

GENERAL SERVICES ADMINISTRATION

CONTRACT NUMBER GS-10F-0076K

DELIVERY ORDER NUMBER N62474-03-F-4037



Draft Final Addendum 01

Sampling and Analysis Plan

(Field Sampling/Quality Assurance Project Plan)

Soil Gas Investigation at SWMU Sites 1, 2, 5, 7, and 18

**Naval Weapons Station Seal Beach Detachment, Concord
Concord, California**

GSA.0129.0002

DRAFT FINAL

October 7, 2003



Engineering Field Activity West
Naval Facilities Engineering Command
Daly City, California



TETRA TECH, INC.

GENERAL SERVICES ADMINISTRATION
Contract No.: 10F-0076K
Order No.: N62474-03-F-4037
GSA.0129.0002

Draft Final Addendum 01
Sampling and Analysis Plan
(Field Sampling Plan and Quality Assurance Project Plan)
**Soil Gas Investigation at
SWMU Sites 1, 2, 5, 7, and 18**
Naval Weapons Station Seal Beach Detachment Concord
Concord, California

October 7, 2003

Prepared for



DEPARTMENT OF THE NAVY
Engineering Field Activity West
Daly City, California

Prepared by



TETRA TECH EM INC.
135 Main Street, Suite 1800
San Francisco, CA 94105
(415) 543-4880

A handwritten signature in black ink that reads "John Bosche".

John Bosche, Project Manager

**DRAFT FINAL ADDENDUM 01
SAMPLING AND ANALYSIS PLAN
(FIELD SAMPLING PLAN AND QUALITY ASSURANCE PROJECT PLAN)
SOIL GAS INVESTIGATION AT SWMU SITES 1,2,5,7, AND 18**

**NAVAL WEAPONS STATION SEAL BEACH DETACHMENT CONCORD
CONCORD, CALIFORNIA**

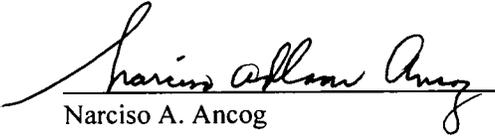
**Contract Number GS-10F-0076K
Order Number N62474-03-F-4037**

GSA. 0129.0002

**Prepared for:
DEPARTMENT OF THE NAVY**

REVIEW AND APPROVAL

Tetra Tech Program QA Manager:  *For* Date: 06 Oct 03
Greg Swanson, Tetra Tech (San Diego)

Navy QA Officer:  Date: 10/6/2003
Narciso A. Ancog

CONTENTS

<u>Section</u>	<u>Page</u>
REVIEW AND APPROVAL	i
DISTRIBUTION LIST	iv
ACRONYMS AND ABBREVIATIONS	v
1.0 INTRODUCTION	1
1.1 PURPOSE OF THE INVESTIGATION	1
1.2 PREVIOUS INVESTIGATIONS	1
1.2.1 Previous Investigations at SWMUs 1, 2, 5, 7, and 18.....	1
1.2.2 Analytical Results	2
1.3 TECHNICAL OR REGULATORY STANDARDS	5
1.4 PROJECT ORGANIZATION	6
2.0 PROJECT AND TASK DESCRIPTION.....	6
2.1 PROJECT OBJECTIVES	6
2.2 PROJECT MEASUREMENTS	6
2.2.1 Sampling Process Design.....	7
2.2.2 Sampling Methods	7
2.2.3 Collection and Handling of Soil Gas Samples.....	7
2.2.4 Analytical Methods.....	9
2.2.5 Selection of Mobile Laboratory	9
2.3 FIELD QUALITY CONTROL SAMPLES.....	10
3.0 QUALITY OBJECTIVES AND CRITERIA FOR MEASUREMENT DATA	11
4.0 SECTIONS NOT REVISED	11
REFERENCES	12

Appendix

A	RESPONSES TO AGENCY COMMENTS
B	STANDARD OPERATING PROCEDURES

LIST OF FIGURES

Figure

- 1 PROPOSED SOIL GAS SAMPLE LOCATIONS

LIST OF TABLES

Table

- 1 KEY PERSONNEL
- 2 SUMMARY OF ANALYTICAL PROGRAM
- 3A COMPARISON OF PROJECT-REQUIRED REPORTING LIMITS AND SCREENING CRITERIA, VOLATILE ORGANIC COMPOUNDS, METHOD TO-15
- 3B COMPARISON OF PROJECT-REQUIRED REPORTING LIMITS AND SCREENING CRITERIA, VOLATILE ORGANIC COMPOUNDS, METHOD 8260B-MODIFIED
- 4 METHOD PRECISION AND ACCURACY GOALS VOLATILE ORGANIC COMPOUNDS ANALYSIS METHODS TO-15 AND 8260B-MODIFIED
- 5 SAMPLE CONTAINER, HOLDING TIME, AND PRESERVATIVE REQUIREMENTS
- 6 FIELD QUALITY CONTROL SAMPLES
- 7 DATA QUALITY OBJECTIVES

DISTRIBUTION LIST

Name	Responsibility	Affiliation
Steve Tyahla	Remedial Project Manager	Naval Facilities Engineering Command, Engineering Field Activity West
Narciso A. Ancog	Quality Assurance (QA) Officer	Naval Facilities Engineering Command, Southwest Division
Phillip Ramsey	Project Manager	U.S. Environmental Protection Agency, Region 9
Jim Pinasco	Project Manager	California Environmental Protection Agency Department of Toxic Substances Control
Laurent Meillier	Project Manager	California Regional Water Quality Control Board, Central Valley Region
Greg Swanson	Program QA Manager	Tetra Tech EM Inc.
Ron Ohta	Project QA Officer	Tetra Tech EM Inc.
John Bosche	Project Manager	Tetra Tech EM Inc.
Kevin Hoch	Analytical Coordinator	Tetra Tech EM Inc.
To be determined	Field Team Leader	Tetra Tech EM Inc.

ACRONYMS AND ABBREVIATIONS

bgs	Below ground surface
DQO	Data quality objective
EPA	U.S. Environmental Protection Agency
FS	Feasibility study
FSP	Field sampling plan
GSA	General Services Administration
HLA	Harding Lawson Associates
IAS	Initial assessment study
MCL	Maximum contaminant level
µg/L	Micrograms per liter
mg/kg	Milligrams per kilogram
Navy	U.S. Department of the Navy
NWSSBD	Naval Weapons Station Seal Beach Detachment
PRG	Preliminary Remediation Goals
QAPP	Quality assurance project plan
RCRA	Resource Conservation and Recovery Act
RFA	Resource Conservation and Recovery Act facility assessment
RI	Remedial investigation
ROD	Record of decision
RWQCB	California Regional Water Quality Control Board
SI	Site investigation
SVOC	Semivolatile organic compound
SWMU	Solid Waste Management Unit
Tetra Tech	Tetra Tech EM Inc.
TPH	Total petroleum hydrocarbons
UST	Underground storage tank
VOC	Volatile organic compound

1.0 INTRODUCTION

Tetra Tech EM Inc. (Tetra Tech) is submitting this addendum to the “Draft Final Field Sampling Plan Remedial Investigation for Groundwater at Solid Waste Management Unit (SWMU) Sites 1, 2, 5, 7, and 18” (Tetra Tech 2001a) (hereinafter referred to as the FSP) and the “Draft Final Quality Assurance Project Plan Remedial Investigation for Groundwater at SWMU Sites 1, 2, 5, 7, and 18” (Tetra Tech 2001b) (hereinafter referred to as the QAPP). This addendum supports additional investigation of the source of volatile organic compounds (VOC) in groundwater at SWMU Sites 1, 2, 5, 7, and 18 at Naval Weapons Station, Seal Beach Detachment Concord (NWSSBD), in Concord, California. The draft final FSP and QAPP were approved as separate documents by the Navy Quality Assurance Officer on December 4, 2000. This addendum provides necessary elements in an integrated format to update both documents. Responses to regulatory comments are presented in [Appendix A](#).

This addendum describes proposed field activities at SWMU Sites 1, 2, 5, 7, and 18, and includes the collection of soil gas samples for VOC analysis.

1.1 PURPOSE OF THE INVESTIGATION

Previous soil and groundwater investigations at SWMU Sites 1, 2, 5, 7, and 18 did not identify a possible source of VOC contamination in groundwater. The Navy proposes a soil gas survey to facilitate identification of a possible source.

1.2 PREVIOUS INVESTIGATIONS

The following sections describe previous investigations at SWMUs 1, 2, 5, 7, and 18.

1.2.1 Previous Investigations at SWMUs 1, 2, 5, 7, and 18

The DTSC performed a Resource Conservation and Recovery Act (RCRA) facility assessment (RFA) at Naval Weapons Station SBD Concord in June 1992. The RFA was performed to evaluate the potential for release of hazardous substances from 49 SWMUs. In 1996, the Navy performed a RFA confirmation study (RFACS) to further evaluate the RFA findings. The RFACS included collection of soil, surface water, groundwater, and septic tank samples; laboratory analysis of the samples; and evaluation of the analytical results. Recommendations resulting from the RFACS included the transfer of TPH impacted sites to the Navy’s UST program designed to address the petroleum hydrocarbon contamination. Sites where low levels of VOCs were detected were recommended for evaluation under

the CERCLA Installation Restoration Program. Results from these investigations are presented in the original FSP and QAPP.

1.2.2 Analytical Results

The following sections discuss the analytical results of the most recent soil and groundwater sampling for the RI activities proposed in the original FSP and QAPP and conducted in February and March. The soil sample depths ranged from approximately 2 to 14 feet bgs. Soil and groundwater samples were analyzed for VOCs (EPA method 8260B) and natural attenuation parameters (EPA Method 300.0), and metals (EPA Method 200.7).

PCE and TCE are the VOCs with the highest detectable concentrations at the Site and are, therefore, the primary focus of the discussion regarding VOC analytical results presented. Additionally, cis and trans 1,2-DCE, which often develop as a result of the degradation of PCE and TCE, are included in the discussion of analytical results for VOCs.

Analytical results for VOCs in soil and groundwater are summarized in [Section 1.2.2.1](#) and [1.2.2.2](#), respectively. Concentrations below the laboratory method reporting limit are estimated concentrations and are distinguished in tables and figures with a “J” after the respective value. When discussing these values in text they are referred to as estimated values.

1.2.2.1 Soil Sample Results

A total of 158 soil samples collected from 39 different locations were analyzed for VOCs. Detectable concentrations of VOCs were reported in 2 of 158 soil samples submitted for analysis.

VOC constituents were not detected above screening criteria in any of the soil samples. TCE and PCE were detected in the sample collected at 28 feet bgs from soil boring SB018 at estimated concentrations of 0.002 mg/kg and 0.001 mg/kg, respectively. SB018 is located at the western end of the locomotive steam-cleaning area (Building 269). TCE was detected in the sample collected at 6 feet bgs from soil boring SB024 at an estimated concentration of 0.0006 mg/kg. SB024 is located near the southwest corner of Building IA-12. The concentrations reported for these samples are near the laboratory method detection limit and are estimated.

The soil-sampling program implemented for the RI was designed to supplement the soil investigation conducted during the RFACS and fill data gaps. Soil sampling locations selected for the RFACS and the RI were targeted to investigate potential sources of VOCs, which have been detected in groundwater at

the Site. Based on the results of the soil investigation described previously and the RFACS soil investigation conducted in 1996, it appears that VOCs have not significantly impacted soil at the Site.

1.2.2.2 Groundwater Sample Results

Because the primary focus of the RI is to determine the nature and extent of potentially impacted groundwater and to identify potential source areas of contaminant release, the two groundwater sample types (grab groundwater and monitoring well samples) are presented together in the following discussion. Although the analytical results for these samples are considered of similar data quality, the data may not be comparable. This is because grab groundwater samples are sometimes biased towards higher constituent concentrations as a result of sample turbidity and the tendency of constituents to adsorb to suspended soils in grab groundwater samples.

Samples were collected from 14 existing groundwater monitoring wells and 32 grab groundwater sample locations. In total, 48 samples were collected and analyzed for VOCs.

PCE, TCE, and cis and trans 1,2-DCE were detected in samples collected from 10 monitoring wells and from 21 grab groundwater sampling locations. PCE and TCE were generally detected at relatively higher concentrations than cis and trans 1,2-DCE.

The highest concentration of PCE detected at the site (102 µg/L) was collected from well MW-10 located downgradient of Building 269. The second highest concentration of PCE detected in groundwater (86 µg/L) was in boring SB024 located downgradient of Building IA-12. PCE was generally detected in groundwater at concentrations between 30 and 50 µg/L at locations in the immediate area of the highest detects downgradient from MW-10 and SB024. Relatively low concentrations of PCE were detected in samples collected from sampling locations in SMWU 2, located south of Kinne Boulevard. PCE was not detected in samples collected from locations upgradient of SWMU 5.

Evaluation of the VOC data indicates that PCE concentrations attenuate rapidly with distance from MW-10. Boring SB009 is located about 50 feet from MW-10 in a downgradient direction. The concentration of PCE at SB009 was 43 µg/L, down from 103 µg/L at MW-10. Boring SB004 is approximately 300 feet downgradient from MW-10. At location, the groundwater concentration of PCE was 33 µg/L. Approximately 600 feet downgradient from Well MW-10 PCE in groundwater was measured at a concentration of 5.1 µg/L in MW-2. The monitoring well farthest to the west is MW-14. Well MW-14 is located approximately 1200 feet from MW-10 and the detected concentration of PCE in groundwater at MW-14 was 2.6 µg/L.

For relative evaluation purposes, the PCE concentrations presented 16 are divided into four general categories, presented below:

<u>PCE Concentration Range</u>	<u>Number of Samples</u>
Not Detected	22
Less Than 5 µg/L	11
5 µg/L to 10 µg/L	6
10 µg/L to 103 µg/L	6

Most of the nondetected concentrations are located in upgradient areas. The upgradient samples are useful for determining that upgradient sources are not present. Samples located at the investigation boundaries were either nondetected for PCE or at concentrations of less than 5 µg/L.

The distribution of TCE was similar to that of PCE within SWMU 5 except the detected concentrations were generally lower. The maximum concentration of TCE in groundwater at the site was detected in soil boring SB024 at a concentration of 38 µg/L. SB024 is located near the west corner and downgradient of Building IA-12 (SB024 is the same location where the second highest concentration of PCE was detected). The second highest concentration of TCE was located MW-10 downgradient from Building 269 (MW-10 is the location where the highest concentration of PCE was detected in groundwater). TCE was not detected in samples collected from locations in SMWU 2 but was detected at low or estimated concentrations between 0.9 and 2.1 µg/L from samples collected from locations upgradient of SWMU 5.

For relative evaluation purposes, the TCE concentrations are divided into four general categories, presented below:

<u>TCE Concentration Range</u>	<u>Number of Samples</u>
Not Detected	22
Less Than 5 µg/L	17
5 µg/L to 10 µg/L	0
10 µg/L to 38 µg/L	6

Cis 1,2-DCE was detected in samples collected from nine locations at concentrations between an estimated concentration of 0.8 µg/L and a quantifiable concentration of 5.6 µg/L. Cis 1,2-DCE was only detected in samples collected from locations within SWMUs 5 and 7 and in downgradient sampling location SB004. Trans 1,2-DCE was detected in samples collected from seven sampling locations at concentrations ranging from an estimated concentration of 0.9 µg/L to a quantifiable concentration of

3.8 µg/L. Trans-1,2-DCE was also only detected in samples collected from locations within SWMUs 5 and 7 and in downgradient sampling location SB004.

The detected concentrations of VOCs in the samples presented previously were primarily associated with samples collected in SWMU 5 and 7 near Building 269. A hazardous waste storage area and steam-cleaning pad are located at Building 269, and a waste oil UST is located upgradient on the southern side of Building IA-12.

1.3 TECHNICAL OR REGULATORY STANDARDS

To better utilize resources, a mobile laboratory will be used for the initial soil gas investigation. Use of the mobile laboratory allows for rapid screening of suspected source areas. However, the mobile laboratory is limited in its ability to achieve the low reporting limits required for comparison to established regulatory screening criteria. Because of this, the Navy and regulators in a conference call on September 15, 2003 agreed that for the mobile laboratory, a screening level of 50µg/m³ would be sufficiently low to identify a significant source of VOC contamination. A subset of 5 samples will also be split and sent to a fixed laboratory for confirmation using low-level analysis.

For the confirmation analysis, the screening goals presented in Table 2c of EPA's "Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Pathway)" will be used as the screening goals. In the few instances where no screening goal is proposed in EPA guidance, the screening goals proposed in Table E-2 of RWQCBs "Screening for Environmental Concern at Sites with Contaminated Soil and Groundwater" will be used. For this initial investigation these screening values will be applied to both shallow soil gas (5 feet bgs) and deeper soil gas (10 feet bgs). Should it be determined that a human health risk assessment is necessary, screening criteria appropriate for the depth sampled will be used. The screening goals are presented in [Tables 3A and 3B](#).

Concentrations of VOCs in soil gas above screening levels do not necessarily indicate that a significant threat to indoor air is present; only that additional evaluation may be warranted. The screening levels may be overly conservative for sites with low permeability soils immediately under buildings or sites with limited soil impact and no groundwater source of VOCs ([RWQCB 2001](#)).

1.4 PROJECT ORGANIZATION

Table 1 presents the responsibilities and contact information for key personnel involved in the soil gas investigation. In some cases, more than one responsibility has been assigned to one person.

2.0 PROJECT AND TASK DESCRIPTION

The following subsections discuss the project objectives and project measurements for the soil gas sampling event.

2.1 PROJECT OBJECTIVES

As stated in Section 1.1, the primary objective of the soil gas sampling is to obtain additional information to assess impact of possible VOC contamination in soil to groundwater

To meet these objectives, the following field activities will be carried out:

- Collect shallow soil gas (5-foot bgs) samples from 25 locations for VOC analysis.
- Collect deeper soil gas (10-foot bgs) samples from 5 locations for VOC analysis.
- If analytical results exceed the screening criteria, step-out sampling will be proposed.

2.2 PROJECT MEASUREMENTS

Initially, thirty soil gas samples will be collected at the site (Figure 1) to investigate possible sources of previously detected VOC contamination in groundwater. Table 2 summarizes the analytical program.

Samples analyzed by the mobile laboratory will be compared to a screening level of $50\mu\text{g}/\text{m}^3$. If VOCs are detected at concentrations exceeding this concentration, the Navy RPM and regulatory agencies will be consulted and additional step-out samples will be considered. A total of seven confirmation samples will be collected and sent to a fixed laboratory for low-level analysis. Three of these locations have been identified on Figure 1 (SG09, SG18, and SG23). Based on the results of the mobile laboratory analysis, four additional locations will be identified for confirmation analysis. The confirmation samples will ideally include locations exhibiting high-, medium-, and low-level VOC contamination as well as a non-detect. If no VOCs are detected by the mobile lab, the additional four locations will be placed nearest the suspected source areas. Once a location has been identified as one of the four additional locations for confirmation analysis, to ensure that sampling conditions are equivalent, a second Geoprobe boring will be advanced within 3-feet laterally of the original boring. From this new boring, split samples will be

collected and analyzed by the mobile and fixed laboratories. [Tables 3A and 3B](#) present the project-required reporting limits and compares these limits to applicable screening criteria. [Table 4](#) presents the laboratory precision and accuracy goals, and [Table 5](#) presents analytical methods, containers, preservatives, and holding times for soil gas samples collected at the Site. [Table 6](#) presents field QC samples.

2.2.1 Sampling Process Design

Shallow soil gas samples will be collected from a depth of 5-feet bgs. Deeper soil gas samples will be collected from 10-feet bgs. Sample locations were biased towards areas where VOCs were previously detected in groundwater, as well as other possible sources of VOC contamination. [Figure 1](#) presents the proposed sampling locations.

2.2.2 Sampling Methods

A direct-push sampling probe will be used to obtain soil gas samples. The following section describes the procedure for collection of soil gas samples.

2.2.3 Collection and Handling of Soil Gas Samples

Geoprobe activities will be carried out following Tetra Tech standard operating procedure (SOP) 054. Soil gas samples will be collected following the methods described in this addendum and in Tetra Tech's SOP 074 for soil gas sampling methods (see [Appendix B](#)). Soil gas samples will be collected using a direct-push probe with a slotted screen-point sampling tip. The direct-push probe consists of 3-foot sections of 1.5-inch-diameter, hollow, tubular steel rods connected by threads. The tip section contains a smaller section of rod that is slotted to allow soil gas to enter. A bulkhead union at the top of the slotted rod accommodates the connection of Tygon tubing that runs from the tip section through the steel rods to the ground surface, where the soil gas samples will be collected. During installation of the probe, hydrated bentonite will be used to seal around the drive rod at ground surface to prevent ambient air intrusion. The inner soil gas pathway from probe tip to the surface should be continuously sealed.

When borings are advanced, the slotted-rod section is covered by the outer drive casing and is protected by a pointed metal drive tip. The probe is advanced through the soil using hydraulic, vibratory, or percussive force. The probe is advanced to the sampling interval, and the outer casing is pulled back about 18 inches, exposing the slotted sampling tip to the surrounding soil.

A sampling pump fitted with a particulate prefilter, a flow controller, and a combination vacuum and pressure gauge will be used to purge soil gas from the probe. Soil gas samples will be collected in 500cc Tedlar bags for mobile laboratory analysis and 6 Liter SUMMA canisters for low-level confirmation analysis. Soil gas samples will be collected following Tetra Tech SOP 074. The procedures are summarized below.

500cc Tedlar Bag

Following purging, the Tedlar bag is attached to the tygon tubing. The valve on the bag is opened. The Tedlar bag is placed in a vacuum chamber. A vacuum is applied to the chamber such that the Tedlar bag is filled with soil gas at a rate of approximately 2 liters per minute. The minimum amount of soil gas required for analysis is approximately 0.25 liter. If less than 0.25 liter of gas is collected after 4 minutes of sampling, raise the probe 0.5 feet. Close the valve on the bag and remove the Tygon tubing.

6 Liter SUMMA Canister

Before the SUMMA canister is attached to the tygon tubing, 3 to 5 volumes of soil gas, or as much as can be removed during a minimum of 3 to 5 minutes of pumping at 100 to 200 milliliters per minute, will be purged from the sampling apparatus. Before the pump is turned off, about 2 inches of the sampling line nearest the entrance port of the pump will be folded over and clamped to prevent ambient air from entering the system. After disconnect from the pump a flow regulator will be placed between the probe and the SUMMA canister to ensure the SUMMA canister is filled at the specified flow rate. The samples will be collected in 6-liter SUMMA canisters. The entrance end of the purged Tygon tubing is connected to the SUMMA canister. The pressure valve on the SUMMA canister is opened, which allows the evacuated canister to draw in soil gas until the canister reaches ambient pressure. When the canister shows that ambient pressure has been reached, close the sampling valve and remove the canister from the sampling line. If less than 0.25 liter is collected after 4 minutes, raise the soil gas probe 0.5 foot, and continue the process for another minute. If the minimum soil gas is not collected, repeat the procedure again. If the minimum required volume of soil gas is still not collected, abandon the process, and record the conducted steps in the field log book. After successfully collecting the soil gas sample the SUMMA canister is labeled with a sample tag attached to the handle of the canister. The label information will be then recorded in the field book and chain of custody.

Samples collected from the 10-foot depths will require a separate boring to be advanced as close to the location of the 5-foot depth sample.

2.2.4 Analytical Methods

Soil gas samples will be analyzed for VOCs following a modified EPA Method 8260 B for mobile lab analysis and EPA Method TO-15 for the low-level confirmation analysis.

EPA Method 8260B-modified uses chromatography/mass spectroscopy (GC/MS) analysis for VOCs in whole air samples collected in 500cc Tedlar bags. An aliquot of sample is withdrawn from the bag with an airtight syringe and introduced to the system using a direct injection technique. The modification of the method involves this direct injection of a whole air sample.

EPA Method TO-15 involves full-scan gas GC/MS analysis for VOCs in whole air samples collected in evacuated stainless-steel canisters. An aliquot of sample is withdrawn from the canister through a mass flow controller and either cryofocused by liquid argon or concentrated using a multisorbent bed. The focused air is then flash-heated through a hydrophobic drying system that removes water from the sample stream prior to analysis by full-scan GC/MS.

2.2.5 Selection of Mobile Laboratory

Mobile laboratories are not included in Tetra Techs Navy laboratory prequalification process. To ensure that the mobile laboratory is capable of producing accurate and precise data, the mobile laboratory selected for this project will be required to demonstrate the successful analysis of a whole air calibration check sample. This whole air calibration check sample will consist of a whole air sample containing the target chemicals at a concentration between 50 and 150 $\mu\text{g}/\text{m}^3$. The mobile laboratory must demonstrate the ability to identify all target analytes and to report concentrations within a range of 75 – 125 percent of the known concentration. Along with documentation demonstrating successful completion of the whole air calibration check sample, a QA/QC package containing at a minimum an SOP (that includes regular calibration verification using the whole air standard), analyst training documentation, and certifications will be submitted prior to selection. Once the laboratory is selected, a field audit will be performed prior to sample analysis. Analysis of field samples is reliant upon successful completion of this field audit.

Section 7.3.2 of EPA SW-846 Method 8260B specifically states the following “Set up the sample introduction system as indicated in the method of choice (Section 7.1). A different calibration is necessary for each method because of the difference in conditions and equipment.” This statement implies that the calibration and sample introduction techniques must be identical. The mobile laboratory modification of this method is that the standards are introduced to the system in liquid form while the samples are introduced in vapor form. In order to meet the detection limits required, a relatively large

volume of vapor must be injected into the system. The possibility exists that this large volume could overwhelm the injection port causing sample to be inadvertently swept out of the injection port through the split valve, effectively diluting the sample. Successful completion of a vapor-based calibration check sample will allow verification that this is not occurring.

To ensure that the analytical system is performing in the field, the laboratory will be required to analyze a gaseous on-site evaluation check sample. Acceptance criteria for this sample will be set at 70 to 130 percent recovery.

The Navy will use all means necessary to identify a mobile laboratory capable of meeting the above specified QA/QC criteria. If an acceptable mobile laboratory is not identified, then all samples will be collected in SUMMA canisters and analyzed for low-level analysis by the fixed laboratory. The Remedial Project Manager Team will be notified of this decision well in advance of mobilization.

2.3 FIELD QUALITY CONTROL SAMPLES

One duplicate sample will be analyzed for every 10 samples collected during this investigation. Duplicate soil gas samples are collected using a “Y” splitter attached to two separate 6-liter SUMMA canisters or Tedlar bags. Duplicates are assigned non-descript sample identification numbers and are submitted blindly to the laboratory.

Five confirmation samples will be collected and sent to a fixed laboratory for low-level analysis. Once a location has been identified for confirmation analysis, to ensure that sampling conditions are equivalent between the sample for the mobile and fixed laboratories, a second Geoprobe boring will be advanced within 3-feet laterally of the original boring. From this new boring, split samples will be collected and analyzed by the mobile and fixed laboratories. To collect the split samples, the boring is prepared as described in [Section 2.2.3](#). Because it is not possible to connect a SUMMA canister and Tedlar bag together using a “Y” connector, the Tedlar bag will be filled first, followed by the SUMMA canister.

Results from the fixed laboratory will be compared to those of the mobile laboratory and an acceptance criterion of 50 percent relative percent difference will be assigned to the confirmation analysis.

Considering that the fixed laboratory will be using a promulgated EPA air method, results from the fixed laboratory will be considered of the highest quality. Although no results will be rejected based on exceeding this criteria, the data user will take this in to account when evaluating the results. Relative percent difference will be calculated as:

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

where:

- A = Fixed laboratory concentration
- B = Mobile laboratory concentration

3.0 QUALITY OBJECTIVES AND CRITERIA FOR MEASUREMENT DATA

[Table 7](#) presents the data quality objectives (DQO) identified for the soil gas investigation.

The DQO process is iterative, and the sampling design may be optimized as data are collected and evaluated. Existing soil data are insufficient to evaluate the extent of possible VOC contamination.

4.0 SECTIONS NOT REVISED

All other sections of the draft final FSP and QAPP ([Tetra Tech 2001a, 2001b](#)), as approved by the Navy in December 2000, remain in effect and are applicable for this field event at NWSSBD Concord.

REFERENCES

- San Francisco Bay Regional Water Quality Control Board (RWQCB). 2001. "Application of Risk-Based Screening Levels and Decision Making to Sites with Impacted Soil and Groundwater." December.
- Tetra Tech EM Inc (Tetra Tech). 2001a. "Draft Final Field Sampling Plan Remedial Investigation for Groundwater SWMU Sites 1, 2, 5, 7, and 18, Naval Weapons Station Seal Beach Detachment Concord, Concord, California." January 23.
- Tetra Tech. 2001b. "Draft Final Quality Assurance Project Plan Remedial Investigation for Groundwater SWMU Sites 1, 2, 5, 7, and 18, Naval Weapons Station Seal Beach Detachment Concord, Concord, California." January 23.

FIGURE

Figure 1

This detailed station map has been deleted from the Internet-accessible version of this document as per Department of the Navy Internet security regulations.

TABLES

TABLE 1
KEY PERSONNEL
SOIL GAS INVESTIGATION AT SWMU SITES 1, 2, 5, 7, AND 18, NWSSBD CONCORD

Name	Organization	Role	Responsibilities	Contact Information
Steven F. Tyahla	Navy	Remedial project manager	<p>Responsible for overall project execution and for coordination with base representatives, regulatory agencies, and Navy management</p> <p>Actively participates in DQO process</p> <p>Provides management and technical oversight during data collection</p>	<p>Naval Facilities Engineering Command, Southwest Division (SWDIV), Daly City, CA</p> <p>TyahlaSF@efawest.navy.mil</p> <p>(650-746-7451)</p>
Narciso A. Ancog	Navy	QA officer	<p>Responsible for QA issues for all SWDIV environmental work</p> <p>Provides government oversight of Tetra Tech's QA program</p> <p>Reviews and approves SAP and any significant modifications</p> <p>Has authority to suspend project activities if Navy quality requirements are not met</p>	<p>Naval Facilities Engineering Command, SWDIV, San Diego, CA</p> <p>ancogna@efds.navy.mil</p> <p>(619) 532-2540</p>
Joanna Canepa	Tetra Tech	Installation coordinator	<p>Responsible for ensuring that all Tetra Tech activities at this installation are carried out in accordance with current Navy requirements</p>	<p>Tetra Tech, San Francisco, CA</p> <p>Joanna.Canepa@ttemi.com</p> <p>(415) 222-8295</p>
Greg Swanson	Tetra Tech	Program QA manager	<p>Responsible for regular discussion and resolution of QA issues with Navy QA officer</p> <p>Provides program-level QA guidance to installation coordinator, project manager, and project teams</p> <p>Reviews and approves SAPs</p> <p>Identifies nonconformances through audits and other QA review activities and recommends corrective action</p>	<p>Tetra Tech, San Diego, CA</p> <p>Greg.Swanson@TtEMI.com</p> <p>(619) 525-7188</p>

TABLE 1 (Continued)
KEY PERSONNEL
SOIL GAS INVESTIGATION AT SWMU SITES 1, 2, 5, 7, AND 18, NWSSBD CONCORD

Name	Organization	Role	Responsibilities	Contact Information
Ron Ohta	Tetra Tech	Project QA officer	<p>Responsible for providing guidance to project teams that are preparing SAPs</p> <p>Verifies that data collection methods specified in SAP comply with Navy and Tetra Tech requirements</p> <p>May conduct laboratory evaluations and audits</p>	<p>Tetra Tech, Sacramento, CA Ron.Ohta@TtEMI.com (916) 853-4506</p>
To be determined	Tetra Tech	Field team leader	<p>Responsible for directing day-to-day field activities conducted by Tetra Tech and subcontractor personnel</p> <p>Verifies that field sampling and measurement procedures follow SAP</p> <p>Provides project manager with regular reports on status of field activities</p>	To be determined
To be determined	Tetra Tech	On-site safety officer	<p>Responsible for implementing health and safety plan and for determining appropriate site control measures and personal protection levels</p> <p>Conducts safety briefings for Tetra Tech and subcontractor personnel and site visitors</p> <p>Can suspend operations that threaten health and safety</p>	To be determined
Kevin Hoch	Tetra Tech	Chemist	<p>Responsible for working with project team to define analytical requirements</p> <p>Assists in selecting a prequalified laboratory to complete required analyses (see Section 2.4 of SAP)</p> <p>Coordinates with laboratory project manager on analytical requirements, delivery schedules, and logistics</p> <p>Reviews laboratory data before they are released to project team</p>	<p>Tetra Tech, San Francisco, CA Kevin.Hoch@TtEMI.com (415) 222-8304</p>

TABLE 1 (Continued)
KEY PERSONNEL
SOIL GAS INVESTIGATION AT SWMU SITES 1, 2, 5, 7, AND 18, NWSSBD CONCORD

Name	Organization	Role	Responsibilities	Contact Information
Wing Tse	Tetra Tech	Database manager	Responsible for developing, monitoring, and maintaining project database under guidance of project manager Works with analytical coordinator during preparation of SAP to resolve sample identification issues	Tetra Tech, San Francisco, CA Wing.Tse@TtEMI.com (415) 222-8326
To be determined	Laboratory	Project manager	Responsible for delivering analytical services that meet requirements of SAP Reviews SAP to understand analytical requirements Works with Tetra Tech analytical coordinator to confirm sample delivery schedules Reviews laboratory data package before it is delivered to Tetra Tech	To be determined
To be determined	Subcontractor	Project manager	Responsible for ensuring that subcontractor activities are conducted in accordance with requirements of SAP Coordinates subcontractor activities with Tetra Tech project manager or field team leader	To be determined

Notes:

DQO Data quality objective
NWSSBD Naval Weapons Station Seal Beach Detachment
QA Quality assurance
RPM Remedial project manager
SAP Sampling and analysis plan
SWDIV Naval Facilities Engineering Command, Southwest Division
Tetra Tech Tetra Tech EM Inc.

TABLE 2
SUMMARY OF ANALYTICAL PROGRAM
SOIL GAS INVESTIGATION AT SWMU SITES 1, 2, 5, 7, AND 18, NWSSBD CONCORD

Location Name (Figure 1)	Sample ID	Depth (feet bgs)	Analyses	Rationale
SG01	324SG001	5	Mobile Laboratory – EPA 8260B	To locate and delineate possible source of VOC contamination
SG02	324SG002	5	Mobile Laboratory – EPA 8260B	To locate and delineate possible source of VOC contamination
SG03	324SG003	5	Mobile Laboratory – EPA 8260B	To locate and delineate possible source of VOC contamination
SG04	324SG004	5	Mobile Laboratory – EPA 8260B	To locate and delineate possible source of VOC contamination
SG05	324SG005	5	Mobile Laboratory – EPA 8260B	To locate and delineate possible source of VOC contamination
SG06	324SG006	5	Mobile Laboratory – EPA 8260B	To locate and delineate possible source of VOC contamination
SG07	324SG007	5	Mobile Laboratory – EPA 8260B	To locate and delineate possible source of VOC contamination
	324SG008	10	Mobile Laboratory – EPA 8260B	To locate and delineate possible source of VOC contamination
SG08	324SG009	5	Mobile Laboratory – EPA 8260B	To locate and delineate possible source of VOC contamination
	324SG010	10	Mobile Laboratory – EPA 8260B	To locate and delineate possible source of VOC contamination
SG09	324SG011	5	Mobile Laboratory – EPA 8260B	To locate and delineate possible source of VOC contamination
	324SG011C	5	Fixed Laboratory - Method TO-15	Low-level confirmation analysis.
SG10	324SG012	5	Mobile Laboratory – EPA 8260B	To locate and delineate possible source of VOC contamination

TABLE 2 (Continued)
SUMMARY OF ANALYTICAL PROGRAM
SOIL GAS INVESTIGATION AT SWMU SITES 1, 2, 5, 7, AND 18, NWSSBD CONCORD

Location Name (Figure 1)	Sample ID	Depth (feet bgs)	Analyses	Rationale
SG11	324SG013	5	Mobile Laboratory – EPA 8260B	To locate and delineate possible source of VOC contamination
SG12	324SG014	5	Mobile Laboratory – EPA 8260B	To locate and delineate possible source of VOC contamination
	324SG015	10	Mobile Laboratory – EPA 8260B	To locate and delineate possible source of VOC contamination
SG13	324SG016	5	Mobile Laboratory – EPA 8260B	To locate and delineate possible source of VOC contamination
SG14	324SG017	5	Mobile Laboratory – EPA 8260B	To locate and delineate possible source of VOC contamination
SG15	324SG018	5	Mobile Laboratory – EPA 8260B	To locate and delineate possible source of VOC contamination
SG16	324SG019	5	Mobile Laboratory – EPA 8260B	To locate and delineate possible source of VOC contamination
SG17	324SG020	5	Mobile Laboratory – EPA 8260B	To locate and delineate possible source of VOC contamination
SG18	324SG021	5	Mobile Laboratory – EPA 8260B	To locate and delineate possible source of VOC contamination
	324SG021C	5	Fixed Laboratory - Method TO-15	Low-level confirmation analysis.
SG19	324SG022	5	Mobile Laboratory – EPA 8260B	To locate and delineate possible source of VOC contamination
SG20	324SG023	5	Mobile Laboratory – EPA 8260B	To locate and delineate possible source of VOC contamination
	324SG024	10	Mobile Laboratory – EPA 8260B	To locate and delineate possible source of VOC contamination

TABLE 2 (Continued)
SUMMARY OF ANALYTICAL PROGRAM
SOIL GAS INVESTIGATION AT SWMU SITES 1, 2, 5, 7, AND 18, NWSSBD CONCORD

Location Name (Figure 1)	Sample ID	Depth (feet bgs)	Analyses	Rationale
SG21	324SG025	5	Mobile Laboratory – EPA 8260B	To locate and delineate possible source of VOC contamination
	324SG025C	5	Fixed Laboratory - Method TO-15	Low-level confirmation analysis.
SG22	324SG026	5	Mobile Laboratory – EPA 8260B	To locate and delineate possible source of VOC contamination
SG23	324SG027	5	Mobile Laboratory – EPA 8260B	To locate and delineate possible source of VOC contamination
SG24	324SG028	5	Mobile Laboratory – EPA 8260B	To locate and delineate possible source of VOC contamination
	324SG029	10	Mobile Laboratory – EPA 8260B	To locate and delineate possible source of VOC contamination
SG25	324SG030	5	Mobile Laboratory – EPA 8260B-modified	To locate and delineate possible source of VOC contamination
NA ^a	324SG031 through 33	TBD	Mobile Laboratory – EPA 8260B-modified	Field duplicate samples
SG01 through SG25	Four additional locations to be selected based on mobile laboratory results. 324SG001C through 324SG030C	TBD	Fixed Laboratory - Method TO-15	Low-level confirmation analysis. Locations to included high-, medium-, and low-level VOC contamination as well as a non-detect location.

Notes:

- a Field duplicate samples will be assigned the same location name as the investigative sample, however they are assigned a distinct Sample ID.
- NA Not applicable
- TBD To be determined
- VOC Volatile organic compounds

TABLE 3A
COMPARISON OF PROJECT-REQUIRED REPORTING LIMITS
AND SCREENING CRITERIA, VOLATILE ORGANIC COMPOUND ANALYSIS,
METHOD TO-15
SOIL GAS INVESTIGATION AT SWMU SITES 1, 2, 5, 7, AND 18, NWSSBD CONCORD

Analyte	Screening Criteria ($\mu\text{g}/\text{m}^3$) ^a	PRRL ($\mu\text{g}/\text{m}^3$)	PRRL Below Screening Criteria?
1,1,2,2-Tetrachloroethane	0.42	0.70	No ^c
1,1,1,2-Tetrachloroethane	3.3	0.70	Yes
1,1,2-Trichloroethane	1.5	0.55	Yes
1,1-Dichloroethane	5,000	0.41	Yes
1,1-Dichloroethene	2,000	0.40	Yes
1,2,4-Trichlorobenzene	2,000	3.8	Yes
1,2,4-Trimethylbenzene	60	0.50	Yes
1,2-Dichlorobenzene	2,000	0.61	Yes
1,2-Dichloroethane	0.94	0.41	No ^c
1,2-Dichloropropane	40	0.47	Yes
1,3,5-Trimethylbenzene	60	0.50	Yes
1,3-Butadiene	0.087	1.1	No ^c
1,3-Dichlorobenzene	1,100	0.61	Yes
1,4-Dichlorobenzene	8,000	0.61	Yes
1,4-Dioxane	NA	1.8	NA
2-Butanone (Methyl Ethyl Ketone)	10,000	1.5	Yes
2-Hexanone	2,000	2.1	Yes
4-Ethyltoluene	NA	2.5	NA
4-Methyl-2-Pentanone (MIBK)	800	2.1	Yes
Acetone	3,500	1.2	Yes
Benzene	3.1	0.32	Yes
Bromodichloromethane	1.4	3.4	No ^c
Bromoform	22	5.2	Yes
Bromomethane	1,000 ^b	0.39	Yes
Carbon Disulfide	7,000	1.6	Yes
Carbon Tetrachloride	1.6	0.64	Yes
Chlorobenzene	60	0.47	Yes
Chloroethane	100,000	0.27	Yes
Chloroform	1.1	0.5	Yes
Chloromethane	1,400 ^b	0.21	Yes
Chlorotoluene	NA	0.53	NA
cis-1,2-Dichloroethene	73,000 ^b	0.4	Yes

TABLE 3A (Continued)
COMPARISON OF PROJECT-REQUIRED REPORTING LIMITS
AND SCREENING CRITERIA, VOLATILE ORGANIC COMPOUND ANALYSIS,
METHOD TO-15
SOIL GAS INVESTIGATION AT SWMU SITES 1, 2, 5, 7, AND 18, NWSSBD CONCORD

Analyte	Screening Criteria ($\mu\text{g}/\text{m}^3$) ^a	PRRL ($\mu\text{g}/\text{m}^3$)	PRRL Below Screening Criteria?
trans-1,2-Dichloroethene	150,000 ^b	2.0	Yes
cis-1,3-Dichloropropene	6.1	0.46	Yes
trans-1,3-Dichloropropene	6.1	0.46	Yes
Cyclohexane	NA	1.7	NA
Dibromochloromethane	90 ^b	4.3	Yes
Ethanol	NA	0.96	NA
Ethylbenzene	22	0.44	Yes
Ethylene Dibromide	0.11	0.78	No ^c
Freon 11	NA	0.57	NA
Freon 113	NA	0.78	NA
Freon 114	NA	0.71	NA
Freon 12	NA	0.5	NA
Heptane	NA	2.1	NA
Hexachlorobutadiene	1.1	5.4	No ^c
m,p-Xylene	21,000 ^b	0.44	Yes
Methylene Chloride	52	0.35	Yes
Methyl-t-Butyl Ether (MTBE)	30,000	1.8	Yes
o-Xylene	21,000 ^b	0.44	Yes
Styrene	10,000	0.43	Yes
Tetrachloroethene	8.1	0.69	Yes
Tetrahydrofuran	NA	1.5	NA
Toluene	4,000	0.38	Yes
Trichloroethene	0.22	0.55	No ^c
Vinyl Acetate	2,000	1.8	Yes
Vinyl Chloride	2.8	0.26	Yes

Notes:

- a Table 2c, "Draft Guidance for Evaluating Vapor Intrusion to Indoor Air Pathway From Groundwater and Soils (Subsurface Vapor Intrusion Guidance) Risk = 1×10^{-6} Target Shallow Soil Gas Concentration" EPA November 2002, unless otherwise noted.
- b Table E-2 Shallow Soil Gas Screening Levels for Evaluation of Potential Indoor-Air Impacts, "Screening for Environmental Concerns at Sites with Contaminated Soil and Groundwater" Interim Final. RWQCB. July 2003.
- c The PRRLs listed in this table reflect the lowest achievable reporting limits following promulgated methodology.

$\mu\text{g}/\text{m}^3$ Micrograms per cubic meter
PRRL Project-required detection limit

TABLE 3B
COMPARISON OF PROJECT-REQUIRED REPORTING LIMITS
AND SCREENING CRITERIA, VOLATILE ORGANIC COMPOUND ANALYSIS,
EPA METHOD 8260B – MOBILE LABORATORY
SOIL GAS INVESTIGATION AT SWMU SITES 1, 2, 5, 7, AND 18, NWSSBD CONCORD

Analyte	Screening Criteria ($\mu\text{g}/\text{m}^3$) ^a	PRRL ($\mu\text{g}/\text{m}^3$)	PRRL at or Below Screening Criteria?
1,1,2,2-Tetrachloroethane	50	50	Yes
1,1,1,2-Tetrachloroethane	50	50	Yes
1,1,2-Trichloroethane	50	50	Yes
1,1-Dichloroethane	50	50	Yes
1,1-Dichloroethene	50	50	Yes
1,2,4-Trichlorobenzene	50	50	Yes
1,2,4-Trimethylbenzene	50	50	Yes
1,2-Dichlorobenzene	50	50	Yes
1,2-Dichloroethane	50	50	Yes
1,2-Dichloropropane	50	50	Yes
1,3,5-Trimethylbenzene	50	50	Yes
1,3-Butadiene	50	50	Yes
1,3-Dichlorobenzene	50	50	Yes
1,4-Dichlorobenzene	50	50	Yes
1,4-Dioxane	50	50	Yes
2-Butanone (Methyl Ethyl Ketone)	50	50	Yes
2-Hexanone	50	50	Yes
4-Ethyltoluene	50	50	Yes
4-Methyl-2-Pentanone (MIBK)	50	50	Yes
Acetone	50	50	Yes
Benzene	50	50	Yes
Bromodichloromethane	50	50	Yes
Bromoform	50	50	Yes
Bromomethane	50	50	Yes
Carbon Disulfide	50	50	Yes
Carbon Tetrachloride	50	50	Yes
Chlorobenzene	50	50	Yes
Chloroethane	50	50	Yes
Chloroform	50	50	Yes
Chloromethane	50	50	Yes
Chlorotoluene	50	50	Yes
cis-1,2-dichloroethene	50	50	Yes

TABLE 3B (Continued)
COMPARISON OF PROJECT-REQUIRED REPORTING LIMITS
AND SCREENING CRITERIA, VOLATILE ORGANIC COMPOUND ANALYSIS,
EPA METHOD 8260B – MOBILE LABORATORY
SOIL GAS INVESTIGATION AT SWMU SITES 1, 2, 5, 7, AND 18, NWSSBD CONCORD

Analyte	Screening Criteria ($\mu\text{g}/\text{m}^3$) ^a	PRRL ($\mu\text{g}/\text{m}^3$)	PRRL at or Below Screening Criteria?
trans-1,2-Dichloroethene	50	50	Yes
cis-1,3-Dichloropropene	50	50	Yes
trans-1,3-Dichloropropene	50	50	Yes
Cyclohexane	50	50	Yes
Dibromochloromethane	50	50	Yes
Ethanol	50	50	Yes
Ethylbenzene	50	50	Yes
Ethylene dibromide	50	50	Yes
Freon 11	50	50	Yes
Freon 113	50	50	Yes
Freon 114	50	50	Yes
Freon 12	50	50	Yes
Heptane	50	50	Yes
Hexachlorobutadiene	50	50	Yes
m,p-Xylene	50	50	Yes
Methylene Chloride	50	50	Yes
Methyl-t-Butyl Ether (MTBE)	50	50	Yes
o-Xylene	50	50	Yes
Styrene	50	50	Yes
Tetrachloroethene	50	50	Yes
Tetrahydrofuran	50	50	Yes
Toluene	50	50	Yes
Trichloroethene	50	50	Yes
Vinyl Acetate	50	50	Yes
Vinyl Chloride	50	50	Yes

Notes:

a A mobile laboratory screening goal of $50 \mu\text{g}/\text{m}^3$ was agreed to by the Navy and regulatory agencies in a conference call on September 15, 2003.

$\mu\text{g}/\text{m}^3$ Micrograms per cubic meter

PRRL Project-required detection limit

TABLE 4
METHOD PRECISION AND ACCURACY GOALS VOLATILE ORGANIC COMPOUND ANALYSIS,
METHODS TO-15 AND 8260B-MODIFIED
SOIL GAS INVESTIGATION AT SWMU SITES 1, 2, 5, 7, AND 18, NWSSBD CONCORD

QC Check	Spike Compound	% Recovery	Relative Percent Difference
Surrogate	1,2-Dichloroethane-d ₄	70 to 130	NA
	Toluene-d ₈	70 to 130	NA
	4-Bromofluorobenzene	70 to 130	NA
Internal Standard	Bromochloromethane	60 to 140	NA
	1,4-Difluorobenzene	60 to 140	NA
	Chlorobenzene-d ₅	60 to 140	NA
Laboratory Control Spike / Laboratory Control Spike Duplicate	1,1-Dichloroethene	70 to 130	25
	cis-1,2-Dichloroethene	70 to 130	25
	trans-1,2-Dichloroethene	70 to 130	25
	Tetrachloroethene (PCE)	70 to 130	25
	Trichloroethene (TCE)	70 to 130	25
On-Site Evaluation Check Sample*	All Analytes	70 to 130	NA

Note:

* The on-site evaluation check sample will be a gaseous check sample.

TABLE 5
SAMPLE CONTAINER, HOLDING TIME, AND PRESERVATIVE REQUIREMENTS
SOIL GAS INVESTIGATION AT SWMU SITES 1, 2, 5, 7, AND 18, NWSSBD CONCORD

Parameter	Method Number	Sample Container	Preservative	Holding Time
Volatile organic compounds – low-level fixed laboratory	EPA TO-15	One – Six liter SUMMA canister	None	30 days
Volatile organic compounds – mobile laboratory	EPA 8260B - Modified *	One – 500cc Tedlar bag	None	3 days

Note:

* EPA 8260-modified indicates modification of the system to allow for direct injection.

EPA U.S. Environmental Protection Agency

TABLE 6
FIELD QUALITY CONTROL SAMPLES
SOIL GAS INVESTIGATION AT SWMU SITES 1, 2, 5, 7, AND 18, NWSSBD CONCORD

Sample Type	Frequency of Analysis	Matrix
Field Duplicate	10 percent	Air

TABLE 7
DATA QUALITY OBJECTIVES
SOIL GAS INVESTIGATION AT SWMU SITES 1, 2, 5, 7, AND 18, NWSSBD CONCORD

STEP 1: State the Problem
VOCs were detected in groundwater during previous investigations of the Site at concentrations exceeding the MCL. Soil sampling conducted in the area did not reveal a source for this groundwater contamination.
STEP 2: Identify the Decisions
Is a source of VOC contamination present in shallow soil at concentrations sufficient to impact groundwater in the vicinity of SWMU Sites 1, 2, 5, 7, and 18 and is this contamination at a concentration that poses an unacceptable risk to human health?
STEP 3: Identify Inputs to the Decisions
<ul style="list-style-type: none"> • Analytical results for VOCs in soil gas and soil at SWMU Sites 1, 2, 5, 7, and 18. • Appropriate screening criteria. • Review of historical information. • Hydrogeologic information.
STEP 4: Define Study Boundaries
<ul style="list-style-type: none"> • The lateral extent of the study area is the area contained within Figure 1. • The vertical extent of the shallow soil gas survey extends from the soil surface down to 10 feet bgs. • Temporal boundaries extend through the period of performance of the task order.
STEP 5: Develop Decision Rules
If VOCs are detected in soil gas samples at concentrations exceeding the screening criteria (50µg/m ³ for mobile laboratory, Table 3A for fixed laboratory), then a second phase of step-out soil gas sampling will be considered to delineate the possible source of contamination and whether the concentrations pose an unacceptable risk to human health. Otherwise, no further investigation will be required.
STEP 6: Specify Tolerable Limits on Decision Errors
Site-specific sampling objectives and the media being investigated limit the use of statistical methods in selecting sampling locations for this investigation. Sampling locations will be based on prior knowledge of site history and existing soil and groundwater data. Tolerable limits on decision errors cannot be precisely defined.
STEP 7: Optimize the Sampling Design
Sampling locations were selected based on site history; therefore, sampling locations are judgmentally placed. A mobile laboratory will be used to efficiently screen the identified target areas. Step-out samples may be necessary if detects exceeding the screening criteria are encountered. Confirmation samples will be analyzed by a fixed laboratory capable of achieving reporting limits low enough for comparison to accepted regulatory screening criteria.

Notes:

- bgs Below ground surface
- EPA U.S. Environmental Protection Agency
- MCL Maximum contaminant level
- PRG Preliminary remediation goal

APPENDIX A
RESPONSES TO AGENCY COMMENTS

RESPONSES TO AGENCY COMMENTS
DRAFT ADDENDUM SAMPLING AND ANALYSIS PLAN (FIELD SAMPLING PLAN AND
QUALITY ASSURANCE PROJECT PLAN) SOIL GAS INVESTIGATION AT
SWMU SITES 1, 2, 5, 7, AND 18 AN ADDENDUM TO THE DRAFT FINAL FIELD SAMPLING
PLAN AND QUALITY ASSURANCE PROJECT PLAN REMEDIAL INVESTIGATION OF
GROUNDWATER AT SWMU SITES 1, 2, 5, 7, AND 18
NAVAL WEAPONS STATION SEAL BEACH DETACHMENT CONCORD
October 7, 2003

The U.S. Environmental Protection Agency (EPA), the State of California Environmental Protection Agency Department of Toxic Substances Control (DTSC), and the San Francisco Bay Regional Water Quality Control Board (RWQCB) reviewed the U.S. Department of the Navy (Navy) document entitled, "Draft Addendum Sampling and Analysis Plan (Field Sampling Plan and Quality Assurance Project Plan) Soil Gas Investigation at SWMUs Sites 1, 2, 5, 7, and 18 an Addendum to the Draft Final Field Sampling Plan and Quality Assurance Project Plan Remedial Investigation of Groundwater at SWMU Sites 1, 2, 5, 7, and 18, Naval Weapons Station Seal Beach Detachment Concord, Concord, California." The document, hereinafter referred to as the draft soil gas sampling and analysis plan [SAP], was dated June 6, 2003, and prepared by Tetra Tech EM Inc. The agencies' comments are provided in the following text along with the Navy's responses.

COMMENTS BY THE EPA ON THE DRAFT SWMUs SAMPLING PLAN ADDENDUM

The EPA comments were presented in a letter dated August 14, 2003.

EPA Comment 1 **U.S. EPA appreciates the opportunity to have met with the Navy and State to discuss the draft Soil Gas SAP on July 23, 2003. At the meeting, U.S. EPA indicated its concern with the overall locations of the soil gas sampling points (higher density samples were proposed at the down-gradient end of the groundwater contamination plume and lower density of samples were proposed at the up-gradient area of groundwater contamination), the lack of multi-level sampling depths (for better depth-specific characterization), and a consideration of laboratory strategy that will result in short turn-around times for analysis and the completion of the survey in one field sampling effort.**

Based upon the discussion, soil gas sampling points were modified as documented in the Navy's August 6, 2003, revised Figure 1, Proposed Soil Gas Sampling Locations. The meeting resulted in the initial number of samples being reduced; however, this initial set of soil gas samples may need to be increased depending on results. The revision includes a total of five two-depth sampling points that are associated with the locomotive wash rack and 1A-12 waste-oil UST. The Navy should clarify in its revised Soil Gas SAP that the multi-depth samples will be collected and specify the sampling depths (5-foot and 10-foot).

Response: Based upon the EPA's comments and concerns, sampling locations and numbers were adjusted as requested. Depth discrete soil gas sampling was also added as requested. The Navy has revised the soil gas SAP to indicate the location and depth of multidepth soil gas samples.

RESPONSES TO AGENCY COMMENTS (Continued)
DRAFT ADDENDUM SAMPLING AND ANALYSIS PLAN (FIELD SAMPLING PLAN AND
QUALITY ASSURANCE PROJECT PLAN) SOIL GAS INVESTIGATION AT
SWMU SITES 1, 2, 5, 7, AND 18 AN ADDENDUM TO THE DRAFT FINAL FIELD SAMPLING
PLAN AND QUALITY ASSURANCE PROJECT PLAN REMEDIAL INVESTIGATION OF
GROUNDWATER AT SWMU SITES 1, 2, 5, 7, AND 18
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD
October 7, 2003

EPA Comment 2 **Laboratory Strategy and Need for Contingency Samples:** U.S. EPA strongly encourages that Navy to consider using a mobile laboratory or a fixed laboratory with quick turn-around and add contingency samples to the plan. As discussed at the July 23 meeting, the use of a mobile laboratory could allow the Navy and the regulators to conduct a more dynamic assessment, by using the real-time data to guide the assessment. Similar benefits may be realized from a fixed lab with quick turnaround, depending on cost. As there was only a general agreement to conduct a first phase with essentially a minimum number of samples, the use of a mobile laboratory or a fixed lab with quick turn-around and contingency samples, would allow the Navy to more efficiently characterize soil gas at the subject areas during one field mobilization. As currently proposed, if significant levels of soil gas are detected, another SAP may need to be developed prior to field mobilization, which is time consuming and costly. As a result, U.S. EPA continues to encourage the Navy to utilize the most cost effective laboratory strategy and the addition of contingency samples to enable the Navy to potentially complete the survey in one phase.

Response: The Navy has evaluated the detection limit capabilities of fixed laboratories versus mobile laboratories in accordance with our discussions on July 23, 2003. In addition, the Navy has evaluated the cost and benefits associated with rush turnaround time analytical testing of soil gas samples. The Navy has identified a limited number of mobile laboratories capable of achieving a detection limit of 50µg/m³.

However, the Navy is concerned with the accuracy of the analytical method used by the mobile laboratory (EPA 8260B-modified). Section 7.3.2 of EPA SW-846 Method 8260B specifically states the following “Set up the sample introduction system as indicated in the method of choice (Section 7.1). A different calibration is necessary for each method because of the difference in conditions and equipment.” This statement implies that the calibration and sample introduction techniques must be identical. The mobile laboratory modification of this method is that the standards are introduced to the system in liquid form while the samples are introduced in vapor form. In order to meet the detection limits required, a relatively large volume of vapor must be injected into the system. The possibility exists that this large volume could overwhelm the injection port causing sample to be inadvertently swept out of the injection port through the split valve, effectively diluting the sample. Successful completion of vapor-based performance evaluation sample will allow verification that this is not occurring.

RESPONSES TO AGENCY COMMENTS (Continued)
DRAFT ADDENDUM SAMPLING AND ANALYSIS PLAN (FIELD SAMPLING PLAN AND
QUALITY ASSURANCE PROJECT PLAN) SOIL GAS INVESTIGATION AT
SWMU SITES 1, 2, 5, 7, AND 18 AN ADDENDUM TO THE DRAFT FINAL FIELD SAMPLING
PLAN AND QUALITY ASSURANCE PROJECT PLAN REMEDIAL INVESTIGATION OF
GROUNDWATER AT SWMU SITES 1, 2, 5, 7, AND 18
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD
October 7, 2003

To ensure that the mobile laboratory is capable of producing accurate and precise data, the mobile laboratory selected for this project will be required to demonstrate the successful analysis of a calibration check sample. This calibration check sample will consist of a whole air sample containing the target chemicals at a concentration between 50 and 150 $\mu\text{g}/\text{m}^3$ (the PRRL). The mobile laboratory must demonstrate the ability to identify all target analytes and to report concentrations within a range of 75 – 125 percent of the true concentration. Along with documentation demonstrating successful completion of the calibration check sample, a QA/QC package containing at a minimum an SOP (that includes routine calibration verification using the whole air standard), analyst training documentation, and certifications will be submitted prior to selection. Once the laboratory is selected, a field audit will be performed prior to sample analysis. Analysis of field samples is dependant upon successful completion of this field audit.

The Navy will use all means necessary to identify a mobile laboratory capable of meeting the above specified QA/QC criteria. If an acceptable mobile laboratory is not identified, then all samples will be collected in SUMMA canisters and analyzed for low-level analysis by the fixed laboratory. The regulatory agencies will be notified of this decision well in advance of mobilization.

EPA Comment 3

U.S. EPA appreciates the Navy providing a copy of the “Certificate of Closure for Used Oil Underground Storage Tank (UST) at Building 1A-12”, dated March 21, 1995. The certificate and attachments (including “RCRA Closure Report Used Oil Storage Tank 1A-12 Naval Weapons Station Concord”) provide important information on a possible source of groundwater contamination at SWMU 5. Based upon U.S. EPA review of the UST report, the following findings should be of interest to the Navy:

- a. The waste-oil UST at Building 1A-12 removed in 1994, appears to have had a release that was associated with the piping. The release resulted in the excavation and disposal of a total of approximately 75 cubic yards of soil that had some total petroleum hydrocarbon (TPH) contamination.**
- b. Due to electrical utilities, the Navy could not completely excavate all TPH impacted soils. There is some low level residual TPH impacted soil at a 21,000 volt-power pole (next to the compressor pad) (see Figures 3 and 4 in RCRA Closure Report).**

RESPONSES TO AGENCY COMMENTS (Continued)
DRAFT ADDENDUM SAMPLING AND ANALYSIS PLAN (FIELD SAMPLING PLAN AND
QUALITY ASSURANCE PROJECT PLAN) SOIL GAS INVESTIGATION AT
SWMU SITES 1, 2, 5, 7, AND 18 AN ADDENDUM TO THE DRAFT FINAL FIELD SAMPLING
PLAN AND QUALITY ASSURANCE PROJECT PLAN REMEDIAL INVESTIGATION OF
GROUNDWATER AT SWMU SITES 1, 2, 5, 7, AND 18
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD
October 7, 2003

- c. Examination of the analytical information for volatile organic compound (VOC) samples indicate that the detection limits are somewhat elevated (between 100-500 µg/kg or parts per billion) and samples were analyzed near the end of the fourteen day holding limit. As a result of the higher detection limits and length of the sample holding times, some VOC may have been presented in soils but were not detected.
- d. Given the above findings, U.S. EPA recommends that the proposed northern soil gas point at UST 1A-12 be located as close to the 21-KV power pole as possible. Also, the Navy should describe the extent appurtenant piping was associated with this tank site; depending on the extent of appurtenant piping, the Navy may need to consider additional sampling points.

Response: Figure 1 has been updated with an additional sampling point near UST 1A-12/21-KV power pole.

EPA Comment 4 **Revise Figure 1, Proposed Soil Gas Sampling Locations:** Please assign soil gas sample numbers to the figure.

Response: Figure 1 has been revised to include sample identification numbers.

EPA Comment 5 In reviewing the revised Figure 1, U.S. EPA notes a potential spatial gap in the sampling points at two locations. Both are in the areas between Buildings 1A-12 and 1A-38. One point should be considered approximately 40 feet due south of soil boring SB024 and the second point approximately 40 feet due south of the UST at 1A-12. These two additional sampling points are illustrated on the revised Figure 1 (see Enclosure B).

Response: Figure 1 has been revised to include the two additional sampling points.

EPA Comment 6 **Table 3, Comparison of Project-Required Reporting Limits and Screening Criteria, Volatile Organic Compound Analysis, Method TO-15:** U.S. EPA has provisional values for trichloroethylene (TCE) that is more health protective than the State toxicity value. Even though not finalized, we recommend that you use “Draft Guidance for Evaluating Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils” (November 2003) to evaluate levels of concern in soil gas (this guidance can be found at: <http://www.epa.gov/correctiveaction/eis/vapor.htm>).

RESPONSES TO AGENCY COMMENTS (Continued)
DRAFT ADDENDUM SAMPLING AND ANALYSIS PLAN (FIELD SAMPLING PLAN AND QUALITY ASSURANCE PROJECT PLAN) SOIL GAS INVESTIGATION AT SWMU SITES 1, 2, 5, 7, AND 18 AN ADDENDUM TO THE DRAFT FINAL FIELD SAMPLING PLAN AND QUALITY ASSURANCE PROJECT PLAN REMEDIAL INVESTIGATION OF GROUNDWATER AT SWMU SITES 1, 2, 5, 7, AND 18
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD
October 7, 2003

Response: Table 3 has been updated to reflect the values presented in Table 2c “Question 4 Generic Screening Levels and Summary Sheet, Risk = 1×10^{-6} ” from “Draft Guidance for Evaluating Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils.”

COMMENTS BY THE RWQCB ON THE DRAFT SWMUs SAMPLING PLAN ADDENDUM

The RWQCB comments were presented in their letter dated July 30, 2003.

A. General Comments:

RWQCB Comment 1 **The Navy needs to integrate PID (Photoionization Detector) readings for TPH (Total Petroleum Hydrocarbons) into the sampling plan. In the event PID values are above screening concentrations, Board Staff recommends the Navy to sample for TPH (C₆ – C₃₀), MTBE (Methyl Tert. Butyl Ether), lead and BTEX (Benzene, Toluene, Ethylbenzene, Xylene) in soils and groundwater when applicable.**

Response: PID readings are normally collected during environmental field investigations to determine the concentration of organic vapors in the breathing zone of field workers for compliance field health and safety plans. In addition to health and safety related readings, PIDs are also often used to measuring organic vapors coming from soil samples and monitoring wells. Although PIDs are frequently used for this purpose, the results are highly variable because there is no standard method for obtaining readings. The concentration of vapors is highly dependent on ambient conditions as well as on the concentration of contaminants in the media being tested. Because PID readings of contaminated media are highly variable and dependent upon the methods and conditions under which they are read, there are and no standard screening levels available for comparison.

