

# FINAL

## Confirmation Sampling and Analysis Report for IRP Site SD-11



**Beale Air Force Base  
California**

Prepared for

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

and

**9 CES/CEV  
Beale Air Force Base,  
California**

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April 1999



**PARSONS  
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**FINAL**

**CONFIRMATION SAMPLING AND ANALYSIS REPORT FOR  
THE AGE MAINTENANCE AREA, IRP SITE SD-11**

**BEALE AIR FORCE BASE, CALIFORNIA**

**Prepared for:**

**Air Force Center for Environmental Excellence  
Brooks Air Force Base, Texas**

**and**

**9 CES/CEV  
Beale Air Force Base, California**

**April 1999**

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## LIST OF ABBREVIATIONS AND ACRONYMS

|            |                                                      |
|------------|------------------------------------------------------|
| µg/L       | Micrograms per liter                                 |
| 1,2-DCE    | 1,2-Dichloroethene                                   |
| 9 CES/CEV  | 9th Civil Engineering Squadron, Environmental Flight |
| AFB        | Air Force Base                                       |
| AFCEE      | Air Force Center for Environmental Excellence        |
| AGE        | Aircraft Ground Equipment                            |
| AST        | Aboveground storage tank                             |
| ASTM       | American Society for Testing and Materials           |
| bgs        | Below ground surface                                 |
| BTEX       | Benzene, toluene, ethylbenzene, and xylenes          |
| CAC        | California Administrative Code                       |
| Cal/EPA    | California Environmental Protection Agency           |
| DI-WET     | Deionized water waste extraction test                |
| DLM        | Designated Level Methodology                         |
| DOT        | Department of Transportation                         |
| EAF        | Environmental attenuation factor                     |
| ES         | Engineering-Science, Inc.                            |
| HVOC       | Halogenated volatile organic compound                |
| IRP        | Installation Restoration Program                     |
| LCC        | Laguna Construction Company, Inc.                    |
| MCLs       | Maximum contaminant levels                           |
| mg/kg      | Milligrams per kilogram                              |
| mg/L       | Milligrams per liter                                 |
| NFI        | No further investigation                             |
| OD         | Outside diameter                                     |
| OVA        | Organic vapor analysis                               |
| Parsons ES | Parsons Engineering Science, Inc.                    |
| PID        | Photoionization detector                             |
| ppmv       | parts per million, by volume                         |
| QA         | Quality assurance                                    |
| QC         | Quality control                                      |
| RBCLA      | Risk-Based Cleanup Level Assessment                  |
| RWQCB      | Regional Water Quality Control Board                 |
| SAI        | Specialized Assays, Inc.                             |
| SAP        | Sampling and Analysis Plan                           |
| SESOIL     | Seasonal Soil Compartment Model                      |
| SVE        | Soil vapor extraction                                |
| TCE        | Trichloroethene                                      |
| TOC        | Total organic carbon                                 |
| TPH        | Total petroleum hydrocarbons                         |
| TPH-d      | Total petroleum hydrocarbons as diesel               |
| TPH-g      | Total petroleum hydrocarbons as gasoline             |
| TVH        | Total volatile hydrocarbons                          |

|       |                                     |
|-------|-------------------------------------|
| TVHA  | Total volatile hydrocarbon analyzer |
| USEPA | US Environmental Protection Agency  |
| UST   | Underground storage tank            |
| VMP   | Vapor monitoring point              |
| VOC   | Volatile organic compound           |
| VW    | Vent well                           |
| WQG   | Water Quality Goal                  |

## SECTION 1

### INTRODUCTION

#### 1.1 PURPOSE

This confirmation sampling and analysis report for Installation Restoration Program (IRP) Site SD-11, Aircraft Ground Equipment (AGE) Maintenance Area at Beale Air Force Base (AFB), California has been prepared by Parsons Engineering Science, Inc. (Parsons ES; formerly Engineering-Science, Inc. [ES]) for submittal to the California Regional Water Quality Control Board (RWQCB), Central Valley Region; the US Air Force Center for Environmental Excellence (AFCEE), Brooks AFB, Texas; and the 9th Civil Engineering Squadron, Environmental Flight (9 CES/CEV) Beale AFB, California. This report has been prepared as part of the AFCEE Extended Bioventing Project (Contract F41624-92-8036, Delivery Order 17). The purposes of this report are to provide the results of the confirmation soil and soil vapor sampling performed at the site in January 1999, and to evaluate the effectiveness of implemented soil remediation at the site.

#### 1.2 SITE AND PROJECT BACKGROUND

##### 1.2.1 Site Description and Background

The AGE Maintenance Area is located in the northwestern portion of Beale AFB (Figure 1.1), and is bounded by Arnold Avenue to the west and Curtis Street to the south (Figure 1.2). Site SD-11 consists of those facilities in the AGE Maintenance Area, including Building 1225, three existing aboveground storage tanks (ASTs), two active oil/water separators, a small pump island, a backfilled underground storage tank (UST) excavation, paved vehicle parking areas, landscaped areas, and unlined drainage channels (Figure 1.2). Building 1086 which is located approximately 400 feet south of the AGE Maintenance Area also has been incorporated into Site SD-11 (Laguna Construction Company, Inc. [LCC], 1998); however, this area is not addressed by this results report.

Based on the Risk-Based Cleanup Level Assessment (RBCLA) of Petroleum Contaminated Soils (Metcalf & Eddy, Inc., 1996), Site SD-11 is located in Geographic Zone C/5 of the 16 separate geographic zones identified for Beale AFB (Figure 1.1). Soils in this geographic zone are generally characterized as being composed of silty sand from 0 to 5 feet below ground surface (bgs), sandy gravel from 5 to 10 feet bgs, and sand from 10 to 80 feet bgs (it should be noted that the RBCLA lithologic assignments were conservative in that, for a given depth interval, the observed most permeable soil type was assigned to the interval). The shallowest expected depth to groundwater in Zone C/5 is 80 feet bgs.

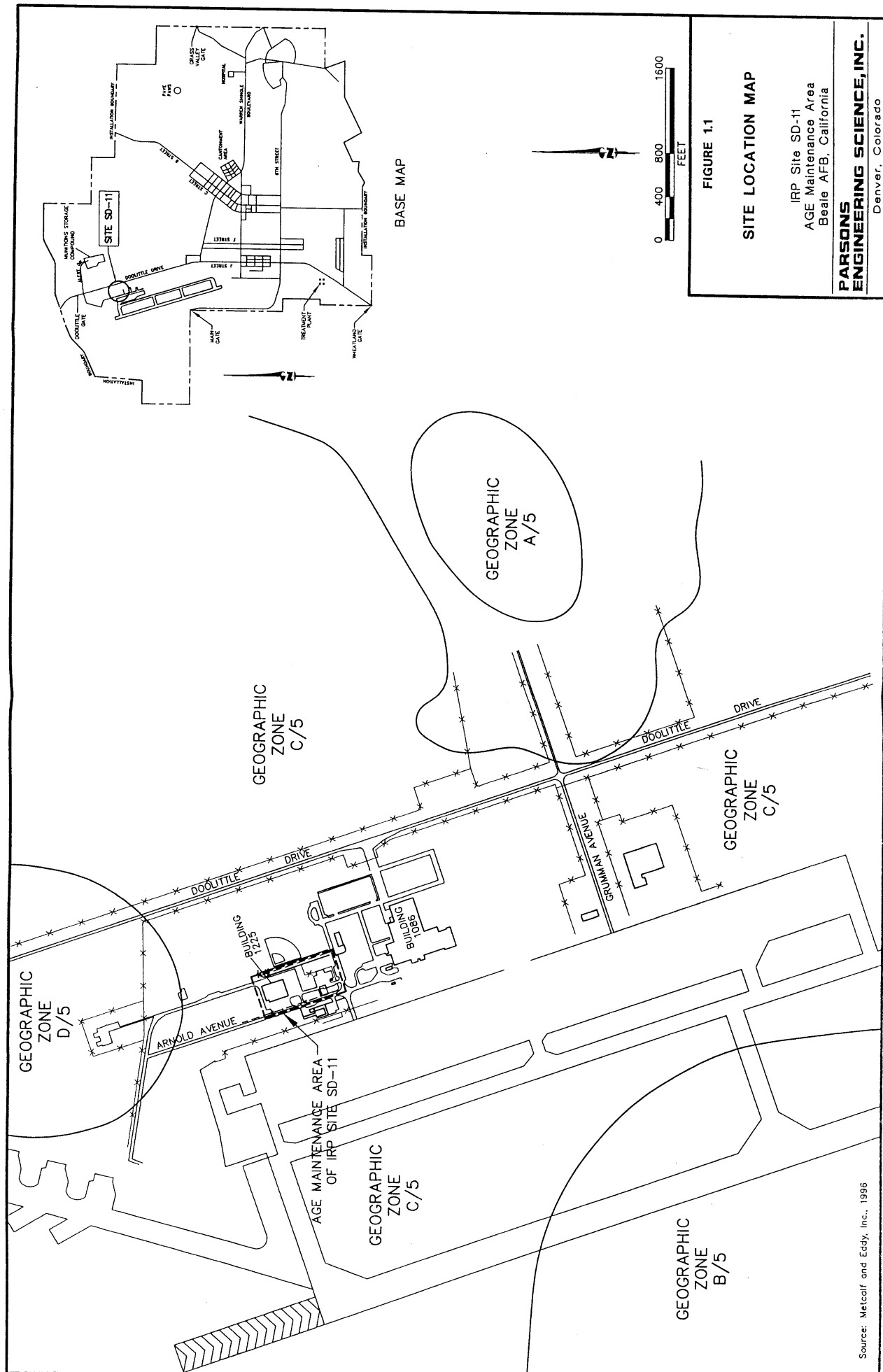


**FIGURE 1.1**  
**SITE LOCATION MAP**

IRP Site SD-11  
AGE Maintenance Area  
Beale AFB, California

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IRP Site SD-11  
AGE Maintenance A  
Beale AFB, Califor

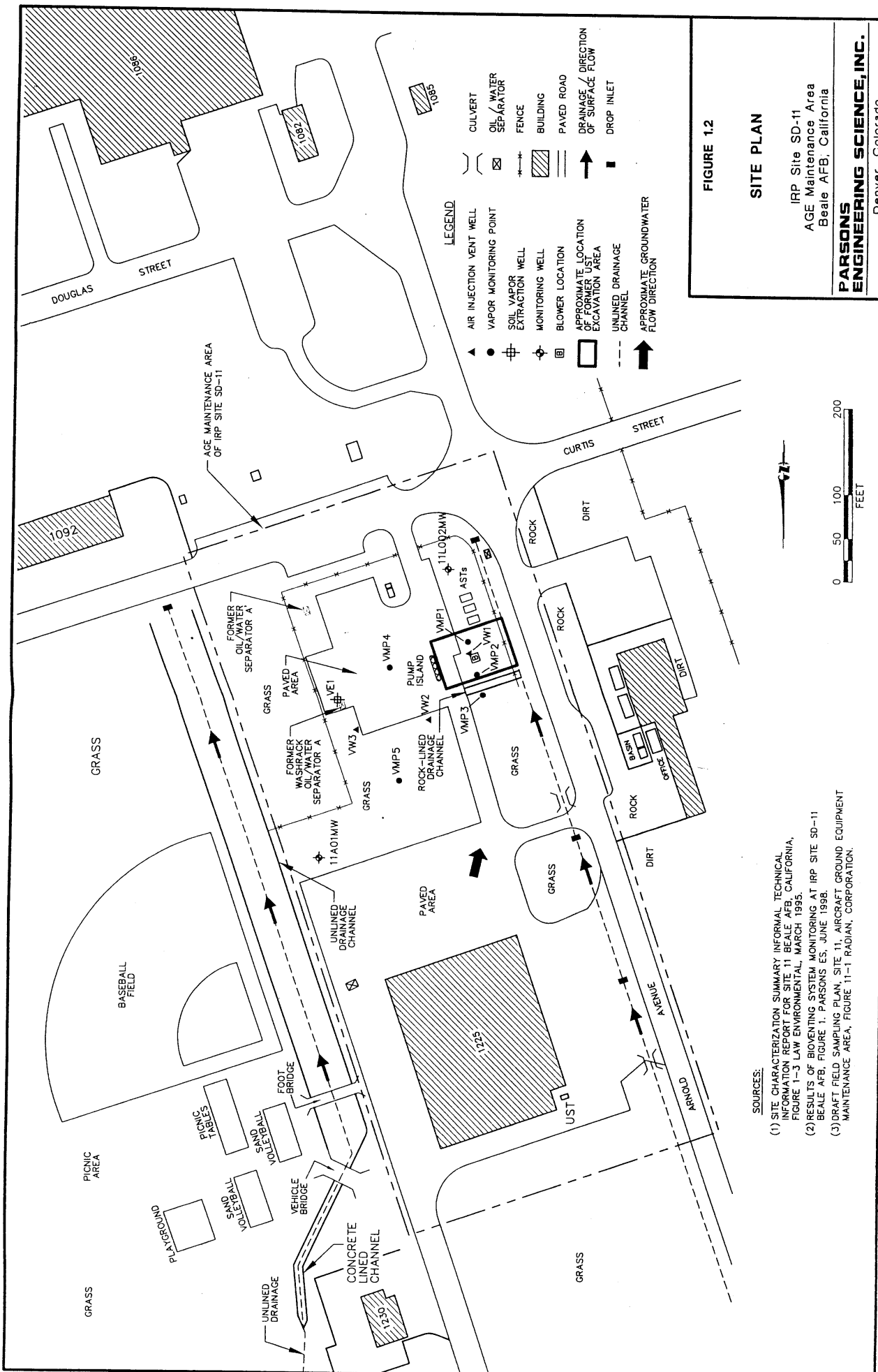
AGE Maintenance Area  
Beale AFB, California

AGE Maintenance Area  
Beale AFB, California

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These general characteristics for Zone C/5 generally agree with site-specific observations for the AGE Maintenance Area at Site SD-11. Soil sampling in the vicinity of the UST excavation has shown that soils consist of layers of gravelly sand, silts, and clays (ES, 1993b). The backfill materials for the former excavation are composed of silty clay with common gravel-sized fragments up to 2 inches in diameter. The base of this backfill material was found at depths between 15 and 20 bgs. Groundwater at the site is present at approximately 85 feet bgs (Radian Corporation, 1998). The first groundwater flow zone is generally unconfined and is expected to flow in a south-southwesterly direction (LCC, 1998).

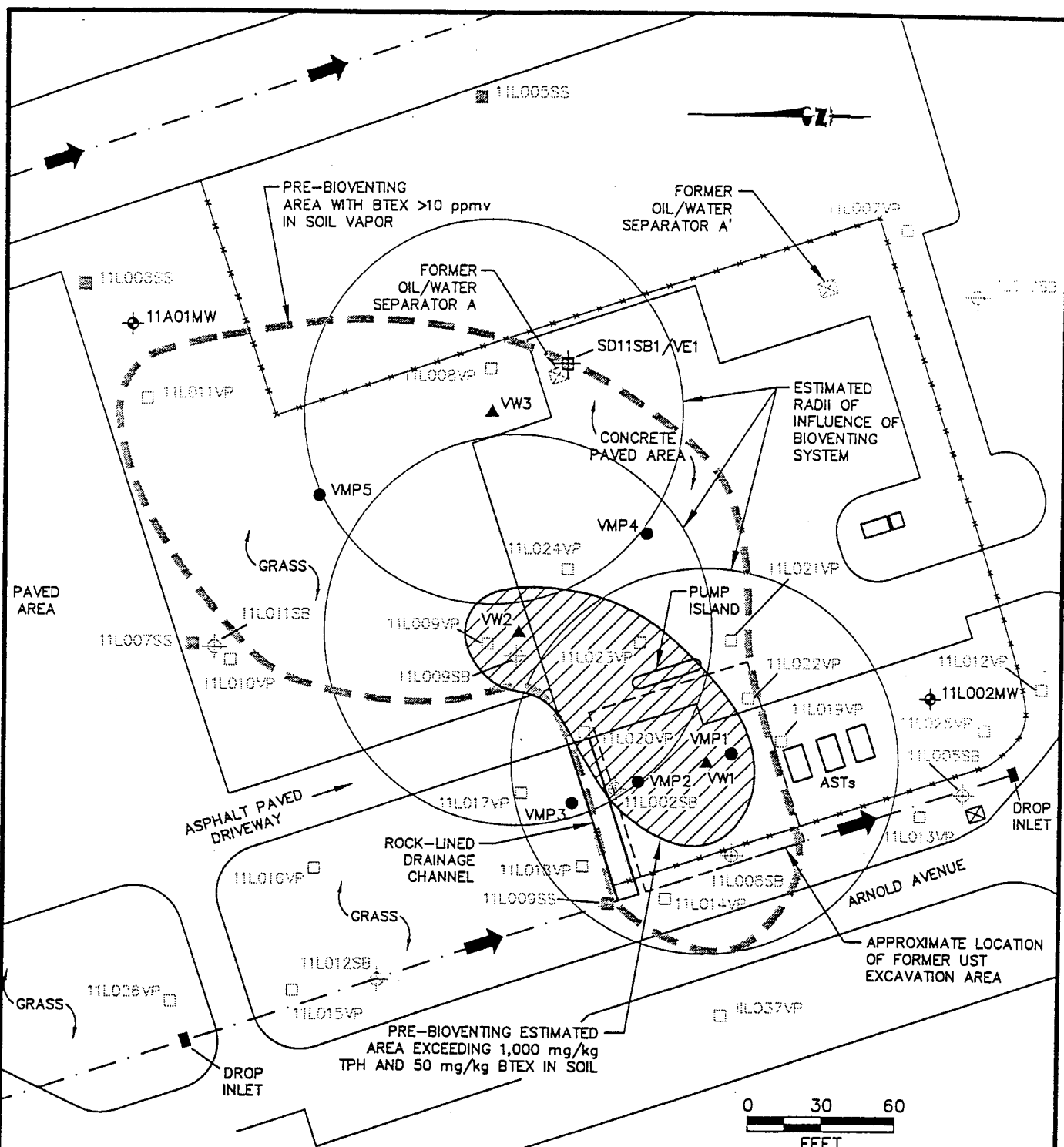
Current and former facilities at Site SD-11 have been used to support AGE maintenance activities for more than 30 years. These activities have included storage of gasoline, diesel, and JP-4 jet fuel in three former USTs connected to a fuel pump island. Identification numbers for the three former USTs are 1225.01, 1225.02, and 1225.03, but it is not known which individual tank contained the above-mentioned fuel products. Vehicle cleaning operations were historically performed at a washrack located near two former oil/water separators on the east side of the AGE Maintenance Area (individually referred to as Oil/Water Separator A and Oil/Water Separator A') (Figure 1.2). In addition, aircraft ground support vehicles have been stored and operated in the paved area south of Building 1225. The former USTs, former oil/water separators, and historic fueling, maintenance, and storage of support vehicles in this area are all identified as potential sources of subsurface contamination in the AGE Maintenance Area at Site SD-11.

During previous site investigations, petroleum hydrocarbon and halogenated volatile organic compound (HVOC) contamination have been identified in site soil, soil vapor, and groundwater. Petroleum hydrocarbon contamination at the site, including benzene, toluene, ethylbenzene, xylenes (BTEX), and total petroleum hydrocarbons (TPH), is primarily the result of fuel releases from the former USTs. Releases of petroleum products during vehicle fueling, maintenance, and storage operations also represent potential sources of subsurface petroleum contamination. Figure 1.3 shows the estimated extent of soil and soil vapor impacted by petroleum hydrocarbons prior to the start of bioventing remediation activities in 1993. The presence of HVOC contamination at the site has been attributed to releases from the former oil/water separators (Gaudette, 1998; LCC, 1998). More complete summaries of previous site investigations are included in the sampling and analysis plan (SAP) (Appendix A).

## **1.2.2 Project Background**

### **1.2.2.1 Bioventing Pilot Test Activities**

In 1992, Site SD-11 was selected as a pilot test site for the AFCEE Bioventing Initiative program. In addition to Site SD-11, bioventing pilot tests and evaluations were also conducted at Sites 3 and 18 at Beale AFB (ES, 1993a, 1993b; AFCEE 1994, 1995). This program included conducting approximately 145 bioventing pilot tests at 56 Air Force installations throughout the country. These tests were designed to collect data on the effectiveness of bioventing for the remediation of soil contaminated with fuel hydrocarbons (e.g., JP-4 jet fuel, diesel fuel, gasoline, or heating oil). A pilot-scale remediation system consisting of one air injection vent well (VW1), three multi-depth soil vapor monitoring points (VMP1, VMP2, and VMP3), a regenerative blower and



# LEGEND

- 11A01MW MONITORING WELL
- VW1 AIR INJECTION VENT WELL (ES, 1993b; PARSONS ES, 1996b)
- VMP1 VAPOR MONITORING POINT (ES, 1993b; PARSONS ES, 1996b)
- SD11SB1/VE1 SOIL BORING COMPLETED AS VAPOR EXTRACTION WELL (LCC, 1998)
- 11L007VP SOIL VAPOR SAMPLE (LAW, 1995)
- 11L002SB SOIL BORING (LAW, 1995)
- 11L009SS SHALLOW SOIL SAMPLE (LAW, 1995)
- UNLINED DRAINAGE CHANNEL/  
DIRECTION OF SURFACE FLOW
- FENCE

FIGURE 1.3

## ESTIMATED EXTENT OF SOIL AND SOIL VAPOR CONTAMINATION PRIOR TO BIOVENTING

IRP Site SD-11  
AGE Maintenance Area  
Beale AFB, California

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housing, air supply piping, and electrical service was installed in the former UST excavation area in April 1993 (Figure 1.2). An initial air-injection bioventing pilot test including soil and soil vapor sampling, in situ respiration testing, and air permeability and oxygen influence testing was performed at the site in April and May 1993.

Following initial testing, the pilot-scale bioventing system was operated continuously from May 1993 to May 1994 before being shut down for 1-year testing. The 1-year testing event was performed in June 1994, following 1 month of system shut down to allow soils to return to equilibrium conditions, and included 1-year soil and soil vapor sampling. Results of the 1-year bioventing pilot test demonstrated that bioventing was an effective technology for remediation of petroleum-contaminated soils present within the unsaturated zone at the AGE Maintenance Area. Total volatile hydrocarbon (TVH) and BTEX concentrations in soil vapor were reduced by as much as 4 orders of magnitude (Appendix A, Table 2.2). While similar reductions were not observed in three confirmatory soil samples collected in July 1994 (Appendix A, Table 2.1), this was likely due to a heterogeneous distribution of contamination and the inherent variability of limited soil sampling (Parsons ES, 1995). Beale AFB personnel continued to operate the pilot-scale bioventing system following the 1-year pilot test.

#### **1.2.2.2 Extended Bioventing Activities**

Based on the favorable pilot testing results, IRP Site SD-11 was included in the AFCEE Extended Bioventing Project (Contract F41624-92-8036, Delivery Order 17) for system expansion (Option 4) and 1 year of system operation and monitoring followed by soil vapor sampling and in situ respiration testing (Option 1). In anticipation of favorable expanded bioventing system Option 1 results, the AFCEE Extended Bioventing Project also provided funding for confirmatory soil sampling and site closure (Option 2), if appropriate. The expanded bioventing system was installed by Parsons ES between May 28 and July 8, 1996 (Parsons ES, 1995; 1996a; 1996b). The expanded system included two additional air injection VWs (VW2 and VW3), two additional VMPs (VMP4 and VMP5), an upgraded 3-horsepower blower system and housing, and associated piping, controls, and electrical service (Figure 1.2). The expanded bioventing system operation began in July 1996.

In April 1998, soil vapor sampling and respiration testing were performed following approximately 21 months of expanded bioventing system operation. Results indicated the following (Parsons ES, 1998a):

- BTEX concentrations in vadose zone soils had been significantly reduced (Appendix A, Table 2.2);
- Slightly elevated concentrations of BTEX were observed only in the soil vapor sample from VMP3-24 (most notably xylenes at 14 parts per million, volume per volume [ppmv]) (Appendix A, Table 2.2);
- Elevated average concentrations of hexane (265 ppmv), cyclohexane (470 ppmv), heptane (70.5 ppmv), trichloroethene (TCE) (10.5 ppmv), 1,2-dichloroethene (1,2-DCE) (75 ppmv), and vinyl chloride (5 ppmv) were detected at VMP4-10

(Appendix A, Table 2.5), but appeared to be the result of excessive air injection flowrates attributable to improper blower system adjustments by another contractor;

- Respiration and fuel biodegradation rates were approximately half those initially observed and essentially "flat" (Appendix A, Table 2.6);
- Concentrations of static oxygen in soils measured near atmospheric levels (20.9 percent) at most locations, and static oxygen concentrations were greater than 5 percent at all but one location, VMP4-10 (3.7 percent) (Appendix A, Table 2.2);

Based on these findings, the residual hydrocarbon contamination remaining in site soils appeared to be composed of less mobile, more biologically recalcitrant, higher molecular weight hydrocarbons. In addition, equilibrium oxygen concentrations exceeding 5 percent indicated that microbial oxygen demand was being met through natural air diffusion and continued air injection was no longer essential. Considering these results, AFCEE and 9 CES/CEV agreed that confirmation sampling was appropriate in the area previously shown to have extensive soil contamination (Figure 1.3) in order to demonstrate that petroleum hydrocarbons contaminants in soil no longer pose a significant risk to groundwater.

Following the Option 1 testing event, LCC (1998) and Metcalf and Eddy, Inc. reconfigured the expanded-scale blower system for soil vapor extraction (SVE) treatment of the HVOCs in site soils. Air extraction began in May 1998 at the vapor extraction well (VE1) installed at the former location of Oil/Water Separator A. At the time of this conversion to SVE, soils in the vicinity of the original pilot-scale bioventing system had benefited from approximately 3 years of air injection bioventing, and soils influenced by the expanded-scale bioventing system had received approximately 1 year and 9 months of bioventing treatment.

This report presents the results of the confirmation sampling performed by Parsons ES in January 1999 at the AGE Maintenance Area of IRP Site SD-11. In preparation for the confirmation sampling event, a site-specific SAP was prepared by Parsons ES (1998b). A copy of the SAP is provided as Appendix A. Following California RWQCB, AFCEE, and Beale AFB approval of the SAP, confirmation soil and soil vapor sampling was conducted at the AGE Maintenance Area between 6 and 12 January 1999. Confirmation soil sampling activities consisted of advancing 4 soil borings to total depths between approximately 33 and 85 feet bgs, and analyzing selected soil samples for total petroleum hydrocarbons as diesel (TPH-d), total petroleum hydrocarbons as gasoline (TPH-g), BTEX, total organic carbon (TOC), and moisture content. A total of 17 soil samples from the 4 borings were submitted for laboratory analysis. In addition, soil vapor samples were collected from the three screened intervals at VMP3 because elevated xylenes concentrations were detected at the 24 feet bgs interval of VMP3 (VMP3-24) during the April 1998 sampling event. Soil vapor samples were field-screened and submitted for laboratory analysis of TVH and BTEX.

### 1.3 SUMMARY OF CONFIRMATION SAMPLING RESULTS

Based on the January 1999 confirmation sampling results, the petroleum hydrocarbon contamination remaining in site soils is present between 11 and 25 feet bgs and does not appear to threaten site groundwater at approximately 85 feet bgs. Sample results also

indicate that BTEX concentrations in soils have been reduced by as much as 3 orders of magnitude as a result of air injection bioventing treatment. The maximum detected concentration of TPH-d (3,290 milligrams per kilogram [mg/kg]) was detected in soils 24 feet bgs near VMP2. The maximum detected concentration of TPH-g (3,020 mg/kg) and soluble TPH-d (2.45J milligrams per liter [mg/L]) were detected in soils approximately 14 feet bgs in the western portion of the former UST excavation. Maximum BTEX concentrations (4.55, 26.7, 11.9, and 67.6 mg/kg, respectively) were detected in soils 16 feet bgs near VW2. BTEX and TPH-g were not detected in any of the seven soil samples collected deeper than 27 feet bgs, and TPH-d were not detected above laboratory reporting limits. Soil vapor sampling results at VMP3 indicate that some BTEX contamination is still present in soils near 24 feet bgs; however, little BTEX contamination is present in deeper soils at 30 and 40 feet bgs. In addition, equilibrium concentrations of oxygen at the deeper screened intervals were found to be sufficient for supporting aerobic biodegradation of fuel contaminants without supplemental air injection.

Site-specific vadose zone modeling was performed because soil soluble TPH-d levels in soils between 11 and 25 feet bgs exceeded the 1 mg/L screening criterion proposed in the SAP (Appendix A). Modeling for BTEX migration also was performed because concentrations of benzene, ethylbenzene, and total xylenes in soil vapor at VMP3-24 exceeded the proposed soil vapor screening criteria (Appendix A). Results of the modeling indicate that concentrations of TPH-d and the BTEX components in soil moisture will not exceed their respective Water Quality Goals (WQGs) at groundwater depth within the 50-year period of the model runs.

Comments received from the California Regional Water Quality Control Board (RWQCB) on the draft version of this report indicate that the California RWQCB will not permit closure of Site SD-11 for petroleum hydrocarbons at this time (California RWQCB, 1999). A copy of these comments is provided in Appendix B. Reasons for this decision include soluble TPH-d concentrations in five of six soil samples, and concentrations of benzene, ethylbenzene, and total xylenes in soil vapor at VMP3-24 exceeding their respective screening criteria as proposed in the SAP (Appendix A). Based on California RWQCB's decision not to permit closure of the site at this time, continued treatment to further reduce petroleum hydrocarbon contaminants in subsurface soil is recommended for Site SD-11. Treatment could readily be implemented by manifolding the existing vent wells (VW1, VW2, and VW3) utilized during expanded-scale bioventing treatment into the SVE system currently being operated and maintained at the site. Annual monitoring (e.g., soil gas sampling and in situ respiration testing) would be used to determine the appropriate time for further confirmation sampling.

#### 1.4 REPORT ORGANIZATION

This confirmation sampling and analysis report for the AGE Maintenance Area of IRP Site SD-11 consists of five sections, including this introduction, and six appendices. Section 2 includes a description of the confirmation soil sampling and analysis activities conducted at the site. Section 3 summarizes confirmation sampling analytical results, compares results to the no further investigation (NFI) criteria established in the SAP, and presents results from site-specific modeling. Section 4 presents conclusions and recommendations, and Section 5 lists the references that were used in preparation of this report.

Appendix A presents a copy of the SAP for the AGE Maintenance Area, which includes a detailed site description and summary of previous site investigations. Appendix B provides a copy of the California RWQCB comments on the draft confirmation sampling and analysis report. Appendix C provides copies of soil boring logs from the January 1999 soil sampling event. Appendix D presents the Parsons ES data quality assessment report. Appendix E presents laboratory analytical data for site environmental and quality assurance/quality control (QA/QC) samples, and chain-of-custody forms. Appendix F provides the input and output files for the modeling analysis.

## SECTION 2

### CONFIRMATION SAMPLING AND ANALYSIS ACTIVITIES

This section summarizes confirmation soil and soil vapor sampling activities, including sampling locations and depths, sampling procedures, analytical methods, and QA/QC procedures followed. These procedures are described in more detail in the confirmation SAP (see Appendix A). The SAP was implemented by qualified Parsons ES scientists trained in conducting soil sampling, records documentation, and chain-of-custody procedures. Soil sample analyses were performed by Specialized Assays Inc. (SAI) of Nashville, Tennessee. Soil vapor analyses were performed by Air Toxics, Ltd., of Folsom, California.

#### 2.1 CONFIRMATION SOIL SAMPLING

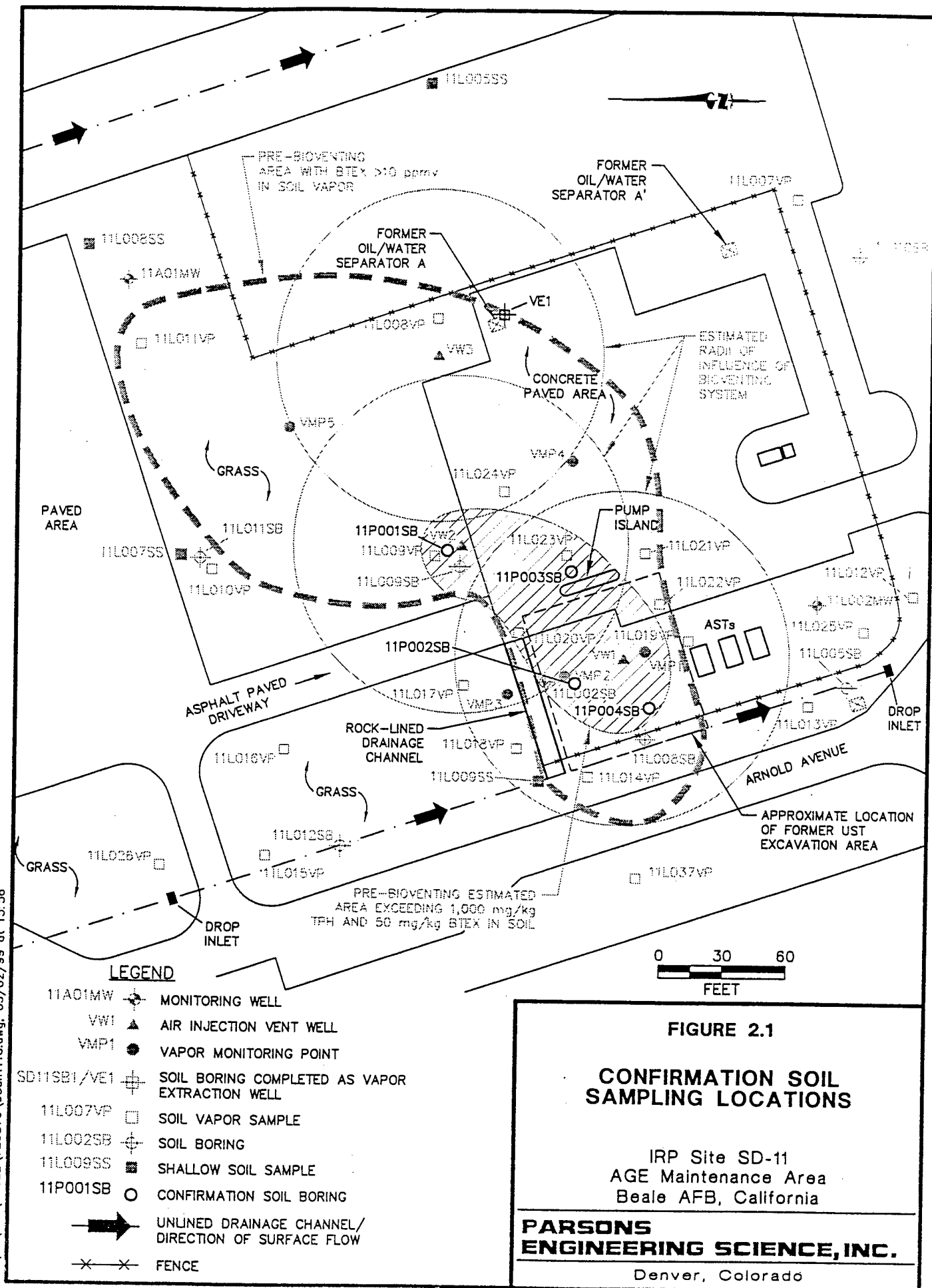
##### 2.1.1 Boring Locations and Sampling Depths

Confirmatory soil sampling was conducted at the site between 6 and 12 January 1999. Four soil borings (11P001SB, 11P002SB, 11P003SB, and 11P004SB) were advanced and sampled in the vicinity of the former USTs, pump island, and area north of the concrete paved area near VW2 (Figure 2.1). Soil borings 11P001SB and 11P002SB were advanced in areas where soil concentrations of TPH greater than 2,000 mg/kg were detected during prior investigations (Appendix A, Tables 2.1 and 2.4). Soil boring 11P001SB was advanced adjacent to VW2 and boring 11P002SB was advanced adjacent to VMP2 and former soil boring 11L002SB to compare results with prior sampling results. Soil boring 11P003SB was advanced adjacent to the fuel pump island immediately east of the UST excavation, an area where elevated TPH concentrations (37,700 ppmv) were detected in soil vapor (Appendix A, Table 2.3), but no previous soil samples had been collected. Soil boring 11P004SB was advanced in the western portion of the UST excavation area.

Soil borings were advanced using a drill rig equipped with 8-inch outside-diameter (OD) hollow-stem augers. In order to best select soil intervals for sampling, continuous coring of the borings was generally performed starting at 10 feet bgs. For soil borings 11P001SB, 11P003SB, and 11P004SB, continuous coring was conducted between 10 feet bgs and the total boring depths of 37, 35, and 33.5 feet bgs, respectively. For soil boring 11P002SB, continuous coring was performed between 10 and 54 feet bgs. Intermittent coring was then performed at 5 foot intervals starting at 60.5 feet bgs and continuing to groundwater, which was encountered at approximately 85 feet bgs.

The total depth of each soil boring was determined based on multiple field observations that indicated the vertical extent of contamination was adequately delineated. Soil boring 11P002SB was advanced to groundwater because the vertical

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extent of contamination based on field measurements and observations was not completely delineated at more shallow depths and contamination in that area of the site has been highest during prior investigations. Samples for geologic logging, field screening, and possible chemical analysis were collected from 10 feet bgs to the total depth of each boring. To provide complete documentation of the sampling event, detailed boring logs were generated by the Parsons ES field geologist. Boring logs from the confirmation sampling event are provided in Appendix C of this report.

### 2.1.2 Soil Sampling Procedures

Undisturbed soil samples, suitable for chemical analysis, were collected from soil borings using a standard split-barrel sampler fitted with three pre-cleaned, 6-inch long, thin-walled, brass sleeves. For each sampling interval, the soil sampler was lowered through the hollow stem of the augers and driven approximately 1.5 feet into undisturbed soil, ahead of the augers. After sample collection, the soil sampler was retrieved, split apart, and the brass sleeves were removed. A portion of soil from each split spoon was examined for physical evidence of hydrocarbon contamination (e.g., odors and staining) and evaluated by soil headspace measurements using a total volatile hydrocarbon analyzer (TVHA) and a photoionization detector (PID). Soil types were described in accordance with the standard Parsons ES soil description format and the Unified Soil Classification System. At each sampling interval, the brass sleeves that were not used for field evaluation were immediately capped with Teflon® tape and plastic endcaps in preparation for possible laboratory submittal.

A total of 17 soil samples, including a minimum of 3 samples per soil boring, were submitted for laboratory analysis. At soil borings 11P001SB, 11P003SB, and 11P004SB, soil samples collected at total depth (37, 35, and 33.5 feet bgs, respectively) were selected for laboratory analysis to verify field results indicating that the vertical extent of contamination had been adequately delineated. Samples were also collected at 11P002SB at 11-11.5 feet bgs and at 11P002SB at 24.5 to 25 feet bgs to determine point-specific contaminant reductions. At soil boring 11P002SB, elevated headspace measurements were measured below 40 feet bgs with the maximum concentrations measured at lithologic interfaces. Headspace measurements generally decreased with depth and were near zero within 5 feet of groundwater. Soil samples from 66 feet bgs and 80 feet bgs were submitted for laboratory analysis.

At all four borings, at least one soil sample for laboratory analysis was selected from the most contaminated sample intervals based on field observations and measurements or based on locations where elevated petroleum hydrocarbon concentrations had been previously observed. In accordance with the SAP, at least two soil samples were collected and submitted for laboratory analysis once the vertical extent of contamination based on headspace was determined. These samples were used to confirm that vertical extent was defined and evaluate if a sufficient "buffer" of clean soil between contaminated soil and groundwater was present at the site.

At boring 11P003SB, poor sample recovery between 10 and 26 feet bgs prevented laboratory submission of samples from this interval. As indicated by soil headspace measurements (Appendix C), the most contaminated intervals in each boring occurred in soils less than 22 feet bgs. Headspace measurements suggested that the most

contaminated soils were present in soil boring 11P001SB at 16 feet bgs (2,223 ppmv of ionizable compounds and 6,000 ppmv of TVH) and soil boring 11P003SB at 11 feet bgs (2,062 ppmv of ionizable compounds and 7,500 ppmv of TVH) (Appendix C).

Soil samples selected for laboratory analysis were labeled with the site name and borehole number, sample depth, and date of collection. Sample containers were placed in an insulated shipping container packed with ice. Samples for laboratory analysis were shipped under standard chain-of-custody procedures to SAI.

### **2.1.3 Equipment Decontamination**

All sampling and downhole equipment were decontaminated in accordance with procedures outlined in the SAP (Appendix A). All decontamination fluids and drill cuttings were containerized on site in labeled US Department of Transportation (DOT)-approved 55-gallon drums. Containerized wastes were transported to the holding area for the contaminated soil treatment cell at the corner of 9th and J Streets. Soil borings were abandoned with a bentonite/cement grout mixture. At the surface, soil boring 11P003SB abandonment involved concrete patch completion to match the existing pavement.

### **2.1.4 Soil Analyses**

All soil samples were analyzed by SAI, a State of California-certified laboratory. Soil samples were analyzed by USEPA Method SW8015-modified for TPH-d and TPH-g, by USEPA Method SW8021B for BTEX, and by American Society for Testing and Materials (ASTM) D-2216 for soil moisture. Soil samples determined by the laboratory to contain total TPH-d above the laboratory reporting limit also were analyzed for soluble TPH-d using the waste extraction test (WET) preparation method described in California Administrative Code (CAC) Title 22, Article 11, Section 66700 (C through F) except that the extraction solution for the test was deionized water (DI-WET). In addition, three soil samples were analyzed for total organic carbon (TOC) content by USEPA Method SW9060.

## **2.2 CONFIRMATION SOIL VAPOR SAMPLING**

Due to the high xylenes concentration (14 ppmv) detected in soil vapor at VMP3-24 during the April 1998 Option 1 sampling event, confirmation soil vapor sampling was performed at VMP3. Following 1 month of air extraction shut down at VW1 and VW2, soil vapor samples for field screening and laboratory analysis were collected from VMP3-24, VMP3-30, and VMP3-40. Soil vapor samples for laboratory analysis were submitted in 1-liter Summa™ canisters to Air Toxics, Ltd. in Folsom, California for analysis of TVH and BTEX by USEPA Method TO-3 referenced to jet fuel.

