BHATE
Environmental Engineers and Scientists
1608 13th Avenue South, Suite 300
Birmingham ■ Alabama ■ 35205
(205) 918-4000
(205) 918-4050 (FAX)

HAFB 2004

FEB 2004

February 5, 2004

Ms. Sandra Martin
NMED/Hazardous Waste Bureau
2905 Rodeo Park Drive East
Santa Fe, New Mexico 87505-6303

Subject: Data Acquisition Plan for Risk Assessment Plan, Officer's Club SS-57
Holloman AFB, New Mexico
USACE – Omaha District
Contract No. DACA45-03-D-0012, DO No. 5
Bhate Project No. 9030024.01

Dear Ms. Martin,

Please find enclosed four copies of the final *Data Acquisition Plan for Risk Assessment Plan, Officer's Club SS-57 – Holloman AFB, New Mexico* for your review.

Bhate Environmental Associates, Inc., appreciates the opportunity to provide services to the U.S. Army Corps of Engineers, Holloman Air Force Base and the State of New Mexico. If you have any questions or need additional assistance, please feel free to contact us at (205) 918-4000.

Cordially,
BHATE ENVIRONMENTAL ASSOCIATES, Inc.

Frank Gardner, P.G.
Program Manager

cc w/ enclosures: Cornelius Amindyas (NMED/HWB)
Steve Jetter (NMED/HWB)
James Harris (USEPA/Region 6)

Enclosures Not Found

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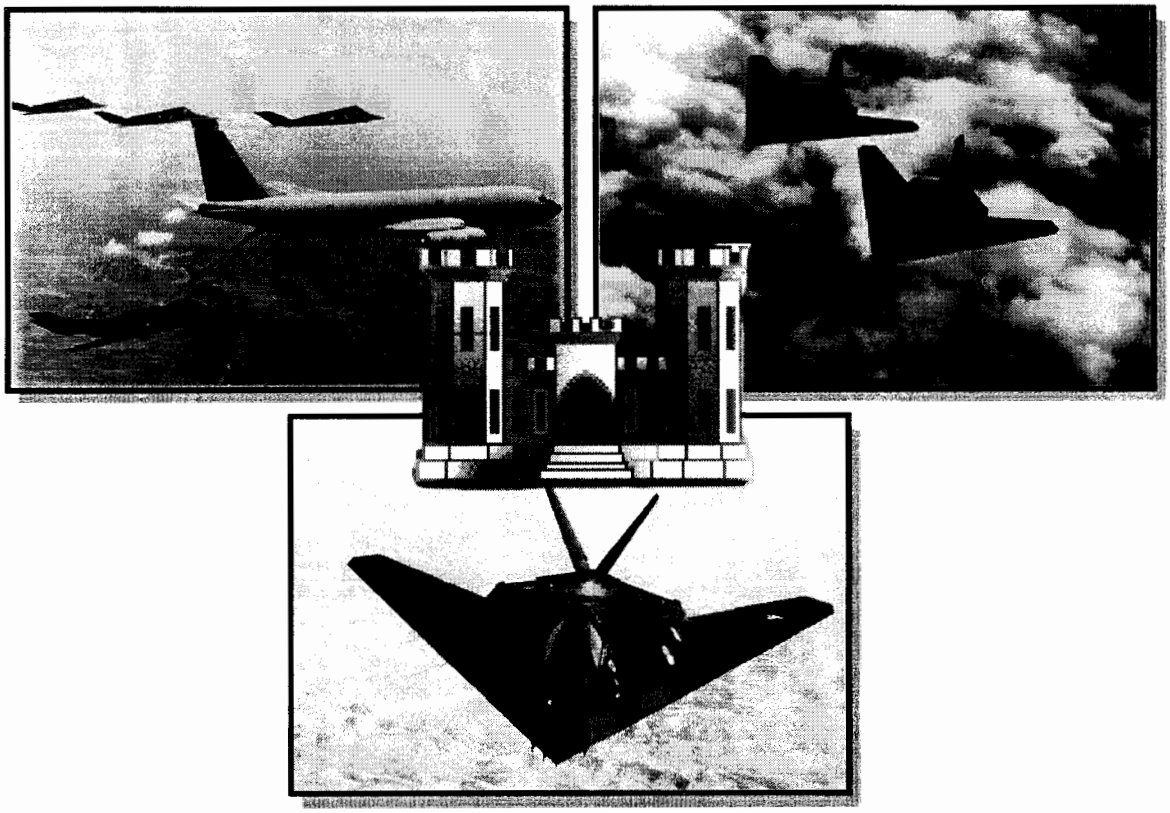
DATA AQUISITION PLAN FOR RISK ASSESSMENT

OFFICER'S CLUB, SITE SS-57



Holloman Air Force Base
New Mexico

February 2004

CONTRACT NO. DACA45-03-D-0023
TASK ORDER NO. 002
Bhate Project No. 9040002.01.03

Headquarters, Air Combat Command
Langley Air Force Base, Virginia

49 CES/CEV
Holloman Air Force Base, New Mexico

DATA ACQUISTION PLAN FOR RISK ASSESSMENT OFFICERS CLUB, SITE SS-57, HOLLOMAN AFB, NEW MEXICO

Prepared for:

49CES/CEV
Holloman Air Force Base
New Mexico

Under Contract To:

US Army Corp of Engineers
Omaha, District
Under Contract No. DACA45-03-D-0023
Task Order No. 0002

February 2004

Prepared by:

Bhate Environmental Associates, Inc.
1608 13th Avenue South, Suite 300
Birmingham, Alabama 35205

Bhate Project No. 9040002.01.03

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DATA ACQUISTION PLAN FOR PRELIMINARY RISK ASSESSMENT OFFICERS CLUB, SITE SS-57 HOLLOMAN AFB, NEW MEXICO

Please sign and date

This report has been reviewed and approved by:

Jerry Pelfry Site Manager	Signature	Date
Scott Dolvin, P.G. Senior Geologist	Signature	Date
Rank Gardner, P.G. Senior Project Manager	Signature	Date

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OFFICERS CLUB, SITE SS-57

HOLLOMAN AFB, NEW MEXICO

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ACRONYMS AND ABBREVIATIONS

AAF	Army Air Field
AFB	Air Force Base
AHA	Activity Hazard Analysis
ANSI	American National Standards Institute
bgs	Below ground surface
Bhate	Bhate Environmental Associates, Inc.
COC	Chain-of-custody
CRZ	Contaminant Reduction Zone
CZ	Construction Zone
DGI	Data Gap Investigation
DPT	Direct Push Technology
EPA	U.S. Environmental Protection Agency
ERPIMS	Environmental Restoration Program Information System
EZ	Exclusion Zone
FID	Flame Ionization Detector
FWEC	Foster Wheeler Environmental Corporation
GC/MS	gas chromatogram/mass spectrogram
GTI	Groundwater Technology Government Services, Inc.
HAFB	Holloman Air Force Base
HASP	Health and Safety Plan
IDW	Investigation derived waste
IRP	Installation Restoration Program
kg	Kilogram
L	Liter
mg	Milligram
mL	Milliliter
MS/MSD	Matrix Spike/Matrix Spike Duplicate
NFA	No Further Action
NMED	New Mexico Environment Department
NMWQCC	New Mexico Water Quality Control Commission
OSHA	Occupational Safety and Health Administration
OVA	Organic vapor analyzer
PID	Photo Ionization Detector
PPE	personal protection equipment
ppbv	parts per billion volume
POL	Petroleum, oil and lubricants
PRA	Preliminary Risk Assessment
QA	Quality assurance
QAPP	Quality Assurance Project Plan
QC	Quality control
SOP	Standard Operating Procedure
SVOC	Semi-volatile organic compounds

TDS	Total dissolved solids
TPH	Total petroleum hydrocarbons
USACE	United States Army Corps of Engineers
USCS	Unified Soil Classification System
USEPA	United States Environmental Protection Agency
VOC	Volatile organic compounds
WWTP	Waste Water Treatment Plant

1 INTRODUCTION

Bhate Environmental Associates, Inc. (Bhate) has been retained by the U.S. Army Corps of Engineers (USACE), under contract DACA45-02-D-0012, Delivery Order No. 5, to conduct a data gap investigation (DGI) in support of the preliminary risk assessment (PRA) at the Officer's Club, site SS-57 at Holloman Air Force Base (HAFB), New Mexico. The objective of this data collection effort is to fill in the data gaps to complete a site-specific risk evaluation. The DGI includes the field investigative tasks as outlined in the USACE Scope of Services: development of a site map to meet the data quality objectives (DQO), completion of additional soil borings with soil sample collections, groundwater collections (at new soil borings as well as existing monitoring wells), soil gas survey, geotechnical analysis and risk assessment report. This document is to provide a work plan that will serve as the primary working document for the site investigation activities at the site and provides the relevant site specific information as it pertains to the requirements as outlined in the Scope of Work for completion of the investigation activities at the site. The primary objective of this DGI is to collect the proper data meeting the DQOs ultimately in support for the closure of the site based on guidance from the New Mexico Environmental Department (NMED). The ultimate objective is to achieve approval for site closure from NMED.

The document has been constructed to provide relevant information on the geologic, hydrologic and other environmental conditions for HAFB and at the site. Information is provided for the entire Base and its surrounding environ as well as site SS-57, specifically. Likewise, the procedures encompassing the investigation: sampling and waste management are presented.

1.1 Base and Site Description

1.1.1 HAFB

HAFB is located in southeastern New Mexico in Otero County, New Mexico, approximately 100 miles north-northeast of El Paso, Texas, and 6 miles west of Alamogordo, New Mexico (Figure 1). The following Base information has been taken from: the *Final Remediation Action Plan Officer's Club, Site SS-57, Holloman Air Force Base, New Mexico by* Foster Wheeler Environmental Corporation and Groundwater Technology Government Services, Inc. (February, 1997); the *Characterization Summary and No Further Action (NFA) Documentation for Installation Restoration Program (IRP) Sites SS-2/5 POL Yard (AOC T), SD-47 POL Washrack Area (SWMU 133), and SS-60 Building 828 (SWMU 230)* by Foster Wheeler (March, 1998) and the *2001 Long-Term Groundwater Monitoring Report, Holloman Air Force Base, New Mexico,* by Foster Wheeler (July 2002).

HAFB was first established in 1942 as Alamogordo Army Air Field (AAF). From 1942 through 1945, Alamogordo AAF served as the training grounds for over 20 different flight groups, flying primarily B-17s, B-24s, and B-29s. After World War II, most operations had ceased at the base. In 1947, Air Material Command announced the air field would be its primary site for the testing and development of un-manned aircraft, guided missiles, and other research programs. On

January 13, 1948, the Alamogordo installation was renamed Holloman Air Force Base, in honor of the late Col. George V. Holloman; a pioneer in guided missile research. In 1968, the 49th Tactical Fighter Wing arrived at HAFB and has remained since. Today, HAFB also serves as the training center for the German Air Force's Tactical Training Center.

1.1.2 Site SS-57

The Officers Club (Building No. 531) is located at the corner of West Eighth Street and West New Mexico Avenue (Figure 2). Congruent to the initial concerns for the site, seven monitoring wells were installed along with fourteen soil borings.

1.2 Physiography

HAFB is located within the Sacramento Mountains Physiographic Province on the western edge of the Sacramento Mountains (Figure 3). The region is characterized by high tablelands with rolling summit plains; cuesta-formed mountains dipping eastward and of west-facing escarpments with the wide bracketed basin forming the basin and range complex. HAFB is approximately 59,600 acres in area, and is located at a mean elevation of 4,093 feet above sea level. The Base is located in the Tularosa Sub-basin which is part of the Central Closed Basins. The San Andreas Mountains bound the basin to the west (about 30 miles) with the Sacramento Mountains approximately 10 miles to the east. At its widest, the basin is about 60 miles east to west and stretches approximately 150 miles north to south.

The site primarily consists of the active Officer's Club building. The immediate surroundings is landscaped and maintained with a parking area to the east.

1.3 Surface Water

The Tularosa Basin contains all of the surface flow in its boundaries. The nearest inflow of surface waters to the Base comes from the Lost River, located in the north-central region of the Base. The upper reaches of the Three Rivers and the Sacramento River are perennial in the basin. HAFB is dissected by several southwest trending arroyos that control the surface drainage. Hay Draw arroyo is located in the far north. Malone and Rita's Draw, which drain into the Lost River, and Dillard Draw arroyos are located along the eastern perimeter of the Base. Approximately 10,000 years ago, indications are of a much wetter climate. The present day Lake Otero encompassed a much larger area, possibly upwards of several hundred square miles. Its remains are the Alkali Flat and Lake Lucero. Lake Lucero is a temporary feature of merely a few inches in depth during the rainy season.

Ancient lakes and streams deposited water bearing deposits over the older bedrock basement material. Fractures, cracks and fissures, in the Permian and Pennsylvanian bedrock, yield small quantities of relatively good quality water in the deeper peripheral. Potable water is only found from a handful of wells near the edges of the basin with more saline water towards the center.

Two of the principal sources of potable water are a long narrow area on the upslope sides of Tularosa and Alamogordo with the other in the far southwestern part of the basin. Alamogordo's water, as well as the Base's, is supplied from Lake Bonito (which is in the Pecos River Basin). Within the boundaries of SS-57 the run-off is controlled by the minimal topographic relief as per the existing grade and landscaping. Appurtenances can be found placed along the perimeter for collection into the Base storm water drainage system..

1.4 Groundwater

The predominance of the groundwater occurs as an unconfined aquifer in the unconsolidated deposits of the central basin, with the primary source of recharge as rainfall percolation and minor amounts of stream run-off along the western edge of the Sacramento Mountains. Surface water/rainfall migrates downward into the alluvial sediments at the edge of the shallow aquifer near the ranges, and flows downgradient through progressively finer-grained sediments towards the central basin. Because the Tularosa Basin is a closed system, water that enters the area only leaves either through evaporation or percolation. This elevated amount of percolation results in a fairly high water table. Beneath HAFB, groundwater ranges from 5 to 50 feet. Flow for the Base is generally towards the southwest with localized influences from the variations in the topography of the Base. Near the arroyos, groundwater flows directly toward the surface drainage feature. Because there haven't been any previous investigations of the site or its immediate surroundings, there is no hydraulic data for the aquifers.

Previous analyses indicate total dissolved solids (TDS) of greater than 10,000 mg/L in groundwater beneath Holloman. This exceeds the New Mexico Water Quality Control Commission (NMWQCC) limit as potable water and thus, the groundwater beneath HAFB has been designated as unfit for human consumption. Likewise, US EPA guidelines have identified the groundwater as a Class IIIB water source, characterized by TDS concentrations exceeding 10,000 mg/L.

Groundwater at the site has been detected from 8½ to 12½ feet bgs. The potentiometric surface indicates a gradient of about 0.019 with nearly a due south flow.

1.5 Climate

As a whole, New Mexico has a mild, arid to semi-arid continental climate characterized by light precipitation totals, abundant sunshine, relatively low humidity and relatively large annual and diurnal temperature range (WRCC, 2003). The climate of the Central Closed Basins varies with elevation. The Base is found in the low areas and is characterized by warm temperatures and dry air. Daytime temperatures often exceed 100°F in the summer months and middle 50s in the winter. A preponderance of clear skies and relatively low humidity permits rapid night time cooling resulting in average diurnal temperature ranges of 25 to 35°F. Potential evapotranspiration, at 67 inches per year, significantly exceeds annual precipitation, usually less than 10 inches (Foster Wheeler and Radian, 1997). The very low rainfall amounts resulting in the arid conditions, which with the topographically induced wind patterns combining with the

sparse vegetation, tend to cause localized "dust devils". Much of the precipitation falls during the mid-summer monsoonal period (July and August) as brief, yet frequent, intense thunderstorms culminating to 30 – 40% of the annual total rainfall.

1.6 Geology

The sedimentary rocks which make up the adjacent mountain ranges are between 500 and 250 million years old (WSMR, 2003). During the period when the area was submerged under the shallow intra-continental sea, the layers of limestone, shale, gypsum and sandstone were deposited. In time, these layers were pushed upward through various tectonic forces forming a large bulge on the surface. Approximately 10 million years ago the center began to subside resulting in a vertical drop of thousands of feet leaving the edges still standing (the present day Sacramento and San Andreas mountain ranges). In the millions of years following, rainfall, snowmelt and wind eroded the mountain sediments depositing them in the valley (i.e., Tularosa Basin). Water carrying eroded gypsum, gravel and other matter continues to flow into the basin.

As the Tularosa Basin is a bolson, which is a basin with no surface drainage outlet, sediments carried by surface water into a closed basin are bolson deposits. The overlying alluvium generally consists of unconsolidated gravels, sands and clays. Soils in the basin are derived from the adjacent ranges as erosional deposits of limestone, dolomite and gypsum. A fining sequence from the ranges towards the basin's center characterizes the area with the near surface soils as alluvial, eolian and lacustrine deposits. The alluvial fan deposits are laterally discontinuous units of interbedded sand, silt and clay while the eolian deposits consist primarily of gypsum sands. The eolian and alluvial deposits are usually indistinguishable due to the reworking of the alluvial sediment by eolian processes. The playa, or lacustrine deposits, consist of clay containing gypsum and are contiguous with the alluvial fan and eolian deposits throughout HAFB. There has been the identification of stiff caliche layers, varying in thickness, at different areas of the Base. At the site, soils are predominantly silty sands and interbedded clays.

Data reviewed of soil borings from previous investigations indicates the soils beneath the site to be heterogeneous ranging from a stiff clay of high plasticity to a poorly-graded gravel. As with much of the base, a cliché layer exists with a nominal depth of approximately 12-feet bgs. Laboratory derived permeability results ranged from 8.5×10^{-7} to 3.4×10^{1} cm/sec (FWEC and GTI, 1997). Stratigraphically, the upper soils consist of approximately 13 to 15 feet of silty sand. Beneath these are varying layers of fine-grained sandy clays and clay for 10 to 12 feet; to a depth of about 25 feet bgs. Below this to about 40 feet bgs, the soils are mostly silt and silty sands.

2 BACKGROUND

In the fall of 1991, hydrogen sulfide (H_2S) odors were identified in the Officers Club building and the site was designated as SS-57. In October of 1991 a geotechnical investigation was completed to evaluate the soil and groundwater conditions in support of determining the source of the odors. The investigation concluded that the odors primarily consisted of carbon disulfide (CS_2) and H_2S. This investigation also identified TPH-Diesel in groundwater at concentrations ranging from 2 to 130 mg/L. Soil concentrations were as high as 1,500 mg/kg at 14 to 15½ feet bgs. A preliminary risk assessment conducted in April 2002 indicated that diesel concentrations exceeded the New Mexico Environment Department (NMED) residential, as well as industrial target levels. A follow-on investigation was conducted in May 1992 to better define the source of the odors and provide any recommendations. The analytical data indicated the source of the H2S odors to be attributed to the degradation of diesel fuel hydrocarbons which leaked from underground storage tank (UST) or pipeline prior to 1991.

In November of 1992, a third investigation was completed by Radian to define the horizontal and vertical extent of the hydrocarbon contamination. Soil analyses included TPH-DRO and bacteria enumeration and a biological screening. These results demonstrated TPH as deep as 18 feet bgs at 12,000 ppm in the soil. Diesel concentrations greater than 1,000 ppm were detected in 14 of the 25 soil samples collected and analyzed. Bacteria counts indicated the eight of the 13 samples analyzed exceeded the minimum bacteria counts required before initiation of remediation in accordance with EPA guidance documents. Likewise, Radian's evaluation proposed that the nutrient (nitrogen and phosphates) concentrations to be too deficient to support bioremediation.

On April 15 through the 18th, GTI performed an AS/SVE pilot test to determine the feasibility of using air sparging in conjunction with SVE to minimize the H2S generation. It was estimated that the organic material would be sufficiently degraded within one year to levels below 1,000 ppm and to levels where H2S was no longer produced, assuming the source had been removed.

Resultant of these investigations, a total of seven monitoring wells have been installed, fourteen soil borings (excluding borings for monitoring wells) have been drilled, and an air sparging/soil vapor extraction (AS/SVE) system was installed.

Based on review of the available data and discussions with NMED, it was decided to conduct a site-specific risk assessment at the site. The results of this risk assessment will be used to develop corrective action plans if necessary or to close the site if the estimated risk is acceptable. As a first step towards conducting a site-specific risk assessment a comprehensive review of available data was conducted. Based on this data review, a few data gaps were identified. This document identifies those data gaps and suggests the methods to be used to collect the data.

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3 DATA AQUISITION PROCEDURES

3.1 Pre-investigation Requirements

3.1.1 AF Form 332

Air Force Form AF Fm 332, Attachment A, authorizes construction work at HAFB and is required for the initiation of any construction work. This work order describes what activities will take place at the location. The AF Fm 332 also is the mechanism by which the utility clearance/dig permit is authorized. Form 332 will be initiated by Bhate. Both the AF Fm 332 and dig permit will be reviewed by required Base personnel for their approvals to begin work in their area or that which may affect a utility under their authority. Prior to the submittal of AF Fm 332, the sampling locations will be clearly indicated with marker flags or stakes.

3.1.2 Dig permit/Utility Clearances

As note above, utility clearance approvals will be completed by Base personnel. Upon receipt of the approved dig permit with the utility clearances, the site supervisor or other authorized project personnel will complete a site walk-down confirming the dig permit authorizations and make any required changes. The following subsections provide detailed descriptions for completing each activity.

3.2 Investigation Requirements

The following data gaps have been identified:

- Recent soil data and groundwater data,
- Soil geotechnical parameters,
- Soil gas data, and
- Screened intervals and total depth of monitoring wells MW-5, MW-7, and MW-9.

During the investigation effort, the site will be sufficiently mapped to scale with particular notation of the perimeter of the building and ancillary structures, sampling locations and existing monitoring wells and surveyed via GPS methods. This map shall show all buildings, roads, sidewalks, paved and unpaved areas.

3.2.1 Chemical Data Acquisition

3.2.1.1 Analytical Methods

Table 3-1 details the analytical requirements for the various samples being collected. Soil and groundwater samples will be analyzed for BTEX (VOCs) by Method 8260, Total Petroleum Hydrocarbons by Texas Method 1005, and carbon fraction (Table 3-2) by Texas Method 1006.

Soil samples will also be analyzed for PAHs (SVOCs) by Method 8270 and soil moisture content. The soil gas samples will only be analyzed for BTEX compounds via TO-15 method and TPH-DRO via NIOSH Method 1550. Table 3-3 details the sample quantities, with QA requirements, for each media to be collected by analysis. Table 3-4 provides the sample container type for each analytical group with sample media.

3.2.1.2 Soil Sampling

The field work for the DGI will be conducted in accordance with HAFB Standard Operating Procedures (SOPs) provided in the Base Wide Quality Assurance Project Plan (QAPP) (Bhate, 2003) which is a field document available to each project personnel. These SOPs outline methodologies for soil boring advancement, soil sampling, soil sample description, field screening, sample management, equipment decontamination, and chain-of-custody procedures. Table 3-1 details the soil sampling analytical groups.

Continuous soil samples will be collected from the borings using Direct Push Technology (DPT) methodology in accordance with HAFB SOP No. 4. Each boring will be visually classified and lithologic described in the field according to HAFB SOP No. 7 and the Unified Soil Classification System (USCS) (ASTM D 2487-92 and ASTM D 2488-90). The specific locations of the borings may be modified based on site-specific (access, any observed or underground utilities, etc.) field conditions. The samples will be placed on ice and shipped under strict chain-of-custody to Elab located in Nashville, Tennessee. Residual soil from the soil sampling will be discarded in accordance with the waste management procedures established in Section 4, Investigative Derived Waste (IDW) Management.

New Soil Borings

Five soil borings (SB-1 to SB-5) will be completed at the locations shown in Figure 4. Samples will be collected continuously at four foot intervals. Soils will be field screened in accordance with HAFB SOP No. 6 using an organic vapor analyzer (OVA) with soil-headspace screening techniques at two foot intervals. Notation will also be made of any visual (discoloration) and/or aromatic indicative of potential contamination.

Two soil samples per boring will be collected and sent for laboratory testing as per the following criteria:

- One soil sample from just above the capillary fringe, and
- Second soil sample from a location above the capillary fringe where the OVA reading is the highest. Based on headspace screening results and noted irregularities with the soil's color and odor, the soil sample, from each soil boring, with the highest OVA reading will be selected for laboratory analyses. Should the screening not identify an interval in which to select, then the sample will be collected at midpoint depth between surface and capillary fringe.

Soil Gas Locations

From each of the soil gas survey locations, a soil sample will be collected from each soil gas sampling interval for chemical analysis and a second soil sample taken from the same depth interval, adjacent location, for the geotechnical analysis via Shelby tube.

3.2.1.3 Groundwater Sampling

During sampling activities, standard water quality parameters from Table 3-1 of the QAPP Addendum for this project (Appendix B) and include pH, conductivity, ORP, dissolved oxygen, temperature and turbidity will be documented per the HAFB SOPs 4 and 9. A flow through cell, or similar, should be used for collection of water quality parameters. Purging of sample locations for groundwater is complete when parameters meet stability within 10% variability over three consecutive readings in a 15-minute period and turbidity has achieved 50 NTUs along with no detectable decrease of the water level during purging/pumping.

New Soil Boring Locations

At each soil boring location, a groundwater sample will be collected for laboratory analyses via DPT methods using a screen point and peristaltic pump or bailer. Low flow or low stress techniques will be used during purging activities for sampling to minimize the disturbance of the water column and generation of IDW. At this time, the hydrogeology for the site has not been documented, so the collection method may warrant changes during the investigation. An alternative procedure involves the completion of temporary well points at each location with development and subsequent sampling via peristaltic pump. If the location demonstrates slow recharge or possibly insufficient volume of water, the alternative method shall be implemented.

Existing Monitoring Well Locations

The following monitoring wells in the vicinity of the Officers Club will be gauged and sampled:

MW-1	MW-5
MW-2	MW-7
MW-3	MW-9

3.2.1.4 Active Soil Gas Sampling

One of the routes of exposure to be evaluated in the risk assessment is indoor inhalation of vapors that may migrate from chemical impacts below the slab of the Officers Club. This route of exposure will be evaluated by developing shallow subsurface and subslab soil concentrations protective of indoor inhalation. If the measured soil concentrations are below the soil target levels (protective of indoor inhalation), the risk is considered acceptable. However, the models available to evaluate this pathway are overly conservative and a more realistic estimate of indoor inhalation risk can be obtained by soil vapor measurements.

Sampling Objectives

The objective of the soil vapor investigation is to collect soil vapor samples in order to assess the potential for migration of hydrocarbons into indoor air from the soil. The soil vapor data will be used to evaluate the concentration and spatial distribution of volatile organic compounds (VOCs) in the vadose zone and to assess the potential for exposure to VOCs via indoor air.

Sample Quality Factors

Soil gas samples collected by an active procedure inherently have factors that affect the quality of the samples. Properties of gases and partitioning phenomena make the factors more important when collecting active samples.

Procedural Factors

Several factors or sampling protocols will influence the measured results: *volume sampled*, *purge volume*, *amount of vacuum applied*, *surface seal*, *thru-rod sampling vs. inert tubing*, and *sample container*. The uncertainty of the effected area sampled will vary proportionally to the **volume** of gas/vapor sampled. The larger the soil vapor withdrawn, the greater the uncertainty as to the exact location from which the soil vapor originated. The **purge volume** should be equivalent or greater than the sampling apparatus volume. This internal volume must be completely purged to ensure a representative sample is collected. Likewise, samples that have been collected under a **high vacuum** may contain contaminants that have partitioned from the sorbed and dissolved phase into soil gas rather the in-situ contaminants present in the "un-disturbed" soil gas. Near surface sampling imposes its own problems for break through of atmospheric gases. This can be eliminated through the use of a **surface seal** of bentonite. Sample quality is optimized when the soil gas is drawn thru **inert tubing** at the sampling depth versus the gas being drawn through the length of the probe rod.

Various **sample containers** have differing advantages and disadvantages for the collection, storage, handling and analysis. Samples collected into Tedlar bags are for quick in-field analyses. This has the advantage of higher sample integrity. However, these are impractical for shipping due to pressure differences applied. Summa canisters provide the best transport capabilities, but because they are evacuated prior to filling, care needs to be taken during sampling to ensure that atmospheric air is not inadvertently sampled nor desorbed from the soil.

Environmental Factors

Other transient effects that can influence the soil gas measured values include temperature, barometric pressure, and precipitation. Because the vapor pressure and water solubility of the contaminants are **temperature** dependant, warmer temperatures will allow for more conservative values, or higher concentrations to be measured. Recording of the ambient temperature is vital to an accurate determination of the contaminant flux. Typically, temperatures should be determined for sampling depths greater than 3 feet bgs. Changes in the

barometric pressure can lead to a pressure gradient between the soil vapor and atmosphere. Low pressures will allow the vapors to flow out of the vadose zone; conversely into the vadose zone during high pressure scenarios. The barometric pressure should be recorded for sampling at shallow depths, less than 5 feet. **Precipitation** infiltration can impact the soil vapor concentrations by displacing the soil vapor, dissolving VOCs and/or creating a "cap" above the soil vapor. Therefore, soil percent moisture should be recorded for shallow samples, less than 3 feet. Sampling as a whole should not be conducted subsequent to a significant rain event of 1-inch or greater.

Sampling Procedure

Active soil gas collection methods involves the withdrawal of the soil vapor from the subsurface under vacuum via a specialized probe with subsequent analysis by a gas chromatogram/mass spectrogram (GC/MS). Data is for the contaminant concentration reported as ppb which can then be used for calculating the contaminant flux across the sampled area. Appendix D is the SOP to be followed for the soil gas sampling developed by the RAM Group, Inc. This document presents a SOP for soil vapor grab sampling using the Geoprobe® Post-Run Tubing (PRT) System with 6-Liter Summa® canisters and NIOSH tubes. Appendices E and F contain the EPA Standard Operating Procedures No. 2042 *Soil Gas Sampling* and No. 1704 *Summa Canister Sampling*, respectively. These two SOPS will provide the additional reference and guidance for the methodologies which the soil gas sampling will be completed.

Soil vapor samples will be collected in humidified Summa™ canisters and analyzed in the laboratory for BTEX constituents using EPA Method Modified TO-15 and TO-3. The TO-15 analysis includes BTEX, MTBE, naphthalene and 2-propanol. TO-3, a more accurate method, is for the TPH-GRO. An additional sample will be collected from the same sampling interval subsequent to the Summa canister; a NIOSH tube for NIOSH method 1550, TPH-DRO.

Two samples per boring will be colleted from three locations (SV1, SV2 and SV3) at a depth just below the level of the slab. Sample depths will be of a shallow sub-surface sample approximately 1-foot below the top of the basement and another approximately 1 foot above the bottom of the basement floor constituting a paired sampling for each location

A small diameter probe is driven into the soil to the prescribed sampling depth. The probe is sealed at the surface to eliminate the infiltration of ambient air. If needed, depending on the probe type, inert tubing is inserted down the probe to the desired depth. The vacuum pump is connected to this tubing and the air is evacuated at approximately 3 L/min for up to 3 volumes of the sampling equipment. The sampling pump is not used during Summa canister sampling. The soil gas sampling is achieved by equilibration. The evacuated canister is connected directly to the sampling probe or down tube. The vacuum from the canister pulls the soil vapors into the canister due to the pressure differential. The approximate time for equilibration with a 6-L canister is 20 minutes.

3.2.2 Soil Geotechnical Data Acquisition

A total of seven geotechnical samples are to be collected. Boring GB-1 will be drilled at a location away from the impacted area (Figure 4) to provide geotechnical parameters for non-impacted soils. This undisturbed soil sample will be collected at a depth above the water table where the lithology is representative of the site, and analyzed for soil geotechnical properties (porosity, dry bulk density, specific gravity, moisture content, and fractional organic carbon content). To ensure that these samples are not impacted, PID readings for soil collected from this zone should not be above background. The six remaining samples are to be collocated with the soil gas samples. Collected from adjacent locations to the soil gas locations, a geotechnical sample will be collected at the same depth interval as the soil gas sampling interval.

The samples will be analyzed for moisture content by ASTM method 2216, dry bulk density by ASTM method D2937, specific gravity by ASTM method D854, and fractional organic carbon content by Walkley-Black method (preferably) or ASTM method 297

3.3 Site Restoration

Upon completion of the site inspection activities, the site will be restored to the original condition. Sampling locations will have been backfilled or grouted to the surface. The site will be canvassed for trash, debris, etc.

Table 3-1. Sample Analytes and Methodologies

Analysis	Soil	Groundwater	Soil Gas
VOCs EPA Method 8260B (BTEX only)	■	■	
BTEX compounds TO-15			■
PAH (SVOCs) (EPA Method 8270C) (PAH only)	■		
TPH (Texas Method 1005)	■	■	
TPH-DRO (NIOSH Method 1550)			■
Carbon Fractions (Texas Method 1006)	■	■	
Moisture Content (TBD)	■		

Table 3-2. Carbon fractions for Polynuclear Aromatic Hydrocarbons

Aliphatics	Aromatics
C6	C7-C8
C6-C8	C8-C10
C8-C10	C10-C12
C10-C12	C12-C16
C12-C16	C16-C21
C16-C35*	C21-C35*

*Analysis may be truncated at C28 if there does not appear to be significant amounts of higher carbons.

Table 3-3. Summary of Analytical Parameters for the Hospital UST

Analyte	Soil		Groundwater		Soil Gas
Location	Borings	Soil Gas	Borings	Wells	
TPH Gasoline-Range Organics/Diesel Range Organics/Oil Range Organic	**20 total samples**		**15 total samples**		7 samples* 6 regular 1 duplicate 0 MS/MSD
	12 samples 10 regular 1 duplicate 1 MS/MSD	8 samples 6 regular 1 duplicate 1 MS/MSD	6 samples 5 regular 0 duplicate 1 MS/MSD	8 samples 6 regular 1 duplicate 1 MS/MSD	
	1 Equipment Blank		1 Equipment Blank		
Volatile Organic Compounds Modified TO-15	**20 total samples**		**15 total samples**		7 samples* 6 regular 1 duplicate 0 MS/MSD
	12 samples 10 regular 1 duplicate 1 MS/MSD	8 samples* 6 regular 1 duplicate 1 MS/MSD	6 samples 5 regular 0 duplicates 1 MS/MSD	8 samples 6 regular 1 duplicates 1 MS/MSD	
	1 Equipment Blank		1 Equipment Blank		
Semi-Volatile Organic Compounds	**20 total samples**		**None**		None
	12 samples 10 regular 1 duplicate 1 MS/MSD	8 samples 6 regular 1 duplicate 1 MS/MSD	None	None	
	1 Equipment Blank				
Carbon Fractions	**20 total samples**		**15 total samples**		None
	12 samples 10 regular 1 duplicate 1 MS/MSD	8 samples 6 regular 1 duplicate 1 MS/MSD	6 samples 5 regular 0 duplicates 1 MS/MSD	8 samples 6 regular 1 duplicates 1 MS/MSD	
	1 Equipment Blank		1 Equipment Blank		

*Only BTEX compounds will be reported for the soil and gas samples at the soil gas locations although the full VOC 8260 analysis will be completed.

One trip blank will be shipped with each cooler that contains VOC samples

Table 3-4. Sample containers by sample media

Media	Analyte Group (quantity)							
	TPH		VOCs		SVOCs		Carbon Fraction	
Soil	8 oz glass jar	(1)	40-mL vials	(3)	40-mL vials	(3)	8 oz glass jar	(1)
Groundwater	1 liter amber	(1)	40-mL vials	(3)	NA	-	1 liter amber	(1)
Soil Gas	NIOSH Tube	(1)	Summa Canisters	(1)	NA	-	NA	-

4 WASTE MANAGEMENT

Investigation-Derived Waste (IDW) generated by the activities of this investigation (Table 4-1) will be managed and characterized according to the following guidelines. Soil cuttings may be treated at the permitted Base landfarm located at the FT-31 site or an off-base facility. Liquid wastes, such as decontamination rinses, are anticipated to be non-hazardous and as such, can be disposed of through the HAFB waste water treatment plant (WWTP). Personal protective equipment (PPE) and other site non-hazardous debris/waste shall be disposed in standard trash receptacle.

4.1 Soil Cuttings

During the soil sampling effort, residual, un-used soils will remain that are not sent to the laboratory for analysis. This residual material will be collected during operations for subsequent disposal at the on-base landfarm.

4.2 Decontamination Procedures

Small equipment, such as sampling tools, will be decontaminated in accordance with the Base Wide QAPP (Bhate, December 2003). The drill rig will be decontaminated at a temporary decontamination pad set up at the site. The containers and decontamination pad will be managed in a secure area and the decontamination water will be allowed to evaporate. Decontamination water is anticipated to be non-hazardous and as such, can be disposed of through the HAFB WWTP. Sediment remaining in the decontamination pad area after the water has either evaporated or been discharge to the WWTP, will be disposed of at the onsite landfarm.

4.3 Personal Protective Equipment, Disposable Sampling Equipment, and Decontamination Pad Materials

PPE and other site non-hazardous debris/waste shall be placed in plastic trash bags and disposed in a standard trash dumpster or receptacle as directed by HAFB personnel.

4.3.1 Hazardous and Special Waste

There is not expected to be any hazardous or special waste generated during the completion of this project.

Table 4-1. Proposed Waste Streams for the Hospital UST Excavation

Activity	Waste Stream		
	PPE	Soil	Water
Equipment Decontamination			
Soil Sampling			
Groundwater Sampling			

5 QAPP ADDENDUM

The laboratory performing the chemical sample analysis will follow the Base Wide Quality Assurance Project Plan Addendum (QAPP) provided as Appendix B to this work plan.

5.1 Standard Operating Procedures

Applicable SOPs for completing this excavation are located in Appendix A of the Base Wide QAPP.

5.2 Sample Identification

Each environmental sample will be identified on the sample label and chain-of-custody (COC) records for each sample collected, regardless of type. Field duplicates will be paired with another random sample and will be blind samples. The duplicate samples will appear in sequence with the regular samples. The identifier nomenclature will adhere to the procedures and guidelines established in the Base Wide QAPP. Sample labeling will adhere to the format provided in the Base Wide QAPP and/or Project QAPP Addendum.

5.3 Sample Documentation

Sample documentation, identification and tracking will adhere to the prescribed methods found in the Base Wide QAPP and/or its respective project specific addendum. All sampling activities will include documentation of significant activities, things during sampling and sample identification information. At a minimum, field log books will be utilized to record dates and times, sampling protocols, project numbers, and sampler's name. Daily Quality Assurance Reports will be completed and submitted weekly to the HAFB Project Manager. Other pertinent information will include COC numbers and air-bill tracking number. Chain-of-custody forms will be completed and included with each sample shipment; one COC per cooler.

At a minimum, the following sample collection information will be logged in the field book:

- Date and time
- Sample identification number
- Project number
- Sampler name
- Preservative (if any)
- Analysis
- Map or schematic of sampling location

If no map of sampling locations is available prior to sampling, a drawing of the site will be sketched on the left page of the field logbook to provide an illustration of all sampling points. Measured distances from sampling points to a fixed reference point will be recorded.

5.4 Field Operations Documentation

The field operations documentation will provide consistent procedures and formats for documentation and management of field records.

5.4.1 Field Logbook

Personnel will use only bound field logbooks for the maintenance of field records. The Project Manager will ensure that all field notes can be efficiently traced, filed and retrieved. All entries will be recorded in indelible, waterproof ink. If errors are made, corrections will be made by crossing a single line through the error, correcting the information, and initialing and dating the correction. Entries will be made in the following format:

Documentation and reporting of events and activities will be made in chronological order on the right page of an open logbook. All entries will be dated and time of entry recorded. At the beginning of each day, the first two entries will be "personnel/contractors on site" and "weather". At the end of each day's entry, the personnel will draw a diagonal line originating from the bottom left corner of the page to the conclusion of the entry and sign along the line indicating the conclusion of the entry or the day's activity. Once completed, the field logbooks become accountable documents and will be maintained as part of the project files.

The following general requirements apply to field log books:

- The left page of the logbook will be used for auxiliary reporting such as sketches, tables, etc.
- The date will be recorded at the top of every page in the left-hand corner of the right page.
- The time of entry recordings will be in columnar form down the left-hand side of the right page.