RWQCB Comment 2 **It is essential that the Navy assess the results of the site assessment workplan focused on IA-17. Board Staff has recommended in a letter to the Navy dated January 21st 2003 to include chlorinated VOCs (Volatile Organic Carbons) (for both soil and groundwater) into the proposed sampling and analysis plan. The proposed assessment will enable an improved site characterization model.**

RESPONSES TO AGENCY COMMENTS (Continued)
DRAFT ADDENDUM SAMPLING AND ANALYSIS PLAN (FIELD SAMPLING PLAN AND QUALITY ASSURANCE PROJECT PLAN) SOIL GAS INVESTIGATION AT SWMU SITES 1, 2, 5, 7, AND 18 AN ADDENDUM TO THE DRAFT FINAL FIELD SAMPLING PLAN AND QUALITY ASSURANCE PROJECT PLAN REMEDIAL INVESTIGATION OF GROUNDWATER AT SWMU SITES 1, 2, 5, 7, AND 18
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD
October 7, 2003

Response: The Navy has received the results of the Investigation Area (IA)-17 site assessment and considered these results during the preparation of the draft final soil gas SAP.

**RWQCB
Comment 3** **The Navy needs to recognize that a DNAPL (Dense Non Aqueous Phase Liquid) source might have remained undetected in the aquifer(s) found below the site. Except for vinyl chloride, PCE and its degradation products are denser than water. There is a possibility that this DNAPL plume acts as a source to vadoze zone soil gas via a groundwater degassing pathway. It seems rather unlikely that a sole chlorinated solvents vadoze zone source would be actively contaminating groundwater following years of anthropogenic inactivity at the site. To better address this hypothesis, the Navy needs to show how the proposed sampling datapoints relates to the collected site's hydrogeological parameters (hydraulic conductivity, stratigraphy). To that purpose, the Navy could map the results (hydraulic conductivity, groundwater velocities) of the aquifer slug testing. Finally, a stratigraphic cross section spanning Building IA-12 through SB-012 needs to be provided to regulatory agencies for review.**

Response: The concentration of VOCs in soil and shallow groundwater at the site does not suggest the potential presence of dense nonaqueous-phase liquid (DNAPL). Please refer to Table 5 of EPA's Quick Reference Fact Sheet entitled "Estimating Potential for Occurrence of DNAPL at Superfund Sites (Office of Solid Waste and Emergency Response Publication 9355.4-07FS)." Site conditions in the vicinity of MW-10, where the highest concentrations of VOCs were detected, do not meet either condition 1 or condition 2 in Table 5 (condition 1: Concentration of DNAPL-related chemicals in groundwater are greater than 1 percent of pure phase volatility, and condition 2: Concentration of DNAPL-related chemicals in soil are greater than 10,000 milligrams per kilogram). If DNAPL had migrated through the aquifer, residual DNAPL and high concentrations of dissolved chlorinated solvents would be present in the upper portion of the aquifer. Because these conditions are not present, the Navy concludes that the potential for DNAPL to be present at the site is extremely low.

The RWQCB previously requested additional cross sections through the area during their review of the draft remedial investigation. The draft final remedial investigation will be revised to contain the requested cross sections.

RESPONSES TO AGENCY COMMENTS (Continued)
DRAFT ADDENDUM SAMPLING AND ANALYSIS PLAN (FIELD SAMPLING PLAN AND
QUALITY ASSURANCE PROJECT PLAN) SOIL GAS INVESTIGATION AT
SWMU SITES 1, 2, 5, 7, AND 18 AN ADDENDUM TO THE DRAFT FINAL FIELD SAMPLING
PLAN AND QUALITY ASSURANCE PROJECT PLAN REMEDIAL INVESTIGATION OF
GROUNDWATER AT SWMU SITES 1, 2, 5, 7, AND 18
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD
October 7, 2003

**RWQCB
Comment 4** **The Navy needs to provide a rationale why the soil gas characterization is focused solely in the vicinity of the SWMU 5 area. Groundwater VOCs detections above MCL (Maximum Contaminant Level) were found in the following monitoring wells located away from SWMU 5: MW-2, 3, and 11. Board Staff recommends including these areas in the soil gas characterization plan.**

Response: The area is being investigated at the request of the agencies to evaluate potential sources that have not yet been discovered. The highest concentrations of VOCs are present in the vicinity of MW-10. No other potentially significant source areas or rationale for additional investigation has been identified.

**RWQCB
Comment 5** **The Navy needs to improve document sections reporting detection limits that will be applied during fieldwork. Board Staff is attaching to this letter an updated version of soil gas and indoor air screening levels concentrations. It is recommended that the Navy apply the most stringent detection limit for soil gas determination. For example, the PCE environmental screening level is 0.41 µg/m³ for indoor air in a residential use setting.**

Response: The Navy and regulatory agencies agreed in a conference call on September 15, 2003 to the use of a screening goal of 50µg/m³ for the sample analyzed by the mobile laboratory. The Navy intends to apply the most stringent detection limits available using summa canisters and EPA Method TO-15 for confirmation sample analysis. Although the laboratory test method detection limits slightly exceed the screening concentrations, detected concentrations are measurable below detection limits (with a J qualifier). Because the detection limits nearly equal the screening levels, the Navy does not propose the use of any special analytical techniques to achieve detection limits equal to or lower than the RWQCB proposed screening levels.

**RWQCB
Comment 6** **The Navy needs to complement the report with a presentation of the phase approach recommended by the regulatory agencies during our 7/23/03 meeting. The Navy needs to outline the rational why specific soil gas samples will be taken at multiple depths. Finally, the Navy needs to outline how an assessment of impacts to indoor air will be triggered using promulgated regulatory criteria.**

Response: Figure 1 presents the proposed locations of the first phase of sampling. Based on the mobile laboratory results of this initial phase, the Navy and regulatory agencies will decide whether additional or step out sampling is necessary and will determine the locations of proposed additional or step out sampling points.

RESPONSES TO AGENCY COMMENTS (Continued)
DRAFT ADDENDUM SAMPLING AND ANALYSIS PLAN (FIELD SAMPLING PLAN AND QUALITY ASSURANCE PROJECT PLAN) SOIL GAS INVESTIGATION AT SWMU SITES 1, 2, 5, 7, AND 18 AN ADDENDUM TO THE DRAFT FINAL FIELD SAMPLING PLAN AND QUALITY ASSURANCE PROJECT PLAN REMEDIAL INVESTIGATION OF GROUNDWATER AT SWMU SITES 1, 2, 5, 7, AND 18
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD
October 7, 2003

Multiple depth sampling is being conducted at the request of the EPA to evaluate soil gas at deeper depths. Impacts to indoor air will be assessed using risk assessment methodologies.

**RWQCB
Comment 7**

The Navy needs to define the land use scenario, groundwater potability, screening depths, to be applied at the site. This step is crucial in defining the regulatory criterions that will screen against the concentrations found at the site. Board Staff is attaching to this correspondence a set of tables outlining the recommended environmental screening levels for this site.

Response:

Land use, groundwater potability, well screen intervals, and regulatory drinking water criteria are all addressed in the draft RI. Following the completion of the draft final RI, soil vapor VOC concentrations will be addressed.

**RWQCB
Comment 8**

To improve our understanding of natural attenuation processes occurring in the vadoze zone, Board Staff recommends sampling the following in-situ parameters: oxygen/ CO₂/ ethene concentrations, ORP (Oxygen Reduction Potential). In order to further assess natural attenuation processes in the vadoze zone, the Navy needs to sample the daughter products generated by the biodegradation of PCE (Tetrachloroethene). These daughter products are: TCE (Trichloroethene), Cis/ Trans DCE (Dichloroethene) and vinyl chloride.

Response:

Natural attenuation parameters have already been analyzed and reported in the draft RI at the request of the RWQCB. All samples previously analyzed for VOCs have included analysis for daughter products of PCE (including TCE, dichloroethene, and vinyl chloride).

**RWQCB
Comment 9**

It is essential to Board Staff, the Navy indicates why (1,1,1,2 and 1,1,2,2) Tetrachloroethane (TCA) and 1, 4 dioxane concentrations will not be reported during this soil gas characterization effort. 1, 4 dioxane is known to be have been used as a solvent stabilizer and has been linked to TCA contaminated environments.

Response:

1,1,1,2- and 1,1,2,2-TCA as well as 1,4-dioxane will be included in the analyte list for EPA Method TO-15. Because the mobile can not reliably quantitate 1,4-dioxane, it will not be included in the analyte list for the mobile laboratory. Table 3 will be updated accordingly.

RESPONSES TO AGENCY COMMENTS (Continued)
DRAFT ADDENDUM SAMPLING AND ANALYSIS PLAN (FIELD SAMPLING PLAN AND
QUALITY ASSURANCE PROJECT PLAN) SOIL GAS INVESTIGATION AT
SWMU SITES 1, 2, 5, 7, AND 18 AN ADDENDUM TO THE DRAFT FINAL FIELD SAMPLING
PLAN AND QUALITY ASSURANCE PROJECT PLAN REMEDIAL INVESTIGATION OF
GROUNDWATER AT SWMU SITES 1, 2, 5, 7, AND 18
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD
October 7, 2003

B. Specific Comments:

RWQCB Comment 1 **Section 1.2.2.2, Groundwater Sample Results, p 3: The Navy needs to outline how sample turbidity will be minimized in the event that groundwater samples are taken. In this section the Navy needs to also acknowledge PCE detections above MCLs made in monitoring wells 2, 3, and 11 into their site model.**

Response: Consistent with agency comments received following the review of the draft RI, additional groundwater sampling is not proposed at this time. In the future, when groundwater samples are collected, turbidity will be minimized in accordance with the SAP associated with the proposed sampling.

RWQCB Comment 2 **Section 2.2.1, Sampling Process Design, p 6: The Navy needs to reassess their proposed project required reporting limits (PRRL) against the attached environmental screening levels. These tables are also available electronically at: <http://www.swrcb.ca.gov/rwqcb2/esl.htm>. For example the PRRL for TCE in a residential scenario is 1.2 µg/ m³ instead of the tabulated (Table 3 Comparison of Project-Required Reporting Limits and Screening Criteria).**

Response: See response to RWQCB General Comment 5.

RWQCB Comment 3 **Section 2.2.3, Collection and Handling of Soil Gas Samples, p 7: The Navy needs to outline how multiple depths sampling points will be set up. Furthermore, the closure post sampling of these probing locations is missing from this section.**

Response: Section 2.2.3 has been updated to include text describing how two borings located adjacent to each other will be required to allow for collection of samples at two depths. Procedures for closure post sampling are described in [Appendix B](#), Tetra Tech EM Inc. Standard Operating Procedure 054.

RESPONSES TO AGENCY COMMENTS (Continued)
DRAFT ADDENDUM SAMPLING AND ANALYSIS PLAN (FIELD SAMPLING PLAN AND
QUALITY ASSURANCE PROJECT PLAN) SOIL GAS INVESTIGATION AT
SWMU SITES 1, 2, 5, 7, AND 18 AN ADDENDUM TO THE DRAFT FINAL FIELD SAMPLING
PLAN AND QUALITY ASSURANCE PROJECT PLAN REMEDIAL INVESTIGATION OF
GROUNDWATER AT SWMU SITES 1, 2, 5, 7, AND 18
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD
October 7, 2003

C. Editorial Comments:

**RWQCB
Comment 1** **Figure 1, Proposed Soil Gas Sampling Locations: This figure needs to be updated with the new soil gas sampling locations discussed on the technical meeting held on 7/23/03 in San Francisco. Furthermore, the Navy needs to erase datapoint SB036 as no VOCs (Volatile Organic Carbon) were associated with this point. The SB012 datapoint should be color coded red. All monitoring wells found at the site should be outlined on this map. The SWMU unit sites need to be comprehensively indicated on the figure. The Underground Storage tanks locations in the proximity of all the SWMUs should be indicated by a different color code on all the figures.**

Response: Figure 1 has been updated as requested.

**RWQCB
Comment 2** **The Navy needs to provide a utility map indicating the locations of sewer/ stormwater lines, utility corridors, petroleum pipeline, clarifiers, oil/water separators, buildings functions and UST locations.**

Response: A utility map was reviewed with agency personnel during the July 23, 2003, meeting, and the Navy received requests during that meeting that the utility map be updated to indicate the location of the oil water separator and other sewer connections at the site. A revised utility map has been prepared and will be included in the draft final RI.

APPENDIX B
STANDARD OPERATING PROCEDURES

SOP APPROVAL FORM

TETRA TECH EM INC.
ENVIRONMENTAL STANDARD OPERATING PROCEDURE

USING THE GEOPROBE SYSTEM

SOP NO. 054

REVISION NO. 1

Last Reviewed: December 1999



Quality Assurance Approved

March 28, 1994

Date

1.0 BACKGROUND

This standard operating procedure (SOP) details all procedures for using the Geoprobe System, a hydraulically operated sampling probe, and its specialized sampling tools. The procedures described within this SOP include soil gas sampling, groundwater sampling, and soil sampling procedures as well as procedures for installing piezometers and vapor sampling implants. This SOP also describes general procedures for rod removal, backfilling, and decontamination which are common elements to all sampling procedures. This SOP No. 054 replaces former draft SOP No. 054 (Geoprobe Soil Gas Sampling) and draft SOP No. 055 (Geoprobe Groundwater Sampling).

Use of the Geoprobe System is only one of many sampling techniques used by Tetra Tech EM Inc. (Tetra Tech); however, it is a preferred sampling method when certain conditions prevail. Specifically, Geoprobe sampling should be considered when sampling is limited to relatively shallow depths and any of the following are factors: (1) costs must be kept very low, (2) the time period is short to perform the sampling, (3) maneuverability is important, and (4) the required sampling volume is limited.

Prior to the use of the Geoprobe equipment, all buried utility lines and other underground structures must be marked because this equipment can penetrate buried piping and tanks. A diagram of the Geoprobe system is shown in Figure 1.

1.1 PURPOSE

The purpose of SOP No. 054 is to establish positioning, preparing, and sampling procedures; piezometer and vapor sampling implant installation procedures; rod removal procedures; backfilling procedures; and decontamination procedures to guide field personnel.

1.2 SCOPE

The procedures outlined in SOP No. 054 are applicable to all Tetra Tech personnel involved in soil gas, soil, or groundwater sampling using the Geoprobe System or any of its specialized equipment. It also is applicable to all personnel using the Geoprobe System to install piezometers and vapor sampling implants. This SOP, in fact, applies to all uses of the Geoprobe System.

1.3 DEFINITIONS

Because Geoprobe Systems is a corporation specializing in an innovative sampling process, many of the terms used to describe its equipment are specialized and specific. For this reason, familiarity with hydraulic system, soil sampling, soil gas sampling, and groundwater sampling terms is necessary. These terms are discussed below.

1.3.1 Hydraulic System Terms

The following terms are principally used to discuss the basic operation of the hydraulic punch and its major components. If terms are encountered while using this SOP that are not listed below, check Sections 1.3.2, 1.3.3, and 1.3.4 below.

Hydraulic Punch: The principal part of the Geoprobe System, the hydraulic punch, looks very much like a small mobile drilling rig and is usually attached to a truck or van. The punch's hydraulic system uses the weight of the vehicle for support and a hydraulic system installed in the vehicle to advance sampling tools into the soil (see Figure 1).

Hammer: The hydraulic hammer pounds the rods and accessories into the soil once the hydraulic punch is unable to push it farther (see Figure 1).

Control Panel: The control panel is located near the hydraulic punch and contains the levers that control the movement of the punch (see Figure 2).

Probe Lever: This lever is found on the control panel and causes the hydraulic punch to push the drive rod and accessories into the soil. Overall, this lever controls the vertical movement of the punch (see Figure 2).

Hammer Lever: This lever is found on the control panel and engages the hydraulic hammer when the hammer release valve is moved to its extended position (see Figure 2).

Hammer Release Valve: This lever is found on the front of the hydraulic punch and allows the hammer to work when in its extended position. If the valve is not extended, pushing the hammer lever will not engage the hammer.

Foot Lever: This lever is found on the control panel and lowers the foot of the hydraulic punch so that it rests on the ground to stabilize the punch (see Figure 2).

Extend Lever: This lever is found on the control panel and controls the horizontal movement of the hydraulic punch. The lever extends the punch out of the van or truck. It also enables the hydraulic punch to extend about 2 feet from the rear of the vehicle (see Figure 2).

Fold Lever: This lever is found on the control panel and folds and unfolds the hydraulic punch so that it can be easily moved and stored (see Figure 2). This lever enables the hydraulic punch to move from the horizontal position to the vertical position.

Electrical Control Switch: This switch is found on the control panel and turns on the Geoprobe System's hydraulic system. None of the other levers work until this switch is turned on. It has slow, fast, and off speed positions (see Figure 2).

Vacuum System Panel: The vacuum system panel is located near the right rear of the vehicle and contains the vacuum system controls, the hydraulic oil cooling switch, and the remote ignition (see Figure 2).

Remote Ignition: This device is found on the vacuum system panel and allows one to start the vehicle's engine from near the hydraulic punch instead of walking around the vehicle and climbing into the vehicle's cab (see Figure 2).

Hydraulic Oil Cooling Switch: This switch is found on the vacuum system panel and turns on the auxiliary cooling system for the hydraulic oil (see Figure 2).

Vacuum/Volume (Vac/Vol) Pump Switch: This switch is found on the vacuum system panel and allows pressure to build up in the vacuum tank (see Figure 2).

Vacuum Line Valve: This valve is found on the vacuum system panel and opens and closes the vacuum line (see Figure 2).

Sample Line Gauge: This gauge is found on the vacuum system panel and registers the sample line pressure in inches of mercury (see Figure 2).

Drive Rod: The Geoprobe drive rod (sometimes called a probe rod) is a high-strength-steel, hollow tube with a 1-inch outer diameter. Though the rods come in 1-foot, 2-foot, and 3-foot lengths, the standard length is 3 feet. Each rod is threaded on both ends and has a male end and a female end (see Figure 3).

Drive Cap: This cap is a steel cap screwed onto the male end of the drive rod so that the rod can be pushed or hammered into the soil without damaging its threads. The drive cap is always installed to the top of the drive rod before advancing probe rods or sampling tools (see Figure 3).

Pull Cap: This cap is a steel cap that screws onto the male end of the drive rod and is used to pull the drive rod from the soil once the sample has been collected (see Figure 3).

Anvil: This piece of steel is placed inside the hydraulic punch at the point where the hammer actually makes contact. The anvil transfers the force of the hammer to the drive cap (see Figure 3).

Rotary-Impact Carbide-Tipped Drill Bit: This 18-inch or 24-inch steel drill bit fits directly into the hydraulic punch and is used to drill through concrete or hard asphalt. The bit does not spin with appreciable torque but is driven by the hammer, spinning only slightly to clear itself of debris (see Figure 3).

Chain-Assisted Pull Cap: This modified pull cap is attached to the hydraulic punch with a chain. It is most useful when the drive rod, for one reason or another, is not aligned directly underneath the hydraulic punch. With this cap, the rod can still be pulled using the punch (see Figure 3).

Rod Extractor: This tool threads onto a drive rod and is sent down into the hole made by a drive rod that has broken in the soil. The rod extractor, which looks a little like a drill bit, is then hammered into the broken rod and is used to pull the broken rod from the soil (see Figure 3).

Rod Pull Plate: This steel plate has a hole in its center through which a drive rod can be fitted. It is used to extract drive rods when installing piezometers, soil gas implants, or to expose the screen to groundwater when using a screen point sampler (see Figure 3).

O-Ring: An O-ring is a rubber ring used to seal sections of drive rods or various other Geoprobe tools so that, once together, they are air- and water-tight.

Teflon Tape: This inert, sticky tape can be used to create air-tight seals when pieces of the drive rod or accessories are threaded together. The tape can replace an O-ring.

1.3.2 Soil Sampling Terms

These terms are usually used when discussing soil sampling using the Geoprobe System. Sometimes, though, the terms are used when discussing other sampling techniques. If terms are encountered while using this SOP that are not listed below, check Sections 1.3.1 above and Sections 1.3.3 and 1.3.4 below.

Shelby Tube: This tube is used to collect large samples of cohesive soils. Its greatest disadvantages are that it cannot be used to sample from depths greater than about 10 feet and has no mechanism to stay closed until reaching the proper depth (see Figure 4).

Shelby-Tube-Drive Head: This 2-inch diameter piece of steel attaches to the Shelby tube using hex bolts. The Shelby-tube-drive head consists of two parts: a standard 2-inch Shelby tube drive head and a Geoprobe drive rod adapter. This allows the 2-inch wide Shelby tube to be driven by the hydraulic punch, which is actually designed for 1-inch diameter drive rods (see Figure 4).

Hex Bolts: These are the bolts used to attach a Shelby tube to a drive head (see Figure 4).

Extruder Latch: This device secures the Shelby tube to the extruder rack during the extrusion process that removes the soil from the tube (see Figure 4).

Extruder Piston: This piston is threaded onto a drive rod, and with the help of the hydraulic punch, extrudes the soil sample from the Shelby tube (see Figure 4).

Probe-Drive Systems: This sampling system allows samples to be collected at deeper depths than the Shelby tube system. Each probe-drive sampler remains closed until it reaches the depth desired and then is opened by those operating the punch by removing a stop pin (see Figure 5). The sampler is then pushed through the soil at the desired depth and removed. Three types of probe-drive samplers exist: the standard sampler, the Kansas sampler, and the large bore probe-drive sampler.

Standard Probe-Drive Sampler: This probe-drive sampler has a diameter of 1 inch and lengths of 10 or 24 inches. Its greatest difference from the other probe-drive sampler is that it does not have a removable cutting shoe (see Figure 5).

Stop Pin: This pin stops the point of a probe-drive sampler from retracting into the sampler tube. Once it is removed, the sample can be collected (see Figure 5).

Piston Rod: This rod connects the drive head of a probe-drive sampler to the sampler's point. Once the stop pin is removed, this rod slides through the sampler, allowing the point to retract inside the tube (see Figure 5).

Drive Head: This head is the top of a probe-drive sampler, which allows the piston rod to slide straight up the sample tube after the piston stop has been removed and the drive rod is advanced (see Figure 5).

Cutting Shoe: This portion of the probe-drive sampler cuts through the soil once the point is allowed to retract inside. The Kansas samplers and large-bore sampler have removable cutting shoes (see Figure 5).

Extruder Rack: This device holds soil samplers in place during extrusion. The Shelby tube extruder rack is shown in Figure 4, and the standard probe-drive extruder rack is shown in Figure 5.

Extension Rod: This long, thin, threaded, solid rod is dropped through a drive rod to the probe-drive sampler so that the stop pin can be removed. Often more than one extension rod (an extension rod string) must be put together to reach the stop pin (see Figure 5).

Extension Rod Handle: This small metal handle screws to the top of the extension rod string so that it can be turned easily while being used to remove the stop pin (see Figure 5).

Large-Bore Probe-Drive Sampler: This probe-drive sampler is 1-1/8 inches in diameter and 24 inches long. Its larger width allows for the collection of larger samples. The diameter also allows for acetate or brass liners to be used in sample collection. These liners can make viewing the sample easier and preparing it for analysis simpler.

Kansas Sampler: This specially designed probe-drive sampler has a removable cutting shoe to enable easy extraction of soil and to allow the shoe to be replaced without replacing the complete sampler.

Kansas Stainless Sampler: This sampler has a stainless-steel sampling tube. It works in the same way as the Kansas sampler.

1.3.3 Soil Gas Sampling Terms

The following terms are used principally to discuss soil gas sampling. A few terms, though, are used while discussing groundwater sampling as well. If unfamiliar terms not listed below are encountered while using this SOP, check Sections 1.3.1 and 1.3.2 above and Section 1.3.4 below.

Expendable Point: These points fit into an expendable point holder that has been threaded into the lead drive rod. When the drive rod is pulled back, these points do not move with it, leaving a gap from which soil gas can be collected. The points are ultimately left in the ground (see Figure 6).

Expendable Point Holder: This holder threads into the leading drive rod. It is used for driving expendable points (see Figure 6).

Retractable Point Holder: This holder lifts off its point, leaving a gap so that soil gas can be drawn, but unlike expendable points, the holder does not separate completely and ultimately is retrieved with the lead drive rod (see Figure 6).

Gas Sampling Cap: When using the standard soil gas sampling method, the gas sampling cap replaces the drive cap on top of the drive rod and allows tubing to be connected to the drive rod. A soil gas sample is drawn through the probe rod through this cap and into a sample container (see Figure 6).

Post-Run Tubing (PRT) System: This system collects soil gas drawn directly through a tube instead of through the drive rod itself. The system involves one of two specially designed point holders, each threaded on top so that an adapter that has been attached to the tube can be screwed into it after being advanced down the drive rod string. The two point holders differ in that one uses a retractable point and the other uses an expendable point (see Figure 7).

PRT Expendable Point Holder: This holder is threaded into the leading probe rod and is used for driving expendable points (see Figure 7).

PRT Adapter: The PRT adapter attaches the tubing through which the soil gas is to be drawn to the point holder, which has been driven to the proper sampling depth (see Figure 7).

Polyethylene Tubing: This tubing is the preferred tubing for connecting the PRT system to the sample container. Its stiff nature, however, sometimes makes it difficult to attach to the sample container and a coupler of Tygon tubing is necessary (see Figure 7).

Tygon Tubing: This tubing is the preferred tubing for connecting soil gas sampling containers to the drive rod and vacuum system. It often is also necessary as a coupler sample between the stiff polyethylene tubing used with PRT sampling systems and the sample container.

Glass Bulb: This bulb of glass has valves on each side and a neoprene septum through which gas can be withdrawn. The bulb is used to collect soil gas and can be used as the container in which the gas is taken for analysis (see Figure 8).

Tedlar Bag: This small bag has a valve on it. It is placed in an air-tight chamber, the air in the chamber is evacuated, and the bag fills with soil gas. The bags can then be taken for analysis.

Tedlar Bag Chamber: Tetra Tech uses these modified, air-tight kitchen containers as vacuum chambers. These chambers are modified with nipples on each side, which enable it to be attached to a vacuum pump, to a Tedlar bag, and to the Tygon tubing.

1.3.4 Groundwater Sampling Terms

The following terms are used to discuss groundwater sampling. If unfamiliar terms not listed below are encountered while using this SOP, check Sections 1.3.1, 1.3.2, and 1.3.3 above.

Mill-Slotted Well Point: This 3-foot long tube has 15 mill-cut slots in it, each 2 inches long and 0.020 inches wide. Only the bottom 2 feet of this tube is slotted, and sometimes mill-slotted well points come in two parts: a 2-foot slotted section and a 1-foot unslotted section. The slots allow groundwater to enter (see Figure 9).

Geoprobe Screen Point Sampler: This sampler has a 19-inch screen that encases a perforated stainless-steel sleeve. Once in place, the screen allows the water to enter the tube and prevents coarse sediment from entering the tube (see Figure 9).

Thieving Tube: This tube is used to extract the water from either mill-slotted well points or Geoprobe screen point samplers, Tetra Tech uses polyethylene tubing as thieving tubes. This tubing is lowered into the water, capped on top, and then extracted. The result is much like putting a straw into a glass of water, sealing the straw with a finger and lifting it. This method is used primarily for the collection of groundwater samples to be analyzed for volatile organic compounds. A check valve can also be attached to the thieving tube which seals the bottom and holds the groundwater within the tube.

Check Valve: This stainless steel valve has a small ball which, when attached to a thieving tube, floats to the top of the groundwater table and then sinks, ultimately sealing the thieving tube with groundwater. Oscillating the thieving tube will allow groundwater to rise within the tube for larger retrieval volume.

Well Mini-Bailer: This specially designed bailer drops through the drive rods and into the groundwater in the mill-slotted well point or screen point. A small ball in the bailer floats to the top and then sinks, ultimately sealing the bailer after it fills with about 40 milliliters of groundwater.

1.4 REFERENCES

The following references were used to prepare this SOP:

Driscoll, F.G. 1987. *Groundwater and Wells*. Second Edition. Johnson Division. St. Paul, Minnesota.

Fisher Scientific. 1991. "The Fisher Catalog of Scientific Instruments."

Geoprobe Systems. 1990. "8-M Operations Manual." July 27.

Geoprobe Systems. 1991. "Accessory Tools Catalog."

Geoprobe Systems. 1992. "Equipment and Tools Catalog."

2.0 POSITIONING, PREPARING AND SAMPLING PROCEDURES

The Geoprobe System uses a hydraulic punch that is usually installed in the back of a van or truck to first push and then to hammer its hollow drive rod through soils. Depending on which tools are attached to the end of the drive rod and which sampling equipment is attached to it, the Geoprobe can be used to remove soil, soil gas, or groundwater. It can also be used to drill through cement or concrete and can aid in the installation of piezometer wells and vapor sampling implants. The following sections detail the procedures for positioning the Geoprobe unit, preparing the sampling system, and sampling with the Geoprobe unit.

2.1 POSITIONING THE GEOPROBE UNIT

Before the Geoprobe System can be used, the Geoprobe hydraulic punch and accessories must be properly positioned near the sampling site. The hydraulic punch and other equipment also needs to be prepared. In cases where concrete or other hard surfaces hinder sampling, the Geoprobe must be used to reach soil. This section details methods to perform these activities.

To position and unload the Geoprobe System use the following procedures:

1. Drive the vehicle containing the Geoprobe System to the sampling location and align the center of the rear of the vehicle with the point at which the sample will be taken. The rear bumper should be 1 to 2 feet from the sampling point so that the foot of the hydraulic punch can be extended out over it.
2. Shut off the vehicle.
3. Put it in park.
4. Set the emergency brake before proceeding.
5. One person only should operate the hydraulic punch and the assembly and disassembly of probe rods and accessories. A second person is usually necessary to handle the samples and to decontaminate equipment. All personnel present must wear steel-toed shoes, gloves, and eye protection. When drilling through concrete or using the hydraulic hammer, ear protection is also necessary.
6. Once ready to take the sample, start the engine using the remote ignition located in the right rear of the vehicle. As a safety device, the remote ignition will not work unless the vehicle is in park.
7. Activate the hydraulic system by turning on the electrical control switch. The vehicle's engine must be running for the hydraulic system to work.
8. Slowly extend the Geoprobe out of the vehicle using the extend lever. Always use the slow speed on the hydraulic controls when positioning the hydraulic punch. The punch and mast should be far enough out of the van or truck so that the mast will not strike the roof when it is unfolded.
9. Unfold the hydraulic punch out of the vehicle using the fold lever. Once the punch has been lined up perpendicular to the ground surface, lower the foot of the punch using the foot lever until the vehicle itself is raised about 1 foot on its springs. This stabilizes the vehicle and punch. **Never lift the vehicle completely off the ground using the foot lever.** Doing so destabilizes the vehicle and hydraulic punch and may cause damage to equipment or injury to those nearby. Also, as pressure is placed on the rod, tools, and accessories, the foot of the punch may begin to lift. Do not allow it to lift farther than 6 inches from the ground. Allowing it to lift farther than 6 inches may throw the vehicle off balance and cause the rod to bend or break.

The Geoprobe System is now positioned. If it is necessary to drill through concrete or hard asphalt, use the following procedures:

1. Raise the hydraulic punch using the probe lever and then deactivate the hydraulic system by turning the electrical control switch to off. The hydraulic system should always be turned off when the hydraulic controls are not being used.
2. Place the drill bit into the hydraulic hammer. The bit is not used with a drive rod or anvil.
3. Activate the hammer rotation control knob, which is located on the hydraulic hammer, by turning the knob counter-clockwise. This allows the drill bit to rotate when the hammer lever on the control panel is pressed.
4. Activate the hammer release valve, which is located on the hydraulic hammer, by pulling the lever out and down.
5. To drill through solid surfaces, both the probe and hammer mechanisms of the hydraulic punch must be used. The hammer mechanism drives the drill bit in a percussion fashion and causes it to turn slightly. The probe mechanism allows the hammer and bit to be raised and lowered so that the bit can clear itself of debris. Once ready to begin, turn on the hydraulic system.
6. Fully depress the hammer lever. This lever needs to remain depressed throughout the drilling procedure and keeps the bit pounding and rotating.
7. Put pressure on the bit by pressing the probe lever down. Using this lever, advance the bit in small increments through the concrete or other hard surface. If advanced too quickly, the bit will bind and stop rotating. Should this happen, raise the punch slightly to allow the bit to rotate. If too little pressure is placed on the bit, too little percussion will occur, and drilling will be slow.
8. Continue drilling, in small increments, until soil has been reached. At that time prepare for sampling.

2.2 PREPARING THE SAMPLING SYSTEM

Before the hydraulic punch is used to sample, decisions must be made concerning which type of sample will be taken, whether several samples will be taken at varying depths, and which type of Geoprobe sampling equipment will be used. The following sections discuss preparation procedures for soil sampling, soil gas sampling, and groundwater sampling.

2.2.1 Soil Sampling

The samplers attached to the hydraulic punch for soil sampling come in two forms. The first type is the 2-inch diameter Shelby tube system that is common to other soil sampling methods. The second system

uses various specially designed probe-drive systems that remain completely sealed while being pushed or driven to a particular depth. They then are opened to allow a sample to be collected. The Shelby tube and probe-drive systems are discussed below.

Shelby Tube System

The Shelby tube is a thin-walled steel tube, 2 inches in diameter and 30 inches long, with four mounting holes around its top. It allows large amounts of soil to be sampled at once, but the soil must be relatively cohesive. Because the tube remains open at all times, the tube cannot be driven to great depths and must be removed and replaced after coring 30 inches of soil. Usually, the Shelby tube system is chosen when large amounts of soil are needed at depths no deeper than 10 feet. Rocky or sandy soils are not conducive to this sampling method.

To prepare for sampling using Shelby tubes, use the following procedures:

1. First attach a Shelby tube to the Shelby-tube-drive head by putting the head's hex bolts through the holes in the tube.
2. Next, screw a Geoprobe drive rod adapter into the top of the drive head to allow the 2-inch-wide Shelby tube to be driven by the hydraulic punch and hammer, which are actually made for 1-inch outer diameter drive rods.
3. A drive cap is then screwed onto the top of Geoprobe drive rod adapter. The tube is now ready to be attached to the hydraulic punch.
4. To attach the tube, raise the hydraulic punch using the probe lever and then turn off the Geoprobe hydraulic system.
5. Lift the hammer latch and insert the anvil inside.
6. Place the assembled Shelby tube sampler so that it is aligned under the anvil.

The hydraulic punch is now ready to drive a Shelby tube and collect a sample core. For collecting soil cores at depths of greater than 30 inches, attach sections of probe rod to an assembled Shelby tube sampler and drive the sampler down the same hole using a new Shelby tube for each 30-inch increment in depth.

Probe-Drive Systems

All of the probe-drive systems work in essentially the same way. A sampler is attached to a hollow drive rod, inserted into the hydraulic punch, and punched or hammered into the soil. Once the sampler reaches the depth at which the sample is to be taken, a stop pin in the sampler is removed using an extension rod that has been dropped through the inside of the hollow drive rod. The release of the stop pin allows the point of the sampler to retract inside the sample tube as the sampler is further advanced into the soil. The probe is then punched through the soil where the sample is to be taken. The rod and probe are then pulled to the surface for sample extraction.

Currently, three types of samplers are used in the probe-drive systems: the standard probe-drive sampler, the Kansas sampler, and the large bore probe-drive sampler. Preparation of each is slightly different. Each is discussed separately below.

Standard Probe-Drive Samplers

The standard probe-drive sampler comes in 10- and 24-inch lengths. The proper length is determined by the size of the sample desired. The point of this sampler is connected to a piston rod that will slide through its length. At its top, the piston rod is connected to the drive head, which keeps it centered and holds the piston stop pin, which stops the piston from sliding.

To prepare the standard probe-drive sampler, use the following procedures:

1. Insure that the sampler is assembled and complete, and that the piston stop pin which is reverse threaded is tightly locked so that the sampler point will not slide into the sampling tube.
2. Attach a shortened Geoprobe drive rod to the sampler so that the total length is nearly the standard 3 feet. If the 10-inch sampler is used, a 2-foot drive rod should be attached, and if the 24-inch sampler is used, a 1-foot drive rod should be attached.
3. Screw a drive cap onto the top of the shortened drive rod. The sampler is now ready for attachment to the hydraulic punch.
4. To insert the probe-drive sampler, raise the hydraulic punch using the probe lever, and then turn the hydraulic system off.

5. Lift the hammer latch and insert the anvil inside.
6. Place the assembled standard probe-drive sampler and shortened drive rod directly under the anvil so that the drive cap touches the anvil and the point of the sampler is aimed at the place where the sample is to be taken. The standard probe-drive sampler and the hydraulic punch should both be vertical.

Kansas Samplers

The Kansas sampler is much like the standard probe-drive sampler. However, it has a removable hardened cutting shoe near its point that allows it to penetrate rockier soils and to be easily replaced and decontaminated. Kansas samplers come in two versions: the Kansas Stainless Sampler, which has a stainless-steel tube, and the Kansas Sampler, which has an alloy steel tube.

To prepare a Kansas sampler, use the following procedures:

1. Ensure that the hardened cutting shoe is in place.
2. Assemble and install the Kansas sampler in the same manner as the standard probe-drive sampler (see Procedures 2 through 7 above).

Large Bore Samplers

The large bore sampler, similar to both types of Kansas samplers, has a removable cutting shoe and works in the same manner. It is slightly larger than the Kansas samplers, usually 24 inches long and 1-1/8 inches wide. The larger bore allows for the use of acetate or brass liners. The soil, therefore, can be removed easily by removing the liner. The acetate liner allows for easy visual examination of the core and can be easily sliced away so that the sample can be prepared for the laboratory. The brass liners come in four 6-inch sections that allow for easy separation and packaging of 6-inch soil samples. Some laboratories accept full 6-inch brass liners, allowing the samples to be collected with a very minimal disturbance to the soil matrix.

To prepare a large-bore sampler, use the following procedures:

1. Place the desired liner into the sampler by unscrewing the cutting shoe and sampler drive head from the two ends and then inserting the liner.
2. Assemble the sampler and attach a 12-inch drive rod to the sampler.
3. Screw a drive cap onto the top of the drive rod.
4. Place the assembled sampler and drive rod under the hydraulic punch in the manner detailed in the section above for preparing standard probe-drive samplers (see Procedures 5, 6, and 7 above).

2.2.2 Soil Gas Sampling

Two main methods are used to collect soil gas using the Geoprobe system: the standard method and the PRT system.

To use the standard method, the drive rods are decontaminated and assembled in an air-tight manner as they are punched into the soil. To ensure an air-tight seal, either Teflon tape or an O-ring can be placed on the male threads of the drive rods. The probe rods are driven approximately 6 inches below the area from where the sample is to be taken. The rods are then lifted approximately 6 inches leaving the expendable point and a small opening between the point and the end of the rod behind. A gas sampling cap is then attached to the top of the rod, a vacuum pump removes the necessary volume of gas, and the sample is collected.

To collect soil gas samples using the PRT system, polyethylene tubing attached to a stainless steel adapter is pushed through the drive rod after the rod is in place. The tubing and adapter is then reverse threaded onto the top of the PRT expendable point holder, and the gas is collected through the tubing. This method increases the accuracy of soil gas sampling, eliminates the potential for leaks in the rod, and simplifies probe rod decontamination.

Standard Method

Only decontaminated drive rods can be used with the standard method. Rods should be decontaminated using the procedures in Section 6.0 of this SOP.

To prepare a decontaminated drive rod for soil gas sampling using the standard method, use the following procedures:

1. Screw an expendable point holder into the female end of a 3-foot drive rod. (Note: a retractable point can also be used with this method; however, decontamination requirements almost always preclude its use.)
2. Place an expendable point into this holder.
3. Screw a drive cap onto the male end of the drive rod.
4. Place the rod into the hydraulic punch.
5. Turn on the hydraulic system.
6. Install the anvil within the hydraulic punch's hammer by lifting the hammer latch and inserting it.
7. Place the assembled drive rod directly under the anvil so that the drive cap faces the anvil and the expendable point is aimed at the desired sampling location.
8. Push sampler and hydraulic punch through the soil to gather the sample.

PRT System

Two types of PRT systems are available. The first uses an expendable point holder and expendable point like the standard method. The second uses a retractable point holder that lifts off of the drive-point without actually separating from it. Both systems allow the threading of a PRT adapter and tubing through the drive rod so that the gas can be taken from the depth required without being sucked through the drive rod.

To prepare the drive rod and sampler for PRT soil gas sampling, use the following procedures:

1. Select the desired PRT sampler (either one with an expendable point or one with a retractable point) and ensure that the PRT adapter easily screws into the threads on top of the sampler. This step is necessary to ensure that the adapter will fit easily when it is affixed from above ground.
2. If using the sampler with an expendable point, attach the point.

3. Screw the sampler to the end of a shortened drive rod so that the total length of the sampler is nearly 3 feet.
4. Screw the drive cap to the other end of the drive rod.
5. Attach the drive rod and sampler to the hydraulic punch using the same procedures detailed in the standard method (see Procedures 4, 5, and 6 above).

2.2.3 Groundwater Sampling

The Geoprobe System offers two systems for collecting groundwater, each with several groundwater sampling options. The first method involves the use of a mill-slotted well point. The second method uses a specially designed Geoprobe screen point sampler.

Mill-Slotted Well Points

The mill-slotted well point is a 2- or 3-foot length of hollow steel tubing with 15-millicut slots in it, each 2 inches long and 0.020 inches wide. Once in place, groundwater enters the tube through these slots. To prepare the mill-slotted well point, use the following procedures:

1. Screw a solid drive point into the female end of the sampler.
2. If a 2-foot well point is being used, screw the sampler to a 1-foot length of drive rod.
3. Screw a drive cap to the other end of the well point or 1-foot drive rod.
4. Place the sampler and rod into the hydraulic punch by raising the punch as much as necessary and turn hydraulic system off.
5. Install the anvil within the hydraulic punch's hammer by lifting the hammer latch and inserting it.
6. Place the mill-slotted well point sampler under the anvil with the drive cap near the anvil and the point aimed at the sampling location.

Geoprobe Screen Point Sampler

The Geoprobe screen point sampler has a 19-inch screen encased in a perforated stainless-steel sleeve. The screen remains encased in the sleeve until the screen point sampler reaches the desired depth. The

rod is then pulled back approximately 19 inches, leaving the screen exposed to the formation. Flexible tubing can be pushed through the drive rod and attached to the sampler using the adapters for the PRT soil gas system, enabling groundwater to be removed without touching the drive rod. Decontaminating the drive rod is subsequently easier.

To prepare a Geoprobe screen point sampler, use the following procedures:

1. Close the screen on the sampler.
2. Attach its expendable point.
3. Attach the sampler to a shortened drive rod so that the assembly is nearly 30 inches long.
4. Place the sampler into the hydraulic punch using the methods detailed for mill-slotted well points (see Procedures 4, 5, and 6 above).

2.3 SAMPLING

Sampling procedures for the Geoprobe hydraulic punch are similar for all samplers and sampling media. This section presents general procedures that apply to all samplers and sample types, and specific operating procedures for soil, soil gas, and groundwater.

2.3.1 General Procedures

All control panel switches have a slow and fast position. All switches should initially be set at the slow position when positioning the punch and the sampling tools. In all cases, the hydraulic system should be shut off when not in operation and when adapters and additional drive rods are put into place. The hydraulic punch should be turned off any time it is not actually in operation.

The Geoprobe hydraulic punch is designed with a key safety feature that will shut it off if the controls are released. If the operator senses that something is wrong, he or she must release the controls and stop operating the punch until all is well. At no time should the foot of the punch be allowed to lift higher than 6 inches off the ground because the punch will destabilize and may bend the drive rod or sampling tube.

Also, at no time should part of a human body be placed on top of a drive cap while the cap is near the anvil or under the foot of the hydraulic punch.

Once the assembled sampler or drive rod is under the anvil, both it and the hydraulic punch should be vertical. Positioning the drive rod and sampler is critical in order to drive the rod vertically. Not positioning the sampler or drive rod vertically will result in problems when attaching subsequent drive rods needed to reach the proper depth and with rod retrieval.

To begin probing in soils of normal texture, use the following procedures:

1. Activate the hydraulic punch and push down on the probe lever on the control panel so that the probe slowly lowers itself. Always use the slow control on the first rod or sampler.
2. Continue to press on the probe lever until the rod or sampler is completely forced into the soil. The point of the rod will then be nearly 3 feet into the soil.

Soils and other materials are often too hard for the hydraulic punch's probe mechanism to penetrate.

When this occurs, the hammer on the hydraulic punch should be used in accordance with the following procedures:

1. Ensure that the hammer rotation valve is closed.
2. Use the hydraulic punch to put pressure on the rod, sampler, and soil. When the probe rod refuses to move, the foot of the hydraulic punch will begin lifting off the ground. Never allow the foot to lift more than 6 inches off the ground, but never use the hammer with the foot resting on the ground surface.
3. If the probe foot lifts off the ground, the hydraulic punch may no longer be perpendicular. If this occurs, use the machine's fold lever, which is located on the control panel, to correct the punch's position.
4. Press the hammer lever on the control panel. The rod should now advance. Never use the hammer unless there is downward pressure on the drive cap because doing so may damage the equipment.
5. Stop hammering periodically and check to see if the probe rods can be advanced using the probe mechanism only.

When samples are to be taken at depths of greater than 3 feet, additional drive rods must be added to those already in the ground. Shelby tube soil sampling procedures for adding rods are discussed in Section 2.3.2. For all other sampling methods, use the following procedures to add drive rods:

1. Using the probe lever, raise the hydraulic punch off the portion of the drive rod protruding from the ground.
2. Unscrew the drive cap from the drive rod.
3. If using the standard method of collecting soil gas or other sampling methods that will draw the sample through the length of the entire drive rod, wrap the threads of the drive rod with Teflon tape or push an O-ring over the threads to make the drive rod string air- and water-tight.
4. Screw another drive rod onto the first drive rod protruding from the ground. Tighten the rods together with a pipe wrench.
5. Screw a drive cap onto the top of the new drive rod.
6. Place the hydraulic punch over the new drive rod and push the rod farther into the ground.

As the rod string is pushed farther into the ground, it will sometimes begin to loosen. The rods should remain tight so that the threads are not damaged. Occasionally, stop probing and twist the rod string with a pipe wrench to ensure that all of the joints remain tightly sealed.

2.3.2 Soil Sampling

This section presents procedures used to sample soils using either the Shelby tube sampling method or any of the probe-drive systems. In all cases, sampling tools should never be advanced farther than their length once they are opened because the sampler will overflow. If the sampler overfills, it could be damaged or expand, causing it to fall off the drive head.

Shelby Tube Sampling Procedures

Because the Shelby tube does not remain closed until it reaches the desired sampling depth and because it is not connected to a drive rod but to a Shelby drive head, sampling procedures for Shelby tubes differ greatly from soil sampling with other methods. New drive rods cannot be continuously added. Sampling

at depths of greater than 30 inches requires a step-like procedure. For example, to sample to a depth of 90 inches, three Shelby tubes are needed. The first is advanced from 0 to 30 inches and then removed. The second is pushed through the hole made by the first and advanced to a depth of 60 inches and removed. The third is also pushed through the 60-inch deep hole and advanced from 60 to 90 inches.

Samplers must be ready to change sampling methods if necessary. For example, if soils are not cohesive, they tend to drop out of the Shelby tube as it is pulled from the ground. Also, if the soils are not cohesive, they tend to collapse into the hole left by the initial tube before the second and third tubes can be pushed into place. For this reason, use of the Shelby tube method is impractical at depths of greater than 10 feet. Rocky soils are also difficult to sample with a Shelby tube sampler because they tend to destroy the sampler while it is being driven into the ground.

To sample using the Shelby tube method, use the following procedures:

1. Turn on the hydraulic system and slowly press the Shelby tube into the soil using the probe lever on the control panel.
2. Once the tube has reached the sampling depth or has been extended to nearly its full 30-inch length, stop the hydraulic punch and raise it off the drive cap and Shelby tube drive head.
3. Unscrew the drive cap.
4. Screw on a pull cap.
5. Lower the hydraulic punch and lift the hammer latch. Remove the anvil. Place the latch around the pull cap so that the latch will hold the cap to the hydraulic hammer.
6. Using the probe lever, raise the hydraulic punch to pull the Shelby tube from the ground.

If the desired sampling depth is greater than 30 inches, additional Shelby tubes and probe rods must be used. The tubes are then prepared for probing using the methods presented in Sections 2.2.1 and 2.3.1 above. To advance the Shelby tube deeper, the tubes are pushed through the hole left by the first tube using the method detailed above.

Once a Shelby tube core has been retrieved from a sampling point, it must be extruded from the Shelby tube sampler using the following procedures:

1. Lower the hydraulic punch using the probe lever so that its mast will not strike the top of the van as it is folded.
2. Lift the foot of the hydraulic punch using the foot lever.
3. Slowly and carefully fold the hydraulic punch using the fold lever.
4. Once the punch is horizontal, the Shelby tube extruder bracket can be placed onto the punch's foot. This bracket will hold the Shelby tube in place and allow the punch to push the soil out of the tube.
5. Screw an extruder piston onto a drive rod and a drive cap on the drive rod's other end.
6. Place the drive rod into place under the horizontal drive punch.
7. Place the full Shelby tube into the extruder rack and secure it with the extruder latch.
8. A pan or container should be held at the end of the Shelby tube to collect sample material as it is extruded.
9. The probe lever activates the hydraulic punch and pushes the soil from the Shelby tube.

Tetra Tech's SOPs on packaging and documenting samples, SOPs Nos. 016, 017, 018, and 019, should be used to prepare the sample for analysis.

Probe-Drive System Sampling Procedures

All three types of probe-drive samplers work in essentially the same way. The sampler is advanced to just before the proper sampling depth and then the drive point is released by removing a stop pin using solid extension rods that have been dropped through the hollow drive rod. The point is then pushed back into the body of the sampler as the sampler fills with the soil sample.

In addition to the general procedures listed in the Section 2.3.1, the probe must be stopped at just before the desired sampling depth so that the stop pin can be removed. Pushing the probe too far will require starting over.

To use the probe-drive sampling system to sample soil, use the following procedures:

1. Attach additional drive rods as discussed in the general procedures in Section 2.3.1.
2. Stop the hydraulic probe just before the desired sampling depth.
3. Raise the hydraulic punch, turn off the hydraulic system, and remove the drive cap.
4. Insert an extension rod into the drive rod and screw additional extension rods together until the assembly reaches the same depth as the sampler.
5. Attach a small extension rod handle to the top of the extension rod.
6. Rotate the extension rod handle clockwise until the leading extension rod has turned the stop pin and disengaged it.
7. Pull and unscrew each extension rod from the hollow drive rod. The stop pin should be attached to the bottom of the extension rod string. If not, repeat Procedures 1 through 6.
8. To sample, mark the drive rod with tape or chalk about 10 inches above the ground if a 10-inch sampler is used or 24 inches from the ground if a 24-inch sampler is used.
9. Replace the drive cap and start the hydraulic system.
10. Drive the rod until the tape or chalk mark touches the ground. Be careful not to overdrive the sampler. Doing so could compact the soil in the sampler or cause it to balloon outward, making soil removal and extrusion difficult.
11. Raise the hydraulic punch and replace the drive cap with the pull cap. Remove the anvil.
12. Latch the pull cap underneath the hydraulic hammer latch and pull the rods out of the ground, disassembling the rod as needed.
13. Check to ensure that a soil sample is now in the sampler.

Once a soil sample has been removed from the ground, it can be extruded using the Geoprobe. The tools supplied by Geoprobe Systems for extruding soil from probe-drive samplers do not require the Geoprobe to be folded and horizontal. If liners are used with large-bore samplers, extrusion is usually unnecessary. When extrusion is necessary for probe-drive samplers, use the following procedures:

1. Raise the foot of the hydraulic punch off the ground using the foot lever on the control panel.
2. Attach the extruder rack onto the foot of the punch so that its crossbeam rests on top of it.

3. Completely disassemble the sampler. In all cases, remove the piston, point, and drive head of the sampler. If using the Kansas and large-bore samplers, unscrew the removable cutting shoe as well.
4. Insert the sample tube into the extruder with its cutting end up.
5. Insert a disposable wooden dowel or the reusable steel piston above the soil and below the hydraulic punch so that pressure on the dowel or piston from the punch will push the soil out of the bottom of the sample tube.
6. Position proper sampling jars or trays under the sample tube and very slowly use the probe lever to force the soil out of the tube. Injury can result if the soil is quickly forced from the tube.

The soil sample is now ready for packaging or on-site laboratory analysis. For large-bore samplers, the soil may be contained in a plastic sleeve that can be sliced away once the soil is to be packaged or in a brass sleeve that may be capped on both ends and shipped to the laboratory as is. Tetra Tech's SOPs on packaging and documenting samples for analysis should be followed when collecting samples using the Geoprobe System.

2.3.3 Soil Gas Sampling Procedures

The standard method and the PRT system are used for collecting soil gas using the Geoprobe System. The standard method requires the drive rods to be sealed together with either O-rings or Teflon tape to ensure an air-tight seal so that soil gas from depths other than the bottom of the drive-rod string cannot penetrate the system.

The PRT system draws soil gas through continuous tubing that is dropped through the drive rod after the drive rod has reached the desired level. The tubing is then attached directly to the point holder at the end of the drive-rod string.

For both methods, the drive rod should be driven to the desired depth. The drive cap should be replaced by the drive pull cap, and the rod should be pulled back out of the hole approximately 6 inches. This 6-inch void is the area where the soil gas sample is collected from. A pipe wrench or vise-grip pliers should be attached to the pipe just above the foot of the hydraulic punch so that the wrench or pliers rests on the foot to stop the drive rod from working its way back down into the hole.

Tygon tubing should be replaced between each sample for both sampling methods to avoid cross contamination.

The standard method and the PRT system sampling procedures are presented below. In addition, procedures for collecting soil gas in Tedlar bags, glass bulbs, and adsorption tubes is also presented below.

Standard Method

To gather a sample using the standard method, raise the hydraulic punch as mentioned above and replace the drive cap with a gas sampling cap. This cap is designed to fit the drive rods and is used to connect them by tube to a vacuum supply. Once the tubing has connected the gas sampling cap to the vacuum supply, remove the volume of air necessary to ensure that none of the gas being drawn was in the rod during probing, and then collect the sample in either Tedlar bags, glass bulbs, or adsorption tubes as discussed below.

PRT System

To use the PRT system (with either an expendable or a retractable point) to collect soil gas samples use the following procedures:

1. Secure the PRT adapter to the end of a piece of polyethylene tubing 1 to 2 feet longer than the total length of the drive-rod string. The adapter must fit tightly within the tubing. If it does not, tape it into place. Also, ensure that the O-ring is in place on the threaded end of the adapter.
2. Remove the drive cap from the probing rod and lower the adapter into it, holding on to the tubing.
3. Grasp the excess tubing and apply downward pressure. Turn the tubing counter-clockwise to engage the adapter threads on the sampler holder.
4. Pull up lightly on the tubing to test engagement of threads. If the adapter has not engaged, try again. If it repeatedly does not engage, soil may have intruded into the drive rod either during probing or, in the case of the retractable point, when the rod was pulled back to leave the point opening. Use the threaded extrusion rods to clean out the threads.

5. In most cases, the adapter will easily screw into place. The sampler is now ready to collect samples in either Tedlar bags, glass bulbs, or adsorption tubes using the procedures presented below. After the sample is collected and the sampler and tube is removed from the ground, the O-ring should be checked to ensure that a good seal exists between the sampler and adapter. If the O-ring is tightly smashed, the seal should be good.
6. Discard polyethylene tubing and use new polyethylene tubing for each sample.

Tedlar Bags

Soil gas can be collected for chemical analysis in a 500-cubic-centimeter Tedlar gas sampling bag by inducing a vacuum on the exterior of the bag. The following procedures should be used to collect soil gas samples in Tedlar bags:

1. For the PRT system, connect a short (6- to 12-inch) piece of Tygon tubing to the free end of the polyethylene tubing protruding out of the drive rod. For the standard method, connect the Tygon tubing to the soil gas sampling cap.
2. Attach the other end of the Tygon tubing to one end of the Tedlar bag chamber. Tetra Tech uses modified, plastic, air-tight kitchen containers for these chambers. They are inexpensive and work well.
3. Connect another piece of Tygon tubing 2 feet to 3 feet long to the other end of the Tedlar bag chamber and to the nipple on the bottom of the vacuum system panel.
4. Place the lid on the Tedlar bag chamber.
5. Turn the vacuum/volume (vac/vol) pump switch on and allow pressure to build in the vacuum tank. Make sure that the vacuum line valve is closed before turning on the pump switch.
6. Open the vacuum line valve and purge three times the volume of ambient air out of the Tedlar bag chamber and PRT tubing or probe rods. The equations for determining purge volumes are as follows:

Probe rods or tubing

$$V = \pi r^2 H$$

where

V = Volume

π = 3.14159

r = Radius of tube or rod

H = Length of tube or rod

Vacuum chamber

$$V = LWH$$

where

V = Volume

L = Length of chamber

W = Width of chamber

H = Height of chamber

7. Close the line valve.
8. Clamp the Tygon tubing shut with hemostats.
9. Remove the lid from the Tedlar bag chamber.
10. Connect a Tedlar gas sampling bag to the fitting inside the Tedlar bag chamber and open the valve on the gas sampling bag.
11. Place the lid back on the Tedlar bag chamber, seal it tightly, and remove the hemostats.
12. Turn the vac/vol pump switch on and open the vacuum line valve to create a vacuum in the chamber. The Tedlar bag should fill once the vacuum is created. The rate at which the Tedlar gas sampling bag fills depends on the permeability of the soil. The minimum amount of soil gas needed for analysis is approximately 0.5 liter. If less than 0.5 liter is collected after 4 minutes of sampling, raise the soil gas probe 0.5 foot and continue to evacuate the vacuum chamber for another minute. If the minimum required volume of soil gas is not collected, repeat the procedure. If the minimum required volume of soil gas is still not collected, abandon the collection process. All steps conducted should be accurately recorded in the logbook even if no samples are satisfactorily collected.
13. After the soil gas sample is collected in the Tedlar bag, clamp the Tygon tubing with hemostats.
14. Turn off the vacuum pump.
15. Remove the vacuum chamber lid.
16. Close the valve on the Tedlar gas sampling bag and remove the bag from the chamber. Label the Tedlar bag with the appropriate information.

Glass Bulbs

The following procedures should be used to collect soil gas in glass bulbs:

1. Turn the vac/vol pump switch on and allow pressure to build in the vacuum tank. Make sure that the vacuum line valve is closed before starting the vacuum pump. The inside scale of the vacuum tank gauge is calibrated in inches of mercury. The outside scale is calibrated for volume in liters (at standard temperature and pressure). Obtain the desired vacuum and turn the vacuum pump off.
2. Connect a short (6- to 12-inch) piece of Tygon tubing to the sample cap or PRT protruding from the drive rod.
3. Connect one end of the labeled glass bulb to the Tygon tubing.
4. Connect another piece of Tygon tubing 3 feet to 5 feet long to the other end of the glass bulb and to the nipple on the bottom of the vacuum system panel.
5. Open the two stopcocks on the glass bulb.
6. Turn off the vacuum pump.
7. Turn the vacuum line valve to its open position.
8. Purge three times the volume of ambient air within the rods, bulb, and tubing. Equations for figuring out volumes are presented in the Tedlar bag discussion.
9. Turn the vacuum line valve to its closed position. Allow the pressure in the sample train to equalize (the sample line gauge should read zero).
10. Close the stopcocks on the glass bulb.
11. Remove the glass bulb and label it with the appropriate information.

Adsorption Tubes

The following procedure should be used to collect soil gas in adsorption tubes:

1. Connect a short (6- to 12-inch) piece of Tygon tubing to the sample cap or PRT protruding from the drive rod.
2. Connect this piece of tubing to the nipple on the bottom of the vacuum system panel and purge three volumes of air from the drive rod or PRT system as described in the discussion of the Tedlar bag method.
3. Use hemostats to clamp the Tygon tubing attached to the drive rod or PRT.
4. Insert the adsorption tube between the Tygon tubing from the drive rod or PRT and the Tygon tubing attached to the vacuum system panel.

5. Remove the hemostats and draw the required volume of air through the adsorption tube.
6. Remove the adsorption tube and place the appropriate caps on the tube ends.
7. Clearly label package, and ship the samples as required by the laboratory or Tetra Tech and U.S. Environmental Protection Agency (EPA) SOPs.

Soil Gas Sampling Pointers

If the needle on the vacuum line valve does not move, the soil at the sampling depth may be saturated, pore space may be too tight to yield a sample, or sampling train may be plugged. If the needle moves back to zero very quickly, either the soil at the sampling depth is very permeable or a leak is present in the sampling train.

In some soils, the needle may return to zero very slowly. The time it takes for the needle to return to zero is called the “recovery” time. Recovery time should be noted for each sample taken. This information will allow relative comparison of soil permeability. Recovery times of greater than 10 minutes should be considered suspect. The effect of leakage in the sampling system increases with longer recovery times. After 10 minutes, the operator should consider either changing the sampling depth, location, or length of pullback from the sampling tip, or switching entirely from soil gas sampling to grab sampling and analysis of soil.

2.3.4 Groundwater Sampling

The two options for sampling groundwater using the Geoprobe System follow procedures similar to those presented in Sections 2.3.2 and 2.3.3 above. The sections below detail procedures for using mill-slotted well point samplers and Geoprobe screen point samplers to sample groundwater.

Mill-Slotted Well Point Sampler

Once the mill-slotted well point reaches groundwater, the water will begin to flow through the slots. When the sample is to be analyzed for volatile organic compounds, do not use a vacuum to suck groundwater from the drive rod. If the sample is to be analyzed for other parameters such as metals, semivolatiles, pesticides, or explosives, using a vacuum on the drive rod is acceptable. In all cases,

polyethylene tubing can be used as a thieving rod by lowering its end into the drive rod, capping or sealing the tube's top, and then removing it. The preferred method for collecting samples for volatile organic analysis is to use a well mini-bailer. To collect groundwater samples with a mini-bailer, use the following procedures:

1. Raise the hydraulic punch, turn off the hydraulic system, and remove the drive cap.
2. Lower a well mini-bailer into the drive rod until it reaches the bottom. As it reaches the bottom, the check ball on the bailer's end will float in the groundwater and then slowly sink to the bottom.
3. Allow a couple of seconds for the ball to sink and set.
4. Pull the well mini-bailer out of the drive rod. The bailer should contain about 20 milliliters of groundwater.
5. Package and document the samples in accordance with Tetra Tech SOPs No. 016, 017, 018, and 019, or a similar EPA-approved procedure.

If a bailer is not required and volatile organic samples are not being collected, a foot valve sampler, vacuum trap, or peristaltic pump can be used to collect samples. Once the sample has been removed and packaged, the mill-slotted well point can be removed and decontaminated.

Geoprobe Screen Point Sampler

The Geoprobe screen point sampler contains a screen and screen plug that allows water to enter the rod. To collect groundwater samples with a Geoprobe screen point sampler, use the following procedures:

1. Push the sampler below the depth necessary to reach groundwater.
2. Raise the hydraulic punch and replace the drive cap with a pull cap. Also, remove the anvil.
3. Latch the pull cap under the hammer latch, and use the probe lever to lift the drive rod about 18 inches. Because the sampler has a expendable point, the point should stay at the deepest depth, and the screen and screen connector should fall out of the bottom of the sampler. Sometimes, however, the screen stays within the sampler and is lifted the 18 inches with the drive rod.
4. To ensure that the screen is exposed, attach a vice grip or pipe wrench to the rod above the foot of the hydraulic punch and raise the hydraulic punch. Then remove the pull cap

and place an extension rod through the tubing to push the screen into place. Additional extension rods can be attached to reach the desired depth.

To remove the groundwater sample for volatile organic analysis, with a well mini-bailer, follow steps 1 through 5 under the mill-slotted well point section above. Tubing can be used as a thieving rod with or without a check valve to collect groundwater samples as well. If the sampler is supplied with the optional PRT expendable point holder, then a PRT adapter can be pushed through the drive rod and threaded into place by following the PRT system Procedures previously discussed. A vacuum trap system or peristaltic pump can then be used to withdraw the sample. The PRT system method, however, should never be used when the sample is to be analyzed for volatile organic compounds because it involves using a vacuum to remove the sample.

3.0 PIEZOMETER AND VAPOR SAMPLING IMPLANT INSTALLATION PROCEDURES

The Geoprobe System's ability to quickly probe into soil allows for easy installation of both piezometers and vapor sampling implants. Both installation procedures are discussed below.

3.1 PIEZOMETER INSTALLATION

Piezometers are tubes that extend to groundwater and enable easy sampling of groundwater on a routine basis (see Figure 10). In addition to installing the piezometer, piezometers must be protected from the weather and from contamination. A well-head protector must therefore be installed around them. In some soil types, preparing the well-head protector may be the first step to installing a piezometer. For this reason, the directions below should be read completely before beginning piezometer installation. If a post-hole digger is to be used for well-head protector installation, Procedure 5 should be performed first. The piezometer should then be advanced through this hole.

To install temporary or permanent piezometers, use the following procedures:

1. Use the hydraulic punch to drive the temporary casing to the desired piezometer installation depth. Use the general procedures outlined in Section 2.3.1 above for details on driving the piezometer casing. The different temporary casings that can be used are described below. Geoprobe Systems also manufactures special drive caps, expendable points, and pull caps that fit these types and sizes of pipe.

- a) 1-7/16-inch outside diameter by 1-3/16-inch inside diameter, RW-flush threaded pipe can be used as a temporary casing. This casing can be driven to an approximately 25- to 30-foot depth. Two sizes of piezometer wells can be installed inside of the temporary casing: (1) 3/4-inch outside diameter by 1/2-inch inside diameter, polyvinyl chloride (PVC) pipe, or (2) 1-inch outside diameter by 3/4-inch inside diameter, PVC pipe.
 - b) 1-13/16-inch outside diameter by 1-1/2-inch inside diameter, EW-flush threaded pipe can be used as a temporary casing. This casing can be driven to an approximately 15- to 20-foot depth. Three sizes of piezometer wells can be installed inside of the temporary casing: (1) 3/4-inch outside diameter by 1/2-inch inside diameter PVC pipe, or (2) 1-inch outside diameter by 3/4-inch inside diameter, PVC pipe, or (3) 1-1/2-inch outside diameter by 1-inch inside diameter, PVC pipe.
 - c) 1-1/4-inch outside diameter by 1-inch inside diameter, NPT-threaded pipe can be used as a temporary casing. This casing can be driven to an approximately 25- to 30-foot depth. Only 3/4-inch outside diameter by 1/2-inch inside diameter, PVC pipe piezometer wells can be installed inside of the temporary casing. If using NPT-threaded pipe, couplers are needed to attach each section of pipe.
2. Once the piezometer casing is at the proper depth, remove the drive cap and install the selected size piezometer pipe inside of the temporary casing.
 3. Using a pull plate, remove the temporary casing.
 4. If the hole stays open, attempt to install a sand pack around the slotted portion of the piezometer, and then place dry granular bentonite on top of the sand pack as a seal. One foot of bentonite is recommended for a good seal.
 5. Dig an 8-inch nominal-diameter hole around the piezometer pipe. This hole should extend to a depth of 1.5 to 2 feet. A post-hole digger can be used for this procedure if the hole is dug prior to driving the temporary casing. The bottom 6 inches of this hole should be filled with dry granular or slurry bentonite. The remainder of the hole should be filled with concrete. A steel, locking, aboveground or flush-mount well protector should be inserted into the wet concrete to provide well-head security. A concrete pad can also be constructed around the steel well-head protector.

3.2 VAPOR SAMPLING IMPLANT INSTALLATION

Figure 11 presents diagrams of vapor sampling implants. To install vapor sampling implants, first punch a drive rod to the desired depth using an expendable point holder and an expendable point. Once at the desired sampling depth, use the following procedures:

1. Disengage the expendable point and retract the probe rod about 1 foot by raising the hydraulic punch, replacing the drive cap with a pull cap, removing the anvil, latching the pull cap onto the hydraulic hammer using its latch, and raising the hydraulic punch again using the probe lever.
2. Lock the rod into place so that it does not sink back into the hole by using vice grip pliers or a pipe wrench.
3. Unlatch the pull cap and raise the hydraulic punch again, leaving room to work freely.
4. Remove the pull cap.
5. Attach appropriate stainless-steel tubing to the vapor implant. If tubing is precut, allow 48 inches more than the required depth of the implant.
6. Insert the implant and tubing down the inside diameter of the probe rods until it stops. Note the length of the tubing inserted to ensure that the desired depth has been reached. Allow the excess tubing to extend out of the drive rod's top.
7. Pour glass beads down the inside diameter of the probe rod using a funnel to create a permeable layer around the implant.
8. Use the tubing extending from the drive rod to stir the beads into place. Do not lift up on the tubing while doing so.
9. Position the remaining tubing through the hole on a rod pull plate, and then place the drive rod through that hole.
10. Attach the plate to the hydraulic punch using its chain and slowly pull the rod up another 18 to 24 inches. While the punch pulls the rod, push down on the tubing so that it stays in place.
11. Pour bentonite seal mixture down the inside diameter of the probe rod. Stir the mixture using the tubing as before. The initial mixture may also be topped with distilled water to initiate the bentonite seal depending on the site and on the role the vapor implant is to play.
12. Pull the drive rod from the hole using the probe rod pull plate already attached, and then plug the hole using granular bentonite or a bentonite slurry mixture.

The vapor sampling implant should now be in place and the stainless steel tubing connected to it should be protruding from the ground. The vapor implant tubing should be protected by a well-head protector in the same manner as the top of the piezometer. Procedure 5 in Section 3.1 describes well-head protector installation.

4.0 ROD REMOVAL PROCEDURES

Throughout the above discussions, it has occasionally been necessary to remove drive rods and samplers. The standard removal procedures involve raising the hydraulic punch, turning off the hydraulic system, replacing the drive cap with a pull cap, removing the anvil, and then latching the pull cap under the hammer latch. The hydraulic punch can then be used to pull the rod from the ground.

Two deviations to this procedure often occur. The first deviation is necessary when sampling tubes are to be left inside the hole as the drive rod is removed, especially when soil gas implants or piezometers have been installed. Because of the presence of these sampling tubes, a pull cap cannot be screwed onto the top of the drive rod. Instead, a rod pull plate is used. This plate is a piece of steel with a hole in it large enough for a drive rod to fit through it. The plate has a hook on one end. The tubing and rod are pushed through the plate, and the pull plate is attached to the latch on the hydraulic punch by a chain. As the punch pulls up, the plate shifts, and the inside of the hole binds on the rod. This binding usually holds the rod to the plate and results in the rod being pulled up as the punch is raised.

The second deviation occurs when the rods have not been pushed perpendicular to the ground. In these cases, a specially designed chain-assisted pull cap is used. This cap looks like a pull cap but has a chain on it that fits under the latch of the hammer. Once the cap is screwed to the drive rod and latched to the probe, raising the probe raises the rod.

In a few cases, drive rods break while in the ground. To retrieve these rods, a rod extractor is used. This extractor looks something like a drill bit and is screwed to the end of a probe rod. A hammer is then used to pound the extractor into the top of the broken rod. The extractor joins the broken rod to the second drive rod so that they can be pulled out together.

5.0 BACKFILLING PROCEDURES

Unless otherwise specified in the site-specific sampling plan, holes made by sampling with Geoprobe System tools are to be backfilled with dry, fine, granular bentonite. Water may be added to activate the bentonite. Tops of the holes may then be filled with soil or concrete as necessary for each particular site.

6.0 DECONTAMINATION PROCEDURES

Between holes, the probe rods and sampling tools must be decontaminated. Because no provisions for decontamination are included in the Geoprobe System, a separate decontamination station must be provided. A wire brush, a barrel brush for reaming out the rods, and soft brushes will clean sticky soil from the probe rods and sampling tools. Follow Tetra Tech SOP No. 002 decontamination procedures when sampling soil or groundwater.

When sampling for soil gas by the standard method, Geoprobe rods and samplers are heated approximately 15 to 20 minutes by a 100,000-British thermal unit heater until they are too hot to touch with the bare hand. They are then allowed to cool before reuse. Do not heat the rods too much or the rod metal will fatigue.

When sampling for soil gas by the PRT method, the probe rods do not have to be decontaminated. However, the PRT expendable point holder and PRT adapter do need to be decontaminated. They can be heated on the dash of the vehicle with the defrost system or scrubbed in Alconox and water. Equipment blank samples can be collected, if necessary, as part of the quality control process.

Sampling plans may have different decontamination requirements. Most plans also require rinsate sample collection as part of the quality control process.

FIGURE 1
GEOPROBE SYSTEM

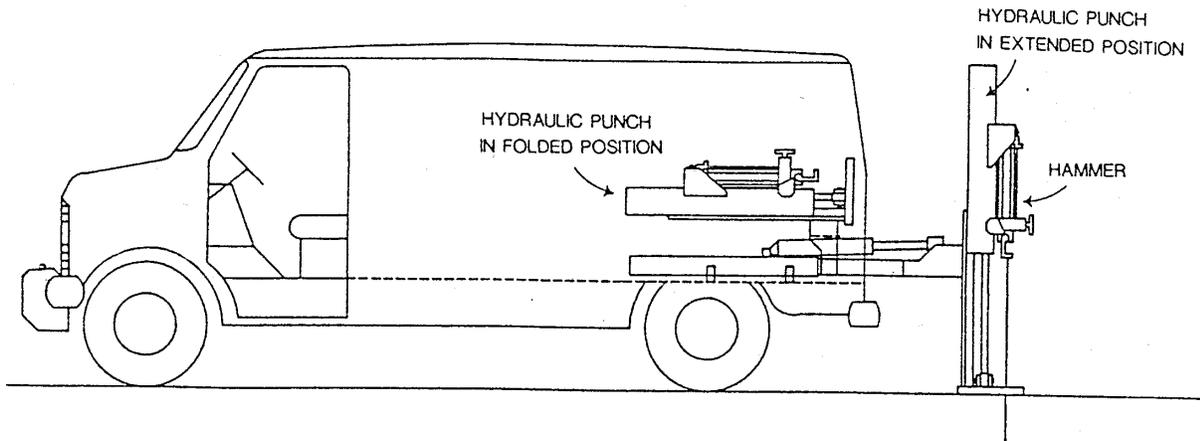
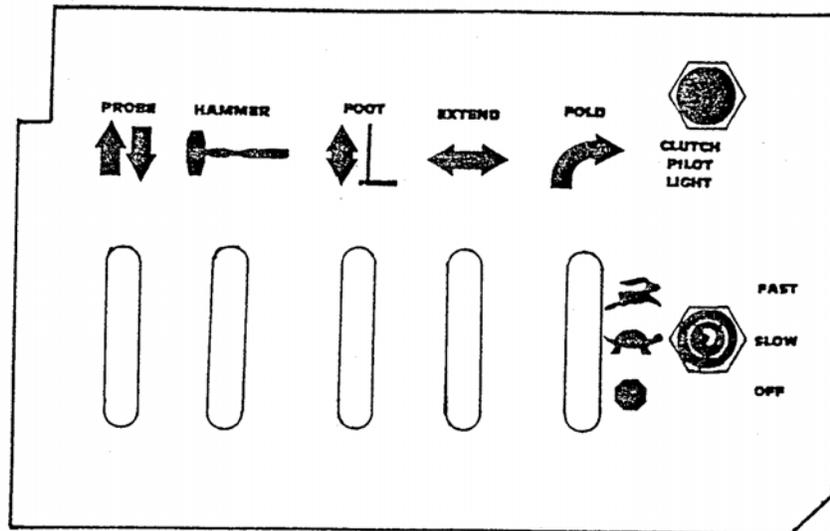
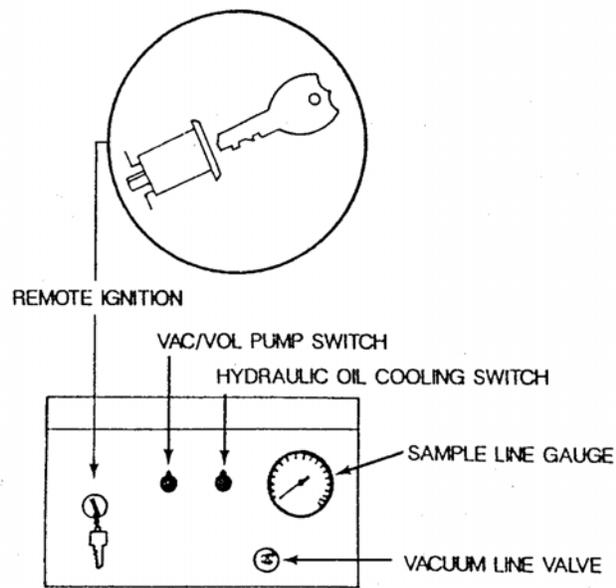


FIGURE 2
CONTROL AND VACUUM SYSTEM PANELS



CONTROL PANEL



VACUUM SYSTEM PANEL

FIGURE 3

GENERAL ACCESSORY TOOLS

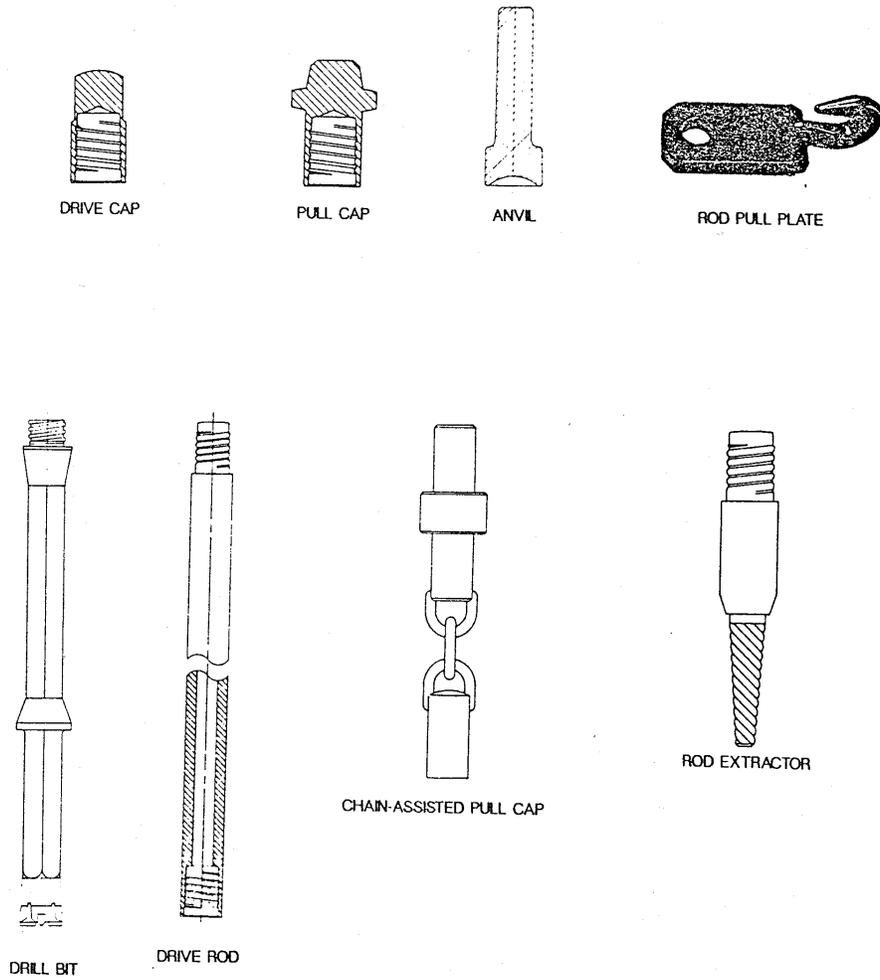


FIGURE 4

SHELBY TUBE ACCESSORIES

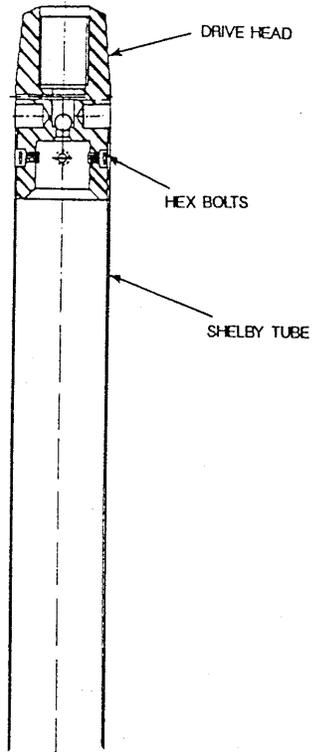
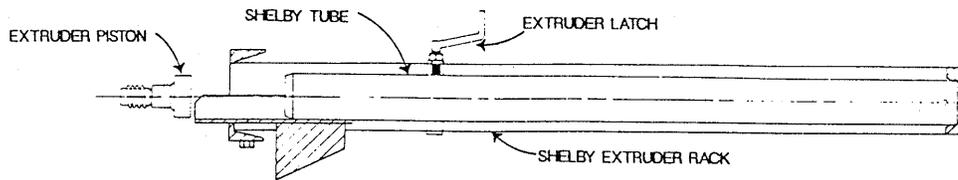


FIGURE 5
PROBE-DRIVE SYSTEM

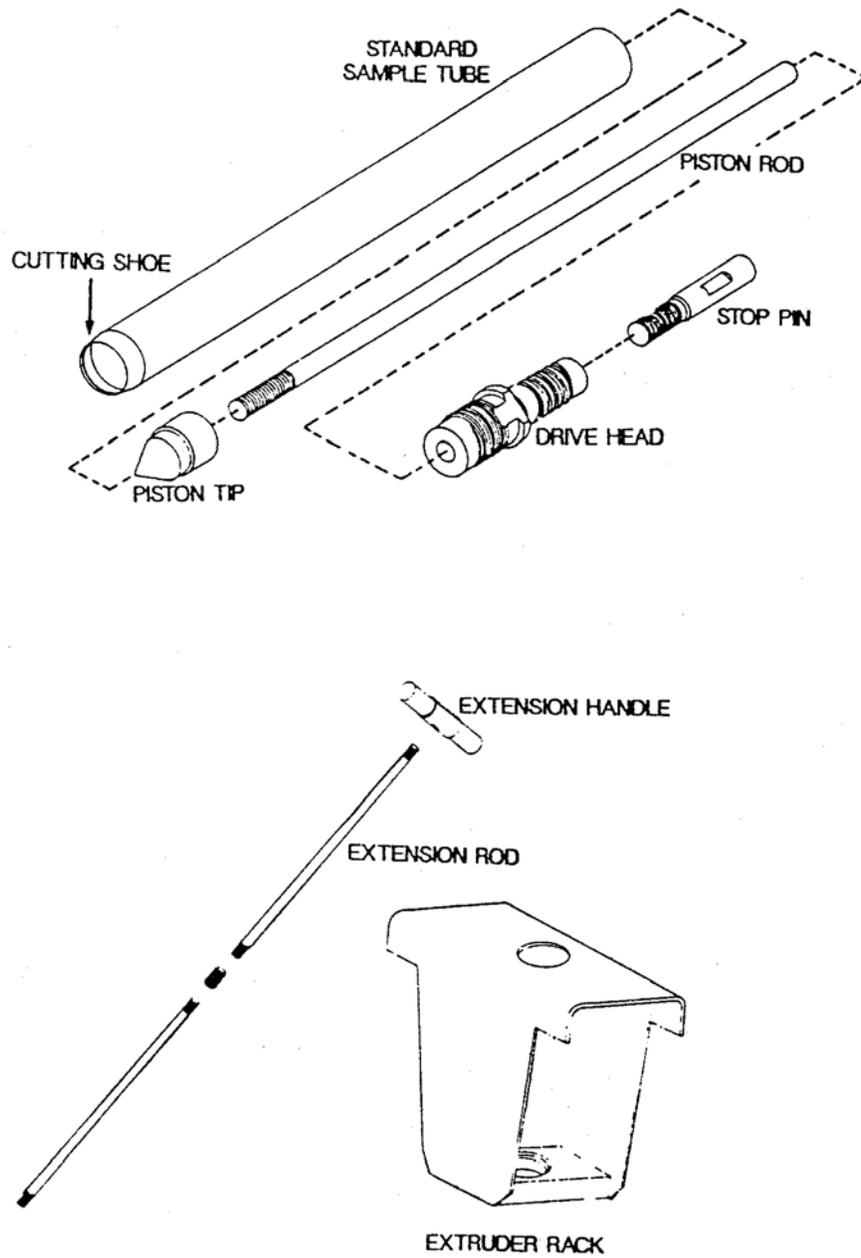
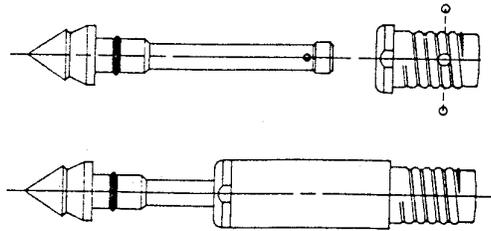
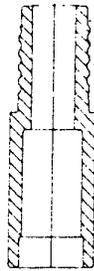


FIGURE 6

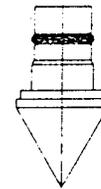
STANDARD SOIL GAS TOOLS



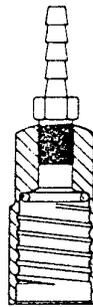
RETRACTABLE POINT HOLDER



EXPENDABLE POINT HOLDER



EXPENDABLE POINT



GAS SAMPLING CAP

FIGURE 7

POST-RUN TUBING (PRT) SYSTEM

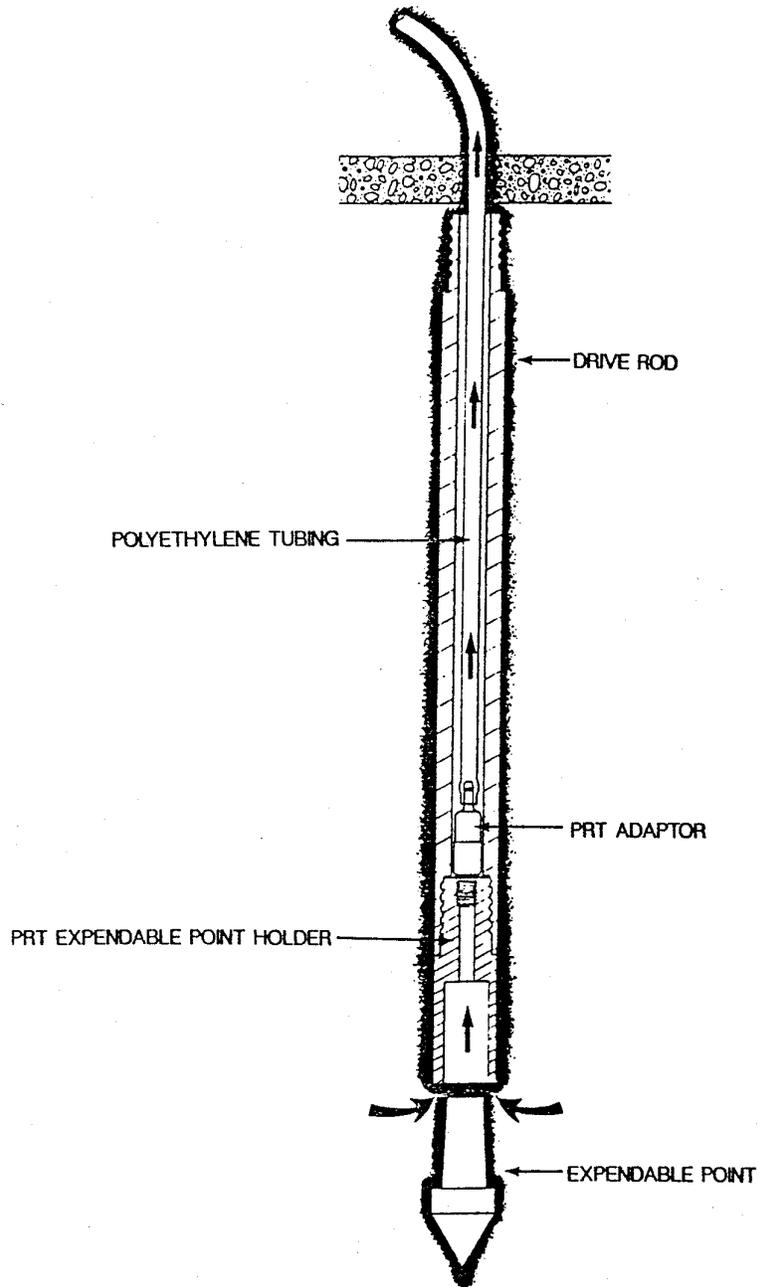
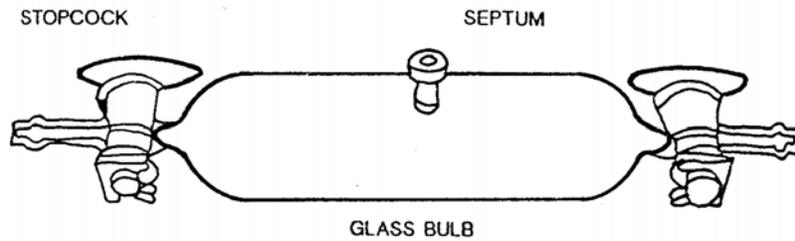


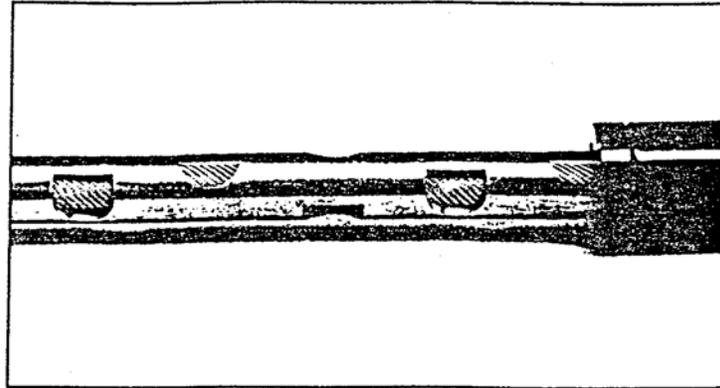
FIGURE 8
SOIL GAS SAMPLE CONTAINER



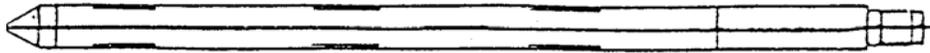
Note: Tedlar bags are also used for collection of soil gas samples; however, they are not shown on this figure.

FIGURE 9

GROUNDWATER SAMPLING TOOLS



SCREEN POINT SAMPLER IN OPEN POSITION



MILL-SLOTTED WELL POINT

FIGURE 10

PIEZOMETER INSTALLATION

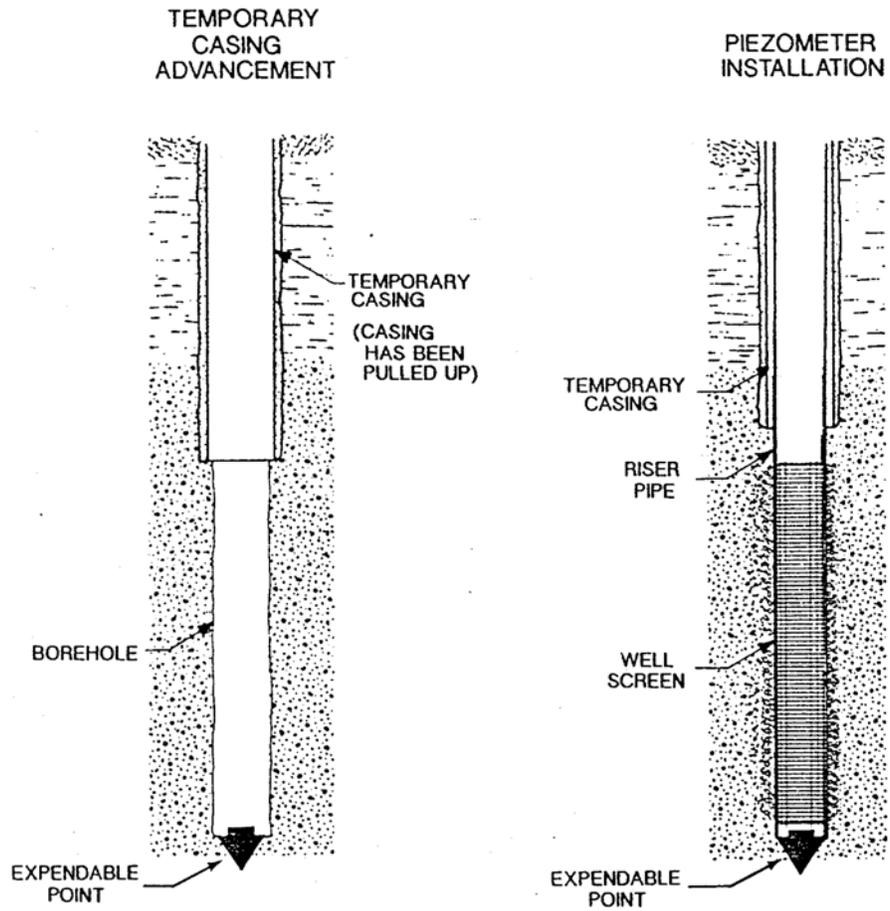
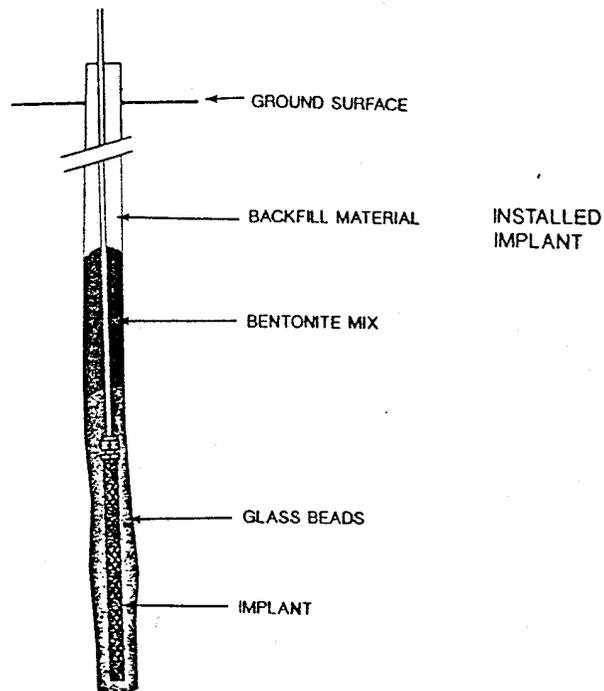
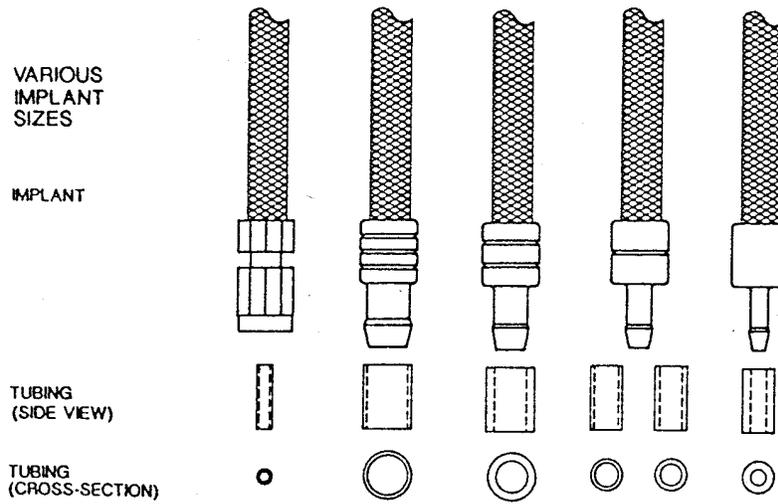


FIGURE 11

VAPOR SAMPLING IMPLANTS



SOP APPROVAL FORM

TETRA TECH EM INC.

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

SOIL GAS SAMPLING METHODS

SOP NO. 074

REVISION NO. 1

Last Reviewed: November 1999

R. Riesing

Quality Assurance Approved

May 21, 1993

Date

1.0 BACKGROUND

Soil gas samples can be collected using several methods. This standard operating procedure (SOP) presents sample collection procedures for collecting soil gas samples in Tedlar® bags, glass sampling bulbs, and stainless-steel canisters. Tedlar® bags and glass sampling bulbs are best suited for on-site or near-site chemical analysis, whereas steel canisters are best suited for shipping samples to a full service laboratory.

1.1 PURPOSE

The purpose of this SOP is to provide guidance for the use of Tedlar® bags, glass sampling bulbs, and stainless-steel canisters for soil gas sample collection. Soil gas samples collected by these methods may be analyzed for volatile organic compounds such as trichloroethene, benzene, and toluene and for inorganic parameters such as nitrogen, oxygen, and carbon dioxide.

1.2 SCOPE

This SOP applies to all personnel collecting soil gas samples in Tedlar® bags, glass sampling bulbs, or stainless-steel canisters. The site-specific work plan and sampling plan should be followed during soil gas sampling activities.

1.3 DEFINITIONS

Soil Gas - The gases or atmosphere filling the void spaces in soils and unconsolidated sediments. These gases may all be of natural origin, but manmade contaminants or by-products may be present in detectable quantities.

1.4 REFERENCES

U.S. Environmental Protection Agency (EPA). 1984. *Characterization of Hazardous Waste Sites - A Methods Manual: Volume II, Available Sampling Methods*. Second Edition. EPA-600/4-84-076. December.

EPA. 1988. *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air*. Method TO-14. Atmospheric Research and Exposure Assessment Laboratory, Research Triangle Park, NC. 600/4-89/017. June.

EPA. 1990. "General Precautions in the Use of Canister Sampling for Measuring VOCs in Ambient Air." *Office of Solid Waste Emergency Response (OSWER). Bulletin Board*.

1.5 REQUIREMENTS AND RESOURCES

When using the Tedlar[®] bag collection method, the following items are needed:

- A sampling port and attached sampling line, ready for sampling
- A pump (SKC universal flow pump or equivalent), capable of pumping at least 3 liters per minute to allow purging of the sample point prior to collection of soil gas samples
- Sampling lines (dedicated, 0.375-inch outer diameter Tygon tubing) to connect all field equipment
- Y-branched plastic (Teflon[®]-lined if available) sampling hose for duplicate collection
- 500-cubic-centimeter (cc) Tedlar[®] bags, with metal fittings
- Vacuum chamber

When using glass sampling bulbs to collect soil gas, the following items are needed:

- A supply of clean 250- or 500-milliliter (mL) glass gas sampling bulbs with stopcock valves
- Tygon tubing or equivalent of appropriate size to connect the sampling bulb to the sample port and vacuum system
- A vacuum pump to purge the sampling system and allow for sample collection. A vacuum/volume system capable of measuring purge volumes is desirable.
- A sampling system with an inline pressure gauge
- A source of heated air to purge and decontaminate the reusable glass sampling bulbs prior to initial use and between each subsequent use. This may consist of a simple hand-held hair drier.

When using steel canisters to collect soil gas, the following items are needed:

- A supply of clean, evacuated stainless-steel canisters (SUMMA canisters) with a pressure gauge to verify internal pressure
- A vacuum pump (SKC universal flow pump or equivalent) to allow purging of the sample point prior to collection of soil gas samples
- Tygon tubing or equivalent of appropriate size for connecting the sampling port to pump (during gas point purging) and the sampling port to stainless steel canister (during sample collection)
- Y-branched tubing (plastic, Teflon[®]-lined if available) for duplicate collection

2.0 PROCEDURES

This section describes selection of soil gas sampling locations and general preparation of the sampling system to be used. This section also provides detailed procedures for collecting samples using Tedlar[®] bags, glass bulbs, and stainless-steel canisters. Finally, this section discusses additional considerations that affect soil gas sampling, including duplicate and equipment blank sample collection, decontamination, and sample transfer, and summarizes the advantages and disadvantages of each sampling method.

2.1 SAMPLING LOCATION SELECTION

Sampling locations should be selected and prepared for sampling as described in a site-specific quality assurance project plan and field sampling plan. Soil gas samples may be collected from depths as shallow as 3 feet or as great as 50 feet, depending on the objectives of the project, the site soil conditions, and the specific equipment used to penetrate to depth. The horizontal spacing of soil gas sampling points (grid size) may be only a few feet or more than 500 feet. Again, this is a function of project-specific objectives and site conditions.

2.2 SAMPLING SYSTEM PREPARATION

The sample probe assemblies may consist of three types: (1) a hand-driven soil gas probe 4 feet in length, (2) a drill rig-driven soil gas probe 2 feet in length, (3) a hydraulic-driven soil gas probe 3 feet in length.

The probes may be assembled in series to reach the desired sampling depth. The probes will be driven to or emplaced at the desired sample collection depth, and then fitted with the Tygon sampling line.

Once fitted with the sampling line, the ambient air within the sampling system is purged. Usually, three system volumes are purged prior to sample collection. If the sampling system purge volume cannot be measured, then a standard purge time of 3 to 5 minutes should be used.

After the system is purged of ambient air but before the pump is turned off, approximately 2 inches of the sampling line closest to the entrance port of the pump should be folded over itself and the tubing should be clamped to keep ambient air from reentering the system. This is not necessary when sampling with glass bulbs because the bulbs are already connected to the sampling line. After the system is purged and sealed to ambient air, the pump should be turned off. Sample collection can now proceed using a Tedlar® bag, a glass bulb, or a stainless-steel canister.

2.3 SAMPLE COLLECTION USING TEDLAR® BAGS

Soil gas can be collected for chemical analysis in a 500-cc Tedlar® gas sampling bag. This can be accomplished by using an SKC pump to induce a vacuum on the exterior of the bag. This will cause the Tedlar® bag to be inflated with soil gas. The following procedure should be used:

1. Connect the free end of the Tygon tubing (previously inserted through the top of the vacuum chamber) to the Tedlar® gas sampling bag. Open the valve on the gas sampling bag and place the tubing into the body of the vacuum chamber.
2. Place the top on the vacuum chamber.
3. Connect the free end of the evacuation tube to the SKC pump.
4. Turn on the pump. This should create a vacuum in the chamber, and the Tedlar® bag should fill at a rate of approximately 2 liters per minute. The rate at which the Tedlar® gas sampling bag fills will depend on the porosity and permeability of the soil.

5. The minimum amount of soil gas needed for analysis is approximately 0.25 liter.
6. If less than 0.25 liter is collected after 4 minutes of sampling, raise the soil gas probe 0.5 foot (if possible). Continue to evacuate the vacuum chamber for another minute. If the minimum required soil gas is not collected, repeat the procedure again. If the minimum required volume of soil gas is still not collected, abandon the collection process. All steps conducted are to be accurately recorded in the field logbook.
7. Remove the top of the vacuum chamber after the soil gas sample is collected in the Tedlar[®] bag.
8. Close the valve on the Tedlar[®] gas sampling bag, clamp the Tygon tubing, and remove the Tedlar[®] gas sampling bag.
9. Turn off the pump.
10. Label the Tedlar[®] bag and its corresponding field datasheet (Figure 1) with the sample number.
11. Fill out the rest of the field datasheet. An alternative documentation procedure is to enter the requisite information in the field logbook.

2.4 SAMPLE COLLECTION USING GLASS BULBS

Soil gas also can be collected for chemical analysis in a glass bulb. When this sampling method is used, the glass bulb must be connected to the sampling system and purged of ambient air along with the sampling line before the sample is collected. The system is purged and the sample is collected using the following procedure:

1. Connect one end of the glass bulb to the sample line and the other end of the glass bulb to the vacuum pump using Tygon tubing, and then open both stopcocks on the bulb.
2. Turn on the vacuum pump and purge the sampling system as discussed in Section 2.2.
3. Turn off the vacuum pump.
4. Observe the inline pressure gauge to determine when the vacuum in the bulb has been filled with soil gas. This may require several minutes, particularly in soils with low porosity and permeability. If the vacuum in the bulb has not dropped after 4 minutes of sampling, raise the soil gas probe in 0.5-foot increments in an attempt to find a more permeable zone. If the soil gas probe is moved, guard against leakage of ambient air into the system and repurge if necessary.

5. Once the vacuum in the gas sampling bulb has been filled, close off the upstream stopcock on the bulb, then the downstream stopcock and disconnect the bulb from the sample line.
6. Label the glass bulb and its corresponding field datasheet with the sample number.
7. Fill out the rest of the field datasheet. An alternative documentation procedure is to enter the requisite information in the field logbook.

2.5 SAMPLE COLLECTION USING STAINLESS-STEEL CANISTERS

Soil gas also can be collected for chemical analysis in a stainless-steel, evacuated canister. Usually, these expensive canisters are used to collect duplicate samples for off-site analysis from locations that are being sampled for field screening analysis using Tedlar[®] bags or glass bulbs.

When this method is used, the canister is connected directly to the purged Tygon sampling tube. To prevent ambient air from entering the canister during sample collection, all connections must be airtight.

To collect soil gas samples using this method, the following procedure is used:

1. Measure the canister pressure reading, ambient air temperature, and ambient air pressure, and record the readings in the field logbook prior to sample collection.
2. Open the canister pressure valve, which will allow the evacuated stainless-steel canister to draw in soil gas until the canister reaches ambient pressure. When the sampling valve on the canister shows that ambient pressure has been reached, close the sampling valve and remove the canister from the sampling line.
3. Measure and record the post-sampling pressure reading on the canister pressure valve.
4. Label the canister and its corresponding field datasheet with the sample number.
5. Fill out the rest of the field datasheet. An alternative documentation procedure is to enter the requisite information in the field logbook.

2.6 DUPLICATE AND EQUIPMENT BLANK COLLECTION

Duplicate soil gas samples will be collected at each site as required in the site-specific sampling plan and quality assurance project plan. Generally, 1 duplicate sample will be collected for every 10 samples collected. Each duplicate is collected in conjunction with a corresponding environmental sample.

To collect duplicate samples, a Y-branched sampling hose will be connected to the vacuum chamber or pump. Two Tedlar[®] bags, glass bulbs, or stainless-steel canisters will be attached, one to each end of the Y-branched hose. Sample collection will proceed as described above. After collection, one sample will be labeled as the environmental sample and one as the duplicate.

Equipment blanks also will be collected at each site as required in the site-specific sampling plan and quality assurance project plan. Generally, 1 blank will be collected for every 10 samples collected. Blanks will be collected by running ambient air through the sampling system immediately after it has been decontaminated, and by collecting the ambient air in a Tedlar[®] bag, glass bulb, or stainless-steel canister using the same procedures used to collect environmental samples. Blank sample collection is conducted upwind of any observed interference, and the location of the sampling should be recorded in the field logbook. Equipment blanks are collected to ensure that field equipment decontamination procedures are adequate.

2.7 DECONTAMINATION

Sampling probes should be decontaminated before the first sample is collected and between sampling points. Probes that are grossly contaminated should be decontaminated using a high pressure steam cleaner. Probes that are not grossly contaminated can be decontaminated by brushing off loose soil particles, then heating the probes until they are warm to the touch to drive off any volatile contaminants. Heating times of 7 to 10 minutes are generally sufficient for this purpose. This brushing and heating method greatly reduces the generation of decontamination fluids.

Glass sampling bulbs also must be decontaminated between each use. This may be accomplished by purging heated air through the bulbs using a hand-held hair drier and the vacuum pump. Highly contaminated bulbs may require decontamination using either a methanol or soapy water wash and a deionized water rinse.

If Y-branched tubing or any other sampling equipment is to be reused, it must also be decontaminated between sampling locations.

2.8 SAMPLE TRANSFER

After collection, each sample container will be transported to the designated laboratory for analysis. In many cases, samples will be analyzed on site in a mobile laboratory.

2.9 ADVANTAGES AND DISADVANTAGES OF EACH SAMPLING METHOD

Tedlar® bags are relatively inexpensive to use but can only be used once and then must be disposed of. If the soil formation being sampled has a low porosity and permeability, such as clay or silty clay, it may not be possible to inflate the Tedlar® bag with soil gas.

Glass bulbs are more expensive than Tedlar® bags but they can be reused indefinitely, as long as they are not broken. However, bulbs must be decontaminated between each use, and periodic equipment blanks must be analyzed to verify that the decontamination procedures used are effective.

Stainless-steel canisters are very expensive and, therefore, are not cost-effective when conducting on-site analysis. The advantage of this type of sampler is that confirmation samples may be collected and shipped off-site for analysis with excellent assurance of sample integrity.

3.0 CAUTIONS

Both Tedlar® bags and glass bulbs are transparent to light, and many volatile compounds are subject to degradation in sunlight. Because of this, samples should be stored in a dark place, such as a cooler, and analyzed as quickly as possible. In general, samples collected in Tedlar® bags or glass bulbs should be analyzed within 24 hours after collection, at a maximum. This will ensure sample integrity and minimize contaminant loss by degradation processes or absorption onto surfaces.

The concentration of volatile organic contaminants in the vapor phase in soil gas is a function of many complex and dynamic variables. Because of this, soil gas results do not usually show a direct correlation to groundwater contamination. However, soil gas may show a good relation to groundwater conditions and is

therefore a very powerful tool for quickly and inexpensively locating sources of volatile organic contamination in groundwater.

While sampling, each sampling location should be screened with a flame ionization detector (FID) or photoionization detector (PID) following sample collection. The result of the FID or PID screening should be recorded on the sample container and field sheet so that the chemist analyzing the sample can determine whether sample dilutions or smaller sample volumes are required for analysis.

FIGURE 1

FIELD DATASHEET FOR SOIL GAS SAMPLING METHODS

Date: _____ Site/Facility Name: _____

Time: _____ Project No.: _____

Sample Container: _____ Tedlar® Bag: _____ Glass Bulb: _____ SUMMA® canister: _____

Sampling location and depth: _____

Description of location: _____

Sample location purged: Yes _____ FID or PID (circle one) Reading: _____

Sample relinquished by: _____ Date/Time: _____

Sample received by: _____ Date/Time: _____

Attach field copy of sample label or write in sample number:

Notes: