FINAL

CORRECTIVE ACTION PLAN FOR THE RISK-BASED CLOSURE OF SITE FT-16 TYNDALL AIR FORCE BASE, FLORIDA

AETC Contract No. F41689-96-D-0710
Order No. 5015

Prepared for
AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE
TECHNOLOGY TRANSFER DIVISION
BROOKS AIR FORCE BASE, TEXAS

and

325 CES/CEVR
TYNDALL AIR FORCE BASE, FLORIDA

August 1999

Prepared by

PARSONS ENGINEERING SCIENCE, INC.
1700 Broadway, Suite 900
Denver, Colorado 80290
and
5390 Triangle Parkway, Suite 100
Norcross, Georgia 30092

TABLE OF CONTENTS

TABLE OF CONTENTS
(CONTINUED)

Page

TABLE OF CONTENTS (CONTINUED)

LIST OF FIGURES

LIST OF TABLES

ACRONYMS AND ABBREVIATIONS

°C	degrees Celsius
AETC	Air Education and Training Command
AFB	Air Force Base
AFCEE/ERT	Air Force Center for Environmental Excellence, Technology Transfer Division
ASTs	aboveground storage tanks
BCs	biodegradation capacities
bgs	below ground surface
BRA	baseline risk assessment
BTEX	benzene, toluene, ethylbenzene, and total xylenes
CAP	corrective action plan
CH_4	methane
CO_2	carbon dioxide
COPCs	chemicals of potential concern
CSM	conceptual site model
CT	central tendency
DO	dissolved oxygen
DOT	US Department of Transportation
EDB	1,2-dibromoethane
ERL	effects range-low
ERM	effects range-medium
ESE	Environmental Science and Engineering
f_{OC}	fraction organic carbon
FAC	Florida Administrative Code
FDEP	Florida Department of Environmental Protection
ft/day	feet per day
ft/ft	feet per foot
ft/yr	feet per year
FTA	fire training area
g/cm^3	grams per cubic centimeter
H^+	hydrogen ion
HDPE	high density polyethylene
HPAHs	high molecular weight PAHs
ID	internal diameter
IDW	investigation-derived wastes
IRIS	Integrated Risk Information System
IRP	Installation Restoration Program
K	hydraulic conductivity
K_{OC}	organic carbon partition coefficient
kg/L	kilograms per liter
LCSs	laboratory control samples
LPAHs	low molecular weight PAHs
LTM	long-term monitoring
LUCAP	Land Use Controls Assurance Plan
LUCIP	Land Use Control Implementation Plan
MDL	method detection limit
mg/L	milligrams per liter
mL/g	milliliters per gram
MNA	monitored natural attenuation
MS/MSDs	matrix spikes/matrix spike duplicates
msl	mean sea level

MTBE	methyl tertiary butyl ether
mV	millivolts
N	nitrogen
NFA	No-Further-Action
NOAA	National Oceanic and Atmospheric Administration
O_2	oxygen
OD	outside diameter
ORP	oxidation-reduction potential
OSHA	Occupational Safety and Health Administration
OSWER	Office of Solid Waste and Emergency Response
OVA	organic vapor analyzer
PAHs	polynuclear aromatic hydrocarbons
Parsons ES	Parsons Engineering Science, Inc.
PELs	Permissible Exposure Limits
PID	photoionization detector
POC	point of compliance
PVC	polyvinyl chloride
QA	quality assurance
QC	quality control
RAP	Remedial Action Plan
RCRA	Resource Conservation and Recovery Act
RI	remedial investigation
RNA	remediation by natural attenuation
SAP	Sampling and Analysis Plan
SQAGs	Sediment Quality Assessment Guidelines
SQL	sample quantitation limit
SU	standard units
SVE	soil vapor extraction
SVOCs	semivolatile organic compounds
TCLs	target cleanup levels
TDS	total dissolved solids
TEL	threshold effects level
TOC	total organic carbon
TPH	total petroleum hydrocarbons
TRPH	total recoverable petroleum hydrocarbons
ug/L	micrograms per liter
USEPA	US Environmental Protection Agency
USGS	US Geological Survey
VOCs	volatile organic compounds

SECTION 1
INTRODUCTION

Parsons Engineering Science, Inc. (Parsons ES) was retained by the Air Force Center for Environmental Excellence, Technology Transfer Division (AFCEE/ERT) under Air Education and Training Command (AETC) Contract No. F41689-96-D-0710, Order No. 5015 to prepare a corrective action plan (CAP) to support a risk-based remediation decision for contaminated soil and groundwater at Site FT-16, Tyndall Air Force Base (AFB), Florida.

1.1 DESCRIPTION OF THE RISK-BASED APPROACH

The objective of risk-based remediation is to reduce the risk of specific chemicals to human health and/or ecological receptors such as animals or plant life. For any chemical to pose a risk, four elements must exist at the site:

- A source of chemical contamination that exceeds or could generate chemical contamination above health-protective or aesthetic standards;
- A mechanism of contaminant release;
- A human or ecological receptor available for chemical contact; and
- A completed pathway through which that receptor will contact the chemical.

If any one of these four elements is absent at a site, there is no current risk. The reduction or elimination of risk can be accomplished by limiting or removing any one of these four elements from the site.

The goal of this risk-based remediation approach is to find the most cost-effective method of reducing present and future risk by combining three risk reduction techniques:

- Chemical Source Reduction - Achieved by natural attenuation processes over time or by engineered removals such as free product recovery, soil vapor extraction (SVE), or *in situ* bioventing.
- Chemical Migration Control - Examples include natural attenuation of a groundwater plume, and SVE to prevent migration of hazardous vapors to a receptor exposure point.
- Receptor Restriction – Examples include land use controls and site fencing to eliminate chemical exposure until natural attenuation and/or engineered remediation reduce the chemical source and/or eliminate the potential for chemical migration to an exposure point.

1.2 RISK-BASED APPROACH TASKS

The major tasks of this risk-based project are:

- Assessing available data and collecting any supplemental site characterization data necessary to define the nature, magnitude, and extent of soil and groundwater contamination and to document to what degree natural attenuation processes are operating at the selected sites;

- Determining whether an unacceptable risk to human health or the environment currently exists or may exist in the foreseeable future using applicable Florida Department of Environmental Protection (FDEP) guidance and regulations, quantitative contaminant fate and transport models, and exposure concentration estimates;
- Evaluating and recommending a remedial alternative that both reduces the source of contamination and minimizes or eliminates risks to potential receptors; and
- Documenting the remedial action selection process in a report that satisfies FDEP requirements.

1.3 REGULATORY REQUIREMENTS

This section describes Florida's tiered approach for risk-based remedial action at sites contaminated with petroleum products. The *Petroleum Contamination Site Cleanup Criteria* rule [Chapter 62.770 of the Florida Administrative Code (FAC)] (FDEP, 1997) presents guidance for determination of remedial requirements for closure of petroleum-contaminated sites, including several mechanisms for determining matrix-specific cleanup criteria. The regulations allow closure of petroleum release sites under several different scenarios, including:

- No-Further-Action (NFA) Proposal Without Conditions,
- NFA Proposal With Conditions, or
- Monitoring-Only Proposal for Natural Attenuation.

A Remedial Action Plan (RAP) must be prepared for sites that do not meet the requirements for NFA or Natural Attenuation. Closure of a site under the NFA-Without-Conditions alternative would allow unrestricted future use of the site (e.g., residential land use), and therefore the requirements and allowable contaminant levels under this alternative are the most restrictive. The NFA-With-Conditions alternative requires that appropriate institutional or engineering controls be implemented to limit receptor exposure; sites seeking closure under this alternative are subject to potentially less stringent cleanup levels. A Natural Attenuation Monitoring Program is a recognized means of remediating a site, with the goal of achieving the NFA target cleanup levels (TCLs).

The actual or potential beneficial use of the groundwater and susceptibility of the aquifer to contamination are considered in the risk-based corrective action program to determine site-specific remediation target levels. All groundwater of the State of Florida is classified according to the following uses:

> Class F-I: Potable water use: groundwater in a single source aquifer described in Rule 62-520.460, FAC. that has a total dissolved solids (TDS) content of less than 3,000 milligrams per liter (mg/L) and was specifically reclassified as Class F-I by the Commission.

Class G-I: Potable water use: groundwater in a single-source aquifer that has a TDS content of less than 3,000 mg/L.

Class G-II: Potable water use: groundwater in an aquifer that has a TDS content of less than 10,000 mg/L, unless otherwise classified by the Commission.

Class G-III: Non-potable water use: groundwater in an unconfined aquifer that has a TDS content of 10,000 mg/L or greater; or that has a TDS content of 3,000-10,000 mg/L and either has been reclassified by the Commission as having no reasonable potential as a future source of drinking water, or has been designated by the FDEP as an exempted aquifer pursuant to Rule 62-28.130(3), FAC.

Class G-IV: Non-potable water use: groundwater in a confined aquifer that has a TDS content of 10,000 mg/L or greater.

The classification of the groundwater beneath Site FT-16 is unknown.

1.3.1 No Further Action

Closure of a petroleum release site under a NFA Proposal (without or with conditions) requires that a site meet the following criteria:

- No free product is present (as specified in 62-770.680 (1)(a), FAC);
- No fire or explosion hazard is present due to release of petroleum or petroleum products ;
- No "excessively contaminated soil" (as defined in 62-770.200, FAC) is present; and
- Matrix-specific target cleanup levels are met.

The *Petroleum Contamination Site Cleanup Criteria* rule (FDEP, 1997) incorporates matrix-specific TCLs for petroleum constituents in the form of "look-up" tables or through reference to other applicable regulations (i.e., state groundwater or surface water regulations). Contaminant concentrations in all affected media at a site must be below all applicable TCLs for the site to qualify for a NFA (with or without conditions) proposal. This comparison also is known as a Tier I assessment.

The rule also allows for the development of alternative cleanup standards based on a site-specific risk assessment for use in a NFA Proposal with conditions (Tier II assessment). These site-specific alternative cleanup standards can be used in place of those presented in the look-up tables.

1.3.2 Natural Attenuation with Monitoring

The FDEP recognizes natural attenuation with monitoring as a viable site remediation strategy. The following criteria must be met to demonstrate that this strategy is appropriate for a site:

- No free product is present (as specified in 62-770.690 (1)(a),FAC);

- Contaminated soil is not present to the extent that it may increase cleanup costs;
- Groundwater contaminant concentrations above applicable TCLs are not migrating beyond a temporary point of compliance (POC);
- Available data show an overall decrease in the mass of contamination; and
- Contaminant concentrations in groundwater do not exceed appropriate criteria (Table IX levels, 62-770, FAC); or the technical evaluations (as specified in 62-770.690 (1)(f), FAC) indicate that natural attenuation is an appropriate remedial alternative.

Natural attenuation with monitoring requires the establishment of a temporary POC based on site-specific conditions relating to land and groundwater use, potentially exposed populations, hydrogeology, and type and concentrations of contaminants. Concentrations of petroleum compounds at the POC cannot exceed levels presented in the rule. Monitoring of natural attenuation to show plume stability and/or contaminant reductions can eventually lead to a proposal for NFA With or Without Conditions.

1.3.3 Summary

In summary, the *Petroleum Contamination Site Cleanup Criteria* rule allows a rapid determination of whether or not a site can qualify for a NFA proposal and/or the appropriateness of natural attenuation with monitoring as a remedial strategy. The rule allows for inclusion of site-specific information in developing alternative cleanup levels for NFA with conditions, and provides guidance on preparation of a RAP if active remediation is warranted.

1.4 REPORT ORGANIZATION

This CAP consists of nine sections, including this introduction, and four appendices. Site background, including operating history and a review of environmental site investigations conducted to date, is provided in the remainder of this section. Section 2 summarizes the 1998 site characterization activities performed by Parsons ES. Physical characteristics of Site FT-16 and surrounding environs are described in Section 3. A Tier I evaluation is completed in Section 4 to identify those site contaminants that are considered chemicals of potential concerns (COPCs). Section 5 summarizes the nature and extent of COPC contamination at the site. Section 6 addresses the effects of natural chemical attenuation processes that are documented to be occurring at the site, and presents quantitative chemical fate and transport analyses. A Tier II evaluation and receptor exposure analyses and conclusions are included in Section 7. Section 8 presents a long-term monitoring (LTM) plan. Section 9 presents references used in preparing this CAP.

Pertinent information from prior investigations is presented in Appendix A. Analytical data sheets and chain-of-custody records are in Appendix B. Boring logs, groundwater sampling forms, and well construction diagrams for all sampling activities completed by Parsons ES during the March 1998 field effort are included in Appendix C. The BIOSCREEN fate and transport model results and related information used in the predictive chemical fate assessment are in Appendix D.

1.5 SITE DESCRIPTION AND BACKGROUND

Tyndall AFB is located in Bay County in the Florida panhandle (Figure 1.1). Site FT-16 is a former fire training area (FTA) located northwest of the main runway and just south of Fred Bayou (also known as Shoal Point Bayou), an extension of East Bay (Figures 1.2 and 1.3). Fred Bayou also is the subject of an ongoing investigation (Site OT-29). Also known as the Shell Bank FTA, Site FT-16 was the original fire training area at Tyndall AFB and was used initially from 1943 to 1952. After 1952, fire training activities were temporarily conducted at another area, but resumed at the Shell Bank site in 1968 and continued until 1980. Prior to 1970, fire training activities took place approximately two to three times per week. From 1970 until 1980, the exercises were held two to four times per month. Waste fuels and solvents from the industrial operations at the Base were commingled and stored in waste storage tanks at the site. Underground fuel lines were used to transfer the waste fuel from the storage area to the burn pit, where the waste was ignited for fire training exercises. Two aboveground storage tanks (ASTs) were moved to the site in 1968 and used to store flammable liquid wastes. The tanks were removed from the site in 1980. No documentation has been found indicating that the underground fuel lines were removed (BCM, 1996).

1.5.1 Previous Investigations

The Shell Bank FTA was identified as an area of concern during an Installation Restoration Program (IRP) Phase I - Records Search (CH2M Hill, 1981). The site was assigned a hazard rating score of 40 and was not considered to pose a threat. No further investigation of the site was recommended. Despite the conclusions of the Phase I investigation, the Shell Bank FTA was further investigated during an IRP Phase II, Stage I investigation (Water and Air Research, 1984). Four backhoe pits were excavated within the previously identified area of concern in order to collect groundwater samples. Low levels of dissolved organic carbon, total organic halogens, and total phenols were detected in the groundwater samples. The Phase II, Stage I Report recommended that additional analyses for specific compounds be conducted at the site.

Environmental Science and Engineering (ESE, 1986) conducted an IRP Phase II, Stage II investigation. Three piezometers were installed to determine the direction of groundwater flow. Groundwater was determined to flow east-northeast toward Fred Bayou. Three monitoring wells were then installed, and groundwater samples were collected for laboratory analysis. Low levels of several purgeable halocarbons and benzene were detected in the groundwater sample from one monitoring well.

An IRP Phase IV - Remedial Investigation was conducted by Geraghty & Miller, Inc. (1991). Twenty-five soil borings were drilled to the water table to collect soil samples for organic vapor headspace analysis. Six shallow monitoring wells and two deep monitoring wells were subsequently installed to further delineate the contaminated areas. Soil samples were collected for laboratory analysis from each of the monitoring well boreholes. Groundwater samples were collected from the eight newly installed and three previously installed monitoring wells. Additionally, two surface water and sediment samples were collected from Fred Bayou.

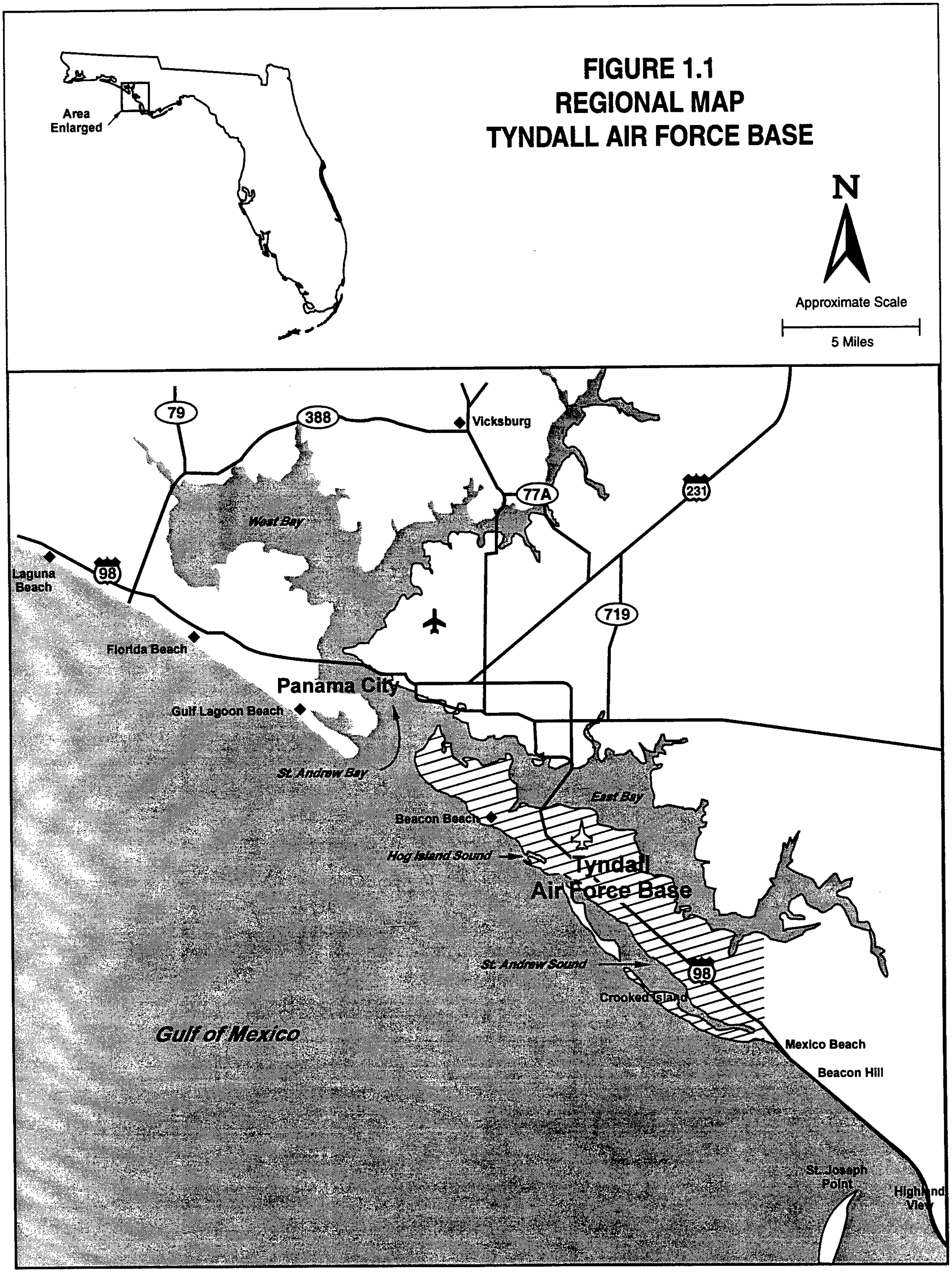
A supplemental Contamination Assessment was conducted by BCM (1996). Two hundred and four soil samples were collected from 84 hand-augered boreholes, and the headspace of each sample was analyzed onsite with an organic vapor analyzer (OVA).

Soil samples from eight of the soil borings were sent to a laboratory for analysis of volatile organic compounds (VOCs), total recoverable petroleum hydrocarbons (TRPH), and Resource Conservation and Recovery Act (RCRA) metals. Two deep [50 feet below ground surface (bgs)] groundwater samples were collected for analysis of VOCs and polynuclear aromatic hydrocarbons (PAHs) near Fred Bayou using a Geoprobe® direct-push sampler. Additionally, BCM installed five additional shallow monitoring wells at the site. Groundwater samples were collected from the 5 newly installed wells and 11 previously installed wells for laboratory analysis for VOCs, semivolatile organic compounds (SVOCs), TRPH, and total lead. Surface water and sediment samples were collected from three locations along the shore of Fred Bayou. Slug tests were conducted in all sixteen site monitoring wells. Pertinent data from the Supplemental CA report are included in Appendix A.

1.5.2 Site OT-29

As discussed above, Fred Bayou also is the subject of an ongoing investigation. Known as Site OT-29, the investigation includes a remedial investigation (RI) and a baseline risk assessment (BRA). The RI and BRA focus on surface water, sediment, and boundary soils that may have been impacted by boat and fuel distribution activities at the bayou. The northern boundary of Site FT-16 is part of Site OT-29 (Figures 1.2 and 1.3). As part of the March 1998 investigation at Site FT-16, sediment and water samples were collected at the edge of the bayou to assess if Site FT-16 contaminants had impacted Site OT-29 media. As discussed in Sections 4 and 5, the analytical data indicate that Site OT-29 is not impacted by site contamination. However, the data are presented in this report so that Tyndall AFB may incorporate them into the ongoing investigation at Site OT-29.

FIGURE 1.1
REGIONAL MAP
TYNDALL AIR FORCE BASE



J:\731854\TYNDALL\REG-MAP.cdr

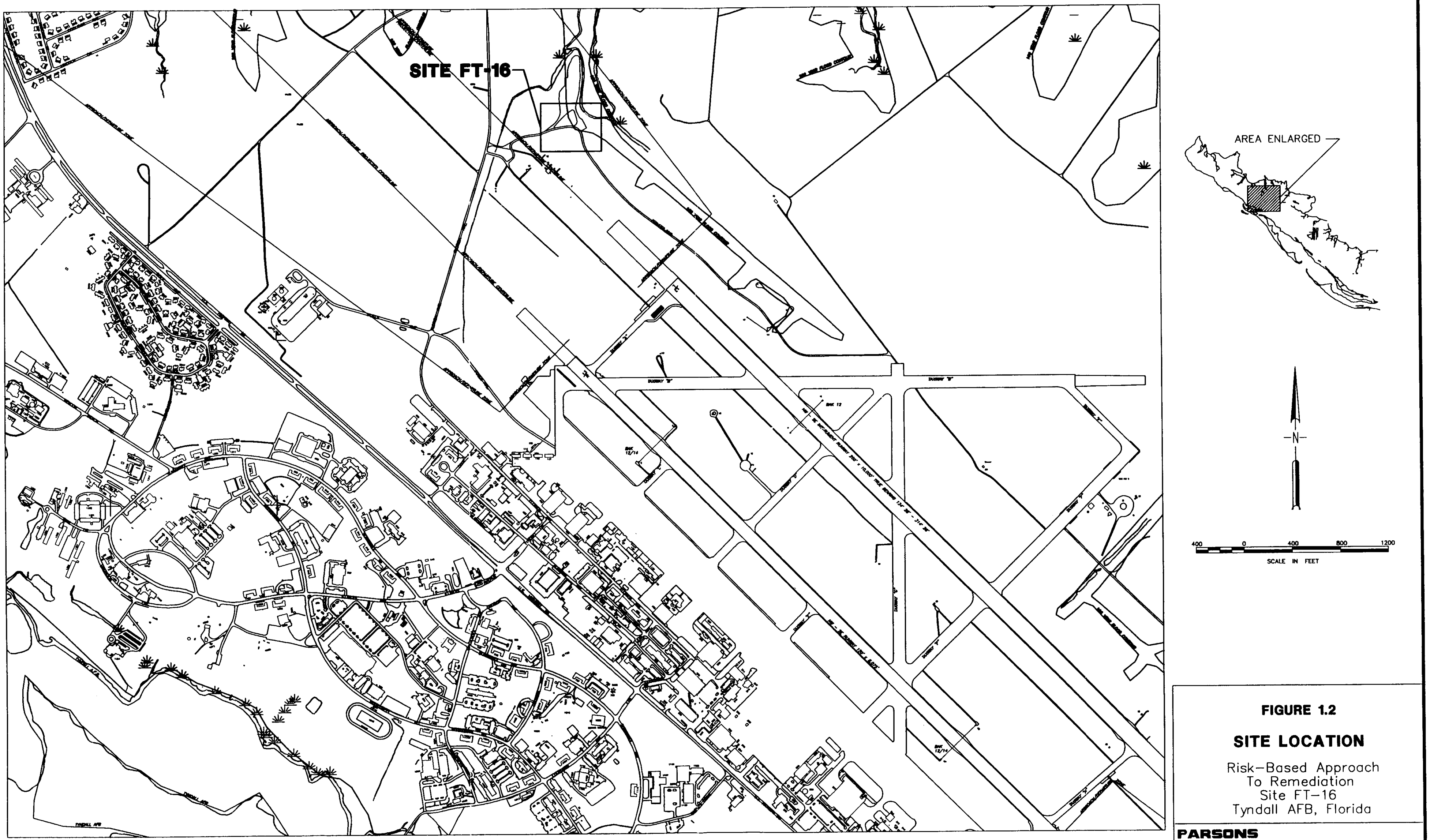


FIGURE 1.2

SITE LOCATION

Risk-Based Approach
To Remediation
Site FT-16
Tyndall AFB, Florida

**PARSONS
ENGINEERING SCIENCE, INC.**
Atlanta, Georgia

J:\731854\CADD\TYNDALL\SITE_LOC_FT

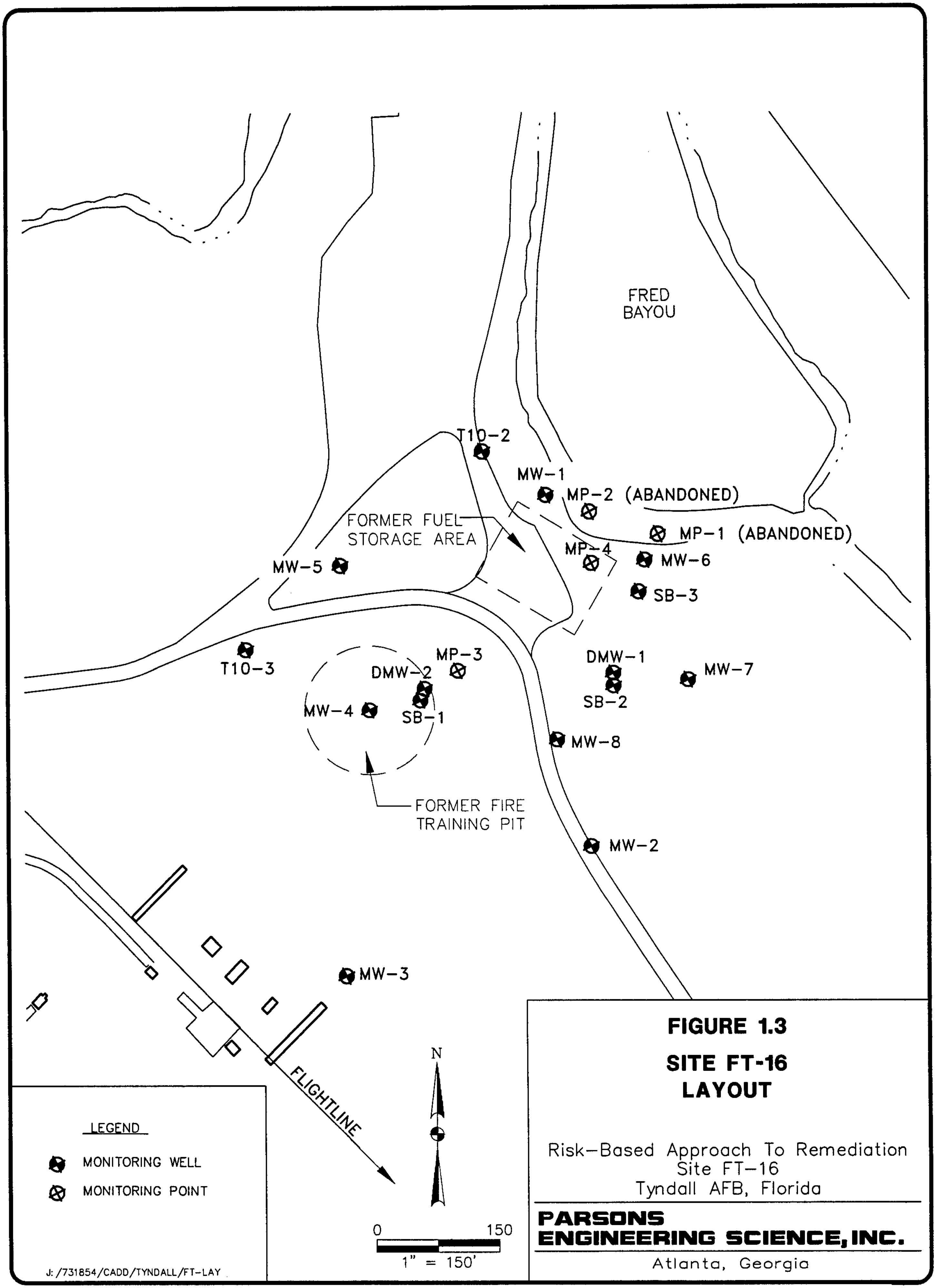


FIGURE 1.3

SITE FT-16
LAYOUT

Risk-Based Approach To Remediation
Site FT-16
Tyndall AFB, Florida

PARSONS
ENGINEERING SCIENCE, INC.
Atlanta, Georgia

SECTION 2
SITE CHARACTERIZATION ACTIVITIES

Since 1984, several soil and groundwater investigations have been conducted at Site FT-16. These investigations focused on characterizing and delineating dissolved hydrocarbons in groundwater and residual fuel hydrocarbons in soils. Parsons ES conducted an investigation at the site during March 1998 to collect site-specific data relevant to quantifying the effects of natural contaminant attenuation processes and to facilitate development and implementation of a risk-based remedial action for Site FT-16. Soil gas, soil, sediment, surface water, and groundwater were sampled to:

- Further delineate the extent of contamination;
- Assess temporal trends in soil and groundwater contaminant concentrations;
- Support contaminant fate and transport analyses; and
- Develop appropriate exposure-point concentrations to compare to final remediation goals.

To the extent practicable, data collected during previous investigations were used to augment this study. Emphasis was placed on collecting data documenting the natural biodegradation and attenuation of fuel hydrocarbons in soils and groundwater at the site.

The March 1998 supplemental site characterization activities performed by Parsons ES at Site FT-16 are briefly described in the remainder of this section. Most site characterization procedures (i.e., soil, soil gas, and groundwater sampling procedures) are described in detail in the project Sampling and Analysis Plan (SAP) (Parsons ES, 1997a).

2.1 SCOPE OF DATA COLLECTION ACTIVITIES

As part of the risk-based remedial approach for Site FT-16, field data collection efforts focused on investigating specific chemical constituents that potentially pose a threat to human health or the environment. The chemicals targeted for study at this site were identified from previous site investigations and from analytical requirements listed in FDEP (1997). The petroleum hydrocarbon and associated constituents identified and addressed as part of this study include benzene, toluene, ethylbenzene, and total xylenes (BTEX); methyl tertiary butyl ether (MTBE), 1,2-dibromoethane (EDB), PAHs, TRPH, and lead. These analytes were targeted based on previous site assessment results.

The risk-based investigation for Site FT-16 was conducted according to the methodologies presented in the *Work Plan for the Risk-Based Investigation and Closure of the Base Exchange Service Station and Site FT-16* (Parsons ES, 1997b), hereafter referred to as the work plan. The work plan was developed according to available guidelines and requirements of the FDEP to support site closure.

The following sampling and testing activities were performed by Parsons ES during March 1998 at the site as part of this investigation:

- Drilled six soil borings;

- Collected nine subsurface soil samples and one duplicate sample for fixed-base laboratory analysis from the six boreholes;
- Installed two permanent and two temporary small-diameter groundwater monitoring points;
- Collected groundwater samples from six existing groundwater monitoring wells and the four newly installed points; and
- Collected three soil gas samples for laboratory analysis from three locations.
- Collected one sediment sample for laboratory analysis from one location at the edge of Fred Bayou (Site OT-29).

Analytical method detection limit (MDL) requirements were considered before site characterization work was initiated under the risk-based remediation investigation. Suitable analytical methods and quality control (QC) procedures were selected (Parsons ES, 1997a) to ensure that the data collected under this program are of sufficient quality to be used in a quantitative risk assessment.

Soil and groundwater samples were analyzed in the field and by Quanterra, Inc. of Arvada, Colorado; Tampa, Florida; and Dallas, Texas. Soil gas samples were analyzed in the field and by Air Toxics, Ltd. of Folsom, California. The laboratory data sheets and chain-of-custody records are presented in Appendix B. The analytical protocols for all samples are summarized in Table 2.1. Table 2.2 summarizes the field and fixed-base laboratory analyses performed by sampling location. These analyses and measurements for various inorganic, geochemical, and physical parameters were performed to document natural biodegradation processes and to assess the potential effectiveness of low-cost source reduction technologies.

2.2 SUBSURFACE SOIL SAMPLING

Soil samples were collected from six soil boreholes (SoBo-1 through SoBo-6) to obtain soil total organic carbon (TOC) data and to further characterize soil contamination at the site at locations where previous investigations indicated relatively high soil contaminant concentrations (Appendix A). Soils were sampled to facilitate evaluation of the potential for contaminant partitioning from soil into groundwater and soil gas, and to assess the magnitude of any changes in contaminant concentrations that have occurred over time. The soil boring locations are presented on Figure 2.1. These borings were advanced using a Geoprobe® hydraulic sampling rig as described in the SAP (Parsons ES, 1997a).

Soil samples for laboratory or field analysis were collected at regular intervals from all boreholes, both above and below the groundwater surface. A total of nine soil samples and one duplicate sample from the six boreholes were submitted to Quanterra Inc. for laboratory analysis. Samples from all six boreholes were described for lithology and field screened for volatile organic vapors using a photoionization detector (PID). Soil borehole information is summarized in Table 2.3, and borehole logs and completion diagrams for the newly-installed monitoring points are included in Appendix C. Soil analytical results are summarized and discussed in Sections 4 and 5.

2.3 MONITORING WELL INSTALLATION AND DEVELOPMENT

Two permanent monitoring points (MP-3 and MP-4) and two temporary monitoring points (MP-1 and MP-2) were installed during the field effort. The purpose of MP-1 and MP-2 is to allow assessment of the magnitude of contaminant concentrations migrating to Site OT-29 (Fred Bayou). Point MP-3 was installed northeast of well SB-1 between the two contaminant source areas to obtain contaminant decay rate information. MP-4 was installed in an area of excessively contaminated soil to assess maximum contaminant concentrations in groundwater. Table 2.3 summarizes the monitoring well completions, and Figure 2.1 presents the monitoring point locations.

MP-1 and MP-2 were constructed using stainless steel screen and riser pipe having an internal diameter (ID) of 0.75 inch. The screens of these two points were one foot long and consisted of stainless steel mesh. These points were installed by driving the metal sections into the ground with a sledge hammer. MP-3 and MP-4 were constructed of Schedule 80 polyvinyl chloride (PVC) screen and riser having an ID of 0.5 inch. The screens of MP-3 and MP-4 were six feet long. All well casing and screen sections were flush-threaded; glued joints were not used. The field geologist recorded the borehole depth and the lengths of all casing sections. Monitoring point completion diagrams are included in Appendix C.

A prepacked screen was utilized for MP-3 and MP-4. The prepacked screens are in 3-foot sections with an outside diameter (OD) of 1.5 inches and an ID of 0.5 inch. The inner component of the prepacked screen consists of 0.5-inch Schedule 80 PVC with 0.01 inch slots. The outer component of the screen is stainless steel wire mesh with a pore size of 0.011 inch. The screens are prepacked with 20/40 grade silica sand.

MP-1 and MP-2 were abandoned following sample collection by pulling the steel pipe and backfilling the borehole with sodium bentonite chips. MP-3 and MP-4 were completed as flush mount wells with a 10 ½-inch diameter well vault set in an approximately 2-foot by 2-foot concrete pad.

Prior to sampling, newly-installed monitoring points were developed. Typically, development removes sediment from inside the well casing and flushes fines, cuttings, and drilling fluids from the sand pack and the portion of the formation adjacent to the screen. Use of the Geoprobe® system to place monitoring points eliminates cuttings and drilling fluids. As a result, development of monitoring points was primarily intended to minimize the amount of fine sediment that might accumulate in the casing.

Monitoring point development was accomplished using a peristaltic pump with dedicated silicon and high density polyethylene (HDPE) tubing. The pump tubing was lowered to the bottom of the point so that fines were agitated and removed in the development water. Development was continued until ten casing volumes of water were removed from the point and the groundwater pH, temperature, conductivity, and dissolved oxygen (DO) concentrations had stabilized. Development logs are included in Appendix C.

2.4 GROUNDWATER SAMPLING

Groundwater samples were collected from the four newly-installed monitoring points and six existing monitoring wells at the site in March 1998. The groundwater sampling locations are shown on Figure 2.1. Samples collected from the ten wells/points were analyzed for fuel-related contaminants and for various inorganic and geochemical indicators to evaluate natural chemical and physical attenuation processes that are occurring at the site. Field and laboratory analytical data collected at each groundwater sampling location are summarized in Table 2.2.

All monitoring wells were purged and sampled using a peristaltic pump with dedicated HDPE and silicon tubing. Purging consisted of removing groundwater from the well until the pH, DO concentration, oxidation-reduction potential (ORP), conductivity, and temperature stabilized.

Within 24 hours of the purge event, groundwater samples were collected from the monitoring wells. The samples were transferred directly from the peristaltic pump discharge tubing into the appropriate sample containers. The water was carefully poured down the inner walls of the sample bottle to minimize aeration of the sample. Sample bottles for BTEX, MTBE, EDB, methane, and Hach® field analyses were filled so that there was no headspace or air bubbles within the container. One duplicate sample was collected during the groundwater sampling event.

Field and laboratory groundwater analytical results are discussed in Sections 4 and 5 of this report. These analytical results are used in Section 6 to evaluate the natural physical, chemical, and biological processes that are affecting the COPCs at this site.

2.5 SOIL GAS SAMPLING

Soil gas sampling was performed at the site, and samples were analyzed using both field (semi-quantitative) and fixed-base laboratory (quantitative) procedures. The purpose of soil gas sampling was to assess the potential risk to future workers at the site from inhalation of volatilized contaminants, and to determine whether or not sufficient oxygen (O_2) is available in the soil gas to sustain aerobic fuel hydrocarbon biodegradation. If O_2 concentrations are significantly lower than background values, and carbon dioxide (CO_2) concentrations are higher than background levels, then the occurrence of aerobic fuel hydrocarbon biodegradation can be inferred. In addition, the O_2 levels allow an assessment of whether there is sufficient O_2 to sustain continuing aerobic biodegradation without engineered addition of oxygen via *in situ* bioventing.

Soil gas samples were collected at three locations (HA-49, HA-61 and HA-72) from 2 to 3 feet bgs as shown on Figure 2.1. These locations were targeted for sampling because previous investigations indicated the presence of relatively elevated contaminant levels in soils. All soil gas samples were screened using field instruments to measure O_2 and CO_2, collected in SUMMA® canisters, and submitted to Air Toxics, Ltd. in Folsom, California for analysis of total petroleum hydrocarbons (TPH) and BTEX using US Environmental Protection Agency (USEPA) Method TO-3. All samples were field screened using the test equipment and methods specified in the SAP (Parsons ES, 1997a). Analytical results for soil gas samples are summarized in Sections 4 and 5.

2.6 SEDIMENT SAMPLING

The sediment sample at the edge of Fred Bayou (Site OT-29) was collected by hand using new, latex gloves. The surficial sediments were removed, and the sample was collected from a depth of approximately 2-4 inches bgs and placed directly into a clean, glass jar. This jar was labeled and sent to the laboratory for analysis.

2.7 EQUIPMENT DECONTAMINATION PROCEDURES

All downhole soil sampling tools were cleaned prior to collection of each sample with a clean water/phosphate-free detergent mix followed by a clean water rinse. Decontaminated tools also were used for installation of the two monitoring wells and soil gas sampling.

New, disposable HDPE and silicon tubing was used to collect the groundwater sample from each well. The only other equipment requiring decontamination was the water level indicator probe. The probe was decontaminated prior to each use with a clean water/phosphate-free detergent mix followed by a distilled water rinse.

2.8 SURVEYING

The newly-installed monitoring points (MP-1 through MP-4) at Site FT-16 were located by a professional surveyor (Sea Level Surveying and Mapping, Inc. of Panama City, Florida). Horizontal coordinates were measured to the nearest 0.1 foot using the incumbent coordinate system, and elevations of the top of the PVC casings were measured to the nearest 0.01 foot relative to US Geological Survey (USGS) benchmarks. The survey tied into one existing monitoring well. The locations of soil boreholes were documented via photographs and using a tape measure.

2.9 INVESTIGATION-DERIVED WASTES (IDW)

Soil cuttings, unused soil samples, and decontamination and purge water and were placed into 55-gallon, US Department of Transportation (DOT)-approved drums. All drums were moved to an on-Base storage area for later disposal by the Base.

2.10 ANALYTICAL DATA QUALITY ASSESSMENT

2.10.1 Introduction

An electronic Level III validation was performed on the March 1998 analytical results obtained from Quanterra. The validation included internal data checks and application of data qualifiers to the analytical results based on adherence to method protocols and project-specific control limits. Method protocols reviewed included:

- Analytical holding times;
- Method blanks;
- Trip blanks;
- Surrogate spikes;
- Matrix spikes/matrix spike duplicates (MS/MSDs);
- Laboratory control samples (LCSs); and
- Sample temperatures during shipping and storage.

Data qualifiers were applied to analytical results during the data validation process. All data were validated using method applicable guidelines and in accordance with the *National Functional Guidelines for Organic Data Review* (USEPA, 1994a) and the *National Functional Guidelines for Inorganic Data Review* (USEPA, 1994b). The following definitions provide explanations of the USEPA (1994a and 1994b) qualifiers assigned to analytical results during data validation. The data qualifiers described were applied to both inorganic and organic results.

U The analyte was not present above the reported sample quantitation limit (SQL).

UJ The analyte was not present above the reported SQL. The associated numerical value may not accurately or precisely represent the concentration necessary to detect the analyte in the sample.

J1 The analyte was analyzed for and positively identified. The anlayte was quantified below the reporting limit and above the method detection limit.

J The analyte was positively identified, but the associated numerical value may not be consistent with the amount actually present in the environmental sample. The data should be considered as a basis for decision-making and are usable for many purposes.

All sample results qualified as "U, UJ, J or J1" and used in accordance with data validation qualifiers applied are usable for the purposes intended. Results qualified as such represent an association to non-compliant QC criteria which has caused the reported concentration to be estimated. Project objectives do not exclude the use of estimated concentrations and therefore the usability of that data point for project purposes.

2.10.2 Data Quality

Data quality for each QC parameter where exceptions were noted during the validation is summarized in this section. Only results that exceeded quality assurance (QA)/QC criteria are presented. All frequency requirements for field sample collection of QA/QC samples (MS/MSDs and blanks) were met. The frequency requirements for laboratory specific method criteria QA/QC also were met. Samples were collected and analyzed as specified in the methods. All samples are representative of the site and comparable with previous and future investigations (when used in accordance with the validation qualifiers).

One water sample for PAH analysis using Method SW8310 required qualification based on accuracy. The surrogate recovery was biased low. All SW8310 compounds for the water sample from MP-4 were qualified as estimated; probably due to matrix interference. Overall surrogate accuracy is acceptable.

Methane was detected in the method blank. However all detected methane concentrations in groundwater are acceptable because they were sufficiently higher the methane blank concentration.

In summary, accuracy and precision were in control. All method specific criteria were in control with the exception of method SW8310 compounds as identified above.

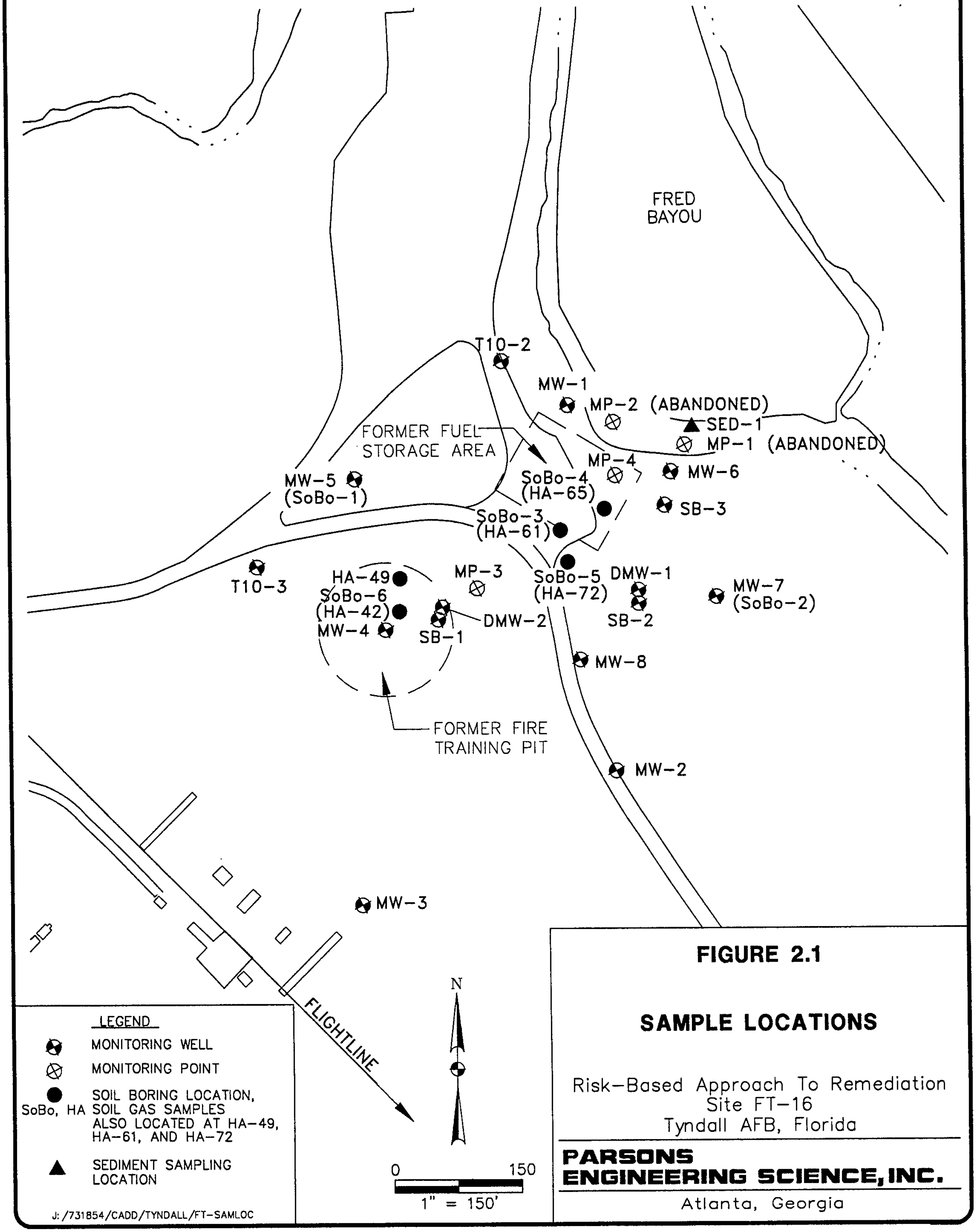


FIGURE 2.1

SAMPLE LOCATIONS

Risk-Based Approach To Remediation
Site FT-16
Tyndall AFB, Florida

PARSONS ENGINEERING SCIENCE, INC.
Atlanta, Georgia

TABLE 2.1
ANALYTICAL PROTOCOL FOR GROUNDWATER, SOIL, AND SOIL GAS SAMPLES
Risk-Based Approach to Remediation
Site FT-16
Tyndall AFB, Florida

MATRIX	METHOD	WHERE ANALYZED
GROUNDWATER		
Ferrous Iron (Fe^{+2})	Colorimetric, Hach Method 8146	Field
Alkalinity as Calcium Carbonate ($CaCO_3$)	Titrimetric, Hach Method 8221	Field
Ammonia as Nitrogen (NH_3-N)	CHEMetrics Method 1510, ASTM 4500: NH_3	Field
Sulfate (SO_4^{-2})	Colorimetric, Hach Method 8051	Field
Total Sulfide	Colorimetric, Hach Method 8131	Field
Conductivity	Direct reading meter	Field
Oxygen	Direct reading meter	Field
pH	Direct reading meter	Field
Redox Potential	Direct reading meter	Field
Temperature	Direct reading meter	Field
BTEX + MTBE	SW8020A	Quanterra[a/]
Ethylene Dibromide	SW8011	Quanterra
Polynuclear Aromatic Hydrocarbons	SW8310	Quanterra
Total Recoverable Petroleum Hydrocarbons	FL-PRO (C8-C40)	Quanterra
Methane (CH_4)	RSK-175	Quanterra
Nitrate as Nitrogen (NO_3^{-1}-N)	E300.0	Quanterra
Total Lead	SW7421	Quanterra
SOIL		
BTEX	SW8020A	Quanterra
Polynuclear Aromatic Hydrocarbons	SW8310	Quanterra
Total Recoverable Petroleum Hydrocarbons	FL-PRO (C8-C40)	Quanterra
Total Organic Carbon	SW9060	Quanterra
SOIL GAS		
BTEX	TO-3	Air Toxics[b/]
Total Petroleum Hydrocarbons	TO-3	Air Toxics
Oxygen	Direct reading meter	Field
Carbon Dioxide	Direct reading meter	Field
SEDIMENT		
Polynuclear Aromatic Hydrocarbons	SW8310	Quanterra
Total Lead	SW7421	Quanterra

Notes:

a/ Quanterra, Inc. of Arvada, Colorado; Austin, Texas (methane only); Tampa, Florida (TRPH and EDB only)

b/ Air Toxics LTD. of Folsom, California

TABLE 2.2
SAMPLE ANALYSES BY LOCATION
Risk-Based Approach to Remediation
Site FT-16
Tyndall AFB, Florida

Sampling Location	Sample Matrix	Sample Depth (ft. bgs) [a/]	Analytes and Analysis									
			BTEX SW8020	PAHs SW8310	TRPH FL-PRO	Total Lead SW7421	EDB SW8011	TOC SW9060	Methane RSK-175	Nitrate E300.0	ORP Field	Alkalinity Field
SoBo-1	Soil	3 - 4						X				
SoBo-1	Soil	4 - 6						X				
SoBo-2	Soil	3 - 4						X				
SoBo-3	Soil	4 - 5.5	X	X	X							
SoBo-4	Soil	4 - 5.5	X	X	X							
SoBo-4	Soil	7 - 8	X	X	X							
SoBo-5	Soil	2 - 3	X	X	X							
SoBo-6	Soil	2 - 3.5	X	X	X							
SoBo-6	Soil	6 - 7	X	X	X							
Sed-1	Sediment	NA		X		X						
MW-3	Groundwater	NA	X						X	X	X	X
MW-4	Groundwater	NA	X	X	X	X	X		X	X	X	X
MW-7	Groundwater	NA	X						X	X	X	X
SB-1	Groundwater	NA	X						X	X	X	X
SB-2	Groundwater	NA	X								X	X
SB-3	Groundwater	NA	X						X	X	X	X
MP-1	Groundwater	NA	X	X	X	X	X				X	X
MP-2	Groundwater	NA	X	X	X	X	X				X	X
MP-3	Groundwater	NA	X						X	X	X	X
MP-4	Groundwater	NA	X	X	X	X	X		X	X	X	X
HA-49	Soil Gas	NA										
HA-61	Soil Gas	NA										
HA-72	Soil Gas	NA										

[a/] ft. bgs = feet below ground surface

NA = not applicable

BTEX = Benzene, Toluene, Ethylbenzene, and Xylenes

PAHs = Polynuclear Aromatic Hydrocarbons

TPH = Total Petroleum Hydrocarbons

EDB = Ethylene Dibromide

TRPH = Total Recoverable Petroleum Hydrocarbons

TOC = Total Organic Carbon

DO = Dissolved Oxygen

ORP = Oxidation Reduction Potential

TABLE 2.2 (Continued)
SAMPLE ANALYSES BY LOCATION
Risk-Based Approach to Remediation
Site FT-16
Tyndall AFB, Florida

Sampling Location	Sample Matrix	Depth (ft. bgs) [a]	Analytes and Analysis								
			Conductivity Field	DO Field	Temperature Field	pH Field	Ferrous Iron Field	Sulfate Field	Sulfides Field	Ammonia Field	BTEX/TPH TO-3
SoBo-1	Soil	3 - 4									
SoBo-1	Soil	4 - 6									
SoBo-2	Soil	3 - 4									
SoBo-3	Soil	4 - 5.5									
SoBo-4	Soil	4 - 5.5									
SoBo-4	Soil	7 - 8									
SoBo-5	Soil	2 - 3									
SoBo-6	Soil	2 - 3.5									
SoBo-6	Soil	6 - 7									
Sed-1	Sediment	NA									
MW-3	Groundwater	NA	X	X	X	X	X	X	X	X	
MW-4	Groundwater	NA	X	X	X	X	X	X	X	X	
MW-7	Groundwater	NA	X	X	X	X	X	X	X	X	
SB-1	Groundwater	NA	X	X	X	X	X	X	X	X	
SB-2	Groundwater	NA	X	X	X	X	X	X	X	X	
SB-3	Groundwater	NA	X	X	X	X	X	X	X	X	
MP-1	Groundwater	NA	X	X	X	X	X	X	X	X	
MP-2	Groundwater	NA	X	X	X	X	X	X	X	X	
MP-3	Groundwater	NA	X	X	X	X	X	X	X	X	
MP-4	Groundwater	NA	X	X	X	X	X	X	X	X	
HA-49	Soil Gas	NA									X
HA-61	Soil Gas	NA									X
HA-72	Soil Gas	NA									X

[a] ft. bgs = feet below ground surface

NA = not applicable

BTEX = Benzene, Toluene, Ethylbenzene, and Xylenes

PAHs = Polynuclear Aromatic Hydrocarbons

TPH = Total Petroleum Hydrocarbons

EDB = Ethylene Dibromide

TRPH = Total Recoverable Petroleum Hydrocarbons

TOC = Total Organic Carbon

DO = Dissolved Oxygen

ORP = Oxidation Reduction Potential

TABLE 2.3
SOIL BORING AND MONITORING POINT INSTALLATION SUMAMRY
Risk-Based Approach to Remediation
Site FT-16
Tyndall AFB, Florida

Well ID	Groundwater Zone	Installation Date	Top of Casing Elevation (ft msl)[a]	Depth to Top of Screen (ft bgs) [b]	Depth to Bottom of Screen (ft bgs)	Casing/ Screen ID (inches)	Total Depth (feet)
Soil Borings							
SoBo-1	NA [c]	3/17/98	NA	NA	NA	NA	8.0
SoBo-2	NA	3/17/98	NA	NA	NA	NA	4.0
SoBo-3	NA	3/17/98	NA	NA	NA	NA	8.0
SoBo-4	NA	3/17/98	NA	NA	NA	NA	12.0
SoBo-5	NA	3/17/98	NA	NA	NA	NA	12.0
SoBo-6	NA	3/18/98	NA	NA	NA	NA	8.0
Groundwater Monitoring Points							
MP-1[d]	Shallow	3/18/98	3.15	2.80	3.80	0.75	3.8
MP-2[d]	Shallow	3/18/98	3.42	2.20	3.20	0.75	3.2
MP-3	Shallow	3/22/98	12.85	1.20	7.20	0.50	7.2
MP-4	Shallow	3/22/98	13.45	3.50	9.50	0.50	9.5

a/ ft msl = feet above mean sea level
b/ ft bgs = feet below ground surface
c/ NA = not applicable
d/ MP-1 and MP-2 were abandoned after sampling

SECTION 3
PHYSICAL CHARACTERISTICS OF THE STUDY AREA

This section describes the physical characteristics of Site FT-16 and adjacent environs at Tyndall AFB, as determined from data collected during previous site investigations (BCM, 1996) and by Parsons ES in March 1998 as part of this risk-based investigation. A summary of site characterization activities completed by Parsons ES to supplement existing data is presented in Section 2 of this CAP.

3.1 PHYSIOGRAPHY

Tyndall AFB is located in the East Gulf Coastal Plain Physiographic Province. This province is characterized by relatively low topographic relief, predominantly sandy soils, and a gradual slope toward the Gulf of Mexico. Physiographic districts within the Gulf Coastal Plain at Tyndall AFB include predominantly Coastal Lowlands. The Coastal Lowlands occur at approximately 25 feet above mean sea level (msl) and include coastal areas and adjacent flood plains. The Coastal Lowlands are characterized by flat, poorly drained topography near the coast and in the flood plains of major rivers. White sand beaches and sand ridges typically border the coastline while flatlands and swamps extend 10 to 15 miles inland. Landforms in the Coastal Lowland reflect their origin in a near-shore environment.

3.2 REGIONAL GEOLOGY

Bay County is located in the south-central part of the Florida Panhandle. The county is situated on the western flank of the Appalachicola Embayment, the regional geologic structure influencing the subsurface sediments. The embayment is a relatively shallow basin between the Ocala and Chattahoochee uplifts. Bay County is underlain by Cenozoic sediments approaching 3,500 feet in thickness. The county is relatively flat in relief and is mostly covered with Pleistocene to recent age quartz sands.

The county has four physiographic provinces which include: the sand hills in the northern section, the sinks and lakes in the north-central section, the flat-woods forest located below an elevation of 70 feet msl (covers most of Bay County), and the beach dunes and wave-cut bluffs of the Gulf Coast. The beach dune deposits are the youngest sediments in the basin and are the most rapidly changing physiographic feature. The land forms along the coast are composed of barrier islands, coastal ridges, estuaries, lagoons, relief spits and bars, and sand dune ridges. In Bay County, eight terraces have been mapped based on their elevations. These terrace deposits can be up to 100 feet thick near the coast, and become thinner inland.

3.3 REGIONAL HYDROGEOLOGY

The hydrostratigraphic units in Bay County are the Surficial Aquifer System, Intermediate Aquifer System or Confining Unit, and Floridan Aquifer System. All hydrostratigraphic units can usually be correlated on the basis of lithology and fossil occurrence.

The Surficial Aquifer System contains the undifferentiated Quaternary sediments and the Citronelle Formation. The typical lithology of the surficial aquifer is primarily fine to coarse quartz sand, with clay, silt, gravel, and clayey sand and sandy clay lenses. Limonite-cemented zones, shell beds, and carbonates are also common. The thickness of the surficial aquifer varies from 40 to 100 feet and the elevation of the water table varies from 0 to 30 feet above msl. The water within the Surficial Aquifer System is generally unconfined, however, beds of low permeability may cause semi-confined or locally confined conditions in its deeper parts. Water table elevations and horizontal gradients generally reflect contours of the land surface. Terraces influence groundwater occurrence and movement due to the elevations of terraces relative to adjacent land, in addition to size and the grading of the sands and locations of bodies of water.

The Intermediate Aquifer System or Confining Unit contains the Alum Bluff Group and Intracoastal Formation. The typical lithology of the Intermediate Aquifer System or Confining Unit is clay, sand, sandy clay, argillaceous limestone, shell beds, and occasional carbonate beds or lenses. The thickness of this unit varies from 210 to 230 feet and the elevation of the top of this unit varies from -30 to -70 feet below msl. The Intermediate Aquifer System or Confining Unit is widespread in Florida and provides an effective aquitard for the Floridan Aquifer System. In places, this unit contains principally poorly-yielding to non-yielding strata, hence the term "Intermediate Confining Unit." In other places, one or more low-to moderate-yielding aquifers may be interlayered with the virtually impermeable confining beds. Even though Bay County contains both hydrogeologic situations, only the confining unit occurs in Southern Bay County. Therefore, there should be negligible leakage between the Surficial Aquifer System and the Floridan Aquifer System at and near Tyndall Air Force Base.

The Floridan Aquifer System contains the Bruce Creek Limestone, St. Marks Formation, Chattahoochee Formation, Suwannee Limestone, Marianna Limestone and Ocala Limestone. The typical lithology of the Floridan Aquifer System is vuggy, fossiliferous, micro-crystalline to granular, argillaceous to sandy, porous limestone and dolomite. The limestone and dolomite may be interbedded with dolomitic sand, silt and clay beds. The Ocala Limestone forms one of the most permeable zones within the Floridan Aquifer System. The extensive development of secondary porosity by dissolution and dolomitization has greatly increased the permeability of the unit. The thickness of the Floridan Aquifer System varies from 900 to 1,000 feet and the elevation of the top of this unit varies from -270 to -320 feet below msl.

When intra-aquifer confining beds are present, the Floridan Aquifer System can be subdivided into an upper and lower aquifer. The Floridan Aquifer System is well confined in southern and central Bay County.

3.4 SITE GEOLOGY AND HYDROGEOLOGY

The subsurface at Site FT-16 is characterized by tan to brown, fine to medium grained sand with traces of silt and organics. Groundwater level measurements were collected from each of the groundwater monitoring wells in March 1998 (Table 3.1). Data indicate that the average depth to groundwater at the site is approximately 3 feet bgs. It was determined that groundwater flows from Site FT-16 northeast toward Fred Bayou at gradients ranging from approximately 0.006 foot per foot (ft/ft) to 0.080 ft/ft. Generally, the gradient increases near the Bayou (Figure 3.1). The average gradient across the site between the former fire training pit and Fred Bayou was determined to be 0.02 ft/ft. Slug test data indicate that hydraulic conductivity at the site ranges from approximately 0.40 to 17 feet per day (ft/day) with an average of approximately 4 ft/day (Appendix A). Based on these data and an effective porosity of 25 percent for sand (Spitz and Moreno, 1996), an average groundwater velocity of 0.32 ft/day (117 feet per year [ft/yr]) was calculated.

3.5 SITE TOPOGRAPHY AND SURFACE WATER

Site FT-16 and the surrounding area have relatively flat topography, with ground elevations at the site at approximately 10 to 15 feet above the msl. The closest surface water body to Site FT-16 is Fred Bayou (Site OT-29), which forms the site's northern border. Surface of the elevation in the bayou is approximately 10 feet below the ground surface at MW-6. The land surface drops off abruptly near the bayou water, and the elevation of the bayou is approximately 10 feet below the ground surface at well MW-6 (Figure 3.1).

3.6 CLIMATOLOGICAL CHARACTERISTICS

Tyndall AFB has a humid, semitropical climate. Daily average temperature in the hottest summer months, July and August, may range from a low of 70°F to a high of 88°F, with an average of approximately 82°F. Winters are mild, with occasional frost from November through February. During the coldest months, December and February, the temperature may be as low as 18°F or as high as 74°F, with the average around 50°F. Average annual rainfall is approximately 64 inches and ranges from 3.5 inches in October to almost 9 inches in July.

3.7 WATER-SUPPLY WELL SURVEY

Groundwater use in the Tyndall AFB area is restricted to industrial wells completed in the Floridan Aquifer. Two former water supply wells have been identified in the vicinity of Site FT-16. These wells include the liquid fuels well at Building 6065, and "Old Dermo" at Building 6032. The Liquid Fuels well is located approximately 2,000 feet north of the site and "Old Dermo" is located approximately 2,500 feet north-northeast of the site. Both wells are completed in the Floridan aquifer at depths ranging from 463 to 600 feet bgs with surface casing set at depths ranging from 315 to 435 feet bgs. Both wells have been plugged and are no longer in use.

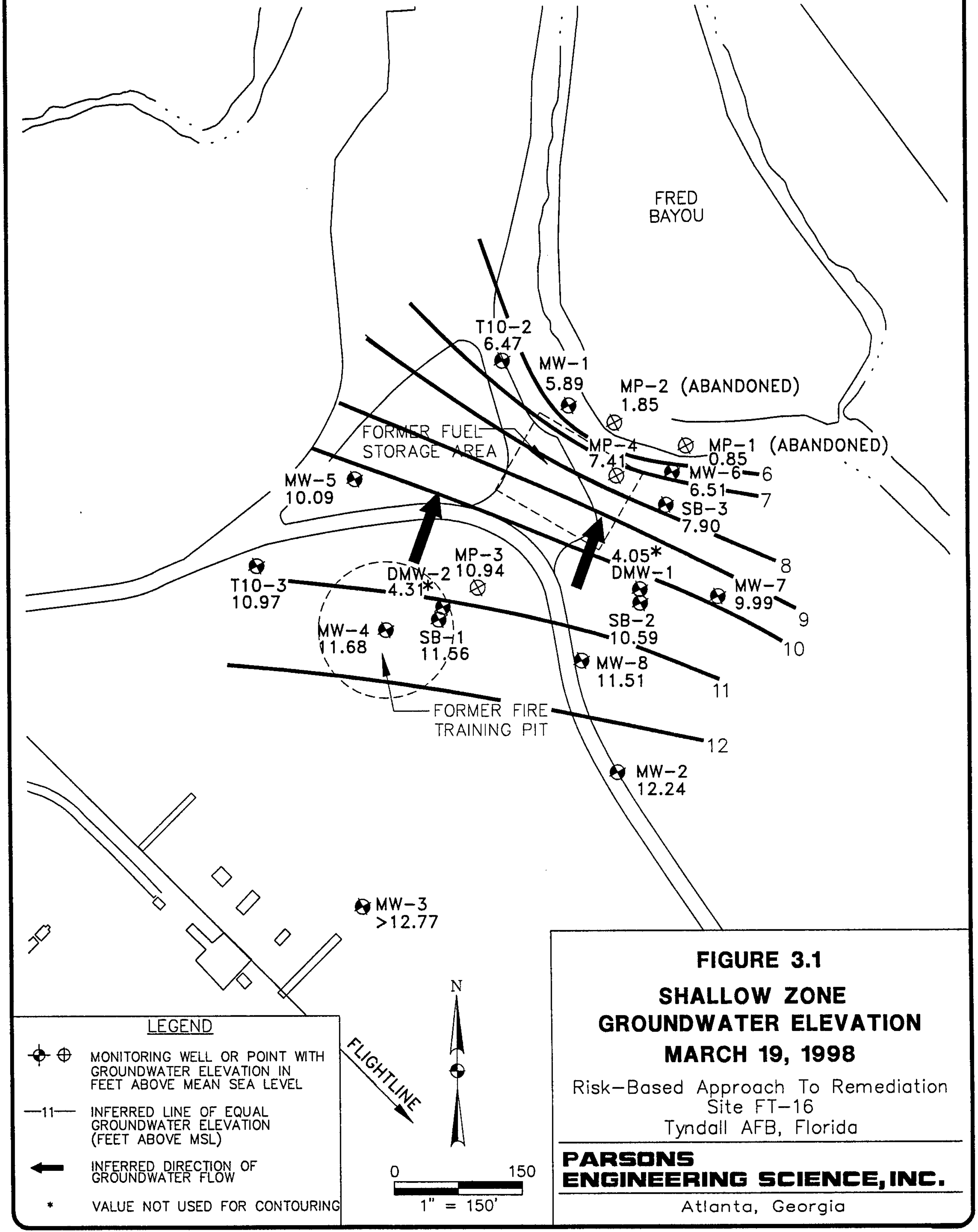


FIGURE 3.1

SHALLOW ZONE GROUNDWATER ELEVATION MARCH 19, 1998

Risk-Based Approach To Remediation
Site FT-16
Tyndall AFB, Florida

PARSONS ENGINEERING SCIENCE, INC.
Atlanta, Georgia

J: /731854/CADD/TYNDALL/FTGWELEV

TABLE 3.1
SUMMARY OF MONITORING WELL GAUGING DATA
MARCH 19, 1998
Risk-Based Approach to Remediation
Site FT-16
Tyndall AFB, Florida

Well Identification	Top of Casing Elevation (ft msl)[a/]	Depth of Screened Interval (ft bgs) [b/]	Depth to Water (feet btoc) [c/]	Water Table Elevation (ft msl)
MW-1	11.83	7.88-17.88	5.94	5.89
MW-2	12.61	7.48-17.48	0.37	12.24
MW-3	12.77	7.76-17.76	--[d/]	> 12.77
MW-4	12.87	5.2-15.2	1.19	11.68
MW-5	11.72	5.04-15.04	1.63	10.09
MW-6	12.27	7.62-17.62	5.76	6.51
MW-7	11.54	5.26-15.26	1.55	9.99
MW-8	14.74	8.18-18.18	3.23	11.51
DMW-1	13.47	42.46-52.46	9.42	4.05
DMW-2	13.13	42.94-52.94	8.82	4.31
SB-1	13.12	4.84-14.84	1.56	11.56
SB-2	13.22	4.93-14.93	2.63	10.59
SB-3	11.75	4.58-14.58	3.85	7.90
T10-2	12.34	NA[e/] - 21.98	5.87	6.47
T10-3	10.78	NA - 21.11	-0.19[d/]	10.97
MP-1	3.15	0.8-3.8	2.30	0.85
MP-2	3.42	0.2-3.2	1.57	1.85
MP-3	12.85	1.2-7.2	1.91	10.94
MP-4	13.45	3.5-9.5	6.04	7.41

Notes:
a/ ft msl = feet above mean sea level
b/ ft bgs = feet below ground surface
c/ ft btoc = feet below top of casing
d/ The water level was above the top of the PVC casing
e/ Top of screened interval information was not available

SECTION 4
TIER 1 ANALYSIS AND IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN

This section presents a screening-level Tier 1 analysis used to select the COPCs that are the focus of this CAP. The COPCs for the site are identified in the Tier 1 analysis based on estimated risks to human health posed by maximum detected contaminant concentrations.

4.1 REGULATORY REVIEW OF THE TIER 1 SCREENING PROCESS

As an initial step in determining the necessity for remedial action, representative concentrations of site contaminants are compared to the NFA-With-Conditions (Direct Exposure II) generic TCLs for soil, which are presented in the *Petroleum Contamination Site Cleanup Criteria* (FDEP, 1997). Contaminant soil concentrations must be below the Direct Exposure II presented in Table IV (based on applicable groundwater criteria specified in 62-770.680 (1)(c), FAC). Concentrations of COPCs in groundwater must be below background concentrations or less than levels presented in Table VI. Maximum dissolved site contaminant concentrations also are compared to the Table IX Natural Attenuation Source Default Values. This comparison provides an initial assessment of the potential appropriateness of monitored natural attenuation (MNA) as a remedial alternative.

The maximum soil contaminant concentrations were not compared to the leachability TCLs presented in Table IV of FDEP (1997). The leachability criteria were established to ensure that leaching of residual contamination adsorbed to soil particles will not result in significant impairment of groundwater quality. At Site FT-16, the vadose zone is thin (average thickness of 3 feet) and groundwater is continually or seasonally in direct contact with contaminated soil, minimizing the significance of downward leaching of contaminants from the vadose zone to the water table. In addition, the impacts of site contamination on groundwater quality have been demonstrated by the results of several years of groundwater monitoring. The gradual desorption of residual fuel contaminants from the soils and dissolution into the groundwater is significant to the extent that the contaminants in soils represent a continuing source of groundwater contamination. The length of time that the soil contamination will continue to cause groundwater contaminant concentrations to exceed Tier 1 TCLs (Table VI levels in Chapter 62-770) is addressed in Section 6.

The *Petroleum Contamination Site Cleanup Criteria* (FDEP, 1997) TCL tables do not include levels for soil gas or sediment. The screening processes for these media are described in Sections 4.3.3 and 5.5.2, respectively.

Those analytes with site concentrations that exceed the appropriate TCLs are considered to be COPCs, and are retained for further analysis concerning the risk-reduction requirements for the site. The nature and extent of these COPCs are described more fully in Section 5. Quantitative fate and transport analyses are presented in Section 6.

4.2 PRELIMINARY CONCEPTUAL SITE MODEL REVIEW

Figure 4.1 presents the preliminary conceptual site model (CSM) developed for Site FT-16. The model was developed using data collected during previous site investigations, and is based on a review of potential receptors and feasible exposure scenarios. The purpose of developing a CSM is to guide the evaluation of available site information, including:

- Potential contaminant sources;
- Mechanisms of contaminant release (e.g., leaching and volatilization);
- Media affected by contaminant releases;
- Potential human and ecological receptors;
- Potential receptor exposure points based on conservative, reasonable land use assumptions; and
- Routes of possible receptor exposure (e.g., inhalation, ingestion, or dermal contact).

The CSM also was developed to provide an outline for addressing all media-specific, current and future exposure scenarios at Site FT-16. The CSM has been constructed to identify potentially completed receptor exposure pathways. For an exposure pathway to be completed, there must be a contaminant source, a release mechanism, a contaminant migration pathway, an exposure point, a receptor, and an exposure route. If any of these components is missing, the pathway is considered incomplete, and receptors are not at risk from exposure to site contaminants.

The two ASTs were removed and all fire training activities ceased in 1980. Therefore, the initial contaminant sources have been removed. Based on the CSM, air, soil, shallow groundwater, surface water, and sediment represent the potentially affected physical media at or downgradient from Site FT-16 (Figure 4.1). On the basis of available site-specific information, current and future land use at Site FT-16 is assumed to be industrial as opposed to residential. Potential release mechanisms and pathways by which contaminants could migrate and impact potential receptors, and that will be evaluated during the data analysis process include the following:

- Volatilization of subsurface contaminants into the soil vapor and the atmosphere and inhalation of the volatilized contaminants by site workers and aboveground receptors;
- Dermal contact or incidental ingestion of contaminated soil by site workers (e.g., during excavation activities);
- Ingestion of contaminants by ecological receptors (e.g., burrowing animals and their predators);
- Soil contaminants leaching to groundwater and dermal contact or incidental ingestion of contaminated groundwater by site workers (e.g., during excavation activities);

- Migration of dissolved contaminants in the groundwater and ingestion by an aboveground receptor either through a groundwater withdrawal point or groundwater discharging to surface water/sediment.

4.3 TIER 1 SCREENING ANALYSIS

It is the intention of the Air Force to obtain FDEP approval for a corrective action for Site FT-16 that will protect potential receptors from unacceptable exposures to site-related chemicals. To accomplish this objective, the COPCs that drive potential risks and impact the final remedial requirements at this site were identified.

FDEP (1997) Tier 1 TCLs are based on 1) analyte-specific toxicity data; 2) an exposure-pathway-specific cancer target risk limit of 10^{-6} (i.e., one additional cancer above the background rate in a population of 1 million people) and a noncancer hazard quotient less than or equal to 1; and 3) conservative receptor exposure assumptions.

4.3.1 Tier 1 Screening Analysis for Soil

TCLs for direct exposure of industrial workers (Direct Exposure II) were selected as the appropriate set of Tier 1 screening values for soil at Site FT-16. The FDEP (1997) guidance provides industrial-scenario TCLs for petroleum constituents in soil that incorporate risks posed by the dermal contact, ingestion, and inhalation exposure pathways. Table 4.1 compares the maximum site concentrations for each compound measured in soil at Site FT-16 during the 1998 risk-based sampling event to the Direct-Exposure II TCLs. Soil contamination "hotspots" detected during the CA (BCM, 1996) were resampled in March 1998; therefore, the March 1998 data are assumed to be representative of current contaminant conditions and are used for the Tier I screening in place of the 1995 data. However, in cases where March 1998 data were not available, BCM (1996) data from September 1995 were used instead. Based on these comparisons, no chemicals are identified as site COPCs in soil.

4.3.2 Tier 1 Screening Analysis for Groundwater

The Tier 1 groundwater TCLs presented by the FDEP (1997) and used in this CAP are based on the conservative assumption of unrestricted future use of groundwater (e.g., use as a drinking water source). Therefore, the TCLs are overly conservative for this site and are not representative of current or anticipated future site conditions. Comparisons of the TCLs for unrestricted groundwater use to maximum concentrations of compounds detected in groundwater samples collected in March 1998 are presented in Table 4.2. In cases where March 1998 data were not available (i.e., 1,2-DCA), data from September 1995 were used instead. The groundwater results from MP-1 and MP-2 are not used in this comparison because, as discussed in Sections 1.5.2 and 5.5.1, they are associated with Site OT-29. Analytical results for Site OT-29 are discussed in Section 5.5.1. Based on these comparisons, benzene, ethylbenzene, total xylenes, and TRPH are identified as the Site FT-16 COPCs in site groundwater. Maximum dissolved contaminant concentrations from March 1998 also are compared to Table IX Natural Attenuation Source Default Values in Table 4.2. No chemicals exceeded their natural attenuation default values.

As shown on Table 4.2, groundwater samples were not analyzed for several metals listed in the FDEP (1997) Table VI. As shown in Table 4.1, concentrations of these metals were substantially less than soil Tier 1 screening levels, and they are not common fuel constituents. Therefore, they will not be assessed further.

4.3.3 Tier 1 Screening Analysis for Soil Gas

FDEP (1997) guidance does not provide TCLs for screening soil gas concentrations or for directly screening ambient air quality data. However, FDEP guidance accounts for the potential for volatilization of contaminants from soils into ambient air in the calculation of the Tier 1 Direct Exposure II TCLs (Table 4.1). No analytes were detected above Tier 1 TCLs in soil, indicating that exposure via volatilization from soil into ambient air and enclosed structures (if structures are built at the site in the future) will not present appreciable risks.

As a secondary means of assessing the potential for exposure via inhalation of volatiles, soil gas samples collected in March 1998 were analyzed for BTEX, and maximum detections of each compound were compared to the chemical-specific Occupational Safety and Health Administration (OSHA) 8-hour time-weighted-average Permissible Exposure Limits (PELs) (NIOSH, 1997). Table 4.3 presents the results of this comparison. No compounds were detected at concentrations above the PELs.

The comparison of soil gas values to ambient air PELs is highly conservative. PELs are based on 8-hour time-weighted averages, whereas the maximum detected value represents a worse-case scenario at a localized "hotspot." Subsurface soil gas concentrations are not representative of potential ambient air exposure concentrations because they do not account for the dilution which would occur as volatiles moved through the soil column and into ambient air. Neither are subsurface soil gas concentrations representative of an exposure concentration for onsite intrusive workers engaged in excavation activities because they do not account for the dilution of soil gas concentrations in ambient air.

4.3.4 Tier 1 Screening Analysis for Sediment

No sediment samples were collected at Site FT-16. The sediment samples collected at Site OT-29 are discussed in Section 5.5.2.

4.3.5 Summary of Site FT-16 COPCs

No chemicals were identified as site COPCs for soil or soil gas. Based on comparisons of the maximum detected site chemical concentrations to the Tier 1 TCLs for groundwater, benzene, ethylbenzene, total xylenes, and TRPH are identified as the groundwater COPCs.

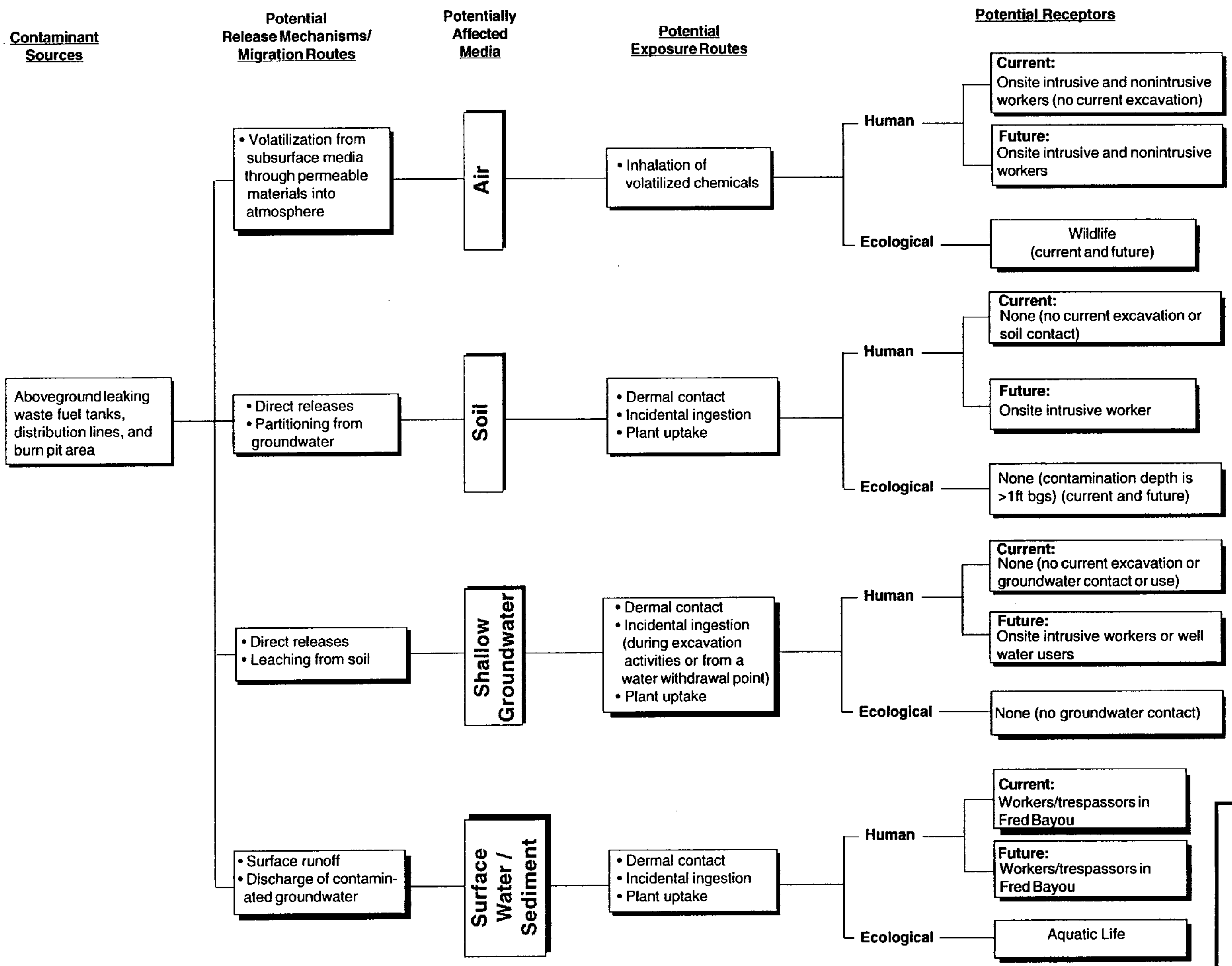


FIGURE 4.1

PRELIMINARY CONCEPTUAL SITE MODEL

Risk-Based Approach to Remediation
Site FT-16
Tyndall AFB, Florida

PARSONS ENGINEERING SCIENCE, INC.
Atlanta, Georgia

j:\731854\tyndall\ft-csm.pm65

TABLE 4.1
COMPARISON OF MAXIMUM SITE SOIL CONCENTRATIONS TO TARGET CLEANUP LEVELS
Risk-Based Approach to Remediation
Site FT-16
Tyndall AFB, Florida

Chemical Name	Units	Maximum Concentration Detected	Location of Maximum Detection	Sample Collection Date	Direct Exposure II[a/]
Acenaphthene	mg/kg [b/]	0.25 U[c/]	SoBo-4	Mar-98	22,000
Acenaphthylene	mg/kg	0.25 U	SoBo-4	Mar-98	11,000
Anthracene	mg/kg	0.25 U	SoBo-4	Mar-98	290,000
Benzo(a)anthracene	mg/kg	0.25 U	SoBo-4	Mar-98	5.1
Benzo(a)pyrene	mg/kg	0.019 U	SoBo-4	Mar-98	0.5
Benzo(b)fluoranthene	mg/kg	0.0045 J1[d/]	SoBo-3	Mar-98	5
Benzo (g,h,i)perylene	mg/kg	0.062 U	SoBo-4	Mar-98	45,000
Benzo(k)fluoranthene	mg/kg	0.014 U	SoBo-4	Mar-98	52
Chrysene	mg/kg	0.014 U	SoBo-4	Mar-98	490
Dibenzo(a,h)anthracene	mg/kg	0.025 U	SoBo-4	Mar-98	0.5
Fluoranthene	mg/kg	0.05 U	SoBo-4	Mar-98	45,000
Fluorene	mg/kg	0.05 U	SoBo-4	Mar-98	24,000
Indeno(1,2,3-cd)pyrene	mg/kg	0.038 U	SoBo-4	Mar-98	5.2
Naphthalene	mg/kg	0.25 U	SoBo-4	Mar-98	8,600
Phenanthrene	mg/kg	0.05 U	SoBo-4	Mar-98	29,000
Pyrene	mg/kg	0.05 U	SoBo-4	Mar-98	40,000
Benzene	mg/kg	0.00060 J1	SoBo-6	Mar-98	1.50
Ethylbenzene	mg/kg	0.037	SoBo-6	Mar-98	240
Toluene	mg/kg	0.00097 J1	SoBo-6	Mar-98	2,000
Xylenes	mg/kg	0.25	SoBo-6	Mar-98	290
1,2-DCA	mg/kg	2.86 U	HA-61	Sep-95	0.9
MTBE [e/]	mg/kg	0.0063 U	SoBo-4	Mar-98	6,100
TRPH [f/]	mg/kg	690	SoBo-3	Mar-98	2,500
Arsenic	mg/kg	0.48 U	HA-26	Sep-95	3.7
Barium	mg/kg	3.5	HA-65	Sep-95	87,000
Cadmium	mg/kg	0.13	HA-65	Sep-95	1,300
Chromium	mg/kg	14	HA-74	Sep-95	430
Lead	mg/kg	9.2	HA-42	Sep-95	1,000
Mercury	mg/kg	0.12 U	HA-26	Sep-95	28
Selenium	mg/kg	0.44	HA-65	Sep-95	10,000
Silver	mg/kg	0.59 U	HA-26	Sep-95	9,100

Notes: No maximum site concentration is above a target cleanup level

[a/] Direct Exposure II is for No Further Action With Conditions (industrial worker scenario)

[b/] mg/kg = milligrams per kilogram

[c/] U= The analyte was analyzed for and is not present above the associated reporting limit

[d/] J1= The analyte was positively identified and has a concentration between the method detection limit and the reporting limit

[e/] MTBE = methyl tert-butyl ether

[f/] TRPH = total recoverable petroleum hydrocarbons

TABLE 4.2
COMPARISON OF MAXIMUM SITE GROUNDWATER CONCENTRATIONS TO TARGET CLEANUP LEVELS
Risk-Based Approach to Remediation
Site FT-16
Tyndall AFB, Florida

Chemical Name	Units	Maximum Concentration Detected	Sample Location of Maximum Detection	Date of Sample	Table VI Target Cleanup Level [a]	Table IX Natural Attenuation Source Default [b]
Benzene	μg/L [c]	71	MP-4	Mar-98	1	100
Ethylbenzene	μg/L	44	MP-4	Mar-98	30	300
Toluene	μg/L	1.1	MP-4	Mar-98	40	400
Xylenes	μg/L	39	SB-2	Mar-98	20	200
MTBE [d]	μg/L	10 U[e]	MP-4	Mar-98	35	350
Acenaphthene	μg/L	1.0 U	MW-4	Mar-98	3	200
Acenaphthylene	μg/L	1.0 U (0.041)[f]	MW-4	Mar-98	0.031	2,100
Anthracene	μg/L	0.1 U	MW-4	Mar-98	0.3	21,000
Benzo(a)anthracene	μg/L	0.13 U (0.062)	MW-4	Mar-98	0.031	20
Benzo(a)pyrene	μg/L	0.24 U (0.067)	MW-4	Mar-98	0.031	20
Benzo(b)fluoranthene	μg/L	0.19 U (0.061)	MW-4	Mar-98	0.031	20
Benzo (g,h,i)perylene	μg/L	0.21 U (0.073)	MW-4	Mar-98	0.031	2,100
Benzo(k)fluoranthene	μg/L	0.18 U (0.061)	MW-4	Mar-98	0.031	50
Chrysene	μg/L	0.21 U (0.075)	MW-4	Mar-98	0.031	500
Dibenzo(a,h)anthracene	μg/L	0.31 U (0.078)	MW-4	Mar-98	0.031	20
Fluoranthene	μg/L	0.21 U	MW-4	Mar-98	0.3	2,800
Fluorene	μg/L	0.21 U	MW-4	Mar-98	30	2,800
Indeno(1,2,3-cd)pyrene	μg/L	0.44 U (0.057)	MW-4	Mar-98	0.031	20
Naphthalene	μg/L	0.6	MP-4	Mar-98	20	200
Phenanthrene	μg/L	0.21 U (0.031)	MW-4	Mar-98	0.031	2,100
Pyrene	μg/L	0.21 U	MW-4	Mar-98	0.3	2,100
1,2-dichloroethane	μg/L	1 U	MW-4	Sep-95	3	300
EDB [g]	μg/L	0.02 U	MP-4	Mar-98	0.02	2
Arsenic	μg/L	NR[h]	NA[i]	NA	50	500
Barium	μg/L	NR	NA	NA	2,000	20,000
Cadmium	μg/L	NR	NA	NA	5	50
Chromium	μg/L	NR	NA	NA	100	1,000
Lead	μg/L	0.005 U	MP -4	Mar-98	15	150
Mercury	μg/L	NR	NA	NA	0.012	20
Selenium	μg/L	NR	NA	NA	5	500
Silver	μg/L	NR	NA	NA	0.07	1,000
TRPH [j]	mg/L[k]	7.1	MP-4	Mar-98	5	50
Chloride	mg/L	NR	NA	NA	250	2,500
Sulfate	mg/L	22.1	MP-3	Mar-98	250	2,500
TDS [l]	mg/L	NR	NA	NA	500	5,000

Note: Shading indicates maximum site concentration is above target cleanup level

[a] Cleanup level for No Further Action With or Without Conditions for groundwater that may affect surface water

[b] Allowable maximum concentration for remediation by natural attenuation with monitoring

[c] μg/L = micrograms per liter

[d] MTBE = methyl tert-butyl ether

[g] EDB = ethylene dibromide, 1,2-dibromoethane

[h] NR = no results available

[i] NA = not applicable

[j] TRPH = total recoverable petroleum hydrocarbons

[k] mg/L = milligrams per liter

[l] TDS = total dissolved solids

[e] U= The analyte was analyzed for and is not present above the associated reporting limit

f/ When the reporting limit is above target clean-up level and chemical is not detected (U), then the method detection limit is given in parantheses; the analyte concentration is below the mdl

I:\TYN-RBIC\REPORT\FT-16\TABLES\Tier1-ft.xls/groundwater

TABLE 4.3
COMPARISON OF MAXIMUM SITE SOIL GAS CONCENTRATIONS DETECTED IN MARCH 1998 TO OSHA PERMISSIBLE EXPOSURE LIMITS
Risk-Based Approach to Remediation
Site FT-16
Tyndall AFB, Florida

Chemical	Maximum Detected Concentration (ppmv [a])	OSHA PEL (ppmv) [b]	Maximum Concentration Above PEL?
Benzene	<0.0026	1	No
Toluene	0.0067	200	No
Ethylbenzene	<0.0026	100	No
Xylenes	0.0034	100	No
TPH [c]	0.54	-- [d]	--

[a] ppmv = Parts per million, volume per volume

[b] Occupational Safety and Health Administration (NIOSH, 1997) 8-hour time-weighted average permissible exposure limit

[c] TPH = Total petroleum hydrocarbons

[d] "--" = No PEL available

SECTION 5
ANALYTICAL DATA SUMMARY AND MAGNITUDE AND EXTENT OF CHEMICALS OF POTENTIAL CONCERN

5.1 OVERVIEW

This section presents analytical results from the March 1998 field sampling event in tabular form, and summarizes the magnitude and extent of COPC contamination in sampled media at Site FT-16. Discussion in this section is primarily limited to those chemicals that were identified as COPCs based on the Tier 1 screening analysis presented in Section 4. Furthermore, this section discusses the impact of Site FT-16 on Site OT-29 (Fred Bayou) and presents the Site OT-29 data collected during the March 1998 field effort.

5.2 SOIL SAMPLING RESULTS

Soil sampling was performed as part of the recent risk-based investigation; analytical results are summarized in Table 5.1. Soil borings were advanced in "hotspots" of contamination (based on the previous BCM investigation) to determine worst case hydrocarbon concentrations in soil (Figure 2.1). The BCM locations that were resampled were HA-42, HA-61, HA-65 and HA-72 (Appendix A, Figure 12). Maximum detected concentrations of individual fuel hydrocarbon-related compounds were compared to Tier 1 TCLs (Table 4.1). Available soil analytical data indicate that there are no soil COPCs.

Two soil samples were collected beneath the water table to assess the vertical extent of contamination. The samples were collected in the areas of most elevated soil contaminant concentrations at the former fuel storage area (SoBo 4) and the former fire training pit (SoBo 6) based on previous investigation results. As shown on Table 5.1, TRPH concentrations decreased slightly with depth, and BTEX concentrations increase with depth. Overall, hydrocarbon concentrations are substantially lower than detected in September 1995.

5.3 GROUNDWATER SAMPLING RESULTS

Groundwater sampling was performed as part of the recent risk-based investigation; analytical results are summarized in Table 5.2. Sampled monitoring wells were selected based on the results of previous investigations. The sampling strategy was to determine the areal extent and magnitude of fuel hydrocarbon and total lead concentrations in groundwater. As shown in Table 4.2, benzene, ethylbenzene, total xylenes, and TRPH for groundwater exceeded Tier 1 TCLs and are, therefore, the groundwater COPCs.

The four COPCs, their maximum concentrations, and the locations where the maximum concentrations were detected in March 1998 were benzene (71 micrograms per liter [µg/L] at MP-4), ethylbenzene (44 µg/L at MP-4), total xylenes (39 µg/L at SB-2), and TRPH (7.1 mg/L at MP-4). The March 1998 distribution of the four dissolved COPCs is presented on Figure 5.1.

5.4 SOIL GAS SAMPLING RESULTS

Soil gas samples were collected at the site to facilitate assessment of the potential risk to future site workers from inhalation of VOCs, and to determine whether or not sufficient O_2 is available in the soil gas to sustain aerobic fuel hydrocarbon biodegradation. Three soil gas samples were collected and analyzed in the field for concentrations of O_2 and CO_2. The samples were collected from a depth of 2 to 3 feet bgs, and the locations of these samples (HA-49, HA-61, and HA-72) are shown on Figure 2.1. The samples also were submitted to Air Toxics, Ltd. of Folsom, California for analysis of BTEX and TPH (referenced to gasoline). Field and laboratory analytical results for 1998 soil gas samples are summarized in Table 5.3. Comparison of maximum soil gas BTEX concentrations to OSHA 8-hour time-weighted average PELs (Table 4.3) indicated that no hydrocarbons pose a potential inhalation risk to future intrusive workers.

The field screening data indicate that the soil gas O_2 level at HA-61, which is in an areas of fuel-contaminated groundwater and soil, has been slightly reduced. This reduction may be due to microbial respiration during aerobic biodegradation of the fuel compounds. The oxygen content of ambient air is 20.8 percent. The concentration of CO_2, which is a metabolic byproduct of biodegradation reactions, is correspondingly slightly elevated at HA-61. The CO_2 content of ambient air is 0.05 percent. The field screening data at HA-49 and HA-72 do not indicate aerobic biodegradation of fuel compounds. The data do indicate that sufficient O_2 is present to sustain continuing aerobic biodegradation without the engineered addition of O_2 via *in situ* bioventing.

5.5 SITE OT-29

This section summarizes the data collected at Site OT-29 and compares the analytical results to TCLs so that Tyndall AFB may incorporate this information into the ongoing investigation at that site. The data include results from monitoring points MP-1 and MP-2 (1998), and sediment sampling locations SD-1, SD-2, and SD-3 (1995) and SED-1 (1998).

5.5.1 Water

Based on the location and geochemistry (conductivity is an order of magnitude greater than other Site FT-16 groundwater samples [Table 6.5]), the water samples collected from MP-1 and MP-2 are likely a mixture of groundwater from the shallow aquifer and surface water from the tidally influenced Fred Bayou. No fuel hydrocarbons or lead were detected at MP-2. Five PAHs and TRPH was detected at MP-1. When compared to the TCLs in Table 4.2, only fluoranthene (1.2 µg/L) and pyrene (0.87 µg/L) exceeded their respective groundwater TCLs. These analytes were not detected in any other well/point sampled for PAHs in 1998. The analytical results are presented in Table 5.2.

5.5.2 Sediment

5.5.2.1 Screening Overview

Screening guidelines currently recommended by USEPA Region IV and the state of Florida for preliminary evaluation of potential ecological risk from sediment contaminants include: the Florida Sediment Quality Assessment Guidelines (SQAGs) (MacDonald, 1994a,b), USEPA (1995) Region IV ecological effects screening values, and National Oceanic and Atmospheric Administration (NOAA) effects-based levels (Long *et al.*, 1995).

SQAGs have been developed for use as a screening tool for biological effects associated with sediment-sorbed contaminants in estuarine systems. SQAGs were derived using a weight-of-evidence approach based on a combination of no-observed-effects and adverse-effects data. Three ranges of effect concentrations were defined for numerous contaminants including a probable effects range, a possible effects range, and a minimal effects range. The probable effects level defines the lower limit of the range of contaminant concentrations that are usually or always associated with adverse biological effects. Sediment contaminants within this range may represent significant hazards to aquatic organisms (MacDonald, 1994b). Contaminant concentrations within the minimal effects range are not likely to be associated with adverse effects on aquatic organisms. The upper limit of the minimal effects range, or threshold effects level (TEL), and the lower limit of the probable effects level define the range of concentrations associated with possible effects. It should be noted that SQAGs do not consider factors influencing bioavailability (e.g., TOC for non-polar organics), and are based primarily on acute toxicity studies due to the general lack of chronic toxicity data for sediment contaminants. USEPA Region IV has adopted Florida SQAG values for all sediment contaminants detected at the OT-29 site. NOAA effects-based levels (Long *et al.*, 1995) were developed by evaluating an extensive database for estuarine and marine sediment contaminants and effects to determine ranges of chemical concentrations associated with adverse biological effects. Two guideline values, "effects range-low" (ERL), and "effects range-medium" (ERM) were developed. The ERL value is based on contaminant concentrations rarely to occasionally associated with effects, and the ERM value is based on concentrations occasionally to frequently associated with adverse effects.

5.5.2.2 Screening Comparison

At the Site FT-16, contaminants detected in sediment samples include low molecular weight PAHs (LPAHs), high molecular weight PAHs (HPAHs), TRPH, and lead. Analytical results and available sediment screening criteria are summarized in Table 5.4.

Several LPAHs were detected in two samples collected in the same location (SD-2 in 1995 and SED-1 in 1998) including anthracene, fluorene, and phenanthrene. LPAHs were not detected in samples at SD-1 and SD-3. The maximum detection for anthracene (0.012 mg/kg at SED-1) was below the lowest screening criterion (TEL value of 0.047 mg/kg). The maximum detection for fluorene (0.025 mg/kg at SED-1) exceeded the TEL (0.021 mg/kg) and ERL (0.019 mg/kg) slightly, but was well below the probable effects level and ERM values (0.144 and 0.54, respectively). For phenanthrene, the maximum detection (0.11 mg/kg at SD-2) was slightly above the TEL (0.87 mg/kg), but below the ERL (0.24 mg/kg) and probable effects level (0.544 mg/kg). A more recent sample from this location (SED-1) contained phenanthrene (0.017 mg/kg) below all screening criteria. Although concentrations of two individual LPAHs exceeded screening criteria slightly, the maximum sum of LPAHs (0.11 mg/kg in SD-2) for any sample was below the lowest total LPAH screening criterion (0.312 mg/kg TEL).

Five HPAHs (benzo(a)anthracene, benzo(a)pyrene, chrysene, fluoranthene and pyrene) were detected in sediment samples SD-2 and/or SED-1 at concentration above the lowest available screening criterion (TEL). For all analytes exceeding TELs, however, concentrations were at or below other threshold values (ERL) and well below probable effects levels. Three HPAHs (chrysene, fluoranthene and pyrene) were detected above the TEL in sediment sample SD-1. No HPAHs were detected in SD-3. Four additional HPAHs without screening criteria (benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, and indeno(1,2,3-cd)pyrene) were also detected.

The maximum detection for benzo(a)anthracene (0.3 mg/kg in SED-1) exceeded the TEL (0.075 mg/kg), but was only slightly above the ERL value (0.26 mg/kg) and was below the probable effects level (0.693 mg/kg). The maximum detection for benzo(a)pyrene (0.26 mg/kg in SED-1) exceeded the TEL (0.089 mg/kg), but was below the ERL (0.43 mg/kg) and probable effects level (0.763 mg/kg). The maximum detection for chrysene (0.22 mg/kg in SED-1) exceeded the TEL (0.108 mg/kg), but was below the ERL (0.38 mg/kg) and probable effects level (0.846 mg/kg). The maximum detection for fluoranthene (0.3 mg/kg in SED-1) exceeded the TEL (0.113 mg/kg), but was below the ERL (0.6 mg/kg) and probable effects level (1.49 mg/kg). The maximum detection for pyrene (0.38 mg/kg in SED-1) exceeded the TEL (0.153 mg/kg), but was below the ERL (0.67 mg/kg) and probable effects level (1.4 mg/kg). The highest concentration of HPAHs in a particular sample (2.3 mg/kg in SED-1) also exceeded the TEL and ERL values for total HPAHs (0.655 and 1.7 mg/kg, respectively), but was below the probable effects level (6.68 mg/kg).

For total PAHs, the maximum sediment concentration (2.35 mg/kg in SED-1) was above the TEL (1.68 mg/kg), but below the ERL (4.02 mg/kg) and the probable effects level (16.8 mg/kg).

For lead, detected concentrations in 3 of 4 samples exceeded the lowest available screening criterion (TEL). The maximum lead detection (66.2 mg/kg in SED-1) exceeded the TEL (30.2 mg/kg) and the ERL (47 mg/kg), but was below the probable effects level (112 mg/kg). Detected concentrations of lead in SD-2 and SD-3 (42.4 and 38.5 mg/kg, respectively) also exceeded the TEL, but were below the ERL screening value. Lead in SD-1 (5.4 mg/kg) was below all screening criteria.

5.5.3 Impact of Site FT-16 Contaminants at Site OT-29

The purpose of sampling sediment and water at the edge of the bayou was to determine if Site FT-16 contaminants were migrating to and impacting the Fred Bayou (Site OT-29). Review of Site FT-16 analytical data shows that the chemicals detected were limited to the BTEX compounds and one 0.6 µg/L detection of naphthalene in groundwater and the BTEX compounds and one 0.0045 mg/kg detection of benzo(b)fluoranthene in soil. Review of the OT-29 water (MP-1 and MP-2) and sediment (SD-1, SD-2, SD-3,and SED-1) show that several PAHs were detected and the BTEX compounds were not detected. Furthermore, sediment samples collected in other parts of Fred Bayou (Site OT-29) had detectable PAH concentrations (Lewis, 1998). This discrepancy between the chemicals detected at FT-16 and OT-29 indicate that the contaminants from FT-16 have not impacted OT-29, and the chemical concentrations detected at OT-29 are likely related to another source (e.g. boat and fuel distribution activities at the Fred Bayou) (Section 1.5.2). Therefore, the chemical concentrations detected at OT-29 during the Site FT-16 investigations will not be further assessed in this report.

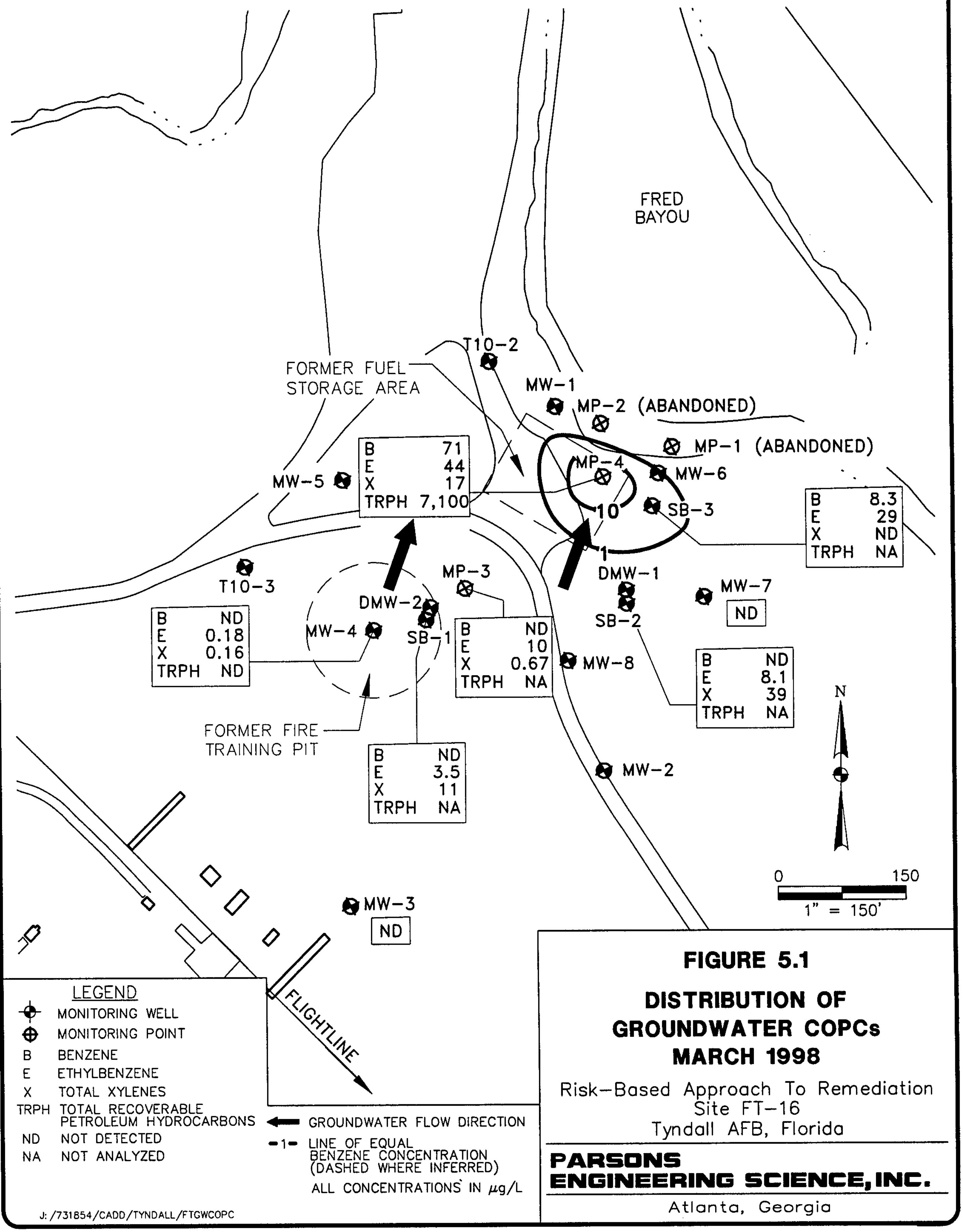


FIGURE 5.1

DISTRIBUTION OF GROUNDWATER COPCs MARCH 1998

Risk-Based Approach To Remediation
Site FT-16
Tyndall AFB, Florida

PARSONS ENGINEERING SCIENCE, INC.
Atlanta, Georgia

TABLE 5.1
SUMMARY OF SOIL ANALYTICAL DATA
Risk-Based Approach to Remediation
Site FT-16
Tyndall AFB, Florida

Analyte	Units	Sample Locations, Intervals, and Dates				
		SoBo-1 (3 - 4) 17-Mar-98	SoBo-1 (4 - 6) 17-Mar-98	SoBo-2 (3 - 4) 17-Mar-98	SoBo-3 (HA-61) (4 - 5.5) 17-Mar-98	SoBo-4 (HA-65) (4 - 5.5) 17-Mar-98
Benzene	mg/kg[a]	NA[b]	NA	NA	0.0059 U[c]	0.0059 U
Ethylbenzene	mg/kg	NA	NA	NA	0.0023 U	0.0024 U
Toluene	mg/kg	NA	NA	NA	0.0059 U	0.0059 U
Xylenes (total)	mg/kg	NA	NA	NA	0.0059 U	0.0059 U
Total BTEX[d]	mg/kg	NA	NA	NA	0.0200 U	0.0201 U
Methyl-tert-butyl ether	mg/kg	NA	NA	NA	0.0059 U	0.0059 U
TRPH (C8-C40)[e]	mg/kg	NA	NA	NA	**690**	**7.4 J1[f]**
Acenaphthene	mg/kg	NA	NA	NA	0.23 U	0.24 U
Acenaphthylene	mg/kg	NA	NA	NA	0.23 U	0.24 U
Anthracene	mg/kg	NA	NA	NA	0.023 U	0.024 U
Benzo(a)anthracene	mg/kg	NA	NA	NA	0.023 U	0.024 U
Benzo(a)pyrene	mg/kg	NA	NA	NA	0.018 U	0.018 U
Benzo(b)fluoranthene	mg/kg	NA	NA	NA	**0.0045 J1**	0.014 U
Benzo(g,h,i)perylene	mg/kg	NA	NA	NA	0.059 U	0.059 U
Benzo(k)fluoranthene	mg/kg	NA	NA	NA	0.013 U	0.013 U
Chrysene	mg/kg	NA	NA	NA	0.047 U	0.047 U
Dibenz(a,h)anthracene	mg/kg	NA	NA	NA	0.023 U	0.024 U
Fluoranthene	mg/kg	NA	NA	NA	0.047 U	0.047 U
Fluorene	mg/kg	NA	NA	NA	0.047 U	0.047 U
Indeno(1,2,3-cd)pyrene	mg/kg	NA	NA	NA	0.035 U	0.035 U
Naphthalene	mg/kg	NA	NA	NA	0.23 U	0.24 U
Phenanthrene	mg/kg	NA	NA	NA	0.047 U	0.047 U
Pyrene	mg/kg	NA	NA	NA	0.047 U	0.047 U
Total Organic Carbon	mg/kg	**1740 J1**	**1320 J1**	**670 J1**	NA	NA

a/ mg/kg = milligrams per kilogram

b/ NA = not analyzed

c/ U = The analyte was analyzed for and was not present above the associated reporting limit

d/ BTEX = benzene, toluene, ethylbenzene, and total xylenes

e/ TRPH = total recoverable petroleum hydrocarbons

f/ J1 = The analyte was positively identified and had a concentration between the method detection limit and the reporting limit

SoBo-4 (7-8) duplicate named SoBo-A (7-8) on chain-of-custody record

I:\TYN-RBIC\REPORT\FT-16\TABLES\Soilsmft.xls

TABLE 5.1 (Continued)
SUMMARY OF SOIL ANALYTICAL DATA
Risk-Based Approach to Remediation
Site FT-16
Tyndall AFB, Florida

Analyte	Units	Sample Locations, Intervals, and Dates				
		SoBo-4 (HA-65) (7 - 8) 17-Mar-98	SoBo-4 Dup (HA-65) (7 - 8) 17-Mar-98	SoBo-5 (HA-72) (2 - 3) 17-Mar-98	SoBo-6 (HA-42) (2 - 3.5) 18-Mar-98	SoBo-6 (HA-42) (6 -7) 18-Mar-98
Benzene	mg/kg	0.0062 U	0.0063 U	0.0059 U	0.0059 U	**0.00060 J1**
Ethylbenzene	mg/kg	0.0025 U	**0.0011 J1**	0.0023 U	0.0023 U	**0.037**
Toluene	mg/kg	0.0062 U	0.0063 U	0.0059 U	0.0059 U	**0.00097 J1**
Xylenes (total)	mg/kg	0.0062 U	0.0063 U	0.0059 U	0.0059 U	**0.25**
Total BTEX	mg/kg	0.0211 U	**0.0011**	0.0200 U	0.0200 U	**0.289**
Methyl-tert-butyl ether	mg/kg	0.0062 U	0.0063 U	0.0059 U	0.0059 U	0.0060 U
TRPH (C8-C40)	mg/kg	12 U	**5.7 J1**	**9.0 J1**	**12**	**7.9 J1**
Acenaphthene	mg/kg	0.25 U	0.25 U	0.23 U	0.23 U	0.24 U
Acenaphthylene	mg/kg	0.25 U	0.25 U	0.23 U	0.23 U	0.24 U
Anthracene	mg/kg	0.025 U	0.025 U	0.023 U	0.023 U	0.024 U
Benzo(a)anthracene	mg/kg	0.025 U	0.025 U	0.023 U	0.023 U	0.024 U
Benzo(a)pyrene	mg/kg	0.019 U	0.019 U	0.018 U	0.018 U	0.018 U
Benzo(b)fluoranthene	mg/kg	0.015 U	0.015 U	0.014 U	0.014 U	0.015 U
Benzo(g,h,i)perylene	mg/kg	0.062 U	0.063 U	0.059 U	0.059 U	0.06 U
Benzo(k)fluoranthene	mg/kg	0.014 U	0.014 U	0.013 U	0.013 U	0.013 U
Chrysene	mg/kg	0.05 U	0.05 U	0.047 U	0.047 U	0.048 U
Dibenz(a,h)anthracene	mg/kg	0.025 U	0.025 U	0.023 U	0.023 U	0.024 U
Fluoranthene	mg/kg	0.05 U	0.05 U	0.047 U	0.047 U	0.048 U
Fluorene	mg/kg	0.05 U	0.05 U	0.047 U	0.047 U	0.048 U
Indeno(1,2,3-cd)pyrene	mg/kg	0.037 U	0.038 U	0.035 U	0.035 U	0.036 U
Naphthalene	mg/kg	0.25 U	0.25 U	0.23 U	0.23 U	0.24 U
Phenanthrene	mg/kg	0.05 U	0.05 U	0.047 U	0.047 U	0.048 U
Pyrene	mg/kg	0.05 U	0.05 U	0.047 U	0.047 U	0.048 U
Total Organic Carbon	mg/kg	NA	NA	NA	NA	NA

a/ mg/kg = milligrams per kilogram

b/ NA = not analyzed

c/ U = The analyte was analyzed for and was not present above the associated reporting limit

d/ BTEX = benzene, toluene, ethylbenzene, and total xylenes

e/ TRPH = total recoverable petroleum hydrocarbons

f/ J1 = The analyte was positively identified and had a concentration between the method detection limit and the reporting limit

SoBo-4 (7-8) duplicate named SoBo-A (7-8) on chain-of-custody record

I:\TYN-RBIC\REPORT\FT-16\TABLES\Soilsmft.xls

TABLE 5.2
SUMMARY OF GROUNDWATER ANALYTICAL DATA
Risk-Based Approach to Remediation
Site FT-16
Tyndall AFB, Florida

		Sample Locations and Dates					
Analyte	**Units**	MP-1 21-Mar-98	MP-2 21-Mar-98	MP-3 21-Mar-98	MP-4 20-Mar-98	MW-3 20-Mar-98	MW-4 20-Mar-98
Benzene	µg/L[a/]	2.0 U[b/]	2.0 U	2.0 U	**71**	2.0 U	2.0 U
Ethylbenzene	µg/L	2.0 U	2.0 U	**1.0 J1**[c/]	**44**	2.0 U	**0.18 J1**
Toluene	µg/L	2.0 U	2.0 U	2.0 U	**1.1 J1**	2.0 U	2.0 U
Xylenes (total)	µg/L	2.0 U	2.0 U	**0.67 J1**	**17**	2.0 U	**0.16 J1**
Total BTEX[d/]	µg/L	8.0 U	8.0 U	**1.67**	**133.1**	8.0 U	**0.34**
Methyl-tert-butyl ether	µg/L	5.0 U	5.0 U	5.0 U	10 U	5.0 U	5.0 U
1,2-Dibromoethane (EDB)	µg/L	0.020 U	0.020 U	NA[e/]	0.020 U	NA	0.020 U
TRPH (C8-C40)[f/]	µg/L	**180 J1**	500 U	NA	**7,100**	NA	500 U
Total Lead	µg/L	5 U	5 U	NA	5 U	NA	5 U
Acenaphthene	µg/L	1.0 U	1.0 U	NA	1.0 UJ[g/]	NA	1.0 U
Acenaphthylene	µg/L	1.0 U	1.0 U	NA	1.0 UJ	NA	1.0 U
Anthracene	µg/L	**0.29**	0.10 U	NA	0.10 UJ	NA	0.10 U
Benzo(a)anthracene	µg/L	0.13 U	0.14 U	NA	0.13 UJ	NA	0.13 U
Benzo(a)pyrene	µg/L	0.23 U	0.24 U	NA	0.23 UJ	NA	0.24 U
Benzo(b)fluoranthene	µg/L	0.18 U	0.19 U	NA	0.18 UJ	NA	0.19 U
Benzo(g,h,i)perylene	µg/L	0.20 U	0.21 U	NA	0.20 UJ	NA	0.21 U
Benzo(k)fluoranthene	µg/L	0.17 U	0.18 U	NA	0.17 UJ	NA	0.18 U
Chrysene	µg/L	0.20 U	0.21 U	NA	0.20 UJ	NA	0.21 U
Dibenz(a,h)anthracene	µg/L	0.30 U	0.31 U	NA	0.30 UJ	NA	0.31 U
Fluoranthene	µg/L	**1.2**	0.21 U	NA	0.20 UJ	NA	0.21 U
Fluorene	µg/L	**5.7**	0.21 U	NA	0.20 UJ	NA	0.21 U
Indeno(1,2,3-cd)pyrene	µg/L	0.44 U	0.45 U	NA	0.43 UJ	NA	0.44 U
Naphthalene	µg/L	**1.9**	1.0 U	NA	**0.60 J**[h/]	NA	1.0 U
Phenanthrene	µg/L	0.20 U	0.21 U	NA	0.20 UJ	NA	0.21 U
Pyrene	µg/L	**0.87**	0.21 U	NA	0.20 UJ	NA	0.21 U

a/ µg/L = micrograms per liter

b/ U = The analyte was analyzed for and is not present above the associated reporting limit

c/ J1 = The analyte was positively identified and has a concentration between the method detection limit and the reporting limit

d/ BTEX = benzene, toluene, ethylbenzene, and total xylenes

e/ NA = not analyzed

f/ TRPH = total recoverable petroleum hydrocarbons

g/ UJ = The reporting limit value may not accurately or precisely represent the concentration necessary to detect the analyte in the sample

h/ J = The analyte was analyzed for and positively identified, but the assoicated numerical value may not be consistent with the amount actually present in the environmental sample

MW-4 duplicate named FT-16,MW-20 on chain-of-custody record

I:\TYN-RBIC\REPORT\FT-16\TABLES\Gwsumft.xls

TABLE 5.2 (Continued)
SUMMARY OF GROUNDWATER ANALYTICAL DATA
Risk-Based Approach to Remediation
Site FT-16
Tyndall AFB, Florida

Analyte	Units	Sample Locations and Dates				
		MW-4 (Dup) 20-Mar-98	MW-7 20-Mar-98	SB-1 20-Mar-98	SB-2 21-Mar-98	SB-3 20-Mar-98
Benzene	µg/L	2.0 U	2.0 U	2.0 U	2.0 U	**8.3**
Ethylbenzene	µg/L	**0.17 J1**	2.0 U	**3.5**	**8.1**	**29**
Toluene	µg/L	2.0 U	2.0 U	2.0 U	**0.14 J1**	2.0 U
Xylenes (total)	µg/L	2.0 U	2.0 U	**11**	**39**	2.0 U
Total BTEX	µg/L	**0.17**	8.0 U	**14.5**	**47.1**	**37.3**
Methyl-tert-butyl ether	µg/L	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,2-Dibromoethane (EDB)	µg/L	0.020 U	NA	NA	NA	NA
TRPH (C8-C40)	µg/L	500 U	NA	NA	NA	NA
Total Lead	µg/L	5 U	NA	NA	NA	NA
Acenaphthene	µg/L	0.99 U	NA	NA	NA	NA
Acenaphthylene	µg/L	0.99 U	NA	NA	NA	NA
Anthracene	µg/L	0.099 U	NA	NA	NA	NA
Benzo(a)anthracene	µg/L	0.13 U	NA	NA	NA	NA
Benzo(a)pyrene	µg/L	0.23 U	NA	NA	NA	NA
Benzo(b)fluoranthene	µg/L	0.18 U	NA	NA	NA	NA
Benzo(g,h,i)perylene	µg/L	0.20 U	NA	NA	NA	NA
Benzo(k)fluoranthene	µg/L	0.17 U	NA	NA	NA	NA
Chrysene	µg/L	0.20 U	NA	NA	NA	NA
Dibenz(a,h)anthracene	µg/L	0.30 U	NA	NA	NA	NA
Fluoranthene	µg/L	0.20 U	NA	NA	NA	NA
Fluorene	µg/L	0.20 U	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	µg/L	0.43 U	NA	NA	NA	NA
Naphthalene	µg/L	0.99 U	NA	NA	NA	NA
Phenanthrene	µg/L	0.20 U	NA	NA	NA	NA
Pyrene	µg/L	0.20 U	NA	NA	NA	NA

a/ µg/L = micrograms per liter

b/ U = The analyte was analyzed for and is not present above the associated reporting limit

c/ J1 = The analyte was positively identified and has a concentration between the method detection limit and the reporting limit

d/ BTEX = benzene, toluene, ethylbenzene, and total xylenes

e/ NA = not analyzed

f/ TRPH = total recoverable petroleum hydrocarbons

g/ UJ = The reporting limit value may not accurately or precisely represent the concentration necessary to detect the analyte in the sample

h/ J = The analyte was analyzed for and positively identified, but the assoicated numerical value may not be consistent
with the amount actually present in the environmental sample

MW-4 duplicate named FT-16,MW-20 on chain-of-custody record

TABLE 5.3
SUMMARY OF SOIL GAS ANALYTICAL DATA
Risk-Based Approach to Remediation
Site FT-16
Tyndall AFB, Florida

Analyte	Sample Locations, Dates, and Units								
	FT16-HA-49 21-Mar-98			FT16-HA-61 21-Mar-98			FT16-HA-72 21-Mar-98		
	ppmv	µg/L	percent	ppmv	µg/L	percent	ppmv	µg/L	percent
Benzene	<0.0026	<0.0086	NA	<0.0020	<0.0065	NA	<0.0020	<0.0065	NA
Toluene	<0.0026	<0.0010	NA	**0.0027**	**0.010**	NA	**0.0067**	**0.026**	NA
Ethylbenzene	<0.0026	<0.0012	NA	<0.0020	<0.0088	NA	<0.0020	<0.0088	NA
Xylenes (total)	**0.0034**	**0.015**	NA	<0.0020	<0.0088	NA	<0.0020	<0.0088	NA
Total BTEX	**0.0034**	**0.015**	NA	**0.0027**	**0.010**	NA	**0.0067**	**0.026**	NA
TPH (C5+ Hydrocarbons)	**0.51**	**2.1**	NA	**0.12**	**0.48**	NA	**0.13**	**0.55**	NA
C2 - C4 Hydrocarbons	**0.027**	**0.050**	NA	<0.020	<0.036	NA	<0.020	<0.036	NA
Oxygen	NA	NA	**20.8**	NA	NA	**18.9**	NA	NA	**20.9**
Carbon Dioxide	NA	NA	**0**	NA	NA	**0.8**	NA	NA	**0**

Notes:
ppmv = parts per million, volume per volume
µg/L = micrograms per liter
Analysis methods are TO-3 (Aromatic Volatiles in Air)
Analysis performed by Air Toxics Ltd. of Folsom, California
BTEX = benzene, toluene, ethylbenzene, and total xylenes
TPH = total petroleum hydrocarbons, referenced to gasoline

I:\TYN-RBIC\REPORT\FT-16\TABLES\Gassumft.xls

TABLE 5.4
COMPARISON OF SEDIMENT ANALYTICAL RESULTS TO SCREENING CRITERIA
Risk-Based Approach to Remediation
Site FT-16
Tyndall AFB, Florida

Analyte	CAS #	SD-1 9/18/95	SD-2 9/18/95	SED-1 (at SD-2) 3/19/98	SD-3 9/18/95	Freq of Detect	*Florida SQAG* [1]		*NOAA* [2]		*USEPA Reg. IV* ECO EV[3]	Lowest Criterion	Max Detect	Maximum Detect Exceeds Criterion?
							TEL	PEL	ERL	ERM				
Low Molecular Wt PAHs (LPAHS) (mg/kg)														
Acenaphthene	83329	0.049 U	0.045 U	0.25 U	0.042 U	0 / 4	0.007	0.089	0.02	0.56	0.007	0.007		Not detected
Acenaphthylene	208968	0.049 U	0.045 U	0.25 U	0.042 U	0 / 4	0.006	0.128	0.04	0.64	0.006	0.006		Not detected
Anthracene	120127	0.049 U	0.045 U	0.012 J	0.042 U	1 / 4	0.047	0.245	0.09	1.10	0.047	0.047	0.012	No
Fluorene	86737	0.049 U	0.045 U	0.025 J	0.042 U	1 / 4	0.021	0.144	0.02	0.54	0.021	0.019	0.025	Fluorene
Naphthalene	91203	0.049 U	0.045 U	0.25 U	0.042 U	0 / 4	0.035	0.391	0.16	2.10	0.035	0.035		Not detected
Phenanthrene	85018	0.049 U	0.11 J	0.017 J	0.042 U	2 / 4	0.087	0.544	0.24	1.50	0.087	0.087	0.11	Phenanthrene
Total LPAHs	--	ND	0.11	0.054	ND	2 / 4	0.312	1.44	0.55	3.16	0.312	0.312	0.11	No
High Molecular Wt PAHs (HPAHS) (mg/kg)														
Benzo(a)anthracene	56553	0.049 U	0.092 J	0.3	0.042 U	2 / 4	0.075	0.693	0.26	1.60	0.075	0.075	0.3	Benzo(a)anthracene
Benzo(a)pyrene	50328	0.049 U	0.079 J	0.26	0.042 U	2 / 4	0.089	0.763	0.43	1.60	0.089	0.089	0.26	Benzo(a)pyrene
Benzo(b)fluoranthene	205992	0.067 J	0.097 J	0.34	0.042 U	3 / 4	ID	ID					0.34	No Screening Criterion
Benzo(k)fluoranthene	207089	0.053 J	0.082 J	0.14	0.042 U	3 / 4	ID	ID					0.14	No Screening Criterion
Benzo(g,h,i)perylene	191242	0.049 U	0.045 U	0.2	0.042 U	1 / 4	ID	ID					0.2	No Screening Criterion
Chrysene	218019	0.051 J	0.092 J	0.22	0.042 U	3 / 4	0.108	0.846	0.38	2.80	0.108	0.108	0.22	Chrysene
Dibenz(a,h)anthracene	53703	0.049 U	0.045 U	0.025 U	0.042 U	0 / 4	0.006	0.135	0.06	0.26	0.006	0.006		Not detected
Fluoranthene	206440	0.056 J	0.18 J	0.3	0.042 U	3 / 4	0.113	1.49	0.60	5.18	0.113	0.113	0.3	Fluoranthene
Indeno(1,2,3-cd)pyrene	193365	0.049 U	0.045 U	0.16	0.042 U	1 / 4	ID	ID					0.16	No Screening Criterion
Pyrene	129000	0.12 J	0.13 J	0.38	0.042 U	3 / 4	0.153	1.40	0.67	2.60	0.153	0.153	0.38	Pyrene
Total HPAHs	--	0.347	0.752	2.3	ND	3 / 4	0.655	6.68	1.70	9.60	0.655	0.655	2.3	Total HPAHs
Total PAHS	--	0.347	0.862	2.354	ND	3 / 4	1.684	16.77	4.02	44.79	1.68	1.68	2.35	Total PAHS
Total Petroleum Hydrocarbons (TPH) (mg/kg)														
TPH	--	9.99 U	64.6	NA	9.09 U	1 / 3							64.6	No Screening Criterion
Metals (mg/kg)														
Lead	7439921	5.4	42.4	66.2	38.5	4 / 4	30.2	112	47	218	30.2	30.2	66.2	Lead

CAS # - Chemical Abstract System Number

[1] SQAG - Sediment Quality Assessment Guidelines: PEL- Probable Effects Level, TEL-Threshold Effects Level, ID-insufficient data to derive sediment quality guidelines from Development of an Approach to the Assessment of Sediment Quality in Florida Coastal Waters, Vol. 1., FDEP, November 1994

[2] NOAA Effects Ranges: ERL- effects range, low; ERM - effects range, medium, from Long et al., 1995

[3] Ecological effects values (ECO EV) from Supplemental Guidance to RAGS: Region 4 Bulletins, Ecological Risk Assessment Bulletin No. 1. (EPA Region 4 Waste Management Division, Nov 1995)

SECTION 6
CHEMICAL FATE ASSESSMENT

6.1 INTRODUCTION

Biodegradation of dissolved fuel constituents and the future migration and persistence of the dissolved COPCs are assessed in this section to support selection of an appropriate remedial alternative for Site FT-16. As used throughout this report, the term "remediation by natural attenuation" (RNA) refers to a subsurface contaminant management strategy that relies on natural physical, chemical, and biological mechanisms to control exposure of potential receptors to concentrations of contaminants in soil, soil gas, and groundwater that exceed regulatory levels. These mechanisms include the processes of advection, hydrodynamic dispersion, dilution from recharge, sorption, volatilization, and biodegradation, which facilitate RNA of a variety of anthropogenic chemicals.

This section summarizes and interprets specific site characterization data relevant to documenting the effectiveness of RNA at minimizing dissolved COPC migration and reducing COPC concentration, mass, and toxicity over time.

6.2 OPERATIVE MECHANISMS OF CONTAMINANT ATTENUATION

Understanding the fate of COPCs in environmental media is critical to evaluating and predicting contaminant distribution patterns. There are several physical, chemical, and biological processes that influence how a chemical behaves in soil and groundwater.

Nondestructive attenuation processes can be described as those physical and chemical processes that may prohibit significant contaminant migration but will not result in a permanent reduction in contaminant mass. Examples of nondestructive attenuation processes include volatilization, sorption, dilution from recharge, advection, and hydrodynamic dispersion. These processes must be evaluated when determining whether some type of remediation is warranted because chemical contamination poses or has the potential to pose a risk to human or ecological receptors. If contamination cannot reach a potential receptor exposure point, the contamination poses no risk.

In comparison to nondestructive chemical attenuation processes, destructive chemical attenuation processes result in the permanent removal of contaminant mass from the environment. Documenting and distinguishing the effects of destructive attenuation processes, such as biodegradation, from nondestructive attenuation processes is critical to evaluating the potential for RNA to bring about a reduction in contaminant mass over time. The effectiveness of destructive attenuation processes at reducing contaminant mass at a site depends on how susceptible the chemical is to biodegradation and whether the site is characterized by physical, chemical, and biological conditions favorable to such processes.

6.2.1 Biodegradation of Dissolved BTEX

Numerous laboratory and field studies have shown that hydrocarbon-degrading bacteria can participate in the degradation of many of the chemical components of different types of fuels (e.g., gasoline) under both aerobic and anaerobic conditions.

Biodegradation of fuel hydrocarbons such as BTEX will occur when an indigenous population of hydrocarbon-degrading microorganisms is present in the soil and groundwater, and sufficient concentrations of electron acceptors and nutrients, including fuel hydrocarbons, are available to these organisms. Soils and groundwater with a history of exposure to fuel hydrocarbon compounds, such as at Site FT-16, generally contain microbial populations capable of facilitating biodegradation reactions (Wiedemeier *et al.*, 1995). The chemical basis for the biodegradation of dissolved BTEX is described in more detail in Section 6.5, where geochemical data relevant to documenting biodegradation at the field scale at Site FT-16 are presented.

6.3 EVIDENCE OF CONTAMINANT BIODEGRADATION OVER TIME

The first step in determining whether COPC constituents are biodegrading in soils and groundwater at Site FT-16 was to compare contaminant concentrations at selected sampling locations over time. The purpose of this comparison was to assess the evidence of field-scale contaminant mass loss. Decreases in the magnitude of contaminant concentrations at a site over time that cannot be explained by physical processes (e.g., source removal, mass transport in groundwater) may be the first indication that contaminants are biodegrading at the site.

6.3.1 Hydrocarbon Concentration Trends in Soil

Biodegradation of soil hydrocarbons present in the vadose zone can proceed if the soil particles to which the contaminants are adsorbed are covered with a water film that supports microbial populations. The presence of abundant soil moisture in the vadose zone can be inferred from the shallow water table depth and the relatively warm ambient air temperature.

Soil BTEX, PAH, and TRPH concentrations from three soil samples collected in September 1995 are compared to samples collected at immediately adjacent locations in March 1998 in Table 6.1. Two of these locations are at the former fuel storage area and the third location is at the former fire training pit. All hydrocarbon concentrations decreased significantly from 1995 to 1998 at the three locations, indicating the effects of biodegradation, volatilization, and leaching.

6.3.2 Hydrocarbon Concentration Trends in Groundwater

Hydrocarbon concentrations measured at four monitoring wells in 1995 and 1998 are summarized in Table 6.2. MW-4 and SB-1 are located at the former fire training pit, and SB-2 and SB-3 are located at the former fuel storage area. Total BTEX concentrations decreased substantially at all locations. The percentage decrease ranged from 43 percent at SB-2 to greater than 99 percent at MW-4. Decreasing dissolved hydrocarbon concentrations indicate that the mass of hydrocarbons input into the groundwater system in the source area (through leaching of residual hydrocarbons in soils) is decreasing.

6.4 SITE SPECIFIC CONTAMINANT BIODEGRADATION RATES

The reduction in COPC concentrations at specific sampling points may be used to estimate a first-order decay rate, provided the plume size is relatively stable or decreasing. It is commonly assumed that biodegradation rates for fuel hydrocarbons in saturated media can be approximated by a first-order decay constant (Chapelle, 1993). Using the equation:

$$C_{(t)} = C_i e^{(-kt)} \qquad (1)$$

Where:
$C_{(t)}$ = concentration at time t
C_i = initial concentration
k = decay rate (T^{-1})
t = time

Table 6.3 summarizes the calculated biodegradation rates for each of the groundwater COPCs except TRPH, for which sufficient data were not available to compute a decay rate. The calculated rates are based on reductions in contaminant concentrations measured at specific sampling points over time (SB-1, SB-2, SB-3, and MW-4 from 1995 to 1998 [Table 6.2]). All attenuation mechanisms, such as dispersion, adsorption, and aerobic and anaerobic degradation are included in these site-specific biodegradation rate estimates.

These rates will be used in Section 6.7 along with other information to predict the fate and transport of groundwater COPCs. However, a simple calculation may be performed now to assess the persistence of COPCs at individual wells. The persistence of benzene at MP-4, location of the maximum detection, may be estimated by solving equation (1) for time. Using the maximum concentration of 71 µg/L as the initial concentration, the TCL of 1 µg/L for the final concentration, and the average benzene first-order decay rate of 1.9 year^{-1} (Table 6.3), benzene is predicted to persist above the TCL at MP-4 for 2.2 years.

6.5 EVIDENCE OF CONTAMINANT BIODEGRADATION VIA MICROBIALLY MEDIATED REDOX REACTIONS

Groundwater geochemical data also can be used to show that COPCs are biodegrading in saturated soil and groundwater at Site FT-16. Fuel hydrocarbon constituents are typically utilized as electron donors in biologically mediated redox reactions under a wide range of geochemical conditions. Therefore, analytical data on potential electron acceptors can be used as geochemical indicators of fuel hydrocarbon biodegradation (Wiedemeier *et al.*, 1995). Reductions in the concentrations of oxidized chemical species that are used by microorganisms to facilitate the oxidation of fuel hydrocarbon compounds within contaminated media are an indication that contaminants are biodegrading. Alternately, an increase in the metabolic byproducts resulting from the reduction of electron acceptors can be used as an indicator of contaminant biodegradation. The availability of potential electron acceptors to participate in contaminant biodegradation reactions can be used to estimate the total contaminant mass that can be biodegraded over time at this site. Coupled with calculated biodegradation rates, this information can be used to predict how much and how quickly COPCs can be removed from saturated soils and groundwater at Site FT-16 as a result of natural processes only.

6.5.1 Relevance of Redox Couples in Biodegradation

Microorganisms obtain energy to replenish enzymatic systems and to reproduce by oxidizing organic matter. Biodegradation of dissolved hydrocarbons is the result of a series of redox reactions that maintain the charge balance within the natural environment. Microorganisms facilitate the degradation of these organic compounds by transferring electrons from the electron donor (i.e., fuel hydrocarbons and native organic carbon) to available electron acceptors. Electron acceptors are elements or compounds that occur in relatively oxidized states and can participate in redox reactions involving these available electron donors. Electron acceptors known to be present in saturated soil and groundwater at Site FT-16 are oxygen, nitrate/nitrogen, sulfate, ferric iron, and carbon dioxide.

Microorganisms facilitate fuel hydrocarbon biodegradation to produce energy for their use. The amount of energy that can be released when a reaction occurs or is required to drive the reaction to completion is quantified by the free energy of the reaction (Stumm and Morgan, 1981). Microorganisms are able to utilize electron transport systems and chemiosmosis to combine energetically favorable and unfavorable reactions to produce energy for life processes (i.e., cell production and maintenance). Microorganisms will facilitate only those redox reactions that will yield energy. By coupling the oxidation of fuel hydrocarbon compounds, which requires energy, to the reduction of other compounds (e.g., oxygen, nitrate/nitrite, manganese, ferric iron, sulfate, and carbon dioxide), which yields energy, the overall reaction will yield energy. Detailed information on the redox reactions required to biodegrade dissolved COPCs is included in Table 6.4. The reader is encouraged to review this information to more fully understand the chemical basis of biodegradation.

Figure 6.1 illustrates the sequence of microbially mediated redox processes based on the amount of free energy released for microbial use. In general, reactions yielding more energy tend to take precedence over processes that yield less energy (Stumm and Morgan, 1981). As Figure 6.1 shows, oxygen reduction would be expected to occur in an aerobic environment with microorganisms capable of aerobic respiration because oxygen reduction yields significant energy. However, once the available oxygen is depleted and anaerobic conditions dominate the interior regions of the contaminant plume, anaerobic microorganisms can utilize other electron acceptors in the following order of preference: nitrate/nitrite, manganese, ferric iron, sulfate, and finally carbon dioxide. Each successive redox reaction provides less energy to the system, and each step down in redox energy yield would have to be paralleled by an ecological succession of microorganisms capable of facilitating the pertinent redox reactions.

The expected sequence of redox processes can be estimated by the ORP of the groundwater. The ORP measures the relative tendency of a solution or chemical reaction to accept or transfer electrons, and can be measured in the field. This measurement can be used as a crude indicator of which redox reactions may be operating at a site. High ORPs mean that the solution (or available redox couple) has a relatively high oxidizing potential.

Microorganisms can only facilitate the biodegradation (oxidation) of the fuel hydrocarbon compounds using redox couples that have a higher ORP than the contaminants. This is why these electron acceptors can be used to oxidize the fuel hydrocarbon compounds. The reduction of highly oxidized species results in an overall decrease in the oxidizing potential of the groundwater. As shown in Figure 6.1, the reduction of oxygen and nitrate will reduce the oxidizing potential to levels at which ferric iron (Fe^{3+}) reduction can occur. As each chemical species that can be used to oxidize the contaminants is exhausted, the microorganisms are forced to use other available electron acceptors with lower oxidizing capacity. When sufficiently low (negative) ORP levels have been developed as a result of these redox reactions, sulfate reduction, and methanogenesis can occur almost simultaneously (Stumm and Morgan, 1981).

ORP values measured in shallow groundwater at Site FT-16 in March 1998 ranged from 189.3 to -291.4 millivolts (mV) (Table 6.5). Areas with the lowest ORPs generally coincided with the presence of fuel-contaminated groundwater, indicating that the progressive use of electron acceptors in the order shown on Figure 6.1 has caused the groundwater in the contaminated areas to become more reducing. These data imply that oxygen, nitrate, manganese, and ferric iron may be used to biodegrade fuel hydrocarbon contaminants at this site. However, many authors have noted that field ORP data alone cannot be used to reliably predict all of the electron acceptors that may be operating at a site, because the platinum electrode probes are not sensitive to some redox couples (e.g., sulfate/sulfide) (Stumm and Morgan, 1981; Godsy, 1994; Lovley *et al.*, 1994). Analytical data on oxidized and reduced species are presented in the following subsections to verify which electron acceptors are actually being used to biodegrade the hydrocarbon COPCs in saturated soil and groundwater at Site FT-16.

Throughout the following subsections, the distributions of geochemical parameters are examined by comparing background concentrations to COPC plume core concentrations. Analytical data from upgradient well MW-3 and cross-gradient well MW-7 are used for background concentrations. Analytical data from MP-4 is used for COPC plume core concentrations.

6.5.2 Dissolved Oxygen

Almost all types of fuel hydrocarbons can be biodegraded under aerobic conditions (Borden, 1994). Mineralization of fuel hydrocarbons to carbon dioxide and water under aerobic conditions involves the use of oxygen as a cosubstrate during the initial stages of metabolism, and as a terminal electron acceptor during the later stages of metabolism for energy production. The reduction of molecular oxygen during the oxidation of the fuel hydrocarbon compounds yields a significant amount of free energy that the microorganisms could utilize.

DO concentrations were measured at groundwater sampling locations in March 1998. Table 6.5 presents the analytical results for DO by sampling location. As shown on the table, DO concentrations range from 0.35 to 2.45 mg/L. The lowest DO concentration is located at SB-2, which is located on the periphery of the COPC plume. All other wells exhibiting COPC concentrations had DO concentrations over 1 mg/L. Based on these observations, it does not appear that aerobic degradation is occurring at the site to any significant extent.

6.5.3 Nitrate

Because anaerobic conditions generally prevail in the site groundwater, nitrate can be used as an electron acceptor by indigenous facultative anaerobes that mineralize fuel hydrocarbon compounds via either denitrification or nitrate reduction processes. Concentrations of nitrate (as nitrogen [N]) measured at the site in March 1998 are summarized in Table 6.5. Background nitrate (as N) concentrations measured in upgradient and cross-gradient wells MW-3 and MW-7 were 0.11 mg/L and less than 0.04 mg/L, respectively. Nitrate (as N) concentrations measured in plume core area wells exhibiting dissolved fuel contamination ranged from 0.12 mg/L to 1.3 mg/L.

If nitrate reduction were occurring, nitrate would decrease within the COPC plume core. However, the nitrate distribution is the reverse with nitrate concentrations elevated inside the plume core. This observation indicates that nitrate reduction is not an important process at this site.

6.5.4 Ammonia

The presence of ammonia in groundwater can result from either nitrate reduction (facilitated by microbes) or fixing of atmospheric nitrogen (also a microbial process). Nitrate is not widespread in groundwater within the aquifer; however, the fixation of atmospheric nitrogen may occur under the anaerobic, methanogenic conditions observed at the site. The presence of ammonia in groundwater is a strong indication of microbial activity.

Ammonia (as N) concentrations measured in groundwater samples collected in March 1998 are summarized in Table 6.5. Ammonia concentrations detected in shallow groundwater varied across the site, with elevated ammonia concentrations occurring in the COPC plume core area. Therefore, production of ammonia appears to be occurring due to increased microbial activity stimulated by the relative abundance of organic carbon (fuel hydrocarbons).

The measured ORPs of the groundwater at this site are not within the range that would be expected for the ammonia-producing conditions implied by the observed ammonia distribution. However, as described in Section 6.5.1, field ORP data alone cannot be used to reliably predict the electron acceptors that may be operating at a site.

6.5.5 Ferrous Iron

Although relatively little is known about the anaerobic metabolic pathways involving the reduction of ferric iron (Fe^{3+}), this process has been shown to be a major metabolic pathway for some microorganisms (Lovley and Phillips, 1988; Chapelle, 1993). Elevated concentrations of ferrous iron (Fe^{2+}) often are found in anaerobic, fuel-contaminated groundwater systems. Concentrations of dissolved ferrous iron once were attributed to the spontaneous and reversible reduction of ferric oxyhydroxides, which are thermodynamically unstable in the presence of organic compounds such as benzene. However, more recent studies suggest that the reduction of ferric iron cannot proceed at all without microbial mediation (Lovley and Phillips, 1988; Lovley *et al.*, 1991; Chapelle, 1993). None of the common organic compounds found in low-temperature, neutral, reducing groundwater could reduce ferric oxyhydroxides to ferrous iron under sterile laboratory conditions (Lovley *et al.*, 1991). This means that the reduction of ferric iron to ferrous iron requires mediation by microorganisms with the appropriate enzymatic capabilities.

To determine if ferric iron is being used as an electron acceptor for fuel biodegradation at Site FT-16, ferrous (reduced) iron concentrations were measured at groundwater sampling locations in March 1998. Background ferrous iron concentrations measured in wells MW-3 and MW-7 were 0.04 mg/L and 0.13 mg/L, respectively. In contrast, the ferrous iron concentration detected in the plume core well exhibiting the highest contaminant concentrations (MP-4) was 1.38 mg/L (Table 6.5). The occurrence of elevated ferrous iron concentrations within contaminated areas indicates that ferric iron is acting as an electron acceptor at these locations. In addition, the measured redox potentials of the groundwater at this site are within the range that would be expected for the ferric iron-reducing conditions implied by the observed ferrous iron distributions (Figure 6.1).

6.5.6 Sulfate

Sulfate also may be used as an electron acceptor during microbial degradation of fuel hydrocarbons under anaerobic conditions (Grbic'-Galic', 1990). Sulfate can be reduced to sulfide during the oxidation of the fuel hydrocarbon compounds. The presence of decreased concentrations of sulfate (and increased concentrations of sulfide) in the source area relative to background concentrations indicates that sulfate is participating in redox reactions at the site. To investigate the potential for sulfate reduction at Site FT-16, sulfate and sulfide concentrations were measured during the March 1998 groundwater sampling event.

Table 6.5 shows the analytical results for sulfate and sulfide in groundwater at Site FT-16. In general, there is not a good correlation between areas of depleted sulfate concentrations and the plume core. However, elevated concentrations of sulfide, which can be produced when sulfate is reduced during fuel hydrocarbon oxidation, generally coincide with elevated fuel hydrocarbon concentrations. The apparent production of sulfide within the contaminated area indicates that microbial populations are using sulfate to oxidize fuel hydrocarbons at the site.

6.5.7 Dissolved Methane

On the basis of free energy yield and the oxidizing potential of the site groundwater, the carbon dioxide/methane (CO_2/CH_4) redox couple also could be used to oxidize fuel hydrocarbon compounds to carbon dioxide and water once the groundwater is sufficiently reducing. To attain these reducing levels, other highly oxidizing chemical species such as oxygen, nitrate, ferric iron, and sulfate must first be reduced. This redox reaction is called methanogenesis or methane fermentation. Methanogenesis yields the least free energy to the system in comparison to other chemical species (Figure 6.1). The presence of methane in groundwater at elevated concentrations relative to background concentrations is a good indicator of methane fermentation.

Dissolved methane was measured at groundwater monitoring wells sampled during the March 1998 sampling event. Table 6.5 presents the analytical data for methane. Methane concentrations detected in the contaminant source areas were elevated relative to background concentrations. Methane concentrations measured at plume core area wells ranged from 0.33 mg/L to 1.5 mg/L. In contrast, background concentrations ranged from

0.011 mg/L to 0.027 mg/L. The presence of elevated methane levels in groundwater at Site FT-16 strongly indicates that biodegradation is occurring via methanogenesis.

The measured ORPs of the groundwater at this site are not within the range that would be expected for the methanogenic conditions implied by the observed methane distributions. However, as described in Section 6.5.1, field ORP data alone cannot be used to reliably predict the electron acceptors that may be operating at a site.

6.5.8 pH

The pH of groundwater samples collected from groundwater monitoring points and monitoring wells in March 1998 was measured (Table 6.5). The pH of a solution is the negative logarithm of the hydrogen ion concentration [H^+]. Groundwater pH values measured at the site ranged from 5.12 to 7.33 standard units (SU) with an average of 6.7 SU. This average pH is within the optimal range for fuel hydrocarbon-degrading microbes of 6 to 8 SU. The presence of acidic pH values indicates that the groundwater alkalinity may be insufficient to fully buffer the groundwater pH against the organic acids produced during microbial reactions.

6.5.9 Temperature

Groundwater temperature was measured at groundwater monitoring wells in March 1998 (Table 6.5). Temperature affects the types and growth rates of bacteria that can be supported in the groundwater environment, with higher temperatures generally resulting in higher growth rates. The temperature of groundwater samples collected from the shallow monitoring wells varied from 17.1 degrees Celsius (°C) to 18.4 °C. These temperatures are warm enough to promote microbial growth and may enhance rates of hydrocarbon biodegradation.

6.6 THEORETICAL ASSIMILATIVE CAPACITY ESTIMATES

The preceding discussions have been devoted to determining if fuel hydrocarbons are biodegrading in saturated soils and groundwater at Site FT-16. Analytical data on reduced and oxidized chemical species indicate that indigenous microorganisms are facilitating the oxidation of fuel hydrocarbons and the reduction of electron acceptors to generate free energy for cell maintenance and production. The question of how much contaminant mass can be biodegraded must be addressed to assess the full potential for long-term intrinsic bioremediation to minimize plume size and mass over time.

Mass balance relationships can be used to determine how much contaminant mass can be degraded by each of the redox reactions that the microorganisms might use to make free energy available for cell maintenance and production. The stoichiometric relationship between the contaminant and the electron acceptor can be used to estimate the expressed assimilative capacity of the groundwater. Once the redox reactions operating at the site have been defined, it is possible to estimate how much contaminant mass can be assimilated or oxidized by available electron acceptors.

Table 6.4 presents the coupled redox reactions that represent the biodegradation of the individual hydrocarbon COPCs, including the stoichiometric mass ratio of electron acceptors needed to oxidize each compound. These stoichiometric mass ratios can be used to estimate the assimilative capacity of the groundwater at Site FT-16. For oxygen, nitrate, and sulfate (which are electron acceptors), this is accomplished by first determining the initial (background) mass of each electron acceptor available in the groundwater. Data on these chemical species were collected at sampling locations upgradient (MW-3) and cross-gradient (MW-7) from the dissolved plume. As groundwater slowly migrates into the source area, electron acceptors are brought into contact with hydrocarbon-degrading microorganisms and site contamination. The change in the electron acceptor mass from background sampling locations to sampling locations within the plume core is divided by the mass ratio from Table 6.4.

For nitrogen fixation, ferric iron reduction, and methanogenesis, the electron acceptor is not measured. Instead, the metabolic byproducts (ammonia, ferrous iron, and methane) are measured. The highest observed concentration of the metabolic byproduct in the plume core wells is divided by the mass ratio from Table 6.4. These numbers are summed to estimate the expressed intrinsic capacity of the groundwater to biodegrade COPCs (Table 6.6).

Nitrate is not listed in Table 6.6. As discussed in Section 6.5.4, nitrate is ultimately reduced to ammonia; however, ammonia can be produced from the reduction of nitrate and from fixation of atmospheric nitrogen. Therefore, only ammonia is used to calculate the intrinsic capacity. On the basis of these calculations, one pore volume of saturated soil and groundwater at Site FT-16 has the capacity to oxidize an average COPC concentration of approximately 3.05 mg/L (3,050 μg/L) (Table 6.6). The maximum COPC concentration at the Site FT-16 in March 1998 was 0.13 mg/L (130 μg/L).

It should be noted that the geochemical data for MP-4 are not internally consistent. As discussed above, DO and nitrate distributions indicate that aerobic respiration and nitrate reduction are not occurring. If these processes are not occurring than the more reductive processes of sulfate reduction and methanogenesis should not be able to proceed. However, geochemical data indicate that these processes are occurring. One reason for this discrepancy may the relatively low hydrocarbon concentrations in groundwater. The low concentrations may not have a consistent significant demand on the electron acceptors.

The assimilative capacity estimate essentially represents an estimate of the COPC reduction capability of one pore volume of groundwater at Site FT-16. The estimate identifies how much contaminant mass can be theoretically oxidized as one pore volume travels through the plume core. In reality, 1 pore volume is expected to move through the contaminated aquifer material in the source area every 2.5 years based on the estimated groundwater velocity of 175 ft/yr and a source area length of approximately 450 feet.

A closed system containing 2 liters of water can be used to help visualize the physical meaning of assimilative capacity. Assume that the first liter contains no fuel hydrocarbons, but it contains fuel-degrading microorganisms and has an assimilative capacity of exactly “x” mg of fuel hydrocarbons. The second liter has no assimilative capacity; however, it contains fuel hydrocarbons. As long as these 2 liters of water are kept separate, biodegradation of fuel hydrocarbons will not occur. If these 2 liters are combined in a closed system, biodegradation will commence and continue until the fuel hydrocarbons or electron acceptors are depleted. If less than “x” mg of fuel hydrocarbons are in the second liter, all of the fuel hydrocarbons will eventually degrade given a sufficient time; likewise, if greater than "x" mg of fuel hydrocarbons were in the second liter of water, only "x" mg of fuel hydrocarbons would ultimately degrade.

This example shows that in a closed system, the measured expressed assimilative capacity eventually should be equivalent to the loss in contaminant mass; however, the groundwater beneath the site is an open system. Electron acceptors can continually enter the system from upgradient flow. Furthermore, contaminant mass can be added to the system through dissolution or leaching from LNAPL or contaminated soils. This means that the assimilative capacity is not fixed as it would be in a closed system, and therefore should not be quantitatively compared to concentrations of dissolved contaminants in the groundwater. Rather, the expressed assimilative capacity of groundwater is intended to serve as a qualitative tool. The fate of COPCs in groundwater is dependent on the relationship between the kinetics of biodegradation and the solute transport velocities (Chapelle, 1994).

6.7 PREDICTING CONTAMINANT TRANSPORT AND FATE – BIOSCREEN MODEL

Understanding the effects of natural physical, chemical, and biological processes on chemicals in the subsurface is an important step in determining potential long-term risks associated with chemical migration in the environment. The behavior of COPCs under the influence of these processes must be quantified to assess the expected persistence, mass, concentration, and toxicity of dissolved COPCs over time at the site; and to estimate potential receptor exposure-point concentrations. If destructive and nondestructive attenuation processes can minimize or eliminate the concentration of contaminants to which a receptor could be exposed, engineered remedial action may not be warranted because no reasonable exposure pathway exists or the exposure pathway would result in insignificant risks. The focus of this section is to predict how the COPCs will be transported and transformed over time based on site data and site-specific contaminant transport and fate models.

BIOSCREEN® is a screening model which simulates RNA of dissolved hydrocarbons at petroleum fuel release sites (Newell and McLeod, 1996). The software is based on the Domenico (1987) analytical solute transport model and is designed to simulate advection, dispersion, adsorption, and aerobic decay as well as anaerobic reactions that have been shown to be the dominant biodegradation processes at many petroleum release sites.

6.7.1 Description of the BIOSCREEN Model

BIOSCREEN® includes three different model types:

1) Solute transport without decay;
2) Solute transport with biodegradation modeled as a first-order decay process (simple, lumped parameter approach); and
3) Solute transport with biodegradation modeled as an "instantaneous" biodegradation reaction.

The first model is appropriate for predicting the movement of conservative (non-degrading) solutes such as chloride. The only attenuation mechanisms simulated are dispersion in the longitudinal, transverse, and vertical directions and adsorption of the chemical to the soil matrix.

With the second model, the solute degradation rate is proportional to the initial solute concentration. This is a conventional method for simulating biodegradation in dissolved hydrocarbon plumes. With this method, dispersion, sorption, and biodegradation parameters are lumped together in a single calibration parameter. The first-order decay model does not account for site-specific information such as the availability of electron acceptors. In addition, it does not assume any biodegradation of dissolved constituents in the source zone. In other words, this model assumes that biodegradation starts immediately downgradient from the source and that it does not decrease the concentrations of dissolved organic compounds in the source zone itself.

First-order expressions may not be accurate for describing biodegradation of organic chemicals in groundwater because electron acceptor limitations are not considered. A more accurate prediction of biodegradation effects may be realized by incorporating the instantaneous reaction equation into a transport model (Newell and McLeod, 1996).

At almost all petroleum release sites, biodegradation is present and can be verified by demonstrating the consumption of aerobic and anaerobic electron acceptors. Therefore, results from the No Biodegradation model are intended only to be used for comparison purposes and to demonstrate the effects of biodegradation on plume migration. The Instantaneous Reaction model is recommended either alone or in addition to the First-Order Decay model for most sites where electron acceptor and metabolic byproduct concentration data have been collected (Newell and McLeod, 1996).

6.7.2 Modeling Objectives

The BIOSCREEN® modeling was performed for Site FT-16 site to accomplish the following three objectives:

- To estimate the maximum migration distance of the dissolved plume over time;
- To assess the persistence of the dissolved plume over time; and
- To support the selection of future remedial actions.

The lateral migration potential and persistence of benzene at Site FT-16 was modeled because, when compared to the other groundwater COPCs identified in Section 4, benzene is both more mobile in the groundwater environment and is considered a toxic carcinogen (has the lowest Table VI TCL of any of the volatile COPCs). In addition, the maximum benzene concentration exceeded its Tier 1 TCL by a relatively large amount compared to the other COPCs. Therefore, benzene will likely be a primary "risk-driver" at this site.

6.7.3 Conceptual Model Design and Limiting Assumptions

BIOSCREEN® has the following limitations:

- As an analytical model, BIOSCREEN® assumes simple groundwater flow conditions; and

- As a screening tool, BIOSCREEN® only approximates the more complicated processes that occur in the field.

Although there has likely been contamination at Site FT-16 for many years (fire training exercises commenced in 1943), only 1998 groundwater quality data were used in the model for the following reasons: 1) historical groundwater quality data prior to 1995 are not available; 2) the source history (e.g., dates and magnitudes of releases) is not well known; and 3) monitoring point MP4, which contained the maximum benzene concentration, was not installed until 1998. In summary, maximum 1998 dissolved benzene concentrations were used as the starting point for model simulations. The source mass was conservatively estimated from 1995 and 1998 soil quality data.

6.7.4 Initial Model Input Data

Input data for the BIOSCREEN® model are used to specify/calculate groundwater velocity, aquifer dispersivity, a retardation factor, a chemical-specific decay coefficient, dissolved hydrocarbon concentrations in the source area, a half-life of the hydrocarbon source, and the dimensions of the source zone. The parameters were obtained from site-specific data and commonly accepted literature values. The BIOSCREEN® input screen is presented in Appendix D. Each of these input values is described in more detail below.

6.7.4.1 Hydrogeology

Seepage Velocity (V_s)

Seepage velocity is the actual interstitial groundwater velocity. It is defined as the hydraulic conductivity times the hydraulic gradient divided by the effective porosity (equation 2). The value of this parameter was calculated to be 175 ft/yr.

$$V_s = \left(\frac{K}{n_e}\right)\left(\frac{dH}{dL}\right) \tag{2}$$

Hydraulic Conductivity (K)

Hydraulic conductivity is a term that describes the relative ease with which water can move through a permeable medium. The horizontal K value used for shallow aquifer modeling (4 ft/day) was derived from slug tests performed by BCM (Section 3.4 and Appendix A).

Hydraulic Gradient (dH/dL)

The hydraulic gradient is a unitless value which represents the change in water table elevation per unit distance in a direction parallel to groundwater flow. The average hydraulic gradient at the site was calculated to be 0.02 ft/ft in Section 3.4. However, a value of 0.03 ft/ft will be used in the BIOSCREEN model because this value represents the area between MP-4 and the Fred Bayou.

Effective Porosity (n_e)

The effective porosity of a medium is the ratio of the volume of interconnected voids to the bulk volume of the aquifer matrix. The effective porosity is typically less than total porosity because of non-interconnected pores, dead-end pores, and boundary effects of aquifer solids. An effective porosity of 0.25 (25%) was used for the model. This value is commonly used for silt and sand lithologies (Newell and McLeod, 1996).

6.7.4.2 Dispersion

Dispersivity is a property of a porous medium that determines the dispersion or spreading characteristics of the medium by a relationship between pore-water velocity and dispersion coefficients. Bioscreen® computes the longitudinal dispersivity based on an estimated plume length, and the transverse dispersivity by using 10% of the longitudinal dispersivity. The default vertical dispersivity is zero. The length of the plume selected for simulation was estimated to be 75 feet based on the distance from MP-4 to Fred Bayou.

6.7.4.3 Adsorption

Retardation Factor

The retardation factor is a measure of the degree of retardation of dissolved organic chemical movement through the aquifer relative to the advective groundwater flow rate. A retardation value of 1.48 was calculated (Table 6.7) using the following formula (equation 3) and input parameters:

$$R=1+(K_d\rho_b/n) \tag{3}$$

where

$K_d = (K_{oc})(f_{oc})$

K_{oc} = Organic Carbon Partition Coefficient

f_{oc} = Fraction Organic Carbon

ρ_b = Soil Bulk Density of Aquifer Matrix

n = Total Porosity

Organic Carbon Partition Coefficient (K_{oc})

The organic carbon partition coefficient is a chemical-specific partition coefficient between organic carbon and water (Newell and McLeod, 1996). The selected K_{oc} value was 79 milliliters per gram [mL/g] which corresponds to benzene (Wiedemeier *et al.*, 1995).

Fraction Organic Carbon (f_{oc})

The fraction organic carbon is the weight fraction of organic carbon in soil and is used in the estimation of the retardation factor. Typical f_{oc} values range from 0.0002 to 0.02 (Newell and McLeod, 1996). The average total organic carbon concentration at the site was determined to be 1,234 mg/kg based on analysis of site soil samples, which translates to a f_{oc} value of 1.234×10^{-3}.

Total Porosity (n)

The porosity of the aquifer matrix is defined as the ratio of the void volume to the bulk volume of aquifer matrix. A total porosity of 0.35 (35%) was assumed for the model.

Soil Bulk Density (ρ_b)

The soil bulk density is the bulk density of the aquifer matrix and is related to the porosity and pure solids density. An estimated value of 1.7 grams per cubic centimeter (g/cm^3) (or kilograms per liter [kg/L]) was used in this model (Newell and McLeod, 1996).

6.7.4.4 Biodegradation

First Order Decay Coefficient and Solute Half- Life

The solute half-life is a chemical-specific value which specifies the amount of time it takes for a compound to degrade to half its original concentration. The first-order decay coefficient is equal to 0.693 divided by the half life of the chemical in groundwater. The half-life of benzene published in literature typically ranges from 0.02 to 2 years (Newell and McLeod, 1996). Instead of using a literature value, a first-order decay coefficient was calculated using site-specific data. These values are discussed in Section 6.4 and presented in Table 6.3. A half-life of 0.36 years was input for benzene, which correlates to the average benzene decay rate computed using site-specific data (Section 6.4).

Instantaneous Reaction Model

Using field and laboratory analytical data, background concentrations and concentrations within the COPC plume core area for each of the electron acceptors/by-products listed below were calculated. Although BTEX compounds dominate the dissolved plumes of fuel releases, there are non-BTEX hydrocarbons that exert a demand on the available electron acceptors. A conservative approach is to reduce all available electron acceptor/by-product concentrations used in the model by thirty percent to account for the possible impacts of non-BTEX organics in groundwater (Newell and McLeod, 1997). Therefore, the delta for each of the indicators was reduced by thirty percent. Since benzene was the only BTEX constituent being modeled, the deltas were reduced by an additional seventy-five percent before being input into the model. Bioscreen® then calculates biodegradation capacities (BCs) for individual parameters. The BC is the amount (in mg/L) of a parameter utilized to biodegrade 1 mg/L of hydrocarbon. The calculated differences are provided below.

Difference in DO

17.5% of {(Background Oxygen Conc.) - (Core Oxygen Conc)}
Change in DO = 0.175*(1.55-1.67) = 0 mg/L

Difference in Nitrate

17.5% of {(Background Nitrate Conc.) - (Core Nitrate Conc.)}
Change in Nitrate = 0.175*(0-0) = 0 mg/L

Difference in Ferrous Iron

17.5% of {(Core Ferrous Iron Conc.)}
Change in Ferrous Iron = 0.175*(1.38) = 0.24 mg/L

Difference in Sulfate

17.5% of {(Background Sulfate Conc.) - (Core Sulfate Conc.)}
Change in Sulfate = 0.175*(3.56-2.45) = 0.19 mg/L

Difference in Methane

17.5% of {(Core Methane Conc.)}
Methane = 0.175*(1.3) = 0.23 mg/L

6.7.4.5 General

The modeled area length and width were set at 375 feet and 150 feet, respectively. The model area dimensions were estimated from site groundwater monitoring data. The simulation period extended from 1998 to 2005 (7 years) for predictive purposes.

6.7.4.6 Source Data

Source Thickness in Saturated Zone

The source thickness in the aquifer (thickness of zone containing residual LNAPL adsorbed to soils) was input as 4 feet, based on 1995 soil quality data.

Source Area Dimensions and Concentrations

BIOSCREEN® assumes a source represented by a vertical plane perpendicular to groundwater flow. The cross-sectional area of the vertical plane was determined using 1998 groundwater analytical data from MP-4 and SB-3.

Source Half-Life

BIOSCREEN® incorporates an approximation for a declining source concentration over time. The declining source term assumes that the mass of modeled constituent in the source area dissolves slowly as fresh groundwater passes through, and that the change in source zone concentration can be approximated as a first-order decay process. The model will compute an estimated source half-life given the estimated mass of modeled constituent present in the source area. A value of 0.04 kg was calculated for the soluble mass, based on the area of excessively contaminated soils from the 1995 investigation (BCM, 1996), and the maximum benzene concentration in groundwater in March 1998. This calculation is presented in Appendix D.

6.7.5 Model Results

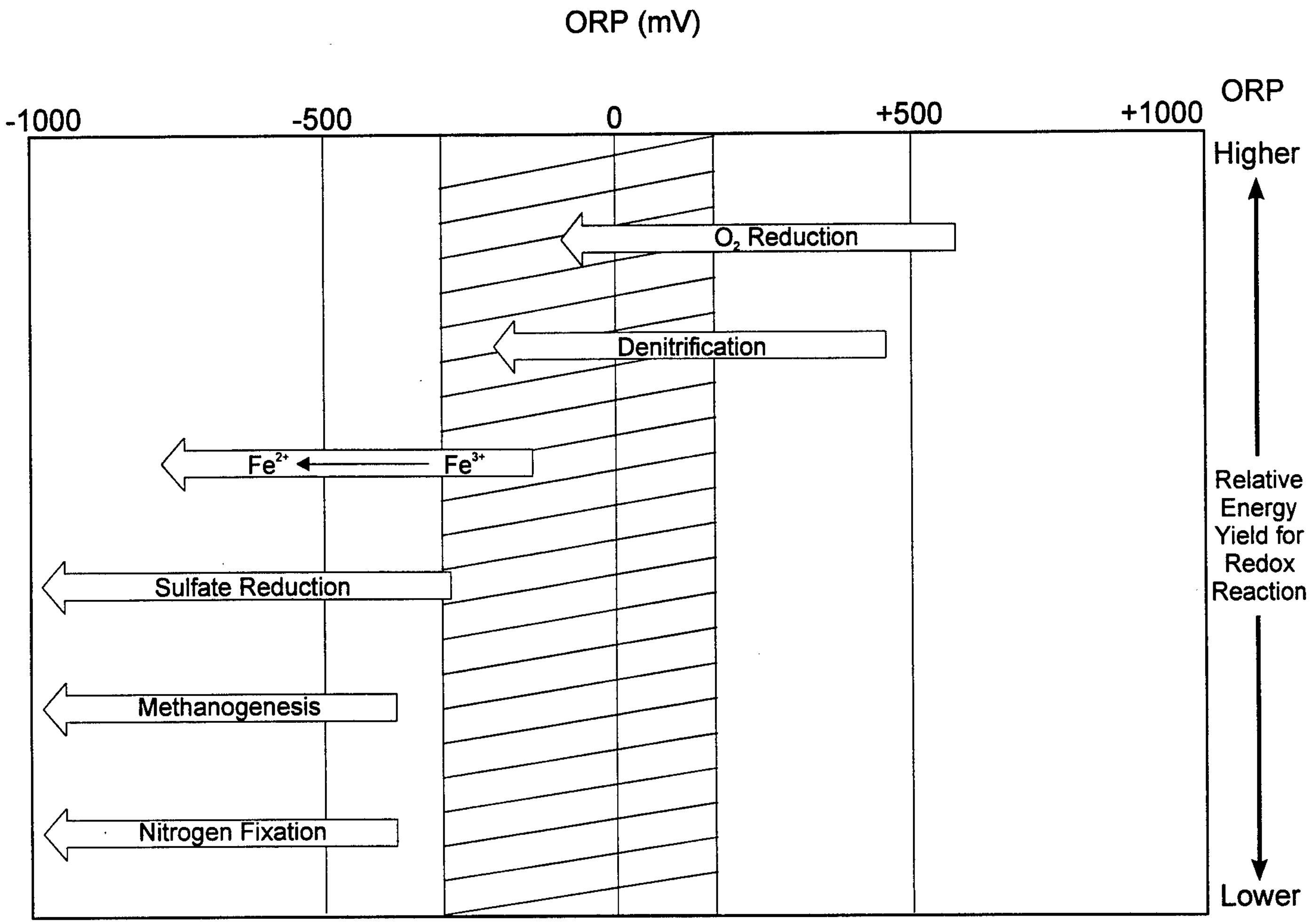
The instantaneous reaction model indicates that the benzene plume will completely attenuate within one year without reaching Fred Bayou (75 feet downgradient from MP-

4, which is the source area simulated by the model). As discussed in Section 6.6, there were some discrepancies in the geochemical data. These discrepancies may make the instantaneous reaction more speculative. The more conservative first-order decay model predicts that a maximum benzene concentration of 18 µg/L will reach Fred Bayou. The model predicts that concentrations of benzene in excess of the FDEP (1997) TCL of 1 µg/L will persist in the aquifer from one (instantaneous reaction model) to seven years (first-order decay model). Model output is presented in Appendix D.

6.7.6 Discussion of Model Results

The predicted persistence of benzene concentrations exceeding 1 µg/L ranged from 1 year (year 1999) to 7 years (year 2005). These estimates are similar to the estimate calculated in Section 6.4, where persistence of benzene at MP-4 was calculated to be 2.2 years (year 2000).

Data collected from monitoring points MP-1 and MP-2 suggest that benzene is not discharging to Fred Bayou. However, the groundwater samples collected from these two points may be diluted by surface water from the Bayou. Therefore, the presence of low levels of benzene at these locations cannot be ruled out. Even if benzene was discharging to Fred Bayou at the maximum value predicted by the conservative fate and transport model (18 µg/L), the FDEP surface water criteria (Rule 62-302.530, FAC) for benzene of 71.28 µg/L would not be exceeded. Review of site analytical data shows that the maximum detected concentration of benzene in groundwater (71 µg/L) also is below surface water criterion.



Notes

ORP = Oxidation Reduction Potential

▨ Range of ORP measured at Site FT-16

1. These reactions would be expected to occur in sequence if the system is moving toward equilibrium.
2. These redox processes occur in order of their energy-yielding potential (provided microorganisms are available to mediate a specific reaction). Reduction of a highly oxidized species decreases the ORP of the system.
3. The ORP of the system determines which electron acceptors are available for organic carbon oxidation.
4. Redox reaction sequence is paralleled by an ecological succession of biological mediators.

Adapted from Stumm and Morgan, 1981.

FIGURE 6.1

SEQUENCE OF MICROBIALLY MEDIATED REDOX PROCESSES

Risk-Based Approach to Remediation
Site FT-16
Tyndall AFB, Florida

PARSONS ENGINEERING SCIENCE, INC.
Atlanta, Georgia

J:\731854\Tyndall\FtRedseq.cdr

TABLE 6.1
HISTORICAL COMPARISON OF SOIL ANALYTICAL DATA
Risk-Based Approach to Remediation
Site FT-16
Tyndall AFB, Florida

		Sample Locations, Intervals, and Dates					
Analyte	**Units**	FT16HA61 (4 - 5.5) 11-Sep-95	SoBo-3 (4 - 5.5) 17-Mar-98	FT16HA65 (4 - 5.5) 14-Sep-95	SoBo-4 (4 - 5.5) 17-Mar-98	FT16HA42 (2 - 3.5) 8-Sep-95	SoBo-6 (2 - 3.5) 18-Mar-98
Benzene	mg/kg[a/]	2.86 U	0.0059 U[b/]	2.78 U	0.0059 U	0.00607 U	0.0059 U
Ethylbenzene	mg/kg	**4.58**	0.0023 U	2.78 U	0.0024 U	0.00607 U	0.0023 U
Toluene	mg/kg	2.86 U	0.0059 U	2.78 U	0.0059 U	0.00607 U	0.0059 U
Xylenes (total)	mg/kg	**32.0**	0.0059 U	2.78 U	0.0059 U	0.00607 U	0.0059 U
Total BTEX[c/]	mg/kg	**36.58**	0.0200 U	11.12 U	0.0201 U	0.02428 U	0.0200 U
TRPH (C8-C40)[d/]	mg/kg	**1,340**	**690**	**6,320**	**7.4 J1[e/]**	**1030**	**12**
Acenaphthene	mg/kg	0.39 U	0.23 U	**0.74 J1**	0.24 U	0.41 U	0.23 U
Acenaphthylene	mg/kg	0.39 U	0.23 U	1.6 U	0.24 U	0.41 U	0.23 U
Anthracene	mg/kg	0.39 U	0.023 U	**0.17 J1**	0.024 U	0.41 U	0.023 U
Benzo(a)anthracene	mg/kg	0.39 U	0.023 U	1.6 U	0.024 U	0.41 U	0.023 U
Benzo(a)pyrene	mg/kg	0.39 U	0.018 U	1.6 U	0.018 U	0.41 U	0.018 U
Benzo(b)fluoranthene	mg/kg	0.39 U	**0.0045 J1**	1.6 U	0.014 U	0.41 U	0.014 U
Benzo(g,h,i)perylene	mg/kg	0.39 U	0.059 U	1.6 U	0.059 U	0.41 U	0.059 U
Benzo(k)fluoranthene	mg/kg	0.39 U	0.013 U	1.6 U	0.013 U	0.41 U	0.013 U
Chrysene	mg/kg	0.39 U	0.047 U	1.6 U	0.047 U	0.41 U	0.047 U
Dibenz(a,h)anthracene	mg/kg	0.39 U	0.023 U	1.6 U	0.024 U	0.41 U	0.023 U
Fluoranthene	mg/kg	0.39 U	0.047 U	**0.80 J1**	0.047 U	0.41 U	0.047 U
Fluorene	mg/kg	0.39 U	0.047 U	**0.77 J1**	0.047 U	0.41 U	0.047 U
Indeno(1,2,3-cd)pyrene	mg/kg	0.39 U	0.035 U	1.6 U	0.035 U	0.41 U	0.035 U
Naphthalene	mg/kg	**0.26 J1**	0.23 U	**2.8**	0.24 U	0.41 U	0.23 U
Phenanthrene	mg/kg	0.39 U	0.047 U	**1.3 J1**	0.047 U	0.41 U	0.047 U
Pyrene	mg/kg	0.39 U	0.047 U	**0.60 J1**	0.047 U	0.41 U	0.047 U

a/ mg/kg = milligrams per kilogram.

b/ U = The analyte was analyzed for and was not present above the associated reporting limit

c/ BTEX = benzene, toluene, ethylbenzene, and total xylenes

d/ TRPH = total recoverable petroleum hydrocarbons

e/ J1 = The analyte was positively identified and had a concentration between the method detection limit and the reporting limit

TABLE 6.2
COMPARISON OF HISTORICAL GROUNDWATER ANALYTICAL DATA
Risk-Based Approach to Remediation
Site FT-16
Tyndall AFB, Florida

Analyte	Units	Sample Locations and Dates			
		MW-4 25-Sep-95	MW-4 20-Mar-98	SB-1 20-Sep-95	SB-1 20-Mar-98
Benzene	µg/L[a/]	**73**	2.0 U[b/]	1 U	2.0 U
Ethylbenzene	µg/L	**27**	**0.18 J1**[c/]	**29**	**3.5**
Toluene	µg/L	**64**	2.0 U	1 U	2.0 U
Xylenes (total)	µg/L	**397**	**0.16 J1**	**100**	**11**
Total BTEX[d/]	µg/L	**561**	**0.34**	**129**	**14.5**
TRPH (C8-C40)[e/]	µg/L	**2,780**	500 U	400 U	NA[f/]
Total Lead	µg/L	**3**	5 U	**5**	NA
Acenaphthene	µg/L	10 U	1.0 U	1 U	NA
Acenaphthylene	µg/L	10 U	1.0 U	1 U	NA
Anthracene	µg/L	10 U	0.10 U	1 U	NA
Benzo(a)anthracene	µg/L	10 U	0.13 U	1 U	NA
Benzo(a)pyrene	µg/L	10 U	0.24 U	1 U	NA
Benzo(b)fluoranthene	µg/L	10 U	0.19 U	1 U	NA
Benzo(g,h,i)perylene	µg/L	10 U	0.21 U	1 U	NA
Benzo(k)fluoranthene	µg/L	10 U	0.18 U	1 U	NA
Chrysene	µg/L	10 U	0.21 U	1 U	NA
Dibenz(a,h)anthracene	µg/L	10 U	0.31 U	1 U	NA
Fluoranthene	µg/L	10 U	0.21 U	1 U	NA
Fluorene	µg/L	10 U	0.21 U	1 U	NA
Indeno(1,2,3-cd)pyrene	µg/L	10 U	0.44 U	1 U	NA
Naphthalene	µg/L	**29**	1.0 U	1 U	NA
Phenanthrene	µg/L	10 U	0.21 U	1 U	NA
Pyrene	µg/L	10 U	0.21 U	1 U	NA

a/ µg/L = micrograms per liter

b/ U = The analyte was analyzed for and is not present above the associated reporting limit

c/ J1 = The analyte was positively identified and has a concentration between the method detection limit and the reporting limit

d/ BTEX = benzene, toluene, ethylbenzene, and total xylenes

e/ TRPH = total recoverable petroleum hydrocarbons

f/ NA = not analyzed

I:\TYN-RBIC\REPORT\FT-16\TABLES\Gwhisft.xls

TABLE 6.2 (Continued)
COMPARISON OF HISTORICAL GROUNDWATER ANALYTICAL DATA
Risk-Based Approach to Remediation
Site FT-16
Tyndall AFB, Florida

		Sample Locations and Dates			
Analyte	Units	SB-2 22-Sep-95	SB-2 21-Mar-98	SB-3 25-Sep-95	SB-3 20-Mar-98
Benzene	µg/L	**9.8**	2.0 U	**48**	**8.3**
Ethylbenzene	µg/L	**64**	**8.1**	**73**	**29**
Toluene	µg/L	**6.4**	**0.14 J1**	1 U	2.0 U
Xylenes (total)	µg/L	**2.5**	**39**	**4.6**	2.0 U
Total BTEX	µg/L	**82.7**	**47.1**	**125.6**	**37.3**
TRPH (C8-C40)	µg/L	**1,330**	NA	**466**	NA
Total Lead	µg/L	**5**	NA	**3**	NA
Acenaphthene	µg/L	10 U	NA	10 U	NA
Acenaphthylene	µg/L	10 U	NA	10 U	NA
Anthracene	µg/L	10 U	NA	10 U	NA
Benzo(a)anthracene	µg/L	10 U	NA	10 U	NA
Benzo(a)pyrene	µg/L	10 U	NA	10 U	NA
Benzo(b)fluoranthene	µg/L	10 U	NA	10 U	NA
Benzo(g,h,i)perylene	µg/L	10 U	NA	10 U	NA
Benzo(k)fluoranthene	µg/L	10 U	NA	10 U	NA
Chrysene	µg/L	10 U	NA	10 U	NA
Dibenz(a,h)anthracene	µg/L	10 U	NA	10 U	NA
Fluoranthene	µg/L	10 U	NA	10 U	NA
Fluorene	µg/L	10 U	NA	10 U	NA
Indeno(1,2,3-cd)pyrene	µg/L	10 U	NA	10 U	NA
Naphthalene	µg/L	10 U	NA	**68**	NA
Phenanthrene	µg/L	10 U	NA	10 U	NA
Pyrene	µg/L	10 U	NA	10 U	NA

a/ µg/L = micrograms per liter

b/ U = The analyte was analyzed for and is not present above the associated reporting limit

c/ J1 = The analyte was positively identified and has a concentration between the method detection limit and the reporting limit

d/ BTEX = benzene, toluene, ethylbenzene, and total xylenes

e/ TRPH = total recoverable petroleum hydrocarbons

f/ NA = not analyzed

TABLE 6.3
COMPOUND-SPECIFIC FIRST-ORDER DECAY COEFFICIENTS AND HALF-LIVES
Risk-Based Approach to Remediation
Site FT-16
Tyndall AFB, Florida

Chemical	Site-Specific First-Order Decay Coefficient (day^{-1})[a]	Site-Specific First-Order Decay Coefficient ($year^{-1}$)	Site-Specific Half-Life[b] (days)	Site-Specific Half-Life (years)	Literature Half-Life[c] (years)
Benzene	0.0052	1.9	132	0.36	0.02 to 2
Toluene	0.0028	1.0	250	0.69	0.02 to 0.17
Ethylbenzene	0.0060	2.2	115	0.32	0.016 to 0.62
Total Xylenes	0.0032	1.2	214	0.59	0.038 to 1
Total BTEX	0.0043	1.6	161	0.44	0.024 to 0.95

[a] First-order decay coefficient is the average of the coefficents determined for SB-1, SB-2, SB-3 and MW-4

[b] Half-life equals 0.693 divided by the first-order decay coefficient

[c] Literature half-life values from ASTM, 1995

TABLE 6.4
COUPLED OXIDATION REACTIONS
Risk-Based Approach to Remediation
Site FT-16
Tyndall AFB, Florida

Coupled Benzene Oxidation Reactions	Stoichiometric Mass Ratio of Electron Acceptor/Byproduct to Compound
$7.5 O_2 + C_6H_6 \Rightarrow 6 CO_{2,g} + 3 H_2O$ *Benzene oxidation /aerobic respiration*	3.07:1
$6 NO_3^- + 6 H^+ + C_6H_6 \Rightarrow 6 CO_{2,g} + 6 H_2O + 3 N_{2,g}$ *Benzene oxidation / denitrification*	4.77:1
$3.75\ NO_3^- + C_6H_6 + 7.5\ H^+ + 0.75\ H_2O \Rightarrow 6\ CO_2 + 3.75\ NH_4^+$ *Benzene oxidation / nitrate reduction*	2.98:1
$60 H^+ + 30 \underline{Fe(OH)_{3,a}} + C_6H_6 \Rightarrow 6 CO_2 + 30 Fe^{2+} + 78 H_2O$ *Benzene oxidation / iron reduction*	21.5:1
$7.5 H^+ + 3.75 SO_4^{2-} + C_6H_6 \Rightarrow 6 CO_{2,g} + 3.75 H_2S^o + 3H_2O$ *Benzene oxidation / sulfate reduction*	4.61:1
$5\ N_2 + C_6H_6 + 10\ H^+ + 12\ H_2O \Rightarrow 6\ CO_2 + 10\ NH_4^+$ *Benzene oxidation / nitrogen fixation*	2.31:1
$4.5 H_2O + C_6H_6 \Rightarrow 2.25 CO_{2,g} + 3.75 CH_4$ *Benzene oxidation / methanogenesis*	0.77:1

Coupled Toluene Oxidation Reactions	Stoichiometric Mass Ratio of Electron Acceptor/Byproduct to Compound
$9 O_2 + C_6H_5CH_3 \Rightarrow 7 CO_{2,g} + 4 H_2O$ *Toluene oxidation /aerobic respiration*	3.13:1
$7.2 NO_3^- + 7.2 H^+ + C_6H_5CH_3 \Rightarrow 7 CO_{2,g} + 7.6 H_2O + 3.6 N_{2,g}$ *Toluene oxidation / denitrification*	4.85:1
$4.5NO_3^- + 9H^+ + 0.5H_2O + C_6H_5CH_3 \Rightarrow 7CO_2 + 4.5NH_4^+$ *Toluene oxidation / nitrate reduction*	3.03:1
$72 H^+ + 36 \underline{Fe(OH)_{3,a}} + C_6H_5CH_3 \Rightarrow 7 CO_2 + 36 Fe^{2+} + 94 H_2O$ *Toluene oxidation / iron reduction*	21.86:1
$9 H^+ + 4.5 SO_4^{2-} + C_6H_5CH_3 \Rightarrow 7 CO_{2,g} + 4.5 H_2S^o + 4 H_2O$ *Toluene oxidation / sulfate reduction*	4.7:1
$6\ N_2 + C_6H_5CH_3 + 12\ H^+ + 14\ H_2O \Rightarrow 7\ CO_2 + 12\ NH_4^+$ *Toluene oxidation / nitrogen fixation*	2.35:1
$5 H_2O + C_6H_5CH_3 \Rightarrow 2.5 CO_{2,g} + 4.5 CH_4$ *Toluene oxidation / methanogenesis*	0.78:1

TABLE 6.4 (CONTINUED)
COUPLED OXIDATION REACTIONS
Risk-Based Approach to Remediation
Site FT-16
Tyndall AFB, Florida

Coupled Ethylbenzene Oxidation reactions	Stoichiometric Mass Ratio of Electron Acceptor/Byproduct to Compound
$10.5 O_2 + C_6H_5C_2H_5 \Rightarrow 8CO_{2,g} + 5H_2O$ *Ethylbenzene oxidation /aerobic respiration*	3.17:1
$8.4 NO_3^- + 8.4H^+ + C_6H_5C_2H_5 \Rightarrow 8CO_{2,g} + 9.2H_2O + 4.2N_{2,g}$ *Ethylbenzene oxidation / denitrification*	4.92:1
$5.25NO_3^- + 10.5H^+ + 0.25H_2O + C_6H_5C_2H_5 \Rightarrow 8CO_2 + 5.25NH_4^+$ *Ethylbenzene oxidation / nitrate reduction*	3.07:1
$84H^+ + \underline{42Fe(OH)_{3,a}} + C_6H_5C_2H_5 \Rightarrow 8CO_2 + 42Fe^{2+} + 110H_2O$ *Ethylbenzene oxidation / iron reduction*	22:1
$10.5H^+ + 5.25SO_4^{2-} + C_6H_5C_2H_5 \Rightarrow 8CO_{2,g} + 5.25H_2S^o + 5H_2O$ *Ethylbenzene oxidation / sulfate reduction*	4.75:1
$7N_2 + C_6H_5C_2H_5 + 14H^+ + 16H_2O \Rightarrow 8CO_2 + 14NH_4^+$ *Ethylbenzene oxidation / nitrogen fixation*	2.38:1
$5.5H_2O + C_6H_5C_2H_5 \Rightarrow 2.75CO_{2,g} + 5.25CH_4$ *Ethylbenzene oxidation / methanogenesis*	0.79:1

Coupled m-Xylene Oxidation Reactions	Stoichiometric Mass Ratio of Electron Acceptor/Byproduct to Compound
$10.5O_2 + C_6H_4(CH_3)_2 \Rightarrow 8CO_{2,g} + 5H_2O$ *m-Xylene oxidation /aerobic respiration*	3.17:1
$8.4NO_3^- + 8.4H^+ + C_6H_4(CH_3)_2 \Rightarrow 8CO_{2,g} + 9.2H_2O + 4.2N_{2,g}$ *m-Xylene oxidation / denitrification*	4.92:1
$5.25NO_3^- + 10.5H^+ + 0.25H_2O + C_6H_4(CH_3)_2 \Rightarrow 8CO_2 + 5.25NH_4^+$ *m-Xylene oxidation / nitrate reduction*	3.07:1
$84H^+ + \underline{42Fe(OH)_{3,a}} + C_6H_4(CH_3)_2 \Rightarrow 8CO_2 + 42Fe^{2+} + 110H_2O$ *m-Xylene oxidation / iron reduction*	22:1
$10.5H^+ + 5.25SO_4^{2-} + C_6H_4(CH_3)_2 \Rightarrow 8CO_{2,g} + 5.25H_2S^o + 5H_2O$ *m-Xylene oxidation / sulfate reduction*	4.75:1
$7N_2 + C_6H_4(CH_3)_2 + 14H^+ + 16H_2O \Rightarrow 8CO_2 + 14NH_4^+$ *m-Xylene oxidation / nitrogen fixation*	2.38:1
$5.5H_2O + C_6H_4(CH_3)_2 \Rightarrow 2.75CO_{2,g} + 5.25CH_4$ *m-Xylene oxidation / methanogenesis*	0.79:1

TABLE 6.5
SUMMARY OF GROUNDWATER GEOCHEMICAL DATA
Risk-Based Approach to Remediation
Site FT-16
Tyndall AFB, Florida

Parameter	Units	MP-1 21-Mar-98	MP-2 21-Mar-98	MP-3 21-Mar-98	MP-4 20-Mar-98	SB-1 20-Mar-98	SB-2 21-Mar-98	SB-3 20-Mar-98	MW-3 20-Mar-98	MW-4 20-Mar-98	MW-7 20-Mar-98
Ferrous Iron	mg/L	0.11	0.04	0.87	1.38	0.10	0.33	0.27	0.04	0.49	0.13
Sulfate	mg/L	81.54	57.24	22.12	2.45	1.54	14.66	2.45	4.13	5.37	2.98
Sulfide	mg/L	3.550	0.010 U	0.176	0.127	0.013	0.680	0.010 U	0.010 U	0.390	0.017
Alkalinity	mg/L	194	159	132	215	136	89	161	6	126	56
Ammonia	mg/L	2	0.1	0.2	2	0.1	0.4	0.3	0.0	0.1	0.0
Nitrate	mg/L	NM	NM	0.12	1.3	0.12	NM	0.74	0.11	0.55	0.04 U
Methane	mg/L	NM	NM	0.49	1.3	0.72	NM	1.5	0.011	0.33	0.027
Temperature	Deg C	18.4	18.1	17.2	18.3	17.1	17.8	17.1	17.7	18.0	17.5
pH	SU	7.33	7.33	6.84	6.41	6.89	6.85	6.98	5.12	6.82	6.45
Conductivity	µS/cm	2,570	2,630	279	529	304	195	351	58	279	148
Dissolved Oxygen	mg/L	0.35	NM	1.46	1.67	1.17	0.33	2.22	0.65	1.04	2.45
ORP	mV	-291.4	-65.5	-120.3	-221.2	-154.6	-211.6	-148.6	189.3	42.1	131.0

Notes:

Methane and Nitrate analysis performed by Quanterra Laboratories

ORP = oxidation reduction potential

mg/L = milligrams per Liter

Deg C = degrees Celcius

SU = Standard Units

µS/cm = microsiemen per centimeter

mV = millivolt

U = not detected above the method detection limit

NM = not measured

I:\TYN-RBIC\FT-16\REPORT\TABLES\Geochmft.xls

TABLE 6.6
ESTIMATED ASSIMILATIVE CAPACITY OF SATURATED SOIL AND GROUNDWATER
Risk-Based Approach to Remediation
Site FT-16
Tyndall AFB, Florida

Electron Acceptor or Metabolic Byproduct	Background Concentration (mg/L)[b/]	Concentration in Core of Plume (mg/L)	COPC Assimilative Capacity[a/] (mg/L)	Benzene Assimilative Capacity[a/] (mg/L)	Ethylbenzene Assimilative Capacity[a/] (mg/L)	Xylenes Assimilative Capacity[a/] (mg/L)
Oxygen	1.55	1.67	0.00	0.00	0.00	0.00
Ferrous Iron	NA[c/]	1.38	0.06	0.06	0.06	0.06
Sulfate	3.56	2.45	0.23	0.24	0.23	0.23
Ammonia[d/]	NA	2.58	1.09	1.12	1.08	1.08
Methane	NA	1.30	1.66	1.69	1.65	1.65
	Total		3.05	3.11	3.02	3.02
	Max. 1998 Concentration		0.13			

[a/] Calculation based on the ratio of the total mass of electron acceptor required to oxidize a given mass of the COPC

[b/] mg/L = milligrams per liter

[c/] NA = not applicable

[d/] Concentration of ammonia = concentration of ammonia reported as N x 1.29 to convert to ammonia as NH_4

I:\TYN-RBIC\REPORT\FT-16\TABLES\Asmcptft.xls

TABLE 6.7
RETARDATION COEFFICIENT CALCULATION
Risk-Based Approach to Remediation
Site FT-16
Tyndall AFB, Florida

Compound	K_{oc} (L/kg [a])	Average Fraction Organic Carbon [b]	Distribution Coefficient K_d (L/kg) Average[c]	Bulk Density (kg/L)[d]	Effective Porosity [d]	Coefficient of Retardation Average
Benzene	79	0.001243	0.098	1.7	0.35	1.48
Toluene	190	0.001243	0.236	1.7	0.35	2.15
Ethylbenzene	468	0.001243	0.582	1.7	0.35	3.83
Total Xylenes	422	0.001243	0.525	1.7	0.35	3.55
Total BTEX						2.75

Notes:

[a] From technical protocol (Wiedemeier *et al.*, 1996)

[b] From laboratory analyses of site soil samples

[c] K_d = Average Fraction Organic Carbon x K_{oc}

[d] Estimated Value

I:\TYN-RBIC\REPORT\FT-16\TABLES\Retardft.xls

SECTION 7
TIER 2 ANALYSIS AND IDENTIFICATION OF FINAL CHEMICALS OF CONCERN

7.1 OBJECTIVE OF SITE-SPECIFIC EVALUATION

The Tier 1 analysis conducted in this CAP (Section 4) identified benzene, ethylbenzene, total xylenes, and TRPH as COPCs in groundwater. These analytes are evaluated in detail to better define/assess the potential adverse health effects they may cause in current or future human receptors.

The Tier 1 screening process is considered protective of human health because the Tier 1 risk-based screening criteria are based on conservative exposure assumptions. However, analytes identified as COPCs in Section 4 of this CAP (i.e., analytes with representative site concentrations exceeding Tier 1 TCLs) should not automatically be considered to be present at Site FT-16 at levels that pose unacceptable threats to human health given the current and future exposure potential at this site. Rather, the exceedences of the screening criteria indicated that further evaluation under more site-specific exposure scenarios is warranted.

In summary, the objectives of developing site-specific target levels (SSTLs) that include exposure assumptions more representative of actual site conditions are 1) to determine whether current or predicted future site concentrations of COPCs present an unacceptable risk to current and future receptors; and 2) to provide a mechanism or reference to assess the cost and time required to lower site concentrations to achieve adequate risk reduction at the site.

7.2 REVISED CONCEPTUAL SITE MODEL

The preliminary CSM presented in Section 4 was used to qualitatively identify potential human and ecological receptors that may be exposed to site-related contaminants, and to define the types of these potential exposures at or in the vicinity of Site FT-16 (Figure 4.1). The preliminary CSM describes onsite release points, the affected physical media, the types of contaminant transport and fate mechanisms that may be involved at the site, each group of potentially exposed populations or receptors, and how each receptor group could come into contact with site-related contamination. This CSM was used to identify which of the exposure assumptions used to develop generic cleanup criteria most closely approximate site conditions. The exposure assumptions incorporated into the generic industrial TCLs for soils (i.e., Table IV Direct-Exposure II TCLs) were identified as generally representative of the types of exposure that could occur at Site FT-16, but perhaps greatly overestimated the magnitude of exposure specific to current and expected future site conditions. For example, Tier 1 screening of groundwater assumed unrestricted future use of groundwater. Therefore, the target cleanup criteria presented in Table VI (FDEP, 1997) which were developed assuming potable use of groundwater, were used in the Tier 1 screening. The preliminary CSM exposure pathways are reevaluated in this section using the chemical fate information presented in Section 6. It is important to emphasize that the purpose of using the preliminary CSM and the conservative, nonsite-specific TCLs to identify COPCs was to ensure that all subsequent assessment activities beyond the Tier 1 screening evaluation address the full range of contaminants that may present some risk to current or future receptors.

The revised CSM for Site FT-16, which is presented on Figure 7.1 and briefly reviewed in the following subsections, identifies only those receptors and exposure pathways that realistically may be involved in actual current or hypothetical future exposures. The outcome of the chemical fate assessment presented in Section 6 and the types of exposures likely to occur at this industrial site are reflected in this revised CSM. Justification for each site-specific exposure assumption is provided in subsequent discussions.

7.2.1 Sources, Affected Media, Release Mechanisms, and Contaminant Environmental Transport

As described in the preliminary CSM (Figure 4.1), releases from fire training activities have contaminated site soil, soil gas, and groundwater with fuel hydrocarbons. The predominant ongoing release mechanism for groundwater COPCs is leaching from contaminated soils. The lack of mobile LNAPL (free product) detections at the site indicates that mobile LNAPL is not a significant, continuing source of groundwater contamination. Site data indicate that RNA is acting to limit migration of contaminants in concentrations above the TCLs. Therefore, future offsite migration of the contaminant plume is not anticipated to occur to a significant degree, and dissolved contaminants should not impact water supply wells (the closest water-supply well is located approximately 2,000 feet to the north [Section 3.7]) or downgradient surface water bodies (Fred Bayou is located 75 feet downgradient from MP-4).

7.2.2 Potentially Exposed Receptors, Exposure Points, and Exposure Routes

The revised CSM for Site FT-16 also refines the identification of potentially exposed receptor populations, receptor exposure points, and exposure routes for realistic scenarios based on specific site conditions. These components better reflect the likelihood and extent of human or ecological receptor contact with site-related contaminants. As described in Section 2, Site FT-16 is entirely within the boundaries of the Base. Therefore, potential onsite receptor groups are currently limited to onsite workers. The only potentially completed pathway to offsite receptors is discharge of low levels of dissolved contaminants to Fred Bayou. However, available data indicate that this discharge, if it is occurring, is insignificant (Section 6.7.7). Furthermore, the current lack of intrusive excavation activity at the site and the lack of contamination in surface soils, prevents contact with contaminated soil or groundwater by current Base personnel.

No resident ecological receptors were identified at Site FT-16 for which soils and/or groundwater are likely contaminant exposure media. Based on the benzene fate and transport results presented in Section 6.7, potential offsite ecological receptors in Fred Bayou should not be impacted by site contamination.

Using the most conservative exposure assumptions appropriate for Site FT-16, the only realistic receptors that are likely to become exposed to site-related contaminants are the onsite intrusive worker involved in demolition, removal, and/or construction activities. Inhalation of VOCs (partitioning from either contaminated soil or groundwater) in ambient air at the site could result in a completed pathway for the onsite intrusive worker. However, as described in Section 6, all soil gas concentrations were substantially below the OSHA PELs; therefore, this pathway is assumed to be insignificant. However, there are potential risks to future construction workers posed by dermal contact with or incidental ingestion of contaminated groundwater during excavation activities. Therefore, these exposure pathways may be completed in the future.

7.2.3 Summary of Exposure Pathway Completion

Given the current and planned future uses of Site FT-16 and the outcome of the chemical fate assessment presented in Section 6, only onsite intrusive workers could be exposed to significant concentrations of site-related contamination in soil and groundwater during excavation activities. Therefore, health-based Tier 2 SSTLs developed for Site FT-16 are those designed to protect hypothetical future onsite intrusive workers from carcinogenic risks and noncarcinogenic hazards via direct contact with or incidental ingestion of soil and groundwater. For completeness, the SSTLs also include the inhalation pathway.

7.3 TIER II ANALYSIS FOR GROUNDWATER

Table 7.1 presents the chemical-specific groundwater SSTLs for Site FT-16. Note that two sets of SSTLs are presented; a reasonable maximum exposure (RME) and a central tendency (CT). The RME SSTLs are designed to illustrate the residual concentration that can persist in onsite groundwater given "high-end" (reasonable maximum) exposure potential, whereas the CT SSTLs better illustrate the residual concentration that can persist in onsite groundwater given mean or average exposure potential. The CT SSTLs are presented for comparative purposes only to provide a less-than-maximum-exposure perspective. RME and CT exposure assumptions are presented on Tables 7.2 and 7.3, respectively.

The groundwater SSTLs are health-based values calculated to protect onsite intrusive workers from health risks associated with exposure to chemical contamination in groundwater. As stated earlier, the generic health-based TCLs for groundwater are calculated assuming purposeful ingestion of onsite groundwater by onsite workers under residential-type exposure conditions (i.e., 30-year exposure duration, 2 liters per day consumption rate, etc.). In reality, these TCLs would apply only if impacted groundwater from Site FT-16 migrated to a drinking water supply source. The groundwater quality data collected at the site since 1995, and the Tier 2 quantitative chemical fate assessment completed in Section 6, demonstrate that no groundwater COPC is expected to migrate to an offsite drinking water supply source.

The construction worker exposure assumptions used to derive the SSTLs were developed for use at Eglin AFB, Florida (McLain, 1998), and have been reviewed and accepted by the FDEP. The exposure pathways incorporated in the SSTLs include dermal exposure, incidental ingestion, and inhalation. COPC toxicity values used in the SSTL derivations are based on toxicity data reported in the Integrated Risk Information System (IRIS) (Micromedex, Inc., 1998) or used by the FDEP to derive the generic Tier 1 target cleanup levels (University of Florida, 1997). The approach used to incorporate the inhalation pathway in the SSTL calculations was derived by toxicologists at the University of Florida for a similar site at Homestead AFB, Florida (University of Florida, 1998).

Based on the data presented in Table 7.1, no groundwater COPC exceeds its Tier II SSTL. SSTLs for TRPH in groundwater were not calculated because sufficient toxicity data were not available. Therefore, there are no final groundwater COPCs.

7.4 SUMMARY OF RISK-REDUCTION REQUIREMENTS

The following conclusions can be drawn:

- Concentrations of target analytes in all sampled media that exceeded applicable health-protective Tier 1 TCLs did not exceed Tier 2 SSTLs; therefore, site contamination does not pose a risk to potential receptors (construction workers) under reasonable current and future land use scenarios.
- Table IX (FDEP, 1997) natural attenuation default source concentration screening levels were not exceeded, indicating the appropriateness of MNA as a remedial alternative.
- Contaminant and geochemical data indicate that biodegradation of fuel hydrocarbons is occurring at the site, primarily via the anaerobic processes of nitrogen fixation and methanogenesis. However, the geochemical data are internally consistent making the assimilative capacity calculations more speculative.
- Available data indicate that the dissolved plume is stable or shrinking and should not significantly impact potential downgradient receptors (Fred Bayou, Site OT-29).
- Tyndall AFB is an active Base where institutional controls can be maintained with a high level of confidence.
- With the exception of potential discharge of contaminants to Fred Bayou at levels substantially below surface water quality standards, none of the potential exposure pathways described in Section 4.4 are considered complete.
- Fate and transport modeling results indicate that residual concentrations of groundwater COPCs above Tier 1 TCLs (the long-term cleanup goals) will not persist for more than seven years.

The USEPA Office of Solid Waste and Emergency Response (OSWER) has written the Interim Final *Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites* (USEPA, 1997). This document outlines a process for determining if a site would be appropriate for monitored natural attenuation. This process was utilized for Site FT-16. The *Petroleum Contamination Site Cleanup Criteria* rule (FDEP, 1997) also provides guidance for monitoring only with natural attenuation scenarios. Per the findings of this investigation, RNA with LTM and institutional controls is the only remedial action recommended for Site FT-16. A LTM plan is proposed in Section 8.

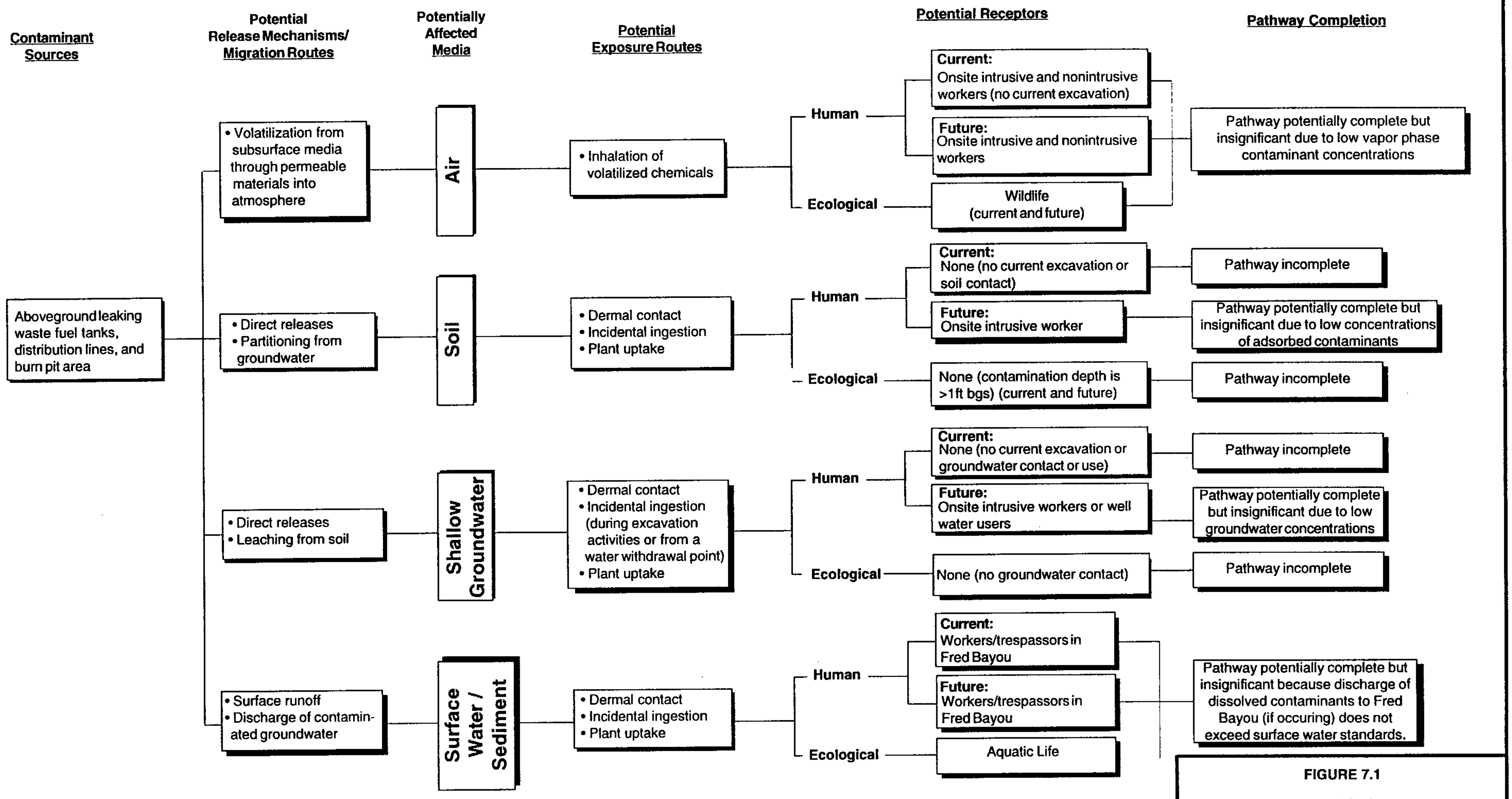


FIGURE 7.1

REVISED
CONCEPTUAL SITE MODEL

Risk-Based Approach to Remediation
Site FT-16
Tyndall AFB, Florida

PARSONS
ENGINEERING SCIENCE, INC.
Atlanta, Georgia

TABLE 7.1

COMPARISON OF MAXIMUM GROUNDWATER DETECTION TO SITE-SPECIFIC TARGET LEVELS (SSTLs)

Risk-Based Approach to Remediation

Site FT-16

Tyndall AFB, Florida

Chemical of Potential Concern	Units	Detected Site Maximum Concentration[a/]	Tier 2 Health-Based SSTL		Does Detected Site Maximum Concentration Exceed SSTL?	
			RME	CT	RME	CT
Benzene	μg/L [b/]	7.10E+01	2.99E+03	4.31E+04	No	No
Ethylbenzene	μg/L	4.40E+01	5.33E+04	6.09E+05	No	No
Xylenes	μg/L	3.90E+01	9.91E+05	1.18E+07	No	No
TRPH [c/]	mg/L [d/]	7.10E+00	-- [e/]	--	--	--

[a/] Maximum detection at Site FT-16 during March 1998 investigation

[b/] ug/L = micrograms per liter

[c/] TRPH = total recoverable petroleum hydrocarbon

[d/] mg/L = milligrams per liter

[e/] SSTL could not be calculated

TABLE 7.2
CALCULATION OF SITE-SPECIFIC TARGET LEVELS (SSTLs) - GROUNDWATER
INDUSTRIAL LAND USE - CONSTRUCTION SCENARIO
RME SCENARIO
Risk-Based Approach to Remediation
Site FT-16
Tyndall AFB, Florida

Exposure Assumptions		
Body Weight (BW)	70	kg
Exposure Frequency (EF)	46	days/yr
Exposure Duration (ED)	1	yr
Ingestion Rate (IR)	0.005	L/hr
Conversion Factor (CF)	0.001	L/cm^3
Exposure Time Dermal(ET_D)	2	hr/day
Permeability Constant (PC)	chem-specific	cm/hr
Surface Area (SA)	5300	cm^2
Oral Absorption Factor (OABS)	chem-specific	unitless
Exposure Time Inhalation (ET_I)	8	hrs/day
Inhalation Rate (InhR)	2.5	m^3/hr
Area of Trench (A)	300000	cm^2
Length of Side Perpendicular to Wind (LS)	15	m
Average Wind Speed (V)	4.47	m/sec
Mixing Height Above Water (MH)	2	m
Molecular Weight (MW)	chem-specific	g/mol
Henry's Law Constant (HLC)	chem-specific	atm m^3/mol
Averaging Time (AT)		
Noncarcinogens	365	days
Carcinogens	25550	days
Target Risk Level (TR)	1.00E-06	unitless
Target Hazard Quotient (THQ)	1	unitless

Toxicity Value Definitions	
RfDo = Reference Dose (Oral)	mg/kg-day
RfDd = Reference Dose (Dermal)	mg/kg-day
RfDi = Reference Dose (Inhalation)	mg/kg-day
SFo = Oral Slope Factor	kg-day/mg
SFd = Dermal Slope Factor	kg-day/mg
SFi = Inhalation Slope Factor	kg-day/mg
SSTL-non = Noncarcinogenic SSTL	mg/L
SSTL-car = Carcinogenic SSTL	mg/L

Mass Transfer Coefficient (K) (cm/s) chem-specific

1/K = 1/K(l) + [(8.2E-5(atm m^3/mol °K)*298°K)/(HCL*K(g))]

Liquid Mass Transfer Coefficient (K(l)) (cm/s) chem-specific

K(l) = ([32(g/mol)/MW]^0.5)*0.0061(cm/sec)

Gas Mass Transfer Coefficient (K(g)) (cm/s) chem-specific

K(g) = ([18(g/mol)/MW]^0.335)*1.39(cm/sec)

Noncarcinogens

SSTL (mg/L) = (THQ*BW*AT)/[ED*EF([1/RfDo*IR*ET]+[1/RfDd*SA*PC*ET*CF]+ [(ET*InhR*CF*K*A)/(RfDi*LS*V*MH)])]

Carcinogens

SSTL (mg/L) = (TR*BW*AT)/[ED*EF([SFo*IR*ET]+[SFd*SA*PC*ET*CF]+ [(SFi*ET*InhR*CF*K*A)/(LS*V*MH)])]

Chemical Name	MW	HLC [a]	PC [b]	OABS [c]	RfDo [d]	RfDd	RfDi	SFo	SFd	SFi	K(g)	K(l)	K	SSTL Carcinogen mg/L	SSTL Non-Carc. mg/L
Volatiles															
Benzene	78.11	5.60E-03	2.10E-02	9.00E-01	3.00E-03	2.70E-03	1.71E-03	2.90E-02	3.22E-02	2.90E-02	8.50E-01	3.90E-03	3.83E-03	3.13E+00	2.99E+00
Ethylbenzene	106.17	7.90E-03	7.40E-02	8.00E-01	1.00E-01	8.00E-02	2.90E-01	-- [e]	--	--	7.67E-01	3.35E-03	3.30E-03	--	5.33E+01
Xylene	106.17	6.70E-03	8.00E-02	8.95E-01	2.00E+00	1.79E+00	1.80E+00	--	--	--	7.67E-01	3.35E-03	3.30E-03	--	9.91E+02
TRPH	cannot compute SSTLs due to lack of toxicity data														

a/ Henry's Law Constants taken from Table 3a of Technical Report: Development of Soil Cleanup Target Levels (SCTLs) for Chapter 62-770, F.A.C. (FDEP, 1997).

b/ Permeability constants taken from or calculated per Dermal Exposure Assessment: Principles and Application (USEPA, 1992).

c/ The oral absorption values were taken from Tables 4a and 4b of Technical Report: Development of Soil Cleanup Target Levels (SCTLs) for Chapter 62-770, F.A.C. (FDEP, 1997).

d/ Toxicity values taken from Tables 4a and 4b of Technical Report: Development of Soil Cleanup Target Levels (SCTLs) for Chapter 62-770, F.A.C. (FDEP, 1997).

e/ "--" indicates that no toxicity data is available.

Note: SSTLs include dermal contact, incidental ingestion, and inhalation pathways.

TABLE 7.3
CALCULATION OF SITE-SPECIFIC TARGET LEVELS (SSTLs) - GROUNDWATER
INDUSTRIAL LAND USE - CONSTRUCTION SCENARIO
CT SCENARIO
Risk-Based Approach to Remediation
Site FT-16
Tyndall AFB, Florida

Exposure Assumptions		
Body Weight (BW)	70	kg
Exposure Frequency (EF)	15	days/yr
Exposure Duration (ED)	1	yr
Ingestion Rate (IR)	0.0025	L/hr
Conversion Factor (CF)	0.001	L/cm^3
Exposure Time Dermal(ET_D)	1	hr/day
Permeability Constant (PC)	chem-specific	cm/hr
Surface Area (SA)	2910	cm^2
Oral Absorption Factor (OABS)	chem-specific	unitless
Exposure Time Inhalation (ET_I)	4	hrs/day
Inhalation Rate (InhR)	0.8	m^3/hr
Area of Trench (A)	300000	cm^2
Length of Side Perpendicular to Wind (LS)	15	m
Average Wind Speed (V)	4.47	m/sec
Mixing Height Above Water (MH)	2	m
Molecular Weight (MW)	chem-specific	g/mol
Henry's Law Constant (HLC)	chem-specific	atm m^3/mol
Averaging Time (AT)		
Noncarcinogens	365	days
Carcinogens	25550	days
Target Risk Level (TR)	1.00E-06	unitless
Target Hazard Quotient (THQ)	1	unitless

Toxicity Value Definitions	
RfDo = Reference Dose (Oral)	mg/kg-day
RfDd = Reference Dose (Dermal)	mg/kg-day
RfDi = Reference Dose (Inhalation)	mg/kg-day
SFo = Oral Slope Factor	kg-day/mg
SFd = Dermal Slope Factor	kg-day/mg
SFi = Inhalation Slope Factor	kg-day/mg
SSTL-non = Noncarcinogenic SSTL	mg/L
SSTL-car = Carcinogenic SSTL	mg/L

Mass Transfer Coefficient (K) (cm/s) chem-specific

1/K = 1/K(l) + [(8.2E-5(atm m^3/mol °K)*298°K)/(HCL*K(g))]

Liquid Mass Transfer Coefficient (K(l)) (cm/s) chem-specific

K(l) = ([32(g/mol)/MW]^0.5)*0.0061(cm/sec)

Gas Mass Transfer Coefficient (K(g)) (cm/s) chem-specific

K(g) = ([18(g/mol)/MW]^0.335)*1.39(cm/sec)

Noncarcinogens

SSTL (mg/L) = (THQ*BW*AT)/[ED*EF([1/RfDo*IR*ET]+[1/RfDd*SA*PC*ET*CF]+[(ET*InhR*CF*K*A)/(RfDi*LS*V*MH)])]

Carcinogens

SSTL (mg/L) = (TR*BW*AT)/[ED*EF([SFo*IR*ET]+[SFd*SA*PC*ET*CF]+[(SFi*ET*InhR*CF*K*A)/(LS*V*MH)])]

Chemical Name	MW	HLC [a/]	PC [b/]	OABS [c/]	RfDo [d/]	RfDd	RfDi	SFo	SFd	SFi	K(g)	K(l)	K	SSTL Carcinogen mg/L	SSTL Non-Carc. mg/L
Volatiles															
Benzene	78.11	5.60E-03	2.10E-02	9.00E-01	3.00E-03	2.70E-03	1.71E-03	2.90E-02	3.22E-02	2.90E-02	8.50E-01	3.90E-03	3.83E-03	4.20E+01	4.31E+01
Ethylbenzene	106.17	7.90E-03	7.40E-02	8.00E-01	1.00E-01	8.00E-02	2.90E-01	-- [e/]	--	--	7.67E-01	3.35E-03	3.30E-03	--	6.09E+02
Xylene	106.17	6.70E-03	8.00E-02	8.95E-01	2.00E+00	1.79E+00	1.80E+00	--	--	--	7.67E-01	3.35E-03	3.30E-03	--	1.18E+04
TRPH	cannot compute SSTLs due to lack of toxicity data														

a/ Henry's Law Constants taken from Table 3a of Technical Report: Development of Soil Cleanup Target Levels (SCTLs) for Chapter 62-770, F.A.C. (FDEP, 1997).

b/ Permeability constants taken from or calculated per Dermal Exposure Assessment: Principles and Application (USEPA, 1992).

c/ The oral absorption values were taken from Tables 4a and 4b of Technical Report: Development of Soil Cleanup Target Levels (SCTLs) for Chapter 62-770, F.A.C. (FDEP, 1997).

d/ Toxicity values taken from Tables 4a and 4b of Technical Report: Development of Soil Cleanup Target Levels (SCTLs) for Chapter 62-770, F.A.C. (FDEP, 1997).

e/ "--" indicates that no toxicity data is available.

Note: SSTLs include dermal contact, incidental ingestion, and inhalation pathways.

SECTION 8
LONG-TERM MONITORING PLAN

8.1 OVERVIEW

The objectives of the LTM plan are as follows:

- Demonstrate that natural attenuation is occurring according to expectations;
- Determine if the dissolved plume is expanding;
- Ensure no impact to downgradient receptors;
- Detect new releases of contaminants to the environment that could impact the effectiveness of the natural attenuation remedy;
- Demonstrate the efficacy of institutional controls that were put in place to protect potential receptors; and
- Detect changes in environmental conditions that may reduce the efficacy of any of the natural attenuation processes (USEPA, 1997).

The LTM plan consists of identifying groundwater sampling locations, developing a sampling and analysis strategy, and ensuring that institutional controls remain intact. In the event that data collected under this LTM program indicate that RNA is insufficient to be protective of human health and the environment, additional engineered controls to augment the beneficial effects of RNA may be necessary. A site-specific groundwater SAP should be prepared prior to initiating the LTM program.

8.2 LONG-TERM GROUNDWATER MONITORING WELLS

Monitoring of groundwater quality in a total of five existing monitoring wells and points is recommended to achieve the above-mentioned objectives. The five existing wells/points, and the rationale for sampling them, are listed below:

- MP-4 (where the highest dissolved contaminant concentrations were detected in 1998),
- MW-3 (to obtain background water quality data and ensure that contaminants are not migrating beneath Site FT-16 from other, upgradient sources),
- MW-4 (to confirm that the contaminant source at the former fire training pit is substantially depleted),
- SB-3 (to confirm that dissolved contaminant levels remain substantially lower than detected in 1995), and
- SB-2 (where the highest dissolved xylenes concentration was detected in 1998).

In addition to these existing wells/points, installation and sampling of a new monitoring point adjacent to Fred Bayou along a direct line between MP-4 and the Bayou is recommended to monitor groundwater quality adjacent to the Bayou. Given the steep topography at the proposed sampling location, a stainless steel, manually-driven monitoring point similar to MP-1 and MP-2 could be used.

8.3 SAMPLING DURATION AND FREQUENCY

Groundwater monitoring will be performed annually for three years to document continued reduction of contaminant concentrations. Because dissolved groundwater contaminant concentrations do not exceed Tier 2 SSTLs, and do not pose a threat to potential receptors under current and anticipated future land use conditions, continuation of monitoring until all Tier 1 TCLs are achieved is not necessary. However, if monitoring results do not support the contaminant reduction trend indicated by the 1995 and 1998 groundwater quality data, and/or if land use plans change, then sampling frequency and duration should be adjusted accordingly.

8.4 ANALYTICAL PROTOCOL

All LTM wells will be sampled and analyzed to verify the effectiveness of naturally-occurring remediation processes at the site. At the beginning of each sampling event, water levels should be measured in all sampled monitoring wells. Groundwater samples collected from the LTM wells should be analyzed for the parameters listed in Table 8.1. If sampling results indicate that geochemical conditions in the plume area (e.g., nitrate, sulfate, and ferrous iron concentrations) are stable over time, then the sampling frequency for these parameters could be reduced. Samples from each well should be analyzed at least once for TCE due to the detection of this compound at a concentration of 10 μg/L in well MW-4 in 1995 (BCM, 1996). If analysis results indicate that TCE is not of concern, then it could be deleted from the analyte list.

8.5 INSTITUTIONAL CONTROLS

Institutional controls should be implemented to ensure that exposure pathways to receptors cannot be completed. The institutional controls will be in accordance with the Land Use Controls Assurance Plan (LUCAP) that is currently being prepared for Tyndall Air Force Base. The LUCAP will be prepared in accordance with EPA Region 4 Federal Facilities Branch Policy (Memorandum from EPA Region 4 Federal Facilities Branch, Assuring Land Use Controls at Federal Facilities, undated). The specific land use controls will be listed in the Land Use Control Implementation Plan (LUCIP) which will be prepared for this site.

TABLE 8.1
LONG-TERM GROUNDWATER MONITORING ANALYTICAL PROTOCOL
Risk-Based Approach to Remediation
Site FT-16
Tyndall AFB, Florida

Analyte	Method/Reference	Comments	Data Use	Recommended Frequency of Analysis	Sample Volume, Sample Container, Sample Preservation	Field or Fixed-Base Laboratory
Ferrous Iron (Fe^{2+})	Colorimetric A3500-Fe D or Hach 25140-25	Filter if turbid	May indicate an anaerobic degradation process due to the depletion of oxygen, nitrate, and manganese	Every Sampling Event	Collect 100 mL of water in a glass container; for Method A3500-FeD, acidify with hydrochloric acid per method	Field
Temperature	E170.1, direct-reading meter	Measure at well-head	Purging adequacy; metabolism rates for microorganisms depend on temperature	Every Sampling Event	Measure at well-head using a flow-through cell	Field
Dissolved Oxygen	Dissolved oxygen meter	Measure at well-head; refer to Method A4500 for a comparable laboratory procedure	Purging adequacy; concentrations less than 1 mg/L generally indicate an anaerobic pathway	Every Sampling Event	Measure at well-head using a flow-through cell	Field
pH	E150.1/SW9040, direct-reading meter	Measure at well-head	Purging adequacy; aerobic and anaerobic processes are pH-sensitive	Every Sampling Event	Measure at well-head using a flow-through cell	Field
Conductivity	E120.1/SW9050, direct-reading meter	Measure at well-head	General water quality parameter used as a marker to verify that site samples are obtained from the same groundwater system	Every Sampling Event	Collect 100–250 mL of water in a glass or plastic container or measure at wellhead using flow-through cell	Field
Ammonia (NH_3)	CHEMetrics Method 1510, ASTM 4500: NH3	Filter if turbid	Most reduced form of nitrogen; metabolic byproduct of anaerobic microbial respiration	Every Sampling Event	Collect water samples in a 100 mL plastic container;	Field

TABLE 8.1 (Continued)
LONG-TERM GROUNDWATER MONITORING ANALYTICAL PROTOCOL
Risk-Based Approach to Remediation
Site FT-16
Tyndall AFB, Florida

Analyte	Method/Reference	Comments	Data Use	Recommended Frequency of Analysis	Sample Volume, Sample Container, Sample Preservation	Field or Fixed-Base Laboratory
Sulfate (SO_4^{2-})	IC method E300 or method SW9056 or Hach SulfaVer 4 method	Method E300 is a Handbook method; method SW9056 is an equivalent procedure. Hach method is Photometric	Substrate for anaerobic microbial respiration	Every Sampling Event	Collect up to 40 mL of water in a glass or plastic container; cool to 4°C	Fixed-base or field (for Hach method)
Oxidation-Reduction Potential (ORP)	A2580 B, direct-reading meter	Measurements are made with electrodes; results are displayed on a meter; samples should be protected from exposure to atmospheric oxygen	The redox potential of groundwater influences and is influenced by biologically mediated reactions; the redox potential of groundwater may range from more than 200 mV to less than -400 mV	Every Sampling Event	Measure at well-head using a flow-through cell	Field
Methane	RSKSOP-114 modified to analyze water samples for methane by headspace sampling with dual thermal conductivity and flame ionization detection.	Method published and used by the USEPA National Risk Management Research Laboratory	The presence of methane indicates the presence of sufficiently reducing conditions for reductive dehalogenation to occur	Every Sampling Event	Collect water samples in 40 mL volatile organic analysis (VOA) vials with butyl gray/Teflon-lined caps (zero headspace); cool to 4°C	Fixed-base
BTEX + TCE	SW8021B or SW8260B	8021B is a GC Method, 8260B is a GC/MS Method	Measured for regulatory compliance.	Every Sampling Event	Collect water samples in a 40 mL VOA vial; cool to 4°C; add hydrochloric acid to pH < 2	Fixed-base
TRPH	FL-PRO	Florida Protocol (C8-C40)	Measured for regulatory compliance.	Every Sampling Event	Collect water samples in a 1L amber jars; cool to 4°C;	Fixed-base

Handbook refers to the AFCEE (1993) "Handbook for the Installation Restoration Program (IRP) Remedial Investigations and Feasibility Studies (RI/FS)."

SECTION 9
REFERENCES

American Society For Testing and Materials (ASTM), 1995. *ASTM Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites.* ASTM Designation: E 1739-95.

BCM. 1996. Supplemental Contamination Assessment Report for Shell Bank Fire Training Area, Site FT-16, Tyndall Air Force Base, Bay County, Florida. April.

Borden, R.C., 1994. Natural Bioremediation of Hydrocarbon-Contaminated Ground Water, Handbook of Remediation, Lewis Publishers, Boca Raton, Florida.

CH2M Hill. 1981. IRP Phase I - Records Search, Tyndall AFB, Florida.

Chapelle, F.H., 1993, Ground-water Microbiology and Geochemistry. John Wiley and Sons, Inc., New York, NY.

Chapelle, F.H., 1994, Assessing the Efficiency of Intrinsic Bioremediation, in Proceedings of the Symposium on Intrinsic Bioremediation of Ground Water, August 30 - September 1, 1994: US Environmental Protection Agency, p. 171.

Domenico, P.A., 1987. An Analytical Model for Multidimensional Transport of a Decaying Contaminant Species. Journal of Hydrology, 91 (1987) 49-58.

Environmental Science and Engineering (ESE). 1986. IRP Phase II, Stage II Investigation, Site FT-16, Tyndall AFB, Florida.

Florida Department of Environmental Protection (FDEP). September 1997. Petroleum Contamination Site Cleanup Criteria. Final.

Geraghty & Miller, Inc. 1991. IRP Phase IV - Remedial Investigation, Site FT-16, Tyndall AFB, Florida.

Godsy, E.M., 1994. Microbiological and geochemical degradation processes, Symposium on Intrinsic Bioremediation in Ground Water, Denver, CO. August 30 - September 1, 1994, p.35-40.

Grbic′-Galic′, D., 1990, Anaerobic microbial transformation of nonoxygenated aromatic and alicyclic compounds in soil, subsurface, and freshwater sediments, In: Bollag, J.M., and Stotzky, G., eds.: Soil Biochemistry: Marcel Dekker, Inc., New York, NY. p. 117-189.

Lewis, B. G. 1998. Telephonic conference with Frank Farmer of Rust Environmental. September 10.

Long, E.R., D.D. MacDonald, S.L. Smith, and F.D. Calder, 1995. Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediments. Environmental Management 19(1): 81-97.

Lovley, D.R., and Phillips, E.J.P., 1988, Novel mode of microbial energy metabolism: organic carbon oxidation coupled to dissimilatory reduction of iron or manganese: Applied and Environmental Microbiology, v. 54, no. 6, p. 1472 - 1480.

Lovley, D.R., Phillips, E.J.P., and Lonergan, D.J., 1991, Enzymatic versus nonenzymatic mechanisms for Fe(III) reduction in aquatic sediments: Environmental Science and Technology, v. 26, no. 6, p. 1062 - 1067.

Lovley, Derek R., Chapelle, Francis H., and Woodward, Joan C., 1994. Use of dissolved H_2 concentrations to determine distribution of microbially catalyzed redox reactions in anoxic groundwater, Environmental Science and Technology, vol. 28, no. 7, p. 1205-1210.

MacDonald, D.D., 1994a. Approach to the Assessment of Sediment Quality in Florida Coastal Waters. Volume 1 - Development and Evaluation of Sediment Quality Assessment Guidelines. Prepared by MacDonald Environmental Sciences, Ltd. for the Florida Department of Environmental Protection, Office of Water Policy. November.

MacDonald, D.D., 1994b. Approach to the Assessment of Sediment Quality in Florida Coastal Waters. Volume 2 - Application of Sediment Quality Assessment Guidelines. Prepared by MacDonald Environmental Sciences, Ltd. for the Florida Department of Environmental Protection, Office of Water Policy. November.

McLain, Captain. 1998. Tables received from Eglin AFB, Florida with construction worker exposure assumptions. June 12.

Micromedex, Inc., 1998. Toxicology, Occupational Medicine and Environmental Series (TOMES) Plus Database. Denver, Colorado.

Newell, C.J. and R.K. McLeod, 1996. BIOSCREEN Natural Attenuation Decision Support System Users Manual, Version 1.3, Air Force Center for Environmental Excellence, Brooks AFB, San Antonio, TX.

Newell, C.J. and R.K. McLeod, 1997. BIOSCREEN Natural Attenuation Decision Support System Users Manual, Version 1.4 Revisions, Air Force Center for Environmental Excellence, Brooks AFB, San Antonio, TX.

NIOSH, 1997. Pocket Guide to Chemical Hazards. U.S. Department of Health and Human Services.

Parsons ES. 1997a. Sampling and Analysis Plan for the Streamlined, Risk-Based Corrective Action and Site Closure Demonstration. Denver, Colorado, September.

Parsons ES. 1997b. Work Plan for the Risk-Based Investigation and Closure of the Base Exchange Service Station and Site FT-16. Atlanta, Georgia and Denver, Colorado.

Spitz, K. and J. Moreno. 1996. A Practical Guide to Groundwater and Solute Transport Modeling. John Wiley & Sons, Inc.

Stumm, W. and Morgan, J.J., 1981, Aquatic Chemistry. John Wiley & Sons, New York, NY.

University of Florida, 1997. Technical report for the Development of Soil Cleanup Target Levels (SCTLs) for Chapter 62-770, F.A.C. Gainesville, FL. Final.

University of Florida, 1998. Letter from Lisa Tonner-Navaro and Stephen Roberts, Ph.D., Center of Environmental and Human Toxicology, to Ligia Mora-Applegate, M.P.H, Bureau of Waste Cleanup, FDEP. June 11.

USEPA, 1994a. USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review. EPA 540/R-94/012.

USEPA, 1994b. USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review. EPA 540/R-94/013.

USEPA, 1995. Supplemental Guidance to RAGS: EPA Region 4 Waste Management Division, Ecological Risk Assessment Bulletin No. 1. November.

USEPA, 1997. Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites, Interim Final, Office of Solid Waste and Emergency Response. December 1. Directive Number 9200.4-17.

USEPA, undated. Memorandum from EPA Region 4 Federal Facilities Branch, Assuring Land Use Controls at Federal Facilities.

Water and Air Research. 1984. IRP Phase II, Stage I Report, Site FT-16, Tyndall AFB, Florida.

Wiedemeier, Todd H., et al. 1995. Technical Protocol for Implementing Intrinsic Remediation with Long-Term Monitoring for Natural Attenuation of Fuel Contamination Dissolved in Groundwater. Revision 0. Air Force Center for Environmental Excellence, Brooks Air Force Base, Texas.

APPENDIX A
PERTINENT DATA FROM PREVIOUS SITE INVESTIGATIONS

TABLES

TA[illegible]4-1
WELL CONSTRUCTION DETAILS
SITE FT-16
TYNDALL AIR FORCE BASE, FLORIDA

WELL NO.	WELL COORDINATES	WELL DIAMETER INCHES	ELEV-TOC FEET	ELEV-GROUND FEET	TOTAL WELL DEPTH FT-BTOC	SCREEN LENGTH FEET	GW ELEV 9/22/95	GW ELEV 10/31/95
T10-1	N396809 E1624298	4	14.08	10.94	24.64	NA	4.19	4.06
T10-2	N396501 E1624385	4	14.76	12.28	21.98	NA	5.56	5.35
T10-3	N396260 E1624090	4	13.35	11.24	21.11	NA	9.25	9.03
SBMW-1	N396194 E162308	2	15.98	13.64	4.84-14.84	10	9.78	9.39
SBMW-2	N396214 E1624550	2	15.91	13.48	4.93- 14.93	10	8.69	8.36
SBMW-3	N396332 E1624580	2	14.16	12.08	4.58 - 14.58	10	6.59	6.41
FT16-MW1	N396449 E1624465	2	15.16	12.28	7.88 - 17.88	10	4.18	3.90
FT16-DMW1	N396230 E1624550	2	16.54	13.78	42.46 52.46	10	3.60	3.27
FT16-MW2	N396012 E1624522	2	15.52	13.04	7.48 17.48	10	10.09	9.70
FT16-DMW2	N396209 E1624313	2	16.18	13.24	42.94- 52.94	10	3.76	3.41
FT16-MW3	N395851 E1624216	2	15.9	13.14	7.76 17.76	10	10.80	10.48
FT16-MW4	N396181 E1624245	4	15.14	13.44	5.2 15.2	10	9.59	9.45
FT16-MW5	N396361 E1624208	4	14.08	12.04	5.04 15.04	10	8.48	8.25
FT16-MW6	N396370 E1624589	4	15.2	12.26	7.62 17.62	10	5.30	5.17
FT16-MW7	N396222 E1624644	4	14.14	11.88	5.26-15.26	10	7.94	7.66
FT16-MW8	N396145 E1624479	4	17.36	15.18	8.18- 18.18	10	9.68	9.35

BTOC = Below Top of Casing
NA = Not Available

TABLE 5-1

SOIL HEADSPACE RESULTS REPORTED IN PARTS PER MILLION (PPM)
SITE FT-16
TYNDALL AIR FORCE BASE, FLORIDA

Location I.D.	Sample Interval	OVA Reading Unfiltered	OVA Reading Filtered	OVA Reading Total
FT16-HA26	0 - 1' 2 - 3.5'	ND 400	ND 350	ND **50**
FT16-HA27	0 - 1' 2 - 3.5'	ND 4	ND 3.5	ND 0.5
FT16-HA28	0 - 1' 2 - 3.5'	ND ND	ND ND	ND ND
FT16-HA29	0 - 1' 2 - 3.5'	ND ND	ND ND	ND ND
FT16-HA30	0 - 1' 2 - 3.5'	ND ND	ND ND	ND ND
FT16-HA31	0 - 1' 2 - 3.5'	ND 600	ND 450	ND **150**
FT16-HA32	0 - 1' 2 - 3.5'	ND 2	ND ND	ND 2
FT16-HA33	0 - 1' 2 - 3.5'	ND ND	ND ND	ND ND
FT16-HA34	0- 1' 2 - 3.5'	ND ND	ND ND	ND ND
FT16-HA35	0 - 1' 2 - 3.5'	ND 290	ND 250	ND 40
FT16-HA36	0 - 1' 2 - 3.5'	ND 1,100	ND 1,100	ND ND
FT16-HA37	0 - 1' 2 - 3.5'	ND ND	ND ND	ND ND
FT16-HA38	0 - 1' 2 - 3.5'	ND 35	ND 35	ND ND
FT16-HA39	0 - 1' 2 - 3.5'	ND ND	ND ND	ND ND
FT16-HA40	0 - 1' 2 - 3.5'	ND ND	ND ND	ND ND
FT16-HA41	0 - 1' 2 - 3.5'	ND 25	ND 25	ND ND

ND = NON DETECT
Bold = At or above 50 ppm, FAC 62-770.200(2)

TABLE 5-1 (Continued)

SOIL HEADSPACE RESULTS REPORTED IN PARTS PER MILLION (ppm)
SITE FT-16
TYNDALL AIR FORCE BASE, FLORIDA

Location I.D.	Sample Interval	OVA Reading Unfiltered	OVA Reading Filtered	OVA Reading Total
FT16-HA42	0 - 1' 2 - 3.5'	ND 125	ND 22	ND **103**
FT16-HA43	0 - 1 2 -3 .5'	ND 60	ND 50	ND 10
FT16-HA44	0 - 1' 2 - 3.5'	ND ND	ND ND	ND ND
FT16-HA45	0 - 1' 2 - 3.5'	ND 150	ND 50	ND **100**
FT16-HA46	0 - 1' 2 - 3.5'	ND 250	ND 150	ND **100**
FT16-HA47	0 - 1' 2 - 3.5'	ND ND	ND ND	ND ND
FT16-HA48	0 - 1' 2 - 3.5'	ND 10	ND 5	ND 5
FT16-HA49	0 - 1' 2 - 3.5'	2 2,500	ND 1,500	2 **1,000**
FT16-HA50	0 - 1' 2 - 3.5'	ND 500	ND 350	ND **150**
FT16-HA51	0- 1' 2- 3.5'	ND ND	ND ND	ND ND
FT16-HA52	0 - 1' 2- 3.5'	ND 1,250	ND 650	ND **600**
FT16-HA53	0 - 1' 2 - 3.5'	ND ND	ND ND	ND ND
FT16-HA54	0 - 1' 2 - 3.5'	ND ND	ND ND	ND ND
FT16-HA55	0 - 1' 2 - 3.5' 4 - 5.5'	ND ND ND	ND ND ND	ND ND ND
FT16-HA56	0 - 1' 2 - 3.5' 4 - 5.5'	ND ND ND	ND ND ND	ND ND ND

ND = NON DETECT
Bold = At or above 50 ppm, FAC 62-770.200(2)

TABLE 5-1 (Continued)

SOIL HEADSPACE RESULTS REPORTED IN PARTS PER MILLION (ppm)
SITE FT-16
TYNDALL AIR FORCE BASE, FLORIDA

Location I.D.	Sample Interval	OVA Reading Unfiltered	OVA Reading Filtered	OVA Reading Total
FT16-HA57	0 - 1'	ND	ND	ND
	2 - 3.5'	ND	ND	ND
	4 - 5.5'	ND	ND	ND
FT16-HA58	0 - 1'	ND	ND	ND
	2 - 3.5'	ND	ND	ND
	4 - 5.5'	ND	ND	ND
FT16-HA59	0 - 1'	ND	ND	ND
	2- 3.5'	ND	ND	ND
	4 - 5.5'	ND	ND	ND
FT16-HA60	0 - 1'	ND	ND	ND
	2 - 3.5'	ND	ND	ND
	4 - 5.5'	50	35	15
FT16-HA61	0 - 1'	ND	ND	ND
	2 - 3.5'	ND	ND	ND
	4 - 5.5'	2,000	800	**1,200**
FT16-HA62	0 - 1'	ND	ND	ND
	2 - 3.5'	ND	ND	ND
	4 - 5.5'	1,500	600	**900**
FT16-HA63	0 - 1'	ND	ND	ND
	2 - 3.5'	ND	ND	ND
	4 - 5.5'	2,000	1,000	**1,000**
FT16-HA64	0 - 1'	ND	ND	ND
	2 - 3.5'	ND	ND	ND
	4 - 5.5'	125	50	**75**
FT16-HA65	0 - 1'	ND	ND	ND
	2 - 3.5'	ND	ND	ND
	4 - 5.5'	7,500	1,500	**6,000**
FT16-HA66	0 - 1'	ND	ND	ND
	2 - 3.5'	175	ND	**175**
	4 - 5.5'	5,000	1,500	**3,500**
FT16-HA67	0 - 1'	ND	ND	ND
	2 - 3.5'	ND	ND	ND
	4 - 5.5'	8,000	3,500	**4,500**

ND = NON DETECT
Bold = At or above 50 ppm, FAC 62-770.200(2)

TABLE 5-1 (Continued)

SOIL HEADSPACE RESULTS REPORTED IN PARTS PER MILLION (ppm)
SITE FT-16
TYNDALL AIR FORCE BASE, FLORIDA

Location I.D.	Sample Interval	OVA Reading Unfiltered	OVA Reading Filtered	OVA Reading Total
FT16-HA68	0 - 1' 2 - 3.5' 4 - 5.5'	ND ND 300	ND ND 150	ND ND **150**
FT16-HA69	0 - 1' 2 - 3.5'	ND ND	ND ND	ND ND
FT16-HA70	0 - 1' 2 - 3.5' 4 - 5.5'	ND 1,500 10,000	ND 50 3,500	ND **1,450** **6,500**
FT16-HA71	0 - 1' 2 - 3.5'	ND ND	ND ND	ND ND
FT16-HA72	0 - 1' 2 - 3.5' 4 - 5.5'	ND 7,000 10,000	ND 100 2,250	ND **6,900** **7,750**
FT16-HA73	0 - 1' 2 - 3.5'	ND 1,500	ND 400	ND **1,100**
FT16-HA74	0 - 1' 2 - 3.5' 4 -5.5'	ND ND 350	ND ND 100	ND ND **250**
FT16-HA75	0 - 1' 2 - 3.5'	ND ND	ND ND	ND ND
FT16-HA76	0 - 1' 2 - 3.5'	ND ND	ND ND	ND ND
FT16-HA77	0 - 1' 2 - 3.5' 4 - 5.5'	ND ND 1,500	ND ND 800	ND ND **700**
FT16-HA78	0 - 1' 2 - 3.5'	ND ND	ND ND	ND ND
FT16-HA79	0 - 1' 2 - 3.5'	ND 125	ND 60	ND **65**
FT16-HA80	0 - 1' 2 - 3.5'	ND ND	ND ND	ND ND
FT16-HA81	0 - 1' 2 - 3.5'	ND 20	ND 15	ND 5

ND = NON DETECT
Bold = At or above 50 ppm, FAC 62-770.200(2)

TABLE 5-1 (Continued)

SOIL HEADSPACE RESULTS REPORTED IN PARTS PER MILLION (ppm)
SITE FT-16
TYNDALL AIR FORCE BASE, FLORIDA

Location I.D.	Sample Interval	OVA Reading Unfiltered	OVA Reading Filtered	OVA Reading Total
FT16-HA95	0 - 1'	ND	ND	ND
	2 - 3.5'	4,000	350	**3,650**
	4 - 5.5'	8,000	2,800	**5,200**
FT16-HA96	0 - 1'	ND	ND	ND
	2 - 3.5'	800	150	**650**
	4 - 5.5'	7,000	200	**6,800**
FT16-HA97	0 - 1'	ND	ND	ND
	2 - 3.5'	ND	ND	ND
	4 - 5.5'	900	300	**600**
FT16-HA98	0 - 1'	ND	ND	ND
	2 - 3.5'	ND	ND	ND
	4 - 5.5'	1,500	500	**1,000**
FT16-HA99	0 - 1'	ND	ND	ND
	2 - 3.5'	120	20	**100**
FT16-HA100	0 - 1'	ND	ND	ND
	2 - 3.5'	ND	ND	ND
FT16-HA101	0 - 1'	ND	ND	ND
	2 - 3.5'	ND	ND	ND
	4 - 5.5'	2,000	150	**1,850**
FT16-HA102	0 - 1'	ND	ND	ND
	2 - 3.5'	ND	ND	ND
	4 - 5.5'	700	50	**650**
FT16-HA103	0 - 1'	ND	ND	ND
	2 - 3.5'	ND	ND	ND
	4 - 5.5'	ND	ND	ND
FT16-HA104	0 - 1'	ND	ND	ND
	2 - 3.5'	ND	ND	ND
	4 - 5.5'	ND	ND	ND
FT16-HA105	0 - 1'	ND	ND	ND
	2 - 3.5'	ND	ND	ND
	4 - 5.5'	ND	ND	ND
FT16-HA106	0 - 1'	ND	ND	ND
	2 - 3.5'	ND	ND	ND
	4 -5.5'	ND	ND	ND

ND = NON DETECT
Bold = At or above 50 ppm, FAC 62-770.200(2)

TABLE 5-1 (Continued)

SOIL HEADSPACE RESULTS REPORTED IN PARTS PER MILLION (ppm)
SITE FT-16
TYNDALL AIR FORCE BASE, FLORIDA

Location I.D.	Sample Interval	OVA Reading Unfiltered	OVA Reading Filtered	OVA Reading Total
FT16-HA107	0 - 1'	ND	ND	ND
	2 - 3.5'	ND	ND	ND
	4 - 5.5'	150	50	**100**
FT16-HA108	0 - 1'	ND	ND	ND
	2 - 3.5'	ND	ND	ND
	4 - 5.5'	ND	ND	ND
	6 - 7.5'	ND	ND	ND
FT16-HA109	0 - 1'	ND	ND	ND
	2 - 3.5'	ND	ND	ND
	4 - 5.5'	ND	ND	ND

ND = NON DETECT
Bold = At or above 50 ppm, FAC 62-770.200(2)

TABLE 5-2
Soil Analytical Results Above Method Quantification Limits
FT-16
Tyndall Air Force Base, Florida

PARAMETER	SAMPLE I.D., DATE SAMPLED, AND RESULTS									
	FT16HA26 (2-3.5')	FT16HA26D (2-3.5')	FT16HA26S (2-3.5')	FT16HA42 (2-3.5')	FT16HA45 (2-3.5')	FT16HA46 (2-3.5')	FT16HA49 (2-3.5')	FT16HA61 (4-5.5')	FT16HA65 (4-5.5')	FT16HA74 (4-5.5')
	9/6/95	9/6/95	9/6/95	9/8/95	9/8/95	9/8/95	9/8/95	9/11/95	9/14/95	9/12/95
VOLATILES (ppb)										
Ethylbenzene	<6.03	<5.95	6.22	<6.07	<5.95	<5.93	<5.88	4580	<2780	<6.11
Methylene Chloride	<6.03	<5.95	4.98B	<6.07	<5.95	<5.93	<5.88	<2860	<2780	<6.11
Total Xylenes	<6.03	<5.95	48.5	<6.07	<5.95	<5.93	<5.88	32000	<2780	<6.11
Total Volatiles	<6.03	<5.95	59.7	<6.07	<5.95	<5.93	<5.88	36580	<2780	<6.11
OVA (ppm)	50	50	50	103	110	100	1000	1200	6000	250
SEMIVOLATILES (ppb)										
Anthracene	<420	<410	<410	<410	<390	<400	<390	<390	170J	<400
Acenaphthene	<420	<410	<410	<410	<390	<400	<390	<390	740J	<400
Dibenzofuran	<420	<410	<410	<410	<390	<400	<390	<390	490J	<400
Fluorene	<420	<410	<410	<410	<390	<400	<390	<390	770J	<400
Phenanthrene	<420	<410	<410	<410	<390	<400	<390	<390	1300J	<400
Carbazole	<420	<410	<410	<410	<390	<400	<390	<390	210J	<400
Fluoranthene	<420	<410	<410	<410	<390	<400	<390	<390	800J	<400

S = USACE Split Sample
D = Duplicate Sample
BMQL = Below Method Quantification Limit
B = Found in Method Balnk
J = Laboratory Estimated value

TABLE 5-2 (Continued)
Soil Analytical Results Above Method Quantification Limits
FT-16
Tyndall Air Force Base, Florida

PARAMETER	SAMPLE I.D., DATE SAMPLED, AND RESULTS									
	FT16HA26 (2-3.5')	FT16HA26 DUP (2-3.5')	FT16HA26S (2-3.5')	FT16HA42 (2-3.5')	FT16HA45 (2-3.5')	FT16HA46 (2-3.5')	FT16HA49 (2-3.5')	FT16HA61 4-6.5')	FT16HA65 (4-6.5')	FT16HA74 (4-5.5')
	9/6/95	9/6/95	9/6/95	9/8/95	9/8/95	9/8/95	9/8/95	9/11/95	9/14/95	9/12/95
SEMIVOLATILES **(ppb)(Continued)**										
Pyrene	<420	<410	<410	<410	<390	<400	<390	<390	600J	<400
Diethylphthalate	<420	<410	<410	<410	<390	<400	<390	<390	<1600	41J
Naphthalene	<420	<410	<410	<410	<390	<400	<390	260J	2800	<400
2-Methylnaphthalene	<420	<410	<410	<410	<390	<400	<390	720	7100	<400
Total PAH	BMQL	BMQL	BMQL	BMQL	BMQL	BMQL	BMQL	980	14980J	41J
TRPH **(ppm)**	19.3	<8.93	<12.4	1030	<8.33	727	29.2	1340	6320	<9.17
METALS **(ppm)**										
Barium	<2.5	<2.5	<1.2	<2.3	<2.1	<2.1	2.5B	2.6B	3.5B	2.9B
Selenium	<0.39	<0.4	<1.2	<0.36	<0.33	<0.33	<0.39	0.37B	0.44B	0.38B
Cadmium	<0.09	<0.09	<1.2	<0.08	<0.07	<0.07	<0.09	<0.07	0.13B	<0.08
Chromium	1.2	0.82B	<1.2	1.3	1.3	1.1	1.5	1.8	2.1	2.3
Lead	1.3	0.86	<1.2	9.2	0.79	1.1	1.3	3.6	3.3	2.1

S = USACE Split Sample
D = Duplicate Sample
BMQL = Below Method Quantification Limit
B = Found in Method Blank
J = Laboratory Estimated Value

TABLE 5-3
Groundwater Analytical Results Above Method Quantification Limits
Site FT-16 Tyndall Air Force Base, Florida

PARAMETER	SAMPLE I.D., DATE SAMPLED AND RESULT								
	FT16MW-1	FT16MW-1D	FT16DMW-1	FT16MW-2	FT16DMW-2	FT16MW-3	FT16MW-4	MCLS$^{(1)}$	MCLS$^{(2)}$
	9/26/95	9/26/95	9/22/95	9/20/95	9/20/95	9/21/95	9/25/95		
***HALOGENATED VOLATILES* (ppb)**									
Chloroform	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	—	6
1,1-Dichloroethane	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	—	700
Trichloroethene (TCE)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	10	—	3
***AROMATIC VOLATILES* (ppb)**									
Benzene	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	**73**	1	1
Ethylbenzene	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	27	—	30 *
Toluene	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	**64**	—	40 *
Total Xylenes	<1.0	<1.0	1.3	<1.0	<1.0	<1.0	**397**	—	20 *
Total Aromatic Volatiles	<1.0	<1.0	1.3	<1.0	<1.0	<1.0	**661**	50	—
***SEMIVOLATILE* (ppb)**									
Naphthalene	<10	<10	<10	<10	<10	<10	**29**	—	6.8$^{(3)}$
2-Methylnaphthalene	<10	<10	<10	<10	<10	<10	18	—	NA
Total Napthalene	BMQL	BMQL	BMQL	BMQL	BMQL	BMQL	47	100	—
***TRPH* (ppb)**	<400	<400	<400	<400	<400	<400	2780	5000	—
***PESTICIDES & PCB's* (ppb)**	BMQL	BMQL	BMQL	BMQL	BMQL	BMQL	BMQL	—	—
***METALS* (ppm)**									
Lead	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.003	0.05	0.015

TRPH	=	Total Recoverable Petroleum Hydrocarbons
(1)	=	Petroleum Contamination Site Cleanup Criteria, FDEP 62-770.730(5)
(2) *	=	FDEP Groundwater Guidance Concentrations; * an asterisk indicates a secondary standard.
(3)	=	Organoleptic
BMQL	=	Below Method Quantification Limits
D	=	Duplicate Sample
NA	=	None Available
Shade/Bold	=	Exceeds a Regulatory Threshold

TABLE [illegible] (Continued)
Groundwater Analytical Results Above Method Quantification Limits
Site FT-16 Tyndall Air Force Base, Florida

PARAMETER	SAMPLE I.D., DATE SAMPLED AND RESULT								
	FT16MW-5	FT16MW-5D	FT16MW-6	FT16MW-6D	FT16MW-6S	FT16MW-7	FT16MW-7D	MCLS$^{(1)}$	MCLS$^{(2)}$
	9/21/95	9/21/95	9/25/95	9/26/95	9/25/95	9/22/95	9/22/95		
HALOGENATED VOLATILES **(ppb)**									
Chloroform	<1.0	<1.0	<1.0	1.6	<1.0	<1.0	<1.0	—	6
1,1-Dichloroethane	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	—	700
Trichloroethene (TCE)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	—	3
AROMATIC VOLATILES **(ppb)**									
Benzene	<1.0	<1.0	**1.1**	**1.5**	**16.8**	<1.0	<1.0	1	1
Ethylbenzene	<1.0	<1.0	<1.0	<1.0	13.4	<1.0	<1.0	—	30 *
Toluene	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	—	40 *
Total Xylenes	<1.0	<1.0	<1.0	<1.0	1.5	<1.0	1.3	—	20 *
Total Aromatic Volatiles	<1.0	<1.0	1.1	1.5	31.7	<1.0	1.3	50	—
SEMIVOLATILE **(ppb)**									
Naphthalene	<10	<10	<10	<10	<10	<10	<10	—	6.8$^{(3)}$
2-Methylnaphthalene	<400	<10	<10	<10	<10	<10	<10	—	NA
Total Napthalene	BMQL	BMQL	BMQL	BMQL	BMQL	BMQL	BMQL	100	—
TRPH **(ppb)**	<400	<400	<400	<400	140	<400	<400	5000	—
PESTICIDES & PCB's **(ppb)**	BMQL	BMQL	BMQL	BMQL	BMQL	BMQL	BMQL	—	—
METALS **(ppm)**									
Lead	0.010	0.006	**0.023**	**0.028**	**0.033**	0.002	0.001	0.05	0.015

TRPH	=	Total Recoverable Petroleum Hydrocarbons
(1)	=	Petroleum Contamination Site Cleanup Criteria, FDEP 62-700.730 (5)
(2) *	=	FDEP Groundwater Guidance Concentrations; * an asterisk indicates a secondary standard.
(3)	=	Organoleptic
BMQL	=	Below Method Quantification Limits
D	=	Duplicate Sample
NA	=	None Available
Shade/Bold	=	Exceeds a Regulatory Threshold

TABLE 5-3 (Continued)
Groundwater Analytical Results Above Method Quantification Limits
Site FT-16 Tyndall Air Force Base, Florida

PARAMETER	SAMPLE I.D., DATE SAMPLED AND RESULT								
	FT16MW-8	FT16MW-8D	T10-1	T10-2	T10-2D	T10-3	SBMW-1	MCLS$^{(1)}$	MCLS$^{(2)}$
	9/21/95	9/21/95	9/20/95	9/26/95	9/26/95	9/20/95	9/20/95		
HALOGENATED VOLATILES **(ppb)**									
Chloroform	5.0	5.0	<1.0	<1.0	<1.0	<1.0	<1.0	—	6
1,1-Dichloroethane	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	—	700
Trichloroethene (TCE)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	—	3
AROMATIC VOLATILES **(ppb)**									
Benzene	**4.7**	**3.6**	<1.0	**4.9**	**1.3**	<1.0	<1.0	1	1
Ethylbenzene	**59**	1.2	<1.0	<1.0	<1.0	<1.0	29	—	30 *
Toluene	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	—	40 *
Total Xylenes	**110**	**118.3**	<1.0	<1.0	<1.0	<1.0	**100**	—	20 *
Total Aromatic Volatiles	**173.7**	**123.1**	<1.0	4.9	1.3	<1.0	**129**	50	—
SEMIVOLATILE **(ppb)**									
Naphthalene	<10	<10	<10	<10	<10	<10	<1.0	—	6.8$^{(3)}$
2-Methylnaphthalene	<10	<10	<10	<10	<10	<10	<1.0	—	NA
Total Napthalene	BMQL	BMQL	BMQL	BMQL	BMQL	BMQL	BMQL	100	—
TRPH **(ppb)**	<400	<400	<400	<400	<400	<400	<400	5000	—
PESTICIDES & PCB's **(ppb)**	BMQL	BMQL	BMQL	BMQL	BMQL	BMQL	BMQL	—	—
METALS **(ppm)**									
Lead	0.001	0.001	**3.0**	<0.001	0.004	<0.001	0.005	0.05	0.015

TRPH	=	Total Recoverable Petroleum Hydrocarbons
(1)	=	Petroleum Contamination Site Cleanup Criteria, FDEP 62-700-730 (5)
(2) *	=	FDEP Groundwater Guidance Concentrations; * an asterisk indicates a secondary standard.
(3)	=	Organoleptic
BMQL	=	Below Method Quantification Limits
D	=	Duplicate Sample
NA	=	None Available
Shade/Bold	=	Exceeds a Regulatory Threshold

TABLE 5-3(Continued)
Groundwater Analytical Results Above Method Quantification Limits
Site FT-16 Tyndall Air Force Base, Florida

PARAMETER	SAMPLE I.D., DATE SAMPLED AND RESULT			
	SBMW-2	SBMW-3	MCLS$^{(1)}$	MCLS$^{(2)}$
	9/22/95	9/25/95		
HALOGENATED VOLATILES (ppb)				
Chloroform	<1.0	<1.0	—	6
1,1-Dichloroethane	5.8	1.5	—	700
Trichloroethene (TCE)	<1.0	<1.0	—	3
AROMATIC VOLATILES (ppb)				
Benzene	**9.8**	**48**	1	1
Ethylbenzene	64	73	—	30 *
Toluene	6.4	<1.0	—	40 *
Total Xylenes	2.5	4.6	—	20 *
Total Aromatic Volatiles	**82.7**	**125.6**	50	—
SEMIVOLATILE (ppb)				
Naphthalene	<10	**68**	—	6.8$^{(3)}$
2-Methylnaphthalene	<10	13	—	NA
Total Napthalene	BMQL	BMQL	100	—
TRPH (ppb)	1330	466	5000	—
PESTICIDES & PCB's (ppb)	BMQL	BMQL	—	
METALS (ppm)				
Lead	0.005	0.003	0.05	0.015

TRPH = Total Recoverable Petroleum Hydrocarbons
(1) = Petroleum Contamination Site Cleanup Criteria, FDEP 62-770.730(5)
(2)* = FDEP Groundwater Guidance Concentrations; * an asterisk indicates a secondary standard.
(3) = Organoleptic
BMQL = Below Method Quantification Limits
D = Duplicate Sample
NA = None Available
Shade/Bold = Exceeds a Regulatory Threshold

TABLE 5-4
SURFACE WATER ANALYTICAL RESULTS
SITE FT-16, TYNDALL AIR FORCE BASE, FLORIDA

PARAMETER	SAMPLE ID, DATE SAMPLED AND RESULTS						
	FT16SW-1	FT16SW-2	FT16SW-2D	FT16SW-2S	FT16SW-3	SURFACE WATER STANDARDS	
	9/18/95	9/18/95	9/18/95	9/18/95	9/18/95	EPA (1)	FLORIDA (2)
HALOGENATED VOLATILES(ppb)	BMQL	BMQL	BMQL	BMQL	BMQL	—	—
AROMATIC VOLATILES(ppb)	BMQL	BMQL	BMQL	BMQL	BMQL	—	—
SEMIVOLATILES (ppb)	BMQL	BMQL	BMQL	BMQL	BMQL	—	—
TRPH(ppm)	<0.4	<0.4	<0.4	0.63	<0.4	NA	NA
METALS (ppm)							
Lead	<0.001	0.001	0.005	<0.003	0.001	0.05	0.0056

(1) = Environmental Protection Agency (EPA) Maximum Contaminant Levels, Ambient Water Quality Criteria, Public Health Effects.
(2) = Florida Surface Water Standards, Florida Administrative Code, Title 62, Department of Environmental Regulation, Chapter 62-302, Class III Classification
BMQL = Below Method Quantification Limit
NA = None Available
J = Laboratory Estimated Value
D = Duplicate Sample
S = USACE Split Sample

TABLE 5-5
SEDIMENT ANALYTICAL RESULTS
SITE FT-16, TYNDALL AIR FORCE BASE, FLORIDA

PARAMETER	SAMPLE ID, DATE SAMPLED AND RESULTS						
	FT16SD-1	FT16SD-2	FT16SD-2D	FT16SD-2S	FT16SD-3	SEDIMENT STANDARDS	
	9/18/96	9/18/96	9/18/96	9/18/96	9/18/96	EPA [1]	FLORIDA [2]
HALOGENATED VOLATILES(ppb)	BMQL	BMQL	BMQL	BMQL	BMQL	—	—
AROMATIC VOLATILES(ppb)	BMQL	BMQL	BMQL	BMQL	BMQL	—	—
SEMIVOLATILES (ppb)	BMQL	BMQL	BMQL	BMQL	BMQL	—	—
Benzo(a)anthracene	<490	92J	<430	<430	<420	330	74.8
Benzo(a)pyrene	<490	79J	<430	<430	<420	330	88.8
Benzo(b)fluoranthene	67J	97J	<430	<430	<420	NA	NA
Benzo(k)fluoranthene	53J	82J	<430	<430	<420	NA	NA
Chrysene	51J	92J	<430	<430	<420	330	108
Fluoranthene	56J	180J	<430	<430	<420	380	113
Phenanthrene	<490	110J	<430	<430	<420	330	86.7
Pyrene	120J	130J	<430	<430	<420	330	153
TRPH(ppm)	<9.99	<9.46	<9.74	64.6	<9.09	NA	NA
METALS (ppm)							
Lead	5.4	36.6	42.4	38.50	1.3	21	30.2

(1) = Draft EPA Region IV Waste Management Division, Sediment Screening Values for Hazardous Waste Sites
(2) = Approach to the Assessment of Sediment Quality in Florida Coastal Waters. Threshold Effect Level Equivalents.
BMQL = Below Method Quantification Limit
NA = None Available
J = Laboratory Estimated Value
D = Duplicate Sample
S = USACE Split Sample

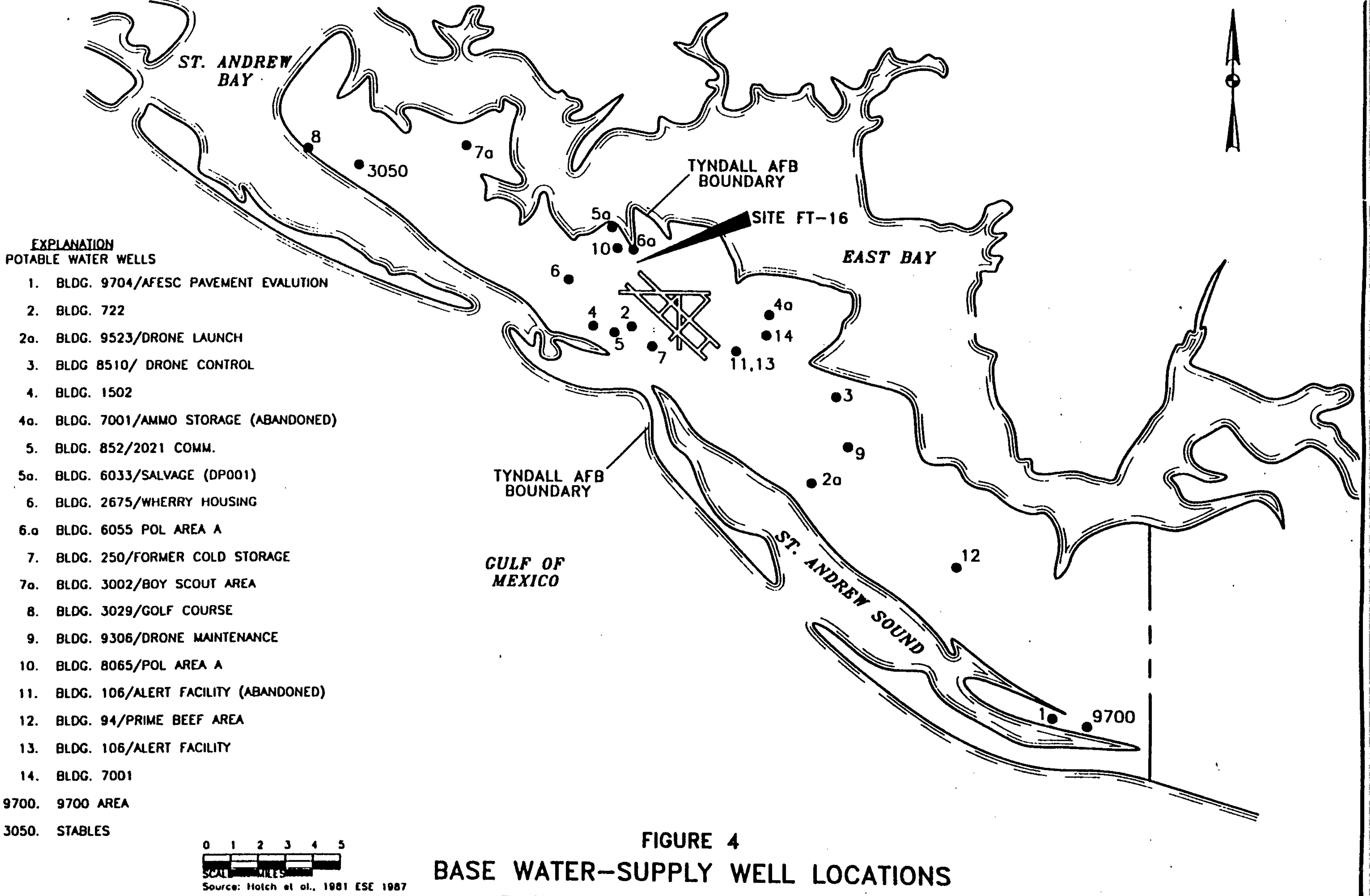
TABLE 5-6
HYDRAULIC CONDUCTIVITY (SLUG) TEST RESULTS
SITE FT-16
TYNDALL AIR FORCE BASE, FLORIDA

WELL NO.	HYDRAULIC CONDUCTIVITY			GROUNDWATER FLOW VELOCITY (FT/DAY)
	FT/SEC	FT/DAY	CM/SEC	
IN	6.30 X 10^{-6}	0.54	1.93 X 10^{-4}	0.018
OUT	1.26 X 10^{-5}	1.10	3.87 X 10^{-4}	0.037
G IN	1.96 X 10^{-5}	1.69	5.98 X 10^{-4}	0.28
G OUT	9.34 X10^{-5}	8.07	2.85 X 10^{-3}	1.35
MW-6				
SLUG IN	7.30 X 10^{-6}	0.63	2.24 X 10^{-4}	0.105
SLUG OUT	6.20 X 10^{-6}	0.53	1.89 X 10^{-4}	0.088
MW-7				
SLUG IN	1.35 X 10^{-4}	11.68	4.12 X 10^{-3}	1.9
SLUG OUT	1.92 X 10^{-4}	16.56	5.84 X 10^{-3}	2.76
MW-8				
SLUG IN	8.40 X 10^{-6}	0.72	2.57 X 10^{-4}	0.047
SLUG OUT	4.60 X 10^{-6}	0.40	1.42 X 10^{-4}	0.067
AVERAGE VALUES				
SLUG IN *	1.04 X 10^{-5}	0.895	3.18 X 10^{-4}	0.131
SLUG OUT *	2.42 X 10^{-5}	2.52	3.57 X 10^{-3}	0.62
AVERAGE HYDRAULIC * CONDUCTIVITY RESULTS/ GROUNDWATER FLOW VELOCITY	1.98 X 10^{-5}	1.71	1.94 X 10^{-3}	0.38

* Average values do not reflect results from MW-7.

FIGURES

K:\0500017\FT-16\FIG-4



EXPLANATION
POTABLE WATER WELLS

1. BLDG. 9704/AFESC PAVEMENT EVALUTION
2. BLDG. 722
2a. BLDG. 9523/DRONE LAUNCH
3. BLDG 8510/ DRONE CONTROL
4. BLDG. 1502
4a. BLDG. 7001/AMMO STORAGE (ABANDONED)
5. BLDG. 852/2021 COMM.
5a. BLDG. 6033/SALVAGE (DP001)
6. BLDG. 2675/WHERRY HOUSING
6.a BLDG. 6055 POL AREA A
7. BLDG. 250/FORMER COLD STORAGE
7a. BLDG. 3002/BOY SCOUT AREA
8. BLDG. 3029/GOLF COURSE
9. BLDG. 9306/DRONE MAINTENANCE
10. BLDG. 8065/POL AREA A
11. BLDG. 106/ALERT FACILITY (ABANDONED)
12. BLDG. 94/PRIME BEEF AREA
13. BLDG. 106/ALERT FACILITY
14. BLDG. 7001
9700. 9700 AREA
3050. STABLES

Source: Hatch et al., 1981 ESE 1987

FIGURE 4
BASE WATER-SUPPLY WELL LOCATIONS
TYNDALL AIR FORCE BASE, FLORIDA

BCM Project No. 09500017
December 1995

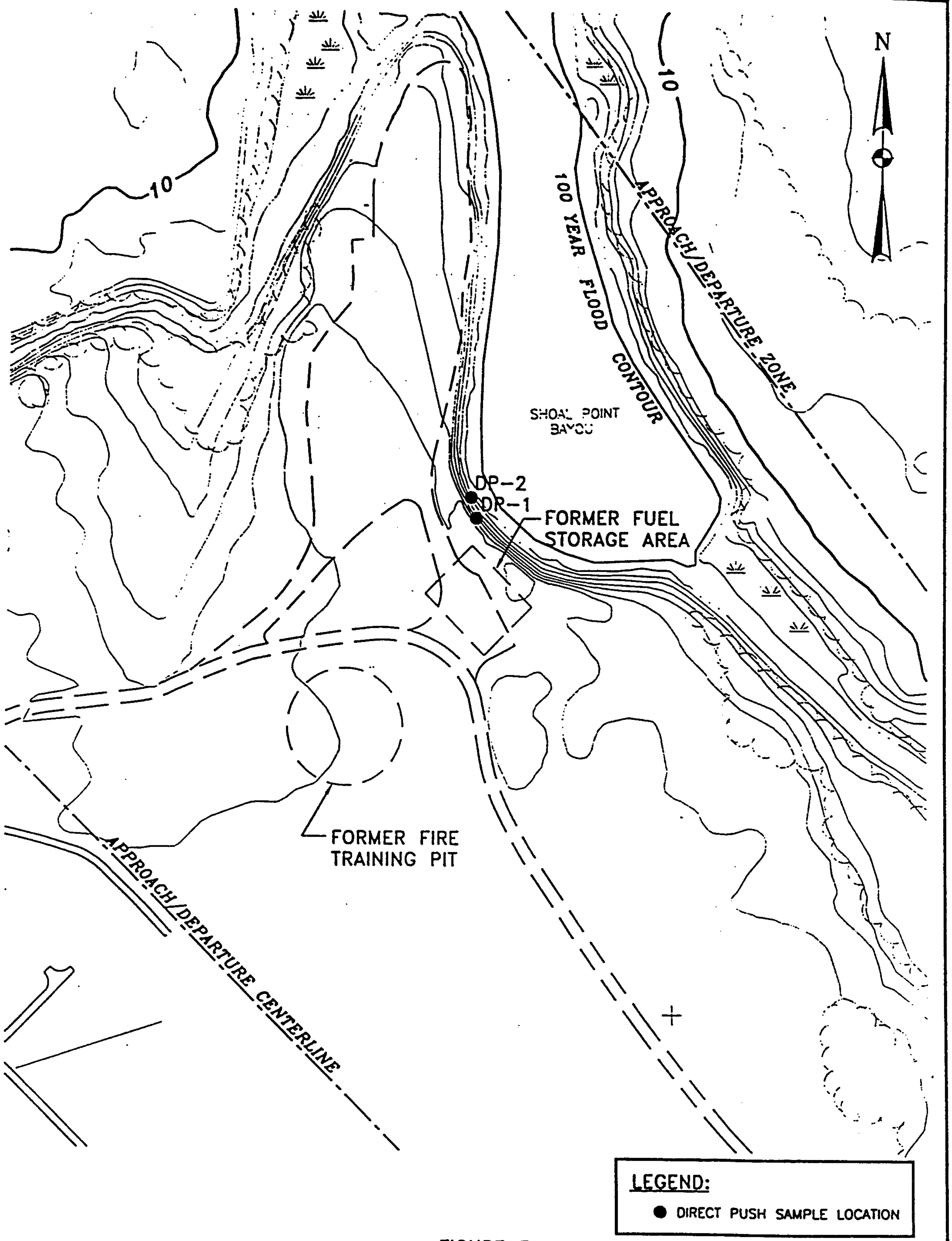
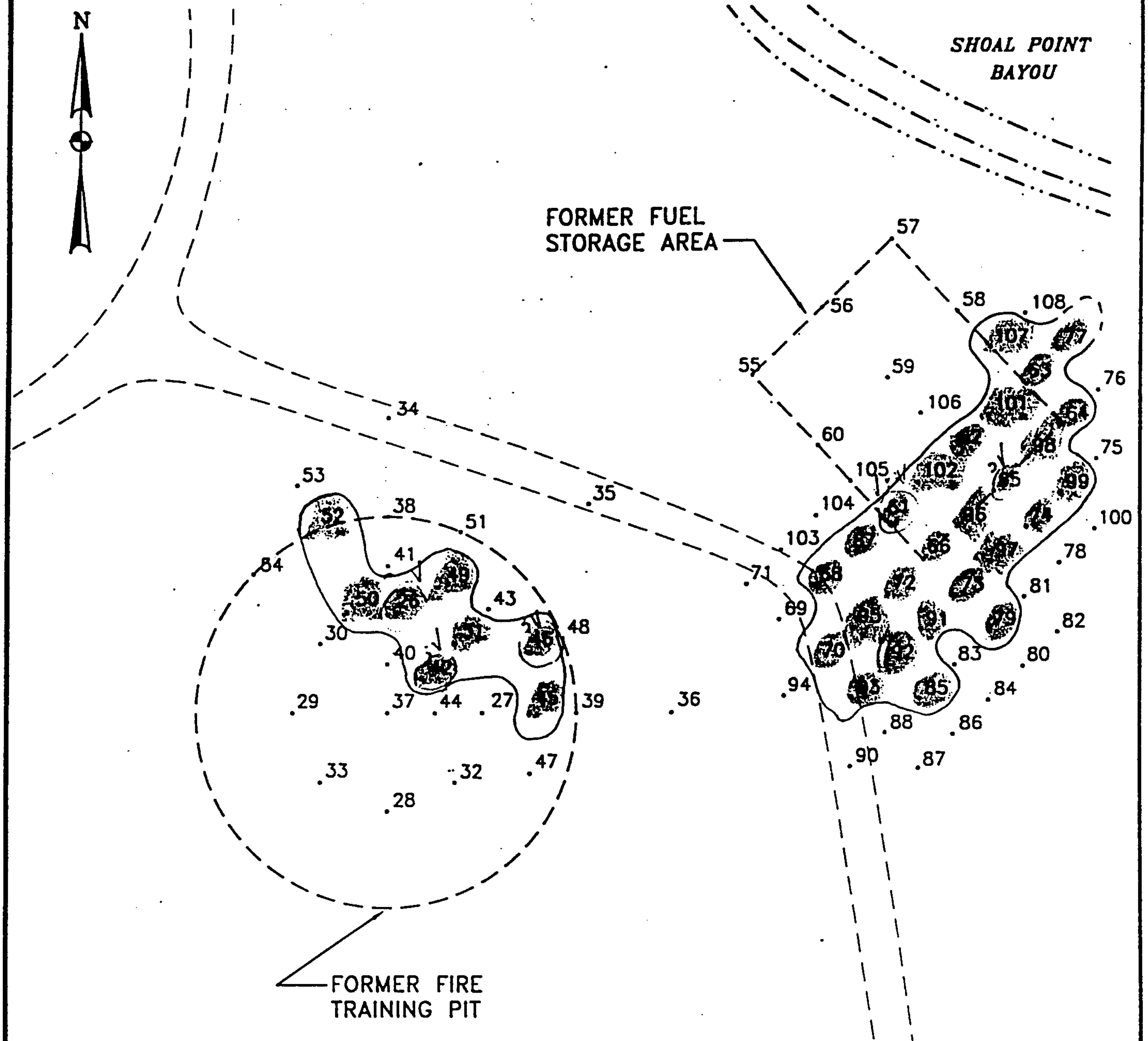


FIGURE 5
DIRECT PUSH SAMPLE LOCATIONS
SITE FT 16
TYNDALL AFB, FLORIDA
SCALE: 1" = 200'

Project No. 09-5000-17
January 1996

K:\353301\FT-16\F-5



LEGEND:
.40 HAND AUGER LOCATION

FIGURE 6

SOIL BORING LOCATION MAP

SITE FT–16
SHELL BANK FIRE TRAINING AREA

SCALE: 1" =80'

2–3.5'

BCM Project No. 09-5000-17
December 1995

K:\09500017\FT-16\FIG-6

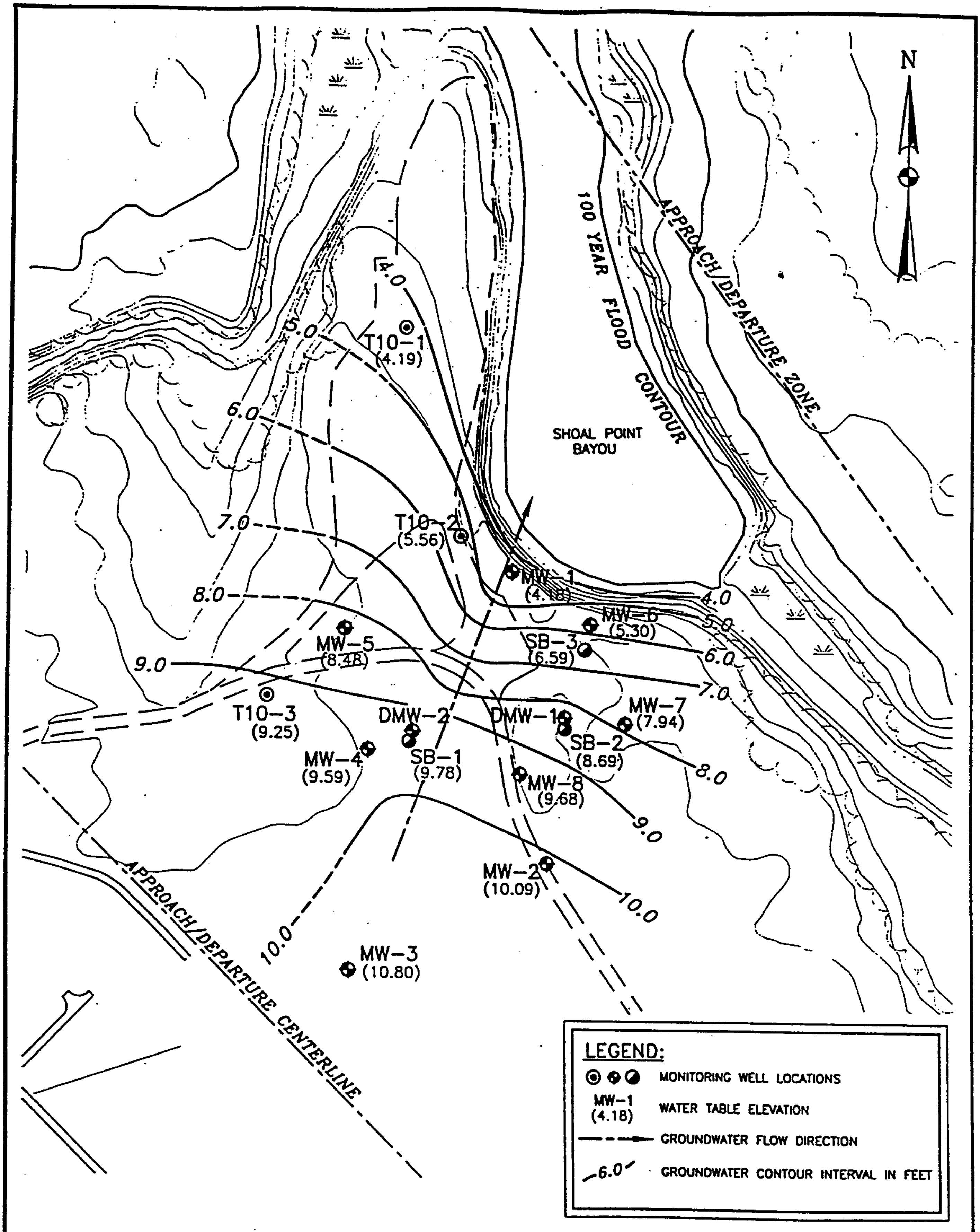


FIGURE 8
GROUNDWATER CONTOUR MAP AND FLOW DIRECTION
(9/22/95)
SITE FT 16
TYNDALL AFB, FLORIDA
SCALE: 1" = 200'

Project No. 09-5000-17
January 1996

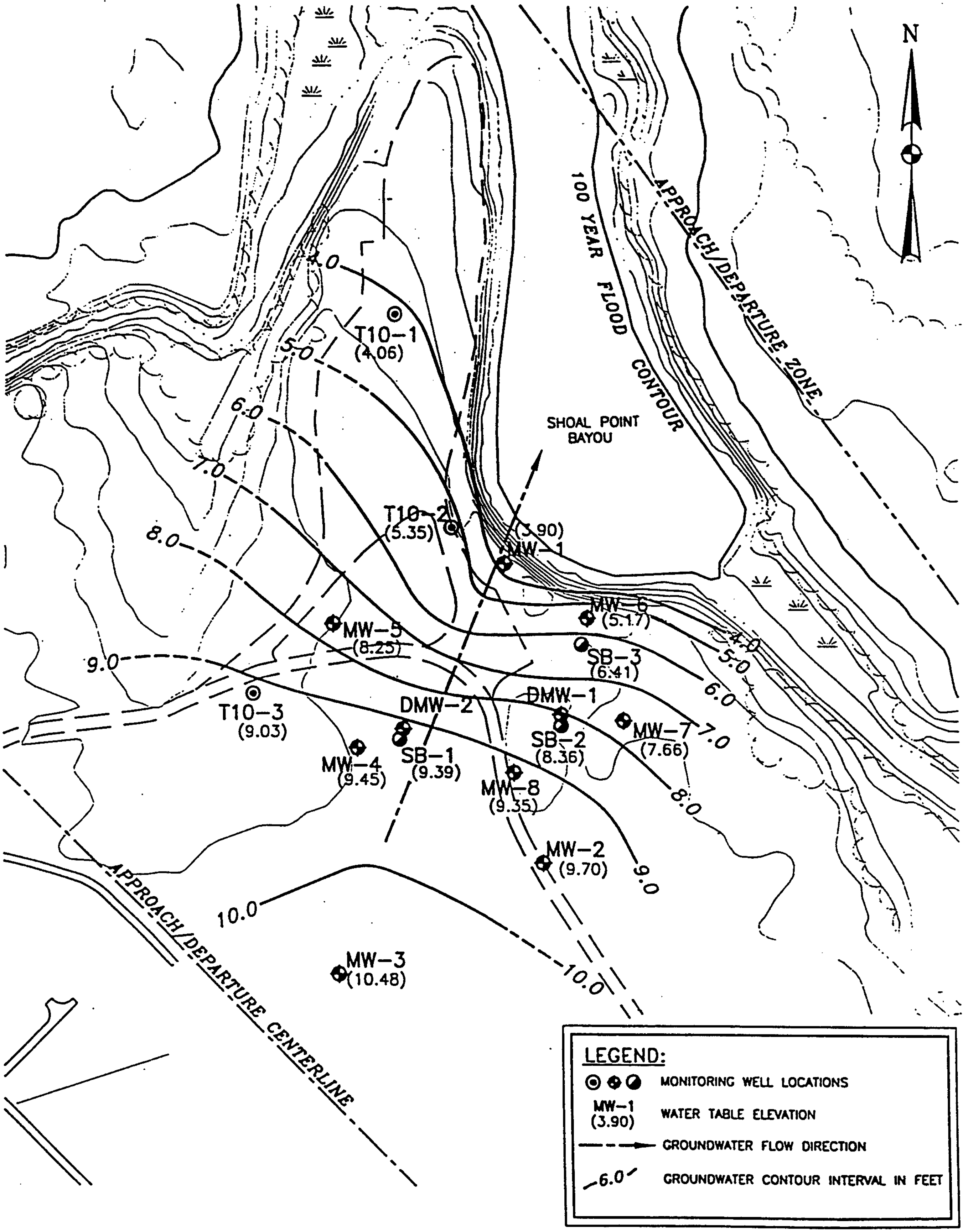


FIGURE 9

GROUNDWATER CONTOUR MAP AND FLOW DIRECTION
(10/31/95)

SITE FT 16
TYNDALL AFB, FLORIDA
SCALE: 1" = 200'

Project No. 09-5000-17
January 1996

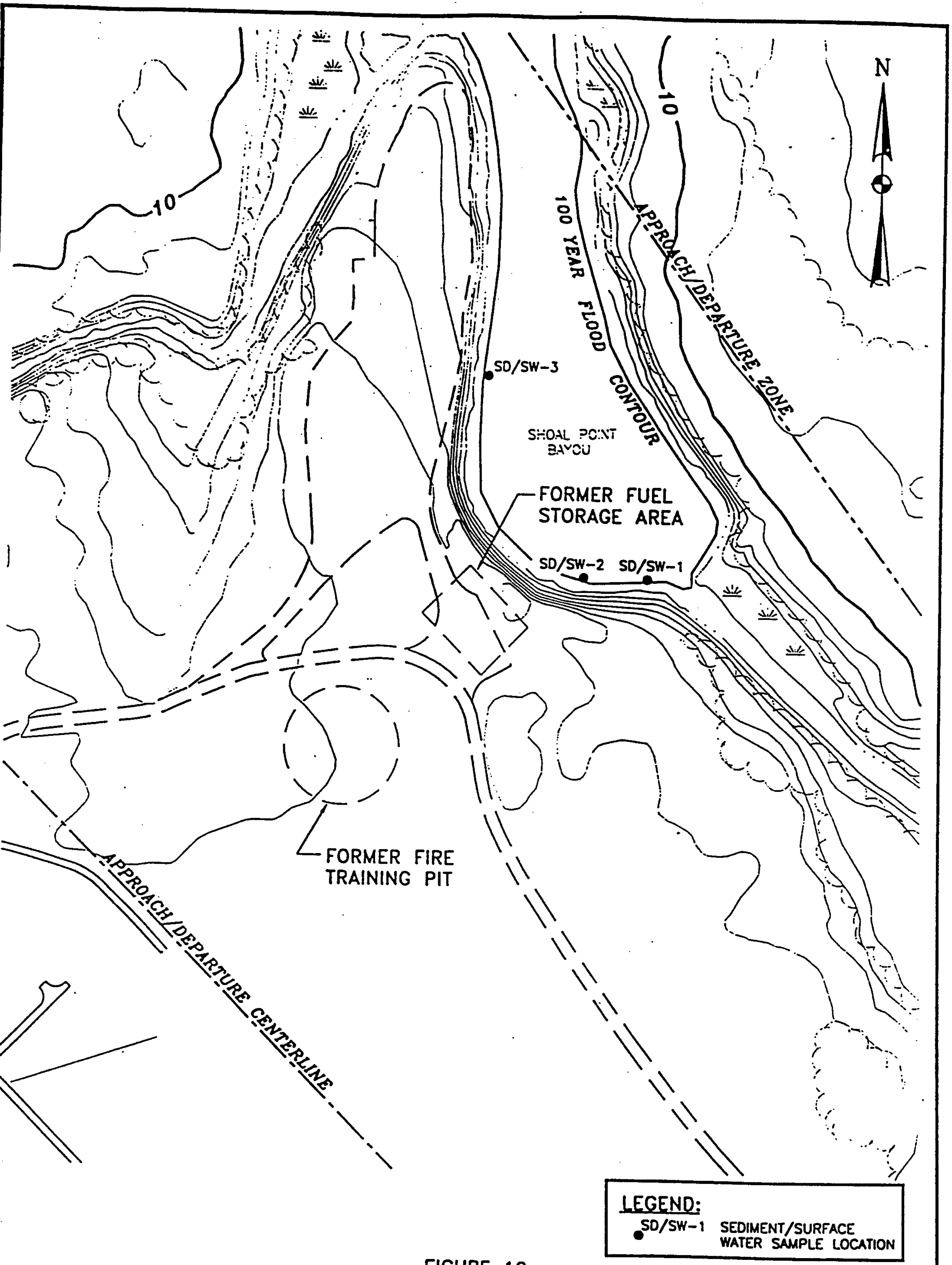
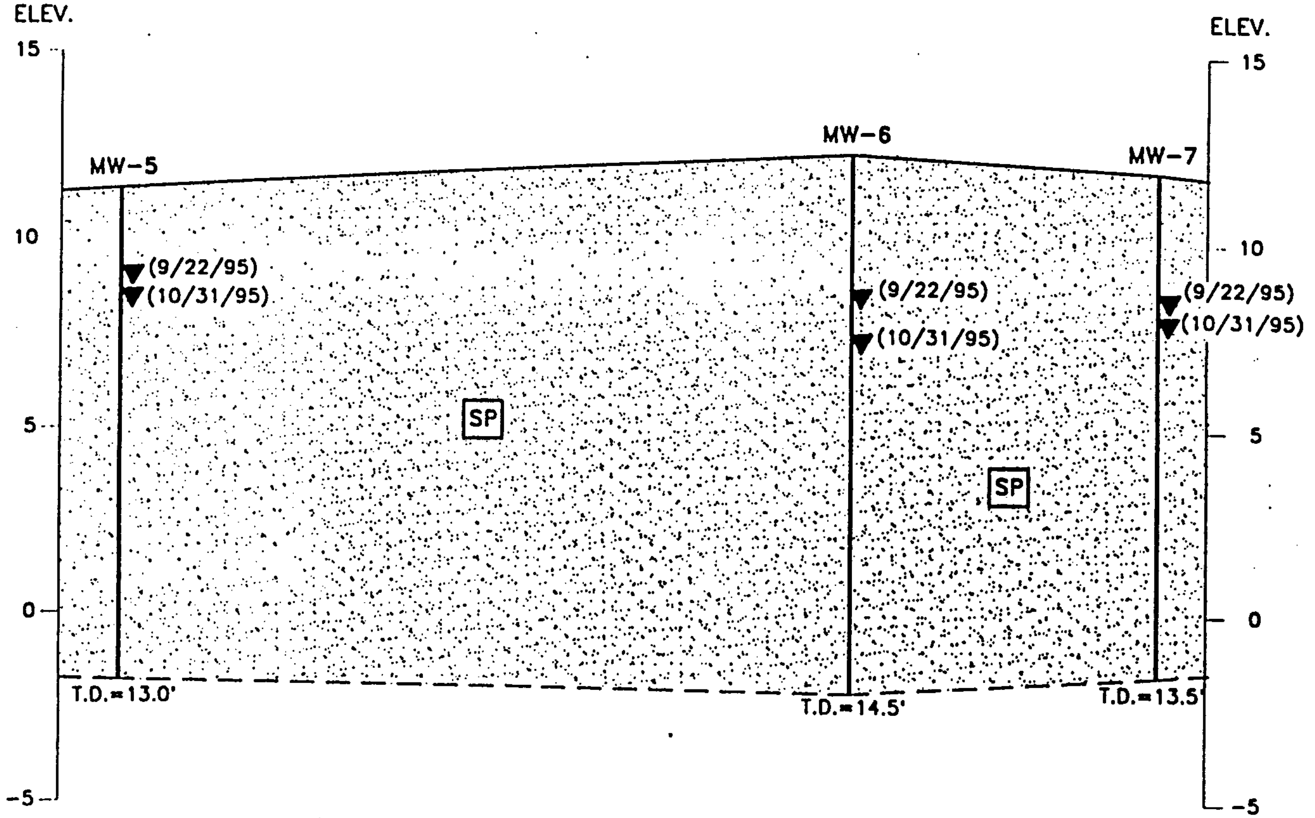


FIGURE 10
SEDIMENT/SURFACE WATER LOCATION MAP
SITE FT 16
TYNDALL AFB, FLORIDA
SCALE: 1" = 200'

Project No. 09-5000-17
January 1996

K:\0500017\FT-16\FIG-8



SCALE:
HORIZ. 1"=100'
VERT. 1"=5'

FIGURE 11
LITHOLOGIC CROSS-SECTION
SITE FT 16
TYNDALL AFB, FLORIDA

LEGEND:

SP	SAND
▼	GROUNDWATER
T.D.	TOTAL DEPTH BELOW GROUND SURFACE

Project No. 09-5000-17
December 1995

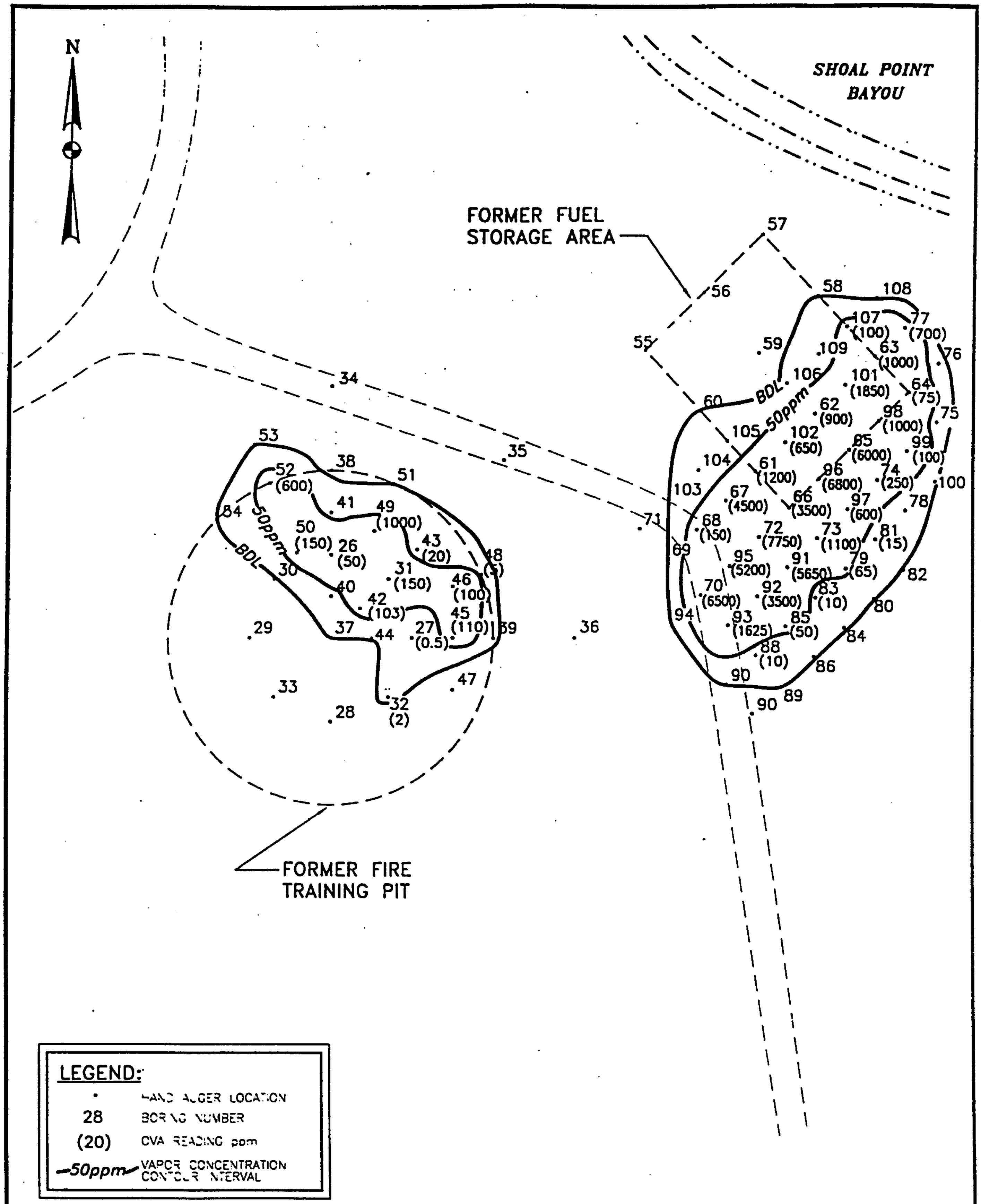


FIGURE 12

SOIL VAPOR MAP

SITE FT-16
SHELL BANK FIRE TRAINING AREA

SCALE: 1" =80'

BCM Project No. 09-5000-17
December 1995

K:\0950001\FT-16\FIG-6

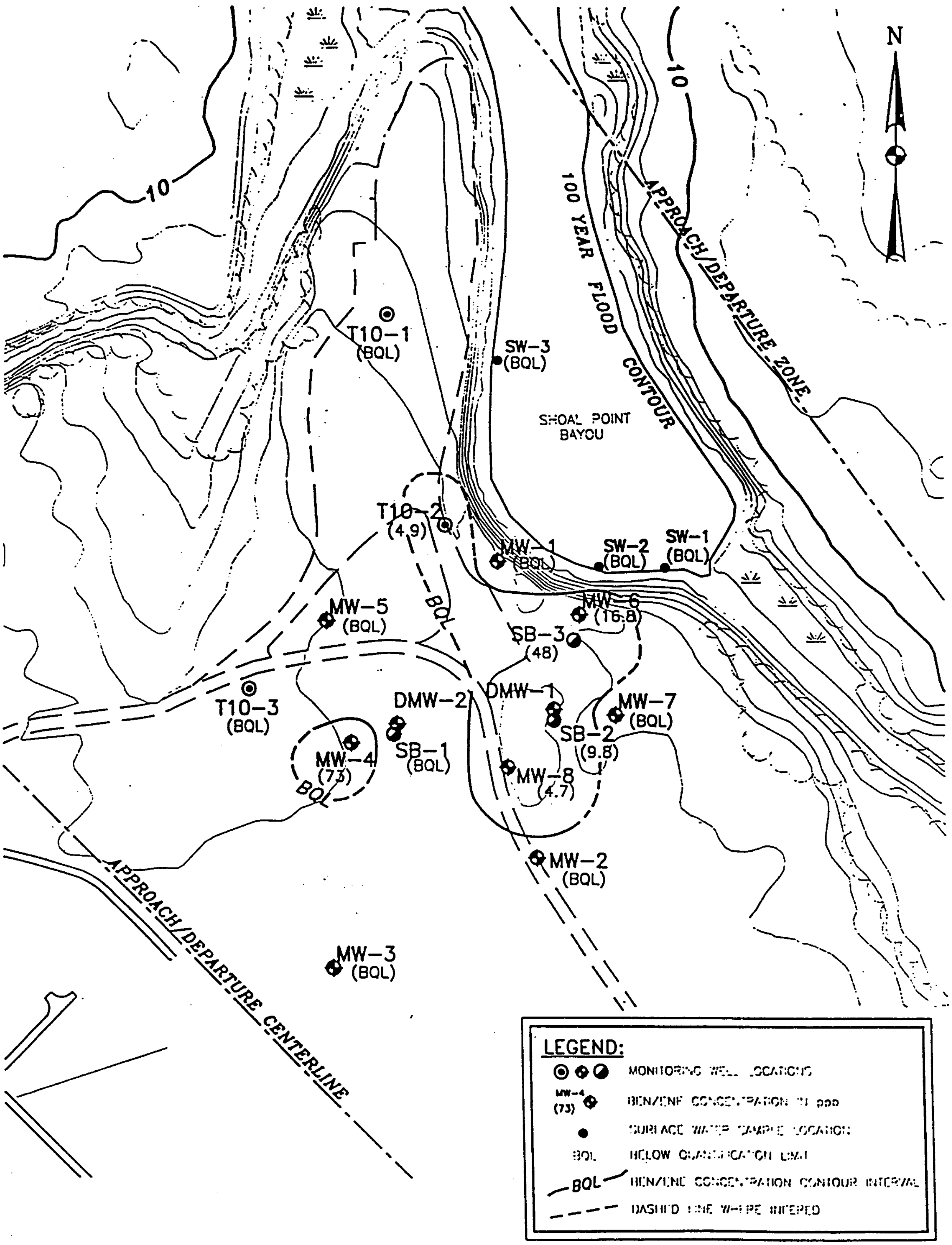


FIGURE 13
BENZENE CONCENTRATION GROUNDWATER CONTOUR MAP
SITE FT 16
TYNDALL AFB, FLORIDA
SCALE: 1" = 200'

Project No. 09-5000-17
January 1996

K:\05000.7\FT-16\

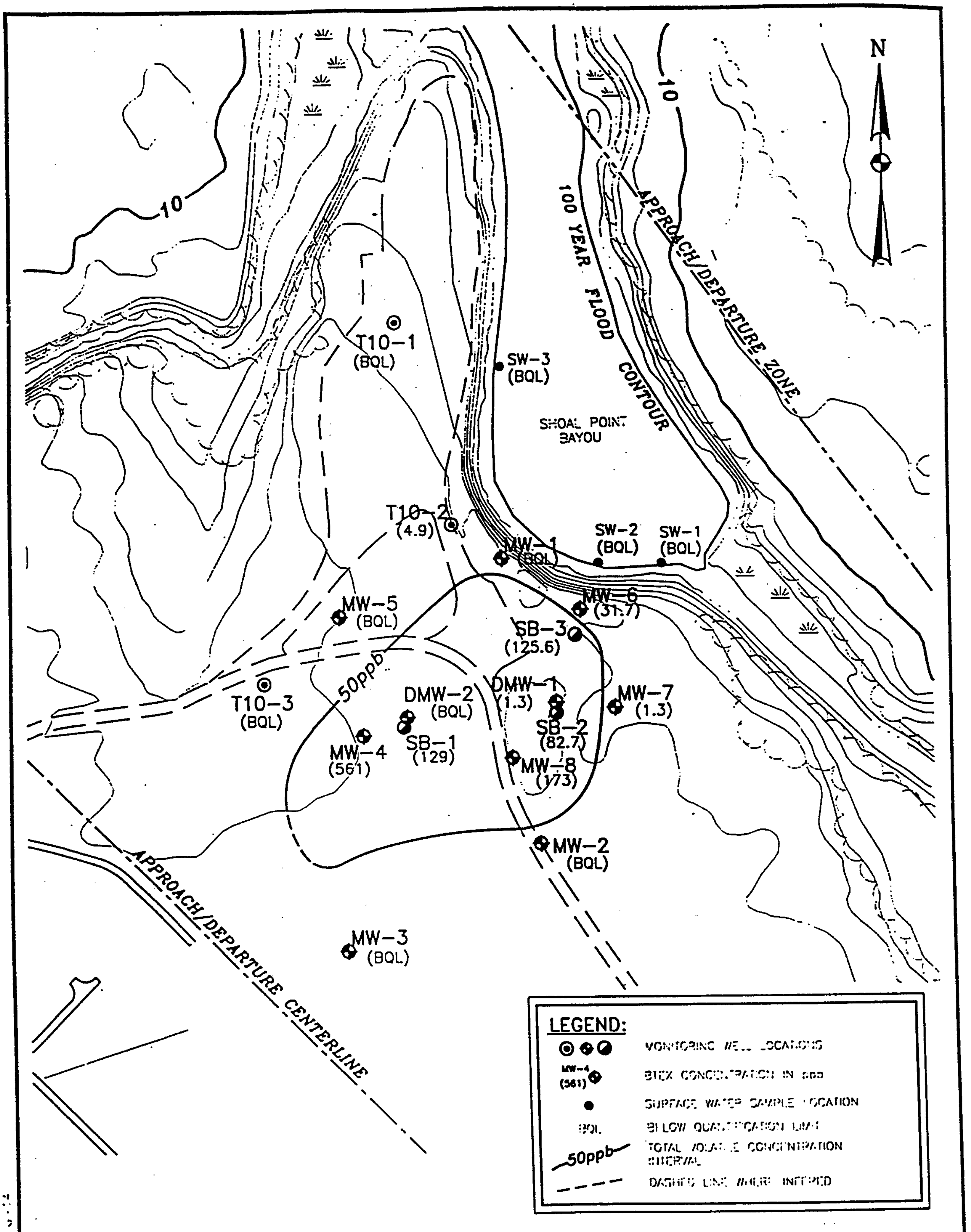


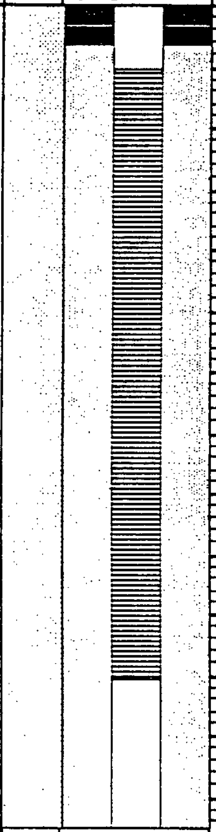
FIGURE 14
TOTAL VOLATILE CONCENTRATION GROUNDWATER CONTOUR MAP
SITE FT 16
TYNDALL AFB, FLORIDA
SCALE: 1" = 200'

Project No. 09-5000-17
January 1996

SOIL BORING LOGS/ MONITORING WELL CONSTRUCTION DIAGRAMS

BCM Engineers **Drilling/Boring Log**

Sheet: 1 of 1
roject: COE-Tyndall Supplemental Contamination Assessment
Well/Boring: FT16-MW4
Project No.: 09-5000-17
Date(s): 9/14/95
Logged By: David Britain
Well/Boring Location: N 396181.08 E 1624244.51
Drilling Method: Hollow stem auger
Drilling Contractor: Kelly Environmental Drilling
Depth to Groundwater:
Date: 9/1/95
Reference: TOC
Elevations - Ground Surface:
Inner Casing:
Outer Casing:
Water Table:
Date:
Reference: TOC
Remarks:

Depth, Sample Pt.	Sample Location	Blows	Lithologic Description	Graphical Logs Strata	Graphical Logs Well Construction	Blow Counts	Elevation
	1	n/a	SAND(SP) fine to medium, poorly sorted, sub angular to sub rounded from 4' to 11.5', light gray, dark gray, dark brown, saturated from 3' to 11.5', petroleum odor from 2' to 11.5'			N/A	
2	2					N/A	
4	3					3-6-11	
6	4					2-3-4	
8	5					3-3-4	
10	6					5-6-6	
12							
14							
16							
20							

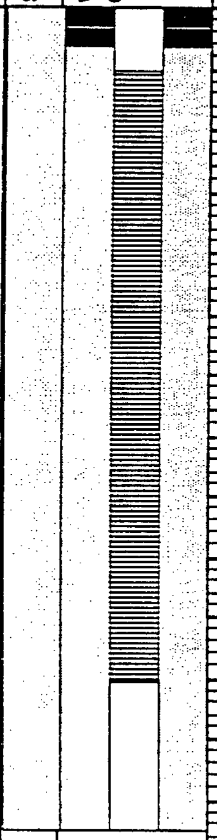
Note: Not all portions of this form are applicable to all projects

6/91

BCM Engineers **Drilling/Boring Log**

Sheet: 1 of 1
Well/Boring: FT16-MW5
Logged By: David Britain

ɔject: COE-Tyndall Supplemental Contamination Assessment
roject No.: 09-5000-17 Date(s): 9/14/95
Well/Boring Location: N 396361.29 E 1624207.93
Drilling Method: Hollow stem auger Drilling Contractor: Kelly Environmental Drilling
Depth to Groundwater: Date: 9/1/95 Reference: TOC
Elevations - Ground Surface: Inner Casing: Outer Casing:
Water Table: Date: Reference: TOC
Remarks:

Depth, Sample Pt.	Sample Location	Blows	Lithologic Description	Graphical Logs		Blow Counts	Elevation
				Strata	Well Construction		
	1	n/a	SAND(SP) fine to medium, poorly sorted, sub angular to sub rounded from 2' to 11.5', tan, dark gray, saturated from 3' to 11.5', petroleum odor from 4' to 5.5', trace of wood debris from 6' to 7.5', trace of silt from 8' to 9.5', trace of sandy clay layers from 10' to 11.5'			N/A	
2	2						
4	3					3-4-8	
6	4					5-6-8	
8	5					4-3-2	
10	6					4-5-4	
12							
14							
16							
20							

Note: Not all portions of this form are applicable to all projects

6.91

BCM Engineers

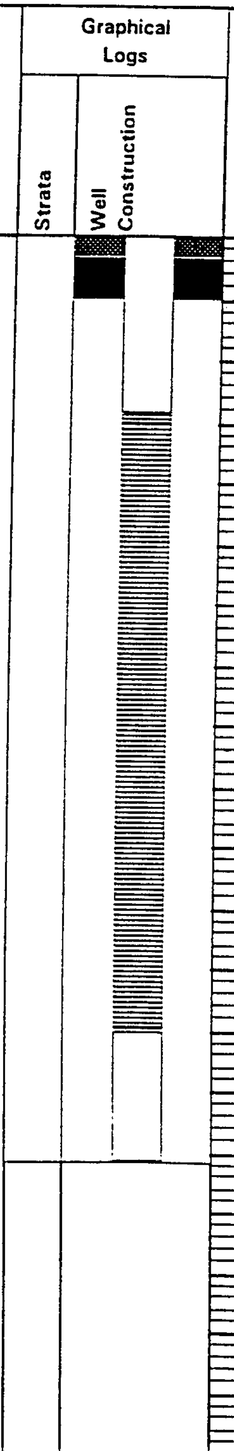
Drilling/Boring Log

Sheet: 1 of 1
Well/Boring: FT16-MW6
Logged By: David Britain

Project: COE-Tyndall Supplemental Contamination Assessment
Project No.: 09-5000-17
Date(s): 9/15/95
Well/Boring Location: N 396370.03 E 1624589.32
Drilling Method: Hollow stem auger
Drilling Contractor: Kelly Environmental Drilling
Depth to Groundwater:
Date: 9/1/95
Reference: TOC
Elevations - Ground Surface:
Inner Casing:
Outer Casing:
Water Table:
Date:
Reference: TOC
Remarks:

Depth, Sample Pt.	Sample Location	Blows	Lithologic Description	Blow Counts	Elevation
	1	n/a		N/A	
2	2			N/A	
4	3			N/A	
6	4		SAND(SP) fine to medium, poorly sorted, sub angular to sub rounded from 6' to 13.5', brown to light gray, dark gray, saturated from 5.5' to 13.5', petroleum odor from 6' to 13.5', trace of silt	2-3-4	
8	5			1-3-4	
10	6			2-2-6	
12	7			3-4-4	
14					
16					
18					
20					

Graphical Logs



Note: Not all portions of this form are applicable to all projects

6/91

BCM Engineers

Drilling/Boring Log

Sheet: 1 of 1
oject: COE-Tyndall Supplemental Contamination Assessment
Well/Boring: FT16-MW7
roject No.: 09-5000-17
Date(s): 9/15/95
Logged By: David Britain
Well/Boring Location: N 396221.52 E 1624643.80
Drilling Method: Hollow stem auger
Drilling Contractor: Kelly Environmental Drilling
Depth to Groundwater:
Date: 9/1/95
Reference: TOC
Elevations - Ground Surface:
Inner Casing:
Outer Casing:
Water Table:
Date:
Reference: TOC
Remarks:

Depth, Sample Pt.	Sample Location	Blows	Lithologic Description	Graphical Logs: Strata / Well Construction	Blow Counts	Elevation
	1				N/A	
2	2				N/A	
4	3	n/a	SAND(SP) fine to medium, poorly sorted, sub angular to sub rounded from 3' to 11.5', saturated from 3' to 11.5', light brown to tan, light gray, dark gray, no odor, trace of sandy clay layers and wood		3-6-8	
6	4				2-3-7	
8	5				3-6-8	
10	6				2-3-5	
12						
14						
16						
20						

Note: Not all portions of this form are applicable to all projects

6/91

BCM Engineers

Drilling/Boring Log

Project: COE-Tyndall Supplemental Contamination Assessment

Sheet: 1 of 1

Project No.: 09-5000-17

Date(s): 9/14/95

Well/Boring: FT16-MW8

Well/Boring Location: N 396144.99 E 1624479.29

Logged By: David Britain

Drilling Method: Hollow stem auger

Drilling Contractor: Kelly Environmental Drilling

Depth to Groundwater:

Date: 9/1/95

Reference: TOC

Elevations - Ground Surface:

Inner Casing:

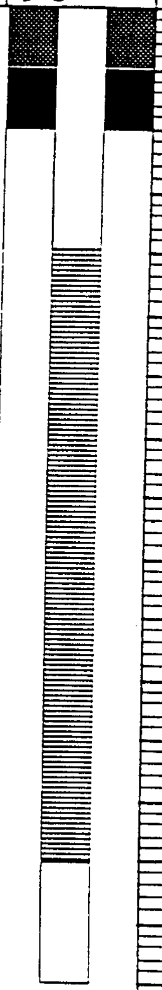
Outer Casing:

Water Table:

Date:

Reference: TOC

Remarks:



Depth, Sample Pt.	Sample Location	Blows	Lithologic Description	Strata	Well Construction	Blow Counts	Elevation
	1					N/A	
2	2					N/A	
4	3	n/a				N/A	
6	4		SAND(SP) fine to medium, poorly sorted, shell from 0 to 3.5', sub angular to sub rounded from 4' to 9.5', brown, dark gray, saturated at 5.5', petroleum odor from 4' to 11.5', trace of silt and wood debris			3-5-7	
8	5					3-3-7	
10	6					5-7-5	
12	7					4-6-8	
14	8					5-6-7	
16	9		SILTY SAND(SP) fine to medium, poorly sorted, dark gray, soft, no odor, trace of sandy clay layers			4-6-6	
18							
20							

Note: Not all portions of this form are applicable to all projects

6/91

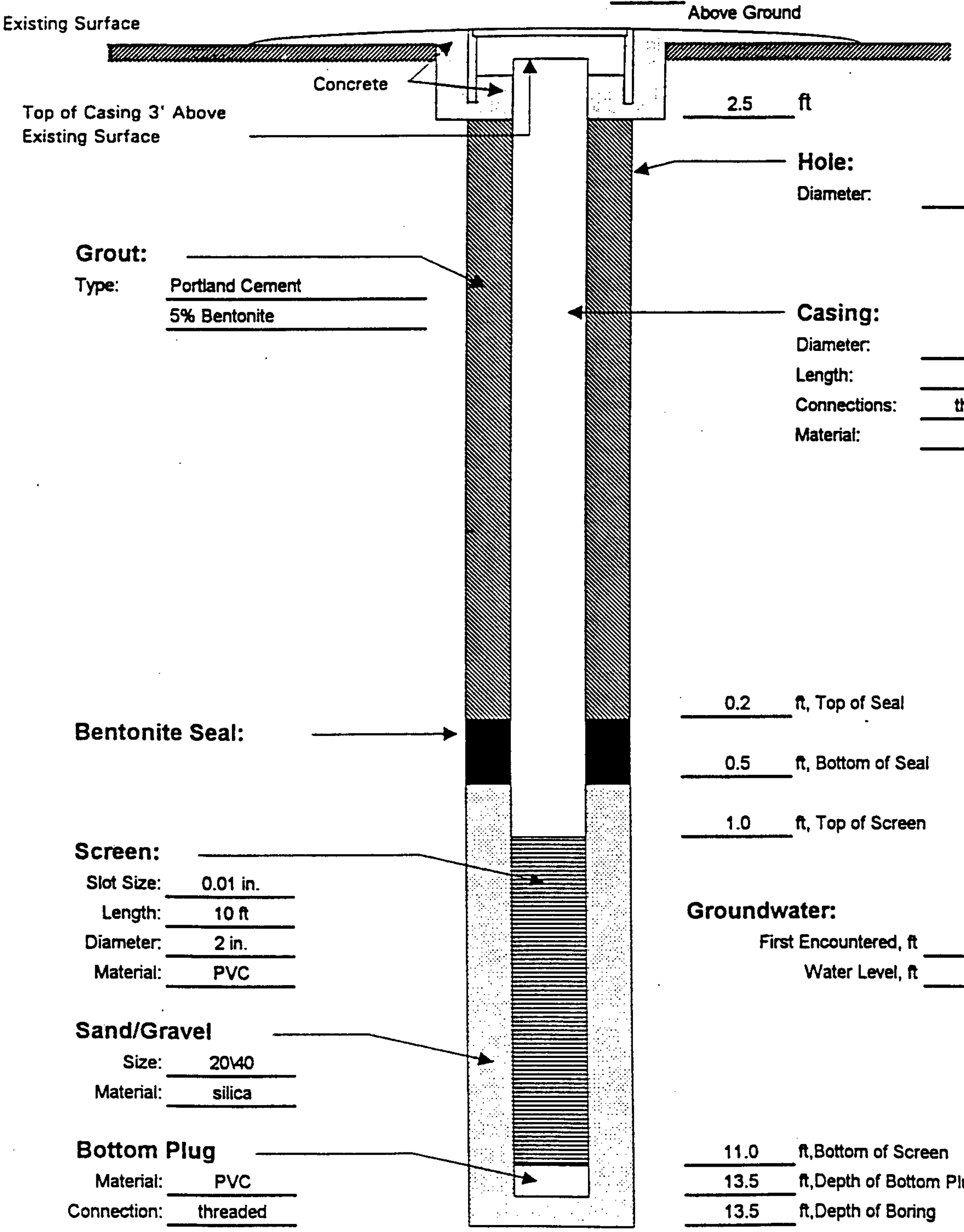
BCM Engineers

Monitoring Well Schematic

Project: Tyndall Supplemental Contamination Assesement
Well/Boring No.: FT16-MW4
Project No.: 09-5000-17
Drilling Supervisor: David Britain
Boring Location:
Date(s): 14-Sep-95
Drilling Method: Hollow stem auger
Drilling Contractor: Kelly Environmental Drilling

3 ft. Protective Casing Above Ground

NOT TO SCALE



2.5 ft

Hole:
Diameter: 8 in.

Grout:
Type: Portland Cement
5% Bentonite

Casing:
Diameter: 2 in.
Length: 4 ft.
Connections: threaded
Material: PVC

Bentonite Seal:

0.2 ft, Top of Seal
0.5 ft, Bottom of Seal
1.0 ft, Top of Screen

Screen:
Slot Size: 0.01 in.
Length: 10 ft
Diameter: 2 in.
Material: PVC

Groundwater:
First Encountered, ft 3.0
Water Level, ft 5.55

Sand/Gravel
Size: 20\40
Material: silica

Bottom Plug
Material: PVC
Connection: threaded

11.0 ft, Bottom of Screen
13.5 ft, Depth of Bottom Plug
13.5 ft, Depth of Boring
Depth from Surface

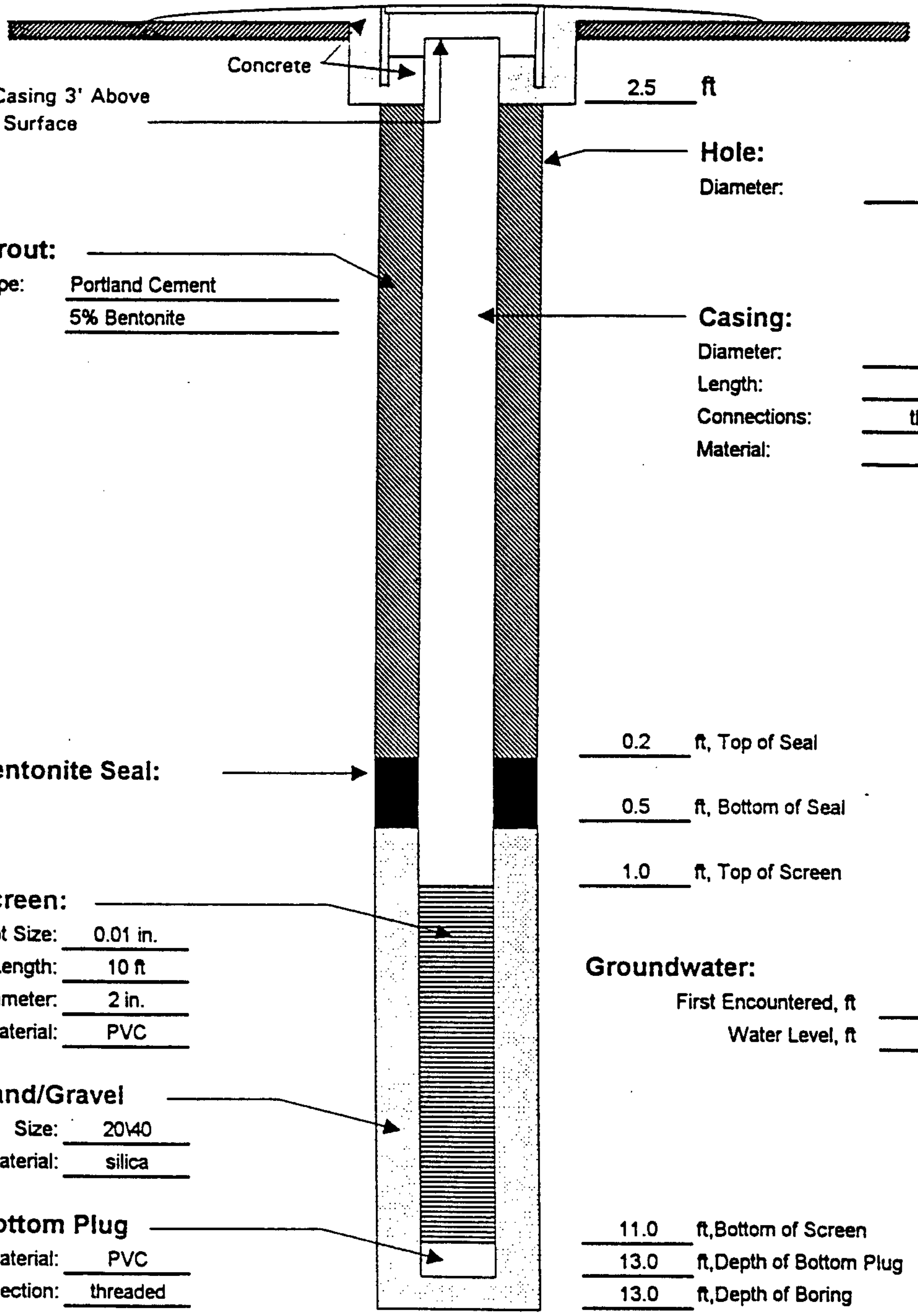
Comments:

BCM Engineers **Monitoring Well Schematic**

Project: Tyndall Supplemental Contamination Assesement
Well/Boring No.: FT16-MW5
Project No.: 09-5000-17
Drilling Supervisor: David Britain
Boring Location:
Date(s): 14-Sep-95
Drilling Method: Hollow stem auger
Drilling Contractor: Kelly Environmental Drilling

NOT TO SCALE

3 ft. Protective Casing Above Ground



2.5 ft

Hole:
Diameter: 8 in.

Grout:
Type: Portland Cement
5% Bentonite

Casing:
Diameter: 2 in.
Length: 4 ft.
Connections: threaded
Material: PVC

Bentonite Seal:

0.2 ft, Top of Seal
0.5 ft, Bottom of Seal
1.0 ft, Top of Screen

Screen:
Slot Size: 0.01 in.
Length: 10 ft
Diameter: 2 in.
Material: PVC

Groundwater:
First Encountered, ft 3.0
Water Level, ft 5.60

Sand/Gravel
Size: 20\40
Material: silica

Bottom Plug
Material: PVC
Connection: threaded

11.0 ft,Bottom of Screen
13.0 ft,Depth of Bottom Plug
13.0 ft,Depth of Boring
Depth from Surface

Comments:

6/91

BCM Engineers **Monitoring Well Schematic**

Project: Tyndall Supplemental Contamination Assesement

Well/Boring No.: FT16-MW6

Project No.: 09-5000-17

Drilling Supervisor: David Britain

Boring Location:

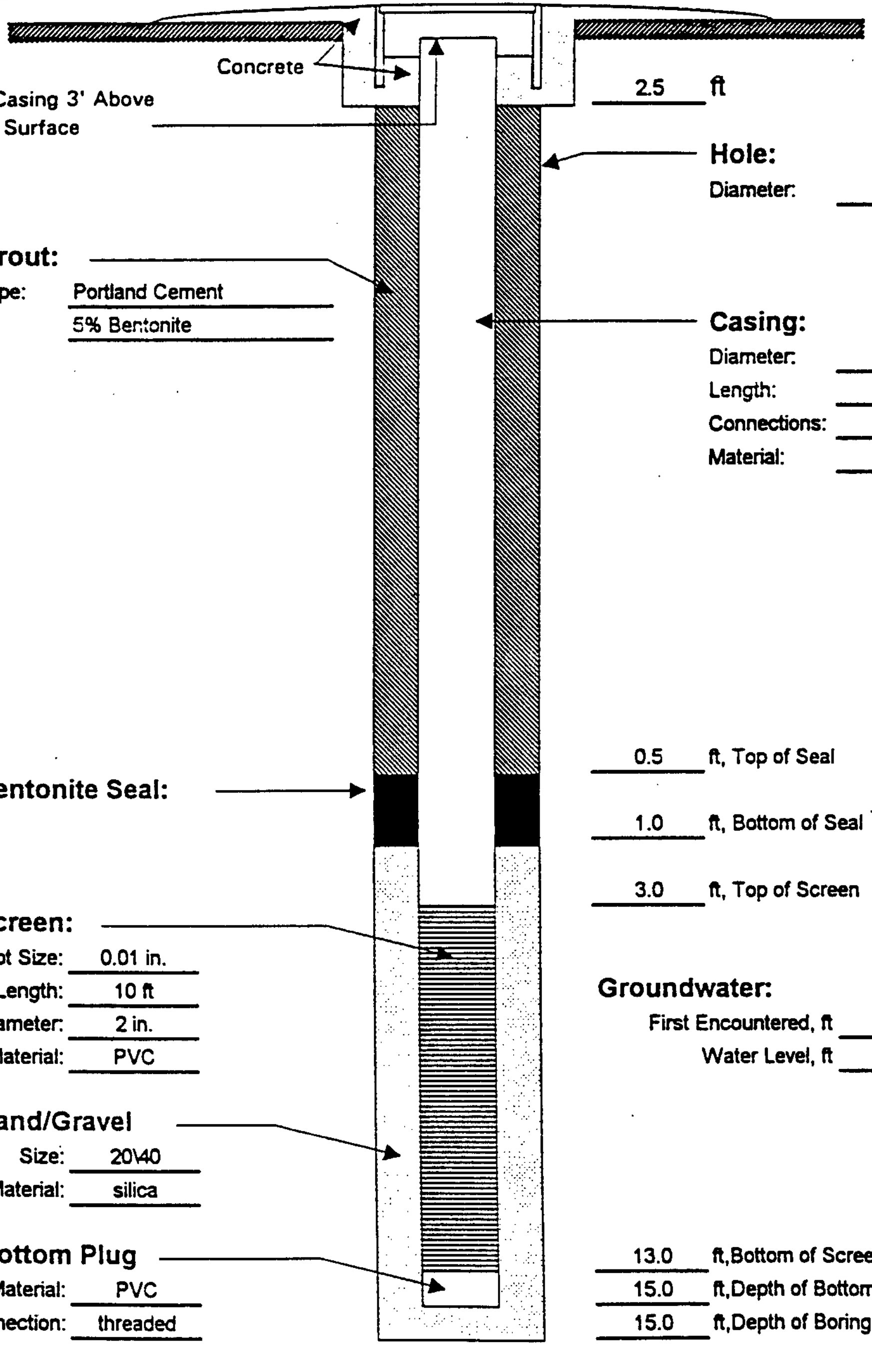
Date(s): 15-Sep-95

Drilling Method: Hollow stem auger

Drilling Contractor: Kelly Environmental Drilling

3 ft. Protective Casing Above Ground

NOT TO SCALE



2.5 ft

Hole:

Diameter: 8 in.

Grout:

Type: Portland Cement

5% Bentonite

Casing:

Diameter: 2 in.

Length: 6 ft.

Connections: threaded

Material: PVC

Bentonite Seal:

0.5 ft, Top of Seal

1.0 ft, Bottom of Seal

3.0 ft, Top of Screen

Screen:

Slot Size: 0.01 in.

Length: 10 ft

Diameter: 2 in.

Material: PVC

Groundwater:

First Encountered, ft 5.5

Water Level, ft 9.90

Sand/Gravel

Size: 20\40

Material: silica

Bottom Plug

Material: PVC

Connection: threaded

13.0 ft, Bottom of Screen

15.0 ft, Depth of Bottom Plug

15.0 ft, Depth of Boring

Depth from Surface

Comments:

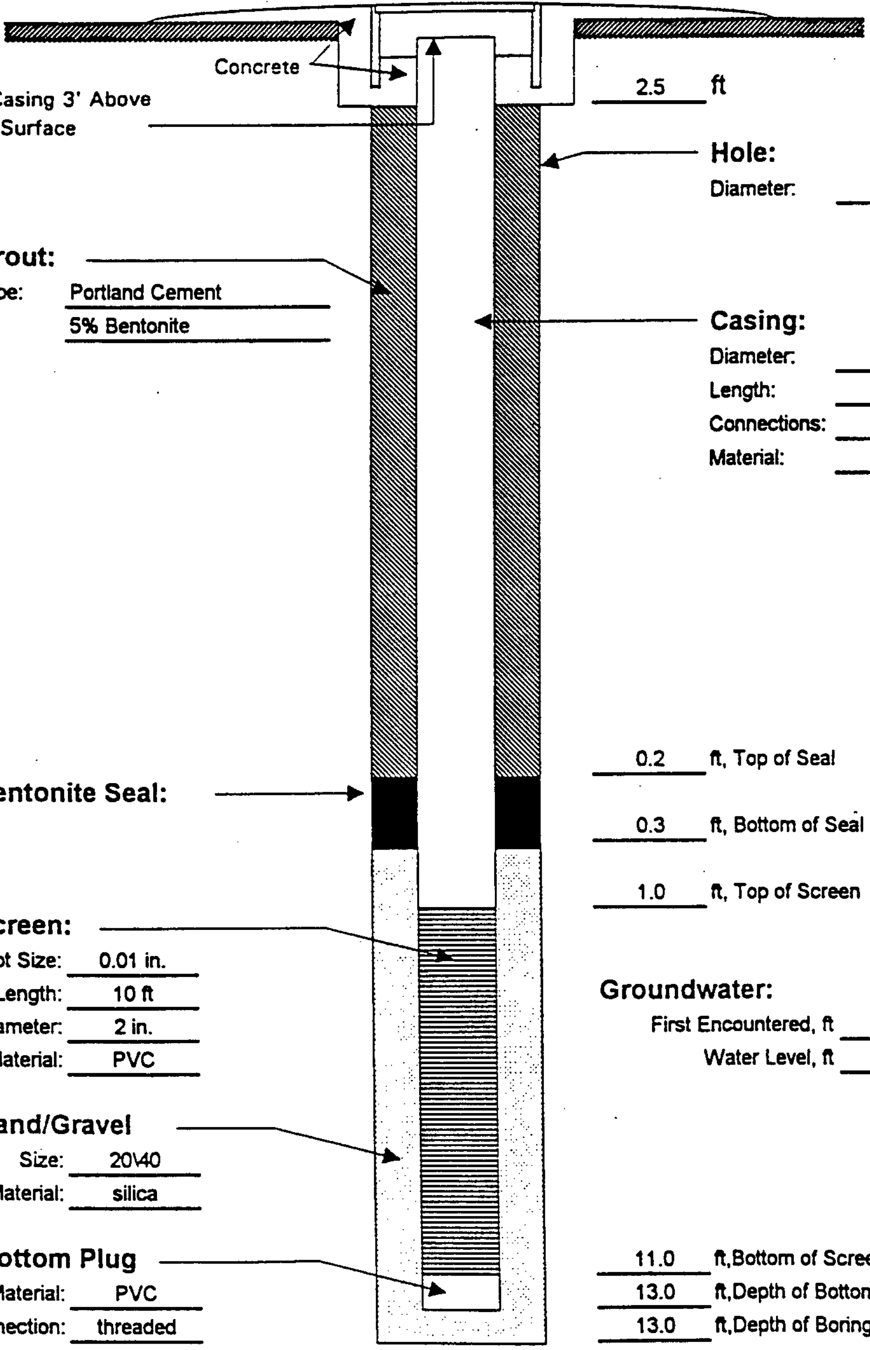
6/91

BCM Engineers **Monitoring Well Schematic**

Project: Tyndall Supplemental Contamination Assesement
Well/Boring No.: FT16-MW7
Project No.: 09-5000-17
Drilling Supervisor: David Britain
Boring Location:
Date(s): 15-Sep-95
Drilling Method: Hollow stem auger
Drilling Contractor: Kelly Environmental Drilling

3 ft. Protective Casing Above Ground

NOT TO SCALE



2.5 ft

Hole:
Diameter: 8 in.

Grout:
Type: Portland Cement
5% Bentonite

Casing:
Diameter: 2 in.
Length: 6 ft.
Connections: threaded
Material: PVC

Bentonite Seal:

0.2 ft, Top of Seal
0.3 ft, Bottom of Seal
1.0 ft, Top of Screen

Screen:
Slot Size: 0.01 in.
Length: 10 ft
Diameter: 2 in.
Material: PVC

Groundwater:
First Encountered, ft 3.0
Water Level, ft 6.20

Sand/Gravel
Size: 20\40
Material: silica

Bottom Plug
Material: PVC
Connection: threaded

11.0 ft, Bottom of Screen
13.0 ft, Depth of Bottom Plug
13.0 ft, Depth of Boring

Depth from Surface

Comments:

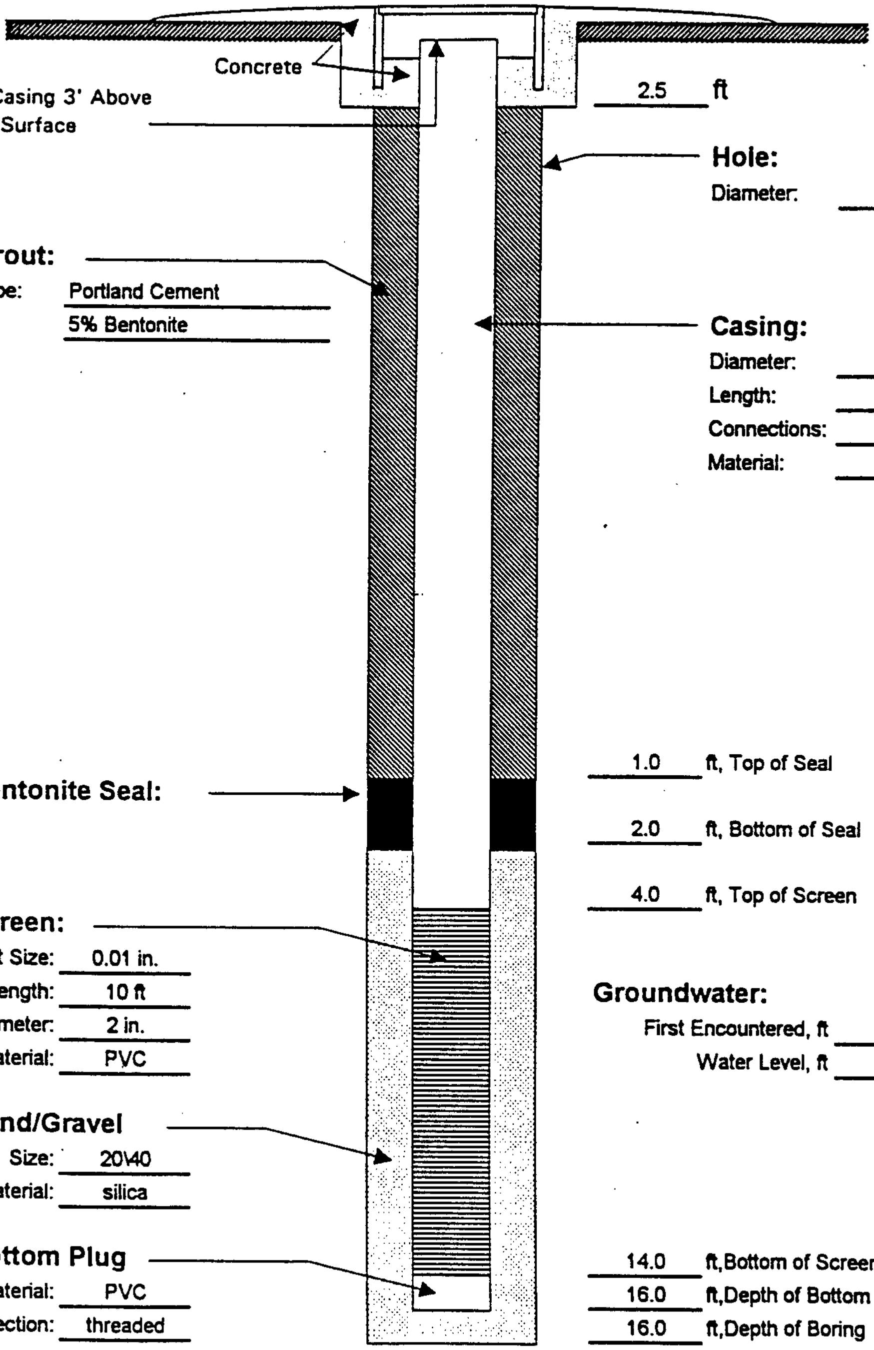
6/91

BCM Engineers **Monitoring Well Schematic**

Project: Tyndall Supplemental Contamination Assesement
Well/Boring No.: FT16-MW8
Project No.: 09-5000-17
Drilling Supervisor: David Britain
Boring Location:
Date(s): 14-Sep-95
Drilling Method: Hollow stem auger
Drilling Contractor: Kelly Environmental Drilling

3 ft. Protective Casing Above Ground

NOT TO SCALE



2.5 ft

Hole:
Diameter: 8 in.

Grout:
Type: Portland Cement
5% Bentonite

Casing:
Diameter: 2 in.
Length: 4 ft.
Connections: threaded
Material: PVC

Bentonite Seal:

1.0 ft, Top of Seal
2.0 ft, Bottom of Seal
4.0 ft, Top of Screen

Screen:
Slot Size: 0.01 in.
Length: 10 ft
Diameter: 2 in.
Material: PVC

Groundwater:
First Encountered, ft 5.5
Water Level, ft 7.68

Sand/Gravel
Size: 20\40
Material: silica

Bottom Plug
Material: PVC
Connection: threaded

14.0 ft, Bottom of Screen
16.0 ft, Depth of Bottom Plug
16.0 ft, Depth of Boring

Depth from Surface

Comments:

6/91

APPENDIX B
LABORATORY ANALYTICAL DATA SHEETS AND CHAIN-OF-CUSTODY RECORDS FROM THE MARCH 1998 SAMPLING EVENT

Quanterra
Environmental
Services

Quanterra Incorporated
4955 Yarrow Street
Arvada, Colorado 80002

303 421-6611 Telephone
303 431-7171 Fax

ANALYTICAL RESULTS
FOR
PARSONS ENGINEERING SCIENCE, INC.

QUANTERRA INCORPORATED, DENVER
PROJECT NUMBER 059558

APRIL 28, 1998

Written by: Ellen La Riviere
Ellen La Riviere, Program Manager

Quanterra
Environmental
Services

Table Of Contents

Standard Deliverables With Supporting Documentation

Report Contents	Section	Number Of Pages
Standard Deliverables		
Introduction • Table of Contents • Narrative • LIMs Report Key • Sample Description • Test Requests • Analytical Results • QC Summary • Chain-of-Custody • Miscellaneous	A	115
Supporting Documentation *[Please Note: A one-page "Description of Supporting Documentation" is provided in the Supporting Documentation section(s).]*		
Volatile GC/MS	B	
Semivolatile GC/MS	C	
Volatile GC	D	311
Semivolatile GC	E	
LC/MS or HPLC	F	312
Metals	G	15
General Chemistry	H	52
Subcontracted Data	I	30
	I	472

Overview

On March 27, 1998, Quanterra Incorporated; Denver Laboratory received sixteen aqueous samples from Parsons Engineering Science, Inc.

This report presents the analytical results as well as supporting information to aid in the evaluation and interpretation of the data and is arranged in the following order:

Overview
Sample Description Information/Analytical Test Requests
Analytical Results
Quality Control Report

Aromatic Volatile Organics Data Review

Each sample was analyzed to achieve the lowest possible reporting limits within the constraints of the method. In some cases, due to interferences or analytes present at concentrations above the linear calibration range of the instrument, samples were diluted. For diluted samples, the reporting limits are adjusted relative to the dilutions required. Quanterra samples 059558-0001-SA, -0002-SA, -0008-SA, -0012-SA, -0014-SA and –0016-SA were analyzed at dilutions for Method 8020A due to the concentration of target compounds present in the samples

Polynuclear Aromatic Hydrocarbons Data Review

Samples 059558-0001-SA, -0002-SA and –0008-SA were analyzed at dilutions for Method 8310 due to the concentration of target compounds in the samples. The reporting limits have been raised accordingly. As a result of the dilutions required, the surrogates were diluted to less than detectable concentrations in these samples.

Dibenz(a,h)anthracene was recovered above the upper control limit in the laboratory control sample (LCS) associated with the Method 8310 QC lot 26 MAR 98-01. Because this would indicate a high bias to the data, and this compound was not detected in the samples, the data was not adversely affected, and no further action was required.

Methane Data Review

The RSK-175 analysis for methane was performed by Quanterra's Austin laboratory.

Due to limitations of the laboratory information management system (LIMS) the spike amount in the duplicate control samples (DCS) represent an average of the spike amounts for the individual DCS. Therefore, the results presented in the summary report differ slightly from the results in the raw data package.

Samples 059558-0001-SA ,-0002-SA, -0006-SA, -0008-SA, -0012-SA, -0014-SA and –0016-SA were analyzed at dilutions for Methane by RSK-175 due to the concentration of the target compound in the samples. The reporting limits have been raised relative to the dilutions required.

Total Petroleum Hydrocarbons Data Review

Analysis for total petroleum hydrocarbons (TPH) by the FL-PRO method was performed by Quanterra's Tampa laboratory.

Samples 059558-0001-SA ,-0002-SA - and –0008-SA were analyzed at dilutions for TPH due to the concentration of the target compound in the samples. The reporting limits have been raised accordingly. As a result of the dilutions required the surrogates were diluted to less than detectable concentrations in sample 059558-0008-SA.

Method 504 Data Review

Analysis for 1,2-Dibromoethane (EDB) by Method 504 was performed by Quanterra's Tampa laboratory.

The 1,1,1,2-tetrachloroethane surrogate was recovered above the upper control limit in sample 059558-0004-SA. Because this would indicate a high bias to the data, and EDB was not detected in the sample, no further action was required by the laboratory.

With the above noted exception, standard analytical protocols were followed in the analysis of the samples and no problems were encountered or anomalies observed. All laboratory quality control samples analyzed in conjunction with the samples in this project were within established control limits.

Footnotes and Data Qualifiers

The data sheets contained in this report may contain a variety of footnotes and data qualifiers. Some footnotes are used with specific tests; for example, footnotes used with the GC/FID Petroleum Hydrocarbon methods to indicate (in the analyst's judgment) the product that appears to be present. Finally, there are a number of general qualifiers that serve to identify problems and pertinent observations made during sample analysis that may not be discussed in the Overview. These are described below:

B Compound is also detected in the blank. The indicated compound was detected in the sample as well as the method blank. Please note that the B flag is not used when the sample result is ND (Not Detected).

G Reporting limit raised due to the matrix of the sample. Indicates that reporting limits were raised due to the presence of non-target compounds or other matrix interferences. The sample may or may not have been diluted. For inorganic methods, the footnote applies only to the flagged analyte. For organic methods, the footnote pertains to all analytes determined by the method.

J Result is detected below the reporting limit or is an estimated concentration. Most commonly, a "J" value indicates that the reported result for the analyte is below the stated reporting limit and is an estimated value. "J" values are applied to organic analytes detected above the MDL but below the reporting limit and for inorganic analytes detected above the IDL but below the reporting limit. Analytes which are not detected at or below the reporting limit are reported as "ND" and do not have "J" flags. Because "J" values may represent false positive concentrations, care should be used when interpreting these data. If there is uncertainty about the quantitation of an analyte such as due to metals serial dilution failure, this footnote may also indicate that a reported result is an estimated concentration, even if it is above the reporting limit.

N Spiked sample recovery not within limits. This qualifier is applied to the parent sample when MS/MSD recoveries are not within acceptable limits.

r This footnote is analyst defined. The data sheets will list "r" footnotes with consecutive numbers. The electronic data deliverable will show "r" data qualifiers. Please see datasheet for exact definition.

Quanterra
Environmental
Services

LIMs Report Key

Section	Description
Cover Letter	Signature page, report narrative as applicable.
Sample Description Information	Tabulated cross-reference between the Lab ID and Client ID, including matrix, date and time sampled, and the date received for all samples in the project.
Sample Analysis Results Sheets	Lists sample results, test components, reporting limits, dates prepared and analyzed, and any data qualifiers. Pages are organized by test.
QC LOT Assignment Report	Cross-reference between lab IDs and applicable QC batches (DCS, LCS, Blank, MS/SD, DU)
Duplicate Control Sample Report	Percent recovery and RPD results, with acceptance limits, for the laboratory duplicate control samples for each test are tabulated in this report. These are measures of accuracy and precision for each test. Acceptance limits are based upon laboratory historical data.
Laboratory Control Sample Report	Percent recovery results for a single Laboratory Control Sample (if applicable) are tabulated in this report, with the applicable acceptance limits for each test.
Matrix Spike/Matrix Spike Duplicate Report	Percent recovery and RPD results for matrix-specific QC samples and acceptance limits, where applicable. This report can be used to assess matrix effects on an analysis.
Single Control Sample Report	A tabulation of the surrogate recoveries for the blank for organic analyses.
Method Blank Report	A summary of the results of the analysis of the method blank for each test.

List of Abbreviations and Terms

Abbreviation	Term	Abbreviation	Term
DCS	Duplicate Control Sample	MSD	Matrix Spike Duplicate
DU	Sample Duplicate	QC Run	Preparation Batch
EB	Equipment Blank	QC Category	LIMs QC Category
FB	Field Blank	QC Lot	DCS Batch
FD	Field Duplicate	ND	Not Detected at or above the reporting limit expressed
IDL	Instrument Detection Limit (Metals)	QC Matrix	Matrix of the laboratory control sample(s)
LCS	Laboratory Control Sample	RL	Reporting Limit
MB	Method Blank	QC	Quality Control
MDL	Method Detection Limit	SA	Sample
MS	Matrix Spike	SD	Spike Duplicate
RPD	Relative Percent Difference	TB	Trip Blank
ppm (part-per-million)	mg/L or mg/kg (usually)	ppb (part-per-billion)	ug/L or ug/kg (usually)
QUAL	Qualifier flag	DIL	Dilution Factor

SAMPLE DESCRIPTION INFORMATION
for
Parsons Engineering Science

Lab ID	Client ID	Matrix	Sampled Date	Sampled Time	Received Date
059558-0001-SA	BX-MW-20	GRND-H20	22 MAR 98	07:00	23 MAR 98
059558-0002-SA	BX-MP-2	GRND-H20	22 MAR 98	07:30	23 MAR 98
059558-0003-SA	FT-16, MP-1	GRND-H20	21 MAR 98	09:00	23 MAR 98
059558-0004-SA	FT-16, MP-2	GRND-H20	21 MAR 98	10:00	23 MAR 98
059558-0005-SA	FT-16, SB-2	GRND-H20	21 MAR 98	11:15	23 MAR 98
059558-0006-SA	FT-16, MP-3	GRND-H20	21 MAR 98	12:15	23 MAR 98
059558-0007-SA	FT-16, MP-3	GRND-H20	22 MAR 98	07:00	23 MAR 98
059558-0008-SA	BX-MW-03	GRND-H20	22 MAR 98	13:15	23 MAR 98
059558-0009-SA	BX-MW-03-97	GRND-H20	22 MAR 98	16:30	23 MAR 98
059558-0010-SA	BX-MW-05-97	GRND-H20	22 MAR 98	10:00	23 MAR 98
059558-0010-MS	BX-MW-05-97	GRND-H20	22 MAR 98	10:00	23 MAR 98
059558-0010-SD	BX-MW-05-97	GRND-H20	22 MAR 98	10:00	23 MAR 98
059558-0011-SA	MW-01	GRND-H20	22 MAR 98	11:30	23 MAR 98
059558-0011-MS	MW-01	GRND-H20	22 MAR 98	11:30	23 MAR 98
059558-0011-SD	MW-01	GRND-H20	22 MAR 98	11:30	23 MAR 98
059558-0012-SA	BX-MW-05	GRND-H20	22 MAR 98	08:45	23 MAR 98
059558-0013-SA	BX-MW-08-97	GRND-H20	22 MAR 98	14:30	23 MAR 98
059558-0014-SA	BX-MW-07	GRND-H20	22 MAR 98	15:30	23 MAR 98
059558-0015-SA	MP-3	GRND-H20	22 MAR 98	17:30	23 MAR 98
059558-0016-SA	MP-1	GRND-H20	22 MAR 98	18:30	23 MAR 98

Quanterra
Environmental
Services

ANALYTICAL TEST REQUESTS
for
Parsons Engineering Science

Lab ID: 059558	Group Code	Analysis Description	Custom Test?
0001 - 0002, 0008	A	Method EPA-9 RSK-175 by GC/FID	Y
		AFCEE	N
		Nitrate, Ion Chromatography	N
		Prep - Total Metals, Furnace AA	N
		AFCEE	N
		Lead, Furnace AA (Totals)	N
		AFCEE	Y
		Aromatic VOAs by Method 8020A with MTBE & TMBs	Y
		GC Prep For Waters	N
		AFCEE	Y
		Aromatic VOAs by Method 8020A with MTBE & TMBs	Y
		Method FL-PRO - TPH (C8-C40)	N
		Prep - TPH (C8-C40)	N
		AFCEE	N
		Polynuclear Aromatic Hydrocarbons, HPLC	N
		AFCEE	N
		Prep - Polynuclear Aromatic Hydrocarbons - HPLC	N
		AFCEE	N
		Polynuclear Aromatic Hydrocarbons, HPLC	N
0011 - 0014, 0016	B	Method EPA-9 RSK-175 by GC/FID	Y
		AFCEE	N
		Nitrate, Ion Chromatography	N
		GC Prep For Waters	N
		AFCEE	Y
		Aromatic VOAs by Method 8020A with MTBE & TMBs	Y
		AFCEE	Y
		Aromatic VOAs by Method 8020A with MTBE & TMBs	Y
0005 , 0015	C	GC Prep For Waters	N
		AFCEE	Y
		Aromatic VOAs by Method 8020A with MTBE & TMBs	Y
		AFCEE	Y
		Aromatic VOAs by Method 8020A with MTBE & TMBs	Y
0003 - 0004	D	Prep - Total Metals, Furnace AA	N
		AFCEE	N
		Lead, Furnace AA (Totals)	N
		AFCEE	Y
		Aromatic VOAs by Method 8020A with MTBE & TMBs	Y
		GC Prep For Waters	N
		AFCEE	Y
		Aromatic VOAs by Method 8020A with MTBE & TMBs	Y

ANALYTICAL TEST REQUESTS
for
Parsons Engineering Science

Lab ID: 059558	Group Code	Analysis Description	Custom Test?
		Method FL-PRO - TPH (C8-C40)	N
		Prep - TPH (C8-C40)	N
		AFCEE	N
		Polynuclear Aromatic Hydrocarbons, HPLC	N
		AFCEE	N
		Prep - Polynuclear Aromatic Hydrocarbons - HPLC	N
		AFCEE	N
		Polynuclear Aromatic Hydrocarbons, HPLC	N
		Method 504 - EDB	N
		Prep-1,2-Dibromoethane (EDB)	N
0006	E	Method EPA-9 RSK-175 by GC/FID	Y
		AFCEE	Y
		Aromatic VOAs by Method 8020A with MTBE & TMBs	Y
		GC Prep For Waters	N
		AFCEE	Y
		Aromatic VOAs by Method 8020A with MTBE & TMBs	Y
0007	F	AFCEE	N
		Nitrate, Ion Chromatography	N
0009 - 0010	G	Prep - Total Metals, Furnace AA	N
		AFCEE	N
		Lead, Furnace AA (Totals)	N
		AFCEE	Y
		Aromatic VOAs by Method 8020A with MTBE & TMBs	Y
		GC Prep For Waters	N
		AFCEE	Y
		Aromatic VOAs by Method 8020A with MTBE & TMBs	Y
		Method FL-PRO - TPH (C8-C40)	N
		Prep - TPH (C8-C40)	N
		AFCEE	N
		Polynuclear Aromatic Hydrocarbons, HPLC	N
		AFCEE	N
		Prep - Polynuclear Aromatic Hydrocarbons - HPLC	N
		AFCEE	N
		Polynuclear Aromatic Hydrocarbons, HPLC	N

AFCEE^Aromatic VOAs by Method 8020A with MTBE & TMBs
Method 8020A

Client Name:	Parsons Engineering Science		
Client ID:	FT-16, MP-1	(0.00,0.00)	
LAB ID:	059558-0003-SA		
Matrix:	GRND-H20	Sampled: 21 MAR 98	Received: 23 MAR 98
Authorized:	24 MAR 98	Prepared: 24 MAR 98	Analyzed: 25 MAR 98
Instrument:	GCPID-H	Dilution: 1.0	

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	ND		2.0	0.056	ug/L
Toluene	ND		2.0	0.15	ug/L
Ethylbenzene	ND		2.0	0.054	ug/L
Xylenes (total)	ND		2.0	0.15	ug/L
tert-Butyl methyl ether	ND		5.0	0.010	ug/L

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	101	%	44 - 165
Fluorobenzene	95	%	44 - 165

ND = Not Detected

Reported By: Shawn Hadley

Approved By: Audrey Cornell

AFCEE^Aromatic VOAs by Method 8020A with MTBE & TMBs
Method 8020A

Client Name: Parsons Engineering Science
Client ID: FT-16, MP-2 (0.00,0.00)
LAB ID: 059558-0004-SA
Matrix: GRND-H20
Authorized: 24 MAR 98
Instrument: GCPID-H
Sampled: 21 MAR 98
Prepared: 24 MAR 98
Dilution: 1.0
Received: 23 MAR 98
Analyzed: 25 MAR 98

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	ND		2.0	0.056	ug/L
Toluene	ND		2.0	0.15	ug/L
Ethylbenzene	ND		2.0	0.054	ug/L
Xylenes (total)	ND		2.0	0.15	ug/L
tert-Butyl methyl ether	ND		5.0	0.010	ug/L

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	102	%	44 - 165
Fluorobenzene	96	%	44 - 165

ND = Not Detected

Reported By: Shawn Hadley

Approved By: Audrey Cornell

AFCEE^Aromatic VOAs by Method 8020A with MTBE & TMBs
Method 8020A

Client Name:	Parsons Engineering Science		
Client ID:	FT-16, SB-2	(0.00,0.00)	
LAB ID:	059558-0005-SA		
Matrix:	GRND-H20	Sampled: 21 MAR 98	Received: 23 MAR 98
Authorized:	24 MAR 98	Prepared: 24 MAR 98	Analyzed: 25 MAR 98
Instrument:	GCPID-H	Dilution: 1.0	

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	ND		2.0	0.055	ug/L
Toluene	0.14	JM	2.0	0.065	ug/L
Ethylbenzene	8.2	d	2.0	0.053	ug/L
Xylenes (total)	40	d	2.0	0.32	ug/L
tert-Butyl methyl ether	ND		5.0	0.061	ug/L

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	104	%	44 - 165
Fluorobenzene	107	%	44 - 165

d = See Preferred Result on Other Column
J = Result is detected below the reporting limit or is an estimated concentration.
M = Preferred Result
ND = Not Detected

Reported By: Shawn Hadley Approved By: Audrey Cornell

AFCEE^Aromatic VOAs by Method 8020A (Second Column)
Method 8020A

Client Name:	Parsons Engineering Science		
Client ID:	FT-16, SB-2	(0.00,0.00)	
LAB ID:	059558-0005-SA		
Matrix:	GRND-H20	Sampled: 21 MAR 98	Received: 23 MAR 98
Authorized:	24 MAR 98	Prepared: 24 MAR 98	Analyzed: 25 MAR 98
Instrument:	GCPID-H	Dilution: 1.0	

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	ND		2.0	0.056	ug/L
Toluene	0.19	Jd	2.0	0.15	ug/L
Ethylbenzene	8.1	M	2.0	0.054	ug/L
Xylenes (total)	39	M	2.0	0.15	ug/L
tert-Butyl methyl ether	ND		5.0	0.010	ug/L

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	121	%	44 - 165
Fluorobenzene	100	%	44 - 165

d = See Preferred Result on Other Column
J = Result is detected below the reporting limit or is an estimated concentration.
M = Preferred Result
ND = Not Detected

Reported By: Shawn Hadley

Approved By: Audrey Cornell

AFCEE^Aromatic VOAs by Method 8020A with MTBE & TMBs
Method 8020A

Client Name:	Parsons Engineering Science				
Client ID:	FT-16, MP-3	(0.00,0.00)			
LAB ID:	059558-0006-SA				
Matrix:	GRND-H2O	Sampled:	21 MAR 98	Received:	23 MAR 98
Authorized:	24 MAR 98	Prepared:	24 MAR 98	Analyzed:	25 MAR 98
Instrument:	GCPID-H	Dilution:	1.0		

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	ND		2.0	0.056	ug/L
Toluene	ND		2.0	0.15	ug/L
Ethylbenzene	1.0	JM	2.0	0.054	ug/L
Xylenes (total)	0.78	Jd	2.0	0.15	ug/L
tert-Butyl methyl ether	ND		5.0	0.010	ug/L

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	97	%	44 - 165
Fluorobenzene	93	%	44 - 165

d = See Preferred Result on Other Column
J = Result is detected below the reporting limit or is an estimated concentration.
M = Preferred Result
ND = Not Detected

Reported By: Shawn Hadley

Approved By: Audrey Cornell

AFCEE^Aromatic VOAs by Method 8020A (Second Column)
Method 8020A

Client Name:	Parsons Engineering Science		
Client ID:	FT-16, MP-3	(0.00,0.00)	
LAB ID:	059558-0006-SA		
Matrix:	GRND-H20	Sampled: 21 MAR 98	Received: 23 MAR 98
Authorized:	24 MAR 98	Prepared: 24 MAR 98	Analyzed: 25 MAR 98
Instrument:	GCPID-H	Dilution: 1.0	

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	ND		2.0	0.056	ug/L
Toluene	ND		2.0	0.15	ug/L
Ethylbenzene	1.1	Jd	2.0	0.054	ug/L
Xylenes (total)	0.67	JM	2.0	0.15	ug/L
tert-Butyl methyl ether	ND		5.0	0.010	ug/L

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	97	%	44 - 165
Fluorobenzene	93	%	44 - 165

d = See Preferred Result on Other Column
J = Result is detected below the reporting limit or is an estimated concentration.
M = Preferred Result
ND = Not Detected

Reported By: Shawn Hadley

Approved By: Audrey Cornell

AFCEE
Polynuclear Aromatic Hydrocarbons, HPLC
Method 8310

Client Name:	Parsons Engineering Science		
Client ID:	FT-16, MP-1	(0.00,0.00)	
LAB ID:	059558-0003-SA		
Matrix:	GRND-H20	Sampled: 21 MAR 98	Received: 23 MAR 98
Authorized:	24 MAR 98	Prepared: 26 MAR 98	Analyzed: 14 APR 98
Instrument:	HPLC-Q	Dilution: 1.0	

Parameter	Result	Qualifier	RL	MDL	Units
Acenaphthene	ND		1.0	0.094	ug/L
Acenaphthylene	ND		1.0	0.041	ug/L
Anthracene	0.89	d	0.10	0.030	ug/L
Benzo(a)anthracene	ND		0.13	0.061	ug/L
Benzo(a)pyrene	ND		0.23	0.066	ug/L
Benzo(b)fluoranthene	ND		0.18	0.060	ug/L
Benzo(g,h,i)perylene	ND		0.20	0.072	ug/L
Benzo(k)fluoranthene	ND		0.17	0.060	ug/L
Chrysene	ND		0.20	0.074	ug/L
Dibenz(a,h)anthracene	ND		0.30	0.077	ug/L
Fluorene	6.4	d	0.20	0.036	ug/L
Fluoranthene	1.2	M	0.20	0.037	ug/L
Indeno(1,2,3-cd)pyrene	ND		0.44	0.056	ug/L
Naphthalene	4.0	d	1.0	0.060	ug/L
Phenanthrene	ND		0.20	0.030	ug/L
Pyrene	1.4	d	0.20	0.044	ug/L

Surrogate	Recovery		Acceptable Range
Terphenyl-d14	120	%	25 - 157

d = See Preferred Result on Other Column
M = Preferred Result
ND = Not Detected

Reported By: Blake Besser

Approved By: Audrey Cornell

AFCEE
Polynuclear Aromatic Hydrocarbons, HPLC (Second Column)
Method 8310

Client Name: Parsons Engineering Science
Client ID: FT-16, MP-1 (0.00,0.00)
LAB ID: 059558-0003-SA
Matrix: GRND-H20 Sampled: 21 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: 26 MAR 98 Analyzed: 14 APR 98
Instrument: HPLC-Q Dilution: 1.0

Parameter	Result	Qualifier	RL	MDL	Units
Acenaphthene	ND		1.0	0.094	ug/L
Acenaphthylene	ND		1.0	0.041	ug/L
Anthracene	0.29	M	0.10	0.030	ug/L
Benzo(a)anthracene	ND		0.13	0.061	ug/L
Benzo(a)pyrene	ND		0.23	0.066	ug/L
Benzo(b)fluoranthene	ND		0.18	0.060	ug/L
Benzo(g,h,i)perylene	ND		0.20	0.072	ug/L
Benzo(k)fluoranthene	ND		0.17	0.060	ug/L
Chrysene	ND		0.20	0.074	ug/L
Dibenz(a,h)anthracene	ND		0.30	0.077	ug/L
Fluorene	5.7	M	0.20	0.036	ug/L
Fluoranthene	1.4	d	0.20	0.037	ug/L
Indeno(1,2,3-cd)pyrene	ND		0.44	0.056	ug/L
Naphthalene	1.9	M	1.0	0.060	ug/L
Phenanthrene	ND		0.20	0.030	ug/L
Pyrene	0.87	M	0.20	0.044	ug/L

Surrogate	Recovery		Acceptable Range
Terphenyl-d14	124	%	25 - 157

d = See Preferred Result on Other Column
M = Preferred Result
ND = Not Detected

Reported By: Blake Besser Approved By: Audrey Cornell

AFCEE
Polynuclear Aromatic Hydrocarbons, HPLC
Method 8310

Client Name: Parsons Engineering Science
Client ID: FT-16, MP-2 (0.00,0.00)
LAB ID: 059558-0004-SA
Matrix: GRND-H20 Sampled: 21 MAR 98 Received: 23 MAR 98
Authorized: 24 MAR 98 Prepared: 26 MAR 98 Analyzed: 17 APR 98
Instrument: HPLC-Q Dilution: 1.0

Parameter	Result	Qualifier	RL	MDL	Units
Acenaphthene	ND		1.0	0.097	ug/L
Acenaphthylene	ND		1.0	0.042	ug/L
Anthracene	ND		0.10	0.031	ug/L
Benzo(a)anthracene	ND		0.14	0.063	ug/L
Benzo(a)pyrene	ND		0.24	0.068	ug/L
Benzo(b)fluoranthene	ND		0.19	0.062	ug/L
Benzo(g,h,i)perylene	ND		0.21	0.074	ug/L
Benzo(k)fluoranthene	ND		0.18	0.062	ug/L
Chrysene	ND		0.21	0.076	ug/L
Dibenz(a,h)anthracene	ND		0.31	0.080	ug/L
Fluorene	ND		0.21	0.037	ug/L
Fluoranthene	ND		0.21	0.038	ug/L
Indeno(1,2,3-cd)pyrene	ND		0.45	0.058	ug/L
Naphthalene	ND		1.0	0.062	ug/L
Phenanthrene	ND		0.21	0.031	ug/L
Pyrene	ND		0.21	0.045	ug/L

Surrogate	Recovery		Acceptable Range
Terphenyl-d14	107	%	25 - 157

ND = Not Detected

Reported By: Blake Besser Approved By: Audrey Cornell

AFCEE
Total Metals

Client Name:	Parsons Engineering Science		
Client ID:	FT-16, MP-1	(0.00,0.00)	
LAB ID:	059558-0003-SA		
Matrix:	GRND-H20	Sampled: 21 MAR 98	Received: 23 MAR 98
Authorized:	24 MAR 98	Prepared: See Below	Analyzed: See Below

Parameter	Result	Qual	Dil	MDL	Rep Lim	Units	Method	Prepared Date	Analyzed Date
Lead	ND		1.0	0.0010	0.0050	mg/L	SW7421	31 MAR 98	01 APR 98

ND = Not Detected

Reported By: Robin Proctor

Approved By: Kathy Wakeman

AFCEE
Total Metals

Client Name:	Parsons Engineering Science		
Client ID:	FT-16, MP-2	(0.00,0.00)	
LAB ID:	059558-0004-SA		
Matrix:	GRND-H2O	Sampled: 21 MAR 98	Received: 23 MAR 98
Authorized:	24 MAR 98	Prepared: See Below	Analyzed: See Below

Parameter	Result	Qual	Dil	MDL	Rep Lim	Units	Method	Prepared Date	Analyzed Date
Lead	ND		1.0	0.0010	0.0050	mg/L	SW7421	31 MAR 98	01 APR 98

ND = Not Detected

Reported By: Robin Proctor

Approved By: Kathy Wakeman

General Inorganics

Client Name:	Parsons Engineering Science				
Client ID:	FT-16, MP-3	(0.00,0.00)			
LAB ID:	059558-0007-SA				
Matrix:	GRND-H2O	Sampled:	22 MAR 98	Received:	23 MAR 98
Authorized:	24 MAR 98	Prepared:	See Below	Analyzed:	See Below

Parameter	Result	Qual	Dil	MDL	Rep Lim	Units	Method	Prepared Date	Analyzed Date
Nitrate as N	0.12	J	1.0	0.040	0.50	mg/L	9056	NA	23 MAR 98

J = Result is detected below the reporting limit or is an estimated concentration.

Reported By: Mark Foster

Approved By: Linda Sullivan

Method EPA-9 RSK-175 by GC/FID
Method EPA-9 RSK-175

Client Name:	Parsons Engineering Science		
Client ID:	FT-16, MP-3	(0.00,0.00)	
LAB ID:	059558-0006-SA		
Matrix:	GRND-H2O	Sampled: 21 MAR 98	Received: 23 MAR 98
Authorized:	24 MAR 98	Prepared: N/A	Analyzed: 27 MAR 98
Instrument:	GCFID-K1A	Dilution: 20	

Parameter	Result	Qualifier	RL	MDL	Units
Methane	490	B	10	1.0	ug/L

B = Compound is also detected in the blank.

Reported By: Quanterra-Austin

Approved By: Cynthia Prentice

59558

Quanterra

Chain of Custody Record

QUA-4124 0797

Client: PARSONS ES	Project Manager: BRAD LEWIS	Date: 3/23/98	Chain of Custody Number: 02285
Address: 5390 TRIANGLE PKWY	Telephone Number (Area Code)/Fax Number: (678) 969-2489/(770) 446-4910	Lab Number:	Page 1 of 1
City: NORCROSS State: GA Zip Code: 30092	Site Contact: Lab Contact: LaRiviere		
Project Name: TYNDALL - FT-16	Carrier/Waybill Number:		
Contract/Purchase Order/Quote No.:			

Sample I.D. No. and Description (Containers for each sample may be combined on one line)	Date	Time	Matrix: Aqueous	Sed.	Soil	Containers & Preservatives: Unpres.	H2SO4	HNO3	HCl	NaOH	ZnAc/NaOH	Analysis: BTEX+MTBE 8020	PAH 8310	EDB 8011	TOT LEAD 7421	TRPH FL-PRO	NITRATE 300.0	METHANE RSK-175	Special Instructions/ Conditions of Receipt
3 FT-16, MP-1	3/21/98	0900	X			5		1	5			X	X	X	X	X			
4 FT-16, MP-2	3/21/98	1000	X			5		1	5			X	X	X	X	X			
5 FT-16, SB-2	3/21/98	1115	X						3			X							
6 FT-16, MP-3	3/21/98	1215	X						6			X						X	
FT-16, MP-3	3/22/98	0700	X			1											X		

Possible Hazard Identification: ☒ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal: ☐ Return To Client ☐ Disposal By Lab ☐ Archive For ______ Months (A fee may be assessed if samples are retained longer than 3 months)

Turn Around Time Required: ☐ 24 Hours ☐ 48 Hours ☐ 7 Days ☐ 14 Days ☐ 21 Days ☐ Other______

QC Requirements (Specify)

1. Relinquished By	Date: 3/23/98	Time: 0600	1. Received By: Anna Marie Weber	Date: 3/23/98 (23)	Time: ~~3:50~~ 1213 144
2. Relinquished By	Date	Time	2. Received By	Date	Time
3. Relinquished By	Date	Time	3. Received By	Date	Time

Comments

DISTRIBUTION: WHITE - Stays with the Sample; CANARY - Returned to Client with Report; PINK - Field Copy

A 111

Quanterra
Environmental
Services

Quanterra Incorporated
4955 Yarrow Street
Arvada, Colorado 80002

303 421-6611 Telephone
303 431-7171 Fax

ANALYTICAL RESULTS
FOR
PARSONS ENGINEERING SCIENCE, INC.

QUANTERRA INCORPORATED, DENVER
PROJECT NUMBER 059550

MAY 11, 1998

Written by: Ellen LaRiviere
Ellen La Riviere, Program Manager

Quanterra
Environmental
Services

Table Of Contents

Standard Deliverables With Supporting Documentation

Report Contents	Section	Number Of Pages
Standard Deliverables		
Introduction • Table of Contents • Narrative • LIMs Report Key • Sample Description • Test Requests • Analytical Results • QC Summary • Chain-of-Custody • Miscellaneous	A	113
Supporting Documentation *[Please Note: A one-page "Description of Supporting Documentation" is provided in the Supporting Documentation section(s).]*		
Volatile GC/MS	B	
Semivolatile GC/MS	C	
Volatile GC	D	360
Semivolatile GC	E	
LC/MS or HPLC	F	499
Metals	G	14
General Chemistry	H	35
Subcontracted Data	I	26 472

Overview

On March 21, 1998, Quanterra Incorporated; Denver Laboratory received eleven soil samples and seven aqueous samples from Parsons Engineering Science, Inc.

This report presents the analytical results as well as supporting information to aid in the evaluation and interpretation of the data and is arranged in the following order:

Overview
Sample Description Information/Analytical Test Requests
Analytical Results
Quality Control Report

Aromatic Volatile Organics Data Review

Each sample was analyzed to achieve the lowest possible reporting limits within the constraints of the method. In some cases, due to interferences or analytes present at concentrations above the linear calibration range of the instrument, samples were diluted. For diluted samples, the reporting limits are adjusted relative to the dilutions required. Quanterra sample 059550-0001-SA was analyzed at a dilution for Method 8020A due to the concentration of target compounds present in the samples

Polynuclear Aromatic Hydrocarbons Data Review

The Method 8310 surrogate in sample 059550-0001-SA was recovered below the lower control limit. The client was contacted on April 30, 1998. Because all other quality control measures were within acceptable limits, a matrix effect is indicated, and the laboratory took no further action.

Dibenz(a,h)anthracene was recovered above the upper control limit in the laboratory control sample (LCS) associated with the Method 8310 QC lot 26 MAR 98-01. Because this would indicate a high bias to the data, and this compound was not detected in the samples, the data was not adversely affected, and no further action was required.

Lead Data Review

Sample 059550-0016-SA was analyzed at a dilution for lead by Method 7421 due to the concentration of lead in the sample. The reporting limit has been raised relative to the dilution required.

Methane Data Review

The RSK-175 analysis for methane was performed by Quanterra's Austin laboratory.

Samples 059550-0001-SA, -0004-SA, -0005-SA, -0017-SA and –0018-SA were analyzed at dilutions for Methane by RSK-175 due to the concentration of the target compound in the samples. The reporting limits have been raised relative to the dilutions required.

Total Petroleum Hydrocarbons Data Review

Analysis for total petroleum hydrocarbons (TPH) by the FL-PRO method was performed by Quanterra's Tampa laboratory.

Sample 059550-0009-SA was analyzed at a dilution for TPH due to the concentration of the target compound in the samples. The reporting limits have been raised accordingly. As a result of the dilutions required the surrogates were diluted to less than detectable concentrations in this sample.

Method 504 Data Review

Analysis for 1,2-Dibromoethane (EDB) by Method 504 was performed by Quanterra's Tampa laboratory.

With the above noted exception, standard analytical protocols were followed in the analysis of the samples and no problems were encountered or anomalies observed. All laboratory quality control samples analyzed in conjunction with the samples in this project were within established control limits.

Footnotes and Data Qualifiers

The data sheets contained in this report may contain a variety of footnotes and data qualifiers. Some footnotes are used with specific tests; for example, footnotes used with the GC/FID Petroleum Hydrocarbon methods to indicate (in the analyst's judgment) the product that appears to be present. Finally, there are a number of general qualifiers that serve to identify problems and pertinent observations made during sample analysis that may not be discussed in the Overview. These are described below:

B Compound is also detected in the blank. The indicated compound was detected in the sample as well as the method blank. Please note that the B flag is not used when the sample result is ND (Not Detected).

G Reporting limit raised due to the matrix of the sample. Indicates that reporting limits were raised due to the presence of non-target compounds or other matrix interferences. The sample may or may not have been diluted. For inorganic methods, the footnote applies only to the flagged analyte. For organic methods, the footnote pertains to all analytes determined by the method.

J Result is detected below the reporting limit or is an estimated concentration. Most commonly, a "J" value indicates that the reported result for the analyte is below the stated reporting limit and is an estimated value. "J" values are applied to organic analytes detected above the MDL but below the reporting limit and for inorganic analytes detected above the IDL but below the reporting limit. Analytes which are not detected at or below the reporting limit are reported as "ND" and do not have "J" flags. Because "J" values may represent false positive concentrations, care should be used when interpreting these data. If there is uncertainty about the quantitation of an analyte such as due to metals serial dilution failure, this footnote may also indicate that a reported result is an estimated concentration, even if it is above the reporting limit.

N Spiked sample recovery not within limits. This qualifier is applied to the parent sample when MS/MSD recoveries are not within acceptable limits.

r This footnote is analyst defined. The data sheets will list "r" footnotes with consecutive numbers. The electronic data deliverable will show "r" data qualifiers. Please see datasheet for exact definition.

LIMs Report Key

Section	Description
Cover Letter	Signature page. report narrative as applicable.
Sample Description Information	Tabulated cross-reference between the Lab ID and Client ID, including matrix, date and time sampled, and the date received for all samples in the project.
Sample Analysis Results Sheets	Lists sample results, test components, reporting limits. dates prepared and analyzed. and any data qualifiers. Pages are organized by test.
QC LOT Assignment Report	Cross-reference between lab IDs and applicable QC batches (DCS. LCS. Blank. MS/SD. DU)
Duplicate Control Sample Report	Percent recovery and RPD results, with acceptance limits. for the laboratory duplicate control samples for each test are tabulated in this report. These are measures of accuracy and precision for each test. Acceptance limits are based upon laboratory historical data.
Laboratory Control Sample Report	Percent recovery results for a single Laboratory Control Sample (if applicable) are tabulated in this report. with the applicable acceptance limits for each test.
Matrix Spike/Matrix Spike Duplicate Report	Percent recovery and RPD results for matrix-specific QC samples and acceptance limits, where applicable. This report can be used to assess matrix effects on an analysis.
Single Control Sample Report	A tabulation of the surrogate recoveries for the blank for organic analyses.
Method Blank Report	A summary of the results of the analysis of the method blank for each test.

List of Abbreviations and Terms

Abbreviation	Term	Abbreviation	Term
DCS	Duplicate Control Sample	MSD	Matrix Spike Duplicate
DU	Sample Duplicate	QC Run	Preparation Batch
EB	Equipment Blank	QC Category	LIMs QC Category
FB	Field Blank	QC Lot	DCS Batch
FD	Field Duplicate	ND	Not Detected at or above the reporting limit expressed
IDL	Instrument Detection Limit (Metals)	QC Matrix	Matrix of the laboratory control sample(s)
LCS	Laboratory Control Sample	RL	Reporting Limit
MB	Method Blank	QC	Quality Control
MDL	Method Detection Limit	SA	Sample
MS	Matrix Spike	SD	Spike Duplicate
RPD	Relative Percent Difference	TB	Trip Blank
ppm (part-per-million)	mg/L or mg/kg (usually)	ppb (part-per-billion)	ug/L or ug/kg (usually)
QUAL	Qualifier flag	DIL	Dilution Factor

SAMPLE DESCRIPTION INFORMATION
for
Parsons Engineering Science

Lab ID	Client ID	Matrix	Sampled Date	Sampled Time	Received Date
059550-0001-SA	FT-16, MP-4 (0.00,0.00)	GRND-H20	20 MAR 98	09:00	21 MAR 98
059550-0002-SA	FT-16, MW-3 (0.00,0.00)	GRND-H20	20 MAR 98	13:30	21 MAR 98
059550-0002-MS	FT-16, MW-3 (0.00,0.00)	GRND-H20	20 MAR 98	13:30	21 MAR 98
059550-0002-SD	FT-16, MW-3 (0.00,0.00)	GRND-H20	20 MAR 98	13:30	21 MAR 98
059550-0003-SA	FT-16, MW-7 (0.00,0.00)	GRND-H20	20 MAR 98	15:00	21 MAR 98
059550-0004-SA	FT-16, SB-1 (0.00,0.00)	GRND-H20	20 MAR 98	16:00	21 MAR 98
059550-0005-SA	FT-16, SB-3 (0.00,0.00)	GRND-H20	20 MAR 98	17:00	21 MAR 98
059550-0006-SA	SOBO-1 (3.00,4.00)	SOIL	17 MAR 98	08:35	21 MAR 98
059550-0007-SA	SOBO-1 (4.00,6.00)	SOIL	17 MAR 98	08:50	21 MAR 98
059550-0007-MS	SOBO-1 (4.00,6.00)	SOIL	17 MAR 98	08:50	21 MAR 98
059550-0007-SD	SOBO-1 (4.00,6.00)	SOIL	17 MAR 98	08:50	21 MAR 98
059550-0008-SA	SOBO-2 (3.00,4.00)	SOIL	17 MAR 98	09:45	21 MAR 98
059550-0009-SA	SOBO-3 (4.00,5.50)	SOIL	17 MAR 98	10:40	21 MAR 98
059550-0010-SA	SOBO-5 (2.00,3.00)	SOIL	17 MAR 98	13:40	21 MAR 98
059550-0011-SA	SOBO-4 (4.00,5.50)	SOIL	17 MAR 98	14:45	21 MAR 98
059550-0012-SA	SOBO-4 (7.00,8.00)	SOIL	17 MAR 98	14:50	21 MAR 98
059550-0013-SA	SOBO-A (7.00,8.00)	SOIL	17 MAR 98	15:00	21 MAR 98
059550-0014-SA	SOBO-6 (2.00,3.50)	SOIL	18 MAR 98	06:30	21 MAR 98
059550-0015-SA	SOBO-6 (6.00,7.00)	SOIL	18 MAR 98	06:45	21 MAR 98
059550-0016-SA	SED-1 (0.00,0.00)	SOIL	19 MAR 98	08:00	21 MAR 98
059550-0017-SA	FT-16, MW-4 (0.00,0.00)	GRND-H20	20 MAR 98	09:45	21 MAR 98
059550-0018-SA	FT-16, MW-20 (0.00,0.00)	GRND-H20	20 MAR 98	18:00	21 MAR 98

A 7

Quanterra
Environmental
Services

ANALYTICAL TEST REQUESTS
for
Parsons Engineering Science

Page 1 of 2

Lab ID: 059550	Group Code	Analysis Description	Custom Test?
0001 , 0017, 0018	A	Method EPA-9 RSK-175 by GC/FID	Y
		AFCEE	N
		Nitrate, Ion Chromatography	N
		Prep - Total Metals, Furnace AA	N
		AFCEE	N
		Lead, Furnace AA (Totals)	N
		AFCEE	Y
		Aromatic VOAs by Method 8020A with MTBE & TMBs	Y
		GC Prep For Waters	N
		AFCEE	Y
		Aromatic VOAs by Method 8020A (Second Column)	Y
		AFCEE	N
		Polynuclear Aromatic Hydrocarbons, HPLC	N
		AFCEE	N
		Prep - Polynuclear Aromatic Hydrocarbons - HPLC	N
		AFCEE	N
		Polynuclear Aromatic Hydrocarbons, HPLC (confir	Nat
		Method FL-PRO - TPH (C8-C40)	N
		Prep - TPH (C8-C40)	N
		Method 504 - EDB	N
		Prep-1,2-Dibromoethane (EDB)	N
0009 - 0015	B	Percent Water	N
		AFCEE	Y
		Aromatic Volatile Organics with MTBE	Y
		GC Prep For Soils	N
		AFCEE	Y
		Polynuclear Aromatic Hydrocarbons, HPLC	Y
		AFCEE	N
		Prep - Polynuclear Aromatic Hydrocarbons, HPLC	N
		AFCEE	Y
		Polynuclear Aromatic Hydrocarbons, HPLC (Confir	Yat
		AFCEE	Y
		Aromatic Volatile Organics (2nd Column)	Y
		Method FL-PRO - TPH (C8-C40)	N
		Prep - TPH (C8-C40) - FL-PRO	N
0002 - 0005	C	Method EPA-9 RSK-175 by GC/FID	Y
		AFCEE	N
		Nitrate, Ion Chromatography	N
		GC Prep For Waters	N
		AFCEE	Y
		Aromatic VOAs by Method 8020A (Second Column)	Y

ANALYTICAL TEST REQUESTS
for
Parsons Engineering Science

Lab ID: 059550	Group Code	Analysis Description	Custom Test?
		AFCEE	Y
		Aromatic VOAs by Method 8020A with MTBE & TMBs	Y
0006 - 0008	D	Total Organic Carbon (TOC)	N
		Prep - Total Organic Carbon	N
		Total Organic Carbon (TOC)	N
		Total Organic Carbon (TOC)	N
		Total Organic Carbon (TOC)	N
		Percent Water	N
0016	E	AFCEE	Y
		Polynuclear Aromatic Hydrocarbons, HPLC (Confirmat	Y
		AFCEE	N
		Prep - Polynuclear Aromatic Hydrocarbons, HPLC	N
		Lead, Furnace AA	N
		Prep - Total Metals, Furnace AA	N
		Percent Water	N
		AFCEE	N
		Polynuclear Aromatic Hydrocarbons, HPLC	N

AFCEE^Aromatic VOAs by Method 8020A with MTBE & TMBs
Method 8020A

Client Name: Parsons Engineering Science
Client ID: FT-16, MP-4 (0.00,0.00)
LAB ID: 059550-0001-SA
Matrix: GRND-H2O
Authorized: 21 MAR 98
Instrument: GCPID-H

Sampled: 20 MAR 98
Prepared: 24 MAR 98
Dilution: 2.0

Received: 21 MAR 98
Analyzed: 25 MAR 98

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	71	M	4.0	0.11	ug/L
Toluene	1.1	JM	4.0	0.30	ug/L
Ethylbenzene	44	M	4.0	0.11	ug/L
Xylenes (total)	17	M	4.0	0.30	ug/L
tert-Butyl methyl ether	ND		10	0.020	ug/L

Surrogate	Recovery		Acceptable Range
a.a.a-Trifluorotoluene	98	%	44 - 165
Fluorobenzene	95	%	44 - 165

J = Result is detected below the reporting limit or is an estimated concentration.
M = Preferred Result
ND = Not Detected

Reported By: Shawn Hadley

Approved By: Barbara Sullivan

AFCEE^Aromatic VOAs by Method 8020A (Second Column)
Method 8020A

Client Name: Parsons Engineering Science
Client ID: FT-16, MP-4 (0.00,0.00)
LAB ID: 059550-0001-SA
Matrix: GRND-H2O
Sampled: 20 MAR 98
Received: 21 MAR 98
Authorized: 21 MAR 98
Prepared: 24 MAR 98
Analyzed: 25 MAR 98
Instrument: GCPID-H
Dilution: 2.0

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	73	d	4.0	0.11	ug/L
Toluene	1.2	Jd	4.0	0.30	ug/L
Ethylbenzene	44	d	4.0	0.11	ug/L
Xylenes (total)	18	d	4.0	0.30	ug/L
tert-Butyl methyl ether	ND		10	0.020	ug/L

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	104	%	44 - 165
Fluorobenzene	96	%	44 - 165

d = See Preferred Result on Other Column
J = Result is detected below the reporting limit or is an estimated concentration.
ND = Not Detected

Reported By: Shawn Hadley

Approved By: Barbara Sullivan

AFCEE^Aromatic VOAs by Method 8020A with MTBE & TMBs
Method 8020A

Client Name: Parsons Engineering Science
Client ID: FT-16, MW-3 (0.00,0.00)
LAB ID: 059550-0002-SA
Matrix: GRND-H2O
Authorized: 21 MAR 98
Instrument: GCPID-H
Sampled: 20 MAR 98
Prepared: 24 MAR 98
Dilution: 1.0
Received: 21 MAR 98
Analyzed: 25 MAR 98

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	ND		2.0	0.055	ug/L
Toluene	ND		2.0	0.065	ug/L
Ethylbenzene	ND		2.0	0.053	ug/L
Xylenes (total)	ND		2.0	0.32	ug/L
tert-Butyl methyl ether	ND		5.0	0.061	ug/L

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	99	%	44 - 165
Fluorobenzene	94	%	44 - 165

ND = Not Detected

Reported By: Shawn Hadley

Approved By: Barbara Sullivan

AFCEE^Aromatic VOAs by Method 8020A with MTBE & TMBs
Method 8020A

Client Name: Parsons Engineering Science
Client ID: FT-16, MW-7 (0.00,0.00)
LAB ID: 059550-0003-SA
Matrix: GRND-H2O
Authorized: 21 MAR 98
Instrument: GCPID-H

Sampled: 20 MAR 98
Prepared: 24 MAR 98
Dilution: 1.0

Received: 21 MAR 98
Analyzed: 25 MAR 98

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	ND		2.0	0.055	ug/L
Toluene	ND		2.0	0.065	ug/L
Ethylbenzene	ND		2.0	0.053	ug/L
Xylenes (total)	ND		2.0	0.32	ug/L
tert-Butyl methyl ether	ND		5.0	0.061	ug/L

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	99	%	44 - 165
Fluorobenzene	95	%	44 - 165

ND = Not Detected

Reported By: Shawn Hadley

Approved By: Barbara Sullivan

AFCEE^Aromatic VOAs by Method 8020A with MTBE & TMBs
Method 8020A

Client Name: Parsons Engineering Science
Client ID: FT-16, SB-1 (0.00,0.00)
LAB ID: 059550-0004-SA
Matrix: GRND-H20
Authorized: 21 MAR 98
Instrument: GCPID-H
Sampled: 20 MAR 98
Prepared: 24 MAR 98
Dilution: 1.0
Received: 21 MAR 98
Analyzed: 25 MAR 98

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	ND		2.0	0.055	ug/L
Toluene	ND		2.0	0.065	ug/L
Ethylbenzene	3.6	d	2.0	0.053	ug/L
Xylenes (total)	11	M	2.0	0.32	ug/L
tert-Butyl methyl ether	ND		5.0	0.061	ug/L

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	101	%	44 - 165
Fluorobenzene	94	%	44 - 165

d = See Preferred Result on Other Column
M = Preferred Result
ND = Not Detected

Reported By: Shawn Hadley

Approved By: Barbara Sullivan

Quanterra
Environmental
Services

AFCEE^Aromatic VOAs by Method 8020A (Second Column)
Method 8020A

Client Name:	Parsons Engineering Science				
Client ID:	FT-16, SB-1 (0.00,0.00)				
LAB ID:	059550-0004-SA				
Matrix:	GRND-H20	Sampled:	20 MAR 98	Received:	21 MAR 98
Authorized:	21 MAR 98	Prepared:	24 MAR 98	Analyzed:	25 MAR 98
Instrument:	GCPID-H	Dilution:	1.0		

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	ND		2.0	0.056	ug/L
Toluene	ND		2.0	0.15	ug/L
Ethylbenzene	3.5	M	2.0	0.054	ug/L
Xylenes (total)	12	d	2.0	0.15	ug/L
tert-Butyl methyl ether	ND		5.0	0.010	ug/L

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	101	%	44 - 165
Fluorobenzene	94	%	44 - 165

d = See Preferred Result on Other Column
M = Preferred Result
ND = Not Detected

Reported By: Shawn Hadley

Approved By: Barbara Sullivan

AFCEE^Aromatic VOAs by Method 8020A with MTBE & TMBs
Method 8020A

Client Name:	Parsons Engineering Science		
Client ID:	FT-16, SB-3 (0.00,0.00)		
LAB ID:	059550-0005-SA		
Matrix:	GRND-H20	Sampled: 20 MAR 98	Received: 21 MAR 98
Authorized:	21 MAR 98	Prepared: 24 MAR 98	Analyzed: 25 MAR 98
Instrument:	GCPID-H	Dilution: 1.0	

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	8.3	M	2.0	0.055	ug/L
Toluene	ND	M	2.0	0.065	ug/L
Ethylbenzene	29	M	2.0	0.053	ug/L
Xylenes (total)	ND	M	2.0	0.32	ug/L
tert-Butyl methyl ether	ND		5.0	0.061	ug/L

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	99	%	44 - 165
Fluorobenzene	97	%	44 - 165

M = Preferred Result
ND = Not Detected

Reported By: Shawn Hadley

Approved By: Barbara Sullivan

AFCEE^Aromatic VOAs by Method 8020A (Second Column)
Method 8020A

Client Name:	Parsons Engineering Science		
Client ID:	FT-16, SB-3 (0.00,0.00)		
LAB ID:	059550-0005-SA		
Matrix:	GRND-H20	Sampled: 20 MAR 98	Received: 21 MAR 98
Authorized:	21 MAR 98	Prepared: 24 MAR 98	Analyzed: 25 MAR 98
Instrument:	GCPID-H	Dilution: 1.0	

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	8.6	d	2.0	0.056	ug/L
Toluene	ND	d	2.0	0.15	ug/L
Ethylbenzene	29	d	2.0	0.054	ug/L
Xylenes (total)	ND	d	2.0	0.15	ug/L
tert-Butyl methyl ether	ND		5.0	0.010	ug/L

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	105	%	44 - 165
Fluorobenzene	97	%	44 - 165

d = See Preferred Result on Other Column
ND = Not Detected

Reported By: Shawn Hadley

Approved By: Barbara Sullivan

AFCEE^Aromatic Volatile Organics with MTBE
Method 8020A

Client Name:	Parsons Engineering Science		
Client ID:	SOBO-3 (4.00,5.50)		
LAB ID:	059550-0009-SA		
Matrix:	SOIL	Sampled: 17 MAR 98	Received: 21 MAR 98
Authorized:	21 MAR 98	Prepared: 23 MAR 98	Analyzed: 23 MAR 98
Instrument:	GCPID-H	Dilution: 1.0	

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	ND		0.0059	0.00059	mg/kg
Toluene	ND		0.0059	0.0014	mg/kg
Ethylbenzene	ND		0.0023	0.00059	mg/kg
Xylenes (total)	ND		0.0059	0.0018	mg/kg
Methyl-tert-butyl ether	ND		0.0059	0.0018	mg/kg

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	104	%	34 - 175
Fluorobenzene	96	%	34 - 175

Percent moisture is 14.8%. All results and limits are reported on a dry weight basis.

ND = Not Detected

Reported By: Shawn Hadley

Approved By: Barbara Sullivan

AFCEE^Aromatic Volatile Organics with MTBE
Method 8020A

Client Name: Parsons Engineering Science
Client ID: SOBO-5 (2.00,3.00)
LAB ID: 059550-0010-SA
Matrix: SOIL
Authorized: 21 MAR 98
Instrument: GCPID-H
Sampled: 17 MAR 98
Prepared: 23 MAR 98
Dilution: 1.0
Received: 21 MAR 98
Analyzed: 23 MAR 98

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	ND		0.0059	0.00059	mg/kg
Toluene	ND		0.0059	0.0014	mg/kg
Ethylbenzene	ND		0.0023	0.00059	mg/kg
Xylenes (total)	ND		0.0059	0.0018	mg/kg
Methyl-tert-butyl ether	ND		0.0059	0.0018	mg/kg

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	105	%	34 - 175
Fluorobenzene	100	%	34 - 175

Percent moisture is 14.8%. All results and limits are reported on a dry weight basis.

ND = Not Detected

Reported By: Shawn Hadley

Approved By: Barbara Sullivan

AFCEE^Aromatic Volatile Organics with MTBE
Method 8020A

Client Name:	Parsons Engineering Science		
Client ID:	SOBO-4 (4.00,5.50)		
LAB ID:	059550-0011-SA		
Matrix:	SOIL	Sampled: 17 MAR 98	Received: 21 MAR 98
Authorized:	21 MAR 98	Prepared: 23 MAR 98	Analyzed: 23 MAR 98
Instrument:	GCPID-H	Dilution: 1.0	

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	ND		0.0059	0.00059	mg/kg
Toluene	ND		0.0059	0.0014	mg/kg
Ethylbenzene	ND		0.0024	0.00059	mg/kg
Xylenes (total)	ND		0.0059	0.0018	mg/kg
Methyl-tert-butyl ether	ND		0.0059	0.0018	mg/kg

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	105	%	34 - 175
Fluorobenzene	101	%	34 - 175

Percent moisture is 15.4%. All results and limits are reported on a dry weight basis.

ND = Not Detected

Reported By: Shawn Hadley

Approved By: Barbara Sullivan

AFCEE^Aromatic Volatile Organics with MTBE
Method 8020A

Client Name:	Parsons Engineering Science		
Client ID:	SOBO-4 (7.00,8.00)		
LAB ID:	059550-0012-SA		
Matrix:	SOIL	Sampled: 17 MAR 98	Received: 21 MAR 98
Authorized:	21 MAR 98	Prepared: 23 MAR 98	Analyzed: 23 MAR 98
Instrument:	GCPID-H	Dilution: 1.0	

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	ND		0.0062	0.00062	mg/kg
Toluene	ND		0.0062	0.0015	mg/kg
Ethylbenzene	ND		0.0025	0.00062	mg/kg
Xylenes (total)	ND		0.0062	0.0019	mg/kg
Methyl-tert-butyl ether	ND		0.0062	0.0019	mg/kg

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	104	%	34 - 175
Fluorobenzene	98	%	34 - 175

Percent moisture is 19.2%. All results and limits are reported on a dry weight basis.

ND = Not Detected

Reported By: Shawn Hadley

Approved By: Barbara Sullivan

AFCEE^Aromatic Volatile Organics with MTBE
Method 8020A

Client Name: Parsons Engineering Science
Client ID: SOBO-A (7.00,8.00)
LAB ID: 059550-0013-SA
Matrix: SOIL
Authorized: 21 MAR 98
Instrument: GCPID-H
Sampled: 17 MAR 98
Prepared: 23 MAR 98
Dilution: 1.0
Received: 21 MAR 98
Analyzed: 23 MAR 98

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	ND		0.0063	0.00063	mg/kg
Toluene	ND		0.0063	0.0015	mg/kg
Ethylbenzene	0.0011	JM	0.0025	0.00063	mg/kg
Xylenes (total)	ND		0.0063	0.0019	mg/kg
Methyl-tert-butyl ether	ND		0.0063	0.0019	mg/kg

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	104	%	34 - 175
Fluorobenzene	99	%	34 - 175

Percent moisture is 20.6%. All results and limits are reported on a dry weight basis.

J = Result is detected below the reporting limit or is an estimated concentration.
M = Preferred Result
ND = Not Detected

Reported By: Shawn Hadley

Approved By: Barbara Sullivan

AFCEE
Aromatic Volatile Organics (2nd Column)
Method 8020A - Second Column

Client Name: Parsons Engineering Science
Client ID: SOBO-A (7.00,8.00)
LAB ID: 059550-0013-SA
Matrix: SOIL
Authorized: 21 MAR 98
Instrument: GCPID-H
Sampled: 17 MAR 98
Prepared: 23 MAR 98
Dilution: 1.0
Received: 21 MAR 98
Analyzed: 23 MAR 98

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	ND		0.0063	0.00032	mg/kg
Toluene	ND		0.0063	0.00057	mg/kg
Ethylbenzene	0.0014	Jd	0.0025	0.00035	mg/kg
Xylenes (total)	ND		0.0063	0.00094	mg/kg
Methyl-tert-butyl ether	ND		0.0063	0.0019	mg/kg

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	105	%	34 - 175
Fluorobenzene	99	%	34 - 175

Percent moisture is 20.6%. All results and limits are reported on a dry weight basis.

d = See Preferred Result on Other Column
J = Result is detected below the reporting limit or is an estimated concentration.
ND = Not Detected

Reported By: Shawn Hadley

Approved By: Barbara Sullivan

AFCEE^Aromatic Volatile Organics with MTBE
Method 8020A

Client Name:	Parsons Engineering Science				
Client ID:	SOBO-6 (2.00,3.50)				
LAB ID:	059550-0014-SA				
Matrix:	SOIL	Sampled:	18 MAR 98	Received:	21 MAR 98
Authorized:	21 MAR 98	Prepared:	23 MAR 98	Analyzed:	23 MAR 98
Instrument:	GCPID-H	Dilution:	1.0		

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	ND		0.0059	0.00059	mg/kg
Toluene	ND		0.0059	0.0014	mg/kg
Ethylbenzene	ND		0.0023	0.00059	mg/kg
Xylenes (total)	ND		0.0059	0.0018	mg/kg
Methyl-tert-butyl ether	ND		0.0059	0.0018	mg/kg

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	103	%	34 - 175
Fluorobenzene	102	%	34 - 175

Percent moisture is 14.7%. All results and limits are reported on a dry weight basis.

ND = Not Detected

Reported By: Shawn Hadley

Approved By: Barbara Sullivan

AFCEE^Aromatic Volatile Organics with MTBE
Method 8020A

Client Name: Parsons Engineering Science
Client ID: SOBO-6 (6.00,7.00)
LAB ID: 059550-0015-SA
Matrix: SOIL
Authorized: 21 MAR 98
Instrument: GCPID-H

Sampled: 18 MAR 98
Prepared: 23 MAR 98
Dilution: 1.0

Received: 21 MAR 98
Analyzed: 23 MAR 98

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	0.00060	JM	0.0060	0.00060	mg/kg
Toluene	0.00097	JM	0.0060	0.0015	mg/kg
Ethylbenzene	0.037	M	0.0024	0.00060	mg/kg
Xylenes (total)	0.25	M	0.0060	0.0018	mg/kg
Methyl-tert-butyl ether	ND		0.0060	0.0018	mg/kg

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	104	%	34 - 175
Fluorobenzene	106	%	34 - 175

Percent moisture is 17.3%. All results and limits are reported on a dry weight basis.

J = Result is detected below the reporting limit or is an estimated concentration.
M = Preferred Result
ND = Not Detected

Reported By: Shawn Hadley

Approved By: Barbara Sullivan

AFCEE
Aromatic Volatile Organics (2nd Column)
Method 8020A - Second Column

Client Name: Parsons Engineering Science
Client ID: SOBO-6 (6.00,7.00)
LAB ID: 059550-0015-SA
Matrix: SOIL
Authorized: 21 MAR 98
Instrument: GCPID-H
Sampled: 18 MAR 98
Prepared: 23 MAR 98
Dilution: 1.0
Received: 21 MAR 98
Analyzed: 23 MAR 98

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	0.00072	Jd	0.0060	0.00030	mg/kg
Toluene	0.00097	Jd	0.0060	0.00054	mg/kg
Ethylbenzene	0.037	d	0.0024	0.00034	mg/kg
Xylenes (total)	0.26	d	0.0060	0.00091	mg/kg
Methyl-tert-butyl ether	ND		0.0060	0.0018	mg/kg

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	120	%	34 - 175
Fluorobenzene	104	%	34 - 175

Percent moisture is 17.3%. All results and limits are reported on a dry weight basis.

d = See Preferred Result on Other Column
J = Result is detected below the reporting limit or is an estimated concentration.
ND = Not Detected

Reported By: Shawn Hadley

Approved By: Barbara Sullivan

AFCEE^Aromatic VOAs by Method 8020A with MTBE & TMBs
Method 8020A

Client Name: Parsons Engineering Science
Client ID: FT-16, MW-4 (0.00,0.00)
LAB ID: 059550-0017-SA
Matrix: GRND-H2O
Authorized: 21 MAR 98
Instrument: GCPID-H
Sampled: 20 MAR 98
Prepared: 24 MAR 98
Dilution: 1.0
Received: 21 MAR 98
Analyzed: 25 MAR 98

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	ND		2.0	0.056	ug/L
Toluene	ND		2.0	0.15	ug/L
Ethylbenzene	0.18	JM	2.0	0.054	ug/L
Xylenes (total)	0.16	JM	2.0	0.15	ug/L
tert-Butyl methyl ether	ND		5.0	0.010	ug/L

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	100	%	44 - 165
Fluorobenzene	98	%	44 - 165

J = Result is detected below the reporting limit or is an estimated concentration.
M = Preferred Result
ND = Not Detected

Reported By: Shawn Hadley

Approved By: Barbara Sullivan

AFCEE^Aromatic VOAs by Method 8020A (Second Column)
Method 8020A

Client Name: Parsons Engineering Science
Client ID: FT-16, MW-4 (0.00,0.00)
LAB ID: 059550-0017-SA
Matrix: GRND-H20
Authorized: 21 MAR 98
Instrument: GCPID-H
Sampled: 20 MAR 98
Prepared: 24 MAR 98
Dilution: 1.0
Received: 21 MAR 98
Analyzed: 25 MAR 98

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	ND		2.0	0.056	ug/L
Toluene	ND		2.0	0.15	ug/L
Ethylbenzene	0.19	Jd	2.0	0.054	ug/L
Xylenes (total)	0.30	Jd	2.0	0.15	ug/L
tert-Butyl methyl ether	ND		5.0	0.010	ug/L

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	100	%	44 - 165
Fluorobenzene	98	%	44 - 165

d = See Preferred Result on Other Column
J = Result is detected below the reporting limit or is an estimated concentration.
ND = Not Detected

Reported By: Shawn Hadley

Approved By: Barbara Sullivan

AFCEE^Aromatic VOAs by Method 8020A with MTBE & TMBs
Method 8020A

Client Name:	Parsons Engineering Science		
Client ID:	FT-16, MW-20 (0.00,0.00)		
LAB ID:	059550-0018-SA		
Matrix:	GRND-H20	Sampled: 20 MAR 98	Received: 21 MAR 98
Authorized:	21 MAR 98	Prepared: 24 MAR 98	Analyzed: 25 MAR 98
Instrument:	GCPID-H	Dilution: 1.0	

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	ND		2.0	0.056	ug/L
Toluene	ND		2.0	0.15	ug/L
Ethylbenzene	0.17	JM	2.0	0.054	ug/L
Xylenes (total)	ND		2.0	0.15	ug/L
tert-Butyl methyl ether	ND		5.0	0.010	ug/L

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	100	%	44 - 165
Fluorobenzene	93	%	44 - 165

J = Result is detected below the reporting limit or is an estimated concentration.
M = Preferred Result
ND = Not Detected

Reported By: Shawn Hadley

Approved By: Barbara Sullivan

AFCEE^Aromatic VOAs by Method 8020A (Second Column)
Method 8020A

Client Name:	Parsons Engineering Science		
Client ID:	FT-16, MW-20 (0.00,0.00)		
LAB ID:	059550-0018-SA		
Matrix:	GRND-H20	Sampled: 20 MAR 98	Received: 21 MAR 98
Authorized:	21 MAR 98	Prepared: 24 MAR 98	Analyzed: 25 MAR 98
Instrument:	GCPID-H	Dilution: 1.0	

Parameter	Result	Qualifier	RL	MDL	Units
Benzene	ND		2.0	0.056	ug/L
Toluene	ND		2.0	0.15	ug/L
Ethylbenzene	0.20	Jd	2.0	0.054	ug/L
Xylenes (total)	ND		2.0	0.15	ug/L
tert-Butyl methyl ether	ND		5.0	0.010	ug/L

Surrogate	Recovery		Acceptable Range
a,a,a-Trifluorotoluene	100	%	44 - 165
Fluorobenzene	94	%	44 - 165

d = See Preferred Result on Other Column
J = Result is detected below the reporting limit or is an estimated concentration.
ND = Not Detected

Reported By: Shawn Hadley

Approved By: Barbara Sullivan

QC LOT ASSIGNMENT REPORT
Organics by Chromatography

Laboratory Sample Number	QC Matrix	QC Category	QC Lot Number (DCS)	QC Run Number (SCS/BLANK)
059550-0001-SA	AQUEOUS	8020-PAR-A	25 MAR 98-H	25 MAR 98-H
059550-0001-SA	AQUEOUS	8020-PAR-A	25 MAR 98-H	25 MAR 98-H
059550-0002-SA	AQUEOUS	8020-PAR-A	25 MAR 98-H	25 MAR 98-H
059550-0002-MS	AQUEOUS	8020-PAR-A	25 MAR 98-H	25 MAR 98-H
059550-0002-SD	AQUEOUS	8020-PAR-A	25 MAR 98-H	25 MAR 98-H
059550-0003-SA	AQUEOUS	8020-PAR-A	25 MAR 98-H	25 MAR 98-H
059550-0004-SA	AQUEOUS	8020-PAR-A	25 MAR 98-H	25 MAR 98-H
059550-0004-SA	AQUEOUS	8020-PAR-A	25 MAR 98-H	25 MAR 98-H
059550-0005-SA	AQUEOUS	8020-PAR-A	25 MAR 98-H	25 MAR 98-H
059550-0005-SA	AQUEOUS	8020-PAR-A	25 MAR 98-H	25 MAR 98-H
059550-0009-SA	SOIL	8020-PR-LS	23 MAR 98-H	23 MAR 98-H
059550-0010-SA	SOIL	8020-PR-LS	23 MAR 98-H	23 MAR 98-H
059550-0011-SA	SOIL	8020-PR-LS	23 MAR 98-H	23 MAR 98-H
059550-0012-SA	SOIL	8020-PR-LS	23 MAR 98-H	23 MAR 98-H
059550-0013-SA	SOIL	8020-PR-LS	23 MAR 98-H	23 MAR 98-H
059550-0013-SA	SOIL	8020-AF-LS	23 MAR 98-H	23 MAR 98-H
059550-0014-SA	SOIL	8020-PR-LS	23 MAR 98-H	23 MAR 98-H
059550-0015-SA	SOIL	8020-PR-LS	23 MAR 98-H	23 MAR 98-H
059550-0015-SA	SOIL	8020-AF-LS	23 MAR 98-H	23 MAR 98-H
059550-0017-SA	AQUEOUS	8020-PAR-A	25 MAR 98-H	25 MAR 98-H
059550-0017-SA	AQUEOUS	8020-PAR-A	25 MAR 98-H	25 MAR 98-H
059550-0018-SA	AQUEOUS	8020-PAR-A	25 MAR 98-H	25 MAR 98-H
059550-0018-SA	AQUEOUS	8020-PAR-A	25 MAR 98-H	25 MAR 98-H

LABORATORY CONTROL SAMPLE REPORT
Organics by Chromatography
Project: 059550

Category: 8020-PAR-A Method 8020A - AFCEE Aromatic Volatile Organics with MTBE
Matrix: AQUEOUS
Date Analyzed: 25 MAR 98
QC Run: 25 MAR 98-H
Concentration Units: ug/L

Analyte	Concentration Spiked	Concentration Measured	Accuracy(%) LCS	Accuracy(%) Limits
Benzene	20.0	21.2	106	75-125
Toluene	20.0	20.6	103	70-125
Chlorobenzene	20.0	20.4	102	75-129
Ethylbenzene	20.0	20.3	102	71-129
Xylenes (total)	60.0	61.7	103	71-133
1,3-Dichlorobenzene	20.0	20.7	104	70-131
1,2-Dichlorobenzene	20.0	20.7	104	61-134
1,4-Dichlorobenzene	20.0	20.9	104	75-126
tert-Butyl methyl ether	20.0	22.3	112	65-138

Surrogates	Concentration Spiked	Concentration Measured	Accuracy(%) LCS	Accuracy(%) Limits
a,a,a-Trifluorotoluene	30.0	29.8	99	44-165
Fluorobenzene	30.0	28.2	94	44-165

Category: 8020-PR-LS Aromatic Volatile Organics (AFCEE-Low Level) with MTBE
Matrix: SOIL
Date Analyzed: 23 MAR 98
QC Run: 23 MAR 98-H
Concentration Units: mg/kg

Analyte	Concentration Spiked	Concentration Measured	Accuracy(%) LCS	Accuracy(%) Limits
Benzene	0.0500	0.0559	112	66-135
Toluene	0.0500	0.0517	103	60-135
Chlorobenzene	0.0500	0.0525	105	66-139
Ethylbenzene	0.0500	0.0523	105	61-139
Xylenes (total)	0.150	0.157	105	61-143
1,3-Dichlorobenzene	0.0500	0.0521	104	60-141
1,4-Dichlorobenzene	0.0500	0.0531	106	66-136
1,2-Dichlorobenzene	0.0500	0.0509	102	51-144
Methyl-tert-butyl ether	0.0500	0.0589	118	25-175

Surrogates	Concentration Spiked	Concentration Measured	Accuracy(%) LCS	Accuracy(%) Limits
a,a,a-Trifluorotoluene	0.0750	0.0783	104	34-175
Fluorobenzene	0.0750	0.0723	96	34-175

Calculations are performed before rounding to avoid round-off errors in calculated results.

SINGLE CONTROL SAMPLE REPORT
Organics by Chromatography

Analyte	Concentration Spiked	Measured	Accuracy(%) SCS	Limits
Category: 8020-PAR-A Matrix: AQUEOUS QC Lot: 25 MAR 98-H QC Run: 25 MAR 98-H Concentration Units: ug/L				
a,a,a-Trifluorotoluene	30.0	29.8	99	44-165
Fluorobenzene	30.0	27.9	93	44-165
Category: 8020-PR-LS Matrix: SOIL QC Lot: 23 MAR 98-H QC Run: 23 MAR 98-H Concentration Units: mg/kg				
a,a,a-Trifluorotoluene	0.0750	0.0788	105	34-175
Fluorobenzene	0.0750	0.0728	97	34-175

Calculations are performed before rounding to avoid round-off errors in calculated results.

METHOD BLANK REPORT
Organics by Chromatography
Project: 059550

Test: 8020-PAR-MDL-AP AFCEE Aromatic VOAs by Method 8020A with MTBE & TMBs
Matrix: AQUEOUS
QC Lot: 25 MAR 98-H QC Run: 25 MAR 98-H Date Analyzed: 25 MAR 98

Analyte	Result	Units	RL	MDL
Benzene	ND	ug/L	2.0	0.056
Toluene	ND	ug/L	2.0	0.15
Ethylbenzene	ND	ug/L	2.0	0.054
Xylenes (total)	ND	ug/L	2.0	0.15
tert-Butyl methyl ether	ND	ug/L	5.0	0.010

Test: 8020-PAR-MDL-2-AP AFCEE Aromatic VOAs by Method 8020A (Second Column)
Matrix: AQUEOUS
QC Lot: 25 MAR 98-H QC Run: 25 MAR 98-H Date Analyzed: 25 MAR 98

Analyte	Result	Units	RL	MDL
Benzene	ND	ug/L	2.0	0.056
Toluene	ND	ug/L	2.0	0.15
Ethylbenzene	ND	ug/L	2.0	0.054
Xylenes (total)	ND	ug/L	2.0	0.15
tert-Butyl methyl ether	ND	ug/L	5.0	0.010

Test: 8020-PAR-MDL-L-S AFCEE Aromatic Volatile Organics with MTBE
Matrix: SOIL
QC Lot: 23 MAR 98-H QC Run: 23 MAR 98-H Date Analyzed: 23 MAR 98

Analyte	Result	Units	RL	MDL
Benzene	ND	mg/kg	0.0050	0.00050
Toluene	ND	mg/kg	0.0050	0.0012
Ethylbenzene	ND	mg/kg	0.0020	0.00050
Xylenes (total)	ND	mg/kg	0.0050	0.0015
Methyl-tert-butyl ether	ND	mg/kg	0.0050	0.0015

ND = Not Detected

MATRIX SPIKE/MATRIX SPIKE DUPLICATE QC REPORT
Organics by Chromatography
Project: 059550

Category: 8020-PAR-A Method 8020A - AFCEE Aromatic Volatile Organics with MTBE
Matrix: AQUEOUS
Sample: 059550-0002
MS Run: 25 MAR 98-H
Units: ug/L

		Concentration		Amount Spiked		% Recovery		Recov. Accep. Limits	RPD MS-MSD	RPD Accept Limits
Analyte	Sample Result	MS Result	MSD Result	MS	MSD	MS	MSD			
Benzene	ND	21.8	21.7	20.0	20.0	109	108	75-125	0.4	20
Toluene	ND	21.2	21.2	20.0	20.0	106	106	70-125	0.0	20
Chlorobenzene	ND	21.1	21.0	20.0	20.0	106	105	75-129	0.4	20
Ethylbenzene	ND	20.6	20.4	20.0	20.0	103	102	71-129	0.9	20
Xylenes (total)	ND	63.5	62.9	60.0	60.0	106	105	71-133	0.9	20
1,3-Dichlorobenzene	ND	21.4	21.2	20.0	20.0	107	106	70-131	0.9	20
1,2-Dichlorobenzene	ND	21.5	21.4	20.0	20.0	108	107	61-134	0.4	20
1,4-Dichlorobenzene	ND	21.4	21.9	20.0	20.0	107	110	75-126	2.3	20
tert-Butyl methyl ether	ND	22.8	23.7	20.0	20.0	114	118	65-138	3.9	20
1,2,3-Trimethylbenzene	NA	NA	NA	NA	20.0	NC	NC	70-130	NC	20
1,3,5-Trimethylbenzene	NA	NA	NA	NA	20.0	NC	NC	70-130	NC	20
1,2,4-Trimethylbenzene	NA	NA	NA	NA	20.0	NC	NC	70-130	NC	20

Surrogates		%Recovery		Rec. Accept. Limits
a,a,a-Trifluorotoluene	98.8	100	99.2	44-165
Fluorobenzene	93.7	94.8	96.1	44-165

NA = Not Applicable
NC = Not Calculated, calculation not applicable.
ND = Not Detected

Calculations are performed before rounding to avoid round-off errors in calculated results.

MATRIX SPIKE/MATRIX SPIKE DUPLICATE QC REPORT
Organics by Chromatography
Project: 059550 (cont.)

Category: 8020-PR-LS Aromatic Volatile Organics (AFCEE-Low Level) with MTBE
Matrix: SOIL
Sample: 059549-0004
MS Run: 23 MAR 98-H
Units mg/kg Units Qualifier: Dry weight

	Concentration			Amount Spiked		% Recovery		Recov. Accep.	RPD	RPD Accept
Analyte	Sample Result	MS Result	MSD Result	MS	MSD	MS	MSD	Limits	MS-MSD	Limits
Benzene	ND	0.0573	0.0603	0.0500	0.0500	115	121	66-135	5.1	30
Toluene	ND	0.0517	0.0537	0.0500	0.0500	103	107	60-135	3.8	30
Chlorobenzene	ND	0.0517	0.0535	0.0500	0.0500	103	107	66-139	3.4	30
Ethylbenzene	ND	0.0497	0.0500	0.0500	0.0500	99	100	61-139	0.6	30
Xylenes (total)	ND	0.148	0.145	0.150	0.150	99	96	61-143	2.3	30
1,3-Dichlorobenzene	ND	0.0465	0.0460	0.0500	0.0500	93	92	60-141	1.1	30
1,4-Dichlorobenzene	ND	0.0481	0.0479	0.0500	0.0500	96	96	66-136	0.4	30
1,2-Dichlorobenzene	ND	0.0429	0.0418	0.0500	0.0500	86	84	51-144	2.6	30
Methyl-tert-butyl ether	ND	0.0587	0.0639	0.0500	0.0500	117	128	25-175	8.5	50

Surrogates		%Recovery		Rec. Accept. Limits
a,a,a-Trifluorotoluene	106	103	103	34-175
Fluorobenzene	102	100	106	34-175

ND = Not Detected

Calculations are performed before rounding to avoid round-off errors in calculated results.

Quanterra
Environmental
Services

AFCEE
Polynuclear Aromatic Hydrocarbons, HPLC
Method 8310

Client Name: Parsons Engineering Science
Client ID: FT-16, MP-4 (0.00,0.00)
LAB ID: 059550-0001-SA
Matrix: GRND-H20 Sampled: 20 MAR 98 Received: 21 MAR 98
Authorized: 21 MAR 98 Prepared: 26 MAR 98 Analyzed: 14 APR 98
Instrument: HPLC-Q Dilution: 1.0

Parameter	Result	Qualifier	RL	MDL	Units
Acenaphthene	ND		1.0	0.093	ug/L
Acenaphthylene	ND		1.0	0.040	ug/L
Anthracene	ND		0.10	0.030	ug/L
Benzo(a)anthracene	ND		0.13	0.060	ug/L
Benzo(a)pyrene	ND		0.23	0.065	ug/L
Benzo(b)fluoranthene	ND		0.18	0.059	ug/L
Benzo(g,h,i)perylene	ND		0.20	0.071	ug/L
Benzo(k)fluoranthene	ND		0.17	0.059	ug/L
Chrysene	ND		0.20	0.073	ug/L
Dibenz(a,h)anthracene	ND		0.30	0.076	ug/L
Fluorene	ND		0.20	0.035	ug/L
Fluoranthene	ND		0.20	0.036	ug/L
Indeno(1,2,3-cd)pyrene	ND		0.43	0.055	ug/L
Naphthalene	0.66	Jd	1.0	0.059	ug/L
Phenanthrene	ND		0.20	0.030	ug/L
Pyrene	ND		0.20	0.043	ug/L

Surrogate	Recovery		Acceptable Range
Terphenyl-d14	18	%	25 - 157

d = See Preferred Result on Other Column
J = Result is detected below the reporting limit or is an estimated concentration.
ND = Not Detected

Reported By: Blake Besser Approved By: Barbara Sullivan

Quanterra
Environmental
Services

AFCEE
Polynuclear Aromatic Hydrocarbons, HPLC (confirmation)
Method 8310

Client Name:	Parsons Engineering Science		
Client ID:	FT-16, MP-4 (0.00,0.00)		
LAB ID:	059550-0001-SA		
Matrix:	GRND-H2O	Sampled: 20 MAR 98	Received: 21 MAR 98
Authorized:	21 MAR 98	Prepared: 26 MAR 98	Analyzed: 14 APR 98
Instrument:	HPLC-Q	Dilution: 1.0	

Parameter	Result	Qualifier	RL	MDL	Units
Acenaphthene	ND		1.0	0.093	ug/L
Acenaphthylene	ND		1.0	0.040	ug/L
Anthracene	ND		0.10	0.030	ug/L
Benzo(a)anthracene	ND		0.13	0.060	ug/L
Benzo(a)pyrene	ND		0.23	0.065	ug/L
Benzo(b)fluoranthene	ND		0.18	0.059	ug/L
Benzo(g,h,i)perylene	ND		0.20	0.071	ug/L
Benzo(k)fluoranthene	ND		0.17	0.059	ug/L
Chrysene	ND		0.20	0.073	ug/L
Dibenz(a,h)anthracene	ND		0.30	0.076	ug/L
Fluorene	ND		0.20	0.035	ug/L
Fluoranthene	ND		0.20	0.036	ug/L
Indeno(1,2,3-cd)pyrene	ND		0.43	0.055	ug/L
Naphthalene	0.60	JM	1.0	0.059	ug/L
Phenanthrene	ND		0.20	0.030	ug/L
Pyrene	ND		0.20	0.043	ug/L

Surrogate	Recovery		Acceptable Range
Terphenyl-d14	18	%	25 - 157

J = Result is detected below the reporting limit or is an estimated concentration.
M = Preferred Result
ND = Not Detected

Reported By: Blake Besser

Approved By: Barbara Sullivan

AFCEE
Polynuclear Aromatic Hydrocarbons, HPLC
Method 8310

Client Name: Parsons Engineering Science
Client ID: SOBO-3 (4.00,5.50)
LAB ID: 059550-0009-SA
Matrix: SOIL
Authorized: 21 MAR 98
Instrument: HPLC-Q
Sampled: 17 MAR 98
Prepared: 31 MAR 98
Dilution: 1.0
Received: 21 MAR 98
Analyzed: 17 APR 98

Parameter	Result	Qualifier	RL	MDL	Units
Acenaphthene	ND		0.23	0.042	mg/kg
Acenaphthylene	ND		0.23	0.057	mg/kg
Anthracene	ND		0.023	0.0030	mg/kg
Benzo(a)anthracene	ND		0.023	0.0040	mg/kg
Benzo(a)pyrene	ND		0.018	0.0026	mg/kg
Benzo(b)fluoranthene	0.0061	Jd	0.014	0.0029	mg/kg
Benzo(g,h,i)perylene	ND		0.059	0.0035	mg/kg
Benzo(k)fluoranthene	ND		0.013	0.0041	mg/kg
Chrysene	ND		0.047	0.0023	mg/kg
Dibenz(a,h)anthracene	ND		0.023	0.0040	mg/kg
Fluorene	ND		0.047	0.0075	mg/kg
Fluoranthene	ND		0.047	0.0028	mg/kg
Indeno(1,2,3-cd)pyrene	ND		0.035	0.0035	mg/kg
Naphthalene	ND		0.23	0.054	mg/kg
Phenanthrene	ND		0.047	0.0065	mg/kg
Pyrene	ND		0.047	0.0030	mg/kg

Surrogate	Recovery		Acceptable Range
Terphenyl-d14	98	%	22 - 167

Percent moisture is 14.8%. All results and limits are reported on a dry weight basis.

d = See Preferred Result on Other Column
J = Result is detected below the reporting limit or is an estimated concentration.
ND = Not Detected

Reported By: Blake Besser

Approved By: Barbara Sullivan

AFCEE
Polynuclear Aromatic Hydrocarbons, HPLC (Confirmation)
Method 8310

Client Name: Parsons Engineering Science
Client ID: SOBO-3 (4.00,5.50)
LAB ID: 059550-0009-SA
Matrix: SOIL
Authorized: 21 MAR 98
Instrument: HPLC-Q
Sampled: 17 MAR 98
Prepared: 31 MAR 98
Dilution: 1.0
Received: 21 MAR 98
Analyzed: 17 APR 98

Parameter	Result	Qualifier	RL	MDL	Units
Acenaphthene	ND		0.23	0.042	mg/kg
Acenaphthylene	ND		0.23	0.057	mg/kg
Anthracene	ND		0.023	0.0030	mg/kg
Benzo(a)anthracene	ND		0.023	0.0040	mg/kg
Benzo(a)pyrene	ND		0.018	0.0026	mg/kg
Benzo(b)fluoranthene	0.0045	JM	0.014	0.0029	mg/kg
Benzo(g,h,i)perylene	ND		0.059	0.0035	mg/kg
Benzo(k)fluoranthene	ND		0.013	0.0041	mg/kg
Chrysene	ND		0.047	0.0023	mg/kg
Dibenz(a,h)anthracene	ND		0.023	0.0040	mg/kg
Fluorene	ND		0.047	0.0075	mg/kg
Fluoranthene	ND		0.047	0.0028	mg/kg
Indeno(1,2,3-cd)pyrene	ND		0.035	0.0035	mg/kg
Naphthalene	ND		0.23	0.054	mg/kg
Phenanthrene	ND		0.047	0.0065	mg/kg
Pyrene	ND		0.047	0.0030	mg/kg

Surrogate	Recovery		Acceptable Range
Terphenyl-d14	100	%	22 - 167

Percent moisture is 14.8%. All results and limits are reported on a dry weight basis.

J = Result is detected below the reporting limit or is an estimated concentration.
M = Preferred Result
ND = Not Detected

Reported By: Blake Besser
Approved By: Barbara Sullivan

AFCEE
Polynuclear Aromatic Hydrocarbons, HPLC
Method 8310

Client Name:	Parsons Engineering Science		
Client ID:	SOBO-5 (2.00,3.00)		
LAB ID:	059550-0010-SA		
Matrix:	SOIL	Sampled: 17 MAR 98	Received: 21 MAR 98
Authorized:	21 MAR 98	Prepared: 31 MAR 98	Analyzed: 17 APR 98
Instrument:	HPLC-Q	Dilution: 1.0	

Parameter	Result	Qualifier	RL	MDL	Units
Acenaphthene	ND		0.23	0.042	mg/kg
Acenaphthylene	ND		0.23	0.058	mg/kg
Anthracene	ND		0.023	0.0031	mg/kg
Benzo(a)anthracene	ND		0.023	0.0040	mg/kg
Benzo(a)pyrene	ND		0.018	0.0026	mg/kg
Benzo(b)fluoranthene	ND		0.014	0.0029	mg/kg
Benzo(g,h,i)perylene	ND		0.059	0.0035	mg/kg
Benzo(k)fluoranthene	ND		0.013	0.0041	mg/kg
Chrysene	ND		0.047	0.0023	mg/kg
Dibenz(a,h)anthracene	ND		0.023	0.0040	mg/kg
Fluorene	ND		0.047	0.0075	mg/kg
Fluoranthene	ND		0.047	0.0028	mg/kg
Indeno(1,2,3-cd)pyrene	ND		0.035	0.0035	mg/kg
Naphthalene	ND		0.23	0.054	mg/kg
Phenanthrene	ND		0.047	0.0065	mg/kg
Pyrene	ND		0.047	0.0031	mg/kg

Surrogate	Recovery		Acceptable Range
Terphenyl-d14	97	%	22 - 167

Percent moisture is 14.8%. All results and limits are reported on a dry weight basis.

ND = Not Detected

Reported By: Blake Besser

Approved By: Barbara Sullivan

AFCEE
Polynuclear Aromatic Hydrocarbons, HPLC
Method 8310

Client Name: Parsons Engineering Science
Client ID: SOBO-4 (4.00,5.50)
LAB ID: 059550-0011-SA
Matrix: SOIL
Authorized: 21 MAR 98
Instrument: HPLC-Q
Sampled: 17 MAR 98
Prepared: 31 MAR 98
Dilution: 1.0
Received: 21 MAR 98
Analyzed: 17 APR 98

Parameter	Result	Qualifier	RL	MDL	Units
Acenaphthene	ND		0.24	0.043	mg/kg
Acenaphthylene	ND		0.24	0.058	mg/kg
Anthracene	ND		0.024	0.0031	mg/kg
Benzo(a)anthracene	ND		0.024	0.0040	mg/kg
Benzo(a)pyrene	ND		0.018	0.0026	mg/kg
Benzo(b)fluoranthene	ND		0.014	0.0030	mg/kg
Benzo(g,h,i)perylene	ND		0.059	0.0035	mg/kg
Benzo(k)fluoranthene	ND		0.013	0.0041	mg/kg
Chrysene	ND		0.047	0.0024	mg/kg
Dibenz(a,h)anthracene	ND		0.024	0.0040	mg/kg
Fluorene	ND		0.047	0.0076	mg/kg
Fluoranthene	ND		0.047	0.0028	mg/kg
Indeno(1,2,3-cd)pyrene	ND		0.035	0.0035	mg/kg
Naphthalene	ND		0.24	0.054	mg/kg
Phenanthrene	ND		0.047	0.0065	mg/kg
Pyrene	ND		0.047	0.0031	mg/kg

Surrogate	Recovery		Acceptable Range
Terphenyl-d14	100	%	22 - 167

Percent moisture is 15.4%. All results and limits are reported on a dry weight basis.

ND = Not Detected

Reported By: Blake Besser

Approved By: Barbara Sullivan

AFCEE
Polynuclear Aromatic Hydrocarbons, HPLC
Method 8310

Client Name: Parsons Engineering Science
Client ID: SOBO-4 (7.00,8.00)
LAB ID: 059550-0012-SA
Matrix: SOIL Sampled: 17 MAR 98 Received: 21 MAR 98
Authorized: 21 MAR 98 Prepared: 31 MAR 98 Analyzed: 18 APR 98
Instrument: HPLC-Q Dilution: 1.0

Parameter	Result	Qualifier	RL	MDL	Units
Acenaphthene	ND		0.25	0.045	mg/kg
Acenaphthylene	ND		0.25	0.061	mg/kg
Anthracene	ND		0.025	0.0032	mg/kg
Benzo(a)anthracene	ND		0.025	0.0042	mg/kg
Benzo(a)pyrene	ND		0.019	0.0027	mg/kg
Benzo(b)fluoranthene	ND		0.015	0.0031	mg/kg
Benzo(g,h,i)perylene	ND		0.062	0.0037	mg/kg
Benzo(k)fluoranthene	ND		0.014	0.0043	mg/kg
Chrysene	ND		0.050	0.0025	mg/kg
Dibenz(a,h)anthracene	ND		0.025	0.0042	mg/kg
Fluorene	ND		0.050	0.0079	mg/kg
Fluoranthene	ND		0.050	0.0030	mg/kg
Indeno(1,2,3-cd)pyrene	ND		0.037	0.0037	mg/kg
Naphthalene	ND		0.25	0.057	mg/kg
Phenanthrene	ND		0.050	0.0068	mg/kg
Pyrene	ND		0.050	0.0032	mg/kg

Surrogate	Recovery		Acceptable Range
Terphenyl-d14	98	%	22 - 167

Percent moisture is 19.2%. All results and limits are reported on a dry weight basis.

ND = Not Detected

Reported By: Blake Besser Approved By: Barbara Sullivan

AFCEE
Polynuclear Aromatic Hydrocarbons, HPLC
Method 8310

Client Name:	Parsons Engineering Science				
Client ID:	SOBO-A (7.00,8.00)				
LAB ID:	059550-0013-SA				
Matrix:	SOIL	Sampled:	17 MAR 98	Received:	21 MAR 98
Authorized:	21 MAR 98	Prepared:	31 MAR 98	Analyzed:	18 APR 98
Instrument:	HPLC-Q	Dilution:	1.0		

Parameter	Result	Qualifier	RL	MDL	Units
Acenaphthene	ND		0.25	0.045	mg/kg
Acenaphthylene	ND		0.25	0.062	mg/kg
Anthracene	ND		0.025	0.0033	mg/kg
Benzo(a)anthracene	ND		0.025	0.0043	mg/kg
Benzo(a)pyrene	ND		0.019	0.0028	mg/kg
Benzo(b)fluoranthene	ND		0.015	0.0031	mg/kg
Benzo(g,h,i)perylene	ND		0.063	0.0038	mg/kg
Benzo(k)fluoranthene	ND		0.014	0.0044	mg/kg
Chrysene	ND		0.050	0.0025	mg/kg
Dibenz(a,h)anthracene	ND		0.025	0.0043	mg/kg
Fluorene	ND		0.050	0.0081	mg/kg
Fluoranthene	ND		0.050	0.0030	mg/kg
Indeno(1,2,3-cd)pyrene	ND		0.038	0.0038	mg/kg
Naphthalene	ND		0.25	0.058	mg/kg
Phenanthrene	ND		0.050	0.0069	mg/kg
Pyrene	ND		0.050	0.0033	mg/kg

Surrogate	Recovery		Acceptable Range
Terphenyl-d14	100	%	22 - 167

Percent moisture is 20.6%. All results and limits are reported on a dry weight basis.

ND = Not Detected

Reported By: Blake Besser   Approved By: Barbara Sullivan

Quanterra
Environmental
Services

AFCEE
Polynuclear Aromatic Hydrocarbons, HPLC
Method 8310

Client Name: Parsons Engineering Science
Client ID: SOBO-6 (2.00,3.50)
LAB ID: 059550-0014-SA
Matrix: SOIL
Authorized: 21 MAR 98
Instrument: HPLC-Q
Sampled: 18 MAR 98
Prepared: 31 MAR 98
Dilution: 1.0
Received: 21 MAR 98
Analyzed: 18 APR 98

Parameter	Result	Qualifier	RL	MDL	Units
Acenaphthene	ND		0.23	0.042	mg/kg
Acenaphthylene	ND		0.23	0.057	mg/kg
Anthracene	ND		0.023	0.0030	mg/kg
Benzo(a)anthracene	ND		0.023	0.0040	mg/kg
Benzo(a)pyrene	ND		0.018	0.0026	mg/kg
Benzo(b)fluoranthene	ND		0.014	0.0029	mg/kg
Benzo(g,h,i)perylene	ND		0.059	0.0035	mg/kg
Benzo(k)fluoranthene	ND		0.013	0.0041	mg/kg
Chrysene	ND		0.047	0.0023	mg/kg
Dibenz(a,h)anthracene	ND		0.023	0.0040	mg/kg
Fluorene	ND		0.047	0.0075	mg/kg
Fluoranthene	ND		0.047	0.0028	mg/kg
Indeno(1,2,3-cd)pyrene	ND		0.035	0.0035	mg/kg
Naphthalene	ND		0.23	0.054	mg/kg
Phenanthrene	ND		0.047	0.0064	mg/kg
Pyrene	ND		0.047	0.0030	mg/kg

Surrogate	Recovery		Acceptable Range
Terphenyl-d14	98	%	22 - 167

Percent moisture is 14.7%. All results and limits are reported on a dry weight basis.

ND = Not Detected

Reported By: Blake Besser

Approved By: Barbara Sullivan

AFCEE
Polynuclear Aromatic Hydrocarbons, HPLC
Method 8310

Client Name: Parsons Engineering Science
Client ID: SOBO-6 (6.00,7.00)
LAB ID: 059550-0015-SA
Matrix: SOIL
Authorized: 21 MAR 98
Instrument: HPLC-Q

Sampled: 18 MAR 98
Prepared: 31 MAR 98
Dilution: 1.0

Received: 21 MAR 98
Analyzed: 18 APR 98

Parameter	Result	Qualifier	RL	MDL	Units
Acenaphthene	ND		0.24	0.044	mg/kg
Acenaphthylene	ND		0.24	0.059	mg/kg
Anthracene	ND		0.024	0.0031	mg/kg
Benzo(a)anthracene	ND		0.024	0.0041	mg/kg
Benzo(a)pyrene	ND		0.018	0.0027	mg/kg
Benzo(b)fluoranthene	ND		0.015	0.0030	mg/kg
Benzo(g,h,i)perylene	ND		0.060	0.0036	mg/kg
Benzo(k)fluoranthene	ND		0.013	0.0042	mg/kg
Chrysene	ND		0.048	0.0024	mg/kg
Dibenz(a,h)anthracene	ND		0.024	0.0041	mg/kg
Fluorene	ND		0.048	0.0077	mg/kg
Fluoranthene	ND		0.048	0.0029	mg/kg
Indeno(1,2,3-cd)pyrene	ND		0.036	0.0036	mg/kg
Naphthalene	ND		0.24	0.056	mg/kg
Phenanthrene	ND		0.048	0.0066	mg/kg
Pyrene	ND		0.048	0.0031	mg/kg

Surrogate	Recovery		Acceptable Range
Terphenyl-d14	98	%	22 - 167

Percent moisture is 17.3%. All results and limits are reported on a dry weight basis.

ND = Not Detected

Reported By: Blake Besser

Approved By: Barbara Sullivan

AFCEE
Polynuclear Aromatic Hydrocarbons, HPLC
Method 8310

Client Name: Parsons Engineering Science
Client ID: SED-1 (0.00,0.00)
LAB ID: 059550-0016-SA
Matrix: SOIL
Authorized: 21 MAR 98
Instrument: HPLC-Q

Sampled: 19 MAR 98
Prepared: 31 MAR 98
Dilution: 1.0

Received: 21 MAR 98
Analyzed: 18 APR 98

Parameter	Result	Qualifier	RL	MDL	Units
Acenaphthene	ND		0.25	0.045	mg/kg
Acenaphthylene	ND		0.25	0.061	mg/kg
Anthracene	ND	d	0.025	0.0032	mg/kg
Benzo(a)anthracene	0.36	d	0.011	0.0042	mg/kg
Benzo(a)pyrene	0.26	M	0.019	0.0027	mg/kg
Benzo(b)fluoranthene	0.34	M	0.015	0.0031	mg/kg
Benzo(g,h,i)perylene	0.23	d	0.062	0.0037	mg/kg
Benzo(k)fluoranthene	0.14	M	0.014	0.0043	mg/kg
Chrysene	0.22	M	0.050	0.0025	mg/kg
Dibenz(a,h)anthracene	ND		0.025	0.0042	mg/kg
Fluorene	0.025	Jd	0.050	0.0079	mg/kg
Fluoranthene	0.30	M	0.050	0.0030	mg/kg
Indeno(1,2,3-cd)pyrene	0.20	d	0.037	0.0037	mg/kg
Naphthalene	ND		0.25	0.057	mg/kg
Phenanthrene	0.033	Jd	0.050	0.0068	mg/kg
Pyrene	0.41	d	0.050	0.0032	mg/kg

Surrogate	Recovery		Acceptable Range
Terphenyl-d14	110	%	22 - 167

Percent moisture is 19.3%. All results and limits are reported on a dry weight basis.

d = See Preferred Result on Other Column
J = Result is detected below the reporting limit or is an estimated concentration.
M = Preferred Result
ND = Not Detected

Reported By: Blake Besser

Approved By: Barbara Sullivan

AFCEE
Polynuclear Aromatic Hydrocarbons, HPLC (Confirmation)
Method 8310

Client Name: Parsons Engineering Science
Client ID: SED-1 (0.00,0.00)
LAB ID: 059550-0016-SA
Matrix: SOIL
Sampled: 19 MAR 98
Received: 21 MAR 98
Authorized: 21 MAR 98
Prepared: 31 MAR 98
Analyzed: 18 APR 98
Instrument: HPLC-Q
Dilution: 1.0

Parameter	Result	Qualifier	RL	MDL	Units
Acenaphthene	ND		0.25	0.045	mg/kg
Acenaphthylene	ND		0.25	0.061	mg/kg
Anthracene	0.012	JM	0.025	0.0032	mg/kg
Benzo(a)anthracene	0.30	M	0.011	0.0042	mg/kg
Benzo(a)pyrene	0.28	d	0.019	0.0027	mg/kg
Benzo(b)fluoranthene	0.46	d	0.015	0.0031	mg/kg
Benzo(g,h,i)perylene	0.20	M	0.062	0.0037	mg/kg
Benzo(k)fluoranthene	0.17	d	0.014	0.0043	mg/kg
Chrysene	0.38	d	0.050	0.0025	mg/kg
Dibenz(a,h)anthracene	ND		0.025	0.0042	mg/kg
Fluorene	0.025	Jd	0.050	0.0079	mg/kg
Fluoranthene	0.38	d	0.050	0.0030	mg/kg
Indeno(1,2,3-cd)pyrene	0.16	M	0.037	0.0037	mg/kg
Naphthalene	ND		0.25	0.057	mg/kg
Phenanthrene	0.017	JM	0.050	0.0068	mg/kg
Pyrene	0.38	M	0.050	0.0032	mg/kg

Surrogate	Recovery		Acceptable Range
Terphenyl-d14	97	%	22 - 167

Percent moisture is 19.3%. All results and limits are reported on a dry weight basis.

d = See Preferred Result on Other Column
J = Result is detected below the reporting limit or is an estimated concentration.
M = Preferred Result
ND = Not Detected

Reported By: Blake Besser

Approved By: Barbara Sullivan

Quanterra
Environmental
Services

AFCEE
Polynuclear Aromatic Hydrocarbons, HPLC
Method 8310

Client Name: Parsons Engineering Science
Client ID: FT-16, MW-4 (0.00,0.00)
LAB ID: 059550-0017-SA
Matrix: GRND-H2O
Authorized: 21 MAR 98
Instrument: HPLC-Q

Sampled: 20 MAR 98
Prepared: 26 MAR 98
Dilution: 1.0

Received: 21 MAR 98
Analyzed: 14 APR 98

Parameter	Result	Qualifier	RL	MDL	Units
Acenaphthene	ND		1.0	0.096	ug/L
Acenaphthylene	ND		1.0	0.041	ug/L
Anthracene	ND		0.10	0.031	ug/L
Benzo(a)anthracene	ND		0.13	0.062	ug/L
Benzo(a)pyrene	ND		0.24	0.067	ug/L
Benzo(b)fluoranthene	ND		0.19	0.061	ug/L
Benzo(g,h,i)perylene	ND		0.21	0.073	ug/L
Benzo(k)fluoranthene	ND		0.18	0.061	ug/L
Chrysene	ND		0.21	0.075	ug/L
Dibenz(a,h)anthracene	ND		0.31	0.078	ug/L
Fluorene	ND		0.21	0.036	ug/L
Fluoranthene	ND		0.21	0.037	ug/L
Indeno(1,2,3-cd)pyrene	ND		0.44	0.057	ug/L
Naphthalene	ND		1.0	0.061	ug/L
Phenanthrene	ND		0.21	0.031	ug/L
Pyrene	ND		0.21	0.044	ug/L

Surrogate	Recovery		Acceptable Range
Terphenyl-d14	120	%	25 - 157

ND = Not Detected

Reported By: Blake Besser

Approved By: Barbara Sullivan

AFCEE
Polynuclear Aromatic Hydrocarbons, HPLC
Method 8310

Client Name: Parsons Engineering Science
Client ID: FT-16, MW-20 (0.00,0.00)
LAB ID: 059550-0018-SA
Matrix: GRND-H2O
Authorized: 21 MAR 98
Instrument: HPLC-Q

Sampled: 20 MAR 98
Prepared: 26 MAR 98
Dilution: 0.99

Received: 21 MAR 98
Analyzed: 14 APR 98

Parameter	Result	Qualifier	RL	MDL	Units
Acenaphthene	ND		0.99	0.092	ug/L
Acenaphthylene	ND		0.99	0.040	ug/L
Anthracene	ND		0.099	0.030	ug/L
Benzo(a)anthracene	ND		0.13	0.059	ug/L
Benzo(a)pyrene	ND		0.23	0.064	ug/L
Benzo(b)fluoranthene	ND		0.18	0.058	ug/L
Benzo(g,h,i)perylene	ND		0.20	0.070	ug/L
Benzo(k)fluoranthene	ND		0.17	0.058	ug/L
Chrysene	ND		0.20	0.072	ug/L
Dibenz(a,h)anthracene	ND		0.30	0.075	ug/L
Fluorene	ND		0.20	0.035	ug/L
Fluoranthene	ND		0.20	0.036	ug/L
Indeno(1,2,3-cd)pyrene	ND		0.43	0.054	ug/L
Naphthalene	ND		0.99	0.058	ug/L
Phenanthrene	ND		0.20	0.030	ug/L
Pyrene	ND		0.20	0.043	ug/L

Surrogate	Recovery		Acceptable Range
Terphenyl-d14	131	%	25 - 157

ND = Not Detected

Reported By: Blake Besser

Approved By: Barbara Sullivan

QC LOT ASSIGNMENT REPORT
High Performance Liquid Chromatography

Laboratory Sample Number	QC Matrix	QC Category	QC Lot Number (DCS)	QC Run Number (SCS/BLANK)
059550-0001-SA	WATER	8310AF-A	26 MAR 98-01	26 MAR 98-01
059550-0001-SA	WATER	8310AF-A	26 MAR 98-01	26 MAR 98-01
059550-0009-SA	SOIL	8310AF-S	31 MAR 98-01	31 MAR 98-01
059550-0009-SA	SOIL	8310AF-S	31 MAR 98-01	31 MAR 98-01
059550-0010-SA	SOIL	8310AF-S	31 MAR 98-01	31 MAR 98-01
059550-0011-SA	SOIL	8310AF-S	31 MAR 98-01	31 MAR 98-01
059550-0012-SA	SOIL	8310AF-S	31 MAR 98-01	31 MAR 98-01
059550-0013-SA	SOIL	8310AF-S	31 MAR 98-01	31 MAR 98-01
059550-0014-SA	SOIL	8310AF-S	31 MAR 98-01	31 MAR 98-01
059550-0015-SA	SOIL	8310AF-S	31 MAR 98-01	31 MAR 98-01
059550-0016-SA	SOIL	8310AF-S	31 MAR 98-01	31 MAR 98-01
059550-0016-SA	SOIL	8310AF-S	31 MAR 98-01	31 MAR 98-01
059550-0017-SA	WATER	8310AF-A	26 MAR 98-01	26 MAR 98-01
059550-0018-SA	WATER	8310AF-A	26 MAR 98-01	26 MAR 98-01

LABORATORY CONTROL SAMPLE REPORT
High Performance Liquid Chromatography
Project: 059550

Category: 8310AF-A AFCEE - Polynuclear Aromatic Hydrocarbons
Matrix: WATER
Date Analyzed: 14 APR 98
QC Run: 26 MAR 98-01
Concentration Units: ug/L

Analyte	Concentration Spiked	Concentration Measured	Accuracy(%) LCS	Accuracy(%) Limits
Acenaphthene	4.00	3.60	90	43-130
Acenaphthylene	4.00	4.20	105	49-125
Anthracene	4.00	3.86	96	54-125
Benzo(a)anthracene	4.00	4.37	109	39-135
Benzo(a)pyrene	4.00	4.19	105	52-125
Benzo(b)fluoranthene	4.00	4.38	110	31-137
Benzo(g,h,i)perylene	4.00	4.45	111	53-125
Benzo(k)fluoranthene	4.00	4.39	110	60-129
Chrysene	4.00	4.26	106	59-134
Dibenz(a,h)anthracene	4.00	4.18	104 #	35-103
Fluorene	4.00	4.01	100	53-125
Fluoranthene	4.00	4.28	107	42-125
Indeno(1,2,3-cd)pyrene	4.00	4.55	114	53-153
Naphthalene	4.00	3.71	93	43-125
Phenanthrene	4.00	4.34	108	52-129
Pyrene	4.00	4.42	110	55-125

Surrogates	Concentration Spiked	Concentration Measured	Accuracy(%) LCS	Accuracy(%) Limits
Terphenyl-d14	20.0	21.6	108	25-157

Category: 8310AF-S AFCEE - Polynuclear Aromatic Hydrocarbons
Matrix: SOIL
Date Analyzed: 17 APR 98
QC Run: 31 MAR 98-01
Concentration Units: mg/kg

Analyte	Concentration Spiked	Concentration Measured	Accuracy(%) LCS	Accuracy(%) Limits
Acenaphthene	0.533	0.479	90	33-140
Acenaphthylene	0.533	0.511	96	39-135
Anthracene	0.533	0.458	86	44-135
Benzo(a)anthracene	0.533	0.475	89	29-145
Benzo(a)pyrene	0.533	0.479	90	42-135
Benzo(b)fluoranthene	0.533	0.501	94	25-147
Benzo(g,h,i)perylene	0.533	0.516	97	43-135
Benzo(k)fluoranthene	0.533	0.502	94	50-139
Chrysene	0.533	0.494	93	49-144
Dibenz(a,h)anthracene	0.533	0.502	94	41-135
Fluorene	0.533	0.491	92	43-135
Fluoranthene	0.533	0.512	96	32-135
Indeno(1,2,3-cd)pyrene	0.533	0.502	94	45-135
Naphthalene	0.533	0.514	96	33-135
Phenanthrene	0.533	0.484	91	42-139
Pyrene	0.533	0.479	90	45-135

Calculations are performed before rounding to avoid round-off errors in calculated results.

LABORATORY CONTROL SAMPLE REPORT
High Performance Liquid Chromatography
Project: 059550

(cont.)

	Concentration		Accuracy(%)	
Surrogates	Spiked	Measured	LCS	Limits
Terphenyl-d14	3.33	3.48	105	22-167

Calculations are performed before rounding to avoid round-off errors in calculated results.

SINGLE CONTROL SAMPLE REPORT
High Performance Liquid Chromatography

Analyte	Concentration Spiked	Concentration Measured	Accuracy(%) SCS	Accuracy(%) Limits
Category: 8310AF-A Matrix: WATER QC Lot: 26 MAR 98-01 QC Run: 26 MAR 98-01 Concentration Units: ug/L				
Terphenyl-d14	20.0	22.8	114	25-157
Category: 8310AF-S Matrix: SOIL QC Lot: 31 MAR 98-01 QC Run: 31 MAR 98-01 Concentration Units: mg/kg				
Terphenyl-d14	3.33	3.43	103	22-167

Calculations are performed before rounding to avoid round-off errors in calculated results.

METHOD BLANK REPORT
High Performance Liquid Chromatography
Project: 059550

Test: 8310-AFCEE-MDL-A AFCEE Polynuclear Aromatic Hydrocarbons, HPLC
Matrix: WATER
QC Lot: 26 MAR 98-01 QC Run: 26 MAR 98-01 Date Analyzed: 14 APR 98

Analyte	Result	Units	RL	MDL
Acenaphthene	ND	ug/L	1.0	0.093
Acenaphthylene	ND	ug/L	1.0	0.040
Anthracene	ND	ug/L	0.10	0.030
Benzo(a)anthracene	ND	ug/L	0.13	0.060
Benzo(a)pyrene	ND	ug/L	0.23	0.065
Benzo(b)fluoranthene	ND	ug/L	0.18	0.059
Benzo(g,h,i)perylene	ND	ug/L	0.20	0.071
Benzo(k)fluoranthene	ND	ug/L	0.17	0.059
Chrysene	ND	ug/L	0.20	0.073
Dibenz(a,h)anthracene	ND	ug/L	0.30	0.076
Fluorene	ND	ug/L	0.20	0.035
Fluoranthene	ND	ug/L	0.20	0.036
Indeno(1,2,3-cd)pyrene	ND	ug/L	0.43	0.055
Naphthalene	ND	ug/L	1.0	0.059
Phenanthrene	ND	ug/L	0.20	0.030
Pyrene	ND	ug/L	0.20	0.043

Test: 8310-AFCEE-MDL-2-A AFCEE Polynuclear Aromatic Hydrocarbons, HPLC (confirmation)
Matrix: WATER
QC Lot: 26 MAR 98-01 QC Run: 26 MAR 98-01 Date Analyzed: 14 APR 98

Analyte	Result	Units	RL	MDL
Acenaphthene	ND	ug/L	1.0	0.093
Acenaphthylene	ND	ug/L	1.0	0.040
Anthracene	ND	ug/L	0.10	0.030
Benzo(a)anthracene	ND	ug/L	0.13	0.060
Benzo(a)pyrene	ND	ug/L	0.23	0.065
Benzo(b)fluoranthene	ND	ug/L	0.18	0.059
Benzo(g,h,i)perylene	ND	ug/L	0.20	0.071
Benzo(k)fluoranthene	ND	ug/L	0.17	0.059
Chrysene	ND	ug/L	0.20	0.073
Dibenz(a,h)anthracene	ND	ug/L	0.30	0.076
Fluorene	ND	ug/L	0.20	0.035
Fluoranthene	ND	ug/L	0.20	0.036
Indeno(1,2,3-cd)pyrene	ND	ug/L	0.43	0.055
Naphthalene	ND	ug/L	1.0	0.059
Phenanthrene	ND	ug/L	0.20	0.030
Pyrene	ND	ug/L	0.20	0.043

ND = Not Detected

METHOD BLANK REPORT
High Performance Liquid Chromatography
Project: 059550

Test: 8310-AFCEE-MDL-S AFCEE Polynuclear Aromatic Hydrocarbons, HPLC
Matrix: SOIL
QC Lot: 31 MAR 98-01 QC Run: 31 MAR 98-01 Date Analyzed: 17 APR 98

Analyte	Result	Units	RL	MDL
Acenaphthene	ND	mg/kg	0.20	0.036
Acenaphthylene	ND	mg/kg	0.20	0.049
Anthracene	ND	mg/kg	0.020	0.0026
Benzo(a)anthracene	ND	mg/kg	0.020	0.0034
Benzo(a)pyrene	ND	mg/kg	0.015	0.0022
Benzo(b)fluoranthene	ND	mg/kg	0.012	0.0025
Benzo(g,h,i)perylene	ND	mg/kg	0.050	0.0030
Benzo(k)fluoranthene	ND	mg/kg	0.011	0.0035
Chrysene	ND	mg/kg	0.040	0.0020
Dibenz(a,h)anthracene	ND	mg/kg	0.020	0.0034
Fluorene	ND	mg/kg	0.040	0.0064
Fluoranthene	ND	mg/kg	0.040	0.0024
Indeno(1,2,3-cd)pyrene	ND	mg/kg	0.030	0.0030
Naphthalene	ND	mg/kg	0.20	0.046
Phenanthrene	ND	mg/kg	0.040	0.0055
Pyrene	ND	mg/kg	0.040	0.0026

Test: 8310-AFCEE-MDL-2-S AFCEE Polynuclear Aromatic Hydrocarbons, HPLC (Confirmation)
Matrix: SOIL
QC Lot: 31 MAR 98-01 QC Run: 31 MAR 98-01 Date Analyzed: 17 APR 98

Analyte	Result	Units	RL	MDL
Acenaphthene	ND	mg/kg	0.20	0.036
Acenaphthylene	ND	mg/kg	0.20	0.049
Anthracene	ND	mg/kg	0.020	0.0026
Benzo(a)anthracene	ND	mg/kg	0.020	0.0034
Benzo(a)pyrene	ND	mg/kg	0.015	0.0022
Benzo(b)fluoranthene	ND	mg/kg	0.012	0.0025
Benzo(g,h,i)perylene	ND	mg/kg	0.050	0.0030
Benzo(k)fluoranthene	ND	mg/kg	0.011	0.0035
Chrysene	ND	mg/kg	0.040	0.0020
Dibenz(a,h)anthracene	ND	mg/kg	0.020	0.0034
Fluorene	ND	mg/kg	0.040	0.0064
Fluoranthene	ND	mg/kg	0.040	0.0024
Indeno(1,2,3-cd)pyrene	ND	mg/kg	0.030	0.0030
Naphthalene	ND	mg/kg	0.20	0.046
Phenanthrene	ND	mg/kg	0.040	0.0055
Pyrene	ND	mg/kg	0.040	0.0026

ND = Not Detected

MATRIX SPIKE/MATRIX SPIKE DUPLICATE QC REPORT
High Performance Liquid Chromatography
Project: 059550

Category: 8310AF-A AFCEE - Polynuclear Aromatic Hydrocarbons
Matrix: WATER
Sample: 059558-0010
MS Run: 26 MAR 98-01
Units: ug/L

Analyte	Sample Result	Concentration MS Result	Concentration MSD Result	Amount Spiked MS	Amount Spiked MSD	% Recovery MS	% Recovery MSD	Recov. Accep. Limits	RPD MS-MSD	RPD Accept Limits
Acenaphthene	ND	3.86	2.91	4.06	3.85	95	76	43-130	23	30
Acenaphthylene	ND	3.92	3.36	4.06	3.85	97	87	49-125	10	30
Anthracene	ND	3.66	3.05	4.06	3.85	90	79	54-125	13	30
Benzo(a)anthracene	ND	4.02	3.31	4.06	3.85	99	86	39-135	14	30
Benzo(a)pyrene	ND	4.17	3.24	4.06	3.85	103	84	52-125	20	30
Benzo(b)fluoranthene	ND	4.21	3.56	4.06	3.85	104	92	31-137	11	30
Benzo(g,h,i)perylene	ND	4.28	3.56	4.06	3.85	105	92	53-125	13	30
Benzo(k)fluoranthene	ND	4.20	3.52	4.06	3.85	103	91	60-129	12	30
Chrysene	ND	4.13	3.58	4.06	3.85	102	93	59-134	9.0	30
Dibenz(a,h)anthracene	ND	4.16	3.49	4.06	3.85	102	91	35-103	12	30
Fluorene	ND	4.07	3.55	4.06	3.85	100	92	53-125	8.4	30
Fluoranthene	ND	4.27	3.63	4.06	3.85	105	94	42-125	11	30
Indeno(1,2,3-cd) pyrene	ND	4.16	3.49	4.06	3.85	102	91	53-153	12	30
Naphthalene	ND	4.22	3.72	4.06	3.85	104	97	43-125	7.3	30
Phenanthrene	ND	4.00	3.50	4.06	3.85	99	91	52-129	8.0	30
Pyrene	ND	4.07	3.45	4.06	3.85	100	90	55-125	11	30

Surrogates		%Recovery		Rec. Accept. Limits
Terphenyl-d14	105	131	118	25-157

ND = Not Detected

Calculations are performed before rounding to avoid round-off errors in calculated results.

MATRIX SPIKE/MATRIX SPIKE DUPLICATE QC REPORT
High Performance Liquid Chromatography
Project: 059550 (cont.)

Category: 8310AF-S AFCEE - Polynuclear Aromatic Hydrocarbons
Matrix: SOIL
Sample: 059549-0004
MS Run: 31 MAR 98-01
Units mg/kg Units Qualifier: Dry weight

	Concentration				Amount Spiked		% Recovery		Recov. Accep.	RPD	RPD Accept
Analyte	Sample Result		MS Result	MSD Result	MS	MSD	MS	MSD	Limits	MS-MSD	Limits
Acenaphthene	ND		0.369	0.513	0.533	0.533	69	96	33-140	33	50
Acenaphthylene	ND		0.427	0.487	0.533	0.533	80	91	39-135	13	50
Anthracene	0.238	d	0.581	0.565	0.533	0.533	72	69	44-135	2.8	50
Benzo(a)anthracene	ND		0.610	0.603	0.533	0.533	114	113	29-145	1.2	50
Benzo(a)pyrene	0.0102	JM	0.534	0.524	0.533	0.533	99	97	42-135	1.9	50
Benzo(b)fluoranthene	ND		0.519	0.505	0.533	0.533	97	95	25-147	2.7	50
Benzo(g,h,i)perylene	ND		0.514	0.511	0.533	0.533	96	96	43-135	0.5	50
Benzo(k)fluoranthene	ND		0.502	0.507	0.533	0.533	94	95	50-139	0.9	50
Chrysene	0.0874	M	0.552	0.513	0.533	0.533	90	83	49-144	7.3	50
Dibenz(a,h)anthracene	ND		0.540	0.558	0.533	0.533	101	105	41-135	3.3	50
Fluorene	ND		0.584	0.555	0.533	0.533	110	104	43-135	5.1	50
Fluoranthene	ND		0.492	0.537	0.533	0.533	92	101	32-135	8.7	50
Indeno(1,2,3-cd) pyrene	ND		0.492	0.499	0.533	0.533	92	94	45-135	1.4	50
Naphthalene	ND		0.541	0.537	0.533	0.533	102	101	33-135	0.7	50
Phenanthrene	0.497	d	0.800	0.778	0.533	0.533	73	68	42-139	2.8	50
Pyrene	ND		0.554	0.662	0.533	0.533	104	124	45-135	18	50

Surrogates		%Recovery		Rec. Accept. Limits
Terphenyl-d14	134	89.4	91.2	22-167

d = See Preferred Result on Other Column
J = Result is detected below the reporting limit or is an estimated concentration.
M = Preferred Result
ND = Not Detected

Calculations are performed before rounding to avoid round-off errors in calculated results.

AFCEE
Total Metals

Client Name:	Parsons Engineering Science				
Client ID:	FT-16, MP-4 (0.00,0.00)				
LAB ID:	059550-0001-SA				
Matrix:	GRND-H20	Sampled:	20 MAR 98	Received:	21 MAR 98
Authorized:	21 MAR 98	Prepared:	See Below	Analyzed:	See Below

Parameter	Result	Qual	Dil	MDL	Rep Lim	Units	Method	Prepared Date	Analyzed Date
Lead	ND		1.0	0.0010	0.0050	mg/L	SW7421	31 MAR 98	01 APR 98

ND = Not Detected

Reported By: Robin Proctor

Approved By: Kathy Wakeman

Metals
Total Metals

Client Name:	Parsons Engineering Science		
Client ID:	SED-1 (0.00,0.00)		
LAB ID:	059550-0016-SA		
Matrix:	SOIL	Sampled: 19 MAR 98	Received: 21 MAR 98
Authorized:	21 MAR 98	Prepared: See Below	Analyzed: See Below

Parameter	Result	Qual	Dil	MDL	Rep Lim	Units	Method	Prepared Date	Analyzed Date
Lead	66.2		10	1.9	6.2	mg/kg	SW7421	01 APR 98	02 APR 98

Percent moisture is 19.3%. All results and limits are reported on a dry weight basis.

Reported By: Robin Proctor

Approved By: Kathy Wakeman

AFCEE
Total Metals

Client Name:	Parsons Engineering Science		
Client ID:	FT-16, MW-4 (0.00,0.00)		
LAB ID:	059550-0017-SA		
Matrix:	GRND-H2O	Sampled: 20 MAR 98	Received: 21 MAR 98
Authorized:	21 MAR 98	Prepared: See Below	Analyzed: See Below

Parameter	Result	Qual	Dil	MDL	Rep Lim	Units	Method	Prepared Date	Analyzed Date
Lead	ND		1.0	0.0010	0.0050	mg/L	SW7421	31 MAR 98	01 APR 98

ND = Not Detected

Reported By: Robin Proctor

Approved By: Kathy Wakeman

Quanterra
Environmental
Services

AFCEE
Total Metals

Client Name:	Parsons Engineering Science		
Client ID:	FT-16, MW-20 (0.00,0.00)		
LAB ID:	059550-0018-SA		
Matrix:	GRND-H20	Sampled: 20 MAR 98	Received: 21 MAR 98
Authorized:	21 MAR 98	Prepared: See Below	Analyzed: See Below

Parameter	Result	Qual	Dil	MDL	Rep Lim	Units	Method	Prepared Date	Analyzed Date
Lead	ND		1.0	0.0010	0.0050	mg/L	SW7421	31 MAR 98	01 APR 98

ND = Not Detected

Reported By: Robin Proctor

Approved By: Kathy Wakeman

QC LOT ASSIGNMENT REPORT
Metals Analysis and Preparation

Laboratory Sample Number	QC Matrix	QC Category	QC Lot Number (DCS)	QC Run Number (SCS/BLANK)
059550-0001-SA	AQUEOUS	PB-LAW-AT	31 MAR 98-R3	31 MAR 98-R3
059550-0016-SA	SOIL	PB-FAA-S	01 APR 98-R2	01 APR 98-R2
059550-0017-SA	AQUEOUS	PB-LAW-AT	31 MAR 98-R3	31 MAR 98-R3
059550-0018-SA	AQUEOUS	PB-LAW-AT	31 MAR 98-R3	31 MAR 98-R3

LABORATORY CONTROL SAMPLE REPORT
Metals Analysis and Preparation

Category: PB-LAW-AT
Matrix: AQUEOUS
QC Lot: 31 MAR 98-R3 QC Run: 31 MAR 98-R3
Concentration Units: mg/L

Analyte	Concentration		Accuracy(%)	
	Spiked	Measured	LCS	Limits
Lead	0.0400	0.0455	114	74-124

Category: PB-FAA-S
Matrix: SOIL
QC Lot: 01 APR 98-R2 QC Run: 01 APR 98-R2
Concentration Units: mg/kg

Analyte	Concentration		Accuracy(%)	
	Spiked	Measured	LCS	Limits
Lead	4.00	3.63	91	83-123

Calculations are performed before rounding to avoid round-off errors in calculated results.

METHOD BLANK REPORT
Metals Analysis and Preparation
Project: 059550

Test: PB-AFCEE2-MDL-AT AFCEE Lead, Furnace AA (Totals)
Matrix: AQUEOUS
QC Lot: 31 MAR 98-R3 QC Run: 31 MAR 98-R3 Date Analyzed: 01 APR 98

Analyte	Result	Units	RL	MDL
Lead	ND	mg/L	0.0050	0.0010

Test: PB-FAA-MDL-S Lead, Furnace AA
Matrix: SOIL
QC Lot: 01 APR 98-R2 QC Run: 01 APR 98-R2 Date Analyzed: 02 APR 98

Analyte	Result	Units	RL	MDL
Lead	ND	mg/kg	0.30	0.091

ND = Not Detected

Quanterra
Environmental
Services

MATRIX SPIKE/MATRIX SPIKE DUPLICATE QC REPORT
Metals Analysis and Preparation
Project: 059550

Category: PB-LAW-AT Lead, Furnace AA / Totals
Matrix: AQUEOUS
Sample: 059558-0010
MS Run: 31 MAR 98-R3
Units: mg/L

		Concentration		Amount	%Recovery		%RPD	Acceptance Limit	
Analyte	Sample Result	MS Result	MSD Result	Spiked MS/MSD	MS	MSD		Recov.	RPD
Lead	ND	0.0440	0.0436	0.0400	110	109	0.9	74-124	15

Category: PB-FAA-S Lead, Furnace AA
Matrix: SOIL
Sample: 059550-0016
MS Run: 01 APR 98-R2
Units mg/kg Units Qualifier: Dry weight

		Concentration		Amount	%Recovery		%RPD	Acceptance Limit	
Analyte	Sample Result	MS Result	MSD Result	Spiked MS/MSD	MS	MSD		Recov.	RPD
Lead	53.4	38.7	35.1	4.00	NC	NC	NC	83-123	10

NC = Not Calculated, calculation not applicable.
ND = Not Detected

Calculations are performed before rounding to avoid round-off errors in calculated results.

General Inorganics

Client Name:	Parsons Engineering Science		
Client ID:	FT-16, MP-4 (0.00,0.00)		
LAB ID:	059550-0001-SA		Received: 21 MAR 98
Matrix:	GRND-H2O	Sampled: 20 MAR 98	Analyzed: See Below
Authorized:	21 MAR 98	Prepared: See Below	

Parameter	Result	Qual	Dil	MDL	Rep Lim	Units	Method	Prepared Date	Analyzed Date
Nitrate as N	1.3		1.0	0.040	0.50	mg/L	9056	NA	21 MAR 98

Reported By: Judy Lange

Approved By: Linda Sullivan

General Inorganics

Client Name:	Parsons Engineering Science		
Client ID:	FT-16, MW-3 (0.00,0.00)		
LAB ID:	059550-0002-SA		
Matrix:	GRND-H2O	Sampled: 20 MAR 98	Received: 21 MAR 98
Authorized:	21 MAR 98	Prepared: See Below	Analyzed: See Below

Parameter	Result	Qual	Dil	MDL	Rep Lim	Units	Method	Prepared Date	Analyzed Date
Nitrate as N	0.11	J	1.0	0.040	0.50	mg/L	9056	NA	21 MAR 98

J = Result is detected below the reporting limit or is an estimated concentration.

Reported By: Judy Lange

Approved By: Linda Sullivan

Quanterra
Environmental
Services

General Inorganics

Client Name:	Parsons Engineering Science		
Client ID:	FT-16, MW-7 (0.00,0.00)		
LAB ID:	059550-0003-SA		
Matrix:	GRND-H2O	Sampled: 20 MAR 98	Received: 21 MAR 98
Authorized:	21 MAR 98	Prepared: See Below	Analyzed: See Below

Parameter	Result	Qual	Dil	MDL	Rep Lim	Units	Method	Prepared Date	Analyzed Date
Nitrate as N	ND		1.0	0.040	0.50	mg/L	9056	NA	21 MAR 98

ND = Not Detected

Reported By: Judy Lange

Approved By: Linda Sullivan

Quanterra
Environmental
Services

General Inorganics

Client Name: Parsons Engineering Science
Client ID: FT-16, SB-1 (0.00,0.00)
LAB ID: 059550-0004-SA
Matrix: GRND-H2O
Sampled: 20 MAR 98
Received: 21 MAR 98
Authorized: 21 MAR 98
Prepared: See Below
Analyzed: See Below

Parameter	Result	Qual	Dil	MDL	Rep Lim	Units	Method	Prepared Date	Analyzed Date
Nitrate as N	0.12	J	1.0	0.040	0.50	mg/L	9056	NA	21 MAR 98

J = Result is detected below the reporting limit or is an estimated concentration.

Reported By: Judy Lange

Approved By: Linda Sullivan

General Inorganics

Client Name: Parsons Engineering Science
Client ID: FT-16, SB-3 (0.00,0.00)
LAB ID: 059550-0005-SA
Matrix: GRND-H2O
Authorized: 21 MAR 98
Sampled: 20 MAR 98
Prepared: See Below
Received: 21 MAR 98
Analyzed: See Below

Parameter	Result	Qual	Dil	MDL	Rep Lim	Units	Method	Prepared Date	Analyzed Date
Nitrate as N	0.74		1.0	0.040	0.50	mg/L	9056	NA	21 MAR 98

Reported By: Judy Lange

Approved By: Linda Sullivan

General Inorganics

Client Name:	Parsons Engineering Science		
Client ID:	SOBO-1 (3.00,4.00)		
LAB ID:	059550-0006-SA		
Matrix:	SOIL	Sampled: 17 MAR 98	Received: 21 MAR 98
Authorized:	21 MAR 98	Prepared: See Below	Analyzed: See Below

Parameter	Result	Qual	Dil	MDL	Rep Lim	Units	Method	Prepared Date	Analyzed Date
Total Organic Carbon	1630	J	1.0	550	2000	mg/kg	9060	30 MAR 98	08 APR 98
Total Organic Carbon	1320	J	1.0	550	2000	mg/kg	9060	30 MAR 98	08 APR 98
Total Organic Carbon	1650	J	1.0	550	2000	mg/kg	9060	30 MAR 98	08 APR 98
Total Organic Carbon	1740	J	1.0	550	2000	mg/kg	9060	30 MAR 98	08 APR 98

J = Result is detected below the reporting limit or is an estimated concentration.

Reported By: Patty Jungk

Approved By: Linda Sullivan

General Inorganics

Client Name: Parsons Engineering Science
Client ID: SOBO-1 (4.00,6.00)
LAB ID: 059550-0007-SA
Matrix: SOIL
Authorized: 21 MAR 98

Sampled: 17 MAR 98
Prepared: See Below

Received: 21 MAR 98
Analyzed: See Below

Parameter	Result	Qual	Dil	MDL	Rep Lim	Units	Method	Prepared Date	Analyzed Date
Total Organic Carbon	1430	J	1.0	550	2000	mg/kg	9060	30 MAR 98	08 APR 98
Total Organic Carbon	1230	J	1.0	550	2000	mg/kg	9060	30 MAR 98	08 APR 98
Total Organic Carbon	1410	J	1.0	550	2000	mg/kg	9060	30 MAR 98	08 APR 98
Total Organic Carbon	1320	J	1.0	550	2000	mg/kg	9060	30 MAR 98	08 APR 98

J = Result is detected below the reporting limit or is an estimated concentration.

Reported By: Patty Jungk

Approved By: Linda Sullivan

Quanterra
Environmental
Services

General Inorganics

Client Name:	Parsons Engineering Science		
Client ID:	SOBO-2 (3.00,4.00)		
LAB ID:	059550-0008-SA		
Matrix:	SOIL	Sampled: 17 MAR 98	Received: 21 MAR 98
Authorized:	21 MAR 98	Prepared: See Below	Analyzed: See Below

Parameter	Result	Qual	Dil	MDL	Rep Lim	Units	Method	Prepared Date	Analyzed Date
Total Organic Carbon	ND		1.0	550	2000	mg/kg	9060	30 MAR 98	08 APR 98
Total Organic Carbon	650	J	1.0	550	2000	mg/kg	9060	30 MAR 98	08 APR 98
Total Organic Carbon	ND		1.0	550	2000	mg/kg	9060	30 MAR 98	08 APR 98
Total Organic Carbon	670	J	1.0	550	2000	mg/kg	9060	30 MAR 98	08 APR 98

J = Result is detected below the reporting limit or is an estimated concentration.
ND = Not Detected

Reported By: Patty Jungk

Approved By: Linda Sullivan

General Inorganics

Client Name:	Parsons Engineering Science		
Client ID:	FT-16, MW-4 (0.00,0.00)		
LAB ID:	059550-0017-SA		
Matrix:	GRND-H20	Sampled: 20 MAR 98	Received: 21 MAR 98
Authorized:	21 MAR 98	Prepared: See Below	Analyzed: See Below

Parameter	Result	Qual	Dil	MDL	Rep Lim	Units	Method	Prepared Date	Analyzed Date
Nitrate as N	0.55		1.0	0.040	0.50	mg/L	9056	NA	21 MAR 98

Reported By: Judy Lange

Approved By: Linda Sullivan

General Inorganics

Client Name: Parsons Engineering Science
Client ID: FT-16, MW-20 (0.00,0.00)
LAB ID: 059550-0018-SA
Matrix: GRND-H20
Authorized: 21 MAR 98

Sampled: 20 MAR 98
Prepared: See Below

Received: 21 MAR 98
Analyzed: See Below

Parameter	Result	Qual	Dil	MDL	Rep Lim	Units	Method	Prepared Date	Analyzed Date
Nitrate as N	0.55		1.0	0.040	0.50	mg/L	9056	NA	21 MAR 98

Reported By: Judy Lange

Approved By: Linda Sullivan

QC LOT ASSIGNMENT REPORT
Wet Chemistry Analysis and Preparation

Laboratory Sample Number	QC Matrix	QC Category	QC Lot Number (DCS)	QC Run Number (SCS/BLANK)
059550-0001-SA	AQUEOUS	NO3-PAR-A	21 MAR 98-N1	21 MAR 98-N1
059550-0002-SA	AQUEOUS	NO3-PAR-A	21 MAR 98-N1	21 MAR 98-N1
059550-0002-MS	AQUEOUS	NO3-PAR-A	21 MAR 98-N1	21 MAR 98-N1
059550-0002-SD	AQUEOUS	NO3-PAR-A	21 MAR 98-N1	21 MAR 98-N1
059550-0003-SA	AQUEOUS	NO3-PAR-A	21 MAR 98-N1	21 MAR 98-N1
059550-0004-SA	AQUEOUS	NO3-PAR-A	21 MAR 98-N1	21 MAR 98-N1
059550-0005-SA	AQUEOUS	NO3-PAR-A	21 MAR 98-N1	21 MAR 98-N1
059550-0006-SA	SOIL	TOC-MG-S	08 APR 98-N1	30 MAR 98-N1
059550-0006-SA	SOIL	TOC-MG-S	08 APR 98-N1	30 MAR 98-N1
059550-0006-SA	SOIL	TOC-MG-S	08 APR 98-N1	30 MAR 98-N1
059550-0006-SA	SOIL	TOC-MG-S	08 APR 98-N1	30 MAR 98-N1
059550-0007-SA	SOIL	TOC-MG-S	08 APR 98-N1	30 MAR 98-N1
059550-0007-SA	SOIL	TOC-MG-S	08 APR 98-N1	30 MAR 98-N1
059550-0007-SA	SOIL	TOC-MG-S	08 APR 98-N1	30 MAR 98-N1
059550-0007-SA	SOIL	TOC-MG-S	08 APR 98-N1	30 MAR 98-N1
059550-0007-MS	SOIL	TOC-MG-S	08 APR 98-N1	30 MAR 98-N1
059550-0007-SD	SOIL	TOC-MG-S	08 APR 98-N1	30 MAR 98-N1
059550-0008-SA	SOIL	TOC-MG-S	08 APR 98-N1	30 MAR 98-N1
059550-0008-SA	SOIL	TOC-MG-S	08 APR 98-N1	30 MAR 98-N1
059550-0008-SA	SOIL	TOC-MG-S	08 APR 98-N1	30 MAR 98-N1
059550-0008-SA	SOIL	TOC-MG-S	08 APR 98-N1	30 MAR 98-N1
059550-0017-SA	AQUEOUS	NO3-PAR-A	21 MAR 98-N1	21 MAR 98-N1
059550-0018-SA	AQUEOUS	NO3-PAR-A	21 MAR 98-N1	21 MAR 98-N1

LABORATORY CONTROL SAMPLE REPORT
Wet Chemistry Analysis and Preparation

Category: NO3-PAR-A
Matrix: AQUEOUS
QC Lot: 21 MAR 98-N1 QC Run: 21 MAR 98-N1
Concentration Units: mg/L

Analyte	Concentration		Accuracy(%)	
	Spiked	Measured	LCS	Limits
Nitrate as N	10.0	10.9	109	90-110

Category: TOC-MG-S
Matrix: SOIL
QC Lot: 08 APR 98-N1 QC Run: 30 MAR 98-N1
Concentration Units: mg/kg

Analyte	Concentration		Accuracy(%)	
	Spiked	Measured	LCS	Limits
Total Organic Carbon	120000	120000	100	91-111

Calculations are performed before **rounding to avoid** round-off errors in calculated results.

METHOD BLANK REPORT
Wet Chemistry Analysis and Preparation
Project: 059550

Test: NO3-AF-IC-PAR-MDL-A AFCEE Nitrate, Ion Chromatography
Matrix: AQUEOUS
QC Lot: 21 MAR 98-N1 QC Run: 21 MAR 98-N1 Date Analyzed: 21 MAR 98

Analyte	Result	Units	RL	MDL
Nitrate as N	ND	mg/L	0.50	0.040

Test: TOC-9060-MG-MDL-S Total Organic Carbon (TOC)
Matrix: SOIL
QC Lot: 08 APR 98-N1 QC Run: 30 MAR 98-N1 Date Analyzed: 08 APR 98

Analyte	Result	Units	RL	MDL
Total Organic Carbon	ND	mg/kg	2000	550

ND = Not Detected

MATRIX SPIKE/MATRIX SPIKE DUPLICATE QC REPORT
Wet Chemistry Analysis and Preparation
Project: 059550

Category: NO3-PAR-A Nitrate as N by Ion Chromatography (Cape Canaveral)
Matrix: AQUEOUS
Sample: 059550-0002
MS Run: 21 MAR 98-N1
Units: mg/L

Analyte	Concentration Sample Result	MS Result	MSD Result	Amount Spiked MS/MSD	%Recovery MS	MSD	%RPD	Acceptance Limit Recov.	RPD
Nitrate as N	0.11 J	20.9	21.1	20.0	104	105	1.2	90-110	20

Category: TOC-MG-S Total Organic Carbon for soils reported in mg/kg.
(Limits for TOC-S also apply for this QC category)
Matrix: SOIL
Sample: 059550-0007
MS Run: 08 APR 98-N1
Units: mg/kg

Analyte	Concentration Sample Result	MS Result	MSD Result	Amount Spiked MS/MSD	%Recovery MS	MSD	%RPD	Acceptance Limit Recov.	RPD
Total Organic Carbon	1320 J	122000	120000	120000	100	99	1.1	91-111	10

J = Result is detected below the reporting limit or is an estimated concentration.

Calculations are performed before rounding to avoid round-off errors in calculated results.

Method EPA-9 RSK-175 by GC/FID
Method EPA-9 RSK-175

Client Name: Parsons Engineering Science
Client ID: FT-16, MP-4 (0.00,0.00)
LAB ID: 059550-0001-SA
Matrix: GRND-H2O
Authorized: 21 MAR 98
Instrument: GCFID-K1A
Sampled: 20 MAR 98
Prepared: N/A
Dilution: 20
Received: 21 MAR 98
Analyzed: 27 MAR 98

Parameter	Result	Qualifier	RL	MDL	Units
Methane	1300	B	10	1.0	ug/L

B = Compound is also detected in the blank.

Reported By: Quanterra-Austin

Approved By: Cynthia Prentice

Quanterra
Environmental Services

Method EPA-9 RSK-175 by GC/FID
Method EPA-9 RSK-175

Client Name: Parsons Engineering Science
Client ID: FT-16, MW-3 (0.00,0.00)
LAB ID: 059550-0002-SA
Matrix: GRND-H2O
Authorized: 21 MAR 98
Instrument: GCFID-K1A
Sampled: 20 MAR 98
Prepared: N/A
Dilution: 1.0
Received: 21 MAR 98
Analyzed: 25 MAR 98

Parameter	Result	Qualifier	RL	MDL	Units
Methane	11	B	0.50	0.052	ug/L

B = Compound is also detected in the blank.

Reported By: Quanterra-Austin

Approved By: Cynthia Prentice

Method EPA-9 RSK-175 by GC/FID
Method EPA-9 RSK-175

Client Name:	Parsons Engineering Science		
Client ID:	FT-16, MW-7 (0.00,0.00)		
LAB ID:	059550-0003-SA		
Matrix:	GRND-H2O	Sampled: 20 MAR 98	Received: 21 MAR 98
Authorized:	21 MAR 98	Prepared: N/A	Analyzed: 25 MAR 98
Instrument:	GCFID-K1A	Dilution: 1.0	

Parameter	Result	Qualifier	RL	MDL	Units
Methane	27	B	0.50	0.052	ug/L

B = Compound is also detected in the blank.

Reported By: Quanterra-Austin

Approved By: Cynthia Prentice

Method EPA-9 RSK-175 by GC/FID
Method EPA-9 RSK-175

Client Name:	Parsons Engineering Science		
Client ID:	FT-16, SB-1 (0.00,0.00)		
LAB ID:	059550-0004-SA		
Matrix:	GRND-H20	Sampled: 20 MAR 98	Received: 21 MAR 98
Authorized:	21 MAR 98	Prepared: N/A	Analyzed: 27 MAR 98
Instrument:	GCFID-K1A	Dilution: 20	

Parameter	Result	Qualifier	RL	MDL	Units
Methane	720	B	10	1.0	ug/L

B = Compound is also detected in the blank.

Reported By: Quanterra-Austin Approved By: Cynthia Prentice

Method EPA-9 RSK-175 by GC/FID
Method EPA-9 RSK-175

Client Name:	Parsons Engineering Science				
Client ID:	FT-16, SB-3 (0.00,0.00)				
LAB ID:	059550-0005-SA				
Matrix:	GRND-H2O	Sampled:	20 MAR 98	Received:	21 MAR 98
Authorized:	21 MAR 98	Prepared:	N/A	Analyzed:	27 MAR 98
Instrument:	GCFID-K1A	Dilution:	25		

Parameter	Result	Qualifier	RL	MDL	Units
Methane	1500	B	12	1.3	ug/L

B = Compound is also detected in the blank.

Reported By: Quanterra-Austin

Approved By: Cynthia Prentice

Method EPA-9 RSK-175 by GC/FID
Method EPA-9 RSK-175

Client Name: Parsons Engineering Science
Client ID: FT-16, MW-4 (0.00,0.00)
LAB ID: 059550-0017-SA
Matrix: GRND-H2O
Authorized: 21 MAR 98
Instrument: GCFID-K1A
Sampled: 20 MAR 98
Prepared: N/A
Dilution: 10
Received: 21 MAR 98
Analyzed: 27 MAR 98

Parameter	Result	Qualifier	RL	MDL	Units
Methane	330	B	5.0	0.52	ug/L

B = Compound is also detected in the blank.

Reported By: Quanterra-Austin

Approved By: Cynthia Prentice

Method EPA-9 RSK-175 by GC/FID
Method EPA-9 RSK-175

Client Name:	Parsons Engineering Science		
Client ID:	FT-16, MW-20 (0.00,0.00)		
LAB ID:	059550-0018-SA		
Matrix:	GRND-H20	Sampled: 20 MAR 98	Received: 21 MAR 98
Authorized:	21 MAR 98	Prepared: N/A	Analyzed: 27 MAR 98
Instrument:	GCFID-K1A	Dilution: 10	

Parameter	Result	Qualifier	RL	MDL	Units
Methane	290	B	5.0	0.52	ug/L

B = Compound is also detected in the blank.

Reported By: Quanterra-Austin

Approved By: Cynthia Prentice

QC LOT ASSIGNMENT REPORT
Subcontracted to Quanterra Lab

Laboratory Sample Number	QC Matrix	QC Category	QC Lot Number (DCS)	QC Run Number (SCS/BLANK)
059550-0001-SA	AQUEOUS	GAS-AUS-A	27 MAR 98-S1	27 MAR 98-S1
059550-0002-SA	AQUEOUS	GAS-AUS-A	25 MAR 98-S1	25 MAR 98-S1
059550-0002-MS	AQUEOUS	GAS-AUS-A	25 MAR 98-S1	25 MAR 98-S1
059550-0002-SD	AQUEOUS	GAS-AUS-A	25 MAR 98-S1	25 MAR 98-S1
059550-0003-SA	AQUEOUS	GAS-AUS-A	25 MAR 98-S1	25 MAR 98-S1
059550-0004-SA	AQUEOUS	GAS-AUS-A	27 MAR 98-S1	27 MAR 98-S1
059550-0005-SA	AQUEOUS	GAS-AUS-A	27 MAR 98-S1	27 MAR 98-S1
059550-0017-SA	AQUEOUS	GAS-AUS-A	27 MAR 98-S1	27 MAR 98-S1
059550-0018-SA	AQUEOUS	GAS-AUS-A	27 MAR 98-S1	27 MAR 98-S1

LABORATORY CONTROL SAMPLE REPORT
Subcontracted to Quanterra Lab
Project: 059550

Category: GAS-AUS-A Gases by Method AUS GC-0019 (Quanterra-Austin)
Matrix: AQUEOUS
Date Analyzed: 27 MAR 98
QC Run: 27 MAR 98-S1
Concentration Units: ug/L

	Concentration		Accuracy(%)	
Analyte	Spiked	Measured	LCS	Limits
Methane	34.5	32.1	93	70-130
Ethane	64.7	55.8	86	70-130
Ethene	60.4	52.7	87	70-130

Category: GAS-AUS-A Gases by Method AUS GC-0019 (Quanterra-Austin)
Matrix: AQUEOUS
Date Analyzed: 25 MAR 98
QC Run: 25 MAR 98-S1
Concentration Units: ug/L

	Concentration		Accuracy(%)	
Analyte	Spiked	Measured	LCS	Limits
Methane	34.1	33.2	97	70-130
Ethane	63.9	57.7	90	70-130
Ethene	59.6	54.2	91	70-130

Calculations are performed before rounding to avoid round-off errors in calculated results.

METHOD BLANK REPORT
Subcontracted to Quanterra Lab
Project: 059550

Test: GASES-AUSTIN-MDL-A Method EPA-9 RSK-175 by GC/FID
Matrix: AQUEOUS
QC Lot: 27 MAR 98-S1 QC Run: 27 MAR 98-S1 Date Analyzed: 27 MAR 98

Analyte	Result		Units	RL	MDL
Methane	0.12	J	ug/L	0.50	0.052

QC Lot: 25 MAR 98-S1 QC Run: 25 MAR 98-S1 Date Analyzed: 25 MAR 98

Analyte	Result		Units	RL	MDL
Methane	0.26	J	ug/L	0.50	0.052

J = Result is detected below the reporting limit or is an estimated concentration.

MATRIX SPIKE/MATRIX SPIKE DUPLICATE QC REPORT
Subcontracted to Quanterra Lab
Project: 059550

Category: GAS-AUS-A Gases by Method AUS GC-0019 (Quanterra-Austin)
Matrix: AQUEOUS
Sample: 059558-0011
MS Run: 27 MAR 98-S1
Units: ug/L

	Concentration			Amount Spiked		% Recovery		Recov.	RPD	RPD
Analyte	Sample Result	MS Result	MSD Result	MS	MSD	MS	MSD	Accep. Limits	MS-MSD	Accept Limits
Methane	17 B	53.1 B	56.1 B	33.8	34.2	107	114	70-130	4.4	30
Ethane	ND	NA	NA	60.0	60.0	NC	NC	70-130	NC	30
Ethene	ND	NA	NA	60.0	60.0	NC	NC	70-130	NC	30

Category: GAS-AUS-A Gases by Method AUS GC-0019 (Quanterra-Austin)
Matrix: AQUEOUS
Sample: 059550-0002
MS Run: 25 MAR 98-S1
Units: ug/L

	Concentration			Amount Spiked		% Recovery		Recov.	RPD	RPD
Analyte	Sample Result	MS Result	MSD Result	MS	MSD	MS	MSD	Accep. Limits	MS-MSD	Accept Limits
Methane	11 B	41.1	43.0	33.5	33.5	90	96	70-130	4.6	30
Ethane	ND	NA	NA	60.0	60.0	NC	NC	70-130	NC	30
Ethene	ND	NA	NA	60.0	60.0	NC	NC	70-130	NC	30

B = Compound is also detected in the blank.
NA = Not Applicable
NC = Not Calculated, calculation not applicable.
ND = Not Detected

Calculations are performed before rounding to avoid round-off errors in calculated results.

Method 504 - EDB
Method 504

Client Name:	Parsons Engineering Science		
Client ID:	FT-16, MP-4 (0.00,0.00)		
LAB ID:	059550-0001-SA		
Matrix:	GRND-H20	Sampled: 20 MAR 98	Received: 21 MAR 98
Authorized:	21 MAR 98	Prepared: 31 MAR 98	Analyzed: 31 MAR 98
Instrument:	GCFID-I	Dilution: 1.0	

Parameter	Result	Qualifier	RL	MDL	Units
EDB (1,2-Dibromoethane)	ND		0.020	0.0060	ug/L

Surrogate	Recovery		Acceptable Range
1,1,1,2-Tetrachloroethane	92.0	%	80 - 120

ND = Not Detected

Reported By: Quanterra-Tampa

Approved By: Lynn S. Calvin

Quanterra
Environmental
Services

Method FL-PRO - TPH (C8-C40)
Method FL-PRO

Client Name:	Parsons Engineering Science		
Client ID:	FT-16, MP-4 (0.00,0.00)		
LAB ID:	059550-0001-SA		
Matrix:	GRND-H20	Sampled: 20 MAR 98	Received: 21 MAR 98
Authorized:	21 MAR 98	Prepared: 26 MAR 98	Analyzed: 02 APR 98
Instrument:	GCFID-I	Dilution: 1.0	

Parameter	Result	Qualifier	RL	MDL	Units
TPH (C8-C40)	7.1		0.50	0.19	mg/L

Surrogate	Recovery		Acceptable Range
o-Terphenyl	111	%	33 - 162
Nonatriacontane	64	%	10 - 109

Reported By: Quanterra-Tampa

Approved By: Lynn S. Calvin

Quanterra
Environmental
Services

Method FL-PRO - TPH (C8-C40)
Method FL-PRO

Client Name: Parsons Engineering Science
Client ID: SOBO-3 (4.00,5.50)
LAB ID: 059550-0009-SA
Matrix: SOIL
Authorized: 21 MAR 98
Instrument: GCFID-I

Sampled: 17 MAR 98
Prepared: 30 MAR 98
Dilution: 5.0

Received: 21 MAR 98
Analyzed: 01 APR 98

Parameter	Result	Qualifier	RL	MDL	Units
TPH (C8-C40)	690		54	49	mg/kg

Surrogate	Recovery		Acceptable Range
o-Terphenyl	ND	%	22 - 166
Nonatriacontane	ND	%	10 - 192

ND = Not Detected

Reported By: Quanterra-Tampa

Approved By: Cynthia Prentice

Method FL-PRO - TPH (C8-C40)
Method FL-PRO

Client Name:	Parsons Engineering Science		
Client ID:	SOBO-5 (2.00,3.00)		
LAB ID:	059550-0010-SA		
Matrix:	SOIL	Sampled: 17 MAR 98	Received: 21 MAR 98
Authorized:	21 MAR 98	Prepared: 30 MAR 98	Analyzed: 01 APR 98
Instrument:	GCFID-I	Dilution: 1.0	

Parameter	Result	Qualifier	RL	MDL	Units
TPH (C8-C40)	9.0	J	11	9.9	mg/kg

Surrogate	Recovery		Acceptable Range
o-Terphenyl	85	%	22 - 166
Nonatriacontane	42	%	10 - 192

J = Result is detected below the reporting limit or is an estimated concentration.

Reported By: Quanterra-Tampa

Approved By: Cynthia Prentice

Method FL-PRO - TPH (C8-C40)
Method FL-PRO

Client Name: Parsons Engineering Science
Client ID: SOBO-4 (4.00,5.50)
LAB ID: 059550-0011-SA
Matrix: SOIL
Authorized: 21 MAR 98
Instrument: GCFID-I

Sampled: 17 MAR 98
Prepared: 30 MAR 98
Dilution: 1.0

Received: 21 MAR 98
Analyzed: 01 APR 98

Parameter	Result	Qualifier	RL	MDL	Units
TPH (C8-C40)	7.4	J	12	11	mg/kg

Surrogate	Recovery		Acceptable Range
o-Terphenyl	80	%	22 - 166
Nonatriacontane	43	%	10 - 192

J = Result is detected below the reporting limit or is an estimated concentration.

Reported By: Quanterra-Tampa

Approved By: Cynthia Prentice

Method FL-PRO - TPH (C8-C40)
Method FL-PRO

Client Name: Parsons Engineering Science
Client ID: SOBO-4 (7.00,8.00)
LAB ID: 059550-0012-SA
Matrix: SOIL
Authorized: 21 MAR 98
Instrument: GCFID-I

Sampled: 17 MAR 98
Prepared: 30 MAR 98
Dilution: 1.0

Received: 21 MAR 98
Analyzed: 01 APR 98

Parameter	Result	Qualifier	RL	MDL	Units
TPH (C8-C40)	ND		12	11	mg/kg

Surrogate	Recovery		Acceptable Range
o-Terphenyl	83	%	22 - 166
Nonatriacontane	51	%	10 - 192

ND = Not Detected

Reported By: Quanterra-Tampa

Approved By: Cynthia Prentice

Method FL-PRO - TPH (C8-C40)
Method FL-PRO

Client Name: Parsons Engineering Science
Client ID: SOBO-A (7.00,8.00)
LAB ID: 059550-0013-SA
Matrix: SOIL
Authorized: 21 MAR 98
Instrument: GCFID-I

Sampled: 17 MAR 98
Prepared: 30 MAR 98
Dilution: 1.0

Received: 21 MAR 98
Analyzed: 01 APR 98

Parameter	Result	Qualifier	RL	MDL	Units
TPH (C8-C40)	5.7	J	13	12	mg/kg

Surrogate	Recovery		Acceptable Range
o-Terphenyl	77	%	22 - 166
Nonatriacontane	38	%	10 - 192

J = Result is detected below the reporting limit or is an estimated concentration.

Reported By: Quanterra-Tampa

Approved By: Cynthia Prentice

Method FL-PRO - TPH (C8-C40)
Method FL-PRO

Client Name:	Parsons Engineering Science				
Client ID:	SOBO-6 (2.00,3.50)				
LAB ID:	059550-0014-SA				
Matrix:	SOIL	Sampled:	18 MAR 98	Received:	21 MAR 98
Authorized:	21 MAR 98	Prepared:	30 MAR 98	Analyzed:	01 APR 98
Instrument:	GCFID-I	Dilution:	1.0		

Parameter	Result	Qualifier	RL	MDL	Units
TPH (C8-C40)	12		12	11	mg/kg

Surrogate	Recovery		Acceptable Range
o-Terphenyl	88	%	22 - 166
Nonatriacontane	59	%	10 - 192

Reported By: Quanterra-Tampa

Approved By: Cynthia Prentice

Quanterra
Environmental
Services

Method FL-PRO - TPH (C8-C40)
Method FL-PRO

Client Name: Parsons Engineering Science
Client ID: SOBO-6 (6.00,7.00)
LAB ID: 059550-0015-SA
Matrix: SOIL
Authorized: 21 MAR 98
Instrument: GCFID-I

Sampled: 18 MAR 98
Prepared: 30 MAR 98
Dilution: 1.0

Received: 21 MAR 98
Analyzed: 01 APR 98

Parameter	Result	Qualifier	RL	MDL	Units
TPH (C8-C40)	7.9	J	12	11	mg/kg

Surrogate	Recovery		Acceptable Range
o-Terphenyl	83	%	22 - 166
Nonatriacontane	89	%	10 - 192

J = Result is detected below the reporting limit or is an estimated concentration.

Reported By: Quanterra-Tampa

Approved By: Cynthia Prentice

Method 504 - EDB
Method 504

Client Name:	Parsons Engineering Science				
Client ID:	FT-16, MW-4 (0.00,0.00)				
LAB ID:	059550-0017-SA				
Matrix:	GRND-H2O	Sampled:	20 MAR 98	Received:	21 MAR 98
Authorized:	21 MAR 98	Prepared:	31 MAR 98	Analyzed:	31 MAR 98
Instrument:	GCFID-I	Dilution:	1.0		

Parameter	Result	Qualifier	RL	MDL	Units
EDB (1,2-Dibromoethane)	ND		0.020	0.0060	ug/L

Surrogate	Recovery		Acceptable Range
1,1,1,2-Tetrachloroethane	94.0	%	80 - 120

ND = Not Detected

Reported By: Quanterra-Tampa

Approved By: Lynn S. Calvin

Method FL-PRO - TPH (C8-C40)
Method FL-PRO

Client Name:	Parsons Engineering Science		
Client ID:	FT-16, MW-4 (0.00,0.00)		
LAB ID:	059550-0017-SA		
Matrix:	GRND-H20	Sampled: 20 MAR 98	Received: 21 MAR 98
Authorized:	21 MAR 98	Prepared: 26 MAR 98	Analyzed: 02 APR 98
Instrument:	GCFID-I	Dilution: 1.0	

Parameter	Result	Qualifier	RL	MDL	Units
TPH (C8-C40)	ND		0.50	0.19	mg/L

Surrogate	Recovery		Acceptable Range
o-Terphenyl	90	%	33 - 162
Nonatriacontane	66	%	10 - 109

ND = Not Detected

Reported By: Quanterra-Tampa

Approved By: Lynn S. Calvin

Method 504 - EDB
Method 504

Client Name:	Parsons Engineering Science		
Client ID:	FT-16, MW-20 (0.00,0.00)		
LAB ID:	059550-0018-SA		
Matrix:	GRND-H20	Sampled: 20 MAR 98	Received: 21 MAR 98
Authorized:	21 MAR 98	Prepared: 31 MAR 98	Analyzed: 31 MAR 98
Instrument:	GCFID-I	Dilution: 1.0	

Parameter	Result	Qualifier	RL	MDL	Units
EDB (1,2-Dibromoethane)	ND		0.020	0.0060	ug/L

Surrogate	Recovery		Acceptable Range
1,1,1,2-Tetrachloroethane	91.0	%	80 - 120

ND = Not Detected

Reported By: Quanterra-Tampa

Approved By: Lynn S. Calvin

Quanterra
Environmental
Services

Method FL-PRO - TPH (C8-C40)
Method FL-PRO

Client Name: Parsons Engineering Science
Client ID: FT-16, MW-20 (0.00,0.00)
LAB ID: 059550-0018-SA
Matrix: GRND-H2O
Authorized: 21 MAR 98
Instrument: GCFID-I

Sampled: 20 MAR 98
Prepared: 26 MAR 98
Dilution: 1.0

Received: 21 MAR 98
Analyzed: 02 APR 98

Parameter	Result	Qualifier	RL	MDL	Units
TPH (C8-C40)	ND		0.50	0.19	mg/L

Surrogate	Recovery		Acceptable Range
o-Terphenyl	97	%	33 - 162
Nonatriacontane	74	%	10 - 109

ND = Not Detected

Reported By: Quanterra-Tampa

Approved By: Lynn S. Calvin

QC LOT ASSIGNMENT REPORT
Sent OUT to Subcontractors

Laboratory Sample Number	QC Matrix	QC Category	QC Lot Number (DCS)	QC Run Number (SCS/BLANK)
059550-0001-SA	AQUEOUS	TPHFLPROA	26 MAR 98-S1	26 MAR 98-S1
059550-0001-SA	AQUEOUS	504-PAR-A	31 MAR 98-S1	31 MAR 98-S1
059550-0009-SA	SOIL	TPHFLPROS	30 MAR 98-S1	30 MAR 98-S1
059550-0010-SA	SOIL	TPHFLPROS	30 MAR 98-S1	30 MAR 98-S1
059550-0011-SA	SOIL	TPHFLPROS	30 MAR 98-S1	30 MAR 98-S1
059550-0012-SA	SOIL	TPHFLPROS	30 MAR 98-S1	30 MAR 98-S1
059550-0013-SA	SOIL	TPHFLPROS	30 MAR 98-S1	30 MAR 98-S1
059550-0014-SA	SOIL	TPHFLPROS	30 MAR 98-S1	30 MAR 98-S1
059550-0015-SA	SOIL	TPHFLPROS	30 MAR 98-S1	30 MAR 98-S1
059550-0017-SA	AQUEOUS	TPHFLPROA	26 MAR 98-S1	26 MAR 98-S1
059550-0017-SA	AQUEOUS	504-PAR-A	31 MAR 98-S1	31 MAR 98-S1
059550-0018-SA	AQUEOUS	TPHFLPROA	26 MAR 98-S1	26 MAR 98-S1
059550-0018-SA	AQUEOUS	504-PAR-A	31 MAR 98-S1	31 MAR 98-S1

PLICATE CONTROL SAMPLE REPORT
nt OUT to Subcontractors
oject: 059550

tegory: TPHFLPROA TPH - Method FL-PRO - Florida TPH Method
trix: AQUEOUS
Lot: 26 MAR 98-S1
ncentration Units: mg/L

Date Analyzed: 02 APR 98

	Concentration						Accuracy Average(%)		Precision (RPD)	
		Measured								
ıalyte	Spiked	DCS1	Qual	DCS2	Qual	AVG	DCS	Limits	DCS	Limit
PH (C8-C40)	1.70	1.70		1.53		1.62	95	55-118	11	20

	Concentration					Accuracy Average(%)	
		Measured					
urrogate	Spiked	DCS1	Qual	DCS2	Qual	DCS	Limits
-Terphenyl	0.100	0.102		0.0938		98	33-162
ionatriacontane	0.600	0.318		0.366		57	10-109

ategory: 504-PAR-A EDB - Method 504 - Cape Canaveral
latrix: AQUEOUS
QC Lot: 31 MAR 98-S1
oncentration Units: ug/L

Date Analyzed: 31 MAR 98

	Concentration						Accuracy Average(%)		Precision (RPD)	
		Measured								
Analyte	Spiked	DCS1	Qual	DCS2	Qual	AVG	DCS	Limits	DCS	Limit
EDB (1,2-Dibromoethane)	0.200	0.200		0.206		0.203	102	75-126	3.0	20

	Concentration					Accuracy Average(%)	
		Measured					
Surrogate	Spiked	DCS1	Qual	DCS2	Qual	DCS	Limits
1,1,1,2-Tetrachloroethane	0.400	0.432		0.427		107	80-120

Category: TPHFLPROS Method FL-PRO, TPH (C8-C40)
Matrix: SOIL
QC Lot: 30 MAR 98-S1
Concentration Units: mg/kg

Date Analyzed: 31 MAR 98

	Concentration						Accuracy Average(%)		Precision (RPD)	
		Measured								
Analyte	Spiked	DCS1	Qual	DCS2	Qual	AVG	DCS	Limits	DCS	Limit
TPH (C8-C40)	56.7	46.8		46.0		46.4	82	63-135	1.7	25

	Concentration					Accuracy Average(%)	
		Measured					
Surrogate	Spiked	DCS1	Qual	DCS2	Qual	DCS	Limits

Calculations are performed before rounding to avoid round-off errors in calculated results.

METHOD BLANK REPORT
Sent OUT to Subcontractors
Project: 059550

Test: TPH-FL-PRO-OUT-A Method FL-PRO - TPH (C8-C40)
Matrix: AQUEOUS
QC Lot: 26 MAR 98-S1 QC Run: 26 MAR 98-S1 Date Analyzed: 02 APR 98

Analyte	Result	Units	RL	MDL
TPH (C8-C40)	ND	mg/L	0.50	0.19

Test: 504-PAR-OUT-A Method 504 - EDB
Matrix: AQUEOUS
QC Lot: 31 MAR 98-S1 QC Run: 31 MAR 98-S1 Date Analyzed: 31 MAR 98

Analyte	Result	Units	RL	MDL
EDB (1,2-Dibromoethane)	ND	ug/L	0.020	0.0060

Test: TPH-FL-PRO-OUT-S Method FL-PRO - TPH (C8-C40)
Matrix: SOIL
QC Lot: 30 MAR 98-S1 QC Run: 30 MAR 98-S1 Date Analyzed: 31 MAR 98

Analyte	Result	Units	RL	MDL
TPH (C8-C40)	ND	mg/kg	10	9.0

ND = Not Detected

MATRIX SPIKE/MATRIX SPIKE DUPLICATE QC REPORT
Sent OUT to Subcontractors
Project: 059550

Category: TPHFLPROA TPH - Method FL-PRO - Florida TPH Method
Matrix: AQUEOUS
Sample: 059558-0010
MS Run: 26 MAR 98-S1
Units: mg/L

		Concentration		Amount Spiked		% Recovery		Recov.		RPD
Analyte	Sample Result	MS Result	MSD Result	MS	MSD	MS	MSD	Accep. Limits	RPD MS-MSD	Accept Limits
TPH (C8-C40)	ND	3.2	3.7	3.4	3.4	94	108	41-101	15	20

Surrogates		%Recovery		Rec. Accept. Limits
o-Terphenyl	92.0	95.2	110	33-162
Nonatriacontane	75.0	55.8	54.9	10-109

ND = Not Detected

Calculations are performed before rounding to avoid round-off errors in calculated results.

Chain of Custody Record

Quanterra

QUA-4124 0797

Client: PARSONS ES
Project Manager: BRAD LEWIS
Date:
Chain of Custody Number: 02283

Address: 5390 TRIANGLE PKWY
Telephone Number (Area Code)/Fax Number: (678) 969-2489 / (770) 446-4910
Lab Number: 59550
Page 1 of 1

City: NORCROSS
State: GA
Zip Code: 30092
Site Contact:
Lab Contact:

Project Name: TYNDALL – FT-16
Carrier/Waybill Number:

Contract/Purchase Order/Quote No.:

			Matrix				Containers & Preservatives						Analysis (Attach list if more space is needed)												
Sample I.D. No. and Description (Containers for each sample may be combined on one line)	Date	Time	Aqueous	Sed.	Soil		Unpres.	H2SO4	HNO3	HCl	NaOH	ZnAc/NaOH	BTEX+MTBE 8020	PAH 8310	EDB 8011	TOT LEAD 7421	TRPH-FLPRO	NITRATE 300.0	METHANE RSK-175						Special Instructions/ Conditions of Receipt
01 FT-16, MP-4	3/20/98	0900	X				6		3	6			X	X	X	X	X	X	X						
02 FT-16, MW-3	3/20/98	1330	X				3			18			X					X	X						MS/MSD
03 FT-16, MW-7	3/20/98	1500	X				1			6			X					X	X						
04 FT-16, SB-1	3/20/98	1600	X				1			6			X					X	X						
05 FT-16, SB-3	3/20/98	1700	X				1			6			X					X	X						

Possible Hazard Identification
☒ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal
☐ Return To Client ☐ Disposal By Lab ☐ Archive For ______ Months (A fee may be assessed if samples are retained longer than 3 months)

Turn Around Time Required
☐ 24 Hours ☐ 48 Hours ☐ 7 Days ☐ 14 Days ☐ 21 Days ☐ Other ______

QC Requirements (Specify)

1. Relinquished By: Date 3/20/98 Time 1830
1. Received By: [illegible] Dalton Date 3-21-98 Time 0835
2. Relinquished By: Date Time
2. Received By: Date Time
3. Relinquished By: Date Time
3. Received By: Date Time

Comments

DISTRIBUTION: WHITE - Stays with the Sample; CANARY - Returned to Client with Report; PINK - Field Copy

[redacted]

Chain of Custody Record

Quanterra

QUA-4124 0797

Client: PARSONS ES	Project Manager: BRAD LEWIS	Date: 3/20/98	Chain of Custody Number: 02280
Address: 5390 TRIANGLE PKWY	Telephone Number (Area Code)/Fax Number: (678) 969-2489 / (770) 446-4910	Lab Number: 59550	Page 1 of 1
City: NORCROSS · State: GA · Zip Code: 30092	Site Contact: · Lab Contact: LaRiviere		
Project Name: TYNDALL - FT-16	Carrier/Waybill Number:		
Contract/Purchase Order/Quote No.			

	Sample I.D. No. and Description (Containers for each sample may be combined on one line)	Date	Time	Matrix: Aqueous	Sed.	Soil		Containers & Preservatives: Unpres.	H2SO4	HNOS	HCl	NaOH	ZnAc/ NaOH		Analysis (Attach list if more space is needed): TOC 8060	BTEX+MTBE 8020	PAHs 8310	TRPH-FL	TOTAL LEAD 7421	Special Instructions/ Conditions of Receipt
06	SoBo-1 (3-4')	3/17/98	0835			X		1X							X					
07	SoBo-1 (4-6')	3/17/98	0850			X		1X							X					MS/MSD
08	SoBo-2 (3-4')	3/17/98	0945			X		1X							X					
09	SoBo-3 (4-5.5')	3/17/98	1040			X		2								X	X	X		
10	SoBo-5 (2-3')	3/17/98	1340			X		2								X	X	X		
11	SoBo-4 (4-5.5')	3/17/98	1445			X		2								X	X	X		
12	SoBo-4 (7-8')	3/17/98	1450			X		2								X	X	X		
13	SoBo-A (7-8')	3/17/98	1500			X		2								X	X	X		
4	SoBo-6 (2-3.5')	3/18/98	0630			X		2								X	X	X		
5	SoBo-6 (6-7')	3/18/98	0645			X		2								X	X	X		
16	SED-1	3/19/98	0800		X			2									X		X	

Possible Hazard Identification
☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal
☐ Return To Client ☐ Disposal By Lab ☐ Archive For ______ Months (A fee may be assessed if samples are retained longer than 3 months)

Turn Around Time Required
☐ 24 Hours ☐ 48 Hours ☐ 7 Days ☐ 14 Days ☐ 21 Days ☐ Other______

QC Requirements (Specify)

1. Relinquished By	Date 3/20/98	Time 1600	1. Received By Rosalie Dalton	Date 3-21-98	Time 0835
2. Relinquished By	Date	Time	2. Received By	Date	Time
3. Relinquished By	Date	Time	3. Received By	Date	Time

Comments

DISTRIBUTION: WHITE - Stays with the Sample; CANARY - Returned to Client with Report; PINK - Field Copy

DISTRIBUTION: WHITE - Stays with the Sample; CANARY - Returned to Client with Report; PINK - Field Copy

Quanterra

SAMPLE CHECKLIST

Project #: 59550 Date/Time Received: 3-21-98 @ 0835

Company Name & Sampling Site: Parsons ES

*Cooler #(s):	1	2	3					
Temperatures:	0.7	1.3	0.3					

Unpacking & Labeling Check Points:

N/A	Yes	No		Initials
	☑	☐	1. Radiation checked, record if reading > 0.5 mR/hr. (________mR/hr)	
	☑	☐	2. Cooler seals intact.	
	☑	☐	3. Chain of custody present.	
	☐	☑	4. Bottles broken and/or are leaking, comment if yes.	

PHOTOGRAPH BROKEN BOTTLES

N/A	Yes	No		Initials
	☑	☐	5. Containers labeled, comment if no.	
	☑	☐	6. pH of all samples checked and meet requirements, note exceptions.	
	☑	☐	7. Chain of custody includes "received by" and "relinquished" by signatures, dates, and times.	
	☐	☑	8. Receipt date(s) > 48 hours past the collection date(s)? If yes, notify PA/PM.	
	☑	☐	9. Chain of custody agrees with bottle count, comment if no.	
	☑	☐	10. Chain of custody agrees with labels, comment if no.	
☐	☑	☐	11. VOA samples filled completely, comment if no.	
☐	☑	☐	12. VOA bottles preserved, check for labels.	
	☐	☑	13. Did samples require preservation with sodium thiosulfate?	
☐	☐	☑	14. If yes to #12, did the samples contain residual chlorine?	
☑	☐	☐	15. Sediment present in "D." dissolved, bottles.	
	☐	☑	16. Are analyses with short holding times requested?	
☐	☑	☐	17. Is extra sample volume provided for MS, MSD or matrix duplicates?	
	☐	☑	18. Multiphase samples present? If yes, comment below.	
	☐	☑	19. Any subsampling for volatiles? If yes, list samples.	

PHOTOGRAPH MULTIPHASE SAMPLES

N/A	Yes	No		Initials
	☑	☐	20. Clear picture taken, labeled, and stapled to project folder.	
☑	☐	☐	21. Subout COC signed and sent with samples to bottle prep?	
	☑	☐	22. Was sample labeling double checked?	

Comments: Include action taken to resolve discrepancies/problems. Include a hard copy of e-mail or use extra paper if more space is needed. Sample 18, 1 of 3 vials for methane has head space. Sample 17, 1 of 3 vials for methane broke, sample 18, 1 of 2 1L ambers for TRPH was broken in bag

Initials:

APPENDIX B

LABORATORY ANALYTICAL DATA SHEETS AND CHAIN-OF-CUSTODY RECORDS FROM THE MARCH 1998 SAMPLING EVENT

Quanterra
Environmental
Services

Quanterra Incorporated
4955 Yarrow Street
Arvada, Colorado 80002

303 421-6611 Telephone
303 431-7171 Fax

ANALYTICAL RESULTS FOR PARSONS ENGINEERING SCIENCE, INC.

QUANTERRA INCORPORATED, DENVER
PROJECT NUMBER 059558

APRIL 28, 1998

Written by: Ellen LaRiviere
Ellen La Riviere, Program Manager

Quanterra
Environmental
Services

Table Of Contents

Standard Deliverables With Supporting Documentation

Report Contents	**Section**	**Number Of Pages**
Standard Deliverables		
Introduction - Table of Contents - Narrative - LIMs Report Key - Sample Description - Test Requests - Analytical Results - QC Summary - Chain-of-Custody - Miscellaneous	**A**	115
Supporting Documentation *[Please Note: A one-page "Description of Supporting Documentation" is provided in the Supporting Documentation section(s).]*		
Volatile GC/MS	**B**	
Semivolatile GC/MS	**C**	
Volatile GC	**D**	311
Semivolatile GC	**E**	
LC/MS or HPLC	**F**	312
Metals	**G**	15
General Chemistry	**H**	52
Subcontracted Data	**I**	30
	I	472

Overview

On March 27, 1998, Quanterra Incorporated; Denver Laboratory received sixteen aqueous samples from Parsons Engineering Science, Inc.

This report presents the analytical results as well as supporting information to aid in the evaluation and interpretation of the data and is arranged in the following order:

Overview
Sample Description Information/Analytical Test Requests
Analytical Results
Quality Control Report

Aromatic Volatile Organics Data Review

Each sample was analyzed to achieve the lowest possible reporting limits within the constraints of the method. In some cases, due to interferences or analytes present at concentrations above the linear calibration range of the instrument, samples were diluted. For diluted samples, the reporting limits are adjusted relative to the dilutions required. Quanterra samples 059558-0001-SA, -0002-SA, -0008-SA, -0012-SA, -0014-SA and –0016-SA were analyzed at dilutions for Method 8020A due to the concentration of target compounds present in the samples

Polynuclear Aromatic Hydrocarbons Data Review

Samples 059558-0001-SA, -0002-SA and –0008-SA were analyzed at dilutions for Method 8310 due to the concentration of target compounds in the samples. The reporting limits have been raised accordingly. As a result of the dilutions required, the surrogates were diluted to less than detectable concentrations in these samples.

Dibenz(a,h)anthracene was recovered above the upper control limit in the laboratory control sample (LCS) associated with the Method 8310 QC lot 26 MAR 98-01. Because this would indicate a high bias to the data, and this compound was not detected in the samples, the data was not adversely affected, and no further action was required.

Methane Data Review

The RSK-175 analysis for methane was performed by Quanterra's Austin laboratory.

Due to limitations of the laboratory information management system (LIMS) the spike amount in the duplicate control samples (DCS) represent an average of the spike amounts for the individual DCS. Therefore, the results presented in the summary report differ slightly from the results in the raw data package.

Samples 059558-0001-SA ,-0002-SA, -0006-SA, -0008-SA, -0012-SA, -0014-SA and –0016-SA were analyzed at dilutions for Methane by RSK-175 due to the concentration of the target compound in the samples. The reporting limits have been raised relative to the dilutions required.

Total Petroleum Hydrocarbons Data Review

Analysis for total petroleum hydrocarbons (TPH) by the FL-PRO method was performed by Quanterra's Tampa laboratory.

Samples 059558-0001-SA ,-0002-SA - and –0008-SA were analyzed at dilutions for TPH due to the concentration of the target compound in the samples. The reporting limits have been raised accordingly. As a result of the dilutions required the surrogates were diluted to less than detectable concentrations in sample 059558-0008-SA.

Method 504 Data Review

Analysis for 1,2-Dibromoethane (EDB) by Method 504 was performed by Quanterra's Tampa laboratory.

The 1,1,1,2-tetrachloroethane surrogate was recovered above the upper control limit in sample 059558-0004-SA. Because this would indicate a high bias to the data, and EDB was not detected in the sample, no further action was required by the laboratory.

With the above noted exception, standard analytical protocols were followed in the analysis of the samples and no problems were encountered or anomalies observed. All laboratory quality control samples analyzed in conjunction with the samples in this project were within established control limits.

Footnotes and Data Qualifiers

The data sheets contained in this report may contain a variety of footnotes and data qualifiers. Some footnotes are used with specific tests; for example, footnotes used with the GC/FID Petroleum Hydrocarbon methods to indicate (in the analyst's judgment) the product that appears to be present. Finally, there are a number of general qualifiers that serve to identify problems and pertinent observations made during sample analysis that may not be discussed in the Overview. These are described below:

B Compound is also detected in the blank. The indicated compound was detected in the sample as well as the method blank. Please note that the B flag is not used when the sample result is ND (Not Detected).

G Reporting limit raised due to the matrix of the sample. Indicates that reporting limits were raised due to the presence of non-target compounds or other matrix interferences. The sample may or may not have been diluted. For inorganic methods, the footnote applies only to the flagged analyte. For organic methods, the footnote pertains to all analytes determined by the method.

J Result is detected below the reporting limit or is an estimated concentration. Most commonly, a "J" value indicates that the reported result for the analyte is below the stated reporting limit and is an estimated value. "J" values are applied to organic analytes detected above the MDL but below the reporting limit and for inorganic analytes detected above the IDL but below the reporting limit. Analytes which are not detected at or below the reporting limit are reported as "ND" and do not have "J" flags. Because "J" values may represent false positive concentrations, care should be used when interpreting these data. If there is uncertainty about the quantitation of an analyte such as due to metals serial dilution failure, this footnote may also indicate that a reported result is an estimated concentration, even if it is above the reporting limit.

N Spiked sample recovery not within limits. This qualifier is applied to the parent sample when MS/MSD recoveries are not within acceptable limits.

r This footnote is analyst defined. The data sheets will list "r" footnotes with consecutive numbers. The electronic data deliverable will show "r" data qualifiers. Please see datasheet for exact definition.

LIMs Report Key

Section	Description
Cover Letter	Signature page, report narrative as applicable.
Sample Description Information	Tabulated cross-reference between the Lab ID and Client ID, including matrix, date and time sampled, and the date received for all samples in the project.
Sample Analysis Results Sheets	Lists sample results, test components, reporting limits, dates prepared and analyzed, and any data qualifiers. Pages are organized by test.
QC LOT Assignment Report	Cross-reference between lab IDs and applicable QC batches (DCS, LCS, Blank, MS/SD, DU)
Duplicate Control Sample Report	Percent recovery and RPD results, with acceptance limits, for the laboratory duplicate control samples for each test are tabulated in this report. These are measures of accuracy and precision for each test. Acceptance limits are based upon laboratory historical data.
Laboratory Control Sample Report	Percent recovery results for a single Laboratory Control Sample (if applicable) are tabulated in this report, with the applicable acceptance limits for each test.
Matrix Spike/Matrix Spike Duplicate Report	Percent recovery and RPD results for matrix-specific QC samples and acceptance limits, where applicable. This report can be used to assess matrix effects on an analysis.
Single Control Sample Report	A tabulation of the surrogate recoveries for the blank for organic analyses.
Method Blank Report	A summary of the results of the analysis of the method blank for each test.

List of Abbreviations and Terms

Abbreviation	Term	Abbreviation	Term
DCS	Duplicate Control Sample	MSD	Matrix Spike Duplicate
DU	Sample Duplicate	QC Run	Preparation Batch
EB	Equipment Blank	QC Category	LIMs QC Category
FB	Field Blank	QC Lot	DCS Batch
FD	Field Duplicate	ND	Not Detected at or above the reporting limit expressed
IDL	Instrument Detection Limit (Metals)	QC Matrix	Matrix of the laboratory control sample(s)
LCS	Laboratory Control Sample	RL	Reporting Limit
MB	Method Blank	QC	Quality Control
MDL	Method Detection Limit	SA	Sample
MS	Matrix Spike	SD	Spike Duplicate
RPD	Relative Percent Difference	TB	Trip Blank
ppm (part-per-million)	mg/L or mg/kg (usually)	ppb (part-per-billion)	ug/L or ug/kg (usually)
QUAL	Qualifier flag	DIL	Dilution Factor

Quanterra
Environmental
Services

SAMPLE DESCRIPTION INFORMATION
for
Parsons Engineering Science

Lab ID	Client ID	Matrix	Sampled Date	Sampled Time	Received Date
059558-0001-SA	BX-MW-20	GRND-H20	22 MAR 98	07:00	23 MAR 98
059558-0002-SA	BX-MP-2	GRND-H20	22 MAR 98	07:30	23 MAR 98
059558-0003-SA	FT-16, MP-1	GRND-H20	21 MAR 98	09:00	23 MAR 98
059558-0004-SA	FT-16, MP-2	GRND-H20	21 MAR 98	10:00	23 MAR 98
059558-0005-SA	FT-16, SB-2	GRND-H20	21 MAR 98	11:15	23 MAR 98
059558-0006-SA	FT-16, MP-3	GRND-H20	21 MAR 98	12:15	23 MAR 98
059558-0007-SA	FT-16, MP-3	GRND-H20	22 MAR 98	07:00	23 MAR 98
059558-0008-SA	BX-MW-03	GRND-H20	22 MAR 98	13:15	23 MAR 98
059558-0009-SA	BX-MW-03-97	GRND-H20	22 MAR 98	16:30	23 MAR 98
059558-0010-SA	BX-MW-05-97	GRND-H20	22 MAR 98	10:00	23 MAR 98
059558-0010-MS	BX-MW-05-97	GRND-H20	22 MAR 98	10:00	23 MAR 98
059558-0010-SD	BX-MW-05-97	GRND-H20	22 MAR 98	10:00	23 MAR 98
059558-0011-SA	MW-01	GRND-H20	22 MAR 98	11:30	23 MAR 98
059558-0011-MS	MW-01	GRND-H20	22 MAR 98	11:30	23 MAR 98
059558-0011-SD	MW-01	GRND-H20	22 MAR 98	11:30	23 MAR 98
059558-0012-SA	BX-MW-05	GRND-H20	22 MAR 98	08:45	23 MAR 98
059558-0013-SA	BX-MW-08-97	GRND-H20	22 MAR 98	14:30	23 MAR 98
059558-0014-SA	BX-MW-07	GRND-H20	22 MAR 98	15:30	23 MAR 98
059558-0015-SA	MP-3	GRND-H20	22 MAR 98	17:30	23 MAR 98
059558-0016-SA	MP-1	GRND-H20	22 MAR 98	18:30	23 MAR 98

ANALYTICAL TEST REQUESTS
for
Parsons Engineering Science

Page 1 of 2

Lab ID: 059558	Group Code	Analysis Description	Custom Test?
0001 - 0002, 0008	A	Method EPA-9 RSK-175 by GC/FID	Y
		AFCEE	N
		Nitrate, Ion Chromatography	N
		Prep - Total Metals, Furnace AA	N
		AFCEE	N
		Lead, Furnace AA (Totals)	N
		AFCEE	Y
		Aromatic VOAs by Method 8020A with MTBE & TMBs	Y
		GC Prep For Waters	N
		AFCEE	Y
		Aromatic VOAs by Method 8020A with MTBE & TMBs	Y
		Method FL-PRO - TPH (C8-C40)	N
		Prep - TPH (C8-C40)	N
		AFCEE	N
		Polynuclear Aromatic Hydrocarbons, HPLC	N
		AFCEE	N
		Prep - Polynuclear Aromatic Hydrocarbons - HPLC	N
		AFCEE	N
		Polynuclear Aromatic Hydrocarbons, HPLC	N
0011 - 0014, 0016	B	Method EPA-9 RSK-175 by GC/FID	Y
		AFCEE	N
		Nitrate, Ion Chromatography	N
		GC Prep For Waters	N
		AFCEE	Y
		Aromatic VOAs by Method 8020A with MTBE & TMBs	Y
		AFCEE	Y
		Aromatic VOAs by Method 8020A with MTBE & TMBs	Y
0005 , 0015	C	GC Prep For Waters	N
		AFCEE	Y
		Aromatic VOAs by Method 8020A with MTBE & TMBs	Y
		AFCEE	Y
		Aromatic VOAs by Method 8020A with MTBE & TMBs	Y
0003 - 0004	D	Prep - Total Metals, Furnace AA	N
		AFCEE	N
		Lead, Furnace AA (Totals)	N
		AFCEE	Y
		Aromatic VOAs by Method 8020A with MTBE & TMBs	Y
		GC Prep For Waters	N
		AFCEE	Y
		Aromatic VOAs by Method 8020A with MTBE & TMBs	Y

ANALYTICAL TEST REQUESTS
for
Parsons Engineering Science

Page 2 of 2

Lab ID: 059558	Group Code	Analysis Description	Custom Test?
		Method FL-PRO - TPH (C8-C40)	N
		Prep - TPH (C8-C40)	N
		AFCEE	N
		Polynuclear Aromatic Hydrocarbons, HPLC	N
		AFCEE	N
		Prep - Polynuclear Aromatic Hydrocarbons - HPLC	N
		AFCEE	N
		Polynuclear Aromatic Hydrocarbons, HPLC	N
		Method 504 - EDB	N
		Prep-1,2-Dibromoethane (EDB)	N
0006	E	Method EPA-9 RSK-175 by GC/FID	Y
		AFCEE	Y
		Aromatic VOAs by Method 8020A with MTBE & TMBs	Y
		GC Prep For Waters	N
		AFCEE	Y
		Aromatic VOAs by Method 8020A with MTBE & TMBs	Y
0007	F	AFCEE	N
		Nitrate, Ion Chromatography	N
0009 - 0010	G	Prep - Total Metals, Furnace AA	N
		AFCEE	N
		Lead, Furnace AA (Totals)	N
		AFCEE	Y
		Aromatic VOAs by Method 8020A with MTBE & TMBs	Y
		GC Prep For Waters	N
		AFCEE	Y
		Aromatic VOAs by Method 8020A with MTBE & TMBs	Y
		Method FL-PRO - TPH (C8-C40)	N
		Prep - TPH (C8-C40)	N
		AFCEE	N
		Polynuclear Aromatic Hydrocarbons, HPLC	N
		AFCEE	N
		Prep - Polynuclear Aromatic Hydrocarbons - HPLC	N
		AFCEE	N
		Polynuclear Aromatic Hydrocarbons, HPLC	N

APPENDIX C
FIELD FORMS FROM THE MARCH 1998 FIELD EFFORT

Sheet 1 of 1

B4 MW-5

BORING NO.:	SoBo-1	CONTRACTOR:		DATE SPUD:	3/17/98
CLIENT:	AFCEE	RIG TYPE:	GEOPROBE	DATE CMPL.:	3/17/98
JOB NO.:	731854	DRLG METHOD:	DIRECT PUSH	ELEVATION:	
LOCATION:	FT-16	BORING DIA.:	2"	TEMP:	
GEOLOGIST:	B LEWIS	DRLG FLUID:		WEATHER:	RAIN

COMENTS:

Elev (ft)	Depth (ft)	Pro-file	US CS	Geologic Description	Sample No.	Sample Depth (ft)	Sample Type	Penet Res	PID(ppm)	TLV(ppm)	TOTAL BTEX(ppm)	TPH (ppm)
	1		0830	2-2 RED CLAY/SILT TOP 2" BOTTOM SAND, TAN, MOIST, LOOSE, NO ODOR					0			
	5											
			0835	2-4 SAND, TAN, WET LOOSE, NO ODOR					0			
	10											
			0850	4-6 SAND W/ FINES DARK BROWN, WET LOOSE TO FIRM NO ODOR					0			
	15											
			0855	6-8 SAA					0			
	20											
				BORING TERM AT 8' BGS								
	25											
	30											
	35											

NOTES

bgs — Below Ground Surface
GS — Ground Surface
TOC — Top of Casing
NS — Not Sampled
SAA — Same As Above

SAMPLE TYPE

D — DRIVE
C — CORE
G — GRAB

▼ Water level drilled

ENGINEERING-SCIENCE, INC.

Sheet 1 of 1

B4 MW-7

BORING NO.:	SoBo-2	CONTRACTOR:		DATE SPUD:	3/17/98
CLIENT:	AFCEE	RIG TYPE:	GEOPROBE	DATE CMPL.:	
JOB NO.:	731854	DRLG METHOD:	DIRECT PUSH	ELEVATION:	
LOCATION:	FT-16	BORING DIA.:	2"	TEMP:	
GEOLOGIST:	B LEWIS	DRLG FLUID:		WEATHER:	RAIN
COMENTS:					

Elev (ft)	Depth (ft)	Pro-file	US CS	Geologic Description	Sample		Sample Type	Penet Res	PID(ppm)	TLV(ppm)	TOTAL BTEX(ppm)	TPH (ppm)
					No.	Depth (ft)						
	1											
		0940		0-2 SAND, LT BROWN TO TAN, MOIST, LOOSE, NO ODOR					0			
	5											
		0945		~~0~~2-4 SAND - TAN TO WHITE, WET, LOOSE, NO ODOR					0			
	10											
	15											
	20											
	25											
	30											
	35											

NOTES

bgs – Below Ground Surface
GS – Ground Surface
TOC – Top of Casing
NS – Not Sampled
SAA – Same As Above

SAMPLE TYPE

D – DRIVE
C – CORE
G – GRAB

▼ Water level drilled

ENGINEERING-SCIENCE, INC.

(14A-61)

Sheet 1 of 1

BORING NO.: SCPO-3
CLIENT: AFCEE
JOB NO.: 731854
LOCATION: FT-16
GEOLOGIST: B LEWIS
COMENTS:

CONTRACTOR: PARSONS
RIG TYPE: GEOPROBE
DRLG METHOD: DIRECT PUSH
BORING DIA.: 2"
DRLG FLUID: —

DATE SPUD: 3/17/98
DATE CMPL.: 3/17/98
ELEVATION:
TEMP:
WEATHER: RAIN

Elev (ft)	Depth (ft)	Pro-file	US CS	Geologic Description	Sample No.	Sample Depth (ft)	Sample Type	Penet Res	PID(ppm)	TLV(ppm)	TOTAL BTEX(ppm)	TPH (ppm)
	1			0-2 SAND, TAN-WHITE, LOOSE, MOIST, NO ODOR					0			
	5								0			
				2-4 SAND, W/FINES LT BROWN, WET, NO ODOR								
	10			4-6 SAA					0			
				6-8 SAND, DARK BROWN, WET SLIGHT ODOR?					0			
	15											
	20											
	25											
	30											
	35											

NOTES
bgs — Below Ground Surface
GS — Ground Surface
TOC — Top of Casing
NS — Not Sampled
SAA — Same As Above

SAMPLE TYPE
D — DRIVE
C — CORE
G — GRAB

▼ Water level drilled

ENGINEERING-SCIENCE, INC.

4A-65

Sheet 1 of 1

BORING NO.: SB-4
CLIENT: AFCEE
JOB NO.: 731854
LOCATION: FT-16
GEOLOGIST: B LEWIS
CONTRACTOR: PARSONS
RIG TYPE: GEOPROBE
DRLG METHOD: DIRECTPUSH
BORING DIA.: 2"
DRLG FLUID: —
DATE SPUD: 3/17/98
DATE CMPL.: 3/17/98
ELEVATION:
TEMP: 60°F
WEATHER: RAIN WIND
COMENTS:

Elev (ft)	Depth (ft)	Pro- file	US CS	Geologic Description	Sample No.	Sample Depth (ft)	Sample Type	Penet Res	PID(ppm)	TLV(ppm)	TOTAL BTEX(ppm)	TPH (ppm)
	1											
			1435	0-2 SAND, fine, tan to white, moist, loose no odor					0			
	5											
				2-4 SAND, fine					0			
	10		1440	orange-brown, wet								
			1445	4-6 SAA, wet					0			
	15		1450	6-8 SAND, tan to white, ~~moi~~ wet, hydrocarbon odor					0			
	20		1455	8-10 SAA					0			
									0			
			1500	10-12 SAA								
	25											
	30											
	35											

NOTES
bgs — Below Ground Surface
GS — Ground Surface
TOC — Top of Casing
NS — Not Sampled
SAA — Same As Above

SAMPLE TYPE
D — DRIVE
C — CORE
G — GRAB

▼ Water level drilled

ENGINEERING-SCIENCE, INC.

4A-72

Sheet 1 of 1

BORING NO.: SO Bo-5
CONTRACTOR: PARSONS
DATE SPUD: 3/17/98
CLIENT: PARSONS
RIG TYPE: GEOPROBE
DATE CMPL.: 3/17/98
JOB NO.: 731854
DRLG METHOD: DP
ELEVATION:
LOCATION: FT-16
BORING DIA.: 2"
TEMP: 60°F
GEOLOGIST: B LEWIS
DRLG FLUID: —
WEATHER: RAIN, WIND
COMENTS:

Elev (ft)	Depth (ft)	Pro-file	USCS	Geologic Description	Sample		Sample Type	Penet Res	PID(ppm)	TLV(ppm)	TOTAL BTEX(ppm)	TPH (ppm)
					No.	Depth (ft)						
	1											
			1335	0-2 SAND, fine, lt brown to brown, loose, moist, no odor					0			
	5											
			1340	2-4 SAA, wet					0			
	10		1345	4-6 SAA, wet					0			
			1350	6-8 SAND, fine, w/ CLAY AND SILT, DARK BROWN, wet, NO ODOR					0			
	15											
			1355	8-10 SAA					0			
	20		1400	10-12 SAA					0			
	25											
	30											
	35											

NOTES

bgs – Below Ground Surface
GS – Ground Surface
TOC – Top of Casing
NS – Not Sampled
SAA – Same As Above

SAMPLE TYPE

D – DRIVE
C – CORE
G – GRAB

▼ Water level drilled

ENGINEERING-SCIENCE, INC.

(CHAW2)

Sheet 1 of 1

BORING NO.:	SoBo-6	CONTRACTOR:	PARSONS	DATE SPUD:	3/18/98
CLIENT:	AFCEE	RIG TYPE:	GEOPROBE	DATE CMPL.:	3/18/98
JOB NO.:	731854	DRLG METHOD:	DIRECT PUSH	ELEVATION:	
LOCATION:	FT-16	BORING DIA.:	2"	TEMP:	
GEOLOGIST:	B LEWIS	DRLG FLUID:	—	WEATHER:	OVERCAST, WIND
COMENTS:					

Elev (ft)	Depth (ft)	Pro-file	US CS	Geologic Description	Sample No.	Sample Depth (ft)	Sample Type	Penet Res	PID(ppm)	TLV(ppm)	TOTAL BTEX(ppm)	TPH (ppm)
	1	0625		0-2 SAND, fine, w/ fines, DARK BROWN, loose, MOIST, no odor					0			
	5											
		0630		2-4 SAND, fine, lt brown to tan, wet, no odor					0			
	10											
		0640		4-6 SAA, w/ slight odor					0			
			0645	6-8 SAND, fine, dark brown, odor wet, loose					0			
	15											
	20											
	25											
	30											
	35											

NOTES

bgs – Below Ground Surface
GS – Ground Surface
TOC – Top of Casing
NS – Not Sampled
SAA – Same As Above

SAMPLE TYPE

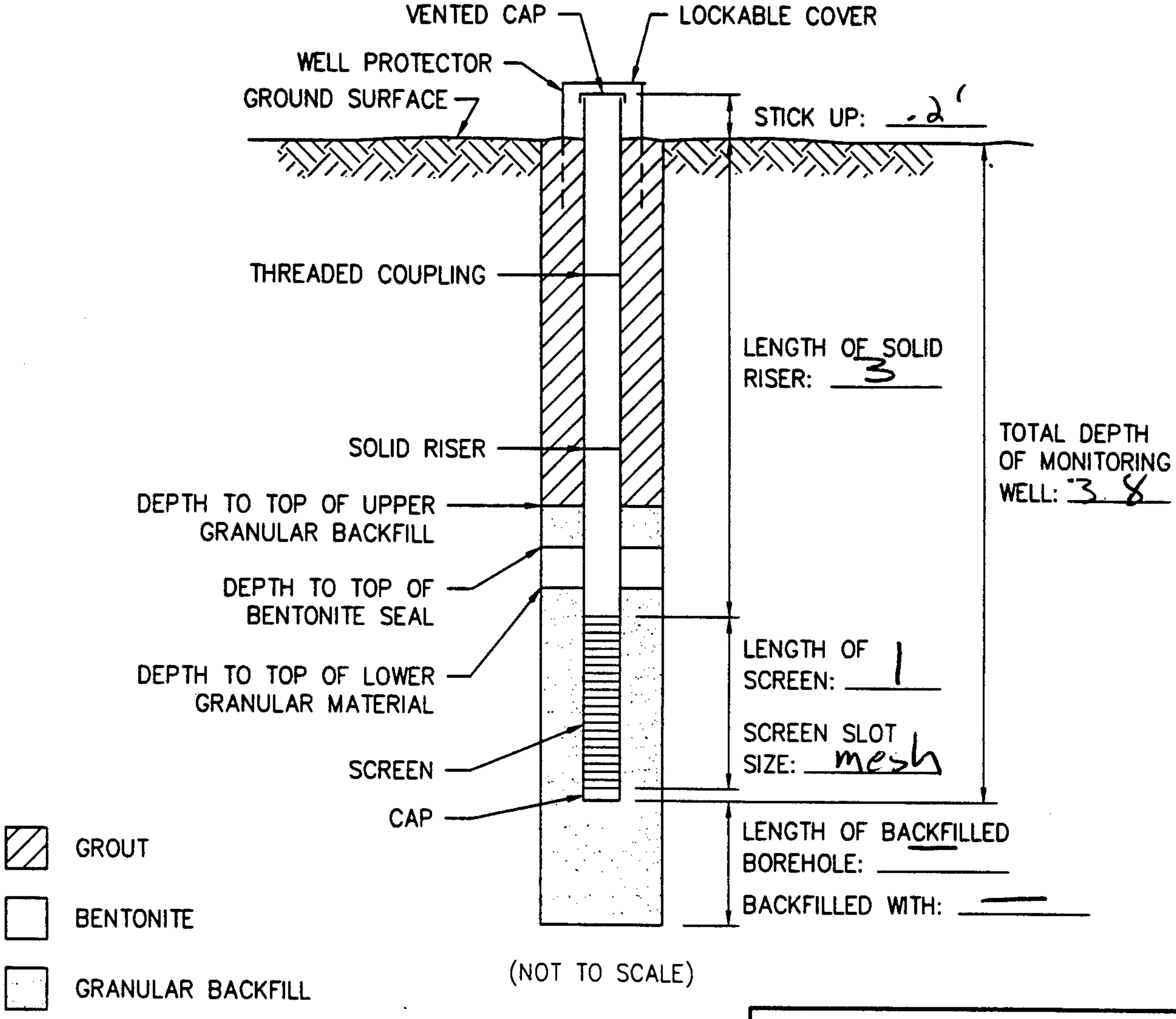
D – DRIVE
C – CORE
G – GRAB

▼ Water level drilled

ENGINEERING-SCIENCE, INC.

MONITORING WELL INSTALLATION RECORD

JOB NAME TYNDALL RBIC FT-16 WELL NUMBER MP-1
JOB NUMBER 231854 INSTALLATION DATE 3/14/98 LOCATION FT-16
DATUM ELEVATION ________ GROUND SURFACE ELEVATION ________
DATUM FOR WATER LEVEL MEASUREMENT ________
SCREEN DIAMETER & MATERIAL STAINLESS STEEL 0.75" DIA SLOT SIZE mesh
RISER DIAMETER & MATERIAL STAINLESS STEEL 0.75" BOREHOLE DIAMETER 0.75"
GRANULAR BACKFILL MATERIAL — ES REPRESENTATIVE B LEWIS
DRILLING METHOD DRIVE POINT DRILLING CONTRACTOR ________



STICK UP: .2'
LENGTH OF SOLID RISER: 3
TOTAL DEPTH OF MONITORING WELL: 3.8
LENGTH OF SCREEN: 1
SCREEN SLOT SIZE: mesh
LENGTH OF BACKFILLED BOREHOLE: ________
BACKFILLED WITH: —

(NOT TO SCALE)

STABILIZED WATER LEVEL ________ FEET BELOW DATUM.
MEASURED ON ________

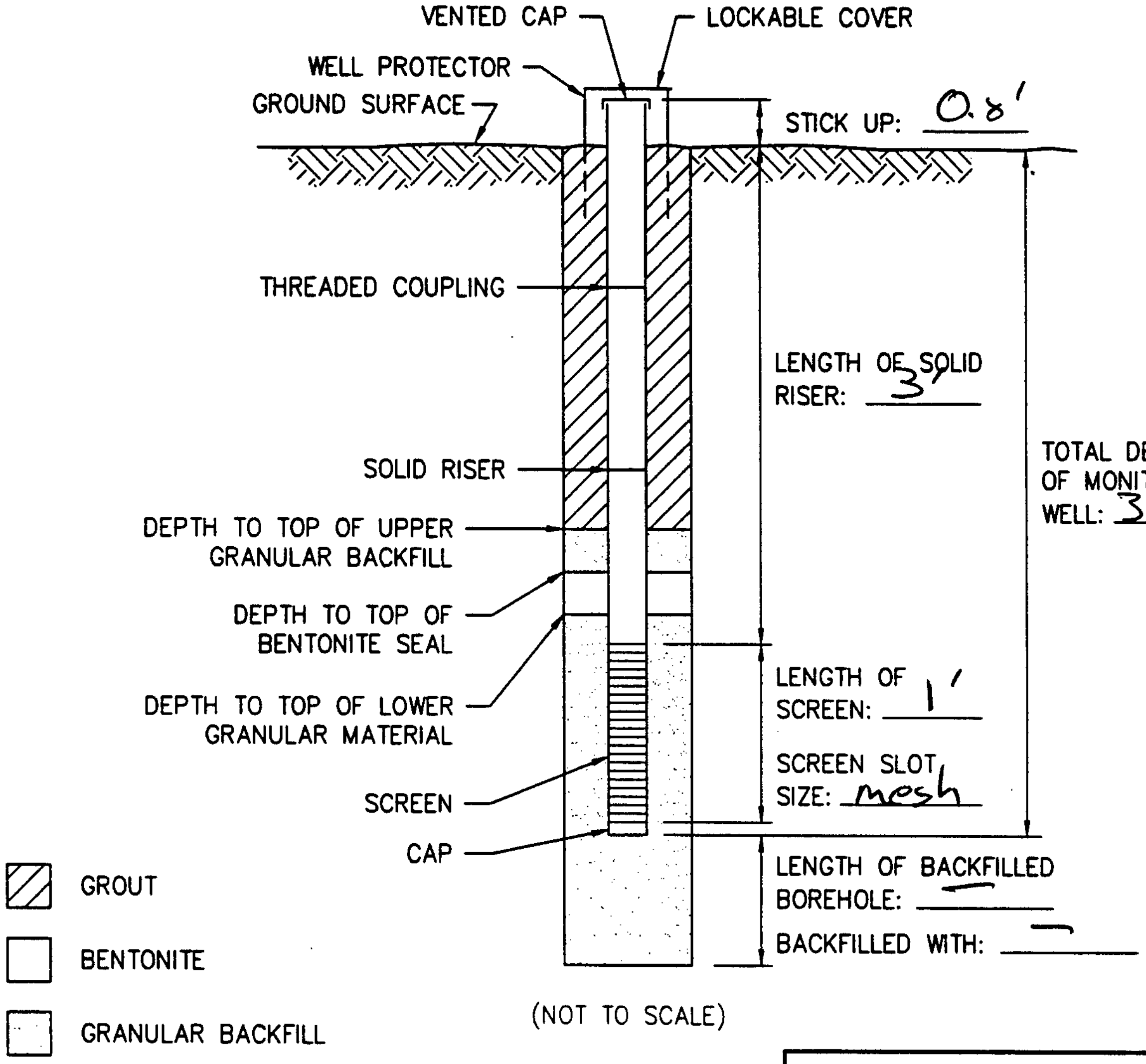
MONITORING WELL INSTALLATION RECORD

ENGINEERING-SCIENCE, INC.

94DN0199, 03/01/94 at 10:22

MONITORING WELL INSTALLATION RECORD

JOB NAME TYNDALL RBIC WELL NUMBER MP-2
JOB NUMBER 731854 INSTALLATION DATE 3/19/98 LOCATION FT-16
DATUM ELEVATION ______ GROUND SURFACE ELEVATION ______
DATUM FOR WATER LEVEL MEASUREMENT ______
SCREEN DIAMETER & MATERIAL STAINLESS STEEL 0.75" DIA SLOT SIZE mesh
RISER DIAMETER & MATERIAL STAINLESS STEEL 0.75" BOREHOLE DIAMETER 0.75
GRANULAR BACKFILL MATERIAL — ES REPRESENTATIVE B LEWIS
DRILLING METHOD DRIVE POINTS DRILLING CONTRACTOR PARSONS



STICK UP: 0.8'
LENGTH OF SOLID RISER: 3'
TOTAL DEPTH OF MONITORING WELL: 3.2'
LENGTH OF SCREEN: 1'
SCREEN SLOT SIZE: mesh
LENGTH OF BACKFILLED BOREHOLE: —
BACKFILLED WITH: —

(NOT TO SCALE)

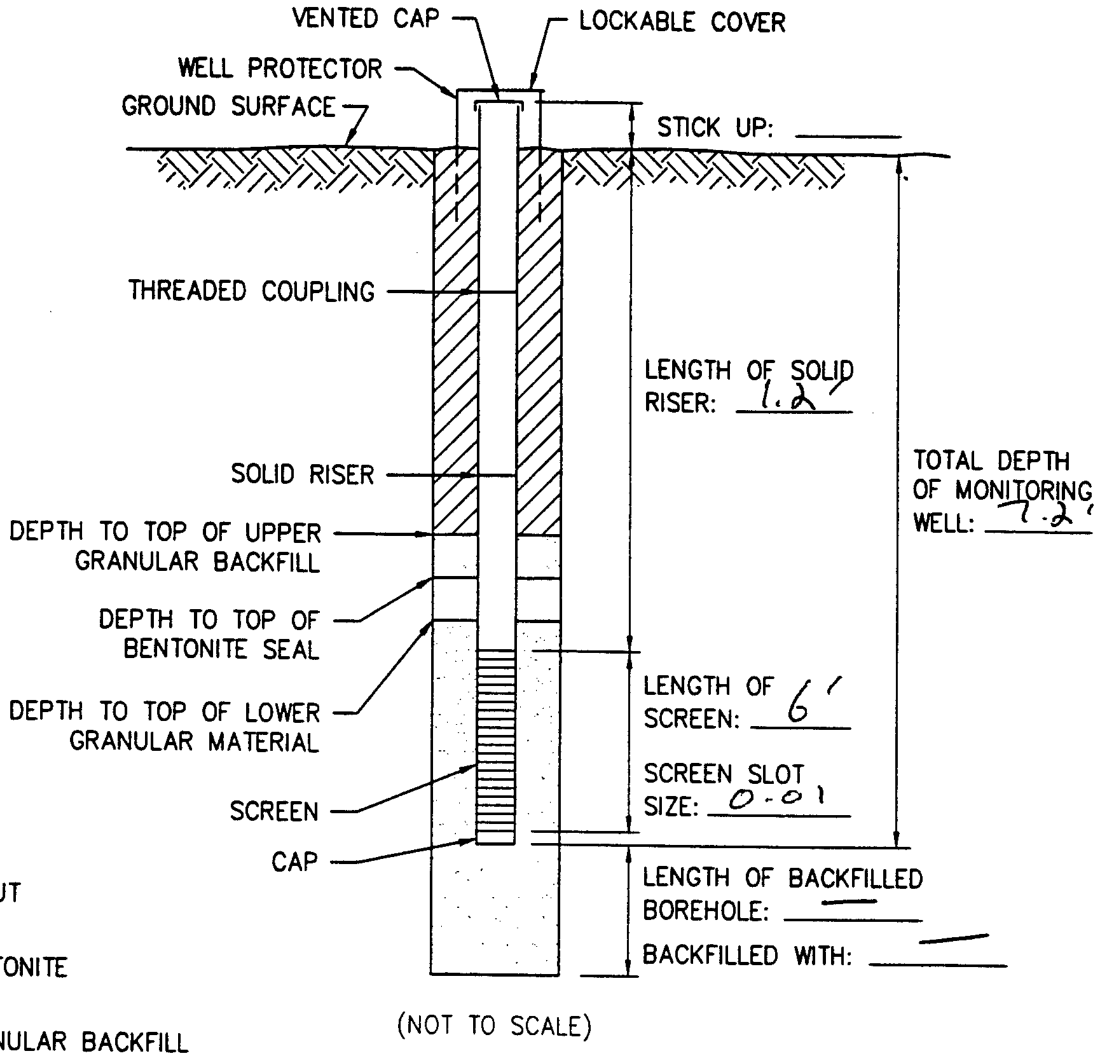
STABILIZED WATER LEVEL ______ FEET BELOW DATUM.
MEASURED ON ______

MONITORING WELL
INSTALLATION RECORD

ENGINEERING-SCIENCE, INC.

MONITORING WELL INSTALLATION RECORD

JOB NAME TYNDALL RBIC FT-16 WELL NUMBER MP-3
JOB NUMBER 731854 INSTALLATION DATE 3/17/98 LOCATION FT-16
DATUM ELEVATION ______ GROUND SURFACE ELEVATION ______
DATUM FOR WATER LEVEL MEASUREMENT ______
SCREEN DIAMETER & MATERIAL SCH 80 PVC 0.5" ~~0.015~~ SLOT SIZE 0.01
RISER DIAMETER & MATERIAL SCH 80 PVC 0.5" BOREHOLE DIAMETER 2"
GRANULAR BACKFILL MATERIAL SAND + BENTONITE ES REPRESENTATIVE B LEWIS
DRILLING METHOD DIRECT PUSH DRILLING CONTRACTOR ______



STICK UP: ______
LENGTH OF SOLID RISER: 1.2'
TOTAL DEPTH OF MONITORING WELL: 7.2'
LENGTH OF SCREEN: 6'
SCREEN SLOT SIZE: 0.01
LENGTH OF BACKFILLED BORECHOLE: —
BACKFILLED WITH: —

▨ GROUT
☐ BENTONITE
░ GRANULAR BACKFILL

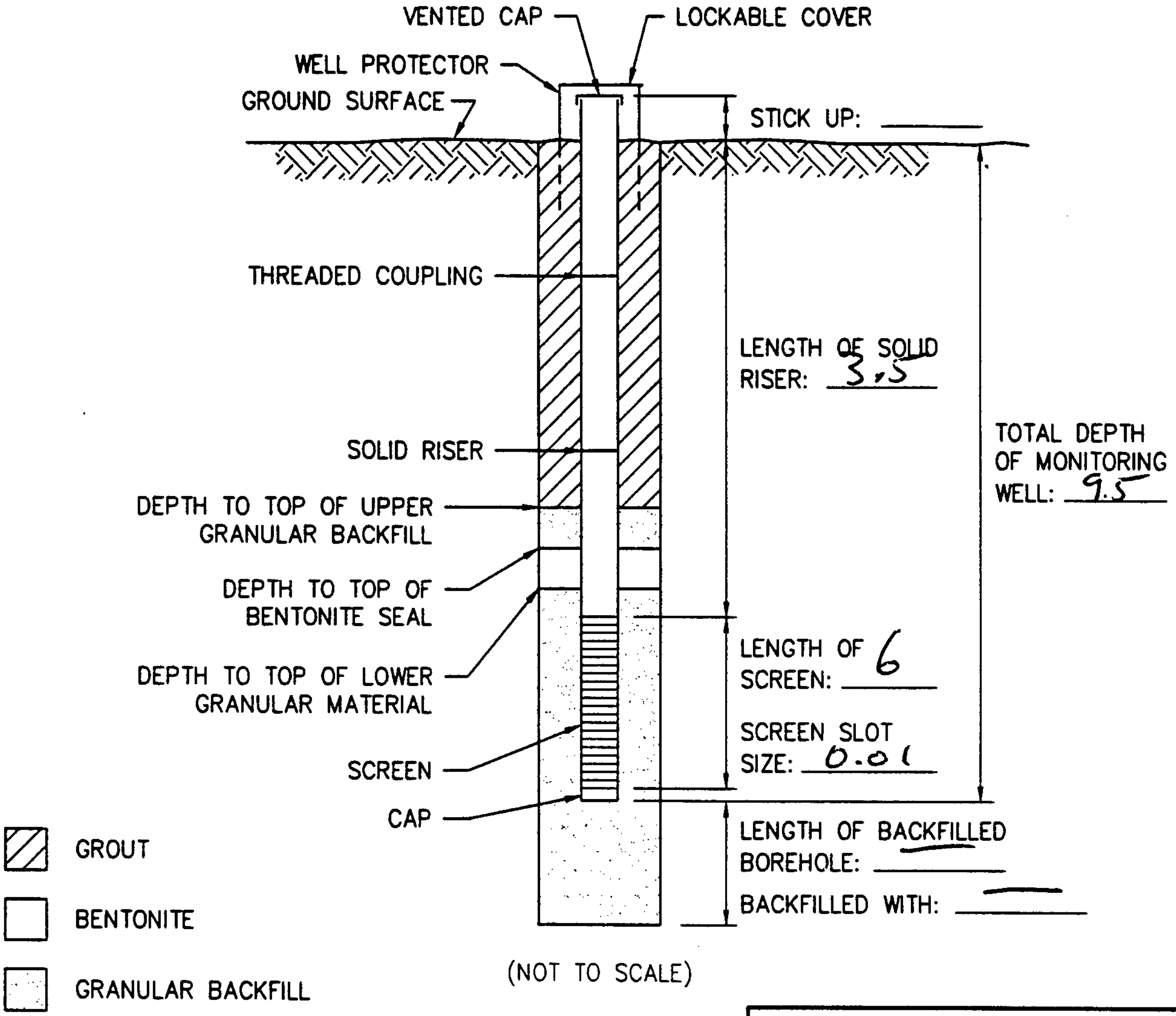
STABILIZED WATER LEVEL ______ FEET BELOW DATUM.
MEASURED ON ______

MONITORING WELL INSTALLATION RECORD

ENGINEERING-SCIENCE, INC.

MONITORING WELL INSTALLATION RECORD

JOB NAME RBIC TYNDALL FT-16 WELL NUMBER MP-4
JOB NUMBER 231854 INSTALLATION DATE 3/18/98 LOCATION
DATUM ELEVATION GROUND SURFACE ELEVATION
DATUM FOR WATER LEVEL MEASUREMENT
SCREEN DIAMETER & MATERIAL SCH80 PVC 0.5'' SLOT SIZE 0.01
RISER DIAMETER & MATERIAL SCH80 PVC 0.5'' BOREHOLE DIAMETER 2
GRANULAR BACKFILL MATERIAL ES REPRESENTATIVE B Lewis
DRILLING METHOD DIRECT PUSH DRILLING CONTRACTOR



STICK UP:
LENGTH OF SOLID RISER: 3.5
TOTAL DEPTH OF MONITORING WELL: 9.5
LENGTH OF SCREEN: 6
SCREEN SLOT SIZE: 0.01
LENGTH OF BACKFILLED BOREHOLE:
BACKFILLED WITH: —

STABILIZED WATER LEVEL FEET BELOW DATUM.
MEASURED ON

MONITORING WELL INSTALLATION RECORD

ENGINEERING-SCIENCE, INC.

MONITORING WELL DEVELOPMENT RECORD

Job Number: 730308.03000
Location PNM - Person Gen. Station
Well Identification MP3

Job Name: AFCEE-RNA
by Roy Brown Date: 3-21-98
Measurement Datum TOC

Pre-Development Information

Time (Start): 1130

Water Level: 1.91'

Total Depth of Well: 6.6'

Water Characteristics

Color Brown Clear V.Cloudy
Odor: [✓ None] Weak Moderate Strong
Any Films or Immiscible Material no
pH Temperature (°C)
Specific Conductance (µS/cm)
Dissolved Oxygen (mg/L)
Redox (mV)

Interim Water Characteristics

Gallons Removed ~3.5 1

pH 6.81

Temperature (°C) 17.4

Specific Conductance(µS/cm) .262

Dissolved Oxygen (mg/L) 1.22

Redox (mV) -166.4

Post-Development Information

Time (Finish): 1230

Water Level: 1.95'

Total Depth of Well: 6.6

Approximate Volume Removed: ~3.5 gal

Water Characteristics

Color Brown Clear [✓ Cloudy]
Odor: [✓ None] Weak Moderate Strong
Any Films or Immiscible Material no
pH 6.84 Temperature (°C) 17.2
Specific Conductance (µS/cm) .279
Dissolved Oxygen (mg/L) 1.46
Redox (mV) -180.3

Comments:

MONITORING WELL DEVELOPMENT RECORD

Job Number: 730308.03000
Job Name: AFCEE-RNA
Location PNM - Person Gen. Station
by Ray Brunner Date: 3-26-98
Well Identification MPW PT16
Measurement Datum TOC

Pre-Development Information

Time (Start): 0815

Water Level: 3' TOC
Total Depth of Well: 9.2' TOC

Water Characteristics

Color Milky Brown Clear [✓ Cloudy]
Odor: None Weak Moderate Strong
Any Films or Immiscible Material ~~[illegible]~~ none
pH 6.40 Temperature (°C) 19.3
Specific Conductance (µS/cm) .530
Dissolved Oxygen (mg/L) 1.69
Redox (mV) -219.3

Interim Water Characteristics

Gallons Removed ~1gal

pH 5.94

Temperature (°C) 18.7

Specific Conductance(µS/cm)

Dissolved Oxygen (mg/L) 1.38

Redox (mV) -226.9

Post-Development Information

Time (Finish): 0845

Water Level: 3' TOC
Total Depth of Well: 9.2' TOC

Approximate Volume Removed: ~2gal

Water Characteristics

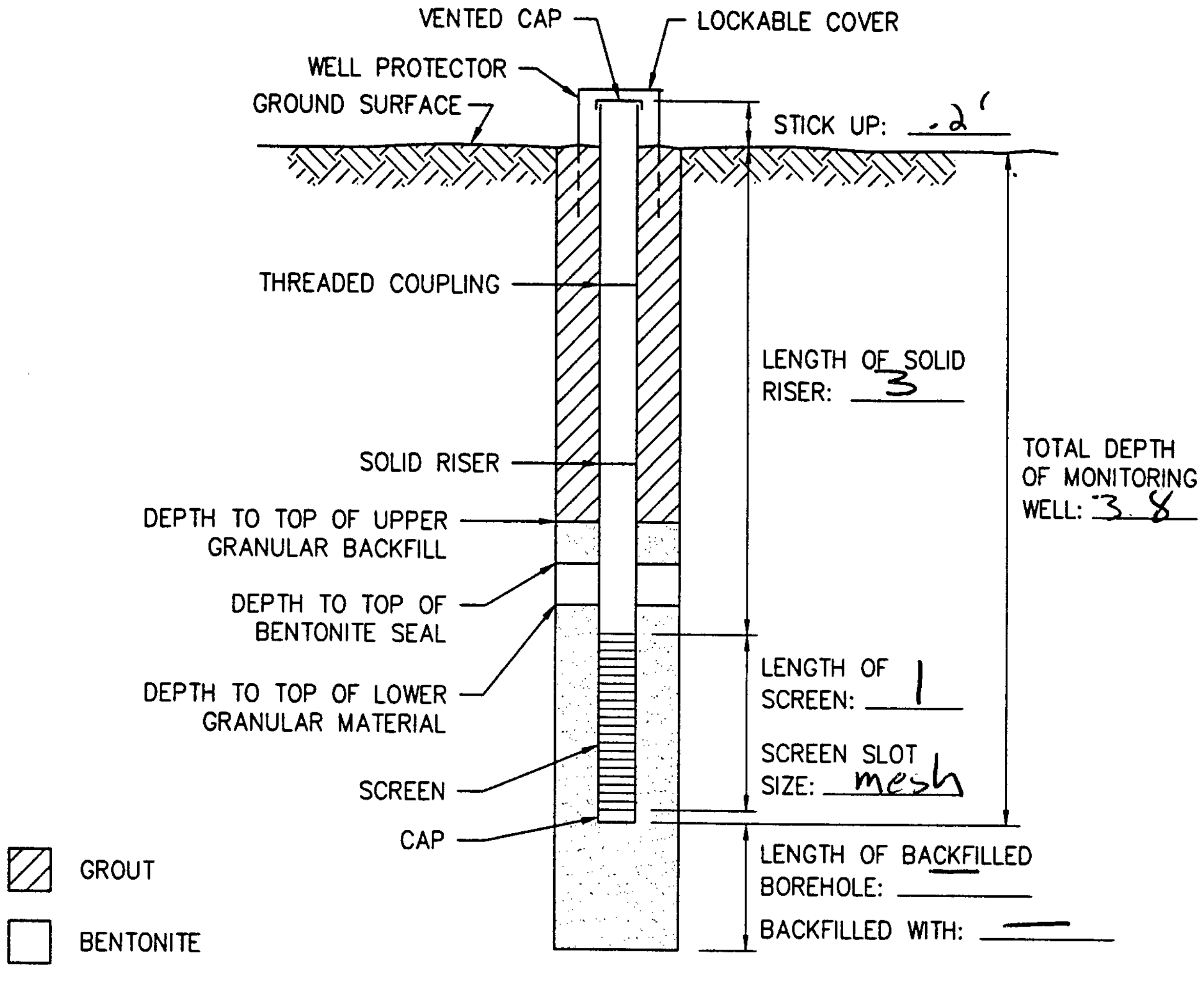
Color — [✓ Clear] Cloudy
Odor: [✓ None] Weak Moderate Strong
Any Films or Immiscible Material none
pH 6.45 Temperature (°C) 18.5
Specific Conductance (µS/cm)
Dissolved Oxygen (mg/L) 1.38
Redox (mV) -220.8

Comments:

l:\forms\develop.doc

MONITORING WELL INSTALLATION RECORD

JOB NAME TYNDALL RBIC FT-16 WELL NUMBER MP-1
JOB NUMBER 231854 INSTALLATION DATE 3/14/98 LOCATION FT-16
DATUM ELEVATION ______ GROUND SURFACE ELEVATION ______
DATUM FOR WATER LEVEL MEASUREMENT ______
SCREEN DIAMETER & MATERIAL STAINLESS STEEL 0.75" DIA SLOT SIZE mesh
RISER DIAMETER & MATERIAL STAINLESS STEEL 0.75" BOREHOLE DIAMETER 0.75"
GRANULAR BACKFILL MATERIAL — ES REPRESENTATIVE B LEWIS
DRILLING METHOD DRIVE POINT DRILLING CONTRACTOR ______



(NOT TO SCALE)

STABILIZED WATER LEVEL ______ FEET
BELOW DATUM.
MEASURED ON ______

MONITORING WELL
INSTALLATION RECORD

ENGINEERING-SCIENCE, INC.

MONITORING WELL INSTALLATION RECORD

JOB NAME TYNDALL RBIC WELL NUMBER MP-2

JOB NUMBER 731854 INSTALLATION DATE 3/19/98 LOCATION FT-16

DATUM ELEVATION ______ GROUND SURFACE ELEVATION ______

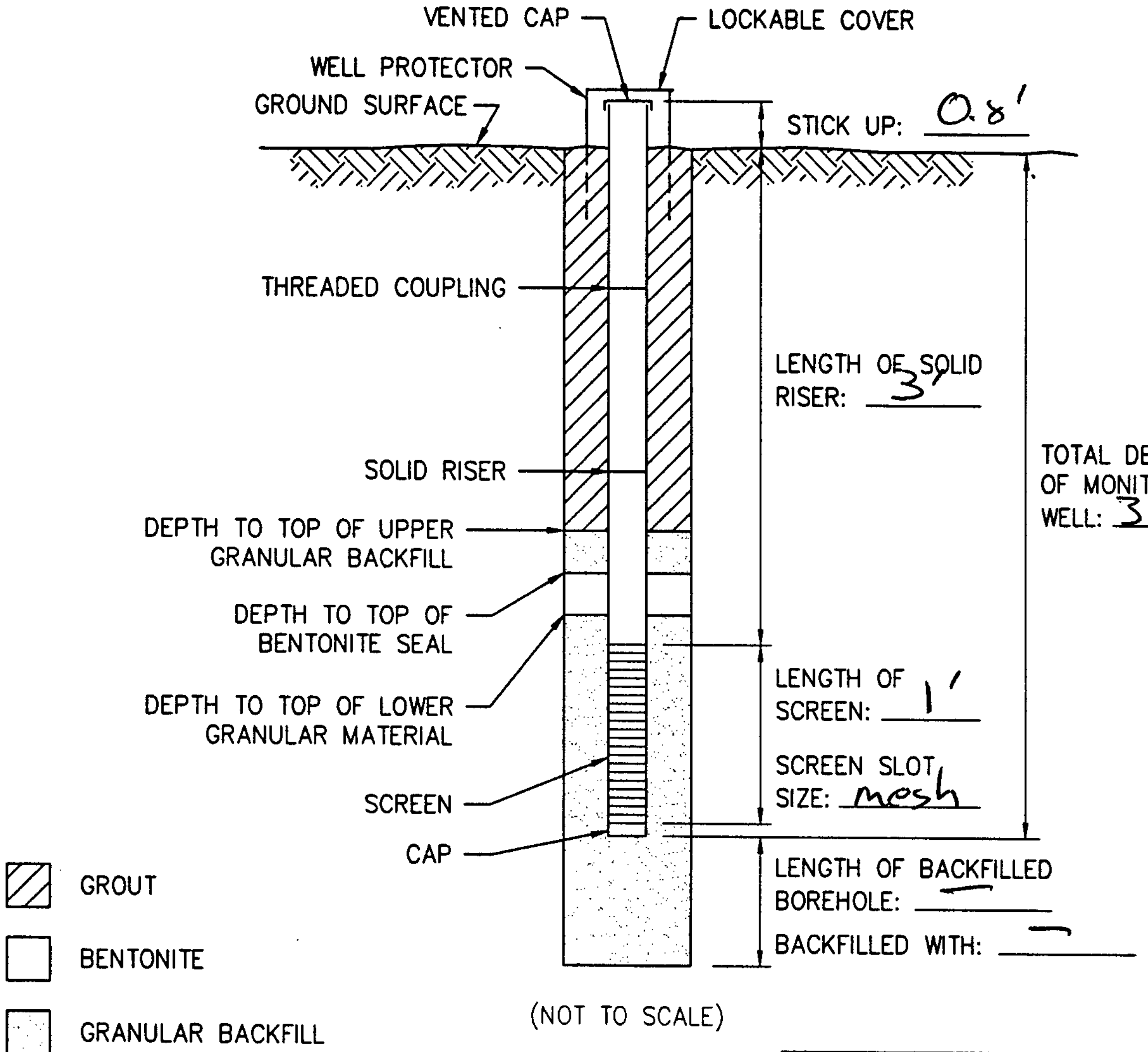
DATUM FOR WATER LEVEL MEASUREMENT ______

SCREEN DIAMETER & MATERIAL STAINLESS STEEL 0.75" DIA SLOT SIZE mesh

RISER DIAMETER & MATERIAL STAINLESS STEEL 0.75" BOREHOLE DIAMETER 0.75

GRANULAR BACKFILL MATERIAL — ES REPRESENTATIVE B LEWIS

DRILLING METHOD DRIVE POINTS DRILLING CONTRACTOR PARSONS



STICK UP: 0.8'

LENGTH OF SOLID RISER: 3'

TOTAL DEPTH OF MONITORING WELL: 3.2'

LENGTH OF SCREEN: 1'

SCREEN SLOT SIZE: mesh

LENGTH OF BACKFILLED BOREHOLE: —

BACKFILLED WITH: —

(NOT TO SCALE)

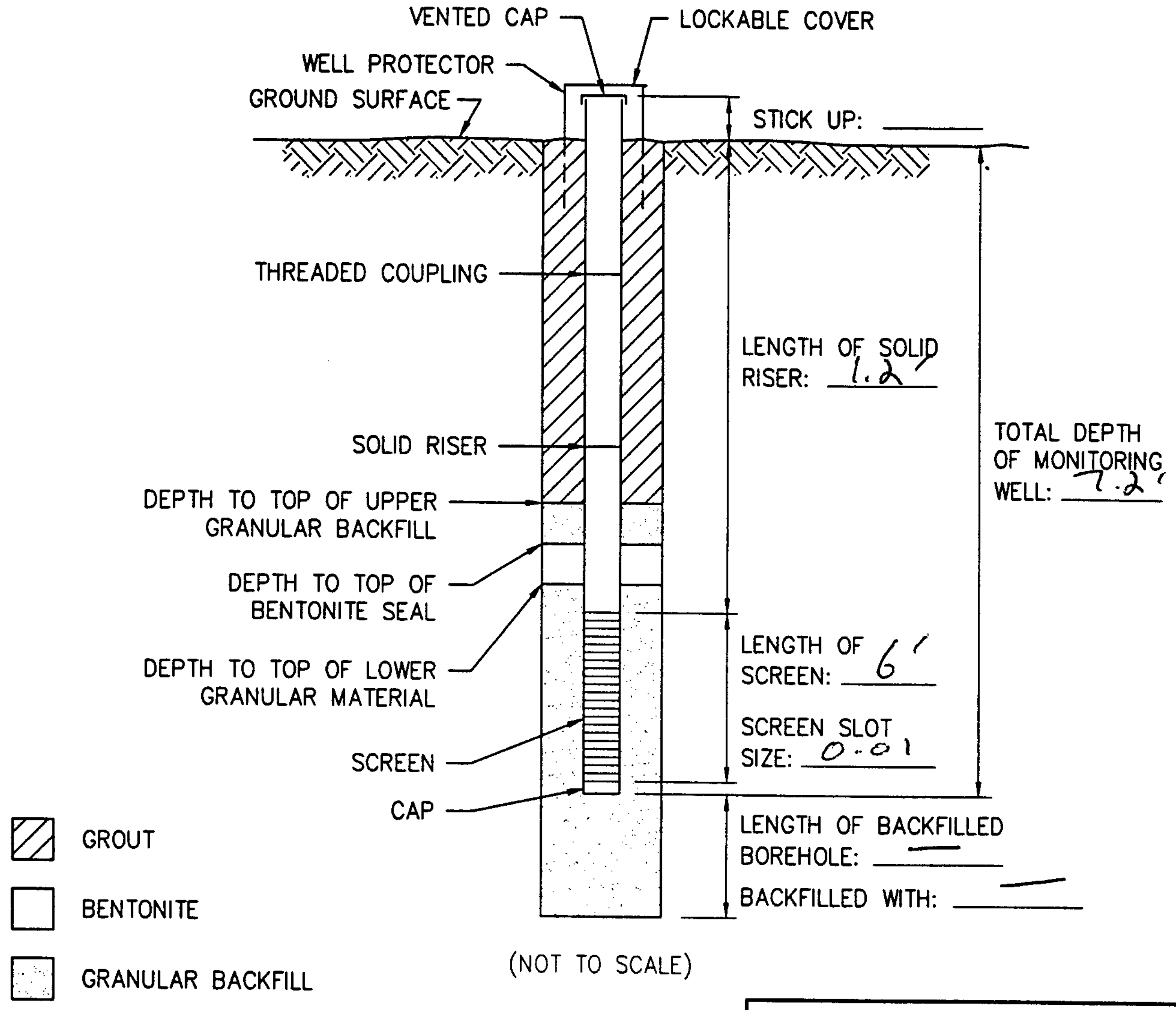
STABILIZED WATER LEVEL ______ FEET BELOW DATUM.
MEASURED ON ______

MONITORING WELL INSTALLATION RECORD

ENGINEERING-SCIENCE, INC.

MONITORING WELL INSTALLATION RECORD

JOB NAME TYNDALL RBIC FT-16 WELL NUMBER MP-3
JOB NUMBER 731854 INSTALLATION DATE 3/17/98 LOCATION FT-16
DATUM ELEVATION ______ GROUND SURFACE ELEVATION ______
DATUM FOR WATER LEVEL MEASUREMENT ______
SCREEN DIAMETER & MATERIAL SCH 80 PVC 0.5" ~~0.015~~ SLOT SIZE 0.01
RISER DIAMETER & MATERIAL SCH 80 PVC 0.5" BOREHOLE DIAMETER 2"
GRANULAR BACKFILL MATERIAL SAND + BENTONITE ES REPRESENTATIVE B LOWIS
DRILLING METHOD DIRECT PUSH DRILLING CONTRACTOR ______



STICK UP: ______
LENGTH OF SOLID RISER: 1.2'
TOTAL DEPTH OF MONITORING WELL: 7.2'
LENGTH OF SCREEN: 6'
SCREEN SLOT SIZE: 0.01
LENGTH OF BACKFILLED BOREHOLE: —
BACKFILLED WITH: —

(NOT TO SCALE)

STABILIZED WATER LEVEL ______ FEET
BELOW DATUM.
MEASURED ON ______

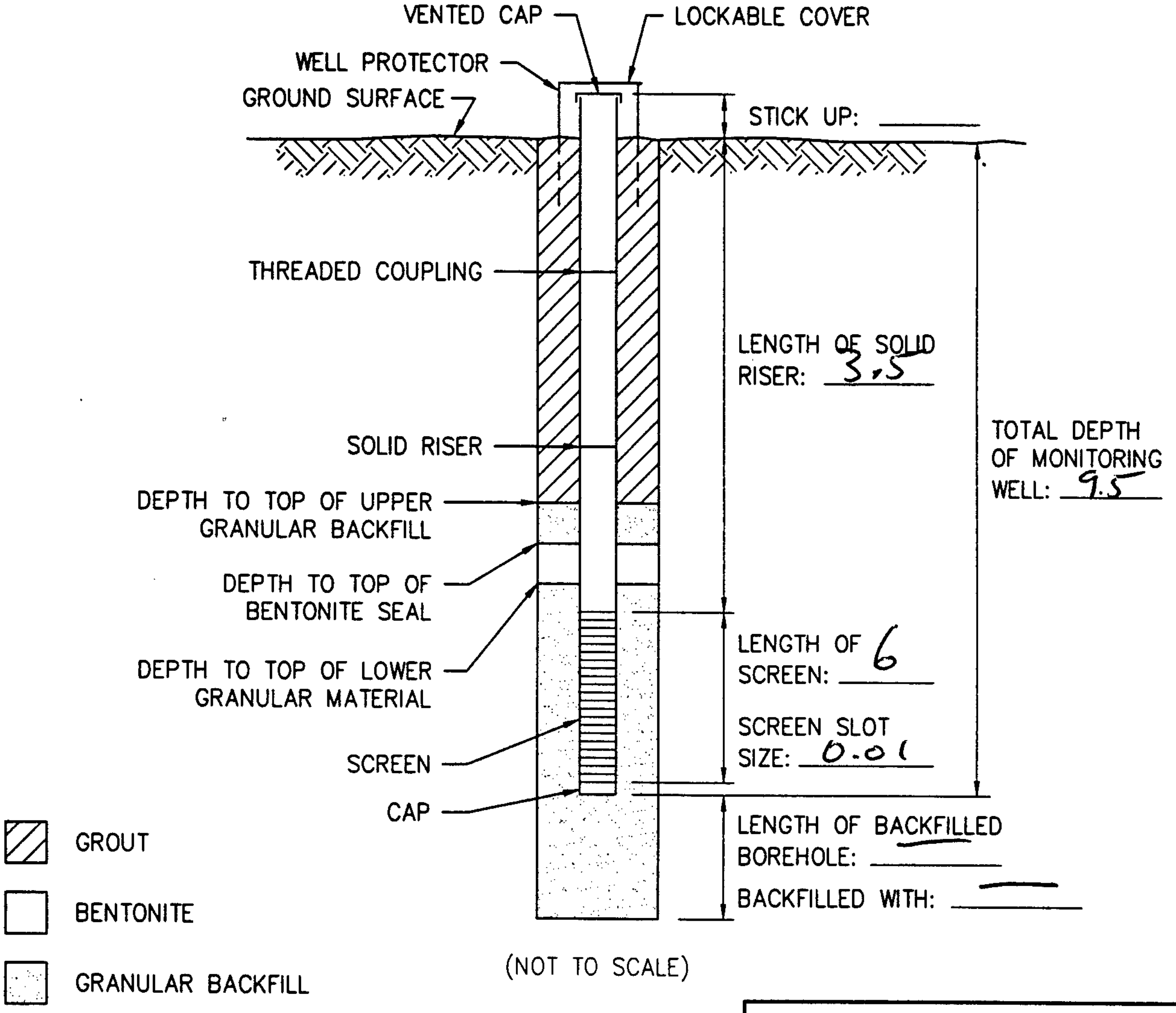
MONITORING WELL
INSTALLATION RECORD

ENGINEERING-SCIENCE, INC.

94DN0199, 03/01/94 at 10:22

MONITORING WELL INSTALLATION RECORD

JOB NAME RBIC TYNDALL FT-16
WELL NUMBER MP-4
JOB NUMBER 231854
INSTALLATION DATE 3/18/98
LOCATION
DATUM ELEVATION
GROUND SURFACE ELEVATION
DATUM FOR WATER LEVEL MEASUREMENT
SCREEN DIAMETER & MATERIAL SCH80 PVC 0.5''
SLOT SIZE 0.01
RISER DIAMETER & MATERIAL SCH80 PVC 0.5''
BOREHOLE DIAMETER 2
GRANULAR BACKFILL MATERIAL
ES REPRESENTATIVE B Lewis
DRILLING METHOD Direct Push
DRILLING CONTRACTOR



STICK UP:
LENGTH OF SOLID RISER: 3.5
TOTAL DEPTH OF MONITORING WELL: 9.5
LENGTH OF SCREEN: 6
SCREEN SLOT SIZE: 0.01
LENGTH OF BACKFILLED BOREHOLE:
BACKFILLED WITH: —

(NOT TO SCALE)

STABILIZED WATER LEVEL _____ FEET BELOW DATUM.
MEASURED ON

MONITORING WELL INSTALLATION RECORD

ENGINEERING-SCIENCE, INC.

MONITORING WELL DEVELOPMENT RECORD

Job Number: 730308.03000
Job Name: AFCEE-RNA
Location PNM - Person Gen. Station
by Roy Brown Date: 3-21-98
Well Identification MP3
Measurement Datum TOC

Pre-Development Information
Time (Start): 1130

Water Level: 1.91'
Total Depth of Well: 6.6'

Water Characteristics

Color Brown Clear V.Cloudy
Odor: [✓ None] Weak Moderate Strong
Any Films or Immiscible Material no
pH____ Temperature (°C)____
Specific Conductance (µS/cm)____
Dissolved Oxygen (mg/L)____
Redox (mV)____

Interim Water Characteristics

Gallons Removed ~3gl

pH 6.81

Temperature (°C) 17.4

Specific Conductance(µS/cm) .262

Dissolved Oxygen (mg/L) 1.22

Redox (mV) -166.4

Post-Development Information
Time (Finish): 1230

Water Level: 1.95'
Total Depth of Well: 6.6

Approximate Volume Removed: ~3.5 gal

Water Characteristics

Color Brown Clear [✓ Cloudy]
Odor: [✓ None] Weak Moderate Strong
Any Films or Immiscible Material no
pH 6.84 Temperature (°C) 17.2
Specific Conductance (µS/cm) .279
Dissolved Oxygen (mg/L) 1.46
Redox (mV) -180.3

Comments:

MONITORING WELL DEVELOPMENT RECORD

Job Number: 730308.03000
Location PNM - Person Gen. Station
Well Identification MP4 RT16

Job Name: AFCEE-RNA
by Ray Bumner Date: 3-20-98
Measurement Datum TOC

Pre-Development Information

Time (Start): 0815

Water Level: 3' TOC

Total Depth of Well: 9.2' TOC

Water Characteristics

Color Milky Brown Clear [✓ Cloudy]
Odor: None Weak Moderate Strong
Any Films or Immiscible Material ~~[illegible]~~ none
pH 6.40 Temperature (°C) 19.3
Specific Conductance (µS/cm) .530
Dissolved Oxygen (mg/L) 1.69
Redox (mV) -219.3

Interim Water Characteristics

Gallons Removed ~1gal

pH 5.94

Temperature (°C) 18.7

Specific Conductance(µS/cm)

Dissolved Oxygen (mg/L) 1.38

Redox (mV) -226.9

Post-Development Information

Time (Finish): 0845

Water Level: 3' TOC

Total Depth of Well: 9.2' TOC

Approximate Volume Removed: ~2gal

Water Characteristics

Color — [✓ Clear] Cloudy
Odor: [✓ None] Weak Moderate Strong
Any Films or Immiscible Material none
pH 6.45 Temperature (°C) 18.5
Specific Conductance (µS/cm)
Dissolved Oxygen (mg/L) 1.38
Redox (mV) -208

Comments:

GROUNDWATER SAMPLING RECORD

Sampling Location FT-16 mp1
Sampling Dates

GROUND WATER SAMPLING RECORD - MONITORING WELL mp1
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 3-21-98, 1998 [✓ a.m.]/p.m.
SAMPLE COLLECTED BY: RDB of Parsons ES
WEATHER: Cloudy cool ~ 50°F wind N ~ 5mph
DATUM FOR WATER DEPTH MEASUREMENT (Describe): TOC Top of casing

MONITORING WELL CONDITION:

[ ] LOCKED: [✓] UNLOCKED
WELL NUMBER (IS - [✓ IS NOT]) APPARENT
STEEL CASING CONDITION IS: OK
INNER PVC CASING CONDITION IS: none
WATER DEPTH MEASUREMENT DATUM ([✓ IS] - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):

Check-off

1 [ ] EQUIPMENT CLEANED BEFORE USE WITH alconox, DI, DI
Items Cleaned (List): all instrument probes

2 [ ] PRODUCT DEPTH none FT. BELOW DATUM
Measured with:

WATER DEPTH 1.5' FT. BELOW DATUM
Measured with: Slope water level indicator

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: cloudy
Odor: none
Other Comments:

4 [ ] WELL EVACUATION:
Method: pump
Volume Removed: ~3 gal
Observations: Water ([✓ slightly] - very) [✓ cloudy]
Water level (rose - fell - [✓ no change])
Water odors: sulfur
Other comments:

Groundwater Sampling Record

Monitoring Well No. MP1 (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:
[ ] Pump, type: Perastaltic
[ ] Other, describe:

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

DIRECT INSTRUMENT READINGS

Time							Measured With
Temp (°C)	17.4	18.3	18.3	18.4			~~YSI 55~~ YSI 55
pH	7.22	7.30	7.15	7.33			Orion 250A
Cond (µS/cm) mS/cm	2.42	2.49	2.52	2.57			Hach
Do (mg/L)	0.88	0.53	0.45	0.35			YSI 55
Redox (mv)	-195.6	-214.2	-282.9	-291.4			Orion 250A
gallons purged		1	2	3			

FIELD CHEMISTRY RESULTS

Analyte	Dilution?	Concentration	Observations/Notes
(1) Sulfate			
(2) Sulfide			
(3) Nitrate			
(4) Nitrite			
(5) Manganese			
(6) Ferrous Iron			
(7) Total Iron			
(8) Alkalinity			
(9) Carbon Dioxide			
(10) Chloride			

Additional Comments:

7 [X] SAMPLE CONTAINERS (material, number, size): 4 1liter amber glass, 1 500ml poly, 6 40ml vials glass

8 [X] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method Containers:
Method Containers:
[X] Preservatives added: HNO3 Total Iron
Method ~~B~~ Btx- MTBE HCL Containers: 500 ml poly 40 ml vials

9 [ ] CONTAINER HANDLING:
[X] Container Sides Labeled
[ ] Container Lids Taped
[X] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:

GROUNDWATER SAMPLING RECORD

Sampling Location FT-16 MP2
Sampling Dates 3-21-98

GROUND WATER SAMPLING RECORD - MONITORING WELL MP2
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 3-21-98, 1998 1000 [✓ a.m.]/p.m.
SAMPLE COLLECTED BY: RDM of Parsons ES
WEATHER: cloudy Cool ~ 50°F wind ~10mph W
DATUM FOR WATER DEPTH MEASUREMENT (Describe): TOC Top of casing

MONITORING WELL CONDITION:
[ ] LOCKED: [✓] UNLOCKED
WELL NUMBER (IS - [✓ IS NOT]) APPARENT
STEEL CASING CONDITION IS: OK
INNER PVC CASING CONDITION IS: N/A
WATER DEPTH MEASUREMENT DATUM (IS - [✓ IS NOT]) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):

Check-off
1 [✓] EQUIPMENT CLEANED BEFORE USE WITH Alconox, DI, Iso, DI
Items Cleaned (List): all instrument probes

2 [✓] PRODUCT DEPTH None FT. BELOW DATUM
Measured with:

WATER DEPTH 1.3' FT. BELOW DATUM
Measured with: Slope water level indicator

3 [✓] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: cloudy
Odor: none
Other Comments:

4 [✓] WELL EVACUATION:
Method: pump
Volume Removed: ~3 gal
Observations: Water ([✓ slightly] - very) cloudy
Water level (rose - fell - [✓ no change])
Water odors: none
Other comments:

Groundwater Sampling Record

Monitoring Well No. MP 2 (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:
[✓] Pump, type: peristaltic
[ ] Other, describe:

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

DIRECT INSTRUMENT READINGS

Time							Measured With
Temp (°C)	17.7	18.0	18.1	18.1			YSI 55
pH	7.00	7.23	7.27	7.33			orion 250A
Cond (~~µS/cm~~) mS/cm	3.08	2.89	2.63	2.63			Hach
Do (mg/L)	16.1	12.2	13.9	14.2			YSI 55
Redox (mv)	-62.9	-67.9	-49.4	-65.5			Orion 250A
gallons purged		1	2	3			

FIELD CHEMISTRY RESULTS

Analyte	Dilution?	Concentration	Observations/Notes
(1) Sulfate			
(2) Sulfide			
(3) Nitrate			
(4) Nitrite			
(5) Manganese			
(6) Ferrous Iron			
(7) Total Iron			
(8) Alkalinity			
(9) Carbon Dioxide			
(10) Chloride			

Additional Comments:

7 [✓] SAMPLE CONTAINERS (material, number, size): 6 40ml glass vials, 4 1 liter glass ambers
1 500ml poly

8 [✓] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method Containers:
Method Containers:
[✓] Preservatives added: HCL BTEX-MTBE
HNO3 Method Total lead Containers: 40ml vials 500ml poly

9 [✓] CONTAINER HANDLING:
[✓] Container Sides Labeled
[ ] Container Lids Taped
[✓] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:

GROUNDWATER SAMPLING RECORD

Sampling Location FT-16 MP3
Sampling Dates 3-21-98

GROUND WATER SAMPLING RECORD - MONITORING WELL MP3
(number)

REASON FOR SAMPLING: ☒ Regular Sampling; ☐ Special Sampling;
DATE AND TIME OF SAMPLING: 3-21-98, 1998 ________ a.m./p.m.
SAMPLE COLLECTED BY: [illegible] of Parsons ES
WEATHER: Cool ~50°F cloudy wind ~7 mph N
DATUM FOR WATER DEPTH MEASUREMENT (Describe): ToC Top of Casing

MONITORING WELL CONDITION:
☐ LOCKED: ☒ UNLOCKED
WELL NUMBER ([✓ IS] - IS NOT) APPARENT
STEEL CASING CONDITION IS: ok
INNER PVC CASING CONDITION IS: ok
WATER DEPTH MEASUREMENT DATUM ([✓ IS] - IS NOT) APPARENT
☐ DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
☐ MONITORING WELL REQUIRED REPAIR (describe):

Check-off
1 [✓] EQUIPMENT CLEANED BEFORE USE WITH Alconox, DI, ISO, DI
Items Cleaned (List): all instrument probes

2 ☐ PRODUCT DEPTH none FT. BELOW DATUM
Measured with:

WATER DEPTH ________ FT. BELOW DATUM
Measured with: Slope water level indicator

3 ☐ WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: Very Cloudy
Odor: none
Other Comments: Sediments

4 ☐ WELL EVACUATION:
Method: [illegible] pump
Volume Removed: ~3.5 gal
Observations: Water (slightly - [✓ very]) cloudy
Water level (rose - fell - [✓ no change])
Water odors: none
Other comments:

Groundwater Sampling Record

Monitoring Well No. MP3 (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:
[X] Pump, type: Parastaltic
[ ] Other, describe:

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

DIRECT INSTRUMENT READINGS

Time							Measured With
Temp (°C)	17.1	17.4	17.1	17.2			YSI 55
pH	6.58	6.81	6.82	6.84			Orion 250A
Cond (µS/cm)	.249	.262	.274	.279			Hach
Do (mg/L)	0.83	1.22	1.40	1.46			YSI 55
Redox (mv)	-110.9	-166.4	-175.5	-180.3			Orion 250A
gallons purged		1	2	3.5			

FIELD CHEMISTRY RESULTS

Analyte	Dilution?	Concentration	Observations/Notes
(1) Sulfate			
(2) Sulfide			
(3) Nitrate			
(4) Nitrite			
(5) Manganese			
(6) Ferrous Iron			
(7) Total Iron			
(8) Alkalinity			
(9) Carbon Dioxide			
(10) Chloride			

Additional Comments:

7 [X] SAMPLE CONTAINERS (material, number, size): 6-40ml glass vials, 1 500ml poly

8 [X] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method Containers:
Method Containers:
[X] Preservatives added: HCL btex-MTBE methane
Method HNO3 nitrate
Containers: 40 ml vials 500 ml poly

9 [X] CONTAINER HANDLING:

[X] Container Sides Labeled
[ ] Container Lids Taped
[X] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:

GROUNDWATER SAMPLING RECORD

Sampling Location F7-16 562
Sampling Dates 3-21-98

GROUND WATER SAMPLING RECORD - MONITORING WELL 562
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 3-21-98, 1998 1115 [✓ a.m.]/p.m.
SAMPLE COLLECTED BY: [illegible] of Parsons ES
WEATHER: cloudy
DATUM FOR WATER DEPTH MEASUREMENT (Describe):

MONITORING WELL CONDITION:
[ ] LOCKED: [X] UNLOCKED
WELL NUMBER ([✓ IS] - IS NOT) APPARENT
STEEL CASING CONDITION IS: OK
INNER PVC CASING CONDITION IS: OK
WATER DEPTH MEASUREMENT DATUM ([✓ IS] - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):

Check-off
1 [X] EQUIPMENT CLEANED BEFORE USE WITH alconox, DI, Iso, DI
Items Cleaned (List): all instrument probes

2 [X] PRODUCT DEPTH none FT. BELOW DATUM
Measured with:

WATER DEPTH FT. BELOW DATUM
Measured with:

3 [X] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: clear
Odor: none
Other Comments:

4 [X] WELL EVACUATION:
Method: pump
Volume Removed:
Observations: Water ([✓ slightly] - very) [✓ cloudy]
Water level (rose - fell - [✓ no change])
Water odors: none
Other comments:

Groundwater Sampling Record

Monitoring Well No. 5B2 (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:
[ ] Pump, type: parastaltic
[ ] Other, describe:

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

DIRECT INSTRUMENT READINGS

Time							Measured With
Temp (°C)	18.2	18.0	17.8	17.8			YSI 55
pH	6 72	6.31	6.87	6.85			Orion 250A
Cond (µS/cm)	.221	.203	.202	.195			Hach
Do (mg/L)	0.84	0.44	0.38	0.33			YSI 55
Redox (mv)	-181.5	-190.0	-210.1	-211.6			Orion 250A
gallons purged		1	2	3			

FIELD CHEMISTRY RESULTS

Analyte	Dilution?	Concentration	Observations/Notes
(1) Sulfate			
(2) Sulfide			
(3) Nitrate			
(4) Nitrite			
(5) Manganese			
(6) Ferrous Iron			
(7) Total Iron			
(8) Alkalinity			
(9) Carbon Dioxide			
(10) Chloride			

Additional Comments:

7 [X] SAMPLE CONTAINERS (material, number, size): 3-40 ml glass vials

8 [X] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method Containers:
Method Containers:
[X] Preservatives added: HCL
Method BTEX-MTBE Containers: 40 ml vials

9 [X] CONTAINER HANDLING:
[X] Container Sides Labeled
[ ] Container Lids Taped
[X] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:

GROUNDWATER SAMPLING RECORD

Sampling Location FT-16 MW7
Sampling Dates 3-21-98

GROUND WATER SAMPLING RECORD - MONITORING WELL MW7
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 3-20-98, 1998 1500 a.m./p.m.
SAMPLE COLLECTED BY: of Parsons ES
WEATHER: Sunny ~65°F windy ~15mph NW
DATUM FOR WATER DEPTH MEASUREMENT (Describe): TOC Top of casing

MONITORING WELL CONDITION:

[ ] LOCKED: [✓] UNLOCKED
WELL NUMBER (IS [✓ - IS NOT]) APPARENT
STEEL CASING CONDITION IS: Broken
INNER PVC CASING CONDITION IS: ok
WATER DEPTH MEASUREMENT DATUM (IS [✓ - IS NOT]) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe): concrete pad need replacing

Check-off

1 [ ] EQUIPMENT CLEANED BEFORE USE WITH Decon dI Alcohol,
Items Cleaned (List): all Instrument probes

2 [ ] PRODUCT DEPTH none FT. BELOW DATUM
Measured with:

WATER DEPTH 1.55 FT. BELOW DATUM
Measured with: Slope water level indicator

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: milky Brown
Odor: none
Other Comments:

4 [ ] WELL EVACUATION:
Method: pump
Volume Removed: 6 gal
Observations: Water ([✓ slightly] - very) ~~cloudy~~ yellow
Water ~~level~~ (rose - fell [✓ - no change])
Water odors: none
Other comments:

Groundwater Sampling Record

Monitoring Well No. MW-7 (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:
[ ] Pump, type: peristaltic
[ ] Other, describe:

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

DIRECT INSTRUMENT READINGS

Time							Measured With
Temp (°C)	17.9	17.8	17.6	17.5			
pH	6.43	6.47	6.41	6.45			
Cond (µS/cm)	.152	.147	.148	.148			
Do (mg/L)	2.75	2.53	2.46	1.45			
Redox (mv)	144.2	148.6	132.4	131.2			
gallons purged		1	4	6			

FIELD CHEMISTRY RESULTS

Analyte	Dilution?	Concentration	Observations/Notes
(1) Sulfate			
(2) Sulfide			
(3) Nitrate			
(4) Nitrite			
(5) Manganese			
(6) Ferrous Iron			
(7) Total Iron			
(8) Alkalinity			
(9) Carbon Dioxide			
(10) Chloride			

Additional Comments:

7 [ ] SAMPLE CONTAINERS (material, number, size): 6 40ml glass vials, 1 1 liter poly

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method Containers:
Method Containers:
[X] Preservatives added: HCL
Method BTEX-MTBE methan Containers: 40mls vials

9 [ ] CONTAINER HANDLING:
[X] Container Sides Labeled
[ ] Container Lids Taped
[X] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:

GROUNDWATER SAMPLING RECORD

MS/MSD

Sampling Location FT-16 MW-3
Sampling Dates 7-20-98

GROUND WATER SAMPLING RECORD - MONITORING WELL MW-3
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING; 7-20-98, 1998 1330 a.m. [✓ p.m.]
SAMPLE COLLECTED BY: KC of Parsons ES
WEATHER: Sunny ~ 70°F windy ~ 15mph NW
DATUM FOR WATER DEPTH MEASUREMENT (Describe): TOC Top of casing

MONITORING WELL CONDITION:

[✓] LOCKED: [ ] UNLOCKED
WELL NUMBER (IS - [✓ IS NOT]) APPARENT
STEEL CASING CONDITION IS: good
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS - [✓ IS NOT]) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe): none

Check-off

1 [✓] EQUIPMENT CLEANED BEFORE USE WITH
Items Cleaned (List): decon all instruments

2 [ ] PRODUCT DEPTH none FT. BELOW DATUM
Measured with:

WATER DEPTH TOC FT. BELOW DATUM
Measured with: sight

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: milky brown
Odor: none
Other Comments:

4 [ ] WELL EVACUATION:
Method: pump
Volume Removed: 7 gal.
Observations: Water (slightly - very) ~~cloudy~~ clear
Water level (rose - fell [✓ - no change])
Water odors: none
Other comments:

Groundwater Sampling Record

Monitoring Well No. MW3 (Cont'd)

MS/MSD

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:
[✓] Pump, type: Parastaltic
[ ] Other, describe:

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

DIRECT INSTRUMENT READINGS

Time							Measured With
Temp (°C)	18.5	17.9	17.7	17.6	17.7		
pH	5.16	5.13	4.95	5.14	5.12		
Cond (µS/cm)	.071	.056	.055	0.059	.058		
Do (mg/L)	1.01	0.85	0.71	0.64	.65		
Redox (mv)	191.3	196.1	188.6	189.3			
gallons purged		1	4	5	7		

FIELD CHEMISTRY RESULTS

Analyte	Dilution?	Concentration	Observations/Notes
(1) Sulfate			
(2) Sulfide			
(3) Nitrate			
(4) Nitrite			
(5) Manganese			
(6) Ferrous Iron			
(7) Total Iron			
(8) Alkalinity			
(9) Carbon Dioxide			
(10) Chloride			

Additional Comments:

7 [ ] SAMPLE CONTAINERS (material, number, size): 6 40ml vials, 1 1liter poly

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method Containers:
Method Containers:
[ ] Preservatives added: HCL
Method BETX + MTBE methane Containers: 40ml vials

9 [ ] CONTAINER HANDLING:

[✓] Container Sides Labeled
[ ] Container Lids Taped
[✓] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:

GROUNDWATER SAMPLING RECORD DUP MW20

Sampling Location FT-16 MW4
Sampling Dates 3-26-98

GROUND WATER SAMPLING RECORD - MONITORING WELL MW4
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 3-20-98, 1998 0945 [✓ a.m.]/p.m.
SAMPLE COLLECTED BY: of Parsons ES
WEATHER: Sunny windy Temp ~ 65° winds ~ 15 mph SW
DATUM FOR WATER DEPTH MEASUREMENT (Describe): TOC Top of Casing

MONITORING WELL CONDITION:
[ ] LOCKED: [ ] UNLOCKED
WELL NUMBER (IS - [✓ IS NOT]) APPARENT
STEEL CASING CONDITION IS: good
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS - [✓ IS NOT]) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe): none

Check-off
1 [X] EQUIPMENT CLEANED BEFORE USE WITH
Items Cleaned (List): all instruments ~~[illegible]~~

2 [ ] PRODUCT DEPTH none FT. BELOW DATUM
Measured with:

WATER DEPTH 1.14 FT. BELOW DATUM
Measured with: slope water level indicator

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: ~~clear~~ sl. cloudy
Odor: none
Other Comments:

4 [ ] WELL EVACUATION:
Method: pump
Volume Removed: ~ 11
Observations: Water (slightly - very) ~~cloudy~~ clear
Water level (rose - fell - [✓ no change])
Water odors: None
Other comments:

Groundwater Sampling Record

Monitoring Well No. MW-4 (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:
[✓] Pump, type: Peristaltic
[ ] Other, describe:

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

DIRECT INSTRUMENT READINGS

Time							Measured With
Temp (°C)	18.7	18.3	18.2	18.2	18.0	18.0	YSI 55
pH	6.40	6.90	6.45	6.86	6.82	6.82	Orion 250A
Cond (µS/cm)	.296	.283	.280	.279	.279	.279	Hach
Do (mg/L)	1.37	1.06	1.02	[illegible]	1.03	1.04	YSI 55
Redox (mv)	69.3	56.2	41.5	37.6	44.7	42.1	Orion 250A
gallons purged		1.5	3	4	7	9	

FIELD CHEMISTRY RESULTS

Analyte	Dilution?	Concentration	Observations/Notes
(1) Sulfate			
(2) Sulfide			
(3) Nitrate			
(4) Nitrite			
(5) Manganese			
(6) Ferrous Iron			
(7) Total Iron			
(8) Alkalinity			
(9) Carbon Dioxide			
(10) Chloride			

Additional Comments:

7 [ ] SAMPLE CONTAINERS (material, number, size): 4 1 liter amber glass, 9 40ml vials
1 500ml poly, 1 liter poly

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method Containers:
Method Containers:
[ ] Preservatives added: Method BTEX + MTBE / methane / Total Iron Containers: 4 40ml vials (HCL) / 500 ml poly (HNO3)

9 [ ] CONTAINER HANDLING:

[x] Container Sides Labeled
[ ] Container Lids Taped
[x] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:

GROUNDWATER SAMPLING RECORD

Sampling Location ~~FP MP4~~ EE-1E
Sampling Dates 3-20-98

GROUND WATER SAMPLING RECORD - MONITORING WELL MP4
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 3-20-98, 1998 0815 [✓ a.m.]/p.m.
SAMPLE COLLECTED BY: of Parsons ES
WEATHER: Sunny ~65°F wind SW ~10 mph
DATUM FOR WATER DEPTH MEASUREMENT (Describe): TOC

MONITORING WELL CONDITION:
[ ] LOCKED: [X] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: good
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM ([✓ IS] - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe): none

Check-off
1 [X] EQUIPMENT CLEANED BEFORE USE WITH Alconox, D.I. water
Items Cleaned (List): pH probe, redox probe, DO probe, cond. probe

2 [✓] PRODUCT DEPTH N/A FT. BELOW DATUM
Measured with: Slope water level indicator

WATER DEPTH 3' FT. BELOW DATUM
Measured with: Slope water level indicator

3 [✓] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: milky brown
Odor: none
Other Comments:

4 [ ] WELL EVACUATION:
Method: peristaltic pump
Volume Removed: ~1/2 gallon
Observations: Water (slightly - very) ~~cloudy~~ clear
Water level (rose - fell - [✓ no change])
Water odors: none
Other comments:

Groundwater Sampling Record

Monitoring Well No. F7-11 MP4 (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:
[X] Pump, type: per
[ ] Other, describe:

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

DIRECT INSTRUMENT READINGS

Time							Measured With
Temp (°C)	18.2	18.3					YSI 55
pH	6.40	6.41					Orion 250A
Cond (µS/cm)	.536	.529					Hach
Do (mg/L)	1.69	1.67					YSI 55
Redox (mv)	-219.3	-221.2					orion 250A
gallons purged	~0	~1					

FIELD CHEMISTRY RESULTS

Analyte	Dilution?	Concentration	Observations/Notes
(1) Sulfate			
(2) Sulfide			
(3) Nitrate			
(4) Nitrite			
(5) Manganese			
(6) Ferrous Iron			
(7) Total Iron			
(8) Alkalinity			
(9) Carbon Dioxide			
(10) Chloride			

Additional Comments:

7 [ ] SAMPLE CONTAINERS (material, number, size): 4 One liter amber glass, 9 40ml glass vials
1 500ml poly, 1 One liter poly

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method Containers:
Method Containers:

[X] Preservatives added:
Method Betx + MTBE / Methane / Total Iron
Containers: 40ml vials / 40ml vials / 500ml poly

9 [ ] CONTAINER HANDLING:

[X] Container Sides Labeled
[ ] Container Lids Taped
[X] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:

GROUNDWATER SAMPLING RECORD

Sampling Location FT-16 SB1
Sampling Dates 3-20-98

GROUND WATER SAMPLING RECORD - MONITORING WELL SB1
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 3-20-98, 1998 1600 a.m./p.m.
SAMPLE COLLECTED BY: RCS of Parsons ES
WEATHER: Sunny ~67°F windy ~15mph nw
DATUM FOR WATER DEPTH MEASUREMENT (Describe): TOC Top of Casing

MONITORING WELL CONDITION:

[ ] LOCKED: [X] UNLOCKED
WELL NUMBER (IS - [✓ IS NOT]) APPARENT
STEEL CASING CONDITION IS: good
INNER PVC CASING CONDITION IS: good
WATER DEPTH MEASUREMENT DATUM (IS - [✓ IS NOT]) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):

Check-off

1 [ ] EQUIPMENT CLEANED BEFORE USE WITH alconox, dI, Isopropanol, dI
Items Cleaned (List): all Instrument probes

2 [ ] PRODUCT DEPTH none FT. BELOW DATUM
Measured with:

WATER DEPTH 1.56' FT. BELOW DATUM
Measured with: Slope water level indicator

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: sl cloudy
Odor: none
Other Comments:

4 [ ] WELL EVACUATION:
Method: pump
Volume Removed: ~4gal
Observations: Water ([✓ slightly] - very) cloudy
Water level (rose - fell - [✓ no change])
Water odors: none
Other comments:

Groundwater Sampling Record

Monitoring Well No. SB-1 (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:
[ ] Pump, type: parastaltic
[ ] Other, describe:

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

DIRECT INSTRUMENT READINGS

Time							Measured With
Temp (°C)	17.9	17.2	17.1	17.1			
pH	6.65	6.66	6.90	6.89			
Cond (µS/cm)	.315	310	.306	.304			
Do (mg/L)	.74	.48	1.18	1.17			
Redox (mv)	-130.3	-135.1	-155.8	-154.6			
gallons purged		2	3	4			

FIELD CHEMISTRY RESULTS

Analyte	Dilution?	Concentration	Observations/Notes
(1) Sulfate			
(2) Sulfide			
(3) Nitrate			
(4) Nitrite			
(5) Manganese			
(6) Ferrous Iron			
(7) Total Iron			
(8) Alkalinity			
(9) Carbon Dioxide			
(10) Chloride			

Additional Comments:

7 [ ] SAMPLE CONTAINERS (material, number, size): 6 40ml vials glass, 1 liter Poly

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method Containers:
Method Containers:
[X] Preservatives added: HCL
Method Betx-MTBE methane Containers: 40 ml vials

9 [ ] CONTAINER HANDLING:

[X] Container Sides Labeled
[ ] Container Lids Taped
[X] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:

GROUNDWATER SAMPLING RECORD

Sampling Location FT-16 SB3
Sampling Dates 3-20-98

GROUND WATER SAMPLING RECORD - MONITORING WELL SB3
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 3-20-98, 1998 1700 a.m./p.m.
SAMPLE COLLECTED BY: TOS of Parsons ES
WEATHER: Sunny ~67°F windy ~15mph NW
DATUM FOR WATER DEPTH MEASUREMENT (Describe): TOC Top of casing

MONITORING WELL CONDITION:
[ ] LOCKED: [✓] UNLOCKED
WELL NUMBER ([✓ IS] - IS NOT) APPARENT
STEEL CASING CONDITION IS: ok
INNER PVC CASING CONDITION IS: ok
WATER DEPTH MEASUREMENT DATUM ([✓ IS] - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):

Check-off
1 [ ] EQUIPMENT CLEANED BEFORE USE WITH alconox, DI, Isopropanol, DI
Items Cleaned (List): all instrument probes

2 [ ] PRODUCT DEPTH none FT. BELOW DATUM
Measured with:

WATER DEPTH 3.84 FT. BELOW DATUM
Measured with: Slope water level indicator

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: ~~cl~~ sl cloudy
Odor: none
Other Comments:

4 [ ] WELL EVACUATION:
Method: Pump
Volume Removed: ~5 gal
Observations: Water (slightly - very) ~~cloudy~~ clear
Water level (rose - fell - no change)
Water odors: none
Other comments:

Groundwater Sampling Record

Monitoring Well No. SB-3 (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:
[X] Pump, type: peristaltic
[ ] Other, describe:

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

DIRECT INSTRUMENT READINGS

Time							Measured With
Temp (°C)	17.3	17.2	17.2	17.1	17.1		
pH	6.95	7.02	6.70	6.95	6.98		
Cond (µS/cm)	~~.35~~ .338	.354	.353	.351	.351		
Do (mg/L)	3.13	3.02	2.47	2.13	2.22		
Redox (mv)	-3.2	-5.0	-129.5	-148.3	-148.6		
gallons purged		1	3	4	5		

FIELD CHEMISTRY RESULTS

Analyte	Dilution?	Concentration	Observations/Notes
(1) Sulfate			
(2) Sulfide			
(3) Nitrate			
(4) Nitrite			
(5) Manganese			
(6) Ferrous Iron			
(7) Total Iron			
(8) Alkalinity			
(9) Carbon Dioxide			
(10) Chloride			

Additional Comments:

7 [ ] SAMPLE CONTAINERS (material, number, size): 6 40ml glass vials, 1 liter poly

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method Containers:
Method Containers:
[X] Preservatives added: HCL BTEX-MTBE
Method Methane Containers: 40ml vials

9 [ ] CONTAINER HANDLING:

[X] Container Sides Labeled
[ ] Container Lids Taped
[X] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:

1

ON-SITE MEASUREMENTS
HACH AND CHEMetrics ANALYSES
~~Keesler AFB, BX Service Station, AOC-A (ST-06)~~ TYND FT-16

SAMPLE DATE 3/20/

SAMPLE I.D. FT-16 MP-4

TIME SAMPLED 0900

TIME ANALYSIS START 0950

TIME ANALYSIS END 1014

FILTERED (circle) [✓ YES] NO

COLOR / ODOR: CLEAN SLIGHT ODOR

HACH DR/700 Measurements:

Analyte	Program	Range	Dilution	Reading	Concentration		Blank[a/,b/]
Ferrous	50.01.1	0 - 5.10 mg/L	1	1.38	1.38	mg/L	sample
						mg/L	sample
Manganese	52.13.1	0 - 20.0 mg/L	1	0.0	0.0	mg/L	sample
						mg/L	sample
Sulfate	45.000	0 - 100 mg/L	1	2.45	2.45	mg/L	DI or 50mg/L
						mg/L	DI or 50mg/L
Sulfide	61.12.1	0 - 0.600 mg/L	1	0.127	0.127	mg/L	DI
						mg/L	DI

HACH Titrations:

Alkalinity Sample Size = 100

Titrate with 1.6 N H_2SO_4

Phenolphthalein Alkalinity	0	digits
BGR	215	digits
	215	total digits

Digit Multiplier X Total Digits = Total Alkalinity (mg/L) = 215

CHEMetrics Color Tests:

Ammonia 2 ppm

Technician: BL

[a/] Sulfate, and sulfide blanks contain respective reagents;
Ferrous iron and manganese blanks are without reagents.

[b/] Ferrous, and manganese blanks should be diluted accordingly if samples are diluted.

2

ON-SITE MEASUREMENTS
HACH AND CHEMetrics ANALYSES
~~Keesler AFB, BX Service Station, AOC-A (ST-06)~~ TYN FT-16

SAMPLE DATE ~~MW-4~~ 3/20/98

TIME SAMPLED 1145

TIME ANALYSIS START 1150

TIME ANALYSIS END 1206

SAMPLE I.D. MW-4

FILTERED (circle) [✓ YES] NO

COLOR / ODOR: CLEAR, SULFUR ODOR

HACH DR/700 Measurements:

Analyte	Program	Range	Dilution	Reading	Concentration		Blank[a/,b/]
Ferrous	50.01.1	0 - 5.10 mg/L	1	0.49	0.49	mg/L	sample
						mg/L	sample
Manganese	52.13.1	0 - 20.0 mg/L	1	0.0	0.0	mg/L	sample
						mg/L	sample
Sulfate	45.000	0 - 100 mg/L	1	3.37	5.37	mg/L	DI or 50mg/L
						mg/L	DI or 50mg/L
Sulfide	61.12.1	0 - 0.600 mg/L	1	0.39	0.39	mg/L	DI
						mg/L	DI

HACH Titrations:

Alkalinity Sample Size = 100

Titrate with 1.6 N H_2SO_4

Phenolphthalein Alkalinity	0 digits
BGR	126 digits
	126 total digits

Digit Multiplier X Total Digits = Total Alkalinity (mg/L) = 126

CHEMetrics Color Tests:

Ammonia 0.1 ppm

Technician: BL

[a/] Sulfate, and sulfide blanks contain respective reagents; Ferrous iron and manganese blanks are without reagents.

[b/] Ferrous, and manganese blanks should be diluted accordingly if samples are diluted.

ON-SITE MEASUREMENTS
HACH AND CHEMetrics ANALYSES
~~Keesler AFB, BX Service Station, AOC-A (ST-06)~~ TYNDALL RBIC

SAMPLE DATE 3/20/98

SAMPLE I.D. MW-3 FT16

FILTERED (circle) [✓ YES] NO

COLOR / ODOR: CLEAR / NO ODOR

TIME SAMPLED 1335
TIME ANALYSIS START 1345
TIME ANALYSIS END 1358

HACH DR/700 Measurements:

Analyte	Program	Range	Dilution	Reading	Concentration		Blank[a/,b/]
Ferrous	50.01.1	0 - 5.10 mg/L	1	0.04	0.04	mg/L	sample
						mg/L	sample
~~Manganese~~	52.13.1	0 - 20.0 mg/L				mg/L	sample
						mg/L	sample
Sulfate	45.000	0 - 100 mg/L	1	4.13	4.13	mg/L	DI or 50mg/L
						mg/L	DI or 50mg/L
Sulfide	61.12.1	0 - 0.600 mg/L	1	-0.040	0.000	mg/L	DI
						mg/L	DI

HACH Titrations:

Alkalinity Sample Size = 100

Titrate with 1.6 N H_2SO_4

Phenolphthalein Alkalinity	0 digits
BGR	6 digits
	6 total digits

Digit Multiplier X Total Digits = Total Alkalinity (mg/L) = 6

CHEMetrics Color Tests:

Ammonia 0 ppm

Technician: BL

[a/] Sulfate, and sulfide blanks contain respective reagents;
Ferrous iron and manganese blanks are without reagents.

[b/] Ferrous, and manganese blanks should be diluted accordingly if samples are diluted.

ON-SITE MEASUREMENTS
HACH AND CHEMetrics ANALYSES

~~Keesler AFB, BX Service Station, AOC-A (ST-06)~~ TYNDALL RBIC.

SAMPLE DATE 3/20/98

TIME SAMPLED 1500

TIME ANALYSIS START 1530

TIME ANALYSIS END 1544

SAMPLE I.D. FT-16, MW-7

FILTERED (circle) [✓ YES] NO

COLOR / ODOR: CLEAR / NO ODOR

HACH DR/700 Measurements:

Analyte	Program	Range	Dilution	Reading	Concentration	Blank[a/,b/]
Ferrous	50.01.1	0 - 5.10 mg/L	1	0.13	0.13 mg/L	sample
					mg/L	sample
~~Manganese~~	52.13.1	0 - 20.0 mg/L			mg/L	sample
					mg/L	sample
Sulfate	45.000	0 - 100 mg/L	1	2.98	2.98 mg/L	DI or 50mg/L
					mg/L	DI or 50mg/L
Sulfide	61.12.1	0 - 0.600 mg/L	1	0.017	0.017 mg/L	DI
					mg/L	DI

HACH Titrations:

Alkalinity Sample Size = 100

Titrate with 1.6 N H_2SO_4

Phenolphthalein Alkalinity	0 digits
BGR	56 digits
	56 total digits

Digit Multiplier X Total Digits = Total Alkalinity (mg/L) = 56

CHEMetrics Color Tests:

Ammonia 0 ppm

Technician: BL

[a/] Sulfate, and sulfide blanks contain respective reagents; Ferrous iron and manganese blanks are without reagents.

[b/] Ferrous, and manganese blanks should be diluted accordingly if samples are diluted.

ON-SITE MEASUREMENTS
HACH AND CHEMetrics ANALYSES
~~Keesler AFB, BX Service Station, AOC-A (ST-06)~~ TYNDALL RBIC

SAMPLE DATE	3/20/98	TIME SAMPLED	1600
SAMPLE I.D.	FT-16, SB-1	TIME ANALYSIS START	1618
		TIME ANALYSIS END	

FILTERED (circle) [✓ YES] NO

COLOR / ODOR: CLEAR / NO ODOR

HACH DR/700 Measurements:

Analyte	Program	Range	Dilution	Reading	Concentration	Blank[a/,b/]
Ferrous	50.01.1	0 - 5.10 mg/L	1	0.10	0.10 mg/L	sample
					mg/L	sample
~~Manganese~~	52.13.1	0 - 20.0 mg/L			mg/L	sample
					mg/L	sample
Sulfate	45.000	0 - 100 mg/L	1	1.54	1.54 mg/L	DI or 50mg/L
					mg/L	DI or 50mg/L
Sulfide	61.12.1	0 - 0.600 mg/L	1	0.013	0.013 mg/L	DI
					mg/L	DI

HACH Titrations:

Alkalinity Sample Size = 100 Titrate with 1.6 N H_2SO_4

Phenolphthalein Alkalinity	0 digits
BGR	136 digits
	136 total digits

Digit Multiplier X Total Digits = Total Alkalinity (mg/L) = 136

CHEMetrics Color Tests:

Ammonia 0.1 ppm

Technician: BL

[a/] Sulfate, and sulfide blanks contain respective reagents;
Ferrous iron and manganese blanks are without reagents.

[b/] Ferrous, and manganese blanks should be diluted accordingly if samples are diluted.

ON-SITE MEASUREMENTS
HACH AND CHEMetrics ANALYSES
~~Keesler AFB, BX Service Station, AOC-A (ST-06)~~ TYNDALL RBIC

SAMPLE DATE 3/20/98

SAMPLE I.D. FT-11 SB-3

TIME SAMPLED 1645

TIME ANALYSIS START 1646

TIME ANALYSIS END

FILTERED (circle) [✓ YES] NO

COLOR / ODOR: CLEAR / SULFUR ODOR

HACH DR/700 Measurements:

Analyte	Program	Range	Dilution	Reading	Concentration		Blank[a/,b/]
Ferrous	50.01.1	0 - 5.10 mg/L	1	0.27	0.27	mg/L	sample
						mg/L	sample
~~Manganese~~	52.13.1	0 - 20.0 mg/L				mg/L	sample
						mg/L	sample
Sulfate	45.000	0 - 100 mg/L	1	2.45	2.45	mg/L	DI or 50mg/L
						mg/L	DI or 50mg/L
Sulfide	61.12.1	0 - 0.600 mg/L	1	0.000	0.000	mg/L	DI
						mg/L	DI

HACH Titrations:

Alkalinity Sample Size = 100

Titrate with 1.6 N H_2SO_4

Phenolphthalein Alkalinity	0	digits
BGR	161	digits
	161	total digits

Digit Multiplier X Total Digits = Total Alkalinity (mg/L) = 161

CHEMetrics Color Tests:

Ammonia 0.3 ppm

Technician:

[a/] Sulfate, and sulfide blanks contain respective reagents;
Ferrous iron and manganese blanks are without reagents.

[b/] Ferrous, and manganese blanks should be diluted accordingly if samples are diluted.

ON-SITE MEASUREMENTS
HACH AND CHEMetrics ANALYSES
~~Keesler AFB, BX Service Station, AOC-A (ST-06)~~ TYNDALL RBIC

SAMPLE DATE ~~MP-1~~ 3/21/98

SAMPLE I.D. MP-1 FT-16

TIME SAMPLED 0900
TIME ANALYSIS START 0910
TIME ANALYSIS END 0935

FILTERED (circle) [✓ YES] NO

COLOR / ODOR: CLEAR / ROTTEN EGGS

HACH DR/700 Measurements:

Analyte	Program	Range	Dilution	Reading	Concentration	Blank[a/,b/]
Ferrous	50.01.1	0 - 5.10 mg/L	1	0.64	mg/L	sample
					mg/L	sample
Manganese	52.13.1	0 - 20.0 mg/L			mg/L	sample
					mg/L	sample
Sulfate	45.000	0 - 100 mg/L	2	40.72	mg/L	DI or 50mg/L
					mg/L	DI or 50mg/L
Sulfide	61.12.1	0 - 0.600 mg/L	25	0.133	mg/L	DI
					mg/L	DI

HACH Titrations:

Alkalinity Sample Size = 50

Titrate with 1.6 N H_2SO_4

Phenolphthalein Alkalinity	0	digits
BGR	96	digits
	96	total digits

2 96
Digit Multiplier X Total Digits = Total Alkalinity (mg/L) = 192

CHEMetrics Color Tests:

Ammonia 2 ppm

Technician: JL

[a/] Sulfate, and sulfide blanks contain respective reagents; Ferrous iron and manganese blanks are without reagents.

[b/] Ferrous, and manganese blanks should be diluted accordingly if samples are diluted.

7D

ON-SITE MEASUREMENTS
HACH AND CHEMetrics ANALYSES
~~Keesler AFB, BX Service Station, AOC-A (ST-06)~~ TYNDALL RBIC

SAMPLE DATE 3/21/98

TIME SAMPLED 0900

TIME ANALYSIS START 0910

TIME ANALYSIS END 0935

SAMPLE I.D. MP-1 DUP FT-16

FILTERED (circle) [✓ YES] NO

COLOR / ODOR: CLEAR / ROTTEN EGG

HACH DR/700 Measurements:

Analyte	Program	Range	Dilution	Reading	Concentration	Blank[a/,b/]
Ferrous	50.01.1	0 - 5.10 mg/L	1	0.11	mg/L	sample
					mg/L	sample
~~Manganese~~	52.13.1	0 - 20.0 mg/L			mg/L	sample
					mg/L	sample
Sulfate	45.000	0 - 100 mg/L	2	38.22	mg/L	DI or 50mg/L
					mg/L	DI or 50mg/L
Sulfide	61.12.1	0 - 0.600 mg/L	25	0.142	mg/L	DI
					mg/L	DI

HACH Titrations:

Alkalinity Sample Size = 50

Titrate with 1.6 N H_2SO_4

Phenolphthalein Alkalinity	0 digits
BGR	97 digits
	97 total digits

Digit Multiplier X Total Digits = Total Alkalinity (mg/L) = 194

2 97

CHEMetrics Color Tests:

Ammonia 2 ppm

Technician: BL

[a/] Sulfate, and sulfide blanks contain respective reagents; Ferrous iron and manganese blanks are without reagents.

[b/] Ferrous, and manganese blanks should be diluted accordingly if samples are diluted.

8

ON-SITE MEASUREMENTS
HACH AND CHEMetrics ANALYSES
~~Keesler AFB, BX Service Station, AOC-A (ST-06)~~ TYNDALL RBIC

SAMPLE DATE	3/21/96	TIME SAMPLED	1000
SAMPLE I.D.	MP-2	TIME ANALYSIS START	1002
		TIME ANALYSIS END	1020

FILTERED (circle) [✓ YES] NO

COLOR / ODOR: CLEAR / NO ODOR

HACH DR/700 Measurements:

Analyte	Program	Range	Dilution	Reading	Concentration		Blank[a/,b/]
Ferrous	50.01.1	0 - 5.10 mg/L	1	0.04	0.04	mg/L	sample
						mg/L	sample
~~Manganese~~	52.13.1	0 - 20.0 mg/L				mg/L	sample
						mg/L	sample
Sulfate	45.000	0 - 100 mg/L	2	28.62	57.24	mg/L	DI or 50mg/L
						mg/L	DI or 50mg/L
Sulfide	61.12.1	0 - 0.600 mg/L	5	0.000	0.000	mg/L	DI
						mg/L	DI

HACH Titrations:

Alkalinity Sample Size = 100 Titrate with 1.6 N H_2SO_4

Phenolphthalein Alkalinity	0	digits
BGR	154	digits
	154	total digits

Digit Multiplier X Total Digits = Total Alkalinity (mg/L) = 159

CHEMetrics Color Tests:

Ammonia 0.1 ppm

Technician: BL

[a/] Sulfate, and sulfide blanks contain respective reagents;
Ferrous iron and manganese blanks are without reagents.

[b/] Ferrous, and manganese blanks should be diluted accordingly if samples are diluted.

ON-SITE MEASUREMENTS
HACH AND CHEMetrics ANALYSES
~~Keesler AFB, BX Service Station, AOC-A (ST-06)~~ TYNDALL RBIC.

SAMPLE DATE 3/21/98

SAMPLE I.D. 513-2

FILTERED (circle) [✓ YES] NO

COLOR / ODOR: CLEAR / SLIGHT ODOR

TIME SAMPLED 1115
TIME ANALYSIS START 1125
TIME ANALYSIS END

HACH DR/700 Measurements:

Analyte	Program	Range	Dilution	Reading	Concentration	Blank[a/,b/]
Ferrous	50.01.1	0 - 5.10 mg/L	1	0.33	mg/L	sample
					mg/L	sample
~~Manganese~~	52.13.1	0 - 20.0 mg/L			mg/L	sample
					mg/L	sample
Sulfate	45.000	0 - 100 mg/L	1	14.66	mg/L	DI or 50mg/L
					mg/L	DI or 50mg/L
Sulfide	61.12.1	0 - 0.600 mg/L	5	0.136	mg/L	DI
					mg/L	DI

HACH Titrations:

Alkalinity Sample Size = 100 Titrate with 1.6 N H_2SO_4

Phenolphthalein Alkalinity	0 digits
BGR	89 digits
	89 total digits

Digit Multiplier X Total Digits = Total Alkalinity (mg/L) = 89

CHEMetrics Color Tests:

Ammonia 0.9 ppm

Technician: BV

[a/] Sulfate, and sulfide blanks contain respective reagents;
Ferrous iron and manganese blanks are without reagents.

[b/] Ferrous, and manganese blanks should be diluted accordingly if samples are diluted.

10

ON-SITE MEASUREMENTS
HACH AND CHEMetrics ANALYSES
~~Keesler AFB, BX Service Station, AOC-A (ST-06)~~ TYNDALL RBIC

SAMPLE DATE 3/21/96

SAMPLE I.D. MP-7, PT-16

TIME SAMPLED 1215

TIME ANALYSIS START 1215

TIME ANALYSIS END 1230

FILTERED (circle) [✓ YES] NO

COLOR / ODOR: Clear, No odor

HACH DR/700 Measurements:

Analyte	Program	Range	Dilution	Reading	Concentration	Blank[a/,b/]
Ferrous	50.01.1	0 - 5.10 mg/L	1	0.87	mg/L	sample
					mg/L	sample
~~Manganese~~	52.13.1	0 - 20.0 mg/L			mg/L	sample
					mg/L	sample
Sulfate	45.000	0 - 100 mg/L	1	22.12	mg/L	DI or 50mg/L
					mg/L	DI or 50mg/L
Sulfide	61.12.1	0 - 0.600 mg/L	1	0.176	mg/L	DI
					mg/L	DI

HACH Titrations:

Alkalinity Sample Size = 50 Titrate with 1.6 N H_2SO_4

Phenolphthalein Alkalinity	0 digits
BGR	66 digits
	66 total digits

Digit Multiplier X Total Digits = Total Alkalinity (mg/L) = 2 X 66 = ~~[illegible]~~ 132

CHEMetrics Color Tests:

Ammonia 0.2 ppm

Technician: BL

[a/] Sulfate, and sulfide blanks contain respective reagents;
Ferrous iron and manganese blanks are without reagents.

[b/] Ferrous, and manganese blanks should be diluted accordingly if samples are diluted.

APPENDIX D
BIOSCREEN MODEL INPUT AND OUTPUT AND SUPPORTING CALCULATIONS

Site FT-16, Tyndall AFB
Soluable Mass Claculation for BIOSCREEN Model
Prepared by Brad Lewis
9/11/98

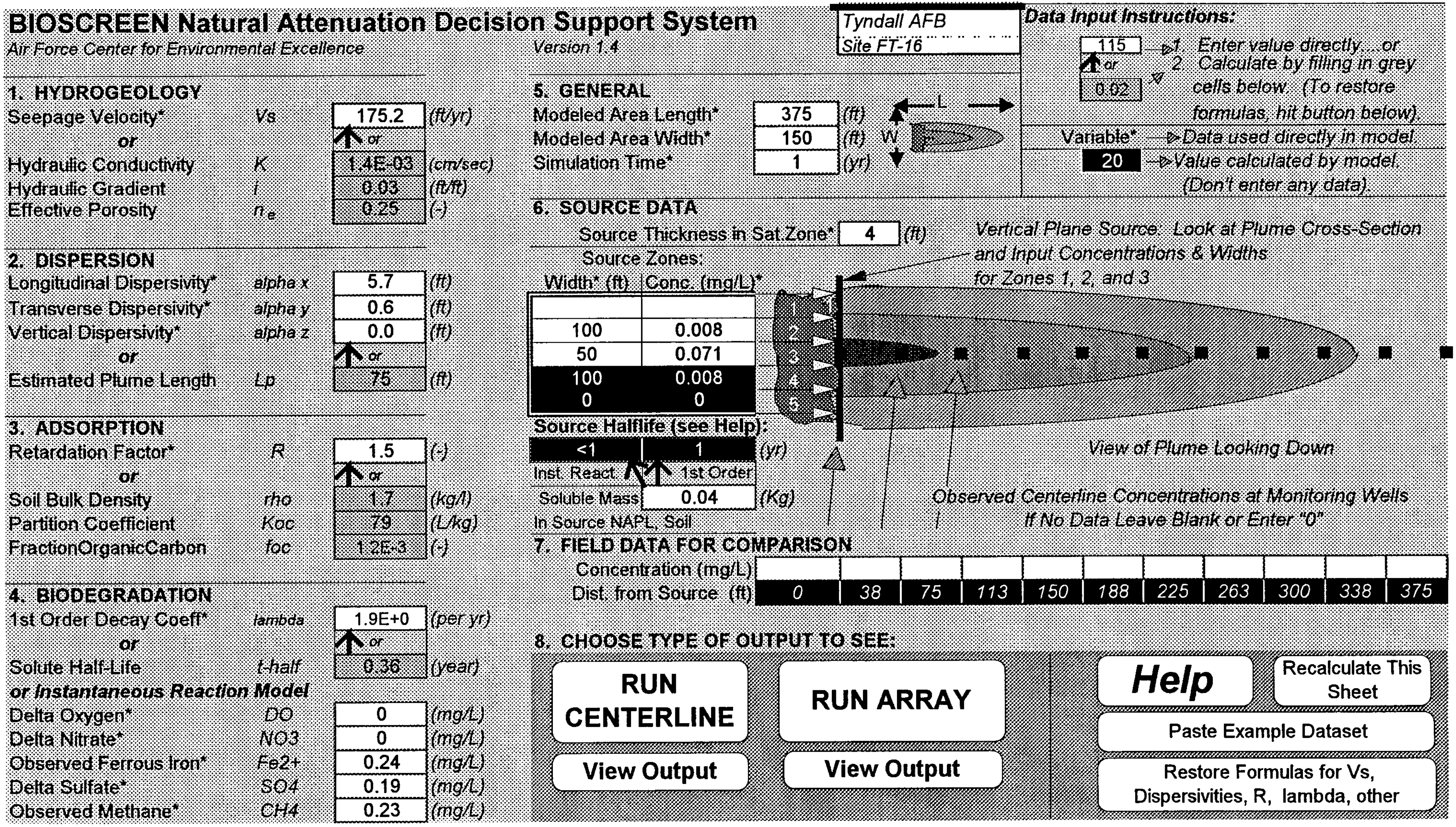
Koc for Benzene = 79 L/kg (fuels protocol for benzene) = Organic Carbon Partion Coefficient
TOC = 1243.3333 average total organic carbon (mg/kg) from site data
FOC 0.0012433 fraction organic carbon
Kd for Benzene= (foc) (Koc) =
KD= 0.0982233

Kd = soil concentration / water concentration = ug/kg / ug/L

Cw= 71 ug/L from site data (MP-4 1998)
Cs= 6.9738567 ug/kg
0.0069739 mg/kg

soluble mass (kg) = (cubic feet of contaminated soil area)(28.3 L/ft3)(bulk density)(Cs)(10-6kg/mg)

27200	area (ft2) of excessively contaminated soil from 1995 BCM data
4	thickness (ft)
28.3	L/ft3
1.7	bulk density (kg/L)
0.0069739	Cs (mg/kg)
0.000001	kg/mg
0.0365037	soluble mass (kg)



BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

Tyndall AFB
Site FT-16

Data Input Instructions:

115 → 1. Enter value directly....or
or 0.02 → 2. Calculate by filling in grey cells below. (To restore formulas, hit button below).

Variable* → Data used directly in model.

20 → Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	Vs	175.2	(ft/yr)
or		or	
Hydraulic Conductivity	K	1.4E-03	(cm/sec)
Hydraulic Gradient	i	0.03	(ft/ft)
Effective Porosity	n_e	0.25	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	5.7	(ft)
Transverse Dispersivity*	alpha y	0.6	(ft)
Vertical Dispersivity*	alpha z	0.0	(ft)
or		or	
Estimated Plume Length	Lp	75	(ft)

3. ADSORPTION

Retardation Factor*	R	1.5	(-)
or		or	
Soil Bulk Density	rho	1.7	(kg/l)
Partition Coefficient	Koc	79	(L/kg)
FractionOrganicCarbon	foc	1.2E-3	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	1.9E+0	(per yr)
or		or	
Solute Half-Life	t-half	0.36	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO	0	(mg/L)
Delta Nitrate*	NO3	0	(mg/L)
Observed Ferrous Iron*	Fe2+	0.24	(mg/L)
Delta Sulfate*	SO4	0.19	(mg/L)
Observed Methane*	CH4	0.23	(mg/L)

5. GENERAL

Modeled Area Length*	375	(ft)
Modeled Area Width*	150	(ft)
Simulation Time*	1	(yr)

6. SOURCE DATA

Source Thickness in Sat.Zone* 4 (ft)

Source Zones:

Width* (ft)	Conc. (mg/L)*
100	0.008
50	0.071
100	0.008
0	0

Source Halflife (see Help):

<1	1	(yr)
Inst. React.	1st Order	

Soluble Mass 0.04 (Kg)
In Source NAPL, Soil

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3

View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

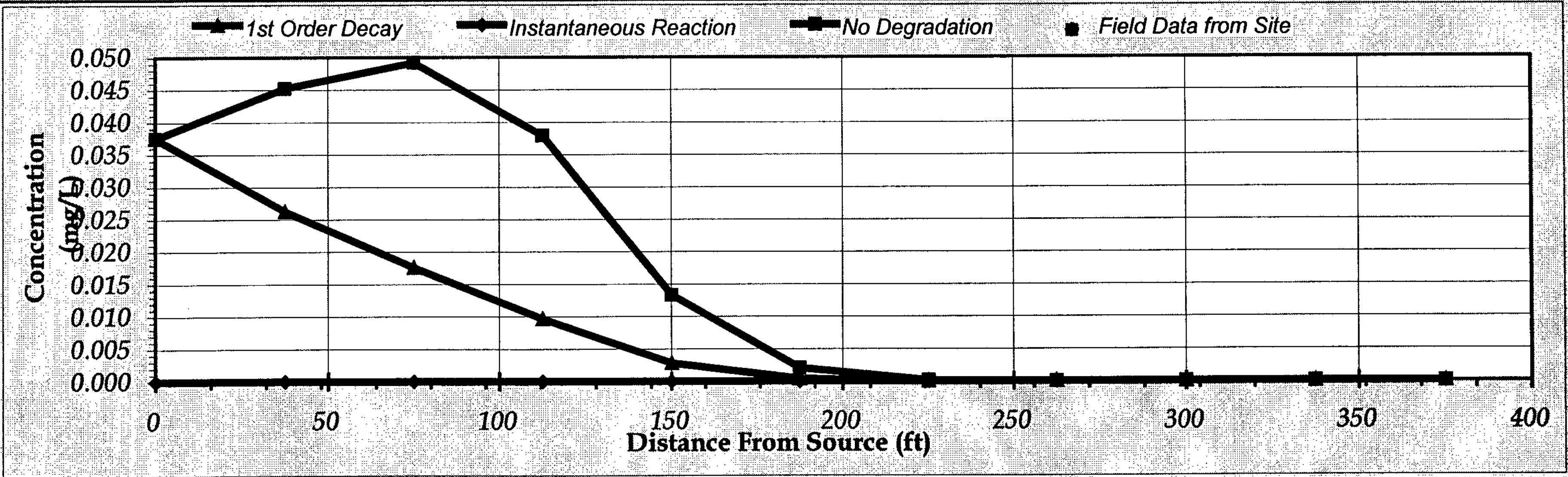
7. FIELD DATA FOR COMPARISON

Concentration (mg/L)											
Dist. from Source (ft)	0	38	75	113	150	188	225	263	300	338	375

8. CHOOSE TYPE OF OUTPUT TO SEE:

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

	Distance from Source (ft)										
TYPE OF MODEL	0	38	75	113	150	188	225	263	300	338	375
No Degradation	0.037	0.045	0.049	0.038	0.013	0.002	0.000	0.000	0.000	0.000	0.000
1st Order Decay	0.037	0.026	0.018	0.010	0.003	0.000	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site											



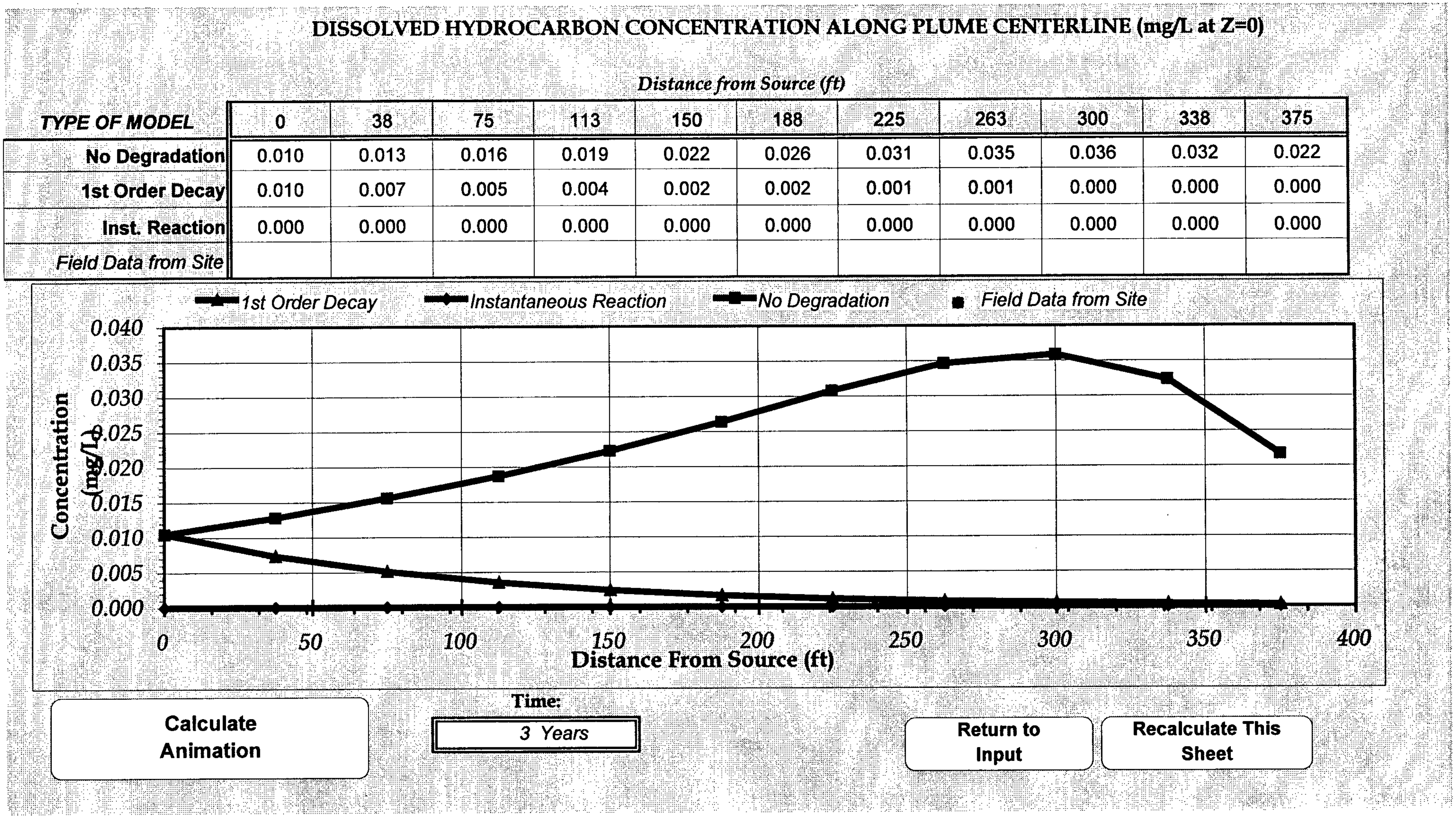
Calculate Animation

Time:

1 Years

Return to Input

Recalculate This Sheet

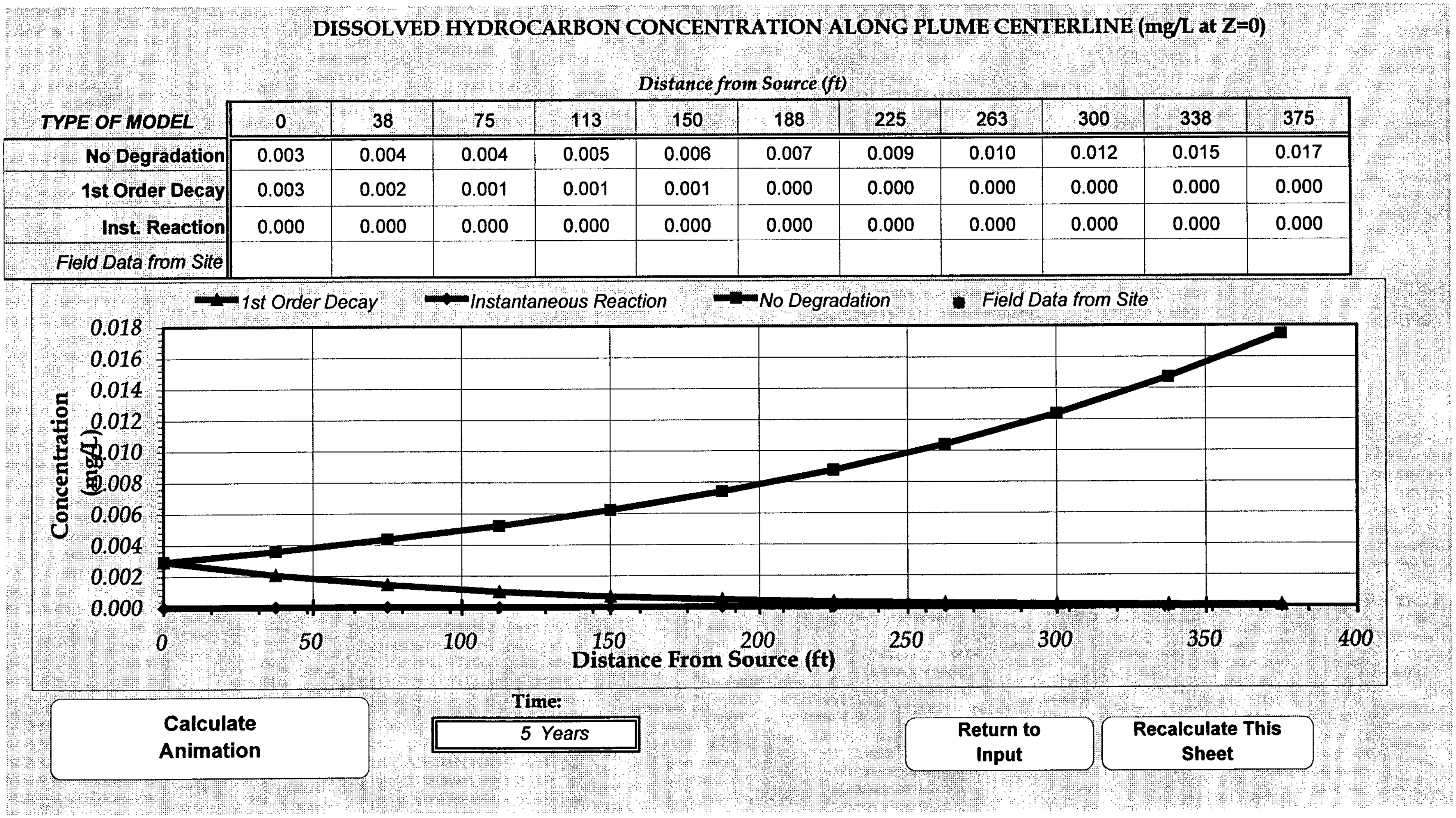


DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	38	75	113	150	188	225	263	300	338	375
No Degradation	0.010	0.013	0.016	0.019	0.022	0.026	0.031	0.035	0.036	0.032	0.022
1st Order Decay	0.010	0.007	0.005	0.004	0.002	0.002	0.001	0.001	0.000	0.000	0.000
Inst. Reaction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site											

Time: 3 Years



DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

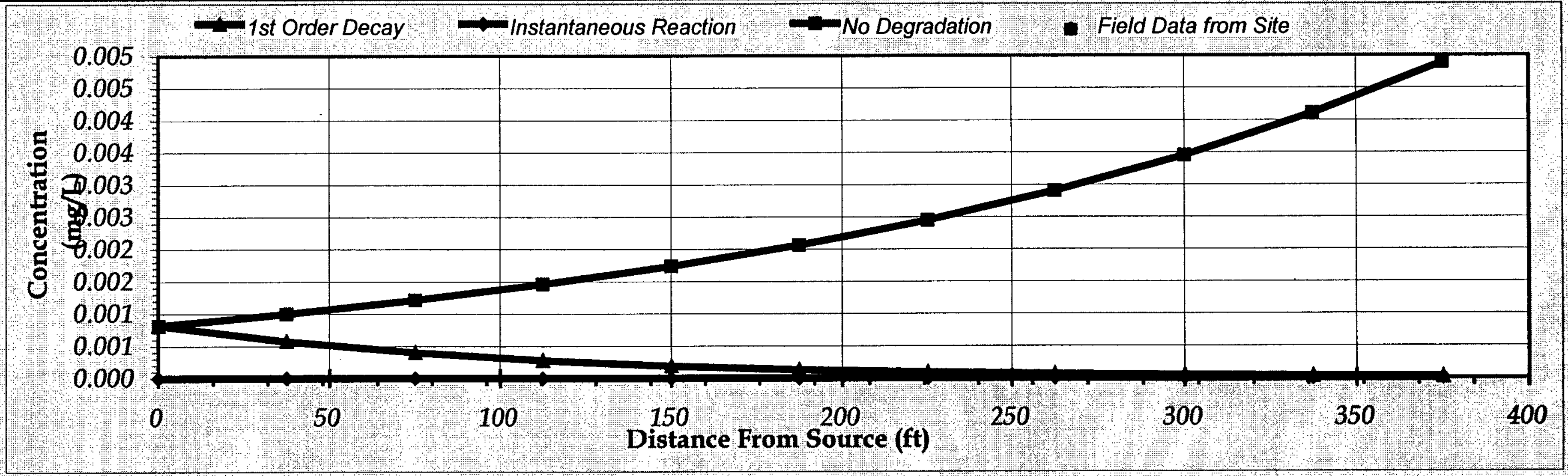
	Distance from Source (ft)										
TYPE OF MODEL	0	38	75	113	150	188	225	263	300	338	375
No Degradation	0.003	0.004	0.004	0.005	0.006	0.007	0.009	0.010	0.012	0.015	0.017
1st Order Decay	0.003	0.002	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site											

Time: 5 Years

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	38	75	113	150	188	225	263	300	338	375
No Degradation	0.001	0.001	0.001	0.001	0.002	0.002	0.002	0.003	0.003	0.004	0.005
1st Order Decay	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site											



Time: 7 Years