5.4.2 Field Analytical Data

The field analytical data collected at the site will include the field screening readings for selection of PPE, as well as field screening for headspace analysis. The breathing zone of the site will be screened for VOCs in the field at the time of sample collection utilizing an OVA, PID or FID. If a high humidity condition exists at the time of sample collecting, then a flame-ionization detector (FID) is recommended since a PID is not a completely reliable screening instrument under these conditions. The field screening data will be recorded in the field logbook.

5.5 Data Reporting

Data obtained during the excavation will be reported according to the Base Wide QAPP. In accordance with USACE EM200-1-6, the investigative data is classified as definitive data. The data will be generated using rigorous, analyte-specific analytical methods where analyte IDs and quantitations are confirmed and QC/QA requirements have been satisfied. For this project, regular, field duplicate and matrix spike/matrix spike duplicate (MS/MSD) samples are to be collected concurrently. The data meet the objectives of the project for level of accuracy and precision required, intended use of the data, analytical methods, time constraints and allowable decision errors. Sampling results will be tabulated and summarized in the Preliminary Risk Assessment report for the site. All data obtained during this investigation will be in Environmental Restoration Program Information Management System (ERPIMS) format and an ERPIMS submittal is required for this project.

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6 HEALTH AND SAFETY REQUIREMENTS

6.1 General Practices

Project Health and Safety practices will adhere to the Base Wide Health and Safety Plan (HASP) (Bhate, 2003) and the project Activity Hazard Analysis (AHA), as included in Appendix C, for the investigation activities at the site. It is anticipated that no greater than modified level D PPE will be required to complete the site inspection and sampling activities. This includes: Occupational Safety and Health Administration (OSHA) approved safety shoes, American National Standards institute (ANSI) approved safety glasses (Z87.1) and hard hat (Z89.1-1997: Type I), sleeved shirt and long pants, and as required, hearing protection, leather work gloves and/or nitrile gloves during sampling.

6.2 Site Security

Site security is part of safety at the site for the investigation. Items of concern include the proper designation and demarcation of the investigation boundaries (i.e., exclusion zone (EZ), contamination reduction zone (CRZ) and construction zone (CZ)), as appropriate. Likewise, compliance with any intrusive work requirements, posting of potential hazards, and control of un-authorized site personnel (Bhate HASP, 2003) will be completed. This is discussed at length in the 2003 Base Wide HASP.

At a minimum, the site will be secured with caution tape surrounding the perimeter of the site delineating the outer boundary of the Construction Zone. This is essential in the utility clearance process and it serves as the demarcation of the site for both project and non-project persons.

6.3 Hydrogen Sulfide Gas Monitoring

Hydrogen sulfide gas has a strong odor that smells like rotten eggs. It is colorless and occurs naturally in the environment. Hydrogen sulfide gas can be formed and released whenever waste containing sulfur is broken down by bacteria. Sewers, septic tanks, livestock waste pits, man holes, well pits, and trucks that transport chemical wastes may release hydrogen sulfide gas. Hydrogen sulfide gas also can be found in groundwater, especially in wells near oil fields or in wells that penetrate shale or sandstone. Hydrogen sulfide gas also is found in petroleum and natural gas. The gas also can be produced by industries that work with sulfur compounds. Hydrogen sulfide gas is heavier than air, so its concentration is usually highest near the bottom of confined spaces.

The main way to be exposed to hydrogen sulfide gas is by breathing it. You also can have skin or eye contact with hydrogen sulfide gas. Hydrogen sulfide gas can be smelled at a level of about 10 parts per billion (ppb). Exposure to higher levels of hydrogen sulfide gas can irritate the eyes, the nose, and the lungs. Although hydrogen sulfide gas has a strong odor, extended exposure deadens the sense of smell. At a level of 50 to 100 parts per million (ppm) of hydrogen sulfide gas in air, the sense of smell begins to break down. As hydrogen sulfide gas levels increase, the

gas can cause eye irritation, dizziness, coughing, and headache. At levels greater than 250 ppm, hydrogen sulfide gas begins to affect your ability to breathe. Exposure to more than 600 ppm can be rapidly fatal. At levels less than 250 ppm, recovery occurs quickly if exposure to hydrogen sulfide gas is ended promptly. Long-term nervous system problems have been found in survivors of short- term, high-level exposures. Some heart defects also have been reported in these cases.

Site and operations monitoring will adhere to the guidelines and protocol established in the HASP Addendum and AHA (Appendix C).

7 FUTURE WORK

Upon completion of the fieldwork, sample analysis and data validation, the laboratory results shall be submitted to the RAM Group for incorporation into the on-going site-specific evaluation.

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8 ORGANIZATION AND SCHEDULE

During the investigation activities at the site, *Mr. Jerry Pelfrey* will serve as the Bhate Site Manager overseeing and directing all investigation sampling activities. Mr. Pelfrey will also provide on-site management of any sub-contractor for the project. *Mr. Frank Gardner* is the Bhate Program Manager and will ensure required project documents, permits, contractual agreements and other program tasks are completed. Key project personnel and others are listed in Table 8-1. The investigation activities are anticipated to begin in the second week of February, 2004 (Figure 5).

Table 8-1. Key Personnel and Responsibilities

Name	Project Title/Assigned Role	Phone Numbers
Frank Gardner	Bhate Program Manager	work: (970) 216-7819
Scott Dolvin	Senior Geologist/Project Manager	work: (205) 918-4028
Jerry Pelfrey	Site Manager/SHSO	work: (505) 679-2100
Dave Rizzuto	Field Manager	work: (505) 679-2011
Greg Dill	Project Geologist	work: (205) 918-4017
Robert Currence	Driller /Environmental Technician	work: (205) 918-4000
Eric Lehnertz	Corporate Health and Safety Officer	work: (205) 918-4029

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9 REFERENCES

Bhate Environmental Associates, Inc. November 2003. *Base Wide Health and Safety Plan.*

Bhate Environmental Associates, Inc. November 2003. *Base Wide Quality Assurance Project Plan.*

Foster Wheeler Environmental Corporation. March 1998. *Characterization Summary and No Further Action (NFA) Documentation for Installation Restoration Program Sites SS-2/5 POL Yard (AOC T), SD-47 POL Washrack Area (SWMU 133), and SS-60 Building 828 (SWMU 230).*

Foster Wheeler Environmental Corporation. July 2002. *2001 Long-Term Groundwater Monitoring Report, Holloman Air Force Base, New Mexico.*

Foster Wheeler Environmental Corporation and Groundwater Technology Government Services, Inc. February 1997. *Final Remediation Action Plan Officer's Club, Site SS-57, Holloman Air Force Base, New Mexico.*

Western Regional Climate Center (WRCC). 2003. *State of New Mexico Desert Research Institute: Climate of New Mexico.* http://www.wrcc.dri.edu/narratives/NEWMEXICO.htm.

White Sands Missile Range (WSMR). 2003. Public Affairs Office: Tularosa Basin Geology. http://www.wsmr.army.mil/paopage/Pages/WU%2360.htm.

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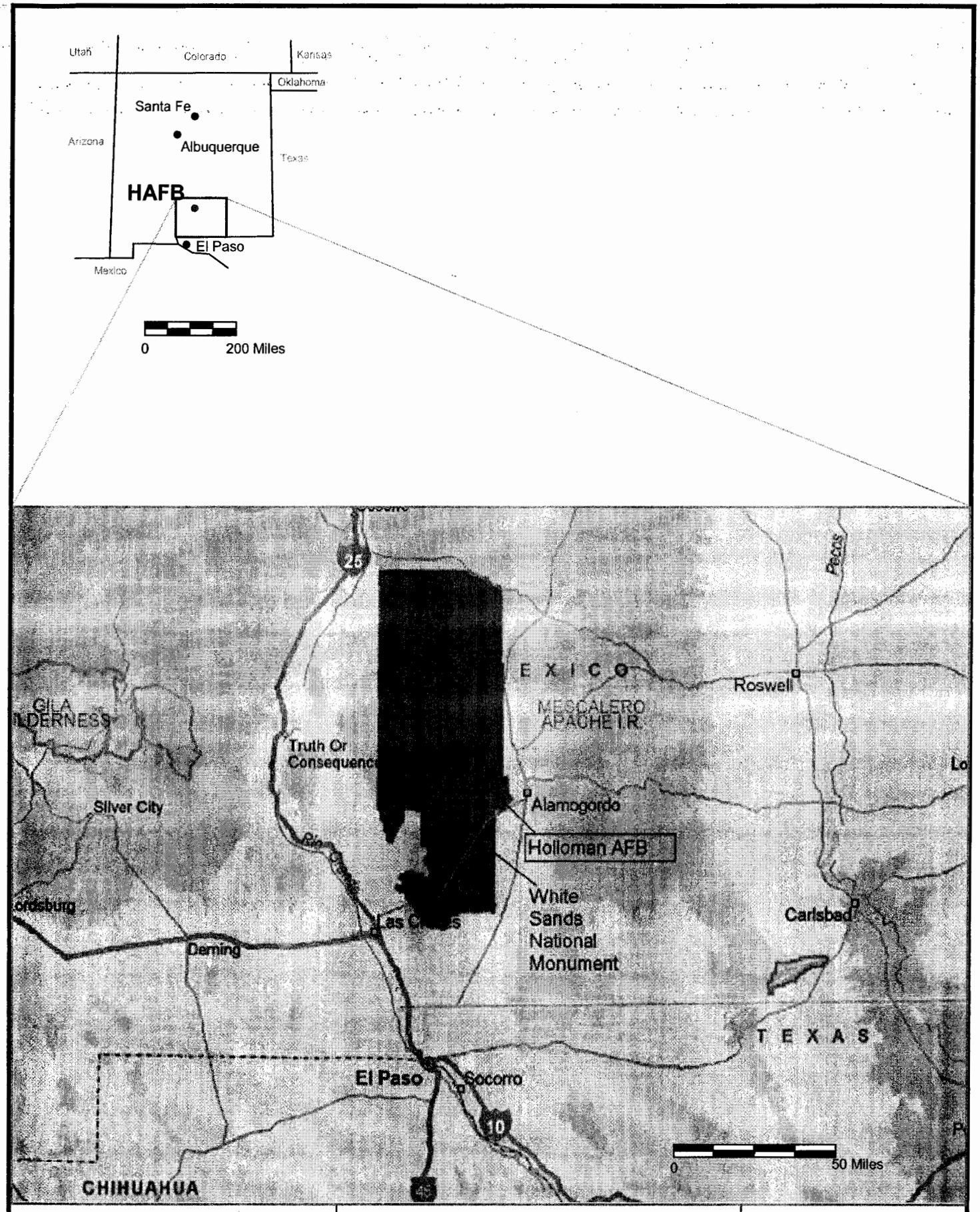
FIGURES



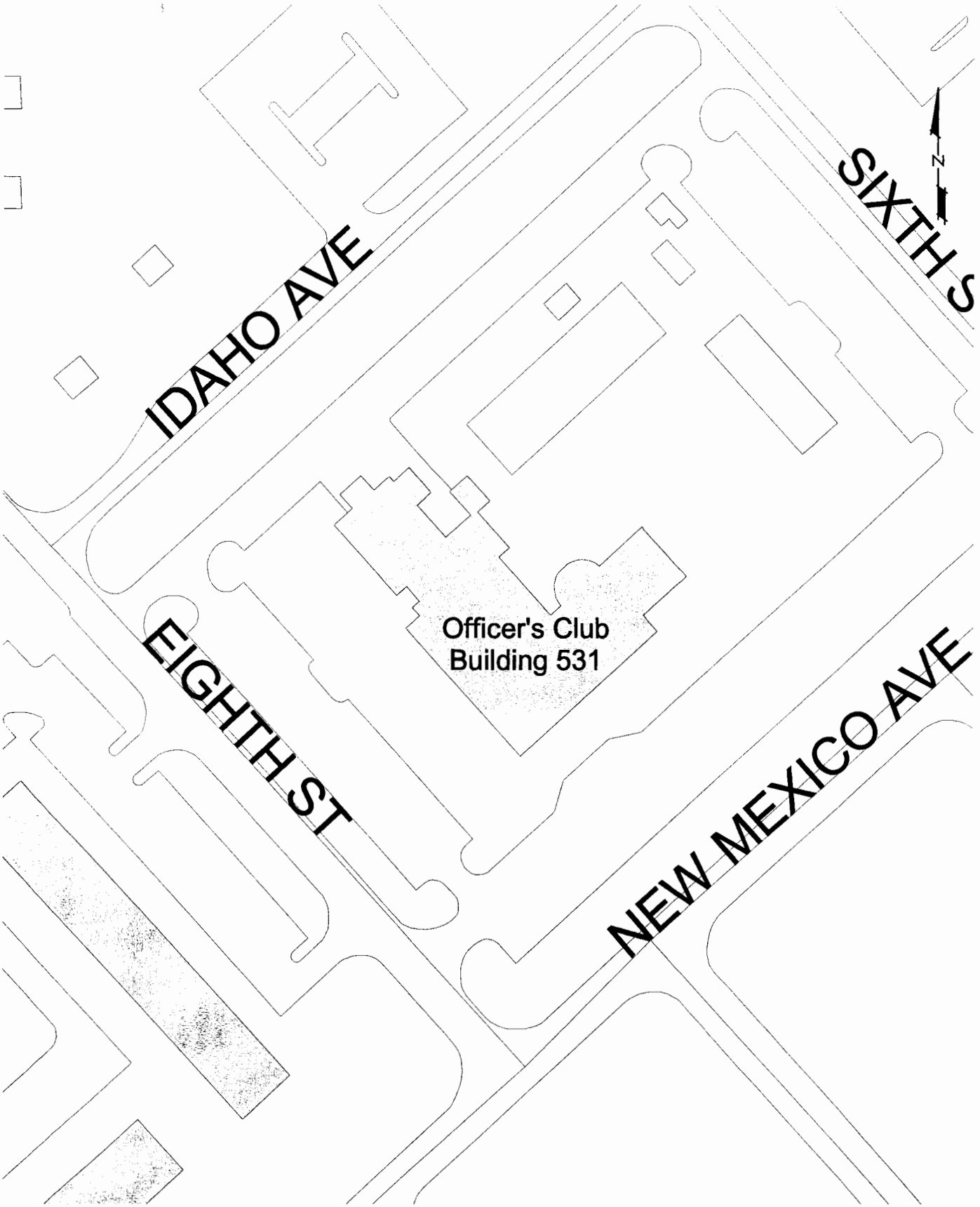
BHATE
Environmental Engineers and Scientists

LOCATION MAP

PROJECT NO.:	SCALE:	DATE:	DRAWN BY: SSD
9040002	SHOWN	8/6/03	FILE: 9040002-01.031-01

Holloman AFB,
New Mexico

Figure 1



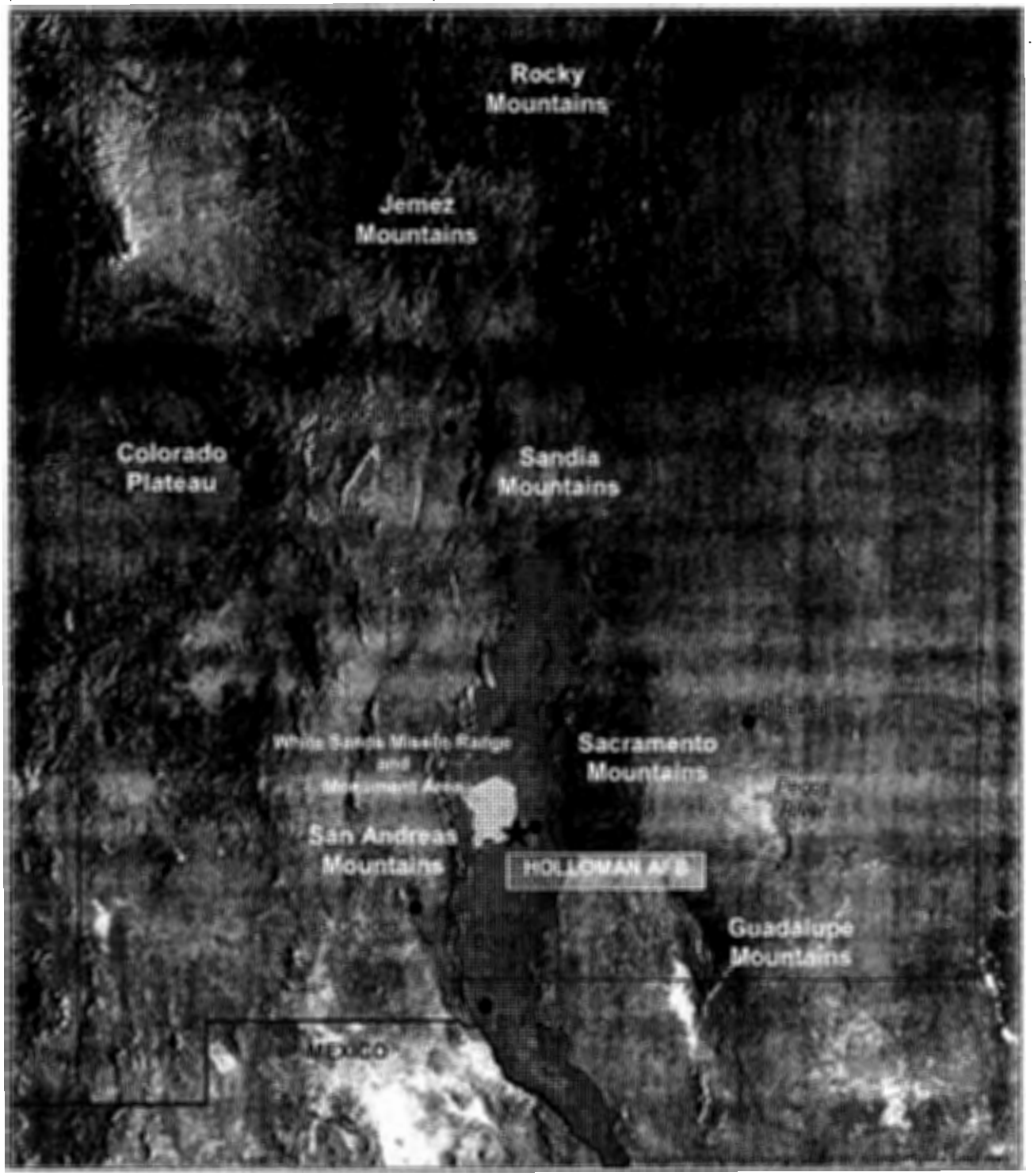
BHATE
Environmental Engineers and Scientists

Site Location Map

PROJECT NO.	SCALE	DATE	DRAWN BY:
9040002	1"=100'	1/27/04	cm
			DRAWING NO: gis

OFFICER'S CLUB
HOLLOMAN AFB
NEW MEXICO

FIGURE 2



NORTH

0 50 Miles

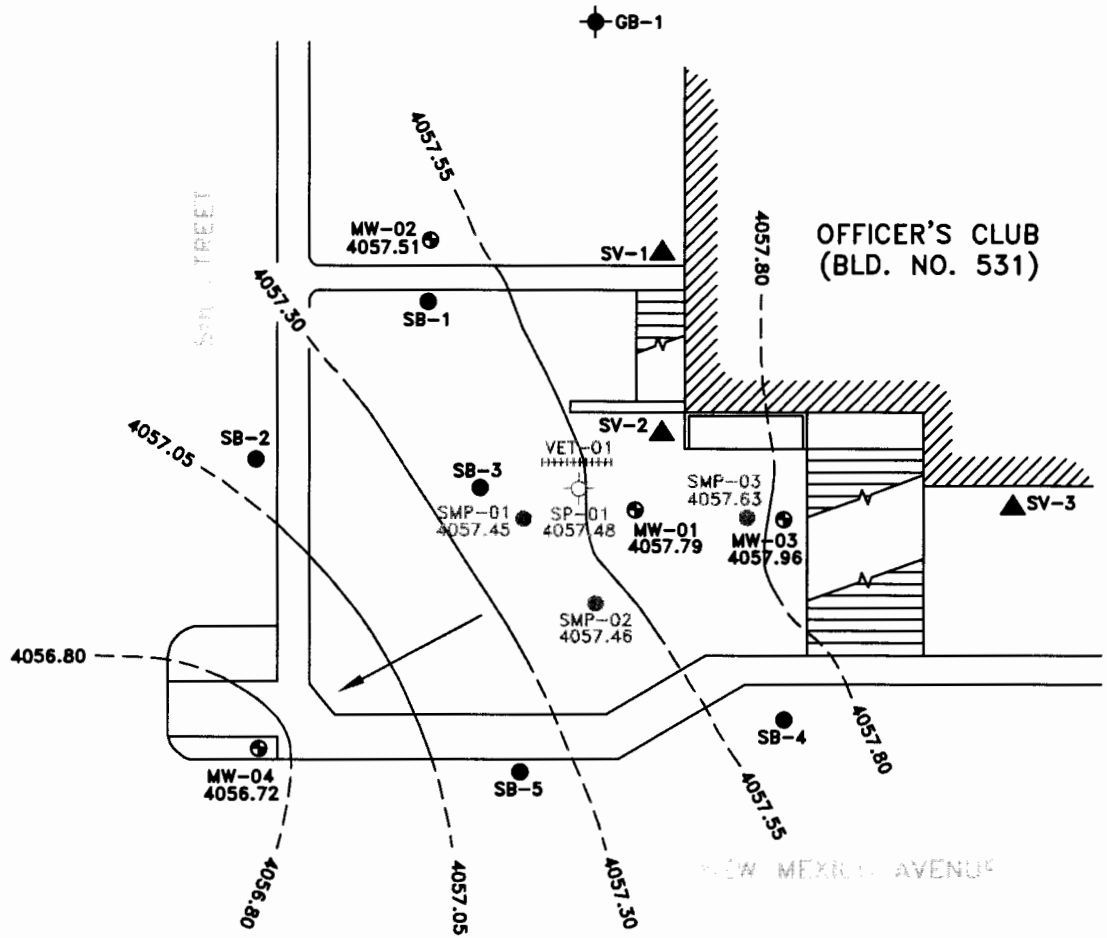
BHATE
Environmental Engineers and Scientists

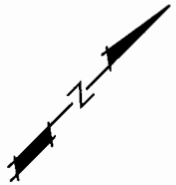
PHYSIOGRAPHIC MAP

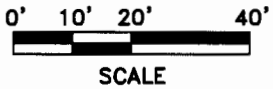
PROJECT NO.:	SCALE:	DATE:	DRAWN BY:
9040002	SHOWN	8/6/03	SSD
			FILE: 9040002-01.03-01

Holloman AFB
New Mexico

Figure 3







LEGEND

- ● PROPOSED SOIL BORING
- ▲ PROPOSED SOIL VAPOR
- GEOTECHNICAL BORING
- MONITOR WELL
- SPARGE POINT
- SPARGE MONITOR POINT
- VAPOR EXTRACTION TRENCH
- GROUNDWATER CONTOUR LINE (INFERRED WHERE DASHED)
- 4057.80 GROUNDWATER ELEVATION (APRIL 9, 1996)
- GROUNDWATER FLOW DIRECTION

NOTE: This information is depicted to provide visual aid within the context of this manual and should not be used as a sole reference in precise dimensioning of features indicated.

BHATE
Environmental Engineers and Scientists

SAMPLING LOCATIONS
OFFICER'S CLUB

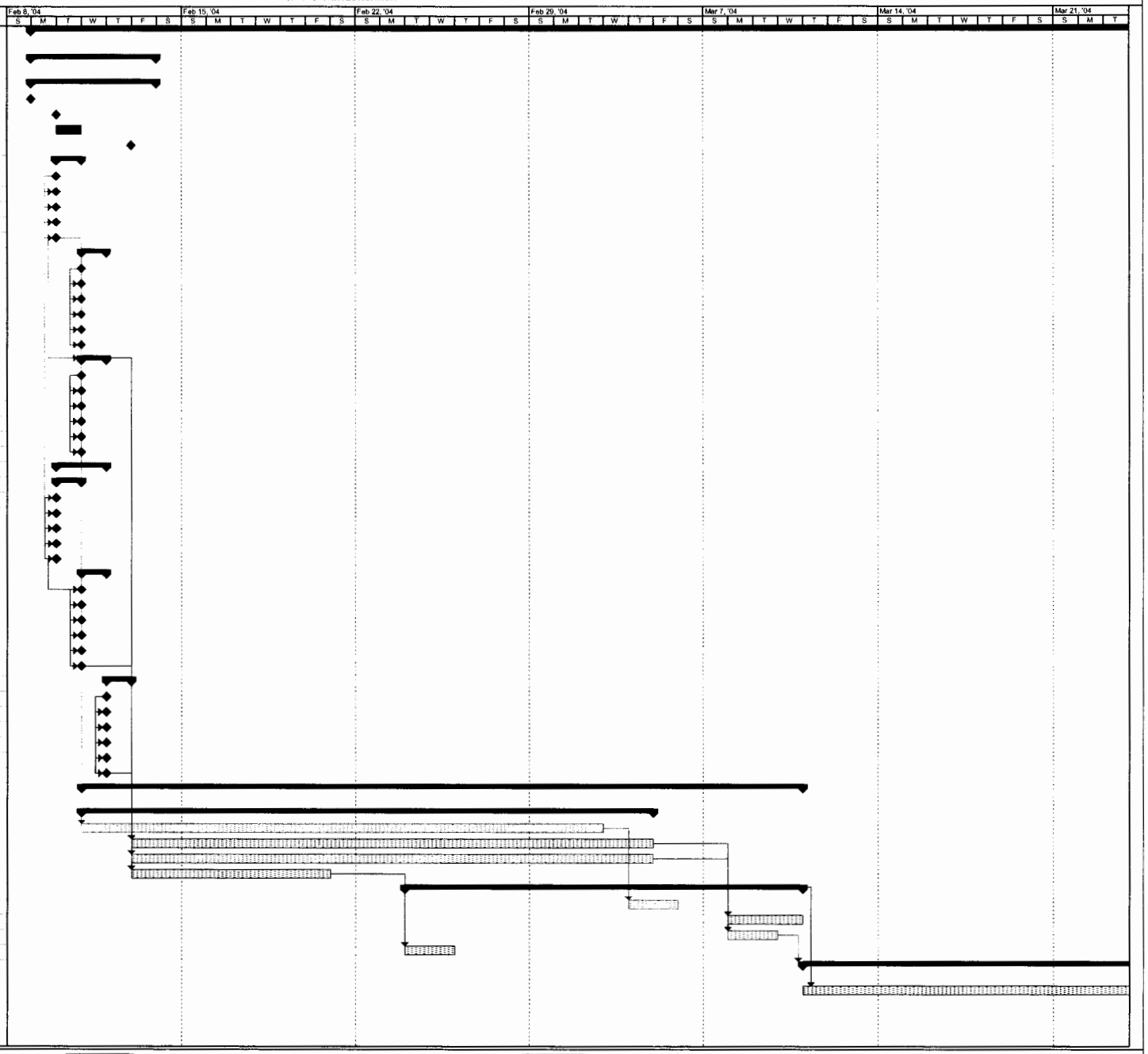
PROJECT NO.	SCALE	DATE	DRAWN BY: MRM
9040002	SHOWN	01/26/04	DRAWING NO: 9040002-03-01

SITE SS-57
HOLLOMAN AFB
NEW MEXICO

Figure 4

OFFICER'S CLUB
SS-57
DATA GAP INVESTIGATION

ID	Task No.	Task Name	Duration	Start	Finish
1		**PROJECT**	**70 days**	**Mon 2/9/04**	**Fri 5/14/04**
2	**1.0**	**FIELD ACTIVITIES**	**5 days**	**Mon 2/9/04**	**Fri 2/13/04**
3	1.1	**Mobilization**	**5 days**	**Mon 2/9/04**	**Fri 2/13/04**
4	1.1.1	Geologist on site	1 day	Mon 2/9/04	Mon 2/9/04
5	1.1.2	Delivery of Geoprobe	1 day	Tue 2/10/04	Tue 2/10/04
6	1.1.3	Site Logistics	1 day	Tue 2/10/04	Tue 2/10/04
7	1.1.4	Geologist off-site	1 day	Fri 2/13/04	Fri 2/13/04
8	1.2	Soil Sampling - New Locations	1 day	Tue 2/10/04	Tue 2/10/04
9	1.2.1	SB1	1 day	Tue 2/10/04	Tue 2/10/04
10	1.2.2	SB2	1 day	Tue 2/10/04	Tue 2/10/04
11	1.2.3	SB3	1 day	Tue 2/10/04	Tue 2/10/04
12	1.2.4	SB4	1 day	Tue 2/10/04	Tue 2/10/04
13	1.2.5	SB5	1 day	Tue 2/10/04	Tue 2/10/04
14	1.3	Soil Sampling - Soil Gas Locations	1 day	Wed 2/11/04	Wed 2/11/04
15	1.3.1	SV1 Shallow	1 day	Wed 2/11/04	Wed 2/11/04
16	1.3.2	SV1 Deep	1 day	Wed 2/11/04	Wed 2/11/04
17	1.3.3	SV2 Shallow	1 day	Wed 2/11/04	Wed 2/11/04
18	1.3.4	SV2 Deep	1 day	Wed 2/11/04	Wed 2/11/04
19	1.3.5	SV3 Shallow	1 day	Wed 2/11/04	Wed 2/11/04
20	1.3.6	SV3 Deep	1 day	Wed 2/11/04	Wed 2/11/04
21	**1.4**	**Geotechnical Sampling**	**1 day**	**Wed 2/11/04**	**Wed 2/11/04**
22	1.4.1	SV1 Shallow	1 day	Wed 2/11/04	Wed 2/11/04
23	1.4.2	SV1 Deep	1 day	Wed 2/11/04	Wed 2/11/04
24	1.4.3	SV2 Shallow	1 day	Wed 2/11/04	Wed 2/11/04
25	1.4.4	SV2 Deep	1 day	Wed 2/11/04	Wed 2/11/04
26	1.4.5	SV3 Shallow	1 day	Wed 2/11/04	Wed 2/11/04
27	1.4.6	SV3 Deep	1 day	Wed 2/11/04	Wed 2/11/04
28	**1.5**	**Groundwater Sampling**	**2 days**	**Tue 2/10/04**	**Wed 2/11/04**
29		**New Soil Borings**	**1 day**	**Tue 2/10/04**	**Tue 2/10/04**
30	1.5.1	SB1	1 day	Tue 2/10/04	Tue 2/10/04
31	1.5.2	SB2	1 day	Tue 2/10/04	Tue 2/10/04
32	1.5.3	SB3	1 day	Tue 2/10/04	Tue 2/10/04
33	1.5.4	SB4	1 day	Tue 2/10/04	Tue 2/10/04
34	1.5.5	SB5	1 day	Tue 2/10/04	Tue 2/10/04
35		**Existing Wells**	**1 day**	**Wed 2/11/04**	**Wed 2/11/04**
36	1.5.6	MW-1	1 day	Wed 2/11/04	Wed 2/11/04
37	1.5.7	MW-2	1 day	Wed 2/11/04	Wed 2/11/04
38	1.5.8	MW-3	1 day	Wed 2/11/04	Wed 2/11/04
39	1.5.9	MW-5	1 day	Wed 2/11/04	Wed 2/11/04
40	1.5.10	MW-7	1 day	Wed 2/11/04	Wed 2/11/04
41	1.5.11	MW-9	1 day	Wed 2/11/04	Wed 2/11/04
42	**1.6**	**Soil Vapor/Gas Sampling**	**1 day**	**Thu 2/12/04**	**Thu 2/12/04**
43	1.6.1	SV-1 Shallow	1 day	Thu 2/12/04	Thu 2/12/04
44	1.6.2	SV-1 Deep	1 day	Thu 2/12/04	Thu 2/12/04
45	1.6.3	SV-2 Shallow	1 day	Thu 2/12/04	Thu 2/12/04
46	1.6.4	SV-2 Deep	1 day	Thu 2/12/04	Thu 2/12/04
47	1.6.5	SV-3 Shallow	1 day	Thu 2/12/04	Thu 2/12/04
48	1.6.6	SV-3 Deep	1 day	Thu 2/12/04	Thu 2/12/04
49	**2.0**	**ANALYTICAL**	**21 days**	**Wed 2/11/04**	**Wed 3/10/04**
50	**2.1**	**Sample Analyses**	**17 days**	**Wed 2/11/04**	**Thu 3/4/04**
51	2.1.1	Soil Samples	13 days	Wed 2/11/04	Tue 3/2/04
52	2.1.2	Groundwater Samples	15 days	Fri 2/13/04	Thu 3/4/04
53	2.1.3	Geotech Sample	15 days	Fri 2/13/04	Thu 3/4/04
54	2.1.4	Soil Gas Samples	6 days	Fri 2/13/04	Fri 2/20/04
55	**2.2**	**Data Validation**	**12 days**	**Tue 2/24/04**	**Wed 3/10/04**
56	2.2.1	Soil Samples	2 days	Thu 3/4/04	Fri 3/5/04
57	2.2.2	Groundwater Samples	3 days	Mon 3/8/04	Wed 3/10/04
58	2.2.3	Geotech Sample	2 days	Mon 3/8/04	Tue 3/9/04
59	2.2.4	Soil Gas Samples	2 days	Tue 2/24/04	Wed 2/25/04
60	**3.0**	**REPORT**	**47 days**	**Thu 3/11/04**	**Fri 5/14/04**
61	3.1	Draft	27 days	Thu 3/11/04	Fri 4/16/04
62	3.2	Draft Review	5 days	Mon 4/19/04	Fri 4/23/04
63	3.3	Comment Response	5 days	Mon 4/26/04	Fri 4/30/04
64	3.4	Final	10 days	Mon 5/3/04	Fri 5/14/04



BHATE

Task | Progress | Summary | Rolled Up Split | Rolled Up Progress | Project Summary | Deadline
Split | Milestone | Rolled Up Task | Rolled Up Milestone | External Tasks | External Milestone

Project Manager: Frank Gardner
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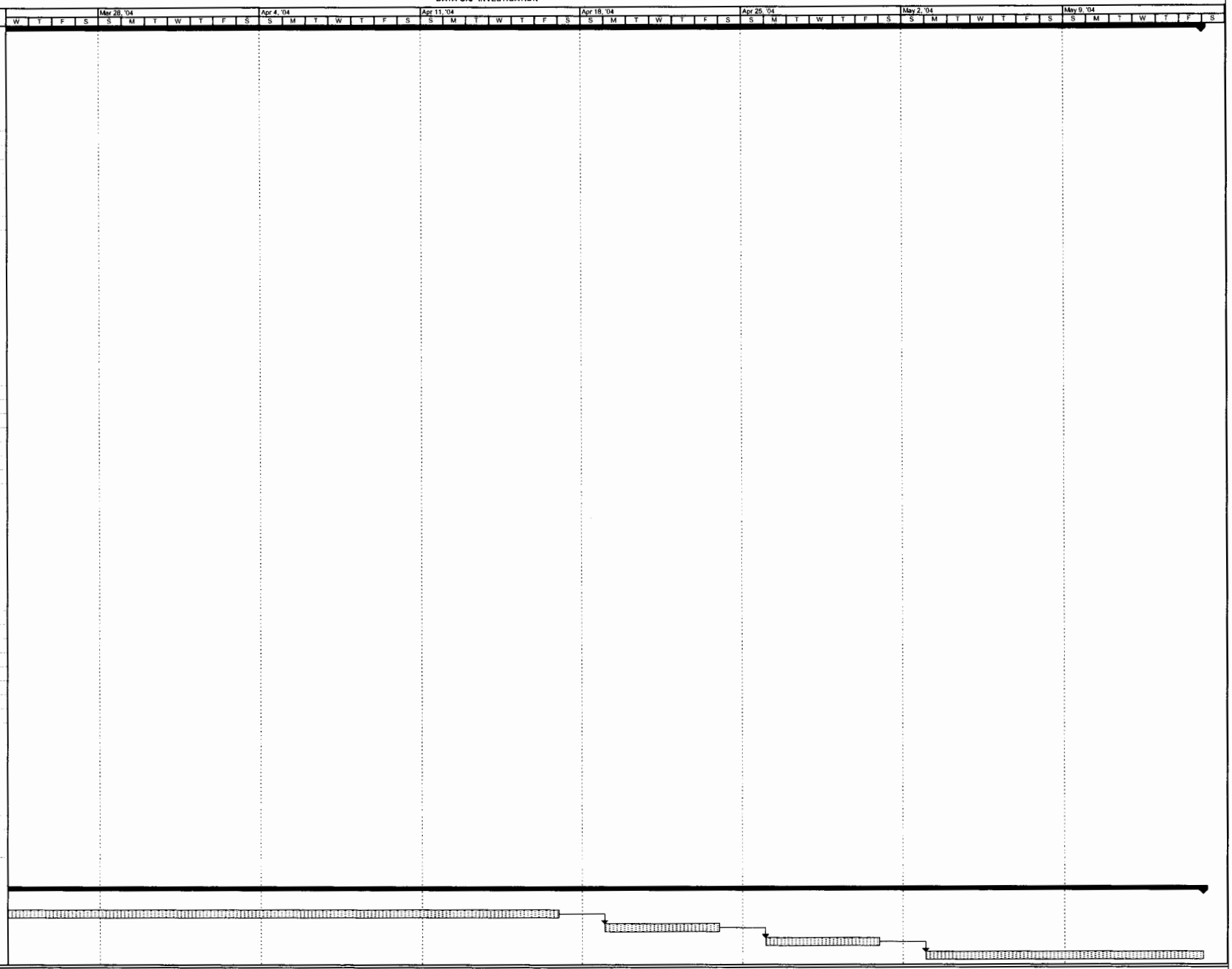
Thu 2/5/04
1

OFFICER'S CLUB
SS-57
DATA GAP INVESTIGATION

ID	Task No.	Task Name
1		**PROJECT**
2	**1.0**	**FIELD ACTIVITIES**
3	**1.1**	**Mobilization**
4	1.1.1	Geologist on site
5	1.1.2	Delivery of Geoprobe
6	1.1.3	Site Logistics
7	1.1.4	Geologist off-site
8	1.2	Soil Sampling - New Locations
9	1.2.1	SB1
10	1.2.2	SB2
11	1.2.3	SB3
12	1.2.4	SB4
13	1.2.5	SB5
14	1.3	Soil Sampling - Soil Gas Locations
15	1.3.1	SV-1 Shallow
16	1.3.2	SV-1 Deep
17	1.3.3	SV-2 Shallow
18	1.3.4	SV-2 Deep
19	1.3.5	SV-3 Shallow
20	1.3.6	SV-3 Deep
21	**1.4**	**Geotechnical Sampling**
22	1.4.1	SV1 Shallow
23	1.4.2	SV1 Deep
24	1.4.3	SV2 Shallow
25	1.4.4	SV2 Deep
26	1.4.5	SV3 Shallow
27	1.4.6	SV3 Deep
28	**1.5**	**Groundwater Sampling**
29		**New Soil Borings**
30	1.5.1	SB1
31	1.5.2	SB2
32	1.5.3	SB3
33	1.5.4	SB4
34	1.5.5	SB5
35		**Existing Wells**
36	1.5.6	MW-1
37	1.5.7	MW-2
38	1.5.8	MW-3
39	1.5.9	MW-5
40	1.5.10	MW-7
41	1.5.11	MW-9
42	**1.6**	**Soil Vapor/Gas Sampling**
43	1.6.1	SV-1 Shallow
44	1.6.2	SV-1 Deep
45	1.6.3	SV-2 Shallow
46	1.6.4	SV-2 Deep
47	1.6.5	SV-3 Shallow
48	1.6.6	SV-3 Deep
49	**2.0**	**ANALYTICAL**
50	**2.1**	**Sample Anlayses**
51	2.1.1	Soil Samples
52	2.1.2	Groundwater Samples
53	2.1.3	Geotech Sample
54	2.1.4	Soil Gas Samples
55	**2.2**	**Data Validation**
56	2.2.1	Soil Samples
57	2.2.2	Groundwater Samples
58	2.2.3	Geotech Sample
59	2.2.4	Soil Gas Samples
60	**3.0**	**REPORT**
61	3.1	Draft
62	3.2	Draft Review
63	3.3	Comment Response
64	3.4	Final



BHATE

Task | Progress | Summary | Rolled Up Split | Rolled Up Progress | Project Summary | Deadline
Split | Milestone | Rolled Up Task | Rolled Up Milestone | External Tasks | External Milestone

Project Manager: Frank Gardner
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Thu 2/5/04
2

APPENDIX A

BASE CIVIL ENGINEER WORK REQUEST AIR FORCE FORM 332

JANUARY 1992

BASE CIVIL ENGINEER WORK REQUEST

(See Back of This Form Set for Instructions)

Form Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average .3 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to the Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project 0704-0188, Washington DC 20503. Please DO NOT RETURN your form to either of these addresses. Send your completed form to HQ AFESC/DEMG.

SECTION 1 - TO BE COMPLETED BY REQUESTER

1. FROM *(Organization)*	2. OFFICE SYMBOL	3. DATE OF REQUEST	4. WORK REQUEST NO. *(For BCE Use)*
5. NAME AND PHONE NO. OF REQUESTER		6. REQUIRED COMPLETION DATE	7. BUILDING, FACILITY OR STREET ADDRESS WHERE WORK IS TO BE ACCOMPLISHED

8. DESCRIPTION OF WORK TO BE ACCOMPLISHED *(Include Sketch or Plan, when appropriate)*

9. BRIEF JUSTIFICATION FOR WORK TO BE ACCOMPLISHED *(Not required for maintenance and repair)*

10. DONATED RESOURCES

	FUNDS		LABOR		MATERIAL		CONTRACT BY REQUESTER		NONE

11. NAME OF REQUESTER	12. GRADE OF REQUESTER	13. SIGNATURE OF REQUESTER *(See Instructions on back)*

14. COORDINATION

SECTION II - FOR BASE CIVIL ENGINEER USE

15. WORK ORDER *(Place an "X" in the appropriate box.)*

	IN- SERVICE		SELF-HELP		CONTRACT		SABER

16. DIRECT SCHEDULED WORK *(Place an "X" in the appropriate box.)*

	EMERGENCY		URGENT		ROUTINE		SELF-HELP		M/C

17. SELF-HELP *(Place an "X" in the appropriate box.)*

	BRIEFING REQUIRED		ADEQUATE COORDINATION		INSPECTION REQUIRED

SECTION III - COMPLETE ONLY IF WORK IS TO BE ACCOMPLISHED BY WORK ORDER

18. WORK CLASS	19. PRIORITY	20. ESTIMATED HOURS	21. ESTIMATED FUNDED COST	22. ESTIMATED TOTAL COST

	23 THERE IS NO NEED FOR AN ENVIRONMENTAL ASSESSMENT (AFR 19-2)		24. A WRITTEN ASSESSMENT IS BEING/HAS BEEN PROCESSED		25. APPROVED		26. DISAPPROVED

27. REMARKS

SECTION IV - APPROVING AUTHORITY

28. NAME AND GRADE *(Please Type or Print)*	29. SIGNATURE	30. DATE

CONTINUATION SHEET FOR AF FORM 332

(COMPUTER GENERATED)

1. FROM *(Organization)*	2. OFFICE SYMBOL	3. DATE OF REQUEST	4. WORK REQUEST NO. *(For BCE Use)*

5. NAME AND PHONE NO. OF REQUESTER	6. REQUIRED COMPLETION DATE	7. BUILDING, FACILITY OR STREET ADDRESS WHERE WORK IS TO BE ACCOMPLISHED

8. DESCRIPTION OF WORK TO BE ACCOMPLISHED *(Include Sketch or Plan, when appropriate)*

APPENDIX B

SS-57 BASE WIDE SITE SAFETY AND HEALTH PLAN ADDENDUM

SITE-SPECIFIC ADDENDUM TO THE BASEWIDE HEALTH AND SAFETY PLAN

DATA ACQUISTION ACTIVITIES FOR OFFICERS CLUB, SITE SS-57 HOLLOMAN AIR FORCE BASE ALAMOGORDO, NEW MEXICO

Prepared for:

49 CES/CEV
Holloman Air Force Base, New Mexico

Under Contract To:

U.S. Army Corps of Engineers
Omaha District
Omaha, Nebraska
Under Contract No. DACA45-03-D-0023
Task Order No. 0002, WAD-1

Prepared by

Bhate Environmental Associates, Inc.
1608 13th Avenue South
Birmingham, Alabama 35205

February 2004

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SITE-SPECIFIC ADDENDUM
HOSPITAL UST SITE
HOLLOMAN AFB, NEW MEXICO

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A - Activity Hazards Analysis

ACRONYMS AND ABBREVIATIONS

AHA	Activity Hazard Analysis
ANSI	American National Standards Institute
Bhate	Bhate Environmental Associates, Inc.
CIH	Certified Industrial Hygienist
EPA	Environmental Protection Agency
HAFB	Holloman Air Force Base
HASP	Health and Safety Plan
HSM	Health and Safety Manager
MSDS	Material Safety Data Sheet
mg/M^3	milligrams per cubic meter of air
NIOSH	National Institute for Occupational Safety and Health
PPE	personal protective equipment
ppm	parts per million
SPF	sun protection factor
SPM	Senior Project Manager
SSHO	Site Safety and Health Officer
USACE	US Army Corps of Engineers

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1 PROJECT SAFETY COORDINATION

1.1 Introduction

This Site-Specific Addendum (SSA) to the Basewide Health and Safety Plan (HASP) submitted by Bhate Environmental Associates, Inc. (Bhate) was developed to address any health and safety issues that may not be adequately addressed in the HASP for implementation on this Scope of Work (SOW). The requirements of this site-specific addendum are applicable to Bhate employees, their subcontractors, and site visitors. The health and safety requirements described in this SSA in addition to those found in the HASP, will apply to field activities pertaining to this SOW conducted at the site.

Bhate will be responsible for overall health and safety of the project and will enforce the requirements of this SSA for site project personnel. Bhate's subcontractors will be required to comply with the requirements of this SSA and also be responsible for site safety related to, or affected by, their specific operations. If any subcontractor activities are not listed in the hazard identification and control section of this SSA, then an addendum describing those hazards and controls will be prepared by the subcontractor and reviewed by Bhate.

A fully trained and experienced Site Safety and Health Officer (SSHO) will be on-site during field activities to implement and enforce the health and safety procedures outlined in this SSA. Before work area entry, site personnel and visitors must attend a site-specific safety and health briefing session, to be conducted by the SSHO. The briefing will cover potential site hazards and specific requirements of this SSA.

The overall responsibility for the health and safety of project personnel lies with the Project Manager. If there is any question whether an unplanned occurrence on site may compromise health and safety, the SSHO has the authority to interrupt operations and to remove personnel from the area. If work is stopped due to any health or safety concern, immediate attention will be given by health and safety personnel, working in cooperation with the Project Manager, to identify and correct the cause of concern as quickly as possible. Any such incident will be fully documented by the SSHO in a report to the HSM and Project Manager.

For emergency developments on the site, communications begin with the SSHO. The SSHO will report safety and/or health related incidents to the HSM and the Project Manager. The SSHO will contact others if additional assistance is needed.

1.2 Responsibilities/Qualifications of Key Personnel

The following summarizes the personnel with operational and health and safety responsibilities for the activities covered by this SSA (Table 1-1).

Table 1-1 Project Team Members with Health and Safety Responsibilities

Title	Name:	Office Telephone:
Site Manager/SSHO	Jerry Pelfrey	(505) 679-2100
Senior Project Manager	Frank Gardner	(970) 216-7819
Health and Safety Manager	Eric Lehnertz, CIH	(205) 918-4000

1.2.1 Project Manager

The Project Manager is the senior Bhate representative for the project. The Project Manager reports directly to Bhate corporate management and site contacts. The Project Manager is committed to overall success of the project, including performance of site work in accordance with this SSA. The Project Manager is responsible for the preparation, organization, and review of projects and plans, including the SSA and is responsible for the selection, assignment, and conduct of site personnel. The Project Manager helps coordinate field activities, site contacts, and regulatory officials, serves as liaison with the USACE, and coordinates preparation of any final reports and supporting documentation. The Project Manager has overall responsibility for the health and safety of Bhate personnel working on site.

1.2.2 Health and Safety Manager

The HSM, a Certified Industrial Hygienist (CIH), will assist with the development, implementation, and oversight of the HASP and this SSA.

1.2.3 Site Health and Safety Supervisor

The SSHO will functionally report to the Site Manager, with secondary and tertiary reporting requirements to the Bhate Project Manager and HSM. The SSHO has delegated authority from the HSM and respective corporate management to enforce this SSA.

The SSHO is responsible for site health and safety. He/she has the authority and responsibility for stopping site work should activities jeopardize the health and safety of workers or the public. (If practical, the Project Manager and HSM should be consulted before any operation is interrupted.) Additional responsibilities of the SSHO include:

- Provide site orientation/safety training for personnel actively involved in site work.
- Facilitate daily safety briefings and inspections.
- Inspect health and safety equipment daily.
- Select protective equipment and clothing in accordance with this SSA.
- Confirm worker's suitability for performance of activities.

- Establish and maintain safety zones in accordance with this SSA.
- Control entry and egress from the work area.
- Coordinate the project safety and health program with site personnel.
- Overview site work hazards.
- Inspect the work site daily to ensure compliance with the safety and health requirements.
- Coordinate medical care.
- Generally enforce the requirements of this SSA.

The SSHO will take the following action(s), as appropriate, and in accordance with this SSA:

- Report all safety and/or health related incidences to the HSM and the Bhate Project Manager.
- Order the immediate shut-down of site activities in case of medical emergency or unsafe practice.
- Restrict visitors from areas of potential exposure to harmful substances.

1.2.4 First Aid/CPR Personnel

At least two people currently certified in first aid/cardio-pulmonary resuscitation (CPR) by the American Red Cross or equivalent agency will be present at the project site at all times during site operations.

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2 PROJECT BACKGROUND AND SCOPE

The objective of this data collection effort is to fill in the data gaps to complete a site-specific risk evaluation. In the Fall of 1991, hydrogen sulfide odors were detected in the Officers Club building and the site was designated as SS-57. The odors were attributed to the degradation of diesel fuel hydrocarbons which leaked from underground storage tank (UST) or pipeline prior to 1991. This incident resulted in several investigations of USTs located in the southwestern corner of the Officers Club.

As part of these investigations, seven monitoring wells have been installed, fourteen soil borings (excluding borings for monitoring wells) have been drilled, and an air sparging/soil vapor extraction (AS/SVE) system was installed.

Further, a preliminary risk assessment conducted in April 2002 indicated that diesel concentrations exceeded the New Mexico Environment Department (NMED) residential, as well as industrial target levels.

Based on review of the available data and discussions with NMED, it was decided to conduct a site-specific risk assessment at the site. The results of this risk assessment will be used to develop corrective action plans if necessary or to close the site if the estimated risk is acceptable.

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3 HAZARD ASSESSMENT AND CONTROLS

3.1 Task Hazard(s) Summary

The potential health and safety hazards of this task are summarized below in Table 3-1. The potential for encountering these hazards is ranked (high, moderate, or low) based on the work to be performed and the hazard control measures to be used.

Table 3-1 Task Hazards Summary

Summary	Hazard potential [High, Moderate, or Low]	Description of potential hazards
v **Safety** (i.e. Walking and working surfaces, heavy equipment, traffic, falls, excavations, power and hand tools, materials handling, confined spaces, electrical safety, etc.)	• Moderate All tasks and their control measures are addressed in Task Specific Activity Hazard Analyses (AHAs)	• Walking and surfaces, • Heavy equipment and vehicular traffic • Materials handling • Slips, trips, and falls
v **Utilities**	• Low	• Buried • Over head • Building Although these hazards should not be associated with this particular scope of work, it is necessary to verify that the hazards can be controlled.
v **Chemical**	• Moderate	• Potential for exposure to neat products should be limited to equipment fluids (fuel, lubricants, coolant, etc.) • Petroleum Hydrocarbons
v **Physical**	• Moderate	• Thermal stressors • Equipment noise
v **Biological** (i.e. Plants, animals, insects, spiders, infectious waste)	• Low	Potential for contact should be minimal.

3.2 Hazard Control Measures

Site personnel will follow the following general safety rules. These precautionary measures are designed to reduce the risks of inadvertent or accidental injury or chemical exposure during on-site operations.

1. Site personnel must attend the Daily Safety Briefing. Participation in daily safety meetings will meet the requirement for weekly safety meetings and therefore will not require a separate weekly safety meeting.
2. Site personnel will be familiar with standard operating procedures and will adhere to instructions and requirements in the SSHP.
3. Any individual taking prescribed drugs shall inform the SSHO of the type of medication. The SSHO will review the matter with the HSM, as necessary, who will decide if the employee can safely work on-site while taking the medication.
4. Medicine and alcohol can exacerbate the effects from exposure to toxic chemicals. While field operations are in effect, alcoholic beverage intake should be minimized or avoided during off-work hours. Personnel performing onsite operations should not take prescribed drugs where the potential for absorption, inhalation, or ingestion of toxic substances exists unless specifically approved by a qualified physician. Do not work when ill.
5. The personal protective equipment specified by the SSHP shall be worn by site personnel.
6. Eating, drinking, chewing tobacco or gum, smoking and any other practice that may increase the possibility of hand-to-mouth contact is prohibited in the work area. (Exceptions may be permitted by the SSHO to allow fluid intake during heat stress conditions.)
7. All lighters, matches, cigarettes and other forms of tobacco are prohibited in the work area.
8. All signs and demarcations shall be followed. Such signs and demarcation shall not be removed except as authorized by the SSHO.
9. No one shall enter a permit-required confined space without a permit. Confined space entry permits shall be implemented as issued.
10. All personnel must follow Hot Work Permits as issued.
11. All personnel must follow the work-rest regimens and other practices required by the heat stress program.
12. Rest breaks shall be taken in approved locations.
13. All personnel must follow lockout/tagout procedures when working on equipment involving moving parts or hazardous energy sources.
14. No person shall operate equipment unless trained and authorized.
15. No one may enter an excavation greater than four feet deep unless authorized by the Competent Person as defined by Title 29 Code of Federal Regulations (CFR) Part 1926 Subpart P. Excavations must be sloped or shored properly. Safe means of access and egress from excavations must be maintained.
16. Ladders and scaffolds shall be solidly constructed, in good working condition and inspected prior to use. No one may use defective ladders or scaffolds.
17. Fall protection or fall arrest systems must be in place when working at elevations greater than six feet for temporary working surfaces and four feet for fixed platforms.

18. Safety belts, harnesses and lanyards must be selected by the SSHO. The user must inspect the equipment prior to use. No defective personal fall protection equipment shall be used. Personal fall protection that has been shock loaded must be discarded.
19. Hand and portable power tools must be inspected prior to use. Defective tools and equipment shall not be used.
20. Ground fault circuit interrupters (GFCIs) shall be used for cord and plug equipment used outdoors or in damp locations. Electrical cords shall be kept out of walkways and puddles unless protected and rated for the service.
21. Improper use, mishandling or tampering with health and safety equipment and samples is prohibited.
22. Horseplay of any kind is prohibited.
23. Possession or use of alcoholic beverages, controlled substances or firearms on any site is forbidden.
24. All incidents, no matter how minor, must be reported immediately to the SSHO.
25. Personnel shall be familiar with the Site Emergency procedures.

As part of the Activity Hazard Analysis (AHA) process, AHAs that summarize the anticipated hazards and control measures for the activities listed in the SOW are included as Attachment A.

3.3 Written Safety Procedures and Programs

Table 3-2 provides a summary of the existing safety procedures and programs will be used for this task or site. Copies of applicable procedures and programs are included in Basewide HASP, as indicated.

Table 3-2 Written Safety Procedures and Programs

Reference Procedure or Program	Applicable Section(s)
Bhate Hazard Communication Program	All (Refer to Basewide HASP)
Bhate Respiratory Protection Program	All (Refer to Basewide HASP)
Bhate Hearing Conservation Program	All (Refer to Basewide HASP)

3.4 Permits

Table 3-3 summarizes the required work permits that must be completed prior to the start of field work. No Bhate work permits are anticipated for this project.

Table 3-3 Required Work Permits

Permit	Notes and comments (reference activities, procedures, and coordination with appropriate organizations):
HAFB Dig Permit	Site Manager will arrange for AF Form 332 to be completed and obtain a dig permit/utility clearance through the HAFB Infrastructure Organization.

4 PERSONAL PROTECTIVE EQUIPMENT

The following personal protective equipment (PPE) as presented in Table 4-1 will be used for the identified activities.

Table 4-1 Personal Protective Equipment by Activity

Activity	Head/Face	Foot	Hands	Respiratory	Clothing
Mobilization / Demobilization	Hard Hat (for overhead hazards), Safety Glasses[1] with rigid side shields.	Steel toed boots	Leather gloves as needed	None[3, 4]	Minimum of long pants and shirts with a minimum 4-inch sleeve
General Site Labor	Hard Hat (for overhead hazards), Safety Glasses[1] with rigid side shields.	Steel toed boots	Leather gloves as needed	None[3, 4]	Minimum of long pants and shirts with a minimum 4-inch sleeve
Equipment Operation	Hard Hat[2] (for overhead hazards), Safety Glasses[1] with rigid side shields.	Steel toed boots. Boot covers for entering and exiting equipment.	Leather gloves as needed	None[3, 4] N95 Air Purifying Respirator with Organic vapor cartridges based on monitoring	Minimum of long pants and shirts with a minimum 4-inch sleeve
Equipment Decontamination	Hard Hat[2] (for overhead hazards), Safety Glasses[1] with rigid side shields.	Steel toed boots. Boot covers.	Chemical resistant gloves	None[3, 4] N95 Air Purifying Respirator with Organic vapor cartridges based on monitoring	Minimum of long pants and shirts with a minimum 4-inch sleeve Tyvek coveralls may be worn as recommended by the SSHO.
Soil and Groundwater Sampling	Hard Hat[2] (for overhead hazards), Safety Glasses[1] with rigid side shields.	Steel toed boots	Chemical resistant gloves	None[3, 4] N95 Air Purifying Respirator with Organic vapor cartridges based on monitoring	Minimum of long pants and shirts with a minimum 4-inch sleeve Tyvek coveralls may be worn as recommended by the SSHO.
Supervision of work	Hard Hat (for overhead hazards), Safety Glasses[1] with rigid side shields.	Steel toed boots	Leather gloves as needed	None[3, 4]	Minimum of long pants and shirts with a minimum 4-inch sleeve

Note:

[1] Safety Glasses with rigid side shields approved by American National Standards Institute (ANSI) Z-87 required at all times.

[2] Hard hats are not required inside fully enclosed equipment cabs.

[3] Voluntary use of respirators is authorized for comfort from nuisance dusts and odors, provided they are issued and used in accordance with established respiratory protection program procedures.

[4] Cartridge change out will occur at the following conditions:

- Damage to cartridge
- Cartridge is wet, restriction in breathing, unusual odors
- Cartridge is visibly clogged with dust, restriction in breathing
- After 40 hours of use with no continuous exposures over the established Permissible Exposure Limits (PELs)
- Changes that may be otherwise identified in 29 CFR 1910.120.

The following qualified person certifies that the selection of PPE is based on best available information about the work requirements and anticipated hazards.

Printed name:	**Signature:**	**Date:**
Eric Lehnertz, CIH, **Bhate Health and Safety Manager**		

5 SITE MONITORING

Site monitoring will be conducted using direct-reading instruments primarily in the workers' breathing zone. To the extent feasible, site operations will be conducted and modified as needed to ensure that personnel are situated upwind of the excavation activities. Initial upwind background and work-zone readings will be obtained before the initiation of activities. Readings of breathing zones (unless location is otherwise specified) will be taken periodically during all activities. The SSHO has the authority to modify the level of protection required for work at this site as well as halt operations as deemed necessary to control personal exposures. Monitoring results will be recorded on an Atmospheric Monitoring Log Field Health and Safety form maintained by the SSHO. Monitoring, calibrating, and maintaining instruments are the responsibility of the SSHO. Table 5-1 summarizes the site monitoring parameters and action levels applicable for direct reading exposure monitoring.

Table 5-1 Direct Reading Exposure Monitoring

Activity(s)	Instrument	Action Level(s) and Frequency	Actions
Soil Boring and Sampling	Volatile Organic Compounds (VOCs) (Total by Photoionization Detector {PID})	0 - 9 ppm Every 15 minutes during intrusive activities	Continue work in required PPE and continue monitoring.
		10 - 49 ppm (Sustained for more than 5 minutes)	**Monitor for benzene.** Ensure personnel are upwind, notify the Site Manager. SSHO may upgrade PPE to Level C respiratory protection with organic vapor cartridge, as necessary. If benzene is detected follow response actions outlined for benzene.
	Benzene (By colorimetric tube or similar) Where indicted by PID readings	No detection up to 0.2 ppm	Continue work activities in required protective equipment.
		> 0.2 ppm	Cease work, exit the area to upwind location and notify the Site Manager.
	Personal DataRam or similar particulate monitor.	=1.5 mg/M^3 particulates (average) not to exceed 5.0 mg/M^3 5 minute monitoring periods every minutes as necessary if visible dust is not controlled	Stop work, increase dust suppression
	Hydrogen Sulfide (H_2S) with Combustible Gas Indicator/4 gas meter	> 5 ppm Upon opening existing wells and every 15 minutes during soil boring or as odors detected.	Cease work, exit the area to upwind location and notify the Site Manager.

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6 SITE CONTROL AND DECONTAMINATION

Site-specific site control measures will be used to control access to the work area. Tables 6-1 summarizes the site control requirements applicable for both general work area.

Table 6-1 Site Control for General Work Area(s)

Location	Site Control Procedure (discuss important elements such as signs, barricades, fencing, briefings, sign-in/out logs, etc.)
General Work Area	The work area will be clearly demarcated with signage and/or caution tape, as needed, or where necessary to restrict foot or vehicle traffic. Entry into the work area will require authorization by the Site Manager.

Required decontamination procedures are described below in Table 6-3.

Table 6-2 Decontamination Procedures by Location

Type of decontamination	Decontamination Methods
Personnel decontamination	Personnel will be required to thoroughly wash hands and face prior to eating, drinking or smoking. Disposable PPE (from potential sampling events) will be collected for proper disposal. Additional decontamination procedures will be developed by the SSHO as needed.
Equipment decontamination	Efforts will be made to minimize equipment contact with contaminated materials. Prior to leaving the work area, equipment (soil boring equipment and hand tools) will be decontaminated. Soils from the dry decontamination process or any liquids for a wet decontamination process will be disposed of properly.

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7 COMMUNICATIONS

Cellular telephones will be available to summon emergency services as required. Refer to Sections 10, 11 and 12 of this SSA for site specific guidance on emergency situations and appropriate actions. Site communication amongst workers shall be a combination of verbal and line of sight hand communications. **Cellular telephone use is not permitted while operating equipment.**

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8 MEDICAL SURVEILLANCE AND TRAINING

The medical surveillance and training requirements for Bhate's on-site personnel working on the debris recycling project will follow the requirements outlined in the Basewide HASP Sections 7.4 and 5, respectively.

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9 HAZARDOUS CHEMICALS

Hazardous chemicals (as defined in 29 CFR 1910.1200) to be brought or used on-site are identified below. This chemical inventory and Material Safety Data Sheet (MSDSs) will be maintained by the SSHO.

Table 9-1 Sample Chemical Identification

Chemical Name	Amount	Location	Purpose
Assorted fuels, lubricants, coolants, etc. necessary for equipment operation	No storage planned. Quantities limited to immediate use requirements of on-site equipment.	No storage planned. Materials to be brought on-site by vendor's maintenance vehicle.	Equipment Servicing and Operation

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10 EMERGENCY ACTION AND RESPONSE

Personnel responsible for coordinating emergency response actions during the SS-57 site remediation activities are identified below in Table 10-1. A map showing directions to the authorized medical facility is attached in Figure 12-1.

Table 10-1 Emergency Coordinator

Responsibility	Name	Phone Number(s)
Task Emergency Coordinator	Jerry Pelfrey	Office (505) 679-2100 Cell (505) 491-8261

If an emergency situation develops which requires evacuation of the work area, the evacuation procedures in Table 10-2 shall be followed.

Table 10-2 Evacuation Procedures

Evacuation Step	Methods and comments:
Notify affected workers	Use of site communication methods as applicable
Evacuate to safe location	Assemble at the primary evacuation site (support area outside of the exclusion zone)
Assemble and account for workers	Emergency Coordinator shall account for personnel using site Sign in/Sign out sheet.
Notify Fire and Emergency Services	Notification as needed.
Complete Incident Report	Follow the Incident Reporting and Investigation Procedure.

Table 10-3 summarizes potential emergency situations and response actions that are applicable for the SS-57 project site.

Table 10-3. Potential Emergency Situations

In case of:	Response actions:
Injury or illness	Treat injury with applicable First Aid. All work related injuries beyond first aid will result in notification of Emergency Services and notification of the employee supervisor. Any employee requiring advanced medical treatment will be accompanied by a knowledgeable company employee that can answer potential questions on job duties and hazards. Make notifications in accordance with the Incident Reporting and Investigation Procedure.
Chemical exposure	First Aid shall be provided such as but not limited to: move victim to fresh air, remove contaminated clothing, flush affected skin with water, and seek medical attention.
Fire or explosion	Notify emergency services immediately. All personnel shall evacuate the immediate area of the fire and move to an upwind location. Personnel shall not engage in fire fighting activities use of fire extinguisher) unless trained to do so and only in the incipient stages of fire.
Adverse weather	Tornados, lightning or other threatening weather conditions will result in an immediate shut down of operations and evacuation of personnel. Lightning proximity will be determined by measuring the time interval between the visually lightning flash and the subsequent sound of thunder. An interval less than 30 seconds will prompt the shut down. Operations will be shut down for the period of the storm passing plus an additional 20 minutes.
Material spill or release	Vehicles and equipment will be maintained and inspected so as to prevent fluid leaks. Should any vehicle fluid leaks occur the equipment will be taken out of service to make necessary repairs and any contaminated material will be clean-up and disposed of properly. Spill kits will be available to facilitate prompt containment and clean-up of spills. Notification will be made in accordance with the Incident Reporting and Investigation Procedure. Storage areas will be designed to have secondary containment as required, work plans executed to accommodate stormwater runoff and minimize the potential for contamination spread.

11 EMERGENCY CONTACTS

In the event of an emergency, the following contacts should be made, as appropriate:

HAFB Emergency Number (using HAFB phone system).....9-911
Operators will assist with Medical, Fire, and Police emergencies

HAFB Security Force.....(505) 572-5037

HAFB Fire Protection.....(505) 572-1117

HAFB Hospital – 49th Medical Group (Main switchboard).....(505) 572-2778

Civilian Hospital (Alamogordo) Gerald Champion Regional Medical Center.....(505) 439-6100

After initial contacts have been made and the situation has stabilized, notify the Site Manager/SSHO, Senior Project Manager, and/or HSM, as appropriate.

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12 HOSPITAL DIRECTIONS

In the event of a true medical emergency ("life or limb"), HAFB Emergency Services should be used. Notification of any injury must be made to HAFB Emergency Services. Bhate personnel and subcontractors should not transport injured personnel to the HAFB Hospital without prior authorization from HAFB Emergency Services.

Other injuries should be treated as necessary at Gerald Champion Regional Medical Center at 2669 Scenic Drive, Alamogordo, NM 88330. From HAFB, exit the Main Gate and proceed east on US-70 onto US-54, continue north on US-54 to Indian Wells Road, turn right heading east to Scenic Drive, and turn left on Scenic proceed to the medical center. A map to this hospital is presented in Figure 12-1.

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FIGURES

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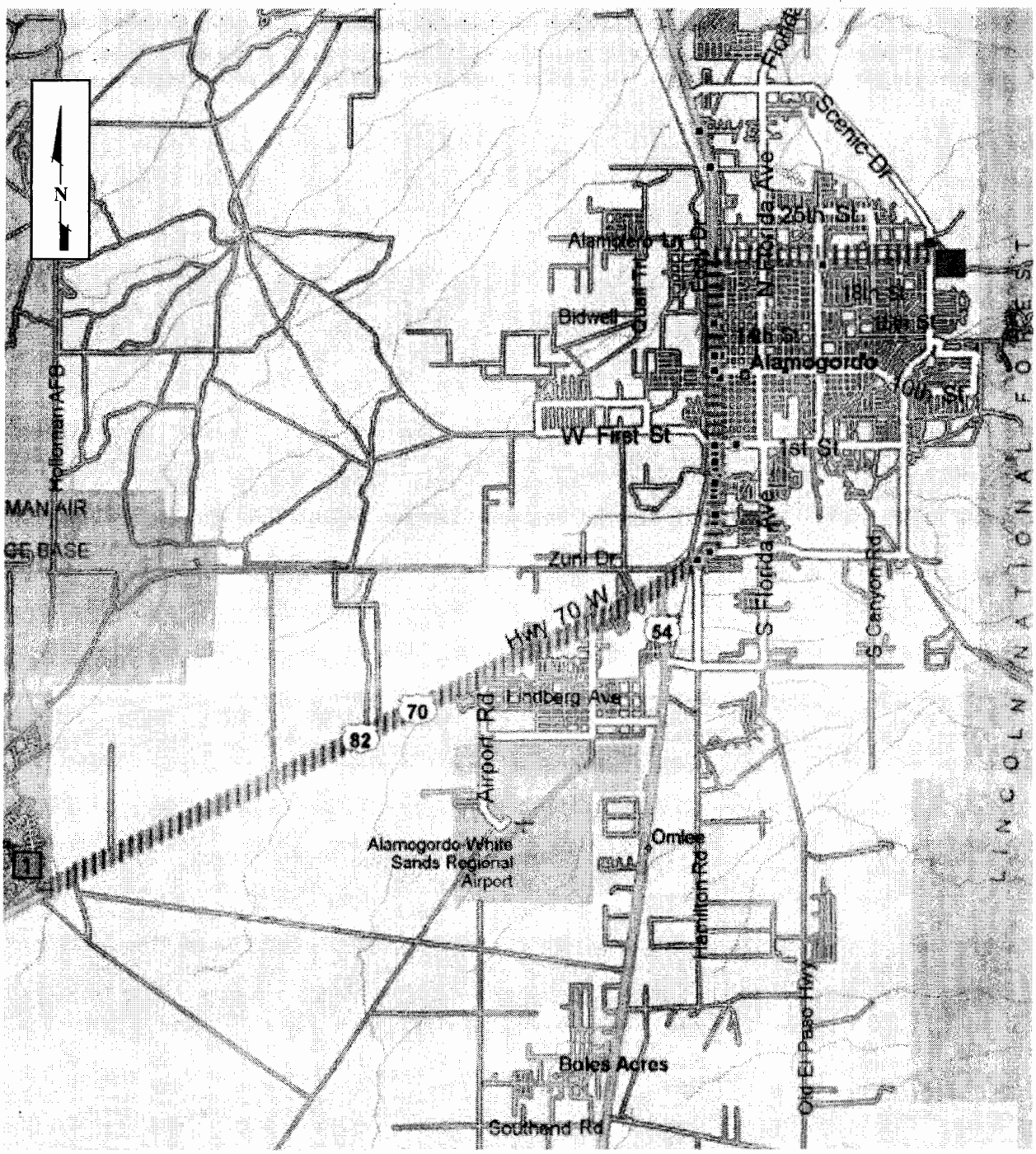
Figure 12-1. Hospital Route Map



Bhate Environmental Associates, Inc. BHATE	Source: Microsoft Expedia Street Maps HOSPITAL ROUTE MAP Gerald Champion Regional Hospital Not to Scale / Date 10/01/03	Holloman Air Force Base Health and Safety Plan Figure 12-1

ATTACHMENTS

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ATTACHMENT A

ACTIVITY HAZARD ANALYSES (AHAS)

AHA No.	AHA Title
AHA – SS-57	Soil Boring and Sampling

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Activity Hazard Analysis (AHA) – SS-57

Task: Soil Boring and Sampling		**Project:** SS-57
Minimum Personal Protective Equipment (PPE): Level D PPE		**Location:** Holloman Air Force Base, New Mexico
Activity	**Potential Hazard(s)**	**Control Measures**
General Site Activities, Mobilization and Demobilization Potential Hazards and control measures presented under General Site Activities apply for all project activities.	Slips, trips, or falls on walking and working surfaces	• Maintain clean work areas by following good housekeeping procedures • Be alert for uneven and variable terrain • Wear slip resistant footwear when walking/working on slippery surfaces or slopes • Provide adequate lighting in all work areas
	Exposure to high noise from heavy equipment and power tools	• Hearing protection will be worn with a noise reduction rating capable of maintaining personal exposure below 85 dBA (ear muffs or plugs); the SSHO will determine the need for hearing protection; all equipment will be equipped with manufacturer's required mufflers
	Eye injury	• Use approved safety glasses with rigid side shields
	Overhead hazards	• Personnel will be required to wear hard hats that meet ANSI Standard Z89.1 in all areas with overhead hazards
	Dropped objects	• Steel toe boots meeting ANSI Standard Z41 will be worn in all project areas
	Back injury from lifting heavy loads	• Site personnel will be instructed on proper lifting techniques • Mechanical devices should be used to reduce manual handling of materials • Team lifting should be utilized if mechanical devices are not available
	Thermal Stressors (i.e. heat stress, cold stress)	• Employees will have appropriate clothing for variable weather • Use of long sleeves or application of sunscreen with a high SPF on exposed skin encouraged • Employees will take breaks and drink plenty of fluids, as necessary, to prevent heat stress • Refer to the Basewide HASP for detailed information on heat and cold stress

AHA – SS-57

Activity	Potential Hazard(s)	Control Measures
General site activities, Mobilization and Demobilization (continued)	Spills/Fire	• Fuel cans will be NFPA approved • Equipment fueling shall be conducted in approved locations • Fuel cans will be equipped with pouring spout or a funnel will be used • Spill and absorbent materials will be readily available • Smoking and open flames are not permitted in fueling/greasing areas
	Vehicle operations in or adjacent work area	• Equipment operators shall exercise caution and maintain control when operating on uneven terrain • Signs, barricades, flagmen, and/or other traffic control devices will be used to control traffic in the work area, as necessary • Use a spotter to back drill rig into position, as necessary
Soil Boring and Sampling	Drill Rig Hazards Including but not limited to: Flying debris, falling objects, noise, hydraulic failures, unguarded machinery, equipment rollover, movement of large, heavy drilling tools, etc.	• Drill rig is to be operated and maintained by qualified operators • A Drill Rig Inspection Checklist (following) should be completed daily to ensure that the rig is operating properly. The inspection will include fittings, cables, pins, connections, lubrication points, operating controls, emergency stop switches, etc. • To the extent possible, the terrain should be level and the condition of the ground such that unexpected movement of the rig is unlikely • Stabilize the rig prior to boring in accordance with manufacturer's recommendations • Wear required PPE (hard hat, safety glasses, work gloves, ear muffs or plugs, steel toe work boots), ensure loose clothing is secured • Maintain good housekeeping on and around drill rig

AHA – SS-57

Activity	Potential Hazard(s)	Control Measures
Soil Boring and Sampling (continued)	Overhead/buried utilities	• Completion of a HAFB Excavation Permit or equivalent permit is required prior to the start of intrusive activities • Overhead utilities should be considered live until determined otherwise. Maintain a minimum distance of 15 feet from overhead utilities • All underground utilities must be clearly marked before beginning work • No borings shall be made within a 4 foot "Buffer Zone" of any utility marking
	Exposure to soil or groundwater contaminants	• To the extent possible, conduct work in a manner that minimizes potential contact with subsurface materials • Refer to Site Monitoring requirements • Wear chemical resistant gloves when handling soil samples • SSHO shall conduct breathing zone monitoring for VOCs with a PID/FID if any odors or visible soil staining are encountered. If there are any detections above background sustained for more than 5 minutes, cease work, exit the area to upwind location. SSHO may require an upgrade in PPE or modification to work methods based on monitoring results • Wash hands and face prior to eating or drinking after handling potentially contaminated materials

Equipment Used	Inspection Requirements	Training Requirements
Level D PPE First Aid Kits Portable Eyewash Fire Extinguishers Direct Push Rig Soil Sampling Equipment PID/FID CGI	Weekly inspections will be performed on fire extinguishers. Weekly inspections will be performed on first aid kits. Portable eye wash will be inspected weekly.	Personnel have read and understand the work plan and AHA Site specific briefing At least two individuals on-site will have current CPR and First aid training Note: Refer to the Basewide HASP for additional guidance, as necessary

APPENDIX C

SS-57 BASE WIDE QUALITY ASSURANCE PROJECT PLAN ADDENDUM

QUALITY ASSURANCE PROJECT PLAN ADDENDUM
DATA ACQUISITION PLAN FOR RISK ASSESSMENT
OFFICERS CLUB, SITE SS-57
HOLLOMAN AIR FORCE BASE
NEW MEXICO

Prepared for:

49CES/CEV
Holloman Air Force Base
New Mexico

Under Contract To:

U.S. Army Corps of Engineers
Omaha, NE
Under Contract No. DACA45-03-D-0008
Delivery Order 1

February 2004

Prepared by:

Bhate Environmental Associates, Inc.
1608 13th Avenue South, Suite 300
Birmingham, Alabama 35205

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QUALITY ASSURANCE PROJECT PLAN ADDENDUM

DATA ACQUISITION PLAN FOR RISK ASSESSMENT

OFFICERS CLUB, SITE SS-57

HOLLOMAN AIR FORCE BASE

NEW MEXICO

REVIEW SHEET

COMMITMENT TO IMPLEMENT THIS BASEWIDE QUALITY ASSURANCE PROJECT PLAN		
Michael J. D'Auben	Scott Dobrin for	February 5, 2004
Project Chemist	Signature	Date
Frank Gardner	Frank Gardner	February 5, 2004
Project Manager	Signature	Date
Jerry Pelfrey	Jerry M. Pelfrey	February 5, 2004
Site Manager	Signature	Date

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QUALITY ASSURANCE PROJECT PLAN ADDENDUM
DATA ACQUISITION PLAN FOR RISK ASSESSMENT
OFFICERS CLUB, SITE SS-57
HOLLOMAN AIR FORCE BASE
NEW MEXICO

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3-2 Summary of Definitive Data

4-1 Summary of Field QC Requirements

4-2 Summary of Laboratory QC Limits

Attachments

ELAB of Nashville – USACE Laboratory Validation Letter

ELAB of Nashville – NELAC Laboratory Certification

LIST OF ACRONYMS

DO	Dissolved Oxygen
DQOs	Data Quality Objectives
DRO	Diesel Range Organics
ERPIMS	Environmental Resources Program Information Management System
FS	Feasibility Study
GRO	Gasoline Range Organics
HAFB	Holloman Air Force Base
LCL	Lower Control Limit
LCS	Laboratory Control Sample
MDL	Method Detection Limit
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MS/MSD	Matrix Spike/Matrix Spike Duplicate
NELAC	National Environmental Laboratory Accreditation Conference
NFA	No Further Action
ng/L	nanogram per liter
ORO	Oil Range Organics
ORP	Oxidation Reduction Potential
QA	Quality Assurance
QAM	Quality Assurance Manual
QAPP	Quality Assurance Project Plan
QC	Quality Control
RPD	Relative Percent Difference
SOPs	Standard Operating Procedures
SS-61	Spill Site 61
SVOC	Semivolatile Organic Compounds
TOC	Total Organic Carbon
UCL	Upper Control Limit
ug/kg	micrograms per kilogram
ug/L	micrograms per liter
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
UST	Underground Storage Tank
VCA	Voluntary Corrective Action
VOA	Volatile Organic Analysis
VOC	Volatile Organic Compound
WP	Work Plan

QUALITY ASSURANCE PROJECT PLAN ADDENDUM

This Quality Assurance Project Plan Addendum (QAPP Addendum) has been developed to assure that sample collection, analyses, and evaluations are legally and scientifically defensible for data acquisition and risk assessment at the Officers Club site (SS-57) at Holloman Air Force Base (HAFB). This document is an addendum to the *Basewide Quality Assurance Project Plan, Holloman Air Force Base, New Mexico* (Bhate, November 2003) (Basewide QAPP) and must be used in conjunction with that document. This document contains the site specific information for the work at SS-57 outlined in the *Data Acquisition for Risk Assessment, Officers Club, Site SS-57, Holloman Air Force Base, New Mexico* (February, 2004).

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1 INTRODUCTION

Bhate Environmental Associates, Inc. (Bhate) has been retained by the U.S. Army Corps of Engineers (USACE), under contracts DACA45-02-D-0008, Delivery Order No. 1, to conduct additional field activities in support of data acquisition for a risk assessment at the Officers Club (SS-57 site) Holloman Air Force Base (HAFB), New Mexico. The primary objective of this field activity is to provide additional information on the site to support the risk assessment at the SS-57 Site.

See the Basewide QAPP and SS-57 Work Plan for additional information on HAFB and the SS-57 site.

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2 PROJECT LABORATORY

The analytical work for this project will be preformed by ELAB of Tennessee, 227 French Landing Drive, Nashville, TN 37228. The laboratory personnel who will be involved with this project include:

- **Rick Davis**, ELAB Vice President of Operations, phone (615) 345-1115
- **Marcia McGinnity**, ELAB Project Manager, phone (615) 345-1115
- **Doris Curry**, ELAB Quality Assurance Manager, phone (615) 345-1115

ELAB is certified by both the National Environmental Laboratory Accreditation Council (NELAC) and the USACE and has extensive previous experience in working on USACE projects. Copies of the laboratory's current certifications can be found in the Attachment to this QAPP Addendum. The ELAB Laboratory Quality Assurance Manual (QAM) and Standard Operating Procedures (SOPs) have been reviewed by Bhate and found to meet all the requirements for this project. The QAM and SOPs are available for further review if required.

In addition, the soil vapor samples collected as part of this project (see Section 2) will be performed by Air Toxics Ltd., 180 Blue Ravine Road, Suite B, Folsom, CA 95630. The primary personnel involved with this project will be:

- **Heidi Hayes**, Air Toxics Laboratory Director, phone (916) 985-1000
- **Diane Dodge**, Air Toxics Project Manager, phone (916) 985-1000
- **James Parker**, Air Toxics Quality Assurance Manager, phone (916) 985-1000

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3 DATA CATEGORIES

The data use determines the required levels of data quality. The two levels of data quality established by the USACE are screening and definitive. Under this QAPP Addendum, the data to be generated under each level in this investigation are presented in Table 3-1 (Screening) and Table 3-2 (Definitive). The Screening data in this project is intended to guide VCA activities and will involve confirmation analysis. The Definitive data generated by the laboratory will be presented with limited data deliverables (i.e. Level II data packages), using a 21 day turn-around-time. None of the data generated during the course of this project will require an Environmental Resources Program Information Management System (ERPIMS) format electronic data deliverable (EDD).

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4 DATA QUALITY ASSURANCE AND QUALITY CONTROL

The general data QA and QC requirements for HAFB are presented in the Basewide QAPP. The field QC requirements for this project are presented in Table 4-1. The project specific laboratory QC limits are listed in Table 4-2.

All final definitive data will be reviewed and validated by the Bhate Senior Chemist, Michael J. D'Auben, based on the guidelines of the USEPA National Functional Guidelines for Data Validation and the site specific laboratory QC limits.

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5 REFERENCES

Bhate, November 2003. *Final Basewide Quality Assurance Project Plan, Holloman Air Force Base, New Mexico.*

Bhate, February 2004. *Data Acquisition Plan for Risk Assessment, Officers Club, Site SS-57, Holloman Air Force Base, New Mexico.*

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TABLES

Table 3-1
Summary of Screening Data

Parameter	Matrix	Testing Method
Volatile Organic Compounds (VOC)	Soil	Headspace by Organic Vapor Analyzer (OVA)
Temperature	Groundwater	multi-parameter sonde and a flow-through cell
Turbidity	Groundwater	multi-parameter sonde and a flow-through cell
pH	Groundwater	multi-parameter sonde and a flow-through cell
Dissolved Oxygen	Groundwater	multi-parameter sonde and a flow-through cell
Conductivity	Groundwater	multi-parameter sonde and a flow-through cell
ORP	Groundwater	multi-parameter sonde and a flow-through cell

Table 3-2
Summary of Definitive Data

Parameter	Matrix	Testing Method
Volatile Organic Compounds (VOCs)	Soil	USEPA SW-846 Method 8260B
Semivolatile Organic Compounds (SVOCs)	Soil	USEPA SW-846 Method 8270C
Total Petroleum Hydrocarbons (TPH)	Soil	TX Method 1005
Carbon Chain	Soil	TX Method 1006
Volatile Organic Compounds (VOCs)	Groundwater	USEPA SW-846 Method 8260B
Total Petroleum Hydrocarbons (TPH)	Groundwater	TX Method 1005
Carbon Chain	Groundwater	TX Method 1006
Benzen, Ethylbenzen, Toluene and Xylene (BETX)	Air	USEAP Method TO-14A collected in 6L Summa canisters

Table 4-1
Summary of Field QC Samples

Matrix	Analysis	Number of Field Samples	Ambient Blanks	Equipment Blanks	Trip Blanks[1]	Field Duplicates	Field Splits	MS/MSD	Total
Soil	VOC by EPA Method 8260B	13	0	1	1	1	0	2	18
	SVOC by EPA Method 8670C	13	0	1	0	1	0	2	17
	TPH by TX Method 1005	13	0	1	0	1	0	2	17
	Carbon Chains by TX Method 1006	13	0	1	0	1	0	2	17
Groundwater	VOC by EPA Method 8260B	11	0	1	1	1	0	2	16
	TPH by TX Method 1005	11	0	1	0	1	0	2	15
	Carbon Chains by TX Method 1006	11	0	1	0	1	0	2	15
Soil Gas	BTEX, MTBE, Naphthalene by EPA Method TO-14A	6	1	0	0	1	0	0	8
	TPH-GRO by TO-03	6	1	0	0	1	0	0	8
	TPH-DRO by NIOSH 1550	6	1	0	0	1	0	0	8

[1]Estimated, one trip blank will accompany every shipment of volatile samples

Table 4-2
Summary of Laboratory QC Limits

Parameter	MDL			LCS						Matrix Spike Water			Matrix Spike Soil		
				Air		Water		Soil		Recovery		MSD	Recovery		MSD
	Air	Water	Soil	LCL	UCL	LCL	UCL	LCL	UCL	LCL	UCL	RPD	LCL	UCL	RPD
BETX per EPA Method 8260B	ppbv	ug/L	ug/kg	%	%	%	%	%	%	%	%	%	%	%	%
Benzene	--	1	1	--	--	70	125	71	123	70	125	20	71	123	20
Ethylbenzene	--	1	1	--	--	75	120	75	120	75	120	20	75	120	20
Toluene	--	1	1	--	--	73	119	63	128	73	119	20	63	128	20
Xylene (total)	--	1	1	--	--	75	122	75	125	75	122	20	75	125	20
1,2-Dichloroethane-d4 (surr)	--	--	--	--	--	74	131	70	125	--	--	--	--	--	--
4-Bromofluorobenzene (surr)	--	--	--	--	--	76	128	75	116	--	--	--	--	--	--
Dibromofluoromethane (surr)	--	--	--	--	--	80	129	64	131	--	--	--	--	--	--
Toluene-d8 (surr)	--	--	--	--	--	85	115	70	123	--	--	--	--	--	--
PAHs by EPA Method 8270C	ppbv	ug/L	ug/kg	%	%	%	%	%	%	%	%	%	%	%	%
Acenaphthene	--	2	100	--	--	40	112	27	116	40	112	20	27	116	20
Acenaphthylene	--	2	100	--	--	37	115	33	120	37	115	20	33	120	20
Anthracene	--	2	100	--	--	45	118	35	122	45	118	20	35	122	20
Benzo(a)anthracene	--	2	100	--	--	43	138	33	139	43	138	20	33	139	20
Benzo(b)fluoranthene	--	2	100	--	--	31	146	30	140	31	146	20	30	140	20
Benzo(k)fluoranthene	--	2	100	--	--	40	127	30	150	40	127	20	30	150	20
Benzo(g,h,i)perylene	--	2	100	--	--	35	129	30	146	35	129	20	30	146	20
Benzo(a)pyrene	--	2	100	--	--	38	144	30	144	38	144	20	30	144	20
Chrysene	--	1	100	--	--	42	142	33	142	42	142	20	33	142	20
Dibenz(a,h)anthracene	--	2	100	--	--	38	130	34	148	38	130	20	34	148	20
Dibenzofuran	--	2	100	--	--	40	115	30	110	40	115	20	30	110	20
Fluoranthene	--	2	100	--	--	47	132	32	122	47	132	20	32	122	20
Fluorene	--	1	100	--	--	41	115	32	127	41	115	20	32	127	20
Indeno(1,2,3-cd)pyrene	--	2	100	--	--	37	130	34	147	37	130	20	34	147	20
Naphthalene	--	2	100	--	--	30	119	30	115	30	119	20	30	115	20
Phenanthrene	--	2	100	--	--	45	117	35	119	45	117	20	35	119	20
Pyrene	--	2	100	--	--	51	137	33	150	51	137	20	33	150	20
2,4,6-Tribromophenol (surr)	--	--	--	--	--	34	129	38	121	--	--	--	--	--	--
2-Fluorobiphenyl (surr)	--	--	--	--	--	30	103	31	100	--	--	--	--	--	--
2-Fluorophenol (surr)	--	--	--	--	--	14	100	21	100	--	--	--	--	--	--
Nitrobenzene-d5 (surr)	--	--	--	--	--	32	107	27	100	--	--	--	--	--	--
Phenol-d5 (surr)	--	--	--	--	--	15	100	19	106	--	--	--	--	--	--
Terphenyl-d14 (surr)	--	--	--	--	--	28	154	35	123	--	--	--	--	--	--
Total Petroleum Hydrocarbons by Texas Method 1005	ppbv	ug/L	ug/kg	%	%	%	%	%	%	%	%	%	%	%	%
C6-C10 (GRO)	--	50	5000	--	--	50	150	50	150	50	150	20	50	150	20
Bromofluorobenzene (surr)	--	--	--	--	--	50	150	50	150	--	--	--	--	--	--
C10-C22 (DRO)	--	50	2000	--	--	50	150	50	150	50	150	25	50	150	25
C22-C36 (ORO)	--	50	2000	--	--	50	150	50	150	50	150	25	50	150	25
Ortho-terphenyl (surr)	--	--	--	--	--	50	150	50	150	--	--	--	--	--	--
Aliphatics Carbon Chain by Texas Method 1006	ppbv	ug/L	ug/kg	%	%	%	%	%	%	%	%	%	%	%	%
C6	--	50	5000	--	--	50	150	50	150	50	150	20	50	150	20
C6-C8	--	50	5000	--	--	50	150	50	150	50	150	20	50	150	20
C8-C10	--	50	5000	--	--	50	150	50	150	50	150	20	50	150	20
Bromofluorobenzene (surr)	--	--	--	--	--	50	150	50	150	--	--	--	--	--	--
C10-C12 (DRO)	--	50	2000	--	--	50	150	50	150	50	150	25	50	150	25
C12-C16 (ORO)	--	50	2000	--	--	50	150	50	150	50	150	25	50	150	25
C16-C35 (ORO)	--	50	2000	--	--	50	150	50	150	50	150	25	50	150	25
Ortho-terphenyl (surr)	--	--	--	--	--	50	150	50	150	--	--	--	--	--	--

Table 4-2
Summary of Laboratory QC Limits

Parameter	MDL			LCS						Matrix Spike Water			Matrix Spike Soil		
				Air		Water		Soil		Recovery		MSD	Recovery		MSD
	Air	Water	Soil	LCL	UCL	LCL	UCL	LCL	UCL	LCL	UCL	RPD	LCL	UCL	RPD
Aromatics Carbon Chain by Texas Method 1006	ppbv	ug/L	ug/kg	%	%	%	%	%	%	%	%	%	%	%	%
C7-C8	--	50	5000	--	--	50	150	50	150	50	150	20	50	150	20
C8-C10	--	50	5000	--	--	50	150	50	150	50	150	20	50	150	20
C10-C12	--	50	5000	--	--	50	150	50	150	50	150	20	50	150	20
Bromofluorobenzene (surr)	--	--	--	--	--	50	150	50	150	--	--	--	--	--	--
C12-C16	--	50	2000	--	--	50	150	50	150	50	150	25	50	150	25
C16-C121	--	50	2000	--	--	50	150	50	150	50	150	25	50	150	25
C21-C35	--	50	2000	--	--	50	150	50	150	50	150	25	50	150	25
Ortho-terphenyl (surr)	--	--	--	--	--	50	150	50	150	--	--	--	--	--	--
BETX in Air per EPA Method TO-14A	ug/m3	ug/L	ug/kg	%	%	%	%	%	%	%	%	%	%	%	%
Benzene	1.6	--	--	70	130	--	--	--	--	--	--	--	--	--	--
Ethylbenzene	2.2	--	--	70	130	--	--	--	--	--	--	--	--	--	--
Ethylbenzene	2.2	--	--	70	130	--	--	--	--	--	--	--	--	--	--
Xylenes (m, p)	2.2	--	--	70	130	--	--	--	--	--	--	--	--	--	--
Xylenes (o)	2.2	--	--	70	130	--	--	--	--	--	--	--	--	--	--
Methyl-tert-butyl ether	7.3	--	--	70	130	--	--	--	--	--	--	--	--	--	--
Naphthalene	11	--	--	70	130	--	--	--	--	--	--	--	--	--	--
2-Propanol	5	--	--	70	130	--	--	--	--	--	--	--	--	--	--
TPH (gasoline range) – calculated method	42	--	--	70	130	--	--	--	--	--	--	--	--	--	--
1,2-Dichloroethane-d4 (surr)	--	--	--	70	130	--	--	--	--	--	--	--	--	--	--
4-Bromofluorobenzene (surr)	--	--	--	70	130	--	--	--	--	--	--	--	--	--	--
Toluene-d8 (surr)	--	--	--	70	130	--	--	--	--	--	--	--	--	--	--
TPH-GRO in Air per EPA Method TO-3	ug/m3	ug/L	ug/kg	%	%	%	%	%	%	%	%	%	%	%	%
C5-C10	100	--	--	70	130	--	--	--	--	--	--	--	--	--	--
Bromofluorobenzene (surr)	--	--	--	70	130	--	--	--	--	--	--	--	--	--	--
TPH-DRO in Air per NIOSH Method 1550	ug	ug/L	ug/kg	%	%	%	%	%	%	%	%	%	%	%	%
TPH-DRO	100	--	--	70	130	--	--	--	--	--	--	--	--	--	--
Ortho-terphenyl (surr)	--	--	--	70	130	--	--	--	--	--	--	--	--	--	--

ELAB of Nashville

USACE Laboratory Validation Letter

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS
12565 WEST CENTER ROAD
OMAHA NE 68144-3869

REPLY TO
ATTENTION OF

December 1, 2003

Hazardous, Toxic and Radioactive Waste
Center of Expertise

Doris Curry
ELAB of Tennessee, LLC
227 French Landing Drive
Nashville, TN 37228

Dear Ms. Curry:

This correspondence addresses the ongoing validation status of ELAB of Tennessee, LLC of Nashville, TN by the U.S. Army Corps of Engineers (USACE) for chemical analysis in support of the Hazardous, Toxic and Radioactive Waste Program.

Your laboratory is now validated for the parameters listed below:

METHOD	PARAMETERS	MATRIX(1)
300 Series	Anions	Water(2)
9010B/9012A	Cyanide	Water(2)
9013/9012A	Cyanide	Solids
8330	Explosives	Water
8330	Explosives	Solids(2)
8151A	Herbicides	Water(2)
8151A	Herbicides	Solids
8081A	Organochlorine Pesticides	Water(2)
8081A	Organochlorine Pesticides	Solids
8082	Polychlorinated Biphenyls	Water(2)
8082	Polychlorinated Biphenyls	Solids(2)
8270C	Semivolatile Organics	Water(2)
8270C	Semivolatile Organics	Solids(2)
6010B/7000A Series	TAL Metals(3)	Water(2)
6010B/7000A Series	TAL Metals(3)	Solids(2)
8260B	Volatile Organics	Water(2)
8260B	Volatile Organics	Solids

Remarks:
1) 'Solids' includes soils, sediments, and solid waste.
2) The laboratory has successfully analyzed a performance evaluation sample for this method/matrix.

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3) TAL Metals: Aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, nickel, potassium, selenium, silver, sodium, thallium, vanadium, and zinc.

4) Anions: Chloride, fluoride, sulfate, nitrate, nitrite, and ortho-phosphate.

Based on acceptable past performance of your laboratory, the validation of your laboratory is hereby extended from November 21, 2003 to March 30, 2004 to provide time to complete the revalidation process.

The USACE reserves the right to conduct additional laboratory inspections or to suspend validation status for any or all of the listed parameters if deemed necessary. It should be noted that your laboratory may not subcontract USACE analytical work to any other laboratory location without the approval of this office.

Any questions or comments can be directed to Richard Kissinger at (402) 697-2569. General questions regarding laboratory validation may be directed to the Laboratory Validation Coordinator at (402) 697-2574.

Sincerely,

for Marcia C. Davies, Ph.D.
Director, USACE Hazardous,
Toxic and Radioactive Waste
Center of Expertise

ELAB of Nashville

NELAC Laboratory Certification

State of Florida
Department of Health, Bureau of Laboratories
This is to certify that

E87646

ELAB of Tennessee, LLC
227 French Landing Drive
Nashville, TN 37228

has complied with Florida Administrative Code 64E-1, for the examination of Environmental samples in the following categories:

NONPOTABLE WATER - Extractable Organics, General Chemistry, Metals, Pesticides-Herbicides-PCB's, Volatile Organics, Whole Effluent Toxicity; SOLID AND CHEMICAL MATERIALS - Extractable Organics, Pesticides-Herbicides-PCB's, General Chemistry, Metals, Volatile Organics

Continued certification is contingent upon successful on-going compliance with the NELAC Standards and FAC Rule 64E-1 regulations. Specific methods and analytes certified are cited on the Laboratory Scope of Accreditation for this laboratory and are on file at the Bureau of Laboratories, P. O. Box 210, Jacksonville, Florida 32231. Clients and customers are urged to verify with this agency the laboratory's certification status in Florida for particular methods and analytes.

EFFECTIVE JULY 1, 2003 **THROUGH JUNE 30, 2004**

Ming S. Chan, Ph.D.
Bureau Chief, Bureau of Laboratories
Florida Department of Health
DH Form 1697, 7/03
NON-TRANSFERABLE 07/02/2003-E87646

Jeb Bush
Governor

John O. Agwunobi, M.D., M.B.A.
Secretary

Laboratory Scope of Accreditation

THIS LISTING OF ACCREDITED ANALYTES SHOULD BE USED ONLY WHEN ASSOCIATED WITH A VALID CERTIFICATE

State Laboratory ID: E87646 **EPA Lab Code: TN00004** **(615) 345-1119**

E87646
ELAB of Tennessee, LLC
227 French Landing Drive
Nashville, TN 37228

Matrix: Non-Potable Water

Analyte	Method/Tech	Category	Certification Type	Effective Date
1,1,1-Trichloroethane	EPA 624	Volatile Organics	NELAP	10/11/2002
1,1,2,2-Tetrachloroethane	EPA 624	Volatile Organics	NELAP	10/11/2002
1,1,2-Trichloroethane	EPA 624	Volatile Organics	NELAP	10/11/2002
1,1-Dichloroethane	EPA 624	Volatile Organics	NELAP	10/11/2002
1,1-Dichloroethylene	EPA 624	Volatile Organics	NELAP	10/11/2002
1,2,4-Trichlorobenzene	EPA 625	Extractable Organics	NELAP	10/11/2002
1,2-Dichlorobenzene	EPA 624	Volatile Organics	NELAP	10/11/2002
1,2-Dichloroethane	EPA 624	Volatile Organics	NELAP	10/11/2002
1,2-Dichloropropane	EPA 624	Volatile Organics	NELAP	10/11/2002
1,3-Dichlorobenzene	EPA 624	Volatile Organics	NELAP	10/11/2002
1,4-Dichlorobenzene	EPA 624	Volatile Organics	NELAP	10/11/2002
2,4,5-T	EPA 615	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
2,4,6-Trichlorophenol	EPA 625	Extractable Organics	NELAP	10/11/2002
2,4-D	EPA 615	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
2,4-DB	EPA 615	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
2,4-Dichlorophenol	EPA 625	Extractable Organics	NELAP	10/11/2002
2,4-Dimethylphenol	EPA 625	Extractable Organics	NELAP	10/11/2002
2,4-Dinitrophenol	EPA 625	Extractable Organics	NELAP	10/11/2002
2,4-Dinitrotoluene (2,4-DNT)	EPA 625	Extractable Organics	NELAP	10/11/2002
2,6-Dinitrotoluene (2,6-DNT)	EPA 625	Extractable Organics	NELAP	10/11/2002
2-Chloroethyl vinyl ether	EPA 624	Volatile Organics	NELAP	10/11/2002
2-Chloronaphthalene	EPA 625	Extractable Organics	NELAP	10/11/2002
2-Chlorophenol	EPA 625	Extractable Organics	NELAP	10/11/2002
2-Methyl-4,6-dinitrophenol	EPA 625	Extractable Organics	NELAP	10/11/2002
2-Nitrophenol	EPA 625	Extractable Organics	NELAP	10/11/2002
3,3'-Dichlorobenzidine	EPA 625	Extractable Organics	NELAP	10/11/2002
4,4'-DDD	EPA 608	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
4,4'-DDE	EPA 608	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
4,4'-DDT	EPA 608	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
4-Bromophenyl phenyl ether	EPA 625	Extractable Organics	NELAP	10/11/2002
4-Chloro-3-methylphenol	EPA 625	Extractable Organics	NELAP	10/11/2002
4-Chlorophenyl phenylether	EPA 625	Extractable Organics	NELAP	10/11/2002
4-Nitrophenol	EPA 625	Extractable Organics	NELAP	10/11/2002
Acenaphthene	EPA 625	Extractable Organics	NELAP	10/11/2002
Acenaphthylene	EPA 625	Extractable Organics	NELAP	10/11/2002
Acrolein (Propenal)	EPA 624	Volatile Organics	NELAP	10/11/2002

"STATE" indicates certification for the analyte by the method specified. "NELAP" further indicates certification compliant with the NELAC Standards.

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State Laboratory ID: E87646 **EPA Lab Code: TN00004** **(615) 345-1119**

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ELAB of Tennessee, LLC
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Nashville, TN 37228

Matrix: Non-Potable Water

Analyte	Method/Tech	Category	Certification Type	Effective Date
Acrylonitrile	EPA 624	Volatile Organics	NELAP	10/11/2002
Aldrin	EPA 608	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
Alkalinity as CaCO3	EPA 310.1	General Chemistry	NELAP	10/11/2002
alpha-BHC (alpha-Hexachlorocyclohexane)	EPA 608	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
Aluminum	EPA 200.7	Metals	NELAP	10/11/2002
Amenable cyanide	EPA 335.1	General Chemistry	NELAP	10/11/2002
Ammonia as N	EPA 350.2	General Chemistry	NELAP	10/11/2002
Anthracene	EPA 625	Extractable Organics	NELAP	10/11/2002
Antimony	EPA 200.7	Metals	NELAP	10/11/2002
Aroclor-1016 (PCB-1016)	EPA 608	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
Aroclor-1221 (PCB-1221)	EPA 608	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
Aroclor-1232 (PCB-1232)	EPA 608	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
Aroclor-1242 (PCB-1242)	EPA 608	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
Aroclor-1248 (PCB-1248)	EPA 608	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
Aroclor-1254 (PCB-1254)	EPA 608	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
Aroclor-1260 (PCB-1260)	EPA 608	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
Arsenic	EPA 200.7	Metals	NELAP	10/11/2002
Arsenic	EPA 6010	Metals	NELAP	10/11/2002
Barium	EPA 200.7	Metals	NELAP	10/11/2002
Benzene	EPA 624	Volatile Organics	NELAP	10/11/2002
Benzidine	EPA 625	Extractable Organics	NELAP	10/11/2002
Benzo(a)anthracene	EPA 625	Extractable Organics	NELAP	10/11/2002
Benzo(a)pyrene	EPA 625	Extractable Organics	NELAP	10/11/2002
Benzo(b)fluoranthene	EPA 625	Extractable Organics	NELAP	10/11/2002
Benzo(g,h,i)perylene	EPA 625	Extractable Organics	NELAP	10/11/2002
Benzo(k)fluoranthene	EPA 625	Extractable Organics	NELAP	10/11/2002
Beryllium	EPA 200.7	Metals	NELAP	10/11/2002
beta-BHC (beta-Hexachlorocyclohexane)	EPA 608	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
Biochemical oxygen demand	EPA 405.1	General Chemistry	NELAP	10/11/2002
bis(2-Chloroethoxy)methane	EPA 625	Extractable Organics	NELAP	10/11/2002
bis(2-Chloroethyl) ether	EPA 625	Extractable Organics	NELAP	10/11/2002
bis(2-Chloroisopropyl) ether	EPA 625	Extractable Organics	NELAP	10/11/2002
bis(2-Ethylhexyl) phthalate (DEHP)	EPA 625	Extractable Organics	NELAP	10/11/2002
Boron	EPA 200.7	Metals	NELAP	10/11/2002
Bromodichloromethane	EPA 624	Volatile Organics	NELAP	10/11/2002
Bromoform	EPA 624	Volatile Organics	NELAP	10/11/2002

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E87646
ELAB of Tennessee, LLC
227 French Landing Drive
Nashville, TN 37228

Matrix: Non-Potable Water

Analyte	Method/Tech	Category	Certification Type	Effective Date
Butyl benzyl phthalate	EPA 625	Extractable Organics	NELAP	10/11/2002
Cadmium	EPA 200.7	Metals	NELAP	10/11/2002
Cadmium	EPA 6010	Metals	NELAP	10/11/2002
Calcium	EPA 200.7	Metals	NELAP	10/11/2002
Carbon tetrachloride	EPA 624	Volatile Organics	NELAP	10/11/2002
Ceriodaphnia dubia	EPA/600/4-90/ 027F SEC. 9	Whole Effluent Toxicity	NELAP	5/31/2001
Ceriodaphnia dubia	EPA/600/4-91/ 002 (1002.0)	Whole Effluent Toxicity	NELAP	5/31/2001
Chemical oxygen demand	EPA 410.4	General Chemistry	NELAP	10/11/2002
Chlordane (tech.)	EPA 608	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
Chloride	EPA 325.2	General Chemistry	NELAP	1/7/2003
Chlorobenzene	EPA 624	Volatile Organics	NELAP	10/11/2002
Chloroethane	EPA 624	Volatile Organics	NELAP	10/11/2002
Chloroform	EPA 624	Volatile Organics	NELAP	10/11/2002
Chromium	EPA 200.7	Metals	NELAP	10/11/2002
Chromium	EPA 6010	Metals	NELAP	10/11/2002
Chrysene	EPA 625	Extractable Organics	NELAP	10/11/2002
cis-1,3-Dichloropropene	EPA 624	Volatile Organics	NELAP	10/11/2002
Cobalt	EPA 200.7	Metals	NELAP	10/11/2002
Conductivity	EPA 120.1	General Chemistry	NELAP	10/11/2002
Copper	EPA 200.7	Metals	NELAP	10/11/2002
Copper	EPA 6010	Metals	NELAP	10/11/2002
Cyprinella leedsi	EPA/600/4-90/ 027F SEC. 9	Whole Effluent Toxicity	NELAP	5/31/2001
Cyprinodon variegatus	EPA/600/4-90/ 027F SEC. 9	Whole Effluent Toxicity	NELAP	5/31/2001
Dalapon	EPA 615	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
Daphnia magna	EPA/600/4-90/ 027F SEC. 9	Whole Effluent Toxicity	NELAP	5/31/2001
delta-BHC	EPA 608	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
Dibenz(a,h) anthracene	EPA 625	Extractable Organics	NELAP	10/11/2002
Dibromochloromethane	EPA 624	Volatile Organics	NELAP	10/11/2002
Dicamba	EPA 615	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
Dichloroprop (Dichlorprop)	EPA 615	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
Dieldrin	EPA 608	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
Diethyl phthalate	EPA 625	Extractable Organics	NELAP	10/11/2002
Dimethyl phthalate	EPA 625	Extractable Organics	NELAP	10/11/2002
Di-n-butyl phthalate	EPA 625	Extractable Organics	NELAP	10/11/2002
Di-n-octyl phthalate	EPA 625	Extractable Organics	NELAP	10/11/2002
Dinoseb (2-sec-butyl-4,6-dinitrophenol, DNBP)	EPA 615	Pesticides-Herbicides-PCB's	NELAP	10/11/2002

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E87646
ELAB of Tennessee, LLC
227 French Landing Drive
Nashville, TN 37228

Matrix: Non-Potable Water

Analyte	Method/Tech	Category	Certification Type	Effective Date
Endosulfan I	EPA 608	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
Endosulfan II	EPA 608	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
Endosulfan sulfate	EPA 608	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
Endrin	EPA 608	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
Endrin aldehyde	EPA 608	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
Ethylbenzene	EPA 624	Volatile Organics	NELAP	10/11/2002
Fluoranthene	EPA 625	Extractable Organics	NELAP	10/11/2002
Fluorene	EPA 625	Extractable Organics	NELAP	10/11/2002
Fluoride	EPA 340.2	General Chemistry	NELAP	10/11/2002
gamma-BHC (Lindane, gamma-Hexachlorocyclohexane)	EPA 608	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
Heptachlor	EPA 608	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
Heptachlor epoxide	EPA 608	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
Hexachlorobenzene	EPA 625	Extractable Organics	NELAP	10/11/2002
Hexachlorobutadiene	EPA 625	Extractable Organics	NELAP	10/11/2002
Hexachlorocyclopentadiene	EPA 625	Extractable Organics	NELAP	10/11/2002
Hexachloroethane	EPA 625	Extractable Organics	NELAP	10/11/2002
Indeno(1,2,3-cd)pyrene	EPA 625	Extractable Organics	NELAP	10/11/2002
Iron	EPA 200.7	Metals	NELAP	10/11/2002
Isophorone	EPA 625	Extractable Organics	NELAP	10/11/2002
Kjeldahl nitrogen - total	EPA 351.2	General Chemistry	NELAP	10/11/2002
Lead	EPA 200.7	Metals	NELAP	10/11/2002
Lead	EPA 6010	Metals	NELAP	10/11/2002
Magnesium	EPA 200.7	Metals	NELAP	10/11/2002
Manganese	EPA 200.7	Metals	NELAP	10/11/2002
MCPA	EPA 615	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
MCPP	EPA 615	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
Menidia beryllina	EPA/600/4-90/ 027F SEC. 9	Whole Effluent Toxicity	NELAP	5/31/2001
Mercury	EPA 245.1	Metals	NELAP	10/11/2002
Mercury	EPA 7470	Metals	NELAP	10/11/2002
Mercury	EPA 7471	Metals	NELAP	10/11/2002
Methoxychlor	EPA 608.2	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
Methyl bromide (Bromomethane)	EPA 624	Volatile Organics	NELAP	10/11/2002
Methyl chloride (Chloromethane)	EPA 624	Volatile Organics	NELAP	10/11/2002
Methylene chloride	EPA 624	Volatile Organics	NELAP	10/11/2002
Mysidopsis bahia	EPA/600/4-90/ 027F SEC. 9	Whole Effluent Toxicity	NELAP	5/31/2001
Naphthalene	EPA 625	Extractable Organics	NELAP	10/11/2002

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State Laboratory ID: E87646 **EPA Lab Code: TN00004** **(615) 345-1119**

E87646
ELAB of Tennessee, LLC
227 French Landing Drive
Nashville, TN 37228

Matrix: Non-Potable Water

Analyte	Method/Tech	Category	Certification Type	Effective Date
Nickel	EPA 200.7	Metals	NELAP	10/11/2002
Nickel	EPA 6010	Metals	NELAP	10/11/2002
Nitrobenzene	EPA 625	Extractable Organics	NELAP	10/11/2002
n-Nitrosodimethylamine	EPA 625	Extractable Organics	NELAP	10/11/2002
n-Nitrosodi-n-propylamine	EPA 625	Extractable Organics	NELAP	10/11/2002
n-Nitrosodiphenylamine	EPA 625	Extractable Organics	NELAP	10/11/2002
Oil & Grease	EPA 1664	General Chemistry	NELAP	10/11/2002
Pentachlorophenol	EPA 625	Extractable Organics	NELAP	10/11/2002
pH	EPA 150.1	General Chemistry	NELAP	10/11/2002
Phenanthrene	EPA 625	Extractable Organics	NELAP	10/11/2002
Phenol	EPA 625	Extractable Organics	NELAP	10/11/2002
Phosphorus, total	EPA 365.2	General Chemistry	NELAP	10/11/2002
Pimephales promelas	EPA/600/4-90/ 027F SEC. 9	Whole Effluent Toxicity	NELAP	5/31/2001
Pimephales promelas	EPA/600/4-91/ 002 (1000.0)	Whole Effluent Toxicity	NELAP	5/31/2001
Potassium	EPA 200.7	Metals	NELAP	10/11/2002
Pyrene	EPA 625	Extractable Organics	NELAP	10/11/2002
Residue-filterable (TDS)	EPA 160.1	General Chemistry	NELAP	10/11/2002
Residue-nonfilterable (TSS)	EPA 160.2	General Chemistry	NELAP	10/11/2002
Residue-total	EPA 160.3	General Chemistry	NELAP	10/11/2002
Selenium	EPA 200.7	Metals	NELAP	10/11/2002
Selenium	EPA 6010	Metals	NELAP	10/11/2002
Silver	EPA 200.7	Metals	NELAP	10/11/2002
Silvex (2,4,5-TP)	EPA 615	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
Sodium	EPA 200.7	Metals	NELAP	10/11/2002
Sulfate	EPA 375.4	General Chemistry	NELAP	10/11/2002
Sulfide	EPA 376.1	General Chemistry	NELAP	10/11/2002
Surfactants - MBAS	EPA 425.1	General Chemistry	NELAP	10/11/2002
Tetrachloroethylene (Perchloroethylene)	EPA 624	Volatile Organics	NELAP	10/11/2002
Thallium	EPA 200.7	Metals	NELAP	10/11/2002
Tin	EPA 200.7	Metals	NELAP	10/11/2002
Toluene	EPA 624	Volatile Organics	NELAP	10/11/2002
Total cyanide	EPA 335.3	General Chemistry	NELAP	10/11/2002
Total hardness as CaCO3	EPA 200.7	Metals	NELAP	10/11/2002
Total nitrate-nitrite	EPA 353.2	General Chemistry	NELAP	10/11/2002
Total organic carbon	EPA 415.1	General Chemistry	NELAP	10/11/2002
Total Petroleum Hydrocarbons (TPH)	EPA 1664	General Chemistry	NELAP	1/7/2003

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E87646
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Matrix: Non-Potable Water

Analyte	Method/Tech	Category	Certification Type	Effective Date
Total phenolics	EPA 420.2	General Chemistry	NELAP	1/7/2003
Toxaphene (Chlorinated camphene)	EPA 608	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
trans-1,2-Dichloroethylene	EPA 624	Volatile Organics	NELAP	10/11/2002
trans-1,3-Dichloropropylene	EPA 624	Volatile Organics	NELAP	10/11/2002
Trichloroethene (Trichloroethylene)	EPA 624	Volatile Organics	NELAP	10/11/2002
Trichlorofluoromethane	EPA 624	Volatile Organics	NELAP	10/11/2002
Vanadium	EPA 200.7	Metals	NELAP	10/11/2002
Vinyl chloride	EPA 624	Volatile Organics	NELAP	10/11/2002
Xylene (total)	EPA 624	Volatile Organics	NELAP	10/11/2002
Zinc	EPA 200.7	Metals	NELAP	10/11/2002
Zinc	EPA 6010	Metals	NELAP	10/11/2002

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State Laboratory ID: E87646 **EPA Lab Code: TN00004** **(615) 345-1119**

E87646
ELAB of Tennessee, LLC
227 French Landing Drive
Nashville, TN 37228

Matrix: Solid and Chemical Materials

Analyte	Method/Tech	Category	Certification Type	Effective Date
1,1,1-Trichloroethane	EPA 8260	Volatile Organics	NELAP	10/11/2002
1,1,2,2-Tetrachloroethane	EPA 8260	Volatile Organics	NELAP	10/11/2002
1,1,2-Trichloroethane	EPA 8260	Volatile Organics	NELAP	10/11/2002
1,1-Dichloroethane	EPA 8260	Volatile Organics	NELAP	10/11/2002
1,1-Dichloroethylene	EPA 8260	Volatile Organics	NELAP	10/11/2002
1,1-Dichloropropene	EPA 8260	Volatile Organics	NELAP	10/11/2002
1,2,3-Trichlorobenzene	EPA 8260	Volatile Organics	NELAP	10/11/2002
1,2,3-Trichloropropane	EPA 8260	Volatile Organics	NELAP	10/11/2002
1,2,4,5-Tetrachlorobenzene	EPA 8270	Extractable Organics	NELAP	10/11/2002
1,2,4-Trichlorobenzene	EPA 8260	Volatile Organics	NELAP	1/7/2003
1,2,4-Trichlorobenzene	EPA 8270	Extractable Organics	NELAP	10/11/2002
1,2,4-Trimethylbenzene	EPA 8260	Volatile Organics	NELAP	10/11/2002
1,2-Dibromo-3-chloropropane (DBCP)	EPA 8260	Volatile Organics	NELAP	10/11/2002
1,2-Dibromoethane (EDB, Ethylene dibromide)	EPA 8260	Volatile Organics	NELAP	10/11/2002
1,2-Dichlorobenzene	EPA 8260	Volatile Organics	NELAP	10/11/2002
1,2-Dichloroethane	EPA 8260	Volatile Organics	NELAP	10/11/2002
1,2-Dichloropropane	EPA 8260	Volatile Organics	NELAP	10/11/2002
1,2-Diphenylhydrazine	EPA 8270	Extractable Organics	NELAP	1/7/2003
1,3,5-Trimethylbenzene	EPA 8260	Volatile Organics	NELAP	10/11/2002
1,3,5-Trinitrobenzene (1,3,5-TNB)	EPA 8270	Extractable Organics	NELAP	1/7/2003
1,3-Dichlorobenzene	EPA 8260	Volatile Organics	NELAP	10/11/2002
1,3-Dichloropropane	EPA 8260	Volatile Organics	NELAP	10/11/2002
1,3-Dinitrobenzene (1,3-DNB)	EPA 8270	Extractable Organics	NELAP	1/7/2003
1,4-Dichlorobenzene	EPA 8260	Volatile Organics	NELAP	10/11/2002
1,4-Dioxane (1,4- Diethyleneoxide)	EPA 8260	Volatile Organics	NELAP	10/11/2002
1,4-Naphthoquinone	EPA 8270	Extractable Organics	NELAP	10/11/2002
1,4-Phenylenediamine	EPA 8270	Extractable Organics	NELAP	1/7/2003
1-Naphthylamine	EPA 8270	Extractable Organics	NELAP	10/11/2002
2,2-Dichloropropane	EPA 8260	Volatile Organics	NELAP	10/11/2002
2,3,4,6-Tetrachlorophenol	EPA 8270	Extractable Organics	NELAP	10/11/2002
2,4,5-Trichlorophenol	EPA 8270	Extractable Organics	NELAP	10/11/2002
2,4,6-Trichlorophenol	EPA 8270	Extractable Organics	NELAP	10/11/2002
2,4-DB	EPA 8151	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
2,4-Dichlorophenol	EPA 8270	Extractable Organics	NELAP	10/11/2002
2,4-Dimethylphenol	EPA 8270	Extractable Organics	NELAP	10/11/2002
2,4-Dinitrophenol	EPA 8270	Extractable Organics	NELAP	10/11/2002

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Analyte	Method/Tech	Category	Certification Type	Effective Date
2,4-Dinitrotoluene (2,4-DNT)	EPA 8270	Extractable Organics	NELAP	10/11/2002
2,6-Dichlorophenol	EPA 8270	Extractable Organics	NELAP	10/11/2002
2,6-Dinitrotoluene (2,6-DNT)	EPA 8270	Extractable Organics	NELAP	10/11/2002
2-Acetylaminofluorene	EPA 8270	Extractable Organics	NELAP	10/11/2002
2-Butanone (Methyl ethyl ketone, MEK)	EPA 8260	Volatile Organics	NELAP	10/11/2002
2-Chloroethyl vinyl ether	EPA 8260	Volatile Organics	NELAP	10/11/2002
2-Chloronaphthalene	EPA 8270	Extractable Organics	NELAP	10/11/2002
2-Chlorophenol	EPA 8270	Extractable Organics	NELAP	10/11/2002
2-Chlorotoluene	EPA 8260	Volatile Organics	NELAP	10/11/2002
2-Hexanone	EPA 8260	Volatile Organics	NELAP	10/11/2002
2-Methyl-4,6-dinitrophenol	EPA 8270	Extractable Organics	NELAP	10/11/2002
2-Methylnaphthalene	EPA 8270	Extractable Organics	NELAP	10/11/2002
2-Naphthylamine	EPA 8270	Extractable Organics	NELAP	10/11/2002
2-Nitroaniline	EPA 8270	Extractable Organics	NELAP	10/11/2002
2-Nitrophenol	EPA 8270	Extractable Organics	NELAP	10/11/2002
2-Picoline (2-Methylpyridine)	EPA 8270	Extractable Organics	NELAP	10/11/2002
3,3'-Dichlorobenzidine	EPA 8270	Extractable Organics	NELAP	10/11/2002
3,3'-Dimethylbenzidine	EPA 8270	Extractable Organics	NELAP	10/11/2002
3-Methylcholanthrene	EPA 8270	Extractable Organics	NELAP	10/11/2002
3-Nitroaniline	EPA 8270	Extractable Organics	NELAP	10/11/2002
4,4'-DDD	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
4,4'-DDE	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
4,4'-DDT	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
4-Aminobiphenyl	EPA 8270	Extractable Organics	NELAP	10/11/2002
4-Chloro-3-methylphenol	EPA 8270	Extractable Organics	NELAP	10/11/2002
4-Chloroaniline	EPA 8270	Extractable Organics	NELAP	10/11/2002
4-Chlorophenol	EPA 8270	Extractable Organics	NELAP	1/7/2003
4-Chlorotoluene	EPA 8260	Volatile Organics	NELAP	10/11/2002
4-Dimethyl aminoazobenzene	EPA 8270	Extractable Organics	NELAP	10/11/2002
4-Methyl-2-pentanone (MIBK)	EPA 8260	Volatile Organics	NELAP	10/11/2002
4-Methylphenol (p-Cresol)	EPA 8270	Extractable Organics	NELAP	10/11/2002
4-Nitroaniline	EPA 8270	Extractable Organics	NELAP	10/11/2002
4-Nitrophenol	EPA 8270	Extractable Organics	NELAP	10/11/2002
5-Nitro-o-toluidine	EPA 8270	Extractable Organics	NELAP	10/11/2002
7,12-Dimethylbenz(a) anthracene	EPA 8270	Extractable Organics	NELAP	10/11/2002
a-a-Dimethylphenethylamine	EPA 8270	Extractable Organics	NELAP	10/11/2002

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Acenaphthene	EPA 8270	Extractable Organics	NELAP	10/11/2002
Acenaphthylene	EPA 8270	Extractable Organics	NELAP	10/11/2002
Acetone	EPA 8260	Volatile Organics	NELAP	10/11/2002
Acetonitrile	EPA 8260	Volatile Organics	NELAP	10/11/2002
Acetophenone	EPA 8270	Extractable Organics	NELAP	10/11/2002
Acrolein (Propenal)	EPA 8260	Volatile Organics	NELAP	10/11/2002
Acrylonitrile	EPA 8260	Volatile Organics	NELAP	10/11/2002
Aldrin	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
Allyl chloride (3-Chloropropene)	EPA 8260	Volatile Organics	NELAP	10/11/2002
alpha-BHC (alpha-Hexachlorocyclohexane)	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
alpha-Chlordane	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
Aluminum	EPA 6010	Metals	NELAP	10/11/2002
Aniline	EPA 8270	Extractable Organics	NELAP	10/11/2002
Anthracene	EPA 8270	Extractable Organics	NELAP	10/11/2002
Antimony	EPA 6010	Metals	NELAP	10/11/2002
Aramite	EPA 8270	Extractable Organics	NELAP	10/11/2002
Aroclor-1016 (PCB-1016)	EPA 8082	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
Aroclor-1221 (PCB-1221)	EPA 8082	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
Aroclor-1232 (PCB-1232)	EPA 8082	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
Aroclor-1242 (PCB-1242)	EPA 8082	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
Aroclor-1248 (PCB-1248)	EPA 8082	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
Aroclor-1254 (PCB-1254)	EPA 8082	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
Aroclor-1260 (PCB-1260)	EPA 8082	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
Arsenic	EPA 6010	Metals	NELAP	10/11/2002
Barium	EPA 6010	Metals	NELAP	10/11/2002
Benzene	EPA 8260	Volatile Organics	NELAP	10/11/2002
Benzidine	EPA 8270	Extractable Organics	NELAP	1/7/2003
Benzo(a)anthracene	EPA 8270	Extractable Organics	NELAP	10/11/2002
Benzo(a)pyrene	EPA 8270	Extractable Organics	NELAP	10/11/2002
Benzo(b)fluoranthene	EPA 8270	Extractable Organics	NELAP	10/11/2002
Benzo(g,h,i)perylene	EPA 8270	Extractable Organics	NELAP	10/11/2002
Benzo(k)fluoranthene	EPA 8270	Extractable Organics	NELAP	10/11/2002
Benzoic acid	EPA 8270	Extractable Organics	NELAP	10/11/2002
Benzyl alcohol	EPA 8270	Extractable Organics	NELAP	10/11/2002
Beryllium	EPA 6010	Metals	NELAP	10/11/2002
beta-BHC (beta-Hexachlorocyclohexane)	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	10/11/2002

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Analyte	Method/Tech	Category	Certification Type	Effective Date
bis(2-Chloroethoxy)methane	EPA 8270	Extractable Organics	NELAP	10/11/2002
bis(2-Chloroethyl) ether	EPA 8270	Extractable Organics	NELAP	10/11/2002
bis(2-Chloroisopropyl) ether	EPA 8270	Extractable Organics	NELAP	10/11/2002
bis(2-Ethylhexyl) phthalate (DEHP)	EPA 8270	Extractable Organics	NELAP	10/11/2002
Bromobenzene	EPA 8260	Volatile Organics	NELAP	10/11/2002
Bromochloromethane	EPA 8260	Volatile Organics	NELAP	10/11/2002
Bromodichloromethane	EPA 8260	Volatile Organics	NELAP	10/11/2002
Bromoform	EPA 8260	Volatile Organics	NELAP	10/11/2002
Butyl benzyl phthalate	EPA 8270	Extractable Organics	NELAP	10/11/2002
Cadmium	EPA 6010	Metals	NELAP	10/11/2002
Calcium	EPA 6010	Metals	NELAP	10/11/2002
Carbazole	EPA 8270	Extractable Organics	NELAP	10/11/2002
Carbon disulfide	EPA 8260	Volatile Organics	NELAP	10/11/2002
Carbon tetrachloride	EPA 8260	Volatile Organics	NELAP	10/11/2002
Chlordane (tech.)	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
Chlorobenzene	EPA 8260	Volatile Organics	NELAP	10/11/2002
Chlorobenzilate	EPA 8270	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
Chloroethane	EPA 8260	Volatile Organics	NELAP	10/11/2002
Chloroform	EPA 8260	Volatile Organics	NELAP	10/11/2002
Chloroprene	EPA 8260	Volatile Organics	NELAP	10/11/2002
Chromium	EPA 6010	Metals	NELAP	10/11/2002
Chromium VI	EPA 7196	Metals,General Chemistry	NELAP	10/11/2002
Chrysene	EPA 8270	Extractable Organics	NELAP	10/11/2002
cis-1,2-Dichloroethylene	EPA 8260	Volatile Organics	NELAP	10/11/2002
cis-1,3-Dichloropropene	EPA 8260	Volatile Organics	NELAP	10/11/2002
Cobalt	EPA 6010	Metals	NELAP	10/11/2002
Copper	EPA 6010	Metals	NELAP	10/11/2002
Corrosivity (pH)	EPA 9040	General Chemistry	NELAP	10/11/2002
Dalapon	EPA 8151	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
delta-BHC	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
Diallate	EPA 8270	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
Dibenz(a,h) anthracene	EPA 8270	Extractable Organics	NELAP	10/11/2002
Dibromochloromethane	EPA 8260	Volatile Organics	NELAP	10/11/2002
Dibromomethane	EPA 8260	Volatile Organics	NELAP	10/11/2002
Dichlorodifluoromethane	EPA 8260	Volatile Organics	NELAP	10/11/2002
Dichloroprop (Dichlorprop)	EPA 8151	Pesticides-Herbicides-PCB's	NELAP	10/11/2002

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Analyte	Method/Tech	Category	Certification Type	Effective Date
Dieldrin	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
Diesel range organics (DRO)	EPA 8015	Extractable Organics	NELAP	1/7/2003
Diethyl phthalate	EPA 8270	Extractable Organics	NELAP	10/11/2002
Dimethoate	EPA 8270	Pesticides-Herbicides-PCB's	NELAP	1/7/2003
Dimethyl phthalate	EPA 8270	Extractable Organics	NELAP	10/11/2002
Di-n-butyl phthalate	EPA 8270	Extractable Organics	NELAP	10/11/2002
Di-n-octyl phthalate	EPA 8270	Extractable Organics	NELAP	10/11/2002
Dinoseb (2-sec-butyl-4,6-dinitrophenol, DNBP)	EPA 8151	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
Dinoseb (2-sec-butyl-4,6-dinitrophenol, DNBP)	EPA 8270	Extractable Organics	NELAP	10/11/2002
Endosulfan I	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
Endosulfan II	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
Endrin	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
Endrin aldehyde	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
Endrin ketone	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	1/7/2003
Ethyl methacrylate	EPA 8260	Volatile Organics	NELAP	10/11/2002
Ethyl methanesulfonate	EPA 8270	Extractable Organics	NELAP	10/11/2002
Ethylbenzene	EPA 8260	Volatile Organics	NELAP	10/11/2002
Famphur	EPA 8270	Pesticides-Herbicides-PCB's	NELAP	1/7/2003
Fluoranthene	EPA 8270	Extractable Organics	NELAP	10/11/2002
Fluorene	EPA 8270	Extractable Organics	NELAP	10/11/2002
gamma-BHC (Lindane, gamma-Hexachlorocyclohexane)	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
gamma-Chlordane	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
Gasoline range organics (GRO)	EPA 8015	Extractable Organics	NELAP	1/7/2003
Heptachlor	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
Heptachlor epoxide	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
Hexachlorobenzene	EPA 8270	Extractable Organics,Pesticides-Herbicides-PCB's	NELAP	10/11/2002
Hexachlorobutadiene	EPA 8260	Volatile Organics	NELAP	10/11/2002
Hexachlorobutadiene	EPA 8270	Extractable Organics	NELAP	10/11/2002
Hexachlorocyclopentadiene	EPA 8270	Extractable Organics,Pesticides-Herbicides-PCB's	NELAP	10/11/2002
Hexachloroethane	EPA 8270	Extractable Organics	NELAP	10/11/2002
Hexachlorophene	EPA 8270	Extractable Organics	NELAP	10/11/2002
Hexachloropropene	EPA 8270	Extractable Organics	NELAP	10/11/2002
Ignitability	EPA 1010	General Chemistry	NELAP	10/11/2002
Indeno(1,2,3-cd)pyrene	EPA 8270	Extractable Organics	NELAP	10/11/2002

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Iodomethane (Methyl iodide)	EPA 8260	Volatile Organics	NELAP	10/11/2002
Iron	EPA 6010	Metals	NELAP	10/11/2002
Isobutyl alcohol (2-Methyl-1-propanol)	EPA 8260	Volatile Organics	NELAP	10/11/2002
Isodrin	EPA 8270	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
Isophorone	EPA 8270	Extractable Organics	NELAP	10/11/2002
Isopropylbenzene	EPA 8260	Volatile Organics	NELAP	10/11/2002
Isosafrole	EPA 8270	Extractable Organics	NELAP	10/11/2002
Kepone	EPA 8270	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
Lead	EPA 6010	Metals	NELAP	10/11/2002
Magnesium	EPA 6010	Metals	NELAP	10/11/2002
Manganese	EPA 6010	Metals	NELAP	10/11/2002
MCPA	EPA 8151	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
MCPP	EPA 8151	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
Mercury	EPA 7470	Metals	NELAP	10/11/2002
Mercury	EPA 7471	Metals	NELAP	10/11/2002
Methacrylonitrile	EPA 8260	Volatile Organics	NELAP	1/7/2003
Methapyrilene	EPA 8270	Extractable Organics	NELAP	10/11/2002
Methoxychlor	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
Methyl bromide (Bromomethane)	EPA 8260	Volatile Organics	NELAP	10/11/2002
Methyl chloride (Chloromethane)	EPA 8260	Volatile Organics	NELAP	10/11/2002
Methyl methacrylate	EPA 8260	Volatile Organics	NELAP	10/11/2002
Methyl methanesulfonate	EPA 8270	Extractable Organics	NELAP	10/11/2002
Methyl parathion (Parathion, methyl)	EPA 8270	Pesticides-Herbicides-PCB's	NELAP	1/7/2003
Methyl tert-butyl ether (MTBE)	EPA 8260	Volatile Organics	NELAP	10/11/2002
Methylene chloride	EPA 8260	Volatile Organics	NELAP	10/11/2002
Molybdenum	EPA 6010	Metals	NELAP	10/11/2002
Naphthalene	EPA 8260	Volatile Organics	NELAP	10/11/2002
Naphthalene	EPA 8270	Extractable Organics	NELAP	10/11/2002
n-Butylbenzene	EPA 8260	Volatile Organics	NELAP	10/11/2002
Nickel	EPA 6010	Metals	NELAP	10/11/2002
Nitrobenzene	EPA 8270	Extractable Organics	NELAP	10/11/2002
Nitroquinoline-1-oxide	EPA 8270	Extractable Organics	NELAP	10/11/2002
n-Nitrosodiethylamine	EPA 8270	Extractable Organics	NELAP	10/11/2002
n-Nitrosodimethylamine	EPA 8270	Extractable Organics	NELAP	10/11/2002
n-Nitroso-di-n-butylamine	EPA 8270	Extractable Organics	NELAP	10/11/2002
n-Nitrosodiphenylamine	EPA 8270	Extractable Organics	NELAP	10/11/2002

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n-Nitrosomethylethylamine	EPA 8270	Extractable Organics	NELAP	10/11/2002
n-Nitrosomorpholine	EPA 8270	Extractable Organics	NELAP	10/11/2002
n-Nitrosopiperidine	EPA 8270	Extractable Organics	NELAP	10/11/2002
n-Nitrosopyrrolidine	EPA 8270	Extractable Organics	NELAP	10/11/2002
n-Propylbenzene	EPA 8260	Volatile Organics	NELAP	10/11/2002
o,o,o-Triethyl phosphorothioate	EPA 8270	Pesticides-Herbicides-PCB's	NELAP	1/7/2003
o-Toluidine	EPA 8270	Extractable Organics	NELAP	10/11/2002
Paint Filter Liquids Test	EPA 9095	General Chemistry	NELAP	10/11/2002
Parathion, ethyl	EPA 8270	Pesticides-Herbicides-PCB's	NELAP	1/7/2003
Pentachlorobenzene	EPA 8270	Extractable Organics	NELAP	10/11/2002
Pentachloroethane	EPA 8260	Volatile Organics	NELAP	10/11/2002
Pentachloronitrobenzene	EPA 8270	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
Pentachlorophenol	EPA 8270	Extractable Organics	NELAP	10/11/2002
Phenacetin	EPA 8270	Extractable Organics	NELAP	10/11/2002
Phenanthrene	EPA 8270	Extractable Organics	NELAP	10/11/2002
Phenol	EPA 8270	Extractable Organics	NELAP	10/11/2002
Phorate	EPA 8270	Pesticides-Herbicides-PCB's	NELAP	1/7/2003
p-Isopropyltoluene	EPA 8260	Volatile Organics	NELAP	10/11/2002
Potassium	EPA 6010	Metals	NELAP	10/11/2002
Pronamide (Kerb)	EPA 8270	Extractable Organics	NELAP	10/11/2002
Propionitrile (Ethyl cyanide)	EPA 8260	Volatile Organics	NELAP	10/11/2002
Pyrene	EPA 8270	Extractable Organics	NELAP	10/11/2002
Pyridine	EPA 8270	Extractable Organics	NELAP	10/11/2002
Reactive sulfide	EPA 7.3.4.2	General Chemistry	NELAP	10/11/2002
Safrole	EPA 8270	Extractable Organics	NELAP	10/11/2002
sec-Butylbenzene	EPA 8260	Volatile Organics	NELAP	10/11/2002
Selenium	EPA 6010	Metals	NELAP	10/11/2002
Silver	EPA 6010	Metals	NELAP	10/11/2002
Sodium	EPA 6010	Metals	NELAP	10/11/2002
Styrene	EPA 8260	Volatile Organics	NELAP	10/11/2002
Sulfate	EPA 9038	General Chemistry	NELAP	10/11/2002
Sulfotepp	EPA 8270	Pesticides-Herbicides-PCB's	NELAP	1/7/2003
Synthetic Precipitation Leaching Procedure	EPA 1312	General Chemistry	NELAP	10/11/2002
tert-Butylbenzene	EPA 8260	Volatile Organics	NELAP	10/11/2002
Tetrachloroethylene (Perchloroethylene)	EPA 8260	Volatile Organics	NELAP	10/11/2002
Thallium	EPA 6010	Metals	NELAP	10/11/2002

"STATE" indicates certification for the analyte by the method specified. "NELAP" further indicates certification compliant with the NELAC Standards.

Laboratory Scope of Accreditation

THIS LISTING OF ACCREDITED ANALYTES SHOULD BE USED ONLY WHEN ASSOCIATED WITH A VALID CERTIFICATE

State Laboratory ID: E87646 **EPA Lab Code: TN00004** **(615) 345-1119**

E87646
ELAB of Tennessee, LLC
227 French Landing Drive
Nashville, TN 37228

Matrix: Solid and Chemical Materials

Analyte	Method/Tech	Category	Certification Type	Effective Date
Thionazin (Zinophos)	EPA 8270	Pesticides-Herbicides-PCB's	NELAP	1/7/2003
Tin	EPA 6010	Metals	NELAP	10/11/2002
Toluene	EPA 8260	Volatile Organics	NELAP	10/11/2002
Total cyanide	EPA 9012	General Chemistry	NELAP	10/11/2002
Total Petroleum Hydrocarbons (TPH)	FL-PRO	Extractable Organics	NELAP	1/7/2003
Toxaphene (Chlorinated camphene)	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	10/11/2002
Toxicity Characteristic Leaching Procedure	EPA 1311	General Chemistry	NELAP	10/11/2002
trans-1,2-Dichloroethylene	EPA 8260	Volatile Organics	NELAP	10/11/2002
trans-1,3-Dichloropropylene	EPA 8260	Volatile Organics	NELAP	10/11/2002
Trichloroethene (Trichloroethylene)	EPA 8260	Volatile Organics	NELAP	10/11/2002
Trichlorofluoromethane	EPA 8260	Volatile Organics	NELAP	10/11/2002
Vanadium	EPA 6010	Metals	NELAP	10/11/2002
Vinyl acetate	EPA 8260	Volatile Organics	NELAP	10/11/2002
Vinyl chloride	EPA 8260	Volatile Organics	NELAP	10/11/2002
Xylene (total)	EPA 8260	Volatile Organics	NELAP	10/11/2002
Zinc	EPA 6010	Metals	NELAP	10/11/2002

"STATE" indicates certification for the analyte by the method specified. "NELAP" further indicates certification compliant with the NELAC Standards.

APPENDIX D

SOIL GAS SAMPLING SOP

RAM GROUP, INC.

FEBRUARY 2004

REV. NO. 0.0

STANDARD OPERATING PROCEDURE (SOP) FOR SOIL VAPOR GRAB SAMPLING ACTIVITIES USING THE GEOPROBE® POST-RUN TUBING SYSTEM WITH 6-LITER SUMMA® CANISTERS AND NIOSH TUBES

February 2004

Prepared by:
Risk Assessment & Management Group, Inc.
7457 Harwin Dr., Suite 238
Houston, TX 77036
Tel: (713) 784-5151
Fax: (713) 784-6105
E-mail: asalhotra@ramgp.com

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1.0 PURPOSE

The objective of the soil vapor investigation is to collect soil vapor samples in order to assess the potential for migration of hydrocarbons into indoor air from the soil. The soil vapor data will be used to evaluate the concentration and spatial distribution of volatile organic compounds (VOCs) in the vadose zone and to assess the potential for exposure to VOCs via indoor air. This document presents a Standard Operating Procedure (SOP) for soil vapor grab sampling using the Geoprobe® Post-Run Tubing (PRT) System with 6-Liter Summa® canisters and NIOSH tubes. In general, the following samples will be obtained:

- Soil vapor samples for chemical analysis,
- Soil samples for chemical analysis,
- Soil samples for geotechnical parameters analysis, and
- Ambient air sample for background conditions.

Soil vapor samples can be obtained using Summa® canisters and NIOSH tubes depending on the types of analyses and the detection limits required. The Summa® canisters are used to collect soil vapor samples for VOCs, naphthalene, and total petroleum hydrocarbons (calculated) - gasoline range (TPHg) using EPA Method TO-15, and TPHg (calibrated) using EPA Method TO-3. For naphthalene, a humidified tube must be used. NIOSH tubes are used to obtain TPH - diesel range (TPHd) using NIOSH Method 1550. For the Summa® canisters, there are several reporting limits depending on the cleaning and certification procedures used for the canisters. The following generalized detection limits apply to the canisters:

- SIM certified – low reporting limits,
- Low Level certified – intermediate reporting limits, and
- Standard Level (not certified) – high reporting limits.

This SOP is for the use of humidified Summa® canisters using TO-15 Standard Level reporting limits for VOCs, naphthalene, and TPHg (calculated), TO-3 reporting limits for TPHg (calibrated), and NIOSH tubes for TPHd using NIOSH Method 1550.

Soil vapor sampling is needed to obtain VOC source term concentrations for modeling potential vapor intrusion into buildings and subsequent health risk assessment for building occupants. A soil vapor sampling approach is described in the remainder of this document. The approach involves the following:

- first purging the sampling line using a vacuum or pump system,
- a volume of soil gas is then collected in a container for later laboratory analysis for site-specific constituents (Table 1),
- VOC soil vapor concentration results are reported in micrograms per cubic meter (ug/m^3), and
- sampling results can then be used to estimate potential VOC concentrations that might occur in indoor air due to subsurface vapor intrusion.

2.0 SCOPE

The methods described are applicable when collecting soil vapor samples in 6-Liter Summa®

canisters and NIOSH tubes using the Geoprobe® Post-Run Tubing (PRT) System. This SOP describes specific equipment to be utilized. In some cases, equivalent equipment may be successfully substituted.

3.0 GLOSSARY

Key definitions are explained in Section 4.

4.0 RESPONSIBILITIES

Project Technical Manager (Atul Salhotra)- Responsible for the selection of specific sampling locations, sampling depths, and analytical parameters.

Field Operations Leader (Dave Rizzuto) - Responsible for coordinating sampling activities including: site access; subcontractor availability, underground utility clearance, sampling supplies, laboratory issues, field equipment, and health and safety plans. This individual will also be responsible for the oversight of the soil vapor sampling activities, collection of soil vapor samples for laboratory analysis, collection of field soil vapor measurements (if applicable), on-site health and safety, shipment of soil vapor samples to the laboratory, and documentation of all field activities.

Field Geologist (Greg Dill) – Responsible for completing the sampling per the project requirements. This person will work with the Geoprobe operator in sample collections. This person is also responsible for the completion of all field forms and collection of field data per this SOP.

Geoprobe Operator (Robert Currence) – Responsible for operation of the Geoprobe drill rig and all requirements of such to complete the project sampling per this SOP. Will assist the field geologist as needed with sampling.

5.0 PROCEDURES

5.1 Overview

Soil vapor samples are collected in 6-Liter Summa® canisters and NIOSH tubes utilizing Geoprobe® direct-push boring methodologies and the PRT system. The target soil vapor sampling depth is determined prior to sampling at each location. Optional field measurements for biogenic gases, such as oxygen, carbon dioxide, and methane, may be collected from each sampling location using a handheld landfill gas meter.

5.2 Direct-Push Geoprobe® Boring and Post-Run Tubing (PRT) Soil Vapor Sampling

This section describes the field methodology that will be utilized to collect the soil vapor samples. Because of site-specific conditions or obstacles, the sampling plan may be modified as needed, based on the professional judgment of the Field Operations Leader and Project Technical Manager. To sample at multiple depths will require multiple adjacent borings due to the emplacement of the expendable points.

The equipment will be positioned at the sampling location and the drive rod and expendable point will be advanced into the subsurface. Once the target sampling depth has been achieved,

the rod is pulled up about 4 to 6 inches to allow the expendable point to be released and void space is created. It may be necessary to use a point popper to disengage the expendable point. Then the sampling tube with adapter is pushed down the inside of the drive rod and is engaged into the point holder by turning counter-clockwise. Once the tubing is engaged, the soil vapor sample can be collected using the PRT system. Detailed information for the PRT system is provided in Attachment B. Disposable Teflon® tubing (0.125-inch inside diameter) will be used for the collection of the soil vapor samples. Prior to collecting the sample, the sampling system will be purged of **seven** volumes of vapor. All calculations of purge volumes will be documented in the field book. The sample train purge volume (one volume) will be calculated by the summation of the following volumes (refer to Attachment C for volume calculations):

1. The volume of Teflon® tubing utilized to extend from the target sampling depth to the surface,
2. The approximate volume of the void space created when the expendable point is withdrawn,
3. Plus an additional 20 milliliters (mL).

Purging of the sampling system will be performed using a 60 cubic centimeters (cc) (1 cc is equivalent to 1 mL) disposable syringe. A new syringe and new Teflon® tubing will be used for each sample collected.

SUMMA® canisters and NIOSH tubes will be used to collect the samples for laboratory analysis. Sections 2.3.1 and 2.3.2 in Attachment A (Guide to Air Sampling and Analysis, Air Toxics Ltd.) provide a detailed description of the procedures to be used for Summa® canister grab sampling.

To confirm that ambient air short-circuiting is not occurring during soil vapor sampling, a leak test should be performed. The leak test includes using 2-propanol as a tracer compound. Household paper towels will be wetted with 2-propanol immediately prior to purging and sampling. The wetted paper towels are placed directly over the top of a bentonite plug located at ground surface where the Geoprobe® rod string enters the ground. A second wetted paper towel is placed around the Teflon® tubing where the tubing exits the rod string. When this short-circuiting test is conducted, 2-propanol will be added to the list of analytes to be analyzed by the laboratory. The procedures will be documented in the field logbook.

Visual inspection of individual PRT system components, including 0-rings, will be performed before and after collection of each soil vapor sample. Documentation of inspection is included in the field logbook. Qualitative testing of the equipment will be performed at the end of each day after the last sample is collected. The test is conducted by applying a vacuum to the sealed assembled system as described in Attachment D.

Vapor Sample Collection using SUMMA® Canisters

The SUMMA® canisters sampling will be used to determine the concentrations of BTEX, MTBE, naphthalene, TPHg (calculated), TPHg (calibrated), and 2-propanol (leak testing). The following steps should be followed for vapor sampling using the SUMMA® canisters:

- Prior to sampling, the system will be purged of **seven** volumes of ambient air using a GilAir Constant flow pump,

- Upon completion of purging the seventh purge volume, the in-line valve to the GilAir Constant flow pump will be closed,
- Insert the Teflon® tubing into a 5-micron particulate filter attached to a 6 -Liter Summa® canister inlet,
- Then, to collect each sample, the field crew will perform the following steps:
    - First, open the valve on the SUMMA® canister, with the pressure gauge attached and record the canister pressure (should be approximately minus (–) 29 inches mercury),
    - The grab sampling period should continue for approximately 3 minutes,
    - Close the sample valve, and record the final canister pressure,
    - If the final pressure is near ambient then remove the SUMMA® canister from pressure gauge and sample tubing,
    - If the final pressure has not reached ambient, then reopen the canister and continue to collect soil gas. This procedure may need to be repeated until an approximate grab sampling period can be determined for the site specific field conditions, which would be used for subsequent sampling locations,
    - Once sampling is completed and the canister has been removed, install ¼ inch brass screw-on cap to SUMMA® canister,
    - Label the canister with the site name, sampling location, date, time, analytical parameter, and sampler identification, and
    - Transport the vapor sample canisters to Air Toxics, Ltd laboratory located in Folsom, California (phone # 1-800-985-5955) via Federal Express using proper chain-of-custody documentation.

Vapor Sample Collection using NIOSH Tubes

NIOSH tube sampling is needed to determine the concentration of TPH (diesel range) in the vapor samples. The NIOSH tube contains an activated charcoal media. The following steps should be followed for obtaining vapor samples using NIOSH Tubes:

- The NIOSH tubes should be received from the laboratory in a cooler with an inside temperature of 2 to 6 degrees Celsius using "Blue Ice" or equivalent,
- A Gil Air personal sampling pump is needed to obtain the vapor samples. The pump should be calibrated prior to use,
- The sampling tubing is connected to the NIOSH tube,
- The sample is collected by connecting the opposite end of the NIOSH tube to a personal sampling pump and drawing the soil gas through the tube as described in the sampling method for Naphthas 1550 (Attachment E). Documentation of flow rate and sampling

time should be entered in the field notebook, as it will be needed to calculate the sample concentration,

- The pump is then turned off and the NIOSH tube is disconnected from the pump and tubing, the ends of the tube are capped, and the tube is stored for shipping to the laboratory in a cooler with an inside temperature of 2 to 6 degrees Celsius, and

- The tube should be labeled and transported to the Air Toxics, Ltd laboratory in Folsom, CA as described above for the SUMMA® canister sampling.

Field Documentation

At a minimum, the following information will be recorded in the field logbook for each soil vapor sample collected:

- Ambient air temperature,
- Sample ID - Sample ID SV-01(10.5) would designate a sample collected at a depth of 10.5 feet at location SV-01. The depth will be rounded to the nearest 0.5 foot,
- Sample depth (with calculations if boring is performed at an angle),
- Sample location with schematic showing at least two measurements to fixed site features,
- Sample date (e.g. 09/21/02),
- Sample time in 24-hour format (e.g. 1350 for 1:50 in the afternoon),
- Length of sampling time,
- Beginning and ending canister pressure, and
- For NIOSH tube sampling, the flow rate and length of sampling time.

5.3 Ambient Air Sample

One background air sample should be collected. The location will be selected in the field based on observed and forecasted wind directions. The location will be in the vicinity of the property line in an upwind position. This sample should be collected in a 6-Liter Summa® canister and NIOSH tube, and analyzed for the same parameters as described in Section 6.0.

5.4 Soil Chemistry and Geotechnical Parameters

Subsurface soil samples should be collected at the same depths in an adjacent boring to those used to obtain soil vapor samples. These samples should be split, and half analyzed for chemical parameters and the other half analyzed for geotechnical parameters needed to develop site-specific target levels.

We suggest that the following soil chemistry parameters be determined; BTEX, MTBE, naphthalene, TPH-GRO (gasoline range), and TPH-DRO (diesel range).

We suggest that the following four soil geotechnical parameters be determined; Dry Bulk Density, Porosity, Volumetric Water/Moisture Content, and Fractional Organic Carbon.

5.6 Optional Biogenic Gas Field Measurement

Following completion of the collection of the sample for laboratory analysis, field measurements may be obtained by field personnel using a field-calibrated GEM-500™ multi-function analyzer, or equivalent. Measurements (e.g., oxygen, carbon dioxide, and methane) will be recorded in the log book. The instrument will be connected directly to the Teflon® tubing and soil vapors will be extracted by the instrument's vacuum pump. It is assumed that soil vapor flow to the instrument will be sufficient to allow for the collection of the field measurements. If the soil vapor flow is not sufficient for direct measurement from the Teflon® tubing, a 60-cc syringe will be utilized to extract soil vapor for collection into a Tedlar® bag. Once sufficient soil vapor volume has been collected and stored in the Tedlar® bag, the instrument will be connected to the Teflon® tubing attached to the Tedlar® bag and the readings will be obtained and recorded.

6.0 LABORATORY ANALYSIS of SOIL VAPOR SAMPLES

The laboratory selected for this project to analyze the vapor samples is Air Toxics, Ltd laboratory located in Folsom, California. The SUMMA® canisters and NIOSH tubes will be prepared for sampling at Air Toxics, Ltd laboratory (certified laboratory). Prior to sampling, each canister will be cleaned and blanked. Following cleaning and blanking, the canisters will be evacuated, leak-checked, their vacuum measured, and prepared for field deployment.

The soil vapor and background air samples will be analyzed for selected volatile organic compounds as specified below following guidance outlined in EPA Methods Modified TO-15 and TO-3, and NIOSH Method 1550.

- BTEX and MTBE – Modified TO-15 (Std. Level),
- Naphthalene – Modified TO-15+Naphthalene (Std. Level),
- TPH (calculated) – Modified TO-15+TPHg (Std. Level),
- TPH gasoline range (C5-C10 or C2-C12) – Modified TO-3 (Std. Level),
- TPH-D (diesel range) – NIOSH 1550, and

- 2-propanol (leak test) – Modified TO-15 (low level).

The project analyte list is provided in Table 1.

7.0 REFERENCES

Air Toxics LTD. *Guide to Air Sampling and Analysis*. Fourth Edition.

9.0 ATTACHMENTS

Table 1 – Target Analyte List

Attachment A - Guide to Air Sampling and Analysis: Canisters and Tedlar® Bags, Fourth Edition, Air Toxics, Ltd.
Attachment B - Geoprobe® Post-Run Tubing System
Attachment C - Purge Volume Calculations
Attachment D - Vacuum Testing Procedure
Attachment E – NIOSH Method 1550

Table 1 - Target Analyte List

EPA Method	Analyte	Reporting Limit
Modified TO-15 + Napthalene	Benzene	1.6 ug/m^3
	Ethylbenzene	2.2 ug/m^3
	Toluene	1.9 ug/m^3
	Xylenes (m, p)	2.2 ug/m^3
	Xylenes (o)	2.2 ug/m^3
	Methyl-tert-butyl ether	7.3 ug/m^3
	Naphthalene	11 ug/m^3
	2-Propanol	5.0 ug/m^3
Modified TO- 3 (gas range)	TPH (gasoline range) – C2-C12(calibrated method)	100 ug/m^3

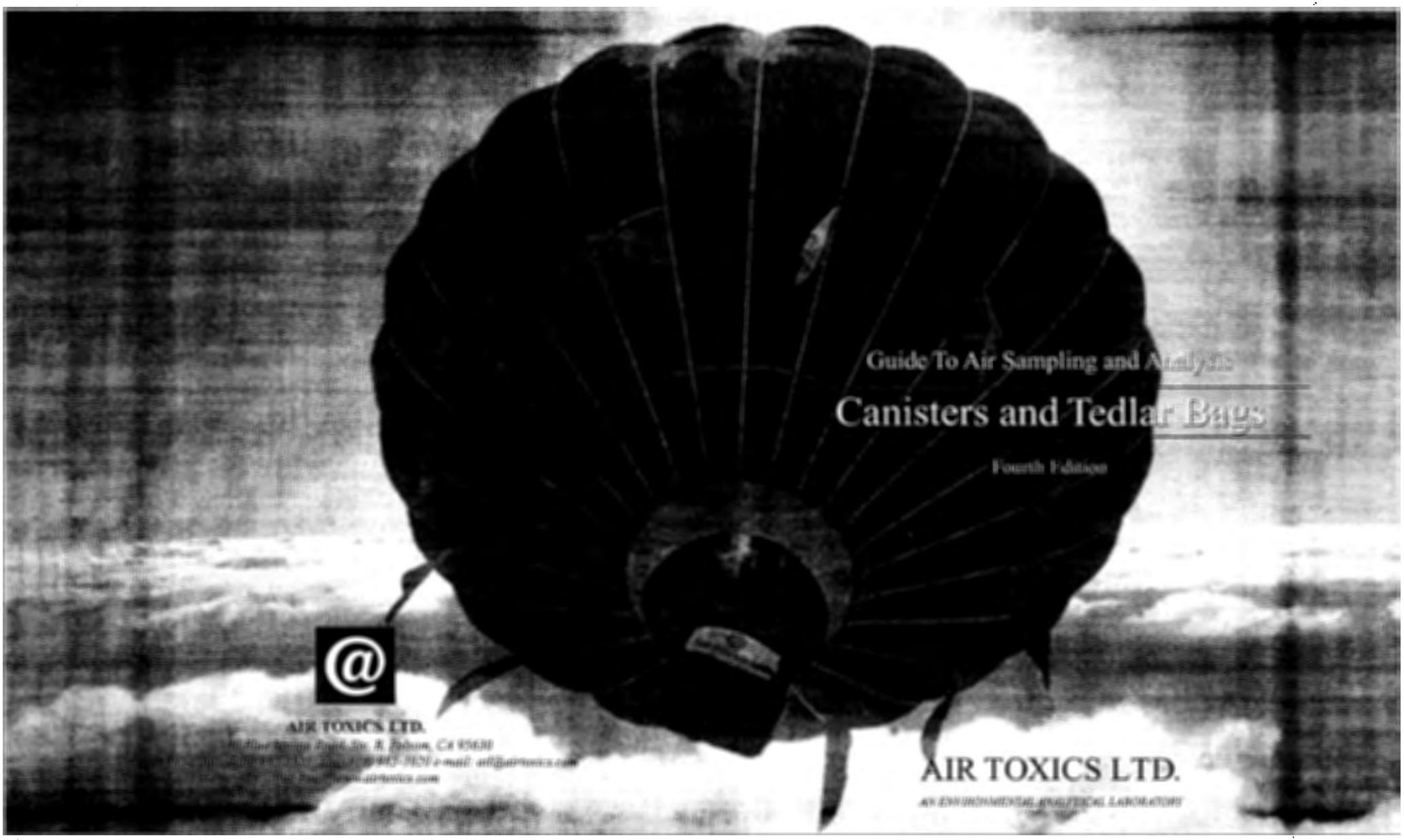
ug/m^3 - micrograms per cubic meter

NIOSH Method	Analyte	Reporting Limit
1550	TPHd (diesel range)	100 ug/sample

ug – micrograms

ATTACHMENT A

Guide to Air Sampling and Analysis: Canisters and Tedlar Bags, Fourth Edition, Air Toxics, Ltd.



Guide To Air Sampling and Analysis

Canisters and Tedlar Bags

Fourth Edition

AIR TOXICS LTD.
[illegible] Folsom, CA 95630
[illegible] e-mail: atl@airtoxics.com
[illegible] www.airtoxics.com

AIR TOXICS LTD.

AN ENVIRONMENTAL ANALYTICAL LABORATORY

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Section 1.0 Introduction

Air Toxics Ltd. presents this guide as a resource for individuals engaged in air sampling. Air sampling can be more involved than water or soil sampling due to the reactivity of chemical compounds in the gas matrix and sample interaction with the sampling equipment and media. Ensuring that air samples are collected properly is an important step in acquiring meaningful analytical results. This guide is not a substitute for experience and cannot possibly address the multitude of actual field conditions. Note that this guide is intended for typical projects involving whole air sampling of volatile organic compounds (VOCs) in canisters and Tedlar bags. Air Toxics Ltd. provides the "Guide to Air Sampling and Analysis - Sorbents, Solutions, and Filters" for other types of sampling.

1.1 Whole Air Sampling of VOCs

There are four general ways to collect compounds in a gas phase sample. A sampler can collect the gas in a container or draw the gas through a sorbent, solution, or filter. This guide focuses on collecting a sample in the most common air sampling containers, Summa canisters and Tedlar bags. The sample can be collected in the container either passively (i.e., by evacuating the canister prior to sampling) or actively (i.e., using a pump). The container is subsequently sealed and transported to the laboratory for analysis. The sample is referred to as a "whole air sample" and the compounds remain in the gas matrix (e.g., ambient air) inside the container.

As a general rule, whole air sampling is best when target compounds are volatile, non-polar, and have boiling points less than 170°C, although exceptions to this rule can be found. Recovery of any given compound in a whole air sample is very much dependent upon the humidity of the sample, the chemical activity of the sample matrix, and the degree of inertness of the container.

1.2 Choosing Between Canisters and Tedlar Bags

Deciding whether a canister or a Tedlar bag should be used for collecting a whole air sample depends on the type of air sampling application. The Tedlar bag is best used as a "ppmv" (parts per million by volume) whole air sample container. In other words, it is best suited for air sampling applications involving compound concentrations well above the low ppbv (parts per billion by volume) range. Soil/landfill gas surveys, monitoring soil vapor extraction (SVE) systems, and sampling for atmospheric/fixed gases are applications well suited for Tedlar bag sampling. Ambient and indoor air projects driven by risk assessment or litigation are better suited for Summa canisters that are cleaned and individually certified free of the target compounds. The different degree of compound inertness between the two sample container surfaces is reflected in their suggested hold times for VOCs – 3 days from sampling to analysis for a Tedlar bag compared to 14-30 days for a Summa canister. Analyses of new Tedlar bags reveal that some VOCs may be present at concentrations in the single digit ppbv range (see Section 3).

Table 1.2. Comparison of Canisters to Tedlar Bags

	Canisters	Tedlar Bags
Common Volumes	1 and 6 L	1, 3, and 5 L
Type of Sampling	Passive (vacuum)	Active (pump required)
Sample Handling	Room temperature	Room temperature
Media Hold Time	Up to 30 days recommended	Indefinite
Hold Time to Analysis	14-30 days	3 days
Surface Inertness	Excellent	Fair
Cleanliness	10% or 100% certified to ppbv/pptv levels	Some VOCs present at 0.5 to 45 ppbv
Sampling Application	Ambient/indoor air, soil/landfill gas, stationary source	Ambient air (fixed gases only), soil/landfill gas, stationary source
Rule of Thumb	"ppbv device"	"ppmv device"
Advantages	Inertness, hold time, ruggedness, no pump	Purchase/shipping cost, availability, convenience

The table above compares the features of canisters and Tedlar bags. Canisters have superior inertness, hold time to analysis, ruggedness, and do not require a sampling pump. Tedlar bags can be purchased inexpensively in bulk, carried to a sampling site in a briefcase, filled in seconds, and shipped easily to the laboratory for analysis. Call Client Services at 800-985-5955 if you have questions regarding sampling media.

1.3 Organization of this Guide

The remainder of this guide is divided into three sections: canister sampling, Tedlar bag sampling, and special sampling considerations. Section 2 on canister sampling and Section 3 on Tedlar bag sampling provide complete sampling media descriptions, practical considerations for sampling, and step-by-step sampling procedures. Photographs illustrate the correct way to assemble the various sampling components. Tables provide detailed information on many operational factors that ultimately influence the quality of the data obtained from a canister or Tedlar bag sample. Section 4 provides considerations for special sampling configurations such as field duplicates and ambient blanks. This section also provides considerations for sampling at altitude, soil/landfill gas sampling, and sample cylinder (or "sample bomb") sampling.

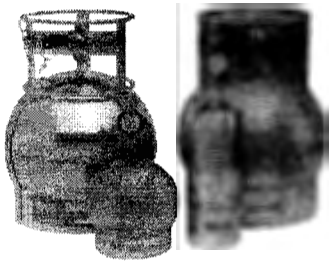
If you have any questions after reading this guide, please call Client Services at 800-985-5955 before proceeding with sampling. Air Toxics Ltd. also provides technical articles on specific air topics in *Air Topics* publications and *In the Air* quarterly newsletters available upon request or on the Internet at *www.airtoxics.com*.

Section 2. Canister Sampling

This section provides a description of air sampling canisters, practical considerations for sampling, and step-by-step instructions for collecting a grab and integrated sample. Photographs illustrate the correct way to assemble the various sampling components. Tables provide detailed information on many operational factors that ultimately influence the quality of the data obtained from a canister sample.

2.1 Introduction to Canisters

An air sampling canister is a container for collecting a whole air sample for ambient and indoor air applications. The canister is best suited for projects involving analysis of compounds in the ppbv range. However, canisters can be used for other applications such as landfill and soil gas involving analysis of compounds in the ppmv range.



A canister can be spherical or cylindrical and is constructed of stainless steel. The canister is prepared for sampling by evacuating the contents to a vacuum of approximately 29.9 inches of Mercury (in. Hg). Opening the stainless steel bellows valve allows the air sample to enter the canister. When the target volume of sample is collected, the valve is closed and the canister is returned to the laboratory.

Canisters can range in volume from less than 1 liter (L) to greater than 6 L. At Air Toxics Ltd., 6 L canisters are used for ambient air samples and for taking integrated samples. 1 L canisters are normally used for taking high concentration (i.e., greater than 5 ppbv) grab samples, although exceptions to these guidelines are common. Variations of air sampling canisters include glass bulbs, sample cylinders (or "sample bombs"), and Summa canisters. Glass bulbs are rarely used in field applications due to lack of ruggedness. Sample cylinders are DOT-approved, high pressure, thick-walled, stainless steel cylinders with a valve at each end (see Section 4.4). The remainder of this section focuses on Summa canisters.

2.1.1 Summa Canister

A Summa canister is a stainless steel container that has had the internal surfaces specially passivated using a "Summa" process. This process combines an electropolishing step with a chemical deactivation step to produce a surface that is nearly chemically inert. A Summa surface has the appearance of a mirror: bright, shiny, and smooth. The degree of chemical inertness of a whole air sample container is crucial to minimizing reactions with the sample and maximizing recovery of target compounds from the container. Air Toxics Ltd. maintains a large inventory of Summa canisters in 6 and 1 L volumes.

2.1.2 Canister Cleaning and Hold Time

Canister sampling differs considerably from collecting a water sample in a VOA vial or a soil sample in an amber jar in that the container (valued at over $450) is cleaned and reused. A canister will hold a high vacuum (i.e., greater than 25 in. Hg) for more than 30 days. Air Toxics Ltd., however, requires that our canisters be returned within 30 days.

☞ Media hold time for a canister is 30 days

Air Toxics Ltd. provides two types of canister cleaning certification, 10% and 100%, depending upon the requirements of the project. The 10% certification process is appropriate for routine ambient air applications and high concentration applications such as soil vapor and landfill gas monitoring. The 10% certification process begins by cleaning canisters using a combination of dilution, heat, and high vacuum. After completing the cleaning steps, 10% of the canisters are certified each day. Canisters are certified for approximately 60 VOCs using GC/MS by Modified EPA Method TO-15. The 10% certification process requires that target compound concentrations be below 0.2 ppbv. Alternatively, the 100% certification (i.e., individual certification) process is appropriate for ambient and indoor air applications driven by risk assessment or litigation that require pptv (parts per trillion by volume) sensitivity. Similar to the 10% certification, the 100% certification also begins with the canister cleaning process. The difference with the 100% certification is that canisters are individually certified for a client-specific list of target compounds using GC/MS by TO-15. The 100% certified canisters are shipped with analytical documentation demonstrating that they are free of the target compounds down to the project reporting limits.

☞ Specify whether your project requires 10% or 100% canister cleaning certification

Although 14 days is the most commonly cited hold time for a canister sample, the hold time is compound specific. For example, non-polar compounds such as chloroform, benzene, and vinyl chloride are stable in a canister for at least 30 days. In fact, EPA Method TO-15 states: "Fortunately, under conditions of normal usage for sampling ambient air, most VOCs can be recovered from canisters near their original concentrations for after storage times of up to thirty days". However, recovery of polar compounds such as methanol and acetone begin to drop significantly after 14 days. Analysis of these samples should be performed within 14 days.

☞ Sample hold time to analysis for a canister is 14-30 days for VOCs

2.2 Associated Canister Hardware

Associated hardware used with the canister includes the valve, brass cap, particulate filter, and vacuum gauge.

2.2.1 Valve

An industry standard, 1/4 in. stainless steel bellows valve (manufactured by Nupro) is mounted at the top of the canister. The valve allows vacuum to be maintained in the canister prior to sampling and seals off the canister once the sample has been collected. No more than a half turn by hand is required to open the valve. Do not over-tighten the valve after sampling or it may become damaged. A damaged valve can leak and possibly compromise the sample. Some canisters have a metal cage near the top to protect the valve.

2.2.2 Brass Cap

Each canister comes with a brass cap (i.e., Swagelok 1/4 in. plug) secured to the inlet of the valve assembly. The cap serves two purposes. First, it ensures that there is no loss of vacuum due to a leaky valve or valve that is accidentally opened during handling. Second, it prevents dust and other particulate matter from fouling the valve. The cap is removed prior to sampling and replaced following sample collection.

☞ Always replace the brass cap following canister sampling

7 Micron

5 Micron

2.2.3 Particulate Filter

Each canister comes with a particulate filter provided separately in the packing box. The filter prevents particulate matter from fouling the valve (or flow controller) and entering the canister. Particulate filters should be cleaned between uses. Air Toxics Ltd. provides two types of particulate filters: 7 micron and 5 micron. The longer, 7 micron particulate filter is normally used with 6 L canisters and whenever an integrated sample is being collected. This device filters particulate matter greater than 7 microns in diameter and does not significantly restrict the flow rate in to the canister. Typical fill times for canisters are shown in the following table. The shorter, 5 micron particulate filter is often used to slow down grab sampling with 1 L canisters and mini-cans. This device is a fritted stainless steel disk that has been pressed into a conventional Swagelok adapter. This device filters particulate matter greater than 5 microns in diameter and has a relatively high pressure drop across the fritted disk. It restricts the flow into the canister and fill times are increased.

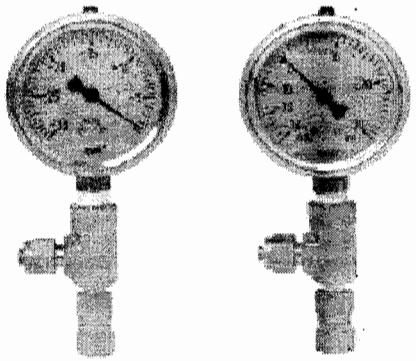
☞ Always use the particulate filter for canister sampling

Table 2.2.3 Fill Times for Canisters

CANISTER VOLUME	7 micron filter	5 micron filter
6 L	16 sec	23 min
1 L	3 sec	4 min
400 mL (mini-can)	1-2 sec	1 min 20 sec

2.2.4 Vacuum Gauge

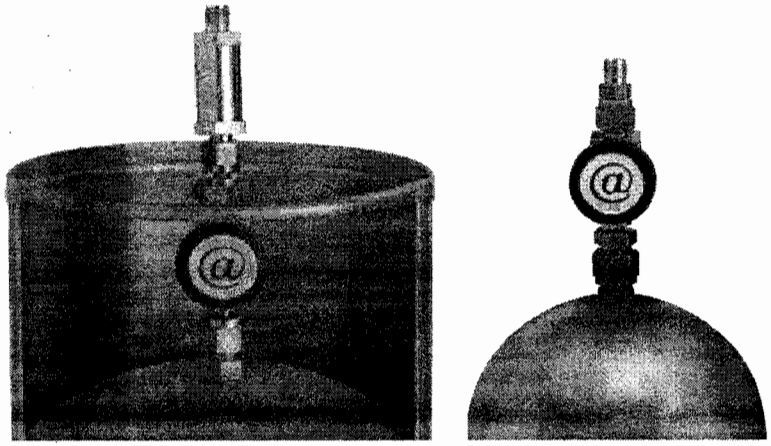
A vacuum gauge can be used to measure the initial vacuum of the canister before sampling and the final vacuum upon completion. A gauge can also be used to monitor the fill rate of the canister when collecting an integrated sample. Gauges are generally not used during the brief interval for grab sampling. Gauges are used only to provide a relative measure of "change". The accuracy of gauges provided by Air Toxics Ltd. is such that gauge-to-gauge comparisons have no merit. Individuals engaged in frequent air sampling or air projects driven by risk assessment or litigation are highly encouraged to purchase and maintain their own gauge. Upon request, Air Toxics Ltd. provides two types of gauges: vacuum gauges reading 0 to 30 in. Hg and vacuum-pressure gauges reading 30 in. Hg to 30 psig (pounds per square inch gage).



☞ Air Toxics Ltd. provides gauges only if requested

2.3 Grab Sampling with Canisters

There are two basic modes of canister sampling: grab and integrated. A grab sample is taken over a short interval (i.e., 1-5 minutes) while an integrated sample is taken over an extended period (e.g., 0.5-2 hours for a 1 L canister and 0.5-24 hours for a 6 L canister). In both modes the canister vacuum is used to draw sample into the canister. This is commonly referred to as passive sampling. Active sampling utilizes a pump to fill the canister. The most common hardware configuration used to take a grab sample are illustrated in the following figure. A particulate filter is used to prevent particulate matter from fouling the valve and entering the canister.



2.3.1 Considerations for Grab Sampling With Canisters

The following are some considerations for collecting a grab sample in a canister.

- **Avoid Leaks in Sampling Train**: All fittings on the sampling hardware are 1/4 in. Swagelok. A 9/16 in. crescent wrench is used to assemble the hardware. It is not necessary to over tighten the fittings; finger tight plus 1/4 turn with the wrench is adequate. In practice this should be tight enough so that the various pieces of equipment, when assembled, cannot be rotated by hand.

- **Verify Gauge Operation**: If the indicator does not read "zero" upon arrival, the gauge either needs to equilibrated or the gauge may be damaged and unusable. Equilibrate the gauge by "cracking" the rubber plug on top of the gauge. For more details on the equilibration procedure, see instructions included with the gauge or call Client Services at 800-985-5955.

- **Verify Initial Vacuum of Canister**: Prior to shipment, each canister is checked for mechanical integrity. However, it is still important to check the vacuum of the canister prior to use and record the initial vacuum on the chain-of-custody. The initial vacuum of the canister should be greater than 25 in. Hg. If the canister vacuum is less than 25 in. Hg, do not use it. Call Client Services at 800-985-5955 and arrange for a replacement canister. If sampling at altitude, there are special considerations for gauge readings and sampling (see Section 4.2). The procedure to verify the initial vacuum of a canister is simple, but unforgiving.

1. Confirm that valve is closed (knob should already be tightened clockwise)
2. Remove the brass cap
3. Attach gauge
4. Attach brass cap to side of gauge tee fitting
5. Open and close valve quickly (a few seconds)
6. Read vacuum on the gauge
7. Record gauge reading on "Initial Vacuum" column of chain-of-custody
8. Verify that canister valve is closed and remove gauge
9. Replace the brass cap

- **Leave Residual Vacuum**: A grab sample can be collected either by allowing the canister to reach ambient conditions or by leaving some residual vacuum (e.g., 5 in. Hg) in the canister. In either case, the final vacuum should be noted on the "Final Vacuum" column on the chain-of-custody. This will enable the laboratory to compare the final vacuum with the receipt vacuum (i.e., the vacuum measured upon arrival at the laboratory). If the two readings differ significantly, Client Services will contact you for instructions on how to proceed.

2.3.2 Step-by-Step Procedures for Canister Grab Sampling

These procedures are for a typical ambient air sampling application and actual field conditions and procedures may vary.

Before you get to the field:

1. Verify contents of the shipped package (e.g., chain-of-custody, canister, particulate filter, and gauge – if requested)
2. Verify that gauge is working properly (see Section 2.3.1)
3. Verify and record initial vacuum of canister (see Section 2.3.1)

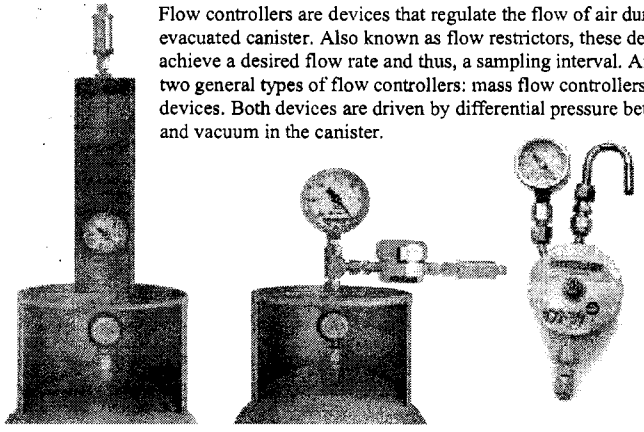
When ready to sample:

4. Remove brass cap
5. Attach particulate filter to canister
6. Open valve 1/2 turn (6 L canister normally takes about 16 sec to fill)
7. Close valve by hand tightening knob clockwise
8. Verify and record final vacuum of canister (repeat steps used to verify initial vacuum)
9. Replace brass cap
10. Fill out canister sample tag
11. Return canister in box provided
    - Unreturned canister charge of $450 each
12. Return sample media in packaging provided. Unreturned equipment charges:
    - $45 per particulate filter
    - $45 per gauge
13. Fill out chain-of-custody and relinquish samples properly
14. Place chain-of-custody in box and retain pink copy
15. Tape box shut and affix custody seal (if applicable) across flap
16. Ship accordingly to meet method holding times

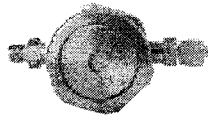
2.4 Integrated Sampling with Canisters and Flow Controllers

An air sample collected over more than a few minutes is referred to as an integrated sample and can provide information on compound concentrations in air averaged or composited over time. An 8- or 10-hour integrated sample can be used to determine indoor air quality in the workplace. Similarly, a 24-hour integrated sample can be an economical and practical approach to determine residential exposure to indoor or outdoor air sources. The most common hardware configurations used to take an integrated sample are illustrated below.

Flow controllers are devices that regulate the flow of air during sampling into an evacuated canister. Also known as flow restrictors, these devices enable a sampler to achieve a desired flow rate and thus, a sampling interval. Air Toxics Ltd. provides two general types of flow controllers: mass flow controllers and critical orifice devices. Both devices are driven by differential pressure between ambient conditions and vacuum in the canister.



Flow controller by Entech



Flow controller by Veriflo

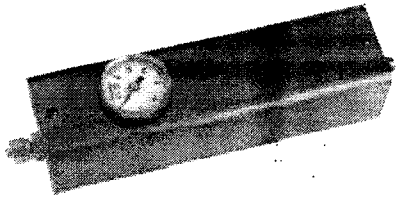
2.4.1 Mass Flow Controller

A mass flow controller employs a diaphragm that actively compensates to maintain a constant mass flow rate. As the differential pressure decreases, the flow rate tends to decrease and the diaphragm responds by opening up to allow more air to pass through. Mass flow controllers can be adjustable or fixed and can provide integrated samples with intervals ranging from hours to days. Air Toxics Ltd. provides a fixed mass flow controller that is calibrated at the laboratory for 24-hour sampling. Adjustable mass flow controllers have a knob that can be adjusted in the field to provide integrated samples with intervals ranging from one to 24 hours. The rugged conditions of field sampling are not usually compatible with adjustable mass flow controllers and Air Toxics Ltd. designed a more reliable flow controller based on a critical orifice design.

2.4.2 Critical Orifice Device

Air Toxics Ltd. designed a critical orifice flow restrictor to provide integrated samples with intervals from 0.5 to 8 hours. The device restricts air flow by forcing the sample to enter a capillary column of minute radius. This device is passive compared to an actively compensating diaphragm and the flow rate decreases as the driving force (differential pressure) decreases. For sampling intervals from 0.5 to

8 hours, however, the flow rate is relatively constant. The main advantages of the Air Toxics Ltd. flow restrictors are improved ruggedness and cleanliness. With no moving or adjustable parts, the Air Toxics Ltd. design is unlikely to lose its flow setting. In addition, a vacuum gauge is built in to the device to monitor sampling progress. To ensure there are no contamination issues from previous use, the capillary column is replaced before shipping to the field.



2.4.3 Sampling Interval and Flow Controller Setting

When you request canisters and flow controllers from Air Toxics Ltd., you will be asked for the sampling interval, and the flow controllers will be pre-set prior to shipment according to the table below. The flow controller is set to collect 5 L of sample over the sample interval. Final canister vacuum is targeted at 5 in. Hg. The flow rate is set at standard atmospheric conditions (approximately sea level). If the air sample is a process (pressurized or under vacuum) or is collected at elevation, the canisters will fill faster or slower depending on the sampling conditions. If you specify the pressure of the source at project set-up, we can set the flow controller accordingly. See Section 4 for a discussion of collecting a sample at elevation. The 24-hr flow controllers should not be used for process or source samples.

Table 2.4.3 Flow Rates for Selected Sampling Intervals (mL/min)

Sampling Interval (hrs)	0.5	1	2	4	8	12	24
6 L Canister	167	83.3	41.7	20.8	11.5	7.6	3.5
1 L Canister	26.6	13.3	6.7	-	-	-	-

Note: Target fill volumes for 6 L and 1 L canisters are 5,000 mL and 800 mL, respectively.

$$\text{Flow Rate(mL/min)} = \frac{\text{Target Fill Volume (mL)}}{\text{Sampling Interval (min)}}$$

2.4.4 Final Canister Vacuum and Flow Controller Performance

Ideally the final vacuum of a 6 L canister should be 5 in. Hg or greater. As long as the differential pressure is greater than 4 in. Hg ambient pressure, then the flow through the device will remain approximately constant as the canister fills. If there is insufficient differential pressure, the flow through the controller will decrease as the canister pressure approaches ambient. Because of the normal fluctuations in the flow rate (due to changes in ambient temperature, pressure, and diaphragm instabilities) during sampling, the final vacuum will range between 2 and 10 in. Hg.

- **If the residual canister vacuum is greater than 5 in. Hg** (i.e., more vacuum), the flow rate was low and less than 5 L of sample was collected. When the canister is pressurized to 5 psig prior to analysis, sample dilution will be greater than normal. This will result in elevated reporting limits.

- **If the residual canister vacuum is less than 5 in. Hg** (i.e., less vacuum), the initial flow rate was high. Once the vacuum decreases below 5 in. Hg, the flow rate begins to drop significantly. This scenario indicates that the sample is skewed in favor of the first portion of the sampling interval.

- **If the final vacuum is near ambient** (i.e., less than 1 in. Hg), there is inadequate differential pressure to drive the flow controller. The sampler cannot be certain the desired sampling interval was achieved before the canister arrived at ambient conditions. The sample could have been acquired over a 1-hour interval (which would be the case if the connection between the canister and flow controller leaked or if the flow controller malfunctioned) or a 24-hour interval. Although the actual sampling interval is uncertain, the canister still contains sample from the site.

Table 2.4.4 Relationship Between Final Canister Vacuum, Volume Sampled, and Dilution Factor (6 L Canister)

Final Vacuum (in. Hg)	0	2.5	5	7.5	10	12.5	15	17.5	20
Volume Sampled (L)	6	5.5	5	4.5	4	3.5	3	2.5	2
Dilution Factor*	1.34	1.46	1.61	1.79	2.01	2.30	2.68	3.22	4.02

* Canister pressurized to 5 psig for analysis

$$\text{Final Reporting Limit} = \text{Method Reporting Limit} \times \text{Dilution Factor (Canister Pressurization)} \times \text{Dilution Factor (Sample Concentration)}$$

$$\text{Dilution Factor (Canister Pressurization)} = \frac{\text{Pressurization for Analysis}}{\text{Receipt Vacuum}} = \frac{14.7\ \text{psig} + \text{Press. for Analysis (psig)}}{14.7\ \text{psig}\left[1 - \frac{\text{Rec. Vac. (in. Hg)}}{29.9\ \text{in. Hg}}\right]}$$

2.4.5 Considerations for Integrated Sampling with Canisters

Collecting an integrated air sample is more involved than collecting a grab sample. Sampling considerations include verifying that the media is ready, monitoring the integrated sampling progress, and avoiding contamination.

- **Avoid Leaks in the Sampling Train**: See Section 2.3.1 for instructions on how to securely assemble sampling hardware. A leak in any one of these connections means that some air will be pulled in through the leak and not through the flow controller. A final pressure near ambient is one indication that there may have been a leak.

- **Verify Initial Vacuum of Canister:** See Section 2.3.1 for instructions on verifying initial canister vacuum. If you are using an Air Toxics Ltd. critical orifice flow controller, note that you can use the built-in gauge. It is important to note both the canister and flow controller serial numbers on the chain-of-custody.

- **Monitor Integrated Sampling Progress**: It is a good idea to monitor the progress of the integrated sampling during the sampling interval. The volume of air sampled is a linear function of canister vacuum. For example, halfway (4 hours) into an 8-hour sampling interval, the canister should be half filled (2.5 L) and the gauge should read approximately 17 in. Hg. More vacuum than 17 in. Hg indicates that the canister is filling too slowly; less than 17 in. Hg and the canister is filling too quickly. If the canister is filling too slowly, a valid sample can still be collected (see Section 2.4.4). If the canister is filling too quickly because of a leak or incorrect flow controller setting, corrective action can be taken. Ensuring all connections are tight may eliminate a leak. It is possible to take an intermittent sample. The time interval need not be continuous. Eight 1-hour increments, taken by opening and closing the canister valve, will yield a valid sample.

Table 2.4.5 Gauge Readings for an 8-Hour Sampling Interval

Sampling Interval (hrs)	0	4	8
Canister Vacuum (in. Hg)	29.9	17.4	5
Volume Sampled (L)	0	2.5	5

- **Avoid Contamination**: Flow controllers should be cleaned between uses. This is normally accomplished by returning them to the laboratory. For large air sampling projects, Air Toxics Ltd. has designed a field conditioning program for 24-hour flow controllers involving a purge manifold. This arrangement provides the sampler with scheduling flexibility, inventory control, and convenience in the field. Air Toxics Ltd. will provide the 24-hour flow controllers, a purge manifold, Teflon tubing, rubber ferrules, vacuum pump, and flow meter. The sampler will need to provide the certified nitrogen cylinder and the certified high pressure regulator. Call Client Services at 800-985-5955 if you are interested in the field conditioning program.

- **Keep Sampling Train Out of Direct Sunlight**: The sampling train should be kept out of direct sunlight during sampling. There will be some flow rate drift if the temperature of the controllers is allowed to vary significantly.

2.4.6 Step-by-Step Procedures for Integrated Sampling

These procedures are for a typical ambient air sampling application and actual field conditions and procedures may vary.

Before you get to the field:

1. Verify contents of the shipped package (e.g., chain-of-custody, canister, particulate filter, and flow controller)
2. Verify initial vacuum of canister (see Section 2.3.1)

When ready to sample:

3. Remove brass cap
4. Attach flow controller to canister
5. Attach particulate filter to flow controller
6. Open valve 1/2 turn
7. Monitor integrated sampling progress periodically (see Section 2.4.5)

At end of sampling interval:

8. Verify and record final vacuum of canister (for 24-hr flow controller repeat steps used to verify initial vacuum and for critical orifice device simply read built-in gauge)
9. Close valve by hand tightening knob clockwise
10. Replace brass cap
11. Fill out canister sample tag
12. Return canisters in boxes provided
    - Unreturned canister charge of $450 each
13. Return sample media in packaging provided. Unreturned equipment charges:
    - $45 per particulate filter
    - $50-500 per flow controller
14. Fill out chain-of-custody and relinquish samples properly
15. Place chain-of-custody in box and retain pink copy
16. Tape box shut and affix custody seal (if applicable) across flap
17. Ship accordingly to meet method holding times

Section 3. Tedlar Bag Sampling

This section provides a description of Tedlar bags, practical considerations for sampling, and step-by-step instructions for collecting a grab sample. Photographs illustrate the correct way to assemble the various sampling components.

3.1 Introduction to Tedlar Bags

A Tedlar bag is a container used to collect a whole air sample for landfill gas, soil gas, and stationary source applications. The Tedlar bag is best suited for projects involving analysis of compounds in the ppmv range. However, Tedlar bags can be used for other applications such as ambient air monitoring for atmospheric/fixed gases. They can be used to collect sulfur compounds, but only if the fittings are non-metallic (e.g., polypropylene, Teflon, or Nylon).

A Tedlar bag is made of two plies of Tedlar film sealed together at the edges and features a valve that allows the interior to be filled. Sample collection requires a pressurized sampling port, a low flow rate pump, or a lung sampler. The bag expands as sample enters. When the target volume of sample is collected, the valve is closed and the Tedlar bag is returned to the laboratory. Air Toxics Ltd. maintains a limited inventory of Tedlar bags in 1 L , 3 L, and 5 L volumes.

3.1.1 Tedlar Film

Tedlar is a trade name for polyvinyl fluoride film developed by DuPont Corporation in the 1960's. This patented fluoropolymer has been used in a wide variety of applications including protective surfacing for signs, exterior wall panels, and aircraft interiors. Tedlar film is tough, yet flexible and retains its impressive mechanical properties over a wide range of temperatures (well below freezing to over 200° F). Tedlar exhibits low permeability to gases, good chemical inertness, good weathering resistance, and low off-gassing.

3.1.2 How "Active" is the Surface of a Tedlar Bag?

The surface of a Tedlar bag is a work in progress. The surface of a new bag is essentially free of VOCs at the single digit ppbv level. Compounds detected from analyzing new Tedlar bags include methylene chloride, toluene, acetone, ethanol, and 2-propanol. Note that 2-propanol has been detected in some new bags up to 45 ppbv. Once the Tedlar bag is used, however, the surface has been exposed to moisture and possibly VOCs. It may irreversibly adsorb many VOCs at the low ppbv level. A series of purges with certified gas will not remove the VOCs from the surface. $15 for a new bag is a small price to pay for peace of mind.

☞ **Never reuse a Tedlar bag when sampling for trace level compounds**

3.1.3 Hold Time for a Tedlar Bag

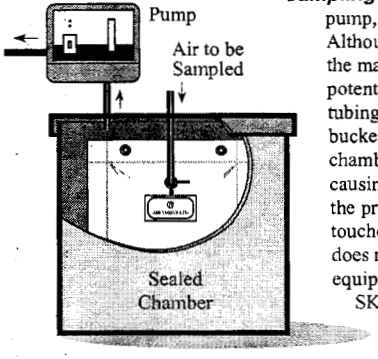
The media hold time for a Tedlar bag is indefinite if stored out of sunlight in a cool, dry location. Tedlar bags can be used to collect samples containing common solvents, hydrocarbons, chlorinated solvents, sulfur compounds, and many other classes of compounds. The sample hold time to analysis varies for different classes of compounds:

- **1 Day**: Sulfur compounds (e.g., hydrogen sulfide and methyl mercaptan) and chemically active compounds (e.g., 1,3-butadiene).
- **3 Days**: Chlorinated solvents, aromatic compounds, and atmospheric/fixed gases (oxygen, nitrogen, carbon dioxide).

3.2 Tedlar Bag Sampling

Using a Tedlar bag to collect an air sample normally involves "active" sampling, unlike an evacuated canister that can be filled "passively" by simply opening the valve. There are two methods commonly used to fill a Tedlar bag: using a pump or a lung sampler.

- ***Sampling with a Pump***: The most common method to fill a Tedlar bag is to use a small pump with low flow rates (50-200 mL/min) and tubing to fill the bag. Air Toxics Ltd. does not provide pumps but they can be rented from equipment providers or purchased from manufacturers such as Neuberger or Gilian.



- ***Sampling with a Lung Sampler***: Alternatively to using a pump, a "lung sampler" can be used to fill a Tedlar bag. Although a little more complicated than simply using a pump, the main advantage to using a lung sampler is that it avoids potential pump contamination. A Tedlar bag with attached tubing is placed in a small airtight chamber (even a 5-gallon bucket can work) with the tubing protruding from the chamber. The sealed chamber is then evacuated with a pump causing the bag to expand and drawing the sample through the protruding tube into the bag. The sample air never touches the wetted surfaces of the pump. Air Toxics Ltd. does not provide lung samplers, but they can be rented from equipment suppliers or purchased by manufacturers such as SKC Inc.

3.2.1 Considerations for Tedlar Bag Sampling

The following are some considerations for collecting a Tedlar bag sample.

- **Fill the Tedlar bag no more than 2/3 full**: Allow for possible expansion due to an increase in temperature or decrease in atmospheric pressure (e.g., the cargo hold of a plane).
- **Keep the Tedlar bag out of sunlight**: Tedlar film is transparent to ultraviolet light (although opaque versions are available) and the sample should be kept out of sunlight to avoid any photo-chemical reactions.
- **Protect the Tedlar bag**: Store and ship the Tedlar bag samples in a protective box at room temperature. An ice chest can be used, but DO NOT CHILL.
- **Fill out the Tedlar bag label**: It is much easier to write the sample information on the label before the Tedlar bag is inflated.
- **Provide a second Tedlar bag**: Consider filling two bags per location in the rare occasion that a defective bag deflates before analysis.
- **Avoid Contamination**: Care should be taken to avoid contamination introduced by the pump or tubing. Begin sampling at locations with the lowest compound concentrations (e.g., sample the SVE effluent before the influent). Decontaminate the pump between uses by purging with certified air for an extended period; better yet, use a lung sampler. Use shortest length possible of Teflon tubing or other inert tubing. Do not reuse tubing. If long lengths of tubing are used, consider purging the tubing with several volumes worth before sampling. If you are concerned about sampling for trace compounds, you shouldn't be using a Tedlar bag (see Section 1.2).
- **Don't Sample Dangerous Compounds in a Tedlar Bag**: Do not ship any explosive substances, radiological or biological agents, corrosives, or extremely hazardous materials to Air Toxics Ltd. Tedlar bag rupture during transit to the laboratory is possible and the sampler assumes full liability.

3.2.2 Step-by-Step Procedures for Tedlar Bag Sampling (Pump)

Note: These procedures are for a typical stationary source (e.g., SVE system) sampling application; actual field conditions and procedures may vary. See additional sampling considerations in Section 4.3 for sampling soil gas or landfill gas.

Before you get to the field:

1. Verify contents of the shipped package (e.g., chain-of-custody, Tedlar bag, and tubing/fittings – if requested)
2. Verify pump cleanliness and operation (Air Toxics Ltd. does not provide pumps)

When ready to sample:

3. Purge sample port
4. Attach new Teflon tubing from sample port or probe to low flow rate pump
5. Purge tubing
6. Fill out Tedlar bag sample tag
7. Attach additional new Teflon tubing from the pump outlet to the Tedlar bag valve
8. Open Tedlar bag valve
9. Collect sample (FILL NO MORE THAN 2/3 FULL)
10. Close Tedlar bag valve by hand tightening valve clockwise
11. Return Tedlar bag in boxes provided (DO NOT CHILL)
12. Fill out chain-of-custody and relinquish samples properly
13. Place chain-of-custody in box and retain pink copy
14. Tape box shut and affix custody seal (if applicable) across flap
15. Ship priority overnight to meet method holding times. 3 DAY HOLD TIME TO ANALYSIS (most analyses)

Section 4. Special Sampling Considerations

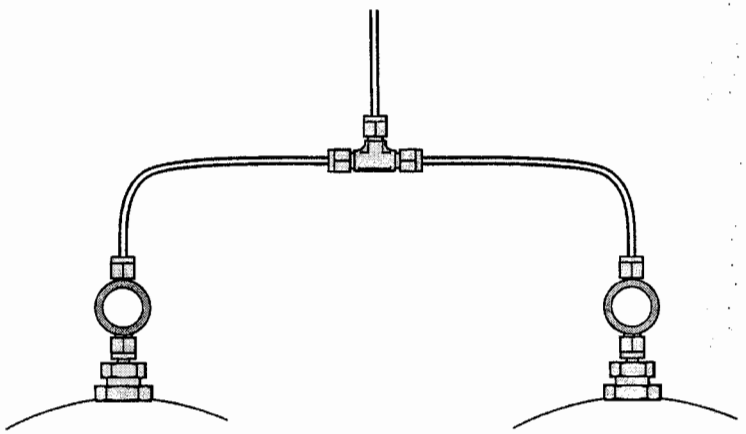
This section provides considerations for special sampling configurations that a sampler may collect in the field such as a field duplicates or an ambient blank. This section also provides considerations for sampling at altitude, soil/landfill gas sampling, and sample cylinder sampling.

4.1 Special Sampling Configurations

Special sampling configurations include a field duplicate, field split, field blank, ambient blank, trip blank, and an equipment rinse. Call Client Services at 800-985-5955 if your project involves any of these special sampling configurations.

4.1.1 Field Duplicate

A field duplicate is a second sample collected in the field simultaneously with the primary sample at one sampling location. The results of the duplicate sample can be compared (e.g., calculate relative percent difference) with the primary sample to provide information on consistency and reproducibility of field sampling procedures. Due to the nature of the gas phase, duplicate samples should be collected from a common inlet. The configuration for collecting a field duplicate includes stainless steel or Teflon tubing connected to a Swagelock "tee". It is imperative that individually certified (i.e., 100% certification process) canisters be used to collect a field duplicate.



4.1.2 Field Split

A field split is similar to a field duplicate in that two samples are collected in the field simultaneously at one sampling location. The main difference is that the samples are sent to separate analytical laboratories. The results of the split samples can be compared (e.g., calculate relative percent difference) to provide information on consistency and reproducibility of analytical procedures between the laboratories. However, due to the nature of air sampling canisters (different surface conditions, cleaning/certification procedures) and differences in analytical laboratory procedures (common in air analysis) the results are almost always meaningless. Please note that Air Toxics Ltd. does not recommend field splits and does not allow Air Toxics Ltd. canisters or other media to be sent to 3rd parties without obtaining prior written consent of Air Toxics Ltd.

4.1.3 Field Blank

A field blank is a sample collected in the field from a certified air source. Analysis of the field blank can provide information on the decontamination procedures used in the field. Clean stainless steel or Teflon tubing and a certified regulator should be used. It is imperative that individually certified canisters (the sample canister and the source canister/cylinder, if applicable) be used to collect a field blank.

4.1.4 Ambient Blank

An ambient blank is an ambient air grab sample collected in the field normally used in conjunction with soil gas or stationary source (e.g., SVE system) sampling. Analysis of the ambient blank can provide information on the ambient levels of site contaminants. It is imperative that an individually certified canister be used to collect an ambient blank.

4.1.5 Trip Blank

When sampling for contaminants in water, the laboratory prepares a trip blank by filling a VOA vial with clean, de-ionized water. The trip blank is sent to the field in a cooler with new sample vials. After sampling, the filled sample vials are placed back in the cooler next to the trip blank and returned to the laboratory. Analysis of the trip blank provides information on decontamination and sample handling procedures in the field as well as the cleanliness of the cooler and packaging.

When sampling for compounds in air, a trip blank provides little, if any, of the information above. A trip blank canister can be individually certified, evacuated, and sent to the field in a box with the sample canisters. Since the valve is closed and the brass cap tightened, it is questionable if the trip blank canister contents are ever "exposed" to sampling conditions. At the laboratory, the trip blank canister will be pressurized prior to analysis with dry, zero air – a matrix that may be entirely different than the sampled air. The recovery of target compounds can vary by matrix (e.g., moisture, carbon dioxide) rendering the trip blank results meaningless. Air Toxics Ltd. does not recommend analyzing a trip blank for air sampling.

4.1.6 Equipment Rinse

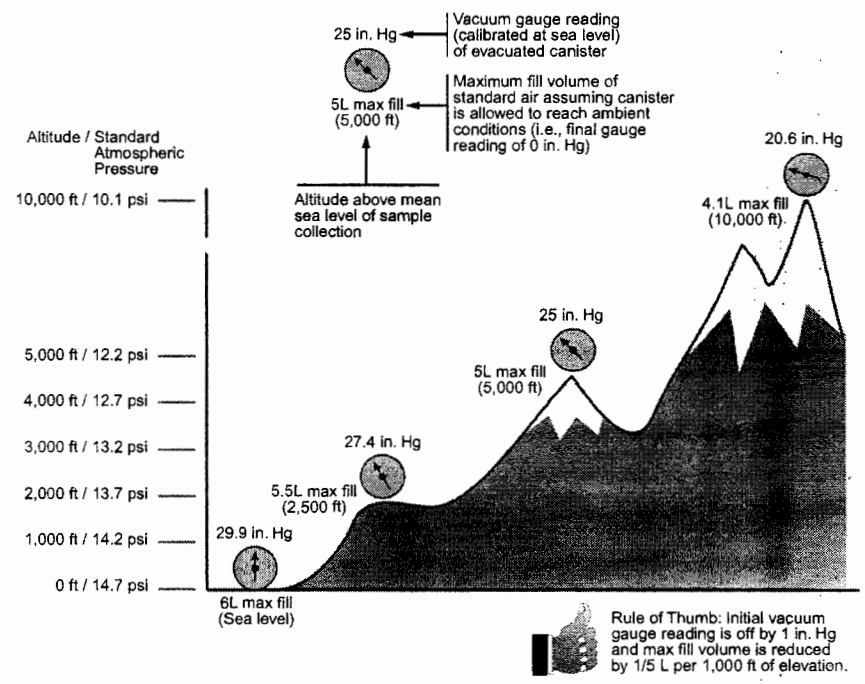
When sampling for contaminants in water, an equipment rinse is accomplished in the field by rinsing the decontaminated sampling equipment (e.g., bailer, submersible pump, tubing) with clean, de-ionized

water. A portion of the rinse water is collected in a VOA vial for analysis. The equipment rinse is similar to a field blank in that it provides information on decontamination procedures of sampling equipment.

When sampling for compounds in air, an equipment rinse can be used to determine if a sampling train has been properly decontaminated. Certified air is connected to the sampling train and fills an individually certified canister.

4.2 Considerations for Sampling at Altitude

Sampling at altitudes significantly above sea level is similar to sampling a stationary source under vacuum (see Section 4.3) in that target fill volumes may be difficult to achieve. The figure below illustrates the relationship between increasing altitude and decreasing atmospheric pressure. Ambient



conditions in Denver at 5,000 ft altitude are quite different than ambient conditions at sea level. Canister sampling is driven by the differential pressure between ambient conditions and the vacuum in the canister. There is less atmospheric pressure in Denver and 5 L is the maximum fill volume of standard air assuming the canister is allowed to reach ambient conditions (i.e., final gauge reading of 0 in. Hg). Theoretically, if you sample high enough (e.g., in space), no sample would enter the canister because there is no pressure difference between the evacuated canister and ambient conditions. To fill a canister to 6 L in Denver, you would need to use an air pump.

Sampling at altitude also affects gauge readings. The gauges supplied by Air Toxics Ltd. (see Section 2.2.4) measure canister vacuum relative to atmospheric pressure and are calibrated at approximately sea level. Before sampling at altitude, the gauges should be equilibrated (see Section 2.3.1). But even after equilibrating the gauge, verifying the initial vacuum of a canister at altitude is misleading. In Denver at 5,000 ft, expect the gauge to read 25, not 29.9 in. Hg. You do not have a bad canister (i.e., leaking or not evacuated properly). The canister is ready for sampling and the gauge is working properly.

☞ **Rule of Thumb: For every 1,000 ft of elevation, the gauge will be off by 1 in. Hg and the fill volume will be reduced by 1/5 L**

If you have questions about sampling at altitude, please call Client Services at 800-985-5955.

4.3 Considerations for Soil/Landfill Gas Sampling

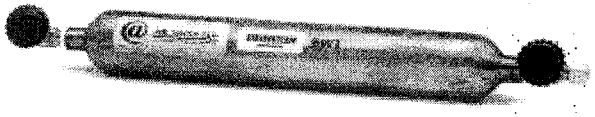
There are some additional sampling considerations for collecting grab samples (canister or Tedlar bag) from a soil boring, landfill boring, SVE system, or landfill gas (LFG) collection system. The general challenge with these samples arises from the need to employ long lengths of tubing to direct the soil gas, landfill gas, or process air to the canister or Tedlar bag. Tubing introduces the potential for contamination and diluting the sample. A good source of detailed information on soil gas sampling is contained in the ASTM D 5314 Standard Guide for Soil Gas Monitoring in the Vadose Zone.

- **Use inert tubing**. Teflon tubing is recommended. Tubing with an outer diameter of 1/4 in. works best with the fittings on the particulate filter.
- **Do not reuse tubing**. $2 per foot for new tubing is a small price to pay for peace of mind.
- **Purge tubing adequately**. A long length of tubing has significant volume of "dead air" inside. Without purging, this air will enter the canister and dilute the sample. Consider using a hand-held PID/FID to confirm that you have purged the tubing and are drawing sample air through the tubing.
- **Avoid leaks in the sampling train**. Leaks of ambient air through fittings between pieces of the sampling train (e.g., tubing to particulate filter) will dilute the sample.

- **Don't sample too fast**. There is no established flow rate for collecting a soil gas or LFG sample, but sampling slower has advantages. First, any leaks in the sampling train will be less prominent at lower flow rates due to less differential pressure across the leaking connection. Second, sampling slower may allow the conditions in the vadose zone or landfill to equilibrate better and produce a more representative grab sample. Consider using a needle valve or even a 5 micron particulate filter (see Section 2.2.3) to reduce the flow rate into the canister or Tedlar bag.
- **Purge the sample port**. A sample port on a SVE system or LFG collection system can accumulate solids or liquids depending upon the location of the port in the process and the orientation of the port. An influent sample port located upstream of a filter or moisture knock-out can be laden with particulates or saturated with water vapor. Heavy particulate matter can clog the particulate filter and foul the canister valve. It is important to prevent liquids from entering the canister. The presence of water in a canister sample will significantly lower the recovery of both non-polar and polar compounds. A sample port oriented downward may have liquid standing in the valve. Purge the sample port adequately before connecting the sampling train.
- **Consider the effects of sampling a process under vacuum or pressure**. When collecting a grab sample from a stationary source such as an SVE system or LFG collection system, some sample ports may be under vacuum or pressure relative to ambient conditions. When the sample port is under vacuum, such as the header pipe from the extraction well network, it may be difficult to fill the canister with the desired volume of sample. A vacuum pump can be used to collect a canister grab sample from a sample port under considerable vacuum. See the related discussion on sampling at altitude in Section 4.2. When the sample port is under pressure, such as the effluent stack downstream of the blower and treatment system, you may inadvertently pressurize the canister. Only a DOT-approved sample cylinder should be used to transport pressurized air samples (see Section 4.4). Under no circumstances should an Air Toxics Ltd. canister be pressurized more than 5 psig for a 6 L canister and 15 psig for a 1 L canister. Bleed off excess pressure by opening the valve temporarily while monitoring the canister with a pressure gauge.

4.4 Considerations for Sample Cylinder Sampling

Sample cylinders, also known as "sample bombs", are DOT-approved, high pressure, thick-walled, stainless steel cylinders with a valve at each end. They were intended for collecting a pressurized sample for petroleum gas applications. Sample cylinders differ from sample canisters in that they do not have a Summa-passivated interior surface and are not evacuated prior to shipment. Sample cylinders are not suitable for analysis of hydrocarbons at ppbv levels. Sample cylinders can be used for analysis of natural gas by ASTM D-1945 and calculation of Btu by ASTM D-3588. Air Toxics Ltd.



assumes that clients requesting a sample cylinder have a pressurized process and sample port with a built-in gauge and 1/4 in. Swagelock fitting to attach to the sample cylinder. Air Toxics Ltd. has an inventory of 500 mL sample cylinders that are particularly suited for landfill gas collection systems (i.e., LFG to energy applications). This section provides step-by-step procedures for sampling with a sample cylinder.

Step-by-Step Procedures for Sample Cylinder Sampling

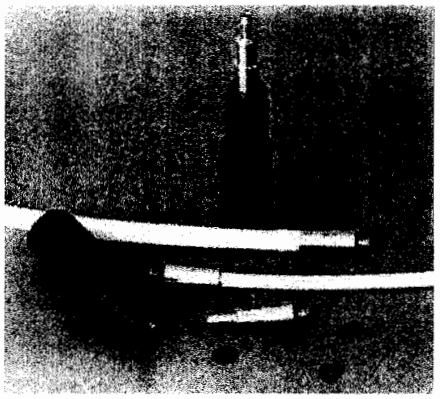
These procedures are for a typical stationary source sampling application and actual field conditions and procedures may vary. Follow all precautions in the site Health and Safety Plan when dealing with a pressurized sample port and sample cylinder.

1. Verify contents of the shipped package (e.g., chain-of-custody, sample cylinder, particulate filter)
2. Verify that gauge on sample port is working properly
3. Purge sample port
4. Remove brass caps on either end of cylinder
5. Attach particulate filter to upstream valve
6. Attach filter/cylinder assembly directly to the sample port
7. Open both valves 1/2 turn
8. Allow sample air to flow through sample cylinder (approximately 10 L for a 500 mL cylinder)
9. Close downstream valve of sample cylinder by hand tightening knob clockwise
10. Allow sample cylinder to pressurize to process pressure (max 100 psig)
11. Close upstream valve of sample cylinder and sample port
12. Detach filter/cylinder assembly from sample port and remove particulate filter
13. Replace brass caps
14. Fill out sample cylinder sample tag
15. Return sample cylinder in box provided
    - Unreturned sample cylinder charge of $650 each.
16. Return sample media in packaging provided. Unreturned equipment charges:
    - $45 per particulate filter
17. Fill out chain-of-custody and relinquish samples properly
18. Place chain-of-custody in box and retain pink copy
19. Tape box shut and affix custody seal (if applicable) across flap
20. Ship accordingly to meet method holding times

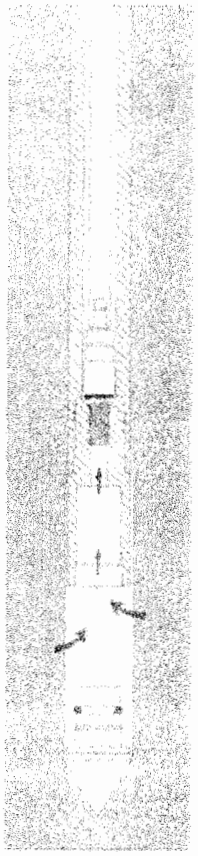
ATTACHMENT B

Geoprobe Post-Run Tubing System

PRT Active Sampling



The Post Run Tubing System (PRT) is an ideal tool for locating and delineating contaminated areas when used properly. It allows the user to collect soil vapor samples quickly and easily at the desired sampling depth WITHOUT the time-consuming complications associated with rod leakage and contamination. O-ring connections enable the PRT system to deliver a vacuum-tight seal that prevents sample contamination from UP hole, and assures that the sample is taken from the desired depth at the BOTTOM of the hole. The sample is drawn through the point holder, through the adapter, and into the sample tubing. The tubing can be replaced after each sample, thus eliminating sample carryover problems and the need to decontaminate the probe rods. The resulting time-savings translates into a higher productivity rate for you and your client.



A cross section of the PRT System showing how soil gas (arrows) is drawn through the inner tubing system.

The PRT is inserted AFTER the probe rods are driven to depth.
Advantages include...

- Increases speed and accuracy of soil gas sampling.
- Eliminates problems associated with rod leakage and sample carryover.
- Utilizes simple design for ease of use and vacuum-tight probing.
- Sampling train and all connections can be checked to verify leak-free status.
- Requires no management of inner tubing during probing.

PRT Applications:

- Rapidly define the extent of VOC contamination in the subsurface, under appropriate conditions.
- Rapidly define potential source areas of VOC contamination over large or small areas.
- Determine the types of VOC contamination present in the subsurface at a facility.
- Rapidly define the potential extent of groundwater contamination and down gradient migration of VOC's under appropriate conditions.
- Determine presence, extent, concentration, and types of landfill gasses (methane, carbon dioxide, et.) present in the subsurface at active and abandoned landfills.
- Locate potential sources and delineate plumes of perchloroethylene (PCE) associated with active or abandoned dry cleaning facilities.
- Locate potential source and delineate plumes of carbon tetrachloride (CCl4) associated with active or abandoned grain storage facilities.
- Locate potential sources and delineate plumes of benzene, toluene, ethyl benzene, and xylenes (BTEX) associated with active or abandoned gasoline storage facilities [both underground storage tanks (UST) and aboveground storage tanks (AST)].
- Locate potential sources and delineate plumes of chlorinated solvents, including compounds such as trichloroethane, trichloroethylene, dichloroethane, and dichloroethylene, associated with active or abandoned facilities where degreasing or metal plastic parts cleaning operations were conducted.

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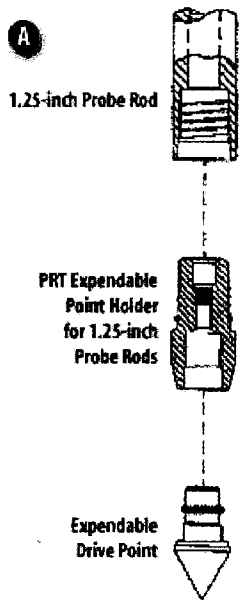
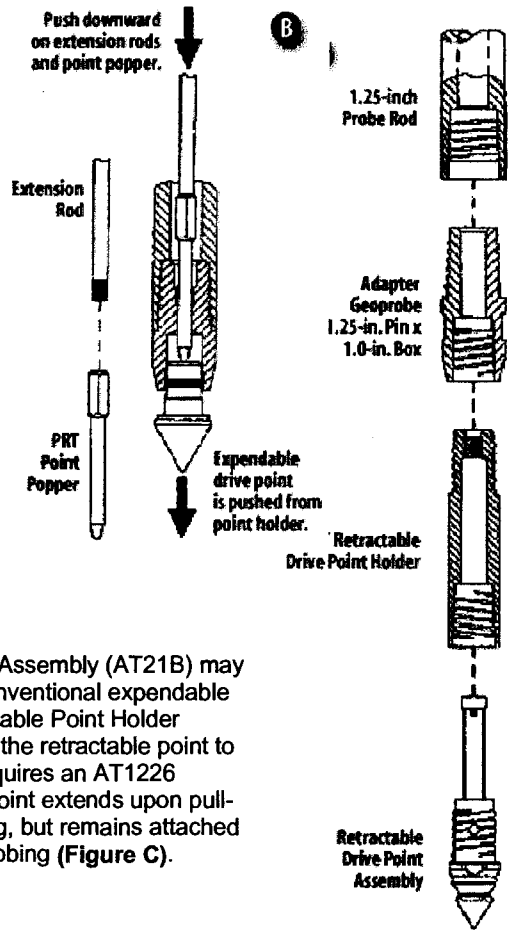
Main Info

➤ Here's How It Works...

PRT Active Sampling



Field technicians can use a PRT Expendable Point Holder to sample soil gas with 1.25-inch probe rods. This point holder accepts 1.1-inch OD Expendable Drive Points at the lower end **(Figure A)**. These points are used because their 1.1-inch OD is smaller than the 1.25-inch probe rods and therefore does not provide an annulus when driven to depth. This size difference also means that a PRT Point Popper may be required to push the expendable drive point out of the point holder before a vapor sample is collected **(Figure B)**.



A Retractable Drive Point Assembly (AT21B) may be used in place of the conventional expendable drive point. A PRT Retractable Point Holder (PR21B) is used to attach the retractable point to the tool string and also requires an AT1226 adapter. The retractable point extends upon pull-back to allow gas sampling, but remains attached to the holder for further probing **(Figure C)**.

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ATTACHMENT C

Purge Volume Calculations

Purge Volume Calculations

Total Purge Volume = Tubing Volume + Pull Back Void Volume + 20 mL

1. Tubing Volume for 1/8-Inch Inside Diameter Tubing

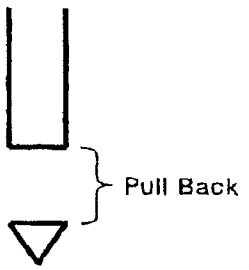
Volume = $\pi \times r^2 \times h$, where: $\pi = 3.14$, r = inside radius of tubing, and h = length of tubing.
For r in inches and h in feet: Volume in mL (cubic centimeters) = $3.14 \times r^2 \times h \times 196.64$

Length (feet)	Volume (mL)	Length (feet)	Volume (mL)	Length (feet)	Volume (mL)
1	2	19	46	37	89
2	5	20	48	38	92
3	7	21	51	39	94
4	10	22	53	40	96
5	12	23	55	41	99
6	14	24	58	42	101
7	17	25	60	43	104
8	19	26	63	44	106
9	22	27	65	45	108
10	24	28	67	46	111
11	27	29	70	47	113
12	29	30	72	48	116
13	31	31	75	49	118
14	34	32	77	50	121
15	36	33	80	51	123
16	39	34	82	52	125
17	41	35	84	53	128
18	43	36	87	54	130

2. Void space behind tip based on pull back

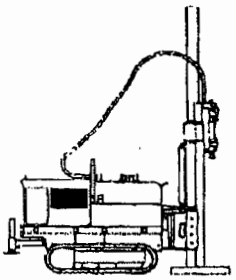
Volume = $\pi \times r^2 \times h$, where: $\pi = 3.14$, r = inside radius of tubing, and h = length of tubing.
The table below was calculated based on rod/tip outside diameter of 3 cm.
Tip shaft/rod inside diameter not included in calculation

Pull Back		Volume		Pull Back		Volume
inches	cm	cc or mL		Inches	cm	cc or mL
0.5	1.27	9		5.5	13.97	99
1	2.54	18		6	15.24	108
1.5	3.81	27		6.5	16.51	117
2	5.08	36		7	17.78	126
2.5	6.35	45		7.5	19.05	135
3	7.62	54		8	20.32	144
3.5	8.89	63		8.5	21.59	153
4	10.16	72		9	22.86	162
4.5	11.43	81		9.5	24.13	170
5	12.7	90		10	25.4	179



ATTACHMENT D

Vacuum Testing Procedure

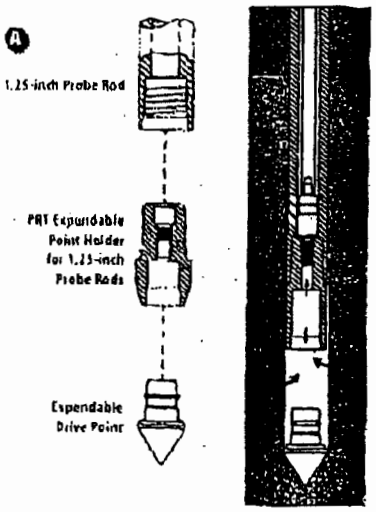


Green Services, Inc.

Geoprobe® Soil Gas Sampling

Prior to the introduction of Post Run Tubing (PRT) soil gas sampling there were less effective ways to collect soil gas samples with a Geoprobe®. An expendable point was driven to the sampling depth and detached by withdrawing the drive rods far enough to create an opening for gas to move into the drive rods from the base of the hole (this has not changed). Then soil gas samples were withdrawn by attaching tubing to the top of the drive rods and applying a vacuum. The large inside diameter (ID) of the drive rods required a large purge volume, and produced samples that were not uniformly representative of contaminant concentrations in the subsurface. Small ID tubing was needed to reduce the purge volume, and was incorporated into the sampling system with an inflatable packer to provide the seal at depth and insure the collection of representative samples*. The packer system functioned well, however it was cumbersome in the field, and had problems with carryover contamination and possible leaks in the pressurized system.

When Geoprobe® introduced the PRT system there was doubt that the seal created with the O-ring was reliable. A test was designed and repeated to determine the reliability of the seal. A drive rod was attached to the point holder, and a PRT adapter with tubing was assembled and installed, as if to collect a sample (as shown). The annular space between the tubing and drive rod ID was then filled with water. A vacuum was then applied to the tubing (as if collecting a sample), and even with the open end of the point holder blocked (where soil gas would enter the system to fill the vacuum), no water was forced through the O-ring seal.



On site this test can be repeated without the water. The assembled system will be sealed (open end of the point holder blocked) and a vacuum applied with a syringe. When the syringe is released, any gases leaked will displace the syringe plunger from its original position. Close attention to detail will be needed when performing this test to prevent leakage of air into the system from the blocked end of the point holder, and not to exceed reasonable vacuum levels that are used to collect samples.

* Procedure from Target Environmental Services.

ATTACHMENT E

NIOSH Method 1550

Table 1 MW: Table 1 CAS: Table 1 RTECS: Table 1

METHOD: 1550, Issue 2 **EVALUATION: FULL** **Issue 1: 15 February 1984**
Issue 2: 15 August 1994

OSHA : Table 1
NIOSH: Table 1
ACGIH: Table 1

PROPERTIES: Table 1

SYNONYMS: Petroleum ether (benzin), rubber solvent, petroleum naphtha, VM&P naphtha, mineral spirits, Stoddard solvent, kerosene (kerosine), coal tar naphtha.

SAMPLING

SAMPLER: SOLID SORBENT TUBE (coconut shell charcoal, 100 mg/50 mg)

FLOW RATE: 0.01 to 0.2 L/min

VOL-MIN: 1.3 L @ 400 mg/m^3; 0.2 L @ 2500 mg/m^3
-MAX: 20 L @ 400 mg/m^3; 3.2 L @ 2500 mg/m^3

SHIPMENT: routine

SAMPLE STABILITY: at least 1 week @ 25 °C

BLANKS: 2 to 10 field blanks per set

BULK SAMPLE: required; 5 to 10 mL

ACCURACY

RANGE STUDIED: see EVALUATION OF METHOD

BIAS: see EVALUATION OF METHOD

OVERALL PRECISION ($\hat{S}_{rT}$): 0.05 [1]

ACCURACY: see EVALUATION OF METHOD

MEASUREMENT

TECHNIQUE: GAS CHROMATOGRAPHY, FID

ANALYTE: naphtha hydrocarbons

DESORPTION: 1 mL CS_2; stand 30 min

INJECTION VOLUME: 5 µL (packed column); 0.1 to 1 µL (capillary column)

TEMPERATURE-INJECTION: 200 to 250 °C
-DETECTOR: 250 to 300 °C
-COLUMN: 50 to 250 °C @ 8 °/min

CARRIER GAS: N_2 or He, 30 mL/min

COLUMN: glass, 3 m x 6-mm, 10% SP-2100 on Supelcoport 80/100 or 30-m fused silica capillary, 0.325-mm ID, 1.0-µm DB-1 or equivalent

CALIBRATION: solutions of bulk naphtha in CS_2

RANGE: 0.5 to 10 mg per sample [2,3,4]

ESTIMATED LOD: 0.1 mg per sample

PRECISION ($\hat{S}_r$): 0.01 [1]

APPLICABILITY: The working range is 100 to 2000 mg/m^3 for a 5-L air sample. This is a general procedure for analysis of various types of hydrocarbon mixtures called "naphthas" which are used as thinners in paints and varnishes and as genera l purpose solvents.

INTERFERENCES: Most naphthas are quite complex. The components elute over a wide temperature range by gas chromatography, making interferences from other substances possible. Columns and conditions must be chosen to obtain the desired degree of separation for a given mixture.

OTHER METHODS: This method combines and replaces Methods S86 [2], S380 [3] and S382 [4]. A similar method appears in the criteria document [5].

REAGENTS:

1. Eluent: Carbon disulfide*, chromatographic quality, containing 0.1% (v/v) octane, 0.5% (v/v) hexadecane or other suitable internal standard.
   NOTE 1: Use an internal standard which is not a major constituent of the sample.
   NOTE 2: Use toluene in place of carbon disulfide for low-boiling analytes [5].
2. Naphtha bulk sample.
3. Nitrogen or helium, purified.
4. Hydrogen, prepurified.
5. Air, filtered.

* See SPECIAL PRECAUTIONS.

EQUIPMENT:

1. Sampler: glass tube, 7 cm long, 6-mm OD, 4-mm ID, flame-sealed ends, containing two sections of activated (600 °C) coconut shell charcoal (front = 100 mg; back = 50 mg) separated by a 2-mm urethane foam plug. A silylated glass wool plug precedes the front section and a 3-mm urethane foam plug follows the back section. Pressure drop across the tube at 1 L/min airflow must be less than 3.4 kPa. Tubes are commercially available.
2. Personal sampling pump, 0.01 to 0.2 L/min, with flexible connecting tubing.
3. Gas chromatograph, FID, integrator and column (page 1550-1).
4. Vials, glass, 2-mL, PTFE-lined crimp caps.
5. Syringe, 10-µL (1-µL syringe for capillary columns) and other convenient sizes for preparing standards, readable to 0.1 µL.
6. Volumetric flasks, 10-mL.
7. Pipet, delivery, 1.0-mL, with pipet bulb.

SPECIAL PRECAUTIONS: Carbon disulfide is toxic and an acute fire and explosion hazard (flash point = -30 °C); work with it only in a hood.

SAMPLING:

1. Calibrate each personal sampling pump with a representative sampler in line.
2. Break the ends of the sampler immediately before sampling. Attach sampler to personal sampling pump with flexible tubing.
3. Sample at an accurately known flow rate between 0.01 and 0.2 L/min for a total sample size which contains between 0.5 and 8 mg naphtha.
4. Cap the samplers with plastic (not rubber) caps and pack securely for shipment. Ship a bulk sample (5 to 10 mL) in a separate container from the sorbent tubes.

SAMPLE PREPARATION:

5. Place the front and back sorbent sections of the sampler tube in separate vials. Discard the glass wool and foam plugs.
6. Add 1.0 mL eluent to each vial. Attach crimp cap to each vial.
7. Allow to stand 30 min with occasional agitation.

CALIBRATION AND QUALITY CONTROL:

8. Calibrate daily with at least six working standards over the range 0.1 to 10 mg naphtha per sample.
   a. Add known amounts of naphtha bulk sample to eluent in 10-mL volumetric flasks and dilute to the mark.

b. Analyze together with samples and blanks (steps 11 and 12).
c. Prepare calibration graph (ratio of peak area of analyte to peak area of internal standard vs. mg naphtha).

9. Determine desorption efficiency (DE) at least once for each batch of charcoal used for sampling in the calibration range (step 8). Prepare three tubes at each of five levels plus three media blanks.
   a. Remove and discard back sorbent section of a media blank sampler.
   b. Inject a known amount of naphtha bulk sample directly onto front sorbent section with a microliter syringe.
   c. Cap the tube. Allow to stand overnight.
   d. Desorb (steps 5 through 7) and analyze together with working standards (steps 11 and 12).
   e. Prepare a graph of DE vs. mg naphtha recovered.
10. Analyze three quality control blind spikes and three analyst spikes to insure that the calibration graph and DE graph are in control.

MEASUREMENT:

11. Set gas chromatograph according to manufacturer's recommendations and to conditions given on page 1550-1. Inject sample aliquot manually using solvent flush technique or with autosampler.
    NOTE 1: The columns and conditions given provide moderate to good separation of components. If less resolution is needed, use shorter, less efficient columns as were used in validation of Methods S86 [2], S380 [3] and S382 [4].
    NOTE 2: If peak area is above the linear range of the working standards, dilute with eluent, reanalyze and apply the appropriate dilution factor in calculations.
12. Measure peak area. Divide the peak area of analyte by the peak area of internal standard on the same chromatogram.

CALCULATIONS:

13. Determine the mass, mg (corrected for DE) of naphtha found in the sample front (W_f) and back (W_b) sorbent sections, and in the average media blank front (B_f) and back (B_b) sorbent sections. NOTE: If $W_b > W_f/10$, report breakthrough and possible sample loss.
14. Calculate concentration, C, of naphtha in the air volume sampled, V (L):

$$C = \frac{(W_f + W_b - B_f - B_b) \cdot 10^3}{V}, \text{ mg/m}^3.$$

EVALUATION OF METHOD:

Methods S86 (Naphtha, Coal Tar), S380 (Petroleum distillate) and S382 (Stoddard Solvent) were issued on March 14, 1975 [2,3,4]. They were validated at 24 °C and approximately 755 mm Hg using 10-, 4- and 3-L air samples, respectively, of 2-50-W Hi-Flash Solvent (Neville Chemical Co.; BP 154 to 195 °C; d 0.893 g/mL), VM&P Naphtha (Amsco Product 1101; BP 120 to 147 °C; d 0.743 g/mL) and Stoddard Solvent (Fisher Scientific Co.; BP 159 to 176 °C; d 0.774 g/mL) [1]. Overall precision and recovery were as shown below, representing a non-significant bias in each method. Breakthrough tests in dry air showed a capacity of 20 to 25 mg of each solvent tested. Capacity at high relative humidity was not determined.

Method	Overall Precision ($\hat{S}_{rT}$)	Bias	Range Studied Accuracy	mg/m^3	mg per sample	Avg. DE	Ref.
S86[b]	0.051	5.99%	±15.0%	193 to 809	2 to 8	0.88	[1,2]
S380[a]	0.052	-4.37%	±12.5%	937 to 3930	4 to 16	0.96	[1,3]
S382[b]	0.052	-3.10%	±11.4%	1417 to 5940	4.5 to 18	0.95	[1,4]

NOTES:
(a) Data based on experiments using an internal standard method with a 10 ft., 1/8" stainless steel column packed with 10% OV-101 on 100/120 mesh Supelcoport.
(b) Data based on experiments using an internal standard method with a 6 ft., 1/8" stainless steel column packed with 1.5% OV-101 on 100/120 mesh Chromosorb W.

REFERENCES:

[1] Documentation of the NIOSH Validation Tests, S86, S380, S382, U.S. Department of Health, Education, and Welfare, Publ. (NIOSH) 77-185 (1977).
[2] NIOSH Manual of Analytical Methods, 2nd ed., V. 2, Method S86, U.S. Department of Health, Education, and Welfare, Publ. (NIOSH) 77-157-B (1977).
[3] Ibid, V. 3, S380, U.S. Department of Health, Education, and Welfare, Publ. (NIOSH) 77-157-B (1977).
[4] Ibid, S382.
[5] Criteria for a Recommended Standard...Occupational Exposure to Refined Petroleum Solvents, U.S. Department of Health, Education, and Welfare, Publ. (NIOSH) 77-192 (July, 1977).

METHOD REVISED BY:

Ardith A. Grote, NIOSH/DPSE; S86, S380 and S382 originally validated under NIOSH Contract CDC-99-74-55.

Table 1. General information.

Exposure Limits, mg/m³ NAME OSHA CAS # Predominant RETECS Hydrocarbon Species	Boiling Range (°C) NIOSH ACGIH	Vapor Pressure, kPa (mm Hg) @ 20 °C	Liquid Density (g/mL @ 15 °C)
Petroleum ether (a) 8032-32-4 OI6180000	30 to 60 C_5-C_6	13 (100) -- (13 °C)	0.63 to 0.66 aliphatic 350; C 1800 --
Rubber solvent (a) SE7449000 8030-30-6	45 to 125 C_5-C_8	(c) 2000 (500 ppm)	0.67 to 0.85 aliphatic 350; C 1800 1590 (400 ppm)
Petroleum naphtha (b) (Petroleum distillates mixture) 8002-05-9 SE7449000	30 to 238 C_6-C_8	5 (40) 2000 (500 ppm)	0.6 to 0.8 350; C 1800 --
VM&P naphtha (a) 8032-32-4 OI6180000	95 to 160 C_7-C_{11}	0.3 to 3 (2 to 20) --	0.72 to 0.76 <20% aromatic350, C 1800 1370 (300 ppm)
Mineral spirits (a) 8052-41-3 WJ89250000	150 to 200 C_9-C_{12}	0.2758(2) 2900 (500 ppm)	0.77 to 0.81 <20% aromatic 350; C 1800 525 (100 ppm)
Stoddard solvent (a) 8052-41-3 WJ8925000	150 to 210 C_9-C_{12}	0.2758 (2) 2900 (500 ppm)	0.75 to 0.80 <20% aromatic 350; C 1800 525 (100 ppm)
Kerosene (a) 8008-20-6 OA5500000	175 to 325 C_9-C_{16}	(c) --	0.8 <20% aromatic 100 --
Coal tar naphtha (b)	110 to 190 C_8-C_{10}	<0.7 (<5) 400 (100 ppm)	0.86 to 0.89

8030-30-6	aromatic 400 (100 ppm)
DE3030000 (NIOSH)	--

(a) As defined by NIOSH Criteria Document [5].
(b) As defined for OSHA PEL.
(c) Not available.

NIOSH Manual of Analytical Methods (NMAM), Fourth Edition, 8/15/94

APPENDIX E

USEPA SOP NO. 2042

SOIL GAS SAMPLING

JUNE 1, 1996

REV. NO. 0.0

SOIL GAS SAMPLING

SOP#: 2042
DATE: 06/01/96
REV. #: 0.0

1.0 SCOPE AND APPLICATION

Soil gas monitoring provides a quick means of waste site evaluation. Using this method, underground contamination can be identified, and the source, extent, and movement of the pollutants can be traced.

This standard operating procedure (SOP) outlines the methods used by U.S. EPA/ERT in installing soil gas wells; measuring organic vapor levels in the soil gas using a Photoionization Detector (PID), Flame Ionization Detector (FID) and/or other air monitoring devices; and sampling the soil gas using Tedlar bags, Tenax sorbent tubes, and/or Summa canisters.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent on site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. EPA endorsement or recommendation for use.

2.0 METHOD SUMMARY

A 3/8" diameter hole is driven into the ground to a depth of four to five feet using a commercially available slam bar. Soil gas can also be sampled at other depths by the use of a longer bar or bar attachments. A 1/4" O.D. stainless steel probe is inserted into the hole. The hole is then sealed around the top of the probe using modeling clay. The gas contained in the interstitial spaces of the soil is sampled by pulling the sample through the probe using an air sampling pump. The sample may be stored in Tedlar bags, drawn through sorbent cartridges, or analyzed directly using a direct reading instrument. The air sampling pump is not used for Summa canister sampling of soil gas. Sampling is achieved by soil gas equilibration with the evacuated Summa canister.

Other field air monitoring devices, such as the combustible gas indicator (MSA CGI/02 Meter, Model 260) and the Organic Vapor Analyzer (Foxboro OVA, Model 128), can also be used dependent on specific site conditions. Measurement of soil temperature using a temperature probe may also be desirable. Bagged samples are usually analyzed in a field laboratory using a portable Photovac GC.

Power driven sampling probes may be utilized when soil conditions make sampling by hand unfeasible (i.e., frozen ground, very dense clays, pavement, etc.). Commercially available soil gas sampling probes (hollow, 1/2 = O.D. steel probes) can be driven to the desired depth using a power hammer (e.g., Bosch Demolition Hammer or Geoprobe™). Samples can be drawn through the probe itself, or through Teflon tubing inserted through the probe and attached to the probe point. Samples are collected and analyzed as described above.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

3.1 Tedlar Bags

Soil gas samples are generally contained in 1.0-L Tedlar bags. Bagged samples are best stored in dark plastic bags placed in coolers to protect the bags from any damage that may occur in the field or in transit. In addition, coolers insure the integrity of the samples by keeping them at a cool temperature and out of direct sunlight. Samples should be analyzed as soon as possible, preferably within 24 - 48 hours.

3.2 Tenax Tubes

Bagged samples can also be drawn onto Tenax or

other sorbent tubes to undergo lab GC/MS analysis. If Tenax tubes are to be utilized, special care must be taken to avoid contamination. Handling of the tubes should be kept to a minimum and only while wearing nylon or other lint-free gloves. After sampling, each tube should be stored in a clean, sealed culture tube; the ends packed with clean glass wool to protect the sorbent tube from breakage. The culture tubes should be kept cool and wrapped in aluminum foil to prevent any photodegradation of samples (see Section 7.4.).

3.3 Summa Canisters

The Summa canisters used for soil gas sampling have a 6 liter sample capacity and are certified clean by GC/MS analysis before being utilized in the field. After sampling is completed, they are stored and shipped in travel cases.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

4.1 PID Measurements

A number of factors can affect the response of a PID (such as the HNu PI 101). High humidity can cause lamp fogging and decreased sensitivity. This can be significant when soil moisture levels are high, or when a soil gas well is actually in groundwater. High concentrations of methane can cause a downscale deflection of the meter. High and low temperature, electrical fields, FM radio transmission, and naturally occurring compounds, such as terpenes in wooded areas, will also affect instrument response.

Other field screening instruments can be affected by interferences. Consult the manufacturers manuals.

4.2 FID Measurements

A number of factors can affect the response of an FID (such as the OVA model 128). High humidity can cause the FID to flame out or not ignite at all. This can be significant when soil moisture levels are high, or when a soil gas well is actually in groundwater. The FID can only read organic based compounds (they must contain carbon in the molecular structure). The FID also responds poorly to hydrocarbons and halogenated hydrocarbons (such as gasoline, propane fuel). High and low temperature, electrical fields and FM radio transmission will also affect instrument response.

4.3 Factors Affecting Organic Concentrations in Soil Gas

Concentrations in soil gas are affected by dissolution, adsorption, and partitioning. Partitioning refers to the ratio of component found in a saturated vapor above an aqueous solution to the amount in the solution; this can, in theory, be calculated using the Henry's Law constants. Contaminants can also be adsorbed onto inorganic soil components or "dissolved" in organic components. These factors can result in a lowering of the partitioning coefficient.

Soil "tightness" or amount of void space in the soil matrix, will affect the rate of recharging of gas into the soil gas well.

Existence of a high, or perched, water table, or of an impermeable underlying layer (such as a clay lens or layer of buried slag) may interfere with sampling of the soil gas. Knowledge of site geology is useful in such situations, and can prevent inaccurate sampling.

4.4 Soil Probe Clogging

A common problem with this sampling method is soil probe clogging. A clogged probe can be identified by using an in-line vacuum gauge or by listening for the sound of the pump laboring. This problem can usually be eliminated by using a wire cable to clear probe (see Section 7.1.3.).

4.5 Underground Utilities

Prior to selecting sample locations, an underground utility search is recommended. The local utility companies can be contacted and requested to mark the locations of their underground lines. Sampling plans can then be drawn up accordingly. Each sample location should also be screened with a metal detector or magnetometer to verify that no underground pipes or drums exist.

5.0 EQUIPMENT/APPARATUS

5.1 Slam Bar Method

- Slam Bar (1 per sampling team).
- Soil gas probes, stainless steel tubing, 1/4" O.D., 5 ft length.
- Flexible wire or cable used for clearing the

tubing during insertion into the well.

- "Quick Connect" fittings to connect sampling probe tubing, monitoring instruments, and Gilian pumps to appropriate fittings on vacuum box.
- Modeling clay.
- Vacuum box for drawing a vacuum around Tedlar bag for sample collection (1 per sampling team).
- Gilian pump Model HFS113A adjusted to approximately 3.0 L/min (1 to 2 per sample team).
- 1/4" Teflon tubing, 2 ft to 3 ft lengths, for replacement of contaminated sample line.
- 1/4" Tygon tubing, to connect Teflon tubing to probes and quick connect fittings.
- Tedlar bags, 1.0 L, at least 1 bag per sample point.
- Soil Gas Sampling labels, field data sheets, logbook, etc.
- PID/FID, or other field air monitoring devices, (1 per sampling team).
- Ice chest, for carrying equipment and for protection of samples (2 per sampling team).
- Metal detector or magnetometer, for detecting underground utilities/pipes/drums (1 per sampling team).
- Photovac GC, for field-lab analysis of bagged samples.
- Summa canisters (plus their shipping cases) for sample, storage and transportation.
- Large dark plastic garbage bags

5.2 Power Hammer Method

- Bosch demolition hammer.
- 1/2" O.D. steel probes, extensions, and points.
- Dedicated aluminum sampling points.
- Teflon tubing, 1/4".
- "Quick Connect" fittings to connect sampling probe tubing, monitoring instruments, and Gilian pumps to appropriate fittings on vacuum box.
- Modeling clay.
- Vacuum box for drawing a vacuum around Tedlar bag for sample collection (1 per sampling team).
- Gilian pump Model HFS113A adjusted to approximately 3.0 L/min (1 to 2 per sample team).
- 1/4" Teflon tubing, 2 ft to 3 ft lengths, for replacement of contaminated sample line.
- 1/4" Tygon tubing, to connect Teflon tubing to probes and quick connect fittings.
- Tedlar bags, 1.0 L, at least 1 bag per sample point.
- Soil Gas Sampling labels, field data sheets, logbook, etc.
- HNu Model P1101, or other field air monitoring devices, (1 per sampling team).
- Ice chest, for carrying equipment and for protection of samples (2 per sampling team).
- Metal detector or magnetometer, for detecting underground utilities/pipes/drums (1 per sampling team).
- Photovac GC, for field-lab analysis of bagged samples.
- Summa canisters (plus their shipping cases) for sample, storage and transportation.
- Generator w/extension cords.
- High lift jack assembly for removing probes.

5.3 Geoprobe™ Method

The Geoprobe is a hydraulically-operated sampling device mounted in a customized four-wheel drive vehicle. The sampling device can be deployed from the truck and positioned over a sample location. The base of the sampling device is positioned on the ground. The weight of the vehicle is hydraulically raised on the base. As the weight of the vehicle is transferred to the probe, the probe is pushed into the ground. A built-in hammer mechanism allows the probe to be driven past some dense stratigraphic horizons. When the probe reaches the sample depth, up to 50 feet under favorable geologic situations, samples can be collected.

Soil gas can be collected from specific depths in two general ways. One method involves withdrawing a sample directly from the probe rods, after evacuating a sufficient volume of air from the probe rods. The other method involves collecting a sample through tubing attached by an adaptor to the bottom probe rod section. Correctly used, this method provides more reliable results. Manufacturer's instructions and the SOP for the Model 5400 Geoprobe™ Operation should be followed when using this method.

6.0 REAGENTS

- PID/FID or calibration gases for field air monitoring devices (such as methane and

isobutylene).

- C Deionized organic-free water, for decontamination.
- C Methanol, HPLC grade, for decontamination.
- C Ultra-zero grade compressed air, for field blanks.
- C Standard gas preparations for Photovac GC calibration and Tedlar bag spikes.
- C Propane Torch (for decontamination of steel probes)

7.0 PROCEDURES

7.1 Soil Gas Well Installation

1. Initially a hole slightly deeper than the desired depth is made. For sampling up to 5 feet, a 5-ft single piston slam bar is used. For deeper depths, a piston slam bar with threaded 4-foot-long extensions can be used. Other techniques can be used, so long as holes are of narrow diameter and no contamination is introduced.

2. After the hole is made, the slam bar is carefully withdrawn to prevent collapse of the walls of the hole. The soil gas probe is then inserted.

3. It is necessary to prevent plugging of the probe, especially for deeper holes. A metal wire or cable, slightly longer than the probe, is placed in the probe prior to inserting into the hole. The probe is inserted to full depth, then pulled up three to six inches, then cleared by moving the cable up and down. The cable is removed before sampling.

4. The top of the sample hole is sealed at the surface against ambient air infiltration by using modeling clay molded around the probe at the surface of the hole.

5. If conditions preclude hand installation of the soil gas wells, the power driven system may be employed. The generator powered demolition hammer is used to drive the probe to the desired depth (up to 12 Ft may be attained with extensions). The probe is pulled up 1-3 inches if the retractable point is used. No clay is needed to seal the hole. After sampling, the probe is retrieved using the high lift jack assembly.

6. If semi-permanent soil gas wells are required, the dedicated aluminum probe points are used. These points are inserted into the bottom of the power driven probe and attached to the Teflon tubing. The probe is inserted as in step 5. When the probe is removed, the point and Teflon tube remain in the hole, which may be sealed by backfilling with clean sand, soil, or bentonite.

7.2 Screening with Field Instruments

1. The well volume <u>must</u> be evacuated prior to sampling. Connect the Gilian pump, adjusted to 3.0 L/min, to the sample probe using a section of Teflon tubing as a connector. The pump is turned on, and a vacuum is pulled through the probe for approximately 15 seconds. Longer time is required for sample wells of greater depths.

2. After evacuation, the monitoring instrument(s) (i.e. HNu or OVA) is connected to the probe using a Teflon connector. When the reading is stable, or peaks, the reading is recorded on soil gas data sheets.

3. Of course, readings may be above or below the range set on the field instruments. The range may be reset, or the response recorded as a greater than or less than figure. Recharge rate of the well with soil gas must be considered when resampling at a different range setting.

7.3 Tedlar Bag Sampling

1. Follow step 7.2.1 to evacuate well volume. If air monitoring instrument screening was performed prior to sample taking, evacuation is not necessary.

2. Use the vacuum box and sampling train (Figure 1) to take the sample. The sampling train is designed to minimize the introduction of contaminants and losses due to adsorption. All wetted parts are either Teflon or stainless steel. The vacuum is drawn indirectly to avoid contamination from sample pumps.

3. The Tedlar bag is placed inside the vacuum box, and attached to the sampling port. The sample probe is attached to the sampling port via Teflon tubing and a "Quick Connect" fitting.

4. A vacuum is drawn around the outside of the bag, using a Gilian pump connected to the vacuum box evacuation port, via Tygon tubing and a "Quick Connect" fitting. The vacuum causes the bag to inflate, drawing the sample.

5. Break the vacuum by removing the Tygon line from the pump. Remove the bagged sample from the box and close valve. Record data on data sheets or in logbooks. Record the date, time, sample location ID, and the PID/FID instrument reading(s) on sample bag label.

CAUTION: Labels should not be pasted directly onto the bags, nor should bags be labeled directly using a marker or pen. Inks and adhesive may diffuse through the bag material, contaminating the sample. Place labels on the edge of the bags, or tie the labels to the metal eyelets provided on the bags. Markers with inks containing volatile organics (i.e., permanent ink markers) should not be used.

Chain of Custody Sheets must accompany all samples submitted to the field laboratory for analysis.

7.4 Tenax Tube Sampling

Samples collected in Tedlar bags may be adsorbed onto Tenax tubes for further analysis by GC/MS.

7.4.1 Additional Apparatus

A. Syringe with a luer-lock tip capable of drawing a soil gas or air sample from a Tedlar bag onto a Tenax/CMS sorbent tube. The syringe capacity is dependent upon the volume of sample begin drawn onto the sorbent tube.

B. Adapters for fitting the sorbent tube between the Tedlar bag and the sampling syringe. The adapter attaching the Tedlar bag to the sorbent tube consists of a reducing union (1/4" to 1/16" O.D. -- Swagelok cat. # SS-400-6-ILV or equivalent) with a length of 1/4" O.D. Teflon tubing replacing the nut on the 1/6" (Tedlar bag) side. A 1/4" I.D. silicone O-ring replaces the ferrules in the nut on the 1/4" (sorbent tube) side of the union.

The adapter attaching the sampling syringe to the sorbent tube consists of a reducing union (1/4" to 1/16" O.D. -- Swagelok Cat. # SS-400-6-ILV or equivalent) with a 1/4" I.D. silicone O-ring replacing the ferrules in the nut on the 1/4" (sorbent tube) side and the needle of a luer-lock syringe needle inserted into the 1/16" side. (Held in place with a 1/16" ferrule.) The luer-lock end of the needle can be attached to the sampling syringe. It is useful to have a luer-lock on/off valve situated between the syringe and the needle.

C. Two-stage glass sampling cartridge (1/4" O.D. x 1/8" I.D. x 5 1/8") contained in a flame-sealed tube (Manufacturer: Supelco Custom Tenax/Spherocarb Tubes) containing two sorbent sections retained by glass wool:

Front section: 150 mg of Tenax-GC
Back section: 150 mg of CMS (Carbonized Molecular Sieve)

These tubes are prepared and cleaned in accordance with EPA Method EMSL/RTP-SOP-EMD-013 by the vendor. The vendor sends ten tubes per lot made to the REAC GC/MS Laboratory and they are tested for cleanliness, precision, and reproductability.

D. Teflon-capped culture tubes or stainless steel tube containers for sorbent tube storage and shipping. These containers should be conditioned by baking at 120 degrees C for at least two hours. The culture tubes should contain a glass wool plug to prevent sorbent tube breakage during transport. Reconditioning of the containers should occur between uses or after extended periods of disuse (i.e., two weeks or more).

E. Nylon gloves or lint-free cloth. (Hewlett Packard Part # 8650-0030 or equivalent.)

7.4.2 Sample Collection

Handle sorbent tubes with care, using nylon gloves (or other lint-free material) to avoid contamination.

Immediately before sampling, break one end of the sealed tube and remove the Tenax cartridge.

Connect the valve on the Tedlar bag to the sorbent tube adapter. Connect the sorbent tube to the sorbent tube adapter with the Tenax (white granular) side of the tube facing the Tedlar bag. Connect the sampling syringe assembly to the CMS (black) side of the sorbent tube. Fittings on the adapters should be finer-tight. Open the valve on the Tedlar bag. Open the on/off valve of the sampling syringe. Depending on work plan stipulations, at least 10% of the soil gas samples analyzed by this GC method must be submitted for confirmational GC/MS analysis (according to modified methods TO-1 [Tenax absorbent] and TO-2 [Carbon Molecular Sieve (CMS) absorbent]). Each soil gas sample must be absorbed on replicate Tenax/CMS tubes. The volume absorbed on a Tenax/CMS tube is dependent on the total concentration of the compounds measured by the photovac/GC or other applicable GC:

Total Concentration (ppm)	Sample Volume (mL)
>10	Use Serial Dilution
10	10 - 50
5	20-100
1	100-250

After sampling, remove the tube from the sampling train with gloves or a clean cloth. DO NOT LABEL OR WRITE ON THE TENAX/CMS TUBE.

Place the sorbent tube in a conditioned stainless steel tube holder or culture tube. Culture tube caps should be sealed with Teflon tape.

7.4.3 Sample Labeling

Each sample tube container (not tube) must be labeled with the site name, sample station number, date sampled, and volume sampled.

Chain of custody sheets must accompany all samples to the laboratory.

7.4.4 Quality Assurance (QA)

Before field use, a QA check should be performed on each batch of sorbent tubes by analyzing a tube by thermal desorption/cryogenic trapping GC/MS.

At least one blank sample must be submitted with each set of samples collected at a site. This trip blank must be treated the same as the sample tubes except no sample will be drawn through the tube.

Sample tubes should be stored out of UV light (i.e., sunlight) and kept on ice until analysis. Samples should be taken in duplicate, when possible.

7.5 Summa Canister Sampling

1. Follow step 7.2.1 to evacuate well volume. If PID/FID readings were taken prior to taking a sample, evacuation is not necessary.

2. Attach a certified clean, evacuated 6-liter Summa canister via the 1/4" Teflon tubing.

3. Open valve on Summa canister. The soil gas sample is drawn into the canister by pressure equilibration. The approximate sampling time for a 6 liter canister is 20 minutes.

4. Site name, sample location, number, and date must be recorded on a chain of custody form and on a blank tag attached to the canister.

8.0 CALCULATIONS

8.1 Field Screening Instruments

Instrument readings are usually read directly from the meter. In some cases, the background level at the soil gas station may be subtracted:

Final Reading = Sample Reading - Background

8.2 Photovac GC Analysis

Calculations used to determine concentrations of individual components by Photovac GC analysis are beyond the scope of this SOP and are covered in ERT SOP #2109, *Photovac GC Analysis for Soil Water and Air/Soil Gas*.

9.0 CALIBRATION

9.1 Field Instruments

It is recommended that the manufacturers' manuals be consulted for correct use and calibration of all instrumentation.

9.2 Gilian Model HFS113A Air Sampling Pumps

Flow should be set at approximately 3.0 L/min; accurate flow adjustment is not necessary. Pumps should be calibrated prior to bringing into the field.

10.0 QUALITY ASSURANCE/ QUALITY CONTROL

10.1 Sample Probe Contamination

Sample probe contamination is checked between each sample by drawing ambient air through the probe via a Gilian pump and checking the response of the FID/PID. If readings are higher than background, replacement or decontamination is necessary.

Sample probes may be decontaminated simply by drawing ambient air through the probe until the HNu reading is at background. More persistent contamination can be washed out using methanol and water, then air drying. For persistent volatile contamination, use of a portable propane torch may be needed. Using a pair of pliers to hold the probe, run the torch up and down the length of the sample probe for approximately 1-2 minutes. Let the probe cool before handling. When using this method, make sure to wear gloves to prevent burns. Having more than one probe per sample team will reduce lag times between sample stations while probes are decontaminated.

10.2 Sample Train Contamination

The Teflon line forming the sample train from the probe to the Tedlar bag should be changed on a daily basis. If visible contamination (soil or water) is drawn into the sampling train, it should be changed immediately. When sampling in highly contaminated areas, the sampling train should be purged with ambient air, via a Gilian pump, for approximately 30 seconds between each sample. After purging, the sampling train can be checked using an FID or PID, or other field monitoring device, to establish the cleanliness of the Teflon line.

10.3 FID/PID Calibration

The FID and PIDs should be calibrated at least once a day using the appropriate calibration gases.

10.4 Field Blanks

Each cooler containing samples should also contain one Tedlar bag of ultra-zero grade air, acting as a field blank. The field blank should accompany the samples in the field (while being collected) and when they are delivered for analysis. A fresh blank must be provided to be placed in the empty cooler pending additional sample collection. One new field blank per cooler of samples is required. A chain of custody sheet must accompany each cooler of samples and should include the blank that is dedicated to that group of samples.

10.5 Trip Standards

Each cooler containing samples should contain a Tedlar bag of standard gas to calibrate the analytical instruments (Photovac GC, etc.). This trip standard will be used to determine any changes in concentrations of the target compounds during the course of the sampling day (e.g., migration through the sample bag, degradation, or adsorption). A fresh trip standard must be provided and placed in each cooler pending additional sample collection. A chain of custody sheet should accompany each cooler of samples and should include the trip standard that is dedicated to that group of samples.

10.6 Tedlar Bag Check

Prior to use, one bag should be removed from each lot (case of 100) of Tedlar bags to be used for sampling and checked for possible contamination as follows: the test bag should be filled with ultra-zero grade air; a sample should be drawn from the bag and analyzed via Photovac GC or whatever method is to be used for sample analysis. This procedure will ensure sample container cleanliness prior to the start of the sampling effort.

10.7 Summa Canister Check

From each lot of four cleaned Summa canisters, one is to be removed for a GC/MS certification check. If the canister passes certification, then it is re-evacuated and all four canisters from that lot are available for sampling.

If the chosen canister is contaminated, then the entire lot of four Summas must be recleaned, and a single canister is re-analyzed by GC/MS for certification.

10.8 Options

10.8.1 Duplicate Samples

A minimum of 5% of all samples should be collected in duplicate (i.e., if a total of 100 samples are to be collected, five samples should be duplicated.) In choosing which samples to duplicate, the following criteria applies: if, after filling the first Tedlar bag, and, evacuating the well for 15 seconds, the second HN (or other field monitoring device being used) reading matches or is close to (within 50%) the first reading, a duplicate sample may be taken.

10.8.2 Spikes

A Tedlar bag spike and Tenax tube spike may be desirable in situations where high concentrations of contaminants other than the target compounds are found to exist (landfills, etc.). The additional level of QA/QC attained by this practice can be useful in determining the effects of interferences caused by these non-target compounds. Summa canisters containing samples are not spiked.

11.0 DATA VALIDATION

11.1 Blanks (Field and Tedlar Bag Check)

For each target compound, the level of concentration found in the sample must be greater than three times the level (for that compound) found in the field blank which accompanied that sample to be considered valid. The same criteria apply to target compounds detected in the Tedlar bag pre-sampling contamination check.

12.0 HEALTH AND SAFETY CONSIDERATIONS

Due to the remote nature of sampling soil gas, special considerations can be taken with regard to health and safety. Because the sample is being drawn from underground, and no contamination is introduced into the breathing zone, soil gas sampling usually occurs in Level D. Ambient air is constantly monitored using the HNu PI101 to obtain background readings during the sampling procedure. As long as the levels in ambient air do not rise above background, no upgrade of the level of protection is needed.

When conducting soil gas sampling, leather gloves should be worn, and proper slam bar techniques should be implemented (bend knees). Also, an underground utility search should be performed prior to sampling. (See Section 4.5).

13.0 REFERENCES

Gilian Instrument Corp., Instruction Manual for Hi Flow Sampler: HFS113, HFS 113 T, HFS 113U, HFS 113 UT, 1983.

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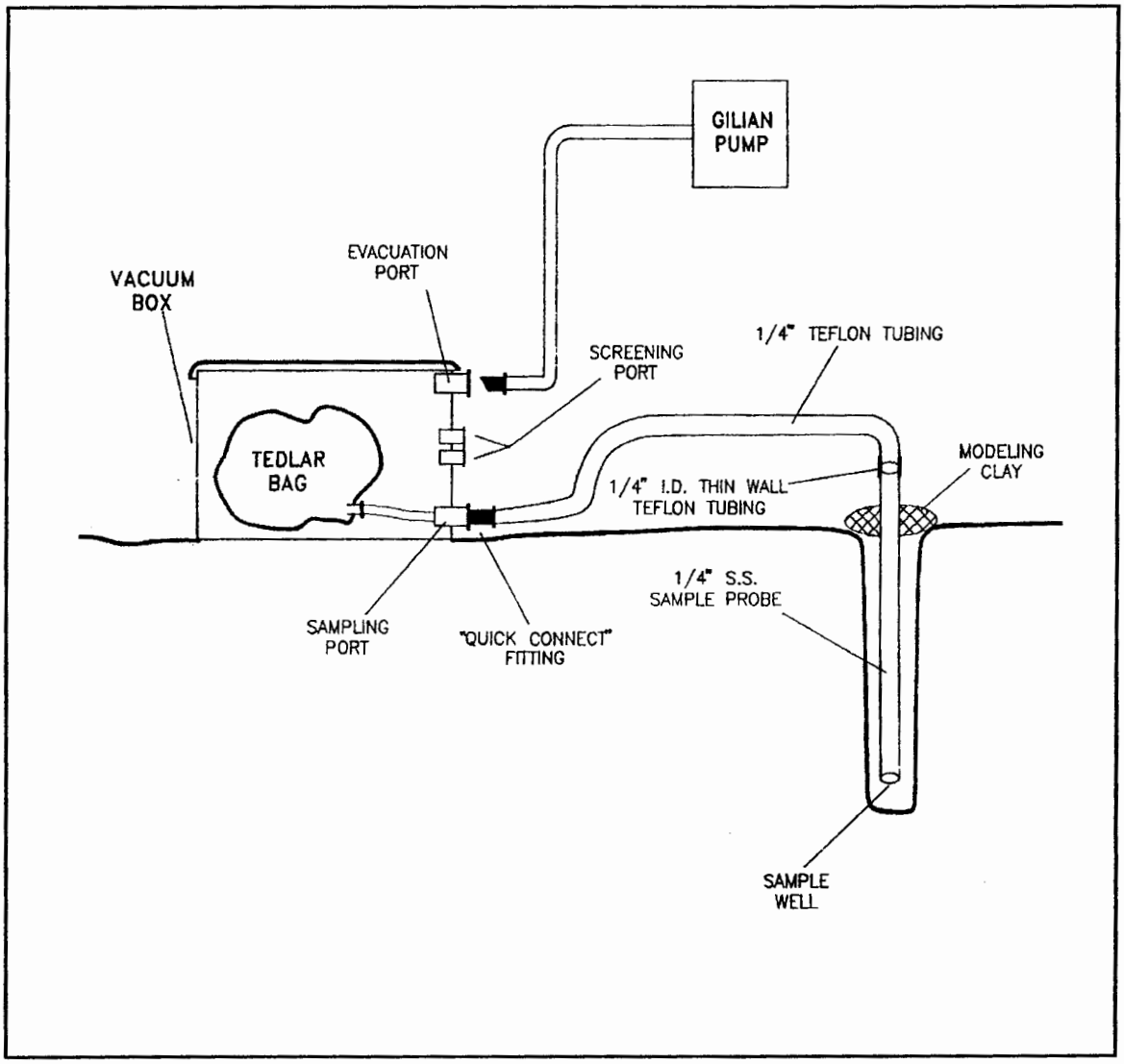
APPENDIX A

Figure

FIGURE 1. Sampling Train Schematic



APPENDIX B

HNu Field Protocol

Field Procedure

The following sections detail the procedures that are to be followed when using the HNu in the field.

Startup Procedure

a. Before attaching the probe, check the function switch on the control panel to ensure that it is in the off position. Attach the probe by plugging it into the interface on the top of the readout module. Use care in aligning the prongs in the probe cord with the plug in; don't force.

b. Turn the function switch to the battery check position. The needle on the meter should read within or above the green battery are on the scale. If not, recharge the battery. If the red indicator light comes on, the battery needs recharging.

c. Turn the function switch to any range setting. Look into the end of the probe for no more than two to three seconds to see if the lamp is on. If it is on, it will give a purple glow. Do not stare into the probe any longer than three seconds. Long term exposure to UV light can damage eyes. Also, listen for the hum of the fan motor.

d. To ZERO the instrument, turn the function switch to the standby position and rotate the zero adjustment until the meter reads zero. A calibration gas is not needed since this is an electronic zero adjustment. If the span adjustment setting is changed after the zero is set, the zero should be rechecked and adjusted, if necessary. Wait 15 to 20 seconds to ensure that the zero reading is stable. If necessary, readjust the zero.

Operational Check

a. Follow the startup procedure.

b. With the instrument set on the 0-20 range, hold a solvent-based major market near the probe tip. If the meter deflects upscale, the instrument is working.

Field Calibration Procedure

a. Follow the startup procedure and the operational check.

b. Set the function switch to the range setting for the concentration of the calibration gas.

c. Attach a regulator (HNu 101-351) to a disposable cylinder of isobutylene gas (HNu 101-351). Connect the regulator to the probe of the HNu with a piece of clean Tygon tubing. Turn on the value on the regulator.

d. After fifteen seconds, adjust the span dial until the meter reading equals the concentration of the calibration gas used. Be careful to unlock the span dial before adjusting it. If the span has to be set below 3.0, calibration internally or return to equipment maintenance for repair.

e. Record in the field logbook: the instrument ID no. (EPA decal or serial number if the instrument is a rental); the initial and final span settings; the date and time; concentration and type of calibration has used; and the name of the person who calibrated the instrument.

Operation

a. Follow the startup procedure, operational check, and calibration check.

b. Set the function switch to the appropriate range. If the concentration of gases or vapors is unknown, set the function switch to the 0-20 ppm range. Adjust it if necessary.

c. While taking care not to permit the HNu to be exposed to excessive moisture, dirt, or contamination, monitor the work activity as specified in the Site Health and Safety Plan.

d. When the activity is completed or at the end of the day, carefully clean the outside of the HNu with a damp disposable towel to remove any visible dirt. Return the HNu to a secure area and place on charge.

e. With the exception of the probe's inlet and exhaust, the HNu can be wrapped in clear plastic to prevent it form becoming contaminated and to prevent water from getting inside in the event of precipitation.

APPENDIX F

USEPA SOP NO. 1704

SUMMA CANISTER SAMPLING

JULY 27, 1995

REV. NO. 0.1

SUMMA CANISTER SAMPLING

SOP#: 1704
DATE: 07/27/95
REV. #: 0.1

1.0 SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to describe a procedure for sampling of volatile organic compounds (VOCs) in ambient air. The method is based on samples collected as whole air samples in Summa passivated stainless steel canisters. The VOCs are subsequently separated by gas chromatography (GC) and measured by mass-selective detector or multidetector techniques. This method presents procedures for sampling into canisters at final pressures both above and below atmospheric pressure (respectively referred to as pressurized and subatmospheric pressure sampling).

This method is applicable to specific VOCs that have been tested and determined to be stable when stored in pressurized and subatmospheric pressure canisters. The organic compounds that have been successfully collected in pressurized canisters by this method are listed in the Volatile Organic Compound Data Sheet (Appendix A). These compounds have been measured at the parts per billion by volume (ppbv) level.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent on site conditions, equipment limitations or limitations imposed by the procedure or other procedure limitations. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. EPA endorsement or recommendation for use.

2.0 METHOD SUMMARY

Both subatmospheric pressure and pressurized sampling modes use an initially evacuated canister. Both modes may also use a mass flow controller/vacuum pump arrangement to regulate flow. With the above configuration, a sample of ambient air is drawn through a sampling train comprised of components that regulate the rate and duration of sampling into a pre-evacuated Summa passivated canister. Alternatively, subatmospheric pressure sampling may be performed using a fixed orifice, capillary, or adjustable micrometering valve in lieu of the mass flow controller/vacuum pump arrangement for taking grab samples or short duration time-integrated samples. Usually, the alternative types of flow controllers are appropriate only in situations where screening samples are taken to assess for future sampling activities.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

After the air sample is collected, the canister valve is closed, an identification tag is attached to the canister, and the canister is transported to a laboratory for analysis. Upon receipt at the laboratory, the canister tag data is recorded. Sample holding times and expiration should be determined prior to initiating field activities.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

Contamination may occur in the sampling system if canisters are not properly cleaned before use. Additionally, all other sampling equipment (e.g., pump and flow controllers) should be thoroughly cleaned.

5.0 EQUIPMENT/APPARATUS

The following equipment/apparatus (Figure 1, Appendix B) is required:

5.1 Subatmospheric Pressure Sampling Equipment

1. VOC canister sampler - whole air sampler capable of filling an initially evacuated canister by action of the flow controlled pump from vacuum to near atmospheric pressure. (Andersen Samplers Inc., Model 87-100 or equivalent).

2. Sampling inlet line - stainless steel tubing to connect the sampler to the sample inlet.

3. Sample canister - leak-free stainless steel pressure vessels of desired volume with valve and Summa passivated interior surfaces (Scientific Instrumentation Specialist, Inc., ID 83843, Andersen Samplers, Inc., or equivalent).

4. Particulate matter filter - 2-µm sintered stainless steel in-line filter (Nupro Co., Model SS-2F-K4-2, or equivalent).

5. Chromatographic grade stainless steel tubing and fittings - for interconnections (Alltech Associates, Cat. #8125, or equivalent). All materials in contact with sample, analyte, and support gases should be chromatographic grade stainless steel.

6. Fixed orifice, capillary, or adjustable micrometering valve - used in lieu of the electronic flow controller/vacuum pump for grab samples or short duration time-integrated samples.

5.2 Pressurized Sampling Equipment

1. VOC canister sampler - whole air sampler capable of filling an initially evacuated canister by action of the flow controlled pump from vacuum to near atmospheric pressure. (Andersen Samplers Inc., Model 87-100).

2. Sampling inlet line - stainless steel tubing to connect the sampler to the sample inlet.

3. Sample canister - leak-free stainless steel pressure vessels of desired volume with valve and Summa passivated interior surfaces (Scientific Instrumentation Specialist, Inc., ID 83843, Andersen Samplers, Inc., or equivalent).

4. Particulate matter filter - 2-µm sintered stainless steel in-line filter (Nupro Co., Model SS-2F-K4-2, or equivalent).

5. Chromatographic grade stainless steel tubing and fittings - for interconnections (Alltech Associates, Cat. #8125, or equivalent). All materials in contact with sample, analyte, and support gases should be chromatographic grade stainless steel.

6.0 REAGENTS

This section is not applicable to this SOP.

7.0 PROCEDURE

7.1 Subatmospheric Pressure Sampling

7.1.1 Sampling Using a Fixed Orifice, Capillary, or Adjustable Micrometering Valve

1. Prior to sample collection, the appropriate information is completed on the Canister Sampling Field Data Sheet (Appendix C).

2. A canister, which is evacuated to 0.05 mm Hg and fitted with a flow restricting device, is opened to the atmosphere containing the VOCs to be sampled.

3. The pressure differential causes the sample to flow into the canister.

4. This technique may be used to collect grab samples (duration of 10 to 30 seconds) or time-integrated samples (duration of 12 to 24 hours). The sampling duration depends on the degree to which the flow is restricted.

5. A critical orifice flow restrictor will have a decrease in the flow rate as the pressure approaches atmospheric.

6. Upon sample completion at the location, the appropriate information is recorded on the

Canister Sampling Field Data Sheet.

7.1.2 Sampling Using a Mass Flow Controller/Vacuum Pump Arrangement (Andersen Sampler Model 87-100)

1. Prior to sample collection the appropriate information is completed on the Canister Sampling Field Data Sheet (Appendix C).

2. A canister, which is evacuated to 0.05 mm Hg and connected in line with the sampler, is opened to the atmosphere containing the VOCs to be sampled.

3. A whole air sample is drawn into the system through a stainless steel inlet tube by a direct drive blower motor assembly.

4. A small portion of this whole air sample is pulled from the inlet tube by a specially modified inert vacuum pump in conjunction with a mass flow controller.

5. The initially evacuated canister is filled by action of the flow controlled pump to near atmospheric pressure.

6. A digital time-program is used to pre-select sample duration and start and stop times.

7. Upon sample completion at the location, the appropriate information is recorded on the Canister Sampling Field Data Sheet.

7.2 Pressurized Sampling

7.2.1 Sampling Using a Mass Flow Controller/Vacuum Pump Arrangement (Anderson Sampler Model 87-100)

1. Prior to sample commencement at the location, the appropriate information is completed on the Canister Sampling Field Data Sheet.

2. A canister, which is evacuated to 0.05 mm Hg and connected in line with the sampler, is opened to the atmosphere containing the VOCs to be sampled.

3. A whole air sample is drawn into the system through a stainless steel inlet tube by a direct drive blower motor assembly.

4. A small portion of this whole air sample is pulled from the inlet tube by a specially modified inert vacuum pump in conjunction with a mass flow controller.

5. The initially evacuated canister is filled by action of the flow controlled pump to a positive pressure not to exceed 25 psig.

6. A digital time-programmer is used to pre-select sample duration and start and stop times.

7. Upon sample completion at the location, the appropriate information is recorded on the Canister Sampling Field Data Sheet.

8.0 CALCULATIONS

1. A flow control device is chosen to maintain a constant flow into the canister over the desired sample period. This flow rate is determined so the canister is filled to about 88.1 kPa for subatmospheric pressure sampling or to about one atmosphere above ambient pressure for pressurized sampling over the desired sample period. The flow rate can be calculated by:

$$F = \frac{(P)(V)}{(T)(60)}$$

where:

F	=	flow rate (cm^3/min)
P	=	final canister pressure, atmospheres absolute
V	=	volume of the canister (cm^3)
T	=	sample period (hours)

For example, if a 6-L canister is to be filled to 202 kPa (two atmospheres) absolute pressure in 24 hours, the flow rate can be calculated by:

$$F = \frac{(2)(6000)}{(24)(60)} = 8.3 cm^3/min$$

2. If the canister pressure is increased, a dilution factor (DF) is calculated and recorded on the sampling data sheet.

$$DF = \frac{Ya}{Xa}$$

where:

Xa	=	canister pressure (kPa, psia) absolute before dilution.
Ya	=	canister pressure (kPa, psia) absolute after dilution.

After sample analysis, detected VOC concentrations are multiplied by the dilution factor to determine concentration in the sampled air.

9.0 QUALITY ASSURANCE/ QUALITY CONTROL

The following general quality assurance procedures apply:

1. All data must be documented on standard chain of custody records, field data sheets, or site logbooks.

2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation, and they must be documented.

10.0 DATA VALIDATION

This section is not applicable to this SOP.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, OSHA, and corporate health and safety practices. Specifically, pressurizing of Summa canisters should be performed in a well ventilated room, or preferably under a fume hood. Care must be taken not to exceed 40 psi in the canisters. Canisters are under pressure, albeit only 20-30 psi, and should not be dented or punctured. They should be stored in a cool dry place and always be placed in their plastic shipping boxes during transport and storage.

12.0 REFERENCES

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APPENDIX A

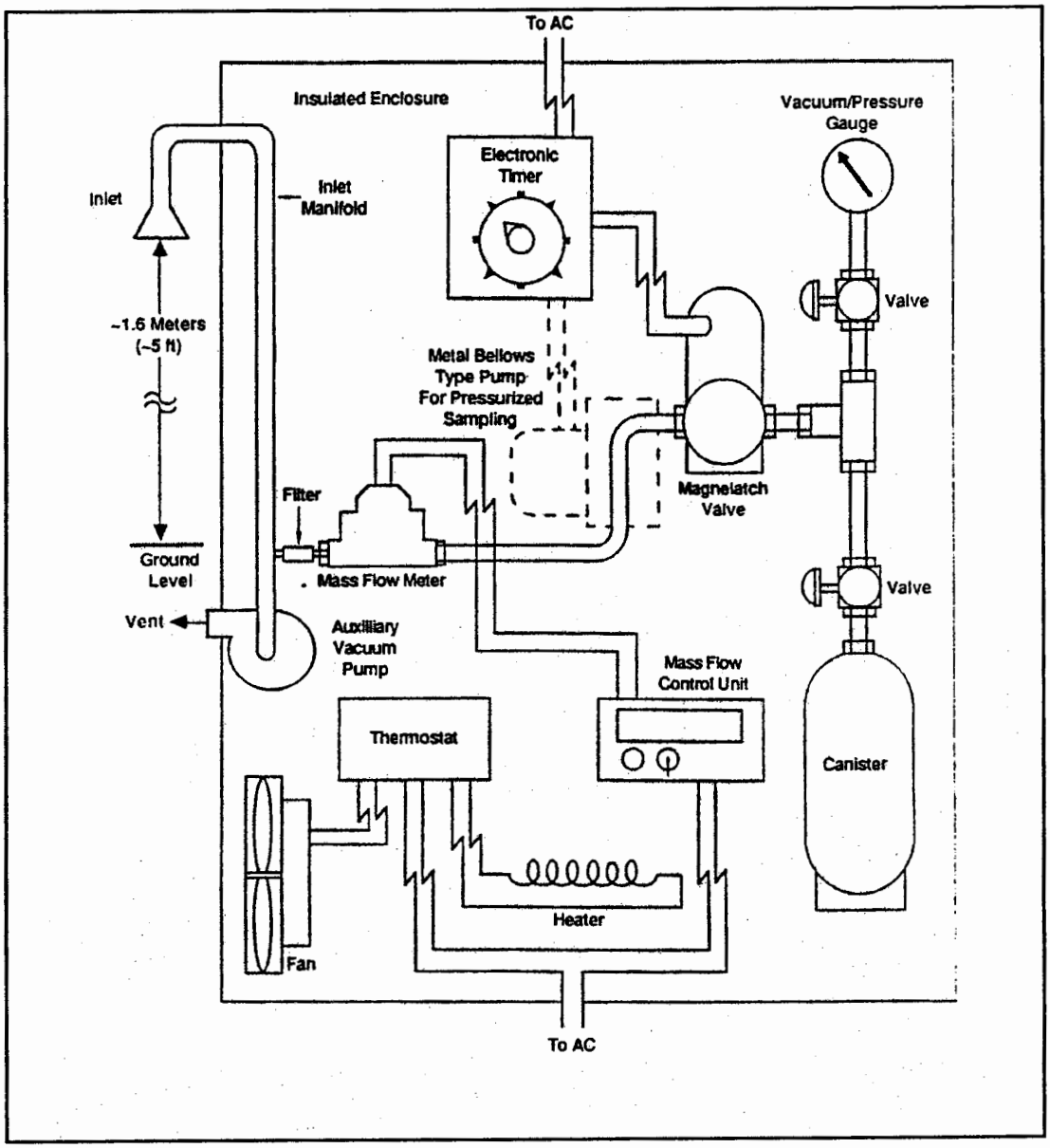
Volatile Organic Compound Data Sheet

TABLE 1. VOLATILE ORGANIC COMPOUND DATA SHEET

COMPOUND (SYNONYM)	FORMULA	MOLECULAR WEIGHT	BOILING POINT (°C)	MELTING POINT (°C)	CAS NUMBER
Freon 12 (Dichlorodifluoromethane)	Cl_2CF_2	120.91	-29.8	-158.0	
Methyl chloride (Chloromethane)	CH_3Cl	50.49	-24.2	-97.1	74-87-3
Freon 114 (1,2-Dichloro-1,1,2,2-tetrafluoroethane)	$ClCF_2CClF_2$	170.93	4.1	-94.0	
Vinyl chloride (Chloroethylene)	$CH_2{=}CHCl$	62.50	-13.4	-1538.0	75-01-4
Methyl bromide (Bromomethane)	CH_3Br	94.94	3.6	-93.6	74-83-9
Ethyl chloride (Chloroethane)	CH_3CH_2Cl	64.52	12.3	-136.4	75-00-3
Freon 11 (Trichlorofluoromethane)	CCl_3F	137.38	23.7	-111.0	
Vinylidene chloride (1,1-Dichloroethene)	$C_2H_2Cl_2$	96.95	31.7	-122.5	75-35-4
Dichloromethane (Methylene chloride)	CH_2Cl_2	84.94	39.8	-95.1	75-09-2
Freon 113 (1,1,2-Trichloro-1,2,2-trifluoroethane)	CF_2ClCCl_2F	187.38	47.7	-36.4	
1,1-Dichloroethane (Ethylidene chloride)	CH_3CHCl_2	98.96	57.3	-97.0	74-34-3
cis-1,2-Dichloroethylene	$CHCl{=}CHCl$	96.94	60.3	-80.5	
Chloroform (Trichloromethane)	$CHCl_3$	119.38	61.7	-63.5	67-66-3
1,2-Dichloroethane (Ethylene dichloride)	$ClCH_2CH_2Cl$	98.96	83.5	-35.3	107-06-2
Methyl chloroform (1,1,1-Trichloroethane)	CH_3CCl_3	133.41	74.1	-30.4	71-55-6
Benzene (Cyclohexatriene)	C_6H_6	78.12	80.1	5.5	71-43-2
Carbon tetrachloride (Tetrachloromethane)	CCl_4	153.82	76.5	-23.0	56-23-5
1,2-Dichloropropane (Propylene dichloride)	$CH_3CHClCH_2Cl$	112.99	96.4	-100.4	78-87-5
Trichloroethylene (Trichloroethene)	$ClCH{=}CCl_2$	131.29	87	-73.0	79-01-6
cis-1,3-Dichloropropene (cis-1,3-dichloropropylene)	$CH_3CCl{=}CHCl$	110.97	76		
trans-1,3-Dichloropropene (cis-1,3-Dichloropropylene)	$ClCH_2CH{=}CHCl$	110.97	112.0		
1,1,2-Trichloroethane (Vinyl trichloride)	$CH_2ClCHCl_2$	133.41	113.8	-36.5	79-00-5
Toluene (Methyl benzene)	$C_6H_5CH_3$	92.15	110.6	-95.0	108-88-3
1,2-Dibromoethane (Ethylene dibromide)	$BrCH_2CH_2Br$	187.88	131.3	9.8	106-93-4
Tetrachloroethylene (Perchloroethylene)	$Cl_2C{=}CCl_2$	165.83	121.1	-19.0	127-18-4
Chlorobenzene (Phenyl chloride)	C_6H_5Cl	112.56	132.0	-45.6	108-90-7
Ethylbenzene	$C_6H_5C_2H_5$	106.17	136.2	-95.0	100-41-4
m-Xylene (1,3-Dimethylbenzene)	$1,3-(CH_3)_2C_6H_4$	106.17	139.1	-47.9	
p-Xylene (1,4-Dimethylxylene)	$1,4-(CH_3)_2C_6H_4$	106.17	138.3	13.3	
Styrene (Vinyl benzene)	$C_6H_5CH{=}CH_2$	104.16	145.2	-30.6	100-42-5
1,1,2,2-Tetrachloroethane	$CHCl_2CHCl_2$	167.85	146.2	-36.0	79-34-5
o-Xylene (1,2-Dimethylbenzene)	$1,2-(CH_3)_2C_6H_4$	106.17	144.4	-25.2	
1,3,5-Trimethylbenzene (Mesitylene)	$1,3,5-(CH_3)_3C_6H_6$	120.20	164.7	-44.7	108-67-8
1,2,4-Trimethylbenzene (Pseudocumene)	$1,2,4-(CH_3)_3C_6H_6$	120.20	169.3	-43.8	95-63-6
m-Dichlorobenzene (1,3-Dichlorobenzene)	$1,3-Cl_2C_6H_4$	147.01	173.0	-24.7	541-73-1
Benzyl chloride (α-Chlorotoluene)	$C_6H_5CH_2Cl$	126.59	179.3	-39.0	100-44-7
o-Dichlorobenzene (1,2-Dichlorobenzene)	$1,2-Cl_2C_6H_4$	147.01	180.5	-17.0	95-50-1
p-Dichlorobenzene (1,4-Dichlorobenzene)	$1,4-Cl_2C_6H_4$	147.01	174.0	53.1	106-46-7
1,2,4-Trichlorobenzene	$1,2,4-Cl_3C_6H_3$	181.45	213.5	17.0	120-82-1
Hexachlorobutadiene (1,1,2,3,4,4-Hexachloro-1,3-butadiene)					

APPENDIX B

FIGURE 1. Subatmospheric/Pressurized Sampling Equipment



APPENDIX C

Canister Sampling Field Data Sheet

Page ___ of ___

SUMMA AIR SAMPLING WORK SHEET

Site: _____ Site#: _____
Samplers: _____ Work Assignment Manager: _____
Date: _____ Project Leader: _____

Sample #					
Location					
SUMMA ID					
Orifice Used					
Analysis/Method					
Time (Start)					
Time (Stop)					
Total Time					
SUMMA WENT TO AMBIENT	YES/NO	YES/NO	YES/NO	YES/NO	YES/NO
Pressure Gauge					
Pressure Gauge					
Flow Rate (Pre)					
Flow Rate (Post)					
Flow Rate (Average)					

MET Station On-site? Y / N

General Comments: