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DRAFT RCRA FACILITY INVESTIGATION OF OFFSITE WEAPONS STORAGE AREA NAS FORT WORTH TX

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DRAFT FIELD SAMPLING PLAN

RCRA FACILITY INVESTIGATION (RFI) OF THE OFFSITE WEAPONS STORAGE AREA

NAVAL AIR STATION (NAS) FORT WORTH JOINT RESERVE BASE (JRB) FORT WORTH, TEXAS

The Environmental Company, Inc.

DRAFT FIELD SAMPLING PLAN

RCRA FACILITY INVESTIGATION (RFI) OF THE OFFSITE WEAPONS STORAGE AREA

NAVAL AIR STATION (NAS) FORT WORTH JOINT RESERVE BASE (JRB) FORT WORTH, TEXAS

Contract No. F41624-95-D-8002
Delivery Order 0009

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LIST OF ACRONYMS AND ABBREVIATIONS

ACBM	Asbestos Containing Building Material
AFBCA	Air Force Base Conversion Agency
AFCEE	Air Force Center for Environmental Excellence
AHERA	Asbestos Hazard Emergency Act
AHU	Air Handling Unit
ASTM	American Society of Testing and Materials
BTEX	Benzene, Toluene, Ethylbenzene, Xylene
CERFA	Community Environmental Response Facilitation Act
CG	Certified Geologist
COC	Chain-of-Custody
CO	Contracting Officer
COR	Contracting Officer's Representative
C.P.G.	Certified Professional Geologist
CSM	Conceptual Site Model
DBCRA	Defense Base Closure Realignment Act
DOT	U.S. Department of Transportation
DNAPL	Dense Non-Aqueous Phase Liquid
DQOs	Data Quality Objectives
EC	Electrical Conductance
EOD	Explosive Ordnance Disposal Range
EPA	U.S. Environmental Protection Agency
FSP	Field Sampling Plan
HSA	Hollow Stem Auger
HSP	Health and Safety Plan
ID	inside diameter
IDW	Investigative-derived waste
IRP	Installation Restoration Program
IRPIMS	Installation Restoration Program Information Management System
LBP	lead-based paint
LLRW	Low-Level Radioactive Waste
MS	Matrix Spike
MSD	Matrix Spike Duplicate
msl	mean sea level
N	Standard Penetration Test Result
NAPL	Non-Aqueous Phase Liquid
NAS	Naval Air Station

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LIST OF ACRONYMS AND ABBREVIATIONS

NTU	Nephlometric Turbidity Unit
OD	Outside diameter
OSHA	Occupational Health and Safety Administration
PACM	Presumed Asbestos Containing Material
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyls
P.E.	Professional Engineer
PID	Photo Ionization Detector
POC	Point-of-Contact
PVC	Polyvinyl chloride
QA	Quality Assurance
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
QC	Quality Control
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RI/FS	Remedial Investigation/Feasibility Study
RLS	Registered Land Surveyor
SAP	Sampling and Analysis Plan
SFM	Surfacing Materials
SHSC	Site Health and Safety Coordinator
SVOC	Semi-Volatile Organic Compound
SWMU	Solid Waste Management Unit
TAC	Texas Administrative Code
TC	Team Chief
TEC	The Environmental Company, Inc.
TNRCC	Texas Natural Resource Conservation Commission
TPH	Total Petroleum Hydrocarbons
TSI	Thermal System Insulation
USCS	United Soil Classification System
UST	Underground Storage Tank
VOC	Volatile Organic Compound
WP	Work Plan
WSA	Weapons Storage Area
3-D	three dimensional

1.0 INTRODUCTION

The Field Sampling Plan (FSP) presents, in specific terms, the requirements and procedures for conducting field operations and investigations. This project-specific FSP has been prepared to ensure that data quality objectives (DQOs) specified for this project are met, field sampling protocols are documented and reviewed in a consistent manner, and collected data are scientifically valid and defensible. This site-specific FSP and the Air Force Center for Environmental Excellence (AFCEE) Quality Assurance Project Plan (QAPP) constitutes, by definition, an AFCEE Sampling and Analysis Plan (SAP).

Naval Air Station Fort Worth (NAS Fort Worth) (formerly Carswell Air Force Base) is currently undergoing property disposal/reuse pursuant to the Defense Base Closure and Realignment Act (DBCRA) of 1990 and Round II of the Base Closure Commission deliberations. This investigation is being conducted to comply with a directive issued by the Texas Natural Resource Conservation Commission (TNRCC) to the Air Force Base Conversion Agency (AFBCA) requesting Resource Conservation Recovery Act (RCRA) Facility Inspections (RFIs) of Solid Waste Management Units (SWMUs) located at NAS Fort Worth. SWMUs identified at the Offsite Weapons Storage Area (WSA) include the Waste Accumulation Area (NO. 59), the Low-Level Radioactive Waste (LLRW) Disposal Area (SWMU 60), and the Waste Disposal Dump (NO. 65). As a result, The Environmental Company, Inc. (TEC) will conduct a RFI investigation of the WSA to evaluate if prior operational practices conducted at the WSA pose a threat to human health or the environment and fulfill Community Environmental Response Facilitation Act (CERFA) requirements.

This FSP was prepared according to the following guidelines: *Interim Final RCRA Facility Investigation (RFI) Guidance (U.S. EPA, 1989)* and *Handbook for the Installation Restoration Program (IRP) Remedial Investigations and Feasibility Studies (RI/FS) (AFCEE, September 1993)*, hereafter referred to as the AFCEE Handbook.

This FSP is required reading for all staff participating in the work effort. The FSP shall be in the possession of the field teams collecting the samples. All contractors and subcontractors shall be required to comply with procedures documented in this FSP to maintain comparability and representativeness of the collected and generated data.

Controlled distribution of the FSP shall be implemented by TEC to ensure that the current approved version is being used. A sequential numbering system will be used to identify controlled copies of the FSP. Controlled copies will be provided to applicable Air Force managers, regulatory agencies, remedial project managers, and quality assurance (QA) coordinators. Whenever Air Force revisions are made or addenda are added to the FSP, a document control system shall be put into place to ensure that all parties holding a controlled copy of the FSP will receive revisions/addenda and that outdated material is removed from circulation. The document control system does not preclude making and using copies of the FSP; however, the holder of controlled copies is responsible for distributing additional material to update any copies within their organizations. The distribution list for controlled copies shall be maintained by TEC.

2.0 PROJECT BACKGROUND

2.1 THE AIR FORCE INSTALLATION RESTORATION PROGRAM

The objective of the U.S. Air Force IRP is to assess past hazardous waste disposal and spill sites at U.S. Air Force Installations and to develop remedial actions for sites that pose a threat to human health and welfare or the environment. A detailed description of the U.S. Air Force IRP program can be found in the Work Plan (WP).

2.2 PROJECT PURPOSE AND SCOPE

This FSP for NAS Fort Worth (AFCEE Contract No. F41624-95-D-8002, Project Number 96-8117) has been prepared by TEC according to the Statement of Work for Delivery Order 0009. Delivery Order 0009 requests environmental services for a RFI of the Offsite WSA.

This FSP presents detailed field operations procedures, environmental sampling procedures, and field measurement protocols that will be implemented during the RFI. Field operations are described in Section 5.0 of this FSP and include the following:

- Field documentation;
- Site reconnaissance, preparation, and restoration;
- General drilling methods;
- Lithologic sampling and description of subsurface soils;
- Borehole abandonment procedures;
- Handling of investigative-derived waste;
- Equipment decontamination procedures;
- Installation and development of groundwater monitoring wells;
- Elevation and topographic surveying; and
- WSA building contamination surveys.

Environmental sampling procedures are described in Section 6.0 of this FSP and include the following:

- Monitoring well purging and sample collection techniques;
- Water level measurements;
- Sediment sampling;
- Surface and subsurface soil sampling;
- Seep sampling;
- Surface water sampling;
- Asbestos sampling;
- Lead-based paint chip bulk sampling;
- Wipe sampling;

- Field quality control sampling;
- Sample identification; and
- Sample packaging and shipping.

This FSP has been prepared to meet project objectives identified in the WP.

2.3 PROJECT SITE DESCRIPTION

The Offsite WSA is a 247 acre parcel of land surrounded by a 264 acre buffer zone easement. It is an off-base facility located approximately 5 miles west of NAS Fort Worth on White Settlement Road in the western portion of Tarrant County. The WSA is surrounded by undeveloped oak woodlands and by pasture land grazed by beef cattle. The WSA is located between two tributaries to Live Oak Creek, which flows east and north before discharging into Lake Worth. Elevations at the WSA range from approximately 720 feet above mean sea level (msl) along the east fence boundary to approximately 770 feet msl near the western fence boundary (Jacobs, 1996).

The Offsite WSA was opened in 1956 and was used for munitions inspections, storage, and disposal. WSA operations ended along with drawdown of activities at the former Carswell AFB in 1992. During its operational period active WSA facilities included:

- Two munition inspection shops;
- 16 ordnance storage buildings;
- One entry control building;
- Emergency power plant;
- Explosive Ordnance Disposal (EOD) Range;
- LLRW disposal facility;
- Water storage tank; and
- Two water supply wells.

The LLRW site (SWMU 60) was remediated during the summer of 1996. The EOD Range was cleared of all unexploded ordnance and remediated with respect to residual explosive ordnance in 1993. Therefore, the LLRW site and the EOD range will not be investigated in this RFI except with respect to potential contaminant migration from the EOD.

Additional information on the description of the WSA and NAS Fort Worth is presented in Section 1.2.1 of the WP which is a companion document to this FSP.

2.4 PROJECT SITE CONTAMINATION HISTORY

Information on previous investigation and site contamination history may be found in Section 2.2 of the WP.

3.0 RCRA FACILITY INSPECTION TASKS

The following sections describe the tasks that will be conducted during the RFI at the Offsite WSA. The overall investigation objectives and task objectives are referenced in Section 3.1. A summary of the investigative tasks, the number of sample locations and the number of samples is provided in Section 3.2. Field activities to be performed during these tasks are described in general terms in Section 3.3. Additional details regarding specific field operations are provided in Section 5.0. Sampling methodologies are described in Section 6.0

3.1 OBJECTIVES

The overall project objectives for this RFI have been presented in Section 1.3 of the WP. As identified below, the RFI field investigation will be completed through a number of individual tasks. Specific objectives associated with each of these investigative tasks are identified in Section 3.3 of the WP.

3.2 SAMPLE ANALYSIS SUMMARY

The field sampling program includes a number of individual tasks which will be performed during this RFI. These tasks include the collection and analysis of samples from the following areas:

- Outdoor material storage and maintenance areas designated as A-1 and A-2;
- Unpaved perimeter of the Waste Accumulation Area and Building 8503 (A-3);
- Vehicle Fueling Area (A-4);
- Disturbed Surface Area southwest of the control fence (A-5);
- EOD Range;
- Bunker floor drain outlets;
- Removed UST locations;
- Drainageways, ditches and seeps;
- Groundwater monitoring;
- Asbestos containing materials in buildings;
- Lead-based paint in buildings; and
- Structural surface contamination.

Tables 3-1 and 3-2 provide a summary of the sampling to be performed during each of these field investigation tasks. Various media are to be sampled during these investigations at multiple locations. Table 3-1 identifies the number of sample locations and the number of samples to be collected by media type during each task. Field samples directly associated with the Offsite WSA, as well as quality control samples, will be collected as part of each investigation. Each sample will undergo various analyses, tailored to the specific task objectives identified in Section 3.3 of the WP. Table 3-2 identifies the number of samples to be collected in support of each investigation and the analyses to be performed.

3.3 FIELD ACTIVITIES

As identified above, the project objective identified in Section 1.3 of the WP will be achieved through a number of investigation tasks. Field activities associated with each are discussed below.

3.3.1 Outdoor Material Storage and Maintenance Areas (A-1, A-2 Investigation Area

Surface and subsurface soil samples will be collected from Areas A-1 and A-2 as identified on Figure 3-1. Area A-1 encompasses approximately 179,800 square feet. Samples from area A-1 will be collected on an established grid with grid lines aligned parallel to the adjacent service roads. It is assumed that the majority of activity was performed adjacent to the service roads. Therefore the first set of grid lines will be placed approximately 10 feet from the edge of the pavement. The next set of lines will be spaced 50 feet apart. All other lines will be spaced 100 feet apart as shown on Figure 3-1. The sampling grid in this area will also be extended across the service roads to the northwest due to the presence of disturbed soil noted during the field reconnaissance effort.

Area A-2 encompasses approximately 36,000 square feet. The area is bound by the service road to the south and the fence to the north. Service road extensions located directly across from each bunker divide the area. Activity in this area is assumed to have taken place close to the roadside. Therefore sample locations will be biased towards the edge of the northern service road and the road extensions as shown in Figure 3-1.

Surface and subsurface soil samples will be collected at each borehole location as shown on Figure 3-1 and at additional biased locations where surface anomalies are identified. Four biased locations are assumed in the plan but are not shown on Figure 3-1. Surface samples will be collected from 0 to 6 inches below ground surface. Subsurface soil samples for chemical characterization will be collected at five foot intervals or directly above bedrock if encountered first. The first subsurface soil sample for chemical characterization will be collected from 6 inches to 28 inches below ground surface. A second sample for chemical characterization will be collected from 66 inches to 88 inches below ground surface or directly above the bedrock surface. Based on an assumed depth to bedrock of 5 feet below ground surface, it is estimated that one surface soil and two subsurface soil samples will be collected from each location for chemical characterization. Head space screening and lithologic descriptions will be completed on all samples. Additional subsurface soil samples may be collected if headspace screening indicates the presence of contamination. Specific details regarding sample intervals, depths, and collection methods are provided in Sections 6 of this FSP.

All subsurface soil samples collected for chemical characterization will be analyzed for VOCs. Surface samples will not be analyzed for volatile organic compounds (VOCs) due to the extended length of time since the site has been in operation and assumed volatilization during that period. All surface and upper subsurface (6 inches to 28 inches) samples will be analyzed for inorganics and explosive related compounds. Ten percent of the surface and upper subsurface samples will also be analyzed for semi-volatile organic compounds (SVOCs) and pesticide/PCBs. Separate aliquots from all deeper samples submitted for VOC analyses will be archived. In the event that inorganic, explosive related compound, SVOCs or pesticides/PCB contamination is detected in the surface or upper subsurface sample, the archived material at that location will be analyzed for the contaminants of concern.

All biased located samples will be analyzed for inorganics, VOCs, SVOCs, pesticides/PCBs, and explosives.

During this investigative task, background conditions in surface and subsurface soil samples will be established. Five surface and subsurface soil background locations will be sampled with one surface and one subsurface sample to be collected at each location. Background locations will be west of the site beyond the property boundary. These locations will be identified during the field effort and are not shown on Figure 3-1. Samples collected from these locations will provide comparative analysis of sample results generated from soil samples collected as part of this task and those from areas A-3, A-4, A-5, the EOD range and bunker floor drains (see sections below). The comparative analysis will be conducted with respect Title 30 TAC 335.554, *Attainment of Risk Reduction Standard Number 1: Closure/Remediation to Background.* All background samples will be analyzed for inorganics and explosive compounds. All subsurface samples will also be analyzed for VOCs. In addition, a surface and subsurface sample from one background location will also be analyzed for pesticides/PCBs and SVOCs.

3.3.2 Waste Accumulation Area and Building 8503 (A-3)

Waste Accumulation Area Containment Investigation. The Waste Accumulation Area containment features will be evaluated. Particular attention will given to potential cracks and staining on the concrete. TEC previously noted one crack. Soils beneath cracks will be investigated by drilling through the concrete and collecting samples for lithologic and chemical characterization. Two holes will be drilled through each 10 feet of cracked concrete identified. In addition to the crack identified previously, one other is assumed to exist.

Subsurface soil samples below the concrete pad will be collected for chemical characterization at five foot intervals or directly above bedrock if encountered first. The first subsurface soil sample for chemical characterization will be collected from a 22 inch interval directly below the pad. Depth to bedrock at this location is reported to be less than five feet below ground surface. Therefore, the second sample for chemical characterization will likely be directly above the bedrock surface. The subsurface soil samples beneath the pad will be analyzed for inorganics and organic compounds including, VOCs, SVOCs, pesticides/PCBs and explosive compounds.

Unpaved Surface Investigation. Three series of surface and subsurface soil samples will be collected in the unpaved areas adjacent to the concrete pad (Figure 3-1). The first series will be located along the entire perimeter within 5 feet of the edge of the pad. The sample locations will be spaced approximately 50 feet apart except those locations adjacent to the Waste Accumulation Area. These locations will be spaced approximately 10 feet apart. The second series of samples will be located within the ditch itself, approximately 10 feet from the edge of the pavement. These samples will be spaced approximately 50 feet apart. The third series for boreholes will be approximately 30 feet beyond the edge of the pavement towards the southwest corner of the area. Provisions for two additional biased surface sample and subsurface sample locations are included in this plan for characterization of anomalous areas. These biased locations are not shown on Figure 3-1.

Surface and subsurface soil samples will be collected at each location as shown on Figure 3-1. Surface samples will be collected from 0 to 6 inches below ground surface. Subsurface soil samples for chemical characterization will typically be collected at five foot intervals or directly above bedrock if encountered first. The first subsurface soil sample for chemical characterization will be collected from 6 inches to 28 inches below ground surface. A second sample for chemical characterization will be collected from 66 inches to 88 inches below ground surface or directly above bedrock. Based on an assumed depth to bedrock of 5 feet below ground surface, it is estimated that one surface soil and two subsurface soil samples will be collected from each location for chemical characterization. Head space screening and lithologic descriptions will be completed on all samples. Additional subsurface soil samples may be collected if headspace screening indicates the presence of contamination. Specific details regarding sample intervals, depths, and collection methods are provided in Section 6 of this FSP.

All subsurface soil samples collected for chemical characterization will be analyzed for VOCs. Surface samples will not be analyzed for VOCs due to the extended length of time since the site has been in operation, and assumed volatilization during that period. All surface and upper subsurface (6 inches to 28 inches) samples will therefore be analyzed for inorganics and explosive related compounds. In order to provide complete characterization at those locations were previous contamination was reported, the surface and upper subsurface samples from the three locations directly adjacent to the Waste Accumulation Area building and the two adjacent locations in the ditch will also be analyzed for SVOCs and pesticide/PCBs (see Figure 3-1).

Separate aliquots from all deeper samples submitted for VOC analysis will be archived. In the event that inorganic, explosive-related compound, SVOC or pesticides/PCB contamination is detected in any surface or upper subsurface sample, the archived material at that location will be analyzed for the contaminants of concern.

All biased located samples will be analyzed for inorganics, VOCs, SVOCs, pesticides/PCBs, and explosives.

3.3.3 Vehicle Fueling Area (A-4)

Four sample locations will be established directly north of the abandoned fuel pump. The locations will be positioned in the area were vehicle fueling took place. Locations will be spaced 5 to 10 feet apart based on observations made in the field. Approximate locations are indicated on Figure 3-1.

Surface and subsurface soil samples will be collected at each location. Surface samples will be collected from 0 to 6 inches below ground surface. Subsurface soil samples for chemical characterization will be collected at five foot intervals or directly above bedrock if encountered first. The first subsurface soil sample for chemical characterization will be collected from 6 inches to 28 inches below ground surface. Based on an assumed depth to bedrock of 5 feet below ground surface, it is estimated that one surface soil and two subsurface soil samples will be collected from each location for chemical characterization. Head space screening and lithologic descriptions will be completed on all samples. Additional subsurface soil samples may be collected if headspace screening indicates the presence of contamination. Specific details regarding sample intervals, depths, and collection methods are provided in Section 6 of this FSP.

Samples collected from the vehicle fueling area will be analyzed for those compounds indicative of contamination from gasoline, diesel, and fuel oils. Surface and subsurface soil sample analyses will include benzene, toluene, ethylbenzene and xylene (BTEX), total petroleum hydrocarbons (TPH) and polycyclic aromatic hydrocarbons (PAH), in accordance with TNRCC PST guidance.

3.3.4 Disturbed Surface Area (A-5)

Surface and subsurface soil samples will be collected at locations as shown on Figure 3-1. Surface samples will be collected from 0 to 6 inches below ground surface. Subsurface soil samples for chemical characterization will be collected at five foot intervals or directly above bedrock if encountered first. The first subsurface soil sample for chemical characterization will be collected from 6 inches to 28 inches below ground surface. A second sample for chemical characterization will be collected from 66 inches to 88 inches below ground surface or directly above bedrock. Based on an assumed depth to bedrock of 5 feet below ground surface, it is estimated that one surface soil and two subsurface soil samples will be collected from each location for chemical characterization. Head space screening and lithologic descriptions will be completed on all samples. Additional subsurface soil samples may be collected if headspace screening indicates the presence of contamination. Specific details regarding sample intervals, depths, and collection methods are provided in Section 6 of this FSP.

All subsurface soil samples collected for chemical characterization will be analyzed for VOCs. Surface samples will not be analyzed for VOCs due to the extended length of time since the site has been in opeation, and assumed volatilization during that period. All surface and upper subsurface (six inches to 28 inches) samples will be analyzed for inorganics and explosive compounds. In order to provide complete characterization, surface and upper subsurface sample from one location will also be analyzed for SVOCs and pesticide/PCBs. Separate aliquots from all deeper samples submitted for VOC analysis will be archived. In the event that inorganic, explosive related compound, SVOC or pesticides/PCB contamination is detected in the surface or upper subsurface sample, the archived material at that location will be analyzed for the contaminants of concern.

3.3.5 EOD Range

Nine sample locations will be positioned on a grid established across the area with 100 foot spacing as shown on Figure 3-1. The grid location and spacing may be modified in the field based on visual observations. It is estimated that two additional biased locations will be established at potential surface anomalies identified in the field.

Surface and subsurface soil samples will be collected at each location. Surface samples will be collected from 0 to 6 inches below ground surface. Subsurface soil samples for chemical characterization will typically be collected at five foot intervals or directly above bedrock if encountered first. The first subsurface soil sample for chemical characterization will be collected from 6 inches to 28 inches below ground surface. A second sample for chemical characterization will be collected from 66 inches to 88 inches below ground surface or directly above bedrock. Based on an assumed depth to bedrock of 5 feet below ground surface, it is estimated that one surface soil and two subsurface soil samples will be collected from each location for chemical characterization. Head space screening and lithologic descriptions will be completed on all samples. Additional subsurface soil samples may be collected if headspace screening indicates the presence of contamination.

The surface and upper subsurface soil sample will be analyzed for inorganics and explosive compounds. The deeper subsurface soil sample will be archived and analyzed for inorganics and explosive compounds if contamination is detected in the upper samples from that location.

3.3.6 Bunker Floor Drain Outlets

Each of the 11 bunkers contains two wall drains. One surface and subsurface sample location will be established immediately outside of each wall drain (see Figure 3-1).

Surface samples will be collected from 0 to 6 inches below ground surface. Subsurface soil samples for chemical characterization will be collected at five foot intervals or directly above bedrock if encountered first. The first subsurface soil sample for chemical characterization will be collected from 6 inches to 28 inches below ground surface. A second sample for chemical characterization will be collected from 66 inches to 88 inches below ground surface or directly above bedrock. Based on an assumed depth to bedrock of 5 feet below ground surface, it is estimated that one surface soil and two subsurface soil samples will be collected from each location for chemical characterization. Head space screening and lithologic descriptions will be completed on all samples. Additional subsurface soil samples may be collected if headspace screening indicates the presence of contamination. Specific details regarding sample intervals, depths, and collection methods are provided in Section 6 of this FSP.

The surface and upper subsurface soil sample will be analyzed for inorganics and explosive compounds. The deeper subsurface soil sample will be archived and analyzed for inorganics and explosive compounds if contamination is detected in the upper samples from that location.

3.2.7 Removed UST Locations

The WSA contained five underground storage tanks (USTs). A summary of the number of boreholes to be installed at each UST location is provided in Table 3-3. General UST locations are shown on Figure 3-1. Specific borehole locations for each UST are shown on Figures 3-3 through 3-7.

Subsurface samples will be collected from each borehole. Samples for volatile organic headspace screening and lithologic descriptions will be collected continuously through the entire borehole. A maximum of three subsurface samples will also be collected from each borehole for analytical characterization.

In those boreholes where headspace screening indicates contamination is not present, a maximum of two samples will be collected from each borehole.

Samples will be analyzed for compounds indicative of contamination from gasoline, diesel and fuel oils. Analyses will include BTEX, TPH and PAH, in accordance with TNRCC PST guidance.

3.3.8 Drainageways and Seeps

Seven drainage ways (D-1 through D-7) drain buildings and surrounding areas located within the inner fence. Drainageways D-8 and D-9 are located to the west of the site and drain the EOD area. In addition to these direct surface water routes, shallow groundwater from the site discharges as seeps in the ravines which surround the site to the south, east, and north (see Figure 3-2).

Surface water samples will be collected all seep locations and at one location downgradient of the site in drainage area D-5 (see Figure 3-2). Surface water samples from all seep locations and D-5 will be analyzed for inorganics, VOCs, SVOCs, and pesticides/PCBs and explosive-related compounds.

Sediment samples will be collected from all seep locations and will be analyzed for inorganics, VOCs, SVOCs and pesticides/PCBs and explosive-related compounds. Sediment samples from drainageways D-1 through D-7 will be analyzed for target contaminants including inorganics, VOCs, and explosive compounds. SVOCs and pesticides/PCBs analyses will also be performed on one centrally located sample from each of the 7 drainageways associated with the fenced WSA (D1 through D-7). EOD drainageways (D-8 and D-9) will be analyzed for inorganics and explosive-related compounds.

Three sediment and surface water background locations will also be established. One surface water and one sediment sample will be collected from each location. Each sample will be analyzed for inorganics and VOC, SVOCs, pesticides/PCB, and explosive compounds.

3.3.9 Groundwater Monitoring

Groundwater sources include the overburden on top of the impervious Walnut Formation and the Paluxy Formation. Groundwater associated across the site is likely to be sporadic and affected by seasonal precipitation.

Seven shallow wells and three deeper wells will be used to characterize the shallow groundwater associated with the overburden and the Paluxy Aquifer. These wells include:

- Three overburden wells (two upgradient and one downgradient) to be installed during the ongoing Jacobs (1996) background study;
- Four overburden wells (all downgradient) to be installed during of this RFI;
- One Paluxy Aquifer well (downgradient) to be installed during the ongoing Jacobs background study (1996); and
- Two Paluxy Aquifer supply wells (downgradient) currently on site.

A second upgradient Paluxy Aquifer well is to be installed by Jacobs, though it will not be sampled during the RFI.

Prior to sampling, an electronic interface probe will be used to determine the static groundwater level (i.e., depth to groundwater) and the presence or absence and potential for floating petroleum product. Should floating product be observed, the depth to the product and the product layer thickness will be determined.

One groundwater sample will be collected from each well using methods described in Sections 6 of this FSP. Temperature, pH, electrical conductivity (EC), and turbidity from all wells will be measured in the field. All groundwater samples will be analyzed for inorganics and organic compounds including, VOCs, SVOCs, pesticides/PCBs and explosive compounds.

3.3.10 Asbestos Survey

Asbestos surveys will be conducted at 24 buildings located within the Offsite WSA. Table 3-4 provides an estimate of the number of samples to be collected from each building. The asbestos survey of all 24 buildings will be completed in accordance the Asbestos Hazard Emergency Response Act (AHERA) standard (40 CFR 763 Subpart E) for locating, collecting, quantifying, and assessing Asbestos Containing Building Materials (ACBMs).

Using product knowledge and past sampling results, some products may be identified as ACM or non-ACM based on visual inspection alone. Such products are identified below.

- Fiberglass, foam, or rubber will not be sampled and will be considered a non-suspect material.
- Transite-like materials such as roofing, siding, walls, ducts, and flues will not be sampled but will be assumed to contain asbestos. Transite-like materials are known to contain 35% to 75% chrysotile. Sampling is therefore not warranted in relation to the increased exposure risk created during sampling by creating friable material during the sampling process.
- Fire rated doors will not be sampled but assumed to be ACBM.

3.3.11 Lead-Based Paint Survey

A survey for lead-based paint (LBP) will be conducted at all 24 buildings located at the Offsite WSA. Paint chip bulk sampling involves physically removing a 2 to 4 square inch piece of paint from the painted surfaces. Prior to the field sampling event, attempts will be made to obtain additional information regarding painting history. This history will be use to develop a sampling scheme unique to the individual buildings. Samples will be collected from each representative interior and exterior component with a distinct painting history. All sampling will be in accordance with Texas Environmental lead Reduction Rules, section 295.212, and USEPA/Housing and Urban Development guidelines (1996).

Table 3-4 provides an estimate of the number of samples to be collected from each building. The sample number estimate takes into account the concrete block construction of typically used at the offsite WSA. Some unfinished interiors that contain little or no painted surfaces. During the actual field investigation, painted building materials such as walls, trims, and moldings will be further evaluated to determine actual sample locations and quantities.

3.3.12 Facility Contamination Survey

Nineteen buildings will be evaluated for possible interior surface contamination. Wipe samples will be collected from each interior surface representative of a distinct area or activity. Offsite WSA buildings are cement block-constructed on concrete slabs with few finished interiors. A number of buildings have multiple rooms or work areas. One wall and one floor wipe sample will be collected from each room or work area.

In addition to the nineteen onsite buildings, three offsite residential building will be selected to establish background conditions for comparative evaluation of the data. One wall and one floor sample will be collected from each offsite building.

Wipe sampling involves wiping a surface of known dimensions with a cotton swab, gauze, or filter paper moistened with an appropriate solvent. Each floor or wall sample will be composited by wiping four representative subsample areas. Individual subsamples are combined to form the sample.

The anticipated number of samples to be collected from each building are identified in Table 3-4. Wipe samples will be analyzed for inorganics and explosive compounds.

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Table 3-1 Summary Of Sample Locations And Numbers

Investigation Tasks	No. of Locations: WSA	Back-ground	Total	No. of Samples: Surface	Sub-surface	Ground-water	Surface Water	Sedi-ment	Asbes-tos	Paint	Wipe	Quality Control[4]	Total
Outdoor Material Storage and Maintenance (A-1 and A-2)	44	5	49	49	93	-	-	-	-	-	-	22	164
[illegible] (A-3)	[illegible]	-	[illegible]	[illegible]	[illegible]	-	-	-	-		-	12	[illegible]
Vehicle Fueling Area (A-4)	4	[illegible]	4	4	8	-	-	-	-	-	-	5	17
[illegible] Area (A-[illegible])	4		4	4	[illegible]			-		-		5	17
[illegible] Range	[illegible]	[illegible]	11	11	11	-			-		-	5	27
[illegible]	[illegible]	-	22	[illegible]	22	-	-		-	-		9	53
Removed UST Locations	9	-	9	-	27[2]	-	-	-	-	-	-	8	35
[illegible]	28	[illegible]	[illegible]	-	-	-	[illegible]	[illegible]	-	-		13	[illegible]
Groundwater Monitoring	7	3	10	-	-	10	-		-	-	-	4	14
[illegible] Survey	[illegible]		[illegible]	-	-	-		-	85		-	4	89
[illegible]-Based Paint	159	-	159	-	-	-	-	-	-	159	-	16	175
[illegible]	44	6	[illegible]	-		-	-		-	-	50	7	57

[1] Background conditions to be derived from samples collected during Outdoor Material Storage and Maintenance Area Task.
[2] Maximum number of samples assuming contamination found in all boreholes.
[3] Maximum number of samples assuming all seep location are discharging during the sampling event.
[4] Quality control samples include field duplicated, trip blanks, equipment blanks, and ambient blanks.

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Table 3-2 Sample Analysis Summary

Sample Type	No. of Samples	PP Metals	VOCs	SVOCs	Pest/PCBs	Explosives	BTEX	TPH	PAHs	Asbestos	Lead (Paint)	Grain Size
						Number of Analyses						
Outdoor Material Storage and Maintenance Areas (A-1 and A-2)												
Surface Soil Samples	49	49	-	9	9	49						2
Subsurface Soil Samples	93	49	93	9	9	49						2
Duplicate Samples	10	10	10	2	2	10						
Trip Blanks	6		6									
Equipment Blanks	5	5	5	1	1	5						
Ambient Blanks	1	1	1	1	1	1						
Waste Accumulation Area /Bulding 8503 (A-3)												
Surface Soil Samples	27	27	-	7	7	27						1
Subsurface Soil Samples	62	37	62	17	17	37						1
Duplicate Samples	5	6	6	3	3	6						
Trip Blanks	3		5									
Equipment Blanks	3	3	3	1	1	3						
Ambient Blanks	1	1	1	1	1	1						
Vehicle Fueling Area (A-4)												
Surface Soil Samples	4						4	4	4			1
Subsurface Soil Samples	8						8	8	8			1
Duplicate Samples	2						2	2	2			
Trip Blanks	1						1					
Equipment Blanks	1						1	1	1			
Ambient Blanks	1						1	1	1			
Disturbed Surface Area (A-5)												
Surface Soil Samples	4	4		1	1	4						1
Subsurface Soil Samples	8	4	8	1	1	4						1
Duplicate Samples	2	1	1	1	1	1						
Trip Blanks	1		1									
Equipment Blanks	1	1	1	1	1	1						
Ambient Blanks	1	1	1	1	1	1						
EOD Range												
Surface Soil Samples	11	11				11						
Subsurface Soil Samples	11	11				11						
Duplicate Samples	3	2				2						
Equipment Blanks	1	1				1						
Ambient Blanks	1	1				1						
Bunker Floor Drains												
Surface Soil Samples	22	22				22						1
Subsurface Soil Samples	22	22				22						1
Duplicate Samples	5	5				5						
Equipment Blanks	3	3				3						
Ambient Blanks	1	1				1						

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Table 3-2 Sample Analysis Summary

Sample Type	No. of Samples	PP Metals	VOCs	SVOCs	Pest/PCBs	Explosives	BTEX	TPH	PAHs	Asbestos	Lead (Paint)	Grain Size
		Number of Analyses										
Removed UST Locations												
Subsurface Soil Samples	27						27	27	27			2
Duplicate Samples	3						3	3	3			
Trip Blanks	2						2					
Equipment Blanks	2						2	2	2			
Ambient Blanks	1						1	1	1			
Drainage Way and Seeps												
Surface Water Samples	14	11	11	11	11	11						
Duplicates Samples	2	1	1	1	1	1						
Sediment Samples	31	31	27	17	17	31						2
Duplicate Samples	3	3	3	2	2	3						
Trip Blanks	4		2									
Equipment Blanks	3	2	2	2	2	2						
Ambient Blanks	1	1	1	1	1	1						
Groundwater Monitoring												
Groundwater Samples	10	10	10	10	10	10						
Duplicate Samples	1	1	1	1	1	1						
Trip Blanks	1		1									
Equipment Blanks	1	1	1	1	1	1						
Ambient Blanks	1	1	1	1	1	1						
Asbestos Survey												
Asbestos Samples	85									85		
Duplicate Samples	4									4		
Lead-Based Paint Survey												
Lead Paint Samples	159										156	
Duplicate Samples	16										16	
Facility Contamination Survey												
Surface Contaminant Samples	44	44				44						
Equipment Blanks	6	6				6						
Ambient Blanks	1	1				1						

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Table 3-3 Summary Of Underground Storage Tanks

Building Number	Tank Contents	Tank Size	Tank Dimensions	Function	Number of Boreholes		
					Tank	Piping	Total
Building 8514	Diesel	1,000 gallons	10 feet by 6 feet	Vehicle Fueling	1	-	1
Building 8507	Fuel Oil	1,000 gallons	10.6 feet by 4 feet	Heating	1	-	1
Building 8505	Diesel	5,000 gallons	18 feet by 8 feet	Power	1	2	3
Building 8500	Fuel Oil	750 gallons	8 feet by 4 feet	Heating	1	2	3
Building 8503	Fuel Oil	2,000 gallons	12 feet by 6 feet	Heating	1	-	1

Table 3-4 Building Characteristics And Estimated Number Of Samples

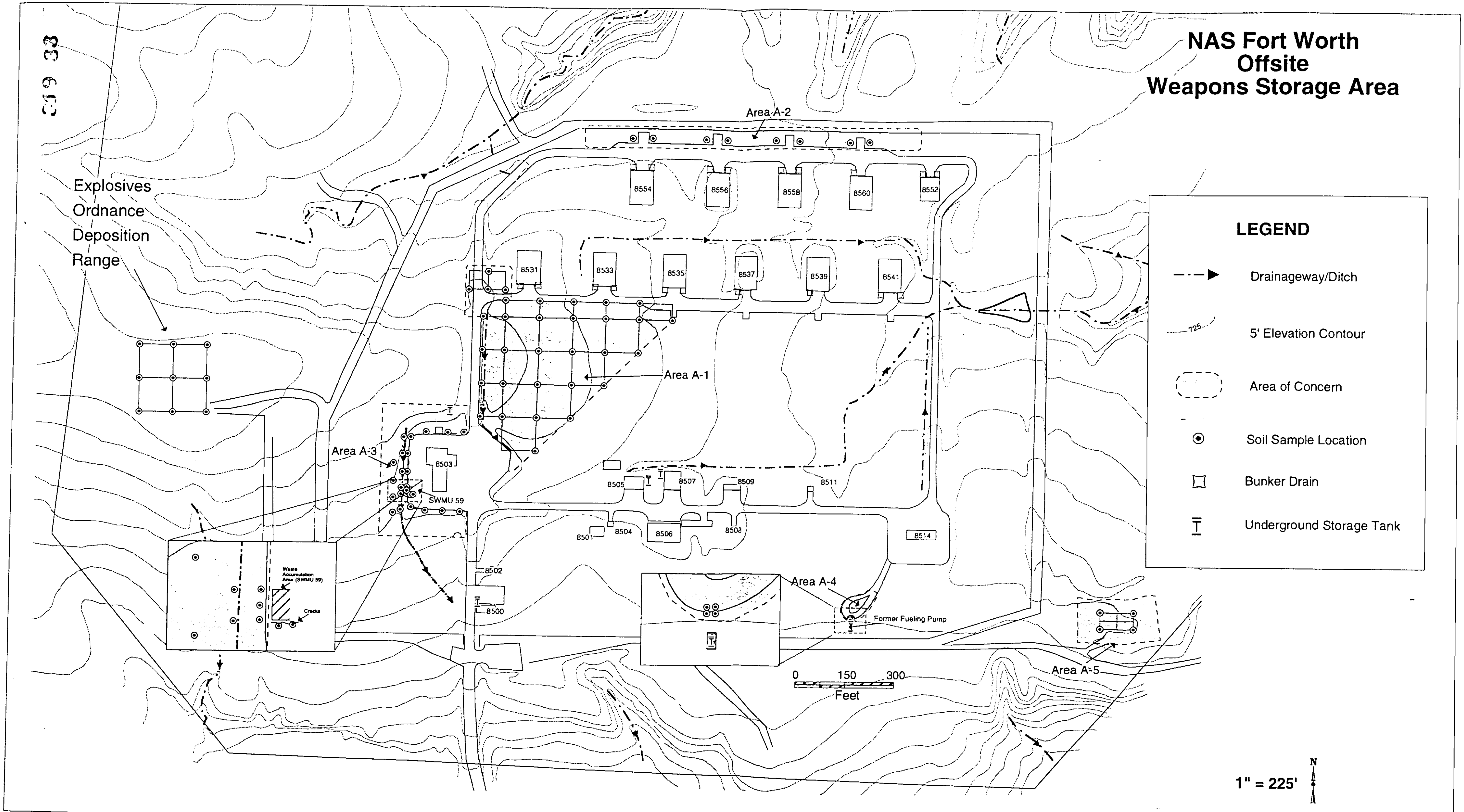
Facility No.	Name/Use	Square Footage	Estimated Number of Samples		
			Asbestos	Lead Paint	Surface Contaminants
8500	Safety, Control and Identification	932	12	9	NA
8501	Water Tank Storage	1219[1]	0	0	NA
8502	Water Supply Facility	78	6	6	NA
8503	Surveillance Inspection Shipping	6,959	18	18	8
8504	Water Supply Facility	78	3	3	NA
8505	Electric Power Station	1,488	1	6	NA
8506	Small Arms Ammunition Storage	5,000	3	18	2
8507	Spares Storage	2,500	0	9	2
8508	Pyrotechnic Storage	351	3	9	2
8509	Segmented Magazine Storage	540	0	6	8
8511	Detonator Storage	126	3	9	1
8512	Waste Accumulation Area SWMU 59	86	0	6	3
8514	Conventional Munitions Shop	2,600	3	12	5
8531	Munitions Storage	1,576	3	9[2]	2[2]
8533	Munitions Storage	1,266	3	0[2]	0[2]

Table 3-4 Building Characteristics And Estimated Number Of Samples (cont)

8535	Munitions Storage	2,147	3	9[2]	2[2]
8537	Munitions Storage	2,147	3	0[2]	0[2]
8539	Munitions Storage	2,147	3	0[2]	0[2]
8541	Munitions Storage	2,147	3	9[2]	2[2]
8552	Munitions Storage	1,060	3	9[2]	2[2]
8554	Munitions Storage	2,146	3	9[2]	2[2]
8556	Munitions Storage	2,146	3	0[2]	0[2]
8558	Munitions Storage	2,146	3	0[2]	0[2]
8560	Munitions Storage	2,146	3	0[2]	0[2]

[1] Approximate square footage extrapolated from Jacobs (1996).

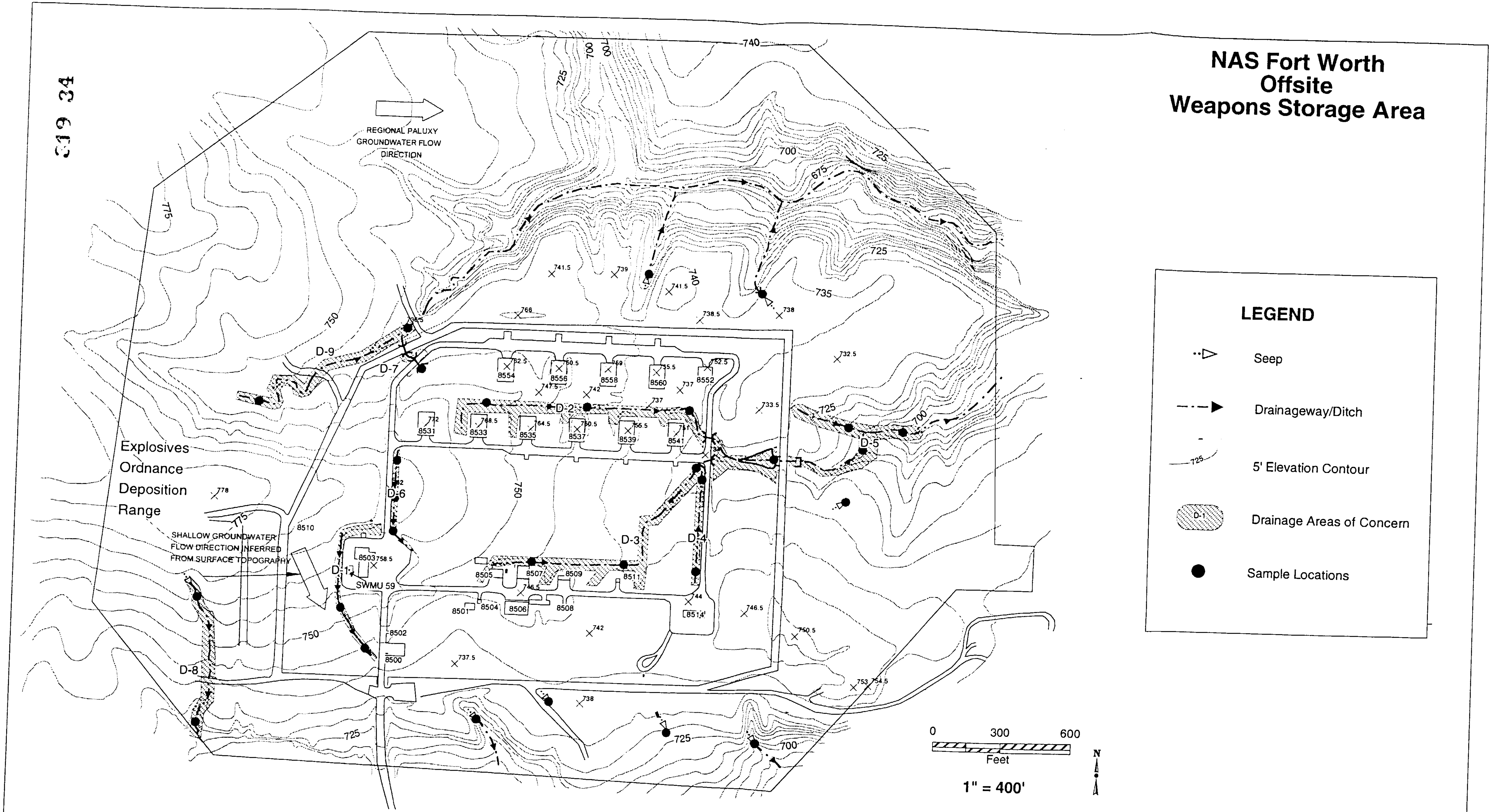
[2] Only representative munitions storage building with identical construction will be sampled for lead paint and suficial contaminants



The Environmental Company, Inc.

Date: December 1996
Project Manager: B. Duffner
Prepared By: WSM
Project No: P-3109

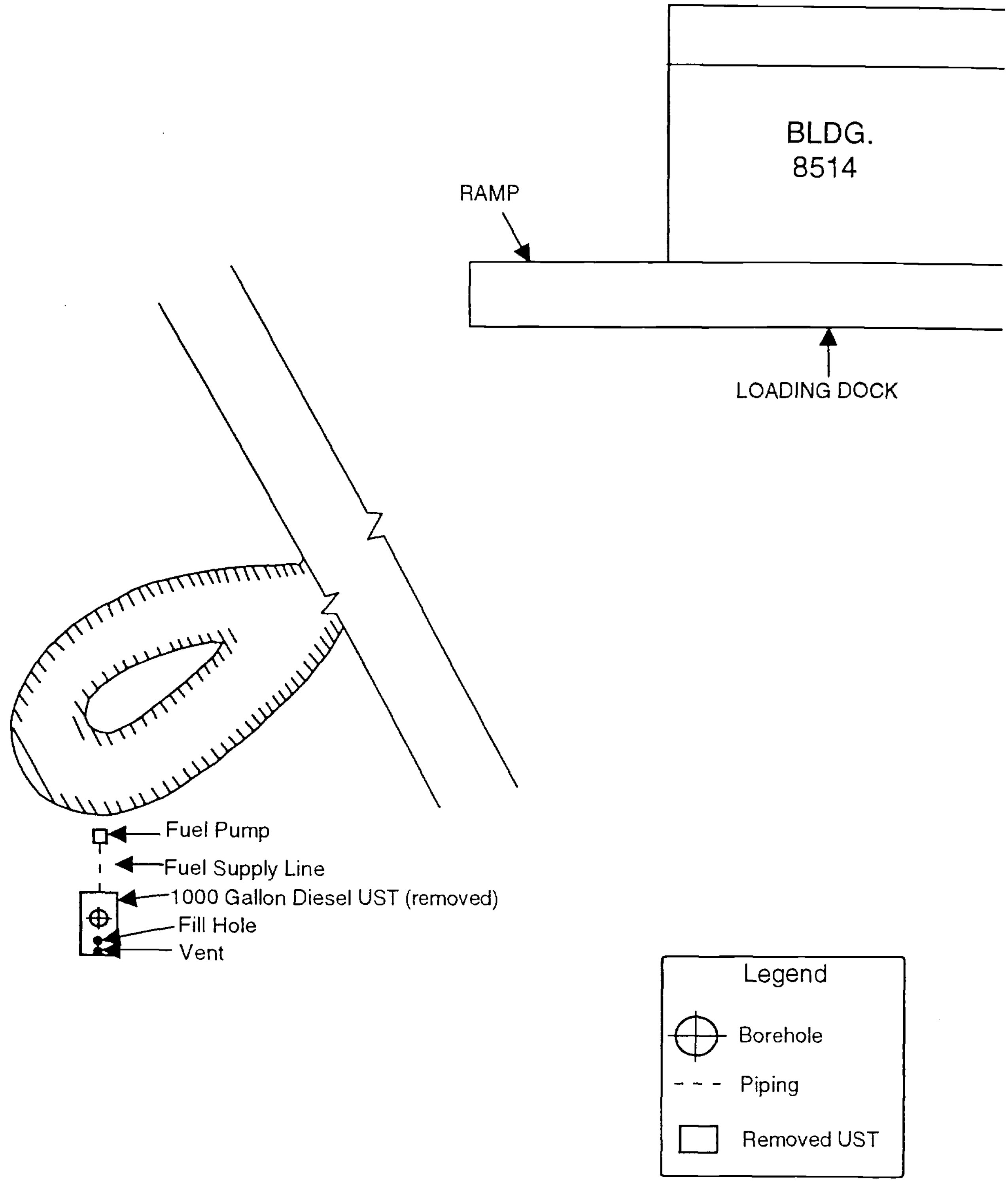
Figure 3-1 -- Surface and Subsurface Soil Sample Locations



The Environmental Company, Inc.

Date: December 1996
Project Manager: B. Duffner
Prepared By: WSM
Project No: P-3109

Figure 3-2 -- Drainageway and Seep Sample Locations

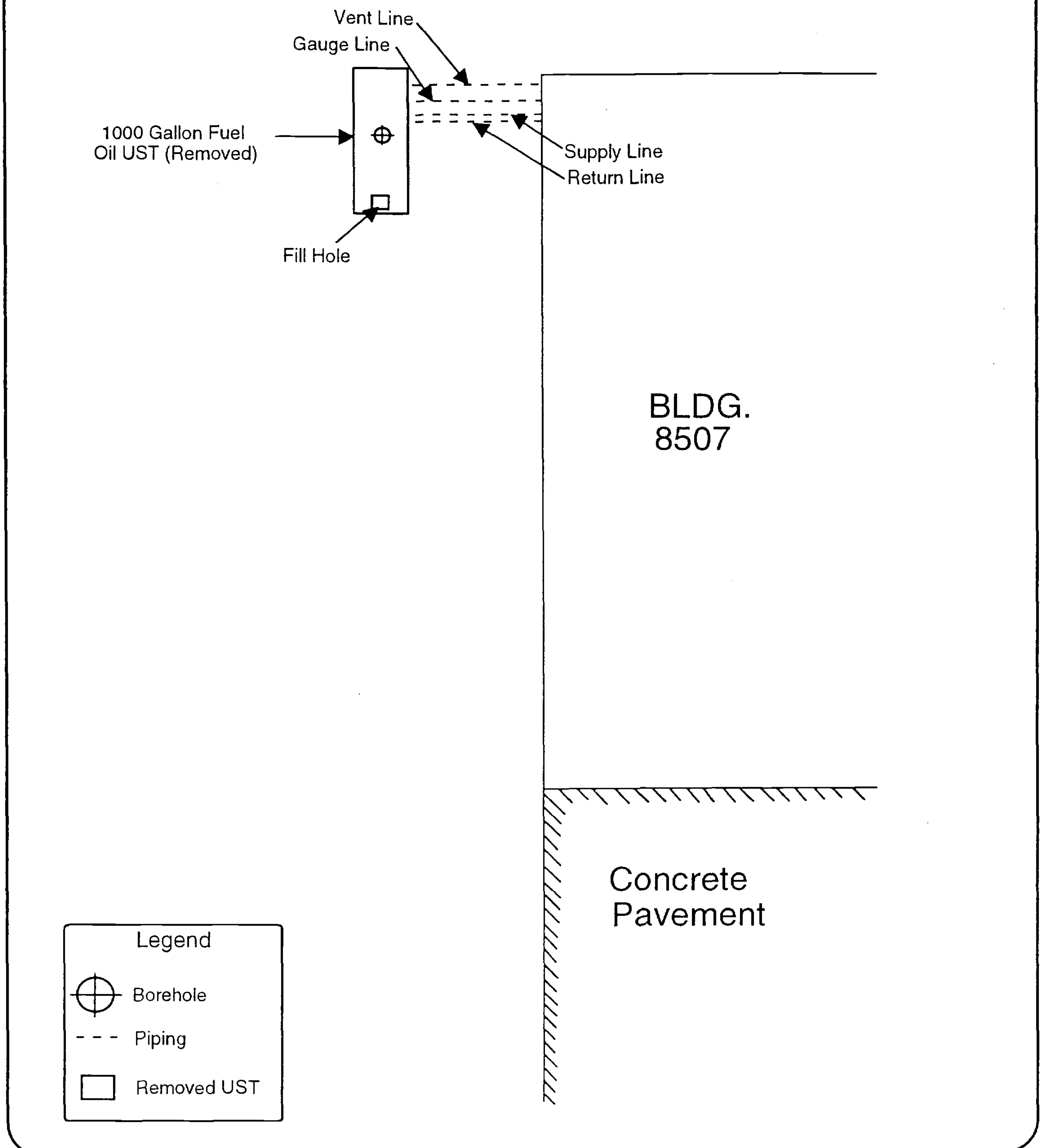


Date 10 December 1996
Project No. 3109
Project Manager B. Duffner
Prepared by AMM

The Environmental Company, Inc.

1 inch = 25 feet

Figure 3-3
Building 8514
UST Borehole Locations



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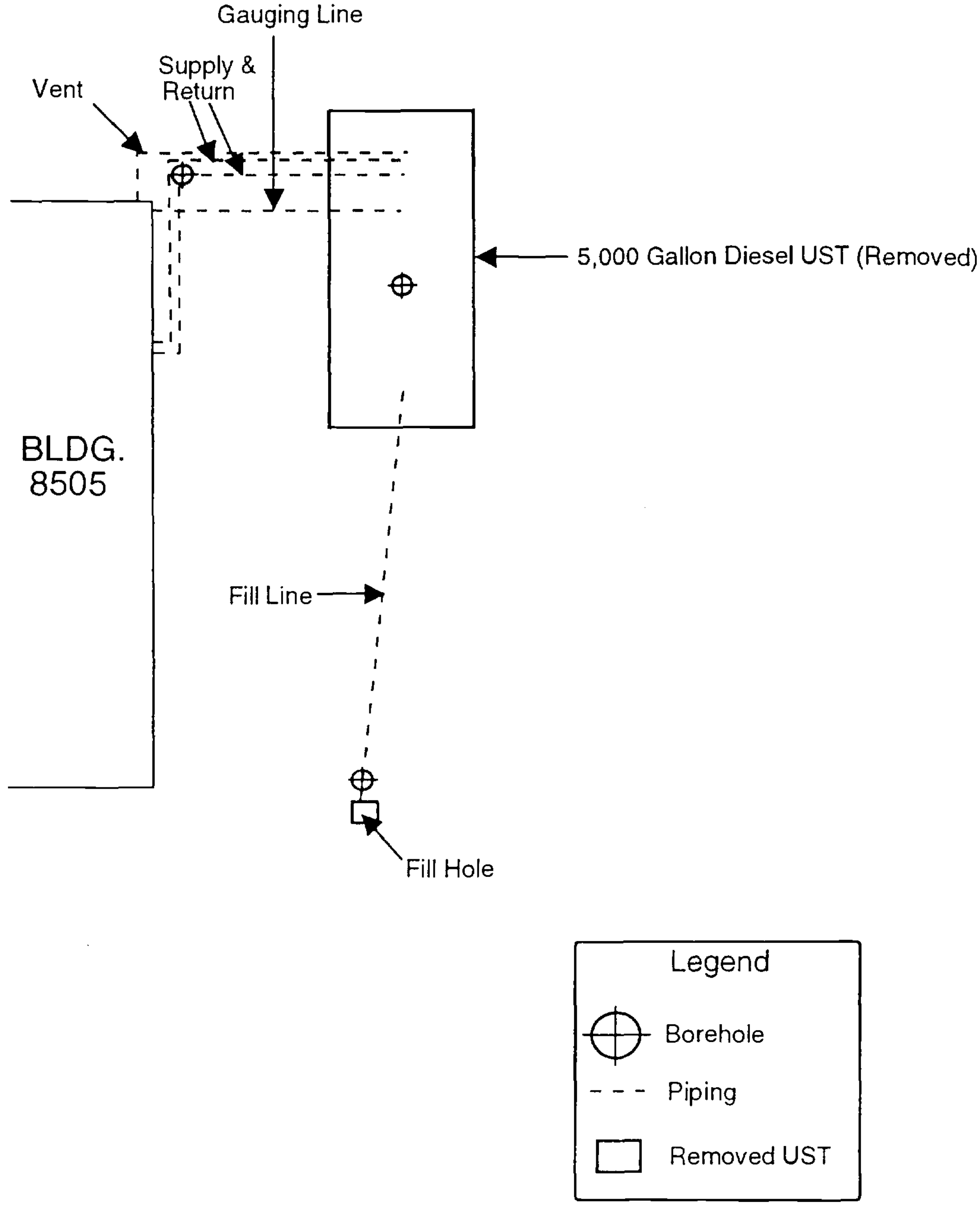
Project No. 3109-025
Project Manager B. Duffner
Prepared by AMM
The Environmental Company, Inc.

Figure 3-4
Building 8507
UST Borehole Locations

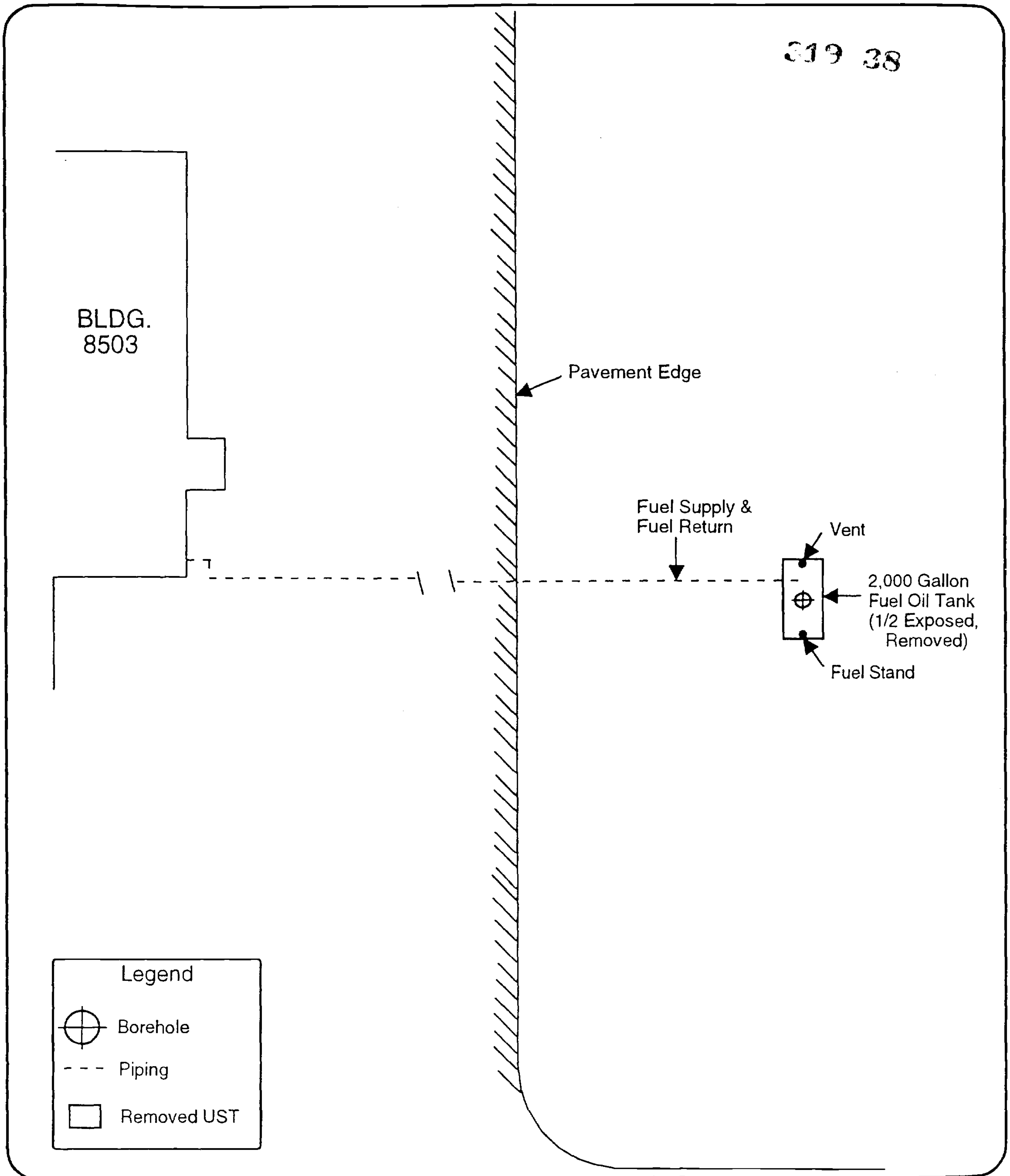


Date 10 December 1996
Project No. 3109-025
Project Manager B. Duffner
Prepared by AMM

The Environmental Company, Inc.

1 inch = 10 feet

Figure 3-5
Building 8505
UST Borehole Locations



Date 20 December 1996

Project No. 3109-025

Project Manager B. Duffner

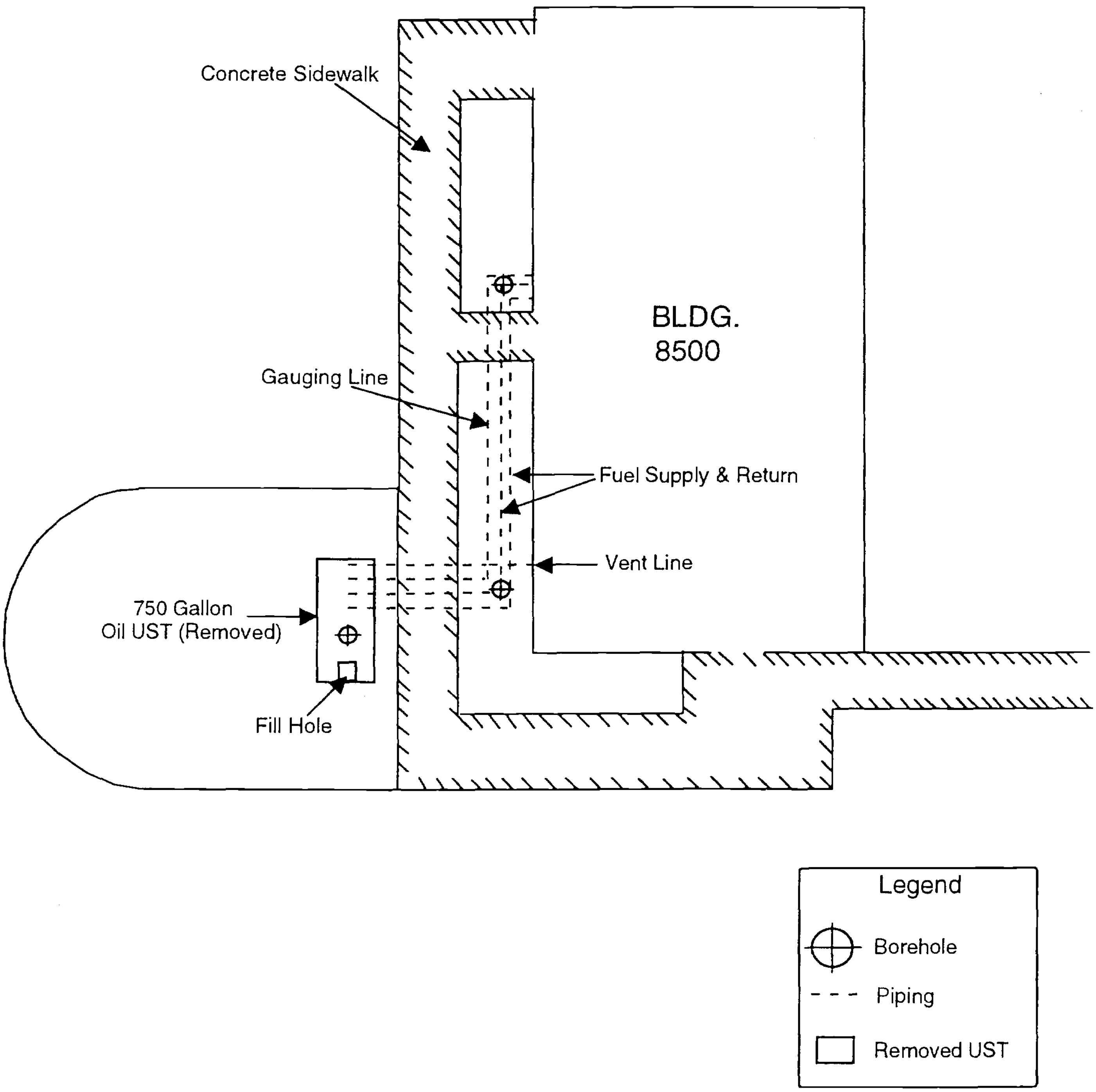
Prepared by AMM

The Environmental Company, Inc.

N

1 inch = 20 feet

Figure 3-6
Building 8503
UST Borehole Locations



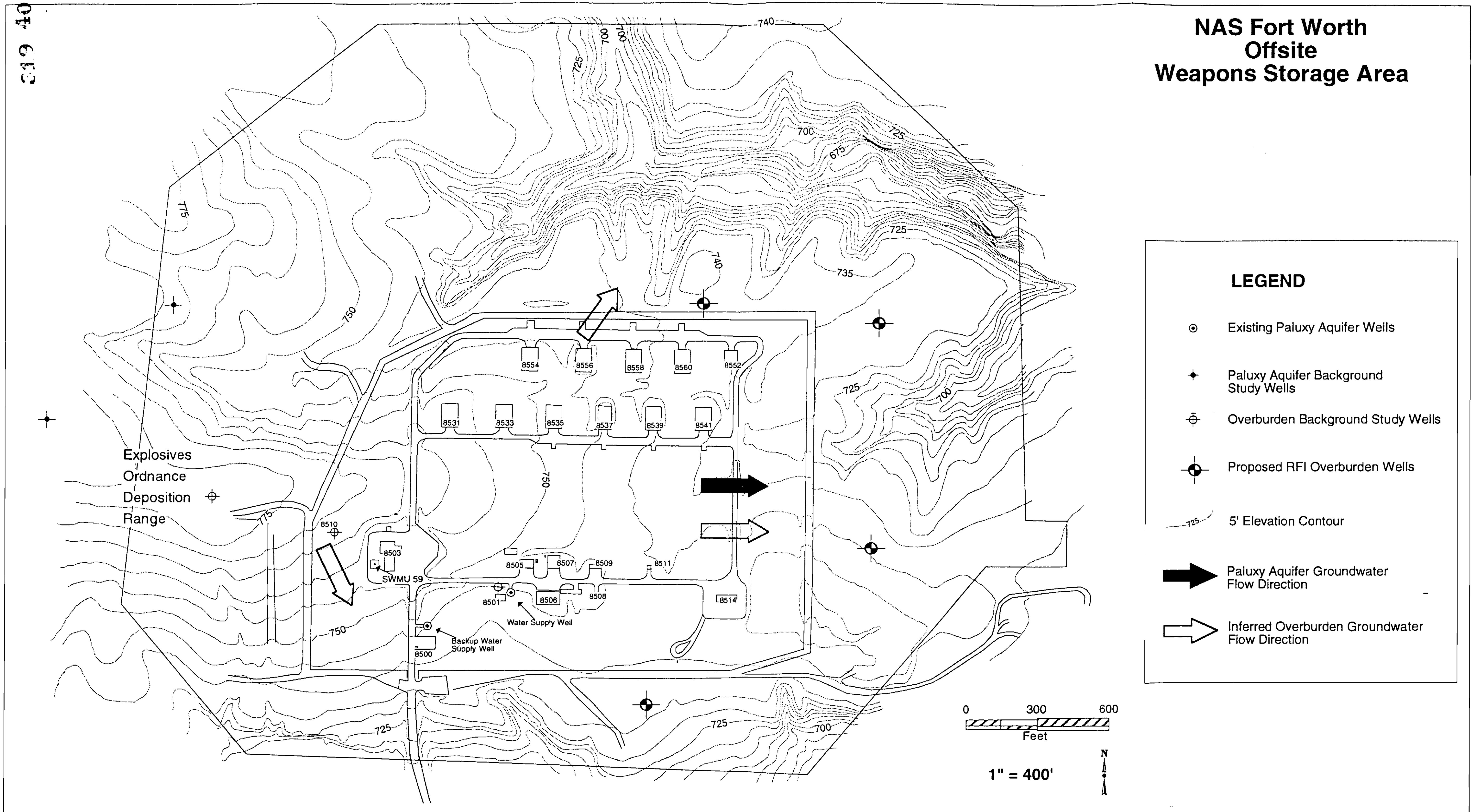
Date 10 December 1996
Project No. 3109-025
Project Manager B. Duffner
Prepared by AMM

The Environmental Company, Inc.

N

1 inch = 10 feet

Figure 3-7
Building 8500
UST Borehole Locations



The Environmental Company, Inc.

Date: December 1996
Project Manager: B. Duffner
Prepared By: DEB
Project No: P-3109

Figure 3-8 -- NAS Fort Worth Offsite Weapons Storage Area Monitoring Well Locations

4.0 PROJECT ORGANIZATION AND RESPONSIBILITY

The TEC project team consists of highly qualified professionals with expertise in project management, quality assurance/quality control (QA/QC), environmental engineering, field investigations, hydrogeology, data management, risk assessment, and other technical/engineering skills. Figure 4-1 is an organizational chart that identifies all key project personnel. Table 4-1 presents POC information for key project personnel. Responsibilities for key TEC project team and AFCEE/AFBCA point-of-contact (POCs) are described below.

AFCEE Contracting Officer. The AFCEE Contracting Officer (CO) will be Mr. Jerry , who is located at Brooks AFB, Texas.

AFCEE Contracting Officer's Representative/Team Chief (COR/TC). The AFCEE COR/TC for Delivery Order No. 0009 is Mr. Charles Rice, who is located at Brooks AFB, Texas. As the appointed COR/TC, Mr. Rice shall be:

- Responsible for technical monitoring of TEC performance and act as the sole technical POC at the AFCEE/ERB;
- Provide technical reviews of TEC's proposals for any changes to Delivery Order No. 0009;
- Coordinate activities with TEC personnel and individuals at NAS Fort Worth, Texas;
- Review invoices/payment vouchers according to Special Contract Requirements provisions of the basic contract;
- Review and accept the completed effort specified in Delivery Order No. 0009;
- Attend meetings as the official government representative; and
- Maintain written records of all actions taken by NAS Fort Worth technical personnel, TEC, and himself for PCO review to ensure that costs, schedule, and technical performance are accurately documented.

Base POC/AFBCA Site Manager. The AFBCA Site Manager and Base POC is Mr. Olen Long, P.E., who is located at NAS Fort Worth, Texas. As Site Manager, Mr. Long will provide the following assistance:

- Provide TEC and project subcontractors with existing engineering plans, drawings, and aerial photographs to facilitate evaluation of the WSA.
- Arrange for personnel identification badges, vehicle passes, and/or entry permits.
- Provide areas for staging, decontamination, and temporary waste storage. TEC will make every effort to remove waste from NAS Fort Worth in an expedient and cost-effective manner.
- Supply sources of electrical power and water. TEC will be responsible for any utility connections required.
- Provide office space for TEC and project subcontractors during the field investigation.

TEC Project Director. The TEC Project Director is Mr. Jack Wilson, P.E., who is located at TEC's corporate headquarters in Charlottesville, Virginia. Mr. Wilson's primary responsibility will be to provide guidance to the TEC Project Manager. Mr. Wilson will perform the following duties:

- Oversee project QA;
- Serve as acting Project Manager in the Project Manager's absence;
- Contact the client on a monthly basis to check on project status and hear the client's perception of the work activity first hand;
- Attend key meetings with the Project Manager and the client as needed;
- Attend key meetings with regulatory officials or other groups involved in the project as needed; and
- Ensure that appropriate corporate resources are being applied to the project.

TEC Project Manager. The TEC Project Manager is Mr. Robert M. Duffner, P.E., who is located at TEC's Issaquah, Washington office and will have primary responsibility for all management matters that affect the project. The Project Manager will be responsible for all aspects of the day-to-day operation of the project. These responsibilities will include:

- Personnel scheduling;
- Budget tracking and control;
- Client relations;
- Technical direction; and
- Production scheduling.

Mr. Duffner will also be responsible for overall QC and coordinate all activities under this delivery order with Air Force representatives.

TEC Quality Assurance Manager. The TEC QA Manager, Dr. A. Scott Neese, will ensure that all work is performed according to the procedures described in the SAP. Dr. Neese is located at TEC's corporate headquarters in Charlottesville, Virginia. He will report to Air Force officials and be responsible for all QA issues. In addition, Dr. Neese will review evaluation reports, field and laboratory audits, and corrective action procedures to ensure that the project meets AFCEE Handbook standards.

TEC Health and Safety Manager. The TEC Health and Safety Manager, Mr. Alistair J. Downie, is located at TEC's corporate headquarters in Charlottesville, Virginia. Mr. Downie will ensure that all field activities are performed according to the approved Health and Safety Plan (HSP) and the provisions of the Occupational Health and Safety Administration (OSHA) 29 CFR 1910.120 for worker health and safety. Mr. Downie will provide assistance, oversight, and senior review of the HSP. The HSP Manager or designee will perform audits to ensure that field work is performed according to the tasks outlined in the FSP.

TEC Field Team Leader. Mr. Donald A. Coleman, CG will serve as the TEC Field Team Leader. He will be responsible for ensuring that the RFI field investigation is performed in a manner that maximizes data quality while maintaining a safe environment for all field personnel. The TEC Field Team Leader or designee will also be responsible for the following:

- Reviewing all field documentation (e.g., soil borings logs, well completion logs, chain-of-custody (COC) forms, monitor well purging forms) for accuracy and completeness;
- Making decisions concerning soil boring, monitoring well, and sample locations;
- Ensuring sample integrity throughout the field investigation; and
- Ensuring that the overall objectives of the field investigation are met according to AFCEE Handbook procedures.

TEC Site Health and Safety Coordinator. The RFI Site Health and Safety Coordinator (SHSC) will be an OSHA-qualified member of the TEC field team and will be responsible for ensuring that health and safety protocols outlined in the HSP are followed by TEC field personnel. During the RFI field investigation, the SHSC or designee will be responsible for drill rig inspections, personnel monitoring, and personnel protection. The SHSC will also investigate all accidents or injuries related to the project that occur at NAS Fort Worth and will have the authority to stop all work on site if deemed necessary for the protection of field personnel. Furthermore, the SHSC will conduct daily tailgate safety meetings with all field personnel to discuss existing and/or potential site hazards before field activities begin. A detailed discussion of SHSC responsibilities is presented in the HSP.

4.1 SUBCONTRACTORS

A significant portion of the RFI will be conducted by subcontractors. To ensure that all subcontractor activities are planned, undertaken, and completed according to the guidelines and standards described in the contract documents, the AFCEE *Handbook*, and project-scoping douments, the project manager will maintain regular contact with project subcontractors. The Project Manager and/or RFI Field Team Leader will be responsible for:

- Meeting periodically with project subcontractors;
- Coordinating and overseeing subcontractor work activities;
- Monitoring subcontractor compliance with project-scoping documents during all phases of the RFI;
- Addressing subcontractor concerns; and
- Resolving potential problems and contractual difficulties.

A number of project subcontractors will assist TEC in completing the RFI field investigation. Project subcontractors will include the following:

- Drillers;
- Land surveyors; and
- Analytical laboratory.

Prior to initiating field activities, TEC will prepare technical scopes of work for project subcontractors so that RFI activities can be effectively coordinated. Specific project subcontractors have not yet been selected for this RFI. As soon as subcontractors are selected, information will be provided to AFCEE. Responsibilities of various project subcontractors are discussed in the following subsections.

4.1.1 Drilling Services

During the RFI field investigation, a Texas-licensed drilling contractor to be named will advance geoprobe explorations and/or soil borings at selected locations (see Section 3.3).

Monitoring wells will be installed according to AFCEE and State of Texas regulations. The drilling contractor will observe all health and safety protocols and equipment decontamination procedures that are described in the HSP and this FSP.

4.1.2 Surveying Services

Land surveying services will be performed by a Texas registered land surveyor (RLS). The surveyor will be selected on the basis of client preference, technical capability as evidenced by previous surveying services, and competitive rate structure.

The RLS will perform the following activities:

- Conduct a records search to identify land owners and determine property boundaries and easements;
- Locate closest easements, establish easements to wells, and establish permanent easement boundaries;
- Prepare a metes and bounds description and plot plan for each easement site; and
- Determine the elevation and coordinates of all geoprobe explorations, hollow-stem auger (HSA) soil borings, hand auger borings, onsite water supply wells, and previously installed groundwater monitoring wells.

All surveying will be performed according to general requirements described in the AFCEE Handbook and Section 5.11 of this FSP.

4.1.3 Analytical Laboratory Services

TEC will select an AFCEE-qualified laboratory to perform analytical laboratory services and QA/QC procedures according to AFCEE and IRPIMS program protocols.

A detailed discussion of laboratory procedures, QA/QC, calibration methods and protocols, data validation, and auditing is presented in the QAPP.

4.1.4 Utility Locator

Prior to initiating RFI field activities, all underground utilities at proposed WSA field areas will be located by reviewing existing site plans and interviewing base personnel. If necessary, TEC will retain a qualified subcontractor to locate site utilities in the vicinity of proposed field activities.

4.1.5 Site Restoration

If appropriate, TEC will retain a qualified subcontractor to restore field sites to pre-field investigation conditions. Conditions that may require site restoration include heavy equipment usage or drilling activity. TEC will identify qualified site restoration contractors prior to initiating intrusive activities. Site restoration, if required, will be coordinated with the AFBCA Site Manager/Base POC to ensure that restoration is conducted according to facility requirements.

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Table 4-1. Key Personnel Point-of-Contact Listing

Mr. Jerry Outley **AFCEE Contracting Officer**	HSC/PKVCC 3207 North Road Brooks AFB, TX 78235-5353 (210)536-4410 (210)536-6003 (FAX)
Mr. Charles Rice **AFCEE COR/TC**	AFCEE/ERB 3207 North Road. Bldg. 532 Brooks AFB, TX 78235-5363 (210)536-6452 (210)536-3609 (FAX)
Mr. Olen Long, P.E. **AFBCA Site Manager/Base POC**	AFBCA/OL-H 6550 White Settlement Road Fort Worth, TX 76114-8137 (817)731-8284 (817)731-8137 (FAX)
Mr. Jack E. Wilson, P.E. **TEC Project Director**	The Environmental Company, Inc. 1230 Cedars Court. Suite 100 Post Office Box 5127 Charlottesville, VA 22905 (804)295-4446 (804)295-5535 (FAX) JEWILSON@tecinc.com (electronic)
Mr. Robert M. Duffner, P.E. **TEC Project Manager**	The Environmental Company, Inc. 710 N.W. Juniper Street, Suite 208 Issaquah, Washington 98207 (206) 557-7899 (206) 557-7878 (FAX) RMDUFFNER@tecinc.com (electronic)

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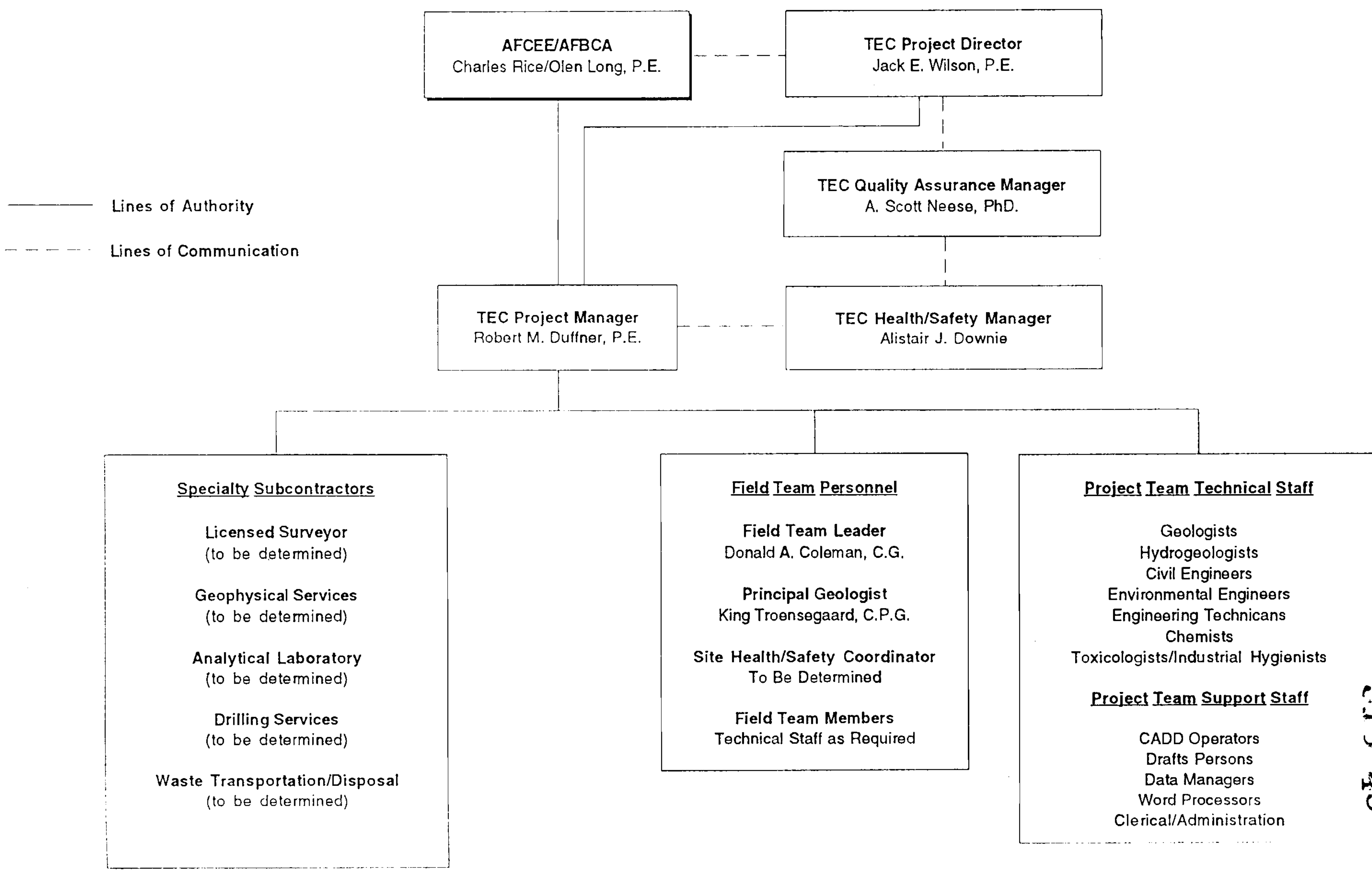
FIGURE 4-1

PROJECT ORGANIZATIONAL CHART



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5.0 FIELD OPERATIONS

TEC will perform or oversee field activities that are described in Section 3 of this FSP. The following sections describe procedures that will be used during field operations. Standards for lithologic descriptions, site reconnaissance and restoration, geoprobe exploration, borehole drilling, monitoring well installation and development, surveying, and waste management are discussed below.

In addition to collecting environmental media samples, TEC will initiate a sampling program of WSA buildings to assess their suitability for public transfer or disposal. Samples will be collected from building interiors.

5.1 GEOLOGIC STANDARDS

Lithologic descriptions for unconsolidated materials (soils [engineering usage] or deposits) will use the name of the predominant particle size (e.g., silt, fine sand, clay). The dimensions of the predominant and secondary sizes will be recorded using the metric system. The grain size and name of the deposit will be accompanied by the predominant mineral content, accessory minerals, color, particle angularity, and any other characteristics. Clastic deposit descriptions will include, as a supplement, symbols of the Unified Soil Classification System (USCS). The color descriptions will be designated by the Munsell Color System.

Local knowledge and experience is indispensable in assisting with the accurate classification, identification, and logging of soil and rock. Whenever possible, TEC will review existing soil boring and monitoring well installation logs from previous investigations completed at the WSA.

Columnar sections, well and boring logs, well construction diagrams, cross sections, and three-dimensional (3-D) diagrams will use patterns shown in Figure 5-1. Supplementary patterns will follow Swanson, R. G., 1981, *Sample Examination Manual*, American Association of Petroleum Geologists, pp. IV-41 and 43.

The scales for maps, geologic cross-sections, or 3-D diagrams will be selected in accordance with the geologic and hydrologic complexity of the area and the purposes of the illustrations. If defining geological conditions requires other scales, additional logs at those scales will be provided.

For orientation, geologic cross-sections will show the northern end on the viewer's right. If the line of cross section is predominantly east-west, the eastern end is on the right. Maps will be oriented with north toward the top, unless the shape of the area dictates otherwise. Orientation will be indicated with a north arrow.

5.2 SITE RECONNAISSANCE, PREPARATION, AND RESTORATION PROCEDURES

5.2.1 Site Reconnaissance

During the presurvey, TEC performed the following tasks:

- Reviewed pertinent base documents;

- Interviewed base personnel who are knowledgeable about environmental conditions at the WSA;
- Conducted multiple site walks to evaluate sampling locations;
- Evaluated site accessibility and security;
- Visually identified potentially contaminated areas (i.e., discolored soils, stressed vegetation); and
- Documented and evaluated site reconnaissance observations and plotted information on updated site maps.

5.2.2 Preparation

Prior to initiating RFI field activities at the WSA, TEC will complete a number of site preparation tasks. These tasks will include:

- Becoming familiar with Air Force rules, policies, procedures, names of local POCs, and emergency telephone numbers;
- Verifying the location of emergency equipment;
- Completing required digging permits (Air Force Form 103);
- Establishing field and communications facilities for TEC field personnel;
- Verifying the location of utilities in areas where subsurface explorations are proposed using existing utility maps, a hand-held magnetometer, or utility probe;
- Determining appropriate vehicle access routes to sampling locations;
- Verify and stake proposed sampling locations and establish sample grids in selected areas; and
- Securing field office space.

In addition to the above-referenced site preparation tasks, it is anticipated that one centrally located decontamination pad will be constructed at the WSA to decontaminate the geoprobe/drilling rig, drill tools, and reusable sampling equipment. The decontamination pad will be lined with heavy-gauge polyethylene sheeting and designed with a collection system to capture decontamination fluids. Smaller decontamination areas for personnel and portable equipment will be provided as necessary. These locations will include basins or tubs to capture decontamination fluids, which will be transferred to a large accumulation drum as necessary.

5.2.3 Site Restoration

Each work site or sampling location will be returned to its pre-investigation condition. Efforts will be made to minimize impacts to work sites and sampling locations, particularly those in or near sensitive environments. After completing work at a field site, all unused or surplus materials and supplies, stakes, flagging, drums, trash, and other non-investigative wastes will be properly containerized and stored on site for subsequent off-site disposal. Decontamination procedures are described in Section 5.12. Equipment staging, temporary storage, and decontamination areas will be restored to pre-field investigation areas. All materials and equipment that are brought to the field sites will be removed at the conclusion of the RFI field investigation.

Site restoration will be coordinated with the AFBCA Site Manager/Base POC to ensure that site restoration is conducted according to facility requirements. A site restoration subcontractor will be retained by TEC where necessary to restore areas following heavy equipment usage or drilling activity.

5.3 GEOPHYSICAL SURVEYS

Not applicable to this delivery order.

5.3.1 General Requirements For Geophysical Surveys

Not applicable to this delivery order.

5.3.2 Surface Geophysical Surveys

Not applicable to this delivery order.

5.3.2.1 Ground Penetrating Radar

Not applicable to this delivery order.

5.3.2.2 Magnetometry

Not applicable to this delivery order.

5.3.2.3 Electromagnetic Methods

Not applicable to this delivery order.

5.3.3 Borehole Geophysical Surveys

Not applicable to this delivery order.

5.3.3.1 Electric Logs

Not applicable to this delivery order.

5.3.3.2 Natural Gamma Ray Logs

Not applicable to this delivery order.

5.3.3.3 Caliper Logs

Not applicable to this delivery order.

5.3.3.4 Electrical Resistivity

Not applicable to this delivery order.

5.4 SOIL GAS SURVEYS

Not applicable to this delivery order.

5.5 BOREHOLE DRILLING, LITHOLOGIC SAMPLING, LOGGING, AND ABANDONMENT

It is anticipated that most soil borings will be advanced using direct push (Geoprobe™) technology. Groundwater monitoring wells and soil borings beyond the capabilities of a geoprobe will be completed using HSA drilling methods. General drilling, logging, and abandonment are discussed in Sections 5.5.1 through 5.5.3. A discussion of the direct push sampling program is presented in Section 6.1.2.4.

5.5.1 General Drilling Procedures

All drilling activities will conform with state and local regulations and be supervised by a state licensed geologist or state licensed engineer. The drilling contractor will obtain and pay for all permits, applications, and other documents required by state and local authorities. The location of all soil borings will be coordinated in writing with the AFBCA POC before drilling commences.

A state-licensed geologist or their designee will be present at each geoprobe exploration or soil boring to:

- Log subsurface soil samples as they are retrieved;
- Observe drilling operations;
- Record subsurface soil conditions, groundwater data, and monitoring well installation procedures; and
- Complete boring logs, groundwater monitoring well completion diagrams, and borehole abandonment forms.

The HSA drill rig or geoprobe will be cleaned and decontaminated according to the procedure described in Section 5.12. The HSA drill rig or geoprobe will not leak any fluids that may enter the borehole or contaminate equipment placed in the hole. The use of rags or absorbent materials to absorb leaking fluids is unacceptable.

Lubricants will not be introduced to mask contaminants. In the event that lubricants are used, TEC will provide AFCEE project personnel with chemical analyses of all lubricants proposed for downhole use. Chemical detection limits will be equivalent to those used in analyzing project groundwater samples. Lubricants with constituents that are toxic or that increase, decrease, or mask the target chemical species of the investigation will not be permitted. TEC will provide analytical results to AFCEE prior to drilling mobilization.

A log of drilling activities will be kept in a bound field notebook. Information in the log book will include location, time on site, personnel and equipment present, down time, materials used, samples collected, measurements taken, and any other observations or information that would be necessary to reconstruct field activities at a later date. All items on the log must be completed, if known.

TEC will direct the drilling contractor to dispose of all trash, waste grout, soil cuttings, and drilling fluids. These activities will be coordinated with the AFBCA POC or representative.

5.5.1.1 HSA Soil Borings

If HSA drilling is required, the following procedures will be used. Soil borings will be advanced with a truck-mounted drill rig using 4.25-inch inside diameter (ID) continuous flight HSA. The soil borings will be advanced approximately 5 feet below any encountered groundwater or until refusal is encountered, whichever occurs first. During borehole advancement, the drilling subcontractor will attempt to collect undisturbed, discrete, and representative samples continuously using a 2-inch outside diameter (OD) split-spoon sampler driven in accordance with ASTM D-1586-84. Soil samples collected from the HSA borings will be visually classified in the field by TEC geologists using ASTM Standard 2488-90. In addition, headspace screening of soil samples will be performed in the field for total organic vapors using a portable photo ionization detector (PID). Results of field headspace screening will be recorded on a boring log (Appendix A). Upon completion of field headspace screening and soil classification, a selected number of representative soil samples will be submitted for laboratory analysis. Additional representative soil samples will be placed in self-sealing polyethylene plastic bags for future reference and stored on site.

5.5.2 Logging

The lithology in all soil borings and geoprobe explorations will be logged. The soil boring log (Appendix A) will be used for recording lithologic logging information. Information on the boring log sheet includes borehole location, drilling information, sampling information such as sample intervals, recovery, and blow counts, and sample description information.

Unconsolidated samples for lithologic description will be obtained continuously to the groundwater table. Continuous sampling will be performed for lithologic information and to accurately profile the vertical distribution of contaminants, if encountered, using field headspace screening methods.

Soil samples collected from the soil borings will be visually classified in the field by TEC geologists in accordance with ASTM D-2488-90 Standard Practice for Description and Identification of Soils (Visual-Manual Procedure). Descriptive information to be recorded in the field will include:

- Identification of the predominant particle sizes and range of particle sizes;
- Percent of gravel, sand, fines, or all three;
- Description of grading and sorting of coarse particles;
- Particle angularity and shape; and
- Maximum particle size or dimension.

Plasticity of fines description include:

- Color using Munsell Color System;
- Moisture (dry, wet, or moist);
- Consistency of fine grained soils;
- Structure of consolidated materials; and
- Cementation (weak, moderate, or strong).

The USCS group symbol will be used and recorded on the Boring Log. Additional information to be recorded includes the depth to the water table, caving or sloughing of the HSA borehole, depths of laboratory samples, presence of organic materials, and other noteworthy observations or conditions, such as the locations of geologic boundaries.

All soil samples will be screened with a PID. Soil samples will be handled carefully to minimize loss of volatiles, and these procedures are described in Section 6.0. Soil cuttings exiting the borehole will be examined for their hazardous characteristics. Materials will be containerized in conformance with RCRA and state and local requirements. Waste handling procedures are discussed in Section 5.13. It is not anticipated that geoprobe explorations will generate significant quantities of soil cuttings during borehole advancement.

5.5.3 Abandonment

Any HSA boring or geoprobe exploration not completed as groundwater monitoring wells will be properly abandoned to reduce the potential for fluid migration (cross-contamination) between formations or sampling zones. Borehole abandonment will be completed according to AFCEE requirements. Each borehole not completed as a groundwater monitoring well will be grouted to ground surface by pumping a mixture of 4 pounds of powdered or granular bentonite, 8 gallons of water, and one 94-pound sack of Type I Portland cement (ASTM C-150). The cement/bentonite grout will be thoroughly mixed using a high shear mixer or paddle and pumped into the borehole. The bottom of the drill pipe will always be positioned below the top of the grout to prevent caving from overlying materials.

All abandoned geoprobe explorations and/or HSA boreholes will be checked 24 to 48 hours after emplacement to assess whether curring is occurring properly. More specific curring specifications may be recommended by the manufacturer and will be followed. If settling has occurred, a sufficient amout of solid bentonite and/or cement will be added to fill the borehole to ground surface. These curing checks and any addition of solid bentonite and/or cement will be recorded in the field log book.

The following checklist outlines standard abandonment procedures:

- Check the borehole for debris;
- Remove any dedicated sampling equipment which will interfere with abandonment;
- Measure total depth of the borehole with a sounding weight and line;
- Use a tremie pipe with a diameter greater that 1 inch to allow for adequate flow of bentonite or neat cement grout (only for boreholes greater than 20 feet);
- Use a grout mixer along with a positive displacement pump to deliver the mixture with positive pressure to the bottom of the borehole;
- Place abandonment materials;
- Sound the borehole at specified intervals to fill any large diameter or deep borehole; and
- Complete the final sealing of the borehole with cement or concrete.

The final step in the abandonment program will be to develop appropriate records and reports. These records will identify methods of abandonment, materials used, and the quantity and mixed weight of all abandonment materials. Abandonment records will clearly establish the location of all abandoned borings. The Texas-licensed driller provided by the drilling subcontractor will file a well abandonment and plugging report with the Executive Director or designee of the TNRCC within 30 days after abandonment is complete (30 TAC 338.48(e) on forms supplied by the Executive director. Records of abandonment will also be included in the RFI report.

5.6 STANDARD MONITORING WELL CONSTRUCTION

As indicated in Section 3.3.8, TEC will attempt to install up to four monitoring wells to evaluate overburden groundwater quality at the offsite WSA.

TEC will install 0.5-inch diameter monitoring wells in selected geoprobe explorations or 2-inch diameter monitoring wells if HSA drilling is required. The on-site TEC geologist will supervise monitoring well construction and will be a state-licensed geologist, hydrogeologist, or geotechnical engineer; or will be certified by the American Institute of Hydrology, American Institute of Professional Geologists, or the National Ground Water Association as a Certified Ground Water Professional. The supervising geologist will affix his/her signature and registration/certification seal to as-built well construction diagrams. Since there is the possibility that floating petroleum products will be encountered, overburden monitoring wells will be screened across the water table. The length of the screen will be such that seasonal water table fluctuations will not cause water levels to rise above or fall below the screened interval. In addition, the well screen will be positioned such that it does not extend into another water-bearing horizon.

If refusal or the bedrock surface is encountered prior to reaching groundwater, the boring will be abandoned according to the guidelines described in Section 5.5.3.

5.6.1 Drilling Requirements

All monitoring well installations will be completed by a Texas-licensed well installer and conform to AFCEE state regulations. The drilling contractor will obtain and pay for all permits, applications, and other documents required by state and local authorities.

5.6.2 Borehole Requirements

If HSA drilling methods are used during the RFI, borehole diameters will be at least 4 inches larger than the outside diameter of the casing and well casing. Geoprobe explorations will be advanced using 2.125-inch OD x 1.60-inch ID stainless steel probe rods.

A completed monitoring well will be straight and plumb. The monitoring well will be sufficiently straight to allow passage of pumps or sampling devices. The monitoring well will be plumb within 1 degree of vertical where the water level is greater than 30 feet below land surface unless otherwise approved by AFCEE. Any request for a waiver from straightness or plumbness specifications will be made, in writing, to AFCEE in advance of mobilization for drilling.

The Boring Log (Appendix A) will document the following information for each boring:

- Boring or well identification (this identification will be unique and not previously used at the Offsite WSA);
- Purpose of boring (e.g., soil sampling, monitoring well);

- Location in relation to a landmark;
- Name of drilling contractor and logger;
- Start and finish dates and times;
- Drilling method;
- Types of drilling fluids and depths at which they were used;
- Diameters of surface casing, casing type, and methods of installation;
- Depth at which saturated conditions were first encountered;
- Lithologic descriptions and depths of lithologic boundaries;
- Sampling interval depths;
- Depth at which drilling fluid lost and the estimated quantity lost;
- Changes in drilling fluid properties;
- Zones of caving or heaving;
- Drilling rate; and
- Drilling rig reactions, such as chatter, rod drops, and bouncing.

5.6.3 Casing Requirements

The casing requirements that will be followed are:

- All casing will be new, unused, and decontaminated according to the specifications of Section 5.12;
- Glue will not be used to join casing, and casings will be joined only with compatible welds or couplings (flush-threaded) that will not interfere with the planned use of the well;
- All PVC will conform to the ASTM Standard F-480-88A or the National Sanitation Foundation Standard 14 (Plastic Pipe System);
- The casing will be straight and plumb within the tolerance stated for the borehole; and
- The driller will cut a notch in the top of the casing to be used as a measuring point for water levels.

TEC will use 0.5-inch ID pre-packed wire-wound stainless steel screen and Schedule 80 polyvinyl chloride (PVC) riser pipe in geoprobe explorations completed as monitoring wells. Two-inch diameter Schedule 40 PVC screen and riser pipe will be used to HSA borings completed as monitoring wells. Installing 0.5- or 2-inch diameter PVC pipe in the boreholes will allow TEC to accurately measure groundwater elevations, estimate principal flow directions, and collect representative groundwater samples for laboratory analysis. When the monitoring well is installed, TEC field personnel will inspect well screen and casing for damage and if necessary, decontaminate casing according to equipment decontamination procedures outlined in Section 5.12. An end cap will be placed on the bottommost section of well screen casing so that any sediment buildup can be captured.

5.6.4 Well Screen Requirements

Well screen requirements are:

- All requirements that apply to casing will also apply to well screen, except for strength requirements;
- Monitoring wells will not be screened across more than one water-bearing unit;
- Screens will be factory slotted or wrapped;
- Screen slots will be sized to prevent 90 percent of the filter pack from entering the well, and for wells where no filter pack is used, the screen slot size will be selected to retain 60 to 70 percent of the formation materials opposite the screen; and
- The bottom of the screen will be capped, and the cap joined to the screen by threads.

Geoprobe explorations completed as groundwater monitoring wells will be constructed with a section of 0.5-inch wire-wound stainless steel wire screen prepacked with 20/40 sand. HSA borings will be completed using 2-inch ID 0.020-inch slotted Schedule 40 PVC well screen positioned near the bottom of each soil boring. Because depth to groundwater is reported to be 5 feet or less below ground surface, the top of the well screen will be positioned approximately 1-2 feet above the static ground water table to allow for seasonal water table fluctuations and measurement of free floating petroleum product if encountered. The proposed well screen length should allow sufficient water to enter the well intake, particularly during dry periods, without diluting sample quality.

5.6.5 Annular Space Requirements

The annular space requirements are:

- The annular space will be filled with a filter pack, a bentonite seal, and casing grout between the well string and the borehole wall;
- Any drilling fluid will be thinned with potable water of known acceptable quality to a density less than 1.2 grams per cubic centimeter (10 lb/gallon) before the annular space is filled, and a mud balance or Marsh Funnel will be kept on site so that drilling fluid density can be measured; and
- As the annular space is being filled, the well string will be centered and suspended such that it does not rest on the bottom of the borehole.

5.6.6 Filter Pack Requirements

The filter pack will consist of clean, chemically inert, and well-rounded silica sand or gravel with less than 2 percent flat particles. The filter pack will have a grain size distribution and uniformity coefficient compatible with formation materials and the screen, as described in Chapter 12 of *Ground Water and Wells*, 2nd Edition, 1986. It will be certified free of contaminants by the vendor.

The filter pack will extend from the bottom of the borehole to a depth of approximately 1-2 feet above the top of the well screen. It will not extend across more than one water-bearing unit. After the filter pack is emplaced, the top of the sand pack will be sounded to verify its depth during placement. An additional filter pack will be placed as required to return the level of the pack to 1-2 feet above the screen.

TEC and the drilling contractor will record the volume of filter sand emplaced in each monitoring well. Potable water may be used to emplace the filter pack as long as extraneous contaminants are not introduced.

5.6.7 Bentonite Seal Requirements

A 100 percent sodium bentonite seal, 1 to 2-feet thick, will be emplaced between the underlying filter pack and the overlying casing grout. Bentonite will be introduced as pellets or chips. If chips or pellets are used, TEC will advise the drilling subcontractor not to use a tremie pipe because the inside of the tremie pipe may become clogged.

TEC will record the type of bentonite used (e.g., chips, pellets, etc.) along with the quantity of bentonite emplaced in each monitoring well.

5.6.8 Casing Grout Requirements

Casing grout will extend from the top of the bentonite seal to ground surface. Grout used in monitoring well construction should always be lump-free. To ensure a lump-free solution, bentonite should always be added to the water first, followed by cement powder and mixed in the following proportions: 94 pounds of neat Type I Portland or American Petroleum Institute Class A cement, not more than 4 pounds of 100 percent sodium bentonite powder, and not more than 8 gallons of potable water. A paddle, shear mixer, or Grout Machine will be used to prepare the grout for the best consistency. Casing grout will be pumped into geoprobe explorations through 3/8-inch OD (1/4-inch ID) polyethylene tubing or through standard 1-inch diameter standard probe rods. Subsequently, the TEC on-site supervisory geologist will direct the drilling subcontractor to sound the borehole to determine if the grout has settled. TEC and the drilling subcontractor will record the quantity of grout emplaced in each groundwater monitoring well.

5.6.9 Surface Completion Requirements

Overburden groundwater monitoring wells will be completed using aboveground surface completions. For aboveground completions, the PVC well casing will extend approximately 3 feet above ground surface. A water-tight ventilated and expandable casing cap will be placed directly over the top of the PVC well casing to minimize the potential for surface water to migrate vertically downward along the borehole annulus. A locking protective steel casing at least 6 inches greater than the diameter of the casing will be suspended over the top of the well casing. Cement will be placed into the annular space between the protective casing and the borehole wall. The protective casing will be centered in a 3-foot diameter, 4-inch thick concrete pad that slopes away to drain water away from the groundwater monitoring well. Dry bentonite pellets or chips will be placed to ground surface in the annular space between the protective casing and the PVC well casing. A weep hole will be drilled in the protective steel casing and coarse sand or pea gravel placed above the bentonite to a point just above the weep hole. Drilling the weep hole will allow surface water to drain from the protective casing.

To minimize damage to the monitoring well installations, the drilling contractor will install three 3-inch diameter steel guard posts radially from each wellhead. The guard posts will be recessed approximately 2 feet into the ground and set in concrete. If requested by the AFBCA, TEC will direct the drilling contractor to paint the protective casing and guard posts.

The identity of the groundwater monitoring well will be permanently marked on the protective steel casing. A typical aboveground groundwater monitoring well completion diagram is shown in Figure 5-2.

5.6.10 Piezometer Requirements

Not applicable to this delivery order.

5.6.11 Well Completion Diagrams

A completion diagram (see Appendix B) will be submitted for each monitoring well installed. It will include the following information:

- Well identification (this will be identical to the boring identification described);
- Drilling method;
- Installation date(s);
- Elevations of ground surface and the measuring point notch;
- Total boring depth;
- Lengths and descriptions of the screen and casing;
- Lengths and descriptions of the filter pack, bentonite seal, casing grout, and any backfilled material;
- Elevation of water surface before and immediately after development; and
- Summary of the material penetrated by the boring.

5.6.12 Suction Lysimeters

Not applicable to this delivery order.

5.7 MONITORING WELL DEVELOPMENT

Monitoring well development will be supervised by the TEC site geologist or engineer. General monitoring well development requirements are:

- All newly installed monitoring wells will be developed no sooner than 24 hours after installation to allow for grout curing;
- All drilling fluids used during well construction will be removed during development;
- Discharge water color and volume will be documented;
- No sediment will remain in the bottom of the well;
- No detergents, soaps, acids, bleaches, or other additives will be used to develop a well;
- All development equipment will be decontaminated according to the specifications of Section 5.12;
- Monitoring wells will be developed using dedicated stainless steel mini-bailers, polyethylene bottom check valves, or dedicated submersible pumps until:
    - The suspended sediment content of the water is less than 0.75 mL/L, as measured in an Imhoff cone according to method E160.5;

- The turbidity remains within a 10 nephelometric turbidity unit range for at least 30 minutes; and
- The stabilization criteria in Section 6.1.1.1.3 are met;
- Discharge water color and volume is documented;
- No sediment remains in the bottom of the well; and
- All reusable development equipment is decontaminated according to the specifications of Section 5.12.

Initially, static groundwater level and total well depth will be measured to calculate the volume of groundwater present in the well casing. The volume of groundwater present will be used to determine the amount of groundwater that will be removed from each monitoring well. If a slowly recharging well does not recover to 80 percent of its static water level within 6 hours, one well volume will be removed. If a slowly recharging monitoring well recovers to static water level conditions in less than 6 hours, a minimum of two well volumes will be removed. As water is evacuated from the monitoring well, well development water will be screened using a PID, containerized, sampled, and disposed of off-site, if necessary. If sample results indicate significant contamination is not present, the water will be discharged directly to the ground surface, as long as it does not leave the fenced WSA area as surface runoff. Physical characteristics such as color, odor, turbidity, and the presence of separate phase product will be recorded on an AFCEE-approved Well Development Record (Appendix C). In addition, the duration of development, estimated quantities of groundwater removed, and recovery times for wells which are pumped dry will also be noted on the Well Development Record.

5.8 ABANDONING MONITORING WELLS

Not applicable to this delivery order.

5.9 AQUIFER TESTS

Not applicable to this delivery order.

5.9.1 Aquifer Testing For Hydraulic Properties

Not applicable to this delivery order.

5.9.1.1 General

Not applicable to this delivery order.

5.9.1.2 Slug Tests

Not applicable to this delivery order.

5.9.1.3 Pumping Tests

Not applicable to this delivery order.

5.9.1.4 Other Test Methods

Not applicable to this delivery order.

5.10 TEST PIT EXCAVATION

Not applicable to this delivery order.

5.11 SURVEYING

5.11.1 General Surveying Requirements

During the premobilization survey, TEC will retain a Texas RLS to conduct a historical records review and identify existing easements, property boundaries, and adjacent landowners. The land surveyor will then conduct a site survey so that a base site map can be prepared. The base site map will be used to locate areas of field activity generated during the RFI field investigation such as geoprobe explorations, sampling grids, surface seeps, monitoring well installations, soil boring locations, and other pertinent data. The site base map will also show geomorphic features and man-made structures in the site area. Surveying will have vertical and horizontal accuracies of 0.01 foot and 1 foot, respectively.

All surveying locations of field activities will be measured by a Texas RLS as the distance in feet from a reference location that is tied to the state plane system. The surveys will be third order (cf. Urquhart, L.C., *1962 Civil Engineering Handbook*, 4th Edition, p. 96 and 97). An XY-coordinate system will be used to identify locations. The X-coordinate will be the east-west axis; the Y-coordinate will be the north-south axis. The reference location is the origin. All surveyed locations will be reported using the state plane coordinate system. The surveyed control information for all data collection points will be recorded and displayed in a table. The table will give the X and Y coordinates in state plane coordinate values, as well as the ground elevation, and the measuring point elevation if the location is a groundwater monitoring well. The elevation of all newly installed flush-mounted groundwater monitoring wells will be surveyed at the water level measuring point (notch) on the well casing and ground surface.

5.12 EQUIPMENT DECONTAMINATION

All field equipment that may directly or indirectly contact samples will be decontaminated at the centrally located decontamination pad. As indicated in Section 5.2, the drilling subcontractor will construct a decontamination pad prior to initiating intrusive field activities. The pad will consist of a plastic-lined pad where drilling equipment such as drill rods and sampling tools can be steam cleaned. Fluids discharged onto the decontamination pad will be allowed to evaporate or recharge site soils.

5.12.1 Heavy Equipment Decontamination

General decontamination procedures for large pieces of equipment include the following:

- Drill rigs or geoprobes will be decontaminated upon entering the site, before leaving the site, or when being moved from one boring location to another to minimize the potential for cross-contamination;
- Portion of the HSA drill rig that stands above the borehole will be steam-cleaned between borings;

- HSA flights, drill bits, plugs, and HSA/geoprobe drill rods will be decontaminated with high-pressure hot water and detergent, scrubbed if necessary, rinsed thoroughly, and allowed to air dry; and
- All casings, screws, and other downhole equipment will be steam-cleaned prior to installation.

5.12.2 Instrument and Reusable Sampling Equipment Decontamination

Instruments such as an electronic water level indicator that contact water will be decontaminated following the procedures for sampling equipment described below. Instruments that are sensitive to soap and solvents such as the pH meter will be rinsed with potable and deionized water. The probes will be cleaned daily and stored overnight according to the manufacturer's recommended procedures.

All reusable field equipment used to collect, handle, or measure samples will be decontaminated before coming into contact with any soil or groundwater sample. The decontamination procedure will match the degree of contamination of the sampling tool. Brushes and soap may be required to remove dirt from split-spoon samplers. Clean, disposable gloves will be worn during and after decontamination so that equipment will not be recontaminated.

General decontamination procedures for sampling and drilling devices such as split-spoon sampler, bailers, and other equipment that can be hand manipulated are as follows:

- Steam clean if practical;
- Scrub equipment with a solution of potable water and a phosphate-free detergent (i.e., Alconox) to remove all dirt from sampling or drilling item;
- Rinse sampling item thoroughly with large quantities of potable water to remove residue dirt and rewash if necessary;
- Rinse item with ASTM Type II Reagant Water;
- Rinse item with pesticide-grade methanol to remove residual organics followed by a hexane rinse; and
- Prior to reuse, allow item to air dry on a clean surface. The item will be covered with aluminum foil or placed in a closed stainless steel, glass, or Teflon container if it is not immediately reused.

5.13 WASTE HANDLING

5.13.1 General Waste Handling Procedures

Wastes will be classified as either non-investigative-derived waste or investigative-derived waste (IDW).

Non-investigative-derived waste may include trash, disposable equipment, and clothing. It will be collected on an as-needed basis to maintain each site in a clean and orderly manner. These wastes will be placed in plastic garbage bags or sealed boxes and transported to a sanitary landfill or collection bin for disposal.

IDW generated during the RFI field investigation may include:

- Waste soils generated from borehole advancement and field sampling activities;

- Waste water generated on site from monitoring well development and pre-sample purging; and
- Decontamination fluids.

IDW will be properly containerized and temporarily stored at each geoprobe exploration/soil boring and monitoring well location using sealed, U.S. Department of Transportation (DOT)-approved steel 55-gallon capacity drums. Soil cuttings generated from soil borings will be containerized in DOT-approved drums with segregation occurring if VOCs are detected with a PID or if other visual signs of contamination exist. The number of containers will be determined on an as-needed basis. IDW will be segregated at the sample sites according to matrix (solid or liquid) and derivation (soil cuttings, drilling fluid, monitoring well development/pre-sample purged groundwater). Each container will be properly labeled with site identification, sampling point, depth, matrix, constituents of concern, and other pertinent information for handling. These drums will be transported to an area within the WSA as designated by the AFBCA POC.

Decontamination water generated during the field investigations will be minimized using steam cleaners. Water will be contained and allowed to evaporate with excess soil residue placed in a DOT-approved waste soil drum.

Samples of waste soil and groundwater will be collected from each DOT-approved drum, composited, and submitted to the analytical laboratory chosen for analysis of selected analytical constituents. Contamination of IDW by other constituents not specifically tested for will be assessed based on results from soil and groundwater samples collected during the soil borings and monitoring wells, respectively. If analytical results do not detect the presence of constituents above TNRCC action levels, byproduct waste water will discharged directly to site soil in the vicinity of the monitoring. Waste soils that do not exceed TNRCC action levels will be spread on the ground in a thin layer at a designated area on site. If regulatory levels are exceeded, wastes will be handled by properly licensed and approved treatment or disposal facilities.

A Waste Inventory Tracking Form (Appendix D) will be used to document waste handling procedures.

5.14 HYDROGEOLOGICAL CONCEPTUAL MODEL

A preliminary conceptual site model (CSM) for the Offsite WSA has been developed and is presented in the WP. TEC will refine the CSM after reviewing data obtained during the RFI.

5.14.1 Analytical or Numerical Model Representations of the Hydrogeological Conceptual Model

Not applicable to this delivery order.

5.15.1 WSA Facilities Surveys and Characterization Programs

TEC will initiate a sampling program of WSA buildings to determine if hazardous materials may be present within or on the structures themselves. As indicated in the Environmmental Baseline Survey (1993), at least five buildings were reported to contain asbestos. However, a complete report with documentation sufficient to develop corrective actions is not available. As a result, an asbestos survey will be performed to determine the types and quantity of this survey. In addition, a LBP sampling program will be conducted as review of construction details indicate LBP may be present.

Munition storage, inspection, or maintenance was conducted in 16 buildings and two shops. Materials used or generated in these facilities included explosives, paint cleaning compounds, and metal residues. Use of these substances may have resulted in these constituents being deposited on interior surfaces. To determine if building decontamination is required, a series of wipe samples will be collected from interior wall and floor surfaces that were used for munition storage, inspection, maintenance, and waste storage.

Sample collection procedures for the WSA building surveys and sampling programs are discussed in Sections 6.1.8, 6.1.9, and 6.1.10 of this FSP.

Figure 5-1. Lithologic Patterns for Illustration

Sediments and Sedimentary Rocks

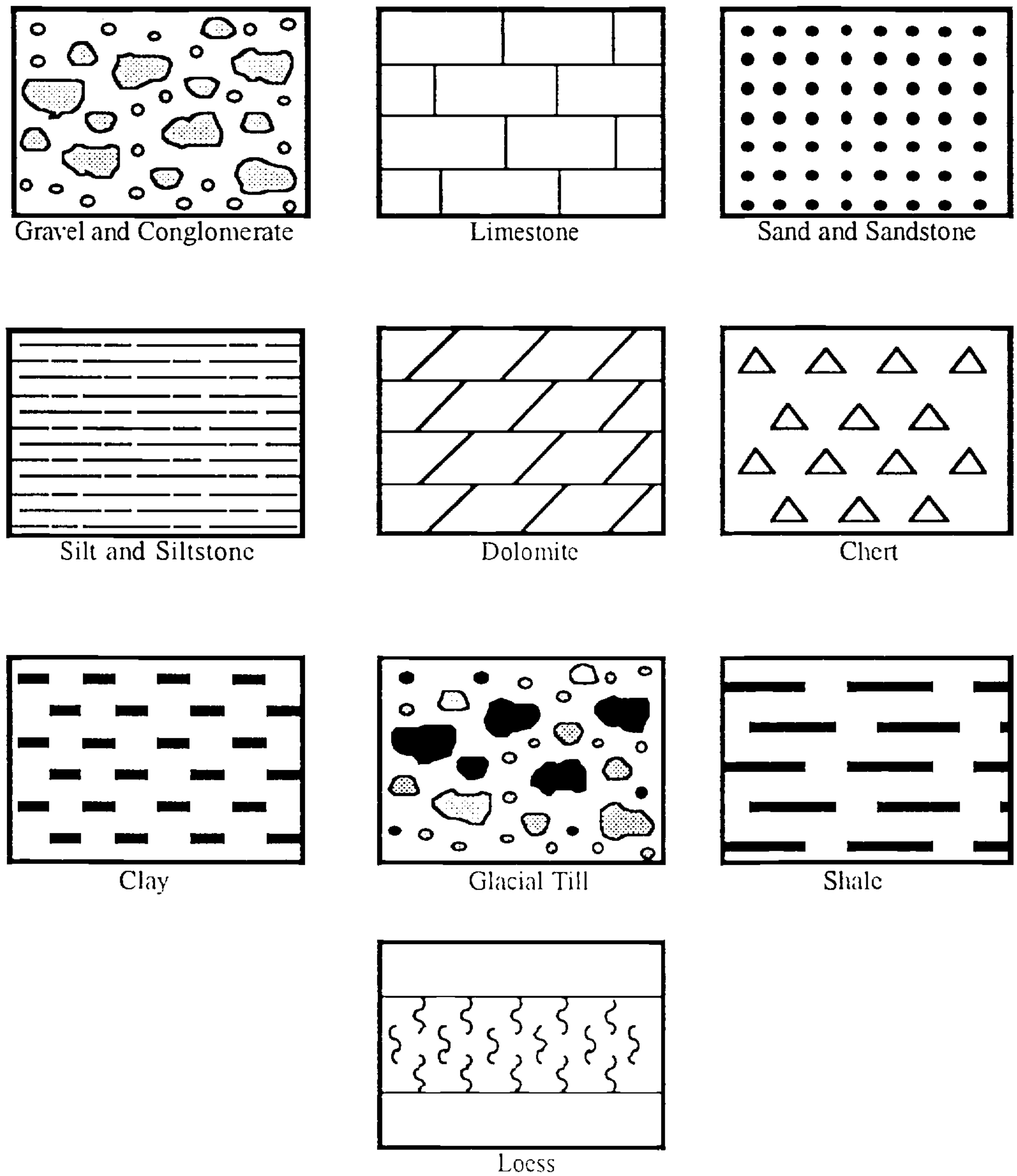
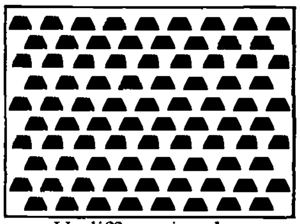
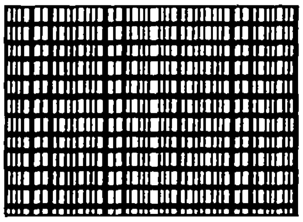


Figure 5-1 (Continued). Lithologic Patterns for Illustration

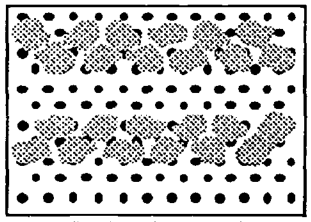
Igneous Rocks



Undifferentiated Intrusive

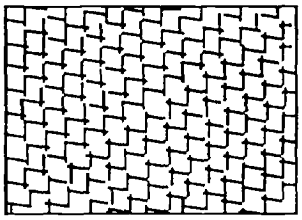


Basalt



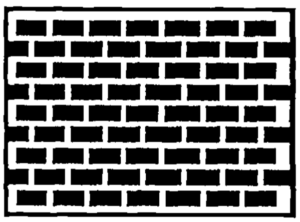
Volcanic Breccia and Tuff

Metamorphic Rocks

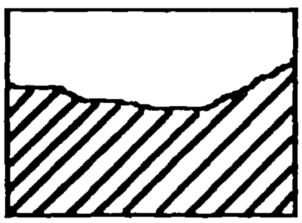


Undifferentiated

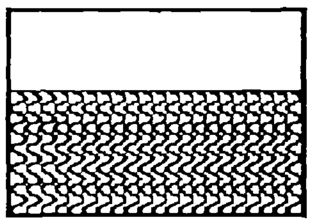
Miscellaneous



Fill

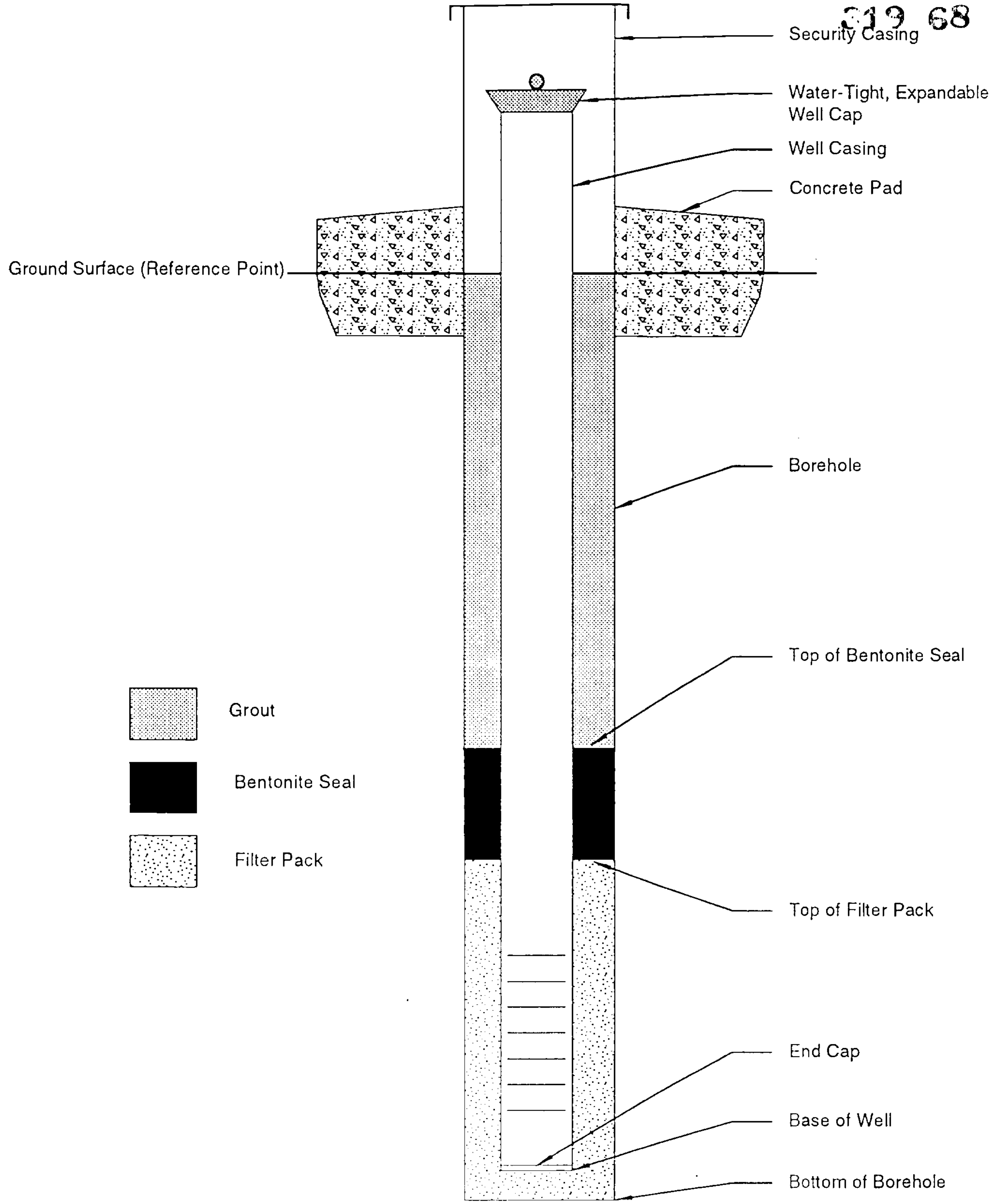


Undifferentiated Bedrock



Residium

319 68



Date: December 1996
Project No.: P3109
Project Manager: R. Duffner
Prepared by: EAD

The Environmental Company, Inc.

NOT TO SCALE

FIGURE 5-2

NAS FORT WORTH RCRA FACILITY INVESTIGATION
TYPICAL ABOVEGROUND MONITORING WELL
COMPLETION DIAGRAM

SOURCE: AFCEE Form WAB.0

6.0 ENVIRONMENTAL SAMPLING

The following sections describe methods and procedures that TEC field personnel will use for collecting environmental samples from organic vapors, surface and subsurface soil, surface sediment, groundwater, and building interior surfaces.

6.1 SAMPLING PROCEDURES

All purging and sampling equipment shall be decontaminated according to the specifications in Section 5.12 prior to any sampling activities and shall be protected from contamination until ready for use.

6.1.1 Groundwater Sampling

6.1.1.1 Monitoring Well Sampling

TEC will collect groundwater samples from 10 onsite wells. These wells will include

- Four monitoring wells installed during the RFI;
- Four monitoring wells installed during Jacobs Engineering Group's background study of the WSA; and
- Two on-site non-potable water supply wells.

Monitoring wells will be sampled in order of anticipated ascending volatility to minimize the potential for cross contamination between wells. All sampling activities shall be recorded in the field log book. Additionally, all sampling data shall be recorded on a Field Sampling Report (Appendix E).

Before groundwater sampling begins, wells shall be inspected for signs of tampering or other damage. If tampering is suspected, (i.e., casing is damaged, lock or cap is missing) this information shall be recorded in the field log book and on the Field Sampling Report (Appendix F), and reported to the TEC supervisory on-site geologist. Wells that are suspected to have been tampered with shall not be sampled until the Field Team Leader has discussed the matter with the Project Manager.

Before the start of sampling activities, plastic sheeting shall be placed on the ground near the monitoring well. The plastic sheeting shall be used to provide a clean working area around the wellhead, and prevent any soil contaminants from contacting sampling equipment. Visible water in the protective casing or in the vaults around the well casing will be removed prior to venting and purging.

Each time a casing cap is removed to measure water level or to collect a sample, the ambient air in the breathing zone shall be checked with a PID to assess the potential for fire, explosion, and safety hazards or other threats to the health of workers. Similarly, air in the well bore shall be checked for organic vapors with a PID and explosive gases with an explosimeter (if warranted). Procedures in the HSP will be followed when high concentrations of organic vapors or explosive gases are detected.

Sampling equipment will be equipped with a positive foot valve to prevent purged water from flowing back into the monitoring well. Purging and sampling will be performed in a manner that minimizes aeration in the well bore and agitation of sediments in the monitoring well and adjacent formation. Because the proposed monitoring well network will consist of both overburden and bedrock monitoring wells, TEC anticipates using a variety of sampling devices to obtain groundwater samples.

The following information will be recorded on a Well Purging Form (Appendix F) each time a well is purged and sampled and encoded in IRPIMS files when required:

- Depth to water before and after purging;
- Well bore volume calculation;
- Sounded total depth of the monitoring well;
- The condition of each well, including visual (mirror) survey;
- The thickness of any nonaqueous layer; and
- Field parameters, such as pH, temperature, electrical conductance, and turbidity.

6.1.1.1.1 Water Level Measurement

Water level measurements will be performed to estimate principal groundwater flow direction(s) and hydraulic gradient. Water levels will be measured from the notch located at the top of the well casing. If well casings are not notched, measurements will be taken from the north edge of the top of the well casing, and a notch made using a decontaminated metal file. The following procedures will be used to measure water levels:

- An interface probe will be lowered into the monitoring well if a non-conductive floating product layer is suspected in groundwater.
- After uncapping the well, a PID calibrated to ambient air conditions will be used to measure and record background and casing headspace organic vapors.
- An explosimeter will be used to measure background and casing headspace for explosive vapors, if warranted.
- Date, well number, field instrument identification number, casing diameter, and other pertinent observations (e.g., availability of sounder port, well condition) will be recorded.
- Depth to groundwater from the top of the well casing will be measured to the nearest 0.01 foot and recorded on the Monitoring Well Static Water Level Form (Appendix G). Water levels will be compared with previous measurements to check for trends and/or discrepancies.
- The water level sounder tape and probe will be thoroughly rinsed before being lowered into each groundwater monitoring well installation.
- An inspection of the surrounding area will be made to assure that all equipment and materials have been retrieved and that the appropriate well cap has been replaced and secured.

Following water level measurement, the total depth of the well from the top of the casing shall be determined using a weighted tape or electronic sounder and shall be recorded on the well sampling form. The water level depth shall then be subtracted from the total depth of the well to determine the height of the water column present in the well casing. All water level and total depth measuring devices shall be routinely checked with a tape measure to ensure measurements are accurate.

6.1.1.1.2 Purging Prior to Sampling

Purging of monitoring wells is performed to evacuate water that has been stagnant in the well and may not be representative of the aquifer. Well purging shall be accomplished using dedicated stainless steel Geoprobe mini-bailers, polyethylene tubing bottom check valves or low flow rate submersible pumps.

At least three well volumes shall be removed from the well before it is sampled. The well bore volume is defined as the volume of submerged casing and well screen. One well volume can be calculated using the following equation (reference: *Ohio EPA Technical Guidance Manual for Hydrogeologic Investigations and Ground Water Monitoring Programs*, June 1993):

$$V = H \times F$$

where

V = one well volume

H = the difference between the depth of well and depth to water (feet)

F = factor for volume of one foot section of casing (gallons)

F can also be calculated from the formula:

$$F = \Pi \quad (D/2)^2 \times 7.48 \text{ gal/ft}$$

where

D = the inside diameter of the well casing (feet)

Wells with yields too low to produce three well volumes before the well goes dry shall be purged to dryness.

Diameter of Casing (inches)	F Factor (gallons)
1.5	0.09
2	0.16
3	0.37
4	0.65
6	1.47

Temperature, pH, electrical conductance (EC), and turbidity shall be measured and recorded on an AFCEE-approved Monitor Well Purging Form (Appendix G) after removing each well volume during purging. Detailed information concerning IDW is presented in Section 5.13.

6.1.1.1.3 Sample Collection

Groundwater samples shall be collected no sooner than 24 hours following monitoring well development. Except as noted below, at least three well volumes shall be removed from the well before it is sampled.

The groundwater sample may be collected after three well volumes have been removed and temperature, pH, and EC have stabilized; and after the water level has recovered to 80 percent of its static level or 16 hours after completion of purging, whichever occurs first. If a monitoring well is bailed or pumped dry before three well volumes can be obtained, the sample shall be collected when a sufficient volume of water has accumulated in the well. Stabilization shall be defined as follows: temperature +/- 1°C, pH +/- 0.1 units, EC +/- 5 percent. If these parameters do not stabilize, the sample shall be collected after six well volumes have been removed, and the anomalous parameters shall be brought to the Field Team Leader's attention. Field equipment shall be calibrated in accordance with the QAPP, Section 5.0 and in Section 7.2 of this FSP.

Before collecting groundwater samples, the TEC sampling team shall don clean, phthalate-free protective gloves. For sample collection, positive displacement submersible pumps will be used. Samples analyzed for VOCs shall be collected first.

If dense non-aqueous phase liquids (DNAPLs) are suspected, a clear bailer will be lowered to the bottom of the well before purging. It will then be retrieved and observed for the presence of DNAPLs. Hydrochloric acid shall be added to the VOC sample bottle as a preservative before introducing sample water. The sample shall be collected from the bailer using a slow, controlled pour down the side of a tilted sample vial to minimize volatilization. The sample vial shall be filled until a meniscus is visible and then it shall be immediately sealed. When the sample vial is capped, it shall be inverted and gently tapped to ensure that no air bubbles are present. Vials with trapped air shall be refilled until no bubbles are present. After the containers are sealed, sample degassing may cause bubbles to form; these bubbles shall be left in the container. These samples shall never be composited, homogenized, or filtered.

The pH of preserved samples shall be checked in the field by pouring a small amount of the water sample onto pH paper. The paper shall not touch the sample inside the container. TEC will not check the pH of acidified VOC samples. The preservation checks shall be documented on COC forms. One preserved VOC sample per day per sampling crew shall be checked with pH paper. The sole purpose of this sample is to check the pH of VOC samples. It shall not be submitted for analysis.

All groundwater samples collected for this RFI will be submitted to the laboratory unfiltered.

Required sample containers, preservation methods, volumes and holding times are given in Section 6.2 and Table 6-1. Sampling equipment shall be decontaminated in accordance with Section 5.12 upon completion of sampling activities.

6.1.1.2 Direct Push Sampling

Not applicable to this delivery order.

6.1.2 Subsurface Soil Sampling

At each geoprobe exploration or HSA soil boring location, subsurface soil samples will be collected continuously to assess geologic and hydrogeologic conditions. TEC will submit a number of undisturbed, discrete, and representative subsurface soil samples for laboratory analysis. At the removed UST locations, soil samples will be collected for laboratory analysis of petroleum hydrocarbons on the basis of petroleum-related odors, discoloration, and PID screening results. Additional subsurface soil samples will be submitted to evaluate the presence or absence of nonvolatile parameters. Analytical constituents are summarized in Table 3-2.

6.1.2.1 Split-Spoon Samples

Subsurface soil samples will be obtained from HSA borings using a stainless steel, continuous drive, split-spoon sampler driven in accordance with ASTM D-1586. Each time a split-spoon sample is taken, a standard penetration test is performed according to ASTM D-1586-84 "Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils." The sample is obtained by driving the sampler a distance of 2 feet into undisturbed soil with a 140-pound hammer free falling a distance of 30 inches. The number of hammer blows are then recorded for each 6 inches of penetration on the drill log (e.g., 5/7/8/10). The standard penetration test result (N) is obtained by adding the middle two blow counts (i.e., 7+8=15 blows per foot) to estimate soil density. The initial 6 inches of penetration are not used to estimate soil density because their primary purpose is to securely seat the split-spoon into the ground. Similarly, the final 6 inches of penetration are not used to estimate soil density because their primary function is to fill the remainder of the split-spoon sampler prior to retrieval.

As soon as the split-spoon is opened, the soils shall be monitored for organic vapors using the PID. TEC does not anticipate the use of sample liners. Air monitoring results shall be recorded on the boring log.

Split-spoon soil samples selected for VOC analysis shall be placed in appropriate sample containers. These containers shall be completely filled to minimize headspace. The sample containers shall then be affixed with a completed sample label, placed in a plastic bag, and placed in an iced cooler held at a temperature below 4 °C.

Samples collected for other analytical parameters shall be collected concurrently with the VOC samples. Soil chemistry samples not being analyzed for VOCs will be composited and homogenized in a stainless-steel bowl using a stainless steel trowel or scoop. The sample shall then be transferred into the appropriate sample container, sealed, labeled, and placed in an iced cooler held at a temperature below 4 °C.

6.1.2.2 Field Headspace Screening

Following collection of split-spoon and geoprobe soil samples, headspace screening will be performed in the field using a portable PID on the remaining portions of samples selected on the basis of initial screening. Soil samples collected from the UST borings and geoprobe explorations will be field screened by filling a self-sealing polyethylene plastic bag with approximately 250 grams of soil. The soil samples will then be vigorously shaken for approximately 30 seconds and allowed to equilibrate a minimum of 15 minutes and a maximum of 2 hours (120 minutes) to a temperature of 25°C. The bag headspace will then be screened for organic vapors by puncturing the bag exterior with the PID probe, inserting the tip to a distance approximately one-half the headspace depth, and recording the highest reading displayed on the instrument meter. The results of field headspace screening will be used to select soil samples from each boring for laboratory analysis of selected analytical constituents (see Table 3-1). The field headspace sample will be saved for future reference and stored on site.

All information regarding field headspace screening results, soil texture, density, consistency, and color shall be recorded on soil boring logs.

6.1.2.3 Sampling by Hand Auger

Hand augering will be used to collect subsurface soil samples at locations where the lack of overburden preclude the use of direct push sampling equipment.

Each hand auger boring will be advanced by manually turning a hand auger, equipped with 3-inch diameter cylindrical stainless steel bits until the auger head fills with soil cuttings. The hand auger is then pulled from the boring with the soil cuttings deposited on plastic sheeting. Hand augering will continue until the desired sampling depth is achieved. After sample lithology has been described and recorded on the boring log, the recovered subsurface soil will be sampled for selected analytical constituents. Nonvolatile parameter samples will be composited in a stainless steel bowl and placed in appropriate sample containers. Sampling equipment will be decontaminated prior to advancing a new hand auger boring to minimize potential for cross-contamination.

6.1.2.4 Direct Push Sampling

Direct push sampling involves advancing a 1.83-foot-long, 1.06-inch diameter stainless steel sampling probe through overburden using direct hydraulic pressure or by using a slide or rotary hammer. A cargo van/truck-mounted geoprobe will be used to collect subsurface soil samples after TEC has established sample grids at the investigation areas (see Section 3.3.1). Subsurface soil samples will be collected in clear plastic, brass, Teflon™ or stainless steel liners and screened in the field for the presence of organic vapors using a portable PID. At each grid node, a geoprobe exploration will be advanced until groundwater or refusal is encountered, whichever occurs first. Soil samples will be collected continuously from ground surface until groundwater or refusal is encountered to evaluate geologic and hydrogeologic conditions. Subsurface soil samples will also be collected for chemical analysis at five-foot intervals or directly above bedrock if encountered first. The first subsurface soil sample for chemical characterization will be collected from 6 inches to 28 inches below ground surface. The second subsurface soil sample for chemical characterization will be collected from 66 inches to 88 inches below ground surface. The upper soil sample will undergo complete characterization as identified in Section 3.3. The lower sample will be analyzed for VOCs, with additional aliquots archived for analysis if contaminants are detected in the upper sample. Additional samples will also be collected and submitted for VOC analysis and archived for additional analysis if field headspace screening results identify possible contamination. Based on an assumed depth to bedrock of 5 feet below ground surface, it is estimated two subsurface soil samples will be collected from each location.

6.1.3 Surface Soil Sampling

A selected number of surface soil samples will be collected at the Offsite WSA to support the RFI risk assessment study. Samples from soils 0 to 1 foot below ground surface will be collected using a decontaminated stainless steel hand auger, stainless steel scoops, trowels, or stainless steel shovels.

The hand auger will be pulled from the surface soil sampling location and the cuttings deposited on plastic sheeting. After describing sample lithology, the recovered surface soil will be composited in a stainless steel bowl and placed in appropriate sample containers. Sampling equipment will be decontaminated prior to advancing a new surface soil boring to minimize potential for cross-contamination.

Gravel, rock, and vegetation will be excluded from surface soil samples. Samples will be collected as quickly as possible to minimize loss of organics. This method generates a less disturbed soil sample. During field sampling activities, TEC will record surface conditions that may affect chemical analyses on a Field Sampling Report. These conditions may include the following:

- Approximate distance to roadways and access roads;
- Obvious deposition of contaminated or clean soil (fill) at the site;
- Evidence of dumping or spillage of contaminants; and
- Soil discoloration, unusual conditions of growing plants, and stressed vegetation.

Surface soil samples collected from the sample grid will be composited and placed in a stainless steel bowl where it will be homogenized by thoroughly mixing with a stainless steel spoon.

6.1.4 Surface Water Sampling

It is anticipitated that one surface water sample will be collected at all seep locations and downgradient drainageways where water is not likely to be present. Efforts will be made to collect surface water samples during or following periods of precipitation whenever possible. Because of safety concerns, surface water sampling will be restricted to daylight hours. To minimize potential for cross-contamination between locations and media, surface water samples will be obtained prior to collecting sediment samples. In addition, surface water sampling will begin with the farthest downgradient sample and move progressively upgradient to minimize potential for cross-contamination between locations and media.

Prior to collecting surface water samples, TEC field personnel will traverse drainageways in the vicinity of the sampling locations and note the location of any additional seeps, oily sheens, odors, stressed vegetation, and discolored soil horizons that are encountered during the RFI.

At seep locations, surface water samples will be collected by submerging a stainless steel, Teflon™, or glass container under the water discharge. At other surface water sampling locations where water is discharging at a relatively high flow rate, a pond sampler may be used.

At each surface water sampling location, a permanent marker (flagged stake in stream bank) will be placed at the site of each surface water sample. TEC field personnel will record the following observations:

- Approximate stream width, depth, and flow rate;
- Color;
- Odor;
- Water quality indicator parameters (pH, temperature, and EC);
- Presence of oily sheens or free product;
- Status (e.g., clean, oil, bubbles, suspended solids, other); and
- Presence of discharge pipes, culverts, or tributaries.

6.1.5 Sediment Sampling

A potentially more reliable indicator of surface water contamination is the underlying sediment. Unlike surface water contamination, which may become diluted or chemically transformed downstream, contaminants have a tendency to accumulate in sediments.

If water is flowing through the drainage ditches at the time of sampling, the order of sediment sampling will begin with the farthest downgradient sample and move progressively upgradient to minimize potential cross-contamination between locations and media. Where appropriate, stream sediment samples will be collected from the active streambed on the stream side nearest the potential contaminant source. During sediment sampling, TEC field personnel will sketch the approximate sampling locations and record the following field observations on a Field Sampling Report:

- Sediment type (e.g., sand, silt, gravel, clay, organic matter);
- The percent recovery, if sediment cores are collected;
- Geomorphology (channel shape, drainageway description, erosional/depositional characteristics);
- Vegetation type;
- Color and/or discoloration;
- Sample depth;
- Odor; and
- Sampling device used.

Sediment samples will be collected for laboratory analysis using either a hand auger or hand corer.

The hand auger will be used if the substrate is hard or otherwise difficult to sample. The device is used in a similar manner as for surface soils. The hand corer collects an undisturbed sediment sample. The corer is forced into the sediment with a smooth continous motion, twisted, then withdrawn in a single smooth motion. A catcher, if used, is removed and the sample deposited in a stainless steel container. The sediment sample is then composited and homogenized and submitted for laboratory analysis.

6.1.6 Soil Gas Sampling

Not applicable to this delivery order.

6.1.7 Indoor Air Sampling

Not applicable to this delivery order.

6.1.8 WSA Building Surveys and Characterization

6.1.8.1 Asbestos Survey

As part of this RFI, asbestos surveys will be conducted at selected WSA buildings to evaluate potential health hazards that may be present and determine the suitability of the WSA for public transfer or disuse. The following sections describe field methods and sample collection procedures as they pertain to asbestos.

6.1.8.2 Field Methods

Specific requirements for conducting ACBM sampling are described in 40 CFR 763.86. Sampling requirements are subdivided into four AHERA ACBM categories:

- Surfacing materials;
- Thermal system insulation;
- Miscellaneous materials; and
- Nonfriable suspected ACBM.

The following steps will be taken during the ACBM survey:

1. TEC will review all documentation provided by NAS Fort Worth from previous asbestos surveys, building inspections, engineering blueprints, as-built drawings, or other information that may be useful in determining homogeneous areas of ACBM or Presumed Asbestos Containing Material (PACM). A homogeneous area is defined as an area which appears uniform throughout in terms of color, texture, and date of material application.

2. TEC will conduct a building walk through to diagram homogeneous sampling areas, determine material types, assess damage and friability of material, estimate ACBM or PACM quantity, and potential exposure. Note: Potential for exposure will be assessed as if the buildings were occupied.

3. TEC will determine the appropriate number of bulk samples to collect using the quantities determined in Step 2. Samples will be collected in a statistically random manner in accordance with EPA guidelines (EPA, 1985). Samples will be collected using the following AHERA guidelines:

Surfacing Material (SFM):

Surfacing materials consist of those materials that are troweled or sprayed on structural members, ceilings, or walls for fireproofing, acoustical, or decorative purposes.

The following provides the number of samples that will be collected based on the estimated area of a surfacing material homogeneous area:

<1,000 square feet	3 samples
1,000-5,000 square feet	5 samples
>5,000 square feet	7 samples

Thermal System Insulation (TSI):

Thermal System Insulation includes insulation on piping and mechanical systems such as boilers and hot water tanks. Each of the insulation types (e.g., different diameters of TSI) will be considered as a separate component of the system and a separate homogeneous area for sampling purposes.

A minimum of three samples will be collected from each homogeneous area. Patched areas of TSI (i.e. less than 6 feet in length) will be sampled only once. Elbows or fittings will be considered a different homogeneous area from the associated lagging and will be sampled independantly.

Miscellaneous Material:

Miscellaneous materials are all other materials that are not TSI or SFM. These materials may include floor and ceiling tiles, roofing, and siding materials.

A minimum of three samples will be collected from each homogeneous areas, with the following exceptions:

- Patterned floor tile will be sampled as one homogenous area.
- Patched areas (i.e. materials that are less than 100 square feet) will be sampled only once.
- Layered floor tiles will be sampled as one homogeneous area, with an effort made to collect each layer in each sample.
- Flooring mastic will be included in the homogeneous area of the associated floor tile, however, the lab will be instructed to report the analysis separately.

4. Sample, ACBM, and PACM locations will be hand plotted on building sketches.

6.1.8.3 Sample Collection

The following section describes the methods that will be used to collect suspect ACBM samples at the WSA. ACBM sampling will be performed according to applicable state and federal regulations, and the following procedures.

- When required, a plastic drop cloth will be placed underneath/around the area of sampling.
- PPE will be donned in accordance with the health and safety plan which is presented under separate cover.
- Polyethylene plastic bags will be labeled with the appropriate sample identification number.
- Sample ID numbers will be noted on the floorplan diagram at the location the sample is taken.
- Friable suspect material will be thoroughly wetted.
- A clean razor knife, chisel, or pair of needle nose pliers will be used to collect a sample approximately the size of a thumbnail. Where possible, samples will be taken in discrete locations without sacrificing sampling randomness. Surrounding material will not be disturbed.
- The sample will be placed into a prenumbered polyethylene plastic bag and immediately sealed.
- The area surrounding the sample location including floor dust will be decontaminated with a moist towelette and the sample location repaired using a non-asbestos putty/caulk or duct tape.
- Equipment used during the ACBM sampling will be decontaminated with a moist towelette. Contaminated towelettes will be placed in a asbestos waste collection bag provided by TEC. The waste collection bag will later be properly disposed of at a landfill that will accept asbestos waste.
- The samples collected from an individual building will be placed in another resealable bag marked with the particular building number from which the samples originated.
- COC documentation with individually listed samples will accompany the samples from the Offsite WSA to the analytical laboratory.

Based upon product knowledge and past sampling results some products may not be sampled but assumed or not assumed ACBM. The following assumptions apply:

- Fiberglass, foam, or rubber will not be sampled as it will be considered a non-suspect material.
- Transite-like materials such as roofing, siding, walls, ducts, and flues will not be sampled but will be assumed to be ACBM. This is done both to reduce the risk of exposure to employees by making a non-friable material friable, and also due to the fact that transite-like materials are known to contain 35 percent to 75 percent chrysotile.
- Flexible AHU connectors will be sampled as a part of this asbestos survey as long as samples can be collected without compromising the integrity of the AH system.

- Fire rated doors will not be sampled but assumed and noted on TEC diagrams as ACBM.

6.1.9 Lead Based Paint Survey

As part of this RFI, a LBP survey will be conducted at all buildings located within the Offsite WSA. Bulk sampling methods and sampling protocols are discussed in the following subsections.

6.1.9.1 Bulk Sampling Methods

Paint chip bulk sampling involves physically removing a 2 to 4 square inch piece of paint from painted surfaces. TEC will take into consideration the date of construction, and painting history of the buildings to develop a sampling scheme unique to the individual buildings. Samples will be collected from each representative interior and exterior component with a distinct painting history. All sampling will be in accordance with Texas Environmental Lead Reduction Rules, Section 295.212, and EPA/HUD guidelines (1996).

Three samples will be collected from each homogeneous sampling area. Homogeneous sampling areas refer to painted surfaces with similar painting histories. For example, it is assumed that all exterior paint on WSA buildings, that appear in both color and texture, to have been applied from the same batch and at the same time are in fact homogeneous areas. TEC will only collect three samples from each painted exterior. If other non-homogeneous areas are encountered (i.e. different color trims or soffits), TEC will sample accordingly.

Small patched areas of paint will only require one sample. Patched areas are painted areas different from surrounding painted surfaces in color or texture, totaling less than 100 square feet. By collecting only one sample from these small areas, TEC avoids significantly damaging the appearance of the painted surface or integrity of the substrate. In support of this methodology, standard industry work practice procedures will still be maintained ensuring discovery of LBP contaminants without excessive sampling.

A short synopsis of methodologies assumed in completing the LBP survey of the WSA are as follows:

- Each building will be sampled separately and homogeneous areas from one building will not be included in determining sampling protocols in another building, even if similairities are evident.
- Three samples will be collected from each homogeneous area, unless that area is a patched area.
- Substrates with like painting histories will be sampled as one homogeneous area.

6.1.9.2 Sampling Protocols

A paint scraper or combination heat gun/paint scraper will be used to collect all layers of paint from the substrate. Where necessary, a heat gun will be used to soften the paint and, due to differential cooling characteristics, separate the paint from the substrate. Prior to sampling, TEC's field personnel, where practical, will place a 4-foot by 4-foot section of plastic beneath each sample location to prevent possible LBP contamination. Where possible LBP samples will be taken from damaged or discrete areas. The following lists the typical steps in collecting a LBP bulk sample:

- Determine a discrete sample location for the suspect LBP.
- Place a 4 x 4 foot section of plastic beneath the sample location to prevent possible contamination (optional).
- Don unpowdered latex gloves to prevent possible contact with skin. Don respirator with HEPA cartridges if sample will be collected overhead and/or chance of ingestion is possible.
- Use the paint scraper and heat gun where needed to displace 2 to 4 square inches of paint onto a collection tray (i.e. piece of paper).
- Funnel the collection tray allowing the sample to fall into the prelabeled polyethylene plastic bag.
- Plot sample locations on floorplan drawings of the buildings.
- Photograph the homogeneous area.
- Clean all settled dust generated during the sampling process using wet wipes.
- Fold the 4 x 4 foot plastic sheet inward and dispose of in a waste collection bag along with the latex gloves and wet wipes. Proper decontamination practices will be followed.
- Seal the surface with new paint and/or spackling, if necessary.

6.1.10 Residue Survey

During the RFI, TEC will collect wipe samples from the interiors of selected Offsite WSA buildings to detemine if residues of suspected contaminants are present. In addition, TEC will collect wipe samples from three structures located outside the WSA perimeter to establish background conditons.

Wipe sampling methology and sample collection procedures are discussed in the following subsections.

6.1.10.1 Wipe Sampling Methodology

Wipe sampling involves wiping a surface area of known demensions with a cotton swab, gauze, or filter paper. The sample is submitted to an analytical laboratory for analysis of target chemical contaminants. TEC will use wet wipe sampling methods to test building interiors for the presence of metal and/or explosive residues existing in WSA buildings

Offsite WSA buildings are block constructed on concrete slabs with few finished interiors. Typical WSA buildings have one or two rooms. Due to the simplicity of WSA building construction, TEC envisions collecting one composite wall sample and one composite floor sample per building. Composite samples will consist of four subsamples. Non-sterile gauze used in the subsampling are combined into one hard-walled collection container (e.g., 50 mL centrifuge tube) and analyzed as one sample. Buildings previously containing various work centers housed under one roof (i.e. paint shop, metal shop), will be taken under special consideration and sampled more intensively.

6.1.10.2 Wipe Sampling Procedures

Wipe samples will be collected using the following procedures:

- Determine wipe sample locations and sketch on floorplan diagram.
- Don clean powderless latex gloves to prevent contamination of the filter by the hand.
- Delineate a section of the surface to be sampled using a plastic template with an open area of 100 square centimenters.
- Withdraw the gauze from its prelabeled collection container.
- Wipe starting at the outside edge and progress toward the center by wiping in concentric squares of decreasing size.
- Reapply wetting agent if drying occurs during the wiping procedure.
- Without allowing the gauze to come into contact with any other surface, fold the piece of filter paper with the exposed side in, then fold it over again. Place the gauze back in the sample collection container and seal tightly.
- Combine four individual samples into one composite sample collection tube to be submitted for composite analysis.
- Properly dispose of latex gloves after each composite sampling to prevent cross-contamination.
- Plot sample numbers on floorplan diagram.
- Fill out COC documentation.

6.1.10.3 Sample Collection

TEC will use a prepackaged sampling kit assembled by an AFCEE-approved analytical laboratory. This sampling kit will contain non-sterile cotton gauze pre-moistened with either a 10 percent Isopropanol and 90 percent water mixture for sampling explosive residues or an acedic acid solution for sampling metals. The gauze will be placed in 50 mL collection jar and marked with a prelabeled sticker to be returned to the laboratory for analysis.

6.2 SAMPLE HANDLING

6.2.1 Sample Containers

Sample containers will be purchased precleaned and treated according to EPA specifications for the methods. If sampling containers are reused, they will be decontaminated between uses by EPA-recommended procedures (i.e., EPA 540/R-93/051). Containers shall be stored in clean areas to prevent exposure to fuels, solvents, and other contaminants. Amber glass bottles will be used where glass containers are specified in Table 6-1.

6.2.2 Sample Volumes, Container Types, and Preservation Requirements

Sample volumes, container types, and preservation requirements for the analytical methods performed on AFCEE samples are listed in Table 6-1.

Sample holding time tracking begins with the collection of samples and continues until the analysis is complete. Holding times for methods required routinely for AFCEE work are specified in Table 6-1. **Samples not preserved or analyzed in accordance with these requirements shall be resampled and analyzed at no additional cost to AFCEE.**

6.2.3 Sample Identification

Samples collected during the RFI will be identified using a coding system to identify each sample obtained during the field investigation. This coding system will allow quick and easy retrieval of information concerning a particular sample. Field identifiers will appear on sample labels, COC forms, field sampling forms, and in any field log books used by TEC field personnel. Because samples collected for this project will be put into the IRPIMS database, IRPIMS-compatible identification numbers will be required.

A list of predetermined field identifiers, numbers, locations, dates, and times will be maintained by TEC and made available to Air Force project personnel upon request. Each field identifier will be composed of several components which are described below:

Site Location: A unique identifier will be used to identify sample station location. This designation may include investigation areas (A1 through A5), monitoring well (MW01), drainageway (DW1 through DW9), seep (SP) bunker drain (BD), underground storage tank (UST) and WSA building (ST).

Sample Matrix: A two-letter designation will be used to identify the specific type of sample being taken. Examples of sample matrix codes that TEC will use during the RFI include the following:

Groundwater	WG	Surface Soil	SO	Sediment	SE
Surface Water	SW	Asbestos	A	Wipe	W

Sample Number: A three-digit identifier will identify the sequential number of the sample collected at a particular station. At locations where only one sample will be collected (e.g., monitoring well, seep, drainageway, field QC, water quality matrix), the sample number will specify the sampling round (i.e., first round, second round).

Table 6-2 presents proposed sample location codes for this RFI field investigation. Table 6-3 presents a list of sample matrix codes that will be used during the RFI.

Duplicate and Blank Samples

Field duplicate samples will be masked when submitted to the analytical laboratory for analysis. The first set of characters will denote the site location, the next set of characters will indicate the sample matrix, and the last series of characters will identify the numerical sequence beginning with the letter A. An example of a duplicate location identifier is shown below:

MW002-WG-A001 - where "MW002" denotes the site location, "WG" signifies the sample matrix is groundwater, and "A001" indicates a groundwater sample was obtained from monitoring well MW002 during the first round of sampling.

All masked samples will have a sample time of 12:00pm.

Ambient blanks, equipment blanks, and trip blanks will be collected as specified in this FSP. Equipment blanks will be correlated to samples taken on the same day. Blanks will be assigned a location identifier of FIELDQC. Blank matrix codes wil be AB for ambient blank, EB for equipment blank, and TB for trip blank. Blanks will be numbered sequentially, beginning with the number 001.

When collecting field samples for laboratory analysis, TEC will combine site location and IRPIMS sample matrix codes and incorporate these codes on COC forms and field log books.

Examples of field identifiers include the following:

- A1028-SO-002 The second subsurface soil sample collected from Investigation Area A1 at grid location 028.
- UST8514-SO-003 The third subsurface soil sample collected from removed UST location 8514.
- BD8560-SS-001 Surface soil sample 001 collected from the bunker drain outlet located at the front entrance to offsite WSA Building 8560.
- MW003-WG-001 The first round groundwater sample collected from monitoring well MW003
- DW4002-SW-001 The first round surface water sample collected from drainageway DW4 at sample location 02
- SP002-SE-001 The first round sediment sample collected from seep SP002.
- QC005-EB-001 The fifth field quality control sample is an equipment blank collected during the first round of sampling.
- ST8507-W-001 Wipe sample 001 collected from offsite WSA building 8507

6.3 SAMPLE CUSTODY

Procedures to ensure the custody and integrity of the samples begin at the time of sampling and continue through transport, sample receipt, preparation, analysis and storage, data generation and reporting, and sample disposal. Records concerning the custody and condition of the samples are maintained in field and laboratory records.

TEC shall maintain COC records for all field and field QC samples. A sample is defined as being under a person's custody if any of the following conditions exist:

- It is in their possession;
- It is in their view, after being in their possession;
- It was in their possession and they locked it up; or

- It is in a designated secure area.

All sample containers shall be sealed in a manner that shall prevent or detect tampering. Tape shall not be used to seal sample containers. Samples shall not be packaged with activated carbon unless prior approval is obtained from AFCEE.

The RFI Field Team Leader will be responsible for overseeing and supervising the implementation of proper sample custody procedures in the field. The Field Team Leader is responsible for ensuring sample custody until the samples have been transferred to a courier or directly to the laboratory.

The following minimum information concerning the sample shall be documented on the COC form (see Appendix H):

- Source of samples (including name, location, and sample type) and unique sample identification;
- Date and time of sample collection;
- Designation of Matrix Spike/Matrix Spike Duplicate (MS/MSD);
- Preservative used;
- Analyses required;
- Name of collector(s);
- Pertinent field data (pH, temperature, etc.);
- Serial numbers of custody seals and transportation cases (if used);
- Custody transfer signatures and dates and times of sample transfer from the field to transporters and to the laboratory; and
- Bill of lading or transporter tracking number (if applicable).

All samples shall be uniquely identified, labeled, and documented in the field at the time of collection in accordance with Section 6.2.3 of the FSP. When transferring samples, the individuals relinquishing and receiving will sign, date, and note the time on the COC record. The analytical laboratory will maintain a file copy, and the completed original will be returned to the TEC Project Manager as part of the final analytical report. This record will serve to document sample custody transfer from the sampler to the laboratory.

Samples collected in the field shall be transported to the laboratory or field testing site as expeditiously as possible via overnight courier. Air bills will be retained as part of the permanent documentation and all sample shipments will be regulated by the DOT as described in 49 CFR Parts 171 through 177.

When a 4 °C requirement for preserving the sample is indicated, the samples shall be packed in ice or chemical refrigerant to keep them cool during transportation. During transit, it is not always possible to rigorously control the temperature of the samples. As a general rule, storage at low temperature is the best way to preserve most samples. A temperature blank (a VOC sampling vial filled with tap water) shall be included in every cooler and used to determine the internal temperature of the cooler upon receipt of the cooler at the laboratory.

Once the samples have been received by the laboratory, a file will be maintained of the original documents (e.g., COC forms, special analytical services request form, etc.) pertinent to sample custody and sample analytical protocol.

6.4 FIELD QUALITY CONTROL SAMPLES

During each sampling effort, a number of field QC samples will be collected and submitted for laboratory analyses. The number of QC samples are presented in Table 3-1. A list of QC samples that will be collected and a brief description of each type is outlined in the following sections.

6.4.1 Ambient Blank

Ambient blanks are used to assess potential introduction of contaminants from ambient sources to the samples during collection. During the RFI field investigation, one representative ambient blank sample will be collected for each distinct field collection event (e.g., UST subsurface soil, geoprobe subsurface soil, surface soil and sediment, surface water).

The ambient blank consists of ASTM Type II reagent grade water poured into a VOC sample vial at the sampling site. It is handled like an environmental sample and transported to the laboratory for analysis. Ambient blanks are prepared only when VOC samples are taken and are analyzed only for VOC analytes.

6.4.2 Equipment Blank

An equipment blank is a sample of ASTM Type II reagent grade water poured into or over the decontaminated sampling device or pumped through the sampling device, collected in a sample container, and transported to the laboratory for analysis. Equipment blanks are used to assess the effectiveness of equipment decontamination procedures. Equipment blanks shall be collected immediately after sampling equipment has been decontaminated. The blank shall be analyzed for all laboratory analyses requested for the environmental samples collected at the site.

It is anticipated that one equipment blank sample will be collected for every 20 samples and at least one blank for each equipment type.

6.4.3 Trip Blank

The trip blank consists of a VOC sample vial filled in the laboratory with ASTM Type II reagent grade water, transported to the sampling site, handled like an environmental sample, and returned to the laboratory for analysis. Trip blanks are not opened in the field. Trip blanks are prepared only when VOC samples are taken and are analyzed only for VOC analytes. Trip blanks are used to assess the potential introduction of contaminants from sample containers or during the transportation and storage procedures. One trip blank shall accompany each cooler of samples sent to the laboratory for analysis of VOCs.

6.4.4 Field Duplicates

A field duplicate sample is a second sample collected at the same location as the original sample. Duplicate samples are collected simultaneously or in immediate succession, using identical recovery techniques, and treated in an identical manner during storage, transportation, and analysis. The sample containers are assigned an identification number in the field such that they cannot be identified (blind duplicate) as duplicate samples by laboratory personnel performing the analysis. Specific locations are designated for collection of field duplicate samples prior to the beginning of sample collection.

Duplicate sample results are used to assess precision of the sample collection process. Precision of soil samples to be analyzed for VOCs is assessed from collocated samples because the compositing process required to obtain uniform samples could result in loss of the compounds of interest.

Ten percent of each sample type and media will be collected in duplicate during the RFI field investigation.

6.4.5 Field Replicates

Not applicable to this delivery order.

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Table 6-1 Requirements for Containers, Preservation Techniques, Sample Volumes, and Holding Times

Name	Analytical Methods	Container[a]	Preserv.[b,c]	Minimum Sample Amount	Maximum Holding Time
Hydrogen ion (pH) (W, S)	SW9040/ SW9045	P, G	None required	N/A	Analyze immediately
Conductance	SW9050	P, G	None required	N/A	Analyze immediately
Temperature	E170.1	P, G	None required	N/A	Analyze immediately
Turbidity	E180.1	P, G	4°C	N/A	48 hours
Mercury	SW7470 SW7471	P, G, T	HNO_3 to pH < 2, 4°C	500 mL or 8 ounces	28 days (water and soil)
Metals (except chromium (VI) and mercury)	SW6010A SW6020 and SW-846 AA methods	P, G, T	HNO_3 to pH < 2, 4°C	500 mL or 8 ounces	180 days (water and soil)
Total petroleum hydrocarbons (TPH)-volatile	SW8015 (modified)	G, Teflon-lined septum, T	4°C, HCl to pH < 2	2 x 40 mL or 4 ounces	14 days (water and soil); 7 days if unpreserved by acid
Total petroleum hydrocarbons (TPH)-extractable	SW8015 (modified)	G, amber, T	4°C	1 liter or 8 ounces	7 days until extraction and 40 days after extraction (water); 14 days until extraction and 40 days after extraction (soil)
Volatile aromatics	SW8020A	G, Teflon-lined septum, T	4°C, HCl to pH < 2, 0.008% $Na_2S_2O_3$	2 x 40 mL or 4 ounces	14 days (water and soil); 7 days if unpreserved by acid

Table 6-1 **Requirements for Containers, Preservation Techniques, Sample Volumes, and Holding Times (Continued)**

Name	Analytical Methods	Container[a]	Preserv.[b,c]	Minimum Sample Amount	Maximum Holding Time
Organochlorine pesticides and polychlorinated biphenyls (PCBs)	SW8080A, SW8081,	G, Teflon-lined cap, T	4°C. pH 5–9	1 liter or 8 ounces	7 days until extraction and 40 days after extraction (water); 14 days until extraction and 40 days after extraction (soil)
Semivolatile organics	SW8270B	G, Teflon-lined cap, T	4°C, 0.008% $Na_2S_2O_3$	1 liter or 8 ounces	7 days until extraction and 40 days after extraction (water); 14 days until extraction and 40 days after extraction (soil)
Volatile organics	SW8240B, SW8010B, SW8260A	G, Teflon lined septum, T	4°C, 0.008% $Na_2S_2O_3$ (HCl to pH < 2 for volatile aromatics by SW8240 and SW8260)[c]	2 x 40 mL or 4 ounces	14 days (water and soil); 7 days if unpreserved by acid
Explosive-Related Compounds	SW8330	P, G, T	Cool at 4°C	I liter or 8 ounces	7 days to extraction (water); 14 days to extraction (soil); analyze within 40 days after extraction.

a. Polyethylene (P); glass (G); brass sleeves in the sample barrel, sometimes called California brass (T).
b. No pH adjustment for soil.

c. Preservation with 0.008 percent $Na_2S_2O_3$ is only required when residual chlorine is present.

TABLE 6-2. Sample Location Codes for RFI Field Investigation

Sample Type	Sample Code	Example Location Identifier
Investigation Area[1]	A1	A1007
Monitoring Well	MW	MW002
Bunker Drain	BD	BD8503
Drainageway (Ditch)[2]	DW	DW001
Removed Underground Storage Tank Location	UST	UST 8514
Seep	SP	SP005
Explosive Ordnance Range	EOD	EOD012
WSA Structure	ST	ST8537
Ambient Blank	AB	AB003
Equipment Blank	EB	EB004
Trip Blank	TB	TB002
Field QC	QC	QC005

1. Investigation Areas include the Outdoor Material Storage and Maintenance Areas (A1, A2), Waste Accumulation Areas and Building 8503, Vehicle Fueling Areas (A-4), and the Disturbed Surface Area (A-5).

2. Drainageways are denoted as DW-1 through DW-9.

TABLE 6-3. List of Sample Matrix Codes

Sample Media	Matrix Code
Surface Soil Grab	SS
Subsurface Soil	SO
Sediment	SE
Surface Water	SW
Groundwater	WG
Floating Product	LF
Water Quality Matrix	WQ
Asbestos	A
Lead-Based Paint	L
Wipe	W

7.0 FIELD MEASUREMENTS

The following subsections discuss field measurements, equipment calibration, and maintenance procedures that will be performed during the RFI. All field measurements will follow procedures described in the AFCEE Handbook (Air Force,1993) and equipment operating manuals.

7.1 PARAMETERS

The following sections describe field measurements that will be performed by TEC personnel during drilling and sample collection. Field measurements will be recorded in field log books or on sampling forms.

7.1.1 Organic Vapor Analysis

During borehole advancement and before sampling groundwater monitoring wells, the air in the breathing zone of on-site personnel will be evaluated for the presence of organic (VOCs, SVOCs, petroleum hydrocarbons) and explosive vapors (lower explosive limit and oxygen content) using a Microtip 2020 PID and explosimeter (Industrial Scientific Model MX 251), respectively, or equivalents. Air monitoring data will be tabulated on a Health and Safety Exposure Monitoring Sheet (Appendix I). Procedures provided in the HSP will be followed. In addition to monitoring the breathing zone around the borehole, the PID will be used to screen for organic vapors in the well bore each time a well casing cap is removed and when performing field headspace screening of subsurface soil samples.

7.1.2 Water Level Measurements

Water level measurements will be taken at all WSA groundwater monitoring wells prior to well development and sample purging. Groundwater levels will be recorded to the nearest 0.01 foot using a Solinst flat tape electronic water level indicator or equivalent. The primary objectives of measuring water levels in the groundwater monitoring wells will be to estimate the volume of water in the well to facilitate well development and sample purging, and to provide a preliminary evaluation of principal groundwater flow direction(s). The total depth of each groundwater monitoring well will also be measured after installation to evaluate their usefulness for future monitoring.

7.1.3 Immiscible Layer Measurements

The Solinst Model 121 Interface Meter or its equivalent will also be used to monitor the groundwater table for the presence of an immiscible layer such as petroleum product. Depth and thickness will be measured to the nearest 0.01 foot.

7.1.4 Electrical Conductance, pH, Temperature, and Turbidity

During well development and sample purging, the above-referenced water quality parameters will be monitored using portable field equipment. TEC anticipates electrical conductance, pH, and groundwater temperature will be monitored using hand-held ORION meters or an equivalent. If another instrument is used, it will be capable of meeting the appropriate QC acceptance criteria. A portable LaMotte Model 2008 Turbidimeter with an accuracy of 2 percent of reading or 0.05 Nephelometric Turbidity Unit (NTU), will be used to facilitate well development.

7.1.5 Ionizing Radiation

TEC will use a hand-held Radalert Nuclear Radiation Monitor to assess background radiation levels during the RFI field investigation.

7.1.6 Monitoring Well Elevation and Coordinates

To evaluate principal groundwater flow elevations, directions, and hydraulic gradients, monitoring well elevations and coordinates will be surveyed or determined by a Texas-registered land surveyor.

7.2 EQUIPMENT CALIBRATION AND QUALITY CONTROL

Field equipment will be calibrated according to manufacturer's instrument manuals and the AFCEE Handbook (1993).

7.2.1 Calibration Frequencies

All field instruments will be calibrated on a daily basis if they are used that day, except for the PID which will be calibrated at least twice per day. In some instances, calibration will be performed more frequently. Calibration will provide QA checks on all field equipment used during the implementation of the RFI field investigation. Each instrument will have an individual identification number. This number will be transcribed on field data records when using a particular instrument for a sampling event. All calibration, repair, and service records will be kept in individual equipment log books maintained for each type of instrument. Field equipment that consistently fails to meet calibration standards or exceeds manufacturer's critical limits will be promptly repaired or replaced. TEC will record equipment calibration on a calibration log sheet (Appendix J). Table 7-1 presents a summary of calibration requirements for field instrumentation.

7.2.2 Calibration Procedures

The following are calibration procedures that will be performed during the RFI.

7.2.2.1 Photo Ionization Detector

The Microtip 2020 PID or equivalent instrument will be calibrated each day according to manufacturer procedures prior to the start of field activities. If the PID is in continuous operation, it will be calibrated at four hour intervals. Instrument calibration will be performed using isobutylene calibration gas of known concentration (100 or 250 ppm). All adjustments to instrument settings will be recorded in a field log book.

7.2.2.2 Interface Meter

The Solinst Model 121 Interface Meter will be calibrated by checking the infrared and conductivity circuits. The infrared circuit detects the presence of a liquid while a conductivity circuit differentiates between conductive liquid (water) and nonconductive liquid (NAPL or DNAPL product).

To check the infrared circuit, with the main and probe switches on, the cleaning brush is inserted into the base of the probe until it reaches the zero measuring point. The zero measuring point is the juncture between the stainless steel body of the probe and the brown Teflon/Delrin base plug. This cuts the infrared beam and activates a steady tone and two lights.

To check the conductivity circuit, with both the main and probe switches on, the probe is inserted into normal tap water as far as the zero measuring point. This causes a single light and intermittent tone to activate.

The tape is calibrated annually by using a surveyor's steel tape to adjust for stretching of the calibrated line.

7.2.2.3 Electrical Conductivity, pH, Temperature, and Turbidity

Each of these instruments will be calibrated according to the requirements specified in Table 7-1.

The pH function will be calibrated immediately before well development and purging using at least two buffer solutions that bracket the expected pH.

The electrical conductivity function will be calibrated using two solutions of known value that bracket the expected ranges of conductivities.

The calibration of the portable turbidimeter (LaMotte Model 2008) will be evaluated by using two supplied standards within the range of anticipated sample turbidities. These standards have been carefully manufactured and are guaranteed to be accurate within one percent.

7.2.3 Field Quality Assurance/Quality Control Program

To ensure that sampling and monitoring activities meet project data quality objectives, QC checks will be implemented for parameters measured in the field. All QC control check information will be recorded in project-specific field log books and/or forms. The following sections discuss control parameters, control units, and corrective actions for the field investigation.

7.2.3.1 Control Parameters

Several parameters will be controlled during the field investigations, sampling, and measurement activities. As previousiy described, calibration of field instruments and operational checks will be conducted periodically. The frequency of field control check duplicates will be a minimum of 10 percent of all field measurements. As applicable, the materials used to verify control parameter measurements will be from certified sources. Instrument use, maintenance, and calibration will follow manufacturer and AFCEE Handbook guidelines.

7.2.3.2 Control Limits

Control limits are specified in Table 7-1. Field instrument calibration accuracy and duplicate precision for field measurements must meet acceptance criteria or instrument readings will be considered suspect. Appropriate corrective actions will be taken whenever field instruments fail to meet acceptance for accuracy and precision.

7.2.3.3 Corrective Action

The corrective action required for field instruments used to measure water quality parameters will include recalibrating and remeasuring the parameter. Corrective action for all field instruments will involve a review of the operator's manual. If necessary, instrument maintenance and repairs will be performed as corrective actions in addition to normally scheduled maintenance operations.

7.3 EQUIPMENT MAINTENANCE AND DECONTAMINATION

7.3.1 Equipment Maintenance

Preventative maintenance procedures will be established so that field instruments can perform their intended functions. Field instrument maintenance records (Appendix K) will be kept in individual instrument files assigned to each individual instrument.

7.3.2 Maintenance Schedules

Preventative maintenance for field equipment will be performed by manufacturers and TEC field personnel. Maintenance routinely precedes each sampling event. However, some field instrumentation will require scheduled and periodic maintenance and calibration. More extensive maintenance will be performed according to the manufacturer's instructions on the basis of use. To minimize the occurrence of instrument failure or malfunction, preventative maintenance will be scheduled. Examples of the preventative maintenance procedures and schedules for field instruments are described below.

pH-Temperature-Electrical Conductance. Preventative maintenance for the hand-held portable pH meters primarily involves proper care of the individual electrodes. Electrodes will be stored in a 1:1 solution of pH 7 buffer and deionized water. Spare parts, such as replacement probes and fresh buffer solutions, will be available at all times. For continuous trouble-free operation of the pH meter and combination pH electrodes, annual factory maintenance will be scheduled.

PID. Field maintenance procedures are limited to keeping the PID probe tip and exterior shell clean and the battery charged. Office maintenance includes cleaning the ultraviolet (UV) lamp window with appropriate lens paper, charging the battery overnight, and wiping the exterior of the unit with a damp cloth and mild detergent. At least one backup UV lamp shall be kept in stock along with lamp filters. For continuous trouble-free operation of the PID, annual factory maintenance will be scheduled.

Turbidimeter. The instrument shall be kept clean and dry, especially the sample chamber. The chamber shall be capped except while inserting or removing the sample tube. The sample chamber should be cleaned with compressed gas. The lamp should be tested for stability prior to initiating field work and replaced at the LaMotte Service Laboratory if necessary. As a rule, AC power should be used if available instead of the battery. If a battery is used, it should be recharged.

Interface Meter. After each use, the tape should be wiped clean and carefully rewound onto the reel. Cleaning the probe entails washing it thoroughly with phosphate-free detergent (Alconox or Liquinox). Clean brushes should be used through the side and base holes to remove any remaining product from the inner areas of the probe. The last steps include scrubbing the bottom pin with steel wool, rinsing the probe thoroughly with distilled water, wiping it dry, then returning it to the holder and turning off both switches. If incorrect signals occur, the probe and reel battery should be changed at the same time using 9 volt Duracell MN1604 or Eveready 522 batteries. Batteries should be replaced after approximately 9 to 10 hours; O-rings should be lubricated. The interface meter tape can also be steam cleaned and rinsed with hexane and distilled water.

Flat Tape Water Level Indicator. As indicated in Section 7.1.2, a flat tape electronic water level indicator will be used to measure groundwater levels in groundwater monitoring wells installed during the RFI field investigation. The electronic water level indicator will be cleaned with a soapy cloth prior to use at each monitoring well followed by a rinse with ASTM Reagent Grade II water. Batteries should be replaced after approximately 9 to 10 hours of use.

7.3.3 Equipment Decontamination

Decontamination procedures for field and sampling equipment are discussed in detail in Section 5.12. TEC will track decontamination of field equipment with an Equipment Decontamination Log Sheet (Appendix L).

7.4 FIELD MONITORING MEASUREMENTS

7.4.1 Groundwater Level Measurements

Water level measurements will be taken in all WSA monitoring wells to determine the elevation of the groundwater table or piezometric surface. These measurements will be taken after all WSA monitoring wells have been installed and developed and their static water levels have recovered completely. Well top elevations will be established by a Texas RLS. Conditions that may affect water levels shall be recorded in the field log.

Water level measurements will be taken with an interface meter or flat tape level indicator and decontaminated according to the specifications in Section 7.3 and 5.12. Groundwater level shall be measured to the nearest 0.01 foot.

Static water levels shall be recorded each time a well is sampled on a Monitor Well Static Water Level Form (Appendix G) and before any equipment enters the well. If the casing cap is airtight, time will be allowed prior to measurement for equilibration of pressures after the cap is removed. Water level measurements will be repeated until the water level has stabilized.

7.4.2 Floating Hydrocarbon Measurements

The thickness of hydrocarbons floating in monitoring wells will be measured with an interface meter. Hydrocarbon detection paste, or any other method that may affect water chemistry, will not be used. When detected, the presence of floating hydrocarbons shall be confirmed by withdrawing a sample with a clear, bottom filling bailer.

7.4.3 Groundwater Discharge Measurements

Groundwater discharge measurements shall be obtained during monitoring well purging. Groundwater discharges may be measured with orifice meters, containers of known volume, or with in-line meters.

7.5 FIELD PERFORMANCE AND SYSTEM AUDITS

Field performance and system audits include on-site independent evaluations of sample collection, analysis, instrument calibration, measurement, and documentation procedures. Although these audits are qualitative, they can readily evaluate the capability and performance of project personnel, instrumentation, field activities, and project documentation.

Field work and project documentation can be audited by the TEC Quality Assurance Director, or by a designated representative. Each auditor will have the organizational freedom to identify quality problems; to initiate, recommend, or provide solutions to quality problems; and to verify implementation of corrective action. Auditors will not have direct responsibilities for the technical aspects of the study audited.

7.5.1 Audit Frequency

Generic Audits. Generic audits of the TEC Quality Assurance Program will be performed periodically for each engineering or environmental program, technical services area, and/or regional operation. At the request of the Vice President responsible for the office work area, audits shall be performed at a frequency warranted by the results of previous audits. The need for more frequent audits shall be based on the following considerations:

- The importance of the activity to the successful completion of stated corporate objectives;
- Significant changes in the functional areas of the quality assurance program, such as significant reorganization or procedural revisions;
- A suspected nonconformance in an item or service; or
- The necessity to verify implementation of required corrective action.

Project Audit. Audit frequency for projects will be performed as per contractual agreements. An audit has not been specified for this RFI. However, the TEC Quality Assurance Director will decide whether an audit is necessary based on an overall consideration of the project and the TEC QA program. Comprehensive audits performed in support of a project may, at the discretion of the Quality Assurance Director, serve to satify the requirements of the generic audit schedule.

Table 7-1. Summary of Calibration and QC Procedures for Screening Methods

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Data Flagging Criteria[b]
SW-846[c]	Moisture	Duplicate sample	1 per 20 samples	% solid RPD £ 15%	Correct problem, repeat measurement. If still out, flag data	J
				RPD > 30%		R
SW9050	Conductance	Calibration with KCl standard	Once per day at beginning of testing	± 5 %	If calibration is not achieved, check meter, standards, and probe; recalibrate	R
		Field duplicate	10% of field samples	± 5 %	Correct problem, repeat measurement	J
SW9040	pH (water)	2-point calibration with pH buffers	Once per day	± 0.05 pH units for every buffer	If calibration is not achieved, check meter, buffer solutions, and probe; replace if necessary; repeat calibration	R
		pH 7 buffer	At each sample location	± 0.1 pH units	Correct problem, recalibrate	R
		Field duplicate	10% of field samples	± 0.1 pH units	Correct problem, repeat measurement	J

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Table 7-1. Summary of Calibration and QC Procedures for Screening Methods (Continued)

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Data Flagging Criteria[b]
E170.1	Temperature	Field duplicate	10% of field samples	± 1.0°C	Correct problem, repeat measurement	J
E180.1	Turbidity	Calibration with one formazin standard per instrument range used	Once per day at beginning of testing	± 5 units, 0–100 range; ± 0.5 units, 0–0.2 range; ± 0.2 units, 0–1 range	If calibration is not achieved, check meter; replace if necessary, recalibrate	R
		Field duplicate	10% of field samples	RPD ≤ 20%	Correct problem, repeat measurement	J
None	Organic vapor concentration (FID and PID)	2 point calibration	Monthly	Response ± 20% of expected value	Recalibrate; replace if necessary	R
		Calibration verification and check	Daily at beginning and end of day	Response ± 20% of expected value	Correct problem, recalibrate	R
8015 M	Hydrocarbon fingerprint	See Section 6.2.2 of QAPP	See Section 6.2.2	See Section 6.2.2	Correct problem, repeat measurement	R

a. All corrective actions shall be documented, and the records shall be maintained by the prime contractor.
b. All screening results shall first be flagged with an "S" and also any other appropriate validation flags identified in the Data

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Flagging Criteria column of the table. (for example "SJ", "SB", "SR").

c. Described in method SW3550.

8.0 RECORDKEEPING

8.1 INTRODUCTION

TEC will maintain field records sufficient to recreate all sampling and measurement activities and to meet all IRPIMS data loading requirements. The requirements listed in this section apply to all measuring and sampling activities. Requirements specific to individual activities are listed in the section that addresses each activity. The information will be recorded with indelible ink in a permanently bound notebook with sequentially numbered pages. These records will be archived in an easily accessible form and made available to the Air Force upon request.

The following information will be recorded for all field activities:

- Location;
- Date and time;
- Identity of people performing activity; and
- Weather conditions.

For field measurements, the numerical value and units of each measurement, and the identity of and calibration results for each field instrument will also be recorded on field logs or in a log book.

The following additional information will be recorded for all sampling activities:

- Sample type and sampling method;
- The identity of each sample and depth(s), where applicable, from which it was collected;
- The amount of each sample;
- Sample description (e.g., color, odor, clarity);
- Identification of sampling devices; and
- Identification of conditions that might affect the representativeness of a sample (e.g., damaged casing or well screen).

Records will be kept for all field activities as a means to maintain full documentation of project QA/QC procedures and compliance. In general, all documents will be completed in permanent black ink. Errors will be corrected by crossing them out with a single line and then dating and initialing. The use of correction fluids is not permissible. The documents used during the RFI field investigation will remain on site, if possible, so that they can be reviewed by interested parties. Forms will be organized and kept in a central file also located on site, if applicable. Records will be kept in the form of log books and standardized forms which have been included as appendices to this FSP.

8.2 LOG BOOKS

TEC field personnel will maintain a log book during the RFI. The Site Log Book is the master field investigation document that is a bound book with hard cover and sequentially numbered pages. The primary objective of the Site Log Book is to maintain, within one document, the actual field data or references to other field documents that contain a specific description of every activity that has occurred in the field on any given day. Any administrative occurrences, conditions, or activities that have affected the field work will be recorded in the Site Log Book.

All field activities entered into the Site Log Book will be signed and dated by the responsible party. The following is a list of the type of information that will be recorded in the Site Log book:

- Name and title of author, date and time of entry, and physical/environmental conditions during the field activity;
- Name and address of field contact;
- Name and titles of field crew;
- Name and titles of all site visitors;
- Documentation of health and safety activities;
- Type of sampled media (e.g., soil, groundwater);
- Number and volume of samples taken;
- Description of sampling points;
- Date and time of collection;
- Sample identification numbers;
- References, maps, and photographs of the sample sites;
- General decontamination procedures;
- Instrument calibration;
- Records of telephone conversations; and
- Weather conditions.

8.3 Field Data Forms

In addition to the above-referenced logbooks, TEC will complete and maintain standardized field data forms for all field activities. Field data forms have been discussed in the applicable sections of this FSP. These forms are included as appendices to this FSP. They consist of the following:

- Boring Log (Appendix A);
- Well Construction Details and Abandonment Form (Appendix B);
- Well Development Record (Appendix C);
- Waste Inventory Tracking Form (Appendix D);
- Field Sampling Report (Appendix E);
- Monitor Well Purging Form (Appendix F);
- Monitor Well Static Water Level Form (Appendix G);
- Chain-Of-Custody Form (Appendix H);

- Health and Safety Exposure Monitoring Sheet (Appendix I);
- Instrument Calibration Log (Appendix J);
- Instrument Maintenance Record (Appendix K); and
- Equipment Decontamination Log Sheet (Appendix L).

9.0 SITE MANAGEMENT

As indicated in Section 4.0, Mr. Charles Rice will serve as the AFCEE COR while Mr. Olen Long will act as the AFBCA POC. The TEC RFI Field Team Leader will work closely with Mssr. Rice and Long to endure that all activities regarding coordination with base personnel and private property owners are accomplished and all necessary permits are obtained. AFBCA will provide the following suport during the RFI:

- Issue digging or appropriate permits before initiating intrusive activities;
- Assist TEC with obtaining existing engineering plans, drawings, diagrams, aerial photographs, and digitized map files, to facilitate the investigation;
- Arrange for personnel identification badges, vehicle passes, or entry permits;
- Arrange for staging areas for storing equipment and supplies, and provide a large supply of potable water;
- Provide the necessary keys to locks;
- Supply electrical and water power to the WSA;
- Provide a secure storage area; and
- Provide field office space, as available.

10.0 VARIANCES

The following are variances from the AFCEE *Handbook*.

If HSA soil borings are advanced, subsurface soil samples will be collected with a split-spoon sampler. However, sample liners will not be used to collect subsurface soil samples for lithologic information and laboratory analysis. Instead, soil samples will be placed directly into polyethylene plastic bags for field headspace screening and soil characterization. After reviewing field headspace screening and lithologic data, selected soil samples will be submitted for laboratory analysis of selected analytical constituents.

TEC will attempt to install four monitoring wells at the Offsite WSA to monitor overburden groundwater. Previous investigations completed at the Offsite WSA indicate that the depth to bedrock is approximately 5 feet below ground surface. Because bedrock is shallow, TEC will use direct push technology (geoprobe) to install these wells. The monitoring wells will consist of a 1-2 foot length of 0.5-inch diameter wire wound stainless steel well screen prepacked with 20/40 sand followed by Schedule 80 PVC well casing. The remaining borehole annulus will consist of approximately one foot of sand above the well screen followed by a 1-2 foot thick bentonite seal and a 1-2 foot thick bentonite/cement casing grout.

TEC will reduce the frequency of collection of field quality control samples in some cases. It is anticipated that one equipment blank sample will be collected for every 20 samples and at least one blank for each equipment type. An ambient blank sample will be collected for each distinct field collection event (e.g., subsurface soil, surface soil, sediment, and surface water).

TEC will not proceed with these requested variances or others that may arise during the RFI until approval is obtained either verbally or in written form from Mr. Olen Long or his designee. Verbal approvals will be confirmed in writing and placed in the project file.

11.0 REFERENCES

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Jacobs Engineering Group Inc., 1996, Final RCRA Facility Investigation for Parcel D and Background Study Work Plan.

Ohio EPA. 1993. Guidance Manual for Hydrogeologic Investigations and Ground Water Monitoring Programs.

Radian Corporation, 1989, Installation Restoration Program RI/FS Stage 2 Draft Final Volume 1: Technical Report for Carswell AFB, Texas.

Swanson, R.G. 1981. *Sample Examination Manual.* American Association of Petroleum Geologists.

Urquhart, L.C., 1962, *Civil Engineering Handbook, 4th Edition.*

U.S. EPA, 1989. Interim Final RCRA Facility Investigation (RFI) Guidance. EPA 530/SW-89-031.

APPENDIX A
BORING LOG

GEOLOGIC BOREHOLE LOG

319110

Borehole (Location) ID: ______________________ Page ____ of ____

AFIID	SiteID	Location Type
Location Description		
Establishing Company	Geologist	Drilling Company
Drilling Foreman	Ground Surface Elevation	Datum
Sampling Device	Borehole Diameter (inches)	Total Depth (Feet)
Date/Time Drilling Started	Date/Time Total Depth Reached	

Depth (feet)	Sampling				USCS ASTM CODE	Lithologic Codes	Lithology Description SOIL TYPE, modifiers/grain size, sorting, color, cement/ lithification, moisture content, porosity, permeability/fracturing	Strat-order	Remarks: Drilling Problems, Equipment, Water levels, Weather, Time
	% Recov	Sample Depth	Blow Counts	PID					

APPENDIX B

WELL CONSTRUCTION DETAILS AND ABANDONMENT FORM

C1911?

WELL CONSTRUCTION DETAILS AND ABANDONMENT FORM

FIELD REPRESENTATIVE: ____________________

DRILLING CONTRACTOR: ____________________

DRILLING TECHNIQUE: ____________________
AUGER SIZE AND TYPE: ____________________

BOREHOLE IDENTIFICATION: ____________________
BOREHOLE DIAMETER: ____________________
WELL IDENTIFICATION: ____________________

WELL CONSTRUCTION START DATE: __________
WELL CONSTRUCTION COMPLETE DATE: __________

SCREEN MATERIAL: ____________________
SCREEN DIAMETER: ____________________
STRATUM-SCREENED INTERVAL (FT): __________

CASING MATERIAL: ____________________
CASING DIAMETER: ____________________

TYPE OF FILTER PACK: ____________________
GRADIATION: ____________________
AMOUNT OF FILTER PACK USED: ____________________

TYPE OF BENTONITE: ____________________
AMOUNT BENTONITE USED: ____________________

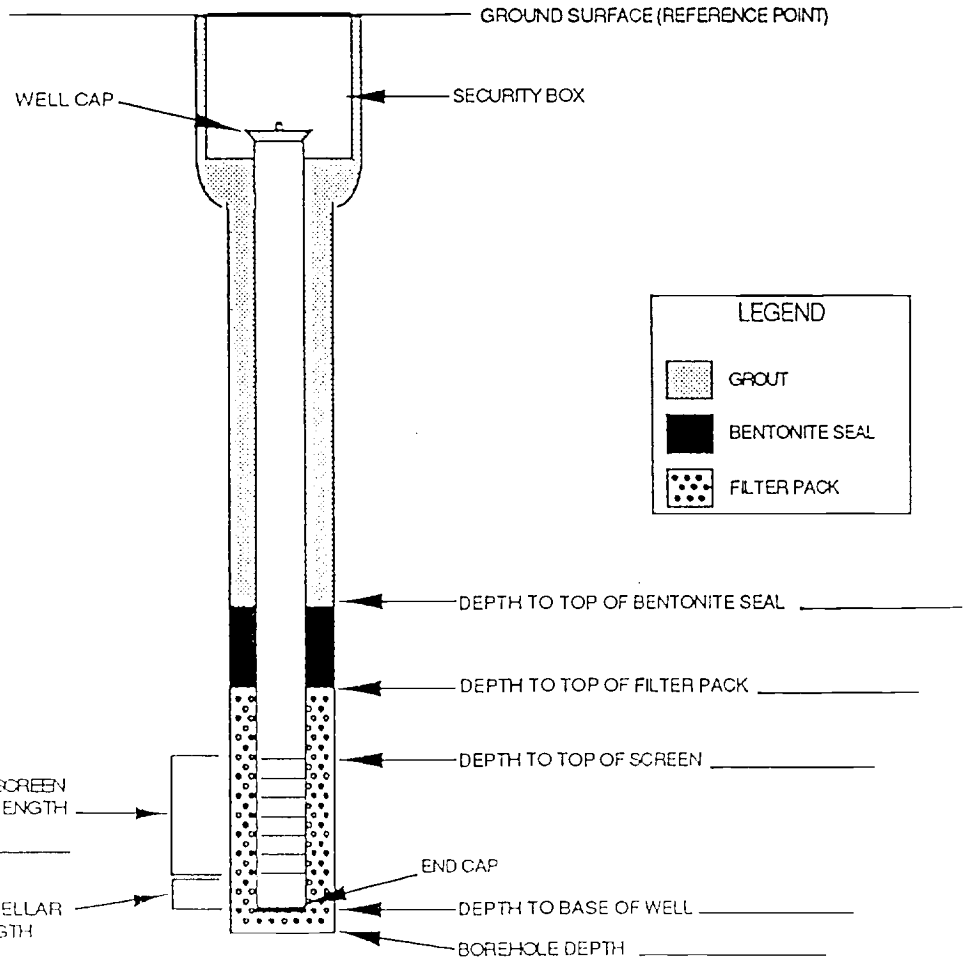
TYPE OF CEMENT: ____________________
AMOUNT CEMENT USED: ____________________
GROUT MATERIALS USED: ____________________

DIMENSIONS OF SECURITY BOX: ____________________

TYPE OF WELL CAP: ____________________
TYPE OF END CAP: ____________________

COMMENTS:

SPECIAL CONDITIONS
(describe and draw)



NOT TO SCALE

INSTALLED BY: ____________________ INSTALLATION OBSERVED BY: ____________________

DISCREPANCIES: ____

AFCEE FORM WAB.0

319113

APPENDIX C

WELL DEVELOPMENT RECORD

WELL DEVELOPMENT RECORD

319114

WELL/PIEZOMETER ID ______
SHEET ______ of ______

PROJECT NAME: ________________ PROJECT NO.: ________________ DATE: ________________

LOCATION: ________________ DATE INSTALLED: ________________

TOTAL DEPTH (FTOC) ____________ CASING DIAMETER ________________

METHODS OF DEVELOPMENT

☐ Swabbing ☐ Bailing ☐ Pumping ☐ Describe ________________

Equipment decontaminated prior to development ☐ Yes ☐ NO

Describe ________________

EQUIPMENT NUMBERS:

pH Meter ____________ EC Meter ____________ Turbidity Meter ____________ Thermometer ____________

CASING VOLUME INFORMATION:

Casing ID (inch)	1.0	1.5	2.0	2.2	3.0	4.0	4.3	5.0	6.0	7.0	8.0
Unit Casing Volume (A) (gal/ft)	0.04	0.09	0.16	0.2	0.37	0.65	0.75	1.0	1.5	2.0	2.6

PURGING INFORMATION:

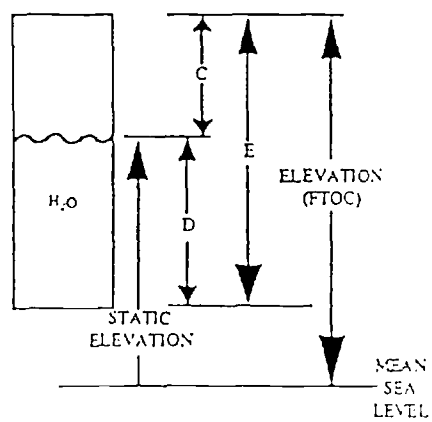
Measured Well Depth (B) ________________ ft.

Measured Water Level Depth (C) ________________ ft.

Length of Static Water Column (D) ________ - ________ = ________ ft.
(B) (C)

Casing Water Volume (E) = ________ x ________ = ________ gal
(A) (D)

Total Purge Volume = ________ (gal)



Date	Time	Water Level (FTOC)	Volume Removed (gal)	pH	EC	Temperature F or C	Turbidity/ Sand (ppm)	Comments

AFCEE FORM WD.0

APPENDIX D

WASTE INVENTORY TRACKING FORM

WASTE INVENTORY TRACKING FORM

LOCATION : ____________________

PROJECT NAME: ____________________

ACTIVITIES: ____________________

Date Waste Generated	Activity Generating Waste (borehole # / well #)	Description of Waste	Field Evidence of Contamination	Estimated Volume	Type of Container (storage ID#)	Location of Container	Waste Characterization	Comments

Note: Describe whether soil or water samples have been collected for waste characterization, include date, if known.

Signature: ____________________

APPENDIX E
FIELD SAMPLING REPORT

FIELD SAMPLING REPORT

319118

LOCATION: ____________________ PROJECT: ____________________

SITE: ____________________

SAMPLE INFORMATION

MATRIX ____________________ SAMPLE ID: ____________________

SAMPLING METHOD ____________ DUP./REP. OF: ____________________

BEGINNING DEPTH ____________ MATRIX SPIKE/MATRIX SPIKE DUPLICATE YES ( ) NO ( )

END DEPTH ____________________

GRAB ( ) COMPOSITE ( ) DATE: __________ TIME: __________

CONTAINER SIZE/TYPE	#	PRESERVATIVE/ PREPARATION	EXTRACTION METHOD	ANALYTICAL METHOD	ANALYSIS

NOTABLE OBSERVATIONS

PID READINGS	SAMPLE CHARACTERISTICS	MISCELLANEOUS
1st	COLOR:	
2nd	ODOR:	
	OTHER:	

GENERAL INFORMATION

WEATHER: SUN/CLEAR _____ OVERCAST/RAIN _____ WIND DIRECTION _______ AMBIENT TEMP _____

SHIPMENT VIA: FED-X _____ HAND DELIVER _____ COURIER _______ OTHER _______

SHIPPED TO: ____

COMMENTS: ____

SAMPLER: ____________________ OBSERVER: ____________________

MATRIX TYPE CODES		SAMPLING METHOD CODES	
DC=DRILL CUTTINGS	SL=SLUDGE	B=BAILER	G=GRAB
WG=GROUND WATER	SO=SOIL	BR=BRASS RING	HA=HAND AUGER
LH=HAZARDOUS LIQUID WASTE	GS=SOIL GAS	CS=COMPOSITE SAMPLE	H=HOLLOW STEM AUGER
SH=HAZARDOUS SOLID WASTE	WS=SURFACE WATER	C=CONTINUOUS FLIGHT AUGER	HP=HYDRO PUNCH
SE=SEDIMENT	SW=SWAB/WIPE	DT=DRIVEN TUBE	SS=SPLIT SPOON
		W=SWAB/WIPE	SP=SUBMERSIBLE PUMP

APPENDIX F
MONITOR WELL PURGING FORM

319120

MONITOR WELL PURGING FORM

PROJECT : ______________________________ DATE: ________________

LOCATION: ______________________________ EXPLOSIMETER BOREHOLE READING ________

WELL ID: ______________________________ PURGE VOLUME
(3 WELLBORE VOLUMES): ______________ (gal)

WELL DEPTH: ______________________________

Time	Depth to Water (ft)	Flow Meter Reading	Volume Purged (gal)	Temp. (°C)	pH	Electrical Conductivity (mmho)	Turbidity N.T.U	Comments

Note: Condition of the well: ____

pH - Calibrate at start and before last reading.

Sampler ______________________________ Observer ______________________________

APPENDIX G
MONITOR WELL STATIC WATER LEVEL FORM

MONITOR WELL STATIC WATER LEVEL FORM 19122

PROJECT NAME: ______________________________ DATE: ___________________

WATER LEVEL INDICATOR ID # ____________ FIELD BOOK # ____________

LOCATION: __________________________________ PAGE # __________________

Monitor Well Number	Time	Depth to Static Water Level (from T.O.C.)	Total Well Depth (ft)	Explosimeter Reading (above background)	PID Reading (above background)

Note: Total well depth to be measured at time of gauging.

Comments: ____

____

____

Sampler ______________________________ Observer ______________________________

APPENDIX H
CHAIN-OF-CUSTODY FORM

The Environmental Company, Inc.

1230 Cedars Court • Suite 100
Post Office Box 5127
Charlottesville, Virginia 22905
(804)295-4446 • fax(804) 295-5535

CHAIN OF CUSTODY RECORD

PROJECT

SAMPLERS: (Signature)

SAMPLE NUMBER	DATE	TIME	MATRIX	NO. CONTAINERS	ANALYSIS REQUIRED										REMARKS OR SAMPLE LOCATION	PRESERVATION: ICED	PRESERVATION: SPECIFY CHEMICALS ADDED AND FINAL pH IF KNOWN

Relinquished by: (Signature) (1)	Date / Time	Received by: (Signature)	Relinquished by: (Signature) (4)	Date / Time	Shipped via:
Relinquished by: (Signature) (2)	Date / Time	Received by: (Signature)	Received for Laboratory by: (Signature)	Date / Time	Shipping Ticket No. 319124
Relinquished by: (Signature) (3)	Date / Time	Received by: (Signature)	Remarks:		

APPENDIX I
HEALTH AND SAFETY EXPOSURE MONITORING SHEET

AFCEE\M20002\FLDLOG.WK3

CAR-J04-05K69904-M2-11412

319126

HEALTH & SAFETY EXPOSURE MONITORING

PROJECT #: ____________________
PROJECT LOCATION : ____________________
PROJECT ACTIVITY: ____________________

DATE: ____________________
LOCATION MONITORED: ____________________
ACTIVITY MONITORED: ____________________

DRILL RIG TYPE/NO: ____________________
PERSONNEL AT THIS LOCATION: ____________________
PERSONNEL AFFECTED BY H&S MONITORING: ____________________

TIME (24 hr clock)	BACK-GROUND	MONITOR INTERVAL (boreholes depth)	FID (ppm)	PID (ppm)	%O2 (%)	% LEL (%)	H2S (ppm)	RAM (ppm)	OTHER	SAMPLES INITIALS

INSTRUMENT	MFGR/ MODEL #	INSTRUMENT SERIAL #	CALIBRATION STANDARD			END OF DAY CALIBRATION CHECK	END OF DAY CALIBRATION CHECK
			CAL GAS	STD (ppm)	LOT #		
FID							
PID							
%O2							
%LEL							
H2S							
RAM							

FIELD TEAM LEADER SIGNATURE ____________________

APPENDIX J

INSTRUMENT CALIBRATION LOG

EQUIPMENT CALIBRATION LOG SHEET

EQUIPMENT NUMBER: ____________________

Page _____ of _____

EQUIPMENT DESCRIPTION: ____________________

DATE	TIME	MANUFACTURER OF STANDARD	LIQUID/GAS NAME	STANDARD CONCENTRATION	STANDARD LOT NO.	EXPIRATION DATE	INITIAL READING	CORRECTED READING	OPERATORO SIGNATURE	COMMENTS

319128

APPENDIX K
INSTRUMENT MAINTENANCE RECORD

INSTRUMENT MAINTENANCE RECORD

EQUIPMENT NAME: ______________________ Page ____ of ________

EQUIPMENT NUMBER: ____________

EQUIPMENT VENDOR: ____________

DATE	PROJECT NUMBER	MAINTENANCE DESCRIPTION	OPERATOR SIGNATURE	DATE COMPLETED

APPENDIX L

EQUIPMENT DECONTAMINATION LOG SHEET

319132

EQUIPMENT DECONTAMINATION LOG SHEET

EQUIPMENT NUMBER: ______________ Page ____ of ________

EQUIPMENT DESCRIPTION: ______________________________

DATE	TIME	DETERGENT WASH	TAP WATER RINSE	SOLVENT RINSE (TYPE)	WATER RINSE (TYPE)	AIR DRY	TYPE OF WRAPPING	RINSATE SAMPLE ID	OPERATOR SIGNATURE	COMMENTS
ITEM		MANUFACTURER		LOT NUMBERS	EXP. DATE					
DETERGENT										
SOLVENT										
WATER										

FINAL PAGE

ADMINISTRATIVE RECORD

FINAL PAGE

FINAL PAGE

ADMINISTRATIVE RECORD

FINAL PAGE