement of purgeable organics at low µg/L concentrations, or by experienced technicians under the close supervision of a qualified analyst.

1.5 The toxicity or carcinogenicity of chemicals used in this method has not been precisely defined. Each chemical should be treated as a potential health hazard, and exposure to these chemicals should be minimized. Each laboratory is responsible for maintaining awareness of OSHA regulations regarding safe handling of chemicals used in this method. Additional references to laboratory safety are available for the information of the analyst (references 4 and 6).

1.6 The following method analytes have been tentatively classified as known or suspected human or mammalian carcinogens: benzene, carbon tetrachloride, 1,4-dichlorobenzene, 1,2-dichloroethane, hexachloro-butadiene, 1,1,2,2-tetrachloroethane, 1,1,2-trichloroethane, chloroform, 1,2-dibromoethane, tetrachloroethene, trichloroethene, and vinyl chloride. Pure standard materials and stock standard solutions of these compounds should be handled in a hood. A NIOSH/MESA approved toxic gas respirator should be worn when the analyst handles high concentrations of these toxic compounds.

2.0 SUMMARY OF METHOD

2.1 Method 8021 provides gas chromatographic conditions for the detection of halogenated and aromatic volatile organic compounds. Samples can be analyzed using direct injection or purge-and-trap (Method 5030). Ground water samples must be analyzed using Method 5030 (where applicable). A temperature program is used in the gas chromatograph to separate the organic compounds. Detection is achieved by an electrolytic conductivity detector (HECD) and a photoionization detector (PID) in series.

2.2 Tentative identifications are obtained by analyzing standards under the same conditions used for samples and comparing resultant GC retention times. Confirmatory information can be gained by comparing the relative response from the two detectors. Concentrations of the identified components are measured by relating the response produced for that compound to the response produced by a compound that is used as an internal standard.

3.0 INTERFERENCES

3.1 Refer to Methods 5030 and 8000.

3.2 Samples can be contaminated by diffusion of volatile organics (particularly chlorofluorocarbons and methylene chloride) through the sample container septum during shipment and storage. A trip blank prepared from organic-free reagent water and carried through sampling and subsequent storage and handling can serve as a check on such contamination.

4.0 APPARATUS AND MATERIALS

4.1 Sample introduction apparatus - Refer to Method 5030 for the appropriate equipment for sample introduction purposes.

4.2 Gas Chromatograph - capable of temperature programming; equipped with variable-constant differential flow controllers, subambient oven controller, photoionization and electrolytic conductivity detectors connected with a short piece of uncoated capillary tubing, 0.32-0.5 mm ID, and data system.

4.2.1 Column - 60 m x 0.75 mm ID VOCOL wide-bore capillary column with 1.5 μm film thickness (Supelco Inc., or equivalent).

4.2.2 Photoionization detector (PID) (Tracor Model 703, or equivalent).

4.2.3 Electrolytic conductivity detector (HECD) (Tracor Hall Model 700-A, or equivalent).

4.3 Syringes - 5 mL glass hypodermic with Luer-Lok tips.

4.4 Syringe valves - 2-way with Luer ends (Teflon or Kel-F).

4.5 Microsyringe - 25 μL with a 2 in. x 0.006 in. ID, 22° bevel needle (Hamilton #702N or equivalent).

4.6 Microsyringes - 10, 100 μL.

4.7 Syringes - 0.5, 1.0, and 5 mL, gas tight with shut-off valve.

4.8 Bottles - 15 mL, Teflon lined with screw-cap or crimp top.

4.9 Analytical balance - 0.0001 g.

4.10 Refrigerator.

4.11 Volumetric flasks, Class A - 10 to 1000 mL.

5.0 REAGENTS

5.1 Reagent grade inorganic chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all inorganic reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available. Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

5.2 Organic-free reagent water. All references to water in this method refer to organic-free reagent water, as defined in Chapter One.

5.3 Methanol, CH_3OH - Pesticide quality or equivalent, demonstrated to be free of analytes. Store away from other solvents.

5.4 Vinyl chloride, (99.9% pure), CH_2=CHCl. Vinyl chloride is available from Ideal Gas Products, Inc., Edison, New Jersey and from Matheson, East Rutherford, New Jersey, as well as from other sources. Certified mixtures of vinyl chloride in nitrogen at 1.0 and 10.0 ppm (v/v) are available from several sources.

5.5 Stock standards - Stock solutions may either be prepared from pure standard materials or purchased as certified solutions. Prepare stock standards in methanol using assayed liquids or gases, as appropriate. Because of the toxicity of some of the organohalides, primary dilutions of these materials of the toxicity should be prepared in a hood.

5.5.1 Place about 9.8 mL of methanol in a 10 mL tared ground glass stoppered volumetric flask. Allow the flask to stand, unstoppered, for about 10 minutes until all alcohol-wetted surfaces have dried. Weigh the flask to the nearest 0.1 mg.

5.5.2 Add the assayed reference material, as described below.

5.5.2.1 Liquids: Using a 100 μL syringe, immediately add two or more drops of assayed reference material to the flask; then reweigh. The liquid must fall directly into the alcohol without contacting the neck of the flask.

5.5.2.2 Gases: To prepare standards for any compounds that boil below 30°C (e.g. bromomethane, chloroethane, chloromethane, dichlorodifluoromethane, trichlorofluoromethane, vinyl chloride), fill a 5 mL valved gas-tight syringe with the reference standard to the 5.0 mL mark. Lower the needle to 5 mm above the methanol meniscus. Slowly introduce the reference standard above the surface of the liquid. The heavy gas rapidly dissolves in the methanol. This may also be accomplished by using a lecture bottle equipped with a Hamilton Lecture Bottle Septum (#86600). Attach Teflon tubing to the side-arm relief valve and direct a gentle stream of gas into the methanol meniscus.

5.5.3 Reweigh, dilute to volume, stopper, and then mix by inverting the flask several times. Calculate the concentration in milligrams per liter (mg/L) from the net gain in weight. When compound purity is assayed to be 96% or greater, the weight may be used without correction to calculate the concentration of the stock standard. Commercially prepared stock standards may be used at any concentration if they are certified by the manufacturer or by an independent source.

5.5.4 Transfer the stock standard solution into a bottle with a Teflon lined screw-cap or crimp top. Store, with minimal headspace, at -10°C to -20°C and protect from light.

5.5.5 Prepare fresh stock standards every two months for gases. Reactive compounds such as 2-chloroethylvinyl ether and styrene may need to be prepared more frequently. All other standards must be replaced after six months. Both gas and liquid standards must be monitored closely by comparison to the initial calibration curve and by comparison to QC reference samples. It may be necessary to replace the standards more frequently if either check exceeds a 25% difference.

5.6 Prepare secondary dilution standards, using stock standard solutions, in methanol, as needed, that contain the compounds of interest, either singly or mixed together. The secondary dilution standards should be prepared at concentrations such that the aqueous calibration standards prepared in Section 5.7 will bracket the working range of the analytical system. Secondary dilution standards should be stored with minimal headspace for volatiles and should be checked frequently for signs of degradation or evaporation, especially just prior to preparing calibration standards from them.

5.7 Calibration standards, at a minimum of five concentrations are prepared in organic-free reagent water from the secondary dilution of the stock standards. One of the concentrations should be at a concentration near, but above, the method detection limit. The remaining concentrations should correspond to the expected range of the concentrations found in real samples or should define the working range of the GC. Standards (one or more) should contain each analyte for detection by this method (e.g. some or all of the target analytes may be included). In order to prepare accurate aqueous standard solutions, the following precautions must be observed.

5.7.1 Do not inject more than 20 μL of alcoholic standards into 100 mL of water.

5.7.2 Use a 25 μL Hamilton 702N microsyringe or equivalent (variations in needle geometry will adversely affect the ability to deliver reproducible volumes of methanolic standards into water).

5.7.3 Rapidly inject the alcoholic standard into the filled volumetric flask. Remove the needle as fast as possible after injection.

5.7.4 Mix aqueous standards by inverting the flask three times.

5.7.5 Fill the sample syringe from the standard solution contained in the expanded area of the flask (do not use any solution contained in the neck of the flask).

5.7.6 Never use pipets to dilute or transfer samples or aqueous standards.

5.7.7 Aqueous standards are not stable and should be discarded after one hour, unless properly sealed and stored. The aqueous standards can be stored up to 12 hours, if held in sealed vials with zero headspace.

5.8 Internal standards - Prepare a spiking solution containing fluorobenzene and 2-bromo-1-chloropropane in methanol, using the procedures described in Sections 5.5 and 5.6. It is recommended that the secondary dilution standard be prepared at a concentration of 5 mg/L of each internal standard compound. The addition of 10 µL of such a standard to 5.0 mL of sample or calibration standard would be equivalent to 10 µg/L.

5.9 Surrogate standards - The analyst should monitor both the performance of the analytical system and the effectiveness of the method in dealing with each sample matrix by spiking each sample, standard, and reagent blank with two or more surrogate compounds. A combination of bromochloromethane, 2-bromo-1-chloropropane and 1,4-dichlorobutane is recommended to encompass the range of the temperature program used in this method. From stock standard solutions prepared as in Section 5.5, add a volume to give 750 µg of each surrogate to 45 mL of organic-free reagent water contained in a 50 mL volumetric flask, mix, and dilute to volume for a concentration of 15 ng/µL. Add 10 µL of this surrogate spiking solution directly into the 5 mL syringe with every sample and reference standard analyzed. If the internal standard calibration procedure is used, the surrogate compounds may be added directly to the internal standard spiking solution (Section 5.8).

6.0 SAMPLE COLLECTION, PRESERVATION, AND HANDLING

6.1 See the introductory material to this chapter, Organic Analytes, Section 4.1.

7.0 PROCEDURE

7.1 Volatile compounds are introduced into the gas chromatograph either by direct injection or purge-and-trap (Method 5030). Method 5030 may be used directly on ground water samples or low-concentration contaminated soils and sediments. For medium-concentration soils or sediments, methanolic extraction, as described in Method 5030, may be necessary prior to purge-and-trap analysis.

7.2 Gas chromatography conditions (Recommended)

7.2.1 Oven settings:

Carrier gas (Helium) Flow rate:	6mL/min.
Temperature program	
Initial temperature:	10°C, hold for 8 minutes at
Program:	10°C to 180°C at 4°C/min
Final temperature:	180°C, hold until all expected compounds have eluted.

7.2.2 The carrier gas flow is augmented with an additional 24 mL of helium flow before entering the photoionization detector. This make-up gas is necessary to ensure optimal response from both detectors.

7.2.3 These halogen-specific systems eliminate misidentifications due to non-organohalides which are coextracted during the purge step. A Tracor Hall Model 700-A detector was used to gather the single laboratory accuracy and precision data presented in Table 2. The operating conditions used to collect these data are:

Reactor tube:	Nickel, 1/16 in OD
Reactor temperature:	810°C
Reactor base temperature:	250°C
Electrolyte:	100% n-Propyl alcohol
Electrolyte flow rate:	0.8 mL/min
Reaction gas:	Hydrogen at 40 mL/min
Carrier gas plus make-up gas:	Helium at 30 mL/min

7.2.4 A sample chromatogram obtained with this column is presented in Figure 5. This column was used to develop the method performance statements in Section 9.0. Estimated retention times and MDLs that can be achieved under these conditions are given in Table 1. Other columns or element specific detectors may be used if the requirements of Section 8.0 are met.

7.3 Calibration - Refer to Method 8000 for proper calibration techniques. Use Table 1 and especially Table 2 for guidance on selecting the lowest point on the calibration curve.

7.3.1 Calibration must take place using the same sample introduction method that will be used to analyze actual samples (see Section 7.4.1).

7.3.2 The procedure for internal or external calibration may be used. Refer to Method 8000 for a description of each of these procedures.

7.4 Gas chromatographic analysis

7.4.1 Introduce volatile compounds into the gas chromatograph using either Method 5030 (purge-and-trap method) or the direct injection method (see Section 7.4.1.1). If the internal standard calibration technique is used, add 10 µL of internal standard to the sample prior to purging.

7.4.1.1 Direct injection - In very limited applications (e.g. aqueous process wastes) direct injection of the sample into the GC system with a 10 µL syringe may be appropriate. The detection limit is very high (approximately 10,000 µg/L), therefore, it is only permitted where concentrations in excess of 10,000 µg/L are expected or for water-soluble compounds that do not purge. The system must be calibrated by direct injection (bypassing the purge-and-trap device).

7.4.2 Follow in Method 8000 for instructions on the analysis sequence, appropriate dilutions, establishing daily retention time windows, and identification criteria. Include a mid-concentration standard after each group of 10 samples in the analysis sequence.

7.4.3 Table 1 summarizes the estimated retention times on the two detectors for a number of organic compounds analyzable using this method.

7.4.4 Record the sample volume purged or injected and the resulting peak sizes (in area units or peak heights).

7.4.5 Calculation of concentration is covered in Method 8000.

7.4.6 If analytical interferences are suspected, or for the purpose of confirmation, analysis using a second GC column is recommended.

7.4.7 If the response for a peak is off-scale, prepare a dilution of the sample with organic-free reagent water. The dilution must be performed on a second aliquot of the sample which has been properly sealed and stored prior to use.

8.0 QUALITY CONTROL

8.1 Refer to Chapter One for specific quality control procedures, and to Method 8000 for gas chromatographic procedures. Quality control to ensure the proper operation of the purge-and-trap device is covered in Method 5030.

8.2 Mandatory quality control to validate the GC system operation is found in Method 8000.

8.3 Calculate surrogate standard recovery on all samples, blanks, and spikes. Determine if recovery is within limits (limits established by performing QC procedure outlined in Method 8000).

8.3.1 If recovery is not within limits, the following are required.

8.3.1.1 Check to be sure that there are no errors in the calculations, surrogate solutions or internal standards. If errors are found, recalculate the data accordingly.

8.3.1.2 Check instrument performance. If an instrument performance problem is identified, correct the problem and re-analyze the extract.

8.3.1.3 If no problem is found, re-extract and re-analyze the sample.

8.3.1.4 If, upon re-analysis, the recovery is again not within limits, flag the data as "estimated concentration".

9.0 METHOD PERFORMANCE

9.1 Method detection limits for these analytes have been calculated from data collected by spiking organic-free reagent water at 0.1 µg/L. These data are presented in Table 1.

9.2 This method was tested in a single laboratory using organic-free reagent water spiked at 10 µg/L. Single laboratory precision and accuracy data for each detector are presented for the method analytes in Table 2.

10.0 REFERENCES

1. Volatile Organic Compounds in Water by Purge-and-Trap Capillary Column Gas Chromatography with Photoionization and Electrolytic Conductivity Detectors in Series, Method 502.2; U.S. Environmental Protection Agency. Environmental Monitoring and Support Laboratory: Cincinnati, OH, September, 1986.

2. The Determination of Halogenated Chemicals in Water by the Purge and Trap Method, Method 502.1; Environmental Protection Agency, Environmental Monitoring and Support Laboratory: Cincinnati, Ohio 45268, September, 1986.

3. Volatile Aromatic and Unsaturated Organic Compounds in Water by Purge and Trap Gas Chromatography, Method 503.1; Environmental Protection Agency, Environmental Monitoring and Support Laboratory: Cincinnati, Ohio, September, 1986.

4. Glaser, J.A.; Forest, D.L.; McKee, G.D.; Quave, S.A.; Budde, W.L. "Trace Analyses for Wastewaters"; Environ. Sci. Technol. 1981, 15, 1426.

5. Bellar, T.A.; Lichtenberg, J.J. The Determination of Synthetic Organic Compounds in Water by Purge and Sequential Trapping Capillary Column Gas Chromatography; U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory: Cincinnati, Ohio, 45268.

TABLE 1.

CHROMATOGRAPHIC RETENTION TIMES AND METHOD DETECTION LIMITS (MDL) FOR VOLATILE ORGANIC COMPOUNDS ON PHOTOIONIZATION DETECTION (PID) AND HALL ELECTROLYTIC CONDUCTIVITY DETECTOR (HECD) DETECTORS

Analyte	PID Ret. Time[a] minute	HECD Ret. Time minute	PID MDL µg/L	HECD MDL µg/L
Dichlorodifluoromethane	-[b]	8.47		0.05
Chloromethane	-	9.47		0.03
Vinyl Chloride	9.88	9.93	0.02	0.04
Bromomethane	-	11.95		1.1
Chloroethane	-	12.37		0.1
Trichlorofluoromethane	-	13.49		0.03
1,1-Dichloroethene	16.14	16.18	ND[c]	0.07
Methylene Chloride	-	18.39		0.02
trans-1,2-Dichloroethene	19.30	19.33	0.05	0.06
1,1-Dichloroethane	-	20.99		0.07
2,2-Dichloropropane	-	22.88		0.05
cis-1,2-Dichloroethane	23.11	23.14	0.02	0.01
Chloroform	-	23.64		0.02
Bromochloromethane	-	24.16		0.01
1,1,1-Trichloroethane	-	24.77		0.03
1,1-Dichloropropene	25.21	25.24	0.02	0.02
Carbon Tetrachloride	-	25.47		0.01
Benzene	26.10	-	0.009	
1,2-Dichloroethane	-	26.27		0.03
Trichloroethene	27.99	28.02	0.02	0.01
1,2-Dichloropropane	-	28.66		0.006
Bromodichloromethane	-	29.43		0.02
Dibromomethane	-	29.59		2.2
Toluene	31.95	-	0.01	
1,1,2-Trichloroethane	-	33.21		ND
Tetrachloroethene	33.88	33.90	0.05	0.04
1,3-Dichloropropane	-	34.00		0.03
Dibromochloromethane	-	34.73		0.03
1,2-Dibromoethane	-	35.34		0.8
Chlorobenzene	36.56	36.59	0.003	0.01
Ethylbenzene	36.72	-	0.005	
1,1,1,2-Tetrachloroethane	-	36.80		0.005
m-Xylene	36.98	-	0.01	
p-Xylene	36.98	-	0.01	
o-Xylene	38.39	-	0.02	
Styrene	38.57	-	0.01	
Isopropylbenzene	39.58	-	0.05	
Bromoform	-	39.75		1.6
1,1,2,2-Tetrachloroethane	-	40.35		0.01
1,2,3-Trichloropropane	-	40.81		0.4

TABLE 1.
(Continued)

Analyte	PID Ret. Time[a] minute	HECD Ret. Time minute	PID MDL µg/L	HECD MDL µg/L
n-Propylbenzene	40.87	-	0.004	
Bromobenzene	40.99	41.03	0.006	0.03
1,3,5-Trimethylbenzene	41.41	-	0.004	
2-Chlorotoluene	41.41	41.45	ND	0.01
4-Chlorotoluene	41.60	41.63	0.02	0.01
tert-Butylbenzene	42.92	-	0.06	
1,2,4-Trimethylbenzene	42.71	-	0.05	
sec-Butylbenzene	43.31	-	0.02	
p-Isopropyltoluene	43.81	-	0.01	
1,3-Dichlorobenzene	44.08	44.11	0.02	0.02
1,4-Dichlorobenzene	44.43	44.47	0.007	0.01
n-Butylbenzene	45.20	-	0.02	
1,2-Dichlorobenzene	45.71	45.74	0.05	0.02
1,2-Dibromo-3-Chloropropane		48.57		3.0
1,2,4-Trichlorobenzene	51.43	51.46	0.02	0.03
Hexachlorobutadiene	51.92	51.96	0.06	0.02
Naphthalene	52.38	-	0.06	
1,2,3-Trichlorobenzene	53.34	53.37	ND	0.03
Internal Standards				
Fluorobenzene	26.84	-		
2-Bromo-1-chloropropane	-	33.08		

[a] Retention times determined on 60 m x 0.75 mm ID VOCOL capillary column. Program: Hold at 10°C for 8 minutes, then program at 4°C/min to 180°C, and hold until all expected compounds have eluted.

[b] Dash (-) indicates detector does not respond.

[c] ND = Not determined.

TABLE 2.
SINGLE LABORATORY ACCURACY AND PRECISION DATA
FOR VOLATILE ORGANIC COMPOUNDS IN WATER[d]

Analyte	Photoionization Detector		Hall Electrolytic Conductivity Detector	
	Recovery,[a] %	Standard Deviation of Recovery	Recovery,[a] %	Standard Deviation of Recovery
Benzene	99	1.2	-[b]	-
Bromobenzene	99	1.7	97	2.7
Bromochloromethane	-	-	96	3.0
Bromodichloromethane	-	-	97	2.9
Bromoform	-	-	106	5.5
Bromomethane	-	-	97	3.7
n-Butylbenzene	100	4.4	-	-
sec-Butylbenzene	97	2.6	-	-
tert-Butylbenzene	98	2.3	-	-
Carbon tetrachloride	-	-	92	3.3
Chlorobenzene	100	1.0	103	3.7
Chloroethane	-	-	96	3.8
Chloroform	-	-	98	2.5
Chloromethane	-	-	96	8.9
2-Chlorotoluene	ND[c]	ND	97	2.6
4-Chlorotoluene	101	1.0	97	3.1
1,2-Dibromo-3-chloropropane	-	-	86	9.9
Dibromochloromethane	-	-	102	3.3
1,2-Dibromoethane	-	-	97	2.7
Dibromomethane	-	-	109	7.4
1,2-Dichlorobenzene	102	2.1	100	1.5
1,3-Dichlorobenzene	104	1.7	106	4.3
1,4-Dichlorobenzene	103	2.2	98	2.3
Dichlorodifluoromethane	-	-	89	5.9
1,1-Dichloroethane	-	-	100	5.7
1,2-Dichloroethane	-	-	100	3.8
1,1-Dichloroethene	100	2.4	103	2.9
cis-1,2 Dichloroethene	ND	ND	105	3.5
trans-1,2-Dichloroethene	93	3.7	99	3.7
1,2-Dichloropropane	-	-	103	3.8
1,3-Dichloropropane	-	-	100	3.4
2,2-Dichloropropane	-	-	105	3.6
1,1-Dichloropropene	103	3.6	103	3.4
Ethylbenzene	101	1.4	-	-
Hexachlorobutadiene	99	9.5	98	8.3
Isopropylbenzene	98	0.9	-	-
p-Isopropyltoluene	98	2.4	-	-

TABLE 2.
(Continued)

Analyte	Photoionization Detector Recovery,[a] %	Photoionization Detector Standard Deviation of Recovery	Hall Electrolytic Conductivity Detector Recovery,[a] %	Hall Electrolytic Conductivity Detector Standard Deviation of Recovery
Methylene chloride	-	-	97	2.8
Naphthalene	102	6.3	-	-
n-Propylbenzene	103	2.0	-	-
Styrene	104	1.4	-	-
1,1,1,2-Tetrachloroethane	-	-	99	2.3
1,1,2,2-Tetrachloroethane	-	-	99	6.8
Tetrachloroethene	101	1.8	97	2.4
Toluene	99	0.8	-	-
1,2,3-Trichlorobenzene	106	1.9	98	3.1
1,2,4-Trichlorobenzene	104	2.2	102	2.1
1,1,1-Trichloroethane	-	-	104	3.4
1,1,2-Trichloroethane	-	-	109	6.2
Trichloroethene	100	0.78	96	3.5
Trichlorofluoromethane	-	-	96	3.4
1,2,3-Trichloropropane	-	-	99	2.3
1,2,4-Trimethylbenzene	99	1.2	-	-
1,3,5-Trimethylbenzene	101	1.4	-	-
Vinyl chloride	109	5.4	95	5.6
o-Xylene	99	0.8	-	
m-Xylene	100	1.4	-	-
p-Xylene	99	0.9	-	-

[a] Recoveries and standard deviations were determined from seven samples and spiked at 10 $\mu g/L$ of each analyte. Recoveries were determined by internal standard method. Internal standards were: Fluorobenzene for PID, 2-Bromo-1-chloropropane for HECD.

[b] Detector does not respond.

[c] ND = Not determined.

[d] This method was tested in a single laboratory using water spiked at 10 $\mu g/L$ (see reference 8).

TABLE 3.
DETERMINATION OF ESTIMATED QUANTITATION LIMITS (EQL) FOR VARIOUS MATRICES[a]

Matrix	Factor[b]
Ground water	10
Low-concentration soil	10
Water miscible liquid waste	500
High-concentration soil and sludge	1250
Non-water miscible waste	1250

[a] Sample EQLs are highly matrix dependent. The EQLs listed herein are provided for guidance and may not always be achievable.

[b] EQL = [Method detection limit (Table 1)] X [Factor (Table 2)]. For non-aqueous samples, the factor is on a wet-weight basis.

FIGURE 1.
PURGING DEVICE

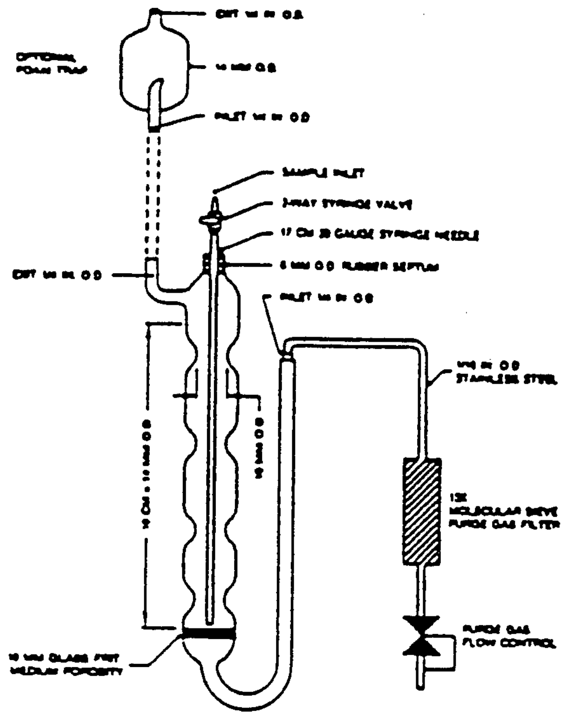


FIGURE 2.
TRAP PACKINGS AND CONSTRUCTION TO INCLUDE DESORB CAPABILITY

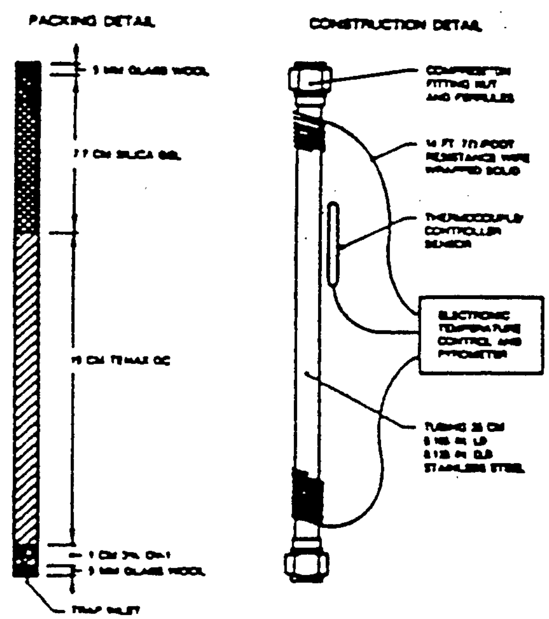


FIGURE 3.
PURGE-AND-TRAP SYSTEM - PURGE MODE

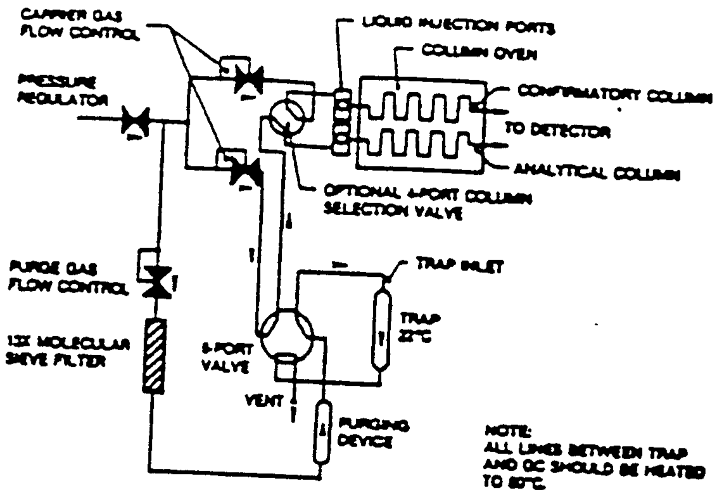


FIGURE 4.
SCHEMATIC OF PURGE-AND-TRAP DEVICE - DESORB MODE

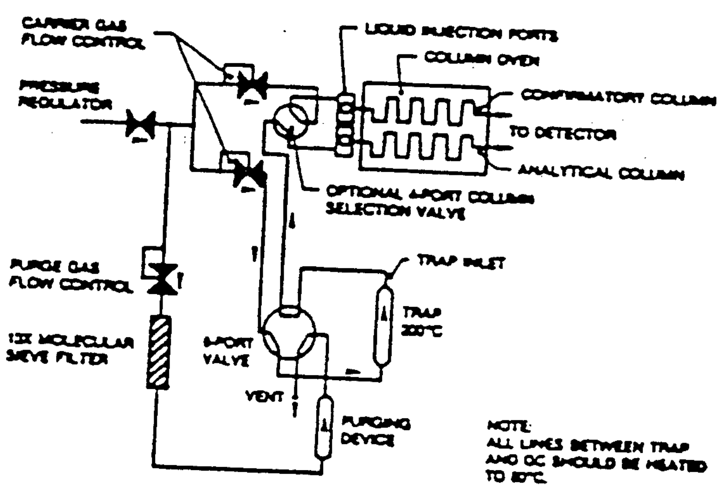
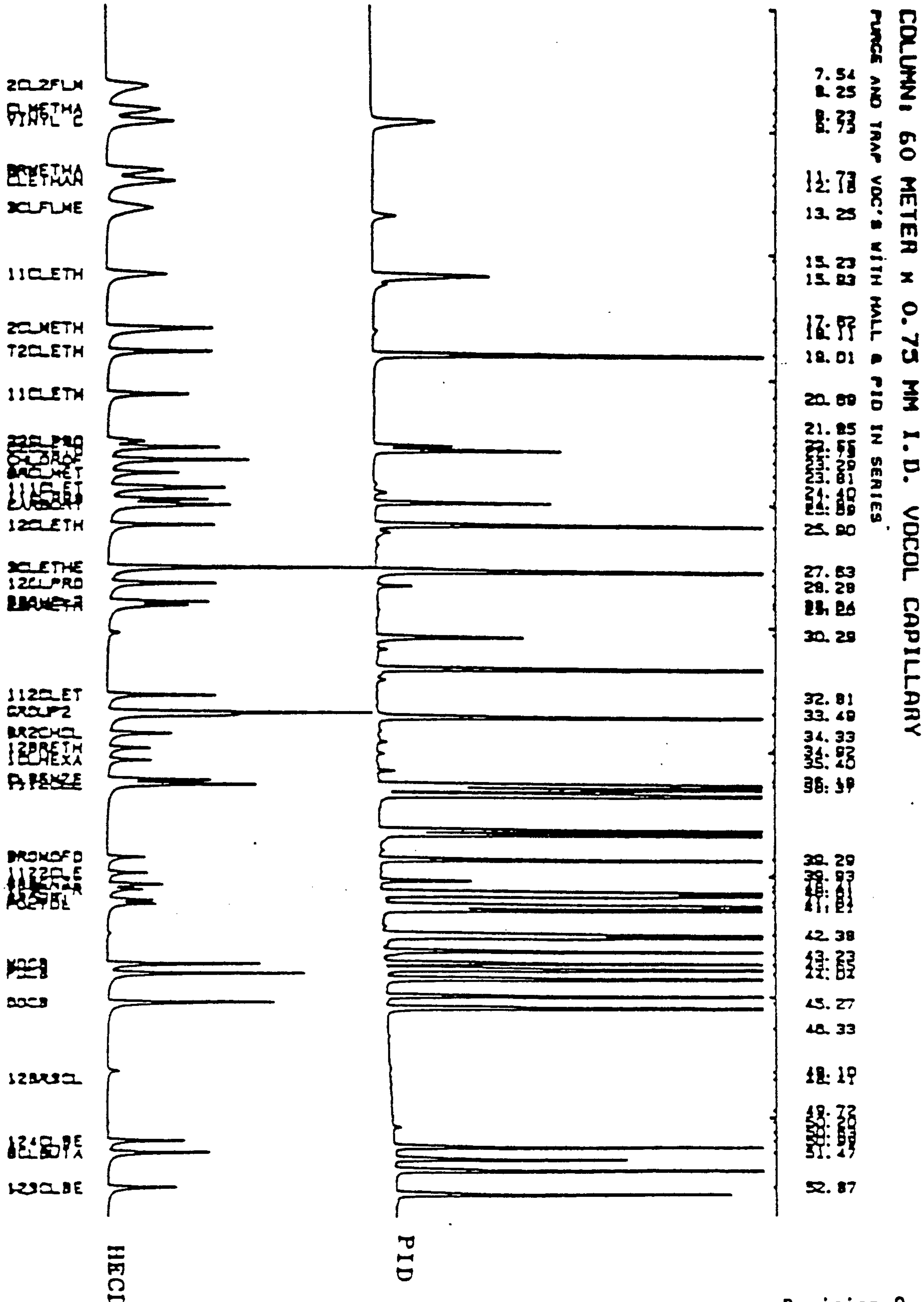


FIGURE 5.
GAS CHROMATOGRAM OF VOLATILE ORGANICS



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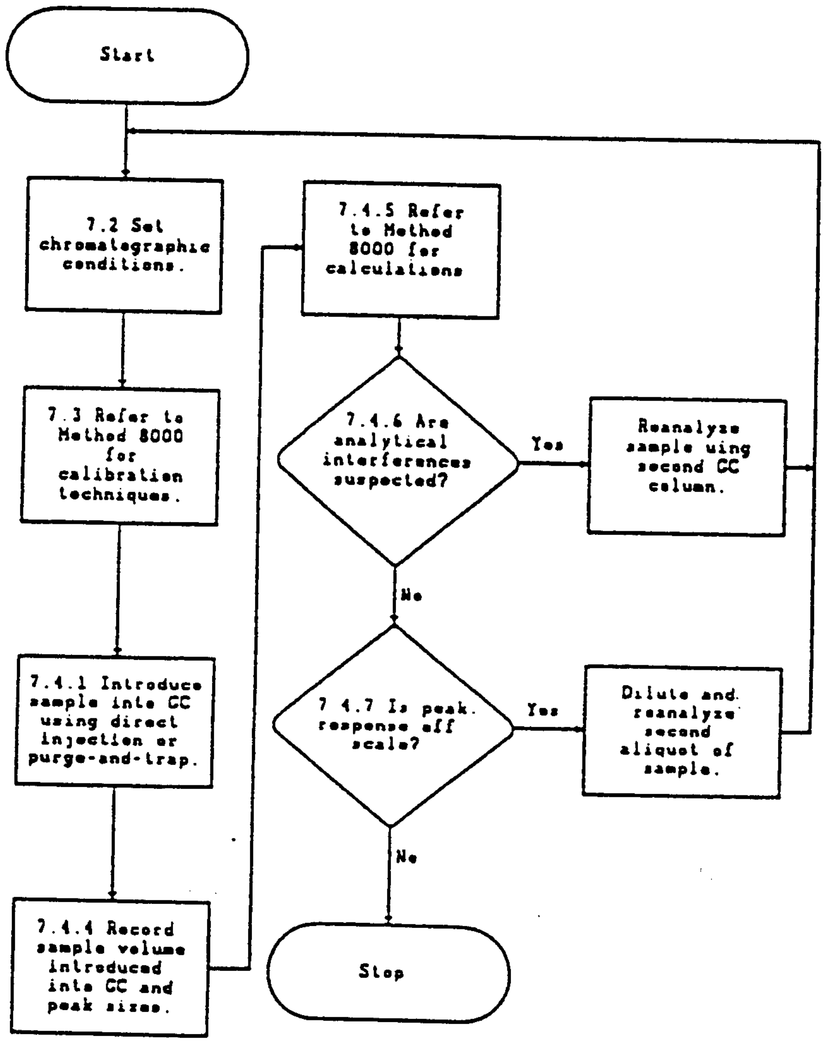
VOLATILE ORGANIC COMPOUNDS IN WATER BY PURGE AND TRAP CAPILLARY COLUMN GAS CHROMATOGRAPHY WITH PHOTOIONIZATION AND ELECTROLYTIC CONDUCTIVITY DETECTORS IN SERIES



METHOD 5021

VOLATILE ORGANIC COMPOUNDS IN SOILS AND OTHER SOLID MATRICES USING EQUILIBRIUM HEADSPACE ANALYSIS

METHOD 5021

VOLATILE ORGANIC COMPOUNDS IN SOILS AND OTHER SOLID MATRICES USING EQUILIBRIUM HEADSPACE ANALYSIS

1.0 SCOPE AND APPLICATION

1.1 Method 5021 is a general purpose method for the preparation of volatile organic compounds (VOCs) in soils/sediments and solid wastes for determination by gas chromatography (GC) or gas chromatography/mass spectrometry (GC/MS). The method is applicable to a wide range of organic compounds that have sufficiently high volatility to be effectively removed from soil samples using an equilibrium headspace procedure. The following compounds have been determined in soils using Method 5021:

Compound	CAS No.[a]
Benzene	71-43-2
Bromochloromethane	74-97-5
Bromodichloromethane	75-27-4
Bromoform	75-25-2
Bromomethane	74-83-9
Carbon tetrachloride	56-23-5
Chlorobenzene	108-90-7
Chloroethane	75-00-3
Chloroform	67-66-3
Chloromethane	74-87-3
Dibromochloromethane	124-48-1
1,2-Dibromo-3-chloropropane	96-12-8
1,2-Dibromoethane	106-93-4
Dibromomethane	74-95-3
1,2-Dichlorobenzene	95-50-1
1,3-Dichlorobenzene	541-73-1
1,4-Dichlorobenzene	106-46-7
Dichlorodifluoromethane	75-71-8
1,1-Dichloroethane	75-34-3
1,2-Dichloroethane	107-06-2
1,1-Dichloroethene	75-35-4
trans-1,2-Dichloroethene	156-60-5
1,2-Dichloropropane	78-87-5
Ethylbenzene	100-41-4
Hexachlorobutadiene	87-68-3
Methylene chloride	75-09-2
Naphthalene	91-20-3
Styrene	100-42-5
1,1,1,2-Tetrachloroethane	630-20-6
1,1,2,2-Tetrachloroethane	79-34-5

Compound	CAS No.[a]
Tetrachloroethene	127-18-4
Toluene	108-88-3
1,2,4-Trichlorobenzene	120-82-1
1,1,1-Trichloroethane	71-55-6
1,1,2-Trichloroethane	79-00-5
Trichloroethene	79-01-6
Trichlorofluoromethane	75-69-4
1,2,3-Trichloropropane	96-18-4
Vinyl chloride	75-01-4
o-Xylene	95-47-6
m-Xylene	108-38-3
p-Xylene	106-42-3
Gasoline Range Petroleum Hydrocarbons	

[a] Chemical Abstract Services Registry Number.

1.2 Method detection limits (MDL), using Method 8260, are compound, matrix, and instrument dependent and vary from approximately 0.1 to 3.4 µg/kg. The applicable concentration range of this method is approximately 10 or 20 µg/kg to 200 µg/kg. Analytes that are inefficiently extracted from the soil will not be detected when present at low concentrations, but they can be measured with acceptable accuracy and precision when present in sufficient concentrations.

1.3 The following compounds may also be analyzed by this procedure or may be used as surrogates:

Compound Name	CAS No.[a]
Bromobenzene	108-86-1
n-Butylbenzene	104-51-8
sec-Butylbenzene	135-98-8
tert-Butylbenzene	98-06-6
2-Chlorotoluene	95-49-8
4-Chlorotoluene	106-43-4
cis-1,2-Dichloroethene	156-59-4
1,3-Dichloropropane	142-28-9
2,2-Dichloropropane	590-20-7
1,1-Dichloropropene	563-58-6
Isopropylbenzene	98-82-8
4-Isopropyltoluene	99-87-6
n-Propylbenzene	103-65-1
1,2,3-Trichlorobenzene	87-61-6
1,2,4-Trimethylbenzene	95-63-6
1,3,5-Trimethylbenzene	108-67-8

[a] Chemical Abstract Services Registry Number.

1.4 Alternatively, the method may be utilized as an automated sample introduction device as a means for screening samples for volatile organics. A suggested configuration is to interface it to Method 8021 but use very minimal calibration and quality control, i.e., a reagent blank and a single calibration standard, to obtain semiquantitative data.

1.5 Method 5021 may be applicable to other compounds that have sufficient volatility to be removed from the soil matrix using the conditions described in this method. It may also be applicable to both listed and non-listed target analytes in other matrices.

1.6 This method is restricted to use by, or under the supervision of, analysts experienced in volatile organic analysis in general and specifically the use of equilibrium headspace devices interfaced to the determinative method selected by the analyst.

2.0 SUMMARY OF METHOD

2.1 Volatile organic compounds (VOCs) are determined from at least a 2 g soil sample by placing the sample into a crimp-seal or screw top glass headspace vial at time of sampling. Each soil sample is fortified with a matrix modifying solution and internal standards and surrogate compounds. This may be done either in the field or in the laboratory upon receipt of samples. Additional sample is collected in a VOA vial for dry weight determination and for high concentration determination if the sample concentration requires it. In the laboratory, the vials are rotated to allow for diffusion of the internal standards and surrogates throughout the matrix. The vials are placed in the autosampler carousel and maintained at room temperature. Approximately 1 hour prior to analysis, the individual vials are moved to a heated zone and allowed to equilibrate. The sample is then mixed by mechanical vibration while the elevated temperature is maintained. The autosampler then pressurizes the vial with helium, allows a portion to enter a sample loop which is then swept through a heated transfer line onto the GC column. Determinative analysis is performed using the appropriate GC or GC/MS method.

3.0 INTERFERENCES

3.1 Volatile organic analyses are subject to major interference problems because of the prevalence of volatile organics in a laboratory. See Method 5000, Sec. 3.0 for common problems and precautions to be followed.

3.2 The sample matrix itself can cause severe interferences by one of several processes or a combination of these processes. These include, but are not necessarily limited to, the absorption potential of the soil, the biological activity of the soil, and the actual composition of the soil. Soils high in oily material and organic sludge wastes inhibit the partitioning of the volatile target analytes into the headspace, therefore, recoveries will be low. This so-called "matrix effect" can be difficult, if not impossible, to overcome. It is recommended that surrogates or additional deuterated compounds (for GC/MS methods) be added to a matrix and analyzed to determine the percent recovery of these compounds. The calculated percent recovery can give some indication of the degree of the matrix effect, but not necessarily correct for it. Alternatively, the use of the high concentration procedure in this method should minimize the problem with oily waste and other organic sludge wastes.

4.0 EQUIPMENT AND SUPPLIES

4.1 Sample Containers - Clear glass, 22 mL soil vials, compatible with the analytical system. The vial must be capable of being hermetically sealed in the field (either crimp cap or screw cap) and be equipped with a Teflon®-lined septum which demonstrates minimum bleed at elevated temperatures while maintaining the seal. Ideally, the vials and septa should have a uniform tare weight. Prior to use, wash the vials and septa with detergent solution, then rinse with tap followed by distilled water. Place vials and septa in an oven at 105°C for 1 hour, then remove and allow to cool. Store in an area free of organic solvents.

4.2 Headspace System - The system described in this method utilizes a totally automated equilibrium headspace analyzer. Such systems are available from several commercial sources. The system used must meet the following specifications.

4.2.1 It must be capable of establishing a reproducible equilibrium at elevated temperatures between a wide variety of sample types and the headspace. Once this is done, the system must be capable of accurately injecting a representative portion of the headspace into a gas chromatograph fitted with a capillary column. This must be accomplished without adversely affecting the chromatography or the detector. The conditions selected for the equipment used in developing this method are listed in Sec. 7.0. Other equipment and conditions may be used if the analyst generates and records accuracy, precision, and MDL data that are comparable to the data in Sec. 9.0 of Method 8260. The equipment used to develop this method and generate the accuracy and precision data listed in Method 8260 was a Tekmar Model 7000 Equilibrium Headspace Autosampler and a Tekmar 7050 Carousel (Tekmar Co., 7143 East Kemper Road, Cincinnati, OH 45249).

4.3 Field Sampling Equipment

4.3.1 A soil sampler which delivers at least 2 g of soil is necessary, e.g., Purge-and-Trap Soil Sampler Model 3780PT (Associated Design and Manufacturing Company, 814 North Henry Street, Alexandria, VA 22314), or equivalent.

4.3.2 An automatic syringe or bottle-top dispenser calibrated to deliver 10.0 mL of matrix modifier solution, e.g., Automatic Vaccinator Model C1377SN (NASCO, 901 Jamesville Ave., P.O. Box 901, Fort Atkinson, WI 53538), or equivalent.

4.3.3 An automatic syringe calibrated to deliver internal standards and surrogate analytes.

4.3.4 Crimping tool for sample vials. If using screw top vials, this is not needed.

4.4 Miscellaneous Equipment

4.4.1 VOA vials - 40 or 60 mL VOA vials with Teflon®-faced septa and crimp seal caps or screw top caps. These vials will be used for sample screening, high concentration analysis (if needed) and dry weight determination.

5.0 REAGENTS

5.1 Organic-Free Reagent Water. All references to water in this method refer to organic-free reagent water, as defined in Chapter One.

5.2 Methanol, CH_3OH - Pesticide quality or equivalent. Store away from other solvents. Purchase in small quantities (½ Liter or 1 Liter size) to minimize contamination.

5.3 See the determinative method and Method 5000 for guidance on the preparation of stock standards and a secondary standard for internal standards, calibration standards, and surrogates.

5.3.1 Calibration spiking solutions - Prepare five spiking solutions in methanol that contain all the target analytes and the surrogate standards. The concentrations of the calibration solutions should be such that the addition of 1.0 µL of each to the 22 mL vials will bracket the analytical range of the detector, e.g., for Method 8260 the suggested concentration range for target analytes and surrogates is 5, 10, 20, 40 and 50 mg/L. The suggested concentration of internal standards is 20 mg/L (internal standards may be omitted for the GC methods if desired). The internal standard may be added separately using 1.0 µL or premixed with the calibration standards maintaining a 20 mg/L concentration in each calibration standard. These concentrations may vary depending on the relative sensitivity of the GC/MS system or any other determinative method that is utilized.

5.3.2 Internal and surrogate standards - Follow the recommendations of the determinative methods for the selection of internal and surrogate standards. A concentration of 20 mg/L in methanol for both internal and surrogate standards will be needed for spiking each sample. If determination is by GC, external standard calibration may be preferred and the internal standard is omitted. The concentration may vary depending on the relative sensitivity of the GC/MS system or any other determinative method that is utilized.

5.4 Blank Preparation - Transfer 10.0 mL (Sec. 5.6) of matrix modifying solution to a sample vial. Add the prescribed amounts of the internal standards and surrogate compounds, and seal the vial. Place it in the autosampler and analyze in the same manner as an unknown sample. Analyzing the blank in this way will indicate possible problems with the autosampler as well as the headspace device.

5.5 Preparation of Calibration Standards - Prepare calibration standards in the same manner as the blanks (Sec. 5.4) using the standards prepared in Sec. 5.3.1.

5.6 Matrix Modifying Solution - Using a pH meter, add concentrated phosphoric acid (H_3PO_4) dropwise to 500 mL of organic-free reagent water until the pH is 2. Add 180 g of NaCl. Mix well until all components are dissolved. Analyze a 10.0 mL portion from each batch per Sec. 5.4 to verify that the solution is free of contaminants. Store in a sealed bottle in an area free of organic chemicals at 4°C.

WARNING: The matrix modifying solution may not be appropriate for soil samples having organic carbon content. See Sec. 6.1.2.

6.0 SAMPLE COLLECTION, PRESERVATION, AND HANDLING

6.1 Two alternative procedures are presented for low concentration sample collection in special headspace sample vials. In either case, collect 3 or 4 vials of sample from each sampling point to allow sample reanalysis if necessary. In addition, a separate portion of sample is taken for dry weight determination and high concentration analysis (if necessary). Prepare a trip blank in the laboratory prior to shipping the sample vials to the field. Add 10.0 mL of matrix modifying solution to a clean 22 mL sample vial (Sec. 4.1). The internal and surrogate standards are added just prior to analysis.

6.1.1 Without matrix modifying solution and standards - Standard 22 mL crimp cap or screw top glass headspace vials (Sec. 4.1) with Teflon®-faced septa are used. Add 2-3 cm (approximately 2 g) of the soil sample (using the purge-and-trap soil sampler, Sec. 4.3.1) to a tared 22 mL headspace vial and seal immediately with the Teflon® side of the septum facing toward the sample. The samples should be introduced into the vials gently to reduce agitation which might drive off volatile compounds.

NOTE: If high concentrations of volatile organics are expected (greater than 200 µg/kg), collection of the sample in the 22 mL vial without the addition of matrix modifying solution allows direct addition of methanol as per the high concentration method in Sec. 7.5.

6.1.2 With matrix modifying solution and standards - Add 2-3 cm (approximately 2 g) of soil sample to a tared 22 mL soil vial using a purge-and-trap soil sampler (Sec. 4.3.1). Add 10.0 mL of matrix modifying solution and the appropriate amount of internal and surrogate standards called for in the determinative method. Seal the vial immediately with the Teflon® side of the septum facing toward the sample. The sample must remain hermetically sealed until the septum is punctured by the headspace analyzer.

WARNING: Preliminary indications are that soil samples having organic carbon content may yield low recoveries when the matrix modifying solution (Sec. 5.6) is used. The matrix modifying solution may not be appropriate for these samples.

6.1.3 Prepare a field blank by adding 10.0 mL of matrix modifying solution plus internal and surrogate standards to a clean 22 mL vial.

NOTE: The addition of the matrix modifying solution and the internal and surrogate standards at the time of sampling (Sec. 6.1.2) is the preferred option unless high concentrations of volatile organics are expected. The matrix modifying solution minimizes dehydrohalogenation reactions through pH adjustment, eliminates biodegradation of the analytes and minimizes losses of analytes by volatility since the vial is not opened in the laboratory. The downside is increased opportunity for contamination of the matrix modifier and standards in a field sampling situation. Also, skilled personnel are required to precisely and accurately add the matrix modifying solution, and especially the internal and surrogate standards. These problems are minimized when added in the laboratory (Sec. 6.1.1), however, there is the likelihood of significant losses of volatile analytes when the vial is reopened in the laboratory.

6.1.4 Fill a 40 or 60 mL VOA vial from each sampling point to use for dry weight determination, sample screening and for high concentration analysis (if necessary). Sample screening is optional since there is no danger of contaminating the headspace device because of carryover from a high concentration sample.

6.2 Sample Storage

6.2.1 Store samples at 4°C until analysis. The sample storage area must be free of organic solvent vapors.

6.2.2 All samples should be analyzed within 14 days of collection. Samples not analyzed within this period must be noted and data are considered minimum values.

7.0 PROCEDURE

7.1 Sample screening - This method (using the low concentration approach), used in conjunction with either Methods 8015 (GC/FID) or 8021 (GC/PID/ELCD), may be used as a sample screening method prior to any of the sample introduction - GC/MS configurations to assist the analyst in determining the approximate concentration of volatile organics present in a sample. This is especially critical prior to the use of volatile organic analysis by purge-and-trap to prevent the contamination of the system by high concentration samples. It can also be helpful prior to the use of this headspace method, to determine whether to proceed with the low concentration method or the high concentration method. High concentrations of volatiles will not contaminate the headspace device. However, it may create contamination problems in the GC or GC/MS system. Whenever this method is utilized for sample screening, very minimal calibration and QC are suggested. In most cases, a reagent blank and a single point calibration are sufficient.

7.2 Determination of sample % dry weight - In certain cases, sample results are desired based on dry-weight basis. When such data are desired, a portion of sample for this determination should be weighed out from the 40 or 60 mL VOA vial (Sec. 6.1.3).

WARNING: The drying oven should be contained in a hood or vented. Significant laboratory contamination may result from a heavily contaminated hazardous waste sample.

7.2.1 Immediately after weighing the sample for extraction, weigh 5-10 g of the sample into a tared crucible. Determine the % dry weight of the sample by drying overnight at 105°C. Allow to cool in a desiccator before weighing. Calculate the % dry weight as follows:

$$\% \text{ dry weight} = \frac{\text{g of dry sample}}{\text{g of sample}} \times 100$$

7.3 The Low Concentration Method utilizing an equilibrium headspace technique is found in Sec. 7.4 and sample preparation for the High Concentration Method is found in Sec. 7.5. The high concentration method is recommended for samples that obviously contain oily material or organic sludge waste (see Sec. 3.3). See Method 5000, Sec. 7.0 for guidance on the selection of a GC or GC/MS determinative method. For the analysis of gasoline, use Method 8021 with GC/PID for BTEX in series with Method 8015 with the GC/FID detector for hydrocarbons. If GC/MS analysis is preferred for BTEX in gasoline, follow Method 8260.

7.4 Low concentration method for soil/sediment and solid waste amenable to the equilibrium headspace method. (Approximate concentration range of 0.5 to 200 µg/kg - the concentration range is dependent upon the determinative method and the sensitivity of each analyte.)

7.4.1 Calibration: Prior to using this introduction technique for any GC or GC/MS method, the system must be calibrated. General calibration procedures are discussed in Method 8000, while the determinative methods and Method 5000 provide specific information on calibration and preparation of standards. Normally, external standard calibration is preferred for the GC methods because of possible interference problems with internal standards. If interferences are not a problem, based on historical data, internal standard calibration is acceptable. The GC/MS methods normally utilize internal standard calibration. The GC/MS methods require instrument tuning prior to proceeding with calibration.

7.4.1.1 Initial calibration: Prepare five 22 mL vials, as described, in Sec. 5.5, and a reagent blank (Sec. 5.4), and proceed according to Sec. 7.4.2 and the determinative method selected. The mixing step is eliminated since no soil is present in the vial.

7.4.1.2 Calibration verification: Prepare a single 22 mL vial as described in Sec. 5.5 by spiking with the midconcentration calibration standard. Proceed according to Sec. 7.4.2.4 (beginning by placing the vial into the autosampler) and the determinative method.

7.4.2 Headspace operating conditions - The conditions described throughout Sec. 7.4 were experimentally optimized using the equipment described in Sec. 4.2.1. If other systems are utilized, it is recommended that the manufacturer's conditions be followed. However, the criteria for this configuration in Method 8260 must be met or exceeded.

7.4.2.1 This method is designed for a 2 g sample size. The sample is prepared in the field by adding 2 g of the soil sample to the 22 mL crimp-seal or screw top glass headspace vial as described in Sec. 6.1.

7.4.2.2 Prior to analysis, weigh the sealed vial and its contents to 0.01 g. If the matrix modifying solution was added at the time of sampling (Sec. 6.1.2), the tare weight includes the 10 mL of matrix modifying solution.

7.4.2.3 If the matrix modifying solution was not added at the time of sampling (Sec. 6.1.1), unseal the vial, rapidly add 10.0 mL of matrix modifying solution and 1 μL of the 20 mg/L internal (if necessary) and surrogate standards (individually or as a mixture). Immediately reseal the vial.

NOTE: Only open and prepare one vial at a time to minimize loss of volatile organics.

7.4.2.4 Mix the samples (on a rotator or shaker) for at least 2 min. Place the vials in the autosampler carrousel at room temperature. The individual vials are moved to a heating zone, and allowed to equilibrate for 50 min at 85°C. Each sample is then mixed by mechanical vibration for 10 min at a mix power of 7.67 Watts while maintaining the temperature at 85°C. The vial is allowed to pressure equilibrate for 5 sec. The autosampler then raises the vial causing a stationary needle to puncture the septum, and pressurize the vial with helium at 10 psi.

7.4.2.5 The pressurized headspace is then vented through a 1 mL sample loop to the atmosphere for 15 sec. The sample is equilibrated within the loop for 5 sec. Finally the carrier gas, at a flow rate of 1.0 mL/min, backflushes the sample loop sweeping the sample through the heated transfer line onto the GC column.

7.4.2.6 Proceed with the analysis as per the determinative method of choice.

7.5 High concentration method

7.5.1 If the sample was collected by Sec. 6.1.1 with no matrix modifying solution added at time of sampling, add 10.0 mL of methanol to the high level soil sample within the tared 22 mL vial. (Weigh the sample to the nearest 0.01 g prior to the addition of methanol.)

7.5.2 Otherwise, transfer approximately 2 g of sample from the 40 or 60 mL VOA vial into a tared 22 mL sample vial (Sec. 5.1). Add 10.0 mL of methanol.

7.5.3 Mix by shaking for 10 min at room temperature. Decant 2 mL of the methanol to a screw top vial with Teflon® faced septa and seal. Withdraw 10 μL, or appropriate volume of extract from Table 2, and inject into a 22 mL vial containing 10.0 mL of matrix modifying solution and internal standards (if required) and surrogates. Analyze by the headspace procedure by placing the vial into the autosampler and proceeding with Sec. 7.4.2.4.

8.0 QUALITY CONTROL

8.1 Refer to Chapter One for specific quality control procedures and Method 5000 for sample preparation QC procedures.

8.2 Before processing any samples, the analyst should demonstrate through the analysis of an organic-free reagent water method blank that all glassware and reagents are interference free. Each time a set of samples is extracted, or there is a change in reagents, a method blank should be processed as a safeguard against chronic laboratory contamination. The blank samples should be carried through all stages of the sample preparation and measurement.

8.3 Initial Demonstration of Proficiency - Each laboratory must demonstrate initial proficiency with each sample preparation and determinative method combination it utilizes, by generating data of acceptable accuracy and precision for target analytes in a clean matrix. The laboratory must also repeat the following operations whenever new staff are trained or significant changes in instrumentation are made. See Sec. 8.0 of Methods 5000 and 8000 for information on how to accomplish this demonstration.

8.4 Sample Quality Control for Preparation and Analysis - See Sec. 8.0 in Method 5000 and Method 8000 for procedures to follow to demonstrate acceptable continuing performance on each set of samples to be analyzed. This includes the method blank, either a matrix spike/matrix spike duplicate or a matrix spike and duplicate sample analysis, a laboratory control sample (LCS) and the addition of surrogates to each sample and QC sample.

8.5 It is recommended that the laboratory adopt additional quality assurance practices for use with this method. The specific practices that are most productive depend upon the needs of the laboratory and the nature of the samples. Whenever possible, the laboratory should analyze standard reference materials and participate in relevant performance evaluation studies.

9.0 METHOD PERFORMANCE

9.1 Single laboratory accuracy and precision data were obtained for the method analytes in two soil matrices: sand and a surface garden soil. These data are found in tables in Method 8260.

10.0 REFERENCES

1. Flores, P., Bellar, T., "Determination of Volatile Organic Compounds in Soils using Equilibrium Headspace Analysis and Capillary Column Gas Chromatography/Mass Spectrometry", U.S. Environmental Protection Agency, Office of Research and Development, Environmental Monitoring Systems Laboratory, Cincinnati, OH, December, 1992.

2. Code of Federal Regulations, 40, Ch. 1, Part 136, Appendix B.

3. Ioffe, B.V., Vitenberg, A.G., "Headspace Analysis and Related Methods in Gas Chromatography", John Wiley and Sons, 1984.

TABLE 1
DETERMINATIVE METHODS INTERFACED TO METHOD 5021

Method Number	Method Name
8015	Nonhalogenated Volatile Organics Using GC/FID
8021	Halogenated and Aromatic Volatiles by GC with Detectors in Series: Capillary Column
8260	Volatile Organics by GC/MS: Capillary Column

TABLE 2
QUANTITY OF METHANOL EXTRACT REQUIRED FOR ANALYSIS OF
HIGH-CONCENTRATION SOILS/SEDIMENTS

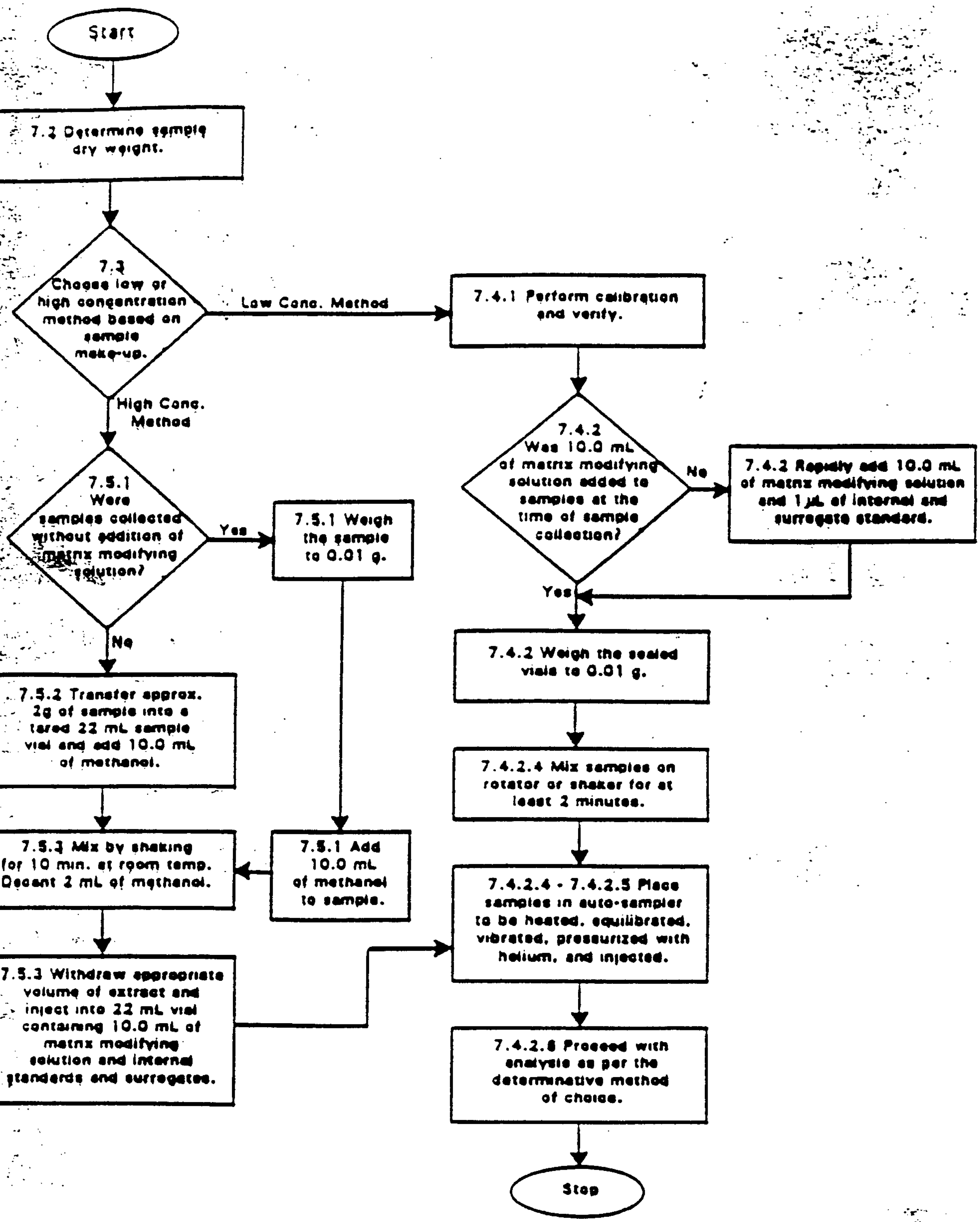
Approximate Concentration Range	Volume of Methanol Extract[a]
500-10,000 µg/kg	100 µL
1,000-20,000 µg/kg	50 µL
5,000-100,000 µg/kg	10 µL
25,000-500,000 µg/kg	100 µL of 1/50 dilution [b]

Calculate appropriate dilution factor for concentrations exceeding this table.

[a] The volume of methanol added to 5 mL of water being purged should be kept constant. Therefore, add to the 5 mL syringe whatever volume of methanol is necessary to maintain a volume of 100 µL added to the syringe.

[b] Dilute an aliquot of the methanol extract and then take 100 µL for analysis.

VOLATILE ORGANIC COMPOUNDS IN SOILS AND OTHER SOLID MATRICES USING EQUILIBRIUM HEADSPACE ANALYSIS



APPENDIX F

METHOD DETECTION LIMIT STUDY

METHOD PERFORMANCE

Method Detection Limits (MDL)

EPA Method 8021 specifies method performance criteria assuming a photo-ionization detector (PID) and a Hall electrolytic conductivity detector (HECD) are used in series. Since we are using different detectors (e.g., flame ionization detector (FID) and an electronic capture detector (ECD)) in parallel as a modification of Method 8021 it was necessary to conduct an instrument specific method detection limit (MDL) study.

The MDL study was conducted in ARA/New England's Environmental Laboratory. The instrument configuration consisted of Tekmar 7000 Static Headspace sampler connected directly via a heated transfer line to the split/splitless capillary injection port of an Hewlett-Packard 5890 series II gas chromatograph equipped with electronic pressure control (EPC). The injection port was run in splitless mode to optimize the detection of trace analytes.

During method development the system was first optimized for the detection of the target analytes. Once a suitable method was finalized, the retention time windows for the individual target compounds were determined. This task involved analyzing three samples of each analyte over a period spanning at least 72-hours. The mean and standard deviation (σ) of the retention times for each target analyte was calculated from the three runs. The retention time window was then set equal to plus or minus 3σ. These results are shown below in Table F-1.

The instrument was then calibrated using a five-point calibration over the range of zero to 100-ppb (parts per billion). The concentrations selected for the calibration curve included 5, 10, 20, 50 and 100-ppb. Acceptance criteria for instrument response linearity is based upon the correlation coefficient (r) of the best fit line for the calibration data points. If r^2 is greater than or equal to 0.995 the calibration was considered valid. The calibration curves for each of the target analytes are included in Appendix F. All of the calibration curves met the acceptance criteria stated above.

Following the instrument calibration a series of seven samples, each at a concentration of 1-ppb for each of the target analytes, were analyzed. The mean concentration and standard deviation for each analyte was determined and is tabulated in Table F-3, at the end of this appendix. The method detection limit (MDL) is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the value is above zero. Assuming a Gausian distribution and multiplying the standard deviation (σ) by the t-Statistic for six degrees of freedom (n-1) at 99% confidence the MDL was determined. These limits are shown below in Table F-1.

This method was tested for accuracy and precision in ARA's laboratory using organic free reagent water spiked at 10μg/L of each target analyte. Accuracy is represented by average percent recovery of seven samples which is calculated as the average measured concentration divided by the actual concentration. Precision is represented as the standard deviation of the seven samples. Laboratory precision and accuracy data for each detector are presented below in Table F-2.

Table F-1. Chromatographic Retention Times and Method Detection Limits (MDL) for Volatile Organic Compounds on Flame Ionization Detector (FID) and Electronic Capture Detector (ECD) Detectors.

Analyte	FID Ret. Time (min)	ECD Ret. Time (min)	FID MDL μg/L	ECD MDL μg/L
1, 1-Dichloroethane	-	2.33	-	0.25
trans 1, 2-Dichloroethene	-	1.97	-	0.16
cis 1, 2-Dichloroethene	2.91	2.93	1.05	0.24
Trichloroethene	5.28	5.30	1.35	0.24
1,4-Dichlorobenzene	13.17	13.19	0.83	0.18
Benzene	4.01	-	0.67	-
Toluene	7.63	-	0.30	-
o-Xylene	10.75	-	0.24	-
Vinyl chloride	0.85	-	1.84	-

Table F-2. Single Laboratory Accuracy and Precision Data For Volatile Organic Compounds In Water.

Analyte	FID Recovery (%)	FID Standard Deviation	ECD Recovery (%)	ECD Standard Deviation
1, 1-Dichloroethane	-	-	94%	4.63
trans 1, 2-Dichloroethene	-	-	99%	6.30
cis 1, 2-Dichloroethene	80%	7.61	93%	4.84
Trichloroethene	85%	6.84	92%	5.19
1,4-Dichlorobenzene	88%	5.11	108%	5.40
Benzene	81%	4.38	-	-
Toluene	85%	4.56	-	-
o-Xylene	87%	3.80	-	-
Vinyl chloride	48%	4.67	-	-

Estimated Quantitation Limits (EQL)

EPA Method 8021 states that the estimated quantitation limit (EQL), which is the minimum concentration that can be reported with reasonable accuracy, is determined as the MDL for each analyte times a response factor. The response factor (which is dependent on the sample matrix) for groundwater and this method is 10. These EQLs are reported in Table 3 in the Experimental Design section.

Table F-3. Method Detection Limits (MDL) Worksheet

Analyte Concentrations by FID in ppb

Standard Concentration: 1 ppb

Sample ID	Vinyl Chloride	trans 1,2-DCE	1,1-DCA	cis 1,2-DCE	Benzene	TCE	Toluene	o-Xylene	1,4-DCB
1	4.10	3.08	0.86	1.10	1.15	1.23	1.36	1.14	1.91
2	5.12	3.63	1.46	1.87	1.45	1.14	1.54	1.27	1.40
3	5.21	3.45	1.78	1.06	1.63	1.68	1.52	1.36	1.64
4	4.42	5.31	1.68	1.22	1.33	1.12	1.37	1.22	1.67
5	5.78	3.75	1.47	1.15	1.47	0.27	1.54	1.28	1.99
6	5.15	3.41	1.39	1.78	1.00	1.35	1.52	1.30	2.19
7	4.45	4.03	1.73	1.24	1.45	1.16	1.62	1.35	1.65
μ	4.89	3.81	1.48	1.35	1.35	1.14	1.50	1.27	1.78
σ	0.59	0.73	0.31	0.33	0.21	0.43	0.10	0.08	0.27
3.14σ	1.84	2.28	0.98	1.05	0.67	1.35	0.30	0.24	0.83

Note: 3.14 is the t-Statistic for n-1 degrees of freedom, 99% Confidence Interval.

Analyte Concentrations by ECD in ppb

Sample ID	trans 1,2-DCE	1,1-DCA	cis 1,2-DCE	TCE	1,4-DCB
1	1.15	0.68	0.68	1.03	0.71
2	1.23	0.70	0.87	1.20	0.82
3	1.27	0.87	0.87	1.19	0.87
4	1.16	0.85	0.73	1.04	0.76
5	1.27	0.83	0.87	1.17	0.82
6	1.25	0.84	0.82	1.16	0.81
7	1.26	0.72	0.80	1.21	0.87
μ	1.23	0.78	0.81	1.14	0.81
σ	0.05	0.08	0.08	0.08	0.06
3.14σ	0.16	0.25	0.24	0.24	0.18

Note: 3.14 is the t-Statistic for n-1 degrees of freedom, 99% Confidence Interval.

Table F-4. Precision and Accuracy Worksheet

Analyte Relative Percent Recoveries by FID

Standard Concentration: 10 ppb

Sample ID	Vinyl Chloride	cis 1,2-DCE	Benzene	TCE	Toluene	o-Xylene	1,4-DCB
1	46	79	76	80	79	82	80
2	42	68	77	85	83	87	89
3	54	89	88	88	92	92	93
4	43	77	80	74	84	89	93
5	47	91	79	92	82	84	86
6	53	80	86	92	90	90	88
7	51	78	79	81	82	83	82
μ	48%	80%	81%	85%	85%	87%	88%
σ	4.67	7.61	4.38	6.84	4.56	3.80	5.11

Analyte Relative Percent Recoveries by ECD

Standard Concentration: 10 ppb

Sample ID	trans 1,2-DCE	1,1-DCA	cis 1,2-DCE	TCE	1,4-DCB
1	91	88	87	85	107
2	105	99	98	98	112
3	97	96	95	93	115
4	95	94	91	89	109
5	95	89	86	87	100
6	107	101	99	99	111
7	104	93	91	94	103
μ	99%	94%	93%	92%	108%
σ	6.30	4.63	4.84	5.19	5.40

Table F-5. Analyte Retention Time Worksheet

FID Retention Times for Target Analytes

Data File ID	Date Analyzed	Time Analyzed	Vinyl Chloride	trans 1,2-DCE	1,1-DCA	cis 1,2-DCE	Benzene	Fluorobenzen*	TCE	Toluene	o-Xylene	1,4-DCB
CAL3_24\ECD00006.DAT	24-Mar-97	20:49	0.853	1.956	2.315	2.907	4.011	4.564	5.276	7.633	10.755	13.170
PA3_25\FID00005.DAT	25-Mar-97	20:49	0.853	1.962	2.322	2.914	4.018	4.565	5.288	7.633	10.752	13.168
PA3_26\FID00005.DAT	26-Mar-97	18:49	0.848	1.947	2.307	2.904	4.009	4.560	5.277	7.630	10.751	13.165
		μ	0.851	1.955	2.315	2.908	4.013	4.563	5.280	7.632	10.753	13.168
		σ	0.003	0.008	0.008	0.005	0.005	0.003	0.007	0.002	0.002	0.003
		3σ	0.009	0.023	0.023	0.015	0.014	0.008	0.020	0.005	0.006	0.008
		Retention Window = 6σ	0.017	0.045	0.045	0.031	0.028	0.016	0.040	0.010	0.012	0.015

ECD Retention Times for Target Analytes

Sample ID	Date Analyzed	Time Analyzed	trans 1,2-DCE	1,1-DCA	cis 1,2-DCE	TCE	1Chloro-2-bromopropane*	1,4-DCB
CAL3_24\ECD00006.DAT	24-Mar-97	20:49	1.976	2.337	2.936	5.299	8.159	13.192
PA3_25\FID00005.DAT	25-Mar-97	20:49	1.977	2.337	2.938	5.299	8.159	13.190
PA3_26\FID00005.DAT	26-Mar-97	18:49	1.963	2.328	2.930	5.293	8.156	13.189
		μ	1.97	2.33	2.93	5.30	8.16	13.19
		σ	0.01	0.01	0.00	0.00	0.00	0.00
		3σ	0.02	0.02	0.01	0.01	0.01	0.00
		Retention Window = 6σ	0.05	0.03	0.02	0.02	0.01	0.01

* Fluorobenzene and 1-Chloro-2-bromopropane

APPENDIX B

CPT PROFILES

PIEZO-CONE PENETRATION TESTS

HANSCOM AIR FORCE BASE
MASSACHUSETTS

Contract No. FO863593C0020
SSG Subtask 8.05

Prepared for:

Armstrong Laboratory
Environics Directorate
AL/EQ
139 Barnes Drive, Suite 2
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March 6, 1997

Prepared by:

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ARA No. 5518

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HANSCOM AIR FORCE BASE
MASSACHUSETTS

INTRODUCTION

Applied Research Associates, Inc. (ARA), under contract to Armstrong Laboratory, conducted Piezo-Electric Cone Penetration Tests (P-CPT) in support of the geotechnical investigation at Hanscom AFB, Massachusetts. The purpose of this effort is to determine whether or not groundwater samples collected from CPT-installed wells produce the same analytical results as groundwater samples collected from conventionally installed wells. This report documents ARA's site investigation efforts, test techniques and analysis of the data for fieldwork conducted from August 1996 to February 1997. Presented in this report are the field testing methods, data analysis techniques and a discussion of the results.

TEST LOCATIONS

Sixty-two cone penetrometer tests have been conducted as a part of the geotechnical investigation at Hanscom AFB in Massachusetts. The CPT test identification and depth of each penetration are listed in Tables 1.1, 1.2, and 1.3.

A total of forty-three 2-inch ID PVC monitoring wells were installed using the penetrometer vehicle. The monitoring well construction details are summarized in Table 1.4.

REPORT OUTLINE

This report is organized into four sections and one Appendix. Section 2 discusses the P-CPT equipment, field procedures and data format. Section 3 is a discussion of the techniques used for estimating soil classification. Section 4 contains a list of references.

The data for the CPT tests are presented in Appendix A. Each profile consists of tip resistance (psi), sleeve friction (psi), friction ratio (sleeve friction/tip resistance), pore pressure (psi), and soil classification.

Table 1.1 CPT Testing Summary at Site 1, Hanscom AFB

Site	Test ID	Date of Test	Depth of Penetration (ft)	Depth to GWT (ft)
1	CPT-02	08/29/96	17.5	4.90
1	CPT-03B	08/29/96	4.0	N/A
1	CPT-MW-04	12/17/96	16.2	13.47
1	CPT-B102-MW	01/10/97	19.3	1.96
1	CPT-B103-MW	01/28/97	15.0	13.47
1	CPT-B104-MW	01/28/97	9.5	7.53
1	CPT-B108-MW	01/11/97	67.3	7.67
1	CPT-B113-MW	12/19/96	49.1	11.12
1	CPT-B115-MW	01/10/97	51.0	18.39
1	CPT-B126-MW	01/11/97	49.9	1.96
1	CPT-RAP1-4S	01/28/97	15.0	2.85
1	CPT-RAP1-5S	01/28/97	10.8	8.79
1	CPT-RAP1-6S	01/09/97	19.2	5.90

Table 1.2 CPT Testing Summary at Site 2, Hanscom AFB

Site	Test ID	Date of Test	Depth of Penetration (ft)	Depth to GWT (ft)
2	CPT-01	08/29/96	44.6	7.40
2	CPT-04	08/30/96	65.0	7.00
2	CPT-B101-MW	01/11/97	22.3	7.67
2	CPT-B105-MW	12/20/96	18.0	10.03
2	CPT-B106-MW	12/21/96	18.0	7.84
2	CPT-B107-MW	12/19/96	17.5	11.12
2	CPT-B109-MW	12/20/96	62.7	8.68
2	CPT-B130-MW	01/09/97	19.3	8.87
2	CPT-B238-MW	01/29/97	12.3	4.93
2	CPT-B239-MW	01/29/97	26.0	4.93
2	CPT-B241-MW	01/11/97	20.3	7.45
2	CPT-B242-MW	01/30/97	40.8	7.45
2	CPT-OW2-1	12/22/96	18.4	11.54
2	CPT-OW2-2	12/22/96	23.3	12.18
2	CPT-OW2-4	01/10/97	35.3	18.39
2	CPT-OW2-6	12/21/96	23.3	11.04
2	CPT-OW2-7	01/10/97	25.3	10.52
2	CPT-RAP2-2S	12/19/96	23.2	6.09
2	CPT-RAP2-2T	12/19/96	69.0	8.80
2	CPT-RAP2-3S	01/09/97	28.9	8.27
2	CPT-RAP2-4S	12/18/96	28.5	6.32
2	CPT-RAP2-4T	12/18/96	32.8	6.32
2	CPT-RAP2-5S	12/21/96	16.5	7.79
2	CPT-RFW-11	12/18/96	21.0	11.79

Table 1.3 CPT Testing Summary at Site 21, Hanscom AFB

Site	Test ID	Date of Test	Depth of Penetration (ft)	Depth to GWT (ft)
21	CPT-05	08/30/96	16.0	15.00
21	CPT-06	08/30/96	21.2	11.70
21	CPT-B20	02/03/97	19.0	8.62
21	CPT-B37	01/31/97	19.0	6.19
21	CPT-B38	02/04/97	20.5	13.93
21	CPT-B39	02/04/97	21.0	12.20
21	CPT-B40	01/31/97	19.1	11.73
21	CPT-B41	01/31/97	17.0	11.28
21	CPT-B42	01/31/97	17.0	7.30
21	CPT-OW-2	01/10/97	16.8	4.96
21	CPT-MWZ-3	01/31/97	21.5	14.80
21	CPT-MWZ-4	02/04/97	20.0	13.77
21	CPT-MWZ-5	02/01/97	20.6	11.53
21	CPT-MWZ-6	02/01/97	20.5	8.51
21	CPT-MWZ-7	01/31/97	14.2	5.30
21	CPT-MWZ-8	01/30/97	21.2	16.01
21	CPT-MWZ-11	02/01/97	20.9	11.17
21	CPT-MWZ-12	01/31/97	22.4	5.30
21	CPT-MWZ-16	02/05/97	11.7	14.34
21	CPT-MWZ-17	02/03/97	20.2	14.34
21	CPT-MWZ-19	01/30/97	15.2	N/A
21	CPT-MWZ-22	02/03/97	21.5	12.22
21	CPT-MWZ-23	01/31/97	21.0	14.39
21	CPT-MWZ-24	02/04/97	20.3	14.39
21	CPT-MWZ-25	01/31/97	13.3	N/A

SECTION 2
TESTING EQUIPMENT AND PROCEDURES

INTRODUCTION

The electric cone penetrometer test (CPT) was originally developed for use in soft soil. Over the years, cone and push system designs have evolved to the point where they can now be used in strong cemented soils and even soft rock. ARA's penetrometer consists of an instrumented probe that is forced into the ground using a hydraulic load frame mounted on a heavy truck with the weight of the truck providing the necessary reaction mass. The probe has a conical tip and a friction sleeve that independently measure vertical resistance beneath the tip as well as frictional resistance on the side of the probe as functions of depth. A schematic view of ARA's penetrometer probe is shown in Figure 2.1. A pressure transducer in the cone is used to measure the pore water pressure as the probe is pushed into the ground (Piezo-CPT).

PIEZO-ELECTRIC CONE PENETROMETER TEST

The cone penetrometer tests are conducted using the ARA penetrometer truck. The penetrometer equipment is mounted inside a van body attached to a ten-wheel truck chassis with a diesel engine. Ballast in the form of metal weights are added to the truck to achieve an overall push capability of 50,000 lbs. Penetration force is supplied by a pair of large hydraulic cylinders bolted to the truck frame.

The penetrometer probe is of standard dimensions having a 1.730-inch diameter, 60° conical tip, and a 1.75-inch diameter by 5.27-inch long friction sleeve. The shoulder between the base of the tip and the porous filter is 0.08 inch long. A 1.85-inch diameter expander, located 5.25 inches behind the top of the friction sleeve and shown in Figure 2.1, pushes the penetration hole open and reduces the frictional drag on the push tubes behind the probe. The penetrometer is normally advanced vertically into the soil at a constant rate of 48 inches/minute, although this rate must sometimes be reduced as hard layers are encountered. The electric cone penetrometer test is conducted in accordance with ASTM D3441 (Ref. 1).

Inside the probe, two load cells independently measure the vertical resistance against the conical tip and the side friction along the sleeve. Each load cell is a cylinder of uniform cross section inside the probe which is instrumented with four strain gages in a full-bridge circuit. Forces are sensed by the load cells and the data are transmitted from the probe assembly via a cable running through the push tubes. The analog data are digitized, recorded, and plotted by computer in the penetrometer truck. A set of data is normally recorded each second, for a minimum resolution of about one data point every 0.8 inch of cone advance. The depth of penetration is measured using a linear displacement transducer mounted inside one of the push cylinders.

Electronic data acquisition equipment for the cone penetrometer consists of a computer with a graphics monitor and a rack of eight signal conditioners. Analog signals are transmitted from the probe to the signal conditioners where the CPT data are amplified and filtered at 1 Hz. Once amplified, the analog signals are transmitted to a high speed analog-to-digital converter board, where the signals are digitized; usually at the rate of one sample per second for the penetration data. The digital data are then read into memory and written to the internal hard disk for future processing. Upon completion of the test, the penetration data is plotted. The digital data are brought to ARA's New England Division in South Royalton, Vermont, for analysis and preparation of report plots.

Saturation of the Piezo-Cone

Penetration pore pressures are measured with a pressure transducer located behind the tip in the lower end of the probe. Water pressures in the soil are sensed through a 250 micron minimum porous polyethylene filter that is 0.25-inch high and 0.202-inch thick. The pressure transducer is connected to the porous filter through a pressure port as shown in Figure 2.1. The pressure port and the filter are filled with a high viscosity silicone oil.

For the pressure transducer to respond rapidly and correctly to changing pore pressures upon penetration, the filter and pressure port must be saturated with oil upon assembly of the probe. A vacuum pump is used to de-air the silicone oil before use and also to saturate the porous filters with oil. The probe is assembled with the pressure transducer facing upwards and the cavity above the pressure transducer is filled with de-aired oil. A previously saturated filter is then placed on a tip and oil is poured over the threads. When the cone tip is screwed into place, excess oil is ejected through the pressure port and filter, thereby forcing out any trapped air.

Saturation of the piezo filter is verified with field calibrations performed on a daily basis and after replacement of the filter. The high viscosity of the silicone oil coupled with the small pore space in the filter prevents the loss of saturation as the cone is pushed through dry soils. Saturation of the cone can be verified with a calibration check at the completion of the penetration. Extensive field experience has proven the reliability of this technique.

Field Calibrations

Many factors can effectively change the calibration factors used to convert the raw instrument readouts, measured in volts, to units of force or pressure. As a quality control measure, as well as a check for instrument damage, the load cells and the pressure transducer are routinely calibrated in the field. Calibrations are completed with the probe ready to insert into the ground so that any factor affecting any component of the instrumentation system will be included and detected during the calibration.

The tip and sleeve load cells are calibrated with the conical tip and friction sleeve in place on the probe. For each calibration, the probe is placed in the push frame and loaded onto a precision reference load cell. The reference load cell is periodically calibrated in ARA's laboratory against instruments traceable to NIST standards. To calibrate the pore pressure transducer, the saturated probe is inserted into a pressure chamber with air pressure supplied by the compressor on the truck. The reference transducer in the pressure chamber is also periodically calibrated against an NIST traceable instrument in ARA's laboratory. Additionally, the linear displacement transducer used to measure the depth of penetration, is periodically checked against a tape measure.

Each instrument is calibrated using a specially developed computer code that displays the output from the reference device and the probe instrument in graphical form. During the calibration procedure, the operator checks for linearity and repeatability in the instrument output. At the completion of each calibration, this code computes the needed calibration factors using a linear regression algorithm. At a minimum, each probe instrument is calibrated at the beginning of each day of field testing. Furthermore, the pressure transducer is recalibrated each time the porous filter is changed and the cone resaturated. Calibrations are also performed to verify the operation of any instrument if any damage is suspected.

Penetration Data Format

Data are presented as profiles of tip resistance and sleeve friction. A sample presentation of data is shown in Figure 2.2. Tip resistance is obtained by dividing the vertical force on the conical tip by the effective tip area (2.35 in^2). The offset between the depth at the tip and the depth at the friction sleeve is corrected by shifting the sleeve friction profile downward so that it corresponds to the depth at the centroid of the tip. In addition to the resistance and sleeve friction, a friction ratio profile is presented for each location. This is simply the sleeve friction expressed as a percentage of the tip resistance. In uncemented soils the friction ratio can be used to determine soil type.

The penetration pore pressure that is measured as the probe is advanced is also plotted in Figure 2.2. As shown in Figure 2.1, the piezo-cone probe senses the pore pressure immediately behind the tip. Currently, there is no accepted standard for the location of the sensing element. ARA chose to locate the sensing element behind the tip since the filter is protected from the direct thrust of the penetrometer and the measured pore pressure can be used to correct the tip resistance data (discussed in the next section) as recommended in Reference 2. The magnitude of the penetration pore pressure is a function of the soil compressibility and, most importantly, permeability. In freely draining soil layers, the measured pore pressures will be very close to the hydrostatic pressure computed from the elevation of the water table. When low permeability soil layers are encountered, excess pore pressures generated by the penetration process can not dissipate rapidly and this results in measured pore pressures which are significantly higher than the hydrostatic pressures. Whenever the penetrometer is stopped to add another section of push tube, or when a pore pressure dissipation test is run, the excess pore pressure may begin to dissipate. When the penetration is resumed, the pore pressure quickly rises to the level measured before the penetrometer was stopped. This process causes some of the spikes that appear in the penetration pore pressure data.

Pore Pressure Correction of Tip Stress

Cone penetrometers, by necessity, must have a joint between the tip and sleeve. Pore pressure acting behind the tip decreases the total tip resistance that would be measured if the penetrometer was without joints. The influence of pore pressure in these joints is compensated for by using the net area concept (Ref. 2). The corrected tip resistance is given by:

$$q_T = q_c + u\left(1 - \frac{A_n}{A_T}\right) \tag{2.1}$$

where:

q_T = corrected tip resistance (psi)

q_c = measured tip resistance (psi)

u = penetration pore pressure measured behind the tip (psi)

A_n = net area behind the tip not subjected to the pore pressure

A_T = projected area of the tip

Hence, for the ARA cone design, the tip resistance is corrected as:

$$q_T = q_c + u\,(.1890) \tag{2.2}$$

Laboratory calibrations have verified Equation 2.2 for ARA's piezo-cone design.

A joint also exists behind the top of the sleeve (see Figure 2.1). However, since the sleeve is designed to have the same cross sectional area on both ends, the pore pressures acting on the sleeve cancel out. Laboratory tests have verified that the sleeve is subjected to equal end area effects. Thus, no correction for pore pressure is needed for the sleeve friction data.

The net effect of applying the pore pressure correction is to increase the tip resistance. Generally, this correction is only significant when the measured tip resistance is very low.

Numerical Editing of the Penetration Data

Any time that the cone penetrometer is stopped or pulled back during a test, misleading data can result. For instance, when the probe is stopped to add the next push tube section, or when a pore pressure dissipation test is run, the excess pore pressures will dissipate towards the hydrostatic pore pressure. When the penetration is resumed, the pore pressure generally rises very quickly to the pressures experienced prior to the pause in the test. In addition, the probe is sometimes pulled back and cycled up and down at intervals in deep holes to reduce soil friction on the push tubes. This results in erroneous tip stress data when the cone is advanced in the previously penetrated hole.

To eliminate this misleading data from the penetration profile, the data is numerically edited before it is plotted or used in further analysis. Each time the penetrometer stops or backs up, as apparent from the depth data, the penetration data is not plotted. Plotting of successive data is resumed only after the tip is fully re-engaged in the soil by one tip length of new penetration. This algorithm also eliminates any data acquired at the ground surface before the tip has been completely inserted into the ground. The sleeve data is similarly treated and this results in the first data point not occurring at the ground surface, as can be seen in the tip and sleeve profiles of Figure 2.2. These procedures ensure that all of the penetration data that is plotted and used for analysis was acquired with the probe advancing fully into undisturbed soil.

MONITORING WELL INSTALLATION

Well Installation Method

Prior to each well placement, a 1.75-inch standard CPT cone was pushed to the designed well completion depth. This first push measured the geologic conditions at that location and provided a guide hole for the larger diameter well. During the CPT push, data was acquired and stored during penetration and a field plot generated at the completion of the penetration.

Monitoring wells were installed by first threading a stainless steel or high-strength plastic tip into one end of a one-meter silt trap section. This well tip acted as the drive point as the well was pushed into the ground. If a silt trap was not used, the tip was threaded directly onto the bottom screen section. A schematic of this well installation procedure is presented in Figure 2.3.

The riser or screen sections were threaded onto one another as required and lowered through the penetrometer push system until the tip rested on the ground surface.

The steel push rods, with a blunt tip attached, were lowered inside the well material until the blunt end came to rest atop the well tip. Push rods were added until the rod string protruded above the top of the well material. The head clamp of the clamping system was then able to clamp the rods and not the well material.

Installation was initiated when the rods drove the well tip into the ground, pulling the well material into the ground with it. Additional screen and riser sections were added as necessary until the screen section was at the designed depth.

Once the desired depth was achieved, the push rods were removed from the well. If required during retraction, the rods were decontaminated using the CPT rig's steam cleaner. Water generated during the rod decontamination process was containerized and delivered to the on-site groundwater treatment facility for disposal.

Well Screen and Riser

The wells were constructed of 2-inch diameter schedule 80 PVC with flush threaded joints. Each section is one meter (3.28 feet) long, has an outside diameter of 2.375 inches. The well screen is constructed of 0.020-inch slot schedule 80 PVC and is configured to match as closely as possible to the existing conventionally installed well screen top and bottom elevations.

Surface Seal

After the well was installed, a flush mounted manhole cover was installed and set in an eighteen (18) inch square concrete cap. The well riser was cut approximately 2 to 3 inches below the top of the cap before the manhole cover and cap were installed. During winter conditions, the well locations were marked with wood stakes which have been spray painted with fluorescent marking paint.

Field Documentation

Field documentation was maintained during the installation of monitoring wells. A monitoring well installation report was completed for each well installed.

DEVELOPMENT OF MONITORING WELLS

Objective

The monitoring wells were developed following their completed installation. Well development was designed to promote the free movement of groundwater through the well screen so that representative groundwater samples can be obtained.

Well Development Procedures

Development of CPT-installed monitoring wells was conducted with the Aardvark well development system. This system is a combination of a mechanical surge block and a venturi air lift silt and water pump. The Aardvark system was cleaned in a liquinox water bath before each use to avoid cross-contamination. Development was achieved by raising and lowering the Aardvark development head in the well repeatedly over a two-foot section of the well screen. During this process field readings were taken of the purge water's temperature, pH, and turbidity at a rate of at least 1 reading per removed well volume. Field parameters were measured with a YSI Model 6820 field water-quality meter. The purging process was continued until the parameters stabilized (less than 0.2 pH units or a 10 percent change for the other parameters among four consecutive readings) and the water was clear and free of fines.

Well Development Records

Well development records were maintained by completing a Well Development Log for each well.

Management of Purge Water

Purge water generated during the well development process was containerized and delivered to the on-site groundwater treatment facility for disposal.

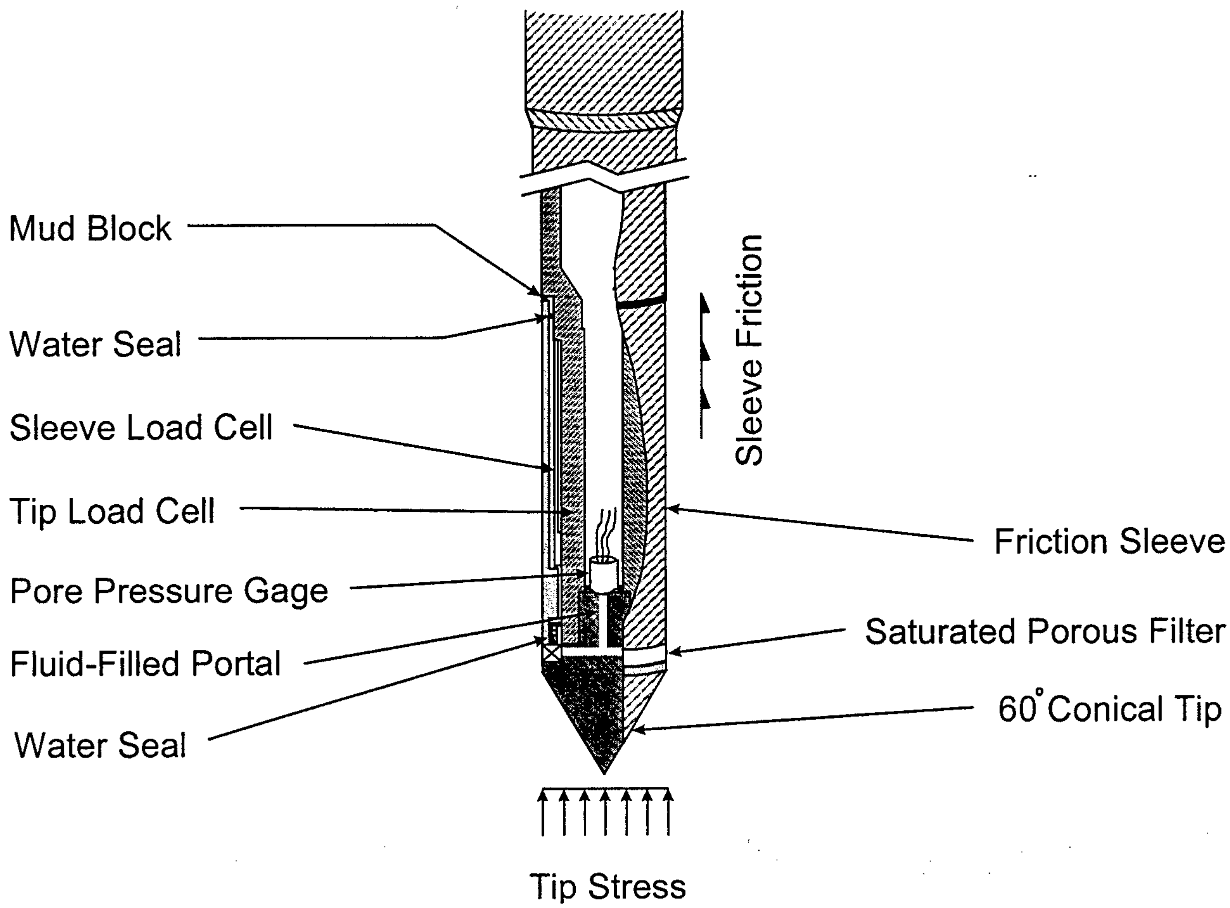

Figure 2.1 Schematic of ARA's cone penetrometer probe.

Figure 2.2 Typical P-CPT penetration profile.

Figure 2.2 Typical P-CPT penetration profile. (concluded)

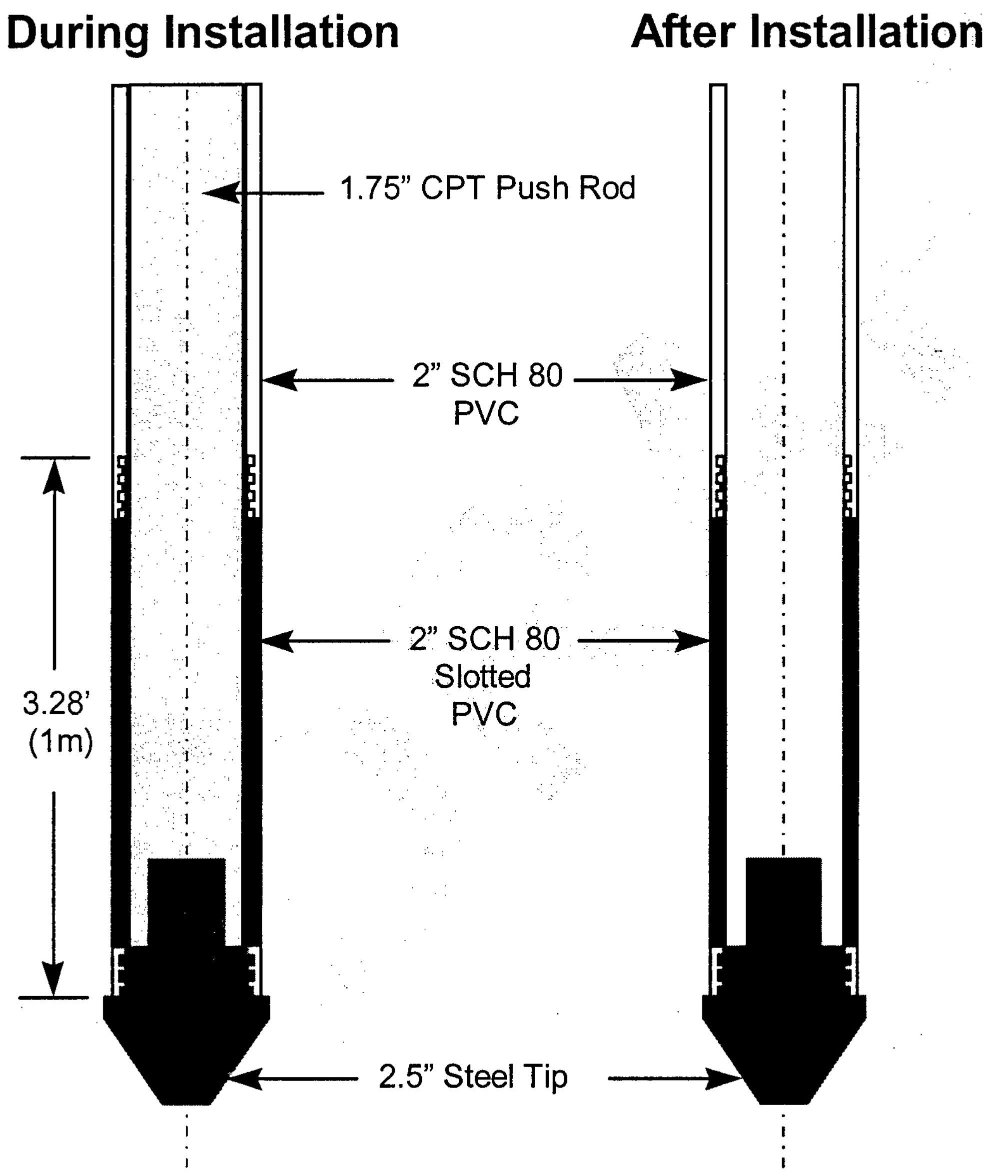

Figure 2.3 Schematic of 2-inch diameter PVC well installation with Cone Penetration Technique (CPT).

SECTION 3

TECHNIQUES FOR ESTIMATING IN SITU SOIL PROPERTIES

OVERVIEW

Presented in this section is a detailed discussion of a typical Piezo-Electric Cone Penetrometer Test (P-CPT) methods for estimating in situ soil properties. All calculations were conducted using a soil density of 115 pcf above the water table and 62.6 pcf below the water table.

LOCATION OF THE SITE WATER TABLE

Generally, the static water table at a given site can be identified from the penetration pore pressures, which will be equal to the hydrostatic pore pressure in freely draining soil layers. When no such layers are present at a site, pore pressure dissipation tests can be performed to determine hydrostatic pressures at depth. In the case of Hanscom AFB, the water table was acquired from the respective of immediately adjacent well. Groundwater table information is used primarily to determine the soil classification as a function of depth.

SOIL CLASSIFICATION

Plots of normalized tip resistance versus friction ratio and normalized tip resistance versus penetration pore pressure can be used to determine soil classification as a function of depth. Both methods of soil classification are based on empirical charts developed by Robertson. The corrected tip stress, q_T, in Figure 3.1 has been corrected for pore pressure effects, as discussed in Section 2, and converted to units of bars (1 bar = 14.7 psi). The pore pressure ratio is defined as:

$$B_q = \frac{u_{meas} - u_o}{q_T - \sigma_{vo}}$$

where: u_{meas} = measured penetration pore pressure

u = static pore pressure, determined from the water table elevation

q_T = corrected tip resistance

σ_v = total overburden stress

and the normalized friction ratio is defined as:

$$f_{SN} = \frac{f_s}{q_T - \sigma_{vo}} \, x \, 100$$

and the normalized tip resistance is defined as:

$$q_{NT} = \frac{q_T - \sigma_{vo}}{\sigma_{v'o}}$$

The intersection point of the q_T and B_q or f_{SN} values normally falls in a classification zone. The classification zone number corresponds to a soil type as shown in the figure. At some depths, the CPT data will fall outside of the range of the classification chart. When this occurs, no data is plotted and a break is seen in the classification profile. Soil classifications for this work were determined using both charts in Figure 3.1. Close analysis of these charts indicates that as the classification numbers vary, so does the soil grain size.

Figure 3.1 Soil Classification Using the Cone Penrometer Test, P.K. Robertson.

SECTION 4

LIST OF REFERENCES

1. American Society for Testing Materials, "Standard Method for Deep Quasi-Static Cone and Friction-Cone Penetration Tests of Soil," ASTM Designation: D3441, 1986.

2. Robertson, P.K. and R.G. Campanella, *Guidelines for Using the CPT, CPTU and Marchetti DMT for Geotechnical Design*, Vol. II, University of British Columbia, Vancouver, BC, Canada, March 1988.

3. *Use of In Situ Test in Geotechnical Engineering*, S.P. Clemence, ed., Geotechnical Special Publications No. 6, proceedings of In Situ '86 Conference, sponsored by Geotechnical Engineering Division of the American Society of Civil Engineers, Blacksburg, VA, June 1986.

APPENDIX

P-CPT PROFILES

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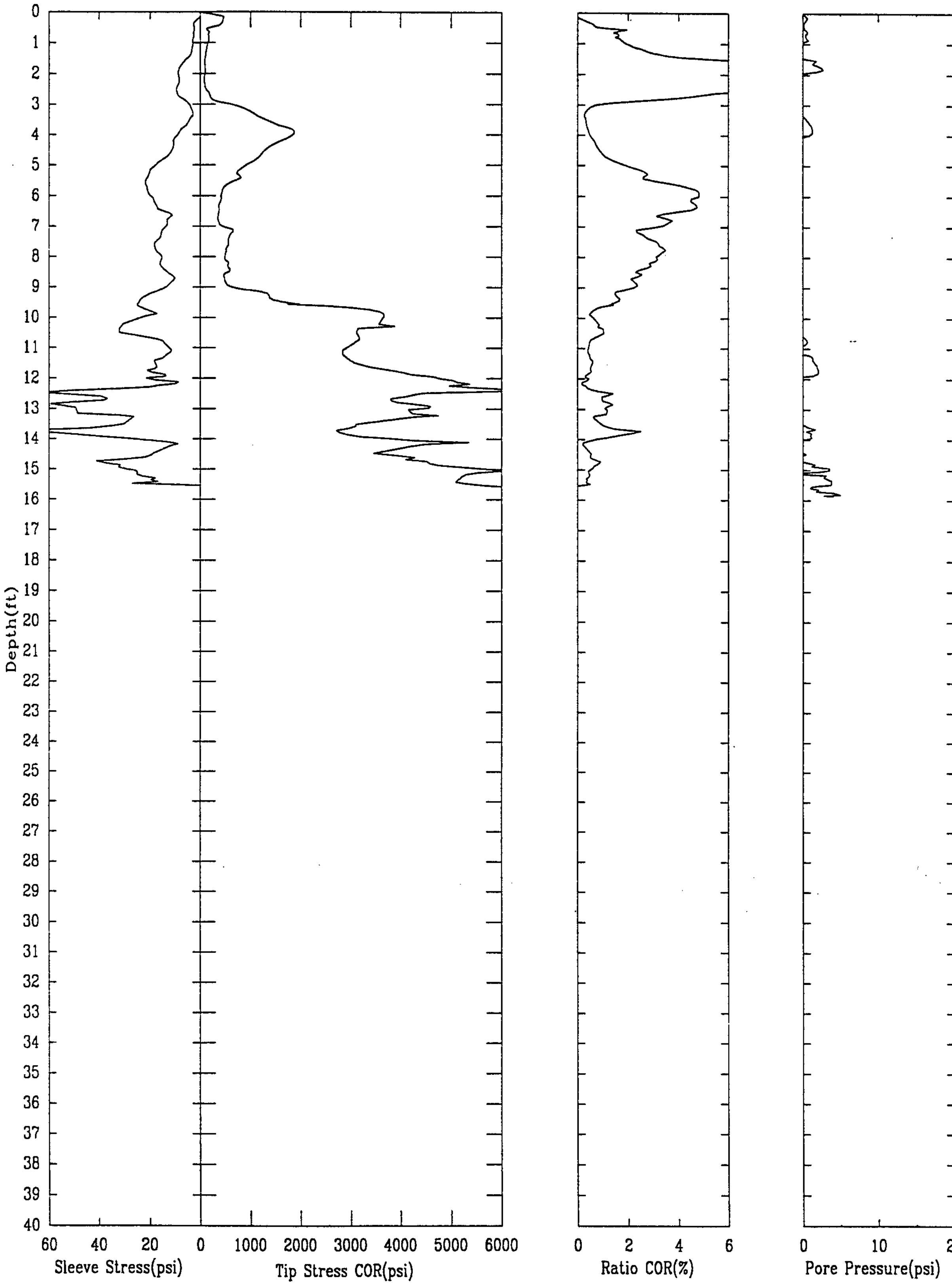

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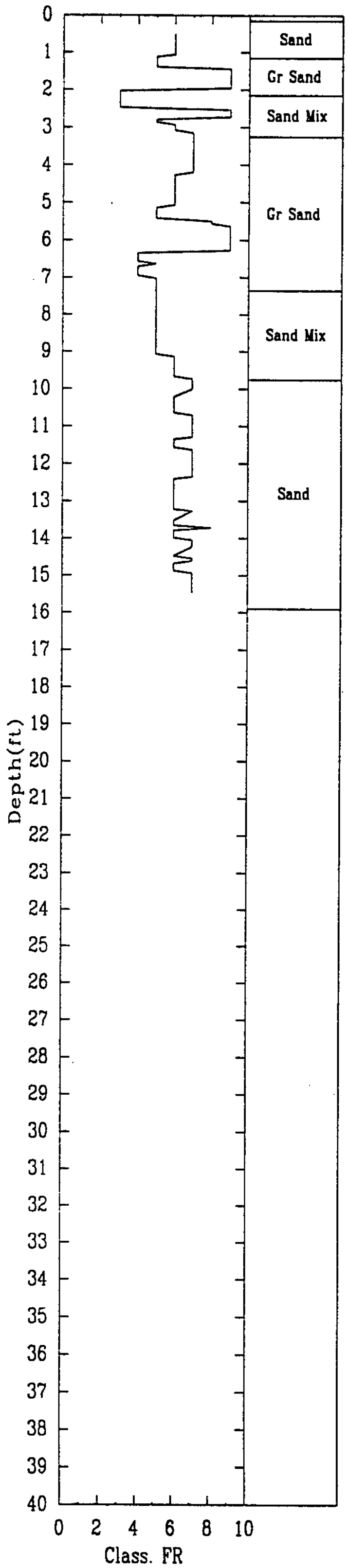

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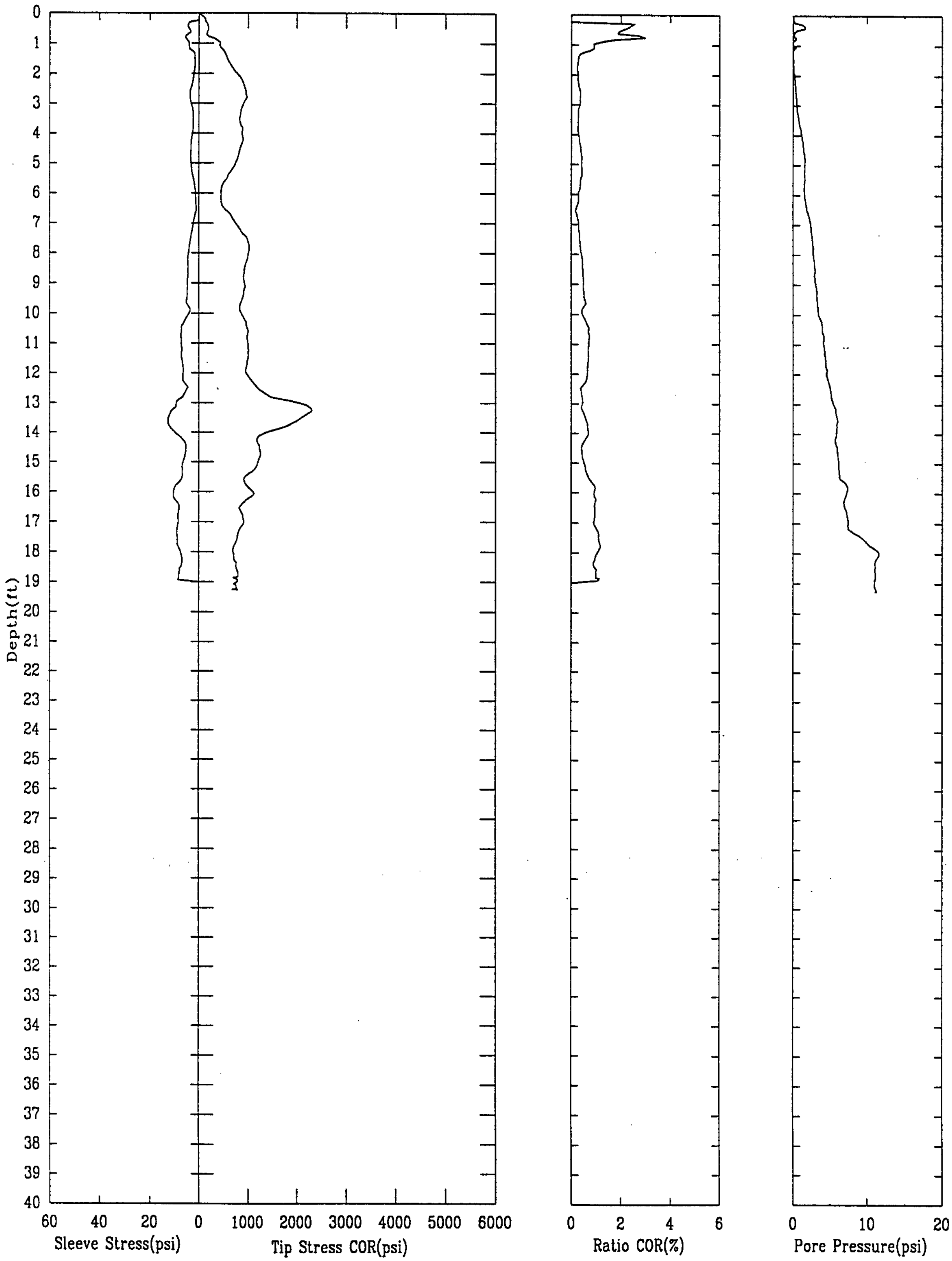

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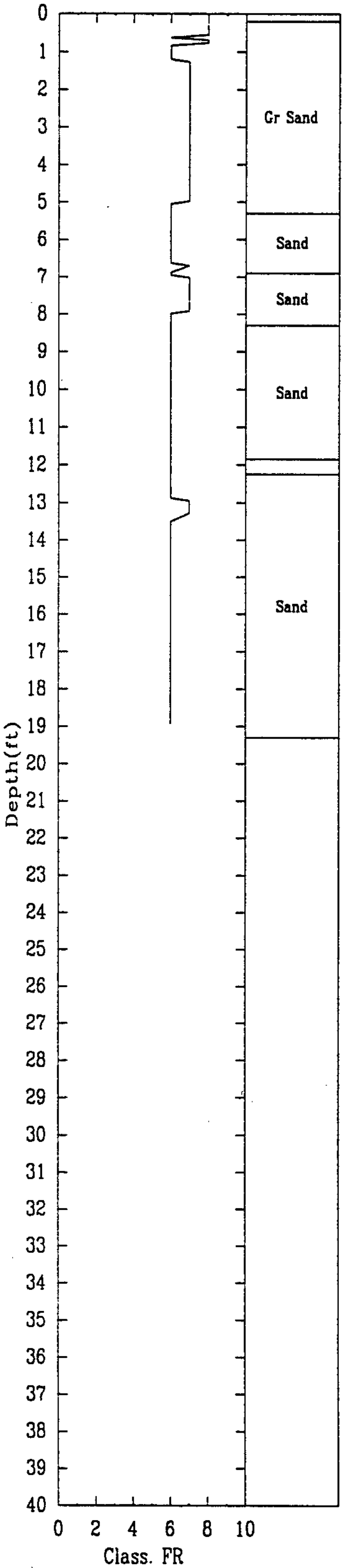

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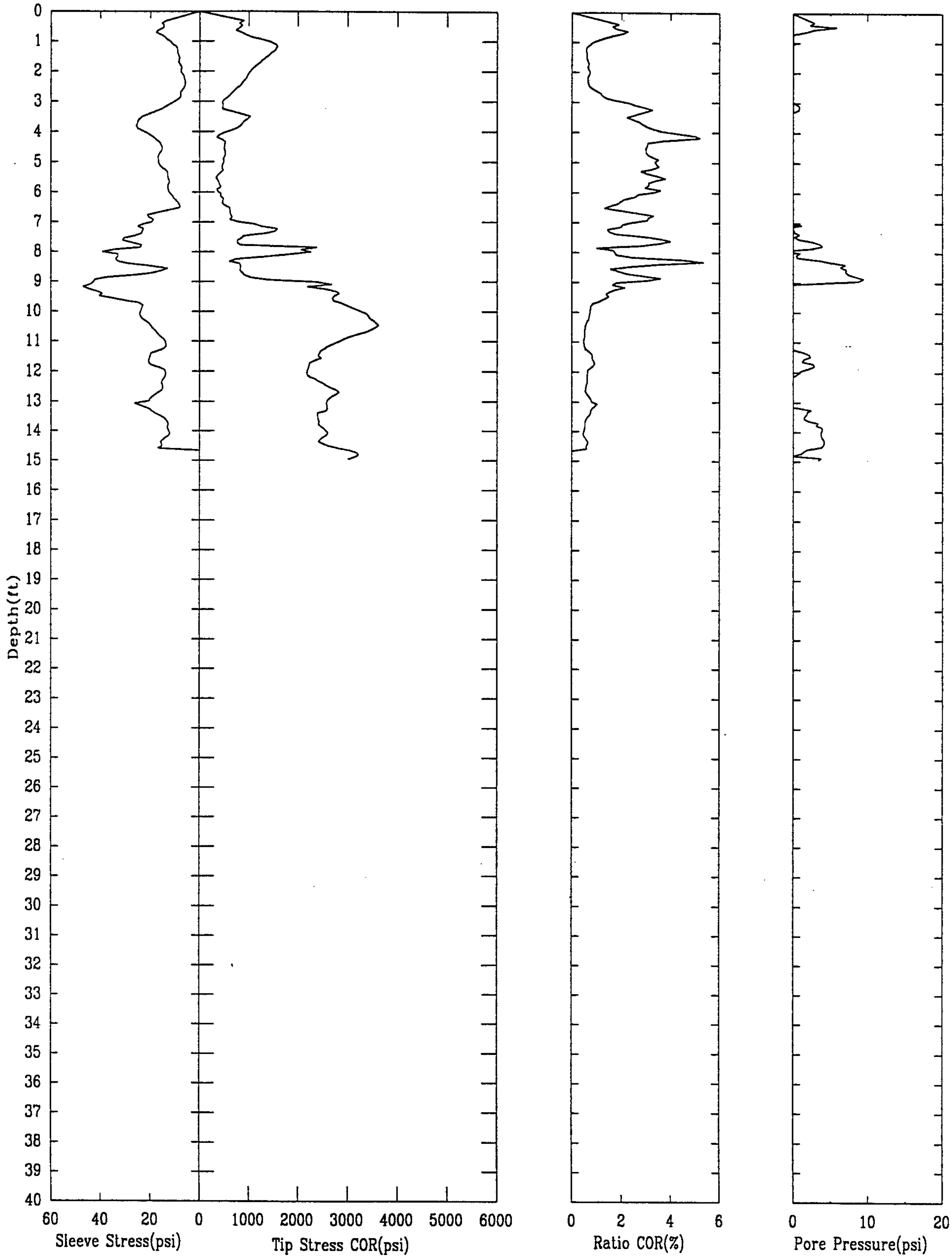

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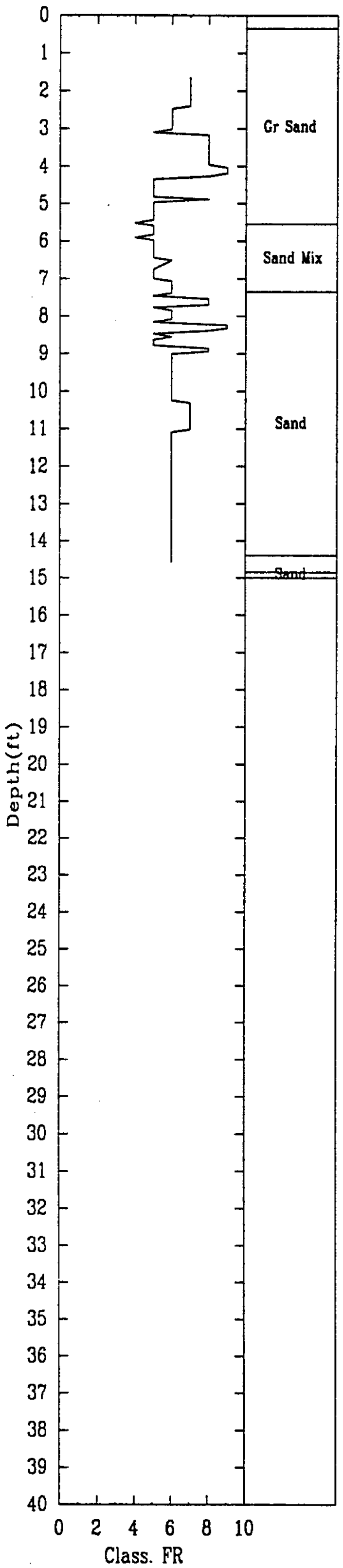

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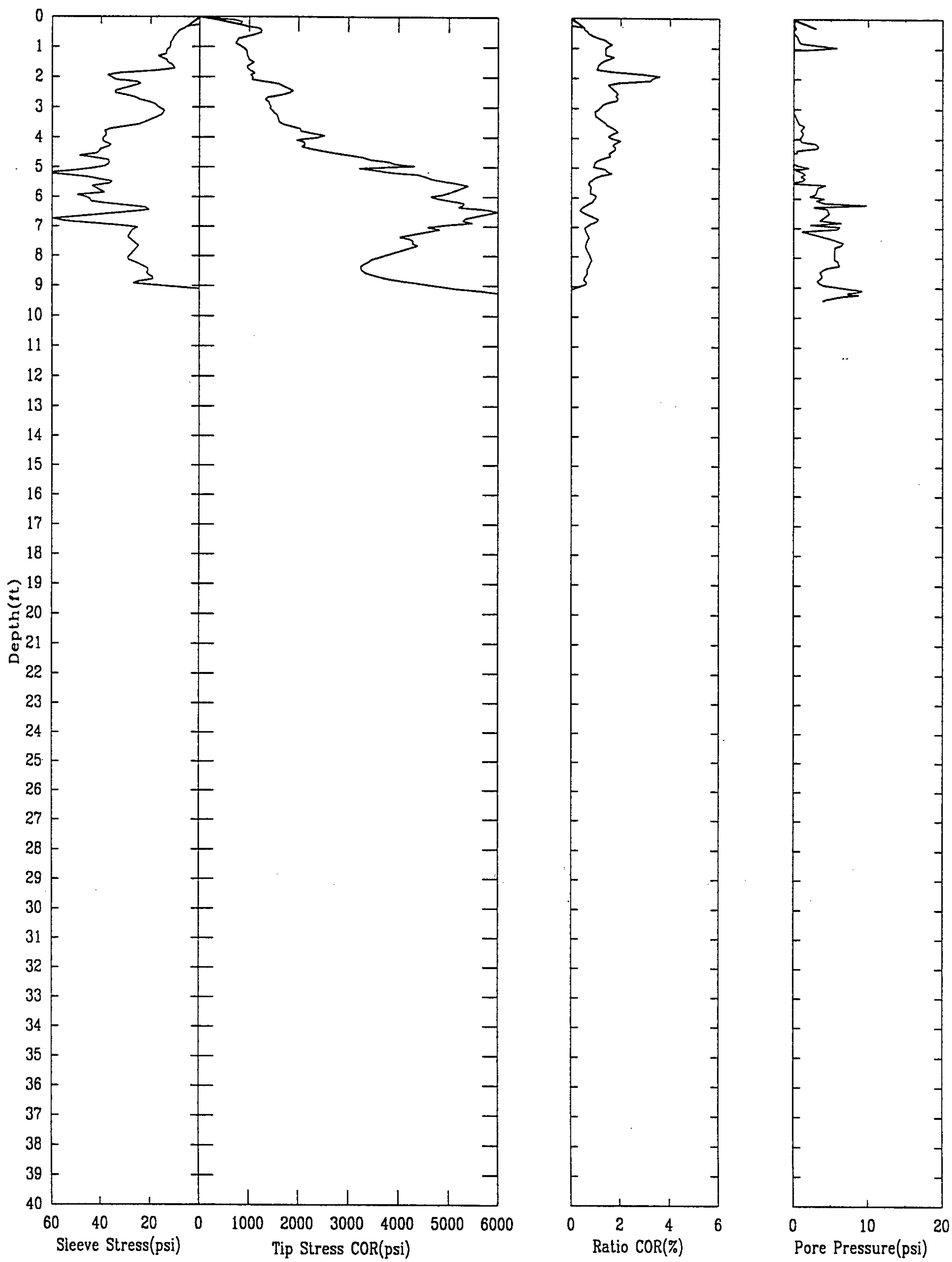

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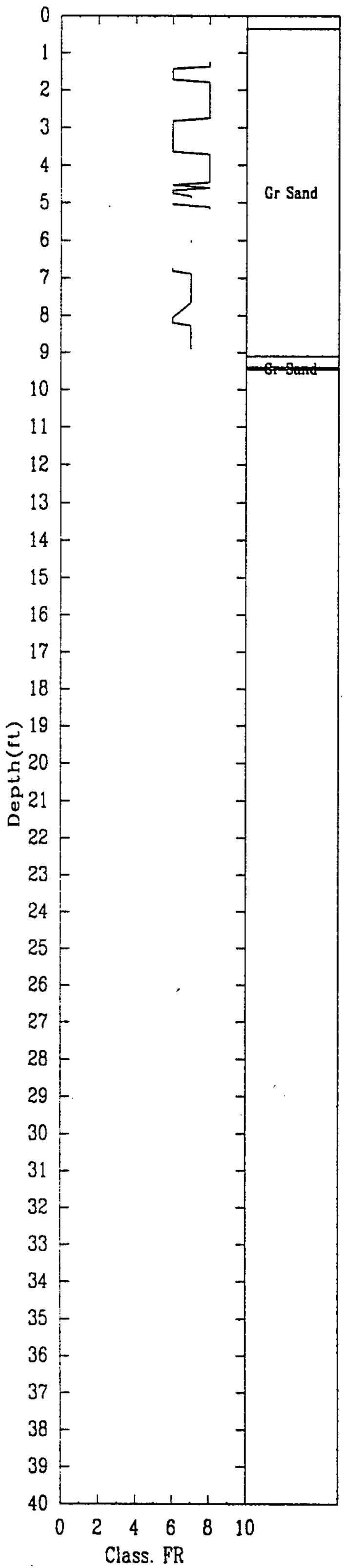

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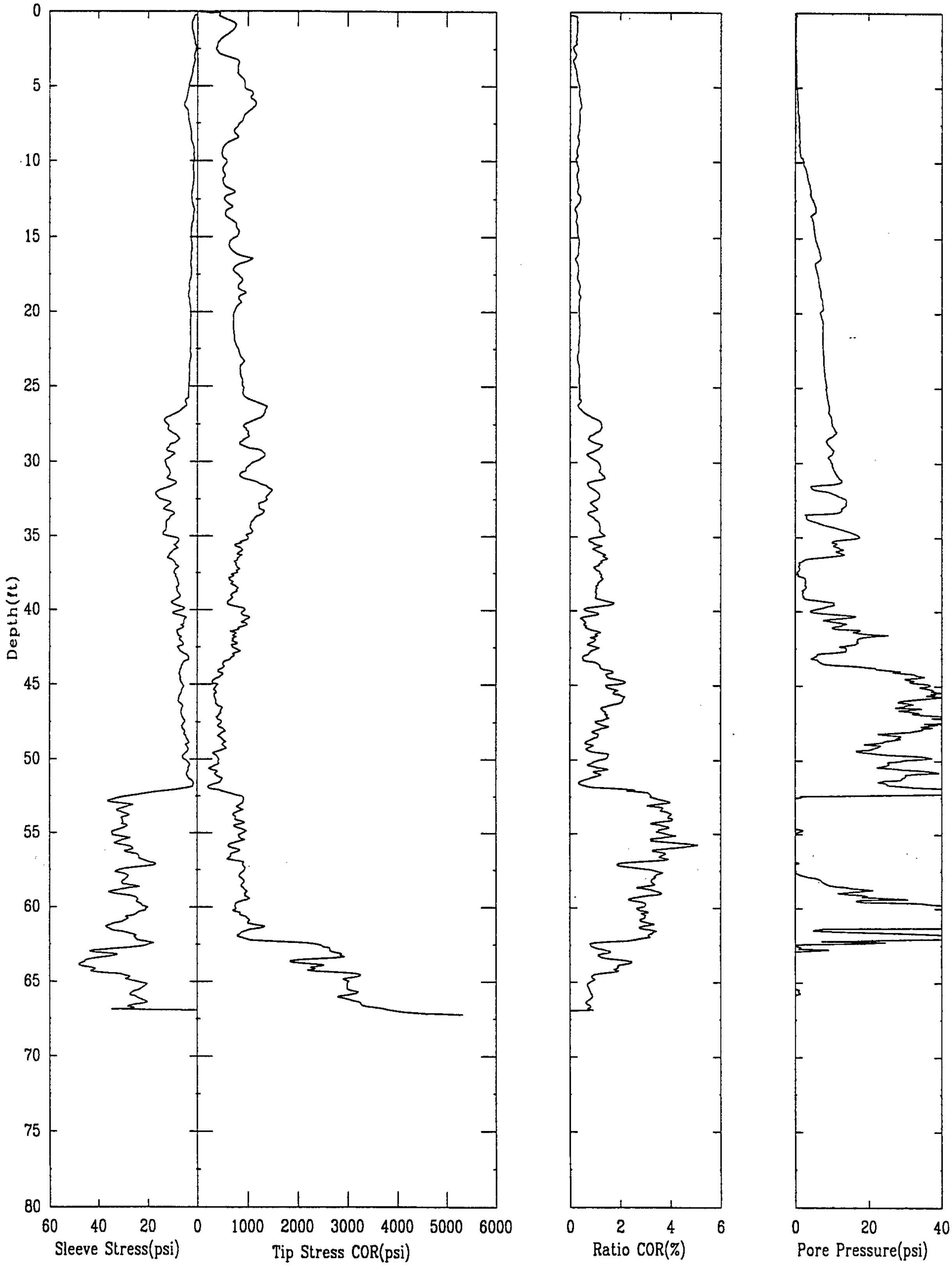

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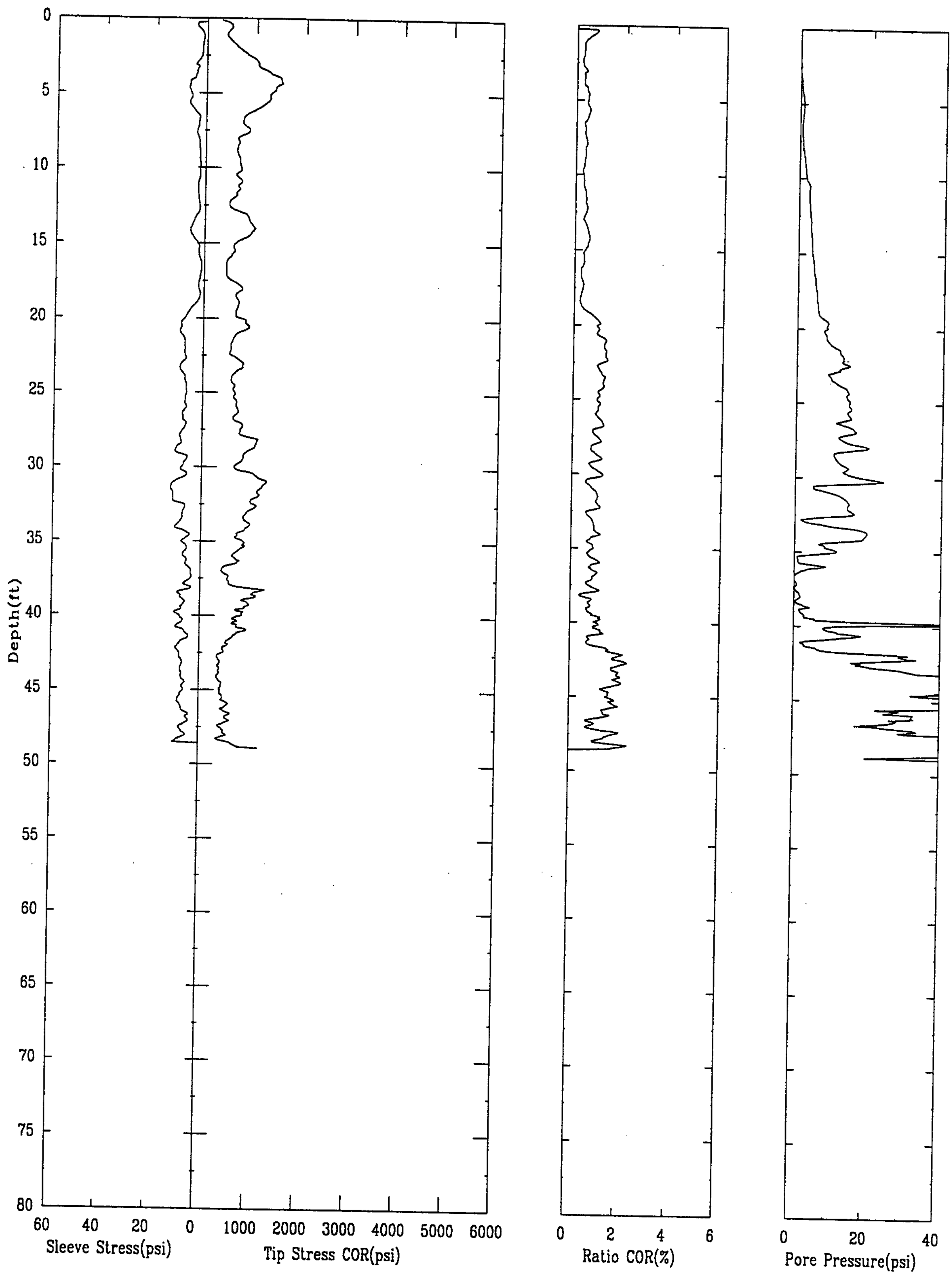

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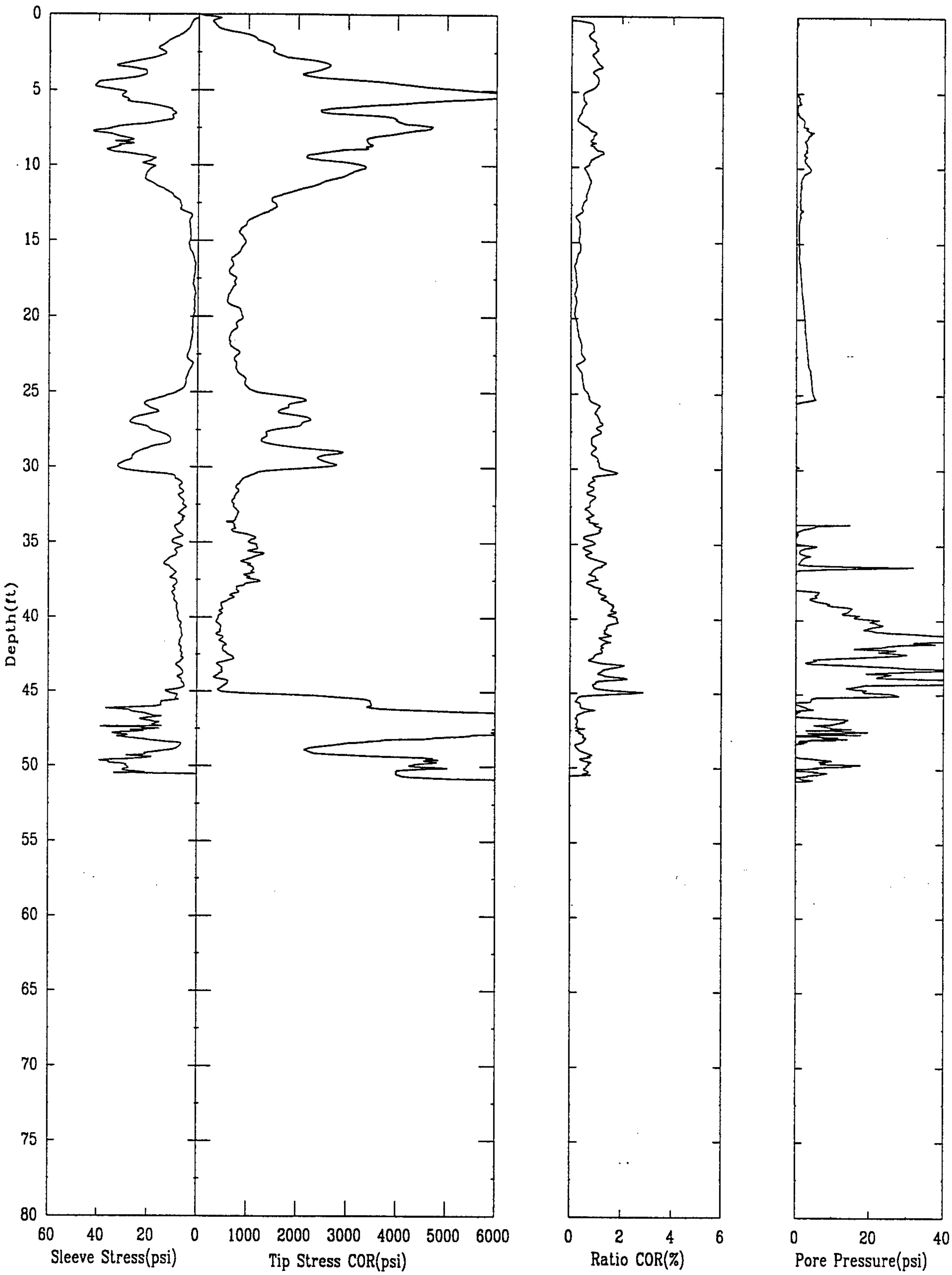

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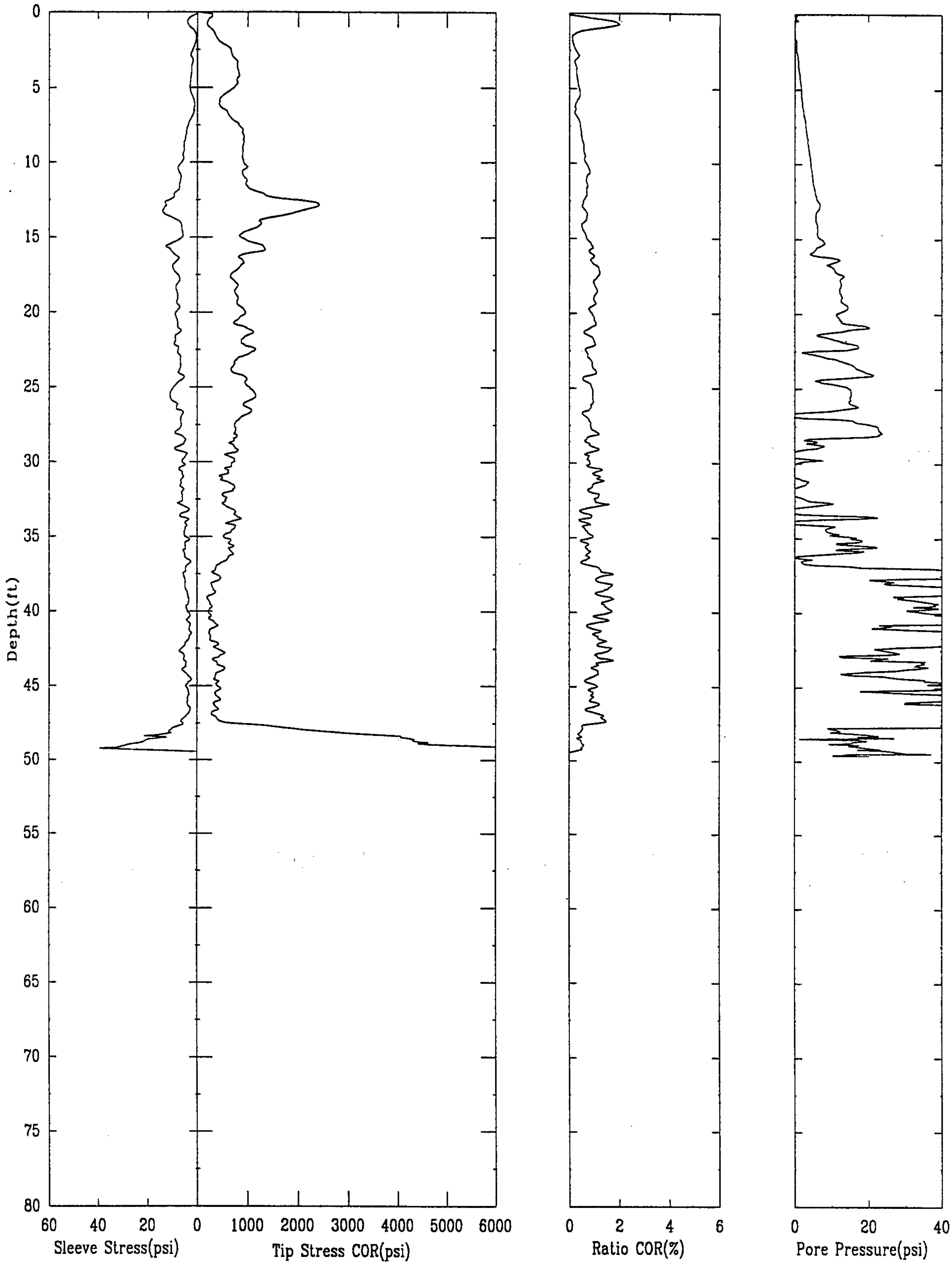

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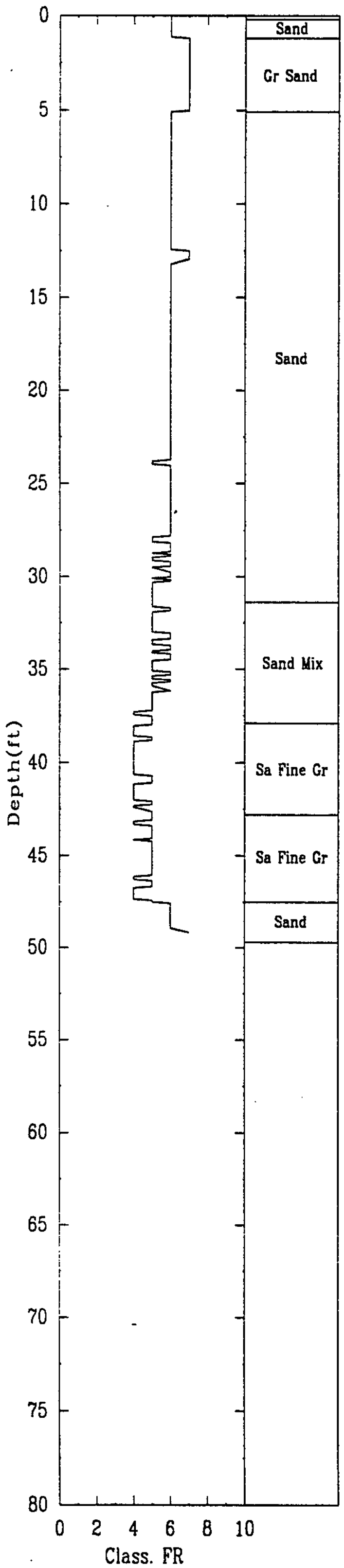

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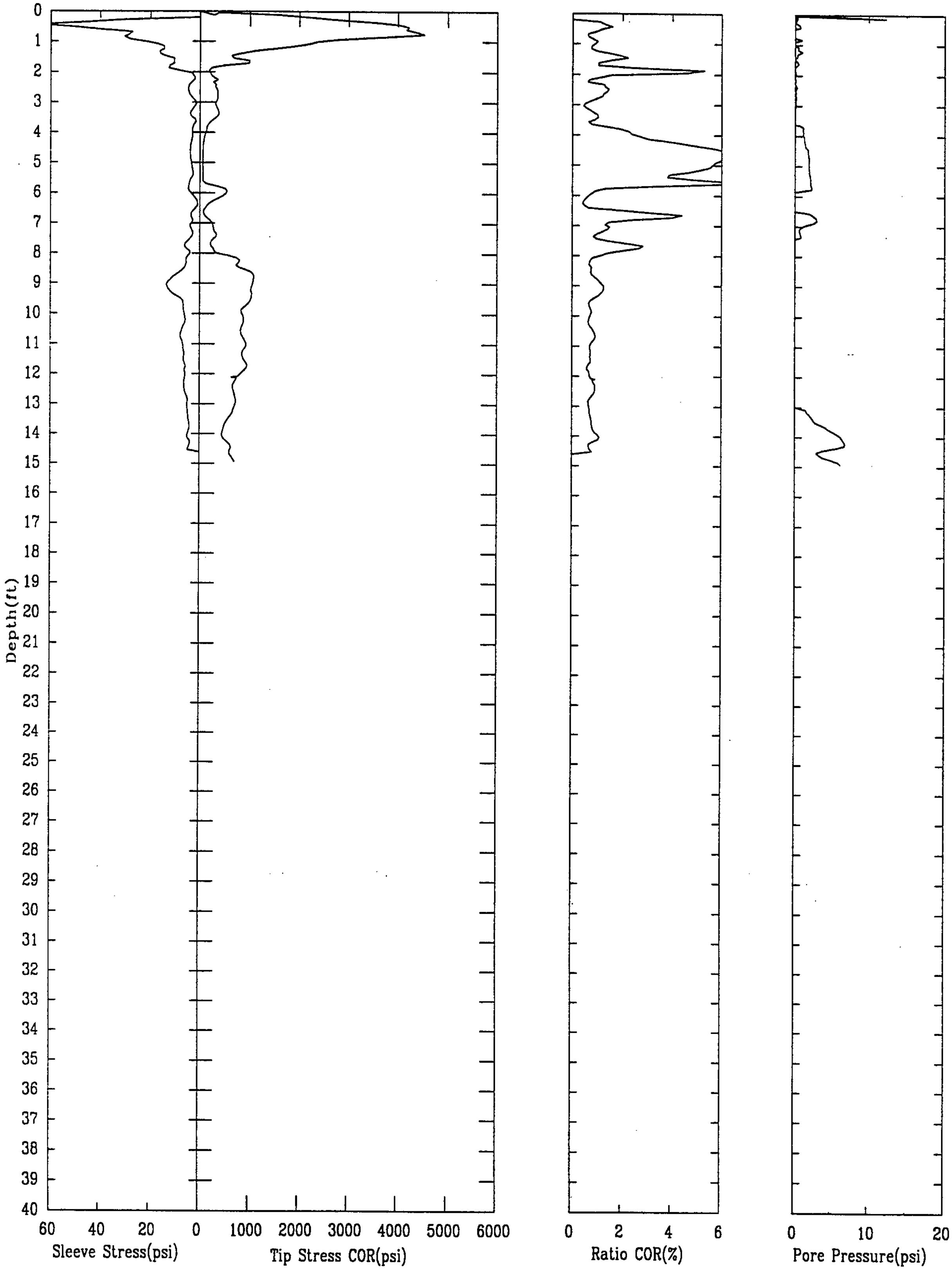

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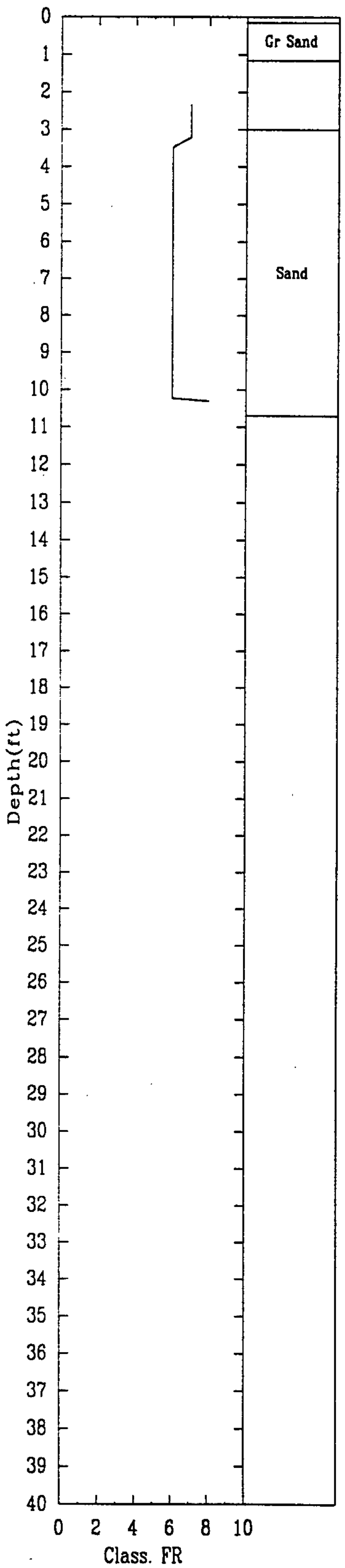

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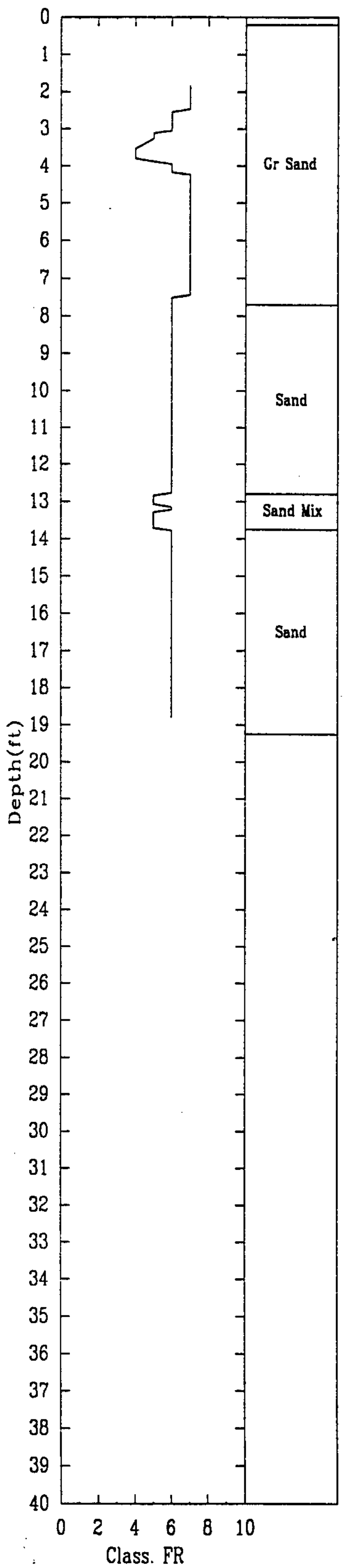

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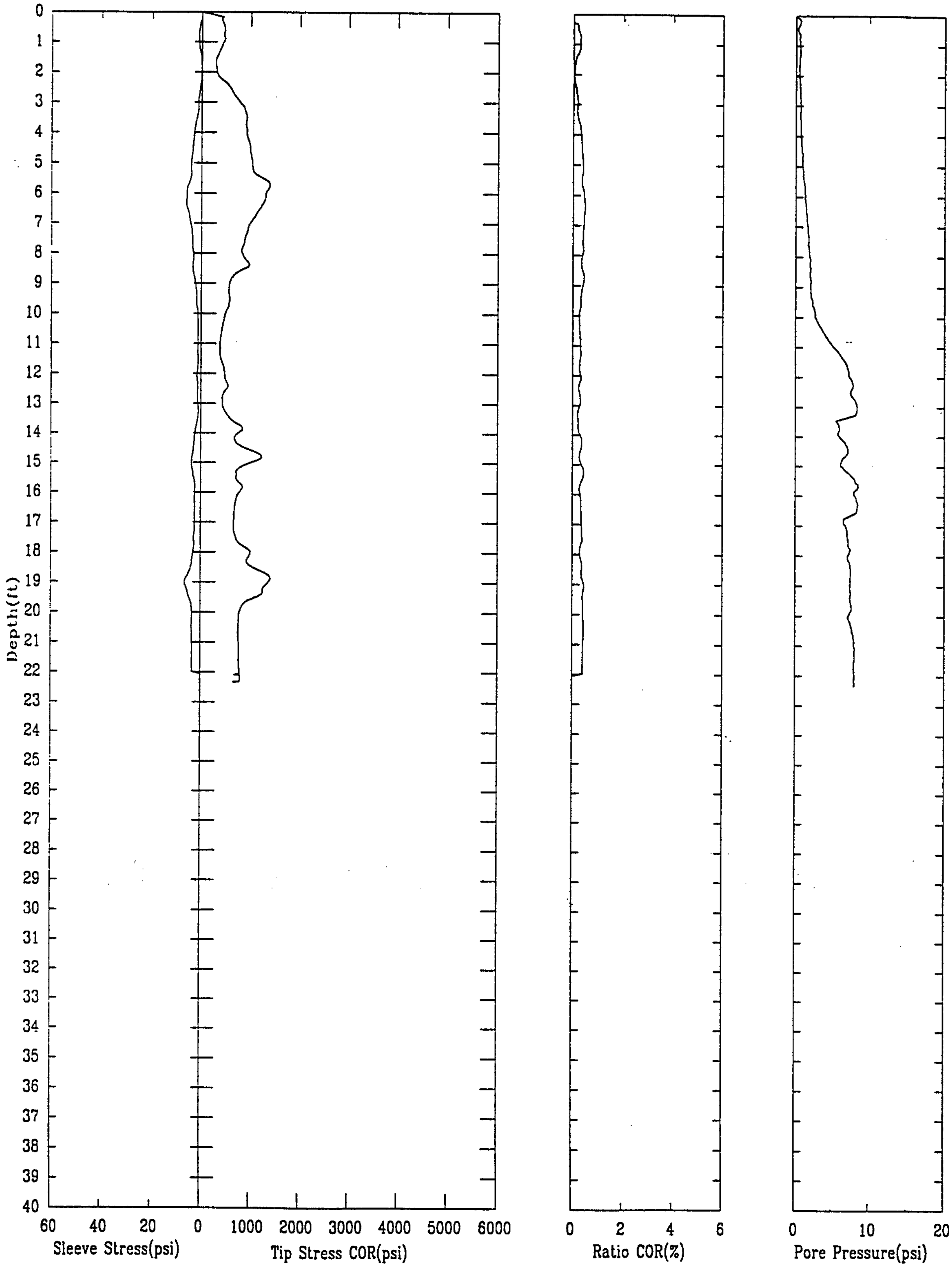

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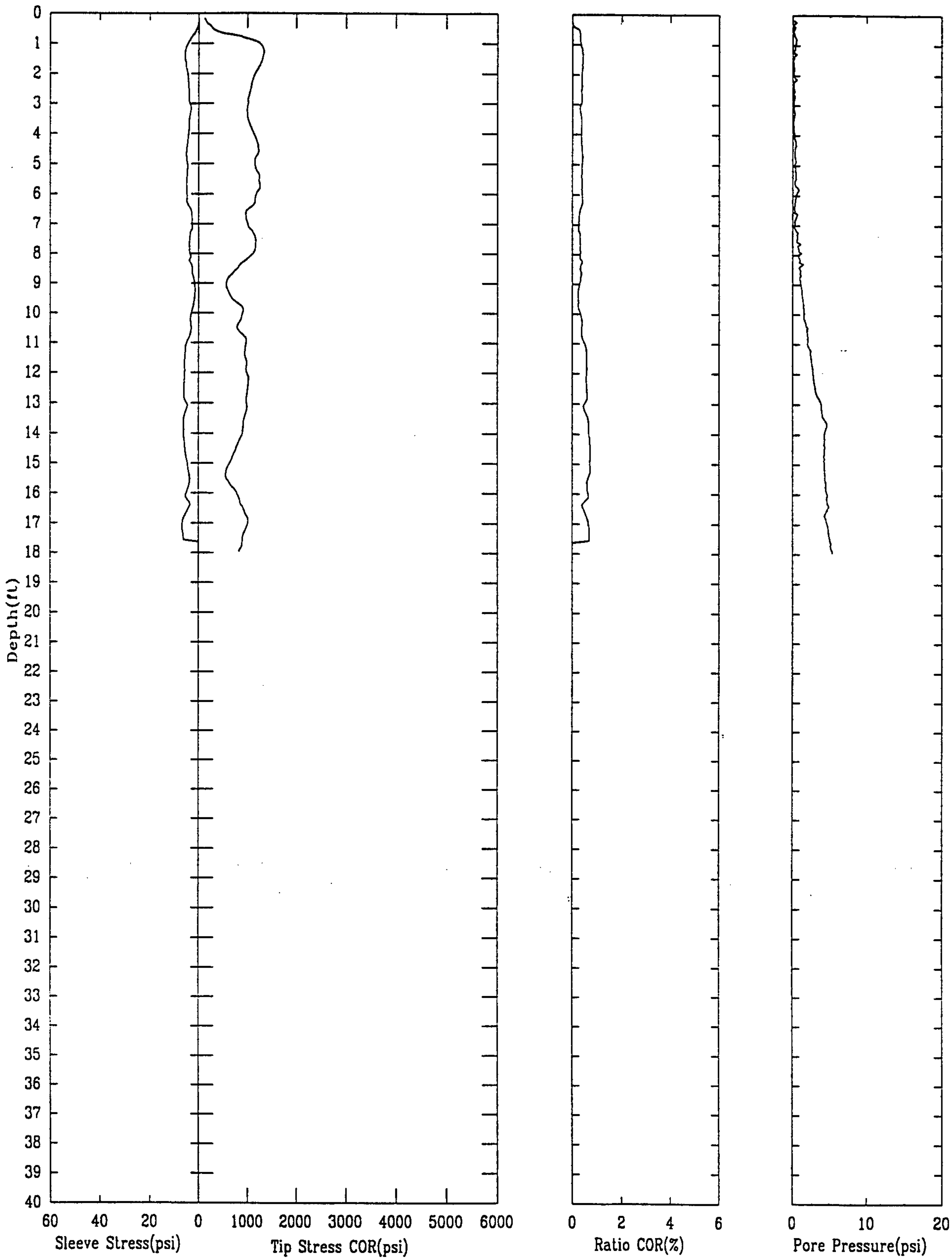
CPT-B105-MW APPLIED RESEARCH ASSOCIATES, INC. 12/20/96



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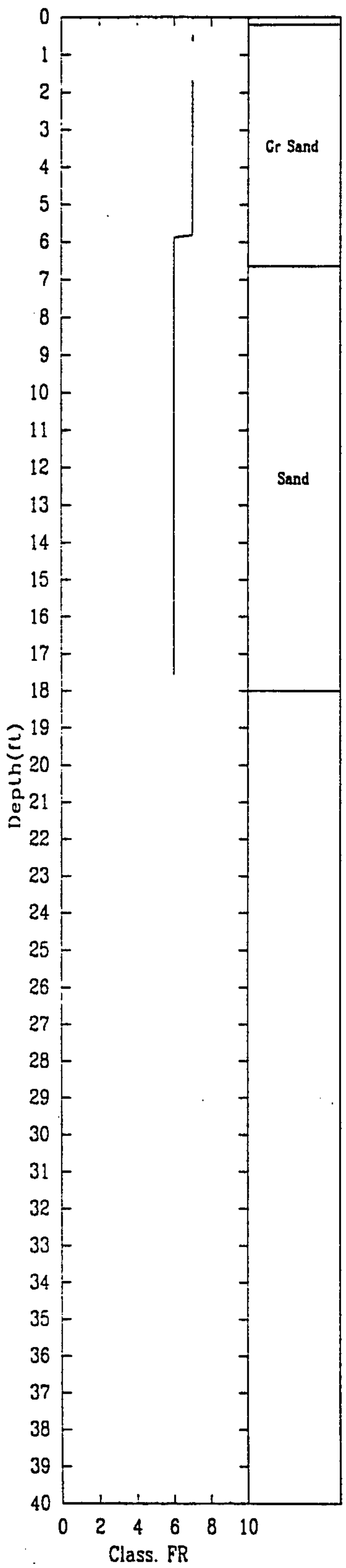

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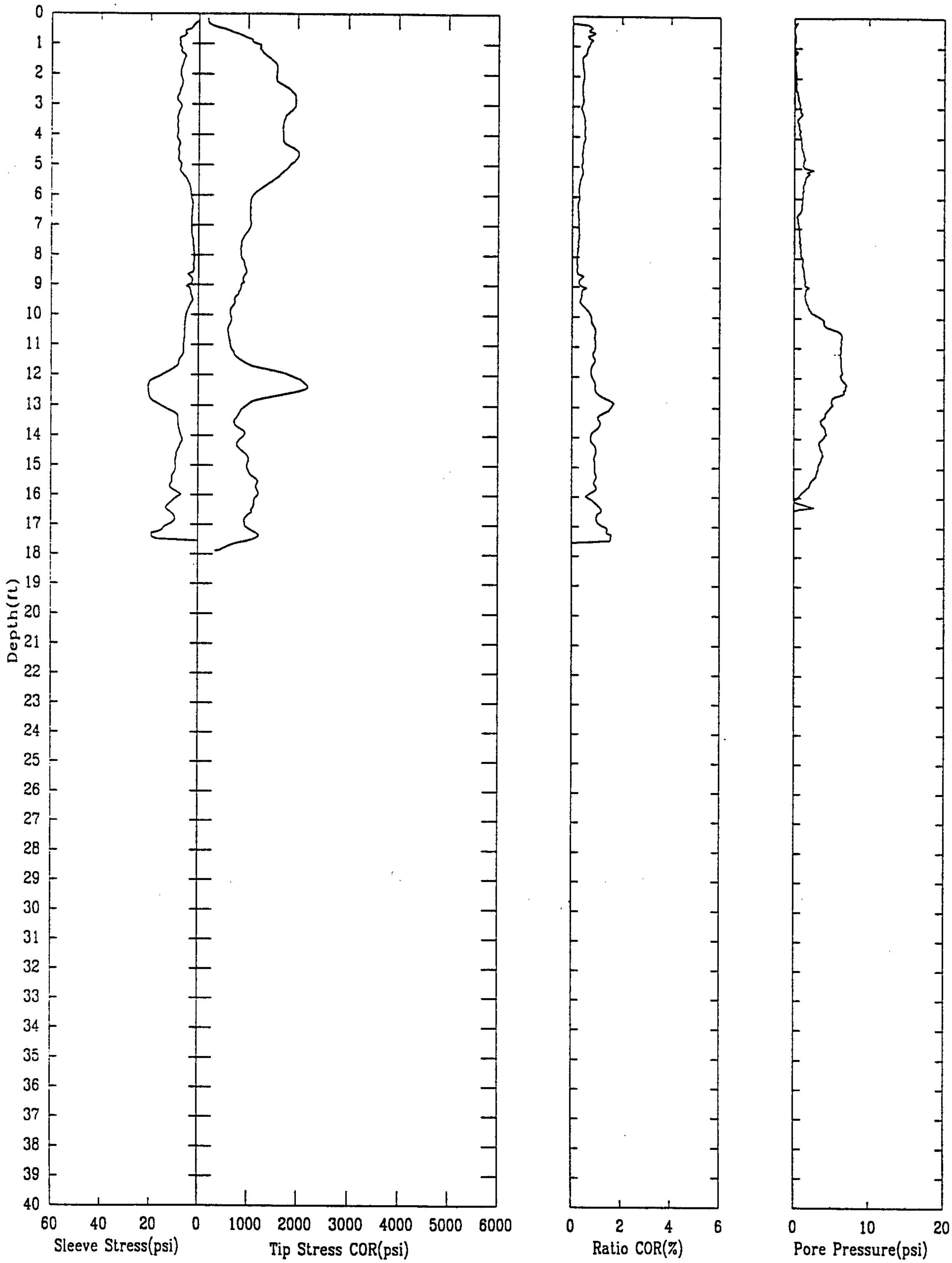
CPT-B106-MW APPLIED RESEARCH ASSOCIATES, INC. 12/21/96



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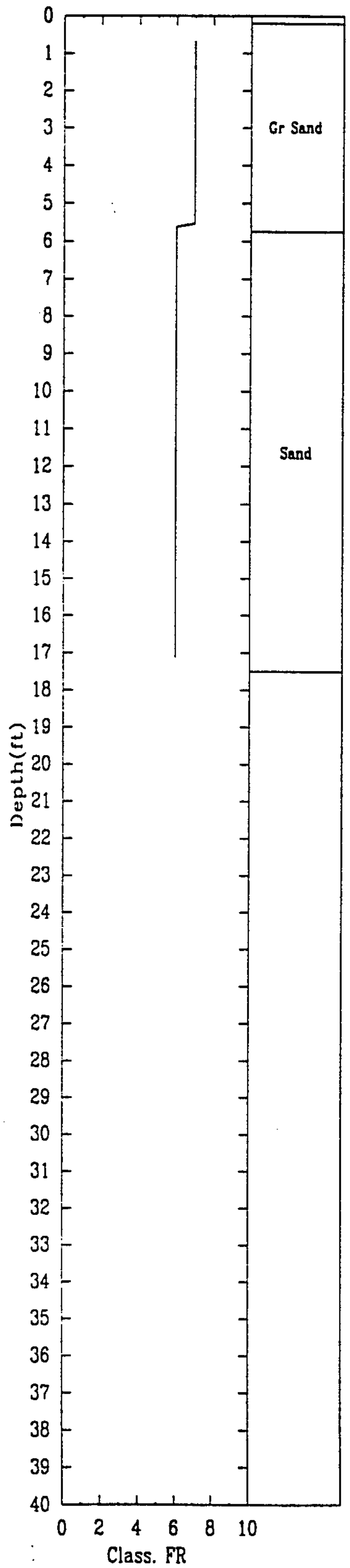

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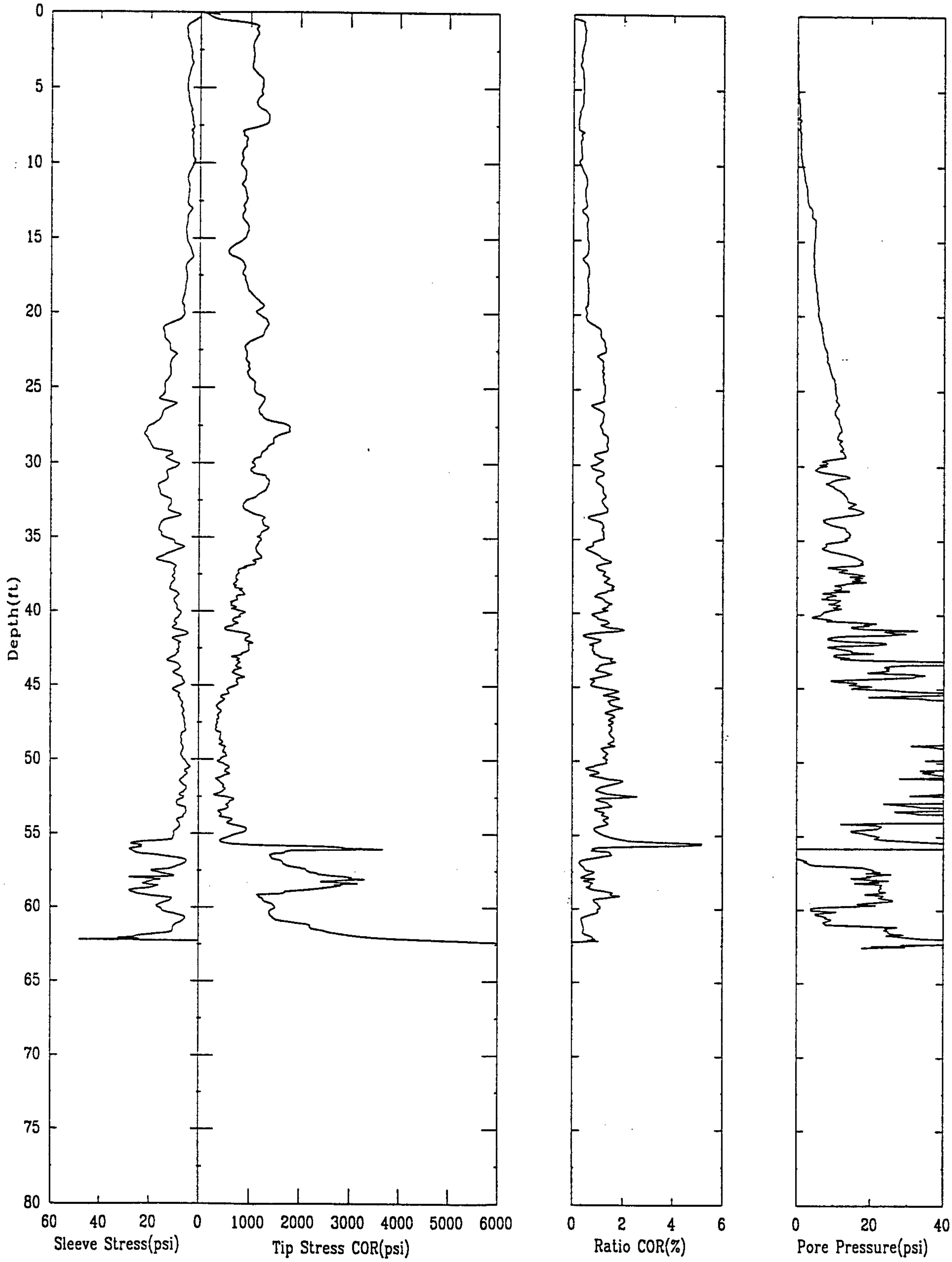

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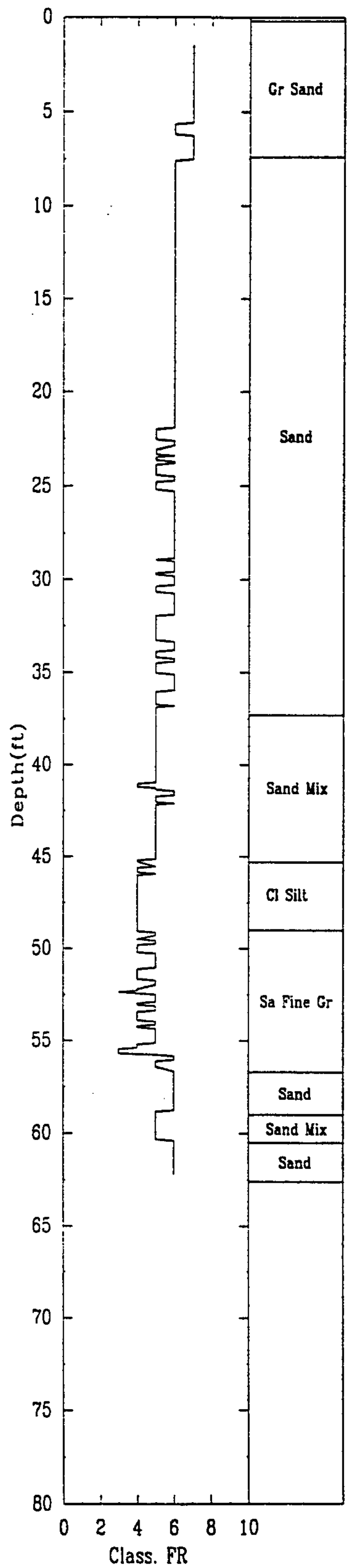

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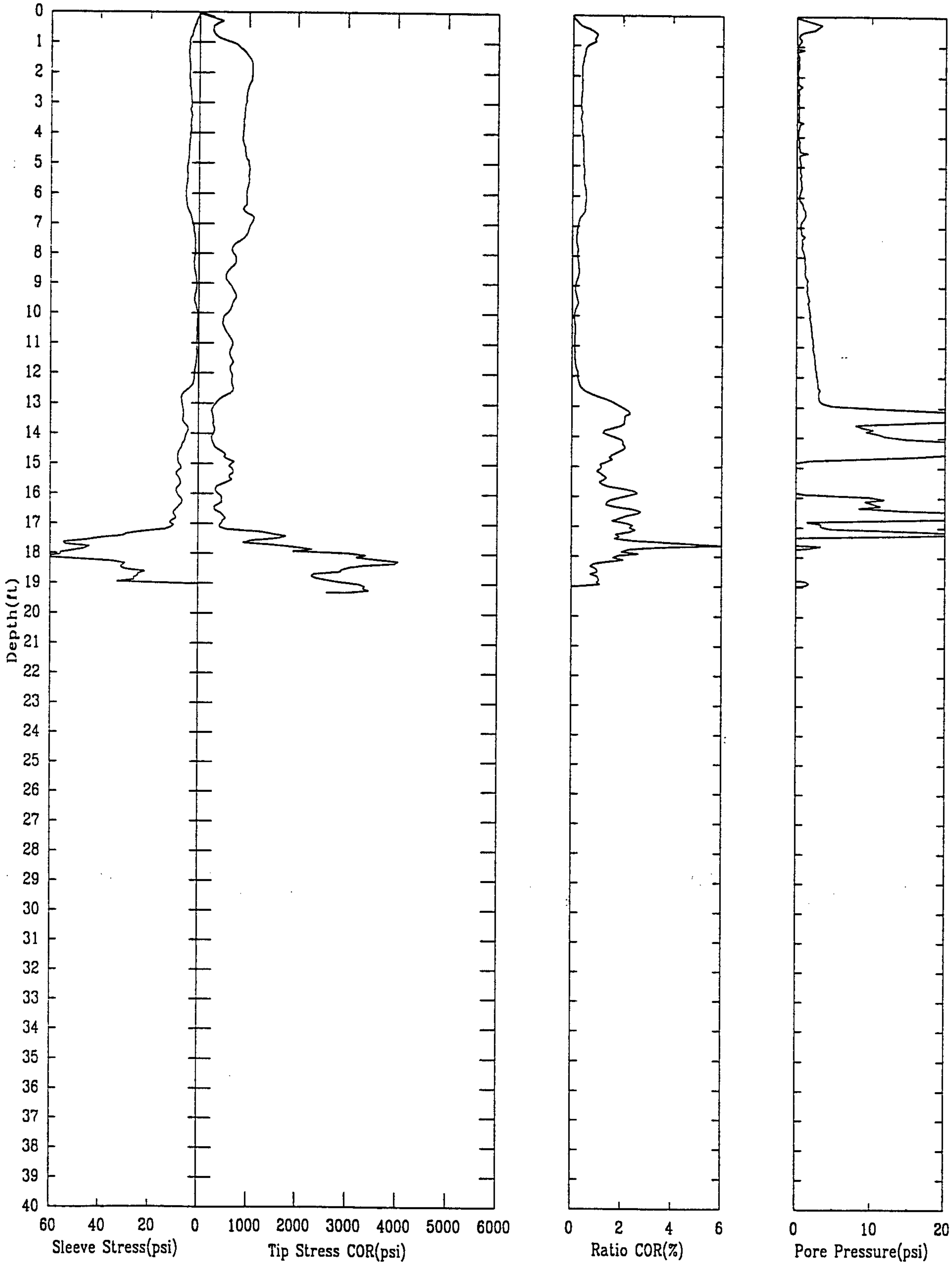
CPT-B130-MW APPLIED RESEARCH ASSOCIATES, INC. 01/09/97



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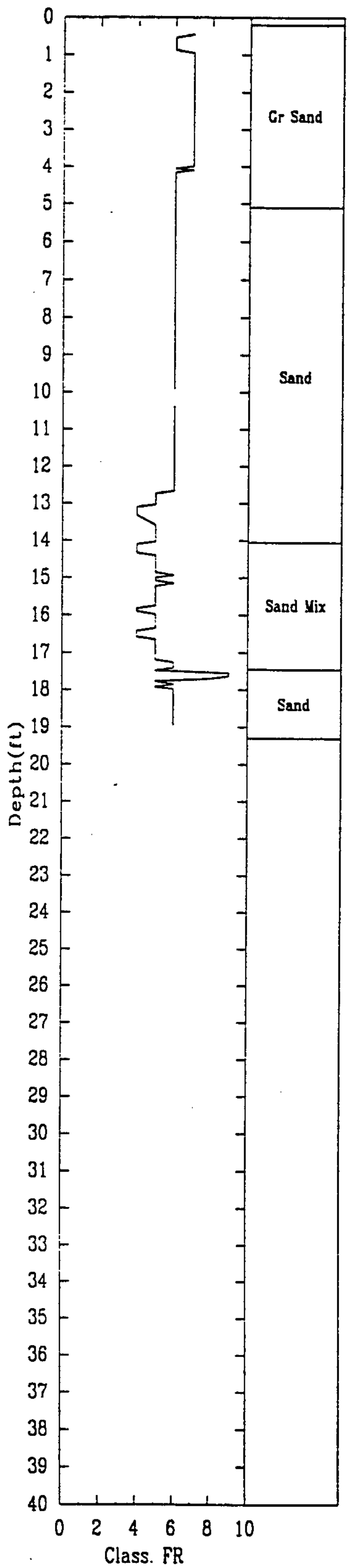
CPT-B130-MW APPLIED RESEARCH ASSOCIATES, INC. 01/09/97



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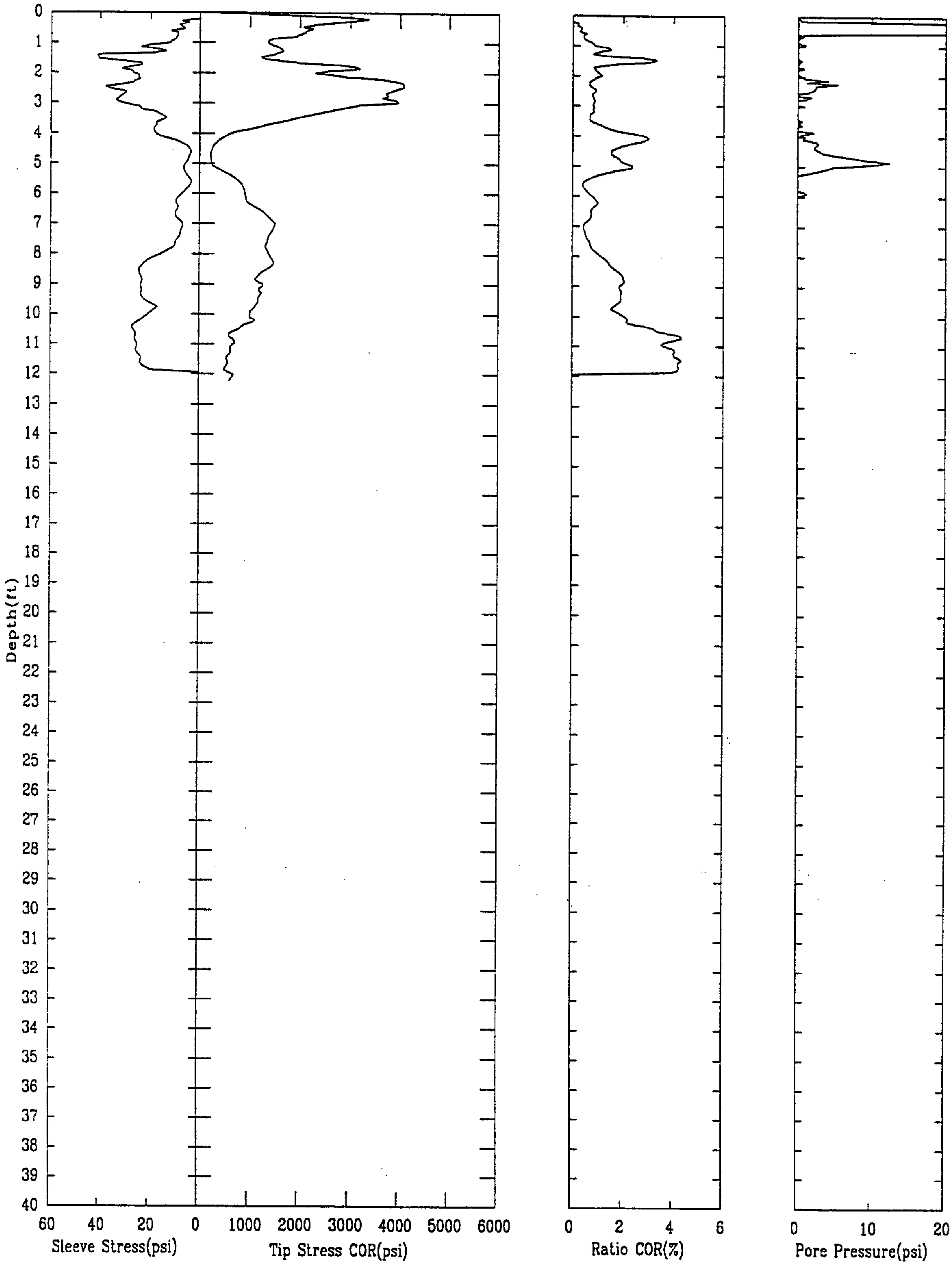
CPT-B238-MW APPLIED RESEARCH ASSOCIATES, INC. 01/29/97



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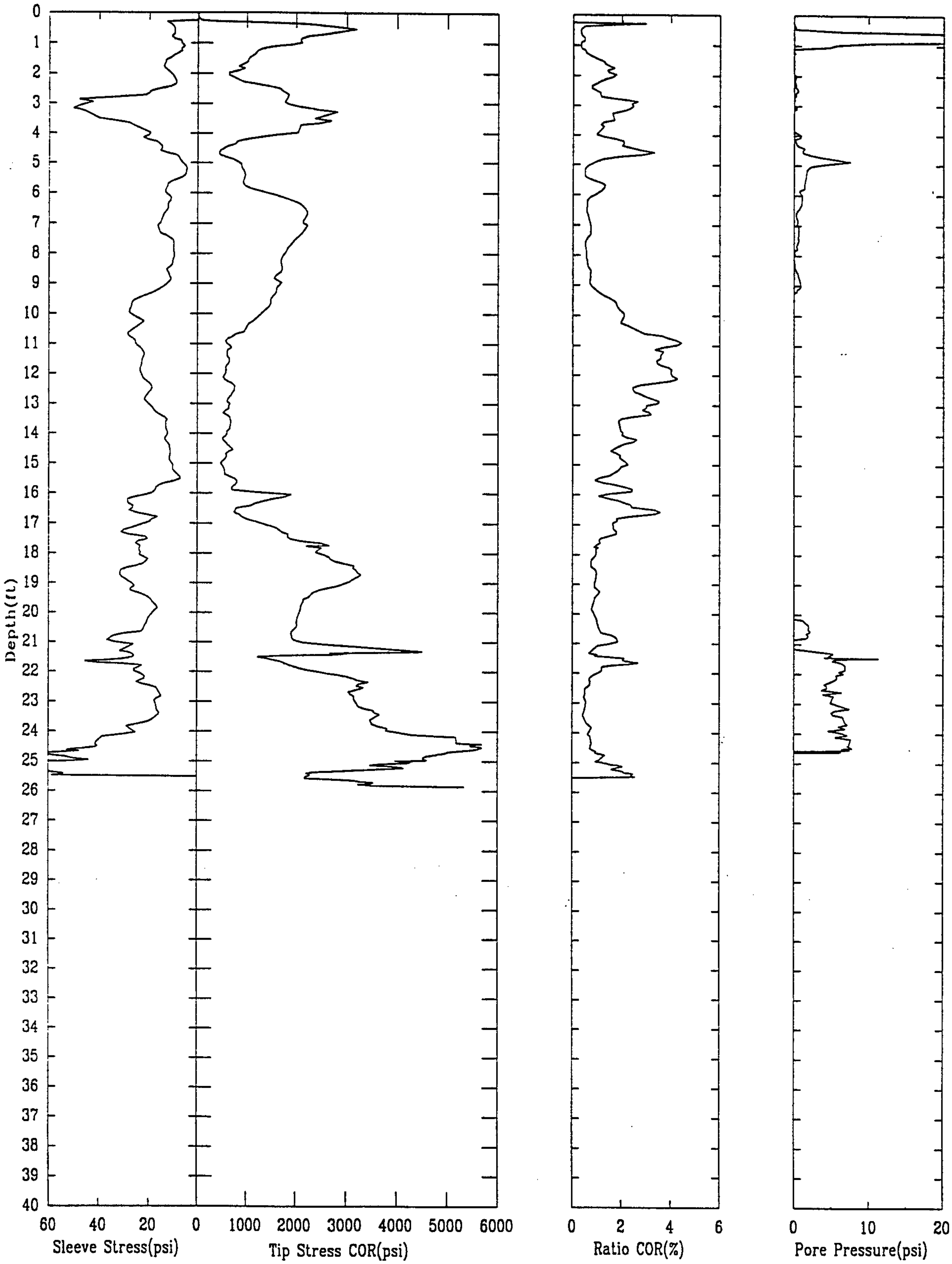
CPT-B239-MW APPLIED RESEARCH ASSOCIATES, INC. 01/29/97



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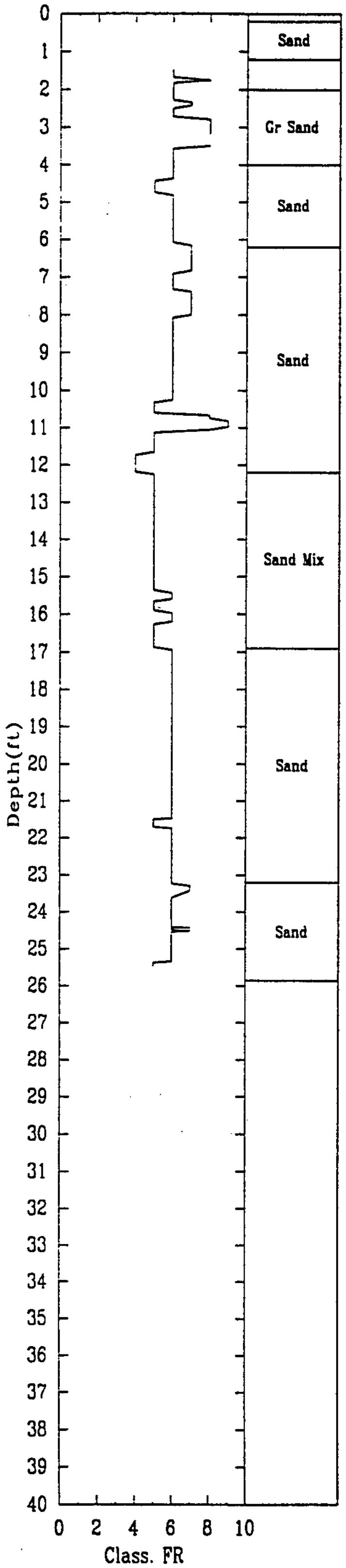

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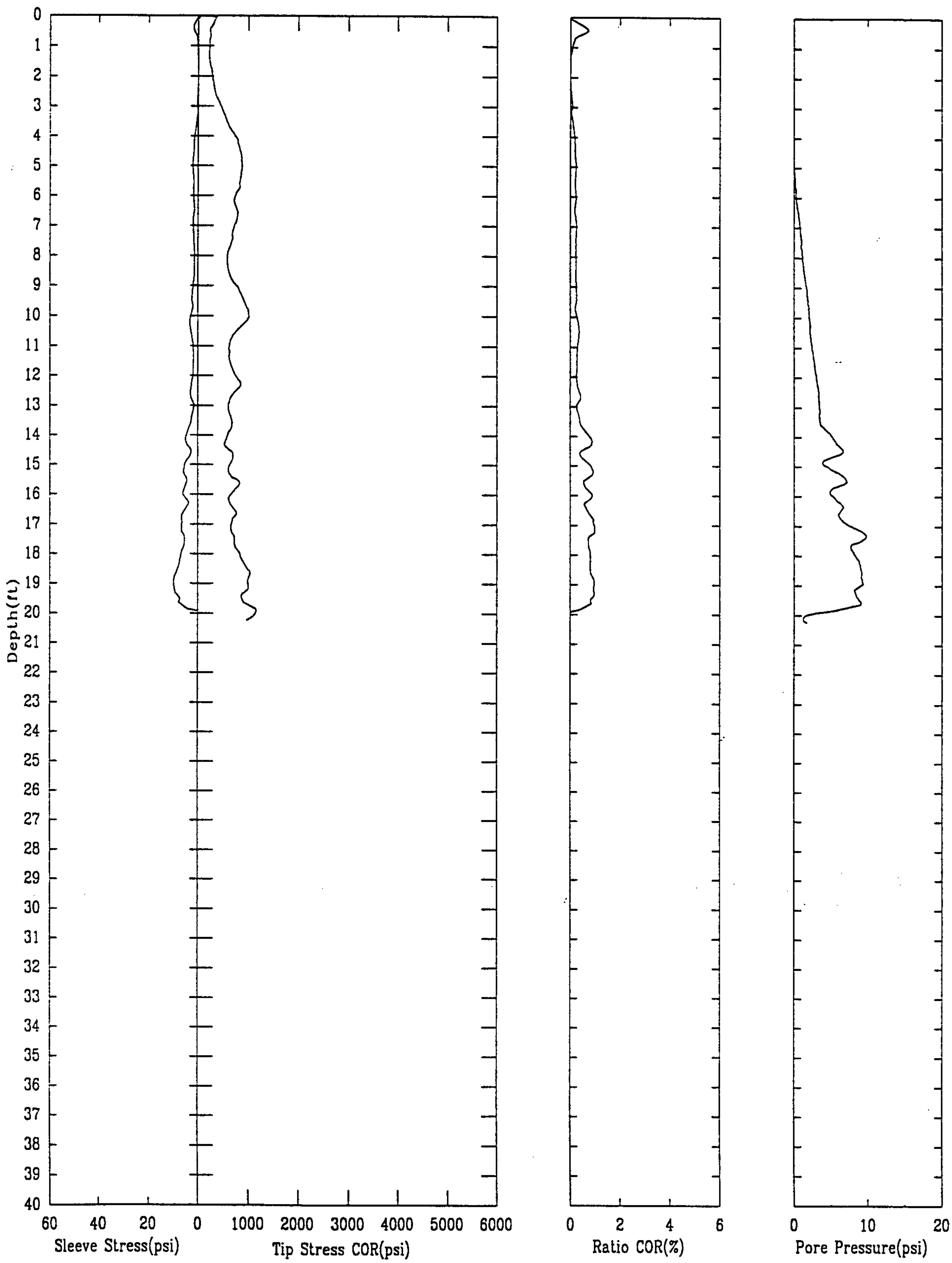

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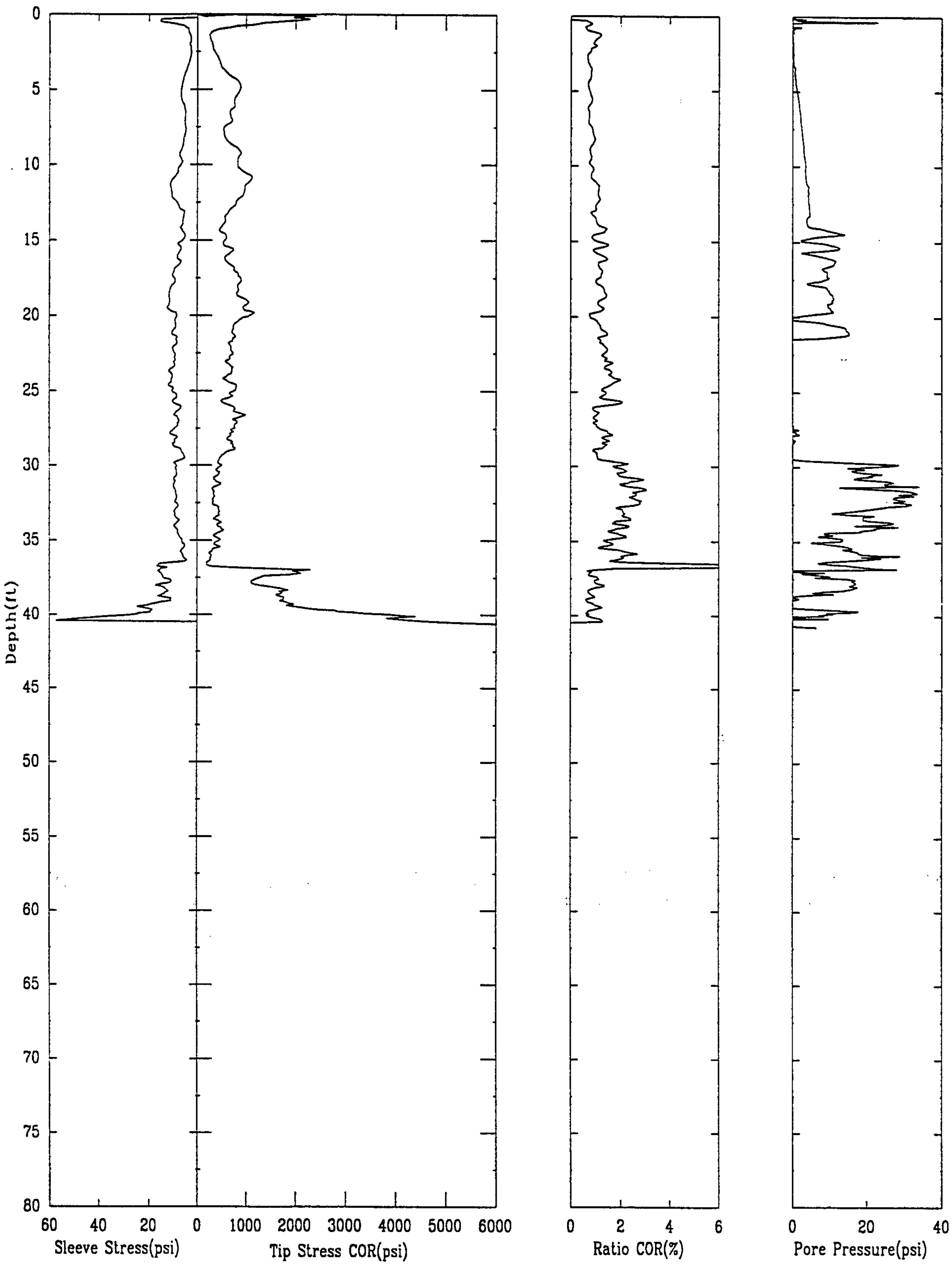

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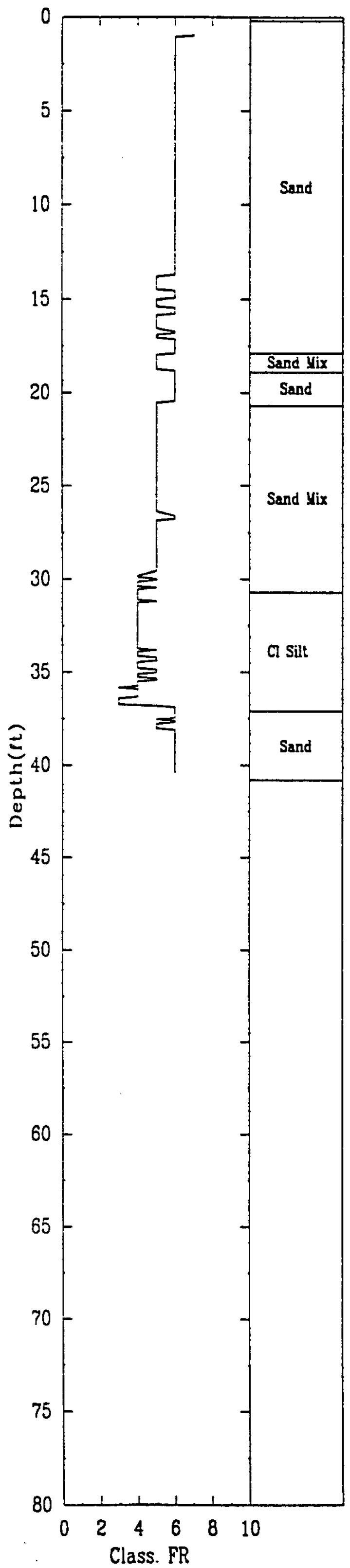

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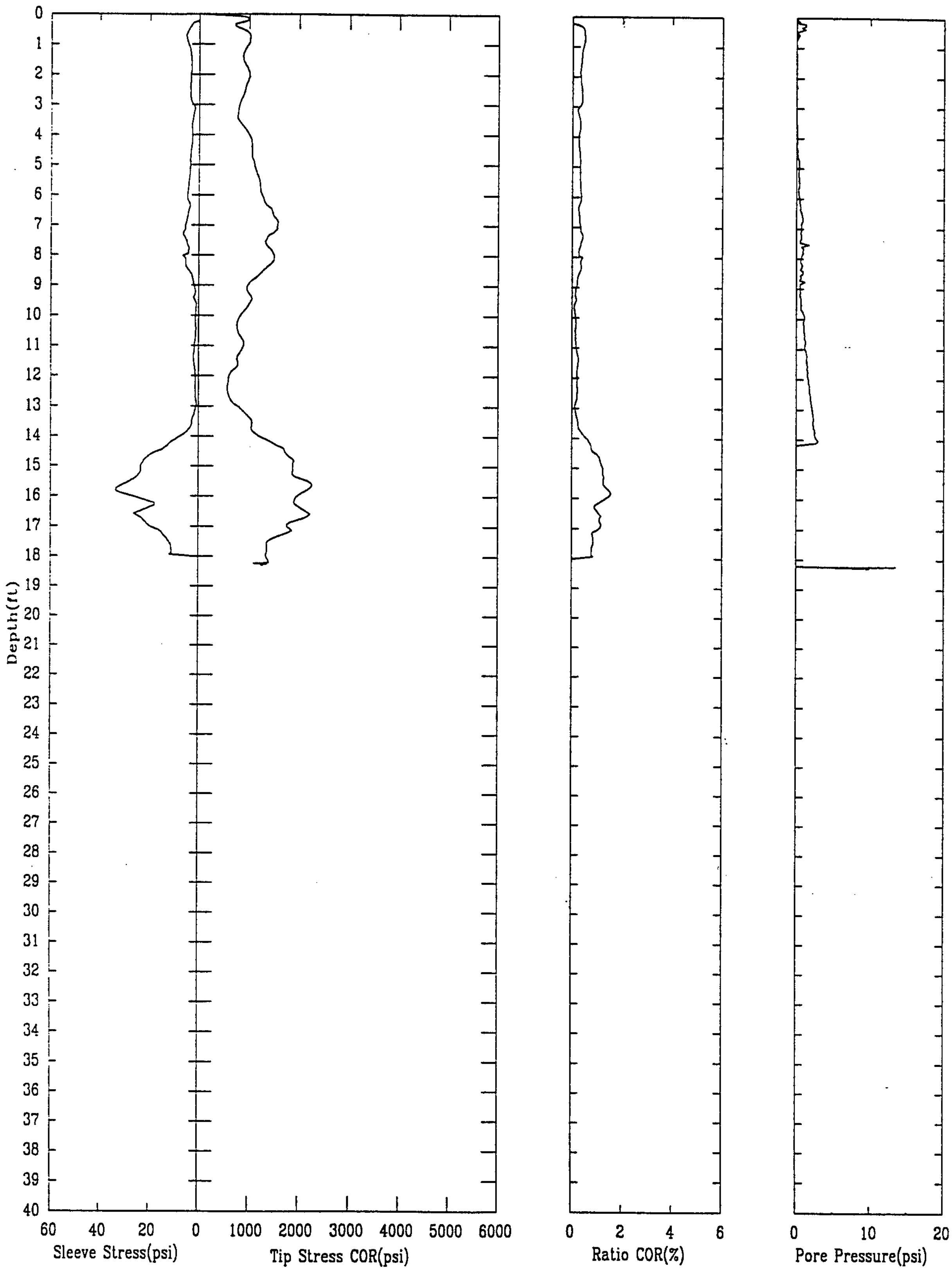
CPT-OW2-1 APPLIED RESEARCH ASSOCIATES, INC. 12/22/96



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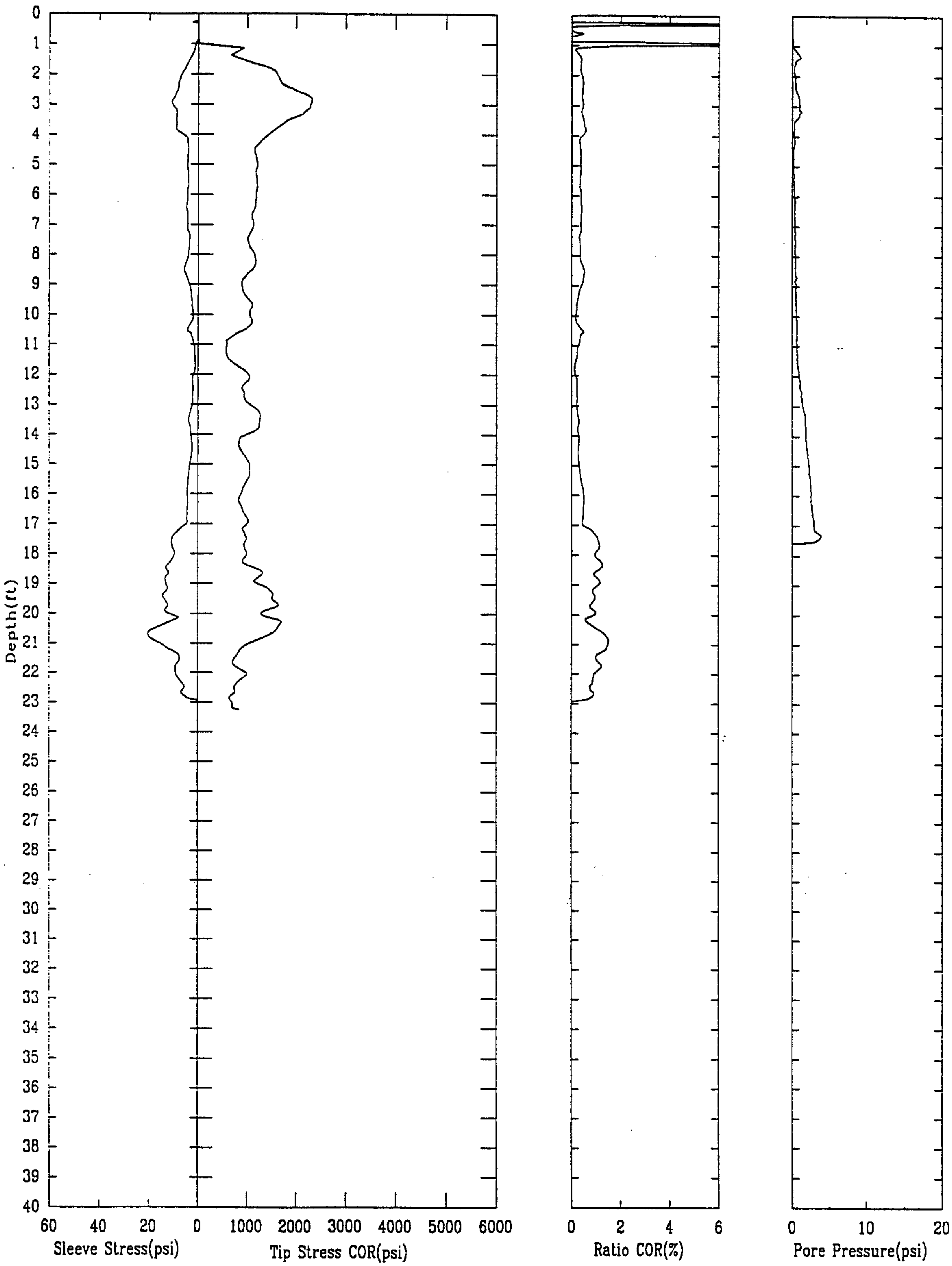
CPT-OW2-2 APPLIED RESEARCH ASSOCIATES, INC. 12/22/96



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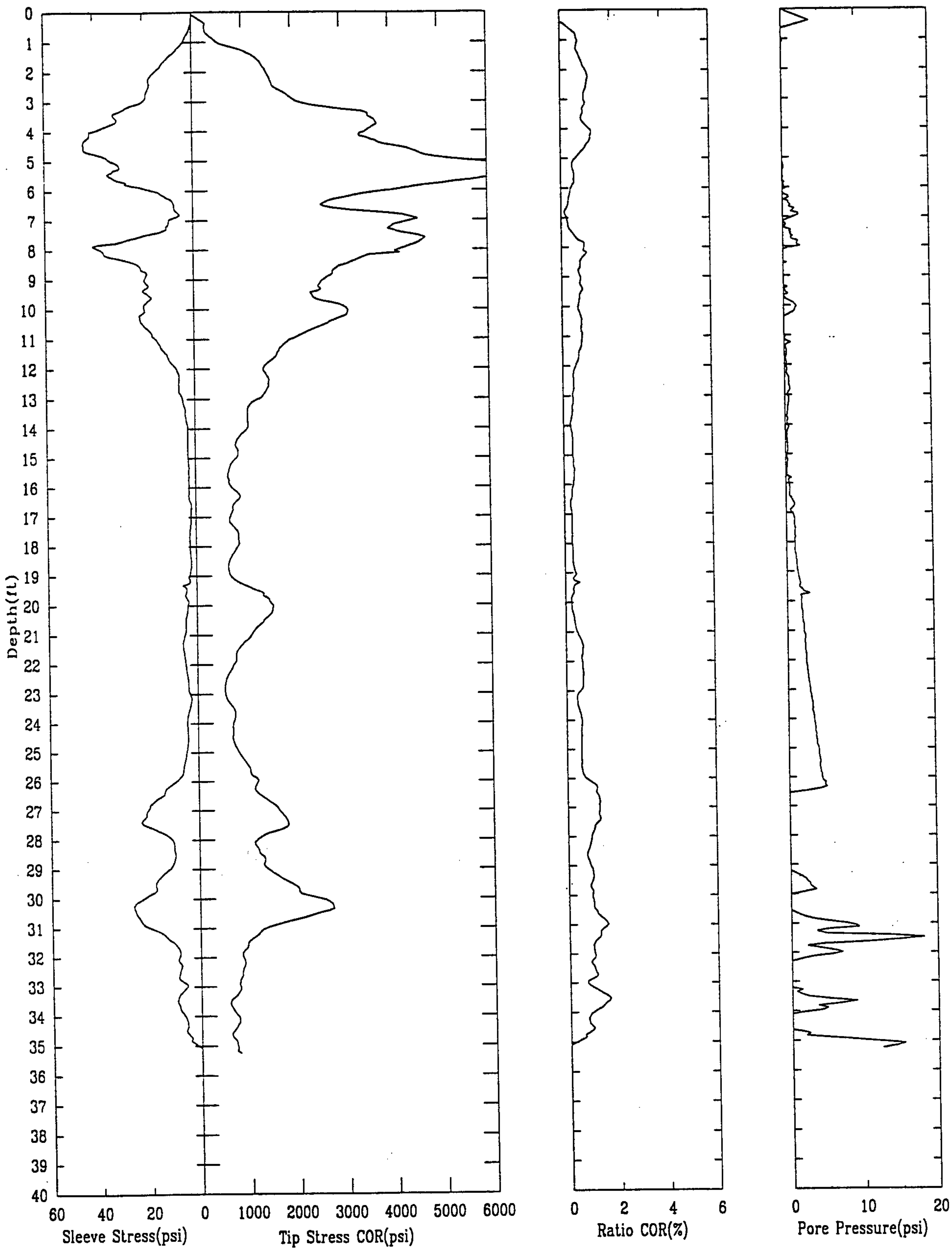
CPT-OW2-4 APPLIED RESEARCH ASSOCIATES, INC. 01/10/97



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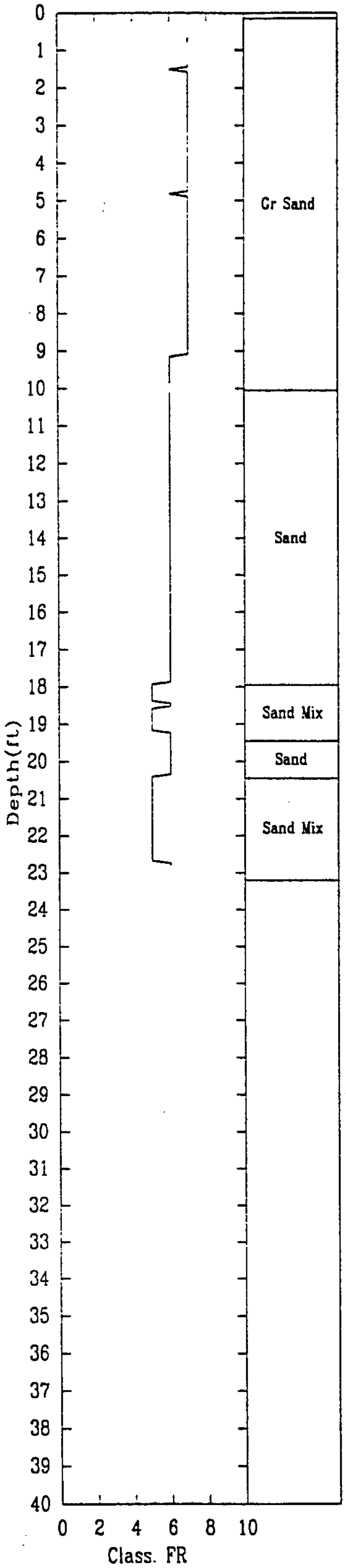

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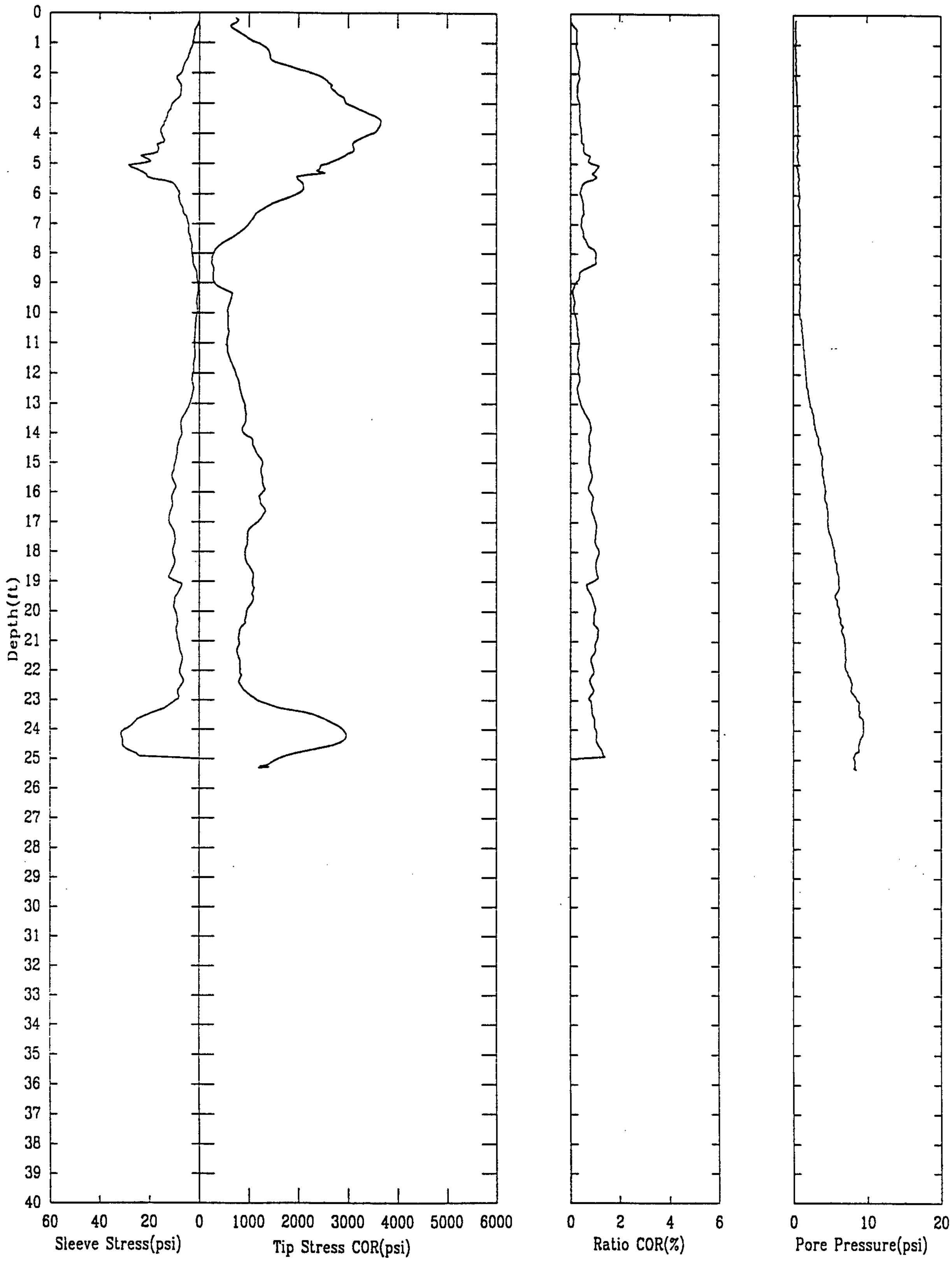
CPT-OW2-7 APPLIED RESEARCH ASSOCIATES, INC. 01/10/97



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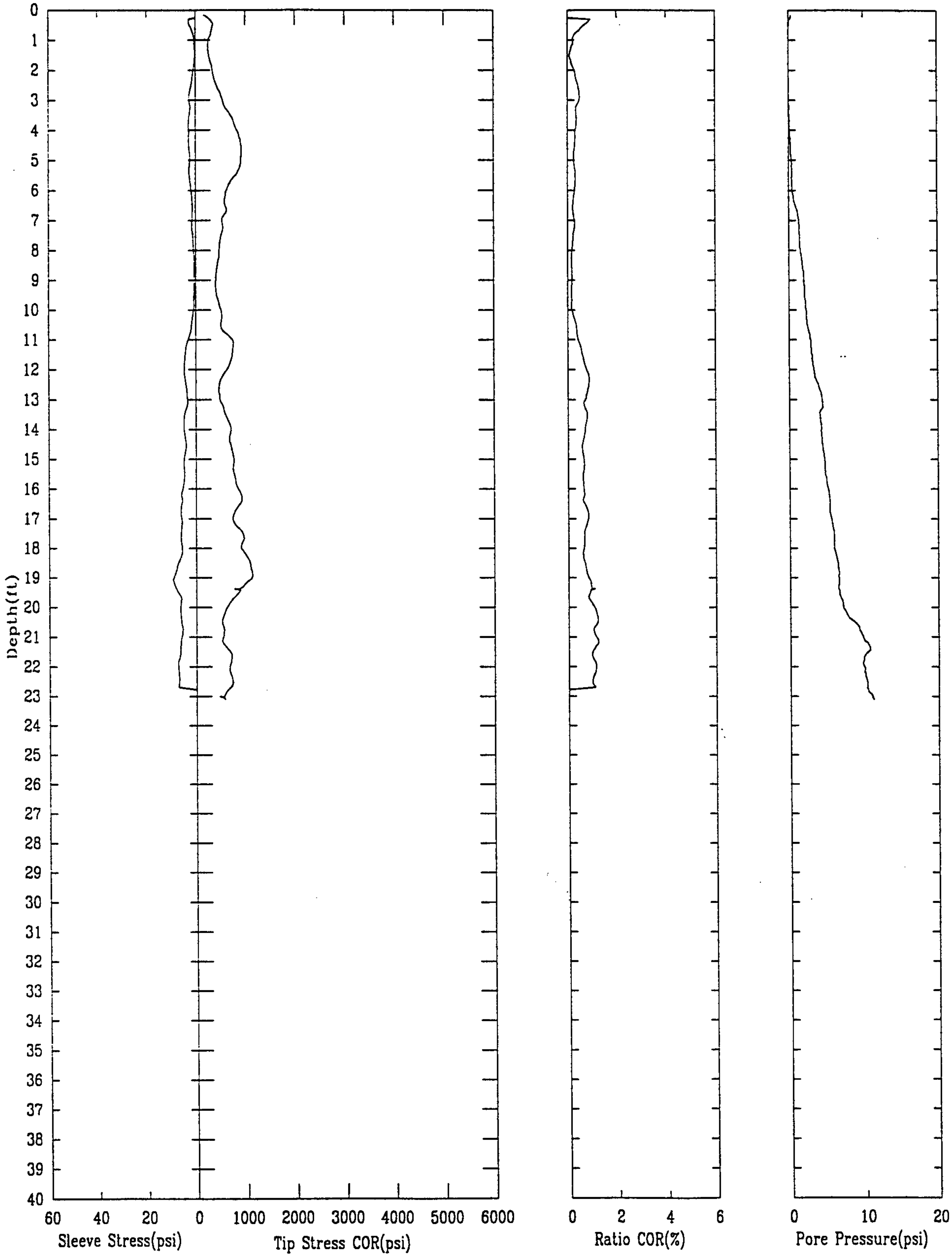

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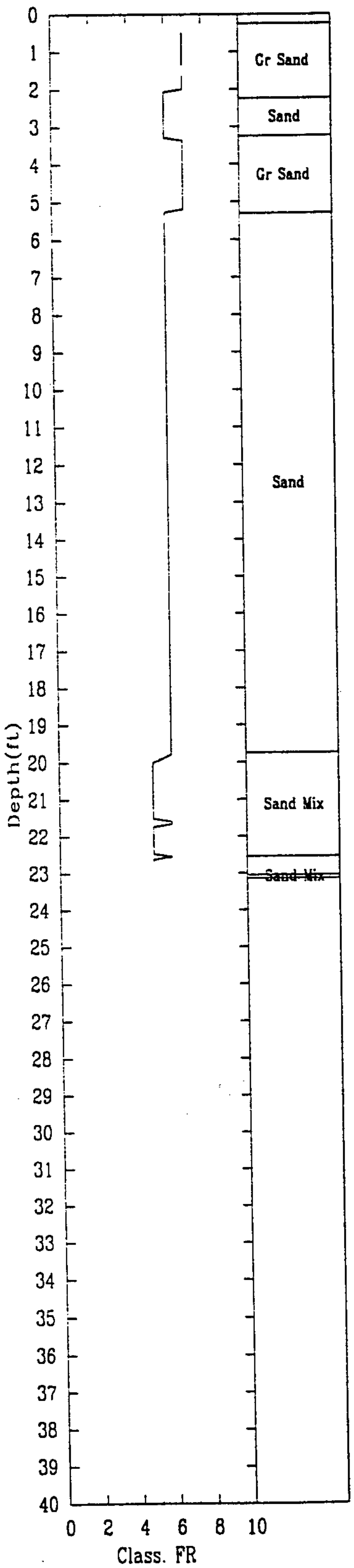

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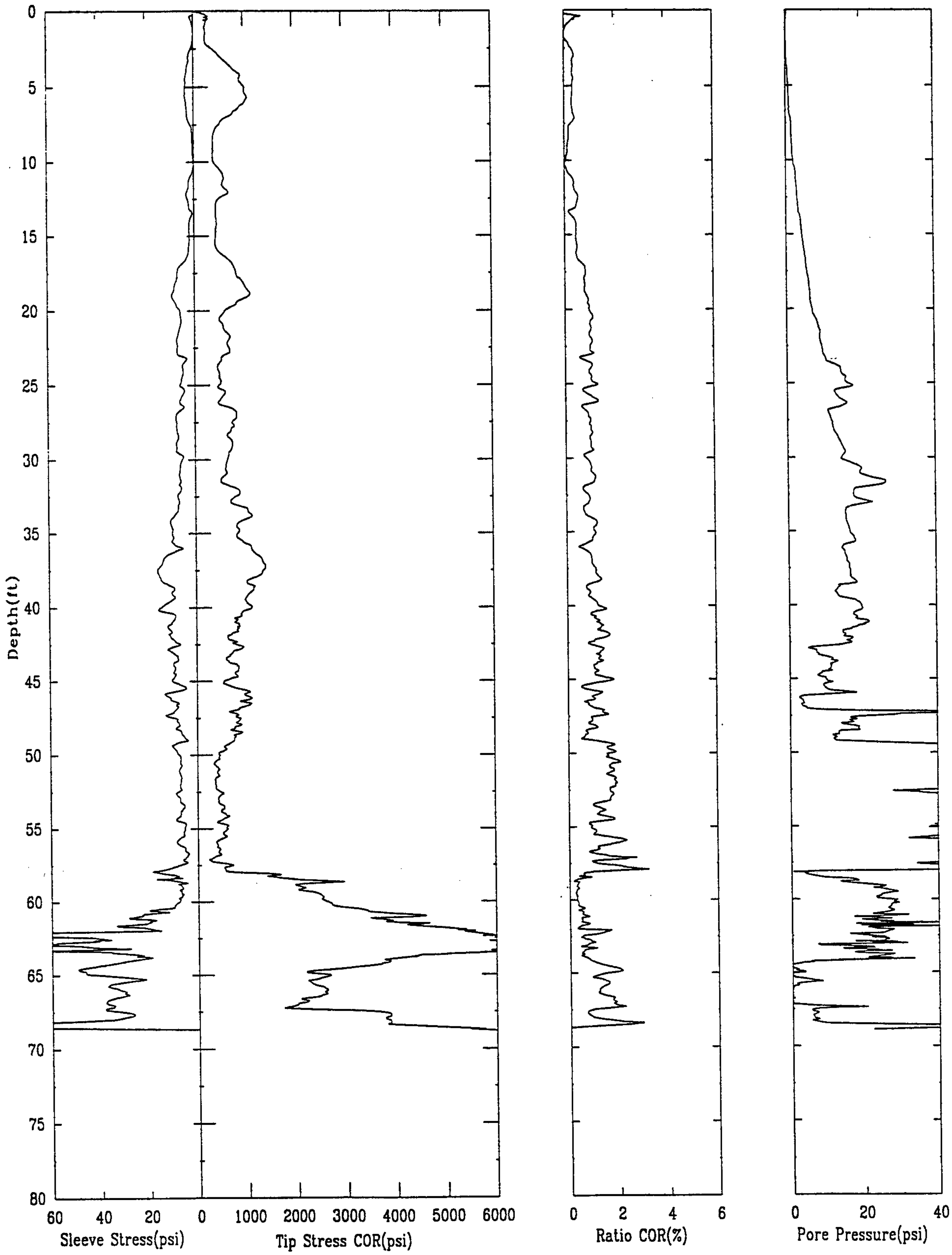

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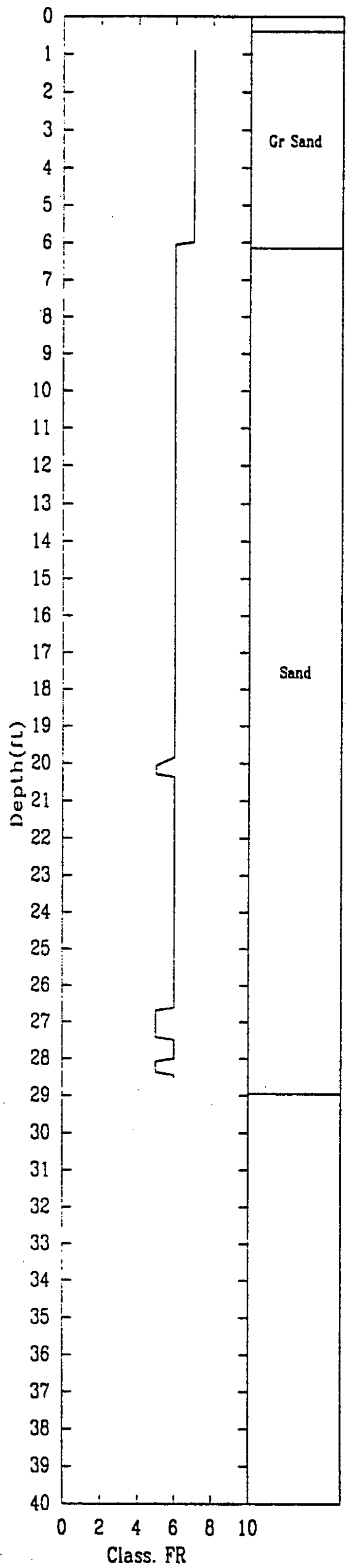
CPT-RAP2-3S APPLIED RESEARCH ASSOCIATES, INC. 01/09/97



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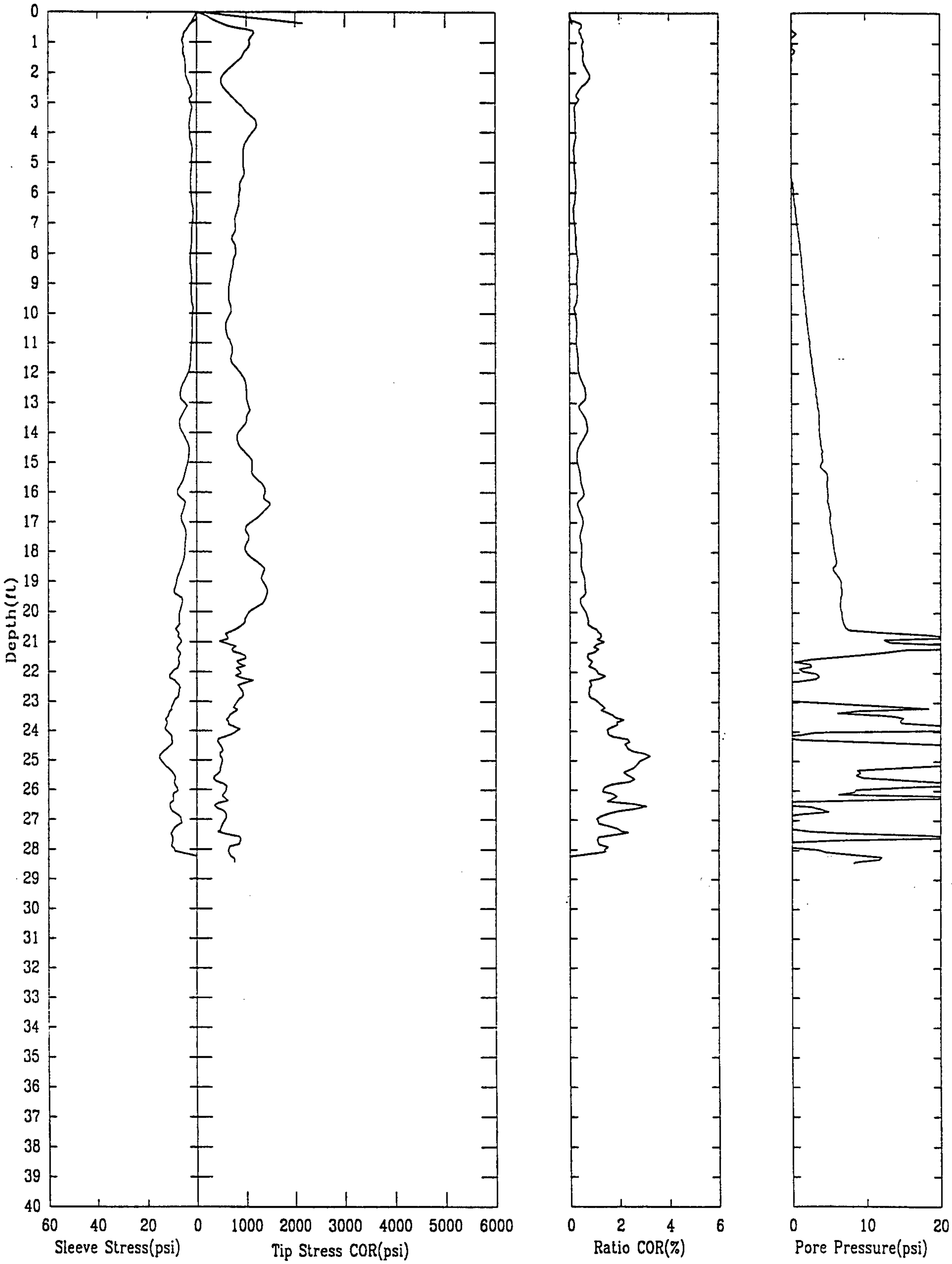

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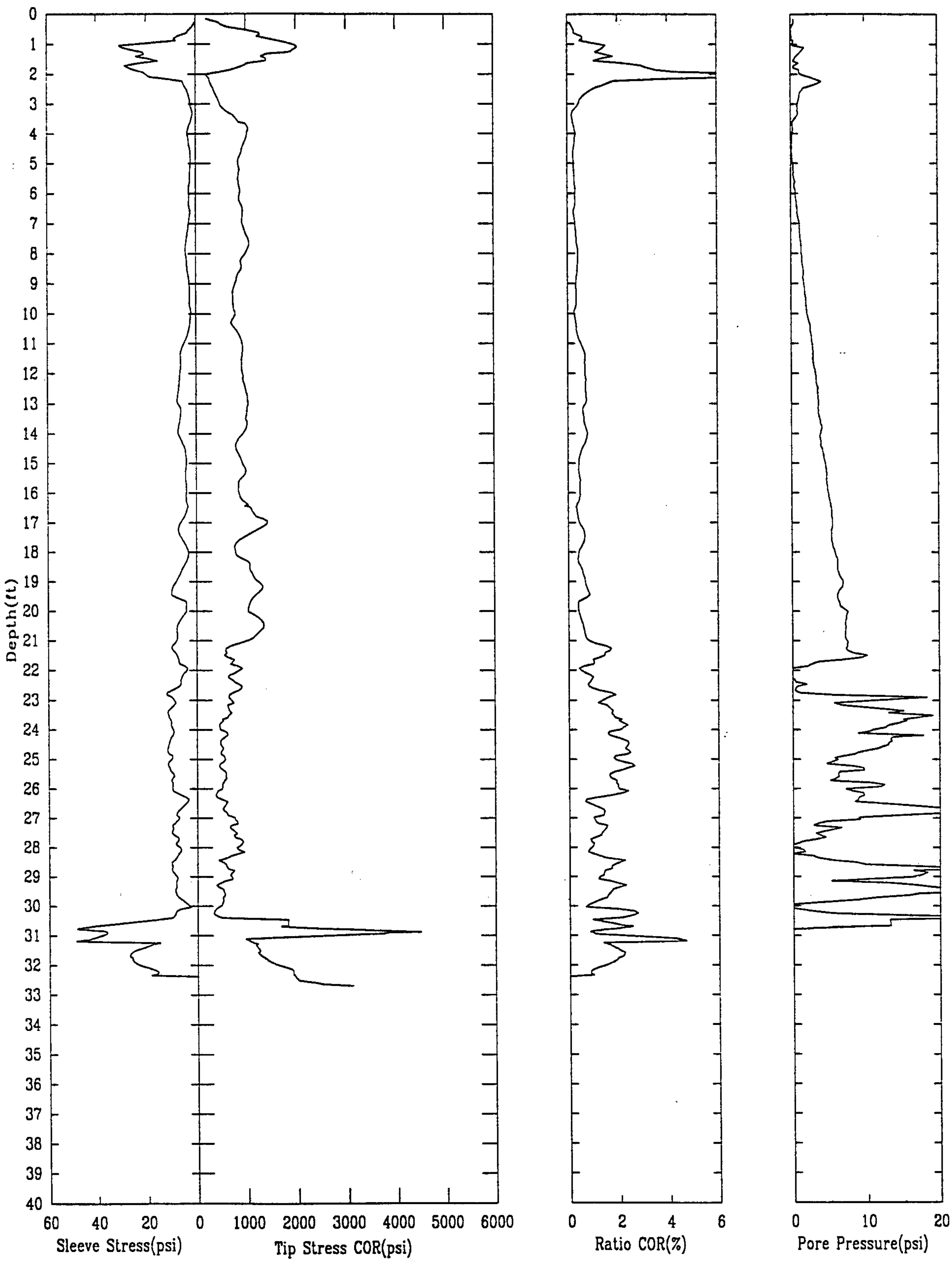

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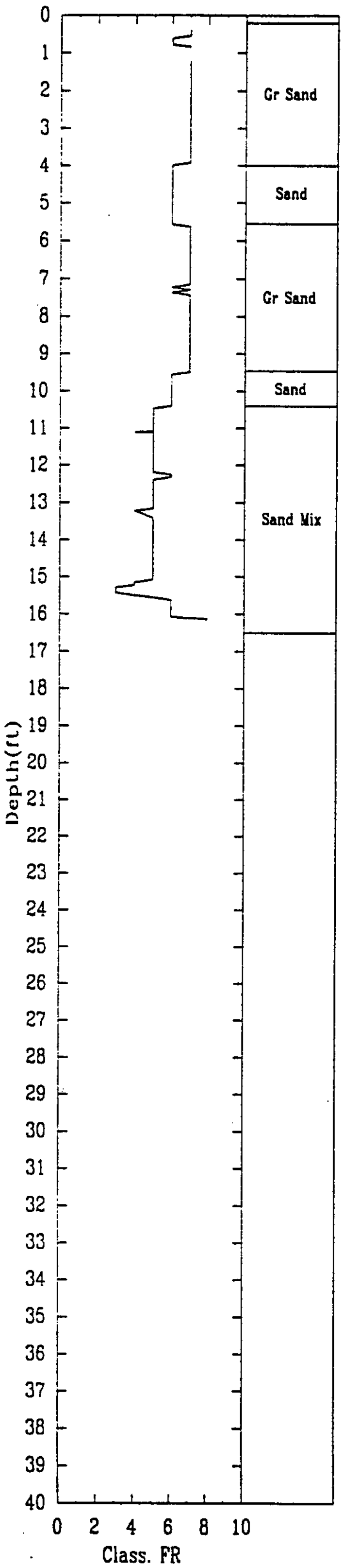

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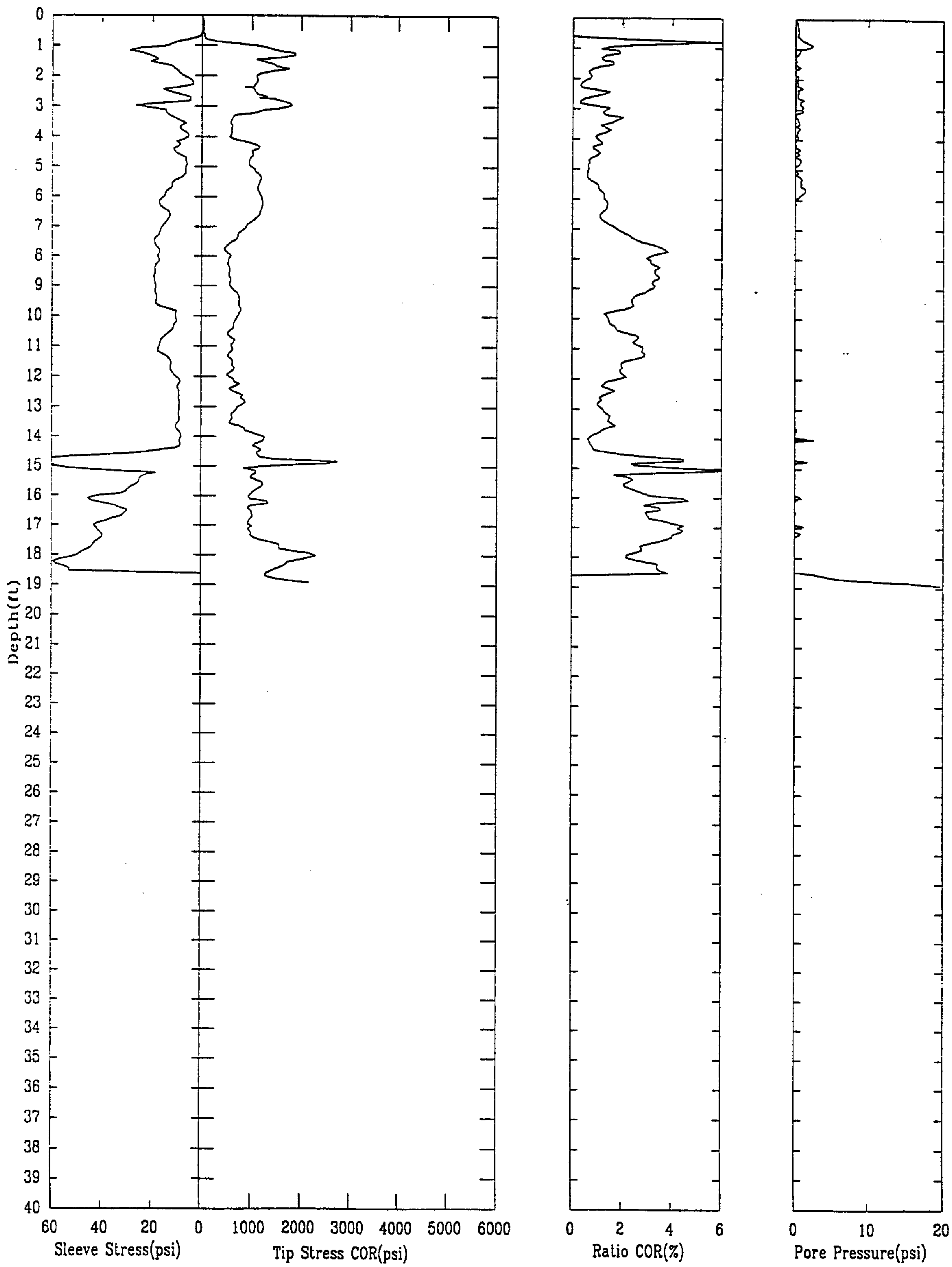
CPT-B20 APPLIED RESEARCH ASSOCIATES, INC. 02/03/97



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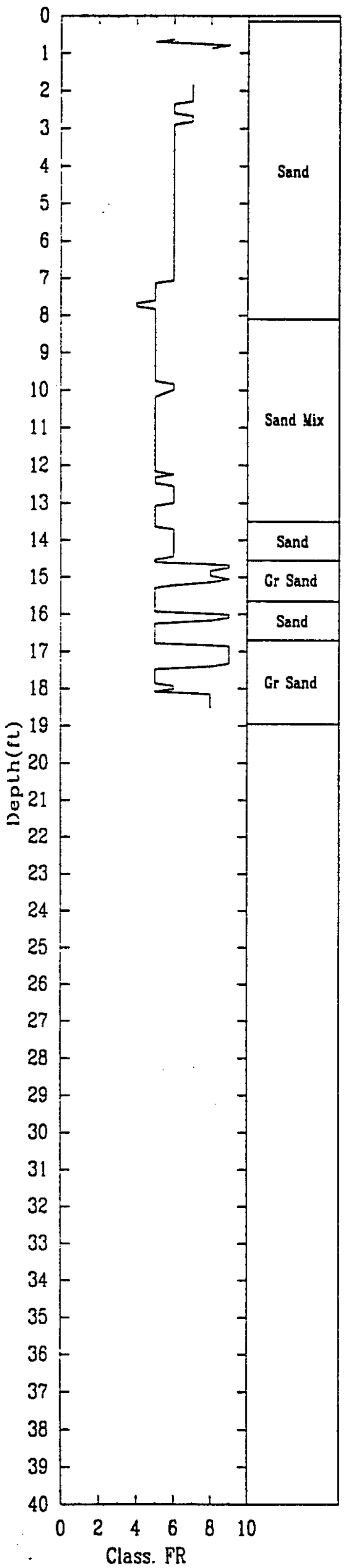

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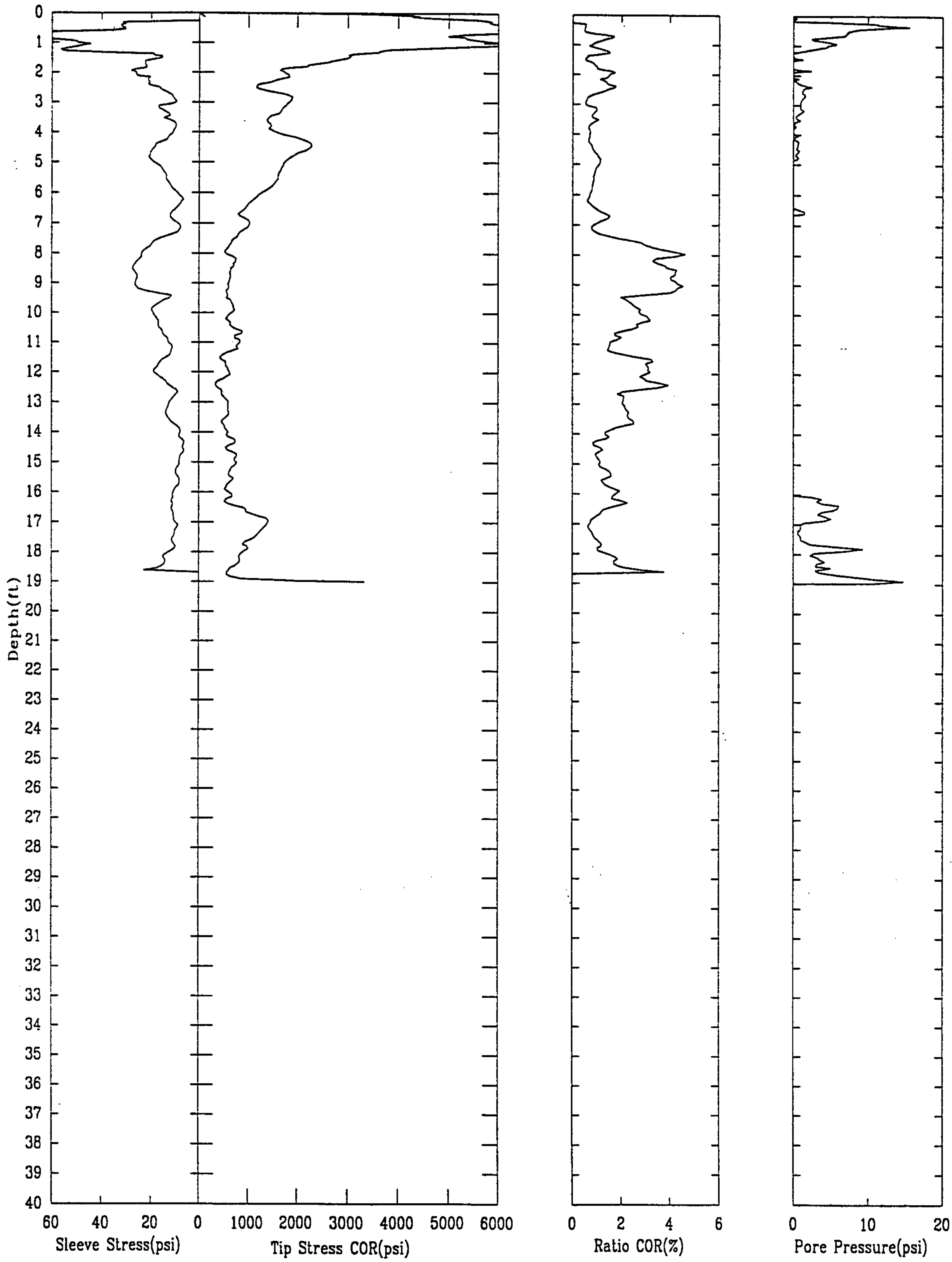
CPT-B37 APPLIED RESEARCH ASSOCIATES, INC. 01/31/97



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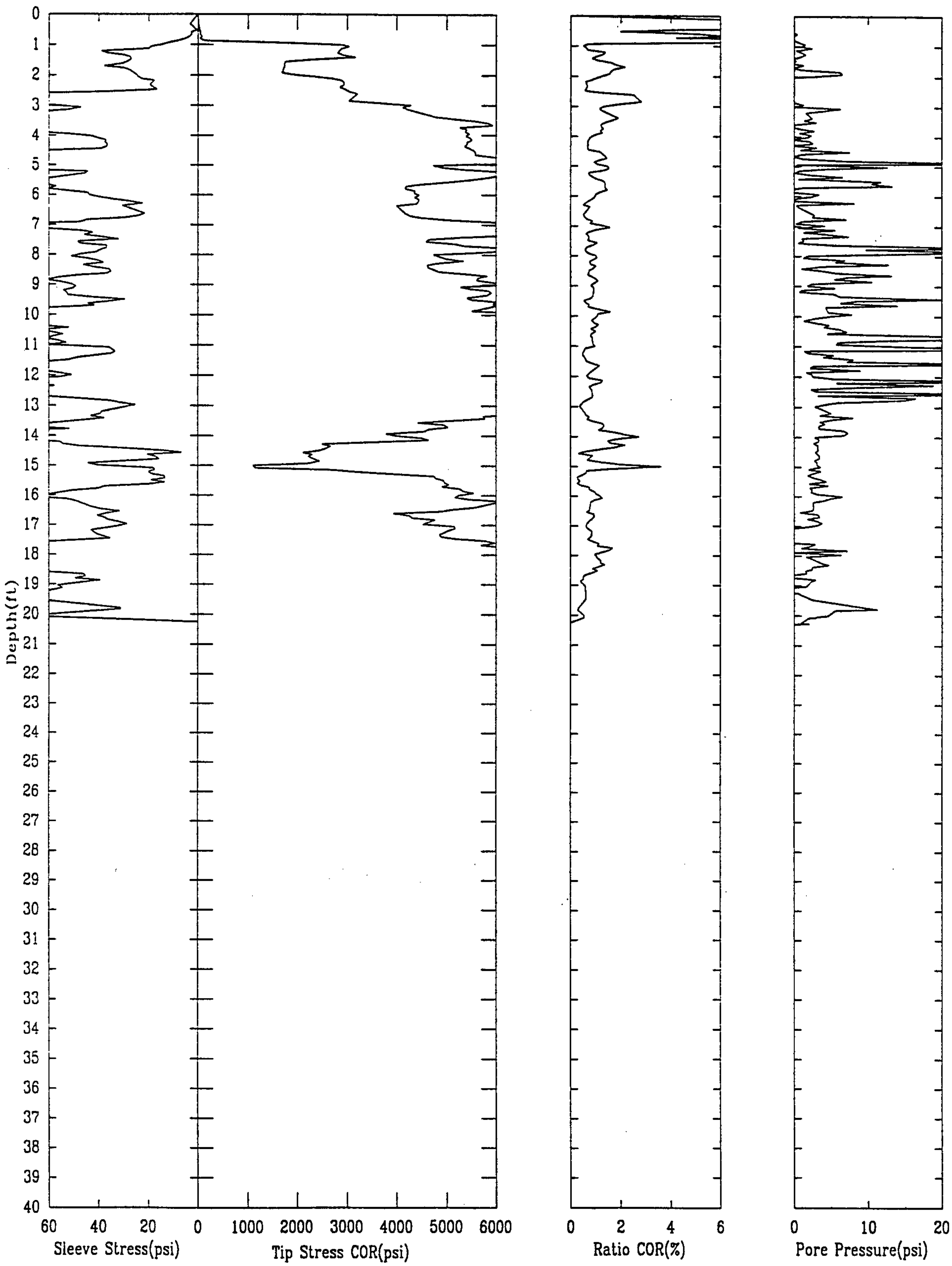
CPT-B38 APPLIED RESEARCH ASSOCIATES, INC. 02/04/97



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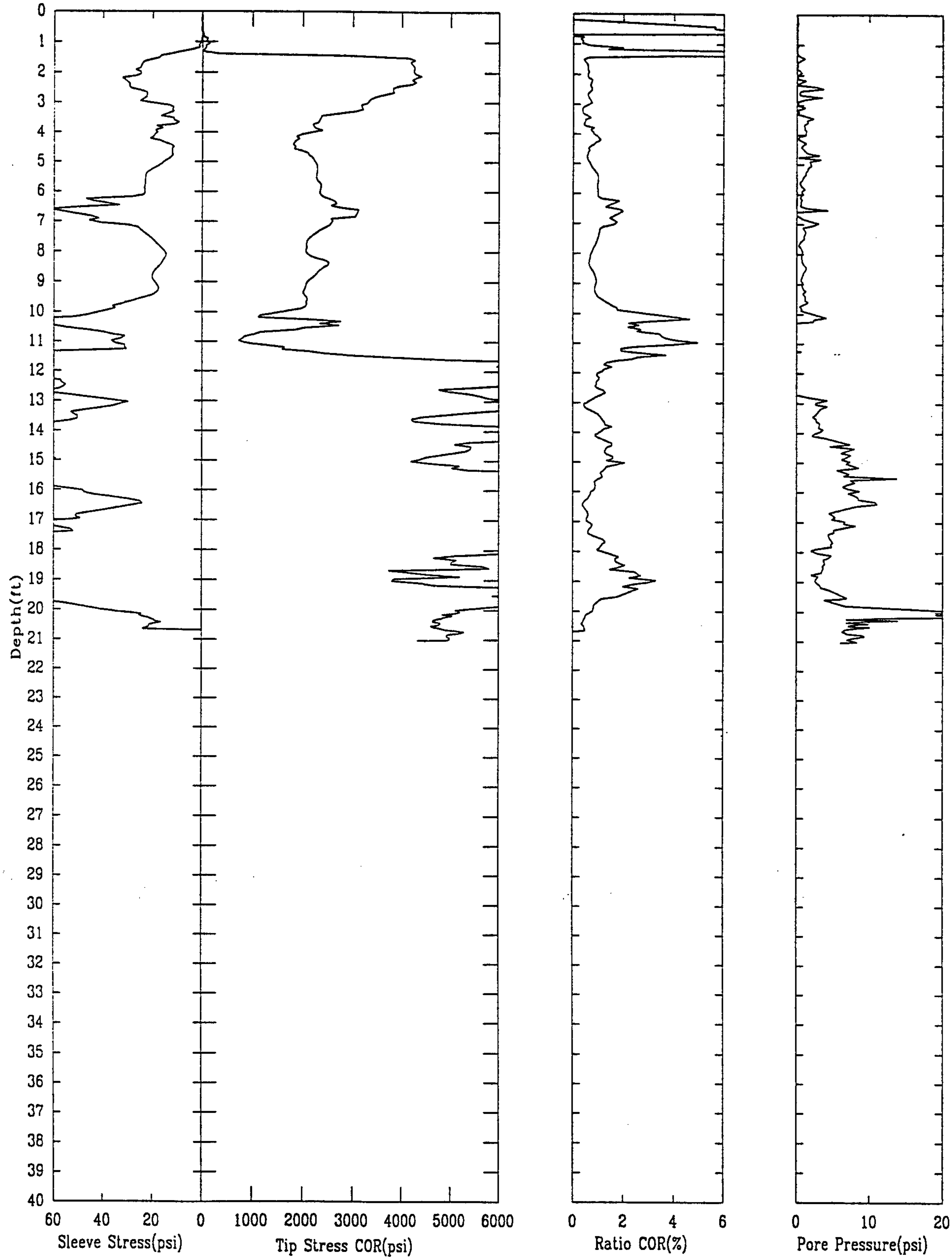
CPT-B39 APPLIED RESEARCH ASSOCIATES, INC. 02/04/97



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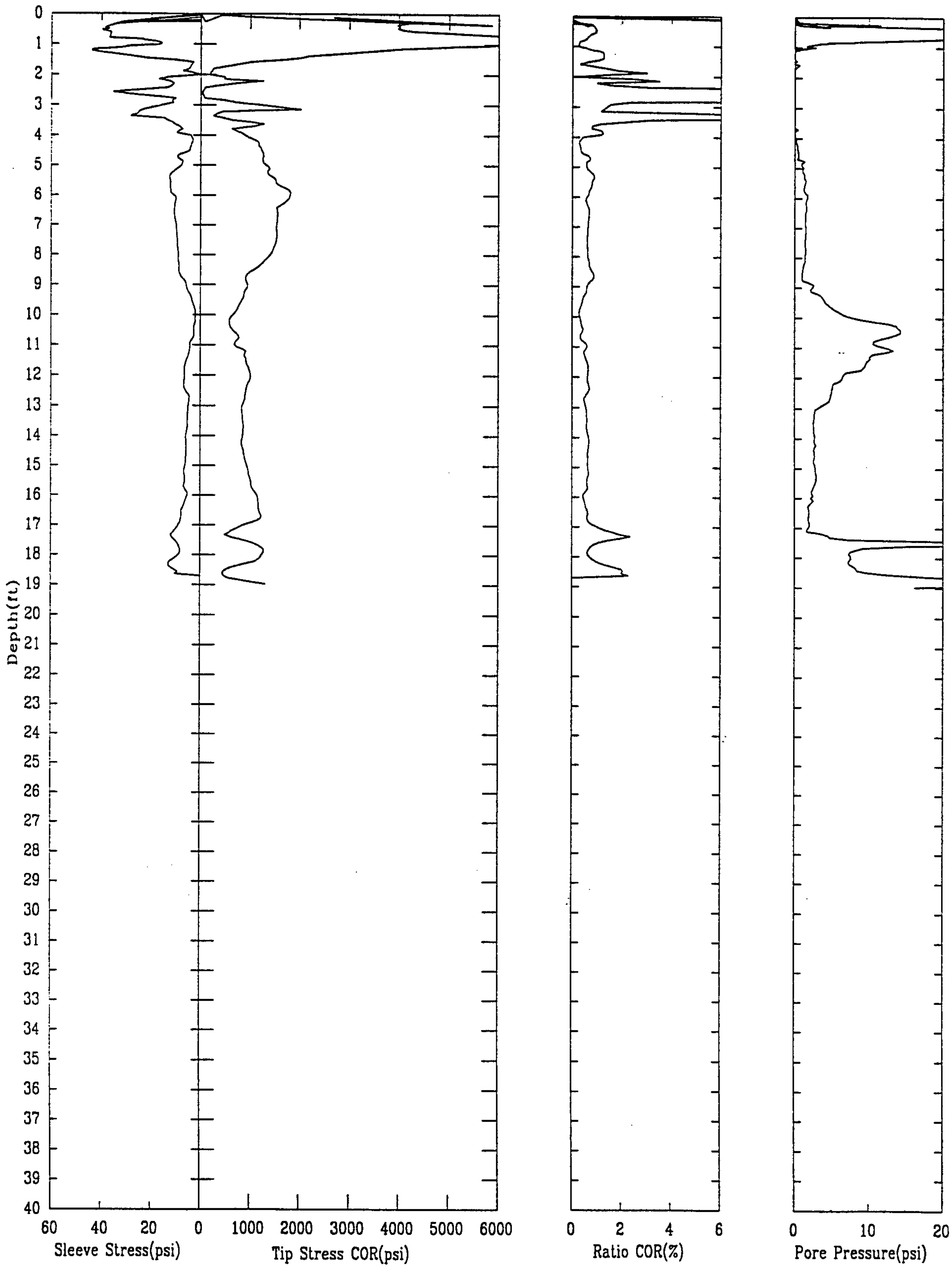
CPT-B40 APPLIED RESEARCH ASSOCIATES, INC. 01/31/97



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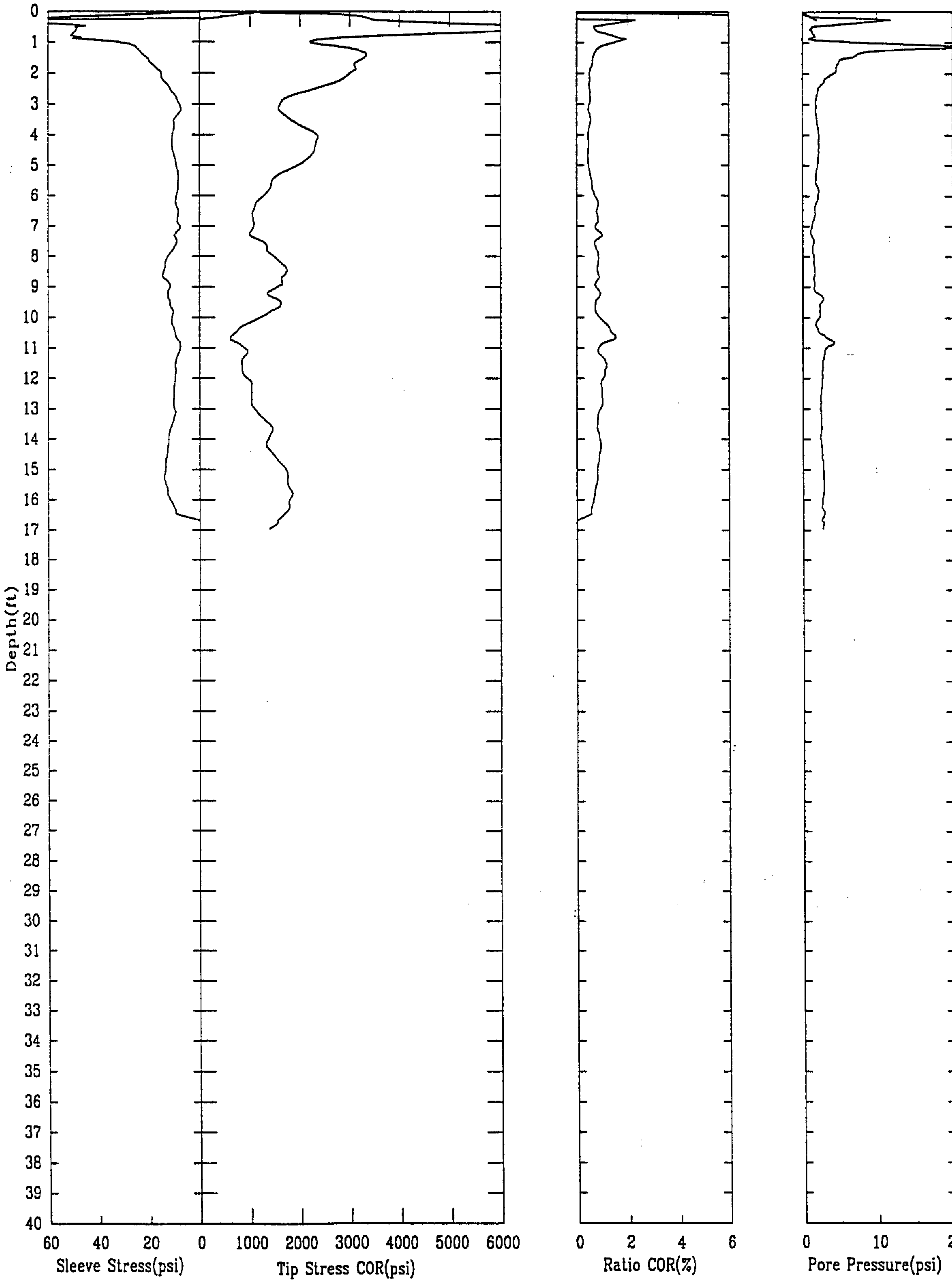
CPT-B41 APPLIED RESEARCH ASSOCIATES, INC. 01/31/97



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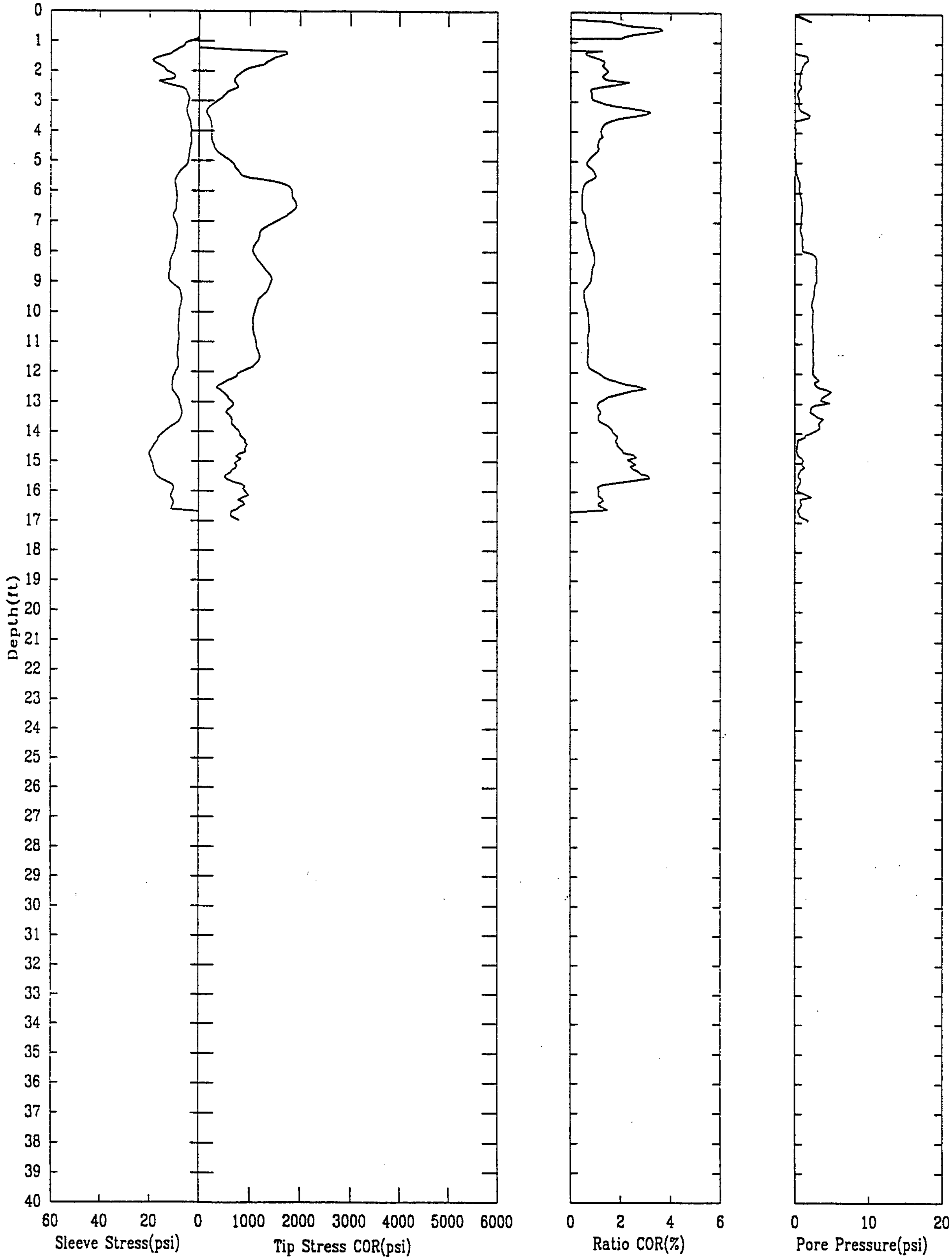

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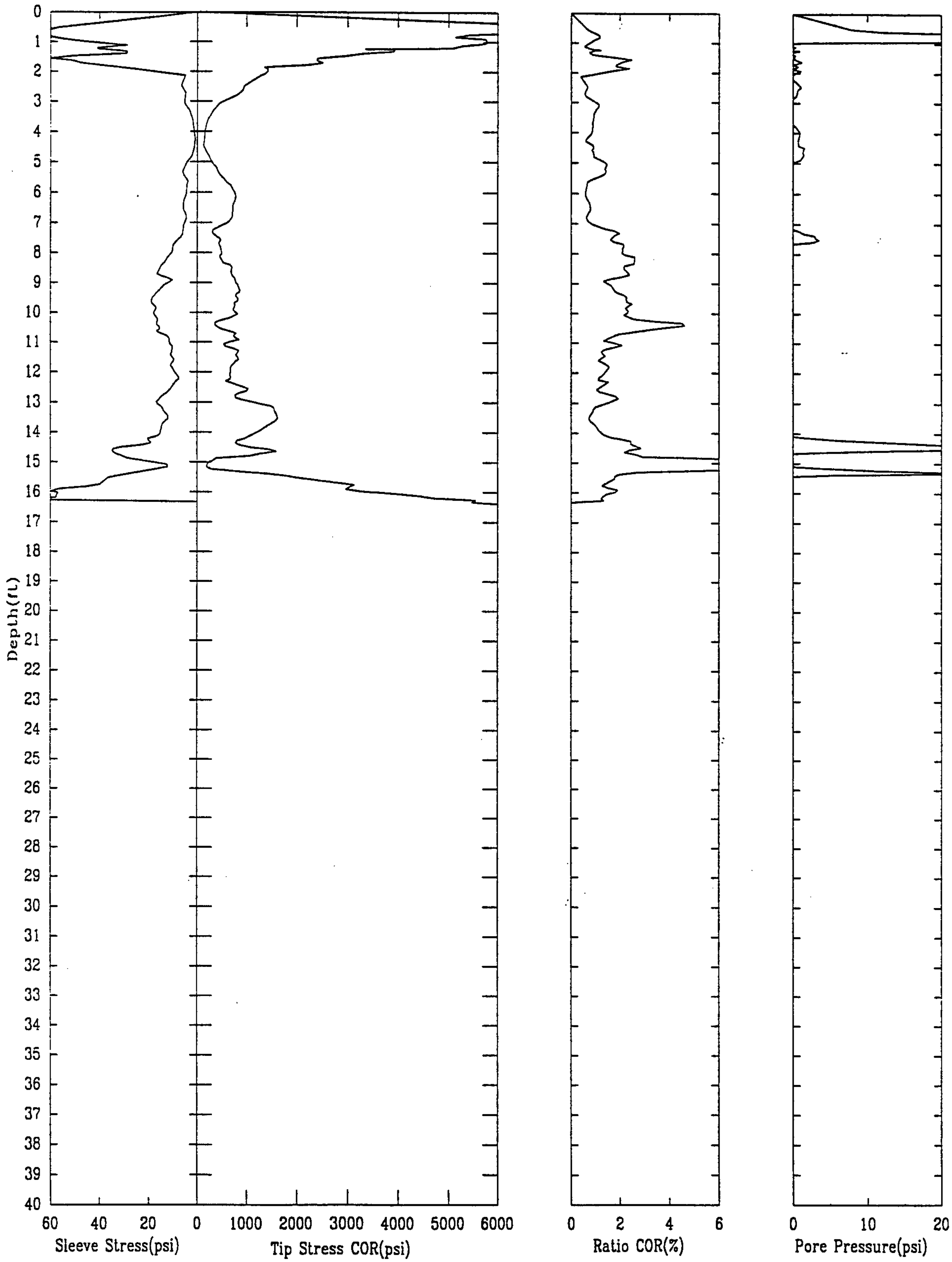
CPT-OW-2 APPLIED RESEARCH ASSOCIATES, INC. 01/31/97



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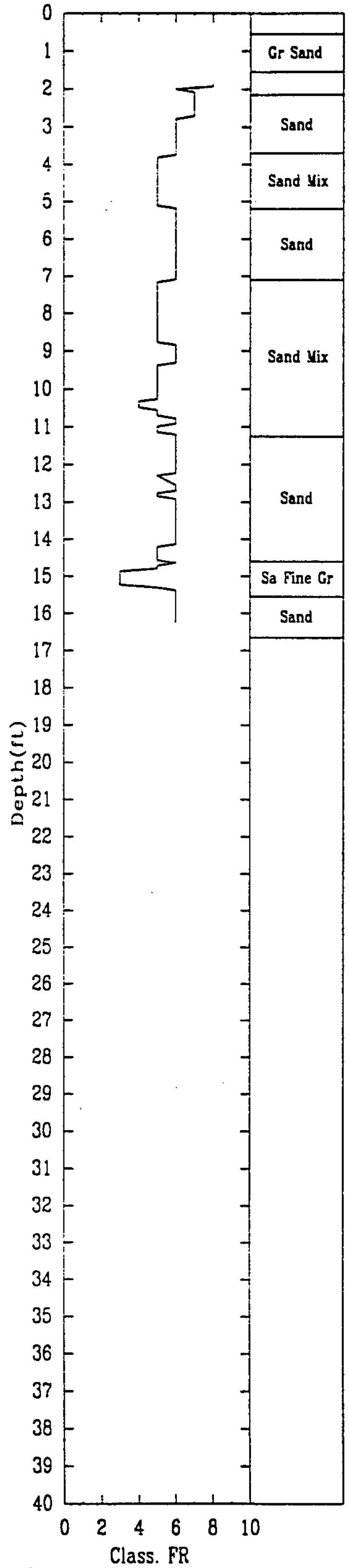

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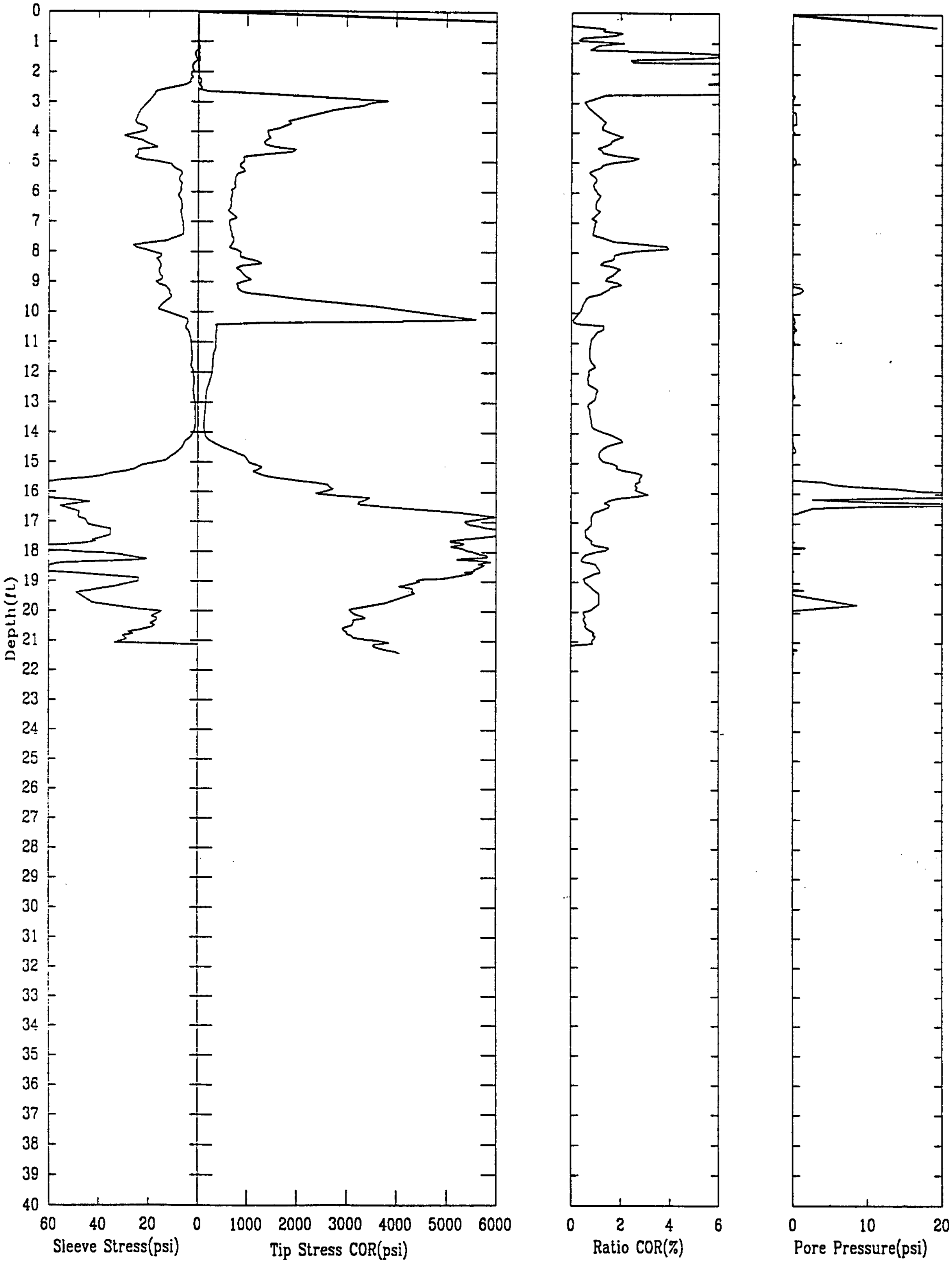
CPT-MWZ-3 APPLIED RESEARCH ASSOCIATES, INC. 01/31/97



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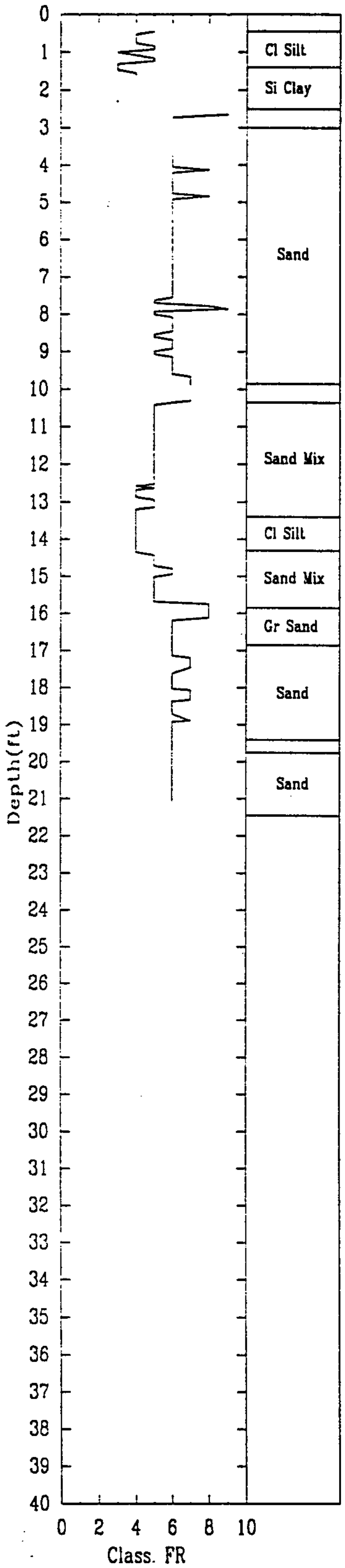

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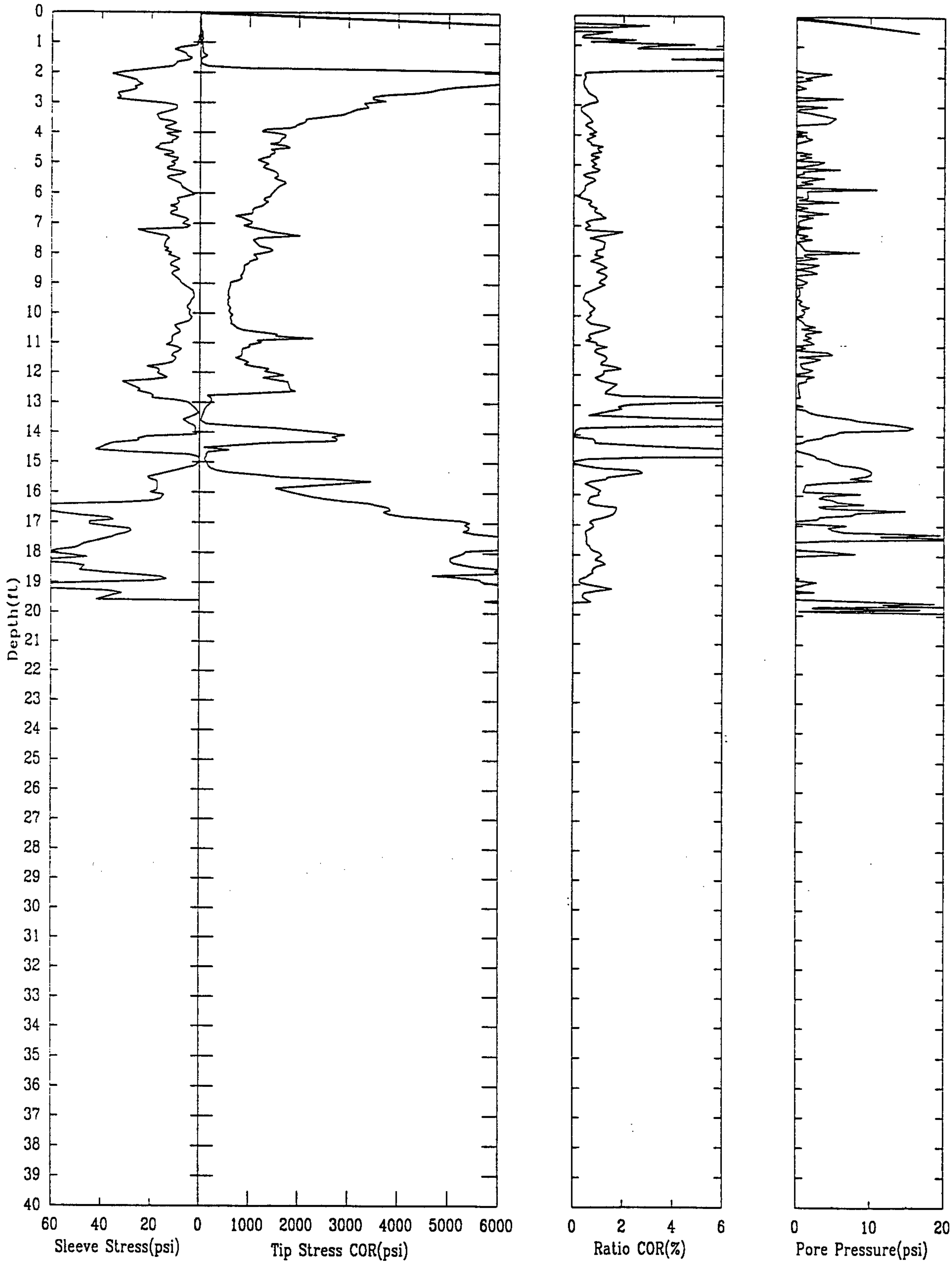
CPT-MWZ-4 APPLIED RESEARCH ASSOCIATES, INC. 02/04/97



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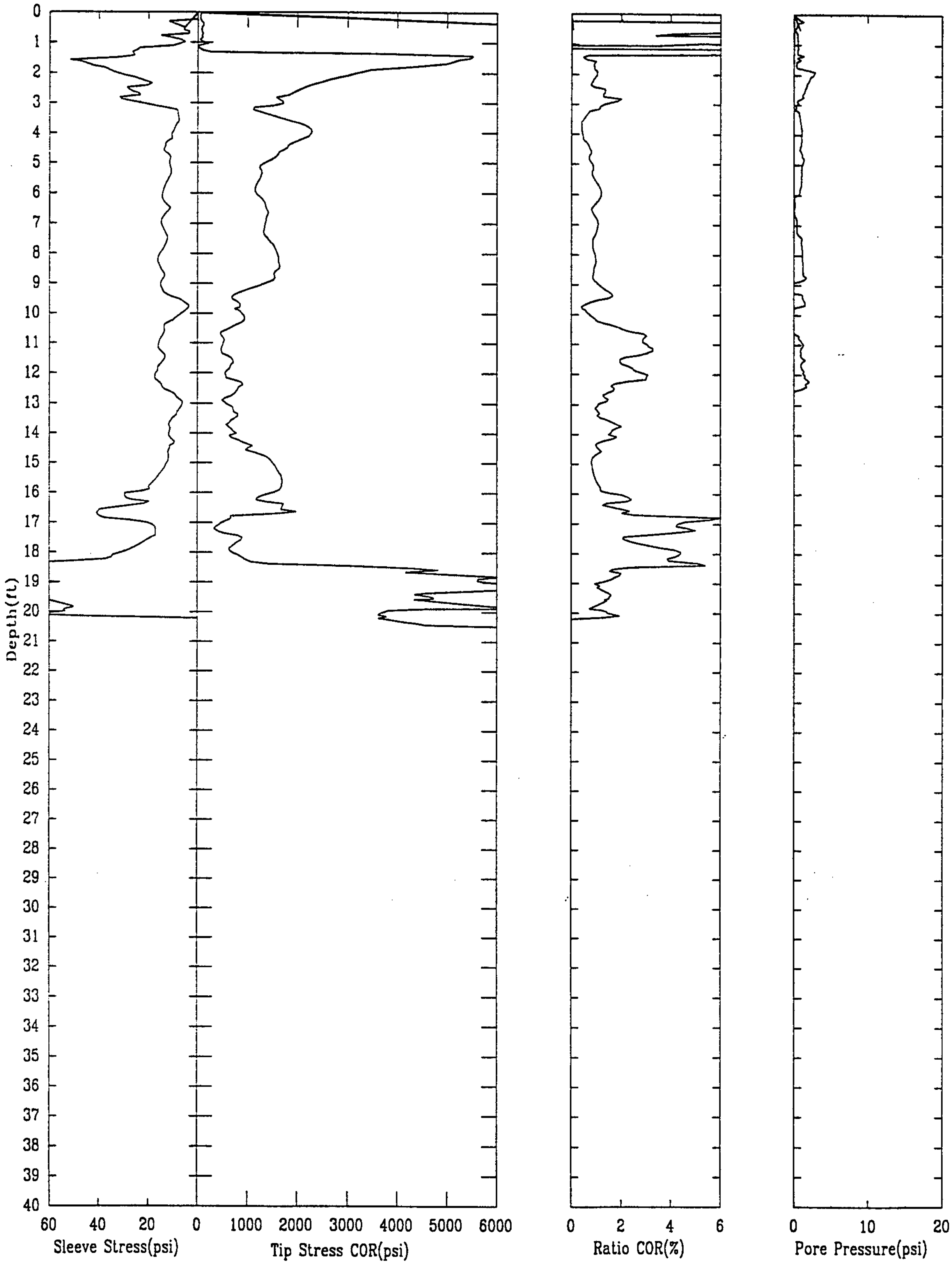
CPT-MWZ-5 APPLIED RESEARCH ASSOCIATES, INC. 02/01/97



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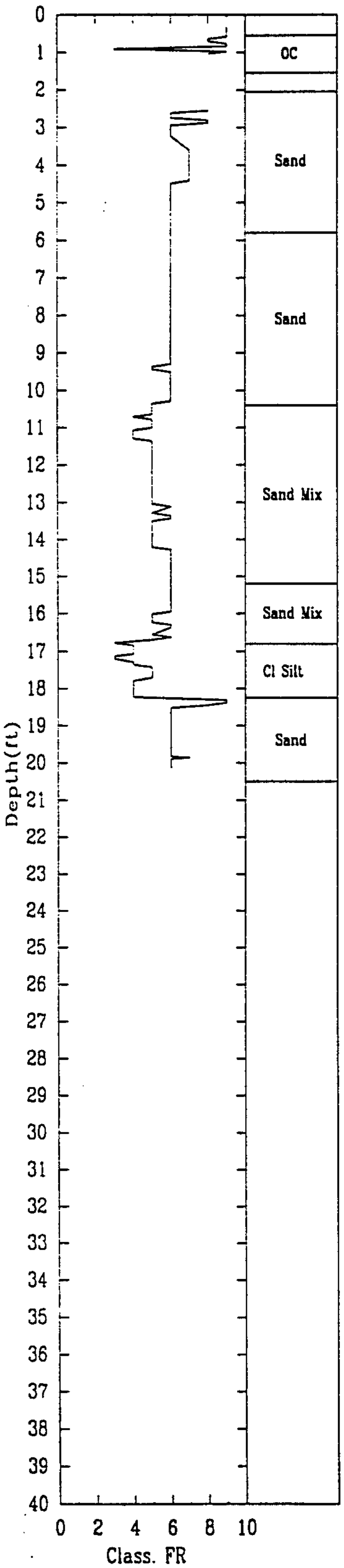

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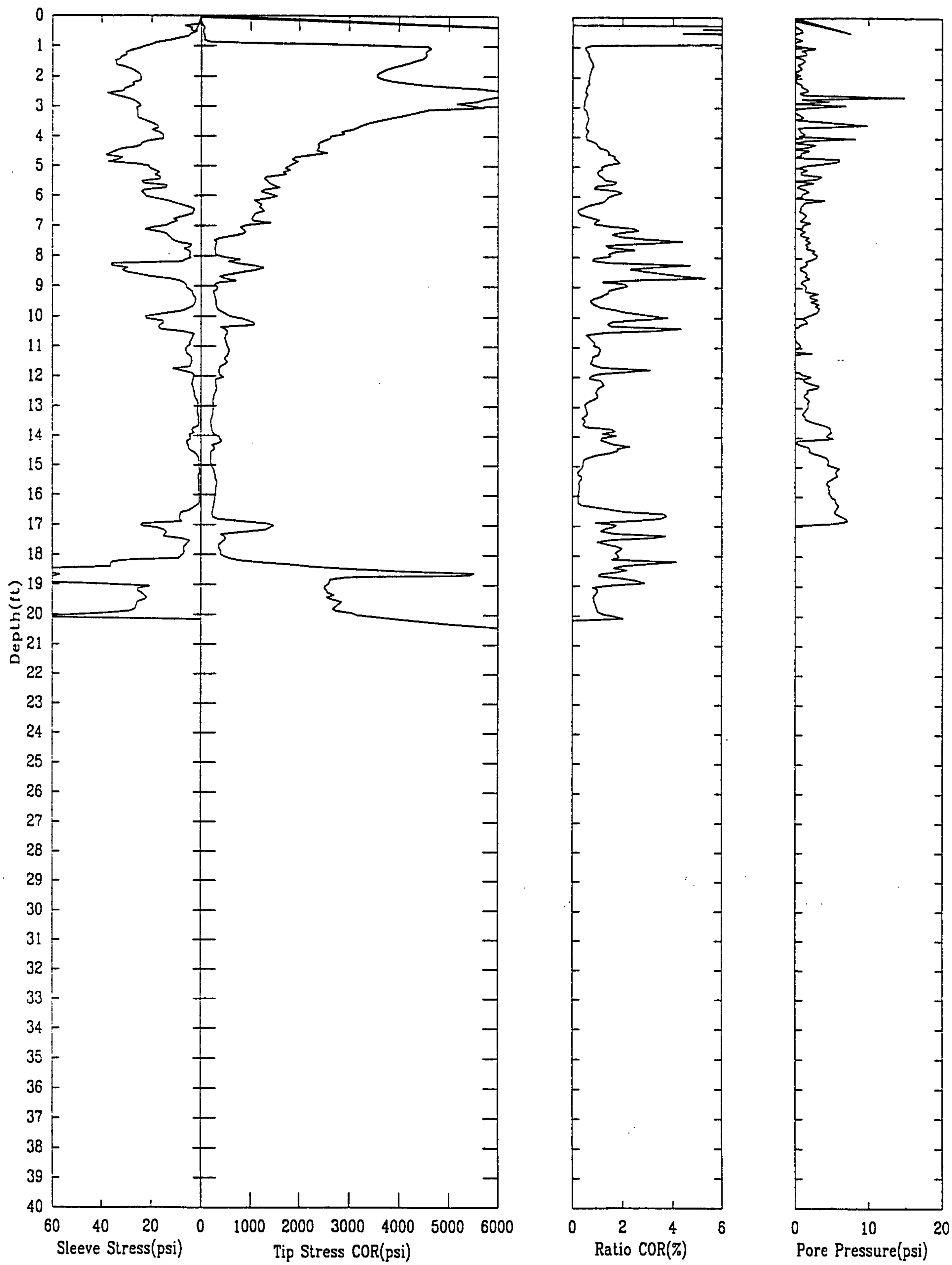

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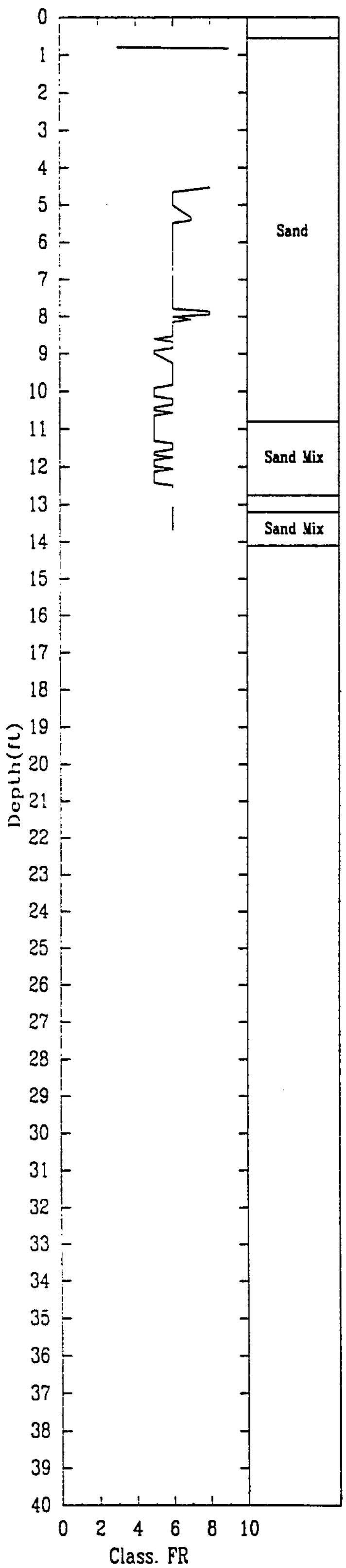

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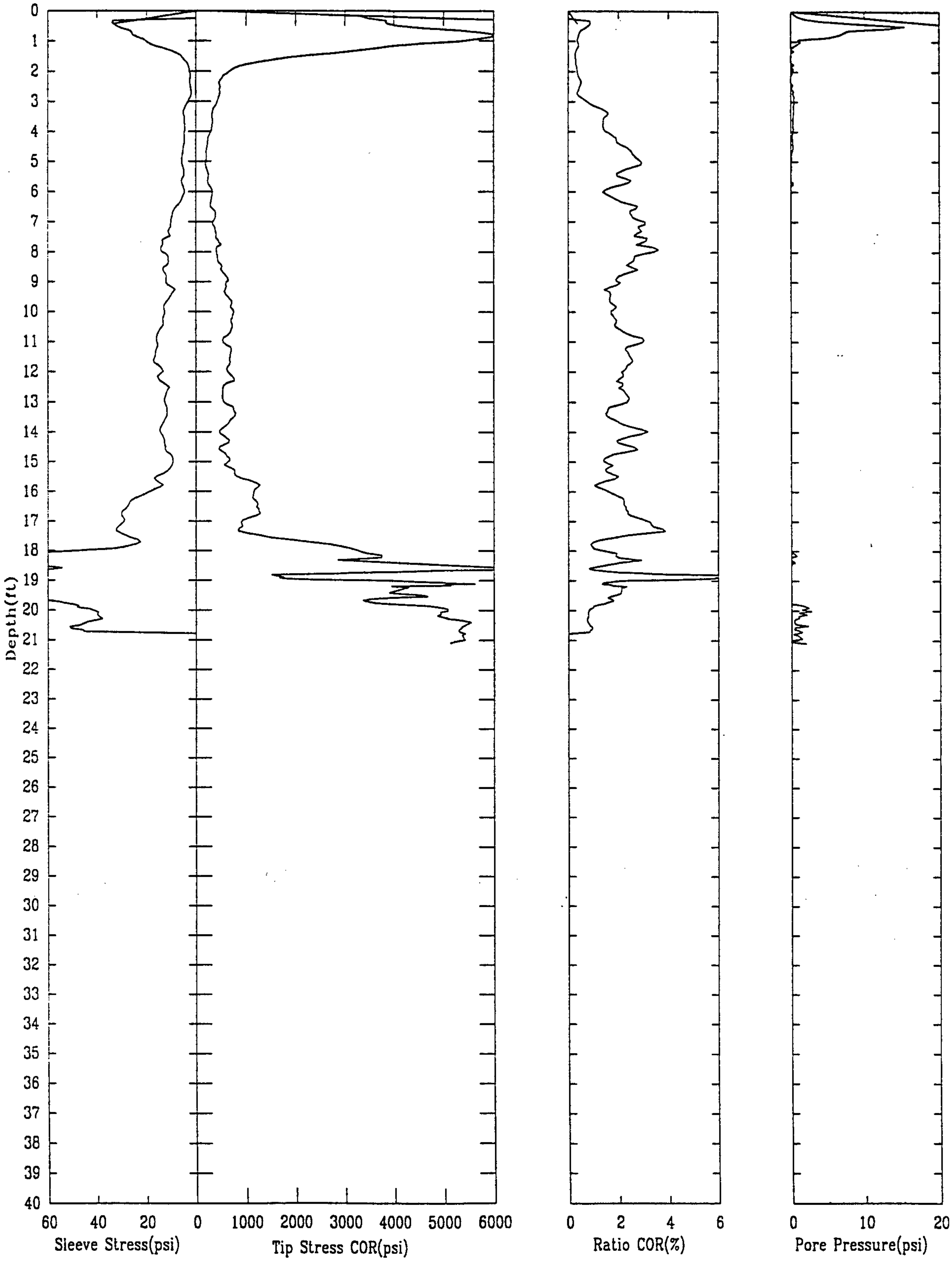

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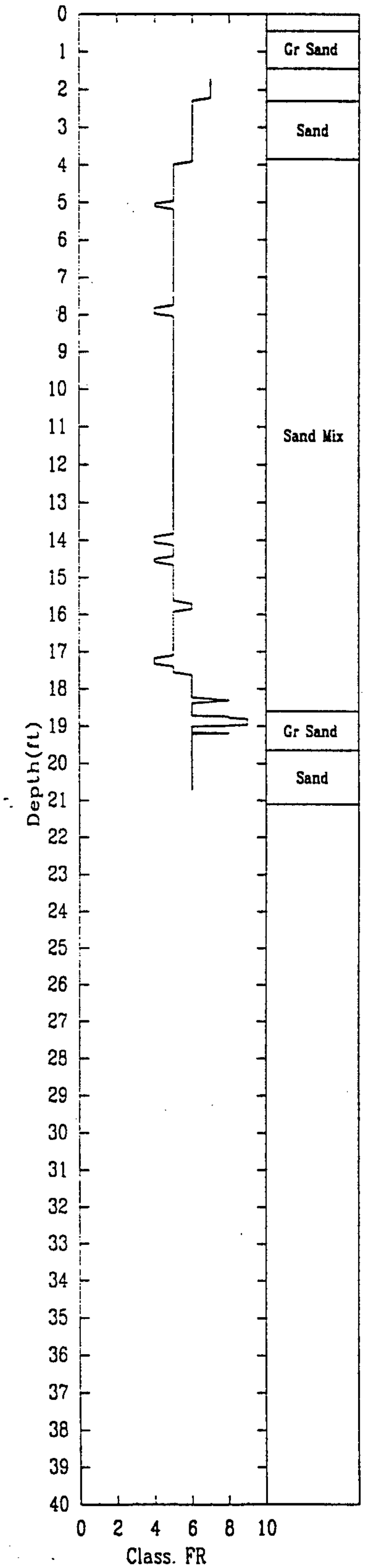

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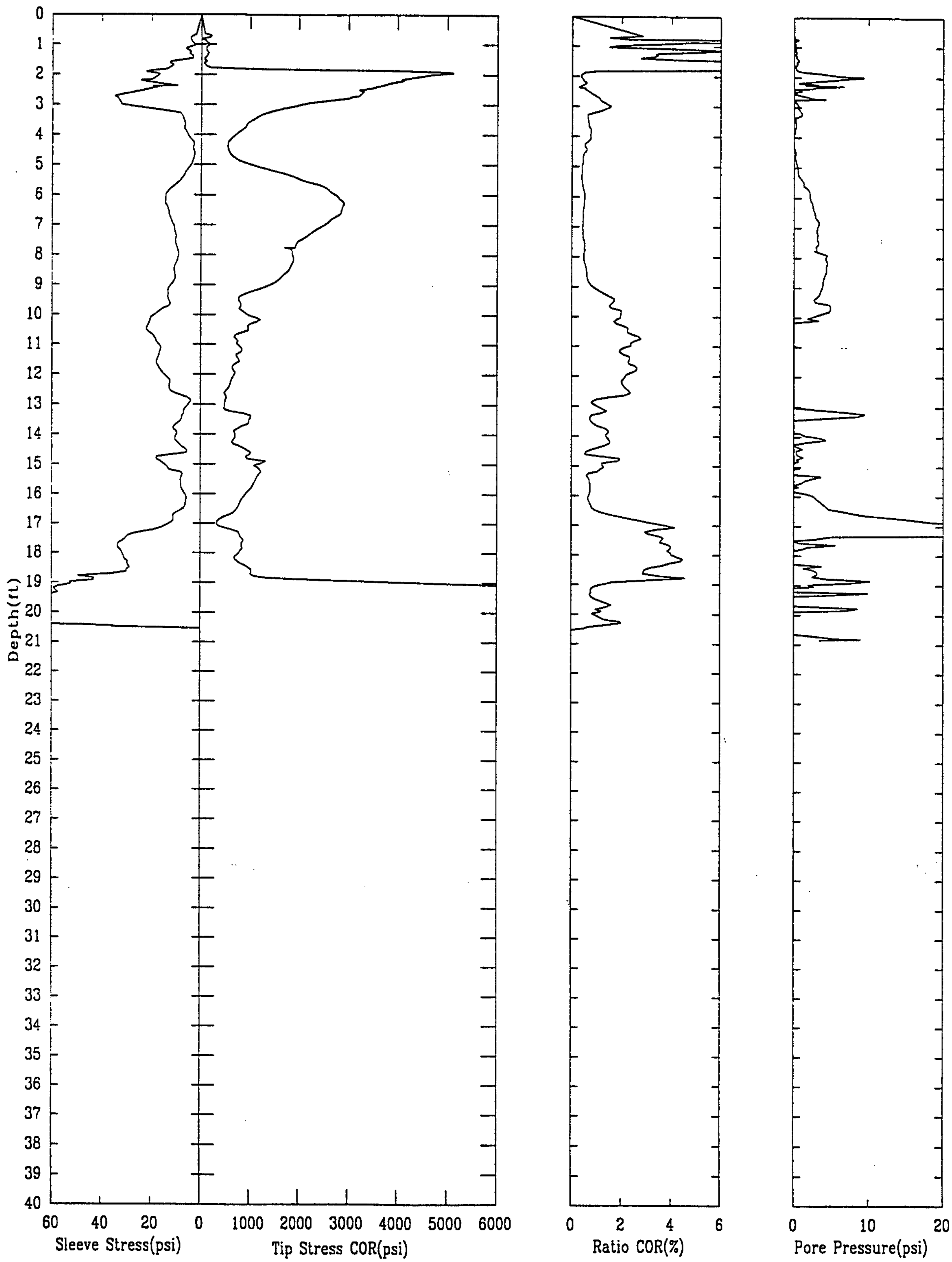

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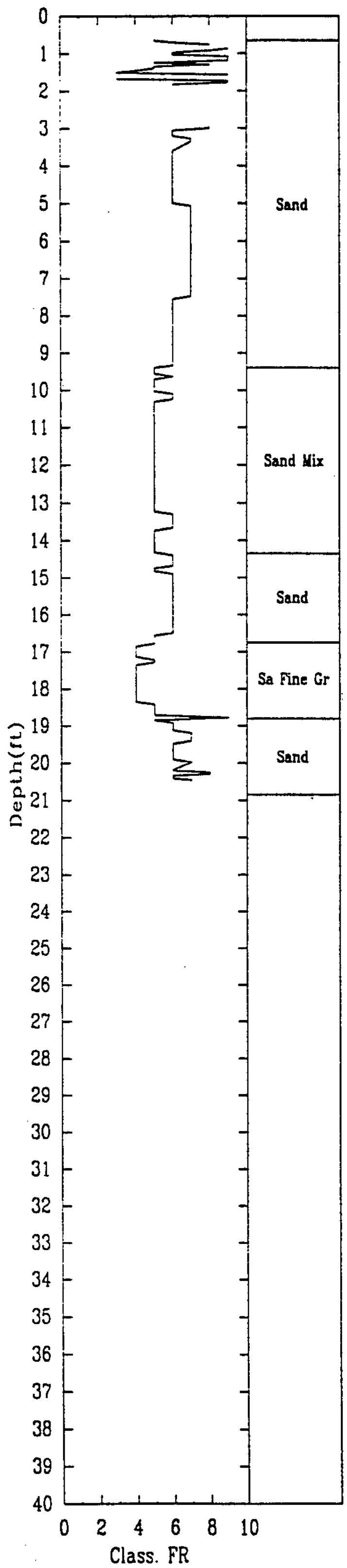

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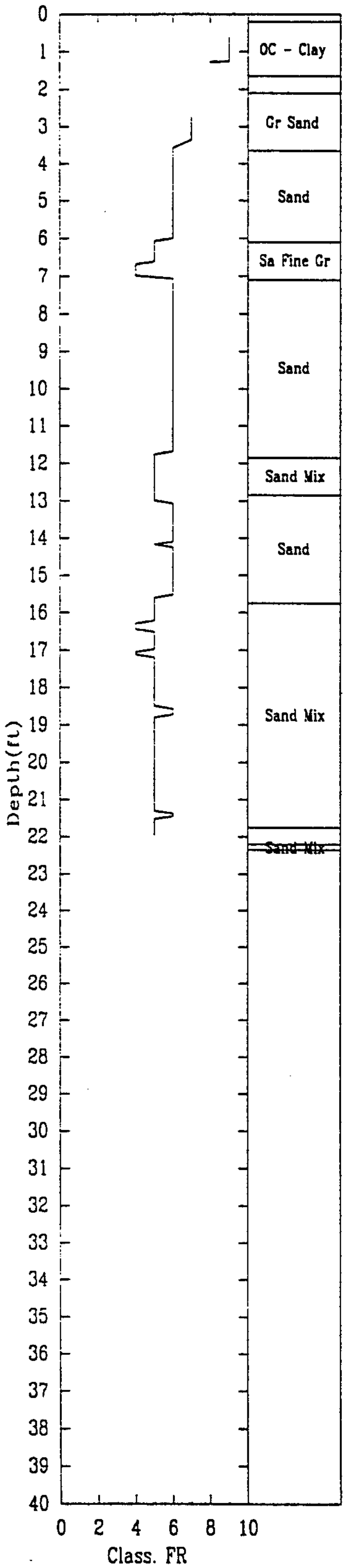

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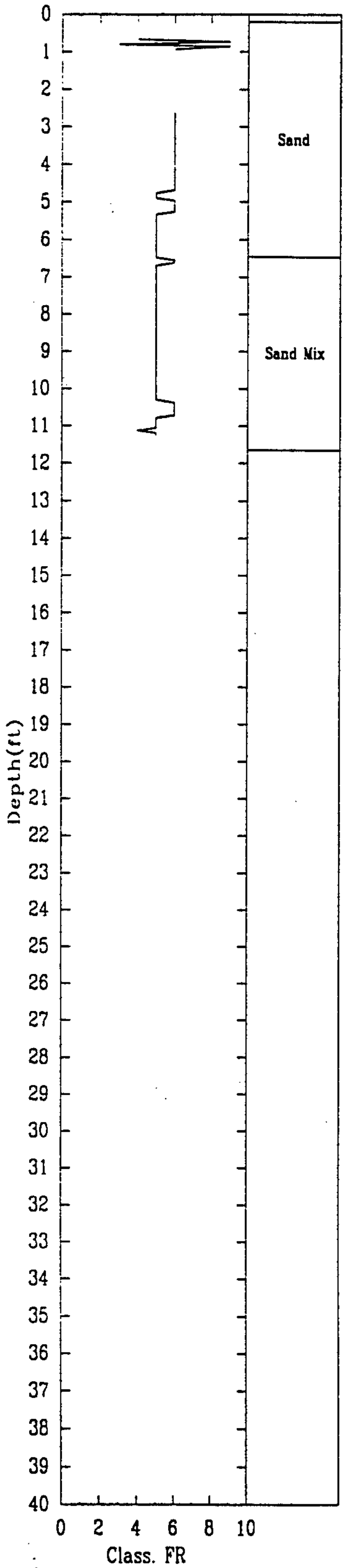
CPT-MWZ-16 APPLIED RESEARCH ASSOCIATES, INC. 02/05/97



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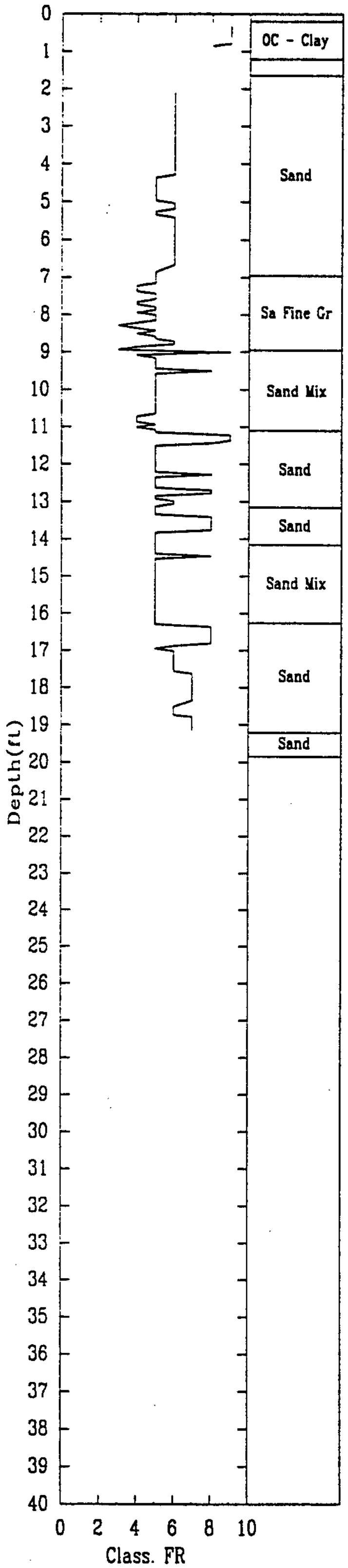

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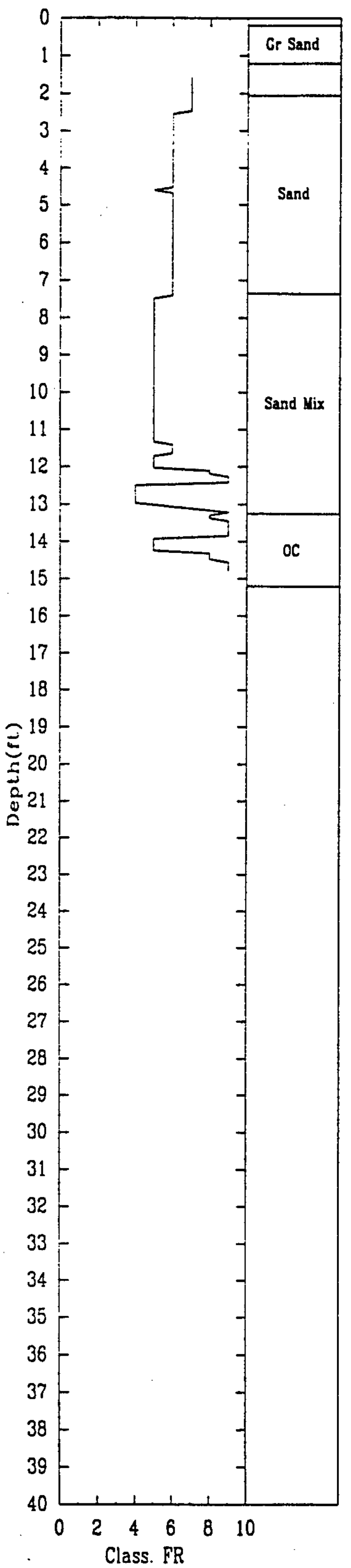
CPT-MWZ-19 APPLIED RESEARCH ASSOCIATES, INC. 01/30/97



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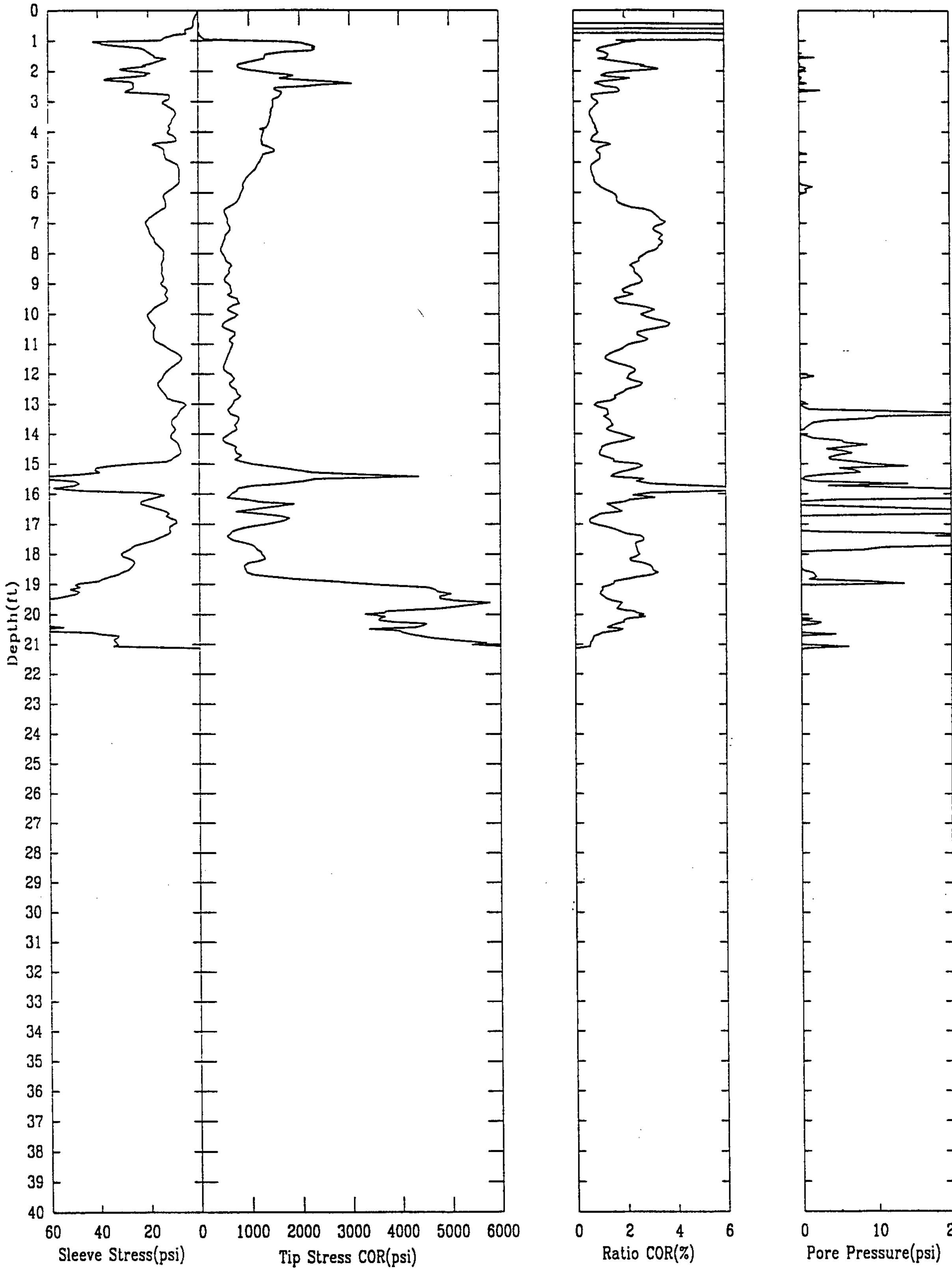

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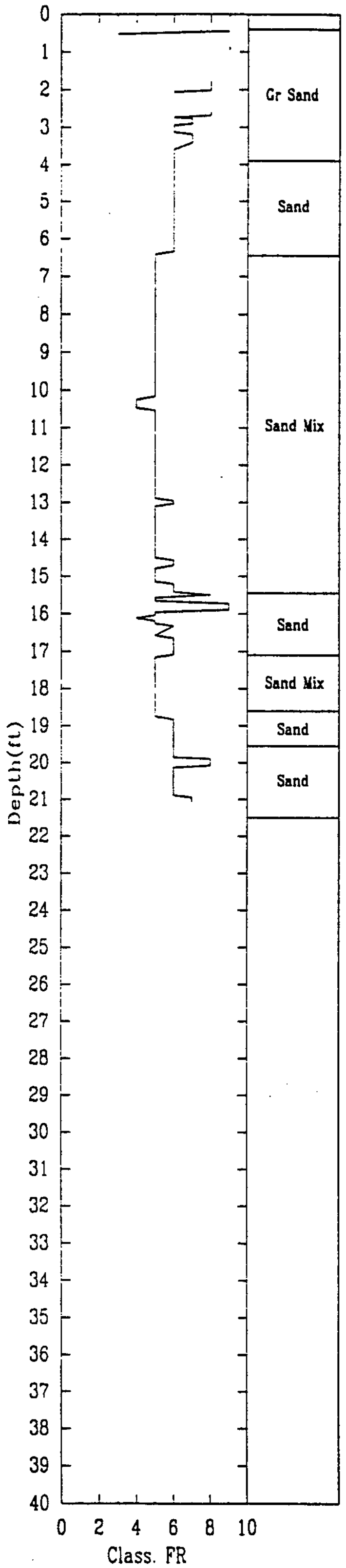

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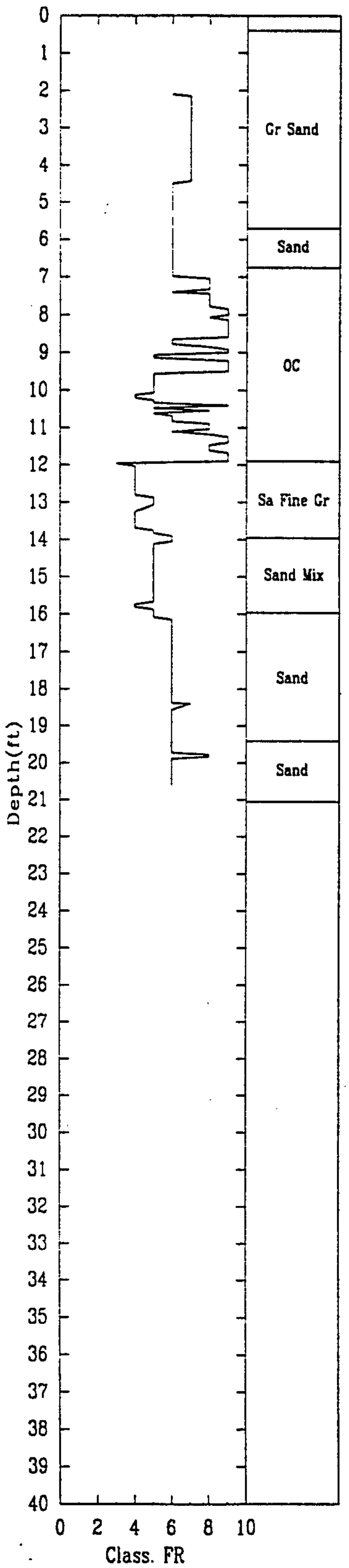

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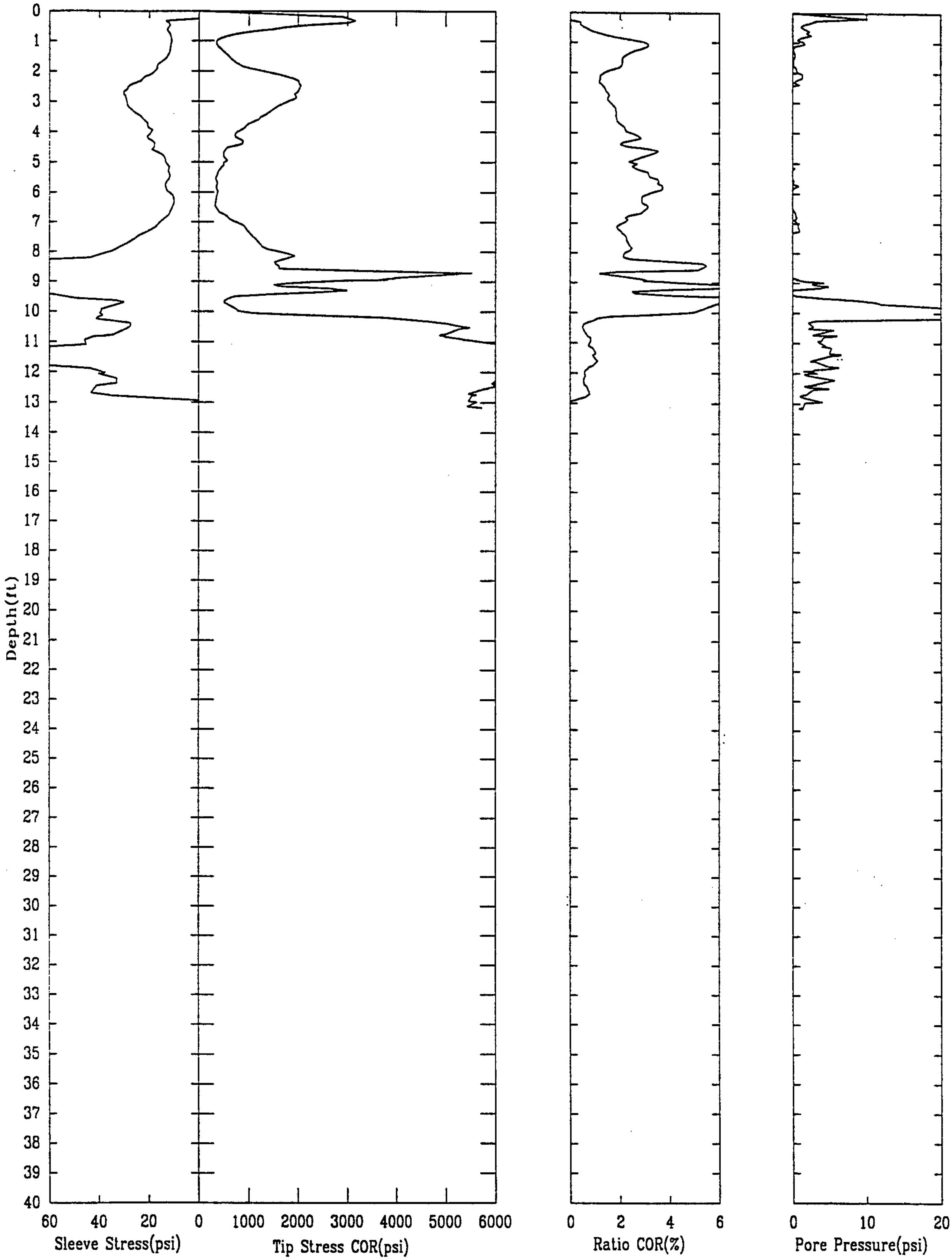

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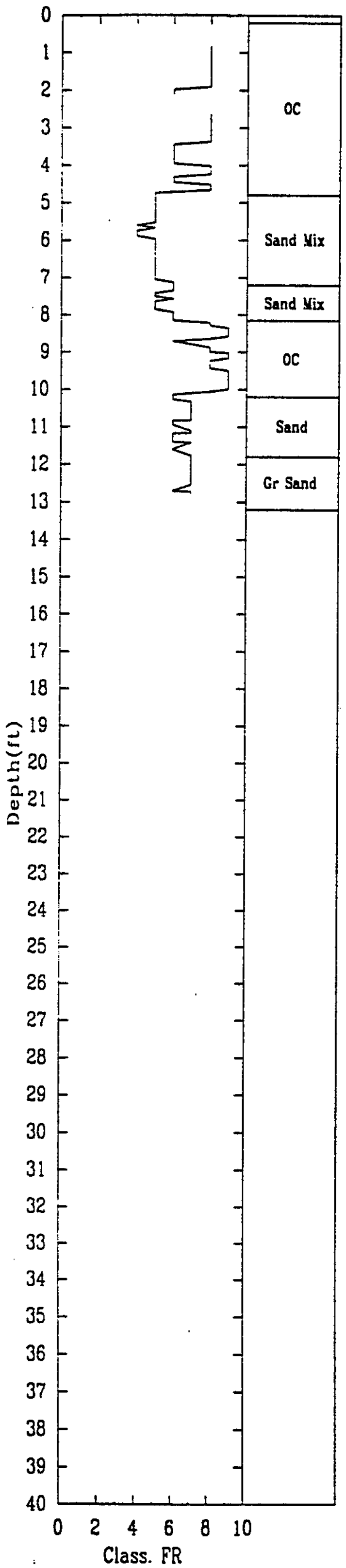

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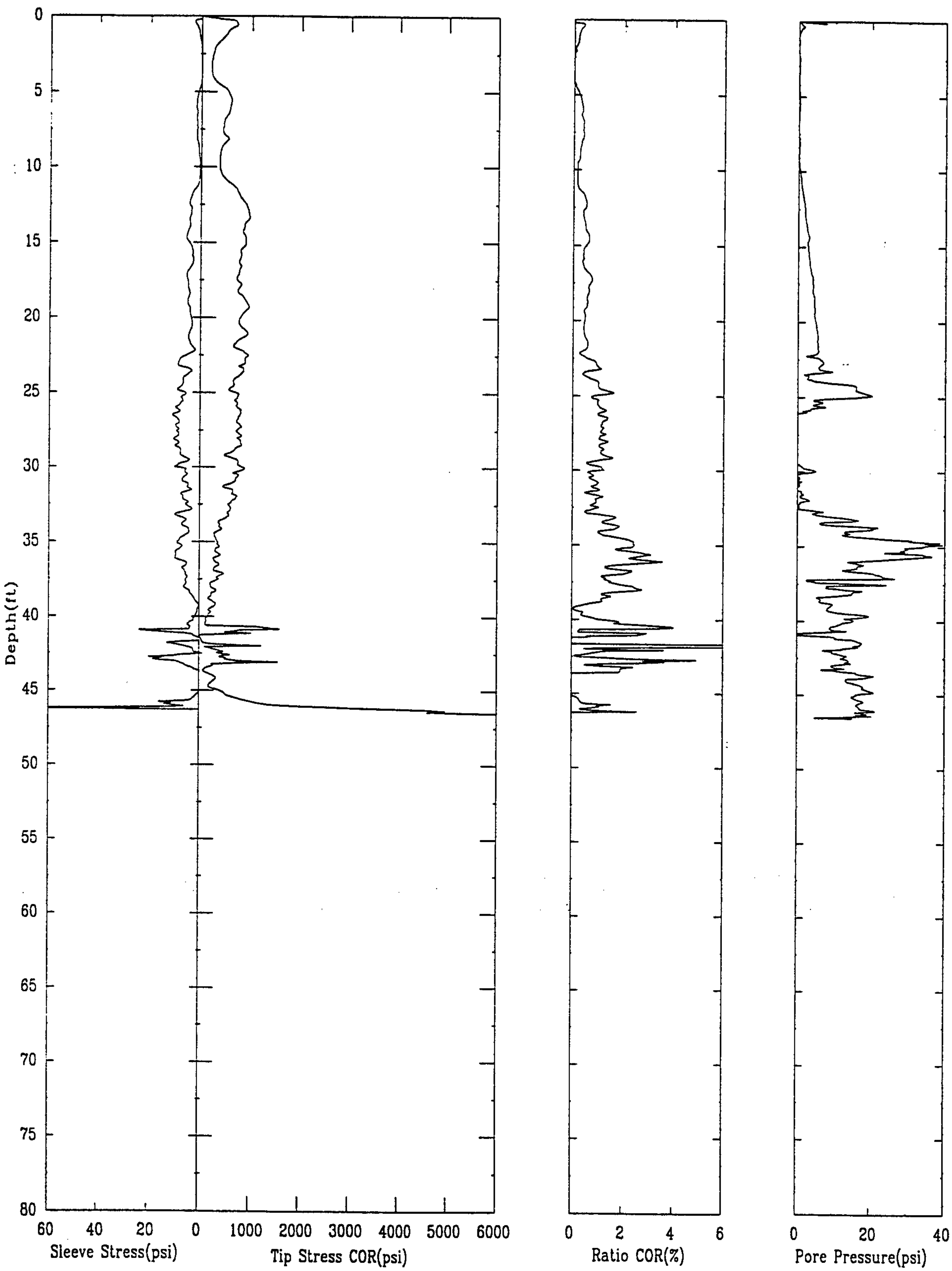

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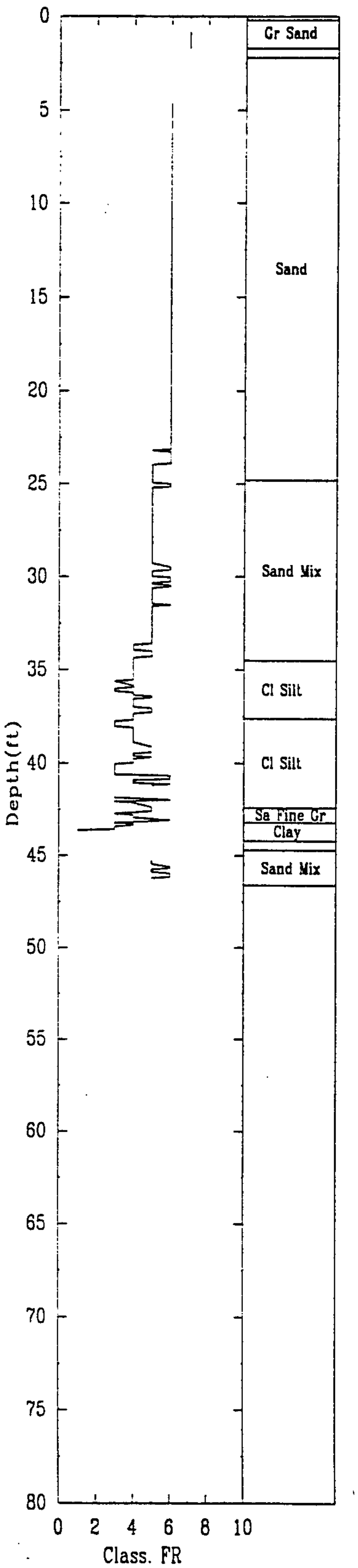

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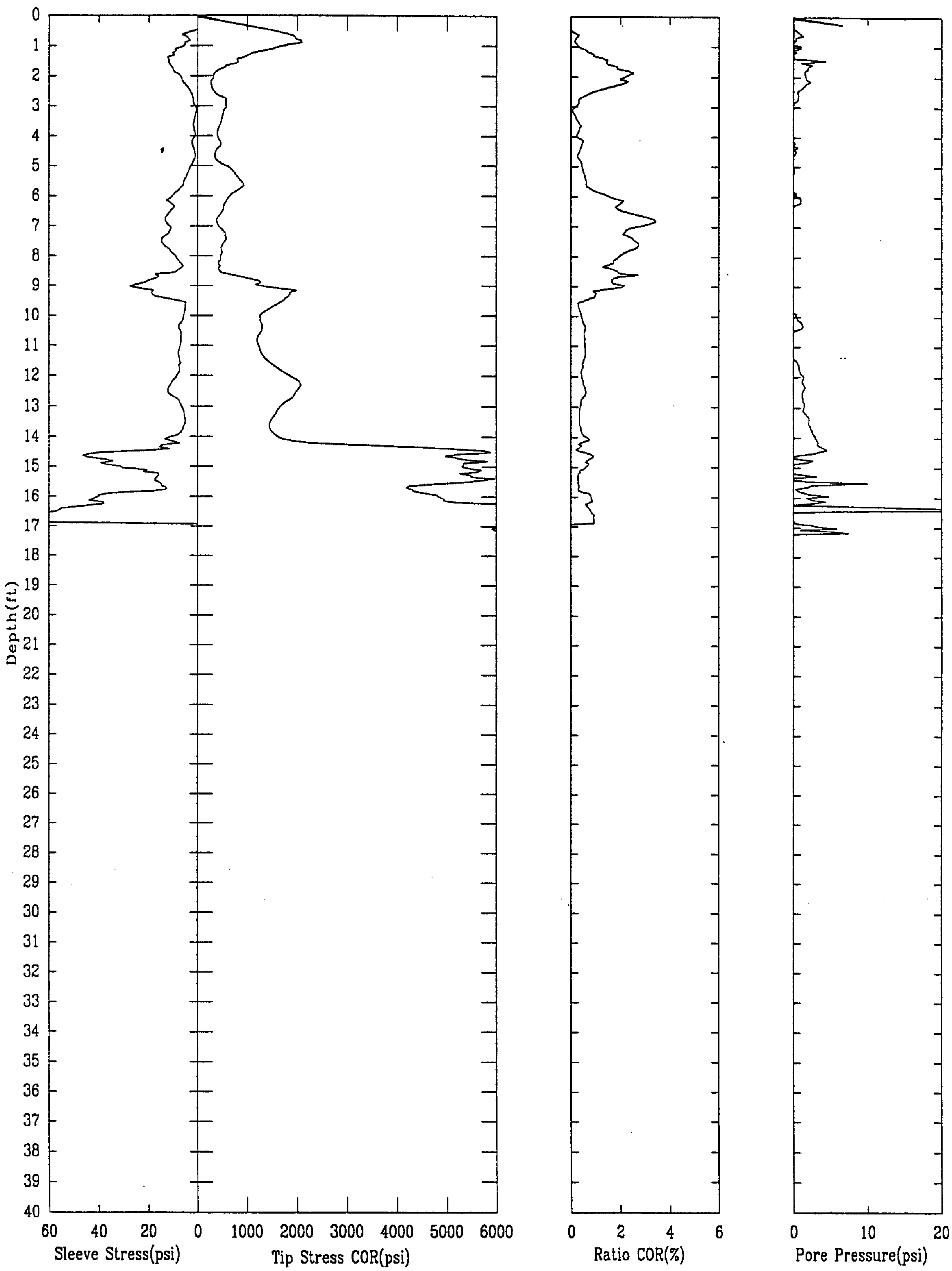
CPT-02 APPLIED RESEARCH ASSOCIATES, INC. 08/29/96



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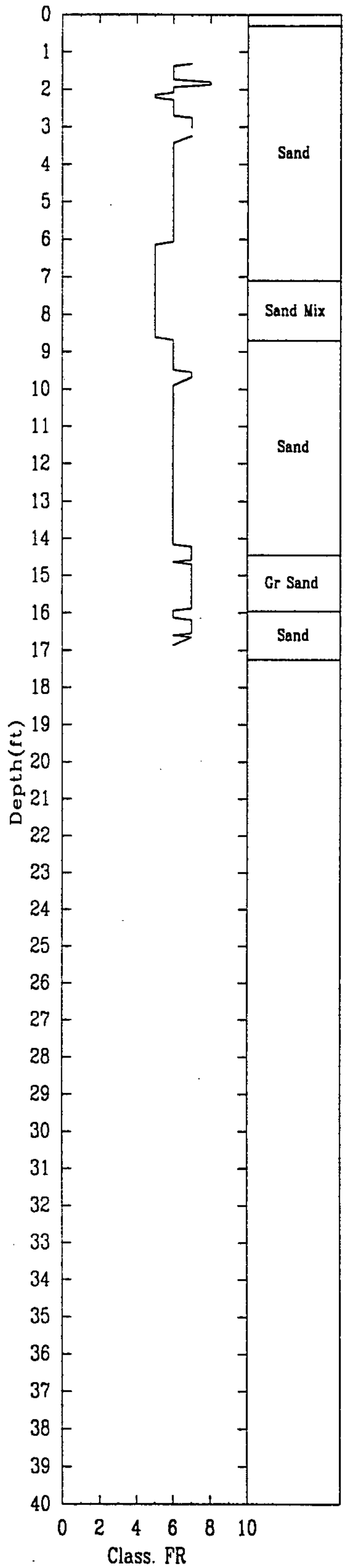

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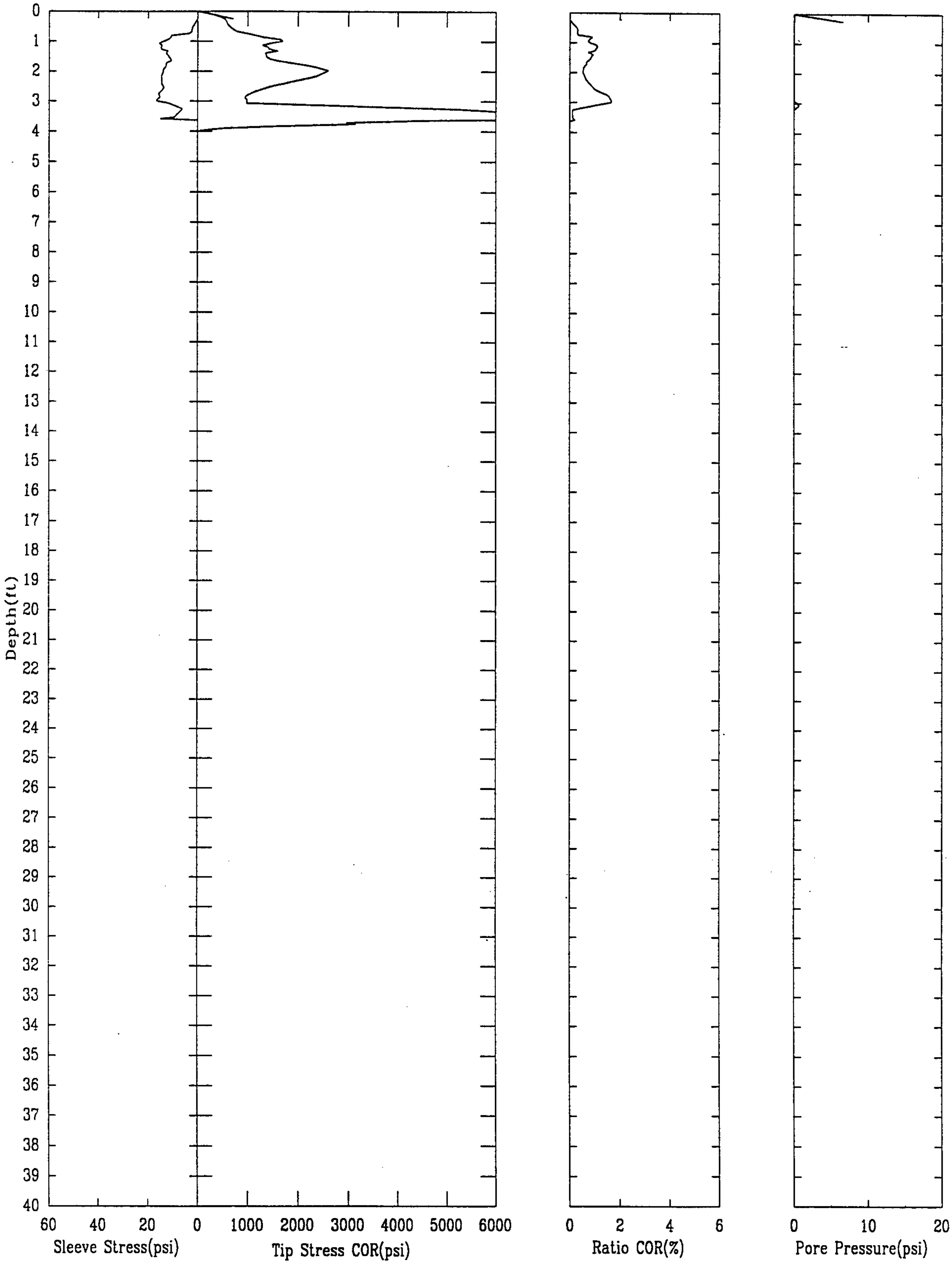
CPT-03B APPLIED RESEARCH ASSOCIATES, INC. 08/29/96



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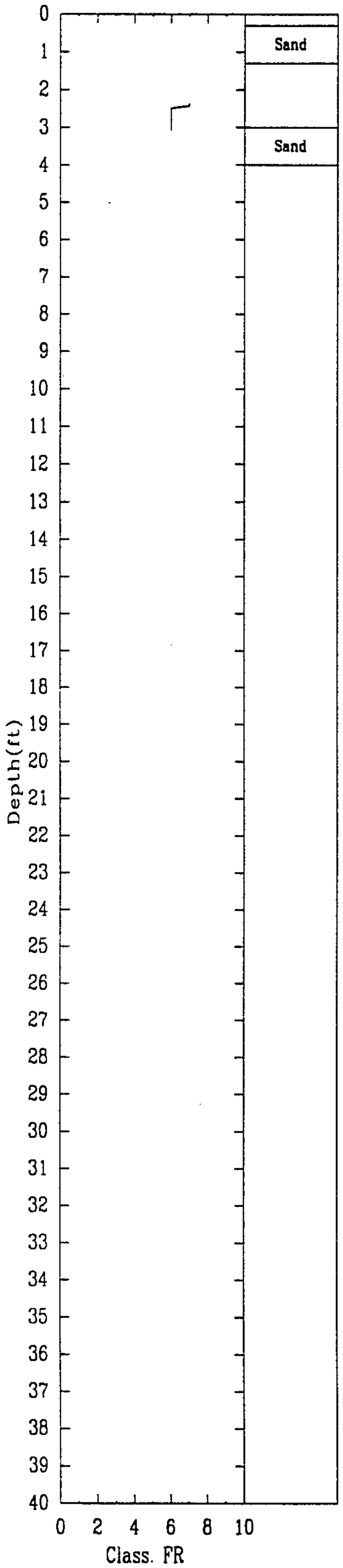
CPT-03B APPLIED RESEARCH ASSOCIATES, INC. 08/29/96



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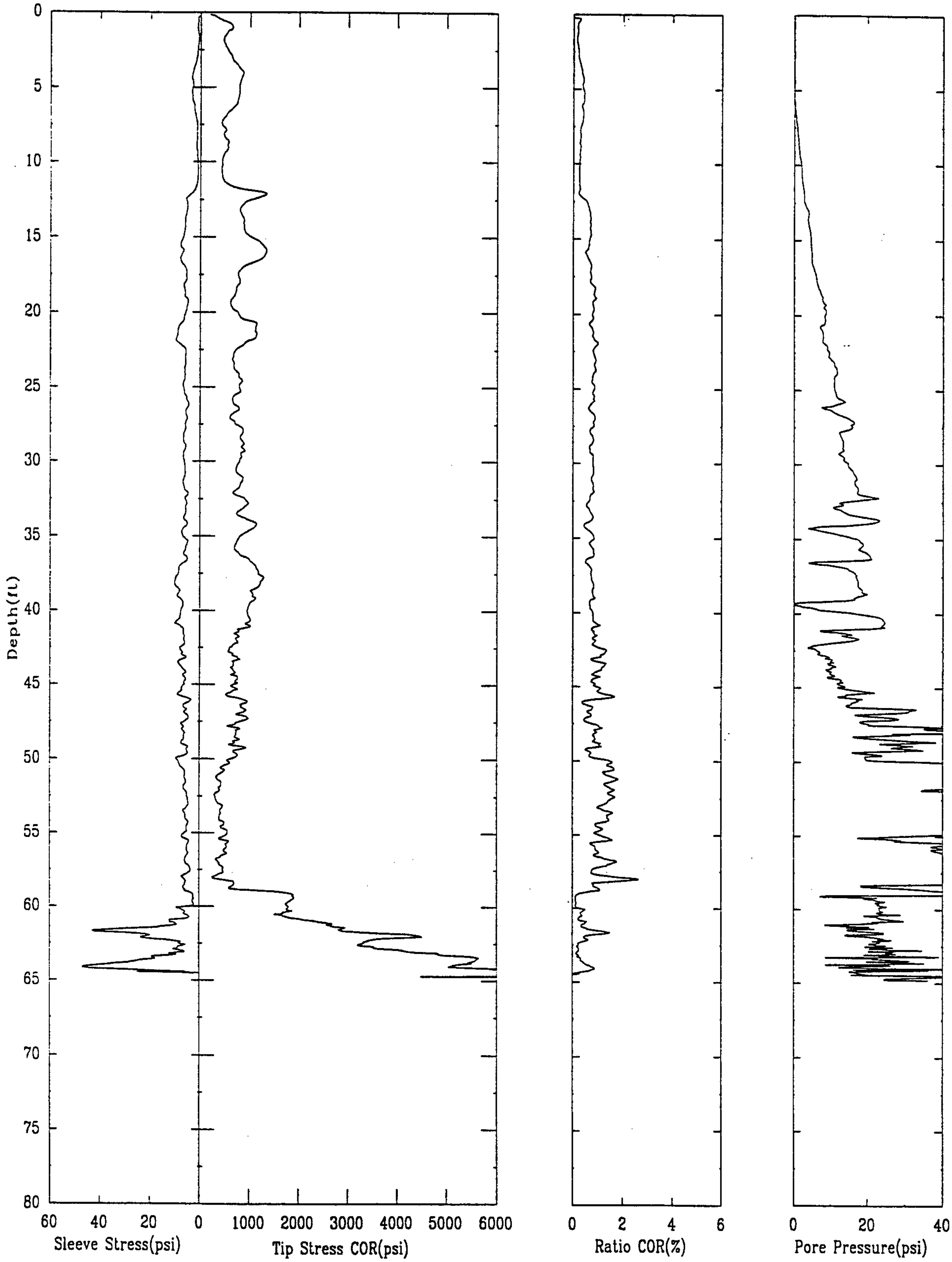
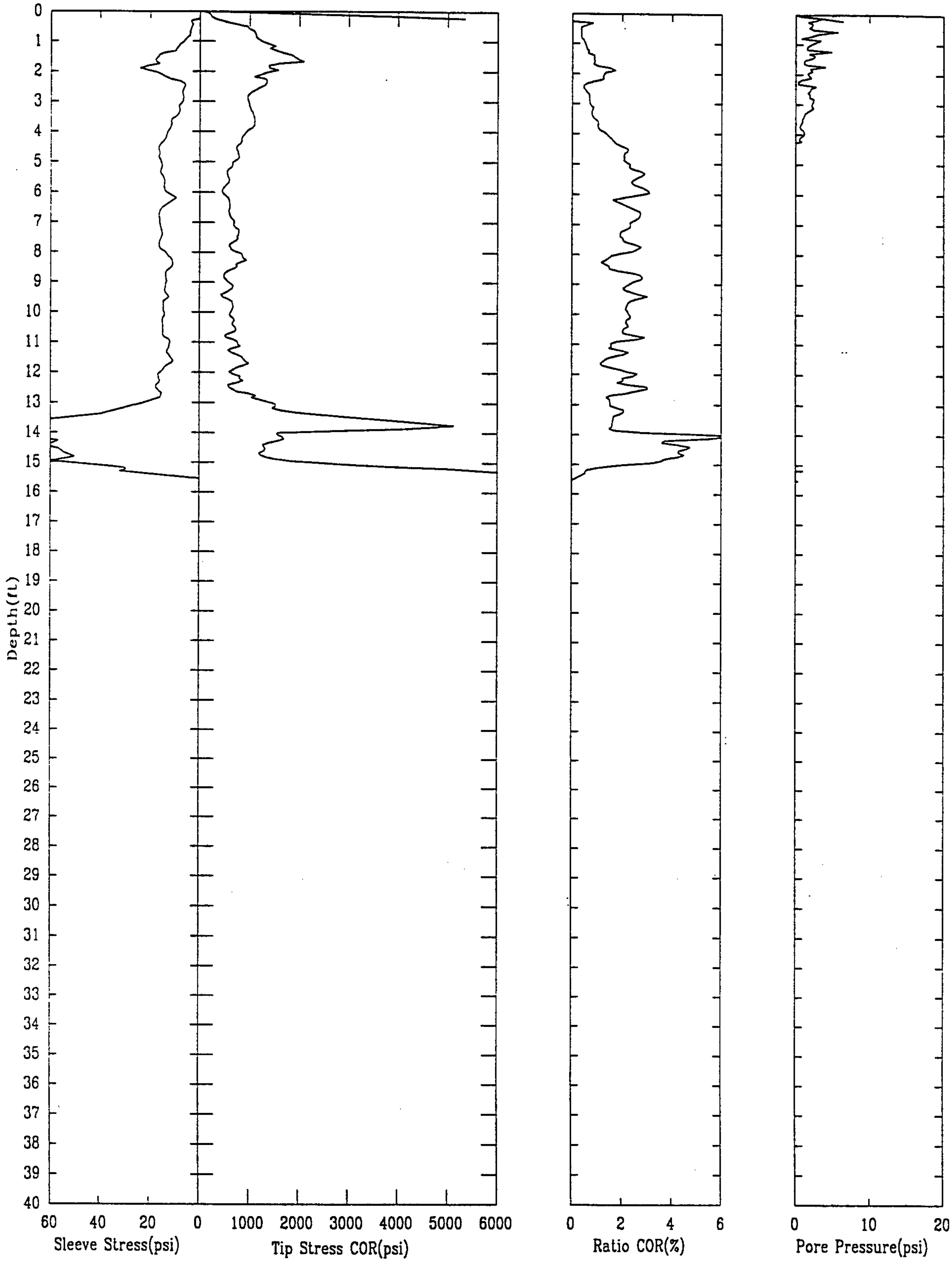
CPT-04 APPLIED RESEARCH ASSOCIATES, INC. 08/30/96



File 530G601.ECP

CPT-05 APPLIED RESEARCH ASSOCIATES, INC. 08/30/96



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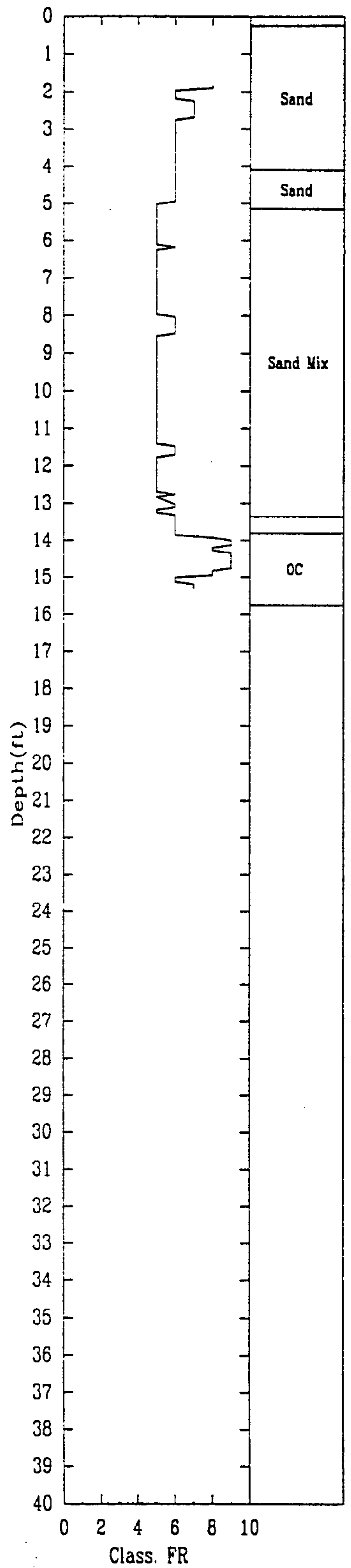
CPT-05 APPLIED RESEARCH ASSOCIATES, INC. 08/30/96



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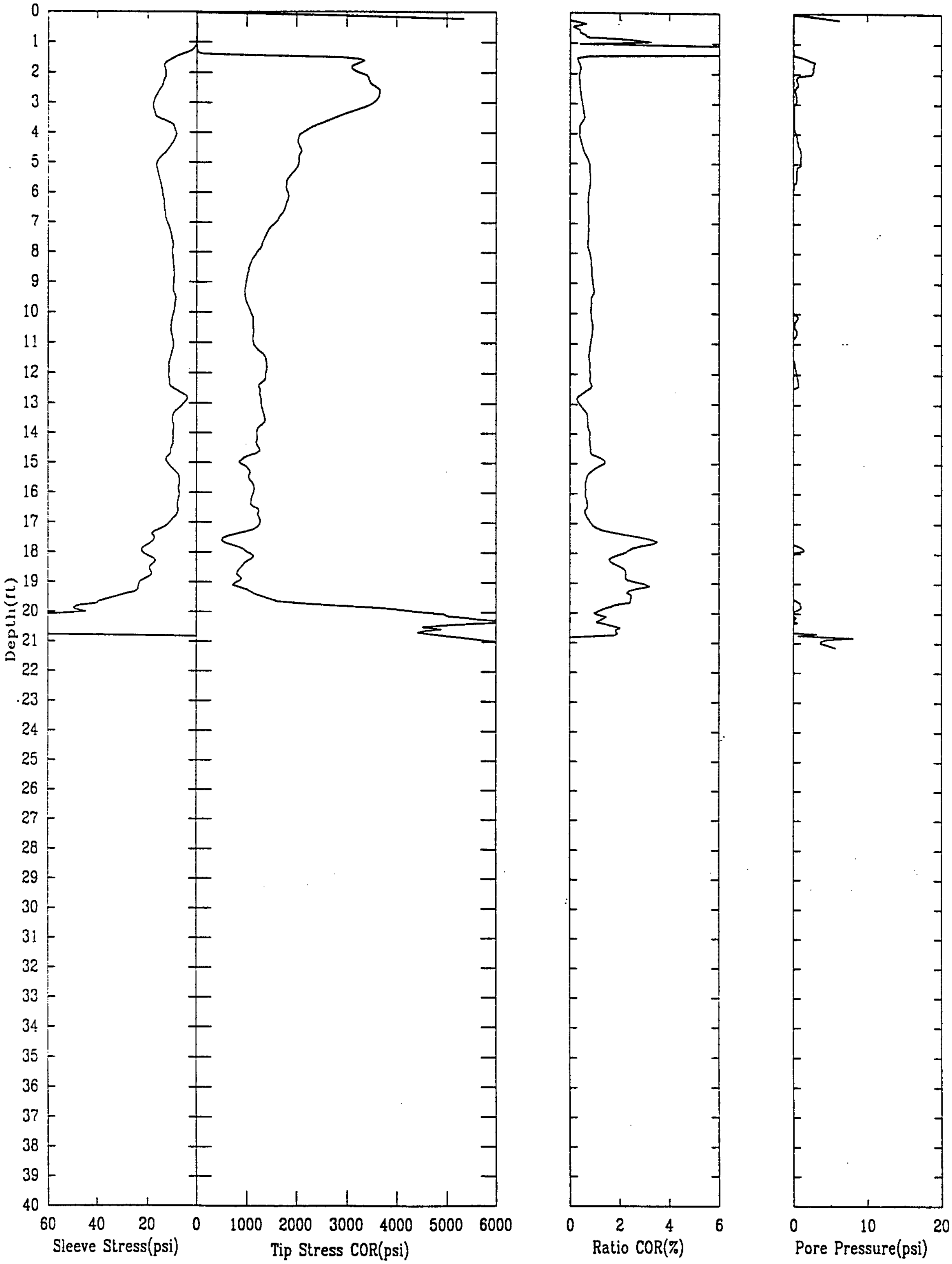

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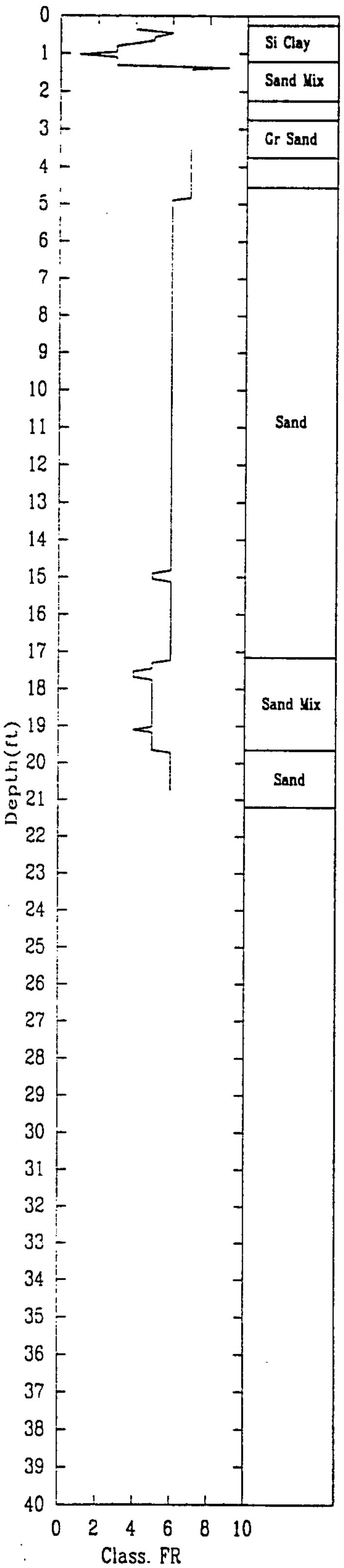


File 530G607.ECP

APPENDIX C

WELL CONSTRUCTION LOGS

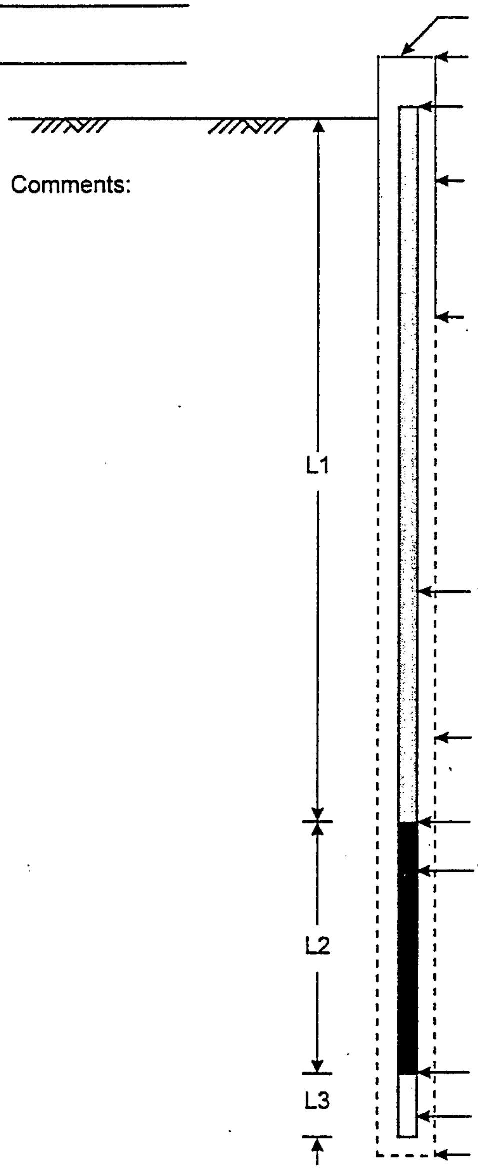
CPT WELL INSTALLATION REPORT

Project: **5518 Direct Push Monitoring Point Assessment**
City/State: **Hanscom AFB, Bedford, MA**
Client: **Armstrong Laboratories, Tyndall AFB, AL/EQA**
Crew Chief: JOEL BORST

Observation Well: DPW-MWZ-7
CPT ID: CPT-MWZ-7
Installation Date: 1-31-97
Location: SITE 21
ARA File No.: 5315713.DAT

Ground El. ______
El. Datum ______

Comments:



Type of Protective Cover/Lock
Depth of Top of Roadway Box below Ground Surface ______ ft
Depth of Top of Riser Pipe below Ground Surface ______ ft
Type of Protective Casing:
Length ______ ft
Inside Diameter ______ in
Depth of Bottom of Roadway Box ______ ft

Seals:

Type	Depth to Top (ft)	Thickness (ft)

Type of Riser Pipe: ***Schd 80 PVC, Timco***
Inside Diameter of Riser Pipe **1.93** in
Type of Backfill around Riser
Diameter of Largest CPT Expander **2.50** in
Depth of Top of Wellpoint ______ ft
Type of Point or Manufacturer: ***Schd 80 PVC, Timco***
Screen Gauge or Size of Openings **0.020** in
Diameter of Wellpoint **2.375** in
Depth of Bottom of Wellpoint 14.1 ft 14.05 HARD BOTTOM
Silt Trap NO
Depth of CPT or DMY 14.35 ft

(Depths refer to ground surface)

Tip Material: Steel Stainless Steel Nylon Other: ______

______ ft	+	2 (m) ~~ft~~	+	0 ft	=	______ ft
Riser length (L1)		Screen length (L2)		Length of silt trap (L3)		Total length

CPT WELL INSTALLATION REPORT

Project: _5518 Direct Push Monitoring Point Assessment_________ Observation Well: DPW-B37

City/State: _Hanscom AFB, Bedford, MA CPT ID: CPT-B37

Client: _Armstrong Laboratories, Tyndall AFB, AL/EQA Installation Date: 1-31-97

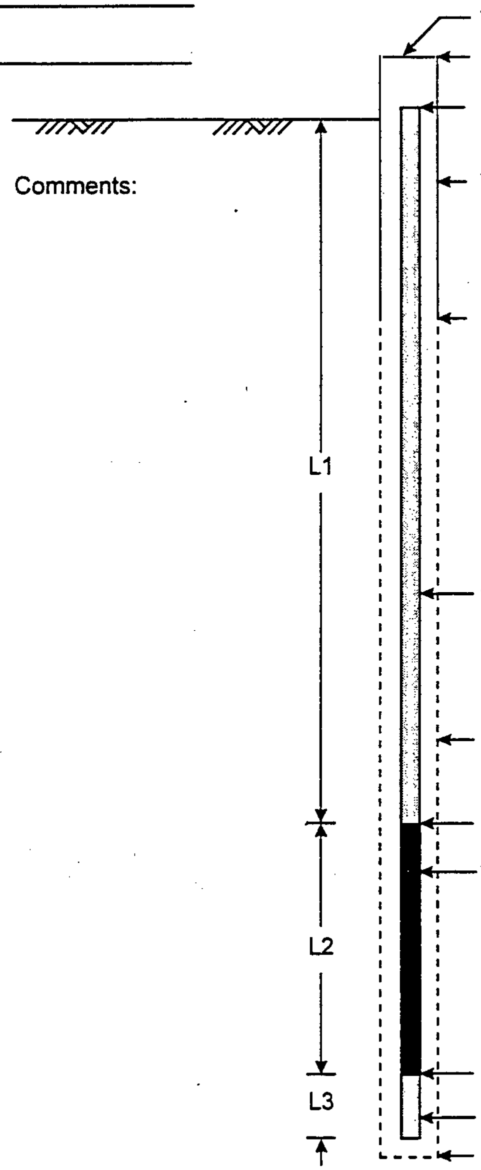
Crew Chief: JOEL BORST Location: SITE 21

ARA File No.: 5315708.DAT

Ground El. ______

El. Datum ______

Comments:



Type of Protective Cover/Lock

Depth of Top of Roadway Box below Ground Surface ____ ft

Depth of Top of Riser Pipe below Ground Surface ____ ft

Type of Protective Casing:

Length ____ ft

Inside Diameter ____ in

Depth of Bottom of Roadway Box ____ ft

Seals:

Type	Depth to Top (ft)	Thickness (ft)

Type of Riser Pipe: ***Schd 80 PVC, Timco***

Inside Diameter of Riser Pipe **1.93** in

Type of Backfill around Riser

Diameter of Largest CPT Expander **2.50** in

Depth of Top of Wellpoint ____ ft

Type of Point or Manufacturer: ***Schd 80 PVC, Timco***

Screen Gauge or Size of Openings **0.020** in

Diameter of Wellpoint **2.375** in

Depth of Bottom of Wellpoint 16.4 ft MUSHY BOTTOM

Silt Trap NO

Depth of CPT or DMY 19.0 ft

(Depths refer to ground surface)

Tip Material: Steel Stainless Steel Nylon Other: ______

____ ft	+	3 (m) ~~ft~~	+	No Ø ft	=	____ ft
Riser length (L1)		Screen length (L2)		Length of silt trap (L3)		Total length

CPT WELL INSTALLATION REPORT

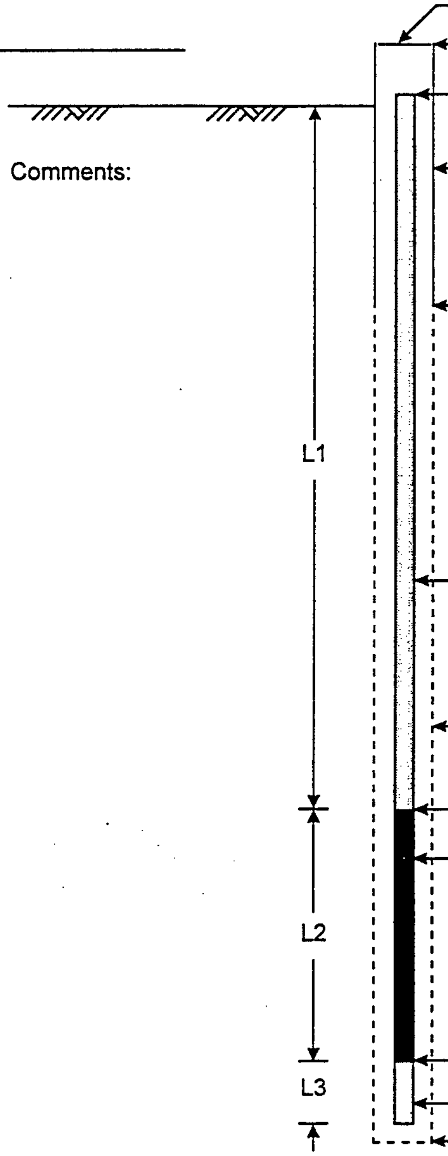
Project: **5518 Direct Push Monitoring Point Assessment**
City/State: **Hanscom AFB, Bedford, MA**
Client: **Armstrong Laboratories, Tyndall AFB, AL/EQA**
Crew Chief: JOEL BORST

Observation Well: DPW - OW2
CPT ID: CPT-OW2
Installation Date: 1-31-97
Location: SITE 21
ARA File No.: 531J705.DAT

Ground El. ____________

El. Datum ____________

Comments:



Type of Protective Cover/Lock

Depth of Top of Roadway Box below Ground Surface ______ ft

Depth of Top of Riser Pipe below Ground Surface ______ ft

Type of Protective Casing:

Length ______ ft

Inside Diameter ______ in

Depth of Bottom of Roadway Box ______ ft

Seals:

Type	Depth to Top (ft)	Thickness (ft)

Type of Riser Pipe: ***Schd 80 PVC, Timco***

Inside Diameter of Riser Pipe **1.93** in

Type of Backfill around Riser

Diameter of Largest CPT Expander **2.50** in

Depth of Top of Wellpoint ______ ft

Type of Point or Manufacturer: ***Schd 80 PVC, Timco***

Screen Gauge or Size of Openings **0.020** in

Diameter of Wellpoint **2.375** in

Depth of Bottom of Wellpoint ______ ft 15.55 MUSHY BOTTOM

Silt Trap NO

Depth of CPT or DMY 16.75 ft

(Depths refer to ground surface)

Tip Material: Steel Stainless Steel Nylon Other: ____________

______ ft	+	3 (m) ~~ft~~	+	0 ft	=	______ ft
Riser length (L1)		Screen length (L2)		Length of silt trap (L3)		Total length

CPT WELL INSTALLATION REPORT

Project: _5518 Direct Push Monitoring Point Assessment_________ Observation Well: DPW-MWZ-23

City/State: _Hanscom AFB, Bedford, MA _______________ CPT ID: CPT-MWZ-23

Client: _Armstrong Laboratories, Tyndall AFB, AL/EQA _________ Installation Date: 1-31-97

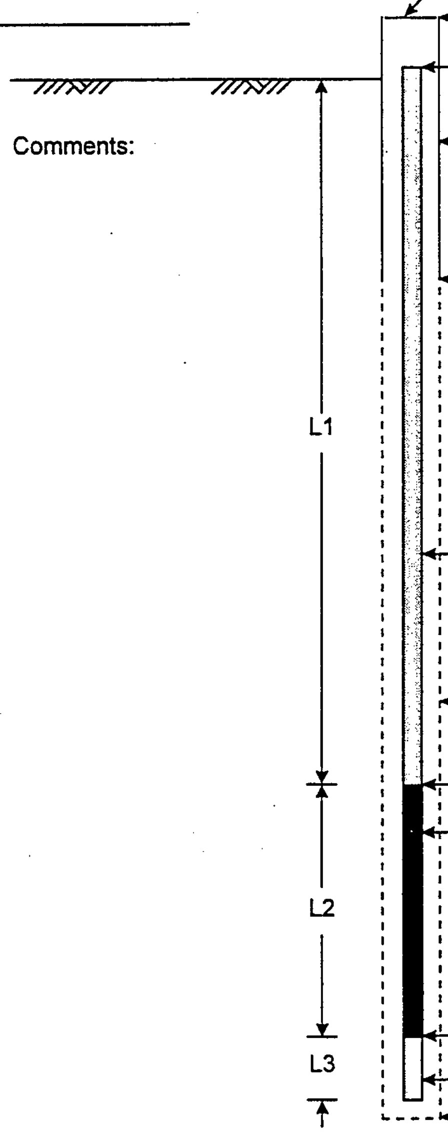
Crew Chief: JOEL BORST Location: SITE 21

ARA File No.: 531J701.DAT

Ground El. ______________

El. Datum ______________

Comments:



Type of Protective Cover/Lock

Depth of Top of Roadway Box below Ground Surface ______ ft

Depth of Top of Riser Pipe below Ground Surface ______ ft

Type of Protective Casing:

Length ______ ft

Inside Diameter ______ in

Depth of Bottom of Roadway Box ______ ft

Seals:

Type	Depth to Top (ft)	Thickness (ft)

Type of Riser Pipe: ***Schd 80 PVC, Timco***

Inside Diameter of Riser Pipe **1.93** in

Type of Backfill around Riser

Diameter of Largest CPT Expander **2.50** in

Depth of Top of Wellpoint ______ ft

Type of Point or Manufacturer: ***Schd 80 PVC, Timco***

Screen Gauge or Size of Openings **0.020** in

Diameter of Wellpoint **2.375** in

Depth of Bottom of Wellpoint 17.85 ft

Silt Trap NO

Depth of CPT or DMY 21.0 ft

(Depths refer to ground surface)

Tip Material: Steel Stainless Steel Nylon Other: ____________

______ ft	+	3 (m) ~~ft~~	+	0 ft	=	______ ft
Riser length (L1)		Screen length (L2)		Length of silt trap (L3)		Total length

CPT WELL INSTALLATION REPORT

Project: 5518 Direct Push Monitoring Point Assessment
Observation Well: DPW-MWZ-6

City/State: Hanscom AFB, Bedford, MA
CPT ID: CPT-MWZ-6

Client: Armstrong Laboratories, Tyndall AFB, AL/EQA
Installation Date: 2-1-97

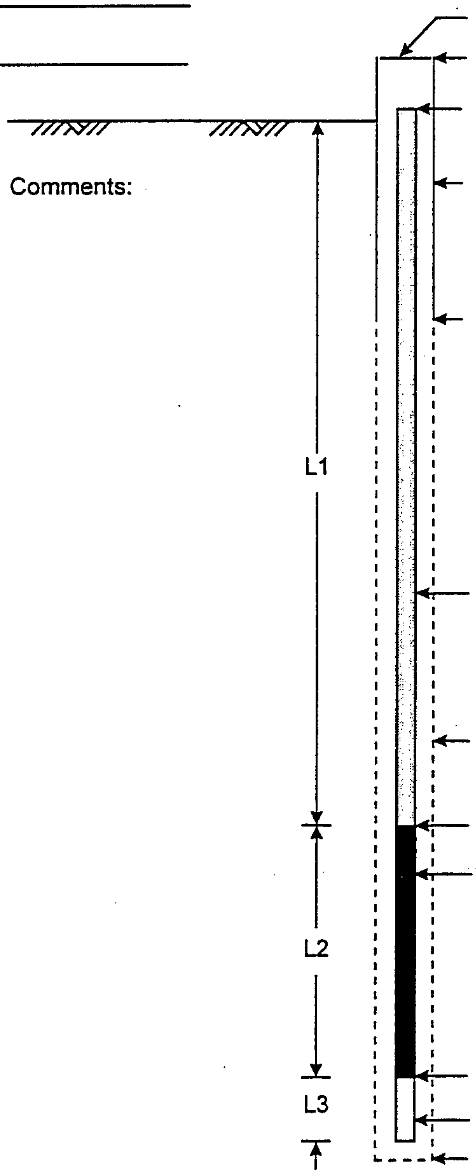
Crew Chief: JOEL BORST
Location: SITE 21

ARA File No.: 501F702.DAT

Ground El. ____________

El. Datum ____________

Comments:



Type of Protective Cover/Lock

Depth of Top of Roadway Box below Ground Surface ______ ft

Depth of Top of Riser Pipe below Ground Surface ______ ft

Type of Protective Casing:

Length ______ ft

Inside Diameter ______ in

Depth of Bottom of Roadway Box ______ ft

Seals:

Type	Depth to Top (ft)	Thickness (ft)

Type of Riser Pipe: ***Schd 80 PVC, Timco***

Inside Diameter of Riser Pipe ***1.93*** in

Type of Backfill around Riser

Diameter of Largest CPT Expander ***2.50*** in

Depth of Top of Wellpoint ______ ft

Type of Point or Manufacturer: ***Schd 80 PVC, Timco***

Screen Gauge or Size of Openings ***0.020*** in

Diameter of Wellpoint ***2.375*** in

Depth of Bottom of Wellpoint ______ ft

Silt Trap NO

Depth of CPT or DMY 20.5 ft

(Depths refer to ground surface)

Tip Material: Steel Stainless Steel Nylon Other: ____________

______ ft	+	3(m) ~~ft~~	+	0 ft	=	______ ft
Riser length (L1)		Screen length (L2)		Length of silt trap (L3)		Total length

CPT WELL INSTALLATION REPORT

Project: _5518 Direct Push Monitoring Point Assessment_____________

City/State: _Hanscom AFB, Bedford, MA _______________

Client: _Armstrong Laboratories, Tyndall AFB, AL/EQA _________

Crew Chief: JOEL BORST

Observation Well: DPW-MWZ-11

CPT ID: CPT-MWZ-11

Installation Date: 2-1-97

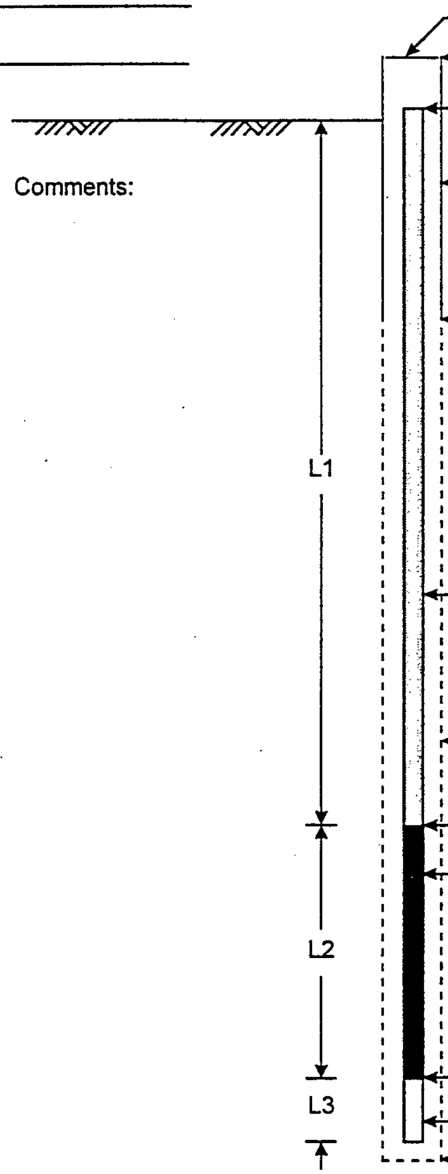
Location: SITE 21

ARA File No.: 5011F707.DAT

Ground El. ______________

El. Datum ______________

Comments:



Type of Protective Cover/Lock

Depth of Top of Roadway Box below Ground Surface ________ ft

Depth of Top of Riser Pipe below Ground Surface ________ ft

Type of Protective Casing:

Length ________ ft

Inside Diameter ________ in

Depth of Bottom of Roadway Box ________ ft

Seals:

Type	Depth to Top (ft)	Thickness (ft)

Type of Riser Pipe: ***Schd 80 PVC, Timco***

Inside Diameter of Riser Pipe **1.93** in

Type of Backfill around Riser

Diameter of Largest CPT Expander **2.50** in

Depth of Top of Wellpoint ________ ft

Type of Point or Manufacturer: ***Schd 80 PVC, Timco***

Screen Gauge or Size of Openings **0.020** in

Diameter of Wellpoint **2.375** in

Depth of Bottom of Wellpoint ________ ft

Silt Trap NO

Depth of CPT or DMY 20.89 ft

(Depths refer to ground surface)

Tip Material: Steel Stainless Steel Nylon Other: ____________

________ ft	+	3 (m) ft	+	NO ft	=	________ ft
Riser length (L1)		Screen length (L2)		Length of silt trap (L3)		Total length

CPT WELL INSTALLATION REPORT

Project: _ **5518 Direct Push Monitoring Point Assessment** ________ Observation Well: DPW- B238

City/State: _ **Hanscom AFB Bedford, MA** ____________ CPT ID: CPT - B238

Client: _**Armstrong Laboratories, Tyndall AFB, AL/EQA** ________ Installation Date: 1-29-97

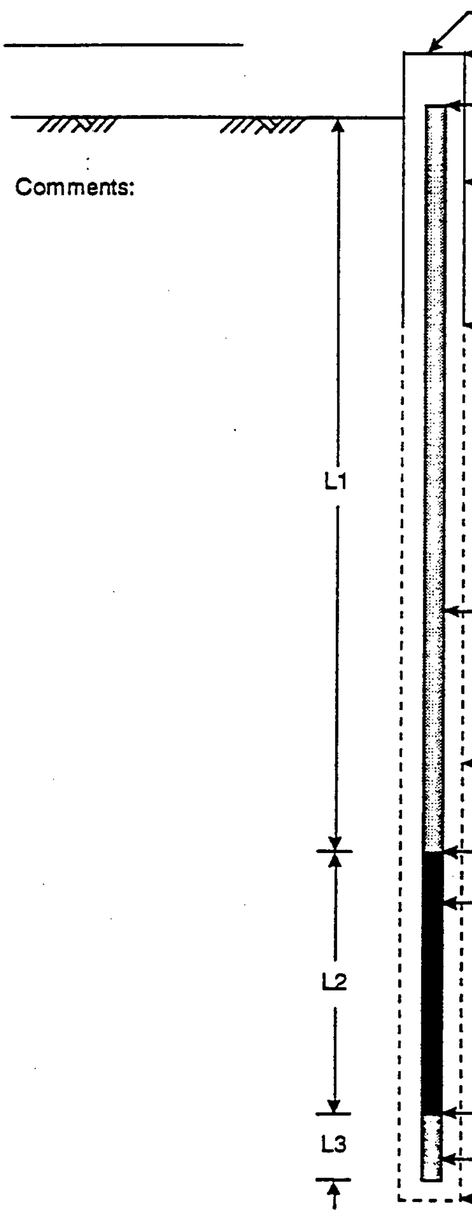
Crew Chief: John Clark Shawn Ricker ____________ Location: SITE 1

ARA File No.: ______

Ground El. ____________

El. Datum ____________

Comments:



Type of Protective Cover/Lock

Depth of Top of Roadway Box below Ground Surface ______ft

Depth of Top of Riser Pipe below Ground Surface ______ft

Type of Protective Casing:

Length ______ft

Inside Diameter ______in

Depth of Bottom of Roadway Box ______ft

Seals:

Type	Depth to Top (ft)	Thickness (ft)

Type of Riser Pipe: ***Schedule 80 PVC, Timco***

Inside Diameter of Riser Pipe ***1.913*** in

Type of Backfill around Riser

Diameter of Largest CPT Expander ***2.5*** in

Depth of Top of Wellpoint ______ft

Type of Point or Manufacturer: ***Schedule 80 PVC, Timco***

Screen Gauge or Size of Openings ***0.020*** in

Diameter of Wellpoint ***2.375*** in

Depth of Bottom of Wellpoint 10.5 ft

Silt Trap No

Depth of Bottom of ~~Borehole~~ CPT 12.0 ft

(Depths refer to ground surface)

Tip Material: Steel Stainless Steel Nylon Other: ____________

______ ft + (2m) ft + 0 ft = ______ ft

Riser length (L1) Screen length (L2) Length of silt trap (L3) Total length

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CPT WELL INSTALLATION REPORT

Project: 5518 Direct Push Monitoring Point Assessment
Observation Well: DPW-RAP1-4S

City/State: Hanscom AFB Bedford, MA
CPT ID: CPT-RAP1-4S

Client: Armstrong Laboratories, Tyndall AFB, AL/EQA
Installation Date: 1-28-97

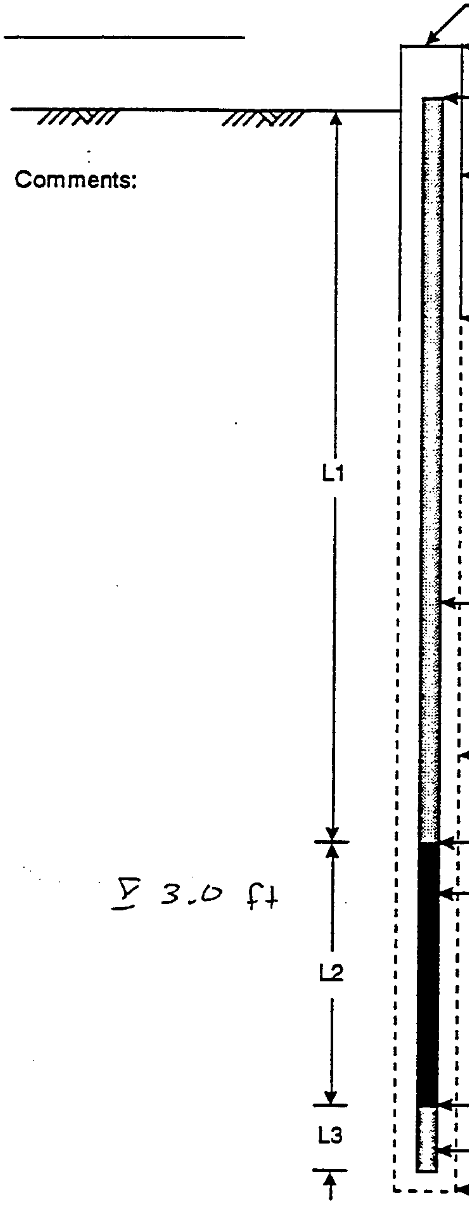
Crew Chief: John Clark, Shawn Ricker
Location: SITE 1

ARA File No.: ______

Ground El. ______

El. Datum ______

Comments:



∑ 3.0 ft

Type of Protective Cover/Lock

Depth of Top of Roadway Box below Ground Surface ______ ft

Depth of Top of Riser Pipe below Ground Surface ______ ft + 0.3

Type of Protective Casing:

Length ______ ft

Inside Diameter ______ in

Depth of Bottom of Roadway Box ______ ft

Seals:

Type	Depth to Top (ft)	Thickness (ft)

Type of Riser Pipe: ***Schedule 80 PVC, Timco***

Inside Diameter of Riser Pipe ***1.913*** in

Type of Backfill around Riser

Diameter of Largest CPT Expander ***2.5*** in

Depth of Top of Wellpoint ______ ft

Type of Point or Manufacturer: ***Schedule 80 PVC, Timco***

Screen Gauge or Size of Openings ***0.020*** in

Diameter of Wellpoint ***2.375*** in

Measured depth 13.0 ft bgs tape may have bound up ~~on~~ and not gone all the way to the bottom.

Depth of Bottom of Wellpoint 14.75 ft

Silt Trap No

Depth of Bottom of ~~Borehole~~ 4S CPT 15.0 ft

(Depths refer to ground surface)

Tip Material: Steel Stainless Steel Nylon Other: ______

______ ft	+	(4m) ft	+	0 ft	=	______ ft
Riser length (L1)		Screen length (L2)		Length of silt trap (L3)		Total length

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CPT WELL INSTALLATION REPORT

Project: _ **5518 Direct Push Monitoring Point Assessment** ________

City/State: _ **Hanscom AFB Bedford, MA** ________

Client: _**Armstrong Laboratories, Tyndall AFB, AL/EQA** ________

Crew Chief: John Clark, Sean Ricker

Observation Well: DPW-RAP1-5S

CPT ID: CPT-RAP1-5S

Installation Date: 1-28-97

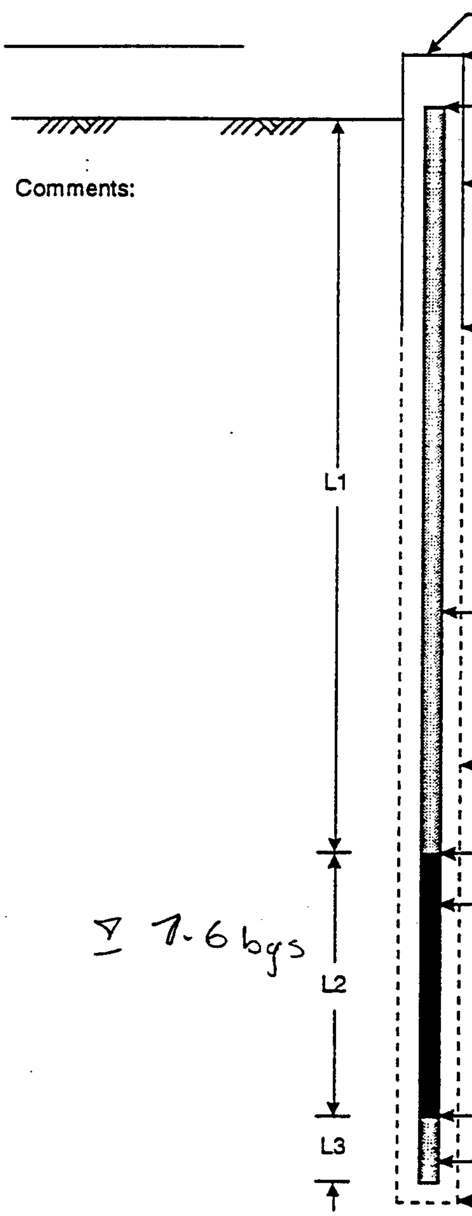
Location: SITE 1

ARA File No.: ________

Ground El. ________

El. Datum ________

Comments:



▽ 7.6 bgs

Type of Protective Cover/Lock

Depth of Top of Roadway Box below Ground Surface ________ ft

Depth of Top of Riser Pipe below Ground Surface ________ ft +0.3

Type of Protective Casing:

Length ________ ft

Inside Diameter ________ in

Depth of Bottom of Roadway Box ________ ft

Seals:

Type	Depth to Top (ft)	Thickness (ft)

Type of Riser Pipe: ***Schedule 80 PVC, Timco***

Inside Diameter of Riser Pipe ***1.913*** in

Type of Backfill around Riser

Diameter of Largest CPT Expander ***2.5*** in

Depth of Top of Wellpoint ________ ft

Type of Point or Manufacturer: ***Schedule 80 PVC, Timco***

Screen Gauge or Size of Openings ***0.020*** in

Diameter of Wellpoint ***2.375*** in

Depth of Bottom of Wellpoint 10.0 ft

Silt Trap No

Depth of Bottom of ~~Borehole~~ CPT 10.5 ft

(Depths refer to ground surface)

Tip Material: Steel Stainless Steel Nylon Other: ________

________ ft +	(3m) ft +	0 ft =	________ ft
Riser length (L1)	Screen length (L2)	Length of silt trap (L3)	Total length

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CPT WELL INSTALLATION REPORT

Project: **5518 Direct Push Monitoring Point Assessment** ________

City/State: **Hanscom AFB Bedford, MA** ________

Client: **Armstrong Laboratories, Tyndall AFB, AL/EQA** ________

Crew Chief: John Clark, Sean Ricker

Observation Well: DPW-B103

CPT ID: CPT-B103

Installation Date: 1-28-97

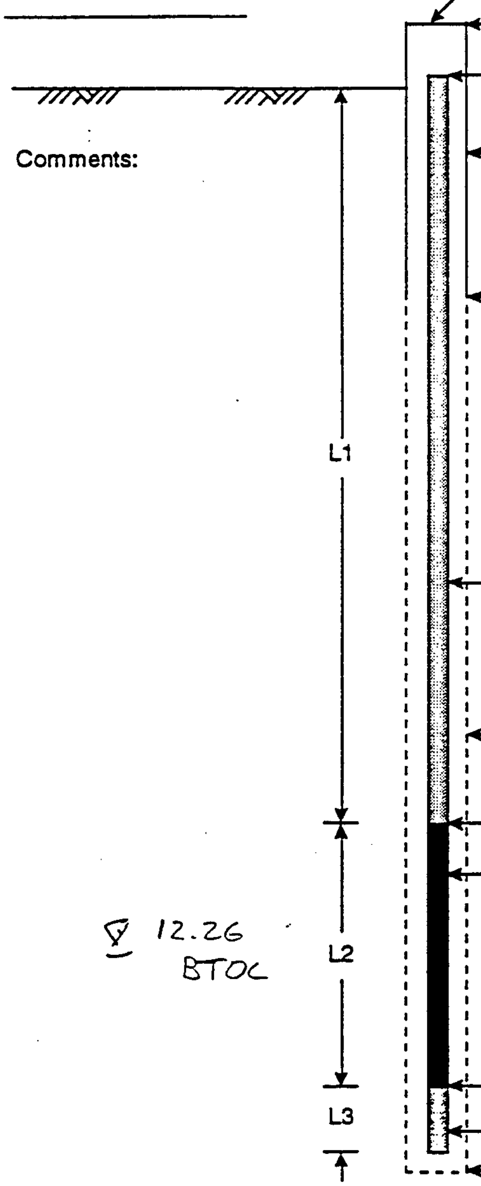
Location: Site 1

ARA File No.: ________

Ground El. ________

El. Datum ________

Comments:



▽ 12.26 BTOC

- Type of Protective Cover/Lock
- Depth of Top of Roadway Box below Ground Surface ______ ft
- Depth of Top of Riser Pipe below Ground Surface ______ ft + 0.31
- Type of Protective Casing:
  - Length ______ ft
  - Inside Diameter ______ in
- Depth of Bottom of Roadway Box ______ ft
- Seals:

Type	Depth to Top (ft)	Thickness (ft)

- Type of Riser Pipe: ***Schedule 80 PVC, Timco***
  - Inside Diameter of Riser Pipe ***1.913*** in
  - Type of Backfill around Riser
- Diameter of Largest CPT Expander ***2.5*** in
- Depth of Top of Wellpoint ______ ft
- Type of Point or Manufacturer: ***Schedule 80 PVC, Timco***
  - Screen Gauge or Size of Openings ***0.020*** in
  - Diameter of Wellpoint ***2.375*** in
- Depth of Bottom of Wellpoint 14.79 ft
- Silt Trap ND
- Depth of Bottom of ~~Borehole~~ CPT 15.0 ft

(Depths refer to ground surface)

Tip Material: Steel Stainless Steel Nylon Other: ________

______ ft	+	(3m) ~~(...)~~ ft	+	0 ft	=	______ ft
Riser length (L1)		Screen length (L2)		Length of silt trap (L3)		Total length

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CPT WELL INSTALLATION REPORT

Project: _ **5518 Direct Push Monitoring Point Assessment** ________ Observation Well: DPW-B104

City/State: _ **Hanscom AFB Bedford, MA** ________ CPT ID: CPT - B104

Client: _**Armstrong Laboratories, Tyndall AFB, AL/EQA** ________ Installation Date: 1-28-97

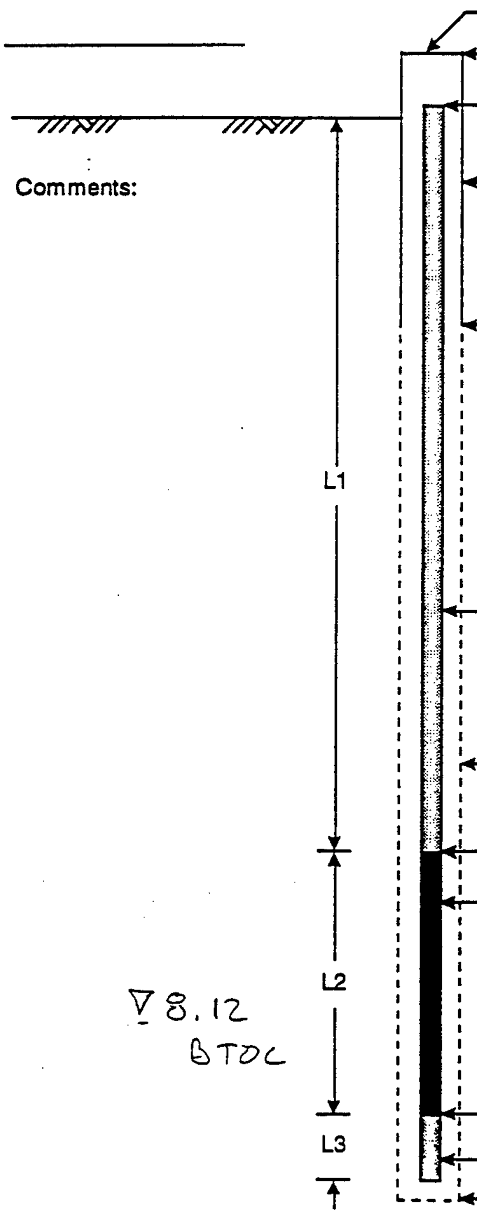
Crew Chief: John Clarke, Sharon Rider ________ Location: SITE 1

ARA File No.: ________

Ground El. ________

El. Datum ________

Comments:



Type of Protective Cover/Lock

Depth of Top of Roadway Box below Ground Surface ________ ft

Depth of Top of Riser Pipe below Ground Surface ________ ft + 4"

Type of Protective Casing:

Length ________ ft

Inside Diameter ________ in

Depth of Bottom of Roadway Box ________ ft

Seals:

Type	Depth to Top (ft)	Thickness (ft)

Type of Riser Pipe: ***Schedule 80 PVC, Timco***

Inside Diameter of Riser Pipe ***1.913*** in

Type of Backfill around Riser

Diameter of Largest CPT Expander ***2.5*** in

Depth of Top of Wellpoint ________ ft

Type of Point or Manufacturer: ***Schedule 80 PVC, Timco***

Screen Gauge or Size of Openings ***0.020*** in

Diameter of Wellpoint ***2.375*** in

Depth of Bottom of Wellpoint 8.87 ft computed 8.5 ft measured

Silt Trap No

Depth of Bottom of ~~Borehole~~ CPT 9.5 ft

(Depths refer to ground surface)

Tip Material: Steel Stainless Steel Nylon Other: ________

________ ft +	2m ft +	0 ft =	________ ft
Riser length (L1)	Screen length (L2)	Length of silt trap (L3)	Total length

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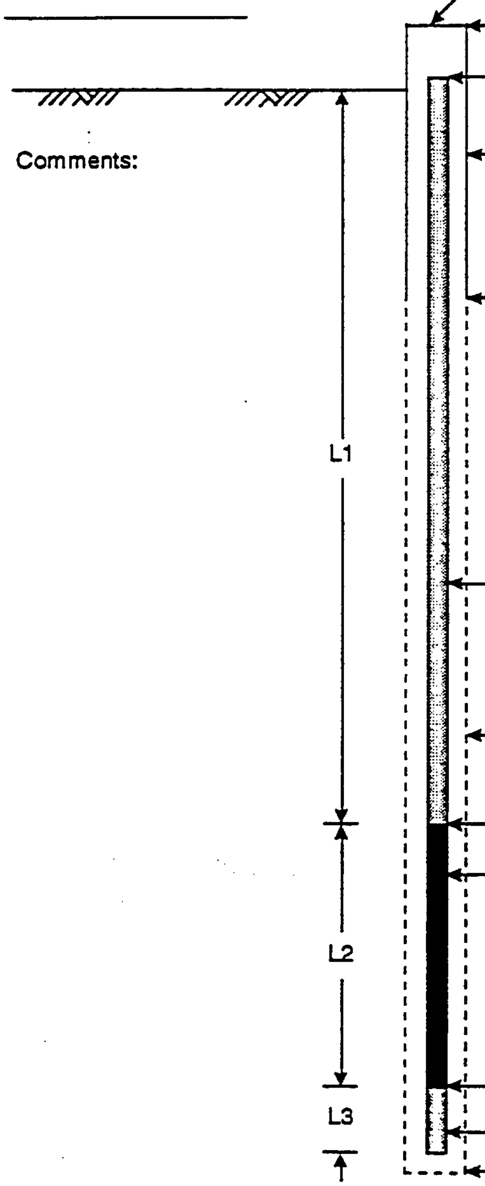
CPT WELL INSTALLATION REPORT

Project: **5518 Direct Push Monitoring Point Assessment**
Observation Well: DPW-B161-MW
City/State: **Hanscom AFB Bedford, MA**
CPT ID: CPT-B101-MW
Client: **Armstrong Laboratories, Tyndall AFB, AL/EQA**
Installation Date: 1-11-97
Crew Chief: 5'
Location: SITE 2 FAM CAMP
ARA File No.: 511J706 DAT

Ground El. ______

El. Datum ______

Comments:



Type of Protective Cover/Lock

Depth of Top of Roadway Box below Ground Surface ______ ft

Depth of Top of Riser Pipe below Ground Surface ______ ft

Type of Protective Casing:

Length ______ ft

Inside Diameter ______ in

Depth of Bottom of Roadway Box ______ ft

Seals:

Type	Depth to Top (ft)	Thickness (ft)

Type of Riser Pipe: ***Schedule 80 PVC, Timco***

Inside Diameter of Riser Pipe **1.913** in

Type of Backfill around Riser

Diameter of Largest CPT Expander **2.5** in

Depth of Top of Wellpoint ______ ft

Type of Point or Manufacturer: ***Schedule 80 PVC, Timco***

Screen Gauge or Size of Openings **0.020** in

Diameter of Wellpoint **2.375** in

Depth of Bottom of Wellpoint 21.8 ft

Silt Trap YES / M

Depth of Bottom of Borehole 22.30 ft

(Depths refer to ground surface)

Tip Material: Steel Stainless Steel Nylon Other: ______

Riser length (L1)	+	Screen length (L2)	+	Length of silt trap (L3)	=	Total length
______ ft	+	16.40 ft	+	3.28 ft	=	______ ft

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CPT WELL INSTALLATION REPORT

Project: _ 5518 Direct Push Monitoring Point Assessment ________

Observation Well: DPW-B241-MW

City/State: _ Hanscom AFB Bedford, MA ________

CPT ID: CPT-B241-MW

Client: _Armstrong Laboratories, Tyndall AFB, AL/EQA ________

Installation Date: 1/11/97

Crew Chief: ________

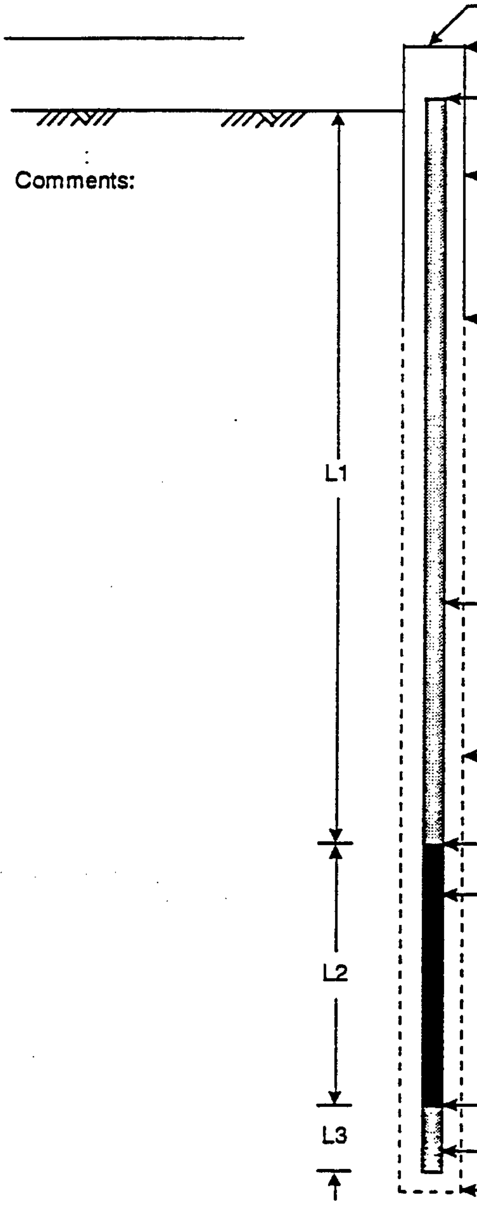
Location: STE #2

ARA File No.: 5115703.DAT

Ground El. ________

El. Datum ________

Comments:



Type of Protective Cover/Lock

Depth of Top of Roadway Box below Ground Surface ____ ft

Depth of Top of Riser Pipe below Ground Surface ____ ft +.25

Type of Protective Casing:

Length ____ ft

Inside Diameter ____ in

Depth of Bottom of Roadway Box ____ ft

Seals:

Type	Depth to Top (ft)	Thickness (ft)

Type of Riser Pipe: ***Schedule 80 PVC, Timco***

Inside Diameter of Riser Pipe **1.913** in

Type of Backfill around Riser

Diameter of Largest CPT Expander **2.5** in

Depth of Top of Wellpoint 5.18 ft

Type of Point or Manufacturer: ***Schedule 80 PVC, Timco***

Screen Gauge or Size of Openings **0.020** in

Diameter of Wellpoint **2.375** in

Depth of Bottom of Wellpoint 15.00 ft

Silt Trap

Depth of Bottom of Borehole 20.28 ft

(Depths refer to ground surface)

Tip Material: Steel Stainless Steel Nylon Other: ________

5.18 ft	+	9.84 ft	+	3.28 ft	=	18.30 ft
Riser length (L1)		Screen length (L2)		Length of silt trap (L3)		Total length

File:I:\5518\docs\WorkPlan\wellinst.doc

Project: 5518 Direct Push Monitoring Point Assessment

Observation Well: DPW-B102-MW

City/State: Hanscom AFB Bedford, MA

CPT ID: CPT-B102-MW

Client: Armstrong Laboratories, Tyndall AFB, AL/EQA

Installation Date: 01-10-97

Crew Chief:

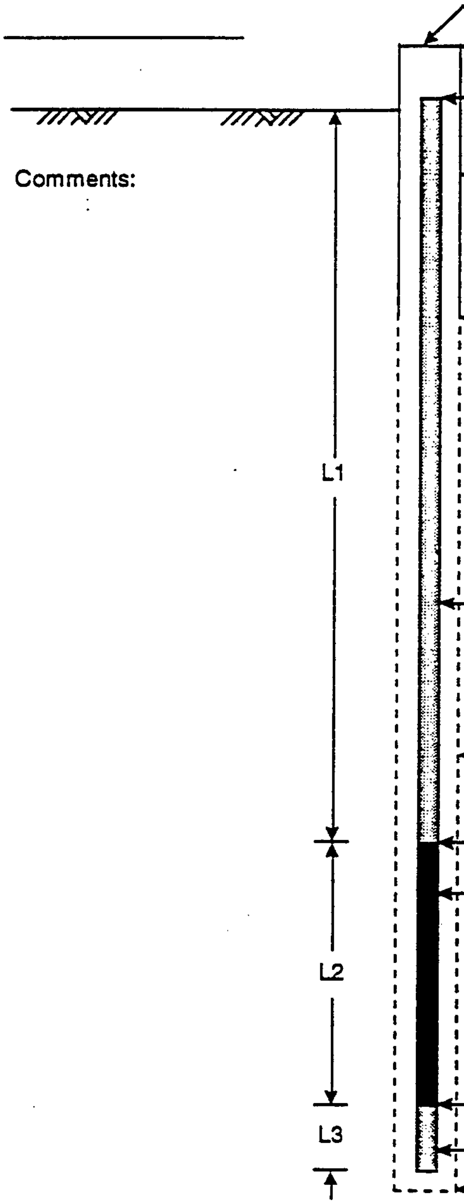
Location: SITE 2

ARA File No.: 510J710.DAT

Ground El. ______

El. Datum ______

Comments:



Type of Protective Cover/Lock

Depth of Top of Roadway Box below Ground Surface ______ ft

Depth of Top of Riser Pipe below Ground Surface ______ ft

Type of Protective Casing:

Length ______ ft

Inside Diameter ______ in

Depth of Bottom of Roadway Box ______ ft

Seals:

Type	Depth to Top (ft)	Thickness (ft)

Type of Riser Pipe: ***Schedule 80 PVC, Timco***

Inside Diameter of Riser Pipe **1.913** in

Type of Backfill around Riser

Diameter of Largest CPT Expander **2.5** in

Depth of Top of Wellpoint 4.28 ft

Type of Point or Manufacturer: ***Schedule 80 PVC, Timco***

Screen Gauge or Size of Openings **0.020** in

Diameter of Wellpoint **2.375** in

Depth of Bottom of Wellpoint 14.12 ft

Silt Trap YES 1M

Depth of Bottom of Borehole 19.30 ft

(Depths refer to ground surface)

Tip Material: Steel Stainless Steel Nylon Other: ______

4.28 ft (Riser length (L1)) + 9.84 ft (Screen length (L2)) + 3.28 ft (Length of silt trap (L3)) = 17.40 ft (Total length)

File:I:\5518\docs\WorkPlan\wellinst.doc

CPT WELL INSTALLATION REPORT

Project: _ **5518 Direct Push Monitoring Point Assessment** ________ Observation Well: DPW-OW2-7

City/State: _ **Hanscom AFB Bedford, MA** ________ CPT ID: CPT-OW2-7

Client: _**Armstrong Laboratories, Tyndall AFB, AL/EQA** ________ Installation Date: 1-10-97

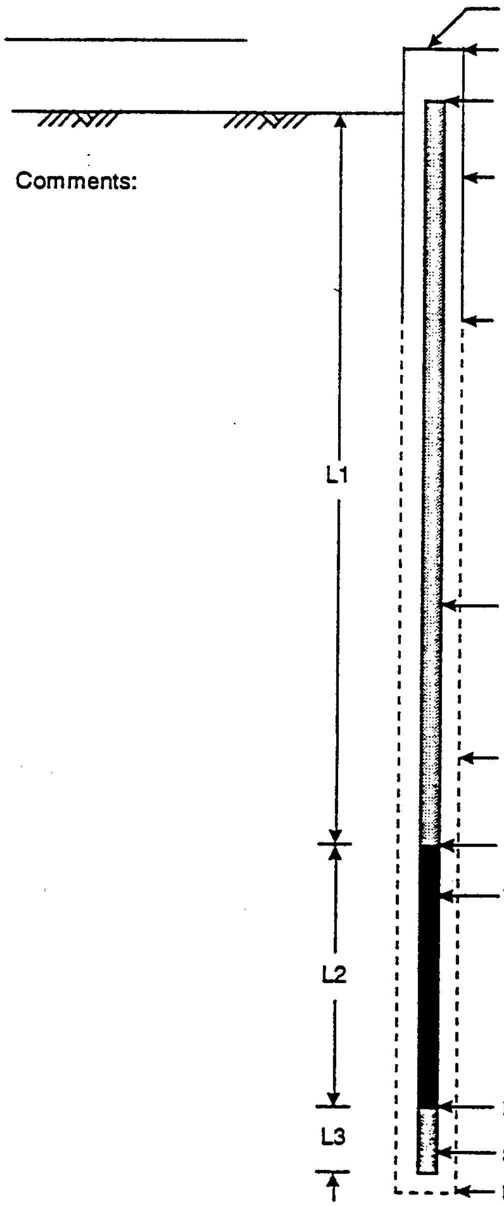
Crew Chief: ________ Location: SITE 2

ARA File No.: 510J709.MW

Ground El. ________

El. Datum ________

Comments:



Type of Protective Cover/Lock

Depth of Top of Roadway Box below Ground Surface ________ ft

Depth of Top of Riser Pipe below Ground Surface ________ ft +0.33

Type of Protective Casing:

Length ________ ft

Inside Diameter ________ in

Depth of Bottom of Roadway Box ________ ft

Seals:

Type	Depth to Top (ft)	Thickness (ft)

Type of Riser Pipe: ***Schedule 80 PVC, Timco***

Inside Diameter of Riser Pipe ***1.913*** in

Type of Backfill around Riser

Diameter of Largest CPT Expander ***2.5*** in

Depth of Top of Wellpoint 13.88 ft

Type of Point or Manufacturer: ***Schedule 80 PVC, Timco***

Screen Gauge or Size of Openings ***0.020*** in

Diameter of Wellpoint ***2.375*** in

Depth of Bottom of Wellpoint 20.44 ft

Silt Trap 1M Yes

Depth of Bottom of Borehole ________ ft 24.05

(Depths refer to ground surface)

Tip Material: Steel Stainless Steel Nylon Other: ________

13.88 ft	+	6.56 (2m) ft	+	3.28 (1M) ft	=	________ ft
Riser length (L1)		Screen length (L2)		Length of silt trap (L3)		Total length

CPT WELL INSTALLATION REPORT

Project: 5518 Direct Push Monitoring Point Assessment
Observation Well: DPW-OW2-4

City/State: Hanscom AFB Bedford, MA
CPT ID: CPT-OW2-4

Client: Armstrong Laboratories, Tyndall AFB, AL/EQA
Installation Date: 1-10-97

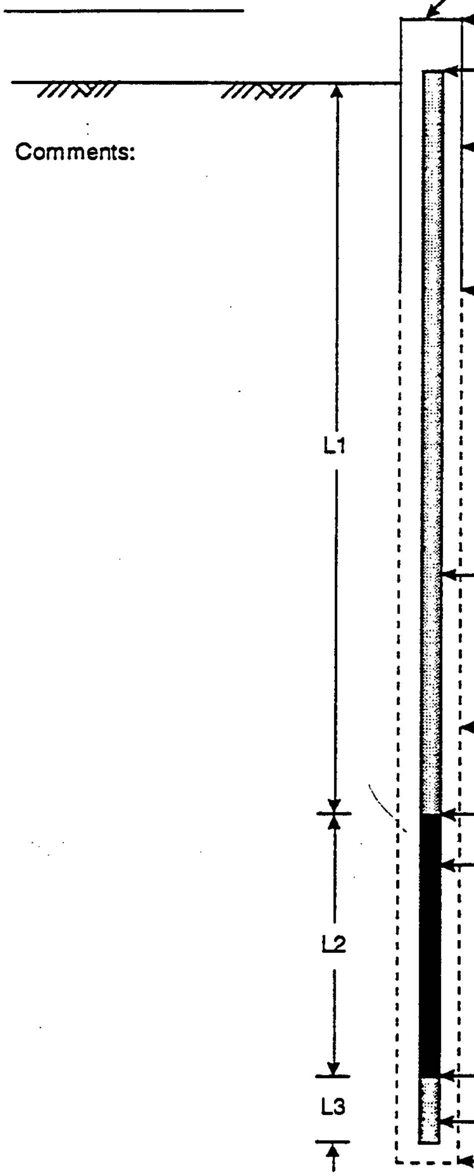
Crew Chief: ______
Location: SITE 2

ARA File No.: 5105704, MW

Ground El. ______

El. Datum ______

Comments:



Type of Protective Cover/Lock

Depth of Top of Roadway Box below Ground Surface ______ ft

Depth of Top of Riser Pipe below Ground Surface ______ ft +0.33 ft

Type of Protective Casing:

Length ______ ft

Inside Diameter ______ in

Depth of Bottom of Roadway Box ______ ft

Seals:

Type	Depth to Top (ft)	Thickness (ft)

Type of Riser Pipe: ***Schedule 80 PVC, Timco***

Inside Diameter of Riser Pipe **1.913** in

Type of Backfill around Riser

Diameter of Largest CPT Expander **2.5** in

Depth of Top of Wellpoint 23.52 ft

Type of Point or Manufacturer: ***Schedule 80 PVC, Timco***

Screen Gauge or Size of Openings **0.020** in

Diameter of Wellpoint **2.375** in

Depth of Bottom of Wellpoint 30.09 ft

Silt Trap 1M YES

Depth of Bottom of Borehole ______ ft

(Depths refer to ground surface)

Tip Material: Steel Stainless Steel Nylon Other: ______

23.52 ft	+	6.56 (2M) ft	+	3.28 (1M) ft	=	33.37 ft
Riser length (L1)		Screen length (L2)		Length of silt trap (L3)		Total length

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CPT WELL INSTALLATION REPORT

Project: _5518 Direct Push Monitoring Point Assessment__________

City/State: _Hanscom AFB, Bedford, MA ____________________

Client: _Armstrong Laboratories, Tyndall AFB, AL/EQA __________

Crew Chief: JOEL BORST

Observation Well: DPW-MWZ-5

CPT ID: CPT-MWZ-5

Installation Date: 2-1-97

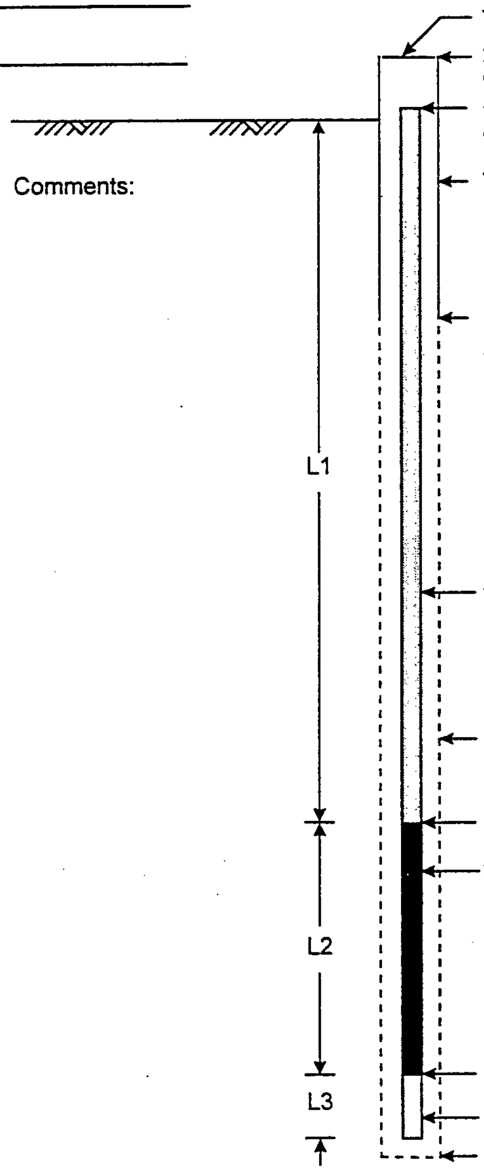
Location: SITE 21

ARA File No.: 501F711.DAT

Ground El. ______________

El. Datum ______________

Comments:



Type of Protective Cover/Lock

Depth of Top of Roadway Box below Ground Surface ______ ft

Depth of Top of Riser Pipe below Ground Surface ______ ft

Type of Protective Casing:

Length ______ ft

Inside Diameter ______ in

Depth of Bottom of Roadway Box ______ ft

Seals:

Type	Depth to Top (ft)	Thickness (ft)

Type of Riser Pipe: ***Schd 80 PVC, Timco***

Inside Diameter of Riser Pipe **1.93** in

Type of Backfill around Riser

Diameter of Largest CPT Expander **2.50** in

Depth of Top of Wellpoint ______ ft

Type of Point or Manufacturer: ***Schd 80 PVC, Timco***

Screen Gauge or Size of Openings **0.020** in

Diameter of Wellpoint **2.375** in

Depth of Bottom of Wellpoint 20.5 ft 20.5

Silt Trap NO

Depth of CPT or DMY 20.6 ft

(Depths refer to ground surface)

Tip Material: Steel Stainless Steel Nylon Other: ____________

______ ft	+	3(m) ~~ft~~	+	0 ft	=	______ ft
Riser length (L1)		Screen length (L2)		Length of silt trap (L3)		Total length

CPT WELL INSTALLATION REPORT

Project: _5518 Direct Push Monitoring Point Assessment_________

City/State: _Hanscom AFB, Bedford, MA ___________________________

Client: _Armstrong Laboratories, Tyndall AFB, AL/EQA ___________

Crew Chief: SHAWN RICKER

Observation Well: DPW-MWZ-3

CPT ID: CPT-MWZ-3

Installation Date: 1-31-97

Location: SITE-21

ARA File No.: ____________

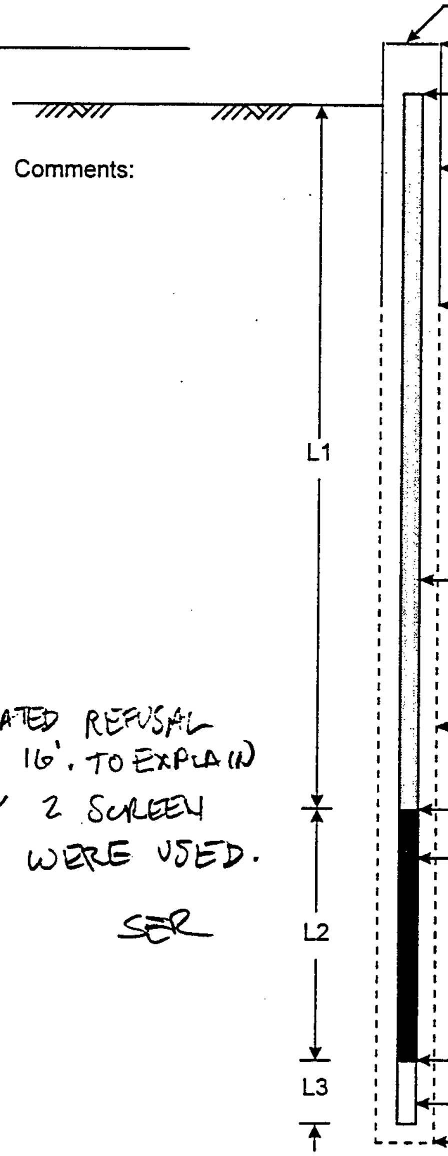
Ground El. ______________

El. Datum ______________

Comments:

I ANTICIPATED REFUSAL TO BE ≈ 16'. TO EXPLAIN WHY ONLY 2 SCREEN SECTIONS WERE USED.

SER



Type of Protective Cover/Lock

Depth of Top of Roadway Box below Ground Surface ________ ft

Depth of Top of Riser Pipe below Ground Surface ________ ft

Type of Protective Casing:

Length ________ ft

Inside Diameter ________ in

Depth of Bottom of Roadway Box ________ ft

Seals:

Type	Depth to Top (ft)	Thickness (ft)

Type of Riser Pipe: ***Schd 80 PVC, Timco***

Inside Diameter of Riser Pipe ***1.93*** in

Type of Backfill around Riser

Diameter of Largest CPT Expander ***2.50*** in

Depth of Top of Wellpoint ________ ft

Type of Point or Manufacturer: ***Schd 80 PVC, Timco***

Screen Gauge or Size of Openings ***0.020*** in

Diameter of Wellpoint ***2.375*** in

Depth of Bottom of Wellpoint 15.7 ft

Silt Trap NO

Depth of CPT or DMY 21.5 ft

(Depths refer to ground surface)

Tip Material: Steel Stainless Steel Nylon Other: ____________

________ ft +	2 (M) ft +	________ ft =	________ ft
Riser length (L1)	Screen length (L2)	Length of silt trap (L3)	Total length

CPT WELL INSTALLATION REPORT

Project: _5518 Direct Push Monitoring Point Assessment_____ Observation Well: DPW-B42

City/State: _Hanscom AFB, Bedford, MA _____ CPT ID: CPT-B42

Client: _Armstrong Laboratories, Tyndall AFB, AL/EQA _____ Installation Date: 1-31-97

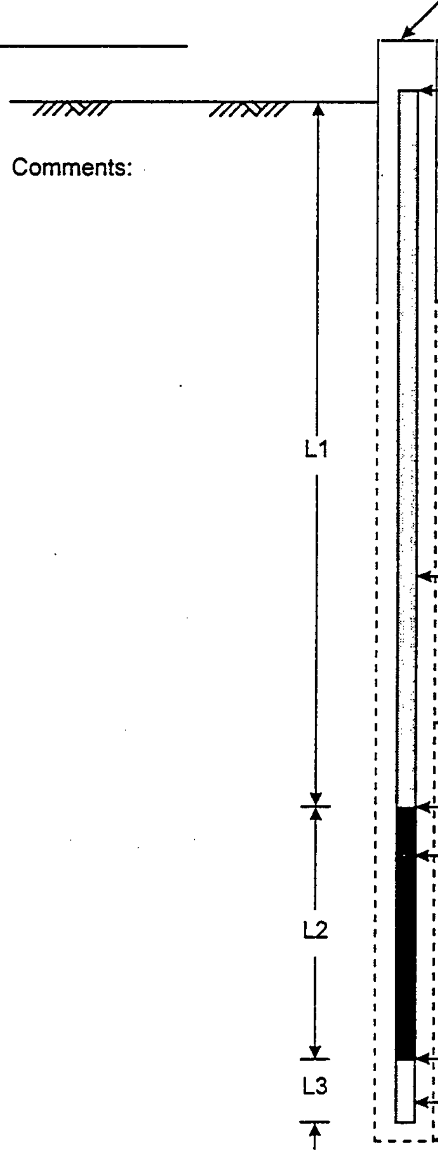
Crew Chief: SHAWN RICKER Location: SITE 21

ARA File No.: 331J712.DAT

Ground El. ________

El. Datum ________

Comments:



Type of Protective Cover/Lock

Depth of Top of Roadway Box below Ground Surface ______ ft

Depth of Top of Riser Pipe below Ground Surface ______ ft

Type of Protective Casing:

Length ______ ft

Inside Diameter ______ in

Depth of Bottom of Roadway Box ______ ft

Seals:

Type	Depth to Top (ft)	Thickness (ft)

Type of Riser Pipe: ***Schd 80 PVC, Timco***

Inside Diameter of Riser Pipe **1.93** in

Type of Backfill around Riser

Diameter of Largest CPT Expander **2.50** in

Depth of Top of Wellpoint ______ ft

Type of Point or Manufacturer: ***Schd 80 PVC, Timco***

Screen Gauge or Size of Openings **0.020** in

Diameter of Wellpoint **2.375** in

Depth of Bottom of Wellpoint 15 ft 15.0 SOLID BOTTOM

Silt Trap No

Depth of CPT or DMY 17 ft

(Depths refer to ground surface)

Tip Material: Steel Stainless Steel Nylon Other: ________

______ ft	+	3 (M) ft	+	0 ft	=	______ ft
Riser length (L1)		Screen length (L2)		Length of silt trap (L3)		Total length

CPT WELL INSTALLATION REPORT

Project: _5518 Direct Push Monitoring Point Assessment__________

City/State: _Hanscom AFB, Bedford, MA ____________

Client: _Armstrong Laboratories, Tyndall AFB, AL/EQA __________

Crew Chief: SHAWN RICKER

Observation Well: DPW-B41

CPT ID: ~~BP~~ CPT-B41

Installation Date: 1-31-97

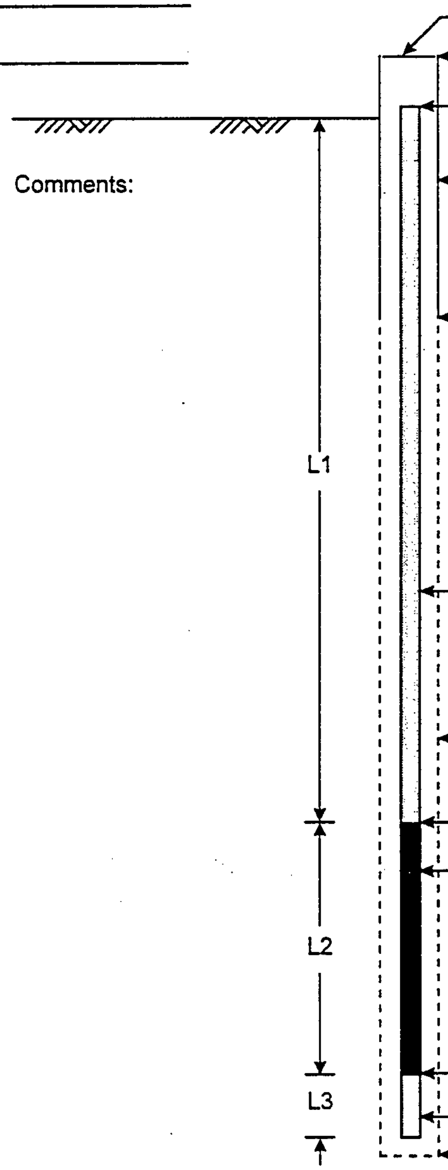
Location: SITE 21

ARA File No.: 3315709.DAT

Ground El. ____________

El. Datum ____________

Comments:



Type of Protective Cover/Lock

Depth of Top of Roadway Box below Ground Surface ______ ft

Depth of Top of Riser Pipe below Ground Surface ______ ft

Type of Protective Casing:

Length ______ ft

Inside Diameter ______ in

Depth of Bottom of Roadway Box ______ ft

Seals:

Type	Depth to Top (ft)	Thickness (ft)

Type of Riser Pipe: ***Schd 80 PVC, Timco***

Inside Diameter of Riser Pipe ***1.93*** in

Type of Backfill around Riser

Diameter of Largest CPT Expander ***2.50*** in

Depth of Top of Wellpoint ______ ft

Type of Point or Manufacturer: ***Schd 80 PVC, Timco***

Screen Gauge or Size of Openings ***0.020*** in

Diameter of Wellpoint ***2.375*** in

Depth of Bottom of Wellpoint 15 ft 14.8 MUSHY

Silt Trap No

Depth of CPT or DMY 17 ft

(Depths refer to ground surface)

Tip Material: Steel Stainless Steel Nylon Other: ____________

______ ft	+	3(M) ft	+	______ ft	=	______ ft
Riser length (L1)		Screen length (L2)		Length of silt trap (L3)		Total length

CPT WELL INSTALLATION REPORT

Project: **5518 Direct Push Monitoring Point Assessment**

City/State: **Hanscom AFB, Bedford, MA**

Client: **Armstrong Laboratories, Tyndall AFB, AL/EQA**

Crew Chief: SHAWN RICKER

Observation Well: DPW- B40

CPT ID: CPT- B40

Installation Date: 1-31-97

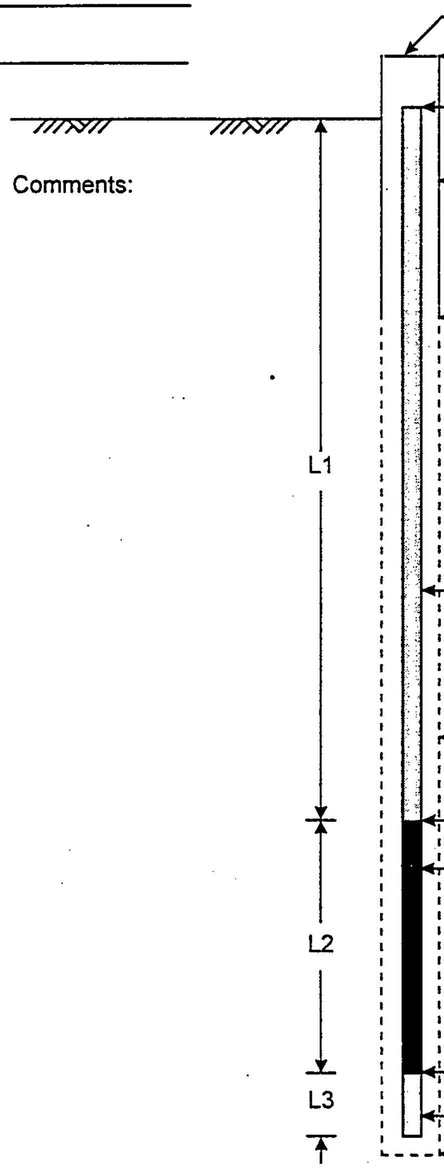
Location: SITE 21

ARA File No.: 331J705.DAT

Ground El. ____________

El. Datum ____________

Comments:



Type of Protective Cover/Lock

Depth of Top of Roadway Box below Ground Surface ______ ft

Depth of Top of Riser Pipe below Ground Surface ______ ft

Type of Protective Casing:

Length ______ ft

Inside Diameter ______ in

Depth of Bottom of Roadway Box ______ ft

Seals:

Type	Depth to Top (ft)	Thickness (ft)

Type of Riser Pipe: ***Schd 80 PVC, Timco***

Inside Diameter of Riser Pipe **1.93** in

Type of Backfill around Riser

Diameter of Largest CPT Expander **2.50** in

Depth of Top of Wellpoint 7 ft

Type of Point or Manufacturer: ***Schd 80 PVC, Timco***

Screen Gauge or Size of Openings **0.020** in

Diameter of Wellpoint **2.375** in

Depth of Bottom of Wellpoint 17 ft [illegible]

Silt Trap NO

Depth of ~~CPT~~ or DMY 19 ft

(Depths refer to ground surface)

Tip Material: Steel Stainless Steel Nylon Other: ____________

______ ft	+	3 (in.) ft	+	NONE ft	=	______ ft
Riser length (L1)		Screen length (L2)		Length of silt trap (L3)		Total length

CPT WELL INSTALLATION REPORT

Project: _5518 Direct Push Monitoring Point Assessment__________

City/State: _Hanscom AFB, Bedford, MA ____________________

Client: _Armstrong Laboratories, Tyndall AFB, AL/EQA __________

Crew Chief: SHAWN RICKER

Observation Well: DPW-MWZ-25

CPT ID: CPT-MWZ-25

Installation Date: 1-31-97

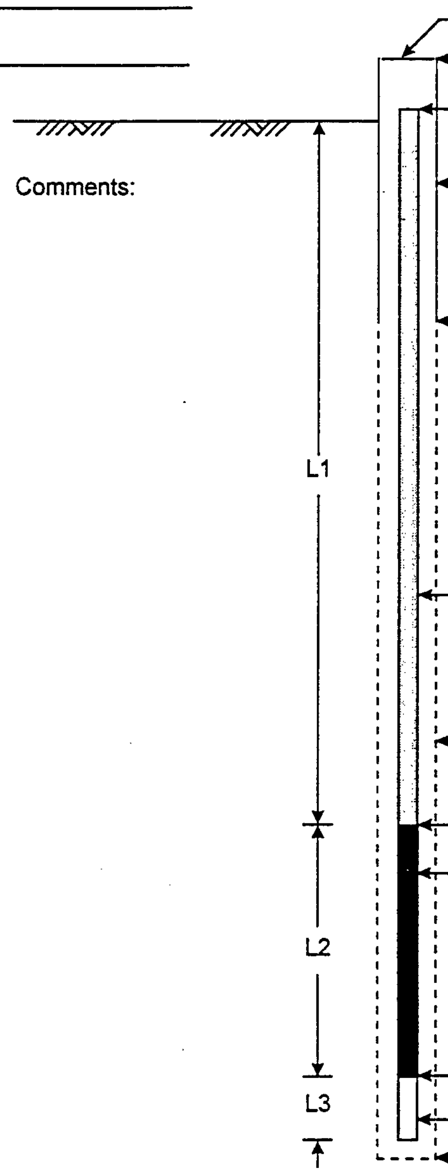
Location: SITE 21

ARA File No.: 331J704

Ground El. ______________

El. Datum ______________

Comments:



Type of Protective Cover/Lock

Depth of Top of Roadway Box below Ground Surface ________ ft

Depth of Top of Riser Pipe below Ground Surface ________ ft

Type of Protective Casing:

Length ________ ft

Inside Diameter ________ in

Depth of Bottom of Roadway Box ________ ft

Seals:

Type	Depth to Top (ft)	Thickness (ft)

Type of Riser Pipe: ***Schd 80 PVC, Timco***

Inside Diameter of Riser Pipe **1.93** in

Type of Backfill around Riser

Diameter of Largest CPT Expander **2.50** in

Depth of Top of Wellpoint ________ ft

Type of Point or Manufacturer: ***Schd 80 PVC, Timco***

Screen Gauge or Size of Openings **0.020** in

Diameter of Wellpoint **2.375** in

Depth of Bottom of Wellpoint 15.9 ft 15.9 SOLID BOTTOM

Silt Trap NO

Depth of CPT or DMY 21.0 ft

CPT TO 15.3' BGS

(Depths refer to ground surface)

Tip Material: Steel Stainless Steel Nylon Other: ____________

Riser length (L1)		Screen length (L2)		Length of silt trap (L3)		Total length
________ ft	+	3(M) ft	+	0 ft	=	________ ft

CPT WELL INSTALLATION REPORT

Project: _5518 Direct Push Monitoring Point Assessment_ | Observation Well: DPW-MWZ-8

City/State: _Hanscom AFB, Bedford, MA_ | CPT ID: CPT-MWZ-8

Client: _Armstrong Laboratories, Tyndall AFB, AL/EQA_ | Installation Date: 1-30-97

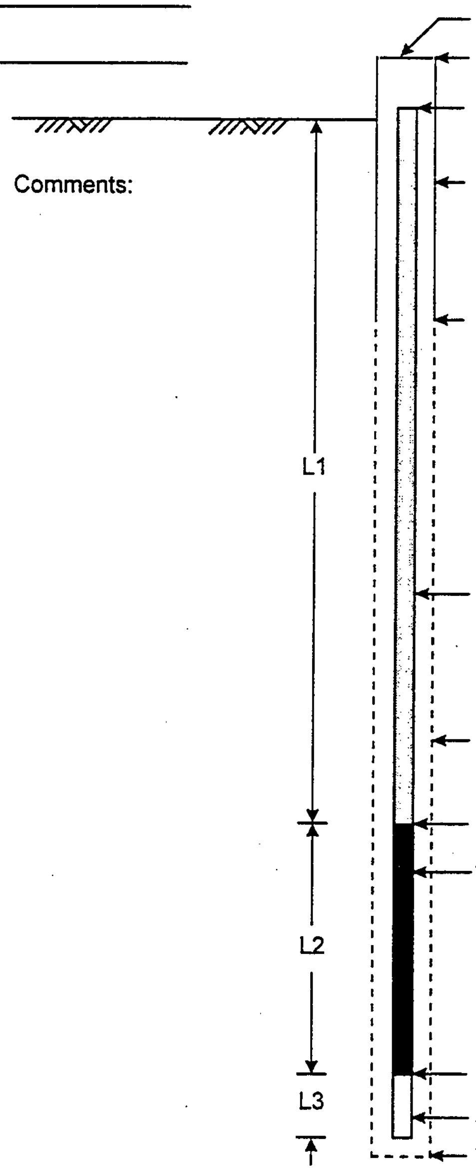
Crew Chief: SHAWN RICKER | Location: SITE 21

ARA File No.: 3303710, MW

Ground El. ______

El. Datum ______

Comments:



- Type of Protective Cover/Lock
- Depth of Top of Roadway Box below Ground Surface ______ ft
- Depth of Top of Riser Pipe below Ground Surface ______ ft
- Type of Protective Casing:
  - Length ______ ft
  - Inside Diameter ______ in
- Depth of Bottom of Roadway Box ______ ft
- Seals:

Type	Depth to Top (ft)	Thickness (ft)

- Type of Riser Pipe: ***Schd 80 PVC, Timco***
  - Inside Diameter of Riser Pipe **1.93** in
  - Type of Backfill around Riser
- Diameter of Largest CPT Expander **2.50** in
- Depth of Top of Wellpoint ______ ft
- Type of Point or Manufacturer: ***Schd 80 PVC, Timco***
  - Screen Gauge or Size of Openings **0.020** in
  - Diameter of Wellpoint **2.375** in
- Depth of Bottom of Wellpoint 20 ft 20 SOFT BOTTOM
- Silt Trap NO
- Depth of CPT or DMY 21.2 ft

(Depths refer to ground surface)

Tip Material: Steel Stainless Steel Nylon Other: ______

______ ft	+	3 M ~~ft~~	+	0 ft	=	______ ft
Riser length (L1)		Screen length (L2)		Length of silt trap (L3)		Total length

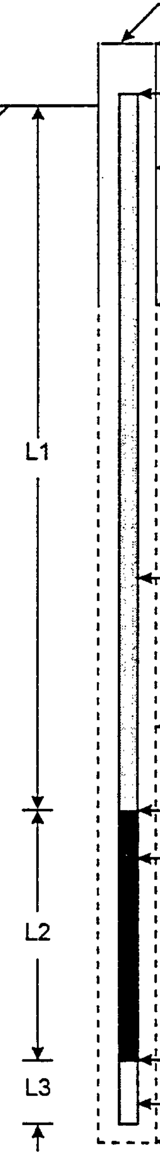
CPT WELL INSTALLATION REPORT

Project: **5518 Direct Push Monitoring Point Assessment**
Observation Well: DPW-MWZ-19
City/State: **Hanscom AFB, Bedford, MA**
CPT ID: CPT-MWZ-19
Client: **Armstrong Laboratories, Tyndall AFB, AL/EQA**
Installation Date: 1-30-97
Crew Chief: SHAWN RICKER
Location: SITE 21
ARA File No.: 330J706.MW
DMP OR MW?

Ground El. ______________

El. Datum ______________

Comments:



Type of Protective Cover/Lock

Depth of Top of Roadway Box below Ground Surface ________ ft

Depth of Top of Riser Pipe below Ground Surface ________ ft

Type of Protective Casing:

Length ________ ft

Inside Diameter ________ in

Depth of Bottom of Roadway Box ________ ft

Seals:

Type	Depth to Top (ft)	Thickness (ft)

Type of Riser Pipe: ***Schd 80 PVC, Timco***

Inside Diameter of Riser Pipe **1.93** in

Type of Backfill around Riser

Diameter of Largest CPT Expander **2.50** in

Depth of Top of Wellpoint ________ ft

Type of Point or Manufacturer: ***Schd 80 PVC, Timco***

Screen Gauge or Size of Openings **0.020** in

Diameter of Wellpoint **2.375** in

Depth of Bottom of Wellpoint 14.9 ft 14.7 MUSHY BOTTOM

Silt Trap NO

Depth of CPT or DMY 15.2 ft

(Depths refer to ground surface)

Tip Material: Steel Stainless Steel Nylon Other: ______________

________ ft	+	2m (6.29 ft	+	0 ft	=	________ ft
Riser length (L1)		Screen length (L2)		Length of silt trap (L3)		Total length

CPT WELL INSTALLATION REPORT

Project: _5518 Direct Push Monitoring Point Assessment_________ Observation Well: DPW-B109

City/State: _Hanscom AFB, Bedford, MA ____________ CPT ID: CPT-B109

Client: _Armstrong Laboratories, Tyndall AFB, AL/EQA ________ Installation Date: 12-21-96

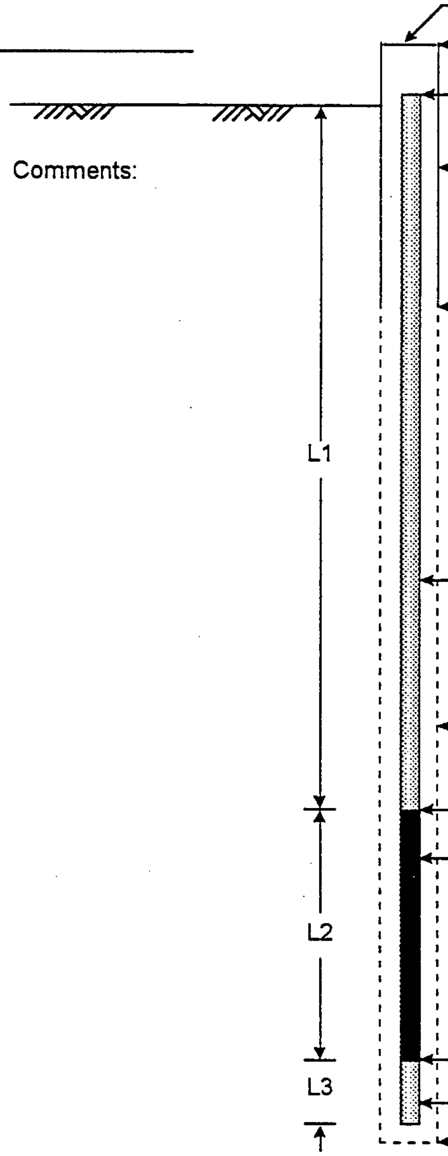
Crew Chief: SEAN PATENAUDE ____________ Location: SITE 2 AIR FIELD

ARA File No.: ______

Ground El. ______________

El. Datum ______________

Comments:



Type of Protective Cover/Lock

Depth of Top of Roadway Box below Ground Surface ______ ft

Depth of Top of Riser Pipe below Ground Surface ______ ft +0.25

Type of Protective Casing:

Length ______ ft

Inside Diameter ______ in

Depth of Bottom of Roadway Box ______ ft

Seals:

Type	Depth to Top (ft)	Thickness (ft)

Type of Riser Pipe: ***Schd 80 PVC, Timco***

Inside Diameter of Riser Pipe **1.93** in

Type of Backfill around Riser

Diameter of Largest CPT Expander **2.50** in

Depth of Top of Wellpoint 59.7 ft

Type of Point or Manufacturer: ***Schd 80 PVC, Timco***

Screen Gauge or Size of Openings **0.020** in

Diameter of Wellpoint **2.375** in

Depth of Bottom of Wellpoint 63.2 ft

Silt Trap NONE

Depth of Bottom of Borehole 64.0 ft DMY PUSH

(Depths refer to ground surface)

Tip Material: ☐ Steel ☑ Stainless Steel ☐ Nylon ☐ Other: ____0____

Riser length (L1)		Screen length (L2)		Length of silt trap (L3)		Total length
59.92 ft	+	3.281 (1 m) ft	+	0 ft	=	63.2 ft

DRAFT

CPT WELL INSTALLATION REPORT

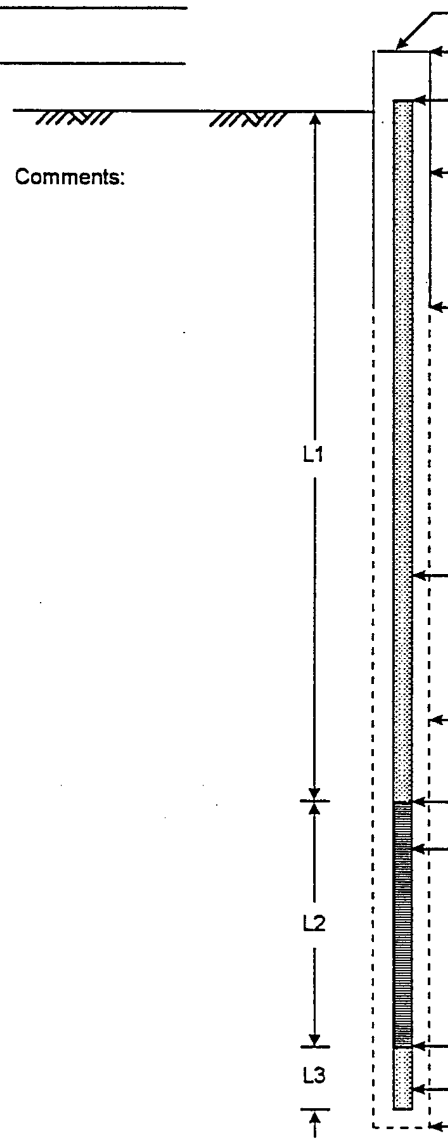
Project: 5518	Observation Well: DPW-RFW-11
City/State: HANSCOM FIELD	CPT ID: CPT-RFW-11
Client:	Installation Date: 12-18-96
Crew Chief: SEAN PATEN~~EAUD~~ AUDE, MARK WIMMER	Location: SITE 2
	ARA File No.: 518D610.MW

Ground El. ______

El. Datum ______

Comments:

1.26



- Type of Protective Cover/Lock
- Depth of Top of Roadway Box below Ground Surface ______ ft
- Depth of Top of Riser Pipe below Ground Surface ______ ft +0.4ft
- Type of Protective Casing:
  - Length ______ ft
  - Inside Diameter ______ in
- Depth of Bottom of Roadway Box ______ ft
- Seals:

Type	Depth to Top (ft)	Thickness (ft)

- Type of Riser Pipe: SCHD 80 PVC
  - Inside Diameter of Riser Pipe 1.93 in
  - Type of Backfill around Riser
- Diameter of Largest CPT Expander 2.5 in
- Depth of Top of Wellpoint 7.23 ft
- Type of Point or Manufacturer:
  - Screen Gauge or Size of Openings 0.020 in
  - Diameter of Wellpoint 2.375 in
- Depth of Bottom of Wellpoint 17.07 ft
- Silt Trap YES, 1m — 1m 20.35 Bottom of silt trap
- Depth of Bottom of Borehole 21.0 ft ~ Depth of Omy

(Depths refer to ground surface)

TIP MATERIAL: NYLON 2.5 inch

Riser length (L1)	+	Screen length (L2)	+	Length of silt trap (L3)	=	Total length
______ ft	+	3m 9.84 ft	+	1m 3.28 ft	=	______ ft

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Draft Printed 12/17/96

DRAFT

CPT WELL INSTALLATION REPORT

Project: 5518

City/State: HANSCOM AFB, MA

Client: AL/EQA

Crew Chief: SHAWN PATENAUDE

Observation Well: DPW-B107

CPT ID: CPT-B-107

Installation Date: 12/19/96

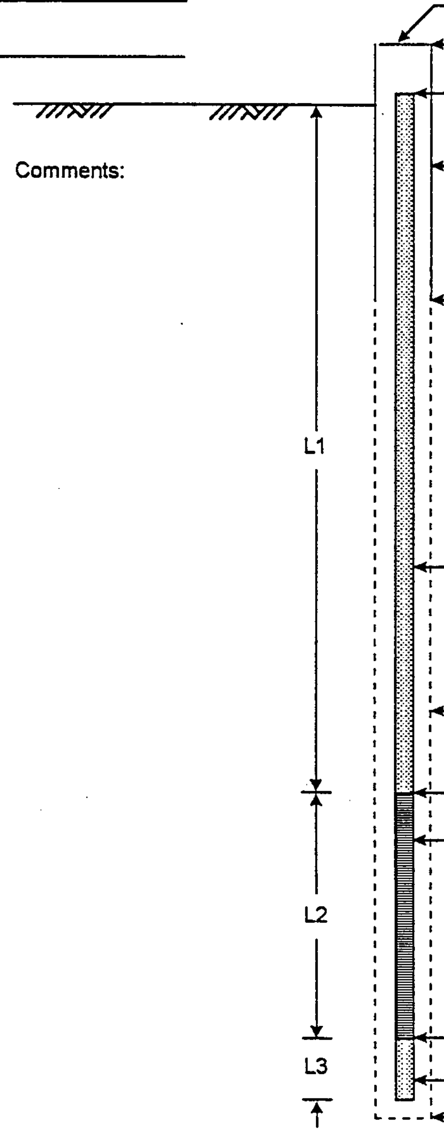
Location: FAMCAMP

ARA File No.: 519D604.MW

Ground El. ______

El. Datum ______

Comments:



Type of Protective Cover/Lock

Depth of Top of Roadway Box below Ground Surface ____ ft +5"

Depth of Top of Riser Pipe below Ground Surface ____ ft

Type of Protective Casing:

Length ____ ft

Inside Diameter ____ in

Depth of Bottom of Roadway Box ____ ft

Seals:

Type	Depth to Top (ft)	Thickness (ft)

Type of Riser Pipe:

Inside Diameter of Riser Pipe 1.93 in

Type of Backfill around Riser

Diameter of Largest CPT Expander 2.5 in

Depth of Top of Wellpoint 4.18 ft

Type of Point or Manufacturer:

Screen Gauge or Size of Openings 0.020 in

Diameter of Wellpoint 2.375 in

Depth of Bottom of Wellpoint 14.02 ft

Silt Trap YES 1M 1m

Depth of Bottom of Borehole 17.3 ft

(Depths refer to ground surface)

TIP: NYLON

4.18 ft + 9.84 (3m) ft + 3.28 (1m) ft = 17.3 ft

Riser length (L1) + Screen length (L2) + Length of silt trap (L3) = Total length

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DRAFT

CPT WELL INSTALLATION REPORT

Project: 5518

City/State: HANSCOM AFB, MA

Client: AL/EQA

Crew Chief: SEAN PATENAUDE

Observation Well: DPW-RAP2-2T

CPT ID: CPT-RAP2-2T

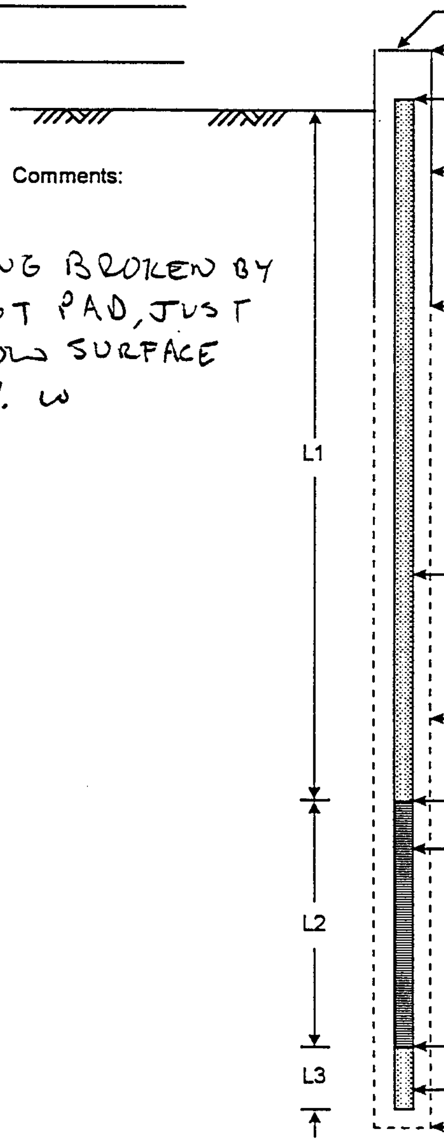
Installation Date: 12-20-96

Location: SITE 2

ARA File No.: 520D601 MW

Ground El. ______

El. Datum ______



Comments:

CASING BROKEN BY FRONT PAD, JUST BELOW SURFACE 3-5". W

Type of Protective Cover/Lock

Depth of Top of Roadway Box below Ground Surface ______ ft

Depth of Top of Riser Pipe below Ground Surface ______ ft

Type of Protective Casing:

Length ______ ft

Inside Diameter ______ in

Depth of Bottom of Roadway Box ______ ft

Seals:

Type	Depth to Top (ft)	Thickness (ft)

Type of Riser Pipe: SCHD 80 PVC TIMCO

Inside Diameter of Riser Pipe 1.93 in

Type of Backfill around Riser

Diameter of Largest CPT Expander 2.5 in

Depth of Top of Wellpoint 56.64 ft

Type of Point or Manufacturer: SCHD 80 PVC TIMCO

Screen Gauge or Size of Openings 0.020 in

Diameter of Wellpoint 2.375 in

Depth of Bottom of Wellpoint 63.2 ft

Silt Trap NO

Depth of Bottom of Borehole 63.2 ft

(Depths refer to ground surface)

TIP MAT. SS

56.64

~~17.26~~ ft + 6.56 (2m) ft + 0 ft = 63.2 ft

Riser length (L1) + Screen length (L2) + Length of silt trap (L3) = Total length

DRAFT

CPT WELL INSTALLATION REPORT

Project: 5518

City/State: HANSCOM AFB, MA

Client: AL/EQA

Crew Chief: SEAN PATENAUDE

Observation Well: DPW-B105

CPT ID: CPT-B105

Installation Date: 12-20-96

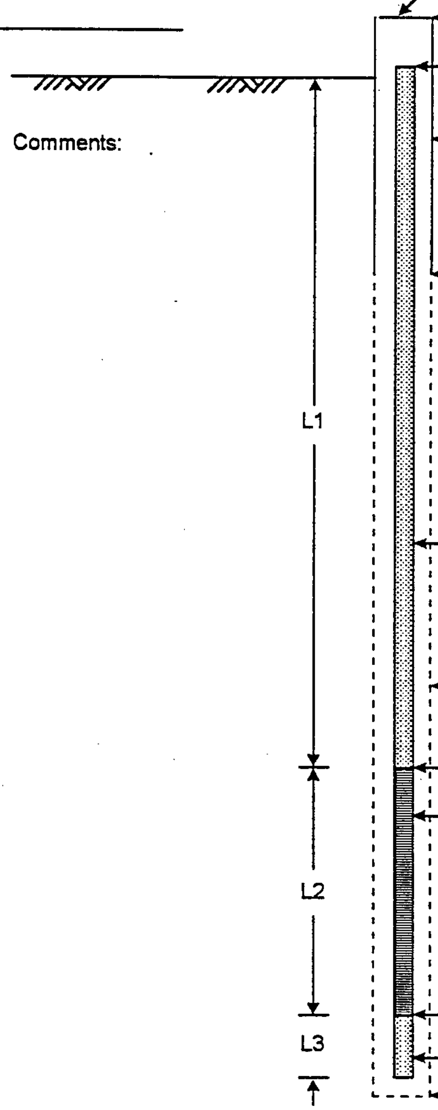
Location: SITE 2 AIR FIELD

ARA File No.: ______

Ground El. ______

El. Datum ______

Comments:



Type of Protective Cover/Lock

Depth of Top of Roadway Box below Ground Surface ______ ft

Depth of Top of Riser Pipe below Ground Surface ______ ft +0.3

Type of Protective Casing: ~~SCHD 80 PVC TIMCO~~

Length ______ ft

Inside Diameter ______ in

Depth of Bottom of Roadway Box ______ ft

Seals:

Type	Depth to Top (ft)	Thickness (ft)

Type of Riser Pipe: SCHD 80 PVC TIMCO

Inside Diameter of Riser Pipe 1.93 in

Type of Backfill around Riser

Diameter of Largest CPT Expander 2.5 in

Depth of Top of Wellpoint ~~4.26~~ ft 4.01

Type of Point or Manufacturer: SCHD 80 PVC TIMCO

Screen Gauge or Size of Openings 0.020 in

Diameter of Wellpoint 2.375 in

Depth of Bottom of Wellpoint ~~14.10~~ ft 13.85

Silt Trap YES 1M

Depth of Bottom of Borehole 18.3 ft DMY PUSH

(Depths refer to ground surface)

TIP: NYLON

4.01 ft	+	9.84 (3m) ft	+	3.281 (1m) ft	=	17.13 ft
Riser length (L1)		Screen length (L2)		Length of silt trap (L3)		Total length

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DRAFT

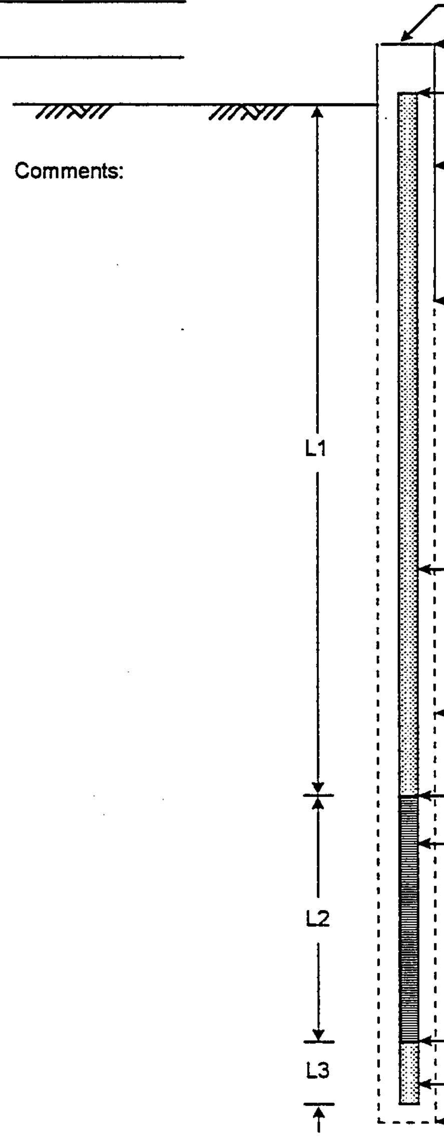
CPT WELL INSTALLATION REPORT

Project: 5518	Observation Well: DPW-RAP2-2S
City/State: HANSCOM AFB MA	CPT ID: CPT-RAP2-2S
Client: AUEQA	Installation Date: 12/19/96
Crew Chief: SEAN PATENAUDE	Location: HANSCOM AFB SITE 2
	ARA File No.: S19D610.MW

Ground El. ______________

El. Datum ______________

Comments:



Type of Protective Cover/Lock

Depth of Top of Roadway Box below Ground Surface ______ ft

Depth of Top of Riser Pipe below Ground Surface ______ ft +7"

Type of Protective Casing:

Length ______ ft

Inside Diameter ______ in

Depth of Bottom of Roadway Box ______ ft

Seals:

Type	Depth to Top (ft)	Thickness (ft)

Type of Riser Pipe: SCHD 80 PVC

Inside Diameter of Riser Pipe 1.93 in

Type of Backfill around Riser

Diameter of Largest CPT Expander 2.5 in

Depth of Top of Wellpoint 2.95 ft 0.9m

Type of Point or Manufacturer: SCHD 80 PVC TIMCO

Screen Gauge or Size of Openings 0.020 in

Diameter of Wellpoint 2.375 in

Depth of Bottom of Wellpoint 19.36 ~~20.02~~ ft 5.9m ~~6.1m~~

Silt Trap YES 1m 22.72(1m) 6.9m

Depth of Bottom of Borehole ~~23.3~~ ft ~~7.1m~~

(Depths refer to ground surface)

TIP: NYLON

@ 2.95 ft	+	16.4 ft	+	(1m) ft	=	______ ft
Riser length (L1)		Screen length (L2)		Length of silt trap (L3)		Total length

DRAFT

CPT WELL INSTALLATION REPORT

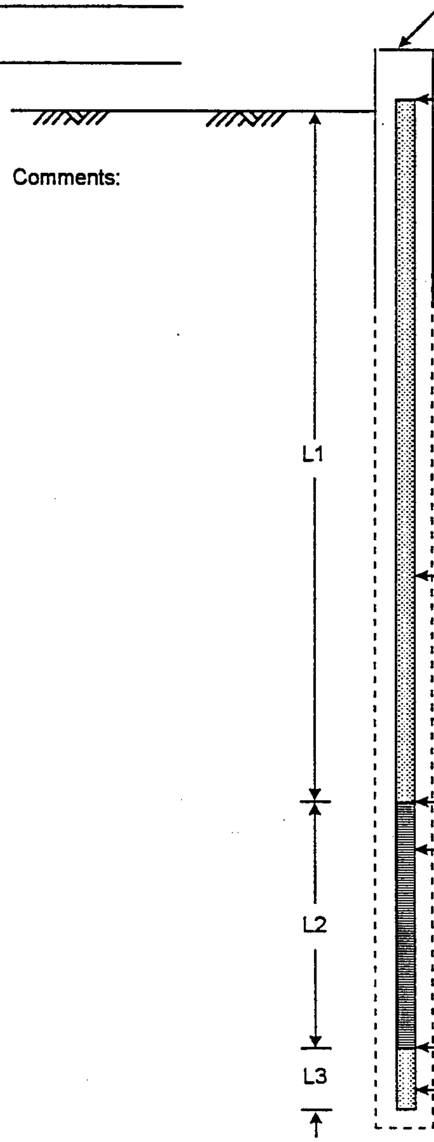
Project: 5518
City/State: HANSCOM FIELD MA
Client: AL/EQA . CHRIS BIANCHI
Crew Chief: SEAN PATENEAUD

Observation Well: DPW-RAP2-4S
CPT ID: CPT-RAP2-4S
Installation Date: 12/18/96
Location: SITE 2
ARA File No.: 518D604.MW

Ground El. ______

El. Datum ______

Comments:



Type of Protective Cover/Lock

Depth of Top of Roadway Box below Ground Surface ______ ft

Depth of Top of Riser Pipe below Ground Surface ______ ft +6" after installation

Type of Protective Casing:

Length ______ ft

Inside Diameter ______ in

Depth of Bottom of Roadway Box ______ ft

Seals:

Type	Depth to Top (ft)	Thickness (ft)

Type of Riser Pipe: SCHD 80 PVC

Inside Diameter of Riser Pipe 1.925 in

Type of Backfill around Riser

Diameter of Largest CPT Expander 2.5 in

Depth of Top of Wellpoint 4.92 ft

Type of Point or Manufacturer: SCHD 80 PVC TIMCO

Screen Gauge or Size of Openings 0.020 in

Diameter of Wellpoint 2.370 in outer

Depth of Bottom of Wellpoint 24.6 ft

Silt Trap ~~______~~ ft NO SUMP

Depth of Bottom of Borehole 28.0 ft

(Depths refer to ground surface)

Tip MATERIAL: Nylon 2.5 inch

4.92 (1.5) ft	+	19.69 (6) ft	+	(0) ft	=	24.61 ft
Riser length (L1)		Screen length (L2)		Length of silt trap (L3)		Total length

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DRAFT

CPT WELL INSTALLATION REPORT

Project: 5518

City/State: HANSCOM FIELD, MA

Client: AFCEE/ERA

Crew Chief: SEAN RICKER

Observation Well: CW-04-DP

CPT ID: CPT-CW-04

Installation Date: 12-17-96

Location: AIR FIELD SITE 1

ARA File No.: ______

Ground El. ______

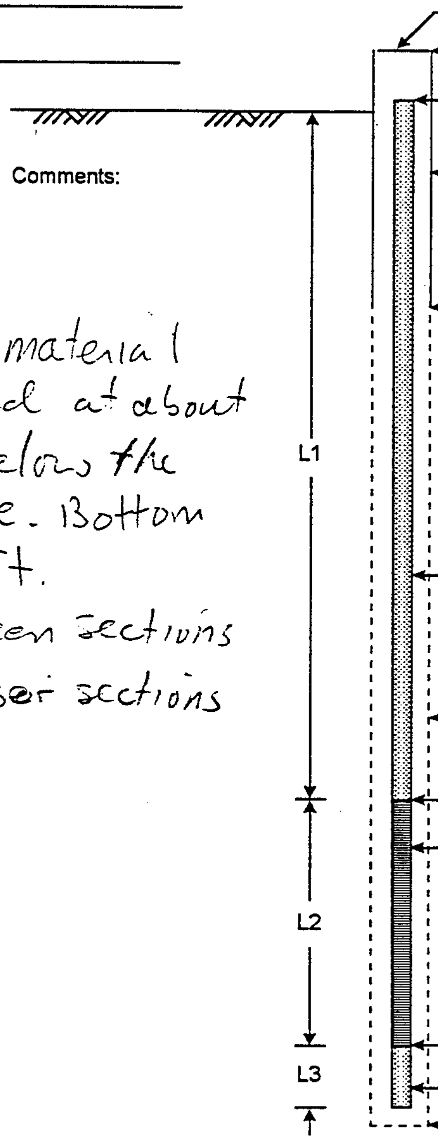
El. Datum ______

Comments:

Well material crushed at about 3 ft. below the Surface. Bottom at 15 ft.

3 screen sections

1.5 riser sections



Type of Protective Cover/Lock

Depth of Top of Roadway Box below Ground Surface ______ ft

Depth of Top of Riser Pipe below Ground Surface ______ ft

Type of Protective Casing:

Length ______ ft

Inside Diameter ______ in

Depth of Bottom of Roadway Box ______ ft

Seals:

Type	Depth to Top (ft)	Thickness (ft)

Type of Riser Pipe: SCHD 80 PVC

Inside Diameter of Riser Pipe ______ in

Type of Backfill around Riser

Diameter of Largest CPT Expander 2.5 in

Depth of Top of Wellpoint ~10.0 ft

Type of Point or Manufacturer:

Screen Gauge or Size of Openings 0.020 in

Diameter of Wellpoint ______ in

Depth of Bottom of Wellpoint ~ 15.0 ft

Silt Trap

Depth of Bottom of Borehole 25.0 ft

(Depths refer to ground surface)

Tip ~~Point~~ · SS 2.5 inch

~2 5.2') ft	+	9.84 (3s) ft	+	0 ft	=	______ ft
Riser length (L1)		Screen length (L2)		Length of silt trap (L3)		Total length

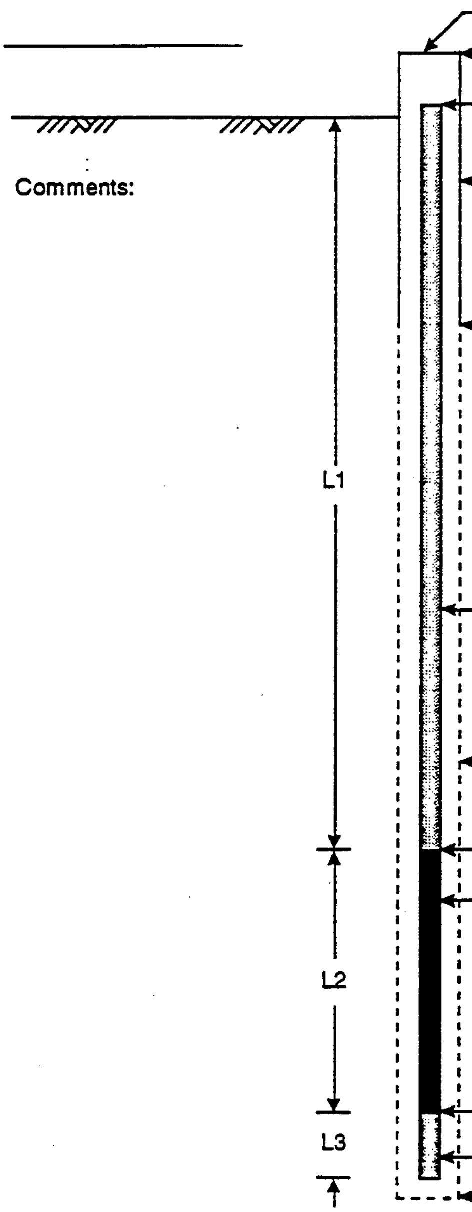
CPT WELL INSTALLATION REPORT

Project: 5518 Direct Push Monitoring Point Assessment	Observation Well: DPW-RAP2-3S
City/State: Hanscom AFB Bedford, MA	CPT ID: CPT-RAP2-3S
Client: Armstrong Laboratories, Tyndall AFB, AL/EQA	Installation Date: 1-09-97
Crew Chief:	Location: SITE 2
	ARA File No.: 509J709.mw

Ground El. ______

El. Datum ______

Comments:



Type of Protective Cover/Lock

Depth of Top of Roadway Box below Ground Surface ______ ft

Depth of Top of Riser Pipe below Ground Surface ______ ft

Type of Protective Casing:

Length ______ ft

Inside Diameter ______ in

Depth of Bottom of Roadway Box ______ ft

Seals:

Type	Depth to Top (ft)	Thickness (ft)

Type of Riser Pipe: ***Schedule 80 PVC, Timco***

Inside Diameter of Riser Pipe **1.913** in

Type of Backfill around Riser

Diameter of Largest CPT Expander **2.5** in

Depth of Top of Wellpoint 0.75 ft

Type of Point or Manufacturer: ***Schedule 80 PVC, Timco***

Screen Gauge or Size of Openings **0.020** in

Diameter of Wellpoint **2.375** in

Depth of Bottom of Wellpoint 23.71 ft

Silt Trap YES 1M

Depth of Bottom of Borehole 28.9 ft

(Depths refer to ground surface)

Tip Material: Steel Stainless Steel Nylon Other: ______

Riser length (L1)		Screen length (L2)		Length of silt trap (L3)		Total length
0.75 ft	+	7X 3.28 ft	+	3.28 ft	=	26.99 ft

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CPT WELL INSTALLATION REPORT

Project: **5518 Direct Push Monitoring Point Assessment**

City/State: **Hanscom AFB Bedford, MA**

Client: **Armstrong Laboratories, Tyndall AFB, AL/EQA**

Crew Chief: ____

Observation Well: DPW-RAP1-6S

CPT ID: CPT-RAP1-6S

Installation Date: 1-9-97

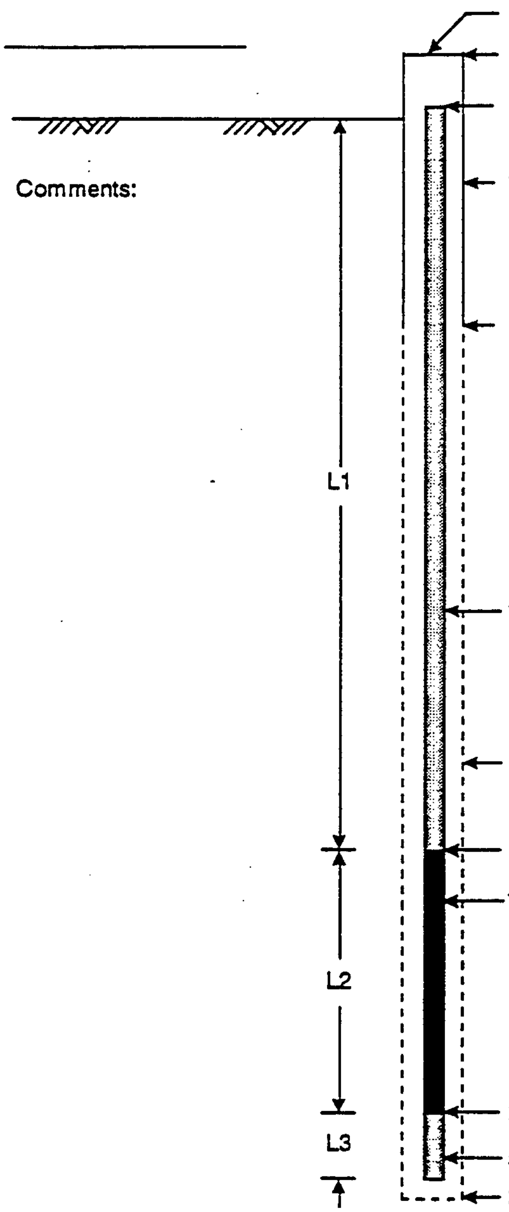
Location: ~~HAN~~ SITE 1 AIRFIELD

ARA File No.: 5C9J7C6.MW

Ground El. ____

El. Datum ____

Comments:



Type of Protective Cover/Lock

Depth of Top of Roadway Box below Ground Surface ____ ft

Depth of Top of Riser Pipe below Ground Surface ____ ft

Type of Protective Casing:

Length ____ ft

Inside Diameter ____ in

Depth of Bottom of Roadway Box ____ ft

Seals:

Type	Depth to Top (ft)	Thickness (ft)

Type of Riser Pipe: ***Schedule 80 PVC, Timco***

Inside Diameter of Riser Pipe **1.913** in

Type of Backfill around Riser

Diameter of Largest CPT Expander **2.5** in

Depth of Top of Wellpoint ____ ft

Type of Point or Manufacturer: ***Schedule 80 PVC, Timco***

Screen Gauge or Size of Openings **0.020** in

Diameter of Wellpoint **2.375** in

Depth of Bottom of Wellpoint 14.5 ft

Silt Trap YES 1M

Depth of Bottom of Borehole 19.8 ft

(Depths refer to ground surface)

Tip Material: Steel Stainless Steel Nylon Other: ____

1.4 ft + 13.12 ft + 3.26 ft = 17.8 ft

Riser length (L1) + Screen length (L2) + Length of silt trap (L3) = Total length

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CPT WELL INSTALLATION REPORT

Project: _ **5518 Direct Push Monitoring Point Assessment** ________ Observation Well: DPW - B130

City/State: _ **Hanscom AFB Bedford, MA** ________ CPT ID: CPT-B130

Client: _**Armstrong Laboratories, Tyndall AFB, AL/EQA** ________ Installation Date: 1-9-97

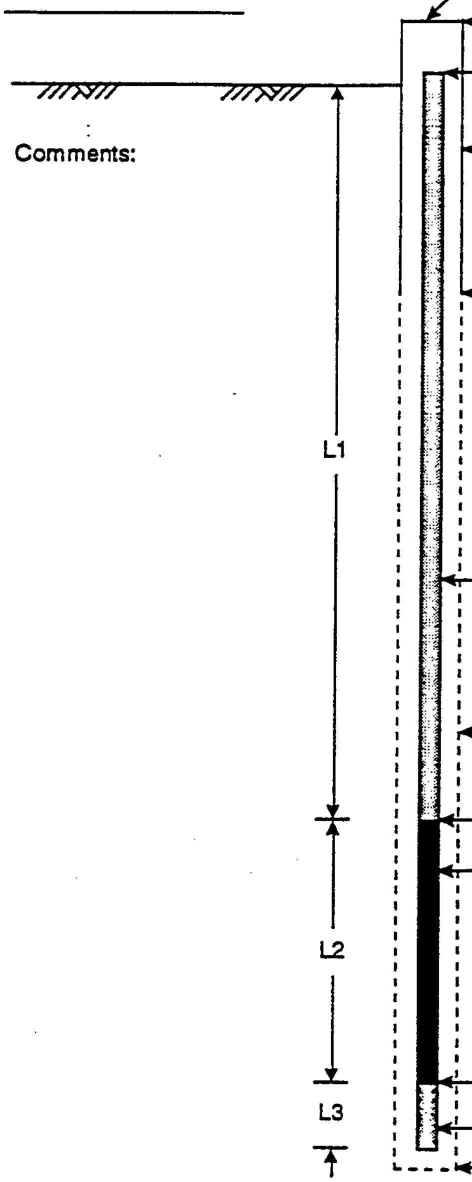
Crew Chief: SHAWN RICKER ________ Location: SITE 2 AIRFIELD

ARA File No.: 509J703.MW

Ground El. ________

El. Datum ________

Comments:



Type of Protective Cover/Lock

Depth of Top of Roadway Box below Ground Surface ______ ft 17.5

Depth of Top of Riser Pipe below Ground Surface ______ ft 3.5"

Type of Protective Casing:

Length ______ ft

Inside Diameter ______ in

Depth of Bottom of Roadway Box ______ ft

Seals:

Type	Depth to Top (ft)	Thickness (ft)

Type of Riser Pipe: ***Schedule 80 PVC, Timco***

Inside Diameter of Riser Pipe **1.913** in

Type of Backfill around Riser

Diameter of Largest CPT Expander **2.5** in

Depth of Top of Wellpoint ______ ft

Type of Point or Manufacturer: ***Schedule 80 PVC, Timco***

Screen Gauge or Size of Openings **0.020** in

Diameter of Wellpoint **2.375** in

Depth of Bottom of Wellpoint 13.92 ~~10.49~~ ft

Silt Trap YES IM

Depth of Bottom of Borehole 19.28 ft

(Depths refer to ground surface)

Tip Material: Steel Stainless Steel Nylon Other: ________

4.08 ft	+	9.84 ft	+	3.28 ft	=	17.2 ft
Riser length (L1)		Screen length (L2)		Length of silt trap (L3)		Total length

File:I:\5518\docs\WorkPlan\wellinst.doc

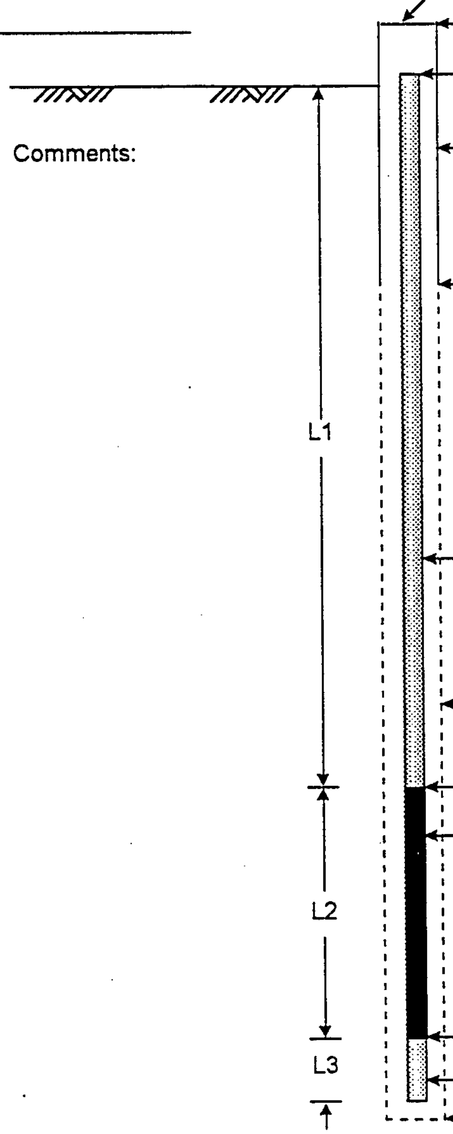
CPT WELL INSTALLATION REPORT

Project: **5518 Direct Push Monitoring Point Assessment**
City/State: **Hanscom AFB, Bedford, MA**
Client: **Armstrong Laboratories, Tyndall AFB, AL/EQA**
Crew Chief: SHAWN PATENAUDE

Observation Well: DWP-OWZ-2
CPT ID: CPT-OWZ-2
Installation Date: 12/22/96
Location: SITE 2 AIRFIELD
ARA File No.: 522D605.DAT

Ground El. ______
El. Datum ______

Comments:



- Type of Protective Cover/Lock
- Depth of Top of Roadway Box below Ground Surface ______ ft
- Depth of Top of Riser Pipe below Ground Surface ______ ft
- Type of Protective Casing:
  - Length ______ ft
  - Inside Diameter ______ in
- Depth of Bottom of Roadway Box ______ ft

Seals:

Type	Depth to Top (ft)	Thickness (ft)

- Type of Riser Pipe: ***Schd 80 PVC, Timco***
  - Inside Diameter of Riser Pipe **1.93** in
  - Type of Backfill around Riser
- Diameter of Largest CPT Expander **2.50** in
- Depth of Top of Wellpoint ______ ft
- Type of Point or Manufacturer: ***Schd 80 PVC, Timco*** +4''
  - Screen Gauge or Size of Openings **0.020** in
  - Diameter of Wellpoint **2.375** in
- Depth of Bottom of Wellpoint 20.0 ft
- Silt Trap
- Depth of Bottom of Borehole 23.4 ft

23.60
.33
23.27

(Depths refer to ground surface)

Tip Material: ☐ Steel ☒ Stainless Steel ☐ Nylon ☐ Other: ______

16.71 ft + 1M ft + 1M ft = ~~24.27~~ 23.27 ft

Riser length (L1) + Screen length (L2) + Length of silt trap (L3) = Total length

CPT WELL INSTALLATION REPORT

Project: 5518 Direct Push Monitoring Point Assessment

Observation Well: DWP-OW2-1

City/State: Hanscom AFB, Bedford, MA

CPT ID: CPT-OW2-1

Client: Armstrong Laboratories, Tyndall AFB, AL/EQA

Installation Date: 12/22/96

Crew Chief: ____________

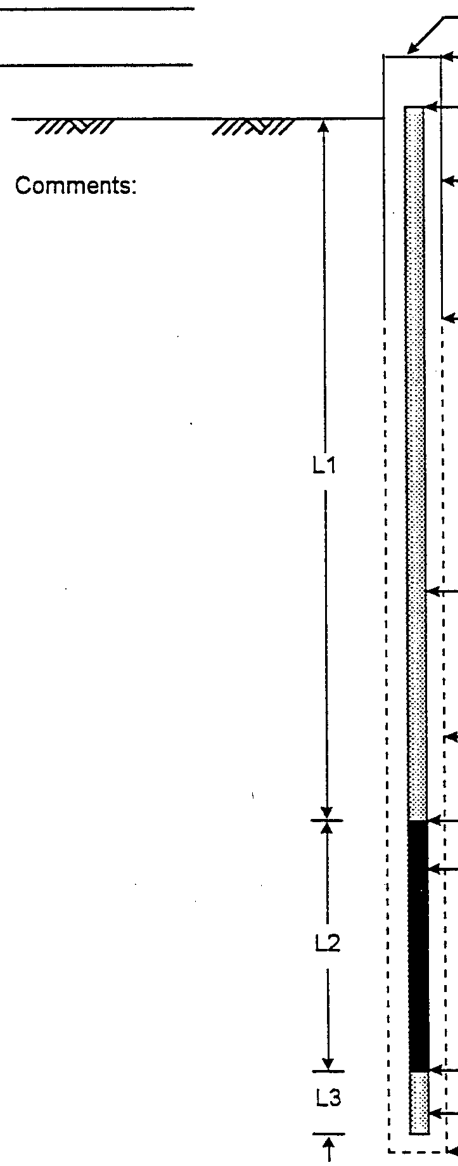
Location: SITE 2 AIRFIELD

ARA File No.: 522D601.DAT

Ground El. ____________

El. Datum ____________

Comments:



Type of Protective Cover/Lock

Depth of Top of Roadway Box below Ground Surface ______ ft

Depth of Top of Riser Pipe below Ground Surface ______ ft

Type of Protective Casing:

Length ______ ft

Inside Diameter ______ in

Depth of Bottom of Roadway Box ______ ft

Seals:

Type	Depth to Top (ft)	Thickness (ft)

Type of Riser Pipe: ***Schd 80 PVC, Timco***

Inside Diameter of Riser Pipe **1.93** in

Type of Backfill around Riser

Diameter of Largest CPT Expander **2.50** in

Depth of Top of Wellpoint ______ ft

Type of Point or Manufacturer: ***Schd 80 PVC, Timco***

Screen Gauge or Size of Openings **0.020** in

Diameter of Wellpoint **2.375** in

Depth of Bottom of Wellpoint 15.12 ft + 4"

Silt Trap

Depth of Bottom of Borehole 18.40 ft 18.60

(Depths refer to ground surface)

Tip Material: ☐ Steel ☒ Stainless Steel ☐ Nylon ☐ Other: ____________

11.74 ft	+	1 M ft	+	1 M ft	=	~~18.60~~ 18.30 ft
Riser length (L1)		Screen length (L2)		Length of silt trap (L3)		Total length

CPT WELL INSTALLATION REPORT

DWP

Project: 5518 Direct Push Monitoring Point Assessment

Observation Well: RAPZ-5S

City/State: Hanscom AFB, Bedford, MA

CPT ID: CPT- RAPZ-5S

Client: Armstrong Laboratories, Tyndall AFB, AL/EQA

Installation Date: 12/21/96

Crew Chief: SHAWN PATENAUDE

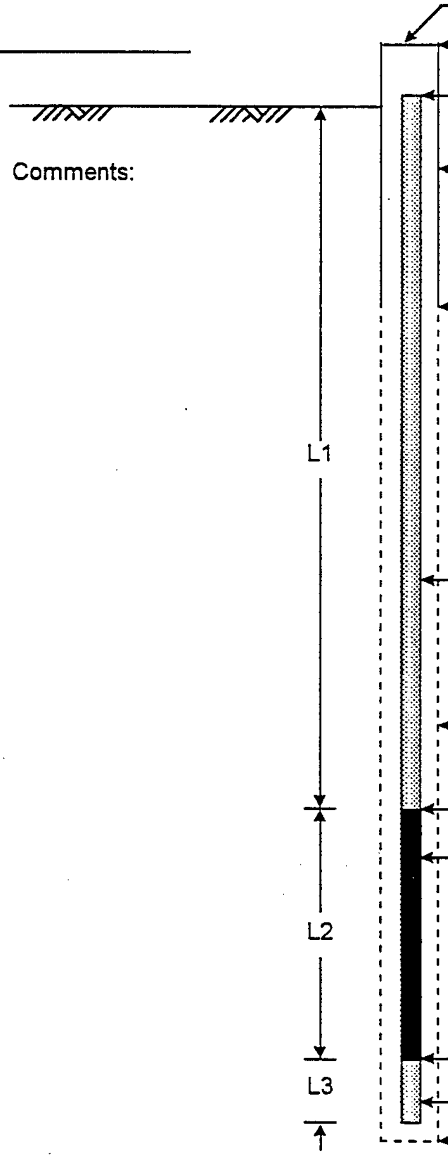
Location: SITE Z

ARA File No.: 521D611.DAT

Ground El. ____

El. Datum ____

Comments:



Type of Protective Cover/Lock

Depth of Top of Roadway Box below Ground Surface ____ ft

Depth of Top of Riser Pipe below Ground Surface ____ ft +.25"

Type of Protective Casing:

Length ____ ft

Inside Diameter ____ in

Depth of Bottom of Roadway Box ____ ft

Seals:

Type	Depth to Top (ft)	Thickness (ft)

Type of Riser Pipe: ***Schd 80 PVC, Timco***

Inside Diameter of Riser Pipe **1.93** in

Type of Backfill around Riser

Diameter of Largest CPT Expander **2.50** in

Depth of Top of Wellpoint 1.18 ft

Type of Point or Manufacturer: ***Schd 80 PVC, Timco***

Screen Gauge or Size of Openings **0.020** in

Diameter of Wellpoint **2.375** in

Depth of Bottom of Wellpoint 14.30 ft

14.80
-.5
14.3

Silt Trap NO

Depth of Bottom of Borehole 16.8 ft

(Depths refer to ground surface)

Tip Material: ☐ Steel ☐ Stainless Steel ☑ Nylon ☐ Other: ____

1.48 ft	+	4M ft	+	0 ft	=	14.60 ft
Riser length (L1)		Screen length (L2)		Length of silt trap (L3)		Total length

CPT WELL INSTALLATION REPORT

Project: **5518 Direct Push Monitoring Point Assessment**
Observation Well: DPW-B106

City/State: **Hanscom AFB, Bedford, MA**
CPT ID: CPT-B106

Client: **Armstrong Laboratories, Tyndall AFB, AL/EQA**
Installation Date: 12/21/96

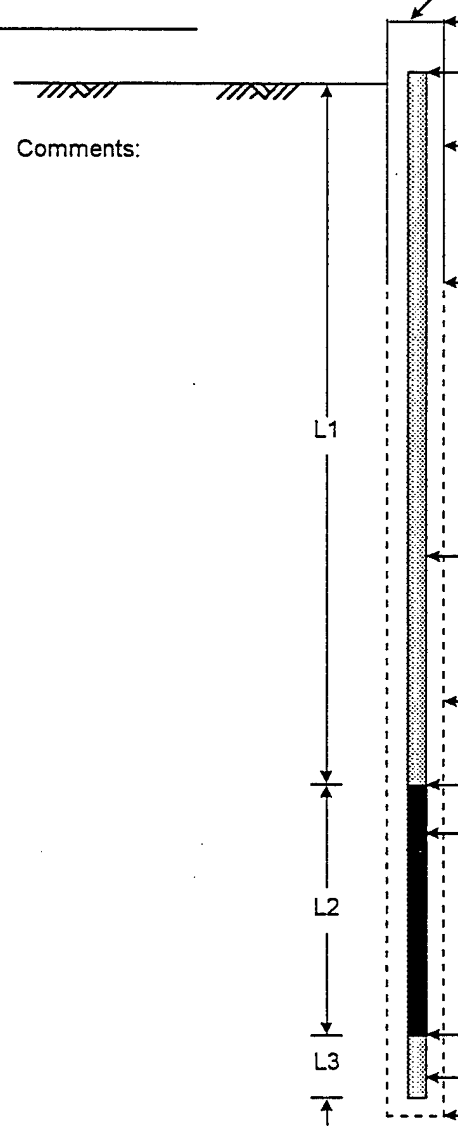
Crew Chief: SHAWN PATENAUDE
Location: SITE Z AIRFIELD

ARA File No.: CPT-FILE 521D607.DAT

Ground El. ______

El. Datum ______

Comments:



Type of Protective Cover/Lock

Depth of Top of Roadway Box below Ground Surface ______ ft

Depth of Top of Riser Pipe below Ground Surface ______ ft   +.3

Type of Protective Casing:

Length ______ ft

Inside Diameter ______ in

Depth of Bottom of Roadway Box ______ ft

Seals:

Type	Depth to Top (ft)	Thickness (ft)

Type of Riser Pipe: ***Schd 80 PVC, Timco***

Inside Diameter of Riser Pipe **1.93** in

Type of Backfill around Riser

Diameter of Largest CPT Expander **2.50** in

Depth of Top of Wellpoint ______ ft

Type of Point or Manufacturer: ***Schd 80 PVC, Timco***

Screen Gauge or Size of Openings **0.020** in

Diameter of Wellpoint **2.375** in

Depth of Bottom of Wellpoint 14.0 ft

Silt Trap Yes 1M

Depth of Bottom of Borehole 17.3 ft   CPT 17.45 BOT
.3
17.15 BGS

(Depths refer to ground surface)

Tip Material: ☐ Steel ☐ Stainless Steel ☑ Nylon ☐ Other: ______

Riser length (L1)		Screen length (L2)		Length of silt trap (L3)		Total length
0.9 ft	+	4M ft	+	1 M ft	=	17.3 ft

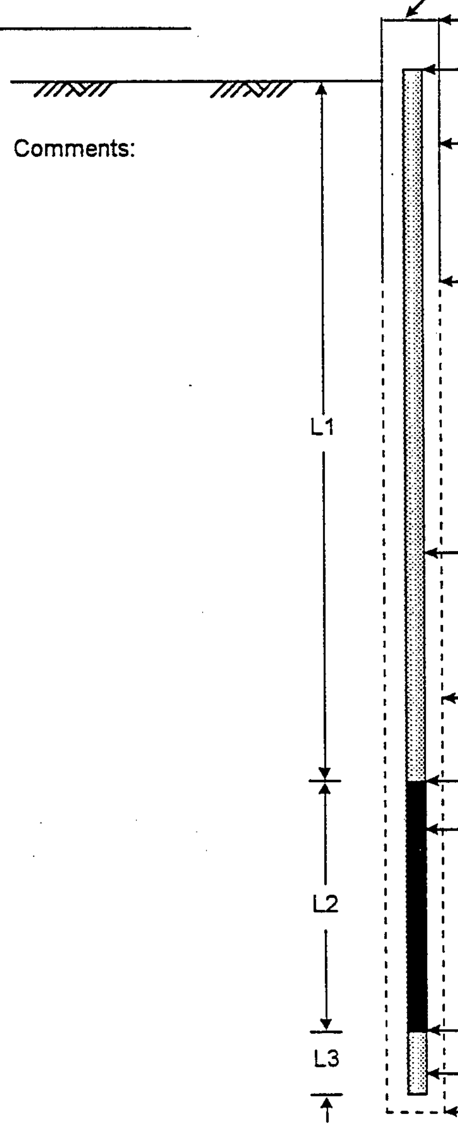
CPT WELL INSTALLATION REPORT

Project: 5518 Direct Push Monitoring Point Assessment
City/State: Hanscom AFB, Bedford, MA
Client: Armstrong Laboratories, Tyndall AFB, AL/EQA
Crew Chief: SEAN ~~PATENEA~~ PATENAUDE

Observation Well: DPW-OW2-6
CPT ID: CPT-OW2-6
Installation Date: 12/21/96
Location: SITE 2 AIRFIELD
ARA File No.:

Ground El.
El. Datum

Comments:



Type of Protective Cover/Lock

Depth of Top of Roadway Box below Ground Surface ____ ft

Depth of Top of Riser Pipe below Ground Surface ____ ft +.3

Type of Protective Casing:

Length ____ ft

Inside Diameter ____ in

Depth of Bottom of Roadway Box ____ ft

Seals:

Type	Depth to Top (ft)	Thickness (ft)

Type of Riser Pipe: ***Schd 80 PVC, Timco***

Inside Diameter of Riser Pipe **1.93** in

Type of Backfill around Riser

Diameter of Largest CPT Expander **2.50** in

Depth of Top of Wellpoint 13.59 ft

Type of Point or Manufacturer: ***Schd 80 PVC, Timco***

Screen Gauge or Size of Openings **0.020** in

Diameter of Wellpoint **2.375** in

Depth of Bottom of Wellpoint 20.15 ft

Silt Trap Yes 1m

Depth of Bottom of Borehole 23.3 ft CPT

(Depths refer to ground surface)

Tip Material: ☐ Steel ☐ Stainless Steel ☑ Nylon ☐ Other: ________

13.59 ft	+	(2m) ft	+	1m ft	=	23.43 ft
Riser length (L1)		Screen length (L2)		Length of silt trap (L3)		Total length

CPT WELL INSTALLATION REPORT

Project: _5518 Direct Push Monitoring Point Assessment_

City/State: _Hanscom AFB, Bedford, MA_

Client: _Armstrong Laboratories, Tyndall AFB, AL/EQA_

Crew Chief: JOEL BORST / SHAWN PATENODE

Observation Well: AWZ-22

CPT ID: DPW-AWZ-22

Installation Date: 03-FEB-97

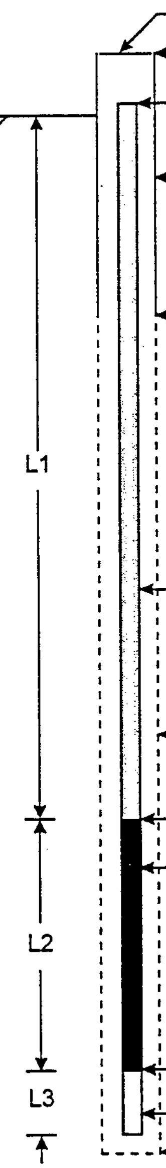
Location: SITE 21

ARA File No.: CPT-503F702.DAT

Ground El. ______

El. Datum ______

Comments:



Type of Protective Cover/Lock

Depth of Top of Roadway Box below Ground Surface ______ ft

Depth of Top of Riser Pipe below Ground Surface ______ ft

Type of Protective Casing:

Length ______ ft

Inside Diameter ______ in

Depth of Bottom of Roadway Box ______ ft

Seals:

Type	Depth to Top (ft)	Thickness (ft)

Type of Riser Pipe: ***Schd 80 PVC, Timco***

Inside Diameter of Riser Pipe **1.93** in

Type of Backfill around Riser

Diameter of Largest CPT Expander **2.50** in

Depth of Top of Wellpoint 9.56 ft

Type of Point or Manufacturer: ***Schd 80 PVC, Timco***

Screen Gauge or Size of Openings **0.020** in

Diameter of Wellpoint **2.375** in

Depth of Bottom of Wellpoint 19.40 ft

Silt Trap

Depth of CPT or DMY 21.50 ft

(Depths refer to ground surface)

Tip Material: Steel Stainless Steel Nylon Other: ______

Riser length (L1)		Screen length (L2)		Length of silt trap (L3)		Total length
9.56 ft	+	9.84 ft	+	Ø ft	=	19.40 ft

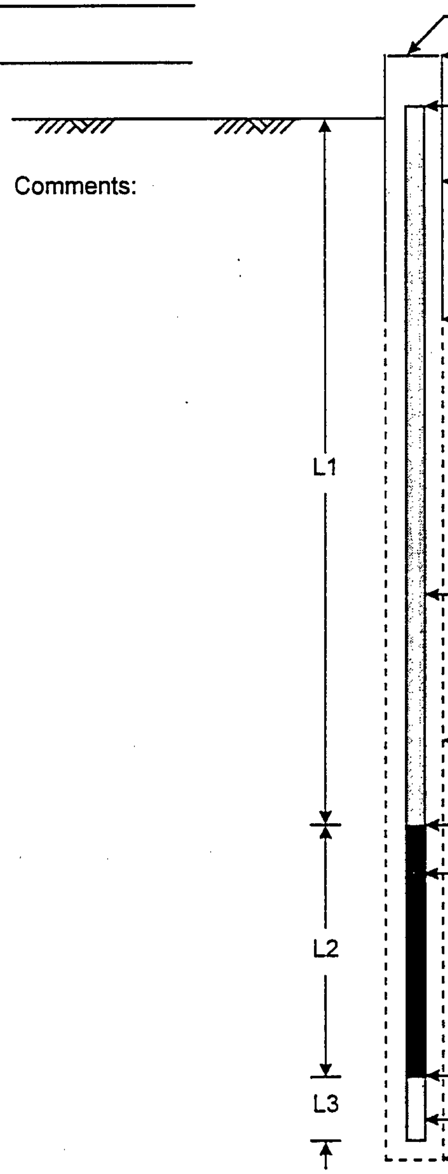
CPT WELL INSTALLATION REPORT

Project: _5518 Direct Push Monitoring Point Assessment_
City/State: _Hanscom AFB, Bedford, MA
Client: _Armstrong Laboratories, Tyndall AFB, AL/EQA
Crew Chief: JOEL BORT / SHAWN PATENAUDE

Observation Well: B-20
CPT ID: DPW-B-20
Installation Date: 03-FEB-97
Location: SITE 21
ARA File No.: CPT - 503F707.DAT

Ground El. ____
El. Datum ____

Comments:



Type of Protective Cover/Lock
Depth of Top of Roadway Box below Ground Surface ____ ft
Depth of Top of Riser Pipe below Ground Surface ____ ft
Type of Protective Casing:
Length ____ ft
Inside Diameter ____ in
Depth of Bottom of Roadway Box ____ ft

Seals:

Type	Depth to Top (ft)	Thickness (ft)

Type of Riser Pipe: ***Schd 80 PVC, Timco***
Inside Diameter of Riser Pipe **1.93** in
Type of Backfill around Riser
Diameter of Largest CPT Expander **2.50** in
Depth of Top of Wellpoint 7.41 ft
Type of Point or Manufacturer: ***Schd 80 PVC, Timco***
Screen Gauge or Size of Openings **0.020** in
Diameter of Wellpoint **2.375** in
Depth of Bottom of Wellpoint 17.25 ft
Silt Trap
Depth of CPT or DMY 19.00 ft

(Depths refer to ground surface)

Tip Material: Steel Stainless Steel Nylon Other: ____

Riser length (L1)		Screen length (L2)		Length of silt trap (L3)		Total length
7.41 ft	+	9.84 ft	+	Ø ft	=	17.25 ft

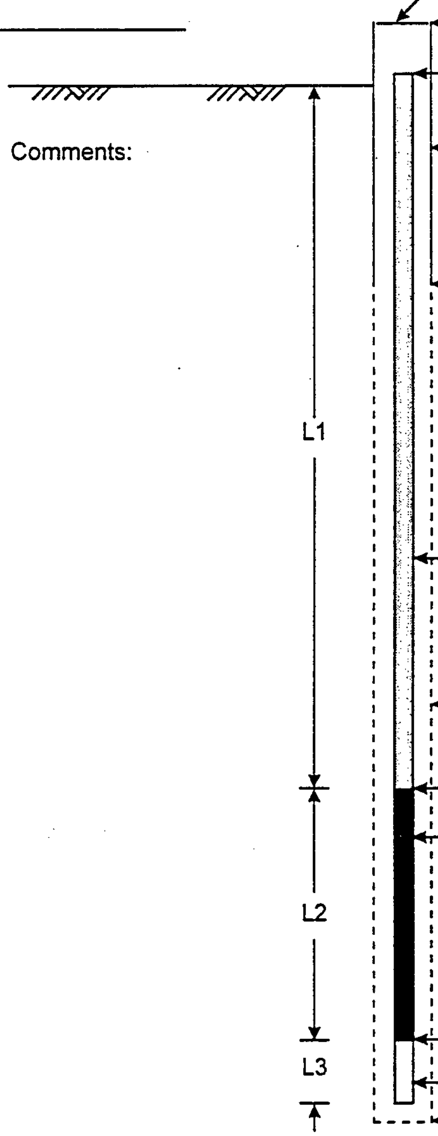
CPT WELL INSTALLATION REPORT

Project: **5518 Direct Push Monitoring Point Assessment**
City/State: **Hanscom AFB, Bedford, MA**
Client: **Armstrong Laboratories, Tyndall AFB, AL/EQA**
Crew Chief: JOEL BORST / SHAWN PATENAUDE

Observation Well: MWZ-17
CPT ID: DWP-MWZ-17
Installation Date: 03-FEB-97
Location: SITE Z1
ARA File No.: CPT·503F716.DAT

Ground El. ______
El. Datum ______

Comments:



Type of Protective Cover/Lock

Depth of Top of Roadway Box below Ground Surface ______ ft

Depth of Top of Riser Pipe below Ground Surface ______ ft

Type of Protective Casing:

- Length ______ ft
- Inside Diameter ______ in

Depth of Bottom of Roadway Box ______ ft

Seals:

Type	Depth to Top (ft)	Thickness (ft)

Type of Riser Pipe: ***Schd 80 PVC, Timco***

- Inside Diameter of Riser Pipe **1.93** in
- Type of Backfill around Riser

Diameter of Largest CPT Expander **2.50** in

Depth of Top of Wellpoint 9.76 ft

Type of Point or Manufacturer: ***Schd 80 PVC, Timco***

- Screen Gauge or Size of Openings **0.020** in
- Diameter of Wellpoint **2.375** in

Depth of Bottom of Wellpoint 19.10 ft

Silt Trap

Depth of CPT or DMY 20.20 ft

(Depths refer to ground surface)

Tip Material: Steel Stainless Steel Nylon Other: ______

Riser length (L1)		Screen length (L2)		Length of silt trap (L3)		Total length
9.76 ft	+	9.84 ft	+	0 ft	=	19.10 ft

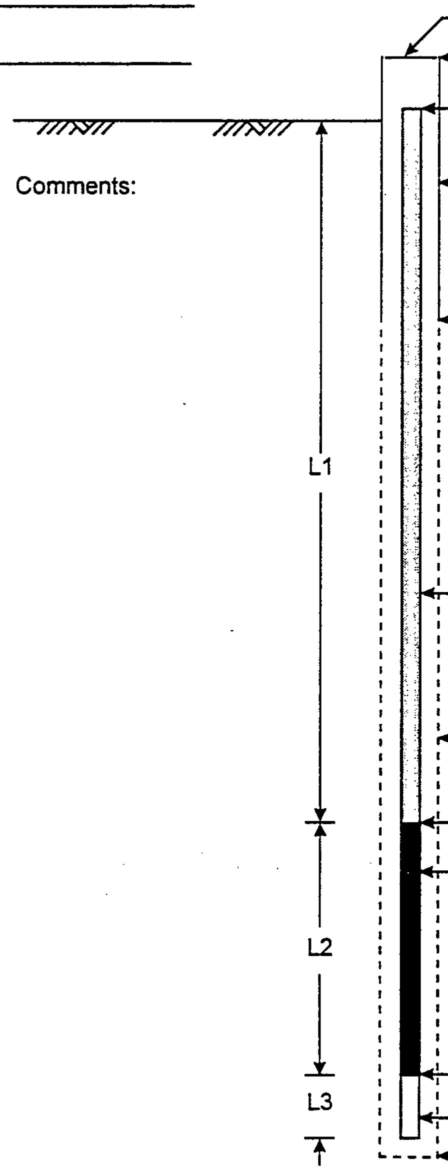
CPT WELL INSTALLATION REPORT

Project: **5518 Direct Push Monitoring Point Assessment**
Observation Well: MWZ-4
City/State: **Hanscom AFB, Bedford, MA**
CPT ID: DWP-MWZ-4
Client: **Armstrong Laboratories, Tyndall AFB, AL/EQA**
Installation Date: 04-FEB-97
Crew Chief: JOEL BORST / SHAWN PATENAUDE
Location: SITE 21
ARA File No.: CPT. 504F702.DAT

Ground El. ______

El. Datum ______

Comments:



Type of Protective Cover/Lock

Depth of Top of Roadway Box below Ground Surface ______ ft

Depth of Top of Riser Pipe below Ground Surface ______ ft

Type of Protective Casing:

Length ______ ft

Inside Diameter ______ in

Depth of Bottom of Roadway Box ______ ft

Seals:

Type	Depth to Top (ft)	Thickness (ft)

Type of Riser Pipe: ***Schd 80 PVC, Timco***

Inside Diameter of Riser Pipe **1.93** in

Type of Backfill around Riser

Diameter of Largest CPT Expander **2.50** in

Depth of Top of Wellpoint 8.16 ft

Type of Point or Manufacturer: ***Schd 80 PVC, Timco***

Screen Gauge or Size of Openings **0.020** in

Diameter of Wellpoint **2.375** in

Depth of Bottom of Wellpoint 18.00 ft

Silt Trap

Depth of CPT or DMY 19.90 ft

(Depths refer to ground surface)

Tip Material: Steel Stainless Steel Nylon Other: ______

Riser length (L1)		Screen length (L2)		Length of silt trap (L3)		Total length
8.16 ft	+	9.84 ft	+	0 ft	=	18.00 ft

CPT WELL INSTALLATION REPORT

Project: _5518 Direct Push Monitoring Point Assessment__________ Observation Well: MWZ-24

City/State: _Hanscom AFB, Bedford, MA ________________________ CPT ID: DWP-MWZ-24

Client: _Armstrong Laboratories, Tyndall AFB, AL/EQA ___________ Installation Date: 04-FEB-97

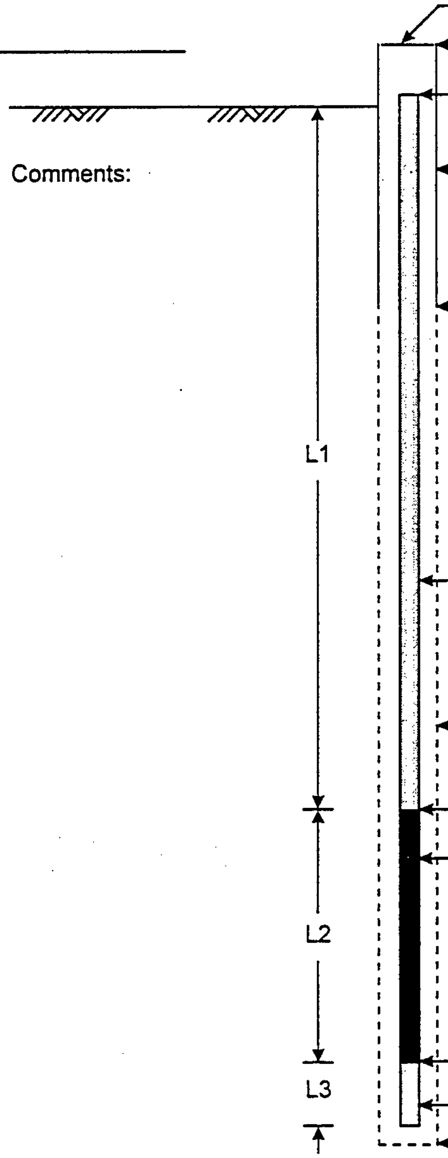
Crew Chief: JOEL BORST / SHAWN PATENRUDE Location: SITE 21

ARA File No.: CPT 504F706.DAT

Ground El. ________________

El. Datum ________________

Comments:



Type of Protective Cover/Lock

Depth of Top of Roadway Box below Ground Surface ________ ft

Depth of Top of Riser Pipe below Ground Surface ________ ft

Type of Protective Casing:

Length ________ ft

Inside Diameter ________ in

Depth of Bottom of Roadway Box ________ ft

Seals:

Type	Depth to Top (ft)	Thickness (ft)

Type of Riser Pipe: ***Schd 80 PVC, Timco***

Inside Diameter of Riser Pipe ***1.93*** in

Type of Backfill around Riser

Diameter of Largest CPT Expander ***2.50*** in

Depth of Top of Wellpoint ________ ft

Type of Point or Manufacturer: ***Schd 80 PVC, Timco***

Screen Gauge or Size of Openings ***0.020*** in

Diameter of Wellpoint ***2.375*** in

Depth of Bottom of Wellpoint 0 ft

Silt Trap

Depth of CPT or DMY 20.20 ft

(Depths refer to ground surface)

Tip Material: Steel Stainless Steel Nylon Other: ______________

________ ft	+	________ ft	+	________ ft	=	________ ft
Riser length (L1)		Screen length (L2)		Length of silt trap (L3)		Total length

* THIS WELL WAS BROKEN @ 14.4 ft

√

CPT WELL INSTALLATION REPORT

Project: _5518 Direct Push Monitoring Point Assessment_
Observation Well: B-39

City/State: _Hanscom AFB, Bedford, MA_
CPT ID: DwP-B-39

Client: _Armstrong Laboratories, Tyndall AFB, AL/EQA_
Installation Date: 04-FEB-97

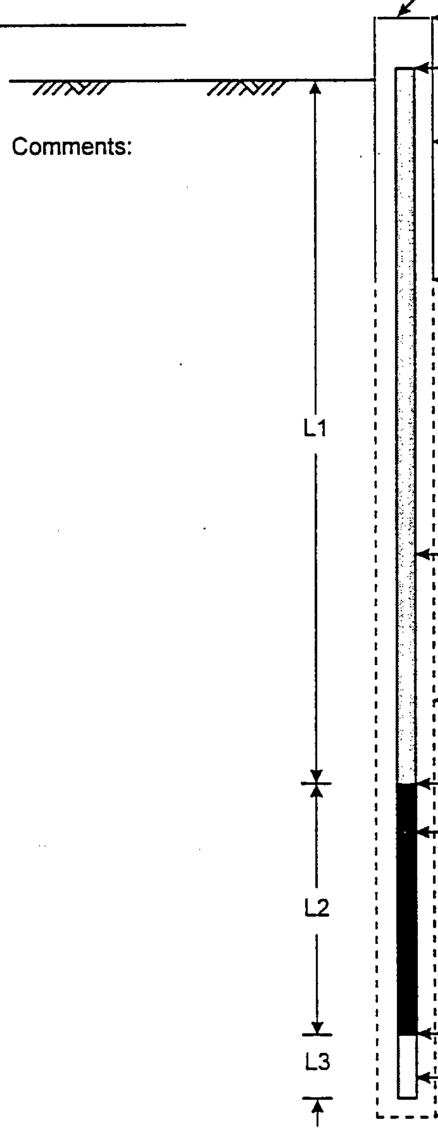
Crew Chief: Joel Borst / Shawn Patenaude
Location: Site 21

ARA File No.: CPT. 504F711.DAT

Ground El. ____________

El. Datum ____________

Comments:



Type of Protective Cover/Lock

Depth of Top of Roadway Box below Ground Surface ________ ft

Depth of Top of Riser Pipe below Ground Surface ________ ft

Type of Protective Casing:

Length ________ ft

Inside Diameter ________ in

Depth of Bottom of Roadway Box ________ ft

Seals:

Type	Depth to Top (ft)	Thickness (ft)

Type of Riser Pipe: ***Schd 80 PVC, Timco***

Inside Diameter of Riser Pipe **1.93** in

Type of Backfill around Riser

Diameter of Largest CPT Expander **2.50** in

Depth of Top of Wellpoint 7.91 ft

Type of Point or Manufacturer: ***Schd 80 PVC, Timco***

Screen Gauge or Size of Openings **0.020** in

Diameter of Wellpoint **2.375** in

Depth of Bottom of Wellpoint 17.75 ft

Silt Trap

Depth of CPT or DMY 21.00 ft

(Depths refer to ground surface)

Tip Material: Steel Stainless Steel Nylon Other: ____________

Riser length (L1)		Screen length (L2)		Length of silt trap (L3)		Total length
7.91 ft	+	9.84 ft	+	Ø ft	=	17.75 ft

CPT WELL INSTALLATION REPORT

Project: **5518 Direct Push Monitoring Point Assessment**

Observation Well: B-39

City/State: **Hanscom AFB, Bedford, MA**

CPT ID: DWP-B-39

Client: **Armstrong Laboratories, Tyndall AFB, AL/EQA**

Installation Date: 04-FEB-97

Crew Chief: JOEL BOIRST / SHAWN PATENFUDE

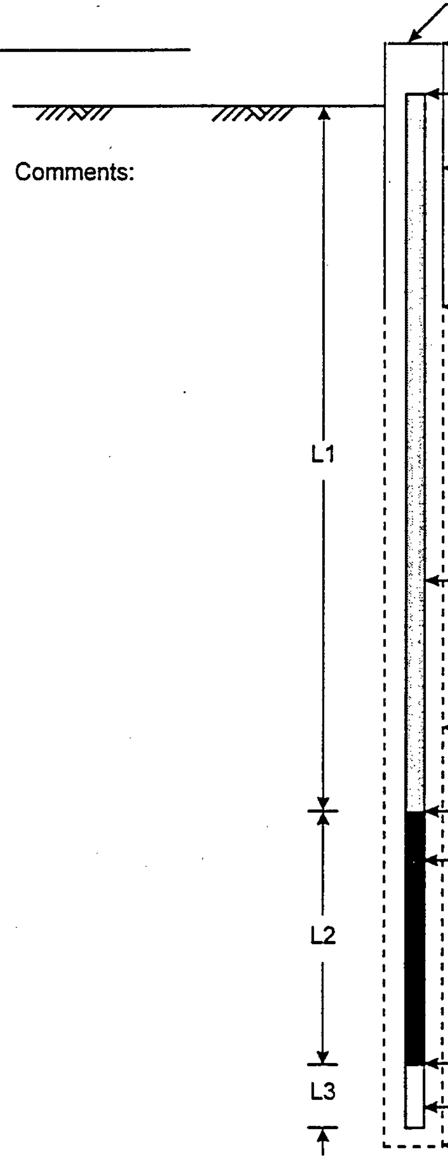
Location: SITE 21

ARA File No.: CPT 504E716

Ground El. ________

El. Datum ________

Comments:



Type of Protective Cover/Lock

Depth of Top of Roadway Box below Ground Surface ____ ft

Depth of Top of Riser Pipe below Ground Surface ____ ft

Type of Protective Casing:

Length ____ ft

Inside Diameter ____ in

Depth of Bottom of Roadway Box ____ ft

Seals:

Type	Depth to Top (ft)	Thickness (ft)

Type of Riser Pipe: ***Schd 80 PVC, Timco***

Inside Diameter of Riser Pipe **1.93** in

Type of Backfill around Riser

Diameter of Largest CPT Expander **2.50** in

Depth of Top of Wellpoint 8.12 ft

Type of Point or Manufacturer: ***Schd 80 PVC, Timco***

Screen Gauge or Size of Openings **0.020** in

Diameter of Wellpoint **2.375** in

Depth of Bottom of Wellpoint 17.96 ft

Silt Trap

Depth of CPT or DMY 20.50 ft

(Depths refer to ground surface)

Tip Material: Steel Stainless Steel Nylon Other: ________

Riser length (L1)		Screen length (L2)		Length of silt trap (L3)		Total length
8.12 ft	+	9.84 ft	+	0 ft	=	17.96 ft

CPT WELL INSTALLATION REPORT

Project: _ **5518 Direct Push Monitoring Point Assessment** ________

Observation Well: DPW-MWZ-11

City/State: _ **Hanscom AFB Bedford, MA** ____________

CPT ID: CPT-MWZ-11

Client: _**Armstrong Laboratories, Tyndall AFB, AL/EQA** ________

Installation Date: 2-1-97

Crew Chief: JOEL BORST

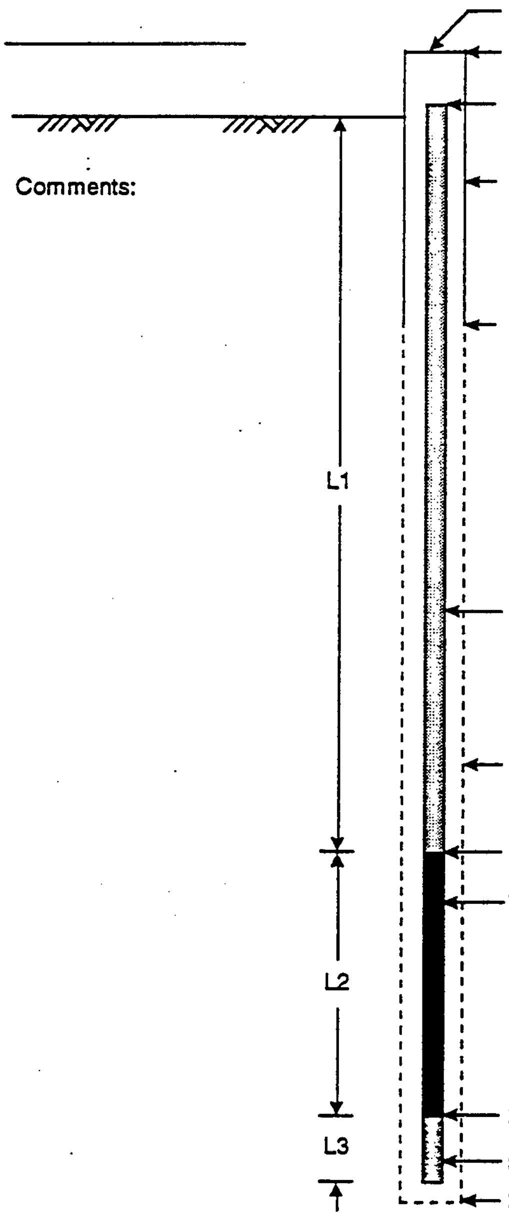
Location: SITE 21

ARA File No.: 501F707.DAT

Ground El. ____________

El. Datum ____________

Comments:



Type of Protective Cover/Lock

Depth of Top of Roadway Box below Ground Surface ______ ft

Depth of Top of Riser Pipe below Ground Surface ______ ft

Type of Protective Casing:

Length ______ ft

Inside Diameter ______ in

Depth of Bottom of Roadway Box ______ ft

Seals:

Type	Depth to Top (ft)	Thickness (ft)

Type of Riser Pipe: ***Schedule 80 PVC, Timco***

Inside Diameter of Riser Pipe **1.913** in

Type of Backfill around Riser

Diameter of Largest CPT Expander **2.5** in

Depth of Top of Wellpoint ______ ft

Type of Point or Manufacturer: ***Schedule 80 PVC, Timco***

Screen Gauge or Size of Openings **0.020** in

Diameter of Wellpoint **2.375** in

Depth of Bottom of Wellpoint 19.86 ft 19.9 SOLID BOTTOM

Silt Trap NO

Depth of Bottom of Borehole CPT 20.89 ft

(Depths refer to ground surface)

Tip Material: Steel Stainless Steel Nylon Other: ________

Riser length (L1)	+	Screen length (L2)	+	Length of silt trap (L3)	=	Total length
______ ft		3 (m) ~~ft~~		0 ft		______ ft

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CPT WELL INSTALLATION REPORT

Project: 5518 Direct Push Monitoring Point Assessment

Observation Well: DPW-MWZ-6

City/State: Hanscom AFB Bedford, MA

CPT ID: CPT-MWZ-6

Client: Armstrong Laboratories, Tyndall AFB, AL/EQA

Installation Date: 2-1-97

Crew Chief: JOEL BORST

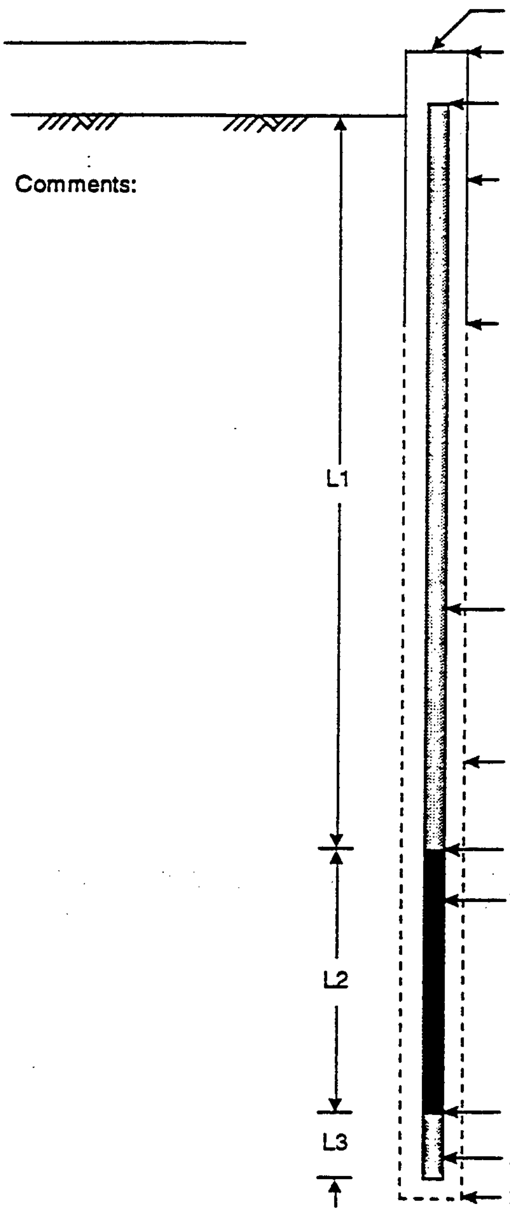
Location: SITE 21

ARA File No.: 501F702.DAT

Ground El. ____________

El. Datum ____________

Comments:



Type of Protective Cover/Lock

Depth of Top of Roadway Box below Ground Surface ______ ft

Depth of Top of Riser Pipe below Ground Surface ______ ft

Type of Protective Casing:

Length ______ ft

Inside Diameter ______ in

Depth of Bottom of Roadway Box ______ ft

Seals:

Type	Depth to Top (ft)	Thickness (ft)

Type of Riser Pipe: ***Schedule 80 PVC, Timco***

Inside Diameter of Riser Pipe ***1.913*** in

Type of Backfill around Riser

Diameter of Largest CPT Expander ***2.5*** in

Depth of Top of Wellpoint ______ ft

Type of Point or Manufacturer: ***Schedule 80 PVC, Timco***

Screen Gauge or Size of Openings ***0.020*** in

Diameter of Wellpoint ***2.375*** in

Depth of Bottom of Wellpoint 18.5 ft 18.8' SOLID BOTTOM

Silt Trap NO

Depth of Bottom of Borehole CPT 20.5 ft

(Depths refer to ground surface)

Tip Material: Steel Stainless Steel Nylon Other: ____________

Riser length (L1)		Screen length (L2)		Length of silt trap (L3)		Total length
______ ft	+	3 (m) ~~ft~~	+	0 ft	=	______ ft

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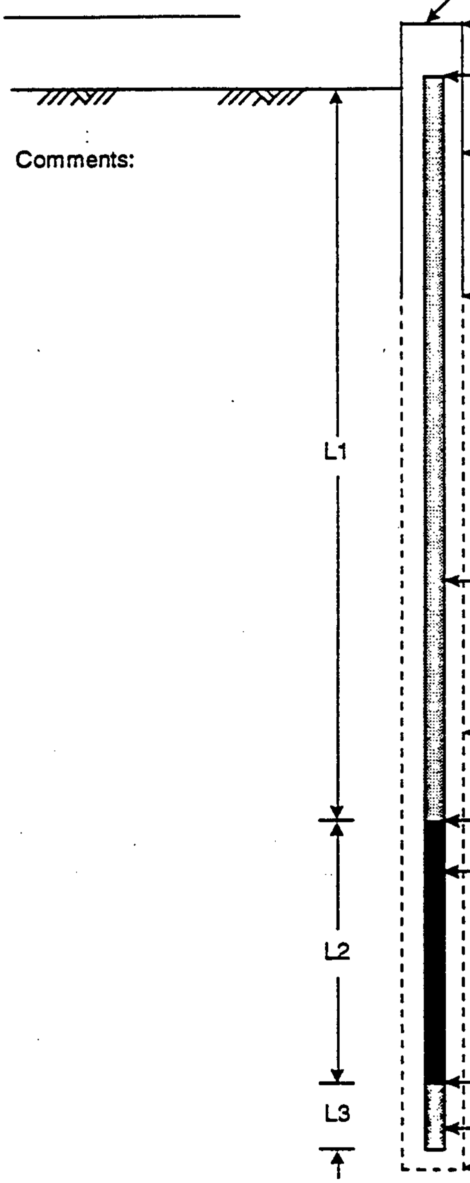
CPT WELL INSTALLATION REPORT

Project: 5518 Direct Push Monitoring Point Assessment
Observation Well: DPT-MWZ-12
City/State: Hanscom AFB Bedford, MA
CPT ID: CPT-MWZ-12
Client: Armstrong Laboratories, Tyndall AFB, AL/EQA
Installation Date: 1-31-97
Crew Chief: JOEL BORST
Location: SITE 21
ARA File No.: 531J718.DAT

Ground El. ____________

El. Datum ____________

Comments:



Type of Protective Cover/Lock

Depth of Top of Roadway Box below Ground Surface ______ ft

Depth of Top of Riser Pipe below Ground Surface ______ ft

Type of Protective Casing:

Length ______ ft

Inside Diameter ______ in

Depth of Bottom of Roadway Box ______ ft

Seals:

Type	Depth to Top (ft)	Thickness (ft)

Type of Riser Pipe: *Schedule 80 PVC, Timco*

Inside Diameter of Riser Pipe 1.913 in

Type of Backfill around Riser

Diameter of Largest CPT Expander 2.5 in

Depth of Top of Wellpoint ______ ft

Type of Point or Manufacturer: *Schedule 80 PVC, Timco*

Screen Gauge or Size of Openings 0.020 in

Diameter of Wellpoint 2.375 in

Depth of Bottom of Wellpoint 20.2 ft 19.5 MUSHY

Silt Trap NO

Depth of Bottom of Borehole CPT 22.4 ft

(Depths refer to ground surface)

Tip Material: Steel Stainless Steel Nylon Other: ____________

______ ft	+	3(m) ~~ft~~	+	0 ft	=	______ ft
Riser length (L1)		Screen length (L2)		Length of silt trap (L3)		Total length

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APPENDIX D

WELL DEVELOPMENT LOGS

WELL DEVELOPMENT LOG

PROJECT: **5518** **Monitoring Point Assess.**	SITE: **Hanscom AFB**	WELL ID: B102-MW	DATE: 02/12/97 ~~02/11/97~~
WELL DEPTH: 17.23' BGS	WATER LEVEL: 2.39-.23 = 2.16' BGS	WEATHER INFORMATION: OVERCAST MID 30'S	

METHOD & EQUIPMENT: **Aardvark Well Development Tool, Purge Pump**

SURGING TIME	PUMPING TIME	VOLUME BAILED DURING SURGING:
BEGIN: 08:50 END:	BEGIN: 08:50 END:	

TIME	MEASUREMENTS			OBSERVATIONS				
	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	CLARITY	COLOR	ODOR	PARTICULATES
T0: 9:36:40	42.82	5.08	0.02	17.70	?	PALE	/	FINE SAND
37:00	42.87	5.08	0.02	17.70				
37:20	42.97	5.10	0.02	17.80				
37:40	42.94	5.11	0.02	18.10				
53:20	44.48	5.12	"	1282.7		Lt BRN		
53:40	44.68	5.15	"	1283.8				
54:00	44.69	5.15	"	1283.8				
54:20	44.70	5.15	"	1283.9				
10:12:40	43.46	5.01	"	402.70		Lt BRN		
13:00	43.77	5.07	"	383.90				
13:20	43.67	5.11	"	361.40				
13:40	43.68	5.16	"	344.00				
END:								

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Comments: (TUES) 02/11/96 : THE WELL WAS USED FOR A TEST TO GET OUR DEVELOPMENT EQUIPMENT RUNNING.

Applied Research Associates, Inc
South Royalton, Vermont
(802) 763-8348

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WELL DEVELOPMENT LOG

PROJECT: **5518** **Monitoring Point Assess.**	SITE: **Hanscom AFB**	WELL ID: B102-MW	DATE: 02/12/96
WELL DEPTH: 17.23' BGS	WATER LEVEL: 2.16' BGS	WEATHER INFORMATION: Low 30's	
METHOD & EQUIPMENT: **Aardvark Well Development Tool, Purge Pump**			
SURGING TIME BEGIN: 8:50 END:	PUMPING TIME BEGIN: 08:50 END:	VOLUME BAILED DURING SURGING: 200 GAL (ESTIMATED FROM GRADUATIONS ON TANK)	

TIME	MEASUREMENTS TEMPERATURE	pH	SPEC. COND.	OBSERVATIONS TURBIDITY	CLARITY	COLOR	ODOR	PARTICULATES
T_0: 09:36:40								
37:00								
37:20								
40								
~~END:~~								

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Comments:

Applied Research Associates, Inc.
South Royalton, Vermont
(802) 763-8348

3/3

WELL DEVELOPMENT LOG

PROJECT: **5518** **Monitoring Point Assess.**	SITE: **Hanscom AFB**	WELL ID: B102-MW	DATE: 02/12/97
WELL DEPTH: 17.23 BGS	WATER LEVEL: 2.16' BGS	WEATHER INFORMATION: OVERCAST Low 30's	
METHOD & EQUIPMENT: **Aardvark Well Development Tool, Purge Pump**			
SURGING TIME BEGIN: 8:50 END:	PUMPING TIME BEGIN: 8:50 END:	VOLUME BAILED DURING SURGING:	

TIME	MEASUREMENTS TEMPERATURE	pH	SPEC. COND.	OBSERVATIONS TURBIDITY	CLARITY	COLOR	ODOR	PARTICULATES
14/12 T0: 12:04:00	44.84	4.62	0.3	423				
05:00	45.56	4.83	0.3	376.				
12/10 12:25:00				486.80				
(12:22) 12:26:00				316.90				
END:								

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Comments:

Applied Research Associates, Inc.
South Royalton, Vermont
(802) 763-8348

WELL DEVELOPMENT LOG

PROJECT: **5518** **Monitoring Point Assess.**	SITE: **Hanscom AFB**	WELL ID: B241	DATE: 02/13/97
WELL DEPTH: SEE CHART	WATER LEVEL: 4.74' FROM TOP O' PVC	WEATHER INFORMATION: WIND CHILL -5 COLD, COLD, COLD	

METHOD & EQUIPMENT: **Aardvark Well Development Tool, Purge Pump**

SURGING TIME	PUMPING TIME	VOLUME BAILED DURING SURGING:
BEGIN: 0840	BEGIN: 0840	
END:	END:	

	TIME	MEASUREMENTS			OBSERVATIONS				
		TEMPERATURE	pH	SPEC. COND.	TURBIDITY	CLARITY	COLOR	ODOR	PARTICULATES
15	T_0:08:56	40.17	6.13	0.02	984.7				
13	08:57	40.29	5.99	0.02	948.8				
15	09:06	40.17	5.94	0.02	1041.6				
13	09:07	40.21	5.78	0.02	902.6				
15	09:13	39.43	5.98	0.03	930.1				
13	09:14	39.53	5.85	0.03	811.8				
13	09:22	36.48	6.05	0.02	549.7				
11	09:23	36.70	5.87	0.02	463.4				
13	09:31	36.79	6.62	0.05	1216.9				
11	09:32	36.96	6.46	0.04	959.7				
	09:37	35.12	6.57	0.04	940.0				
11	09:38	35.27	6.47	0.04	817.2				
	END:								

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Comments:

Applied Research Associates, Inc.
South Royalton, Vermont
(802) 763-8348

WELL DEVELOPMENT LOG

2 of 3

PROJECT: **5518** **Monitoring Point Assess.**	SITE: **Hanscom AFB**	WELL ID: B241	DATE: 02/13/97
WELL DEPTH: SEE CHART	WATER LEVEL: 4.74' FROM TOP OF PVC	WEATHER INFORMATION: COLD, COLD, COLD WIND CHILL (-5)	
METHOD & EQUIPMENT: **Aardvark Well Development Tool, Purge Pump**			
SURGING TIME BEGIN: 0840 END:	PUMPING TIME BEGIN: 0840 END:	VOLUME BAILED DURING SURGING:	

	TIME	MEASUREMENTS			OBSERVATIONS				
		TEMPERATURE	pH	SPEC. COND.	TURBIDITY	CLARITY	COLOR	ODOR	PARTICULATES
11/9	T_0: 09:59	37.88	6.44	0.04	? 14.90				
	~~09:~~10:00	39.99	6.16	0.04	648.10				
11/9	10:14	41.48	6.32	0.02	309.7				
	10:15	41.58	6.26	0.02	288.0				
15/13	11:18	46.67	6.63	0.03	835.1				
	11:19	47.82	6.35	0.03	563.0				
15/13	11:27	45.36	6.41	0.03	508.5				
	11:28	46.13	6.29	0.03	453.8				
15/13	11:31	44.00	6.27	0.05	746.7				
	11:32	43.98	6.03	0.05	659.6				
	11:36	43.52	6.44	0.03	320.4				
13	11:37	43.72	6.24	0.03	254.5				
	END:								

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3 \pi r^3$

Comments: 9'-7' = NO WATER

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WELL DEVELOPMENT LOG

PROJECT: **5518** **Monitoring Point Assess.**	SITE: **Hanscom AFB**	WELL ID: B241	DATE: 02/13/97
WELL DEPTH: SEE CHART	WATER LEVEL: 4.74' FROM TOP OF PVC	WEATHER INFORMATION: COLD	
METHOD & EQUIPMENT: **Aardvark Well Development Tool, Purge Pump**			
SURGING TIME BEGIN: 0840 END:	PUMPING TIME BEGIN: 0840 END:	VOLUME BAILED DURING SURGING: 50 GAL (ESTIMATED)	

		MEASUREMENTS			OBSERVATIONS				
	TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	CLARITY	COLOR	ODOR	PARTICULATES
13/11	T_0: 11:46	43.75	6.47	0.02	36.9				
	11:47	44.56	6.30	0.02	~~25.0~~ 425.7				
3/11	11:51	42.23	6.29	0.04	373.7				
	11:52	42.45	6.21	0.04	321.5				
11/9	12:02	42.98	6.47	0.02	295.7				
	12:03	43.56	6.35	0.02	249.9				
11/9	12:06	39.66	6.40	0.00	383.9				
	12:07	40.32	6.22	0.01	351.8				
9/7	12:15	39.28	6.31	0.02	143.2				
	12:16	39.65	6.24	0.02	122.6				
	END:								

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Comments: 7/5 -- No H_2O.

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WELL DEVELOPMENT LOG

PROJECT: **5518** **Monitoring Point Assess.**	SITE: **Hanscom AFB**	WELL ID: RAP1-5S	DATE: 02/13/97
WELL DEPTH: 10.19	WATER LEVEL: 8.79	WEATHER INFORMATION: COLD	
METHOD & EQUIPMENT: **Aardvark Well Development Tool, Purge Pump**			
SURGING TIME BEGIN: 14:00:00 END:	PUMPING TIME BEGIN: 14:00:00 END: 14:10:00	VOLUME BAILED DURING SURGING: Ø Gals	

TIME	MEASUREMENTS			OBSERVATIONS				
	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	CLARITY	COLOR	ODOR	PARTICULATES
T_0:								
END:								

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Comments:

THERE WAS NOT ENOUGH H_2O TO PUMP.
SURGED FOR 15MIN.

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WELL DEVELOPMENT LOG

PROJECT: **5518** **Monitoring Point Assess.**	SITE: **Hanscom AFB**	WELL ID: B-103-AW	DATE: 02/13/97
WELL DEPTH: 15.31 ft BGS	WATER LEVEL: 14.31' TOP OF PVC	WEATHER INFORMATION: COLD, CLEAR + WINDY	
METHOD & EQUIPMENT: **Aardvark Well Development Tool, Purge Pump**			
SURGING TIME BEGIN: 1425:00 END:	PUMPING TIME BEGIN: — END: —	VOLUME BAILED DURING SURGING: Ø	

TIME	MEASUREMENTS			OBSERVATIONS				
	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	CLARITY	COLOR	ODOR	PARTICULATES
T_0:								
END:								

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Comments: ONLY 1 ft OF H2O / NOT ENOUGH TO PUMP
SURGE FOR 15 MIN.

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WELL DEVELOPMENT LOG

PROJECT: **5518** **Monitoring Point Assess.**	SITE: **Hanscom AFB**	WELL ID: B-104-MW	DATE: 02/013/97
WELL DEPTH: 8.74 ft BGS	WATER LEVEL: 8.82' TOP OF PVC	WEATHER INFORMATION: COLD, CLEAR & WINDY	
METHOD & EQUIPMENT: **Aardvark Well Development Tool, Purge Pump**			
SURGING TIME BEGIN: Ø END:	PUMPING TIME BEGIN: Ø END:	VOLUME BAILED DURING SURGING:	

TIME	MEASUREMENTS			OBSERVATIONS				
	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	CLARITY	COLOR	ODOR	PARTICULATES
T_0:								
END:								

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Comments: DIDN'T SURGE WELL DUE TO LACK OF H_2O

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WELL DEVELOPMENT LOG

PROJECT: **5518** **Monitoring Point Assess.**	SITE: **Hanscom AFB**	WELL ID: RAPI-4S	DATE: 02/14/97
WELL DEPTH: 14.63 ft	WATER LEVEL: 3.31' TOP OF PVC	WEATHER INFORMATION: OVERCAST, COLD, SNOWING	
METHOD & EQUIPMENT: **Aardvark Well Development Tool, Purge Pump**			
SURGING TIME BEGIN: 08:25 END: 10:30	PUMPING TIME BEGIN: 08:25 END: 09:15	VOLUME BAILED DURING ~~SURGING~~: PUMPING	

	TIME	MEASUREMENTS: TEMPERATURE	pH	SPEC. COND.	OBSERVATIONS: TURBIDITY	CLARITY	COLOR	ODOR	PARTICULATES
15/	T_0: 08:39	44.35	7.17	0.01	1284.0				
/13	08:40	48.40	7.20	0.01	1293.1				
15/	08:50	38.39	7.34	0.06	1270.3				
/13	08:51	39.15	7.37	0.07	1271.9				
13/	09:09	38.31	7.30	0.07	1269.5				
/11	09:10	39.16	7.28	0.07	1271.4				
11/	09:21	38.73	7.31	0.00	1270.0				
/9	09:22	37.74	7.25	0.01	1267.7				
9/									
/7									
	END:								

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Comments: FOR THE FIRST TEN MINUTES THE H_2O WAS VERY SILTY.

@ 08:55 MOVED DEVELOPMENT TOOL UP 2 ft. VERY LITTLE H_2O COMING UP.

@ 09:18 STOPPED PUMPING, FLUSH SYSTEM FOR SAMPLE JUST SURGING ONLY

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WELL DEVELOPMENT LOG

PROJECT: **5518** **Monitoring Point Assess.**	SITE: **Hanscom AFB**	WELL ID: OW2-2	DATE: 2/17/97
WELL DEPTH: 23.39' BGS	WATER LEVEL: 0.35' TOP PVC 12.63' TOP OF PVC	WEATHER INFORMATION: SUNNY, COOL	
METHOD & EQUIPMENT: **Aardvark Well Development Tool, Purge Pump**			
SURGING TIME BEGIN: END:	PUMPING TIME BEGIN: END:	VOLUME BAILED DURING SURGING:	

	MEASUREMENTS			OBSERVATIONS				
TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	CLARITY	COLOR	ODOR	PARTICULATES
T_0: 16:26:00	41.12	7.07	0.15	1274.6				
29/18 16:27:00	40.95	7.19	0.15	1274.2				
20/18 T10: 34:00	37.63	7.30	0.11	1266.7				
35:00	37.35	7.36	0.11	1072.0				
29/18 T20: 41:00	34.59	7.35	0.20	1259.5				
42:00	34.51	7.39	0.20	1259.3				
18/16 T8 58:00	31.92	7.41	0.00?	1213.1				
T8 59:00	31.95	7.47	0.00?	1192.0				
18/16 T15 17:08:00	32.02	7.23	0.00	1253.4				
T15 17:09:00	32.02	7.35	0.00	1253.4				
END:								

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Comments:

1 SCREEN = 3.28'

BOT OF SCRN = 20.14'

BOT OF WELL = 23.39

T10 => @ ~~13~~ 14MIN

T20 => @ 20MIN

-> STOP DUE TO COLD

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WELL DEVELOPMENT LOG

PROJECT: **5518** **Monitoring Point Assess.**	SITE: **Hanscom AFB**	WELL ID: 002-2	DATE: 2/18/97
WELL DEPTH: 23.39' BGS	WATER LEVEL: 12.85 TOP	WEATHER INFORMATION: WINDY - WARM	
METHOD & EQUIPMENT: **Aardvark Well Development Tool, Purge Pump**			
SURGING TIME BEGIN: 08:35 END: 09:05	PUMPING TIME BEGIN: 0835 END: 0920	VOLUME BAILED DURING SURGING: < 10 GALS	

		MEASUREMENTS			OBSERVATIONS				
	TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	CLARITY	COLOR	ODOR	PARTICULATES
T3	T0: 8:39:0	39.29	6.97	0.00	1271.5				
7/8	8:40:00	39.33	7.06	0.00	1080.5				
T10	46:00	39.58	7.18	0.098	1272.1				
9/8	47:00	39.62	7.24	0.10	1272.1				
T15	51:00	39.45	7.27	0.10	1271.6				
18	52:00	39.55	7.31	0.10	1271.8				
8/16	T0 59:00	40.09	7.32	0.11	1272.7				
	9:00:00	40.26	7.35	0.11	1273.1				
	END:								

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Comments:

QUESTIONS w/ CONDUCTIVITY

@ T0 18/16 NO WATER FLOW MUST PURGE TO GET SAMPLE

9:19 STOP PUMPING / NO WATER

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WELL DEVELOPMENT LOG

1/1

PROJECT: 5518 Monitoring Point Assess.	SITE: Hanscom AFB	WELL ID: BFW-11	DATE: 02/18/97
WELL DEPTH: 20.34' BGS	WATER LEVEL: .31 PVC 12.71' TOP	WEATHER INFORMATION: WARM, WINDY	
METHOD & EQUIPMENT: Aardvark Well Development Tool, Purge Pump			
SURGING TIME BEGIN: 10:35 STOPPED FOR 20M END: SEE NOTES	PUMPING TIME BEGIN: 10:35 STOPPED FOR 20M END: SEE NOTES	VOLUME BAILED DURING SURGING: 10-15 GAL	

	TIME	MEASUREMENTS			OBSERVATIONS				
		TEMPERATURE	pH	SPEC. COND.	TURBIDITY	CLARITY	COLOR	ODOR	PARTICULATES
17/15	T0: 10:36	47.24	7.37	0.102	1288.8				
	10:37	47.26	7.33	0.102	1226.1				
	T10 :46:00	48.42	7.38	0.060	1291.7				
	T10 :47:00	48.44	7.35	0.060	1291.7				
	T15 :51:00	47.84	7.32	0.061	1290.2				
	T15 :52:00	47.86	7.30	0.061	1290.2				
15/13	~~No H_2O~~								
17/	T0 13:36:00	53.77	7.25	0.068	861.80				
	T0 13:37:00	53.69	7.22	0.070	885.20				
	T5 13:41:00	54.10	7.03	0.069	807.3				
	T5 13:42:00	54.06	7.02	0.068	558.5				
	T10 13:46:00	53.24	7.00	0.108	663.6				
	T10 ~~END~~ 13:47:00	53.23	6.98	0.091	540.1				

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Comments:

SCREEN 17.42 -> 7.58 3 SECT.

SILT TRAP

NO SILT

~~STOPPED AFTER 10MIN / NO WATER~~?

@ 15/13 NOT ENOUGH H_2O TO PUMP SO

15/13 NO WATER

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WELL DEVELOPMENT LOG

PROJECT: **5518** **Monitoring Point Assess.**	SITE: **Hanscom AFB**	WELL ID: B107-MW	DATE: 2/18/97
WELL DEPTH: 17.21 - BGS SILT TRAP	WATER LEVEL: 0.36' TOP 2 GRND 8.67' T.O.P. 8.31	WEATHER INFORMATION: WARM, WINDY	
METHOD & EQUIPMENT: **Aardvark Well Development Tool, Purge Pump**			
SURGING TIME BEGIN: 15:30 END:	PUMPING TIME BEGIN: 15:30 END:	VOLUME BAILED DURING SURGING:	

		MEASUREMENTS			OBSERVATIONS				
	TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	CLARITY	COLOR	ODOR	PARTICULATES
14/12	T0: 15:38:00	49.53	6.83	0.071	1265.1				
	T0 39:00	49.49	6.85	0.071	1048.6				
	T10	46.64	6.73	.027	1287.9				
	T10	46.61	6.73	.028	1243.2				
	T15 15:51:00	46.77	6.65	0.048	1288.2				
	T15 15:52:00	46.74	6.68	0.048	1289.1				
	T20 15:55:00	46.68	6.64	0.048	1287.9				
	T20 56:00	46.66	6.68	0.049	1287.9				
12/10	T0 16:03:00	47.07	6.68	0.024	1288.6				
	T0 16:04:00	46.96	6.72	0.024	1112.3				
	T10 13:00	46.97	6.50	0.025	1288.3				
	T10 14:00	46.95	6.57	0.026	1009.1				
	T15 19:00	46.88	6.51	0.026	1288.1				
	T15 ~~END~~: 20:00	46.82	6.57	0.026	1270.3				

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3 \pi r^3$

Comments:

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WELL DEVELOPMENT LOG

PROJECT: **5518** **Monitoring Point Assess.**	SITE: **Hanscom AFB**	WELL ID: B107-MW	DATE: 2/18/97
WELL DEPTH:	WATER LEVEL:	WEATHER INFORMATION:	
METHOD & EQUIPMENT: ~~Aardvark Well Development Tool~~, Purge Pump			
SURGING TIME BEGIN: END: X	PUMPING TIME BEGIN: END: 15 MIN.	VOLUME BAILED DURING SURGING:	

TIME	MEASUREMENTS TEMPERATURE	pH	SPEC. COND.	OBSERVATIONS TURBIDITY	CLARITY	COLOR	ODOR	PARTICULATES
T_0: 17:05:00	46.66	5.74	0.05	220.80				
17:06:00	46.60	5.74	0.05	271.90				
17:11:00	46.46	5.70	0.05	3.20				
17:12:00	46.44	5.69	0.05	3.20				
17:16:00	46.69	5.69	0.05	1.20				
17:17:00	46.67	5.69	0.05	1.10				
END:								

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Comments:

THIS SHEET CONTAINS PURGE PUMP SAMPLES

TOTAL PUMP OUT OF WELL => 55 GALS

15 MIN @ 3 GAL/MIN + 10 SURGE + PUMP

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WELL DEVELOPMENT LOG

PROJECT: **5518 Monitoring Point Assess.**	SITE: **Hanscom AFB**	WELL ID: CWZ-1	DATE: 2/19/97
WELL DEPTH: 18.18' bGS	WATER LEVEL: 0.33' TOP 12.59' T.O.R = 12.26'	WEATHER INFORMATION: WARM, OVERCAST	
METHOD & EQUIPMENT: **Aardvark Well Development Tool, Purge Pump** SURGE SCREEN IN H_2O TABLE → PURGE PUMP			
* SURGING TIME BEGIN: 08:30 END:	PUMPING TIME BEGIN: 09:55:0 END: 10:10:0	VOLUME BAILED DURING SURGING: 53 GALS	

TIME	MEASUREMENTS: TEMPERATURE	pH	SPEC. COND.	OBSERVATIONS: TURBIDITY	CLARITY	COLOR	ODOR	PARTICULATES
T_2: 9:58:00	51.37	6.86	.057	91.6				
T_2 9:59:00	51.37	6.63	.057	74.2				
T_{10} 10:07:0	50.72	6.91	.056	1.6				
T_{10} 10:08:0	~~54~~.67	6.54	.055	2.0				
T_{15} 10:11:0	50.26	6.27	0.05	0.2	No WE	ARE NOT	LYING	!!
T_{15} 10:12:0	50.33	6.13	0.05	0.0				
END:								

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Comments:

NOTE: SURGING & PUMPING WILL BE DONE SEPARATELY.

15/13, 13/~~14~~

AARDVARK WAS PUMPING DURING SURGING. — No H_2O

0.8649 GALS/THIS WELL

15/13 - 20MIN SURGE
14/12 - 20MIN SURGE
WELL PUMPED @ 3GAL/MIN FOR 15MIN => 45 GAL
WHILE SUCTIONING SILT REMOVED 8GALS

53 GALS

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WELL DEVELOPMENT LOG

PROJECT: **5518** **Monitoring Point Assess.**	SITE: **Hanscom AFB**	WELL ID: B130	DATE: 2/19/97
WELL DEPTH: 17.15' BGS	WATER LEVEL: 0.26 TOP 9.45' T.O.P. = 9.19'	WEATHER INFORMATION: WARM, OVERCAST	
METHOD & EQUIPMENT: **Aardvark Well Development Tool, Purge Pump** AARDVARK SURGE w/ PURGE PUMP AFTER			
SURGING TIME BEGIN: 10:35 END: 11:20	PUMPING TIME BEGIN: END:	VOLUME BAILED DURING SURGING: => 10 GAL " " " PUMPING => 45 GAL TOTAL => $\boxed{55 \text{ GAL}}$	

TIME	MEASUREMENTS TEMPERATURE	pH	SPEC. COND.	OBSERVATIONS TURBIDITY	CLARITY	COLOR	ODOR	PARTICULATES
T_0: 11:42:00	47.97	6.56	.064	37.6				
T_0: 11:43	48.15	6.42	.064	36.2				
T_{10} 11:49	47.99	6.81	.062	1.1				
T_{10} 11:50	48.22	6.60	.063	.5				
T_{15} 11:53	47.16	6.96	.063	.1				
T_{15} 11:54	47.47	6.66	.063	.0				
END:								

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Comments:

BOT OF SCREEN = 14.11

4.92 ft OF H_2O (14/12; 12/10, 11/9)

15m 15m 15m => 45m SURGE

SUCTIONING = 11:25 START
11:35 STOP

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WELL DEVELOPMENT LOG

PROJECT: **5518** **Monitoring Point Assess.**	SITE: **Hanscom AFB**	WELL ID: RAP2-5(S)	DATE: 02/19/97
WELL DEPTH: 14.49' BGS	WATER LEVEL: 0.26 TOP 8.41' T.O.P. 8.15' BGS	WEATHER INFORMATION: WARM, OVERCAST	
METHOD & EQUIPMENT: **Aardvark Well Development Tool, Purge Pump** AARDVARK SURGE PURGE PUMP AFTER			
SURGING TIME BEGIN: 13:30 END:	PUMPING TIME BEGIN: 20 MIN END:	VOLUME BAILED DURING SURGING: => 6 GALS PUMPING => 60 GALS 66 GALS	

TIME	MEASUREMENTS TEMPERATURE	pH	SPEC. COND.	OBSERVATIONS TURBIDITY	CLARITY	COLOR	ODOR	PARTICULATES
T_0: 14:30:00	45.77	6.98	0.064	40.6				
T_0 31:00	46.77	6.93	0.066	32.1				
T_{10} 40:00	46.12	7.27	0.062	12.9				
T_{10} 41:00	46.26	7.10	0.062	9.0				
T_{15} 45:00	45.79	7.08	0.062	7.2				
T_{15} 46:00	45.89	6.97	0.062	6.1				
END:								

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Comments:

14.49 - 8.15 = 6.34 ft OF H_2O

(14.5/12.5 15MIN, 12.5/10.5 15MIN, 10.5/8.5 15MIN) => 45MIN + 5MIN SETUP + 5MIN GAS + 20MIN PUMP + 10MIN B.D. 1H30M

DURING SURGE: 1^{ST} & 2^{ND} 2ft SECTION => 6 GALS
3^{RD} 2ft SECTION => 0 GALS

DUE TO ~~NO~~ VERY LITTLE SILT IN BOTTOM SKIPPED SUCTIONING STEP

PUMP FOR 20MIN => 60 GALS
@ 3GAL/MIN

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WELL DEVELOPMENT LOG

PROJECT: **5518** **Monitoring Point Assess.**	SITE: **Hanscom AFB**	WELL ID: RAPZ-Z6)	DATE: 02/19/97 / 02/20/97
WELL DEPTH: 22.84' BGS	WATER LEVEL: 0.52 T.O.P. 6.98' T.O.R. 6.46'	WEATHER INFORMATION: WARM, OVERCAST, WINDY	
METHOD & EQUIPMENT: **Aardvark Well Development Tool, Purge Pump** AARDVARK SURGE/PUMP PURGE PUMP AFTER			
SURGING TIME BEGIN: 16:10 / 07:50 END: 17:25 / 08:20	PUMPING TIME BEGIN: 15 MIN @ END: 3 GAL/MIN	VOLUME BAILED DURING SURGING: => 51 GALS SUCTIONING => 12 GALS PUMPING => ~~45 GALS~~ TOTAL → 108 GALS	

TIME	MEASUREMENTS			OBSERVATIONS				
	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	CLARITY	COLOR	ODOR	PARTICULATES
T0: 9:09:0	45.71	8.30	0.051	562.4				
T0 9:10:0	45.71	7.64	0.048	494.9				
T10 9:16:0	47.90	7.36	0.041	5.8				
T10 9:17:0	48.43	6.79	0.041	4.9				
T15 9:21:0	47.41	6.87	0.041	2.6				
T15 9:22:0	47.53	6.46	0.041	2.6				
END:								

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Comments:

16.3856 of H_2O

(19.5/17.5, 17.5/15.5, 15.5/13.5, 13.5/11.5, 11.5/9.5, 9.5/7.5, 8.5/6.5)

15m 15m 15m 15m 15m | 15MIN 15MIN

50 GALS | 1 GAL => 51 GALS

START @ 07:50

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WELL DEVELOPMENT LOG

PROJECT: 5518 Monitoring Point Assess.	SITE: Hanscom AFB	WELL ID: B101-MW	DATE: 02/20/97
WELL DEPTH: 21.83' B.G.S.	WATER LEVEL: 0.23 TOP 8.32' T.O.P. = 8.09'	WEATHER INFORMATION: Sunny, Cool, Windy	

METHOD & EQUIPMENT: **Aardvark Well Development Tool, Purge Pump**

Aardvark surge/Pump → Purge Pump After

SURGING TIME	PUMPING TIME	VOLUME BAILED DURING SURGING:
BEGIN: 09:50	BEGIN: 15 MIN @	w/ Suctioning => 30 GALS
END: 11:05	END: 3 GAL/MIN	Pumping => 45 GALS
		TOTAL => 75 GALS

TIME	MEASUREMENTS: TEMPERATURE	pH	SPEC. COND.	OBSERVATIONS: TURBIDITY	CLARITY	COLOR	ODOR	PARTICULATES
T0: 11:27:0	48.18	6.45	0.056	452.1				
T0 11:28:0	48.17	6.10	0.056	407.0				
T10 11:36:0	46.75	6.22	0.055	3.2				
T10 11:37:0	46.81	5.85	0.055	1.6				
T15 11:41:0	46.93	5.85	0.056	1.1				
T15 11:42:0	47.00	5.77	0.054	1.1				
END:								

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Comments:

13.74' of H_2O

18.75 BOT. OF SCREEN

(18.75/16.75, 16.75/14.75, 14.75/12.75, 12.75/10.75, 10.75/8.75)

15 min, 15 min, 15 min, 15 min, 15 min

05, 20, 35, 50

30 GALS /w ~~Surg~~ Suctioning

$y = Mx + B$

$y^2 = Mx^2$

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WELL DEVELOPMENT LOG

PROJECT: **5518** **Monitoring Point Assess.**	SITE: **Hanscom AFB**	WELL ID: RAPZ-3(S)	DATE: 02/20/97
WELL DEPTH: 27' BGS	WATER LEVEL: 0.28% 5.35' T.O.P. => 5.07'	WEATHER INFORMATION:	
METHOD & EQUIPMENT: **Aardvark Well Development Tool, Purge Pump**			
SURGING TIME BEGIN: 12:00 END: 13:40	PUMPING TIME BEGIN: 15 MIN @ END: 3 GAL/MIN	VOLUME BAILED DURING SURGING: SECTIONING => 60 GALS PUMPING => 45 GALS TOTAL => 105 GALS	

TIME	MEASUREMENTS: TEMPERATURE	pH	SPEC. COND.	OBSERVATIONS: TURBIDITY	CLARITY	COLOR	ODOR	PARTICULATES
T0: 14:06	50.62	6.14	0.041	264.6				
T0 14:07	51.40	6.00	0.041	462.1				
T10 14:15	48.54	7.10	0.038	5.5				
T10 14:16	48.60	6.64	0.038	5.2				
T15	48.52	6.74	0.038	3.2				
T15	48.72	6.43	0.038	3.0				
END:								

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Comments:

23.73 B.T. OF SCREEN

23.75/21.75, 21.75/19.75, 19.75/17.75, 17.75/15.75, 15.75/13.75, 13.75/11.75, 11.75/9.75, 9.75/7.75, 7.75/5.75

10 10 10 10 10 10 10 10 10 => 90 MIN

H2O STILL FLOWING

LIGHT FLOW

NO H2O

* NOTE: BEING THAT THERE IS SO MANY SECTIONS OF SCREEN WE WILL ONLY SURGE THE 2' SECT. FOR 10 MIN.

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WELL DEVELOPMENT LOG

PROJECT: 5518 Monitoring Point Assess.	SITE: Hanscom AFB	WELL ID: B105-MW	DATE: 02/20/97
WELL DEPTH: 18.13' BGS	WATER LEVEL: 0.23' TOP 11.03' TOP ⇒ 10.80' BGS	WEATHER INFORMATION: WARM, SUNNY, BREEZY	
METHOD & EQUIPMENT: Aardvark Well Development Tool AND Purge Pump			
SURGING TIME BEGIN: 15:45 END:	PUMPING TIME BEGIN: SEE BELOW END:	VOLUME BAILED DURING SURGING: 5 GALS TOTAL	

TIME	MEASUREMENTS TEMPERATURE	pH	SPEC. COND.	OBSERVATIONS TURBIDITY	CLARITY	COLOR	ODOR	PARTICULATES
T0: 16:43:00	49.39	6.97	0.191	172.9				
To 16:44:00	49.39	6.71	0.191	151.4				
16:49:00	51.26	6.52	0.189	38.0				
16:50:00	51.22	6.22	0.189	31.5				
16:54:00	51.28	6.21	0.20	47.60				
16:55:00	50.64	5.99	0.20	53.20				
END:								

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Comments:

~~15.~~ 14.85' BOT. OF SCREEN

4.05' OF H_2O

(14.85/12.85 , 12.85/10.85)

15 SEC/ft RECHARGE

5 GALS

11.34 IN³/1ft OF WELL

=> 0.00656 ft³/ft WELL

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WELL DEVELOPMENT LOG

PROJECT: **5518** **Monitoring Point Assess.**	SITE: **Hanscom AFB**	WELL ID: B106	DATE: 02/21/97
WELL DEPTH: 17.1' BGS	WATER LEVEL: 0.24' TOP 8.51' TOR ⇒ 8.27' BGS	WEATHER INFORMATION: WINDY, WARM	
METHOD & EQUIPMENT: **Aardvark Well Development Tool, AND Purge Pump**			
SURGING TIME BEGIN: 8:10 END:	PUMPING TIME BEGIN: SEE BELOW END:	VOLUME BAILED DURING ~~SURGING~~: WHOLE PROCESS TOTAL: 7 GALS	

TIME	MEASUREMENTS TEMPERATURE	pH	SPEC. COND.	OBSERVATIONS TURBIDITY	CLARITY	COLOR	ODOR	PARTICULATES
T0: 09:45:0	46.31	7.90	0.058	716.2				
09:46:0	46.63	7.67	0.058	557.8				
09:54:00	45.21	7.82	0.057	222.6				
09:55:00	45.36	7.61	0.057	173.3				
10:04:00	43.80	7.74	0.055	154.4				
10:05:00	44.72	7.54	0.056	123.7				
END:								

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Comments:

8.51 0.24

(13.82/11.82 , 11.82/9.82 , 10.0/8.0)

15 MIN 15 MIN 15 MIN

PUMPING TIMES

1 MIN PUMP
50 SEC
1 MIN 10 SEC
1 MIN
1 MIN 12 SEC

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WELL DEVELOPMENT LOG

PROJECT: 5518 Monitoring Point Assess.	SITE: Hanscom AFB	WELL ID: RAPZ-4(S)	DATE: 02/21/97
WELL DEPTH: 24.52' BGS	WATER LEVEL: 0.38' TOC 7.13' T.O.P. = 6.75' BGS	WEATHER INFORMATION: WINDY, WARM	
METHOD & EQUIPMENT: Aardvark Well Development Tool, Purge Pump			
SURGING TIME BEGIN: 14:30:0 END:	PUMPING TIME BEGIN: 10 MIN @ END: 3 GALS/MIN	VOLUME BAILED DURING SURGING: 50 GALS SUCTIONING: 15 GALS PUMPING: 30 GALS TOTAL: 95 GALS	

TIME	MEASUREMENTS TEMPERATURE	pH	SPEC. COND.	OBSERVATIONS TURBIDITY	CLARITY	COLOR	ODOR	PARTICULATES
T_0: 16:50	50.94	6.66	0.08	584.80				
T6 16:51	51.02	6.38	0.08	474.50				
T3 16:54	49.56	6.45	0.08	20.20				
T5 16:55	49.97	6.24	0.09	15.70				
T10 16:59	49.43	6.10	0.08	5.70				
T20 17:	49.45	6.04	0.08	5.60				
END:								

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Comments:

(24.5/22.5, 22.5/20.5, 20.5/18.5, 18.5/16.5, 16.5/14.5, 14.5/12.5, 12.5/10.5, 10.5/8.5, 9.0/7.0)
10 10 10 10 10 10 10 10 10

* NOTE: DUE TO AMOUNT OF SCREEN IN H_2O + CLEARITY OF INITIAL H_2O SURGING WILL BE DONE 10 MIN/SECTION.

4ft SILT

* NOTE: DUE TO THE CLEARITY OF H_2O T5 + T10 SAMPLES WERE TAKEN INSTEAD OF T10 + T15.

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WELL DEVELOPMENT LOG

PROJECT: **5518** **Monitoring Point Assess.**	SITE: **Hanscom AFB**	WELL ID: RAPZ-2(T)	DATE: 02/21/97
WELL DEPTH: 62.19' BGS	WATER LEVEL: 9.84' BGS	WEATHER INFORMATION: WINDY, COOL, OVERCAST	
METHOD & EQUIPMENT: **Aardvark Well Development Tool, Purge Pump**			
SURGING TIME BEGIN: 11:05 END:	PUMPING TIME BEGIN: 15 MIN @ END: 1 GAL/MIN	VOLUME BAILED DURING SURGING: => 22 GALS PUMPING => 15 GALS TOTAL = 37 GALS	

TIME	MEASUREMENTS: TEMPERATURE	pH	SPEC. COND.	OBSERVATIONS: TURBIDITY	CLARITY	COLOR	ODOR	PARTICULATES
T_0:	50.31	7.82	0.132	87.4				
T0:	50.57	7.74	0.133	74.2				
T10:	51.51	7.69	0.132	121.8				
T10:	51.52	7.68	0.132	104.7				
T15: 13:19:00	50.94	7.63	0.131	31.7				
T15: 13:19:00	51.01	7.64	0.131	29.2				
END:								

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Comments:

60/58, 58/56 ~~SURGING~~

15 15 SUCTIONING => 15 GALS

$\underbrace{15 \quad 15}_{7\ GALS}$

* NOTE: DID NOT SURGE 62.19 -> 60 FEET

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WELL DEVELOPMENT LOG

PROJECT: **5518** **Monitoring Point Assess.**	SITE: **Hanscom AFB**	WELL ID: 8109-MW	DATE: 02/24/97
WELL DEPTH: 62.61' BGS	WATER LEVEL: 0.26 10.07' T.O.P - 9.79'	WEATHER INFORMATION: WINDY, SUNNY, WARM	
METHOD & EQUIPMENT: **Aardvark Well Development Tool, Purge Pump**			
SURGING TIME BEGIN: 14:00 END: 14:35	PUMPING TIME BEGIN: END:	VOLUME BAILED DURING SURGING: SUCTIONING: 10 GALS PUMPING:	

TIME	MEASUREMENTS TEMPERATURE	pH	SPEC. COND.	OBSERVATIONS TURBIDITY	CLARITY	COLOR	ODOR	PARTICULATES
T_0:								
END:								

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Comments:

(62.5/60.5, 61.5/59.5)
15 15 => 30MIN

*NOTE: DID NOT PUMP DUE TO WATER BEING AT 47 ft BGS (10' GALS)
POMP IS LIMITED TO 40 ft OF HEAD

2/26/97
PUMPING: 1M 30s SAMPLE
RECHARGE: 2M
PUMPING: 1M 30s SAMPLE
RECHARGE: 2M
PUMP 1M 30s SAMPLE

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GROUNDWATER SAMPLING LOG

PROJECT: 5518	SITE: 2	WELL ID: DPW-B101	DATE: 4-23-97
WELL DEPTH: 18.55	SCREEN LENGTH: 5m	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 7.24	WEATHER INFORMATION: Sunny, 18.7°C	

METHOD & EQUIPMENT: Low Flow with Grundfos Redi-flo Submersible Pump

TUBING TYPE: Teflon coated polyethylene | Pump depth | 10.55 ft btoc | 87 Hz

SAMPLING PERSONNEL: Chris Bianchi (JCB) and Marty Gildea (MLG)

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO		COMMENTS:
(units)	°C		mS/cm	NTU	mg/L		
T_0: 1310							∇ 7.2 @ T_0
1318							∇ 7.46, 1125 ml/min
1321							∇ 7.48, 1065 ml/min
1326	Hooked up YSI		cell				∇ 7.41 825 ml/min
1329	4 gal bucket dump						
1330	10.95	4.40	0.085	9.3	11.83		
1333	11.19	4.42	0.085	7.8	11.66		
1334							∇ 7.42 800 ml/min
1336	11.33	4.43	0.085	5.5	11.63		
1339	11.36	4.44	0.085	4.1	11.62		
END:							

Samples Collected: 2x40ml VOA and 2 Replicate 40ml VOA, Sq. 1019-1022

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Discharge at top of bucket ≈ 4' above ground

PURGE Vol ≈ 7 gal.

GROUNDWATER SAMPLING LOG

PROJECT: **5518**	SITE: 2	WELL ID: B101	DATE: 4-23-97
WELL DEPTH:	SCREEN LENGTH: 15 ft	WELL DIAMETER: **2"**	CASING TYPE: **PVC**
MEASUREMENT POINT: **TOC**	WATER LEVEL: 7.16	WEATHER INFORMATION: Same as Previous	

METHOD & EQUIPMENT: ***Low Flow with Grundfos Redi-flo Submersible Pump***

TUBING TYPE: ***Teflon coated polyethylene*** | Pump Depth: 10.3 ft btoc | Pump Dial: 83

SAMPLING PERSONNEL: ***Chris Bianchi (JCB) and Marty Gildea (MLG)***

TIME	TEMPERATURE 1	pH 4	SPEC. COND. 2	TURBIDITY 5	DO 3		COMMENTS:
(units)	°C		mS/cm	NTU	mg/L		
T_0: 1405							
1409							500 ml/min
1411							7.26 ▽ 1050 ml/m
1414	YSI Cell						900 ml/m
1417							7.26 ▽
1418	10.94	4.88	0.084	23.9	10.96		900 ml/m
1421	10.91	4.85	0.085	24.6	10.88		
1424	10.82	4.90	0.085	25.5	10.87		
1427	10.77	4.91	0.084	27.2	10.83		7.26 ▽ 900 ml/m
1430	Rinsed out	YSI	cell because of		high Turb. readings		
1433	10.72	4.82	0.084	4.4	10.98		
1436	10.51	4.97	0.084	4.0	10.97		900 ml/m @ 1439
1439	10.64	4.99	0.086	3.4	10.96		
1442	10.64	4.99	0.084	6.0	10.91		
1443	Samples Collected						
	Seq. #s	1023-	1026	Two Replicates to ITS			
END:							

Samples Collected: 2 x 40 mL VOAs and 2 Replicate 40 mL VOAs

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Discharge at ≈ ~~40~~ 4 ft ags (above ground surface)

Purge Vols,: 4 gals + 4.5 gal + 0.5 = 9 gals.

GROUNDWATER SAMPLING LOG

PROJECT: 5518	SITE: 1	WELL ID: B102	DATE: 5/2/97
WELL DEPTH: 14 ft bgs	SCREEN LENGTH: 11 ft	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 4.42 ft	WEATHER INFORMATION: COOL, SUNNY 8°C	

METHOD & EQUIPMENT: *Low Flow with Grundfos Redi-flo Submersible Pump*

TUBING TYPE: *Teflon coated polyethylene* | PUMP DEPTH: 11.5 ft btoc | DIAL: 56 Hz

SAMPLING PERSONNEL: *Chris Bianchi (JCB) and Marty Gildea (MLG)*

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO	▽	COMMENTS:
(units)	°C	pH	mS/cm	NTU	mg/L	ft/btoc	
T_0: 0820	STARTED PUMP						
0825	CONNECT CELL					4.48	450 ml/min
0830	9.20	4.59	.025	58.9	6.52	4.47	300 ml/min
0833	8.91	4.72	.049	71.2	6.29		480 ml/min
0836	9.16	4.77	.041	75.3	4.33	4.49	
0839	9.54	4.83	.052	58.7	3.61		
0842	9.67	4.86	.104	57.8	3.19	4.49	450 ml/min
0845	9.48	4.85	.017	59.0	3.19		
0848	9.43	4.81	.083	57.2	3.04		
0851	9.68	4.8'	-.03	54.5	2.91	4.49	400 ml/min AIR BUBBLES?
0854	9.81	4.78	.035	24.5	2.82		
0900	9.86	4.81	.038	25.7	2.93	4.49	400 ml/min
0903							MISSED?
0906	9.94	4.82	.032	25.3	2.93		
0909	9.88	4.82	.041	24.8	2.96		
0912	9.93	4.83	.064	24.9	3.00	4.49	400 ml/min AIR BUBBLES?
0915	9.92	4.81	-.04	13.6	2.94		
0924	9.57	4.81	.055	12.8	2.94		RINSED CELL
0927	9.20	4.82	.038	12.8	2.92	4.55	760 ml/min
0933	SAMPLES	TAKEN				4.52	500 ml/min
			SLOWED	DIAL TO	53 Hz	BEFORE	SAMPLING
END:							

PREVIOUS FILE

FILE B102.CW

Samples Collected: 2 x 40 ml VOA (SEQ 1145, 1146)

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

PURGE VOLS: 4.0 + 4.0 + 2.5 gAL

NOTE: IN "RUN" MODE, THE SPECIFIC CONDUCTIVITY IS UNSTABLE. ~~REPEATED ATTEMPTS TO REMOVE POSSIBLE AIR BUBBLES, UNSUCCESSFUL~~

NOTE: 0830-0854 SAVED UNDER PREVIOUS FILE

File: GROUNDWATER SAMPLING LOG.doc

GROUNDWATER SAMPLING LOG

PROJECT: 5518	SITE: 1	WELL ID: DPW-B102	DATE: 5/2/97
WELL DEPTH: 13.95	SCREEN LENGTH: 3. m	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 1.66 ft btoc	WEATHER INFORMATION: COOL, CLOUDY 11°C	
METHOD & EQUIPMENT: Low Flow with Grundfos Redi-flo Submersible Pump			
TUBING TYPE: Teflon coated polyethylene	PUMP DEPTH: 9.0 ft btoc	DIAL: ~~60~~ 55 Hz	
SAMPLING PERSONNEL: Chris Bianchi (JCB) and Marty Gildea (MLG)			

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO	∇	COMMENTS:
(units)	°C		mS/cm	NTU	mg/L	ft/btoc	
T_0: 1003	PUMP	STARTED					
1005						1.75	670 ml/min
1008						1.75	680 ml/min
1013	CONNECT CELL						680 ml/min
1020	RECALIBRATED SPECIFIC CONDUCTIVITY						
1025	RECONNECT CELL						
1030	10.58	4.90	.085	7.0	1.36		
1033	10.68	4.92	.012	11.8	1.62		680 ml/min
1036	10.71	4.89	.092	6.3	1.28		
1039	10.73	4.89	0.091	4.9	1.24		
1042	10.70	4.90	0.075	5.0	1.22	1.75	680 mL/min
1045	10.67	4.89	0.094	4.8	1.20		~~680 mL/min~~
1047	COLLECTED SAMPLES						
1050							~~70~~ 770 mL/min
END:							

Samples Collected: 2 x 40 ml VOA (SEQ # 1147, 1148)

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft: $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

PURGE VOL: 4.5 + 3 + .5 = 8 gals

CUT PVC → MEASUREMENT T.O.C. NEW ∇ (.56 ft CASING REMOVED)

AFTER RECALIBRATING SPEC. COND, THE NUMBERS LOOKED FINE, UNTILL RECONNECTING TO CELL. ONCE AGAIN VALUES WERE UNSTABLE. .00 → .09 → .00 → .09 ....

FILE INCLUDES UNIT.

File: GROUNDWATER SAMPLING LOG.doc

GROUNDWATER SAMPLING LOG

PROJECT: **5518**	SITE: 2	WELL ID: ~~DPW-B109~~ B105	DATE: 4-26-97
WELL DEPTH: 15'	SCREEN LENGTH: 10'	WELL DIAMETER: **2"**	CASING TYPE: **PVC**
MEASUREMENT POINT: **TOC**	WATER LEVEL: 11.33	WEATHER INFORMATION: PARTLY CLOUDY COOL, BREEZY	

METHOD & EQUIPMENT: ***Low Flow with Grundfos Redi-flo Submersible Pump***

TUBING TYPE: ***Teflon coated polyethylene*** | PUMP DEPTH = 17' BTOC | DIAL:

SAMPLING PERSONNEL: ***Chris Bianchi (JCB) and Marty Gildea (MLG)***

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO	▽	COMMENTS:
(units)							
T₀: 1317	PUMP ON!					11.33	
1318						11.43	760 mL/MIN
1320						11.42	740 mL/MIN
1324							760 mL/MIN
1327	CONNECTED SONDE						
1329	BEGAN LOGGING					11.40	720 mL/MIN
1332	15.14	5.07	0.483	50.0	11.62		
1336	15.47	5.04	0.506	133.5	11.69		
1338						11.40	
1340	16.57	5.14	0.526	170.0	11.95		820 mL/min
1344	16.93	5.53	0.549	7.0	12.28		740 mL/min
1348	16.55	5.55	0.571	6.4	11.71		
1356	16.61	5.59	0.586	18.5	11.47		
1400	16.80	5.60	0.592	27.2	11.44	11.39	680 mL/MIN
1404							
1408	Flushed Cell						
1412	13.32	5.48	0.614	15.4	12.34	11.39	740 mL/MIN
1448	15.05	5.58	0.673	2.3	12.18	11.38	640 mL/MIN
1452	14.63	5.58	0.668	3.3	12.05	11.38	640 mL/MIN
1456	14.14	5.57	0.691	3.1	12.12		
1457	COLLECTED SAMPLES.						
END:							

Samples Collected: 2 x 40 mL VOA's ; SER # 1098, 1099

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

PURGE VOLUME: 3 + 5 + 5 + 5

GROUNDWATER SAMPLING LOG

PROJECT: **5518**	SITE: 2	WELL ID: DPW-B105	DATE: 4-26-97
WELL DEPTH: ~~8.0~~ 14.85	SCREEN LENGTH: 1m	WELL DIAMETER: **2"**	CASING TYPE: **PVC**
MEASUREMENT POINT: **TOC**	WATER LEVEL: ~~8.48~~ 8.47	WEATHER INFORMATION: Sunny 16°C	
METHOD & EQUIPMENT: ***Low Flow with Grundfos Redi-flo Submersible Pump***			
TUBING TYPE: ***Teflon coated polyethylene***	Pump Depth: 14 ft btoc	Dial: 77	
SAMPLING PERSONNEL: ***Chris Bianchi (JCB) and Marty Gildea (MLG)***			

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO	∇	COMMENTS:
(units)							
T_0: 1604							8.47
1608						8.73	~~8.73~~ 970 mL/min
1615						8.71	~~8.71~~ 900 mL/min
1616						8.64	
1619						8.64	500 mL/min
1624	CONNECTED SONDE.						
1627						8.64	500 mL/min
1628	14.61	5.31	0.360	8.1	11.03		
1632	14.93	5.37	0.365	8.7	11.11	8.64	500 mL/min
1636	15.0	5.53	0.365	7.1	10.96		
1640	15.25	5.55	0.363	5.6	11.02		
1644	15.74	5.56	0.357	6.0	11.03		
1648	16.31	5.56	0.362	6.9	10.97		
1652	16.09	5.56	0.368	9.9	11.33		
1656	RINSED	CELL					
1700	14.26	5.57	0.362	8.4	11.95		500 mL/min
1704	14.22	5.55	0.366	8.0	11.82		
1708	COLLECTED	SAMPLES.					
END:							

Samples Collected: 2 X 40 mL VOA's ~~1~~ (SEQ# 1100, 1101) + 1 X 40 mL EQUIP. BLNK.

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

PURGE VOL = 4.5 + 4.0 + 0.25 = 8.75 GALS

GROUNDWATER SAMPLING LOG

YSI: B107.DP

PROJECT: **5518**	SITE: 2	WELL ID: DPW-B107	DATE: 4-22-97	
WELL DEPTH: 17.21	SCREEN LENGTH: 3m	WELL DIAMETER: **2"**	CASING TYPE: **PVC**	
MEASUREMENT POINT: **TOC**	WATER LEVEL: 7.63	WEATHER INFORMATION: Sunny 12°C		
METHOD & EQUIPMENT: ***Low Flow with Grundfos Redi-flo Submersible Pump***				
TUBING TYPE: ***Teflon coated polyethylene***	Pump Depth: ~~9.4 ft~~ 10.0 ft			
SAMPLING PERSONNEL: ***Chris Bianchi (JCB) and ~~Marty Gildea (MLG)~~*** ~~RGW~~ MLG				

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO	DO	COMMENTS:
(units)				NTU	% (day 4)	~~DO~~ mg/L	
T_0: 1127							600 ml / 0.25
1239 Started over once again				Flow rate ≈			700ml/min
Pump at 10.0 ft btoc,			Pump dial 80 Hz				
12:54	10.3	~~0.049~~	~~9~~				1050/min
12:54		5.88	0.049	4.8	96.7		
12:57	10.53	5.16	0.049	3.4	99.0	Water level 8.16	
13:00	10.54	4.72	0.048	3.5	99.5		
13:03	10.41	4.48	0.047	4.1	100.0		
13:05 Water level 8.20							
13:06	10.25	4.36	0.048	2.9	99.9		
13:08	Flow rate		~~Ht~~ Hz 80				975 ml/min
13:09	10.48	4.29	0.048	2.7	100.2 (11.19) DO mg/L		
13:12	10.77	4.32	0.049	2.0	98.5 (10.92)		2.5% change in DO
13:15	10.75	4.31	0.048	2.5	99.6 (11.05)		1.2% change in DO
13:18	10.73	4.32	0.048	2.1	98.4	(10.92)	
13:19		∇=	8.11				
13:20	Flow rate						750ml/min
13:21	10.80	4.32	0.048	3.6		10.83	
13:23		∇ =	8.04				
13:27	11.01	4.46	0.049	2.0		10.63	
End							
END:							

Samples Collected: 2 40 ml VOA with 2 drops of HCl Sq. 1007 and 1008

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$ 1009 Eqip. Blk

No redox probe

Total Purge volume unknown because of problems with pumb.

GROUNDWATER SAMPLING LOG

YSI: B107.cw

PROJECT: 5518	SITE: 2	WELL ID: B107	DATE: 4-22-97
WELL DEPTH: 14.0 ft	SCREEN LENGTH: 10 ft	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 10.39	WEATHER INFORMATION: Cloudy 15°C	
METHOD & EQUIPMENT: Low Flow with Grundfos Redi-flo Submersible Pump			
TUBING TYPE: Teflon coated polyethylene | Pump Depth: 12' 6.5" btoc | 70 Hz			
SAMPLING PERSONNEL: Chris Bianchi (JCB) and Marty Gildea (MLG)			

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO		COMMENTS:
(units)	°C			NTU	mg/L		
T_0: 1614							
1620	Flow	~~675~~	ml/min			675	ml/min
1626	~~∇ 10.47~~					10.47	∇ 1627 YSI
1630	~~∇ 10.50~~					10.50	∇
1630	10.62	6.38	0.054	3.0	11.04		
1632						525	ml/min
1633	11.00	6.30	0.057	1.8	10.82		
1634						460	ml/min
1635						10.45	∇
1636	11.31	6.24	0.056	1.5	10.73		
1639	11.50	6.23	0.057	1.2	10.59		
1640	2 Samples collected					10.42	∇
1704	Equipment blank						
1710						10.39	∇
END:							

Samples Collected: 2 40ml VOA, 1 Equipment Blank

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Purge 6 gallons total

Bucket dumps
1 ½ dumps

GROUNDWATER SAMPLING LOG

PROJECT: 5518	SITE: 2	WELL ID: B109	DATE: 4.29.97
WELL DEPTH: 69ft bgs	SCREEN LENGTH: 10ft	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 11.92	WEATHER INFORMATION: Sonny 15°C	

METHOD & EQUIPMENT: *Low Flow with Grundfos Redi-flo Submersible Pump*

TUBING TYPE: *Teflon coated polyethylene* | Pump Depth: 63 ft btoc | Dial: 79 Hz

SAMPLING PERSONNEL: Chris Bianchi (JCB) and ~~Marty Gildea (MLG)~~ RGW

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO	▼	COMMENTS:
(units)	°C		mS/cm	NTU	mg/L	(ft btoc)	
T0: ~~0847~~ 0827	Pump started						
0830						12.09	
0832							730 mL/min
0835	CONNECTED	SOND AFTER MEASUREMENT				11.99	635 ml/min
0838							600mL/min
0840						12.01	
0842	11.70	5.82	0.175	126.3	1.01		
0845	12.02	5.85	0.174	82.5	0.85	12.01	600mL/min
0848	12.29	5.87	0.174	60.4	0.78		
0851	12.32	5.88	0.175	50.5	0.71		
0854	12.43	5.89	0.175	30.3	0.66		640mL/min
0857	12.55	5.89	0.175	28.4	0.61		~~Drained Cell~~
0900	12.58	5.92	0.177	45.9	1.57	12.02	between measurement
0903	12.64	5.91	0.175	22.4	0.60		
0906	12.71	5.91		21.8			
~~090~~ 0909	12.73	5.92	0.176	18.8	0.51		
0912	12.75	5.93	0.175	17.3	0.50		640mL/min
0915	12.87	5.93	0.177	14.2	0.48	12.02	
0918	12.85	5.93	0.175	14.4	0.47		
0921	Collected	Samples					
END:							

Samples Collected: 2 x 40mL VOAs (Seq. #s 1115-1116)

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Purge Vols: 4 + ~~4~~5 = 9gals

GROUNDWATER SAMPLING LOG

PROJECT: **5518**	SITE: 2	WELL ID: DPW-B109	DATE: 4-29-97
WELL DEPTH: 62.8	SCREEN LENGTH: 1m	WELL DIAMETER: **2"**	CASING TYPE: **PVC**
MEASUREMENT POINT: **TOC**	WATER LEVEL: 9.13	WEATHER INFORMATION: Sunny 13°C in Shade	

METHOD & EQUIPMENT: ***Low Flow with Grundfos Redi-flo Submersible Pump***

TUBING TYPE: ***Teflon coated polyethylene*** | Pump Depth: 60 ft btoc | Dial:

SAMPLING PERSONNEL: ***Chris Bianchi (JCB) and ~~Marty Gildea (MLG)~~*** RGW

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO	▼	COMMENTS:
(units)	°C		mS/cm	NTU	mg/L	ft btoc	
T_0:	Well not developed very well. Dropping pump pushed water out the top						
	and in about 5 min. it had only dissipated about 1 ft.						
0941	Pump Started						
0944	At 21 ft of draw down, stopped					10.73	200ml/min
0947	flow without letting pump drain and					12.00	
0950	measured recovery at about 0.1 ft /25 to 30s					13.60	
1004	over about 0.5 ft. Calculated in flow to be about 120 ml/min.					20.7	
	we put a restricter on end of out flow so we						
	could drop the flow rate down to ≈100ml/min						
	without outflow tube draining and getting air in will try to sample this way.						
1021	CONNECTED SOND and cell						
1024	slowed flow rate again after measurement					23.1	120 mL/min
1027	14.38	6.06	0.176	80.2	2.56	22.55	90mL/min
1030	14.76	6.08	0.176	78.9	2.45		
1033	15.10	6.09	0.176	119.7	2.33		130mL/min adjust rate
1036	15.44	6.11	0.177	94.1	2.13	22.37	125mL/min adjust rate
1039	15.65	6.12	0.178	75.3	2.04	22.03	85ml/min
1042	15.91	6.13	0.180	68.9	1.97		~~115~~
1045	16.25	6.14	0.178	32.2	1.89	21.33	115ml/min
1048	16.56	6.15	0.182	46.2	1.77		
1051	16.69	6.16	0.181	72.7	1.80	21.20	130ml/min
1055	Samples Collected					21.46	after disconnecting cell
END:							

Samples Collected: 2 x 40ml VOAs (Seq. #s 1117-1118)

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$ Sched 80 PVC 565.2 ml/ft

Sched 80 PVC 2" Area = 2.874 in² ≈ ~~0.2395 ft²~~ ≈ 0.020 ft³

Vol of well is ~~12.7 gals~~ ft³ 1.07 ft³ ≈ 30.2L

Purge Vols: 2 gals + 2.5 gals = 4.5 gals

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GROUNDWATER SAMPLING LOG

PROJECT: **5518**	SITE: 2	WELL ID: DPW-B130	DATE: 4-24-97
WELL DEPTH:	SCREEN LENGTH: ~~9.2~~ 3m	WELL DIAMETER: **2"**	CASING TYPE: **PVC**
MEASUREMENT POINT: **TOC**	WATER LEVEL: 8.1	WEATHER INFORMATION: Cloudy 42°F	

METHOD & EQUIPMENT: ***Low Flow with Grundfos Redi-flo Submersible Pump***

TUBING TYPE: ***Teflon coated polyethylene*** Pump Depth: 9.2 ft Dial: 77 Hz

SAMPLING PERSONNEL: ***Chris Bianchi (JCB) and Marty Gildea (MLG)***

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO	▽	COMMENTS:
(units)							
T₀: 1136							
1138						8.21	8
1139						8.21	1600 mL/min
1147						8.15	550 mL/min
1149	Connected Sond, start Logging						
1151						8.12	
1154	7.64	4.62	0.069	72.7	12.27		700 mL/min
1157	7.95	4.92	0.067	87.8	11.73		
1158						8.15	650 mL/min
1200	8.73	5.15	0.067	106.8	11.50		
1203	9.03	5.24	0.069	131.5	11.56		Turbidity High
1204	Rinse Sond						
1206	— Re-connect Sond.						
1209	8.43	5.38	0.067	4.9	11.90		
12 11	Air in line, increased flow rate for few seconds						
1212	8.53	5.45	0.067	13.7	11.70		
1214							720 mL/min
1215	9.16	5.38	0.067	35.3	11.59		
1218	9.83	5.47	0.071	87.4	11.83		620 mL/min
1221	9.13	5.40	0.068	23.0	11.73		
1222							475 mL/min
1224	9.08	5.39	0.068	13.7	11.70	Change	Dial setting to 78 Hz
1227	8.97	5.37	0.069	8.3	11.68	8.14	420 mL/min
1229	Increased	Pump Dial	again to	95 Hz,	flow had	stopped	
~~120~~ 1230	8.94	5.39	0.067	10.2	11.69		
~~END:~~ 1233	9.02	5.38	0.068	8.9	11.67		280 mL/min

Samples Collected: 2 x 40 mL VOAs + 2 Dups + 2 Replicates Sq # 1051-1056

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Collected samples even though Turb. was 7.5 NTUs

Samples Collected @ 1237

Purge Vols.: 4 gal + 4 gals + 2 gals = 10 gals

GROUNDWATER SAMPLING LOG

PROJECT: **5518**	SITE: 2	WELL ID: B130	DATE: 4·24·97
WELL DEPTH:	SCREEN LENGTH: 10'	WELL DIAMETER: **2"**	CASING TYPE: **PVC**
MEASUREMENT POINT: **TOC**	WATER LEVEL: 10.74	WEATHER INFORMATION: CLOUDY, 42° F	
METHOD & EQUIPMENT: ***Low Flow with Grundfos Redi-flo Submersible Pump***			
TUBING TYPE: ***Teflon coated polyethylene***	PUMP DEPTH = 12'	DIAL: 78 Hz	
SAMPLING PERSONNEL: ***Chris Bianchi (JCB) and Marty Gildea (MLG)***			

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO	∇	COMMENTS:
(units)	°C		MS/cm	NTU	mg/L	ft From TOC	
T_0: 1312	Pump on						
1314						10.77	900 mL/min
1317							~~600~~ ~~650 mL/min~~ OOps!
1319						10.77	900 mL/min
1322	Connected Sond						
1327	8.85	5.45	0.077	5.1	12.02	10.77	720 mL/min
1330	8.96	5.45	0.072	4.3	11.76		
	9.12	5.74	0.078	4.8	11.68	10.76	400 mL/min
1336	9.37	5.49	0.078	3.6	11.72		540 mL/min
END:							

Samples Collected: 2 x 40 mL VOA's (SEQ #: 1057 - 1058)

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

PURGE VOL = 4.5 GAL

GROUNDWATER SAMPLING LOG

PROJECT: **5518**	SITE: 1	WELL ID: B238	DATE: 5-3-97
WELL DEPTH: 10 ft bgs	SCREEN LENGTH: 5ft	WELL DIAMETER: **2"**	CASING TYPE: **PVC**
MEASUREMENT POINT: **TOC** Black mark on PVC	WATER LEVEL: 3.50	WEATHER INFORMATION: Cloudy, cool, 12°C	
METHOD & EQUIPMENT: ***Low Flow with Grundfos Redi-flo Submersible Pump***			
TUBING TYPE: ***Teflon coated polyethylene***	Pump Depth: 7.5 ft	Dial 65 Hz	
SAMPLING PERSONNEL: ***Chris Bianchi (JCB) and Marty Gildea (MLG)***			

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO	▼	COMMENTS:	
(units)	°C		mS/cm	NTU	mg/cm	ft btoc		
T₀: 0841	STARTED PUMP							
0859	VERY SLOW RECHARGE					3.93	75 ml/min	
~~08~~ 0902						3.99	90 ml/min	
0904	("DRIPPING" FLOW RATE)					4.00	75 ml/min	
0910						4.21	100 ml/min	
0916	CONNECT SOND CELL					4.90	150 ml/min	
0924	10.99	5.29	.090	13.4	4.74	4.81	125 ml/min	
0927	11.02	5.36	.090	15.0	4.70			FLUSHING BUBBLES IN LINE
0930	11.51	5.68	.095	24.5	3.50		150 ml/min	
0933	11.69	5.90	.093	18.5	2.70	5.02	150 ml/min	
0936	11.77	5.97	.094	14.3	2.62			
0939	11.77	6.01	.093	12.2	2.68	4.83	~~80~~ ml/min	*
0942	11.73	6.05	.095	9.2	2.89			
0945	11.83	6.06	".10"	16.30	~~4.75~~ 4.11			
0948	11.94	6.05	.096	15.2	4.75			
0951	11.98	6.04	.095	12.7	5.08	4.95		
0957	11.89	5.97	.093	11.3	5.41			
1000	11.85	5.99	.095	10.6	5.74			
10.03	11.90	6.00	.093	9.2	5.95			
1006	11.94	5.97	.096.	12.9	6.20	5.30	210	
1012	COLLECT SAMPLES							
END:								

Samples Collected: 2 x 40 mL VOA (SEQ #, 1153, 1154) + 2 Equip. Blnks. (1155, 1156)

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

PURGE VOLS: 4.0

GROUNDWATER SAMPLING LOG

PROJECT: 5518	SITE: 1	WELL ID: DPW - B238	DATE: 5/3/97
WELL DEPTH: 10.27 ft	SCREEN LENGTH: 2 m	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC NEW TOP OF PVC, Black mark	WATER LEVEL: ~~4.28~~ 4.28	WEATHER INFORMATION: Cloudy overcast, 13°C	
METHOD & EQUIPMENT: Low Flow with Grundfos Redi-flo Submersible Pump			
TUBING TYPE: Teflon coated polyethylene	Pump Depth: 7.5 ft	Dial:	
SAMPLING PERSONNEL: Chris Bianchi (JCB) and Marty Gildea (MLG)			

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO	▼	COMMENTS:
(units)	°C		mS/cm	NTU	mg/cm	ft btoc	
T_0: 1037	Pump Started						
1049						6.16	100 ml/min
1050	CONNECT SOND CELL						VERY SLOW FLOW
1053	11.56	6.32	.018	8.0	10.81		
1057	11.75	6.25	.000	14.2	11.23		
1106	12.19	6.14	.151	22.9	8.34	6.62	50 ml/min
1109	12.31	6.26	.151	28.4	8.32		
1112	12.89	6.35	.169	56.8	7.90	6.18	150 ml/min
1115	13.05	6.41	.171	66.6	7.63		
1118	13.13	6.42	.17	74.00	7.76		
1121	13.26	6.44	.17	71.50	7.66		
1124	14.21	6.36	.165	100.0	6.26		
1127	14.52	6.29	.167	71.7	4.93	6.12	
1133	15.01	6.27	.199	98.4	4.27		50 ml/min
1136	15.37	6.22	.203	101.8	3.42		140 ml/min
1139	15.42	6.23	.203	96.4	3.42		
1142	15.86	6.20	.220	84.2	2.93		
1145	16.36	6.19	.223	74.2	2.78		
1148	16.72	6.18	.224	94.8	2.24		
1151	COLLECT SAMPLES						UNDETERMINABLY SLOW FLOW RATE. NOT MUCH MORE THAN ~~FAST~~ FAST DRIPPING.
END:							

CLEARED AIR IN LINE

CONSISTANT FLOW RATE ADJUSTMENT REQ'D.
AIR BUBBLES IN LINE.

Samples Collected: 2x 40 ml VOA (seq # 1157, 1158)

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

PURGE VOLS: 3.0 gal TOTAL

Note: Cut 0.65 ft off of PVC wellcasing.
Pump depth and water level measure from new top of PVC

GROUNDWATER SAMPLING LOG

PROJECT: 5518	SITE: 2	WELL ID: B241(S)	DATE: 5-1-97
WELL DEPTH: 16 ~~17~~ ft bgs	SCREEN LENGTH: 13 ft	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 6.63 ft	WEATHER INFORMATION: Sunny 18°C	

METHOD & EQUIPMENT: Low Flow with Grundfos Redi-flo Submersible Pump

TUBING TYPE: Teflon coated polyethylene | Pump Depth: 13 ft btoc | Dial: 63 Hz

SAMPLING PERSONNEL: Chris Bianchi (JCB) and Marty Gildea (MLG)

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO	▼	COMMENTS:
(units)	°C		mS/cm	NTU	mg/L	(ft btoc)	
T0: 1001	Pump Started						PUMP STARTED
1006						6.67	720 ml/min
1011						6.67	550 ml/min
1022	CONNECTED CELL, Cleared line of air befor connecting cell.						
1027						6.68	850 ml/min
1028	REDUCED FLOW RATE						
1030	14.43	4.63	0.037	44.1	7.53		620 ml/min
1033	14.97	4.70	0.039	99.7	7.25		
1036	15.11	4.72	0.039	147.9	7.23		Knoked air bubbles out of hose
1039	15.07	4.74	0.038	96.7	7.29	6.68	600 mL/min
1042	15.05	4.76	0.038	212.3	7.46		
1045	Drained Sond cell because of air on Turb. probe						
1048	15.45	4.81	.039	768.3	7.10	6.68	620 ml/min
1052	DRAINED SOND CELL BECAUSE OF AIR, PUT RESTRICTOR @ END OF LINE						
1057	14.35	4.78	.040	74.4	7.58		230 ml/min
1100	15.22	4.79	.039	112.7	7.12		
1103	16.56	4.77	.039	~~175~~ 175.5	7.15	6.66	220 ml/min
1106	18.02	4.77	.039	245.4	6.99		
1109	19.12	4.80	.042	260.4	6.52		
1112	20.02	4.81	.044	320.6	6.34	6.66	200 ml/min
1115	20.55	4.80	.041	377.0	6.47		
1118	19.18	4.78	.048	636.7	6.81		800 ml/min TRIED FLUSHING AIR
1121	16.99	4.80	.038	799.5	7.18	6.67	450 ml/min
1124	15.88	4.86	.040	962.8	6.94		
1127	SAMPLES COLLECTED					6.68	620 ml/min
END:							

Samples Collected: 2 X 40mL VOAs (Seq #s 1131, 1136)

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Purge Vols: 2.5 + 4.0 gals + 4.0 + 4.0 gal = 14.5 gal TOTAL

* DONT TRUST TURBIDITY READINGS (WATER IS CLEAR)

GROUNDWATER SAMPLING LOG

PROJECT: 5518	SITE: Z	WELL ID: DPW-B241(S)	DATE: 5.1.97
WELL DEPTH: ~~18~~.14.97	SCREEN LENGTH: 3 m	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC New TOC (see note)	WATER LEVEL: 3.81	WEATHER INFORMATION: Sunny 25°C	
METHOD & EQUIPMENT: Low Flow with Grundfos Redi-flo Submersible Pump			
TUBING TYPE: Teflon coated polyethylene	Pump Depth: 10 ft	Dial: 62 Hz	
SAMPLING PERSONNEL: Chris Bianchi (JCB) and Marty Gildea (MLG)			

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO	▼	COMMENTS:
(units)	°C		mS/cm	NTU	mg/L	ft bTOC	
T_0: 1202	PUMP STARTED						
1207						3.84	250 ml/min
1210	CONNECTED	GEOL,	CLEARE	LINE OF AIR		3.83	275 ml/min
1215	16.24	4.78	.051	92.1	7.25		
1218	18.07	4.83	.056	112.8	6.72	3.84	260 ml/min
1221	19.92	4.84	.054	148.9	6.42		
1224	21.36	4.83	.053	206.7	6.24		
1227	22.46	4.82	.053	1007.8	6.13	3.85	370 ml/min
1230	21.73	4.83	.052	225.7	6.11		
1233	21.47	4.84	.053	275.6	6.19		330 ml/min
1236	21.55	4.73	.051	55.0	6.21		
1239	21.72	4.82	.055	79.5	6.21		
1242	22.20	4.85	.05	71.50	6.07	3.85	340 ml/min
1245							
1248	22.15	4.78	.053	117.1	5.83		
1250	SAMPLES	COLLECTED				3.85	450 ml/min
END:							

Samples Collected: 2 x 40 ml VOA = (SEQ #'s 1137, 1138)

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

NOTE: CUT 0.41 ft off of well to get ready for man hole cover

PURGE VOLUME = 3.0 + 4.0 gal = 7.0 gal

* TURBIDITY (AIR BUBBLES FORMING)?

GROUNDWATER SAMPLING LOG

PROJECT: 5518	SITE: 1	WELL ID: DPW-RAP1-4S	DATE: 4-23-97
WELL DEPTH:	SCREEN LENGTH: 4 m	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 3.05	WEATHER INFORMATION: Sunny cool 53° F 11°C	

METHOD & EQUIPMENT: *Low Flow with Grundfos Redi-flo Submersible Pump*

TUBING TYPE: *Teflon coated polyethylene* | Pump Depth: 8.42 ft

SAMPLING PERSONNEL: *Chris Bianchi (JCB) and Marty Gildea (MLG)*

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO		COMMENTS:
(units)							
T0: 0902	Started Pump.						
	Very slow rate, 2 ft of draw down.						
0928	Stopped pump to let ∇ come back to normal.						
0940	Surged with a Wattera, dropped ∇ to 6 btoc						
	moving to RAP2-4S						
1135	Water level ∇ 3.08, try this well again						
T0: 1142	Pump on						
1211	TWO SAMPLES COLLECTED (e.g., DPW-RAP1-4S)						
*NOTE:	NO PARAMETER MEASUREMENTS WERE TAKEN ~~FROM~~ AT THIS WELL LOCATION SINCE WE COULD NOT MAINTAIN A CONSTANT FLOW / HEAD WHILE PUMPING. THE FLOW RATE WAS APPROX. 150 - 200 ML/MIN AND VERY TURBID (GUESTIMATION: 1000 - 2000 NTU). WE FELT WE WOULD NOT GET ACCURATE READINGS SO DECIDED TO COLLECT SAMPLES ~~AS~~ AND MOVE ON.						
END:							

Samples Collected: 2 X 40 ml VOA'S AND 1 X EQUIP. BLNK

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

PURGED APPRX: 3.0 GALLONS.

GROUNDWATER SAMPLING LOG

PROJECT: **5518**	SITE: 1	WELL ID: RAP1-4S	DATE: 4-23-97
WELL DEPTH:	SCREEN LENGTH:	WELL DIAMETER: **2"**	CASING TYPE: **PVC**
MEASUREMENT POINT: **TOC**	WATER LEVEL: 5.03	WEATHER INFORMATION:	
METHOD & EQUIPMENT: ***Low Flow with Grundfos Redi-flo Submersible Pump***			
TUBING TYPE: ***Teflon coated polyethylene*** | Pump depth: ~~10~~ 9.7 ft btoc | 57 Hz Dial setting			
SAMPLING PERSONNEL: ***Chris Bianchi (JCB) and Marty Gildea (MLG)***			

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO		COMMENTS:
(units)	°C		mS/cm	NTU	mg/L		
T0: 1022	Flow rate					900	~~900~~ ml/min
1036	Hooked up	YSI Flow-thru cell					
1039	–	Flow and ∇		975 ml/min		6.11	∇
1039	12.20	5.57	0.074	4.2	4.73		
1047						6.15	∇
1045	12.64	5.64	0.07	~~2~~ 3.10	4.38		
1048	12.44	5.50	0.073	2.9	4.21		
1051	12.07	5.61	0.070	2.40	4.08	975	ml/min
1057	12.18	~~4.04~~ 5.64	0.65	2.1	4.04		
1100	12.44	5.64	0.067	2.4	3.86		
1101						6.17	∇
END:							

Samples Collected: 2x40 ml VOAs ~~and 2 Replicates @ 1019 1022~~ |

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

5gal Bucket dumps 11+s = 2.5 buckets 12½ gal

GROUNDWATER SAMPLING LOG

PROJECT: **5518**	SITE: 1	WELL ID: RAP1-6.5	DATE: 5·1·97
WELL DEPTH: 14.5 ft	SCREEN LENGTH: 14.5 ft	WELL DIAMETER: **2"**	CASING TYPE: **PVC**
MEASUREMENT POINT: **TOC**	WATER LEVEL: ~~6.67~~ 6.97	WEATHER INFORMATION: Cloudy, Windy 22°C↓	
METHOD & EQUIPMENT: ***Low Flow with Grundfos Redi-flo Submersible Pump***			
TUBING TYPE: ***Teflon coated polyethylene***	Pump Depth: 9.5 ft btoc	Dial. 68	
SAMPLING PERSONNEL: ***Chris Bianchi (JCB) and Marty Gildea (MLG)***			

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO	▼	COMMENTS:
(units)	°C		mS/cm	NTU	mg/L	ft btoc	
T0: 1412	STARTED PUMP						
1415	ORANGE, FLOCCULATED GLOBS, FOLLOWED BY DILUTED ORANGE					7.12	490 mL/min
1422						7.14	740 mL/min
1426						7.08	390 mL/min
1428	CONNECT CELL						
1436	18.44	5.99	.108	11.3	1.92	7.08	390 mL/min
1439	18.64	5.97	.108	10.1	1.95		
1442	18.74	5.96	.109	12.9	1.98	7.06	380 mL/min
1445	18.80	5.95	.109	10.1	1.98		
1448	18.80	5.95	.109	9.0	1.99	7.07	380 mL/min
1451	18.99	5.92	0.109	8.7	1.99	~~7.06~~	
1454	19.12	5.91	0.109	8.4	2.00	7.06	370 ml/min
1457	Collected	Samples					
1500						7.06	400 mL/min
END:							

Samples Collected: 2 x 40mL VOAs + 2 equip Blks (Seq # 1139 -1142)

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Purge Vols: 4 + 2.0 ≈ 6.0 gals.

GROUNDWATER SAMPLING LOG

PROJECT: 5518	SITE: 1	WELL ID: DPW-RAP1-6S	DATE: 5/1/97
WELL DEPTH: 14.6 ft	SCREEN LENGTH: 4 m	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC NEW TOC	WATER LEVEL: 5.35	WEATHER INFORMATION: CLOUDY, WINDY 19° C	
METHOD & EQUIPMENT: Low Flow with Grundfos Redi-flo Submersible Pump			
TUBING TYPE: Teflon coated polyethylene	PUMP DEPTH 8.0 ft btoc	DIAL: 68	
SAMPLING PERSONNEL: Chris Bianchi (JCB) and Marty Gildea (MLG)			

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO	▽	COMMENTS:
(units)	°C		mS/cm	NTU	mg/L	ft BTOC	
T_0: 1525	STARTED	PUMP				~~5.46~~	
1529						5.46	350 ml/min
1532						5.46	300 mL/min
1537	CONNECT CELL						~~300 ml/min~~
1539	18.00	5.32	.098	207.8	4.25		300 ml/min
15.42	18.33	5.32	.102	170.5	4.04		
1545	18.75	5.30	.105	97.3	4.20		
1548	19.17	5.28	0.106	80.5	3.66	5.42	290 mL/min
1551	19.46	5.26	0.105	76.5	3.82		
1554	19.74	5.25	.103	71.2	3.84		
1557	20.02	5.25	0.103	65.9	3.74	5.42	270 ml/min
1600	20.32	5.25	.104	60.3	3.75		
1603	20.57	5.24	.103	57.7	3.76		
1606	Samples Collected						290 mL/min
1611							
END:							

Samples Collected: 2 x 40 mL VOAs (Seq # 1143-1144)

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

PURGE VOLS: 4 gals

NOTE: CUT 0.56 ft of pvc casing off well to get it ready for man hole cover

GROUNDWATER SAMPLING LOG

PROJECT: **5518**	SITE: 2	WELL ID: RAP2-25	DATE: 4-24-97
WELL DEPTH:	SCREEN LENGTH: 20 ft	WELL DIAMETER: **2"**	CASING TYPE: **PVC**
MEASUREMENT POINT: **TOC**	WATER LEVEL: 5.75	WEATHER INFORMATION: Cloudy, 50°F	
METHOD & EQUIPMENT: **Low Flow with Grundfos Redi-flo Submersible Pump**			
TUBING TYPE: **Teflon coated polyethylene**	Pump Depth: 10 ft	Dial Setting: 71 Hz	
SAMPLING PERSONNEL: **Chris Bianchi (JCB) and Marty Gildea (MLG)**			

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO	∇	COMMENTS:
(units)						ft btoc	
T_0: 1558							
1603						5.81	1500 mL/min
1606						5.90	960mL/min
1608	Connected Sond.						
1611							900mL/min
1612	7.92	3.64	0.073	27.7	8.11	5.88	
1615	8.22	3.79	0.074	16.2	7.96		900mL/min
1616						5.89	
1618	8.38	4.09	0.074	11.0	7.43		900 mL/min
1621	8.39	4.20	0.074	9.1	7.30		
1624	8.40	4.27	0.074	7.5	7.20		
1627	8.41	4.28	0.074	7.3	7.12		880mL/min
1630	8.44	4.28	0.074	8.3	7.09		
1633	8.46	4.31	0.074	9.4	7.08		
1634	Rince Sond Cell,						
	Down load data to lap top						
~~1642~~ 1645	8.38	4.43	0.073	3.7	7.16		810
1647	Collected Samples						
END:							

Samples Collected: 2 x 40ml VOAs Sq # 1059-1060

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3 \pi r^3$

Purge Vols.: 4+4+4

GROUNDWATER SAMPLING LOG

PROJECT: **5518**	SITE: 2	WELL ID: DPW-RAP2-25	DATE: 4-24-97
WELL DEPTH:	SCREEN LENGTH: 5m	WELL DIAMETER: **2"**	CASING TYPE: **PVC**
MEASUREMENT POINT: **TOC**	WATER LEVEL: 6.27	WEATHER INFORMATION: Cloudy 50°F	

METHOD & EQUIPMENT: ***Low Flow with Grundfos Redi-flo Submersible Pump***

TUBING TYPE: ***Teflon coated polyethylene*** | Pump Depth: 10 ft | Dial Setting: 70 Hz

SAMPLING PERSONNEL: ***Chris Bianchi (JCB) and Marty Gildea (MLG)***

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO	▼	COMMENTS:
(units)	°C		mS/cm	NTU	mg/L		
T_0: 1726							
1728						6.62	1200 ~~mg/L~~ mL/min
1730	Changed flow rate @ 1729, new level					6.30	770 ~~mg/L~~ mL/min
1731	Connect Sond					6.32	
1734							700 ~~mg/L~~ mL/min
1736	8.31	4.69	0.054	181.2	7.03	6.35	
1739	8.76	4.55	0.053	199.9	6.81		720 ~~mg/L~~ mL/min
1742	9.23	4.54	0.054	121.6	6.86		
1745	9.36	4.52	0.053	68.1	6.90	6.35	700 ~~mg/L~~ mL/min
1748	9.37	4.64	0.053	43.5	7.05		
1751	9.36	4.74	0.052	33.4	7.19		
1754	Drained Sond, not rinse, just removed the connectors						
1757	9.27	4.38	0.052	27.7	7.20	~~6.37~~	700 ~~mg/L~~ mL/min
1800	9.26	4.45	0.052	24.6	7.17	6.37	
1803	9.15	4.46	0.053	16.7	7.41		
1806	9.26	4.49	0.051	14.2	7.19		
Changed to 5min intervals → 1810	9.33	4.39	0.052	11.7	8.02		Drained Sond again
1814							500 mL/min
1815	9.27	4.43	0.052	8.2	7.33		450 mL/min
1820	9.30	4.59	0.052	5.6	7.29		
1830	10.21	4.32	0.054	10.6	7.11	6.37	770 mL/min; ADJUSTED FLOW
1840	9.25	4.24	0.052	8.7	7.14	6.37	700 mL/min
END:							

Samples Collected: 2 x 40 mL VOA's (SER # 1061-1062)

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Purge Vols: 4 + 4 + 4 + 4.5 = 16.5 GALS

COLLECTED SAMPLES BEFORE PARAMETERS MET CRITERIA. GETTING DARK AND UNSAFE.

GROUNDWATER SAMPLING LOG

PROJECT: **5518**	SITE: 2	WELL ID: RAP2-2T	DATE: 4-25-97
WELL DEPTH: 75 ft	SCREEN LENGTH: 15'	WELL DIAMETER: **2"**	CASING TYPE: **PVC**
MEASUREMENT POINT: **TOC**	WATER LEVEL: 9.57	WEATHER INFORMATION: Cloudy 4°C	

METHOD & EQUIPMENT: **Low Flow with Grundfos Redi-flo Submersible Pump**

TUBING TYPE: **Teflon coated polyethylene** | Pump Depth: ~~60.5 ft~~ 61.3 ft btoc | Dial:

SAMPLING PERSONNEL: **Chris Bianchi (JCB) and Marty Gildea (MLG)**

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO	▼	COMMENTS:
(units)							
T_0: 0823							
0826						9.65	675 mL/min @ 0828
0830						9.61	▼ measured to PVC this time instead of casing, easier to read. will continue for this test
0832						9.60	675 mL/min
0835	Connect Sond						650 mL/min after Sond
~~0837~~ 0840	9.89	6.22	0.177	8.2	0.75	9.60	625 mL/min
0844	10.02	6.44	0.177	6.7	0.61	9.60	625 mL/min
0848	10.15	6.60	0.175	6.5	0.54		
0852	10.27	6.71	0.176	4.1	0.50		
0856	10.35	6.79	0.176	3.9	0.46		
0900	10.42	6.85	0.178	3.7	0.43		
0904	10.55	6.90	0.177	3.5	0.40		
0908	10.62	6.94	0.178	3.5	0.41	9.60	600 mL/min
0909	Samples Collected						
END:							

Samples Collected: 2 x 40 mL VOA + 2 DUPS + 2 REPS (Seq. # 1064 - 1069)

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3 \pi r^3$

Purge Vols: 4 + 4 + 2 = 10 gals

GROUNDWATER SAMPLING LOG

PROJECT: **5518**	SITE: 2	WELL ID: DPW-RAP2-2T	DATE: 4-25-97
WELL DEPTH:	SCREEN LENGTH: 2 m	WELL DIAMETER: **2"**	CASING TYPE: **PVC**
MEASUREMENT POINT: **TOC**	WATER LEVEL: ~~8.49~~ 8.45 ft	WEATHER INFORMATION: Cloudy, 8°C	
METHOD & EQUIPMENT: ***Low Flow with Grundfos Redi-flo Submersible Pump***			
TUBING TYPE: ***Teflon coated polyethylene***	Pump Depth: 60 ft	Dial: 88 Hz	
SAMPLING PERSONNEL: ***Chris Bianchi (JCB) and Marty Gildea (MLG)***			

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY * (NTU)	DO	▼	COMMENTS:
(units)							
T_0: 0946	PUMP ON						
0954						~~11.30~~ 11.03	380 mL/min
0956							380mL/min
1002						11.09	375mL/min
1011						11.20	400mL/min
1013	Reset Pump setting to 88 Hz because ~~do~~ dropping ▼						330mL/min
1018	Connect Sond					10.75	260mL/min after sond
1024	11.02	6.78	0.170	728.4	1.69	10.68	280mL/min
1028	11.12	6.88	0.172	552.9	1.41	10.66	300mL/min
1032	11.17	6.95	0.174	522.1			
1036	11.25	7.00	0.173	406.5	1.08		
1040							
1044						10.69	
1048							330mL/min
1050	Drained and rince sond						
1056	11.74	7.08	0.175	511.5	0.88		
1100	11.91	7.11	0.175	382.2	0.77	10.97	350mL/min
1104							
1108							
1112	11.90	7.21	0.176	442	~~0.072~~ 0.72		
1116	11.92	7.23	0.173	380	0.62	11.00	400 mL/MIN
END:							

Samples Collected: 6 x 40mL VOA's ; SEQ # 1072 - 1077. ALSO COLLECTED 2 EQUIP. BLNKS FOLLOWING DECON PROCEDURES.

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Purge Vols: 4 + 4 + 4 = 12 GALS

* NOTE: TURBIDITY WAS CALIBRATED FOR 0 - 100 NTUS, values > 100 are approximate.

GROUNDWATER SAMPLING LOG

PROJECT: 5518	SITE: 2	WELL ID: DPW-RAP2-35	DATE: 4-23-97
WELL DEPTH:	SCREEN LENGTH: 7m	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 4.78	WEATHER INFORMATION:	

METHOD & EQUIPMENT: *Low Flow with Grundfos Redi-flo Submersible Pump*

TUBING TYPE: *Teflon coated polyethylene* | Pump depth: 11.5' | Dial setting: 73

SAMPLING PERSONNEL: *Chris Bianchi (JCB) and Marty Gildea (MLG)*

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO	▼	COMMENTS:
(units)							
T_0:							
1558						▽4.86	840 mL/min @ ~~1558~~
1559						▽4.86	825 mL/min
1601	CONNECT SONDE						
1603	BEGIN LOGGING YSI DATA						
1605						▽4.85	750 mL/min
1606	11.76	5.38	0.045	45.5	10.48		
1609							
1612	11.77	5.47	0.049	18.8	10.26	4.86	750 mL/min
1615	11.96	5.50	0.050	12.3	10.16	4.86	750 mL/min
1618	11.99	5.51	0.051	7.2	10.11		
1621	12.00	5.52	0.050	5.9	10.06		
1624	12.00	5.53	0.052	4.5	9.99		
1636	COLLECTED TWO VOA'S (SEQ # 1027, 1028)						
1638	COLLECTED TWO MORE VOA'S (SEQ # 1029, 1030)						
END:							

Samples Collected: 4 x 40mL VOA'S

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

PURGE VOL = 9 GALLONS

GROUNDWATER SAMPLING LOG

PROJECT: 5518	SITE: 2	WELL ID: RAP2-3S	DATE: 4-23-97
WELL DEPTH:	SCREEN LENGTH: 23.6 ft	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 6.53 ft	WEATHER INFORMATION: Sun go'in down, cool.	

METHOD & EQUIPMENT: **Low Flow with Grundfos Redi-flo Submersible Pump**

TUBING TYPE: **Teflon coated polyethylene** | Pump Depth: 14 ft | Dial Setting: 75 Hz

SAMPLING PERSONNEL: **Chris Bianchi (JCB) and Marty Gildea (MLG)**

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO	∇	COMMENTS:
(units)	°C		mS/cm	NTU	mg/L	ft btoc	
T_0: 1657							
1700						6.70	1200 mL/min
1704							1140 mL/min
1706	Connect Sond					6.68	1050 mL/min
1708	Started Logging						
1709	10.39	5.44	0.043	31.3	8.53		
1712	10.43	5.39	0.044	21.2	8.52		
1715	10.49	5.36	0.044	11.7	8.53		
1718	10.50	5.35	0.044	6.6	8.50		
							~~810 mL~~
1720						6.68	1080 mL/m
1721	10.50	5.34	0.046	5.0	8.47		
1722	Disconnected Sond to collect samples						
END:							

Samples Collected: 2 x 40 mL VOA and 2 Replicate Sq. #s 1031-1034

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Purge Vols#: 3gal + 4gal

GROUNDWATER SAMPLING LOG

PROJECT: 5518	SITE: 2	WELL ID: RAP2-4S	DATE: 4-24-97
WELL DEPTH:	SCREEN LENGTH: 25 ft	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: ~~7.03~~ 7.09	WEATHER INFORMATION: OVERCAST, COOL (≈ 40/50); EXPECTING RAIN IN PM	
METHOD & EQUIPMENT: Low Flow with Grundfos Redi-flo Submersible Pump			
TUBING TYPE: Teflon coated polyethylene	Pump Depth: 15 ft	Pump Dial: 77 Hz	
SAMPLING PERSONNEL: Chris Bianchi (JCB) and Marty Gildea (MLG)			

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO	▼	COMMENTS:
(units)	°C		mS/cm	NTU	mg/L	ft from TOC	
T_0: 1000	Pump on					~~7.17~~	~~1520 mL/min~~
1002						7.17	15020 mL/min
1006						7.17	1380 mL/min
1008	Connected Sond					7.16	1200 mL/min
1012	8.34	4.05	0.072	24.5	10.73	7.16	1200 mL/min
1015	8.47	3.82	0.072	13.7	10.73		
1018	8.57	3.75	0.073	9.9	10.71		
1020						7.16	1200 mL/min
1021	8.58	3.70	0.074	9.9	10.70		
1024	8.59	3.67	0.074	6.7	10.54		
1026						7.17	1200 mL/min
1027	8.59	3.63	0.074	5.8	10.52		
1030	8.61	3.58	0.074	5.7	10.51		
1033	8.57	3.59	0.075	~~5.~~4.8	10.42	7.17	1200 mL/min
1034	8.57	3.59	0.074	4.9	10.43		
END:							

Samples Collected: 6 x 40 mL VOA'S. AFTER DECON COLLECTED 2 x 40 mL EQUIP. BLNKS

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$ SEQ #: 1043 - 1049

PURGE VOLUME = 4 + 4.5 + 3 = 11.5 GALS

GROUNDWATER SAMPLING LOG

PROJECT: **5518**	SITE: 2	WELL ID: DPW-OW2-1	DATE: 4-28-97
WELL DEPTH:	SCREEN LENGTH: 3 m	WELL DIAMETER: **2"**	CASING TYPE: **PVC**
MEASUREMENT POINT: **TOC**	WATER LEVEL: ~~10.34~~ 10.34	WEATHER INFORMATION: Sunny 13°C, breeze	
METHOD & EQUIPMENT: ***Low Flow with Grundfos Redi-flo Submersible Pump***			
TUBING TYPE: ***Teflon coated polyethylene*** | Pump Depth: 12.3 ft btoc | Dial: 82Hz			
SAMPLING PERSONNEL: ***Chris Bianchi (JCB) and Marty Gildea (MLG)***			

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO	∇ ft btoc	COMMENTS:
(units)							
T0: 0930	STARTED PUMP					12.34	
0935	PULLED ALL OF THE PUMP HOSE OUT TO TRY TO DEGAS LINE						
0938	RESTARTED PUMP						
0940						10.45	
0943						10.44	710 mL/MIN
0949						10.43	710 mL/MIN
~~1051~~ 0951	CONNECT SOND						
~~1057~~ 0957	~~14.68~~	~~5.31~~	~~0.082~~	~~9.6~~	~~10.11~~		600mL/min
1000	14.68	5.31	0.082	9.6	10.11		500mL/min
1004	15.49	5.35	0.082	7.3	10.12		540mL/min
1008				5.1			
~~100~~ 1012	16.45	5.40	0.082	7.0	9.98		
1016	16.83	5.52	0.083	6.5	9.83		
1018	COLLECTED SAMPLES						
END:							

Samples Collected: COLLECTE 6 x 40 mL VOA'S AND TWO EQUIP BLNKS

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

PURGE VOLUME: 4.5 + 2.5 + 4.5 = 11.5 gals

GROUNDWATER SAMPLING LOG

PROJECT: **5518**	SITE: 2	WELL ID: OB2-1	DATE: 4.26.97
WELL DEPTH: 15'	SCREEN LENGTH: 5'	WELL DIAMETER: **2"**	CASING TYPE: **PVC**
MEASUREMENT POINT: **TOC**	WATER LEVEL: 9.74'	WEATHER INFORMATION: PARTLY CLOUDY, COOL, LIGHT BREEZE	

METHOD & EQUIPMENT: ***Low Flow with Grundfos Redi-flo Submersible Pump***

TUBING TYPE: ***Teflon coated polyethylene*** | Pump Depth: 12.0 ft | Dial: 85

SAMPLING PERSONNEL: ***Chris Bianchi (JCB) and Marty Gildea (MLG)***

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO	$\underline{\nabla}$	COMMENTS:
(units)							
T_0: 1050	TURNED ON PUMP					~~9.84~~	
1052						9.81	920 mL/MIN
1055						9.81	920 mL/MIN
1057	CONNECT SOND					9.80	840 mL/MIN
1100	12.05	5.44	0.085	22.3	10.54		
11.04	12.49	5.31	0.085	8.4	10.63	9.80	840 mL/MIN
11.08	12.67	5.59	0.084	8.0	10.30		
11.12	12.58	5.78	0.086	5.0	10.01		
1116 ~~1016~~	13.07	5.84	0.085	4.2	9.98	9.79	820 mL/min
1119 ~~1019~~	Collected Samples						
END:							

Samples Collected:

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Purge Vols: 4 +

GROUNDWATER SAMPLING LOG

PROJECT: 5518	SITE: 2	WELL ID: DPW-OW2.4	DATE: 4-29-97
WELL DEPTH: 30.0 ft bgs	SCREEN LENGTH: 2m	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 17.21	WEATHER INFORMATION: Sunny 15°C shade	
METHOD & EQUIPMENT: Low Flow with Grundfos Redi-flo Submersible Pump			
TUBING TYPE: Teflon coated polyethylene	Pump Depth: 27.0 ft btoc	Dial: 100 Hz	
SAMPLING PERSONNEL: Chris Bianchi (JCB) and ~~Marty Gildea (MLG)~~ RGW			

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO	▼	COMMENTS:
(units)	°C		mS/cm	NTU	mg/L	(ft btoc)	
T₀: 1135	Pump on					17.20	prior to pump
1139						17.32	590 mL/min
1140	CONNECTED	SOND CELL					
1145	14.19	6.02	0.317	29.8	0.99	17.25	~~275~~ ml/min 350 ml/min
1148	14.51	6.06	0.329	15.3	0.93		
1151	14.92	6.07	0.325	21.3	0.91		PID ≈ 0.5-1.0
1154	15.34	6.07	0.319	29.3	0.89	17.28	330 mL/min
1157	15.73	6.07	0.325	32.0	0.84		
1200	16.10	6.08	0.324	25.9	0.80		
1203	16.53	6.08	0.325	21.9	0.76	17.25	330 mL/min
1206	16.82	6.09	0.323	17.6	0.72		
1209	17.03	6.09	0.320	14.8	0.69		
12~~12~~				13.8			PID#: 5.0
1215	17.37	6.09	0.321	14.1	0.64		
1217	Collected	Samples					
END:							

Samples Collected: 2 x 40 mL VOAs + 2 Duplicates and 2 equip. blanks (~~Seq~~ # 1119 - ~~##~~ 1124)

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Purge Vols.: 5 gals

#PID TEST: Put 200 ml in Beaker @ 1214
Put wand sampling tube in head
space and recorded

GROUNDWATER SAMPLING LOG

PROJECT: **5518**	SITE: 2	WELL ID: OW2-4	DATE: 4.29.97
WELL DEPTH: 30 ft	SCREEN LENGTH: 5 ft	WELL DIAMETER: **2"**	CASING TYPE: **PVC**
MEASUREMENT POINT: **TOC**	WATER LEVEL: 16.65	WEATHER INFORMATION: Sunny 17°C shade	

METHOD & EQUIPMENT: **Low Flow with Grundfos Redi-flo Submersible Pump**

TUBING TYPE: **Teflon coated polyethylene** | Pump Depth ~~26.7~~ 23.5 ft btoc | Dial: 100 Hz

SAMPLING PERSONNEL: **Chris Bianchi (JCB) and ~~Marty Gildea (MLG)~~** RGW

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO	▼	COMMENTS:
(units)	°C		mS/cm	NTU	mg/L	(ft btoc)	
T0: Pump Depth had to be 23.5 because pump wouldn't go to the bottom raised up two ft.							
1238	Pump Started - Discharge is brown and silty.						
1241							540 mL/min
1245						16.87	730 mL/min
1247	Connecting Sond after measurment.						350 mL/min
	Re-adjust pump rate after sond because flow stopped.						
1251	16.61	6.36	0.157	347.1	1.46		
1254	17.00	6.44	0.167	237.5	0.99	16.76	350 mL/min
1257	17.56	6.48	0.176	171.2	0.89		
1300	17.95	6.51	0.183	112.5	0.82		
1303	18.14	6.52	0.186	74.7	.080		
1306	18.36	6.53	0.192	53.6	0.74		
1309	18.34	6.53	0.193	34.1	0.69		
1312	18.28	6.53	0.196	28.7	0.66		
1315	17.24	6.56	0.202	1147.1	9.06		cell cleaned and not fully purged
1318	17.51	6.44	0.207	30.4	0.71	16.87	660 ml/min
1321	17.14	6.41	0.206	19.4	0.61		
1324	16.65	6.38	0.205	20.5	0.55		
1327	16.45	6.36	0.203	26.0	0.48		
1330	16.45	6.35	0.200	38.8	0.45	16.84	650 mL/min
1333	16.43	6.35	0.202	56.3	0.45		
1336	16.41	6.35	0.201	121.9	0.43		
1339	16.45	6.35	0.200	159.6	0.42		PID: 7.0 in Beaker
1342	16.52	6.35	0.198	192.4	0.42		650 mL/min
END: 1345	Samples Collected					16.87	

Samples Collected: 2 x 40mL VOAs + 2 Dups + 2 Equip. Blk (Seq # 1125-1130)

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Purge Volume = $\frac{4\text{ gals}}{\cancel{16.87}\ \text{pids}}$ + 4 gals + 1.5 = 9.5 gals

GROUNDWATER SAMPLING LOG

PROJECT: 5518	SITE: 2	WELL ID: DPW-OW2.6	DATE: 4-28-97
WELL DEPTH: 19.8	SCREEN LENGTH: 2m	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 9.51	WEATHER INFORMATION: Cloudy, raining 9.0°C	
METHOD & EQUIPMENT: Low Flow with Grundfos Redi-flo Submersible Pump			
TUBING TYPE: Teflon coated polyethylene	Pump Depth: 16.8 ft	Dial: 79 HZ	
SAMPLING PERSONNEL: Chris Bianchi (JCB) and ~~Marty Gildea (MLG)~~ RGW			

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO	▼ BTOC	COMMENTS:
(units)							
T_0: 1148							
1155						10.03'	Flowrate 300ml/min
1158						10.35	400ml/min
1205	Connected Sond						
1207							400ml/min
1209	8.73	5.67	0.329	122.3	1.30	10.23	
1212	8.96	5.71	0.333	141.4	1.12		400ml/min
1215	8.92	5.74	0.336	183.5	1.01		300ml/min
	~~Willa~~ Wilson kinked the hose ~~so~~ so had to readjust flow rate						
1217							550ml
1218	8.85	5.72	0.334	201.0	0.96	10.25'	425ml/min
1221	8.87	5.74	0.338	173.4	0.89		
1224	8.97	5.75	0.334	169.3	0.82		
1227	9.09	5.76	0.335	167.9	0.79	10.24	440ml/min
1232	Samples taken						
END:							

Samples Collected: 2 x 40 ml (1105, 1106) + 1 Equip Blank

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Purge Vols: 2.5 Gal + 3 gal = 5.5 gal

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GROUNDWATER SAMPLING LOG

PROJECT: **5518**	SITE: 2	WELL ID: OW2-6	DATE: 4-28-97
WELL DEPTH: 20 ft bgs.	SCREEN LENGTH: 5 ft	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 8.48 ft	WEATHER INFORMATION: Raining 8.6°C	
METHOD & EQUIPMENT: *Low Flow with Grundfos Redi-flo Submersible Pump*			
TUBING TYPE: *Teflon coated polyethylene*	Pump Depth: 16.5 ft btoc	Dial: 79 Hz	
SAMPLING PERSONNEL: *Chris Bianchi (JCB) and* ~~*Marty Gildea (MLG)*~~ RGW			

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO	▼	COMMENTS:
(units)	°C		mS/cm	NTU	mg/L	(ft btoc)	
T_0: 1418	Started	Pump					
1422						9.12	675 mL/min
1426	Discharge	has visual	flakes	of a rust orange			500 mL/min
1428	color material	that	smells	sulphurous		9.05	
1435	No reading on PID						475 mL/min
1437						9.06	475 mL/min
1440	Connected	Sond					
1445	9.25	6.15	0.222	5.2	7.02		475 mL/min
1448	9.30	6.13	0.217	6.9	7.13		
1451	9.35	6.14	0.215	5.9	7.25		475 mL/min
1454	9.35	6.15	0.213	4.3	7.36	9.06	475 mL/min
1456	Collected	Samples					
END:							

Samples Collected: 2 x 40 mL VOAs (Seq # 1109·1110)

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Purge Vols: 4 + 1 = 50 gals

GROUNDWATER SAMPLING LOG

PROJECT: 5518	SITE: 2	WELL ID: DPW-OW2-7	DATE: 4.28.97
WELL DEPTH: 20.21 bgs	SCREEN LENGTH: 2m	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 8.62	WEATHER INFORMATION: Misting and Foggy 8.5°C	
METHOD & EQUIPMENT: Low Flow with Grundfos Redi-flo Submersible Pump			
TUBING TYPE: Teflon coated polyethylene	Pump Depth: 17 ft btoc	Dial: 85 Hz/92 Hz	
SAMPLING PERSONNEL: Chris Bianchi (JCB) and ~~Marty Gildea (MLG)~~ RGW			

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO	▼	COMMENTS:
(units)	°C		mS/cm	NTU	mg/L	(ft btoc)	
T0: 1523	Pump Started. - Well depth, is not correct or there						
1527	is an obstruction, pump only went down to 14 ft btoc.						400 ml/min
	So, I pulled it up 2 ft and started sampling. will check						
	depth again later after sampling.						
1529	Connected Sond @ 1531					10.65	325 mL/min
1533	Reset Pump rate after hooking up Sond. up to 92 Hz						
1536	8.57	5.81	0.056	166.4	9.08		490 mL/min
1539	8.47	5.86	0.077	200.6	7.07		
1540	@1541 Reset Pump rate again to 94 Hz					10.88	
1542	8.61	5.77	0.092	202.0	5.77		
1543	Air bubbles passed, so reset pump rate back to 93 Hz						
1545	9.36	5.87	0.086	257.4	4.88		430 ml/min
1548	9.39	5.87	0.095	250.8	4.84		
1606	9.92	5.78	0.096	327.9	4.47		380 ml/min
1609	9.88	5.76	0.096	360.2	3.92		
1612	9.72	5.74	0.097	345.8	3.27		
1615	9.77	5.74	0.097	367.4	3.22		490 ml/min
	Water level drawn down past the top of the pump.						
1616	Collecting samples						
1620	When started to decon pump, lots of fine sand and silt						
	came out of hose, need more developing.						
	Well was probably filled with sand and silt.						
END:							

Samples Collected: 2 x 40 ml VOAs

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3 \pi r^3$

GROUNDWATER SAMPLING LOG

PROJECT: **5518**	SITE: 2	WELL ID: GW2-7	DATE: 4.28.97
WELL DEPTH: 20 ft bgs	SCREEN LENGTH: 5 ft	WELL DIAMETER: **2"**	CASING TYPE: **PVC**
MEASUREMENT POINT: *TOC*	WATER LEVEL: 8.37	WEATHER INFORMATION: Foggy and Misting 8.5°c	
METHOD & EQUIPMENT: ***Low Flow with Grundfos Redi-flo Submersible Pump***			
TUBING TYPE: ***Teflon coated polyethylene***	Pump Depth: 15 ft bgs	Dial: 86	
SAMPLING PERSONNEL: ***Chris Bianchi (JCB) and ~~Marty Gildea (MLG)~~*** RGW			

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO	▼	COMMENTS:
(units)	°C		mS/cm	NTU	mg/L	ft btoc	
T_0: 1644	Pump on						
1647						9.8	550 ml/min
1650	Connected	Sond Cell					
1654	8.17	5.97	0.099	45.2	3.77		540 ml/min
1657	8.60	6.00	0.108	44.0	3.10	9.81	
~~16~~ 1700	9.06	5.98	0.108	43.3	2.92		560 ml/min
1703	9.29	5.97	0.108	~~43~~ 42.3	2.87		540 ml/min
1705	Collected	Samples					
						9.88	
END:							

Samples Collected: 2 x 40 ml VOAs (1113 · 1114)

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Purge Vols: 3 gals

WELL DEVELOPMENT LOG

PROJECT: **5518** **Monitoring Point Assess.**	SITE: **Hanscom AFB**	WELL ID: -B102-MW	DATE: 02/12/96
WELL DEPTH: 17.23' BGS	WATER LEVEL: 2.16' BGS	WEATHER INFORMATION: Low 30'S	
METHOD & EQUIPMENT: **Aardvark Well Development Tool, Purge Pump**			
SURGING TIME BEGIN: 8:50 END:	PUMPING TIME BEGIN: 08:50 END:	VOLUME BAILED DURING SURGING: 200 GAL (ESTIMATED FROM GRADUATIONS ON TANK)	

TIME	MEASUREMENTS			OBSERVATIONS				
	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	CLARITY	COLOR	ODOR	PARTICULATES
T_0: 09:36:40								
37:00								
37:20								
40								
~~END:~~								

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Comments:

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WELL DEVELOPMENT LOG

3/3

PROJECT: **5518** **Monitoring Point Assess.**	SITE: **Hanscom AFB**	WELL ID: B102-MW	DATE: 02/12/97
WELL DEPTH: 17.23 BGS	WATER LEVEL: 2.16' BGS	WEATHER INFORMATION: OVERCAST Low 30's	
METHOD & EQUIPMENT: **Aardvark Well Development Tool, Purge Pump**			
SURGING TIME BEGIN: 8:50 END:	PUMPING TIME BEGIN: 8:50 END:	VOLUME BAILED DURING SURGING:	

	MEASUREMENTS			OBSERVATIONS				
TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	CLARITY	COLOR	ODOR	PARTICULATES
14/12 T0: 12:04:00	44.84	4.62	0.3	423				
05:00	45.56	4.83	0.3	376.				
-								
-								
-								
-								
7/10 12:25:00				486.80				
12:26:00				316.90				
(12:22)								
END:								

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Comments:

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WELL DEVELOPMENT LOG

PROJECT: **5518** **Monitoring Point Assess.**	SITE: **Hanscom AFB**	WELL ID: B241	DATE: 02/13/97
WELL DEPTH: SEE CHART	WATER LEVEL: 4.74' FROM TOP O' PVC	WEATHER INFORMATION: WIND CHILL -5 COLD, COLD, COLD	
METHOD & EQUIPMENT: **Aardvark Well Development Tool, Purge Pump**			
SURGING TIME BEGIN: 0840 END:	PUMPING TIME BEGIN: 0840 END:	VOLUME BAILED DURING SURGING:	

	TIME	MEASUREMENTS TEMPERATURE	pH	SPEC. COND.	OBSERVATIONS TURBIDITY	CLARITY	COLOR	ODOR	PARTICULATES
15	T_0:08:56	40.17	6.13	0.02	984.7				
3	08:57	40.29	5.99	0.02	948.8				
15	09:06	40.17	5.94	0.02	1041.6				
13	09:07	40.21	5.78	0.02	902.6				
15	09:13	39.43	5.98	0.03	930.1				
13	09:14	39.53	5.85	0.03	811.8				
13	09:22	36.48	6.05	0.02	549.7				
11	09:23	36.70	5.87	0.02	463.4				
13	09:31	36.79	6.62	0.05	1216.9				
11	09:32	36.96	6.46	0.04	959.7				
	09:37	35.12	6.57	0.04	940.0				
11	09:38	35.27	6.47	0.04	817.2				
	END:								

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Comments:

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WELL DEVELOPMENT LOG

2063

PROJECT: **5518** **Monitoring Point Assess.**	SITE: **Hanscom AFB**	WELL ID: B241	DATE: 02/13/97
WELL DEPTH: SEE CHART	WATER LEVEL: 4.74' FROM TOP OF PVC	WEATHER INFORMATION: COLD, COLD, COLD WIND CHILL(-5)	
METHOD & EQUIPMENT: **Aardvark Well Development Tool, Purge Pump**			

SURGING TIME	PUMPING TIME	VOLUME BAILED DURING SURGING:
BEGIN: 0840	BEGIN: 0840	
END:	END:	

		MEASUREMENTS			OBSERVATIONS				
	TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	CLARITY	COLOR	ODOR	PARTICULATES
11/9	T₀: 09:59	37.88	6.44	0.04	? 14.90				
	~~09:~~10:00	39.99	6.16	0.04	648.10				
11/9	10:14	41.48	6.32	0.02	309.7				
	10:15	41.58	6.26	0.02	288.0				
15/13	11:18	46.67	6.63	0.03	835.1				
	11:19	47.82	6.35	0.03	563.0				
15/13	11:27	45.36	6.41	0.03	508.5				
	11:28	46.13	6.29	0.03	453.8				
15/13	11:31	44.00	6.27	0.05	746.7				
	11:32	43.98	6.03	0.05	659.6				
	11:36	43.52	6.44	0.03	320.4				
13	11:37	43.72	6.24	0.03	254.5				
	END:								

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Comments: 9'-7' = NO WATER

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WELL DEVELOPMENT LOG

PROJECT: **5518** **Monitoring Point Assess.**	SITE: **Hanscom AFB**	WELL ID: B102-MW	DATE: 02/12/97 ~~02/11/97~~
WELL DEPTH: 17.23' BGS	WATER LEVEL: 2.39'-.23 = 2.16' BGS	WEATHER INFORMATION: OVERCASTS MID 30'S	
METHOD & EQUIPMENT: **Aardvark Well Development Tool, Purge Pump**			
SURGING TIME BEGIN: 08:50 END:	PUMPING TIME BEGIN: 08:50 END:	VOLUME BAILED DURING SURGING: —	

TIME	MEASUREMENTS TEMPERATURE	pH	SPEC. COND.	OBSERVATIONS TURBIDITY	CLARITY	COLOR	ODOR	PARTICULATES
To: 9:36:40	42.82	5.08	0.02	17.70		PALE	/	FINE SAND
37:00	42.87	5.08	0.02	17.70				
37:20	42.97	5.10	0.02	17.80	?			
37:40	42.94	5.11	0.02	18.10				
53:20	44.48	5.12	"	1282.7		Lt BRN		
53:40	44.68	5.15	"	1283.8				
54:00	44.69	5.15	"	1283.8				
54:20	44.70	5.15	"	1283.9				
10:12:40	43.46	5.01	"	402.70		Lt BRN		
13:00	43.77	5.07	"	383.90				
13:20	43.67	5.11	"	361.40				
13:40	43.68	5.16	"	344.00				
END:								

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Comments: (TUES) 02/11/96 : THIS WELL WAS USED FOR A TEST TO GET OUR DEVELOPMENT EQUIPMENT RUNNING.

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3063

WELL DEVELOPMENT LOG

PROJECT: **5518** **Monitoring Point Assess.**	SITE: **Hanscom AFB**	WELL ID: B241	DATE: 02/13/97
WELL DEPTH: SEE CHART	WATER LEVEL: 4.74' FROM TOP OF PVC	WEATHER INFORMATION: COLD	
METHOD & EQUIPMENT: **Aardvark Well Development Tool, Purge Pump**			
SURGING TIME BEGIN: 0840 END:	PUMPING TIME BEGIN: 0840 END:	VOLUME BAILED DURING SURGING: 50 GAL (ESTIMATED)	

		MEASUREMENTS			OBSERVATIONS				
	TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	CLARITY	COLOR	ODOR	PARTICULATES
13/11	To: 11:46	43.75	6.47	0.02	36.9				
	11:47	44.56	6.30	0.02	~~25.0~~ 425.7				
13/11	11:51	42.23	6.29	0.04	373.7				
	11:52	42.45	6.21	0.04	321.5				
11/9	12:02	42.98	6.47	0.02	295.7				
	12:03	43.56	6.35	0.02	249.9				
11/9	12:06	39.66	6.40	0.00	383.9				
	12:07	40.32	6.22	0.01	351.8				
9/7	12:15	39.28	6.31	0.02	143.2				
	12:16	39.65	6.24	0.02	122.6				
	END:								

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3 \pi r^3$

Comments: 7/5 -- No H_2O.

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WELL DEVELOPMENT LOG

PROJECT: **5518** **Monitoring Point Assess.**	SITE: **Hanscom AFB**	WELL ID: 8238	DATE: 02/25
WELL DEPTH: 10.19' B.G.S.	WATER LEVEL: 5.44' B.G.S.	WEATHER INFORMATION: Cold, Cold	

METHOD & EQUIPMENT: **Aardvark Well Development Tool, Purge Pump** AND

SURGING TIME	PUMPING TIME	VOLUME BAILED DURING SURGING:
BEGIN: 08:55 END: 09:40	BEGIN: END: SEE BELOW	& SUCTIONING: 2 GALS; PUMPING: 1/2 GAL; TOTAL: 2 1/2 GALS

TIME	MEASUREMENTS: TEMPERATURE	pH	SPEC. COND.	OBSERVATIONS: TURBIDITY	CLARITY	COLOR	ODOR	PARTICULATES
To: 10:20	48.11	6.80	0.12	1427.6				
To 10:21	48.00	6.79	0.12	1427.4				
T10 10:31	37.94	6.84	0.13	1402.0				
T10 10:32	38.15	6.73	0.13	1402.4				
T15								
T15								
END:								

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Comments:

5.92
.48
5.44

(10/8, 8/6, 7/5)
$\underbrace{15 \quad 15 \quad 15}_{2\ GALS}$ = 45 MIN

SUCTION 10 MIN

NOTE: ONLY TOOK 2 SAMPLE DUE TO LACK OF WATER

PUMPING
ON 30 SEC
OFF 2 MIN
ON 15 SEC
OFF 2 MIN
ON 15 SEC

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WELL DEVELOPMENT LOG

PROJECT: **5518** **Monitoring Point Assess.**	SITE: **Hanscom AFB**	WELL ID: RAPI-6(S)	DATE: 2/24/97
WELL DEPTH: 17.88' BGS	WATER LEVEL: 6.35' 6.23' TOP	WEATHER INFORMATION: WINDY, COOL, SUNNY	
METHOD & EQUIPMENT: **Aardvark Well Development Tool, AND Purge Pump**			
SURGING TIME BEGIN: 15:50 END: 16:50	PUMPING TIME BEGIN: 15MIN @ END: 3 GALS/MIN	VOLUME BAILED DURING SURGING: 15GALS; a SURGING: ; PUMPING: 45GALS; 60GALS	

TIME	TEMPERATURE	~~pH~~ COND	pH ~~SPEC. COND.~~	TURBIDITY	CLARITY	COLOR	ODOR	PARTICULATES
T0: 17:21	45.85	0.07	6.53	546.30				
T0 17:22	45.89	0.07	6.38	461.30				
T10 17:27	46.19	0.06	6.36	16.30				
T10 17:28	46.18	0.06	6.14	11.10				
T15 17:31	45.80	0.05	6.19	14.80				
T15 17:32	45.90	0.05	6.04	8.40				
END:								

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Comments:

$\left(\frac{14.5}{12.5}, \frac{12.5}{10.5}, \frac{10.5}{8.5}, \frac{8.5}{6.5} \right)$

$\underbrace{15 \quad 15 \quad 15 \quad 15}_{15\ \text{Gals}}$

~~PUMP~~ 4 ft OF SILT

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WELL DEVELOPMENT LOG

PROJECT: **5518** **Monitoring Point Assess.**	SITE: **Hanscom AFB**	WELL ID: OWZ-6	DATE: 02/25
WELL DEPTH: 23.10' BGS	WATER LEVEL: 12.27' BGS.	WEATHER INFORMATION: COLD, COLD, WINDY	
METHOD & EQUIPMENT: **Aardvark Well Development Tool AND Purge Pump**			
SURGING TIME BEGIN: 11:10 END: 12:15	PUMPING TIME BEGIN: SEE BELOW END:	VOLUME BAILED DURING SURGING: < 15 GALS	

TIME	MEASUREMENTS TEMPERATURE	pH	SPEC. COND.	OBSERVATIONS TURBIDITY	CLARITY	COLOR	ODOR	PARTICULATES
T_0: 13:05	48.30	6.26	0.19	1427.4				
T0 13:06	48.27	6.24	0.20	1427.4				
T10 13:13	47.76	6.30	0.12	187.80				
T10 13:14	47.77	6.21	0.12	120.70				
T15 13:17	47.58	6.40	0.21	437.90				
T15 13:18	47.79	6.20	0.21	805.80				
END:								

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Comments:

12.52
.25
12.27

(20/18, 18/16, 16/14, 14/12)
15 15 15 15

10 GALS

NOTE: THIS WELL WOULD NOT SUPPORT 3 GALS/MIN

PUMP: 1M 30S
RECHARGE: 2M
REPEATED 4 TIMES

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WELL DEVELOPMENT LOG

PROJECT: **5518** **Monitoring Point Assess.**	SITE: **Hanscom AFB**	WELL ID: OW2-7	DATE: 2/25/97
WELL DEPTH: 23.49' B.G.S.	WATER LEVEL: .35 11.91' T.O.P. => 11.56'	WEATHER INFORMATION: COLD, WINDY, SNOWY	
METHOD & EQUIPMENT: **Aardvark Well Development Tool, AND Purge Pump**			
SURGING TIME BEGIN: 14:45 END: 15:50	PUMPING TIME BEGIN: END:	VOLUME BAILED DURING SURGING: < 10 GALS	

	MEASUREMENTS			OBSERVATIONS				
TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	CLARITY	COLOR	ODOR	PARTICULATES
T_0:								
END:								

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Comments:

(20/18, 18/16, 16/14, 14/12)
15, 15, 15, 15
1 HOUR

NOTE: WHEN WE WENT DOWN WITH SUCTION TOOL THERE WAS NO H_2O.
WILL PUMP TOMMORROW - 2/26/97

2/26
H_2O TABLE @ 12.64'
SILT @ 16.00'
NOT ENOUGH H_2O TO PUMP OR SUCTION.

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WELL DEVELOPMENT LOG

PROJECT: **5518** **Monitoring Point Assess.**	SITE: **Hanscom AFB**	WELL ID: B4Z-MW	DATE: 2/26
WELL DEPTH: 15.28' BGS	WATER LEVEL: 8.33' BGS	WEATHER INFORMATION: WARM, BREEZY	
METHOD & EQUIPMENT: **Aardvark Well Development Tool, AND Purge Pump**			
SURGING TIME BEGIN: 10:05 END:	PUMPING TIME BEGIN: END: SEE BELOW	VOLUME BAILED DURING SURGING: @SUCTIONING: 2GALS PUMPING: 5GALS TOTAL: 7GALS	

TIME	MEASUREMENTS: TEMPERATURE	pH	SPEC. COND.	OBSERVATIONS: TURBIDITY	CLARITY	COLOR	ODOR	PARTICULATES
To: 11:27:00	49.16	6.55	0.232	14320				
To 11:28:00	49.18	6.55	0.232	1413Q1				
11:31:00	49.22	6.52	0.23	574.10				
11:32:00	49.21	6.46	0.23	526.8				
11:36:00	48.92	6.45	0.23	114.3				
11:37:00	48.93	6.40	0.23	106.0				
END:								

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Comments:

15.28 BOT.

9.00
.67
8.33

6.95' OF H_2O

$\underbrace{(15/13,\ 13/11,\ 11/9,\ 9/8)}$

15 15 15 15 => 1 hrs

1
2GALS

PUMPING
30 SEC PUMP
5 MIN RECHARGE
30 SEC PUMP
5 MIN RECHARGE
30 SEC PUMP

NOTE: SAMPLES WERE TAKEN FROM EACH PUMP SESSION

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WELL DEVELOPMENT LOG

PROJECT: 5518 Monitoring Point Assess.	SITE: Hanscom AFB	WELL ID: B41	DATE: 2/26
WELL DEPTH: 14.84'	WATER LEVEL: 11.76' BGS	WEATHER INFORMATION: SUNNY, WARM, BREEZY	
METHOD & EQUIPMENT: Aardvark Well Development Tool, AND Purge Pump			
SURGING TIME BEGIN: 11:55 END: 12:25	PUMPING TIME BEGIN: SEE BELOW END:	VOLUME BAILED DURING SURGING: SUCTIONING: 0 GALS PUMPING: 1 GAL	

TIME	MEASUREMENTS TEMPERATURE	pH	SPEC. COND.	OBSERVATIONS TURBIDITY	CLARITY	COLOR	ODOR	PARTICULATES
T_0: 1343:00	47.57	7.61	0.035	1425.6				
13:49:00	47.68	7.13	0.036	1426.0				
END:								

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Comments:

12.17
.41
11.76

14.84
11.86
2.98'

(14.8/12.8, 13.8/11.8)
55 10
15 15
0 GALS

NOTE: WOULD'NOT PUMP BUT 10SEC AT A TIME
VERY SILTY H_2O. WELL WOULD RECHARGE
VERY SLOWLY. THE WATER COMING UP WAS
VERY SILTY DIDN'T TAKE ANY SAMPLES

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WELL DEVELOPMENT LOG

PROJECT: 5518 Monitoring Point Assess.	SITE: Hanscom AFB	WELL ID: B40-MW	DATE: 02/26
WELL DEPTH: 16.7' B.G.S.	WATER LEVEL: 12.05' B.G.S	WEATHER INFORMATION: SUNNY, WARM, BREEZY	
METHOD & EQUIPMENT: Aardvark Well Development Tool, AND Purge Pump			
SURGING TIME BEGIN: 13:25 END:	PUMPING TIME BEGIN: END: SEE BELOW	VOLUME BAILED DURING SURGING:	

TIME	MEASUREMENTS TEMPERATURE	pH	SPEC. COND.	OBSERVATIONS TURBIDITY	CLARITY	COLOR	ODOR	PARTICULATES
3/3/97 To: 13:55:00	47.92	6.95	0.073	912.8				
13:56:00	47.69	6.60	0.074	288.0				
END:								

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Comments:

12.46
.41
12.05

(16.7/14.7, 14.7/12.7)

.5 .5

1 GAL

NOTE: NO H_2O ON THIS ONE.

NOT ABLE TO GET SAMPLE

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WELL DEVELOPMENT LOG

PROJECT: **5518** **Monitoring Point Assess.**	SITE: **Hanscom AFB**	WELL ID: B39-MW	DATE: 2/26/97
WELL DEPTH: 17.54' BGS	WATER LEVEL: 12.96' BGS	WEATHER INFORMATION: WARM, SUNNY, BREEZY	
METHOD & EQUIPMENT: **Aardvark Well Development Tool, AND Purge Pump**			
SURGING TIME BEGIN: 14:50 END:	PUMPING TIME BEGIN: END: SEE BELOW	VOLUME BAILED DURING SURGING: 2GALS SUCTIONING: 0GALS PUMPING: 2GALS (4GALS)	

TIME	MEASUREMENTS TEMPERATURE	pH	SPEC. COND.	OBSERVATIONS TURBIDITY	CLARITY	COLOR	ODOR	PARTICULATES
T0: 14:02:00	48.32	6.47	0.134	1427.7				
14:03:00	48.21	6.48	0.135	1427.4				
END:								

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Comments:

(17.5/15.5, 15.5/13.5,)

15 15 = 30MIN

2GALS

DEPTH => 17.38' BGS

NOTE: NO WATER CAME UP WHILE SUCTIONING — PURGE PUMP PRODUCED VERY SILTY H_2O

WASN'T ABLE TO GET A SAMPLE

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WELL DEVELOPMENT LOG

PROJECT: **5518** **Monitoring Point Assess.**	SITE: **Hanscom AFB**	WELL ID: B38	DATE: 2/27/97
WELL DEPTH: 17.95' BGS	WATER LEVEL: 14.02' BGS	WEATHER INFORMATION: WARM, RAINY, WET	
METHOD & EQUIPMENT: **Aardvark Well Development Tool, AND Purge Pump**			
SURGING TIME BEGIN: 08:35 END: 09:10	PUMPING TIME BEGIN: END:	VOLUME BAILED DURING SURGING: ABSUCTIONING: 3GALS	

3/7

TIME	MEASUREMENTS TEMPERATURE	pH	SPEC. COND.	OBSERVATIONS TURBIDITY	CLARITY	COLOR	ODOR	PARTICULATES
T0: 14:24:00	49.06	6.54	0.008	1429.3				
14:25:00	48.98	6.57	0.006	1429.1				
END:								

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Comments:

(17.95/15.95, 15.95/13.95)
15 15

NOTE: NO SAMPLE TAKEN.

REMOVED ALL SILT

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WELL DEVELOPMENT LOG

PROJECT: **5518** **Monitoring Point Assess.**	SITE: **Hanscom AFB**	WELL ID: MWZ-07	DATE: 2/27/97
WELL DEPTH: 14.03' BGS	WATER LEVEL: 6.15' BGS	WEATHER INFORMATION: RAINY, WARM, WET	
METHOD & EQUIPMENT: **Aardvark Well Development Tool, AND Purge Pump**			
SURGING TIME BEGIN: 09:55 END:	PUMPING TIME BEGIN: SEE BELOW END:	VOLUME BAILED DURING SURGING: 7 GALS SUCTIONING: 3 GALS PUMPING: ~~8 GALS~~ 18 GALS	

TIME	MEASUREMENTS: TEMPERATURE	pH	SPEC. COND.	OBSERVATIONS: TURBIDITY	CLARITY	COLOR	ODOR	PARTICULATES
T_0: 11:22:00	47.06	6.46	0.337	1425.6				
11:23:00	47.21	6.47	0.338	1426.0				
11:28:00	45.69	6.35	0.33	198.90				
11:29:00	45.71	6.39	0.33	183.30				
11:39:00	46.70	6.27	0.27	228.3				
11:40:00	46.74	6.33	0.27	205.0				
END:								

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Comments:

(14/12, 12/10, 10/8, 8/6)
10 25 40 55
15 15 15 15

7 Gals

03/03/97 PUMPING TEST

CPT WELL => H_2O LEVEL: 6.39' TIME PUMPING: 49s

RECHARGE RATE: 2m 25s/ft

NOTES: MODERATELY CLEAR H_2O

AUGER WELL => H_2O LEVEL: 5.94' TIME PUMPING: 1m 54s

RECHARGE RATE: 3m 21s/ft

NOTE: COULD SMELL A FUEL ODER WHEN TAKING SAMPLS. PID DID NOT PICK IT UP [illegible]

PUMPING

1 MIN PUMPING
4 MIN RECHARGE
1 MIN PUMP
4 MIN RECHARGE
30 SEC PUMP

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WELL DEVELOPMENT LOG

PROJECT: **5518** **Monitoring Point Assess.**	SITE: **Hanscom AFB**	WELL ID: MWZ-06	DATE: 2/27/97
WELL DEPTH: 18.78' BGS	WATER LEVEL: 8.58' BGS	WEATHER INFORMATION:	
METHOD & EQUIPMENT: **Aardvark Well Development Tool, AND Purge Pump**			
SURGING TIME BEGIN: 12:15 END: 13:30	PUMPING TIME BEGIN: SEE BELOW END:	VOLUME BAILED DURING SURGING: SUCTIONING: 10 GALS PUMPING: 6 GALS 16 GALS	

TIME	MEASUREMENTS TEMPERATURE	pH	SPEC. COND.	OBSERVATIONS TURBIDITY	CLARITY	COLOR	ODOR	PARTICULATES
T_0: 14:00:00	53.19	6.34	0.267	1440.4				
14:01:00	53.25	6.41	0.283	1440.6				
14:05:00	53.12	6.40	0.160	509.6				
14:06:00	53.12	6.43	0.160	481.0				
14:16:00	.26	6.35	0.287	169.6				
14:17:00	53.22	6.40	0.288	140.4				
END:								

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Comments:

(18.7/16.7, 16.7/14.7, 14.7/12.7, 12.7/10.7, 10.7/8.7)

15 30 45 60 75

15 15 15 15 15

10 GALS

NOTE: COULD SMELL ODOR (FUEL).

PUMPING

30 SEC PUMP

4 MIN RECHARGE

30 SEC P

4 MIN R

30 SEC P

4 MIN R

30 SEC P

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WELL DEVELOPMENT LOG

PROJECT: **5518** **Monitoring Point Assess.**	SITE: **Hanscom AFB**	WELL ID: AWZ-11	DATE: 2/27/97
WELL DEPTH: 19.93' BGS	WATER LEVEL: 11.43' BGS	WEATHER INFORMATION: RAINY, WARM, WET	
METHOD & EQUIPMENT: **Aardvark Well Development Tool, AND Purge Pump**			
SURGING TIME BEGIN: 14:40:00 END:	PUMPING TIME BEGIN: END:	VOLUME BAILED DURING SURGING: SUCTIONING: 5 GALS PUMPING: 3 GALS 8 GALS	

TIME	MEASUREMENTS: TEMPERATURE	pH	SPEC. COND.	OBSERVATIONS: TURBIDITY	CLARITY	COLOR	ODOR	PARTICULATES
T_0: 16:01:0	55.21	6.39	0.219	1445.4				
16:02:0	55.23	6.39	0.219	1445.5				
16:11:0	54.13	6.50	0.120	1443.0				
16:12:0	54.24	6.43	0.120	1443.2				
16:18:0	54.27	6.36	0.00	1443.3				
16:19:0	54.34	6.35	0.00	1443.5				
3/3/97 14:14:00	52.38	6.23	0.215	555.6				
14:15:00	52.14	6.19	0.217	468.6				
END:								

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Comments:

11.43

(19.93/17.93, 17.93/15.93, 15.93/13.93, 13.93/11.93)

35   30   35   40

PUMPING

30 SEC → SAMPLE
5 MIN
10 SEC
5 MIN
10 SEC → SAMPLE
5 MIN
3 SEC → SAMPLE

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WELL DEVELOPMENT LOG

PROJECT: **5518** **Monitoring Point Assess.**	SITE: **Hanscom AFB**	WELL ID: MW2-12	DATE: 2/28
WELL DEPTH: 20.08' BGS	WATER LEVEL: 7.82' BGS	WEATHER INFORMATION: OVERCAST, WARM	
METHOD & EQUIPMENT: **Aardvark Well Development Tool, AND Purge Pump**			
SURGING TIME BEGIN: 0805 END:	PUMPING TIME BEGIN: SEE BELOW END:	VOLUME BAILED DURING SURGING: + SUCTIONING: 2 GALS PUMPING: 0 2 GALS	

TIME	MEASUREMENTS TEMPERATURE	pH	SPEC. COND.	OBSERVATIONS TURBIDITY	CLARITY	COLOR	ODOR	PARTICULATES
3/2 T_0:	48.68	6.80	0.17	1428.7		GRAY		
T_0:	48.47	6.65	0.16	1428.2		GRAY		
END:								

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Comments:

YSI SAMPLES TAKEN 3/3/97

(20/18, 18/16, 16/14, 14/12, 12/10)
05 20 35 ~~50~~ 55 ~~05~~ 10

CPT WELL
H2O LEVEL: 7.89' BGS
PUMP TIME: 50 s
RECHARGE: 2M 01s / .2 ft

AUGERED WELL
RECHARGE: 1M 02s/.2 ft

PUMPING
3 SEC PUMP
5 MIN RECHARGE
3 SEC PUMP

REMOVED SILT
NO SAMPLE

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WELL DEVELOPMENT LOG

PROJECT: **5518** **Monitoring Point Assess.**	SITE: **Hanscom AFB**	WELL ID: MWZ-23	DATE: 2/28/97
WELL DEPTH: 17.78	WATER LEVEL: 14.57' BGS	WEATHER INFORMATION:	
METHOD & EQUIPMENT: **Aardvark Well Development Tool, Purge Pump**			
SURGING TIME BEGIN: 10:15 END: 10:50	PUMPING TIME BEGIN: END: SEE BELOW	VOLUME BAILED DURING SURGING: ~ SUCTIONING 0 GALS	

TIME	MEASUREMENTS TEMPERATURE	pH	SPEC. COND.	OBSERVATIONS TURBIDITY	CLARITY	COLOR	ODOR	PARTICULATES
3/97 To: 14:44:00	49.64	7.31	0.117	1431.0				
14:45:00	49.65	7.29	0.117	1431.0				
END:								

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Comments:

14.88
.31
14.57

(17.7/15.7, 16.5/14.5)

3/3/97 PUMPED 5SEC

PUMPING
5SEC

REMOVED SILT + MOVED ON
NO SAMPLE TODAY

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WELL DEVELOPMENT LOG

PROJECT: **5518** **Monitoring Point Assess.**	SITE: **Hanscom AFB**	WELL ID: OW2	DATE: 2/28
WELL DEPTH: 16.37	WATER LEVEL: 5.50' BGS	WEATHER INFORMATION:	
METHOD & EQUIPMENT: **Aardvark Well Development Tool, AND Purge Pump**			
SURGING TIME BEGIN: 11:25 END: 12:45	PUMPING TIME BEGIN: SEE BELOW END:	VOLUME BAILED DURING SURGING:	

TIME	MEASUREMENTS TEMPERATURE	pH	SPEC. COND.	OBSERVATIONS TURBIDITY	CLARITY	COLOR	ODOR	PARTICULATES
T_0: 14:54:00	43.66	7.51	0.049	777?				
14:55:00	44.59	7.21	0.049	345.6				
END:								

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Comments:

16.30/14.3, 14.3/12.3, 12.3/10.3, 10.3/8.3, 8.3/6.3

40 55 10 25

3/3/97 PUMPED 20SEC
SOFT BOTTOM

PUMPING

NO SAMPLE

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WELL DEVELOPMENT LOG

PROJECT: **5518** **Monitoring Point Assess.**	SITE: **Hanscom AFB**	WELL ID: B37	DATE: 2/28/97
WELL DEPTH: 16.77' BGS	WATER LEVEL:	WEATHER INFORMATION:	
METHOD & EQUIPMENT: **Aardvark Well Development Tool, Purge Pump**			
SURGING TIME BEGIN: 13:45 END:	PUMPING TIME BEGIN: END: SEE BELOW	VOLUME BAILED DURING SURGING: 4 SUCTIONINGS: 1 GAL	

TIME	MEASUREMENTS TEMPERATURE	pH	SPEC. COND.	OBSERVATIONS TURBIDITY	CLARITY	COLOR	ODOR	PARTICULATES
3/9/97 T_0: 15:02:00	46.78	5.64	0.310	1424.3				
15:03:00	47.32	5.35	0.317	733.5				
END:								

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

7.48 GAL/FT³ .154 GALS/FT

Comments:

(16.7/14.7, 14.7/12.7, 12.7/10.7, 10.7/8.7, 8.7/6.7)

45 00 :50 :20 35 35 45 50

.10 ft RECHARGE => 3M 45 S

THIS WELL HAS A RECHARGE OF .25 GALS/HR

3/3/97 PUMPED 20 SEC

PUMPING

No H_2O

No SAMPLE TODAY

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WELL DEVELOPMENT LOG

PROJECT: 5518 Monitoring Point Assess.	SITE: Hanscom AFB	WELL ID: MWZ-8	DATE: 2/28
WELL DEPTH: 19.88' BGS	WATER LEVEL: 15.91' BGS	WEATHER INFORMATION: Sunny, Warm	
METHOD & EQUIPMENT: Aardvark Well Development Tool, Purge Pump			
SURGING TIME BEGIN: 15:55 END: 16:25	PUMPING TIME BEGIN: END:	VOLUME BAILED DURING SURGING: 5 GALS	

TIME	MEASUREMENTS TEMPERATURE	pH	SPEC. COND.	OBSERVATIONS TURBIDITY	CLARITY	COLOR	ODOR	PARTICULATES
3/3/97 To: 15:27:00	49.00	6.85	0.284	632.2				
15:28:00	49.32	6.79	0.285	537.9				
END:								

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Comments:

(19.8/17.8, 17.8/15.8)
10 25

No H2O

Removed silt

No pumping
No sample

3/3/97 Pumped

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WELL DEVELOPMENT LOG

PROJECT: **5518** **Monitoring Point Assess.**	SITE: **Hanscom AFB**	WELL ID: MWZ-19	DATE: 2/28/97
WELL DEPTH: ???	WATER LEVEL: NO H_2O	WEATHER INFORMATION: SUNNY, WARM	
METHOD & EQUIPMENT: **Aardvark Well Development Tool, Purge Pump**			
SURGING TIME BEGIN: Ø END:	PUMPING TIME BEGIN: Ø END:	VOLUME BAILED DURING SURGING: Ø	

TIME	MEASUREMENTS TEMPERATURE	pH	SPEC. COND.	OBSERVATIONS TURBIDITY	CLARITY	COLOR	ODOR	PARTICULATES
T_0:								
END:								

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Comments:

THIS WELL HAS NO WATER.

MEASURED WELL DEPTH (TO SILT) => 14.30' BGS

MEASURED ADJACENT 4" WELL => 16.97' BGS TO H_2O

ALSO 4" WELL IS ≈ 1 ft BELOW 2" WELL IN ELEVATION

THEREFORE MWZ-19 (2") IS 3.67 ft SHORT OF BEING IN H_2O TABLE.

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WELL DEVELOPMENT LOG

PROJECT: **5518** **Monitoring Point Assess.**	SITE: **Hanscom AFB**	WELL ID: MWZ-25	DATE: 2/28/97
WELL DEPTH: 19.5' B.G.S.	WATER LEVEL: No H_2O	WEATHER INFORMATION: SUNNY, WARM	
METHOD & EQUIPMENT: **Aardvark Well Development Tool, Purge Pump**			
SURGING TIME BEGIN: Ø END:	PUMPING TIME BEGIN: Ø END:	VOLUME BAILED DURING SURGING: Ø	

TIME	MEASUREMENTS			OBSERVATIONS				
	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	CLARITY	COLOR	ODOR	PARTICULATES
T_0:								
END:								

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Comments:

THIS WELL HAD NO WATER.

MEASURED WELL DEPTH (TO SILT) => 15.52' BGS

MEASURED 4" WELL DEPTH (TO H_2O) => 17.44' BGS

THEREFORE: 2" WELL MWZ-25 IS 1.92 ft SHORT OF BEING IN THE H_2O TABLE.

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WELL DEVELOPMENT LOG

PROJECT: **5518** **Monitoring Point Assess.**	SITE: **Hanscom AFB**	WELL ID: AWZ-5	DATE: 3/01/97
WELL DEPTH: 20.41' BGS	WATER LEVEL: 12.13' BGS	WEATHER INFORMATION: OVERCAST, EMMINANT RAIN	
METHOD & EQUIPMENT: **Aardvark Well Development Tool, Purge Pump**			
SURGING TIME BEGIN: 0815 END: 0915	PUMPING TIME BEGIN: END:	VOLUME BAILED DURING SURGING: + SUCTIONING: 5 GALS PUMPING:	

TIME	MEASUREMENTS TEMPERATURE	pH	SPEC. COND.	OBSERVATIONS TURBIDITY	CLARITY	COLOR	ODOR	PARTICULATES
3/97 T_0: 14:34:00	52.30	7.17	0.068	28.4?				
14:35:00	52.76	7.07	0.065	1438.6				
END:								

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3 \pi r^3$

Comments:

(20.4/18.4, 18.4/16.4, 16.4/14.4, 14.4/12.4)

15 30 45 60

$\underbrace{\hphantom{xxxxxxxxxxxxxxxx}}_{\text{5 GALS}}$

3/3/97 PUMPED FOR 30 SEC

PUMPING

NOT ENOUGH H_2O

REMOVED SILT

NO SAMPLE

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WELL DEVELOPMENT LOG

PROJECT: **5518** **Monitoring Point Assess.**	SITE: **Hanscom AFB**	WELL ID: MWZ-4	DATE: 3/01/97
WELL DEPTH: 17.9' BGS	WATER LEVEL: 14.18' BGS	WEATHER INFORMATION:	
METHOD & EQUIPMENT: **Aardvark Well Development Tool, Purge Pump**			
SURGING TIME BEGIN: 0950 END: 10:25	PUMPING TIME BEGIN: END:	VOLUME BAILED DURING SURGING: No H_2O	

TIME	MEASUREMENTS TEMPERATURE	pH	SPEC. COND.	OBSERVATIONS TURBIDITY	CLARITY	COLOR	ODOR	PARTICULATES
T_0:								
END:								

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Comments:

(17.9/16.0 c), 16/14)
50 05

NOTE: DUE TO DAMAGED SCREEN A WEIGHT HAD TO BE ADDED TO THE DISCHARGE HEAD DURING SURGING

No H_2O, COULD NOT GET ALL THE SILT OUT

Pumping
No H_2O

3/3/97 PUMPED 2 SEC
VERY SILTY
OPAQUE WATER

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WELL DEVELOPMENT LOG

PROJECT: **5518** **Monitoring Point Assess.**	SITE: **Hanscom AFB**	WELL ID: MWZ-17	DATE: 03/01/97
WELL DEPTH: 18.94' BGS.	WATER LEVEL: 14.01' BGS	WEATHER INFORMATION:	
METHOD & EQUIPMENT: **Aardvark Well Development Tool, AND Purge Pump**			
SURGING TIME BEGIN: 10:55 END: 11:30	PUMPING TIME BEGIN: END:	VOLUME BAILED DURING SURGING: + SUCTIONING: 1 GAL PUMPING:	

TIME	MEASUREMENTS TEMPERATURE	pH	SPEC. COND.	OBSERVATIONS TURBIDITY	CLARITY	COLOR	ODOR	PARTICULATES
T_0:								
END:								

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Comments:

(19/17, 17/15, 16/14)
55 10 25

NOTE:
VERY LITTLE SILT CAME INTO WELL.
PUMPED OUT WELL w/ PURGE PUMP 5 SEC

03/03/97 - PUMPED 5 SEC
VERY SILTY
NO SAMPLE

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WELL DEVELOPMENT LOG

PROJECT: 5518 Monitoring Point Assess.	SITE: Hanscom AFB	WELL ID: B20-MW	DATE: 03/03/97
WELL DEPTH: 17.04' BGS	WATER LEVEL: 8.94' BGS	WEATHER INFORMATION: Sunny, Cool	
METHOD & EQUIPMENT: Aardvark Well Development Tool, AND Purge Pump			
SURGING TIME BEGIN: 0815 END: 0920	PUMPING TIME BEGIN: END: SEE BELOW	VOLUME BAILED DURING SURGING: 0 GALS	

TIME	MEASUREMENTS TEMPERATURE	pH	SPEC. COND.	OBSERVATIONS TURBIDITY	CLARITY	COLOR	ODOR	PARTICULATES
T_0: 15:17:00	50.95	6.19	0.326	14.6?				
15:18:00	51.37	6.27	0.329	1435.8				
END:								

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Comments:

(17/15, 15/13, 13/11, 11/9)
15 30 45 60

3/3/97 PUMPED: 25 SEC

NO WATER
NO SAMPLE

REMOVED SILT

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WELL DEVELOPMENT LOG

PROJECT: **5518** **Monitoring Point Assess.**	SITE: **Hanscom AFB**	WELL ID: MW2-22	DATE: 03/03/96
WELL DEPTH: 19.54' BGS	WATER LEVEL: 12.43' B.G.S.	WEATHER INFORMATION:	
METHOD & EQUIPMENT: **Aardvark Well Development Tool, AND Purge Pump**			
SURGING TIME BEGIN: 1000 END: 10:35	PUMPING TIME BEGIN: END:	VOLUME BAILED DURING SURGING: 1 GAL	

TIME	MEASUREMENTS			OBSERVATIONS				
	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	CLARITY	COLOR	ODOR	PARTICULATES
T_0:								
END:								

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Comments:

19.5/17.5, 17.5/15.5, 15.5/13.5, 14.0/12.0

00

2 GALS

ABORTED

3/3/97 PUMPED: 10S

NO PUMPING

NO SAMPLE

REMOVED SILT

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WELL DEVELOPMENT LOG

PROJECT: **5518** **Monitoring Point Assess.**	SITE: **Hanscom AFB**	WELL ID: MWZ-03	DATE: 03/03/97
WELL DEPTH: 15.5' BGS	WATER LEVEL: 14.32' BGS	WEATHER INFORMATION: Sunny, Cool	
METHOD & EQUIPMENT: **Aardvark Well Development Tool** AND **Purge Pump**			
SURGING TIME BEGIN: END: Ø	PUMPING TIME BEGIN: END: Ø	VOLUME BAILED DURING SURGING: Ø	

	MEASUREMENTS			OBSERVATIONS				
TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	CLARITY	COLOR	ODOR	PARTICULATES
T_0:								
END:								

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Comments:

1 ft OF H_2O IN WELL

NO SURGING

3/3 { PUMP
5 SEC VERY SILTY

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WELL DEVELOPMENT LOG

PROJECT: 5518 Monitoring Point Assess.	SITE: Hanscom AFB	WELL ID: OWZ-4	DATE: 03/04/97
WELL DEPTH: 33.35 ' BGS	WATER LEVEL: 19.07 ' BGS	WEATHER INFORMATION: SNOW FLURRIES, COOL	
METHOD & EQUIPMENT: Aardvark Well Development Tool AND Purge Pump			
SURGING TIME BEGIN: 09:00 END: 10:15	PUMPING TIME BEGIN: 15MIN @ END: 3GAL/MIN	VOLUME BAILED DURING SURGING: 15GALS SECTIONING: 5GALS PUMPING: 45 GALS 65 GALS	

TIME	MEASUREMENTS			OBSERVATIONS				
	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	CLARITY	COLOR	ODOR	PARTICULATES
To: 10:53:00	48.71	6.64	0.26	490.60				
To 10:54:00	48.70	6.46	0.26	436.50				
T10 11:03:0	51.24	6.23	0.25	23.10				
T10 11:04:0	50.99	6.12	0.25	19.70				
T15 11:07:0	51.49	6.24	0.25	23.70				
T15 11:08:0	51.47	6.08	0.25	22.90				
END:								

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Comments:

(23/25, 25/27, 27/29, 28/30)

15 30 45 60

15GALS

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APPENDIX E

FIELD SAMPLING LOGS

SAMPLING ROUND 1
APRIL - MAY 1997

GROUNDWATER SAMPLING LOG

PROJECT: **5518**	SITE: 2	WELL ID: DPW- RFW-11	DATE: 4-25-97
WELL DEPTH:	SCREEN LENGTH: 3 m	WELL DIAMETER: **2"**	CASING TYPE: **PVC**
MEASUREMENT POINT: *TOC*	WATER LEVEL: 10.25	WEATHER INFORMATION: Sunny, 13°C	
METHOD & EQUIPMENT: ***Low Flow with Grundfos Redi-flo Submersible Pump***			
TUBING TYPE: ***Teflon coated polyethylene***	Pump Depth: 12.5 ft btoc	Dial: 84 Hz	
SAMPLING PERSONNEL: ***Chris Bianchi (JCB) and Marty Gildea (MLG)***			

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO	▼	COMMENTS:
(units)							
T_0: 1418							
1425						10.29	650 mL/min
1430						10.29	650 mL/min
1435	Connected Sond						
1442						10.26	375 mL/min
1444	12.67	4.90	0.681	6.3	11.05	10.26	
1448	12.86	4.83	0.669	4.6	10.80		
1450	Flow stopped because air in the line. Flushed line at a higher flow rate, which stirred up well. Drained and reconnected sond						
1500	11.07	4.73	0.634	41.0	10.08	10.26	460 mL/min
1504	11.07	4.31	0.625	41.6	12.80		
	Disconnecting Sond and rinsing						
1508	11.51	5.17	0.591	26.4	12.21		
1512	12.42	4.42	0.626	15.3	12.51		HAVING DIFFICULTY MAINTAINING CONSTANT FLOW.
1516	13.34	5.06	0.632	10.9	11.73	10.25	
1520	13.76	5.17	0.617	8.5	11.06	10.25	
1524	10.73	5.15	0.626	116.8	11.82	10.28	PURGED AIR FROM LINE
1528	10.81	5.29	0.539	122.7	12.23	10.26	475 mL/MIN
1532	11.36	5.15	0.599	53.0	10.33		
1536	11.88	5.18	0.582	36.7	10.08		
1540	12.17	5.21	0.582	27.2	10.09	10.25	340 mL/MIN
1544	12.59	5.24	0.584	19.0	10.30	10.23	340 mL/MIN
END:							

Samples Collected: 4 x 40 mL VOA's ; SEQ # 1078 - 1081 * NOTE SAMPLES COLLECTED BEFORE TURBIDITY CRITERIA MET.

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3 \pi r^3$

PURGE VOL. = 4 + 5 + 3.5 = 12.5 GAL.

GROUNDWATER SAMPLING LOG

PROJECT: 5518	SITE: ~~RFW-II~~ 2	WELL ID: RFW-11	DATE: 4-25-97
WELL DEPTH:	SCREEN LENGTH: 10'	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 12.32	WEATHER INFORMATION: SUNNY/HAZY, 13°C	

METHOD & EQUIPMENT: Low Flow with Grundfos Redi-flo Submersible Pump

TUBING TYPE: Teflon coated polyethylene | PUMP DEPTH = 14' bTOC | DIAL: 84

SAMPLING PERSONNEL: Chris Bianchi (JCB) and Marty Gildea (MLG)

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO	▼	COMMENTS:
(units)	°C		mS/cm	NTU	mg/L	feet bTOC	
T_0: 1617						12.32	
1620						12.40	570 mL/min
1624						12.40	570 mL/min
1627	CONNECT	SONDE					
1630						12.37	430 mL/min
1632	12.48	5.49	0.169	3.2	11.02	12.35	200 mL/min
1636	12.78	5.53	0.175	2.7	10.93		
1640	13.16	5.55	0.098	2.9	11.03		
1644	14.62	5.57	0.198	18.6	10.67		640 mL/min
1648	13.18	5.63	0.199	55.5	10.94	12.42	PURGED AIR FROM LINES
1652	12.59	5.55	0.203	94.9	10.88	12.42	400 mL/min
1656	12.82	5.55	0.218	150.9	10.87		
1700	12.25	5.54	0.222	1582.4	11.32		
1704	10.19	5.56	0.238	2.1	11.19	12.46	520 mL/min
1708	10.70	5.55	0.223	2.1	10.86		
1712	11.31	5.58	0.240	2.0	10.67		
1716	11.96	5.59	0.237	2.1	10.52		
1719	Collected	Samples					
END:							

Samples Collected: 2 x 40 mL VOAs + 2 Dup + 2 Reps (~~So~~ Seq. #s 1082-1087)

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

PURGE VOLUME: 4+4

GROUNDWATER SAMPLING LOG

PROJECT: 5518	SITE: 21	WELL ID: DPW-B39	DATE: 5-6-97
WELL DEPTH: meas. 17.0 (17.58)	SCREEN LENGTH: 3m	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 11.13	WEATHER INFORMATION: Cloudy 13°C	

METHOD & EQUIPMENT: *Low Flow with Grundfos Redi-flo Submersible Pump*

TUBING TYPE: *Teflon coated polyethylene* | Depth of Pump: 14.0 ft | Dial:

SAMPLING PERSONNEL: *Chris Bianchi (JCB) and Marty Gildea (MLG)*

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO	▼	COMMENTS:
(units)							
T_0: 1414	Started pumping						
~~14~~ 1432						12.49	100 mL/min
1500	Getting nervous that pump may ~~be~~ be clogged						
	with silt so, we pulled it out to check.						
1512	started again						
1520	Flow rate is so low and drawdown is					12.98	155 mL/min
1531	> 0.3 ft, so we will just take samples					12.72	75 mL/min
	after we get 1 gallon of purge volume.						
1557	SAMPLES						
END:							

Samples Collected:

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Sched 80 566 ml/ft

NOTE: BOTTOM MEASURE ~~TO 17 FT~~ 17 ft deep. Probably 1/2 ft of silt.

Purge Volumes: 1 gal. (turned off pump to check for silt) + 1.5 = 2.5 GAL

~~Seco~~ Second try!

File: GROUNDWATER SAMPLING LOG.doc

PAGE 1/2

GROUNDWATER SAMPLING LOG

PROJECT: 5518	SITE: 21	WELL ID: B39	DATE: 5.6.97
WELL DEPTH: 20.0	SCREEN LENGTH: 10.0	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: ~~12.29~~ 12.30	WEATHER INFORMATION: Cloudy 13°C	

METHOD & EQUIPMENT: Low Flow with Grundfos Redi-flo Submersible Pump

TUBING TYPE: Teflon coated polyethylene | Depth of Pump 14.5' | DIAL: 90 Hz

SAMPLING PERSONNEL: Chris Bianchi (JCB) and Marty Gildea (MLG)

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO	▼	COMMENTS:
(units)						(ft btoc)	
To: 1620	Started Pump.						
1622						12.38	90 mL/min
1627						12.47	200 ml/min
1630						12.50	175 ml/min
1634						12.40	125 ml/min
1637						12.47	150 ml/min
1642	CONNECTED	SOND				12.47	155 ml/min
1645	13.96	6.61	0.033	314.3	9.91		
1648	13.97	6.40	0.067	471.3	9.68	12.45	100 ml/min
1651	14.05	6.27	0.124	712.5	9.20	12.50	200 mL/min
1654	14.07	6.14	0.215	559.4	8.69	12.53	150 ml/min
1657	14.09	6.12	0.303	366.0	8.55		
1700	14.16	6.21	0.385	441.8	8.52		
1703	14.29	6.02	0.485	396.3	8.16	12.55	150 ml/min
1706	14.30	6.03	0.519	144.9	7.98	12.49	150 ml/min
1709	14.26	6.05	0.547	314.0	7.88	12.48	100 ml/min
1712	14.24	6.05	0.600	117.7	7.85		
1715	14.21	6.17	0.601	322.9	7.86		purged to get air bubbles out
1718	15.31	6.01	0.609	695.0	7.27	12.85	190 ml/min
1721	15.44	5.90	0.933	136.0	6.67		140 ml/min
1724	15.20	5.87	1.215	68.2	6.30	12.64	180 ml/min
1727	15.12	5.95			~~6.00~~		
1730	15.21	5.95	1.215	43.4	6.00		
1733	~~1733~~ 15.08	5.99	1.060	48.9	6.14		
1736	14.94	6.03	0.892	61.0	6.40		
~~END~~: 1739	14.76	6.01	0.922	91.3	6.44		

Samples Collected: 2 x 40mL VOAs + 2 Dup 40mL VOAs + 3 Reps 40mL VOAs + 2 Equip Blanks after Decon.

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Purge Vols: 4 gallons

GROUNDWATER SAMPLING LOG

(continued)

PROJECT: 5518	SITE:	WELL ID: B39	DATE: 5-6-97
WELL DEPTH:	SCREEN LENGTH:	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL:	WEATHER INFORMATION:	
METHOD & EQUIPMENT: Low Flow with Grundfos Redi-flo Submersible Pump			
TUBING TYPE: Teflon coated polyethylene			
SAMPLING PERSONNEL: Chris Bianchi (JCB) and Marty Gildea (MLG)			

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO		COMMENTS:
(units)							
T_0: 1742	14.65	6.25	0.840	100.1	6.60	12.48	100ml/min
1744	Collecting Samples						
END:							

Samples Collected:

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

GROUNDWATER SAMPLING LOG

PROJECT: 5518	SITE: 21	WELL ID: B42	DATE: 5-4-97
WELL DEPTH: 15 ft bgs	SCREEN LENGTH: 10 ft	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC Black Mark on PVC	WATER LEVEL: 9.08	WEATHER INFORMATION: Partly Cloudy 18°C	
METHOD & EQUIPMENT: Low Flow with Grundfos Redi-flo Submersible Pump			
TUBING TYPE: Teflon coated polyethylene	Pump Depth: ~~13.0~~ 13.0 ft btoc	Dial: 73 Hz	
SAMPLING PERSONNEL: Chris Bianchi (JCB) and Marty Gildea (MLG)			

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO	▼	COMMENTS:
(units)	°C		mS/cm	NTU	mg/L	(ft btoc)	
T_0: ~~1248~~ 1241 Pump Started							
1247						9.25	400 mL/min
1252	Connect	Sond Cell @	1255			9.22	410 mL/min
1258						9.22	425 mL/min
1300	17.52	4.63	0.075	31.7	6.50		
1303	16.98	4.74	0.077	58.4	6.06		
1306	16.59	4.79	0.080	114.6	5.87		
1309	16.48	4.91	0.087	120.6	5.54		Air bubbles affecting Turb. Probe
1312	17.14	5.05	0.091	190.0	5.15	9.22	400 mL/min
1315	17.73	5.06	0.098	208.8	5.21		
1318	18.26	5.15	0.103	246.7	4.92		
1321	18.68	5.19	0.110	288.5	4.67		
1324	18.98	4.97	0.119	11.1	4.82	9.22	450 ML/MIN
1327	19.11	5.24	0.126	13.4	4.43		
1330	19.12	5.29	0.133	12.5	4.20		
1333	19.04	5.34	0.136	13.8	4.12		
1336	18.94	5.39	0.144	14.4	3.96		
1339	18.64	5.43	0.150	19.0	3.81		AIR BUBBLES AFFECTING
1342	18.01	5.47	0.153	24.9	3.74		TURB. PROBE
1345	17.32	5.49	0.158	31.0	3.69		
1348	COLLECT	SAMPLES				9.24	450 ML/MIN
END:							

Samples Collected: 2 X 40 ML VOA + 3 x 40 REP

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{spnere} = 4/3\pi r^3$

PURGE VOL 4.0 + 3.5 = 7.5

GROUNDWATER SAMPLING LOG

PROJECT: 5518	SITE: 21	WELL ID: DPW-B42	DATE: 5-5-97
WELL DEPTH: 15.28	SCREEN LENGTH: 3m	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC from old PVC top	WATER LEVEL: 7.35	WEATHER INFORMATION: Sunny 20°C	
METHOD & EQUIPMENT: Low Flow with Grundfos Redi-flo Submersible Pump			
TUBING TYPE: Teflon coated polyethylene	Pump Depth: 11.3 ft	Dial	
SAMPLING PERSONNEL: Chris Bianchi (JCB) and Marty Gildea (MLG)			

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO	▼	COMMENTS:
(units)	°C		mS/cm	NTU	mg/L	(ft btoc)	
T_0: 1433	Pump Started						
1435						8.33	120 mL/min
1456						8.31	100 mL/min
1500	CONNECTED SOND						
1503						8.45	100 mL/min
1506	22.80	4.67	0.064	75.8	7.86		
1509	22.67	4.70	0.065	67.3	7.67		
1512	23.27	4.70	0.063	65.4	6.89		AIR BUBBLES IN LINE
1515	23.72	4.69	0.064	67.6	6.72		
1518	23.46	4.68	0.066	75.4	6.89		
1521	23.22	4.63	0.068	142.2	6.85		
1524	23.02	4.68	0.074	75.5	6.84	8.87	200 mL/min
1527	22.72	4.75	0.079	92.4	6.11		
1530	22.69	4.77	0.080	158.9	5.65		
1533	22.72	4.81	0.083	263.1	5.43		
1536	22.44	4.77	0.085	233.4	5.36		
1539	22.35	4.78	0.086	214.9	5.39		AIR BUBBLES IN LINE
1542	23.40	4.85	0.090	350.8	5.23		
1545	22.98	5.15	0.111	525.8	3.44		Having a lot of problems with air bubbles
1548	22.67	5.20	0.118	289	3.09		
1551	22.59	5.23	0.119	417.7	3.01		
1554	22.65	5.28	0.122	350.5	2.96		Accidently shut off pump, and all water drained back in the well
1603	23.08	5.20	0.106	310.7	3.27		
1606	22.82	5.36	0.123	146.0	2.33		
1609	22.48	5.39	0.132	55.8	2.06		
~~END:~~ 1612	21.92	5.35	0.108	81.6	2.83		

Samples Collected:

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

DPW-B42 Page 2/2

GROUNDWATER SAMPLING LOG

Continued

PROJECT: 5518	SITE:	WELL ID: DPW-B42	DATE:
WELL DEPTH:	SCREEN LENGTH:	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL:	WEATHER INFORMATION:	

METHOD & EQUIPMENT: *Low Flow with Grundfos Redi-flo Submersible Pump*

TUBING TYPE: *Teflon coated polyethylene*

SAMPLING PERSONNEL: *Chris Bianchi (JCB) and Marty Gildea (MLG)*

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO		COMMENTS:
(units)							
T_0: 1615	21.56	5.32	0.104	61.4	2.97		
1618	21.21	5.46	0.125	40.2	2.30		
1621	21.64	5.49	0.132	24.1	1.97		
1623	20.82	5.52	0.136	19.1	1.84		
1627	20.80	5.53	0.141	13.0	1.79		
~~1630~~	~~21.25~~	~~5.49~~	~~0.141~~				
1630	COLLECT	SAMPLES					
END:							

Samples Collected:______________________________________

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

PURGE VOL 4.0 + 1.5 = 5.5

10.57 TOS

GROUNDWATER SAMPLING LOG

PROJECT: 5518	SITE: Z1	WELL ID: DPW-MWZ-05	DATE: 05-12-97
WELL DEPTH: 20.41' BGS	SCREEN LENGTH: 3m	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 10.43 ft btoc	WEATHER INFORMATION: P. Sunny, MILD, Breezy 18°C	
METHOD & EQUIPMENT: Low Flow with Grundfos Redi-flo Submersible Pump			
TUBING TYPE: Teflon coated polyethylene	PUMP DEPTH: 15.5 ft btoc	DIAL: 90	
SAMPLING PERSONNEL: ~~Chris Bianchi (JCB) and Marty Gildea (MLG)~~ WAR, SRP			

TIME	TEMPERATURE 3%	pH .1 unit	SPEC. COND. 3%	TURBIDITY 10%	DO 10%	▼	COMMENTS:
(units)	°C	UNIT	mS/cm	NTU	mg/L		(LEGIBLE ENGLISH)
T_0: 0945	AR @ TREATMENT FACILITY						
1015	AR @ SITE Z1						
1042	PUMP STARTED						
1058	CALIBRATION FOR YSI COMPLETE!						
1100	FLOW (EXTRACTION) IS EXTREMLY SLOW						
	< 50mL/MIN			~~DT~~ H2O LEVEL =>		11.50	
1110	VERY SLOW EXTRACTION (DRIP... DRIP.. etc)					12.29	"FLUSHED LINE FOR BUBBLES"
1132						12.13	< 50mL/MIN
1142						12.35	PURGE BUBBLES
1154						12.50	< 50mL/MIN
1223	* TOO SLOW FOR H2O QUALITY					12.91	< 50mL/MIN
	MEASURMENTS.						
1250						12.98	< 50mL/MIN
1258	SAMPLES COLLECTED						
END:							

Samples Collected: 2 x 40mL VOA SEQ. # 1264, 1265

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$ SCHED. 80 => 566mL/ft

PURGE VOL: 1 1/4 GAL

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10.0 TOS

GROUNDWATER SAMPLING LOG

PROJECT: 5518	SITE: 21	WELL ID: MWZ-05	DATE: 5-12-97
WELL DEPTH: 20 ft BGS	SCREEN LENGTH: 10 ft	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 10.31' btoc	WEATHER INFORMATION: CLEAR, BREEZY, 25°C	

METHOD & EQUIPMENT: Low Flow with Grundfos Redi-flo Submersible Pump

TUBING TYPE: Teflon coated polyethylene | PUMP DEPTH: 15.5 ft btoc | DIOL:

SAMPLING PERSONNEL: ~~Chris Bianchi (JCB) and Marty Gildea (MLG)~~ WAR, SRP

TIME	TEMPERATURE 3%	pH .1	SPEC. COND 3%	TURBIDITY 10%	DO 10%	▼	COMMENTS:
(units)	°C	UNIT	mS/cm	NTU	mg/L		
T_0:	REPLICATES WILL BE TAKEN ON THIS WELL.						
13:25	Pump started						
1327						11.20	200mL/min
1330						11.30	75mL/MIN
1335						11.38	50mL/MIN
1345						11.32	<50mL/MIN
1412						11.52	<50mL/MIN
1420	* FLOW TO SLOW FOR H2O QUALITY MEASUREMENT						
1420	SAMPLES COLLECTED						
END:							

Samples Collected: 2x40mL VOA + 3x40mL REPS + 2 EQ. BLK

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

SEQ. # 1266 → 1272

PURGE VOL: 1 1/4 GAL

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GROUNDWATER SAMPLING LOG

PROJECT: 5518	SITE: 21	WELL ID: MWZ-06 (DPW)	DATE: 5.8.97
WELL DEPTH: 18.78 ft bgs	SCREEN LENGTH: 3 m	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 7.26	WEATHER INFORMATION: clear, windy, 9°C	

METHOD & EQUIPMENT: **Low Flow with Grundfos Redi-flo Submersible Pump**

TUBING TYPE: **Teflon coated polyethylene** / Pump Depth is 13.8 ~~15.2~~ ft btoc / Dial: 77

SAMPLING PERSONNEL: **Chris Bianchi ~~(JCB)~~ and Marty Gildea ~~(MLG)~~** / WAR, SRP

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO	▼	COMMENTS:
(units)							
T0: 0700 arrive @ site,	begin to calibrate, CELL PHONE INOP - GO TO BASE PHONE TO CALL FOR BARO. PRESSURE, ALL SENSORS CALIBRATED						30.00
0812	PUMP STARTED						
0830	Extremely slow well					7.42	< 50 ml/min
0930	AFTER PURGING 1.5 GALS FROM WELL						
	TOOK 2 40ML SAMPLES						
0930	COLLECTED SAMPLE					8.05	
END:							

Samples Collected: 2 40ml VOAS #1201, 1202

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

PURGE VOL: 1.5 GALS

GROUNDWATER SAMPLING LOG

PROJECT: 5518	SITE: 21	WELL ID: MW2-06	DATE: 5-8-97
WELL DEPTH: 18.5	SCREEN LENGTH: ~~2m~~ 10 ft	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 6.29 ft btoc	WEATHER INFORMATION: Clear, Windy 12°C	

METHOD & EQUIPMENT: Low Flow with Grundfos Redi-flo Submersible Pump

TUBING TYPE: Teflon coated polyethylene | PUMP DEPTH: 13.8 ft btoc | DIAL: 74

SAMPLING PERSONNEL: Chris Bianchi (~~JCB~~) and Marty Gildea (~~MLG~~) / WAR, SRP

TIME	TEMPERATURE 3%	pH .1 unit	SPEC. COND. 3%	TURBIDITY 10%	DO 10%	▼ —	COMMENTS:
(units)	°C	~~ms/cm~~	mS/cm	NTU	mg/L		
T_0: 1005	Pump Started					6.55	< 50mL/min
1035						7.07	150mL/MIN
1041	~~STARTED~~ CONNECTED SONDE CELL					7.14	150mL/MIN
1045	11.42	5.74	0.142	556.4	7.01	7.12	150mL/MIN
1048	11.53	5.77	0.272	834.5	4.82	7.13	150mL/MIN
1051	11.68	5.82	0.351	906.4	3.42	7.11	100mL/MIN
1054	11.93	5.87	0.409	1412.4	2.90	7.08	90mL/MIN
1057	12.11	5.97	0.422	1135.7	2.04	7.41	150mL/MIN
1100	12.31	6.23	0.421	1116.7	1.61	7.35	150mL/MIN
1103	12.46	6.30	0.413	705.7	1.55	7.33	150mL/MIN
1106	12.59	6.33	0.409	523.5	1.57	7.31	150mL/MIN
1109	12.67	6.35	0.405	503.2	1.55	7.27	100mL/MIN
1112	12.82	6.35	0.401	378.3	1.59	7.31	175mL/MIN
1115	12.94	6.35	0.399	377.4	1.56	7.34	150mL/MIN
1118	13.10	6.35	0.400	511.6	1.55	7.32	140mL/MIN
1121	13.24	6.34	0.404	197.0	1.57	—	—
1124	13.26	6.34	0.404	179.3	1.48		100mL/MIN
1126	COLLECTED SAMPLE						
END:							

Purge to remove air bubbles

Samples Collected: 2 VOA's, 1203, 1204

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3 \pi r^3$

PURGE Vol: 2 GALS

GROUNDWATER SAMPLING LOG

PROJECT: 5518	SITE: 21	WELL ID: DPW-MWZ-07	DATE: 5.7.97
WELL DEPTH: 14.03 ft bgs	SCREEN LENGTH: 2m	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 5.41	WEATHER INFORMATION: WINDY, P.CLOUDY, 15°C	
METHOD & EQUIPMENT: Low Flow with Grundfos Redi-flo Submersible Pump			
TUBING TYPE: Teflon coated polyethylene	Pump Depth ~~9.7~~ 10.5 ft btopvc.	DIAL: 69	
SAMPLING PERSONNEL: Chris Bianchi (JCB) and Marty Gildea (MLG) JCB, WAR, SRP			

TIME	TEMPERATURE	pH ~~.1%~~ .1 unit	SPEC. COND.	TURBIDITY	DO	▼	COMMENTS:
(units)	3%		3%	10%	10%		
T_0: 1335	pump started						
1342						5.78	170mL/min
1346						5.78	150mL/min
1351						6.00	250mL/min
1354						5.91	150 ml/min
1358						5.90	150 ml/min
1400	CONNECTED TO SONDE CELL					5.90	
1405						5.88	150ml/MIN
1409	14.42	6.43	0.299	211.7	2.30		
1412	14.09	6.64	0.388	222.9	1.99	6.19	200 mL/min
1415	14.13	6.70	0.411	218.7	1.78	6.04	190ml/MIN
1418	14.37	6.74	0.438	181.7	1.68	6.03	190ml/MIN
1421	14.61	6.77	0.441	176.4	1.69	6.02	160ml/MIN
1424	14.68	Collected Samples					
END:							

Samples Collected: 2 40mL VOA'S (1195, 1196)

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

PURGE Vol: 3 GALS

GROUNDWATER SAMPLING LOG

PROJECT: 5518	SITE: 21	WELL ID: MW207	DATE: 5-7-97
WELL DEPTH: 19.0 bgs	SCREEN LENGTH: 10 ft	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 4.60 ft	WEATHER INFORMATION: WINDY, P. CLOUDY, ~~50s~~ 15°C	
METHOD & EQUIPMENT: Low Flow with Grundfos Redi-flo Submersible Pump			
TUBING TYPE: Teflon coated polyethylene	PUMP DEPTH: 10.1 ft btoc	DIAL:	
SAMPLING PERSONNEL: Chris Bianchi (JCB) and Marty Gildea (MLG)			

TIME	TEMPERATURE 3%	pH .1 UNIT	SPEC. COND. 3%	TURBIDITY 10%	DO 10%	▼	COMMENTS:
(units)	°C		mS/cm	NTU	mg/L	ft btoc	
T_0: 1457	PUMP STARTED						
1506						5.62	~~50ml/min~~
1605	PUMP RE-STARTED						
	* 1500 - 1545 PUMPING @ MIN RATE WELL WOULD ALLOW, STOPPED PUMPING TO PULL PUMP & CHECK. FLUSHED PUMP OUT + RETURNED TO WELL.						COULDN'T GET FLOW TO STABILIZE.
1610						5.86	
1616						6.46	
1630	COLLECTED SAMPLE						
		PUMPED 1.25 GALS					
END:							

Samples Collected:

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

PURGE VOL: 2 gal (1 PRIOR TO RESTART, 1 TILL SAMPLE)

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GROUNDWATER SAMPLING LOG

PROJECT: **5518**	SITE: SITE 21	WELL ID: DPW-MW311	DATE: 5.9.97
WELL DEPTH: 19.93 ft bgs	SCREEN LENGTH: 3m	WELL DIAMETER: **2"**	CASING TYPE: **PVC**
MEASUREMENT POINT: **TOC**	WATER LEVEL: 10.03 ft btoc	WEATHER INFORMATION: OVERCAST, CALM, SPRINKLES, 8°C	
METHOD & EQUIPMENT: **Low Flow with Grundfos Redi-flo Submersible Pump**			
TUBING TYPE: **Teflon coated polyethylene**	PUMP DEPTH: 15.0 ft btoc	DIAL:	
SAMPLING PERSONNEL: ~~Chris Bianchi (JCB) and Marty Gildea (MLG)~~ SRP, WAR			

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO		COMMENTS:
(units)							
T₀: 0750	PUMP STARTED						
	0755 YSI CALS COMPLETE (DO, SPEC COND, PH, & TURB)						
0800						9.80	
0815						10.05	
	* UNABLE TO SAMPLE WITHOUT						
	DRAWING H_2O TABLE BELOW SCREEN						
	SECTION. SAMPLE WILL BE TAKEN WITH PURGE						
	PUMP (B40 METHOD)						
0830	STARTED PURGING 3 VOLUMES.						
0848/50	COLLECTED SAMPLES						
	*PURGE PUMP WAS PLACED @ 2 ft FROM						
	THE BOTTOM OF THE WELL.						
END:							

Samples Collected: 2x40mL VOAS SEQ# 1258, 1259

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3 \pi r^3$

PURGE VOL: 1.0 GAL

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TOS ⇒ 12.0 ft.

GROUNDWATER SAMPLING LOG

PROJECT: 5518	SITE: Z1	WELL ID: MWZ-11	DATE: 5.9.97
WELL DEPTH: 22 ft bgs	SCREEN LENGTH: 10 ft	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 8.10 ft btoc	WEATHER INFORMATION: Rain, Calm, 10°C	

METHOD & EQUIPMENT: Low Flow with Grundfos Redi-flo Submersible Pump

TUBING TYPE: Teflon coated polyethylene / Pump Depth: 15 ft btoc / Dial: 80

SAMPLING PERSONNEL: Chris Bianchi (JCB) and Marty Gildea (MLG)

TIME	TEMPERATURE 3%	pH .1	SPEC. COND. 3%	TURBIDITY 10%	DO 10%	▽	COMMENTS:
(units)							
T_0: 0925	Pump Started						
0932						8.58	150 mL/min
0936						8.57	165 mL/min
0939						8.54	150 mL/min
0944	CONNECTED SONDE CELL					8.67	150 mL/min
0948	9.99	5.51	0.040	34.5	9.63		
0951	10.01	5.01	0.256	64.6	5.93	8.50	150 mL/min
0954	10.03	4.97	0.367	50.5	4.04		
0957	10.61	4.95	0.440	103.4	2.90	8.80	150 ml/min
1000	10.81	4.90	0.442	148.5	2.36	8.73	150 ml/min
1003	10.89	4.89	0.446	77.0	2.03	8.65	150 ml/min
1006	11.09	4.90	0.450	58.0	2.11	8.58	150 ml/min
1009	11.18	4.90	0.453	46.8	2.00	8.52	135 ml/min
1012	11.43	4.90	0.455	66.1	1.93	8.62	175 ml/min
1015	11.53	4.91	0.454	41.7	1.79	8.61	150 ml/min
1018	11.65	4.92	0.455	129.9	1.68	8.50	100 ml/min
1021	11.65	4.94	0.453	28.5	1.79	8.55	150 ml/min
1024	11.60	4.96	0.451	44.4	1.65	8.58	150 ml/min
1027	11.55	4.97	0.451	21.3	1.58		
1030	COLLECTED SAMPLES						
END:							

Samples Collected: 2 x 40 mL VOA #1260, 1261

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3 \pi r^3$

PURGE VOL: 3 GALS

10.24

GROUNDWATER SAMPLING LOG

PROJECT: 5518	SITE: 21	WELL ID: DPW MW212	DATE: 5-8-97
WELL DEPTH: 20.08 ft btoc (6.95)	SCREEN LENGTH: 3m	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 6.42 ft btoc	WEATHER INFORMATION: SUNNY, BREEZY 15°C	
METHOD & EQUIPMENT: Low Flow with Grundfos Redi-flo Submersible Pump			
TUBING TYPE: Teflon coated polyethylene	PUMP DEPTH: 15.2 ft btoc	DIAL: 78 (FLUCTUATED)	
SAMPLING PERSONNEL: ~~Chris Bianchi (JCB) and Marty Gildea (MLG)~~ SRP, WAR			

TIME	TEMPERATURE 3%	pH .1 UNIT	SPEC. COND. 3%	TURBIDITY 10%	DO 10%	▼	COMMENTS: (LEGIBLE ENGLISH)
(units)	°C	UNIT	mS/cm	NTU	mg/L	ft btoc	
T_0: 1300	START PUMP						
1340	VERY SLOW WELL					8.10	
	CANNOT OBTAIN MINIMAL FLOW W/OUT						
	CONTINUING TO DRAW DOWN WELL.						
	"PUMP CONTROLLER NEEDS A 'FINE' FREQ. ADJUSTMENT"						
1350	'FLUSHED'; TRIED TO EXPELL ~~H2O~~ AIR BUBBLES					9.25	
	IN THE HOSE						
1400	DISCHARGE IS VERY SLOW (DRIP... DRIP... etc.)					9.14	
	LETTING WELL RECHARGE. WHILE EXTRACTING SMALL AMOUNT						
1425	WATER BEGINING TO DISCOLOR (GRND H_2O)					9.2	
	1.0 GAL OF DISCHARGE						
1449	COLLECTED SAMPLES						
			*NOT ABLE TO GET H_2O QUALITY				
			READINGS DUE TO THE ~~DISMAL~~ POOR				
			RECHARGE.				
END:							

Samples Collected: 2-40mL VOAS 1207, 1208

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

PURGE VOL: 1.25 GALS

GROUNDWATER SAMPLING LOG

10.00

PROJECT: 5518	SITE: Z1	WELL ID: MWZ-12	DATE: 5-8-97
WELL DEPTH: 20.0 ft BGS	SCREEN LENGTH: 10 ft	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 6.88 ft btoc	WEATHER INFORMATION: SUNNY, BREEZY 16°C	

METHOD & EQUIPMENT: **Low Flow with Grundfos Redi-flo Submersible Pump**

TUBING TYPE: **Teflon coated polyethylene** | PUMP DEPTH: 15.2 ft btoc | DIAL:

SAMPLING PERSONNEL: ~~Chris Bianchi (JCB) and Marty Gildea (MLG)~~ SRP, WAR

TIME	TEMPERATURE 3%	pH .1 UNIT	SPEC. COND 3%	TURBIDITY 10%	DO 10%		COMMENTS:
(units)	°C	UNIT	mS/CM	NTU	mg/L		(LEGIBLE ENGLISH)
T0: 1518	PUMP STARTED						
			VERY SLOW RECHARGE SIMILAR				
		TO DIRECT PUSH WELL.					
1533						7.24	15 ml/MIN
1547						8.60	DREW WELL DOWN TO TRY TO 'FLUSH' AIR BUBBLES
1615						8.35	
1645						8.90	
	* FLOW IS TOO SLOW FOR H_2O QUALITY						
	READINGS.						
1649	COLLECTED SAMPLES						
END:							

Samples Collected: 2 x ~~40~~ML SAMPLE + 2 x 40mL ~~REPS~~ DUPS => 4 x 40mL VOA's

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$ (SEQ # 1254 -> 1257)

PURGE VOL: 1.5 GAL

GROUNDWATER SAMPLING LOG

PROJECT: **5518**	SITE: Z1	WELL ID: DWP-MWZ-07	DATE: 5.14.97
WELL DEPTH: 18.94' B.G.S.	SCREEN LENGTH: 3m	WELL DIAMETER: **2"**	CASING TYPE: **PVC**
MEASUREMENT POINT: **TOC**	WATER LEVEL: 14.0' btoc	WEATHER INFORMATION: CLEAR, BREEZY, 15°C	
METHOD & EQUIPMENT: **Low Flow with Grundfos Redi-flo Submersible Pump**			
TUBING TYPE: **Teflon coated polyethylene**	PUMP DEPTH: 17.0' btoc	DIAL: 96	
SAMPLING PERSONNEL: ~~**Chris Bianchi (JCB) and Marty Gildea (MLG)**~~ SZP, WAR			

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO	▼	COMMENTS:
(units)							
T_0: 0905	PUMP STARTED					14.40	
0915						14.38	<25ml/MIN
0925	* MUST STOP/START FREQUENTLY TO KEEP					14.25	<25ml/MIN
	FLOW. (DRIP... DRIP... DRIP... etc)						
0940						14.28	<25ml/MIN
0952						14.50	<25ml/MIN
1000						14.64	<25 ML/MIN.
1015						14.65	<25 ML/MIN
1030						14.60	<25 ML/MIN.
1045						14.70	<25 ML/MIN
	* FLOW (EXTRACTION) TOO SLOW TO						
	GET H2O QUALITY MEASUREMENTS						
1102						14.75	<25ml/MIN
1130	COLLECTED SAMPLES						
END:							

Samples Collected: 2 x 40ml VOA + 2 x 40ml VOA's DUPS TO ARA

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

SEQ #'s 1287 → 1290

PURGE VOL: 1 1/4 GALS

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GROUNDWATER SAMPLING LOG

PROJECT: 5518	SITE: 21	WELL ID: MW2-17	DATE: 5-14-97
WELL DEPTH: 20' B.G.S.	SCREEN LENGTH: 10 ft	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 12.04' btoc	WEATHER INFORMATION: Clear, light wind, 20°c	

METHOD & EQUIPMENT: **Low Flow with Grundfos Redi-flo Submersible Pump**

TUBING TYPE: **Teflon coated polyethylene** / Pump Depth: 17.0' btoc / Dial: 90

SAMPLING PERSONNEL: ~~Chris Bianchi (JCB) and Marty Gildea (MLG)~~ SRP, WAR

TIME	TEMPERATURE 3%	pH .1unit	SPEC. COND. 3%	TURBIDITY 10%	DO 10%	▼	COMMENTS:
(units)							
T_0:	*EQBLK TAKEN BEFORE PUMP WAS LOWERED INTO THIS WELL.						
1202	Pump STARTED						
1205						12.68	150 ml/min
1207						12.63	75 ml/min
1209						12.62	7 ml/min
1211						12.58	125 ml/min
1213						12.57	125 ml/min
1221						12.56	150 ml/min
1223						12.55	150 ml/min
1224	21.37	5.72	0.539	289.1	10.86	12.55	150 ml/min
1227	21.39	5.82	0.878	193.3	6.62	12.53	100 ml/min
1230	21.78	5.89	0.909	274.8	4.56	12.52	90 ml/min, Purge air bubble
1233	22.27	5.89	0.960	233.5	2.49	12.51	150 ml/min
1236	22.34	5.86	0.980	446.5	2.12	12.52	140 ml/min
1239	22.56	5.87	1.012	309.9	1.75		
1242	22.65	5.83	1.026	251.8	2.12		
1245	22.94	5.83	1.025	373.3	1.92	12.52	125 ml/min
1248	23.14	5.84	1.026	382.3	1.72		
1251	23.20	5.86	1.014	339.6	1.62		
1258	SAMPLES COLLECTED						
END:							

Samples Collected: 2x40ml VOA's + 3 + 40ml VOA's SEQ#'s 1293-1297

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

PURGE VOL: 2 GALS

GROUNDWATER SAMPLING LOG

PROJECT: **5518**	SITE: 21	WELL ID: DPW-OW-2	DATE: 5.12.97
WELL DEPTH: 16.37' BGS	SCREEN LENGTH: 3m	WELL DIAMETER: **2"**	CASING TYPE: **PVC**
MEASUREMENT POINT: **TOC**	WATER LEVEL: 6.13' btoc	WEATHER INFORMATION: P.Cloudy, Calm, 13°C	

METHOD & EQUIPMENT: **Low Flow with Grundfos Redi-flo Submersible Pump**

TUBING TYPE: **Teflon coated polyethylene** / Pump Depth: 10.7' btoc / Dial: 73

SAMPLING PERSONNEL: ~~**Chris Bianchi (JCB) and Marty Gildea (MLG)**~~ SRP, WAR

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO		COMMENTS:
(units)							
T_0:	* Measured 15.31' btoc to the top of the silt/sediment						
	Chart says 16.37' BGS for well depth.						
0800	Pump started						
0815						8.51	50ml/min
0835						8.55	50ml/min
0855						8.55	50ml/min
0908						8.56	60ml/min
0933						8.65	60ml/min
1000						8.63	60ml/min
1013	Collected samples						
	* Due to flow being < 100ml/min						
	No H_2O quality measurements						
	were taken.						
	* Collected samples from potable						
	H_2O tank (out of discharge hose).						
	(No HCl)						
END:							

Samples Collected: 2×40ml VOA's Seq.# 1273, 1274

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Purge Vol: 1 1/2 Gals

GROUNDWATER SAMPLING LOG

PROJECT: **5518**	SITE: Z1	WELL ID: OW-2	DATE: 5.13.97
WELL DEPTH: 20' B.G.S.	SCREEN LENGTH: 10 ft	WELL DIAMETER: **2"**	CASING TYPE: **PVC**
MEASUREMENT POINT: **TOC**	WATER LEVEL: 7.60' btoc	WEATHER INFORMATION: OVERCAST, CALM, 21°C	

METHOD & EQUIPMENT: **Low Flow with Grundfos Redi-flo Submersible Pump**

TUBING TYPE: **Teflon coated polyethylene** / PUMP DEPTH: 13.2' btoc / DIAL: 70

SAMPLING PERSONNEL: **Chris Bianchi (JCB) and Marty Gildea (MLG)**

TIME	TEMPERATURE 3%	pH .1	SPEC. COND. 3%	TURBIDITY 10%	DO 10%	▼	COMMENTS:
(units)	°C	UNIT	mS/cm	NTU	mg/L		
T_0:	* 2.5 ft	ELEV.	DIFFERENCE	BETWEEN			
	DPW +	CW	(CW BEING +	2.5')			
1036	PUMP	STARTED					
1042						7.75	75 mL/MIN
1044						7.83	150 mL/MIN
1046						7.85	90 mL/MIN
1048						7.90	100 mL/MIN
1051						7.88	90 mL/MIN
1055						7.90	100 mL/MIN
1104						7.88	100 mL/MIN
1106	18.03	5.76	0.002	2.3	8.49		
1109	18.09	5.75	0.002	2.0	8.22	7.90	90 mL/MIN
1112	18.04	5.71	0.002	2.7	7.64		
1115	17.98	5.70	0.003	3.9	7.50	7.88	75 mL/MIN
1118	17.96	5.65	0.009	8.9	7.75		
1121						7.89	100 mL/MIN
1124	17.92	5.89	0.034	24.7	8.67	7.88	90 mL/MIN
1127	17.89	5.94	0.048	34.8	8.99		
1130	17.91	5.98	0.061	37.9	9.31		
1133	17.97	6.02	0.066	44.8	10.10	7.95	125 mL/MIN
1136	18.04	6.06	0.073	38.9	7.51		
1139	18.06	6.05	0.074	43.1	8.38		
1142	18.06	6.05	0.078	37.6	7.96		
1145	18.18	6.06	0.079	30.5	8.51	7.87	100 mL/MIN
1148	18.23	6.06	0.079	31.9	8.36		
END: 1151	18.31	6.06	0.080	27.8	8.63		

Samples Collected: ~~#~~ 2 x 40 mL VOA's 1277, 1278

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

SAMPLES COLLECTED => 1153

PURGE VOL: 1 1/2 GALS

GROUNDWATER SAMPLING LOG

PROJECT: 5518	SITE: 2	WELL ID: DPW-RAP2-4	DATE: 4-24-97
WELL DEPTH:	SCREEN LENGTH: 6 m	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 6.0	WEATHER INFORMATION: Cloudy ≈ ~~44°F~~ 44°F	
METHOD & EQUIPMENT: Low Flow with Grundfos Redi-flo Submersible Pump			
TUBING TYPE: Teflon coated polyethylene	Depth of Pump: 15 ft	Pump Dial: 76 Hz	
SAMPLING PERSONNEL: Chris Bianchi (JCB) and Marty Gildea (MLG)			

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO	▼	COMMENTS:
(units)	°C		mS/cm	NTU	mg/L		
T₀: 0838							
0840						6.07	1540 ml/min
0841						6.07	1560 ml/min
0844	Connect	Sond				6.07	
0846						6.07	1200 ml/min
0848	9.23	5.84	0.186	67.8	9.45	~~6.07~~	~~1220 ml/min @0850~~
0851	9.36	5.62	0.187	29.4	9.23	6.07	1220 ml/min
0854	9.44	5.51	0.182	18.5	9.08		1230 ml/min
0857	9.45	5.48	0.178	12.4	8.97		
0859	~~9.43~~	~~5.47~~	~~0.173~~	~~8.6~~	~~8.80~~	6.07	1260 mL/min
~~08~~							
0900	9.43	5.47	0.173	8.6	8.80		
0903	9.43	5.48	0.174	7.9	8.79		
0906	~~9.46~~ 9.49	5.54	0.171	6.9	8.69		
0908	Rinse	Sond	Cell				
0915	9.50	5.43	0.172	4.2	8.52		1260 mL/min
	9.51	5.44	0.172	4.2	8.61		
0920	Samples	Collected					
END:							

Samples Collected: 2 x 40 ml VOAs + 2 Dups + 2 Repl.; Sq. 1036 - 1041

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Purge Vols.: 4 gals + 4 gals + 4 gals

GROUNDWATER SAMPLING LOG

PROJECT: **5518**	SITE: 2	WELL ID: DPW-OW2-2	DATE: 4-26-97
WELL DEPTH:	SCREEN LENGTH: 1m	WELL DIAMETER: **2"**	CASING TYPE: **PVC**
MEASUREMENT POINT: **TOC**	WATER LEVEL: 10.57	WEATHER INFORMATION: Partly Cloudy, 14.5°C	
METHOD & EQUIPMENT: ***Low Flow with Grundfos Redi-flo Submersible Pump***			
TUBING TYPE: ***Teflon coated polyethylene***	Pump Depth: 18.7 ft btoc	Dial:	
SAMPLING PERSONNEL: ***Chris Bianchi (JCB) and Marty Gildea (MLG)***			

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO		COMMENTS:
(units)							
T_0: Well NOT DEVELOPED ~~PRBRE~~ ~~PROPERLY~~ PROPERLY. CAN'T GET ~~AND~~ ANY FLOW FROM THE WELL.							
END:							

Samples Collected:__________

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3 \pi r^3$

GROUNDWATER SAMPLING LOG

Ambient Background well

PROJECT: 5518	SITE: 2	WELL ID: RAP2-5S	DATE: 4-28-97
WELL DEPTH: 14.6	SCREEN LENGTH: 14.6	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 8.53' T.O.C.	WEATHER INFORMATION: Shitty, Rainy 8.5°C	
METHOD & EQUIPMENT: Low Flow with Grundfos Redi-flo Submersible Pump			
TUBING TYPE: Teflon coated polyethylene	Pump Depth: 9 ft btoc	Dial: 75 Hz	
SAMPLING PERSONNEL: Chris Bianchi (JCB) and Marty Gildea (MLG)			

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO	▼	COMMENTS:
(units)	°C		mS/cm	NTU	mg/L	ft btoc	
T_0: 0938	Pump on						
0943						8.63	900 ml/min
0946							800 ml/min
0949						8.63	900 ml/min
0954							1000 ml/min
0956	Connect Sond						
0957							~~480ml~~ 880 ml/min
1003	7.31	6.16	0.092	29.0	11.75	8.63	880 ml/min
1006	7.34	6.22	0.094	24.4	11.73		
1007	Tapped Cell to shake out air bubbles						
1009	7.33	6.28	0.091	20.1	11.69		
1012	7.36	6.16	0.091	18.1	11.72		720 ml/min
1015	7.46	5.75	0.091	11.0	11.91		
1018	~~1018~~	5.70	0.090	7.8	11.89		300 ml/min
1019	Increase Dial setting 82 Hz						
1021	~~4.~~ 7.48	5.63	0.093	7.3	11.88		250 ml/min
1023	Increased Dial again to 104 Hz					8.61	880 ml/min
1024	7.39	5.56	0.093	9.7	12.01		
1027	7.41	5.48	0.091	5.5	11.58		Flow stopped
1030	7.42	5.65	0.092	8.6	11.56		
1033	7.78	5.91	0.090	224.0	11.94		Pump purged air out
1036	7.81	5.75	0.093	133.7	11.75	8.59	640 ml/min
1039	8.96	5.65	0.090	474.9	12.35		
Flushed	cell with	DI water				8.56	
1045	8.22	5.11	0.094	417.8	12.63		880 ml/min
END: continue on next Page							

Samples Collected:

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Purge Vols: 4 gal + 4 + 4 + 1.5 = 13.5 gals

GROUNDWATER SAMPLING LOG

PROJECT: 5518	SITE:	WELL ID: RAP2-5S	DATE: continued
WELL DEPTH:	SCREEN LENGTH:	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL:	WEATHER INFORMATION:	

METHOD & EQUIPMENT: *Low Flow with Grundfos Redi-flo Submersible Pump*

TUBING TYPE: *Teflon coated polyethylene*

SAMPLING PERSONNEL: *Chris Bianchi (JCB) and ~~Marty Gildea (MLG)~~* RGW

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO	ϕ	COMMENTS:
(units)	°C		mS/cm	NTU	mg/L	ft btoc	
1048	7.90	5.19	0.091	409.7	12.43		
1051	8.32	5.20	0.093	247.6	11.95		400 ml/min
1054	8.45	5.54	0.090	73.5	12.67		

TOOK samples - parameters Keep becoming unstable due to attempts to Keep flow stable 12 gals plus pumped should be representative.

END:

Samples Collected: 2 x 40 ml VOA SEQ # 1103 1104

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

GROUNDWATER SAMPLING LOG

Ambient Background Well - Do not sample from Direct Push Pair

PROJECT: 5518	SITE: 1	WELL ID: B104	DATE: 5-2-97
WELL DEPTH: 13 ft bgs	SCREEN LENGTH: 10 ft	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC 3.2 ags	WATER LEVEL: 9.03	WEATHER INFORMATION: Sunny 18°C	
METHOD & EQUIPMENT: Low Flow with Grundfos Redi-flo Submersible Pump			
TUBING TYPE: Teflon coated polyethylene	Pump Depth: 11 ft	Dial: VARIED DUE TO AIR BUBBLES 70-85 Hz	
SAMPLING PERSONNEL: Chris Bianchi (JCB) and Marty Gildea (MLG)			

[illegible] WITHIN BIUC.DF

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO	▼	COMMENTS:
(units)	°C		mS/cm	NTU	mg/L	ft btoc	
T_0: 1310	STARTED	PUMP					
1314						9.20	840 ml/min
1320						9.13	850 ml/min
1324	CONNECT	CELL					TURNED DIAL → 70-81 Hz
1330	15.97	5.61	.188	185.8	9.04		
1333	16.68	5.70	.189	201.4	8.99	9.08	200 ml/min
1336	16.71	5.74	0.176	271.8	9.31	9.18	reduced flow rate
1339	14.54	5.69	0.198	270.8	9.81	9.12	690 mL/min
1342	14.48	5.71	0.186	283.5	9.69		
1345	15.21	5.79	.187	685	9.65	9.10	440 mL/min
1348	14.38	5.70	.174	321.4	9.86		
1351	11.73	5.67	.182	421.4	10.52		
1354	11.54	5.67	.184	536.1	10.47	9.21	1500 ml/min
1357	11.43	5.67	.184	659.4	10.50		
1402	COLLECTED	SAMPLES					
END:							

Samples Collected: 2 x 40 ml VOA (SEQ # 1149, 1150)

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Purge Vols: 3.5 + 4.0 + 4.5 + 2.5 gal

AIR BUBBLES EFFECTING TURBIDITY (SUN)

GROUNDWATER SAMPLING LOG

PROJECT: 5518	SITE: 1	WELL ID: B103	DATE: 5/2/97
WELL DEPTH: 15 ft bgs	SCREEN LENGTH: 10 ft	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 15.38 ft	WEATHER INFORMATION: SUNNY BREEZY 19°C	

METHOD & EQUIPMENT: *Low Flow with Grundfos Redi-flo Submersible Pump*

TUBING TYPE: *Teflon coated polyethylene* | PUMP DEPTH: 13 ft btoc | DIAL:

SAMPLING PERSONNEL: *Chris Bianchi (JCB) and Marty Gildea (MLG)*

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO	▼	COMMENTS:
(units)	°C		mS/cm	NTU	mg/L	ft btoc	
T_0: 1448	STARTED	PUMPING					
1515	"IRON BACTERIA"	IN WELL				15.52	570 ml/min
1517	CONNECT	CELL					
1521	16.82	5.82	.160	35.5	1.29		560 ml/min
1524	16.63	5.94	.153	45.0	1.05		
1527	16.76	5.95	.151	60.4	1.50		120 ml/min
1530	17.19	5.97	.156	55.3	1.72		
1533	17.47	6.01	.160	22[illegible].8	1.22		380 ml/min
1536	17.71	6.02	.161	252.4	1.03		
1542	14.91	5.84	.149	86.3	2.55		520 ml/min
1545	14.83	5.96	.153	84.8	2.43		
1548	15.27	6.00	.155	20.4	1.92		
1551	15.91	6.02	.155	8.5	1.19		
1554	16.55	6.03	.156	13.3	1.00		
1557	17.08	6.02	.159	14.3	0.96		
1600	16.56	6.01	.157	17.1	1.02		
						15.57	WATER BELOW SCREEN INLET
1603	16.88	5.97	.156	15.5	.89		630 ml/L
1606	16.96	6.00	.154	12.0	1.51		
1609	16.64	6.01	0.154	10.9	1.45		
1612	16.69	6.01	0.155	20.7	1.57		Quickly increased rate to clear air from line.
1615	16.57	6.02	0.159	9.1	0.95		720 mL/min
1618	16.53	6.02	0.157	32.9	0.84		
1619	Collecting Samples. Readings are not consistent because we can't keep air from forming in the line.						
END:							

AIR BUBBLES? TAPPED CELL

CLEARED AIR IN LINE

Samples Collected: 2 × 40 ml VOA (SEQ # 1151, 1152)

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

PURGE VOL: 4.0 + 4.0 + 2.5

GROUNDWATER SAMPLING LOG

PROJECT: **5518**	SITE: l	WELL ID: DPW-B103	DATE: 5-2-97
WELL DEPTH: ~~to~~ ~~15~~ 15 ft bgs	SCREEN LENGTH: 3m	WELL DIAMETER: **2"**	CASING TYPE: **PVC**
MEASUREMENT POINT: *TOC*	WATER LEVEL: 11.60 ~~12.60~~	WEATHER INFORMATION: Sunny warm. 19°C	
METHOD & EQUIPMENT: ***Low Flow with Grundfos Redi-flo Submersible Pump***			
TUBING TYPE: ***Teflon coated polyethylene***	Pump Depth: ~~11.5 ft~~ 13.5 ft btoc		Dial:
SAMPLING PERSONNEL: ***Chris Bianchi (JCB) and Marty Gildea (MLG)***			

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO		COMMENTS:
(units)							
T_0:	COULD NOT GET CONSTANT ~~F~~ FLOW, or any ~~ft~~ sustained flow.						
END:							

Samples Collected: NONE

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Note: Cut 0.56 ft of TOP of PVC to get ready for man hole ~~cove~~ cover. Water level and pump depth based on new to of PVC.

GROUNDWATER SAMPLING LOG

PROJECT: 5518	SITE: 21	WELL ID: DPW - B41	DATE: 5-6-97
WELL DEPTH: 15.21 silt at ≈14.4	SCREEN LENGTH: 3m	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 10.4	WEATHER INFORMATION: Cloudy 12°C	

METHOD & EQUIPMENT: Low Flow with Grundfos Redi-flo Submersible Pump

TUBING TYPE: Teflon coated polyethylene | Pump Depth: 12.5 ft btoc | Dial: N/A

SAMPLING PERSONNEL: Chris Bianchi (JCB) and Marty Gildea (MLG)

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO	▼	COMMENTS:
(units)							
T_0: 0806							
0811	~~Porn~~					10.51	
0819						10.51	30 mL/min
0824						10.47	30 mL/min
	Pump eventually stop. ~~the~~ When we pulled it out it had been clogged with silt.						
	Using 12V purge pump we pumped about 10 gals from the well, all very silty, never cleaned up.						
	we will try B41 to ~~se~~ compare flow rate and siltyness. After 10 gals, wells still producing silts, so we pumped about 8 more gallons.						
	Purged well by ~~lett~~ pumping untill pump stopped then we let well rechange which took about 30 seconds						
	Samples Collected using 12V purgepump, very ~~silt~~ ~~sandy~~. sandy silty samples.						
END:							

Samples Collected: 2 x 40mL VOAs (Seq. # 1176-1177)

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Purge Vols: 18 gals with 12V purge pump.

GROUNDWATER SAMPLING LOG

PROJECT: **5518**	SITE: 21	WELL ID: B41	DATE: 5-6-97
WELL DEPTH: 15 ftbgs	SCREEN LENGTH: 10 ft	WELL DIAMETER: **2"**	CASING TYPE: **PVC**
MEASUREMENT POINT: **TOC** Top of steel, white mark	WATER LEVEL: 12.46	WEATHER INFORMATION: Cloudy, high cloudcover drizzled 13°C	

METHOD & EQUIPMENT: ***Low Flow with Grundfos Redi-flo Submersible Pump***

TUBING TYPE: ***Teflon coated polyethylene*** | ~~12.2~~ Pump Depth: ~~14.8~~ 14.5 ftbtoc | Dial 82

SAMPLING PERSONNEL: ***Chris Bianchi (JCB) and Marty Gildea (MLG)***

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO	▼	COMMENTS:
(units)							
T_0: 0956	Started Pump.						
1001						12.65	L
1004						12.78	410 mL/min
~~1012~~						12.73	300 mL/m
1012						12.62	315 mL/min
1013	CONNECTED	SOND CELL				12.50	270 mL/min
1015							
1019						12.45	275 mL/min
1024	11.74	5.41	0.031	10.5	11.29		
1027	12.07	5.37	0.031	13.3	11.37	12.44	310 mL/min
1030	12.24	5.37	0.031	10.9	11.37		
1033	12.28	5.41	0.032	11.8	11.28		
1036	12.38	5.49	0.031	14.0	11.14		
1039	12.46	5.54	0.032	11.8	11.00		
1042	12.49	5.60	0.031	7.7	11.00		Flushed air bubbles from line
1045	12.72	5.51	0.030	12.9	11.19		
1048	12.65	5.52	0.032	11.2	11.13		
1051	12.51	5.52	0.032	12.1	11.12		
1054	12.56	5.52	0.031	11.4	11.44	12.45	350 ml/min
1056	COLLECTED	SAMPLES					
1102						12.25	75 mL/min - Probably another air bubble?
END:							

Samples Collected: 2 x 40mL VOAs + 2 x 40mL VOA Duplicates (Seq#'s 1172-1175)

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Purge Vols: 4.5 + 1.0 = 5.5 gals.

GROUNDWATER SAMPLING LOG

PROJECT: 5518	SITE:	WELL ID: B38	DATE: 5-6-97
WELL DEPTH:	SCREEN LENGTH:	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 16.42	WEATHER INFORMATION:	

METHOD & EQUIPMENT: *Low Flow with Grundfos Redi-flo Submersible Pump*

TUBING TYPE: *Teflon coated polyethylene*

SAMPLING PERSONNEL: *Chris Bianchi (JCB) and Marty Gildea (MLG)*

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO		COMMENTS:
(units)							
T_0:							
Didn't sample because DPW-B38 was dry, see previous page							
END:							

Samples Collected:____________________

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

GROUNDWATER SAMPLING LOG

PROJECT: **5518**	SITE: 21	WELL ID: DPW-B40	DATE: 5-7-97
WELL DEPTH: 16.7 ftbgs silt @ 16 ft btoc	SCREEN LENGTH: 3m	WELL DIAMETER: **2"**	CASING TYPE: **PVC**
MEASUREMENT POINT: **TOC** Black mark	WATER LEVEL: 10.81	WEATHER INFORMATION: Partly Cloudy, cool 10.5°c	
METHOD & EQUIPMENT: ***Low Flow with Grundfos Redi-flo Submersible Pump***			
TUBING TYPE: ***Teflon coated polyethylene***	Pump Depth: 13.6 ft btoc	Dial: 86	
SAMPLING PERSONNEL: ***Chris Bianchi (JCB) and Marty Gildea (MLG)***			

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO	▼	COMMENTS:
(units)	°C		mS/cm	NTU	mg/L	ft btoc	
T_0: 08~~25~~30	Pump Started.						
0833						11.11	0 mL/min
0841						11.22	100 mL/min
0843						11.60	350 mL/min
0848						11.59	275 mL/min 86/87 Hz
0849	CONNECT SOLID CELL						
0854	9.83	5.80	0.077	96.8	9.77	11.51	225 mL/min
0857	9.65	5.87	0.089	127.2	9.37	11.67	250 mL/min 87/88 Hz
0900	9.72	5.93	0.097	121.2	9.19		
0903	9.77	6.01	0.099	94.0	9.01	11.51	245 mL/MIN
0906	9.79	6.05	0.101	92.3	9.00	11.25	90 mL/MIN
0909	9.97	6.06	0.105	864.9	9.00		Flushed air bubbles from the line.
0912	9.78	6.08	0.108	330.3	9.06	11.33	130 mL/min
0915	9.60	6.09	0.106	323.9	9.18	11.31	200 mL/MIN
0918	9.46	6.10	0.106	277.5	9.78		
0921	9.43	6.10	0.106	134.5	9.71		
0924	9.32	6.10	0.108	53.0	9.38		AIR BUBBLE IN LINE
0927	9.25	6.10	0.108	216.6	9.47		FLUSHED AIR FROM LINE
0930	9.43	6.12	0.105	117.5	9.62		
0933	9.68	6.13	0.105	481.8	9.59	11.51	200 ml/Min
0936	9.81	6.13	0.106	477.8	9.49		
0939	9.88	6.13	0.106	278.9	9.41		
0942	10.02	6.11	0.106	292.3	9.33	11.51	200 ml/MIN
0945	10.25	6.11	0.109	258.5	9.30		
0948	10.39	6.12	0.109	107.6	9.29		
END: 0951	Accidently shut pump off. well too silty now.						Do B40 first then back

Samples Collected: 2 x 40 mL VOAs (seq # 1193-1194

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Purge Vols: 4 gallons -

Used 12V Purge Pump and purged 4.5 gallons and took samples from Purge Pump.

Samples Collected at 1201

GROUNDWATER SAMPLING LOG

PROJECT: 5518	SITE: 21	WELL ID: B40	DATE: 5-7-97
WELL DEPTH: 17 bgs	SCREEN LENGTH: 10 ft	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC White Mark on Steel	WATER LEVEL: 13.12	WEATHER INFORMATION: ~~Poor~~ Mostly Cloudy, 12°C	
METHOD & EQUIPMENT: Low Flow with Grundfos Redi-flo Submersible Pump			
TUBING TYPE: Teflon coated polyethylene	Pump Depth: 15.90 ft btoc	Dial: 83	
SAMPLING PERSONNEL: Chris Bianchi (JCB) and Marty Gildea (MLG)			

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO	▼	COMMENTS:
(units)	°C		mS/cm	NTU	mg/L	ft btoc	
T0: 1030	Pump started.						
1037						13.33	280mL/min
1049	CONNECTED	SOND	CELL @	1050		13.27	200mL/min
1054	12.90	6.06	0.046	31.9	10.44		Flushed air bubbles
1057	13.55	5.90	0.046	45.0	10.41	13.34	280mL/min
1100	14.26	5.84	0.045	57.5	10.18		84Hz
1103	15.06	5.84	0.046	56.4	9.96		
1106	15.33	5.85	0.046	61.2	9.86		
1109	15.48	5.85	0.045	58.4	9.83		
1112	16.25	5.83	0.045	77.9	9.72	13.30	INCREASE FLOW RATE TO DISLODGE AIR BUBBLES. 200mL/MIN
1115	16.27	5.83	0.046	77.9	9.75		
1118	16.42	5.83	0.045	73.5	9.73		
1121	COLLECT	SAMPLES					
END:							

Samples Collected:__________

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Purge Vols: 4.0 GALS

GROUNDWATER SAMPLING LOG

7.94'

PROJECT: 5518	SITE: Z1	WELL ID: DAW-MWZ-23	DATE: 5-13-97
WELL DEPTH: 17.78' BGS.	SCREEN LENGTH: 3m	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 13.57' btoc	WEATHER INFORMATION: P. Cloudy, Calm 14°C	

METHOD & EQUIPMENT: **Low Flow with Grundfos Redi-flo Submersible Pump**

TUBING TYPE: **Teflon coated polyethylene** / Pump Depth: 15.6' btoc / Dial:

SAMPLING PERSONNEL: ~~Chris Bianchi (JCB) and Marty Gildea (MLG)~~ SRP, WAR

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO		COMMENTS:
(units)							
T_0: 0650 Arrive at site and move to MWZ-23							
0727	Upon lowering the pump into the well,						
	we discovered the well ~~to~~ is cracked						
	at 10.5 ft btoc. Will not be able to						
	sample this well since the pump						
	can't be lowered ~~the~~ into the H2O ~~level~~						
	table.						
0730	YSI calibration complete.						
END:							

Samples Collected:

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

GROUNDWATER SAMPLING LOG

PROJECT: 5518	SITE: Z1	WELL ID: MWZ-23	DATE: 5.12.97
WELL DEPTH: 19' B.G.S.	SCREEN LENGTH: 10 ft	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: ~~Z~~ 16.32 ft btoc	WEATHER INFORMATION: P. Cloudy, Calm, 13°C	

METHOD & EQUIPMENT: ***Low Flow with Grundfos Redi-flo Submersible Pump***

TUBING TYPE: ***Teflon coated polyethylene***

SAMPLING PERSONNEL: ***Chris Bianchi (JCB) and Marty Gildea (MLG)***

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO		COMMENTS:
(units)							
T_0:	* SINCE WE COULD NOT WORK THE DPW						
	AT THIS LOCATION WE WILL NOT BE						
	SAMPLING FROM THIS WELL. SEE PREV. PAGE.						
END:							

Samples Collected:____________________

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

GROUNDWATER SAMPLING LOG

7.2 TOS

PROJECT: **5518**	SITE: 21	WELL ID: DPW-337	DATE: 5.13.97
WELL DEPTH: 16.77' BGS	SCREEN LENGTH: 3m	WELL DIAMETER: **2"**	CASING TYPE: **PVC**
MEASUREMENT POINT: **TOC**	WATER LEVEL: 6.47' btoc	WEATHER INFORMATION: OVERCAST, CALM, 21°C	
METHOD & EQUIPMENT: ***Low Flow with Grundfos Redi-flo Submersible Pump***			
TUBING TYPE: ***Teflon coated polyethylene*** / PUMP DEPTH: 11.9' btoc / DIAL:			
SAMPLING PERSONNEL: ~~**Chris Bianchi (JCB) and Marty Gildea (MLG)**~~ SRP, WAR			

TIME	TEMPERATURE 3%	pH .1	SPEC. COND. 3%	TURBIDITY 10%	DO 10%		COMMENTS:
(units)	°C	UNIT	mS/cm	NTU	mg/L		
T_0:	* EQUIPMENT BLANKS TAKEN PRIOR TO PUMPING (WORKING) THIS WELL						
	AFTER TALKING TO MLG (@ 1045A) WE ARE DISPOSING OF DI RINSE + POTABLE H_2O RINSE #2 AFTER DECON PROCEDURE AT EACH WELL. LIQUINOX RINSE + H_2O RINSE #1 WILL BE RECYCLED.						
1258	PUMP STARTED						
1311						7.01	<50mL/MIN
1328	DIAL AT 72 (DRIP... DRIP... DR... etc)					7.45	<50mL/MIN
1345	HAVING TROUBLE GETTING ANY FLOW WITHOUT A CONTINUOUS DRAW DOWN.						
1402	TRIED TO PURGE OUT BUBBLES					8.68	
1406	WITH THE DIAL AT 80 STILL NOT ENOUGH TO GET FLOW. BUBBLES ???					9.75	
1434	DIAL => 82					10.35	<50mL/MIN
1453	DIAL => 83						<50mL/MIN
	* MOVING PUMP DOWN 2ft TO 14.0' btoc TO ALLOW FOR ENOUGH H_2O TO SAMPLE.						
1507	COLLECTED SAMPLES						
END:							

Samples Collected: 2x40mL VOA 1281, 1282

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3 \pi r^3$

PURGE VOL: 1 1/4 GAL

GROUNDWATER SAMPLING LOG

PROJECT: **5518**	SITE: 21	WELL ID: B37	DATE: 5.13.97
WELL DEPTH: 17' BGS	SCREEN LENGTH: 10 ft	WELL DIAMETER: **2"**	CASING TYPE: **PVC**
MEASUREMENT POINT: **TOC**	WATER LEVEL: 6.07' btoc	WEATHER INFORMATION: OVERCAST, Lt. BREEZE, 23°C	
METHOD & EQUIPMENT: ***Low Flow with Grundfos Redi-flo Submersible Pump***			
TUBING TYPE: ***Teflon coated polyethylene*** / PUMP DEPTH: ~~13.0~~/~~14.0~~' btoc / DIAL: 83			
SAMPLING PERSONNEL: ***Chris Bianchi (JCB) and Marty Gildea (MLG)***			

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO		COMMENTS:
(units)							
T_0:	* T.O.C.	IS 1ft	BELOW	DPW.			
1532	PUMP STARTED						
1540						~~8~~ 8.99	75 ml/min
1542						9.05	90 ml/min
1544						9.10	90 ml/min
1549						9.17	60 ml/min
1555						10.09	100 ml/min
	* ON THIS WELL WE REALIZED THAT						
	WE COULD NOT GET ANY FLOW (DISCHARGE)						
	WITHOUT GETTING SIGNIFICANT DRAW DOWN.						
	THE LOW FLOW METHOD WILL NOT WORK						
	ON THIS WELL. THE RECHARGE IS TOO						
	SLOW. THEREFORE WE DREW THE WELL						
	DOWN SO NOT TO DISTURB THE SEDIMENT						
	ON THE BOTTOM OR PULL THE LEVEL DOWN						
	WITHIN 2 ft OF THE ~~SC~~ INTAKE OF THE						
	PUMP. ~~THEN WE~~ TO GET ENOUGH WELL						
	H_2O UP TO SAMPLE.						
1615						10.25	100 ml/min
1625	SAMPLES COLLECTED						
END:							

Samples Collected: 2x40ml + 2x40ml DUPLICATES FOR ARA

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

SEQ# 1283
1284
1285
1286

PURGE VOL: 1 1/2 GALS

GROUNDWATER SAMPLING LOG

PROJECT: **5518**	SITE: Z1	WELL ID: DPW-MWZ-22	DATE: 5.14.97
WELL DEPTH: 19.54' BGS	SCREEN LENGTH: 3m	WELL DIAMETER: **2"**	CASING TYPE: **PVC**
MEASUREMENT POINT: **TOC**	WATER LEVEL: 10.60' btoc	WEATHER INFORMATION: CLEAR, Lt. BREEZE 12°C	
METHOD & EQUIPMENT: **Low Flow with Grundfos Redi-flo Submersible Pump**			
TUBING TYPE: **Teflon coated polyethylene** / PUMP DEPTH: 15.0 ft btoc / DIAL: 90			
SAMPLING PERSONNEL: **Chris Bianchi (JCB) and Marty Gildea (MLG)**			

TIME	TEMPERATURE	pH	SPEC. COND.	TURBIDITY	DO		COMMENTS:
(units)							
T_0: 0700	AR. @ SITE						
0730	PUMP STARTED						
0752	YSI CAL.	COMPLETE				12.10	<25ml/MIN
0800						12.25	<25ml/MIN
	*NOT ABLE TO	STABILIZE	DRAW DOWN				~~<25~~
0805						12.60	<25ml/MIN
0817						12.81	<25ml/MIN
0830	SAMPLING	TERMINATED		PER JCB			
END:							

Samples Collected:

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft : $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

SAMPLING ROUND 2A
SEPTEMBER - OCTOBER 1998

GROUNDWATER SAMPLING LOG

PROJECT: 4808	SITE: Hanscom	WELL ID: MW-B107	DATE: 9/21/98
WELL DEPTH: 17.21	SCREEN LENGTH: /	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: ~~9.57~~ 9.76	WEATHER INFORMATION: Cloudy 70°	
METHOD & EQUIPMENT: Low Flow			
TUBING TYPE: HDPE (dedicated)		Pump Depth: (below TOC) 12.0	
SAMPLING PERSONNEL: EST, Greg Cataldo			

TIME	TEMP.	SPEC. COND.	DO	pH	TURBIDITY	▼	FIOW RATE	COMMENTS:
(units)	° c	mS/cm	mg/L		NTU	ft btoc	ml/min	
T_0 [redacted]	16.08	0.128	5.72	5.56	10.10	9.81	150	
1005	16.52	0.128	5.34	5.45		9.83		
1010	16.47	0.128	5.15	5.39		9.83	125	
1015	16.29	0.128	5.08	5.37	3.82	9.85	200	
1020	15.96	0.128	5.05	5.36		9.85	200	
1025	15.66	0.128	5.09	5.35	1.60	9.89	200	
1030	15.95	0.128	5.03	5.35	1.10	9.85	200	
1040	16.06	0.128	5.07	5.34	1.15	9.88	200	
1050	16.68	0.128	4.92	5.33		9.81	200	
1100	17.08	0.129	4.97	5.32	1.10	9.83	200	
1110	13.91	0.127	5.16	5.31	0.61	9.98	380	
1105	14.06	0.127	5.22	5.32	0.71	9.99	380	
1120	14.19	0.127	5.15	5.32	0.72	9.99	380	
1130	14.12	0.127	5.29	5.32	0.68	9.99	380	
END:								

Notes: ______________________________

Sequence Numbers: 1301 1302 1303 Duplicates: ________ ________ ________

Purge Volume: __________ gals.

Information for 2 in. Well: Sched 40 = 617 ml/ft (0.163 gal/ft), Sched 80 = 565 ml/ft (0.145 gal/ft)

GROUNDWATER SAMPLING LOG

PROJECT: 4808	SITE: Hanscom	WELL ID: B 107	DATE: 9/21/92
WELL DEPTH:	SCREEN LENGTH:	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 12.65	WEATHER INFORMATION:	
METHOD & EQUIPMENT: Low Flow			
TUBING TYPE: HDPE (dedicated)		Pump Depth: (below TOC) 14.0'	
SAMPLING PERSONNEL: EST, Greg Cataldo			

TIME	TEMP.	SPEC. COND.	DO	pH	TURBIDITY	▼	FlOW RATE	COMMENTS:
(units)	°c	mS/cm	mg/L		NTU	ft btoc	ml/min	Started Purging at 1220
T₀: 1230	18.20	.133	5.45	4.53	60.4	12.75	100	
1240	16.58	.132	4.71	4.36	55.5	12.71	100	
1245	16.30	.131	4.88	4.35	29.4	12.75	100	
1250	16.54	.131	4.68	4.40	16.6	12.73	100	
1255	16.85	.131	4.68	4.41	11.4	12.74	100	
1305	17.45	.132	4.60	4.43	6.5	12.74	100	Switched N_2 tanks
1310	17.11	.131	4.59	4.46	6.0	12.72	100	
1315	17.08	.131	4.65	4.49	4.5	12.72	100	
1320	17.22	.131	4.60	4.50	4.3	12.73	100	
1325	17.30	.131	4.91	4.50	4.2	12.75	100	
								Sampled at 1335
END:								

Notes: ______

Sequence Numbers: 1304 1305 1306 Duplicates: ______ ______ ______

Purge Volume: 2.5 gals.

Information for 2 in. Well: Sched 40 = 617 ml/ft (0.163 gal/ft), Sched 80 = 565 ml/ft (0.145 gal/ft)

GROUNDWATER SAMPLING LOG

PROJECT: 4808	SITE: Hanscom	WELL ID: DPW 101-MW	DATE: 9/22/98
WELL DEPTH: 18.55	SCREEN LENGTH: 16.4	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 9.82	WEATHER INFORMATION: RAINY 45°	
METHOD & EQUIPMENT: Low Flow			
TUBING TYPE: HDPE (dedicated)		Pump Depth: (below TOC) 12.00'	
SAMPLING PERSONNEL: EST, Greg Cataldo			

TIME	TEMP.	SPEC. COND.	DO	pH	TURBIDITY	▼	FLOW RATE	COMMENTS:
(units)	°c	mS/cm	mg/L		NTU	ft btoc	ml/min	Started Purging 0850
T₀ 0900	12.89	.136	12.94	4.66	4.60	~~10.13~~ 10.13	300	
0905	13.07	.137	8.37	4.81	4.55	10.12	300	Tilted Cell to get air out.
0910	13.04	.137	7.58	4.84	3.62	10.11	300	
0915	13.04	.137	8.53	4.74	2.67	10.13	300	
0920	12.87	.136	7.43	4.84	3.08	10.12	300	
0925	12.89	.136	6.60	4.87	1.83	10.11	300	
0930	12.79	.136	6.67	4.87	1.80	10.12	300	
0933	12.80	.136	6.45	4.87	1.84	10.13	300	
								Sampled at 0940
END:								

Notes:

Sequence Numbers: 1307 1308 1309 Duplicates:

Purge Volume: 12.9 ~~gals.~~ liters

Information for 2 in. Well: Sched 40 = 617 ml/ft (0.163 gal/ft), Sched 80 = 565 ml/ft (0.145 gal/ft)

GROUNDWATER SAMPLING LOG

PROJECT: 4808	SITE: Hanscom	WELL ID: MWH01	DATE: 9/22/98
WELL DEPTH: 18.50	SCREEN LENGTH: 15'	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 9.63	WEATHER INFORMATION: RAINY 75°	
METHOD & EQUIPMENT: Low Flow			
TUBING TYPE: HDPE (dedicated)		Pump Depth: (below TOC) 12'	
SAMPLING PERSONNEL: EST, Greg Cataldo			

TIME	TEMP.	SPEC. COND.	DO	pH	TURBIDITY	▼	FlOW RATE	COMMENTS:
(units)	° c	mS/cm	mg/L	-	NTU	ft btoc	ml/min	Started Purging 0955
T₀: 1020	18.72	.153	16.21	4.18	15.6	9.65	120	Problems with Regulator
1025	17.94	.152	8.59	4.38	11.3	9.67	120	
1030	18.12	.151	7.28	4.47	8.8	9.65	120	
1035	18.14	.151	6.66	4.54	7.4	9.66	120	
1040	18.02	.151	6.48	4.55	6.4	9.66	120	
1045	18.02	.151	5.99	4.58	5.8	9.65	120	
1048	18.12	.151	5.98	4.59	5.8	9.67	120	
								Sampled at 1055
END:								

Notes: ~~1310~~

Sequence Numbers: 1310 1311 1312 Duplicates: ______ ______ ______

Purge Volume: __________ gals.

Information for 2 in. Well: Sched 40 = 617 ml/ft (0.163 gal/ft), Sched 80 = 565 ml/ft (0.145 gal/ft)

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GROUNDWATER SAMPLING LOG

PROJECT: 4808	SITE: Hanscom	WELL ID: DW-RAP 2-35	DATE: 9/22/98
WELL DEPTH: 27.00	SCREEN LENGTH: 26.24	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 9.25	WEATHER INFORMATION: RAINY 75°	
METHOD & EQUIPMENT: Low Flow			
TUBING TYPE: HDPE (dedicated)		Pump Depth: (below TOC) 12	
SAMPLING PERSONNEL: EST, Greg Cataldo			

TIME	TEMP.	SPEC. COND.	DO	pH	TURBIDITY	▼	FlOW RATE	COMMENTS:
(units)	°c	mS/cm	mg/L		NTU	ft btoc	ml/min	Started Purging at 1150
T0: 1200	19.48	.119	7.04	5.66	7.3	9.28	200	
1205	19.29	.119	6.84	5.72	7.9	9.28	200	
1210	19.31	.120	6.56	5.76	6.5	9.28	200	
1215	19.36	.121	6.36	5.80	6.5	9.28	200	
1220	19.36	.121	6.29	5.81	6.5	9.28	200	
								Sampled at 1230
END:								

Notes: ______

Sequence Numbers: 1313 1314 1315 Duplicates: ______ ______ ______

Purge Volume: 6 ~~gals.~~ liters

Information for 2 in. Well: Sched 40 = 617 ml/ft (0.163 gal/ft), Sched 80 = 565 ml/ft (0.145 gal/ft)

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GROUNDWATER SAMPLING LOG

PROJECT: **4808**	SITE: **Hanscom**	WELL ID: RAP2-3S	DATE: 9/22/98
WELL DEPTH: 33.60	SCREEN LENGTH: 33.60	WELL DIAMETER: **2"**	CASING TYPE: **PVC**
MEASUREMENT POINT: **TOC**	WATER LEVEL: 9.75	WEATHER INFORMATION:	
METHOD & EQUIPMENT: ***Low Flow***			
TUBING TYPE: **HDPE (dedicated)**		Pump Depth: (below TOC) ~~12~~ 11.5'	
SAMPLING PERSONNEL: **EST, Greg Cataldo**			

TIME	TEMP.	SPEC. COND.	DO	pH	TURBIDITY	▼	FlOW RATE	COMMENTS:
(units)	°c	mS/cm	mg/L		NTU	ft btoc	ml/min	Started Purging at 1245
T_0: 1255	13.16	.111	11.48	5.05	65	9.84	400	
1300	13.10	.113	8.04	5.15	33	9.90	400	
1305	12.9	.115	6.98	5.19	11.5	9.90	400	N_2 tank changed
1320	13.11	.116	6.54	5.20	8.4	9.90	400	
1325	13.09	.116	6.35	5.20	8.5	9.90	400	
1328	13.14	.117	6.43	5.20	8.1	9.90	400	
								Sampled at 1335
END:								

Notes: Obstruction at 18' below ground surface raised pump to 11.5' bgs and started purging per Chris Bianchi

Sequence Numbers: 1316 1317 1318 Duplicates: ______ ______ ______

Purge Volume: 17.2 ~~gals.~~ liters

Information for 2 in. Well: Sched 40 = 617 ml/ft (0.163 gal/ft), Sched 80 = 565 ml/ft (0.145 gal/ft)

GROUNDWATER SAMPLING LOG

PROJECT: 4808	SITE: Hanscom	WELL ID: DPW-B-105	DATE: 9/23/98
WELL DEPTH: 18.13	SCREEN LENGTH: 3.28'	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 11.52	WEATHER INFORMATION: SUNNY 60°-65°	
METHOD & EQUIPMENT: Low Flow			
TUBING TYPE: HDPE (dedicated)		Pump Depth: (below TOC) 13.5'	
SAMPLING PERSONNEL: EST, Greg Cataldo			

TIME	TEMP.	SPEC. COND.	DO	pH	TURBIDITY	▼	FIOW RATE	COMMENTS:
(units)	°c	mS/cm	mg/L		NTU	ft btoc	ml/min	Started Purging at 0915
T0: 0925	14.62	.291	7.10	5.25	20.8	11.67	150	
0930	14.70	.281	6.28	5.27	11.0	11.65	150	
0935	14.72	.279	6.05	5.28	7.0	11.66	150	
0940	14.76	.275	5.83	5.29	4.5	11.64	150	
0945	14.86	.273	~~5.22~~ 5.23	5.30	3.2	11.65	150	
0950	15.03	.277	4.53	5.31	3.3	11.66	150	
0955	14.97	.278	4.07	5.32	3.5	11.64	150	
0958	14.97	.278	3.79	5.32	2.9	11.65	150	
~~09~~ 1001	14.96	.277	3.38	5.32	3.1	11.65	150	
1004	14.98	.277	2.96	5.33	2.6	11.64	150	
1007	14.98	.279	2.76	5.34	2.5	11.65	150	
1010	15.06	.281	2.81	5.34	2.5	11.65	150	
								Sampled at 1015
END:								

Notes: ______

Sequence Numbers: 1319 1320 1321 Duplicates: 1322 1323 1324

Purge Volume: 9.0 ~~gals.~~ liters

Information for 2 in. Well: Sched 40 = 617 ml/ft (0.163 gal/ft), Sched 80 = 565 ml/ft (0.145 gal/ft)

GROUNDWATER SAMPLING LOG

PROJECT: 4808	SITE: Hanscom	WELL ID: MW-B-105	DATE: 9/23/98
WELL DEPTH: 15.00 bgs	SCREEN LENGTH: 10'	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 14.71	WEATHER INFORMATION: Sunny 65-70°	
METHOD & EQUIPMENT: Low Flow			
TUBING TYPE: HDPE (dedicated)		Pump Depth: (below TOC) 16.5'	
SAMPLING PERSONNEL: EST, Greg Cataldo			

TIME	TEMP.	SPEC. COND.	DO	pH	TURBIDITY	▼	FlOW RATE	COMMENTS:
(units)	° c	mS/cm	mg/L		NTU	ft btoc	ml/min	Started Purging at 1145
T_0:								
1155	15.85	.275	18.85	5.03	12.0	14.81	150	
1200	15.78	.279	12.75	5.09	9.1	14.78	150	
1205	15.86	.286	12.25	5.14	8.1	14.82	150	
1210	15.82	.280	11.84	5.13	7.4	14.80	150	
1213	15.75	.280	11.71	5.19	7.6	14.81	150	
1216	15.81	.280	11.59	5.21	7.2	14.81	150	
								Sampled at 1225
END:								

Notes:

Sequence Numbers: 1325 1326 1327 Duplicates: 1328 1329 1330

Purge Volume: 4.8 ~~gals.~~ liters

Information for 2 in. Well: Sched 40 = 617 ml/ft (0.163 gal/ft), Sched 80 = 565 ml/ft (0.145 gal/ft)

GROUNDWATER SAMPLING LOG

PROJECT: 4808	SITE: Hanscom	WELL ID: DPW-B-109	DATE: 9/23/98
WELL DEPTH: 62.61	SCREEN LENGTH: ~~8~~ 1 meter	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 10.65'	WEATHER INFORMATION: Sunny 65-70°	
METHOD & EQUIPMENT: Low Flow			
TUBING TYPE: HDPE (dedicated)		Pump Depth: (below TOC) 61.0 ft	
SAMPLING PERSONNEL: EST, Greg Cataldo			

Liters Purged	TIME (units)	TEMP. °C	SPEC. COND. mS/cm	DO mg/L	pH	TURBIDITY NTU	▼ ft btoc	FlOW RATE ml/min	COMMENTS: Started Purging 1300	
3.05	To: 1310	14.20	.191	18.57	5.71	>200	16.05	200	Started at 500ml for 3MIN	1.5
3.55	1315	14.78	.192	16.82	5.90	>200	16.21	100	then 250ml for 3MIN	0.75
4.05	1320	15.19	.192	12.97	5.99	>200	16.30	100	then 200ml For 4MIN	0.8
4.55	1325	15.39	.194	8.16	6.07	>200	16.36	100	then Kept it at 100ml	
5.05	1330	15.74	.195	4.06	6.14	>200	16.15	100		
5.55	1335	15.84	.195	3.50	6.17	>200	16.05	100		
6.05	1340	15.98	.196	~~1.57~~ 1.47	6.22	>200	15.65	100		
6.55	1345	15.98	.196	1.20	6.25	>200	15.29	100		
7.05	1350	16.29	.197	1.48	6.28	>200	14.93	100		
7.55	1355	16.37	.197	1.89	6.29	>200	14.74	100		
8.05	1400	16.33	.197	3.84	6.31	~~>200~~ >200	14.55	100		
8.55	1405	16.47	.197	5.97	6.33	>200	14.42	100		
9.05	1410	16.45	.198	7.33	6.34	>200	14.32	100		
9.55	1415	16.57	.198	7.81	6.35	>200	14.11	100		
10.05	1420	16.73	.198	8.10	6.36	>200	13.91	100	Achieved 5 well volume	
									~~Sampling~~ Sampling	
									Criteria Met per EPA	
									low-flow Protocol	
									Sampled at 1425	
	END:									

Notes: ______

Sequence Numbers: 1331 1332 1333 Duplicates: 1334 1335 1336

Purge Volume: ___________ gals.

Information for 2 in. Well: Sched 40 = 617 ml/ft (0.163 gal/ft), Sched 80 = 565 ml/ft (0.145 gal/ft) × 3.3 ft = .4785 gal

.4785 gal = 1 well volume

2.5 gal = 5 well volumes = 10.0 liters

Purged 5 well volumes before Sampling

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GROUNDWATER SAMPLING LOG

PROJECT: 4808	SITE: Hanscom	WELL ID: MW B-109	DATE: 9-23-98
WELL DEPTH: 69.00	SCREEN LENGTH: 10'	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 14.45	WEATHER INFORMATION: Sunny 65°-70°	
METHOD & EQUIPMENT: Low Flow			
TUBING TYPE: HDPE (dedicated)		Pump Depth: (below TOC) 64.0 Ft	
SAMPLING PERSONNEL: EST, Greg Cataldo			

Liters Purged	TIME	TEMP.	SPEC. COND.	DO	pH	TURBIDITY	▼	FlOW RATE	COMMENTS:
	(units)	° c	mS/cm	mg/L		NTU	ft btoc	ml/min	Started Purging at 1445
5.0	T₀: 1455	11.89	.194	1.89	6.46	85.0	14.52	500	
7.5	1500	11.80	.195	1.45	6.49	85.2	14.50	500	
10.0	1505	11.75	.195	3.51	6.51	79.3	14.51	500	
12.5	1510	11.72	.196	1.44	6.52	103.3	14.50	500	
15.0	1515	11.68	.196	0.91	6.53	110	14.49	500	
17.5	1520	11.70	.196	0.93	6.54	104.8	14.48	500	
20.0	1525	11.63	.196	0.98	6.54	78.9	14.50	500	
22.5	1530	11.70	.196	0.95	6.54	79.6	14.50	500	
25.0	1535	11.68	.197	0.93	6.55	77.3	14.51	500	
27.5	1540	11.61	.197	0.94	6.55	54.6	14.50	500	
30.0	1545	11.62	.197	0.92	6.55	52.6	14.50	500	
31.5	1548	11.61	.197	0.92	6.55	51.8	14.50	500	
									Sampled at 1550
									b/c acheived 5
									well volumes per
									EPA Low-Flow-Protocol
	END:								

Notes:

Sequence Numbers: ~~13.37~~ 1337 1338 1339 Duplicates: 1340 1341 1342

Purge Volume: ___________ gals.

Information for 2 in. Well: Sched 40 = 617 ml/ft (0.163 gal/ft), Sched 80 = 565 ml/ft (0.145 gal/ft)

1 well Volume = 1.45 gal

5 well Volume = 7.25 gal = 30.0 liters

GROUNDWATER SAMPLING LOG

PROJECT: **4808**	SITE: **Hanscom**	WELL ID: OW OW2-6	DATE: 9/24/98
WELL DEPTH: 23.10	SCREEN LENGTH: 2 Meters	WELL DIAMETER: **2"**	CASING TYPE: **PVC**
MEASUREMENT POINT: **TOC**	WATER LEVEL: 12.11	WEATHER INFORMATION: Sunny 65°	
METHOD & EQUIPMENT: ***Low Flow***			
TUBING TYPE: **HDPE (dedicated)**		Pump Depth: (below TOC) 16.5'	
SAMPLING PERSONNEL: **EST, Greg Cataldo**			

TIME	TEMP.	SPEC. COND.	DO	pH	TURBIDITY	▼	FLOW RATE	COMMENTS:
(units)	°c	mS/cm	mg/L		NTU	ft btoc	ml/min	Started Purging at 0915
T₀: 0925	12.50	.339	2.16	5.17	99.4	12.24	300	
0930	12.60	.340	2.27	5.11	74.2	12.22	300	
0935	12.56	.340	2.17	5.09	45.5	12.25	300	
0940	12.61	.341	2.25	5.08	38.6	12.21	300	
0945	12.70	.339	2.24	5.06	27.8	12.22	300	
0950	12.80	.337	2.25	5.05	22.1	12.21	300	
0955	12.87	.336	2.29	5.05	16.6	12.22	300	
1000	12.94	.338	2.33	5.04	14.1	12.22	300	
1005	13.02	.338	2.35	5.04	14.4	12.22	300	
1008	13.03	.339	2.35	5.04	14.2	12.21	300	
								Sampled at 1015
END:								

Notes: ______

Sequence Numbers: 1343 1344 1345 Duplicates: ______ ______ ______

Purge Volume: ______ gals.

Information for 2 in. Well: Sched 40 = 617 ml/ft (0.163 gal/ft), Sched 80 = 565 ml/ft (0.145 gal/ft)

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GROUNDWATER SAMPLING LOG

PROJECT: **4808**	SITE: **Hanscom**	WELL ID: 0W2-6	DATE: 9/24/98
WELL DEPTH: 20.00'	SCREEN LENGTH: 5 feet	WELL DIAMETER: **2"**	CASING TYPE: **PVC**
MEASUREMENT POINT: ***TOC***	WATER LEVEL: 11.67	WEATHER INFORMATION: SUNNY 70°	
METHOD & EQUIPMENT: ***Low Flow***			
TUBING TYPE: **HDPE (dedicated)**		Pump Depth: (below TOC) 16.5	
SAMPLING PERSONNEL: **EST, Greg Cataldo**			

TIME	TEMP.	SPEC. COND.	DO	pH	TURBIDITY	▼	FLOW RATE	COMMENTS:
(units)	°C	mS/cm	mg/L		NTU	ft btoc	ml/min	Started Purging at 1040
T_0: 1050	12.80	.319	1.58	5.58	50	13.19	300	H_2S Odor, Purge Water Black
1055	12.54	.314	0.31	5.20	39	13.14	300	
1100	12.42	.310	0.21	5.09	23.5	13.11	300	
1105	12.66	.309	0.21	5.05	14.0	13.12	300	
1110	12.33	.310	0.20	5.02	9.4	13.10	300	
1113	12.38	.310	0.21	5.02	8.6	13.11	300	
1116	12.32	.310	0.21	5.02	8.6	13.12	300	
								Sampled at 1125
END:								

Notes: __________

Sequence Numbers: 1346 1347 1348 Duplicates: __________

Purge Volume: __________ gals.

Information for 2 in. Well: Sched 40 = 617 ml/ft (0.163 gal/ft), Sched 80 = 565 ml/ft (0.145 gal/ft)

GROUNDWATER SAMPLING LOG

PROJECT: 4808	SITE: Hanscom	WELL ID: DPW-RAP2-2T	DATE: 9/28/98
WELL DEPTH: 62.19	SCREEN LENGTH: 2 meters	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 10.3	WEATHER INFORMATION: Sunny 70°	
METHOD & EQUIPMENT: Low Flow			
TUBING TYPE: HDPE (dedicated)		Pump Depth: (below TOC) 58'	
SAMPLING PERSONNEL: EST, Greg Cataldo			

liters purged	TIME	TEMP.	SPEC. COND.	DO	pH	TURBIDITY	▼	FLOW RATE	COMMENTS:
	(units)	°c	mS/cm	mg/L		NTU	ft btoc	ml/min	Started Purging at 0915
4	T₀ 0925	10.37	.240	6.01	6.53	>200	12.18	400	
6	0930	10.30	.265	1.67	6.52	>200	11.88	400	
8	0935	10.30	.270	0.92	6.56	>200	11.57	400	
12	0940	10.34	.282	0.76	6.59	>200	11.48	400	
16	0945	10.30	.285	0.57	6.63	>200	11.28	400	
20	0950	10.39	.286	0.44	6.65	>200	11.24	400	
24	0955	10.36	.287	0.35	6.67	>200	11.23	400	
									Sampled at 1000
	END:								

Notes:

Sequence Numbers: 1349 1350 1351 Duplicates: 1352 1353 1354

Purge Volume: 6 gal gals.

Information for 2 in. Well: Sched 40 = 617 ml/ft (0.163 gal/ft), Sched 80 = 565 ml/ft (0.145 gal/ft)

0.163 × 7 = 1.141 1 well volume

1.14 × 5 = 5.7 gal × 4 = 22.8 liters

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GROUNDWATER SAMPLING LOG

PROJECT: **4808**	SITE: **Hanscom**	WELL ID: RAP2-2T	DATE: 9/28/98
WELL DEPTH: 75.30'	SCREEN LENGTH: 15.20'	WELL DIAMETER: **2"**	CASING TYPE: **PVC**
MEASUREMENT POINT: **TOC**	WATER LEVEL: 11.88	WEATHER INFORMATION: Sunny 70°	
METHOD & EQUIPMENT: **Low Flow**			
TUBING TYPE: **HDPE (dedicated)**		Pump Depth: (below TOC) 60.5'	
SAMPLING PERSONNEL: **EST, Greg Cataldo**			

TIME	TEMP.	SPEC. COND.	DO	pH	TURBIDITY	▼	FlOW RATE	COMMENTS:
(units)	° c	mS/cm	mg/L		NTU	ft btoc	ml/min	Started Purging at 10³⁰
T₀: 1040	10.46	.277	0.54	6.85	68.8	11.97	400	
1045	10.41	.284	0.47	6.81	37.4	11.98	400	
1050	10.33	.290	0.28	6.79	23.8	11.97	400	
1055	10.29	.296	0.24	6.78	12.0	11.98	400	
1100	10.24	.300	0.23	6.77	11.7	11.98	400	
1103	10.25	.301	0.22	6.77	11.6	11.97	400	
								Sampled at 1110
END:								

Notes: ____

Sequence Numbers: 1355 1366 1357 Duplicates: 1358 1359 1360

Purge Volume: 16 ~~gals.~~ liters

Information for 2 in. Well: Sched 40 = 617 ml/ft (0.163 gal/ft), Sched 80 = 565 ml/ft (0.145 gal/ft)

GROUNDWATER SAMPLING LOG

PROJECT: 4808	SITE: Hanscom	WELL ID: RAP2-2S DOW	DATE: 9/28/98
WELL DEPTH: 19.56	SCREEN LENGTH: 5 meters	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 8.32	WEATHER INFORMATION: Sunny 70-75	
METHOD & EQUIPMENT: Low Flow			
TUBING TYPE: HDPE (dedicated)		Pump Depth: (below TOC) 11.5	
SAMPLING PERSONNEL: EST, Greg Cataldo			

TIME	TEMP.	SPEC. COND.	DO	pH	TURBIDITY	▼	FlOW RATE	COMMENTS:
(units)	° c	mS/cm	mg/L		NTU	ft btoc	ml/min	Started Purging at 1145
T0: 1155	11.98	.161	2.47	5.22	13.0	8.47	500	
1200	12.10	.149	2.54	4.59	7.5	8.38	500	
1205	12.02	.144	2.72	4.43	5.3	8.42	500	
1208	12.04	.143	2.79	4.38	4.0	8.41	500	
1211	11.99	.141	2.84	4.34	3.4	8.39	500	
1214	12.00	.140	2.90	4.31	3.2	8.41	500	
1217	12.07	.140	2.94	4.28	3.4	8.40	500	
								Sampled at 1220
END:								

Notes: ____

Sequence Numbers: 1361 1362 1363 Duplicates: ____ ____ ____

Purge Volume: ____ gals.

Information for 2 in. Well: Sched 40 = 617 ml/ft (0.163 gal/ft), Sched 80 = 565 ml/ft (0.145 gal/ft)

GROUNDWATER SAMPLING LOG

PROJECT: **4808**	SITE: **Hanscom**	WELL ID: RAP2-25	DATE: 7/28/98
WELL DEPTH: 14'	SCREEN LENGTH:	WELL DIAMETER: **2"**	CASING TYPE: **PVC**
MEASUREMENT POINT: **TOC**	WATER LEVEL: 8.38	WEATHER INFORMATION: Sunny 70-75°	
METHOD & EQUIPMENT: **Low Flow**			
TUBING TYPE: **HDPE (dedicated)**		Pump Depth: (below TOC) ~~11.5~~ 12.0'	
SAMPLING PERSONNEL: **EST, Greg Cataldo**			

TIME	TEMP.	SPEC. COND.	DO	pH	TURBIDITY	▼	FLOW RATE	COMMENTS:
(units)	°c	mS/cm	mg/L		NTU	ft btoc	ml/min	Started Purging at 1300
T_0: 1310	13.41	.126	4.93	3.94	8.7	8.47	200	
1315	13.29	.125	4.91	3.89	5.9	8.45	200	
1320	13.28	.125	4.87	3.86	3.8	8.44	200	
1325	13.31	.125	4.87	3.84	2.6	8.43	200	
1330	13.41	.126	4.87	3.83	2.0	8.44	200	
1333	13.42	.126	4.87	3.83	1.8	8.42	200	
1336	13.49	.126	4.86	3.83	1.8	8.43	200	
								Sampled at 1340
END:								

Notes:

Sequence Numbers: 1364 1365 1366 Duplicates:

Purge Volume: 8 ~~gals.~~ liters

Information for 2 in. Well: Sched 40 = 617 ml/ft (0.163 gal/ft), Sched 80 = 565 ml/ft (0.145 gal/ft)

GROUNDWATER SAMPLING LOG

PROJECT: 4808	SITE: Hanscom	WELL ID: AOW-13-102-MW	DATE: 9/29/98
WELL DEPTH: 17.23	SCREEN LENGTH: 3 Meters	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 2.43	WEATHER INFORMATION: Sunny 65°	
METHOD & EQUIPMENT: Low Flow			
TUBING TYPE: HDPE (dedicated)		Pump Depth: (below TOC) 9'	
SAMPLING PERSONNEL: EST, Greg Cataldo			

TIME	TEMP.	SPEC. COND.	DO	pH	TURBIDITY	▼	FlOW RATE	COMMENTS:
(units)	° c	mS/cm	mg/L		NTU	ft btoc	ml/min	Started Purging at 0915
T₀ 0928	13.45	.117	0.60	3.68	1.2	2.45	400	
0931	13.41	.117	0.53	3.60	0.76	2.47	400	
0935	13.41	.116	0.46	3.54	0.73	2.48	400	
0938	13.41	.116	0.41	3.51	0.72	2.47	400	
								Sampled at 0945
END:								

Notes: ____________________

Sequence Numbers: 1370 1371 1372 Duplicates: ______ ______ ______

Purge Volume: 12 ~~gals.~~ liters

Information for 2 in. Well: Sched 40 = 617 ml/ft (0.163 gal/ft), Sched 80 = 565 ml/ft (0.145 gal/ft)

GROUNDWATER SAMPLING LOG

PROJECT: **4808**	SITE: **Hanscom**	WELL ID: B-102	DATE: 9/29/98
WELL DEPTH: 14.00	SCREEN LENGTH: 11.00'	WELL DIAMETER: **2"**	CASING TYPE: **PVC**
MEASUREMENT POINT: **TOC**	WATER LEVEL: 4.0'	WEATHER INFORMATION: SUNNY 65°	
METHOD & EQUIPMENT: **Low Flow**			
TUBING TYPE: **HDPE (dedicated)**		Pump Depth: (below TOC) ~~9'~~ ~~ft~~ 11.5'	
SAMPLING PERSONNEL: **EST, Greg Cataldo**			

TIME	TEMP.	SPEC. COND.	DO	pH	TURBIDITY	▼	FLOW RATE	COMMENTS:
(units)	°c	mS/cm	mg/L		NTU	ft btoc	ml/min	Started Purging at 10[15]
T₀: 1025	14.41	.103	0.39	3.56	20.4	4.0	400	
1030	14.40	.103	0.33	3.54	19.8	4.0	400	
1035	14.39	.103	0.29	3.52	18.0	4.0	400	
1040	14.40	.103	0.26	3.51	16.2	4.0	400	
1045	14.41	.103	0.25	3.51	15.8	4.0	400	
1050	14.39	.103	0.24	3.51	15.0	4.0	400	
1055	14.38	.103	0.23	3.52	12.9	4.0	400	
1100	14.38	.103	0.22	3.52	12.0	4.0	400	
~~1100~~ 1105	14.41	.103	0.22	3.52	10.5	4.0	400	
1108	14.42	.103	0.22	3.52	9.9	4.0	400	
~~1115~~ 1113		.103	0.22	3.52	9.6	4.0	400	
1116		.103	0.22	3.52	9.2	4.0	400	
								Sampled at 11[20]
END:								

Notes: ______

Sequence Numbers: 1373 1374 1375 Duplicates: ______ ______ ______

Purge Volume: ______ gals.

Information for 2 in. Well: Sched 40 = 617 ml/ft (0.163 gal/ft), Sched 80 = 565 ml/ft (0.145 gal/ft)

GROUNDWATER SAMPLING LOG

PROJECT: 4808	SITE: Hanscom	WELL ID: DPW-B-241-S	DATE: 9/29/98
WELL DEPTH: 18.25	SCREEN LENGTH: 3 meters	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 4.98	WEATHER INFORMATION: Sunny 70°	
METHOD & EQUIPMENT: Low Flow			
TUBING TYPE: HDPE (dedicated)		Pump Depth: (below TOC) 10'	
SAMPLING PERSONNEL: EST, Greg Cataldo			

TIME	TEMP.	SPEC. COND.	DO	pH	TURBIDITY	▼	FlOW RATE	COMMENTS:
(units)	°c	mS/cm	mg/L		NTU	ft btoc	ml/min	Started Purging at 12¹⁰
T₀: 1220	11.83	.141	2.40	3.89	4.6	5.05	400	
1225	11.82	.139	2.56	3.84	2.8	5.05	400	
1230	11.79	.137	2.67	3.81	2.2	5.06	400	
1233	11.81	.137	2.68	3.81	2.2	5.04	400	
								Sampled at 1240
END:								

Notes: ______

Sequence Numbers: 1376 1377 1378 Duplicates: ______ ______ ______

Purge Volume: ______ gals.

Information for 2 in. Well: Sched 40 = 617 ml/ft (0.163 gal/ft), Sched 80 = 565 ml/ft (0.145 gal/ft)

GROUNDWATER SAMPLING LOG

PROJECT: **4808**	SITE: **Hanscom**	WELL ID: MW-B-241-S	DATE: 9/29/98
WELL DEPTH: 17.00'	SCREEN LENGTH: 13.00'	WELL DIAMETER: **2"**	CASING TYPE: **PVC**
MEASUREMENT POINT: ***TOC***	WATER LEVEL: 7.18	WEATHER INFORMATION: SUNNY 70-75°	
METHOD & EQUIPMENT: ***Low Flow***			
TUBING TYPE: **HDPE (dedicated)**		Pump Depth: (below TOC) ~~10.0'~~ 13.0'	
SAMPLING PERSONNEL: **EST, Greg Cataldo**			

TIME	TEMP.	SPEC. COND.	DO	pH	TURBIDITY	▼	FlOW RATE	COMMENTS:
(units)	°C	mS/cm	mg/L		NTU	ft btoc	ml/min	Started Purging at 1300
T0: 1305	13.22	.113	4.94	3.71	27.2	7.21	500	
1310	13.05	.114	4.44	3.67	28.8	7.20	500	
1315	13.08	.115	4.26	3.65	25.0	7.22	500	
1320	13.03	.115	4.19	3.64	20.2	7.21	500	
1325	13.02	.115	4.13	3.63	15.1	7.20	500	
1330	12.99	.115	4.12	3.62	11.8	7.22	500	
1335	13.01	.115	4.09	3.62	10.6	7.20	500	
1338	13.03	.115	4.07	3.61	7.8	7.19	500	
1341	13.07	.115	4.09	3.61	7.0	7.20	500	
1344	12.95	.115	4.09	3.61	6.8	7.22	500	
								Sampled at 1350
END:								

Notes: ______________________

Sequence Numbers: 1379 1380 1381 Duplicates: ________ ________ ________

Purge Volume: 25 ~~gals.~~ liters

Information for 2 in. Well: Sched 40 = 617 ml/ft (0.163 gal/ft), Sched 80 = 565 ml/ft (0.145 gal/ft)

GROUNDWATER SAMPLING LOG

PROJECT: **4808**	SITE: **Hanscom**	WELL ID: DAW-RFW-11	DATE: 9/30/98
WELL DEPTH: 20.34	SCREEN LENGTH: 3meters	WELL DIAMETER: **2"**	CASING TYPE: **PVC**
MEASUREMENT POINT: **TOC**	WATER LEVEL: 13.18	WEATHER INFORMATION: Overcast 65°	
METHOD & EQUIPMENT: **Low Flow**			
TUBING TYPE: **HDPE (dedicated)**		Pump Depth: (below TOC) 15.0'	
SAMPLING PERSONNEL: **EST, Greg Cataldo**			

TIME	TEMP.	SPEC. COND.	DO	pH	TURBIDITY	▼	FlOW RATE	COMMENTS:
(units)	°c	mS/cm	mg/L		NTU	ft btoc	ml/min	Started Purging 0825
To: 0825	14.58	.358	3.34	4.62	10.0	13.22	400	
0830	14.57	.358	3.28	4.60	4.9	13.24	400	
0835	14.53	.357	3.15	4.55	2.7	13.22	400	
0840	14.44	.351	2.91	4.53	1.8	13.24	400	
0843	14.42	.352	2.89	4.52	1.2	13.22	400	
0846	14.40	.344	2.81	4.53	1.0	13.24	400	SAMPLED @ 0850
END:								

Notes: ______

Sequence Numbers: 1382 1383 1384 Duplicates: ______

Purge Volume: ______ gals.

Information for 2 in. Well: Sched 40 = 617 ml/ft (0.163 gal/ft), Sched 80 = 565 ml/ft (0.145 gal/ft)

GROUNDWATER SAMPLING LOG

PROJECT: 4808	SITE: Hanscom	WELL ID: RFW-11	DATE: 9/30/98
WELL DEPTH: 17.20'	SCREEN LENGTH: 10.0	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 15.54	WEATHER INFORMATION: Overcast 65°	
METHOD & EQUIPMENT: Low Flow			
TUBING TYPE: HDPE (dedicated)		Pump Depth: (below TOC) 15.0'	
SAMPLING PERSONNEL: EST, Greg Cataldo			

TIME	TEMP.	SPEC. COND.	DO	pH	TURBIDITY	▼	FlOW RATE	COMMENTS:
(units)	° c	mS/cm	mg/L		NTU	ft btoc	ml/min	Started Purging at 09'
T₀: 0920	15.16	.405	4.41	4.46	33.4	15.56	200	
0925	15.25	.404	4.34	4.43	14.6	15.58	200	
0930	15.35	.398	4.22	4.42	8.5	15.56	200	
0935	15.48	.394	4.12	4.43	4.6	15.58	200	
0940	15.54	.397	4.11	4.43	4.1	15.54	200	
0943	15.60	.397	4.13	4.44	4.0	15.55	200	
								Sampled at 0950
END:								

Notes:

Sequence Numbers: 1385 1386 1387 Duplicates:

Purge Volume: 8.0 ~~gals.~~ liters

Information for 2 in. Well: Sched 40 = 617 ml/ft (0.163 gal/ft), Sched 80 = 565 ml/ft (0.145 gal/ft)

GROUNDWATER SAMPLING LOG

PROJECT: **4808**	SITE: **Hanscom**	WELL ID: DPW-RAP2-4S	DATE: 9/30/98
WELL DEPTH: 24.52	SCREEN LENGTH: 6 Meters	WELL DIAMETER: **2"**	CASING TYPE: **PVC**
MEASUREMENT POINT: **TOC**	WATER LEVEL: 8.00	WEATHER INFORMATION: Overcast 65°-70°	
METHOD & EQUIPMENT: **Low Flow**			
TUBING TYPE: **HDPE (dedicated)**		Pump Depth: (below TOC) 15.0'	
SAMPLING PERSONNEL: **EST, Greg Cataldo**			

TIME	TEMP.	SPEC. COND.	DO	pH	TURBIDITY	▼	FlOW RATE	COMMENTS:
(units) 1030	°c	mS/cm	mg/L		NTU	ft btoc	ml/min	Started Purging at 10^{20}
T_0:	15.19	.199	5.35	4.85	7.2	8.18	500	
1035	15.11	.197	5.33	4.84	6.8	8.12	500	
1040	15.07	.196	5.33	4.82	4.4	8.11	500	
1045	15.01	.196	5.36	4.81	3.7	8.10	500	
1050	14.96	.196	5.35	4.80	2.6	8.11	500	
1055	14.95	.196	5.34	4.79	2.3	8.11	500	
1058	14.95	.196	5.32	4.79	2.4	8.11	500	
								Sampled at 11^{05}
END:								

Notes: ______

Sequence Numbers: 1388 1389 1390 Duplicates: ______ ______ ______

Purge Volume: 22.5 ~~gals.~~ liters

Information for 2 in. Well: Sched 40 = 617 ml/ft (0.163 gal/ft), Sched 80 = 565 ml/ft (0.145 gal/ft)

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GROUNDWATER SAMPLING LOG

PROJECT: **4808**	SITE: **Hanscom**	WELL ID: KAP2-45	DATE: 9/30/98
WELL DEPTH: 25.00	SCREEN LENGTH: 20.00	WELL DIAMETER: **2"**	CASING TYPE: **PVC**
MEASUREMENT POINT: **TOC**	WATER LEVEL: 7.05	WEATHER INFORMATION:	

METHOD & EQUIPMENT: **Low Flow**

TUBING TYPE: **HDPE (dedicated)** Pump Depth: (below TOC) 15.8'

SAMPLING PERSONNEL: **EST, Greg Cataldo**

TIME	TEMP.	SPEC. COND.	DO	pH	TURBIDITY	▼	FlOW RATE	COMMENTS:
(units)	°C	mS/cm	mg/L		NTU	ft btoc	ml/min	Started Purging at 1120
T0: 1130	15.59	.171	4.45	5.04	18.8	7.67	500	
1135	15.69	.168	4.64	4.99	9.3	7.66	500	
1140	15.64	.168	4.72	4.97	5.2	7.67	500	
1145	15.67	.168	4.81	4.95	3.6	7.66	500	
1150	15.69	.168	4.86	4.94	2.6	7.67	500	
1155	15.65	.169	4.93	4.93	2.4 GC	7.69	500	
1158	15.64	.169	4.97	4.93	~~2~~1.9	7.70	500	
								Sampled at 1205
END:								

Notes:

Sequence Numbers: 1391 1392 1393 Duplicates:

Purge Volume: 22.5 ~~gals.~~ liters

Information for 2 in. Well: Sched 40 = 617 ml/ft (0.163 gal/ft), Sched 80 = 565 ml/ft (0.145 gal/ft)

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GROUNDWATER SAMPLING LOG

PROJECT: **4808**	SITE: **Hanscom**	WELL ID: MW-RAP1-6S	DATE: 9/30/98
WELL DEPTH: ~~14.95~~ 17.88	SCREEN LENGTH: 4 Meters	WELL DIAMETER: **2"**	CASING TYPE: **PVC**
MEASUREMENT POINT: **TOC**	WATER LEVEL: 5.32	WEATHER INFORMATION: Overcast 65°-70°	
METHOD & EQUIPMENT: **Low Flow**			
TUBING TYPE: **HDPE (dedicated)**		Pump Depth: (below TOC) 9.0'	
SAMPLING PERSONNEL: **EST, Greg Cataldo**			

TIME	TEMP.	SPEC. COND.	DO	pH	TURBIDITY	▼	FlOW RATE	COMMENTS:
(units)	° c	mS/cm	mg/L		NTU	ft btoc	ml/min	Started Purging at 1235
T0: 1245	15.70	.145	0.61	4.36	22.0	5.38	500	
1250	15.75	.148	0.75	4.27	13.0	5.36	500	
1255	15.69	.149	0.84	4.24	7.3	5.37	500	
1300	15.75	.149	0.88	4.22	5.9	5.36	500	
1305	15.77	.149	0.88	4.21	4.6	5.39	500	
1310	15.94	.149	0.93	4.21	3.4	5.41	500	
1313	15.86	.149	0.94	4.20	2.9	5.38	500	
1314	15.87	.150	0.96	4.20	2.9	5.37	500	
								SAMPLED AT 1325
END:								

Notes: ________________

Sequence Numbers: 1394 1395 1396 Duplicates: 1397 1398 1399

Purge Volume: 25 ~~gals.~~ liters

Information for 2 in. Well: Sched 40 = 617 ml/ft (0.163 gal/ft), Sched 80 = 565 ml/ft (0.145 gal/ft)

GROUNDWATER SAMPLING LOG

PROJECT: 4808	SITE: Hanscom	WELL ID: RAP1-6S	DATE: 9/30/98
WELL DEPTH: 14.50	SCREEN LENGTH: 14.50	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 6.93	WEATHER INFORMATION:	
METHOD & EQUIPMENT: Low Flow			
TUBING TYPE: HDPE (dedicated)		Pump Depth: (below TOC) ~~14.0'~~ ~~13.5'~~ 11.0'	
SAMPLING PERSONNEL: EST, Greg Cataldo			

TIME	TEMP.	SPEC. COND.	DO	pH	TURBIDITY	▼	FlOW RATE	COMMENTS:
(units)	°c	mS/cm	mg/L		NTU	ft btoc	ml/min	Started Purging at 1340
T0: 1350	16.71	.144	0.36	4.62	31.1	7.02	250	
1355	16.54	.145	0.31	4.61	15.4	6.95	250	
1400	16.58	.148	0.28	4.63	10.0	6.97	250	
1403	16.53	.145	0.28	4.63	9.6	6.96	250	
1406	16.57	.145	0.28	4.63	9.3	6.95	250	
								Sampled at 1410
END:								

Notes:

Sequence Numbers: 1400 ~~1403~~ 1401 ~~1402~~ ~~1404~~ 1402 Duplicates: ~~1405~~ 1403 1404 1405

Purge Volume: 7.5 ~~gals.~~ liters

Information for 2 in. Well: Sched 40 = 617 ml/ft (0.163 gal/ft), Sched 80 = 565 ml/ft (0.145 gal/ft)

GROUNDWATER SAMPLING LOG

PROJECT: **4808**	SITE: **Hanscom**	WELL ID: DP(1)-MW2-06	DATE: 10/01/98
WELL DEPTH: 18.78	SCREEN LENGTH: 3 Meters	WELL DIAMETER: **2"**	CASING TYPE: **PVC**
MEASUREMENT POINT: **TOC**	WATER LEVEL: 9.93	WEATHER INFORMATION: Overcast 70°	
METHOD & EQUIPMENT: **Low Flow**			
TUBING TYPE: **HDPE (dedicated)**		Pump Depth: (below TOC) ~~13.5'~~ ~~14.0~~ 13.5'	
SAMPLING PERSONNEL: **EST, Greg Cataldo**			

TIME	TEMP.	SPEC. COND.	DO	pH	TURBIDITY	▼	FlOW RATE	COMMENTS:
(units)	°c	mS/cm	mg/L		NTU	ft btoc	ml/min	Started Purging 0955
T0: 1005	21.69	.504	0.11	5.98	92.3	10.35	200	
1010	22.16	.509	0.08	6.02	111	10.42	200	
1015	22.31	.570	0.05	6.04	82.2	10.49	200	
1020	22.41	.510	0.06	6.07	75.3	10.50	200	
1025	22.53	.510	0.07	6.08	43.8	10.52	200	
1030	22.48	.509	0.05	6.08	37.3	10.55	200	Slight Sheen ON
1035	22.25	.506	0.07	6.08	24.1	10.59	200	purgewater Surface
1040	22.05	.502	0.04	6.08	20.4	10.63	200	
1045	22.12	.498	0.10	6.07	19.7	10.62	200	
1050	22.14	.496	0.10	6.07	19.1	10.67	200	
1055	22.09	.493	0.10	6.07	17.3	10.71	200	
1100	21.97	.491	0.10	6.07	18.7	10.76	200	
1105	21.80	.489	0.10	6.07	18.7	10.74	200	
1110	21.67	.485	0.10	6.06	18.6	10.75	200	
								Sampled at 1115
END:								

Notes: ____________________

Sequence Numbers: 1406 1407 1408 Duplicates: 1409 1410 1411

Purge Volume: ________ gals.

Information for 2 in. Well: Sched 40 = 617 ml/ft (0.163 gal/ft), Sched 80 = 565 ml/ft (0.145 gal/ft)

GROUNDWATER SAMPLING LOG

PROJECT: 4808	SITE: Hanscom	WELL ID: MW2-06	DATE: 10/01/98
WELL DEPTH: 18.50	SCREEN LENGTH: 10	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 10.52	WEATHER INFORMATION: Overcast 70°	
METHOD & EQUIPMENT: Low Flow			
TUBING TYPE: HDPE (dedicated)		Pump Depth: (below TOC) 13.5'	
SAMPLING PERSONNEL: EST, Greg Cataldo			

TIME	TEMP.	SPEC. COND.	DO	pH	TURBIDITY	▼	FlOW RATE	COMMENTS:
(units)	°c	mS/cm	mg/L		NTU	ft btoc	ml/min	Started Purging 11²⁵
T₀: 1135	21.53	.521	0.10	6.19	>200	11.22	150	
1140	21.52	.522	0.14	6.20	>200	11.24	150	
1145	21.33	.521	0.15	6.20	182.5	11.23	150	
1150	21.24	.520	0.14	6.20	161.4	11.15	150	
1155	21.12	.520	0.13	6.20	121.8	11.13	150	
1200	21.05	.519	0.13	6.19	100.3	11.11	150	Switching to 10min reads
1210	21.13	.519	0.12	6.18	78.2	11.08	150	
1220	20.46	.518	0.12	6.17	70.0	11.07	150	
1230	20.11	.516	0.13	6.18	60.2	11.11	150	
1240	20.12	.515	0.10	6.19	49.4	11.08	150	
1250	19.99	.514	0.11	6.20	36.3	11.09	150	
1300	20.36	.513	0.09	6.21	29.9	11.08	150	
1310	20.00	.513	0.09	6.23	21.6	11.08	150	
1320	20.85	.514	0.10	6.24	18.2	11.07	150	
1325 ~~1330~~	20.78	.513	0.09	6.25	12.6	11.08	150	Switched back to 5min
1330	20.67	.513	0.09	6.25	8.8	11.09	150	
1335	20.65	.513	0.08	6.25	9.5	11.07	150	
1338	20.68	.512	0.09	6.26	8.0	11.08	150	
								Sampled at 1345
END:								

Notes: D.O Sensor Malfunctioning

Sequence Numbers: 1412 1413 1414 Duplicates: 1415 1416 1417

Purge Volume: 20.7 ~~gals.~~ liters

Information for 2 in. Well: Sched 40 = 617 ml/ft (0.163 gal/ft), Sched 80 = 565 ml/ft (0.145 gal/ft)

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GROUNDWATER SAMPLING LOG

PROJECT: **4808**	SITE: **Hanscom**	WELL ID: DPW-NWZ-12	DATE: 10/02/98
WELL DEPTH: 20.05	SCREEN LENGTH: 3 meters	WELL DIAMETER: **2"**	CASING TYPE: **PVC**
MEASUREMENT POINT: **TOC**	WATER LEVEL: 8.2	WEATHER INFORMATION: Clear 55°-60°	
METHOD & EQUIPMENT: ***Low Flow***			
TUBING TYPE: **HDPE (dedicated)**		Pump Depth: (below TOC) 15.0' → 18.0' → 19.0'	
SAMPLING PERSONNEL: **EST, Greg Cataldo**			

TIME	TEMP.	SPEC. COND.	DO	pH	TURBIDITY	▼	FlOW RATE	COMMENTS:
(units)	°c	mS/cm	mg/L		NTU	ft btoc	ml/min	Started Purging at 755
To: 0800	13.95	0.407	1.10	5.12	158.0	12.23	180	
0810	13.86	.406	1.02	5.15	>200	13.10	~~135~~ 150	lowered Pump to 18'
0815	13.12	.407	0.96	5.15	>200	13.75	150	
0820	13.30	.401	0.59	5.07	>200	14.21	150	
0825	13.34	.396	0.60	5.05	>200	15.21	150	
0830	13.65	.400	1.03	5.14	>200	15.91	100	
0835	13.52	.402	1.38	5.23	>200	16.30	100	
0840	13.31	.398	1.47	5.25	>200	16.33	100	lowered to 19.'
0845	13.41	.382	0.45	5.11	>200	16.61	100	
0850	13.51	.381	0.87	5.15	>200	16.68	100	
0855	13.62	.372	1.11	5.17	>200	16.77	100	
0900	13.82	.369	1.25	5.16	>200	16.93	100	
0905	13.93	.367	1.25	5.15	>200	17.07	100	
0910	14.19	.363	1.29	5.14	>200	17.22	100	
0915	14.18	.360	1.26	5.15	>200	17.38	100	
0917								Well Dry at 17.51'
								Sampled at 0940
END:								

Notes: ______

Sequence Numbers: 1418 1419 1420 Duplicates: ______ ______ ______

Purge Volume: ______ gals.

Information for 2 in. Well: Sched 40 = 617 ml/ft (0.163 gal/ft), Sched 80 = 565 ml/ft (0.145 gal/ft)

GROUNDWATER SAMPLING LOG

PROJECT: **4808**	SITE: **Hanscom**	WELL ID: MW2-12	DATE: 10/02/98
WELL DEPTH: 20.00'	SCREEN LENGTH: 10.00'	WELL DIAMETER: **2"**	CASING TYPE: **PVC**
MEASUREMENT POINT: **TOC**	WATER LEVEL: 8.39	WEATHER INFORMATION: Clear 55°-60°	
METHOD & EQUIPMENT: **Low Flow**			
TUBING TYPE: **HDPE (dedicated)**		Pump Depth: (below TOC) 18.0'	
SAMPLING PERSONNEL: **EST, Greg Cataldo**			

TIME	TEMP.	SPEC. COND.	DO	pH	TURBIDITY	▼	FlOW RATE	COMMENTS:
(units)	°c	mS/cm	mg/L		NTU	ft btoc	ml/min	Started Purging at 0930
T0: 0940	15.10	.271	0.86	5.25	>200	11.65	150	
0945	14.90	.269	0.87	5.23	>200	12.34	150	
0950	14.66	.272	1.05	5.23	>200	12.75	150	
0955	14.51	.293	3.21	5.29	>200	12.78	150	
1000	14.81	.310	2.98	5.32	>200	12.75	100	Lowered pump to 18.5'
1005	15.42	.321	1.13	5.32	>200	13.69	100	
1010	15.67	.324	0.83	5.33	>200	14.31	100	
1015	15.69	.330	0.89	5.37	>200	15.18	100	
1020	15.53	.335	1.01	5.39	>200	15.76	100	
1025	15.48	.339	1.17	5.43	>200	16.22	100	
1030	15.46	.345	1.41	5.45	>200	16.44	100	
1035	15.23	.354	3.51	5.53	>200	16.64	100	
1038								Went Dry at 16.69
								Sampled at 1105
END:								

Notes: __________

Sequence Numbers: 1421 1422 1423 Duplicates: ______ ______ ______

Purge Volume: ________ gals.

Information for 2 in. Well: Sched 40 = 617 ml/ft (0.163 gal/ft), Sched 80 = 565 ml/ft (0.145 gal/ft)

pg 1/2

GROUNDWATER SAMPLING LOG

PROJECT: 4808	SITE: Hanscom	WELL ID: BPW-MW-11	DATE: 10/02/98
WELL DEPTH: 19.93	SCREEN LENGTH: [illegible]	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 12.12	WEATHER INFORMATION: Clear 55°-60°	
METHOD & EQUIPMENT: Low Flow			
TUBING TYPE: HDPE (dedicated)		Pump Depth: (below TOC) 15'	
SAMPLING PERSONNEL: EST, Greg Cataldo			

TIME	TEMP.	SPEC. COND.	DO	pH	TURBIDITY	▼	FlOW RATE	COMMENTS:
(units)	°c	mS/cm	mg/L		NTU	ft btoc	ml/min	Started Purging at 1055
T₀: 1105	16.96	.376	0.71	4.99	>200	12.69	150	
1110	17.14	.373	0.72	4.99	>200	12.67	150	
1115	16.85	.380	0.57	5.02	>200	12.64	150	
1120	16.64	.386	0.54	5.06	>200	12.67	150	
1125	16.75	.396	0.48	5.10	>200	12.68	150	
1130	16.81	.405	0.41	5.16	>200	12.67	150	
1135	16.76	.411	0.37	5.19	>200	12.68	150	
1140	16.79	.416	0.34	5.21	>200	12.69	150	
1145	16.88	.421	0.30	5.21	>200	12.72	200	FLOW ROSE
1150	16.91	.423	0.29	5.25	>200	12.73	200	
1155	16.90	.425	0.27	5.26	>200	12.73	200	
1200	16.95	.428	0.26	5.26	>200	12.74	200	
1205	16.94	.431	0.27	5.27	>200	12.74	200	
1210	17.06	.434	0.25	5.28	>200	12.75	200	
1215	17.02	.437	0.26	5.28	>200	12.74	200	
1220	17.04	.440	0.26	5.28	>200	12.76	200	
1225	16.96	.444	0.24	5.28	>200	12.76	200	
1230	17.04	.447	0.25	5.29	>200	12.76	200	
1235	17.07	.449	0.24	5.29	>200	12.76	200	
1240	17.09	.452	0.25	5.30	>200	12.76	200	
1245	17.21	.461	0.24	5.30	>200	12.76	200	
1250	17.13	.463	0.26	5.30	>200	12.76	200	
1255	16.86	.467	0.22	5.29	>200	12.76	200	
1300	16.62	.470	0.23	5.29	>200	12.76	200	
END:								SWITCHED TO 10 MIN. READINGS

Notes: ______

Sequence Numbers: ______ ______ ______ Duplicates: ______ ______ ______

Purge Volume: ______ gals.

Information for 2 in. Well: Sched 40 = 617 ml/ft (0.163 gal/ft), Sched 80 = 565 ml/ft (0.145 gal/ft)

GROUNDWATER SAMPLING LOG

CONT'D pg 2/2

PROJECT: 4808	SITE: Hanscom	WELL ID: DPW - MW2 - 11	DATE: 10/02/98
WELL DEPTH: 19.93	SCREEN LENGTH:	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL:	WEATHER INFORMATION:	
METHOD & EQUIPMENT: Low Flow			
TUBING TYPE: HDPE (dedicated)		Pump Depth: (below TOC)	
SAMPLING PERSONNEL: EST, Greg Cataldo			

liters purged= 33.75

TIME	TEMP.	SPEC. COND.	DO	pH	TURBIDITY	▼	FlOW RATE	COMMENTS:
(units)	° c	mS/cm	mg/L		NTU	ft btoc	ml/min	
T0: 1310	16.69	.477	0.24	5.29	170	12.76	200	
1320	17.06	.482	0.22	5.31	>200	12.76	200	
1330	17.33	.487	0.23	5.33	>200	12.76	200	
1340	17.11	.491	0.22	5.33	>200	12.78	200	
1350	17.02	.496	0.23	5.32	>200	12.78	200	SAMPLED at 1355
								b/c achieved 5 well volumes
END:								

Notes: ______________________________

Sequence Numbers: 1424 1425 1426 Duplicates: ________ ________ ________

Purge Volume: ___________ gals.

Information for 2 in. Well: Sched 40 = 617 ml/ft (0.163 gal/ft), Sched 80 = 565 ml/ft (0.145 gal/ft)

GROUNDWATER SAMPLING LOG

PROJECT: 4808	SITE: Hanscom	WELL ID: MW2-11	DATE: 10/2/98
WELL DEPTH: 20'	SCREEN LENGTH: 10'	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 12.3'	WEATHER INFORMATION: 55-60°, Clear	
METHOD & EQUIPMENT: Low Flow			
TUBING TYPE: HDPE (dedicated)		Pump Depth: (below TOC) 15'→17'→19.2'	
SAMPLING PERSONNEL: EST, Greg Cataldo			

TIME	TEMP.	SPEC. COND.	DO	pH	TURBIDITY	▼	FlOW RATE	COMMENTS:
(units)	°c	mS/cm	mg/L		NTU	ft btoc	ml/min	Started Purging at 1405
T0: 1415	17.37	.283	0.63	5.48	66.1	15.95	175	
1420	18.12	.281	0.69	5.50	97.0	16.35	100	
1425	18.78	.283	1.97	5.65	97.2	16.53	100	
1430	18.89	.290	3.18	5.68	76.3	17.05	50	CANNOT ACHIEVE A STATIC DRAWDOWN @ 50 mL/min
1433	16.70	.296	1.32	5.56	109.6	17.82	500	
1436	16.23	.294	0.94	5.50	105.3	18.24	500	WENT DRY
1456								SAMPLED
END:								

Notes: ______

Sequence Numbers: 1427 1428 1429 Duplicates: ______ ______ ______

Purge Volume: ______ gals.

Information for 2 in. Well: Sched 40 = 617 ml/ft (0.163 gal/ft), Sched 80 = 565 ml/ft (0.145 gal/ft)

GROUNDWATER SAMPLING LOG

PROJECT: 4808	SITE: Hanscom	WELL ID: DPW-NWZ-07	DATE: 10/5/98
WELL DEPTH: 14.03	SCREEN LENGTH: 2 meters	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 8.13	WEATHER INFORMATION: Clear 55°-60°	
METHOD & EQUIPMENT: Low Flow			
TUBING TYPE: HDPE (dedicated)		Pump Depth: (below TOC) 12.0'	
SAMPLING PERSONNEL: EST, Greg Cataldo			

TIME	TEMP.	SPEC. COND.	DO	pH	TURBIDITY	▼	FlOW RATE	COMMENTS:
(units)	°c	mS/cm	mg/L		NTU	ft btoc	ml/min	Started Purging at 0845
T_0: 0855	17.36	.395	0.73	5.19	70.5	~~10~~ 11.09	200	
0900	17.40	.394	0.67	5.15	69.5	11.20	200	
0905	17.46	.394	0.57	5.08	90.3	11.41	200	
0910	17.38	.395	0.51	5.05	84.3	11.59	150	
0915	16.94	.394	0.49	5.02	88.0	11.30	150	
0920	16.89	.395	0.45	4.96	70.1	11.15	150	
0925	17.02	.395	0.43	4.93	56.5	11.02	150	
0930	16.85	.397	0.41	4.90	42.6	10.93	150	
0935	16.85	.397	0.39	4.88	35.8	10.83	150	
0940	16.91	.396	0.38	4.86	27.6	10.78	150	
0945	16.94	.397	0.37	4.85	21.8	10.81	150	
0950	17.07	.396	0.37	4.85	16.2	10.77	150	
0955	17.14	.396	0.36	4.85	14.5	10.76	150	
1000	17.08	.397	0.35	4.86	12.5	10.74	150	
1005	17.13	.397	0.35	4.86	11.8	10.68	150	
1010	17.29	.396	0.34	4.86	10.4	10.70	150	
1015	17.36	.396	0.34	4.87	9.1	10.69	150	
1018	17.32	.397	0.33	4.87	8.7	10.70	150	
1024	17.39	.397	0.33	4.87	8.7	10.71	150	
								Sampled at 1025
END:								

Notes: ____________________

Sequence Numbers: 1430 1431 1432 Duplicates: ________ ________ ________

Purge Volume: __________ gals.

Information for 2 in. Well: Sched 40 = 617 ml/ft (0.163 gal/ft), Sched 80 = 565 ml/ft (0.145 gal/ft)

GROUNDWATER SAMPLING LOG

PROJECT: 4808	SITE: Hanscom	WELL ID: MWZ-07	DATE: 10/5/98
WELL DEPTH: 19.00	SCREEN LENGTH: 10.00	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 9.05	WEATHER INFORMATION: SUNNY 60°-65°	
METHOD & EQUIPMENT: Low Flow			
TUBING TYPE: HDPE (dedicated)		Pump Depth: (below TOC) ~~15.0'~~ 12.0'	
SAMPLING PERSONNEL: EST, Greg Cataldo			

TIME	TEMP.	SPEC. COND.	DO	pH	TURBIDITY	▼	FlOW RATE	COMMENTS:
(units)	°c	mS/cm	mg/L		NTU	ft btoc	ml/min	Started Purging at 11:05
T_0: 11:15	20.27	.504	0.54	~~5.45~~ 5.45	21.2	10.93	100	
11:20	20.36	.506	0.46	5.43	20.6	10.97	100	
11:25	20.33	.511	0.48	5.37	17.5	11.03	100	
11:30	20.28	.511	0.49	5.37	17.1	11.08	100	
11:35	20.31	.516	0.51	5.32	16.2	11.07	100	
11:40	20.37	.519	0.51	5.29	13.5	11.05	100	
11:45	20.27	.524	0.57	5.22	10.1	11.06	100	
11:50	20.16	.527	0.58	5.15	5.3	11.04	100	
11:55	20.20	.518	0.61	5.18	4.3	11.08	100	
12:00	20.29	.512	0.63	5.16	3.6	11.06	100	
12:03	20.31	.511	0.63	5.17	3.4	11.07	100	
								Sampled at 12:10
END:								

Notes:

Sequence Numbers: 1433 1434 1435 Duplicates:

Purge Volume: ______ gals.

Information for 2 in. Well: Sched 40 = 617 ml/ft (0.163 gal/ft), Sched 80 = 565 ml/ft (0.145 gal/ft)

GROUNDWATER SAMPLING LOG

PROJECT: 4808	SITE: Hanscom	WELL ID: DPW-B238	DATE: 10/05/98
WELL DEPTH: 9.70'	SCREEN LENGTH: 2 Meters	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 6.35'	WEATHER INFORMATION: Sunny 70°	
METHOD & EQUIPMENT: Low Flow			
TUBING TYPE: HDPE (dedicated)		Pump Depth: (below TOC) 9.00'	
SAMPLING PERSONNEL: EST, Greg Cataldo			

TIME	TEMP.	SPEC. COND.	DO	pH	TURBIDITY	▼	FLOW RATE	COMMENTS:
(units)	°C	mS/cm	mg/L		NTU	ft btoc	ml/min	Started Purging at 1400
T0: 1410	17.82	.151	1.11	5.68	54.9	7.98	75	
1415	17.85	.148	0.93	5.57	49.6	8.52	50	
1416								Well Dry at 8.59'
								purged for 15 minutes
								at 75ml/min well
								to be considered dry
								with very little to no
								significant recovery
								S.W.L taken at 1430
								= 8.57' btoc
								Will not attempt to
								Collect conventional well
END:								

Notes: ____________________

Sequence Numbers: Not Sampled ________ Duplicates: ________ ________ ________

Purge Volume: ________ gals.

Information for 2 in. Well: Sched 40 = 617 ml/ft (0.163 gal/ft), Sched 80 = 565 ml/ft (0.145 gal/ft)

SAMPLING ROUND 2B
MARCH 1999

GROUNDWATER SAMPLING LOG

PROJECT: **4808**	SITE: **Hanscom**	WELL ID: DPW-RAP 2 4S	DATE: 3/23/99
WELL DEPTH: 25.4	SCREEN LENGTH: 19.6	WELL DIAMETER: **2"**	CASING TYPE: **PVC**
MEASUREMENT POINT: **TOC**	WATER LEVEL: 6.41	WEATHER INFORMATION: 40°F Clear, windy	
METHOD & EQUIPMENT: **Low Flow**			
TUBING TYPE: **HDPE (dedicated)**		Pump Depth: (below TOC) 14	
SAMPLING PERSONNEL: (Print names of all personnel) **EST,** J. CARLIN, C. MAZZOLINI (PVC)			

TIME	TEMP.	SPEC. COND.	DO	pH	TURBIDITY	▼	FlOW RATE	COMMENTS:
(units)	°c	mS/cm	mg/L		NTU	ft btoc	ml/min	Flush MOUNT (DP)
T0: 1620	—	—	—	—	—	6.41	500	
1625	9.69	0.192	2.51	5.23	18.1	6.45	500	Flow Cell Full
1630	9.27	0.204	3.67	5.38	8.9	6.49	500	
1635	9.09	0.206	4.41	5.45	6.6	6.49	500	
1640	9.07	0.205	4.15	5.46	4.6	6.49	500	
1645	8.96	0.202	2.71	5.49	4.7	6.51	500	
1650	8.97	0.200	3.51	5.54	3.7	6.50	500	
1700	8.98	0.199	3.96	5.57	3.9	6.48	500	
1710	8.96	0.198	3.94	5.56	3.8	6.50	500	
								Sample collected
								@ 1715
END:								

Notes:

Sequence Numbers: 1445 1446 1447 Duplicates: N/A

Purge Volume: 6.2 gals.

Information for 2 in. Well: Sched 40 = 617 ml/ft (0.163 gal/ft), Sched 80 = 565 ml/ft (0.145 gal/ft)

GROUNDWATER SAMPLING LOG

PROJECT: 4808	SITE: Hanscom	WELL ID: RAP 2-4S	DATE: 3/23/99
WELL DEPTH: 25	SCREEN LENGTH: 25	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL:	WEATHER INFORMATION: 40-45°F, Clear, Windy	
METHOD & EQUIPMENT: Low Flow			
TUBING TYPE: HDPE (dedicated)		Pump Depth: (below TOC) 20'	
SAMPLING PERSONNEL: (Print names of all personnel) EST, J CARLIN, C. MAZZOLINI			

TIME	TEMP.	SPEC. COND.	DO	pH	TURBIDITY	▼	FlOW RATE	COMMENTS:
(units)	°c	mS/cm	mg/L	s.u	NTU	*ft btoc	ml/min	*steel prot. casing
T₀: 1440	7.82	0.080	7.64	6.61		8.13	375	
1445	7.60	0.076	5.02	6.28	195	8.15	375	
1450	7.71	0.079	5.05	6.08	195	8.17	375	
1500	7.79	0.078	4.58	5.75	—	8.15	375	
1510	7.65	0.079	2.87	5.51	19.6	8.15	375	
1520	7.57	0.079	3.37	5.48	12.5	8.15	375	
1530	7.58	0.080	3.36	5.46	9.5	8.15	375	
1540	7.54	0.081	3.43	5.41	9.7	8.15	375	
1545	7.56	0.081	3.41	5.47	10.1	8.15	375	
1550	7.55	0.081	3.46	5.50	9.6	8.15	375	Sampled @ 1600
END:								

Notes: STAND pipe (REF POINT)

Sequence Numbers: 1442 1443 1444 Duplicates: N/A

Purge Volume: 6.5 gals.

Information for 2 in. Well: Sched 40 = 617 ml/ft (0.163 gal/ft), Sched 80 = 565 ml/ft (0.145 gal/ft)

GROUNDWATER SAMPLING LOG

DPW

PROJECT: 4808	SITE: Hanscom	WELL ID: RAP2-2T	DATE: 3/23/99
WELL DEPTH: 61.83	SCREEN LENGTH: 6.5	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 9.82	WEATHER INFORMATION: 35°F - 40°F clear, windy	

METHOD & EQUIPMENT: **Low Flow**

TUBING TYPE: **HDPE (dedicated)** Pump Depth: (below TOC) 58'

SAMPLING PERSONNEL: (Print names of all personnel) EST, J. CARLIN, C. MAZZOLINI

TIME	TEMP.	SPEC. COND.	DO	pH	TURBIDITY	▼	FLOW RATE	COMMENTS:
(units)	°C	mS/cm	mg/L		NTU	ft btoc*	ml/min	*TOP of PVC RISER
T_0: 1155	—	—	—	—	—	9.75	160	
1200	9.28	0.194	—	—	>200	10.52	160	FLOW Cell Full
1205	9.14	0.208	3.85	5.44	>200	10.24	400	
1210	9.21	0.228	2.93	5.58	>200	10.25	400	
1215	9.19	0.241	2.61	5.63	>200	10.25	400	
1225	9.24	0.256	2.17	5.81	>200	10.15	400	Stopped pump to EMPTY PURGE BUCKET.
1245	9.16	0.268	2.79	6.05	>200	10.15	400	
1255	9.16	0.266	3.71	6.18	>200	10.15	400	Changed Gas TANK
1310	9.23	0.265	4.00	6.22	>200	10.05	400	
1320	9.28	0.263	4.50	6.27	>200	10.05	400	
1330	9.40	0.260	4.98	6.30	>200	10.05	400	
1340	9.68	0.257	5.15	6.36	>200	10.05	400	
1350	9.70	0.253	5.31	6.39	>200	10.05	400	f2
								Sampled @ 1355
END:								

Notes:

Sequence Numbers: 1439 1440 1441 Duplicates: — — —

Purge Volume: 11 gals.

Information for 2 in. Well: Sched 40 = 617 ml/ft (0.163 gal/ft), Sched 80 = 565 ml/ft (0.145 gal/ft)

File: SamplingLog for a single well.doc

GROUNDWATER SAMPLING LOG

WPW-

PROJECT: 4808	SITE: Hanscom	WELL ID: RAP 2-2I	DATE: 3/23
WELL DEPTH: 74.1 (SLT)	SCREEN LENGTH: 15	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 10.99	WEATHER INFORMATION: Cloudy 35-40°F	
METHOD & EQUIPMENT: Low Flow			
TUBING TYPE: HDPE (dedicated)		Pump Depth: (below TOC) 70	
SAMPLING PERSONNEL: (Print names of all personnel) EST, JOHN CARLIN, Chris Mazzolini			

TIME	TEMP.	SPEC. COND.	DO	pH	TURBIDITY	▼	FlOW RATE	COMMENTS:
(units)	°c	mS/cm	mg/L		NTU	ft btoc	ml/min	
T_0: 1025	8.87	0258	1.53	6.12	28.6	11.02	500	
1030	9.03	0.227	0.88	6.25	12.5	11.11	500	
1035	9.07	0.286	0.78	6.38	13.1	11.10	500	
1045	9.10	0.296	0.70	6.55	14.9	11.10	500	
1055	9.11	0.302	0.69	6.64	13.6	11.10	500	
1105	9.12	0.306	0.65	6.72	13.3	11.10	500	
1115	9.13	0.308	0.59	6.70	13.0	11.10	500	
								1120
END:								

Notes:

Sequence Numbers: 1451 1452 1453 Duplicates:

Purge Volume: 6.2 gals.

Information for 2 in. Well: Sched 40 = 617 ml/ft (0.163 gal/ft), Sched 80 = 565 ml/ft (0.145 gal/ft)

File: SamplingLog for a single well.doc

GROUNDWATER SAMPLING LOG

DPW-RAP 1-6S

PROJECT: 4808	SITE: Hanscom	WELL ID: DPW-RAP 1-6	DATE: 3/24/99
WELL DEPTH: 17.41	SCREEN LENGTH: 13	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: ~~17.41~~ 5.34	WEATHER INFORMATION: 40°F overcast, rain	
METHOD & EQUIPMENT: Low Flow			
TUBING TYPE: HDPE (dedicated)		Pump Depth: (below TOC) 12.5	
SAMPLING PERSONNEL: (Print names of all personnel) EST, John Carlin, C. Mazzolini			

TIME	TEMP.	SPEC. COND.	DO	pH	TURBIDITY	▼	FLOW RATE	COMMENTS:
(units)	°c	mS/cm	mg/L	S.U.	NTU	ft btoc	ml/min	
T0: 1320	8.61	0.108	2.63	4.56	25.55	5.56	500	
1325	8.25	0.108	[illegible]	4.52	37.4	5.55	500	
1330	7.98	0.108	1.80	4.49	27.5	5.55	500	
1340	7.85	0.106	1.76	4.45	21.8	5.55	500	
1350	7.72	0.106	1.62	4.46	21.4	5.55	500	Rain falling
1400	7.89	0.105	1.50	4.47	24.6	5.55	500	
1410	7.84	0.106	1.52	4.47	21.9	5.55	500	
1420	7.87	0.105	1.50	4.47	22.1	5.55	500	
								Sampled @ 1430
END:								

Notes: Rain began to fall during purging, heavy @ times

Sequence Numbers: 1457 1458 1459 Duplicates: N/A

Purge Volume: 7.5 gals.

Information for 2 in. Well: Sched 40 = 617 ml/ft (0.163 gal/ft), Sched 80 = 565 ml/ft (0.145 gal/ft)

File: SamplingLog for a single well.

GROUNDWATER SAMPLING LOG

PROJECT: 4808	SITE: Hanscom	WELL ID: RAP 1-6S	DATE: 3/24/99
WELL DEPTH: 13.80	SCREEN LENGTH: 3.8	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 6.92	WEATHER INFORMATION: 40°F Cloudy	
METHOD & EQUIPMENT: Low Flow			
TUBING TYPE: HDPE (dedicated)		Pump Depth: (below TOC) 9.0'	
SAMPLING PERSONNEL: (Print names of all personnel) EST, John Carlin, Chris Mazolini			

TIME	TEMP.	SPEC. COND.	DO	pH	TURBIDITY	▼	FLOW RATE	COMMENTS:
(units)	°c	mS/cm	mg/L		NTU	ft btoc	ml/min	
T_0: 1155	—	—	—	—	—	6.92	200	
1200	7.32	0.102	2.34	7.01	126.9	6.95	200	
1205	7.06	0.102	1.26	6.38	48.4	7.01	300	
1215	6.97	0.103	1.76	5.49	25.9	7.05	300	
1225	7.02	0.104	1.81	5.08	23.8	7.05	300	
1235	6.97	0.106	1.99	4.87	16.3	7.05	300	
1245	7.03	0.107	2.11	4.77	13.9	7.05	300	
1255	7.04	0.108	2.19	4.73	12.2	7.05	300	
1305	7.02	0.108	2.18	4.71	11.5	7.05	300	
								1310 sampled
END:								

Notes: ______

Sequence Numbers: 1454 1455 1456 Duplicates: N/A

Purge Volume: 4.7 gals.

Information for 2 in. Well: Sched 40 = 617 ml/ft (0.163 gal/ft), Sched 80 = 565 ml/ft (0.145 gal/ft)

GROUNDWATER SAMPLING LOG

PROJECT: 4808	SITE: Hanscom	WELL ID: DPW RAP 2-2S	DATE: 3/24/99
WELL DEPTH: 22.65	SCREEN LENGTH: 16	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 6.60	WEATHER INFORMATION: 35-40°F Cloudy	
METHOD & EQUIPMENT: Low Flow			
TUBING TYPE: HDPE (dedicated)		Pump Depth: (below TOC) 14.5	
SAMPLING PERSONNEL: (Print names of all personnel) EST, J. CARLIN, C MAZZOLINI			

TIME	TEMP.	SPEC. COND.	DO	pH	TURBIDITY	▼	FlOW RATE	COMMENTS:
(units)	°C	mS/cm	mg/L		NTU	ft btoc	ml/min	
T0: 0715	8.15	0.159	1.12	5.38	21.2	6.65	450	
0720	8.21	0.167	1.06	5.36	26.3	6.60	450	
0725	8.04	0.162	0.97	5.29	21.4	6.60	450	
0730	7.96	0.159	0.99	5.22	19.6	6.60	450	
0740	7.82	0.156	1.11	5.71	13.0	6.59	450	
0800	7.85	0.161	1.01	5.64	9.2	6.59	450	
0810	7.79	0.151	0.94	5.51	8.4	6.59	450	
0820	7.73	0.149	0.81	5.64	7.4	6.59	450	
0830	7.75	0.140	0.86	5.76	7.3	6.59	450	
0840	7.71	0.112	0.79	5.80	7.0	6.59	450	
0850	7.74	0.108	0.80	5.83	6.9	6.59	450	
0900	7.70	0.106	0.83	5.81	7.0	6.59	450	
								Sample Collected
								@ 0910 Am
END:								

Notes: ______

Sequence Numbers: 1448 1449 1450 Duplicates: N/A

Purge Volume: 11.7 gals.

Information for 2 in. Well: Sched 40 = 617 ml/ft (0.163 gal/ft), Sched 80 = 565 ml/ft (0.145 gal/ft)

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GROUNDWATER SAMPLING LOG

PROJECT: 4808	SITE: Hanscom	WELL ID: RAP 2-2S	DATE: 3/24/99
WELL DEPTH: 11.79	SCREEN LENGTH: 11.7	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 6.74	WEATHER INFORMATION: 35-40°F ~~Cloudy~~, ~~windy~~	
METHOD & EQUIPMENT: Low Flow			
TUBING TYPE: HDPE (dedicated)		Pump Depth: (below TOC) 7'	
SAMPLING PERSONNEL: (Print names of all personnel) EST, J. CARLIN C. Mazzolini			

TIME	TEMP.	SPEC. COND.	DO	pH	TURBIDITY	▼	FlOW RATE	COMMENTS: STANDPIPE
(units)	°C	mS/cm	mg/L		NTU	ft btoc	ml/min	
T_0:	—	—	—	—	—	6.74	N/A	
0940	6.58	.088	2.62	6.51	5.6	6.80	150	pump submerged
0945	6.57	.087	1.79	5.98	5.4	6.80	150	
0950	6.57	.086	1.37	5.65	5.4	6.80	150	3.7 gal
1000	6.64	.083	1.64	7.98	5.5	6.88	350	
1010	7.05	.082	1.63	8.21	4.6	6.88	350	
1020	7.15	.083	1.63	5.37	2.7	6.88	350	5.4 gal
1030	7.00	.082	1.62	4.96	2.0	6.90	500	
1040	7.03	.080	1.61	4.19	1.8	6.90	500	
1050	7.06	.080	1.60	4.24	1.7	6.90	500	
1100	7.04	.083	1.03	4.38	1.3	6.90	500	
1110	7.07	.079	1.00	4.39	1.4	6.90	500	
1120	7.09	.79	0.99	4.41	1.3	6.90	500	9.1 gal
1130	—	—	—	—	—	—	—	Sample collected
								1130 3/24/99
END:								

Notes: ______

Sequence Numbers: 1436 1437 1438 Duplicates: ______ ______ ______

Purge Volume: 9.1 gals.

Information for 2 in. Well: Sched 40 = 617 ml/ft (0.163 gal/ft), Sched 80 = 565 ml/ft (0.145 gal/ft)

GROUNDWATER SAMPLING LOG

PROJECT: 4808	SITE: Hanscom	WELL ID: DPW OW2-6	DATE: 3/25/99
WELL DEPTH: 21.2	SCREEN LENGTH: 6.56	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 13.1	WEATHER INFORMATION: 45°F Clear, windy	
METHOD & EQUIPMENT: Low Flow			
TUBING TYPE: HDPE (dedicated)		Pump Depth: (below TOC) 18	
SAMPLING PERSONNEL: (Print names of all personnel) EST, C. Mazzolini J Carlin STEEL TOP			

TIME	TEMP.	SPEC. COND.	DO	pH	TURBIDITY	▼	FLOW RATE	COMMENTS:
(units)	°c	mS/cm	mg/L		NTU	ft btoc	ml/min	
T_0: 1515	9.92	0.272	2.67	5.83	44.3	13.20	750	
1520	9.46	0.322	2.60	5.84	38.7	13.20	500	
1525	9.47	0.339	2.66	5.86	31.2	13.20	500	
1535	9.45	0.361	2.84	5.90	28.4	13.20	500	
1545	9.13	0.371	2.98	5.91	67.5	13.20	500	
1555	9.34	0.384	3.14	5.95	47.5	13.20	500	
1605	9.35	0.380	3.09	5.42	79.9	13.20	500	
1615	9.25	0.384	3.16	5.30	75.9	13.20	500	
1625	9.26	0.380	3.08	5.30	79.8	13.20	500	
1635	9.25	0.383	3.09	5.29	78.7	13.20	500	
END:								

Notes: ___

Sequence Numbers: 1482 1483 1484 Duplicates: ___ ___ ___

Purge Volume: 9.3 gals.

Information for 2 in. Well: Sched 40 = 617 ml/ft (0.163 gal/ft), Sched 80 = 565 ml/ft (0.145 gal/ft)

GROUNDWATER SAMPLING LOG

PROJECT: 4808	SITE: Hanscom	WELL ID: OW 2-6	DATE: 3/25/99
WELL DEPTH: 19.10	SCREEN LENGTH: 5.0	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 12.24	WEATHER INFORMATION: 45°F clear, Windy	
METHOD & EQUIPMENT: Low Flow			
TUBING TYPE: HDPE (dedicated)		Pump Depth: (below TOC) 17	
SAMPLING PERSONNEL: (Print names of all personnel) EST, C. Mazzolini (PVC)			

TIME	TEMP.	SPEC. COND.	DO	pH	TURBIDITY	▼	FlOW RATE	COMMENTS:
(units)	° c	mS/cm	mg/L		NTU	ft btoc	ml/min	
T0: 1350	10.03	0.256	2.50	5.83	22.8	11.80	300	Conventional Well
1355	9.80	0.255	1.72	5.60	22.8	13.10	150	Both Flush Mounted
1400	9.99	0.261	1.22	5.31	27.2	12.82	150	
1405	10.02	0.251	1.09	5.28	17.8	12.85	150	
1415	10.07	0.253	1.04	5.27	9.6	12.85	150	
1425	10.03	0.256	1.00	5.27	7.7	12.85	150	
1435	9.94	0.262	.98	5.26	7.3	12.85	150	
1445	9.96	0.263	.99	5.26	6.9	12.85	150	
1455	9.96	0.262	1.00	5.26	6.5	12.85	150	
1505	9.96	0.263	1.01	5.27	6.3	12.85	150	
END:								

Notes: ______

Sequence Numbers: 1479 1480 1481 Duplicates: ______ ______ ______

Purge Volume: 3 gals.

Information for 2 in. Well: Sched 40 = 617 ml/ft (0.163 gal/ft), Sched 80 = 565 ml/ft (0.145 gal/ft)

GROUNDWATER SAMPLING LOG

PROJECT: 4808	SITE: Hanscom	WELL ID: B109	DATE: 3/25/99
WELL DEPTH: 71.05	SCREEN LENGTH:	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 13.19	WEATHER INFORMATION: Clear 45°F	
METHOD & EQUIPMENT: Low Flow			
TUBING TYPE: HDPE (dedicated)		Pump Depth: (below TOC)	
SAMPLING PERSONNEL: (Print names of all personnel) EST, C. Mazzolini		~~PVC~~ Metal PIPE	

TIME	TEMP.	SPEC. COND.	DO	pH	TURBIDITY	▼	FlOW RATE	COMMENTS: Start Pump 1105
(units)	°c	mS/cm	mg/L		NTU	ft btoc	ml/min	
T_0: 1115	11.14	0.170	1.31	5.85	77.4	13.21	300	
1120	11.03	0.171	1.16	5.83	63.1	13.22	300	
1125	10.91	0.171	1.08	5.82	64.2	13.22	300	
1135	10.84	0.172	0.94	5.84	83.7	13.22	300	
1145	11.05	0.172	0.92	5.84	95.0	13.22	300	
1155	11.06	0.172	0.88	5.89	117.8	13.22	300	
1205	11.18	0.173	0.80	5.90	21.1	13.22	300	
1215	11.19	0.173	0.83	5.90	17.8	13.22	300	
1225	11.16	0.173	0.81	5.90	15.3	13.22	306	
1235	11.16	0.173	0.82	5.91	15.0	13.22	300	
END:								

Notes:

Sequence Numbers: 1473 1474 1475 Duplicates: 1476 1477 1478

Purge Volume: 6 gals.

Information for 2 in. Well: Sched 40 = 617 ml/ft (0.163 gal/ft), Sched 80 = 565 ml/ft (0.145 gal/ft)

GROUNDWATER SAMPLING LOG

PROJECT: 4808	SITE: Hanscom	WELL ID: DAW-B109	DATE: 3/25/99
WELL DEPTH: 62.21	SCREEN LENGTH: 2	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 9.94	WEATHER INFORMATION: Clear 45°F	
METHOD & EQUIPMENT: Low Flow			
TUBING TYPE: HDPE (dedicated)		Pump Depth: (below TOC) 61'	
SAMPLING PERSONNEL: (Print names of all personnel) EST, C. Marzolini (PVC)			

TIME	TEMP.	SPEC. COND.	DO	pH	TURBIDITY	▼	FLOW RATE	COMMENTS:
(units)	°C	mS/cm	mg/L		NTU	ft btoc	ml/min	
T_0: 0900	10.84	0.167	3.61	5.63		9.32	200	
0905	10.83	0.167	2.77	5.48	75.5	11.91	200	
0910	10.53	0.167	1.82	5.66	90.8	14.02	200	
0915	10.72	0.168	1.68	5.67	94.5	14.02	200	
0925	10.66	0.172	1.42	5.65	>200	13.75	200	
0935	11.04	0.173	1.29	5.69	>200	13.59	200	
0945	11.30	0.173	1.20	5.73	>200	13.31	200	
0955	10.76	0.173	1.15	5.76	>200	13.22	200	
1005	11.52	0.172	1.07	5.78	>200	13.02	200	
1015	11.44	0.172	1.02	5.81	>200	13.00	200	
1025	10.76	0.172	.96	5.81	>200	12.90	200	
1035	11.20	0.172	.94	5.82	>200	12.90	200	
1045	11.20	0.172	.93	5.83	>200	12.90	200	
END:								

Notes: 1470 1471 1472

Sequence Numbers: ~~1467~~ ~~1468~~ ~~1469~~ Duplicates: ~~1470~~ 1467 ~~1471~~ 1468 ~~1472~~ 1469

Purge Volume: 5.2 gals.

Information for 2 in. Well: Sched 40 = 617 ml/ft (0.163 gal/ft), Sched 80 = 565 ml/ft (0.145 gal/ft)

GROUNDWATER SAMPLING LOG

PROJECT: 4808	SITE: Hanscom	WELL ID: DPW MWZ-06	DATE: 3/26/99
WELL DEPTH: 17.87	SCREEN LENGTH: ~~3~~ 10'	WELL DIAMETER: ~~2"~~/1.5	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 7.22	WEATHER INFORMATION: Sunny, Slight Breeze, 50°F	
METHOD & EQUIPMENT: Low Flow			
TUBING TYPE: HDPE (dedicated)		Pump Depth: (below TOC) 12'	
SAMPLING PERSONNEL: (Print names of all personnel) EST, C. Mazzolini		PVC	

TIME	TEMP.	SPEC. COND.	DO	pH	TURBIDITY	▼	FlOW RATE	COMMENTS:
(units)	° c	mS/cm	mg/L		NTU	ft btoc	ml/min	
T0: 1415	12.22	.387	3.15	7.13	100	7.80	400	1.5" DIA
1420	10.94	.385	2.71	7.23	105	7.85	400	
1425	10.90	.384	2.24	7.36	110	7.85	200	
1430	10.80	.389	1.70	7.51	98	7.85	200	
1440	10.79	.390	1.63	7.56	85	7.85	200	
1450	10.89	.388	1.45	7.61	1020	7.85	200	
1500	10.77	.386	1.40	7.64	96.1	7.85	200	
1510	10.90	.390	1.43	7.64	68.7	7.85	200	
1520	10.91	.389	1.39	7.65	69.7	7.85	200	
1530	10.90	.389	1.38	7.64	69.2	7.85	200	
END:								

Notes: ______

Sequence Numbers: 1539 1540 1541 Duplicates: 1542 1543 1544

Purge Volume: 6.7 gals.

Information for 2 in. Well: Sched 40 = 617 ml/ft (0.163 gal/ft), Sched 80 = 565 ml/ft (0.145 gal/ft)

GROUNDWATER SAMPLING LOG

PROJECT: 4808	SITE: Hanscom	WELL ID: MW Z - 06	DATE: 3/26/99
WELL DEPTH: 18.13	SCREEN LENGTH: 10.0 ft	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 6.17	WEATHER INFORMATION: Sunny, Slight Breeze, 48°F	
METHOD & EQUIPMENT: Low Flow			
TUBING TYPE: HDPE (dedicated)		Pump Depth: (below TOC) 13'	
SAMPLING PERSONNEL: (Print names of all personnel) EST, C. Marzzolini		PVC	

TIME	TEMP.	SPEC. COND.	DO	pH	TURBIDITY	▼	FIOW RATE	COMMENTS:
(units)	°C	mS/cm	mg/L		NTU	ft btoc	ml/min	
T0: ~~9.77~~	,							
1240	9.90	.311	3.56	5.99	>200	7.2	150	
1245	9.97	.303	3.56	6.64	>200	7.05	220	
1250	9.68	.317	3.12	6.81	>200	7.3	300	
1255	9.82	.335	2.61	6.98	>200	7.51	300	
1300	9.87	.339	2.38	7.07	105	7.62	300	
1310	9.88	.343	2.01	7.53	100	7.62	300	
1320	10.02	.348	1.85	7.66	85	7.85	300	
1330	10.02	.354	1.75	7.70	30.8	7.85	300	
1340	9.99	.355	1.64	7.74	10.5	7.85	300	
1350	9.99	.356	1.62	7.76	8.7	7.85	300	
1400	9.99	.357	1.60	7.76	8.5	7.85	300	
END:								

Notes: ______

Sequence Numbers: 1533 1534 1535 Duplicates: 1536 1537 1538

Purge Volume: 5.5 gals.

Information for 2 in. Well: Sched 40 = 617 ml/ft (0.163 gal/ft), Sched 80 = 565 ml/ft (0.145 gal/ft)

GROUNDWATER SAMPLING LOG

PROJECT: 4808	SITE: Hanscom	WELL ID: DPW-B241S	DATE: 3/26/99
WELL DEPTH: 19.18	SCREEN LENGTH: 10'	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 6.75	WEATHER INFORMATION: 40°F Sunny, Windy	
METHOD & EQUIPMENT: Low Flow			
TUBING TYPE: HDPE (dedicated)		Pump Depth: (below TOC) 14'	
SAMPLING PERSONNEL: (Print names of all personnel) EST, C. Mazzolini		Steel Top	

TIME	TEMP.	SPEC. COND.	DO	pH	TURBIDITY	▼	FIOW RATE	COMMENTS:
(units)	°c	mS/cm	mg/L		NTU	ft btoc	ml/min	
T_0: 0845	5.58	.055	4.71	7.82	14.8	6.80	1000	
0850	5.47	.056	3.67	7.61	13.1	6.78	500	
0855	5.40	.056	3.45	7.69	11.3	6.80	500	
0900	5.43	.056	3.34	7.72	11.3	6.80	500	
0910	5.47	.056	3.32	7.71	3.1	6.80	500	
0920	5.51	.056	3.29	7.61	3.5	6.80	500	
0930	5.51	.056	3.38	7.56	3.4	6.80	500	
0940	5.53	.057	3.35	7.53	3.3	6.80	500	
0950	5.55	.056	3.36	7.52	3.3	6.80	500	
END:								

Notes: ______

Sequence Numbers: 1485 1486 1487 Duplicates: — — —

Purge Volume: 8.7 gals.

Information for 2 in. Well: Sched 40 = 617 ml/ft (0.163 gal/ft), Sched 80 = 565 ml/ft (0.145 gal/ft)

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GROUNDWATER SAMPLING LOG

PROJECT: 4808	SITE: Hanscom	WELL ID: MW B241 S	DATE: 3/26/99
WELL DEPTH: 17.88	SCREEN LENGTH: 13	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 3.91	WEATHER INFORMATION: Sunny, windy, 43°F	
METHOD & EQUIPMENT: Low Flow			
TUBING TYPE: HDPE (dedicated)		Pump Depth: (below TOC) 11.5	
SAMPLING PERSONNEL: (Print names of all personnel) EST, C. Mazzolini PVC			

TIME	TEMP.	SPEC. COND.	DO	pH	TURBIDITY		FlOW RATE	COMMENTS:
(units)	°c	mS/cm	mg/L		NTU	ft btoc	ml/min	
To: 1010	6.87	.067	7.29	7.40	9.8	3.95	700	
1015	6.45	.069	3.14	6.48	11.7	3.95	600	
1020	6.35	.069	3.04	6.39	11.4	3.95	500	
1025	6.23	.069	3.06	6.45	11.6	3.95	500	
1035	6.20	.069	3.06	6.58	10.5	4.00	500	
1045	6.13	.069	3.06	6.77	7.7	4.00	500	
1055	6.14	.070	3.11	6.92	6.5	4.00	500	
1105	6.14	.070	3.10	6.95	6.5	4.00	500	
1115	6.14	.070	3.11	6.96	6.7	4.00	500	
END:								

Notes: ______

Sequence Numbers: 1488 1489 1490 Duplicates: ______ ______ ______

Purge Volume: 8.7 gals.

Information for 2 in. Well: Sched 40 = 617 ml/ft (0.163 gal/ft), Sched 80 = 565 ml/ft (0.145 gal/ft)

GROUNDWATER SAMPLING LOG

PROJECT: 4808	SITE: Hanscom	WELL ID: MW Z-11	DATE: 3/29/99
WELL DEPTH: 22.61	SCREEN LENGTH: 8	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 7.73	WEATHER INFORMATION: Cloudy, 60°F	
METHOD & EQUIPMENT: Low Flow			
TUBING TYPE: HDPE (dedicated)		Pump Depth: (below TOC) 18.6	
SAMPLING PERSONNEL: (Print names of all personnel) EST, J Cadin, Mazzolini PVC			

TIME	TEMP.	SPEC. COND.	DO	pH	TURBIDITY	▼	FlOW RATE	COMMENTS:
(units)	°c	mS/cm	mg/L		NTU	ft btoc	ml/min	
T0: 1530	12.34	.320	.75	7.32		8.29	200.	
1535	12.09	.321	1.26	7.32	205.2	8.30	200	
1540	11.73	.322	1.28	7.28	170.6	8.40	200.	
1545	11.60	.325	1.35	7.24	95.2	8.40	200	
1550	1147	.324	1.35	7.22	101.3	8.40	350	
1600	11.46	.321	1.31	7.20	112.4	8.40	350	
1610	11.44	318	1.36	7.15	170.5	8.45	400	
1620	11.37	.317	1.33	7.14	115.8	8.45	400	
1630	11.36	.317	1.34	7.13	112.9	8.45	400	
END:								

Notes: ____________________

Sequence Numbers: 1554 1555 1556 Duplicates: ______ ______ ______

Purge Volume: 4.5 gals.

Information for 2 in. Well: Sched 40 = 617 ml/ft (0.163 gal/ft), Sched 80 = 565 ml/ft (0.145 gal/ft)

GROUNDWATER SAMPLING LOG

PROJECT: 4808	SITE: Hanscom	WELL ID: DPW-MW2-11	DATE: 3/29/99
WELL DEPTH: 19.90	SCREEN LENGTH: 9.8	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 9.92	WEATHER INFORMATION: Sunny, 60°F	
METHOD & EQUIPMENT: Low Flow			
TUBING TYPE: HDPE (dedicated)		Pump Depth: (below TOC) 15'	
SAMPLING PERSONNEL: (Print names of all personnel) EST, C. Mazzolini		PVC	

TIME	TEMP.	SPEC. COND.	DO	pH	TURBIDITY	▼	FlOW RATE	COMMENTS:
(units)	°c	mS/cm	mg/L		NTU	ft btoc	ml/min	
T0: 1315	16.70	.244	1.34	7.14	63.1	10.65	50	Slow recharge
1320	17.62	.248	1.25	7.15	66.5	10.70	50	throughout purge
1325	17.71	.249	1.23	7.18	67.2	10.70	50	
1330	17.99	.250	1.22	7.23	69.3	10.80	50	
1335	18.45	.256	1.14	7.25	112.1	10.85	50	
1340	18.78	.258	1.15	7.27	120.0	10.85	50	
1345	18.94	.260	1.13	7.34	122.4	10.85	50	
1350	19.13	.265	0.52	7.33	128.1	11.20	50	
1400	15.81	.263	1.55	7.36	144.6	11.45	50	22L
1410	15.92	.262	1.56	7.33	139.1	12.00	75	
1420	16.40	.258	1.63	7.23	133.5	12.10	75	
1430	16.73	.257	1.70	7.23	143.5	12.20	75	
1440	17.38	.263	1.68	7.20	148.2	12.20	75	
1450	17.58	.267	1.74	7.18	166.0	12.20	75	
1500	17.64	.274	1.70	7.12	180.0	12.20	75	
1510	17.62	.276	1.71	7.15	165.0	12.20	75	
1520	17.60	.277	1.72	7.14	163.4	12.20	75	9.2
END:								

Notes: ____________________

Sequence Numbers: 1551 1552 1553 Duplicates: ______ ______ ______

Purge Volume: 1.8 gals.

Information for 2 in. Well: Sched 40 = 617 ml/ft (0.163 gal/ft), Sched 80 = 565 ml/ft (0.145 gal/ft)

GROUNDWATER SAMPLING LOG

PROJECT: **4808**	SITE: **Hanscom**	WELL ID: MW Z-7	DATE: 3/29/99
WELL DEPTH: 18.69	SCREEN LENGTH: 10.0	WELL DIAMETER: **2"**	CASING TYPE: **PVC**
MEASUREMENT POINT: **TOC**	WATER LEVEL: 3.44	WEATHER INFORMATION: Sunny, 58°F	
METHOD & EQUIPMENT: **Low Flow**			
TUBING TYPE: **HDPE (dedicated)**		Pump Depth: (below TOC) 13'	
SAMPLING PERSONNEL: (Print names of all personnel) **EST,** C. Mazzolini, J Carlin DVC			

TIME	TEMP.	SPEC. COND.	DO	pH	TURBIDITY	▼	FlOW RATE	COMMENTS:
(units)	° c	mS/cm	mg/L		NTU	ft btoc	ml/min	
T0: 1125	10.76	.418	2.39	7.45	99.0	4.44	220	
1130	10.22	.410	3.16	7.52	150.8	5.10	220	
1135	10.59	.400	2.67	7.42	167.4	5.61	120	
1140	10.88	.380	1.98	7.37	143.7	5.65	120	
1145	10.89	.366	1.71	7.29	121.2	5.70	120	
1155	10.83	.356	1.52	7.30	100.4	5.75	120	
1205	10.86	.350	1.48	7.26	94.7	5.80	120	
1215	10.95	.339	1.35	7.28	88.5	5.80	120	
1225	10.82	.328	1.32	7.17	65.2	5.90	120	
1235	10.89	.328	1.29	7.26	60.2	6.10	150	
1245	10.85	.325	1.23	7.00	59.4	6.10	120	
1255	10.88	.323	1.26	6.98	59.2	6.10	120	
1305	10.89	.322	1.24	7.00	58.0	6.10	120	
END:								

Notes: ______

Sequence Numbers: 1548 1549 1550 Duplicates: ______ ______ ______

Purge Volume: 3.0 gals.

Information for 2 in. Well: Sched 40 = 617 ml/ft (0.163 gal/ft), Sched 80 = 565 ml/ft (0.145 gal/ft)

GROUNDWATER SAMPLING LOG

PROJECT: 4808	SITE: Hanscom	WELL ID: DPW-MW2-7	DATE: 3/29/99
WELL DEPTH: 14.00	SCREEN LENGTH: ~~Endless~~ 6.5	WELL DIAMETER: 2"	CASING TYPE: PVC
MEASUREMENT POINT: TOC	WATER LEVEL: 4.15	WEATHER INFORMATION: Sunny, 55 °F	
METHOD & EQUIPMENT: Low Flow			
TUBING TYPE: HDPE (dedicated)		Pump Depth: (below TOC) 11.0	
SAMPLING PERSONNEL: (Print names of all personnel) EST, C. Mazzolini		PVC	

TIME	TEMP.	SPEC. COND.	DO	pH	TURBIDITY	▼	FlOW RATE	COMMENTS:
(units)	° C	mS/cm	mg/L		NTU	ft btoc	ml/min	
T0: 0945	11.20	.324	4.36	7.00	39.1	4.80	200	
0950	10.29	.399	4.08	7.04	85.2	4.85	200	
0955	9.83	.424	3.28	7.08	114.6	4.85	200	
1000	9.73	.506	2.06	7.21	10.1	4.95	200	
1010	9.79	.581	2.11	7.36	8.3	5.00	200	
1020	9.78	.603	2.10	7.40	7.0	5.00	200	
1030	9.75	.613	1.91	7.42	6.10	5.10	200	
1040	9.60	.618	1.76	7.42	6.05	5.10	200	
1050	9.90	.619	1.64	7.42	6.00	5.10	200	
1100	9.89	.617	1.61	7.42	5.95	5.10	200	
1110	9.88	.618	1.60	7.42	5.90	5.10	200	
END:								

Notes: ______

Sequence Numbers: 1545 1546 1547 Duplicates: ______

Purge Volume: 3.7 gals.

Information for 2 in. Well: Sched 40 = 617 ml/ft (0.163 gal/ft), Sched 80 = 565 ml/ft (0.145 gal/ft)

File: SamplingLog for a single well.doc

APPENDIX F

LABORATORY ANALYTICAL RESULTS

SAMPLING ROUND 1
APRIL - MAY 1997

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(802) 763-8348

Sample Number
B102

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab
Contract: 5518
Operator: MLG
Matrix: WATER
Analysis Method: 70522F1.MTH
Sample Vol: 10 ML
Instrument Method: 70522F1.MTH
GC Column: CAP **ID:** 0.54 mm

Lab Sample ID: 1145
Vial Number: 5
Date Analyzed: 28 May 97 04:21 PM
Sequence Number: 1
Lab File ID: FID00005.D
Sequence Name: 1RUN0528
Sample Info: B102
Dilution Factor: 1
ISTD Amount: 20

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	18 U
156-60-5	trans-1,2-Dichloroethene	10 U
540-59-0	1, 1-Dichloroethane	2.5 U
75-34-3	cis-1, 2-Dichloroethene	10 U
156-59-2	Benzene	5 U
79-01-6	Trichloroethene	1.9 J
108-88-3	Toluene	10 U
106-46-7	1, 4-Dichlorobenzene	10 U
95-47-6	Xylene (o)	10 U

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Sample Number
DPW-B102

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab
Contract: 5518
Operator: MLG
Matrix: WATER
Analysis Method: 70522F1.MTH
Sample Vol: 10 ML
Instrument Method: 70522F1.MTH
GC Column: CAP **ID:** 0.54 mm

Lab Sample ID: 1148
Vial Number: 6
Date Analyzed: 28 May 97 05:03 PM
Sequence Number: 1
Lab File ID: FID00006.D
Sequence Name: 1RUN0528
Sample Info: DPW-B102
Dilution Factor: 1
ISTD Amount: 20

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	18 U
156-60-5	trans-1,2-Dichloroethene	10 U
540-59-0	1, 1-Dichloroethane	2.5 U
75-34-3	cis-1, 2-Dichloroethene	7 J
156-59-2	Benzene	5 U
79-01-6	Trichloroethene	13.2
108-88-3	Toluene	10 U
106-46-7	1, 4-Dichlorobenzene	10 U
95-47-6	Xylene (o)	10 U

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Sample Number
RAP1-4S

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab
Contract: 5518
Operator: MLG
Matrix: WATER
Analysis Method: 70430F.MTH
Sample Vol: 10 ML
Instrument Method: 70430F.MTH
GC Column: CAP **ID:** 0.54 mm

Lab Sample ID: 1014
Vial Number: 3
Date Analyzed: 06 May 97 07:57 PM
Sequence Number: 1
Lab File ID: FID00003.D
Sequence Name: 1RUN0506
Sample Info: RAP1-4S
Dilution Factor: 1
ISTD Amount: 19.75

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	18 U
156-60-5	trans-1,2-Dichloroethene	10 U
540-59-0	1, 1-Dichloroethane	2.5 U
75-34-3	cis-1, 2-Dichloroethene	10 U
156-59-2	Benzene	5 U
79-01-6	Trichloroethene	0.9 J
108-88-3	Toluene	10 U
106-46-7	1, 4-Dichlorobenzene	10 U
95-47-6	Xylene (o)	10 U

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Sample Number
DPW-RAP1-4S

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab
Contract: 5518
Operator: MLG
Matrix: WATER
Analysis Method: 70430F.MTH
Sample Vol: 10 ML
Instrument Method: 70430F.MTH
GC Column: CAP **ID:** 0.54 mm

Lab Sample ID: 1017
Vial Number: 6
Date Analyzed: 06 May 97 09:45 PM
Sequence Number: 1
Lab File ID: FID00006.D
Sequence Name: 1RUN0506
Sample Info: DPW-RAP1-4S

Dilution Factor: 1
ISTD Amount: 19.65

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	18 U
156-60-5	trans-1,2-Dichloroethene	10 U
540-59-0	1, 1-Dichloroethane	2.5 U
75-34-3	cis-1, 2-Dichloroethene	0.6 J
156-59-2	Benzene	5 U
79-01-6	Trichloroethene	1.4 J
108-88-3	Toluene	2 J
106-46-7	1, 4-Dichlorobenzene	10 U
95-47-6	Xylene (o)	1.3 J

Report File: RPT0430.XLX
Report Date: 6/24/97

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Sample Number

RAP1-6S

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab
Contract: 5518
Operator: MLG
Matrix: WATER
Analysis Method: 70520F1.MTH
Sample Vol: 10 ML
Instrument Method: 70515F1.MTH
GC Column: CAP **ID:** 0.54 mm

Lab Sample ID: 1140
Vial Number: 11
Date Analyzed: 21 May 97 02:07 AM
Sequence Number: 3
Lab File ID: FID00011.D
Sequence Name: 1RUN0520
Sample Info: RAP1-6S

Dilution Factor: 1
ISTD Amount: 50

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	3.7 J
156-60-5	trans-1,2-Dichloroethene	0.9 J
540-59-0	1, 1-Dichloroethane	2.5 U
75-34-3	cis-1, 2-Dichloroethene	39.6
156-59-2	Benzene	5 U
79-01-6	Trichloroethene	15
108-88-3	Toluene	10 U
106-46-7	1, 4-Dichlorobenzene	10 U
95-47-6	Xylene (o)	10 U

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Sample Number
DPW-RAP1-6S

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab
Contract: 5518
Operator: MLG
Matrix: WATER
Analysis Method: 70522F1.MTH
Sample Vol: 10 ML
Instrument Method: 70522F1.MTH
GC Column: CAP **ID:** 0.54 mm

Lab Sample ID: 1143
Vial Number: 4
Date Analyzed: 28 May 97 03:40 PM
Sequence Number: 1
Lab File ID: FID00004.D
Sequence Name: 1RUN0528
Sample Info: DPW-RAP1-6S
Dilution Factor: 1
ISTD Amount: 20

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	18 U
156-60-5	trans-1,2-Dichloroethene	10 U
540-59-0	1, 1-Dichloroethane	2.5 U
75-34-3	cis-1, 2-Dichloroethene	10 U
156-59-2	Benzene	5 U
79-01-6	Trichloroethene	3.4
108-88-3	Toluene	10 U
106-46-7	1, 4-Dichlorobenzene	10 U
95-47-6	Xylene (o)	10 U

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Sample Number
B101

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab
Contract: 5518
Operator: MLG
Matrix: WATER
Analysis Method: 70430F.MTH
Sample Vol: 10 ML
Instrument Method: 70430F.MTH
GC Column: CAP **ID:** 0.54 mm

Lab Sample ID: 1023
Vial Number: 10
Date Analyzed: 07 May 97 00:06 AM
Sequence Number: 1
Lab File ID: FID00010.D
Sequence Name: 1RUN0506
Sample Info: B101

Dilution Factor: 1
ISTD Amount: 19.92

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	18 U
156-60-5	trans-1,2-Dichloroethene	0.5 J
540-59-0	1, 1-Dichloroethane	2.5 U
75-34-3	cis-1, 2-Dichloroethene	10 U
156-59-2	Benzene	5 U
79-01-6	Trichloroethene	1.4 J
108-88-3	Toluene	10 U
106-46-7	1, 4-Dichlorobenzene	2.3 J
95-47-6	Xylene (o)	1.2 J

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Sample Number
DPW-B101

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab
Contract: 5518
Operator: MLG
Matrix: WATER
Sample Vol: 10 ML
Analysis Method: 70430F.MTH
Instrument Method: 70430F.MTH
GC Column: CAP **ID:** 0.54 mm

Lab Sample ID: 1021
Date Analyzed: 06 May 97 11:31 PM
Lab File ID: FID00009.D
Sample Info: DPW-B101
Vial Number: 9
Sequence Number: 1
Sequence Name: 1RUN0506

Dilution Factor: 1
ISTD Amount: 19.92

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	18 U
156-60-5	trans-1,2-Dichloroethene	0.4 J
540-59-0	1, 1-Dichloroethane	2.5 U
75-34-3	cis-1, 2-Dichloroethene	10 U
156-59-2	Benzene	5 U
79-01-6	Trichloroethene	1.4 J
108-88-3	Toluene	1.4 J
106-46-7	1, 4-Dichlorobenzene	10 U
95-47-6	Xylene (o)	10 U

Report File: RPT0430.XLX

Re,

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Sample Number
B105

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab
Contract: 5518
Operator: MLG
Matrix: WATER
Analysis Method: 70507F1.MTH
Sample Vol: 10 ML
Instrument Method: 70507F1.MTH
GC Column: CAP **ID:** 0.54 mm

Lab Sample ID: 1098
Vial Number: 10
Date Analyzed: 13 May 97 00:52 AM
Sequence Number: 1
Lab File ID: FID00010.D
Sequence Name: 1RUN0512
Sample Info: B105
Dilution Factor: 1
ISTD Amount: 20

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	18 U
156-60-5	trans-1,2-Dichloroethene	10 U
540-59-0	1, 1-Dichloroethane	2.5 U
75-34-3	cis-1, 2-Dichloroethene	5.3 J
156-59-2	Benzene	5 U
79-01-6	Trichloroethene	4.2
108-88-3	Toluene	2.7 J
106-46-7	1, 4-Dichlorobenzene	12.3
95-47-6	Xylene (o)	10 U

Report File: RPT0507.XLX
Report Date: 6/23/97

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Sample Number
DPW-B105

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab
Contract: 5518
Operator: MLG
Matrix: WATER
Analysis Method: 70507F1.MTH
Sample Vol: 10 ML
Instrument Method: 70507F1.MTH
GC Column: CAP **ID:** 0.54 mm

Lab Sample ID: 1100
Vial Number: 11
Date Analyzed: 13 May 97 01:28 AM
Sequence Number: 1
Lab File ID: FID00011.D
Sequence Name: 1RUN0512
Sample Info: DPW-B105

Dilution Factor: 1
ISTD Amount: 20

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	18 U
156-60-5	trans-1,2-Dichloroethene	0.7 J
540-59-0	1, 1-Dichloroethane	2.5 U
75-34-3	cis-1, 2-Dichloroethene	3.1 J
156-59-2	Benzene	5 U
79-01-6	Trichloroethene	3.5
108-88-3	Toluene	10 U
106-46-7	1, 4-Dichlorobenzene	17.9
95-47-6	Xylene (o)	10 U

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Sample Number
B107

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab
Contract: 5518
Operator: MLG
Matrix: WATER
Analysis Method: 70430F.MTH
Sample Vol: 10 ML
Instrument Method: 70430F.MTH
GC Column: CAP **ID:** 0.54 mm

Lab Sample ID: 1010
Vial Number: 9
Date Analyzed: 06 May 97 03:22 PM
Sequence Number: 1
Lab File ID: FID00009.D
Sequence Name: 1RUN0505
Sample Info: B107
Dilution Factor: 1
ISTD Amount: 19.62

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	18 U
156-60-5	trans-1,2-Dichloroethene	0.5 J
540-59-0	1, 1-Dichloroethane	2.5 U
75-34-3	cis-1, 2-Dichloroethene	10 U
156-59-2	Benzene	5 U
79-01-6	Trichloroethene	1.5 J
108-88-3	Toluene	1.4 J
106-46-7	1, 4-Dichlorobenzene	10 U
95-47-6	Xylene (o)	1.2 J

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Sample Number
DPW-B107

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab
Contract: 5518
Operator: MLG
Matrix: WATER
Analysis Method: 70430F.MTH
Sample Vol: 10 ML
Instrument Method: 70430F.MTH
GC Column: CAP **ID:** 0.54 mm

Lab Sample ID: 1007
Vial Number: 7
Date Analyzed: 06 May 97 02:08 PM
Sequence Number: 1
Lab File ID: FID00007.D
Sequence Name: 1RUN0505
Sample Info: DPW-B107

Dilution Factor: 1
ISTD Amount: 19.76

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	18 U
156-60-5	trans-1,2-Dichloroethene	0.5 J
540-59-0	1, 1-Dichloroethane	2.5 U
75-34-3	cis-1, 2-Dichloroethene	10 U
156-59-2	Benzene	5 U
79-01-6	Trichloroethene	1.2 J
108-88-3	Toluene	10 U
106-46-7	1, 4-Dichlorobenzene	1.6 J
95-47-6	Xylene (o)	10 U

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Sample Number
B109

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab
Contract: 5518
Operator: MLG
Matrix: WATER
Analysis Method: 70515F1.MTH
Sample Vol: 10 ML
Instrument Method: 70515F1.MTH
GC Column: CAP **ID:** 0.54 mm

Lab Sample ID: 1115
Date Analyzed: 17 May 97 00:18 AM
Lab File ID: FID00009.D
Sample Info: B109
Vial Number: 9
Sequence Number: 3
Sequence Name: 1RUN0516
Dilution Factor: 1
ISTD Amount: 50

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	18 U
156-60-5	trans-1,2-Dichloroethene	0.7 J
540-59-0	1, 1-Dichloroethane	2.5 U
75-34-3	cis-1, 2-Dichloroethene	10.7
156-59-2	Benzene	5 U
79-01-6	Trichloroethene	28.2
108-88-3	Toluene	10 U
106-46-7	1, 4-Dichlorobenzene	10 U
95-47-6	Xylene (o)	10 U

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Sample Number
DPW-B109

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab

Contract: 5518
Operator: MLG

Matrix: WATER
Sample Vol: 10 ML

Analysis Method: 70515F1.MTH
Instrument Method: 70515F1.MTH
GC Column: CAP **ID:** 0.54 mm

Lab Sample ID: 1117
Date Analyzed: 17 May 97 00:55 AM
Lab File ID: FID00010.D
Sample Info: DPW-B109

Vial Number: 10
Sequence Number: 3
Sequence Name: 1RUN0516

Dilution Factor: 1
ISTD Amount: 50

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	18 U
156-60-5	trans-1,2-Dichloroethene	10 U
540-59-0	1, 1-Dichloroethane	2.5 U
75-34-3	cis-1, 2-Dichloroethene	11.5
156-59-2	Benzene	5 U
79-01-6	Trichloroethene	23.4
108-88-3	Toluene	0.7 J
106-46-7	1, 4-Dichlorobenzene	10 U
95-47-6	Xylene (o)	10 U

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Sample Number

B130

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab

Matrix: WATER
Sample Vol: 10 ML

Contract: 5518
Operator: MLG
Analysis Method: 70507F1.MTH
Instrument Method: 70507F1.MTH
GC Column: CAP **ID:** 0.54 mm

Lab Sample ID: 1057
Date Analyzed: 09 May 97 08:52 PM
Lab File ID: FID00003.D
Sample Info: B130

Vial Number: 3
Sequence Number: 1
Sequence Name: 1RUN0509

Dilution Factor: 1
ISTD Amount: 20

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	18 U
156-60-5	trans-1,2-Dichloroethene	10 U
540-59-0	1, 1-Dichloroethane	2.5 U
75-34-3	cis-1, 2-Dichloroethene	10 U
156-59-2	Benzene	5 U
79-01-6	Trichloroethene	5.9
108-88-3	Toluene	10 U
106-46-7	1, 4-Dichlorobenzene	3.8 J
95-47-6	Xylene (o)	10 U

Report File: RPT0507.XLX

Report Date: 6/23/97

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Sample Number
DPW-B130

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab
Contract: 5518
Operator: MLG
Matrix: WATER
Analysis Method: 70507F1.MTH
Sample Vol: 10 ML
Instrument Method: 70507F1.MTH
GC Column: CAP **ID:** 0.54 mm

Lab Sample ID: 1051
Vial Number: 11
Date Analyzed: 09 May 97 00:39 AM
Sequence Number: 1
Lab File ID: FID00011.D
Sequence Name: 1RUN0508
Sample Info: DPW-B130

Dilution Factor: 1
ISTD Amount: 20

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	18 U
156-60-5	trans-1,2-Dichloroethene	10 U
540-59-0	1, 1-Dichloroethane	2.5 U
75-34-3	cis-1, 2-Dichloroethene	10 U
156-59-2	Benzene	5 U
79-01-6	Trichloroethene	6.3
108-88-3	Toluene	10 U
106-46-7	1, 4-Dichlorobenzene	4.2 J
95-47-6	Xylene (o)	10 U

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Sample Number

B241(s)

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab

Contract: 5518
Operator: MLG

Matrix: WATER
Sample Vol: 10 ML

Analysis Method: 70520F1.MTH
Instrument Method: 70515F1.MTH
GC Column: CAP ID: 0.54 mm

Lab Sample ID: 1136
Date Analyzed: 21 May 97 00:17 AM
Lab File ID: FID00008.D
Sample Info: B241(s)

Vial Number: 8
Sequence Number: 3
Sequence Name: 1RUN0520

Dilution Factor: 1
ISTD Amount: 50

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	18 U
156-60-5	trans-1,2-Dichloroethene	10 U
540-59-0	1, 1-Dichloroethane	2.5 U
75-34-3	cis-1, 2-Dichloroethene	5.1 J
156-59-2	Benzene	5 U
79-01-6	Trichloroethene	6.3
108-88-3	Toluene	10 U
106-46-7	1, 4-Dichlorobenzene	10 U
95-47-6	Xylene (o)	10 U

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Sample Number
DPW-B241(S)

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab
Contract: 5518
Operator: MLG
Matrix: WATER
Analysis Method: 70520F1.MTH
Sample Vol: 10 ML
Instrument Method: 70515F1.MTH
GC Column: CAP **ID:** 0.54 mm

Lab Sample ID: 1138
Vial Number: 10
Date Analyzed: 21 May 97 01:31 AM
Sequence Number: 3
Lab File ID: FID00010.D
Sequence Name: 1RUN0520
Sample Info: DPW-B241(S)

Dilution Factor: 1
ISTD Amount: 50

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	18 U
156-60-5	trans-1,2-Dichloroethene	10 U
540-59-0	1, 1-Dichloroethane	2.5 U
75-34-3	cis-1, 2-Dichloroethene	10 U
156-59-2	Benzene	5 U
79-01-6	Trichloroethene	2.8
108-88-3	Toluene	10 U
106-46-7	1, 4-Dichlorobenzene	10 U
95-47-6	Xylene (o)	10 U

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Sample Number
RAP2-2S

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab
Contract: 5518
Operator: MLG
Matrix: WATER
Analysis Method: 70507F1.MTH
Sample Vol: 10 ML
Instrument Method: 70507F1.MTH
GC Column: CAP **ID:** 0.54 mm

Lab Sample ID: 1059
Vial Number: 4
Date Analyzed: 09 May 97 09:27 PM
Sequence Number: 1
Lab File ID: FID00004.D
Sequence Name: 1RUN0509
Sample Info: RAP2-2S
Dilution Factor: 1
ISTD Amount: 20

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	18 U
156-60-5	trans-1,2-Dichloroethene	10 U
540-59-0	1, 1-Dichloroethane	2.5 U
75-34-3	cis-1, 2-Dichloroethene	10 U
156-59-2	Benzene	5 U
79-01-6	Trichloroethene	4.3
108-88-3	Toluene	10 U
106-46-7	1, 4-Dichlorobenzene	2.6 J
95-47-6	Xylene (o)	10 U

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Sample Number
DPW-RAP2-2S

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab
Contract: 5518
Operator: MLG
Matrix: WATER
Analysis Method: 70507F1.MTH
Sample Vol: 10 ML
Instrument Method: 70507F1.MTH
GC Column: CAP **ID:** 0.54 mm

Lab Sample ID: 1061
Vial Number: 7
Date Analyzed: 09 May 97 11:13 PM
Sequence Number: 1
Lab File ID: FID00007.D
Sequence Name: 1RUN0509
Sample Info: DPW-RAP2-2S

Dilution Factor: 1
ISTD Amount: 20

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	18 U
156-60-5	trans-1,2-Dichloroethene	1.9 J
540-59-0	1, 1-Dichloroethane	2.5 U
75-34-3	cis-1, 2-Dichloroethene	357.5
156-59-2	Benzene	5 U
79-01-6	Trichloroethene	210.3
108-88-3	Toluene	10 U
106-46-7	1, 4-Dichlorobenzene	20.8
95-47-6	Xylene (o)	10 U

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Sample Number
RAP2-2T

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab
Contract: 5518
Operator: MLG
Matrix: WATER
Analysis Method: 70507F1.MTH
Sample Vol: 10 ML
Instrument Method: 70507F1.MTH
GC Column: CAP **ID:** 0.54 mm

Lab Sample ID: 1064
Vial Number: 9
Date Analyzed: 10 May 97 00:23 AM
Sequence Number: 1
Lab File ID: FID00009.D
Sequence Name: 1RUN0509
Sample Info: RAP2-2T

Dilution Factor: 1
ISTD Amount: 20

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	89.8
156-60-5	trans-1,2-Dichloroethene	4 J
540-59-0	1, 1-Dichloroethane	40.1
75-34-3	cis-1, 2-Dichloroethene	622.6
156-59-2	Benzene	2.1 J
79-01-6	Trichloroethene	208.1
108-88-3	Toluene	10 U
106-46-7	1, 4-Dichlorobenzene	16.7
95-47-6	Xylene (o)	2.3 J

Report File: RPT0507.XLX

Report Date: 6/23/97

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Sample Number
DPW-RAP2-2T

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab
Contract: 5518
Operator: MLG
Matrix: WATER
Analysis Method: 70507F1.MTH
Sample Vol: 10 ML
Instrument Method: 70507F1.MTH
GC Column: CAP **ID:** 0.54 mm

Lab Sample ID: 1072
Vial Number: 11
Date Analyzed: 10 May 97 01:34 AM
Sequence Number: 1
Lab File ID: FID00011.D
Sequence Name: 1RUN0509
Sample Info: DPW-RAP2-2T

Dilution Factor: 1
ISTD Amount: 20

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	86.2
156-60-5	trans-1,2-Dichloroethene	6.3 J
540-59-0	1, 1-Dichloroethane	39.3
75-34-3	cis-1, 2-Dichloroethene	596
156-59-2	Benzene	1.9 J
79-01-6	Trichloroethene	190.7
108-88-3	Toluene	10.6
106-46-7	1, 4-Dichlorobenzene	15.6
95-47-6	Xylene (o)	2.2 J

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Sample Number
RAP2-3S

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab
Contract: 5518
Operator: MLG
Matrix: WATER
Analysis Method: 70507F1.MTH
Sample Vol: 10 ML
Instrument Method: 70507F1.MTH
GC Column: CAP **ID:** 0.54 mm

Lab Sample ID: 1031
Vial Number: 4
Date Analyzed: 08 May 97 08:36 PM
Sequence Number: 1
Lab File ID: FID00004.D
Sequence Name: 1RUN0508
Sample Info: RAP2-3S

Dilution Factor: 1
ISTD Amount: 20

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	18 U
156-60-5	trans-1,2-Dichloroethene	10 U
540-59-0	1, 1-Dichloroethane	2.5 U
75-34-3	cis-1, 2-Dichloroethene	10 U
156-59-2	Benzene	5 U
79-01-6	Trichloroethene	2.1 J
108-88-3	Toluene	10 U
106-46-7	1, 4-Dichlorobenzene	10 U
95-47-6	Xylene (o)	10 U

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Sample Number
DPW-RAP2-3S

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab

Matrix: WATER
Sample Vol: 10 ML

Contract: 5518
Operator: MLG
Analysis Method: 70507F1.MTH
Instrument Method: 70507F1.MTH
GC Column: CAP **ID:** 0.54 mm

Lab Sample ID: 1028
Date Analyzed: 08 May 97 08:01 PM
Lab File ID: FID00003.D
Sample Info: DPW-RAP2-3S

Vial Number: 3
Sequence Number: 1
Sequence Name: 1RUN0508

Dilution Factor: 1
ISTD Amount: 20

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	18 U
156-60-5	trans-1,2-Dichloroethene	10 U
540-59-0	1, 1-Dichloroethane	2.5 U
75-34-3	cis-1, 2-Dichloroethene	10 U
156-59-2	Benzene	5 U
79-01-6	Trichloroethene	0.8 J
108-88-3	Toluene	10 U
106-46-7	1, 4-Dichlorobenzene	10 U
95-47-6	Xylene (o)	10 U

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Sample Number
RAP2-4S

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab
Contract: 5518
Operator: MLG
Matrix: WATER
Analysis Method: 70507F1.MTH
Sample Vol: 10 ML
Instrument Method: 70507F1.MTH
GC Column: CAP **ID:** 0.54 mm

Lab Sample ID: 1044
Vial Number: 9
Date Analyzed: 08 May 97 11:30 PM
Sequence Number: 1
Lab File ID: FID00009.D
Sequence Name: 1RUN0508
Sample Info: RAP2-4S

Dilution Factor: 1
ISTD Amount: 20

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	18 U
156-60-5	trans-1,2-Dichloroethene	10 U
540-59-0	1, 1-Dichloroethane	2.5 U
75-34-3	cis-1, 2-Dichloroethene	10 U
156-59-2	Benzene	5 U
79-01-6	Trichloroethene	4.7
108-88-3	Toluene	10 U
106-46-7	1, 4-Dichlorobenzene	4.8 J
95-47-6	Xylene (o)	10 U

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Sample Number
DPW-RAP2-4S

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab
Contract: 5518
Operator: MLG
Matrix: WATER
Analysis Method: 70507F1.MTH
Sample Vol: 10 ML
Instrument Method: 70507F1.MTH
GC Column: CAP **ID:** 0.54 mm

Lab Sample ID: 1036
Vial Number: 7
Date Analyzed: 08 May 97 10:20 PM
Sequence Number: 1
Lab File ID: FID00007.D
Sequence Name: 1RUN0508
Sample Info: DPW-RAP2-4S
Dilution Factor: 1
ISTD Amount: 20

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	18 U
156-60-5	trans-1,2-Dichloroethene	10 U
540-59-0	1, 1-Dichloroethane	2.5 U
75-34-3	cis-1, 2-Dichloroethene	10 U
156-59-2	Benzene	5 U
79-01-6	Trichloroethene	9
108-88-3	Toluene	10 U
106-46-7	1, 4-Dichlorobenzene	4.3 J
95-47-6	Xylene (o)	10 U

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Sample Number
OW2-1

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab
Contract: 5518
Operator: MLG
Matrix: WATER
Analysis Method: 70507F1.MTH
Sample Vol: 10 ML
Instrument Method: 70507F1.MTH
GC Column: CAP **ID:** 0.54 mm

Lab Sample ID: 1096
Vial Number: 7
Date Analyzed: 12 May 97 11:00 PM
Sequence Number: 1
Lab File ID: FID00007.D
Sequence Name: 1RUN0512
Sample Info: OW2-1
Dilution Factor: 1
ISTD Amount: 20

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	18 U
156-60-5	trans-1,2-Dichloroethene	0.3 J
540-59-0	1, 1-Dichloroethane	2.5 U
75-34-3	cis-1, 2-Dichloroethene	9.2 J
156-59-2	Benzene	5 U
79-01-6	Trichloroethene	5.1
108-88-3	Toluene	10 U
106-46-7	1, 4-Dichlorobenzene	13.2
95-47-6	Xylene (o)	10 U

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Sample Number
DPW-OW2-1

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab
Contract: 5518
Operator: MLG
Matrix: WATER
Analysis Method: 70507F1.MTH
Sample Vol: 10 ML
Instrument Method: 70507F1.MTH
GC Column: CAP **ID:** 0.54 mm

Lab Sample ID: 1088
Date Analyzed: 12 May 97 09:45 PM
Lab File ID: FID00005.D
Sample Info: DPW-OW2-1
Vial Number: 5
Sequence Number: 1
Sequence Name: 1RUN0512
Dilution Factor: 1
ISTD Amount: 20

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	18 U
156-60-5	trans-1,2-Dichloroethene	1.1 J
540-59-0	1, 1-Dichloroethane	2.5 U
75-34-3	cis-1, 2-Dichloroethene	21.4
156-59-2	Benzene	5 U
79-01-6	Trichloroethene	7.6
108-88-3	Toluene	10 U
106-46-7	1, 4-Dichlorobenzene	22.5
95-47-6	Xylene (o)	10 U

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Sample Number: OW2-4

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab
Contract: 5518
Operator: MLG
Matrix: WATER
Analysis Method: 70520F1.MTH
Sample Vol: 10 ML
Instrument Method: 70515F1.MTH
GC Column: CAP ID: 0.54 mm

Lab Sample ID: 1126
Vial Number: 4
Date Analyzed: 20 May 97 09:51 PM
Sequence Number: 3
Lab File ID: FID00004.D
Sequence Name: 1RUN0520
Sample Info: OW2-4
Dilution Factor: 1
ISTD Amount: 50

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	18 U
156-60-5	trans-1,2-Dichloroethene	10 U
540-59-0	1, 1-Dichloroethane	2.5 U
75-34-3	cis-1, 2-Dichloroethene	17.3
156-59-2	Benzene	2.5 J
79-01-6	Trichloroethene	3.6
108-88-3	Toluene	1 J
106-46-7	1, 4-Dichlorobenzene	10 U
95-47-6	Xylene (o)	10 U

Report File: FID00004.XLR
Report Date: 6/18/97

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Sample Number
DPW-OW2-4

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab
Contract: 5518
Operator: MLG
Matrix: WATER
Analysis Method: 70515F1.MTH
Sample Vol: 10 ML
Instrument Method: 70515F1.MTH
GC Column: CAP   ID: 0.54 mm

Lab Sample ID: 1119 1:1000
Vial Number: 11
Date Analyzed: 17 May 97 01:33 AM
Sequence Number: 3
Lab File ID: FID00011.D
Sequence Name: 1RUN0516
Sample Info: DPW-OW2-4 1:1000
Dilution Factor: 1000
ISTD Amount: 50

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	18 U
156-60-5	trans-1,2-Dichloroethene	768.4 D
540-59-0	1, 1-Dichloroethane	2.5 U
75-34-3	cis-1, 2-Dichloroethene	10 U
156-59-2	Benzene	5 U
79-01-6	Trichloroethene	227.1 D
108-88-3	Toluene	10 U
106-46-7	1, 4-Dichlorobenzene	10 U
95-47-6	Xylene (o)	10 U

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Sample Number
OW2-6

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab
Contract: 5518
Operator: MLG
Matrix: WATER
Analysis Method: 70507F1.MTH
Sample Vol: 10 ML
Instrument Method: 70507F1.MTH
GC Column: CAP **ID:** 0.54 mm

Lab Sample ID: 1110
Vial Number: 9
Date Analyzed: 14 May 97 01:33 AM
Sequence Number: 1
Lab File ID: FID00009.D
Sequence Name: 1RUN0513
Sample Info: OW2-6

Dilution Factor: 1
ISTD Amount: 20

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	40.1
156-60-5	trans-1,2-Dichloroethene	12.5
540-59-0	1, 1-Dichloroethane	121.6
75-34-3	cis-1, 2-Dichloroethene	2009.6
156-59-2	Benzene	31.6
79-01-6	Trichloroethene	1944.2
108-88-3	Toluene	2.3 J
106-46-7	1, 4-Dichlorobenzene	10.7
95-47-6	Xylene (o)	4.7 J

Report File: RPT0507.XLX

Report Date: 6/23/97

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Sample Number
DPW-OW2-6

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab
Contract: 5518
Operator: MLG
Matrix: WATER
Analysis Method: 70507F1.MTH
Sample Vol: 10 ML
Instrument Method: 70507F1.MTH
GC Column: CAP **ID:** 0.54 mm

Lab Sample ID: 1105
Vial Number: 7
Date Analyzed: 14 May 97 00:17 AM
Sequence Number: 1
Lab File ID: FID00007.D
Sequence Name: 1RUN0513
Sample Info: DPW-OW2-6

Dilution Factor: 1
ISTD Amount: 20

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	101.7
156-60-5	trans-1,2-Dichloroethene	19.1
540-59-0	1, 1-Dichloroethane	98.4
75-34-3	cis-1, 2-Dichloroethene	2488.1
156-59-2	Benzene	34.4
79-01-6	Trichloroethene	1477.1
108-88-3	Toluene	2.7 J
106-46-7	1, 4-Dichlorobenzene	10.8
95-47-6	Xylene (o)	6.8 J

Report File: RPT0507.XLX

Report Date: 6/23/97

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Sample Number
OW2-6

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab
Contract: 5518
Operator: MLG
Matrix: WATER
Analysis Method: 70515F1.MTH
Sample Vol: 10 ML
Instrument Method: 70515F1.MTH
GC Column: CAP **ID:** 0.54 mm

Lab Sample ID: 1109 1:100
Vial Number: 4
Date Analyzed: 16 May 97 09:08 PM
Sequence Number: 3
Lab File ID: FID00004.D
Sequence Name: 1RUN0516
Sample Info: OW2-6 RERUN OF VIAL #1110
Dilution Factor: 100
ISTD Amount: 50

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	18 U
156-60-5	trans-1,2-Dichloroethene	49.1 D
540-59-0	1, 1-Dichloroethane	2.5 U
75-34-3	cis-1, 2-Dichloroethene	2445 D
156-59-2	Benzene	5 U
79-01-6	Trichloroethene	1838.4 D
108-88-3	Toluene	10 U
106-46-7	1, 4-Dichlorobenzene	10 U
95-47-6	Xylene (o)	10 U

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Sample Number
DPW-OW2-6

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab
Contract: 5518
Operator: MLG
Matrix: WATER
Analysis Method: 70515F1.MTH
Sample Vol: 10 ML
Instrument Method: 70515F1.MTH
GC Column: CAP **ID:** 0.54 mm

Lab Sample ID: 1106 1:100
Vial Number: 3
Date Analyzed: 16 May 97 08:29 PM
Sequence Number: 3
Lab File ID: FID00003.D
Sequence Name: 1RUN0516
Sample Info: DPW-OW2-6 RERUN OF SAMPLE # 1105
Dilution Factor: 100
ISTD Amount: 50

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	18 U
156-60-5	trans-1,2-Dichloroethene	10 U
540-59-0	1, 1-Dichloroethane	2.5 U
75-34-3	cis-1, 2-Dichloroethene	4478.7 D
156-59-2	Benzene	5 U
79-01-6	Trichloroethene	1844.7 D
108-88-3	Toluene	10 U
106-46-7	1, 4-Dichlorobenzene	10 U
95-47-6	Xylene (o)	10 U

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Sample Number
OW2-7

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab
Contract: 5518
Operator: MLG
Matrix: WATER
Analysis Method: 70515F1.MTH
Sample Vol: 10 ML
Instrument Method: 70515F1.MTH
GC Column: CAP **ID:** 0.54 mm

Lab Sample ID: 1113
Vial Number: 6
Date Analyzed: 16 May 97 10:24 PM
Sequence Number: 3
Lab File ID: FID00006.D
Sequence Name: 1RUN0516
Sample Info: OW2-7

Dilution Factor: 1
ISTD Amount: 50

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	18 U
156-60-5	trans-1,2-Dichloroethene	10 U
540-59-0	1, 1-Dichloroethane	2.5 U
75-34-3	cis-1, 2-Dichloroethene	21.7
156-59-2	Benzene	5 U
79-01-6	Trichloroethene	188.8
108-88-3	Toluene	10 U
106-46-7	1, 4-Dichlorobenzene	10 U
95-47-6	Xylene (o)	10 U

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Sample Number
DPW-OW2-7

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab
Contract: 5518
Operator: MLG
Matrix: WATER
Analysis Method: 70515F1.MTH
Sample Vol: 10 ML
Instrument Method: 70515F1.MTH
GC Column: CAP **ID:** 0.54 mm

Lab Sample ID: 1111
Date Analyzed: 16 May 97 09:46 PM
Lab File ID: FID00005.D
Sample Info: DPW-OW2-7
Vial Number: 5
Sequence Number: 3
Sequence Name: 1RUN0516
Dilution Factor: 1
ISTD Amount: 50

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	18 U
156-60-5	trans-1,2-Dichloroethene	0.6 J
540-59-0	1, 1-Dichloroethane	2.5 U
75-34-3	cis-1, 2-Dichloroethene	5.3 J
156-59-2	Benzene	5 U
79-01-6	Trichloroethene	25.4
108-88-3	Toluene	10 U
106-46-7	1, 4-Dichlorobenzene	10 U
95-47-6	Xylene (o)	10 U

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Sample Number
RFW-11

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab
Contract: 5518
Operator: MLG
Matrix: WATER
Analysis Method: 70507F1.MTH
Sample Vol: 10 ML
Instrument Method: 70507F1.MTH
GC Column: CAP **ID:** 0.54 mm

Lab Sample ID: 1082
Vial Number: 4
Date Analyzed: 12 May 97 09:07 PM
Sequence Number: 1
Lab File ID: FID00004.D
Sequence Name: 1RUN0512
Sample Info: RFW-11

Dilution Factor: 1
ISTD Amount: 20

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	18 U
156-60-5	trans-1,2-Dichloroethene	1.4 J
540-59-0	1, 1-Dichloroethane	2.5 U
75-34-3	cis-1, 2-Dichloroethene	6.2 J
156-59-2	Benzene	5 U
79-01-6	Trichloroethene	30.1
108-88-3	Toluene	10 U
106-46-7	1, 4-Dichlorobenzene	20.2
95-47-6	Xylene (o)	10 U

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Sample Number
DPW-RFW-11

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab
Contract: 5518
Operator: MLG
Matrix: WATER
Analysis Method: 70507F1.MTH
Sample Vol: 10 ML
Instrument Method: 70507F1.MTH
GC Column: CAP **ID:** 0.54 mm

Lab Sample ID: 1078
Vial Number: 3
Date Analyzed: 12 May 97 08:29 PM
Sequence Number: 1
Lab File ID: FID00003.D
Sequence Name: 1RUN0512
Sample Info: DPW-RFW-11
Dilution Factor: 1
ISTD Amount: 20

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	18 U
156-60-5	trans-1,2-Dichloroethene	0.5 J
540-59-0	1, 1-Dichloroethane	2.5 U
75-34-3	cis-1, 2-Dichloroethene	42.2
156-59-2	Benzene	2.1 J
79-01-6	Trichloroethene	173.7
108-88-3	Toluene	10 U
106-46-7	1, 4-Dichlorobenzene	4.6 J
95-47-6	Xylene (o)	10 U

Report File: RPT0507.XLX

Report Date: 6/23/97

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Sample Number
B37

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab
Contract: 5518
Operator: MLG
Matrix: WATER
Analysis Method: 70604F1.MTH
Sample Vol: 10 ML
Instrument Method: 70604F1.MTH
GC Column: CAP **ID:** 0.54 mm

Lab Sample ID: 1285
Vial Number: 10
Date Analyzed: 06 Jun 97 06:26 PM
Sequence Number: 1
Lab File ID: FID00010.D
Sequence Name: 1RUN0606
Sample Info: B37

Dilution Factor: 1
ISTD Amount: 20

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	18 U
156-60-5	trans-1,2-Dichloroethene	10 U
540-59-0	1, 1-Dichloroethane	2.5 U
75-34-3	cis-1, 2-Dichloroethene	10 U
156-59-2	Benzene	5 U
79-01-6	Trichloroethene	2.5 U
108-88-3	Toluene	10 U
106-46-7	1, 4-Dichlorobenzene	10 U
95-47-6	Xylene (o)	10 U

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Sample Number
DPW-B37

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab
Contract: 5518
Operator: MLG
Matrix: WATER
Analysis Method: 70604F1.MTH
Sample Vol: 10 ML
Instrument Method: 70604F1.MTH
GC Column: CAP **ID:** 0.54 mm

Lab Sample ID: 1281
Vial Number: 7
Date Analyzed: 06 Jun 97 04:21 PM
Sequence Number: 1
Lab File ID: FID00007.D
Sequence Name: 1RUN0606
Sample Info: DPW-B37

Dilution Factor: 1
ISTD Amount: 20

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	18 U
156-60-5	trans-1,2-Dichloroethene	1.8 J
540-59-0	1, 1-Dichloroethane	2.5 U
75-34-3	cis-1, 2-Dichloroethene	10 U
156-59-2	Benzene	1.1 J
79-01-6	Trichloroethene	2.5 U
108-88-3	Toluene	2.9 J
106-46-7	1, 4-Dichlorobenzene	10 U
95-47-6	Xylene (o)	10 U

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Sample Number
B39

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab
Contract: 5518
Operator: JCB
Matrix: WATER
Analysis Method: 70522F1.MTH
Sample Vol: 10 ML
Instrument Method: 70522F1.MTH
GC Column: CAP **ID:** 0.54 mm

Lab Sample ID: 1180
Vial Number: 6
Date Analyzed: 30 May 97 09:34 PM
Sequence Number: 1
Lab File ID: FID00006.D
Sequence Name: 1RUN0530
Sample Info: B39
Dilution Factor: 1
ISTD Amount: 20

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	17.1 J
156-60-5	trans-1,2-Dichloroethene	1.6 J
540-59-0	1, 1-Dichloroethane	2.5 U
75-34-3	cis-1, 2-Dichloroethene	8.2 J
156-59-2	Benzene	6.9
79-01-6	Trichloroethene	18.2
108-88-3	Toluene	10 U
106-46-7	1, 4-Dichlorobenzene	34
95-47-6	Xylene (o)	10 U

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Sample Number
DPW-B39

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab
Contract: 5518
Operator: JCB
Matrix: WATER
Analysis Method: 70522F1.MTH
Sample Vol: 10 ML
Instrument Method: 70522F1.MTH
GC Column: CAP **ID:** 0.54 mm

Lab Sample ID: 1178
Vial Number: 5
Date Analyzed: 30 May 97 08:55 PM
Sequence Number: 1
Lab File ID: FID00005.D
Sequence Name: 1RUN0530
Sample Info: DPW-B39
Dilution Factor: 1
ISTD Amount: 20

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	18 U
156-60-5	trans-1,2-Dichloroethene	3.8 J
540-59-0	1, 1-Dichloroethane	2.5 U
75-34-3	cis-1, 2-Dichloroethene	10 U
156-59-2	Benzene	5 U
79-01-6	Trichloroethene	2 J
108-88-3	Toluene	1.6 J
106-46-7	1, 4-Dichlorobenzene	10 U
95-47-6	Xylene (o)	10 U

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Sample Number
B40

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab
Contract: 5518
Operator: JCB
Matrix: WATER
Analysis Method: 70522F1.MTH
Sample Vol: 10 ML
Instrument Method: 70522F1.MTH
GC Column: CAP **ID:** 0.54 mm

Lab Sample ID: 1189
Vial Number: 8
Date Analyzed: 30 May 97 10:51 PM
Sequence Number: 1
Lab File ID: FID00008.D
Sequence Name: 1RUN0530
Sample Info: B40

Dilution Factor: 1
ISTD Amount: 20

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	18 U
156-60-5	trans-1,2-Dichloroethene	2.1 J
540-59-0	1, 1-Dichloroethane	2.5 U
75-34-3	cis-1, 2-Dichloroethene	10 U
156-59-2	Benzene	5 U
79-01-6	Trichloroethene	1.3 J
108-88-3	Toluene	10 U
106-46-7	1, 4-Dichlorobenzene	10 U
95-47-6	Xylene (o)	10 U

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Sample Number
DPW-B40

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab
Contract: 5518
Operator: JCB
Matrix: WATER
Analysis Method: 70522F1.MTH
Sample Vol: 10 ML
Instrument Method: 70522F1.MTH
GC Column: CAP **ID:** 0.54 mm

Lab Sample ID: 1193
Vial Number: 11
Date Analyzed: 31 May 97 00:45 AM
Sequence Number: 1
Lab File ID: FID00011.D
Sequence Name: 1RUN0530
Sample Info: DPW-B40
Dilution Factor: 1
ISTD Amount: 20

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	18 U
156-60-5	trans-1,2-Dichloroethene	10 U
540-59-0	1, 1-Dichloroethane	2.5 U
75-34-3	cis-1, 2-Dichloroethene	10 U
156-59-2	Benzene	5 U
79-01-6	Trichloroethene	1.2 J
108-88-3	Toluene	2.2 J
106-46-7	1, 4-Dichlorobenzene	10 U
95-47-6	Xylene (o)	10 U

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Sample Number
B41

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab
Contract: 5518
Operator: JCB
Matrix: WATER
Analysis Method: 70522F1.MTH
Sample Vol: 10 ML
Instrument Method: 70522F1.MTH
GC Column: CAP **ID:** 0.54 mm

Lab Sample ID: 1172
Vial Number: 3
Date Analyzed: 30 May 97 07:37 PM
Sequence Number: 1
Lab File ID: FID00003.D
Sequence Name: 1RUN0530
Sample Info: B41

Dilution Factor: 1
ISTD Amount: 20

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	18 U
156-60-5	trans-1,2-Dichloroethene	10 U
540-59-0	1, 1-Dichloroethane	2.5 U
75-34-3	cis-1, 2-Dichloroethene	10 U
156-59-2	Benzene	5 U
79-01-6	Trichloroethene	1.2 J
108-88-3	Toluene	10 U
106-46-7	1, 4-Dichlorobenzene	10 U
95-47-6	Xylene (o)	10 U

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Sample Number
DPW-B41

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab
Contract: 5518
Operator: JCB
Matrix: WATER
Analysis Method: 70522F1.MTH
Sample Vol: 10 ML
Instrument Method: 70522F1.MTH
GC Column: CAP **ID:** 0.54 mm

Lab Sample ID: 1176
Vial Number: 4
Date Analyzed: 30 May 97 08:16 PM
Sequence Number: 1
Lab File ID: FID00004.D
Sequence Name: 1RUN0530
Sample Info: DPW-B41

Dilution Factor: 1
ISTD Amount: 20

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	18 U
156-60-5	trans-1,2-Dichloroethene	0.8 J
540-59-0	1, 1-Dichloroethane	2.5 U
75-34-3	cis-1, 2-Dichloroethene	10 U
156-59-2	Benzene	5 U
79-01-6	Trichloroethene	1.8 J
108-88-3	Toluene	4.8 J
106-46-7	1, 4-Dichlorobenzene	10 U
95-47-6	Xylene (o)	10 U

Report File: FID00004.XLR

Report Date: 6/19/97

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Sample Number: B42

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab
Contract: 5518
Operator: MLG
Matrix: WATER
Analysis Method: 70522F1.MTH
Sample Vol: 10 ML
Instrument Method: 70529F1.MTH
GC Column: CAP **ID:** 0.54 mm

Lab Sample ID: 1162
Vial Number: 7
Date Analyzed: 30 May 97 00:14 AM
Sequence Number: 3
Lab File ID: FID00007.D
Sequence Name: 1RUN0529
Sample Info: B42
Dilution Factor: 1
ISTD Amount: 20

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	18 U
156-60-5	trans-1,2-Dichloroethene	10 U
540-59-0	1, 1-Dichloroethane	2.5 U
75-34-3	cis-1, 2-Dichloroethene	10 U
156-59-2	Benzene	5 U
79-01-6	Trichloroethene	1.9 J
108-88-3	Toluene	10 U
106-46-7	1, 4-Dichlorobenzene	10 U
95-47-6	Xylene (o)	10 U

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Sample Number
DPW-B42

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab
Contract: 5518
Operator: MLG
Matrix: WATER
Analysis Method: 70522F1.MTH
Sample Vol: 10 ML
Instrument Method: 70529F1.MTH
GC Column: CAP **ID:** 0.54 mm

Lab Sample ID: 1167
Vial Number: 8
Date Analyzed: 30 May 97 00:53 AM
Sequence Number: 3
Lab File ID: FID00008.D
Sequence Name: 1RUN0529
Sample Info: DPW-B42

Dilution Factor: 1
ISTD Amount: 20

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	18 U
156-60-5	trans-1,2-Dichloroethene	0.7 J
540-59-0	1, 1-Dichloroethane	2.5 U
75-34-3	cis-1, 2-Dichloroethene	10 U
156-59-2	Benzene	5 U
79-01-6	Trichloroethene	2 J
108-88-3	Toluene	10 U
106-46-7	1, 4-Dichlorobenzene	10 U
95-47-6	Xylene (o)	10 U

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Sample Number
MWZ-05

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab

Contract: 5518
Operator: MLG

Matrix: WATER
Sample Vol: 10 ML

Analysis Method: 70604F1.MTH
Instrument Method: 70604F1.MTH
GC Column: CAP **ID:** 0.54 mm

Lab Sample ID: 1266
Date Analyzed: 06 Jun 97 00:40 AM
Lab File ID: FID00007.D
Sample Info: MWZ-05

Vial Number: 7
Sequence Number: 1
Sequence Name: 1RUN0605

Dilution Factor: 1
ISTD Amount: 20

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	18 U
156-60-5	trans-1,2-Dichloroethene	10 U
540-59-0	1, 1-Dichloroethane	2.5 U
75-34-3	cis-1, 2-Dichloroethene	10 U
156-59-2	Benzene	5 U
79-01-6	Trichloroethene	2.5 U
108-88-3	Toluene	1.4 J
106-46-7	1, 4-Dichlorobenzene	10 U
95-47-6	Xylene (o)	10 U

Report File: RPT0604.XLX

Report Date: 6/19/97

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Sample Number
DPW-MWZ-05

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab
Contract: 5518
Operator: MLG
Matrix: WATER
Analysis Method: 70604F1.MTH
Sample Vol: 10 ML
Instrument Method: 70604F1.MTH
GC Column: CAP **ID:** 0.54 mm

Lab Sample ID: 1264
Vial Number: 6
Date Analyzed: 06 Jun 97 00:01 AM
Sequence Number: 1
Lab File ID: FID00006.D
Sequence Name: 1RUN0605
Sample Info: DPW-MWZ-05

Dilution Factor: 1
ISTD Amount: 20

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	18 U
156-60-5	trans-1,2-Dichloroethene	10 U
540-59-0	1, 1-Dichloroethane	2.5 U
75-34-3	cis-1, 2-Dichloroethene	10 U
156-59-2	Benzene	2 J
79-01-6	Trichloroethene	2.5 U
108-88-3	Toluene	1.6 J
106-46-7	1, 4-Dichlorobenzene	10 U
95-47-6	Xylene (o)	10 U

Report File: RPT0604.XLX
Report Date: 6/19/97

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Sample Number
MWZ-06

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab
Contract: 5518
Operator: MLG
Matrix: WATER
Analysis Method: 70522F1.MTH
Sample Vol: 10 ML
Instrument Method: 70522F1.MTH
GC Column: CAP **ID:** 0.54 mm

Lab Sample ID: 1203
Vial Number: 7
Date Analyzed: 03 Jun 97 08:49 PM
Sequence Number: 1
Lab File ID: FID00007.D
Sequence Name: 1RUN0603
Sample Info: MWZ-06

Dilution Factor: 1
ISTD Amount: 20

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	10.7 J
156-60-5	trans-1,2-Dichloroethene	4.7 J
540-59-0	1, 1-Dichloroethane	3.5
75-34-3	cis-1, 2-Dichloroethene	1.9 J
156-59-2	Benzene	194.2
79-01-6	Trichloroethene	2 J
108-88-3	Toluene	10 U
106-46-7	1, 4-Dichlorobenzene	4.1 J
95-47-6	Xylene (o)	3.3 J

Report File: FID00007.XLR

Report Date: 6/19/97

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Sample Number
DPW-MWZ-06

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab
Contract: 5518
Operator: MLG
Matrix: WATER
Analysis Method: 70522F1.MTH
Sample Vol: 10 ML
Instrument Method: 70522F1.MTH
GC Column: CAP **ID:** 0.54 mm

Lab Sample ID: 1201
Vial Number: 6
Date Analyzed: 03 Jun 97 08:09 PM
Sequence Number: 1
Lab File ID: FID00006.D
Sequence Name: 1RUN0603
Sample Info: DPW-MWZ-06
Dilution Factor: 1
ISTD Amount: 20

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	8.6 J
156-60-5	trans-1,2-Dichloroethene	5.9 J
540-59-0	1, 1-Dichloroethane	2.5 U
75-34-3	cis-1, 2-Dichloroethene	5.6 J
156-59-2	Benzene	786.4
79-01-6	Trichloroethene	2.5
108-88-3	Toluene	49.4
106-46-7	1, 4-Dichlorobenzene	9.1 J
95-47-6	Xylene (o)	2.8 J

Report File: FID00006.XLR

Report Date: 6/19/97

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Sample Number: MWZ-07

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab
Contract: 5518
Operator: MLG
Matrix: WATER
Analysis Method: 70522F1.MTH
Sample Vol: 10 ML
Instrument Method: 70522F1.MTH
GC Column: CAP ID: 0.54 mm

Lab Sample ID: 1199
Vial Number: 5
Date Analyzed: 03 Jun 97 07:28 PM
Sequence Number: 1
Lab File ID: FID00005.D
Sequence Name: 1RUN0603
Sample Info: MWZ-07
Dilution Factor: 1
ISTD Amount: 20

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	5.8 J
156-60-5	trans-1,2-Dichloroethene	10 U
540-59-0	1, 1-Dichloroethane	2.5 U
75-34-3	cis-1, 2-Dichloroethene	7.2 J
156-59-2	Benzene	22.4
79-01-6	Trichloroethene	11.9
108-88-3	Toluene	2.1 J
106-46-7	1, 4-Dichlorobenzene	7.2 J
95-47-6	Xylene (o)	10 U

Report File: FID00005.XLR
Report Date: 6/19/97

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Sample Number
DPW-MWZ-07.

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab
Contract: 5518
Operator: MLG
Matrix: WATER
Analysis Method: 70522F1.MTH
Sample Vol: 10 ML
Instrument Method: 70522F1.MTH
GC Column: CAP **ID:** 0.54 mm

Lab Sample ID: 1195
Vial Number: 3
Date Analyzed: 03 Jun 97 06:05 PM
Sequence Number: 1
Lab File ID: FID00003.D
Sequence Name: 1RUN0603
Sample Info: DPW-MWZ-07. Reran this sample since it was run in
Dilution Factor: 1
ISTD Amount: 20

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	4.3 J
156-60-5	trans-1,2-Dichloroethene	2.6 J
540-59-0	1, 1-Dichloroethane	2.5 U
75-34-3	cis-1, 2-Dichloroethene	10 U
156-59-2	Benzene	166.9
79-01-6	Trichloroethene	1.5 J
108-88-3	Toluene	26.1
106-46-7	1, 4-Dichlorobenzene	1.6 J
95-47-6	Xylene (o)	2.9 J

Report File: FID00003.XLR

Report Date: 6/19/97

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Sample Number
MWZ-11

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab
Contract: 5518
Operator: MLG
Matrix: WATER
Analysis Method: 70604F1.MTH
Sample Vol: 10 ML
Instrument Method: 70604F1.MTH
GC Column: CAP **ID:** 0.54 mm

Lab Sample ID: 1260
Vial Number: 4
Date Analyzed: 05 Jun 97 10:41 PM
Sequence Number: 1
Lab File ID: FID00004.D
Sequence Name: 1RUN0605
Sample Info: MWZ-11
Dilution Factor: 1
ISTD Amount: 20

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	18 U
156-60-5	trans-1,2-Dichloroethene	3.2 J
540-59-0	1, 1-Dichloroethane	2.5 U
75-34-3	cis-1, 2-Dichloroethene	10 U
156-59-2	Benzene	60.2
79-01-6	Trichloroethene	2.5 U
108-88-3	Toluene	40.4
106-46-7	1, 4-Dichlorobenzene	89.6
95-47-6	Xylene (o)	15.3

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Sample Number
DPW-MWZ-11

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab
Contract: 5518
Operator: MLG
Matrix: WATER
Analysis Method: 70604F1.MTH
Sample Vol: 10 ML
Instrument Method: 70604F1.MTH
GC Column: CAP **ID:** 0.54 mm

Lab Sample ID: 1258
Vial Number: 3
Date Analyzed: 05 Jun 97 10:01 PM
Sequence Number: 1
Lab File ID: FID00003.D
Sequence Name: 1RUN0605
Sample Info: DPW-MWZ-11
Dilution Factor: 1
ISTD Amount: 20

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	18 U
156-60-5	trans-1,2-Dichloroethene	10 U
540-59-0	1, 1-Dichloroethane	2.5 U
75-34-3	cis-1, 2-Dichloroethene	4.6 J
156-59-2	Benzene	131.6
79-01-6	Trichloroethene	0.7 J
108-88-3	Toluene	30
106-46-7	1, 4-Dichlorobenzene	5.6 J
95-47-6	Xylene (o)	4.4 J

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Sample Number
MWZ-12

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab
Contract: 5518
Operator: MLG
Matrix: WATER
Analysis Method: 70604F1.MTH
Sample Vol: 10 ML
Instrument Method: 70604F1.MTH
GC Column: CAP **ID:** 0.54 mm

Lab Sample ID: 1254
Vial Number: 10
Date Analyzed: 05 Jun 97 01:41 AM
Sequence Number: 7
Lab File ID: FID00010.D
Sequence Name: 1RUN0604
Sample Info: MWZ-12

Dilution Factor: 1
ISTD Amount: 20

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	18 U
156-60-5	trans-1,2-Dichloroethene	10 U
540-59-0	1, 1-Dichloroethane	2.5 U
75-34-3	cis-1, 2-Dichloroethene	10 U
156-59-2	Benzene	114.2
79-01-6	Trichloroethene	2.5 U
108-88-3	Toluene	8.8 J
106-46-7	1, 4-Dichlorobenzene	9.4 J
95-47-6	Xylene (o)	14.1

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Sample Number
DPW-MWZ-12

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab
Contract: 5518
Operator: MLG
Matrix: WATER
Analysis Method: 70522F1.MTH
Sample Vol: 10 ML
Instrument Method: 70522F1.MTH
GC Column: CAP **ID:** 0.54 mm

Lab Sample ID: 1207
Date Analyzed: 03 Jun 97 10:07 PM
Lab File ID: FID00009.D
Sample Info: DPW-MWZ-12
Vial Number: 9
Sequence Number: 1
Sequence Name: 1RUN0603
Dilution Factor: 1
ISTD Amount: 20

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	18 U
156-60-5	trans-1,2-Dichloroethene	3.2 J
540-59-0	1, 1-Dichloroethane	2.5 U
75-34-3	cis-1, 2-Dichloroethene	10 U
156-59-2	Benzene	83.5
79-01-6	Trichloroethene	3.4
108-88-3	Toluene	2.4 J
106-46-7	1, 4-Dichlorobenzene	5.7 J
95-47-6	Xylene (o)	10 U

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New England Division
(802) 763-8348

Sample Number
MWZ-17

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab
Contract: 5518
Operator: MLG
Matrix: WATER
Analysis Method: 70610F1.MTH
Sample Vol: 10 ML
Instrument Method: 70604F1.MTH
GC Column: CAP **ID:** 0.54 mm

Lab Sample ID: 1293
Vial Number: 8
Date Analyzed: 10 Jun 97 09:42 PM
Sequence Number: 1
Lab File ID: FID00008.D
Sequence Name: 1RUN0610
Sample Info: MWZ-17

Dilution Factor: 1
ISTD Amount: 20

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	18 U
156-60-5	trans-1,2-Dichloroethene	10 U
540-59-0	1, 1-Dichloroethane	2.5 U
75-34-3	cis-1, 2-Dichloroethene	10 U
156-59-2	Benzene	14.7
79-01-6	Trichloroethene	2.5 U
108-88-3	Toluene	3.4 J
106-46-7	1, 4-Dichlorobenzene	19.4
95-47-6	Xylene (o)	7.5 J

Applied Research Associates, Inc.
New England Division
(802) 763-8348

Sample Number
DPW-MWZ-17

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab
Contract: 5518
Operator: MLG
Matrix: WATER
Analysis Method: 70610F1.MTH
Sample Vol: 10 ML
Instrument Method: 70604F1.MTH
GC Column: CAP **ID:** 0.54 mm

Lab Sample ID: 1287
Vial Number: 3
Date Analyzed: 10 Jun 97 06:00 PM
Sequence Number: 1
Lab File ID: FID00003.D
Sequence Name: 1RUN0610
Sample Info: DPW-MWZ-17

Dilution Factor: 1
ISTD Amount: 20

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	18 U
156-60-5	trans-1,2-Dichloroethene	10 U
540-59-0	1, 1-Dichloroethane	2.5 U
75-34-3	cis-1, 2-Dichloroethene	10 U
156-59-2	Benzene	10.6
79-01-6	Trichloroethene	2.5 U
108-88-3	Toluene	8.7 J
106-46-7	1, 4-Dichlorobenzene	24.9
95-47-6	Xylene (o)	10 U

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Sample Number

OW-2

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab
Contract: 5518
Operator: MLG
Matrix: WATER
Analysis Method: 70604F1.MTH
Sample Vol: 10 ML
Instrument Method: 70604F1.MTH
GC Column: CAP **ID:** 0.54 mm

Lab Sample ID: 1277
Vial Number: 5
Date Analyzed: 06 Jun 97 02:59 PM
Sequence Number: 1
Lab File ID: FID00005.D
Sequence Name: 1RUN0606
Sample Info: OW-2

Dilution Factor: 1
ISTD Amount: 20

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	18 U
156-60-5	trans-1,2-Dichloroethene	10 U
540-59-0	1, 1-Dichloroethane	2.5 U
75-34-3	cis-1, 2-Dichloroethene	10 U
156-59-2	Benzene	5 U
79-01-6	Trichloroethene	2.5 U
108-88-3	Toluene	0.9 J
106-46-7	1, 4-Dichlorobenzene	10 U
95-47-6	Xylene (o)	10 U

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Sample Number
DPW-0W-2

Volatile Organics Analysis Data Sheet

Lab Name: NED Environmental Lab
Contract: 5518
Operator: MLG
Matrix: WATER
Analysis Method: 70604F1.MTH
Sample Vol: 10 ML
Instrument Method: 70604F1.MTH
GC Column: CAP **ID:** 0.54 mm

Lab Sample ID: 1273
Vial Number: 9
Date Analyzed: 06 Jun 97 01:59 AM
Sequence Number: 1
Lab File ID: FID00009.D
Sequence Name: 1RUN0605
Sample Info: DPW-0W-2
Dilution Factor: 1
ISTD Amount: 20

CAS NO.	COMPOUND	CONCENTRATION (ug/L) - Q
75-01-4	Vinyl Chloride	18 U
156-60-5	trans-1,2-Dichloroethene	10 U
540-59-0	1, 1-Dichloroethane	2.5 U
75-34-3	cis-1, 2-Dichloroethene	10 U
156-59-2	Benzene	5 U
79-01-6	Trichloroethene	2.5 U
108-88-3	Toluene	0.7 J
106-46-7	1, 4-Dichlorobenzene	10 U
95-47-6	Xylene (o)	10 U

SAMPLING ROUND 2
MARCH 1999

Committed To *Your* Success

Severn Trent Laboratories
55 South Park Drive
Colchester VT 05446

Tel: (802) 655-1203
Fax: (802) 655-1248

Analytical Report

Applied Research Associates
RR Box 120A
Waterman Road
So. Royalton, VT 05068

Attention : Chris Bianchi

Date : 04/08/99
ETR Number : 73039
Project No.: 99000
No. Samples: 13
Arrived : 03/31/99

Standard analyses were performed in accordance with Methods for Analysis of Water and Wastes, EPA-600/4/79-020, Test Methods for Evaluating Solid Waste, SW-846, or Standard Methods for the Examination of Water and Wastewater. All results are in mg/l unless otherwise noted.

Lab No./ Method No.	Sample Description/ Parameter	Result
381424	DPW B241-S:03/26/99 @0955(Water)	
5030_8260B	Analysis, VOA Low Water	C
381425	MW-241S:03/26/99 @1120(Water)	
5030_8260B	Analysis, VOA Low Water	C
381426	MW2-06:03/26/99 @1405(Water)	
5030_8260B	Analysis, VOA Low Water	C
381427	MW2-06DUP:03/26/99 @1405(Water)	
5030_8260B	Analysis, VOA Low Water	C
381428	DPW MW2-06:03/26/99 @1535(Water)	
5030_8260B	Analysis, VOA Low Water	C
381429	DPW MW2-06DUP:03/26/99 @1535(Water)	
5030_8260B	Analysis, VOA Low Water	C
381430	032699-EB:03/26/99 @1620(Water)	
5030_8260B	Analysis, VOA Low Water	C
381431	032699-TB:03/26/99 (Water)	
5030_8260B	Analysis, VOA Low Water	C

Comments/Notes

C = Procedure/analysis completed

< Cont. Next Page >

Severn Trent Laboratories
55 South Park Drive
Colchester VT 05446
Tel: (802) 655-1203
Fax: (802) 655-1248

Committed To *Your* Success

Analytical Report

Applied Research Associates
RR Box 120A
Waterman Road
So. Royalton, VT 05068

Attention : Chris Bianchi

Date : 04/08/99
ETR Number : 73039
Project No.: 99000
No. Samples: 13
Arrived : 03/31/99

Standard analyses were performed in accordance with Methods for Analysis of Water and Wastes, EPA-600/4/79-020, Test Methods for Evaluating Solid Waste, SW-846, or Standard Methods for the Examination of Water and Wastewater. All results are in mg/l unless otherwise noted.

Lab No./ Method No.	Sample Description/ Parameter	Result
381432	DPW MWZ-07:03/29/99 @1115(Water)	
5030_8260B	Analysis, VOA Low Water	C
381433	MWZ-07:03/29/99 @1310(Water)	
5030_8260B	Analysis, VOA Low Water	C
381434	DPW MWZ-11:03/29/99 @1525(Water)	
5030_8260B	Analysis, VOA Low Water	C
381435	MWZ-11:03/29/99 @1635(Water)	
5030_8260B	Analysis, VOA Low Water	C
381436	032999-EB:03/29/99 @1700(Water)	
5030_8260B	Analysis, VOA Low Water	C

Comments/Notes

C = Procedure/analysis completed

< Last Page > Submitted By : Kim B. Watson STL VT

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The following Qualifiers may be used when reporting any Organic parameters analyzed by Gas Chromatography/mass Spectometry (GCMS). Any additional qualifiers used in the reports will be described in the case narrative. These flags are based on the EPA Contract Laboratory Program statement of work.

GC/MS Qualifiers

A-	The reported Tentatively Identified Compound (TIC) is a suspected Aldol-condensation product.
B-	The reported analyte was detected in the associated method blank as well as the sample.
D -	This flag identifies all compounds identified in an analysis at a secondary dilution factor. This flag alerts data users that any discrepancies between the concentrations reported for the dilutions may be due to dilution of the sample or extract. It additionally indicates that spike recoveries may have been diluted below quantifiable levels.
E-	Compound quantitation is above the instrument's calibration range for this analysis.
J -	Indicates an estimated value.
U-	Indicates compound was analyzed for but not detected above the reporting limit.
X,Y,Z -	Laboratory defined flags. These flags must be fully described, and such description attached to the Sample Data Summary Package and the case Narrative. Begin by using "X" and go on to "Y" as necessary. These flags may also be used to combine several flags, as needed.

Output of Disk Deliverables

Thu Apr 15 14:32:12 EDT 1999

VOA Disk Deliverables on Directory: /opt/tp/envision/results/73039.diskBOB_8260B.

V_N_99-04-02_13_42_NMYICVLCS.20
V_N_99-04-05_09_13_NMYALCS.20
V_N_99-04-05_10_38_VBLKH2.20
V_N_99-04-05_18_26_DPWB241-S.20
V_N_99-04-05_18_55_MW-241S.20
V_N_99-04-05_19_25_032699-EB.20
V_N_99-04-05_19_54_032699-TB.20
V_N_99-04-05_21_19_NMYBLCS.20
V_N_99-04-05_22_05_VBLKH6.20
V_N_99-04-06_00_44_MW2-06.20
V_N_99-04-06_01_13_MW2-06DUP.20
V_N_99-04-06_01_44_DPWMW2-06.20
V_N_99-04-06_02_13_DPWMW2-06DUP.20
V_N_99-04-06_02_43_MWZ-07.20
V_N_99-04-06_03_13_DPWMWZ-11.20
V_N_99-04-06_03_43_MWZ-11.20
V_N_99-04-06_04_12_DPWMWZ-07.20
V_N_99-04-06_09_39_NMYCLCS.20
V_N_99-04-06_10_49_VBLKH7.20
V_N_99-04-06_13_09_DPWMWZ-07RE.20

BNA Disk Deliverables on Directory: /opt/tp/envision/results/73039.diskBOB_8260B.

Output Disk File: //opt/tp/envision/results/73039.diskBOB_8260B/73039.VOA

Done.

Revised 4/15/99

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

APPRES SAMPLE NO.

DPW B241-S

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 73039

Matrix: (soil/water) WATER Lab Sample ID: 381424

Sample wt/vol: 5.000 (g/mL) ML Lab File ID: N381424V

Level: (low/med) LOW Date Received: 03/31/99

% Moisture: not dec. ________ Date Analyzed: 04/05/99

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-01-4	Vinyl Chloride	1.0	U
156-60-5	trans-1,2-Dichloroethene	1.0	U
75-34-3	1,1-Dichloroethane	1.0	U
156-59-2	cis-1,2-Dichloroethene	1.0	U
71-43-2	Benzene	1.0	U
79-01-6	Trichloroethene	1.0	U
108-88-3	Toluene	1.0	U
95-47-6	Xylene (o)	1.0	U
106-46-7	1,4-Dichlorobenzene	1.0	U

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

APPRES SAMPLE NO.

MW-241S

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 73039

Matrix: (soil/water) WATER Lab Sample ID: 381425

Sample wt/vol: 5.000 (g/mL) ML Lab File ID: N381425V

Level: (low/med) LOW Date Received: 03/31/99

% Moisture: not dec. ________ Date Analyzed: 04/05/99

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-01-4	Vinyl Chloride	1.0	U
156-60-5	trans-1,2-Dichloroethene	1.0	U
75-34-3	1,1-Dichloroethane	1.0	U
156-59-2	cis-1,2-Dichloroethene	1.6	
71-43-2	Benzene	1.0	U
79-01-6	Trichloroethene	2.8	
108-88-3	Toluene	1.0	U
95-47-6	Xylene (o)	1.0	U
106-46-7	1,4-Dichlorobenzene	1.0	U

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

APPRES SAMPLE NO.

MW2-06

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 73039

Matrix: (soil/water) WATER Lab Sample ID: 381426

Sample wt/vol: 5.000 (g/mL) ML Lab File ID: N381426V

Level: (low/med) LOW Date Received: 03/31/99

% Moisture: not dec. ________ Date Analyzed: 04/06/99

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-01-4	Vinyl Chloride	1.0	U
156-60-5	trans-1,2-Dichloroethene	1.0	U
75-34-3	1,1-Dichloroethane	1.0	U
156-59-2	cis-1,2-Dichloroethene	1.0	U
71-43-2	Benzene	1.1	
79-01-6	Trichloroethene	1.0	U
108-88-3	Toluene	1.0	U
95-47-6	Xylene (o)	1.0	U
106-46-7	1,4-Dichlorobenzene	1.0	U

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

APPRES SAMPLE NO.

MW2-06DUP

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 73039

Matrix: (soil/water) WATER Lab Sample ID: 381427

Sample wt/vol: 5.000 (g/mL) ML Lab File ID: N381427V

Level: (low/med) LOW Date Received: 03/31/99

% Moisture: not dec. ________ Date Analyzed: 04/06/99

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-01-4	Vinyl Chloride	1.0	U
156-60-5	trans-1,2-Dichloroethene	1.0	U
75-34-3	1,1-Dichloroethane	1.0	U
156-59-2	cis-1,2-Dichloroethene	1.0	U
71-43-2	Benzene	1.0	
79-01-6	Trichloroethene	1.0	U
108-88-3	Toluene	0.27	J
95-47-6	Xylene (o)	1.0	U
106-46-7	1,4-Dichlorobenzene	1.0	U

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

APPRES SAMPLE NO.

DPW MW2-06

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 73039

Matrix: (soil/water) WATER Lab Sample ID: 381428

Sample wt/vol: 5.000 (g/mL) ML Lab File ID: N381428V

Level: (low/med) LOW Date Received: 03/31/99

% Moisture: not dec. ________ Date Analyzed: 04/06/99

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL)

CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-01-4	Vinyl Chloride	1.0	U
156-60-5	trans-1,2-Dichloroethene	1.0	U
75-34-3	1,1-Dichloroethane	1.0	U
156-59-2	cis-1,2-Dichloroethene	1.0	U
71-43-2	Benzene	1.5	
79-01-6	Trichloroethene	1.0	U
108-88-3	Toluene	0.29	J
95-47-6	Xylene (o)	1.0	U
106-46-7	1,4-Dichlorobenzene	1.0	U

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

APPRES SAMPLE NO.

DPW MW2-06DUP

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 73039

Matrix: (soil/water) WATER Lab Sample ID: 381429

Sample wt/vol: 5.000 (g/mL) ML Lab File ID: N381429V

Level: (low/med) LOW Date Received: 03/31/99

% Moisture: not dec. ________ Date Analyzed: 04/06/99

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-01-4	Vinyl Chloride	1.0	U
156-60-5	trans-1,2-Dichloroethene	1.0	U
75-34-3	1,1-Dichloroethane	1.0	U
156-59-2	cis-1,2-Dichloroethene	1.0	U
71-43-2	Benzene	1.5	
79-01-6	Trichloroethene	1.0	U
108-88-3	Toluene	0.32	J
95-47-6	Xylene (o)	1.0	U
106-46-7	1,4-Dichlorobenzene	1.0	U

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

APPRES SAMPLE NO.

032699-EB

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 73039

Matrix: (soil/water) WATER Lab Sample ID: 381430

Sample wt/vol: 5.000 (g/mL) ML Lab File ID: N381430V

Level: (low/med) LOW Date Received: 03/31/99

% Moisture: not dec. ________ Date Analyzed: 04/05/99

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-01-4	Vinyl Chloride	1.0	U
156-60-5	trans-1,2-Dichloroethene	1.0	U
75-34-3	1,1-Dichloroethane	1.0	U
156-59-2	cis-1,2-Dichloroethene	1.0	U
71-43-2	Benzene	1.0	U
79-01-6	Trichloroethene	1.0	U
108-88-3	Toluene	1.0	U
95-47-6	Xylene (o)	1.0	U
106-46-7	1,4-Dichlorobenzene	1.0	U

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

APPRES SAMPLE NO.

032699-TB

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 73039

Matrix: (soil/water) WATER Lab Sample ID: 381431

Sample wt/vol: 5.000 (g/mL) ML Lab File ID: N381431V

Level: (low/med) LOW Date Received: 03/31/99

% Moisture: not dec. ________ Date Analyzed: 04/05/99

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-01-4	Vinyl Chloride	1.0	U
156-60-5	trans-1,2-Dichloroethene	1.0	U
75-34-3	1,1-Dichloroethane	1.0	U
156-59-2	cis-1,2-Dichloroethene	1.0	U
71-43-2	Benzene	1.0	U
79-01-6	Trichloroethene	1.0	U
108-88-3	Toluene	0.77	J
95-47-6	Xylene (o)	1.0	U
106-46-7	1,4-Dichlorobenzene	1.0	U

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

APPRES SAMPLE NO.

DPW MWZ-07

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 73039

Matrix: (soil/water) WATER Lab Sample ID: 381432

Sample wt/vol: 5.000 (g/mL) ML Lab File ID: N381432V

Level: (low/med) LOW Date Received: 03/31/99

% Moisture: not dec. ________ Date Analyzed: 04/06/99

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-01-4	Vinyl Chloride	0.73	J
156-60-5	trans-1,2-Dichloroethene	1.0	U
75-34-3	1,1-Dichloroethane	1.0	U
156-59-2	cis-1,2-Dichloroethene	1.3	
71-43-2	Benzene	1.8	
79-01-6	Trichloroethene	1.0	U
108-88-3	Toluene	4.2	
95-47-6	Xylene (o)	1.0	U
106-46-7	1,4-Dichlorobenzene	1.0	U

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

APPRES SAMPLE NO.

DPW MWZ-07RE

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 73039

Matrix: (soil/water) WATER Lab Sample ID: 381432R1

Sample wt/vol: 5.000 (g/mL) ML Lab File ID: N381432I2V

Level: (low/med) LOW Date Received: 03/31/99

% Moisture: not dec. ________ Date Analyzed: 04/06/99

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL)

CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L

CAS NO.	COMPOUND	CONCENTRATION (UG/L)	Q
75-01-4	Vinyl Chloride	0.69	J
156-60-5	trans-1,2-Dichloroethene	1.0	U
75-34-3	1,1-Dichloroethane	1.0	U
156-59-2	cis-1,2-Dichloroethene	1.3	
71-43-2	Benzene	1.7	
79-01-6	Trichloroethene	1.0	U
108-88-3	Toluene	3.7	
95-47-6	Xylene (o)	0.27	J
106-46-7	1,4-Dichlorobenzene	1.0	U

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

APPRES SAMPLE NO.

MWZ-07

Lab Name: SEVERN TRENT LABORATORIES   Contract: 99000

Lab Code: INCHVT   Case No.: 99000   SAS No.:   SDG No.: 73039

Matrix: (soil/water) WATER   Lab Sample ID: 381433

Sample wt/vol: 5.000 (g/mL) ML   Lab File ID: N381433V

Level: (low/med) LOW   Date Received: 03/31/99

% Moisture: not dec. ________   Date Analyzed: 04/06/99

GC Column: DB-624   ID: 0.53 (mm)   Dilution Factor: 1.0

Soil Extract Volume:________(uL)   Soil Aliquot Volume: ________(uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-01-4	Vinyl Chloride	1.8	
156-60-5	trans-1,2-Dichloroethene	1.0	U
75-34-3	1,1-Dichloroethane	1.0	U
156-59-2	cis-1,2-Dichloroethene	3.2	
71-43-2	Benzene	0.22	J
79-01-6	Trichloroethene	1.6	
108-88-3	Toluene	1.0	U
95-47-6	Xylene (o)	1.0	U
106-46-7	1,4-Dichlorobenzene	1.0	U

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

APPRES SAMPLE NO.

DPW MWZ-11

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 73039

Matrix: (soil/water) WATER Lab Sample ID: 381434

Sample wt/vol: 5.000 (g/mL) ML Lab File ID: N381434V

Level: (low/med) LOW Date Received: 03/31/99

% Moisture: not dec. ________ Date Analyzed: 04/06/99

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-01-4	Vinyl Chloride	1.0	U
156-60-5	trans-1,2-Dichloroethene	1.0	U
75-34-3	1,1-Dichloroethane	1.0	U
156-59-2	cis-1,2-Dichloroethene	0.38	J
71-43-2	Benzene	0.54	J
79-01-6	Trichloroethene	0.53	J
108-88-3	Toluene	1.0	U
95-47-6	Xylene (o)	1.0	U
106-46-7	1,4-Dichlorobenzene	1.0	U

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

APPRES SAMPLE NO.

MWZ-11

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 73039

Matrix: (soil/water) WATER Lab Sample ID: 381435

Sample wt/vol: 5.000 (g/mL) ML Lab File ID: N381435V

Level: (low/med) LOW Date Received: 03/31/99

% Moisture: not dec. ________ Date Analyzed: 04/06/99

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-01-4	Vinyl Chloride	1.0	U
156-60-5	trans-1,2-Dichloroethene	1.0	U
75-34-3	1,1-Dichloroethane	1.0	U
156-59-2	cis-1,2-Dichloroethene	1.0	U
71-43-2	Benzene	1.0	U
79-01-6	Trichloroethene	1.0	U
108-88-3	Toluene	1.0	U
95-47-6	Xylene (o)	1.0	U
106-46-7	1,4-Dichlorobenzene	1.0	U

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

NMY ICVLCS

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 73039

Matrix: (soil/water) WATER Lab Sample ID: NMY ICVLCS

Sample wt/vol: 5.000 (g/mL) ML Lab File ID: NMY010QV

Level: (low/med) LOW Date Received: ________

% Moisture: not dec. ________ Date Analyzed: 04/02/99

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-71-8	Dichlorodifluoromethane	12	
74-87-3	Chloromethane	11	
75-01-4	Vinyl Chloride	11	
74-83-9	Bromomethane	10	
75-00-3	Chloroethane	12	
75-69-4	Trichlorofluoromethane	10	
107-02-8	Acrolein	49	
76-13-1	Freon TF	10	
75-35-4	1,1-Dichloroethene	10	
67-64-1	Acetone	51	
74-88-4	Methyl Iodide	11	
75-15-0	Carbon Disulfide	10	
107-05-1	Allyl Chloride	10	
75-09-2	Methylene Chloride	9.8	
107-13-1	Acrylonitrile	11	
156-60-5	trans-1,2-Dichloroethene	10	
540-59-0	1,2-Dichloroethene (total)	21	
1634-04-4	Methyl-t-Butyl Ether	11	
75-34-3	1,1-Dichloroethane	11	
108-05-4	Vinyl Acetate	11	
126-99-8	Chloroprene	10	
156-59-2	cis-1,2-Dichloroethene	11	
78-93-3	2-Butanone	56	
107-12-0	Propionitrile	46	
126-98-7	Methacrylonitrile	13	
74-97-5	Bromochloromethane	11	
109-99-9	Tetrahydrofuran	150	
67-66-3	Chloroform	10	
71-55-6	1,1,1-Trichloroethane	10	
56-23-5	Carbon Tetrachloride	11	
78-83-1	Isobutyl Alcohol	600	
71-43-2	Benzene	10	
107-06-2	1,2-Dichloroethane	11	

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

NMY ICVLCS

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 73039

Matrix: (soil/water) WATER Lab Sample ID: NMY ICVLCS

Sample wt/vol: 5.000 (g/mL) ML Lab File ID: NMY010QV

Level: (low/med) LOW Date Received: ________

% Moisture: not dec. ________ Date Analyzed: 04/02/99

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
79-01-6	Trichloroethene	11	
78-87-5	1,2-Dichloropropane	11	
80-62-6	Methyl Methacrylate	10	
74-95-3	Dibromomethane	10	
123-91-1	1,4-Dioxane	580	
75-27-4	Bromodichloromethane	11	
110-75-8	2-Chloroethyl Vinyl Ether	12	
10061-01-5	cis-1,3-Dichloropropene	10	
108-10-1	4-Methyl-2-pentanone	55	
108-88-3	Toluene	10	
10061-02-6	trans-1,3-Dichloropropene	10	
97-63-2	Ethyl Methacrylate	11	
79-00-5	1,1,2-Trichloroethane	10	
127-18-4	Tetrachloroethene	9.2	
591-78-6	2-Hexanone	55	
124-48-1	Dibromochloromethane	11	
106-93-4	1,2-Dibromoethane	11	
108-90-7	Chlorobenzene	11	
630-20-6	1,1,1,2-Tetrachloroethane	11	
100-41-4	Ethylbenzene	10	
1330-20-7	Xylene (total)	33	
100-42-5	Styrene	11	
75-25-2	Bromoform	11	
98-82-8	Isopropylbenzene	10	
1476-11-5	cis-1,4-Dichloro-2-butene	10	
79-34-5	1,1,2,2-Tetrachloroethane	11	
95-47-6	Xylene (o)	11	
96-18-4	1,2,3-Trichloropropane	11	
110-57-6	trans-1,4-Dichloro-2-butene	11	
541-73-1	1,3-Dichlorobenzene	10	
106-46-7	1,4-Dichlorobenzene	11	
95-50-1	1,2-Dichlorobenzene	10	
96-12-8	1,2-Dibromo-3-Chloropropane	10	

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

NMY ICVLCS

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 73039

Matrix: (soil/water) WATER Lab Sample ID: NMY ICVLCS

Sample wt/vol: 5.000 (g/mL) ML Lab File ID: NMY010QV

Level: (low/med) LOW Date Received: ________

% Moisture: not dec. ________ Date Analyzed: 04/02/99

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
120-82-1	1,2,4-Trichlorobenzene	10	
87-68-3	Hexachlorobutadiene	10	
91-20-3	Naphthalene	10	
590-20-7	2,2-Dichloropropane	10	
563-58-6	1,1-Dichloropropene	9.9	
142-28-9	1,3-Dichloropropane	10	
108-86-1	Bromobenzene	10	
103-65-1	n-Propylbenzene	11	
95-49-8	2-Chlorotoluene	11	
106-43-4	4-Chlorotoluene	10	
108-67-8	1,3,5-Trimethylbenzene	10	
98-06-6	tert-Butylbenzene	11	
95-63-6	1,2,4-Trimethylbenzene	10	
135-98-8	sec-Butylbenzene	10	
99-87-6	4-Isopropyltoluene	10	
104-51-8	n-Butylbenzene	10	
87-61-6	1,2,3-Trichlorobenzene	9.4	

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

NMYA LCS

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 73039

Matrix: (soil/water) WATER Lab Sample ID: NMYA LCS

Sample wt/vol: 5.000 (g/mL) ML Lab File ID: NMY010AQV

Level: (low/med) LOW Date Received: ________

% Moisture: not dec. ________ Date Analyzed: 04/05/99

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL)

CONCENTRATION UNITS:
(ug/L or ug/Kg) UG/L

CAS NO.	COMPOUND	UG/L	Q
75-01-4	Vinyl Chloride	11	
156-60-5	trans-1,2-Dichloroethene	9.8	
75-34-3	1,1-Dichloroethane	11	
156-59-2	cis-1,2-Dichloroethene	10	
71-43-2	Benzene	10	
79-01-6	Trichloroethene	10	
108-88-3	Toluene	10	
95-47-6	Xylene (o)	10	
106-46-7	1,4-Dichlorobenzene	11	

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

NMYB LCS

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 73039

Matrix: (soil/water) WATER Lab Sample ID: NMYB LCS

Sample wt/vol: 5.000 (g/mL) ML Lab File ID: NMY010BQV

Level: (low/med) LOW Date Received: ________

% Moisture: not dec. ________ Date Analyzed: 04/05/99

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-01-4	Vinyl Chloride	11	
156-60-5	trans-1,2-Dichloroethene	10	
75-34-3	1,1-Dichloroethane	11	
156-59-2	cis-1,2-Dichloroethene	11	
71-43-2	Benzene	9.9	
79-01-6	Trichloroethene	11	
108-88-3	Toluene	10	
95-47-6	Xylene (o)	11	
106-46-7	1,4-Dichlorobenzene	10	

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

NMYC LCS

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 73039

Matrix: (soil/water) WATER Lab Sample ID: NMYC LCS

Sample wt/vol: 5.000 (g/mL) ML Lab File ID: NMY010CQV

Level: (low/med) LOW Date Received: ________

% Moisture: not dec. ________ Date Analyzed: 04/06/99

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume: ________ (uL) Soil Aliquot Volume: ________ (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-01-4	Vinyl Chloride	11	
156-60-5	trans-1,2-Dichloroethene	9.8	
75-34-3	1,1-Dichloroethane	10	
156-59-2	cis-1,2-Dichloroethene	10	
71-43-2	Benzene	10	
79-01-6	Trichloroethene	10	
108-88-3	Toluene	9.7	
95-47-6	Xylene (o)	9.9	
106-46-7	1,4-Dichlorobenzene	10	

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

VBLKH2

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 73039

Matrix: (soil/water) WATER Lab Sample ID: VBLKH2

Sample wt/vol: 5.000 (g/mL) ML Lab File ID: NMYB001AV

Level: (low/med) LOW Date Received: ________

% Moisture: not dec. ________ Date Analyzed: 04/05/99

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-01-4	Vinyl Chloride	1.0	U
156-60-5	trans-1,2-Dichloroethene	1.0	U
75-34-3	1,1-Dichloroethane	1.0	U
156-59-2	cis-1,2-Dichloroethene	1.0	U
71-43-2	Benzene	1.0	U
79-01-6	Trichloroethene	1.0	U
108-88-3	Toluene	1.0	U
95-47-6	Xylene (o)	1.0	U
106-46-7	1,4-Dichlorobenzene	1.0	U

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

VBLKH6

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 73039

Matrix: (soil/water) WATER Lab Sample ID: VBLKH6

Sample wt/vol: 5.000 (g/mL) ML Lab File ID: NMYB001BV

Level: (low/med) LOW Date Received: ________

% Moisture: not dec. ________ Date Analyzed: 04/05/99

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-01-4	Vinyl Chloride	1.0	U
156-60-5	trans-1,2-Dichloroethene	1.0	U
75-34-3	1,1-Dichloroethane	1.0	U
156-59-2	cis-1,2-Dichloroethene	1.0	U
71-43-2	Benzene	1.0	U
79-01-6	Trichloroethene	1.0	U
108-88-3	Toluene	1.0	U
95-47-6	Xylene (o)	1.0	U
106-46-7	1,4-Dichlorobenzene	1.0	U

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

VBLKH7

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 73039

Matrix: (soil/water) WATER Lab Sample ID: VBLKH7

Sample wt/vol: 5.000 (g/mL) ML Lab File ID: NMYB001CV

Level: (low/med) LOW Date Received: ________

% Moisture: not dec. ________ Date Analyzed: 04/06/99

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-01-4	Vinyl Chloride	1.0	U
156-60-5	trans-1,2-Dichloroethene	1.0	U
75-34-3	1,1-Dichloroethane	1.0	U
156-59-2	cis-1,2-Dichloroethene	1.0	U
71-43-2	Benzene	1.0	U
79-01-6	Trichloroethene	1.0	U
108-88-3	Toluene	1.0	U
95-47-6	Xylene (o)	1.0	U
106-46-7	1,4-Dichlorobenzene	1.0	U

FORM 2
WATER VOLATILE SYSTEM MONITORING COMPOUND RECOVERY

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 73039

	CLIENT SAMPLE NO.	SMC1 (TOL) #	SMC2 (DCE) #	SMC3 (BFB) #	OTHER (DCB) #	TOT OUT
01	NMY ICVLCS	106	98	100	102	0
02	NMYA LCS	104	100	104	102	0
03	VBLKH2	108	104	108	102	0
04	DPW B241-S	108	100	106	108	0
05	MW-241S	102	104	104	100	0
06	032699-EB	106	104	112	110	0
07	032699-TB	108	110	110	108	0
08	NMYB LCS	106	100	106	104	0
09	VBLKH6	110	104	108	106	0
10	MW2-06	104	114	116	106	0
11	MW2-06DUP	106	104	116	106	0
12	DPW MW2-06	92	100	108	102	0
13	DPW MW2-06DU	94	96	104	104	0
14	MWZ-07	106	98	104	106	0
15	DPW MWZ-11	102	96	106	108	0
16	MWZ-11	108	96	120	114	0
17	DPW MWZ-07	120*	96	106	104	1
18	NMYC LCS	100	100	104	98	0
19	VBLKH7	104	98	108	106	0
20	DPW MWZ-07RE	118*	104	106	104	1
21						
22						
23						
24						
25						
26						
27						
28						
29						
30						

		QC LIMITS
SMC1 (TOL)	= Toluene-d8	(88-110)
SMC2 (DCE)	= 1,2-Dichloroethane-d4	(72-141)
SMC3 (BFB)	= Bromofluorobenzene	(72-122)
OTHER (DCB)	= 1,2-Dichlorobenzene-d4	(69-124)

Column to be used to flag recovery values

* Values outside of contract required QC limits

D System Monitoring Compound diluted out

FORM 3
WATER VOLATILE LAB CONTROL SAMPLE

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 73039

Matrix Spike - Sample No.: NMY ICVLCS

COMPOUND	SPIKE ADDED (ug/L)	SAMPLE CONCENTRATION (ug/L)	LCS CONCENTRATION (ug/L)	LCS % REC #	QC. LIMITS REC.
Xylene (m,p)	20		21	105	78-116
Dichlorodifluoromethane	10		12	120*	78-116
Chloromethane	10		11	110	68-118
Vinyl Chloride	10		11	110	78-118
Bromomethane	10		10	100	72-118
Chloroethane	10		12	120*	65-113
Trichlorofluoromethane	10		10	100	67-111
Acrolein	50		49	98	60-140
Freon TF	10		10	100	60-140
1,1-Dichloroethene	10		10	100	75-113
Acetone	50		51	102	60-140
Methyl Iodide	10		11	110	60-140
Carbon Disulfide	10		10	100	60-140
Allyl Chloride	10		10	100	60-140
Methylene Chloride	10		9.8	98	80-110
Acrylonitrile	10		11	110	60-140
trans-1,2-Dichloroethen	10		10	100	77-109
1,2-Dichloroethene (tot	20		21	105	60-140
Methyl-t-Butyl Ether	10		11	110	60-140
1,1-Dichloroethane	10		11	110	81-111
Vinyl Acetate	10		11	110	60-140
Chloroprene	10		10	100	60-140
cis-1,2-Dichloroethene	10		11	110	81-121
2-Butanone	50		56	112	60-140
Propionitrile	100		46	46*	60-140
Methacrylonitrile	10		13	130	60-140
Bromochloromethane	10		11	110*	73-107
Tetrahydrofuran	140		150	107	60-140

Column to be used to flag recovery and RPD values with an asterisk

* Values outside of QC limits

COMMENTS: ______________________

FORM 3
WATER VOLATILE LAB CONTROL SAMPLE

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 73039

Matrix Spike - Sample No.: NMY ICVLCS

COMPOUND	SPIKE ADDED (ug/L)	SAMPLE CONCENTRATION (ug/L)	LCS CONCENTRATION (ug/L)	LCS % REC #	QC. LIMITS REC.
Chloroform	10		10	100	74-106
1,1,1-Trichloroethane	10		10	100	74-122
Carbon Tetrachloride	10		11	110*	62-106
Isobutyl Alcohol	500		600	120	60-140
Benzene	10		10	100	78-116
1,2-Dichloroethane	10		11	110	80-110
Trichloroethene	10		11	110*	70-109
1,2-Dichloropropane	10		11	110	79-115
Methyl Methacrylate	10		10	100	60-140
Dibromomethane	10		10	100	83-117
1,4-Dioxane	500		580	116	60-140
Bromodichloromethane	10		11	110	78-112
2-Chloroethyl Vinyl Eth	10		12	120	60-140
cis-1,3-Dichloropropene	10		10	100	60-140
4-Methyl-2-pentanone	50		55	110	60-140
Toluene	10		10	100	78-126
trans-1,3-Dichloroprope	10		10	100	60-140
Ethyl Methacrylate	10		11	110	60-140
1,1,2-Trichloroethane	10		10	100	81-126
Tetrachloroethene	10		9.2	92	71-107
2-Hexanone	50		55	110	60-140
Dibromochloromethane	10		11	110	72-112
1,2-Dibromoethane	10		11	110	90-114
Chlorobenzene	10		11	110	81-115
1,1,1,2-Tetrachloroetha	10		11	110*	72-108
Ethylbenzene	10		10	100	74-124
Xylene (total)	30		33	110	60-140
Styrene	10		11	110	80-124

Column to be used to flag recovery and RPD values with an asterisk

* Values outside of QC limits

COMMENTS: ______

FORM 3
WATER VOLATILE LAB CONTROL SAMPLE

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 73039

Matrix Spike - Sample No.: NMY ICVLCS

COMPOUND	SPIKE ADDED (ug/L)	SAMPLE CONCENTRATION (ug/L)	LCS CONCENTRATION (ug/L)	LCS % REC #	QC. LIMITS REC.
Bromoform	10		11	110	82-120
Isopropylbenzene	10		10	100	78-124
cis-1,4-Dichloro-2-bute	10		10	100	60-140
1,1,2,2-Tetrachloroetha	10		11	110*	74-108
Xylene (o)	10		11	110	81-125
1,2,3-Trichloropropane	10		11	110	81-137
trans-1,4-Dichloro-2-bu	10		11	110	60-140
1,3-Dichlorobenzene	10		10	100	79-119
1,4-Dichlorobenzene	10		11	110	83-123
1,2-Dichlorobenzene	10		10	100	76-110
1,2-Dibromo-3-Chloropro	10		10	100	33-132
1,2,4-Trichlorobenzene	10		10	100	81-135
Hexachlorobutadiene	10		10	100	80-120
Naphthalene	10		10	100	78-130
2,2-Dichloropropane	10		10	100	42-130
1,1-Dichloropropene	10		9.9	99	72-124
1,3-Dichloropropane	10		10	100	79-113
Bromobenzene	10		10	100	84-116
n-Propylbenzene	10		11	110	83-117
2-Chlorotoluene	10		11	110*	73-107
4-Chlorotoluene	10		10	100	74-124
1,3,5-Trimethylbenzene	10		10	100	72-112
tert-Butylbenzene	10		11	110	80-124
1,2,4-Trimethylbenzene	10		10	100	75-123
sec-Butylbenzene	10		10	100	77-123
4-Isopropyltoluene	10		10	100	79-119
n-Butylbenzene	10		10	100	77-123
1,2,3-Trichlorobenzene	10		9.4	94	81-137

Column to be used to flag recovery and RPD values with an asterisk

* Values outside of QC limits

COMMENTS: ______________________

FORM 3
WATER VOLATILE LAB CONTROL SAMPLE

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 73039

Matrix Spike - Sample No.: NMYA LCS

COMPOUND	SPIKE ADDED (ug/L)	SAMPLE CONCENTRATION (ug/L)	LCS CONCENTRATION (ug/L)	LCS % REC #	QC. LIMITS REC.
Xylene (o)	10		10	100	81-125
Vinyl Chloride	10		11	110	78-118
trans-1,2-Dichloroethen	10		9.8	98	77-109
1,1-Dichloroethane	10		11	110	81-111
cis-1,2-Dichloroethene	10		10	100	81-121
Benzene	10		10	100	78-116
Trichloroethene	10		10	100	70-109
Toluene	10		10	100	78-126
1,4-Dichlorobenzene	10		11	110	83-123

Column to be used to flag recovery and RPD values with an asterisk

* Values outside of QC limits

RPD: 0 out of 0 outside limits
Spike Recovery: 0 out of 9 outside limits

COMMENTS: ______________________

FORM 3
WATER VOLATILE LAB CONTROL SAMPLE

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 73039

Matrix Spike - Sample No.: NMYB LCS

COMPOUND	SPIKE ADDED (ug/L)	SAMPLE CONCENTRATION (ug/L)	LCS CONCENTRATION (ug/L)	LCS % REC #	QC. LIMITS REC.
Xylene (o)	10		11	110	81-125
Vinyl Chloride	10		11	110	78-118
trans-1,2-Dichloroethen	10		10	100	77-109
1,1-Dichloroethane	10		11	110	81-111
cis-1,2-Dichloroethene	10		11	110	81-121
Benzene	10		9.9	99	78-116
Trichloroethene	10		11	110*	70-109
Toluene	10		10	100	78-126
1,4-Dichlorobenzene	10		10	100	83-123

Column to be used to flag recovery and RPD values with an asterisk

* Values outside of QC limits

RPD: 0 out of 0 outside limits
Spike Recovery: 1 out of 9 outside limits

COMMENTS: ______________________________

FORM 3
WATER VOLATILE LAB CONTROL SAMPLE

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 73039

Matrix Spike - Sample No.: NMYC LCS

COMPOUND	SPIKE ADDED (ug/L)	SAMPLE CONCENTRATION (ug/L)	LCS CONCENTRATION (ug/L)	LCS % REC #	QC. LIMITS REC.
Xylene (o)	10		9.9	99	81-125
Vinyl Chloride	10		11	110	78-118
trans-1,2-Dichloroethen	10		9.8	98	77-109
1,1-Dichloroethane	10		10	100	81-111
cis-1,2-Dichloroethene	10		10	100	81-121
Benzene	10		10	100	78-116
Trichloroethene	10		10	100	70-109
Toluene	10		9.7	97	78-126
1,4-Dichlorobenzene	10		10	100	83-123

Column to be used to flag recovery and RPD values with an asterisk

* Values outside of QC limits

RPD: 0 out of 0 outside limits
Spike Recovery: 0 out of 9 outside limits

COMMENTS: ____________________

FORM 4
VOLATILE METHOD BLANK SUMMARY

CLIENT SAMPLE NO.

VBLKH2

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 73039

Lab File ID: NMYB001AV Lab Sample ID: VBLKH2

Date Analyzed: 04/05/99 Time Analyzed: 1038

GC Column: DB-624 ID: 0.53 (mm) Heated Purge: (Y/N) N

Instrument ID: N

THIS METHOD BLANK APPLIES TO THE FOLLOWING SAMPLES, MS and MSD:

	SAMPLE NO.	LAB SAMPLE ID	LAB FILE ID	TIME ANALYZED
01	NMYA LCS	NMYA LCS	NMY010AQV	0913
02	DPW B241-S	381424	N381424V	1826
03	MW-241S	381425	N381425V	1855
04	032699-EB	381430	N381430V	1925
05	032699-TB	381431	N381431V	1954
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COMMENTS:

FORM 4
VOLATILE METHOD BLANK SUMMARY

CLIENT SAMPLE NO.

VBLKH6

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 73039

Lab File ID: NMYB001BV Lab Sample ID: VBLKH6

Date Analyzed: 04/05/99 Time Analyzed: 2205

GC Column: DB-624 ID: 0.53 (mm) Heated Purge: (Y/N) N

Instrument ID: N

THIS METHOD BLANK APPLIES TO THE FOLLOWING SAMPLES, MS and MSD:

	SAMPLE NO.	LAB SAMPLE ID	LAB FILE ID	TIME ANALYZED
01	NMYB LCS	NMYB LCS	NMY010BQV	2119
02	MW2-06	381426	N381426V	0044
03	MW2-06DUP	381427	N381427V	0113
04	DPW MW2-06	381428	N381428V	0144
05	DPW MW2-06DU	381429	N381429V	0213
06	MWZ-07	381433	N381433V	0243
07	DPW MWZ-11	381434	N381434V	0313
08	MWZ-11	381435	N381435V	0343
09	DPW MWZ-07	381432	N381432V	0412
10				
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COMMENTS:

FORM 4
VOLATILE METHOD BLANK SUMMARY

CLIENT SAMPLE NO.

VBLKH7

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 73039

Lab File ID: NMYB001CV Lab Sample ID: VBLKH7

Date Analyzed: 04/06/99 Time Analyzed: 1049

GC Column: DB-624 ID: 0.53 (mm) Heated Purge: (Y/N) N

Instrument ID: N

THIS METHOD BLANK APPLIES TO THE FOLLOWING SAMPLES, MS and MSD:

	SAMPLE NO.	LAB SAMPLE ID	LAB FILE ID	TIME ANALYZED
01	NMYC LCS	NMYC LCS	NMY010CQV	0939
02	DPW MWZ-07RE	381432R1	N381432I2V	1309
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COMMENTS:

Severn Trent Laboratories
55 South Park Drive
Colchester VT 05446

Tel: (802) 655-1203
Fax: (802) 655-1248

Committed To *Your* Success

Analytical Report

Applied Research Associates
RR Box 120A
Waterman Road
So. Royalton, VT 05068

Attention : Chris Bianchi

Date : 04/07/99
ETR Number : 72980
Project No.: 99000
No. Samples: 18
Arrived : 03/26/99

Standard analyses were performed in accordance with Methods for Analysis of Water and Wastes, EPA-600/4/79-020, Test Methods for Evaluating Solid Waste, SW-846, or Standard Methods for the Examination of Water and Wastewater. All results are in mg/l unless otherwise noted.

Lab No./ Method No.	Sample Description/ Parameter	Result
380940	DPW-RAP2-2T:03/23/99 @1120(Water)	
5030_8260B	Analysis, VOA Low Water	C
380941	RAP2-2T:03/23/99 @1355(Water)	
5030_8260B	Analysis, VOA Low Water	C
380942	RAP2-4S:03/23/99 @1600(Water)	
5030_8260B	Analysis, VOA Low Water	C
380943	DPW-RAP2-4S:03/23/99 @1715(Water)	
5030_8260B	Analysis, VOA Low Water	C
380944	DPW-RAP2-2S:03/24/99 @0910(Water)	
5030_8260B	Analysis, VOA Low Water	C
380945	RAP2-2S:03/24/99 @1130(Water)	
5030_8260B	Analysis, VOA Low Water	C
380946	RAP1-6S:03/24/99 @1310(Water)	
5030_8260B	Analysis, VOA Low Water	C
380947	DPW-RAP1-6S:03/24/99 @1430(Water)	
5030_8260B	Analysis, VOA Low Water	C

Comments/Notes

C = Procedure/analysis completed

< Cont. Next Page >

Committed To *Your* Success

Severn Trent Laboratories
55 South Park Drive
Colchester VT 05446

Tel: (802) 655-1203
Fax: (802) 655-1248

Analytical Report

Applied Research Associates
RR Box 120A
Waterman Road
So. Royalton, VT 05068

Attention : Chris Bianchi

Date : 04/07/99
ETR Number : 72980
Project No.: 99000
No. Samples: 18
Arrived : 03/26/99

Standard analyses were performed in accordance with Methods for Analysis of Water and Wastes, EPA-600/4/79-020, Test Methods for Evaluating Solid Waste, SW-846, or Standard Methods for the Examination of Water and Wastewater. All results are in mg/l unless otherwise noted.

Lab No./ Method No.	Sample Description/ Parameter	Result
380948	032399-EB:03/23/99 @1740(Water)	
5030_8260B	Analysis, VOA Low Water	C
380949	032499-EB:03/24/99 @1500(Water)	
5030_8260B	Analysis, VOA Low Water	C
380950	032599-TB:03/17/99 (Water)	
5030_8260B	Analysis, VOA Low Water	C
380951	DPW-B109:03/25/99 @1050(Water)	
5030_8260B	Analysis, VOA Low Water	C
380952	DPW-B109 DUP:03/25/99 @1050(Water)	
5030_8260B	Analysis, VOA Low Water	C
380953	MWB-109:03/25/99 @1240(Water)	
5030_8260B	Analysis, VOA Low Water	C
380954	MWB-109 DUP:03/25/99 @1240(Water)	
5030_8260B	Analysis, VOA Low Water	C
380955	OW2-6:03/25/99 @1510(Water)	
5030_8260B	Analysis, VOA Low Water	C

Comments/Notes

C = Procedure/analysis completed

< Cont. Next Page >

Committed To *Your* Success

Severn Trent Laboratories
55 South Park Drive
Colchester VT 05446
Tel: (802) 655-1203
Fax: (802) 655-1248

Analytical Report

Applied Research Associates
RR Box 120A
Waterman Road
So. Royalton, VT 05068

Attention : Chris Bianchi

Date : 04/07/99
ETR Number : 72980
Project No.: 99000
No. Samples: 18
Arrived : 03/26/99

Standard analyses were performed in accordance with Methods for Analysis of Water and Wastes, EPA-600/4/79-020, Test Methods for Evaluating Solid Waste, SW-846, or Standard Methods for the Examination of Water and Wastewater. All results are in mg/l unless otherwise noted.

Lab No./ Method No.	Sample Description/ Parameter	Result
380956	DPW2-6:03/25/99 @1640(Water)	
5030_8260B	Analysis, VOA Low Water	C
380957	032599-EB:03/25/99 @1705(Water)	
5030_8260B	Analysis, VOA Low Water	C

Comments/Notes

C = Procedure/analysis completed

< Last Page > Submitted By : Kim B. Watson STL VT

Committed To *Your* Success

The following Qualifiers may be used when reporting any Organic parameters analyzed by Gas Chromatography/mass Spectometry (GCMS). Any additional qualifiers used in the reports will be described in the case narrative. These flags are based on the EPA Contract Laboratory Program statement of work.

GC/MS Qualifiers

A- The reported Tentatively Identified Compound (TIC) is a suspected Aldol-condensation product.

B- The reported analyte was detected in the associated method blank as well as the sample.

D - This flag identifies all compounds identified in an analysis at a secondary dilution factor. This flag alerts data users that any discrepancies between the concentrations reported for the dilutions may be due to dilution of the sample or extract. It additionally indicates that spike recoveries may have been diluted below quantifiable levels.

E- Compound quantitation is above the instrument's calibration range for this analysis.

J - Indicates an estimated value.

U- Indicates compound was analyzed for but not detected above the reporting limit.

X,Y,Z - Laboratory defined flags. These flags must be fully described, and such description attached to the Sample Data Summary Package and the case Narrative. Begin by using "X" and go on to "Y" as necessary. These flags may also be used to combine several flags, as needed.

Output of Disk Deliverables

Thu Apr 15 13:58:02 EDT 1999

VOA Disk Deliverables on Directory: /opt/tp/envision/results/72980.diskBOB_8260B.

```
V_N_99-04-02_13_42_NMYICVLCS.20
V_N_99-04-02_14_57_VBLKG9.20
V_N_99-04-02_15_23_RAP2-2T.20
V_N_99-04-02_15_53_RAP2-4S.20
V_N_99-04-02_16_23_DPW-RAP2-4S.20
V_N_99-04-02_16_54_DPW-RAP2-2S.20
V_N_99-04-02_17_24_RAP2-2S.20
V_N_99-04-02_17_54_RAP1-6S.20
V_N_99-04-02_18_24_DPW-RAP1-6S.20
V_N_99-04-02_18_54_032399-EB.20
V_N_99-04-02_19_23_032499-EB.20
V_N_99-04-02_19_54_DPW-RAP2-2T.20
V_N_99-04-05_09_13_NMYALCS.20
V_N_99-04-05_10_38_VBLKH2.20
V_N_99-04-05_12_01_DPW-RAP2-2SDL.20
V_N_99-04-05_12_27_032599-TB.20
V_N_99-04-05_12_58_DPW-B109.20
V_N_99-04-05_13_29_DPW-B109DUP.20
V_N_99-04-05_13_59_MWB-109.20
V_N_99-04-05_14_30_MWB-109DUP.20
V_N_99-04-05_15_01_OW2-6.20
V_N_99-04-05_15_31_DPW2-6.20
V_N_99-04-05_16_01_032599-EB.20
```

BNA Disk Deliverables on Directory: /opt/tp/envision/results/72980.diskBOB_8260B.

Output Disk File: //opt/tp/envision/results/72980.diskBOB_8260B/72980.VOA

Done.

Revised
4/15/99
QR

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

APPRES SAMPLE NO.

DPW-RAP2-2T

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 72980

Matrix: (soil/water) WATER Lab Sample ID: 380940

Sample wt/vol: 5.000 (g/mL) ML Lab File ID: N380940D2V

Level: (low/med) LOW Date Received: 03/26/99

% Moisture: not dec. ________ Date Analyzed: 04/02/99

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 65.7

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-01-4	Vinyl Chloride	290	
156-60-5	trans-1,2-Dichloroethene	66	U
75-34-3	1,1-Dichloroethane	120	
156-59-2	cis-1,2-Dichloroethene	2600	
71-43-2	Benzene	66	U
79-01-6	Trichloroethene	750	
108-88-3	Toluene	66	U
95-47-6	Xylene (o)	66	U
106-46-7	1,4-Dichlorobenzene	66	U

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

APPRES SAMPLE NO.

RAP2-2T

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 72980

Matrix: (soil/water) WATER Lab Sample ID: 380941

Sample wt/vol: 5.000 (g/mL) ML Lab File ID: N380940DV

Level: (low/med) LOW Date Received: 03/26/99

% Moisture: not dec. ________ Date Analyzed: 04/02/99

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 71.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-01-4	Vinyl Chloride	310	
156-60-5	trans-1,2-Dichloroethene	71	U
75-34-3	1,1-Dichloroethane	120	
156-59-2	cis-1,2-Dichloroethene	2700	
71-43-2	Benzene	71	U
79-01-6	Trichloroethene	800	
108-88-3	Toluene	71	U
95-47-6	Xylene (o)	71	U
106-46-7	1,4-Dichlorobenzene	71	U

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

APPRES SAMPLE NO.

RAP2-4S

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 72980

Matrix: (soil/water) WATER Lab Sample ID: 380942

Sample wt/vol: 5.000 (g/mL) ML Lab File ID: N380941DV

Level: (low/med) LOW Date Received: 03/26/99

% Moisture: not dec. ________ Date Analyzed: 04/02/99

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-01-4	Vinyl Chloride	1.0	U
156-60-5	trans-1,2-Dichloroethene	1.0	U
75-34-3	1,1-Dichloroethane	1.0	U
156-59-2	cis-1,2-Dichloroethene	1.0	U
71-43-2	Benzene	1.0	U
79-01-6	Trichloroethene	1.0	U
108-88-3	Toluene	1.0	U
95-47-6	Xylene (o)	1.0	U
106-46-7	1,4-Dichlorobenzene	1.0	U

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

APPRES SAMPLE NO.

DPW-RAP2-4S

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 72980

Matrix: (soil/water) WATER Lab Sample ID: 380943

Sample wt/vol: 5.000 (g/mL) ML Lab File ID: N380942V

Level: (low/med) LOW Date Received: 03/26/99

% Moisture: not dec. ________ Date Analyzed: 04/02/99

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-01-4	Vinyl Chloride	1.0	U
156-60-5	trans-1,2-Dichloroethene	1.0	U
75-34-3	1,1-Dichloroethane	1.0	U
156-59-2	cis-1,2-Dichloroethene	1.0	U
71-43-2	Benzene	1.0	U
79-01-6	Trichloroethene	0.58	J
108-88-3	Toluene	1.0	U
95-47-6	Xylene (o)	1.0	U
106-46-7	1,4-Dichlorobenzene	1.0	U

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

APPRES SAMPLE NO.

DPW-RAP2-2S

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 72980

Matrix: (soil/water) WATER Lab Sample ID: 380944

Sample wt/vol: 5.000 (g/mL) ML Lab File ID: N380943V

Level: (low/med) LOW Date Received: 03/26/99

% Moisture: not dec. ________ Date Analyzed: 04/02/99

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-01-4	Vinyl Chloride	1.0	U
156-60-5	trans-1,2-Dichloroethene	1.0	U
75-34-3	1,1-Dichloroethane	1.0	U
156-59-2	cis-1,2-Dichloroethene	120	E
71-43-2	Benzene	1.0	U
79-01-6	Trichloroethene	10	
108-88-3	Toluene	1.0	U
95-47-6	Xylene (o)	1.0	U
106-46-7	1,4-Dichlorobenzene	1.0	U

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

APPRES SAMPLE NO.

DPW-RAP2-2SDL

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 72980

Matrix: (soil/water) WATER Lab Sample ID: 380944D1

Sample wt/vol: 5.000 (g/mL) ML Lab File ID: N380944DV

Level: (low/med) LOW Date Received: 03/26/99

% Moisture: not dec. ________ Date Analyzed: 04/05/99

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 3.1

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-01-4	Vinyl Chloride	3.1	U
156-60-5	trans-1,2-Dichloroethene	3.1	U
75-34-3	1,1-Dichloroethane	3.1	U
156-59-2	cis-1,2-Dichloroethene	150	D
71-43-2	Benzene	3.1	U
79-01-6	Trichloroethene	12	D
108-88-3	Toluene	3.1	U
95-47-6	Xylene (o)	3.1	U
106-46-7	1,4-Dichlorobenzene	3.1	U

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

APPRES SAMPLE NO.

RAP2-2S

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 72980

Matrix: (soil/water) WATER Lab Sample ID: 380945

Sample wt/vol: 5.000 (g/mL) ML Lab File ID: N380944V

Level: (low/med) LOW Date Received: 03/26/99

% Moisture: not dec. ________ Date Analyzed: 04/02/99

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-01-4	Vinyl Chloride	1.0	U
156-60-5	trans-1,2-Dichloroethene	1.0	U
75-34-3	1,1-Dichloroethane	1.0	U
156-59-2	cis-1,2-Dichloroethene	1.0	U
71-43-2	Benzene	1.0	U
79-01-6	Trichloroethene	1.0	U
108-88-3	Toluene	1.0	U
95-47-6	Xylene (o)	1.0	U
106-46-7	1,4-Dichlorobenzene	1.0	U

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

APPRES SAMPLE NO.

RAP1-6S

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 72980

Matrix: (soil/water) WATER Lab Sample ID: 380946

Sample wt/vol: 5.000 (g/mL) ML Lab File ID: N380945V

Level: (low/med) LOW Date Received: 03/26/99

% Moisture: not dec. ________ Date Analyzed: 04/02/99

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-01-4	Vinyl Chloride	1.0	U
156-60-5	trans-1,2-Dichloroethene	1.0	U
75-34-3	1,1-Dichloroethane	1.0	U
156-59-2	cis-1,2-Dichloroethene	8.4	
71-43-2	Benzene	1.0	U
79-01-6	Trichloroethene	2.7	
108-88-3	Toluene	1.0	U
95-47-6	Xylene (o)	1.0	U
106-46-7	1,4-Dichlorobenzene	1.0	U

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

APPRES SAMPLE NO.

DPW-RAP1-6S

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 72980

Matrix: (soil/water) WATER Lab Sample ID: 380947

Sample wt/vol: 5.000 (g/mL) ML Lab File ID: N380946V

Level: (low/med) LOW Date Received: 03/26/99

% Moisture: not dec. ________ Date Analyzed: 04/02/99

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-01-4	Vinyl Chloride	1.0	U
156-60-5	trans-1,2-Dichloroethene	1.0	U
75-34-3	1,1-Dichloroethane	1.0	U
156-59-2	cis-1,2-Dichloroethene	1.0	U
71-43-2	Benzene	1.0	U
79-01-6	Trichloroethene	1.0	U
108-88-3	Toluene	1.0	U
95-47-6	Xylene (o)	1.0	U
106-46-7	1,4-Dichlorobenzene	1.0	U

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

APPRES SAMPLE NO.

032399-EB

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 72980

Matrix: (soil/water) WATER Lab Sample ID: 380948

Sample wt/vol: 5.000 (g/mL) ML Lab File ID: N380947V

Level: (low/med) LOW Date Received: 03/26/99

% Moisture: not dec. ________ Date Analyzed: 04/02/99

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-01-4	Vinyl Chloride	1.0	U
156-60-5	trans-1,2-Dichloroethene	1.0	U
75-34-3	1,1-Dichloroethane	1.0	U
156-59-2	cis-1,2-Dichloroethene	1.0	U
71-43-2	Benzene	1.0	U
79-01-6	Trichloroethene	1.0	U
108-88-3	Toluene	0.48	J
95-47-6	Xylene (o)	1.0	U
106-46-7	1,4-Dichlorobenzene	1.0	U

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

APPRES SAMPLE NO.

032499-EB

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 72980

Matrix: (soil/water) WATER Lab Sample ID: 380949

Sample wt/vol: 5.000 (g/mL) ML Lab File ID: N380948V

Level: (low/med) LOW Date Received: 03/26/99

% Moisture: not dec. ________ Date Analyzed: 04/02/99

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-01-4	Vinyl Chloride	1.0	U
156-60-5	trans-1,2-Dichloroethene	1.0	U
75-34-3	1,1-Dichloroethane	1.0	U
156-59-2	cis-1,2-Dichloroethene	1.0	U
71-43-2	Benzene	1.0	U
79-01-6	Trichloroethene	1.0	U
108-88-3	Toluene	0.35	J
95-47-6	Xylene (o)	1.0	U
106-46-7	1,4-Dichlorobenzene	1.0	U

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

APPRES SAMPLE NO.

032599-TB

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 72980

Matrix: (soil/water) WATER Lab Sample ID: 380950

Sample wt/vol: 5.000 (g/mL) ML Lab File ID: N380950V

Level: (low/med) LOW Date Received: 03/26/99

% Moisture: not dec. ________ Date Analyzed: 04/05/99

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL)

CONCENTRATION UNITS:
(ug/L or ug/Kg) UG/L

CAS NO.	COMPOUND	UG/L	Q
75-01-4	Vinyl Chloride	1.0	U
156-60-5	trans-1,2-Dichloroethene	1.0	U
75-34-3	1,1-Dichloroethane	1.0	U
156-59-2	cis-1,2-Dichloroethene	1.0	U
71-43-2	Benzene	1.0	U
79-01-6	Trichloroethene	1.0	U
108-88-3	Toluene	1.1	
95-47-6	Xylene (o)	1.0	U
106-46-7	1,4-Dichlorobenzene	1.0	U

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

APPRES SAMPLE NO.

DPW-B109

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 72980

Matrix: (soil/water) WATER Lab Sample ID: 380951

Sample wt/vol: 5.000 (g/mL) ML Lab File ID: N380951V

Level: (low/med) LOW Date Received: 03/26/99

% Moisture: not dec. ________ Date Analyzed: 04/05/99

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-01-4	Vinyl Chloride	1.0	U
156-60-5	trans-1,2-Dichloroethene	1.0	U
75-34-3	1,1-Dichloroethane	1.0	U
156-59-2	cis-1,2-Dichloroethene	4.5	
71-43-2	Benzene	1.0	U
79-01-6	Trichloroethene	8.2	
108-88-3	Toluene	1.4	
95-47-6	Xylene (o)	1.0	U
106-46-7	1,4-Dichlorobenzene	1.0	U

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

APPRES SAMPLE NO.

DPW-B109 DUP

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 72980

Matrix: (soil/water) WATER Lab Sample ID: 380952

Sample wt/vol: 5.000 (g/mL) ML Lab File ID: N380952V

Level: (low/med) LOW Date Received: 03/26/99

% Moisture: not dec. ________ Date Analyzed: 04/05/99

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-01-4	Vinyl Chloride	1.0	U
156-60-5	trans-1,2-Dichloroethene	1.0	U
75-34-3	1,1-Dichloroethane	1.0	U
156-59-2	cis-1,2-Dichloroethene	4.7	
71-43-2	Benzene	1.0	U
79-01-6	Trichloroethene	9.2	
108-88-3	Toluene	1.0	U
95-47-6	Xylene (o)	1.0	U
106-46-7	1,4-Dichlorobenzene	1.0	U

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

APPRES SAMPLE NO.

MWB-109

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 72980

Matrix: (soil/water) WATER Lab Sample ID: 380953

Sample wt/vol: 5.000 (g/mL) ML Lab File ID: N380953V

Level: (low/med) LOW Date Received: 03/26/99

% Moisture: not dec. ________ Date Analyzed: 04/05/99

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-01-4	Vinyl Chloride	1.0	U
156-60-5	trans-1,2-Dichloroethene	1.0	U
75-34-3	1,1-Dichloroethane	1.0	U
156-59-2	cis-1,2-Dichloroethene	4.5	
71-43-2	Benzene	1.0	U
79-01-6	Trichloroethene	10	
108-88-3	Toluene	0.30	J
95-47-6	Xylene (o)	1.0	U
106-46-7	1,4-Dichlorobenzene	1.0	U

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

APPRES SAMPLE NO.

MWB-109 DUP

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 72980

Matrix: (soil/water) WATER Lab Sample ID: 380954

Sample wt/vol: 5.000 (g/mL) ML Lab File ID: N380954V

Level: (low/med) LOW Date Received: 03/26/99

% Moisture: not dec. ________ Date Analyzed: 04/05/99

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-01-4	Vinyl Chloride	1.0	U
156-60-5	trans-1,2-Dichloroethene	1.0	U
75-34-3	1,1-Dichloroethane	1.0	U
156-59-2	cis-1,2-Dichloroethene	5.2	
71-43-2	Benzene	1.0	U
79-01-6	Trichloroethene	10	
108-88-3	Toluene	1.0	U
95-47-6	Xylene (o)	1.0	U
106-46-7	1,4-Dichlorobenzene	1.0	U

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

APPRES SAMPLE NO.

OW2-6

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 72980

Matrix: (soil/water) WATER Lab Sample ID: 380955

Sample wt/vol: 5.000 (g/mL) ML Lab File ID: N380955DV

Level: (low/med) LOW Date Received: 03/26/99

% Moisture: not dec. ________ Date Analyzed: 04/05/99

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 195.6

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-01-4	Vinyl Chloride	200	U
156-60-5	trans-1,2-Dichloroethene	200	U
75-34-3	1,1-Dichloroethane	140	J
156-59-2	cis-1,2-Dichloroethene	4100	
71-43-2	Benzene	200	U
79-01-6	Trichloroethene	6700	
108-88-3	Toluene	200	U
95-47-6	Xylene (o)	200	U
106-46-7	1,4-Dichlorobenzene	200	U

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

APPRES SAMPLE NO.

DPW2-6

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 72980

Matrix: (soil/water) WATER Lab Sample ID: 380956

Sample wt/vol: 5.000 (g/mL) ML Lab File ID: N380956DV

Level: (low/med) LOW Date Received: 03/26/99

% Moisture: not dec. ________ Date Analyzed: 04/05/99

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 33.8

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-01-4	Vinyl Chloride	21	J
156-60-5	trans-1,2-Dichloroethene	34	U
75-34-3	1,1-Dichloroethane	47	
156-59-2	cis-1,2-Dichloroethene	1200	
71-43-2	Benzene	34	U
79-01-6	Trichloroethene	430	
108-88-3	Toluene	34	U
95-47-6	Xylene (o)	34	U
106-46-7	1,4-Dichlorobenzene	34	U

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

APPRES SAMPLE NO.

032599-EB

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 72980

Matrix: (soil/water) WATER Lab Sample ID: 380957

Sample wt/vol: 5.000 (g/mL) ML Lab File ID: N380957V

Level: (low/med) LOW Date Received: 03/26/99

% Moisture: not dec. ________ Date Analyzed: 04/05/99

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-01-4	Vinyl Chloride	1.0	U
156-60-5	trans-1,2-Dichloroethene	1.0	U
75-34-3	1,1-Dichloroethane	1.0	U
156-59-2	cis-1,2-Dichloroethene	1.0	U
71-43-2	Benzene	1.0	U
79-01-6	Trichloroethene	0.25	J
108-88-3	Toluene	1.6	
95-47-6	Xylene (o)	1.0	U
106-46-7	1,4-Dichlorobenzene	1.0	U

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

VBLKG9

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 72980

Matrix: (soil/water) WATER Lab Sample ID: VBLKG9

Sample wt/vol: 5.000 (g/mL) ML Lab File ID: NMYB002V

Level: (low/med) LOW Date Received: ________

% Moisture: not dec. ________ Date Analyzed: 04/02/99

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-01-4	Vinyl Chloride	1.0	U
156-60-5	trans-1,2-Dichloroethene	1.0	U
75-34-3	1,1-Dichloroethane	1.0	U
156-59-2	cis-1,2-Dichloroethene	1.0	U
71-43-2	Benzene	1.0	U
79-01-6	Trichloroethene	1.0	U
108-88-3	Toluene	1.0	U
95-47-6	Xylene (o)	1.0	U
106-46-7	1,4-Dichlorobenzene	1.0	U

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

VBLKH2

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 72980

Matrix: (soil/water) WATER Lab Sample ID: VBLKH2

Sample wt/vol: 5.000 (g/mL) ML Lab File ID: NMYB001AV

Level: (low/med) LOW Date Received: ________

% Moisture: not dec. ________ Date Analyzed: 04/05/99

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-01-4	Vinyl Chloride	1.0	U
156-60-5	trans-1,2-Dichloroethene	1.0	U
75-34-3	1,1-Dichloroethane	1.0	U
156-59-2	cis-1,2-Dichloroethene	1.0	U
71-43-2	Benzene	1.0	U
79-01-6	Trichloroethene	1.0	U
108-88-3	Toluene	1.0	U
95-47-6	Xylene (o)	1.0	U
106-46-7	1,4-Dichlorobenzene	1.0	U

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

NMYA LCS

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 72980

Matrix: (soil/water) WATER Lab Sample ID: NMYA LCS

Sample wt/vol: 5.000 (g/mL) ML Lab File ID: NMY010AQV

Level: (low/med) LOW Date Received: ________

% Moisture: not dec. ________ Date Analyzed: 04/05/99

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-01-4	Vinyl Chloride	11	
156-60-5	trans-1,2-Dichloroethene	9.8	
75-34-3	1,1-Dichloroethane	11	
156-59-2	cis-1,2-Dichloroethene	10	
71-43-2	Benzene	10	
79-01-6	Trichloroethene	10	
108-88-3	Toluene	10	
95-47-6	Xylene (o)	10	
106-46-7	1,4-Dichlorobenzene	11	

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

NMY ICVLCS

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 72980

Matrix: (soil/water) WATER Lab Sample ID: NMY ICVLCS

Sample wt/vol: 5.000 (g/mL) ML Lab File ID: NMY010QV

Level: (low/med) LOW Date Received: ________

% Moisture: not dec. ________ Date Analyzed: 04/02/99

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume: ________ (uL) Soil Aliquot Volume: ________ (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-71-8	Dichlorodifluoromethane	12	
74-87-3	Chloromethane	11	
75-01-4	Vinyl Chloride	11	
74-83-9	Bromomethane	10	
75-00-3	Chloroethane	12	
75-69-4	Trichlorofluoromethane	10	
107-02-8	Acrolein	49	B
76-13-1	Freon TF	10	
75-35-4	1,1-Dichloroethene	10	
67-64-1	Acetone	51	B
74-88-4	Methyl Iodide	11	
75-15-0	Carbon Disulfide	10	
107-05-1	Allyl Chloride	10	
75-09-2	Methylene Chloride	9.8	
107-13-1	Acrylonitrile	11	B
156-60-5	trans-1,2-Dichloroethene	10	
540-59-0	1,2-Dichloroethene (total)	21	
1634-04-4	Methyl-t-Butyl Ether	11	
75-34-3	1,1-Dichloroethane	11	
108-05-4	Vinyl Acetate	11	
126-99-8	Chloroprene	10	
156-59-2	cis-1,2-Dichloroethene	11	
78-93-3	2-Butanone	56	
107-12-0	Propionitrile	46	B
126-98-7	Methacrylonitrile	13	
74-97-5	Bromochloromethane	11	
109-99-9	Tetrahydrofuran	150	
67-66-3	Chloroform	10	
71-55-6	1,1,1-Trichloroethane	10	
56-23-5	Carbon Tetrachloride	11	
78-83-1	Isobutyl Alcohol	600	B
71-43-2	Benzene	10	
107-06-2	1,2-Dichloroethane	11	

FORM 2
WATER VOLATILE SYSTEM MONITORING COMPOUND RECOVERY

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 72980

	CLIENT SAMPLE NO.	SMC1 (TOL) #	SMC2 (DCE) #	SMC3 (BFB) #	OTHER (DCB) #	TOT OUT
01	NMY ICVLCS	106	98	100	102	0
02	VBLKG9	104	98	104	102	0
03	RAP2-2T	106	100	108	104	0
04	RAP2-4S	106	100	110	104	0
05	DPW-RAP2-4S	104	106	104	102	0
06	DPW-RAP2-2S	104	108	110	108	0
07	RAP2-2S	104	102	114	112	0
08	RAP1-6S	106	104	112	108	0
09	DPW-RAP1-6S	104	108	108	102	0
10	032399-EB	110	102	106	104	0
11	032499-EB	106	100	110	108	0
12	DPW-RAP2-2T	110	104	120	114	0
13	NMYA LCS	104	100	104	102	0
14	VBLKH2	108	104	108	102	0
15	DPW-RAP2-2SD	104	106	108	104	0
16	032599-TB	106	100	108	108	0
17	DPW-B109	106	106	108	102	0
18	DPW-B109 DUP	104	104	104	104	0
19	MWB-109	108	106	112	110	0
20	MWB-109 DUP	106	104	100	102	0
21	OW2-6	106	106	108	106	0
22	DPW2-6	100	104	106	104	0
23	032599-EB	106	106	108	104	0
24						
25						
26						
27						
28						
29						
30						

		QC LIMITS
SMC1 (TOL)	= Toluene-d8	(88-110)
SMC2 (DCE)	= 1,2-Dichloroethane-d4	(72-141)
SMC3 (BFB)	= Bromofluorobenzene	(72-122)
OTHER(DCB)	= 1,2-Dichlorobenzene-d4	(69-124)

Column to be used to flag recovery values

* Values outside of contract required QC limits

D System Monitoring Compound diluted out

FORM 3
WATER VOLATILE LAB CONTROL SAMPLE

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 72980

Matrix Spike - Sample No.: NMY ICVLCS

COMPOUND	SPIKE ADDED (ug/L)	SAMPLE CONCENTRATION (ug/L)	LCS CONCENTRATION (ug/L)	LCS % REC #	QC. LIMITS REC.
Xylene (m,p)	20		21	105	78-116
Dichlorodifluoromethane	10		12	120*	78-116
Chloromethane	10		11	110	68-118
Vinyl Chloride	10		11	110	78-118
Bromomethane	10		10	100	72-118
Chloroethane	10		12	120*	65-113
Trichlorofluoromethane	10		10	100	67-111
Acrolein	50		49	98	60-140
Freon TF	10		10	100	60-140
1,1-Dichloroethene	10		10	100	75-113
Acetone	50		51	102	60-140
Methyl Iodide	10		11	110	60-140
Carbon Disulfide	10		10	100	60-140
Allyl Chloride	10		10	100	60-140
Methylene Chloride	10		9.8	98	80-110
Acrylonitrile	10		11	110	60-140
trans-1,2-Dichloroethen	10		10	100	77-109
1,2-Dichloroethene (tot	20		21	105	60-140
Methyl-t-Butyl Ether	10		11	110	60-140
1,1-Dichloroethane	10		11	110	81-111
Vinyl Acetate	10		11	110	60-140
Chloroprene	10		10	100	60-140
cis-1,2-Dichloroethene	10		11	110	81-121
2-Butanone	50		56	112	60-140
Propionitrile	100		46	46*	60-140
Methacrylonitrile	10		13	130	60-140
Bromochloromethane	10		11	110*	73-107
Tetrahydrofuran	140		150	107	60-140

Column to be used to flag recovery and RPD values with an asterisk

* Values outside of QC limits

COMMENTS: ____________________

FORM 3
WATER VOLATILE LAB CONTROL SAMPLE

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 72980

Matrix Spike - Sample No.: NMY ICVLCS

COMPOUND	SPIKE ADDED (ug/L)	SAMPLE CONCENTRATION (ug/L)	LCS CONCENTRATION (ug/L)	LCS % REC #	QC. LIMITS REC.
Chloroform	10		10	100	74-106
1,1,1-Trichloroethane	10		10	100	74-122
Carbon Tetrachloride	10		11	110*	62-106
Isobutyl Alcohol	500		600	120	60-140
Benzene	10		10	100	78-116
1,2-Dichloroethane	10		11	110	80-110
Trichloroethene	10		11	110*	70-109
1,2-Dichloropropane	10		11	110	79-115
Methyl Methacrylate	10		10	100	60-140
Dibromomethane	10		10	100	83-117
1,4-Dioxane	500		580	116	60-140
Bromodichloromethane	10		11	110	78-112
2-Chloroethyl Vinyl Eth	10		12	120	60-140
cis-1,3-Dichloropropene	10		10	100	60-140
4-Methyl-2-pentanone	50		55	110	60-140
Toluene	10		10	100	78-126
trans-1,3-Dichloroprope	10		10	100	60-140
Ethyl Methacrylate	10		11	110	60-140
1,1,2-Trichloroethane	10		10	100	81-126
Tetrachloroethene	10		9.2	92	71-107
2-Hexanone	50		55	110	60-140
Dibromochloromethane	10		11	110	72-112
1,2-Dibromoethane	10		11	110	90-114
Chlorobenzene	10		11	110	81-115
1,1,1,2-Tetrachloroetha	10		11	110*	72-108
Ethylbenzene	10		10	100	74-124
Xylene (total)	30		33	110	60-140
Styrene	10		11	110	80-124

Column to be used to flag recovery and RPD values with an asterisk

* Values outside of QC limits

COMMENTS: ______________________________________

FORM 3
WATER VOLATILE LAB CONTROL SAMPLE

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 72980

Matrix Spike - Sample No.: NMY ICVLCS

COMPOUND	SPIKE ADDED (ug/L)	SAMPLE CONCENTRATION (ug/L)	LCS CONCENTRATION (ug/L)	LCS % REC #	QC. LIMITS REC.
Bromoform	10		11	110	82-120
Isopropylbenzene	10		10	100	78-124
cis-1,4-Dichloro-2-bute	10		10	100	60-140
1,1,2,2-Tetrachloroetha	10		11	110*	74-108
Xylene (o)	10		11	110	81-125
1,2,3-Trichloropropane	10		11	110	81-137
trans-1,4-Dichloro-2-bu	10		11	110	60-140
1,3-Dichlorobenzene	10		10	100	79-119
1,4-Dichlorobenzene	10		11	110	83-123
1,2-Dichlorobenzene	10		10	100	76-110
1,2-Dibromo-3-Chloropro	10		10	100	33-132
1,2,4-Trichlorobenzene	10		10	100	81-135
Hexachlorcbutadiene	10		10	100	80-120
Naphthalene	10		10	100	78-130
2,2-Dichloropropane	10		10	100	42-130
1,1-Dichloropropene	10		9.9	99	72-124
1,3-Dichloropropane	10		10	100	79-113
Bromobenzene	10		10	100	84-116
n-Propylbenzene	10		11	110	83-117
2-Chlorotoluene	10		11	110*	73-107
4-Chlorotoluene	10		10	100	74-124
1,3,5-Trimethylbenzene	10		10	100	72-112
tert-Butylbenzene	10		11	110	80-124
1,2,4-Trimethylbenzene	10		10	100	75-123
sec-Butylbenzene	10		10	100	77-123
4-Isopropyltoluene	10		10	100	79-119
n-Butylbenzene	10		10	100	77-123
1,2,3-Trichlorobenzene	10		9.4	94	81-137

Column to be used to flag recovery and RPD values with an asterisk

* Values outside of QC limits

COMMENTS: ______

FORM 3
WATER VOLATILE LAB CONTROL SAMPLE

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 72980

Matrix Spike - Sample No.: NMYA LCS

COMPOUND	SPIKE ADDED (ug/L)	SAMPLE CONCENTRATION (ug/L)	LCS CONCENTRATION (ug/L)	LCS % REC #	QC. LIMITS REC.
Xylene (o)	10		10	100	81-125
Vinyl Chloride	10		11	110	78-118
trans-1,2-Dichloroethen	10		9.8	98	77-109
1,1-Dichloroethane	10		11	110	81-111
cis-1,2-Dichloroethene	10		10	100	81-121
Benzene	10		10	100	78-116
Trichloroethene	10		10	100	70-109
Toluene	10		10	100	78-126
1,4-Dichlorobenzene	10		11	110	83-123

Column to be used to flag recovery and RPD values with an asterisk

* Values outside of QC limits

RPD: 0 out of 0 outside limits
Spike Recovery: 0 out of 9 outside limits

COMMENTS: ______

FORM 4
VOLATILE METHOD BLANK SUMMARY

CLIENT SAMPLE NO.

VBLKG9

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 72980

Lab File ID: NMYB002V Lab Sample ID: VBLKG9

Date Analyzed: 04/02/99 Time Analyzed: 1457

GC Column: DB-624 ID: 0.53 (mm) Heated Purge: (Y/N) N

Instrument ID: N

THIS METHOD BLANK APPLIES TO THE FOLLOWING SAMPLES, MS and MSD:

	SAMPLE NO.	LAB SAMPLE ID	LAB FILE ID	TIME ANALYZED
01	NMY ICVLCS	NMY ICVLCS	NMY010QV	1342
02	RAP2-2T	380941	N380940DV	1523
03	RAP2-4S	380942	N380941DV	1553
04	DPW-RAP2-4S	380943	N380942V	1623
05	DPW-RAP2-2S	380944	N380943V	1654
06	RAP2-2S	380945	N380944V	1724
07	RAP1-6S	380946	N380945V	1754
08	DPW-RAP1-6S	380947	N380946V	1824
09	032399-EB	380948	N380947V	1854
10	032499-EB	380949	N380948V	1923
11	DPW-RAP2-2T	380940	N380940D2V	1954
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COMMENTS:

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

NMY ICVLCS

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 72980

Matrix: (soil/water) WATER Lab Sample ID: NMY ICVLCS

Sample wt/vol: 5.000 (g/mL) ML Lab File ID: NMY010QV

Level: (low/med) LOW Date Received: ________

% Moisture: not dec. ________ Date Analyzed: 04/02/99

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
79-01-6	Trichloroethene	11	
78-87-5	1,2-Dichloropropane	11	
80-62-6	Methyl Methacrylate	10	
74-95-3	Dibromomethane	10	
123-91-1	1,4-Dioxane	580	
75-27-4	Bromodichloromethane	11	
110-75-8	2-Chloroethyl Vinyl Ether	12	
10061-01-5	cis-1,3-Dichloropropene	10	
108-10-1	4-Methyl-2-pentanone	55	
108-88-3	Toluene	10	
10061-02-6	trans-1,3-Dichloropropene	10	
97-63-2	Ethyl Methacrylate	11	
79-00-5	1,1,2-Trichloroethane	10	
127-18-4	Tetrachloroethene	9.2	
591-78-6	2-Hexanone	55	
124-48-1	Dibromochloromethane	11	
106-93-4	1,2-Dibromoethane	11	
108-90-7	Chlorobenzene	11	
630-20-6	1,1,1,2-Tetrachloroethane	11	
100-41-4	Ethylbenzene	10	
1330-20-7	Xylene (total)	33	
100-42-5	Styrene	11	
75-25-2	Bromoform	11	
98-82-8	Isopropylbenzene	10	
1476-11-5	cis-1,4-Dichloro-2-butene	10	
79-34-5	1,1,2,2-Tetrachloroethane	11	
95-47-6	Xylene (o)	11	
96-18-4	1,2,3-Trichloropropane	11	
110-57-6	trans-1,4-Dichloro-2-butene	11	
541-73-1	1,3-Dichlorobenzene	10	
106-46-7	1,4-Dichlorobenzene	11	
95-50-1	1,2-Dichlorobenzene	10	
96-12-8	1,2-Dibromo-3-Chloropropane	10	

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

NMY ICVLCS

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 72980

Matrix: (soil/water) WATER Lab Sample ID: NMY ICVLCS

Sample wt/vol: 5.000 (g/mL) ML Lab File ID: NMY010QV

Level: (low/med) LOW Date Received: ________

% Moisture: not dec. ________ Date Analyzed: 04/02/99

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
120-82-1	1,2,4-Trichlorobenzene	10	
87-68-3	Hexachlorobutadiene	10	
91-20-3	Naphthalene	10	B
590-20-7	2,2-Dichloropropane	10	
563-58-6	1,1-Dichloropropene	9.9	
142-28-9	1,3-Dichloropropane	10	
108-86-1	Bromobenzene	10	
103-65-1	n-Propylbenzene	11	
95-49-8	2-Chlorotoluene	11	
106-43-4	4-Chlorotoluene	10	
108-67-8	1,3,5-Trimethylbenzene	10	
98-06-6	tert-Butylbenzene	11	
95-63-6	1,2,4-Trimethylbenzene	10	
135-98-8	sec-Butylbenzene	10	
99-87-6	4-Isopropyltoluene	10	
104-51-8	n-Butylbenzene	10	
87-61-6	1,2,3-Trichlorobenzene	9.4	

FORM 4
VOLATILE METHOD BLANK SUMMARY

CLIENT SAMPLE NO.

VBLKH2

Lab Name: SEVERN TRENT LABORATORIES Contract: 99000

Lab Code: INCHVT Case No.: 99000 SAS No.: SDG No.: 72980

Lab File ID: NMYB001AV Lab Sample ID: VBLKH2

Date Analyzed: 04/05/99 Time Analyzed: 1038

GC Column: DB-624 ID: 0.53 (mm) Heated Purge: (Y/N) N

Instrument ID: N

THIS METHOD BLANK APPLIES TO THE FOLLOWING SAMPLES, MS and MSD:

	SAMPLE NO.	LAB SAMPLE ID	LAB FILE ID	TIME ANALYZED
01	NMYA LCS	NMYA LCS	NMY010AQV	0913
02	DPW-RAP2-2SD	380944D1	N380944DV	1201
03	032599-TB	380950	N380950V	1227
04	DPW-B109	380951	N380951V	1258
05	DPW-B109 DUP	380952	N380952V	1329
06	MWB-109	380953	N380953V	1359
07	MWB-109 DUP	380954	N380954V	1430
08	OW2-6	380955	N380955DV	1501
09	DPW2-6	380956	N380956DV	1531
10	032599-EB	380957	N380957V	1601
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COMMENTS:

FORM IV VOA