FINAL
WORK PLAN FOR *IN-SITU* BIOREMEDIATION OF CHLORINATED ALIPHATIC HYDROCARBONS USING A PERMEABLE REACTIVE BIOWALL
OPERABLE UNIT 1
ALTUS AIR FORCE BASE, OKLAHOMA

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Prepared for:

AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE
SAN ANTONIO, TEXAS

and

ALTUS AIR FORCE BASE
ALTUS, OKLAHOMA

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ACRONYMS AND ABBREVIATIONS

°C	degrees Celsius
μg/L	micrograms per liter
AFB	Air Force Base
AETC	Air Education Training Command
AFCEE/ERT	Air Force Center for Environmental Excellence, Technology Transfer Division
AMC	Air Mobility Command
bgs	below ground surface
CAH	chlorinated aliphatic hydrocarbon
CMS	corrective measures study
CT	carbon tetrachloride
DCA	Dichloroethane
DCE	Dichloroethene
DO	dissolved oxygen
FT-03	Fire Training Area 3
FT-07	Fire Training Area 4
ft/day	feet per day
ft/ft	foot per foot
gpm	gallons per minute
HSA	hollow stem auger
IA	interim action
IDW	investigation-derived waste
K	hydraulic conductivity
LCSs	laboratory control samples
LF 3	Landfill Number 3
LF-04	Landfill Number 4
LMBs	laboratory method blanks
MAC	Military Airlift Command
mg/L	milligrams per liter
N	Nitrogen
ORP	oxidation-reduction potential
OU-1	Operable Unit 1
Parsons	Parsons, Inc.
PCE	Tetrachloroethene
PLFAs	phospholipid fatty acids
POC	point of contact
POL	petroleum, oil, and lubricants
PVC	polyvinyl chloride
QA/QC	quality assurance/quality control
QC	quality control
RCRA	Resource Conservation and Recovery Act
Redox	reduction-oxidation
RFI	RCRA facilities investigation

SAC	Strategic Air Command
SWMU 7	Solid Waste Management Unit 7
T	Transmissivity
TAC	Tactical Air Command
TCA	Tetrachloroethane
TCE	Trichloroethene
TOC	total organic carbon
USEPA	US Environmental Protection Agency
VC	vinyl chloride
VFAs	volatile fatty acids
VOC	volatile organic compound

SECTION 1

INTRODUCTION

This work plan describes the field methods Parsons, Inc. (Parsons) will employ to assess the applicability and feasibility of promoting the *in-situ* bioremediation of chlorinated aliphatic hydrocarbons (CAHs, or chlorinated solvents) in groundwater using a permeable reactive biowall at Operable Unit 1 (OU-1), Altus Air Force Base (AFB), Oklahoma. This work plan has been prepared for the Technology Transfer Division of the Air Force Center for Environmental Excellence (AFCEE/ERT) and Altus AFB by Parsons, and is submitted in accordance with AFCEE Contract No. F41624-00-D-8024, Delivery Order No. 0011.

The biowall will be constructed across the path of groundwater flow along the downgradient (eastern) edge of Landfill Number 3 (LF 3) at OU-1. The biowall will contain a mixture of locally derived, actively-composting shredded plant material (bark mulch) and coarse sand. This treatment method relies on the flow of groundwater under a natural hydraulic gradient through the biowall to promote contact with soluble organic matter. Under these conditions, microbial fermentation of organic carbon within the biowall produces hydrogen which supports the reductive dechlorination of CAHs in the groundwater.

1.1 SCOPE OF WORK

This project is being conducted by AFCEE in conjunction with Parsons and Altus AFB to document the *in-situ* bioremediation of CAH impacted groundwater using a permeable reactive biowall. Specifically, the objective of this field application is to determine if a permeable reactive biowall is a viable treatment option for CAHs in shallow groundwater at OU-1. Activities associated with this project include the following:

- Installation of a 500-foot long, 1.5-foot wide, and 25-foot deep permeable reactive biowall using continuous trenching technology;
- Installation of 10 groundwater monitoring wells using hollow stem auger (HSA) drilling technology;
- Installation of four soil vapor monitoring points using HSA drilling technology;
- Baseline sampling of groundwater and soil vapor at the biowall sampling network immediately following installation of the biowall;

- Process monitoring of groundwater and soil vapor at the biowall sampling network 6 and 12 months after installation; and

- Preparation of a report detailing the results of the field application.

The materials and methodologies to accomplish these activities are described in Section 4.

This work plan consists of seven sections, including this introduction, and three appendices. Section 2 presents a review and analysis of available, previously reported, site-specific data. Section 3 provides an overview of enhanced biodegradation of chlorinated solvents using bark mulch at OU1. Section 4 describes system installation and the procedures to be followed for data collection. Section 5 describes the quality assurance/quality control (QA/QC) measures to be used during this project. Section 6 describes the final report, and Section 7 contains the references used in preparing this document. Appendix A contains the Program Health and Safety Plan. Appendix B contains the project-specific addendum to the Program Health and Safety Plan. Appendix C contains pertinent historical data.

1.2 BACKGROUND

Altus AFB occupies an area of over 2,500 acres in eastern Jackson County, Oklahoma. It is bordered by the city of Altus on the west, Highway 62 on the south, and agricultural land on the north and east (Figure 1.1).

Altus AFB began operating as a flight-training Base in 1942. The Base was deactivated 5 days after the completion of the European phase of World War II, and was given to the city of Altus for use as a municipal airport. At the beginning of the Korean conflict, Altus AFB was reactivated under the Tactical Air Command (TAC) in January 1953. In late 1953, the Strategic Air Command (SAC) was given control of the Base. The 577th Strategic Missile Squadron was assigned to the Base between 1961 and 1965.

In 1968, control of Altus AFB was transferred to the Military Airlift Command (MAC), and the Base became the training center for the C-5A transport aircraft. Since 1968, the primary mission of Altus AFB has been training aircraft crews for SAC and MAC operations. On July 1, 1992, MAC became the Air Mobility Command (AMC). In late 1992, land northeast of Altus AFB was acquired by the Base to allow for the construction of new runways and taxiways to be used for the training of crews for C-17 aircraft. On July 1, 1993, Altus AFB was transferred from AMC to the Air Education Training Command (AETC).

Landfill Number 4 (LF-04), located on approximately 15 acres in the northeastern portion of Altus AFB (Figure 1.2), operated from 1956 through 1983. LF-04 includes LF 3 and the Petroleum, Oil, and Lubricant (POL) Tank Sludge Burial area. LF 3 is located at the eastern end of Taxiway 3, and the POL Tank Sludge Burial area is located north of LF 3 (Figure 1.3). LF-04 is bordered by the Ozark 4.6 lateral irrigation canal on the west and south, Stinking Creek on the northeast, an unnamed drainage canal on the north, and the old Base boundary and Taxiway "M" on the east.

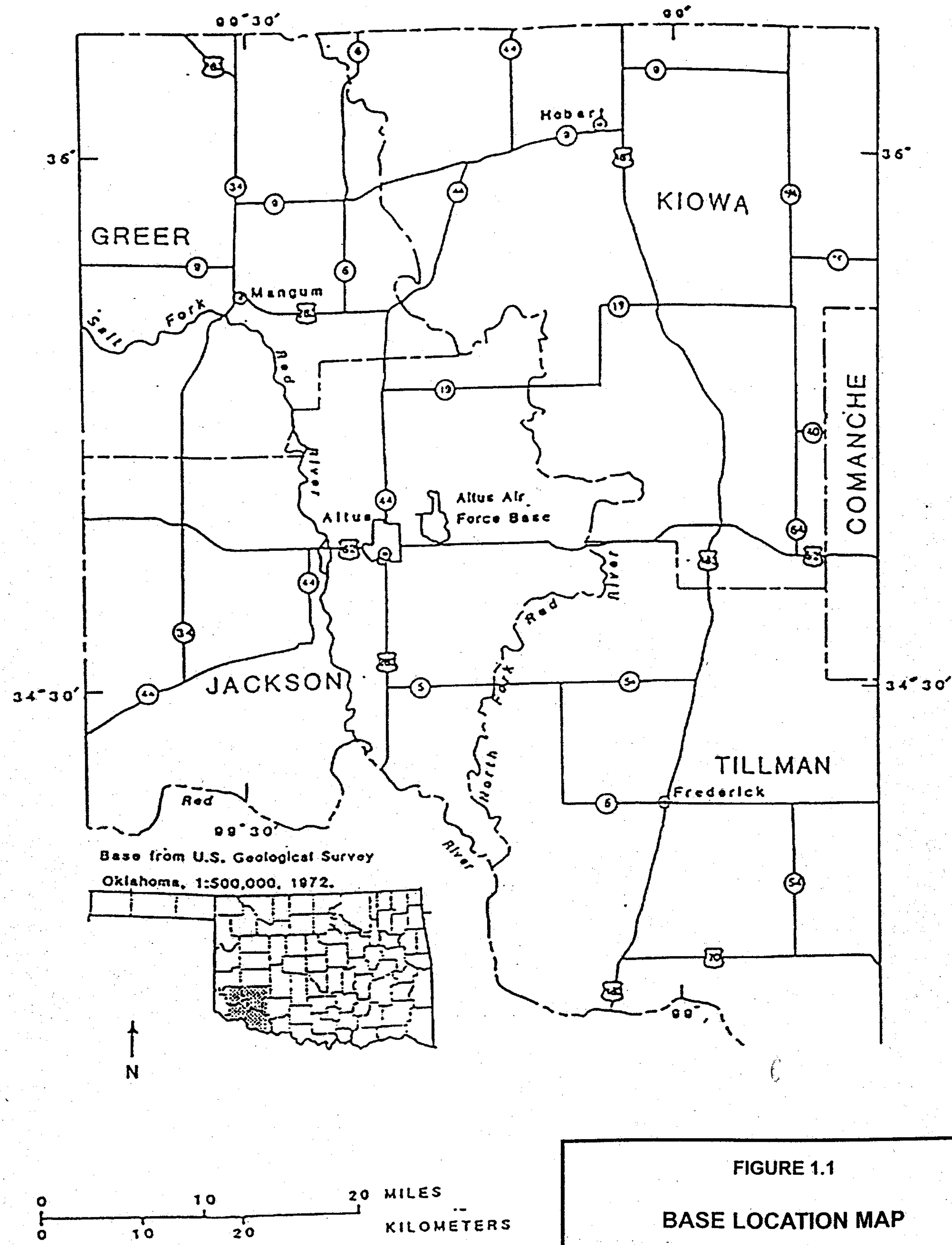

FIGURE 1.1

BASE LOCATION MAP

Operable Unit 1
Altus AFB, Oklahoma

Source: USGS, 1996.

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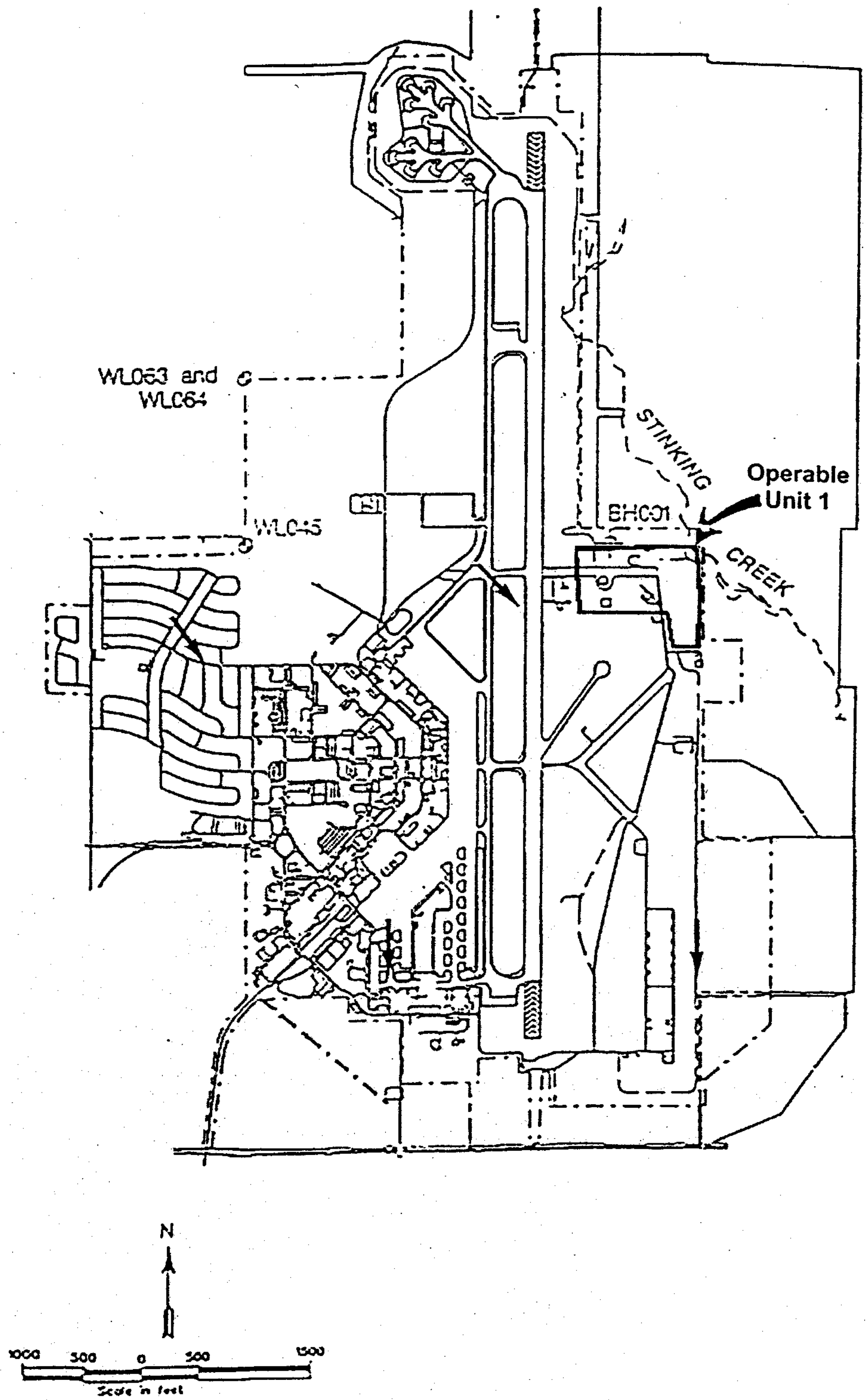

LEGEND

- BACKGROUND WELL
- BOREHOLE
- GROUNDWATER FLOW DIRECTION

FIGURE 1.2

SITE LOCATION MAP

Operable Unit 1
Altus AFB, Oklahoma

Source: USGS, 1996.

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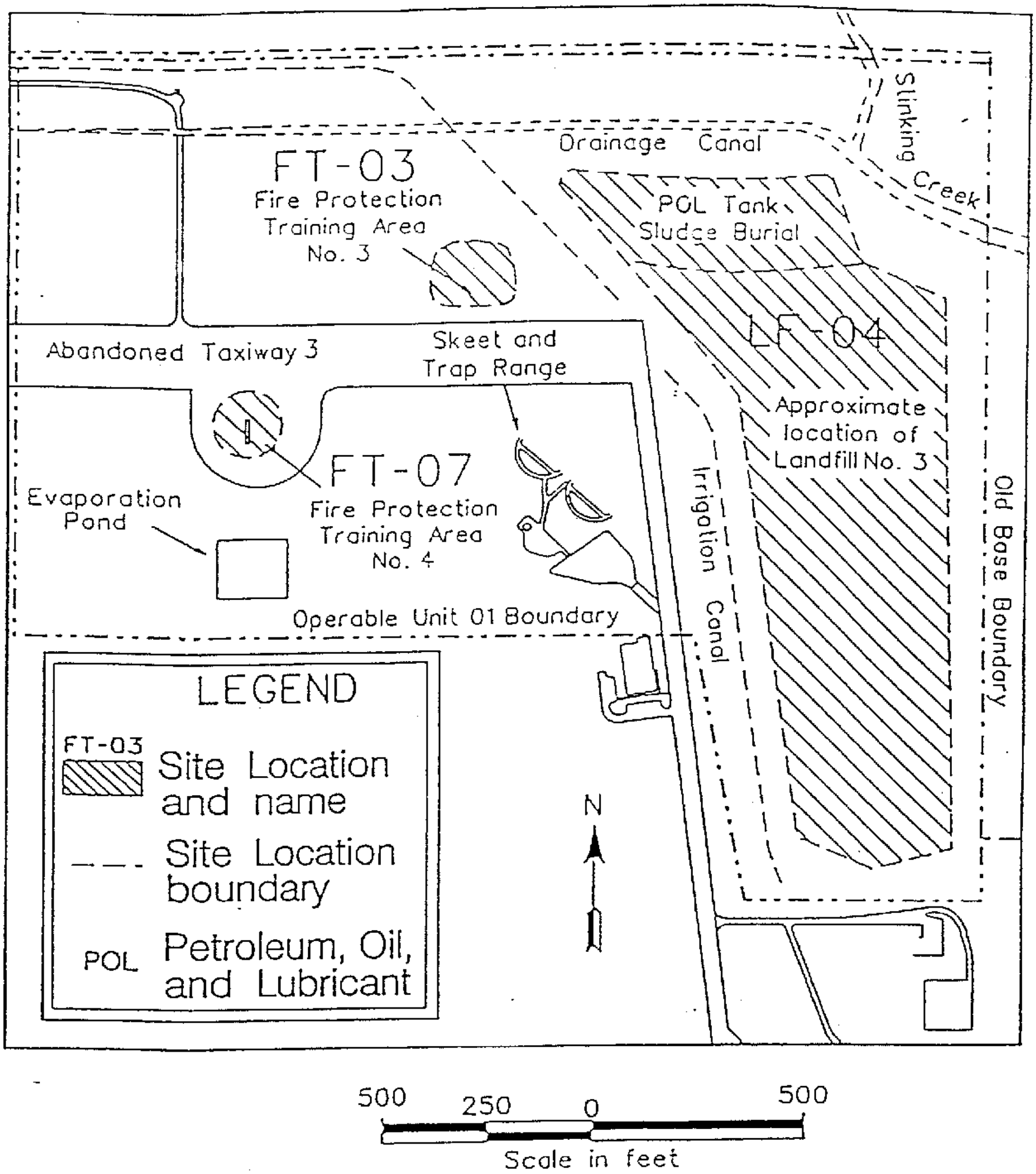

FIGURE 1.3

OU-1 SITE LOCATIONS

Operable Unit 1
Altus AFB, Oklahoma

Source: USGS, 1996.

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From 1956 to 1965, the LF 3 portion of LF-04 received waste materials including garbage, wood, metal, paper, and shop wastes. After 1965, LF 3 (also known as Solid Waste Management Unit 7 [SWMU 7]), received construction debris, concrete, brush, and several drums of paint waste. The sludge burial area located in the northern portion of LF-04 received POL tank sludge from the 1950s through the 1970s. Through the early 1960s, it was common practice to burn waste materials prior to disposal.

From 1956 to 1965, waste at LF 3 was buried in trenches with an east-west orientation and depths ranging from 6 to 8 feet below ground surface (bgs). After 1965, waste was buried 6 feet bgs in trenches with a north-south orientation. POL tank sludge waste was buried 3 feet bgs at the northern and northwestern edges of LF-04.

LF-04 is one portion of OU-1. Other sites within OU-1 include Fire Training Area 3 (FT-03), Fire Training Area 4 (FT-07), and the Skeet and Trap Range (Figure 1.3). Historical waste management activities at OU-1 have resulted in low concentrations of CAHs in groundwater beneath, and immediately to the southeast of OU-1.

SECTION 2

SITE-SPECIFIC DATA REVIEW

Site-specific data were reviewed to evaluate groundwater flow and contaminant transport and to determine locations for installation of the permeable reactive biowall and groundwater monitoring wells. The following sections are based upon review and summary of data from the *Remediation by Natural Attenuation Treatability Study Report, Operable Unit 1, Altus Air Force Base, Altus, Oklahoma* (Parsons, 1999) and the *Resource Conservation and Recovery Act (RCRA) Facilities Investigation (RFI)/Interim Action (IA)/Corrective Measures Study (CMS), Altus AFB, Oklahoma* (Altus AFB, 2002). The reader is referred to these documents for a more detailed review of site-specific data. A site plan illustrating the location of existing features at and within the general area of OU-1, including the proposed biowall, is provided as Figure 2.1.

2.1 SURFACE FEATURES

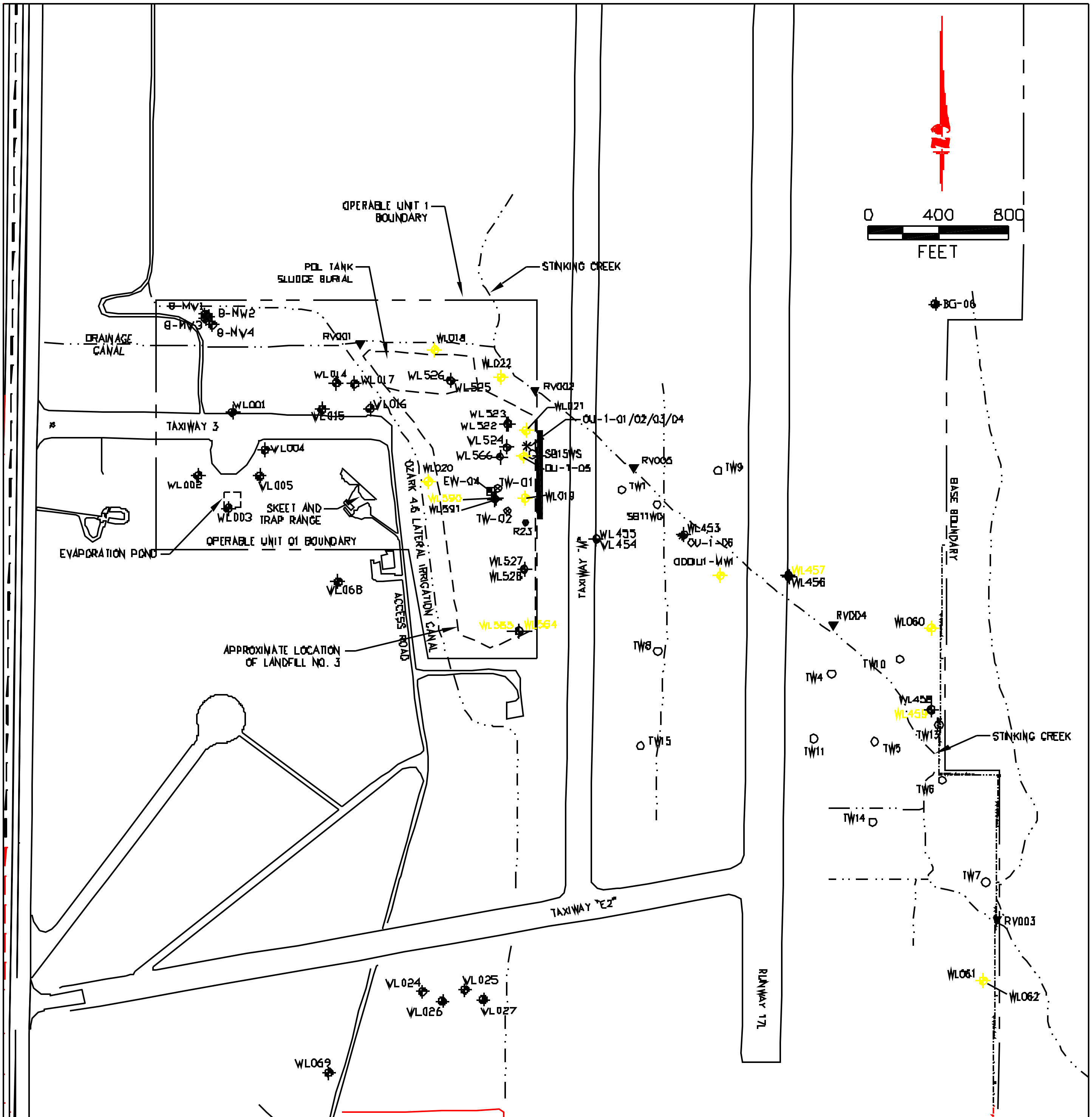
Altus AFB is located in the Central Redbed Plains characterized by a gently sloping land surface. Base surface elevations range from 1,330 to 1,390 feet above mean sea level. Relief at, and within the vicinity of OU-1 has resulted from stream erosion and landfill and runway construction. Surface topography within the immediate vicinity of the proposed biowall is flat with a slight swale along the biowall footprint. The footprint of the proposed biowall is vegetated with native grasses.

Runoff from OU-1 is drained by Stinking Creek. Stinking Creek, temporarily diverted during construction of the C-17 runway, has been returned to its original channel, except that the creek now flows beneath Taxiway “M” and Runway 17L via a concrete culvert. Other ditches have been dug to collect surface water drainage from the area and channel the flow into Stinking Creek. The Ozark 4.6 Lateral irrigation canal flows southeastward through OU-1, but receives drainage from the Base. Flow in the canal occurs only during the irrigation season, from June to August; at other times the canal is dry or ponded.

Manmade features in the general area of proposed biowall include an access roads Perimeter Road, Taxiways E2 and M, Runway 17L, and parking lots. No buildings are located within the general area. Manmade features within the immediate vicinity of the proposed biowall are limited protective surface casings associated with groundwater monitoring wells installed during previous investigations.

2.2 GEOLOGY

The Base is underlain almost entirely by the Hennessey Group of Permian age, except in the northern portion of the Base where unconsolidated terrace deposits are present. The Hennessey Group in southwestern Oklahoma ranges in thickness from 200 to 1,000



LEGEND

- CONE PENEROMETER SAMPLING LOCATION
- EXISTING MONITORING POINT
- EXISTING WELL CLUSTER
- EXISTING MONITORING WELL LOCATION
- SURFACE WATER
- PROPOSED LOCATION OF PERMEABLE REACTIVE BIOWALL

FIGURE 2.1

SITE PLAN WITH PROPOSED PERMEABLE REACTIVE BIOWALL LOCATION

Operable Unit 1
Altus AFB, Oklahoma

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feet, and consists of reddish-brown shale with thin interbeds of siltstone and sandstone. The uppermost 5 to 40 feet of the formation is predominantly yellowish-gray, buff, tan, orange, yellow, or greenish gray shale. The estimated regional dip of the Hennessey Group is to the west at less than 1 degree.

Surface soils overlying the Hennessey Group at the Base consist of three major types: Tillman/Hollister, Miles, and Altus. Tillman/Hollister soil consists of clay loams with 0 to 1 percent slopes and is the most extensive unit in Jackson County. The Tillman/Hollister soil type has a reddish-brown, granular, clay loam surface layer, underlain by a more clayey and block-structured subsoil, with respective thicknesses of approximately 10 and 18 inches. The Miles soil type is characterized by a fine, sandy loam surface soil and a reddish-brown, sandy clay loam subsoil, with thicknesses of approximately 10 and 44 inches, respectively. Both layers are friable, noncalcareous, and neutral to mildly alkaline. The Altus soil type consists of dark grayish-brown, friable, fine sandy loam at the surface. The subsoil, approximately 2 feet thick, is a moderately tight, brown sandy clay. Material beneath the subsoil is generally a stiff calcareous clay containing many soft carbonate concretions. The thickness of the surface soils generally ranges from 10 to 25 feet.

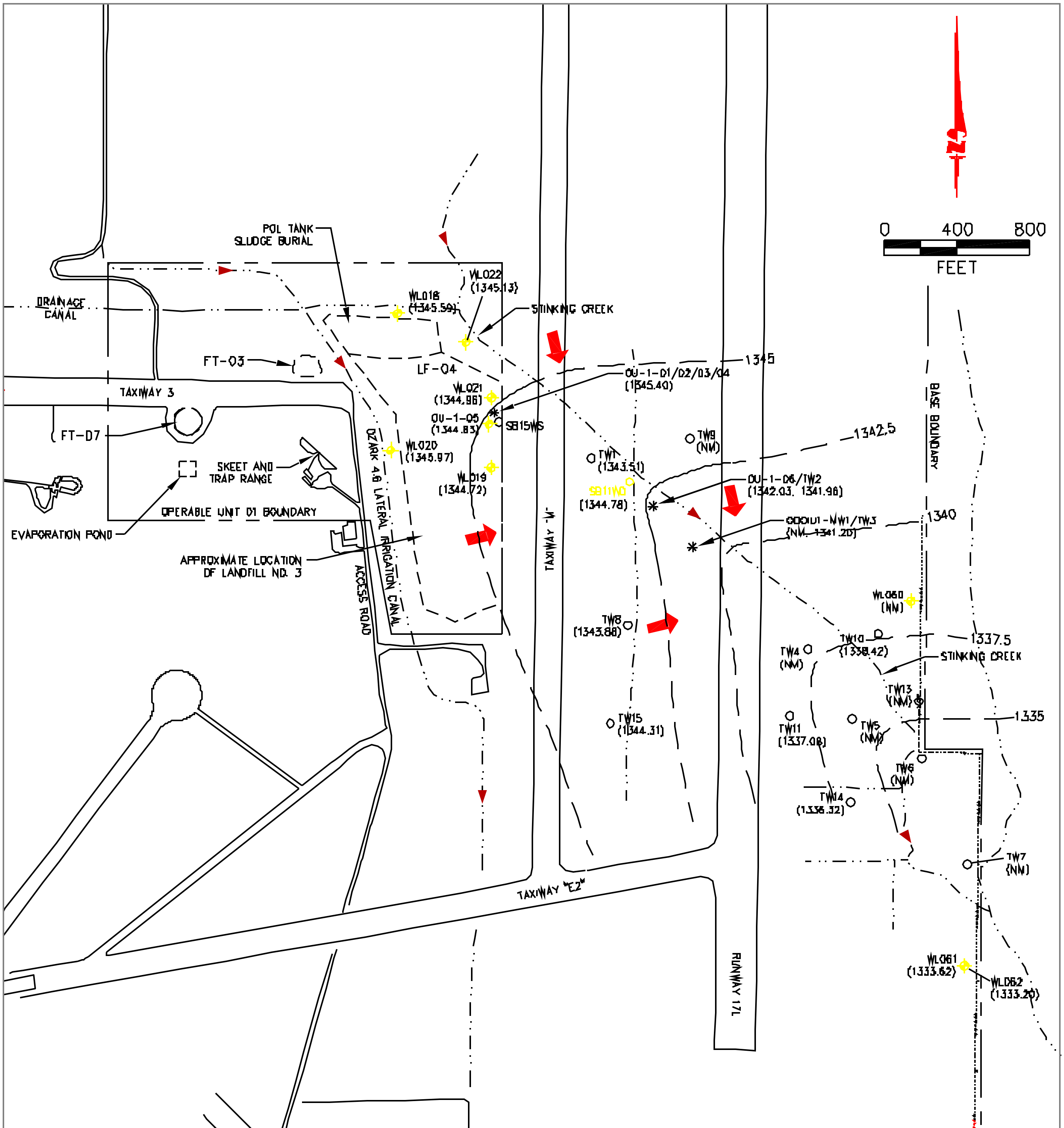
Soil boring advanced during previous investigations suggest that the footprint of the proposed biowall is underlain by approximately 5 feet of clayey silt. A stiff clay is present at the base of the clayey silt and extends to a depth of approximately 30 feet bgs. Though the area within the immediate vicinity of the proposed biowall was extensively characterized, only a limit number of boring logs are available. These logs are provided in Appendix C.

2.3 HYDROGEOLOGY

The primary hydrogeologic unit beneath the Base is the Hennessey Group. On the Base, two water-bearing zones have been encountered in the upper 42 feet. The depths of the two water-bearing zones coincide with the two distinct lithologic layers, the less-consolidated clay material extending to a depth of 20 to 30 feet bgs, and the underlying layer of well-cemented, better-lithified shale of the Hennessey Group.

Shallow groundwater occurs under unconfined conditions and generally flows to the southeast at the Base. Groundwater flow at OU1 is generally toward drainage canals and Stinking Creek. Shallow groundwater occurs at, and immediately east of OU-1, at a seasonally variable depth of approximately 6 to 12 feet bgs. The groundwater surface slopes toward the southeast with an average horizontal hydraulic gradient of approximately 0.003 foot per foot (ft/ft) based on water level measurements taken in April 1997 and 1999 (Parsons, 1999). Figure 2.2 illustrates the contoured shallow groundwater elevation data for April 1999.

During a previous investigation (Parsons, 1999), slug tests were performed at four monitoring wells to provide estimates for the hydraulic conductivity of the two water-bearing zones. The hydraulic conductivity values obtained ranged from 8.4 to 20 feet per day (ft/day) in the overburden clay. Using the hydraulic conductivity (8.4 to 20 ft/day), lateral hydraulic gradient (0.003 ft/ft), and an estimated effective porosity (5 percent), the



LEGEND

- MONITORING WELL LOCATION
- MONITORING POINT LOCATION
- WELL CLUSTER
- SURFACE WATER
- GROUNDWATER FLOW DIRECTION
- NM NOT MEASURED

FIGURE 2.2

GROUNDWATER ELEVATION
CONTOUR MAP
APRIL 1999

Operable Unit 1
Altus AFB, Oklahoma

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advective groundwater flow velocity in the overburden clay is calculated to range between 0.50 and 1.20 ft/day [183 to 438 feet per year (ft/yr)].

These groundwater flow velocities correspond to velocities for the upper water bearing zone at OU-1 given in the RFI/IA/CMS (Altus AFB, 2002) of 0.07 ft/day to 1.0 ft/day in the northern portion of the site, 1.0 ft/day on the central portion of the site, and 0.04 ft/day to 0.32 ft/day in the southern portion of the site.

2.4 NATURE AND EXTENT OF CONTAMINATION

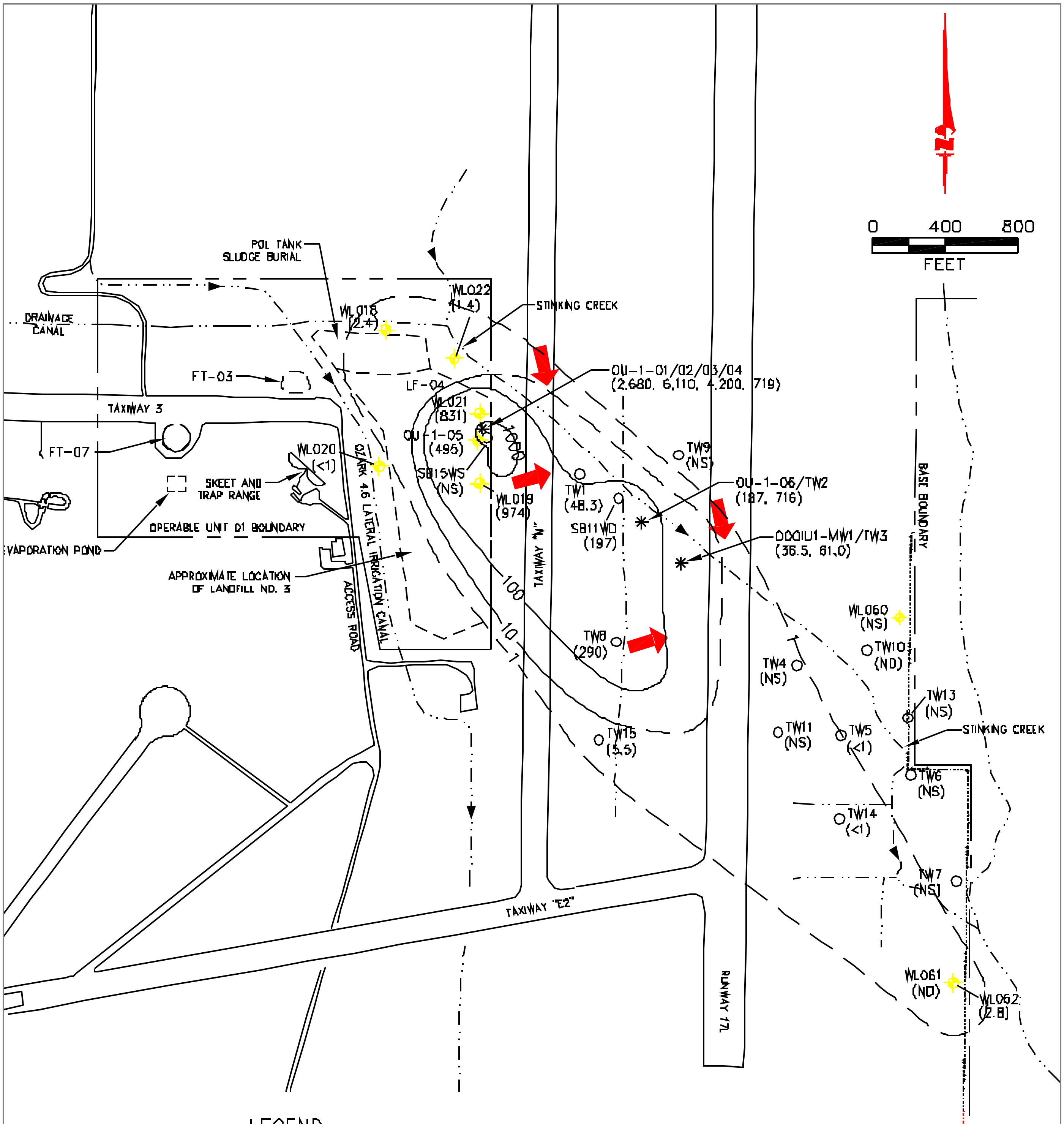
As described in Section 1.2, historical waste management activities at OU-1 have resulted in CAHs in groundwater beneath, and immediately to the southeast of OU-1. Groundwater quality data from previous investigations indicate that trichloroethene (TCE) and the dichloroethene (DCE) isomer *cis*-1,2-DCE are the most prevalent CAHs in both extent and concentration in groundwater at OU-1.

The areal extent of TCE based on groundwater quality samples collected in April 1999 is illustrated in Figure 2.3. The areal extent of TCE based on groundwater quality samples collected in July 2001 in both the upper and lower water bearing zones are illustrated on maps included in Appendix C (Altus AFB, 2002). The source of TCE contamination appears to be LF-04. A plume of dissolved TCE originates from LF-04 (in the vicinity of clustered monitoring wells OU-1-01/02/03/4/05 and extends southeastward approximately 4,000 feet to the Base's eastern boundary. Concentrations of TCE in April 1999 ranged up to 6,110 micrograms per liter (µg/L) at monitoring location OU-1-02. The maximum TCE concentrations detected during the RFI was 27,000 µg/L at monitoring location WL250 and 15,000 µg/L at monitoring location WL566 (Altus AFB, 2002).

Migration of the TCE plume to the northeast appears to be limited by Stinking Creek. None of the groundwater samples collected from monitoring wells or points northeast of Stinking Creek during previous investigations contained detectable levels of TCE or other CAHs. Stinking Creek may be exerting hydraulic control, resulting in no further TCE plume migration northeast of Stinking Creek. Hydraulic control could occur under both gaining- and losing-stream scenarios and could vary seasonally. Under a losing-stream scenario, the groundwater influx could create a barrier to flow in the form of a subtle mound. Under a gaining-stream scenario, a significant percentage of under-flow could be captured by the creek. Vertical migration occurs between the upper and lower water bearing zones. The permeable reaction biowall is intended to only treat groundwater in the upper zone to a maximum depth of 25 bgs.

2.5 GROUNDWATER USE AND POTENTIAL RECEPTORS

Except for a few wells used for domestic and livestock purposes, the Hennessey Group is not a primary water source in the Base area. The Base obtains its water from the city of Altus, which obtains water from wells located 16 miles south of the Base and from Lake Altus located 15 miles north of the Base. Well yields in the area of the Base vary. Monitoring wells at the Base, probably screened in soils overlying the Hennessey Group, yield from less than 1 gallon per minute (gpm) to 10 gpm. There are two private wells screened in the Hennessey Group near the Base. One well, located approximately 8,000



LEGEND

- MONITORING WELL LOCATION
- MONITORING POINT LOCATION
- WELL CLUSTER
- SURFACE WATER
- 1 — LINE OF EQUAL TCE CONCENTRATION IN SHALLOW GROUNDWATER (µg/L) (DASHED WHERE INFERRED)
- (13.6) TCE CONCENTRATION (µg/L)
- (NS) NOT SAMPLED
- (ND) NOT DETECTED AT OR ABOVE LABORATORY DETECTION LIMITS
- GROUNDWATER FLOW DIRECTION

FIGURE 2.3

DISTRIBUTION OF TCE IN SHALLOW GROUNDWATER AND SURFACE WATER APRIL 1999

Operable Unit 1
Altus AFB, Oklahoma

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feet west of (upgradient from) LF-04, has a total depth of 60 feet, a depth to water of 19 feet, and a yield of 150 gpm. The other well, located approximately 4,000 feet north of (crossgradient from) LF-04, has a total depth of 122 feet, a depth to water of 60 feet, and a yield of 100 gpm.

SECTION 3

ENHANCED BIOREMEDIATION OF CHLORINATED SOLVENTS USING BARK MULCH

3.1 BIODEGRADATION OF CHLORINATED SOLVENTS

Chlorinated solvents can be transformed, directly or indirectly, by biological processes (e.g., Bouwer *et al*., 1981; Bower, 1994; Freedman and Gossett, 1989; Alvarez-Cohen and McCarty, 1991; Chapelle, 1993; McCarty and Semprini, 1994; Vogel, 1994; Suflita and Townsend, 1995; Bradley and Chapelle, 1996 and 1998). Biodegradation of chlorinated solvents, also termed CAHs, and chlorinated benzenes results from the same general processes that bring about biodegradation of fuel hydrocarbons. However, a more complex series of processes often is involved, as CAHs and chlorinated benzenes may act either as substrates (electron donors) or electron acceptors depending upon the prevailing geochemical conditions.

Chlorinated solvents may undergo biodegradation through three different pathways: use as an electron acceptor, use as an electron donor, or cometabolism, which is degradation resulting from exposure to a catalytic enzyme fortuitously produced during an unrelated process. At a given site, one or all of these processes may be operating, although at many sites the use of CAHs as electron acceptors appears to be the most likely.

In a pristine aquifer, native organic carbon is utilized as an electron donor and dissolved oxygen (DO) is utilized first as the prime electron acceptor. Where anthropogenic carbon (e.g., fuel hydrocarbons, landfill leachate, less-chlorinated CAHs, or chlorinated benzenes with four or fewer chlorines) is present, it also may be utilized as an electron donor. Most chlorinated solvents that can act as electron donors have thus far only been demonstrated to do so under aerobic conditions, with the notable exception of vinyl chloride (VC) (Bradley and Chapelle, 1996 and 1998). After the DO is consumed, anaerobic microorganisms typically use native electron acceptors (as available) in the following order of preference: nitrate, manganese oxide, ferric iron oxyhydroxide, sulfate, and finally carbon dioxide. Evaluation of the distribution of these electron acceptors can provide evidence of where and how biodegradation of chlorinated solvents is occurring.

Under anaerobic conditions, biodegradation of chlorinated solvents usually proceeds through a process called reductive dehalogenation. This is the only common biological reaction know to degrade tetrachloroethene (PCE), TCE, tetrachloroethane (TCA), carbon tetrachloride (CT), and chlorinated benzenes with more than four chlorines. During reductive dehalogenation, the halogenated hydrocarbon is used as an electron acceptor, not as a source of carbon, and a halogen atom is removed and replaced with a hydrogen atom. Figure 3.1 illustrates the transformation of chlorinated ethenes via reductive dehalogenation. In general, reductive dehalogenation occurs by sequential dechlorination. For the chlorinated ethenes, dechlorination progresses from PCE to TCE to DCE to VC to ethene.

During reductive dehalogenation of TCE, all three isomers of DCE theoretically can be produced; however, Bouwer (1994) reports that under the influence of biodegradation, *cis*-1,2-DCE is a more common intermediate than *trans*-1,2-DCE, and that 1,1-DCE is the least prevalent intermediate of the three DCE isomers. Reductive dehalogenation of chlorinated solvent compounds is associated with the accumulation of daughter products and an increase in chloride.

Reductive dehalogenation affects each of the chlorinated solvents differently. PCE, TCE, and CT are the most susceptible of these compounds to reductive dehalogenation because they are the most oxidized. Conversely, VC and chloromethane are the least susceptible to reductive dehalogenation because they are the least oxidized of these compounds. Reductive dehalogenation has been demonstrated under nitrate- and sulfate-reducing conditions, but the most rapid biodegradation rates, affecting the widest range of CAHs, occur under methanogenic conditions (Bouwer, 1994).

Because CAH compounds are used as electron acceptors, there must be an appropriate source of carbon for microbial growth in order for reductive dehalogenation to occur. Potential carbon sources include fuel hydrocarbons, low-molecular-weight compounds (e.g., lactate, acetate, methanol, or glucose) present in natural organic matter or plant materials, or less-chlorinated compounds such as VC, DCE, dichloroethane (DCA), or chloroethane. An evaluation of chlorinated ethene groundwater data suggests that the natural biodegradation of chlorinated ethenes at OU-1 is electron-donor limited. A mixture of locally derived, actively-composting shredded plant material (bark mulch) and coarse sand will be used to remediate the shallow solvent plume at OU-1 by overcoming the observed electron donor limitation.

The most common approach utilized to date to stimulate reductive dehalogenation has been addition of a carbon source dissolved in groundwater. This approach may prove effective in some applications, but in many cases may have difficulty competing with pump-and-treat remedial systems because the carbon source must be continuously injected. Other approaches involving the emplacement of semi-soluble and solid materials also are promising. For this project, a bark mulch mixture will be installed in a one-time event by continuous trenching technology. This will significantly reduce overall operation and maintenance costs, and provide sufficient carbon to drive reductive dechlorination for many years.

3.2 BIODEGRADATION AT OU-1

Compounds detected at the OU-1 site assumed to be parent compounds include TCE and low levels of PCE (less than 1 µg/L). Degradation daughter products detected in groundwater at the site that are not considered to have been released but are a product of biodegradation include *cis*-1,2-DCE, and a few detections of low levels of VC (less than 3 µg/L). The presence of *cis*-1,2-DCE suggests reductive dehalogenation of TCE under reducing conditions. However, the concentrations of *cis*-1,2-DCE generally are an order

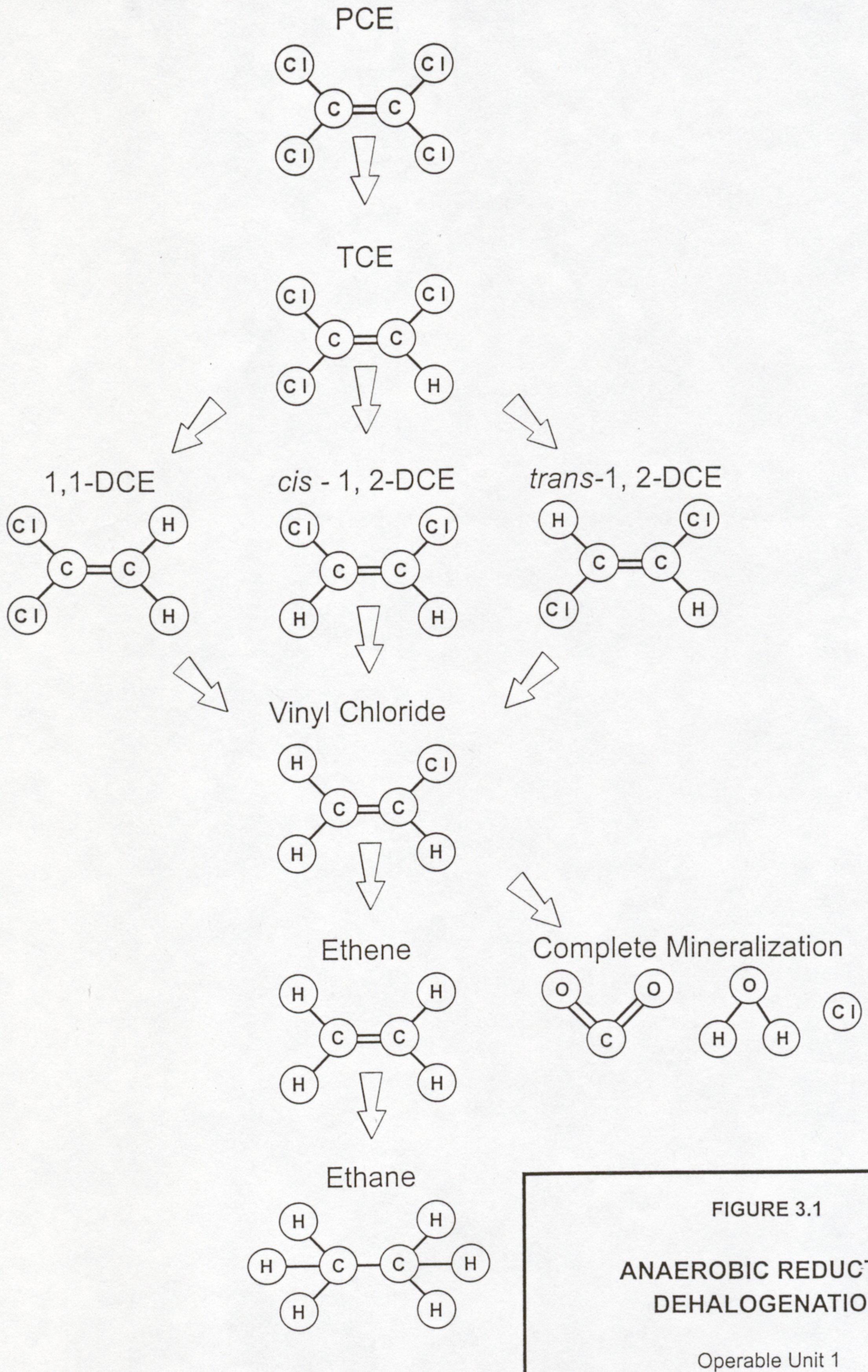

FIGURE 3.1

ANAEROBIC REDUCTIVE DEHALOGENATION

Operable Unit 1
Altus AFB, Oklahoma

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of magnitude less than TCE, and the extent of the *cis*-1,2-DCE plume is somewhat less than the extent of TCE. This suggests that the reducing conditions necessary for TCE degradation are likely limited to the landfill proper. The relative lack of VC indicates that further anaerobic degradation of DCE is not occurring at OU-1.

The limited occurrence of daughter products at OU-1 does suggests that under sufficiently reducing conditions, degradation of chlorinated solvents can occur. The presence of low levels of fuel hydrocarbons suggests that a source of organic substrate may have been present at one time in sufficient quantities to induce limited reductive dehalogenation of the chlorinated compounds. However, there currently is not sufficient organic substrate present to cause significant degradation of contaminant mass at the site.

SECTION 4

SYSTEM INSTALLATION AND ADDITIONAL DATA COLLECTION

4.1 FIELD ACTIVITIES

Field activities associated with this project include installation of system components (i.e., biowall, groundwater monitoring wells and soil vapor monitoring points), baseline sampling, and subsequent process monitoring. Specifically, these activities include the following:

- Installation of a 500-foot long, 1.5-foot wide, and 25-foot deep biowall using continuous trenching technology;
- Installation of 10 groundwater monitoring wells using HSA drilling technology;
- Installation of four soil vapor monitoring points using HSA drilling technology;
- Baseline sampling of the proposed groundwater monitoring wells and two preexisting groundwater monitoring wells, and sampling of the proposed soil vapor monitoring points immediately following installation of the biowall; and
- Process monitoring of proposed and preexisting groundwater monitoring wells, and proposed soil vapor monitoring points 6 and 12 months after installation of the biowall.

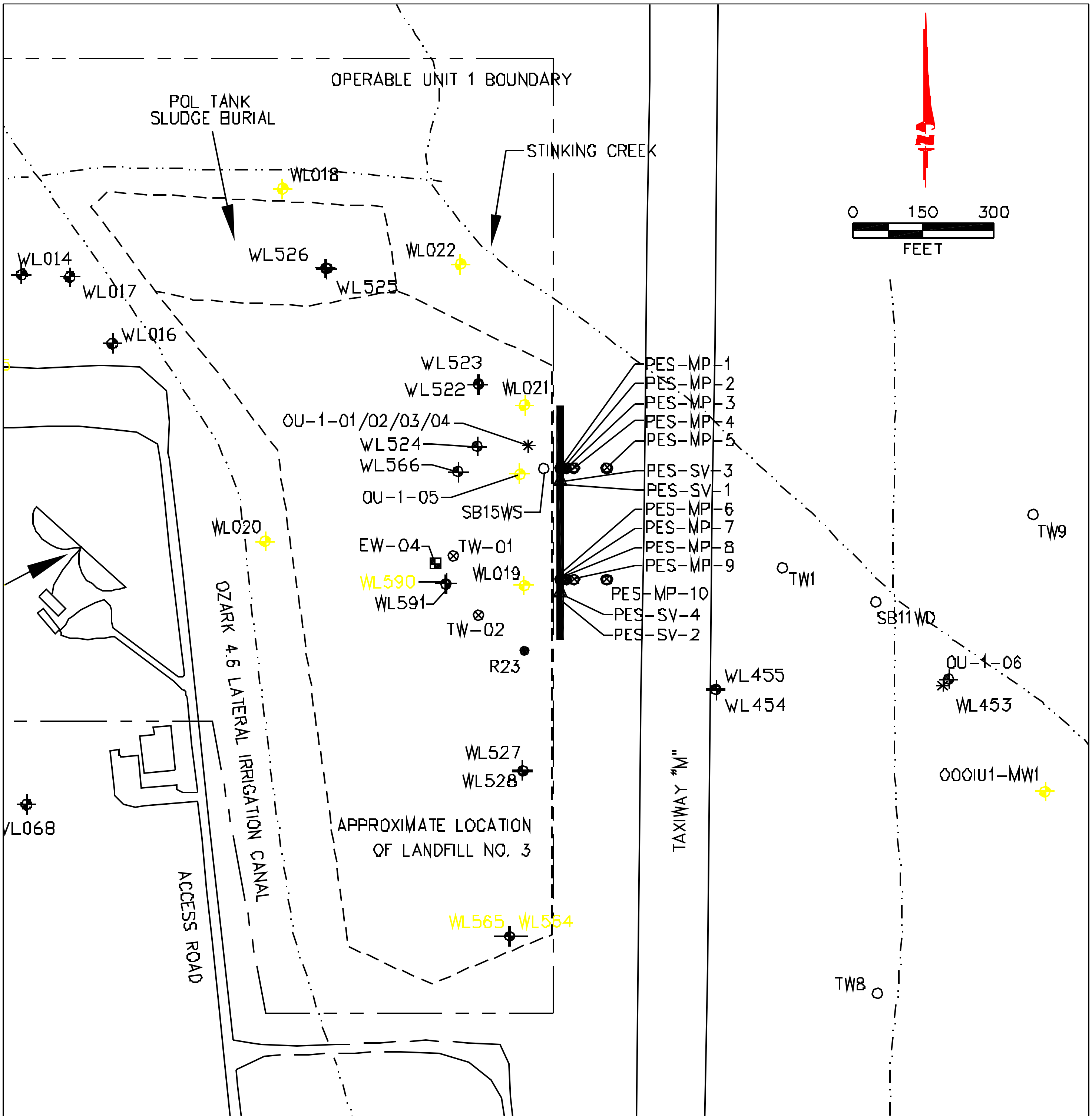
The layout for the aforementioned system components is illustrated on Figure 4.1. The layout for proposed groundwater monitoring wells and soil vapor monitoring points is more clearly illustrated on Figure 4.2. Baseline and process monitoring activities are summarized in Tables 4.1 and 4.2, respectively.

4.2 SITE MANAGEMENT

The following paragraphs outline site management issues pertaining to the field activities to be conducted under this project, including Base support.

4.2.1 Altus Air Force Base Support

Altus AFB will provide the following support during field activities:



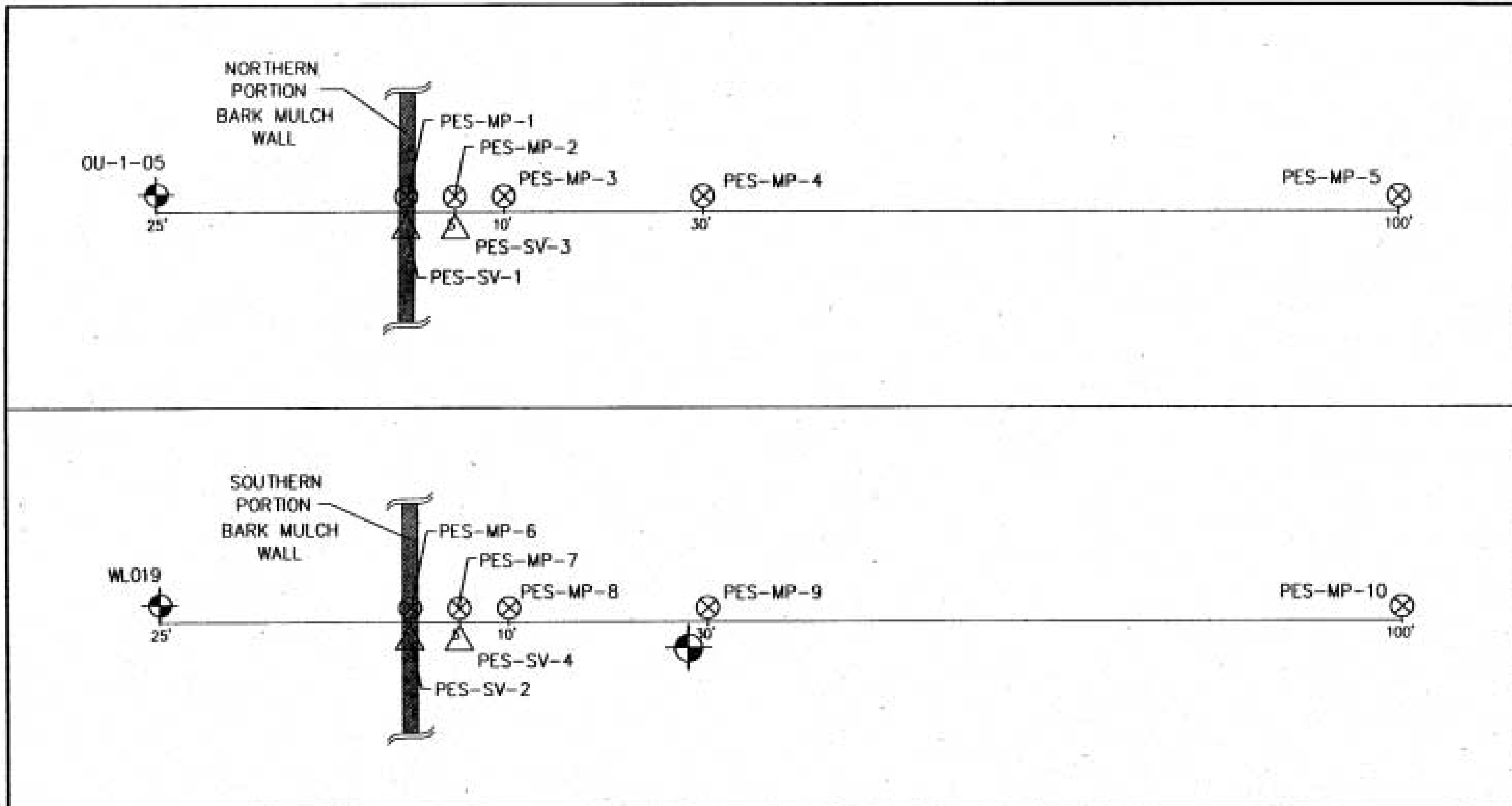
LEGEND

- △ PROPOSED SOIL VAPOR MONITORING POINTS
- ⊗ PROPOSED GROUNDWATER MONITORING WELLS
- ○ EXISTING MONITORING POINT LOCATION
- ⊕ EXISTING MONITORING WELL LOCATION
- ✳ EXISTING WELL CLUSTER
- — · · — SURFACE WATER
- ▬ PROPOSED PERMEABLE REACTIVE BIOWALL

FIGURE 4.1

LOCATION OF PROPOSED PERMEABLE REACTIVE BIOWALL AND ASSOCIATED MONITORING LOCATIONS

Operable Unit 1
Altus AFB, Oklahoma



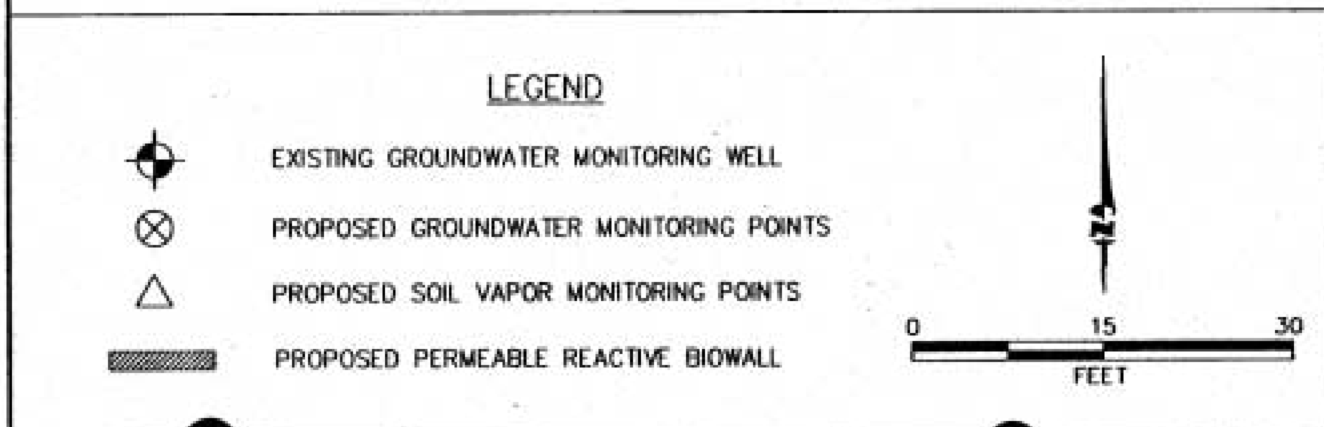


FIGURE 4.2

LOCATION OF PROPOSED GROUNDWATER MONITORING WELL AND SOIL VAPOR MONITORING POINTS WITH RESPECT TO PERMEABLE REACTIVE BIOWALL

Operable Unit 1
Altus AFB, Oklahoma

TABLE 4.1
SUMMARY OF BASELINE SAMPLING ACTIVITIES
OPERABLE UNIT 1
ALTUS AFB, OKLAHOMA

					Mulch Analyses	Soil Analyses	Soil Vapor Analyses	Groundwater Analyses										
Location	Monitoring Point Installation	System Location	Aquifer Test Analysis	Water Level Measurement	VOCs[a/] SW8260B	Total Organic Carbon SW9060mod	Oxygen, Carbon Dioxide, Methane[b/]	VOCs (SW8260B)	Methane, Ethane, Ethene	Dissolved Hydrogen AM20GAX	Nitrate + Nitrite (E300.1)	Sulfate (E300.1)	Chloride (E300.1)	Dissolved Organic Carbon (SW9060M)	Volatile Fatty Acids Microbial Insights	Phospholipid Fatty Acids Microbial Insights	Well Head Analyses[c/]	Mobile Lab Analyses[d/]
Proposed Soil Vapor Monitoring Points																		
PES-SV-1	X	Within Biowall					1											
PES-SV-2	X	Within Biowall					1											
PES-SV-3	X	Downgradient of Biowall					1											
PES-SV-4	X	Downgradient of Biowall					1											
Proposed Groundwater Monitoring Points																		
PES-MP-1	X	Within Biowall	X	X				1	1		1	1	1	1	1	1	1	1
PES-MP-2	X	Downgradient of Biowall	X	X		1		1	1		1	1	1	1			1	1
PES-MP-3	X	Downgradient of Biowall		X				1	1		1	1	1	1			1	1
PES-MP-4	X	Downgradient of Biowall		X		1		1	1		1	1	1	1			1	1
PES-MP-5	X	Downgradient of Biowall		X				1	1		1	1	1	1			1	1
PES-MP-6	X	Within Biowall	X	X				1	1		1	1	1	1	1	1	1	1
PES-MP-7	X	Downgradient of Biowall	X	X		1		1	1		1	1	1	1			1	1
PES-MP-8	X	Downgradient of Biowall		X				1	1		1	1	1	1			1	1
PES-MP-9	X	Downgradient of Biowall		X		1		1	1		1	1	1	1			1	1
PES-MP-10	X	Downgradient of Biowall		X				1	1		1	1	1	1			1	1
Existing Monitoring Wells or Points																		
OU-1-01		Upgradient of Biowall		X				1	1		1	1	1	1			1	1
WL019		Upgradient of Biowall		X				1	1		1	1	1	1			1	1
SUBTOTALS			4	12	2	4	4	12	12	0	12	12	12	12	2	2	12	12
QA/QC																		
Duplicates								1	1		1	1	1	1			1	1
MS								1										
MSD								1										
Trip Blanks								1										
				TASK TOTAL:	2	4	4	16	13	0	13	13	13	13	2	2	13	13

[a/] Volatile organic compounds (VOCs) to include aromatic and chlorinated aliphatic hydrocarbons.
[b/] Soil gas readings for oxygen, carbon dioxide, and methane will be measured with a calibrated field meter (Lantech GEM-500 or equivalent).
[c/] Well head analyses include dissolved oxygen, oxidation-reduction potential, pH, temperature, and conductivity.
[d/] Mobile lab analyses include carbon dioxide, alkalinity, ferrous iron, hydrogen sulfide, and manganese.

TABLE 4.2
SUMMARY OF PROCESS MONITORING ACTIVITIES[a/]
OPERABLE UNIT 1
ALTUS AFB, OKLAHOMA

Location	System Location	Aquifer Test Analysis	Water Level Measurement	Mulch Analyses: VOCs[b/] SW8260B	Soil Analyses: Total Organic Carbon SW9060mod	Soil Vapor Analyses: Oxygen, Carbon Dioxide, Methane[c/]	Groundwater Analyses: VOCs (SW8260B)	Methane, Ethane, Ethene	Dissolved Hydrogen AM20GAX	Nitrate + Nitrite (E300.1)	Sulfate (E300.1)	Chloride (E300.1)	Dissolved Organic Carbon (SW9060M)	Volatile Fatty Acids Microbial Insights	Phospholipid Fatty Acids Microbial Insights	Well Head Analyses[d/]	Mobile Lab Analyses[e/]
Proposed Soil Vapor Monitoring Points																	
PES-SV-1	Within Biowall					1											
PES-SV-2	Within Biowall					1											
PES-SV-3	Downgradient of Biowall					1											
PES-SV-4	Downgradient of Biowall					1											
Proposed Groundwater Monitoring Points																	
PES-MP-1	Within Biowall	X	X				1	1	1	1	1	1	1	1	1	1	1
PES-MP-2	Downgradient of Biowall	X	X		1		1	1	1	1	1	1	1			1	1
PES-MP-3	Downgradient of Biowall		X				1	1		1	1	1	1			1	1
PES-MP-4	Downgradient of Biowall		X		1		1	1		1	1	1	1			1	1
PES-MP-5	Downgradient of Biowall		X				1	1		1	1	1	1			1	1
PES-MP-6	Within Biowall	X	X				1	1	1	1	1	1	1	1	1	1	1
PES-MP-7	Downgradient of Biowall	X	X		1		1	1	1	1	1	1	1			1	1
PES-MP-8	Downgradient of Biowall		X				1	1		1	1	1	1			1	1
PES-MP-9	Downgradient of Biowall		X		1		1	1		1	1	1	1			1	1
PES-MP-10	Downgradient of Biowall		X				1	1		1	1	1	1			1	1
Existing Monitoring Points																	
OU-1-01	Upgradient of Biowall		X				1	1		1	1	1	1			1	1
WL019	Upgradient of Biowall		X				1	1		1	1	1	1			1	1
SUBTOTALS		4	12	2	4	4	12	12	4	12	12	12	12	2	2	12	12
QA/QC																	
Duplicates							1	1		1	1	1	1			1	1
MS							1										
MSD							1										
Trip Blanks							1										
			TASK TOTAL:	2	4	4	16	13	4	13	13	13	13	2	2	13	13

[a/] Includese monitoring activities to be performed at six and twelve months following construction of the biowall and surface amendment, for a total of two sampling events.

[b/] Volatile organic compounds (VOCs) to include aromatic and chlorinated aliphatic hydrocarbons.

[c/] Soil gas readings for oxygen, carbon dioxide, and methane will be measured with a calibrated field meter (Lantech GEM-500 or equivalent).

[d/] Well head analyses include dissolved oxygen, oxidation-reduction potential, pH, temperature, and conductivity.

[e/] Mobile lab analyses include carbon dioxide, alkalinity, ferrous iron, hydrogen sulfide, and manganese.

- **Provide Site Access to Field Team Members.** The Base point of contact (POC) will provide Parsons daily access to the site, and issue Parsons any and all required personnel badges and vehicle passes.

- **Provide Scheduling Information.** The Base POC will notify Parsons of any Base activities that may adversely affect field activities and/or impact the sampling schedule. In turn, Parson will provide the Base POC with advanced notification of planned field activities.

- **Underground Utility Clearances.** Before commencing field activities, the proposed biowall location, and proposed groundwater monitoring wells and soil vapor monitoring locations will be checked for underground utilities by Parsons and Base engineering personnel. The Base will provide all applicable utility drawings to Parsons. A copy of these drawings will be maintained at the site during installation of the biowall and advancement of groundwater and soil vapor monitoring points.

4.2.2 Contingency Plans

This subsection describes steps that will be taken by Parsons to minimize delays during the investigations. Potential problems that could be encountered during the field effort include:

- Access and coordination difficulties;

- Equipment breakdowns; and

- Abnormal site conditions (e.g., severe weather, unexpected airfield operations).

4.2.2.1 Access and Coordination Contingencies

Anticipated support needs are outlined in Section 4.2.1. In the event that site access difficulties arise, the Base POC will be contacted to resolve the problem. The Parsons site manager and field team leader will be responsible for notifying the Base POC of access or coordination difficulties.

4.2.2.2 Equipment Contingencies

Equipment to be employed on this project include conventional construction equipment for installation of the proposed biowall, HSA drilling equipment for the installation of proposed monitoring wells, and field sampling and testing instruments for baseline and process monitoring.

Operational equipment problems identified during installation of the biowall and/or monitoring wells are to be directed to the Parsons site manager who will arrange for either the prompt repair or replacement of the affected equipment. The Base POC will be informed of any action or delay that impacts the project schedule.

In the event of operation problems with field sampling or testing instruments, field personnel will contact the Parsons field team leader and refer to the instrument's instruction manual for troubleshooting procedures and guidance. Field personnel are also encouraged to contact the instruments manufacturer and/or supplier. If necessary, backup instruments will be obtained. However, any such decisions will be made by the Parsons site manager or field team leader after consideration of other potential solutions. Equipment will be maintained, and extra batteries and other standard replacement parts will be carried in order to avoid downtime due to minor problems.

4.2.2.3 Weather and Operational Contingencies

Severe weather and Base operations could potentially impact field activities. Should severe weather (e.g., lightning) threaten the project site, the Parsons site manager or field team leader will temporarily suspend all field activities. When site activities are suspended due to severe weather, field team members will be notified immediately. Upon notification they will secure all equipment and the work area as quickly as possible, evacuate the work area, and gather at a pre-determined location. Work will resume when the threat of severe weather has past.

Base operations (e.g., heightened state of alert, increased air traffic activity) potentially impacting field activities will be identified by the Base POC, who will subsequently notify the Parsons site manager or field team leader. Based on the recommendations of the Base POC, the Parsons site manager or field team leader may elect to temporarily suspend or limit field operations. If it is determined that field activities are to be suspended, the field team will secure all equipment and the work areas and depart the site. If it is determined that field activities will continue, but on a limited basis, equipment and work areas associated with suspended activities will be secured.

Additional guidance regarding other unidentified contingencies (e.g., spill responses, injuries, etc.) is provided in the Program Health and Safety Plan (Appendix A) and the project-specific addendum to the Program Health and Safety Plan (Appendix B).

4.2.3 Waste Handling

Investigation-derived waste (IDW) will include soil generated during installation of the proposed groundwater and soil monitoring points, purge water generated during development of proposed groundwater monitoring points, and equipment decontamination rinsate. Generated IDW will be managed in accordance with Base IDW management procedures.

4.3 SYSTEM INSTALLATION

System components to be installed under this project include a biowall, 10 groundwater monitoring wells, and 4 soil vapor monitoring points. The proposed locations for these features are illustrated on Figures 4.1 and 4.2.

4.3.1 Biowall Location

The biowall will be constructed across the path of groundwater flow on the downgradient edge (eastern boundary) of OU-1 (Figure 4.1). This location was identified during a site walk on 15 February 2002.

4.3.2 Biowall Installation

The biowall will consist of an approximately 500-foot long, 1.5-foot wide, and 25-foot deep linear trench filled to the ground surface with a mixture (based on volume) of approximately 60 percent mulch and 40 percent coarse sand. A continuous trenching machine will be employed to excavate the trench for the biowall and simultaneously place the mulch and sand mixture into the trench. The trencher is a track-mounted vehicle that has a cutting boom resembling a large chain saw (i.e., linked chain belt with cutting teeth). A steel box with a hopper assembly is fitted atop the cutting boom. The cutting boom excavates a trench by simultaneously rotating the cutting chain and advancing the boom until the desired depth of excavation relative to the ground surface has been achieved. The steel box and hopper assembly provide for stabilization of the trench sidewalls during excavation and subsequent placement of the sand and mulch mixture, which is introduced through the feed hopper. Simultaneous excavation and placement of backfill materials eliminates concerns associated with open excavations.

The mulch will be a mixture of approximately 25 percent cotton gin compost and 75 percent shredded plant material generated during seasonal landscaping operations (i.e., tree and brush removal) at the Base and throughout the surrounding community. The mulch will be stockpiled at the Base and allowed to compost for a minimum period of 30 days prior to installation of the biowall. Samples of mulch will be collected at the time of emplacement, and submitted to a fixed-base laboratory for volatile organic compound (VOC) analysis using US Environmental Protection Agency (USEPA) Method 8260B. The coarse sand will be common sand used in concrete and bedding applications.

Soil generated during excavation of the biowall will be graded atop the installed biowall. The location and extent of the biowall will be marked with metal fence posts painted a high visibility color.

Immediately following construction of the biowall, two groundwater monitoring wells and two soil vapor monitoring points will be installed within the footprint of the biowall (Figures 4.1 and 4.2). These points will be used to assess baseline conditions immediately following installation of the biowall, and monitor system performance at 6 and 12 months following installation of the biowall. Installation of these and other monitoring wells and points is described below.

4.3.3 Groundwater and Soil Monitoring Locations

The proposed locations for the 10 groundwater monitoring wells and 4 soil vapor monitoring points are illustrated on Figures 4.1 and 4.2. These locations were determined from a review of available site data as described in Section 2. Construction details for these proposed monitoring points are summarized in Table 4.3.

Groundwater monitoring wells will be installed within the footprint of the biowall, and at distances of 5, 10, 30, and 100 feet downgradient (to the east) of the biowall (Figures 4.1 and 4.2). These points will be used to monitor groundwater geochemical indicators and contaminant concentrations within and immediately downgradient of the biowall over a period of 12 months. Two existing upgradient groundwater monitoring wells (OU-1-01 and WL019) also will be monitored.

TABLE 4.3
PROPOSED GROUNDWATER MONITORING WELL
AND SOIL VAPOR MONITORING POINT CONSTRUCTION SUMMARY
OPERABLE UNIT 1
ALTUS AFB, OKLAHOMA

Identification	Well Diameter (inches)	Total Depth (feet bgs)[a/]	Screened Interval (feet bgs)	Depth to Top of Screen (feet bgs)	Feet of Riser (feet)	Feet of Screen (feet)
Soil Vapor Monitoring Points						
PES-SV-1	0.5	7.5	5-7.5	5	5	2.5
PES-SV-2	0.5	7.5	5-7.5	5	5	2.5
PES-SV-3	0.5	7.5	5-7.5	5	5	2.5
PES-SV-4	0.5	7.5	5-7.5	5	5	2.5
Groundwater Monitoring Wells						
PES-MP-1	2.0	24	14-24	14	14	10
PES-MP-2	2.0	24	14-24	14	14	10
PES-MP-3	2.0	24	14-24	14	14	10
PES-MP-4	2.0	24	14-24	14	14	10
PES-MP-5	2.0	24	14-24	14	14	10
PES-MP-6	2.0	24	14-24	14	14	10
PES-MP-7	2.0	24	14-24	14	14	10
PES-MP-8	2.0	24	14-24	14	14	10
PES-MP-9	2.0	24	14-24	14	14	10
PES-MP-10	2.0	24	14-24	14	14	10

[a/] feet bgs indicates depth in feet below ground surface.

Soil vapor monitoring points will be installed within the footprint of the biowall, and at a distance of 5 feet downgradient of the biowall (Figures 4.1 and 4.2). These points will be used to monitor the biochemical processes within and immediately downgradient of the biowall over a period of 12 months.

4.3.4 Drilling and Soil Sampling Procedures

Drilling for installation of the groundwater monitoring wells will be accomplished using HSA drilling technology. Boreholes will be advanced to achieve the depths identified in Table 4.3. A Parsons field scientist will be responsible for collecting soil samples, maintaining a detailed descriptive log of all subsurface materials recovered during drilling, and properly labeling and storing samples. During borehole advancement, soil samples for visual description will be collected at a frequency sufficient to identify the depths of significant stratigraphic contacts or other soil properties.

Soil samples will be collected using split-spoon samplers from each borehole at approximately 5-foot intervals. A portion of each sample will be used to measure the total ionizable VOC concentration in soil headspace using a photoionization detector (PID). At four borehole locations (Table 4.1), one soil sample collected from the screened interval (i.e., below the groundwater table) and will be submitted to a fixed-base laboratory for total organic carbon (TOC) analysis using USEPA Method SW9060-modified.

Drilling for installation of soil vapor monitoring points will also be accomplished using HSA drilling technology. Boreholes will be advanced to achieve the depths identified in Table 4.3. Given their shallow total depth (approximately 7.5 feet bgs) and close proximity to those boreholes advanced for the groundwater monitoring points, soil samples will not be collected from the boreholes advanced for the soil vapor monitoring points.

4.3.5 Groundwater Monitoring Well and Soil Vapor Monitoring Point Installation

This section describes the procedures to be used for installation of the 10 groundwater monitoring wells and 4 soil vapor monitoring points.

4.3.5.1 Pre-Installation Activities

All necessary permits will be obtained prior to mobilizing to the field. In addition, all underground utility lines will be located, and proposed drilling locations will be cleared prior to any intrusive activities. Responsibilities for these permits and clearances are discussed in Section 4.2.

Water to be used in well installation and equipment cleaning will be obtained from an onsite water supply. Water use approval will be verified by contacting the appropriate facility personnel. The field scientist will make the final determination as to the suitability of site water for these activities.

4.3.5.2 Materials Decontamination

All completion materials will be inspected by the field scientist and determined to be clean and acceptable prior to use. If not factory sealed, riser, screen, end caps, and surface plugs will be cleaned prior to use with a high-pressure, steam/hot-water cleaner using approved water. Materials that cannot be cleaned to the satisfaction of the field scientist will not be used.

4.3.5.3 Screen and Casing

Groundwater monitoring wells and soil vapor monitoring points will be installed using HSA drilling technology. Groundwater monitoring wells will be constructed of 2-inch nominal diameter, flush-threaded, Schedule 40 polyvinyl chloride (PVC) screen and riser. The screens will be factory slotted with 0.010-inch openings. Total depths, and screen and riser lengths for each of the groundwater monitoring points are summarized in Table 4.3. The casing string will be fitted with a PVC bottom cap and a locking end cap.

Soil vapor monitoring points will be constructed of 0.5-inch nominal diameter, flush-threaded, Schedule 40 PVC screen and riser. The screens will be factory slotted with 0.010-inch openings. Total depths, and screen and riser lengths for each of the soil vapor monitoring points are summarized in Table 4.3. The casing string will be fitted with a PVC bottom cap and a sampling valve.

The field scientist will verify and record the total depth of each monitoring well/point, the lengths of all casing sections, and the depth to the top of all completion materials. All lengths and depths will be measured to the nearest 0.1 foot.

4.3.5.4 Groundwater and Soil Vapor Monitoring Point Completion

Groundwater monitoring wells and soil vapor monitoring points will be completed in similar manners. A graded sand filter pack will be installed around the lower screened interval and will extend at least 2 feet above the top of the screen. The sand filter will consist of 20-40 silica sand. A filter pack seal will be installed above the filter pack using sodium bentonite pellets. The pellet seal will be a minimum of 2 feet thick and will be hydrated in place with potable water. The pellet seal will be overlain by a bentonite/cement grout that will extend to within approximately 2 feet bgs. The grout will be overlain by concrete that will extend to the ground surface. Each groundwater and soil vapor monitoring point will be completed slightly below-grade, with an a slightly above-grade flush-mounted protective casing.

4.3.5.5 Groundwater Monitoring Well Development

All installed groundwater monitoring wells will require development prior to sampling. Development removes sediment from inside the well casing and flushes fines from the portion of the formation adjacent to the screen. Development will be accomplished using a bailer or a submersible pump.

Development will be continued until a minimum 10 casing volumes of water have been removed from the well and until pH, temperature, specific conductance, DO, and water clarity (turbidity) stabilize. If the water remains turbid, development will continue until the turbidity of the water produced has been stable after the removal of several additional casing volumes. Development water will be managed in accordance with Base IDW management procedures.

A development record will be maintained for each injection and monitoring well. The development record will be completed in the field by the field scientist. Development records will include:

- Injection or groundwater monitoring well number;
- Date and time of development;
- Development method;
- Predevelopment water level and well depth;
- Volume of water produced;
- Description of water produced;
- Post development water level and well depth; and
- Field analytical measurements, including pH and specific conductance.

4.3.5.6 Equipment Decontamination Procedures

Prior to arriving at the site, and between each monitoring point, drill bits, drill pipe, drill casing, instrumented probes, samplers, tools, and other downhole equipment will be decontaminated using a high-pressure, steam/hot water wash. Only potable water will be used for decontamination. All rinsate will be managed in accordance with Base IDW procedures.

Potable water to be used in equipment cleaning, decontamination, or grouting will be obtained from a Base water supply. Use of the Base water supply will be verified by contacting the appropriate facility personnel. The field scientist will make the final determination as to the suitability of site water for these activities. Precautions will be taken to minimize any impact to the surrounding area that might result from decontamination operations.

4.3.5.7 Datum Survey

The locations and elevations of the newly installed monitoring wells will be surveyed by a registered surveyor. Horizontal locations will be measured relative to Universal Transverse Mercator coordinate system to the nearest 0.1 foot. The elevation of the ground surface adjacent to each monitoring well and measurement datum (top of the casing) will be measured relative to an existing benchmark location. Vertical elevations will be measured with respect to the National Vertical Datum of 1998 to the nearest 0.01 foot.

4.4 MEASUREMENT OF BASELINE GEOCHEMICAL CONDITIONS AND CONTAMINANT PROFILES

After installation of the biowall and groundwater and soil vapor monitoring points, Parsons will perform baseline monitoring to characterize initial site-specific geochemical and contaminant conditions in accordance with the *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater* (USEPA, 1998). Parsons will evaluate geochemical, metabolic byproduct, and contaminant breakdown product data to evaluate the potential for existing reductive dehalogenation, future enhanced reductive dehalogenation, and any expected changes in the above profile as a result of substrate addition (i.e., the mulch contained in the biowall).

Baseline monitoring activities are summarized in Table 4.1 and include soil vapor sampling at the 4 proposed soil vapor monitoring points immediately following installation of the biowall, and groundwater sampling at the 10 proposed and 2 existing groundwater monitoring wells immediately following installation of the biowall.

Soil vapor samples will be analyzed for oxygen, carbon dioxide, and methane. Groundwater samples will be analyzed for oxidation-reduction potential (ORP), DO, pH, specific conductance, temperature, ferrous iron, manganese, hydrogen sulfide, sulfate, alkalinity, carbon dioxide, nitrate + nitrite (as nitrogen [N]), chloride, methane, ethane, ethene, dissolved organic carbon, VOCs, dissolved hydrogen, volatile fatty acids (VFAs), and phospholipid fatty acids (PLFAs) (Tables 4.1 and 4.4).

4.4.1 Soil Vapor Sampling

Soil vapor sampling will be conducted by qualified scientists and technicians from Parsons who are trained in the performance of soil vapor sampling, records documentation, and chain-of-custody procedures. In addition, sampling personnel will have thoroughly reviewed this work plan prior to sample collection and will have a copy of the work plan available onsite for reference. Soil vapor samples will be collected from the four proposed soil vapor monitoring locations. Soil vapor samples will be collected for onsite measurement and laboratory analyses (Tables 4.1 and 4.4). Onsite measurements will be made in the field using a direct reading meter. The meter will be calibrated according to the manufactures' specifications prior to field use.

In general, purging and sampling will follow the procedures outlined in *Test Plan and Technical Protocol for a Field Treatability Test for Bioventing* (Hinchee et. al., 1992). Soil vapor samples for onsite measurement will be collected in Tedlar® bags using an electrical vacuum pump and Tygon® or Teflon® tubing.

4.4.2 Groundwater Sampling

Groundwater sampling will be conducted by qualified scientists and technicians from Parsons who are trained in the performance of groundwater sampling, records documentation, and chain-of-custody procedures. In addition, sampling personnel will have thoroughly reviewed this work plan prior to sample collection and will have a copy of the work plan available onsite for reference. Groundwater samples will be collected from 10 proposed and 2 previously installed groundwater monitoring wells (Table 4.1).

TABLE 4.4
ANALYTICAL PROTOCOLS FOR
GROUNDWATER, MULCH/SOIL, AND SOIL VAPOR SAMPLES
OPERABLE UNIT 1
ALTUS AFB, OKLAHOMA

MATRIX Analyte	**METHOD**	**FIELD (F) OR ANALYTICAL LABORATORY (L)**
WATER		
Redox Potential	Direct-reading meter	F
Dissolved Oxygen	Direct-reading meter	F
pH	Direct-reading meter	F
Specific Conductance	Direct-reading meter	F
Temperature	Direct-reading meter	F
Ferrous Iron	Colorimetric, Hach Method 8146 (or similar)	F
Manganese	Colorimetric, Hach Method 8034 (or similar)	F
Alkalinity (Carbonate [CO_3^{-2}]	Titrimetric, Hach Method 8221 (or similar)	F
Hydrogen Sulfide	Colorimetric, Hach Method 8131 or HS-C	F
Carbon Dioxide	Titrimetric, CHEMetrics Method 4500 (or similar)	F
Nitrate + Nitrite [as Nitrogen (N)]	E300.1	L
Sulfate	E300.1	L
Chloride	E300.1	L
Methane, Ethane, Ethene	AM-20GAX[a/]	L
Dissolved Hydrogen	AM-20GAX	L
Dissolved Organic Carbon	SW9060	L
VOCs[b/]	SW8260B	L
Volatile Fatty Acids	Microbial Insights SOP	L
Phospholipid Fatty Acids	Microbial Insights SOP	L
MULCH		
VOCs	SW8260B	L
SOIL		
Total Organic Carbon	SW9060 modified	L
SOIL VAPOR		
Oxygen, Carbon Dioxide, Methane	Direct-reading meter	F

[a/] AM-20GAX = Microseeps, Inc. laboratory standard operating procedure.

[b/] VOCs = volatile organic compounds.

In order to maintain a high degree of quality control (QC) during this sampling event, the procedures described in the following sections will be followed.

4.4.3 Preparation for Sampling

All equipment to be used for sampling will be assembled and properly cleaned and calibrated (if required) prior to arriving in the field. In addition, all record-keeping materials will be gathered prior to mobilizing to the field.

4.4.3.1 Equipment Cleaning

All portions of sampling and test equipment that will contact the sample matrix will be thoroughly cleaned before each use. This includes the water-level probe and cable, test equipment for onsite use, and other equipment or portions thereof that will contact the samples. Based on the types of sample analyses to be conducted, the following cleaning protocol will be used:

- Wash with potable water and phosphate-free laboratory detergent (Alconox®);
- Rinse with potable water;
- Rinse with isopropyl alcohol;
- Rinse with distilled or deionized water; and
- Air dry the equipment prior to use (to the extent practical).

Any deviations from these procedures will be documented in the field scientist's field notebook and on the groundwater sampling record.

Laboratory-supplied sample containers will be cleaned and sealed by the laboratory. The type of container provided and the method of container decontamination will be documented in the laboratory’s permanent record of the sampling event.

4.4.3.2 Equipment Calibration

As required, field analytical equipment will be calibrated according to the manufacturers’ specifications prior to field use. This applies to equipment used for onsite measurements of DO, pH, specific conductance, ORP, other field parameters listed in Table 4.4.

4.4.4 Groundwater Sampling Procedures

Special care will be taken to prevent contamination of the groundwater and extracted samples. The primary way in which sample contamination can occur is through cross-contamination due to insufficient cleaning of equipment between wells. To prevent such contamination, the water-level probe and cable used to determine static water levels and total well depths will be thoroughly cleaned before and after field use and between uses at different sampling locations according to the procedures presented in Section 4.4.2.1. A peristaltic pump or disposable bailers will be used for purging and sampling each groundwater sampling location.

A clean pair of new, disposable nitrile or latex gloves will be worn each time a different monitoring location is sampled. The following paragraphs present the procedures to be followed for groundwater sample collection. These activities will be performed in the order presented below. Exceptions to this procedure will be noted in the sampler's field notebook and on the groundwater sampling form.

4.4.4.1 Preparation of Location

Prior to starting the sampling procedure, the area around the existing and new groundwater monitoring points will be cleared of foreign materials, such as brush, rocks, and debris. These procedures will prevent sampling equipment from inadvertently contacting debris around the monitoring location. In addition, the sampling location will be inspected for the integrity of the protective cover, lock, external surface seal, concrete pad, cap, datum reference, and internal surface seal.

4.4.4.2 Water Level and Total Depth Measurements

Prior to removing any water from the sampling well, the static water level will be measured. An electric water-level probe will be used to measure the depth to groundwater below the datum to the nearest 0.01 foot. After measuring the static water level, the water-level probe will be slowly lowered to the bottom of the well if the well depth is not known, and the depth will be measured to the nearest 0.01 foot. Based on these measurements, the volume of water to be purged from the monitoring well will be calculated. Otherwise, previously recorded well depths will be used to calculate purge volumes.

4.4.4.3 Purging Before Sampling

The volume of water contained within the monitoring well casing at the time of sampling will be calculated, and a minimum of three times the calculated volume will be removed from the monitoring well. Purge waters will be handled in accordance with the procedures outlined in Section 4.2.3.

4.4.4.4 Sample Extraction

A peristaltic pump or disposable bailer will be used to extract groundwater for the sample. The extracted groundwater will be transferred directly into the appropriate sample containers. The water will be carefully poured down the inner walls of the sample container to minimize aeration of the sample.

Unless other instructions are given by the analytical laboratory, sample containers will be completely filled so that no air space remains in the container. Excess water collected during sampling will be handled according to the procedures outlined in Section 4.2.3.

If a groundwater monitoring well is evacuated to a dry state during purging, the monitoring well will be allowed to recharge, and the sample will be collected as soon as sufficient water is present to obtain the necessary sample quantity. Sample compositing or sampling over a lengthy period by accumulating small volumes of water at different times to obtain a sample of sufficient volume will not be permitted.

4.4.5 Onsite Groundwater and Soil Vapor Parameter Measurement

As indicated in Table 4.4, many of the groundwater and soil vapor chemical parameters will be measured onsite by Parsons personnel. Some of the measurements will be made with direct-reading meters, while others will be made using a Hach® or CHEMetrics® portable colorimeter or titration kit in accordance with manufacturer-specified procedures. These procedures are described in the following subsections.

Samples will be collected after stable conditions have been obtained. Stability will be determined between successive purge volumes equal to one calculated saturated casing volume. Stability is obtained when the temperature, specific conductance, and pH fall within the following acceptable ranges: ±0.2 degrees Celsius (°C), ±100 microsiemens per centimeter, and ±0.2 pH units, respectively.

All glassware or plasticware used in the analyses will have been cleaned prior to sample collection by thoroughly washing with a solution of Alconox® and water, and rinsing with distilled water and isopropyl alcohol to prevent interference or cross contamination between measurements. If concentrations of an analyte are greater than the range detectable by the titrimetric method, the analysis will be repeated by diluting the groundwater sample with distilled water until the analyte concentration falls to a level within the range of the method. All rinsate and sample reagents accumulated during groundwater analysis will be collected in glass containers fitted with screw caps. These waste containers will be clearly labeled as to their contents and carefully stored for later transfer to the approved disposal facility.

4.4.5.1 Dissolved Oxygen Measurements

DO measurements will be made using a meter with a sensor in a flow-through cell or a downhole oxygen sensor. Multiple measurements will be taken before groundwater sample acquisition during well purging, with the final measurement made immediately prior to completion of the well purge. When DO measurements are taken in monitoring wells that have not yet been sampled, the existing monitoring wells will be purged until DO levels stabilize. DO measurements will be recorded on the groundwater sampling record.

4.4.5.2 pH, Temperature, and Specific Conductance

Because the pH, temperature, and specific conductance of a groundwater sample can change significantly within a short time following sample acquisition, these parameters will be measured in the field in a flow-through cell during the purging process as described for DO in Section 4.4.5.1. The measured values will be recorded in the groundwater sampling record.

4.4.5.3 Carbon Dioxide Measurements

Carbon dioxide is a byproduct of biological reactions and can be used to evaluate the bioactivity of the groundwater system. Carbon dioxide concentrations in groundwater will be measured in the field by experienced Parsons scientists via titrimetric analysis using CHEMetrics® Method 4500 (0 to 250 milligrams per liter [mg/L]), or equivalent.

4.4.5.4 Alkalinity Measurements

Alkalinity in groundwater helps buffer the groundwater system against acids generated through both aerobic and anaerobic biodegradation processes. Alkalinity of the groundwater sample will be measured in the field by experienced Parsons scientists via titrimetric analysis using USEPA-approved Hach® Method 8221 (0 to 5,000 mg/L as calcium carbonate), or equivalent.

4.4.5.5 Sulfate and Hydrogen Sulfide Measurements

Sulfate in groundwater is a potential electron acceptor for fuel-hydrocarbon biodegradation in anaerobic environments, and sulfide is produced during sulfate reduction. Sulfate will be measured in the laboratory (Table 4.4), or Parsons scientists may measure sulfate and hydrogen sulfide concentrations via colorimetric analysis with a Hach® DR/700 Portable Colorimeter after appropriate sample preparation. USEPA-approved Hach® Methods 8051 (0 to 70.0 mg/L sulfate) and 8131 (0.60 mg/L hydrogen sulfide) or equivalent will be used to prepare samples and analyze sulfate and hydrogen sulfide concentrations, respectively.

4.4.5.6 Ferrous Iron Measurements

Iron is an important trace nutrient for bacterial growth, and different states of iron can affect the ORP of the groundwater and act as an electron acceptor for biological metabolism under anaerobic conditions. Ferrous iron concentrations will be measured in the field via colorimetric analysis with a Hach® DR/700 Portable Colorimeter after appropriate sample preparation. Hach® Method 8146, or equivalent, for ferrous iron (0 to 3.0 mg/L) will be used to prepare and quantitate the samples.

4.4.5.7 Manganese Measurements

Manganese is a potential electron acceptor in anaerobic environments. Manganese concentrations will be quantitated in the field using colorimetric analysis with a Hach® DR/700 Portable Colorimeter. USEPA-approved Hach® Method 8034 (0 to 20.0 mg/L), or equivalent, will be used to prepare the samples for quantitation of manganese concentrations.

4.4.5.8 Oxidation/Reduction Potential

The ORP of groundwater is an indicator of the relative tendency of a solution to accept or transfer electrons. Reduction/oxidation (redox) reactions in groundwater are usually biologically mediated; therefore, the ORP of a groundwater system depends upon and influences rates of biodegradation. ORPs can be used to provide real-time data on the location of the contaminant plume, especially in areas undergoing anaerobic biodegradation. The ORP of a groundwater sample taken inside the contaminant plume should be somewhat lower than that of a sample taken in an upgradient location.

The ORP of a groundwater sample can change significantly within a short time following sample acquisition and exposure to atmospheric oxygen. Therefore, this parameter will be measured in a flow-through cell as described for DO in Section 4.4.5.1.

4.4.6 Handling of Samples for Laboratory Analysis

This section describes the handling of samples from the time of sampling until the samples are delivered to the laboratory.

4.4.6.1 Sample Preservation

The laboratory will add any necessary chemical preservatives prior to shipping the sample containers to the field. Samples will be prepared for transportation to the analytical laboratory by placing the samples in a cooler containing ice to maintain a shipping temperature of 4 °C or lower.

4.4.6.2 Sample Container and Labels

Sample containers and appropriate container lids will be provided by the fixed base laboratory. The sample containers will be filled as described in Section 4.4.4.4, and the container lids will be tightly closed. The sample label will be firmly attached to the container side, and the following information will be legibly and indelibly written on the label:

- Facility name;
- Sample station identification;
- Sample type (e.g., groundwater, soil, surface water, sediment);
- Sampling date;
- Sampling time;
- Preservatives added;
- Sample collector's initials; and
- Analyses requested.

4.4.6.3 Sample Shipment

After the samples are sealed and labeled, they will be packaged for transport to the laboratory. The packaged samples will be delivered to the laboratory as soon as possible (within holding limits) after sample collection.

The following packaging and labeling procedures will be followed:

- Package sample so that it will not leak, spill, or vaporize from its container;
- Cushion samples to avoid breakage; and
- Add ice to container to keep samples cool.

4.4.6.4 Chain-of-Custody Control

Chain-of-custody documentation for the shipment of samples from the field to the laboratory will be completed.

4.4.6.5 Sampling Records

In order to provide complete documentation of the sampling event, detailed records will be maintained by the field scientist. At a minimum, these records will include the following information:

- Sample location (facility name);
- Sample station identification;
- Date and time of sampling;
- Sampling method;
- Field observations of sample appearance and odor;
- Weather conditions;
- Water level prior to purging (groundwater samples only);
- Monitoring well depth (groundwater samples only);
- Purge volume (groundwater samples only);
- Monitoring well/point condition (soil vapor and groundwater samples);
- Sampler's identification;
- Field measurements; and
- Any other relevant information.

Groundwater sampling information will be recorded on a groundwater sampling form.

4.4.6.6 Laboratory Analyses

Laboratory analyses will be performed on collected soil, soil vapor, and groundwater samples as well as the QA/QC samples described in Section 5. The analytical methods for these sampling events are listed in Table 4.4. Prior to sampling, the laboratory will provide a sufficient number of analyte-appropriate sample containers for the samples to be collected. All containers, preservatives, and shipping requirements will be consistent with USEPA or other appropriate protocol.

Laboratory personnel will specify the necessary QC samples and prepare appropriate QC sample containers. For samples requiring chemical preservation, preservatives will be added to containers by the laboratory. Containers and ice chests with adequate padding will be provided by laboratory personnel. Sampling personnel will fill the sample containers and return the samples to the field laboratory.

4.5 PROCESS MONITORING

In order to monitor system performance over time, Parsons will sample the 10 proposed groundwater monitoring wells, the 4 proposed soil vapor monitoring points, and 2 existing groundwater monitoring wells at 6 and 12 months after installation of the biowall. Process monitoring activities are summarized in Table 4.2. The procedures listed in Section 4.4 will be used for these monitoring events.

4.6 AQUIFER TESTING

To evaluate the impact of the bioremediation processes on the hydraulic conductivity of the biowall and aquifer, slug tests will be conducted at four of the proposed groundwater monitoring locations. A slug test is a single-well hydraulic test used to determine the hydraulic conductivity of an aquifer in the immediate vicinity of screened interval of the tested well. Slug tests can be used for both confined and unconfined aquifers that have a transmissivity of less than 7,000 square feet per day. Slug testing can be performed using either a rising head or a falling head test; at this site, both methods will be used in sequence.

Slug tests will be conducted immediately following installation of the biowall to establish baseline conditions, and 6 and 12 months after installation. The monitoring locations to be tested are identified in Tables 4.1 and 4.2.

4.6.1 Definitions

- **Hydraulic Conductivity (K)**. A quantitative measure of the ability of porous material to transmit water; defined as the volume of water that will flow through a unit cross-sectional area of porous or fractured material per unit time under a unit hydraulic gradient.

- **Transmissivity (T)**. A quantitative measure of the ability of an aquifer to transmit water. It is the product of the hydraulic conductivity and the saturated thickness of the water-bearing zone.

- **Slug Test**. Two types of tests are possible: rising head and falling head. A slug test consists of adding a slug of water or a solid cylinder of known volume to the well to be tested or removing a known volume of water or cylinder and measuring the rate of recovery of water level inside the well. The slug of a known volume acts to raise or lower the water level in the well.

- **Rising Head Test**. A test used in an individual well within the saturated zone to estimate the hydraulic conductivity of the surrounding formation adjacent to the screened interval by lowering the water level in the well and measuring the rate of recovery of the water level. The water level may be lowered by pumping, bailing, or removing a submerged slug from the well.

- **Falling Head Test**. A test used in an individual well to estimate the hydraulic conductivity of the surrounding formation adjacent to the screened interval by raising the water level in the well by insertion of a slug or quantity of water, and then measuring the rate of drop in the water level.

4.6.2 Equipment

The following equipment will be used to conduct a slug test:

- Teflon®, PVC, or metal slugs;
- Nylon or polypropylene rope;
- Electric water-level indicator;
- Pressure transducer/sensor;
- Field logbook/forms; and
- Automatic data recording instrument (such as the Hermit Environmental Data Logger®, In-Situ, Inc. Model SE3000, or equivalent).

4.6.3 General Test Methods

Aquifer hydraulic conductivity tests (slug tests) are accomplished by either removal of a slug or quantity of water (rising head) or introduction of a slug (falling head), and then allowing the water level to stabilize while taking water-level measurements at closely spaced time intervals.

Because hydraulic testing will be completed on existing wells, it will be assumed that the wells were properly developed and that water levels have stabilized. Slug testing will proceed only after multiple water-level measurements over time show that static water levels are in equilibrium. During the slug test, the water level change should be influenced only by the introduction (or removal) of the slug volume. Other factors, such as inadequate well development or extended pumping, may lead to inaccurate results; in addition, slug tests will not be performed on wells with free product. The Parsons field scientist will determine when static equilibrium has been reached in the well. The pressure transducer, slugs, and any other downhole equipment will be decontaminated prior to and immediately after the performance of each slug test using the procedures described in Section 4.4.3.1.

4.6.4 Falling Head Test

The falling head test is the first step in the two-step slug testing procedure. The following steps describe procedures to be followed during performance of the falling head test.

1. Decontaminate all downhole equipment prior to initiating the test.

2. Open the well. Where wells are equipped with water-tight caps, the well should be unsealed at least 24 hours prior to testing to allow the water level to stabilize. The protective casing will remain locked during this time to prevent vandalism.

3. Prepare the aquifer slug test data form with entries for:

   - Borehole/well number,
   - Project number,
   - Project name,
   - Aquifer testing team,
   - Climatic data,
   - Top of well casing elevation,
   - Identification of measuring equipment being used,
   - Static water level, and
   - Date.

4. Measure the static water level in the well to the nearest 0.01 foot.

   - Lower the decontaminated pressure transducer into the well and allow the displaced water to return to its static level. This can be determined by periodic water-level measurements until the static water level in the well is within 0.01 foot of the original static water level.
   - Lower the decontaminated slug into the well to just above the water level in the well.
   - Turn on the data logger and quickly lower the slug below the water table, being careful not to disturb the pressure transducer. Follow the owner's manual for proper operation of the data logger.
   - Terminate data recording when the water level stabilizes in the well. The well will be considered stabilized for termination purposes when it has recovered 80 to 90 percent from the initial displacement.

4.6.5 Rising Head Test

After completion of the falling head test, the rising head test will be performed. The following steps describe the rising head slug test procedure:

1. Measure the water level in the well to the nearest 0.01 foot to ensure that it has returned to the static water level.

2. Initiate data recording and quickly withdraw the slug from the well. Follow the owner's manual for proper operation of the data logger.

3. Terminate data recording when the water level stabilizes in the well, and remove the pressure transducer from the well and decontaminate. The well will be considered stabilized for termination purposes when it has recovered 80 to 90 percent from the initial displacement.

4.6.6 Slug Test Data Analysis

Data obtained during slug testing will be analyzed using the computer code AQTESOLV™ (Geraghty & Miller, 1994) or similar, and the method of Cooper *et al*. (1967) for confined aquifers or the method of Bouwer and Rice (1976) and Bouwer (1989) for unconfined conditions.

4.7 SCHEDULE

Parsons will stage sufficient mulch and sand for the biowall at LF-03 prior to mobilization of the trenching subcontractor. Trenching operations are tentatively scheduled to begin June 17th, 2002. Installation of the biowall is anticipated to take 10 days, including re-grading and leveling the site. Once the biowall is constructed, the drilling contractor will mobilize to the site and install the monitoring network. Baseline sampling will then be performed. All installation and baseline sampling activities will be performed continuously, and will be completed within 30 days of mobilizing the trenching subcontractor. Process monitoring will be conducted at 6 and 12 months following installation of the biowall (approximately December 2002 June 2003). A draft results report will be submitted within 60 days of the final process monitoring event. The final results report will be issued within 45 days of receiving all comments on the draft report.

SECTION 5

QUALITY ASSURANCE/QUALITY CONTROL

Field QA/QC procedures will include collection of field duplicates and rinsate, field, and trip blanks; decontamination of all equipment that contacts the sample medium before and after each use; use of analyte-appropriate containers; and chain-of-custody procedures for sample handling and tracking. All samples to be transferred to the laboratory for analysis will be clearly labeled to indicate sample number, location, matrix (e.g., groundwater), and analyses requested. Samples will be preserved in accordance with the analytical methods to be used, and water sample containers will be packaged in coolers with ice to maintain a temperature of 4 °C or less.

All field sampling activities will be recorded in a bound, sequentially-paginated field notebook in permanent ink. All sample collection entries will include the date, time, sample locations and numbers, notations of field observations, and the sampler's name and signature. Field QC samples will be collected in accordance with the program described below, and as summarized in Table 5.1.

QA/QC sampling will include collection and analysis of duplicate groundwater samples, trip blanks, and matrix spike samples. Internal laboratory QC procedures will involve the analysis of laboratory control samples (LCSs) and laboratory method blanks (LMBs). QA/QC objectives for each of these samples, blanks, and spikes are described below.

Duplicate groundwater samples will be collected at a frequency of one for every 20 or fewer samples of similar matrix. Each duplicate water sample will be collected concurrently with, and by the same method as, the primary sample. Duplicate water samples will be analyzed for VOCs and geochemical parameters. (i.e., methane, ethane, and ethane; TOC; nitrate and nitrite; chloride; and sulfate).

A trip blank will be analyzed to assess the effects of ambient conditions on sampling results during the transportation of samples. The trip blank will be prepared by the laboratory, and will be transported inside each sample shipment containing samples for VOC analysis. Trip blanks will be analyzed for VOCs only.

Matrix spikes will be prepared in the laboratory and used to establish matrix effects for samples analyzed for VOCs. Sufficient extra sample volume will be submitted to the laboratory to allow matrix spike preparation and analysis. LCSs and LMBs will be prepared internally by the laboratory and will be analyzed each day samples from the sites are analyzed. Samples will be reanalyzed in cases where the LCS or LMB are out of

TABLE 5.1
QA/QC SAMPLING PROGRAM
OPERABLE UNIT 1
ALTUS AFB, OKLAHOMA

QA/QC Sample Type	Minimum Frequency to be Collected and Analyzed [a/]	Analytes
Duplicates	5 to 10 percent of groundwater samples	VOCs; methane, ethane, and ethene; TOC; nitrate and nitrite; chloride; and sulfate.
Trip Blanks	One (1) per sample shipment containing VOC samples	VOCs
Matrix Spike Samples	5 to 10 percent of groundwater samples	VOCs
Laboratory Control Sample	One per method per medium per analytical batch	Laboratory control charts (Method Specific)
Laboratory Method Blanks	One per method per medium per analytical batch	Laboratory control charts (Method Specific)

QA/QC - quality assurance/quality control
TOC - total organic carbon
VOCs - volatile organic compounds

[a/] Actual frequency of QA/QC samples may be altered by the Parsons field scientist, but will not be less than minimum QA/QC sampling frequency.

the control limits. Control charts for LCSs and LMBs will be developed by the laboratory and monitored for the analytical methods used.

SECTION 6

DATA ANALYSIS AND REPORT

Parsons will compile, analyze, and interpret field test data in a Field Application Results Report. Parsons will provide defensible conclusions regarding, but not limited to: the efficiency of electron donor utilization for reductive dehalogenation as compared to metabolic (e.g., sulfate reduction, methane production) and anabolic (i.e., biomass) processes; growth and development of microbial populations; magnitude and composition of dissolved organic carbon in the biowall; loss of electron donor; effective zone of influence; apparent electron donor requirements; observed changes in site-geochemistry; actual/significant changes in contaminant concentrations and mass (considering volatilization, dilution, degradation, and daughter product formation and persistence); reaction kinetics and residence time; and feasibility and cost-effectiveness of the full-scale implementation. Based upon the results of the field application, continued monitoring and/or system expansion will be evaluated.

SECTION 7

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APPENDIX A

PROGRAM HEALTH AND SAFETY PLAN

PROGRAM HEALTH AND SAFETY PLAN

FOR ENHANCED IN SITU BIOREMEDIATION OF HALOGENATED COMPOUNDS

Prepared for:

AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE

AFCEE CONTRACT F41624-00-D-8024, DO-0011

October 2000

Prepared by:

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SECTION 1

PURPOSE AND POLICY

The purpose of this program health and safety plan is to establish protection standards and mandatory safety practices for all Parsons Engineering Science, Inc. (Parsons ES) and subcontractor personnel involved in enhanced bioremediation pilot tests at several United States Air Force installations. The goal of this safety program is to conduct the entire project with **zero accidents**. All task activities shall be designed for zero accidents. This plan provides guidance for safe operations on enhanced bioremediation pilot test sites and provides for contingencies that may arise during field operations. Site-specific information is not included in this plan and will be addressed in the formal health and safety plan addenda. All Parsons ES field team members and subcontractors are responsible for reading and conforming to this plan and the associated addenda. All personnel will be required to sign the Plan Acceptance Form located in Appendix B. No employee will perform a project activity that he or she believes may endanger his or her health and safety or the health and safety of others.

All personnel must share responsibility in performing all work in such a manner and under such conditions to preclude or minimize the possibility of damage to property or injury to themselves or others. Carelessness or disregard of accepted safety, health, and fire protection standards will not be tolerated. Any field team member who does not comply with established safety procedures will be subject to immediate dismissal from the site.

A project description and scope of work summary for the project are provided in Section 2. Section 3 presents the project team organization, personnel responsibilities, and lines of authority. Training and medical monitoring requirements are contained in Section 4. Section 5 presents a safety and health risk analysis. Section 6 contains the program emergency response plan. Program requirements for levels of protection are included in Section 7, and air monitoring procedures are provided in Section 8. Site control measures, including designation of site work zones, are contained in Section 9, and Section 10 provides decontamination procedures. Section 11 contains information on the use and calibration of air monitoring equipment. Appendix A contains an example of an Emergency Contacts Form to be used in each formal health and safety plan addendum prepared for all investigation sites. Appendix B contains a Plan Acceptance Form, Site-Specific Training Record Form, Field Experience Documentation Form, Air Monitoring Data Forms, Accident Report Form, Near-Miss Incident Form, Shipping Paper, Daily Vehicle Inspection Report, and Respirator Use Forms. Appendix C contains job analyses for project activities.

SECTION 2

PROJECT DESCRIPTION AND SCOPE OF WORK

2.1 PROJECT DESCRIPTION

Under this delivery order (DO), Parsons ES will provide services to the U.S. Air Force Center for Environmental Excellence (AFCEE) through the contract Parsons ES has with AFCEE to demonstrate the use of enhanced bioremediation via vegetable oil injection and bark mulch permeable reaction zones to reduce concentrations of solvents (chlorinated aliphatic hydrocarbons) in the groundwater and soil at various Air Force installations nationwide.

2.2 SCOPE OF WORK

Site activities will include use of direct push technologies to include the Geoprobe® direct-push technology or cone-penetrometer technology (CPT); monitoring and injection point installation; vegetable oil injection; continuous trenching; soil, oil, and groundwater sampling; and aquifer testing. Field work is expected to begin in December 2000 and will be completed in December 2001.

SECTION 3

PROGRAM TEAM ORGANIZATION

The Parsons ES team assigned to the bioremediation treatability studies project, their responsibilities, and lines of authority are outlined below.

Name	Task Assigned
Mr. Doug Downey, P.E.	Technical Manager
Mr. Todd Wiedemeier, P.G.	Technical Director
Mr. Bruce Henry, P.G.	Project Manager
Mr. Timothy Mustard, C.I.H.	Program Health and Safety Manager
Mr. Steven Hicks	Whiteman AFB Site Manager
Mr. Ted Hartfelder	Cape Canaveral Site Manager
Mr. Scott Hoxworth	Assistant Cape Canaveral Site Manager
To be assigned	Site Health and Safety Officers
To be assigned	Alternate Health and Safety Officers
Mr. Patrick Haas	AFCEE Contracting Officer's Technical Representative (COR)

The technical director and manager, Mr. Doug Downey and Mr. Todd Wiedemeier, are responsible for conduct and review of all technical work on this project to ensure technical accuracy and adequacy. They will provide advice to the project manager and project personnel on technical issues.

The project manager, Mr. Bruce Henry, is directly responsible for the execution of all phases of this project. He is responsible for planning, staffing, assuring adequate planning for health and safety and quality assurance/quality control (QA/QC), execution of each phase, coordination with AFCEE, and interpretation of data and reporting. The project manager will also coordinate with the site manager to obtain permission for site access, coordination of activities with appropriate officials, and serve as the liaison with public officials. The project manager will also ensure that quality work is accomplished on schedule.

The program health and safety manager, Mr. Timothy Mustard, will ensure that all field activities are performed with strict adherence to OSHA requirements and this program health and safety plan. He will be responsible for updating and revising the program health and safety plan, as needed, and for ensuring that all field team members meet health and safety training and medical monitoring requirements.

The site health and safety officer (SHSO) along with the project manager is responsible for ensuring that day-to-day project activities are performed in strict conformance with the program health and safety plan. Through action and example, the SHSO will instill a sincere attitude toward the zero accident philosophy for this program, and will help field personnel develop a better understanding of accident prevention and loss control. The SHSO, project manager, and program health and safety manager have the authority to stop work if actions or conditions are judged to be unsafe or not in conformance with the program health and safety plan.

The site manager will support the project manager for the specific work the team will accomplish at each site and will be responsible for scheduling and coordinating the testing activities at the respective sites. The site manager will assist the project manager in the day-to-day organization and execution of the various project tasks. The site manager will also apply the zero accident philosophy in designing field tasks. He will use any downtime in the field for safety training and educational purposes, to the extent possible.

SECTION 4

SITE-SPECIFIC EMPLOYEE TRAINING AND MEDICAL MONITORING REQUIREMENTS

The Parsons ES corporate health and safety manual, incorporated by reference, presents general requirements for Parsons ES employee training and medical monitoring. All field team members will have completed the 40-hour basic health and safety training as specified by the Occupational Safety and Health Administration (OSHA) in Title 29, Code of Federal Regulations, Part 1910.120, paragraph (e) (29 CFR 1910.120[e]) and the 8-hour annual refresher training thereafter. All supervisory personnel onsite will be required to have completed an 8-hour supervisor course as required in 29 CFR 1910.120(e).

In addition to the 40-hour course, all field employees will be required to have completed a minimum of 3 days onsite training under the supervision of a trained and experienced supervisor, not necessarily at one of the current investigation sites. If this training is received during a current bioremediation treatability study, the training will be documented on the Field Experience Documentation Form provided in Appendix B. Employees will not participate in field activities until they have been trained to the level required by their job function and responsibility. In addition, at least one person on every Parsons ES field crew will have current certification in Red Cross or equivalent first-aid and cardiopulmonary resuscitation (CPR). All training documentation for Parsons ES personnel will be verified by the SHSO and maintained by the health and safety manager.

All Parsons ES field team members will be on current medical monitoring programs in accordance with federal OSHA requirements (29 CFR 1910.120) and Parsons ES corporate policies. Listed below are additional health and safety training and medical monitoring requirements for this project.

4.1 ADDITIONAL SAFETY TRAINING REQUIREMENTS

If Level B (self-contained breathing apparatus [SCBA]) respiratory protection is used, additional training may be required for those personnel involved. This training will be conducted onsite as necessary by a qualified, Level B-experienced supervisor. Employees will also be trained in use, care, maintenance, limitations, and disposal of personal protective equipment (PPE) in accordance with 29 CFR 1910.132. All field team members must have site-specific training as discussed in the following subsection.

4.1.1 Site-Specific Safety Training

Site-specific safety and health training will be conducted by the Parsons ES SHSO for all personnel who will engage in any field work under this contract. Site-specific safety training will address the activities, procedures, monitoring, and equipment applicable to the site operations, as well as site or facility layout, potential hazards, and emergency response services at the site. Additional topics that will be addressed at the safety briefings will include:

- Names of responsible health and safety personnel;
- Zero accident performance philosophy
- Identification of site hazards and measures for eliminating or reducing hazard risk;
- Site contingencies and emergency procedures;
- Exposure risk;
- Symptoms of exposure and exposure treatment for chemical contaminants;
- Use, care, maintenance, and limitations of PPE;

- Decontamination procedures to be followed;
- Location of safety equipment;
- Review of planned activities and specialized training necessary for personnel to perform their work with zero accidents;
- Defined safety procedures to be followed during field activities; and
- Emergency and evacuation procedures.

4.1.2 Daily Safety Briefings

Daily safety briefings will also be conducted prior to commencement of field activities. Discussion and coordination of field team activities, discussion of hazards faced that day, and discussion of hazard mitigation procedures will be held with all field team members. Documentation of training and briefings, including agenda and signatures of attending personnel, will be maintained onsite. Site-specific training forms are provided in Appendix B.

4.2 MEDICAL MONITORING REQUIREMENTS

Prior to being assigned to the field activities, each Parsons ES employee will receive a preassignment or baseline physical examination. Preassignment screening has two major functions: 1) determination of an individual's fitness for duty, including the ability to perform work while wearing PPE; and 2) provision of baseline data for comparison with future medical data. Medical qualification/certification documentation will be maintained by the program health and safety manager. All medical examinations and procedures will be performed by or under the supervision of a licensed physician, preferably an occupational physician. The examination content will be determined by the examining physician in accordance with 29 CFR 1910.120(f).

SECTION 5

SAFETY AND HEALTH RISK ANALYSIS AND HAZARD MITIGATION

5.1 CHEMICAL HAZARDS

The chemicals of primary concern occurring at the bioremediation sites include chlorinated solvents. In particular, the chlorinated solvents tetrachloroethene (PCE), trichloroethene (TCE), isomers of dichloroethene (DCE), and vinyl chloride. In addition, petroleum fuels and the associated petroleum hydrocarbon constituents benzene, toluene, ethylbenzene, and xylenes (BTEX) may also be encountered.

Table 5.1 summarizes the health hazards and properties of the aforementioned compounds. If other compounds are discovered at these sites, the pertinent information about these compounds will be provided in Table 5.1 of the site-specific addenda. The health hazards or other physical/chemical hazards (e.g., corrosiveness, flammability) of the compounds will then be communicated to the onsite employees.

Hazardous substances of primary concern identified are those potentially occurring in contaminated groundwater, soils, or air.

5.2 PHYSICAL HAZARDS

In addition to the hazardous substances potentially present at the sites, other physical hazards or hazardous conditions may be expected at the sites during the course of performing investigation or remediation activities. These hazards include possible risks from injury while working around motor vehicles including the auger drilling rig, Geoprobe® unit, stationary or moving equipment, fire or explosion hazards, slip, trip, and

TABLE 5.1 HEALTH HAZARD QUALITIES OF HAZARDOUS SUBSTANCES OF CONCERN

Compound	PEL [a/] (ppm)	TLV [b/] (ppm)	IDLH [c/] (ppm)	Odor Threshold[d/] (ppm)	Ionization Potential[e/] (eV)	Physical Description/Health Effects/Symptoms
Benzene	1 (29 CFR 1910.1028) [f/]	0.5 (skin)[g/]	500	4.7	9.24	Colorless to light-yellow liquid (solid<42°F) with an aromatic odor. Eye, nose, skin, and respiratory system irritant. Causes giddiness, headaches, nausea, staggered gait, fatigue, anorexia, exhaustion, dermatitis, bone marrow depression, and leukemia. Mutagen, experimental teratogen, and carcinogen.
1,1-Dichloroethene (DCE) (Vinylidene Chloride)	1	5	NA [h/]	NA	10.00	Colorless liquid or gas (>89°F) with a mild, sweet, chloroform-like odor. Irritates eyes, skin, and throat. Causes dizziness, headaches, nausea, shortness of breath, liver and kidney dysfunctions, and lung inflammation Mutagen and carcinogen.
1,2-Dichloroethene (DCE) (cis- and trans-isomers)	200	200	1,000	0.085-500	9.65	Colorless liquid (usually a mixture of cis- and trans- isomers), with a slightly acrid, chloroform-like odor. Irritates eyes and respiratory system. CNS depressant. Cis- isomer is a mutagen.
Diesel Fuel	400 [i/]	400 [i/]	1,100 [i/]	0.08	NA	Colorless to brown, slightly viscous liquid with a gasoline- or kerosene-like odor. Irritates eyes, nose, and throat. Causes dizziness, drowsiness, headaches, nausea, dry cracked skin, and chemical pneumonia.
Ethylbenzene	100	100	800 (10% LEL) [j/]	0.25-200	8.76	Colorless liquid with an aromatic odor. Irritates eyes, skin, and mucous membranes. Causes dermatitis, headaches, narcosis, and coma. Mutagen and experimental teratogen.
Gasoline	300	300	NA	0.005-10	NA	Clear/amber flammable, volatile liquid with a characteristic odor. Irritate eyes, skin, and mucous membranes. Causes dermatitis, headaches, fatigue, blurred vision, dizziness, slurred speech, confusion, convulsions, chemical pneumonia, and possible liver and kidney damage. In animals, causes liver and kidney cancer. Monitor for BTEX constituents. Carcinogen.
Jet Fuel	400 [i/]	400 [i/]	1,100 [i/]	0.08-1	NA	Colorless to light-brown liquid with a fuel-like odor. Long-term effects include liver, kidney, and CNS damage. JP-4 is a questionable carcinogen.
2-Methylnaphthalene	NA	NA	NA	0.003-0.04	7.96	Colorless gas or solid with a disagreeable garlic or rotten cabbage odor. Irritates eyes, skin, nose, and throat.
Naphthalene	10	10	250	0.3	8.12	Colorless to brown solid (shipped as a molten liquid) with a mothball-like odor. Irritates eyes, skin, and bladder. Causes headaches, confusion, excitement, convulsions, coma, vague discomfort, nausea, vomiting, abdominal pain, profuse sweating, jaundice, hematoma, hemoglobin in

TABLE 5.1 HEALTH HAZARD QUALITIES OF HAZARDOUS SUBSTANCES OF CONCERN

Compound	PEL [a] (ppm)	TLV [b] (ppm)	IDLH [c] (ppm)	Odor Threshold [d] (ppm)	Ionization Potential [e] (eV)	Physical Description/Health Effects/Symptoms
						the urine, renal shutdown, dermatitis, optic nerve disorders, and corneal and liver damage. Experimental teratogen and questionable carcinogen.
Perchlorethylene (Tetrachloroethene or PCE)	25 [k]	25	150	5-50	9.32	Colorless liquid with a mild chloroform odor. Eye, nose, skin and throat irritant. Causes nausea, flushed face and neck, vertigo, dizziness, headaches, hallucinations, incoordination, drowsiness, coma, pulmonary changes, and skin redness. Cumulative liver, kidney, and CNS damage. In animals, causes liver tumors. Mutagen, experimental teratogen, and carcinogen.
Toluene	100	50 (skin)	500	0.2-40 [l]	8.82	Colorless liquid with sweet, pungent, benzene-like odor. Irritates eyes and nose. Causes fatigue, weakness, dizziness, headaches, hallucinations or distorted perceptions, confusion, euphoria, dilated pupils, nervousness, tearing, muscle fatigue, insomnia, skin tingling, dermatitis, bone marrow changes, and liver and kidney damage. Mutagen and experimental teratogen.
1,1,1-Trichloroethane (TCA) (Methyl Chloroform)	350	350	700	20-500	11.00	Colorless liquid with a mild chloroform-like odor. Irritates eyes and skin. Causes headaches, exhaustion, CNS depression, poor equilibrium, dermatitis, liver damage, cardiac arrhythmia, hallucinations or distorted perceptions, motor activity changes, aggression, diarrhea, and nausea or vomiting. Mutagen, experimental teratogen, and questionable carcinogen.
Trichloroethene (TCE)	50	50	1,000	21.4-400	9.45	Clear, colorless or blue liquid with chloroform-like odor. Irritates skin and eyes. Causes fatigue, giddiness, headaches, vertigo, visual disturbances, tremors, nausea, vomiting, drowsiness, dermatitis, skin tingling, cardiac arrhythmia, and liver injury. In animals, causes liver and kidney cancer. Mutagen, experimental teratogen, and carcinogen.
Vinyl Chloride	1 (29 CFR 1910.1017) [f]	1	NA	260	9.99	Colorless gas (liquid<7°F) with a pleasant odor at high concentrations. Severe irritant to skin, eyes, and mucous membranes. Causes weakness, abdominal pain, gastrointestinal bleeding, enlarged liver, pallor or blue skin on the extremities, liver cancer, and frostbite (liquid). Also attacks lymphatic system. Mutagen, experimental teratogen, and carcinogen.
Xylene (o-, m-, and p-isomers)	100	100	900	0.05-200 [k]	8.56 8.44 (p)	Colorless liquid with aromatic odor. P-isomer is a solid <56°F. Irritates eyes, skin, nose, and throat. Causes dizziness, drowsiness, staggered gait, incoordination, irritability, excitement, corneal irregularities, conjunctivitis, dermatitis, anorexia, nausea, vomiting, abdominal pain,

TABLE 5.1 HEALTH HAZARD QUALITIES OF HAZARDOUS SUBSTANCES OF CONCERN

Compound	PEL [a/] (ppm)	TLV [b/] (ppm)	IDLH [c/] (ppm)	Odor Threshold[d/] (ppm)	Ionization Potential[e/] (eV)	Physical Description/Health Effects/Symptoms
						and olfactory and pulmonary changes. Also targets blood, liver, and kidneys. Mutagen and experimental teratogen.

a/ PEL = Permissible Exposure Limit. OSHA-enforced average air concentration to which a worker may be exposed for an 8-hour workday without harm. Expressed as parts per million (ppm) unless noted otherwise. PELs are published in the *NIOSH Pocket Guide to Chemical Hazards*, 1994. Some states (such as California) may have more restrictive PELs. Check state regulations.

b/ TLV = Threshold Limit Value - Time-Weighted Average. Average air concentration (same definition as PEL, above) recommended by the American Conference of Governmental Industrial Hygienists (ACGIH), *1999 TLVs® and BEIs®*.

c/ IDLH = Immediately Dangerous to Life or Health. Air concentration at which an unprotected worker can escape without debilitating injury or health effects. Expressed as ppm unless noted otherwise. IDLH values are published in the *NIOSH Pocket Guide to Chemical Hazards*, 1994.

d/ When a range is given, use the highest concentration.

e/ Ionization Potential, measured in electron volts (eV), used to determine if field air monitoring equipment can detect substance. Values are published in the *NIOSH Pocket Guide to Chemical Hazards*, June 1997.

f/ Refer to expanded rules for this compound.

g/ (skin) = Refers to the potential contribution to the overall exposure by the cutaneous route.

h/ NA = Not available.

i/ Based on exposure limits for petroleum distillates (petroleum naphtha).

j/ Indicates that the IDLH value was based on 10% of the lower explosive limit for safety considerations, even though relevant toxicological data indicated that irreversible health effects or impairment of escape existed only at higher concentrations *(NIOSH Pocket Guide to Chemical Hazards, 1997).*

k/ NIOSH recommends reducing exposure to the lowest feasible concentration, and limiting the number of workers exposed.

l/ Olfactory fatigue has been reported for the compound and odor may not serve as an adequate warning property.

fall hazards; electrical hazards; and excessive noise conditions. Additional physical hazards include heat stress and cold-related exposures.

The guidelines presented in this section are applicable to all types of equipment that may be used during field activities at the Air Force installations. Individual equipment types or certain specialized equipment may require additional safety considerations or specialized training prior to its use. Should any specialized equipment be required during the performance of a task, the program health and safety manager will ensure that operators receive appropriate training. The program health and safety manager is also responsible for ensuring that all equipment is routinely inspected and that any piece of equipment considered unsafe is not used until the unsafe conditions are corrected or repaired.

5.2.1 Heavy Equipment, Trenching Rigs, and Drilling Rigs

Working with large motor vehicles could be a major hazard at these sites. Injuries can result from equipment dislodging and striking unsuspecting personnel, and impacts from flying objects or overturning of vehicles. Vehicles and heavy equipment design and operation will be in accordance with 29 CFR, Subpart O, 1926.600 through 1926.602. In particular, the following precautions will be used to help prevent injuries and accidents:

- Daily vehicle inspections will be conducted and documented.
- Do not back up large motor vehicles unless the vehicle has backup warning lights and a reverse signal alarm audible above the surrounding noise level, or an observer signals it is safe to do so.
- No riders other than the driver are permitted on heavy equipment.
- Motor vehicle cabs will be kept free of all nonessential items and all loose items will be secured.
- Drilling rig masts will be lowered to the ground and parking brakes will be set before shutting off the vehicle.

- Drilling rig brakes, cables, kill switches, hydraulic lines, light signals, fire extinguishers, fluid levels, steering, tires, horn, and other safety devices will be inspected daily.
- All personnel working at and around the drilling rig must be informed of the locations of the kill switches.
- Only qualified operators will be allowed to operate heavy equipment.
- When heavy equipment is left unattended, loads must be lowered, controls neutralized, power shut off, and brakes set. Wheels must be chocked if a vehicle is parked on an incline.

When working near a backhoe or excavator, field personnel will maintain sight contact with the operator. Field personnel shall not work within the swing radius of the backhoe boom while the equipment is operating. The swing radius will be defined by fully extending the boom and defining the radius with traffic cones, barrier tape, or other suitable means, such as inscribing the radius on the soil surface using the bucket. Personnel will not cross the demarcated line without first establishing eye contact with the operator. The operator will lower the bucket to the ground on either side of the trench and remove his hands and feet from the controls and/or turn the backhoe off, before allowing personnel access to the area within the swing radius of the backhoe arm. Backhoe operations will resume only after all personnel have left the area within the swing radius.

When working near a drill rig, personnel shall be aware of snag hazards from rotating tools and pinch and crush hazards from suspended tools. No loose, dangling clothing will be allowed. Personnel will also be aware of falling object hazards and wear hard hats at all times. Personnel will be aware of slip, trip, and fall hazards from drilling equipment, tools, and well construction materials that may be lying on the ground in the vicinity of the drill rig. To reduce the threat of slip, trip, and fall hazards, the area immediately around the drill rig will be kept clear of equipment and supplies. Use of a downhole hammer will require the use of an air compressor. The compressor air hoses will be checked daily prior to startup for cracks or other defects that could result in injuries. Refer to Section 5.2.7 for noise associated with drill rig, downhole hammer, and air compressor.

5.2.2 Hazards Associated with the CPT or Geoprobe® Unit

The CPT and Geoprobe® units consists of a hydraulically-driven press mounted on the bed of a pick-up truck, with power supplied to the cylinder via a power-take-off on the truck. A list of safety instructions provided by the Geoprobe® manufacturer is provided below, and will be followed by all Parsons ES and subcontractor personnel.

- Never operate the controls without proper training.
- Always take the vehicle out of gear and set the emergency brake before engaging the remote ignition.
- If the vehicle is parked on a loose or soft surface, do not fully raise the rear of the vehicle with the probe foot, as the vehicle may fall or move, causing injury.
- Always extend the probe unit out from the vehicle, and deploy the foot to clear the vehicle roof line before folding the probe unit out.
- Operators must wear OSHA-approved steel-toed shoes, and keep feet clear of the probe foot.
- Only one person should operate the probe machine and assemble/disassemble the probe rods and accessories.
- Never place hands on top of a rod while it is under the machine.
- Turn off the hydraulic system while changing rods, inserting the hammer anvil or attaching accessories.

- While operating the controls, the operator must stand to the control side of the probe machine, clear of the probe foot and mast.

- Wear safety glasses at all times during the operation of this machine.

- Never exert down pressure on the probe rod so as to lift the machine base over six inches off the ground.

- Wear ear muffs or disposable foam earplugs when in the vicinity of the operation of equipment, aircraft noise or other sources of high intensity noise.

5.2.3 Support Vehicles

Contractor/subcontractor personnel shall wear seat belts and obey posted speed limits. Personnel shall comply with applicable state, local, and installation traffic regulations. Current or anticipated hazardous road conditions (i.e., ice, construction) will be addressed at the daily safety briefings. No personnel shall ride in the bed of pickup trucks or standing on the side or riding on the fenders of heavy equipment.

Personnel will conduct a "walk-around" inspection of the vehicle before moving it to ensure they do not drive over personnel or equipment.

No personally-owned vehicles (POVs) will be driven into contaminated areas, nor will contaminated equipment, personnel, or material be transported in POVs. POVs must be left in support zones on-site. Stunt driving, racing, and horseplay are prohibited and will be subject to disciplinary action, including dismissal.

5.2.4 Subsurface Hazards

Before intrusive field activities are performed, efforts must be made to determine if underground installations (i.e., sewers, and telephone, water, fuel, and electrical lines) will be encountered and if so, where such underground installations are located. The site manager will ensure that all underground installations have been identified prior to any intrusive operations.

5.2.5 Electrical Hazards

Some of the equipment used during bioremediation is powered by electricity. Maintenance and daily activities require personnel to use, handle, and control this equipment. Safe work practices must be strictly observed to avoid serious injury and death.

According to 29 CFR 1910.269(l), only qualified employees may work on or with exposed energized lines or parts of equipment, or in areas containing unguarded, uninsulated, energized lines or parts of equipment operating at 50 volts (V) or more. Qualified employees must be trained in accordance with 29 CFR 1910.269(a) and certified as such by the employer.

Ordinary 120 V electricity may be fatal. Extensive studies have shown that currents as low as 10 to 15 milliamps (mA) can cause loss of muscle control and that 12 V may, on good contact, cause injury. Therefore, all voltages should be considered dangerous.

Electricity can paralyze the nervous system and stop muscular action. Frequently, electricity may affect the breathing center at the base of the brain and interrupt the transmission of the nerve impulses to the muscles responsible for breathing. In other cases, the electrical current directly affects the heart, causing it to cease pumping blood. Death follows due to a lack of oxygen in the body. Therefore, a victim must be freed from the live conductor promptly by use of a nonconducting implement, such as a piece of wood, or by turning off the electricity to at least this point of contact. Bare hands should never be used to remove a live wire from a victim or a victim from an electrical source. Artificial respiration or CPR should be applied immediately and continuously until breathing is restored, or until a physician or emergency medical technician arrives.

General rules for recognizing electrical safety are provided below.

- Only authorized and qualified personnel will perform electrical installations or repairs.

- All electrical wires and circuits will be assumed to be "live," unless it can be positively determined they are not.

- Appropriate protective clothing will be worn by personnel performing electrical work.

- All electrical equipment will be properly grounded and class-approved for the location.

- Ground fault circuit interrupter receptacles and circuit breakers will be installed where required by the National Electric Code and 29 CFR 1926.404.

- Electrical control panels will not be opened unless necessary.

- No safety device will be made inoperative by removing guards, using oversized fuses, or by blocking or bypassing protective devices, unless it is absolutely essential to the repair or maintenance activity, and then only after alerting operating personnel and the maintenance supervisor.

- All power tools will have insulated handles, be electrically grounded, or be double insulated.

- Fuse pullers will be used to change fuses.

- Metal ladders, metal tape measures, and other metal tools will not be used around electrical equipment or overhead electrical lines.

- Wires and extension cords will be placed or arranged so as to not pose a tripping hazard.

5.2.6 Slip, Trip, and Fall Hazards

Existing site conditions may pose a number of slip, trip, and fall hazards, such as:

- Open excavations, pits, or trenches;

- Slippery surfaces;
- Steep or uneven grades;
- Surface obstructions; and
- Construction materials or debris.

The extension cords connecting pumps to power supplies also provide a trip and fall hazard. Caution must be exercised and unnecessary personnel should avoid the area of the cord.

All field team members will be instructed to be cognizant of potential safety hazards and immediately inform the SHSO or the site manager about any new hazards. If the hazard cannot be immediately removed, actions must be taken to warn site workers about the hazard. The site will be kept in a neat, organized, and orderly fashion. Rubbish, trash, or debris generated by the project team shall be picked up and properly disposed of on a daily basis. Items such as tools, equipment, and hoses will be properly stored when not in use.

5.2.7 Noise-Induced Hearing Loss

Work onsite may involve the use of equipment such as drilling rigs, downhole hammers, pumps, compressors, and generators. The exposure of unprotected site workers to this noise or to aircraft noise during site activities can result in noise-induced hearing loss. Heavy equipment can emit noise levels exceeding the federal OSHA time-weighted average (TWA) limit of 85 decibels (dB). Noise levels in the area of the drilling rig and Geoprobe® unit will be presumed in exceedance of the OSHA TWA, and hearing protection will be required. Foam ear plugs will generally provide adequate protection. The SHSO will ensure that either ear muffs or disposable foam earplugs are made available to, and are used by, all personnel in the vicinity of the operation of equipment, aircraft noise or other sources of high intensity noise.

5.2.8 Fire or Explosion Hazards

Fuels and solvents may have been released into the soils at the Army installations and vapors from these fuels may be flammable or explosive. Therefore, precautions will be taken when performing investigation and remediation activities to ensure that combustible or explosive vapors have not accumulated, or that an ignition source is not introduced into a flammable atmosphere.

OSHA standards for fire protection and prevention are included in 29 CFR Subpart F, 1926.150 through 1926.154. Of particular concern on these sites are:

- Proper storage of flammables;
- Adequate numbers of 20 lb A:B:C type fire extinguishers;
- Use of intrinsically safe (explosion-proof) equipment where appropriate; and
- Monitoring for development of an explosive atmosphere.

5.2.9 Electric Power Line Clearance and Thunderstorms

Above- and below-ground utility lines may pose a safety hazard to workers during excavation or drilling. Extra precautions will be exercised when drilling near electrical lines. The minimum clearance between overhead electrical lines of 50 kilovolts (kV) or less and the drill rig mast is 20 feet. The location of underground utilities must be determined prior to excavation or drilling. No drilling will take place without the identification of underground utility lines by a representative of the utility company(ies) or by the appropriate installation personnel. All permits, licenses, and/or rights-of-entry required by state, local, and/or installation authorities will be the responsibility of the contractor. Drilling operations and other tasks performed outdoors must cease during thunderstorms.

The SHSO will provide onsite surveillance of the drilling subcontractor to ensure that personnel meet these requirements. If deficiencies are noted, work will be stopped and corrective actions implemented. Reports of health and safety deficiencies and the corrective actions taken will be forwarded to the installation manager by the SHSO.

5.2.10 Effects and Prevention of Heat Stress

Adverse weather conditions are important considerations in planning and conducting site operations. Hot or cold weather can cause physical discomfort, loss of efficiency, and personal injury. These conditions are discussed further below.

If the body's physiological processes fail to maintain a normal body temperature because of excessive heat, a number of physical reactions can occur. They can range from mild symptoms such as fatigue; irritability; anxiety; and decreased concentration, dexterity, or movement; to death. Medical help must be obtained for the more serious cases of heat stress. One or more of the following actions will help reduce heat stress:

- Provide plenty of liquids. To replace body fluids (water and electrolytes) lost due to perspiration, each employee must drink 1 to 1.5 gallons of water or commercial electrolyte mix per day. Workers are encouraged to frequently drink small amounts, i.e. one cup every 15-20 minutes.

- Field personnel are cautioned to minimize alcohol intake during off-duty hours.

- Provide cooling devices (e.g., water jackets or ice vests) to aid natural body ventilation. These devices, however, add weight, and their use should be balanced against worker mobility.

- Wear long cotton underwear, which acts as a wick to help absorb moisture and protect the skin from direct contact with heat-absorbing protective clothing.

- Install portable emergency showers and/or hose-down facilities to reduce body temperature and to cool protective clothing.

- In extremely hot weather, conduct nonemergency response operations in the early morning or evening.

- Ensure that adequate shelter is available to protect personnel against sun, heat, or other adverse weather conditions which decrease physical efficiency and increase the probability of accidents.

- In hot weather, rotate workers wearing protective clothing.

- Maintain good hygienic standards by frequent changing of clothing and daily showering. Clothing should be permitted to dry during rest periods. Workers who notice skin problems should immediately consult the SHSO.

5.2.10.1 Heat-Related Problems

- Heat rash: Caused by continuous exposure to heat and humid air, and aggravated by chafing clothes. Decreases ability to tolerate heat and is a nuisance.

- Heat cramps: Caused by profuse perspiration with inadequate fluid intake and chemical replacement, especially salts. Signs include muscle spasms and pain in the extremities and abdomen.

- Heat exhaustion: Caused by increased stress on various organs to meet increased demands to cool the body. Signs include shortness of breath; increased pulse rate (120-200 beats per minute); pale, cool, moist skin; profuse sweating; and dizziness and exhaustion.

- Heat stroke: The most severe form of heat stress. Body must be cooled immediately to prevent severe injury and/or death. Signs include red, hot, dry skin; no perspiration; nausea; dizziness and confusion; strong, rapid pulse; and possibly coma. Medical help must be obtained immediately.

5.2.10.2 Heat-Stress Monitoring

Monitoring of personnel wearing impermeable clothing will begin when the ambient temperature is 70°F (21°C) or above. Table 5.2 presents the suggested frequency for such monitoring. Monitoring frequency will increase as the ambient temperature increases or as slow recovery rates are observed. Heat-stress monitoring will be performed by a person with current first-aid certification who is trained to recognize heat-stress symptoms. For monitoring the body's recuperative capabilities in response to excess heat, one or more of the techniques listed below will be used. Other methods of heat-stress monitoring may also be used, such as the wet-bulb globe temperature index from the current edition American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) Booklet.

To monitor the worker, measure:

- Heart rate: Count the radial pulse during a 30-second period as early as possible during the rest period.
    - If the heart rate exceeds 110 beats per minute at the beginning of the rest period, the next work cycle will be shortened by one-third and the rest period will remain the same.
    - If the heart rate still exceeds 110 beats per minute at the next rest period, the following work cycle will be reduced by one-third.
- Oral temperature: Use a clinical thermometer (3 minutes under the tongue) or similar device to measure the oral temperature at the end of the work period (before drinking).

TABLE 5.2
SUGGESTED FREQUENCY OF PHYSIOLOGICAL MONITORING FOR FIT AND ACCLIMATIZED WORKERS[a/]

Adjusted Temperature[b/]	Normal Work Ensemble[c/]	Impermeable Ensemble[d/]
90°F (32.2°C) or above	After each 45 minutes of work	After each 15 minutes of work
87.5° - 90°F (30.8°- 32.2° C)	After each 60 minutes of work	After each 30 minutes of work
82.5° -87.5° F (28.1°- 30.8°C)	After each 90 minutes of work	After each 60 minutes of work
77.5°-82.5° F (25.3°- 28.1°C)	After each 120 minutes of work	After each 90 minutes of work
72.5°-77.5°F (22.5°- 25.3°C)	After each 150 minutes of work	After each 120 minutes of work

a/ For work levels of 250 kilocalories/per hour.

b/ Calculate the adjusted air temperature (ta adj) by using this equation: ta adj = ta °F + (13 x sunshine multiplier [i.e., 50 percent sunshine equals a .5 multiplier). Measure air temperature (ta) with a standard mercury-in-glass thermometer, with the bulb shielded from radiant heat. Estimate the sunshine multiplier by judging what percent of time the sun is not covered by clouds that are thick enough to produce a shadow (100 percent sunshine - no cloud cover and a sharp, distinct shadow; 0 percent sunshine = no shadows).

c/ A normal work ensemble consists of cotton coveralls or other cotton clothing with long sleeves and trousers.

d/ Saranex®, Poly-Coated Tyvek®, Etc.

- If oral temperature exceeds 99.6° (37.6°C), the next work cycle will be reduced by one-third without changing the rest period.
- If oral temperature still exceeds 99.6°F (37.6°C) at the beginning of the next rest period, the following work cycle will be reduced by one-third.
- No worker will be permitted to wear a semipermeable or impermeable garment when oral temperature exceeds 100.6°F (38.1°C).

5.2.11 Cold Exposure

It is possible that work on this project may be conducted during the winter months; therefore, injury due to cold exposure may become a problem for field personnel. Cold exposure symptoms, including hypothermia and frostbite, will be monitored when personnel are exposed to low temperatures for extended periods of time.

Persons working outdoors in temperatures at or below freezing may suffer from cold exposure. During prolonged outdoor periods with inadequate clothing, effects of cold exposure may even occur at temperatures well above freezing. Cold exposure may cause severe injury by freezing exposed body surfaces (frostbite), or may result in profound generalized cooling (hypothermia), possibly causing death. Areas of the body which have high surface area-to-volume ratios such as fingers, toes, and ears are the most susceptible to frostbite.

Two factors influence the development of a cold injury: ambient temperature and wind velocity. Wind chill is used to describe the chilling effect of moving air in combination with low temperature. For example, 14°F with a wind speed of 15 miles per hour (mph) is equivalent in chilling effect to still air at -18°F. Cold exposure is particularly a threat to site workers if the body cools suddenly when chemical-protective equipment is removed, and the clothing underneath is perspiration-soaked. The presence of wind greatly increases the rate of cooling.

Local injury resulting from cold is included in the generic term frostbite. There are several degrees of damage. Frostbite of the extremities can be categorized into:

- Frost nip or incipient frostbite: characterized by suddenly blanching or whitening of skin.

- Superficial frostbite: skin has a waxy or white appearance and is firm to the touch, but tissue beneath is resilient.

- Deep frostbite: tissues are cold, pale, and solid; an extremely serious injury.

Systemic hypothermia, or lowering of the core body temperature, is caused by exposure to freezing or rapidly dropping temperatures. Symptoms are usually exhibited in five stages:

- Shivering and uncoordination;
- Apathy, listlessness, sleepiness, and (sometimes) rapid cooling of the body to less than 95°F (35°C);
- Unconsciousness, glassy stare, slow pulse, and slow respiratory rate;
- Freezing of the extremities; and
- Death.

5.2.11.1 Evaluation and Control

TLVs recommended for properly clothed workers for periods of work at temperatures below freezing are shown in Table 5.3. For exposed skin, continuous exposure should not be permitted when the air speed and temperature results in an equivalent chill temperature of -32ºC (-25.6ºF). Superficial or deep local tissue freezing will occur only at temperatures below -1ºC (30.3ºF) regardless of wind speed.

Special protection of the hands is required to maintain manual dexterity for the prevention of accidents. If fine work is to be performed with bare hands for more than 10 to 20 minutes in an environment below 16ºC (60.8ºF), special provisions should be established for keeping the workers' hands warm. For this purpose, warm air jets, radiant heaters (fuel burner or electric radiator), or contact warm plates may be used. At temperatures below -1ºC (30.2ºF), metal handles of tools and control bars should be covered by thermal insulating material.

TABLE 5.3

THRESHOLD LIMIT VALUES WORK/ WARM-UP SCHEDULE FOR FOUR-HOUR SHIFT

Air Temperature - Sunny Sky		No Noticeable Wind		5 mph Wind		10 mph Wind		15 mph Wind		20 mph Wind	
ºC (approx.)	ºF (approx.)	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks
-26° to -28°	-15° to -19°	(Norm. Breaks)	1	(Norm. Breaks)	1	75 min	2	55 min	3	40 min	4
-29° to -31°	-20° to -24°	(Norm. Breaks)	1	75 min	2	55 min	3	40 min	4	30 min	5
-32° to -34°	-25° to -29°	75 min	2	55 min	3	40 min	4	30 min	5	Non-emergency work should cease	
-35° to -37°	-30° to -34°	55 min	3	40 min	4	30 min	5	Non-emergency work should cease			
-38° to -39°	-35° to -39°	40 min	4	30 min	5	Non-emergency work should cease					
-40° to -42°	-40° to -44°	30 min	5	Non-emergency work should cease							
-43° & below	-45° & below	Non-emergency work should cease									

Notes for Table 5.3

1. Schedule applies to any 4-hour work period with moderate to heavy work activity, with warm-up periods in a warm location and with an extended break (e.g., lunch) at the end of the 4-hour work period in a warm location. For light-to-moderate work (limited physical movement): apply the schedule one step lower. For example, at -35ºC (-30ºF) with no noticeable wind (Step 4), a worker at a job with little physical movement should have a maximum work period of 40 minutes with 4 breaks in a 4 hour period (Step 5).

2. The following is suggested as a guide for estimating wind velocity if accurate information is not available: 5 mph; light flag moves; 10 mph: light flag fully extended; 15 mph: raises newspaper sheet; 20 mph: blowing and drifting snow.

3. In general the warm-up schedule provided above slightly under-compensates for the wind at the warmer temperatures, assuming acclimatization and clothing appropriate for winter work. On the other hand, the chart slightly over-compensates for the actual temperatures in the colder ranges, since windy conditions rarely prevail at extremely low temperatures.

4. TLVs apply only for workers in dry clothing.

To prevent contact frostbite, workers should wear gloves. When cold surfaces below -7ºC (19.4ºF) are within reach, a warning will be given to the workers by the supervisor or SHSO to prevent inadvertent contact with bare skin. If the air temperature is -17.5ºC (0ºF) or less, the hands should be protected by mittens. Machine controls and tools for use in cold conditions should be designed so that they can be handled without removing the mittens.

Provisions for additional total body protection are required if work is performed in an environment at or below 4ºC (39.2ºF). The workers will wear cold protective clothing appropriate for the level of cold and physical activity. If the air velocity at the job site is increased by wind, draft, or artificial ventilating equipment, the cooling effect of the wind should be reduced by shielding the work area or by wearing an easily removable windbreak garment. If the available clothing does not give adequate protection to prevent hypothermia or frostbite, work will be modified or suspended until adequate clothing is made available or until weather conditions improve.

5.2.11.2 Work-Warming Regimen

If work is performed continuously in the cold at an equivalent chill temperature (ECT) below -7ºC (19.4ºF), heated warming shelters (tents, cabins, rest rooms) will be made available nearby. The workers will be encouraged to use these shelters at regular intervals, the frequency depending on the severity of the environmental exposure. The onset of heavy shivering, frostnip, the feeling of excessive fatigue, drowsiness, irritability, or euphoria are indications for immediate return to the shelter. When entering the heated shelter, the outer layer of clothing should be removed and the remainder of the clothing loosened to permit sweat evaporation, or a change of dry work clothing should be provided. A change of dry work clothing may be necessary to prevent workers from returning to work with wet clothing. Dehydration, or the loss of body fluids, occurs insidiously in the cold environment and may increase the susceptibility of the worker to cold injury due to a significant change in blood flow to the extremities. Warm sweet drinks and soups should be provided at the work site to provide caloric intake and fluid volume. The intake of coffee should be limited because of the diuretic and circulatory effects.

For work practices at or below -12ºC (10.4ºF) ECT, the following should apply:

- The workers will be under constant protective observation (buddy system or supervision).
- The work rate should not be so high as to cause heavy sweating that will result in wet clothing; if heavy work must be done, rest periods will be taken in unheated shelters, and the opportunity for changing into dry clothing should be provided.
- New employees should not be required to work full-time in the cold during the first days of employment until they become accustomed to the working conditions and required protective clothing.
- The weight and bulkiness of clothing should be included in estimating the required work performances and weights to be lifted by the worker.
- The work should be arranged in such a way that sitting still or standing still for long periods is minimized. Unprotected metal chair seats will not be used. The worker should be protected from drafts to the greatest extent possible.
- The workers will be instructed in safety and health procedures relative to cold exposures.

5.3 BIOLOGICAL HAZARDS

Various biological hazards may be encountered at the installations. These hazards include pathogenic organisms or diseases such as Hantavirus, Bubonic Plague, Equine Encephalitis, and Lyme Disease. Other biological hazards include insects, snakes, spiders, and cactuses or other harmful plants (such as poison ivy).

Hantavirus has been reported from the "Four Corners" area of the southwestern U.S. The Four Corners strain of Hantavirus has had a 60 percent mortality rate. Deer mice are the primary reservoir for the virus. The virus is excreted in mouse feces, urine, and saliva. People become infected when the virus is inhaled, through breaks in the skin, by ingesting contaminated food or water, or by being bitten by an infected rodent.

The incubation period for Hantavirus may be three days to six weeks. Symptoms include fever, chills, headache, dizziness, muscle aches, dry cough, nausea, vomiting, abdominal cramps, diarrhea, and shortness of breath. Progression of the disease leads to fluid in the lungs, heart irregularities, and kidney failure. Personnel will use HEPA-equiped air-purifying respirators when working in rodent-infested areas or when entering sheds of buildings containing mice infestations.

Bubonic plague is a bacterial disease which is spread to humans by fleas that have bitten an infected animal. Bubonic plague displays symptoms rapidly. Chills and fever are soon accompanied by swelling of the lymph nodes, usually on one side of the body. These painful swellings are usually dark blue to black, hence the other common name for this disease, "black death." The disease is treatable with antibiotics. Field personnel must wear Tyvek® suits with leg seams taped to boots or boot covers to minimize contact with fleas while working in prairie dog towns.

Equine encephalitis, an inflammation of the brain, can be carried by mosquitoes. Field personnel must wear long-sleeved clothing and/or use insect repellents if they are working in areas of mosquito infestations.

Bites from wood ticks may result in the transmission of Lyme disease - a serious and often fatal bacterial disease. The *Borrelia burgdorferi* bacteria infects wood ticks, which can bite humans and transfer the bacteria into the bloodstream. Transmission of Lyme disease is most likely in late spring, summer, and early fall.

There are three stages of Lyme disease, although not everyone will proceed through all the stages or experience all the symptoms. The initial symptoms may include a red rash that is circular and blotchy and expands around the tick bite, and flu-like symptoms such as fatigue, headaches, fever, swollen glands, and stiffness and pain in muscles and joints. The next stage can occur from a few days to a few weeks after the initial stage. Symptoms of this phase may include irregular heartbeat, facial paralysis, joint pain, irritability, headaches, dizziness, poor coordination, weakness, severe fatigue, and memory loss. The third stage may occur weeks to years after the second stage. Arthritis, often in the knees, is the most common symptom of this stage. The arthritis may disappear and recur many times, and chronic arthritis may develop.

Prompt medical treatment with antibiotics is usually successful in preventing further complications from this disease. Lyme disease becomes more difficult to treat the longer treatment is delayed. Long-sleeved shirts with snug collar and cuffs, pants tucked into socks, and personal protective equipment will offer some protection. However, the use of tick repellent may also be warranted. Personnel should perform self-checks for ticks at the end of each work day.

The potential exists for contact with snakes or insects which may cause injury or disease when performing investigation or remediation activities at the installations. There are plants which may be injurious (i.e., thorns) as well. Sturdy work clothes and shoes will be worn by field personnel to help prevent injuries. Personnel should be aware that rattlesnakes, water moccasins or alligators may be present in an area and should therefore exercise caution, especially when working in previously undisturbed areas and locations around animal dens and wetland habitats.

Poison ivy, poison oak, and poison sumac can be encountered at many installations. Poison ivy is a woody vine leaves are divided into three leaflets. Poison oak is a low branching shrub with leaflets also in threes. Poison sumac is a shrub or small tree occurring in swamps. Poison sumac have 7 to 13 leaflets which resemble those of green ash trees. All of these species are poisonous and can cause contact dermatitis. Personnel must wear Tyvek® suits or other protective clothing when working in areas containing these plant species.

Black widow spiders and scorpions may also be present onsite. The black widow spider has a shiny black body about the size of a pea, with a red or yellow hourglass-shaped mark on its abdomen. It weaves shapeless diffuse webs in undisturbed areas. A bite may result in severe pain, illness, and possible death from complications, but usually not from the bite itself. There are several types of scorpions native to the United States. Scorpions may be brown to yellowish in color, and range from 1/2 inch to 8 inches in length. Their bodies are divided into two parts: a short, thick upper body, and a long abdomen with a six-segment tail. A scorpion has six pairs of jointed appendages: one pair of small pincers, one pair of large claws, and four pairs of jointed legs. They are most active at night. A scorpion sting is very painful, but usually will not result in death.

In addition to spiders and scorpions, bees and wasps may be nuisances to field personnel. Properly trained personnel will administer first aid should a bee or wasp sting occur.

SECTION 6

EMERGENCY RESPONSE PLAN

All hazardous waste site activities will present a degree of risk to onsite personnel. During routine operations, risk is minimized by establishing good work practices, staying alert, and using proper PPE. Unpredictable events such as physical injury, chemical exposure, or fire may occur and must be anticipated. The sections below establish procedures and guidelines for emergencies.

6.1 GUIDELINES FOR PRE-EMERGENCY PLANNING AND TRAINING

Employees must read this program health and safety plan and the appropriate site-specific addendum to this plan, and familiarize themselves with the information provided. Prior to project initiation, the SHSO will conduct a meeting with the field team members to review the provisions of this program health and safety plan and the addendum, and to review the emergency response plan. Employees are required to have a copy of the emergency contacts and telephone numbers immediately accessible onsite and know the route to the nearest emergency medical services. The emergency contacts, telephone numbers, and routes to the hospital will be provided in the site-specific health and safety plan addendum prepared for each site. Appendix A provides a guideline for preparing this information.

6.2 EMERGENCY RECOGNITION AND PREVENTION

Emergency conditions are considered to exist if:

- Any member of the field crew is involved in an accident or experiences any adverse effects or symptoms of exposure while onsite.

- A condition is discovered that suggests the existence of a situation more hazardous than anticipated (e.g. flammable atmospheres).

- Concentrations of combustible vapors reach or exceed 10 percent of the lower explosive limit (LEL).

- A fire or explosion hazard exists.

- Concentrations of organic vapors measured in the worker breathing zone by a photoionization detector (PID) are above background air concentrations greater than an amount equal to the lowest permissible exposure limit (PEL) of a contaminant of concern onsite.

- A vehicle accident occurs.

Preventive measures are listed below.

- Site workers must maintain visual contact and should remain close together to assist each other during emergencies. (Use the buddy system.)

- During continual operations, onsite workers act as safety backup to each other. Offsite personnel provide emergency assistance.

- All field crew members should make use of all of their senses to alert themselves to potentially dangerous situations to avoid (e.g., presence of strong and irritating or nauseating odors).

- Personnel will practice unfamiliar operations prior to performing them in the field.

- Field crew members will be familiar with the physical characteristics of investigations and field demonstrations, including:

    - Wind direction in relation to contamination zones;

    - Accessibility to co-workers, equipment, vehicles and communication devices;

- Communication signals and devices;
- Hot zone locations (areas of known or suspected contamination);
- Site access; and
- Nearest water sources.

- Personnel and equipment in the designated work area should be minimized, consistent with effective site operations.

The discovery of any condition that would suggest the existence of a situation more hazardous than anticipated, will result in the reevaluation of the hazard and the level of protection required, and may result in a temporary evacuation of the field team from the immediate work area. Such conditions may include an adverse effect or symptom of exposure experienced by a field team member, or the exceedance of the action levels for organic vapors and/or combustible vapors. If the action levels for organic vapors and/or combustibles are exceeded, procedures will be followed as stated in Section 7 of this health and safety plan.

In the event of an accident, the SHSO or site manager will complete the Accident Report Form provided in Appendix B. Copies of the completed forms will be maintained by the program health and safety manager in the health and safety file of the affected employee. Follow-up action should be taken to correct the situation that caused the accident.

Near-miss incidents will also be documented using the form provided in Appendix B, and filed with the onsite health and safety records, as well as with the program health and safety manager. Near-miss incidents are defined as any incident which could have led to injury or property damage, but for whatever reason, did not. The assessment of near-miss incidents provides a better measure of safety program effectiveness than simply tracking accidents, since near-misses tend to occur at much higher frequencies than actual accidents.

6.3 PERSONNEL ROLES, LINES OF AUTHORITY, AND COMMUNICATION PROCEDURES DURING AN EMERGENCY

When an emergency occurs, decisive action is required. Rapidly made choices may have far-reaching, long-term consequences. Delays of minutes can create or exacerbate life-threatening situations. Personnel must be ready to respond to emergency situations immediately. All personnel will know their own responsibilities during an emergency, know who is in charge during an emergency, and the extent of that person's authority. This section outlines personnel roles, lines of authority, and communication procedures during emergencies.

In the event of an emergency situation at the site, the site manager will assume total control and will be responsible for onsite decision-making. The designated alternate for the site manager will be the SHSO. These individuals have the authority to resolve all disputes about health and safety requirements and precautions. They will also be responsible for coordinating all activities until emergency response teams (ambulance, fire department, etc.) arrive onsite.

The site manager and/or SHSO will ensure that the necessary Army personnel, Parsons ES personnel, and agencies are contacted as soon as possible after the emergency occurs. All onsite personnel must know the location of the nearest phone and the location of the emergency phone number list.

6.4 EVACUATION ROUTES AND PROCEDURES, SAFE DISTANCES, AND PLACES OF REFUGE

In the event of emergency conditions, decontaminated employees will evacuate the area as instructed, transport decontaminated injured personnel, or take other measures to ameliorate the situation. Evacuation routes and safe distances will be decided upon and posted by the field team prior to initiating work. Evacuation routes will be oriented upwind of the exclusion zone. Wind direction will be monitored through the use of wind socks, surveyors flagging or other appropriate measures.

6.5 DECONTAMINATION OF PERSONNEL DURING AN EMERGENCY

Procedures for leaving a contaminated area must be planned and implemented prior to going onsite. Decontamination areas and procedures will be established based on anticipated site conditions. If a member of the field crew is exposed to chemicals, the emergency procedures outlined below will be followed:

- Another team member (buddy) will assist or remove the individual from the immediate area of contamination to an upwind location.
- Precautions will be taken to avoid exposure of other individuals to the chemical.
- If the chemical is on the individual's clothing, the clothing will be removed if it is safe to do so.
- Administer first aid and transport the victim to the nearest medical facility, if necessary.

If uninjured employees are required to evacuate a contaminated area in an emergency situation, emergency decontamination procedures will be followed. At a minimum, these would involve moving into a safe area and removing protective equipment. Care will be taken to minimize contamination of the safe area and personnel. Contaminated clothing will be placed in plastic garbage bags or other suitable containers. Employees will wash or shower as soon as possible.

6.6 EMERGENCY SITE SECURITY AND CONTROL

For this project, the site manager (or designated representative) must know who is onsite and who is in the work area. Personnel access into the work area will be controlled. In an emergency situation, only necessary rescue and response personnel will be allowed into the exclusion zone.

6.7 PROCEDURES FOR EMERGENCY MEDICAL TREATMENT AND FIRST AID

The following general procedures will be implemented in the event of an emergency. Site-specific addenda will incorporate specific emergency procedures, emergency contact names and telephone numbers and a map detailing the route to the local hospital.

6.7.1 Chemical Exposure

In the event of chemical exposure (skin contact, inhalation, ingestion) the following procedures will be implemented:

- Another team member (buddy) will assist or remove the individual from the immediate area of contamination to an upwind location.
- Precautions will be taken to avoid exposure of other individuals to the chemical.
- If the chemical is on the individual's clothing, the clothing will be removed if it is safe to do so.
- If the chemical has contacted the skin, the skin will be washed with copious amounts of water, preferably under a shower.
- In case of eye contact, an emergency eyewash will be used. Eyes will be washed for at least 15 minutes. Emergency eyewashes will comply with ANSI Z-358.1 and filled with tempered water maintained no cooler than 60°F and no warmer than 95°F. Eyewashes will be capable of delivering 0.4 to 0.8 gallons of water to both eyes for a minimum of 15 minutes. Each jobsite will have at least one emergency eyewash station. Each crew will have, at a minimum, an ANSI-approved personal eyewash suitable for initial eye flushing while the injured person is moved to an emergency eyewash station or medical facility.
- If necessary, the victim will be transported to the nearest hospital or medical center. If necessary, an ambulance will be called to transport the victim.

6.7.2 Personal Injury

In the event of personal injury:

- Field team members trained in first aid can administer treatment to an injured worker.

- The victim will be transported to the nearest hospital or medical center. If necessary, an ambulance will be called to transport the victim.

- The SHSO or site manager is responsible for the completion of the appropriate accident report form.

6.7.3 Fire or Explosion

In the event of fire or explosion, personnel will evacuate the area immediately. Administer necessary first aid to injured employees. Personnel will proceed to a safe area and telephone the emergency support services designated in the appropriate sit-specific addendum. Upon contacting the emergency support services, state your name, nature of the hazard (fire, high combustible vapor levels), the location of the incident, and whether there were any physical injuries requiring an ambulance. Do not hang up until the emergency support services personnel have all of the additional information they may require.

SECTION 7

LEVELS OF PROTECTION AND PERSONAL PROTECTIVE EQUIPMENT REQUIRED FOR SITE ACTIVITIES

7.1 PERSONAL PROTECTIVE EQUIPMENT

The personal protection level prescribed for the bioremediation treatability studies is OSHA Level D (no respiratory or chemical protective clothing), with a contingency for the use of OSHA Level C or B as site conditions require (Figure 7.1). Unless certain compounds are ruled out through use of appropriate air monitoring techniques such as Dräger® tubes, portable sampling pumps, or an onsite gas chromatograph (GC), Level C respiratory protection (air-purifying respirator [APR]) cannot be used. Level C protection may only be used on this project when vapors in air are adequately identified and quantified and Level C respirator-use criteria are met. Level B (supplied air) respiratory protection must be used on this project in the presence of unknown vapor constituents or if benzene or vinyl chloride is detected at or above 1 part per million, volume per volume (ppmv). This is based primarily on the toxicity and inadequate warning properties (high odor threshold) for benzene and vinyl chloride. In addition, the PEL for 1,1-DCE is also 1 ppmv. The presence of 1,1-DCE can only be confirmed by laboratory analysis. Air monitoring must be conducted in the worker breathing zone when the potential occurrence of these compounds exists.

Ambient air monitoring of organic gases/vapors (using photoionization detectors such as an HNU® or Photovac® MicroTIP®, or by colorimetric analysis with Dräger® tubes) will be used to select the appropriate level of personal protection. If there is the potential for vinyl chloride at the site, a reading of 1 ppmv or greater above background in the worker breathing zone as indicated by a PID will require the use of a Dräger® tube or the equivalent to determine if vinyl chloride is present at a concentration greater than or equal

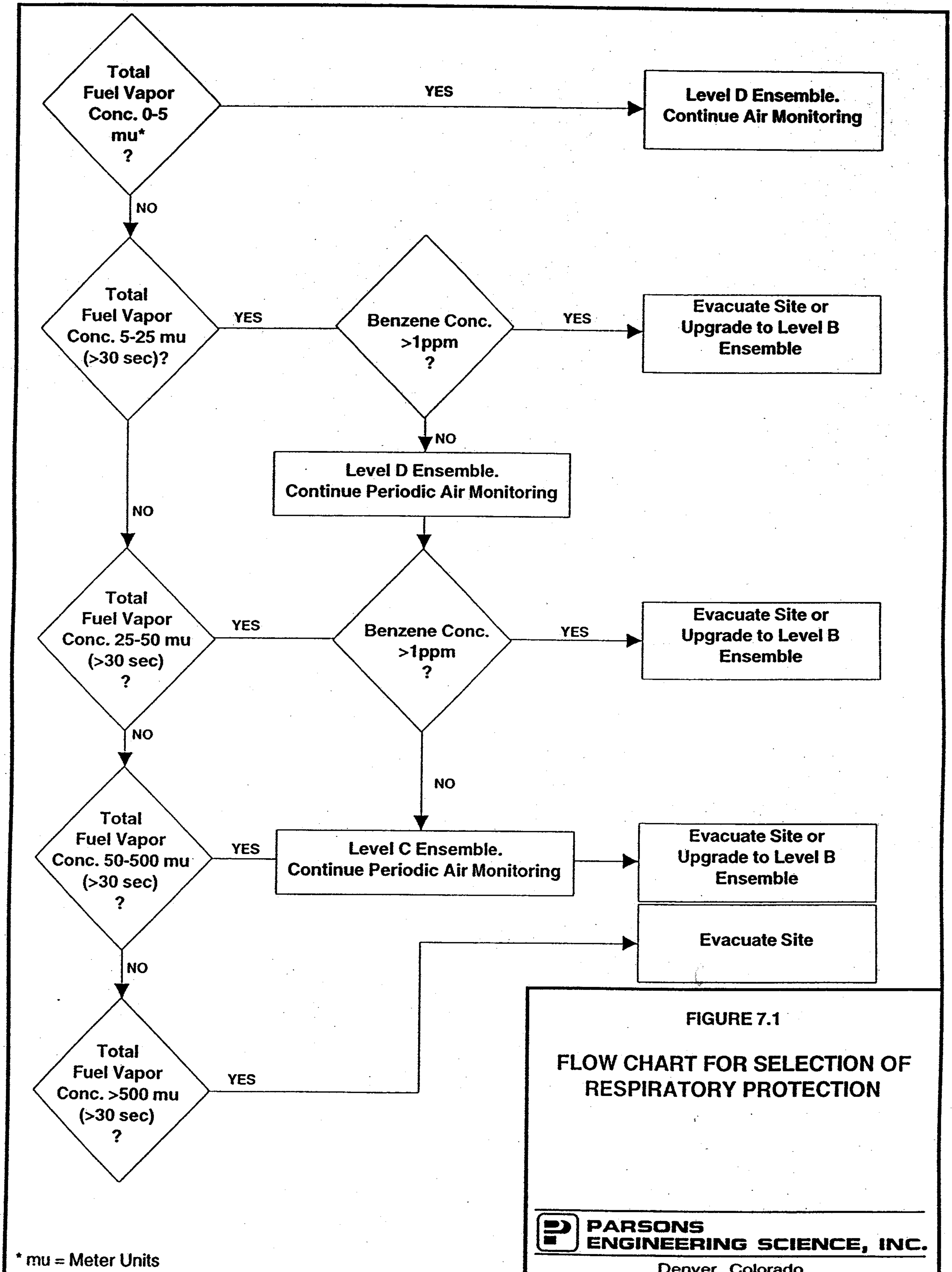

FIGURE 7.1

FLOW CHART FOR SELECTION OF RESPIRATORY PROTECTION

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to the PEL of 1 ppmv. Due to the inadequate warning properties of vinyl chloride, Level B protection must be used if concentrations of vinyl chloride exceed 1 ppmv above background in the worker breathing zone. If vinyl chloride is not present, continue to monitor the air in the worker breathing zone. If concentrations in the worker breathing zone persist above 1 ppmv as indicated by the PID, periodic use of the vinyl chloride Dräger® tubes must be used to confirm the absence of vinyl chloride.

If there exists the potential for 1,1-DCE at the site, the following will occur since there is no Dräger® tube for 1,1-DCE. If sustained air monitoring readings in the worker breathing zone indicate vapor concentrations greater than or equal to 1 ppm above background for 30 seconds or longer, the field crew will be forced to evacuate and ventilate the area until readings are less than 1 ppm in the worker breathing zone. If ventilation is inadequate, air samples will be taken to confirm or deny the existence of the contaminants of concern and/or the crew will upgrade to Level B respiratory protection. These samples will be sent to a lab to analyzed by Environmental Protection Agency (EPA) Compendium Method TO-14 or the equivalent.

If the aforementioned solvents are not present, the flow chart presented in Figure 7.1 will be used to select respiratory protection against volatile hydrocarbon constituents. If the portable air monitoring equipment indicates organic vapor concentrations of 0-5 meter units (mu), site workers will continue air monitoring in a Level D ensemble. If organic vapors reach 5-25 mu for more than 30 seconds, and benzene concentrations exceed 1 ppmv, site workers will evacuate the area or upgrade to Level B ensemble, if trained to do so. If benzene concentrations are less than 1 ppmv in the breathing zone, and vapors are in the range of 5-25 mu, the site crews may continue in Level D ensembles with periodic air monitoring. If organic vapor concentrations reach 25-50 mu for more than 30 seconds and benzene concentrations exceed 1 ppmv in the worker breathing zone, site crews will evacuate the area or upgrade to Level B ensembles. If benzene concentrations are less than 1 ppmv, and vapors are in the range of 25-50 mu, site workers will don full facepiece APRs equipped with organic vapor cartridges (National Institute for Occupational Safety and Health [NIOSH]-approved), and continue periodic monitoring. If organic vapor concentrations reach 50-500 mu for more than 30 seconds, site crews will evacuate the site or upgrade to Level B ensembles. If organic vapor concentrations exceed 500 mu for more than 30 seconds, site crews will evacuate the site.

Before work can be performed in Level B respiratory protection, the project manager must be notified. He will initiate the change order process with the Army or decide to halt activities at that site. (Level B operations also require approval from Parsons ES corporate health and safety.) The SHSO will determine whether it is safe to continue activities without respiratory protection or assign an upgrade to Level C protection.

The use of PPE will be required when handling contaminated samples and working with potentially contaminated materials. The SHSO must ensure that all field personnel are properly trained in use, maintenance, limitations (including breakthrough time), and disposal of PPE assigned to them, in accordance with federal OSHA regulations in 29 CFR 1910.132. Disposable PPE will be used whenever possible to simplify decontamination, to reduce generation of contaminated washwater, and to avoid potential problems with chemical permeation (breakthrough). Single-use PPE (such as Tyvek®) will be disposed of whenever personnel go through decontamination. At most, a single item of disposable PPE (including respirator cartridges) will be used for no more than one day and will then be disposed of. Double layers of gloves will be used when personnel are handling contaminated soil or water, or equipment to minimize breakthrough. If personnel note chemical odors on their hands, clothing or skin after wearing PPE, or develop skin irritation or rashes, consult with the SHSO and decide on alternate actions and/or seek medical attention.

Respirator and other PPE selection will be determined for each of the sites individually and variations from what is specified in this plan will be presented in the site-specific addenda. The criteria will be based on previously collected data indicating the contaminants of concern and their concentrations. Respiratory protection against chlorinated solvents will be discussed in the site-specific addenda. Hard hats will be worn in the vicinity of the auger drilling rig and Geoprobe® unit and in all other areas where a head impact hazard exists. Steel-toed, steel-shank leather workboots will be worn by all field personnel.

The following personal protective ensemble is required only when handling contaminated samples or equipment.

Mandatory Equipment	Optional Equipment
• Vinyl or latex inner gloves • 4H or SilverShield® outer gloves	• Air-purifying respirator (equipped with organic vapor/high-efficiency particulate air [HEPA] cartridges) • Self-contained breathing apparatus or air-line respirator in pressure-demand mode • Rubber safety boots • Disposable Tyvek® coveralls • Outer disposable boot covers • Saranex® suits • Chemical goggles

7.2 EQUIPMENT NEEDS

Each field team will have the following items readily available:

- Copy of this program health and safety plan, site-specific addendum, and a separate list of emergency contacts;
- First aid kit which includes PPE for bloodborne pathogens;
- Eyewash station;
- Paper towels;

- Duct tape;
- Water (for drinking and washing);
- Plastic garbage bags;
- Fire extinguisher; and
- Earplugs.

7.3 EQUIPMENT DISPOSAL

All reusable PPE (such as hard hats and respirators), if contaminated, will be decontaminated in accordance with procedures specified in Section 10 of this health and safety plan. Contaminated single-use PPE (such as Tyvek® suits and protective gloves) will be properly disposed of according to installation requirements.

SECTION 8

FREQUENCY AND TYPES OF AIR MONITORING

Air monitoring will be used to identify and quantify airborne levels of hazardous substances. Periodic monitoring is required during on site activities. The types of monitoring and equipment to be used are as follows:

Type of Equipment	Minimum Calibration Frequency	Parameter(s) to be Measured	Minimum Sampling Frequency	Sampling Locations
Photoionization Detector	1/day	Benzene Organic Vapors	2/hour for general site activities	Breathing Zone
Explosivity Meter	1/day	Combustible Gases	2/hour	Soil Borings Monitoring Wells
Sensidyne® or Drager® Tubes	None (check manufacturer's requirements)	Benzene Organic Vapors	When PID exceeds lowest PEL of the contaminants of concern	Breathing Zone
Dosimeter Badges	None	Benzene Organic Vapors	As needed on workers with greatest exposure to contamination initially detected by Drager® tubes	Breathing Zone
Portable Air Sampling Pumps	Prior to and after each use	Benzene Organic Vapors	As needed on workers with greatest exposure to contamination initially detected by Drager® tubes	Breathing Zone

During bioremediation activities, a photoionization detector (such as an HNU® or MicroTIP®) will be used to measure ambient air concentrations in the worker breathing zone. The size of the PID lamp will be determined for each site individually, based on the ionization potential of the contaminants. This information will be presented in the site-specific addenda.

Evacuation may be necessary if the lowest PEL of a contaminant of concern is exceeded above background in the breathing zone of the site workers. This evacuation will be necessary until the area is well ventilated or the respiratory protection is upgraded, if possible. Any detectable concentration above background concentrations in the breathing zone will necessitate following the respiratory protection flowchart (Figure 7.1). The explosivity meter will be used at last twice per hour to measure combustible gas levels at the wellhead or borehole when a potential exists for combustible vapors. At 10 percent of the LEL, evacuate the area and allow the borehole to ventilate.

Worker exposure monitoring will be conducted to document any exposures of Parsons ES site personnel to organic vapors. Portable air sampling pumps or dosimeter badges will be used for personal exposure monitoring, if necessary. The following general protocols will be followed if badges or pumps are used.

Passive Dosimeter Badges

An organic vapor monitoring badge will be attached in the worker's breathing zone for an eight-hour period when the potential for exposure exists. The exposed badges and a blank will be sent to the laboratory for analysis. These personal dosimeter badges work by means of diffusion eliminating the need for a pump, calibration or batteries.

Portable Sampling Pumps

- The portable pump will be calibrated to the required flow rate (in liters per minute) following the manufacturer's calibration procedures.
- The pump will be equipped with the appropriate sorbent tube for the particular organic compounds to be monitored (e.g., charcoal for volatile organics).

- A personal air monitoring data sheet (provided in Appendix B) listing pump flow rates, start and stop times, sorbent tube used, etc. will be completed.

- The pump will undergo a post calibration to determine final flow rates.

- The laboratory analytical results will be disclosed to the employee(s) monitored.

- The analytical results will be placed in the employee’s permanent medical file for documentation of any exposures received.

SECTION 9

SITE CONTROL MEASURES

The following site control measures will be followed to minimize potential contamination of workers, protect the public from potential site hazards, and control access to the sites. Site control involves the physical arrangement and control of the operation zones and the methods for removing contaminants from workers and equipment. The first aspect, site organization, is discussed in this section. The second aspect, decontamination, is considered in the next section.

9.1 SITE ORGANIZATION-OPERATION ZONES

The following organization-operation zones will be established on the site or around a particular site feature (e.g., the drill rig).

- Exclusion Zone (Contamination Zone),
- Contamination Reduction Zone, and
- Support Zone.

The site manager and/or SHSO will be responsible for establishing the size and distance between zones at the site or around the site feature. Considerable judgment is required to ensure safe working distances for each zone are balanced against practical work considerations.

9.1.1 Exclusion Zone (Contamination Zone)

The exclusion zone includes the areas where active investigation or cleanup operations take place. Within the exclusion zone, prescribed levels of PPE must be worn by all personnel. The hotline, or exclusion zone boundary, is initially established based upon the presence of actual wastes or apparent spilled material, or through air monitoring, and is placed around all physical indicators of hazardous substances. For drilling operations, the hotline will be located at a distance equal to the drilling rig boom height or 25 feet, whichever is greater, from the drill rig. The hotline generally consists of an easily identifiable physical boundary (e.g., bright orange or yellow flagging attached to stakes, and may be readjusted based upon subsequent observations and measurements. This boundary will be physically secured and posted or well-defined by physical and geographic boundaries.

Under some circumstances, the exclusion zone may be subdivided into zones based upon environmental measurements or expected onsite work conditions.

9.1.2 Contamination Reduction Zone

If decontamination is required, a contamination reduction zone will be established between the exclusion zone and the support zone. The contamination reduction zone will be located upwind of the exclusion zone. This zone provides an area to prevent or reduce the transfer of hazardous materials which may have been picked up by personnel or equipment leaving the exclusion area. All decontamination activities occur in this area. The organization of the contamination reduction zone, and the control of decontamination operations, are described in Section 10.

9.1.3 Support Zone

The support zone is the outermost area of the site and is considered a noncontaminated or clean area. The support zone contains the command post for field operations, first-aid stations, and other investigation and cleanup support. Normal work clothes are appropriate apparel within this zone; potentially contaminated personnel, clothing or equipment are not permitted.

9.2 SITE SECURITY

Site security is necessary to prevent exposure of unauthorized, unprotected individuals in the work area. The areas immediately surrounding the work area will be clearly marked through use of warning signs, traffic cones, barrier tape, rope, or other suitable means.

Site security will be enforced by the SHSO or a designated alternate who will ensure that only authorized personnel are allowed in the work area and that entry personnel have the required level of PPE, are trained under the requirements of 29 CFR 1910.120, and are on a current medical monitoring program.

9.3 SITE COMMUNICATION

Internal site communication is necessary to alert field team members in the exclusion and contamination reduction zones to:

- Emergency conditions;
- To convey safety information; and
- Communicate changes or clarification in the work to be performed.

For internal site communication, the field team members will use prearranged hand signals (and responses). Radios and/or compressed air horns may also be used for communication.

External site communication is necessary to coordinate emergency response teams and to maintain contact with essential offsite personnel. A telephone will be available for use in external site communication. A list of emergency contact telephone numbers will be provided in subsequent addenda.

9.4 SAFE WORK PRACTICES

To ensure a strong safety-awareness program during field operations, field personnel will be adequately trained for their particular tasks. In addition, standing work orders will be developed and communicated to all field personnel, as will the provisions of this program health and safety plan and the appropriate addenda. Sample standing work orders for personnel entering the contamination reduction zone and exclusion zone are as follows:

- No horseplay at any time;
- No smoking, eating, drinking or chewing of tobacco or gum;
- Alcoholic beverage intake and illegal drug use is prohibited during the work shift and will result in immediate dismissal from the site;
- No matches or lighters;
- No personal vehicles;
- Check in/check out at access control points;
- Use the buddy system;
- Wear appropriate PPE;
- Avoid walking through puddles or stained soil;
- Upon discovery of unusual or unexpected conditions, immediately evacuate and reassess the site conditions and health and safety practices;
- Conduct safety briefings prior to onsite work;
- Conduct daily safety meetings; and
- Take precautions to reduce injuries resulting from heavy equipment and other tools.

SECTION 10

DECONTAMINATION PROCEDURES

10.1 PERSONNEL DECONTAMINATION PROCEDURES

An exclusion zone, contamination reduction zone, and support zone will be established whenever field personnel are using PPE. Decontamination station layout will be made on a site-specific basis and will be based on the level of PPE used, the types of chemical hazards encountered, and the site conditions, including topography, wind direction, and traffic patterns. Defined site access and egress points will be established and personnel will enter and exit only through these points. As a general rule, persons assisting in the decontamination station may be in one level lower of respiratory protection than required in the work zone.

A guideline for personnel decontamination is presented in Figure 10.1. This procedure may be modified by the SHSO if necessary.

If personnel are in Level D-modified protection (no respirator but using protective gloves and/or suits and other equipment), a portable decontamination station will be set up at the site. The decontamination station will include provisions for collecting disposable PPE (e.g., garbage bags); washing boots, gloves, vinyl rain suits, field instruments and tools; and washing hands, face, and other exposed body parts. Onsite personnel will shower at the end of the work day. Refuse from decontamination will be properly disposed of in accordance with US Air Force installation protocols.

Decontamination equipment will include:

- Plastic buckets and pails;

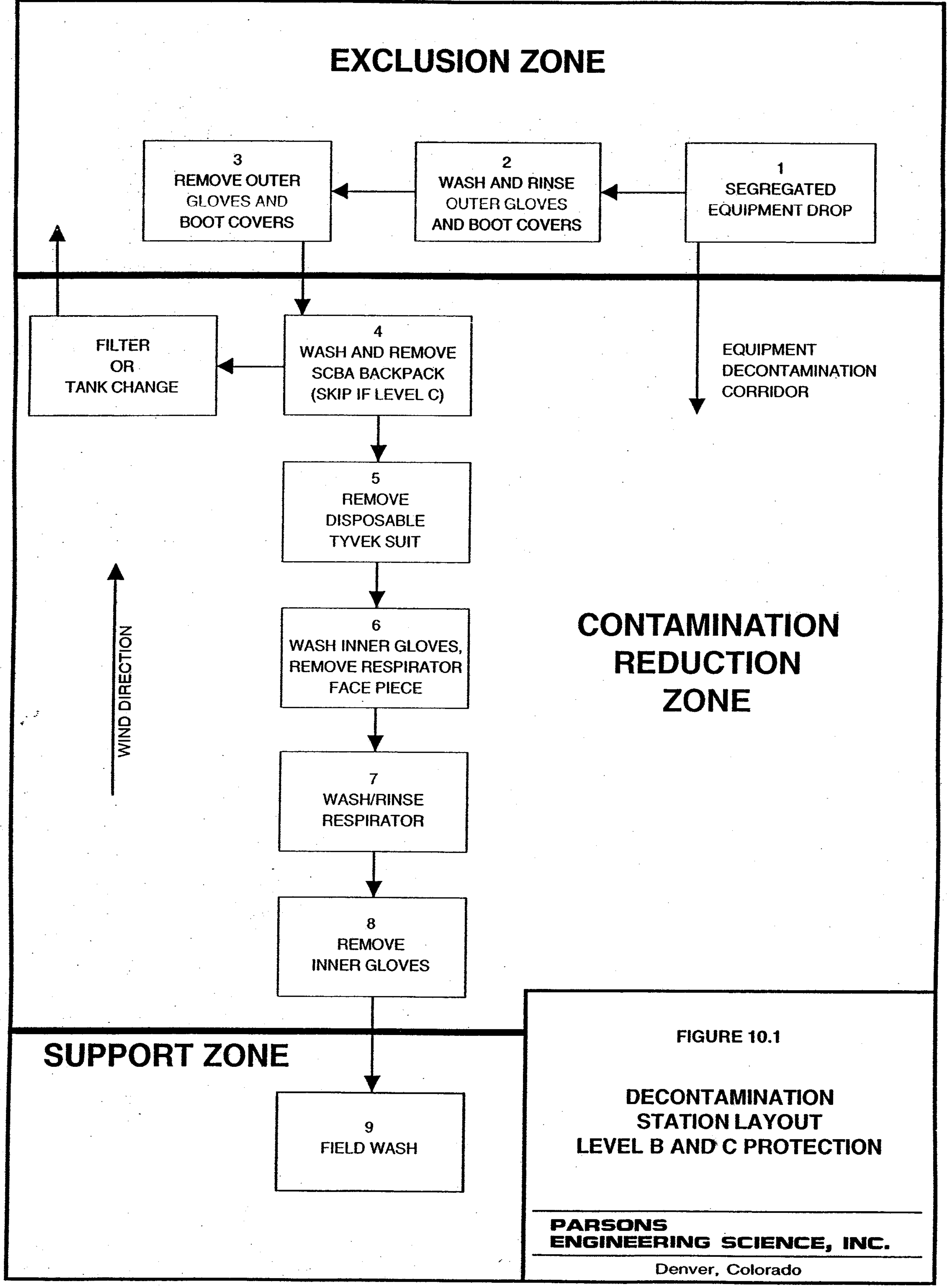

FIGURE 10.1

DECONTAMINATION
STATION LAYOUT
LEVEL B AND C PROTECTION

PARSONS
ENGINEERING SCIENCE, INC.
Denver, Colorado

- Scrub brushes and long-handle brushes;
- Detergent;
- Containers of water;
- Paper towels;
- Plastic garbage bags;
- Plastic or steel 55-gallon barrels;
- Distilled water; and
- An eyewash station.

10.2 DECONTAMINATION OF EQUIPMENT

Decontamination of drilling rigs will be conducted at a designated location. High-pressure steam-cleaning of the rig will be necessary prior to the beginning of the drilling operation, between borehole locations, and before the drilling rig leaves the project site. All sampling equipment will be decontaminated prior to use, between samples, and between sampling locations. PPE will consist of splash protective clothing, eye protection, gloves, and boot covers, as necessary.

SECTION 11

AIR MONITORING EQUIPMENT USE AND CALIBRATION PROCEDURES

11.1 PHOTOVAC MICROTIP® AIR ANALYZER

The MicroTIP® is a direct-reading instrument used in conjunction with the span gas kit. To calibrate the MicroTIP®, press the power switch. Allow the MicroTIP® to warm up; the display will read “Ready.” Press the calibration switch; the display will read “Connect zero gas then press enter.” Connect the bag of zero gas to the MicroTIP® inlet (or allow the MicroTIP® to sample clean air) and press enter; the display will read “Calibrating now please wait.” The display will then read "Span Conc.?" Enter the span concentration (usually 100 ppmv isobutylene). Connect the bag of span gas to the tip inlet and press enter; the display will read “Connect span gas then press enter.” The MicroTIP® will then calibrate. When the display reads “Ready,” the MicroTIP® has completed the calibration and is ready for use. Repeat the calibration daily.

To use the MicroTIP®, press the power switch and wait for the instrument to display the date, time, event number, current detected concentrations, and instrument status “ready.” The minimum, maximum, and average concentrations measured in each 15-second period are automatically recorded in memory. The keyboard also allows for direct numeric entry.

Since a calibration gas (i.e., isobutylene) is used which typically differs from the contaminants of concern, it may be necessary to combine the instrument reading with a response factor to more closely approximate the concentration of the contaminants of concern. MSDSs for all chemicals (including calibration gases such as isobutylene) used in the field will be maintained by the field team.

Relative response factors are found in Table 11.1 for MicroTIP® models MP-100 and HL-200 with a 10.6 eV lamp. For these instruments, a more accurate concentration may be obtained by dividing the instrument reading by the appropriate relative response factor from Table 11.1 for the contaminant of concern.

For MicroTIP® instrument models MP-1000, HL-2000, IS-3000, and EX-4000 with a 10.6 eV lamp, the instrument reading is multiplied by the appropriate response factor from Table 11.2 for the contaminant of concern.

11.2 HNU® PHOTOIONIZATION DETECTOR

To calibrate the HNU®, turn the function switch to the “standby” mode and use the zero control to zero the instrument. Connect a bag of span gas (usually 100 ppmv isobutylene). Turn the function switch to the 0-200 range position and adjust the span control setting to read the ppmv concentration of the standard. Recheck the zero setting as previously described. If readjustment is needed, repeat the calibration step. This provides a two-point calibration to zero and the gas-standard point. Repeat the calibration daily. If the span setting from calibration is 0.0 or if calibration cannot be achieved, then the lamp must be cleaned.

To use the HNU® connect the probe to the instrument by matching the alignment slot in the probe connector to the key in the 12-pin connector on the control panel. Twist the probe connector until a distinct snap and lock is felt. Turn the function switch to battery check position. The needle should read within or above the green battery arc on the scale plate. If the needle is in the lower position of the battery arc, the instrument should be recharged before use. If the red light comes on, the battery should be recharged. Next, turn the functions switch to the on position, and the instrument is ready to take direct air readings.

TABLE 11.1

MICROTIP® RELATIVE RESPONSE FACTORS (10.6 eV LAMP)
INSTRUMENT MODELS MP-100 & HL-200

Compound	Relative Response Factor	Compound	Relative Response Factor
Acetaldehyde	0.17	Hydrogen Sulfide	0.25
Acetic Acid	0.09	Isobutyl Acetate	0.52
Acetone	0.86	Isobutyraldehyde	1.02
Acetone Cyanohydrin	0.93	Isopentane	0.12
Acrolein	0.28	Isoprene	2.12
Allyl Chloride	0.26	Isopropyl Acetate	0.43
Ammonia	0.10	Isopropyl Alcohol	0.23
Benzene	1.78	Methyl Bromide	0.45
1,3-Butadiene	1.43	Methyl tert-Butyl Ether	1.22
n-Butanol	0.27	Methyl Ethyl Ketone	1.10
see-Butanol	0.36	Methyl Isobutyl Ketone	0.87
n-Butyl Acetate	0.35	Methyl Mercaptan	1.60
n-Butyl Acrylate	0.53	Methyl Methacrylate	0.67
n-Butyl Mercaptan	1.36	Monoethylamine	1.25
n-Butylaldehyde	0.65	Monomethylamine	1.06
Carbon Disulfide	0.65	n-Octane	0.39
Chlorobenzene	2.24	n-Pentane	0.09
Cyclohexane	0.53	Perchloroethylene	1.40
Cyclohexanone	1.11	n-Propyl Acetate	0.31
1,2-Dichlorobenzene (ortho)	2.25	n-Propyl Alcohol	0.18
cis-1,2-Dichloroethylene	1.20	Propionaldehyde	0.56
trans-1,2-Dichloroethylene	2.21	Propylene	0.87
Diisobutylene	2.10	Propylene Oxide	0.13
1,4-Dioxane	0.83	Styrene	2.20
Epichlorohydrin	0.11	Tetrahydrofuran	0.65
Ethyl Alcohol	0.13	Toluene	1.91
Ethyl Acetate	0.25	Trichloroethylene	1.61
Ethyl Acrylate	0.30	Trimethylamine	1.35
Ethylene	0.09	Vinyl Acetate	0.84
Ethyl Mercaptan	1.82	Vinyl Bromide	2.24
Furfuryl Alcohol	1.43	Vinyl Chloride	0.51
n-Heptane	0.27	Vinylidene Chloride (1,1-DCE)	1.16
n-Hexane	0.20		

Note: Concentration = $\frac{\text{Instrument Reading}}{\text{Relative Response Factor}}$

TABLE 11.2

MICROTIP® RESPONSE FACTORS (10.6 eV LAMP) INSTRUMENT MODELS MP-1000, HL-2000, IS-3000 & EX-4000

Compound	Response Factor	Compound	Response Factor
Acetaldehyde	6.6	n-Hexane	5.6
Acetic Acid	18.9	Hydrogen Sulfide	3.7
Acetone	1.2	Isobutyl Acetate	2.3
Acetone Cyanohydrin	1.2	Isobutyraldehyde	1.1
Acrolein	3.7	Isopentane	7.8
Allyl Chloride	4.3	Isoprene	0.6
Ammonia	10.1	Isopropyl Acetate	2.4
Benzene	0.6	Isopropyl Alcohol	4.5
1,3-Butadiene	0.7	Methyl Bromide	2.3
n-Butanol	4.6	Methyl tert-Butyl Ether	0.8
see-Butanol	3.0	Methyl Ethyl Ketone	0.9
n-Butyl Acetate	2.9	Methyl Isobutyl Ketone	1.1
n-Butyl Acrylate	1.9	Methyl Mercaptan	0.6
n-Butyl Mercaptan	0.7	Methyl Methacrylate	1.5
n-Butylaldehyde	1.9	Monoethylamine	0.8
Carbon Disulfide	1.4	Monomethylamine	1.0
Chlorobenzene	0.4	n-Octane	2.6
Cyclohexane	1.9	n-Pentane	10.8
Cyclohexanone	0.9	Perchloroethylene	0.7
1,2-Dichlorobenzene (ortho)	0.4	n-Propyl Acetate	3.5
cis-1,2-Dichloroethylene	0.8	n-Propyl Alcohol	6.3
trans-1,2-Dichloroethylene	0.4	Propionaldehyde	1.9
Diisobutylene	0.6	Propylene Oxide	7.1
Dimethylamine	1.5	Styrene	0.5
Di-n-propylamine	0.5	Tetrahydrofuran	1.5
1,4-Dioxane	1.2	Toluene	0.5
Epichlorohydrin	10.3	Trichloroethylene	0.6
Ethanol	11.1	Trimethylamine	0.9
Ethyl Acetate	4.2	Vinyl Acetate	1.2
Ethyl Acrylate	3.3	Vinyl Bromide	0.4
Ethylene	10.0	Vinyl Chloride	2.0
Ethyl Mercaptan	0.6	Vinylidene Chloride (1,1-DCE)	0.9
n-Heptane	3.7		

Note: Concentration = Instrument Reading x Response Factor

11.3 EXPLOSIVITY METER

An explosivity meter is used to measure oxygen and combustible gas levels. The instrument provides characteristic warning signals when deficient oxygen conditions or unacceptable levels of combustible gas are detected.

To use the explosivity meter, turn the unit on and wait a few seconds for the readings to stabilize. Check the battery charge and the alarms before using the instrument. Set the LEL indicator to zero and the oxygen indicator to 20.9 percent.

To calibrate the instrument, attach a bag, bulb or balloon of span gas and wait for the readings to stabilize. Adjust the instrument to read the LEL percent of the calibration gas. Remove the span gas and allow the instrument to exhaust. The combustible sensor will read 000-percent LEL in clean air.

11.4 SENSIDYNE® OR DRÄGER® COLORIMETRIC GAS ANALYSIS TUBES

Colorimetric tubes can be used to give an instantaneous reading of various organic compounds. Their aim is to determine very small concentrations of a compound in the shortest amount of time. To sample with a colorimetric tube use the Dräger® or Sensidyne® bellows pump and select the appropriate tube (for example, a tube marked benzene to look for benzene). Break off both ends on the pump's break-off plate. Insert the tube into the pump head (the tube should be inserted with the arrow pointing towards the pump). There is a specific number of suction strokes for each tube/compound. Each box of tubes will have instructions for how many suction strokes are required for that compound.

APPENDIX A

EMERGENCY CONTACTS

APPENDIX A

EMERGENCY CONTACTS

In the event of any situation or unplanned occurrence requiring assistance, the appropriate contact(s) should be made from a list similar to this which will be prepared in the health and safety plan addenda. For emergency situations, telephone or radio contact should be made with the site point of contact or site emergency personnel who will then contact the appropriate response teams.

Contingency Contacts	Telephone Number
Nearest phone located at the work site	________________________
Site Fire Department	________________________
Site Contact	________________________
Site Medical Services	________________________
Site Emergency Telephone Number	________________________
Site Security/Police	________________________
Medical Emergency	
Hospital Name	________________________
Hospital Address	________________________
Hospital Telephone Number	________________________
Ambulance Service	________________________
Airlift Helicopter	________________________

Directions and/or Map to the Hospital

Parsons ES Contacts

Bruce Henry Project Manager	(303) 831-8100 (w) (303) 422-4019 (h)
Timothy Mustard, CIH (Denver) Program Health and Safety Manager	(303) 831-8100 (w) (303) 450-9778 (h)
Edward Grunwald, CIH (Atlanta) Corporate Health and Safety Manager	(678) 969-2394 (w) (404) 299-9970 (h)
Judy Blakemore (Denver) Assistant Program Health and Safety Manager	(303) 831-8100 (w) (303) 828-4028 (h) (303) 817-9734 (m)

USAEC Contacts

Patrick Haas, AFCEE Project Officer	(210) 536-4314 (w)

APPENDIX B

PROJECT HEALTH AND SAFETY FORMS

PLAN ACCEPTANCE FORM

PROJECT HEALTH AND SAFETY PLAN

Instructions: This form is to be completed by each person to work on the subject project work site and returned to the safety manager.

I have read and agree to abide by the contents of the Health and Safety Plan for the following project:

____

____

____

Signed

____

Date

RETURN TO:

Office Health and
Safety Representative
Parsons Engineering Science, Inc.
1700 Broadway, Suite 900
Denver, CO 80290

SITE SPECIFIC TRAINING RECORD

Project:____________________________________
Project No.:________________________________
Date:______________________________________
Trainer:____________________________________

On this date, the following individuals were provided site-specific training in accordance with OSHA regulations contained in 29CFR1910.120(e):

Name (Print)	Employee No.	Employee Signature

Forward this form to:

Office Health and Safety Representative
Parsons Engineering Science, Inc.
1700 Broadway, Suite 900
Denver, Colorado 80290

PARSONS ENGINEERING SCIENCE, INC.

FIELD EXPERIENCE

DOCUMENTATION FORM

OSHA requires (29CFR1910.120(e)) that personnel involved in hazardous waste operations have 40-hours of initial training and a minimum of three days field experience working under the direction of a trained and experienced supervisor. This form serves to document the three days of additional field training/experience.

Employee Name:____

Employee Number (or Social Security No.):________________________

Project Name(s):____

Project Number(s):_______________________________________

Dates of Field Training:____________________________________

Summary of Activities Performed:______________________________

____

____

Levels of Respiratory Protection Used:___________________________

____

Comments:

Field Supervisor Signature:__________________________________

Date:____

Return this form to the Office Health and Safety Representative

PARSONS ENGINEERING SCIENCE, INC.
PERSONAL AIR MONITORING DATA FORM

PROJECT NAME_______________________________ PROJECT NUMBER:____________________

Person Sampling	Person(s) Sampled/Location	Date	Time	PID/BG** (PPM)	Dräger (PPM)	LEL/BG (%)	O_2/BG (%)	Other	Notes

PID	Explosimeter	Other
Model____________	Model____________	Model____________
Serial #____________	Serial #____________	Serial #____________
Cal.* Gas____________	Cal Gas____________	Cal Gas____________
Cal. Reading____________	Cal. Reading____________	Cal. Reading____________
BG Reading____________	BG Reading____________	BG Reading____________

* Cal = Calibration
**BG = Background

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ENGINEERING-SCIENCE, INC.
AIR MONITORING DATA FORM

Project: ________________

Project No.: ______________

Date: ________________

Name(s): ______________

Sample No	Pump No.	Sorbant/ Cartridge	Initial Flow Rate	Final Flow Rate	Ave. Flow Rate	Start Time	Stop Time	Total Elapsed Time	Total Volume Air	Analyses Performed	Notes

022/722426/8.WW6

ACCIDENT REPORT FORM

Project: ______________________

EMPLOYER

1. Name: ______________________
2. Mail Address: ______________________
   (No. and Street) (City or Town) (State and Zip)
3. Location (if different from mail address: ______________________

____

INJURED OR ILL EMPLOYEE

4. Name: ______________________ Social Security No.: ______________
   (first) (middle) (last)
5. Home Address: ______________________
   (No. and Street) (City or Town) (State and Zip)
6. Age: ________ 7. Sex: male ( ) female ( )
8. Occupation: ______________________
   (specific job title, not the specific activity employee was performing at time of injury)
9. Department: ______________________
   (enter name of department in which injured person is employed, even though they may have been temporarily working in another department at the time of injury)

THE ACCIDENT OR EXPOSURE TO OCCUPATIONAL ILLNESS

10. Place of accident of exposure: ______________________
    (No. and Street) (City or Town) (State and Zip)
11. Was place of accident or exposure on employer's premises? Yes ( ) No ( )
12. What was the employee doing when injured? ______________________
    (be specific--was employee using tools or equipment
    ____
    or handling material?)
    ____
13. How did the accident occur? ______________________
    (describe fully the events that resulted in the injury or occupational illness.
    ____
    Tell what happened and how. Name objects and substances involved. Give details on all factors that led to
    ____
    accident. Use separate sheet for additional space).
14. Time of accident: ______________________

15. ES WITNESS TO ACCIDENT ______________________________________
(Name) (Affiliation) (Phone No.)

____
(Name) (Affiliation) (Phone No.)

____
(Name) (Affiliation) (Phone No.)

OCCUPATIONAL INJURY OR OCCUPATIONAL ILLNESS

16. Describe injury or illness in detail; indicate part of body affected:

____

____

17. Name the object or substance that directly injured the employee. (for example, object that struck employee; the vapor or poison inhaled or swallowed; the chemical or radiation that irritated the skin; or in cases of strains, hernias, etc., the object the employee was lifting, pulling, etc.).

____

____

18. Date of injury or initial diagnosis of occupational illness: ______________________
(date)

19. Did the accident result in employee fatality? Yes ( ) No ( )

20. Number of lost days ____/restricted workdays ____ resulting from injury or illness?

OTHER

21. Name and address of physician:______________________________________
(No. and Street) (City or Town) (State and Zip)

22. If hospitalized, name and address:______________________________________
(No. and Street) (City or Town) (State and Zip)

Date of report: ____________ Prepared by:______________________________

Official position:________________________

"NEAR MISS" INCIDENT INVESTIGATION REPORT FORM

1) Project name and number:______________________________

2) "Near miss" location:______________________________

3) Incident date and time:______________________________

4) Personnel present (optional):______________________________

5) Describe incident:______________________________
____
____
____
____

6) What action or condition contributed to incident?______________________________
____
____
____

7) What action was taken or suggested to prevent reoccurrence?______________________________
____
____
____

8) Comments______________________________
____
____

9) Date of report________________ Prepared by______________________

10) Office health and safety representative review:

______________________________ ______________________
Signature Date

PARSONS ENGINEERING SCIENCE

SHIPPING PAPER

Shipping Paper No.:________

Page__1__ of ________ ______Parsons Engineering Science____ Date:______________

(name of carrier)

Consignee: Phone:	Shipper: Phone:
Street:	Street:
City: State: Zip:	City: State: Zip:
Route	Vehicle License

No. of Units and Packaging Type	HM	Basic Description (proper shipping name, hazard class, subsidiary risk, identification No. [UN], and packaging group)	Total Quantity (weight, volume, etc.)

PLACARDS TENDERED: yes ☐ no ☐

I HEREBY DECLARE THAT THE CONTENTS OF THIS CONSIGNMENT ARE FULLY AND ACCURATELY DESCRIBED ABOVE BY PROPER SHIPPING NAME AND ARE CLASSIFIED, PACKED, MARKED, AND LABELED, AND ARE IN ALL RESPECTS IN PROPER CONDITION FOR TRANSPORT ACCORDING TO THE APPLICABLE INTERNATIONAL AND NATIONAL GOVERNMENT REGULATIONS.

Name and Title of Shipper	Place and date
Emergency Telephone Number CHEM-TEL, 800/255-3924	Signature of Shipper

ATTACH MATERIAL SAFETY DATA SHEETS

S\FORMS\SHIPTEMP.WW2

PARSONS ENGINEERING SCIENCE, INC.
DAILY VEHICLE INSPECTION REPORT

☑ = OK ☒ = Adjustment Made [R] = Repair Needed

Date:________________ Time: __________ License Plate Number:__________

Vehicle Make and Type:________________ Rental Agency ________________

General Vehicle Inspection:

1. Windshield ☐
2. Vehicle Exterior ☐
3. Vehicle Interior ☐
4. Leaks under Vehicle ☐

Check that the following are in proper working order:

1. Lights:
   a. Headlights ☐
   b. Taillights ☐
   c. Turn Signals ☐
   d. Brake Lights ☐
   e. Back-up Lights ☐
   f. Interior Lights ☐
2. Brakes ☐
3. Horn ☐
4. Tires properly inflated (refer to sticker on door or vehicle manual) ☐
5. Spare tire present and properly inflated ☐
6. Windshield wipers ☐
7. Windshield washers ☐
8. Defrosters/Defoggers ☐
9. Battery terminals free of corrosion ☐
10. Cooling system hoses ☐
11. Belts ☐
12. Fluid levels: (Circle approximate level)

a.	Oil: Full	1 Quart low	Does not register
b.	Coolant: Full cool	Needs some coolant	Does not register
c.	Transmission: Full	1 Pint low	Does not register

(NOTE: Check transmission fluid while vehicle is running!)

d. Fuel: E 1/4 1/2 3/4 F

Please note any problems, unusual conditions, repairs made or fluids added (except fuel):

____

____

____

AIR PURIFYING RESPIRATOR
(APR)

LOG

SITE:

LOCATION:

DATES OF INVESTIGATION:

User	Date of Use	Cleaned and Inspected Prior To Use (Initials)	Cartridges Changed Prior to Use (Yes, No, N/A)	Total Hours on Cartridge

APR Performance Comments:

Project H&S Officer or Parsons ES Project Manager

Date

Return to the Office Health and Safety Representative at the Completion of field activities.

022/722426/7.WW6

SUPPLIED AIR RESPIRATOR
(SAR)

LOG

SITE:

LOCATION:

DATES OF INVESTIGATION:

User	Date of Use	SAR#	Satisfactory (Yes/No)	Check-Out Initials	Date Cleaned

SAR Performance Comments:

Project H&S Officer
or
Parsons ES Project Manager

Date

Return to Office Health and Safety Representative
at the completion of field activities.

022/722426/7.WW6

SELF-CONTAINED BREATHING APPARATUS
(SCBA)

LOG

SITE:

LOCATION:

DATES OF INVESTIGATION:

User	Date of Use	SCBA#	Satisfactory (Yes/No)	Check-Out Initials	Date Cleaned

SCBA Performance Comments:

Project H&S Officer
or
Parsons ES Project Manager

Date

Return to Office Health and Safety Representative
at the completion of field activities.

APPENDIX C

JOB SAFETY ANALYSES

PARSONS ENGINEERING SCIENCE, INC.
JOB SAFETY ANALYSIS

ACTIVITY: General Health and Safety

Potential Hazards	Recommended Controls
Slip, Trip, Fall, Loss of Balance	Site safety briefing Stay alert Maintain firm footing Use "buddy" system Watch for obstacles
Heat/Cold Stress	Wear appropriate clothing Monitor for heat/cold stress as recommended in the HASP Provide adequate drinking water (minimum 1.5 gallons/person) Carry communication equipment
Fire Hazards	Have approved fire protection devices available (see HASP) Equipment will be shut down prior to fueling Use good housekeeping procedures
Noise/Eye Hazards	Use hearing protection when appropriate Use approved safety glasses
Sharp Objects	Wear boots with steel toes and shanks Have a current tetanus booster as recommended by occupational physician Be extra cautious in areas containing medical "sharps"
Biohazard	Biohazard training Stay alert for snakes, insects, and animals Wear high-top safety boots
Physical Exertion	Follow work/rest regime Use "buddy" system Use proper lifting technique, size up the load, never twist or turn when lifting
Construction Hazards	Wear hard-hat, safety glasses, steel-toe/shank boots, and hearing protection when working near heavy equipment Never enter excavations Stay alert Maintain eye contact/communication with equipment operator when working in vicinity

PARSONS ENGINEERING SCIENCE, INC.
JOB SAFETY ANALYSIS

ACTIVITY: Geoprobe Operations

Potential Hazards	Recommended Controls
Operations Hazards Faulty/Damaged Equipment Hand/Power tools Falling Objects Pinch/Contact Points Fire Hazards	Conduct utilities search prior to operation Wear hard-hat and steel-toe/shank boots and proper PPE (see HASP) Stay alert, watch for pinch/contact points (sliding platforms, rotary equipment, etc.) Never place hands on top of rod while it is under the machine Maintain eye contact/communication with equipment operator when working in vicinity Equipment will be operated by trained/experienced personnel only Equipment will be inspected upon arrival and at the beginning of each shift Take vehicle out of gear and set emergency brake before engaging the remote ignition Turn off the hydraulic system while changing rods, inserting the hammer anvil, or attaching accessories Stand to the control side of the machine, clear of the foot and mast Never exert down pressure on the probe rod so as to lift the machine base over 6 inches off the ground Keep feet and hands clear of moving/suspended materials and equipment Machine guards shall remain in place Carry fire extinguisher on board vehicle Be aware of locations of kill switches
Chemical Hazards	Conduct daily site safety briefing Conduct air monitoring as described in the HASP and use the appropriate PPE level Avoid contact with contaminated soil and groundwater Avoid breathing dust by using dust suppression, if necessary Be aware of possible exposure symptoms (e.g., headache, nausea, dizziness, sleepiness, etc.) Immediately report any exposure symptoms to the Site Health and Safety Officer
Physical Exertion	Follow work/rest regime Use "buddy" system Use proper lifting technique, size up the load, never twist or turn when lifting
Noise/Eye Hazards	Use hearing protection when appropriate Use approved safety glasses

ACTIVITY: Geoprobe Operations

Potential Hazards	Recommended Controls
Slip, Trip, Fall, Loss of Balance	Site safety briefing Stay alert Maintain firm footing Watch for obstacles Keep work area free of cords, cables, tools, equipment, etc., to prevent a tripping hazard
Biohazard	Biohazard training Stay alert for snakes, insects, and animals Wear high-top safety boots
Heat/Cold Stress	Wear appropriate clothing Monitor for heat/cold stress as recommended in the HASP Carry drinking water (minimum 1.5 gallons per person) Carry communication equipment
Fire Hazards	Have approved fire protection devices available (see HASP) Equipment will be shut down prior to fueling Use good housekeeping procedures
Sharps/Metal Fragments	Wear boots with steel toes and shanks Have a current tetanus booster as recommended by occupational physician

Equipment to be used	Inspection Requirements	Training Requirements
Communications Equipment Air Monitoring Instruments Drill Rig	Function Test: Communications Equipment Air Monitoring Instruments Inspect Drill Rig Daily	Site-specific training Biohazard training 40-hr OSHA hazardous waste operations training Read and comply with the HASP

PARSONS ENGINEERING SCIENCE, INC.
JOB SAFETY ANALYSIS

ACTIVITY: Drill Rig Operations

Potential Hazards	Recommended Controls
Operations Hazards Faulty/Damaged Equipment Hand/Power tools Falling Objects Pinch/Contact Points Fire Hazards	Wear hardhat and steel-toe/shank boots and proper PPE (see HASP) Stay alert, watch for pinch/contact points (sliding platforms, rotary equipment, etc.) Maintain eye contact/communication with equipment operator when working in vicinity Equipment will be operated by trained/experienced personnel only Equipment will be inspected upon arrival and at the beginning of each shift (e.g., frayed cables, worn fittings, etc.) Equipment found to be unsafe will be tagged and locked out Keep feet and hands clear of moving/suspended materials and equipment Machine guards shall remain in place Use long-handled shovels to remove auger cuttings Carry fire extinguisher on board vehicle Be aware of locations of kill switches
Chemical Hazards	Conduct daily site safety briefing Conduct air monitoring as described in Section 8 of the HASP and use the appropriate PPE level Avoid contact with contaminated soil and groundwater Avoid breathing dust by using dust suppression, if necessary Be aware of possible exposure symptoms (e.g., headache, nausea, dizziness, sleepiness, etc.) Immediately report any exposure symptoms to the Site Health and Safety Officer
Physical Exertion	Follow work/rest regime Use "buddy" system Use proper lifting technique, size up the load, never twist or turn when lifting
Noise/Eye Protection	Use hearing protection when appropriate Use approved safety glasses
Slip, Trip, Fall, Loss of Balance	Site safety briefing Stay alert Maintain firm footing Watch for obstacles

PARSONS ENGINEERING SCIENCE, INC.
JOB SAFETY ANALYSIS

ACTIVITY: Drill Rig Operations

Potential Hazards	Recommended Controls
Biohazard	Biohazard training Stay alert for snakes, insects, and animals Wear high-top safety boots
Heat/Cold Stress	Wear appropriate clothing Monitor for heat/cold stress as recommended in the HASP Carry drinking water (minimum 1.5 gallons per person) Carry communication equipment
Fire Hazards	Have approved fire protection devices available (see HASP) Equipment will be shut down prior to fueling Use good housekeeping procedures
Sharps/Metal Fragments	Wear boots with steel toes and shanks Have a current tetanus booster as recommended by occupational physician

Equipment to be used	Inspection Requirements	Training Requirements
Communications Equipment Air Monitoring Instruments Drill Rig	Function Test: Communications Equipment Air Monitoring Instruments Inspect Drill Rig Daily	Site-specific training Biohazard training 40-hr OSHA hazardous waste operations training Read and comply with the HASP

PARSONS ENGINEERING SCIENCE, INC.
JOB SAFETY ANALYSIS

ACTIVITY: Backhoe Operations

Potential Hazards	Recommended Controls
Underground/Aboveground Utilities	Conduct utilities search prior to operations Mark utility locations for avoidance
Impact by Backhoe Arm (boom)	Fully extend bucket arm and define swing radius by inscribing an arc in the soil with the bucket or by delineating swing radius with traffic cones, barrier tape, or other suitable means No personnel will be allowed within swing radius during operations Personnel must establish eye contact with the operator and wait until the backhoe bucket is swung to one side and lowered to the ground, or the unit shut off, before entering the swing radius area.
Noise/Eye/Foot/Head Impact Hazards	Wear hearing protection when working near the backhoe Wear eye protection Wear hard hat Wear steel-toed, steel-shanked work boots
Excavation Cave-In	No person shall enter the excavation until it is properly sloped/shored and certified by a competent person Personnel must stay at least 3 feet away from sides and ends of trench. If workers must approach closer than 3 feet, they shall wear safety harness and be attached to a life line.
Chemical Hazards	Conduct daily site safety briefing Conduct air monitoring as described in the HASP and use the appropriate PPE level Avoid contact with contaminated soil and groundwater Avoid breathing dust by using dust suppression, if necessary Be aware of possible exposure symptoms (e.g., headache, nausea, dizziness, sleepiness, etc.) Immediately report any exposure symptoms to the Site Health and Safety Officer
Physical Exertion	Follow work/rest regime Use "buddy" system Use proper lifting technique, size up the load, never twist or turn when lifting

PARSONS ENGINEERING SCIENCE, INC.
JOB SAFETY ANALYSIS

ACTIVITY: Backhoe Operations

Potential Hazards	Recommended Controls
Slip, Trip, Fall, Loss of Balance	Site safety briefing Stay alert Maintain firm footing Watch for obstacles Keep work area free of cords, cables, tools, equipment, etc., to prevent a tripping hazard
Biohazard	Biohazard training Stay alert for snakes, insects, and animals Wear high-top safety boots
Heat/Cold Stress	Wear appropriate clothing Monitor for heat/cold stress as recommended in the HASP Carry drinking water (minimum 1.5 gallons per person) Carry communication equipment
Fire Hazards	Have approved fire protection devices available (see HASP) Equipment will be shut down prior to fueling Use good housekeeping procedures

Equipment to be used	Inspection Requirements	Training Requirements
Communications Equipment Air Monitoring Instruments Backhoe	Function Test: Communications Equipment Air Monitoring Instruments Inspect backhoe Daily	Site-specific training Biohazard training 40-hr OSHA hazardous waste operations training Read and comply with the HASP

PARSONS ENGINEERING SCIENCE, INC.
JOB SAFETY ANALYSIS

ACTIVITY: General Field Vehicle Operations

Potential Hazards	Recommended Controls
Speeding	Observe posted speed limits Keep vehicle under control Operate at lesser speeds consistent with conditions
Backing up	Visual check around and behind vehicle Backup alarm or use observer to guide you Notify bystanders that vehicle is backing up (verbally or sound horn)
Unsafe Equipment	Perform vehicle inspection prior to shift Repair or replace defective equipment
Unfamiliar Area	Obtain map and/or detailed directions Lock doors
Unfamiliar Vehicle (e.g., rental car)	Familiarize yourself with controls Adjust seat, mirrors, etc. prior to putting vehicle in motion Set radio stations prior to putting vehicle in motion

PARSONS ENGINEERING SCIENCE, INC.
JOB SAFETY ANALYSIS

ACTIVITY: Concrete Coring/Chip Sampling

Potential Hazards	Recommended Controls
Nois e/Eye Hazards	Use hearing protection Use approved safety glasses
Electrical Hazards	Conduct utility clearance prior to coring to avoid electrical and other utilities Connect coring machine to ground-fault circuit interrupter (GFCI)) Inspect power cords for defects; replace if necessary Wear rubber-soled boots
Physical Exertion	Follow work/rest regime Use "buddy" system Use proper lifting technique, size up the load, never turn or twist when lifting
Heat/Cold Stress	Wear appropriate clothing Monitor for heat/cold stress as recommended in the HASP Provide adequate drinking water (minimum 1.5 gallons/person)
Slip, Trip, Fall, Loss of Balance	Stay alert Keep electrical cords and water hoses out of way as much as possible Watch for obstacles Maintain firm footing Use "buddy" system
Pinch/Contact Points	Keep hands and feet clear of rotating machinery Wear steel-toed safety boots Wear leather gloves

APPENDIX B

PROJECT-SPECIFIC ADDENDUM TO THE PROGRAM HEALTH AND SAFETY PLAN

ADDENDUM TO THE
PROGRAM HEALTH AND SAFETY PLAN
FOR

ENHANCED *IN-SITU* BIOREMEDIATION OF HALOGENATED COMPOUNDS

ALTUS AIR FORCE BASE
OKLAHOMA

April 2002

REVIEWED AND APPROVED BY:

	Name	Date
Project Manager		
Program Health & Safety Manager		

1.0 INTRODUCTION

This addendum modifies the existing Program Health and Safety Plan (HASP) entitled *Program Health and Safety Plan for Enhanced In-Situ Bioremediation of Halogenated Compounds* (Parsons Engineering Science, Inc., 2000) for conducting enhanced bioremediation pilot studies at several US Air Force installations.

Under Air Force Center for Environmental Excellence Contract No. F41624-00-D-8024, Delivery Order 0011, Parsons, Inc. (Parsons) will document the enhanced *in-situ* bioremediation of chlorinated aliphatic hydrocarbon (CAH) impacted groundwater using a permeable reactive biowall (biowall) at Operable Unit 1 (OU-1), Altus Air Force Base (the Base), Altus, Oklahoma. This addendum to the aforementioned Program HASP was prepared to address the field task associated with Delivery Order No. 0011. Included or referenced in this addendum are the scope of services, site-specific description and history, project team organization, hazard evaluation of known or suspected chemicals, evaluation of physical hazards, emergency contact information and decontamination procedures. All other applicable portions of the Program HASP remain in effect.

Site-specific health and safety briefings will be conducted daily prior to the commencement of field activities to communicate the site-specific hazards, activities, and procedures to all field personnel. Documentation of training and briefings, including agenda and signatures of attending personnel, will be maintained onsite.

2.0 SCOPE OF SERVICES

Field activities associated with this project include installation of system components (i.e., biowall, groundwater and soil vapor monitoring points), baseline sampling, and subsequent process monitoring. Specifically, these activities include the following:

- Installation of a 500-foot long, 1.5-foot wide, and 25-foot deep biowall using continuous trenching technology;
- Installation of 10 groundwater monitoring points using hollow stem auger (HSA) drilling technology;
- Installation of four (4) soil vapor monitoring points using HSA drilling technology;
- Baseline sampling of proposed and preexisting groundwater monitoring points, and proposed soil vapor monitoring points immediately following installation of the biowall; and
- Process monitoring of proposed and preexisting groundwater monitoring points, and proposed soil vapor monitoring points 6 and 12 months after installation of the biowall.

A continuous trenching machine will be employed to excavate the trench for the biowall and simultaneously place a mixture of sand and mulch into the trench. The trencher is a track-mounted vehicle that has a cutting boom resembling a large chain saw (i.e., linked chain belt with cutting teeth). A steel box with a hopper assembly is fitted atop the cutting boom. The cutting boom excavates a trench by rotating the cutting chain until the boom has achieved the desired depth of excavation relative to the ground surface. The steel box and hopper assembly provide for stabilization of the excavation sidewall during excavation and subsequent placement of the sand and mulch mixture, which is introduced through the feed hopper. Simultaneous excavation and placement of backfill materials eliminates concerns associated with open excavations.

3.0 SITE DESCRIPTION AND HISTORY

The Base occupies an area of over 2,500 acres in eastern Jackson County, Oklahoma. It is bordered by the city of Altus on the west, Highway 62 on the south, and agricultural land on the north and east. The city of Altus is located approximately 140 miles southwest of Oklahoma City, Oklahoma.

OU-1 is located in the northeast corner of the Base. OU-1 consists of several former waste management areas, including Landfill No. 3 and the petroleum, oils, and lubricants (POL) Tank Sludge Burial area. Historical waste management activities at OU-1 have resulted in low concentrations of CAHs and petroleum hydrocarbons in groundwater at the project site. The proposed location for the biowall is along a portion of the eastern boundary of OU-1. Groundwater and soil vapor monitoring points will be installed within the immediate vicinity (i.e., 100 feet) of the biowall. The project site is essentially flat with a surface cover of native grasses. Physical features within the immediate vicinity of the project site are limited to surface casings for existing groundwater monitoring points.

4.0 PROJECT TEAM ORGANIZATION

The project team assigned to the intrinsic remediation demonstration activities at Altus AFB is identified below.

Mr. Bruce Henry	Project Manager
Mr. Todd Wiedemeier	Technical Director
Mr. Micah Goodspeed	Site Manager
Mr. Micah Goodspeed	Site Health and Safety Officer
Mr. Dewey Cooper	Altus Air Force Base Site Contact
Mr. James Gonzales	AFCEE Contact

5.0 HAZARD EVALUATION

5.1 Chemical Hazards

Potential chemical hazards are addressed below and in the Program HASP. Project-specific hazards are identified below.

As identified in Section 3.0, historical waste management activities at OU-1 have resulted in low concentrations of CAHs and petroleum hydrocarbons in groundwater at the project site. The primary chlorinated solvents include trichloroethene (TCE), and the daughter product cis-1,2 dichloroethene (cis-1,2-DCE). Concentrations of TCE in groundwater samples collected in April 1999 ranged from 6,110 micrograms per liter (μg/L) to less than the analytical methods detection limit (< 1 μg/L). Concentrations of cis-1,2-DCE in the same groundwater samples ranged from 590 μg/L to less than the analytical methods detection limit (< 1 μg/L). Concentrations of benzene and toluene were detected at 1.0 and 1.4 μg/L, respectively in the collected samples.

Health hazard qualities for the aforementioned compounds are presented at the end of this addendum. Material Safety Data Sheets for PID calibration gases (see Section 11 of the Program HASP) will be maintained onsite during field operations for reference to safety hazards and storage criteria.

If additional compounds are discovered during the course of field activities, this health and safety plan addendum shall be amended and pertinent information about the compounds will be communicated to all field personnel.

5.2 Physical Hazards

Potential physical hazards at this site include risks associated with construction equipment, the HSA drill rig, and the continuous trenching machine; the operation of motor vehicles; the presence of overhead and underground utilities; slip, trip, and fall hazards; excessive noise; and severe weather exposure (i.e., excessive heat, lightning, etc.).

Safe work practices related to the site physical hazards are contained in Sections 5 and 9 of the Program HASP.

5.2.1 Noise-Induced Hearing Loss

Hearing protection will be required for personnel working within 30 feet of construction and drilling equipment. Additional information on noise protection is available in Section 5.2.7 of the Program HASP.

5.3 Biological Hazards

Various biological hazards may be encountered at Altus AFB. These hazards include snakes; scorpions; pathogenic organisms or diseases such as Hantavirus, Bubonic Plague, Equine Encephalitis, and Lyme Disease. Other biological hazards include insects, spiders, and cactuses or other harmful plants (such as poison ivy). Sturdy work clothes and shoes will be worn by field personnel to help prevent injuries.

5.3.1 Venomous Snakes

The prairie rattlesnake is a venomous snake that may be encountered at some sites. . It is brownish or greenish brown with blotches of variable shape bordered with white along their backs. It ranges in length from three to five feet. These snakes are not particularly aggressive and inhabit fields, pine habitats, sandy areas, cultivated land, forests, rocky slopes, and along streams. They are active at night on or near paved roads.

Some rattlesnakes, such as the eastern diamondback rattlesnake do not always rattle before striking. These snakes are up to six feet long with brown, black, and beige diamond marks on their backs. They typically live in old animal burrows in forests near palmetto bushes, but can also live near fresh or salt water.

Rattlesnakes often seek cover under rocks, shrubs, and logs. Personnel should check carefully before sitting down in these types of areas, and never place hands or feet where they are not easily seen.

The cottonmouth or water moccasin has a thick body, typically two to four feet long. It is light brown with black and olive patterns when young, and all black when older. It has no rattle, is aggressive, and may strike several times. It typically lives near fresh-water swamps, lakes, streams, and ditches.

Coral snakes are skinny and approximately two feet long, and have black noses and distinguishing rings of red, yellow, and black along their bodies. They do not have long fangs, and actually chew on a person to inject venom. While other snakes make look like coral snakes, the coral snakes have red and yellow colorations touching, while the non-poisonous snakes have red and black colorations touching.

The bite of a venomous snake is extremely painful and swells rapidly. It is usually marked by one or more puncture marks created by the fangs. Skin discoloration may occur within hours. Also common are weakness, sweating, faintness, nausea, tender lymph nodes, and tingling or numbness of the tongue, mouth, or scalp. The victim should be transported to the hospital as quickly as possible. First aid should consist of keeping the victim as calm and immobile as possible, preferably lying down, and immobilizing the bitten extremity, keeping it at or below heart level to slow the spread of any poison through the body. Do not cut the wound, apply a tourniquet, or use a snakebite kit. Cold therapy is not recommended, nor is alcohol, sedatives, aspirin, or any medicine containing aspirin. Transport the victim to the hospital as soon as possible. If possible (without undo risks to personnel), obtain the snake for identification purposes.

5.3.2 Insect/Arachnid Bites and Stings

Poisonous insects and insect-like creatures at some sites may include red fire ants, bees (honeybees, bumble bees, wasps, and hornets), mosquitoes, spiders, and scorpions.

Red fire ants may be observed, especially in the vicinity of existing monitoring wells. Do not stand on, place equipment on, or otherwise disturb the anthills. It is also advisable to place a four-foot square piece of plywood where personnel need to stand. An insect repellent may be used if it does not interfere with the desired sampling analyses. Tyvek® suits can be worn or latex booties can be taped at the top to the pants of field personnel. Frequent self-checks for crawling ants should also be performed.

Mild insect stings and bites should be treated by applying a baking soda paste or ice wrapped in a wet cloth. Do not pull out stingers with tweezers or your fingers. Stingers should be gently scraped from the skin, working from the side of the sting, using your fingernail, the edge of a credit card, a dull knife blade, or other straightedge object.

Equine encephalitis, an inflammation of the brain, can be carried by mosquitoes. Symptoms range from none to mild, flu-like symptoms (fever, headache, sore throat) to rare infection of the central nervous system with sudden fever and severe headaches followed quickly by seizures and coma. In the more severe variety, the mortality rate is up to 60%, with permanent brain damage in many of the survivors. Field personnel must wear long-sleeved clothing and/or use DEET-containing insect repellents if they are working in areas of mosquito infestations.

The two poisonous spiders likely to be encountered are the Brown Recluse and the Black Widow. They are usually found in buildings, utility box or monitoring well covers, or piles of debris, rocks, wood, or leaves. These spiders are typically non-aggressive, and bite only when disturbed. The Brown Recluse is up to one inch long with a violin or "fiddle" shaped mark on the top of the head. It is generally brown, but more poisonous varieties may be pale-brown, reddish-brown, orange, or gray. The Black Widow is a smaller, bulbous black spider with a red or yellow hourglass-shaped mark on the underside. It weaves shapeless diffuse webs in undisturbed areas.

Persons who are believed to have been bitten by a Brown Recluse or Black Widow spider should be immediately transported to a hospital. The spider should be collected for confirmation of the species.

Reactions to a Brown Recluse spider bite may be nothing, immediate, or delayed, depending upon the sensitivity of the person bitten and the amount of venom injected. A small white blister often occurs at the bite site surrounded by a swollen area. Within 24 to 36 hours, the victim may experience fever, chills, restlessness, weakness, nausea, and joint pain. Within 24 hours, the bite site can erupt into a "volcanic lesion", which produces a hole in the flesh due to damaged gangrenous tissue. The open wound may range in size from an adult thumbnail to the span of a hand, with recovery taking months, and sometimes requiring plastic surgery and skin grafts.

Reactions to a Black Widow spider include intense pain at the site of the bite after approximately 15 to 60 minutes, followed by profuse sweating, rigid abdominal muscles, muscle spasms, breathing difficulty, slurred speech, poor coordination, dilated pupils, and generalized swelling of face and extremities. Death may occur due to complications, but usually not from the bite itself.

Contrary to popular belief, the tarantula is harmless to humans, with a bite similar to a bee sting, producing mild to moderate pain and slight swelling. It is tan or brown to black in color, and is typically nocturnal.

There are several types of scorpions native to the United States. Scorpions may be brown to yellowish in color, and range from 1/2 inch to 8 inches in length. Their bodies are divided into two parts: a short, thick upper body, and a long abdomen with a six-segment tail. A scorpion has six pairs of jointed appendages: one pair of small pincers, one pair of large claws, and four pairs of jointed legs. They are most active at night. A scorpion sting is very painful, but usually will not result in death.

If insect/arachnid stings or bites become red or inflamed or symptoms such as nausea, dizziness, shortness of breath, appear, medical care will be sought. Apply antiseptic solution to prevent infection, and ice packs to relieve swelling. Immediate care is needed if a person is allergic to insect bites/stings. Personnel with insect allergies should inform the Project Manager, Site Manager, Project Health and Safety Officer, and Site Safety and Health Officer (SSHO). If an allergic person receives a spider bite or insect bite/sting, seek immediate medical attention, keep the victim calm, and check vital signs frequently. Rescue breathing should be given if necessary to supply oxygen to the victim. The victim may experience swelling of the breathing passageways. If this occurs, the person providing the rescue breathing may have to slightly increase the air pressure to ensure that the victim receives an adequate supply of air.

5.3.3 Ticks

The primary hazards associated with ticks are Lyme disease and Rocky Mountain Spotted Fever. In the southeastern United States, Lyme disease is transmitted by the Deer Tick. This tick is very small (about the size of this asterisk: *), is red in color, and has black legs. Transmission of Lyme disease is most likely in late spring, summer, and early fall.

There are three stages of Lyme disease, although not everyone will proceed through all the stages or experience all the symptoms. The initial symptoms may include a red rash that is circular and blotchy and expands around the tick bite, and flu-like symptoms such as fatigue, headaches, fever, swollen glands, and stiffness and pain in muscles and joints. The next stage can occur from a few days to a few weeks after the initial stage. Symptoms of this phase may include irregular heartbeat, facial paralysis, joint pain, irritability, headaches, dizziness, poor coordination, weakness, severe fatigue, and memory loss. The third stage may occur weeks to years after the second stage. Arthritis, often in the knees, is the most common symptom of this stage. The arthritis may disappear and recur many times, and chronic arthritis may develop.

People get Rocky Mountain spotted fever from the bite of an infected tick or by contamination of the skin with the contents of an attached tick when it is removed from the skin. Rocky Mountain spotted fever is spread from person to person, except rarely by blood transfusion. People with Rocky Mountain spotted fever get a sudden fever (which can last for 2 or 3 weeks), severe headache, tiredness, deep muscle pain, chills, nausea, and a characteristic rash. The rash might begin on the legs or arms, can include the soles of the feet or palms of the hands, and can spread rapidly to the trunk or the rest of the body. Symptoms usually begin 3 to 12 days after a tick bite.

If found crawling on a person, ticks should be removed and burned or smashed between two rocks. Do not smash ticks with fingers. If a tick is found to be holding onto the skin, the tick should be covered with Vaseline until it can no longer breathe and backs out of the skin. At that time, all parts of the tick should be removed with tweezers. Areas of the skin where the tick may have crawled, as well as bite area will be scrubbed with soap and water. Hot showers are to be taken as soon as possible after site departure to wash away all ticks that have not adhered to the skin. Prompt medical treatment with antibiotics is usually successful in preventing further complications from Lyme disease. Lyme disease becomes more difficult to treat the longer treatment is delayed. .

To prevent tick bites, it is recommended that DEET (vapor-active repellent) be applied to any exposed skin surface (except lips and eyes), and apply permethrin repellent spray to field clothing. It should be noted that the permethrin repellent should be allowed to dry on the clothing before putting the clothing onto the body. This combination of deet and permethrin provides the maximum protection from ticks. Long-sleeved shirts with snug collar and cuffs, pants tucked into socks, and personal protective equipment will offer some protection. Personnel should perform self-checks for ticks at the end of each workday

5.3.4 Fleas

Bubonic plague is a bacterial disease that is spread to humans by fleas that have bitten an infected animal. Bubonic plague displays symptoms rapidly. Chills and fever are soon accompanied by swelling of the lymph nodes, usually on one side of the body. These painful swellings are usually dark blue to black, hence the other common name for this disease, "black death." The disease is treatable with antibiotics. Field personnel must wear Tyvek® suits with leg seams taped to boots or boot covers to minimize contact with fleas while working in prairie dog towns.

5.3.5 Rodents

Hantavirus has been reported from the "Four Corners" area of the southwestern U.S. The Four Corners strain of Hantavirus has had a 60 percent mortality rate. Deer mice are the primary reservoir for the virus. The virus is excreted in mouse feces, urine, and saliva. People become infected when the virus is inhaled, through breaks in the skin, by ingesting contaminated food or water, or by being bitten by an infected rodent.

The incubation period for Hantavirus may be three days to six weeks. Symptoms include fever, chills, headache, dizziness, muscle aches, dry cough, nausea, vomiting, abdominal cramps, diarrhea, and shortness of breath. Progression of the disease leads to fluid in the lungs, heart irregularities, and kidney failure. Personnel will use HEPA-equipped air-purifying respirators when working in rodent-infested areas or when entering sheds of buildings containing mice infestations.

Small rodents, called nutria, have also been observed at some sites. Resembling beavers with round tails, these animals have created an abundance of burrows that provide a tripping hazard for field personnel. Care must be taken when walking in grassy areas to avoid tripping or twisting of ankles and knees.

5.3.6 Poisonous/Spiny Plants

The majority of skin reactions following contact with offending plants is allergic in nature and is characterized by general symptoms of headache and fever, itching, redness, and a rash.

Some of the most common and severe allergic reactions result from contact with plants of the poison ivy group, including poison oak and poison sumac. Such plants produce a severe rash characterized by redness, blisters, swelling, and intense burning and itching. The victim also may develop a high fever and may be very ill. Ordinarily, the rash begins within a few hours after exposure, but it may be delayed for 24 to 48 hours.

The most distinctive features of poison ivy, poison oak, and poison sumac are their leaves. Poison ivy is a woody vine whose leaves are divided into three leaflets. Poison oak is a low branching shrub with leaflets also in threes. Poison sumac is a shrub or small tree occurring in swamps. Poison sumac has 7 to 13 leaflets that resemble those of green ash trees. In certain seasons, all three plants also have greenish-white flowers and berries that grow in clusters.

A person experiencing symptoms of poison ivy or poison oak should remove contaminated clothing; wash all exposed areas thoroughly with soap and water. Apply calamine or other poison ivy/oak/sumac lotion if the rash is mild. Seek medical advice if a severe reaction occurs, or if there is a known history of previous sensitivity. Oak/ivy/sumac cleanser can be used after site work or after potential exposure to reduce chances of irritation. Personnel must wear Tyvek® suits or other protective clothing when working in areas containing these plant species.

The star thistle plant is a gray-green to blue-green plant with yellow or pale purple thistle-like flowers with sharp spines, and grows to heights varying from six inches to five feet. The blooming period is typically from May to June. The star thistle is poisonous to horses when ingested, but is harmless to humans except for the spiny nature of the plants, which can result in scratches and lacerations. Personnel are advised to wear sturdy work clothes including long-sleeved shirts and heavy work gloves as necessary.

Cactuses and other non-poisonous spiny or thorny plants may also be common at the various installations. Personnel are advised to wear sturdy work clothes, including long-sleeved shirts and heavy work gloves as necessary to protect against skin punctures.

6.0 EMERGENCY RESPONSE PLAN

Emergency response protocols are provided in Section 6 of the Program HASP. Accident reporting requirements are specified on Page 6-3 of the Program HASP. Appendix B of the Program HASP contains the Parsons accident report form, which must be completed following an accident. Site-specific emergency response information is outlined below.

6.1 Emergency Information

Listed below are the names and telephone numbers for medical and emergency services in the event of any situation or unplanned occurrence requiring assistance. For emergency situations, telephone or radio contact should be made with the site point of contact or site emergency personnel who will then contact the appropriate response team. A list of emergency contacts must be posted at the site.

Contingency Contacts	Firm or Agency	Telephone Number
Police	City of Altus (non emergency)	(580) 481-2220
	Emergency	911
Fire	City of Altus (non emergency)	(580) 481-2230
	Emergency	911

Hospital	Jackson County Memorial Hospital 1200 East Pecan Altus, Oklahoma	(580) 482-4781
Ambulance	Altus AFB	911
Poison Control Center		(800) 523-2222
Dewey Cooper	Site Contact	(580) 481-7605
James Gonzales	AFCEE Contact	(210) 536-4324
Medical Emergency	Altus AFB Hospital Building 46 Altus AFB, Oklahoma *Located on Altus AFB north of B Avenue between Altus Road and 1st Street*	(580) 481-5970
Base Hospital		

6.2 Directions to Base Hospital from OU-1

Exit the Base using the South Gate and turn right (west) on US Highway 62 (Broadway Street) and proceed approximately 1.5 miles to South Park Lane. The city pool is at the northeast corner US Highway 62 and South Park Lane. Turn left (south) on South Park Lane and proceed west approximately two blocks. The hospital is on the east side of South Park Lane. The route to the hospital is shown on Figure 6.1.

Parsons Contacts	**Telephone Number**
Bruce Henry Parsons Project Manager	(303) 831-8100 or 764-1986 (W) (303) 422-4019 (H)
Timothy Mustard, C.I.H. Program Health and Safety Manager (Denver)	(303) 831-8100 or 764-8810 (W) (303) 450-9778 (H)
Ed Grunwald, C.I.H. Corporate Health and Safety Manager (Atlanta)	(678) 969-2394 (W) (404) 299-9970 (H)
Judy Blakemore Asst. Program Health and Safety Manager (Denver)	(303) 831-8100 or 764-8861 (W) (303) 831-4028 (H) (303) 817-9743 (M)
Parsons 24-Hour Emergency Contact Service	(866) 727-1411 (toll free)

Figure 6.1 Directions to Hospital

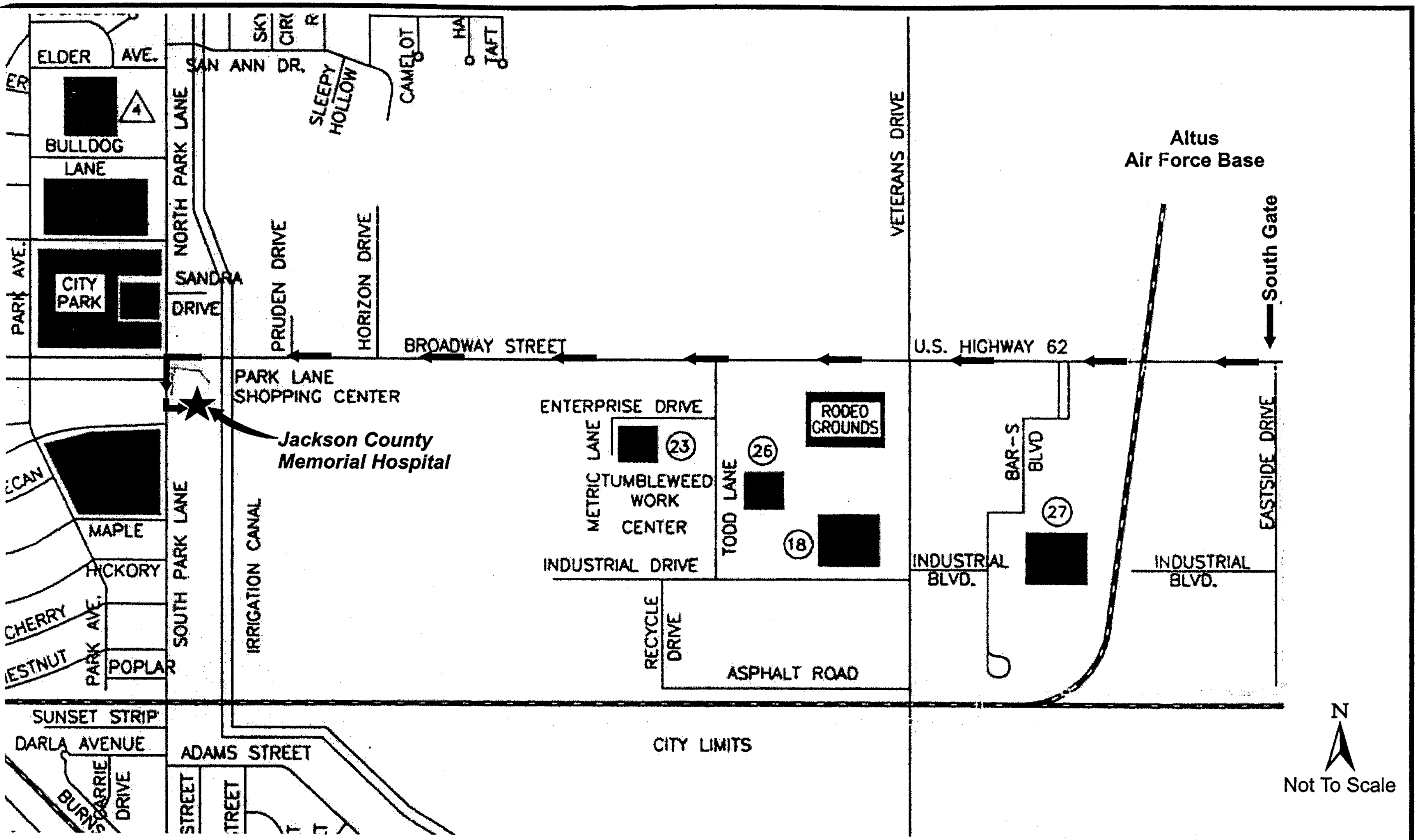


FIGURE 6.1

DIRECTION TO JACKSON COUNTY MEMORIAL HOSPITAL

OU-1 Permeable Reactive Biowall
Altus AFB, Oklahoma

PARSONS
Denver, Colorado

Source: Glenn Briggs & Associates, Inc, 2000

draw\738863altus.cdr scan nap 3/25/02

7.0 LEVELS OF PROTECTION AND PERSONAL PROTECTIVE EQUIPMENT REQUIRED FOR SITE ACTIVITIES

The personal protection level prescribed for field activities at Altus AFB is Occupational Safety and Health Administration (OSHA) Level D with a contingency for the use of OSHA Level C or B, as site conditions require. This addendum and the flow chart presented in Figure 7.1 of the Program HASP will be used to select respiratory protection with the following comments and additions.

If sustained air-monitoring readings in the worker-breathing zone indicate vapor concentrations greater than background for 30 seconds or longer, the field crew will be forced to evacuate and ventilate the area until readings are less than 1 part per million (ppm) in the worker-breathing zone. If ventilation is inadequate, air samples will be taken to confirm or deny the existence of the contaminants of concern and/or the crew will upgrade to Level B respiratory protection. These air samples will be sent to a lab to be analyzed by US Environmental Protection Agency (USEPA) Compendium Method TO-14 or the equivalent. Decisions for further actions and for levels of respiratory protection will be made after consulting with the project manager and program health and safety manager.

Section 7 of the Program HASP contains guidelines for levels of protection and the selection of personal protective equipment (PPE). PPE will be required when handling contaminated samples and when working with potentially contaminated materials. See page 7-4 of the Program HASP for PPE to be used.

8.0 FREQUENCY AND TYPES OF AIR MONITORING

A photoionization detector (PID) with an 11.7 electron volts (eV) (HNU®) or equivalent lamp will be used for air monitoring during this project since the ionization potentials of the contaminants of concern are below 11.7 eV.

HEALTH HAZARD QUALITIES OF HAZARDOUS SUBSTANCES OF CONCERN

Compound	PEL [a/] (ppm)	TLV [b/] (ppm)	IDLH [c/] (ppm)	Odor Threshold[d/] (ppm)	Ionization Potential[e/] (eV)	Physical Description/Health Effects/Symptoms
Benzene	1 (29 CFR 1910.1028) [f/]	0.5 (skin) [g/]	500	4.7	9.24	Colorless to light-yellow liquid (solid<42°F) with an aromatic odor. Eye, nose, skin, and respiratory system irritant. Causes giddiness, headaches, nausea, staggered gait, fatigue, anorexia, exhaustion, dermatitis, bone marrow depression, and leukemia. Mutagen, experimental teratogen, and carcinogen.
Chloroform (Trichloromethane)	2	10	500	205 [h/]	11.42	Colorless, heavy liquid with pleasant odor. Irritates eyes and skin. Anaesthetic. Causes dizziness, mental dullness, nausea, confusion, headache, fatigue, anesthesia, and enlarged liver. Also attacks kidneys and heart. In animals, causes liver and kidney cancer. Mutagen, experimental teratogen, and carcinogen.
1,1-Dichloroethene (DCE) (Vinylidene Chloride)	1	5	NA [i/]	NA	10.00	Colorless liquid or gas (>89°F) with a mild, sweet, chloroform-like odor. Irritates eyes, skin, and throat. Causes dizziness, headaches, nausea, shortness of breath, liver and kidney dysfunctions, and lung inflammation. Mutagen and carcinogen.
1,2-Dichloroethene (DCE) (cis- and trans-isomers)	200	200	1,000	0.085-500	9.65	Colorless liquid (usually a mixture of cis- and trans- isomers), with a slightly acrid, chloroform-like odor. Irritates eyes and respiratory system. CNS depressant. Cis- isomer is a mutagen.
Toluene	100	50 (skin)	500	0.2-40 [h/]	8.82	Colorless liquid with sweet, pungent, benzene-like odor. Irritates eyes and nose. Causes fatigue, weakness, dizziness, headaches, hallucinations or distorted perceptions, confusion, euphoria, dilated pupils, nervousness, tearing, muscle fatigue, insomnia, skin tingling, dermatitis, bone marrow changes, and liver and kidney damage. Mutagen and experimental teratogen.
Trichloroethene (TCE)	50	50	1,000	21.4-400	9.45	Clear, colorless or blue liquid with chloroform-like odor. Irritates skin and eyes. Causes fatigue, giddiness, headaches, vertigo, visual disturbances, tremors, nausea, vomiting, drowsiness, dermatitis, skin tingling, cardiac arrhythmia, and liver injury. In animals, causes liver and kidney cancer. Mutagen, experimental teratogen, and carcinogen.

a/ PEL = Permissible Exposure Limit. OSHA-enforced average air concentration to which a worker may be exposed for an 8-hour workday without harm. Expressed as parts per million (ppm) unless noted otherwise. PELs are published in the *NIOSH Pocket Guide to Chemical Hazards*, 1997. Some states (such as California) may have more restrictive PELs. Check state regulations.

b/ TLV = Threshold Limit Value - Time-Weighted Average. Average air concentration (same definition as PEL, above) recommended by the American Conference of Governmental Industrial Hygienists (ACGIH), 2001 *TVLs® and BEIs®*.

HEALTH HAZARD QUALITIES OF HAZARDOUS SUBSTANCES OF CONCERN

Compound	PEL [a/] (ppm)	TLV [b/] (ppm)	IDLH [c/] (ppm)	Odor Threshold[d/] (ppm)	Ionization Potential[e/] (eV)	Physical Description/Health Effects/Symptoms

c/ IDLH = Immediately Dangerous to Life or Health. Air concentration at which an unprotected worker can escape without debilitating injury or health effects. Expressed as ppm unless noted otherwise. IDLH values are published in the *NIOSH Pocket Guide to Chemical Hazards* , 1997.
d/ When a range is given, use the highest concentration.
e/ Ionization Potential, measured in electron volts (eV), used to determine if field air monitoring equipment can detect substance. Values are published in the *NIOSH Pocket Guide to Chemical Hazards* , June 1997.
f/ Refer to expanded rules for this compound.
g/ (skin) = Refers to the potential contribution to the overall exposure by the cutaneous route.
h/ Olfactory fatigue has been reported for the compound and odor may not serve as an adequate warning property.
i/ NA = Not available.

APPENDIX C

SELECTED DATA FROM PREVIOUS SITE INVESTIGATIONS

GEOLOGIC BORING LOG

BORING NO.:	OU-1-05	CONTRACTOR:	USEPA	DATE SPUD:	4/8/97 2:00p
CLIENT:	AFCEE	RIG TYPE:	Giddings	DATE CMPL.:	4/9/97 11:30a
JOB NO.:	722450.36020	DRLG METHOD:	Hollow Stem Auger	ELEVATION:	
LOCATION:	Altus AFB OU-1	BORING DIA.:	6.5"	TEMP:	45°F
GEOLOGIST:	Cindy Merrill	DRLG FLUID:	none	WEATHER:	Windy, rain
COMENTS:					

Elev (ft)	Depth (ft)	Profile	USCS	Geologic Description	Sample No.	Sample Depth (ft)	Sample Type	Penet Res	PID (ppm)	TLV (ppm)	TOTAL BTEX (ppm)	TPH (ppm)
	1		OL	loose grey clayey SILT								
						4.5			7.0			
	5		CL	red-brown silty CLAY		7.5			21.5			
	10–25			no samples collected 9' to BOH; sampler will not penetrate								
			CH	formable stiff red-brown CLAY								
	30					30.			Ø			
				BOH								
	35											

NOTES

- BGS – Below Ground Surface
- GS – Ground Surface
- TOC – Top of Casing
- NS – Not Sampled
- SA – Same As Above

SAMPLE TYPE

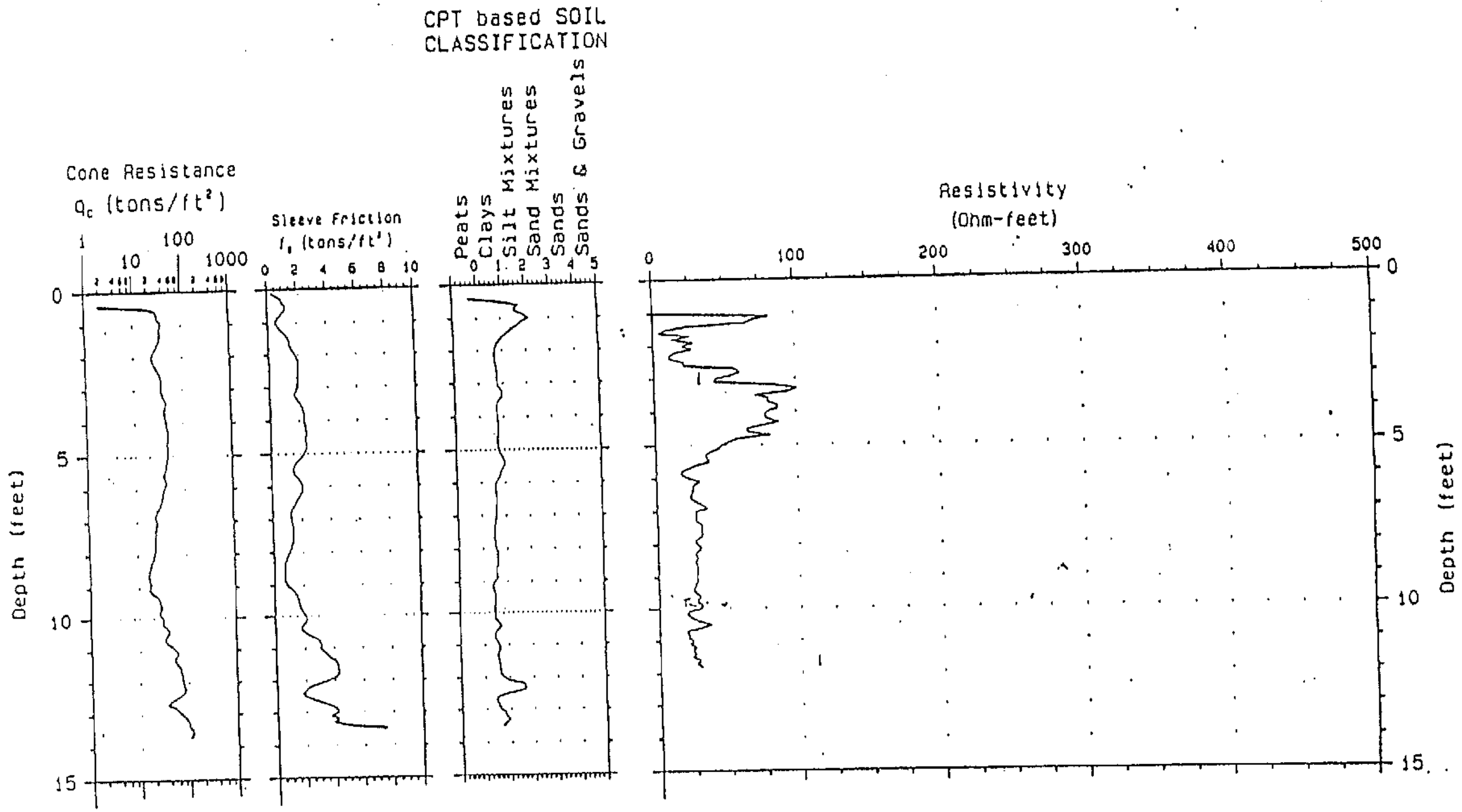
- D – DRIVE
- C – CORE
- G – GRAB
- Water level drilled

FIGURE 3.3

GEOLOGIC BORING LOG

OU1
Remediation by Natural Attenuation TS
Altus AFB, Oklahoma

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado



CPT: R23

STATE COORDINATES:

EASTING (ft.)	NORTHING (ft.)	ELEVATION (ft.)
0	0	0

Project: Altus AFB

HTRW DRILLING LOG (CONTINUATION SHEET)

PROJECT	INSPECTOR	HOLE NUMBER	SHEET
Altus AFB - TCE Vertical Extent Evaluation	[signature]	000IU1-MW1	2 of 6

ELEV. (a)	DEPTH (b)	DESCRIPTION OF MATERIALS (c)	FIELD SCREENING RESULTS (d)	GEOTECH SAMPLE OR CORE BOX NO. (e)	ANALYTICAL SAMPLE NO. (f)	BLOW COUNT (g)	REMARKS (h)
	0	Lean Clay (CL) - dk brown, roots	BZ=ND				Topsoil
		Lean Clay (CL) - med. stiff, moist, reddish brown, low plastic w/ thin plastic zones. Fill	BKgd=ND				Fill
	1						
	2						
	3						
	4						
	5		BZ=ND				
	6						
	7	Lean Clay (CL) soft, very moist, dark brownish gray, low plastic, trace of fine sand, Alluvium					Alluvium
	8						
	9						
	10		BZ=ND				

PROJECT: Altus AFB - TCE Vertical Extent Eval.

HOLE NO. 000IU1-MW1

FORM 5056A-R, AUG 94 (Proponent: CECW-EG)

HTRW DRILLING LOG (CONTINUATION SHEET)

PROJECT	INSPECTOR	HOLE NUMBER
...ct Altus AFB- TCE ...ical Extent Evaluation	[signature]	000IU1-MW1
		SHEET 3 OF 6 SHEETS

ELEV. (a)	DEPTH (b)	DESCRIPTION OF MATERIALS (c)	FIELD SCREENING RESULTS (d)	GEOTECH SAMPLE OR CORE BOX NO. (e)	ANALYTICAL SAMPLE NO. (f)	BLOW COUNT (g)	REMARKS (h)
		Lean Clay (CL) - med. stiff, moist, reddish brown, low plastic, Residual Clay					Residual Clay
	11						11
	12						12
	13						13
	14						14
	15		BZ=ND				15
	16						16
	17						17
	18	Shale - tougher drilling, dry, red to reddish brown, blocky texture w/ fissile structure, weathered.					Weathered Shale
	19						19
	20		BZ=ND				20

PROJECT Altus AFB - TCE Vertical Extent Eval.

HOLE NO. 000IU1-MW1

NG FORM 5056A-R, AUG 94 (Proponent: CECW-EG)

HTRW DRILLING LOG (CONTINUATION SHEET)

HOLE NUMBER	SHEET	SHEETS
000IUI-MWI	4	of 6

PROJECT: Altus AFB - TCE [Vertic]al Extent Evaluation

INSPECTOR: [signature]

ELEV. (a)	DEPTH (b)	DESCRIPTION OF MATERIALS (c)	FIELD SCREENING RESULTS (d)	GEOTECH SAMPLE OR CORE BOX NO. (e)	ANALYTICAL SAMPLE NO. (f)	BLOW COUNT (g)	REMARKS (h)
	20	Weathered Shale (as above)	BZ=ND				Weathered Shale
	20.5	← cuttings becoming moist.					
	21						
	22						
	23	← Cutting dry again - tougher drilling.					
	24						
	25		BZ=ND				
	26	← Wet Zone - containing small pieces of shale					
	27						
	27.5	Shale Bedrock - tough drilling, hard consistency, dry, reddish brown, Shale					Shale
	28						
	29						set surface casing.
	30		BZ=ND				Stopped at 30 ft. 5/13/97

PROJECT: Altus AFB - TCE Vertical Extent Eval.

HOLE NO. 000IUI-MWI

FORM 5056A-R, AUG 94 (Proponent: CECW-EG)

HTRW DRILLING LOG (CONTINUATION SHEET)

HOLE NUMBER: 000IUI-MWI

PROJECT: Altus AFB - TCE Vertical Extent Evaluation

INSPECTOR: [signature]

SHEET 5 OF 6 SHEETS

ELEV. (a)	DEPTH (b)	DESCRIPTION OF MATERIALS (c)	FIELD SCREENING RESULTS (d)	GEOTECH SAMPLE OR CORE BOX NO. (e)	ANALYTICAL SAMPLE NO. (f)	BLOW COUNT (g)	REMARKS (h)
Fracture	30–32	NCR - No Core Recovery	Bkgd=ND BZ=ND	Core Box #1		Core Run #1	Started 5/16/97 R= 1.0'/3.0' RQD= 0.4'/3.0'
	32–33	Shale - Dark red, hard. Core broken up during extraction from core barrel.	HS=ND	Geotech			
	33–34	NCR				Core Run #2	R= 4.3'/5.0' RQD= 1.5'/5.0'
	34	Shale ← Thin horizontal siltstone layer					
	35	Siltstone - light greenish gray.	BZ=ND				Siltstone
	35.5–38	Shale }- Gypsum Inclusion Zone (36)					Shale
	37				VOCs metals VOCs metals VOCs metals	} Lab Duplicate } COE split	# 000IUI-SM-MW01-045 @ 9:50
	38		HS=ND				
	38–40	← Fracture zone from 38.2 to 39.9 ft. Very weathered - appears to be water bearing }- Large gypsum inclusion (39)	BZ=ND			Core Run #3	R= 3.1'/3.1' RQD= 1.8'/3.1' Drill rig lost circulation - Lost 300 gallons water from pit.

PROJECT: Altus AFB - TCE Vertical Extent Eval. HOLE NO.: 000IUI-MWI

ENG FORM 5056A-R, AUG 94 (Proponent: CECW-EG)

TRW DRILLING LOG (CONTINUATION SHEET)

PROJECT AHus AFB- TCE Vertical Extent Evaluation

INSPECTOR [signature]

HOLE NUMBER 000IUI-MW1

SHEET 6 OF 6 SHEETS

ELEV. (a)	DEPTH (b)	DESCRIPTION OF MATERIALS (c)	FIELD SCREENING RESULTS (d)	GEOTECH SAMPLE OR CORE BOX NO. (e)	ANALYTICAL SAMPLE NO. (f)	BLOW COUNT (g)	REMARKS (h)
Fracture:!		Shale (as above)					Shale
	41			Geotech			End of Coring 41
			BZ=ND				
	42						42 Bottom of Boring @ 42 ft. Installed Monitoring Well (5/16/97)

PROJECT AHus AFB-TCE Vertical Extent Eval.

HOLE NO. 000IUI-MW1

FORM 5056A-R, AUG 94 (Proponent: CECW-EG)