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IAS TREATABILITY STUDY REPORT

OPERABLE UNIT NO. 10
(SITE 35)
MCB, CAMP LEJEUNE, NORTH CAROLINA

CONTRACT TASK ORDER 0323

NOVEMBER 14, 1996

Prepared for:

DEPARTMENT OF THE NAVY
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LIST OF ACRONYMS

acfm	actual cubic feet per minute
ASTs	Aboveground Storage Tanks
Baker	Baker Environmental, Inc.
bgs	below ground surface
BTEX	Benzene, Toluene, Ethylbenzene, and Xylenes
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfm	cubic feet per minute
CFR	Code of Federal Regulations
CHCs	Total Chlorinated Hydrocarbons
CLEAN	Comprehensive Long-Term Environmental Action Navy
DO	Dissolved Oxygen
DON	Department of the Navy
ESD	Explanation of Significant Differences
FFA	Federal Facilities Agreement
FS	Feasibility Study
gpm	gallons per minute
IAS	In Situ Air Sparging
LANTDIV	Atlantic Division, Naval Facilities Engineering Command
MCB	Marine Corps Base
µg/L	micrograms per liter
mg/L	milligrams per liter
NC DEHNR	North Carolina Department of Environment, Health and Natural Resources
NC DOT	North Carolina Department of Transportation
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
OU	Operable Unit
PID	Photoionization Detector
PRAP	Proposed Remedial Action Plan
psi	pounds per square inch
PVC	polyvinyl chloride
RAAs	Remedial Action Alternatives
RAOs	Remedial Action Objectives
RAC	Remedial Action Contract
RBCs	Risk-Based Concentrations
RCRA	Resource Conservation and Recovery Act

LIST OF ACRONYMS
(Continued)

RD	Remedial Design
ROD	Record of Decision
ROI	Radius of Influence
SARA	Superfund Amendments and Reauthorization Act
TLV	Threshold Limit Value
TWA	Time-Weighted Average
USCS	Unified Soil Classification System
USEPA	United States Environmental Protection Agency
USTs	Underground Storage Tanks
VOCs	Volatile Organic Compounds

EXECUTIVE SUMMARY

Introduction

This report has been prepared by Baker Environmental, Inc. to present the results of the In-Situ Air Sparging (IAS) Treatability Study conducted at Operable Unit No. 10, Site 35 Camp Geiger Area Fuel Farm during the summer of 1996. This report includes a summary of the IAS treatability study activities and results, conclusions and recommendations. It has been submitted to USEPA Region IV; the NC DEHNR; Camp Lejeune Environmental Management Department; OHM Corporation; and to the Naval Facilities Engineering Command, Atlantic Division for their review.

Purpose of the IAS Treatability Study

The purpose of the treatability study was as follows: to assess the applicability of IAS technology in addressing the shallow groundwater contamination at Site 35 by evaluating the effectiveness, implementability, and cost of a full-scale treatment system; to obtain sufficient data to afford the development of a full-scale system remedial design; and finally to assess the impact of air emissions on human health and the environment, and verify that air emissions will not impact the proposed highway project.

Site Location and Description

Camp Lejeune is located in Onslow County, North Carolina near the city of Jacksonville. It currently covers approximately 234 square miles and is bisected by the New River. Camp Geiger is located at the extreme northwest corner of Camp Lejeune and contains a mixture of troop housing, personnel support and training facilities. Camp Geiger is roughly bounded by Brinson Creek to the north and northeast, the abandoned Seaboard Railroad right of way to the east, Curtis Road to the south, and U.S. Route 17 to the west.

Site 35, Camp Geiger Area Fuel Farm refers a former fuel storage and dispensing facility that was located just north of the intersection of Fourth and "G" Streets. The Fuel Farm consisted primarily of five, 15,000-gallon aboveground storage tanks, a pump house, a fuel loading/unloading pad, an oil water separator, and a distribution island situated just north of the intersection of Fourth and "G" Streets. The facility actively served Camp Geiger and the New River Air Station from 1945 to the Spring of 1995, when it was demolished to make way for a six-lane divided highway proposed by the North Carolina Department of Transportation.

Site History

During the lifetime of the facility several releases of product occurred. Reports of a release from an underground distribution line near one of the ASTs date back to 1957-58. Apparently, the leak occurred as the result of damage to a dispensing pump. On another occasion, a leak in an underground line at the station was reportedly responsible for the loss of roughly 30 gallons per day of gasoline over an unspecified period (Law, 1992). The leaking line was subsequently sealed and replaced. In April 1990, an undetermined amount of fuel was discovered by Camp Geiger personnel along two unnamed drainage channels north of the Fuel Farm. Apparently, the source of the fuel, believed to be diesel or jet fuel, was an unauthorized discharge from a tanker truck.

Previous investigations have been conducted by Water and Air Research, Inc. (WAR), Environmental Science and Engineering (ESE), NUS Corporation (NUS), Law Engineering (Law), and Baker Environmental, Inc. (Baker).

IAS Treatability Study

The IAS treatability study consisted of the following activities: monitoring well and soil gas probe installation; pre-study sampling; the treatability study that occurred in two tests (deep and shallow air injection); and post-study sampling. The IAS treatability study occurred between July 9, 1996 and August 29, 1996.

Monitoring Well and Soil Gas Probe Installation

A total of 12 monitoring wells and two air injection wells were installed at Plume B, while a total of eleven monitoring wells and one air injection well were installed at Plume C. Six soil gas probes were installed at Plume B to monitor the vadose zone during the performance of the treatability study at the site.

Pre-Study Sampling

Pre-study sampling was conducted for a duration of 24 hours prior to the start-up of the IAS system. The system consisted of monitoring soil gas and groundwater to establish a baseline set of physical and chemical data conditions in the vadose zone and surficial aquifer.

Treatability Study

The treatability study was conducted at Plume B in two separate tests. Both test consisted of two phases of different air flow rates. The first test consisted of injecting air into the lower portion of the surficial aquifer at 7.5 acfm and 20 acfm. The second test consisted of injecting air into the upper portion of the aquifer at 5 and 20 acfm.

An approximate radius of influence of 20 feet was observed during phase I (7.5 acfm) of the deep air injection test. Phase II (20 acfm) of the deep injection test yielded an approximate radius of influence of 25 feet. A radius of influence was not observed during phase I (5 acfm) of the shallow air injection test. Phase II (20 acfm) of the shallow air injection test yielded an approximate radius of influence of ten feet.

Post-Study Sampling

Post-study sampling was conducted for a duration of 24 hours following the commencement of the study. The sampling consisted of monitoring soil gas and groundwater at the site as it returns to steady conditions. The sampling also monitored any changes to the baseline physical and chemical data conditions in the aquifer and vadose zone that may have occurred as a result of the treatability study.

Site Geology

In general the findings of the treatability study are consistent with the findings of the supplemental groundwater investigation and the remedial investigation. The upper most soils at Plume B consist of peat with lesser amounts of sand, silt, and clay. The upper most soils at Plume C consist of sand with lesser amounts of silt and clay. Immediately below this are calcareous sands with varying amounts of shell and fossiliferous limestone fragments. A generally fine sand with lesser amounts of clay is present below the calcareous sands and shell/limestone fragments. This layer is generally known as the Castle Hayne confining unit and is colored a distinctive greenish-gray and has a noticeable change in moisture content, becoming dryer.

Conclusions

Based on the results of the IAS treatability study it can be concluded that:

- IAS via vertical air injection will have limited effectiveness remediating CHCs at the base of the surficial aquifer. The semi-confining unit is too impermeable to allow air injection below the base of the surficial aquifer and underneath the contaminants.

- Vertical air injection in the area of the Plume C treatability study wells is inappropriate due to the presence of a subsurface clay layer. This clay layer will inhibit the vertical release of contaminants to the atmosphere and may result in the horizontal migration of contaminants off site.

- Results of groundwater sampling indicate BTEX contamination is not present in the area of the Plume B or Plume C wells. There are three possible reasons for the lack of contamination at these locations:

    1) The source of the contamination has been removed during the previous soil removal action at the former fuel farm.

    2) The contamination has not migrated to the IAS treatability study location.

    3) The contamination is being naturally attenuated in the approximately 10-foot thick peat bog located along the banks of Brinson Creek.

- Vertical air injection from the deep air injection wells did have a favorable impact at Plume B. A radius of influence of 20 feet was observed at a flow rate of 7.5 acfm. The radius of influence increased to approximately 30 feet when the air flow was increased to 20 acfm.

- Vertical air injection from the shallow air injection wells did not have a favorable impact at Plume B. Due to the lack of shear strength of the peat material, air pathways were unable to be developed and sustained from an air injection point just below the peat layer.

- Due to BTEX results, IAS, if implemented in the area between the eastern edge of the proposed right-of-way and Brinson Creek, will not impact the BTEX contamination.

Recommendations

- An IAS system where air is injected horizontally along the top of the semi-confining layer is preferable to conventional vertical air injection. Such a system should be more effective in remediating the CHC and BTEX contamination at this site. It is estimated that the cost of this system should be approximately equal to RAA 3, Groundwater Collection and On-Site Treatment, which was identified as the preferred contingent alternative in the Final Interim ROD (Baker, 1995).

- Due to poor site conditions, difficult access, and a lack of BTEX contamination in groundwater in the area between the eastern edge of the proposed right-of-way and Brinson Creek, an IAS system will likely be more effective if constructed along the western edge of the proposed right-of-way as shown on Figure 7-1.

- A field pilot test of a horizontal IAS system should be conducted in the area west of the proposed right-of-way to ensure it's effectiveness prior to full-scale implementation.

1.0 INTRODUCTION

This Treatability Study Report has been prepared by Baker Environmental, Inc. (Baker) under the United States Department of the Navy (DON), Atlantic Division, Naval Facilities Engineering Command (LANTDIV) Comprehensive Long-Term Environmental Action Navy (CLEAN) Program for Contract Task Order 0323, Operable Unit (OU) No. 10, Site 35 - Camp Geiger Area Fuel Farm, Marine Corps Base (MCB), Camp Lejeune, North Carolina. The treatability study was conducted as part of the Remedial Design (RD) for surficial groundwater at Site 35. This document has been prepared in accordance with the requirements of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) for remedial actions [40 Code of Federal Regulations (CFR) 300.430]. The NCP regulations were promulgated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), commonly referred to as Superfund, and amended by the Superfund Amendments and Reauthorization Act (SARA) signed into law on October 17, 1986. The USEPA's document Guide for Conducting Treatability Studies Under CERCLA (USEPA, 1992) has been used as guidance for preparing this document.

Camp Lejeune was placed on the CERCLA National Priorities List (NPL) on October 4, 1989 (54 Federal Register 41015, October 4, 1989). The United States Environmental Protection Agency (USEPA) Region IV, the North Carolina Department of Environment, Health and Natural Resources (NC DEHNR) and the DON then entered into a Federal Facilities Agreement (FFA) for Camp Lejeune. The primary purpose of the FFA is to ensure that environmental impacts associated with past and present activities at Camp Lejeune are thoroughly investigated and appropriate CERCLA response/Resource Conservation and Recovery Act (RCRA) corrective action alternatives are developed and implemented as necessary to protect public health and the environment.

1.1 Purpose and Organization

The purpose of this document is to present the results of the treatability study of in-situ air sparging (IAS) technology conducted at Site 35.

Section 1.0 of this document includes this introduction and site background information. Section 2.0 contains a description of in situ air sparging (IAS) technology and its limitations along with a discussion of remedial design/remedial action implementation considerations. The objectives of the treatability study are presented in Section 3.0. The monitoring well and soil gas probe installation details are provided in Section 4.0 along with a discussion of the site geology and hydrogeology. Section 5.0 contains the pilot test procedures and operations. The results from the pilot test are described in Section 6.0. Conclusions and recommendations for the pilot test are provided in Section 7.0.

1.2 Site Background

1.2.1 Site Location and Description

Camp Lejeune is a training base for the U.S. Marine Corps, located in Onslow County, North Carolina. The Activity, as the base is referred to, covers approximately 236 square miles and includes 14 miles of coastline. Camp Lejeune is bounded to the southeast by the Atlantic Ocean, to the northeast by State Route 24, and to the west by U.S. Route 17. The town of Jacksonville, North Carolina, is located north of the Activity (see Figure 1-1).

Camp Geiger is located at the extreme northwest corner of Camp Lejeune. The main entrance to Camp Geiger is off U.S. Route 17, approximately 3.5 miles southwest of the city of Jacksonville, North Carolina. Site 35, the decommissioned Camp Geiger Area Fuel Farm, refers primarily to five, 15,000-gallon aboveground storage tanks (ASTs), a pump house, and a fuel unloading pad formerly situated within Camp Geiger just north of the intersection of Fourth and G Streets (see Figure 1-2).

Site 35 is contained within OU No. 10, one of 17 operable units at Camp Lejeune. An "operable unit," as defined by the NCP, is a discrete action that comprises an incremental step toward comprehensively addressing site problems.

The Interim Feasibility Study (FS) study area consists of a portion of OU No. 10 measuring approximately 18 acres. More specifically, the study area consists of contaminated groundwater in the portion of the surficial aquifer that is located roughly between the former fuel farm and Brinson Creek (see Figure 1-2).

1.2.2 Site History

Construction of Camp Geiger was completed in 1945, four years after construction of Camp Lejeune was initiated. Originally, the ASTs were used for the storage of No. 6 fuel oil, but were later converted for storage of other petroleum products including unleaded gasoline, diesel fuel, and kerosene. The date of their conversion is not known. The ASTs at the site are reported to be the original tanks. Demolition of the fuel farm ASTs was completed in 1995.

Product was dispensed from the ASTs via trucks and underground piping. Routinely, the ASTs at Site 35 supplied fuel to an adjacent dispensing pump. A leak in the underground line from the ASTs to the dispensing island was reportedly responsible for the loss of roughly 30 gallons per day of gasoline over an unspecified period (Law, 1992). The leaking line was subsequently sealed and replaced.

The ASTs at Site 35 were used to dispense gasoline, diesel, and kerosene to government vehicles and to supply underground storage tanks (USTs) in use at Camp Geiger and the nearby New River Marine Corps Air Station until the spring of 1995. The ASTs were supplied by commercial carrier trucks which delivered product to fill ports located on the fuel unloading pad at the southern end of the facility. Six short-run (120 feet maximum), underground fuel lines were utilized to distribute the product from the unloading pad to the ASTs.

Reports of a release from an underground distribution line near one of the ASTs date back to 1957-58 (ESE, 1990). Apparently, the leak occurred as the result of damage to a dispensing pump. At that time, the Camp Lejeune Fire Department estimated that thousands of gallons of fuel were released, although records of the incident cannot be located. The fuel reportedly migrated to the east and northeast toward Brinson Creek. Interceptor trenches were excavated and the captured fuel was ignited and burned.

Another abandoned underground distribution line extended from the ASTs to the former Mess Hall Heating Plant, located adjacent to D Street, between Third and Fourth Streets. The underground line dispensed No. 6 fuel oil to a UST which fueled the Mess Hall boiler. The Mess Hall, located across "D" Street to the west, is believed to have been demolished along with its Heating Plant in the 1960s.

In April 1990, an undetermined amount of fuel had been discovered by Camp Geiger personnel along the unnamed drainage channels north of the fuel farm. Apparently, the source of the fuel, believed to be diesel or jet fuel, was an unauthorized discharge from a tanker truck that was never identified. The Activity reportedly initiated an emergency clean-up action that included the removal of approximately 20 cubic yards of soil.

Decommissioning of the fuel farm began in the spring of 1995 and was completed in July 1995. The ASTs were cleaned, dismantled and removed along with associated concrete foundations, slabs on grade, berms, and underground piping. The fuel farm was removed to make way for a six-lane, divided highway proposed by the North Carolina Department of Transportation (NC DOT) (see Figure 1-2).

In addition to the fuel farm dismantling, soil remediation activities began in August 1995 along the highway right-of-way as per an Interim Record of Decision (ROD) executed on September 15, 1994. To date, all identified contaminated soil has been excavated and removed from the site.

1.2.3 Previous Investigations and Findings

Previous investigations conducted at Site 35 include the Initial Assessment Study of Marine Corps Base, Camp Lejeune, North Carolina (WAR, 1983); Final Site Summary Report, MCB Camp Lejeune (ESE, 1990); Draft Field Investigation/Focused Feasibility Study, Camp Geiger Fuel Spill Site (NUS, 1990); Underground Fuel Investigation and Comprehensive Site Assessment (Law, 1992); Addendum Report of Underground Fuel Investigation and Comprehensive Site Assessment (Law, 1993); Interim Remedial Action Remedial Investigation/Feasibility Study for Soil (Baker, 1994); Comprehensive Remedial Investigation Report (Baker, 1995a); and Interim Feasibility Study for Surficial Groundwater in the vicinity of the Former Fuel Farm (Baker, 1995b).

A comprehensive RI was conducted by Baker in 1994 to evaluate the nature and extent of the threat to public health and the environment caused by the release of hazardous substances, pollutants, or contaminants, and to support a Feasibility Study evaluation of potential remedial alternatives. The RI field program was initiated on April 11, 1994. Data gathering activities were derived from a soil gas survey and groundwater screening investigation, a soil investigation, a groundwater investigation, a surface water and sediment investigation, and an ecological investigation. In April 1996, Baker performed a supplemental field investigation to characterize the vertical and horizontal extent of fuel- and solvent-related contamination along the proposed IAS curtain boundary. This investigation consisted of installation and sampling of a total of 36 temporary monitoring wells. These wells were installed at 12 locations and as 3-well clusters designed to monitor the upper, middle, and lower regions of the surficial aquifer (see Figure 2-3).

Several areas of fuel- and solvent-related groundwater contamination were identified in the surficial aquifer in the area north of Fourth Street. Organic contaminant concentrations detected in the upper and lower portions of the surficial aquifer during the May 1994 sampling round, conducted by Baker, are shown in Figures 1-3 and 1-4, respectively. Additional figures depicting the nature and extent of groundwater contamination are provided in the Final RI Report (Baker, 1995a). A water table contour map indicating general groundwater flow directions in the surficial aquifer is provided in Figure 1-5. As shown in Figures 1-6 and 1-7, a hydrogeologic cross-section was developed for the area paralleling Brinson Creek which shows the various soil types for the area in which the IAS system was installed. An additional hydrogeologic cross-section was developed from the temporary well boring logs, which is provided in Appendix A. This cross-section indicates that the soil lithologies vary significantly between the southern and northern portions of the site. As shown in Appendix A, the surficial aquifer in the northern region north of temporary well TW-19 is comprised mainly of medium and fine-grained sands, whereas the region to the south of TW-19 contains at least one significant silt/clay lens of varying thickness.

Two additional areas of solvent-related groundwater contamination have been identified adjacent to Site 35. The extent and sources of this contamination have not been identified and additional RI activities are planned. In addition, significant levels of organic and inorganic contamination were identified in sediment samples.

Following the completion of the RI, a Final Interim Proposed Remedial Action Plan (PRAP) (Baker, 1995c) and Final Interim ROD for surficial groundwater at Site 35 were prepared (Baker, 1995d). These documents detailed five potential Remedial Action Alternatives (RAAs) developed in the FS for the remediation of organic chemical contaminated surficial groundwater at Site 35. More specifically, the following Remedial Action Objectives (RAOs) were developed in the FS for the surficial aquifer:

- Mitigate the potential for direct exposure to the contaminated groundwater in the surficial aquifer.
- Minimize or prevent the horizontal and vertical migration of contaminated groundwater in the surficial aquifer.
- Restore the surficial aquifer to the remediation levels established for the groundwater contaminants of concern.

The remediation levels established for the contaminants of concern are provided in Table 1-1. These levels were based on the NC DEHNR Water Quality Standards for Groundwater (15A NCAC 2L.0202).

RAA 5, In Well Aeration with Off-Gas Carbon Adsorption was selected in the Final Interim ROD contingent upon the successful execution of preliminary field pilot-scale tests. This RAA is interim in nature because it represents only one phase of a comprehensive investigation and remediation at Site 35 and is not intended to represent the final solution for OU No. 10. This particular interim action focuses on containment and remediation of organic groundwater contamination in the surficial aquifer located in the vicinity of the fuel farm and extending downgradient towards Brinson Creek. A remediation system installed in this area would be designed to mitigate the migration of groundwater contamination from OU No. 10 prior to its discharge into Brinson Creek.

Other media of concern such as sediment and groundwater in the upgradient portion of the surficial aquifer will be addressed during subsequent RI/FS activities that are scheduled to commence later this year. Soil contamination at Site 35 was excavated and removed as part of a separate Interim Remedial Action completed in the Spring of 1996.

The viability of in well aeration technology (RAA 5) at Camp Lejeune is being evaluated by means of a field pilot test currently underway at another site (OU No. 14, Site 69). Whether or not in well aeration is applied at Site 35 is dependent, in part, on the results of the field pilot test at Site 69. If it is determined, based on the results of the field pilot test, that in well aeration cannot perform as required, the Interim ROD (Baker, 1995d) indicated that RAA 3 (Groundwater Collection and On-Site Treatment) would be substituted as the Interim Preferred Remedial Action. To date, the field pilot test of in well aeration technology has experienced delays in being implemented at Site 69 which further delays field pilot-scale tests at Site 35. In the meantime, EPA, NC DEHNR, LANTDIV, Camp Lejeune, and Baker staff agreed that a treatability study of IAS technology would be appropriate at this site. If the results of this test are sufficiently positive, a request may be made to prepare an Explanation of Significant Differences (ESD) document to modify the selected alternative.

2.0 OVERVIEW OF IN-SITU AIR SPARGING TECHNOLOGY

2.1 Description

IAS is a technology in which air is bubbled through a contaminated aquifer. Air bubbles traverse horizontally and vertically through the soil column, creating an underground stripper that removes contaminants by volatilization and, for some contaminants, particularly fuel-related compounds, by biodegradation. The air bubbles carry the contaminants upward until they can be recovered by a vapor extraction system or released to the atmosphere.

IAS is a commercially available technology for removing volatile organic chemicals from groundwater. Various technical papers have been published documenting its effectiveness at sites across the U.S. In general, the available literature indicates that IAS is most frequently used to remediate shallow groundwater (i.e., less than 20 feet below the ground surface [bgs]); however, in theory there is no limit to its application.

At Site 35, the area east of the former fuel farm, between Brinson Creek and the proposed divided highway, is located, for the most part, within the limits of the Brinson Creek 100-year floodplain. The area is characteristically marshy with the groundwater surface generally situated within three feet of the ground surface throughout the year. This type of site does not avail itself to traditionally-applied vapor extraction due to the lack of a sufficiently thick unsaturated soil zone. Consequently, the contaminants removed from the shallow groundwater at Site 35 via IAS will be most likely discharged to the atmosphere directly.

2.2 Limitations

The effectiveness of IAS system generally increases with increasing intrinsic permeability (k, cm^2). Soils should have an intrinsic permeability of at least 10^{-9} for air sparging to be effective (EPA/510/B-94/003). Silty sands generally have k values in the range of 10^{-10} to 10^{-8}. Therefore, the soils at Site 35, which are predominantly silty sands, are potentially amenable to IAS. Organic compounds with Henry's law constants greater than 0.01 atm-m^3/mol (EPA/542/B-94/013) or 100 atm (EPA/510/B-94/003) are typically considered amenable to stripping. All of the VOCs of concern have Henry's constants that are greater than these values.

As previously indicated, IAS is generally applied to remediate contamination in shallow groundwater (i.e., less than 20 feet bgs). At Site 35, the area of contamination is distributed throughout a shallow groundwater zone that varies in depth from approximately 32 to 40 feet. Lighter molecular weight fuel contaminants are more prevalent near the groundwater surface, while heavier halogenated compounds are concentrated atop a semi-confining layer at the base of the shallow groundwater zone. In general, the lighter contaminants near the groundwater surface should be easier and less costly to remove than the heavier contaminants at the base of the shallow zone. This is due, in part, to the higher volatility of the lighter compounds and, in part, because of the greater energy required to inject air in the deeper zone.

The track record for IAS shows that it has indeed been applied more at sites contaminated with fuels rather than solvents. This is probably due in part to the larger number of fuel-related versus solvent-contaminated sites, the biodegradability of fuel-related contaminants, and the fact that the majority of fuel-related sites are characterized by contamination at or near the groundwater surface.

IAS systems utilize injected air and are often combined with vapor extraction systems to control the migration of contaminants. At Site 35, between Brinson Creek and the proposed divided highway, the groundwater surface is generally within three feet of the ground surface throughout the year. The available unsaturated soil zone is insufficiently thick to afford the application of vapor extraction. Without vapor extraction, the migration of contaminants in the vadose zone is uncontrolled. However, as illustrated by the following example calculations, vapor emissions are anticipated to be low and should not pose an unacceptable risk to human health or the environment.

To provide a conservative estimate, or upper bound, of the vapor emission rate prior to performing the treatability study, it can be assumed that, at steady-state, the contaminant vapor emission rate will equal the dissolved contaminant migration rate to the IAS system. Thus, this upper bound can be calculated from an estimate of the groundwater specific discharge q [ft/d], width of the IAS barrier W [ft], the depth below the groundwater table to the injection point H [ft], and dissolved contaminant concentration C_{gw} [lb/ft^3] as follows:

$$\text{Emissions}_{max} = q\ [ft/d] \times W\ [ft/d] \times H\ [ft] \times C_{gw}\ [lb/ft^3]$$

Based on the available Site 35 data from the RI Report, conservative estimates for these parameters are as follows: $q = 0.06$ ft/d (based on $K = 0.001$ cm/s, $I = 0.02$), $W = 200$ ft, $H = 25$ ft, $C_{gw} = 0.00006$ lb/ft^3 ($\approx$1,000 μg/L). Inserting these values into the above emissions equation results in a maximum surficial emission rate of approximately 0.02 lb/d.

Assuming four sparging wells are installed over the 200-foot wide capture zone with a combined air flow rate of 40 cubic feet per minute (cfm) (i.e., four wells spaced 50 feet apart with 10 cfm per well), the resulting contaminant air concentration passing through the vadose zone would be 3.5×10^{-7} lb/ft^3 or 5.6 mg/m^3. For a qualitative risk assessment, this value can be compared to the threshold limit value (TLV) for an 8-hour exposure (i.e., time-weighted average (TWA)) for benzene and TCE, which are 32 mg/m^3 and 269 mg/m^3, respectively. Additional risk assessment analyses can be performed based on the air sampling results from the treatability study.

Another potential concern associated with the IAS system is the amount of contamination that will be retained in the soils (i.e., resulting contaminant concentrations) since implementation of a soil vapor extraction system to collect volatilized contaminants in the vadose zone may not be possible. Based on an vapor contaminant concentration of 5.6 mg/m^3 and assuming an equilibrium soil-vapor partitioning coefficient of 3.3 L/kg for benzene and 2.5 L/kg for TCE (see calculations provided in Appendix B), the degree of soil contamination resulting from this contaminated air is approximately 0.018 mg/kg for benzene and 0.014 mg/kg for TCE. The acceptable U.S. EPA risk-based concentrations (RBCs) for exposure to contaminated soil (i.e., accidental ingestion) under a residential use scenario are 22 mg/kg and 58 mg/kg for benzene and TCE, respectively. Thus, the IAS system should not create soil contamination that poses an unacceptable risk to human health or the environment.

2.3 Treatability Study Design Basis

The IAS alternative in the Interim FS (Baker, 1995b), Remedial Action Alternative (RAA) 4, included installation of an IAS "curtain," or barrier, to contain and treat contaminated groundwater as it flows towards Brinson Creek. The conceptual design for RAA 4 included a total of 43 sparging (i.e., air injection) wells spaced approximately 25 feet apart. As shown in Figure 2-1, a total capture zone approximately 1000 feet in width was assumed based on available data. The capture zone width was based on containing groundwater contaminated above the NC DEHNR-based groundwater standards (Table 1-1). As shown in Figure 2-1, the sparging curtain is expected to be located approximately 25 feet downgradient, or east, of the highway's eastern right of way. A soil vapor extraction system was included in the FS as part of RAA 4, since it is typically required for an IAS system as a safeguard measure for controlling vapor emissions. RAA 4 was not selected because of the high water table conditions in the capture zone area along Brinson Creek.

One of the goals of the treatability study are to refine the conceptual design in the FS using test data as well as additional groundwater contaminant data obtained during the Supplemental Groundwater Investigation (SGI) at Site 35. The Draft SGI Report is scheduled to be submitted in November 1996. A summary of the available groundwater data through the 1994 RI for the fuel-related (i.e., benzene, toluene, ethylbenzene, and xylenes (BTEX)) and solvent-related (i.e., total chlorinated hydrocarbons (CHCs)) contamination in the vicinity of Brinson Creek is provided in Figure 2-2. Total concentrations of BTEX and CHCs detected during the April 1996 field investigation are shown in Figure 2-3.

Groundwater sampling results from the most recent field investigation and previous studies conducted by ESE (1990), NUS (1990), Law (1992 and 1993), and Baker (1994), indicate three primary areas of contamination that intercept the proposed sparging curtain boundary. Hypothetical contaminant plumes for these areas were developed (Figure 2-4) to estimate capture zones and to identify additional data needs. These plumes have been identified as plumes A, B, and C for purposes of this report. These plumes are considered hypothetical since it is unknown if each plume originates from a single source area or if it is actually a composite of two or more plumes originating from multiple sources. The two northern plumes (A and B) represent BTEX contamination associated with monitoring wells MW-20 and MW-16, respectively. The southern plume (plume C) consists of chlorinated solvent contamination, primarily TCE and 1,2-DCE, associated with monitoring well MW-19. A fourth potential area of solvent contamination (not shown), plume D, is located south of plume C near wells 35MW-34B, 35MW-35B, and 35MW-36B (see Figures 1-3 and 1-4). This zone of contamination does not appear to have encroached as near to Brinson Creek as plumes A, B, and C. The concentrations in plume D are three orders of magnitude less than the plume C contamination and appear to represent a separate contaminant source.

Of the three or four plumes intercepting the sparging curtain boundary, plumes B and C contain the bulk of the contaminant mass in the groundwater and pose the most risk to receptors in Brinson Creek. The significance of these two plumes with respect to the remedial design/action is discussed later in this section. Groundwater data (Figure 2-2) show that BTEX levels associated with plume A attenuate rapidly in the downgradient direction, suggesting natural attenuation mechanisms (i.e., biodegradation) are preventing appreciable contamination from reaching the creek. With respect to plume D, contaminant levels in this area only slightly exceed established cleanup levels. Therefore, with containment/treatment of the upgradient source area, natural attainment of the cleanup levels in plumes A and D may be possible through dilution and dispersion.

Conceptually, the shallow aquifer can be divided into two regions; an upper region in which the majority of the BTEX contamination resides, and a lower region that contains the bulk of the solvent-related contamination. The thickness of the shallow aquifer is approximately 30 to 35 feet, with the water table located approximately two to three feet bgs along the sparge curtain boundary. BTEX compounds were generally detected in the upper 0 to 15 feet of aquifer; whereas, the highest concentrations of chlorinated compounds were detected in the lower 20 to 35 feet of aquifer (i.e., above the semi-confining layer). BTEX concentrations in the upper aquifer are generally about two orders of magnitude higher in the upper aquifer than in the lower aquifer.

Plume B is generally a shallow BTEX plume with contamination in the center of the plume extending into the middle portion of the shallow aquifer (approximately 25 feet bgs) and contamination near the edges of the plume extending only to about 15 feet bgs. Plume B is approximately 300 feet in width. The centerline of the plume appears to be located near well TW-23. Soil conditions across Plume B appear more uniform compared to those across Plume C. Most of the saturated aquifer material across Plume B is composed of medium- and fine-grained sands. Thin silt/clay stringers were observed in some of the borings, however, the soils are predominantly sands.

In contrast to Plume B, Plume C is generally a deeper chlorinated solvent plume (mainly TCE and 1,2-DCE) with contamination generally absent in the upper 10 feet of aquifer and then increases dramatically with depth to the confining layer located 30-35 feet bgs. Plume C appears to be at least 450 feet in width. As shown in Figure 2-4, part of plume C overlaps with plume B. The highest concentrations of the TCE and 1,2 DCE contamination are centered near well locations TW-16 and TW-17. Soil boring logs from the wells installed along Plume C indicate a much more heterogeneous condition. Boring log TW-16 indicates either silty clay or clayey silt from 6.5 to 25 feet bgs. Silt and clay was also apparent in boring TW-17 down to 18.5 feet bgs with silty sand down to about 24.5 feet bgs. Borings TW-16 and TW-17 contained the highest concentrations of TCE and 1,2-DCE. The thicknesses of the silt/clay and clay/silt lenses appear to dramatically decrease in the northwestern direction along the sparge curtain boundary. A silt/clay lens was only detected from about 8.5 to 9.5 feet in boring TW-18.

Since plumes B and C essentially represent two distinct sites with different types of contamination and soils, two short-term (6-day) pilot-scale tests were proposed for Site 35, one for plume B and one for plume C. The treatability study for plume B was proposed to be conducted first since the soil lithology is more homogeneous and contains more sand and less silt than the aquifer materials located further south in the plume C area. Thus, prior to implementing the treatability study the plume B area appeared to be more conducive to IAS technology and had the greatest chance of success. If the plume B treatability study was determined to be successful (i.e., air can be effectively injected into the aquifer with no signs of entrapment below confining layers), then the plume C treatability study could also be performed. This area contains the highest levels of solvent-related contamination and poses the greatest treatment challenge with respect to IAS. It was anticipated that the scope of work for the plume C pilot test would be very similar to the first plume B pilot test. However, modifications and adjustments could be made to the plume C study based on data obtained and lessons learned from the first test.

To accommodate the two different types and zones of contamination, two sparging wells were proposed for the plume B treatability study, as shown in Figure 2-5. The upper sparging well would be screened approximately 14 to 16 feet bgs, whereas the lower sparging well would be screened from approximately 32 to 34 feet bgs. Exact screen placements were to be determined in the field based on actual conditions. As shown in Figure 2-6, only one deep sparging well was proposed for plume C because of the silt/clay and clay silt lenses present from approximately 7 to 23 feet bgs. Air injected into the plume C sparging well would be expected to travel horizontally within the lower sand layer and beneath the silt/clay lenses. The air would gradually travel upward as the silt/clay lenses become thinner and eventually disappear.

As shown in Figures 2-5 and 2-6, as the injected air exits the well screen and travels upward towards the water table, it fans out radially, forming a parabolic-shaped zone of influence (under homogeneous conditions). Soil heterogeneities, however, such as silt stringers or very permeable sand lenses, can dramatically alter this flow regime by trapping air and forcing it to move laterally and/or by creating preferential flow paths. Thus, changes in lithology may preclude the sparge curtain from treating certain zones of contamination. Because of the "fanning-out" effect, the length of the radius of influence (ROI) of a sparging well is typically least at the bottom of the well and greatest near the water table. Since the sparging wells cannot be placed below the semi-confining layer, chlorinated hydrocarbons located immediately above this layer may pass beneath and/or between the sparging wells. To minimize this problem, sparging wells may need to be tightly spaced in the deep zones of contamination (i.e., plume C). In areas with mainly shallow contamination, a longer spacing may be feasible, depending on lithology.

The results of the short-term treatability studies were expected to provide key information concerning the effectiveness and implementability of IAS technology at the Site 35 plumes. However, the short-term studies would not provide conclusive evidence as to the effectiveness of the sparge curtain to mitigate long-term contaminant migration. Furthermore, since the plume B treatability study would only be performed for a short duration, it could not provide data regarding potential enhancement of biodegradation rates in this area. For these reasons, a long-term (i.e., 12 to 18-month) barrier effectiveness test was proposed for plumes B and C, provided the short-term treatability study(s) yield(s) promising results. The long-term study would essentially represent the first phase of the interim remedial action, in which permanent, full-scale equipment and utilities would be installed by the Remedial Action Contract (RAC) contractor and operated at the site. During this period, new and existing monitoring wells located up-, down-, and cross-gradient of the sparge curtain boundary would be monitored to track contamination in both untreated and treated areas. Near the end of this time frame, one of the following decisions would be made based on sampling results:

- Continue operation of the existing system
- Expand the existing IAS system to include additional areas if necessary (e.g., plume A and/or plume D)
- Discontinue use of the sparging system in plume B and/or plume C in favor of an alternate technology (i.e., in-well aeration)

3.0 TREATABILITY STUDY OBJECTIVES

At Site 35 IAS is proposed as part of an interim remedial action. The focus of this interim action is the contaminated surficial groundwater in the area located east of the former Site 35 fuel farm, between Brinson Creek and the proposed divided highway. As this represents only a portion of the contaminated shallow groundwater identified at the site, this action is referred to as an Interim Remedial Action. That is, it represents only a portion of a more comprehensive investigation and remediation at Site 35 and will not necessarily be the final solution for OU No. 10.

The objectives of the treatability study are as follows:

- Assess the applicability of IAS technology in addressing shallow groundwater contamination at Site 35 by evaluating the effectiveness, implementability, and cost of a full-scale treatment system.
- Obtain sufficient data to afford the development of a full-scale system remedial design.
- Assess the impact of air emissions on human health and the environment, and verify that air emissions will not impact the proposed highway project.

4.0 MONITORING WELL AND SOIL GAS PROBE INSTALLATION

Groundwater monitoring wells and soil gas monitoring probes were installed to assist in monitoring the performance of the IAS system. This section describes the installation of the 26 monitoring wells and six soil gas monitoring probes at Plumes B and C.

4.1 Monitoring Well Installation

This section describes the installation of the 14 monitoring wells at Plume B and the 12 monitoring wells at Plume C.

4.1.1 Plume B

A total of 12 monitoring wells and 2 air injection wells were installed at Plume B from July 9 through July 14, 1996. The locations of the monitoring and air injection wells are shown on Figure 4-1. Drilling and well installation was performed by Parratt-Wolff, Inc. of East Syracuse, New York.

Subsurface soil samples were collected continuously during the drilling of monitoring wells 35MW-44B, 35MW-46A, 35MW-46B, 35MW-49A, and 35MW-50A to provide detailed subsurface stratigraphic information to depths ranging from approximately 12 to 35 feet below the ground surface (bgs). Subsurface soil samples were collected on five-foot centers during the drilling of monitoring wells 35MW-47B, 35MW-48B, 35MW-49B, and 35MW-50B to confirm subsurface stratigraphy to 31.5-feet (bgs). Subsurface soil samples were not collected from monitoring wells 35MW-44A, 35MW-45A, 35MW-45B, 35MW-47A, and 35MW-48A. Soil samples were obtained via two-foot long, two-inch diameter, split spoons. Standard penetration resistance values were obtained as per American Society for Testing Materials (ASTM) Method D 1586-84 and recorded on the boring logs. The samples were visually classified in the field using the Unified Soil Classification System (USCS). There were no environmental samples collected from the well borings during the monitoring well installation activities. Boring logs are provided in Appendix C.

Six of the monitoring wells (35MW-45A, 35MW-46A, 35MW-47A, 35MW-48A, 35MW-49A, and 35MW-50A) were installed to monitor the upper portion of the surficial aquifer with well screens set from two to 12 feet bgs. The other six monitoring wells (35MW-45B, 35MW-46B, 35MW-47B, 35MW-48B, 35MW-49B, and 35MW-50B) were installed to monitor the lower portion of the surficial aquifer with well screens set from 26 to 31 feet bgs. Wells 35MW-44A and 35MW-44B were installed to provide air injection points beneath the ground surface. All of the wells were constructed of two-inch diameter, schedule 40, polyvinyl chloride (PVC) casing with threaded joints and two-inch diameter, PVC well screens with No. 10-slot (0.01-inch) openings. The well screens were set at two feet bgs and extended to 12 feet bgs. The air injection well screens were set from 14 to 16 feet bgs and 32 to 34 feet bgs, respectively. A uniform sand pack with grains ranging between 0.01 and 0.03 inches in diameter was placed in the annulus around each well screen to approximately 0.5 to two feet above the top of the screen. A bentonite clay seal approximately 1.5 to two feet thick was placed atop the sand pack. A cement-bentonite slurry was used to fill the remaining annular space to the ground surface. The PVC well casings were set to stick-up above the ground surface approximately three feet. Protective steel casings with locking caps were placed over the PVC well casings and set into concrete collars. Well construction details are provided on Table 4-1.

The 12 monitoring wells and two air injection wells were developed to remove fines and stabilize the sand pack around the well screens establishing a hydraulic connection between the well and the watertable aquifer. A two-inch diameter centrifugal pump with a modified check valve and dedicated black flex hose tubing was utilized for this purpose. Each well was pumped until the turbidity readings were less than 10 NTUs. The water in the well was surged with a surge block assembly for 20 minutes in an effort to loosen fines and reorient the sand grains in the sand pack into a tighter configuration.

Monitoring well 35MW-44B purged dry after one well volume (5.5 gallons). The well recharged at approximately 0.03 gallons per minute (gpm). An alternate well development method was used approximately two weeks after the initial attempt to develop the well. This method consisted of forcing compressed air into the well which pushes the water within the well out the top of the well. This method also failed to provide a good hydraulic connection between the well and the surficial aquifer. It is likely that the low productivity of this well was due to the small length (2 feet) well screen and/or a low hydraulic conductivity formation that the screen was set in.

4.1.2 Plume C

A total of 11 monitoring wells and one air injection well were installed at Plume C from August 19 through August 29, 1996. The locations of the monitoring and air injection wells are shown on Figure 4-2. Drilling and well installation was performed by Parratt-Wolff, Inc. of East Syracuse, New York.

Subsurface soil samples were collected continuously during the drilling of monitoring well 35MW-51B to provide detailed subsurface stratigraphic information to a depth 31 feet bgs. Subsurface soil samples were collected on five-foot centers during the drilling of monitoring wells 35MW-52B, 35MW-53B, 35MW-54B, 35MW-55B, 35MW-56B, 35MW-57B, and 35MW-58B to confirm subsurface stratigraphy to depths ranging from 32 to 34 feet bgs. Only one subsurface soil sample was collected during the drilling of monitoring well 35MW-55A from a depth of five to seven feet bgs. Subsurface soil samples were not collected from monitoring wells 35MW-52A, 35MW-54A, and 35MW-53A. Soil samples were obtained via two-foot long, two-inch diameter, split spoons. Standard penetration resistance values were obtained as per ASTM Method D 1586-84 and recorded on the boring logs. The samples were visually classified in the field using the USCS. There were no environmental samples collected from the well borings during the monitoring well installation activities. Boring logs are provided in Appendix C.

All of the monitoring wells were installed to monitor the portion of the surficial aquifer between the bottom of a clay layer and the top of the semi-confining unit. These wells were constructed of two-inch diameter, schedule 40, PVC casing with threaded joints and two-inch diameter, PVC well screens with No. 10-slot (0.01-inch) screen openings except for 35MW-51B. The tops of the well screens were set at depths ranging from seven to 24 feet bgs and extended to 12 to 31 feet bgs. Well 35MW-51B was installed to provide an injection point for the air to enter beneath the ground surface. This well was constructed of two-inch diameter, schedule 40, PVC casing with threaded joints and a two-inch diameter, PVC, continuous wound screen with 0.01-inch openings. This type of screen was utilized at this location to provide a larger area for the air to escape the injection well. The top of the well screen was set at 24 feet bgs and extended to 26 feet bgs. A uniform sand pack with grains ranging between 0.01 and 0.03 inches in diameter was placed in the annulus around the screens to approximately two to three feet above the top of the screen. A bentonite-clay seal approximately two to three feet thick was placed atop the sand pack. A cement-bentonite slurry was used to fill the remaining annular space to the ground surface. The PVC well casings were set to stick up above the ground surface approximately three feet. Protective steel casings with locking caps were placed over the PVC well casings and set into concrete collars. Well construction details are provided on Table 4-2.

The 11 monitoring wells and single air injection well were developed to remove fines and stabilize the sand pack around the well screens establishing a hydraulic connection between the well and the watertable aquifer. A two-inch diameter centrifugal pump with a modified check valve and dedicated black flex hose tubing was utilized for this purpose. Each well was pumped until a minimum of 10 well volumes were removed from the well and subsequent pH and conductivity readings stabilized. The water in monitoring well 35MW-55A was surged with a surge block assembly in an effort to loosen fines and reorient the sand grains in the sand pack into a tighter configuration.

4.2 Soil Gas Probe Installation

The intention of the soil gas probe installation was to provide vadose zone monitoring points to aid the evaluation of the effectiveness of the air sparging system. A total of six soil gas probes were installed at Plume B. The locations of the soil gas probes are shown on Figure 4-1.

The soil gas probes were constructed of one-inch diameter, schedule 40, PVC casing. All probes were five feet in length with a one-foot long well screen located at the end. The screen consisted of 0.1-inch slots spaced every 0.5-inches and 1/8-inch diameter holes spaced every 0.5-inches. The top of the probes were capped with a barbed fitting to allow for air samples to be obtained. Expendable drive points were placed on the end of the probes for installation purposes. Each probe was installed approximately 15 inches bgs. A bentonite seal was placed around the probe at the ground surface to mitigate air from being drawn into the probe from the atmosphere.

4.3 Geology and Hydrogeology

This section describes the local geologic and hydrogeologic conditions in the Plume B and Plume C areas. The discussion presented in this section is based primarily on the drilling observations made during the installation of 14 monitoring wells at Plume B and 12 monitoring wells at Plume C. Specific regional and site-wide geologic and hydrogeologic conditions are discussed in detail in the Final RI Report (Baker, 1995a) and the Final Treatability Study Work Plan (Baker, 1996).

4.3.1 Plume B

The geologic conditions of the surficial aquifer local to the leading edge of Plume B were ascertained during the installation of 14 monitoring wells, 35MW-44A and B through 35MW-50A and B. The subsurface strata were logged during the installation of the deeper wells (wells with a "B" designation) to a maximum depth of 35 feet below ground surface. Boring logs are provided in Appendix C. The monitoring well locations in the Plume B area, as well as four cross section lines are shown on Figure 4-3. The four geologic cross sections are shown on Figures 4-4 through 4-7.

For the purposes of this treatability study, the subsurface strata in the Plume B vicinity were divided into four engineering geologic units, as follows:

> Peat: The Peat material was encountered in every boring installed in the Plume B area from the ground surface to a depth below ground surface of approximately 9 to 11 feet. The material encompassed by this unit consists of dark brown peat with decomposed wood and roots. This material is typically extremely to very loose as illustrated by the split spoon blow counts recorded in the boring log as WOH (weight of hammer).
>
> Sand: The sand unit was encountered in every boring installed in the Plume B area from depth of approximately 9 to 11 feet below the ground surface to a depth of 15 to 20 feet

below the ground surface. The sand unit is characterized as a dark brown to brown, very loose, fine grained sand with a trace silt and wood splinters/decomposed wood. As shown on Figures 4-6 and 4-7, the sand increases in thickness to the northeast.

Sand and Fossiliferous Limestone: This unit was encountered in each of the deep borings installed in the Plume B area from a depth of approximately 15 to 20 feet below the ground surface to 28.5 to 30 feet below the ground surface. This unit is characterized as a brown to yellow brown, medium dense fine to medium grained sand with some to little sandstone nodules, little cemented shell material/shell fragments and a trace silt. With depth, this unit grades to a light grey, medium dense to dense fossiliferous limestone with fine grained sand, little shell material/shell fragments and a trace silt.

Semi-Confining Unit: The semi-confining unit was encountered in each of the deep borings in the Plume B area at a depth of approximately 28.5 to 30 feet below the ground surface. The semi-confining consists of green grey, medium dense fine grained sand with a trace of silt, clay, shell material and fossiliferous limestone. This unit is distinctly more fine grained and compacted than the overlying sand and fossiliferous limestone unit.

Each of these units appear to be generally flat lying and were laterally extensive with only minor lithologic variations over the Plume B IAS study area, as illustrated in the cross sections shown on Figures 4-4 through 4-7.

Groundwater was encountered at approximately 0.5 feet below the ground surface at each boring location to the total depth of each bore hole. Static groundwater elevations, collected after monitoring well installation and stabilization were not measured; therefore, the groundwater gradient (direction or magnitude) was not determined for the IAS study. However, based on the Final RI Report (Baker, 1995d), the groundwater flow in the Plume B area is to the northwest towards Brinson Creek.

The following generalizations may be made based on the Final RI Report, the Final Treatability Study Work Plan and observations during drilling and well development:

- Groundwater was first encountered near the ground surface in the peat unit and in each unit thereafter to the total depth of the borings. The entire surficial aquifer unit, down to the top of the semi-confining unit was saturated.

- Although substantial amounts of water were encountered in the surficial peat material, this unit was noted as having a low structural competence as implied by the standard penetration test WOH designation. The most productive, competent water bearing units in the surficial aquifer appear to be the sand, and sand and fossiliferous limestone units.

- The lowermost unit encountered at this site, the semi-confining unit displays a substantially lower permeability than the overlying units. This unit is typically considered a "marker bed" in the Camp Geiger area and acts as a hydrogeologic boundary, or a unit that retards vertical flow between the shallow, surficial aquifer and deeper aquifer systems. The top of the semi-confining unit constitutes the base of the surficial aquifer.

4.3.2 Plume C

The geologic conditions of the surficial aquifer local to the leading edge of Plume C were ascertained during the installation of 12 monitoring wells, 35MW-51B through 35MW-58B. The subsurface strata were logged during the installation of the deeper wells (wells with a "B" designation) to a maximum depth of 34 feet below ground surface. Boring logs are provided in Appendix C. The monitoring well locations in the Plume C area, as well as three cross section lines are shown on Figure 4-8. The three geologic cross sections are shown on Figures 4-9 through 4-11.

For the purposes of this treatability study, the subsurface strata in the Plume C vicinity were divided into four primary engineering geologic units, as described in the following paragraphs.

- Silty Sand: Silty sand is the uppermost unit identified in the Plume C area and extends from the ground surface to depths of approximately 3 to 7 feet below the ground surface. The material encompassed by this unit consists of dark brown to brown, very loose fine grained sand with some to trace silt and little rooted/plant material.

- Clay: The clay unit was encountered in every boring in the Plume C area from depths of approximately 1 to 7 feet below the ground surface to 15 to 21 feet below the ground surface. Although this unit exhibited substantial lateral and vertical variability, it may be described in general terms for the purpose of this treatability study as a brown to grey, very soft to soft (plastic) sandy to silty clay. This unit also was characterized as moist, often with saturated overlying and underlying units.

- Sand: The sand unit was encountered in each of the deep borings/monitoring wells (designated with a "B") from depths of approximately 15 to 21 feet below the ground surface to 30 to 33.5 feet below the ground surface. Similar to the clay unit, the sand unit also displayed substantial lateral and vertical variability. In general, this unit consists of brown to light grey, loose to medium dense, fine to medium grain sand with traces of silt, sandstone nodules, and shell material/fragments. Locally (e.g., in the vicinity of 35MW-51B), this unit also contains fossiliferous limestone with fine grained sand and trace silt and cemented shell material/fragments.

- Semi-Confining Unit: This unit was encountered in each of the deep borings in the Plume C area at a depth of approximately 30 to 33.5 feet below the ground surface. The semi-confining unit consists of a green grey, medium dense fine grained sand with a trace of silt, clay, shell material and fossiliferous limestone. As in the Plume B area, this unit is distinctly more fine grained and compacted than the overlying sand unit.

The silty sand, sand and semi-confining units appear to be relatively flat lying and were laterally extensive over the Plume C IAS study area, as illustrated in the cross sections shown on Figures 4-9 through 4-11. The sand unit did increase in thickness in the northeast portion of the site in the vicinity of monitoring well 35MW-55B. The clay unit increased in thickness from approximately five feet in the northeast portion of the Plume C area (35MW-55B) to over 16 feet in the southwest portion of the area (35MW-58B) as illustrated on Figure 4-10. The decreasing clay thickness corresponded to an increasing sand unit thickness in the northeast portion of the area.

Groundwater was typically encountered in the sand unit underlying the clay at depths of 10 to 21 feet below the ground surface. Local wet zones (e.g., in monitoring well 35MW-51B) were encountered in the silty sand above the clay unit. Static groundwater elevations were not measured for the IAS study; therefore, the groundwater gradient (direction or magnitude) was not determined. However, based on the Final RI Report (Baker, 1995a), the groundwater flow in the Plume C area is to the northwest towards Brinson Creek.

The following generalizations may be made based on the Final RI Report, the Final Treatability Study Work Plan and observations during drilling and well development:

- The sand unit underlying the clay unit appears to be the principle water bearing unit in the surficial aquifer. Small amounts of water were noted in the silty sand above the clay unit.
- The clay unit appears to act as a partial hydraulic boundary and may retard both vertical and horizontal flow.
- The lowermost unit encountered at this site, the semi-confining unit appears to display a substantially lower permeability than the overlying sand unit. This unit is typically considered a "marker bed" in the Camp Geiger area and acts as a hydrogeologic boundary, or a unit that retards vertical flow between the shallow, surficial aquifer and deeper aquifer systems. The top of the semi-confining unit constitutes the base of the surficial aquifer.

The effect of these features on the effectiveness of the IAS study is discussed in Section 5.0.

5.0 TREATABILITY STUDY PROCEDURES AND OPERATION

The following sections describe the procedures and operation of the IAS treatability study at OU 10, Site 35, Plume B.

5.1 Pre-Study Sampling

Pre-study sampling was conducted for a duration of 24 hours prior to the start-up of the IAS system. The sampling consisted of monitoring soil gas and groundwater to establish a baseline set of physical and chemical data conditions in the vadose zone and surficial aquifer.

5.1.1 Soil Gas Monitoring

Six soil gas probes were sampled prior to the start-up of the IAS system. The water table at Plume B was encountered just below the ground surface. At soil gas probe locations SG-1, SG-2, SG-3, and SG-6 no vadose zone was present to be monitored. Only soil gas probes SG-4 and SG-5 were installed in areas where a vadose zone was present.

Soil gas samples were obtained by pumping air from soil gas probes SG-4 and SG-5 for approximately 45 seconds utilizing a Dawson electric air sampling pump. All of the instruments used to monitor the air contained pumps to draw air from the probe into the instrument for analysis. Air samples were analyzed for percent oxygen, volatile organic compounds (VOCs), and pressure utilizing an O_2/LEL meter, photoionization detector (PID) and SUMMA canister, and magnehelic pressure gauges, respectively, as indicated in Table 5-1. Soil gas probes SG-1, SG-2, SG-3, and SG-6 were monitored for percent oxygen, VOCs, and pressure utilizing an O_2/LEL meter, PID, and magnehelic pressure gauges. These samples reflect only the ambient air from within the probes and not the air from the surrounding vadose zone. The high water table prohibited the use of the Dawson electric air sampling pump to obtain samples from the surrounding vadose zone at these locations.

5.1.2 Groundwater Monitoring

Twelve groundwater monitoring wells were sampled prior to the start-up of the IAS system as indicated in Table 5-1. Dissolved oxygen readings were obtained from monitoring wells 35MW-45A/B, 35MW-46A/B, 35MW-47A/B, 35MW-48A/B, 35MW-49A/B, and 35MW-50A/B utilizing a YSI Model 55 Dissolved Oxygen meter. Groundwater samples were collected from monitoring wells 35MW-46A/B and 35MW-50A/B for analysis at a fixed-base laboratory for VOCs. Static water level readings were collected on a hourly basis from monitoring wells 35MW-45A/B, 35MW-46B, and 35MW-47A utilizing a Hermit data logger.

5.2 Study Implementation

This section describes the IAS equipment utilized for the Plume B treatability study, the performance of the system, and the monitoring and sampling conducted during the study.

5.2.1 In-Situ Air Sparging Equipment

The IAS equipment was constructed atop a flat bed trailer and consisted primarily of an oil-free rotary vane air compressor which was powered by a gasoline engine. The compressor was equipped with a pressure relief valve, check valve, and pressure gauge and was plumbed to one-inch diameter, schedule 40, steel pipe with a bleed valve to control air flow and a sampling port to monitor helium concentrations in the air stream. Flow gauges and gate valves were located on the system to monitor and control the flow of air into the ground. Schedule 40, one-inch diameter, high temperature hose was used to connect the steel pipe to the injection well head. A process flow diagram depicting the equipment and instrumentation is provided on Figure 5-1.

5.2.2 In-Situ Air Sparging System Performance

The treatability study was comprised of two tests (deep and shallow air injection) each consisting of two phases (low and high flow rates). The first test injected air into the deeper zone at flow rates of approximately 7.5 and 20 actual cubic feet per minute (acfm) and air pressures of approximately 15.5 and 18.8 pounds per square inch (psi), respectively. The second test consisted of injecting air into the shallow zone at flow rates of approximately five and 20 acfm with corresponding air pressures of approximately seven and eight psi, respectively. The step from the lower flow rate to the higher flow rate did not occur until steady sate was obtained during the low flow phase. Table 5-2 presents the durations of each test phase and the associated flow rates. Helium was added to the air flow at a rate sufficient to yield a total helium concentration of approximately two to four percent of the air flow volume. A Mark 9822 Helium Detector was utilized to monitor the concentration of helium in the air stream.

5.2.3 Study Sampling

Sampling during the treatability study consisted of monitoring soil gas and groundwater at the site to evaluate any changes to the baseline data collected during pre-test sampling. Table 5-3 presents the sampling conducted during the treatability study.

5.2.3.1 Soil Gas Monitoring

Six soil gas probes were monitored during the operation of the IAS system. The water table at Plume B was encountered just below the ground surface. At soil gas probe locations SG-1, SG-2, SG-3, and SG-6 no vadose zone was present to be monitored. Only soil gas probes SG-4 and SG-5 were installed in areas where a vadose zone was present.

Soil gas samples were obtained by pumping air from soil gas probes SG-4 and SG-5 for approximately 45 seconds utilizing a Dawson electric air sampling pump. All of the instruments used to monitor the air contained pumps to draw air from the probe into the instrument for analysis. Air samples were analyzed for percent oxygen, VOCs, pressure, and helium utilizing an O_2/LEL meter, PID and SUMMA canister, magnehelic pressure gauges, and helium detector, respectively, as presented in Table 5-3. Soil gas probes SG-1, SG-2, SG-3, and SG-6 were monitored for percent oxygen, VOCs, pressure, and helium utilizing an O_2/LEL meter, HNU, magnehelic pressure gauges, and helium detector. These samples reflect only the ambient air from within the probes and not the air from the surrounding vadose zone. The high water table prohibited the use of the Dawson electric air sampling pump to obtain samples from the surrounding vadose zone at these locations.

5.2.3.2 Groundwater Monitoring

Twelve groundwater monitoring wells were sampled during the operation of the IAS system as indicated in Table 5-3. Dissolved oxygen readings were obtained from monitoring wells 35MW-45A/B, 35MW-46A/B, 35MW-47A/B, 35MW-48A/B, 35MW-49A/B, and 35MW-50A/B utilizing a YSI Model 55 Dissolved Oxygen meter. Groundwater samples were collected from monitoring wells 35MW-46A/B and 35MW-50A/B for analysis at a fixed-base laboratory for VOCs.

Water levels were collected on a hourly basis from monitoring wells 35MW-45A/B, 35MW-46B, and 35MW-47A utilizing a Hermit data logger.

5.2.3.3 Groundwater Tracer Gas Monitoring

The fourteen groundwater monitoring wells at Plume B were monitored to detect the presence of helium. This monitoring was conducted to provide data regarding the zone of influence of the air injection well.

Modified slip caps were installed on the tops of the well casings to capture and monitor the ambient air inside the wells. The ambient air within the monitoring wells was analyzed for helium utilizing a helium detector. The frequency of this monitoring is shown in Table 5-3.

5.3 Post-Study Sampling

Post-study sampling was conducted for a duration of 24 hours following the commencement of the study. The sampling consisted of monitoring soil gas and groundwater at the site as it returns to steady conditions. The sampling also monitored any changes to the baseline physical and chemical data conditions in the aquifer and vadose zone that may have occurred as a result of the treatability study.

5.3.1 Soil Gas Monitoring

Six soil gas probes were monitored at the conclusion of the IAS study. The water table at Plume B was encountered just below the ground surface. At soil gas probe locations SG-1, SG-2, SG-3, and SG-6 no vadose zone was present to be monitored. Only soil gas probes SG-4 and SG-5 were installed in areas where a vadose zone was present.

Soil gas samples were obtained by pumping air from soil gas probes SG-4 and SG-5 for approximately 45 seconds utilizing a Dawson electric air sampling pump prior. The instrument used to monitor the air contained a pump to draw air from the probe into the instrument for analysis. Air samples were analyzed for VOCs and helium utilizing SUMMA canisters and a helium detector, respectively, as indicated in Table 5-4. Soil gas probes SG-1, SG-2, SG-3, and SG-6 were monitored for helium utilizing a helium detector. These samples reflect only the ambient air from within the probes and not the air from the surrounding vadose zone. The high water table prohibited the use of the Dawson electric air sampling pump to obtain samples from the surrounding vadose zone at these locations.

5.3.2 Groundwater Monitoring

Twelve groundwater monitoring wells were sampled following the operation of the IAS system as indicated in Table 5-4. Dissolved oxygen readings were obtained from monitoring wells 35MW-44B, 35MW-45A/B, 35MW-46A/B, 35MW-47A/B, 35MW-48A/B, 35MW-49A/B, and 35MW-50A/B utilizing a YSI Model 55 Dissolved Oxygen meter. Groundwater samples were collected from monitoring wells 35MW-46A/B and 35MW-50A/B for analysis at a fixed-base laboratory for VOCs. Water levels were collected on a hourly basis from monitoring wells 35MW-45A/B, 35MW-46B, and 35MW-47A utilizing a Hermit data logger.

6.0 TREATABILITY STUDY RESULTS

This section describes the results of the IAS treatability study. Dissolved oxygen in groundwater, ambient air helium concentrations, static water levels, groundwater analytical results, air sampling analytical results, and the radius of influence will be discussed and evaluated in the following sections. The percent oxygen, PID results, and pressure readings from the six soil gas probes did not indicate any effects from the treatability study. Therefore, this data will not be presented in this report. All of the data contained on the graphs and figures in this section which have been impacted by this IAS study have been color coded to assist in presenting the results of the treatability study (e.g., monitoring well 35MW-47A has been colored green on all the figures and graphs). This data evaluation will provide the necessary input to recommend a full-scale remedial system at Operable Unit No. 10, Site 35. Conclusions and design recommendations for the selection of a remediation system will be presented in Section 7.0.

Monitoring well 35MW-44B was intended to be the injection well for the deep injection test. Three separate attempts failed to inject air into the aquifer via 35MW-44B. Each attempt consisted of delivering approximately 20 psi of pressure into the well. The first attempt lasted for six hours while the second and third attempts consisted of 3-1/2 and three hours each, respectively. The steady state conditions within 35MW-44B were disturbed from these attempts of injecting air into the well. Therefore, the data obtained from this well was considered biased and was not discussed in this report. It is likely that the inability to inject air into the aquifer through this well was due to the small length (2 feet) of well screen and/or a low hydraulic conductivity formation that the screen was set in. As an alternative, monitoring well 35MW-47B was utilized as the injection well for the deep air injection portion of the treatability study.

The effectiveness of this treatability study was limited somewhat by the inability to inject air into 35MW-44B. One of the goals of the study was to inject air as close as possible to the top of the semi-confining unit due to the higher levels of contamination occurring in the deeper wells. This would have provided the ability to direct a greater volume of air through the areas of the highest contamination. This modification to the study influenced the data from the deeper monitoring wells. This was due to the fact that the monitoring wells were no longer in a position to intercept the air flow being injected from a deeper well. The performance of the study was, nevertheless, valid and provided the necessary input required for the performance-based design of a full-scale system.

6.1 Dissolved Oxygen

The monitoring of dissolved oxygen (DO) in the groundwater assisted in evaluating the radius of influence from the treatability study. The DO readings indicated that the IAS system did impact the groundwater beneath the site. The discussion on the dissolved oxygen results has been divided between the shallow and deep monitoring wells as follows.

6.1.1 Shallow Monitoring Wells

The pre-study or baseline DO readings for the shallow monitoring wells ranged from 0.14 to 0.25 milligrams per liter (mg/L) as presented in Table 6-1. An increase in DO was observed in the shallow monitoring wells during phase I (7.5 acfm) and phase II (20 acfm) of the deep air injection (35MW-47B) test and during phase II (20 acfm) of the shallow air injection (35MW-44A) test.

Three of the seven shallow monitoring wells (35MW-44A, 45A, and 47A) were influenced during phase I of the deep air injection test as indicated in Table 6-1. The increase in DO from these three wells ranged from 0.82 to 10.91 mg/L. Four of the seven shallow monitoring wells (35MW-44A, 45A, 46A and 47A) were influenced during phase II of the deep air injection test as indicated in Table 6-1. The increase in DO from these four wells ranged from 0.92 to 11.71 mg/L. It should be noted that during the duration of the deep air injection test slugs of aerated groundwater were ejected from the top of 35MW-44A in a cyclic fashion. Therefore, it is assumed that the groundwater from this well was saturated with DO during the deep air injection test.

The DO readings declined during the post study between the deep and shallow air injection tests as shown on Figure 6-1. The decline in DO concentrations continued through phase I (5 acfm) of the shallow air injection test. The next increase in DO concentrations did not occur until phase II of the shallow air injection test. The DO increased from 0.67 to 6.35 mg/L in monitoring well 35MW-45A during phase II.

A plot of the DO concentrations from the shallow monitoring wells during the study are shown on Figure 6-1. Only sporadic data was obtained from monitoring well 35MW-44A due to the surging condition of the groundwater within the well, therefore it was not displayed on Figure 6-1. Three monitoring wells (35MW-44A, 45A, and 47A) were impacted during phase I of the deep air injection test yielding a radius of influence of approximately 20 feet as shown on Figure 6-2. Four monitoring wells (35MW-44A, 45A, 46A and 47A) were impacted during phase II of the deep air injection test yielding a radius of influence of approximately 20+ feet as shown on Figure 6-2. Only one monitoring well (35MW-45A) was impacted during phase II of the shallow air injection test yielding a radius of influence of approximately 10 feet as shown on Figure 6-3.

6.1.2 Deep Monitoring Wells

The pre-study DO readings for the deep monitoring wells ranged from 0.13 to 0.25 milligrams per liter (mg/L) as presented in Table 6-2. An increase in DO was observed in a deep monitoring well during phase II (20 acfm) of the deep air injection (35MW-47B) test. No other changes in the DO concentrations occurred in the deep monitoring wells during the treatability study.

One of the seven deep monitoring wells (35MW-45B) was influenced during phase II of the deep air injection test as indicated in Table 6-2. This increase in DO occurred during one reading and ranged from 0.14 to 2.70 mg/L. This spike in DO indicated that the groundwater may have been impacted in a horizontal fashion more than what was expected at this site. A plot of the DO concentrations from the deep monitoring wells during the study are shown on Figure 6-4. It should be noted that the plotted DO concentration for 35MW-47B is residual DO from this well being utilized as the deep air injection well. These readings are not associated with the shallow air injection test.

6.2 Helium

Helium gas was utilized as a tracer element to monitor impacts, such as the radius of influence, that the IAS system had on the site. Helium was added to the air flow at a rate sufficient to yield a total helium concentration of approximately two to four percent. The helium readings indicated that the IAS system positively impacted the site.

6.2.1 Shallow Monitoring Wells

The ambient air inside the wells was analyzed for helium utilizing a helium detector during the performance of the treatability study. The pre-study helium readings were zero as presented in Table 6-3. Helium was detected in the shallow monitoring wells during phase I (7.5 acfm) and phase II

(20 acfm) of the deep air injection (35MW-47B) test. Helium was also detected during phase I (5 acfm) and phase II (20 acfm) of the shallow air injection (35MW-44A) test. A plot of the helium concentrations detected in the ambient air from the monitoring wells during the study is provided on Figure 6-5.

Helium was detected in four shallow monitoring wells (35MW-44A, 45A, 46A, and 47A) ranging from 0.01 to 5.1 percent helium by volume during the deep air injection test as indicated in Table 6-3. The injected helium concentration by volume ranged from 0.8 to 6.0 percent during the deep air injection test. The concentrations of detected helium in the ambient air within the monitoring wells correlated well with the volume of helium being injected into the system. These results yielded an estimated radius of influence of approximately 20 feet for the deep air injection test as shown on Figure 6-2.

Helium was detected in one shallow monitoring well (35MW-45A) during the shallow air injection test as shown on Figure 6-5. The increase in helium occurred near the end of phase I and throughout phase II and ranged from 0.08 to 2.0 percent helium by volume during the shallow air injection test as shown on Table 6-3. These concentrations correlated well with the range of helium being injected (0.56 to 4.4 percent) into the air stream. This increase in helium yielded an approximate radius of influence of 10 feet as shown on Figure 6-3.

6.2.2 Deep Monitoring Wells

Helium was not detected in any of the deep monitoring wells during the entire study as shown on Table 6-4. Therefore, the helium data indicated that the study did not impact the lower portion of the aquifer.

6.2.3 Soil Gas Probes

Six soil gas probes were monitored for helium throughout the study. Helium was detected during phase I (7.5 acfm) and phase II (20 acfm) of the deep air injection (35MW-47B) portion of the study as shown on Figure 6-6. Helium was detected in SG-1 at concentrations ranging from 1.7 to 2.9 percent helium by volume during phase I and 0.71 to 1.0 percent helium by volume during phase II of the deep air injection test as indicated in Table 6-5. Soil gas probe SG-2 detected helium ranging from 0.01 to 0.04 percent helium by volume during phase II of the deep air injection test. Helium was not detected in any of the soil gas probes during the shallow air injection (35MW-44A) portion of the study.

The detection of helium in SG-1 yielded an approximate radius of influence of 20 feet during phase I and II of the deep air injection test. The detection of helium in SG-2 during phase II of the deep air injection test suggests that the radius of influence may have reached as far as 30 feet at a flow rate of 20 acfm from the deep air injection test.

6.3 Static Water Levels

Static water levels were recorded in four monitoring wells throughout the site to monitor any influence the treatability study had on the water table aquifer utilizing data loggers. Monitoring wells 35MW-45A, 45B, 46B, and 47A were chosen to be monitored on a hourly basis during the pre-study, deep and shallow air injection tests, and post-study.

The treatability study impacted the water table aquifer beneath the site during the deep air injection test as shown on Figure 6-7. The greatest impact was noticed in the deep monitoring wells (35MW-45B and 46B) during the first few hours of each phase of the deep air injection test. Approximately half the magnitude of the impact from the deep wells was noticed by the shallow monitoring wells (35MW-45A and 47A). The large drop in the water level following the deep air injection test was likely due to a combination of the treatability study mounding the groundwater beneath the site and the immediate drop in pressure on the aquifer when the treatability study commenced. Once the injection of air into the aquifer commenced the water table formed a depression due to the lack of pressure combined with the groundwater discharging away from the site due to the mounding condition of the water table. The site recharged to its pre-study conditions within a few hours of the post study as shown on Figure 6-7.

Only a slight impact was noticed on the water table aquifer during the shallow air injection test. An increase of approximately 1/2 foot was noticed during the second phase of the shallow air injection test in monitoring well 35MW-47A as shown on Figure 6-7.

6.4 Groundwater Analytical Results

Groundwater samples were collected and analyzed for VOCs during each phase of the treatability study to determine if the study had an impact on the contaminants in the groundwater during the duration of the treatability study. The samples were collected from four monitoring wells, two shallow (35MW-46A and 50A) and two deep (35MW-46B and 50B). All of the samples were collected utilizing a peristaltic pump with dedicated tubing and were sent to a fixed-base laboratory for VOC analysis.

The groundwater samples were collected during the beginning of the pre-study, at the end of phase I and II of the deep and shallow injection tests, and during the post-study monitoring. No noticeable decline in site contaminants was noticed during the treatability study. The majority of the contaminants detected were chlorinated solvents such as chlorobenzene, 1,2-dichloroethene (total), and trichloroethene.

The pre-study groundwater samples detected chlorobenzene, 1,2-dichloroethene (total), trichloroethene, and vinyl chloride ranging in concentrations from 1.2 J to 120 μg/L as presented in Table 6-6. The detected compounds during phase I of the deep air injection test consisted of benzene, 1,2-dichloroethene (total), trichloroethene, and vinyl chloride and ranged from 1.1 to 130 μg/L as indicated in Table 6-7. 1,2-dichloroethene (total), trichloroethene, and vinyl chloride were detected in the groundwater samples collected during phase II of the deep air injection test at concentrations ranging from 1.0 J to 99 μg/L as presented in Table 6-8. The detected compounds during phase I of the shallow air injection test consisted of 1,2-dichloroethene (total), trichloroethene, and vinyl chloride and ranged from 1.0 J to 120 μg/L as indicated in Table 6-9. Benzene, chlorobenzene, 1,2-dichloroethene (total), methylene chloride, and trichloroethene were detected in the groundwater samples collected during phase II of the shallow air injection test at concentrations ranging from 1.0 J to 130 μg/L as presented in Table 6-10. The post-study groundwater samples detected 1,2-dichloroethene (total) and trichloroethene ranging in concentrations from 1.2 J to 130 μg/L as presented in Table 6-11.

The concentrations of the detected compounds varied slightly from each phase of the tests. The minor changes did not indicate any influence on the contaminants in the groundwater from the short duration of the treatability study. A noticeable impact may have been observed on the monitoring wells sampled if the radius of influence from the treatability study would have encompassed these monitoring wells.

6.5 Air Sampling Analytical Results

A total of 12 air samples were collected during the duration of the treatability study via SUMMA canisters to evaluate any contaminants which may have been released to the ambient air of the site and within the vadose zone. Eight of the samples (SUMMA canister ID # 0048, 12586, 0169, 93279, 12403, 93040, 0039, and 92039) were collected from soil gas probes SG-4 and SG-5 to monitor the vadose zone. The remaining four samples (SUMMA canister ID # 04330, 92003, 12544, and 93148) consisted of ambient air and were obtained in the vicinity of the two air injection wells and the IAS trailer location. All of the samples were analyzed for TO-14 at a fixed-based laboratory. The air sampling locations and corresponding SUMMA canister ID numbers are shown on Figure 6-8. The detected analytical results are displayed in Table 6-12 and an evaluation of the analytical results is provided in the following paragraphs.

The following section presents a qualitative comparison of Plume B air sampling data collected for the IAS treatability study to human health risk-based criteria. The purpose of this qualitative risk evaluation is to determine if there is a potential for adverse health effects to occur in the absence of collecting the off-gas from the IAS technology. Therefore, only the data from the four ambient air samples were compared to relevant risk-based criteria and discussed qualitatively.

Under the IAS treatability study, four ambient air monitoring samples were analyzed for volatile organic compounds (VOCs). Table 6-12 presents the VOCs detected in the ambient air monitoring samples. The positive detections were compared qualitatively to USEPA Region III Ambient Air Risk-Based Concentrations (RBCs). All detected VOCs are retained for further consideration. M-Xylene, p-xylene, toluene, tetrachloroethene, cis-1,2-dichloroethene, chloromethane, carbon disulfide, and dichlorodifluoromethane were detected at maximum concentrations below their respective ambient air RBCs. N-Butane and pentane were also detected. However, it should be noted that there were no risk-based criteria established for n-butane and pentane.

Benzene was detected in one out of four samples at a detected concentration exceeding the ambient air RBC. However, this detection of benzene was only detected in one of the four samples and seems to be isolated. Consequently, this suggests that the potential for adverse health effects to occur during the operation of an IAS treatment system would be unlikely.

6.6 Radius of Influence

The treatability study was operated at two flow rates during the shallow and deep air injection tests to determine an optimum flow rate and a corresponding radius of influence for the in-situ air sparging technology at this site. The radius of influence and corresponding flow rates will be discussed in the following sections and will be split between the deep air injection test and the shallow air injection test.

6.6.1 Deep Air Injection Test

The deep air injection test provided valuable data for evaluating the radius of influence and determining the optimum flow rate for Site 35. The deep air injection test utilized monitoring well 35MW-47B for the air injection location. Air was injected at two different flow rates (7.5 and 20 acfm) as shown on the system head curve (Figure 6-9).

An approximate radius of influence of 20 feet was observed during phase I (7.5 acfm) of the deep air injection well (35MW-47B) as indicated by the supporting data obtained from the monitoring wells and soil gas probes previously discussed. The monitoring well data indicated a radius of influence greater than 20 feet for phase II (20 acfm) of the deep air injection test. The soil gas data indicated a radius of influence of approximately 30 feet for the same phase. It was estimated that injecting air approximately 26 feet bgs at 20 acfm will yield a radius of influence of approximately 25 feet away from the sparge point. Three geologic cross-sections have been developed to assist in visualizing the approximate radius of influence from the IAS system. Figure 6-10 shows the locations of the geologic cross sections for Plume B. Figures 6-11, 6-12, and 6-13 provide three different cross sections of the site. The monitoring points which were impacted during the pilot test have been displayed in color.

6.6.2 Shallow Air Injection Test

The shallow air injection test provided valuable data for evaluating the radius of influence and determining the optimum flow rate for Site 35. The shallow air injection test utilized monitoring well 35MW-44A for the air injection location. Air was injected at two different flow rates (5 and 20 acfm) as shown on the system head curve (Figure 6-14).

A radius of influence was not observed during phase I (5 acfm) of the shallow air injection test as indicated by the supporting data obtained from the monitoring wells and soil gas probes previously discussed. The monitoring well data indicated a radius of influence of approximately 10 feet for phase II (20 acfm) of the shallow air injection test. This radius of influence did not sustain the entire 24 hour period that the system was operating during this phase. This was most likely due to the subsurface stratigraphy in which the shallow air injection well was located. This stratigraphy consisted mainly of peat material. The air pathways which were developing early during phase II failed to sustain themselves due to the poor shear strength associated with this peat material located in the first 12 feet bgs. Three geologic cross-sections have been developed to assist in visualizing the approximate radius of influence from the IAS system. Figure 6-10 shows the locations of the geologic cross sections for Plume B. Figures 6-15, 6-16, and 6-17 show three different cross sections of the site. The monitoring points which were impacted during the pilot test have been displayed in color.

6.7 Additional Groundwater Sample Results

An additional round of post-test groundwater samples were collected from four monitoring wells at Plume B during October 1996. These samples were collected to determine if any significant changes to the groundwater contamination has occurred since the completion of the pilot test and also as a follow up to the lack of BTEX contamination in this area compared to the contamination upgradient. Four groundwater samples were collected from Plume C to assist in evaluating the extent of the contamination at Site 35. This data was valuable in recommending an IAS system for Site 35.

The groundwater analytical results did not indicate any significant changes in the contaminants at Plume B when compared to the previous data collected from Plume B during the treatability study. 1,2-Dichloroethene and trichloroethene were detected at concentrations ranging from 12 to 160 μg/L as presented in Table 6-14. These concentrations correlated well with the analytical results from the previous treatability study sampling conducted in August 1996.

Additional groundwater samples were collected from a few monitoring wells upgradient of the IAS treatability study location. It was in these wells that significant groundwater contamination was detected in the surficial aquifer prior to the soil removal action at the former fuel farm location. The levels of BTEX from the samples collected during October 1996 were an order of magnitude less than those samples collected prior to the soil removal. Therefore, it is believed that the decline in the BTEX contamination at the site may be somewhat attributed to the removal of the contaminated soil.

The analytical results from the groundwater collected at plume C detected similar compounds from Plume B but at increased concentrations. The concentrations of the compounds detected ranged from 23 to 1400 µg/L as indicated in Table 6-15. The contamination in the deep wells was significantly greater than the contamination in the shallow wells.

7.0 CONCLUSIONS AND RECOMMENDATIONS

This section provides the conclusions from the IAS treatability study and recommendations for the design of a full-scale IAS system. These conclusions and recommendations are supported by the information in Sections 1.0 through 6.0 of this report.

7.1 Conclusions

Based on the results of the IAS treatability study it can be concluded that:

- IAS via vertical air injection will have limited effectiveness remediating CHCs at the base of the surficial aquifer. The semi-confining unit is too impermeable to allow air injection below the base of the surficial aquifer and underneath the contaminants.

- Vertical air injection in the area of the Plume C treatability study wells is inappropriate due to the presence of a subsurface clay layer. This clay layer will inhibit the vertical release of contaminants to the atmosphere and may result in the horizontal migration of contaminants off site.

- Results of groundwater sampling indicate BTEX contamination is not present in the area of the Plume B or Plume C wells. There are three possible reasons for the lack of contamination at these locations:

    1) The source of the contamination has been removed during the previous soil removal action at the former fuel farm.

    2) The contamination has not migrated to the IAS treatability study location.

    3) The contamination is being naturally attenuated in the approximately 10-foot thick peat bog located along the banks of Brinson Creek.

- Vertical air injection from the deep air injection wells did have a favorable impact at Plume B. A radius of influence of 20 feet was observed at a flow rate of 7.5 acfm. The radius of influence increased to approximately 30 feet when the air flow was increased to 20 acfm.

- Vertical air injection from the shallow air injection wells did not have a favorable impact at Plume B. Due to the lack of shear strength of the peat material, air pathways were unable to be developed and sustained from an air injection point just below the peat layer.

- Due to BTEX results, IAS, if implemented in the area between the eastern edge of the proposed right-of-way and Brinson Creek, will not impact the BTEX contamination.

7.2 Recommendations

- An IAS system where air is injected horizontally along the top of the semi-confining layer is preferable to conventional vertical air injection. Such a system should be more effective in remediating the CHC and BTEX contamination at this site. It is estimated that the cost of this system should be approximately equal to RAA 3, Groundwater Collection and On-Site Treatment, which was identified as the preferred contingent alternative in the Final Interim ROD (Baker, 1995).

- Due to poor site conditions, difficult access, and a lack of BTEX contamination in groundwater in the area between the eastern edge of the proposed right-of-way and Brinson Creek, an IAS system will likely be more effective if constructed along the western edge of the proposed right-of-way as shown on Figure 7-1.

- A field pilot test of a horizontal IAS system should be conducted in the area west of the proposed right-of-way to ensure it's effectiveness prior to full-scale implementation.

8.0 REFERENCES

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TABLES

TABLE 1-1

ORGANIC COCs THAT EXCEED REMEDIATION LEVELS
IAS TREATABILITY STUDY
OPERABLE UNIT NO. 10 (SITE 35)
CAMP LEJEUNE, NORTH CAROLINA

Contaminant of Concern	RL$^{(1,2)}$	Basis of RL
Benzene	1	NC WQS
Trichloroethene	2.8	NC WQS
cis-1,2-Dichloroethene	70	NC WQS
trans-1,2-Dichloroethene	70	NC WQS
Ethylbenzene	29	NC WQS
Methyl Tertiary Butyl Ether	200	NC WQS
Xylenes	530	NC WQS

Notes:

(1) RL = Remediation Level
(2) Groundwater RLs expressed as μg/L (ppb)
NC WQS = North Carolina Water Quality Standard

TABLE 4-1

MONITORING WELL CONSTRUCTION DETAILS - PLUME B
IAS TREATABILITY STUDY
OPERABLE UNIT NO. 10 (SITE 35)
CAMP LEJEUNE, NORTH CAROLINA

Well Number	Completion Date	Ground Surface Elevation (feet MSL)	Top of PVC Casing Elevation	Screened Interval		Total Depth of Well (feet bgs)
				Depth (feet bgs)	Elevation (feet MSL)	
35MW-44A	7/11/96	2.8	5.76	14 - 16	-11.2 - -13.2	16.2
35MW-44B	7/14/96	2.8	5.35	32 - 34	-29.2 - -31.2	34.2
35MW-45A	7/11/96	2.8	5.46	2 - 12	0.8 - -9.2	12.5
35MW-45B	7/14/96	2.8	5.60	26 - 31	-23.2 - -28.2	31.5
35MW-46A	7/9/96	2.4	5.26	2 - 12	0.4 - -9.6	12.5
35MW-46B	7/9/96	2.8	5.74	26 - 31	-23.2 - -28.2	31.5
35MW-47A	7/10/96	2.6	5.49	2 - 12	0.6 - -9.4	12.5
35MW-47B	7/10/96	2.8	5.77	26 - 31	-23.2 - -28.2	31.5
35MW-48A	7/10/96	2.3	5.20	2 - 12	0.3 - -9.7	12.5
35MW-48B	7/11/96	2.4	5.13	26 - 31	-23.6 - -28.6	31.5
35MW-49A	7/10/96	2.4	4.99	2 - 12	0.4 - -9.6	12.5
35MW-49B	7/10/96	2.3	4.98	26 - 31	-23.7 - -28.7	31.5
35MW-50A	7/11/96	2.6	5.37	2 - 12	0.6 - -9.4	12.5
35MW-50B	7/11/96	2.9	5.45	26 - 31	-23.1 - -28.1	31.5

TABLE 4-2

MONITORING WELL CONSTRUCTION DETAILS - PLUME C
IAS TREATABILITY STUDY
OPERABLE UNIT NO. 10 (SITE 35)
CAMP LEJEUNE, NORTH CAROLINA

Well Number	Completion Date	Ground Surface Elevation (feet MSL)	Top of PVC Casing Elevation	Screened Interval Depth (feet bgs)	Screened Interval Elevation (feet MSL)	Total Depth of Well (feet bgs)
35MW-51B	8/21/96	2.5	5.20	24 - 26	-21.5 - -23.5	31
35MW-52A	8/24/96	3.1	5.91	18 - 23	-14.9 - -19.9	23
35MW-52B	8/24/96	3.0	5.88	22 - 27	-19.0 - -24.0	32
35MW-53A	8/26/96	3.3	6.39	15.5 - 20.5	-12.2 - -17.2	21
35MW-53B	8/25/96	3.0	6.31	22 - 27	-19.0 - -24.0	32
35MW-54A	8/25/96	3.3	6.36	18 - 23	-14.7 - -19.7	23
35MW-54B	8/25/96	3.2	6.25	22 - 27	-18.8 - -23.8	32
35MW-55A	8/24/96	2.3	5.07	7 - 12	-4.7 - -9.7	12
35MW-55B	8/23/96	2.9	6.09	21 - 26	-18.1 - -23.1	32
35MW-56B	8/23/96	6.3	8.99	15 - 25	-8.7 - -18.7	34
35MW-57B	8/22/96	2.8	5.74	17 - 27	-14.2 - -24.2	32
35MW-58B	8/26/96	6.9	9.97	21 - 31	-14.1 - -24.1	32

TABLE 5-1

PRE-STUDY SAMPLING MATRIX - PLUME B
IAS TREATABILITY STUDY
OPERABLE UNIT NO. 10 (SITE 35)
CAMP LEJEUNE, NORTH CAROLINA

Matrix	Location	Analysis	Frequency	Method	Total Samples
Soil Gas	All probes	Oxygen	t = 0	O_2/LEL	6
Soil Gas	All probes	VOCs	t = 0	Vapor analyzer	6
Soil Gas	SG4, SG5	VOCs	t = 0	SUMMA, TO-14	2
Soil Gas	All probes	Pressure	t = 0	Pressure gauge	6
Groundwater	All wells except 44A/B	D.O.	t = 0	D.O. meter	12
Groundwater	46A/B, 50A/B	VOCs	t = 0	Lab, SW 846 8240	4
Groundwater	45A/B, 46B, 47A	Water Level	Hourly	Data Logger	96

TABLE 5-2

TEST PHASE DURATIONS - PLUME B
IAS TREATABILITY STUDY
OPERABLE UNIT NO. 10 (SITE 35)
CAMP LEJEUNE, NORTH CAROLINA

Task Name	Wed Aug 7	Thu Aug 8	Fri Aug 9	Sat Aug 10	Sun Aug 11	Mon Aug 12	Tue Aug 13	Wed Aug 14
Pre Study Sampling	▨	▨						
Deep Well Air Injection Phase I (7.5 acfm)		▨	▨					
Deep Well Air Injection Phase II (20 acfm)			▨	▨				
Post Study Sampling				▨	▨			
Shallow Well Air Injection Phase I (5 acfm)					▨	▨		
Shallow Well Air Injection Phase II (20 acfm)						▨	▨	
Post Study Sampling							▨	▨

TABLE 5-3

TREATABILITY STUDY SAMPLING MATRIX - PLUME B
IAS TREATABILITY STUDY
OPERABLE UNIT NO. 10 (SITE 35)
CAMP LEJEUNE, NORTH CAROLINA

Matrix	Location	Analysis	Frequency	Method	Total Samples
Deep Air Injection					
Soil Gas	All probes	Oxygen	t = 4,18,22,42	O_2/LEL	24
Soil Gas	All probes	VOCs	t = 4,18,42	Vapor analyzer	18
Soil Gas	SG4, SG5	VOCs	t = 18,42	SUMMA, TO-14	4
Soil Gas	All probes	Pressure	t = 4,18,22,24,42	Pressure gauge	30
Soil Gas	All Probes	Helium	t = 4,18,22,24,42	Helium Detector	30
Groundwater	All wells except 44A/B	D.O.	t = 2,4,17,21,24,26,41	D.O. meter	84
Groundwater	46A/B, 50A/B	VOCs	t = 19,44	Lab, SW 846 8240	8
Groundwater	45A/B, 46B, 47A	Water Level	Hourly	Data Logger	176
Groundwater Off-Gas	All Wells	Helium	t = 4,6,17,22,24,27,30,41	Helium Detector	112
Shallow Air Injection					
Soil Gas	SG4, SG5	VOCs	t = 23,25,48	SUMMA, TO-14	6
Soil Gas	All Probes	Helium	t = 3,9,23,27,30,33,47	Helium Detector	42
Groundwater	All wells except 44A/B	D.O.	t = 0,2,5,8,24,27,30,33,47	D.O. meter	108
Groundwater	46A/B, 50A/B	VOCs	t = 24,48	Lab, SW 846 8240	8
Groundwater	45A/B, 46B, 47A	Water Level	Hourly	Data Logger	192
Groundwater Off-Gas	All Wells	Helium	t = 3,5,9,23,26,30,33,47	Helium Detector	112

TABLE 5-4

POST-STUDY SAMPLING MATRIX - PLUME B
IAS TREATABILITY STUDY
OPERABLE UNIT NO. 10 (SITE 35)
CAMP LEJEUNE, NORTH CAROLINA

Matrix	Location	Analysis	Frequency	Method	Total Samples
Deep Air Injection					
Groundwater	All wells except 44A/B	D.O.	t = 2,6,10,23	D.O. meter	48
Groundwater	45A/B, 46B, 47A	Water Level	Hourly	Data Logger	96
Shallow Air Injection					
Soil Gas	All Probes	Helium	t = 4,8,22	Helium Detector	18
Soil Gas	SG4, SG5	VOCs	t = 22	SUMMA, TO-14	2
Groundwater	All wells except 44A/B	D.O.	t = 4,8,22	D.O. meter	36
Groundwater	46A/B, 50A/B	VOCs	t = 22	Lab, SW 846 8240	8
Groundwater	45A/B, 46B, 47A	Water Level	Hourly	Data Logger	96
Groundwater Off-Gas	All Wells	Helium	t = 4,8,22	Helium Detector	42

TABLE 6-1

SHALLOW MONITORING WELL DISSOLVED OXYGEN CONCENTRATIONS - PLUME B
IAS TREATABILITY STUDY
OPERABLE UNIT NO. 10 (SITE 35)
CAMP LEJEUNE, NORTH CAROLINA

Test	Phase	Flow Rate (acfm)	Time (hours)	44A	45A	46A	47A	48A	49A	50A
Pre-Study		0	0	NA	0.25	0.20	0.14	0.14	0.15	0.20
Deep Air Injection	I	7.5	2	NA	2.60	0.19	4.88	0.29	0.15	0.23
			4.5	NA	1.18	0.30	5.82	0.18	0.29	0.49
			17	10.91	0.82	0.25	8.21	0.14	0.12	0.26
	II	20	2.5	NA	0.71	0.98	9.50	0.29	0.31	0.18
			5	NA	1.62	0.93	9.70	0.36	0.25	0.28
			7	NA	5.98	1.23	9.33	0.31	0.20	0.32
			22	NA	2.65	0.92	11.71	0.25	0.23	0.30
Post Study			2	12.17	4.41	7.33	7.27	NA	NA	NA
			6	11.58	2.38	4.40	5.54	NA	NA	NA
			10	9.35	2.01	0.50	4.61	NA	NA	NA
Shallow Air Injection	I	5	0	4.46	1.75	0.28	2.92	0.28	0.31	0.28
			2	NA	1.72	0.17	3.11	0.24	0.24	0.17
			5	NA	1.70	0.18	2.85	0.36	0.26	0.23
			8	NA	1.57	0.18	2.30	0.21	0.29	0.25
			23	NA	0.67	0.10	1.88	0.18	0.16	0.07
	II	20	2	NA	5.18	0.13	2.10	0.07	0.20	0.04
			5	NA	5.50	NA	2.27	NA	NA	NA
			8	NA	6.35	0.20	1.89	0.15	0.15	0.13
			23	NA	5.78	0.16	1.75	0.20	0.21	0.13
Post Study		0	4	NA	1.66	0.19	1.56	0.22	0.19	0.23
			8	NA	2.07	0.16	1.60	0.15	0.24	0.16
			24	NA	1.78	0.22	1.43	0.05	0.35	0.14

Notes: NA - Not analyzed

TABLE 6-2

DEEP MONITORING WELL DISSOLVED OXYGEN CONCENTRATIONS - PLUME B
IAS TREATABILITY STUDY
OPERABLE UNIT NO. 10 (SITE 35)
CAMP LEJEUNE, NORTH CAROLINA

Test	Phase	Flow Rate (acfm)	Time (hours)	44B	45B	46B	47B	48B	49B	50B
Pre-Study		0	0	NA	0.25	0.23	0.16	0.15	0.13	0.22
Deep Air Injection	I	7.5	2	NA	0.12	0.19	NA	0.14	0.16	0.21
			4.5	NA	0.26	0.30	NA	0.15	0.28	0.16
			17	NA	0.11	0.14	NA	0.18	0.13	0.36
	II	20	2.5	NA	0.14	0.18	NA	0.18	0.17	0.14
			5	NA	0.17	0.16	NA	0.14	0.21	0.33
			7	NA	2.70	0.17	NA	0.25	0.21	0.23
			22	NA	0.16	0.13	NA	0.22	0.24	0.27
Post Study			2	NA	NA	NA	NA	NA	NA	NA
			6	NA	NA	NA	NA	NA	NA	NA
			10	NA	NA	NA	NA	NA	NA	NA
Shallow Air Injection	I	5	0	4.75	0.18	0.23	8.55	0.19	0.10	0.12
			2	4.00	0.18	0.16	5.88	0.18	0.16	0.23
			5	3.31	0.18	0.18	4.26	0.15	0.17	0.21
			8	3.10	0.19	0.17	2.85	0.14	0.15	0.18
			23	2.75	0.11	0.14	2.21	0.13	0.14	0.15
	II	20	2	2.40	0.19	0.12	0.52	0.30	0.08	0.09
			5	4.58	0.20	NA	NA	NA	NA	NA
			8	1.81	0.18	0.22	0.13	0.16	0.20	0.11
			23	1.78	0.15	0.18	0.15	0.14	0.14	0.12
Post Study		0	4	1.54	0.17	0.16	0.16	0.17	0.17	0.22
			8	1.59	0.22	0.23	0.14	0.10	0.13	0.23
			24	1.55	0.17	0.26	0.15	0.05	0.13	0.22

Notes: NA- Not analyzed

TABLE 6-3

SHALLOW MONITORING WELL PERCENT HELIUM BY VOLUME - PLUME B
IAS TREATABILITY STUDY
OPERABLE UNIT NO. 10 (SITE 35)
CAMP LEJEUNE, NORTH CAROLINA

Test	Phase	Flow Rate (acfm)	Time (hours)	44A	45A	46A	47A	48A	49A	50A
Pre-Study		0	0	0	0	0	0	0	0	0
Deep Air Injection	I	7.5	2	NA	2.60	0.01	4.60	0	0	0
			4.5	NA	3.10	0.40	4.20	0	0	0
			17	0.82	1.20	0	5.10	0	0	0
	II	20	2.5	0.15	2.20	1.50	1.70	0.02	0	0
			5	0.35	2.00	1.80	2.00	0.02	0	0
			7	0	1.50	1.00	1.60	0	0	0
			11	0.07	0.38	0.21	1.60	0	0	0
			22	0.08	1.60	1.30	1.60	0	0	0
Post Study			2	NA	NA	NA	NA	NA	NA	NA
			6	NA	NA	NA	NA	NA	NA	NA
			10	NA	NA	NA	NA	NA	NA	NA
Shallow Air Injection	I	5	2	NA	0.17	0.01	0.27	0	0	0
			5	NA	0.10	0	0.18	0	0	0
			8	NA	0.08	0	0.17	0	0	0
			23	NA	1.00	0	0.10	0	0	0
	II	20	2	NA	1.90	0	0.06	0	0	0
			5	NA	0.88	0	0.08	0	0	0
			8	NA	2.00	0	0.08	0	0	0
			23	NA	1.50	0	0.08	0	0	0
Post Study		0	4	0	0.81	0	0.10	0	0	0
			8	0	0.56	0	0.09	0	0	0
			24	0	0	0	0	0	0	0

Notes: NA- Not analyzed

TABLE 6-4

DEEP MONITORING WELL PERCENT HELIUM BY VOLUME - PLUME B
IAS TREATABILITY STUDY
OPERABLE UNIT NO. 10 (SITE 35)
CAMP LEJEUNE, NORTH CAROLINA

Test	Phase	Flow Rate (acfm)	Time (hours)	44B	45B	46B	47B	48B	49B	50B
Pre-Study		0	0	0	0	0	0	0	0	0
Deep Air Injection	I	7.5	2	NA	0	0	NA	0	0	0
			4.5	NA	0	0	NA	0	0	0
			17	0	0	0	NA	0	0	0
	II	20	2.5	0	NA	NA	NA	NA	NA	0
			5	0	0	0	NA	0	0	0
			7	0	0	0	NA	0	0	0
			11	0	0	0	NA	0	0	0
			22	0	0	0	NA	0	0	0
Post Study			2	NA	NA	NA	NA	NA	NA	NA
			6	NA	NA	NA	NA	NA	NA	NA
			10	NA	NA	NA	NA	NA	NA	NA
Shallow Air Injection	I	5	2	0	0	0	0	0	0	0
			5	0	0	0	0	0	0	0
			8	0	0	0	0	0	0	0
			23	0	0	0	0	0	0	0
	II	20	2	0	0	0	0	0	0	0
			5	0	0	0	0	0	0	0
			8	0	0	0	0	0	0	0
			23	0	0	0	0	0	0	0
Post Study		0	4	0	0	0	0	0	0	0
			8	0	0	0	0	0	0	0
			24	0	0	0	0	0	0	0

Notes: NA - Not analyzed

TABLE 6-5

SOIL GAS PROBE PERCENT HELIUM BY VOLUME - PLUME B
IAS TREATABILITY STUDY
OPERABLE UNIT NO. 10 (SITE 35)
CAMP LEJEUNE, NORTH CAROLINA

Test	Phase	Flow Rate (acfm)	Time (hours)	SG-1	SG-2	SG-3	SG-4	SG-5	SG-6
Pre-Study		0	0	0	0	0	0	0	0
Deep Air Injection	I	7.5	3.5	2.90	0	0	0	0	0
			18	1.70	0	0	0	0	0
	II	20	2.5	0.71	0	0.01	0	0	0
			5	1.00	0.01	0	0	0	0
			24	0.83	0.04	0	0	0	0
Shallow Air Injection	I	5	2.5	0.04	0	0	0	0	0
			8	0	0	0	0	0	0
			23	0	0	0	0	0	0
	II	20	2	0	0	0	0	0	0
			5	0	0	0	0	0	0
			8	0	0	0	0	0	0
			23	0	0	0	0	0	0
Post Study		0	4	0	0	0	0	0	0
			8	0	0	0	0	0	0
			24	0	0	0	0	0	0

TABLE 6-6

PRE-TEST GROUNDWATER ANALYTICAL RESULTS - PLUME B
IAS TREATABILITY STUDY
OPERABLE UNIT NO. 10 (SITE 35)
CAMP LEJEUNE, NORTH CAROLINA

Volatile Organic Compounds	35-GW-46A-01-00 (μg/L)	35-GW-46B-01-00 (μg/L)	35-GW-50A-01-00 (μg/L)	35-GW-50B-01-00 (μg/L)
Chlorobenzene	1.2 J	5.0 U	5.0 U	5.0 U
1,2-Dichloroethene (total)	120	88	11	37
Trichloroethene	24	8.5	2.0 J	2.4 J
Vinyl Chloride	1.4 J	1.2 J	10 U	10 U

TABLE 6-7

DEEP AIR INJECTION, PHASE I, GROUNDWATER ANALYTICAL RESULTS - PLUME B
IAS TREATABILITY STUDY
OPERABLE UNIT NO. 10 (SITE 35)
CAMP LEJEUNE, NORTH CAROLINA

Volatile Organic Compounds	35-GW-46A-02-20 (µg/L)	35-GW-46B-02-20 (µg/L)	35-GW-50A-02-20 (µg/L)	35-GW-50B-02-20 (µg/L)
Benzene	1.0 U	1.0 U	1.1	1.0 U
1,2-Dichloroethene (total)	130	86	10	36
Trichloroethene	22	8.5	2.1 J	2.1 J
Vinyl Chloride	10 U	1.1 J	10 U	10 U

TABLE 6-8

DEEP AIR INJECTION, PHASE II, GROUNDWATER ANALYTICAL RESULTS - PLUME B
IAS TREATABILITY STUDY
OPERABLE UNIT NO. 10 (SITE 35)
CAMP LEJEUNE, NORTH CAROLINA

Volatile Organic Compounds	35-GW-46A-03-24 (µg/L)	35-GW-46B-03-24 (µg/L)	35-GW-50A-03-24 (µg/L)	35-GW-50B-03-24 (µg/L)
1,2-Dichloroethene (total)	99	77	9.9	41
Trichloroethene	13	7.4	1.9 J	2.6 J
Vinyl Chloride	10 U	1.0 J	10 U	10 U

TABLE 6-9

SHALLOW AIR INJECTION, PHASE I, GROUNDWATER ANALYTICAL RESULTS
PLUME B
IAS TREATABILITY STUDY
OPERABLE UNIT NO. 10 (SITE 35)
CAMP LEJEUNE, NORTH CAROLINA

Volatile Organic Compounds	35-GW-46A-04-23 (µg/L)	35-GW-46B-04-23 (µg/L)	35-GW-50A-04-23 (µg/L)	35-GW-50B-04-23 (µg/L)
1,2-Dichloroethene (total)	120	79	10	36
Trichloroethene	21	7.3	1.8 J	1.7 J
Vinyl Chloride	10 U	1.0 J	10 U	10 U

TABLE 6-10

SHALLOW AIR INJECTION, PHASE II, GROUNDWATER ANALYTICAL RESULTS
PLUME B
IAS TREATABILITY STUDY
OPERABLE UNIT NO. 10 (SITE 35)
CAMP LEJEUNE, NORTH CAROLINA

Volatile Organic Compounds	35-GW-46A-05-24 (µg/L)	35-GW-46B-05-24 (µg/L)	35-GW-50A-05-24 (µg/L)	35-GW-50B-05-24 (µg/L)
Benzene	1.0 U	1.0 U	1.3	1.0 U
Chlorobenzene	5.0 U	5.0 U	1.0 J	5.0 U
1,2-Dichloroethene (total)	130	80	9.7	32
Methylene Chloride	5.0 U	5.0 U	3.5 JB	3.7 JB
Trichloroethene	22	6.9	2.6 J	2.0 J

TABLE 6-11

POST TEST GROUNDWATER ANALYTICAL RESULTS - PLUME B
IAS TREATABILITY STUDY
OPERABLE UNIT NO. 10 (SITE 35)
CAMP LEJEUNE, NORTH CAROLINA

Volatile Organic Compounds	35-GW-46A-06-24 (µg/L)	35-GW-46B-06-24 (µg/L)	35-GW-50A-06-24 (µg/L)	35-GW-50B-06-24 (µg/L)
1,2-Dichloroethene (total)	130	70	9.9	28
Trichloroethene	23	6.8	1.8 J	1.2 J

TABLE 6-12

AIR SAMPLING ANALYTICAL RESULTS - PLUME B
IAS TREATABILITY STUDY
OPERABLE UNIT NO. 10 (SITE 35)
CAMP LEJEUNE, NORTH CAROLINA

SUMMA Canister ID #	0048	12586	0169	93279	04330	92003	12403	93040	12544	0039	92039	93148
Sampling Location	SG-4	SG-5	SG-4	SG-5	47B	44A	SG-4	SG-5	44A	SG-4	SG-5	TRAILER
Test	Pre-Study	Pre-Study	Deep Inj.	Deep Inj.	Deep Inj.	Shallow Inj.	Shallow Inj.	Shallow Inj.	Shallow Inj.	Post-Study	Post-Study	Post-Study
Phase			Phase I	Phase I	Phase II	Phase I	Phase I	Phase I	Phase II			
Date Collected	27-Jul	Jul 27	Aug 9	Aug 9	Aug 10	Aug 12	Aug 12	Aug 12	Aug 13	Aug 14	Aug 14	Aug 14
Time Collected	1400	1400	945	945	905	745	900	900	800	650	650	650
Units	PPB(V/V)	PPB(V/V)	PPB(V/V)	PPB(V/V)	PPB(V/V)	PPB(V/V)	PPB(V/V)	PPB(V/V)	PPB(V/V)	PPB(V/V)	PPB(V/V)	PPB(V/V)
M-Xylene & P-Xylene	6.4	2.2	0.57	0.44	0.43 U	0.73	0.42 U	0.42 U	0.41 U	0.42 U	0.42 U	0.41 U
Ethylbenzene	2.1	0.57	0.43 U	0.42 U	0.43 U	0.43 U	0.42 U	0.42 U	0.41 U	0.42 U	0.42 U	0.41 U
Styrene	1.5	0.67	0.43 U	0.42 U	0.43 U	0.43 U	0.42 U	0.42 U	0.41 U	0.42 U	0.42 U	0.41 U
N-Butane	4.5	1.9	1.3	0.42 U	0.61	1.6	0.65	0.42 U	0.53	0.92	0.42 U	0.92
Toluene	26	9.4	2.1	1.6	0.43 U	1.3	1.2	0.82	0.41 U	1	0.61	0.49
Pentane	4.7	1.2	0.91	0.42 U	0.46	1.3	0.45	0.42 U	0.41 U	0.5	0.42 U	0.44
N-Hexane	1.7	0.42 U	0.43 U	0.42 U	0.43 U	0.43 U	0.42 U	0.42 U	0.41 U	0.42 U	0.42 U	0.41 U
N-Octane	1	0.42 U	0.43 U	0.42 U	0.43 U	0.43 U	0.42 U	0.42 U	0.41 U	0.42 U	0.42 U	0.41 U
N-Undecane	3.4	1.4	0.6	1.4	0.43 U	0.43 U	0.5	0.42 U	0.41 U	0.43	0.42 U	0.41 U
N-Dodecane	1.1	0.79	0.43 U	0.42 U	0.43 U	0.43 U	0.42 U	0.42 U	0.41 U	0.42 U	0.42 U	0.41 U
Nonane	1.6	0.42 U	0.43 U	0.42 U	0.43 U	0.43 U	0.42 U	0.42 U	0.41 U	0.42 U	0.42 U	0.41 U
N-Decane	7.5	0.42 U	1.1	1.2	0.43 U	0.43 U	1.6	0.88	0.41 U	0.95	0.74	0.41 U
Tetrachloroethene	0.44 U	0.42 U	0.43 U	0.42 U	1.1	0.43 U	0.49	0.42 U	0.41 U	0.42 U	0.42 U	0.41 U
N-Heptane	0.71	0.42 U	0.43 U	0.42 U	0.43 U	0.43 U	0.42 U	0.42 U	0.41 U	0.42 U	0.42 U	0.41 U
cis-1,2-Dichloroethene	2.3	0.42 U	0.43 U	0.42 U	1.4	0.8	0.42 U	0.42 U	0.75	0.42 U	0.42 U	0.41 U
Chloroform	0.44 U	1.4	0.43 U	0.96	0.43 U	0.43 U	0.42 U	0.74	0.41 U	0.42 U	0.9	0.41 U
Benzene	14	1.4	13	35	0.43 U	0.77	21	42	0.41 U	19	40	0.41 U
Chloromethane	0.61	0.42 U	0.73	0.42 U	0.63	0.65	1.1	0.42 U	0.84	1	0.42 U	0.59
Carbon Disulfide	1.4	0.64 U	0.64 U	0.63 U	0.64 U	1	1.4	0.64 U	0.62 U	0.62 U	0.63 U	0.61 U
Dichlorodifluoromethane	0.68	0.7	0.74	0.8	0.61	0.64	0.65	0.64	0.59	0.66	0.68	0.64
O-Xylene	1.9	0.74	0.43 U	0.42 U	0.43 U	0.43 U	0.42 U	0.42 U	0.41 U	0.42 U	0.42 U	0.41 U
1,2,4-Trimethylbenzene	1.1	0.57	0.43 U	0.42 U	0.43 U	0.43 U	0.42 U	0.42 U	0.41 U	0.42 U	0.42 U	0.41 U
Cumene	5	1.8	0.72	0.58	0.43 U	0.43 U	0.57	0.42 U	0.41 U	0.48	0.42 U	0.41 U
Alpha-Methylstyrene	1.5	0.42 U	0.43 U	0.42 U	0.43 U	0.43 U	0.42 U	0.42 U	0.41 U	0.42 U	0.42 U	0.41 U

TABLE 6-13

COMPARISON OF POSITIVE DETECTIONS TO AMBIENT AIR RBCs
IAS TREATABILITY STUDY
OPERABLE UNIT NO. 10 (SITE 35)
CAMP LEJEUNE, NORTH CAROLINA

Contaminant	Minimum Value (PPB)	Maximum Value (PPB)	SUMMA Canister ID# of Maximum Detected Value	Location of Maximum Detected Value	Frequency of Detection	Region III Ambient Air RBC(1) (PPB)	No. of RBC Exceedences
M-Xylene & P-Xylene	0.73	0.73	92003	44A	1/4	7,300	0
N-Butane	0.53	1.6	92003	44A	4/4	NE	NA
Toluene	0.49	1.3	92003	44A	2/4	420	0
Pentane	0.44	1.3	92003	44A	3/4	NE	NA
Tetrachloroethene	1.1	1.1	04330	47B	1/4	3.1	0
cis-1,2-Dichloroethene	0.75	1.4	04330	47B	3/4	37	0
Benzene	0.77	0.77	92003	44A	1/4	0.22	1
Chloromethane	0.59	0.84	12544	44A	4/4	0.99	0
Carbon Disulfide	1	1	92003	44A	1/4	730	0
Dichlorodifluoromethane	0.59	0.64	92003, 93148	44A, Trailer	4/4	210	0

Notes:

(1) USEPA Region III Risk-Based Concentration Table. January-June, 1996.
NE - Not established
NA - Not applicable

TABLE 6-14

SUPPLEMENTAL POST-TEST GROUNDWATER ANALYTICAL RESULTS - PLUME B
IAS TREATABILITY STUDY
OPERABLE UNIT NO. 10 (SITE 35)
CAMP LEJEUNE, NORTH CAROLINA

Volatile Organic Compounds	35-GW-46A-07 µg/L	35-GW-46B-07 µg/L	35-GW-50A-07 µg/L	35-GW-50B-07 µg/L
1,2-Dichloroethene (total)	160	75	12	31
Trichloroethene	25	10 U	10 U	10 U

TABLE 6-15

SUPPLEMENTAL POST-TEST GROUNDWATER ANALYTICAL RESULTS - PLUME C
IAS TREATABILITY STUDY
OPERABLE UNIT NO. 10 (SITE 35)
CAMP LEJEUNE, NORTH CAROLINA

Volatile Organic Compounds	35-GW-53A-07 µg/L	35-GW-55A-07 µg/L	35-GW-56B-07 µg/L	35-GW-57B-07 µg/L
1,2-Dichloroethene (total)	270	410	1400	1200
1,1,2,2-Tetrachloroethane	10 U	10 U	10 U	35
Trichloroethene	63	180	870	780
Vinyl Chloride	10 U	10 U	44	23

FIGURES

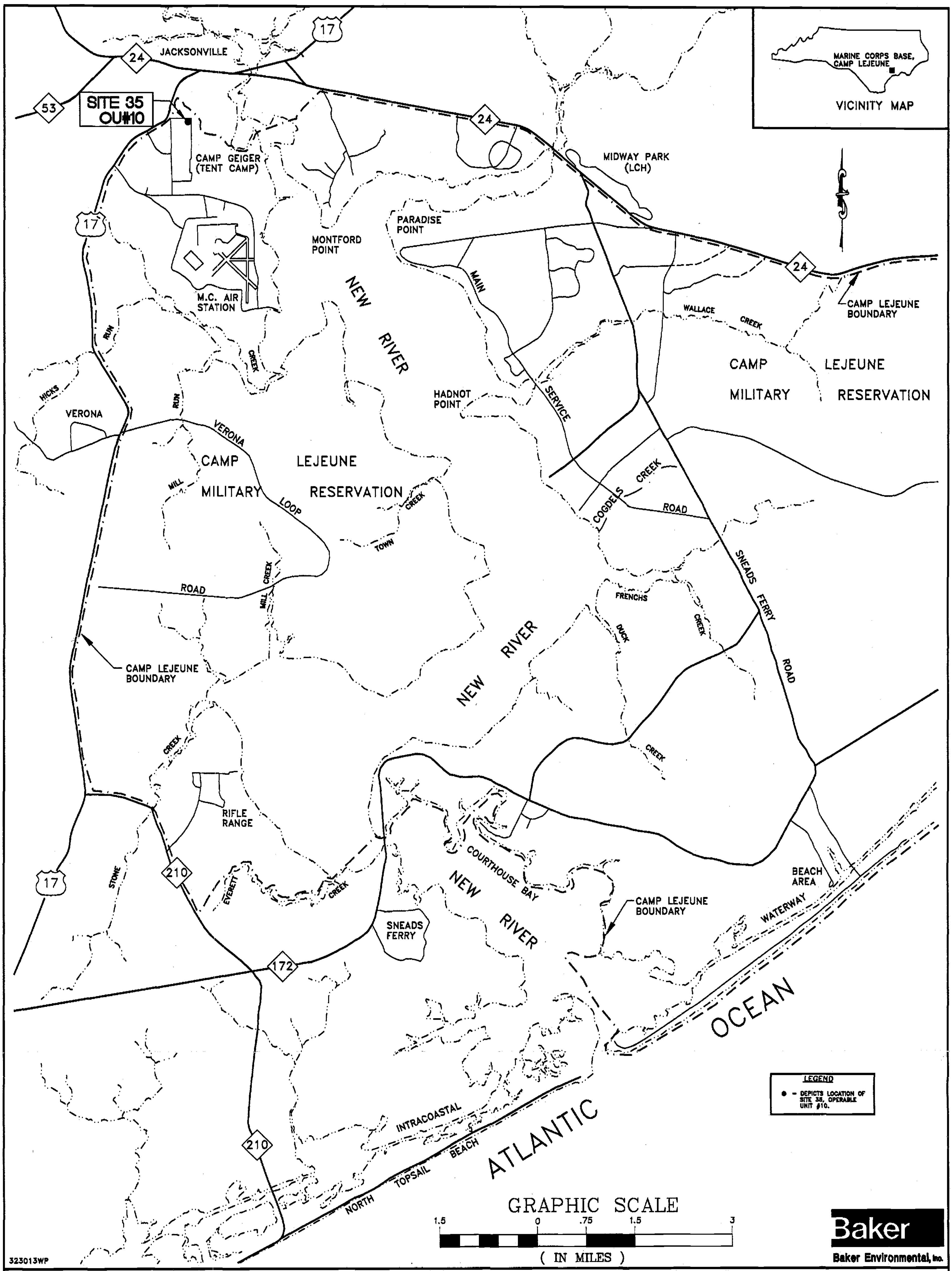
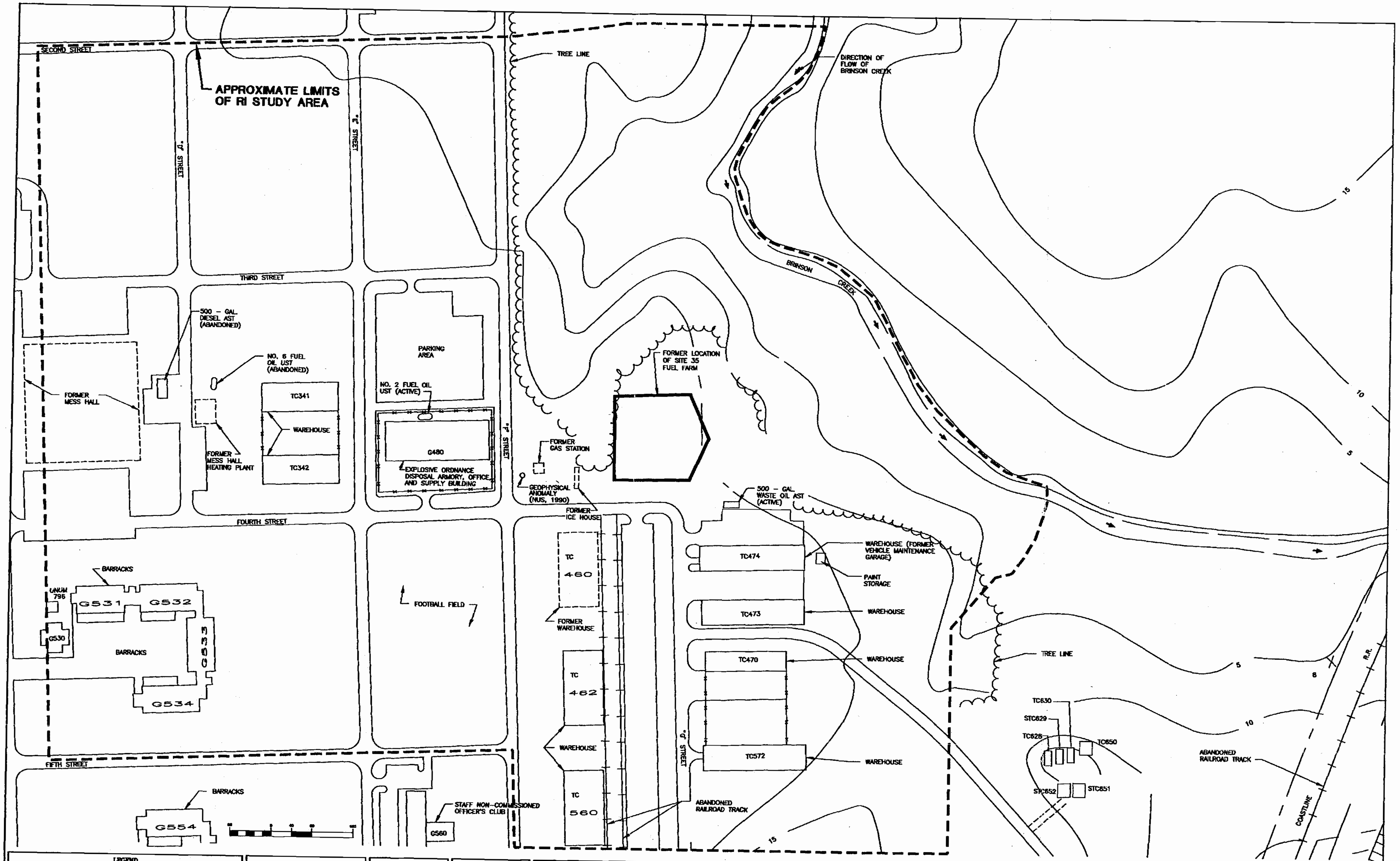


FIGURE 1-1
CAMP LEJEUNE AND SITE 35
LOCATION MAP
SITE 35, CAMP GEIGER AREA FUEL FARM
CONTRACT TASK ORDER – 0323

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



LEGEND

- FENCE LINE
—10— - CONTOUR LINES DEPICTING SURFICIAL RELIEF

DATE	MAY 1995
SCALE	SEE BAR SCALE
DRAWN	WJH
REVIEWED	JSC
S.O.#	62470-323-0000-07000
CADD#	323014WP

NORTH

SITE 35, IAS TREATABILITY STUDY
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

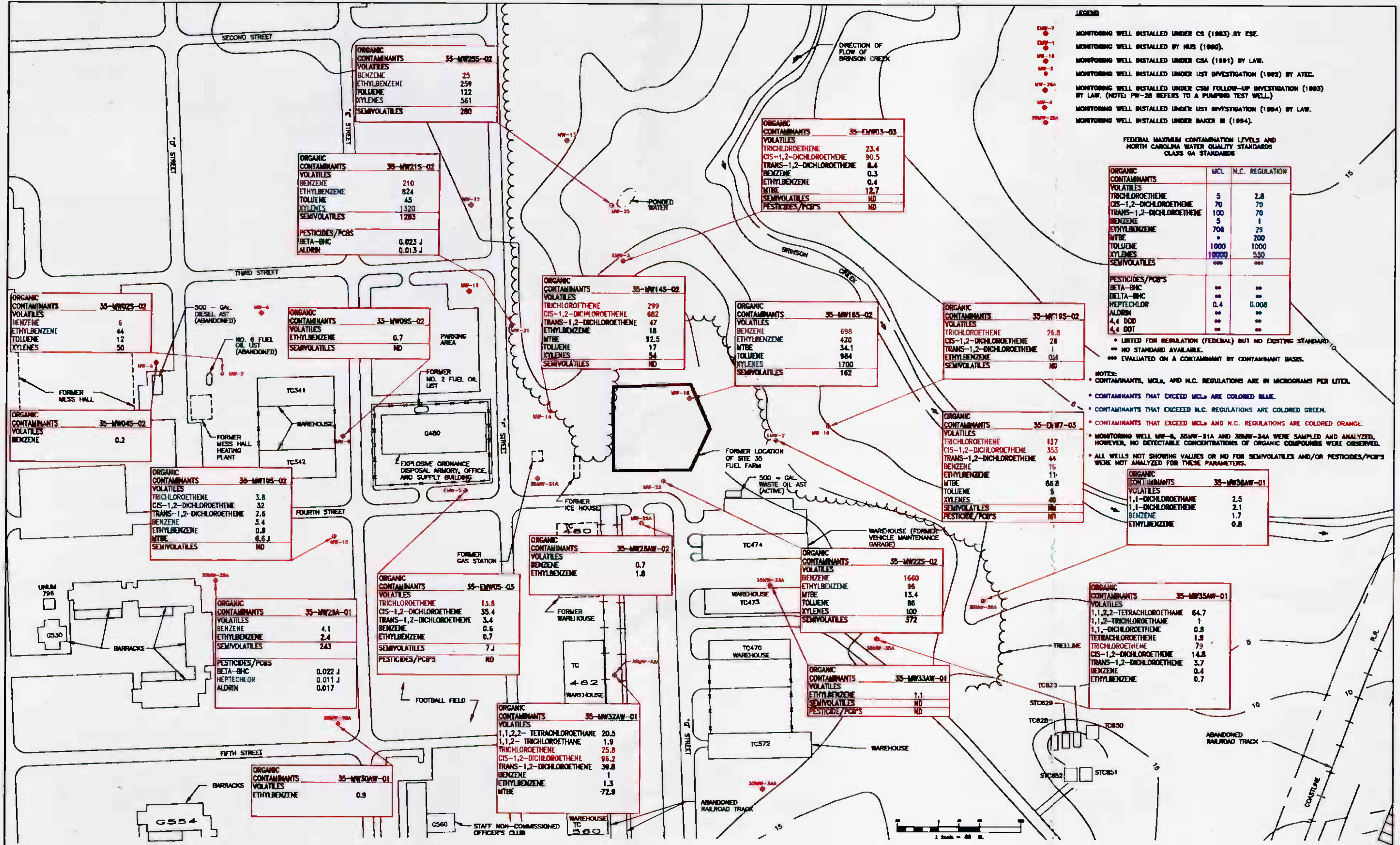
BAKER ENVIRONMENTAL, Inc.
Coraopolis, Pennsylvania

Baker
Baker Environmental, Inc.

SITE PLAN
CONTRACT TASK ORDER - 0323

SCALE SEE BAR SCALE
DATE MAY 1995

FIGURE No.
1-2



LEGEND

EMW-7 ●	MONITORING WELL INSTALLED UNDER CS (1983) BY ESE.
EMW-1 ●	MONITORING WELL INSTALLED BY NUS (1990).
MW-16 ●	MONITORING WELL INSTALLED UNDER CSA (1991) BY LAW.
MW-2 ●	MONITORING WELL INSTALLED UNDER UST INVESTIGATION (1992) BY ATEC.
MW-26A ●	MONITORING WELL INSTALLED UNDER CSM FOLLOW-UP INVESTIGATION (1993) BY LAW. (NOTE: PW-28 REFERS TO A PUMPING TEST WELL.)
MW-4 ●	MONITORING WELL INSTALLED UNDER UST INVESTIGATION (1994) BY LAW.
35MW-23A ●	MONITORING WELL INSTALLED UNDER BAKER III (1994).

FEDERAL MAXIMUM CONTAMINATION LEVELS AND NORTH CAROLINA WATER QUALITY STANDARDS CLASS GA STANDARDS

ORGANIC CONTAMINANTS	MCL	N.C. REGULATION
VOLATILES		
TRICHLOROETHENE	5	2.8
CIS-1,2-DICHLOROETHENE	70	70
TRANS-1,2-DICHLOROETHENE	100	70
BENZENE	5	1
ETHYLBENZENE	700	29
MTBE	*	200
TOLUENE	1000	1000
XYLENES	10000	530
SEMIVOLATILES	***	***
PESTICIDES/PCB'S		
BETA-BHC	**	**
DELTA-BHC	**	**
HEPTECHLOR	0.4	0.008
ALDRIN	**	**
4,4 DDD	**	**
4,4 DDT	**	**

* LISTED FOR REGULATION (FEDERAL) BUT NO EXISTING STANDARD.
** NO STANDARD AVAILABLE.
*** EVALUATED ON A CONTAMINANT BY CONTAMINANT BASIS.

NOTES:
- CONTAMINANTS, MCLs, AND N.C. REGULATIONS ARE IN MICROGRAMS PER LITER.
- CONTAMINANTS THAT EXCEED MCLs ARE COLORED BLUE.
- CONTAMINANTS THAT EXCEED N.C. REGULATIONS ARE COLORED GREEN.
- CONTAMINANTS THAT EXCEED MCLs AND N.C. REGULATIONS ARE COLORED ORANGE.
- MONITORING WELL MW-8, 35MW-31A AND 35MW-34A WERE SAMPLED AND ANALYZED, HOWEVER, NO DETECTABLE CONCENTRATIONS OF ORGANIC COMPOUNDS WERE OBSERVED.
- ALL WELLS NOT SHOWING VALUES OR ND FOR SEMIVOLATILES AND/OR PESTICIDES/PCB'S WERE NOT ANALYZED FOR THESE PARAMETERS.

ORGANIC CONTAMINANTS	35-MW25S-02
VOLATILES	
BENZENE	25
ETHYLBENZENE	259
TOLUENE	122
XYLENES	561
SEMIVOLATILES	280

ORGANIC CONTAMINANTS	35-MW21S-02
VOLATILES	
BENZENE	210
ETHYLBENZENE	824
TOLUENE	45
XYLENES	1320
SEMIVOLATILES	1283
PESTICIDES/PCBS	
BETA-BHC	0.023 J
ALDRIN	0.013 J

ORGANIC CONTAMINANTS	35-EMW03-03
VOLATILES	
TRICHLOROETHENE	23.4
CIS-1,2-DICHLOROETHENE	90.5
TRANS-1,2-DICHLOROETHENE	8.4
BENZENE	0.3
ETHYLBENZENE	0.4
MTBE	12.7
SEMIVOLATILES	ND
PESTICIDES/PCB'S	ND

ORGANIC CONTAMINANTS	35-MW02S-02
VOLATILES	
BENZENE	6
ETHYLBENZENE	44
TOLUENE	12
XYLENES	50

ORGANIC CONTAMINANTS	35-MW09S-02
VOLATILES	
ETHYLBENZENE	0.7
SEMIVOLATILES	ND

ORGANIC CONTAMINANTS	35-MW14S-02
VOLATILES	
TRICHLOROETHENE	299
CIS-1,2-DICHLOROETHENE	682
TRANS-1,2-DICHLOROETHENE	47
ETHYLBENZENE	18
MTBE	92.5
TOLUENE	17
XYLENES	54
SEMIVOLATILES	ND

ORGANIC CONTAMINANTS	35-MW18S-02
VOLATILES	
BENZENE	698
ETHYLBENZENE	420
MTBE	34.1
TOLUENE	984
XYLENES	1700
SEMIVOLATILES	162

ORGANIC CONTAMINANTS	35-MW19S-02
VOLATILES	
TRICHLOROETHENE	26.8
CIS-1,2-DICHLOROETHENE	28
TRANS-1,2-DICHLOROETHENE	1
ETHYLBENZENE	0.8
SEMIVOLATILES	ND

ORGANIC CONTAMINANTS	35-MW04S-02
VOLATILES	
BENZENE	0.2

ORGANIC CONTAMINANTS	35-MW10S-02
VOLATILES	
TRICHLOROETHENE	3.8
CIS-1,2-DICHLOROETHENE	32
TRANS-1,2-DICHLOROETHENE	2.6
BENZENE	3.4
ETHYLBENZENE	0.9
MTBE	6.6 J
SEMIVOLATILES	ND

ORGANIC CONTAMINANTS	35-EMW7-03
VOLATILES	
TRICHLOROETHENE	137
CIS-1,2-DICHLOROETHENE	353
TRANS-1,2-DICHLOROETHENE	44
BENZENE	16
ETHYLBENZENE	11
MTBE	68.8
TOLUENE	5
XYLENES	40
SEMIVOLATILES	ND
PESTICIDE/PCB'S	ND

ORGANIC CONTAMINANTS	35-MW36AW-01
VOLATILES	
1,1-DICHLOROETHANE	2.5
1,1-DICHLOROETHENE	2.1
BENZENE	1.7
ETHYLBENZENE	0.8

ORGANIC CONTAMINANTS	35-MW28AW-02
VOLATILES	
BENZENE	0.7
ETHYLBENZENE	1.8

ORGANIC CONTAMINANTS	35-EMW05-03
VOLATILES	
TRICHLOROETHENE	13.8
CIS-1,2-DICHLOROETHENE	35.4
TRANS-1,2-DICHLOROETHENE	3.4
BENZENE	0.6
ETHYLBENZENE	0.7
SEMIVOLATILES	7 J
PESTICIDES/PCB'S	ND

ORGANIC CONTAMINANTS	35-MW22S-02
VOLATILES	
BENZENE	1660
ETHYLBENZENE	96
MTBE	13.4
TOLUENE	86
XYLENES	100
SEMIVOLATILES	372

ORGANIC CONTAMINANTS	35-MW29A-01
VOLATILES	
BENZENE	4.1
ETHYLBENZENE	2.4
SEMIVOLATILES	243
PESTICIDES/PCBS	
BETA-BHC	0.022 J
HEPTECHLOR	0.011 J
ALDRIN	0.017

ORGANIC CONTAMINANTS	35-MW35AW-01
VOLATILES	
1,1,2,2-TETRACHLOROETHANE	64.7
1,1,2-TRICHLOROETHANE	1
1,1,-DICHLOROETHENE	0.8
TETRACHLOROETHENE	1.9
TRICHLOROETHENE	79
CIS-1,2-DICHLOROETHENE	14.8
TRANS-1,2-DICHLOROETHENE	3.7
BENZENE	0.4
ETHYLBENZENE	0.7

ORGANIC CONTAMINANTS	35-MW33AW-01
VOLATILES	
ETHYLBENZENE	1.1
SEMIVOLATILES	ND
PESTICIDE/PCB'S	ND

ORGANIC CONTAMINANTS	35-MW32AW-01
VOLATILES	
1,1,2,2- TETRACHLOROETHANE	20.5
1,1,2- TRICHLOROETHANE	1.9
TRICHLOROETHENE	25.8
CIS-1,2-DICHLOROETHENE	96.2
TRANS-1,2-DICHLOROETHENE	39.8
BENZENE	1
ETHYLBENZENE	1.3
MTBE	72.9

ORGANIC CONTAMINANTS	35-MW30AW-01
VOLATILES	
ETHYLBENZENE	0.9

LEGEND

-◆-◆- - FENCE LINE
—15— - CONTOUR LINES DEPICTING SURFICIAL RELIEF

LEGEND CONTINUED IN UPPER RIGHT HAND CORNER.

DATE	OCT. 1994
SCALE	1" = 80'
DRAWN	W.JH
REVIEWED	JSC
S.O.#	62470-323-0000-07000
CADD#	323008WP

NORTH

SITE 35, IAS TREATABILITY STUDY
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

BAKER ENVIRONMENTAL, Inc.
Coraopolis, Pennsylvania

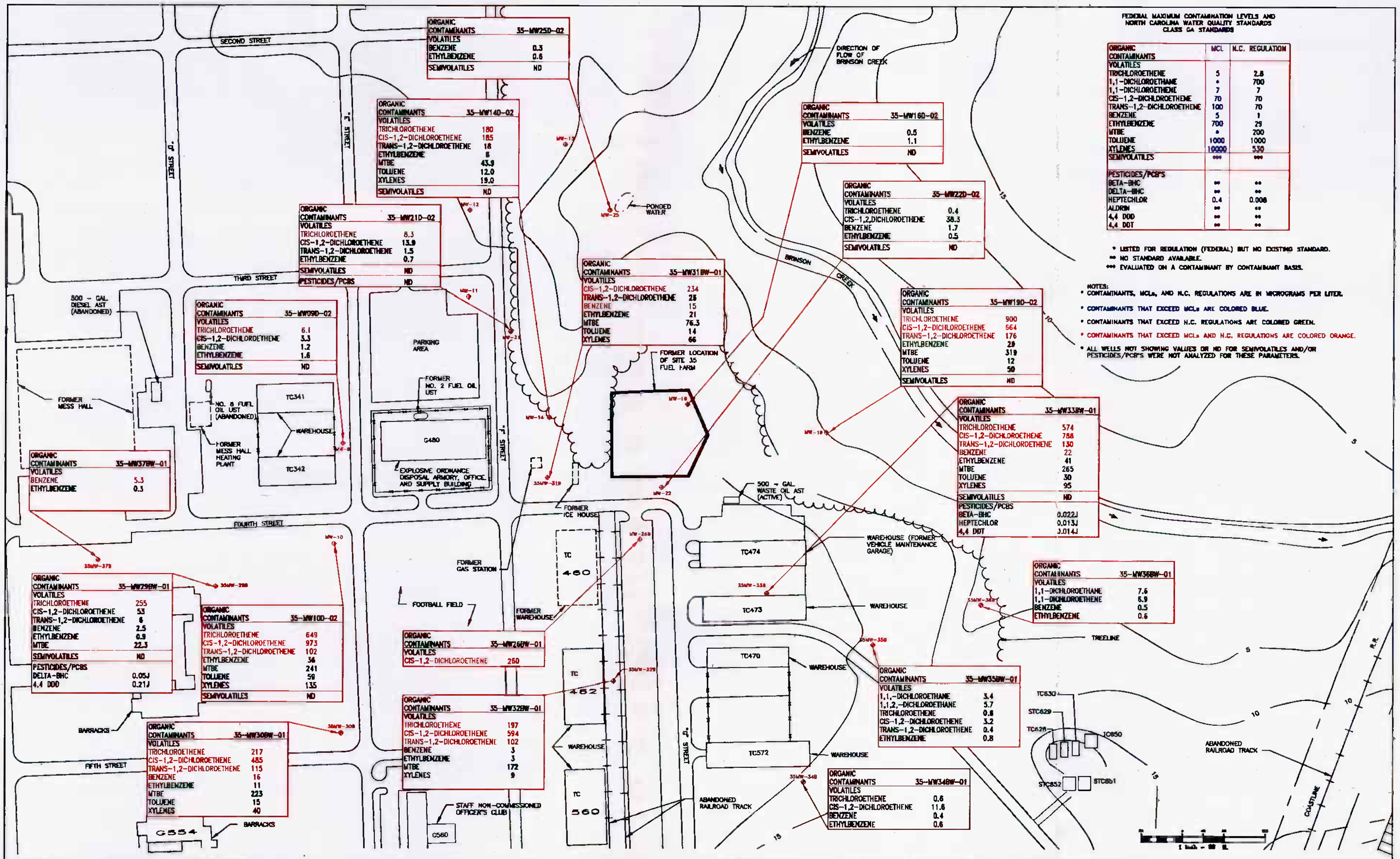
Baker
Baker Environmental, Inc.

DETECTED ORGANICS IN UPPER PORTION
OF SURFICIAL AQUIFER
CONTRACT TASK ORDER - 0323

SCALE 1" = 80'
DATE OCT. 1994

FIGURE No.
1-3

00215.BBB2Y



ORGANIC CONTAMINANTS	35-MW25D-02
VOLATILES	
BENZENE	0.3
ETHYLBENZENE	0.6
SEMIVOLATILES	ND

ORGANIC CONTAMINANTS	35-MW14D-02
VOLATILES	
TRICHLOROETHENE	180
CIS-1,2-DICHLOROETHENE	185
TRANS-1,2-DICHLOROETHENE	18
ETHYLBENZENE	6
MTBE	43.9
TOLUENE	12.0
XYLENES	19.0
SEMIVOLATILES	ND

ORGANIC CONTAMINANTS	35-MW21D-02
VOLATILES	
TRICHLOROETHENE	8.3
CIS-1,2-DICHLOROETHENE	13.9
TRANS-1,2-DICHLOROETHENE	1.5
ETHYLBENZENE	0.7
SEMIVOLATILES	ND
PESTICIDES/PCBS	ND

ORGANIC CONTAMINANTS	35-MW09D-02
VOLATILES	
TRICHLOROETHENE	6.1
CIS-1,2-DICHLOROETHENE	3.3
BENZENE	1.2
ETHYLBENZENE	1.6
SEMIVOLATILES	ND

ORGANIC CONTAMINANTS	35-MW37BW-01
VOLATILES	
BENZENE	5.3
ETHYLBENZENE	0.3

ORGANIC CONTAMINANTS	35-MW16D-02
VOLATILES	
BENZENE	0.5
ETHYLBENZENE	1.1
SEMIVOLATILES	ND

ORGANIC CONTAMINANTS	35-MW22D-02
VOLATILES	
TRICHLOROETHENE	0.4
CIS-1,2,DICHLOROETHENE	38.3
BENZENE	1.7
ETHYLBENZENE	0.5
SEMIVOLATILES	ND

ORGANIC CONTAMINANTS	35-MW31BW-01
VOLATILES	
CIS-1,2-DICHLOROETHENE	234
TRANS-1,2-DICHLOROETHENE	28
BENZENE	15
ETHYLBENZENE	21
MTBE	76.3
TOLUENE	14
XYLENES	66

ORGANIC CONTAMINANTS	35-MW19D-02
VOLATILES	
TRICHLOROETHENE	900
CIS-1,2-DICHLOROETHENE	664
TRANS-1,2-DICHLOROETHENE	176
ETHYLBENZENE	29
MTBE	319
TOLUENE	12
XYLENES	50
SEMIVOLATILES	ND

ORGANIC CONTAMINANTS	35-MW33BW-01
VOLATILES	
TRICHLOROETHENE	574
CIS-1,2-DICHLOROETHENE	788
TRANS-1,2-DICHLOROETHENE	130
BENZENE	22
ETHYLBENZENE	41
MTBE	265
TOLUENE	30
XYLENES	95
SEMIVOLATILES	ND
PESTICIDES/PCBS	
BETA-BHC	0.022J
HEPTECHLOR	0.013J
4,4 DDT	3.014J

ORGANIC CONTAMINANTS	35-MW36BW-01
VOLATILES	
1,1-DICHLOROETHANE	7.6
1,1-DICHLOROETHENE	6.9
BENZENE	0.5
ETHYLBENZENE	0.6

ORGANIC CONTAMINANTS	35-MW29BW-01
VOLATILES	
TRICHLOROETHENE	255
CIS-1,2-DICHLOROETHENE	53
TRANS-1,2-DICHLOROETHENE	6
BENZENE	2.5
ETHYLBENZENE	0.9
MTBE	22.3
SEMIVOLATILES	ND
PESTICIDES/PCBS	
DELTA-BHC	0.05J
4.4 DDD	0.21J

ORGANIC CONTAMINANTS	35-MW10D-02
VOLATILES	
TRICHLOROETHENE	649
CIS-1,2-DICHLOROETHENE	973
TRANS-1,2-DICHLOROETHENE	102
ETHYLBENZENE	36
MTBE	241
TOLUENE	59
XYLENES	135
SEMIVOLATILES	ND

ORGANIC CONTAMINANTS	35-MW26BW-01
VOLATILES	
CIS-1,2-DICHLOROETHENE	260

ORGANIC CONTAMINANTS	35-MW32BW-01
VOLATILES	
TRICHLOROETHENE	197
CIS-1,2-DICHLOROETHENE	594
TRANS-1,2-DICHLOROETHENE	102
BENZENE	3
ETHYLBENZENE	3
MTBE	172
XYLENES	9

ORGANIC CONTAMINANTS	35-MW30BW-01
VOLATILES	
TRICHLOROETHENE	217
CIS-1,2-DICHLOROETHENE	485
TRANS-1,2-DICHLOROETHENE	115
BENZENE	16
ETHYLBENZENE	11
MTBE	223
TOLUENE	15
XYLENES	40

ORGANIC CONTAMINANTS	35-MW35BW-01
VOLATILES	
1,1,-DICHLOROETHANE	3.4
1,1,2,-DICHLOROETHANE	5.7
TRICHLOROETHENE	0.8
CIS-1,2-DICHLOROETHENE	3.2
TRANS-1,2-DICHLOROETHENE	0.4
ETHYLBENZENE	0.8

ORGANIC CONTAMINANTS	35-MW34BW-01
VOLATILES	
TRICHLOROETHENE	0.6
CIS-1,2-DICHLOROETHENE	11.6
BENZENE	0.4
ETHYLBENZENE	0.6

FEDERAL MAXIMUM CONTAMINATION LEVELS AND
NORTH CAROLINA WATER QUALITY STANDARDS
CLASS GA STANDARDS

ORGANIC CONTAMINANTS	MCL	N.C. REGULATION
VOLATILES		
TRICHLOROETHENE	5	2.8
1,1-DICHLOROETHANE	*	700
1,1-DICHLOROETHENE	7	7
CIS-1,2-DICHLOROETHENE	70	70
TRANS-1,2-DICHLOROETHENE	100	70
BENZENE	5	1
ETHYLBENZENE	700	29
MTBE	*	200
TOLUENE	1000	1000
XYLENES	10000	530
SEMIVOLATILES	***	***
PESTICIDES/PCB'S		
BETA-BHC	**	**
DELTA-BHC	**	**
HEPTECHLOR	0.4	0.008
ALDRIN	**	**
4,4 DDD	**	**
4,4 DDT	**	**

* LISTED FOR REGULATION (FEDERAL) BUT NO EXISTING STANDARD.
** NO STANDARD AVAILABLE.
*** EVALUATED ON A CONTAMINANT BY CONTAMINANT BASIS.

NOTES:

- CONTAMINANTS, MCLs, AND N.C. REGULATIONS ARE IN MICROGRAMS PER LITER.
- CONTAMINANTS THAT EXCEED MCLs ARE COLORED BLUE.
- CONTAMINANTS THAT EXCEED N.C. REGULATIONS ARE COLORED GREEN.
- CONTAMINANTS THAT EXCEED MCLs AND N.C. REGULATIONS ARE COLORED ORANGE.
- ALL WELLS NOT SHOWING VALUES OR ND FOR SEMIVOLATILES AND/OR PESTICIDES/PCB'S WERE NOT ANALYZED FOR THESE PARAMETERS.

LEGEND

35MW-29B ◆ – MONITORING WELL INSTALLED UNDER BAKER III (1994).
MW-10 ◆ – MONITORING WELL INSTALLED UNDER CSA (1991) BY LAW.
–X–X– – FENCE LINE
—15— – CONTOUR LINES DEPICTING SURFICIAL RELIEF

DATE	OCT. 1994
SCALE	1" = 80'
DRAWN	W.JH
REVIEWED	JSC
S.O.#	62470-323-0000-07000
CADD#	32300WP

NORTH

SITE 35, IAS TREATABILITY STUDY
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

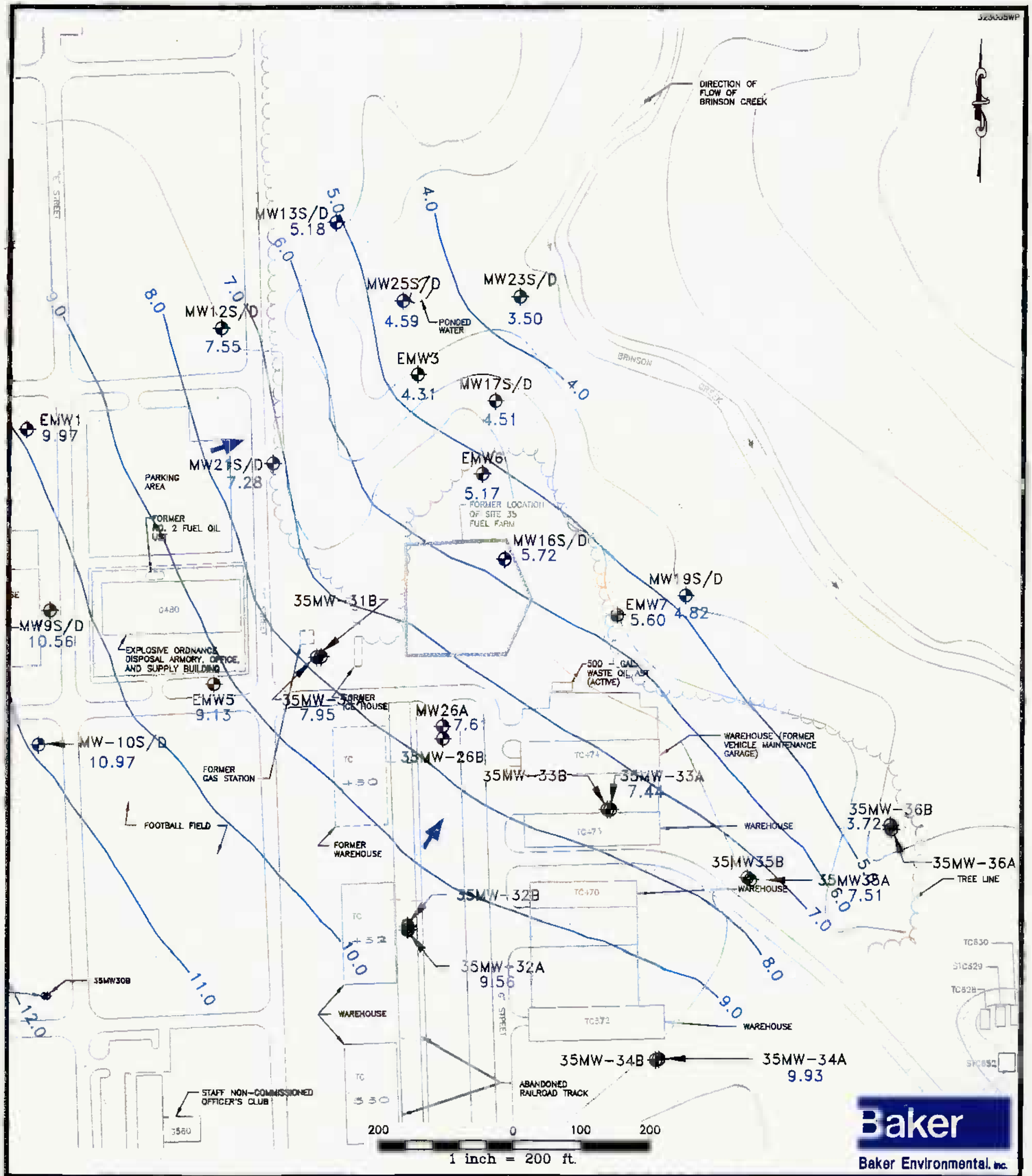
BAKER ENVIRONMENTAL, Inc.
Coraopolis, Pennsylvania

Baker
Baker Environmental, Inc.

DETECTED ORGANICS IN LOWER
PORTION OF SURFICIAL AQUIFER
CONTRACT TASK ORDER – 0323

SCALE 1" = 80'
DATE OCT. 1994

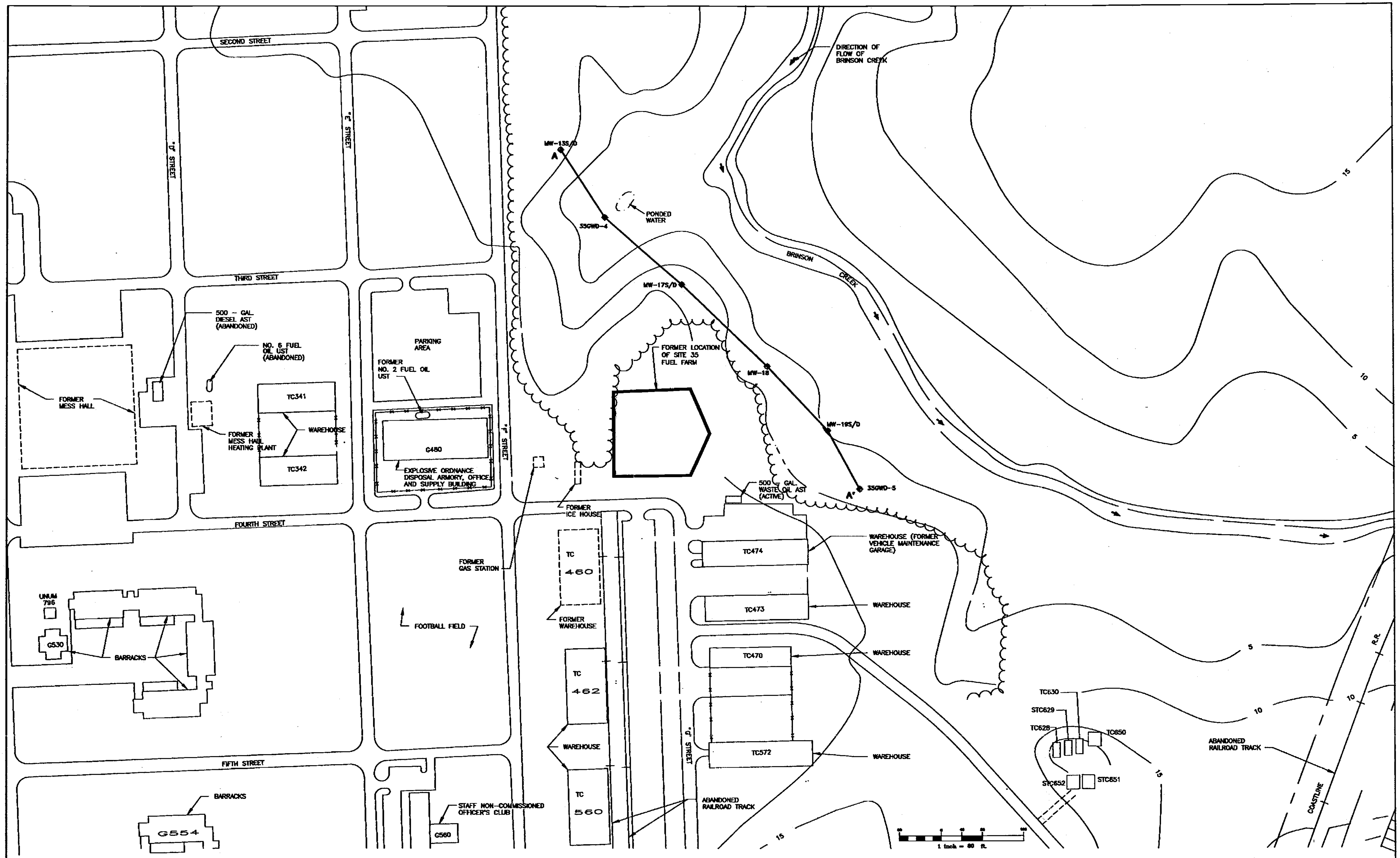
FIGURE No.
1 – 4



LEGEND

—×—×—	FENCE LINE
--15--	CONTOUR LINES DEPICTING SURFICIAL RELIEF
MW19S/D ⊕ 4.82	MONITORING WELL LOCATION AND DESCRIPTION (MEASURED STATIC WATER LEVEL IN BLUE)
11.0 ——	GROUNDWATER CONTOUR
➔	INDICATES DIRECTION OF GROUNDWATER FLOW

FIGURE 1-5
GROUNDWATER CONTOUR MAP
FOR SURFICIAL AQUIFER
SITE 35
CTO-323
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



LEGEND

-x-x-	- FENCE LINE
—15—	- CONTOUR LINES DEPICTING SURFICIAL RELIEF
35GWD-5 ◆	- MONITORING WELL LOCATION AND DESCRIPTION

DATE	OCT. 1994
SCALE	1" = 80'
DRAWN	WJH
REVIEWED	JSC
S.O.#	62470-323-0000-07000
CADD#	323015WP

SITE 35, IAS TREATABILITY STUDY
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

BAKER ENVIRONMENTAL,Inc.
Coraopolis, Pennsylvania

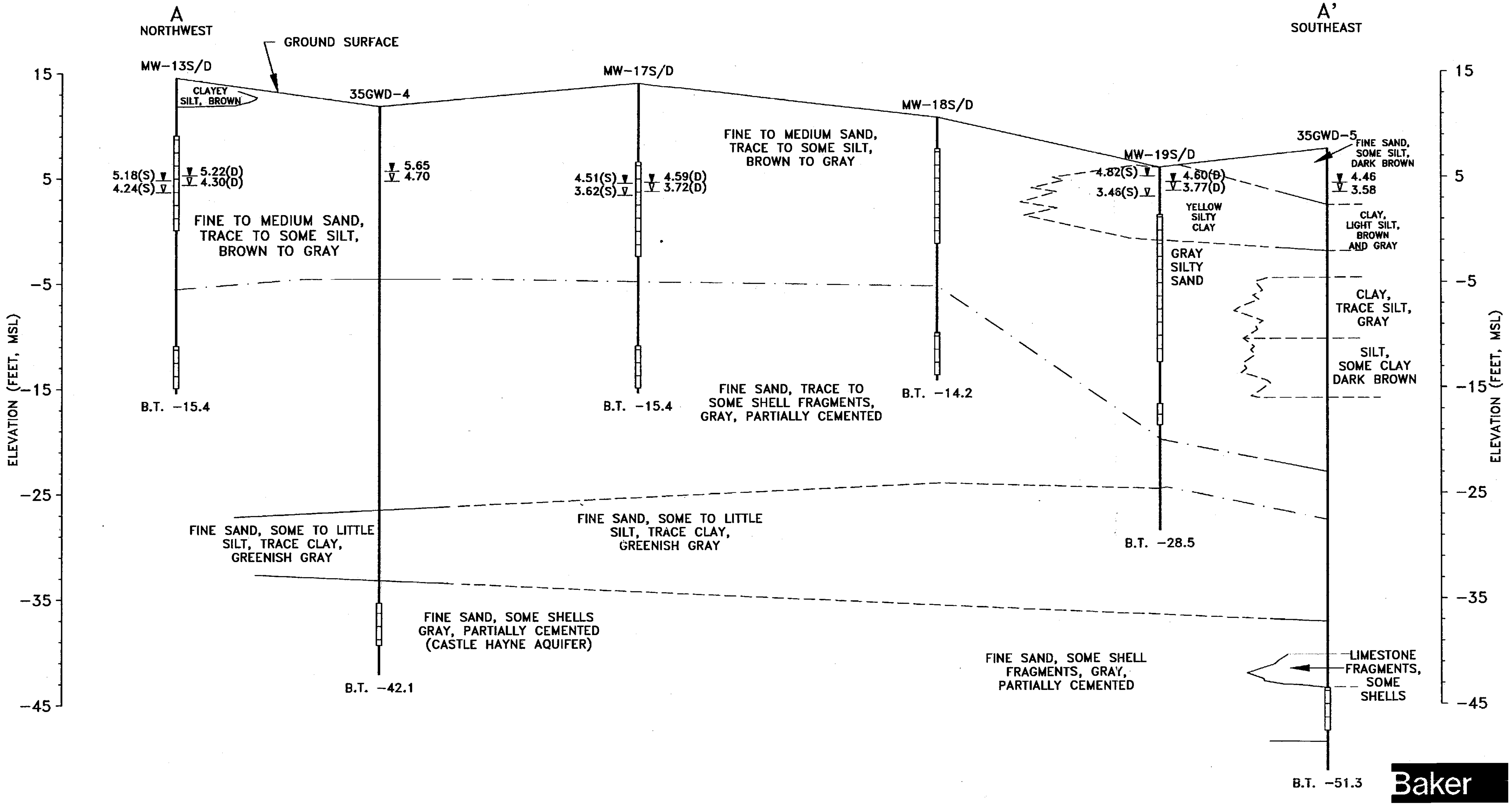
Baker
Baker Environmental, Inc.

CROSS-SECTION LOCATION
SITE 35, IAS TREATABILITY STUDY
CONTRACT TASK ORDER - 0323

SCALE 1" = 80'
DATE SEPT. 1994

FIGURE No.
1-6

323012WP



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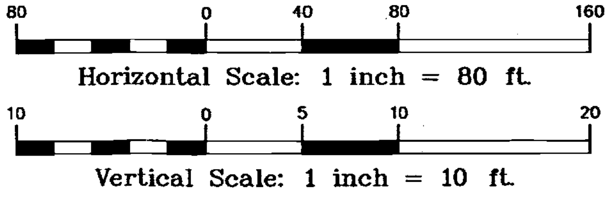
LEGEND

▼	GROUNDWATER ELEVATION (X)
▽	GROUNDWATER ENCOUNTERED DURING DRILLING
B.T. X'	BORING TERMINATED, ELEVATION MSL
ND ND	BENZENE CONCENTRATIONS (ug/L) IN GROUNDWATER TOTAL VOC CONCENTRATIONS (ug/L) IN GROUNDWATER
[ND]	TPH CONCENTRATIONS (mg/kg) IN SOILS
▯	WELL SCREEN INTERVAL
ND	NOT DETECTED AT METHOD DETECTION LIMITS
———	ESTIMATED BY BAKER BORING
— — —	PROJECTED BETWEEN KNOWN POINTS
— · —	INFERRED FROM OTHER CONSULTANT BORINGS



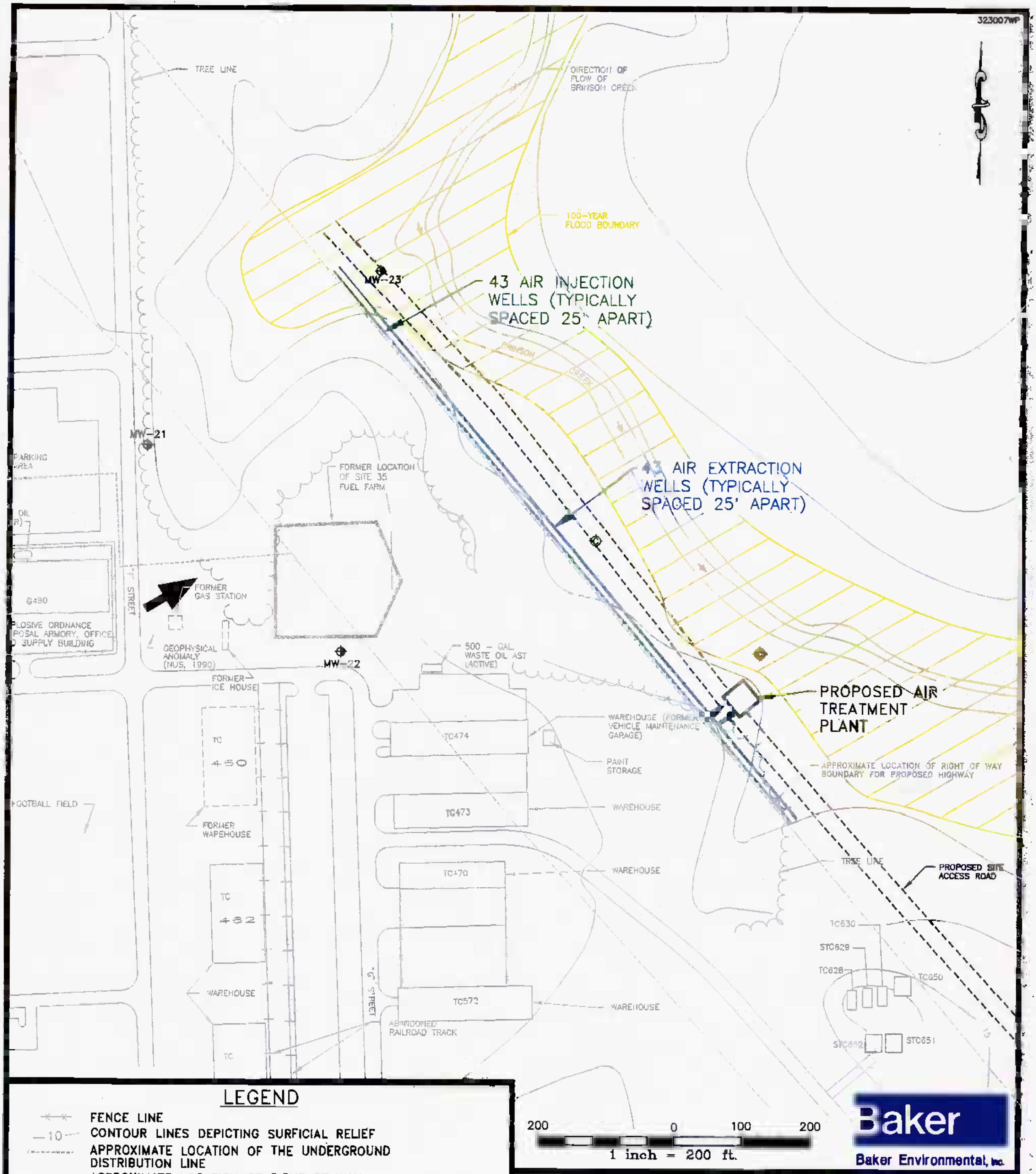
Horizontal Scale: 1 inch = 80 ft.

Vertical Scale: 1 inch = 10 ft.

THE SOIL BORING INFORMATION IS CONSIDERED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT THE RESPECTIVE BORING LOCATIONS. SUBSURFACE CONDITIONS INTERPOLATED BETWEEN BORINGS ARE ESTIMATED BASED ON ACCEPTED SOIL ENGINEERING PRINCIPLES AND GEOLOGIC JUDGEMENT.

FIGURE 1-7
HYDROGEOLOGIC CROSS-SECTION A-A'
SITE 35, IAS TREATABILITY STUDY
CTO-0323

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



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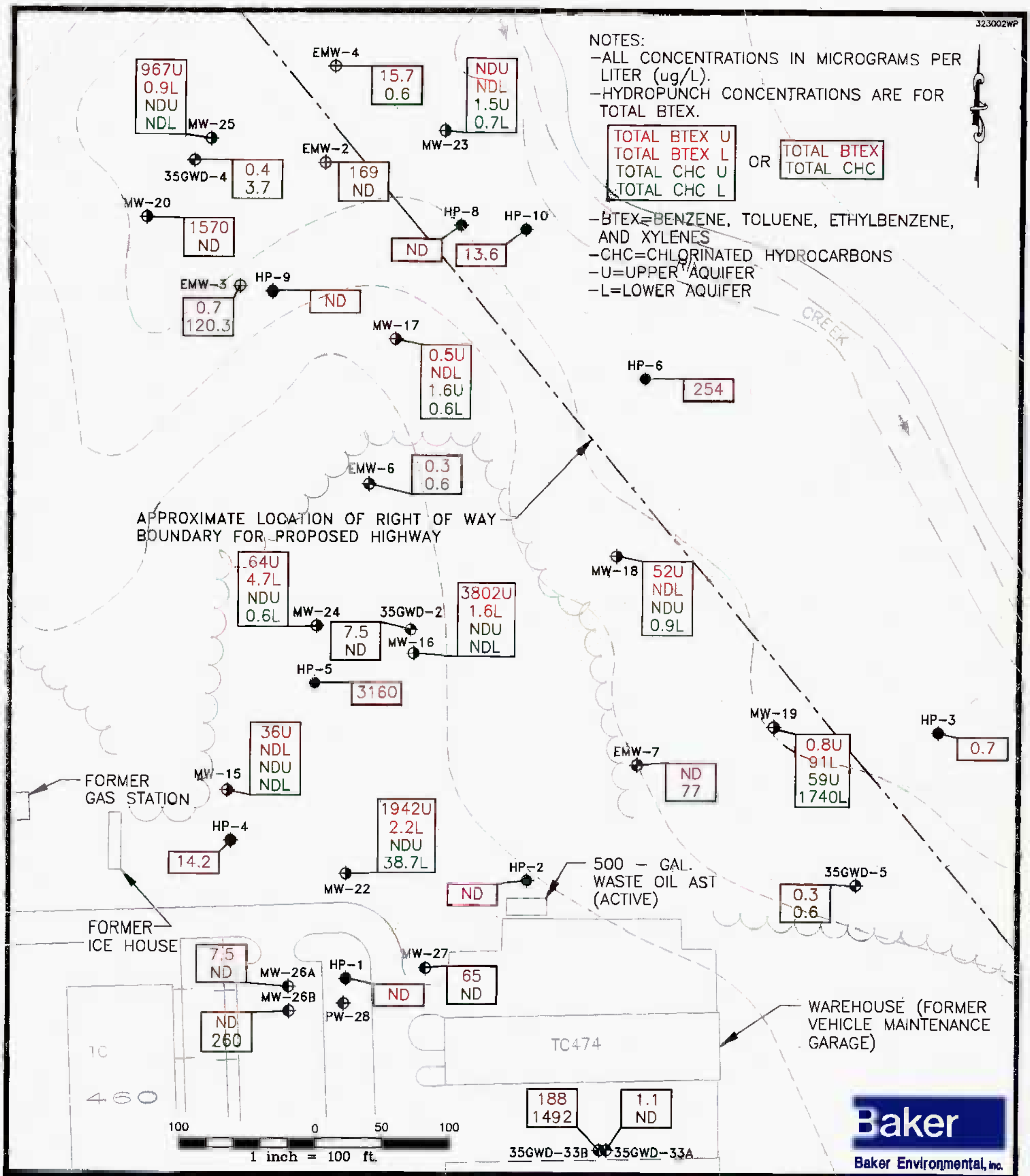
LEGEND

- —×—×— FENCE LINE
- —10— CONTOUR LINES DEPICTING SURFICIAL RELIEF
- ········ APPROXIMATE LOCATION OF THE UNDERGROUND DISTRIBUTION LINE
- —·—·— APPROXIMATE LOCATION OF RIGHT OF WAY BOUNDARY FOR PROPOSED HIGHWAY
- —◆— AIR EXTRACTION CONVEYANCE LINE
- —◆— AIR INJECTION CONVEYANCE LINE
- ➔ APPROXIMATE GROUNDWATER FLOW DIRECTION
- ▨ 100 YEAR FLOOD BOUNDARY (ref. FIRM FLOOD INSURANCE RATE MAP, ONSLOW COUNTY, NORTH CAROLINA; FEMA COMMUNITY PANEL NUMBER 3 70340 0305C.
- ----- PROPOSED LOCATION OF SITE ACCESS ROAD
- MW-23 ⊕ EXISTING WELL CLUSTER IN THE SURFICIAL AQUIFER
- 35GWD-3 ⊕ EXISTING WELL IN THE DEEP AQUIFER
- © PROPOSED WELL CLUSTER IN THE SURFICIAL AQUIFER

FIGURE 2-1
RAA 4: IN SITU AIR SPARGING AND
OFF-GAS CARBON ADSORPTION
SITE PLAN - SITE 35
CTO-0323
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

00 745 RR BHV



NOTES:
- ALL CONCENTRATIONS IN MICROGRAMS PER LITER (ug/L).
- HYDROPUNCH CONCENTRATIONS ARE FOR TOTAL BTEX.

TOTAL BTEX U TOTAL BTEX L TOTAL CHC U TOTAL CHC L	OR	TOTAL BTEX TOTAL CHC

- BTEX=BENZENE, TOLUENE, ETHYLBENZENE, AND XYLENES
- CHC=CHLORINATED HYDROCARBONS
- U=UPPER AQUIFER
- L=LOWER AQUIFER

LEGEND

EMW-7 ⊕ MONITORING WELL INSTALLED UNDER CS (1986) BY ESE.

EMW-1 ⊕ MONITORING WELL INSTALLED BY NUS (1990).

MW-1 ⊕ MONITORING WELL INSTALLED UNDER CSA (1991) BY LAW.

MW-26 ⊕ MONITORING WELL INSTALLED UNDER CSM FOLLOW-UP INVESTIGATION (1993) BY LAW. (NOTE: PW-28 REFERS TO A PUMPING TEST WELL.)

HP-18 ● "HYDROPUNCH" SAMPLING POINT UNDER CSA (1991) BY LAW.

35GWD-4 ⊕ MONITORING WELL INSTALLED UNDER RI (1994) BY BAKER.

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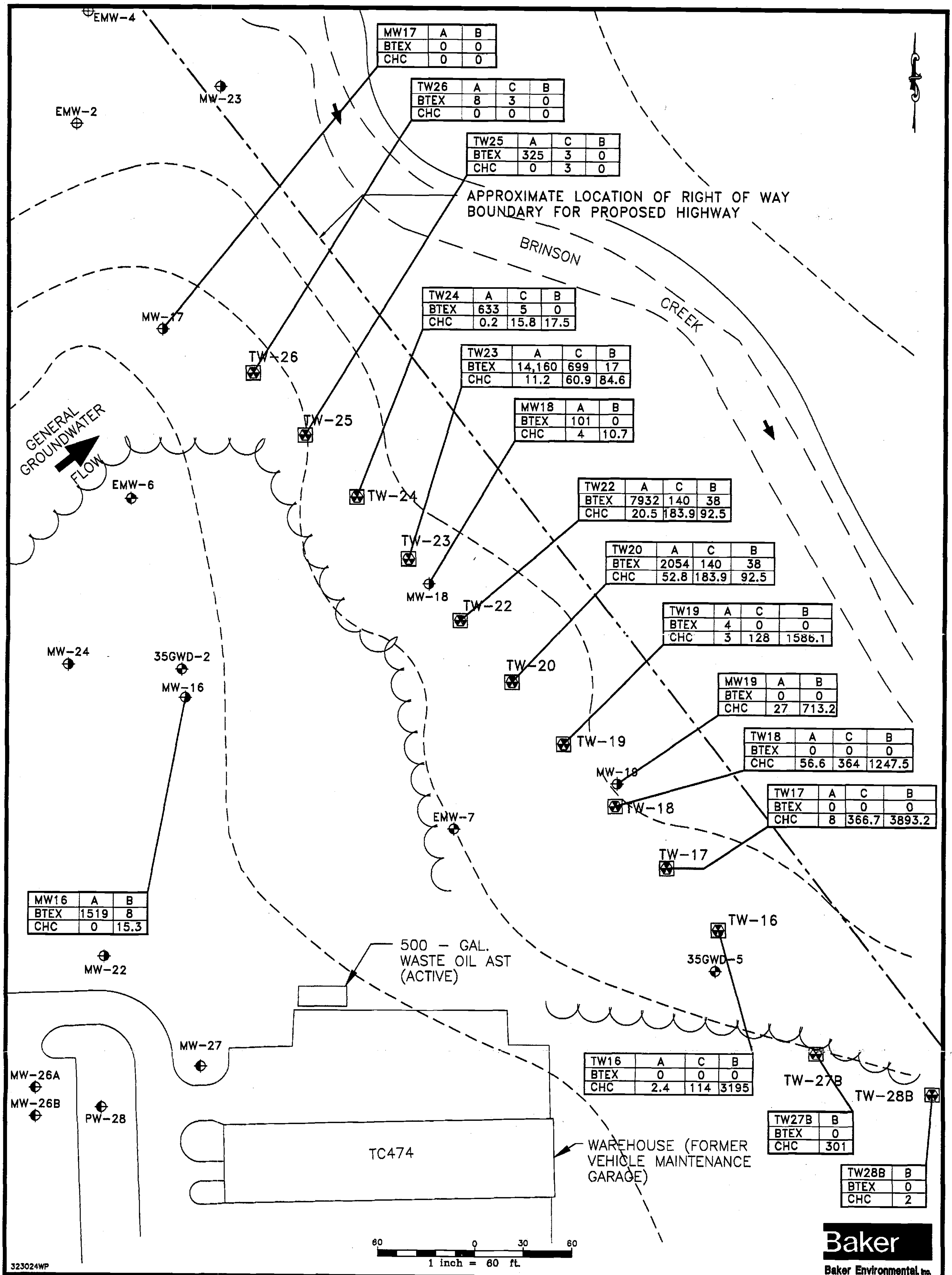
FIGURE 2-2
SUMMARY OF SURFICIAL AQUIFER CONTAMINATION IN TREATABILITY STUDY AREA
SITE 35
CTO-0323

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



MW17	A	B
BTEX	0	0
CHC	0	0

TW26	A	C	B
BTEX	8	3	0
CHC	0	0	0

TW25	A	C	B
BTEX	325	3	0
CHC	0	3	0

TW24	A	C	B
BTEX	633	5	0
CHC	0.2	15.8	17.5

TW23	A	C	B
BTEX	14,160	699	17
CHC	11.2	60.9	84.6

MW18	A	B
BTEX	101	0
CHC	4	10.7

TW22	A	C	B
BTEX	7932	140	38
CHC	20.5	183.9	92.5

TW20	A	C	B
BTEX	2054	140	38
CHC	52.8	183.9	92.5

TW19	A	C	B
BTEX	4	0	0
CHC	3	128	1586.1

MW19	A	B
BTEX	0	0
CHC	27	713.2

TW18	A	C	B
BTEX	0	0	0
CHC	56.6	364	1247.5

TW17	A	C	B
BTEX	0	0	0
CHC	8	366.7	3893.2

MW16	A	B
BTEX	1519	8
CHC	0	15.3

TW16	A	C	B
BTEX	0	0	0
CHC	2.4	114	3195

TW27B	B
BTEX	0
CHC	301

TW28B	B
BTEX	0
CHC	2

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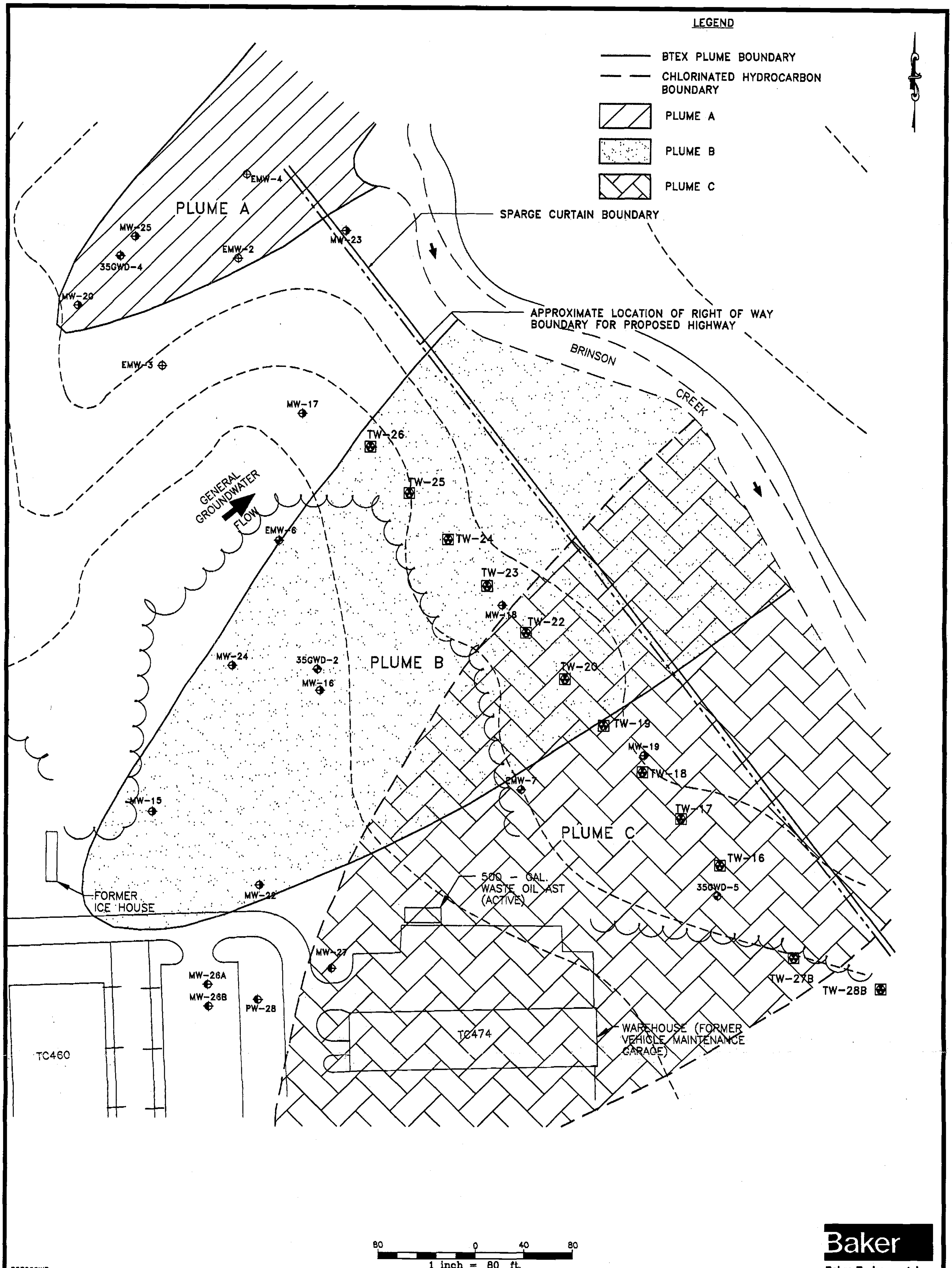
LEGEND

EMW-7 ⊕	MONITORING WELL INSTALLED UNDER CS (1986) BY ESE.
EMW-1 ⊕	MONITORING WELL INSTALLED BY NUS (1990).
MW-1 ⊕	MONITORING WELL INSTALLED UNDER CSA (1991) BY LAW.
MW-26 ⊕	MONITORING WELL INSTALLED UNDER CSM FOLLOW-UP INVESTIGATION (1993) BY LAW. (NOTE: PW-28 REFERS TO A PUMPING TEST WELL.)
⊠	TEMPORARY WELL CLUSTER
CHC	TOTAL CHLORINATED HYDROCARBONS
BTEX	TOTAL BTEX
A	WELLS WITH 10' SCREEN LENGTH PLACED 5'-15' BGS, ACROSS THE WATER TABLE.
C	WELLS WITH 5' SCREEN LENGTH PLACED WITHIN A 18 1/2' - 27 1/2' BGS INTERVAL.
B	WELLS WITH 5' SCREEN LENGTH PLACED WITHIN A 30' - 40' BGS INTERVAL (SCREENED ON TOP OF THE CONFINING UNIT).

FIGURE 2-3
DETECTED BTEX AND
TOTAL CHLORINATED SOLVENTS
IN SURFICIAL AQUIFER (APRIL 1996)
SITE 35, CAMP GEIGER
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



323022WP

LEGEND

EMW-7 ⊕	MONITORING WELL INSTALLED UNDER CS (1986) BY ESE.
EMW-1 ⊕	MONITORING WELL INSTALLED BY NUS (1990).
MW-1 ⊕	MONITORING WELL INSTALLED UNDER CSA (1991) BY LAW.
MW-26 ⊕	MONITORING WELL INSTALLED UNDER CSM FOLLOW-UP INVESTIGATION (1993) BY LAW. (NOTE: PW-26 REFERS TO A PUMPING TEST WELL.)
⊠	TEMPORARY WELL CLUSTER
CHC	TOTAL CHLORINATED HYDROCARBONS
BTEX	TOTAL BTEX
A	WELLS WITH 10' SCREEN LENGTH PLACED 5'-15' BGS, ACROSS THE WATER TABLE.
C	WELLS WITH 5' SCREEN LENGTH PLACED WITHIN A 18 1/2' - 27 1/2' BGS INTERVAL.
B	WELLS WITH 5' SCREEN LENGTH PLACED WITHIN A 30' - 40' BGS INTERVAL (SCREENED ON TOP OF THE CONFINING UNIT).

FIGURE 2-4
CONCEPTUAL CONTAMINANT PLUMES
INTERCEPTING SPARGING CURTAIN
SITE 35
CTO - 0323

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

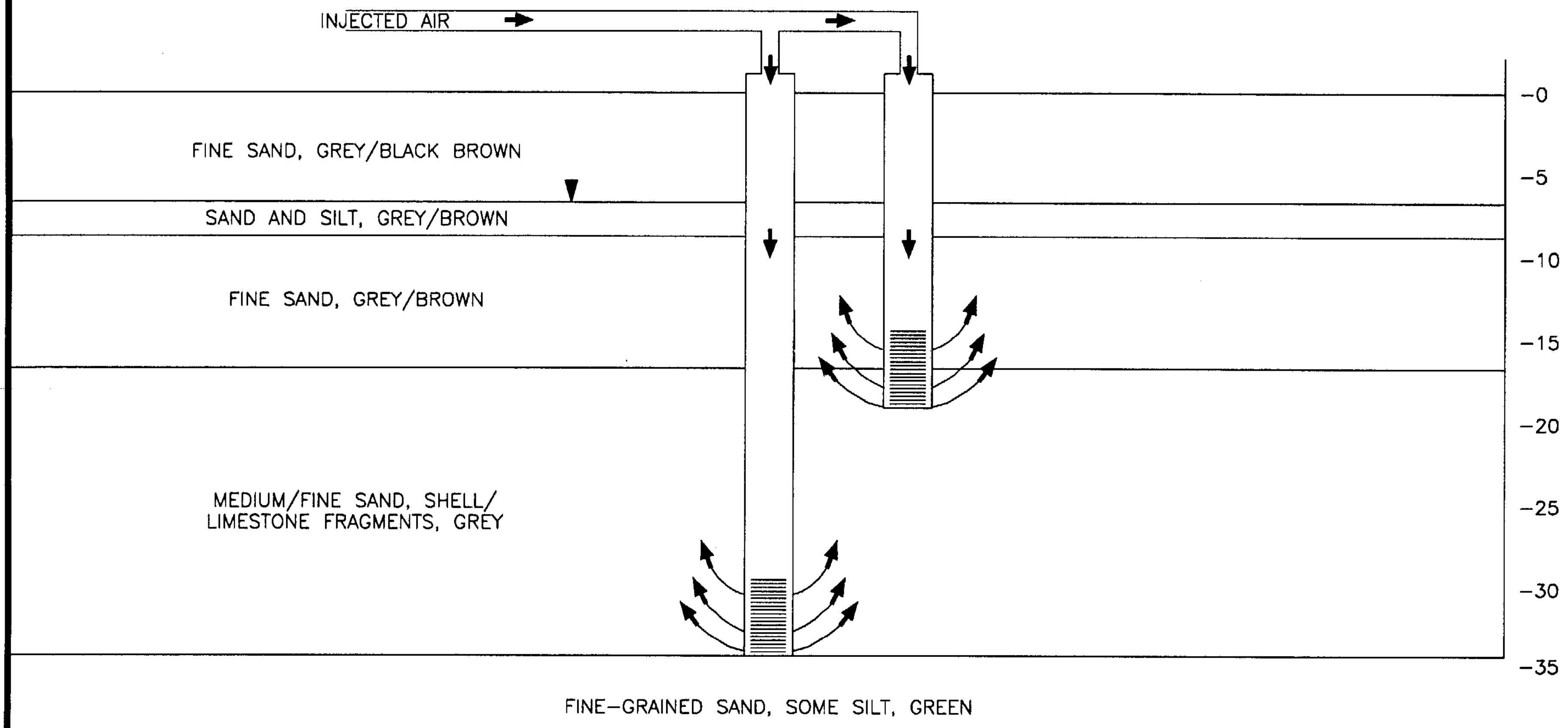


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FIGURE 2-5
PLUME B PILOT TEST
PROPOSED SPARGING WELLS
SITE 35
CTO-0323
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

323020WP

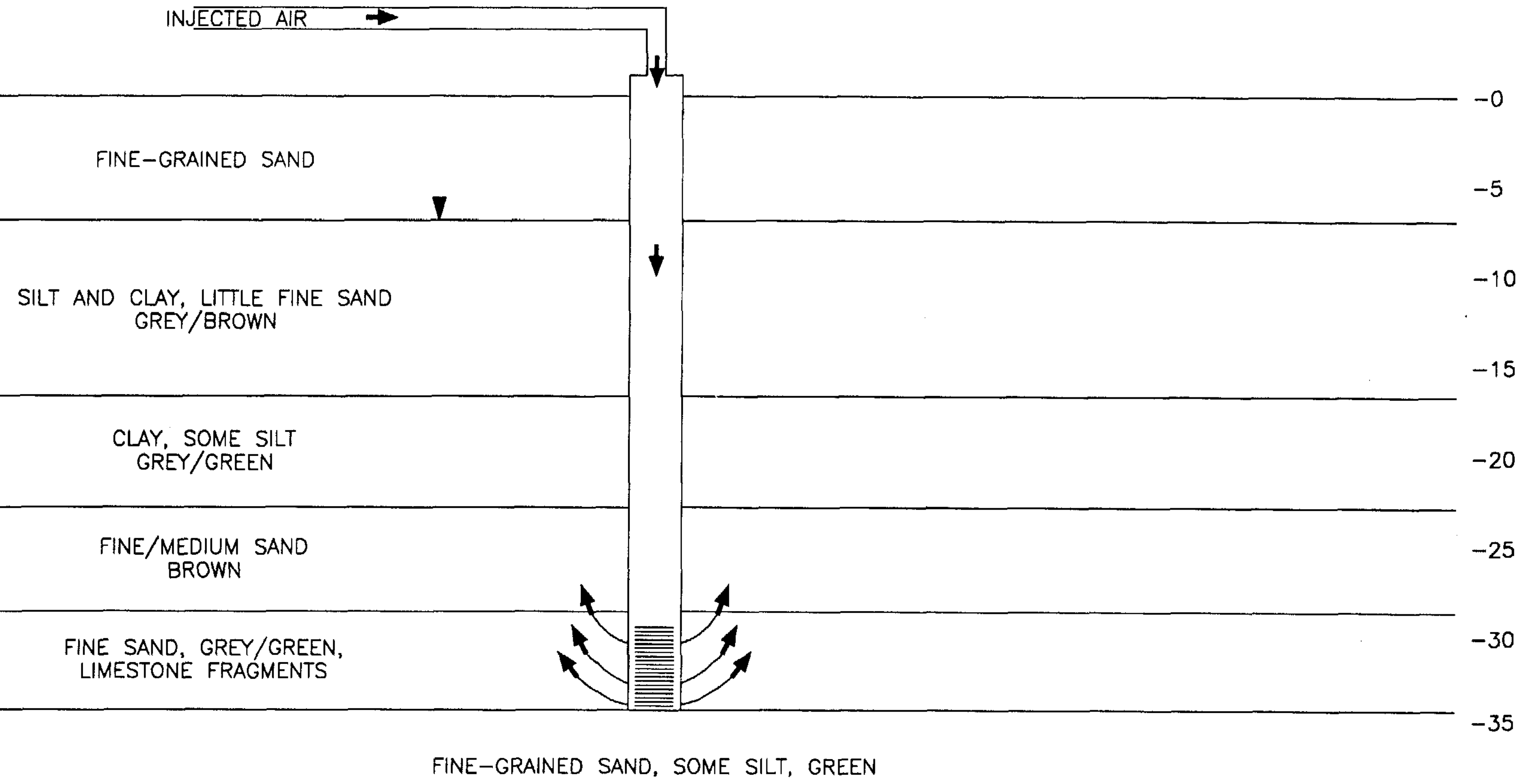

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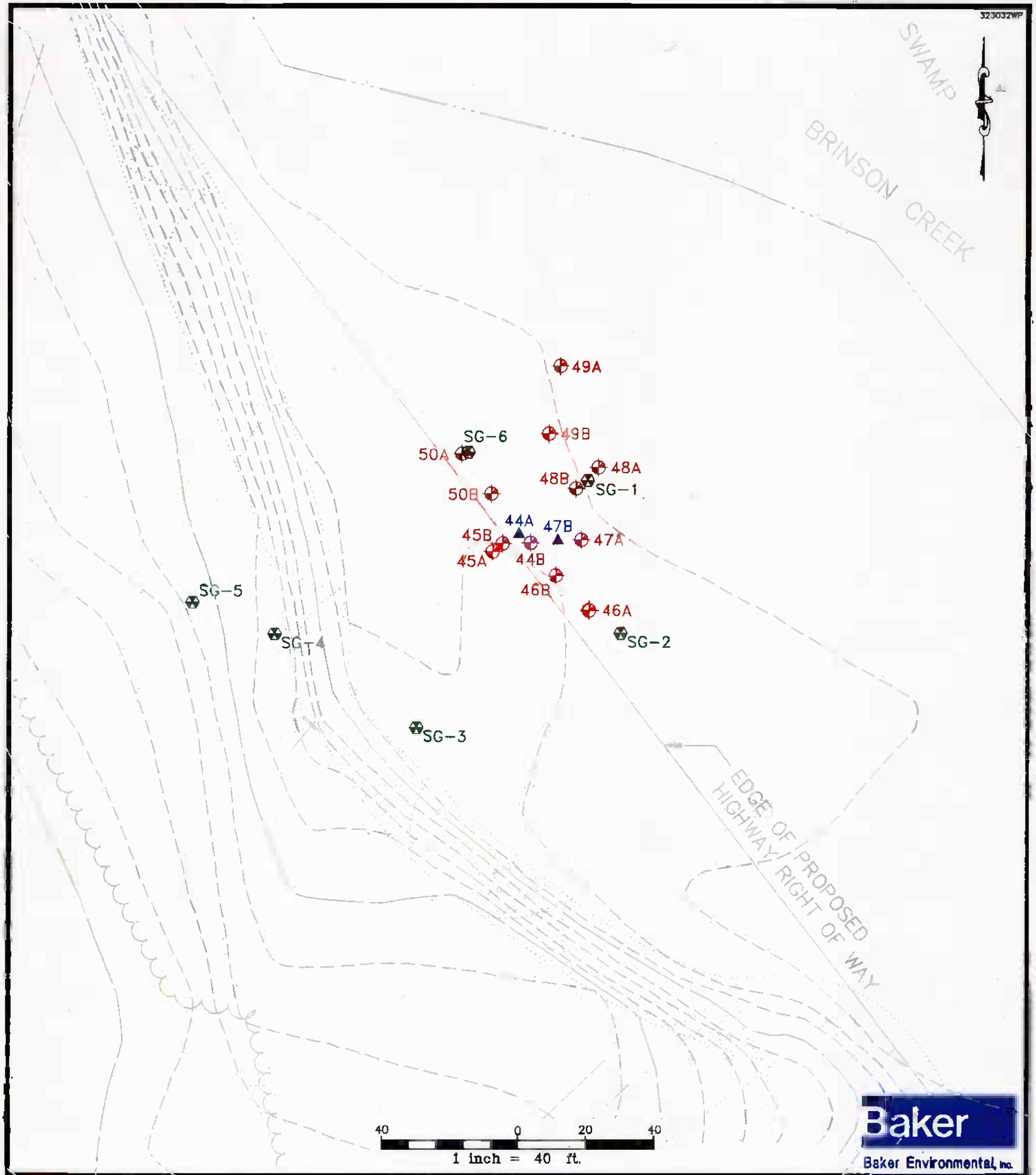
FIGURE 2-6
PLUME C PILOT TEST
PROPOSED SPARGING WELLS
SITE 35
CTO-0323
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

323019WP



LEGEND

44B ⊕ – PLUME B MONITORING WELL LOCATION

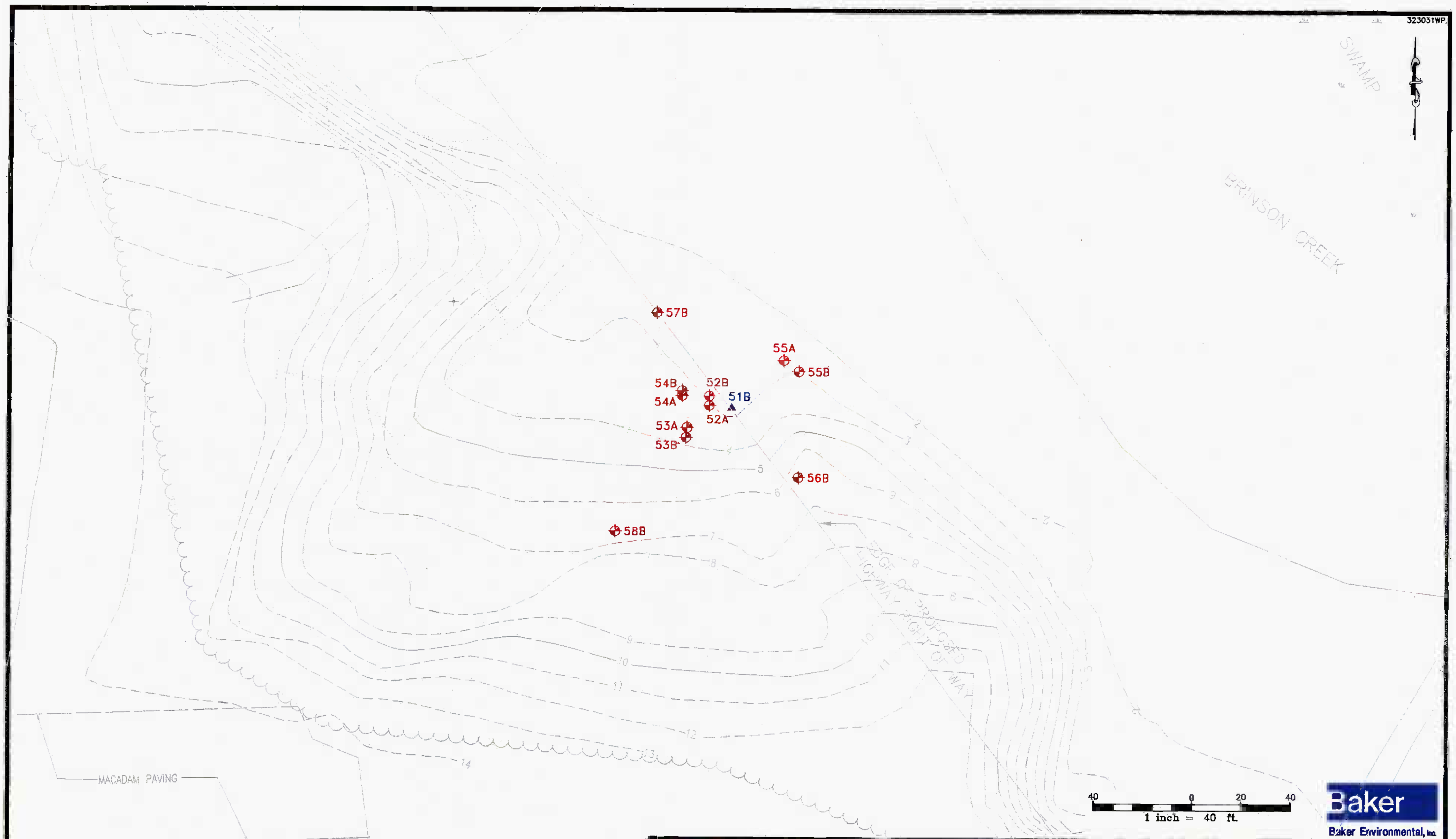
44A ▲ – PLUME B AIR INJECTION WELL LOCATION

SG-1 ⊗ – PLUME B SOIL GAS PROBE LOCATION

SOURCE: X

FIGURE 4-1
MONITORING WELL, AIR INJECTION
WELL, AND SOIL GAS PROBE
LOCATION MAP – PLUME B
IAS TREATABILITY STUDY
OPERABLE UNIT NO. 10 (SITE 35)
MCB CAMP LEJEUNE,
NORTH CAROLINA

00215 BB B6 Y



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LEGEND

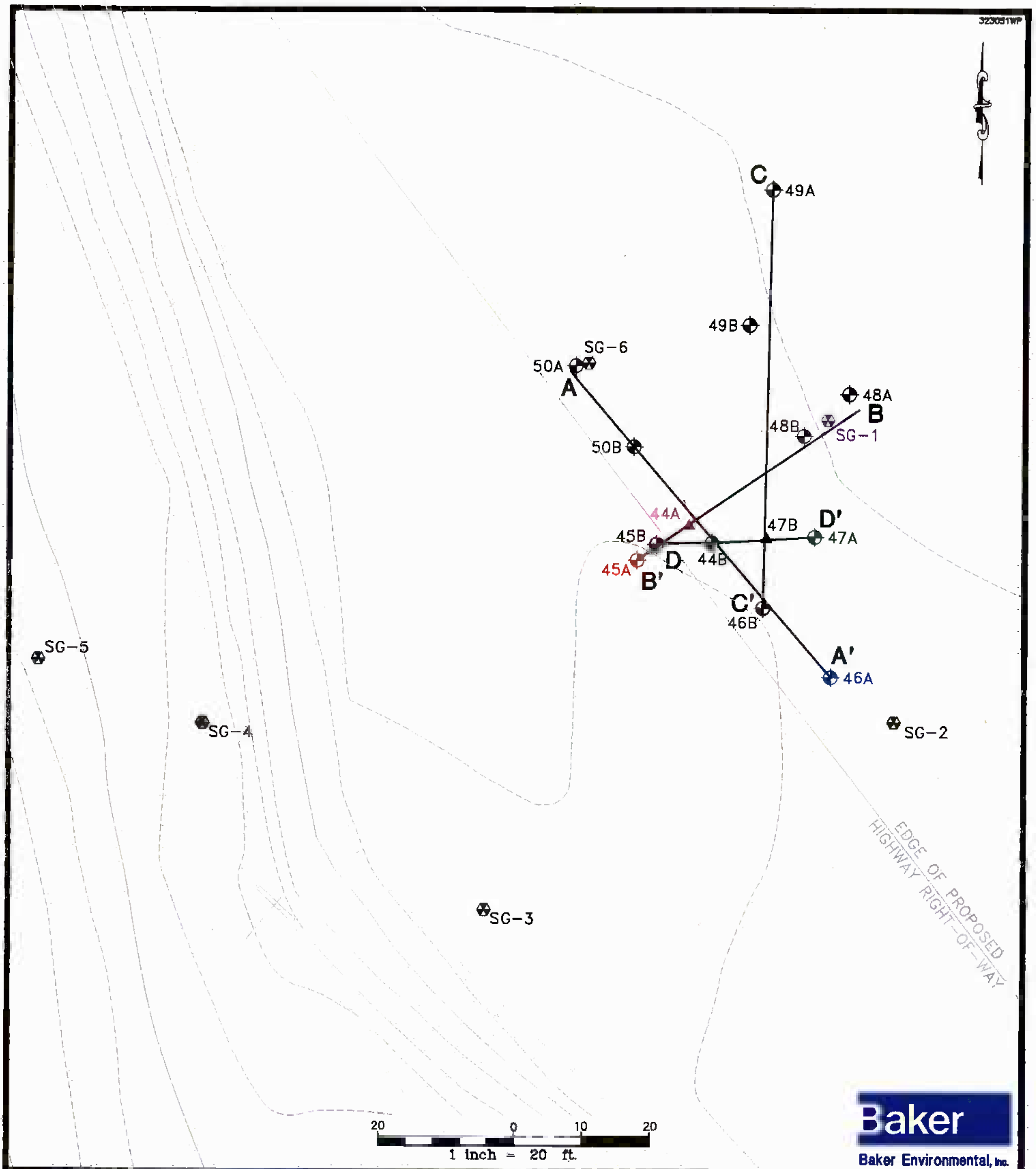
52B ⊕ – PLUME C MONITORING WELL LOCATION

51B ▲ – PLUME C AIR INJECTION WELL LOCATION

SOURCE: X

FIGURE 4-2
MONITORING WELL AND
AIR INJECTION WELL
LOCATION MAP – PLUME C
IAS TREATABILITY STUDY
OPERABLE UNIT NO. 10 (SITE 35)

MCB CAMP LEJEUNE,
NORTH CAROLINA



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LEGEND

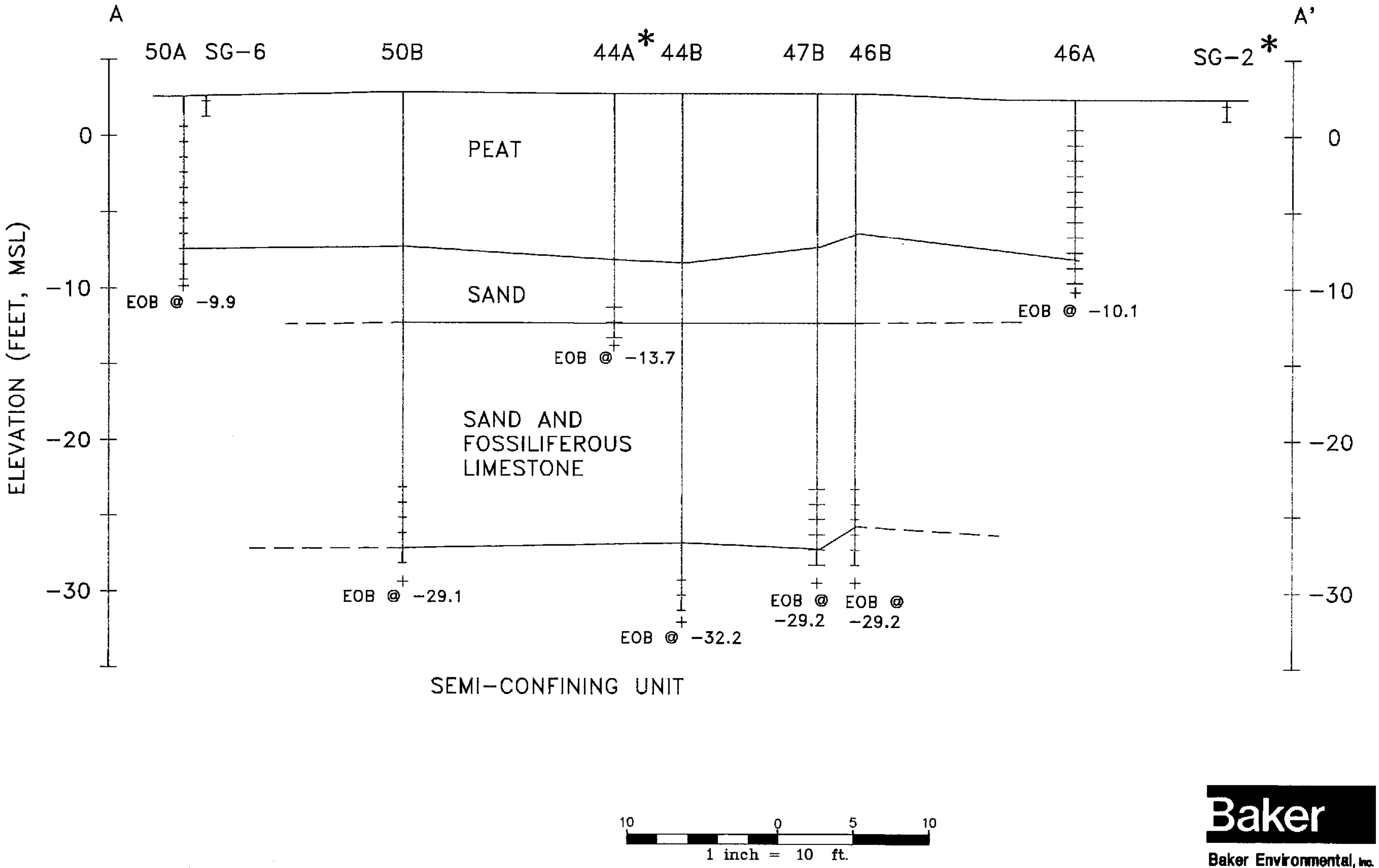
44B ⊕ – PLUME B MONITORING WELL LOCATION

44A ▲ – PLUME B AIR INJECTION WELL LOCATION

SG-1 ⊗ – PLUME B SOIL GAS PROBE LOCATION

FIGURE 4-3
GEOLOGIC CROSS-SECTION LOCATIONS –
PLUME B
IAS TREATABILITY STUDY
OPERABLE UNIT NO. 10 (SITE 35)

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



LEGEND

‡ MONITORING WELL SCREENED INTERVAL

* SUBSURFACE SOIL SAMPLES NOT COLLECTED FOR SOIL CLASSIFICATION

EOB END OF BORING

MSL MEAN SEA LEVEL

—— GEOLOGIC CONTACT — — ASSUMED GEOLOGIC CONTACT

REFER TO FIGURE 4-3 FOR CROSS SECTION LOCATIONS

FIGURE 4-4
GEOLOGIC CROSS SECTION A-A' - PLUME B
IAS TREATABILITY STUDY
OPERABLE UNIT NO. 10 (SITE 35)

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

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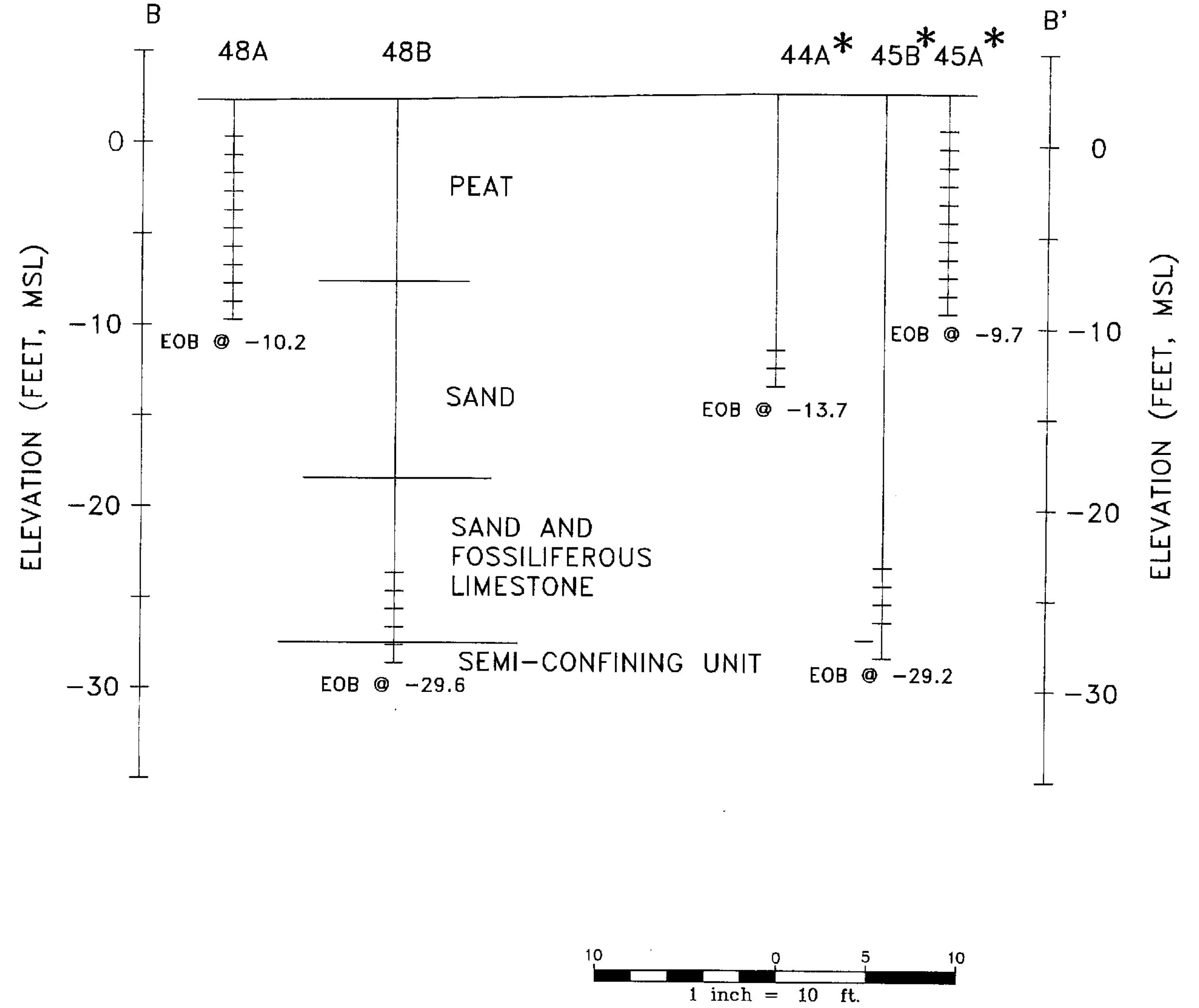

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LEGEND

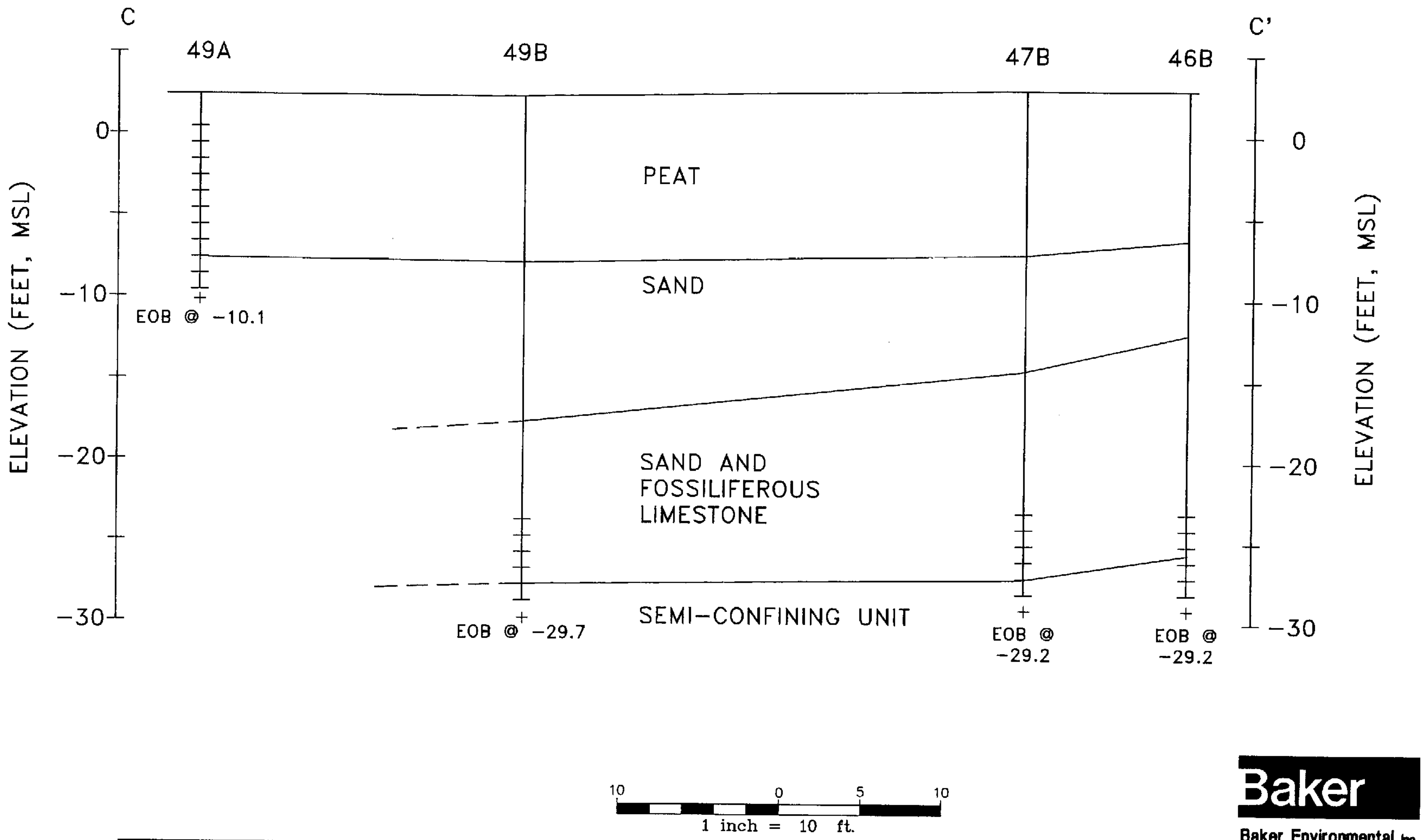
‡	MONITORING WELL SCREENED INTERVAL
*	SUBSURFACE SOIL SAMPLES NOT COLLECTED FOR SOIL CLASSIFICATION
EOB	END OF BORING
MSL	MEAN SEA LEVEL
——	GEOLOGIC CONTACT
-----	ASSUMED GEOLOGIC CONTACT

REFER TO FIGURE 4−3 FOR CROSS SECTION LOCATIONS

FIGURE 4−5
GEOLOGIC CROSS SECTION B−B' − PLUME B
IAS TREATABILITY STUDY
OPERABLE UNIT NO. 10 (SITE 35)

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

323042WP



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LEGEND

‡ MONITORING WELL SCREENED INTERVAL

EOB END OF BORING

MSL MEAN SEA LEVEL

—— GEOLOGIC CONTACT

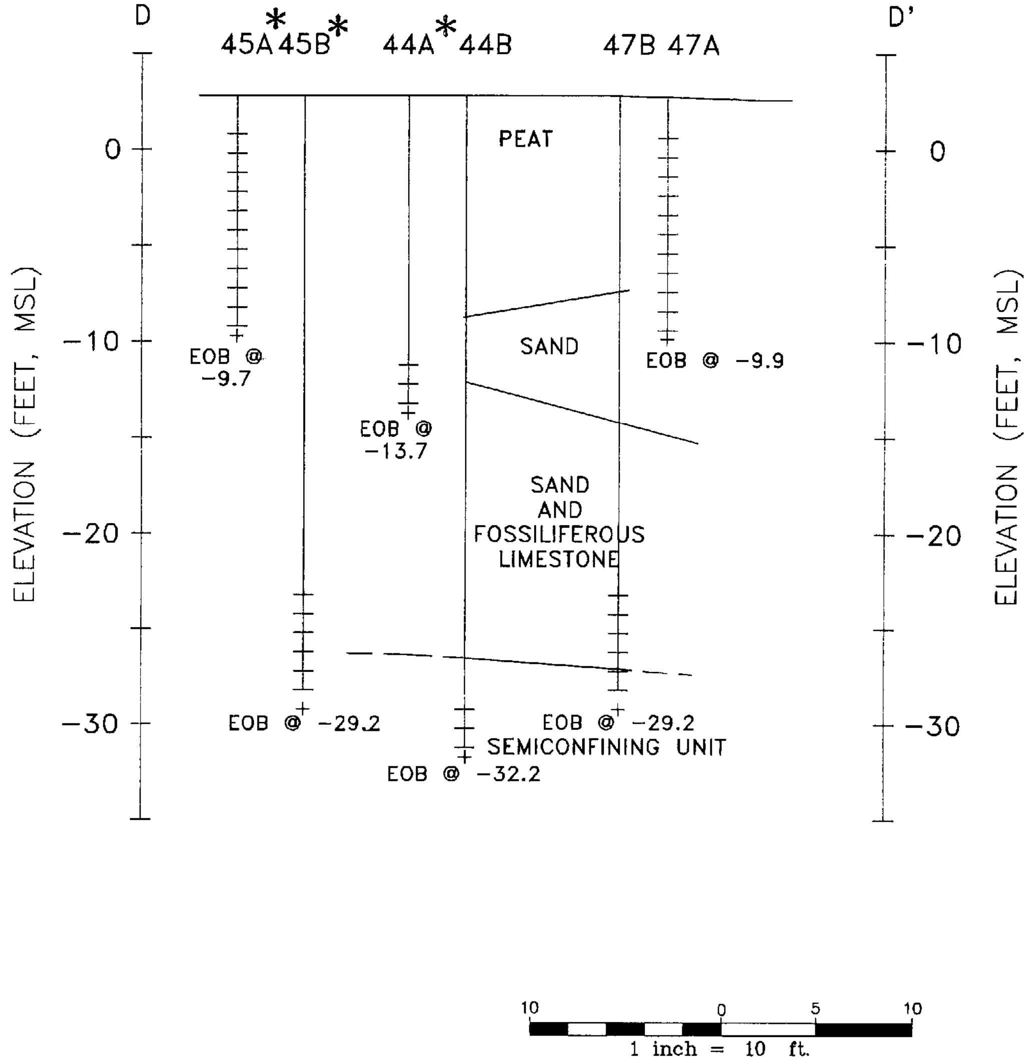
— — ASSUMED GEOLOGIC CONTACT

REFER TO FIGURE 4-3 FOR CROSS SECTION LOCATIONS

FIGURE 4-6
GEOLOGIC CROSS SECTION C-C' - PLUME B
IAS TREATABILITY STUDY
OPERABLE UNIT No. 10 (SITE 35)

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

323053WP



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LEGEND

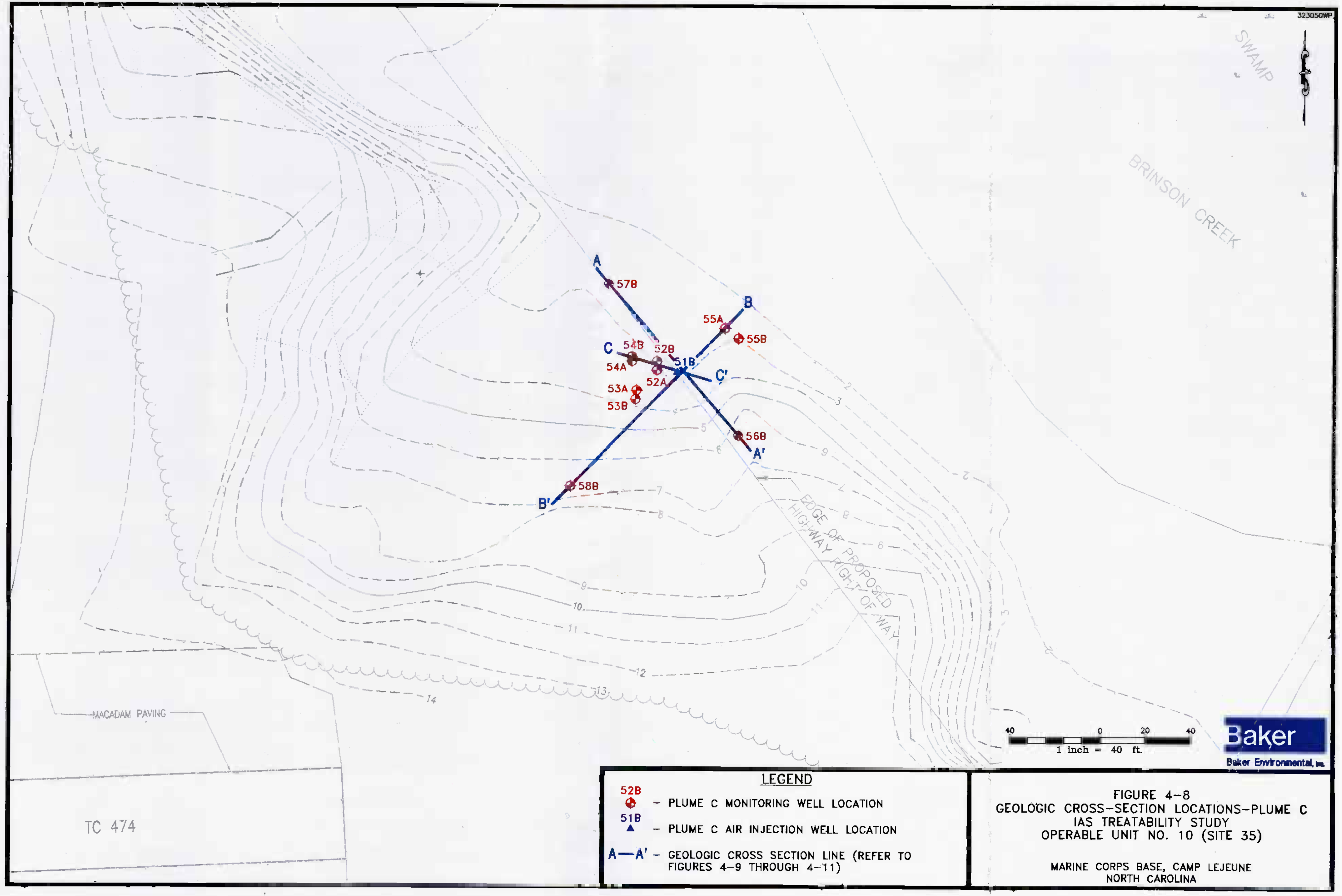
‡	MONITORING WELL SCREENED INTERVAL
*	SUBSURFACE SOIL SAMPLES NOT COLLECTED FOR SOIL CLASSIFICATION
EOB	END OF BORING
MSL	MEAN SEA LEVEL
———	GEOLOGIC CONTACT
— —	ASSUMED GEOLOGIC CONTACT

REFER TO FIGURE 4-3 FOR CROSS SECTION LOCATIONS

FIGURE 4-7
GEOLOGIC CROSS SECTION D-D' – PLUME B
IAS TREATABILITY STUDY
OPERABLE UNIT NO. 10 (SITE 35)

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

323054WP



LEGEND

52B ⊕ – PLUME C MONITORING WELL LOCATION

51B ▲ – PLUME C AIR INJECTION WELL LOCATION

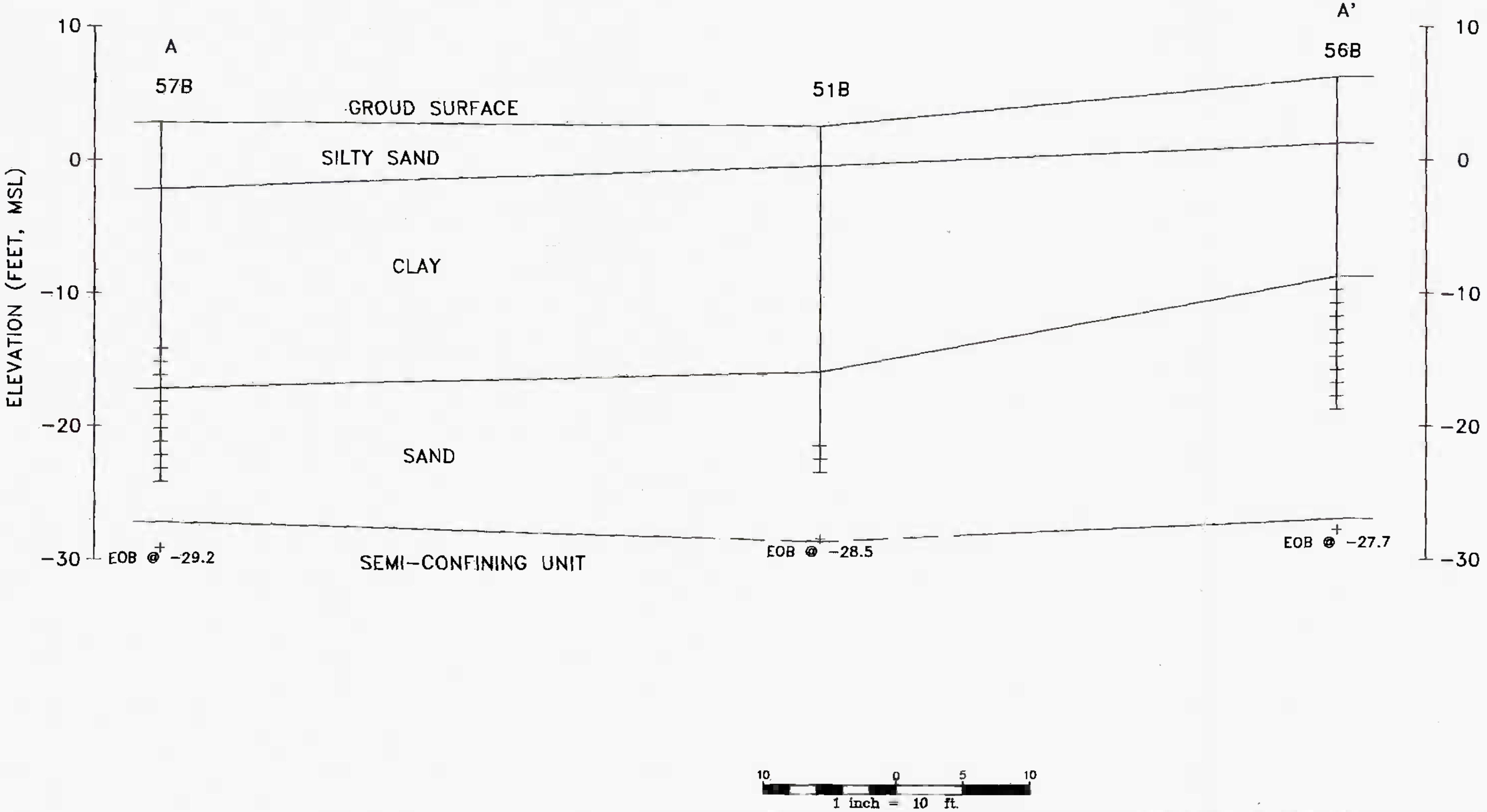
A—A' – GEOLOGIC CROSS SECTION LINE (REFER TO FIGURES 4-9 THROUGH 4-11)

FIGURE 4-8
GEOLOGIC CROSS-SECTION LOCATIONS-PLUME C
IAS TREATABILITY STUDY
OPERABLE UNIT NO. 10 (SITE 35)

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

00215BB01Y

323045WP



LEGEND

‡ MONITORING WELL SCREENED INTERVAL
EOB END OF BORING
MSL MEAN SEA LEVEL
—— GEOLOGIC CONTACT
— — ASSUMED GEOLOGIC CONTACT
REFER TO FIGURE 4-8 FOR CROSS SECTION LOCATIONS

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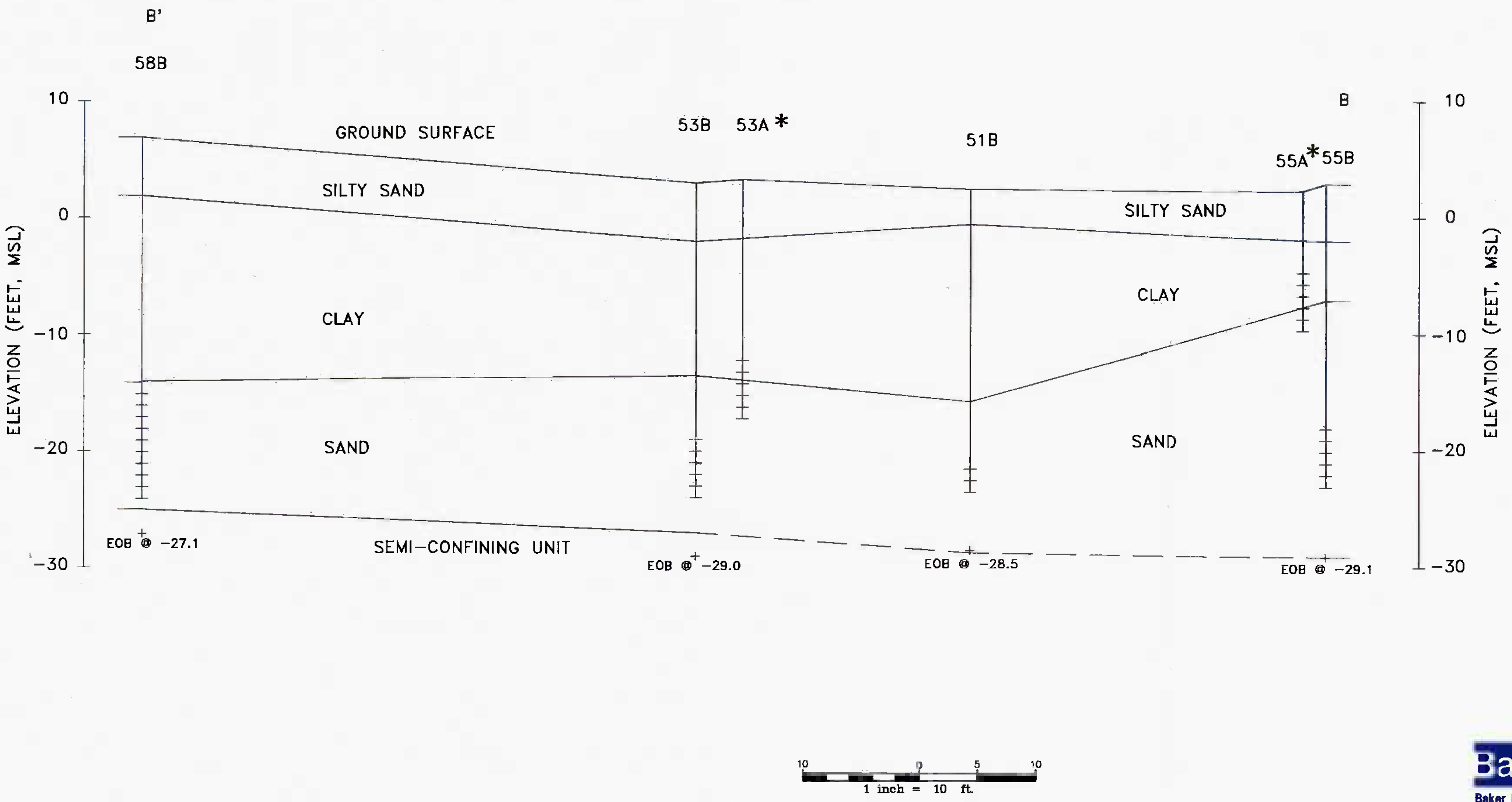
FIGURE 4-9
GEOLOGIC CROSS SECTION A-A'-PLUME C
IAS TREATABILITY STUDY
OPERABLE UNIT No. 10 (SITE 35)
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

00215BB B7Z

323046WP



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LEGEND

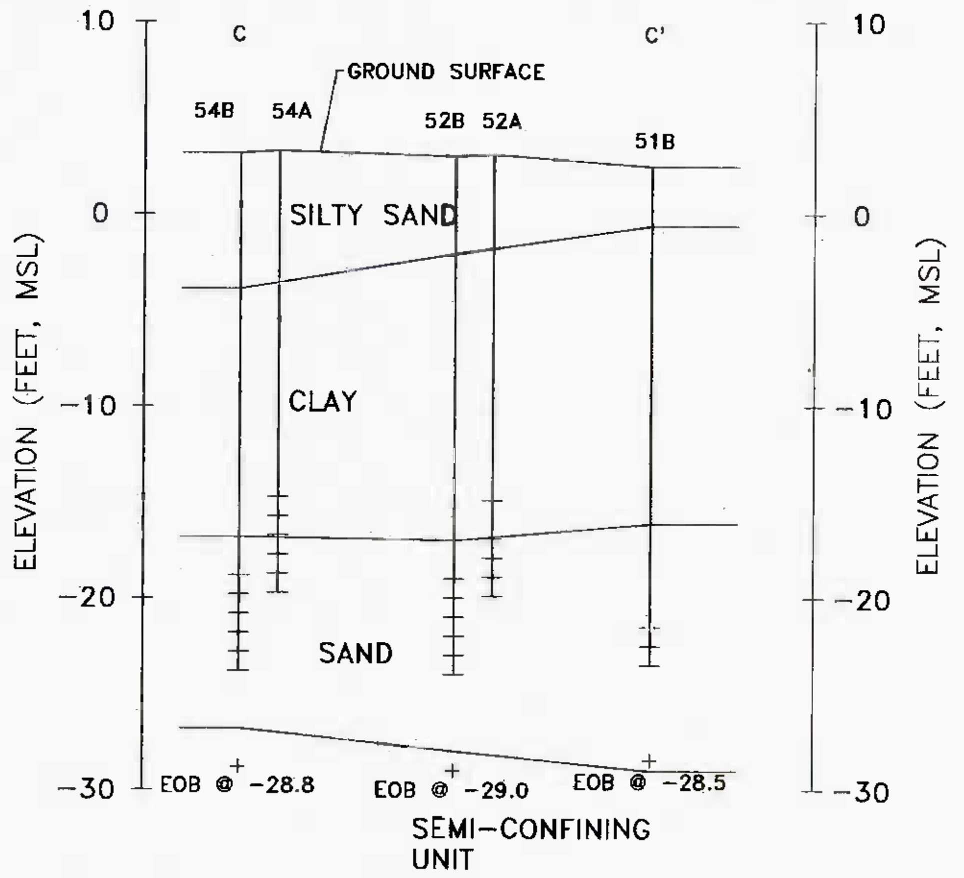
‡	MONITORING WELL SCREENED INTERVAL
*	SUBSURFACE SOIL SAMPLES NOT COLLECTED FOR SOIL CLASSIFICATION
EOB	END OF BORING
MSL	MEAN SEA LEVEL
———	GEOLOGIC CONTACT
— —	ASSUMED GEOLOGIC CONTACT

REFER TO FIGURE 4-8 FOR CROSS SECTION LOCATION

FIGURE 4-10
GEOLOGIC CROSS SECTION B-B'-PLUME C
IAS TREATABILITY STUDY
OPERABLE UNIT No. 10 (SITE 35)

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

323047WP



10 0 5 10

1 inch = 10 ft.

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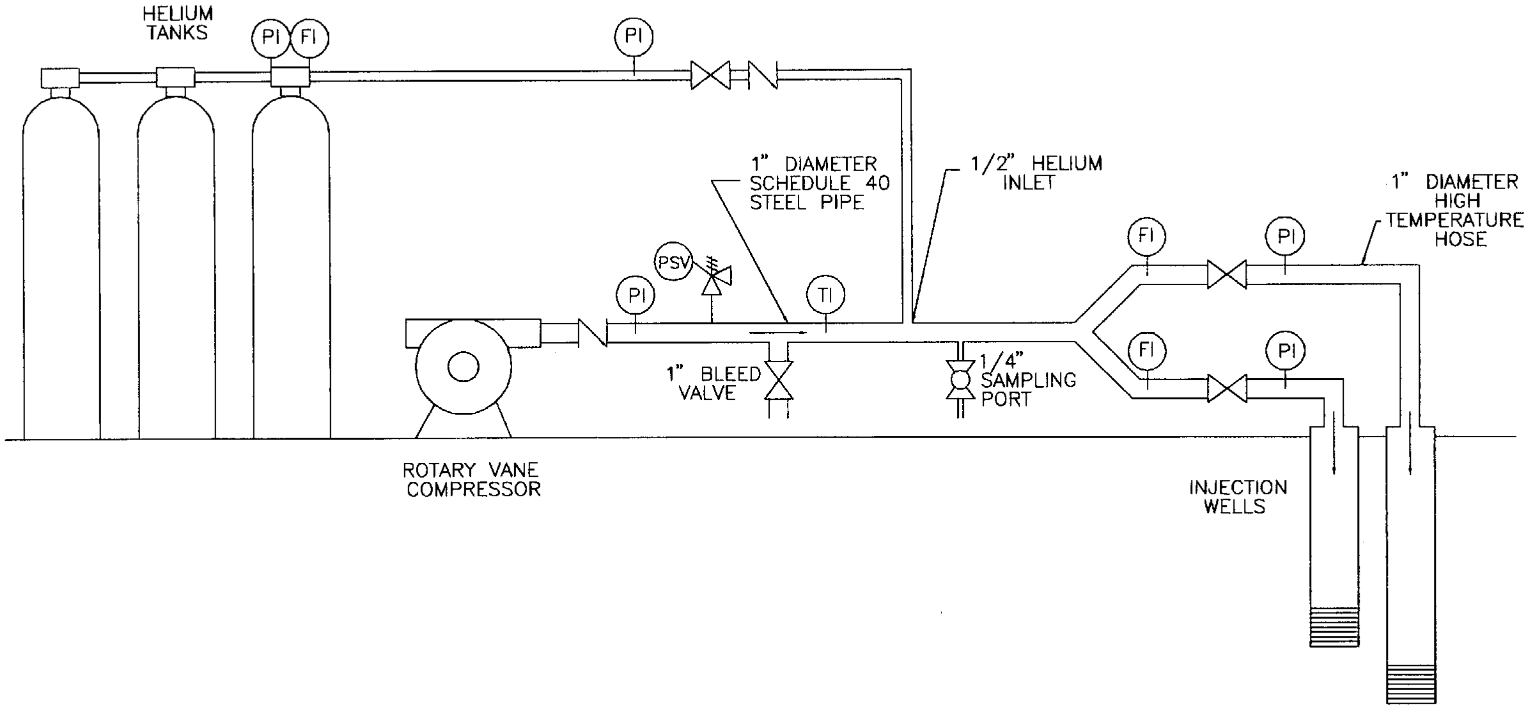
LEGEND

‡	MONITORING WELL SCREENED INTERVAL
EOB	END OF BORING
MSL	MEAN SEA LEVEL
———	GEOLOGIC CONTACT
-----	ASSUMED GEOLOGIC CONTACT

REFER TO FIGURE 4-8 FOR CROSS SECTION LOCATIONS

FIGURE 4-11
GEOLOGIC CROSS SECTION C-C'-PLUME C
IAS TREATABILITY STUDY
OPERABLE UNIT No. 10 (SITE 35)

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



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LEGEND

⋈ GATE VALVE

BALL VALVE

CHECK VALVE

PRESSURE SAFETY VALVE (PSV)

FI – FLOW INDICATOR

PI – PRESSURE INDICATOR

TI – TEMPERATURE INDICATOR

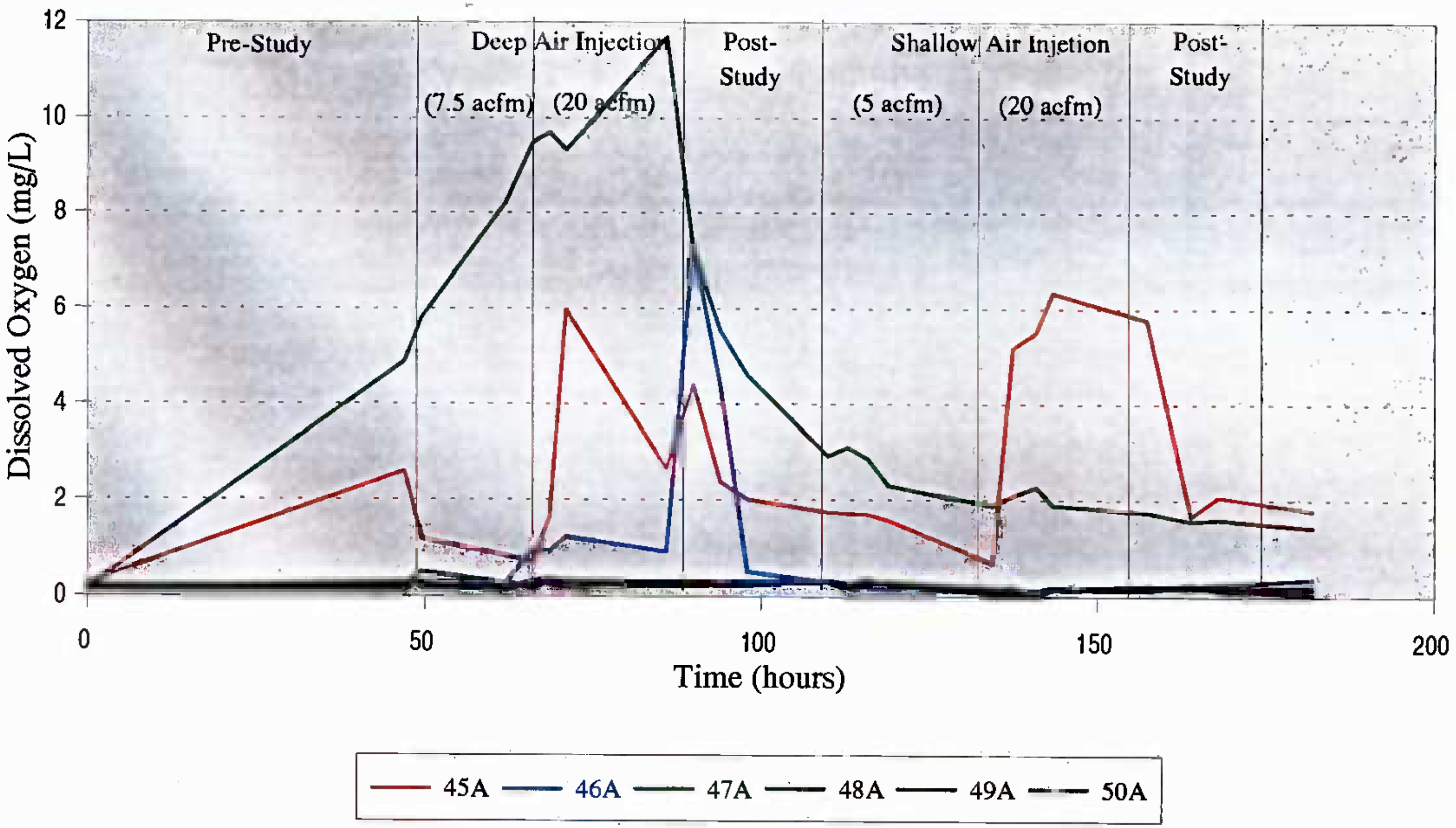
SOURCE: X

FIGURE 5-1
IAS PROCESS FLOW DIAGRAM
IAS TREATABILITY STUDY
OPERABLE UNIT NO. 10 (SITE 35)

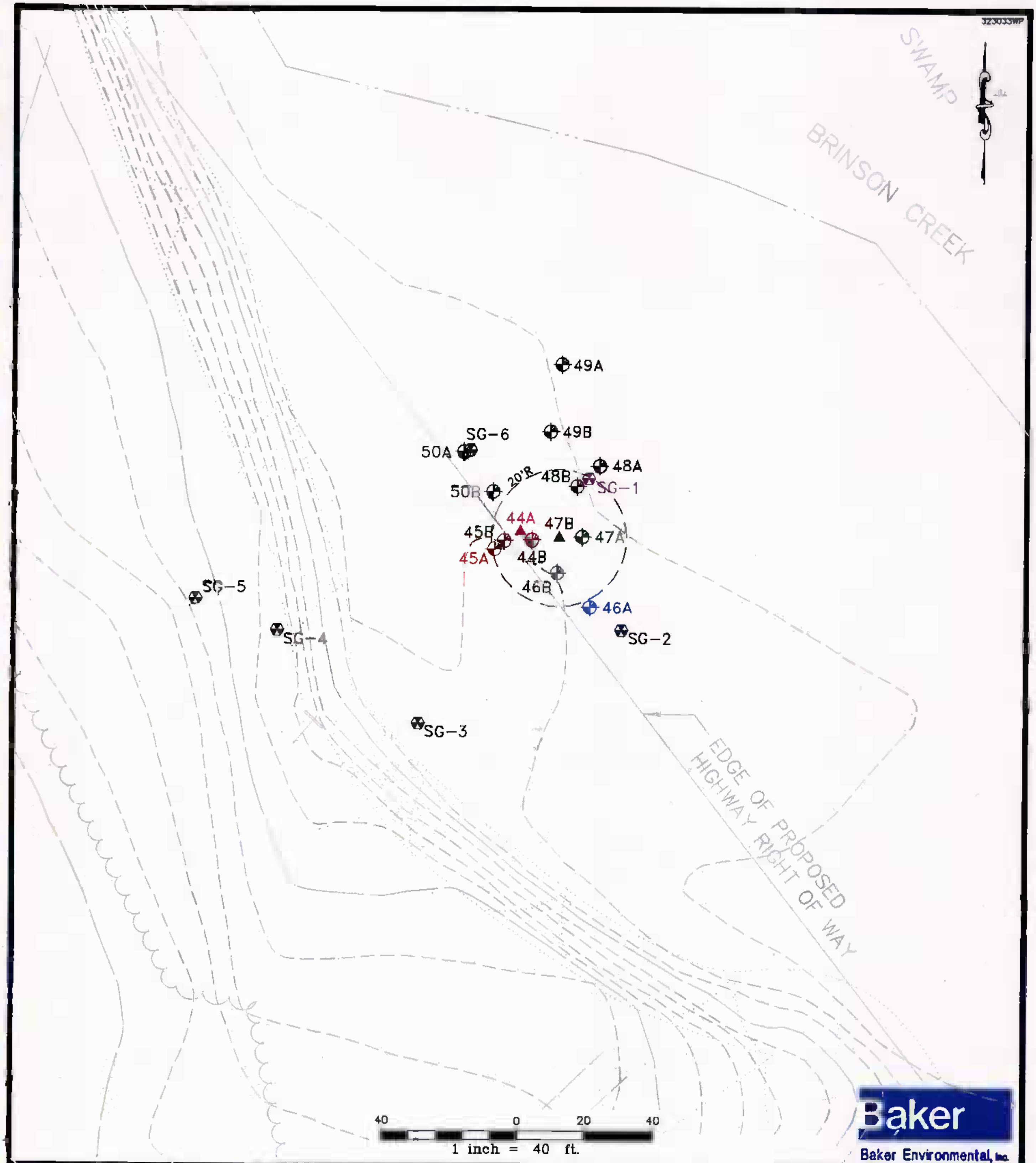
MCB CAMP LEJEUNE,
NORTH CAROLINA

323039WP

Figure 6-1
Shallow Monitoring Wells
Dissolved Oxygen (D.O.)
IAS Treatabillity Study
Operable Unit No. 10 (Site 35)
MCB Camp Lejeune, North Carolina



00715BBB8V



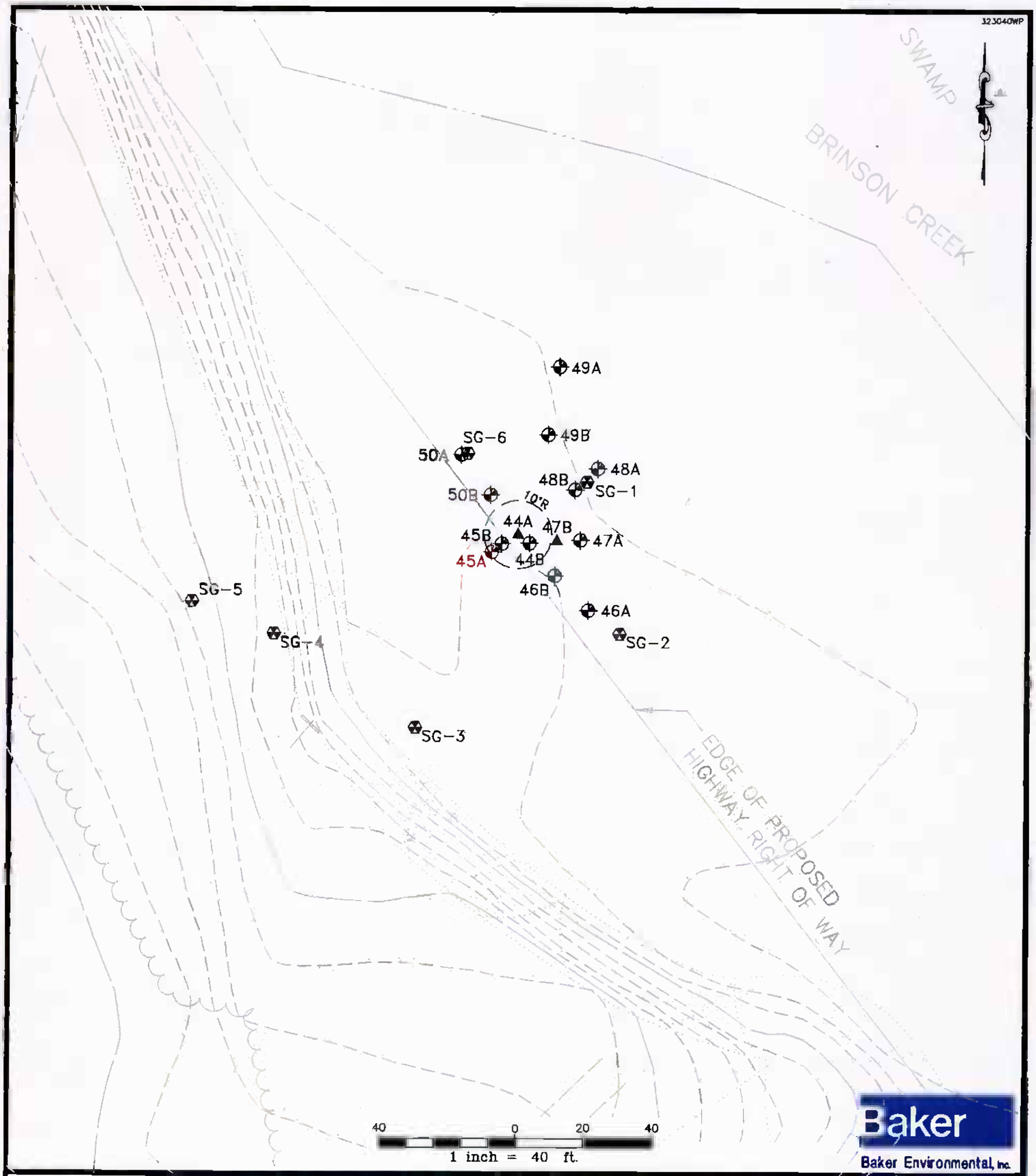
LEGEND

44B ⊕ – PLUME B MONITORING WELL LOCATION
44A ▲ – PLUME B AIR INJECTION WELL LOCATION
SG-1 ⊗ – PLUME B SOIL GAS PROBE LOCATION

SOURCE: X

FIGURE 6-2
APPROXIMATE RADIUS OF INFLUENCE DEEP AIR INJECTION TEST – PLUME B IAS TREATABILITY STUDY OPERABLE UNIT NO. 10 (SITE 35)

MCB CAMP LEJEUNE,
NORTH CAROLINA



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LEGEND

44B
⊕ – PLUME B MONITORING WELL LOCATION

44A
▲ – PLUME B AIR INJECTION WELL LOCATION

SG-1
⊗ – PLUME B SOIL GAS PROBE LOCATION

SOURCE: X

FIGURE 6-3
APPROXIMATE RADIUS OF INFLUENCE SHALLOW AIR INJECTION TEST – PLUME B IAS FEASIBILITY STUDY OPERABLE UNIT NO. 10 (SITE 35)

MCB CAMP LEJEUNE,
NORTH CAROLINA

Figure 6-4
Deep Monitoring Wells
Dissolved Oxygen (D.O.)
IAS Treatability Study
Operable Unit No. 10 (Site 35)
MCB Camp Lejeune, North Carolina

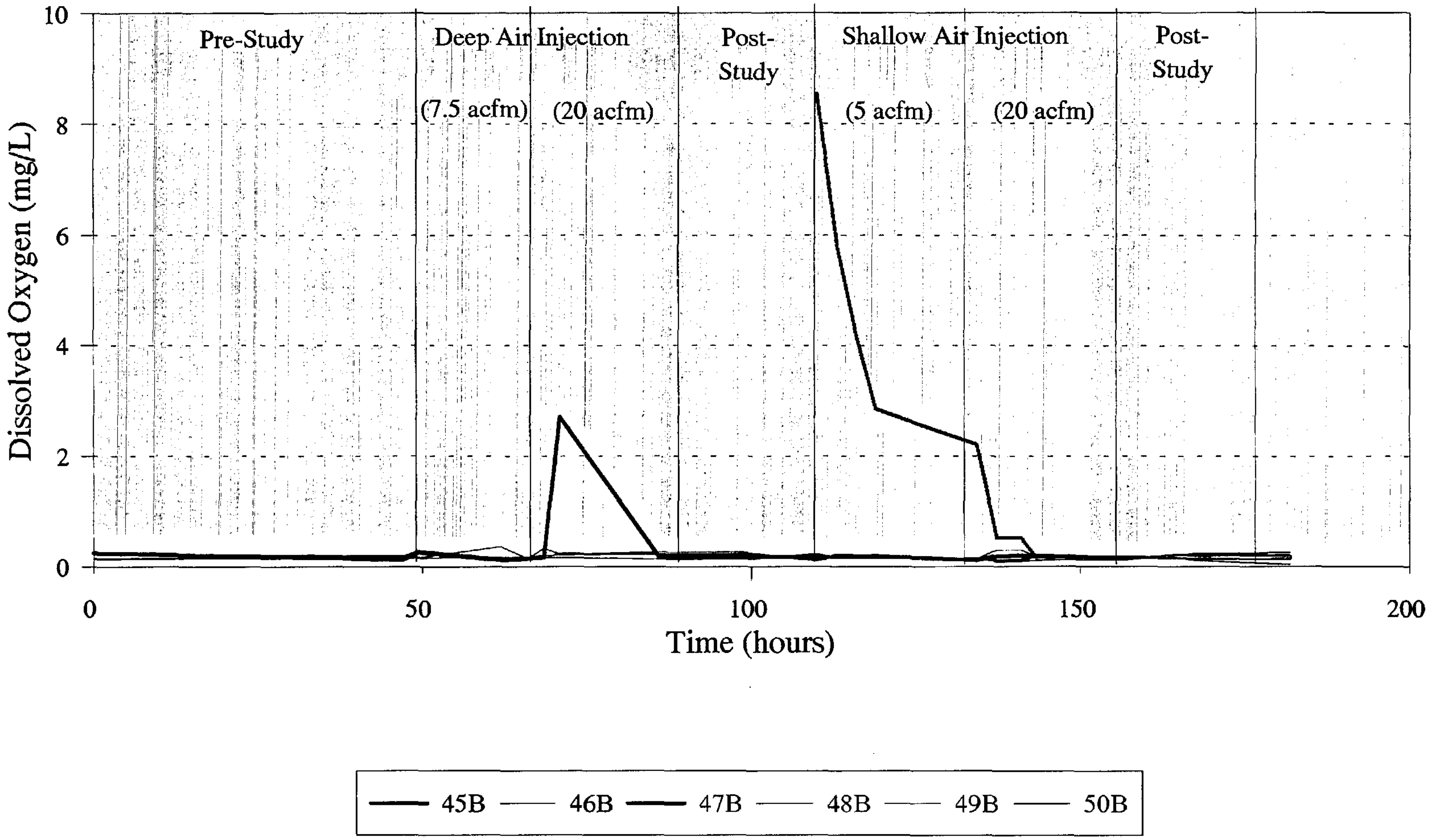


Figure 6-5

Shallow Monitoring Wells
Percent Helium by Volume
IAS Treatability Study

Operable Unit No. 10 (Site 35)
MCB Camp Lejeune, North Carolina

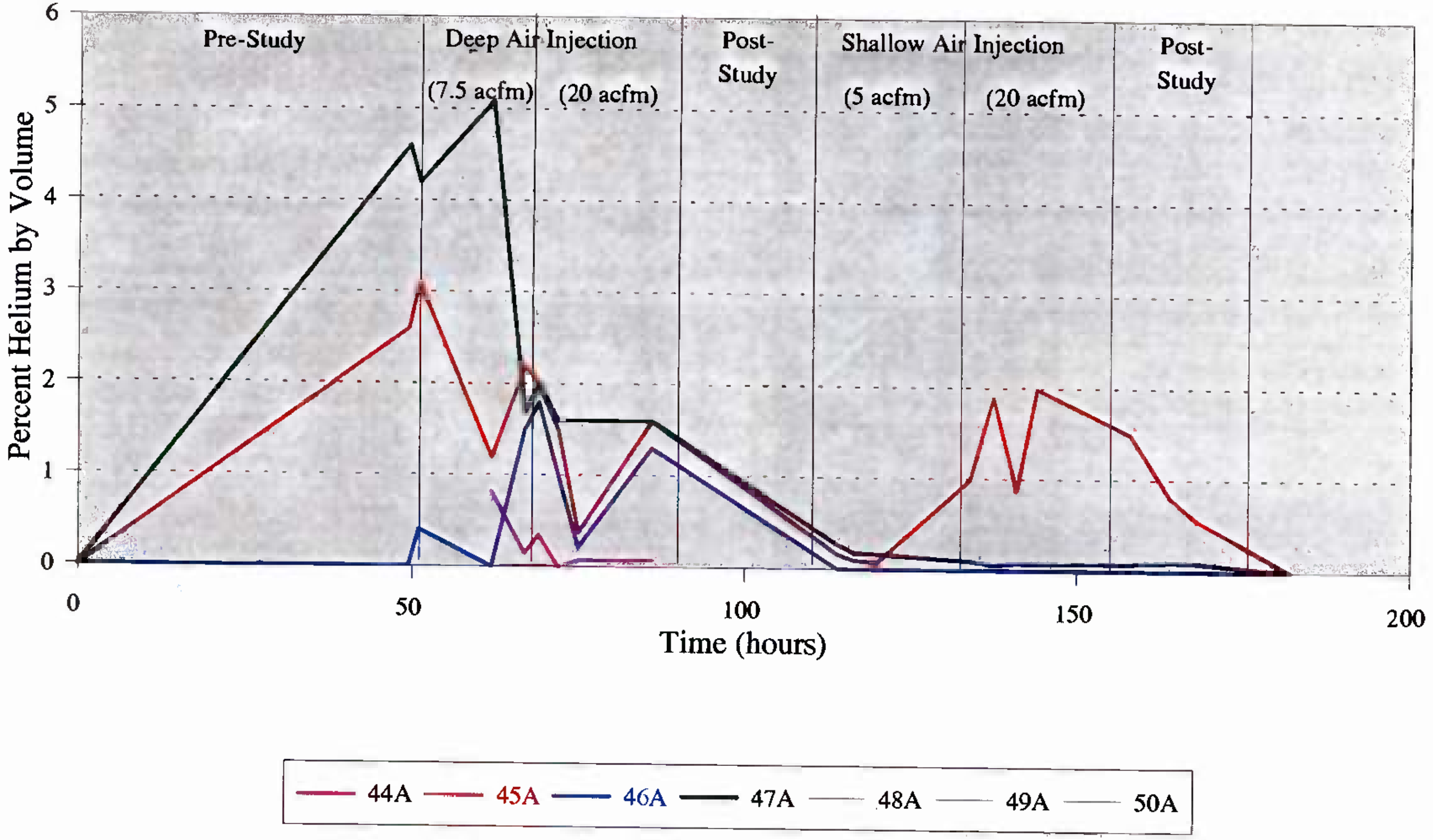


Figure 6-6
Soil Gas Probes
Percent Helium bv Volume
IAS Treatability Study
Operable Unit No. 10 (Site 35)
MCB Camp Lejeune, North Carolina

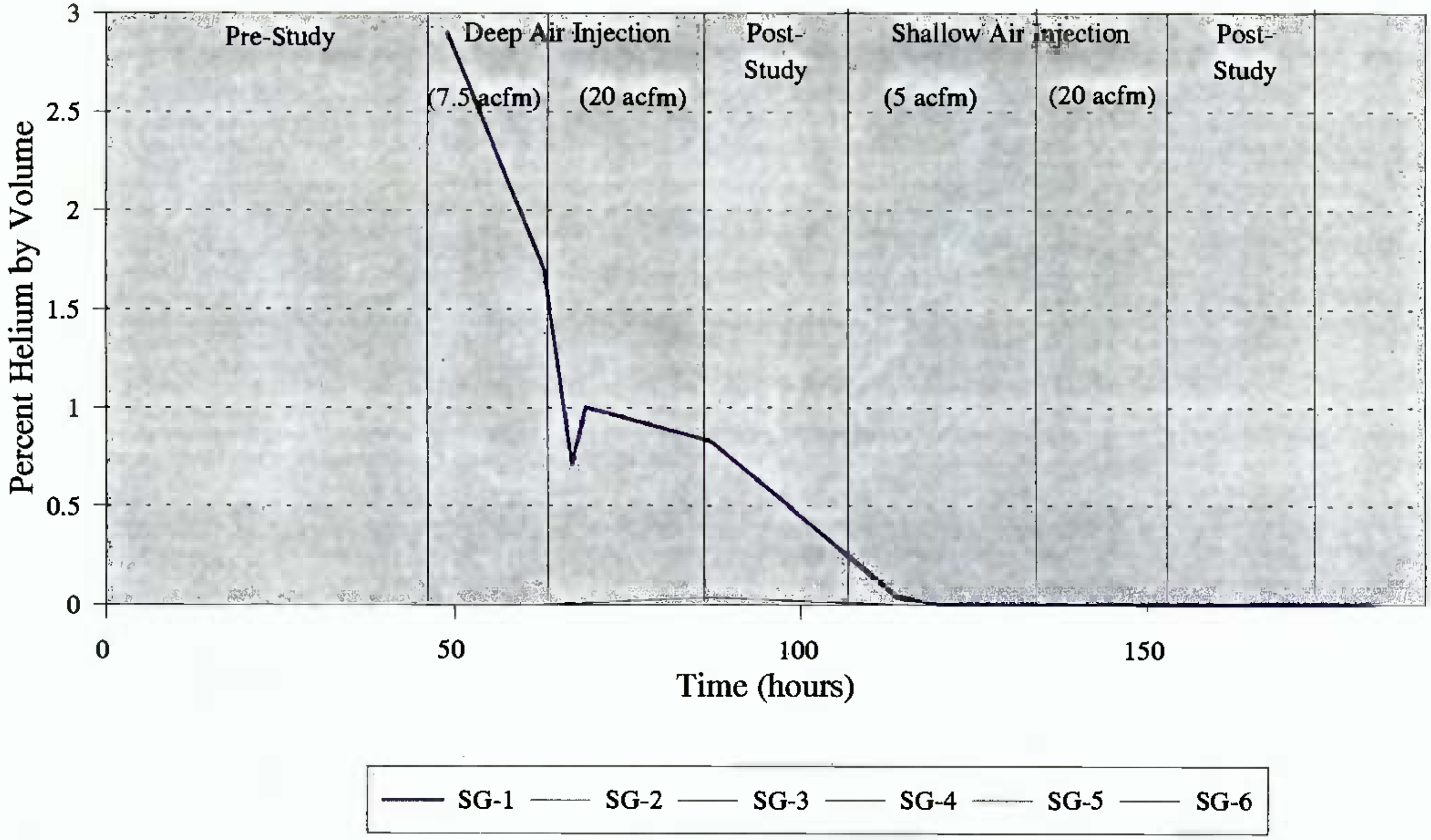
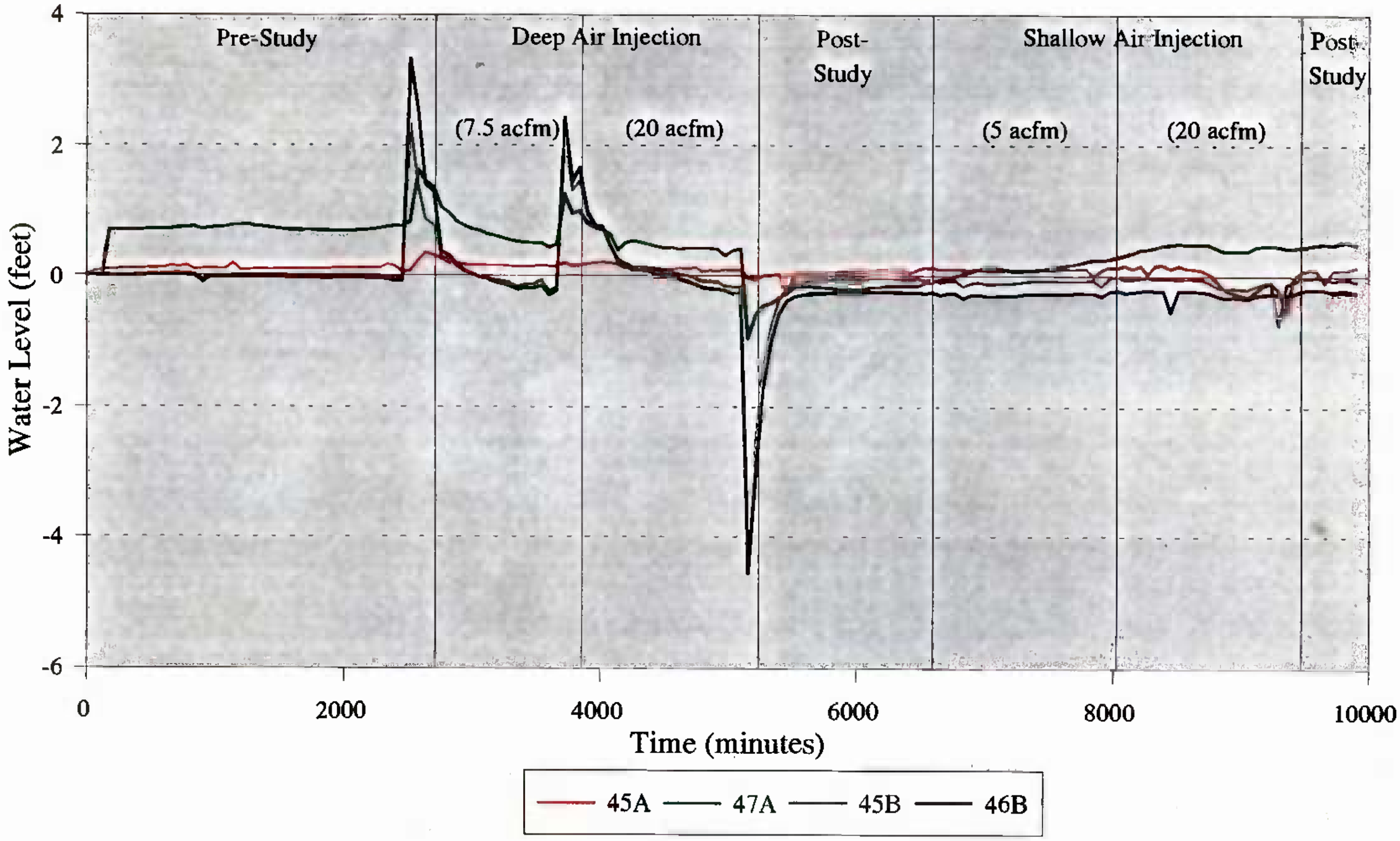
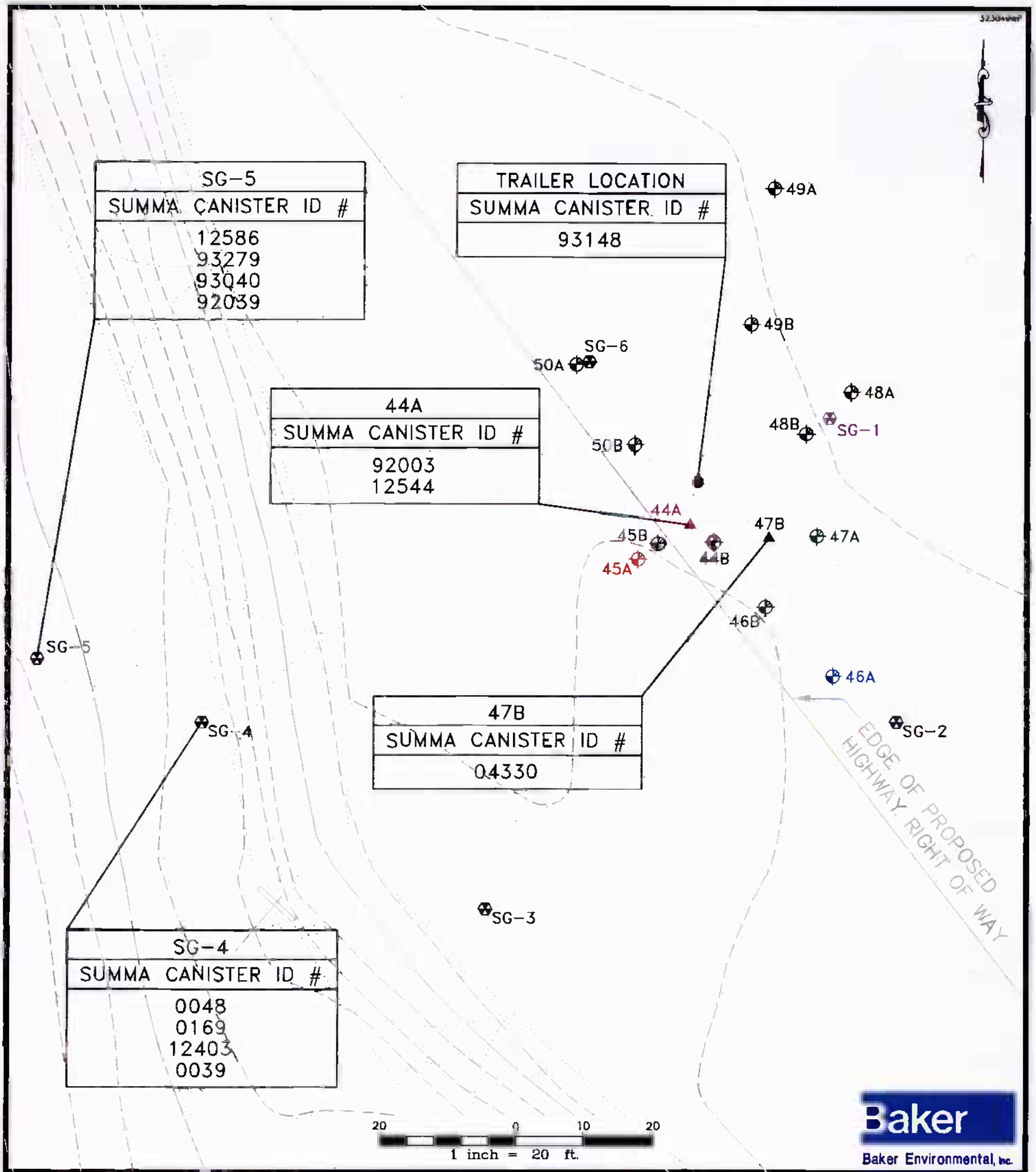


Figure 6-7
Static Water Level Readings - Plume B
IAS Treatabilitv Studv
Operable Unit No. 10 (Site 35)
MCB Camp Lejeune, North Carolina





LEGEND

44B ⊕ – PLUME B MONITORING WELL LOCATION

44A ▲ – PLUME B AIR INJECTION WELL LOCATION

SG-1 ⊗ – PLUME B SOIL GAS PROBE LOCATION

SOURCE: X

FIGURE 6-8
AIR SAMPLING LOCATIONS – PLUME B
IAS TREATABILITY STUDY
OPERABLE UNIT NO. 10 (SITE 35)

MCB CAMP LEJEUNE,
NORTH CAROLINA

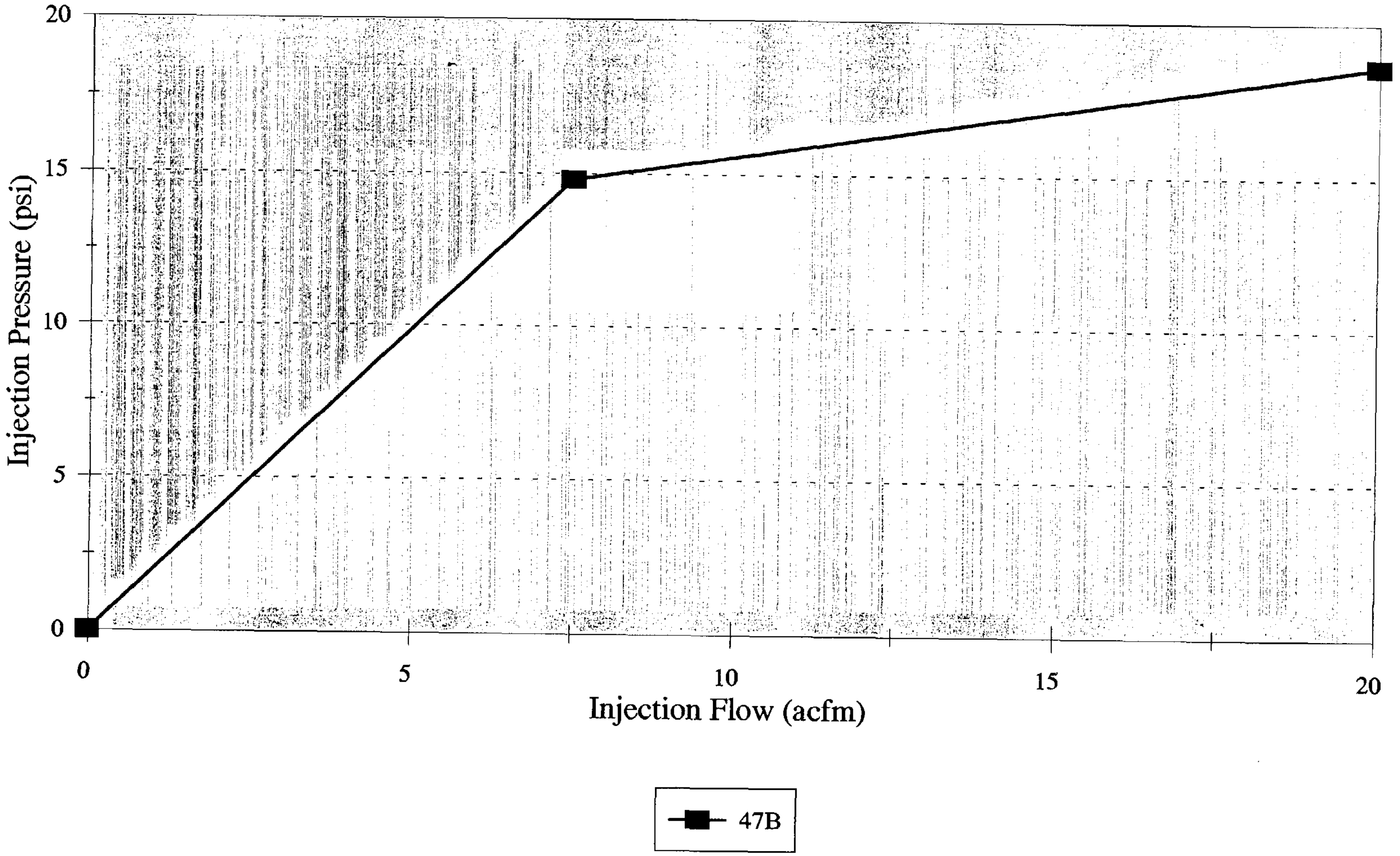
Figure 6-9

Deep Air Injection Well - System Head Curve

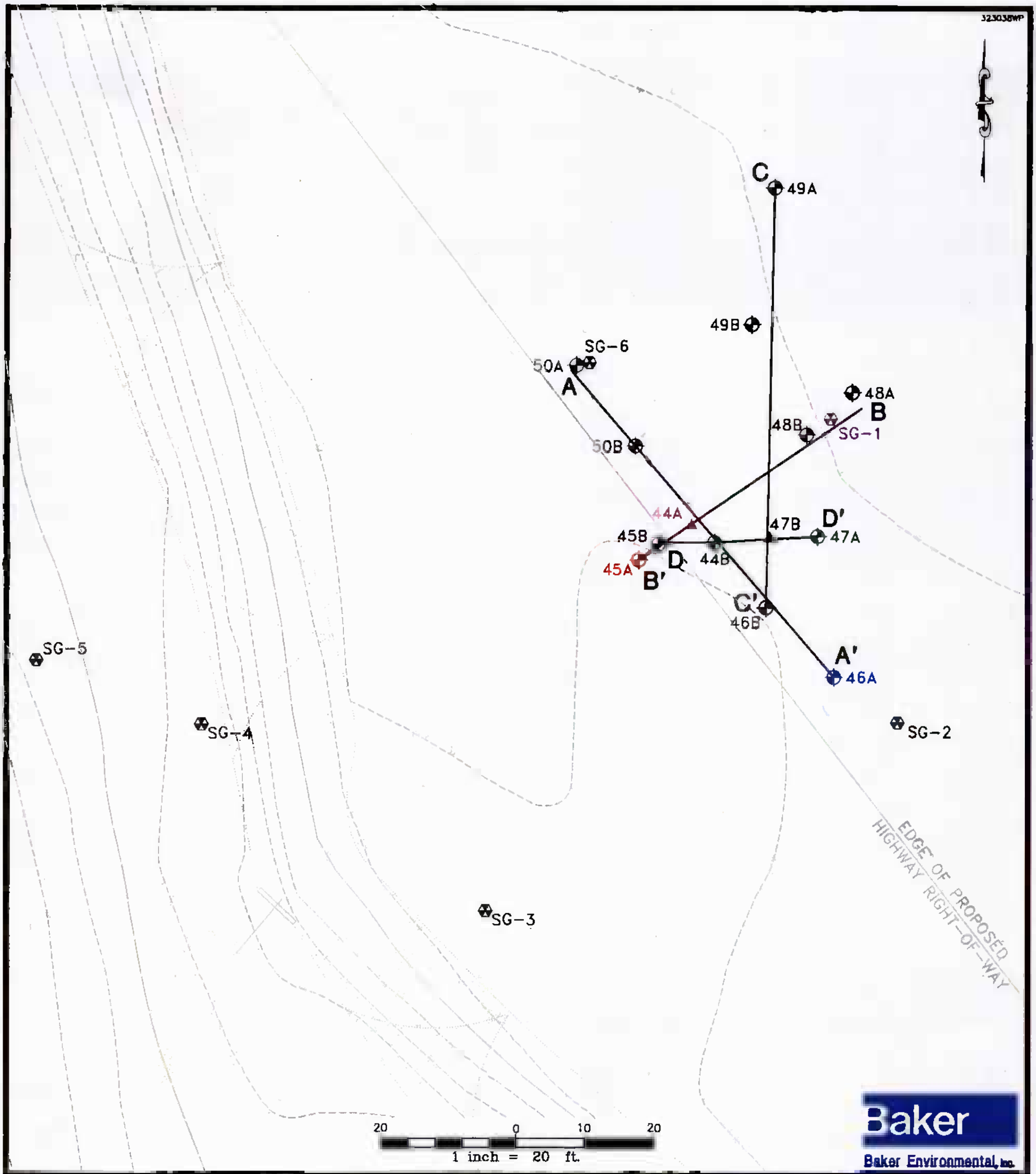
IAS Treatability Study

Operable Unit No. 10 (Site 35)

MCB Camp Lejeune, North Carolina



323038WP



LEGEND

44B ⊕ – PLUME B MONITORING WELL LOCATION

44A ▲ – PLUME B AIR INJECTION WELL LOCATION

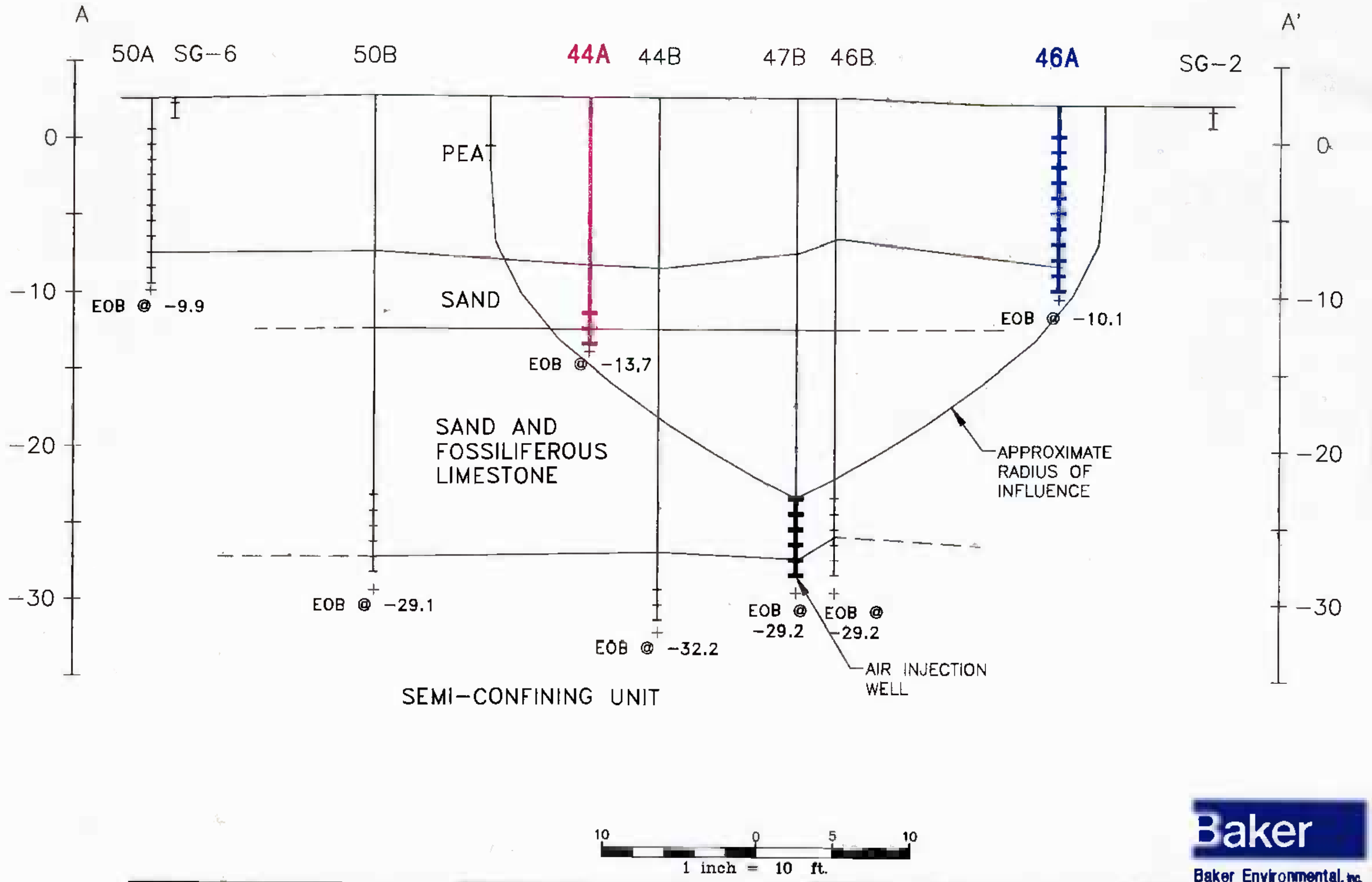
SG-1 ⊗ – PLUME B SOIL GAS PROBE LOCATION

SOURCE: X

FIGURE 6-10
GEOLOGIC CROSS-SECTION LOCATIONS –
PLUME B
IAS TREATABILITY STUDY
OPERABLE UNIT NO. 10 (SITE 35)

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

00215BB B10Y



Baker
Baker Environmental, Inc.

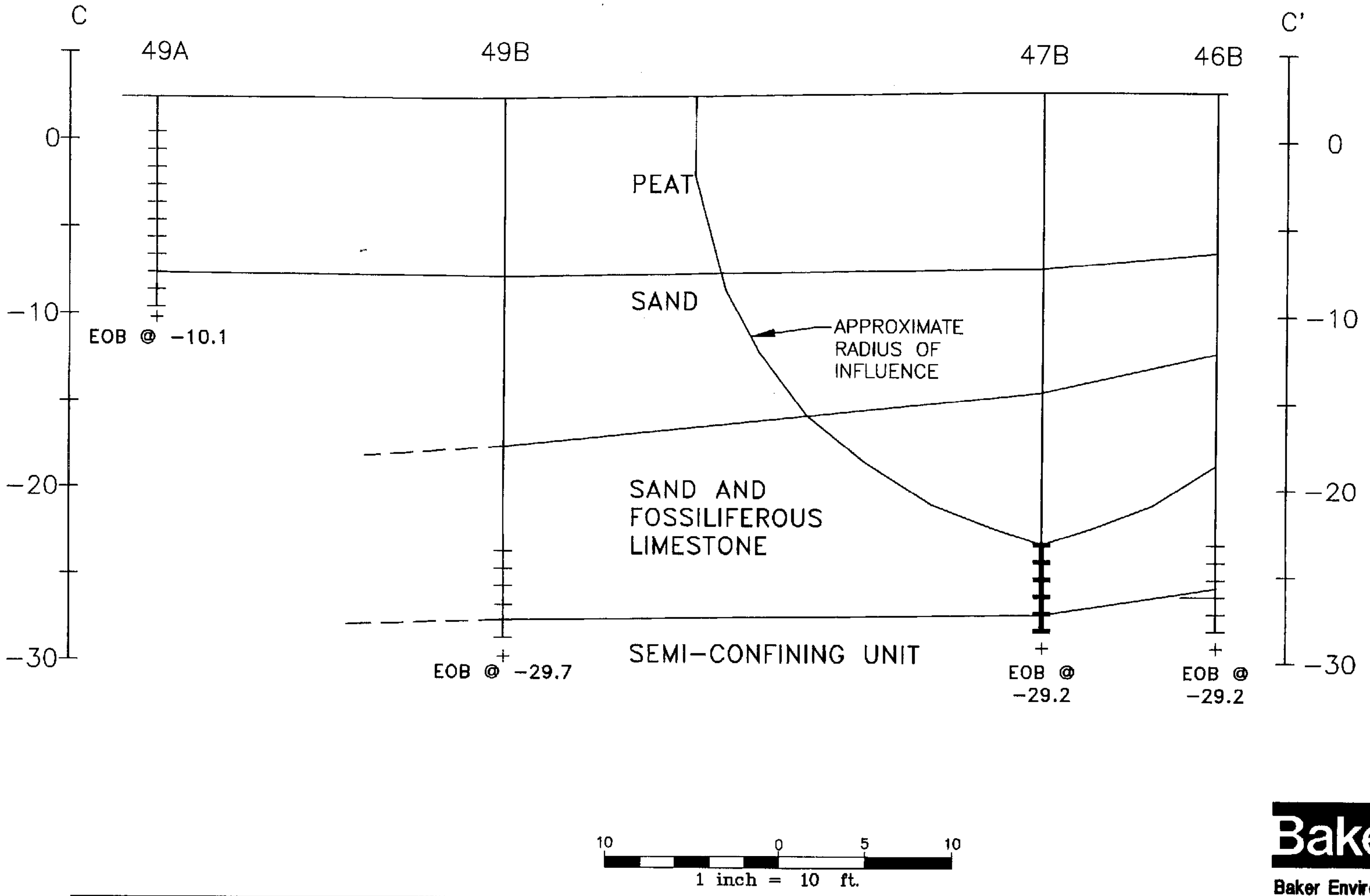
LEGEND

‡	MONITORING WELL SCREENED INTERVAL
EOB	END OF BORING
MSL	MEAN SEA LEVEL
—	GEOLOGIC CONTACT

NOTE: COLORED WELLS INDICATE MONITORING WELLS INFLUENCED DURING PILOT TEST.

FIGURE 6-11
GEOLOGIC CROSS SECTION A-A' - PLUME B
DEEP AIR INJECTION TEST
IAS TREATABILITY STUDY
OPERABLE UNIT NO. 10 (SITE 35)

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



Baker

Baker Environmental, Inc.

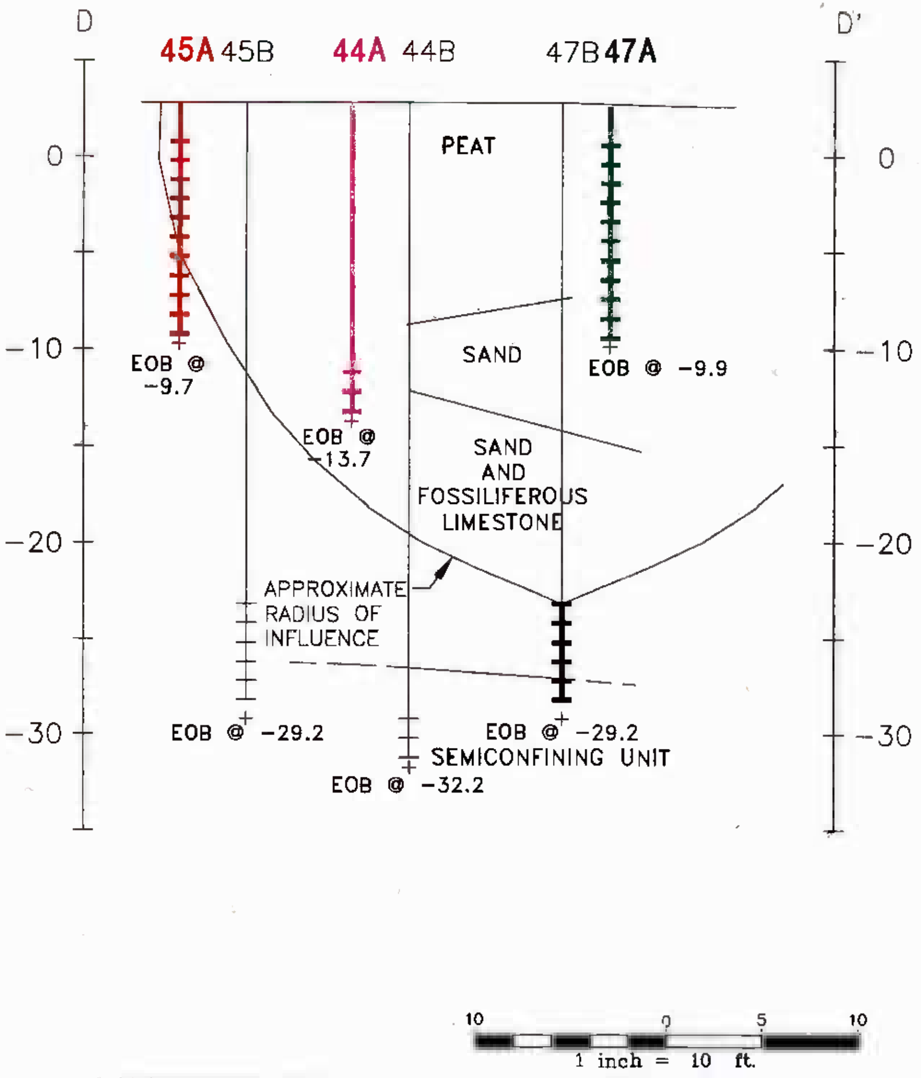
LEGEND

‡	MONITORING WELL SCREENED INTERVAL
EOB	END OF BORING
MSL	MEAN SEA LEVEL
——	GEOLOGIC CONTACT

NOTE: COLORED WELLS INDICATE MONITORING WELLS INFLUENCED DURING PILOT TEST.

FIGURE 6-12
GEOLOGIC CROSS SECTION C-C' - PLUME B
DEEP AIR INJECTION TEST
IAS TREATABILITY STUDY
OPERABLE UNIT NO. 10 (SITE 35)

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



Baker

Baker Environmental, Inc.

LEGEND

‡	MONITORING WELL SCREENED INTERVAL
EOB	END OF BORING
MSL	MEAN SEA LEVEL
—	GEOLOGIC CONTACT

NOTE: COLORED WELLS INDICATE MONITORING WELLS INFLUENCED DURING PILOT TEST.

FIGURE 6-13
GEOLOGIC CROSS SECTION D-D' - PLUME B
DEEP AIR INJECTION TEST
IAS TREATABILITY STUDY
OPERABLE UNIT NO. 10 (SITE 35)

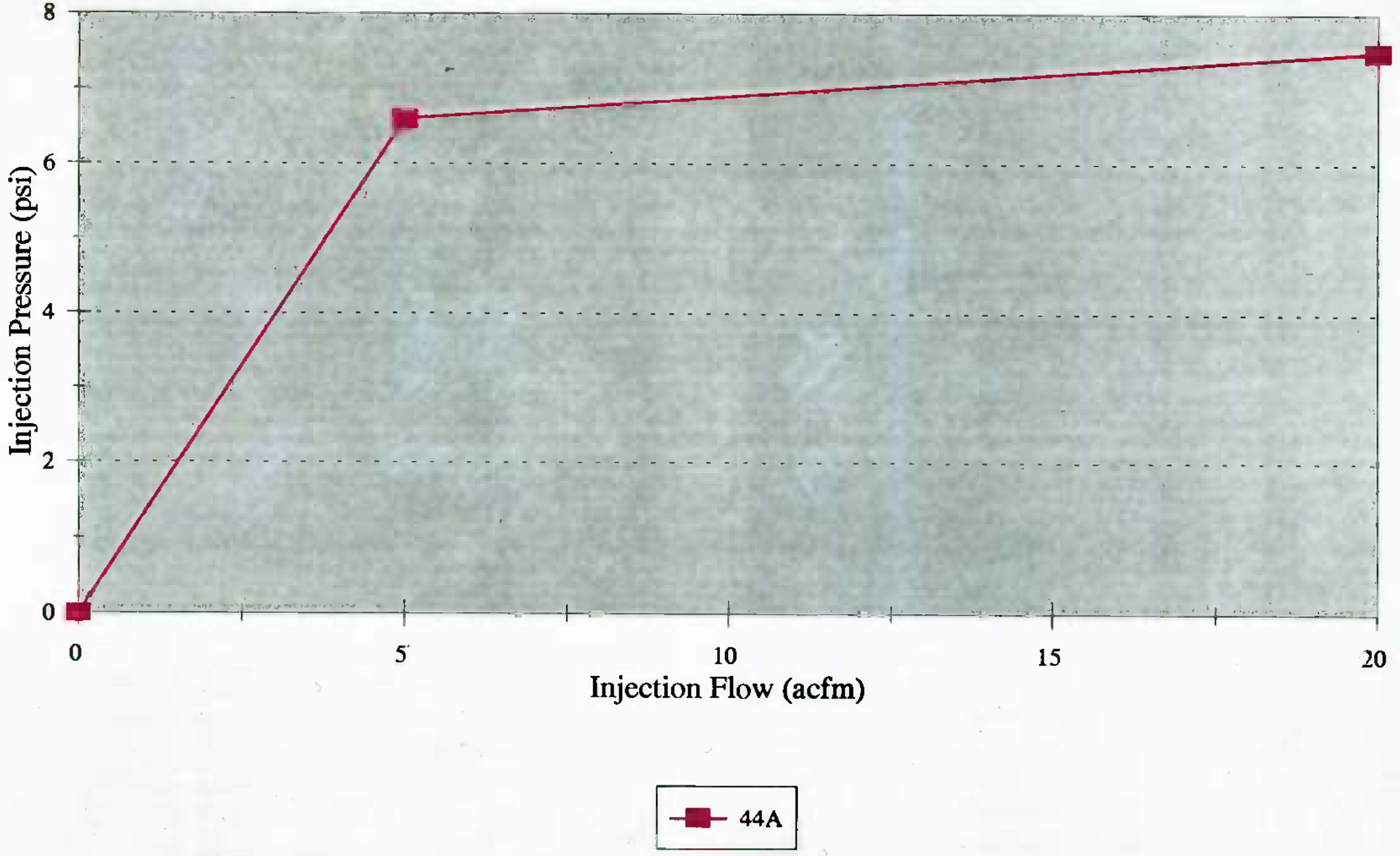
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

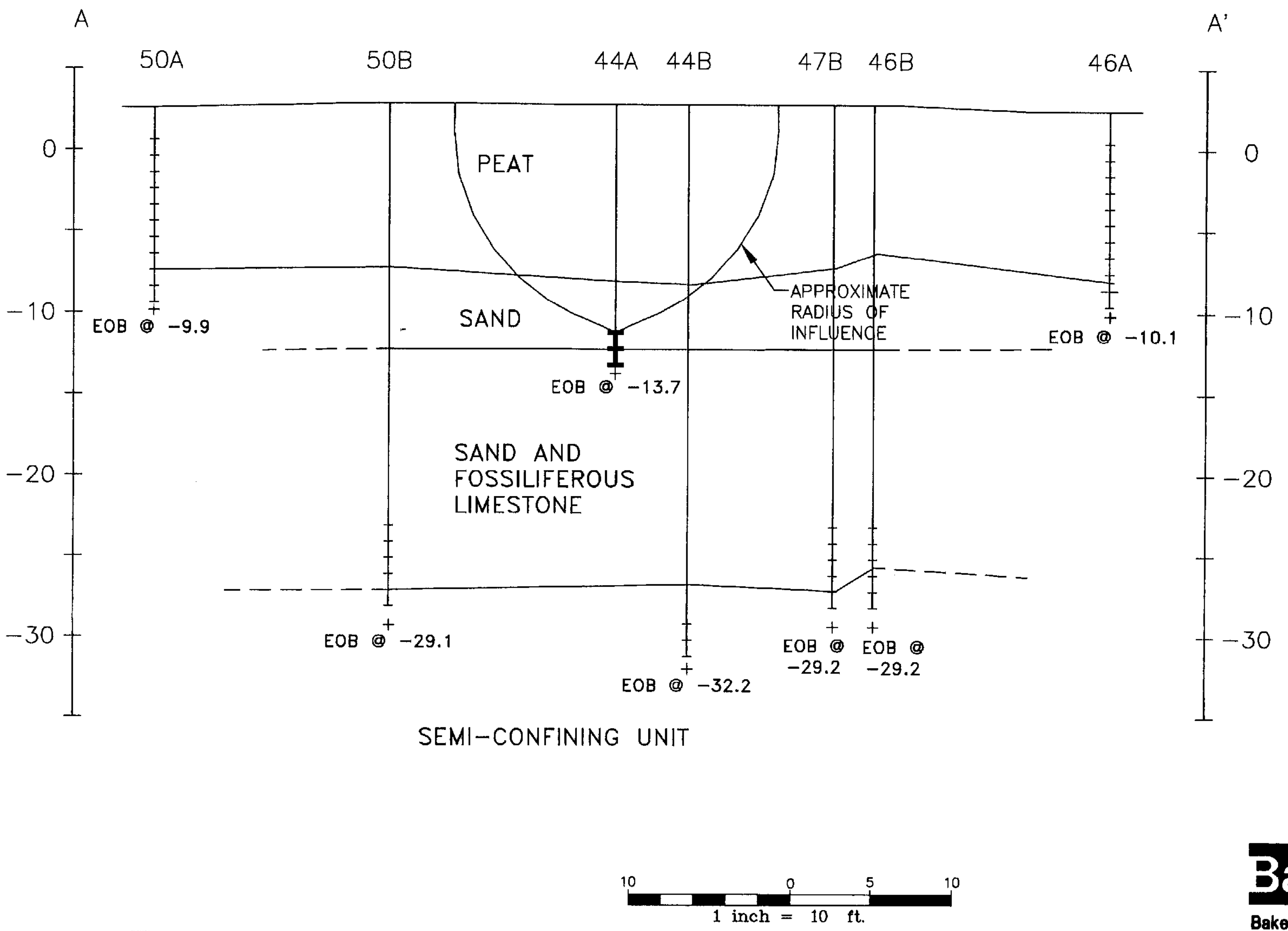
323037WP

00215BBB11Y

Figure 6-14

Shallow Air Injection Well - System Head Curve
IAS Treatabilty Study
Operable Unit No. 10 (Site 35)
MCB Camp Lejeune, North Carolina





Baker

Baker Environmental, Inc.

LEGEND

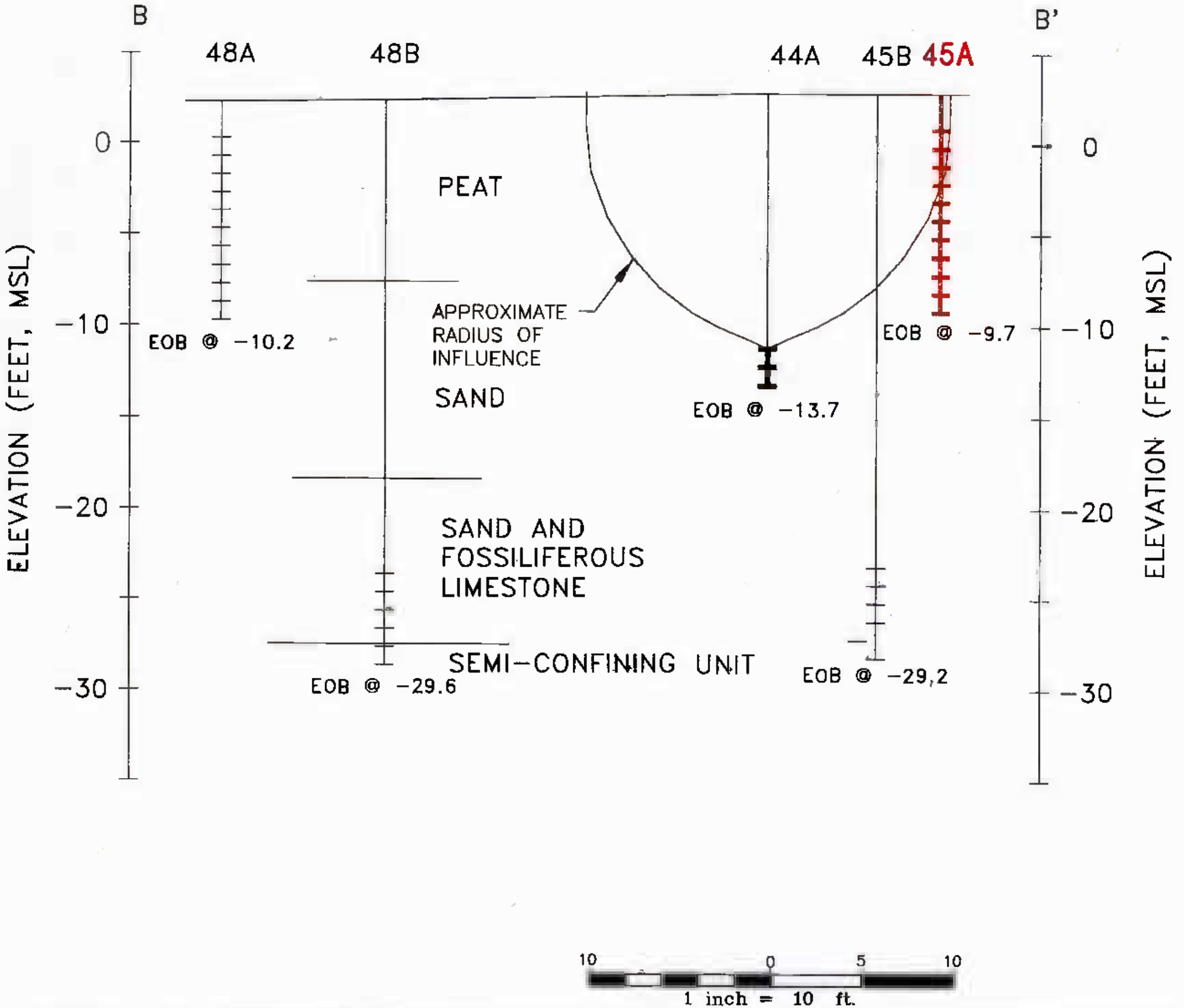
‡	MONITORING WELL SCREENED INTERVAL
EOB	END OF BORING
MSL	MEAN SEA LEVEL
──	GEOLOGIC CONTACT

NOTE: COLORED WELLS INDICATE MONITORING WELLS INFLUENCED DURING PILOT TEST.

FIGURE 6-15
GEOLOGIC CROSS SECTION A-A' - PLUME B
SHALLOW AIR INJECTION TEST
IAS TREATABILITY STUDY
OPERABLE UNIT NO. 10 (SITE 35)

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

323041WP



Baker

Baker Environmental, Inc.

LEGEND

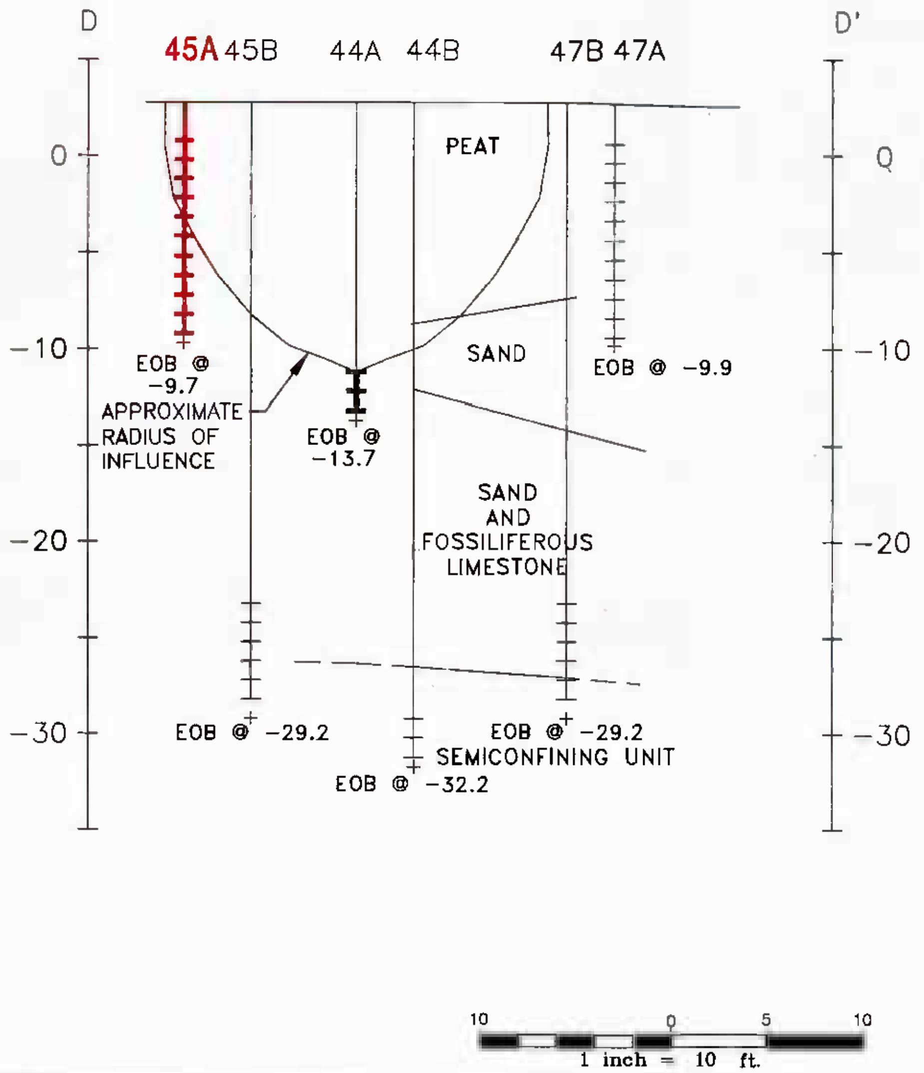
‡	MONITORING WELL SCREENED INTERVAL
EOB	END OF BORING
MSL	MEAN SEA LEVEL
—	GEOLOGIC CONTACT

NOTE: COLORED WELLS INDICATE MONITORING WELLS INFLUENCED DURING PILOT TEST.

FIGURE 6−16
GEOLOGIC CROSS SECTION B−B' − PLUME B
SHALLOW AIR INJECTION TEST
IAS TREATABILITY STUDY
OPERABLE UNIT NO. 10 (SITE 35)
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

323055WP

00715RRB12Y



Baker
Baker Environmental, Inc.

LEGEND

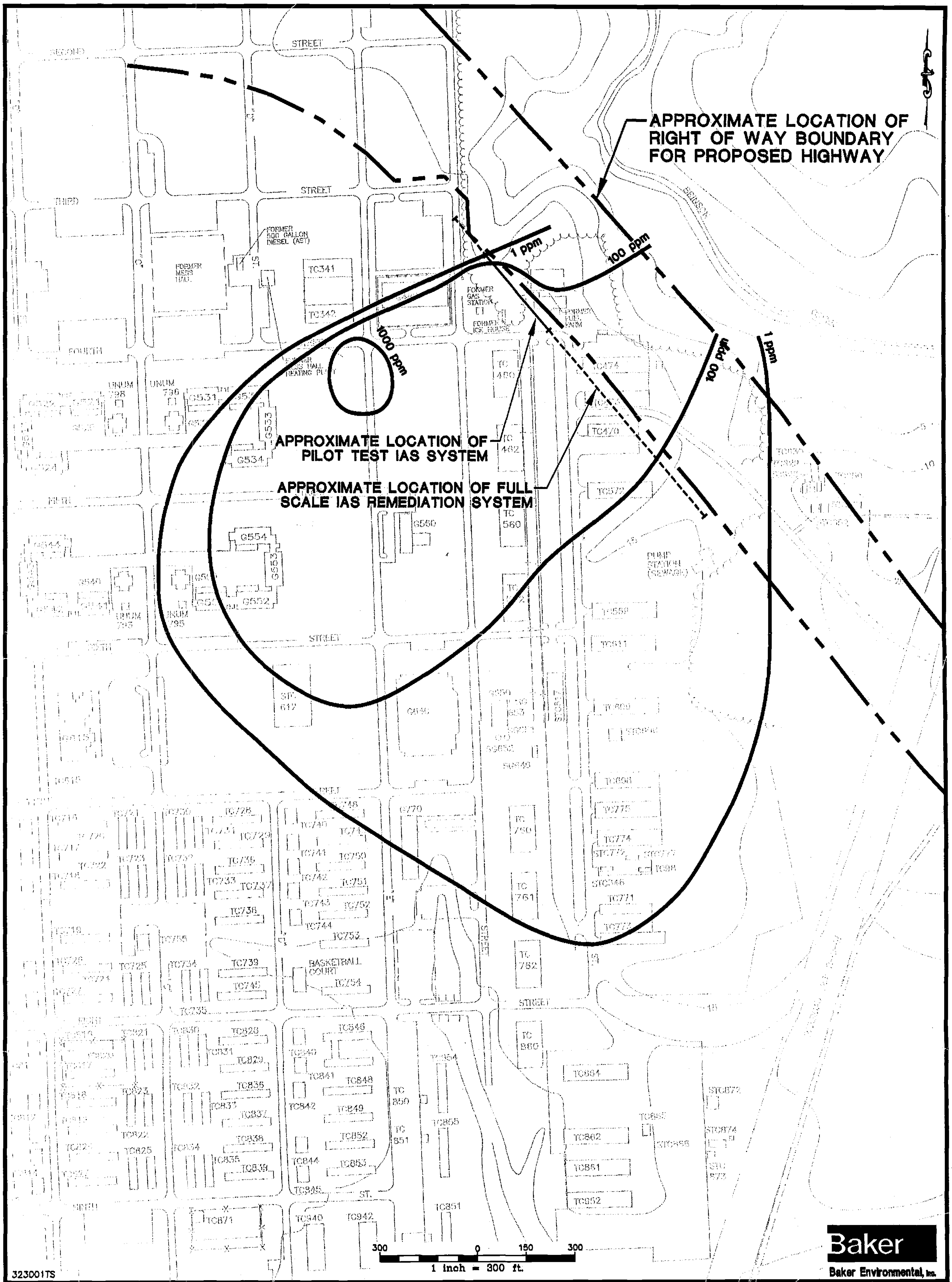
‡	MONITORING WELL SCREENED INTERVAL
EOB	END OF BORING
MSL	MEAN SEA LEVEL
—	GEOLOGIC CONTACT

NOTE: COLORED WELLS INDICATE MONITORING WELLS INFLUENCED DURING PILOT TEST.

FIGURE 6-17
GEOLOGIC CROSS SECTION D-D' – PLUME B
SHALLOW AIR INJECTION TEST
IAS TREATABILITY STUDY
OPERABLE UNIT NO. 10 (SITE 35)

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

323044WP



LEGEND

▬ ▬ ▬ – APPROXIMATE LIMITS OF U.S. HIGHWAY 17 BYPASS

━━━ – LIMITS OF SOLVENT-RELATED IN THE LOWER PORTION OF THE SURFICIAL AQUIFER CONTAMINATION FROM SGI RESULTS

- - - - - - - – APPROX. LOCATION OF FULL SCALE IAS REMEDIATION SYSTEM

——— – APPROX. LOCATION OF PILOT TEST IAS SYSTEM

SOURCE: LANTDIV, OCT. 1991

FIGURE 7-1
LOCATION OF PROPOSED IAS REMEDIATION SYSTEM
IAS TREATABILITY STUDY
OPERABLE UNIT NO. 10 (SITE 35)

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

00215BB022

APPENDIX A
HYDROGEOLOGIC CROSS SECTIONS

CROSS SECTION TW26 - TW27

Drawing No. 1/2

MICHAEL BAKER, JR., INC.

DESIGN PAD

Computed by RPH

Checked by

Date

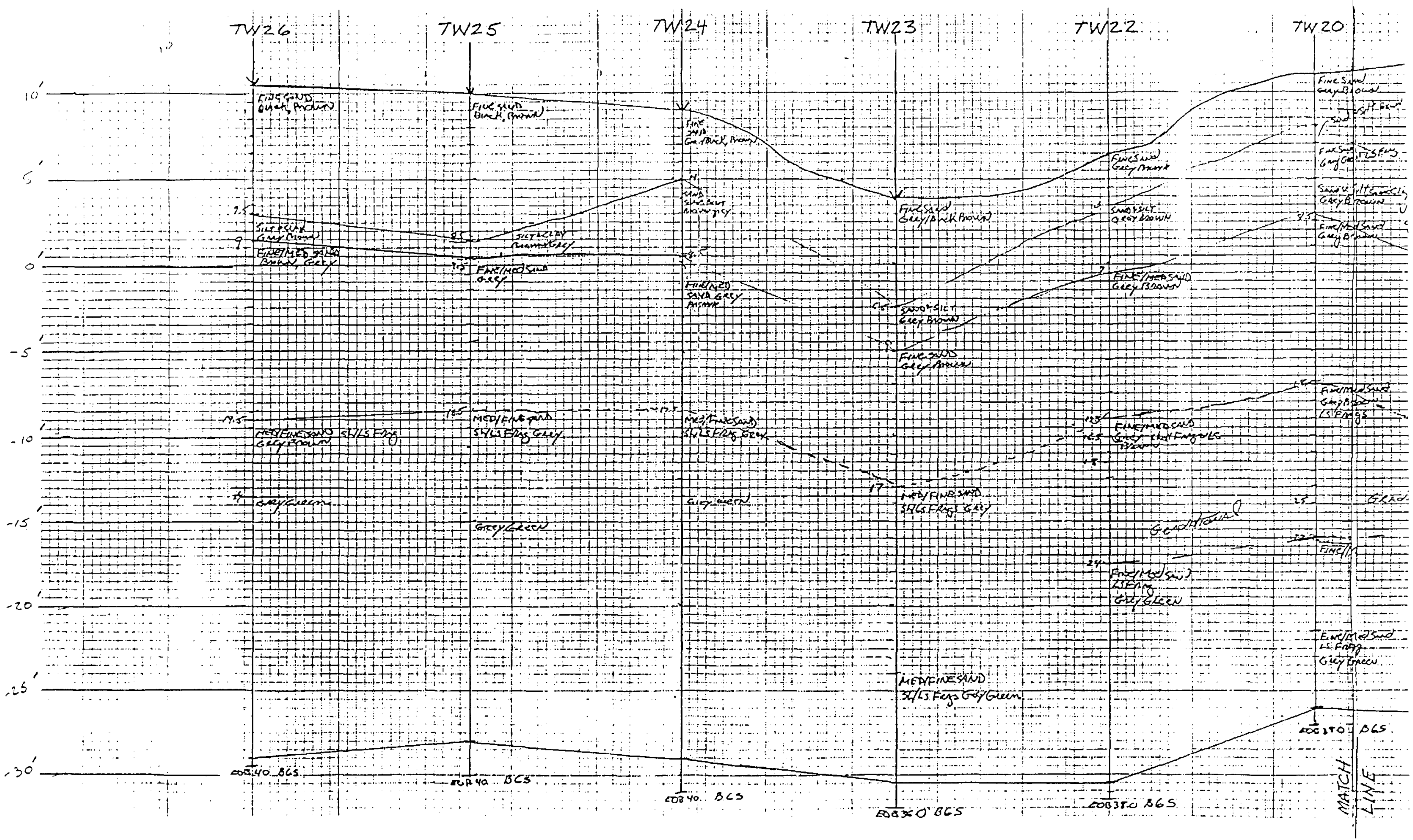
Subject

S.O. No.

Sheet No.

d by

MATCH LINE CROS



MATCH LINE

No CROSS SECTION TW26 - TW27 Drawing No. 2/2

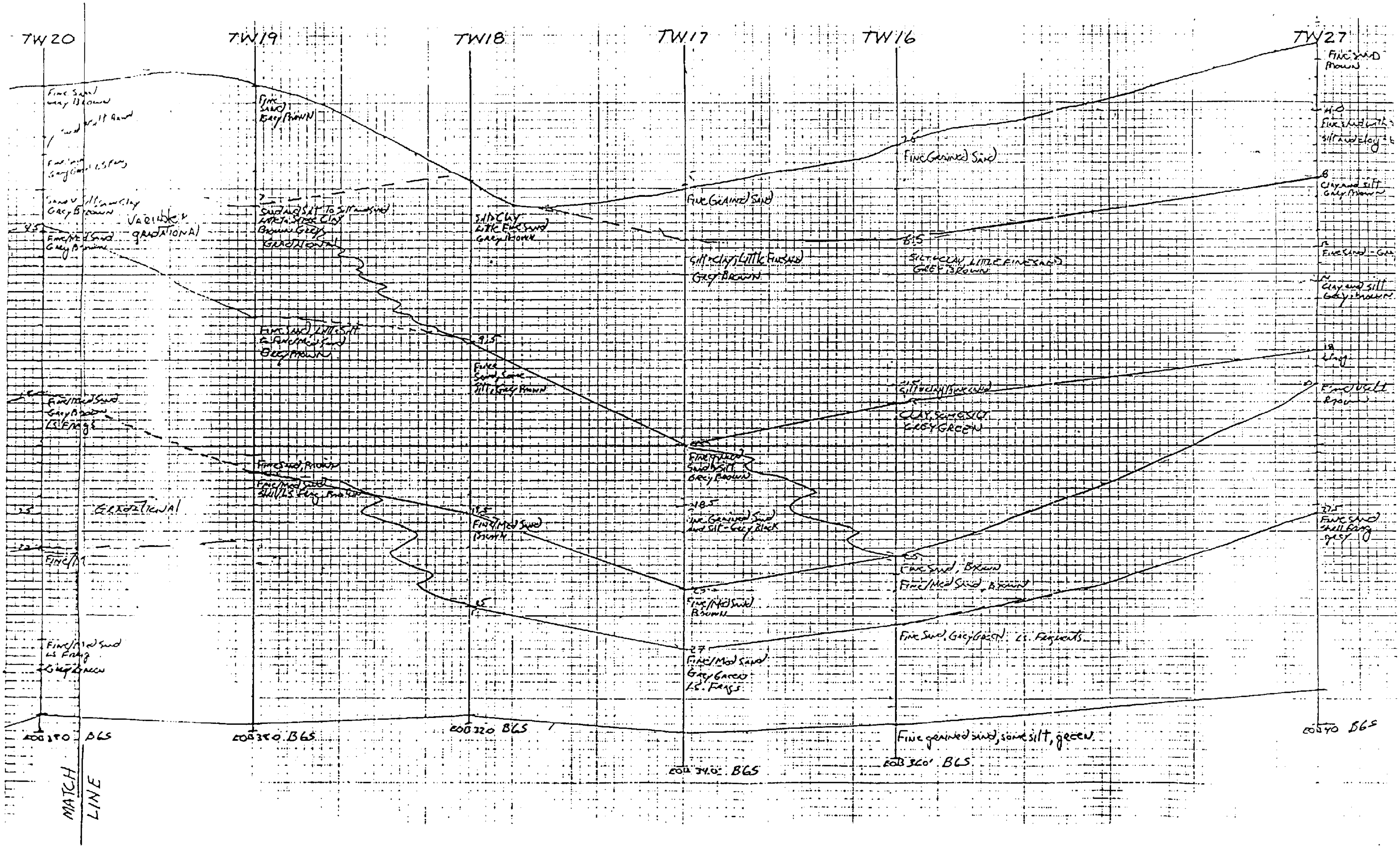
ct No ____ d by RPA Checked by ______ Date ______

MICHAEL BAKER, JR., INC.

DESIGN PAD

Subject ______ S.O. No ______

Sheet No ______ of ______



APPENDIX B
CONTAMINANT CONCENTRATION CALCULATIONS

S.O. No. CTO-0323

Subject: Soil-Vapor Contaminant Concentration Estimates

MCB Camp Lejeune, O.U. No. 10 Sheet No. 1 of 3

Site 35 Drawing No.

Computed by GJR Checked By RPA Date 4-26-96

Vapor Emission and Resulting Soil Contamination - Site 35 IAS Pilot Test

$\text{Emissions}_{Max} = q \times W \times H \times C_{gw}$; Emission in pounds/day

where q = groundwater flow rate (ft/d)

W = width of IAS barrier (ft)

H = depth below water table to injection point (ft)

C_{gw} = dissolved contaminant concentration (lb/ft^3)

Assume: $q = 0.06$ ft/d, based on hydraulic conductivity, K, of 0.001 cm/s and hydraulic gradient, I, of 0.02

$H = 25$ ft

$W = 200$ ft

$C_{gw} = 6.0 \times 10^{-5}$ lb/ft^3 ($\approx$ 1,000 ug/L)

$\text{Emissions}_{max} = (0.06 \text{ ft/d})(200 \text{ ft})(25 \text{ ft})(6.0 \times 10^{-5} \text{ lb/ft}^3)$

$\text{Emissions}_{max} = 0.02$ lb/d of contaminant

$C_{vapor} = \text{Emissions}_{max} / Q_{IAS}$; Vapor emission contaminant concentrati

Assume: 4 IAS wells spaced 50 ft apart with flowrate = 10 ft^3/min each

Total Flow, Q = 4 wells x 10 ft^3/min/well

$Q = 40$ ft^3/min

$C_{vapor} = (0.02 \text{ lb/day}) / [(40 \text{ ft}^3/\text{min})(1440 \text{ min/d})]$

$C_{vapor} = 3.5 \times 10^{-7}$ lb/ft^3 $= 5.6 \times 10^{-3}$ g/m^3, mg/L

S.O. No. CTO-0323

Subject: Soil-Vapor Contaminant Concentration Estimates
MCB Camp Lejeune, O.U. No 10
Site 35

Sheet No. 2 of 3

Drawing No.

Computed by CJR Checked By RPA Date 4-26-96

Vapor Emission and Resulting Soil Contamination - Site 35 IAS Pilot Test

Total soil concentration, $C_{Total} = C_{sorbed} + C_{moisture}\,\theta_m + C_{vapor}\,\theta_v/\rho_s$

where C_{sorbed} = contaminants sorbed directly onto soil (mg/kg)

$C_{moisture}$ = contaminants dissolved in soil moisture (mg/L)

θ_m = soil moisture content (L-H$_2$O/kg-soil)

C_{vapor} = contaminants in soil vapor (mg/L)

θ_v = vapor void fraction

ρ_s = soil bulk density (kg/L)

In Equilibrium: $C_{moisture} \times H = C_{vapor}$

where H = Henry's Law Constant

$C_{moisture} \times K_d = C_{sorbed}$

where K_d = partitioning coefficient (L/kg)

$K_d = K_{oc} \times f_{oc}$, K_{oc} = adsorption coefficient for o.c.

f_{oc} = organic carbon (O.C) content

$\therefore C_{sorbed} = C_{vapor}\,(K_d/H)$

$C_{moisture} = C_{vapor}\,(1/H)$

$$C_{Total} = C_{vapor}\left[K_d/H + \theta_m/H + \theta_v/\rho_s\right]$$

S.O. No. CTO-0323

Subject: Soil-Vapor Contaminant Concentration Estimates

MCB Camp Lejeune, O.U. No 10 Sheet No. 3 of 3

Site 35 Drawing No.

Computed by GJR Checked By RPA Date 4-26-96

<u>Vapor Emission and Resulting Soil Contamination - Site 35 IAS Pilot Test</u>

Assume: $\theta_m \approx 0.1\ L\text{-}H_2O/kg_{soil}$

$\theta_v \approx 0.2\ L\text{-}air/L\text{-}soil$

$\rho_s \approx 1.7\ kg/L$

$f_{oc} \approx 0.01\ g\ o.c./g\text{-}soil$

For Benzene, $H = 0.22$, $K_{oc} = 60\ L/kg$

For TCE, $H = 0.44$, $K_{oc} = 94\ L/kg$

$$C_{Total-Benzene} = C_{vapor}\left[\frac{(60\ L/kg)(0.01)}{0.22} + \frac{0.1\ L/kg}{0.22} + \frac{0.2}{1.7\ kg/L}\right]$$

$$C_{Total-Benzene} = C_{vapor}\left[2.73\ L/kg + 0.45\ L/kg + 0.12\ L/kg\right]$$

$$C_{Total-Benzene} = C_{vapor}\left[3.3\ L/kg\right]$$

$$C_{vapor} = 5.6 \times 10^{-3}\ mg/L$$

$$C_{Total-Benzene} = (5.6 \times 10^{-3}\ mg/L)(3.3\ L/kg)$$

$$C_{Total-Benzene} = 0.018\ mg/kg$$

$$C_{Total-TCE} = C_{vapor}\left[\frac{(94\ L/kg)(.01)}{0.44} + \frac{0.1\ L/kg}{0.44} + \frac{0.2}{1.7\ kg/L}\right]$$

$$C_{Total-TCE} = C_{vapor}\left[2.14\ L/kg + 0.23\ L/kg + 0.12\ L/kg\right]$$

$$C_{Total-TCE} = C_{vapor}\left[2.5\ L/kg\right]$$

$$C_{Total-TCE} = (5.6 \times 10^{-3}\ mg/L)(2.5\ L/kg)$$

$$C_{Total-TCE} = 0.014\ mg/kg$$

APPENDIX C
BORING LOGS

PLUME B

Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-Situ Air Sparging Plume B
CTO NO.: 322
BORING NO.: MW3544A
COORDINATES: EAST: ______ NORTH: ______
ELEVATION: SURFACE: ______ TOP OF PVC CASING: ______

RIG: #82

	SPLIT SPOON	CASING	AUGERS	CORE BARREL	DATE	PROGRESS (FT.)	WEATHER	WATER DEPTH (FT.)	TIME
SIZE (DIAM.)	1-3/8"		6 1/4"		7-11-96	0-16.5	cloudy, 80's	.5	
LENGTH	2.0		5'						
TYPE	Std.		HSA						
HAMMER WT.	140 lbs.								
FALL	30"								
STICK UP									

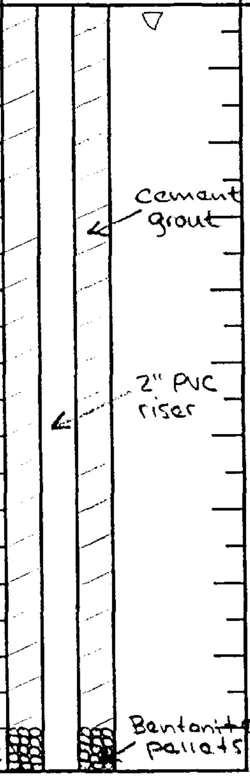
REMARKS: Augered to 16.5' (bgs) depth. HNu background is .4 ppm
no split spoon samples were collected

SAMPLE TYPE

S = Split Spoon
T = Shelby Tube
R = Air Rotary
D = Denison
A = Auger
W = Wash
C = Core
P = Piston
N = No Sample

Well Information	Diam.	Type	Top Depth (ft.)	Bottom Depth (ft.)
Riser	2.0"	Schedule 40 PVC	+3.0'	-14.0
Screen	2.0"	Schedule 40 0.01 Slot	-14.0	-16.0

Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
1								
2								
3					.4			
4					/.4			
5	A-N	—	—			Auger to depth		
6								
7								
8								
9								
10								



Match to Sheet 2

DRILLING CO.: Parratt-Wolff
DRILLER: G. Lansing
BAKER REP.: J.E. Zimmerman
BORING NO.: MW3544A
SHEET 1 OF 2

Baker
Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

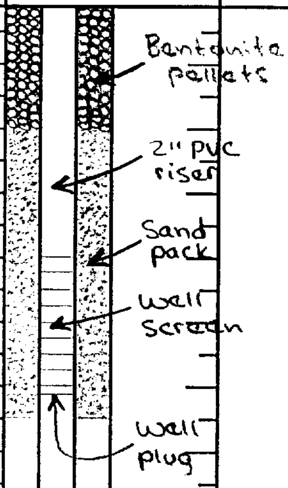
PROJECT: Treatability Study In-Situ Air Sparging Plume B
CTO NO.: 323 BORING NO.: MW3544A

SAMPLE TYPE

S = Split Spoon
T = Shelby Tube
R = Air Rotary
D = Denison
A = Auger
W = Wash
C = Core
P = Piston
N = No Sample

DEFINITIONS

SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5')
RQD = Rock Quality Designation (%)
PID = Photoionization Detector
ppm = parts per million

Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
						Continued from Sheet 1		
11								
12								
13	A N	–	–		.4/.4	Auger to depth		
14								
15								
16								
16.5								
17						End of Boring		
18						TD: 16.5' (bgs)		
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								
30								

DRILLING CO.: Parratt-Wolff BAKER REP.: J.E. Zimmerman
DRILLER: G. Lansing BORING NO.: MW3544A SHEET 2 OF

Baker

Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-Situ Air Sparging Plume 8
CTO NO.: 323
BORING NO.: MW35448
COORDINATES: EAST: NORTH:
ELEVATION: SURFACE: TOP OF PVC CASING:

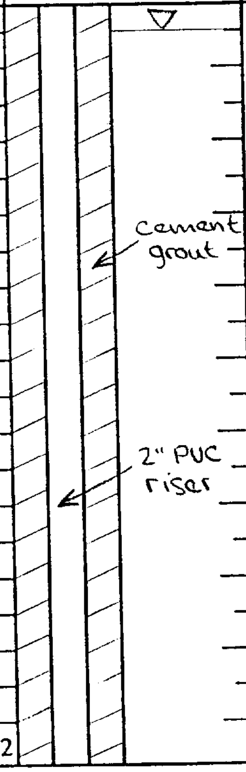
RIG: #82	SPLIT SPOON	CASING	AUGERS	CORE BARREL	DATE	PROGRESS (FT.)	WEATHER	WATER DEPTH (FT.)	TIME
SIZE (DIAM.)	1-3/8"		6 1/4		7-14-96	0 - 35.0	overcast, rain (80's)	.5	
LENGTH	2.0		5'						
TYPE	Std.		HSA						
HAMMER WT.	140 lbs.								
FALL	30"								
STICK UP									

REMARKS: Borehole continuously sampled to a 35.0' (bgs) depth. HNu background range is .4 to .5 ppm.

SAMPLE TYPE

S = Split Spoon
T = Shelby Tube
R = Air Rotary
D = Denison
A = Auger
W = Wash
C = Core
P = Piston
N = No Sample

Well Information	Diam.	Type	Top Depth (ft.)	Bottom Depth (ft.)
Riser	2.0"	Schedule 40 PVC	+3.0	-32.0
Screen	2.0"	Schedule 40 0.01 Slot	-32.0	-34.0

Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
1 (1.0)	M-N	–	–		.4/.4			
2, 3 (3.0)	S-1	.3/2.0 15%	WOH/24"		.4/.4			
4, 5 (5.0)	S-2	.4/2.0 20%	WOH/24"		.4/.4	PEAT MATERIAL w/ decomposed WOOD and ROOTED MATERIAL Dark brown, very loose, wet		
6, 7 (7.0)	S-3	.8/2.0 40%	WOH/24"		.4/.4			
8, 9 (9.0)	S-4	1.0/2.0 50%	WOH/24"		.4/.4			
10	S-5	1.0/2.0 50%	WOH/24"		.4/.4	Match to Sheet 2		

DRILLING CO.: Parratt-Wolff
DRILLER: G. Lansing
BAKER REP.: J.E. Zimmerman
BORING NO.: MW35448
SHEET 1 OF 3

Baker
Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

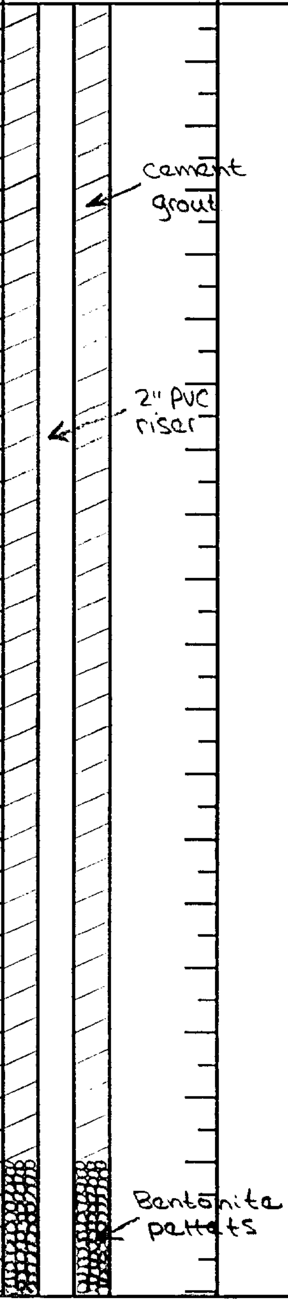
PROJECT: Treatability Study In-Situ Air Sparging Plume B
CTO NO.: 323 BORING NO.: MW3544B

SAMPLE TYPE

S = Split Spoon A = Auger
T = Shelby Tube W = Wash
R = Air Rotary C = Core
D = Denison P = Piston
N = No Sample

DEFINITIONS

SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5')
RQD = Rock Quality Designation (%)
PID = Photoionization Detector
ppm = parts per million

Depth (ft.)		Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
11	11.0	S-5	50%	WOH/24		.4/.4	Continued from Sheet 1		
12 13	13.0	S-6	1.3/2.0 65%	WOH/12' 1 1		.4/.4	SAND, fine grained w/ trace silt, little decomposed wood splinters. Brown, very loose, wet.		
14 15	15.0	S-7	1.6/2.0 80%	1 1 1 5		.4/.4			
16 17	17.0	S-8	1.6/2.0 80%	2 5 11 21		.4/.4	SAND, fine to medium grained, trace silt, cemented shell material, trace shell fragments. Orange/brownish staining. Brown/yellowish brown and white, medium dense, wet.		
18 19	19.0	S-9	1.8/2.0 90%	29 20 19 28		.4/.4			
20 21	21.0	S-10	1.0/2.0 50%	14 15 16 15		.4/.4	SAND, fine grained, trace silt, little cemented sandstone nodules, trace shell material/shell fragments. Brown/yellowish brown/light greenish gray to light gray and white, dense/medium dense, wet		
22 23	23.0	S-11	1.2/2.0 60%	11 15 21 21		.4/.4			
24 25	25.0	S-12	1.0/2.0 50%	8 10 13 16		.4/.4			
26 27	27.0	S-13	1.4/2.0 70%	11 16 18 23		.4/.4	FOSSILIFEROUS LIMESTONE w/SAND, fine grained, trace silt, little shell material/shell fragments, micrite (matrix). Light gray and white dense to medium dense, wet		
28 29	29.0	S-14	1.6/2.0 80%	8 19 13 13		.5/.5			
30		S-15	1.8/2.0	13 10		.5/.5			

DRILLING CO.: Parratt-Wolff BAKER REP.: J.E. Zimmerman

DRILLER: G. Lansing BORING NO.: MW3544B SHEET 2 O

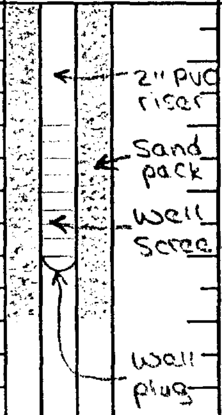
Baker
Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-situ Air Sparging Plume B
CTO NO.: 323 BORING NO.: MW3544B

SAMPLE TYPE		DEFINITIONS
S = Split Spoon	A = Auger	SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5')
T = Shelby Tube	W = Wash	RQD = Rock Quality Designation (%)
R = Air Rotary	C = Core	PID = Photoionization Detector
D = Denison	P = Piston	ppm = parts per million
N = No Sample		

Depth (ft.)		Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
		S-15	90%	10 8		.5/.5	Continued from Sheet 2		
31	31.0								
32		S-16	2.0/2.0 100%	5 6 5 9		.5/.5	SAND, fine grained, trace silt, trace clay, trace shell material, trace fossiliferous limestone, micrite (matrix). Greenish gray to white, medium dense, wet		
33	33.0								
34		S-17	2.0/2.0 100%	5 5 6 5		.5/.5			
35	35.0								
6							End of Boring		
7							TD: 35.0' (bgs)		
8									
9									
0									
1									
2									
3									
4									
5									
6									
7									
8									
9									
0									



DRILLING CO.: Parratt-Wolff BAKER REP.: J.E. Zimmerman

DRILLER: G. Lansing BORING NO.: MW3544B SHEET 3 OF 3

Baker
Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-situ Air Sparging Plume E
CTO NO.: 323
BORING NO.: MW354SA
COORDINATES: EAST:
NORTH:
ELEVATION: SURFACE:
TOP OF PVC CASING:

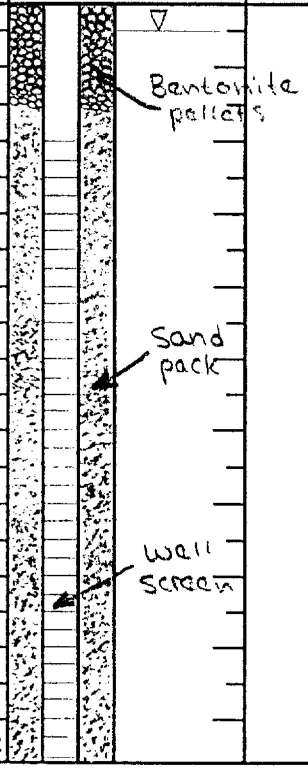
RIG: # 82					DATE	PROGRESS (FT.)	WEATHER	WATER DEPTH (FT.)	TIME
	SPLIT SPOON	CASING	AUGERS	CORE BARREL					
SIZE (DIAM.)	1-3/8"		6 1/4"		7-11-96	0-12.5	cloudy, 80's	.5	
LENGTH	2.0		5						
TYPE	Std.		HSA						
HAMMER WT.	140 lbs.								
FALL	30"								
STICK UP									

REMARKS: Augered to 12.5' (bgs) depth. HNu background is .4ppm No split spoon samples were collected

SAMPLE TYPE

S = Split Spoon
T = Shelby Tube
R = Air Rotary
D = Denison
A = Auger
W = Wash
C = Core
P = Piston
N = No Sample

Well Information	Diam.	Type	Top Depth (ft.)	Bottom Depth (ft.)
Riser	2.0"	Schedule 40 PVC	+2.0	-2.0
Screen	2.0"	Schedule 40 0.01 Slot	-2.0	-12.0

Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
1								
2								
3								
4	A N	–	–		.4/.4			
5						Auger to depth		
6								
7								
8								
9								
10								

Match to Sheet 2

DRILLING CO.: Parratt-Wolff
BAKER REP.: J. E. Zimmerman
DRILLER: G. Lansing
BORING NO.: MW354SA
SHEET 1 OF

Baker
Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-situ Air Sparging Plume B
CTO NO.: 323 BORING NO.: MW3545A

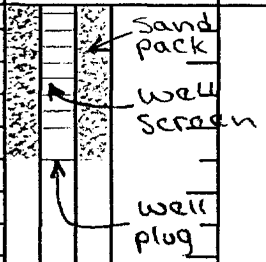
SAMPLE TYPE

S = Split Spoon	A = Auger
T = Shelby Tube	W = Wash
R = Air Rotary	C = Core
D = Denison	P = Piston

N = No Sample

DEFINITIONS

SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5')
RQD = Rock Quality Designation (%)
PID = Photoionization Detector
ppm = parts per million

Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
						Continued from Sheet 1	 	
11	A-N	—	—	.4/.4		Auger to depth		
12						↓		
12.5								
13						End of Boring		
14						TD: 12.5' (bgs)		
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								
30								

DRILLING CO.: Parratt-Wolff BAKER REP.: J. E. Zimmerman
DRILLER: G. Lansing BORING NO.: MW3545A SHEET 2 OF 2

Baker

Baker Environmental, Inc

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-situ Air Sparging Plume B
CTO NO.: 323
BORING NO.: MW354SB
COORDINATES: EAST:
NORTH:
ELEVATION: SURFACE:
TOP OF PVC CASING:

RIG: #82

	SPLIT SPOON	CASING	AUGERS	CORE BARREL	DATE	PROGRESS (FT.)	WEATHER	WATER DEPTH (FT.)	TIME
SIZE (DIAM.)	1-3/8"		6 1/4"		7-14-96	0-32.0	overcast, hazy (70's)	.5	
LENGTH	2.0		5						
TYPE	Std.		HSA						
HAMMER WT.	140 lbs.								
FALL	30"								
STICK UP									

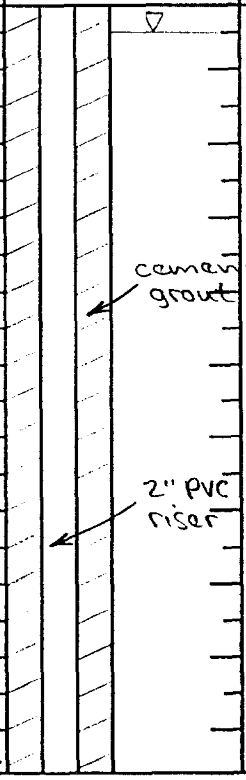
REMARKS: Augered to 32.0' (bgs) depth. HNu background is .6 ppm
No split spoon samples were collected

SAMPLE TYPE

S = Split Spoon
T = Shelby Tube
R = Air Rotary
D = Denison
A = Auger
W = Wash
C = Core
P = Piston
N = No Sample

Well Information	Diam.	Type	Top Depth (ft.)	Botto Depth (ft.)
Riser	2.0"	Schedule 40 PVC	+3.0	-26.
Screen	2.0"	Schedule 40 0.01 Slot	-26.0	-31.

Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MS
1								
2								
3								
4					.6/.6			
5	A-N	—	—			Auger to 13.0' (bgs)		
6								
7								
8								
9								
10								



Match to Sheet 2

DRILLING CO.: Parratt-Wolff
BAKER REP.: J.E. Zimmerman
DRILLER: G. Lansing
BORING NO.: MW354SB
SHEET 1 O

Baker
Baker Environmental, Inc

TEST BORING AND WELL CONSTRUCTION RECORD

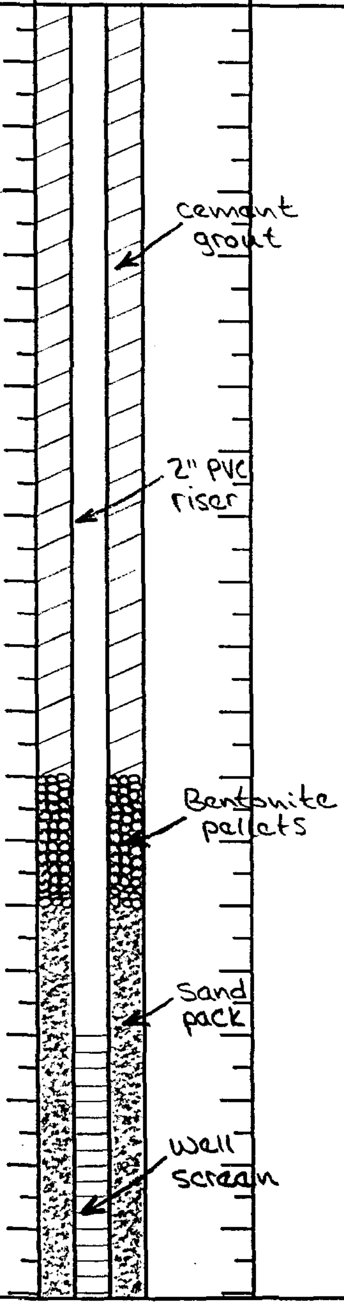
PROJECT: Treatability Study In-situ Air Sparging Plume B
CTO NO.: 323
BORING NO.: MW354SB

SAMPLE TYPE

S = Split Spoon
T = Shelby Tube
R = Air Rotary
D = Denison
A = Auger
W = Wash
C = Core
P = Piston
N = No Sample

DEFINITIONS

SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5')
RQD = Rock Quality Designation (%)
PID = Photoionization Detector
ppm = parts per million

Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
						Continued from Sheet 1		
11								
12	A-N	–	–			Auger to 13.0' (bgs)		
13								
14								
15								
16								
17								
18								
19	N	–	–		.6/.6	Drill to depth		
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								
30								

DRILLING CO.: Parratt-Wolff
BAKER REP.: J.E. Zimmerman
DRILLER: G. Lansing
BORING NO.: MW354SB
SHEET 2 OF

Baker
Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

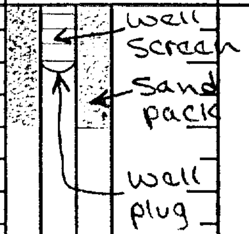
PROJECT: Treatability Study In-situ Air Sparging Plume B
CTO NO.: 323
BORING NO.: MW3545B

SAMPLE TYPE

S = Split Spoon
T = Shelby Tube
R = Air Rotary
D = Denison
A = Auger
W = Wash
C = Core
P = Piston
N = No Sample

DEFINITIONS

SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5')
RQD = Rock Quality Designation (%)
PID = Photoionization Detector
ppm = parts per million

Depth (ft.)		Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
							Continued from Sheet 2		
31		N	–	–		.6/.6	Drill to depth		
32	32.0						End of Boring		
33							TD: 32.0' (bgs)		
34									
35									
6									
7									
8									
9									
0									
1									
2									
3									
4									
5									
6									
7									
8									
9									
0									

DRILLING CO.: Parratt-Wolff
BAKER REP.: J.E. Zimmerman
DRILLER: G. Lansing
BORING NO.: MW3545B
SHEET 3 OF

Baker
Baker Environmental, Inc

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-situ Air Sparging Plume B
CTO NO.: 323 BORING NO.: MW3546A
COORDINATES: EAST: ______ NORTH: ______
ELEVATION: SURFACE: ______ TOP OF PVC CASING: ______

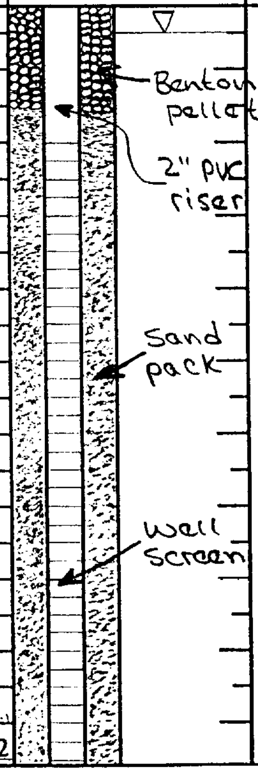
RIG: #82	SPLIT SPOON	CASING	AUGERS	CORE BARREL	DATE	PROGRESS (FT.)	WEATHER	WATER DEPTH (FT.)	TIME
SIZE (DIAM.)	1-3/8"		6 1/4'		7-9-96	0-12.5	Partly Cloudy, humid (70's)	.5	
LENGTH	2.0		5'						
TYPE	Std.		HSA						
HAMMER WT.	140 lbs.								
FALL	30"								
STICK UP									

REMARKS: Augered to 8.0' (bgs). Sampled from 8.0 to 12.0' (bgs). Hnu background is .4 ppm.

SAMPLE TYPE

S = Split Spoon
T = Shelby Tube
R = Air Rotary
D = Denison
A = Auger
W = Wash
C = Core
P = Piston
N = No Sample

Well Information	Diam.	Type	Top Depth (ft.)	Bottom Depth (ft.)
Riser	2.0"	Schedule 40 PVC	+3.0'	-2.0'
Screen	2.0"	Schedule 40 0.01 Slot	-2.0'	-12.0'

Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
1 2 3 4 5 6 7 8 8.0	A-N	–	–		.4/.4	Auger to 8.0' (bgs)		
9 10 10.0	S-1	.8/2.0 40%	Woll/24"		.4/.4	PEAT MATERIAL w/ decomposed WOOD and ROOTED MATERIAL Dk. brown, very loose, wet.		
	A-N	–	–		.4/.4	Match to Sheet 2		

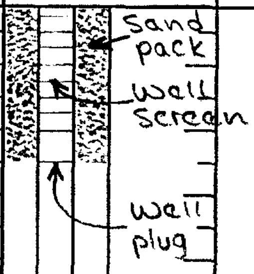
DRILLING CO.: Parratt-Wolff BAKER REP.: J. E. Zimmerman
DRILLER: G. Lansing BORING NO.: MW3546A SHEET 1 OF

Baker
Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-situ Air Sparging Plume B
CTO NO.: 323 BORING NO.: MW3546A

SAMPLE TYPE		DEFINITIONS
S = Split Spoon	A = Auger	SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5')
T = Shelby Tube	W = Wash	RQD = Rock Quality Designation (%)
R = Air Rotary	C = Core	PID = Photoionization Detector
D = Denison	P = Piston	ppm = parts per million
N = No Sample		

Depth (ft.)		Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL
11		S-2	.7/2.0	WOH/24"		.4/.4	Continued from Sheet 1 SAND, fine grained w/ trace silt. DK. brown to brown, very loose, wet.		
12	12.0		35%						
	12.5	A-N	-	-		.4/.4			
13							End of Boring		
14							TD: 12.5' (bgs)		
15									
16									
17									
18									
19									
20									
21									
22									
23									
24									
25									
26									
27									
28									
29									
30									

DRILLING CO.: Parratt-Wolff BAKER REP.: J.E. Zimmerman
DRILLER: G. Lansing BORING NO.: MW3546A SHEET 2 OF

Baker
Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-situ Air Sparging Plume B
CTO NO.: 323
BORING NO.: MW35S46B
COORDINATES: EAST:
NORTH:
ELEVATION: SURFACE:
TOP OF PVC CASING:

RIG:	SPLIT SPOON	CASING	AUGERS	CORE BARREL	DATE	PROGRESS (FT.)	WEATHER	WATER DEPTH (FT.)	TIME
SIZE (DIAM.)	1-3/8"		6¼"		7-9-96	0-32.0	partly cloudy humid (90's)	.5	
LENGTH	2.0		5'						
TYPE	Std.		HSA						
HAMMER WT.	140 lbs.								
FALL	30"								
STICK UP									

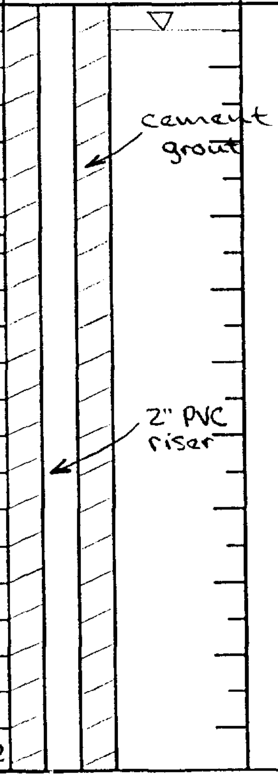
REMARKS: Borehole continuously sampled to a 31.0' (bgs) depth. HNu background is .5ppm

SAMPLE TYPE

S = Split Spoon
T = Shelby Tube
R = Air Rotary
D = Denison
A = Auger
W = Wash
C = Core
P = Piston
N = No Sample

Well Information	Diam.	Type	Top Depth (ft.)	Bottom Depth (ft.)
Riser	2.0"	Schedule 40 PVC	+3.0	-26.0
Screen	2.0"	Schedule 40 0.01 Slot	-26.0	-31.0

Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
1 1.0	A-N	–	–		.5/.5			
2 3 3.0	S-1	.4/2.0 20%	WoH/24"		.5/.5	PEAT MATERIAL w/ decomposed WOOD and ROOTED MATERIAL Dark brown, very loose, wet		
4 5 5.0	S-2	.5/2.0 25%	WoH/24"		.5/.5			
6 7 7.0	S-3	.5/2.0 25%	WoH/24"		.5/.5			
8 9 9.0	S-4	.3/2.0 15%	WoH/24"		.5/.5			
10	S-5	.6/2.0 30%	WoH/24"		.5/.5	Match to Sheet 2		



DRILLING CO.: Parratt-Wolff
BAKER REP.: J. E. Zimmerman
DRILLER: G. Lansing
BORING NO.: MW35S46B
SHEET 1 OF 3

Baker
Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

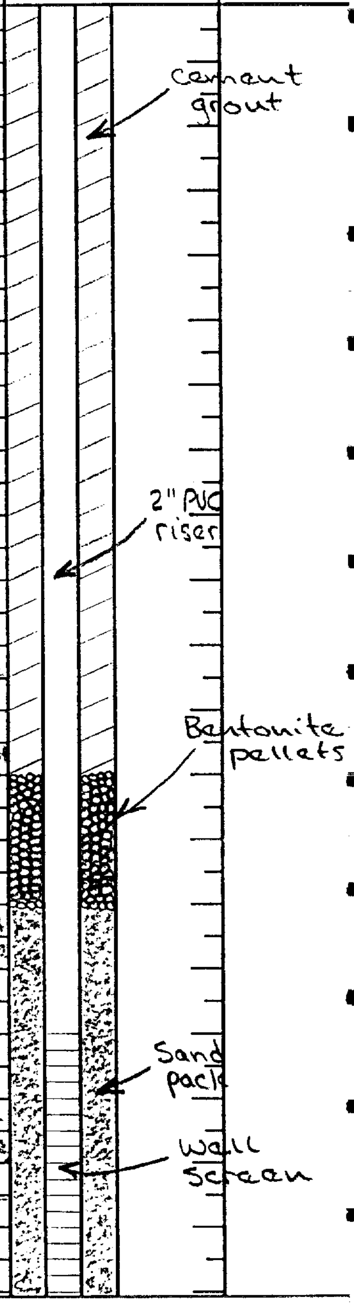
PROJECT: Treatability Study In-situ Air Sparging Plume B
CTO NO.: 323
BORING NO.: MW3546B

SAMPLE TYPE	
S = Split Spoon	A = Auger
T = Shelby Tube	W = Wash
R = Air Rotary	C = Core
D = Denison	P = Piston
N = No Sample	

DEFINITIONS

SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5')
RQD = Rock Quality Designation (%)
PID = Photoionization Detector
ppm = parts per million

Depth (ft.)		Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
11	11.0	S-5	30%	WOH/24"		.5/.5	Continued from Sheet 1 SAND, fine grained w/trace silt, little wood splinters Dark brown to brown, very loose, wet.		
12 13	13.0	S-6	.4/2.0 20%	WOH/24"		.5/.5			
14 15	15.0	S-7	.6/2.0 30%	WOH/6"		.5/.5	SAND, fine grained w/trace silt. Brown to gray, very loose, wet.		
16 17	17.0	S-8	.9/2.0 45%	1 3 11 18		.5/.5	SAND, fine to medium grained, trace silt, cemented shell material, trace shell fragments. Brown/yellowish brown/gray/white, medium dense, wet.		
18 19	19.0	S-9	1.4/2.0 70%	17 9 19 21		.5/.5	FOSSILIFEROUS LIMESTONE trace/little SAND, fine grained, trace silt, little shell material, micrite (matrix) Gray/light gray/white, wet		
20 21	21.0	S-10	1.8/2.0 90%	15 15 15 21		.5/.5	SAND, fine to medium grained w/trace silt trace shell material. Light greenish gray/white dense, wet		
22 23	23.0	S-11	1.0/2.0 50%	20 27 22 19		.5/.5	SAND, fine grained w/ trace silt, little cemented sandstone nodules, trace shell fragments. Light greenish gray/white, wet		
24 25	25.0	S-12	2.0/2.0 100%	17 17 16 18		.5/.5	SAND, fine grained w/ trace silt, trace shell material. Light greenish gray/light gray, med. dense		
26 27	27.0	S-13	2.0/2.0 100%	14 16 16 17		.5/.5	FOSSILIFEROUS LIMESTONE W/SAND, fine grained trace silt, little shell material, cemented shell fragments. Light gray and white, dense wet.		
28 29	29.0	S-14	1.8/2.0 90%	25 17 18 12		.5/.5			
30		S-15	2.0/2.0	7 6		.5/.5	SAND, fine grained w/trace silt, trace clay, trace shell		



DRILLING CO.: Parratt-Wolff
BAKER REP.: J.E. Zimmerman
DRILLER: G. Lansing
BORING NO.: MW3546B
SHEET 2 OF

Baker
Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-situ Air Sparging Plume B
CTO NO.: 323
BORING NO.: MW35468
COORDINATES: EAST:
NORTH:
ELEVATION: SURFACE:
TOP OF PVC CASING:

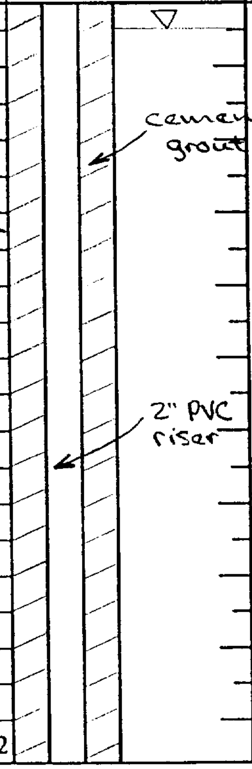
RIG:	SPLIT SPOON	CASING	AUGERS	CORE BARREL	DATE	PROGRESS (FT.)	WEATHER	WATER DEPTH (FT.)	TIME
SIZE (DIAM.)	1-3/8"		6 1/4"		7-9-96	0 - 32.0	partly cloudy humid, (90's)	.5	
LENGTH	2.0		5'						
TYPE	Std.		HSA						
HAMMER WT.	140 lbs.								
FALL	30"								
STICK UP									

REMARKS: Borehole continuously sampled to a 31.0' (bgs) depth. HNu background is .5ppm

SAMPLE TYPE

S = Split Spoon
T = Shelby Tube
R = Air Rotary
D = Denison
A = Auger
W = Wash
C = Core
P = Piston
N = No Sample

Well Information	Diam.	Type	Top Depth (ft.)	Bottom Depth (ft.)
Riser	2.0"	Schedule 40 PVC	+3.0	-26.0
Screen	2.0"	Schedule 40 0.01 Slot	-26.0	-31.0

Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
1.0	A-N	–	–		.5/.5			
3.0	S-1	.4/2.0 20%	WOH/24"		.5/.5	PEAT MATERIAL w/ decomposed WOOD and ROOTED MATERIAL Dark brown, very loose, wet		
5.0	S-2	.5/2.0 25%	WOH/24"		.5/.5			
7.0	S-3	.5/2.0 25%	WOH/24"		.5/.5			
9.0	S-4	.3/2.0 15%	WOH/24"		.5/.5			
	S-5	.6/2.0 30%	WOH/24"		.5/.5	Match to Sheet 2		

DRILLING CO.: Parratt-Wolff
BAKER REP.: J. E. Zimmerman
DRILLER: G. Lansing
BORING NO.: MW35468
SHEET 1 OF 3

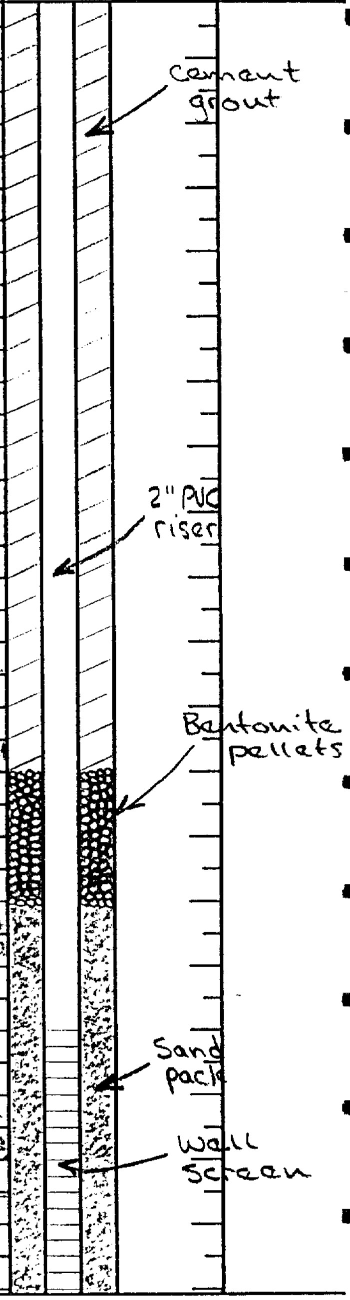
Baker
Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-situ Air Sparging Plume B
CTO NO.: 323
BORING NO.: MW3546B

SAMPLE TYPE		DEFINITIONS
S = Split Spoon	A = Auger	SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5')
T = Shelby Tube	W = Wash	RQD = Rock Quality Designation (%)
R = Air Rotary	C = Core	PID = Photoionization Detector
D = Denison	P = Piston	ppm = parts per million
N = No Sample		

Depth (ft.)		Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
11	11.0	S-5	30%	WOH/24"		.5/.5	Continued from Sheet 1 SAND, fine grained w/trace silt, little wood splinters Dark brown to brown, very loose, wet.		
12 13	13.0	S-6	.4/2.0 20%	WOH/24"		.5/.5			
14 15	15.0	S-7	.6/2.0 30%	WOH/6"		.5/.5	SAND, fine grained w/trace silt. Brown to gray, very loose, wet.		
16 17	17.0	S-8	.9/2.0 45%	1 3 11 18		.5/.5	SAND, fine to medium grained, trace silt, cemented shell material, trace shell fragments. Brown/yellowish brown/gray/white, medium dense, wet.		
18 19	19.0	S-9	1.4/2.0 70%	17 9 19 21		.5/.5	FOSSILIFEROUS LIMESTONE trace/little SAND, fine grained, trace silt, little shell material, micrite (matrix) Gray/light gray/white, wet		
20 21	21.0	S-10	1.8/2.0 90%	15 15 15 21		.5/.5	SAND, fine to medium grained w/trace silt trace shell material. Light greenish gray/white dense, wet		
22 23	23.0	S-11	1.0/2.0 50%	20 27 22 19		.5/.5	SAND, fine grained w/ trace silt, little cemented sandstone nodules, trace shell fragments. Light greenish gray/white, wet		
24 25	25.0	S-12	2.0/2.0 100%	17 17 16 18		.5/.5	SAND, fine grained w/ trace silt, trace shell material. Light greenish gray/light gray, med. dense		
26 27	27.0	S-13	2.0/2.0 100%	14 16 16 17		.5/.5	FOSSILIFEROUS LIMESTONE w/SAND, fine grained trace silt, little shell material, cemented shell fragments. Light gray and white, dense wet.		
28 29	29.0	S-14	1.8/2.0 90%	25 17 18 12		.5/.5			
30		S-15	2.0/2.0	7 6		.5/.5	SAND, fine grained w/trace silt, trace clay, trace shell		

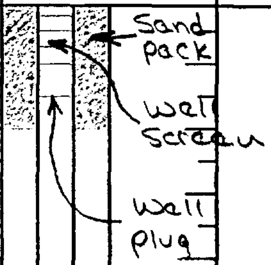


DRILLING CO.: Parratt-Wolff
BAKER REP.: J.E. Zimmerman
DRILLER: G. Lansing
BORING NO.: MW3546B
SHEET 2 OF

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-situ Air Sparging Plume B
CTO NO.: 323
BORING NO.: MW3546B

SAMPLE TYPE		DEFINITIONS
S = Split Spoon	A = Auger	SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5')
T = Shelby Tube	W = Wash	RQD = Rock Quality Designation (%)
R = Air Rotary	C = Core	PID = Photoionization Detector
D = Denison	P = Piston	ppm = parts per million
N = No Sample		

Depth (ft.)		Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
31	31.0	S-15	100%	7 6		.5/.5	Continued from Sheet 2 fragments/shell material, trace fossiliferous limestone, micrite (as matrix). Light gray/white/greenish gray, wet		
32	32.0	N	-	--		.5/.5			
33							End of Boring		
34							TD: 32.0' (bgs)		
35									
6									
7									
8									
9									
0									
1									
2									
3									
4									
5									
6									
7									
8									
9									
0									

DRILLING CO.: Parratt-Wolff
BAKER REP.: J.E. Zimmerman
DRILLER: G. Lansing
BORING NO.: MW3546B

Baker
Baker Environmental, Inc

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-situ Air Sparging Plume 8
CTO NO.: 323 BORING NO.: MW3547A
COORDINATES: EAST: NORTH:
ELEVATION: SURFACE: TOP OF PVC CASING:

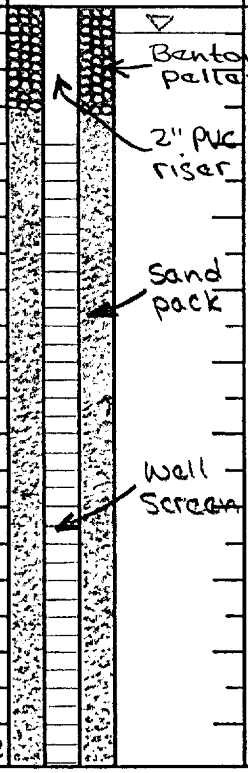
RIG: # 82					DATE	PROGRESS (FT.)	WEATHER	WATER DEPTH (FT.)	TIME
	SPLIT SPOON	CASING	AUGERS	CORE BARREL					
SIZE (DIAM.)	1-3/8"		6 1/4"		7-9-96	0 - 12.5	overcast, rain shower	.5	
LENGTH	2.0		5'						
TYPE	Std.		HSA						
HAMMER WT.	140 lbs.								
FALL	30"								
STICK UP									

REMARKS: Augered to 12.5' (bgs) depth. HNu background is .5 ppm
No split spoon samples were collected

SAMPLE TYPE

S = Split Spoon
T = Shelby Tube
R = Air Rotary
D = Denison
A = Auger
W = Wash
C = Core
P = Piston
N = No Sample

Well Information	Diam.	Type	Top Depth (ft.)	Bottor Depth (ft.)
Riser	2.0"	Schedule 40 PVC	+3.0	-2.0
Screen	2.0"	Schedule 40 0.01 Slot	-2.0	-12.0

Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL
1								
2								
3								
4								
5	A-N	—	—		.5/.5	Auger to depth	 	
6								
7								
8								
9								
10						Match to Sheet 2		

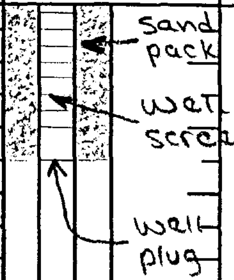
DRILLING CO.: Parratt-Wolff BAKER REP.: J.E. Zimmerman
DRILLER: G. Lansing BORING NO.: MW3547A SHEET 1 OI

Baker
Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-situ Air Sparging Plume B
CTO NO.: 323
BORING NO.: MW35471A

SAMPLE TYPE		DEFINITIONS
S = Split Spoon	A = Auger	SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5')
T = Shelby Tube	W = Wash	RQD = Rock Quality Designation (%)
R = Air Rotary	C = Core	PID = Photoionization Detector
D = Denison	P = Piston	ppm = parts per million
N = No Sample		

Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
						Continued from Sheet 1	 sand pack well screen well plug	
11					.5/.5			
12	A-N	–	–			Auger to depth		
12.5								
13						End of Boring		
14						TD: 12.5' (bgs)		
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								
30								

DRILLING CO.: Parratt-Wolff
BAKER REP.: J.E. Zimmerman
DRILLER: G. Lansing
BORING NO.: MW35471A
SHEET 2 OF

Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-situ Air Sparging Plume B
CTO NO.: 323
BORING NO.: MW3547B
COORDINATES: EAST: NORTH:
ELEVATION: SURFACE: TOP OF PVC CASING:

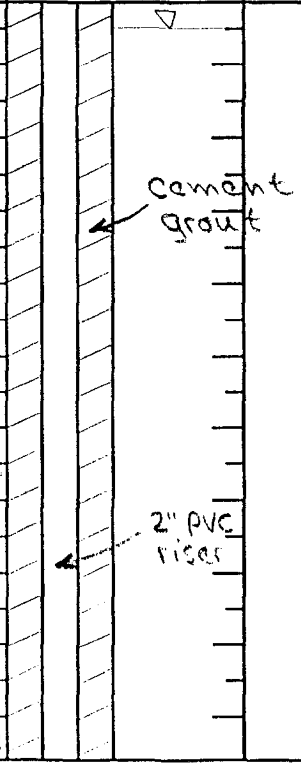
RIG: #82	SPLIT SPOON	CASING	AUGERS	CORE BARREL	DATE	PROGRESS (FT.)	WEATHER	WATER DEPTH (FT.)	TIME
SIZE (DIAM.)	1-3/8"		6 1/4"		7-10-96	0-32.0	overcast, rain humid (70's)	.5	
LENGTH	2.0		5'						
TYPE	Std.		HSA						
HAMMER WT.	140 lbs.								
FALL	30"								
STICK UP									

REMARKS: Borehole sampled at 5' intervals between 5.0' and 32.0' (bgs). Hnu background is .4 ppm

SAMPLE TYPE

S = Split Spoon
T = Shelby Tube
R = Air Rotary
D = Denison
A = Auger
W = Wash
C = Core
P = Piston
N = No Sample

Well Information	Diam.	Type	Top Depth (ft.)	Bottom Depth (ft.)
Riser	2.0"	Schedule 40 PVC	+3.0	-26.0
Screen	2.0"	Schedule 40 0.01 Slot	-26.0	-31.0

Depth (ft.)		Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
1–5	5.0	A-N	–	–		.4/.4	Auger to 5.0' (bgs)		
5–7	7.0	S-1	.3/2.0 15%	WOH/24"		.4/.4	PEAT MATERIAL w/ decomposed wood, ROOTED MATERIAL. Dark brown, very loose wet.		
7–10	10.0	A-N	–	–		.4/.4			
		S-2	.6	WOH/24"		.4/.4	Match to Sheet 2		

DRILLING CO.: Parratt-Wolff
BAKER REP.: J.E. Zimmerman
DRILLER: G. Lansing
BORING NO.: MW3547B
SHEET 1 OF

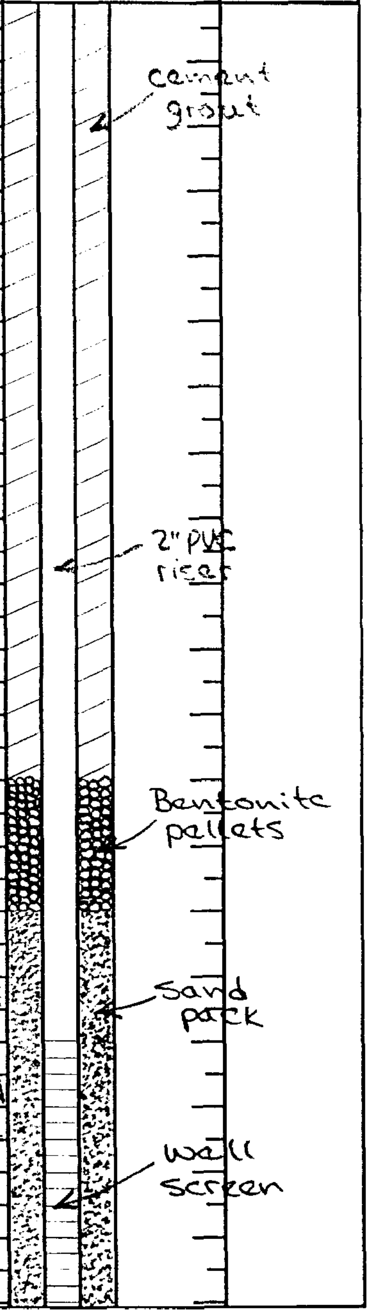
Baker
Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-situ Air Sparging Plume B
CTO NO.: 323 BORING NO.: MW3547B

SAMPLE TYPE		DEFINITIONS
S = Split Spoon	A = Auger	SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5')
T = Shelby Tube	W = Wash	RQD = Rock Quality Designation (%)
R = Air Rotary	C = Core	PID = Photoionization Detector
D = Denison	P = Piston	ppm = parts per million
N = No Sample		

Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
						Continued from Sheet 1		
11 12 12.0	S-2	.6/2.0 30%	WOH 24"		.4/.4	SAND, fine grained w/trace silt, little decomposed wood splinters. Dark brown to brown, very loose wet.		
13 14 15 15.0	N	-	-		.4/.4			
16 17 17.0	S-3	NR	WOH 6"		.4/.4	NO RECOVERY		
18 19 20 20.0	N	-	-		.4/.4			
21 22 22.0	S-4	1.7/2.0 85%	13 12 11 14		.4/.4	SAND, fine grained w/trace silt, some cemented sandstone nodules, trace shell fragments/shell material. Light greenish gray to light gray and white, medium dense, wet.		
23 24 25 25.0	N	-	-		.4/.4			
26 27 27.0	S-5	1.5/2.0 75%	5 8 7 14		.4/.4	FOSSILIFEROUS LIMESTONE W/SAND, fine grained trace silt, little shell material and cemented shell fragments. Light gray and white, medium dense, wet		
28 29 30 30.0	N	-	-		.4/.4			



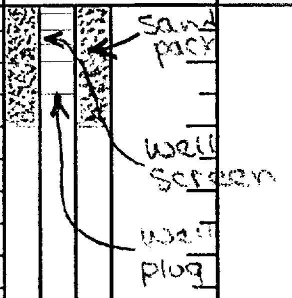
DRILLING CO.: Parratt-Wolff BAKER REP.: J.E. Zimmerman
DRILLER: G. Lansing BORING NO.: MW3547B SHEET 2 OF 3

Baker
Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-situ Air Sparging Plume B
CTO NO.: 323
BORING NO.: MW35-47B

SAMPLE TYPE		**DEFINITIONS**
S = Split Spoon	A = Auger	SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5')
T = Shelby Tube	W = Wash	RQD = Rock Quality Designation (%)
R = Air Rotary	C = Core	PID = Photoionization Detector
D = Denison	P = Piston	ppm = parts per million
N = No Sample		

Depth (ft.)		Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
31		S-6	1.5 2.0 75%	13 13 13 17		.4 .4	Continued from Sheet 2 SAND, fine grained, trace silt, trace clay, trace shell material, trace fossiliferous limestone		
32	32.0								
33							End of Boring		
34							TO: 32.0'(bgs)		
35									
6									
7									
8									
9									
0									
1									
2									
3									
4									
5									
6									
7									
8									
9									
0									

DRILLING CO.: Parratt-Wolff
BAKER REP.: J.E. Zimmerman
DRILLER: G. Lansing
BORING NO.: MW35-47B
SHEET 3 OF

Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-situ Air Sparging Plume B
CTO NO.: 323 BORING NO.: MW3548A
COORDINATES: EAST: NORTH:
ELEVATION: SURFACE: TOP OF PVC CASING:

RIG: #82

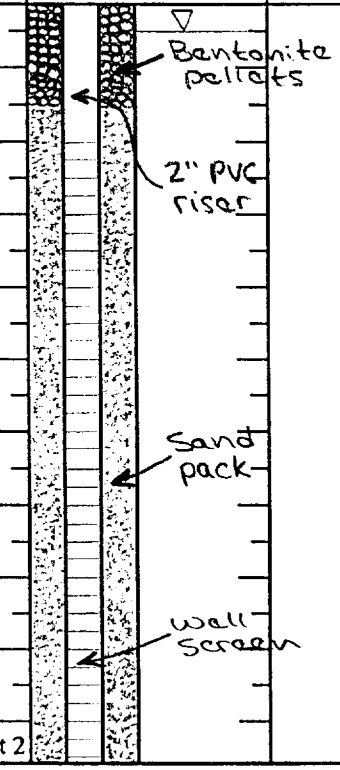
	SPLIT SPOON	CASING	AUGERS	CORE BARREL	DATE	PROGRESS (FT.)	WEATHER	WATER DEPTH (FT.)	TIME
SIZE (DIAM.)	1-3/8"		6 1/4"		7-10-96	0-12.5	Cloudy, humid (80's)	.5	
LENGTH	2.0		5'						
TYPE	Std.		HSA						
HAMMER WT.	140 lbs.								
FALL	30"								
STICK UP									

REMARKS: Augered to 12.5' (bgs) depth. HNu background is .5ppm
No split spoon samples were collected

SAMPLE TYPE

S = Split Spoon
T = Shelby Tube
R = Air Rotary
D = Denison
A = Auger
W = Wash
C = Core
P = Piston
N = No Sample

Well Information	Diam.	Type	Top Depth (ft.)	Bottom Depth (ft.)
Riser	2.0"	Schedule 40 PVC	+3.0	-2.0
Screen	2.0"	Schedule 40 0.01 Slot	-2.0	-12.0

Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
1								
2								
3								
4								
5								
6	A-N	—	-		.5/.5	Auger to depth		
7								
8								
9								
10						Match to Sheet 2		

DRILLING CO.: Parratt-Wolff BAKER REP.: J. E. Zimmerman
DRILLER: G. Lansing BORING NO.: MW3548A SHEET 1 OF 2

Baker
Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

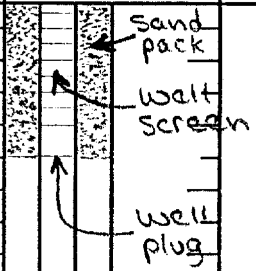
PROJECT: Treatability Study In-situ Air Sparging Plume B
CTO NO.: 323 BORING NO.: MW3548A

SAMPLE TYPE

S = Split Spoon
T = Shelby Tube
R = Air Rotary
D = Denison
A = Auger
W = Wash
C = Core
P = Piston
N = No Sample

DEFINITIONS

SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5')
RQD = Rock Quality Designation (%)
PID = Photoionization Detector
ppm = parts per million

Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
						Continued from Sheet 1		
11								
12	A-N	–	–		.5/.5	Auger to depth		
12.5								
13						End of Boring		
14						TD: 12.5' (bgs)		
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								
30								

DRILLING CO.: Parratt-Wolff BAKER REP.: J.E. Zimmerman
DRILLER: G. Lansing BORING NO.: MW3548A SHEET 2 OF

Baker
Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-situ Air Sparging Plume B
CTO NO.: 323 BORING NO.: MW3548B
COORDINATES: EAST: NORTH:
ELEVATION: SURFACE: TOP OF PVC CASING:

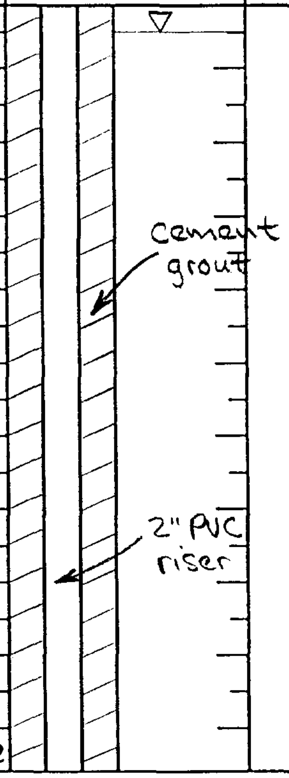
RIG: #82	SPLIT SPOON	CASING	AUGERS	CORE BARREL	DATE	PROGRESS (FT.)	WEATHER	WATER DEPTH (FT.)	TIME
SIZE (DIAM.)	1-3/8"		6 1/4"		7-11-96	0 - 32.0	overcast light rain (70's)	.5	
LENGTH	2.0		5'						
TYPE	Std.		HSA						
HAMMER WT.	140 lbs.								
FALL	30"								
STICK UP									

REMARKS: Borehole sampled at 5' intervals between 5.0' and 32.0' (bgs)
Hnu background is .5 ppm.

SAMPLE TYPE

S = Split Spoon
T = Shelby Tube
R = Air Rotary
D = Denison
A = Auger
W = Wash
C = Core
P = Piston
N = No Sample

Well Information	Diam.	Type	Top Depth (ft.)	Bottom Depth (ft.)
Riser	2.0"	Schedule 40 PVC	+3.0	-26.0
Screen	2.0"	Schedule 40 0.01 Slot	-26.0	-31.0

Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
1 2 3 4 5 5.0	A-N	-	-		.5/.5	Auger to 5.0' (bgs)		
6 7 7.0	S-1	1.0/2.0 50%	WOH 24"		.5/.5	PEAT MATERIAL W/ decomposed WOOD, ROOTED MATERIAL Dark brown/brown very loose, wet		
8 9 10 10.0	A-N	—	—		.5/.5			
	S-2	50%	1/12" 1/12"		.5/.5	Match to Sheet 2		

DRILLING CO.: Parratt-Wolff BAKER REP.: J. E. Zimmerman
DRILLER: G. Lansing BORING NO.: MW3548B SHEET 1 OF 3

Baker

Baker Environmental, Inc.

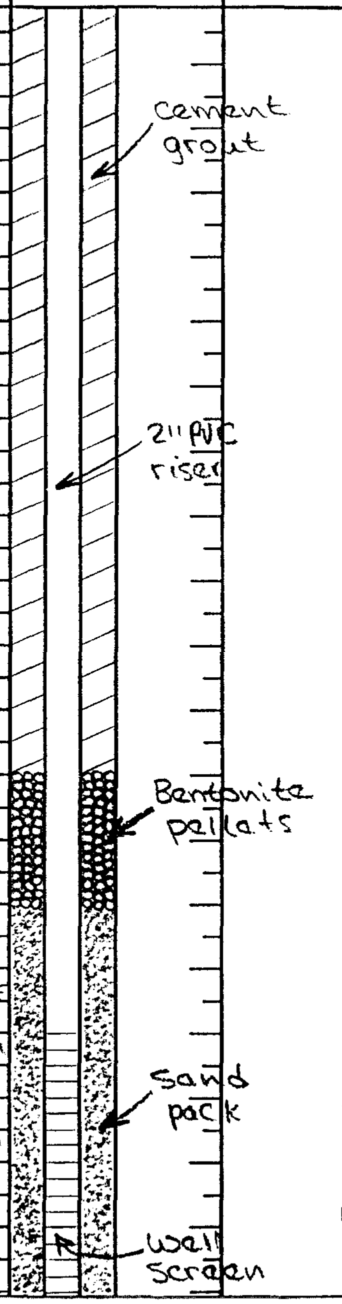
TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-Situ Air Sparging Plume B

CTO NO.: 323 BORING NO.: MW3548B

SAMPLE TYPE		DEFINITIONS
S = Split Spoon	A = Auger	SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5')
T = Shelby Tube	W = Wash	RQD = Rock Quality Designation (%)
R = Air Rotary	C = Core	PID = Photoionization Detector
D = Denison	P = Piston	ppm = parts per million
N = No Sample		

Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
10 11 12	S-2	1.0/2.0 50%	1/12" 1/12"		.5/.5	Continued from Sheet I SAND, fine grained w/ trace silt, little decomposed wood splinters. Dark brown/brown, very loose, wet		
12.0 13 14 15	N	–	–		.5/.5			
15.0 16 17	S-3	1.2/2.0 60%	1 1 3 6		.5/.5	SAND, fine grained w/ trace silt. Brown, loose to very loose, wet		
17.0 18 19 20	N	–	–		.5/.5			
20.0 21 22	S-4	1.3/2.0 65%	13 19 18 23		.5/.5	SAND, fine grained w/ trace silt, some cemented sandstone nodules, trace shell material/shell fragments. Light greenish gray to light gray and white, dense wet.		
22.0 23 24 25	N	–	–		.5/.5			
25.0 26 27	S-5	1.7/2.0 85%	10 12 13 18		.5/.5	FOSSILIFEROUS LIMESTONE w/ SAND, fine grained trace silt, little shell material, cemented shell fragments. Light gray and white, medium dense, wet		
27.0 28 29 30	N	–	–		.5/.5			
30.0								



DRILLING CO.: Parratt-Wolff BAKER REP.: J.E. Zimmerman

DRILLER: G. Lansing BORING NO.: MW3548B SHEET 2 OF

Baker

Baker Environmental, Inc.

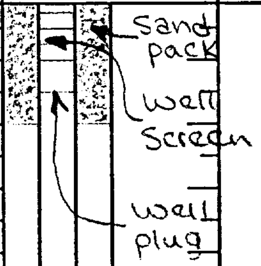
TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-situ Air Sparging Plume B

CTO NO.: 323

BORING NO.: MW35488

SAMPLE TYPE	DEFINITIONS
S = Split Spoon T = Shelby Tube R = Air Rotary D = Denison A = Auger W = Wash C = Core P = Piston N = No Sample	SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5') RQD = Rock Quality Designation (%) PID = Photoionization Detector ppm = parts per million

Depth (ft.)		Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
							Continued from Sheet 2		
31		S-6	1.6 2.0 80%	17 18 20 24		.5 .5	SAND, fine grained, trace silt, trace clay, trace shell material, trace foss. lime, micrite, wet		
32	32.0						End of Boring		
33									
34							TD: 32.0' (bgs)		
35									
6									
7									
8									
9									
0									
1									
2									
3									
4									
5									
6									
7									
8									
9									
0									

DRILLING CO.: Parratt-Wolff

BAKER REP.: J.E. Zimmerman

DRILLER: G. Lansing

BORING NO.: MW35488

SHEET 3 OF 3

Baker
Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-situ Air Sparging Plume B
CTO NO.: 323
BORING NO.: MW3549A
COORDINATES: EAST: ______ NORTH: ______
ELEVATION: SURFACE: ______ TOP OF PVC CASING: ______

RIG: #82	SPLIT SPOON	CASING	AUGERS	CORE BARREL	DATE	PROGRESS (FT.)	WEATHER	WATER DEPTH (FT.)	TIME
SIZE (DIAM.)	1-3/8"		6 1/4"		7-10-96	0-12.5	cloudy, humid (80's)	.5	
LENGTH	2.0		5'						
TYPE	Std.		HSA						
HAMMER WT.	140 lbs.								
FALL	30"								
STICK UP									

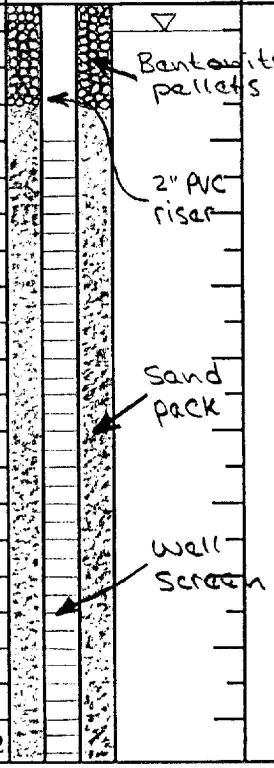
REMARKS: Augered to 8.0'(bgs). Sampled from 8.0 to 12.0'(bgs)
HNu background is .5 ppm

SAMPLE TYPE

S = Split Spoon
T = Shelby Tube
R = Air Rotary
D = Denison
A = Auger
W = Wash
C = Core
P = Piston
N = No Sample

Well Information	Diam.	Type	Top Depth (ft.)	Bottom Depth (ft.)
Riser	2.0"	Schedule 40 PVC	+3.0	-2.0
Screen	2.0"	Schedule 40 0.01 Slot	-2.0	-12.0

Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
1–8	A-N	—	—		.5/.5	Auger to 8.0'(bgs)		
8.0–10.0	S-1	.5/2.0 25%	WOH/18" 2		.5/.5	PEAT MATERIAL w/little decomposed WOOD and ROOTED MATERIAL. Dark brown/brown, very loose, wet		
10.0	S-2	45%	WOH/[illegible]		.5/.5	Match to Sheet 2		



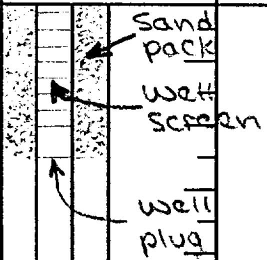
DRILLING CO.: Parratt-Wolff
BAKER REP.: J.E. Zimmerman
DRILLER: G. Lansing
BORING NO.: MW3549A
SHEET 1 OF

Baker
Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-situ Air Sparging Plume B
CTO NO.: 323
BORING NO.: MW3549A

SAMPLE TYPE		DEFINITIONS
S = Split Spoon	A = Auger	SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5')
T = Shelby Tube	W = Wash	RQD = Rock Quality Designation (%)
R = Air Rotary	C = Core	PID = Photoionization Detector
D = Denison	P = Piston	ppm = parts per million
N = No Sample		

Depth (ft.)		Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
							Continued from Sheet 1		
11		S-2	.9/2.0	1 2 2		.5/.5	SAND, fine grained w/ trace silt, little decomposed wood splinters Dark brown / brown, loose, wet		
12	12.0		45%						
	12.5	A-N	—	—		.5/.5			
13							End of Boring		
14							TD: 12.5' (bgs)		
15									
16									
17									
18									
19									
20									
21									
22									
23									
24									
25									
26									
27									
28									
29									
30									

DRILLING CO.: Parratt-Wolff
BAKER REP.: J.E. Zimmerman
DRILLER: G. Lansing
BORING NO.: MW3549A
SHEET 2 OF 2

Baker
Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-situ Air Sparging Plume B
CTO NO.: 323
BORING NO.: MW3549B
COORDINATES: EAST:
NORTH:
ELEVATION: SURFACE:
TOP OF PVC CASING:

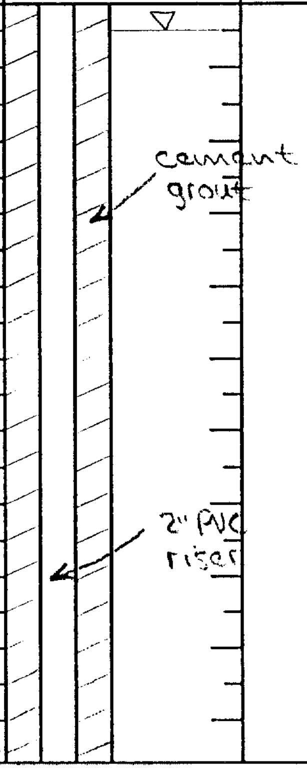
RIG: #82					DATE	PROGRESS (FT.)	WEATHER	WATER DEPTH (FT.)	TIME
	SPLIT SPOON	CASING	AUGERS	CORE BARREL					
SIZE (DIAM.)	1-3/8"		6 1/4"		7-10-96	0-32.0	cloudy, humid (80's)	.5	
LENGTH	2.0		5'						
TYPE	Std.		HSA						
HAMMER WT.	140 lbs.								
FALL	30"								
STICK UP									

REMARKS: Borehole sampled at 5' intervals between 5.0' and 32.0' (bgs). HNu background is .5 ppm

SAMPLE TYPE

S = Split Spoon
T = Shelby Tube
R = Air Rotary
D = Denison
A = Auger
W = Wash
C = Core
P = Piston
N = No Sample

Well Information	Diam.	Type	Top Depth (ft.)	Bottom Depth (ft.)
Riser	2.0"	Schedule 40 PVC	+3.0	-26.0
Screen	2.0"	Schedule 40 0.01 Slot	-26.0	-31.0

Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
1 2 3 4 5	A-N	—	—		.5/.5	Auger to 5.0' (bgs)	 cement grout 2" PVC riser	
5.0 6 7	S-1	.4/2.0 20%	WOH/24"		.5/.5	PEAT MATERIAL w/ decomposed WOOD ROOTED MATERIAL Dark brown, very loose, wet		
7.0 8 9 10	A-N	—	—		.5/.5			
10.0	S-2	.4/2.0	WOH/24"		.5/.5	Match to Sheet 2		

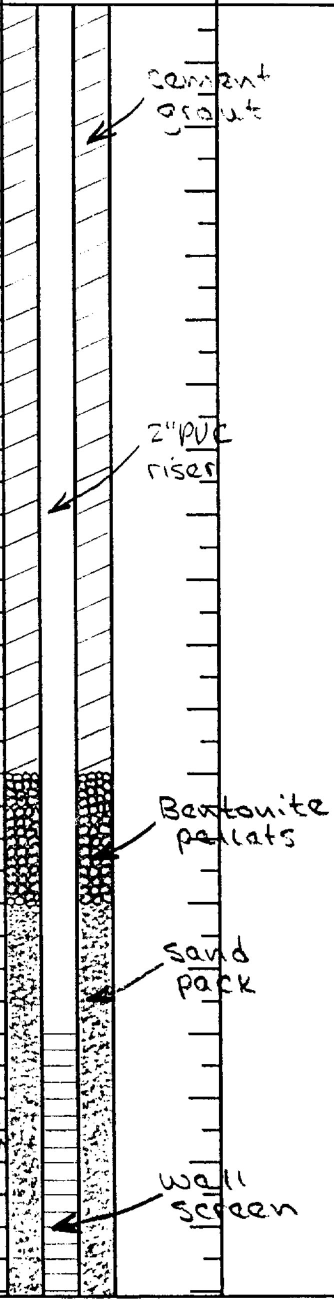
DRILLING CO.: Parratt-Wolff
BAKER REP.: J.E. Zimmerman
DRILLER: G. Lansing
BORING NO.: MW3549B
SHEET 1 OF

Baker
Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-situ Air Sparging Plume B
CTO NO.: 323
BORING NO.: MW3549B

SAMPLE TYPE		DEFINITIONS
S = Split Spoon	A = Auger	SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5')
T = Shelby Tube	W = Wash	RQD = Rock Quality Designation (%)
R = Air Rotary	C = Core	PID = Photoionization Detector
D = Denison	P = Piston	ppm = parts per million
N = No Sample		

Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
11 12 12.0	S-2	.4/2.0 20%	WOH/24"		.5/.5	Continued from Sheet 1 SAND, fine grained w/ trace silt, little decomposed wood splinters. Dark brown/brown very loose, wet.		
13 14 15 15.0	N	–	–		.5/.5			
16 17 17.0	S-3	1.2/2.0 60%	1 1 1 1		.5/.5	SAND, fine grained w/trace silt. Brown, very loose, wet		
18 19 20 20.0	N	–	–		.5/.5			
21 22 22.0	S-4	1.3/2.0 65%	13 12 12 19		.5/.5	SAND, fine grained w/ trace silt, some cemented sandstone nodules, trace shell fragments/shell material. Light greenish gray to light gray and white, medium dense, wet.		
23 24 25 25.0	N	–	–		.5/.5			
26 27 27.0	S-5	1.6/2.0 80%	13 13 12 15		.5/.5	FOSSILIFEROUS LIMESTONE w/SAND, fine grained, trace silt, little shell material, cemented shell fragments. Light gray and white, medium dense, wet.		
28 29 30 30.0	N	–	–		.5/.5			

DRILLING CO.: Parratt-Wolff
BAKER REP.: J. E. Zimmerman
DRILLER: G. Lansing
BORING NO.: MW3549B
SHEET 2 OF 3

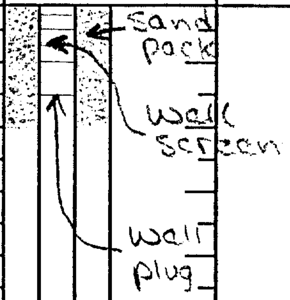
Baker
Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-Situ Air Sparging Plume B
CTO NO.: 323
BORING NO.: MW35498

SAMPLE TYPE		DEFINITIONS
S = Split Spoon	A = Auger	SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5')
T = Shelby Tube	W = Wash	RQD = Rock Quality Designation (%)
R = Air Rotary	C = Core	PID = Photoionization Detector
D = Denison	P = Piston	ppm = parts per million
N = No Sample		

Depth (ft.)		Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
							Continued from Sheet 2		
31		S-6	1.8/2.0 90%	10 13 15 18		.5/.5	SAND, fine grained, trace silt, trace shell mat., trace fossiliferous lime, trace clay, micrite, wet		
32	32.0								
33							End of Boring		
34							TD: 32.0' (bgs)		
35									
6									
7									
8									
9									
0									
1									
2									
3									
4									
5									
6									
7									
8									
9									
0									



DRILLING CO.: Parratt-Wolff
BAKER REP.: J.E. Zimmerman
DRILLER: G. Lansing
BORING NO.: MW35498
SHEET 3 OF

Baker

Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-situ Air Sparging Plume B
CTO NO.: 323
BORING NO.: MW3550A
COORDINATES: EAST: ______ NORTH: ______
ELEVATION: SURFACE: ______ TOP OF PVC CASING: ______

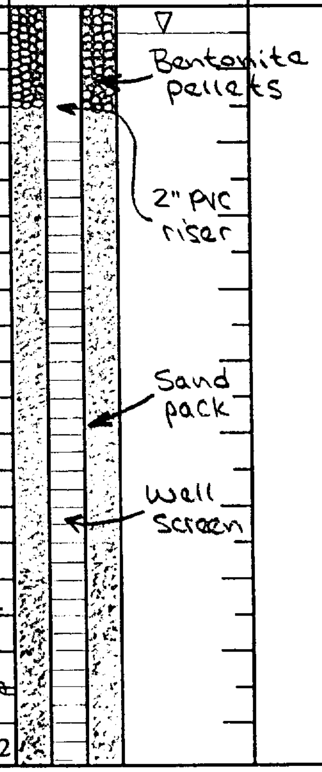
RIG: #82					DATE	PROGRESS (FT.)	WEATHER	WATER DEPTH (FT.)	TIME
	SPLIT SPOON	CASING	AUGERS	CORE BARREL					
SIZE (DIAM.)	1-3/8"		6 1/4"		7-11-96	0-12.5	overcast, rain (70's)	.5	
LENGTH	2.0		5'						
TYPE	Std.		HSA						
HAMMER WT.	140 lbs.								
FALL	30"								
STICK UP									

REMARKS: Augered to 8.0' (bgs). Sampled from 8.0 to 12.0' (bgs)
HNu background is .6 ppm.

SAMPLE TYPE

S = Split Spoon	A = Auger
T = Shelby Tube	W = Wash
R = Air Rotary	C = Core
D = Denison	P = Piston
N = No Sample	

Well Information	Diam.	Type	Top Depth (ft.)	Bottom Depth (ft.)
Riser	2.0"	Schedule 40 PVC	+3.0	-2.0
Screen	2.0"	Schedule 40 0.01 Slot	-2.0	-12.0

Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
1								
2								
3								
4	A-N	-	-		.6/.6	Auger to 8.0' (bgs)		
5								
6								
7								
8								
8.0 9	S-1	.9/2.0 45%	WOH 24"		.6/.6	PEAT MATERIAL w/ little decomposed WOOD and ROOTED MATERIAL. Dark brown, very loose wet		
10 10.0	S-2	85%	WOH/24"		.6/.6	Match to Sheet 2		

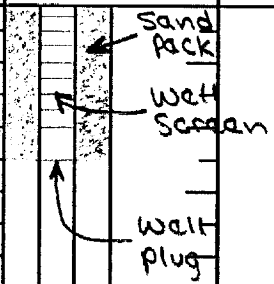
DRILLING CO.: Parratt-Wolff
BAKER REP.: J. E. Zimmerman
DRILLER: G. Lansing
BORING NO.: MW3550A
SHEET 1 OF 2

Baker
Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-situ Air Sparging Plume B
CTO NO.: 323
BORING NO.: MW35S0A

SAMPLE TYPE		DEFINITIONS
S = Split Spoon	A = Auger	SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5')
T = Shelby Tube	W = Wash	RQD = Rock Quality Designation (%)
R = Air Rotary	C = Core	PID = Photoionization Detector
D = Denison	P = Piston	ppm = parts per million
N = No Sample		

Depth (ft.)		Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
11		S-2	1.7/2.0 85%	WOH/24"		.6/.6	Continued from Sheet 1 SAND, fine grained w/ trace silt and decomposed wood splinters Dark brown/brown, very loose, wet.		
12	12.0								
	12.5	M-N	—	—		.6/.6			
13							End of Boring		
14							TD: 12.5' (bgs)		
15									
16									
17									
18									
19									
20									
21									
22									
23									
24									
25									
26									
27									
28									
29									
30									

DRILLING CO.: Parratt-Wolff
BAKER REP.: J.E. Zimmerman
DRILLER: G. Lansing
BORING NO.: MW35S0A
SHEET 2 OF

Baker

Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-Situ Air Sparging Plume B
CTO NO.: 323
BORING NO.: MW3550B
COORDINATES: EAST:
NORTH:
ELEVATION: SURFACE:
TOP OF PVC CASING:

RIG: #82					DATE	PROGRESS (FT.)	WEATHER	WATER DEPTH (FT.)	TIME
	SPLIT SPOON	CASING	AUGERS	CORE BARREL					
SIZE (DIAM.)	1-3/8"		6 1/4"		7-11-96	0 - 32.0	overcast humid (80's)	.5	
LENGTH	2.0		5'						
TYPE	Std.		HSA						
HAMMER WT.	140 lbs.								
FALL	30"								
STICK UP									

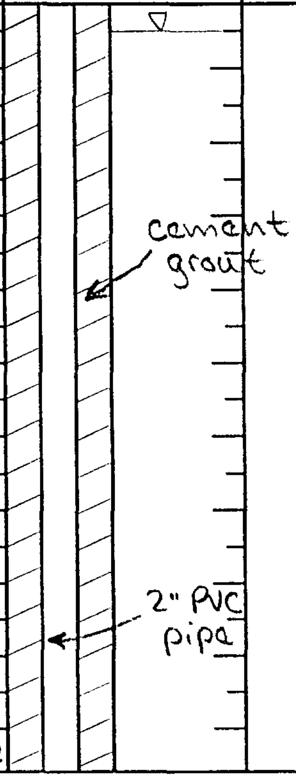
REMARKS: Borehole sampled at 5' intervals between 5.0' and 32.0' (bgs). HNu background is .4 ppm.

SAMPLE TYPE

S = Split Spoon
T = Shelby Tube
R = Air Rotary
D = Denison
A = Auger
W = Wash
C = Core
P = Piston
N = No Sample

Well Information	Diam.	Type	Top Depth (ft.)	Bottom Depth (ft.)
Riser	2.0"	Schedule 40 PVC	+3.0	-26.0
Screen	2.0"	Schedule 40 0.01 Slot	-26.0	-31.0

Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
1 2 3 4 5 5.0	A-N	–	–		.4/.4	Auger to 5.0' (bgs)		
6 7 7.0	S-1	.4/2.0 20%	WOH/24"		.4/.4	PEAT MATERIAL w/ decomposed WOOD ROOTED MATERIAL. Dark brown, very loose, wet		
8 9 10 10.0	A-N	–	–		.4/.4			
	S-2	.9/2.0	WOH/24"		.4/.4	Match to Sheet 2		



DRILLING CO.: Parratt-Wolff
BAKER REP.: J.E. Zimmerman
DRILLER: G. Lansing
BORING NO.: MW3550B
SHEET 1 OF 3

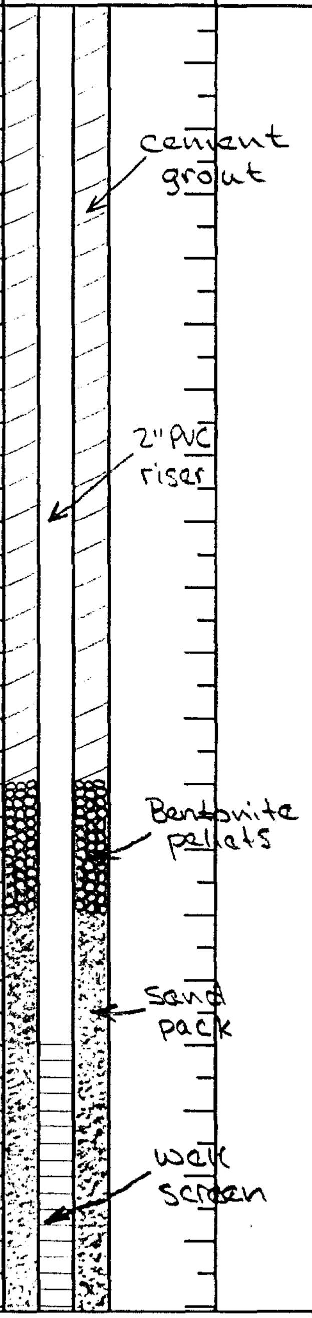
Baker
Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-situ Air Sparging Plume B
CTO NO.: 323 BORING NO.: MW3550B

SAMPLE TYPE		DEFINITIONS
S = Split Spoon	A = Auger	SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5')
T = Shelby Tube	W = Wash	RQD = Rock Quality Designation (%)
R = Air Rotary	C = Core	PID = Photoionization Detector
D = Denison	P = Piston	ppm = parts per million
N = No Sample		

Depth (ft.)		Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
							Continued from Sheet 1		
11 12	12.0	S-2	.9/2.0 45%	WOH 24		.4/.4	SAND, fine grained w/ trace silt, little decomposed wood splinters Dark brown to brown, very loose, wet		
13 14 15	15.0	N	-	-		.4/.4			
16 17	17.0	S-3	.3/2.0 15%	2 3 8 11		.4/.4	SAND, fine to medium grained w/ trace silt cemented shell material, trace shell fragments. Brown to yellowish brown and white, medium dense, wet		
18 19 20	20.0	N	-	-		.4/.4			
21 22	22.0	S-4	1.3/2.0 65%	11 12 11 16		.4/.4	SAND, fine grained w/ trace silt, little cemented sandstone nodules, trace shell fragments / shell material. Light greenish gray to light gray and white, medium dense, wet		
23 24 25	25.0	N	-	-		.4/.4			
26 27	27.0	S-5	1.2/2.0 60%	10 17 17 18		.4/.4	FOSSILIFEROUS LIMESTONE w/ SAND, fine grained, trace silt, little shell material and cemented shell fragments Light gray and white, dense, wet		
28 29 30	30.0	N	-	-		.4/.4			



DRILLING CO.: Parratt-Wolff BAKER REP.: J.E. Zimmerman

DRILLER: G. Lansing BORING NO.: MW3550B SHEET 2 OF

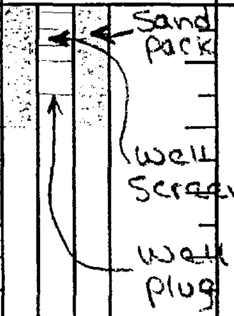
Baker
Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-situ Air Sparging Plume B
CTO NO.: 323
BORING NO.: MW3550B

SAMPLE TYPE	DEFINITIONS
S = Split Spoon T = Shelby Tube R = Air Rotary D = Denison A = Auger W = Wash C = Core P = Piston N = No Sample	SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5') RQD = Rock Quality Designation (%) PID = Photoionization Detector ppm = parts per million

Depth (ft.)		Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
31		S-6	1.3/2.0 65%	12 18 18 12		.4/.4	Continued from Sheet 2 SAND, Fine grained w/ trace silt, trace clay, trace shell mat., trace foss. lime., micrite, wet		
32	32.0						End of Boring		
33									
34							TD: 32.0' (bgs)		
35									
6									
7									
8									
9									
0									
1									
2									
3									
4									
5									
6									
7									
8									
9									
0									



DRILLING CO.: Parratt-Wolff
BAKER REP.: J.E. Zimmerman
DRILLER: G. Lansing
BORING NO.: MW3550B
SHEET 3 OF 3

PLUME C

Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-Situ Air Sparging Plume C
CTO NO.: 323
BORING NO.: MW355IB
COORDINATES: EAST:
NORTH:
ELEVATION: SURFACE:
TOP OF PVC CASING:

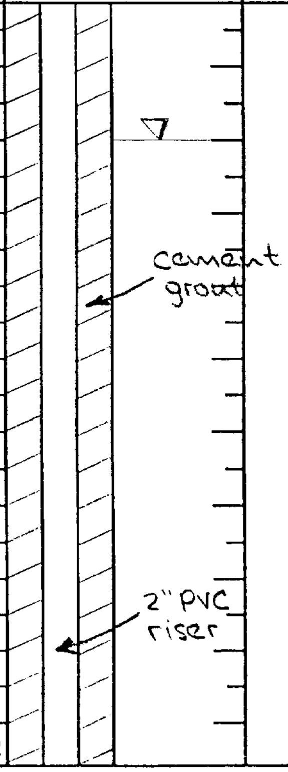
RIG: #82	SPLIT SPOON	CASING	AUGERS	CORE BARREL	DATE	PROGRESS (FT.)	WEATHER	WATER DEPTH (FT.)	TIME
SIZE (DIAM.)	1-3/8"		6-1/4"		8-21-96	0-31.0	clear, hot, 90's	≈ 2.0	
LENGTH	2.0		5.0						
TYPE	Std.		HSA						
HAMMER WT.	140 lbs.								
FALL	30"								
STICK UP									

REMARKS: Augered to 1.0' (bgs). Continuously sampled from 1.0' (bgs) to 31.0' (bgs). HNu background is .8 ppm.

SAMPLE TYPE

S = Split Spoon
T = Shelby Tube
R = Air Rotary
D = Denison
A = Auger
W = Wash
C = Core
P = Piston
N = No Sample

Well Information	Diam.	Type	Top Depth (ft.)	Bottom Depth (ft.)
Riser	2.0"	Schedule 40 PVC	+3.0	-24.0
Screen	2.0"	Schedule 40 0.01 Slot	-24.0	-26.0

Depth (ft.)		Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
1	1.0	A-N	-	-		.8/.8	Auger to 1.0' (bgs)		
2 3	3.0	S-1	90%	WOH/12" 1/12"		.8/.8	SAND, fine grained w/ trace to some silt little rooted material. Dark brown to brown very loose, wet.		
4 5	5.0	S-2	90%	WOH/6" 1 1		.8/.8	Sandy CLAY w/some silt, trace decomposed wood splinters. Brown to gray, very soft wet to moist.		
6 7	7.0	S-3	30%	WOH/6" 1 1 2		.8/.8	Sandy CLAY w/some silt. Oxidation (orange/brown) staining. Gray. very loose to very soft moist		
8 9	9.0	S-4	30%	2 2 3 2		.8/.8	CLAY w/little silt, trace sand, fine grained. oxidation (orange/brown) staining. Gray soft, moist		
10		S-5	1.4/2.0 70%	WOH/12"		.8/.8	Silty CLAY w/trace to little sand, fine grained. Match to Sheet 2		

DRILLING CO.: Parratt-Wolff
BAKER REP.: J.E. Zimmerman
DRILLER: R. Bush
BORING NO.: MW355IB
SHEET 1 OF 3

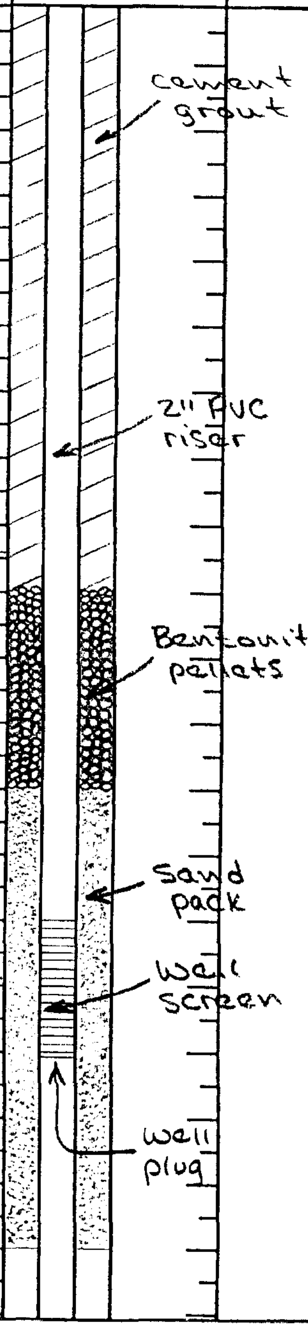
Baker
Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-Situ Air Sparging Plume C
CTO NO.: 323
BORING NO.: MW35S1B

SAMPLE TYPE		DEFINITIONS
S = Split Spoon	A = Auger	SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5')
T = Shelby Tube	W = Wash	RQD = Rock Quality Designation (%)
R = Air Rotary	C = Core	PID = Photoionization Detector
D = Denison	P = Piston	ppm = parts per million
N = No Sample		

Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MS
11 11.0	S-5	70%	1 3		.8/.8	Continued from Sheet 1		
12 13 13.0	S-6	1.0/2.0 50%	3 3 3 2		.8/.8	Oxidation (orange/brown) staining. Gray to brown, soft to loose, moist		
14 15 15.0	S-7	1.3/2.0 60%	WoH/12" 2 1		.8/.8	CLAY w/silt and trace sand, fine grained. Dark greenish gray, soft (plastic) moist.		
16 17 17.0	S-8	1.4/2.0 70%	WoH/24"		.8/.8	CLAY w/silt. Dark greenish gray to very dark gray, very soft (plastic) moist		
18 19 19.0	S-9	1.5/2.0 75%	1 1 1 1		.8/.8			
20 21 21.0	S-10	1.1/2.0 55%	WoH/12" 1/12"		.8/.8	SAND, fine grained w/trace silt. Dark gray, very loose, wet		
22 23 23.0	S-11	1.1/2.0 55%	WoH/12" 1 1		.8/.8	SAND, fine to medium grained, trace silt. Gray to brown, very loose, wet.		
24 25 25.0	S-12	1.6/2.0 80%	6 10 9 9		.8/.8	SAND, fine to medium grained, trace silt, cemented shells, trace shell frags. Brown/yellow brown/white, med. dense		
26 27 27.0	S-13	1.3/2.0 65%	8 10 12 14		.8/.8	SAND, fine grained, tr. silt, little cemented sandstone nodules, cemented shell mat/frags Light greenish gray/light gray		
28 29 29.0	S-14	1.8/2.0 90%	14 18 16 17		.8/.8	FOSSILIFEROUS LIMESTONE/ SAND, fine grained, tr. silt, tr. cemented shell mat./frags, micrite. Wet		
30	S-15	90%	12 12		.8/.8	SAND, fine grained, tr. silt, tr. cemented shell mat./frags, micrite. Light gray/white, wet		



DRILLING CO.: Parratt-Wolff
BAKER REP.: J. E. Zimmerman
DRILLER: R. Bush
BORING NO.: MW35S1B
SHEET 2 O

Baker
Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-Situ Air Sparging Plume C
CTO NO.: 323
BORING NO.: MW3551B

SAMPLE TYPE		DEFINITIONS
S = Split Spoon	A = Auger	SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5')
T = Shelby Tube	W = Wash	RQD = Rock Quality Designation (%)
R = Air Rotary	C = Core	PID = Photoionization Detector
D = Denison	P = Piston	ppm = parts per million
N = No Sample		

Depth (ft.)		Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
31	31.0	S-15	90%	6 9		.8/.8	Continued from Sheet 2 SAND, fine grained, trace silt trace clay, trace shell mat.		
32							End of Boring		
33							TD: 31.0' (bgs)		
34									
35									
6									
7									
8									
9									
0									
1									
2									
3									
4									
5									
6									
7									
8									
9									
0									

DRILLING CO.: Parratt-Wolff
BAKER REP.: J.E. Zimmerman
DRILLER: R. Bush
BORING NO.: MW3551B
SHEET 3 OF 3

Baker
Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-Situ Air Sparging Plume C
CTO NO.: 323 BORING NO.: MW3552A
COORDINATES: EAST: NORTH:
ELEVATION: SURFACE: TOP OF PVC CASING:

RIG: #82					DATE	PROGRESS (FT.)	WEATHER	WATER DEPTH (FT.)	TIME
	SPLIT SPOON	CASING	AUGERS	CORE BARREL					
SIZE (DIAM.)	1-3/8"		6-1/4"		8-24-96	0-23.0'	clear, warm (70's)		
LENGTH	2.0		5.0						
TYPE	Std.		HSA						
HAMMER WT.	140 lbs.								
FALL	30"								
STICK UP									

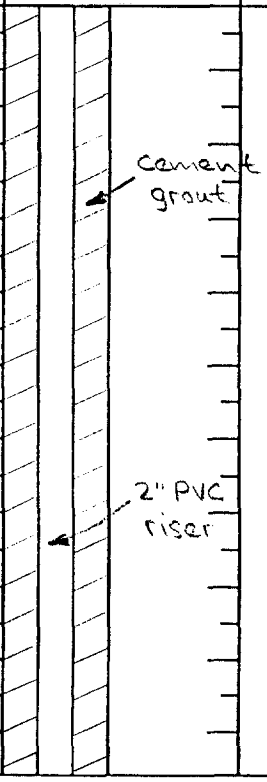
REMARKS: Auger to 5.0' (bgs). Drill from 5.0' (bgs) to 23.0' (bgs). No split spoon samples were collected. HNu background is .5ppm.

SAMPLE TYPE

S = Split Spoon
T = Shelby Tube
R = Air Rotary
D = Denison
A = Auger
W = Wash
C = Core
P = Piston
N = No Sample

Well Information	Diam.	Type	Top Depth (ft.)	Bottom Depth (ft.)
Riser	2.0"	Schedule 40 PVC	+3.0	-18.0
Screen	2.0"	Schedule 40 0.01 Slot	-18.0	-23.0

Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
1								
2								
3	A-N	–	–		.5/.5	Auger to 5.0' (bgs)		
4								
5 5.0								
6								
7								
8	N	–	–		.5/.5	Drill to 23.0' (bgs)		
9								
10						Match to Sheet 2		



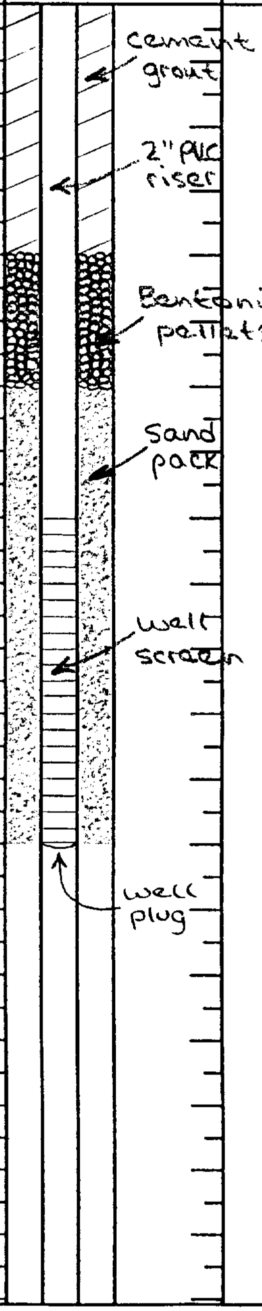
DRILLING CO.: Parratt-Wolff BAKER REP.: J.E Zimmerman
DRILLER: R. Bush BORING NO.: MW3552A SHEET 1 OF 2

Baker
Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-Situ Air Sparging Plume C
CTO NO.: 323
BORING NO.: MW3552A

SAMPLE TYPE	DEFINITIONS
S = Split Spoon T = Shelby Tube R = Air Rotary D = Denison A = Auger W = Wash C = Core P = Piston N = No Sample	SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5') RQD = Rock Quality Designation (%) PID = Photoionization Detector ppm = parts per million

Depth (ft.)		Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
							Continued from Sheet 1		
11									
12									
13									
14									
15		N	—	—		.5/.5	Drill to 23.0' (bgs)		
16									
17									
18									
19									
20									
21									
22									
23	23.0						End of Boring TD: 23.0' (bgs)		
24									
25									
26									
27									
28									
29									
30									

DRILLING CO.: Parratt-Wolff
BAKER REP.: J.E. Zimmerman

DRILLER: R. Bush
BORING NO.: MW3552A
SHEET 2 OF

Baker
Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-Situ Air Sparging Plume C
CTO NO.: 323 BORING NO.: MW35S2B
COORDINATES: EAST: NORTH:
ELEVATION: SURFACE: TOP OF PVC CASING:

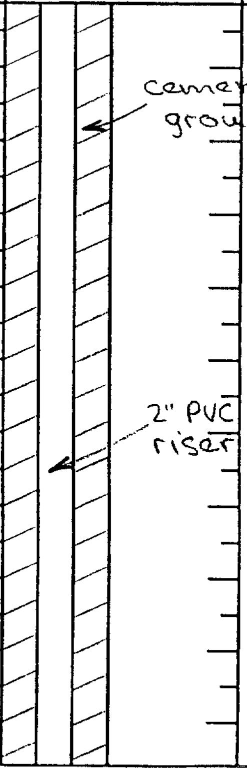
RIG: #82					DATE	PROGRESS (FT.)	WEATHER	WATER DEPTH (FT.)	TIME
	SPLIT SPOON	CASING	AUGERS	CORE BARREL					
SIZE (DIAM.)	1-3/8"		6-1/4"		8-24-96	0-32.0	Clear, warm humid (70's)		
LENGTH	2.0		5.0						
TYPE	Std.		HSA						
HAMMER WT.	140 lbs.								
FALL	30"								
STICK UP									

REMARKS: Auger to 5.0' (bgs). Sampled at 5' intervals from 5.0' (bgs) to 32.0' (bgs). HNu background is .5ppm.

SAMPLE TYPE

S = Split Spoon A = Auger
T = Shelby Tube W = Wash
R = Air Rotary C = Core
D = Denison P = Piston
N = No Sample

Well Information	Diam.	Type	Top Depth (ft.)	Bottom Depth (ft.)
Riser	2.0"	Schedule 40 PVC	+3.0	-22.0
Screen	2.0"	Schedule 40 0.01 Slot	-22.0	-27.0

Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
1 2 3 4 5 5.0	A-N	–	–		.5/.5	Auger to 5.0' (bgs)		
6 7 7.0	S-1	.6/2.0 30%	1 1 1 3		.5/.5	Sandy CLAY w/some silt. Oxidation (orange/brown) stain is traceable. Gray, very loose, moist		
8 9 10 10.0	N				.5/.5			
	S-2	60%			.5/.5	Match to Sheet 2		

DRILLING CO.: Parratt-Wolff BAKER REP.: J. E. Zimmerman
DRILLER: R. Bush BORING NO.: MW35S2B SHEET 1 OF 3

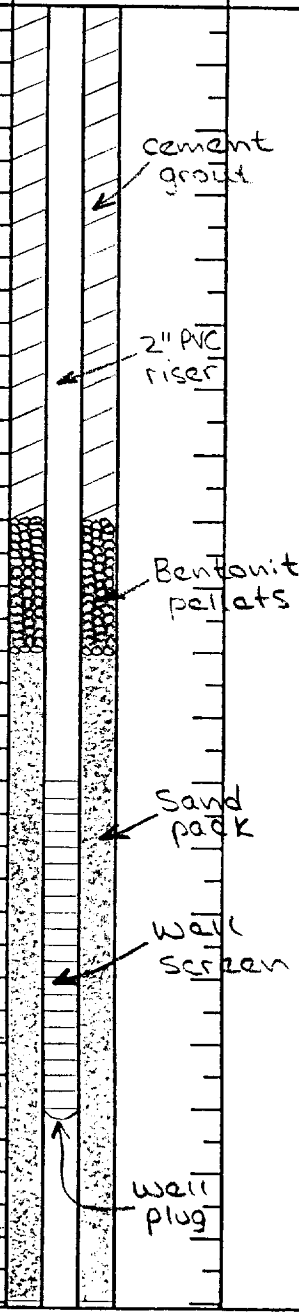
Baker
Baker Environmental, Inc

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-Situ Air Sparging Plume C
CTO NO.: 323
BORING NO.: MW3552B

SAMPLE TYPE		DEFINITIONS
S = Split Spoon	A = Auger	SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5')
T = Shelby Tube	W = Wash	RQD = Rock Quality Designation (%)
R = Air Rotary	C = Core	PID = Photoionization Detector
D = Denison	P = Piston	ppm = parts per million
N = No Sample		

Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
11 12 12.0	S-2	1.2/2.0 60%	3 3 3 1		.5/.5	Continued from Sheet 1 Silty CLAY w/trace Sand fine grained. Oxidation (orange/brown) stain is traceable. Gray soft to medium stiff, moist		
13 14 15 15.0	N				.5/.5			
16 17 17.0	S-3	1.3/2.0 65%	3 WOH/18"		.5/.5	CLAY w/ Silt. Dark greenish gray, very soft (plastic), moist		
18 19 20 20.0	N				.5/.5			
21 22 22.0	S-4	1.2/2.0 60%	1 2 2 3		.5/.5	SAND, fine to medium grained w/trace silt Gray to brown, loose, wet		
23 24 25 25.0	N				.5/.5			
26 27 27.0	S-5	1.6/2.0 80%	3 4 5 8		.5/.5	SAND, fine to medium grained, trace silt cemented shell material, trace shell fragments		
28 29 30 30.0	N				.5/.5	SAND, fine grained, trace silt, little cemented sandstone nodules, trace to little cemented shell mat. Brown/light greenish gray/light gray, wet		



DRILLING CO.: Parratt-Wolff
BAKER REP.: J.E. Zimmerman
DRILLER: R. Bush
BORING NO.: MW3552B
SHEET 2 OF 3

Baker
Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-Situ Air Sparging Plume C
CTO NO.: 323
BORING NO.: MW3552B

SAMPLE TYPE	DEFINITIONS
S = Split Spoon T = Shelby Tube R = Air Rotary D = Denison A = Auger W = Wash C = Core P = Piston N = No Sample	SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5') RQD = Rock Quality Designation (%) PID = Photoionization Detector ppm = parts per million

Depth (ft.)		Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
							Continued from Sheet 2		
31		S-6	2.0/2.0	12 10		.5/.5	SAND, fine grained cemented shells (micrite) SAND, fine grained, tr. silt tr. clay, tr shell mat. Greenish gray/white, damp		
32	32.0		100%	15 12					
33							End of Boring		
34							TD: 32.0' (bgs)		
35									
6									
7									
8									
9									
0									
1									
2									
3									
4									
5									
6									
7									
8									
9									
0									

DRILLING CO.: Parratt-Wolff
BAKER REP.: J.E. Zimmerman
DRILLER: R. Bush
BORING NO.: MW3552B
SHEET 3 OF

Baker
Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-Situ Air Sparging, Plume C
CTO NO.: 323 BORING NO.: MW3553A
COORDINATES: EAST: NORTH:
ELEVATION: SURFACE: TOP OF PVC CASING:

RIG: #82	SPLIT SPOON	CASING	AUGERS	CORE BARREL	DATE	PROGRESS (FT.)	WEATHER	WATER DEPTH (FT.)	TIME
SIZE (DIAM.)	1-3/8"		6-1/4"		8-26-96	0 - 21.0	Partly cloudy mild (60's)		
LENGTH	2.0		5.0						
TYPE	Std.		HSA						
HAMMER WT.	140 lbs.								
FALL	30"								
STICK UP									

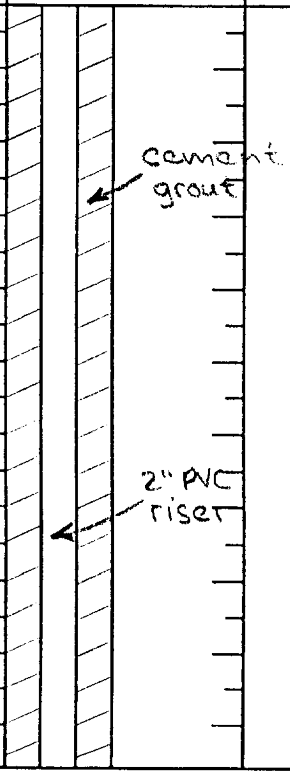
REMARKS: Augered to 5.0' (bgs). Drilled from 5.0' (bgs) to 21.0' (bgs). HNu background is .4 ppm. No split spoon samples were collected.

SAMPLE TYPE

S = Split Spoon A = Auger
T = Shelby Tube W = Wash
R = Air Rotary C = Core
D = Denison P = Piston
N = No Sample

Well Information	Diam.	Type	Top Depth (ft.)	Bottom Depth (ft.)
Riser	2.0"	Schedule 40 PVC	+ 3.0	-15.5
Screen	2.0"	Schedule 40 0.01 Slot	-15.5	-20.5

Depth (ft.)		Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
1									
2									
3		N	—	—		.4/.4	Auger to 5.0' (bgs)		
4									
5	5.0								
6									
7									
8						.4/.4	Drill to 21.0' (bgs)		
9									
10							Match to Sheet 2		



DRILLING CO.: Parratt-Wolff BAKER REP.: J. E. Zimmerman
DRILLER: R. Bush BORING NO.: MW3553A SHEET 1 OF 2

Baker

Baker Environmental, Inc.

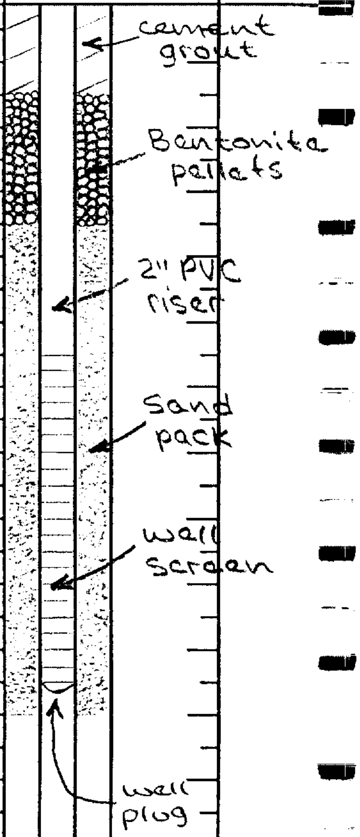
TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-Situ Air Sparging Plume C

CTO NO.: 323 BORING NO.: MW3553A

SAMPLE TYPE		DEFINITIONS
S = Split Spoon	A = Auger	SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5')
T = Shelby Tube	W = Wash	RQD = Rock Quality Designation (%)
R = Air Rotary	C = Core	PID = Photoionization Detector
D = Denison	P = Piston	ppm = parts per million
N = No Sample		

Depth (ft.)		Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MS'
							Continued from Sheet 1		
11									
12									
13									
14									
15		N	—	—		.4/.4	Drill to 21.0' (bgs)		
16									
17									
18									
19									
20									
21	21.0								
22							End of Boring		
23							TD: 21.0' (bgs)		
24									
25									
26									
27									
28									
29									
30									



DRILLING CO.: Parratt-Wolff BAKER REP.: J. E. Zimmerman

DRILLER: R. Bush BORING NO.: MW3553A SHEET 2 O

Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-Situ Air Sparging Plume C
CTO NO.: 323
BORING NO.: MW3553B
COORDINATES: EAST:
NORTH:
ELEVATION: SURFACE:
TOP OF PVC CASING:

RIG: #82

	SPLIT SPOON	CASING	AUGERS	CORE BARREL
SIZE (DIAM.)	1-3/8"		6-1/4"	
LENGTH	2.0		5.0	
TYPE	Std.		HSA	
HAMMER WT.	140 lbs.			
FALL	30"			
STICK UP				

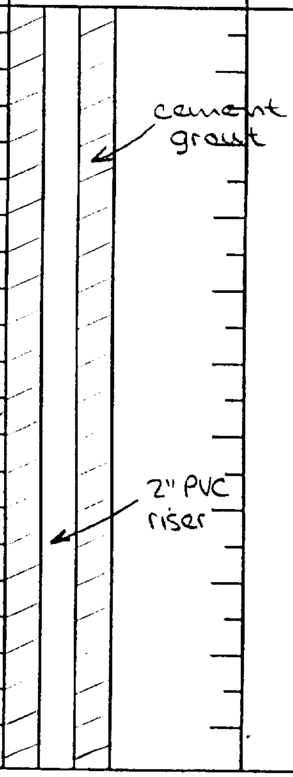
DATE	PROGRESS (FT.)	WEATHER	WATER DEPTH (FT.)	TIME
8-25-96	0-32.0	clear, very warm (80's)		

REMARKS: Augered to 5.0' (bgs). Sampled at 5' intervals from 5.0' (bgs) to 32.0' (bgs). HNu background is .4 ppm.

SAMPLE TYPE

S = Split Spoon
T = Shelby Tube
R = Air Rotary
D = Denison
A = Auger
W = Wash
C = Core
P = Piston
N = No Sample

Well Information	Diam.	Type	Top Depth (ft.)	Bottom Depth (ft.)
Riser	2.0"	Schedule 40 PVC	+3.0	-22.0
Screen	2.0"	Schedule 40 0.01 Slot	-22.0	-27.0

Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
1 2 3 4 5 — 5.0	AN	–	–		.4/.4	Auger to 5.0' (bgs)	 cement grout 2" PVC riser	
6 7 — 7.0	S-1	2.0/2.0 100%	WOH 18" 1		.4/.4	Sandy CLAY/CLAY w/ some silt. Oxidation "local deposits"/streaks (orange) are traceable. Bluish gray/greenish gray, very soft (little plastic), damp		
8 9 10 — 10.0	N	–	–		.4/.4			
	S-2	100%			.4/4	Match to Sheet 2		

DRILLING CO.: Parratt-Wolff
BAKER REP.: J.E. Zimmerman
DRILLER: R. Bush
BORING NO.: MW3553B
SHEET 1 OF 3

Baker
Baker Environmental, Inc.

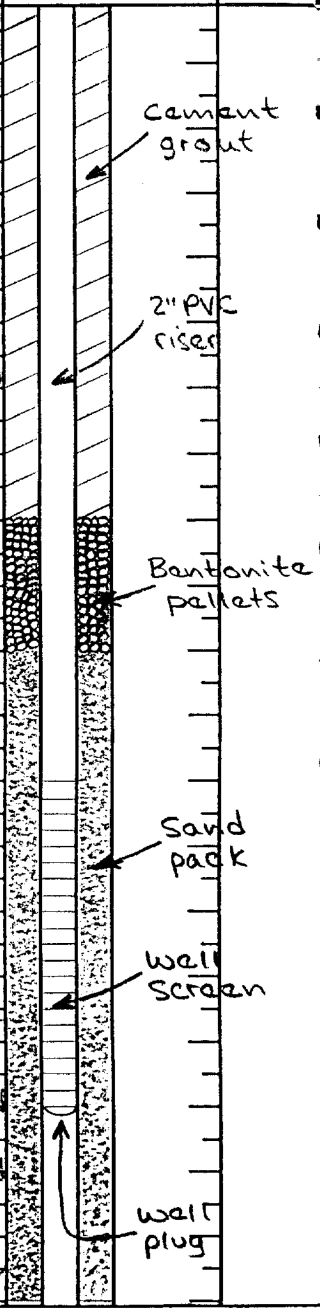
TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-Situ Air Sparging Plume C
CTO NO.: 323
BORING NO.: MW35S3B

SAMPLE TYPE		DEFINITIONS
S = Split Spoon	A = Auger	SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5')
T = Shelby Tube	W = Wash	RQD = Rock Quality Designation (%)
R = Air Rotary	C = Core	PID = Photoionization Detector
D = Denison	P = Piston	ppm = parts per million
N = No Sample		

Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Elevation (ft. MS
11 12 12.0	S-2	2.0/2.0 100%	2 2 2 2		.4/.4	Continued from Sheet 1 CLAY w/some silt. Brownish gray, soft (little plastic), damp	
13 14 15 15.0	N	-	-		.4/.4		
16 17 17.0	S-3	2.0/2.0 100%	1 2 3 4		.4/.4	CLAY w/some silt. Dark gray, soft (little plastic) damp.	
18 19 20 20.0	N	-	-		.4/.4	SAND, fine to medium grained w/trace silt, cemented shell material, trace shell fragments. Brown to yellowish brown to light greenish gray, loose to medium dense, wet.	
21 22 22.0	S-4	1.0/2.0 50%	3 3 1 1		.4/.4		
23 24 25 25.0	N	-	-		.4/.4		
26 27 27.0	S-5	1.9/2.0 95%	8 9 9 10		.4/.4	SAND, fine to medium grained, trace silt, little to some cemented sandstone nodules, trace to some cemented shell mat./fragments Light greenish gray to light gray/white, medium dense, wet.	
28 29 30 30.0	N	-	-		.4/.4		

Well Installation Detail



DRILLING CO.: Parratt-Wolff
BAKER REP.: J. E. Zimmerman
DRILLER: R. Bush
BORING NO.: MW35S3B
SHEET 2 O

Baker
Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-Situ Air Sparging Plume C.
CTO NO.: 323 BORING NO.: MW35S3B

SAMPLE TYPE		DEFINITIONS
S = Split Spoon	A = Auger	SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5')
T = Shelby Tube	W = Wash	RQD = Rock Quality Designation (%)
R = Air Rotary	C = Core	PID = Photoionization Detector
D = Denison	P = Piston	ppm = parts per million
N = No Sample		

Depth (ft.)		Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
			2.0/2.0	6			Continued from Sheet 2		
31		S-6		6 9		.4/.4	SAND, fine grained w/ trace silt, trace clay trace shell mat, Greenish gray/white, damp		
32	32.0		100%	8					
33							End of Boring		
34							TD: 32.0' (bgs)		
35									
6									
7									
8									
9									
0									
1									
2									
3									
4									
5									
6									
7									
8									
9									
0									

DRILLING CO.: Parratt-Wolff BAKER REP.: J. E. Zimmerman

DRILLER: R. Bush BORING NO.: MW35S3B SHEET 3 OF 3

Baker
Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-Situ Air Sparging Plume C
CTO NO.: 323
BORING NO.: MW3554A
COORDINATES: EAST:
NORTH:
ELEVATION: SURFACE:
TOP OF PVC CASING:

RIG: #82

	SPLIT SPOON	CASING	AUGERS	CORE BARREL	DATE	PROGRESS (FT.)	WEATHER	WATER DEPTH (FT.)	TIME
SIZE (DIAM.)	1-3/8"		6-1/4"		8-25-96	0-23.0	mostly cloudy, mild (60's)		
LENGTH	2.0		5.0						
TYPE	Std.		HSA						
HAMMER WT.	140 lbs.								
FALL	30"								
STICK UP									

REMARKS: Augered to 5.0' (bgs). Drilled from 5.0' (bgs) to 23.0' (bgs). No split spoon samples were collected. Hnu background is .4ppm

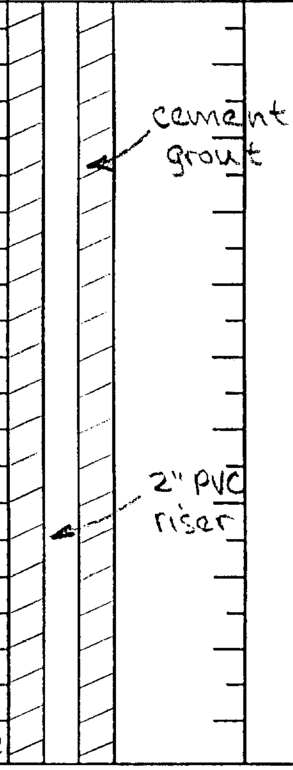
SAMPLE TYPE

S = Split Spoon
T = Shelby Tube
R = Air Rotary
D = Denison
A = Auger
W = Wash
C = Core
P = Piston
N = No Sample

Well Information	Diam.	Type	Top Depth (ft.)	Bottom Depth (ft.)
Riser	2.0"	Schedule 40 PVC	+3.0	-18.0
Screen	2.0"	Schedule 40 0.01 Slot	-18.0	-23.0

Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
1								
2								
3	A-N	–	–		.4/.4	Auger to 5.0' (bgs)		
4								
5 (5.0)								
6								
7								
8	N	–	–		.4/.4	Drill to 23.0' (bgs)		
9								
10								

Match to Sheet 2



DRILLING CO.: Parratt-Wolff
BAKER REP.: J. E. Zimmerman
DRILLER: R. Bush
BORING NO.: MW3554A
SHEET 1 OF

Baker
Baker Environmental, Inc

TEST BORING AND WELL CONSTRUCTION RECORD

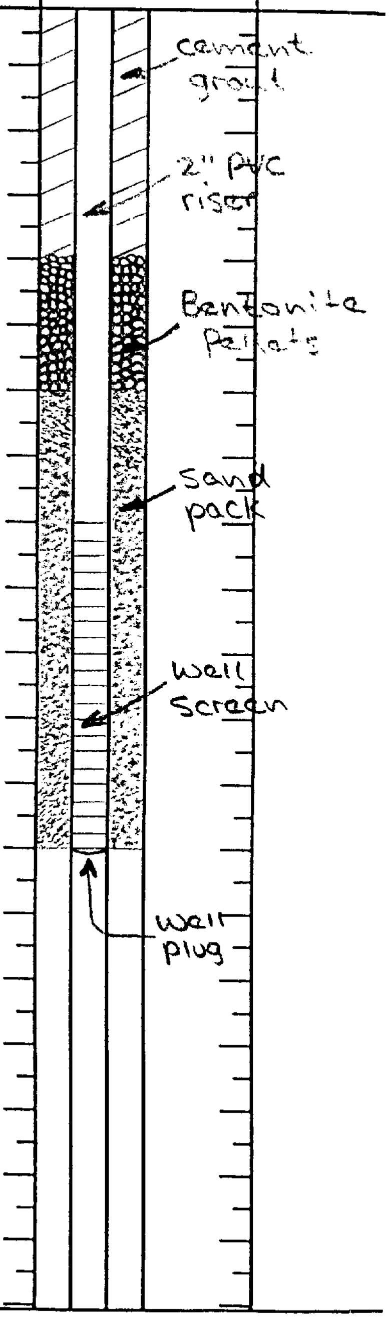
PROJECT: Treatability Study In-Situ Air Sparging Plumec
CTO NO.: 323
BORING NO.: MW3554A

SAMPLE TYPE

S = Split Spoon
T = Shelby Tube
R = Air Rotary
D = Denison
A = Auger
W = Wash
C = Core
P = Piston
N = No Sample

DEFINITIONS

SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5')
RQD = Rock Quality Designation (%)
PID = Photoionization Detector
ppm = parts per million

Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
						Continued from Sheet 1		
11								
12								
13								
14								
15								
16	N	-	-		.4/.4	Drill to 23.0' (bgs)		
17								
18								
19								
20								
21								
22								
23								
23.0						End of Boring		
24								
25						TD: 23.0' (bgs)		
26								
27								
28								
29								
30								

DRILLING CO.: Parratt-Wolff
BAKER REP.: J.E. Zimmerman
DRILLER: R. Bush
BORING NO.: MW3554A
SHEET 2 OF

Baker
Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-Situ Air Sparging Plume C
CTO NO.: 323
BORING NO.: MW35S4B
COORDINATES: EAST:
NORTH:
ELEVATION: SURFACE:
TOP OF PVC CASING:

RIG: #82	SPLIT SPOON	CASING	AUGERS	CORE BARREL
SIZE (DIAM.)	1-3/8"		6-1/4"	
LENGTH	2.0		5.0	
TYPE	Std.		HSA	
HAMMER WT.	140 lbs.			
FALL	30"			
STICK UP				

DATE	PROGRESS (FT.)	WEATHER	WATER DEPTH (FT.)	TIME
8-24-96	0 - 17.0	partly cloudy, very warm (80's)		
8-25-96	17 - 32.0	mostly cloudy, mild (60's)		

REMARKS: Augered to 5.0' (bgs). Sampled at 5.0' intervals from 5.0' (bgs) to 32.0' (bgs). HNu background range is .4ppm to .5ppm.

SAMPLE TYPE

S = Split Spoon
T = Shelby Tube
R = Air Rotary
D = Denison
A = Auger
W = Wash
C = Core
P = Piston
N = No Sample

Well Information	Diam.	Type	Top Depth (ft.)	Bottom Depth (ft.)
Riser	2.0"	Schedule 40 PVC	+3.0	-22.0
Screen	2.0"	Schedule 40 0.01 Slot	-22.0	-27.0

Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
1 2 3 4 5 5.0	A-N	-	-		.5/.5	Auger to 5.0' (bgs)	Cement grout	
6 7 7.0	S-1	NR	WOH/24"		.5/.5	NO Recovery	2" PVC riser	
8 9 10 10.0	N	-	-		.5/.5			
	S-2	100%			.5/.5	Match to Sheet 2		

DRILLING CO.: Parratt-Wolff
BAKER REP.: J.E. Zimmerman
DRILLER: R. Bush
BORING NO.: MW35S4B
SHEET 1 OF 3

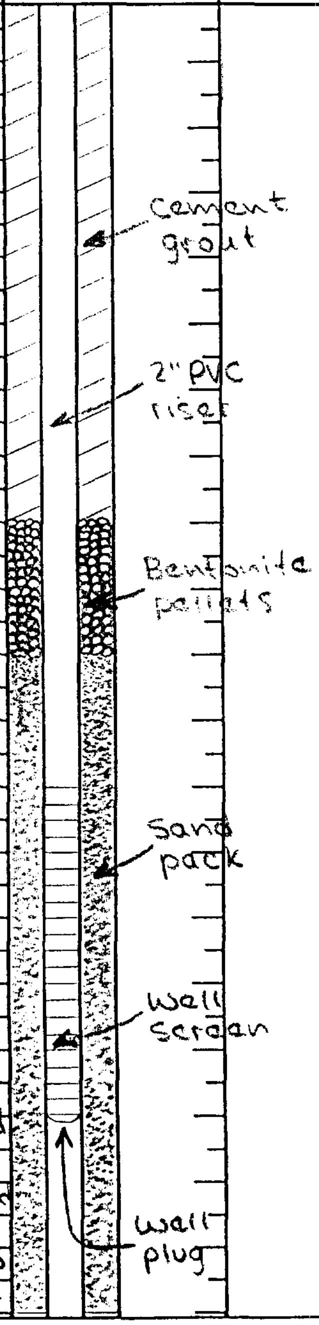
Baker
Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-Situ Air Sparging Plume C
CTO NO.: 323
BORING NO.: MW3554B

SAMPLE TYPE	DEFINITIONS
S = Split Spoon T = Shelby Tube R = Air Rotary D = Denison A = Auger W = Wash C = Core P = Piston N = No Sample	SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5') RQD = Rock Quality Designation (%) PID = Photoionization Detector ppm = parts per million

Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
11 12 12.0	S-2	2.0/2.0 100%	WOH/24"		.5/.5	Continued from Sheet 1 CLAY w/little silt, tr. sand, fine grained oxidation (orange brown) staining. Gray, very soft (plastic) moist		
13 14 15 15.0	N	–	–		.5/.5			
16 17 17.0	S-3	2.0/2.0 100%	WOH/12" 1 2		.5/.5	CLAY w/silt. Dark olive gray, very soft (plastic), moist		
18 19 20 20.0	N	–	–		.4/.4			
21 22 22.0	S-4	1.4/2.0 70%	2 2 3 1		.4/.4	SAND, fine to medium grained w/trace silt cemented shell material, trace shell fragments. Brown to yellowish brown to light greenish gray, loose to medium dense, wet.		
23 24 25 25.0	N	–	–		.4/.4			
26 27 27.0	S-5	1.8/2.0 90%	4 12 10 16		.4/.4	SAND, fine to medium grained, trace silt, little to some cemented sandstone nodules, trace to some cemented shell mat. / fragments Light greenish gray to light gray/white, med. dense, wet.		
28 29 30 30.0	N	–	–		.4/.4			



DRILLING CO.: Parratt-Wolff
BAKER REP.: J.E. Zimmerman
DRILLER: R. Bush
BORING NO.: MW3554B
SHEET 2 OF

Baker
Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-Situ Air Sparging Plume C
CTO NO.: 323
BORING NO.: MW35S4B

SAMPLE TYPE

S = Split Spoon
T = Shelby Tube
R = Air Rotary
D = Denison
A = Auger
W = Wash
C = Core
P = Piston
N = No Sample

DEFINITIONS

SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5')
RQD = Rock Quality Designation (%)
PID = Photoionization Detector
ppm = parts per million

Depth (ft.)		Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
							Continued from Sheet 2		
31		S-6	1.8/2.0 90%	10 10 13 13		.4/.4	SAND, Fine grained, tr. silt, tr. clay, tr. shell mat. Greenish gray/white medium dense, damp		
32	32.0								
33							End of Boring		
34							TD: 32.0' (bgs)		
35									
6									
7									
8									
9									
0									
1									
2									
3									
4									
5									
6									
7									
8									
9									
0									

DRILLING CO.: Parratt-Wolff
BAKER REP.: J.E. Zimmerman
DRILLER: R. Bush
BORING NO.: MW35S4B
SHEET 3 OF

Baker
Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-Situ Air Sparging Plume C
CTO NO.: 323
BORING NO.: MW35SSA
COORDINATES: EAST:
NORTH:
ELEVATION: SURFACE:
TOP OF PVC CASING:

RIG: #82				
	SPLIT SPOON	CASING	AUGERS	CORE BARREL
SIZE (DIAM.)	1-3/8"		6-1/4"	
LENGTH	2.0		5.0	
TYPE	Std.		HSA	
HAMMER WT.	140 lbs.			
FALL	30"			
STICK UP				

DATE	PROGRESS (FT.)	WEATHER	WATER DEPTH (FT.)	TIME
8-24-96	0-12.0	clear, warm humid (70's)		

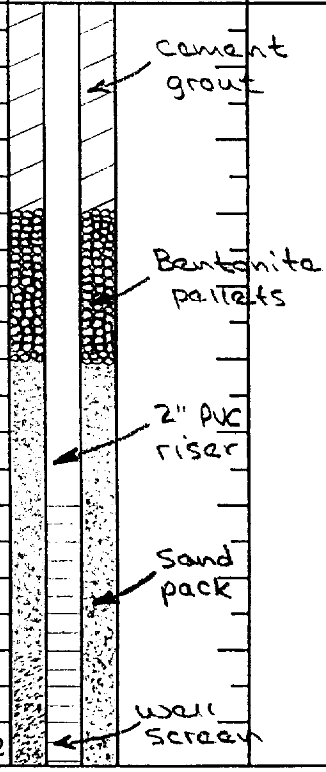
REMARKS: Augered to 12.0'(bgs). Split spoon sample collected from 7.0' (bgs) to 9.0'(bgs) only. HNu background is .5 ppm.

SAMPLE TYPE

S = Split Spoon
T = Shelby Tube
R = Air Rotary
D = Denison
A = Auger
W = Wash
C = Core
P = Piston
N = No Sample

Well Information	Diam.	Type	Top Depth (ft.)	Bottom Depth (ft.)
Riser	2.0"	Schedule 40 PVC	+3.0	-7.0
Screen	2.0"	Schedule 40 0.01 Slot	-7.0	-12.0

Depth (ft.)		Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
1									
2									
3									
4		A-N	—	—		.5/.5	Auger to 7.0'(bgs)		
5									
6									
7	7.0								
8		S-1	1.0/2.0	1 3 3 2		.5/.5	Sandy CLAY w/ some silt SAND, fine grained w/ trace silt. Oxidation (orange) staining. Bluish gray, soft to loose, moist		
9	9.0		50%						
10		A-N	—	—		.5/.5	Auger to 12.0'(bgs) ↓ Match to Sheet 2		



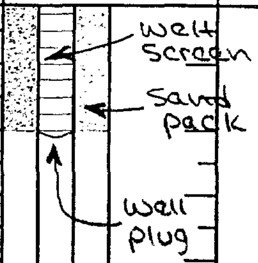
DRILLING CO.: Parratt-Wolff
BAKER REP.: J.E. Zimmerman
DRILLER: R. Bush
BORING NO.: MW35SSA
SHEET 1 OF 2

Baker
Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-Situ Air Sparging Plume C
CTO NO.: 323
BORING NO.: MW35S5A

SAMPLE TYPE		DEFINITIONS
S = Split Spoon	A = Auger	SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5')
T = Shelby Tube	W = Wash	RQD = Rock Quality Designation (%)
R = Air Rotary	C = Core	PID = Photoionization Detector
D = Denison	P = Piston	ppm = parts per million
N = No Sample		

Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MS
						Continued from Sheet 1		
11	A-N	–	–		.5/.5	Auger to 12.0' (bgs)		
12 12.0								
13						End of Boring		
14						TD: 12.0' (bgs)		
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								
30								

DRILLING CO.: Parratt-Wolff
BAKER REP.: J. E. Zimmerman
DRILLER: R. Bush
BORING NO.: MW35S5A
SHEET 2 O

Baker
Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-Situ Air Sparging Plume C
CTO NO.: 323
BORING NO.: MW35SSB
COORDINATES: EAST:
NORTH:
ELEVATION: SURFACE:
TOP OF PVC CASING:

RIG: #82

	SPLIT SPOON	CASING	AUGERS	CORE BARREL	DATE	PROGRESS (FT.)	WEATHER	WATER DEPTH (FT.)	TIME
SIZE (DIAM.)	1-3/8"		6-1/4"		8-23-96	0-32.0	Clear, warm humid (80's)		
LENGTH	2.0		5.0						
TYPE	Std.		HSA						
HAMMER WT.	140 lbs.								
FALL	30"								
STICK UP									

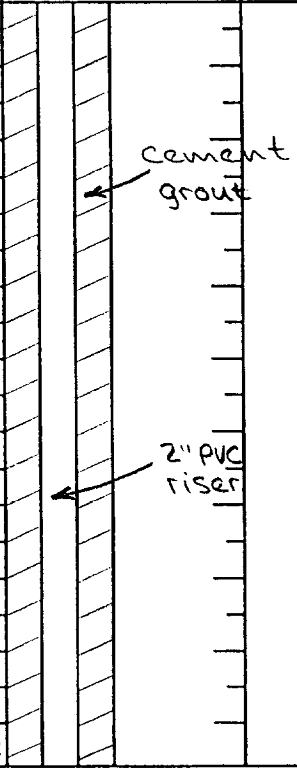
REMARKS: Augered to 5.0' (bgs). Sampled at 5' intervals from 5.0' (bgs) to 32.0' (bgs). Hnu background is .5 ppm

SAMPLE TYPE

S = Split Spoon
T = Shelby Tube
R = Air Rotary
D = Denison
A = Auger
W = Wash
C = Core
P = Piston
N = No Sample

Well Information	Diam.	Type	Top Depth (ft.)	Bottom Depth (ft.)
Riser	2.0"	Schedule 40 PVC	+3.0	-21.0
Screen	2.0"	Schedule 40 0.01 Slot	-21.0	-26.0

Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
0–5.0	A-N	—	—		.5/.5	Auger to 5.0' (bgs)		
5.0–7.0	S-1	1.7/2.0 85%	1 1 1 3		.5/.5	Sandy CLAY w/ some silt. Oxidation (dark brownish orange "local deposits" and streaks. Blueish gray to greenish gray, soft (little plastic), damp		
7.0–10.0					.5/.5			
10.0	S-2	65%			.5/.5	Match to Sheet 2		



DRILLING CO.: Parratt-Wolff
BAKER REP.: J.E Zimmerman
DRILLER: R. Bush
BORING NO.: MW35SSB
SHEET 1 OF 3

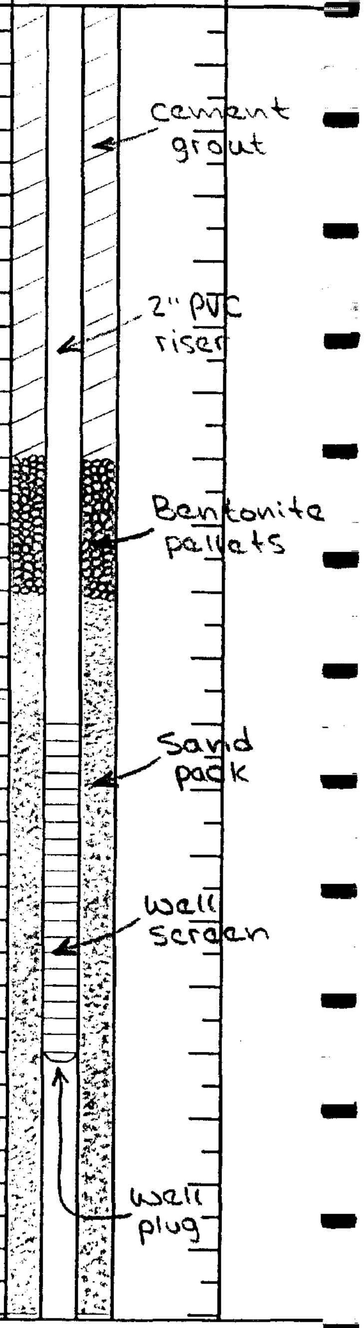
Baker
Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-Situ Air Sparging Plume C
CTO NO.: 323 BORING NO.: MW35SSB

SAMPLE TYPE	DEFINITIONS
S = Split Spoon T = Shelby Tube R = Air Rotary D = Denison A = Auger W = Wash C = Core P = Piston N = No Sample	SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5') RQD = Rock Quality Designation (%) PID = Photoionization Detector ppm = parts per million

Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MS
11 12 12.0	S-2	1.3/2.0 65%	1 1 1 3		.5/.5	Continued from Sheet 1 SAND, fine grained w/ trace silt. Gray, very loose, wet		
13 14 15 15.0					.5/.5			
16 17 17.0	S-3	1.0/2.0 50%	3 2 2 1		.5/.5	SAND, fine grained w/ little to some silt. Brownish gray loose, wet		
18 19 20 20.0					.5/.5			
21 22 22.0	S-4	1.1/2.0 55%	1 6 4 1		.5/.5	SAND, fine to medium grained w/trace silt, cemented shell mat, little cemented sandstone nodules, trace shell fragments. Brownish gray to brown/white, medium dense, wet		
23 24 25 25.0					.5/.5			
26 27 27.0	S-5	1.2/2.0 60%	16 14 10 11		.5/.5	SAND, fine grained/ CEMENTED SHELL MATERIAL/SHELL FRAGMENTS w/trace silt. Light gray/white medium dense, wet		
28 29 30 30.0					.5/.5			



DRILLING CO.: Parratt-Wolff BAKER REP.: J. E. Zimmerman
DRILLER: R. Bush BORING NO.: MW35SSB SHEET 2 O

Baker
Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-Situ Air Sparging Plume C
CTO NO.: 323 BORING NO.: MW35SSB

SAMPLE TYPE		DEFINITIONS
S = Split Spoon	A = Auger	SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5')
T = Shelby Tube	W = Wash	RQD = Rock Quality Designation (%)
R = Air Rotary	C = Core	PID = Photoionization Detector
D = Denison	P = Piston	ppm = parts per million
N = No Sample		

Depth (ft.)		Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
							Continued from Sheet 2		
31		S-6	2.0/2.0 100%	11 14 15 13		.5/.5	SAND, fine grained, tr. silt, trace clay, tr. shell material. Greenish gray/white, med. dense, damp		
32	32.0						End of Boring		
33									
34							TD: 32.0' (bgs)		
35									
6									
7									
8									
9									
0									
1									
2									
3									
4									
5									
6									
7									
8									
9									
0									

DRILLING CO.: Parratt-Wolff BAKER REP.: J. E. Zimmerman
DRILLER: R. Bush BORING NO.: MW35SSB SHEET 3 OF 3

Baker
Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-Situ Air Sparging Plume C
CTO NO.: 323 BORING NO.: MW3556B
COORDINATES: EAST: NORTH:
ELEVATION: SURFACE: TOP OF PVC CASING:

RIG: *82					DATE	PROGRESS (FT.)	WEATHER	WATER DEPTH (FT.)	TIME
	SPLIT SPOON	CASING	AUGERS	CORE BARREL					
SIZE (DIAM.)	1-3/8"		6-1/4"		8-23-96	0-34.0	clear, mild (60's)		
LENGTH	2.0		5.0						
TYPE	Std.		HSA						
HAMMER WT.	140 lbs.								
FALL	30"								
STICK UP									

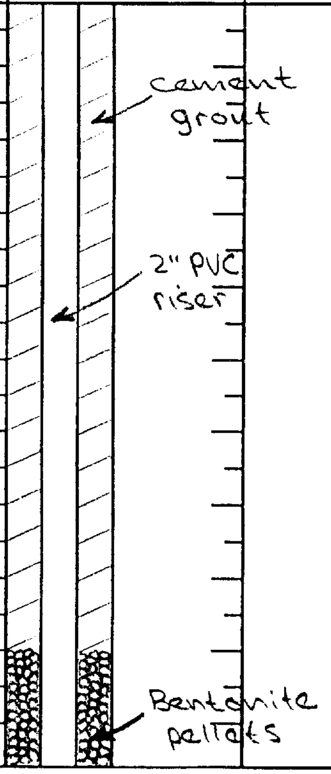
REMARKS: Augered to 5.0' (bgs). Sampled at 5' intervals from 5.0' (bgs) to 32.0' (bgs). HNu background is .5 ppm.

SAMPLE TYPE

S = Split Spoon
T = Shelby Tube
R = Air Rotary
D = Denison
A = Auger
W = Wash
C = Core
P = Piston
N = No Sample

Well Information	Diam.	Type	Top Depth (ft.)	Bottom Depth (ft.)
Riser	2.0"	Schedule 40 PVC	+3.0	-15.0
Screen	2.0"	Schedule 40 0.01 Slot	-15.0	-25.0

Depth (ft.)		Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
1									
2									
3		A-N	-	-		.5/.5	Auger to 5.0' (bgs)		
4									
5	5.0								
6		S-1	1.3/2.0	WOH/12" 1 2		.5/.5	Silty CLAY w/trace sand, fine grained Brownish gray, very soft, moist		
7	7.0		65%						
8									
9		N							
10	10.0	S-2	55%			.5/.5	Match to Sheet 2		



DRILLING CO.: Parratt-Wolff BAKER REP.: J. E. Zimmerman
DRILLER: R. Bush BORING NO.: MW3556B SHEET 1 OF

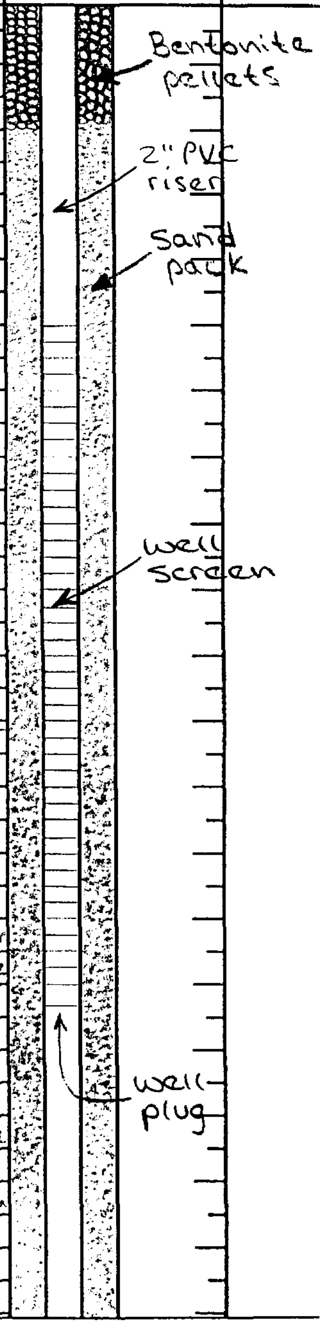
Baker
Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-Situ Air Sparging Plume C
CTO NO.: 323
BORING NO.: MW35S6B

SAMPLE TYPE	DEFINITIONS
S = Split Spoon T = Shelby Tube R = Air Rotary D = Denison A = Auger W = Wash C = Core P = Piston N = No Sample	SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5') RQD = Rock Quality Designation (%) PID = Photoionization Detector ppm = parts per million

Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
						Continued from Sheet 1		
11 12 12.0	S-2	1.1/2.0 55%	2 3 3 4		.5/.5	CLAY w/little silt, tr. sand, fine grained Oxidation (orange brown) staining. Gray soft to medium stiff, moist		
13 14 15 15.0	N							
16 17 17.0	S-3	.8/2.0 40%	2 3 3 3		.5/.5	SAND, fine grained w/trace silt. Greenish gray, loose, wet		
18 19 20 20.0	N							
21 22 22.0	S-4	1.4/2.0 70%	1 3 17 54		.5/.5	SAND, fine to medium grained w/trace silt cemented shell mat. tr. shell frags		
23 24 25 25.0	N					SAND, fine to medium grained, tr. silt, little to some cemented sandstone nodules Brown/yellowish brown light greenish gray/white		
26 27 27.0	S-5	1.6/2.0 80%	6 26 17 6		.5/.5	SAND, fine grained/ CEMENTED SHELL MATERIAL/SHELL FRAGMENTS w/trace silt. Light gray and white, medium dense, wet		
28 29 30 30.0	N							



DRILLING CO.: Parratt-Wolff
BAKER REP.: J.E. Zimmerman
DRILLER: R. Bush
BORING NO.: MW35S6B
SHEET 2 OF

Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-Situ Air Sparging Plume C
CTO NO.: 323 BORING NO.: MW3556B

SAMPLE TYPE		DEFINITIONS
S = Split Spoon	A = Auger	SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5')
T = Shelby Tube	W = Wash	RQD = Rock Quality Designation (%)
R = Air Rotary	C = Core	PID = Photoionization Detector
D = Denison	P = Piston	ppm = parts per million
N = No Sample		

Depth (ft.)		Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
31 32	320	S-6	1.8/2.0 90%	7 13 14 12		.5/.5	Continued from Sheet SAND, fine to medium grained CEMENTED SHELL MATERIAL | SHELL FRAGS tr. silt, micrite. Light gray to white, medium dense, wet	Sand pack	
33 34	340	S-7	2.0/2.0 100%	11 14 15 15		.5/.5	SAND, fine grained, trac clay, dam		
35							End of Boring TD: 34.0' (bgs)		
6									
7									
8									
9									
0									
1									
2									
3									
4									
5									
6									
7									
8									
9									
0									

DRILLING CO.: Parratt-Wolff BAKER REP.: J.E. Zimmerman

DRILLER: R. Bush BORING NO.: MW3556B SHEET 3 OF

Baker
Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-Situ Air Sparging Plume C
CTO NO.: 323
BORING NO.: MW3557B
COORDINATES: EAST:
NORTH:
ELEVATION: SURFACE:
TOP OF PVC CASING:

RIG: #82

	SPLIT SPOON	CASING	AUGERS	CORE BARREL
SIZE (DIAM.)	1-3/8"		6-1/4"	
LENGTH	2.0		5.0	
TYPE	Std.		HSA	
HAMMER WT.	140 lbs.			
FALL	30"			
STICK UP				

DATE	PROGRESS (FT.)	WEATHER	WATER DEPTH (FT.)	TIME
8-22-96	0-32.0	Partly cloudy vary warm (80's)		

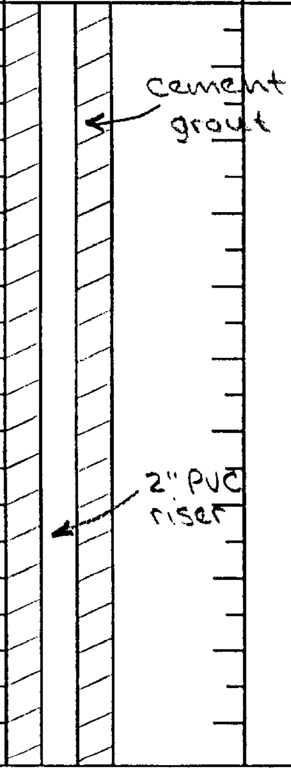
REMARKS: Augered to 5.0' (bgs). Sampled at 5' intervals from 5.0' (bgs) to 32.0' (bgs). Hnu background is .4 ppm.

SAMPLE TYPE

S = Split Spoon
T = Shelby Tube
R = Air Rotary
D = Denison
A = Auger
W = Wash
C = Core
P = Piston
N = No Sample

Well Information	Diam.	Type	Top Depth (ft.)	Bottom Depth (ft.)
Riser	2.0"	Schedule 40 PVC	+3.0	-17.0
Screen	2.0"	Schedule 40 0.01 Slot	-17.0	-27.0

Depth (ft.)		Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
1 2 3 4 5	5.0	A-N	–	–		.4/.4	Augered to 5.0' (bgs)		
6 7	7.0	S-1	1.2/2.0 60%	WOH/24"		.4/.4	Silty CLAY w/ trace sand, fine grained Brownish gray, very soft, moist		
8 9 10	10.0	N				.4/.4			
		S-2	NR			.4/.4	Match to Sheet 2		



DRILLING CO.: Parratt-Wolff
BAKER REP.: J. E. Zimmerman
DRILLER: R. Bush
BORING NO.: MW3557B
SHEET 1 OF 3

Baker

Baker Environmental, Inc.

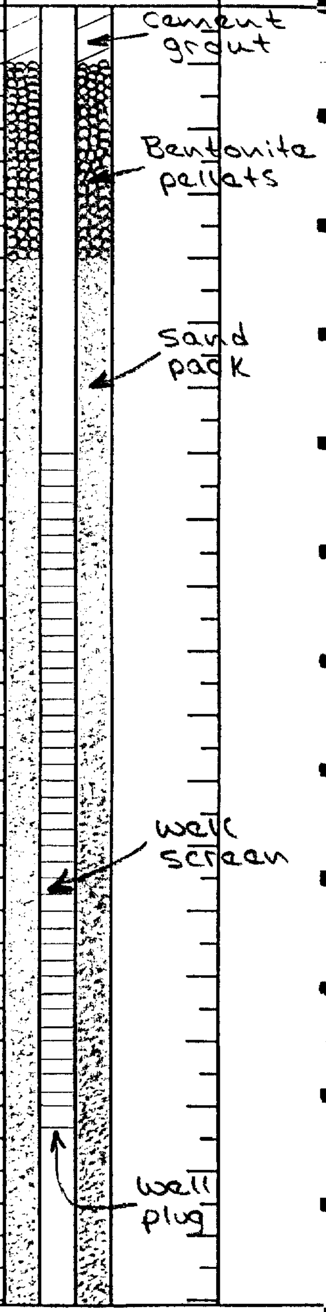
TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-Situ Air Sparging Plume C

CTO NO.: 323

BORING NO.: MW35S7B

SAMPLE TYPE		DEFINITIONS
S = Split Spoon	A = Auger	SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5')
T = Shelby Tube	W = Wash	RQD = Rock Quality Designation (%)
R = Air Rotary	C = Core	PID = Photoionization Detector
D = Denison	P = Piston	ppm = parts per million
N = No Sample		

Depth (ft.)		Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MS
							Continued from Sheet 1		
11 12	12.0	S-2	NR	WOH/12" 1-1		.4/.4	No Recovery		
13 14 15	15.0	N.				.4/.4			
16 17	17.0	S-3	1.9/2.0 95%	WOH/18" 1		.4/.4	CLAY w/ silt. Greenish gray, very soft, moist		
18 19 20	20.0	N				.4/.4			
21 22	22.0	S-4	1.0/2.0 50%	1 2 2 3		.4/.4	SAND, fine grained w/little silt. Dark gray, loose, wet		
23 24 25	25.0	N				.4/.4			
26 27	27.0	S-5	1.8/2.0 90%	7 10 13 15		.4/.4	SAND, fine to medium grained, tr. silt, cemented shell material, tr. shell fragments.		
28 29 30	30.0	N				.4/.4	SAND, fine to medium grained, tr. silt, little cemented sandstone nodules tr. to little cemented shells		

DRILLING CO.: Parratt-Wolff

BAKER REP.: J.E. Zimmerman

DRILLER: R. Bush

BORING NO.: MW35S7B

SHEET 2 O

Baker

Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-Situ Air Sparging Plume C

CTO NO.: 323

BORING NO.: MW3557B

SAMPLE TYPE		DEFINITIONS
S = Split Spoon	A = Auger	SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5')
T = Shelby Tube	W = Wash	RQD = Rock Quality Designation (%)
R = Air Rotary	C = Core	PID = Photoionization Detector
D = Denison	P = Piston	ppm = parts per million
N = No Sample		

Depth (ft.)		Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
							Continued from Sheet		
31		S-6	1.8/2.0 90%	10 9 7 10		.4/.4	SAND, fine grained, tr. silt, tr. clay, tr. shell material. Greenish gray/white, medium dense, damp	sand pack	
32	32.0						End of Boring		
33									
34							TD: 32.0' (bgs)		
35									
6									
7									
8									
9									
0									
1									
2									
3									
4									
5									
6									
7									
8									
9									
0									

DRILLING CO.: Parratt-Wolff

BAKER REP.: J.E. Zimmerman

DRILLER: R. Bush

BORING NO.: MW3557B

SHEET 3 OF 3

Baker
Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-Situ Air Sparging Plume C
CTO NO.: 323
BORING NO.: MW355BB
COORDINATES: EAST: NORTH:
ELEVATION: SURFACE: TOP OF PVC CASING:

RIG: # 82	SPLIT SPOON	CASING	AUGERS	CORE BARREL	DATE	PROGRESS (FT.)	WEATHER	WATER DEPTH (FT.)	TIME
SIZE (DIAM.)	1-3/8"		6-1/4"		8-26-96	0-34.0	mostly cloudy warm (80's)		
LENGTH	2.0		5.0						
TYPE	Std.		HSA						
HAMMER WT.	140 lbs.								
FALL	30"								
STICK UP									

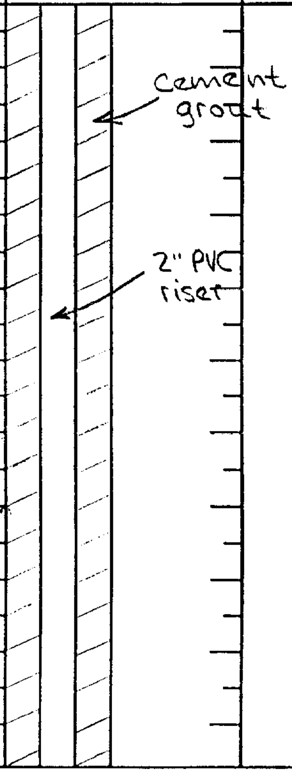
REMARKS: Augered to 5.0' (bgs). Sampled at 5' intervals from 5.0' (bgs) to 32.0' (bgs)
Hnu background is .4ppm

SAMPLE TYPE

S = Split Spoon
T = Shelby Tube
R = Air Rotary
D = Denison
A = Auger
W = Wash
C = Core
P = Piston
N = No Sample

Well Information	Diam.	Type	Top Depth (ft.)	Bottom Depth (ft.)
Riser	2.0"	Schedule 40 PVC	+3.0	-21.0
Screen	2.0"	Schedule 40 0.01 Slot	-21.0	-31.0

Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
1 2 3 4 5 5.0	A-N	-	-		.4/.4	Auger to 5.0' (bgs)		
6 7 7.0	S-1		2 2 3 3		.4/.4	CLAY w/silt. Oxidation (orange) staining w/ heavier "local deposits" Blueish gray/grayish brown, soft to medium stiff, damp		
8 9 10 10.0	N	-	-		.4/.4			
	S-2				.4/4	CLAY w/Silt Match to Sheet 2		



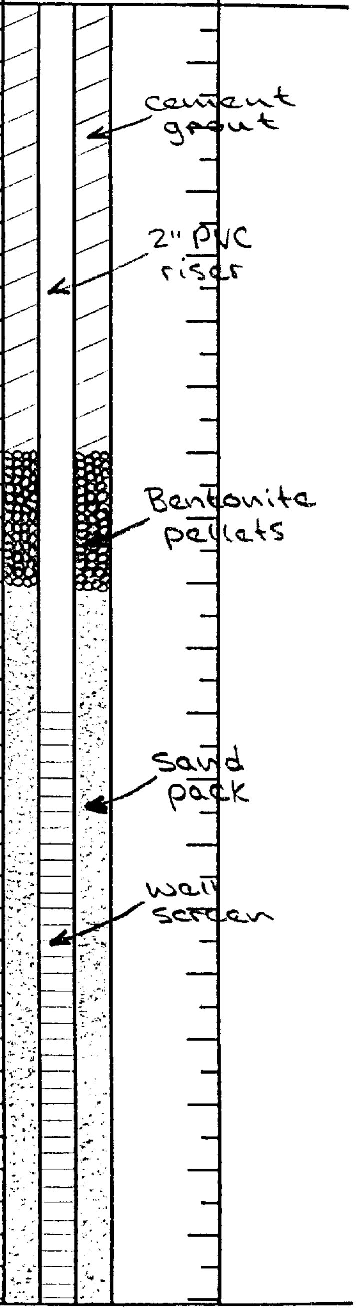
DRILLING CO.: Parratt-Wolff
BAKER REP.: J. E. Zimmerman
DRILLER: R. Bush
BORING NO.: MW355BB
SHEET 1 OF

Baker
Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-Situ Air Sparging Plume C
CTO NO.: 323
BORING NO.: MW3558B

SAMPLE TYPE		DEFINITIONS
S = Split Spoon	A = Auger	SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5')
T = Shelby Tube	W = Wash	RQD = Rock Quality Designation (%)
R = Air Rotary	C = Core	PID = Photoionization Detector
D = Denison	P = Piston	ppm = parts per million
N = No Sample		

Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
						Continued from Sheet 1		
11 12 12.0	S-2	1.8/2.0 90%	3 4 4 3		.4/.4	Sandy CLAY w/little silt Oxidation (orange) streaks Grayish brown to gray, soft to medium stiff damp to moist		
13 14 15 15.0	N				.4/.4			
16 17 17.0	S-3	1.5/2.0 75%	WoH/18" 1		.4/.4	CLAY w/silt. Dark olive gray, soft (quite plastic), damp		
18 19 20 20.0	N				.4/.4			
21 22 22.0	S-4	1.6/2.0 80%	4 4 8 7		.4/.4	SAND, fine to coarse grained w/trace silt. Dark gray to brown, loose, wet.		
23 24 25 25.0	N				.4/.4			
26 27 27.0	S-5	1.4/2.0 70%	2 2 6 4		.4/.4	SAND, fine to medium grained, tr. silt. Oxidation (brownish orange) staining is heavy. Brown, loose, wet.		
28 29 30 30.0	N				.4/.4			

DRILLING CO.: Parratt-Wolff
BAKER REP.: J. E. Zimmerman
DRILLER: R. Bush
BORING NO.: MW3558B
SHEET 2 OF :

Baker
Baker Environmental, Inc.

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Treatability Study In-Situ Air Sparging Plume C
CTO NO.: 323
BORING NO.: MW3558B

SAMPLE TYPE		DEFINITIONS
S = Split Spoon	A = Auger	SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5')
T = Shelby Tube	W = Wash	RQD = Rock Quality Designation (%)
R = Air Rotary	C = Core	PID = Photoionization Detector
D = Denison	P = Piston	ppm = parts per million
N = No Sample		

Depth (ft.)		Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
31		S-6	1.9 / 2.0 95%	10 13 15 17		.4 / .4	Continued from Sheet SAND, fine to medium grained, tr. silt, little to some cemented sandstone nodules, tr. to some cemented shell mat./shell frags.	Well screen Sand pack	
32	32.0								
33		S-7	2.0 / 2.0 100%	7 7 10 13		.4 / .4	SAND, fine grained, tr. silt, tr. clay, tr. shell greenish gray/white	Well plug	
34	34.0						End of Boring		
35							TD = 34.0' (bgs)		
6									
7									
8									
9									
0									
1									
2									
3									
4									
5									
6									
7									
8									
9									
0									

DRILLING CO.: Parratt-Wolff
BAKER REP.: J.E. Zimmerman
DRILLER: R. Bush
BORING NO.: MW3558B
SHEET 3 OF 3