

DRAFT

Work Plan for the Risk-Based Remediation of Site SS-15A



**Homestead Air Reserve Base
Florida**

Prepared For

**Air Force Center for Environmental Excellence
Technology Transfer Division
Brooks Air Force Base, Texas**

and

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**Air Force Base Conversion Agency
Homestead Air Reserve Base, Florida**

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September 1997



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REMEDATION OF SITE SS-15A**

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FLORIDA**

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SECTION 1

INTRODUCTION

This work plan, prepared by Parsons Engineering Science, Inc. (Parsons ES), describes the scope of work required for the collection and analysis of data to support a risk-based remediation decision for soil and groundwater contaminated with fuel hydrocarbons at Site SS-15A, Homestead Air Reserve Base (ARB) (formerly Homestead Air Force Base). The work is being performed for the Air Force Center for Environmental Excellence, Technology Transfer Division (AFCEE/ERT) under Air Mobility Command (AMC) contract No. F11623-94-00024, Order No. 39.

1.1 DESCRIPTION OF THE RISK-BASED APPROACH

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

- A source of chemical contamination that exceeds or could generate chemical contamination above health-protective or aesthetic standards;
- A mechanism of contaminant release;
- A human or ecological receptor available for chemical contact; and
- A completed pathway for that receptor to come into contact with the chemical. If any one of these three elements is absent at a site, there is no current risk. The reduction or elimination of risk can be accomplished by limiting or removing any one of these three elements from the site (i.e., by interrupting completed exposure pathways).

The goal of risk-based remediation is to find the most cost-effective method of reducing present and future risk by combining one or more of the following risk-reduction techniques:

- **Chemical Source Reduction** - Achieved by natural attenuation processes over time or by engineered removals such as free product recovery, soil vapor extraction (SVE), or *in situ* bioventing.
- **Chemical Migration Control** - Examples include the natural attenuation of a groundwater plume, and SVE to prevent migration of hazardous vapors to a receptor exposure point.

- **Receptor Restriction**-Land use controls and site fencing can control receptor exposure to site contaminants until natural attenuation and/or engineered remediation reduce the chemical source and/or eliminate the potential for chemical migration to an exposure point.

1.2 RISK-BASED APPROACH FOR SITE SS-15A

The major tasks of this risk-based project, as illustrated on Figure 1.1, are:

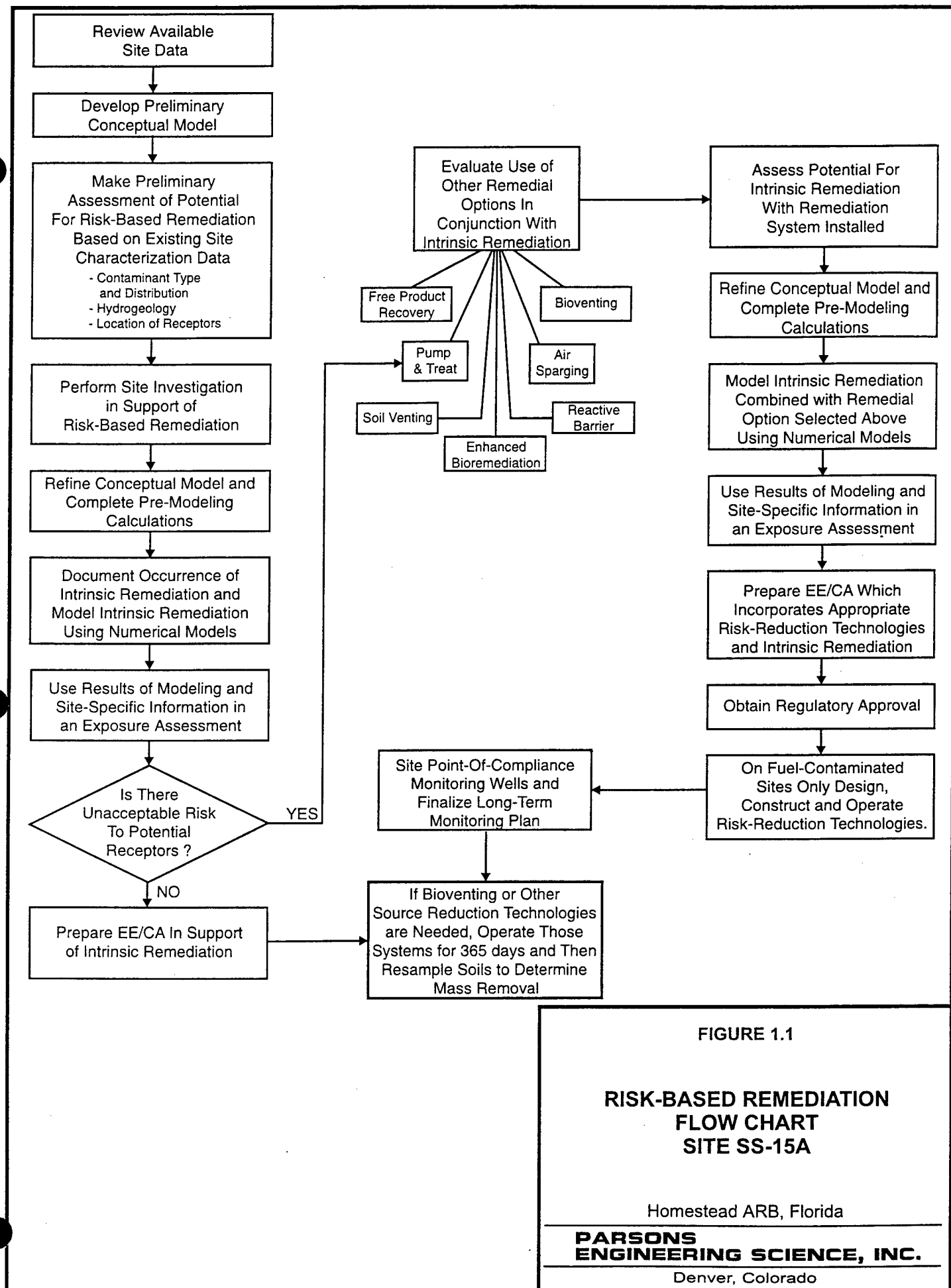
1. Collecting supplemental site characterization data necessary to define the nature, magnitude, and extent of soil, soil gas, and groundwater contamination and to document to degree to which natural attenuation processes are operating at Site SS-15A;
2. Determining whether an unacceptable risk to human health or the environment currently exists or may occur in the foreseeable future using reasonable exposure scenarios, quantitative contaminant transport and fate models and exposure concentration estimates; and
3. Evaluating and recommending a remedial alternative that both reduces the source of contamination and minimizes or eliminates risks to potential receptors associated with the site-related contamination.
4. Documenting the remedial action selection process in a Long-Term Monitoring (LTM) plan or Remedial Action Plan (RAP) which fully satisfies Florida Department of Environmental Protection (FDEP) requirements.

The contamination at Site SS-15A occurs in discrete areas that are associated with various fuel distribution lines. Detailed characterization of each contaminated area is beyond the scope of this project. Therefore, one discrete area that evidences relatively elevated soil and groundwater contaminant levels will be the focus of the characterization effort. Available data indicate that the site is sufficiently homogenous that the results of the detailed risk-based analysis of the selected area can then be used to evaluate risks posed by chemical contamination at other portions of Site SS-15A.

The northern end of apron line AP-26 was selected for the focused study because of the relatively high levels of contamination detected in this area and the relatively large number of groundwater monitoring wells that have been installed (providing historical data). All work will be performed in accordance with guidance and requirements specified in the Sampling and Analysis Plan (SAP) (Appendix A) and Health and Safety Plan (HASP) (Appendix B).

1.3 REGULATORY REQUIREMENTS

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



specific cleanup criteria. The regulations allow closure of petroleum release sites under several different scenarios, including:

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

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

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

- Class F-I: Potable water use: groundwater in a single source aquifer described in Rule 62-520.460, FAC. that has a total dissolved solids (TDS) content of less than 3,000 milligrams per liter (mg/L) and was specifically reclassified as Class F-I by the Commission.
- Class G-I: Potable water use: groundwater in a single-source aquifer that has a TDS content of less than 3,000 mg/L.
- Class G-II: Potable water use: groundwater in an aquifer that has a TDS content of less than 10,000 mg/L, unless otherwise classified by the Commission.
- Class G-III: Non-potable water use: groundwater in an unconfined aquifer that has a TDS content of 10,000 mg/L or greater; or that has a TDS content of 3,000-10,000 mg/L and either has been reclassified by the Commission as having no reasonable potential as a future source of drinking water, or has been designated by the FDEP as an exempted aquifer pursuant to Rule 62-28.130(3), FAC.
- Class G-IV: Non-potable water use: groundwater in a confined aquifer that has a TDS content of 10,000 mg/L or greater.

The groundwater beneath Site SS-15A has been classified as Class G-II (OHM, 1997).

1.3.1 No Further Action

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

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

The final draft *Petroleum Contamination Site Cleanup Criteria* rule (FDEP, 1997) incorporates matrix-specific Target Cleanup Levels for petroleum constituents in the form of "look-up" tables or through reference to other applicable regulations (i.e., state groundwater or surface water regulations). Contaminant concentrations in all affected media at a site must be below all applicable Target Cleanup Levels for the site to qualify for a NFA (with or without conditions) proposal. However, the rule also allows for the development of alternative cleanup standards based on a site-specific risk assessment for use in a NFA Proposal with conditions. These site-specific alternative cleanup standards can be used in place of those presented in the look-up tables.

1.3.2 Natural Attenuation With Monitoring

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

- No free product is present (as specified in 62-770.680 (1)(a),FAC);
- Contaminated soil is not present to the extent that it may increase cleanup costs;
- Groundwater contaminant concentrations above applicable target cleanup levels are not migrating beyond a temporary point of compliance (POC);
- Available data show an overall decrease in the mass of contamination; and
- Contaminant concentrations in groundwater do not exceed appropriate criteria (Table IX levels, 62-770, FAC); or the technical evaluations (as specified in 62-770.690 (e)(2), FAC) indicate that natural attenuation is an appropriate remedial alternative.

Natural attenuation with monitoring requires the establishment of a temporary POC based on site-specific conditions relating to land and groundwater use, potentially exposed populations, hydrogeology, and type and concentrations of contaminants.

Concentrations of petroleum compounds at the POC cannot exceed levels presented in the rule. Monitoring of natural attenuation to show plume stability and/or contaminant reductions can eventually lead to a proposal for NFA With or Without Conditions.

1.3.3 Summary

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

1.4 WORK PLAN ORGANIZATION

This work plan consists of six sections, including this introduction, and three appendices. Section 2 summarizes existing data on the physical characteristics and nature and extent of contamination at Site SS-15A, and presents a conceptual site model that will aid in defining necessary site characterization activities and subsequent data analyses. The proposed sampling strategy for the collection of additional site characterization data is presented in Section 3. Section 4 discusses the proposed risk analysis methods and the results report format. Section 5 includes a proposed schedule defining milestone dates for the project at Site SS-15A. Section 6 lists the references used in preparing this document. Appendices A and B contain the site-specific SAP and HASP, respectively. Appendix C contains selected historical soil and groundwater analytical results for Site SS-15A.

SECTION 2

SITE BACKGROUND INFORMATION

Information regarding the environmental setting and the nature and extent of contamination at Site SS-15A is summarized in this section. Pertinent figures and tables from previously prepared reports are presented in Appendix C.

2.1 SITE DESCRIPTION AND BACKGROUND

Homestead ARB is located in Dade County, Florida, approximately 25 miles south of the City of Miami and 1.5 miles west of Biscayne Bay (Figure 2.1). The FDEP facility designation for Site SS-15A is No. 138521996 and the Dade County Department of Environmental Resources (DERM) identifier is No. UT-5272. Site SS-15A, the flightline apron, is located in the southeastern portion of the Base and encompasses an asphalt and concrete covered area approximately 7,600 feet long and 1,130 feet wide (Figure 2.2). The site contains 26 abandoned underground jet fuel distribution lines (AP-4 through AP-29). The adjacent Site SS-15B, located southeast of Site SS-15A, is the location of nine former pumphouses and tank farms.

The 26 four- (AP-19) to six-inch-diameter (all others) steel distribution lines extend northwest from the former pumphouses beneath the flightline apron. The lines are spaced on 293-foot centers, and six valve boxes, spaced at 136-foot intervals, are located along each distribution line. The lines were installed beginning in 1956, and the fuel distribution lines and fuel farm tanks were abandoned in late 1993 and early 1994 (OHM, 1997). The SS-15A distribution lines had not been in service since the early 1960s. The fuel storage tanks were removed by OHM (1995a) during December 1993 through February 1994. The fuel hydrant system (FHS) piping was purged of fuel, tested, and grouted during January and February 1994, and the fuel pipelines were grouted in March 1994 (OHM 1995a).

Previous investigation activities at Site SS-15A have included:

- Collection and analysis of soil samples from 232 boreholes along and between the fuel distribution piping beneath the flightline apron; installation and sampling of 84 temporary monitoring wells (TMWs); installation and sampling of 149 permanent monitoring wells; and performance of 11 aquifer slug tests (OHM, 1995a);
- Installation of 15 shallow monitoring wells, overdevelopment of 32 shallow monitoring wells, and collection and analysis of groundwater samples from 69 shallow monitoring wells (first-quarter monitoring only [MO] event) (OHM, 1995b);

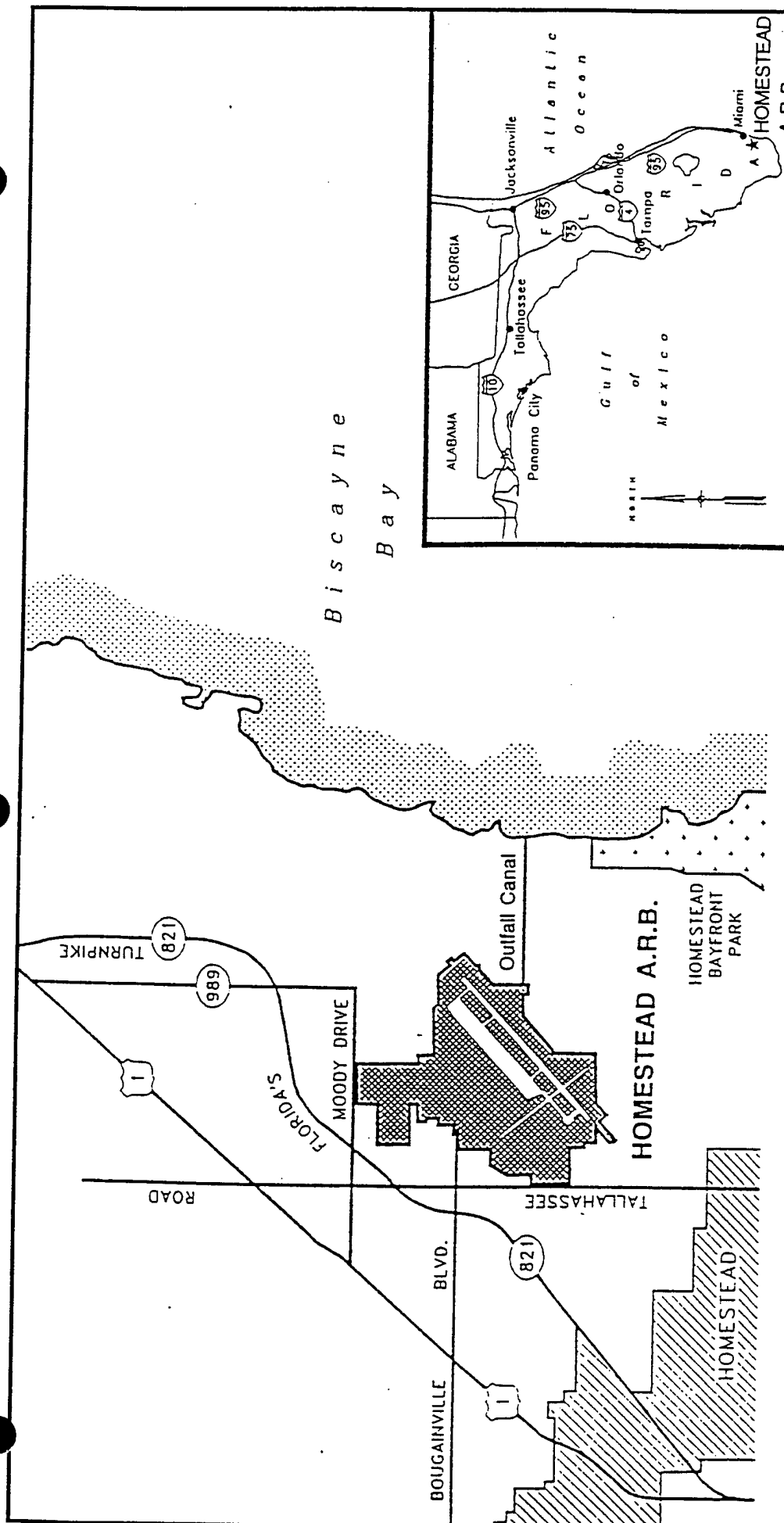


FIGURE 2.1

LOCATION OF HOMESTEAD ARB (FORMERLY HOMESTEAD AFB)

Risk-Based Approach to Remediation
Site SS-15A
Homestead ARB, Florida

**PARSONS
ENGINEERING SCIENCE, INC.**
Denver, Colorado

- Installation of 3 shallow monitoring wells, overdevelopment of 6 shallow monitoring wells, and collection and analysis of groundwater samples from 73 shallow monitoring wells (second-quarter MO event) (OHM, 1996a);
- Overdevelopment of 1 shallow monitoring well, and the collection and analysis of groundwater samples from 76 shallow monitoring wells (third-quarter MO event) (OHM, 1996b).
- Installation of 5 shallow and 2 intermediate-depth monitoring wells, and collection and analysis of groundwater samples from 81 shallow and 2 intermediate-depth monitoring wells (fourth-quarter MO event) (OHM, 1996c).
- Installation of 2 shallow monitoring wells, and collection and analysis of groundwater samples from 51 shallow monitoring wells (year two first quarter MO event) (OHM, 1997).
- Installation of two pilot-scale bioventing systems, soil and soil gas sampling, air permeability testing and in situ respiration testing were performed at Site SS-15B by OHM and Parsons ES in October and November 1996 and February 1997 (Parsons ES, 1997).

The overdevelopment of 39 monitoring wells was an interim remedial action performed to reduce the concentrations of dissolved petroleum constituents. Each overdeveloped well was pumped for approximately 6.5 hours per day for 3 to 4 days, at rates of 4 to 20 gallons per minute (gpm). Contaminant concentrations in groundwater samples in excess of 50 micrograms per liter ($\mu\text{g/L}$) decreased significantly after overdevelopment in 29 of 35 observed instances (OHM, 1996c). At AP-26, well MW-75 was overdeveloped in September or October 1995, and MW-104 was overdeveloped in April 1996 (OHM, 1996c).

Bioventing pilot testing was performed by Parsons ES at the adjacent Site SS-15B in November 1996 and February 1997 (Parsons ES, 1997). System installation, including air injection vent wells and soil gas monitoring points, was performed by OHM under the direction of Parsons ES. Testing included installation of two pilot-scale bioventing systems, and performing air permeability and in situ respiration testing in the vicinities of former Buildings 890 (PH9) and 845 (PH2) to determine the feasibility of using bioventing technology to remediate vadose zone soils. Work included analyzing soil gas samples collected in the pilot test areas (Site SS-15B) and along apron line AP29 (Site SS-15A). Soil gas results indicated that soil gas in areas with significant vadose zone fuel contamination had elevated TVH concentrations and depleted oxygen concentrations. These soil gas results indicated that aerobic biodegradation of fuel hydrocarbons was occurring, but was limited by oxygen supply, and that injecting oxygen (ambient air) would stimulate biodegradation of residual fuel hydrocarbons.

Pilot testing results indicated that bioventing was a technically feasible remedial alternative. Air permeability testing indicated that the use of horizontal air injection wells (as opposed to vertical wells) was the more effective method of supplying oxygen to vadose zone soils, and that a zone of pressure and oxygen influence of approximately 20 feet from horizontal vent wells was achievable. Vertical air injection wells were found to be less efficient in supplying oxygen to vadose zone soils because the shallow

groundwater limited the available screened interval, and uniform radial flow was not achievable because of the variable geology. An average biological degradation rate of approximately 1,460 milligrams per kilogram (mg/kg) of hydrocarbons per year was estimated based on a measured oxygen utilization rate of 6.2 percent per day.

2.2 TOPOGRAPHY AND SURFACE HYDROLOGY

Homestead ARB and the surrounding area has relatively flat topography, with elevations ranging from approximately 5 to 10 feet above mean sea level (msl). Natural drainage is generally poor because the groundwater table occurs at or near the land surface. Surface drainage at Homestead ARB has been improved, and the water table has been lowered in some areas by the construction of a system of drainage canals within and at the perimeter of the Base. Surface runoff from the flightline apron area flows into the flightline canal, which is located approximately 265 feet southeast of the southeastern edge of the apron area and is oriented parallel to the apron and runway. Surface water in the flightline canal flows southeast into Biscayne Bay via other canals.

2.3 GEOLOGY AND HYDROGEOLOGY

The uppermost geologic strata underlying the Homestead ARB area belong to the Pleistocene-age limestones of the Miami Oolite and the underlying Fort Thompson Formation. Beneath Homestead ARB, the Miami Oolite consists of soft oolitic limestone interbedded with sandy limestone and thin layers of hard limestone. Solution features and pockets of silty sand and shell fragments are common (OHM, 1995a). The thickness of the Miami Oolite beneath Homestead ARB ranges from 15 to 20 feet. The underlying Fort Thompson Formation consists of approximately 50 feet of calcareous sandstone and sandy limestone. Beneath Site SS-15A, the Miami Oolite is overlain by a 2- to 3-foot-thick fill layer consisting of silty sand, crushed limerock Base course, and asphalt and concrete pavement. The Miami Oolite and Fort Thompson Formation are highly permeable and are the principal components of the Biscayne aquifer in the Homestead area (OHM, 1995a).

Groundwater occurs predominantly in three aquifers in Dade County: the surficial aquifer system (Biscayne aquifer), the intermediate confining unit (which also contains permeable, water-bearing zones), and the underlying Floridian aquifer. The Biscayne aquifer underlies Homestead ARB and all of Dade County, and is the sole source of fresh water for these areas. Because the Biscayne aquifer is the sole source of fresh water in Dade County, and is the only aquifer system potentially impacted by fuel releases at Homestead ARB, only this aquifer is discussed in this section. The unconfined Biscayne aquifer is approximately 75 to 85 feet thick in the Homestead ARB area. The water table surface generally is encountered at depths between 5 and 6 feet below ground surface (bgs). The regional shallow groundwater flow direction is to the southeast, with local flow variations in response to topography, pumping wells, and canals.

Shallow aquifer characteristics at Site SS-15A have been determined at the site using slug test data. Hydraulic conductivity values for the surficial aquifer ranged from 6.5 to 98 feet per day (ft/day). Using the average horizontal hydraulic gradient of 0.00009 foot per foot (ft/ft) and an estimated effective porosity of 20 percent, the horizontal groundwater flow velocity has been calculated to be 0.014 ft/day or 5.1 feet per year

(ft/yr) (OHM, 1995a). Shallow aquifer characteristics determined by Geraghty & Miller (1992) in the Site SS-15B pump house area included a groundwater flow velocity of 2.6 ft/day or 950 ft/yr, based on a nominal hydraulic conductivity of 0.1 foot per second (ft/sec) (8,640 ft/day). This relatively high hydraulic conductivity may be representative of groundwater flow through significant fractures that may have been enlarged by solutioning. Similar to the regional flow direction, groundwater at Site SS-15A migrates toward the southeast.

2.4 NATURE AND EXTENT OF CONTAMINATION

2.4.1 Site-Wide Summary of Detected Contamination

The fuel hydrocarbon contamination in soil and shallow groundwater at Site SS-15A occurs in a number of isolated areas beneath the flightline apron and generally in the vicinity of fuel line valve boxes. Because of the very flat groundwater gradient, groundwater and soil contamination typically are coincident, and development of extensive dissolved contaminant plumes extending downgradient from the source areas has not occurred to any appreciable extent. Analytical results for "vertical extent" wells indicate that the dissolved contamination is limited to the shallow portion of the surficial aquifer (< 25 feet bgs) (OHM, 1996c; Geraghty & Miller, 1993).

The maximum concentrations of petroleum constituents detected in groundwater samples during the MO event performed in January 1997 (and the locations of the detections) were 28 µg/L benzene (AP12-MW24), 148 µg/L total aromatic volatile organics (VOAs) (AP10-MW9), 41 µg/L methyl tertiary butyl ether (MTBE) (AP14-MW97), 131 µg/L total naphthalenes (AP26-MW114), 1,500 µg/L total polycyclic aromatic hydrocarbons (PAHs) excluding naphthalenes (AP11-MW14), and 76J mg/L total petroleum hydrocarbons (TPH) (AP11-MW14). The "J" qualifier indicates an estimated value. Quarterly groundwater monitoring results for all Site SS-15A wells for the period from October 1995 through January 1997 are presented in Appendix C.

Soil contamination is confined mainly to the upper 6 to 7 feet of the subsurface. Maximum contaminant concentrations detected in soil samples collected in 1994 (and the locations of the detections) were 170 milligrams per kilogram (mg/kg) toluene (AP29-SB6), 39.0 mg/kg ethylbenzene (AP18-SB1), 110.0 mg/kg xylenes (AP18-SB1), 176.0 mg/kg total VOAs (AP18-SB1), 435.95 mg/kg total PAHs excluding naphthalenes (AP20-SB6), 169.0 mg/kg total naphthalenes (AP20-SB6), and 15,000 mg/kg TPH (AP8-SB6) (OHM, 1995a). Benzene, halogenated volatile organic compounds (VOCs), and MTBE were not detected above practical quantitation limits (PQLs) in any of these soil samples. Soil analytical results from the 1994 sampling event performed by OHM (1995a) are contained in Appendix C.

As described in Section 1.2, the site investigation described in this work plan will focus on the northern end of apron line AP-26 area, with findings of the fate and transport evaluations for this area applied to all contaminated areas under the flightline apron. Descriptions in the following subsections will focus primarily on the apron line AP-26 area. However, as described in the following subsections, soil, soil gas, and/or groundwater sampling also will be performed at a small number of other apron lines within Site SS-15A that exhibited relatively high contaminant levels.

2.4.2 Apron Line AP-26, Valve Box 1

Environmental sampling results specific to the northern end of Apron Line AP-26, which is the area selected for detailed characterization and analysis, are summarized in the following paragraphs.

2.4.2.1 Soil Contamination

During 1994, soil borings were drilled and sampled adjacent to valve box 1 on apron line 26. Excessively contaminated soil [>50 parts per million, volume per volume (ppmv) in the sample headspace] was detected at three locations (SB-1/MW-75, MW-76, and MW-77) (Figure 2.3). Analytical results from laboratory analysis of soil samples from SB-1 included 23.9 mg/kg total VOAs, 30.7 mg/kg total PAHs (excluding naphthalenes), and 35.0 mg/kg total naphthalenes. More detailed analytical data are contained in Appendix C.

2.4.2.2 Groundwater Contamination

Groundwater samples have been collected from seven permanent monitoring wells (MW-75, -76, -104, -113, -114, and -115) in the vicinity of valve box 1 (Figures 2.4 and 2.5). The maximum concentrations of dissolved fuel hydrocarbon compounds detected in groundwater samples during the January 1997 MO event include 2 $\mu\text{g/L}$ benzene (MW-76), 21 $\mu\text{g/L}$ total VOAs (MW-75), 114 $\mu\text{g/L}$ total PAHs excluding naphthalenes (MW-75), and 390 $\mu\text{g/L}$ total naphthalenes (MW-75). Sheens and/or small globules of light, nonaqueous phase liquid (LNAPL) were observed during purging of well MW-75 during the last two quarters of the first year of the MO program (OHM, 1996b and 1996c). More detailed analytical data are contained in Appendix C.

2.4.2.3 Soil Gas Contamination

Soil gas samples were not collected during previous investigations at Site SS-15A, except for limited sampling along Apron Line AP-29. Results of this AP-29 sampling, together with elevated field headspace screening results for soil samples collected along the apron lines, is indicative of the presence of elevated volatile fuel hydrocarbon concentrations in soil gas. Excessively contaminated soil [organic vapor analyzer-flame ionization detector (OVA-FID) headspace results > 50 ppmv] was detected at 74 locations in the apron area in 1994, including 3 locations at AP-26 (OHM, 1995a). Soil field headspace screening results are provided in Appendix C.

2.4.3 Surface Water and Sediment Contamination (Site SS-15B)

Surface water and sediment are not present at Site SS-15A. However, free-phase hydrocarbons were observed in the flightline canal at Site SS-15B in December 1989, immediately after a fuel spill at Pumphouse 9 (Geraghty & Miller, 1993). In December 1989, surface water samples from eight locations and sediment samples from seven locations along the flightline canal were collected and analyzed for dissolved fuel hydrocarbon contamination. Results from the surface water and sediment investigation indicated that these media were not significantly impacted by the release.

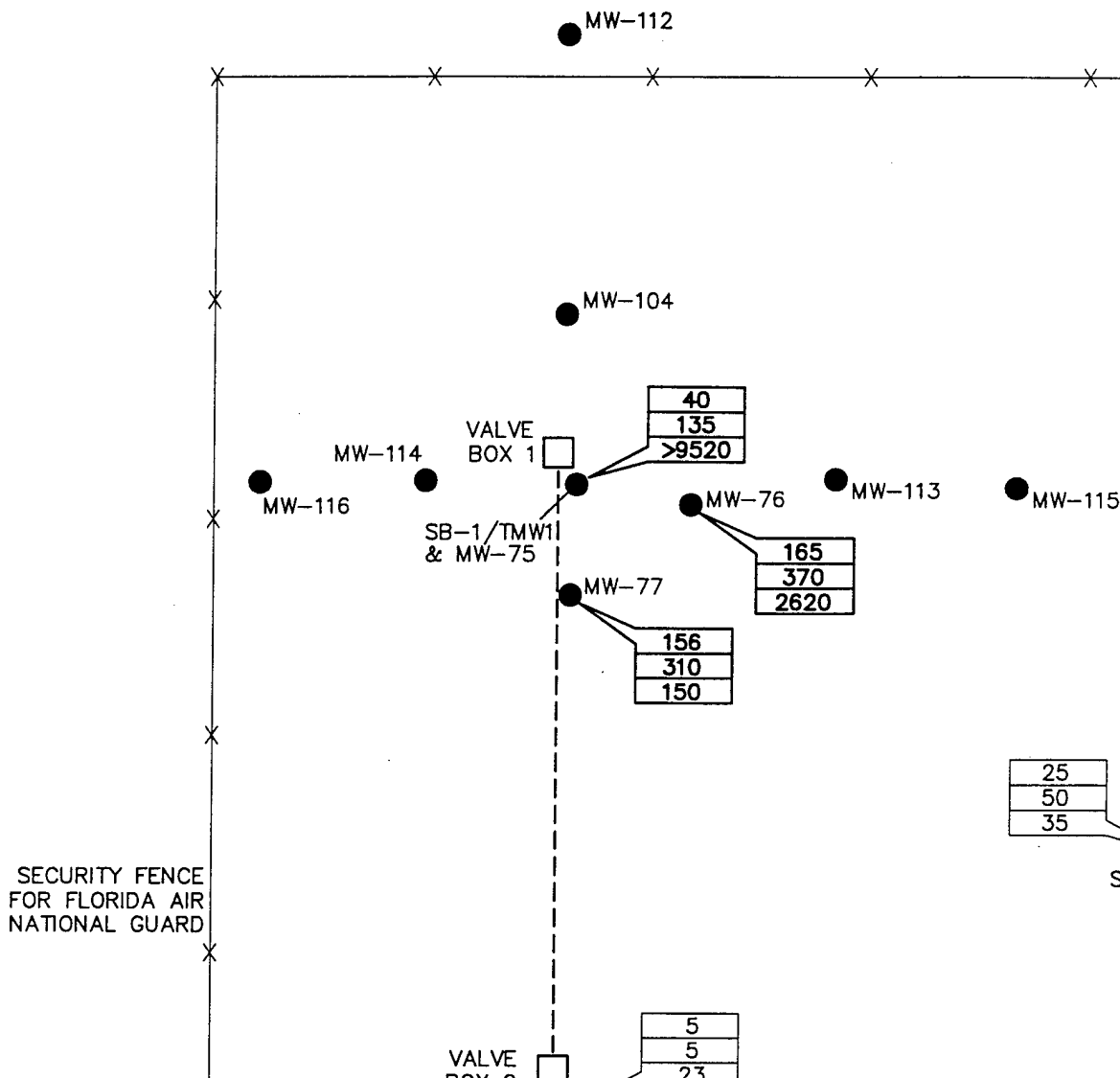


FIGURE 2.3

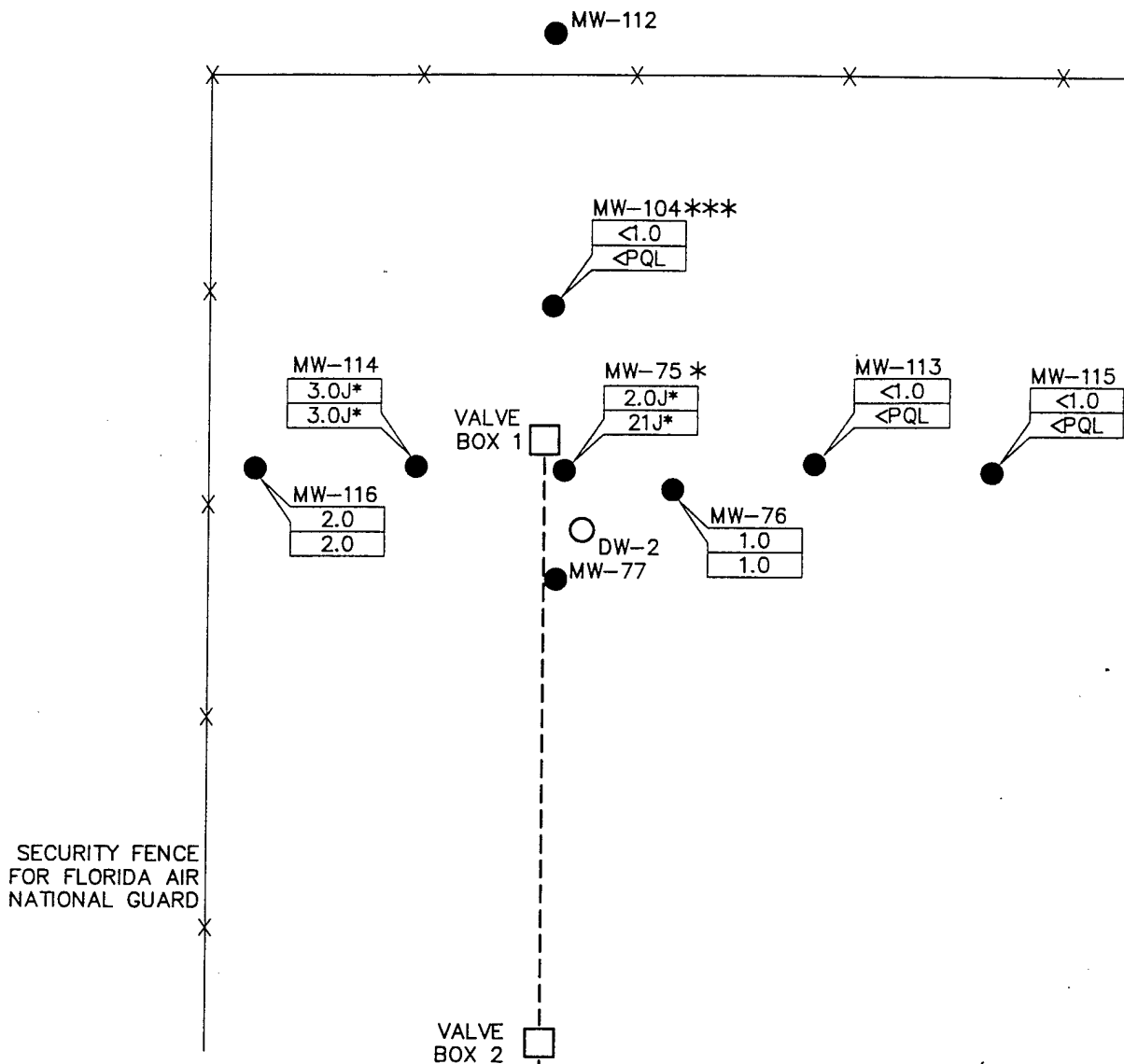
SOIL HEADSPACE SCREENING RESULTS AT APRON LINE AP-26

Risk-Based Approach to Remediation
Site SS-15A
Homestead ARB, Florida

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

K:\AFCE\1298\97DN0756, 09/09/97 at 14:18

SOURCE OHM, 1995a



LEGEND

- APRON LINE RE/DEFUELING VALVE BOX
- EXISTING SHALLOW MONITORING WELL
- EXISTING INTERMEDIATE MONITORING WELL
- OVERDEVELOPED WELL
- * 1st YEAR - 1st QUARTER
- *** 1st YEAR - 3rd QUARTER

BENZENE
TOTAL VOAs

NOTE: ALL CONCENTRATIONS ARE EXPRESSED IN $\mu\text{g/L}$. <PQL=LESS THAN PRACTICAL QUANTITATION LIMIT.
J*= ESTIMATED VALUE DUE TO ELEVATED SURROGATE RECOVERY

0 20 40 80
SCALE: 1"=40'

FIGURE 2.4

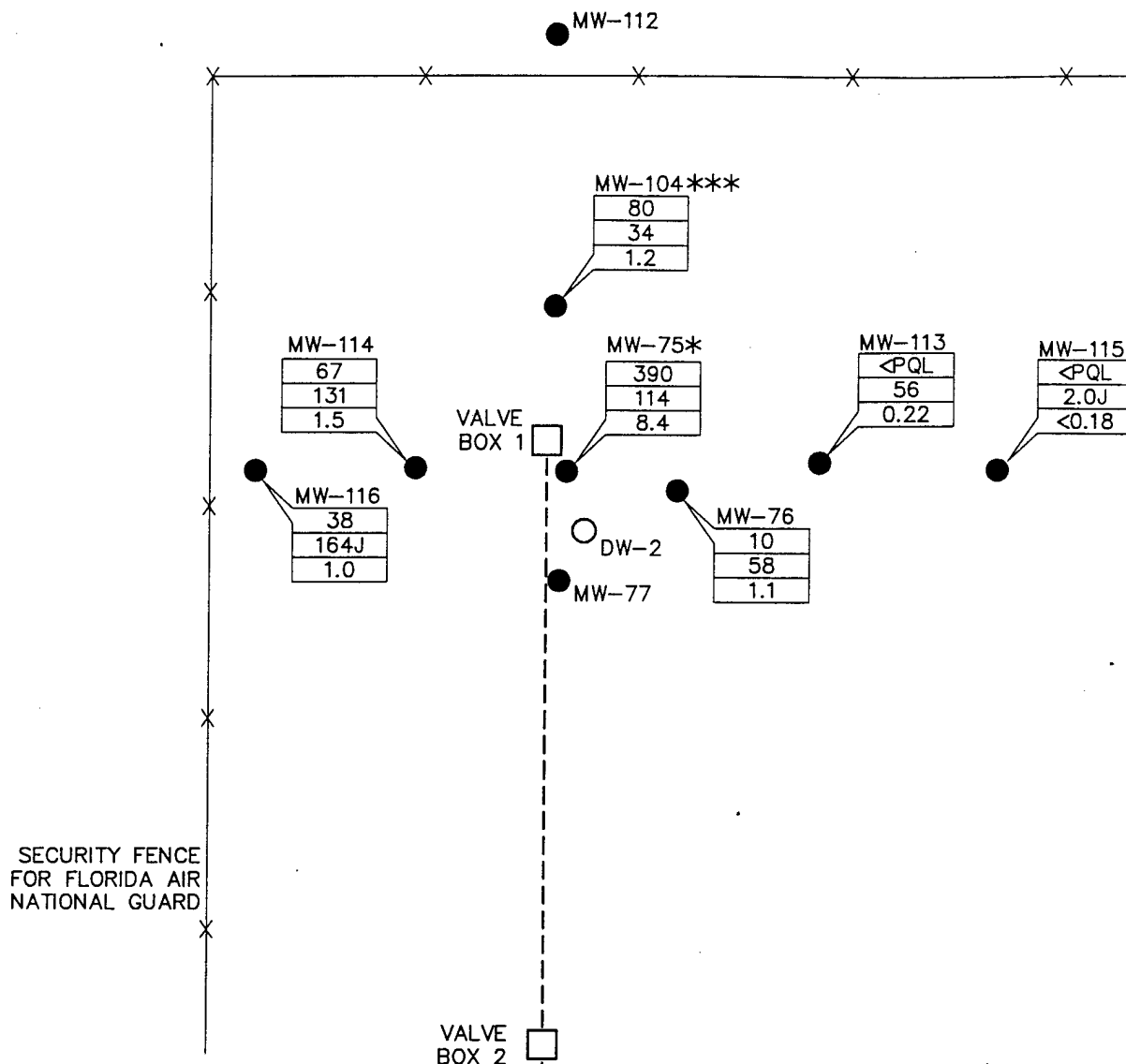
GROUNDWATER QUALITY MAP (BENZENE AND TOTAL VOAS) FOR APRON LINE AP-26

Risk-Based Approach to Remediation
Site SS-15A
Homestead ARB, Florida

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SOURCE OHM, 1995a



LEGEND

□ APRON LINE RE/DEFUELING VALVE BOX

● EXISTING SHALLOW MONITORING WELL

○ EXISTING INTERMEDIATE MONITORING WELL

○ OVERDEVELOPED WELL

* 1st YEAR - 1st QUARTER

*** 1st YEAR - 3rd QUARTER

<9.0J	TOTAL NAPHTHALENES
<9.0J	TOTAL PAHs
NA	TPH (mg/l)

NOTE: ALL CONCENTRATIONS ARE EXPRESSED IN $\mu\text{g/L}$ EXCEPT WHERE NOTED.
 <PQL=LESS THAN PRACTICAL QUANTITATION LIMIT.
 J= ESTIMATED VALUE, BELOW THE PQL AND AT OR ABOVE THE MDL.

0 20 40 80
 SCALE: 1"=40'

FIGURE 2.5

GROUNDWATER QUALITY MAP (TOTAL NAPHTHALENES, PAHs, AND TPH) FOR APRON LINE AP-26

Risk-Based Approach to Remediation
 Site SS-15A
 Homestead ARB, Florida

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SOURCE OHM, 1995a

2.5 PRELIMINARY CONCEPTUAL SITE MODEL REVIEW

Figure 2.6 presents the preliminary conceptual site model (CSM) developed for Site SS-15A. The model presented in Figure 2.6 was developed using data collected during previous site investigations and is based on a review of potential receptors and feasible exposure scenarios. The purpose of developing a CSM is to guide the evaluation of available site information and to determine potential data gaps, including:

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

Figure 2.6 was developed to provide an outline for addressing all media-specific, current and future exposure scenarios at Site SS-15A.

2.5.1 Contamination Source Assessment

Based on previous site investigations, soil, soil gas, and groundwater beneath the flightline apron has been contaminated with petroleum hydrocarbons as the result of spills and leaks in the fueling system. Soil contamination occurs in a number of discrete areas, primarily as residual LNAPL in the vadose (unsaturated) zone (shallower than 6 to 7 feet bgs). Concentrations of total VOAs, PAHs (including naphthalene), and TRPH detected in soil samples from the site exceeded the FDEP and DERM target cleanup levels. The general lack of mobile LNAPL (free product) detections at the site indicate that mobile LNAPL is not a significant, continuing source of groundwater contamination.

Historical groundwater quality data indicate that concentrations of dissolved fuel constituents in groundwater are decreasing, suggesting that the contaminant sources also are dwindling due to the affects of leaching, volatilization, and biodegradation. Rates of contaminant mass reduction due to RNA will be evaluated in the CAP to determine whether or not the applicable FDEP NFA criteria are likely to be achieved within five years per Rule 62-770.690, FAC.

The contaminant release mechanisms which will be considered in the CAP include partitioning from LNAPL into groundwater and into soil gas. This approach is consistent with the nature of contamination detected at the site, the physical characteristics of the surrounding area, and the physiochemical properties of the chemicals of potential concern (COPCs).

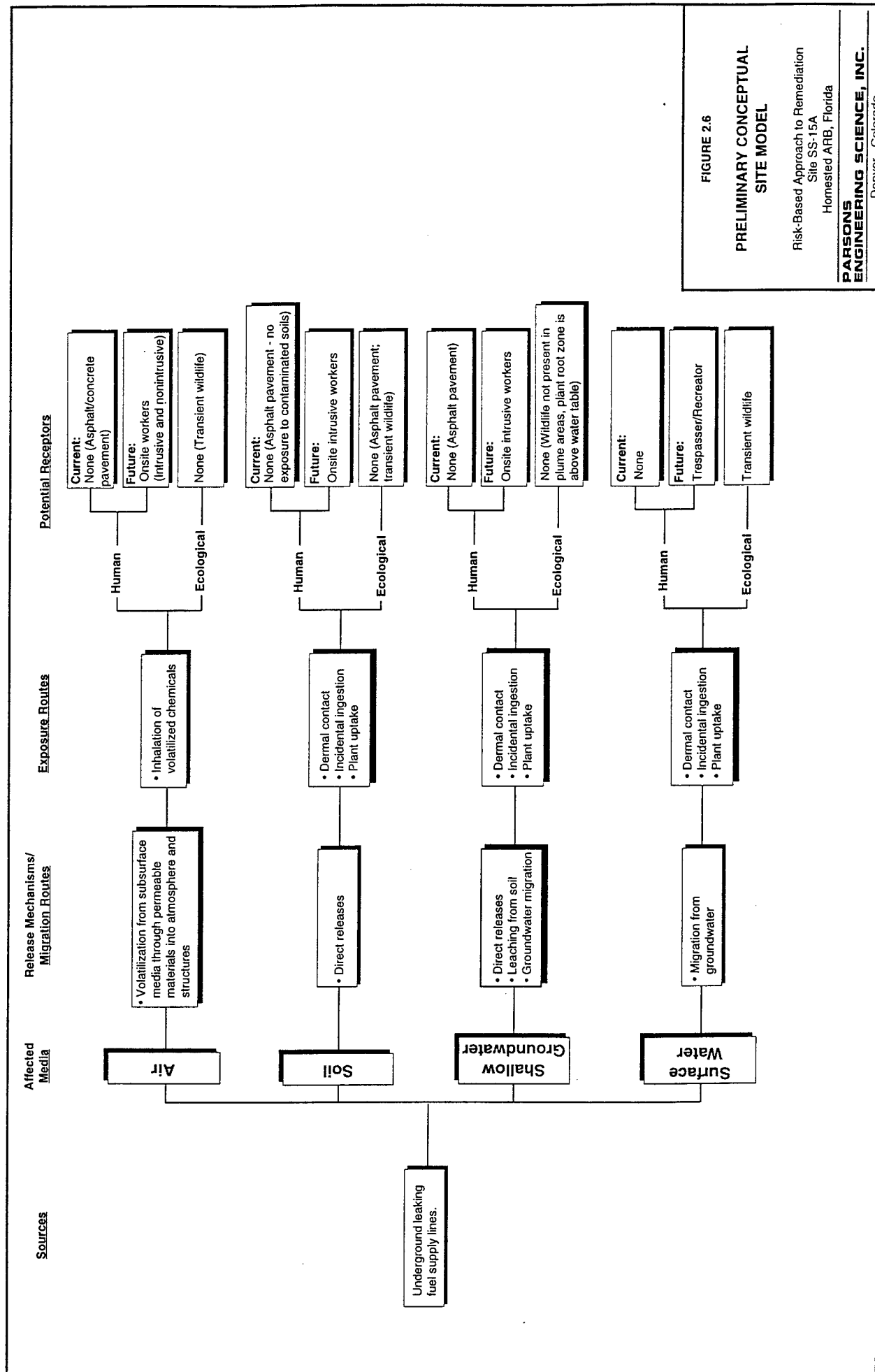


FIGURE 2.6
PRELIMINARY CONCEPTUAL
SITE MODEL

Risk-Based Approach to Remediation
Site SS-15A
Homestead ARB, Florida

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2.5.2 Land Use and Potential Receptors

Land use is important in determining populations that currently may be exposed to site-related contamination and/or that may be exposed in the future. Site SS-15A is adjacent to and services the runway at Homestead ARB. Portions of the site are currently used by the Florida Air National Guard (ANG) and the Air Force Reserve Command (OHM, 1995a). Much of the aircraft apron is currently inactive. Based on a 1993 Base Realignment and Closure (BRAC) recommendation, approximately one-third of the Base will continue to be used for Florida ANG or Air Force Reserve operations, including the area containing apron lines AP-26 through AP-29 in the northeastern corner of Site SS-15A and AP-1 through AP-3 in the southwestern corner. Once environmental restoration is completed, the remainder of the Base will be leased and/or sold. The Dade County Aviation Department is slated as the primary lessee of the non-cantonment portion of the Base (the portion that will not be used for Air Force Reserve operations) (OHM, 1995a). Areas of SS-15A that are not used by the Florida ANG or Air Force Reserve are reportedly designated for light industrial use.

The downgradient Base boundary is approximately 1,000 feet from Site SS-15A. Offsite land adjacent to the Base to the east, southeast, and west is primarily used for agricultural purposes. There is a small residential area southwest of the Base, and additional residential areas to the north. Unless all aviation activities at the Base cease, it is highly unlikely that the site would be available for residential use. Therefore, future onsite land use is expected to remain industrial. Access to the Base is limited; however, it is conceivable that trespassers could potentially contact site-related contaminants if discharge of contaminated groundwater to a surface water body occurs. Based on these land use assumptions, potential current and future populations that could be exposed to contaminated media include onsite non-intrusive industrial workers, onsite intrusive industrial workers, and offsite recreators and trespassers (via contact with potentially impacted surface water at Site SS-15B).

Although numerous plant and wildlife species are known to occur on and near Homestead ARB, Site SS-15A is in a heavily developed, active industrial portion of the Base that is extensively covered with asphalt and concrete. The industrial setting and operational activity levels in the immediate vicinity, coupled with a lack of suitable wildlife habitat, essentially preclude the presence of terrestrial and aquatic wildlife populations at the site. Based on the lack of vegetation and suitable wildlife habitat, and on the absence of exposure pathways to media to which wildlife could readily be exposed (e.g., soils or surface water), the only ecological receptors that could potentially be exposed to contaminants in site media under current or anticipated future land uses are receptors in the offsite, downgradient flightline canal (e.g., amphibians). This pathway is currently incomplete, and would only be completed if dissolved contaminants migrate and discharge to the canal.

2.5.3 Exposure Pathways

An understanding of potential exposure pathways is important in determining how actual or potential receptors could contact contaminated media and how that contact could result in the uptake of chemicals. An exposure pathways analysis reviews the contaminant sources, locations, and types of environmental releases with population

locations and activity patterns to determine the potentially significant pathways of receptor exposure. A completed exposure pathway consists of four necessary elements:

- A source and mechanism of chemical release,
- An environmental transport medium,
- A point of potential contact with a receptor, and
- A feasible route of exposure at the exposure point.

If one or more of these elements is missing, the pathway is incomplete and there is no exposure.

The source of petroleum contamination at Site SS-15A is JP-4 jet fuel that leaked from the transfer pipes used to distribute the fuel from storage tanks to the flightline. Use of the pipelines for fuel distribution ceased in the 1960s. Leaking fuel would have impacted shallow soil in the vicinity of the leak. The water table at the site generally is encountered at 5 to 6 feet bgs, but may occur at or near the land surface during the wet season (OHM, 1995a). Therefore, groundwater also could have been impacted directly by the leaking fuel or indirectly by leaching of contaminants from vadose zone soil. VOCs in the jet fuel could volatilize and impact subsurface soil gas, and infiltrate into buildings via cracks in the foundation, or discharge into the atmosphere via cracks in the pavement. Due to the presence of the asphalt/concrete cover at the site, surface water runoff should not contact contaminated media, and therefore was not considered a potential transport matrix. However, discharge of contaminated groundwater into downgradient surface water may be a completed exposure pathway in the future if the dissolved contaminant plume migrates to a surface water body. The nearest downgradient surface water body is the flightline canal, located approximately 250 feet southeast of the flightline tarmac. Based on the above information, air, soil, shallow groundwater, and surface water represent the potentially affected physical media at Site SS-15A (Figure 2.6).

The concrete/asphalt covering limits both the contaminant transport mechanisms and the potential exposure points at Site SS-15A. This barrier prevents contact with contaminated soil or groundwater by current onsite personnel, and acts as a barrier to migration of soil or soil gas contaminants into the ambient atmosphere. There are currently no buildings at Site SS-15A. Therefore, infiltration of organic vapors into structures is an incomplete pathway for current receptors. However, if future land use at the Base involves construction of buildings at the site, then this pathway could potentially become completed.

Site hydrogeology is described in Section 2.2. In summary, the groundwater gradient at the site is very shallow (0.00003 ft/ft to 0.00015 ft/ft), and groundwater flow is generally to the south-southeast with local variations. The shallow gradient indicates that the groundwater and plume migration rate should be slow, reducing the likelihood that site contaminants could impact surface water via groundwater migration and discharge.

*Flow
or seep*

A water supply well survey was completed as part of the 1995 CAR (OHM, 1995a). Active, on-Base potable wells are located 8,000 feet west-northwest of the flightline apron, and wells used for emergency backup of the Base's normal wellfield are located 4,500 feet northwest of the flightline apron but are currently inactive. No public water supply wells are located within a 0.5-mile radius of the Base. Based on this information, migration of contaminated groundwater to potable drinking water sources is considered to be an incomplete pathway.

Based on the industrial/commercial land use scenario and site-specific contaminated media information, the following human receptor exposure routes may potentially be completed and will be evaluated during the data analysis process:

- Dermal contact with or incidental ingestion of contaminated soil by onsite intrusive workers (e.g., during future excavation activities);
- Dermal contact with or incidental ingestion of contaminated groundwater by onsite intrusive workers (e.g., during future excavation activities);
- Inhalation of volatilized contaminants that have migrated into aboveground structures by future onsite nonintrusive industrial workers; and
- Incidental ingestion of and dermal contact with surface water by offsite recreators or trespassers.

Available information indicates that none of these pathways currently is completed. Therefore, only potential future exposure will be assessed.

2.6 IDENTIFICATION OF DATA GAPS

As described in Section 1, one of the major tasks of this streamlined risk-based approach to remediation of Site SS-15A is to collect any supplemental site characterization data necessary to define the nature, magnitude, and extent of soil and groundwater contamination and to document the degree to which natural attenuation processes are operating at the site.

Soil sampling data from 1994 (OHM, 1995a) will be supplemented by additional sampling to assess the potential risk to future onsite intrusive workers from exposure to contaminated subsurface soils and the potential for partitioning of contaminants from soil into the groundwater. Analysis of selected soil samples for total organic carbon (TOC) will facilitate an assessment of the degree to which migration of dissolved contaminants in groundwater is retarded relative to the advective groundwater flow velocity. Because soil gas sampling has not been performed, *in situ* soil gas characterization data will be collected to assess the potential risks associated with the inhalation pathway for the future nonintrusive worker.

Groundwater monitoring data from 1994 through January 1997 provide an indication of whether dissolved contaminant concentrations are decreasing over time. Data from other available MO reports (e.g., year two second and third quarter) also will be evaluated during preparation of the CAP. Analysis of groundwater samples collected for this risk-based corrective action study for COPCs will provide additional data

regarding temporal trends. Groundwater geochemical data also will be collected to provide qualitative evidence of the degree to which biodegradation is occurring, and the dominant biodegradation processes operating in site groundwater. The geochemical data and historic groundwater monitoring data will be used to assess the rate of contaminant reduction and the risk to future receptors. Collection of these data is discussed in Section 3.

SECTION 3

SUPPLEMENTAL SITE CHARACTERIZATION ACTIVITIES

To facilitate development and implementation of a risk-based remedial action for Site SS-15A, additional site-specific data will be collected. Soil gas, soil, and groundwater will be sampled to :

- Further delineate the extent of contamination;
- Support contaminant fate and transport analyses;
- Develop appropriate exposure-point concentrations to compare to final remediation goals; and
- Evaluate and design an appropriate remedial alternative for the site.

A sufficient number of samples from background and contaminated areas will be collected and analyzed to accurately assess the potential risk to human health and the environment posed by the site.

The supplemental site characterization activities that will be performed at Site SS-15A are briefly described in this Section. Table 3.1 lists the analytical methods for each of the environmental media to be sampled. Most site characterization procedures (e.g., soil, soil gas, and groundwater sampling procedures) are described in detail in the project SAP, which is included as Appendix A. The SAP also lists analytical PQLs for targeted analytes.

3.1 SOIL SAMPLING

Soil samples will be collected near the northern end of apron line AP-26, where previous investigation results indicated relatively high soil and groundwater contaminant concentrations. Soils will be sampled to facilitate evaluation of the potential for contaminant partitioning from soil into groundwater and soil gas, to define the lateral and vertical extent of soil contamination at this locale within Site SS-15A, and to assess the magnitude of any changes in contaminant concentrations that have occurred over time.

A total of five soil boreholes will be drilled at the locations shown on Figure 3.1. At a minimum, the boreholes will be advanced to the water table at a depth of approximately 5 feet bgs. Soil samples will be collected continuously for description and photoionization detector (PID) headspace screening. If visual/olfactory observation and PID headspace screening indicate the presence of soil contamination at the water

SOIL GAS, SOIL, AND GROUNDWATER SAMPLING PROTOCOL
RISK-BASED APPROACH TO REMEDIATION
SITE SS-15A
HOMESTEAD ARB, FLORIDA

Matrix: Soil Gas

Analysis	Method	Required		Field or Laboratory	Analysis Classification *	Data Use
		Quantitation Limit				
Carbon Dioxide	Direct reading meter	0.2%		F	A	To determine carbon dioxide content and to infer biological degradation of fuel-related compounds.
Oxygen	Direct reading meter	0.2%		F	A	To determine oxygen content, the presence or absence of aerobic degradation processes, and/or the effect of engineered systems on increasing oxygen content in soil.
Fuel Hydrocarbon Vapor content	Total combustible hydrocarbon meter	1 ppmv		F	A	A field screening method to determine extent of soil contamination, the need for source removal, and the effect of source removal techniques on soil contamination.
Benzene	EPA TO-3	0.01 µg/L		L	B	Quantitative analysis to determine the nature and extent of soil contamination, the potential for adverse air quality effects, the need for source removal, and the effect of source removal techniques on specific compounds.
Toluene	EPA TO-3	0.01 µg/L		L	B	Same as benzene.
Ethylbenzene	EPA TO-3	0.01 µg/L		L	B	Same as benzene.
Xylene	EPA TO-3	0.05 µg/L		L	B	Same as benzene.

TABLE (CONTINUED)

SOIL GAS, SOIL, AND GROUNDWATER SAMPLING PROTOCOL RISK-BASED APPROACH TO REMEDIATION SITE SS-15A HOMESTEAD ARB, FLORIDA

Matrix: Soil Gas

Analysis	Method	Required		Field or Laboratory	Analysis Classification *	Data Use
		Quantitation Limit				
TVH	EPA TO-3	0.1 ppmv		L	B	Noncompound-specific analysis to determine the extent of soil contamination, the need for source removal, and the effect of source removal techniques at reducing fuel-related contamination.

* Analysis classification groups analysis requirements by method or groups a suite of analytical requirements by expected frequency. A = easily accomplished, required; B = more substantial analytical requirements, required; C = focused analytical requirements to satisfy fate and transport data needs, limited; D = isolated tools, very limited.

TABLE 3 (CONTINUED)

SOIL GAS, SOIL, AND GROUNDWATER SAMPLING PROTOCOL
RISK-BASED APPROACH TO REMEDIATION
SITE SS-15A
HOMESTEAD ARB, FLORIDA

Matrix: Soil

Analysis	Method	Required Quantitation		Field or Laboratory	Analysis Classification *	Data Use
		Limit	low reading			
Total Ionizable Hydrocarbons	Direct reading meter			L	A	A field screening method to determine the extent of soil contamination, the need for source removal, and the effect of source removal techniques on soil contamination.
Benzene	GC Method SW8020	See Appendix A		L	B	Quantitative analysis to determine the nature and extent of soil contamination, the mass of contaminant present, the degree of weathering, the need for source removal, and the effect of source removal techniques on specific compounds.
Toluene	GC Method SW8020	See Appendix A		L	B	Same as benzene.
Ethylbenzene	GC Method SW8020	See Appendix A		L	B	Same as benzene.
Xylenes	GC Method SW8020	See Appendix A		L	B	Same as benzene.
MTBE	GC Method SW8020	See Appendix A		L	B	Same as benzene.
Acenaphthene	Method SW8270 or 8310	See Appendix A		L	B	Quantitative analysis to determine the nature and extent of soil contamination, the mass of contaminant present, the degree of weathering, the need for source removal, and the effect of source removal techniques on specific compounds.
Acenaphthylene	Method SW8270 or 8310	See Appendix A		L	B	Same as acenaphthene

TABLE (CONTINUED)

SOIL GAS, SOIL, AND GROUNDWATER SAMPLING PROTOCOL
RISK-BASED APPROACH TO REMEDIATION
SITE SS-15A
HOMESTEAD ARB, FLORIDA

Matrix: Soil

Analysis	Required			Field or Laboratory	Analysis Classification *	Data Use
	Method	Quantitation Limit				
Anthracene	Method SW8270 or 8310	See Appendix A	L	B	Same as acenaphthene	
Benzo (a) anthracene	Method SW8270 or 8310	See Appendix A	L	B	Same as acenaphthene	
Benzo (a) pyrene	Method SW8270 or 8310	See Appendix A	L	B	Same as acenaphthene	
Benzo (b) fluoranthene	Method SW8270 or 8310	See Appendix A	L	B	Same as acenaphthene	
Benzo (g, h, i) perylene	Method SW8270 or 8310	See Appendix A	L	B	Same as acenaphthene	
Benzo (k) fluoranthene	Method SW8270 or 8310	See Appendix A	L	B	Same as acenaphthene	
Chrysene	Method SW8270 or 8310	See Appendix A	L	B	Same as acenaphthene	
Dibenzo (a, h) anthracene	Method SW8270 or 8310	See Appendix A	L	B	Same as acenaphthene	
Fluoranthene	Method SW8270 or 8310	See Appendix A	L	B	Same as acenaphthene	
Fluorene	Method SW8270 or 8310	See Appendix A	L	B	Same as acenaphthene	
Ideno (1, 2, 3-c, d) pyrene	Method SW8270 or 8310	See Appendix A	L	B	Same as acenaphthene	
Naphthalene	Method SW8270 or 8310	See Appendix A	L	B	Same as acenaphthene	
Phenanthrene	Method SW8270 or 8310	See Appendix A	L	B	Same as acenaphthene	
Pyrene	Method SW8270 or 8310	See Appendix A	L	B	Same as acenaphthene	

TABLE (CONTINUED)

SOIL GAS, SOIL, AND GROUNDWATER SAMPLING PROTOCOL RISK-BASED APPROACH TO REMEDIATION SITE SS-15A HOMESTEAD ARB, FLORIDA

Matrix: Soil

Analysis	Method	Required Quantitation		Field or Laboratory	Analysis Classification *	Data Use
		Limit				
TRPH	FL-PRO	See Appendix A	L	B	A noncompound-specific method to determine the extent of soil contamination, the need for source removal, and the effect of source removal techniques on soil contamination.	
TOC	Modified SW9060	See Appendix A	L	D	Relatively high amounts of TOC may indicate a reducing environment and may indicate the need for analysis of electron acceptors associated with that environment; the rate of migration of fuel-related compounds in groundwater depends on the amount of TOC in phreatic soils; the rate of release of fuel-related compounds from the source to groundwater is in part dependent on the amount of TOC in the unsaturated soil.	

* Analysis classification groups analysis requirements by method or groups a suite of analytical requirements by expected frequency. A = easily accomplished, required; B = more substantial analytical requirements, required; C = focused analytical requirements to satisfy fate and transport data needs, limited; D = isolated tools, very limited.

TABLE 3 (CONTINUED)

SOIL GAS, SOIL, AND GROUNDWATER SAMPLING PROTOCOL
RISK-BASED APPROACH TO REMEDIATION
SITE SS-15A
HOMESTEAD ARB, FLORIDA

Matrix: Groundwater

Analysis	Method	Required Quantitation		Field or Laboratory	Analysis Classification *	Data Use
		Limit				
Depth to Water	Water probe	0.01 ft		F	A	Hydrogeological characterization; well development.
Thickness of NAPL Fuel	Oil/water probe	0.01 ft		F	A	To determine extent of potential continuing source to groundwater, the mass of source contamination, and the need for source removal.
Temperature	E170.1	0.2°C		F	A	Well development.
Dissolved Oxygen	Direct Reading Meter	0.2 mg/L		F	A	Data input to fate and transport model; depleted levels generally indicate inhibited aerobic degradation and potential presence of anaerobic degradation processes; concentrations less than 1 mg/L correlate well to elevated dissolved-phase BTEX contamination.
pH	E150.1/direct reading	0.2		F	A	Aerobic and anaerobic processes are pH-sensitive.
Redox Potential	A2580B/direct reading	2mV		F	A	The redox potential of groundwater influences and is influenced by the nature of the biologically mediated degradation of contaminants.

TABLE 3 (CONTINUED)

SOIL GAS, SOIL, AND GROUNDWATER SAMPLING PROTOCOL
RISK-BASED APPROACH TO REMEDIATION
SITE SS-15A
HOMESTEAD ARB, FLORIDA

Matrix: Groundwater

Analysis	Method	Required Quantitation		Field or Laboratory	Analysis Classification *	Data Use
		Limit				
Benzene	GC Method SW8020	See Appendix A	L	B	Primary compound-specific analytes used to estimate and monitor intrinsic remediation; determine nature and extent of contamination and the degree of weathering, and to establish and demonstrate compliance with site-specific remediation goals.	
Toluene	GC Method SW8020	See Appendix A	L	B	Same as benzene.	
Ethylbenzene	GC Method SW8020	See Appendix A	L	B	Same as benzene.	
Xylenes	GC Method SW8020	See Appendix A	L	B	Same as benzene.	
MTBE	GC Method SW8020		L	B	Same as benzene.	
Trimethylbenzene isomers	GC Method SW8020	See Appendix A	L	B	To monitor and correct for plume dilution effects in fate and transport model setup.	
Acenaphthene	SW846 Method 8270 or 8310	See Appendix A	L	B	To determine nature and extent of this compound, the degree of weathering, and to establish and demonstrate compliance with site-specific remediation goals.	
Acenaphthylene	SW846 Method 8270 or 8310	See Appendix A	L	B	Same as acenaphthene	
Anthracene	SW846 Method 8270 or 8310	See Appendix A	L	B	Same as acenaphthene	
Benzo (a) anthracene	SW846 Method 8270 or 8310	See Appendix A	L	B	Same as acenaphthene	
Benzo (a) pyrene	SW846 Method 8270 or 8310	See Appendix A	L	B	Same as acenaphthene	
Benzo (b) fluoranthene	SW846 Method 8270 or 8310	See Appendix A	L	B	Same as acenaphthene	

TABLE 3 (CONTINUED)

SOIL GAS, SOIL, AND GROUNDWATER SAMPLING PROTOCOL
RISK-BASED APPROACH TO REMEDIATION
SITE SS-15A
HOMESTEAD ARB, FLORIDA

Matrix: Groundwater

Analysis	Method	Required		Field or Laboratory	Analysis Classification *	Data Use
		Quantitation Limit	Quantitation Limit			
Benzo (g, h, i) perylene	SW846 Method 8270 or 8310	See Appendix A	See Appendix A	L	B	Same as acenaphthene
Benzo (k) fluoranthene	SW846 Method 8270 or 8310	See Appendix A	See Appendix A	L	B	Same as acenaphthene
Chrysene	SW846 Method 8270 or 8310	See Appendix A	See Appendix A	L	B	Same as acenaphthene
Fluoranthene	SW846 Method 8270 or 8310	See Appendix A	See Appendix A	L	B	Same as acenaphthene
Fluorene	SW846 Method 8270 or 8310	See Appendix A	See Appendix A	L	B	Same as acenaphthene
Ideno (1, 2, 3-c, d) pyrene	SW846 Method 8270 or 8310	See Appendix A	See Appendix A	L	B	Same as acenaphthene
Naphthalene	SW846 Method 8270 or 8310	See Appendix A	See Appendix A	L	B	Same as acenaphthene
Phenanthrene	SW846 Method 8270 or 8310	See Appendix A	See Appendix A	L	B	Same as acenaphthene
Pyrene	SW846 Method 8270 or 8310	See Appendix A	See Appendix A	L	B	Same as acenaphthene
Alkalinity	Hach Method 8221/E360.1	See Appendix A	See Appendix A	F/L	C	To verify that groundwater samples are obtained from same system and to measure the buffering capacity of the aquifer.
Nitrate	E353.1	See Appendix A	See Appendix A	L	C	Secondary substrate electron acceptor for microbial respiration if oxygen is depleted; data input to fate and transport model.
Sulfate	HACH SulfaVer 4	--	--	F	C	Potential substrate for anaerobic microbial respiration; will be used semi-quantitatively when evaluating intrinsic remediation.
Dissolved Sulfide	HACH Method 8131	--	--	F	C	Product of sulfate-based anaerobic microbial respiration; analyze in conjunction with sulfate analysis.

TABLE (CONTINUED)

SOIL GAS, SOIL, AND GROUNDWATER SAMPLING PROTOCOL
RISK-BASED APPROACH TO REMEDIATION
SITE SS-15A
HOMESTEAD ARB, FLORIDA

Matrix: Groundwater

Analysis	Method	Required Quantitation Limit	Field or Laboratory	Analysis Classification *	Data Use
Carbon Dioxide	Chemetrics Method 4500	--	F	C	Carbon dioxide can be an electron acceptor for anaerobic microbial respiration; the presence of free carbon dioxide dissolved in groundwater is unlikely given natural buffering capacities. If detected, concentrations will be compared to background levels to determine if they are elevated, which could suggest aerobic degradation.
Conductivity	E120.1/ SW9050	See Appendix A	F/L	C	General water quality indicator used to verify that samples are obtained from the same groundwater system.
Methane	RSKSOP 175	See Appendix A	L	C	The presence of methane suggests BTEX degradation via an anaerobic pathway utilizing carbon dioxide (carbonate) as the electron acceptor (methanogenesis). If detected, concentrations will be compared to background levels to determine if they are elevated, which could suggest anaerobic degradation.
Total Hydrocarbons	FL-PRO	See Appendix A	L	B	To estimate the extent of contamination and to monitor the reduction in fuel-related contamination due to natural attenuation.

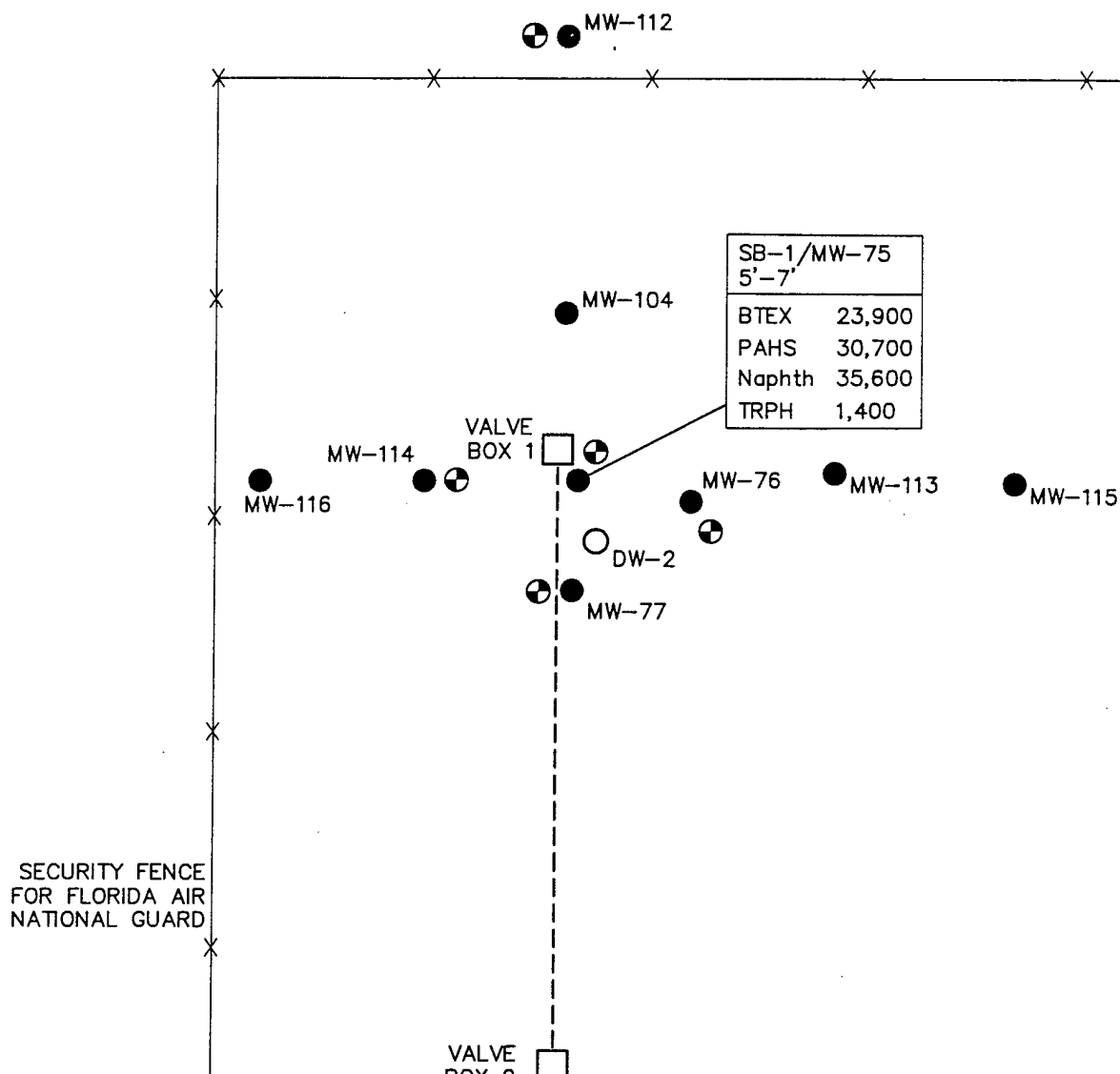
TABLE 3 (CONTINUED)

SOIL GAS, SOIL, AND GROUNDWATER SAMPLING PROTOCOL
RISK-BASED APPROACH TO REMEDIATION
SITE SS-15A
HOMESTEAD ARB, FLORIDA

Matrix: Groundwater

Analysis	Method	Required		Field or Laboratory	Analysis Classification*	Data Use
		Quantitation Limit				
Ferrous iron (Fe^{2+})	HACH Method 8146	0.06 mg/L		F	C	May indicate an anaerobic degradation process as a result of depletion of other electron acceptors such as oxygen and nitrate.
Manganese	Hach Method 8034			F	C	May indicate an anaerobic degradation process as a result of depletion of other electron acceptors such as oxygen and nitrate.
Ammonia	Chemetrics Method 4500			F	C	An indicator of microbial activity.

* Analysis classification groups analysis requirements by method or groups a suite of analytical requirements by expected frequency. A = easily accomplished, required; B = more substantial analytical requirements, required; C = focused analytical requirements to satisfy fate and transport data needs, limited; D = isolated tools, very limited.



LEGEND

- APRON LINE RE/DEFUELING VALVE BOX
- EXISTING SHALLOW MONITORING WELL AND SOIL GAS SAMPLING LOCATION
- EXISTING INTERMEDIATE MONITORING WELL
- PROPOSED SOIL SAMPLING LOCATION

1994 DATA FROM OHM (1995a)

SAMPLE LOCATION	SAMPLE DEPTH (ft bgs)
BTEX ($\mu\text{g/kg}$)	
PAHS ($\mu\text{g/kg}$)	
(Excluding Naphthalenes)	
Naphthalenes ($\mu\text{g/kg}$)	
TRPH (mg/kg)	

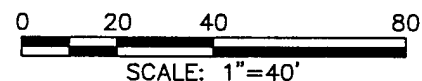


FIGURE 3.1

PROPOSED SOIL, SOIL GAS, AND GROUNDWATER SAMPLING LOCATIONS AT APRON LINE AP-26

Risk-Based Approach to Remediation
Site SS-15A
Homestead ARB, Florida

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table, then the borehole will be advanced sufficiently below the water table to define the vertical extent of contamination.

One soil borehole will be drilled immediately adjacent to well MW-75, where a soil sample was collected in 1994 (OHM, 1995a). One soil sample will be collected from the same 5- to 7-foot-bgs interval to allow assessment of how contaminant concentrations have changed over time. A maximum of two additional soil samples will be collected above and/or below this interval to define the vertical extent of soil contamination. Three of the remaining four boreholes will be drilled approximately 25 feet from MW-75 to define the lateral extent of contamination. To accomplish this objective, a minimum of one and maximum of two soil samples will be collected from each of these boreholes for laboratory analysis. The sampling depths will be determined in the field on the basis of visual/olfactory observations and PID headspace screening results. If field observations do not indicate the presence of fuel contamination, then one sample will be collected from immediately above the water table. The fifth soil borehole will be drilled upgradient from the site adjacent to well MW-112. The purpose of this borehole will be to obtain a minimum of two soil samples for TOC analysis from an uncontaminated or minimally contaminated area. These samples will be collected from strata that are representative of the primary water-bearing zones through which dissolved contaminants migrate. Table 3.2 lists the analyses proposed for soil samples from each location. Sampling procedures are described in the SAP (Appendix A).

Three additional soil samples will be collected from relatively contaminated zones associated with other previously-investigated apron lines to provide further information regarding how contaminant concentrations have changed since the 1994 soil sampling event. One sample will be collected immediately adjacent to SB-1 at Apron Line AP-18 from the 4- to 6-foot-bgs interval (see Appendix C for location of this borehole). The sample collected from SB-1 at this depth in 1994 contained the highest total VOA and total naphthalene concentrations detected at Site SS-15A (OHM, 1995a). The second sample will be collected immediately adjacent to SB-6 at Apron Line AP-20 from the 3- to 5-foot-bgs interval (see Appendix C for location of this borehole). The 1994 sample from this location contained the highest total PAH concentration (exclusive of naphthalenes) detected at Site SS-15A (OHM, 1995a). The third sample will be collected adjacent to AP15-SB2 from a depth of 2 to 4 feet bgs. Elevated concentrations of PAHs were previously detected at this location.

If soil gas analyses (Section 3.4) indicate that oxygen concentrations are depleted (<5%), then each soil borehole which exhibits fuel contamination will be completed as a temporary vent well for potential use in air injection bioventing or soil vapor extraction. The temporary vent wells will be constructed of 2-inch-diameter polyvinyl chloride (PVC) screen and riser pipe with a screened interval extending from approximately 2 to 7 feet bgs. If these wells are not used for bioventing/SVE testing, they will be abandoned and grouted in place.

3.2 MONITORING WELL INSTALLATION

The magnitude and lateral/vertical extent of dissolved fuel contamination in groundwater at Apron Line AP-26 appears to be adequately defined for the purposes of

TABLE 3.2
SITE-SPECIFIC SAMPLING STRATEGY
RISK-BASED APPROACH TO REMEDIATION
SITE SS-15A
HOMESTEAD ARB, FLORIDA

Media	Sample Location	Analysis Classification *	Media	Sample Location	Analysis Classification *
Water	AP26-MW75	A, C	Soil Gas	AP26-MW75	A, B
Water	AP26-MW76	A, C	Soil Gas	AP26-MW76	A, B
Water	AP26-MW77	A, C	Soil Gas	AP26-MW77	A
Water	AP26-MW104	A, C	Soil Gas	AP26-MW104	A
Water	AP26-MW112	A, C	Soil Gas	AP26-MW112	A
Water	AP26-MW113	A, C	Soil Gas	AP26-MW113	A
Water	AP26-MW114	A, C	Soil Gas	AP26-MW114	A
Water	AP26-MW115	A, C	Soil Gas	AP26-MW115	A
Water	AP26-MW116	A, C	Soil Gas	AP26-MW116	A
Water	AP26-DW2	A, C	Soil Gas	AP18-MW41	A, B
Water	AP12 and AP10 Wells	A, B, C			
Soil	Adj. to AP26-MW112	A, D			
Soil	All other locations	A, B			

* Analysis classification groups analysis requirements by method or groups a suite of analytical requirements by expected frequency. A = easily accomplished, required; B = more substantial analytical requirements, required; C = focused analytical requirements to satisfy fate and transport data needs, limited; D = isolated tools, very limited. Table 3.1 describes analysis classification requirements by medium.

this risk-based analysis by the existing monitoring well network. Therefore, installation of additional monitoring wells is not proposed.

The installation and sampling of three new wells in the vicinity of AP26-MW116 was recommended in the year two first quarter MO report (OHM, 1997) to bound the dissolved contamination detected in well MW116 and establish a perimeter well array for this location. The decision on whether or not to install these wells will be made based on the results of the second quarter 1997 MO report (OHM, in preparation). The year two first quarter monitoring results for this well indicated that only the target analytes that exceeded NFA target cleanup levels were benzene, acenaphthene, and benzo(a)anthracene. Benzene, acenaphthene, and benzo(a)anthracene were detected at concentrations of 2 µg/L, 33 µg/L, and 11 µg/L, respectively; the NFA target cleanup levels for these compounds are 1 µg/L, 20 µg/L, and 0.2 µg/L, respectively. Therefore, each of the detected concentrations did not substantially exceed the NFA target cleanup levels, and none of the concentrations exceeded the target cleanup levels for implementing natural attenuation with monitoring (Table 4.2).

3.3 GROUNDWATER SAMPLING

A total of nine shallow and one intermediate-depth (vertical extent) wells will be sampled in the apron line AP-26 area for a suite of geochemical indicator parameters to provide site-specific documentation of the occurrence of natural attenuation of fuel contaminants, including the effects of sorption and aerobic and anaerobic biodegradation. Groundwater sampling procedures are described in detail in the SAP (Appendix A). Figure 3.1 identifies the locations of the groundwater monitoring wells to be sampled, and Table 3.2 lists the analyses proposed for samples from each location. As shown on the table, many of the geochemical parameters will be measured in the field using direct-reading meters or portable colorimetric (e.g., Hach® or CHEMetrics®) test equipment. Some of these targeted geochemical analytes (e.g., oxygen, sulfate, and nitrate) are depleted during intrinsic bioremediation of fuel compounds, and others (e.g., ferrous iron and methane) are produced. Therefore, measuring the distribution of these analytes in groundwater provides a direct indication that bioremediation is occurring. Measurement of parameters such as pH and temperature indicate if conditions are suitable for continued growth of fuel-degrading organisms. Analysis of groundwater samples for fuel contaminants is not proposed due to the availability of quarterly monitoring data.

Groundwater samples also will be obtained from a maximum of eight selected wells at other apron lines within Site SS-15A that have evidenced relatively elevated dissolved contaminant concentrations. These wells will include MW-24 at AP-12, where the highest benzene concentrations have been detected; and MW-9 at AP-10, where the highest total VOA concentrations have been detected. A maximum of three other wells in the immediate vicinity of both of these wells also will be sampled. To the extent possible, these wells will be located upgradient, cross-gradient, and downgradient from the most contaminated well, respectively. The primary objective of this sampling is to obtain groundwater geochemical data to confirm that geochemical conditions are sufficiently homogenous across Site SS-15A to allow the results of the focused risk-based analysis performed for the AP-26 area to be extrapolated to the rest of the site. However, wells that are not sampled quarterly for fuel constituents by

OHM (see Appendix C), also will be sampled for aromatic VOCs and PAHs using USEPA Methods SW8020 and SW8270 or SW8310, respectively.

3.4 SOIL GAS SAMPLING

Soil gas samples will be collected from the AP-26 area, which is the focus of the detailed investigation; and the northern end of AP-18, which had high soil VOA results (176 mg/kg) during the 1994 investigation (OHM, 1995a). A total of 12 soil gas samples will be collected and field screened for total volatile hydrocarbons (TVH), oxygen, and carbon dioxide. Based on field screening results, a total of four samples (two samples from each of two areas) will be submitted to the laboratory and analyzed for TVH and benzene, toluene, ethylbenzene, and xylenes (BTEX). Soil gas data will be used to assess the potential risk to future workers at the site from inhalation of volatilized contaminants, and to determine whether or not sufficient oxygen is available in the soil gas to sustain aerobic fuel hydrocarbon biodegradation. If oxygen concentrations are significantly lower than background values, and carbon dioxide concentrations are higher than background, then the occurrence of aerobic fuel hydrocarbon biodegradation can be inferred. In addition, the oxygen levels will allow an assessment of whether there is sufficient oxygen to sustain continuing aerobic biodegradation without engineered addition of oxygen via *in situ* bioventing.

Soil gas samples will be collected from existing groundwater monitoring wells that have screens extending above the groundwater surface. At AP-26, these wells include existing wells MW-116, MW-75, MW-114, MW-77, MW-76, MW-113, MW-112, MW-104, and MW-115 (Figure 3.1). At AP-18, soil gas samples will be obtained from wells MW-41, MW-42, and MW-43 (Figure 3.2). Soil gas sampling procedures are described in detail in the SAP (Appendix A). Table 3.2 lists the analyses proposed for samples from each well location.

3.5 MOBILE LNAPL SAMPLING

If mobile LNAPL is encountered on the water table in sufficient quantity, at least one LNAPL sample will be collected and analyzed for a full suite of chemical constituents to determine the fraction of LNAPL constituents that can partition into the groundwater and contribute to the dissolved contaminant plume. To date, only sheens or small globules of mobile LNAPL have been detected in one well proposed for sampling (AP-26-MW75). Therefore, it is not anticipated that sufficient mobile LNAPL volume for sampling will be encountered during this investigation.

3.6 AQUIFER TESTING

Site-specific aquifer characteristics have previously been determined by Geraghty & Miller (1992) and OHM (1995a). Hydraulic conductivity, hydraulic gradient, and advective groundwater flow velocities determined during these investigations are discussed in Section 2.3. The available data are considered sufficient for this study, and additional aquifer testing is not proposed.

LEGEND



APRON LINE RE/DEFUELING
VALVE BOX



EXISTING SHALLOW
MONITORING WELL

VALVE
BOX 1



MW-41



MW-42



MW-43

VALVE
BOX 2



VALVE
BOX 3



0 20 40 80

SCALE: 1"=40'

FIGURE 3.2

**SOIL GAS
SAMPLING LOCATIONS
AT APRON LINE AP-18**

Risk-Based Approach to Remediation
SS-15A
Homestead ARB, Florida

**PARSONS
ENGINEERING SCIENCE, INC.**

Denver, Colorado

3.7 SOURCE REMOVAL FEASIBILITY TESTING

It is possible that some level of soil or groundwater remediation may be required to reduce the source of BTEX and PAH contamination at Site SS-15A. There are two potential reasons why limited source removal may be required. The first reason could be to reduce potential exposure of future intrusive (excavation) workers to soil contaminants. The second reason for source reduction could be to reduce the long-term leaching of contaminants into groundwater and thereby reduce the long-term monitoring requirements at the site. The need for source reduction will be carefully examined using risk exposure calculations and fate and transport models discussed in Section 4.

The most likely source reduction technology for Site SS-15A would be air injection bioventing. A bioventing pilot test conducted at Site SS-15B determined that air injection is possible in Homestead's shallow soils, but that the Oolite formation was extremely porous which resulted in short-circuiting to the surface and a limited radius of influence. A separate pilot test in the AP-26 area may be beneficial to determine how the concrete/asphalt apron may increase the radius of oxygen influence and the distribution of injected air. As discussed in Section 3.1, several of the proposed soil borings at AP-26 could be converted into temporary air injection vent wells for a pilot test.

Bioventing is an innovative technology which uses low rates of air injection to supply oxygen to soil bacteria employed in the biodegradation of fuel hydrocarbons. The Air Force and Parsons ES have successfully used bioventing for remediation of hundreds of fuel spill sites (Downey *et al.*, 1993). A bioventing pilot test will be performed if the soil gas survey indicates that the soil gas at the site is depleted (< 5%) in oxygen, indicating significant hydrocarbon contamination and biological activity. If oxygen concentrations are depleted, air injection should supply oxygen and stimulate biological activity and increase rates of hydrocarbon biodegradation. Test procedures described in the Air Force bioventing protocol document (Hinchee *et al.*, 1992) will be followed, and will include an oxygen influence test and *in situ* respiration test.

A two-day *in situ* respiration test will be completed at each of the temporary vent wells which exhibited initial oxygen levels below 5 percent. The objective of the *in situ* respiration test is to determine the rate at which soil bacteria degrade petroleum hydrocarbons. Respiration tests will be performed at selected monitoring points where bacteria biodegradation of hydrocarbons is indicated by low oxygen levels and elevated carbon dioxide concentrations in the soil gas. A 1-cubic feet per minute (cfm) pump will be used to inject air into the selected vent wells/monitoring points which contain low levels (< 5%) of oxygen. A 12-hour air injection period will be used to oxygenate local contaminated soils. At the end of the air injection period, the air supply will be cut off, and oxygen and carbon dioxide levels will be monitored for the following 48 hours. The decline in oxygen concentrations over time will be used to estimate rates of bacterial degradation of fuel residuals.

Following the respiration test, one of the temporary vent wells will be used to inject 10-20 standard cubic feet per minute (scfm) of air into the soil beneath the apron.

During this oxygen influence test, oxygen levels will be monitored in the other vent wells and nearby monitoring wells which are screened above the water table. After several days of air injection, the radius of oxygen influence will be estimated. Water levels also will be measured in existing monitoring wells at AP-26 to determine if air injection has the added benefit of groundwater depression at this site. At other sites, Parsons ES has observed localized groundwater depression which aids in the movement of oxygen and enhances biodegradation of fuel residuals near the water table.

If significant mobile LNAPL is encountered, and if analysis reveals that the LNAPL constitutes a significant BTEX source, it is possible that additional product recovery will be required in the source area. To date, free product has only been detected as a sheen and oil beads at well AP26-MW75. During field work, Parsons ES will carefully examine the existing and proposed new wells to determine if free product exists on the groundwater at this site. Bail-down tests will be performed at any well containing more than one inch of free product to determine the rate of free product recovery that may be feasible at this site.

3.8 FIELD AND LABORATORY QA/QC SAMPLES

As a check on the quality of field sampling activities (sampling, packaging, shipment, and handling) quality assurance/quality control (QA/QC) samples will be collected and analyzed. These samples will include trip blanks, field blanks, equipment rinseate samples, and field duplicates/replicates. QA/QC sampling for soil and groundwater will include replicates/duplicates at a frequency of 10 percent, rinseate samples (soil sampling only) at a frequency of 10 percent, one field blank, and a trip blank for each individual shipping cooler sent to the analytical laboratory containing samples for VOA analysis. A rinseate sample will not be collected during groundwater sampling because dedicated sampling equipment will be used. For soil gas, only a duplicate sample will be collected. The procedures for the collection of field QA/QC samples are discussed in Section 5 of the SAP (Appendix A). Laboratory QA/QC samples also are described in the SAP, and will include one matrix spike analysis, one laboratory control sample, and one laboratory blank sample test for each specific analysis requested.

SECTION 4

DATA ANALYSIS, MODELING, AND REPORT PREPARATION

4.1 DATA ANALYSIS

Data analysis for Site SS-15A will consist of the following elements:

- 1) Analyzing the nature, magnitude, and extent of contamination in each sampled matrix by plotting analytical data for selected contaminants on site maps;
- 2) Assessing if contaminant mass has been decreasing over time due to natural attenuation;
- 3) Using available contaminant data to estimate a site-specific biodegradation rate for selected dissolved contaminants;
- 4) Using available soil and groundwater geochemical data to assess if conditions are sufficient to support continued natural degradation of dissolved contaminants, and to compute an expressed assimilative capacity for the aquifer;
- 5) Finalizing the characterization of contaminant source areas, site-specific exposure pathways, land use, and potential receptors;
- 6) Performing a generic (Tier 1) screening against NFA criteria to identify chemicals of potential concern; and
- 7) Performing a site-specific (Tier 2) screening to establish alternative site-specific cleanup levels that are still health-protective based on data and assumptions about the likelihood and nature of exposure at the site.

Data analysis steps 1 through 3 are self-explanatory. Steps 4 through 7 are described in the following subsections.

4.1.1 Step 4 - Geochemical Data Analysis and Assimilative Capacity Calculation

Microorganisms obtain energy for cell production and maintenance by catalyzing the transfer of electrons from electron donors to electron acceptors. This transfer results in the oxidation of the electron donor and the reduction of the electron acceptor. Electron donors at the site are natural organic carbon and fuel hydrocarbon compounds. Fuel hydrocarbons are completely degraded or detoxified if they are used as the primary electron donor for microbial metabolism (Bouwer, 1992). Electron acceptors are elements or compounds that occur in relatively oxidized states, and typically can

include oxygen, nitrate, ferric iron, sulfate, and carbon dioxide. Microorganisms preferentially use electron acceptors while metabolizing fuel hydrocarbons (Bouwer, 1992). Dissolved oxygen (DO) is used first as the prime electron acceptor. After the DO is consumed, anaerobic microorganisms typically use electron acceptors (as available) in the following order of preference: nitrate, ferric iron hydroxide, sulfate, and finally, carbon dioxide. Because the biodegradation of fuel hydrocarbons should deplete the concentrations of these electron acceptors, analysis of spatial variations in electron acceptor concentrations can provide evidence of biodegradation, and the degree to which it is occurring.

Also during anaerobic biodegradation, there is an increase in the concentrations of metabolic byproducts derived from the microbial degradation of fuel hydrocarbons. Metabolic byproducts include ferrous iron produced during iron reduction, and methane produced during methanogenesis, which uses carbon dioxide as the electron acceptor. Therefore, analysis of spatial variations in concentrations of these byproducts can provide additional evidence of biodegradation.

The amount of contaminant mass that can be biodegraded will be calculated to assess the full potential for long-term remediation by natural attenuation (RNA) to attain site-specific cleanup goals. Mass-balance relationships will be used to determine how much contaminant mass can be degraded by each of the redox reactions used by microorganisms to obtain free energy for cell maintenance and production. The stoichiometric relationship between the contaminant and the electron acceptor will be used to estimate the expressed assimilative capacity of the groundwater. The assimilative capacity is a measure of the amount of contaminant mass that theoretically can be assimilated or oxidized by available electron acceptors. This analysis, when coupled with the biodegradation rate mentioned in step 3, provides the basis for determining the potential for continued COPC mass reduction in saturated media at the site.

4.1.2 Step 5 - Characterizing Contaminant Sources, Land Use, Exposure Pathways, and Potential Receptors

Contaminant sources, land use, exposure pathways, and potential receptors were preliminarily characterized in Section 2.5 on the basis of currently available data. Additional data collected during the field program for this risk-based project will be used to refine the characterization of these risk elements as appropriate.

4.1.3 Step 6 - Screening Against No-Further-Action Criteria

As an initial step in determining the necessity for remedial action, representative concentrations of site contaminants will be compared to the NFA Without Conditions target cleanup levels for soil and groundwater presented in Tables IV and V of the final draft *Petroleum Contamination Site Cleanup Criteria* (FDEP, 1997). Contaminant soil concentrations must be below the levels presented in the Direct Exposure Table I and the leachability target levels presented in Table IV (based on applicable groundwater criteria specified in 62-770.680 (1)(c), FAC). Concentrations of chemicals of concern in groundwater must be below background concentrations or less than levels presented in Table V. If the groundwater is impacting, or may impact, surface water, the levels presented in Table VI also will apply.

If representative concentrations of petroleum contaminants exceed the NFA Without Conditions target levels, the concentrations will then be compared to the NFA With Conditions target cleanup levels presented in the rule. Contaminant soil concentrations must be less than the direct exposure levels presented in Table II and the leachability target levels presented in Table IV (based on applicable groundwater criteria, as specified in 62-770.680 (1)(c), FAC). Concentrations of chemicals of concern in groundwater also will be compared to the same criteria applicable to a No Further Action proposal.

As a preliminary assessment of the significance of site contamination, and to better focus work plan activities on chemicals and areas which may be the most important contributors to potential risk, the results of previous soil and groundwater analyses have been compared to the target cleanup levels applicable to both NFA scenarios. Site analyte concentrations below the health-protective NFA target levels are not considered to be a threat to human health and the environment, and therefore are not retained for further risk/remedial analysis.

Maximum contaminant detections in soil samples collected during installation of groundwater monitoring wells as part of the CAR (OHM, 1995a), and maximum detections from the 1996 and first quarter 1997 groundwater monitoring were compared to target cleanup levels. This information is presented in Tables 4.1 and 4.2. Sampling locations corresponding to the maximum analytical results also are noted on the tables.

Several of the BTEX detections exceed the leachability criteria, although they do not exceed the direct exposure levels. Several PAHs exceeded the Direct Exposure I and II and leachability levels. Direct Exposure I and II levels are for NFA With and Without Conditions, respectively. In addition, naphthalene and TRPH were detected above the leachability criteria, and TRPH were detected above the Direct Exposure I and II levels.

Detected concentrations of benzene, MTBE, several PAHs, naphthalene, TRPH, trichlorofluoromethane, trichloroethene (TCE) and vinyl chloride (VC) in groundwater exceeded applicable NFA cleanup target levels. Groundwater concentrations also were compared to the Natural Attenuation Default Source concentrations from Table IX. Maximum detected levels of TRPH, naphthalene, and benzo(a)anthracene exceeded the default levels.

4.1.4 Step 7 - Development of Alternative Cleanup Levels

For those contaminants exceeding Target Cleanup Levels for NFA (With or Without Conditions), alternative cleanup standards for soil and/or groundwater contaminated with petroleum products may be developed based on a site-specific risk assessment. Development of alternative standards for those chemicals which are already below the more stringent levels provided in the rule should not be necessary.

The risk assessment will include a site-specific exposure assessment, which may include:

- Chemical concentrations in all contaminated media;

TABLE 4.1
COMPARISON OF MAXIMUM SITE SOIL CONCENTRATIONS
TO TARGET CLEANUP LEVELS
RISK-BASED APPROACH TO REMEDIATION
SITE SS-15A
HOMESTEAD ARB, FLORIDA

Chemical Name	Maximum Concentration Detected (mg/kg) ^{a/}	Location of Maximum Detection	Direct Exposure ^{b/}		Leachability (mg/kg)
			I (mg/kg)	II (mg/kg)	
Benzene	ND	—	1.1	1.50	0.007
Toluene	170	AP29-SB6	300	2,000	0.4
Ethylbenzene	39	AP18-SB1	240	240	0.4
Xylenes	110	AP18-SB1	290	290	0.3
VOAs	176	AP18-SB1	—	—	—
MTBE	ND	—	350	6,100	0.2
Acenaphthene	8.1	AP20-SB6	2,300	22,000	4
Acenaphthylene	9.3		1,100	11,000	22
Benzo(a)pyrene	16	AP20-SB6	0.1	0.50	7.8
Benzo (g,h,i)perylene	9		2,300	45,000	13,000
Benzo(b)fluoranthene/Benzo(k)fluoranthene	37	AP20-SB6	1.4	5.00	9.8
Chrysene/Benzo(a)anthracene	65	AP20-SB6	1.4	5.10	2.9
Fluoranthene	85		2,800	45,000	550
Fluorene	13		2,100	24,000	87
Indeno(1,2,3-cd)pyrene/Dibenzo(a,h)anthracene	18	AP20-SB6	0.1	0.50	14
Phenanthrene/Anthracene	120	AP20-SB6	1,900	29,000	120
Pyrene	64		2,200	40,000	570
Total PAHs	436		—	—	—
Naphthalene	60	SP18-SB1	1,000	8,600	1
1-Methylnaphthalene	31		—	—	—
2-Methylnaphthalene	78		—	—	—
Total naphthalenes	169		—	—	—
TRPH	15,000	AP8-SB6	370	2,600	340
1,2-dibromoethane	ND		—	—	—
Lead	15		500	1,000	5 (TCLP)

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

VOAs = total benzene, toluene, ethylbenzene, and xylenes; MTBE = methyl tertbutyl ether; TRPH = total recoverable petroleum hydrocarbons; PAHs = polynuclear aromatic hydrocarbons; TCLP = toxicity characteristic leaching procedure.

a/ mg/kg = milligrams per kilogram.

b/ Direct Exposure I and II are for No Further Action Without or With Conditions, respectively.

TABLE 4.2
COMPARISON OF MAXIMUM SITE GROUNDWATER CONCENTRATIONS
TO TARGET CLEANUP LEVELS
RISK-BASED APPROACH TO REMEDIATION
SITE SS-15A
HOMESTEAD ARB, FLORIDA

Chemical Name	Maximum Concentration Detected ($\mu\text{g/L}$) ^{a/}	Location of Maximum Detection	Table V Target Cleanup Level ^{b/} ($\mu\text{g/L}$)	Table IX Natural Attenuation Source Default ^{c/} ($\mu\text{g/L}$)
Benzene	87	AP12-MW24	1	100
Toluene	8		1,000	400
Ethylbenzene	140		700	300
Xylenes	21		10,000	200
VOAs	169		--	--
MTBE	63	AP23-MW67	35	350
Acenaphthene	130	AP26-MW75	20	200
Acenaphthylene	46		210	2,100
Anthracene	20		2,100	21,000
Benzo (g,h,i)perylene	18		210	2,100
Benzo(a)anthracene	38	AP26-MW75	0.2	20
Benzo(a)pyrene	19	AP26-MW75	0.2	20
Benzo(k)fluoranthene	12	AP26-MW75	0.5	50
Chrysene	48	AP26-MW75	5	500
Fluoranthene	100		280	2,800
Indeno(1,2,3-cd)pyrene	8	AP26-MW75	0.2	20
Fluorene	40		280	2,800
Phenanthrene	100		210	2,100
Pyrene	61		210	2,100
Total PAHs	571		--	--
Naphthalene	400	AP23-MW67	20	200
1-Methylnaphthalene	560		--	--
2-Methylnaphthalene	640		--	--
Total naphthalenes	1,500		--	--
TRPH (mg/L) ^{d/}	76	AP11-MW14	5	50
trans-1,2-dichloroethylene	9		100	--
cis-1,2-dichloroethylene	19		70	--
Trichloroethene	5	AP16-MW27, AP17-MW109	3	--
Trichlorofluoromethane	9	AP21-MW54	3	--
Vinyl chloride	4	AP17-MW40	1	--

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

VOAs = total benzene, toluene, ethylbenzene, and xylenes; MTBE = methyl tertbutyl ether; TRPH = total recoverable petroleum hydrocarbons; PAHs = polynuclear aromatic hydrocarbons.

a/ $\mu\text{g/L}$ = micrograms per liter.

b/ Cleanup level for No Further Action With or Without Conditions.

c/ Allowable maximum concentration for remediation by natural attenuation with monitoring

d/ mg/L = milligrams per liter.

- Exposure factors (i.e., exposure duration and frequency);
- Soil properties;
- Potential exposure pathways and routes;
- Current or potential future exposed populations; and
- Expected contaminant concentrations to which actual or potential receptors may be exposed.

In establishing alternative cleanup target levels, the following factors will be used, as appropriate:

- Calculations using a lifetime cancer risk level of 1.0×10^{-6} ;
- A hazard index of 1 or less;
- Best achievable detection limits;
- Naturally occurring background concentrations; and
- Nuisance, organoleptic, or aesthetic considerations.

Fate and transport models for selected chemicals of concern may be used as evidence that human health and environmental risks from alternative cleanup target levels are acceptable. These alternative cleanup target levels will be used as goals for site remediation as needed, and for eventual closure under an NFA With Conditions proposal. The benefits of using natural attenuation to achieve alternative cleanup levels will be compared to the benefits of using engineered source reduction to speed the natural attenuation process. The recommended remediation alternative will be selected based on the best combination of timely risk reduction and cost-effectiveness.

4.2 MODELING

The types of models that will be used to support the risk-based analyses, and the modeling objectives, are described in this subsection.

4.2.1 Groundwater Modeling

Analytical models are relatively inexpensive to construct and use, and can provide useful approximations of solute fate and transport in simple, uniform hydrogeologic settings. Analytical models can be used to:

- Estimate the migration distance of contaminants at a site over time;
- Predict exposure-point concentrations over time at varying distances from the source; and

- Assess if use of RNA is feasible to attain site-specific or generic numeric standards.

If contaminant concentrations exceed site-specific standards, then an analytical groundwater model such as Bioscreen® (Newell *et al.*, 1996) that incorporates site-specific data (e.g., groundwater velocity, contaminant decay rate, and retardation coefficient) will be used. The modeling will estimate the distance that selected dissolved COCs will migrate from the source area, and whether the contaminant concentrations will decrease to below site-specific standards within a reasonable timeframe before any receptor pathways are completed. The desirability of low-cost source reduction techniques, such as bioventing, to supplement the beneficial effects of natural attenuation also will be evaluated during the modeling process, as appropriate.

4.2.2 Inhalation Modeling

If the generic and site-specific screening activities described in Sections 4.1.3 and 4.1.4 indicate that contaminant concentrations in soil gas are of potential concern, then several chemical flux and atmospheric transport equations will be coupled to simulate the concentrations of volatile COCs in outdoor ambient air under normal atmospheric conditions, the concentrations of volatile COCs to which future construction workers would potentially be exposed during construction (excavation) activities, and the concentrations of volatile COCs potentially accumulating within future onsite buildings. The ultimate objective of this modeling is to determine if subsurface sources (i.e., contaminated soils and dissolved contamination) could cause exposure-point concentrations in either outdoor or indoor air that may pose an unacceptable risk to potential onsite receptors via the inhalation exposure route. Most of the equations are based on the predictive contaminant migration equations presented by ASTM (1995) in the *Standard Guide for Risk-based Corrective Action Applied at Petroleum Release Sites*. Other models that may be used are the Farmer Model (USEPA, 1992b) and the indoor air dispersion model (Michelson *et al.*, 1993).

4.3 REPORT PREPARATION

Using all available site characterization data, the risks posed by site contamination will be evaluated and a corrective action plan (CAP) will be prepared. The CAP will summarize all pertinent site characterization information and the results of the risk-based analyses described earlier in this work plan, including fate and transport modeling results. The CAP will either recommend NFA (with or without conditions) or an appropriate remedial action [e.g., RNA with long-term monitoring (LTM) or RNA/LTM combined with engineered source removal]. Each remedial alternative will be carefully compared using protectiveness, implementability, and cost as the primary evaluation criteria. The closure report will be structured to emphasize the results of field investigations, risk analyses, and remedial alternatives evaluation. Figure 4.1 presents an example closure report outline.

FIGURE 4.1
EXAMPLE REPORT OUTLINE
RISK-BASED APPROACH TO REMEDIATION
HOMESTEAD ARB, FLORIDA

EXECUTIVE SUMMARY

- 1.0 Introduction
 - 1.1 Purpose and Scope
 - 1.2 Site Background
 - 1.3 Report Organization
 - 2.0 Site Description
 - 2.1 Physical Setting
 - 2.2 Nature and Extent of Contamination
 - 2.2.1 Previous Investigations
 - 2.2.2 Recent Data
 - 2.2.3 Contaminants Exceeding No Further Action Criteria
 - 2.3 Indicator Analyte Data
 - 2.4 Discussion of Evidence of Intrinsic Remediation
 - 3.0 Evaluation Methods and Criteria
 - 3.1 Remedial Action Objectives
 - 3.2 Potential Exposure Pathways for Human/Ecological Receptors
 - 3.3 Site-Specific Fate and Transport Models
 - 3.4 Achieving No Further Action Criteria
 - 3.5 Site-Specific Cleanup Goals
 - 3.6 Review of Evaluation Criteria
 - 3.6.1 Protectiveness
 - 3.6.2 Implementability
 - 3.6.3 Cost
 - 4.0 General Description of Potential Remedial Alternatives (Examples)
 - 4.1 Alternative 1: Natural Attenuation/Long-Term Monitoring
 - 4.2 Alternative 2: Bioventing to Remove Soil Source(s)/Natural Attenuation/Long-Term Monitoring
 - 4.3 Alternative 3: Remove Free Product/Natural Attenuation
 - 4.4 Alternative 4: Soil Vapor Extraction/Groundwater Pump and Treat
 - 5.0 Comparative Analysis of Remedial Alternatives
 - 5.1 Protectiveness
 - 5.2 Implementability
 - 5.2.1 Technical
 - 5.2.2 Administrative
 - 5.3 Cost
 - 5.3.1 Capital Costs
 - 5.3.2 Operating Costs
 - 5.3.3 Present Worth Cost
 - 6.0 Recommended Remedial Alternative
 - 7.0 References
- Appendix A: Data Evaluation for Risk Analysis
Appendix B: Development of Site-Specific Cleanup Goals
Appendix C: Quantitative Exposure Assessment Data (Model Simulations)

SECTION 5

SCHEDULE

<u>Event</u>	<u>Date</u>
Submit Draft Work Plan to Homestead ARB and AFCEE	September 10, 1997
Receipt of Homestead ARB and AFCEE Comments	September 26, 1997
Submit Final Work Plan to Homestead ARB and AFCEE (If required)	October 10, 1997
Begin Field Work	October 20, 1997
Meeting with FDEP and Homestead ARB to Discuss Exposure Scenarios	November 1997
Submit Preliminary Results to Homestead ARB and AFCEE	December 19, 1997
Meeting With FDEP and AFCEE to Discuss Preliminary Results	January 13, 1998
Submit Draft CAP to Homestead ARB and AFCEE	March 13, 1998
Receipt of Homestead ARB and AFCEE Comments	April 10, 1998
Submit Draft Final CAP to Homestead ARB, AFCEE, FDEP, and DERM	May 1, 1998

SECTION 6

REFERENCES

- Bouwer, E.J., 1992. Bioremediation of Subsurface Contaminants, In R. Mitchell, editor, Environmental Microbiology, Wiley-Liss, New York, New York.
- Florida Administrative Code, Chapter 62-770. 1977. *Petroleum Contamination Site Cleanup Criteria*. June 19.
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- Hichee, R.E., Ong, S.K., Miller, R.N., Downey, D.C., and R. Frandt. 1992. *Test Plan and Technical Protocol for a Field Treatability Test for Bioventing*. January.
- Michelson, K.D, D.L Kringel, G.L. Ginsberg, and W.H. Koch. 1993. Comparative analysis of two models to estimate vapor intrusion through a building foundation and associated cancer risks. Air & Waste Management Association, Denver, CO. June 13.
- Newell, C.J., McLeod, R.K., and Gonzales, J.R. 1996. BIOSCREEN Natural Attenuation Decision Support System User's Manual, Version 1.3. June.
- Parsons ES. 1997. Final Remedial Action Plan for Homestead Air Force Base, Site SS-15B.
- OHM Remediation Services Corp. 1995. *Contamination Assessment Report, Flightline Pumphouse and Apron Building No. 840 to Building No. 890, Homestead Air Reserve Base, Dade County, Florida*. Prepared for U.S. Corps of Engineers, Homestead Area Office.
- OHM Remediation Services Corp. 1995a. *Site SS-15A, Flightline Apron, First Quarter (Annual) Monitoring Only Report, Homestead Air Reserve Base, Dade County, Florida*. Prepared for U.S. Air Force Center for Environmental Excellence, Base Closure Restoration Division (ERB).
- OHM Remediation Services Corp. 1996a. *Site SS-15A, Flightline Apron, Second Quarter (Annual) Monitoring Only Report, Homestead Air Reserve Base, Dade*

County, Florida. Prepared for U.S. Air Force Center for Environmental Excellence, Base Closure Restoration Division (ERB).

OHM Remediation Services Corp. 1996b. *Site SS-15A, Flightline Apron, Third Quarter (Annual) Monitoring Only Report, Homestead Air Reserve Base, Dade County, Florida.* Prepared for U.S. Air Force Center for Environmental Excellence, Base Closure Restoration Division (ERB).

OHM Remediation Services Corp. 1996c. *Site SS-15A, Flightline Apron, Fourth Quarter (Annual) Monitoring Only Report, Homestead Air Reserve Base, Dade County, Florida.* Prepared for U.S. Air Force Center for Environmental Excellence, Base Closure Restoration Division (ERB).

OHM Remediation Services Corp. 1997. *Site SS-15A, Flightline Apron, Year Two First Quarter Monitoring Only Report, Homestead Air Reserve Base, Dade County, Florida.* Prepared for U.S. Air Force Center for Environmental Excellence, Base Closure Restoration Division (ERB).

USEPA. 1992, *Guidelines for Exposure Assessment*; Notice, Federal Register, Vol. 57, No. 104 (Friday, May 29, 1992).

APPENDIX A
EMERGENCY CONTACTS

APPENDIX A

EMERGENCY CONTACTS

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

Contingency Contacts

Telephone Number

Nearest phone located at the work site

Site Fire Department

Site Contact

Site Medical Services

Site Emergency Telephone Number

Site Security/Police

Medical Emergency

Hospital Name

Hospital Address

Hospital Telephone Number

Ambulance Service

Airlift Helicopter

Directions and/or Map to the Hospital

Parsons ES Contacts

Doug Downey
Project Manager

303-831-8100
303-670-0512

John Hicks
Site Manager

(303) 831-8100 (work)
(303) 270-3181 (home)

Timothy Mustard, CIH (Denver)
Program Health and Safety Manager

(303) 831-8100 (work)
(303) 450-9778 (home)

Edward Grunwald, CIH (Atlanta)
Corporate Health and Safety Manager

(404) 235-2300 (work)
(404) 299-9970 (home)

Judy Blakemore (Denver)
Assistant Program Health and Safety Manager

(303) 831-8100 (work)
(303) 828-4028 (home)
(303) 817-9743 (mobile)

APPENDIX B
PROJECT HEALTH AND SAFETY FORMS

PLAN ACCEPTANCE FORM

PROJECT HEALTH AND SAFETY PLAN

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

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

Signed

Date

RETURN TO:

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

PARSONS ENGINEERING SCIENCE, INC.

FIELD EXPERIENCE

DOCUMENTATION FORM

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

Employee Name: _____

Employee Number (or Social Security No.): _____

Project Name(s): _____

Project Number(s): _____

Dates of Field Training: _____

Summary of Activities Performed: _____

Levels of Respiratory Protection Used: _____

Comments:

Field Supervisor Signature: _____

Date: _____

Return this form to the Office Health and Safety Representative

LOG

DATES OF INVESTIGATION:

[illegible]

APR Performance Comments:

Project H&S Officer
or
Parsons ES Project Manager

Date _____

022/722426/7.WW6

15. ES WITNESS TO
ACCIDENT

(Name)

(Affiliation)

(Phone No.)

(Name)

(Affiliation)

(Phone No.)

(Name)

(Affiliation)

(Phone No.)

OCCUPATIONAL INJURY OR OCCUPATIONAL ILLNESS

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

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

18. Date of injury or initial diagnosis of occupational illness:

(date)

19. Did the accident result in employee fatality?

Yes ()

No ()

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

OTHER

21. Name and address of physician:

(No. and Street)

(City or Town)

(State and Zip)

22. If hospitalized, name and address:

(No. and Street)

(City or Town)

(State and Zip)

Date of report: _____

Prepared by: _____

Official position: _____

SUPPLIED AIR RESPIRATOR
(SAR)

LOG

SITE:

LOCATION:

DATES OF INVESTIGATION:

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

SAR Performance Comments:

Project H&S Officer
or
Parsons ES Project Manager

Date

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

**PARSONS ENGINEERING SCIENCE
SHIPPING PAPER**

Page 1 of _____ Parsons Engineering Science Shipping Paper No.: _____
(name of carrier) Date: _____

Consignee:		Phone:		Shipper:		Phone:	
Street:				Street:			
City:		State:		Zip:		City:	
State:		Zip:		State:		Zip:	
Route						Vehicle License	
No. of Units and Packaging Type		HM		Basic Description (proper shipping name, hazard class, subsidiary risk, identification No. [UN], and packaging group)			Total Quantity (weight, volume, etc.)

PLACARDS TENDERED: yes ☐ no ☐

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

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

ATTACH MATERIAL SAFETY DATA SHEETS

PROJECT NAME _____

PROJECT NUMBER: _____

[illegible]

Explosimeter

Other

Model_____	Model_____	Model_____
Serial #_____	Serial #_____	Serial #_____
Cal. * Gas_____	Cal Gas_____	Cal Gas_____
Cal. Reading_____	Cal. Reading_____	Cal. Reading_____
BG Reading_____	BG Reading_____	BG Reading_____

*** Cal = Calibration**

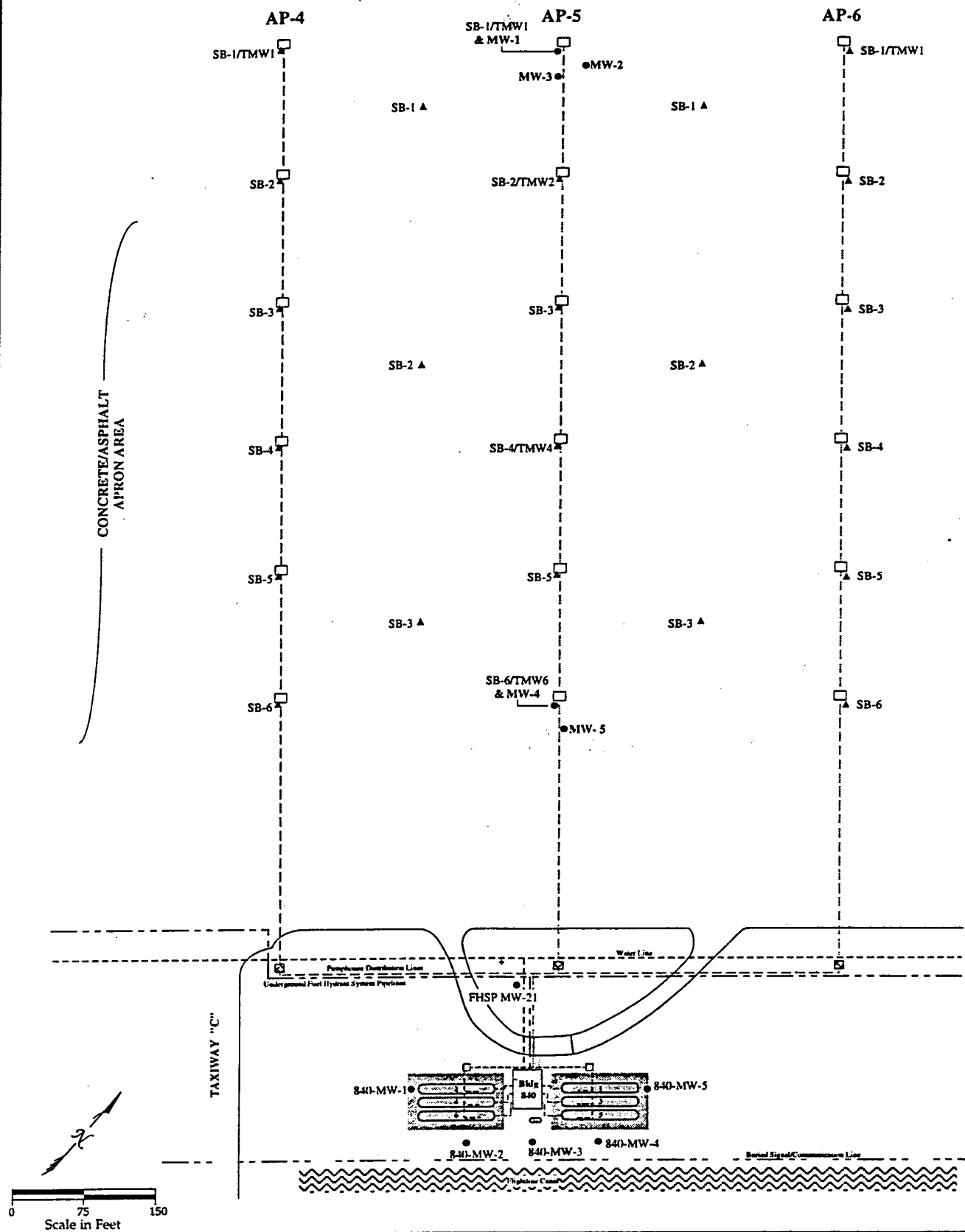
****BG = Background**

APPENDIX A

SAMPLING AND ANALYSIS PLAN

SOIL BORING AND MONITORING WELL LOCATIONS

APRON LINES AP-4 THROUGH AP-29



OHM
Remediation
Services Corp.

LEGEND



Former Asphalt and
Earthen Embankment



Former Steel UST

+ Water Hydrant

Soil Boring &
Temporary Monitoring
Well (where indicated)

• Monitoring Well



Re/Defueling
Valve Box

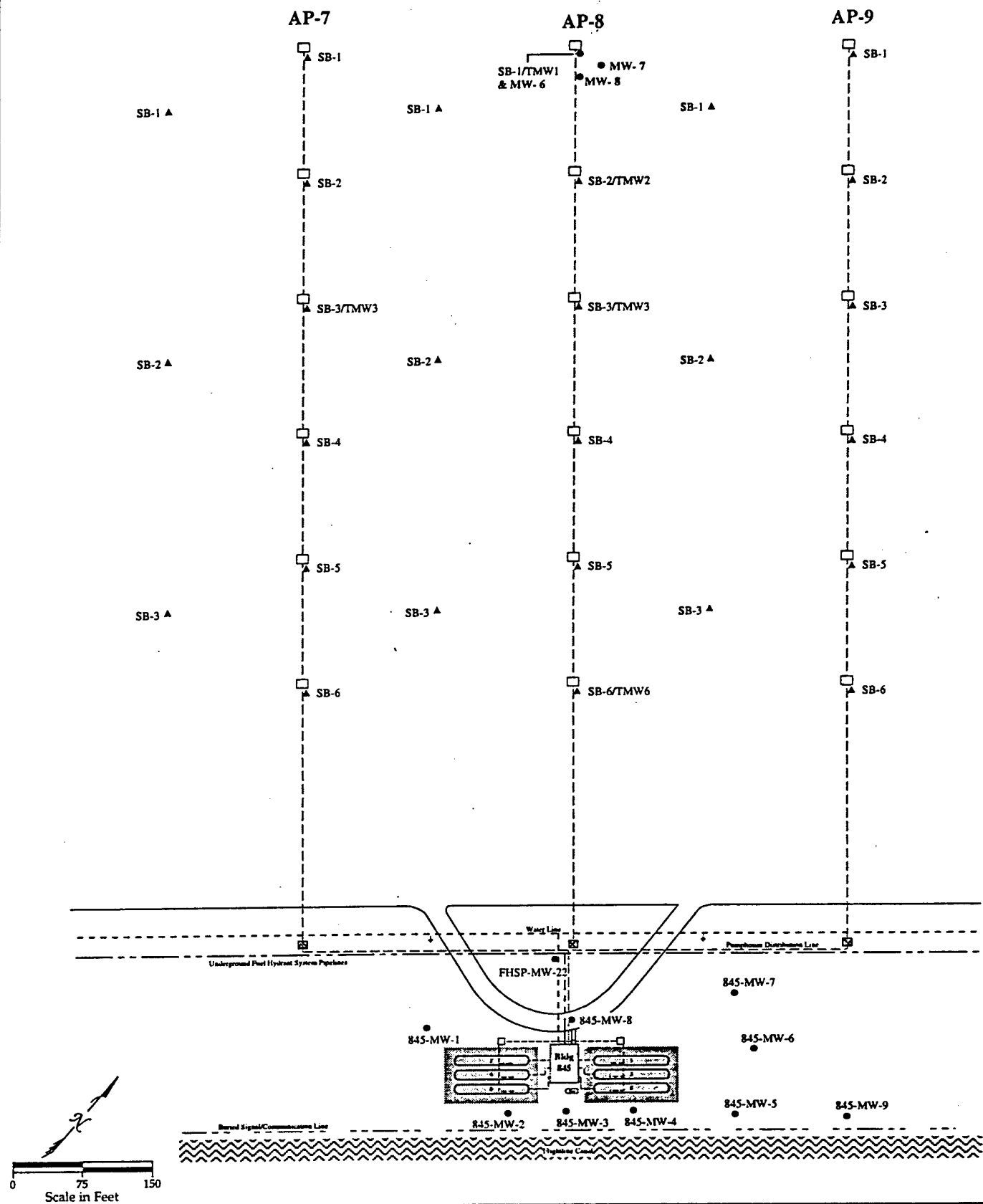


Apron Line
Valve Box

FIGURE 8.2b
SOIL BORING AND MONITORING WELL
LOCATION PLAN
APRON LINES AP-4, 5 & 6 (BLDG. NO. 840)

PROJECT NO. 15170
U. S. ARMY CORPS OF ENGINEERS
HOMESTEAD AIR RESERVE BASE
HOMESTEAD, FLORIDA

Date: 1/28/95 | Drawn by: KGH | Scale: As Shown



OHM
Remediation
Services Corp.

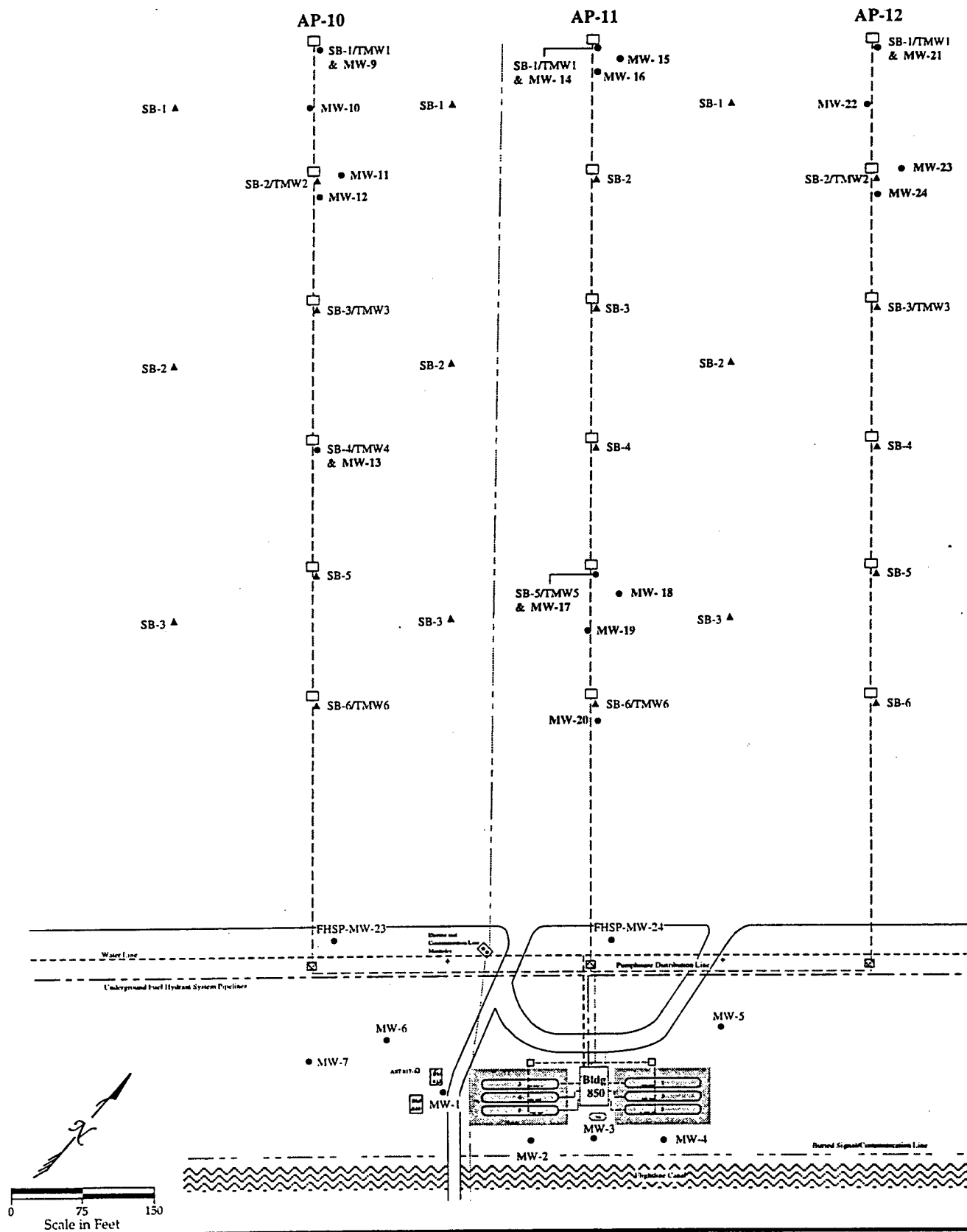
LEGEND

- | | | |
|---------------------------------------|---|------------------------|
| Former Asphalt and Earthen Embankment | Water Hydrant | Re/Defueling Valve Box |
| Former Steel UST | Soil Boring & Temporary Monitoring Well (where indicated) | Apron Line Valve Box |
| | Monitoring Well | |

FIGURE 9.2b
SOIL BORING AND MONITORING WELL
LOCATION PLAN
APRON LINES AP-7, 8 & 9 (BLDG. NO. 845)

PROJECT NO. 15170
U. S. ARMY CORPS OF ENGINEERS
HOMESTEAD AIR RESERVE BASE
HOMESTEAD, FLORIDA

Date: 1/28/95 | Drawn by: KGH | Scale: As Shown



OHM
Remediation
Services Corp.

LEGEND

Former Asphalt and
Earthen Embankment

Former Steel UST

• Water Hydrant

Soil Boring &
▲ Temporary Monitoring
Well (where indicated)

• Monitoring Well

□ Re/Defueling
Valve Box

□ Apron Line
Valve Box

FIGURE 10.2b
SOIL BORING AND MONITORING WELL
LOCATION PLAN
APRON LINES AP-10, 11 & 12 (BLDG. NO. 850)

PROJECT NO. 15170
U. S. ARMY CORPS OF ENGINEERS
HOMESTEAD AIR RESERVE BASE
HOMESTEAD, FLORIDA

Date: 1/29/95 | Drawn by: KGH | Scale: As Shown

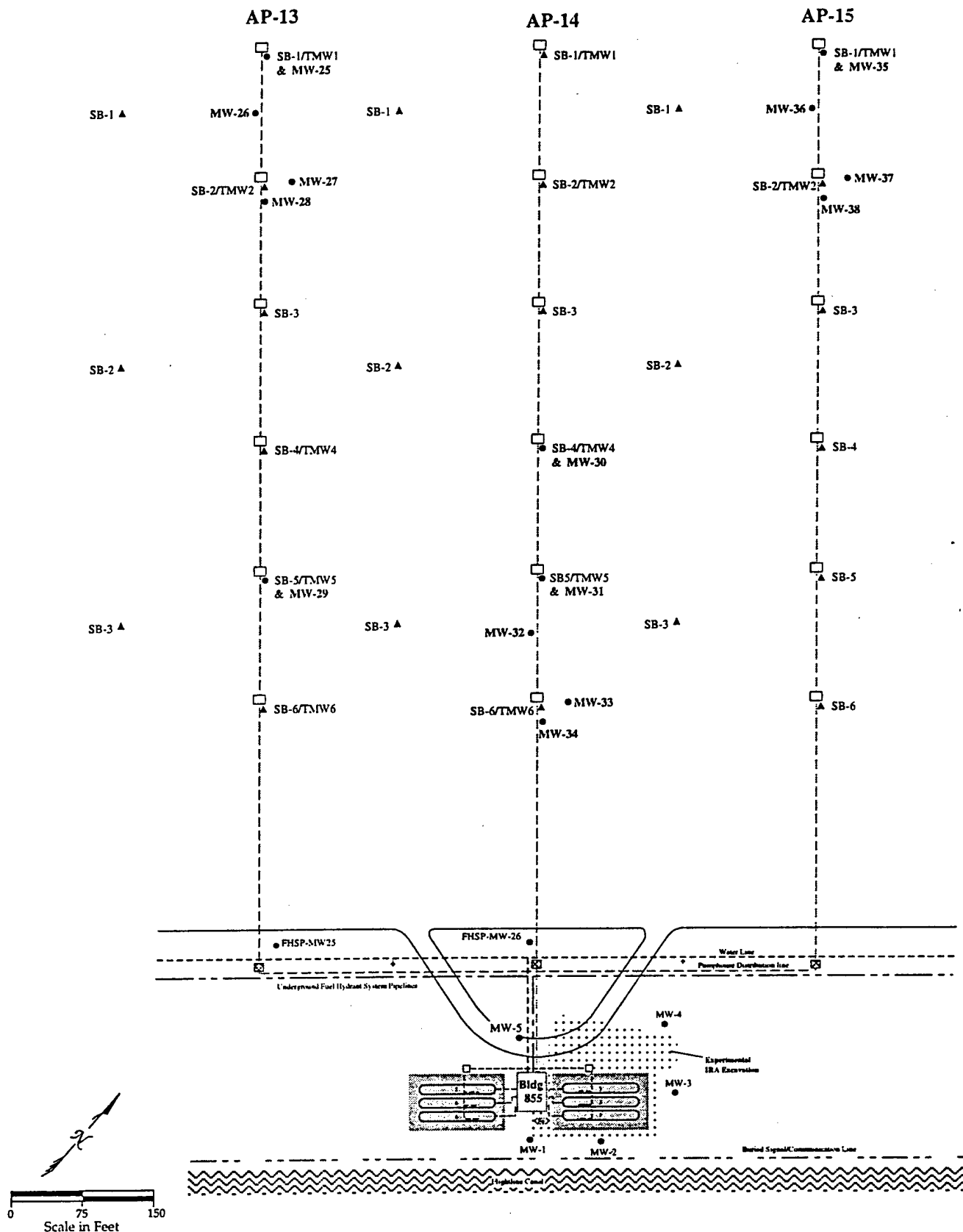


FIGURE 11.2b
SOIL BORING AND MONITORING WELL
LOCATION PLAN
APRON LINES AP-13, 14 & 15 (BLDG. NO. 855)
PROJECT NO. 15170
U. S. ARMY CORPS OF ENGINEERS
HOMESTEAD AIR RESERVE BASE
HOMESTEAD, FLORIDA
 Date: 2/3/95 | Drawn by: KGH | Scale: As Shown



OHM
 Remediation
 Services Corp.

LEGEND

- | | | |
|---------------------------------------|---|------------------------|
| Former Asphalt and Earthen Embankment | Soil Boring & Temporary Monitoring Well (where indicated) | Re/Defueling Valve Box |
| Former Steel UST | Monitoring Well | Apron Line Valve Box |

CONCRETE/ASPHALT
APRON AREA

AP-16

AP-17

SB-1 ▲

SB-1 ▲

SB-1

SB-1/TMW1
& MW-40

SB-2

SB-2

SB-3

SB-3

SB-2 ▲

SB-2 ▲

SB-4

SB-4

SB-5/TMW5
& MW-39

SB-5

SB-3 ▲

SB-3 ▲

SB-6/TMW6

SB-6

FHSP-MW-27

FHSP-MW-28

Water Line

Underground Fuel Hydrant System Pipeline

Petroleum Distribution Line

MW-5

MW-4

MW-2

MW-3

MW-1

Bldg 857

Dashed Signal/Communications Line

Hydrant Cover

0 75 150
Scale in Feet



OHM
Remediation
Services Corp.

LEGEND

Former Asphalt and
Earthen Embankment

Former Steel UST

Water Hydrant

Soil Boring &
Temporary Monitoring
Well (where indicated)

Monitoring Well

Re/Defueling
Valve Box

Apron Line
Valve Box

FIGURE 12.2b
SOIL BORING AND MONITORING WELL
LOCATION PLAN
APRON LINES AP-16 & 17 (BLDG. NO. 857)

PROJECT NO. 15170
U. S. ARMY CORPS OF ENGINEERS
HOMESTEAD AIR RESERVE BASE
HOMESTEAD, FLORIDA

Date: 1/30/95 | Drawn by: KGII | Scale: As Shown

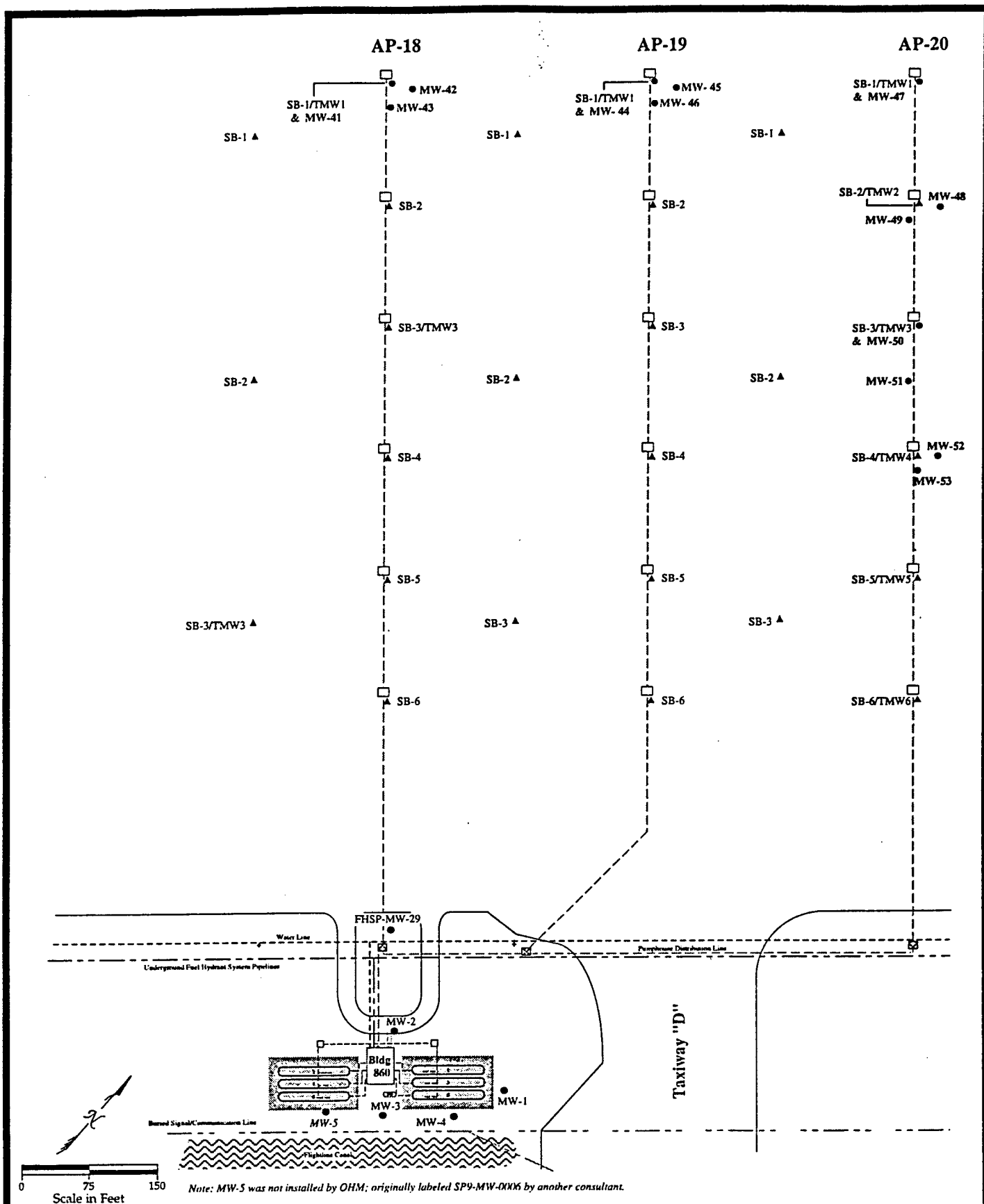


FIGURE 13.2b
SOIL BORING AND MONITORING WELL
LOCATION PLAN
APRON LINES AP-18, 19 & 20 (BLDG. NO. 860)
PROJECT NO. 15170
U. S. ARMY CORPS OF ENGINEERS
HOMESTEAD AIR RESERVE BASE
HOMESTEAD, FLORIDA

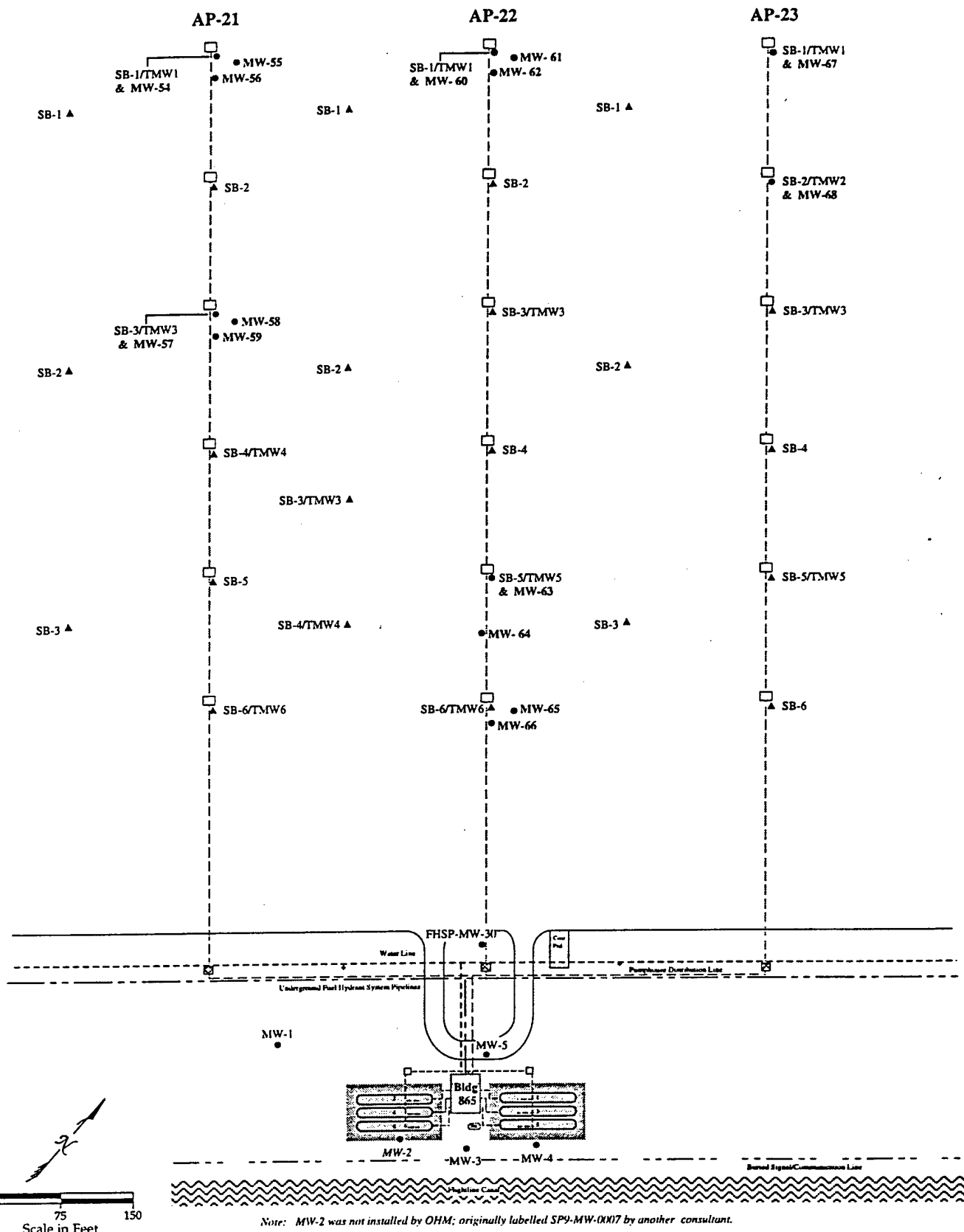
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OHM
Remediation
Services Corp.

LEGEND

- Former Asphalt and Earthen Embankment
- Former Steel UST
- Water Hydrant
- Soil Boring & Temporary Monitoring Well (where indicated)
- Monitoring Well
- Re/Defueling Valve Box
- Apron Line Valve Box



OHM
Remediation
Services Corp.

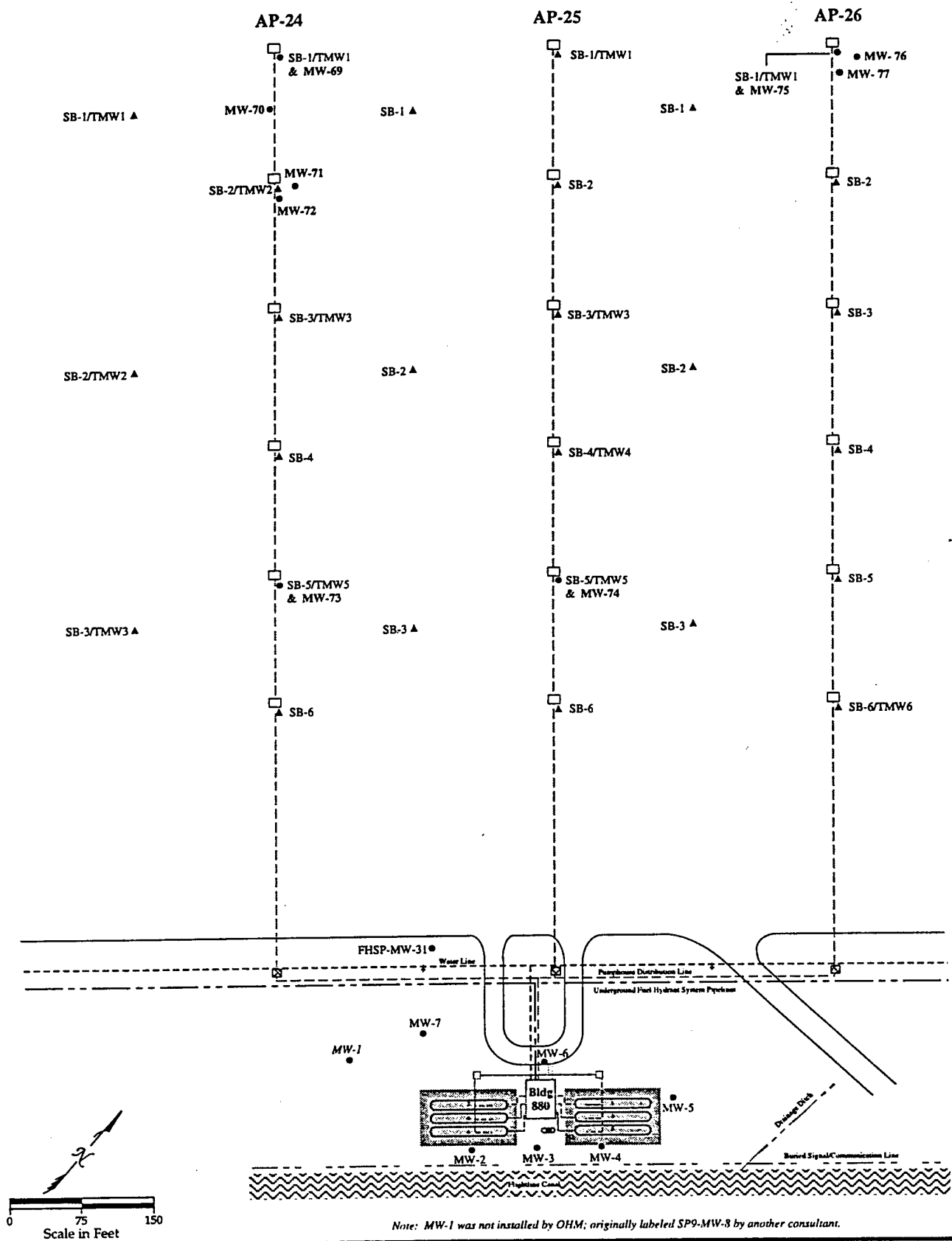
LEGEND

- | | | | | | | | |
|--|---------------------------------------|--|-----------------|--|---|--|------------------------|
| | Former Asphalt and Earthen Embankment | | Water Hydrant | | Soil Boring & Temporary Monitoring Well (where indicated) | | Re/Defueling Valve Box |
| | Former Steel UST | | Monitoring Well | | Apron Line Valve Box | | |

FIGURE 14.2b
SOIL BORING AND MONITORING WELL
LOCATION PLAN
APRON LINES AP-21, 22 & 23 (BLDG. NO. 865)

PROJECT NO. 15170
U. S. ARMY CORPS OF ENGINEERS
HOMESTEAD AIR RESERVE BASE
HOMESTEAD, FLORIDA

Date: 1/30/95 | Drawn by: KGH | Scale: As Shown



Note: MW-1 was not installed by OHM; originally labeled SP9-MW-8 by another consultant.



LEGEND

- | | | |
|---------------------------------------|---|------------------------|
| Former Asphalt and Earthen Embankment | Water Hydrant | Re/Defueling Valve Box |
| Former Steel UST | Soil Boring & Temporary Monitoring Well (where indicated) | Apron Line Valve Box |
| | Monitoring Well | |

FIGURE 15.2b
SOIL BORING AND MONITORING WELL
LOCATION PLAN
APRON LINES AP-24, 25 & 26 (BLDG. NO. 880)

PROJECT NO. 15170
U. S. ARMY CORPS OF ENGINEERS
HOMESTEAD AIR RESERVE BASE
HOMESTEAD, FLORIDA

Date: 1/31/95 | Drawn by: KGH | Scale: As Shown

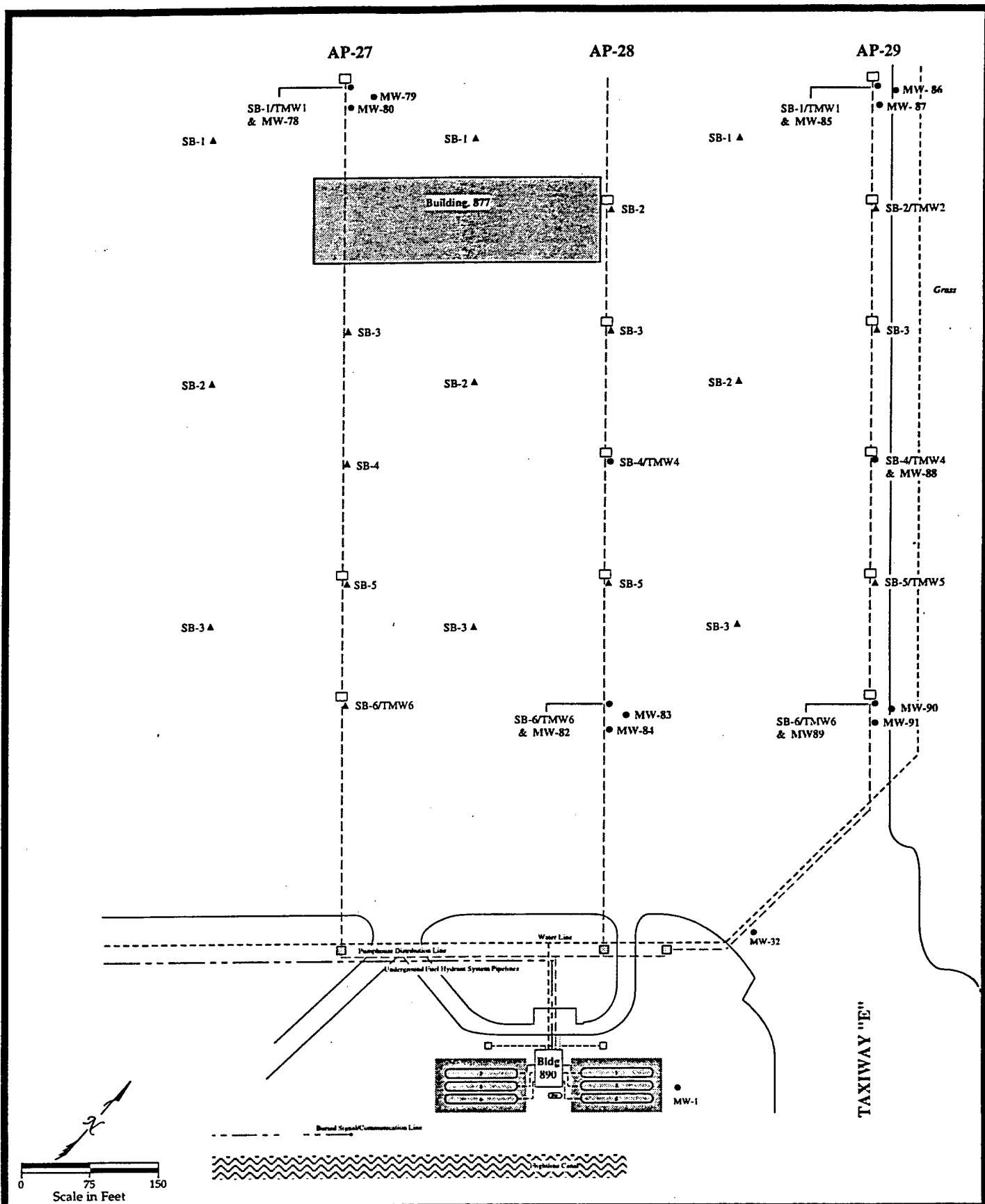


FIGURE 16.2b
SOIL BORING AND MONITORING WELL
LOCATION PLAN
APRON LINES AP-27, 28 & 29 (BLDG. NO. 890)

PROJECT NO. 15170
U. S. ARMY CORPS OF ENGINEERS
HOMESTEAD AIR RESERVE BASE
HOMESTEAD, FLORIDA

Date: 2/9/95 | Drawn by: KGH | Scale: As Shown

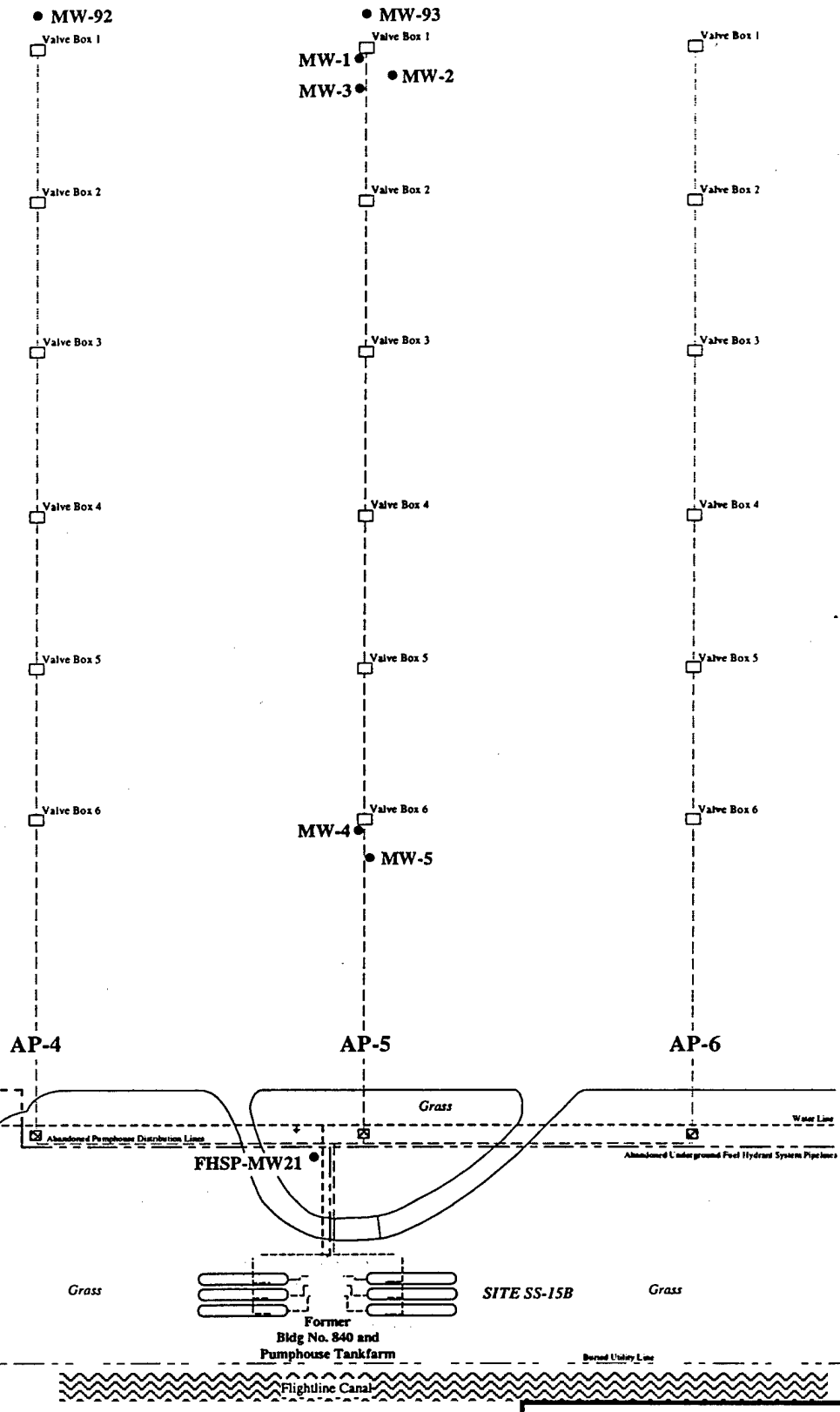


OHM
Remediation
Services Corp.

LEGEND

- Former Asphalt and Earthen Embankment
- Former Steel UST
- Water Hydrant
- Soil Boring & Temporary Monitoring Well (where indicated)
- Monitoring Well
- Re/Defueling Valve Box
- Apron Line Valve Box

CONCRETE/ASPHALT
APRON AREA
SITE SS-15A



Scale in Feet
0 75 150



OHM Remediation
Services Corp.

LEGEND

- Former Asphalt and Earthen Embankment for Pumphouse USTs
- Former 50,000 Gallon Pumphouse UST
- Water Hydrant
- Existing Shallow Monitoring Well
- Apron Line Re/Defueling Valve Box
- Former Apron Line Valve Box

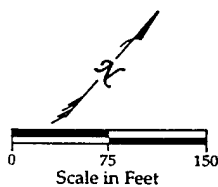
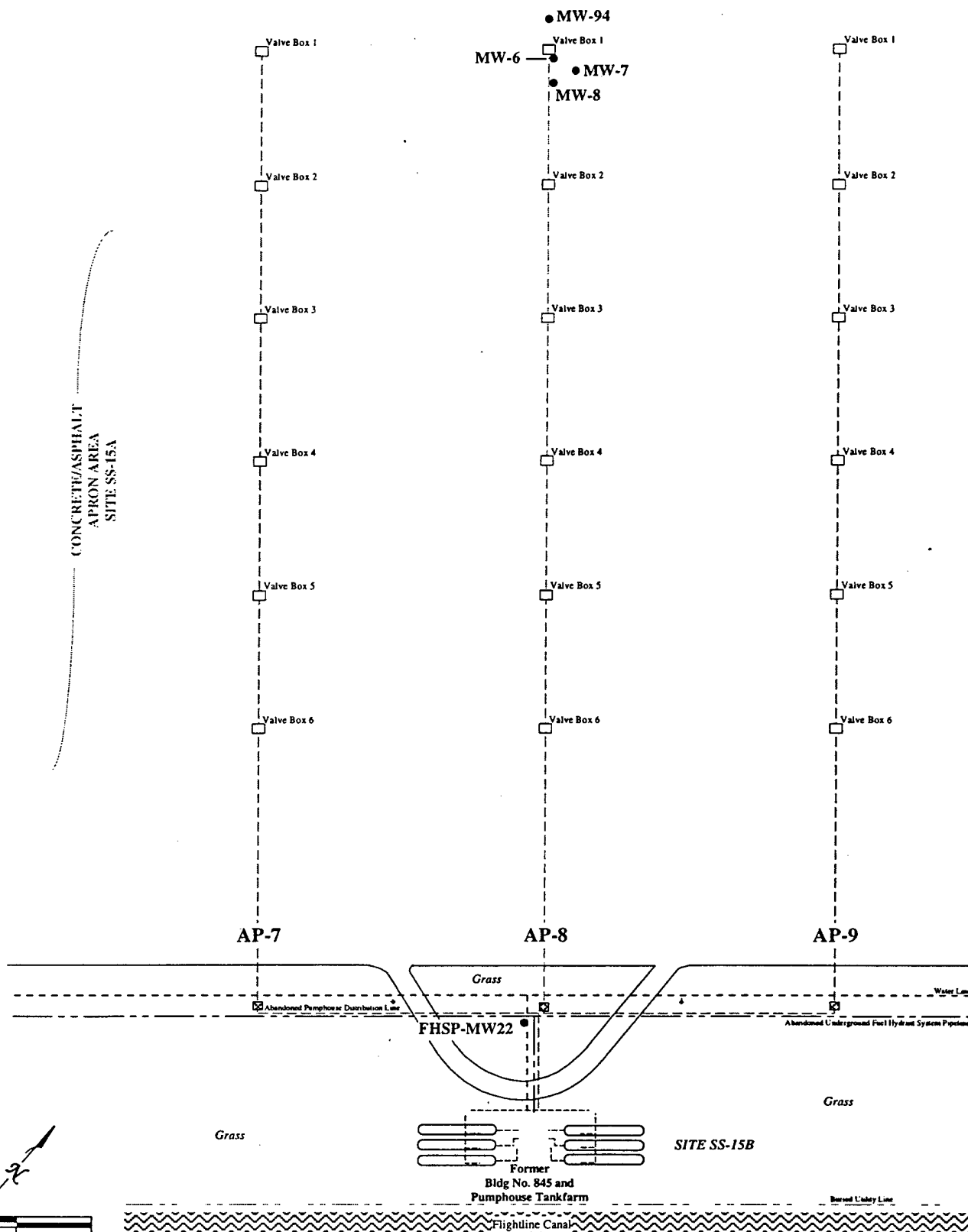
MOP: 2ND YEAR - 1ST QTR (DEC-96/MAR-97)

FIGURE 4.1.1
MONITORING WELL LOCATION DETAIL
SITE SS-15A, APRON LINES
AP-4, 5 & 6

AIR FORCE CENTER FOR
ENVIRONMENTAL EXCELLENCE (AFCEE)
HOMESTEAD AIR RESERVE BASE
HOMESTEAD, FLORIDA

Rev. 00 Date: 12-Jun-97 Drawn by: KGH OHM No. 17572

CONCRETE/ASPHALT
APRON AREA
SITE SS-15A



LEGEND

Former Asphalt and
Earthen Embankment
for Pumphouse USTs



Former 50,000 Gallon
Pumphouse UST

Water Hydrant

Existing Shallow
Monitoring Well

Apron Line
Re/Defueling
Valve Box

Former Apron
Line Valve Box

MOP: 2ND YEAR - 1ST QTR (DEC-96/MAR-97)

FIGURE 4.2.1
MONITORING WELL LOCATION DETAIL
SITE SS-15A, APRON LINES
AP-7, 8 & 9

AIR FORCE CENTER FOR
ENVIRONMENTAL EXCELLENCE (AFCEE)
HOMESTEAD AIR RESERVE BASE
HOMESTEAD, FLORIDA

Rev. 00 | Date: 12-Jun-97 | Drawn by: KGH | OHM No. 17572

OHM Remediation
Services Corp.



**OHM Remediation
Services Corp.**

LEGEND

- LEGEND**
- | | | | | | |
|---|--|---|---------------------------------------|---|---------------------------------|
|  | Former Asphalt and Earthen Embankment for Pumphouse USTs |  | Water Hydrant |  | Apron Line Re/Fueling Valve Box |
|  | Former 50,000 Gallon Pumphouse UST |  | Existing Shallow Monitoring Well |  | Former Apron Line Valve Box |
| | |  | Existing Intermediate Monitoring Well | | |

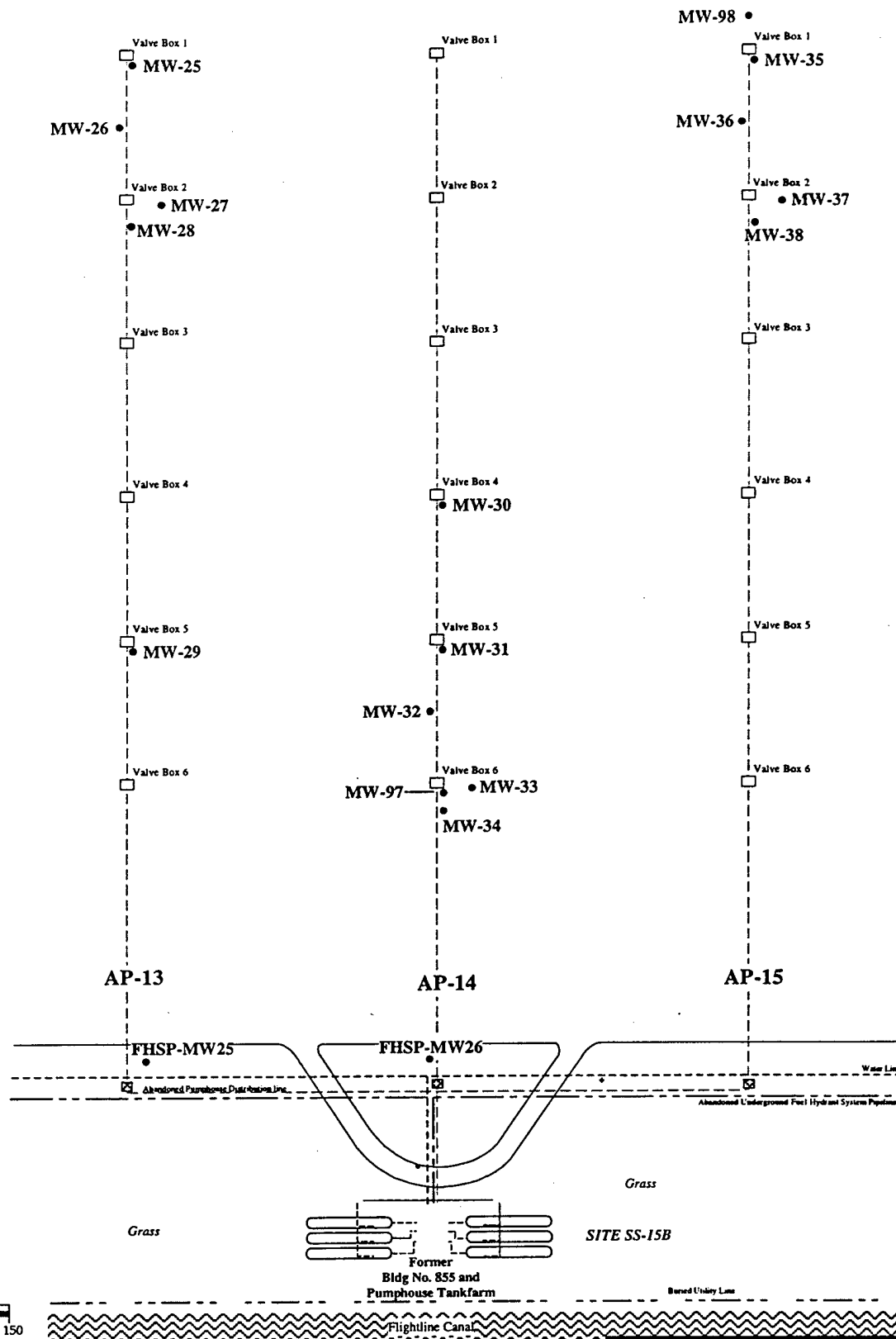
MOP: 2ND YEAR - 1ST QTR (DEC-96/MAR-97)

FIGURE 4.3.1
MONITORING WELL LOCATION DETAIL
SITE SS-15A, APRON LINES
AP-10, 11 & 12

**AIR FORCE CENTER FOR
ENVIRONMENTAL EXCELLENCE (AFCEE)
HOMESTEAD AIR RESERVE BASE
HOMESTEAD, FLORIDA**

Rev. 00	Date: 12-Jun-97	Drawn by: KGH	OHM No. 17572
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CONCRETE/ASPHALT
APRON AREA
SITE SS-15A



OHM Remediation
Services Corp.

LEGEND

Former Asphalt and
Earthen Embankment
for Pumphouse USTs

Former 50,000 Gallon
Pumphouse UST

+ Water Hydrant
• Existing Shallow
Monitoring Well

Apron Line
Re/Defueling
Valve Box

Former Apron
Line Valve Box

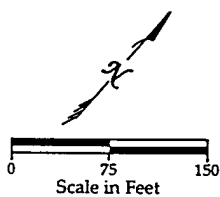
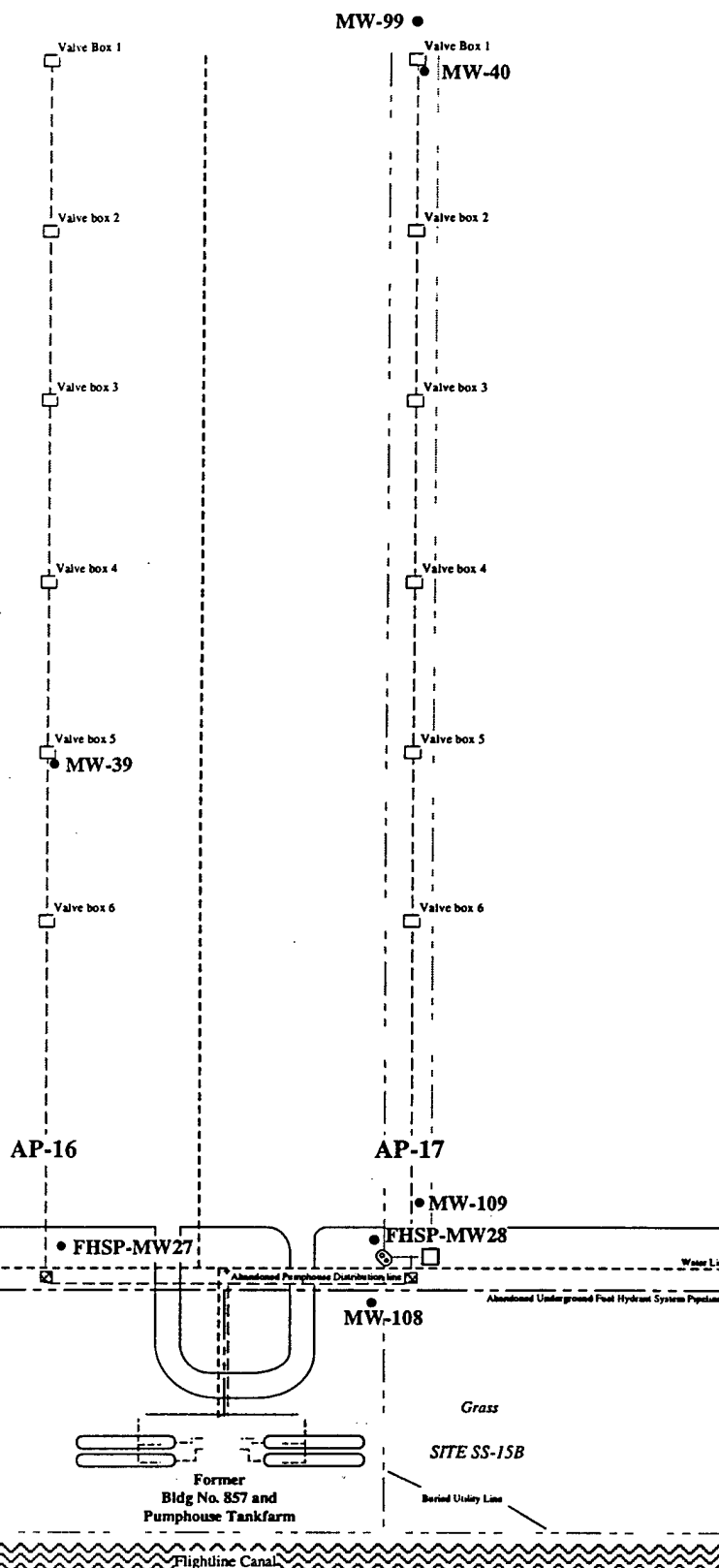
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FIGURE 4.4.1
MONITORING WELL LOCATION DETAIL
SITE SS-15A, APRON LINES
AP-13, 14 & 15

AIR FORCE CENTER FOR
ENVIRONMENTAL EXCELLENCE (AFCEE)
HOMESTEAD AIR RESERVE BASE
HOMESTEAD, FLORIDA

Rev. 00 Date: 12-Jun-97 Drawn by: KGH OHM No. 17572

CONCRETE/ASPHALT
APRON AREA
SITE SS-15A



LEGEND

Former Asphalt and
Earthen Embankment
for Pumphouse USTs

Former 50,000 Gallon
Pumphouse UST

Water Hydrant
Existing Shallow
Monitoring Well

Apron Line
Re/Defueling
Valve Box

Former Apron
Line Valve Box

MOP: 2ND YEAR - 1ST QTR (DEC-96/MAR-97)

FIGURE 4.5.1
MONITORING WELL LOCATION DETAIL
SITE SS-15A, APRON LINES
AP-16 & 17

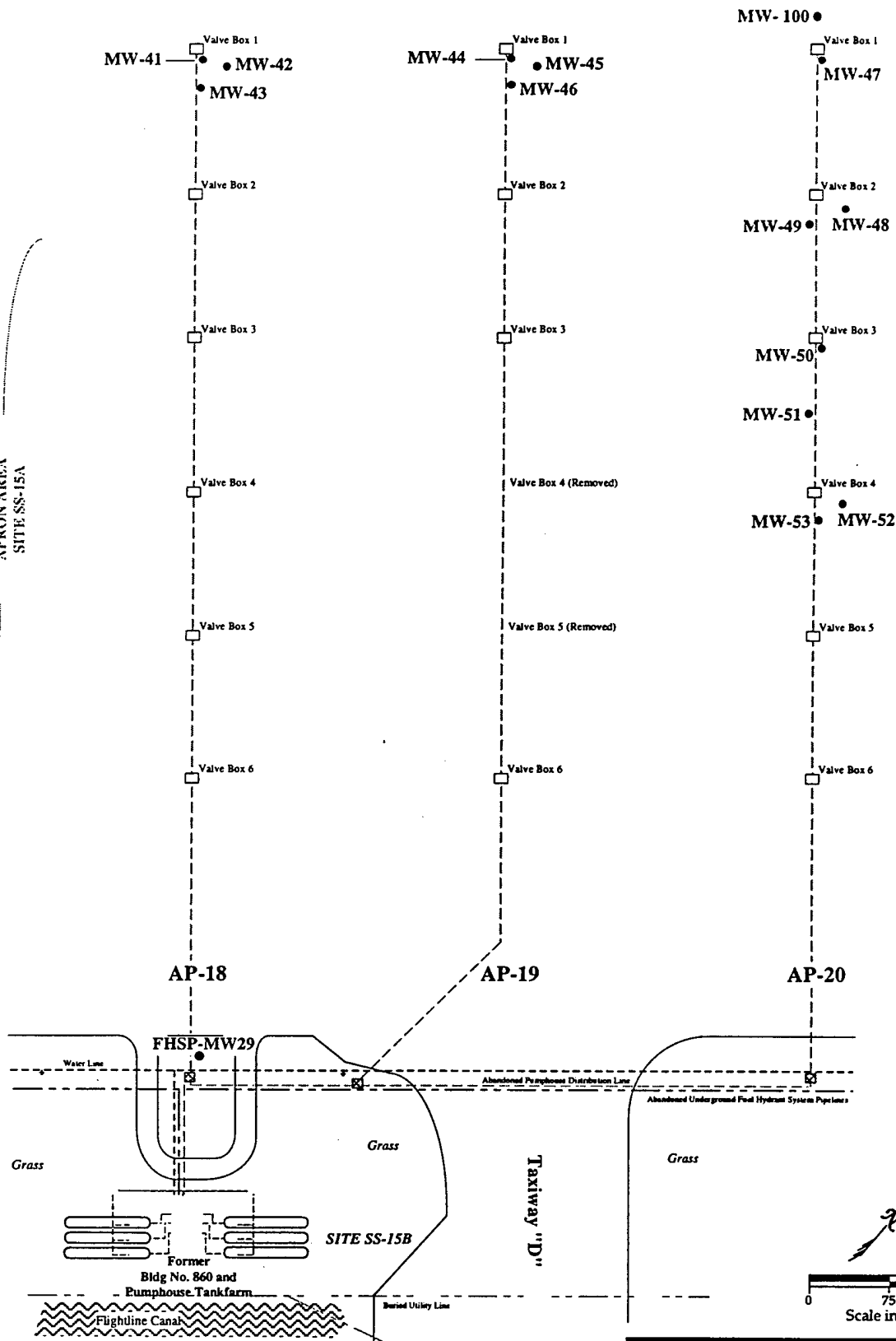
AIR FORCE CENTER FOR
ENVIRONMENTAL EXCELLENCE (AFCEE)
HOMESTEAD AIR RESERVE BASE
HOMESTEAD, FLORIDA

Rev. 00 | Date: 12-Jun-97 | Drawn by: KGH | OHM No. 17572



**OHM Remediation
Services Corp.**

CONCRETE/ASPHALT
APRON AREA
SITE SS-15A



LEGEND

Former Asphalt and Earthen Embankment for Pumphouse USTs



Former 50,000 Gallon Pumphouse UST

+ Water Hydrant

● Existing Shallow Monitoring Well



Apron Line Re/Defueling Valve Box



Former Apron Line Valve Box

MOP: 2ND YEAR - 1ST QTR (DEC-96/MAR-97)

FIGURE 4.6.1
MONITORING WELL LOCATION DETAIL
SITE SS-15A, APRON LINES
AP-18, 19 & 20

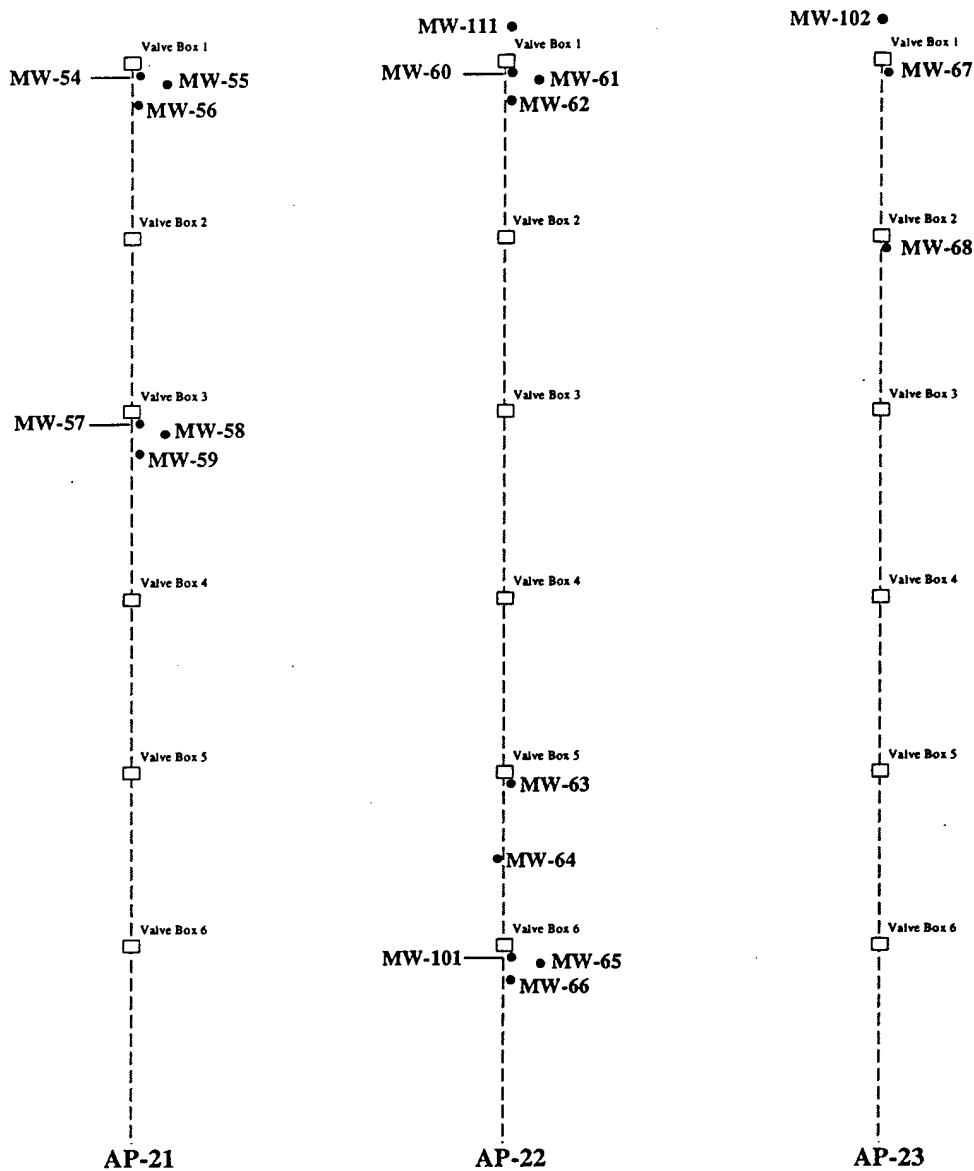
AIR FORCE CENTER FOR
ENVIRONMENTAL EXCELLENCE (AFCEE)
HOMESTEAD AIR RESERVE BASE
HOMESTEAD, FLORIDA

Rev. 00 | Date: 12-Jun-97 | Drawn by: KGH | OHM No. 17572



OHM Remediation
Services Corp.

CONCRETE/ASPHALT
APRON AREA
SITE SS-15A

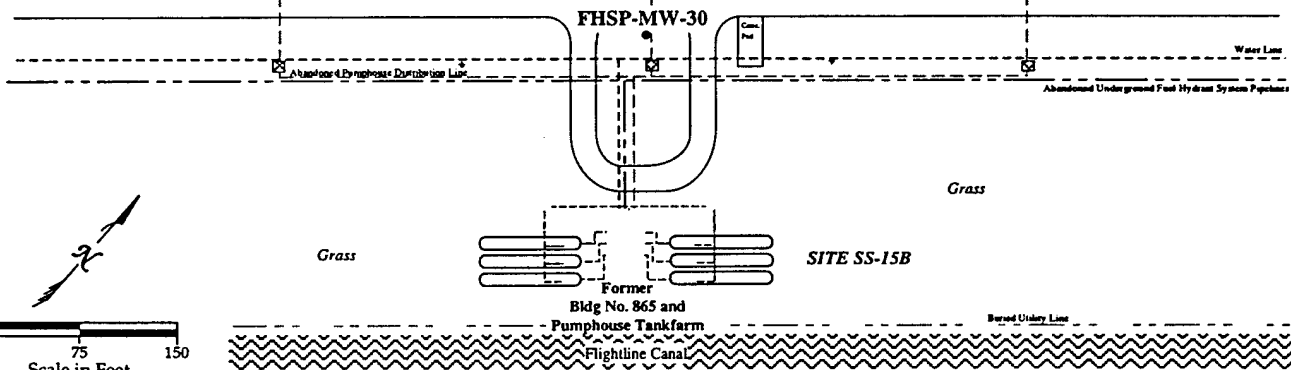


Bldg. No.
7784

Bldg. No.
7785

Bldg. No.
7786

Bldg. No.
7787



Scale in Feet
0 75 150

LEGEND

Former Asphalt and Earthen Embankment for Pump House USTs
Former 50,000 Gallon Pump House UST

Water Hydrant
Existing Shallow Monitoring Well

Apron Line Re/Defueling Valve Box

Former Apron Line Valve Box

MOP: 2ND YEAR - 1ST QTR (DEC-96/MAR-97)

FIGURE 4.7.1
MONITORING WELL LOCATION DETAIL
SITE SS-15A, APRON LINES
AP-21, 22 & 23

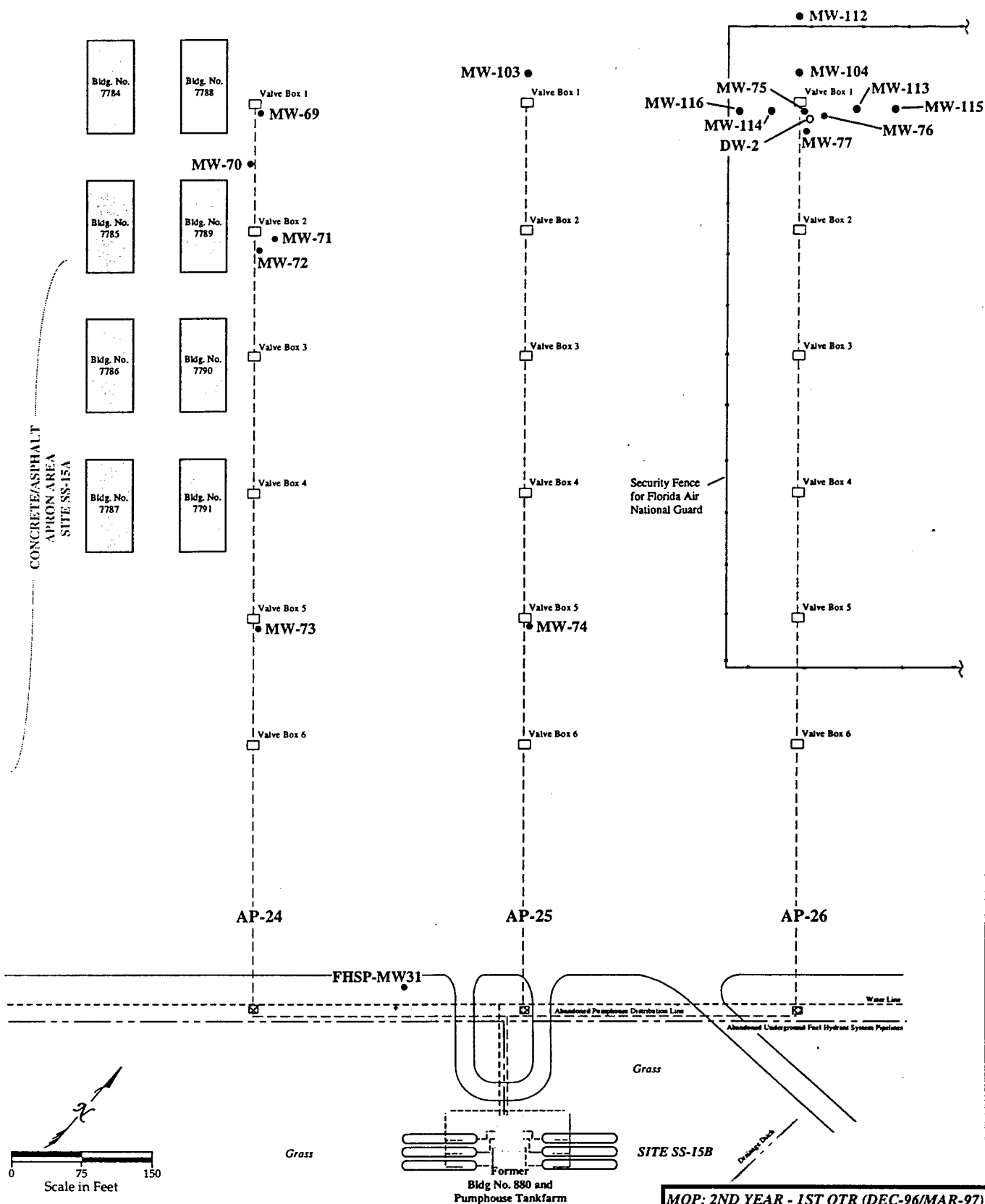
AIR FORCE CENTER FOR
ENVIRONMENTAL EXCELLENCE (AFCEE)
HOMESTEAD AIR RESERVE BASE
HOMESTEAD, FLORIDA

Rev. 00 Date: 12-Jun-97 Drawn by: KGH OHM No. 17572



OHM Remediation
Services Corp.

CONCRETE/ASPHALT
APRON AREA
SITE SS-15A



MOP: 2ND YEAR - 1ST QTR (DEC-96/MAR-97)

FIGURE 4.8.1
MONITORING WELL LOCATION DETAIL
SITE SS-15A, APRON LINES
AP-24, 25 & 26

AIR FORCE CENTER FOR
ENVIRONMENTAL EXCELLENCE (AFCEE)
HOMESTEAD AIR RESERVE BASE
HOMESTEAD, FLORIDA

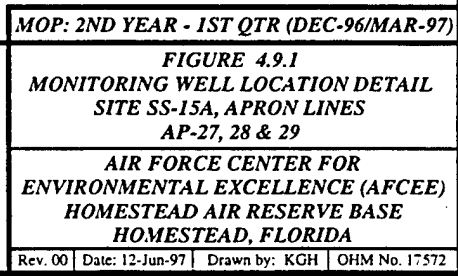
Rev. 00 | Date: 12-Jun-97 | Drawn by: KGH | OHM No. 17572



OHM Remediation
Services Corp.

LEGEND

- Former Asphalt and Earthen Embankment for Pumphouse USTs
- Former 50,000 Gallon Pumphouse UST
- Water Hydrant
- Existing Shallow Monitoring Well
- Existing Intermediate Monitoring Well
- Apron Line Re/Defueling Valve Box
- Former Apron Line Valve Box



**OHM Remediation
Services Corp.**

LEGEND

- LEGEND**
- | | | | | | |
|---|--|---|----------------------------------|---|-----------------------------------|
|  | Former Asphalt and Earthen Embankment for Pumphouse USTs |  | Water Hydrant |  | Apron Line Re/Defueling Valve Box |
|  | Former 50,000 Gallon Pumphouse UST |  | Existing Shallow Monitoring Well |  | Former Apron Line Valve Box |

**SOIL SAMPLE ANALYSIS RESULTS AND
SOIL SAMPLE HEADSPACE OVA/FID SCREENING RESULTS
APRON LINES AP-4 THROUGH AP-29**

TABLE 8.4 - SOIL SAMPLE ANALYSES: BLDG. NO. 840/APRON LINES AP4, AP5 & AP6

SOIL BORING NUMBER Laboratory Sample I.D. No. Date Drilled & Sampled	PIPELINE		AP-4		AP-5				AP-6	
FIELD DATA	SB-130	SB-1	SB-1	SB-2	SB-4	SB-6	SB-1	SB-1	SB-1	SB-1
	T4-00706-4	T4-00774-1	T4-00784-1	T4-00784-2	T4-00784-3	T4-00784-4	T4-00784-1	T4-00784-1	T4-00784-1	T4-00784-5
	03/05/94	03/11/94	03/12/94	03/12/94	03/12/94	03/12/94	03/12/94	03/12/94	03/12/94	03/12/94
Total Boring Depth (ft, BLS)	4'	5'	5'	5'	5'	5'	5'	5'	5'	5'
Sample Depth (ft, BLS)	0'-2'	1'-3'	3'-5'	1'-3'	1'-3'	1'-3'	1'-3'	1'-3'	1'-3'	1'-3'
OVA/FID Screening of Sample (ppm**)	100	83	105	220	224	752	105	105	105	485
LABORATORY ANALYSES										
1,2-Dichloroethane (1,2-DCA)	<310	<6.2	<6.2	<1500	<5.9	<1500	<6.2	<6.2	<6.2	<1800
TOTAL VOHs (29 species)	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Benzene	420	<6.2	<6.2	<1500	<5.9	<1500	<6.2	<6.2	<6.2	<1800
Toluene	1300	<6.2	<6.2	<1500	<5.9	<1500	<6.2	<6.2	<6.2	<1800
Ethylbenzene	510	<6.2	<6.2	<1500	<5.9	<1500	<6.2	<6.2	<6.2	<1800
Total Xylenes	1600	26	<6.2	5200	7.6	14000	<6.2	<6.2	<6.2	4900
TOTAL VOAs	3830	26	<PQL	5200	7.6	21000	<PQL	<PQL	<PQL	14000
Methyl-Tert-Butyl-Ether (MTBE)	<3100	<62	<62	<15000	<59	<15000	<62	<62	<62	18900
Acenaphthene	<400	<790	<1600	<1600	<1600	<2400	<1600	<1600	<1600	<18000
Acenaphthylene	<400	<790	<1600	<1600	<1600	<2400	<1600	<1600	<1600	<12000
Benzo(a)pyrene	1000	<790	<1600	<1600	<1600	<2400	<1600	<1600	<1600	<12000
Benzo(g,h,i)perylene	560	<790	<1600	<1600	<1600	<2400	<1600	<1600	<1600	<12000
Benzo(b,k)fluoranthene	2300	<790	<1600	<1600	<1600	<2400	<1600	<1600	<1600	<12000
Chrysene+Benzo(a)anthracene	3000	<790	<1600	2200	<1600	<2400	<1600	<1600	<1600	<12000
Fluoranthene	1900	<790	<1600	2600	<1600	<2400	<1600	<1600	<1600	<12000
Fluorene	<400	<790	<1600	<1600	<1600	<2400	<1600	<1600	<1600	<12000
Indeno(1,2,3-cd)pyrene+										
Dibenzo(a,h)anthracene	910	<790	<1600	<1600	<1600	<2400	<1600	<1600	<1600	<12000
Phenanthrene+Anthracene	1100	<790	<1600	1600	<1600	<2400	<1600	<1600	<1600	<12000
Pyrene	1600	<790	<1600	2200	<1600	<2400	<1600	<1600	<1600	<12000
TOTAL PAHs (excl. naphthalenes)	12370	<PQL	<PQL	8600	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Naphthalene	<400	3100	1700	2700	4400	7000	1700	1700	1700	19000
1-Methylnaphthalene	<400	1700	<1600	<1600	2300	<2400	<1600	<1600	<1600	16000
2-Methylnaphthalene	<400	6900	4300	2700	6900	8400	4300	4300	4300	41000
TOTAL Naphthalenes	<PQL	11700	6000	5400	13600	15400	6000	6000	6000	76000
TRPH, mg/kg	61	530	420	470	4500	1600	420	420	420	4600
1,2-Dibromoethane (EDB)	<310	<6.2	<6.2	<1500	<5.9	<1500	<6.2	<6.2	<6.2	<1800
Total Lead, mg/kg	4.4	0.9	<0.5	2.6	2.5	<0.5	<0.5	<0.5	<0.5	1.5

All units for soil samples are ug/kg, unless otherwise specified. Units for the EQB samples are all ug/l, unless otherwise specified. **Methane corrected.
 <PQL = Less Than The Practical Quantitation Limit; EQB = Equipment Blank; DUP = Duplicate Sample; BLS = Below Land Surface.

TABLE 9.4 - SOIL SAMPLE ANALYSES: BLDG. NO. 845/APRON LINES AP7, AP8 & AP9

SOIL BORING NUMBER Laboratory Sample I.D. No.	AP-7			AP-8		
	SB-3	SB-3(DUP)	SB-1	SB-2	SB-3	SB-6
FIELD DATA	T4-00784-6	T4-00784-7	T4-00806-1	T4-00806-2	T4-00806-3	T4-00806-4
Date Drilled & Sampled	03/14/94	03/14/94	03/15/94	03/15/94	03/15/94	03/15/94
Total Boring Depth (ft, BLS)	5'	5'	5'	5'	5'	5'
Sample Depth (ft, BLS)	1'-3'	1'-3'	1'-3'	1'-3'	1'-3'	3'-5'
OVA/FID Screening of Sample (ppm**)	83	95	2630	3435	487	613
LABORATORY ANALYSES						
1,2-Dichloroethane (1,2-DCA)	<5.9	<1400	<1500	<1400	<300	<6.0
TOTAL VOHs (29 species)	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Benzene	<290	<1400	<3000	<1500	<300	<6.0
Toluene	<290	<1400	<3000	<1500	<300	<6.0
Ethylbenzene	<290	<1400	<3000	5200	460	9.2
Total Xylenes	<290	<1400	25000	11000	1500	17
TOTAL VOAs	<PQL	<PQL	25000	16200	1960	26.2
Methyl-Tert-Butyl-Ether (MTBE)	<2900	<14000	<30000	<15000	<3000	<60
Acenaphthene	<7500	<12000	<8200	<12000	<7800	<13000
Acenaphthylene	<7500	<12000	<8200	<12000	<7800	<13000
Benzo(a)pyrene	<7500	<12000	<8200	<12000	<7800	<13000
Benzo(g,h,i)perylene	<7500	<12000	<8200	<12000	<7800	<13000
Benzo(b,k)fluoranthene	<7500	<12000	<8200	<12000	<7800	<13000
Chrysene+Benzo(a)anthracene	<7500	<12000	<8200	<12000	<7800	<13000
Fluoranthene	<7500	<12000	<8200	<12000	<7800	<13000
Fluorene	<7500	<12000	<8200	<12000	<7800	<13000
Indeno(1,2,3-cd)pyrene+	<7500	<12000	<8200	<12000	<7800	<13000
Dibenzo(a,h)anthracene	<7500	<12000	<8200	<12000	<7800	<13000
Phenanthrene+Anthracene	<7500	<12000	<8200	<12000	<7800	<13000
Pyrene	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
TOTAL PAHs (excl. naphthalenes)	11000	22000	23000	25000	13000	16000
Naphthalene	12000	23000	20000	21000	11000	<13000
1-Methylnaphthalene	30000	34000	59000	64000	35000	65000
2-Methylnaphthalene	53000	79000	102000	110000	59000	81000
TOTAL Naphthalenes	2800	3700	9600	8700	4000	15000
TRPH, mg/kg	<5.9	<1400	<1500	<1400	<300	<6.0
1,2-Dibromoethane (EDB)	0.6	<0.50	5.3	<0.50	<0.50	<0.50
Total Lead, mg/kg						

All units for soil samples are ug/kg, unless otherwise specified. Units for the EQB samples are all ug/l, unless otherwise specified. **Methane corrected.
 <PQL = Less Than The Practical Quantitation Limit; EQB = Equipment Blank; DUP = Duplicate Sample; BLS = Below Land Surface.

TABLE 10.4 - SOIL SAMPLE ANALYSES: BLDG. NO. 850/APRON LINES AP-10, AP11 & AP12

SOIL BORING NUMBER		AP-10						AP-11				AP-12					
Laboratory Sample I.D. No.		SB-1	SB-2	SB-2(r/p)	SB-3	SB-4	SB-6	AP10-EOB	SB-1	AP11-EOB	SB-5	SB-5(DUP)	SB-6	SB-1	SB-2	SB-3	SB-4
FIELD DATA		T4-00837-2	T4-00837-4	NA	T4-00837-3	T4-00837-5	T4-00837-1	T4-01283-1	T4-00837-8	T4-00837-10	T4-00837-7	T4-00837-6	T4-00837-9	T4-00859-1	T4-00859-2	T4-00859-3	T4-00859-4
Date Drilled & Sampled		03/16/94	03/16/94	04/21/94	03/16/94	03/16/94	03/16/94	Equipment	03/16/94	Equipment	03/16/94	03/16/94	03/16/94	03/17/94	03/17/94	03/17/94	03/17/94
Total Boring Depth (ft. BLS)		5'	5'	6'	5'	5'	5'	Blank at	5'	Blank at	5'	5'	5'	5'	5'	5'	5'
Sample Depth (ft. BLS)		1'-3'	1'-3'	0'-2 1/2'-4'	1'-3'	1'-3'	3'-5'	AP10-SB2	1'-3'	AP11-SB1	3'-5'	3'-5'	3'-5'	1'-3'	3'-5'	1'-3'	1'-3'
OVA/FID Screening of Sample (ppm**)		432	30	3145/1040	450	1228	278	On 04/21/94	6500	On 03/16/94	1218	575	2995	513	4445	530	50
LABORATORY ANALYSES																	
1,2-Dichloroethane (1,2-DCA)		<730	<310	NA	<5.8	<2500	<6.2	<1.0	<770	<1.0	<810	<740	<780	<290	<750	<730	<5.9
TOTAL VOCs (29 species)		<PQL	<PQL	NA	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Benzene		<730	<310	NA	<730	<3100	<6.2	<1.0	<770	<1.0	<810	<740	<780	<730	<750	<730	<5.9
Toluene		<730	550	NA	<730	<3100	<6.2	<1.0	2100	<1.0	<810	<740	1500	<730	<750	<730	<5.9
Ethylbenzene		1400	2300	NA	<730	<3100	<6.2	<1.0	3000	<1.0	3800	<740	2000	<730	3900	1300	<5.9
Total Xylenes		4100	11000	NA	<730	3700	<6.2	<1.0	15000	<1.0	7400	4200	3500	<730	17000	3000	7.0
TOTAL VOCs		5500	13850	NA	<PQL	3700	<PQL	<PQL	20100	<PQL	11200	4200	7000	1100	20800	4300	7.0
Methyl-Tert-Butyl-Ether (MTBE)		<7300	<3100	NA	<7300	<31000	<6.2	<1.0	<7700	<1.0	<8100	<7400	<7800	<7300	<7500	<7300	<5.9
Acenaphthene		<8000	<4000	NA	<800	<7900	<420	<1.0	<8200	<1.0	<8000	<6000	<800	<4000	<1200	<2000	<400
Acenaphthylene		<8000	<4000	NA	<800	<7900	<420	<1.0	<8200	<1.0	<8000	<6000	<800	<4000	<1200	<2000	<400
Benzo(a)pyrene		<8000	<4000	NA	<800	<7900	<420	<1.0	<8200	<1.0	<8000	<6000	<800	<4000	<1200	<2000	<400
Benzo(g,h,i)perylene		<8000	<4000	NA	<800	<7900	<420	<1.0	<8200	<1.0	<8000	<6000	<800	<4000	<1200	<2000	<400
Benzo(b,k)fluoranthene		<8000	<4000	NA	<800	<7900	<420	<1.0	<8200	<1.0	<8000	<6000	<800	<4000	<1200	<2000	<400
Chrysene+Benzo(a)anthracene		<8000	<4000	NA	<800	<7900	<420	<1.0	<8200	<1.0	<8000	<6000	<800	<4000	<1200	<2000	<400
Fluoranthene		<8000	<4000	NA	<800	<7900	<420	<1.0	<8200	<1.0	<8000	<6000	<800	<4000	<1200	<2000	<400
Fluorene		<8000	<4000	NA	<800	<7900	<420	<1.0	<8200	<1.0	<8000	<6000	<800	<4000	<1200	<2000	<400
Indeno(1,2,3-cd)pyrene+Dibenz(a,h)anthracene		<8000	<4000	NA	<800	<7900	<420	<1.0	<8200	<1.0	<8000	<6000	<800	<4000	<1200	<2000	<400
Phenanthrene+Anthracene		<8000	<4000	NA	<800	<7900	<420	<1.0	<8200	<1.0	<8000	<6000	<800	<4000	<1200	<2000	<400
Pyrene		<8000	<4000	NA	<800	<7900	<420	<1.0	<8200	<1.0	<8000	<6000	<800	<4000	<1200	<2000	<400
TOTAL PAHs (Excl. Naphthalenes)		<PQL	<PQL	NA	<4300	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Naphthalene		9200	5300	NA	2000	<7900	<420	<1.0	6300	<1.0	17000	12000	1500	5500	2400	6100	<400
1-Methylnaphthalene		<8000	5600	NA	1500	<7900	<420	<1.0	7500	<1.0	10000	6600	1200	4800	2700	6800	<400
2-Methylnaphthalene		9600	18000	NA	5000	14000	<420	<1.0	30000	<1.0	15000	17000	4400	5500	4200	13000	<400
TOTAL Naphthalenes		18800	29900	NA	8500	14000	<PQL	<PQL	43800	<PQL	42000	35600	7100	15800	9300	23900	<PQL
TRPH, mg/kg		4400	1200	NA	1000	4100	660	<1.0	6200	<1.0	3200	1200	220	3100	720	1800	70
1,2-Dibromomethane (EDB)		<730	<310	NA	<5.8	<2500	<6.2	<0.005	<770	<0.005	<810	<740	<780	<290	<750	<730	<5.9
Total Lead, mg/kg		<0.50	<0.50	NA	0.1	<0.50	<0.50	NA	0.0	NA	<0.50	<0.50	<0.50	<0.50	<0.50	1.0	1.2

Units for the EOB samples are ug/kg, unless otherwise specified. Units for the TRPH samples are mg/kg.

All units for soil samples are ug/kg, unless otherwise specified. Units for the EOB samples are all ug/l, unless otherwise specified. **Methane corrected.
 <PQL = Less Than The Practical Quantitation Limit; EOB = Equipment Blank; DUP = Duplicate Sample; NA = Not Analyzed; BLS = Below Land Surface.

TABLE 11.4 - SOIL SAMPLE ANALYSES: BLDG. NO. 855/APRON LINES AP-13, AP14 & AP15

FIELD DATA	AP-13					AP-14					AP-15		
	SB-1	SB-2	SB-4	SB-5	SB-6	SB-1	SB-2	SB-4	SB-5	SB-5(DUP)	SB-6	SB-1	SB-2
Laboratory Sample I.D. No	T4-00866-1	T4-00866-2	T4-00866-12	T4-00866-13	T4-00866-11	T4-00866-3	T4-00866-4	T4-00866-8	T4-00866-7	T4-00866-5	T4-00866-6	T4-00866-9	T4-00866-10
Date Drilled & Sampled	03/17/94	03/17/94	03/18/94	03/18/94	03/18/94	03/17/94	03/17/94	03/18/94	03/18/94	03/18/94	03/18/94	03/18/94	03/18/94
Total Boring Depth (ft. BLS)	5'	5'	5'	7'	5'	5'	5'	5'	5'	5'	7'	6'	6'
Sample Depth (ft. BLS)	1.5'-3.5'	1.5'-3.5'	3'-5'	1'-3'	3'-5'	1'-3'	1'-3'	1'-3'	1'-3'	1'-3'	3'-5'	4'-6'	2'-4'
OVA/ID Screening of Sample (ppm**)	2350	6840	180	2210	370	2925	790	65	90	50	>9850	>9875	>9875
LABORATORY ANALYSES													
1,2-Dichloroethane	<760	<330	<5.8	<780	<760	<740	<750	<5.8	<5.8	<5.9	<740	<730	<750
TOTAL VOHs (29 species)	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Benzene	<770	<330	<5.8	<780	<760	<730	<760	<5.8	<5.8	<5.9	<740	<730	<740
Toluene	<770	<330	<5.8	<780	<760	<730	<760	<5.8	<5.8	<5.9	870	<730	<740
Ethylbenzene	1800	460	<5.8	1900	3100	1800	3400	12	<5.8	<5.9	<740	2200	4900
Total Xylenes	10000	1800	8.5	6700	7700	11000	9400	36	13	<5.9	9300	6700	12000
TOTAL VOAs	11800	2260	8.5	8600	11000	12800	12800	48	13	<PQL	10170	8900	16900
Methyl-Tert-Butyl-Ether (MTBE)	<7700	<3300	<5.8	<7800	<7600	<7300	<7600	<5.8	<5.8	<5.9	<7400	<7300	<7400
Acenaphthene	<6000	<390	<450	<800	<800	<5900	<400	<390	<400	<400	<4000	720	<12000
Acenaphthylene	<6000	<390	<450	<800	<800	<5900	<400	<390	<400	<400	<4000	380	<12000
Benzo(a)pyrene	<6000	<390	<450	<800	<800	<5900	2500	<390	1800	<400	<4000	1200	<12000
Benzo(g,h,i)perylene	<6000	<390	<450	<800	<800	<5900	1600	<390	1500	<400	<4000	1100	<12000
Benzo(b,k)fluoranthene	<6000	410	<450	<800	<800	<5900	5300	<390	4200	<400	<4000	2900	<12000
Chrysene+Benzo(a)anthracene	<6000	600	<450	<800	<800	<5900	7300	<390	5700	<400	<4000	3800	<12000
Fluoranthene	<6000	900	<450	<800	<800	<5900	8000	<390	5800	<400	<4000	4000	<12000
Fluorene	<6000	560	<450	<800	<800	<5900	<400	<390	490	<400	<4000	730	<12000
Indeno(1,2,3-cd)pyrene+	<6000	<390	<450	<800	<800	<5900	2900	<390	2100	<400	<4000	1600	<12000
Dibenzo(a,h)anthracene	<6000	1400	<450	<800	<800	<5900	66000	<390	5300	<400	<4000	5300	<12000
Phenanthrene+Anthracene	<6000	830	<450	<800	<800	<5900	6400	<390	4600	<400	<4000	3800	<12000
Pyrene	<PQL	4700	<PQL	<PQL	<PQL	<PQL	100000	<PQL	31490	<PQL	<PQL	25530	<PQL
TOTAL PAHs (excl. naphthalenes)	11000	670	<450	1300	3800	36000	1200	400	<400	<400	36000	550	29000
Naphthalene	7400	<390	<450	<800	3700	13000	2600	<390	<400	400	21000	1500	15000
1-Methylnaphthalene	21000	730	<450	2200	8400	47000	3500	1400	<400	800	42000	3000	54000
2-Methylnaphthalene	39400	1400	<PQL	3500	15900	96000	7300	1800	<PQL	1200	99000	5050	98000
TOTAL Naphthalenes	2000	49	46	690	750	7400	790	160	51	76	2400	770	5300
TRPH, mg/kg	<760	<330	<5.8	<780	<760	<740	<750	<5.8	<5.8	<5.9	<740	<730	<750
1,2-Dibromoethane (EDB)	<0.50	0.8	5.4	<0.50	<0.50	5.1	3.0	2.4	1.5	2.4	<0.50	<730	<750
Total Lead, mg/kg												0.9	3.4

All units for soil samples are ug/kg, unless otherwise specified. Units for the EQB samples are all ug/l, unless otherwise specified. **Methane corrected.
 <PQL = Less Than The Practical Quantitation Limit; EQB = Equipment Blank; DUP = Duplicate Sample; BLS = Below Land Surface.

TABLE 12.4 - SOIL SAMPLE ANALYSES: BLDG. NO. 857/APRON LINES AP16 & AP17

FIELD DATA	AP-16		AP-16/17		AP-17
	SB-5	SB-6	SB-1	SB-1	
Laboratory Sample I.D. No.	T4-00866-14	T4-00866-15	T4-00866-15	T4-00866-15	T4-00866-15
Date Drilled & Sampled	03/18/94	03/18/94	03/18/94	03/18/94	03/18/94
Total Boring Depth (ft, BLS)	6'	6'	6'	6'	6'
Sample Depth (ft, BLS)	4'-6"	0'-2"	2'-4"	4'-6"	4'-6"
OVA/FID Screening of Sample (ppm**)	3160	1490	50	935	935
LABORATORY ANALYSES					
1,2-Dichloroethane					
TOTAL VOHs (29 species)	<PQL	<PQL	<PQL	<PQL	<PQL
Benzene	<770	<5.8	<5.8	<5.8	<780
Toluene	<770	<5.8	<5.8	<5.8	<780
Ethylbenzene	2100	<5.8	<5.8	<5.8	1300
Total Xylenes	6700	<5.8	<5.8	<5.8	1700
TOTAL VOAs	8800	29	29	<PQL	7600
Methyl-Tert-Butyl-Ether (MTBE)	<7700	<58	<58	<58	10600
Acenaphthene	<4200	<380	<380	<380	<7800
Acenaphthylene	<4200	<380	<380	<380	<410
Benzo(a)pyrene	<4200	<380	<380	<380	1100
Benzo(g,h,i)perylene	<4200	<380	<380	<380	860
Benzo(b,k)fluoranthene	<4200	560	<380	<380	580
Chrysene+Benzo(a)anthracene	<4200	620	<380	<380	1900
Fluoranthene	<4200	740	590	590	2100
Fluorene	<4200	<380	<380	<380	2500
Indeno(1,2,3-cd)pyrene + Dibenzo(a,h)anthracene	<4200	<380	<380	<380	<410
Phenanthrene+Anthracene	<4200	740	660	660	910
Pyrene	<4200	680	520	520	1400
TOTAL PAHs (excl. naphthalenes)	<PQL	3340	2220	2220	2400
Naphthalene	29000	3100	<380	<380	13750
1-Methylnaphthalene	5100	400	<380	<380	2200
2-Methylnaphthalene	45000	2700	<380	<380	2100
TOTAL Naphthalenes	79100	6200	<PQL	<PQL	5900
TRPH, mg/kg	2700	400	63	63	10200
1,2-Dibromoethane (EDB)	<770	<5.8	<5.8	<5.8	760
Total Lead, mg/kg	<0.50	3.1	2.3	2.3	<780

All units for soil samples are ug/kg, unless otherwise specified. Units for the EQB samples are all ug/l, unless otherwise specified. **Methane corrected.
 <PQL = Less Than The Practical Quantitation Limit; EQB = Equipment Blank; DUP = Duplicate Sample; BLS = Below Land Surface.

TABLE 13.4 - SOIL SAMPLE ANALYSES: BLDG. NO. 860/APRON LINES AP18, AP19 & AP20

FIELD DATA	AP-17/18			AP-18			AP-19			AP-20		
	SB-3	SB-1	SB-1(DUP)	AP18-EOB	SB-3	SB-1	SB-1	SB-2	SB-3	SB-4	SB-5	SB-6
Laboratory Sample I.D. No.	T4-00880-5	T4-00880-2	T4-00880-3	T4-00880-10	T4-00880-4	T4-00880-7	T4-00880-9	T4-00880-8	T4-00895-2	T4-00895-3	T4-00895-4	T4-00895-5
Date Drilled & Sampled	03/19/94	03/19/94	03/19/94	Equipment Blank at AP18-SB1 On 03/19/94	03/19/94	03/21/94	03/21/94	03/21/94	03/21/94	03/22/94	03/22/94	03/22/94
Total Boring Depth (ft. BLS)	6'	6'	6'		6'	6'	6'	6'	6'	6'	7'	7'
Sample Depth (ft. BLS)	4'-6"	4'-6"	4'-6"		4'-6"	0'-2"	4'-6"	0'-2"	0'-2"	4'-6"	3'-5"	3'-5"
OVA/FID Screening of Sample (ppm**)	125	>9800	>9650	80		3550	6025	3900	1350	900	>9700	75
LABORATORY ANALYSES												
1,2-Dichloroethane (1,2-DCA)	<6.1	<12000	<13000	<1.0	<5.9	<730	<2700	<29	<5.7	<6.2	<740	<5.8
TOTAL VOHs (29 species)	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Benzene	<6.1	<12000	<13000	<1.0	<5.9	<730	<14000	<730	<5.7	<6.2	<12000	<5.8
Toluene	<6.1	21000	27000	<1.0	<5.9	<730	<14000	900	7.9	<6.2	<12000	<5.8
Ethylbenzene	<6.1	35000	39000	<1.0	<5.9	2200	19000	1200	33	12	<12000	<5.8
Total Xylenes	<6.1	94000	110000	<1.0	<5.9	4000	68000	4900	233	73	29000	<5.8
TOTAL VOAs	<PQL	150000	176000	<PQL	<5.9	6200	87000	7000	273.9	85	29000	<PQL
Methyl-Tert-Butyl-Ether (MTBE)	<6.1	<120000	<130000	<1.0	<5.9	<7300	<140000	<7300	<5.7	<6.2	<12000	<5.8
Acenaphthene	550	<4600	<4200	<1.0	5500	<2000	<1600	<1900	950	3300	<7700	8100
Acenaphthylene	<400	7200	9300	<1.0	<2000	<2000	<1600	<1900	<380	<400	<7700	850
Benzo(a)pyrene	1000	<4600	<4200	<1.0	10000	<2000	<1600	<1900	560	4200	<7700	16000
Benzo(g,h,i)perylene	770	<4600	<4200	<1.0	4700	<2000	<1600	<1900	440	3400	<7700	9000
Benzo(b,k)fluoranthene	2200	<4600	<4200	<1.0	21000	<2000	2600	2700	1300	9000	<7700	37000
Chrysene • Benzo(a)anthracene	3200	<4600	<4200	<1.0	32000	<2000	3100	4100	1800	13000	<7700	65000
Fluoranthene	4400	<4600	<4200	<1.0	39000	2500	4100	5900	2400	17000	9500	85000
Fluorene	640	<4600	<4200	<1.0	10000	<2000	<1600	<1900	910	3800	<7700	13000
Indeno(1,2,3-cd)pyrene • Dibenz(a,h)anthracene	1200	<4600	<4200	<1.0	9400	<2000	<1600	<1900	660	5200	<7700	18000
Phenanthrene • Anthracene	5000	<4600	<4200	<1.0	56000	3500	3900	6900	4200	28000	15000	120000
Pyrene	3600	<4600	<4200	<1.0	31000	2200	3700	4800	2000	14000	<7700	64000
TOTAL PAHs (excl. naphthalenes)	22560	7200	9300	<PQL	228600	8200	17400	24400	15220	100900	24500	435950
Naphthalene	440	46000	60000	<1.0	<2000	18000	3800	5700	2500	4400	23000	1400
1-Methylnaphthalene	<400	23000	31000	<1.0	<2000	7400	2400	3900	2000	2600	16000	1800
2-Methylnaphthalene	450	58000	78000	<1.0	<2000	21000	6700	9900	6800	5400	38000	2600
TOTAL Naphthalenes	890	127000	169000	<PQL	<PQL	46400	12900	19500	11300	12400	77000	5800
TRPH, mg/kg	140	5100	5800	<1.0	520	2600	600	1100	890	1000	2800	90
1,2-Dibromoethane (EOB)	<6.1	<12000	<13000	<0.005	<5.9	<730	<2700	<29	<5.7	<6.2	<740	<5.8
Total Lead, mg/kg	17	1.4	2.0	NA	2.4	3.5	1.9	1.8	0.8	1.2	1.3	1.8

All units for soil samples are ug/kg, unless otherwise specified. Units for the EOB samples are all ug/l, unless otherwise specified. **Methane corrected.
 <PQL = Less Than The Practical Quantitation Limit; EOB = Equipment Blank; DUP = Duplicate Sample; BLS = Below Land Surface.

TABLE 14.4 - SOIL SAMPLE ANALYSES: BLDG. NO. 865/APRON LINES AP21, AP22 & AP23

FIELD DATA	AP-20/21		AP-21				AP-21/22	
	SB-2	SB-1	SB-3A	SB-3(DUP)	SB-4	SB-6	SB-3	SB-4
Laboratory Sample I.D. No.	T4-00922-1	T4-00895-1	T4-00914-2	T4-00914-4	T4-00914-3	T4-00914-1	T4-00922-2	T4-00922-4
Date Drilled & Sampled	03/24/94	03/22/94	03/23/94	03/23/94	03/23/94	03/23/94	03/24/94	03/24/94
Total Boring Depth (ft, BLS)	6'	6'	6'	6'	6'	7'	6'	7'
Sample Depth (ft, BLS)	2'-4'	4'-6'	4'-6'	4'-6'	2'-4'	3'-5'	0'-2'	3'-5'
OVA/FID Screening of Sample (ppm**)	70	>9650	125	55	2450	325	65	95
LABORATORY ANALYSES								
1,2-Dichloroethane (1,2-DCA)	<6.0	<740	<6.1	<5.8	<300	<300	<5.8	<7.7
TOTAL VOHS (29 species)	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Benzene	<5.8	<740	<6.1	<5.8	<300	<300	<6.0	<7.7
Toluene	<5.8	<740	<6.1	<5.8	<300	<300	<6.0	<7.7
Ethylbenzene	<5.8	<740	<6.1	<5.8	370	540	<6.0	<7.7
Total Xylenes	<5.8	2300	<6.1	<5.8	480	1900	<6.0	<7.7
TOTAL VOAS	<PQL	2300	<PQL	<PQL	850	2440	<PQL	<PQL
Methyl-Tert-Butyl-Ether (MTBE)	<5.8	<740	<6.1	<5.8	<3000	<3000	<6.0	<7.7
Acenaphthene	2100	2000	<390	1200	2600	<410	<390	<400
Acenaphthylene	<390	<400	<390	<400	<2000	<410	<390	<400
Benzo(a)pyrene	1900	2000	750	4200	4400	<410	<390	860
Benzo(g,h,i)perylene	700	1600	580	2800	2700	<410	<390	<400
Benzo(b,k)fluoranthene	4100	4600	1500	8600	9300	<410	<390	2000
Chrysene+Benzo(a)anthracene	8500	6900	2100	11000	13000	<410	510	2700
Fluoranthene	13000	8400	2900	9900	16000	<410	650	3200
Fluorene	2600	2200	930	1700	1600	<410	<390	<400
Indeno(1,2,3-cd)pyrene + Dibenzo(a,h)anthracene	1300	2500	670	3900	4200	<410	<390	800
Phenanthrene+Anthracene	20000	12000	5100	8200	27000	<410	700	3800
Pyrene	11000	7100	2500	7500	13000	<410	630	2500
TOTAL PAHs (excl. naphthalenes)	65200	49300	17030	59000	93800	<PQL	2490	15860
Naphthalene	4200	3500	890	410	13000	<410	<390	<400
1-Methylnaphthalene	850	3500	<390	<400	2400	<410	<390	<400
2-Methylnaphthalene	1500	7300	<390	<400	6900	<410	<390	<400
TOTAL Naphthalenes	6550	14300	890	410	22300	<PQL	<PQL	<PQL
TRPH, mg/kg	360	1100	230	280	1200	300	140	21
1,2-Dibromoethane (EDB)	<6.0	<740	<6.1	<5.8	<300	<300	<5.8	<7.7
Total Lead, mg/kg	1.8	1.6	5.5	3.4	1.4	1.5	2.9	2.0

All units for soil samples are ug/kg, unless otherwise specified. Units for the EQB samples are all ug/l, unless otherwise specified. **Methane corrected.
 <PQL = Less Than The Practical Quantitation Limit; EQB = Equipment Blank; DUP = Duplicate Sample; BLS = Below Land Surface.

TABLE 15.4 - SOIL SAMPLE ANALYSES: BLDG. NO. 880/APRON LINES AP24, AP25 & AP26

SOIL BORING NUMBER	AP-23/24			AP-24			AP-25				AP-26				
	SB-1	SB-2	SB-3	SB-1	SB-2	SB-3	SB-5	SB-1	SB-1(DUP)	SB-3	SB-4	SB-5	SB-1	SB-5	SB-6
Laboratory Sample I.D. No	T4-00935-10	T4-00935-8	T4-00935-5	T4-0933-3	T4-0933-1	T4-0933-2	T4-0933-4	T4-00935-6	T4-00935-7	T4-00935	T4-00935-4	T4-0933-5	T4-0933-6	T4-00958-1	
Date Drilled & Sampled	03/25/94	03/25/94	03/25/94	03/26/94	03/26/94	03/26/94	03/26/94	03/25/94	03/25/94	03/25/94	03/25/94	03/26/94	03/25/94	03/26/94	
Total Boring Depth (ft. BLS)	6'	6'	6'	7'	7'	7'	6'	7'	7'	7'	7'	7'	7'	6'	
Sample Depth (ft. BLS)	2'-4'	4'-6'	2'-4'	5'-7'	5'-7'	5'-7'	4'-6'	3'-5'	3'-5'	5'-7'	5'-7'	3'-5'	5'-7'	4'-6'	
OVAFID Screening of Sample (ppm**)	62	270	250	4150	8920	850	1030	125	80	225	325	3525	>9725	1150	
LABORATORY ANALYSES															
1,2-Dichloroethane (1,2-DCA)	<6.0	<5.9	<6.0	<5.9	<300	<1500	<6.1	<5.9	<5.9	<5.8	<6.0	<1500	<2900	<120	
TOTAL VOHs (29 species)	<POL	<POL	<POL	<POL	<POL	<POL	<POL	<POL	<POL	<POL	<POL	<POL	<POL	<POL	
Benzene	<6.0	<5.9	<6.0	<5.9	<1500	<1500	<750	<5.9	<5.9	<5.8	<6.0	<1500	<2900	<120	
Toluene	<6.0	<5.9	<6.0	<5.9	<1500	<1500	<750	<5.9	<5.9	<5.8	<6.0	<1500	3700	<120	
Ethylbenzene	<6.0	<5.9	<6.0	<5.9	6100	<1500	<750	<5.9	<5.9	<5.8	<6.0	<1500	3200	<120	
Total Xylenes	<6.0	<5.9	<6.0	<5.9	19000	<1500	1200	<5.9	<5.9	<5.8	<6.0	<1500	17000	<120	
TOTAL VOAs	<POL	<POL	<POL	<POL	25100	<POL	1200	<POL	<POL	<POL	<POL	<POL	23900	<POL	
Methyl-Tert-Butyl-Ether (MTBE)	<60	<59	<60	<59	<15000	<15000	<7500	<59	<59	<58	<60	<15000	<2900	<1200	
Acenaphthene	<400	<380	<380	<1200	<3900	<400	<1900	<410	580	<380	<400	<390	<4000	<780	
Acenaphthylene	<400	<380	<380	<1200	<3900	<400	<1900	<410	<400	<380	<400	<390	<4000	<780	
Benzo(a)pyrene	<400	<380	<380	<1200	<3900	<400	<1900	<410	770	680	<400	<390	<4000	<780	
Benzo(g,h,i)perylene	<400	<380	<380	<1200	<3900	1000	5100	490	2700	3400	930	<390	4300	<780	
Benzo(b,k)fluoranthene	440	<380	<380	<1200	<3900	1500	5600	1500	4700	4600	1500	<390	5900	<780	
Chrysene+Benzo(a)anthracene	410	<380	<380	<1200	<3900	2200	5400	2000	5700	5700	2000	560	7100	<780	
Fluoranthene	<400	<380	<380	<1200	<3900	<400	<1900	410	1400	550	<400	<390	<4000	<780	
Fluorene	<400	<380	<380	<1200	<3900	<400	<1900	<410	940	1800	<400	<390	<4000	<780	
Indeno(1,2,3-cd)pyrene+Dibenz(a,h)anthracene	<400	<380	<380	<1200	<3900	2400	2500	1600	7100	6600	1900	580	7500	<780	
Phenanthrene+Anthracene	<400	520	<380	<1200	<3900	1700	7300	1600	4800	4200	1600	500	5900	<780	
Pyrene	410	<380	<380	<1200	<3900	<POL	8800	8070	29890	28830	8350	1660	30700	<POL	
TOTAL PAHs (excl. naphthalenes)	1260	520	<POL	<POL	4100	<400	2100	<410	<400	<380	<400	2400	13000	1600	
Naphthalene	<400	<380	<380	1700	4100	<400	910	<410	<400	<380	<400	2000	7600	2000	
1-Methylnaphthalene	<400	<380	<380	2300	<3900	1200	5100	<410	<400	<380	<400	3800	15000	5900	
2-Methylnaphthalene	<400	<380	<380	3400	14000	1200	7200	<410	<POL	<POL	<POL	8200	35600	9500	
TOTAL Naphthalenes	<POL	<POL	<POL	7400	18100	2110	7200	<POL	<POL	<POL	<POL	8200	35600	9500	
TRPH, mg/kg	230	120	68	210	800	630	1200	51	290	62	470	360	1400	910	
1,2-Dibromoethane (EDB)	<6.0	<5.9	<6.0	<5.9	<300	<1500	<6.1	<5.9	<5.9	<5.8	<6.0	<1500	<2900	<120	
Total Lead, mg/kg	2.1	7.4	3.9	2.2	12.0	3.0	3.0	1.5	2.2	2.3	1.8	1.8	2.6	1.8	

All units for soil samples are ug/kg, unless otherwise specified. Units for the EOB samples are all ug/l, unless otherwise specified. **Methane corrected.

<POL = Less Than The Practical Quantitation Limit; EOB = Equipment Blank; DUP = Duplicate Sample; BLS = Below Land Surface.

TABLE 16.4 - SOIL SAMPLE ANALYSES: BLDG. NO. 890/APRON LINES AP27, AP28 & AP29

SOIL BORING NUMBER		AP-27			AP-28			AP-29				
Laboratory Sample I.D. No.		SB-1	SB-6	SB-4	SB-6	SB-1	SB-2	SB-4	SB-4(DUP)	SB-5	SB-6	
T4-01088-1		T4-00958-4	T4-00958-5	T4-01025-3	T4-01025-1	T4-01025-2	T4-00958-6	T4-00970-1	T4-00958-2	T4-00958-3		
FIELD DATA												
Date Drilled & Sampled		04/04/94	03/28/94	03/28/94	03/31/94	03/31/94	03/31/94	03/28/94	03/28/94	03/28/94		
Total Boring Depth (ft. BLS)		7'	7'	7'	7'	7'	7'	7'	7'	7'		
Sample Depth (ft. BLS)		4'-7"	3'-5"	5'-7"	3'-5"	3'-7"	5'-7"	5'-7"	5'-7"	5'-7"		
OVA/FID Screening of Sample (ppm**)		4150	1238	>9550	4405	7910	555	8991	>9980	85		
LABORATORY ANALYSES												
1,2-Dichloroethane (1,2-DCA)		<5.8	<620	<6.1	<1500	<3700	<6.0	<6000	<1200	<6.2		
Chlorobenzene		<5.8	<620	9.4/36	<1500	<3700	<6.0	<6000	<1200	<6.2		
TOTAL VOHs (29 species)		<PQL	<PQL	9.4/36	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL		
Benzene		<3700	<620	<6.1	<1500	<3700	<6.0	<6000	<1200	<6.2		
Toluene		6800	1700	9.2	<1500	7300	<6.0	38000	10000	7.2		
Ethylbenzene		<3700	4500	28	<1500	<3700	<6.0	6800	3900	<6.2		
Total Xylenes		15000	<620	5.8	6700	12000	<6.0	<6000	<1200	<6.2		
TOTAL VOAs		21800	6200	43	6700	19300	<PQL	44800	13900	7.2		
Methyl-Tert-Butyl-Ether (MTBE)		<37000	<6200	<6.1	<15000	<37000	<6.0	<60000	<12000	<6.2		
Acenaphthene		620	1100	810	<3900	<1600	<410	<2000	<2000	<410		
Acenaphthylene		<420	<810	<800	<3900	<1600	<410	<2000	<2000	<410		
Benzo(a)pyrene		<420	1100	1000	<3900	<1600	<410	<2000	<2000	<410		
Benzo(g,h,i)perylene		<420	<810	<800	<3900	<1600	<410	<2000	<2000	<410		
Benzo(b,k)fluoranthene		470	2200	2300	<3900	<1600	<410	<2000	<2000	<410		
Chrysene+Benzo(a)anthracene		480	2900	2900	<3900	<1600	<410	<2000	<2000	<410		
Fluoranthene		690	3700	3800	4600	2400	<410	<2000	<2000	<410		
Fluorene		<420	<810	<800	<3900	<1600	<410	<2000	<2000	<410		
Indeno(1,2,3-cd)pyrene+Dibenzof(a,h)anthracene		<420	840	930	<3900	<1600	<410	<2000	<2000	<410		
Phenanthrene+Anthracene		660	6700	3300	7000	2900	<410	<2000	<2000	<410		
Pyrene		560	3400	3300	4200	2200	<410	<2000	<2000	<410		
TOTAL PAHs (excl. naphthalenes)		3480	21940	18340	15800	7500	<PQL	<PQL	<PQL	<PQL		
Naphthalene		6300	1800	2300	8600	5500	770	6700	11000	530		
1-Methylnaphthalene		4300	1600	1300	13000	3800	800	6200	5300	<410		
2-Methylnaphthalene		8500	3000	4400	24000	7900	1800	25000	14000	820		
TOTAL Naphthalenes		19100	6400	8000	45600	17200	3370	37900	30300	1350		
TRPH, mg/kg		1100	850	620	2100	680	430	2600	3500	1000		
1,2-Dibromoethane (EDB)		<5.8	<620	<6.1	<1500	<3700	<6.0	<6000	NA	<6.2		
Total Lead, mg/kg		11.0	1.5	3.5	2.2	3.9	5.7	9.6	15.0	1.3		

All units for soil samples are ug/mg, unless otherwise specified. Units for the EQB samples are all ug/l unless otherwise specified. **Methane corrected.
 <PQL = Less Than The Practical Quantitation Limit; EQB = Equipment Blank; NA = Not Analyzed; DUP = Duplicate Sample; BLS = Below Land Surface.

GROUNDWATER MONITORING SAMPLE ANALYSIS RESULTS

(10/95 - 1/97 SAMPLING EVENTS)

APRON LINES AP-4 THROUGH AP-29

Table 6.0
Comparison of Year One (First through Fourth Quarter) and Year Two First Quarter MO Groundwater Analytical Results
Site SS-15A Flightline Apron, Homestead ARB

MONITORING WELL NO./FIELD NO.	AP5-MW1 (v)				AP5-FHSP-MW21 (v)				AP5-MW6 (v)			
	Year 1 Quarter 1 10/09/98	Year 1 Quarter 2 01/05/99	Year 1 Quarter 3 04/04/99	Year 1 Quarter 4 07/15/98	Year 1 Quarter 1 10/09/98	Year 1 Quarter 2 01/05/99	Year 1 Quarter 3 04/09/98	Year 1 Quarter 4 07/16/98	Year 1 Quarter 1 10/09/98	Year 1 Quarter 2 01/05/99	Year 1 Quarter 3 04/04/99	Year 1 Quarter 4 07/12/98
Depth to Water at Sampling (ft. bgs)	4.92	4.88	5.50	4.92	2.39	2.80	2.88	2.07	4.80	5.05	5.49	5.07
Groundwater Elevation (ft. MVD)	2.00	1.84	1.43	2.10	1.97	1.78	1.38	2.29	2.15	1.90	1.46	1.88
LABORATORY ANALYSES												
Volatile Organic Hydrocarbons (SW-448 Method 8010)												
Toluene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethylbenzene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Xylenes	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TOTAL VOCs	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Volatile Organic Aromatics (SW-448 Method 8020)												
Benzene	19	2	12	2	<1	<1	<1	<1	<1	<1	<1	<1
Toluene	44	44	44	44	44	44	44	44	44	44	44	44
Ethylbenzene	4	5	18	44	44	44	44	44	44	44	44	44
Xylenes	44	44	5	44	44	44	44	44	44	44	44	44
TOTAL VOCs	38	7	35	2	<POL	<POL	<POL	<POL	<POL	<POL	<POL	<POL
Methyl-Tert-Butyl-Ether (MTBE)	<35	<25	<25	<25	<35	<35	<35	<35	<35	<35	<35	<35
Polyaromatic Hydrocarbons (SW-448 Method 8100/8108/8120)												
Acenaphthene	48	48	48	48	48	48	48	48	48	48	48	48
Acenaphthylene	48	48	48	48	48	48	48	48	48	48	48	48
Anthracene	48	48	48	48	48	48	48	48	48	48	48	48
Benzo (g,h,i) Pyrene	48	48	48	48	48	48	48	48	48	48	48	48
Benzo (a) Anthracene	48	48	48	48	48	48	48	48	48	48	48	48
Benzo (e) Pyrene	48	48	48	48	48	48	48	48	48	48	48	48
Benzo (k) Fluoranthene	48	48	48	48	48	48	48	48	48	48	48	48
Chrysene	48	48	48	48	48	48	48	48	48	48	48	48
Fluoranthene	48	48	48	48	48	48	48	48	48	48	48	48
Indeno (1,2,3-cd) Pyrene	48	48	48	48	48	48	48	48	48	48	48	48
Fluorene	48	48	48	48	48	48	48	48	48	48	48	48
Phenanthrene	48	48	48	48	48	48	48	48	48	48	48	48
Pyrene	48	48	48	48	48	48	48	48	48	48	48	48
TOTAL PAHs (excl. naphthalenes)	<POL	<POL	<POL	<POL	<POL	<POL	<POL	<POL	<POL	<POL	<POL	<POL
Naphthalene	20	48	8	48	48	48	48	48	48	48	48	48
1-Methylnaphthalene	12	48	48	48	48	48	48	48	48	48	48	48
2-Methylnaphthalene	14	48	48	48	48	48	48	48	48	48	48	48
TOTAL NAPHTHALENES	48	<POL	8	48	48	48	48	48	48	48	48	48
Total Petroleum Hydrocarbons (EPA Method 418.1/PL-PRO)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Only compounds detected below the reporting limit are listed.
 <POL = Less than Practical Quantitation Limit.
 NA = Not Analyzed.
 NS = Not Sampled.
 * Indicates well was developed prior to quarter MO sampling.
 ** Well redeveloped and analyzed for PAHs by SW-448 Method 8270.

AP5-MW1 (v) is a source well following Year Two First Quarter.
 AP5-FHSP-MW21 (v) is a source well following Year Two First Quarter.
 AP5-MW6 (v) is a source well following Year Two First Quarter.

FDEP allows a Maximum DL of 10 ug/L for PAHs - A POL of 5 ug/L is used for SW-448 Method 8270.
 Note: Year 1 perimeter well standard for benzene = 50 ug/L. Year 2 perimeter well standard for benzene = 1 ug/L.
 *** Well redelegated by the FDEP as a perimeter well following Year One Fourth Quarter.
 **** Well redelegated by QHM as a source well following Year Two First Quarter.

Table 6.0
Comparison of Year One (First through Fourth Quarter) and Year Two First Quarter MO Groundwater Analytical Results
Site SS-15A Flightline Apron, Homestead ARB

MONITORING WELL NO./FIELD NO.	AP10-MW09 (G)				AP11-MW14 (D)				AP11-MW17 (G)			
	Year 1 Quarter 1 09/18/98	Year 1 Quarter 2 01/08/99	Year 1 Quarter 3 07/18/98	Year 1 Quarter 4 12/21/97	Year 1 Quarter 1 01/10/98	Year 1 Quarter 2 07/18/98 - 08/19/98	Year 1 Quarter 3 01/02/97	Year 1 Quarter 4 10/02/98	Year 1 Quarter 1 01/08/98	Year 1 Quarter 2 07/17/98	Year 1 Quarter 3 04/04/98	Year 1 Quarter 4 07/17/98
MOP SAMPLING EVENT	Date Sampled	Date Sampled	Date Sampled	Date Sampled	Date Sampled	Date Sampled	Date Sampled	Date Sampled	Date Sampled	Date Sampled	Date Sampled	Date Sampled
Depth to Water at Sampling (ft. bgs)	5.03	5.08	5.53	4.87	5.12	4.75 - 4.89	5.40	4.01	4.78	4.37	5.15	5.03
Groundwater Elevation (ft. NGVD)	1.80	1.84	1.40	2.08	1.81	2.18 - 2.24	1.53	2.88	1.84	2.22	1.44	1.54
LABORATORY ANALYSES												
Volatiles Organic Hydrocarbons (SW-448 Method 8010)	Units											
Trans-1,2-Dichloroethene	ug/l	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cis-1,2-Dichloroethene	ug/l	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Trichloroethene	ug/l	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Trichlorofluoromethane	ug/l	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Vinyl Chloride	ug/l	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Volatiles Organic Aromatics (SW-448 Method 8020)	ug/l											
Benzene	ug/l	13	22	13	18	23	6.7	4	4	11	4	3
Toluene	ug/l	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
Ethylbenzene	ug/l	140	130	76	130	38.7	38.7	8	4	8	4	8
Total Xylenes	ug/l	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
TOTAL VOCs	ug/l	153	132	88	140	46	44.7	4	7	19	4	3
Methyl-Tert-Butyl-Ether (MTBE)	ug/l	<35	<35	<35	<35	<35	<35	<35	<35	<35	<35	<35
Polynuclear Aromatic Hydrocarbons (SW-448 Method 8100/8101/8102/8103)	ug/l											
Acenaphthene	ug/l	<5	28	20	<5	38	<5	<5	<5	<5	<5	<5
Acenaphthylene	ug/l	<5	8	6	<5	8	<5	<5	<5	<5	<5	<5
Anthracene	ug/l	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Benzo (g,h,i) Pyrene	ug/l	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Benzo (k) Anthracene	ug/l	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Benzo (a) Pyrene	ug/l	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Benzo (b) Fluoranthene	ug/l	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Chrysene	ug/l	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Fluoranthene	ug/l	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Indeno (1,2,3-cd) Pyrene	ug/l	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Fluorene	ug/l	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Phenanthrene	ug/l	7	<5	<5	<5	8	<5	<5	<5	<5	<5	<5
Pyrene	ug/l	<5	<5	<5	<5	7	<5	<5	<5	<5	<5	<5
1-Methylnaphthalene	ug/l	110	17	28	35	130	<POL	<POL	<POL	<POL	<POL	<POL
2-Methylnaphthalene	ug/l	<5	22	22	11	130	88	300	34	11	8	13
TOTAL NAPHTHALENES	ug/l	84	22	28	14	240	130	580	38	11	8	13
TOTAL PETROLEUM HYDROCARBONS (EPA Method 418.1/FL-PRO)	ug/l	188	81	118	80	340	378	1500	112	28	16	18
TPH/TPH	mg/l	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH/TPH	mg/l	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Only compounds detected above their respective PQLs are listed
 *PQL = Less than Practical Quantitation Limit
 NA = Not Analyzed
 NS = Not Sampled
 * Speciated well used overdeveloped prior to quarter MO sampling
 ** Well resampled and analyzed for PAHs by SW-448 Method 8210
 FDEP Above a Maximum DL of 10 ug/l for PAHs - A PQL of 5 ug/l is used for SW-448 Method 8210
 Note: Year 1 perimeter well standard for benzene = 50 ug/l, Year 2 perimeter well standard for benzene = 1 ug/l
 *** Well redesignated by the FDEP as a perimeter well following Year One Fourth Quarter
 **** Well redesignated by OHM as a source well following Year Two First Quarter

Table 6.0
Comparison of Year One (First through Fourth Quarter) and Year Two First Quarter MO Groundwater Analytical Results
Site SS-15A Flightline Apron, Homestead ARB

MONITORING WELL NO./FIELD NO.	AP12-MW21 (d)				AP12-MW24 (d)				AP12-MW20 (d)			
	Year 1 Quarter 1	Year 1 Quarter 2	Year 1 Quarter 3	Year 1 Quarter 4	Year 1 Quarter 1	Year 1 Quarter 2	Year 1 Quarter 3	Year 1 Quarter 4	Year 1 Quarter 1	Year 1 Quarter 2	Year 1 Quarter 3	Year 1 Quarter 4
MOP SAMPLING EVENT	10/09/98	01/09/99	04/04/99	07/17/98	01/02/97	01/09/98	04/04/98	07/17/98	01/02/97	01/09/98	04/04/98	07/17/98
One Sampled	4.84	4.88	8.37	4.88	8.37	8.80	8.30	8.90	8.31	8.80	8.30	8.90
Depth to Water at Sampling (ft. bgs)	4.84	4.88	8.37	4.88	8.37	8.80	8.30	8.90	8.31	8.80	8.30	8.90
Groundwater Elevation (ft. NGVD)	1.86	1.82	1.43	2.23	1.53	1.82	1.42	2.23	1.51	1.81	1.42	2.23
LABORATORY ANALYSES												
Volatile Organic Aromatics (SW-448 Method 8010)												
Benzene	4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Toluene	4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethylbenzene	4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Xylenes	4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TOTAL VOCs	4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Volatile Organic Aromatics (SW-448 Method 8020)												
Benzene	1	32	7	4	8.7	8.7	23	4.5	28	NS	NS	NS
Toluene	4	44	4	4	44	44	44	44	44	NS	NS	NS
Ethylbenzene	4	120	24	10	31.7	71	14	20	6	NS	NS	NS
Total Xylenes	4	17	4	4	44	44	44	44	44	NS	NS	NS
TOTAL VOCs	4	169	31	27	48.7	158	37	83	34	NS	NS	NS
Methyl-Tert-Butyl-Ether (MTBE)	4-25	<25	<25	<25	<25	<25	<25	<25	<25	NS	NS	NS
Polynuclear Aromatic Hydrocarbons (SW-448 Method 8100/8120/8170)												
Acenaphthene	ugl	28	45	45	45	45	45	45	45	NS	NS	NS
Acenaphthylene	ugl	9	45	45	45	45	45	45	45	NS	NS	NS
Anthracene	ugl	45	45	45	45	45	45	45	45	NS	NS	NS
Benz(a,h,i) Pyrene	ugl	45	45	45	45	45	45	45	45	NS	NS	NS
Benz(a) Anthracene	ugl	45	45	45	45	45	45	45	45	NS	NS	NS
Benz(a) Pyrene	ugl	45	45	45	45	45	45	45	45	NS	NS	NS
Benz(a) Fluoranthene	ugl	45	45	45	45	45	45	45	45	NS	NS	NS
Chrysene	ugl	45	45	45	45	45	45	45	45	NS	NS	NS
Fluoranthene	ugl	45	45	45	45	45	45	45	45	NS	NS	NS
Indeno (1,2,3-cd) Pyrene	ugl	45	45	45	45	45	45	45	45	NS	NS	NS
Fluorene	ugl	8	45	45	45	45	45	45	45	NS	NS	NS
Phenanthrene	ugl	45	45	45	45	45	45	45	45	NS	NS	NS
Pyrene	ugl	45	45	45	45	45	45	45	45	NS	NS	NS
TOTAL PAHs (excl. naphthalenes)	ugl	45	45	45	45	45	45	45	45	NS	NS	NS
Naphthalene	ugl	230	31	17	38	20	18	7	7	NS	NS	NS
1-Methylnaphthalene	ugl	130	34	28	25	19	18	48	9	NS	NS	NS
2-Methylnaphthalene	ugl	170	22	13	22	12	8	45	13	NS	NS	NS
TOTAL NAPHTHALENES	ugl	530	87	47	85	51	44	7	48	NS	NS	NS
Total Petroleum Hydrocarbons (EPA Method 418.1/FL-PRO)												
TPH/TPH1	mg/l	NA	NA	NA	NA	NA	NA	NA	NA	NS	NS	NS
TPH/TPH2	mg/l	NA	NA	NA	NA	NA	NA	NA	NA	NS	NS	NS

Only compounds detected above their respective PQL are listed
 *PQL = Less than Practical Quantitation Limit
 NA = Not Analyzed
 NS = Not Sampled
 *Indicates well was overdeveloped prior to quarter MO sampling
 **Well resampled and analyzed for PAHs by SW-448 Method 8270

AP12-MW21 (d) : above PAC Chapter 82-770 groundwater target level
 AP12-MW24 (d) : above FDEP MO groundwater standard
 AP12-MW20 (d) : above FDEP MO groundwater standard

FDEP Adhere a Maximum DL of 10 ug/l for PAHs - A PQL of 5 ug/l is used for SW-448 Method 8270
 Note: Year 1 permitter well standard for benzene = 50 ug/l, Year 2 permitter well standard for benzene = 1 ug/l
 ***Well redegraded by the FDEP as a permitter well following Year One Fourth Quarter
 ****Well redegraded by CH2M as a source well following Year Two First Quarter

Table 6.0
Comparison of Year One (First through Fourth Quarter) and Year Two First Quarter MO Groundwater Analytical Results
Site SS-15A Flightline Apron, Homestead ARB

MONITORING WELL NO./FIELD NO.	AP15-MW27 (U)				AP15-MW28 (U)				AP15-MW98 (P)			
	Year 1 Quarter 1*	Year 1 Quarter 2	Year 1 Quarter 3	Year 1 Quarter 4	Year 2 Quarter 1	Year 2 Quarter 2	Year 2 Quarter 3	Year 2 Quarter 4	Year 3 Quarter 1	Year 3 Quarter 2	Year 3 Quarter 3	Year 3 Quarter 4
HOP SAMPLING EVENT	1002/265	01/10/96	04/05/96	07/18/96	01/03/97	04/05/96	07/18/96	01/03/97	09/28/95	01/10/96	04/05/96	07/22/96
Date Sampled	5.15	8.85	8.21	8.49	8.18	5.98	8.23	5.58	4.10	4.84	5.24	4.50
Depth to Water at Sampling (ft. bslc)	2.49	1.79	1.43	2.15	1.48	1.78	1.54	2.19	2.56	1.82	1.42	2.16
Groundwater Elevation (ft. NGVD)												
Unit												
LABORATORY ANALYSES												
Volatiles Organic Hydrocarbons (SW-448 Method 8010)												
Trans-1,2-Dichloroethene	4	7	6	6	5	5	5	4	4	6	5	6
Cis-1,2-Dichloroethene	4	6	6	7	8	7	6	4	4	16	13	13
Trichloroethene	1	1	<1	<1	<1	<1	<1	<1	<1	3	4	2
Trichlorofluoromethane	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Vinyl Chloride	1	2	<1	1	2	3	<1	2	<1	<1	<1	<1
Volatiles Organic Aromatics (SW-448 Method 8020)												
Benzene	1	10	3	11	3	3	<1	4	<1	<1	<1	2
Toluene	4	4	4	4	4	4	4	4	4	4	4	4
Ethylbenzene	4	4	4	4	4	4	4	4	4	4	4	4
Total Xylenes	4	4	4	4	4	4	4	4	4	4	4	4
TOTAL VOAs	4	4	4	4	4	4	4	4	4	4	4	4
Methyl-Tert-Butyl-Ether (MTBE)	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25
Polynuclear Aromatic Hydrocarbons (SW-448 Method 8100/8102/8103)												
Acenaphthene	5-50	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Acenaphthylene	5-50	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Anthracene	5-50	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Benzo (g,h,i) Perylene	5-50	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Benzo (a) Anthracene	5-50	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Benzo (k) Fluoranthene	5-50	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Chrysene	5-50	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Fluoranthene	5-50	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Indene (1,2,3-cd) Pyrene	5-50	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Fluorene	5-50	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Phenanthrene	5-50	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Pyrene	5-50	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
TOTAL PAHs (excl. naphthalenes)	<POL	<POL	<POL	<POL	<POL	<POL	<POL	<POL	<POL	<POL	<POL	<POL
Naphthalene	5-50	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
1-Methylnaphthalene	5-50	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
2-Methylnaphthalene	5-100	<5	<5	<5	<10	<5	<5	<5	<10	<5	<5	<10
TOTAL NAPHTHALENES	<POL	<POL	<POL	<POL	<POL	<POL	<POL	<POL	<POL	<POL	<POL	<POL
Total Petroleum Hydrocarbons (EPA Method 418.1/PL-PRO)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TRP/TPH ¹	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
TPH ¹	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l

Only compounds detected above their respective PQLs are listed
 *PQL = Less than Practical Quantitation Limit
 bsc = below top of casing
 NA = Not Analyzed
 NS = Not Sampled
 * Indicates well was overdeveloped prior to quarter MO sampling
 ** Well resampled and analyzed for PAHs by SW-448 Method 8270

Table 6.0
Comparison of Year One (First through Fourth Quarter) and Year Two First Quarter MO Groundwater Analytical Results
Site SS-15A Flightline Apron, Homestead ARB

MONITORING WELL NO./FIELD NO.	AP18-MW33 (L)				AP18-FHSP-MW27 (P)				AP17-MW40 (L)			
	Year 1 Quarter 1*	Year 1 Quarter 2	Year 1 Quarter 3	Year 1 Quarter 4	Year 1 Quarter 1*	Year 1 Quarter 2	Year 1 Quarter 3	Year 1 Quarter 4	Year 1 Quarter 1*	Year 1 Quarter 2	Year 1 Quarter 3	Year 1 Quarter 4
MOP SAMPLING EVENT	09/28/95	01/11/96	04/09/96	07/23/96	10/09/95	01/03/97	04/10/96	07/23/96	09/25/95	01/11/96	04/09/96	07/23/96
Date Sampled	4.89	4.80	5.37	4.45	2.75	5.14	3.00	3.18	4.91	3.12	5.37	4.78
Depth to Water at Sampling (ft. bgs)												
Groundwater Elevation (ft. NGVD)	1.92	1.81	1.34	2.18	2.03	1.47	1.78	1.62	1.90	1.78	1.33	2.14
Units												
LABORATORY ANALYSES												
Volatile Organic Hydrocarbons (SW-846 Method 810)												
Trans-1,2-Dichloroethene	4	7	5	4	7	4	4	4	NA	NA	NA	4
Cis-1,2-Dichloroethene	4	18	11	11	19	8	8	7	NA	NA	NA	4
Trichloroethene	1	<1	<1	<1	3	5	3	5	NA	NA	NA	<1
Trichlorofluoromethane	1	<1	<1	<1	<1	<1	<1	<1	NA	NA	NA	<1
Vinyl Chloride	1	<1	<1	<1	<1	<1	<1	<1	NA	NA	NA	<1
Volatile Organic Aromatics (SW-846 Method 8020)												
Benzene	23	42	44	47	27	4	<1	<1	NA	NA	NA	4
Toluene	4	<1	<1	<1	<1	<1	<1	<1	NA	NA	NA	4
Ethylbenzene	13	13	7	14	6	<1	<1	<1	NA	NA	NA	4
Total Xylenes	4	<1	<1	<1	<1	<1	<1	<1	NA	NA	NA	4
TOTAL VOCs	38	55	51	61	33	1	<1	<1	NA	NA	NA	4
Methyl-Tert-Butyl-Ether (MTBE)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Polynuclear Aromatic Hydrocarbons (SW-846 Method 8100/8102/8270)												
Acenaphthene	22	7	8	43	43	43	43	43	11	43	13	43
Acenaphthylene	43	43	43	43	43	43	43	43	43	43	17	43
Anthracene	43	43	43	43	43	43	43	43	43	43	43	43
Benzo (a,h,i) Pyrene	43	43	43	43	43	43	43	43	43	43	43	43
Benzo (a) Anthracene	43	43	43	43	43	43	43	43	43	43	43	43
Benzo (a) Pyrene	43	43	43	43	43	43	43	43	43	43	43	43
Benzo (k) Fluoranthene	43	43	43	43	43	43	43	43	43	43	43	43
Chrysene	43	43	43	43	43	43	43	43	43	43	43	43
Fluoranthene	43	43	43	43	43	43	43	43	43	43	43	43
Indeno (1,2,3-cd) Pyrene	43	43	43	43	43	43	43	43	43	43	43	43
Fluorene	43	43	43	43	43	43	43	43	43	43	43	43
Phenanthrene	11	43	43	43	43	43	43	43	12	43	8	43
Pyrene	43	43	43	43	43	43	43	43	9	43	43	43
TOTAL PAHs (incl. naphthalenes)	33	7	14	<1	<1	<1	<1	<1	32	7	35	<1
Naphthalene	240	93	100	120	78	43	43	43	170	160	290	140
1-Methylnaphthalene	150	57	73	78	34	43	43	43	90	39	83	55
2-Methylnaphthalene	130	44	48	84	45	43	43	43	68	82	110	77
TOTAL NAPHTHALENES	520	194	222	282	155	135	43	43	338	251	483	272
Total Petroleum Hydrocarbons (EPA Method 418.1/FL-PRO)												
TPH/TPH	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
TPH	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Only compounds detected above their respective PQLs are listed
 *PQL = 1.0 ug/l for VOCs, 0.10-1.0 ug/l for PAHs, 1.0 ug/l for TPH
 NA = Not Analyzed
 NS = Not Sampled
 ** Locality well not investigated prior to earlier MO sampling
 *** Well redesignated by the FDEP as a source well following Year One Fourth Quarter
 **** Well redesignated by OHM as a source well following Year Two First Quarter

Table 6.0
Comparison of Year One (First through Fourth Quarter) and Year Two First Quarter MO Groundwater Analytical Results
Site SS-15A Flightline Apron, Homestead ARB

MONITORING WELL NO./FIELD NO.											
MOP SAMPLING EVENT											
Year 1 Quarter 1	Year 1 Quarter 2	Year 1 Quarter 3	Year 1 Quarter 4	Year 2 Quarter 1	Year 2 Quarter 2	Year 2 Quarter 3	Year 2 Quarter 4	Year 3 Quarter 1	Year 3 Quarter 2	Year 3 Quarter 3	Year 3 Quarter 4
09/25/95	01/11/96	04/08/96	07/22/96	01/02/97	04/10/96	07/28/96	01/08/97	NS	02/15/98	04/10/98	07/28/98
4.80	4.98	5.44	4.80	5.30	2.87	2.70	3.35	NS	2.89	3.01	2.59 - 2.40
1.99	1.81	1.35	2.19	1.49	1.78	2.02	1.37	NS	1.75	1.83	2.09 - 2.24
Units											
LABORATORY ANALYSES											
Volatile Organic Hydrocarbons (SW-448 Method 8010)											
Trans-1,2-Dichloroethene	ug/l	NA	5	4	NA	NA	NA	Well not yet installed	NA	NA	NA
Cis-1,2-Dichloroethene	ug/l	NA	12	8	NA	NA	NA	NA	NA	NA	NA
Trichloroethene	ug/l	NA	<1	NA	NA	NA	<1	<1	NA	NA	NA
Trichlorofluoromethane	ug/l	NA	<1	NA	NA	NA	<1	<1	NA	NA	NA
Vinyl Chloride	ug/l	NA	1	3	NA	NA	<1	<1	NA	NA	NA
Volatile Organic Aromatics (SW-448 Method 8020)											
Benzene	ug/l	1	<1	<1	<1	10	4	<1	NA	NA	NA
Toluene	ug/l	4	<4	<4	<4	NA	NA	<4	NA	NA	NA
Ethylbenzene	ug/l	4	<4	<4	<4	NA	NA	<4	NA	NA	NA
Total Xylenes	ug/l	4	<4	<4	<4	NA	NA	<4	NA	NA	NA
TOTAL VOAs	ug/l	1	<1	<1	<1	10	4	<1	NA	NA	NA
Methyl-Tert-Butyl-Ether (MTBE)	ug/l	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25
Polynuclear Aromatic Hydrocarbons (SW-448 Method 8100/8102/8104/8106/8108/8110/8112/8114/8116/8118/8120/8122/8124/8126/8128/8130/8132/8134/8136/8138/8140/8142/8144/8146/8148/8150/8152/8154/8156/8158/8160/8162/8164/8166/8168/8170/8172/8174/8176/8178/8180/8182/8184/8186/8188/8190/8192/8194/8196/8198/8200/8202/8204/8206/8208/8210/8212/8214/8216/8218/8220/8222/8224/8226/8228/8230/8232/8234/8236/8238/8240/8242/8244/8246/8248/8250/8252/8254/8256/8258/8260/8262/8264/8266/8268/8270/8272/8274/8276/8278/8280/8282/8284/8286/8288/8290/8292/8294/8296/8298/8300/8302/8304/8306/8308/8310/8312/8314/8316/8318/8320/8322/8324/8326/8328/8330/8332/8334/8336/8338/8340/8342/8344/8346/8348/8350/8352/8354/8356/8358/8360/8362/8364/8366/8368/8370/8372/8374/8376/8378/8380/8382/8384/8386/8388/8390/8392/8394/8396/8398/8400/8402/8404/8406/8408/8410/8412/8414/8416/8418/8420/8422/8424/8426/8428/8430/8432/8434/8436/8438/8440/8442/8444/8446/8448/8450/8452/8454/8456/8458/8460/8462/8464/8466/8468/8470/8472/8474/8476/8478/8480/8482/8484/8486/8488/8490/8492/8494/8496/8498/8500/8502/8504/8506/8508/8510/8512/8514/8516/8518/8520/8522/8524/8526/8528/8530/8532/8534/8536/8538/8540/8542/8544/8546/8548/8550/8552/8554/8556/8558/8560/8562/8564/8566/8568/8570/8572/8574/8576/8578/8580/8582/8584/8586/8588/8590/8592/8594/8596/8598/8600/8602/8604/8606/8608/8610/8612/8614/8616/8618/8620/8622/8624/8626/8628/8630/8632/8634/8636/8638/8640/8642/8644/8646/8648/8650/8652/8654/8656/8658/8660/8662/8664/8666/8668/8670/8672/8674/8676/8678/8680/8682/8684/8686/8688/8690/8692/8694/8696/8698/8700/8702/8704/8706/8708/8710/8712/8714/8716/8718/8720/8722/8724/8726/8728/8730/8732/8734/8736/8738/8740/8742/8744/8746/8748/8750/8752/8754/8756/8758/8760/8762/8764/8766/8768/8770/8772/8774/8776/8778/8780/8782/8784/8786/8788/8790/8792/8794/8796/8798/8800/8802/8804/8806/8808/8810/8812/8814/8816/8818/8820/8822/8824/8826/8828/8830/8832/8834/8836/8838/8840/8842/8844/8846/8848/8850/8852/8854/8856/8858/8860/8862/8864/8866/8868/8870/8872/8874/8876/8878/8880/8882/8884/8886/8888/8890/8892/8894/8896/8898/8900/8902/8904/8906/8908/8910/8912/8914/8916/8918/8920/8922/8924/8926/8928/8930/8932/8934/8936/8938/8940/8942/8944/8946/8948/8950/8952/8954/8956/8958/8960/8962/8964/8966/8968/8970/8972/8974/8976/8978/8980/8982/8984/8986/8988/8990/8992/8994/8996/8998/9000/9002/9004/9006/9008/9010/9012/9014/9016/9018/9020/9022/9024/9026/9028/9030/9032/9034/9036/9038/9040/9042/9044/9046/9048/9050/9052/9054/9056/9058/9060/9062/9064/9066/9068/9070/9072/9074/9076/9078/9080/9082/9084/9086/9088/9090/9092/9094/9096/9098/9100/9102/9104/9106/9108/9110/9112/9114/9116/9118/9120/9122/9124/9126/9128/9130/9132/9134/9136/9138/9140/9142/9144/9146/9148/9150/9152/9154/9156/9158/9160/9162/9164/9166/9168/9170/9172/9174/9176/9178/9180/9182/9184/9186/9188/9190/9192/9194/9196/9198/9200/9202/9204/9206/9208/9210/9212/9214/9216/9218/9220/9222/9224/9226/9228/9230/9232/9234/9236/9238/9240/9242/9244/9246/9248/9250/9252/9254/9256/9258/9260/9262/9264/9266/9268/9270/9272/9274/9276/9278/9280/9282/9284/9286/9288/9290/9292/9294/9296/9298/9300/9302/9304/9306/9308/9310/9312/9314/9316/9318/9320/9322/9324/9326/9328/9330/9332/9334/9336/9338/9340/9342/9344/9346/9348/9350/9352/9354/9356/9358/9360/9362/9364/9366/9368/9370/9372/9374/9376/9378/9380/9382/9384/9386/9388/9390/9392/9394/9396/9398/9400/9402/9404/9406/9408/9410/9412/9414/9416/9418/9420/9422/9424/9426/9428/9430/9432/9434/9436/9438/9440/9442/9444/9446/9448/9450/9452/9454/9456/9458/9460/9462/9464/9466/9468/9470/9472/9474/9476/9478/9480/9482/9484/9486/9488/9490/9492/9494/9496/9498/9500/9502/9504/9506/9508/9510/9512/9514/9516/9518/9520/9522/9524/9526/9528/9530/9532/9534/9536/9538/9540/9542/9544/9546/9548/9550/9552/9554/9556/9558/9560/9562/9564/9566/9568/9570/9572/9574/9576/9578/9580/9582/9584/9586/9588/9590/9592/9594/9596/9598/9600/9602/9604/9606/9608/9610/9612/9614/9616/9618/9620/9622/9624/9626/9628/9630/9632/9634/9636/9638/9640/9642/9644/9646/9648/9650/9652/9654/9656/9658/9660/9662/9664/9666/9668/9670/9672/9674/9676/9678/9680/9682/9684/9686/9688/9690/9692/9694/9696/9698/9700/9702/9704/9706/9708/9710/9712/9714/9716/9718/9720/9722/9724/9726/9728/9730/9732/9734/9736/9738/9740/9742/9744/9746/9748/9750/9752/9754/9756/9758/9760/9762/9764/9766/9768/9770/9772/9774/9776/9778/9780/9782/9784/9786/9788/9790/9792/9794/9796/9798/9800/9802/9804/9806/9808/9810/9812/9814/9816/9818/9820/9822/9824/9826/9828/9830/9832/9834/9836/9838/9840/9842/9844/9846/9848/9850/9852/9854/9856/9858/9860/9862/9864/9866/9868/9870/9872/9874/9876/9878/9880/9882/9884/9886/9888/9890/9892/9894/9896/9898/9900/9902/9904/9906/9908/9910/9912/9914/9916/9918/9920/9922/9924/9926/9928/9930/9932/9934/9936/9938/9940/9942/9944/9946/9948/9950/9952/9954/9956/9958/9960/9962/9964/9966/9968/9970/9972/9974/9976/9978/9980/9982/9984/9986/9988/9990/9992/9994/9996/9998/10000											
Total Petroleum Hydrocarbons (EPA Method 418.1/PL-PRO)											
TPH	mg/l	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH	mg/l	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH	mg/l	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH	mg/l	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH	mg/l	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

One compound detected above its respective PQL is listed
 PQL = Limit of Quantitation
 NA = Not Analyzed
 NS = Not Sampled
 * Indicates well not sampled prior to water table sampling
 ** Well sampled and analyzed for PAHs by SW-448 Method 8270

TPH = Total Recoverable Petroleum Hydrocarbons
 EPA Method 418.1 utilized for Year 1 Quarter 1 and 2 analyses
 J = Estimated value, below the PQL and at or above the MDL
 J* = Estimated value, due to sorbed sorbent recovery

AP17-MW88 [D] : Source Well
 AP17-FHSP-MW28 [D] : above FAC Chapter 62-770 groundwater target level
 AP17-MW108 [D] : above FAC Chapter 62-770 groundwater target level

FDEP Allows a Maximum DL of 10 ug/l for PAHs - A PQL of 5 ug/l is used for SW-448 Method 8270
 Note: Year 1 perimeter well standard for benzene = 50 ug/l, Year 2 perimeter well standard for benzene = 1 ug/l
 *** Well redesignated by the FDEP as a perimeter well following Year One Fourth Quarter
 **** Well redesignated by OHM as a source well following Year Two First Quarter

Table 6.0
Comparison of Year One (First through Fourth Quarter) and Year Two First Quarter MO Groundwater Analytical Results
Site SS-15A Flightline Apron, Homestead ARB

MONITORING WELL NO./FIELD NO.		AP18-MW41 (p)				AP18-FHSP-MW38 (p)				AP18-MW44 (p)			
MOP SAMPLING EVENT		Year 1 Quarter 1	Year 1 Quarter 2	Year 1 Quarter 3	Year 1 Quarter 4	Year 1 Quarter 1	Year 1 Quarter 2	Year 1 Quarter 3	Year 1 Quarter 4	Year 1 Quarter 1	Year 1 Quarter 2	Year 1 Quarter 3	Year 1 Quarter 4
Date Sampled		07/28/95	01/11/96	04/08/96	07/27/96	01/08/97	10/06/95	01/12/96	04/10/96	07/28/96	01/11/96	08/25/96	07/22/96
Depth to Water at Sampling (ft. bgs)		8.09	8.20	8.85	4.85	5.88	2.77	3.06	3.78	3.82	4.94	5.83	4.83
Groundwater Elevation (ft. NGVD)		1.91	1.80	1.25	2.15	1.42	2.06	1.77	1.57	2.01	2.03	1.34	2.14
Units													
LABORATORY ANALYSES													
Volatiles Organic Hydrocarbons (SW-44 Method 8010)													
Trans-1,2-Dichloroethene	ug/l	<4	<4	<4	<4	NA	<4	<4	<4	<4	NA	NA	NA
Cis-1,2-Dichloroethene	ug/l	<4	<4	<4	<4	NA	<4	<4	<4	<4	NA	NA	NA
Trichloroethene	ug/l	<1	<1	<1	<1	NA	<1	<1	<1	<1	NA	NA	NA
Trichlorofluoromethane	ug/l	<1	<1	<1	<1	NA	<1	<1	<1	<1	NA	NA	NA
Vinyl Chloride	ug/l	<1	<1	<1	<1	NA	<1	<1	<1	<1	NA	NA	NA
Nonhalogenated Aromatics (SW-44 Method 8020)													
Benzene	ug/l	2	1	<1	<1	<1	<1	<1	<1	<1	18	<1	<1
Toluene	ug/l	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
Ethylbenzene	ug/l	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
Total Xylenes	ug/l	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
TOTAL VOAs	ug/l	2	1	<1	<1	<1	<1	<1	<1	<1	18	<1	<1
Methyl-Tert-Butyl-Ether (MTBE)	ug/l	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25
Polynuclear Aromatic Hydrocarbons (SW-44 Method 8100/8102/8107)													
Acenaphthene	ug/l	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
Acenaphthylene	ug/l	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
Anthracene	ug/l	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
Benzo (a,h,i) Pyrene	ug/l	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
Benzo (a) Anthracene	ug/l	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
Benzo (b) Pyrene	ug/l	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
Benzo (k) Fluoranthene	ug/l	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
Chrysene	ug/l	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
Fluoranthene	ug/l	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
Indene (1,2,3-cd) Pyrene	ug/l	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
Fluorene	ug/l	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
Phenanthrene	ug/l	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
Pyrene	ug/l	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
TOTAL PAHs (excl. naphthalenes)	ug/l	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Naphthalene	ug/l	10	11	11	27	8	8	8	<4	<4	18	<4	<4
1-Methylnaphthalene	ug/l	8	8	12	<4	<4	<4	<4	<4	<4	7	<4	<4
2-Methylnaphthalene	ug/l	<4	<4	<4	<4	<4	<4	<4	<4	<4	8	<4	<4
TOTAL NAPHTHALENES	ug/l	18	19	23	27	6	6	6	<4	<4	25	<4	<4
Total Petroleum Hydrocarbons (EPA Method 418.1/FL-PRO)		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TRBHTPH		mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l

Only compounds which are shown their respective PQLs are listed
 <PQL = Not Detected
 NA = Not Analyzed
 NA = Not Sampled
 * Indicates well was redeveloped prior to making MO samples
 ** Well redeveloped and analyzed for PAHs by SW-44 Method 8270

FDEP Above a Maximum DL of 10 ug/l for PAHs - A PQL of 5 ug/l is used for SW-44 Method 8270
 Note: Year 1 perimeter well standard for benzene = 50 ug/l, Year 2 perimeter well standard for benzene = 1 ug/l
 *** Well redesignated by the FDEP as a perimeter well following Year One Fourth Quarter
 **** Well redesignated by ODM as a source well following Year Two First Quarter

Table 6.0
Comparison of Year One (First through Fourth Quarter) and Year Two First Quarter MO Groundwater Analytical Results
Site SS-15A Flightline Apron, Homestead ARB

MONITORING WELL NO FIELD NO.		AP20-MW50 (L)				AP20-MW100 (P)				AP21-MW54 (S)			
MOP SAMPLING EVENT		Year 1 Quarter 1	Year 1 Quarter 2	Year 1 Quarter 3	Year 1 Quarter 4	Year 1 Quarter 1	Year 1 Quarter 2	Year 1 Quarter 3	Year 1 Quarter 4	Year 1 Quarter 1	Year 1 Quarter 2	Year 1 Quarter 3	Year 1 Quarter 4
Date Sampled		01/11/98	07/24/98	04/11/98	07/24/98	01/10/97	07/24/98	04/11/98	07/24/98	09/14/95	01/12/98	04/11/98	07/24/98
Depth to Water at Sampling (ft. bgs)		NS	8.18	8.41	8.78	4.31	8.08	8.38	4.70	4.78	8.10	5.42	4.08
Groundwater Elevation (ft. NGVD)		NS	1.77	1.82	2.18	2.54	1.80	1.49	2.15	2.10	1.78	1.47	2.81
LABORATORY ANALYSES		Units	PQL										
Volatile Organic Hydrocarbons (SW-448 Method 8010)													
Trans-1,2-Dichloroethene	ug/l	4	<4	<4	<4	<4	<4	<4	<4	NA	<4	<4	NA
Chloro-1,2-Dichloroethene	ug/l	4	<4	<4	<4	<4	<4	<4	<4	NA	<4	<4	NA
Trichloroethene	ug/l	1	<1	<1	<1	<1	<1	<1	<1	NA	<1	<1	NA
Trichlorofluoromethane	ug/l	1	<1	<1	<1	<1	<1	<1	<1	NA	<1	<1	NA
Vinyl Chloride	ug/l	1	<1	<1	<1	<1	<1	<1	<1	NA	<1	<1	NA
Volatile Organic Aromatics (SW-448 Method 8030)													
Benzene	ug/l	1	15	<1	3	<1	<1	<1	<1	8	<1	<1	<1
Toluene	ug/l	4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
Ethylbenzene	ug/l	4	<4	<4	<4	<4	<4	<4	<4	15	<4	<4	<4
Total Xylenes	ug/l	4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
TOTAL VOAs	ug/l	4	<4	<4	<4	<4	<4	<4	<4	24	<4	<4	<4
Methyl-Tert-Butyl-Ether (MTBE)													
MTBE	ug/l	4-25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25
Polynuclear Aromatic Hydrocarbons (SW-448 Method 8100/8104/8270)													
Acenaphthene	ug/l	8-50	<8	<8	<8	<8	<8	<8	<8	<8	<8	<8	<8
Acenaphthylene	ug/l	8-50	<8	<8	<8	<8	<8	<8	<8	<8	<8	<8	<8
Anthracene	ug/l	8-50	<8	<8	<8	<8	<8	<8	<8	<8	<8	<8	<8
Benzo (a,h,i) Pyrene	ug/l	8-50	<8	<8	<8	<8	<8	<8	<8	<8	<8	<8	<8
Benzo (a) Anthracene	ug/l	8-50	<8	<8	<8	<8	<8	<8	<8	<8	<8	<8	<8
Benzo (k) Pyrene	ug/l	8-50	<8	<8	<8	<8	<8	<8	<8	<8	<8	<8	<8
Benzo (b) Fluoranthene	ug/l	8-50	<8	<8	<8	<8	<8	<8	<8	<8	<8	<8	<8
Chrysene	ug/l	8-50	<8	<8	<8	<8	<8	<8	<8	<8	<8	<8	<8
Fluoranthene	ug/l	8-50	<8	<8	<8	<8	<8	<8	<8	<8	<8	<8	<8
Indeno (1,2,3-cd) Pyrene	ug/l	8-50	<8	<8	<8	<8	<8	<8	<8	<8	<8	<8	<8
Fluorene	ug/l	8-50	7	<8	<8	<8	<8	<8	<8	<8	<8	<8	<8
Phenanthrene	ug/l	8-50	<8	<8	<8	<8	<8	<8	<8	<8	<8	<8	<8
Pyrene	ug/l	8-50	<8	<8	<8	<8	<8	<8	<8	<8	<8	<8	<8
TOTAL PAHs (excl. naphthalenes)	ug/l	7	<8	<8	<8	<8	<8	<8	<8	<8	<8	<8	<8
Naphthalene	ug/l	12	8	<8	8	<8	<8	<8	<8	38	<8	<8	<8
1-Methylnaphthalene	ug/l	13	8	<8	8	<8	<8	<8	<8	14	<8	<8	<8
2-Methylnaphthalene	ug/l	15	8	<8	8	<8	<8	<8	<8	14	<8	<8	<8
TOTAL NAPHTHALENES	ug/l	42	<42	<42	10	<42	<42	<42	<42	67	<42	<42	<42
Total Petroleum Hydrocarbons (EPA Method 418.1/PL-PRO)													
TPH/TPH	mg/l	0.10-1.0	<0.1	2.8	2.8	2.8	2.8	2.8	2.8	NA	2.8	2.8	2.8

Only compounds detected above their respective PQLs are listed
 PQL = Less than Practical Quantitation Limit
 NA = Not Analyzed
 NS = Not Sampled
 * Indicates well was developed prior to quarter MO sampling
 ** Well resampled and analyzed for PAHs by SW-448 Method 8270

AP20-MW50 (L) shows FAC Character 8270 groundwater target level
 AP20-MW100 (P) shows FDEP MO groundwater target level
 FDEP allows a Maximum DL of 10 ug/l for PAHs. A PQL of 8 ug/l is used for SW-448 Method 8270
 Note: Year 1 petroleum was analyzed for benzene + 50 ug/l. Year 2 petroleum was analyzed for benzene + 1 ug/l
 *** Well resampled by the FDEP as a petroleum well following Year One Fourth Quarter
 **** Well resampled by O&A as a source well following Year Two First Quarter

Table 6.0
Comparison of Year One (First through Fourth Quarter) and Year Two First Quarter MO Groundwater Analytical Results
Site SS-15A Flightline Apron, Homestead ARB

MONITORING WELL NO./FIELD NO.	AP22-MW63 (a)				AP22-MW68 (a)				AP22-MW101 (a)			
	Year 1 Quarter 1 09/25/95	Year 1 Quarter 2 01/15/96	Year 1 Quarter 3 04/12/96	Year 1 Quarter 4 07/26/96	Year 2 Quarter 1 01/07/97	Year 2 Quarter 2 04/12/96	Year 2 Quarter 3 07/26/96	Year 2 Quarter 4 01/07/97	Year 1 Quarter 1* 09/25/95	Year 1 Quarter 2 01/15/96	Year 1 Quarter 3 04/12/96	Year 1 Quarter 4 07/26/96
Depth to Water at Sampling (ft. bgs)	4.84	4.86	8.03	3.78	5.18	4.07	3.88	4.35	3.84	4.25	4.41	3.87
Groundwater Elevation (ft. NGVD)	1.83	1.71	1.34	2.00	1.41	1.71	2.10	1.43	2.04	1.73	1.37	2.11
LABORATORY ANALYSES												
Unit: PQL												
Volatiles Organic Hydrocarbons (SW-448 Method 8010)												
Trans-1,2-Dichloroethane	4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cis-1,2-Dichloroethane	4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Trichloroethane	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Trichlorofluoromethane	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Vinyl Chloride	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Volatiles Organic Aromatics (SW-448 Method 8030)												
Benzene	1	20	8	10	37	1-NA	<1	<1	61	6	<1	<1
Toluene	4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
Ethylbenzene	4	12	<4	7	<4	<4	<4	<4	14	8	<4	<4
Total Xylenes	4	<4	<4	<4	<4	<4	<4	<4	21	<4	<4	<4
TOTAL VOCs	32	32	17	17	37	1-NA	<PQL	<PQL	88	13	8	<PQL
Methyl-Tert-Butyl-Ether (MTBE)	4-25	<35	<35	<35	<35	<35	<35	<35	<35	<35	<35	<35
Polynuclear Aromatic Hydrocarbons (SW-448 Method 8100/8104/8270)												
Acenaphthene	8-50	<5	<5	<5	<5	<5	<5	<5	88	120	18	43
Acenaphthylene	8-50	<5	<5	<5	<5	<5	<5	<5	18	15	<5	<5
Anthracene	8-50	<5	<5	<5	<5	<5	<5	<5	20	8	<5	<5
Benzo (a,h,i) Pyrene	8-50	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Benzo (a) Anthracene	8-50	<5	<5	<5	<5	<5	<5	<5	7	<5	<5	<5
Benzo (a) Pyrene	8-50	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Benzo (k) Fluoranthene	8-50	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Chrysene	8-50	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Fluoranthene	8-50	<5	<5	<5	<5	<5	<5	<5	20	16	12	<5
Indeno (1,2,3-cd) Pyrene	8-50	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Fluorene	8-50	<5	<5	<5	<5	<5	<5	<5	32	18	10	<5
Phenanthrene	8-50	<5	<5	<5	<5	<5	<5	<5	48	28	17	<5
Pyrene	8-50	<5	<5	<5	<5	<5	<5	<5	25	8	7	<5
TOTAL PAHs (excl. naphthalenes)	<PQL	75	41	84	<PQL	39	<PQL	<PQL	239	214	84	37
Naphthalene	8-50	75	41	84	35-28	87	<5	<5	180	70	28	7
1-Methylnaphthalene	8-50	46	88	120	82-41	72	<5	<5	100	83	19	18
2-Methylnaphthalene	8-100	33	84	30-24	85	27	<5	<5	120	100	26	31
TOTAL NAPHTHALENES	171	142	272	224	117-81	82	<PQL	<PQL	330	253	73	65
Total Petroleum Hydrocarbons (EPA Method 816.1/PL-PRO)												
TRPH/TPH	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
TPH	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Only compounds detected above their respective PQLs are listed
 <PQL = Less than Practical Quantitation Limit
 NA = Not Analyzed
 NS = Not Sampled
 * Indicates well was redeveloped prior to quarter MO sampling
 ** Well re-sampled and analyzed for PAHs by SW-448 Method 8270

TPH = Total Petroleum Hydrocarbons
 EPA Method 816.1 utilized for Year 1 Quarter 1 and 2 analyses
 J = Estimated value, below the PQL and at or above the MOL
 J* = Estimated value, due to observed sample recovery

TPH = Total Recoverable Petroleum Hydrocarbons
 EPA Method 816.1 utilized for Year 1 Quarter 1 and 2 analyses
 J = Estimated value, below the PQL and at or above the MOL
 J* = Estimated value, due to observed sample recovery

above FAC Chapter 82-770 groundwater target level
 : above FDEP MO groundwater standard
 FDEP Above a Maximum DL of 10 ug/l for PAHs - A PQL of 5 ug/l is used for SW-448 Method 8270
 Note: Year 1 perimeter well standard for benzene = 50 ug/l, Year 2 perimeter well standard for benzene = 1 ug/l
 *** Well redesignated by the FDEP as a perimeter well following Year One Fourth Quarter
 **** Well redesignated by O&M as a source well following Year Two First Quarter

Table 6.0
Comparison of Year One (First through Fourth Quarter) and Year Two First Quarter MO Groundwater Analytical Results
Site SS-15A Flightline Apron, Homestead ARB

MONITORING WELL NO./FIELD NO.		AP23-MW87 (b)				AP23-MW102 (p)				AP24-MW88 (b)					
MOP SAMPLING EVENT		Year 1 Quarter 1 st	Year 1 Quarter 2 nd	Year 1 Quarter 3 rd	Year 1 Quarter 4 th	Year 2 Quarter 1 st	Year 2 Quarter 2 nd	Year 2 Quarter 3 rd	Year 2 Quarter 4 th	Year 1 Quarter 1 st	Year 1 Quarter 2 nd	Year 1 Quarter 3 rd	Year 1 Quarter 4 th	Year 2 Quarter 1 st	Year 2 Quarter 2 nd
Date Sampled		09/28/95	01/15/96	04/15/96	07/26/96-08/29/96	01/07/97	01/15/98	04/15/98	07/26/98	01/07/97	01/14/98	04/15/98	07/26/98	01/07/97	01/07/97
Depth to Water at Sampling (ft. bgs)		4.94	5.13	5.28	4.80 - 4.68	5.51	4.84	5.02	5.15	4.92	5.38	5.43	4.96	5.85	5.85
Groundwater Elevation (ft. NGVD)		1.93	1.74	1.59	2.07 - 2.21	1.38	1.95	1.77	1.64	2.13	2.14	1.78	2.10	1.41	1.41
LABORATORY ANALYSES															
Units															
Volatile Organic Halocarbons (SW-846 Method 8010)															
Trans-1,2-Dichloroethene	ug/l	NA	<4	<4	<4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cis-1,2-Dichloroethene	ug/l	NA	<4	<4	<4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Trichloroethene	ug/l	NA	<1	<1	<1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Trichlorofluoromethane	ug/l	NA	<1	<1	<1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Vinyl Chloride	ug/l	NA	<1	<1	<1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Volatile Organic Aromatics (SW-846 Method 8020)															
Benzene	ug/l	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Toluene	ug/l	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
Ethylbenzene	ug/l	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
Total Xylenes	ug/l	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
TOTAL VOCs	ug/l	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Methyl-Tert-Butyl-Ether (MTBE)	ug/l	38	83	34	28.7	28.7	<25	<25	<25	<25	<25	<25	<25	<25	<25
Polynuclear Aromatic Hydrocarbons (SW-846 Method 8100/8310/8270)															
Acenaphthene	ug/l	<4	<4	<4	8310 - 8270	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
Acenaphthylene	ug/l	<4	<4	<4	29 - <10	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
Anthracene	ug/l	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
Benzo (a,h,i) Pyrene	ug/l	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
Benzo (a) Anthracene	ug/l	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
Benzo (k) Pyrene	ug/l	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
Benzo (k) Fluoranthene	ug/l	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
Chrysene	ug/l	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
Fluorene	ug/l	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
Indeno (1,2,3-cd) Pyrene	ug/l	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
Fluoranthene	ug/l	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
Phenanthrene	ug/l	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
Pyrene	ug/l	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
TOTAL PAHs (excl. naphthalenes)	ug/l	<PQL	<PQL	<PQL	38 - <PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Naphthalene	ug/l	840	230	74	370 - 400	130	<4	<4	<4	<4	<4	<4	<4	<4	<4
1-Methylnaphthalene	ug/l	350	170	31	150 - 140	81	<4	<4	<4	<4	<4	<4	<4	<4	<4
2-Methylnaphthalene	ug/l	370	110	31	180 - 180	100	<4	<4	<4	<4	<4	<4	<4	<4	<4
TOTAL NAPHTHALENES	ug/l	1360	510	136	700 - 760	311	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Total Petroleum Hydrocarbons (EPA Method 418.1/PL-PRO)															
TPH/TPH ₁	mg/l	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
0.10 - 1.0															

Only compounds detected above their respective PQLs are listed
 *PQL = Less than Practical Quantitation Limit
 NA = Not Analyzed
 NS = Not Sampled
 * Indicates well was overdeveloped prior to quarter MO sampling
 ** Well sampled and analyzed for PAHs by SW-846 Method 8270
 s = Perimeter Well
 b = Source Well
 TPH = Total Petroleum Hydrocarbons
 TPH₁ = Total Recoverable Petroleum Hydrocarbons
 EPA Method 418.1 utilized for Year 1 Quarter 1 and 2 analyses
 J = Estimated value, below the PQL and at or above the MQL
 J* = Estimated value, due to elevated surrogate recovery
 FDEP allows a Maximum DL of 10 ug/l for PAHs - A PQL of 5 ug/l is used for SW-846 Method 8270
 Note: Year 1 perimeter well standard for benzene = 50 ug/l. Year 2 perimeter well standard for benzene = 1 ug/l
 *** Well redesignated by the FDEP as a perimeter well following Year One Fourth Quarter
 **** Well redesignated by OHM as a source well following Year Two First Quarter

Table 6.0
Comparison of Year One (First through Fourth Quarter) and Year Two First Quarter MO Groundwater Analytical Results
Site SS-15A Flightline Apron, Homestead ARB

MONITORING WELL NO. FIELD NO.	AP26-MW73 [p]***				AP26-MW76 [p]***				AP26-MW104 [p]***			
	Year 1 Quarter 1 09/20/95	Year 1 Quarter 2 01/15/96	Year 1 Quarter 3 07/15/96 - 08/28/96	Year 1 Quarter 4 01/09/97	Year 1 Quarter 1 NS	Year 1 Quarter 2 NS	Year 1 Quarter 3 04/16/96	Year 1 Quarter 4 07/31/96	Year 1 Quarter 1 09/20/95	Year 1 Quarter 2 01/15/96	Year 1 Quarter 3 05/03/96	Year 1 Quarter 4 07/31/96
Depth to Water at Sampling (ft. bgs)	4.91	5.23	4.97 - 4.72	5.55	NS	NS	5.48	5.10	4.18	5.05	4.77	4.78
Groundwater Elevation (ft. NGVD)	2.07	1.75	2.01 - 2.26	1.43	NS	NS	1.92	2.00	2.64	1.77	2.05	2.04
LABORATORY ANALYSES												
Volatile Organic Hydrocarbons (SW 446 Method 8010)												
Trans-1,2-Dichloroethene	4	NA	NA	NA	NS	NS	NA	NA	NA	NA	NA	NA
Cis-1,2-Dichloroethene	4	NA	NA	NA	NS	NS	NA	NA	NA	NA	NA	NA
Trichloroethene	1	NA	NA	NA	NS	NS	NA	NA	NA	NA	NA	NA
Trichlorofluoromethane	1	NA	NA	NA	NS	NS	NA	NA	NA	NA	NA	NA
Vinyl Chloride	1	NA	NA	NA	NS	NS	NA	NA	NA	NA	NA	NA
Volatile Organic Aromatics (SW 446 Method 8020)												
Benzene	1	2	13	21	NS	NS	2	5	1	<1	<1	<1
Toluene	4	<4	<4	<4	NS	NS	<4	<4	<4	<4	<4	<4
Ethylbenzene	4	21	31	19.7	NS	NS	<4	<4	<4	15	<4	<4
Total Xylenes	4	<4	5	<4	NS	NS	<4	<4	<4	<4	<4	<4
TOTAL VOCs	23	24	32	21.7	NS	NS	2	5	<PQL	23	<PQL	<PQL
Methyl-Tert-Butyl Ether (MTBE)	4 - 25	<25	<25	<25	NS	NS	<25	<25	<25	<25	<25	<25
Polynuclear Aromatic Hydrocarbons (SW 446 Method 8100/8101/8270)												
Acenaphthene	5 - 50	21	130 - 222	20	NS	NS	40	69	<4	19	<4	35
Acenaphthylene	5 - 50	8	<5 - <10	<5	NS	NS	<5	<5	<5	<5	<5	<5
Anthracene	5 - 50	7	<5 - <10	8	NS	NS	<5	<5	<5	<5	<5	<5
Benzo (g,h,i) Pyrene	5 - 50	<5	<5 - <10	<5	NS	NS	<5	<5	<5	<5	<5	<5
Benzo (a) Anthracene	5 - 50	<5	<5 - <10	<5	NS	NS	<5	<5	<5	<5	<5	<5
Benzo (a) Pyrene	5 - 50	<5	<5 - <10	<5	NS	NS	<5	<5	<5	<5	<5	<5
Benzo (k) Fluoranthene	5 - 50	<5	<5 - <10	<5	NS	NS	<5	<5	<5	<5	<5	<5
Chrysene	5 - 50	<5	<5 - <10	<5	NS	NS	<5	<5	<5	<5	<5	<5
Fluoranthene	5 - 50	15	28 - 12	14	NS	NS	13	18	<5	<5	<5	<5
Indeno (1,2,3-cd) Pyrene	5 - 50	<5	<5 - <10	<5	NS	NS	<5	<5	<5	<5	<5	<5
Fluorene	5 - 50	13	27 - 22	23	NS	NS	14	25	<5	<5	<5	<5
Phenanthrene	5 - 50	24	49 - 35	39	NS	NS	16	31	8	13	<5	17
Pyrene	5 - 50	14	17 - <10	10	NS	NS	8	8	<5	<5	<5	<5
1-Methyl-naphthalene	5 - 50	84	232 - 91	114	NS	NS	82	143	<5	<5	<PQL	75
2-Methyl-naphthalene	5 - 50	180	330 - 230	150	NS	NS	37	58	5	49	<5	34
1-Methyl-naphthalene	5 - 50	85	310 - 120	110	NS	NS	62	84	31	88	<5	31
2-Methyl-naphthalene	5 - 100	92	240 - 150	130	NS	NS	52	84	22	84	<5	23
TOTAL NAPHTHALENES		357	880 - 520	390	NS	NS	<PQL	151	27	58	<5	28
Total Petroleum Hydrocarbons (EPA Method 418.1/PL-PRO)		NA	4.8	8.4	NS	NS	0.43	1.1	NA	171	<PQL	203
TPH/TPH	mg/L	0.10 - 1.0			NS	NS	0.43	1.1	NA	NA	NA	0.64

Only compounds detected above their respective PQLs are listed.
 *PQL = Last then Practical Quantitation Limit
 NS = Not Sampled
 NA = Not Analyzed
 *Indicates well was overdeveloped prior to quarter MO sampling
 ** Well reinstalled and analyzed for PAHs by SW-446 Method 8270

AP26-MW73 [p]***
 FDEP Above a Maximum DI of 10 ug/L for PAHs. A PQL of 5 ug/L is used for SW-446 Method 8270
 Note: Year 1 perimeter well standard for benzene = 50 ug/L, Year 2 perimeter well standard for benzene = 1 ug/L
 *** Well reinstalled by the FDEP as a perimeter well following Year One Fourth Quarter
 **** Well reinstalled by ODM as a source well following Year Two First Quarter

Table 6.0
Comparison of Year One (First through Fourth Quarter) and Year Two First Quarter MO Groundwater Analytical Results
Site SS-15A Flightline Apron, Homestead ARB

MONITORING WELL NO./FIELD NO.	MOP SAMPLING EVENT	AP28-MW113 (g)***				AP28-MW114 (g)***				AP27-MW76 (g)			
		Year 1 Quarter 1	Year 1 Quarter 2	Year 1 Quarter 3	Year 1 Quarter 4	Year 2 Quarter 1	Year 2 Quarter 2	Year 2 Quarter 3	Year 2 Quarter 4	Year 1 Quarter 1	Year 1 Quarter 2	Year 1 Quarter 3	Year 1 Quarter 4
LABORATORY ANALYSES	Date Sampled	NS	NS	NS	09/10/96	01/06/97	01/06/97	01/06/97	01/06/97	08/29/95	01/16/96	01/16/96	08/02/96
	Depth to Water at Sampling (ft. bgs)	NS	NS	NS	4.08	5.52	5.52	5.51	5.51	5.40	5.51	5.77	5.37
	Groundwater Elevation (ft. NGVD)	NS	NS	NS	2.85	1.38	1.38	1.39	1.39	1.99	1.78	1.82	2.02
	Units	POL											
Volatile Organic Halocarbons (SW-846 Method 8010)	Trans-1,2-Dichloroethene	ug/l	4							NA	NA	NA	NA
	Cis-1,2-Dichloroethene	ug/l	4							NA	NA	NA	NA
	Trichloroethene	ug/l	1							NA	NA	NA	NA
	Trichlorofluoromethane	ug/l	1							NA	NA	NA	NA
Volatile Organic Aromatics (SW-846 Method 8020)	Vinyl Chloride	ug/l	1							NA	NA	NA	NA
	Benzene	ug/l	1										
	Toluene	ug/l	4										
	Ethylbenzene	ug/l	4										
TOTAL VOCs	Total Xylenes	ug/l	4										
	Total VOCs	ug/l	4										
	Methyl-Tert-Butyl-Ether (MTBE)	ug/l	4-25										
	Methyl-Tert-Butyl-Ether (MTBE)	ug/l	4-25										
Polynuclear Aromatic Hydrocarbons (SW-846 Method 8100/8120)	Acenaphthene	ug/l	5-50										
	Acenaphthylene	ug/l	5-50										
	Anthracene	ug/l	5-50										
	Benzo (g,h,i) Perylene	ug/l	5-50										
TOTAL PAHs (excl. naphthalenes)	Benzo (a) Anthracene	ug/l	5-50										
	Benzo (k) Fluoranthene	ug/l	5-50										
	Chrysene	ug/l	5-50										
	Fluoranthene	ug/l	5-50										
TOTAL PAHs (excl. naphthalenes)	Indeno (1,2,3-cd) Pyrene	ug/l	5-50										
	Fluorene	ug/l	5-50										
	Phenanthrene	ug/l	5-50										
	Pyrene	ug/l	5-50										
TOTAL PAHs (excl. naphthalenes)	Naphthalene	ug/l	5-50										
	1-Methylnaphthalene	ug/l	5-50										
	2-Methylnaphthalene	ug/l	5-50										
	TOTAL NAPHTHALENES	ug/l	5-100										
Total Petroleum Hydrocarbons (EPA Method 418.1/PL-PRO)	TPH/TPH	mg/l	0.10-1.0										
	TPH/TPH	mg/l	0.10-1.0										
	TPH/TPH	mg/l	0.10-1.0										
	TPH/TPH	mg/l	0.10-1.0										

Only compounds detected above their respective PQLs are listed
 *PQL = Less than Practical Quantitation Limit
 NS = Not Analyzed
 NA = Not Sampled
 ** Indicates well was redeveloped prior to quarter MO sampling
 *** Well redeveloped and analyzed for PAHs by SW-846 Method 8270

AP28-MW113 (g)*** : shows FAC Chapter 65.370 groundwater target level
 AP28-MW114 (g)*** : shows FDEP MO procedure for monitoring
 FDEP allows a Maximum DL of 10 ug/l for PAHs - A PQL of 1 ug/l is used for SW-846 Method 8270
 Note: Year 1 petroleum well standard for benzene = 50 ug/l, Year 2 petroleum well standard for benzene = 1 ug/l
 *** Well redeveloped by the FDEP as a petroleum well following Year One Fourth Quarter
 **** Well redeveloped by OHM as a source well following Year Two First Quarter

Table 6.0
Comparison of Year One (First through Fourth Quarter) and Year Two First Quarter MO Groundwater Analytical Results
Site SS-15A Flightline Apron, Homestead ARB

MONITORING WELL NO./FIELD NO.	HOP SAMPLING EVENT	AP27-MW105 (D)				AP28-MW82 (G)			
		Year 1 Quarter 1*	Year 1 Quarter 2	Year 1 Quarter 3	Year 1 Quarter 4	Year 1 Quarter 1*	Year 1 Quarter 2	Year 1 Quarter 3	Year 1 Quarter 4
	Date Sampled	09/29/95	01/16/96	04/18/96	08/02/96	08/20/95	01/17/96	04/18/96	08/02/96
	Depth to Water at Sampling (ft. bgs)	4.39	5.26	5.44	5.00	3.78	4.07	4.29	3.30
	Groundwater Elevation (ft. NGVD)	2.87	1.80	1.82	2.06	2.02	1.74	1.52	2.51
	Units								
LABORATORY ANALYSES									
Volatile Organic Hydrocarbons (SW-846 Method 8010)									
Trans-1,2-Dichloroethene	ug/l	NA	NA	NA	NA	NA	NA	NA	NA
Cis-1,2-Dichloroethene	ug/l	NA	NA	NA	NA	NA	NA	NA	NA
Trichloroethene	ug/l	NA	NA	NA	NA	NA	NA	NA	NA
Trichlorofluoromethane	ug/l	NA	NA	NA	NA	NA	NA	NA	NA
Vinyl Chloride	ug/l	NA	NA	NA	NA	NA	NA	NA	NA
Volatile Organic Aromatics (SW-846 Method 8020)									
Benzene	ug/l	<1	<1	<1	<1	<1	<1	<1	<1
Toluene	ug/l	<4	<4	<4	<4	<4	<4	<4	<4
Ethylbenzene	ug/l	<4	<4	<4	<4	<4	<4	<4	<4
Total Xylenes	ug/l	<4	<4	<4	<4	<4	<4	<4	<4
TOTAL VOCs	ug/l	<POL	<POL	<POL	<POL	<POL	<POL	<POL	<POL
Methyl-Tert-Butyl-Ether (MTBE)	ug/l	<35	<35	<35	<35	<35	<35	<35	<35
Polynuclear Aromatic Hydrocarbons (SW-846 Method 8100/8108/870)									
Acenaphthene	ug/l	18	<5	11	<5	<5	<5	<5	<5
Acenaphthylene	ug/l	<5	<5	<5	<5	<5	<5	<5	<5
Anthracene	ug/l	<5	<5	<5	<5	<5	<5	<5	<5
Benzo (b,h,i) Perylene	ug/l	<5	<5	<5	<5	<5	<5	<5	<5
Benzo (a) Anthracene	ug/l	<5	<5	<5	<5	<5	<5	<5	<5
Benzo (a) Pyrene	ug/l	<5	<5	<5	<5	<5	<5	<5	<5
Benzo (k) Fluoranthene	ug/l	<5	<5	<5	<5	<5	<5	<5	<5
Chrysene	ug/l	<5	<5	<5	<5	<5	<5	<5	<5
Fluoranthene	ug/l	7	<5	<5	<5	<5	<5	<5	<5
Indeno (1,2,3-cd) Pyrene	ug/l	<5	<5	<5	<5	<5	<5	<5	<5
Fluorene	ug/l	11	<5	<5	<5	<5	<5	<5	<5
Phenanthrene	ug/l	8	<5	<5	<5	<5	<5	<5	<5
Pyrene	ug/l	<5	<5	<5	<5	<5	<5	<5	<5
TOTAL PAHs (excl. naphthalenes)	ug/l	41	<5	16	<POL	<POL	<POL	<POL	<POL
Naphthalene	ug/l	98	39	32	26	13	<5	<5	7
1-Methylnaphthalene	ug/l	84	39	32	28	<5	<5	<5	15
2-Methylnaphthalene	ug/l	58	35	29	25	14	<5	<5	18
TOTAL NAPHTHALENES	ug/l	220	113	92	82	27	<POL	<POL	40
Total Petroleum Hydrocarbons (EPA Method 418.1/FL-PRO)									
TPH/TPH	mg/l	NA	NA	NA	0.48	NA	NA	NA	NA

Only compounds detected above their respective PQLs are listed

*PQL = 1.0 ug/l for all compounds

NA = Not Analyzed

** Not Sampled

** Not Sampled, analyzed prior to water MO sampling

** Not Sampled and analyzed for PAHs by SW-846 Method 8270

above FAC Chapter 82-770 groundwater target level

above FDEP MO groundwater standard

FDEP Allows a Maximum CL of 10 ug/l for PAHs. A PQL of 5 ug/l is used for SW-846 Method 8270

Note: Year 1 perimeter well standard for benzene = 50 ug/l, Year 2 perimeter well standard for benzene = 1 ug/l

*** Well redeployed by the FDEP as a perimeter well following Year One Fourth Quarter

**** Well redeployed by ODA as a source well following Year Two First Quarter

APPENDIX B

HEALTH AND SAFETY PLAN

**HEALTH AND SAFETY PLAN
FOR THE DEMONSTRATION OF
REMEDIATION BY THE RISK-BASED APPROACH AT
SITE SS-15A, HOMESTEAD ARB, FLORIDA**

Prepared for:

**AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE (AFCEE)
TECHNOLOGY TRANSFER DIVISION (ERT)
BROOKS AIR FORCE BASE, TEXAS 78235-5363**

AMC CONTRACT F11623-94-00024

Order #39

September 1997

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SECTION 1

PURPOSE AND POLICY

The purpose of this program health and safety plan is to establish personnel protection standards and mandatory safety practices for all Parsons Engineering Science, Inc. (Parsons ES) and subcontractor personnel involved in the risk-based remediation of Homestead Air Reserve Base (ARB), Florida. This plan provides guidance for general operations on risk-based demonstration sites and provides for contingencies that may arise during field operations. Site-specific information is not included in this plan and will be addressed in the formal health and safety plan addenda. All Parsons ES field team members and subcontractors are responsible for reading and conforming to this plan and the associated addenda. No employee will perform a project activity that he or she believes may endanger his or her health and safety or the health and safety of others. All personnel will strive for a record of zero accidents on this project. To the greatest extent possible, work tasks will be designed and conducted to minimize or eliminate hazards to personnel.

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

SECTION 2

PROJECT DESCRIPTION AND SCOPE OF WORK

2.1 PROJECT DESCRIPTION

Under this contract, Parsons ES will provide services to the Air Force Center for Environmental Excellence (AFCEE) that will demonstrate the use of the risk-based approach to reduce concentrations of fuel hydrocarbons in groundwater at Site SS-15A, Homestead ARB, Florida.

The purpose of the demonstrations is to develop a closure plan with a new approach to site remediation which focuses on risk reduction rather than arbitrary numerical cleanup standards, and emphasizes natural biodegradation and other natural attenuation mechanisms to reduce risk.

2.2 SCOPE OF WORK

Site characterization activities in support of the risk-based demonstrations may include excavating; auger drilling; use of the Geoprobe®, cone penetrometer (CPT), and Hydropunch® direct-push technologies, monitoring well and monitoring point installation; soil, soil gas, surface water, and groundwater sampling; and aquifer testing.

SECTION 3

PROGRAM TEAM ORGANIZATION

The Parsons ES team assigned to the risk-based demonstrations, their responsibilities, and lines of authority are outlined below.

<u>Name</u>	<u>Task Assigned</u>
Mr. Allan Udin	Program Sponsor
Mr. John Stewart	Program Manager
Mr. Doug Downey	Project Manager
Mr. John Hicks	Site Manager
Mr John Hall	Field Site Manager
Mr. Timothy Mustard	Program Health and Safety Manager
Ms. Leigh Benson	Technical Director
To be assigned	Site Health and Safety Officer
To be assigned	Alternate Health and Safety Officer
Mr. Sam Taffinder	AFCEE/ERT Point of Contact (POC)

The program manager, Mr. John Stewart, will be the Parsons ES POC for program matters, and will interface with the contracting officer, Base representatives, and the AMC and AFCEE project technical representatives

The technical director, Ms. Leigh Benson, is responsible for conduct and review of all technical work on this project to ensure technical accuracy and adequacy. He will provide advice to the project manager and project personnel on technical issues. He will also be responsible for peer review of all deliverables prior to submission.

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

The program health and safety manager, Mr. Timothy Mustard, will ensure that all field activities are performed with strict adherence to OSHA requirements and the program health and safety plan. He will be responsible for updating and revising the

program health and safety plan, as needed, and for ensuring that all field team members meet health and safety training and medical monitoring requirements.

The site health and safety officer (SHSO) along with the project manager is responsible for ensuring that day-to-day project activities are performed in strict conformance with the program health and safety plan. The SHSO, project manager, and program health and safety manager have the authority to stop work if actions or conditions are judged to be unsafe or not in conformance with the program health and safety plan. The SHSO will also be responsible for ensuring that field personnel are in compliance with Occupational Safety and Health Administration (OSHA) requirements for training and medical monitoring prior to and for the duration of the field activities.

The site manager will support the project manager for the specific work the team will accomplish at each site and will be responsible for scheduling and coordinating the testing activities at the respective sites. The site manager will assist the project manager in the day-to-day organization and execution of the various project tasks.

SECTION 4

SITE-SPECIFIC EMPLOYEE TRAINING AND MEDICAL MONITORING REQUIREMENTS

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

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

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

4.1 ADDITIONAL SAFETY TRAINING REQUIREMENTS

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

4.1.1 Site-Specific Safety Briefings

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

- Names of responsible health and safety personnel;
- Identification of site hazards;
- Site contingencies and emergency procedures;
- Exposure risk;
- Symptoms of exposure and exposure treatment for chemical contaminants;
- Use, care, maintenance, and limitations of PPE;
- Decontamination procedures to be followed;
- Location of safety equipment;
- Review of planned activities;
- Defined safety procedures to be followed during field activities; and
- Emergency and evacuation procedures.

Safety briefings will be conducted daily prior to commencement of field activities. Documentation of training and briefings, including agenda and signatures of attending personnel, will be maintained onsite. Site-specific training forms are provided in Appendix B.

4.2 MEDICAL MONITORING REQUIREMENTS

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

SECTION 5

SAFETY AND HEALTH RISK ANALYSIS

5.1 CHEMICAL HAZARDS

The chemicals of primary concern occurring at the USAF sites include gasoline; jet propulsion fuel grade four (JP-4); and the associated petroleum hydrocarbon constituents benzene, toluene, ethylbenzene, and xylenes (BTEX).

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

Hazardous substances of primary concern identified are those potentially occurring in contaminated groundwater, soils, sediment, surface water, air, buildings, or abandoned structures.

5.2 PHYSICAL HAZARDS

In addition to the hazardous substances potentially present at the USAF sites, other physical hazards or hazardous conditions may be expected at the sites during the course of performing risk-based demonstration activities. These hazards include possible risks from injury while working around motor vehicles including the auger drilling rig, Geoprobe® unit, and the CPT rig; stationary or moving equipment; fire or explosion hazards; slip, trip, and fall hazards; electrical hazards; and excessive noise conditions. Additional physical hazards include heat stress and cold-related exposures.

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

TABLE 5.1 HEALTH HAZARD QUALITIES OF HAZARDOUS SUBSTANCES OF CONCERN

Compound	PEL ^{a/} (ppm)	TLV ^{b/} (ppm)	IDLH ^{c/} (ppm)	Odor Threshold ^{d/} (ppm)	Ionization Potential ^{e/} (eV)	Physical Description/Health Effects/Symptoms
Acenaphthene	0.2 mg/m ³ ^{b/}	0.2 mg/m ³ ^{b/}	80 mg/m ³ ^{b/}	0.08	NA ^{b/}	White needle-like crystals. Irritates eyes, skin, and mucous membranes. Causes dermatitis, bronchitis, and lung, kidney, and skin cancer. Carcinogen.
Acenaphthylene	0.2 mg/m ³ ^{b/}	0.2 mg/m ³ ^{b/}	80 mg/m ³ ^{b/}	NA	NA	Crystalline solid. Irritates and burns eyes and skin. Causes dizziness, suffocation, dermatitis, bronchitis, and lung, kidney, and skin cancer. Mutagen and carcinogen.
Arsenic (Inorganic, as As)	0.01 mg/m ³ (29 CFR 1910.1018) ^{b/}	0.01 mg/m ³	5 mg/m ³	NA	NA	Silver-gray or tin-white, brittle, odorless solid. Causes ulceration of the nasal septum, dermatitis, gastrointestinal disturbances, nervous system degeneration, respiratory irritation, skin spots, and lung and lymphatic cancer. Mutagen, experimental teratogen, and carcinogen.
Benzene	1 (29 CFR 1910.1028) ^{b/}	10	500	4.7	9.24	Colorless to light-yellow liquid (solid < 42°F) with an aromatic odor. Eye, nose, skin, and respiratory system irritant. Causes giddiness, headaches, nausea, staggered gait, fatigue, anorexia, exhaustion, dermatitis, bone marrow depression, and leukemia. Mutagen, experimental teratogen, and carcinogen.
Chromium metal	1 mg/m ³	0.5 mg/m ³	250 mg/m ³	NA	NA	Blue-white to steel gray, lustrous, brittle, hard, odorless, metallic solid. Irritates eyes, skin, and respiratory system. Causes lung fibrosis. Explosive.
Chromium (II) and (III) Compounds (as Cr)	0.5 mg/m ³	0.5 mg/m ³	250 mg/m ³ (II) 25 mg/m ³ (III)	NA	NA	Properties vary with compound. Irritates eyes and causes sensitization dermatitis.
Copper (dust/mists)	1 mg/m ³	1 mg/m ³	100 mg/m ³	NA	NA	Reddish, lustrous, malleable, and odorless, solid metal. Irritates eyes, nose, skin, and pharynx. Causes a metallic taste, nasal perforation, nausea, vomiting, and dermatitis. In animals, causes anemia and lung, liver, and kidney damage. Experimental teratogen and questionable carcinogen.

TABLE 5.1 HEALTH HAZARD QUALITIES OF HAZARDOUS SUBSTANCES OF CONCERN

Compound	PEL ^{a/} (ppm)	TLV ^{b/} (ppm)	IDLH ^{c/} (ppm)	Odor Threshold ^{d/} (ppm)	Ionization Potential ^{e/} (eV)	Physical Description/Health Effects/Symptoms
para-Cresol (4-Methylphenol)	5 (skin) ^{y/}	5 (skin)	250	.00047-0.0455	8.97	Crystalline solid (liquid > 95°F) with a sweet, tarry odor. Irritates eyes, skin, mucous membranes. Causes CNS effects, confusion, depression, respiratory failure, shortness of breath, irregular and rapid respiration, weak pulse, eye and skin burns, dermatitis, and lung, liver, kidney, and pancreatic damage. Mutagen and questionable carcinogen.
Dinitrotoluene (DNT)	1.5 mg/m ³ (skin)	0.15 mg/m ³ (skin)	50 mg/m ³	NA	NA	Orange-yellow, crystalline solid with a characteristic odor. Causes permanent tissue damage due to oxygen deficiency, blue skin, anemia, jaundice, and reproductive effects. In animals, causes liver, skin, and kidney tumors. Mutagen, experimental teratogen, and carcinogen.
Ethylbenzene	100	100	800	0.25-200	8.76	Colorless liquid with an aromatic odor. Irritates eyes, skin, and mucous membranes. Causes dermatitis, headaches, narcosis, and coma. Mutagen and experimental teratogen.
Fluorene	0.2 mg/m ³ ^{z/}	0.2 mg/m ³ ^{z/}	80 mg/m ³ ^{z/}	NA	NA	Small, white, crystalline plates, fluorescent when impure. Irritates eyes and skin. Affects respiratory system, bladder, and kidneys. Carcinogen.
Gasoline	300	300	NA	0.005-10	NA	Clear/amber flammable, volatile liquid with a characteristic odor. Irritates eyes, skin, and mucous membranes. Causes dermatitis, headaches, fatigue, blurred vision, dizziness, slurred speech, confusion, convulsions, chemical pneumonia, and possible liver and kidney damage. In animals, causes liver and kidney cancer. Monitor for BTEX constituents. Carcinogen.
Jet Fuel	400 ^{z/}	400 ^{z/}	1,000 ^{z/}	0.08-1	NA	Colorless to light-brown liquid with a fuel-like odor. Long-term effects include liver, kidney, and CNS damage. JP-4 is a questionable carcinogen.
Lead	0.05 mg/m ³ (29 CFR 1910.1025) ^{y/}	0.15 mg/m ³	100 mg/m ³	NA	NA	Heavy, ductile, bluish-gray, soft metal. Irritates eyes. Causes weakness, exhaustion, insomnia, facial pallor, anorexia, low-weight, malnutrition, constipation, abdominal pain, gastritis, colic, constipation, gingival lead line, anemia, wrist and ankle paralysis, joint pains, tremors, low blood

TABLE 5.1 HEALTH HAZARD QUALITIES OF HAZARDOUS SUBSTANCES OF CONCERN

Compound	PEL ^{a/} (ppm)	TLV ^{b/} (ppm)	IDLH ^{c/} (ppm)	Odor Threshold ^{d/} (ppm)	Ionization Potential ^{e/} (eV)	Physical Description/Health Effects/Symptoms
Mercury (aryl, inorganic, and vapors)	0.1 mg/m ³ (ceiling) ^v (skin) 0.05 mg/m ³ (vapor) (skin)	0.1 mg/m ³ (skin) 0.025 mg/m ³ (inorg) (skin)	10 mg/m ³	NA	NA	pressure, and kidney disease. Mutagen, experimental teratogen, and suspected carcinogen. Silver-white, heavy, odorless, liquid or tin-white ductile, malleable, soft, solid metal. Corrosive to skin, eyes, and mucous membranes. Causes dermatitis, coughing, chest pain, shortness of breath, bronchitis, lung inflammation, ringing in the ears, tremors, insomnia, irritability, indigestion, headaches, fatigue, weakness, fever, salivation, inflammatory disease of the mouth, gastrointestinal disturbances, anorexia, low-weight, and protein in the urine. Mutagen, experimental teratogen, and questionable carcinogen.
Mesitylene (1,3,5-Trimethylbenzene)	25 ^{m/}	25 ^{m/}	NA	0.027 ^{m/}	8.39	Colorless liquid with a distinctive, aromatic odor. Irritates eyes, skin, nose, throat, and respiratory system. Causes bronchitis, hypochromic anemia, headaches, drowsiness, fatigue, dizziness, nausea, incoordination, vomiting, confusion, and chemical pneumonia. Mutagen.
1-Methylnaphthalene	NA	NA	NA	0.02	NA	Colorless liquid. Irritates skin. Causes skin photosensitization, corneal damage, decreased urinary output, flushing, headache, restlessness, fever, nausea, anorexia, diarrhea, anemia, liver injury, convulsions, and com
2-Methylnaphthalene	NA	NA	NA	0.003-0.04	7.96	Colorless gas or solid with a disagreeable garlic or rotten cabbage odor. Irritates eyes, skin, nose, and throat.
4-Methylphenol (para-Cresol)	5 (skin)	5 (skin)	250	.00047-0.0455	8.97	Crystalline solid (liquid >95°F) with a sweet, tarry odor. Irritates eyes, skin, mucous membranes. Causes CNS effects, confusion, depression, respiratory failure, shortness of breath, irregular and rapid respiration, weak pulse, eye and skin burns, dermatitis, and lung, liver, kidney, and pancreatic damage. Mutagen and questionable carcinogen.
MTBE	NA	40 (proposed)	NA	NA	NA	Colorless liquid. Irritates eyes, skin, nose, throat, and lungs. Causes difficulty concentrating and thinking, headaches, dizziness, weakness, nausea, lightheadedness, and fainting. Carcinogen.

TABLE 5.1 HEALTH HAZARD QUALITIES OF HAZARDOUS SUBSTANCES OF CONCERN

Compound	PEL ^{a/} (ppm)	TLV ^{b/} (ppm)	IDLH ^{c/} (ppm)	Odor Threshold ^{d/} (ppm)	Ionization Potential ^{e/} (eV)	Physical Description/Health Effects/Symptoms
Naphthalene	10	10	250	0.3	8.1	Colorless to brown solid (shipped as a molten liquid) with a mothball-like odor. Irritates eyes, skin, and bladder. Causes headaches, confusion, excitement, convulsions, coma, vague discomfort, nausea, vomiting, abdominal pain, profuse sweating, jaundice, hematoma, hemoglobin in the urine, renal shutdown, dermatitis, optic nerve disorders, and corneal and liver damage. Experimental teratogen and questionable carcinogen.
Phenanthrene	0.2 mg/m ³ s ^{f/}	0.2 mg/m ³ s ^{f/}	80 mg/m ³ s ^{f/}	NA	NA	Colorless, shining crystals with a faint, aromatic odor. Causes burns to skin and eyes, dermatitis, bronchitis, and lung, skin, and kidney cancer. Mutagen and carcinogen.
Phenol	5 (skin)	5 (skin)	250	0.05-5	8.50	Colorless to light-pink, crystalline solid with a burning taste and a sweet acrid odor. Irritates eyes, nose, and throat. Causes anorexia, low-weight, weakness, muscle aches and pain, dark urine, blue skin, skin burns, dermatitis, tremors, twitching, convulsions, and damage to the liver, kidneys, pancreas, spleen, and lungs. Ingestion can cause gangrene and corrosion of the lips, mouth, throat, esophagus, and stomach. Mutagen, experimental teratogen, and questionable carcinogen.
Pseudocumene (1,2,4-Trimethylbenzene)	25	25	NA	0.027	8.27	Colorless liquid with a distinctive, aromatic odor. Irritates eyes, skin, nose, throat, and respiratory system. Causes bronchitis, hypochromic anemia, headaches, drowsiness, fatigue, dizziness, nausea, incoordination, vomiting, confusion, CNS depression, and chemical pneumonia.
Selenium	0.2 mg/m ³	0.2 mg/m ³	1 mg/m ³	0.0002 mg/m ³ s ^{g/}	NA	Amorphous or crystalline, red to gray solid. Irritates eyes, skin, nose, and throat. Causes visual disturbances, pallor, nervousness, depression, headaches, chills, fever, shortness of breath, bronchitis, metallic taste, garlic breath, gastrointestinal disturbances, dermatitis, brittle hair and nails, and eye and skin

TABLE 5.1 HEALTH HAZARD QUALITIES OF HAZARDOUS SUBSTANCES OF CONCERN

Compound	PEL ^{a/} (ppm)	TLV ^{b/} (ppm)	IDLH ^{c/} (ppm)	Odor Threshold ^{d/} (ppm)	Ionization Potential ^{e/} (eV)	Physical
						Description/Health Effects/Symptoms
						burns. In animals, causes cirrhosis and localized death of liver tissue, and kidney and spleen damage. Experimental teratogen and questionable carcinogen.
Toluene	100	50 (skin)	500	0.2-40 ^{a/}	8.82	Colorless liquid with sweet, pungent, benzene-like odor. Irritates eyes and nose. Causes fatigue, weakness, dizziness, headaches, hallucinations or distorted perceptions, confusion, euphoria, dilated pupils, nervousness, tearing, muscle fatigue, insomnia, skin tingling, dermatitis, bone marrow changes, and liver and kidney damage. Mutagen and experimental teratogen.
1,2,4-Trimethylbenzene (Pseudocumene)	25	25	NA	0.027	8.27	Colorless liquid with a distinctive, aromatic odor. Irritates eyes, skin, nose, throat, and respiratory system. Causes bronchitis, hypochromic anemia, headaches, drowsiness, fatigue, dizziness, nausea, incoordination, vomiting, confusion, CNS depression, and chemical pneumonia.
1,3,5-Trimethylbenzene (Mesitylene)	25 ^{m/}	25 ^{m/}	NA	0.027 ^{m/}	8.39	Colorless liquid with a distinctive, aromatic odor. Irritates eyes, skin, nose, throat, and respiratory system. Causes bronchitis, hypochromic anemia, headaches, drowsiness, fatigue, dizziness, nausea, incoordination, vomiting, confusion, and chemical pneumonia. Mutagen.
Xylene (o-, m-, and p-isomers)	100	100	900	0.05-200 ^{a/}	8.56 8.44 (p)	Colorless liquid with aromatic odor. P-isomer is a solid <56°F. Irritates eyes, skin, nose, and throat. Causes dizziness, drowsiness, staggered gait, incoordination, irritability, excitement, corneal irregularities, conjunctivitis, dermatitis, anorexia, nausea, vomiting, abdominal pain, and olfactory and pulmonary changes. Also targets blood, liver, and kidneys. Mutagen and experimental teratogen.

a/ PEL = Permissible Exposure Limit. OSHA-enforced average air concentration to which a worker may be exposed for an 8-hour workday without harm.

Expressed as parts per million (ppm) unless noted otherwise. PELs are published in the *NIOSH Pocket Guide to Chemical Hazards*, 1994. Some states (such as California) may have more restrictive PELs. Check state regulations.

b/ TLV = Threshold Limit Value - Time-Weighted Average. Average air concentration (same definition as PEL, above) recommended by the American

TABLE 5.1 HEALTH HAZARD QUALITIES OF HAZARDOUS SUBSTANCES OF CONCERN

Compound	PEL ^{a/} (ppm)	TLV ^{b/} (ppm)	IDLH ^{c/} (ppm)	Odor Threshold ^{d/} (ppm)	Ionization Potential ^{e/} (eV)	Physical Description/Health Effects/Symptoms
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Conference of Governmental Industrial Hygienists (ACGIH), 1996 TLVs[®] and BEIs[®].

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

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

e/ Ionization Potential, measured in electron volts (eV), used to determine if field air monitoring equipment can detect substance. Values are published in the *NIOSH Pocket Guide to Chemical Hazards*, June 1994.

f/ mg/m³ = milligrams per cubic meter.

g/ Based on coal tar pitch volatiles.

h/ NA = Not available.

i/ Refer to expanded rules for this compound.

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

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

l/ (ceiling) = Ceiling concentration which should not be exceeded at any time.

m/ Based on 1,2,4-Trimethylbenzene.

n/ Based on selenium oxide.

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

5.2.1 General Vehicle Operations

The following safety procedures will be followed when operating a motor vehicle within a USAF installation:

- Seat belts will be worn at all times.
- Obey all traffic and speed limit signs.
- Park in designated areas.
- Be aware of construction equipment and other vehicles operating in the area.
- Be aware of pedestrian traffic.
- Acquire eye contact and permission from the vehicle/equipment operator to enter an area around operating vehicles.
- Never crouch down in front of or behind a vehicle.
- Drivers must visually check around the vehicle before moving it.
- Vehicles will never be loaded beyond the designed passenger capacity or beyond the rated load capacity.
- Vehicles will never be loaded in a manner that obscure the driver's front or side views.

The daily vehicle maintenance report located in Appendix B must be completed by the vehicle drivers for all field vehicles (including rented vehicles) upon initial receipt of the vehicle and every morning thereafter, prior to use, that the vehicle is used on a Parsons ES project.

5.2.2 Large Motor Vehicles including Drilling Rigs

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

- Do not back up large motor vehicles unless the vehicle has backup warning lights and a reverse signal alarm audible above the surrounding noise level, or an observer signals it is safe to do so.
- Motor vehicle cabs will be kept free of all nonessential items and all loose items will be secured.

- Drilling rig masts will be lowered to the ground and parking brakes will be set before shutting off the vehicle.
- Drilling rig brakes, cables, kill switches, hydraulic lines, light signals, fire extinguishers, fluid levels, steering, tires, horn, and other safety devices will be inspected daily.
- All personnel working at and around the drilling rig must be informed of the locations of the kill switches.
- Only qualified operators will be allowed to operate the drilling rig or other heavy equipment.
- When working near a backhoe, field personnel will maintain sight contact with the operator.
- The limits of the swing radius of the backhoe must be marked on the ground with cones or boundary tape. Personnel will not enter this bounded area until the backhoe has been shut down, and the operator signals that it is acceptable to enter. Backhoe operations will resume only after personnel have left the area within the swing radius.

5.2.3 Hazards Associated with the Geoprobe® Unit

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

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

- While operating the controls, the operator must stand to the control side of the probe machine, clear of the probe foot and mast.
- Wear safety glasses at all times during the operation of this machine.
- Never exert down pressure on the probe rod so as to lift the machine base over six inches off the ground.

5.2.4 Hazards Associated with the Cone Penetrometer Equipment

The CPT equipment is typically housed in a stainless-steel body mounted on a triple-axle truck chassis. Caution will be exercised by personnel assisting in the positioning of the truck at each sampling location. The truck is not always equipped with an audible back-up signal. Movement of the truck and push rod coupling and uncoupling will be performed only by the equipment operators. Caution will also be exercised while climbing in and out of the CPT truck. The safety railing at the back of the CPT truck will be in the upright position when personnel are in the truck.

5.2.5 Subsurface Hazards

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

5.2.6 Electrical Hazards

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

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

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

Electricity can paralyze the nervous system and stop muscular action. Frequently, electricity may affect the breathing center at the base of the brain and interrupt the transmission of the nerve impulses to the muscles responsible for breathing. In other cases, the electrical current directly affects the heart, causing it to cease pumping blood. Death follows due to a lack of oxygen in the body. Therefore, a victim must be freed from the live conductor promptly by use of a nonconducting implement, such

as a piece of wood, or by turning off the electricity to at least this point of contact. Bare hands should never be used to remove a live wire from a victim or a victim from an electrical source. Artificial respiration or CPR should be applied immediately and continuously until breathing is restored, or until a physician or emergency medical technician arrives.

General rules for recognizing electrical safety are provided below.

- Only authorized and qualified personnel will perform electrical installations or repairs.
- All electrical wires and circuits will be assumed to be "live," unless it can be positively determined they are not.
- Appropriate protective clothing will be worn by personnel performing electrical work.
- All electrical equipment will be properly grounded and class-approved for the location.
- Ground fault circuit interrupter receptacles and circuit breakers will be installed where required by the National Electric Code and 29 CFR 1926.404.
- Electrical control panels will not be opened unless necessary.
- No safety device will be made inoperative by removing guards, using oversized fuses, or by blocking or bypassing protective devices, unless it is absolutely essential to the repair or maintenance activity, and then only after alerting operating personnel and the maintenance supervisor.
- All power tools will have insulated handles, be electrically grounded, or be double insulated.
- Fuse pullers will be used to change fuses.
- Metal ladders, metal tape measures, and other metal tools will not be used around electrical equipment or overhead electrical lines.
- Wires and extension cords will be placed or arranged so as to not pose a tripping hazard.

5.2.7 Slip, Trip, and Fall Hazards

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

- Open excavations, pits, or trenches;
- Slippery surfaces;
- Steep or uneven grades;

- Surface obstructions; and
- Construction materials or debris.

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

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

5.2.8 Noise-Induced Hearing Loss

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

5.2.9 Fire or Explosion Hazards

Fuels and solvents have been released into the soils at many of the USAF installations and vapors from these fuels may be flammable or explosive. In addition, drilling or other intrinsic activities may be performed in former or existing landfill areas. Therefore, precautions will be taken when performing risk-based demonstration activities to ensure that combustible or explosive vapors have not accumulated, or that an ignition source is not introduced into a flammable atmosphere.

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

- Proper storage of flammables;
- Adequate numbers and types of fire extinguishers;
- Use of intrinsically safe (explosion-proof) equipment where appropriate; and
- Monitoring for development of an explosive atmosphere.

The SHSO will ensure that the above concerns are adequately mitigated.

5.2.10 Electric Power Line Clearance and Thunderstorms

Extra precautions will be exercised when drilling near overhead electrical lines. As stated in 29 CFR 1926.550, the minimum clearance between overhead electrical lines of 50 kilovolts (kV) or less and the drill rig is 10 feet. For lines rated over 50 kV, the minimum clearance between the lines and any part of the rig is 10 feet plus 0.4 inches for each kV over 50 kV. Drilling operations must cease during thunderstorms.

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

5.2.11 Effects and Prevention of Heat Stress

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

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

- Provide plenty of liquids. To replace body fluids (water and electrolytes) lost due to perspiration, each employee must drink 1 to 1.5 gallons of water or commercial electrolyte mix per day. Workers are encouraged to frequently drink small amounts, i.e. one cup every 15-20 minutes.
- Field personnel are cautioned to minimize alcohol intake during off-duty hours.
- Provide cooling devices (e.g., water jackets or ice vests) to aid natural body ventilation. These devices, however, add weight, and their use should be balanced against worker mobility.
- Wear long cotton underwear, which acts as a wick to help absorb moisture and protect the skin from direct contact with heat-absorbing protective clothing.
- Install portable emergency showers and/or hose-down facilities to reduce body temperature and to cool protective clothing.
- In extremely hot weather, conduct non-emergency response operations in the early morning or evening.

- Ensure that adequate shelter is available to protect personnel against sun, heat, or other adverse weather conditions which decrease physical efficiency and increase the probability of accidents.
- In hot weather, rotate workers wearing protective clothing.
- Maintain good hygienic standards by frequent changing of clothing and daily showering. Clothing should be permitted to dry during rest periods. Workers who notice skin problems should immediately consult the SHSO.

5.2.11.1 Heat-Related Problems

- Heat rash: Caused by continuous exposure to heat and humid air, and aggravated by chafing clothes. Decreases ability to tolerate heat and is a nuisance.
- Heat cramps: Caused by profuse perspiration with inadequate fluid intake and chemical replacement, especially salts. Signs include muscle spasms and pain in the extremities and abdomen.
- Heat exhaustion: Caused by increased stress on various organs to meet increased demands to cool the body. Signs include shortness of breath; increased pulse rate (120-200 beats per minute); pale, cool, moist skin; profuse sweating; and dizziness and exhaustion.
- Heat stroke: The most severe form of heat stress. Body must be cooled immediately to prevent severe injury and/or death. Signs include red, hot, dry skin; no perspiration; nausea; dizziness and confusion; strong, rapid pulse; and possibly coma. Medical help must be obtained immediately.

5.2.11.2 Heat-Stress Monitoring

Monitoring of personnel wearing impermeable clothing will begin when the ambient temperature is 70°F (21°C) or above. Table 5.2 presents the suggested frequency for such monitoring. Monitoring frequency will increase as the ambient temperature increases or as slow recovery rates are observed. Heat-stress monitoring will be performed by a person with current first-aid certification who is trained to recognize heat-stress symptoms. For monitoring the body's recuperative capabilities in response to excess heat, one or more of the techniques listed below will be used. Other methods of heat-stress monitoring may also be used, such as the wet-bulb globe temperature index from the American Conference of Governmental Industrial Hygienists (ACGIH) (1994-1995) Threshold Limit Value (TLV) Booklet.

To monitor the worker, measure:

- Heart rate: Count the radial pulse during a 30-second period as early as possible during the rest period.
 - If the heart rate exceeds 110 beats per minute at the beginning of the rest period, the next work cycle will be shortened by one-third and the rest period will remain the same.

TABLE 5.2
SUGGESTED FREQUENCY OF PHYSIOLOGICAL MONITORING FOR
FIT AND ACCLIMATIZED WORKERS^{a/}

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

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

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

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

d/ Saranex[•], Poly-Coated Tyvek[•], Etc.

- If the heart rate still exceeds 110 beats per minute at the next rest period, the following work cycle will be reduced by one-third.
- Oral temperature: Use a clinical thermometer (3 minutes under the tongue) or similar device to measure the oral temperature at the end of the work period (before drinking).
 - If oral temperature exceeds 99.6° (37.6°C), the next work cycle will be reduced by one-third without changing the rest period.
 - If oral temperature still exceeds 99.6°F (37.6°C) at the beginning of the next rest period, the following work cycle will be reduced by one-third.
 - No worker will be permitted to wear a semipermeable or impermeable garment when oral temperature exceeds 100.6°F (38.1°C).

5.2.12 Cold Exposure

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

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

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

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

- Frost nip or incipient frostbite: characterized by suddenly blanching or whitening of skin.
- Superficial frostbite: skin has a waxy or white appearance and is firm to the touch, but tissue beneath is resilient.
- Deep frostbite: tissues are cold, pale, and solid; an extremely serious injury.

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

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

5.2.12.1 Evaluation and Control

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

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

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

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

5.2.12.2 Work-Warming Regimen

If work is performed continuously in the cold at an equivalent chill temperature (ECT) below -7°C (19.4°F), heated warming shelters (tents, cabins, rest rooms) will

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

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

Notes for Tables 5.3

- Schedule applies to any 4-hour work period with moderate to heavy work activity, with warm-up periods in a warm location and with an extended break (e.g., lunch) at the end of the 4-hour work period in a warm location. For light-to-moderate (limited physical movement): apply the schedule one step lower. For example, at -35°C (-30°F) with no noticeable wind (Step 4), a worker at a job with little physical movement should have a maximum work period of 40 minutes with 4 breaks in a 4-hour period (Step 5)
- The following is suggested as a guide for estimating wind velocity if accurate information is not available: 5 mph: light flag moves; 10 mph: light flag fully extended; 15 mph: raises newspaper sheet; 20 mph: blowing and drifting snow.
- In general the warm-up schedule provided above slightly under-compensates for the wind at the warmer temperatures, assuming acclimatization and clothing appropriate for winter work. On the other hand, the chart slightly over-compensates for the actual temperatures in the colder ranges, since windy conditions rarely prevail at extremely low temperatures.
- TLVs apply only for workers in dry clothing.

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

For work practices at or below -12°C (10.4°F) ECT, the following should apply:

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

5.3 BIOLOGICAL HAZARDS

Various biological hazards may be encountered at the USAF installations. These hazards include pathogenic organisms or diseases such as Bubonic Plague, Equine Encephalitis, and Lyme Disease. Other biological hazards include insects, snakes, spiders, and cactuses.

Bubonic plague is a bacterial disease which is spread to humans by fleas that have bitten an infected animal. Bubonic plague displays symptoms rapidly. Chills and fever are soon accompanied by swelling of the lymph nodes, usually on one side of the body. These painful swellings are usually dark blue to black, hence the other common name for this disease, "black death." The disease is treatable with antibiotics. Field

personnel must wear Tyvek® suits with leg seams taped to boots or boot covers to minimize contact with fleas while working in prairie dog towns.

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

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

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

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

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

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

Poison ivy, poison oak, and poison sumac can be encountered at many USAF installations. Poison ivy is a woody vine leaves are divided into three leaflets. Poison oak is a low branching shrub with leaflets also in threes. Poison sumac is a shrub or

small tree occurring in swamps. Poison sumac have 7 to 13 leaflets which resemble those of green ash trees. All of these species are poisonous and can cause contact dermatitis. Personnel must wear Tyvek® suits or other protective clothing when working in areas containing these plant species.

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

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

SECTION 6

EMERGENCY RESPONSE PLAN

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

6.1 GUIDELINES FOR PRE-EMERGENCY PLANNING AND TRAINING

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

6.2 EMERGENCY RECOGNITION AND PREVENTION

Emergency conditions are considered to exist if:

- Any member of the field crew is involved in an accident or experiences any adverse effects or symptoms of exposure while onsite.
- A condition is discovered that suggests the existence of a situation more hazardous than anticipated (e.g. flammable atmospheres).
- Concentrations of combustible vapors reach or exceed 10 percent of the lower explosive limit (LEL).
- A fire or explosion hazard exists.
- Concentrations of organic vapors measured in the worker breathing zone by a photoionization detector (PID) are above background air concentrations greater than an amount equal to the lowest permissible exposure limit (PEL) of a contaminant of concern onsite.

- A vehicle accident occurs.

Preventive measures are listed below.

- Site workers must maintain visual contact and should remain close together to assist each other during emergencies. (Use the buddy system.)
- During continual operations, onsite workers act as safety backup to each other. Offsite personnel provide emergency assistance.
- All field crew members should make use of all of their senses to alert themselves to potentially dangerous situations to avoid (e.g., presence of strong and irritating or nauseating odors).
- Personnel will practice unfamiliar operations prior to performing them in the field.
- Field crew members will be familiar with the physical characteristics of investigations and field demonstrations, including:
 - Wind direction in relation to contamination zones;
 - Accessibility to co-workers, equipment, vehicles and communication devices;
 - Communication signals and devices;
 - Hot zone locations (areas of known or suspected contamination);
 - Site access; and
 - Nearest water sources.
- Personnel and equipment in the designated work area should be minimized, consistent with effective site operations.

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

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

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

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

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

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

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

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

In the event of emergency conditions, decontaminated employees will evacuate the area as instructed, transport decontaminated injured personnel, or take other measures to ameliorate the situation. Evacuation routes and safe distances will be decided upon and posted by the field team prior to initiating work.

6.5 DECONTAMINATION OF PERSONNEL DURING AN EMERGENCY

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

- Another team member (buddy) will assist or remove the individual from the immediate area of contamination to an upwind location.

- Precautions will be taken to avoid exposure of other individuals to the chemical.
- If the chemical is on the individual's clothing, the clothing will be removed if it is safe to do so.
- Administer first aid and transport the victim to the nearest medical facility, if necessary.

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

6.6 EMERGENCY SITE SECURITY AND CONTROL

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

6.7 PROCEDURES FOR EMERGENCY MEDICAL TREATMENT AND FIRST AID

6.7.1 Chemical Exposure

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

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

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

6.7.2 Personal Injury

In the event of personal injury:

- Field team members trained in first aid can administer treatment to an injured worker.
- The victim will be transported to the nearest hospital or medical center. If necessary, an ambulance will be called to transport the victim.
- The SHSO or site manager is responsible for the completion of the appropriate accident report form.

6.7.3 Fire or Explosion

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

SECTION 7

LEVELS OF PROTECTION AND PERSONAL PROTECTIVE EQUIPMENT REQUIRED FOR SITE ACTIVITIES

7.1 PERSONAL PROTECTIVE EQUIPMENT

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

Ambient air monitoring of organic gases/vapors (using photoionization detectors such as an HNU® or Photovac® MicroTIP®, or by colorimetric analysis with Dräger® tubes) will be used to select the appropriate level of personal protection. The flow chart presented in Figure 7.1 will be used to select respiratory protection against volatile hydrocarbon constituents. If the portable air monitoring equipment indicates organic vapor concentrations of 0-5 meter units (mu), site workers will continue air monitoring in a Level D ensemble. If organic vapors reach 5-25 mu for more than 30 seconds, and benzene concentrations exceed 1 ppmv, site workers will evacuate the area or upgrade to Level B ensemble, if trained to do so. If benzene concentrations are less than 1 ppmv in the breathing zone, and vapors are in the range of 5-25 mu, the site crews may continue in Level D ensembles with periodic air monitoring. If organic vapor concentrations reach 25-50 mu for more than 30 seconds and benzene concentrations exceed 1 ppmv in the worker breathing zone, site crews will evacuate the area or upgrade to Level B ensembles. If benzene concentrations are less than 1 ppmv, and vapors are in the range of 25-50 mu, site workers will don full facepiece APRs equipped with organic vapor cartridges (National Institute for Occupational Safety and Health [NIOSH]-approved), and continue periodic monitoring. If organic vapor concentrations reach 50-500 mu for more than 30 seconds, site crews will evacuate the site or upgrade to Level B ensembles. If organic vapor concentrations exceed 500 mu for more than 30 seconds, site crews will evacuate the site.

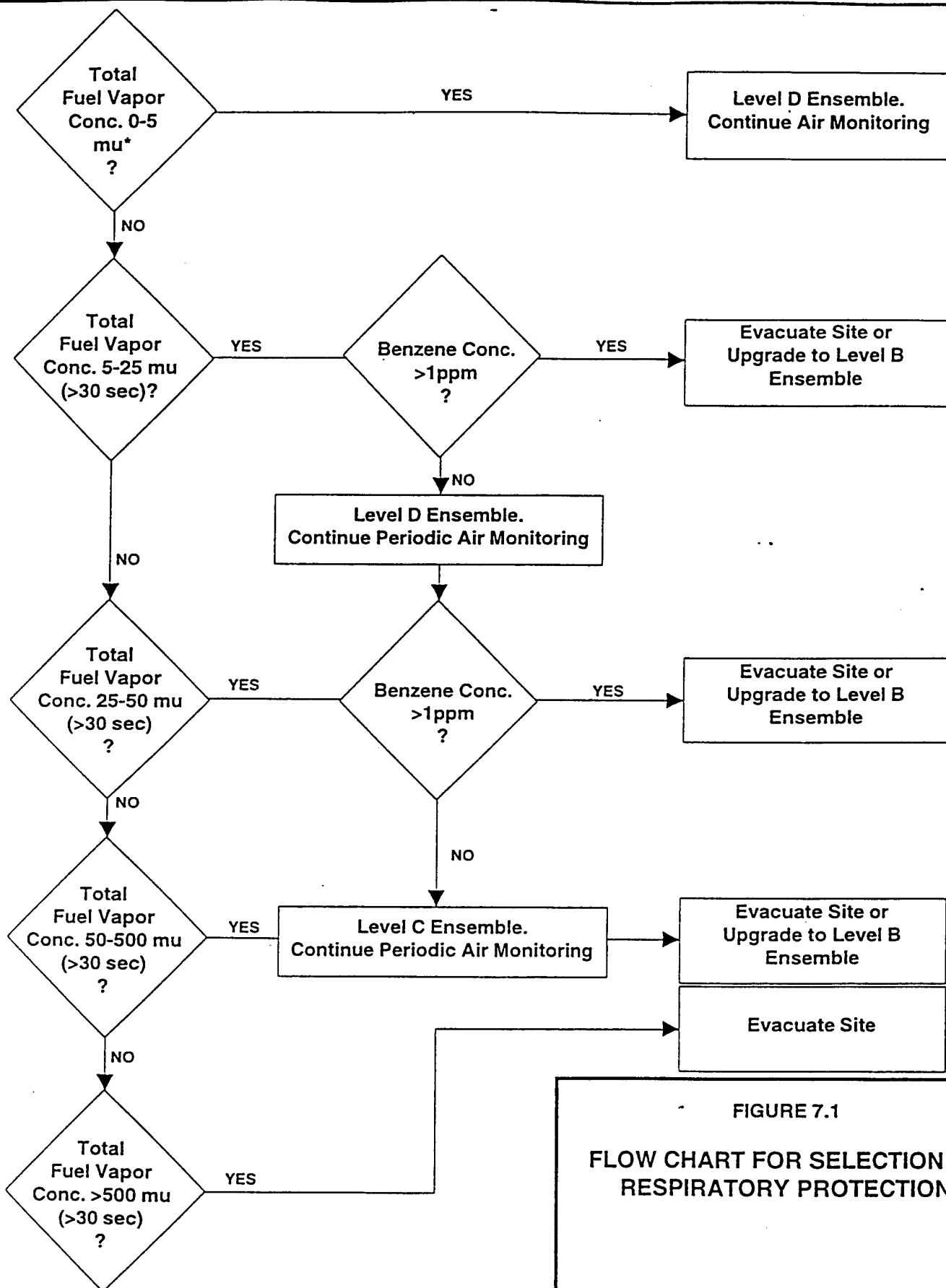


FIGURE 7.1

FLOW CHART FOR SELECTION OF RESPIRATORY PROTECTION



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* mu = Meter Units

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

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

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

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

Mandatory Equipment

- Vinyl or latex inner gloves
- 4H or SilverShield® outer gloves

Optional Equipment

- Air-purifying respirator (equipped with organic vapor/high-efficiency particulate air [HEPA] cartridges)
- Self-contained breathing apparatus or air-line respirator in pressure-demand mode
- Rubber safety boots

- Disposable Tyvek® coveralls
- Outer disposable boot covers
- Saranex® suits
- Chemical goggles

7.2 EQUIPMENT NEEDS

Each field team will have the following items readily available:

- Copy of this program health and safety plan, site-specific addendum, and a separate list of emergency contacts;
- First aid kit which includes PPE for bloodborne pathogens;
- Eyewash bottle;
- Paper towels;
- Duct tape;
- Water (for drinking and washing);
- Plastic garbage bags;
- Fire extinguisher; and
- Earplugs.

7.3 EQUIPMENT DISPOSAL

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

SECTION 8

FREQUENCY AND TYPES OF AIR MONITORING

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

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

During risk-based demonstration activities, a photoionization detector (such as an HNU® or MicroTIP®) will be used to measure ambient air concentrations in the worker breathing zone. The size of the PID lamp will be determined for each USAF site

individually, based on the ionization potential of the contaminants. This information will be presented in the site-specific addenda.

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

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

Passive Dosimeter Badges

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

Portable Sampling Pumps

- The portable pump will be calibrated to the required flow rate (in liters per minute) following the manufacturer's calibration procedures.
- The pump will be equipped with the appropriate sorbent tube for the particular organic compounds to be monitored (e.g., charcoal for volatile organics).
- A personal air monitoring data sheet (provided in Appendix B) listing pump flow rates, start and stop times, sorbent tube used, etc. will be completed.
- The pump will undergo a post calibration to determine final flow rates.
- The laboratory analytical results will be disclosed to the employee(s) monitored.
- The analytical results will be placed in the employee's permanent medical file for documentation of any exposures received.

SECTION 9

SITE CONTROL MEASURES

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

9.1 SITE ORGANIZATION-OPERATION ZONES

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

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

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

9.1.1 Exclusion Zone (Contamination Zone)

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

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

9.1.2 Contamination Reduction Zone

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

9.1.3 Support Zone

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

9.2 SITE SECURITY

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

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

9.3 SITE COMMUNICATION

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

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

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

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

9.4 SAFE WORK PRACTICES

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

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

SECTION 10

DECONTAMINATION PROCEDURES

10.1 PERSONNEL DECONTAMINATION PROCEDURES

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

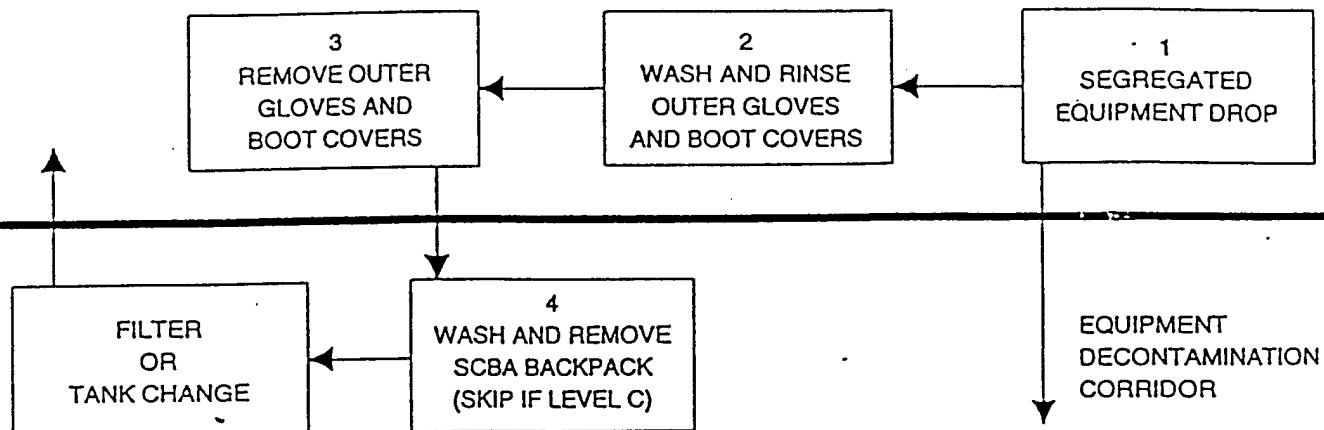
A guideline for personnel decontamination is presented in Figure 10.1. This procedure may be modified by the SHSO if necessary.

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

Decontamination equipment will include:

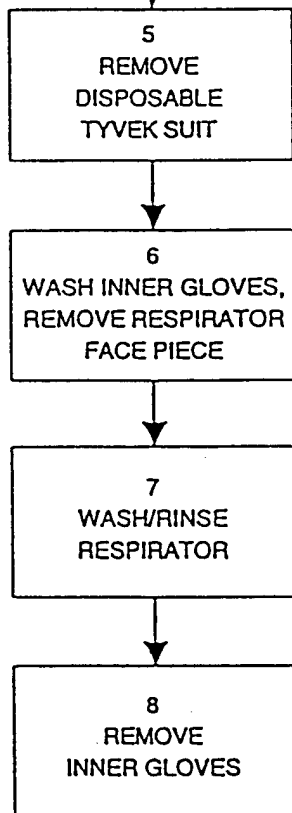
- Plastic buckets and pails;
- Scrub brushes and long-handle brushes;
- Detergent;
- Containers of water;
- Paper towels;
- Plastic garbage bags;
- Plastic or steel 55-gallon barrels;

EXCLUSION ZONE



CONTAMINATION REDUCTION ZONE

WIND DIRECTION



SUPPORT ZONE

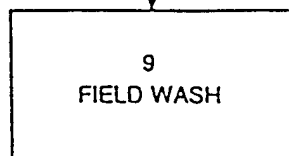


FIGURE 10.1

DECONTAMINATION
STATION LAYOUT
LEVEL B AND C PROTECTION

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- Distilled water; and
- An eyewash station.

10.2 DECONTAMINATION OF EQUIPMENT

Decontamination of drilling rigs will be conducted at a designated location. High-pressure steam-cleaning of the rig will be necessary prior to the beginning of the drilling operation, between borehole locations, and before the drilling rig leaves the project site. All sampling equipment will be decontaminated prior to use, between samples, and between sampling locations.

SECTION 11

AIR MONITORING EQUIPMENT USE AND CALIBRATION PROCEDURES

11.1 PHOTOVAC MICROTIP® AIR ANALYZER

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

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

Since a calibration gas (i.e., isobutylene) is used which typically differs from the contaminants of concern, it may be necessary to combine the instrument reading with a response factor to more closely approximate the concentration of the contaminants of concern.

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

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

TABLE 11.1
MICROTIP® RELATIVE RESPONSE FACTORS (10.6 eV LAMP)
INSTRUMENT MODELS MP-100 & HL-200

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

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

TABLE 11.2
MICROTIP® RESPONSE FACTORS (10.6 eV LAMP)
INSTRUMENT MODELS MP-1000, HL-2000, IS-3000 & EX-4000

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

Note: Concentration = Instrument Reading x Response Factor

11.2 HNU® PHOTOIONIZATION DETECTOR

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

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

11.3 EXPLOSIVITY METER

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

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

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

11.4 SENSIDYNE® OR DRÄGER® COLORIMETRIC GAS ANALYSIS TUBES

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

APPENDIX C

HISTORIC GROUNDWATER AND SOIL ANALYTICAL RESULTS SUMMARY TABLES AND HISTORIC SAMPLING LOCATION FIGURES

(OHM 1995a) Soil and groundwater results tables and sampling location figures with posted results for selected analytes.

(OHM 1997) Cumulative groundwater MO results tables; sampling location figures with posted results for selected analytes for year two first quarter results.

SAMPLING AND ANALYSIS PLAN

FOR

RISK-BASED SITE CLOSURE DEMONSTRATION

Prepared for:

**AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE (AFCEE)
TECHNOLOGY TRANSFER DIVISION**

BROOKS AIR FORCE BASE, TEXAS 78235-5000

AMC CONTRACT F11623-94-00024, Delivery Order 39

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SECTION 1

INTRODUCTION AND DATA QUALITY OBJECTIVES

1.1 INTRODUCTION

The purpose of this site-specific sampling and analysis plan (SAP) is to describe the procedures to be followed when collecting data in support of site characterization and the long-term monitoring plan (LTMP) which will be completed as a part of the Risk-Based Site Closure Demonstration at Homestead Air Reserve Base (ARB), Florida. Specific quality assurance (QA) sampling requirements are summarized herein as part of the site-specific sampling procedures. These additional samples will be used to determine the precision, accuracy, completeness, and representativeness of the final data set.

The remainder of Section 1 discusses data quality objectives. Soil gas sampling is described in Section 2; procedures for soil and sediment sampling are presented in Section 3; groundwater sampling procedures are described in Section 4; and field quality assurance/quality control (QA/QC) samples are described in Section 5. Section 6 describes field data reduction, validation, and reporting; Section 7 presents analytical procedures for groundwater and soil/sediment sampling. References used in this SAP are listed in Section 8.

1.2 DATA QUALITY OBJECTIVES

The objectives of collecting and analyzing environmental samples are 1) to determine the three-dimensional distribution of hydrocarbon and (as appropriate) lead contamination at the site; 2) to obtain the data needed to evaluate the effectiveness of specific remedial approaches, including and natural attenuation of groundwater; 3) to establish site-specific remediation goals that minimize or eliminate risk potential to receptors and limit offsite migration of site-related contamination; and 4) to prepare a site closure report to progress toward a final site remedy. This section has been developed for use in conjunction with sampling activities to be undertaken at the various sites, and describes the QA/QC procedures and protocols that will be used during sample analysis. This section will serve as a controlling mechanism during the investigations to ensure that a sufficient quantity of data is collected and that all data collected are valid, reliable, and defensible.

1.3 ANALYTICAL DATA QUALITY LEVELS

Data quality objectives (DQOs) for the analyses described herein are defined in the interim final guidance, *Data Quality Objectives Process for Superfund* (USEPA, 1993).

The analytical levels for this project's DQOs will conform to the two USEPA-defined categories of data. These data categories are defined below (USEPA, 1993):

Screening Data with Definitive Confirmation - Screening data are generated by rapid, less precise methods of analysis with less rigorous sample preparation. Sample preparation steps may be restricted to simple procedures such as dilution with a solvent, instead of elaborate extraction/digestion and cleanup. Screening data provide analyte identification and quantification, although the quantification may be relatively imprecise. At least 10 percent of the screening data are confirmed using analytical methods, QA/QC procedures, and QC criteria associated with definitive data. Screening data without associated confirmation data are not considered to be data of known quality. Results of field laboratory analyses conducted at the site will be considered screening-category data.

Definitive Data - Definitive data are generated using rigorous analytical methods, such as approved USEPA reference methods. Data are analyte-specific, with confirmation of analyte identity and concentration. Methods produce tangible raw data (e.g., chromatograms, spectra, digital values) in the form of hard-copy printouts or computer-generated electronic files. Data may be generated at the site or at an off-site location, as long as the QA/QC requirements are satisfied. For the data to be definitive, either analytical or total measurement error must be determined. Results of fixed-based laboratory analyses of samples collected at the site will be considered definitive data.

During the AFCEE streamlined, risk-based site closure demonstration, the following data quality levels will be used as indicated:

- Screening analyses with definitive confirmation will be used for the air screening in worker breathing zones for health and safety purposes. This category may also be used to screen samples to select portions for further analysis. For example, soil gas or sample headspace may be screened to determine if laboratory analyses are required. In addition, this data category will be used to determine the presence of geochemical parameters that support natural attenuation of fuel hydrocarbon contaminants in groundwater. Resulting data will be used to evaluate the effectiveness of natural attenuation at the site.
- Definitive analyses will be used to satisfy the requirements for site characterization, risk analysis, decision document preparation, and site cleanup prioritization. USEPA Level III data from previous site investigations will be combined with newly acquired definitive data to evaluate the magnitude and extent of contamination at the site. Definitive data acquired during the investigation will be used to evaluate potential receptor risks and to develop remedial alternatives.

An effective QA program addresses DQOs for both field sampling and laboratory methodologies. The contractor's field QA efforts will focus on assuring that samples are representative of the conditions in the various environmental media at the time of sampling. Fixed-based laboratory QA efforts will be aimed primarily at assuring that analytical procedures provide sufficient accuracy and precision to reliably quantify

contaminant levels in environmental samples. The contract laboratory also will ensure that analyzed portions are representative of each sample, and that the results obtained from analysis of each sample are comparable to those obtained from analysis of other similar samples.

1.4 DATA QUALITY ASSESSMENT CRITERIA

Data assessment criteria will be used to evaluate the quality of both the field sampling and screening methods and laboratory performance for the project, and are expressed in terms of analytical precision, accuracy, representativeness, completeness, and comparability. Procedures used to assess data accuracy and precision are in accordance with *Guidelines Establishing Test Procedures for the Analyses of Pollutants*, Appendix III, "Example Quality Assurance and Quality Control Procedures for Organic Priority Pollutants" (40 CFR 136), and the respective analytical methods from the USEPA (1995) *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods*, SW-846, and the applicable Florida Department of Environmental Protection (FDEP) specifications for Method FL-PRO (total recoverable petroleum hydrocarbons).

1.4.1 Precision

Precision is the measure of variability among individual sample measurements under prescribed conditions. The results of laboratory control samples (LCS) demonstrate the precision of the methods. When the LCS results meet the accuracy criteria, (USEPA, 1995) results are believed to be precise. This is based on the LCS being within control limits in comparison to LCS results from previous analytical batches of similar methods and matrices. The relative percent difference (RPD) of field duplicate, laboratory sample duplicate, and matrix spike/matrix spike duplicates (MS/MSD) results demonstrate the precision of the sample matrix. Precision will be expressed in terms of RPD between the values resulting from duplicate analyses. RPD is calculated as follows:

$$RPD = [(x1 - x2)/X][100]$$

where:

- x1 = analyte concentration in the primary sample
- x2 = analyte concentration in the duplicate sample
- X = average analyte concentration in the primary and the duplicate sample.

Acceptable levels of precision will vary according to the sample matrix, the specific analytical method, and the analytical concentration relative to the method detection limit (MDL). For field duplicate samples, the target RPDs are ≤ 35 percent for soil and water samples. Precision criteria for the laboratory QC samples are defined by limits listed in Table 1.1 and issued by FDEP for Florida TRPH method FL-PRO. An RPD within the control limit indicates satisfactory precision in a measurement system.

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TABLE 1.1
QC^{a/} ACCEPTANCE CRITERIA
RISK-BASED APPROACH TO REMEDIATION

Parameter/Method	Analyte	Accuracy Water (% R) ^{b/}	Precision Water (RPD) ^{c/}	Accuracy Soil (% R)	Precision Soil (RPD)
Aromatic Volatile Organic Compounds SW5030A/SW8020A (W ^{d/} , S ^{e/})	1,2-Dichlorobenzene	61-134	≤ 20	51-144	≤ 30
	1,3-Dichlorobenzene	70-131	≤ 20	60-141	≤ 30
	1,4-Dichlorobenzene	75-126	≤ 20	66-136	≤ 30
	Benzene	75-125	≤ 20	66-135	≤ 30
	Chlorobenzene	75-129	≤ 20	66-139	≤ 30
	Ethylbenzene	71-129	≤ 20	61-139	≤ 30
	Toluene	70-125	≤ 20	60-135	≤ 30
	Xylenes, total	71-133	≤ 20	61-143	≤ 30
	<i>Surrogates:</i>				
	Bromochlorobenzene	46-136	NA ^{f/}	36-146	NA
	Bromofluorobenzene	48-138	NA	38-148	NA
	Difluorobenzene	48-138	NA	38-148	NA
	Fluorobenzene	44-165	NA	34-175	NA
	1,1,1-Trifluorotoluene	44-165	NA	34-175	NA
Methane SW3810 Modified (W)	Methane	70-130	≤ 20	NA	NA
	Ethane	70-130	≤ 20	NA	NA
	Ethene	70-130	≤ 20	NA	NA
Volatile Organics SW5030A/SW8260A (W, S)	1,1,1,2-Tetrachloroethane	72-125	≤ 20	62-108	≤ 30
	1,1,1-Trichloroethane	75-125	≤ 20	65-135	≤ 30
	1,1,2,2-Tetrachloroethane	74-125	≤ 20	64-135	≤ 30
	1,1,2-Trichloroethane	75-127	≤ 20	65-135	≤ 30
	1,1-Dichloroethane	72-125	≤ 20	62-135	≤ 30
	1,1-Dichloroethene	75-125	≤ 20	65-135	≤ 30
	1,1-Dichloropropene	75-125	≤ 20	65-135	≤ 30
	1,2,3-Trichlorobenzene	75-137	≤ 20	65-147	≤ 30
	1,2,3-Trichloropropane	75-125	≤ 20	65-135	≤ 30
	1,2,4-Trichlorobenzene	75-135	≤ 20	65-145	≤ 30
	1,2,4-Trimethyl Benzene	75-125	≤ 20	65-135	≤ 30
	1,2-Dichloroethane	68-127	≤ 20	58-137	≤ 30
	1,2-Dichlorobenzene	75-125	≤ 20	65-135	≤ 30
	1,2-Dibromo-3-chloropropane	59-125	≤ 20	49-135	≤ 30
	1,2-Dichloropropane	70-125	≤ 20	60-135	≤ 30
	1,2-Dibromoethane	75-125	≤ 20	65-135	≤ 30
	1,3,5-Trimethylbenzene	72-112	≤ 20	62-135	≤ 30
	1,3-Dichlorobenzene	75-125	≤ 20	65-135	≤ 30
	1,4-Dichlorobenzene	75-125	≤ 20	65-135	≤ 30
	1-Chlorohexane	75-125	≤ 20	65-135	≤ 30
	2,2-Dichloropropane	75-125	≤ 20	65-135	≤ 30
	2-Chlorotoluene	73-125	≤ 20	63-135	≤ 30
	4-Chlorotoluene	74-125	≤ 20	64-135	≤ 30
	Benzene	75-125	≤ 20	65-135	≤ 30
	Bromobenzene	75-125	≤ 20	65-135	≤ 30
	Bromochloromethane	73-125	≤ 20	63-135	≤ 30
	Bromodichloromethane	75-125	≤ 20	65-135	≤ 30

TABLE 1.1 (Continued)
QC^{a/} ACCEPTANCE CRITERIA
RISK-BASED APPROACH TO REMEDIATION

Parameter/Method	Analyte	Accuracy Water (% R) ^{b/}	Precision Water (RPD) ^{c/}	Accuracy Soil (% R)	Precision Soil (RPD)
Volatile Organics (Cont) SW5030A/SW8260A (W, S)	Bromoform	75-125	≤ 20	65-135	≤ 30
	Bromomethane	72-125	≤ 20	62-135	≤ 30
	Carbon Tetrachloride	62-125	≤ 20	52-135	≤ 30
	Chlorobenzene	75-125	≤ 20	65-135	≤ 30
	Chlorodibromomethane	75-125	≤ 20	65-135	≤ 30
	Chloroethane	65-125	≤ 20	55-135	≤ 30
	Chloroform	74-125	≤ 20	64-135	≤ 30
	Chloromethane	75-125	≤ 20	65-135	≤ 30
	Cis-1,2-Dichloroethene	75-125	≤ 20	65-135	≤ 30
	Cis-1,3-Dichloropropene	74-125	≤ 20	64-135	≤ 30
	Dibromochloromethane	73-125	≤ 20	63-135	≤ 30
	Dibromomethane	69-127	≤ 20	59-137	≤ 30
	Dichlorodifluoromethane	75-125	≤ 20	65-135	≤ 30
	Dichloropropene	75-125	≤ 20	65-135	≤ 30
	Ethylbenzene	75-125	≤ 20	65-135	≤ 30
	Hexachlorobutadiene	75-125	≤ 20	65-135	≤ 30
	Isopropylbenzene	75-125	≤ 20	65-135	≤ 30
	m-Xylene	75-125	≤ 20	65-135	≤ 30
	Methylene Chloride	75-125	≤ 20	65-135	≤ 30
	n-Butylbenzene	75-125	≤ 20	65-135	≤ 30
	n-Propylbenzene	75-125	≤ 20	65-135	≤ 30
	Naphthalene	75-125	≤ 20	65-135	≤ 30
	o-Xylene	75-125	≤ 20	65-135	≤ 30
	p-Isopropyltoluene	75-125	≤ 20	65-135	≤ 30
	p-Xylene	75-125	≤ 20	65-135	≤ 30
	Sec-Butylbenzene	75-125	≤ 20	65-135	≤ 30
	Styrene	75-125	≤ 20	65-135	≤ 30
	Trichloroethene	71-125	≤ 20	61-135	≤ 30
	Tetrachloroethylene	71-125	≤ 20	61-135	≤ 30
	Toluene	74-125	≤ 20	64-135	≤ 30
	Trans-1,2-Dichloroethene	75-125	≤ 20	65-135	≤ 30
	Trans-1,3-Dichloropropene	66-125	≤ 20	56-135	≤ 30
	Trichlorofluoromethane	67-125	≤ 20	57-135	≤ 30
	Vinyl Chloride	46-134	≤ 20	36-144	≤ 30
	Xylenes, Total	75-125	≤ 20	65-135	≤ 30
	Surrogates:				
	Dibromofluoromethane	75-125	NA	65-135	NA
	Toluene-D8	75-125	NA	65-135	NA
	4-Bromofluorobenzene	75-125	NA	65-135	NA
	1,2-Dichloroethane-D4	62-139	NA	52-149	NA

TABLE 1.1 (Continued)
QC^a/ ACCEPTANCE CRITERIA
RISK-BASED APPROACH TO REMEDIATION

Parameter/Method	Analyte	Accuracy Water (% R) ^b	Precision Water (RPD) ^c	Accuracy Soil (% R)	Precision Soil (RPD)
Semivolatile Organics Base/Neutral Extractables SW3510B/SW8270B (W) SW3550A/SW8270B (S)	1,2,4-Trichlorobenzene	44-142	≤ 20	34-152	≤ 30
	1,2-Dichlorobenzene	42-155	≤ 20	32-135	≤ 30
	1,3-Dichlorobenzene	36-125	≤ 20	26-135	≤ 30
	1,4-Dichlorobenzene	30-125	≤ 20	25-135	≤ 30
	2,4-Dinitrotoluene	39-139	≤ 20	29-149	≤ 30
	2,6-Dinitrotoluene	51-125	≤ 20	41-135	≤ 30
	2-Chloronaphthalene	60-125	≤ 20	50-135	≤ 30
	2-Methylnaphthalene	41-125	≤ 20	31-135	≤ 30
	2-Nitroaniline	50-125	≤ 20	40-135	≤ 30
	3,3'-Dichlorobenzidine	29-175	≤ 20	25-175	≤ 30
	3-Methylphenol	41-144	≤ 20	31-154	≤ 30
	3-Nitroaniline	51-125	≤ 20	41-135	≤ 30
	4-Bromophenyl Phenyl Ether	53-127	≤ 20	43-137	≤ 30
	4-Chloroaniline	45-136	≤ 20	35-146	≤ 30
	4-Chlorophenyl Phenyl Ether	51-132	≤ 20	41-142	≤ 30
	4-Nitroaniline	40-143	≤ 20	30-153	≤ 30
	Acenaphthalene	47-125	≤ 20	37-135	≤ 30
	Acenaphthene	49-125	≤ 20	39-135	≤ 30
	Anthracene	45-165	≤ 20	35-175	≤ 30
	Benz (a) Anthracene	51-133	≤ 20	41-143	≤ 30
	Benzo (a) Pyrene	41-125	≤ 20	31-135	≤ 30
	Benzo (b) Fluoranthene	37-125	≤ 20	27-135	≤ 30
	Benzo (g,h,i) Perylene	34-149	≤ 20	25-159	≤ 30
	Benzo (k) Fluoranthene	37-125	≤ 20	27-135	≤ 30
	Benzyl Alcohol	35-125	≤ 20	25-135	≤ 30
	Bis (2-chloroethoxy) Methane	49-125	≤ 20	39-135	≤ 30
	Bis (2-chloroethyl) Ether	44-125	≤ 20	34-135	≤ 30
	Bis (2-chloroisopropyl) Ether	36-166	≤ 20	26-175	≤ 30
	Bis (2-ethylhexyl) Phthalate	33-129	≤ 20	25-139	≤ 30
	Butyl Benzyl Phthalate	26-125	≤ 20	25-135	≤ 30
	Carbazole	34-132	≤ 20	25-142	≤ 30
	Chrysene	55-133	≤ 20	45-143	≤ 30
	Di-n-Butyl Phthalate	34-126	≤ 20	25-136	≤ 30
	Di-n-Octyl Phthalate	38-127	≤ 20	28-137	≤ 30
	Dibenzo (a,h) Anthracene	50-125	≤ 20	40-135	≤ 30
	Dibenzofuran	52-125	≤ 20	42-135	≤ 30
	Diethyl Phthalate	37-125	≤ 20	27-135	≤ 30
	Dimethyl Phthalate	25-175	≤ 20	25-175	≤ 30
	Fluoranthene	47-125	≤ 20	37-135	≤ 30
	Fluorene	48-139	≤ 20	38-149	≤ 30
	Hexachlorobenzene	46-133	≤ 20	36-143	≤ 30
	Hexachlorobutadiene	25-125	≤ 20	25-135	≤ 30
	Hexachlorocyclopentadiene	41-125	≤ 20	31-135	≤ 30
	Hexachloroethane	25-153	≤ 20	25-163	≤ 30

TABLE 1.1 (Continued)
QC^a/ ACCEPTANCE CRITERIA
RISK-BASED APPROACH TO REMEDIATION

Parameter/Method	Analyte	Accuracy Water (% R) ^{b/}	Precision Water (RPD) ^{c/}	Accuracy Soil (% R)	Precision Soil (RPD)
Semivolatile Organics Base/Neutral Extractable SW3510B/SW8270B (W) SW3550A/SW8270B (S) (Cont)	Indeno (1,2,3-c,d) Pyrene	27-160	≤ 20	25-170	≤ 30
	Isophorone	26-175	≤ 20	25-175	≤ 30
	N-Nitrosodi-n-propylamine	37-125	≤ 20	27-135	≤ 30
	N-Nitrosodiphenylamine	27-125	≤ 20	25-135	≤ 30
	Naphthalene	50-125	≤ 20	40-135	≤ 30
	Nitrobenzene	46-133	≤ 20	36-143	≤ 30
	p-Chloroaniline	56-125	≤ 20	46-135	≤ 30
	Phenanthrene	54-125	≤ 20	44-135	≤ 30
	Pyrene	47-136	≤ 20	37-146	≤ 30
Semivolatile Organics Acid Extractables SW3510B/SW8270B (W) SW3550A/SW8270B (S)	2,4,5-Trichlorophenol	25-175	≤ 20	25-175	≤ 30
	2,4,6-Trichlorophenol	39-128	≤ 20	29-138	≤ 30
	2,4-Dichlorophenol	46-125	≤ 20	36-135	≤ 30
	2,4-Dimethylphenol	45-139	≤ 20	35-149	≤ 30
	2,4-Dinitrophenol	30-151	≤ 20	25-161	≤ 30
	2-Chlorophenol	41-125	≤ 20	31-135	≤ 30
	2-Methylphenol	25-125	≤ 20	25-135	≤ 30
	2-Nitrophenol	44-125	≤ 20	34-135	≤ 30
	4,6-Dinitro-2-Methyl Phenol	26-134	≤ 20	25-144	≤ 30
	4-Chloro-3-Methyl Phenol	44-125	≤ 20	34-135	≤ 30
	4-Methylphenol	33-125	≤ 20	25-135	≤ 30
	4-Nitrophenol	25-131	≤ 20	25-141	≤ 30
	Benzoic Acid	25-162	≤ 20	25-172	≤ 30
	Pentachlorophenol	28-136	≤ 20	38-146	≤ 30
	Phenol	25-125	≤ 20	25-135	≤ 30
	<i>Surrogates:</i>				
	2,4,6-Tribromophenol	25-134	NA	25-144	NA
	2-Fluorobiphenyl	43-125	NA	34-135	NA
	2-Fluorophenol	25-125	NA	25-135	NA
	Nitrobenzene-D5	32-125	NA	25-135	NA
	Phenol-D5	25-125	NA	25-135	NA
	Terphenyl-D14	42-126	NA	32-136	NA
Polynuclear Aromatic Hydrocarbons SW3510B/SW8310 (W) SW2550A/SW8310 (S)	1-Methylnaphthalene	25-150	≤ 30	25-160	≤ 50
	2-Methylnaphthalene	25-150	≤ 30	25-160	≤ 50
	Acenaphthalene	49-125	≤ 30	39-135	≤ 50
	Acenaphthene	43-130	≤ 30	33-140	≤ 50
	Anthracene	54-125	≤ 30	44-135	≤ 50
	Benzo (a) Anthracene	39-135	≤ 30	29-145	≤ 50
	Benzo (a) Pyrene	52-125	≤ 30	42-135	≤ 50
	Benzo (b) Fluoranthene	31-137	≤ 30	25-147	≤ 50
	Benzo (g,h,i) Perylene	53-125	≤ 30	43-135	≤ 50
	Benzo (k) Fluoranthene	60-129	≤ 30	50-139	≤ 50
	Chrysene	59-134	≤ 30	49-144	≤ 50
	Dibenzo (a,h) Anthracene	51-125	≤ 30	41-135	≤ 50
	Fluoranthene	42-125	≤ 30	32-135	≤ 50
	Fluorene	53-125	≤ 30	43-135	≤ 50

TABLE 1.1 (Continued)
QC^w ACCEPTANCE CRITERIA
RISK-BASED APPROACH TO REMEDIATION

Parameter/Method	Analyte	Accuracy Water (% R) ^{b/}	Precision Water (RPD) ^{c/}	Accuracy Soil (% R)	Precision Soil (RPD)
Polynuclear Aromatic Hydrocarbons SW3510B/SW8310 (W) SW2550A/SW8310 (S)	Indeno (1,2,3-c,d) Pyrene	55-125	≤ 30	45-135	≤ 50
	Naphthalene	43-125	≤ 30	33-135	≤ 50
	Phenanthrene	52-129	≤ 30	42-139	≤ 50
	Pyrene	55-125	≤ 30	45-135	≤ 50
	<i>Surrogates:</i> Terphenyl-D14	25-157	NA	22-167	NA
ICP Screen for Metals SW3005A/SW6010A (W) SW3050A/SW6010A (S)	Aluminum	80-120	≤ 15	80-120	≤ 25
	Antimony	80-120	≤ 15	80-120	≤ 25
	Arsenic	80-120	≤ 15	80-120	≤ 25
	Barium	80-120	≤ 15	80-120	≤ 25
	Beryllium	80-120	≤ 15	80-120	≤ 25
	Cadmium	80-120	≤ 15	80-120	≤ 25
	Calcium	80-120	≤ 15	80-120	≤ 25
	Chromium	80-120	≤ 15	80-120	≤ 25
	Cobalt	80-120	≤ 15	80-120	≤ 25
	Copper	80-120	≤ 15	80-120	≤ 25
	Iron	80-120	≤ 15	80-120	≤ 25
	Lead	80-120	≤ 15	80-120	≤ 25
	Magnesium	80-120	≤ 15	80-120	≤ 25
	Manganese	80-120	≤ 15	80-120	≤ 25
	Molybdenum	80-120	≤ 15	80-120	≤ 25
	Nickel	80-120	≤ 15	80-120	≤ 25
	Potassium	80-120	≤ 15	80-120	≤ 25
	Selenium	80-120	≤ 15	80-120	≤ 25
	Silver	80-120	≤ 15	80-120	≤ 25
	Sodium	80-120	≤ 15	80-120	≤ 25
	Thallium	80-120	≤ 15	80-120	≤ 25
	Vanadium	80-120	≤ 15	80-120	≤ 25
	Zinc	80-120	≤ 15	80-120	≤ 25
SW3020A/SW7421 (W) SW3050A/SW7421 (S)	Lead	74-124	≤ 15	74-124	≤ 25
	Cadmium	80-122	≤ 15	80-122	≤ 15
SW3020A/SW7131A (W) SW3050A/SW7131A (S)					
Common Anions SW9060	Bromide	86-112	≤ 20	86-112	≤ 30
	Chloride	91-111	≤ 20	91-111	≤ 30
	Fluoride	86-114	≤ 20	86-114	≤ 30
	Nitrate	90-110	≤ 20	90-110	≤ 30
	Nitrite	88-116	≤ 20	88-116	≤ 30
	Phosphate	87-110	≤ 20	87-110	≤ 30
	Sulfate	88-115	≤ 20	88-115	≤ 30

TABLE 1.1 (Continued)
QC^{a/} ACCEPTANCE CRITERIA
RISK-BASED APPROACH TO REMEDIATION

Parameter/Method	Analyte	Accuracy Water (% R) ^{b/}	Precision Water (RPD) ^{c/}	Accuracy Soil (% R)	Precision Soil (RPD)
E160.1	Total Dissolved Solids	NA	≤ 20	NA	NA
E160.2	Total Suspended Solids	NA	≤ 20	NA	NA
E310.1	Alkalinity	80-120	≤ 20	80-120	NA
E353.1	Nitrogen, nitrate/nitrite	80-120	≤ 20	80-120	NA
SW9050	Conductance	NA	≤ 20	NA	NA
SW9040	pH	NA	NA	NA	NA
EPA Method TO-13 for Soil	Benzene			70-130	±30
Gas Volatile Organics	Toluene			70-130	±30
	Ethylbenzene			70-130	±30
	m,p-Xylene			70-130	±30
	o-Xylene			70-130	±30
	Total Volatile Hydrocarbons			NA	NA
ASTM Method D3416 for Methane in Soil Gas	Methane			75-125	±25

Criteria: Sample, QC sample and blank I.S. area must be within ±40% of the calibration checks I.S. area.

Retention

Time (R.T.) must be within ±0.5 minutes of the calibration check's R.T.

SOURCE: AFCEE QAPP, Version 2.0, January 1997

^{a/} QC = Quality Control

^{b/} %R = Percent Recovery

^{c/} RPD = Relative percent difference

^{d/} W = Water

^{e/} S = Soil

^{f/} NA = Not Applicable

1.4.2 Accuracy

Accuracy is a measure of the closeness of a reported concentration to the true value. Accuracy is expressed as a bias (high or low) and is determined by calculating percent recovery (%R) from MS/MSDs, LCSs, and surrogate spikes. MS/MSD and surrogate spike %Rs indicate accuracy relevant to a unique sample matrix. LCS %Rs indicate accuracy relevant to an analytical batch lot, and are strictly a measure of analytical accuracy conditions independent of samples and matrices. The %R of an analyte, and the resulting degree of accuracy expected for the analysis of QC spiked samples, are dependent upon the sample matrix, method of analysis, and the compound or element being measured. The concentration of the analyte relative to the detection limit of the method also is a major factor in determining the accuracy of the measurement.

Accuracy is expressed as %R and is calculated as follows:

$$\%R = [(A-B)/C] \times 100$$

where:

- A = spiked sample concentration
- B = measured sample concentration (without spike)
- C = concentration of spike added.

Accuracy criteria for the laboratory are defined by control limits listed in Table 1.1 and issued by FDEP for Florida TRPH method FL-PRO.

1.4.3 Completeness

Completeness is defined as the percentage of laboratory measurements judged to be valid on a method-by-method basis. Valid data are defined as all data and/or qualified data considered to meet the DQOs for this project. Data completeness is expressed as percent complete (PC) and should be ≥ 90 percent. The goal for meeting analytical holding times is 100 percent. At the end of each sampling event, the completeness of the data will be assessed. If any data omissions are apparent, the parameter in question will be resampled and/or reanalyzed, if feasible. The laboratory results will be monitored as they become available to assess laboratory performance and its effect on data completeness requirements. When appropriate, additional samples will be collected to ensure that laboratory performance meets PC requirements.

PC is calculated as follows:

$$PC = \frac{N_A}{N_I} \times 100$$

Where:

N_A = Actual number of valid analytical results obtained

N_I = Theoretical number of results obtainable under ideal conditions.

1.4.4 Comparability

Comparability expresses the confidence with which data from one sample, sampling round, site, laboratory, or project can be compared to those from another. Comparability during sampling is dependent upon sampling program design and time periods. Comparability during analysis is dependent upon analytical methods, detection limits, laboratories, units of measure, and sample preparation procedures.

Comparability is determined on a qualitative rather than quantitative basis. For this project, comparability of all data collected will be ensured by adherence to standard sample collection procedures, standard field measurement procedures, and standard reporting methods, including consistent units. For example, concentrations will be reported in a manner consistent with general industry practice (e.g., soil data will be reported on a dry-weight basis).

In addition, to support the comparability of fixed-base laboratory analytical results with those obtained in previous or future testing, all samples will be analyzed by USEPA-approved methods, where available. The USEPA-recommended maximum permissible holding times for organic and inorganic parameters will not be exceeded. All analytical standards will be traceable to standard reference materials. Instrument calibrations will be performed in accordance with USEPA method specifications, and will be checked at the frequency specified for the methods. The results of these analyses can then be compared with analyses by other laboratories and/or with analyses for other sites addressed by this site investigation.

1.4.5 Representativeness

Representativeness expresses the extent to which collected data define site contamination. Where appropriate, sample results will be statistically characterized to determine the degree to which the data accurately and precisely represent a characteristic of a population, parameter variation at a sampling point, a process, or an environmental condition.

Sample collection, handling, and analytical procedures will strive to obtain the most representative sample possible. Representative samples will be achieved by the following:

- Collection of samples from locations fully representing site conditions;
- Use of appropriate sampling procedures, including equipment and equipment decontamination;
- Use of appropriate analytical methods for the required parameters and project reporting limits; and
- Analysis of samples within the required holding times.

Sample representativeness also is affected by the portion of each collected sample that is chosen for analysis. The laboratory will adequately homogenize all samples prior to taking aliquots for analysis to ensure that the reported results are representative of the sample received. Because many homogenization techniques may cause loss of contaminants through volatilization, homogenization for all volatile organic compound (VOC) method analyses will be performed with extreme care to minimize these risks.

SECTION 2

SOIL GAS SAMPLING

2.1 INTRODUCTION

Soil gas data will be used to assess the potential risk to future workers at the site and to determine whether or not sufficient oxygen is available in the soil gas to sustain aerobic fuel hydrocarbon biodegradation. Samples will be collected from groundwater monitoring wells that have screens extending above the groundwater surface.

2.2 SOIL GAS SAMPLING PROCEDURES

The test equipment and methods that will be required to conduct field soil gas sampling at this site are generally described in *Addendum One to Test Plan and Technical Protocol for a Field Treatability Test for Bioventing - Using Soil Gas Surveys to Determine Bioventing Feasibility and Natural Attenuation Potential* (Downey and Hall, 1994). During soil gas screening, soil gas will be collected from groundwater monitoring wells with screened intervals extending above the groundwater surface.

A 1-cfm vacuum pump will be operated for approximately 30 seconds at each location to purge soil gas and collect a representative sample. A Gas Tech multi-gas meter will be continuously sample the purge stream to insure that total volatile hydrocarbon (TVH) levels have stabilized. Once stabilized, oxygen, TVH and carbon dioxide levels will be recorded. At several points with high TVH levels a sample will be collected in a 3-liter Tedlar bag for laboratory analysis. The multi-gas meter has range settings of 0 to 25 percent for both O₂ and CO₂. Before analyzing samples, the analyzer must be calibrated and the battery charge checked. The analyzer will be calibrated daily using atmospheric conditions of O₂ (20.9 percent) and CO₂ (0.05 percent) and a gas standard containing 0.0 percent O₂ and 5.0 percent CO₂. The TVH analyzer will be calibrated daily using a 5,000 ppmv methane calibration gas.

Sample locations identified for laboratory analytical, compound-specific analysis will be sampled using 3-liter Tedlar® bags and a vacuum chamber. The samples will then be transferred to 1-liter SUMMA® canisters and shipped to Air Toxics, Inc. in Folsom, California for compound-specific analysis using US Environmental Protection Agency (USEPA) analytical Method TO-13.

Field quality assurance/quality control (QA/QC) procedures for soil gas will include collection of one field duplicate for every 10 samples collected (e.g., frequency of 10 percent), use of analyte-appropriate containers, and chain-of-custody procedures for sample handling and tracking. All samples to be transferred to the analytical laboratory

for analysis will be clearly labeled to indicate sample number, location, matrix (e.g., soil gas), and analyses requested. Samples will be preserved in accordance with the analytical method to be used.

All field sampling activities will be recorded in a bound, sequentially paginated field notebook in permanent ink. All sample collection entries will include the date, time, sample locations and numbers, notations of field observations, and the sampler's name and signature.

The analytical laboratory will conduct one matrix spike analysis, one laboratory control sample, and one laboratory blank test for each specific analysis requested for soil gas (i.e., required only once for soil gas since only one analytical method will be used).

SECTION 3

SOIL/SEDIMENT SAMPLING

3.1 INTRODUCTION

Soil and sediment sampling may be performed as part of the site characterization. The following sections describe borehole installation, soil sampling, procedures for equipment decontamination, and datum surveying procedures to be used as part of the soil sampling field effort.

3.2 SOIL AND SEDIMENT SAMPLING PROCEDURES

3.2.1 Soil Sampling

Soil sampling in unconsolidated soils and poorly consolidated limestone will be accomplished using a truck-mounted drill rig. Prior to sampling, a hole will be cut through the concrete or asphalt pavement using either a concrete saw, coring tool, or solid-flight auger. Soil borings will be drilled by continuously advancing a two-foot by two-inch-diameter split-spoon sampler containing 4- to 6-inch-long brass sleeves. The split-spoon will be advanced by driving with a 140-pound hammer mounted on the drill rig. After advancing the split-spoon sampler for each two-foot interval, the sampler will be extracted and opened. Selected brass sleeves will be sealed with Teflon® tape and capped with plastic caps, labeled, and submitted to the laboratory. Alternatively, samples for analysis of non-volatile parameters may be immediately placed into laboratory-supplied jars for laboratory submittal. Another portion of each sample will be placed into a self-sealing plastic bag or clean glass jar covered with aluminum foil and a screw-on cap for field headspace screening. Samples for headspace screening will be allowed to equilibrate for approximately 10 minutes, then screened for organic vapors using a PID. Field screening results will be used to select samples for laboratory analysis and to determine the vertical extent of contamination. All samples will be examined for evidence of contamination, and soil types will be described and classified according to the Unified Soil Classification System.

All sampling equipment will be decontaminated prior to use and between uses, as described in Section 3.7. If subsurface conditions are such that the planned installation technique does not produce acceptable results another technique deemed more appropriate to the type of soils present will be used. Any alternate soil sampling procedure used must be approved by the Parsons ES site manager and will be appropriate for the subsurface lithologies present at the site.

The Parsons ES field hydrogeologist will be responsible for observing all borehole installation and sampling activities, maintaining a detailed log of the target sample interval, and properly labeling and storing samples. An example of the proposed geologic boring log form is presented in Figure 3.1. The descriptive log will contain:

- Sample interval (top and bottom depth);
- Sample recovery;
- Presence or absence of contamination (e.g., staining, odor or elevated headspace screening readings);
- Soil or rock description of the target sampling interval, including relative density, color, major textural constituents, minor constituents, porosity, relative moisture
- content, plasticity of fines, cohesiveness, grain size, structure or stratification, relative permeability, and any other significant observations; and
- The depth of lithologic contacts and/or significant textural changes, measured and recorded to the nearest 0.1 foot (1 inch) if present within the target interval.

3.2.2 Sediment Sampling

Sediment samples (if scoped in the site-specific work plan) will be collected from the upper six inches of the sediment layer using a stainless steel hand trowel, placed in a 500 ml glass jar with minimum headspace, and sealed using a Teflon® sheet and screw-on lid.

3.3 SAMPLE HANDLING

This section describes the handling of soil and sediment samples from the time of sampling until the samples arrive at the laboratory.

3.3.1 Sample Containers and Labels

New, factory-cleaned brass sample sleeves and end caps or glass jars will be provided by the laboratory. The sample label will be firmly attached to the sample sleeve or jar immediately after sample collection, and the following information will be legibly and indelibly written on the label:

- Facility name;
- Sample identification;
- Sample depth;
- Sampling date;

GEOLOGIC BORING LOG

Sheet 1 of 1

BORING NO.: _____ CONTRACTOR: _____ DATE SPUD: _____
 CLIENT: _____ RIG TYPE: _____ DATE CMPL.: _____
 JOB NO.: _____ DRLG METHOD: _____ ELEVATION: _____
 LOCATION: _____ BORING DIA.: _____ TEMP: _____
 GEOLOGIST: _____ DRLG FLUID: _____ WEATHER: _____
 COMMENTS: _____

Elev (ft)	Depth (ft)	Pro- file	US CS	Geologic Description	Sample		Penet Res	PID(ppm)	TLV(ppm)	TOTAL BTEX(ppm)	TPH (ppm)
					No.	Depth (ft)					
	1										
	5										
	10										
	15										
	20										
	25										
	30										
	35										

NOTES

bgs - Below Ground Surface
 GS - Ground Surface
 TOC - Top of Casing
 NS - Not Sampled
 SAA - Same As Above
 U - Undetected

SAMPLE TYPE

D - DRIVE
 C - CORE
 G - GRAB



Water level drilled

FIGURE 3.1

GEOLOGIC BORING LOG

Risk-Based Approach to Remediation

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- Sampling time; and
- Sample collector's initials.

3.3.2 Sample Preservation

Samples will be properly prepared for transportation to the laboratory by placing the samples in an adequately padded cooler containing ice to maintain an approximate shipping temperature of 4 degrees centigrade (°C).

3.3.3 Sample Shipment

After the samples are sealed and labeled, they will be packaged for transport to the analytical laboratory. Samples will be shipped priority overnight via Federal Express®. The following packaging and labeling procedures will be followed:

- Package sample so that it will not leak, spill, or vaporize from its container;
- Label shipping container with:
 - Sample collector's name, address, and telephone number;
 - Laboratory's name, address, and telephone number;
 - Description of sample;
 - Quantity of sample; and
 - Date of shipment.

The packaged samples will be delivered to the laboratory as soon as possible after sample acquisition, and in accordance with analytical method-specific holding times.

3.3.4 Chain-of-Custody Control

After the samples have been collected, chain-of-custody procedures will be followed to establish a written record of sample handling and movement between the sampling site and the laboratory. Each shipping container will have a chain-of-custody form completed in triplicate by the sampling personnel. One copy of this form will be kept by the sampling team and the other two copies will be sent to the laboratory. One of the laboratory copies will become a part of the permanent record for the sample and will be returned with the sample analytical results. The chain-of-custody will contain the following information:

- Sample identification number;
- Sample collector's printed name and signature;
- Date and time of collection;

- Place and address of collection;
- Sample matrix;
- Analyses requested;
- Signatures of individuals involved in the chain of possession; and
- Inclusive dates of possession.

The chain-of-custody documentation will be placed inside the shipping container so that it will be immediately apparent to the laboratory personnel receiving the container, but will not be damaged or lost during transport. The shipping container will be sealed so that it will be obvious if the seal has been tampered with or broken.

3.3.5 Sampling Records

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

- Sample location (facility name);
- Sample identification;
- Sample location map or detailed sketch;
- Date and time of sampling;
- Sampling method;
- Field observations of
 - Sample appearance,
 - Sample odor;
- Weather conditions;
- Sampler's identification;
- Any other relevant information.

3.4 LABORATORY ANALYSES

Laboratory analyses will be performed by the designated laboratory on all soil samples and the required QA/QC samples (see Section 3.5 and Section 5). Soil samples will be analyzed by USEPA analytical method 8020 for aromatic volatile organic compounds (including MTBE), and selected samples will be analyzed by USEPA analytical method 8270B for polynuclear aromatic hydrocarbons (PAHs), and

total recoverable petroleum hydrocarbons (TRPH) using Method FL-PRO. In addition to these three methods, selected soil samples will also be analyzed for total organic carbon (TOC) by method SW 9060M. All containers, preservatives, and shipping requirements will be consistent with the laboratory protocol. Laboratory personnel will specify any additional QC samples required. Shipping containers, ice chests with adequate padding, and cooling media will be sent by the laboratory to the site.

3.5 QUALITY ASSURANCE/QUALITY CONTROL SAMPLES

As a check on the quality of field sampling activities (sampling, containerization, shipment, and handling) QA/QC trip blanks, field blanks, equipment rinseate samples, and field replicates will be sent to the laboratory. QA/QC sampling will include replicates for soil samples (frequency of 10 percent), rinseate samples (frequency of 10 percent), and a trip blank for each individual shipping cooler sent to the analytical laboratory containing samples for volatile organic compound (VOC) analysis. The procedures for the collection of field QA/QC samples are discussed in Section 5 of this SAP. Laboratory QA/QC procedures will include one matrix spike analysis, one laboratory control sample, and one laboratory blank sample test for each specific analysis requested.

3.6 MANAGEMENT OF SOIL RESIDUALS

Soil cuttings and excess soil samples will be placed in US Department of Transportation (DOT)-approved 55-gallon drums. Drums will be labeled with the site name, drilling date, and borehole number. Parsons ES will coordinate with Homestead ARB to dispose of the soil and drums in an approved manner.

3.7 EQUIPMENT DECONTAMINATION PROCEDURES

Water to be used in equipment cleaning will be obtained from one of the Base's onsite water supplies. Base personnel will assist Parsons ES field personnel in locating a suitable source. Water use approval will be verified by contacting the appropriate facility personnel. Only potable water will be used for decontamination. If the quality of the water source is questionable, then a decontamination water field blank will be collected for laboratory analysis. The procedures for the collection of the decontamination water blank are described in Section 5. The Parsons ES field scientist will make the final determination as to the suitability of site water for these activities.

Prior to arriving at the site, and between each borehole installation, the drill rig augers and bits, rods, samplers, tools and other downhole equipment will be decontaminated at a designated location. The decontamination fluids will be stored in 55-gallon DOT-approved drums for proper treatment and disposal. All down-hole sampling tools will be cleaned between boreholes with a clean water/phosphate-free detergent mix followed by a clean water rinse. All surfaces that contact the soil samples (i.e., split-spoon sampler) will be cleaned between each soil sample within a borehole. Materials that cannot be cleaned to the satisfaction of the Parsons ES field scientist will not be used. All decontamination activities will be conducted in a manner so that the excess water will be controlled and not allowed to flow into any open borehole.

Fuel, lubricants, and other similar substances will be handled in a manner consistent with accepted safety procedures and standard operating practices. The drill rig will not be allowed onsite unless it is free from leaks in all hydraulic and fuel lines, and is free of any exterior oil and grease.

Surface runoff such as miscellaneous spills and leaks, precipitation, and spilled decontamination fluids will not be allowed to enter any boring. Berms around the borehole and surficial bentonite packs, as appropriate, will be used to prevent cross-contamination.

3.8 SURVEY OF BOREHOLE LOCATIONS

The horizontal locations of the new boreholes will be located by Parsons ES field personnel after completion of sampling procedures. Horizontal locations will be measured relative to previously installed groundwater wells that have established coordinates (i.e., previously surveyed by a registered surveyor). Horizontal distances will be recorded to the nearest 0.1 foot by measuring the distance from each borehole to three established locations [monitoring wells or other previously surveyed locations (e.g., building corners) deemed more appropriate by field personnel]. These distances will be used to locate each borehole on any additional maps generated as part of the risk-based investigation. At the discretion of the site manager, selected boreholes may be located by a professional surveyor. Horizontal coordinates will be measured to the nearest 0.1 foot using the incumbent coordinate system, and vertical ground surface elevations will be measured to the nearest 0.1 foot relative to US Geological Survey (USGS) benchmarks.

3.9 BOREHOLE ABANDONMENT

Boreholes will be abandoned by filling them with bentonite pellets or chips to the base of the pavement. The bentonite will be hydrated in place with potable water at 2-foot intervals to ensure proper hydration and subsequent sealing of the borehole. The concrete or asphalt at the site will be patched with ready-mix concrete or asphalt patch material troweled to match the existing grade.

SECTION 4

MONITORING WELL INSTALLATION, DEVELOPMENT, AND GROUNDWATER SAMPLING

4.1 INTRODUCTION

This section describes the scope of work required for installing new groundwater monitoring wells, developing newly installed groundwater monitoring wells, and collecting groundwater samples from existing and new monitoring wells. Sampling of permanently installed new and existing wells will be completed using a peristaltic pump for collection of all chemical/geochemical parameters. If the groundwater is too deep to allow use of a peristaltic pump (e.g., deeper than 20-25 feet bgs), then an alternate sampling device will be used. Potential alternate sampling devices include bailers or a Grundfos Redi-Flo II® pump. In order to maintain a high degree of QC during this sampling event, the procedures described in the following sections will be followed.

Development and groundwater sampling will be conducted by qualified Parsons ES scientists and technicians trained in the conduct of well sampling, records documentation, and chain-of-custody procedures. In addition, sampling personnel will have thoroughly reviewed the work plan and this site-specific sampling and analysis plan prior to sample acquisition and will have a copy of both available onsite for reference.

Activities that will occur during groundwater sampling are summarized below:

- Assembly and preparation of equipment and supplies;
- Inspection of existing wells, including:
 - Protective cover, cap and lock,
 - External surface seal and pad,
 - Well stick-up, cap, and datum reference,
 - Internal surface seal,
 - Condition of any dedicated equipment, if present;
- Groundwater sampling, including:
 - Water level measurements,

- Visual inspection of borehole water,
- Well purging,
- Sampling;
- Sample preservation and shipment, including:
 - Sample preparation and preservation, as appropriate,
 - Onsite measurement of physical parameters,
 - Sample labeling,
 - Sample packaging in appropriate shipping containers;
- Completion of sampling records;
- Completion of chain-of-custody records; and
- Sample shipment via overnight courier.

Detailed groundwater water sampling and sample handling procedures are presented in following sections.

4.2 DEVELOPMENT PROCEDURES

Newly installed monitoring wells will be developed prior to sampling to remove fine sediments and introduced fluids from the portion of the formation adjacent to the screened interval. Development of monitoring wells will be accomplished using a peristaltic pump or electric submersible pump and, if necessary to obtain acceptable water clarity, a surging device. Monitoring well development will occur a minimum of 24 hours prior to sampling.

Development will continue until a minimum of 10 casing volumes have been removed, and the water pH, temperature, and specific conductance have stabilized. If the development water is still turbid after removal of the minimum number of casing volumes, development will continue until the water becomes clear or the turbidity of the water produced has been stable after the removal of several additional casing volumes. In low-yield wells that go dry during development, development activity will be staged over a period of time to allow water to refill the well bore. In the event that the minimum number of casing volumes cannot be removed, the water volume recovered and the deficiency will be noted in the development records.

A development record will be maintained for each monitoring point and well. The development record will be completed in the field by the field scientist. Figure 4.1 is an example of a development record used for similar well installations. Development records will include:

Job Number: _____
Location: _____
Well Number _____

Job Name: _____
By _____ Date _____
Measurement Datum _____

Pre-Development Information

Time (Start): _____

Water Level: _____

Total Depth of Well: _____

Water Characteristics

Color _____ Clear Cloudy
Odor: None Weak Moderate Strong
Any Films or Immiscible Material _____
pH _____ Temperature(oF oC) _____
Specific Conductance(μ S/cm) _____

Interim Water Characteristics

Gallons Removed _____

pH _____

Temperature (oF oC) _____

Specific Conductance(μ S/cm) _____Post-Development Information

Time (Finish): _____

Water Level: _____

Total Depth of Well: _____

Approximate Volume Removed: _____

Water Characteristics

Color _____ Clear Cloudy
Odor: None Weak Moderate Strong
Any Films or Immiscible Material _____
pH _____ Temperature(oF oC) _____
Specific Conductance(μ S/cm) _____

Comments: _____

FIGURE 4.1

MONITORING POINT
DEVELOPMENT RECORD**PARSONS
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- Monitoring well number;
- Date and time of development;
- Development method;
- Monitoring well depth;
- Volume of water produced;
- Description of water produced;
- Post-development water level and monitoring well depth; and
- Field analytical measurements, including pH and specific conductivity.

Development waters will be collected and transported to a licensed off-Base disposal facility.

4.3 GROUNDWATER MONITORING WELL CONSTRUCTION AND PREPARATION FOR SAMPLING

4.3.1 Monitoring Well Installation

At each well location, a soil borehole will be drilled and sampled as described in Section 3.2. The concrete at each well location will first be cored with a 12-inch diameter core barrel to provide space to install the well box. Following soil sampling, each well borehole will be reamed using approximately 8-inch diameter hollow-stem augers. The groundwater monitoring wells will be constructed through the augers using 2.0-inch ID, flush-threaded, Schedule 40 PVC well casing and screen. The screens will consist of 10-foot-long sections of 0.020-inch factory-slotted screen with threaded bottom caps. The annular space will be backfilled with clean, 6/20 silica sand to 1 foot above the top of the screen. An approximately 2-foot thick layer of bentonite pellets will be placed on top of the sand pack, and the remainder of the annular space will be filled with cement grout. The top of the casing will be sealed with a locking, watertight cap. The surface completion will consist of an 8-inch-diameter, flush-mounted well box set in a concrete collar sloping away from the well box and matching the site grade. A concrete pad that slopes away from the well will be constructed around the well as appropriate. The field scientist will verify and record the total depth of the monitoring point, the lengths of all casing sections, and the depth to the top of all monitoring well completion materials. All lengths and depths will be measured to the nearest 0.1 foot.

4.3.2 Preparation for Sampling New and Existing Monitoring Wells

All equipment to be used for sampling will be assembled and properly cleaned and calibrated (if required) prior to the beginning of the sampling event. In addition, all

record keeping materials will be gathered prior to leaving the office. A brief organizational meeting will be held to ensure proper communication between project management staff and field personnel.

4.4 EQUIPMENT DECONTAMINATION

All portions of sampling and test equipment that will contact the sample will be thoroughly cleaned before each use. This equipment may include water-level probe and cable, test equipment for onsite use, and other equipment or portions thereof that will contact the samples. The following decontamination protocol will be used:

- Clean with potable water and phosphate-free laboratory detergent (Liquinox® or equivalent);
- Rinse with potable water;
- Rinse with distilled or deionized water;
- Rinse with isopropanol; and
- Air dry the equipment prior to use.

Submersible pumps used for purging or sampling will be decontaminated by placing the pump and discharge hose into a potable water/laboratory detergent solution, washing the pump and discharge hose exterior, and pumping the solution through the pump and hose. The pump and hose exterior will then be rinsed with potable water, and potable water will be pumped through the pump and hose until all of the detergent solution has been removed. If the pump will be used for sampling only (and not for purging prior to sampling), then the pump and hose exterior will be rinsed with distilled or deionized water, and the pump exterior will be rinsed with isopropanol, then air dried.

All decontamination fluids will be temporarily placed in 55-gallon DOT approved containers for proper disposal.

Any deviations from these procedures will be documented in the field scientist's field notebook and on the groundwater sampling form. If pre-cleaned dedicated sampling equipment is used, the decontamination protocol specified above will not be required. Laboratory-supplied sample containers will be cleaned and sealed by the laboratory and therefore will not need to be cleaned in the field. Field/trip blanks and equipment rinseate samples will be collected to ensure that all containers and field equipment are free of contamination.

4.5 EQUIPMENT CALIBRATION

As required, field analytical equipment will be calibrated according to the manufacturer's specifications prior to field use. This applies to equipment used for onsite chemical measurements such as pH, electrical conductivity, and temperature.

Additional details on the calibration of field equipment are presented in Section 6 of this SAP.

4.6 SAMPLING PROCEDURES

Special care will be taken to prevent contamination of the groundwater samples. The two primary ways in which sample contamination can occur are through contact with improperly cleaned equipment and by cross-contamination through insufficient decontamination of equipment between wells. To prevent such contamination, the peristaltic pump and water level probe and cable used to determine static water levels and total well depth will be thoroughly cleaned before and after field use and between uses at different sampling locations according to the procedures presented in Section 4.4. In addition to the use of properly cleaned equipment, a clean pair of new, disposable nitrile gloves will be worn each time a different well or station is sampled. New, clean tubing will be used for the peristaltic pump. If other types of pumps or bailers are used, then they will be dedicated to the well or properly decontaminated. Wells will be sampled sequentially from areas suspected to be least contaminated to areas suspected to be more contaminated. Plastic will be placed around each of the wells to be sampled and sampling equipment will not be allowed to come in contact with the ground surface at any time during the sampling event.

The following paragraphs present the procedures for groundwater sample acquisition from all groundwater sampling locations. These activities will be performed in the same order as presented below. Exceptions to this procedure will be noted in the Parsons ES field scientist's field notebook.

4.6.1 Preparation of Location

Prior to starting the sampling procedure, the area around the well or sampling location will be cleared of foreign materials, such as brush, rocks, and debris. These procedures will prevent sampling equipment from inadvertently contacting debris around the monitoring well. New, clean plastic will be placed around the well to prevent the contamination of both the ground surface and any equipment that may come into contact with the ground surface.

4.6.2 Water Level and Total Depth Measurements

Prior to removing any water from new monitoring points or existing wells, the static water level will be measured. An electrical water level probe will be used to measure the depth to groundwater below the datum to the nearest 0.01 foot. If the total depth of the well is not known or is suspected to be inaccurate, total well depth will be measured by slowly lowering the water level probe to the bottom of the well. Total well depth will be measured to the nearest 0.01 foot. Total depth will only be measured when absolutely necessary to minimize the amount of sediment disturbance in the well. Based on water level and total depth information, the volume of water to be purged from the well can be calculated.

4.6.3 Well Purging

Both conventional purging, purging and micropurging procedures are described in this subsection. It is expected that conventional purging procedures will be used at Homestead ARB Site SS-15A.

4.6.3.1 Conventional Purging

The volume of water contained within the monitoring well/point casing at the time of sampling will be calculated, and at least three times the calculated volume will be removed from the well/point. Purging will continue until the measured field parameters (see below) have stabilized (less than 0.2 standard pH units or a 10-percent change for the other parameters over a 5-minute period). A peristaltic pump will be used for monitoring well and monitoring point purging, depth and volume permitting, and a bailer or electric submersible pump (e.g., a Grundfos Redi-Flo II® pump or Enviro-Tech® ES Series battery-operated purge pump), will be used to purge all monitoring wells in which a peristaltic pump cannot be used. All purge waters will be collected for proper disposal.

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

DO measurements will be made during the purging process using a meter with a downhole oxygen sensor or a sensor in a flow-through cell. Monitoring wells/points will be purged until DO levels stabilize. The lowest stable DO readings will be recorded.

Because the pH, temperature, and specific conductance of a groundwater sample can change significantly within a short time following sample acquisition, these parameters will be measured in the field in unfiltered, unpreserved, "fresh" water collected using the same technique as the samples taken for laboratory analyses. The measurements will be made in a flow-through cell. The measured values will be recorded on the groundwater sampling record.

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

The ORP of a groundwater sample can change significantly within a short time following sample acquisition and exposure to atmospheric oxygen. As a result, this parameter will be measured in the field in unfiltered, unpreserved, "fresh" water

collected by the same technique as the samples taken for laboratory analyses. The measurements will be made in a flow through cell.

4.6.3.2 Micropurging

The static groundwater inside each well will be purged using a peristaltic pump. The well will be purged at a very low flow rate [10 milliliters per minute (ml/min) to 1,000 ml/min]. The objective of micropurging is to remove a small volume of water at a low flow rate from a discrete portion of the screened interval of the well without disturbing stagnant water within the casing. Therefore, the well purge rate must never be greater than the recharge rate of the well. During purging, the water level in the well will be monitored to ensure that no drawdown in the well occurs. The water level monitoring will allow the sampling technician to control pumping rates to minimize drawdown. As long as no drawdown is observed during pumping, it may be assumed that the low pumping rate within the discrete, screened portion of the well has not pulled stagnant casing water into the sample.

The pH, temperature, ORP, dissolved oxygen, and specific conductivity will be continuously monitored during well purging using a flow-through cell. The flow-through cell will be attached directly to the discharge tubing of the pump using Teflon®-lined polyethylene tubing. New tubing will be used at each well. Purging will continue until the parameters have stabilized (less than 0.2 standard pH units or a 10-percent change for the other parameters over a 5-minute period) and the water is clear and free of fines. Research conducted on low-flow micropurging has found that dissolved oxygen and specific conductance readings are the most useful field indicator parameters for stabilization of background water chemistry during purging (Barcelona, *et. al.*, 1994). The research also concluded that stabilization of dissolved oxygen and specific conductance shows some correlation to stabilization of VOC concentrations in "formation" waters.

All purge water will be placed in DOT-approved 55-gallon drums supplied by the Base. The Base will be responsible for sampling, laboratory analysis, and arranging for the disposal of any contaminated or potentially contaminated purge and development water.

4.6.4 Sample Extraction

A peristaltic pump with new tubing for each well will be used to extract groundwater samples from wells where the groundwater depth is less than 20 to 25 feet bgs. All sampling equipment will be gently lowered into the water to prevent splashing and extracted gently to prevent creation of an excessive vacuum in the well. The sample will be transferred directly to the appropriate sample container. The water should be carefully poured down the inner walls of the sample bottle to minimize aeration of the sample. Sample containers for VOC analysis will be filled at approximately 200 ml/min and all other sample collection rates will not exceed 400 ml/min. Samples for VOC analysis will be collected after the well has been purged and after all field sampling parameters have been recorded at the well.

Unless other instructions are given by the analytical laboratory, sample containers will be completely filled so that no air space remains in the container. Excess water collected during sampling will be placed into the 55-gallon containers used for well purge waters and disposed of at a licensed, off-Base disposal facility.

4.7 ONSITE CHEMICAL PARAMETER MEASUREMENT

Because many chemical parameters of a groundwater sample can change significantly within a short time following sample acquisition, these parameters will be measured in the field using Hach® or CHEMetrics® test kits. The following discussion describes the field procedures for obtaining the onsite chemical parameter measurements. For information on individual instrument calibration procedures, please refer to the manufacture's calibration procedure for the instrument.

Groundwater quality measurements such as temperature, pH, specific conductivity, dissolved oxygen, and reduction/oxidation (redox) potential will be continuously monitored during well purging using a flow-through cell. The flow-through cell will be attached directly to the discharge tubing of the pump. A new piece of tubing will be used for each well. All groundwater quality measuring equipment will be decontaminated following the procedures described in Section 4.4. The groundwater quality measuring equipment will be calibrated between each well following the manufacturer's recommended calibration procedures. The measurements observed immediately before groundwater sampling begins will be considered the final measurements for the sample, and will be recorded in the field notebook and on the point-specific sampling form.

Groundwater quality measurements such as nitrate, nitrite, manganese, ferrous iron, sulfate, sulfide, and alkalinity will be measured in the field using HACH® or CHEMetrics® field analysis methods. All appropriate equipment and glassware associated with the field analysis of groundwater samples will be decontaminated following the procedures described in Section 4.4. Groundwater samples for these measurements will be collected after all sample containers for laboratory analyses have been filled. Two 250-ml bottles of groundwater will be collected and capped for field analysis. The field analysis of groundwater samples should begin immediately after collection. Direct sunlight, contact with air, and high temperatures may greatly affect the concentrations of the analytes in question. If possible, analyses will be run indoors, and groundwater samples will be capped and stored in a cooler with a temperature maintained at 4°C when not in use. Duplicate analyses will be run at a frequency of 25 percent, or one duplicate sample for every four field analyses. One blank (distilled water) analysis will be performed for each sampling round.

4.8 LABORATORY SAMPLE HANDLING

This section describes the handling of samples to be analyzed by the fixed-based laboratory from the time of sampling until the samples arrive at the laboratory.

4.8.1 Sample Container and Labels

Sample containers and appropriate container lids will be provided by the laboratory. The sample containers will be filled as described in Section 4.6.4, and the container lids will be tightly closed. Container lids will not be removed at any time prior to sample collection. The sample label will be firmly attached to the container side, and the following information will be legibly and indelibly written on the label:

- Facility name;
- Sample identification;
- Sample type (groundwater, surface water, etc.);
- Sampling date;
- Sampling time;
- Preservatives added; and
- Sample collector's initials.

4.8.2 Sample Preservation

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

4.8.3 Sample Shipment

After the samples are sealed and labeled, they will be packaged for transport to the analytical laboratory. Samples will be shipped priority overnight via Federal Express®. The following packaging and labeling procedures will be followed:

- Package sample so that it will not leak, spill, or vaporize from its container;
- Label shipping container with:
 - Sample collector's name, address, and telephone number;
 - Laboratory's name, address, and telephone number;
 - Description of sample;
 - Quantity of sample; and
 - Date of shipment.

The packaged samples will be delivered to the laboratory as soon as possible after sample acquisition, and within method-specific holding times.

4.8.4 Chain-of-Custody Control

After the samples have been collected, chain-of-custody procedures will be followed as described in Section 3.4.4.

4.8.5 Sampling Records

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

- Sample location (facility name);
- Sample identification;
- Sample location map or detailed sketch;
- Date and time of sampling;
- Sampling method;
- Field observations of
 - Sample appearance,
 - Sample odor;
- Weather conditions;
- Water level prior to purging;
- Total well depth;
- Approx Purge volume;
- Water level after purging;
- Well condition;
- Sampler's identification;
- Field measurements of pH, temperature, and specific conductivity; and
- Any other relevant information.

Groundwater sampling activities will be recorded on a groundwater sampling form or in the field scientist's field notebook. Figure 4.2 shows an example of the groundwater sampling record.

4.9 LABORATORY ANALYSES

Laboratory analyses will be performed on all groundwater samples and the required QA/QC samples (see Section 4.10). The analytical methods are listed in the Work Plan. Prior to sampling, arrangements will be made with the laboratory to provide a sufficient number of appropriate sample containers for the samples to be collected. All containers, preservatives, and shipping requirements will be consistent with laboratory protocol.

Laboratory personnel will specify any additional QC samples and prepare bottles for all samples. For samples requiring chemical preservation, preservatives will be added to containers by the laboratory prior to shipping. Shipping containers with adequate padding and cooling media will be sent by the laboratory to the site. Sampling personnel will fill the sample containers and return the samples to the laboratory.

4.10 QUALITY ASSURANCE/QUALITY CONTROL PROCEDURES AND SAMPLING

Field QA/QC samples for groundwater sampling will include collection of field duplicates; equipment rinseate samples, and trip/field blanks; other QA/QC procedures include decontamination of the water level probe, use of analyte-appropriate containers, and chain-of-custody procedures for sample handling and tracking. All samples to be transferred to the analytical laboratory for analysis will be clearly labeled to indicate sample number, location, matrix (e.g., groundwater), and analyses requested. Samples will be preserved in accordance with the analytical methods to be used, and water sample containers will be packaged in coolers with ice to maintain an approximate temperature of 4°C.

All field sampling activities will be recorded in a bound, sequentially paginated field notebook in permanent ink. All sample collection entries will include the date, time, sample locations and numbers, notations of field observations, and the sampler's name and signature.

Groundwater QA/QC sampling frequency for equipment rinseate samples will be 10 percent or one sample for every ten wells/locations sampled. In the event that less than 10 wells will be sampled in an event, a minimum of one sample will be collected. A ten percent frequency (one sample for every 10 environmental samples collected) also applies to field duplicates. One trip will be sent with each sample shipment. One field blank will be collected during the field sampling event. The procedures for the collection of field QA/QC samples are described in Section 5. The laboratory should plan to conduct one matrix spike analysis, one laboratory control sample, and one laboratory blank test for each specific analysis requested.

FIGURE 4.2
GROUNDWATER SAMPLING RECORD

Sampling Location Homestead ARB
Sampling Dates _____

GROUND WATER SAMPLING RECORD - MONITORING WELL _____
(Identification)

REASON FOR SAMPLING: ☒ Regular Sampling; ☐ Special Sampling;
DATE AND TIME OF SAMPLING: _____ at _____ a.m./p.m.
SAMPLE COLLECTED BY: _____ of Parsons ES
WEATHER: _____
DATUM FOR WATER DEPTH MEASUREMENT (Describe): _____

MONITORING WELL CONDITION:

☐ LOCKED: ☐ UNLOCKED

WELL NUMBER (IS - IS NOT) APPARENT

STEEL CASING CONDITION IS: _____

INNER PVC CASING CONDITION IS: _____

WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT

☐ DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR

☐ MONITORING WELL REQUIRED REPAIR (describe): _____

Check-off

1 ☐ EQUIPMENT CLEANED BEFORE USE WITH _____
Items Cleaned (List): _____

2 ☐ PRODUCT DEPTH _____ FT. BELOW DATUM
Measured with: _____

WATER DEPTH _____ FT. BELOW DATUM
Measured with: _____

3 ☐ WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: _____
Odor: _____
Other Comments: _____

4 ☐ WELL EVACUATION:
Method: _____
Volume Removed: _____
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: _____
Other comments: _____

FIGURE 4.2 (cont.)
Groundwater Sampling Record

Monitoring Well No. _____ (Continued)

5 [] SAMPLE EXTRACTION METHOD:

[] Bailer made of: _____
 [] Pump, type: _____
 [] Other, describe: _____

Sample obtained is [X] GRAB; [] COMPOSITE SAMPLE

6 [] ON-SITE MEASUREMENTS:

Time							Measured with
Temp (°C)							
pH							
Cond (µS/cm)							
DO (mg/L)							
Redox (mV)							
gallons purged							

7 [] SAMPLE CONTAINERS (material, number, size): _____

8 [] ON-SITE SAMPLE TREATMENT:

[] Filtration: Method _____ Containers: _____
 Method _____ Containers: _____
 Method _____ Containers: _____

[] Preservatives added:
 Method _____ Containers: _____
 Method _____ Containers: _____
 Method _____ Containers: _____
 Method _____ Containers: _____

9 [] CONTAINER HANDLING:

[] Container Sides Labeled
 [] Container Lids Taped
 [] Containers Placed in Ice Chest

10 [] OTHER COMMENTS: _____

4.11 SURVEYING OF MONITORING WELLS

All newly-installed monitoring wells will be located by a professional surveyor. Horizontal coordinates will be measured to the nearest 0.1 foot using the incumbant coordinate system, and elevations of the top of the PVC well casing and the ground surface adjacent to the well will be measured to the nearest 0.01 foot relative to US Geological Survey (USGS) benchmarks. The survey will tie into at least one existing monitoring well and one prominent cultural feature (e.g., building corner or road intersection).

SECTION 5

FIELD QUALITY ASSURANCE/QUALITY CONTROL SAMPLES

As a check on field sampling, QA/QC samples will be collected during each sampling event. Definitions for field QA/QC samples are presented below.

5.1 FIELD DUPLICATES

A field duplicate is defined as two or more samples collected independently at the same sampling location during a single act of sampling. Soil and sediment samples are divided into two equal parts (replicates) for analysis. Field duplicates will be indistinguishable from other samples by the laboratory. Each of the field duplicates will be uniquely identified with a coded identifier, which will be in the same format as other sample identifiers. Duplicate sample results are used to assess the precision of the sample collection process. During the collection of VOC samples, compositing should not be performed due to the potential for target compound loss. Ten percent of all field samples will be field duplicates.

5.2 FIELD BLANKS

The field blank is used to indicate potential contamination by VOCs during sample collection activities. A field blank will consist of a sample of distilled/deionized water poured into a laboratory-supplied sample container at the sampling site while sampling activities are underway. The container is sealed in the field and handled/transported as a normal sample.

5.3 TRIP BLANKS

The trip blank is used to indicate potential contamination by VOCs during sample collection, shipping, handling, and extraction. A trip blank will consist of a sample of distilled/deionized water poured into a laboratory-supplied sample container at the laboratory, transported to the sampling site, and returned to the laboratory with the volatile organics samples. The blank is placed in each cooler containing water or soil matrix VOC samples returning to the laboratory for analysis. The trip blank is not opened until analysis in the laboratory with the corresponding site samples.

5.4 EQUIPMENT RINSEATE BLANKS

Equipment rinseate blanks consist of distilled or deionized water poured into or pumped through the sampling device following decontamination. The rinseate is transferred to an appropriate sample bottle for the analysis and transported to the

laboratory. The equipment rinseate samples are analyzed for the same laboratory parameters as the site samples. Equipment blanks are used to measure to contamination introduced to a sample set from improperly decontaminated sampling equipment. Five percent of all field samples will be equipment rinseate samples.

5.5 DECONTAMINATION WATER BLANK

A decontamination water blank is designed to check the purity of potable water used for equipment decontamination during the field operation. Decontamination water blanks will be collected at the discretion of the field scientist. If the decontamination water is of questionable purity, then a blank sample will be collected. Decontamination water blanks are collected by filling the appropriate sample container directly from the potable water source. Decontamination water blanks are labeled, preserved, handled, and shipped in the same manner as an environmental water sample. The blank will be analyzed for the same analytes and parameters as the environmental samples.

SECTION 6

FIELD DATA REDUCTION, VALIDATION, AND REPORTING

The following sections describe field analytical instrumentation calibration, and field data reporting, validation, reduction, and review.

6.1 CALIBRATION PROCEDURES AND FREQUENCY FOR FIELD TEST EQUIPMENT

Instruments and equipment used to gather, generate, or measure environmental data in the field will be calibrated with sufficient frequency and in such a manner that accuracy and reproducibility of results are consistent with the manufacturer's specifications. Field instruments may include a soil gas Gas Tech multi-gas meter, field GC, pH meter, digital thermometer, O₂/CO₂ meter, TVH meter, specific conductivity meter, dissolved oxygen meter, oxidation reduction potential meter, and Hach® spectrophotometer. A summary of calibration frequency and acceptance criteria is presented in Table 6.1.

6.2 FIELD DATA REDUCTION

During processing of field data, validation checks will be performed by individuals designated by the project manager. The purpose of these checks is to identify outliers; that is, data which do not conform within two standard deviations to the pattern established by other observations. The Students "t" test will be used to identify outliers when the total number of samples is less than 31, and the normal distribution will be used to identify others when the total number of samples is greater than 31. Although outliers may be the result of transcription errors or instrument breakdowns, they may also be manifestations of a greater degree of spatial or temporal variability than expected. Therefore, after an outlier has been identified, a decision must be made concerning its further use. Obvious mistakes in data will be corrected when possible, and the corrected values will be inserted. If the correct value cannot be obtained, the datum may be excluded. An attempt will be made to explain the existence of the outlier. If no plausible explanation can be found for the outlier, it may be excluded, and a note to that effect will be included in the report. Also, an attempt will be made to determine the effect of the outlier both when included in and when excluded from the data set, and the results will be discussed in the report. In addition, the data will be compared against those obtained in previous investigations (where available) and against applicable standards and guidelines.

TABLE 6.1
FIELD SCREENING METHODS ANALYTICAL PROTOCOL
SUMMARY OF QC^a/ PROCEDURES
RISK-BASED APPROACH TO REMEDIATION

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action ^{b/}	Reporting Limit
SW9050	Conductance	Calibration with potassium chloride standard	Once per day at beginning of testing	± 5%	If calibration is not achieved, check meter, standards, and probe; recalibrate	0.02 µmhos/cm
		Field duplicate	10% of field samples	± 5%	Correct problem, repeat measurement	
SW9040	pH (water)	2-point calibration with pH buffers	Once per day at beginning of testing	± 0.05 pH units for every buffer	If calibration is not achieved, check meter, buffer solutions, and probe; replace if necessary; repeat calibration	pH units
		pH 7 buffer	At each sample location	± 0.1 pH units	Correct problem, recalibrate	
		Field duplicate	10% of field samples	± 0.1 pH units	Correct problem, repeat measurement	
E170.1	Temperature	Field duplicate	10% of field samples	± 1.0°C ^d	Correct problem, repeat measurement	°C
ASTM ^{d/} D1498	Oxidation-reduction potential	Calibration with one standard	Once per day at beginning of testing	Two successive readings ± 10 millivolts	Correct problem, recalibrate	pe ^{e/} units
		Field duplicate	10% of field samples	± 10 millivolts	Correct problem, repeat measurement	
Hach TM 8221	Alkalinity	Accuracy check, (3 concentration points)	Once per day	± 50 %	Correct problem by standard solutions, and optical cell; replace if necessary; repeat calibration check	20.0 mg/L ^{f/}
		Field duplicate	10% of field samples	± 10 %	Correct problem, repeat measurement	

TABLE 6.1 (Continued)
FIELD SCREENING METHODS ANALYTICAL PROTOCOL
SUMMARY OF QC PROCEDURES
QUALITY ASSURANCE PROJECT PLAN
STREAMLINED RISK-BASED APPROACH TO REMEDIATION

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action ^{b/}	Reporting Limit
E360.1	Dissolved oxygen	Calibration check with one standard, and zero meter with sodium sulfate solution	Once per day at beginning of testing	± 5 %	Correct problem by checking meter, standard solutions, replace if necessary; repeat calibration check	0.5 mg/L
		Field duplicate	10% of field samples	RPD ^{d/} < 20%	Correct problem, repeat measurement	
HACH™ 8039	Nitrate (NO ₃)	Calibration check with one standard, and zero meter w/sodium sulfate solution	Once per day at beginning of testing	± 5 %	Correct problem by checking meter, standard solutions, replace if necessary; repeat calibration check	0.07 mg/L
		Accuracy check, (3 concentration points)	Once per day	± 50 %	Correct problem by checking meter, standard solutions, and optical cell; replace if necessary; repeat calibration check	
		Field duplicate	10% of field samples	± 10 %	Correct problem, repeat measurement	
HACH™ 8040	Nitrite (NO ₂)	Calibration check with one standard	Once per day at beginning of testing	± 50 %	Correct problem by checking meter, standard solutions, and optical cell; replace if necessary; repeat calibration check	0.01 mg/L
		Accuracy check, (3 concentration points)	Once per day	± 50 %	Correct problem by checking meter, standard solutions, and optical cell; replace if necessary; repeat calibration check	
		Field duplicate	10% of field samples	± 10 %	Correct problem, repeat measurement	

TABLE 6.1 (Continued)
FIELD SCREENING METHODS ANALYTICAL PROTOCOL
SUMMARY OF QC PROCEDURES
QUALITY ASSURANCE PROJECT PLAN
STREAMLINED RISK-BASED APPROACH TO REMEDIATION

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action ^{b/}	Reporting Limit
Hach™ 8146	Ferrous Iron (Fe ²⁺)	Calibration check with one standard	Once per day at beginning of testing	± 50 %	Correct problem by checking meter, standard solutions, and optical cell; replace if necessary; repeat calibration check	0.024 mg/L
		Accuracy check, (3 concentration points)	Once per day	± 50 %	Correct problem by checking meter, standard solutions, and optical cell; replace if necessary; repeat calibration check	
		Field duplicate	10% of field samples	± 10 %	Correct problem, repeat measurement	
Hach™ 8034	Manganese	Calibration check with one standard	Once per day at beginning of testing	± 50 %	Correct problem by checking meter, standard solutions, and optical cell; replace if necessary; repeat calibration check	0.024 mg/L
		Accuracy check, (3 concentration points)	Once per day	± 50 %	Correct problem by checking meter, standard solutions, and optical cell; replace if necessary; repeat calibration check	
		Field duplicate	10% of field samples	± 10 %	Correct problem, repeat measurement	
Hach™ 8131	Hydrogen Sulfide (H ₂ S)	Calibration check with one standard	Once per day at beginning of testing	± 50 %	Correct problem by checking meter, standard solutions, and optical cell; replace if necessary; repeat calibration check	0.024 mg/L

TABLE 6.1 (Continued)
FIELD SCREENING METHODS ANALYTICAL PROTOCOL
SUMMARY OF QC PROCEDURES
QUALITY ASSURANCE PROJECT PLAN
STREAMLINED RISK-BASED APPROACH TO REMEDIATION

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action ^{b/}	Reporting Limit
HACH™ 8051		Accuracy check, (3 concentration points)	Once per day	± 50 %	Correct problem by checking meter, standard solutions, and optical cell; replace if necessary; repeat calibration check	
		Field duplicate	10% of field samples	± 10 %	Correct problem, repeat measurement	
		Calibration check with one standard	Once per day at beginning of testing	± 50 %	Correct problem by checking meter, standard solutions, and optical cell; replace if necessary; repeat calibration check	0.01 mg/L
		Accuracy check, (3 concentration points)	Once per day	± 50 %	Correct problem by checking meter, standard solutions, and optical cell; replace if necessary; repeat calibration check	
HACH™ 8131	Sulfide (S ²⁻)	Field duplicate	10% of field samples	± 10 %	Correct problem, repeat measurement	
		Calibration check with one standard	Once per day at beginning of testing	± 50 %	Correct problem by checking meter, standard solutions, and optical cell; replace if necessary; repeat calibration check	NA ^{b/}
		Accuracy check, (3 concentration points)	Once per day	± 50 %	Correct problem by checking meter, standard solutions, and optical cell; replace if necessary; repeat calibration check	
		Field duplicate	10% of field samples	± 10 %	Correct problem, repeat measurement	

TABLE 6.1 (Continued)
FIELD SCREENING METHODS ANALYTICAL PROTOCOL
SUMMARY OF QC PROCEDURES
QUALITY ASSURANCE PROJECT PLAN
STREAMLINED RISK-BASED APPROACH TO REMEDIATION

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action ^{b/}	Reporting Limit
Gas Tech Multi-gas Meter	TVH and Methane	Accuracy check, (2 concentration points)	Once per day	± 20 %	Correct problem by checking meter, check gas standards, correlate with lab analysis	20 ppmv
		Field duplicate	10% of field samples	± 20 %	Correct problem, repeat measurement	
Gas Tech Multi-gas Meter	Oxygen, Carbon Dioxide	Calibration check with ambient air and one standard	Once per day at beginning of testing	± 10 %	Correct problem by checking meter, gas standards, and reaction cell; replace if necessary; repeat calibration check	0.5 %
		Accuracy check, (2 concentration points)	Once per day	± 10 %	Correct problem by checking meter, gas standard, and reaction cell; replace if necessary; repeat calibration check	
		Field duplicate	10% of field samples	± 10 %	Correct problem, repeat measurement	

- ^{a/} QC = quality control.
^{b/} All corrective actions will be documented, and the records will be maintained by the prime contractor.
^{c/} °C = degrees Celsius.
^{d/} ASTM = American Society for Testing and Materials.
^{e/} pe = potential platinum electrode.
^{f/} mg/L = milligrams per liter.
^{g/} RPD = relative percent difference.
^{h/} NA = not applicable.

6.3 REVIEW OF FIELD RECORDS

All field records are evaluated for the following:

Completeness of field records. The check of field record completeness will ensure that all requirements for field activities have been fulfilled, complete records exist for each field activity, and that the procedures specified in the SAP (or approved as field change requests) were implemented. Field documentation will ensure sample integrity and provide sufficient technical information to recreate each field event. The results of the completeness check will be documented, and environmental data affected by incomplete records will be identified in the technical report.

Identification of valid samples. The identification of valid samples involves interpretation and evaluation of the field records to detect problems affecting the representativeness of environmental samples. For example, field records can indicate whether a well is properly constructed or if unanticipated environmental conditions were encountered during construction. The lithologic and geophysical logs may be consulted to determine if a well is screened only in the water-bearing zone of concern. Records also should note sample properties such as clarity, color, odor, etc. Photographs may show the presence or absence of obvious sources of potential contamination, such as operating combustion engines near a well during sampling. Judgments of sample validity will be documented in the technical report, and environmental data associated with poor or incorrect field work will be identified.

Correlation of data. The results of field tests obtained from similar areas will be correlated. For example, soil gas TVH readings and VOC analysis results may be correlated. The findings of these correlations will be documented, and the significance of anomalous data will be discussed in the technical report.

Identification of anomalous field test data. Anomalous field data will be identified and explained to the extent possible. For example, a water temperature for one well that is significantly higher than any other well temperature in the same aquifer will be explained in the technical report.

Accuracy and precision of field data and measurements. The assessment of the quality of field measurements will be based on instrument calibration records and a review of any field corrective actions. The accuracy and precision of field measurements will be discussed.

Field record review is an ongoing process. Field team leaders will be responsible for ensuring that proper documentation is recorded during each site's sampling activities.

6.4 FIELD DATA VALIDATION AND REPORTING

The contractor analyst will review 100 percent of all screening data prior to reporting. Screening data will constitute all analytical method results from analyses performed in the field laboratory environment. The contractor will determine if their

data quality objectives (DQOs) for field data have been met, and also will calculate the percent complete (PC) for field data results.

At a minimum, the review of screening data will focus on the following topics:

- Holding times;
- Method blanks;
- Field instrumentation detection limits;
- Analytical batch control records including calibrations, and spike recoveries; and
- Flag all results with an "S" to denote sample results from field screening versus fixed laboratory results.

Field data will be validated using four different procedures, as described below:

- Routine checks (e.g., looking for errors in identification codes) will be made during the processing of data.
- Internal consistency of a data set will be evaluated. This step will involve plotting the data and testing for outliers.
- Checks for consistency of the data set over time will be performed. This can be accomplished by comparing data sets against gross upper limits obtained from historical data sets, or by testing for historical consistency. Anomalous data will be identified.
- Checks may be made for consistency with parallel data sets. An example of such a check would be comparing data from the same region of the aquifer or volume of soil.

SECTION 7

FIXED-BASE LABORATORY ANALYTICAL PROCEDURES

Application of a specific analytical method depends on the sample matrix and the analytes to be identified. Methods for each of the parameters likely to be included in the analytical program, as well as detection limits, are discussed in the following subsections. All analytical methods are USEPA approved.

7.1 ANALYTICAL METHODS

Analytical procedures will follow the established USEPA and/or American Society for Testing and Materials (ASTM) methods as recommended by AFCEE wherever such methods exist for a specified analyte. All approved methods are presented in Table 7.1. The referenced methods are defined in the following documents:

- USEPA (1983) *Methods for Chemical Analysis of Water and Wastes*, EPA 600/4-79-020.
- USEPA (1995) *Test Methods for Evaluating Solid Waste, Physical and Chemical Methods*, SW846, 3rd Edition , Update IIB.
- *American Society for Testing and Materials Methods* (ASTM, 1995).

One additional analytical method that may be used is the Florida TRPH method FL-PRO. Applicable guidance and specifications issued for this method by the FDEP will be followed.

7.1.2 Detection and Quantitation Limits

This section describes the terms, definitions, and formulas that will be used for detection and quantitation limits.

7.1.3 Instrument Detection Limit

The instrument detection limit (IDL) reflects the instrument operating efficiency, not sample preparation or concentration/dilution factors. The IDL is operationally defined as three times the standard deviation of seven replicate analyses of the lowest concentration that is statistically different from a blank. This represents 99-percent confidence that the signal identified is the result of the presence of the analyte, and not random noise.

7.1.4 Method Detection Limit

The method detection limit (MDL) is the lowest concentration at which a specific analyte in a matrix can be measured and reported with 99-percent confidence that the analyte concentration is greater than zero. MDLs are experimentally determined and verified for each target analyte of the methods in the sampling program. The laboratory will determine MDLs for each analyte and matrix type prior to analysis of project samples. MDLs are based on the results of seven matrix spikes at the estimated MDL, and are statistically calculated in accordance with the Title 40, Code of Federal Regulations Part 136 (40 CFR 136). The standard deviation of the seven replicates is determined and multiplied by 3.14 (i.e., the 99-percent confidence interval from the one-sided Students T-test). MDLs must be determined annually as a minimum. The MDLs to be used are intended to allow that both nondetects and detects will be usable to the fullest extent possible for the project.

7.1.5 Project Reporting Limit

To define analytical data reporting limits that meet project DQOs, potential risk-based screening criteria were identified. State-specified "clean closure" concentrations, risk-based preliminary remediation goals (PRGs), regulatory concentrations, or other relevant soil, groundwater, and surface water action levels will be reviewed to identify the most stringent comparison criteria for each matrix likely to be applicable. The project reporting limits (PRLs), listed as the practical quantitation limits (PQL) in Table 7.1, will be reviewed in comparison to the risk-based screening criteria. Project reporting limits are those published in the current AFCEE QAPP Version 2.0 (1997) and by the FDEP (for Florida TRPH method FL-PRO), or as established historically by the laboratory when not available in the AFCEE QAPP. If state regulatory guidance standards for analytical method reporting limits are lower than the PQLs listed in Table 7.1, then the state-required limits will supersede the PQLs in Table 7.1.

The PRL is equivalent to the current PQL guidance listed in the AFCEE (1996) QAPP. Because the project remediation goals are developed for risk-based site closure, all sample results will be reported at or above the MDL for each analyte. All results above the MDL but below the PQL will be qualified in the data deliverable from the laboratory with a "FJ" flag. The "FJ" flag will denote the sample result as below the PQL (see Section 7.6.2). Where practical, MDLs must be lower than the risk-based criterion determined for the project. Laboratories must verify the PRLs by analyzing a standard at or below the PRL within the calibration curve.

All analytical results for soils (both nondetected and detected) will be reported on a dry-weight basis (i.e., corrected for moisture content). The moisture content for each soil sample will be reported. The equation for moisture content given for the SW-846 Method SW3550 is as follows:

$$\frac{\text{Initial Weight} - \text{Dried Weight}}{\text{Initial Weight}} \times 100 = \% \text{ moisture}$$

The result of the sample on a dry-weight basis is as follows:

$$\frac{\text{Result of analysis on wet weight basis}}{100 - \% \text{ Moisture}} = \text{Result of analysis on a dry-weight basis}$$

TABLE 7.1
PRACTICAL QUANTITATION LIMITS
RISK-BASED APPROACH TO REMEDIATION

Parameter/Method	Analyte	Water		Soil	
		PQL ^{a/}	Unit	PQL	Unit
Aromatic Volatile Organics Compounds SW5030A/SW8020A (W ^{d/} , S ^{e/})	1,2-Dichlorobenzene	4.0	µg/L ^{b/}	0.004	mg/kg ^{c/}
	1,3-Dichlorobenzene	4.0	µg/L	0.004	mg/kg
	1,4-Dichlorobenzene	3.0	µg/L	0.003	mg/kg
	Benzene	2.0	µg/L	0.002	mg/kg
	Chlorobenzene	2.0	µg/L	0.002	mg/kg
	Ethylbenzene	2.0	µg/L	0.002	mg/kg
	Toluene	2.0	µg/L	0.002	mg/kg
	Xylenes, Total	2.0	µg/L	0.002	mg/kg
Methane SW3810 Modified (W)	Methane	2.0	µg/L	NA ^{v/}	NA
	Ethane	4.0	µg/L	NA	NA
	Ethene	2.0	µg/L	NA	NA
Volatile Organics SW5030A/SW8260A (W, S)	1,1,1,2-Tetrachloroethane	0.5	µg/L	0.003	mg/kg
	1,1,1-Trichloroethane	0.8	µg/L	0.004	mg/kg
	1,1,2,2-Tetrachloroethane	0.4	µg/L	0.002	mg/kg
	1,1,2-Trichloroethane	1.0	µg/L	0.005	mg/kg
	1,1-Dichloroethane	0.4	µg/L	0.002	mg/kg
	1,1-Dichloroethene	1.2	µg/L	0.006	mg/kg
	1,1-Dichloropropene	1.0	µg/L	0.005	mg/kg
	1,2,3-Trichlorobenzene	0.3	µg/L	0.002	mg/kg
	1,2,3-Trichloropropane	3.2	µg/L	0.02	mg/kg
	1,2,4-Trichlorobenzene	0.4	µg/L	0.002	mg/kg
	1,2,4-Trimethylbenzene	1.3	µg/L	0.007	mg/kg
	1,2-Dichloroethane	0.6	µg/L	0.003	mg/kg
	1,2-Dichlorobenzene	0.3	µg/L	0.002	mg/kg
	1,2-Dibromo-3-Chloropropane	2.6	µg/L	0.01	mg/kg
	1,2-Dichloropropane	0.4	µg/L	0.002	mg/kg
	1,2-Dibromoethane	0.6	µg/L	0.003	mg/kg
	1,3,5-Trimethylbenzene	0.5	µg/L	0.003	mg/kg
	1,3-Dichlorobenzene	1.2	µg/L	0.006	mg/kg
	1,3-Dichloropropane	0.4	µg/L	0.002	mg/kg
	1,4-Dichlorobenzene	0.3	µg/L	0.002	mg/kg
	1-Chlorohexane	0.5	µg/L	0.003	mg/kg
	2,2-Dichloropropane	3.5	µg/L	0.02	mg/kg
	2-Chlorotoluene	0.4	µg/L	0.002	mg/kg
	4-Chlorotoluene	0.6	µg/L	0.003	mg/kg
	Benzene	0.4	µg/L	0.002	mg/kg
	Bromobenzene	0.3	µg/L	0.002	mg/kg
	Bromochloromethane	0.4	µg/L	0.002	mg/kg
	Bromodichloromethane	0.8	µg/L	0.004	mg/kg
	Bromoform	1.2	µg/L	0.006	mg/kg
	Bromomethane	1.1	µg/L	0.005	mg/kg
	Carbon Tetrachloride	2.1	µg/L	0.01	mg/kg
	Chlorobenzene	0.4	µg/L	0.002	mg/kg
	Chloroethane	1.0	µg/L	0.005	mg/kg
	Chloroform	0.3	µg/L	0.002	mg/kg
	Chloromethane	1.3	µg/L	0.007	mg/kg
	Cis-1,2-Dichloroethene	1.2	µg/L	0.006	mg/kg
	Cis-1,3-Dichloropropene	1.0	µg/L	0.005	mg/kg

TABLE 7.1 (Continued)
PRACTICAL QUANTITATION LIMITS
RISK-BASED APPROACH TO REMEDIATION

Parameter/Method	Analyte	Water		Soil	
		PQL ^{a/}	Unit	PQL	Unit
Volatile Organics (Cont) SW5030A/SW8260A (W, S)	Dibromochloromethane	0.5	µg/L	0.003	mg/kg
	Dibromomethane	2.4	µg/L	0.01	mg/kg
	Dichlorodifluoromethane	1.0	µg/L	0.005	mg/kg
	Ethylbenzene	0.6	µg/L	0.003	mg/kg
	Hexachlorobutadiene	1.1	µg/L	0.005	mg/kg
	Isopropylbenzene	0.5	µg/L	0.008	mg/kg
	m-Xylene	0.5	µg/L	0.003	mg/kg
	Methylene Chloride	0.3	µg/L	0.002	mg/kg
	n-Butylbenzene	1.1	µg/L	0.005	mg/kg
	n-Propylbenzene	0.4	µg/L	0.002	mg/kg
	Naphthalene	0.4	µg/L	0.002	mg/kg
	o-Xylene	1.1	µg/L	0.005	mg/kg
	p-Isopropyltoluene	1.2	µg/L	0.006	mg/kg
	p-Xylene	1.3	µg/L	0.007	mg/kg
	Sec-Butylbenzene	1.3	µg/L	0.007	mg/kg
	Styrene	0.4	µg/L	0.002	mg/kg
	Trichloroethene	1.0	µg/L	0.01	mg/kg
	Tert-Butylbenzene	1.4	µg/L	0.007	mg/kg
	Tetrachloroethylene	1.4	µg/L	0.007	mg/kg
	Toluene	1.1	µg/L	0.005	mg/kg
	Trans-1,2-Dichloroethene	0.6	µg/L	0.003	mg/kg
	Trans-1,3-Dichloropropene	1.0	µg/L	0.005	mg/kg
	Trichlorofluoromethane	0.8	µg/L	0.004	mg/kg
	Vinyl Chloride	1.1	µg/L	0.009	mg/kg
Semivolatile Organics Base/Neutral Extractables SW3510B/SW8270B (W) SW3550A/SW8270B (S)	1,2,4-Trichlorobenzene	10.0	µg/L	0.7	mg/kg
	1,2-Dichlorobenzene	10.0	µg/L	0.7	mg/kg
	1,3-Dichlorobenzene	10.0	µg/L	0.7	mg/kg
	1,4-Dichlorobenzene	10.0	µg/L	0.7	mg/kg
	2,4-Dinitrotoluene	10.0	µg/L	0.7	mg/kg
	2,6-Dinitrotoluene	10.0	µg/L	0.7	mg/kg
	2-Chloronaphthalene	10.0	µg/L	0.7	mg/kg
	2-Methylnaphthalene	10.0	µg/L	0.7	mg/kg
	2-Nitroaniline	50.0	µg/L	3.3	mg/kg
	3-Nitroaniline	50.0	µg/L	3.3	mg/kg
	3,3'-Dichlorobenzidine	20.0	µg/L	1.3	mg/kg
	4-Bromophenyl Phenyl Ether	10.0	µg/L	0.7	mg/kg
	4-Chloroaniline	20.0	µg/L	1.3	mg/kg
	4-Chlorophenyl Phenyl Ether	10.0	µg/L	0.7	mg/kg
	4-Nitroaniline	50.0	µg/L	3.3	mg/kg
	Acenaphthylene	10.0	µg/L	0.7	mg/kg
	Acenaphthene	10.0	µg/L	0.7	mg/kg
	Anthracene	10.0	µg/L	0.7	mg/kg
	Benz (a) Anthracene	10.0	µg/L	0.7	mg/kg
	Benzo (a) Pyrene	10.0	µg/L	0.7	mg/kg
	Benzo (b) Fluoranthene	10.0	µg/L	0.7	mg/kg
	Benzo (g,h,i) Perylene	10.0	µg/L	0.7	mg/kg

TABLE 7.1 (Continued)
PRACTICAL QUANTITATION LIMITS
RISK-BASED APPROACH TO REMEDIATION

Parameter/Method	Analyte	Water		Soil	
		PQL ^{a/}	Unit	PQL	Unit
Semivolatile Organics Base/Neutral Extractables SW3510B/SW8270B (W) SW3550A/SW8270B (S) (Cont)	Benzyl Alcohol	20.0	µg/L	1.3	mg/kg
	Bis (2-Chlorethyl) Ether	10.0	µg/L	0.7	mg/kg
	Bis (2-Chloroethoxy) Methane	10.0	µg/L	0.7	mg/kg
	Bis (2-Chloroisopropyl) Ether	10.0	µg/L	0.7	mg/kg
	Bis (2-Ethylhexyl) Phthalate	10.0	µg/L	0.7	mg/kg
	Butyl Benzylphthalate	10.0	µg/L	0.7	mg/kg
	Chrysene	10.0	µg/L	0.7	mg/kg
	Di-n-Butylphthalate	10.0	µg/L	0.7	mg/kg
	Di-n-Octylphthalate	10.0	µg/L	0.7	mg/kg
	Dibenz (a,h) Anthracene	10.0	µg/L	0.7	mg/kg
	Dibenzofuran	10.0	µg/L	0.7	mg/kg
	Diethyl Phthalate	10.0	µg/L	0.7	mg/kg
	Dimethyl Phthalate	10.0	µg/L	0.7	mg/kg
	Fluoranthene	10.0	µg/L	0.7	mg/kg
	Fluorene	10.0	µg/L	0.7	mg/kg
	Hexachlorobenzene	10.0	µg/L	0.7	mg/kg
	Hexachlorobutadiene	10.0	µg/L	0.7	mg/kg
	Hexachlorocyclopentadiene	10.0	µg/L	0.7	mg/kg
	Hexachloroethane	10.0	µg/L	0.7	mg/kg
	Indeno (1,2,3-cd) Pyrene	10.0	µg/L	0.7	mg/kg
	Isophorone	10.0	µg/L	0.7	mg/kg
	n-Nitrosodiphenylamine	10.0	µg/L	0.7	mg/kg
	n-Nitrosodi-n-Propylamine	10.0	µg/L	0.7	mg/kg
	Naphthalene	10.0	µg/L	0.7	mg/kg
	Nitrobenzene	10.0	µg/L	0.7	mg/kg
	Phenanthrene	10.0	µg/L	0.7	mg/kg
	Pyrene	10.0	µg/L	0.7	mg/kg
Semivolatile Organics Acid Extractables SW3510B/SW8270B (W) SW3550A/SW8270B (S)	2,4,5-Trichlorophenol	50.0	µg/L	3.3	mg/kg
	2,4,6-Trichlorophenol	10.0	µg/L	0.3	mg/kg
	2,4-Dichlorophenol	10.0	µg/L	0.3	mg/kg
	2,4-Dimethylphenol	10.0	µg/L	0.3	mg/kg
	2,4-Dinitrophenol	50.0	µg/L	3.3	mg/kg
	2-Chlorophenol	10.0	µg/L	0.3	mg/kg
	2-Methylphenol	10.0	µg/L	0.3	mg/kg
	2-Nitrophenol	10.0	µg/L	0.3	mg/kg
	4,6-Dinitro-2-Methylphenol	50.0	µg/L	3.3	mg/kg
	4-Chloro-3-Methylphenol	20.0	µg/L	1.3	mg/kg
	4-Methylphenol	10.0	µg/L	0.3	mg/kg
	4-Nitrophenol	50.0	µg/L	1.6	mg/kg
	Benzoic Acid	50.0	µg/L	1.6	mg/kg
	Pentachlorophenol	50.0	µg/L	3.3	mg/kg
	Phenol	10.0	µg/L	0.3	mg/kg
Polynuclear Aromatic Hydrocarbons SW3510B/SW8310 (W) SW3550A/SW8310 (S)	Acenaphthene	18.0	µg/L	1.2	mg/kg
	Acenaphthylene	23.0	µg/L	1.54	mg/kg
	Anthracene	6.6	µg/L	0.44	mg/kg
	Benz (a) Anthracene	0.13	µg/L	0.009	mg/kg
	Benzo (a) Pyrene	0.23	µg/L	0.015	mg/kg

TABLE 7.1 (Continued)
PRACTICAL QUANTITATION LIMITS
RISK-BASED APPROACH TO REMEDIATION

Parameter/Method	Analyte	Water		Soil	
		PQL ^{a/}	Unit	PQL	Unit
Polynuclear Aromatic Hydrocarbons SW3510B/SW8310 (W) SW3550A/SW8310 (S) (Cont)	Benzo (b) Fluoranthene	0.18	µg/L	0.012	mg/kg
	Benzo (g,h,i) Perylene	0.76	µg/L	0.05	mg/kg
	Benzo (k) Fluoranthene	0.17	µg/L	0.011	mg/kg
	Chrysene	1.5	µg/L	0.1	mg/kg
	Dibenzo (a,h) Anthracene	0.3	µg/L	0.02	mg/kg
	Fluoranthrene	2.1	µg/L	0.14	mg/kg
	Fluorene	2.1	µg/L	0.14	mg/kg
	Indeno (1,2,3-c,d) Pyrene	0.43	µg/L	0.03	mg/kg
	Naphthalene	18.0	µg/L	1.2	mg/kg
	Phenanthrene	6.4	µg/L	0.42	mg/kg
	Pyrene	2.7	µg/L	0.18	mg/kg
ICP Screen for Metals SW3005A/SW6010A (W) SW3050A/SW6010A (S)	Aluminum	0.5	mg/L ^{e/}	50.0	mg/kg
	Antimony	0.4	mg/L	40.0	mg/kg
	Arsenic	0.6	mg/L	60.0	mg/kg
	Barium	0.02	mg/L	2.0	mg/kg
	Beryllium	0.003	mg/L	0.3	mg/kg
	Cadmium	0.04	mg/L	4.0	mg/kg
	Calcium	0.1	mg/L	10.0	mg/kg
	Chromium	0.07	mg/L	7.0	mg/kg
	Cobalt	0.07	mg/L	7.0	mg/kg
	Copper	0.06	mg/L	6.0	mg/kg
	Iron	0.07	mg/L	7.0	mg/kg
	Lead	0.5	mg/L	50.0	mg/kg
	Magnesium	0.3	mg/L	30.0	mg/kg
	Manganese	0.02	mg/L	2.0	mg/kg
	Molybdenum	0.08	mg/L	8.0	mg/kg
	Nickel	0.15	mg/L	15.0	mg/kg
	Potassium	5.0	mg/L	500.0	mg/kg
	Selenium	0.8	mg/L	80.0	mg/kg
	Silver	0.07	mg/L	7.0	mg/kg
	Sodium	0.3	mg/L	30.0	mg/kg
	Thallium	0.4	mg/L	40.0	mg/kg
	Vanadium	0.08	mg/L	8.0	mg/kg
	Zinc	0.02	mg/L	2.0	mg/kg
SW3020A/SW7421 (W) SW3050A/SW7421 (S) SW3020A/SW7131 (W) SW3050A/SW7131 (S)	Lead	0.005	mg/L	0.5	mg/kg
	Lead				
	Cadmium	0.001	mg/L	0.1	mg/kg
	Cadmium				
Common Anions SW9056	Bromide	0.1	mg/L	0.1	mg/kg
	Chloride	0.2	mg/L	0.2	mg/kg
	Fluoride	0.2	mg/L	0.2	mg/kg
	Nitrate	0.1	mg/L	0.1	mg/kg
	Nitrite	0.4	mg/L	0.1	mg/kg
	Phosphate	0.1	mg/L	0.1	mg/kg
	Sulfate	0.2	mg/L	0.2	mg/kg

TABLE 7.1 (Continued)
PRACTICAL QUANTITATION LIMITS
RISK-BASED APPROACH TO REMEDIATION

Parameter/Method	Analyte	Water		Soil	
		PQL ^{a/}	Unit	PQL	Unit
E160.1	Total Dissolved Solids	10.0	mg/L	NA	NA
E160.2	Total Suspended Solids	5.0	mg/L	NA	NA
E310.1	Alkalinity	10.0	mg/L	NA	NA
E353.1	Nitrogen, Nitrate/Nitrite	0.1	mg/L	NA	NA
SW9050	Conductance	NA	NA	NA	NA
SW9040	pH	NA	NA	NA	NA

SOURCE: AFCEE QAPP, Version 1.1, February 1996

^{a/} PQLs = practical quantitation limits. PQLs are equal to the project reporting limits.

^{b/} µg/L = micrograms per liter.

^{c/} mg/kg = milligrams per kilogram.

^{d/} W = water.

^{e/} S = soil.

^{f/} NA = not applicable.

^{g/} mg/L = milligrams per liter.

7.1.6 Sample Quantitation Limit

Sample quantitation limits (SQLs) are defined as the MDL multiplied by the dilution factor (DF) required to analyze the sample, and corrected for moisture or sample size. These adjustments may be due to matrix effects or to the high concentrations of some analytes. For example, if an analyte is present at a concentration that is greater than the linear range of the analytical method, the sample must be diluted for accurate quantitation. The DF raises the reporting limit, which then becomes the SQL. Because the reported SQLs take into account sample characteristics and analytical adjustments, they are the most relevant quantitation limits for evaluating nondetected chemicals.

7.1.7 Reporting Units

The following are the prescribed reporting units for all analytical methods:

Soil and sediment samples - organics: micrograms per kilogram ($\mu\text{g/kg}$), dry-weight basis;

Soil and sediment samples - inorganics/metals: milligrams per kilogram (mg/kg), dry-weight basis;

Water samples - inorganics/metals: milligrams per liter (mg/L); and

Water samples - organics: micrograms per liter ($\mu\text{g/L}$).

7.2 LABORATORY QUALITY CONTROL DATA

Laboratory QC data are necessary to determine the precision and accuracy of the analyses, confirm matrix interferences, and demonstrate target compound contamination of sample results. QC samples will be analyzed routinely by the analytical laboratory as part of the laboratory QC procedures. Contract laboratories performing definitive data quality analyses require a more stringent QC program than those performing screening-level data quality analyses. Definitions for QC samples are presented below. Frequency and acceptance requirements are defined in Table 7.2. All precision and accuracy control limit criteria are defined in Table 1.1.

7.2.1 Holding Time

Holding times for sample extraction and/or analysis as required by the methods will be met for all samples. The holding time is calculated from the date and time of sample collection to the time of sample preparation and/or analysis. All sample analyses to include dilutions and second-column confirmation will meet the required holding times. Results for samples exceeding holding time will be qualified as unusable (flagged "R"). Table 7.3 defines applicable method-specific analytical holding times.

TABLE 7.2
SUMMARY OF CALIBRATION AND QC PROCEDURES
Risk-Based Approach to Remediation

Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action ^{b/}
Aromatic Volatile Organic Compounds SW8020A and Alcohols SW8015B	Five-point initial calibration for all analytes	Initial calibration prior to sample analysis	$RSD^d < 20\%$ for CFs ^d or RFs ^d or >0.995 correlation coefficient	Correct problem then repeat initial calibration
	Second-source calibration verification	Once per five-point initial calibration	All analytes within $\pm 15\%$ of expected value	Correct problem then repeat initial calibration
	Retention time window calculated for each analyte	Each initial calibration and calibration verification	± 3 times standard deviation for each analyte retention time from 72-hour study	Correct problem then reanalyze all samples analyzed since the last retention time check
	Initial calibration verification	Daily, before sample analysis	All analytes within $\pm 15\%$ of expected value	Correct problem then repeat initial calibration
	Continuing calibration verification	After every 10 samples and at the end of the analysis sequence	All analytes within $\pm 15\%$ of expected value	Correct problem then repeat initial calibration verification and reanalyze all samples since last successful calibration verification
	Demonstrate ability to generate acceptable accuracy and precision using four replicate analyses of a QC check sample	Once per analyst	QC acceptance criteria	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria
	Method blank	One per analytical batch	No analytes detected $> PRL^f$	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank
	LCS ^g for all analytes	One LCS per analytical batch	QC acceptance criteria	Correct problem then reprep and analyze the LCS and all samples in the affected analytical batch
	Second-column confirmation	100% for all positive results	Same as for initial or primary column analysis	Same as for initial or primary column analysis

TABLE (Continued)
SUMMARY OF CALIBRATION AND QC^u PROCEDURES
Risk-Based Approach to Remediation

Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action ^{b/}
Aromatic Volatile Organic Compounds SW8020A and Alcohols SW8015B (cont)	MDL ^u study	Once per year	Detection limits established shall meet QAPP-established criteria	Re-establish MDL
	Surrogate spike	Every sample, spiked sample, standard, and method blank	QC acceptance criteria	Correct problem then re-extract and analyze sample
	MS/MSD ^u	One MS/MSD per every 20 project samples per matrix	QC acceptance criteria	Re-extract and re-analyze the MS and MSD sample within holding time
	Results reported between MDL and PRL	None	None	None
	Five-point initial calibration for all analytes	Initial calibration prior to sample analysis	SPCCs ^u average RF $\geq 0.30^u$; and RSD for all calibration analytes $\leq 30\%$	Correct problem then repeat initial calibration
Volatile Organics SW8260A	Second-source calibration verification	Once per five-point initial calibration	All analytes within $\pm 25\%$ of expected value	Correct problem then repeat initial calibration
	Retention time window calculated for each analyte	Each initial calibration and calibration verifications	± 3 times standard deviation for each analyte retention time from 72-hour study	Correct problem then reanalyze all samples analyzed since the last retention time check
	Calibration verification	Daily, before sample analysis, every 12 hours of analysis time, and at end of analysis sequence	SPCCs average RF ≥ 0.30 , and CCCs ^u $< 20\%$ drift; and all calibration analytes within $\pm 25\%$ of expected value	Correct problem then repeat initial calibration
	Demonstrate ability to generate acceptable accuracy and precision using four replicate analyses of a QC check sample	Once per analyst	QC acceptance criteria	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria

TABLE (Continued)
SUMMARY OF CALIBRATION AND QC^w PROCEDURES
Risk-Based Approach to Remediation

Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action ^v
Volatile Organics SW8260A (cont)	Check of mass spectral ion intensities using BFB ^w	Prior to initial calibration and calibration verification	Refer to criteria listed in the method description	Retune instrument and verify
	IS ^w	Every sample, spiked sample, standard, and method blank	Retention time ± 30 seconds; EICP ^w area within -50% to +100% of last calibration verification (12 hours) for each	Inspect mass spectrometer or GC ^w for malfunctions; mandatory reanalysis of samples analyzed while system was malfunctioning
	Method blank	One per analytical batch	No analytes detected > PRL	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank
	LCS for all analytes	One LCS per analytical batch	QC acceptance criteria	Correct problem then reprep and analyze the LCS and all samples in the affected analytical batch
	Surrogate spike	Every sample, spiked sample, standard, and method blank	QC acceptance criteria	Correct problem then reextract and analyze sample
	MS/MSD	One MS/MSD per every 20 project samples per matrix	QC acceptance criteria	Re-extract and re-analyze the MS and MSD sample within holding time
	MDL study	Once per year	Detection limits established shall meet QAPP-established criteria	Re-establish MDL
	Results reported between MDL and PRL	None	None	None
	Five-point initial calibration for all analytes	Initial calibration prior to sample analysis	SPCCs average RF ≥ 0.05 ; and RSD for all calibration analytes $\leq 30\%$	Correct problem then repeat initial calibration
	Second-source calibration verification	Once per five-point initial calibration	All analytes within $\pm 25\%$ of expected value	Correct problem then repeat initial calibration
Semi-volatile Organics SW8270B				

TABLE (Continued)
SUMMARY OF CALIBRATION AND QC^W PROCEDURES
Risk-Based Approach to Remediation

Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action ^{b/}
Semi-volatile Organics SW8270B (cont)	Retention time window calculated for each analyte	Each initial calibration and calibration verifications	± 3 times standard deviation for each analyte retention time from 72-hour study	Correct problem then reanalyze all samples analyzed since the last retention time check
	Calibration verification	Daily, before sample analysis, every 12 hours of analysis time, and at end of analysis sequence	SPCCs average RF ≥ 0.05 ; and CCCs $< 20\%$ drift; and all calibration analytes within $\pm 25\%$ of expected value	Correct problem then repeat initial calibration
	Demonstrate ability to generate acceptable accuracy and precision using four replicate analytes of a QC check sample	Once per analyst	QC acceptance criteria	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria
	Check of mass spectral ion intensities using DFTPP	Prior to initial calibration and calibration verification	Refer to criteria listed in the method description	Retune instrument and verify
	IS	Every sample, spiked sample, standard, and method blank	Retention time ± 30 seconds; EICP area within -50% to $+100\%$ of last calibration verification (12 hours) for each	Inspect mass spectrometry or GC for malfunctions; mandatory reanalysis of samples analyzed while system was malfunctioning
	Method blank	One per analytical batch	No analytes detected $> PRL$	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank
	LCS for all analytes	One LCS per analytical batch	QC acceptance criteria	Correct problem then reprep and analyze the LCS and all samples in the affected analytical batch

TABLE (Continued)
SUMMARY OF CALIBRATION AND QC PROCEDURES
Risk-Based Approach to Remediation

Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action ^{b/}
Semi-volatile Organics SW8270B (cont)	Surrogate spike	Every sample, spiked sample, standard, and method blank	QC acceptance criteria	Correct problem then re-extract and analyze sample
	MS/MSD	One MS/MSD per every 20 project samples per matrix	QC acceptance criteria	Re-extract and re-analyze the MS and MSD sample within holding time
	MDL study	Once per year	Detection limits established shall meet QAPP-established criteria	Re-establish MDL
	Results reported between MDL and PRL	None	None	None
Polynuclear Aromatic Hydrocarbons SW8310, Formaldehyde SW8315, Ethylene Glycol SW8315 modified, and Methyl Carbamate Pesticides SW8318	Five-point initial calibration for all analytes	Initial calibration prior to sample analysis	$RSD^d < 20\%$ for CF_s^d or Rf_s^d or > 0.995 correlation coefficient	Correct problem then repeat initial calibration
	Second-source calibration verification	Once per five-point initial calibration	All analytes within $\pm 15\%$ of expected value	Correct problem then repeat initial calibration
	Retention time window calculated for each analyte	Each initial calibration and calibration verifications	± 3 times standard deviation for each analyte retention time from 72-hour study	Correct problem then reanalyze all samples analyzed since the last retention time check

TABLE (Continued)
SUMMARY OF CALIBRATION AND QC PROCEDURES
Risk-Based Approach to Remediation

Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action ^{b/}
Polynuclear Aromatic Hydrocarbons SW8310, Formaldehyde SW8315, Ethylene Glycol SW8315 modified, and Methyl Carbamate Pesticides SW8318 (cont)	Initial calibration verification	Daily, before sample analysis	All analytes within $\pm 15\%$ of expected value	Correct problem then repeat initial calibration
	Continuing calibration verification	After every 10 samples and at the end of the analysis sequence	All analytes within $\pm 15\%$ of expected value	Correct problem then repeat initial calibration verification and reanalyze all samples since last successful calibration verification
	Demonstrate ability to generate acceptable accuracy and precision using four replicate analyses of a QC check sample	Once per analyst	QC acceptance criteria	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria
	Method blank	One per analytical batch	No analytes detected > PRL	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank
	LCS for all analytes	One LCS per analytical batch	QC acceptance criteria	Correct problem then reprep and analyze the LCS and all samples in the affected analytical batch
	Surrogate spike	Every sample, spiked sample, standard, and method blank	QC acceptance criteria	Correct problem then re-extract and analyze sample

TABLE (Continued)
SUMMARY OF CALIBRATION AND QC^a PROCEDURES
Risk-Based Approach to Remediation

Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action ^{b/}
ICP Metals SW6010A and SW6010 Trace analyses	MS/MSD	One MS/MSD per every 20 project samples per matrix	QC acceptance criteria	Re-extract and re-analyze the MS and MSD sample within holding time
	Confirmation ^{b/}	100% for all positive results	Same as for initial or primary analysis	Same as for initial or primary analysis
	MDL study	Once per year	Detection limits established shall meet QAPP-established criteria	Re-establish MDL
	Results reported between MDL and PRL	None	None	None
	Initial multipoint calibration (minimum 3 standards and a blank)	Daily initial calibration prior to sample analysis	Correlation coefficient ≥ 0.995 for linear regression	Correct problem then repeat initial calibration
	Second-source calibration check standard	Once per initial daily multipoint calibration	Analyte within $\pm 10\%$ of expected value	Correct problem then repeat initial calibration
	Highest calibration standard	Before beginning a sample run	All analytes within $\pm 5\%$ of expected value	Correct problem then repeat initial calibration
	Calibration blank	After every 10 samples and at end of the analysis sequence	No analyte detected $>PQL$.	Repeat twice, and average results; if average is not within ± 3 standard deviations of background mean, terminate analysis; locate and correct problem; reanalyze previous 10 samples
	Continuing calibration verification (Instrument Check Standard)	After every 10 samples and at the end of the analysis sequence	All analyte(s) within $\pm 10\%$ of expected value	Repeat calibration and reanalyze all samples since last successful calibration
	Demonstrate ability to generate acceptable accuracy and precision using four replicate analyses of a QC check sample	Once per analyst	QC acceptance criteria	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria

TABLE 2 (Continued)
SUMMARY OF CALIBRATION AND QC^w PROCEDURES
Risk-Based Approach to Remediation

Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action ^{b/}
ICP Metals SW6010A and SW6010 Trace analyses (cont)	Method blank	One per analytical batch	No analytes detected > PRL	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank
	Interference check solution (ICS)	At the beginning and end of an analytical run or twice during an 8 hour period, whichever is more frequent	Within $\pm 20\%$ of expected value	Terminate analysis; correct problem; reanalyze ICS, reanalyze all affected samples
	LCS for the analyte	One LCS per analytical batch	QC acceptance criteria	Correct problem then reprep and analyze the LCS and all samples in the affected analytical batch
	Dilution test	Each new sample matrix	1:4 dilution must agree within $\pm 10\%$ of the original determination	Perform post-digestion spike addition
	Post-digestion spike addition	When dilution test fails	Recovery within 75-125% of expected results	Correct problem then reanalyze post-digestion spike addition
	MS/MSD	One MS/MSD per every 20 project samples per matrix	QC acceptance criteria	Re-extract and re-analyze the MS and MSD sample within holding time
	MDL study	Once per year	Detection limits established shall meet QAPP-established criteria	Re-establish MDL
	Results reported between MDL and PRL	None	None	None

TABLE 2 (Continued)
SUMMARY OF CALIBRATION AND QC^W PROCEDURES
Risk-Based Approach to Remediation

Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action ^{b/}
Lead and Lead-Based Paint SW7421, Selenium SW7740, Arsenic SW7060A, and Cadmium SW7131A	Initial multipoint calibration (minimum 3 standards and a blank)	Daily initial calibration prior to sample analysis	Correlation coefficient ≥ 0.995 for linear regression	Correct problem then repeat initial calibration
	Second-source calibration check standard	Once per initial daily multipoint calibration	Analyte within $\pm 10\%$ of expected value	Correct problem then repeat initial calibration
	Calibration blank	Once per initial daily multipoint calibration	No analyte detected > PRL	Correct problem then reanalyze calibration blank and all samples associated with blank
	Continuing calibration verification	After every 10 samples and at the end of the analysis sequence	The analyte within $\pm 20\%$ of expected value	Correct problem then repeat calibration and reanalyze all samples since last successful calibration
	Demonstrate ability to generate acceptable accuracy and precision using four replicate analyses of a QC check sample	Once per analyst	QC acceptance criteria	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria
	Method blank	One per analytical batch	No analytes detected > PRL	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank
	LCS for the analyte	One LCS per analytical batch	QC acceptance criteria	Correct problem then reprep and analyze the LCS and all samples in the affected analytical batch

TABLE 2 (Continued)
SUMMARY OF CALIBRATION AND QC^a PROCEDURES
Risk-Based Approach to Remediation

Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action ^{b/}
Lead and Lead-Based Paint SW7421, Selenium SW7740, Arsenic SW7060A, and Cadmium SW7131A (cont)	New matrix check; five-fold dilution test	Each new sample matrix	Five times dilution sample result must be $\pm 10\%$ of the undiluted sample result	Perform recovery test
	Recovery test	When new matrix check fails	Recovery within 85-115% of expected results	Run all samples by the method of standard addition
	MS/MSD	One MS/MSD per every 20 project samples per matrix Once per year	QC acceptance criteria	Re-extract and re-analyze the MS and MSD sample within holding time
	MDL study		Detection limits established shall meet QAPP-established criteria	Re-establish MDL
	Results reported between MDL and PRL	None	None	None
Organo-phosphorus Pesticides SW8141A	Five-point initial calibration for all analytes	Initial calibration prior to sample analysis	$RSD^d < 20\%$ for CFs ^d or Rfs ^d or > 0.995 correlation coefficient	Correct problem then repeat initial calibration
	Second-source calibration verification	Once per five-point initial calibration	All analytes within $\pm 15\%$ of expected value	Correct problem then repeat initial calibration
	Retention time window calculated for each analyte	Each initial calibration and calibration verifications	± 3 times standard deviation for each analyte retention time from 72-hour study	Correct problem then reanalyze all samples analyzed since the last retention time check
	Initial calibration verification	Daily, before sample analysis	All analytes within $\pm 15\%$ of expected value	Correct problem then repeat initial calibration

TABLE 2 (Continued)
SUMMARY OF CALIBRATION AND QC^{a/} PROCEDURES
Risk-Based Approach to Remediation

Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action ^{b/}
Organo-phosphorus Pesticides SW8141A (cont)	Continuing calibration verification	After every 10 samples and at the end of the analysis sequence	All analytes within $\pm 15\%$ of expected value	Correct problem then repeat initial calibration verification and reanalyze all samples since last successful calibration verification
	Demonstrate ability to generate acceptable accuracy and precision using four replicate analyses of a QC check sample	Once per analyst	QC acceptance criteria	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria
	Method blank	One per analytical batch	No analytes detected > PRL	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank
	LCS for all analytes	One LCS per analytical batch	QC acceptance criteria	Correct problem then reprep and analyze the LCS and all samples in the affected analytical batch
	Surrogate spike	Every sample, spiked sample, standard, and method blank	QC acceptance criteria	Correct problem then re-extract and analyze sample
	MS/MSD	One MS/MSD per every 20 project samples per matrix	QC acceptance criteria	Re-extract and re-analyze the MS and MSD sample within holding time
	Second-column confirmation	100% for all positive results	Same as for initial or primary column analysis	Same as for initial or primary column analysis
	MDL study	Once per year	Detection limits established shall meet QAPP-established criteria	Re-establish MDL
	Results reported between MDL and PRL	None	None	None
	Five-point initial calibration for all analytes	Initial calibration prior to sample analysis	$RSD^d < 20\%$ for CFs^d or Rf_s^d or > 0.995 correlation coefficient	Correct problem then repeat initial calibration
Chlorinated Herbicides SW8151	Second-source calibration verification	Once per five-point initial calibration	All analytes within $\pm 15\%$ of expected value	Correct problem then repeat initial calibration
	Retention time window calculated for each analyte	Each initial calibration and calibration verifications	± 3 times standard deviation for each analyte retention time from 72-hour study	Correct problem then reanalyze all samples analyzed since the last retention time check

TABLE 2 (Continued)
SUMMARY OF CALIBRATION AND QC^{a/} PROCEDURES
Risk-Based Approach to Remediation

Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action ^{b/}
Chlorinated Herbicides SW8151 (cont)	Initial calibration verification	Daily, before sample analysis	All analytes within $\pm 15\%$ of expected value	Correct problem then repeat initial calibration
	Continuing calibration verification	After every 10 samples and at the end of the analysis sequence	All analytes within $\pm 15\%$ of expected value	Correct problem then repeat initial calibration verification and reanalyze all samples since last successful calibration verification
	Demonstrate ability to generate acceptable accuracy and precision using four replicate analytes of a QC check sample	Once per analyst	QC acceptance criteria	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria
	Method blank	One per analytical batch	No analytes detected > PRL	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank
	LCS for all analytes	One LCS per analytical batch	QC acceptance criteria	Correct problem then reprep and analyze the LCS and all samples in the affected analytical batch
	Surrogate spike	Every sample, spiked sample, standard, and method blank	QC acceptance criteria	Correct problem then re-extract and analyze sample
	MS/MSD	One MS/MSD per every 20 project samples per matrix	QC acceptance criteria	Re-extract and re-analyze the MS and MSD sample within holding time
	Second-column confirmation	100% for all positive results	Same as for initial or primary column analysis	Same as for initial or primary column analysis
	MDL study	Once per year	Detection limits established shall meet QAPP-established criteria	Re-establish MDL
	Results reported between MDL and PRL	None	None	None
Organo-chlorine Pesticides and PCBs SW8081	Five-point initial calibration for all analytes	Initial calibration prior to sample analysis	$RSD^d < 20\%$ for CFs ^{d/} or Rfs ^{d/} or > 0.995 correlation coefficient	Correct problem then repeat initial calibration

TAB 2 (Continued)
SUMMARY OF CALIBRATION AND QC^u PROCEDURES
Risk-Based Approach to Remediation

Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action ^{b/}
Organo-chlorine Pesticides and PCBs SW8081 (cont)	Second-source calibration verification	Once per five-point initial calibration	All analytes within $\pm 15\%$ of expected value	Correct problem then repeat initial calibration
	Retention time window calculated for each analyte	Each initial calibration and calibration verifications	± 3 times standard deviation for each analyte retention time from 72-hour study	Correct problem then reanalyze all samples analyzed since the last retention time check
	Initial calibration verification	Daily, before sample analysis	All analytes within $\pm 15\%$ of expected value	Correct problem then repeat initial calibration
	Continuing calibration verification	After every 10 samples and at the end of the analysis sequence	All analytes within $\pm 15\%$ of expected value	Correct problem then repeat initial calibration verification and reanalyze all samples since last successful calibration verification
	Breakdown check (Endrin and DDT)	Daily prior to analysis of samples	Degradation $\leq 20\%$	Repeat breakdown check
	Demonstrate ability to generate acceptable accuracy and precision using four replicate analytes of a QC check sample	Once per analyst	QC acceptance criteria	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria
	Method blank	One per analytical batch	No analytes detected > PRL	Correct problem reprep and analyze method blank and all samples processed with the contaminated blank
	LCS for all analytes	One LCS per analytical batch	QC acceptance criteria	Reprep and analyze the LCS and all samples in the affected analytical batch
	Surrogate spike	Every sample, spiked sample, standard, and method blank	QC acceptance criteria	Correct problem then re-extract and analyze sample
	MS/MSD	One MS/MSD per every 20 project samples per matrix	QC acceptance criteria	Re-extract and re-analyze the MS and MSD sample within holding time
	Second-column confirmation	100% for all positive results	Same as for initial or primary column analysis	Same as for initial or primary column analysis

TAB 2 (Continued)
SUMMARY OF CALIBRATION AND QC PROCEDURES
Risk-Based Approach to Remediation

Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action ^{b/}
Volatile and Extractable Total Petroleum Hydrocarbons SW8015 modified	MDL study	Once per year	Detection limits established shall meet QAPP-established criteria	Re-establish MDL
	Results reported between MDL and PRL	None	None	None
	Five-point initial calibration for all analytes	Initial calibration prior to sample analysis	%RSD < 20% or >0.995 correlation coefficient	Correct problem then repeat initial calibration
	Initial calibration verification	Daily, before sample analysis	All concentration levels of gasoline-range organics within $\pm 15\%$ of expected value	Correct problem then repeat initial calibration
	Continuing calibration verification	After every 10 samples and at the end of the analysis sequence	All concentration levels within $\pm 15\%$ of initial calibration	Correct problem then repeat initial calibration verification and reanalyze all samples since last successful calibration verification
	Demonstrate ability to generate acceptable accuracy and precision using four replicate analytes of a QC check sample	Once per analyst	QC acceptance criteria	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria
	Method blank	One per analytical batch	No TPH detected > PRL	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank
	LCS for all analytes	One LCS per analytical batch	QC acceptance criteria	Correct problem then reprep and analyze the LCS and all samples in the affected analytical batch
	Surrogate spike	Every sample, spiked sample, standard, and method blank	QC acceptance criteria,	Correct problem then re-extract and analyze sample
	MS/MSD	One MS/MSD per every 20 project samples per matrix	QC acceptance criteria	Re-extract and re-analyze the MS and MSD sample within holding time

TABLE (Continued)
SUMMARY OF CALIBRATION AND QC PROCEDURES
Risk-Based Approach to Remediation

Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action ^b
Volatile and Extractable Total Petroleum Hydrocarbons SW8015 modified (cont)	MDL study	Once per year	Detection limits established shall meet QAPP-established criteria	Re-establish MDL
	Results reported between MDL and PRL	None	None	None
Mercury SW7470 and SW7471	Initial multipoint calibration (minimum 5 standards and a blank)	Daily initial calibration prior to sample analysis	Correlation coefficient ≥ 0.995 for linear regression	Correct problem then repeat initial calibration
	Second-source calibration check standard	Once per initial daily multipoint calibration	Analyte within $\pm 10\%$ of expected value	Correct problem then repeat initial calibration
	Calibration blank	Once per initial daily multipoint calibration, every 10 samples, and ending	No analyte detected > PRL	Correct problem then reanalyze calibration blank and all samples associated with blank
	Continuing calibration verification	After every 10 samples and at the end of the analysis sequence	The analyte within $\pm 20\%$ of expected value	Correct problem then repeat calibration and reanalyze all samples since last successful calibration
	Demonstrate ability to generate acceptable accuracy and precision using four replicate analytes of a QC check sample	Once per analyst	QC acceptance criteria	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria
	Method blank	One per analytical batch	No analytes detected > PRL	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank
	LCS for the analyte	One LCS per analytical batch	QC acceptance criteria	Correct problem then reprep and analyze the LCS and all samples in the affected analytical batch

TABLE (Continued)
SUMMARY OF CALIBRATION AND QC PROCEDURES
Risk-Based Approach to Remediation

Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action ^{b/}
Mercury SW7470 and SW7471 (cont)	New matrix check; five-fold dilution test	Each new sample matrix	Five times dilution sample result must be $\pm 10\%$ of the undiluted sample result	Perform recovery test
	Recovery test	When new matrix check fails	Recovery within 85-115% of expected results	Run all samples by the method of standard addition
	MS/MSD	One MS/MSD per every 20 project samples per matrix	QC acceptance criteria	Re-extract and re-analyze the MS and MSD sample within holding time
	MDL study	Once per year	Detection limits established shall meet QAPP-established criteria	Re-establish MDL
	Results reported between MDL and PRL	None	None	None
	Multipoint calibration for all analytes (minimum 3 standards and one calibration blank)	Initial calibration prior to sample analysis	Correlation coefficient ≥ 0.995 for linear regression	Correct problem then repeat initial calibration
Common Anions E300.0	Second-source calibration verification	Once per multipoint calibration	All analytes within $\pm 10\%$ of expected value	Correct problem then repeat initial calibration
	Retention time window calculated for each analyte	Each initial calibration and calibration verifications	± 3 times standard deviation for each analyte retention time from 72-hour study	Correct problem then reanalyze all samples analyzed since the last retention time check
	Initial calibration verification	Daily, before sample analysis or when eluent is changed	All analytes within $\pm 10\%$ of expected value	Correct problem then repeat initial calibration
	Continuing calibration verification	After every 10 samples and at the end of the analysis sequence	Instrument response within $\pm 10\%$ of expected response	Correct problem then repeat initial calibration verification and reanalyze all samples since last successful calibration verification
		After every analytical batch	All analytes within $\pm 10\%$ of expected value	Correct problem then repeat initial calibration verification and reanalyze all samples since last successful calibration verification

TABLE (Continued)
SUMMARY OF CALIBRATION AND QC PROCEDURES
Risk-Based Approach to Remediation

Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action ^{iv}
Common Anions E300.0 (cont)	Demonstrate ability to generate acceptable accuracy and precision using four replicate analyses of a QC check sample	Once per analyst	QC acceptance criteria	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria
	Method blank	One per analytical batch	No analytes detected > PRL	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank
	LCS for all analytes	One LCS per analytical batch	QC acceptance criteria	Correct problem then reprep and analyze the LCS and all samples in the affected analytical batch
	MS/MSD	One MS/MSD per every 20 project samples per matrix	QC acceptance criteria	Re-extract and re-analyze the MS and MSD sample within holding time
	MDL study	Once per year	Detection limits established shall meet QAPP-established criteria	Re-establish MDL
	Results reported between MDL and PRL	None	None	None
	Multipoint calibration curve (minimum three standards and a blank)	Initial calibration prior to sample analysis	Correlation coefficient ≥ 0.995 for linear regression	Correct problem then repeat initial calibration
	Second-source calibration verification	After each new stock standard preparation	Chromium within $\pm 10\%$ of expected value	Correct problem then repeat initial calibration
	Continuing calibration verification	After every 15 samples and at the end of the analysis sequence	Chromium within $\pm 20\%$ of expected value	Correct problem then repeat initial calibration and reanalyze all samples since last successful calibration
	Demonstrate ability to generate acceptable accuracy and precision using four replicate analyses of a QC check sample	Once per analyst	QC acceptance criteria	Recalculate results; locate and fix problem with system and then rerun demonstration
Hexavalent Chromium SW7196	Verification check to ensure lack of reducing condition and/or interference	Once for every sample matrix analyzed	Spike recovery between 85-115%	If check indicates interference, dilute and reanalyze sample persistent interference indicates the need to use and alternate method

TABLE (Continued)
SUMMARY OF CALIBRATION AND QC PROCEDURES
Risk-Based Approach to Remediation

Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action ^v
Hexavalent Chromium SW7196 (Cont)	MDL study	Once per year	Detection limits established shall be < the PQLs	None
	Method blank	One per analytical batch	No analyte detected > PQL	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank
	LCS	One LCS per analytical batch	QC acceptance criteria	Correct problem then reprep and analyze the LCS and all samples in the affected analytical batch
	MS/MSD	One MS/MSD per every 20 project samples per matrix	QC acceptance criteria	Re-extract and re-analyze the MS and MSD sample within holding time
	MDL study	Once per year	Detection limits established shall meet QAPP-established criteria	Re-establish MDL
	Results reported between MDL and PQL	None	None	None
	Multipoint calibration for all analytes (minimum 3 standards and one calibration blank)	Initial calibration prior to sample analysis	Correlation coefficient ≥ 0.995 for linear regression	Correct problem then repeat initial calibration
Total Petroleum Hydrocarbons E418.1	Second-source calibration verification	Once per multipoint calibration	All analytes within $\pm 10\%$ of expected value	Correct problem then repeat initial calibration
	Retention time window calculated for each analyte	Each initial calibration and calibration verifications	± 3 times standard deviation for each analyte retention time from 72-hour study	Correct problem then reanalyze all samples analyzed since the last retention time check
	Initial calibration verification	Daily, before sample analysis or when eluent is changed	All analytes within $\pm 10\%$ of expected value	Correct problem then repeat initial calibration
	Continuing calibration verification	After every 10 samples and at the end of the analysis sequence	Instrument response within $\pm 5\%$ of expected response	Correct problem then repeat initial calibration verification and reanalyze all samples since last successful calibration verification

TAB 1 (Continued)
SUMMARY OF CALIBRATION AND QC PROCEDURES
Risk-Based Approach to Remediation

Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action ^{b/}
Total Petroleum Hydrocarbons E418.1 (Cont)		After every analytical batch	All analytes within $\pm 10\%$ of expected value	Correct problem then repeat initial calibration verification and reanalyze all samples since last successful calibration verification
	Demonstrate ability to generate acceptable accuracy and precision using four replicate analytes of a QC check sample	Once per analyst	QC acceptance criteria	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria
	Method blank	One per analytical batch	No analytes detected > PRL	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank
	LCS for all analytes	One LCS per analytical batch	QC acceptance criteria	Correct problem then reprep and analyze the LCS and all samples in the affected analytical batch
	MS/MSD	One MS/MSD per every 20 project samples per matrix	QC acceptance criteria	Re-extract and re-analyze the MS and MSD sample within holding time
	MDL study	Once per year	Detection limits established shall meet QAPP-established criteria	Re-establish MDL
	Results reported between MDL and PRL	None	None	None

a/ QC = quality control.

b/ All corrective actions associated with project work will be documented, and all records will be maintained by the laboratory.

c/ RSD = relative standard deviation.

d/ CF = control factor.

e/ RF = response factor.

f/ PRL = project reporting limit.

n/ IS = internal standard.

o/ EICP = extracted ion current profile.

p/ GC = gas chromatograph.

g/ LCS = laboratory control sample.

h/ MDL = method detection limit.

i/ MS/MSD = matrix spike/matrix spike duplicate.

j/ SPCC = system performance check compound.

k/ $\leq 30\%$ = except for >0.10 for bromoform and >0.01 for chloromethane and 1,1-dichloroethane.

l/ CCC = continuing calibration check.

m/ BFB = 4-bromofluorobenzene.

TABLE 7.3
REQUIREMENTS FOR CONTAINERS, PRESERVATION TECHNIQUES,
SAMPLE VOLUMES, AND HOLDING TIMES
RISK-BASED APPROACH TO REMEDIATION

Name	Analytical Methods	Container ^{a/}	Preservation ^{b/c/}	Minimum Sample Volume or Weight	Maximum Holding Time
Alkalinity	E310.2	P, G	4°C	50 ml	14 days
Common Anions	E300.0	P, G	4°C	50 ml	28 days for Br ⁻ , F ⁻ , Cl ⁻ , and SO ₄ ²⁻ ; 48 hours for NO ₃ ⁻ , NO ₂ ⁻ and PO ₄ ³⁻
Filterable Residue	E160.1	P, G	4°C	100 ml	7 days
Nonfilterable Residue	E160.2	P, G	4°C	100 ml	7 days
Hydrogen Ion (pH)	SW9040/ SW9045	P, G	4°C	50 ml or 4 ounces	Analyze immediately
Ammonia, Nitrogen	E350.1	P, G	4°C, H ₂ SO ₄ to pH < 2	500 ml	28 days
Nitrogen, Nitrate/Nitrite	E353.2	P, G	4°C, H ₂ SO ₄ to pH < 2	500 ml	28 days
Cadmium	SW7131A	P, G, T	HNO ₃ to pH < 2, 4°C	500 ml or 8 ounces	180 days (water and soil)
Mercury	SW7470/ SW7471	P, G, T	HNO ₃ to pH < 2, 4°C	500 ml or 8 ounces	28 days (water and soil)
Metals ^{d/} (except Cadmium and Mercury)	SW6010A and SW7XXX ^{e/}	P, G, T	HNO ₃ to pH < 2, 4°C	500 ml or 8 ounces	180 days (water and soil)
Total Petroleum Hydrocarbons (TVH)- Gasoline	SW8015 (modified)	G, Teflon®-lined septum, T	4°C, HCl to pH < 2	3 x 40 ml or 4 ounces	14 days (water and soil); 7 days if unpreserved by acid

TABLE 7.3 (Continued)
REQUIREMENTS FOR CONTAINERS, PRESERVATION TECHNIQUES,
SAMPLE VOLUMES, AND HOLDING TIMES
RISK-BASED APPROACH TO REMEDIATION

Name	Analytical Methods	Container ^{a/}	Preservation ^{b/c/}	Minimum Sample Volume or Weight	Maximum Holding Time
Total Petroleum Hydrocarbons (TEH)-Diesel	SW8015 (modified)	G, amber, T	4°C	2 liters or 8 ounces	7 days until 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 ₂ S ₂ O ₃	3 x 40 ml or 4 ounces	14 days (water and soil)
Volatile Halocarbons	SW8010A	G, Teflon®-lined septum, T	4°C, HCl to pH < 2, 0.008% Na ₂ S ₂ O ₃	3 x 40 ml or 4 ounces	14 days (water and soil)
Formaldehyde	SW8315	G, Teflon®-lined cap, T	4°C, pH 5-9	2 liters or 8 ounces	7 days until extraction and 40 days after extraction (water); 14 days until extraction and 40 days after extraction (soil)
Ethylene Glycol	SW8315 modified	G, Teflon®-lined cap, T	4°C, pH 5-9	2 liters or 8 ounces	7 days until extraction and 40 days after extraction (water); 14 days until extraction and 40 days after extraction (soil)
Alcohol Scan	SW8015B	G, Teflon®-lined septum, T	4°C, HCl to pH < 2, 0.008% Na ₂ S ₂ O ₃	3 x 40 ml or 4 ounces	14 days (water and soil); 7 days if unpreserved by acid

TABLE 7.3 (Continued)
REQUIREMENTS FOR CONTAINERS, PRESERVATION TECHNIQUES,
SAMPLE VOLUMES, AND HOLDING TIMES
RISK-BASED APPROACH TO REMEDIATION

Name	Analytical Methods	Container ^{a/}	Preservation ^{b/c/}	Minimum Sample Volume or Weight	Maximum Holding Time
Total Petroleum Hydrocarbons (TPH)	E418.1	G, amber, T	4°C	2 liters or 8 ounces	7 days until extraction and 40 days after extraction (water); 14 days until extraction and 40 days after extraction (soil)
Chlorinated Herbicides	SW8151	G, Teflon®-lined cap, T	4°C, pH 5-9	2 liters or 8 ounces	7 days until extraction and 40 days after extraction (water); 14 days until extraction and 40 days after extraction (soil)
Organochlorine Pesticides and Polychlorinated Biphenyls (PCBs)	SW8081	G, Teflon®-lined cap, T	4°C, pH 5-9	2 liters or 8 ounces	7 days until extraction and 40 days after extraction (water); 14 days until extraction and 40 days after extraction (soil)
Organophosphorus Pesticides	SW8141A	G, Teflon®-lined cap, T	4°C, pH 5-9	2 liters 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 ₂ S ₂ O 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)

TABLE 7.3 (Continued)
REQUIREMENTS FOR CONTAINERS, PRESERVATION TECHNIQUES,
SAMPLE VOLUMES, AND HOLDING TIMES
RISK-BASED APPROACH TO REMEDIATION

Name	Analytical Methods	Container ^{a/}	Preservation ^{b/c/}	Minimum Sample Volume or Weight	Maximum Holding Time
Volatile organics	SW8260A/8240	G, Teflon®-lined septum, T	4°C, 0.008% Na ₂ S ₂ O ₃ (HCl to pH < 2 for volatile aromatics by SW8240 and SW8260) ^b	3 x 40 ml or 4 ounces	14 days (water and soil)
Polynuclear Aromatic Hydrocarbons (PAHs)	SW8310	G, Teflon®-lined cap, T	4°C, store in dark, 0.008% Na ₂ S ₂ O ₃	2 liters or 8 ounces	7 days until extraction (water); 14 days until extraction and 40 days after extraction (soil)
Methyl Carbamate Herbicides	SW8318	G, Teflon®-lined cap, T	4°C, pH 5-9	2 liters or 8 ounces	7 days until extraction (water); 14 days until extraction and 40 days after extraction (soil)
Lead (paint)	SW7421	P, G	4°C	2 ounces	180 days
Asbestos	NIOSH 7400	P, G	4°C	2 ounces	NA ^{f/}

a/ Polyethylene (P); glass (G); brass sleeves in the sample barrel (T).

b/ No pH adjustment for soil.

c/ Preservation with 0.008 percent Na₂S₂O₃ is only required when residual chlorine is present.

d/ All metals collected for a dissolved portion analysis will be filtered in the field prior to preservation.

e/ SW7XXX is all graphite furnace atomic absorption methods, SW7421, 7060, 7131, and 7740.

f/ Not applicable.

7.2.3 Method Blanks

Method blanks are designed to detect contamination of the field samples in the laboratory environment. Method blanks verify that interferences caused by contaminants in solvents, reagents, glassware, or in other sample processing hardware are known and minimized. The method blank will be ASTM Type II water (or equivalent) for water samples, and a purified solid matrix (Ottawa sand or equivalent) for soil samples. The concentration of target compounds in the blanks must be less than or equal to the PRL (Table 7.1). Exceptions are not made for common laboratory contaminants. If the blank contaminant concentration is not less than the specified limit, then the source of contamination will be identified, and corrective action will be taken. SQLs and detection limits will not be raised because of blank contamination. Analytical data will not be corrected for presence of analytes in blanks.

7.2.4 Laboratory Control Samples

Laboratory control samples (LCSs) are blank spikes made from clean laboratory-simulated matrices (reference method blank matrices) spiked with known concentrations of all target analytes of interest at levels approximately 10 times the MDLs. The LCS is carried through the complete sample preparation and analysis procedures. LCSs are designed to check the instrument and method accuracy. An LCS will be analyzed with every analytical batch. Failure of the LCS to meet %R criteria listed in Table 1.1 requires corrective action before any further analyses can continue. All sample results associated with the out-of-control LCS must be reanalyzed after control has been reestablished.

7.2.5 Surrogate Spike Analyses

Surrogate spike analyses are used to determine the efficiency of analyte recovery in sample preparation and analysis in relation to sample matrix. Calculated %R of the spike is used to measure the accuracy of the analytical method for an individual sample. A surrogate spike is prepared by adding to an environmental sample (before extraction) a known concentration of a compound similar in type to the target analytes (i.e., a surrogate compound) to be analyzed for organic target compounds. Surrogate compounds as specified in the methods will be added to all samples analyzed, including method blanks, MS/MSDs, LCSs, field samples, and duplicate samples. Surrogate spike recoveries should fall within the limits established by the AFCEE QAPP Version 2.0 (1997) or, in the case of Florida TRPH method FL-PRO, within FDEP criteria.

7.2.6 Matrix Spike/Matrix Spike Duplicate

Matrix spike (MS) samples are designed to check the accuracy of the analytical procedures for the sample matrix by analyzing a field sample spiked in the laboratory with a known standard solution containing all the target analytes. A matrix spike duplicate (MSD) is the second of a pair of laboratory MS samples. The MSDs are designed to check the precision and accuracy of analytical procedures by sample matrix.

One MS/MSD pair will be collected for every group of 20 project samples of similar matrix. Field blanks or duplicates are not to be used as MS/MSDs. If surrogate and target analyte compounds concentrations are out of control in the MS/MSD, but the associated accuracy and precision are in control in the LCS, then the out-of-control situation will be attributed to a matrix interference. If the laboratory system is shown to be out-of-control (i.e., if the LCS is out-of-control), then re-extraction and reanalysis will be required. The laboratory will report the data from any reanalysis that is performed.

7.2.7 Analytical Batches

Analytical batches will be designated in the laboratory at a minimum of one batch per sample delivery group (SDG). Each SDG will be comprised of a maximum of 20 project samples of similar matrix collected within a 7-day period. Included in each SDG of 20 (or fewer) samples per analytical method will be an analytical batch identification number. This identification number will clearly allow a reviewer to determine the association between field samples and QC samples. Analytical batches also will be inclusive of preparation lots and calibration periods.

7.2.8 Retention Times

Retention time (RT) is the amount of time required for a target compound to elute from the chromatographic column, and the instrument detector to record a signal response. The RT window is the allowable deviation from the true expected RT for any one compound. A peak response within this RT window will constitute a positive detection for that compound. RT windows are QC criteria for all gas chromatograph (GC) and high-performance liquid chromatography (HPLC) methods. RT windows are determined through replicate analyses of a standard over multiple days. The calculation of RT windows is described in USEPA (1995) Method SW8000A. Corrective action is required when the RT windows are out of control.

7.2.9 Internal Standards

Internal standards (ISs) are compounds of known concentrations used to quantitate the concentrations of target detections in field and QC samples. ISs are added to all samples after sample extraction or preparation. Because of this, ISs provide for the accurate quantitation of target detections by allowing for the effects of sample loss through extraction, purging, and/or matrix effects. ISs are used for any method requiring an IS calibration. Corrective action is required when ISs are out of control.

7.2.10 Interference Check Standard

The interference check standard (ICS) is used to verify the background and interelement correction factors for metals in method SW6010A. The ICS is analyzed at the beginning and end of each analytical sequence. Method-specific acceptance limits listed in Table 1.1 will apply.

7.2.11 Second Column Confirmation

Quantitative confirmation of results at or above the PQL for samples analyzed by GC or HPLC will be required and will be completed within the method-required holding times. For GC methods, a second column is used for confirmation. For HPLC methods, a second column or a different detector is used. The result of the first column/detector will be the result reported.

7.2.12 Control Limits

The control limits associated with all method QC will follow guidance established in the AFCEE (1996) QAPP. For methods not defined in the AFCEE (1996) QAPP (e.g., SW3810 modified for methane), the acceptance criterion in Table 1.1 is listed as suggested guidance.

7.2.13 Calibration Requirements

Analytical instruments will be calibrated in accordance with the analytical methods. All analytes reported will be present in the initial and continuing calibrations, and these calibrations must meet the acceptance criteria specified in Table 1.1. Records of standard preparation and instrument calibration will be maintained by the contract laboratory. Records will unambiguously trace the preparation of standards and their use in calibration and quantitation of sample results. Calibration standards will be traceable to standard materials.

Analyte concentrations are determined with either calibration curves or response factors (RFs). For GC and GC/mass spectroscopy (MS) methods, when using RFs to determine analyte concentrations, the average RF from the initial five-point calibration will be used. The continuing calibration will not be used to update the RFs from the initial five-point calibration.

7.2.14 Standard Materials

Standard materials used in calibration and to prepare samples will be traceable to National Institute of Standards and Technology (NIST), USEPA, American Association of Laboratory Accreditation (A2LA) or other equivalent approved source, if available. The standard materials will be current, in accordance with the following expiration policy: The expiration dates for ampulated solutions will not exceed the manufacturer's expiration date or one year from the date of receipt, whichever occurs first. Expiration dates for laboratory-prepared stock and diluted standards will be no later than the expiration date of the stock solution or material, or the date calculated from the holding time allowed by the applicable analytical method, whichever occurs first. The laboratory will label standard and QC materials with expiration dates.

7.3 SAMPLE CUSTODY REQUIREMENTS

Sample custody begins in the field at the time of collection and continues throughout the laboratory analytical process. COC forms will be prepared at the time sample collection and will accompany the samples through the laboratory sample processing.

To facilitate the documentation of sample custody, the laboratory will track the progress of sample preparation, analysis, and report preparation. Samples received by the laboratory will be checked carefully for label identification, COC forms, and any discrepancies. The laboratory will also note physical damage, incomplete sample labels, incomplete paperwork, discrepancies between sample labels and paperwork, broken or leaking containers, and inappropriate caps or bottles. On the day of receipt of samples from the contractor, the laboratory will send signed facsimile copies of all COCs and sample log-in receipt forms to the contractor. All discrepancies and/or potential problems (e.g., lack of sample volume) will be discussed immediately with the contractor's project task manager.

The laboratory sample custodian will be required to provide a report to the contractor of any problems observed with any of the samples received. This report will also document the condition of samples, sample numbers received, corresponding laboratory numbers, and the estimated date for completion of analysis. The laboratory must receive written permission from the contractor before sending any samples (originally scheduled to be analyzed at their facility) to another laboratory. Analyses will not be performed on samples whose integrity has been compromised or is suspect.

7.4 SAMPLE HANDLING

Laboratory sample custody will be maintained by the following procedures:

1. The laboratory will designate a sample custodian responsible for maintaining custody of the samples and all associated paperwork documenting that custody.
2. Upon receipt of the samples, the sample custodian will sign the original COC form and compare the analyses requested thereon with the label on each sample container.
3. A qualitative assessment of each sample container will be performed to note any anomalies such as broken or leaking bottles or lack of preservation (e.g., ice melted enroute). This assessment will be recorded as part of the incoming COC procedure.
4. If the COC and samples correlate, and there has been no tampering with the custody seals, the "received by laboratory" box on the COC form will be signed and dated.
5. Care will be exercised to document any labeling or descriptive errors. In the event of discrepancies, breakage, or conditions that could compromise the validity of analyses, the laboratory project coordinator will immediately contact the task manager as part of the corrective action process.
6. Samples will be logged into the laboratory management computer system, which includes a tracking system for extraction and analysis dates. The laboratory will assign a laboratory work number to each sample for identification purposes. The sample custodian will log the laboratory work number and the field sample identification into a laboratory sample custody log. The laboratory sample

custody log may either be hard copy or computerized, depending on the laboratory's system.

7. The samples will be stored in a secured area at a temperature of approximately 4 ± 2 degrees Celsius ($^{\circ}\text{C}$) or cooler (as applicable) until analyses commence. The laboratory log should also contain the laboratory storage cooler number (if applicable) that the sample will be stored in while on the laboratory's premises. Samples will be logged when they are removed and returned from storage for analysis. Samples must be stored in separate coolers from those used to store analytical standards, reagents, and/or QC samples.
8. The samples will be distributed to the appropriate analysts, with names of individuals who receive samples recorded in internal laboratory records.
9. The original COC form will accompany the laboratory report submittal and will become a permanent part of the project records.
10. Data generated from the analysis of samples also must be kept under proper custody by the laboratory.

Upon analysis, a laboratory lot control number will be assigned to the sample. All samples within a given laboratory analysis group (e.g., samples sharing the same laboratory QC measurement samples) will have identical laboratory lot control numbers.

Disposal of sample containers and remaining sample material will be the responsibility of the laboratory. Samples should be disposed of appropriately when all analyses and related QA/QC work are completed.

7.5 SAMPLE IDENTIFICATION AND SAMPLE CUSTODY RECORDS

The laboratory conducting the analysis of the samples will provide the data user with information on the laboratory sample identification system. With knowledge of this laboratory sample identification system, data generated at the laboratory can be tracked by both the laboratory and field sample identification systems.

Each sample will be logged into the laboratory system by assigning it a unique sample number. This laboratory number and the field sample identification number will be recorded on the laboratory report.

7.6 LABORATORY DATA REDUCTION, VALIDATION, AND REPORTING

7.6.1 Review Procedures for Definitive Data

The fixed-base laboratory will review 100 percent of all definitive data prior to reporting. The establishment of detection and control limits will be verified. Any control limits outside of the acceptable ranges specified in the analytical methods will be identified. Any trends or problems with the data will be evaluated. Any laboratory-established detection limits that exceed the established method-specified limits will be identified. The absence of records supporting the establishment of control criteria or detection limits will be noted. Analytical batch QC, calibration check samples, method

calibrations, continuing calibration verifications, corrective action reports, the results of reanalysis, sample holding times, sample preservations, and any resampling and analysis all will be evaluated.

Samples associated with out-of-control QC data will be identified in the data package case narrative, and an assessment of the utility of such analytical results will be made. The check of laboratory data completeness will ensure that:

- All samples and analyses specified in the SAP have been processed;
- Complete records exist for each analysis and the associated QC samples; and
- Procedures specified in this SAP have been implemented.

The results of the completeness check will be documented.

An analyst other than the original data processor, will be responsible for reviewing all steps of the data processing. All input parameters, calibrations, and transcriptions will be checked. All manually input, computer-processed data will be checked. Each page of checked data will be signed and dated by the verifier.

QC sample results (LCSs, MS/MSDs, surrogates, initial calibration standards, and continuing calibration standards) are compared against stated criteria for accuracy and precision (Table 7.2). QC data must meet acceptance levels prior to processing the analytical data. If QC standards are not met, the cause will be determined. If the cause can be corrected without affecting the integrity of the analytical data, processing of the data will proceed. If the resolution jeopardizes the integrity of the data, reanalysis will occur. Decisions to repeat sample collection and analyses may be made by the contractor project manager based on the extent of the deficiencies and their importance in the overall context of the project.

7.6.2 Laboratory Data Reporting Flags

The following qualifiers must be used by the laboratory when reporting sample results.

Qualifier	Description
J	The analyte was positively identified, the quantitation is an estimation.
U	The analyte was analyzed for, but not detected. The associated numerical value is at or below the MDL.
F	The analyte was positively identified but the associated numerical value is below the PQL.
R	The data are unusable due to deficiencies in the ability to analyze the sample and meet QC criteria.
B	The analyte was found in an associated blank, as well as in the sample.
M	A matrix effect was present.
T	Tentatively identified compound (using GC/MS)

7.6.3 Contractor Data Reporting Flags

The following define the contractor organic and inorganic data validation qualifiers:

- U - The material was analyzed for, but was not detected above the level of the associated value. The associated value is the PRL (e.g., the nondetect level).
- J - The associated value is an estimated quantity.
- R - The data are unusable (Note: analyte may or may not be present).
- UJ - The material was analyzed for but was not detected. The associated value is an estimate and may be inaccurate or imprecise.

7.6.4 Data Validation and Assessment of Usability

Data from QC samples will be assessed by the contractor using the procedures and criteria presented earlier in this section. This assessment will be a continuous process in which QA problems are identified immediately, and the appropriate corrective action is implemented. Additionally, the contractor will assess the usability of analytical data. Any limitations on data use will be expressed quantitatively to the extent practicable and will be documented in any reporting of the data.

This data usability review will include a review of the analytical methods, quantitation limits, and other factors important in determining the precision, accuracy, completeness, and representativeness of the final data set. The outcome of this data review will be a data set appropriate to support quantitative fate and transport analyses and risk analysis. The data evaluation methods defined in *Risk Assessment Guidance for Superfund (RAGS), Volume 1: Human Health Evaluation Manual* (USEPA, 1989) and the *Guidance for Data Useability in Risk Assessment* (USEPA, 1992) will be used as appropriate.

7.6.5 Hard-Copy Data Deliverables

Data deliverables required for the analytical results include both a hard copy and an electronic copy. Hard-copy reporting of analytical results will include analytical results summaries for all field samples, and their associated QA/QC samples. The laboratory will be required to provide two copies of each hard copy data reporting package. Data reporting requirements for hard-copy analytical reports are in Table 7.4 as those items listed with an asterisk.

7.6.6 Electronic Data Deliverables

To facilitate data handling and management, both field and laboratory data will be entered into a computerized format. All data will be delivered to the contractor from the laboratory in the database format specified in the *Installation Restoration Program Information Management System (IRPIMS) Data Loading Handbook*, Version 2.2, AFCEE, 1991. The laboratory will be responsible for running QC Tools on the analytical data files prior to delivery to the contractor.

TABLE 7.4
REQUIRED LABORATORY DELIVERABLES

Method Requirements	Laboratory Deliverables (Definitive Data)
Requirements for all methods: - Case narrative	Project identification Analytical method description and reference citation. Discussion of unusual circumstances, problems, and nonconformances. Any format to discuss issues which may affect data quality *
Monthly QA report	Signed and dated when samples were* received at laboratory
- Chain of Custody (COC)	Specific deliverable depends upon* type of analysis
- Dates of sample preparation and analysis (including first run and subsequent runs).	Specific deliverable depends upon type* of analysis
- Quantitation limits achieved.	Specific deliverable depends upon* type of analysis
- Dilution or concentration factors.	Any format*
- Summary analytical batch report including analytical batch samples, method of analysis, matrix description, date of sample collection and receipt, laboratory identification number of each environmental sample plus identification number of each batch quality control (QC) sample (including Matrix Spike/Matrix Spike Duplicate (MS/MSD), calibration check, etc.).	QC summary report*
- Method reporting limits.	QC summary report*
- QC limits.	Any format
- Practical Quantitation Limit (PQL) verification standard (weekly).	Any format *
- Corrective action reports.	Any format
- A copy of all raw laboratory analytical data.	(chromatograms, mass spectra and data system printouts)
- Example sample calculation	Any format
- A copy of the sample preparation data form for each method indicating sample identification number, batch identification number, and date of preparation.	Any format (preparation, extraction, or digestion data)
Percent moisture for all soil samples	Any format *

TABLE 7.4 (Concluded)
REQUIRED LABORATORY DELIVERABLES

Method Requirements	Laboratory Deliverables (Definitive Data)
Requirements for organic analytical methods:	
- Sample data sheets.	Summary information only ^{a/} *
- Surrogate recoveries.	Summary information only *
- MS/MSD.	Summary information only *
- Method blank analysis.	Summary information only *
- Laboratory control spike (LCS)	Summary information only*
- Instrument performance check (Tuning).	Summary information only
- Degradation/breakdown (SW8080).	Summary information only
- Initial calibration data	Summary information only
- Continuing calibration data.	Summary information only
- Calibration blank data	Summary information only
- Internal standard area and retention time summary data.	Summary information only
- Retention time windows	Summary information only*
- Second-column confirmation. To be done for all compounds that are detected above reporting limit	Summary information only*
- Analysis run log.	No format
Requirements for inorganic analytical methods	
Metals:	
- Sample data sheets.	Summary information only *
- Initial and continuing calibration.	Summary information only
- Method blank, taken through sample preparation.	Summary information only *
- Calibration blank data.	Summary information only
- Interference check sample.	Summary information only
- Laboratory control spike/laboratory control spike duplicate.	Summary information only*
- Matrix spike/matrix spike duplicate.	Summary information only *
- Post-digestion spike sample recovery	Summary information only
- Method of standard additions	Summary information only
- Serial dilutions	Summary information only
- Analysis run logs	No format

* Indicates hard-copy deliverables required for QC summary package of Option 3 and 4.

a\ Summarized results can be in any format that provides the necessary data to completely validate that QC parameter. Example formats are the form equivalents to those defined for the USEPA Contract Laboratory Program (CLP) or SW-846 programs.

The laboratory reporting system will be implemented and tested prior to beginning the sampling. Any problems detected in format will be corrected by laboratory prior to providing any electronic deliverables to the contractor. All data entered into the electronic data files will correspond to the data contained in the original laboratory reports and other documents associated with sampling and the laboratory hard copy data deliverable packages.

7.6.7 Quality Assurance Reports

At monthly intervals beginning with the initiation of sampling activities, the laboratory will submit to the contractor's project task manager an internal QA report that documents laboratory-related QA/QC issues. These reports will include discussions of any conditions adverse or potentially adverse to quality, such as:

- Responses to the findings of any internal or external systems or performance laboratory audits;
- Any laboratory or sample conditions which necessitate a departure from the methods or procedures specified in this SAP;
- Any missed holding times or problems with laboratory QC acceptance criteria; and
- The associated corrective actions taken.

Submittal of QA reports will not preclude earlier contractor notification of such problems when timely notice can reduce the loss or potential loss of quality, time, effort, or expense. Appropriate steps will be taken to correct any QA/QC concerns as they are identified. The QA reports and a summary of the laboratory QA/QC program and results will be included in the final project report.

7.7 CORRECTIVE ACTION

The following procedures have been established to assure that conditions adverse to data quality are promptly investigated, evaluated, and corrected. Adverse conditions may include malfunctions, deficiencies, deviations, and errors.

When a significant condition adverse to data quality is noted at the laboratory, the cause of the condition will be determined, and corrective action will be taken to prevent repetition. Condition identification, cause, reference documents, and corrective action planned will be documented and reported to the contractor QA officer by the laboratory QC coordinator. Following implementation of corrective action, the laboratory QC coordinator will report the actions taken and their results to the contractor project manager and QA officer. A record of the action taken and results will be attached to the data report package. If samples are reanalyzed, the assessment procedures will be repeated, and the control limits will be reevaluated to ascertain if corrective actions have been successful.

Implementation of corrective action is verified by documented follow-up action. All project personnel have the responsibility, as part of the normal work duties, to identify, report, and solicit approval of corrective actions for conditions adverse to data quality.

Corrective actions will be initiated in the following instances:

- When predetermined acceptance criteria are not attained (Tables 7.1, 7.2, and 7.3) (objectives for precision, accuracy, and completeness);
- When the prescribed procedure or any data compiled are faulty;
- When equipment or instrumentation is determined to be faulty;
- When the traceability of samples, standards, or analysis results is questionable;
- When QA requirements have been violated;
- When designated approvals have been circumvented;
- As a result of systems or performance audits;
- As a result of regular management assessments;
- As a result of intralaboratory or interlaboratory comparison studies; and
- At any other instance of conditions significantly adverse to quality.

Laboratory project management and staff, such as QA auditors, document and sample control personnel, and laboratory groups, will monitor work performance in the normal course of daily responsibilities.

The laboratory QC coordinator or designated alternate will audit work at the laboratory. Items, activities, or documents ascertained to be compliant with QA requirements will be documented, and corrective actions will be mandated in the audit report. The contractor QA officer and laboratory QC coordinator will log, maintain, and control the audit findings.

The contractor QA officer and laboratory QC coordinators are responsible for documenting all out-of-control events or non-conformance with QA protocols. The QC checks, their frequency, acceptance criteria, and corrective actions for out-of-control data are summarized in Table 1.1 for each analytical method. A nonconformance report will summarize each nonconformance condition. The laboratory will notify the contractor project manager or QA officer of any laboratory QA/QC nonconformances upon their discovery. Copies of all field change requests and corrective action forms will be maintained in the project files. A stop-work order may be initiated by the contractor if corrective actions are insufficient.

7.7 AUDITS

This section describes participation in external and internal systems audits for AFCEE contractors and laboratories.

7.7.1 System Audits

System audits review laboratory operations and the resulting documentation. An onsite audit ensures that the laboratory has all the personnel, equipment, and internal standard operating procedures (SOPs) needed for performance of contract requirements in place and operating. The system audits ensure that proper analysis documentation procedures are followed, that routine laboratory QC samples are analyzed, and that any nonconformances are identified and resolved.

7.7.2 Internal Audits

The laboratory must conduct internal system audits on a periodic basis. The results of these audits will be documented by the laboratory QC coordinator, and the laboratory will provide the contractor with the results of these internal audits.

7.7.3 External Audits

The contractor project QA officer or designee may conduct an external system audit of the laboratory during the performance project samples. This audit would evaluate the capabilities and performance of laboratory personnel, items, and activities. It also documents the measurement systems and identifies and corrects any deficiencies. The contractor QA manager acts on audit results by documenting deficiencies and informing the contractor project manager of the need for corrective action. The contractor project manager may suspend operations until problems are resolved. If conditions adverse to quality are detected, or if the contractor project manager requests additional audits, additional unscheduled audits may be performed.

In addition to the contractor audit of the laboratory, various state and/or federal agencies may conduct an audit prior to the commencement of the project, and may conduct additional audits as deemed necessary. The frequency and schedule of any such audits will be established by the auditing agency and coordinated directly with the laboratory.

7.7.4 Performance Audits

Laboratory performance audits may be conducted to determine the accuracy and implementation of the SAP by the contractor QA manager or designee prior to initiation of field sampling. Unplanned audits may be implemented if requested by the contractor project manager. In addition to in-house performance audits, the laboratory may also participate in interlaboratory performance evaluation studies for different state or federal agencies. The contractor project QA manager will act to correct any laboratory performance problems.

7.8 PREVENTIVE MAINTENANCE

7.8.1 Procedures

Equipment, instruments, tools, gauges, and other items requiring preventive maintenance will be serviced in accordance with the manufacturers' specified recommendations or written procedures developed by the operators.

7.8.2 Schedules

Manufacturers' procedures identify the schedule for servicing critical items in order to minimize the downtime of the measurement system. It will be the responsibility of the individual operator assigned to a specific instrument to adhere to the instrument maintenance schedule and to promptly arrange any necessary service. Servicing of the equipment, instruments, tools, gauges, and other items will be performed by qualified personnel.

The laboratory will establish logs to record maintenance and service procedures and schedules. All maintenance records will be documented and will be traceable to the specific equipment, instruments, tools, and gauges. Records produced for laboratory instruments will be reviewed, maintained, and filed by the operators at the laboratories.

7.8.3 Spare Parts

A list of critical spare parts will be requested from manufacturers and identified by the operator. These spare parts will be stored for availability and use in order to reduce downtime due to equipment failure and repair.

7.9 SUBCONTRACT LABORATORY SERVICES

The laboratory will assume responsibility for providing all analytical services specified in the laboratory agreement. Should it be agreed in writing that the laboratory may use an additional subcontract laboratory facility, the primary laboratory will supply to the contractor the SOPs, MDL studies, and QA plans for the other laboratories that are used. The laboratory will be responsible for communicating all analytical guidelines and QC requirements of the project to these laboratories. The QA officers from both the primary laboratory and the contractor will monitor the data from subcontract laboratories and correct any QC nonconformances.

SECTION 8

REFERENCES

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From: Hansen, Jerry E, Mr, HQAFCEE [Jerry.Hansen@HQAFCEE.brooks.af.mil]

Sent: Tuesday, August 08, 2000 10:16 AM

To: 'nwalton@dtic.mil'

Subject: Distribution statement for AFCEE/ERT reports

Norman, This is a followup to our phone call. The eight boxes of reports you received from us are all for unlimited distribution. If you have any questions, you can contact me at DSN 240-4353.

08/08/2000