## **2.3 FIELD AND LABORATORY DATA QUALITY ASSURANCE/QUALITY CONTROL**

Laboratory and field QA/QC procedures established for the site were followed to ensure that the analytical data generated during the January 1999 confirmation sampling event would be technically sound, statistically valid, and properly documented. QA/QC requirements are detailed in the SAP (Appendix A). Parsons ES also preformed a Level III validation of Site SD-11 analytical data. Results of this assessment indicate that no

data should be rejected based on validation, and that all data are useable for the purposes intended. A copy of the data quality assessment report has been provided as Appendix D.

### **2.3.1 Laboratory QA/QC Procedures and Results**

Generated analytical data were evaluated by the test laboratory in accordance with internal laboratory QC program, which certifies that the data generated are of reliable quality. Analytical data quality was measured through a system of analyzing blanks, spike samples, and standards and statistically evaluating the results. With respect to the data generated during confirmation sampling, all laboratory QC parameters were within required acceptance limits.

To ensure product quality, Parsons ES also provided an assessment of the generated data in accordance with their own internal procedures. Elements of this assessment included, but were not limited to, the following: sample holding times, analytical methods used, reporting limits, dilution factors, and consistency between hardcopy and electronic analytical data deliverables. The following observations were made during this assessment.

1. All six (6) soil samples submitted for soluble TPH-d analysis (California DI-WET) were not analyzed within the 14 day, method-prescribed holding time due to laboratory error. Results from this analysis were qualified as estimated.
2. Low matrix spike recoveries were associated with one (1) soil sample submitted for both soluble TPH-d and BTEX analyses. Results from the associated analyses for this sample were qualified as estimated.

Since project objectives do not exclude the use of estimated concentrations, the analytical data generated during the confirmation sampling event is useable for its intended purpose (i.e., assessing the degree of remediation attained as a result of bioventing treatment).

### **2.3.2 Field QA/QC Procedures and Results**

To assess the variability due to the sample collection process or inherent in the media sample, two replicate soil samples were collected in the field during confirmation sampling. These samples were identified as 11P005SB (replicate of 11P001SB) and 11P006SB (replicate of 11P004SB). Each replicate sample was collected at the same time and location as its associated primary counterpart, and submitted to the same laboratory for identical analysis. Limited sample volume, however, precluded collection of soil aliquots from the same depth interval at each location for both the primary and replicate samples. Relative percent difference (RPD) values were calculated to evaluate how closely the analytical results between the replicate and primary sample agree. Calculated RPDs for all detected compounds were high. This is likely due to the non-homogeneous nature of the soil matrix, and the fact that the sampling technique involved collecting replicate samples from adjacent sample depth intervals. It should be noted that there are no established QA/QC limits for RPD values for replicate samples, and the high RPDs are likely the result of heterogeneity of the sample matrix.

## SECTION 3

### CONFIRMATION SAMPLING RESULTS

This section summarizes the analytical results from the confirmation sampling event performed in January 1999. Soil boring logs from the confirmation sampling event are included in Appendix C, and complete soil and soil vapor analytical results are presented in Appendix E. The analytical results are compared to pre-bioventing contaminant concentrations and evaluated in accordance with target cleanup levels proposed in the SAP (Appendix A). In addition, sampling results are utilized in a contaminant modeling analysis performed specifically for vadose zone soils at the AGE Maintenance Area.

#### 3.1 SOIL ANALYTICAL RESULTS

Confirmation soil sampling analytical results are presented in Table 3.1. Total TPH-d was detected above laboratory reporting limits in six samples at concentrations ranging from 11.9 mg/kg (11P001SB at 16 to 16.5 feet bgs) to 3,290 mg/kg (11P002SB at 24 to 24.5 feet bgs). TPH-d was not detected above the laboratory reporting limit in soils deeper than 25 feet bgs. However, the laboratory did report very low concentrations of TPH-d between the instrument detection limit and the reporting limit. These results have been flagged ("J") as estimated concentrations.

Total TPH-g were detected in eight samples at concentrations ranging from 3.95 mg/kg (11P003SB at 26.5 to 27 feet bgs) to 3,020 mg/kg (11P004SB at 13.5 to 14.5 feet bgs). TPH-g was not detected in soils deeper than 27 feet bgs.

Soluble TPH-d analysis was performed on six samples with total TPH-d above the reporting limit (samples collected at 11 to 11.5 feet bgs, 15 to 15.5 feet bgs, and 16 to 16.5 feet bgs at 11P001SB, 24 to 24.5 feet bgs and 24.5 to 25 feet bgs at 11P002SB, and 13.5 to 14.5 feet bgs at 11P004SB). Soluble TPH-d results ranged from 0.95J to 2.45J mg/L.

TPH contamination in the AGE Maintenance Area appears to be restricted to soils less than 27 feet bgs. Other than soils in the vicinity of 11P002SB, the greatest mass of TPH contamination appears in soils between 13 and 17 feet bgs.

Similar to the TPH results, no BTEX contamination was evident in soils deeper than 27 feet bgs and the greatest BTEX contamination was evident in soils between 13 and 17 feet bgs. Maximum concentrations of benzene (4.55 mg/kg), toluene (26.7 mg/kg), ethylbenzene (11.9 mg/kg), and xylenes (67.6 mg/kg) were detected in the 16- to 16.5-foot sample interval at 11P001SB. In soils between 17 and 27 feet bgs, maximum total BTEX concentrations measured less than 0.31 mg/kg.

**TABLE 3.1**  
**JANUARY 1999 SOIL ANALYTICAL RESULTS FOR TPH AND BTEX**  
**IRP SITE SD-11, AGE MAINTENANCE AREA**  
**BEALE AFB, CALIFORNIA**

| Soil Boring            | SBD <sup>a/</sup><br>(feet bgs) <sup>c/</sup> | SED <sup>b/</sup><br>(feet bgs) | Total TPH                      |                      | California DI-WET<br>Soluble TPH-d<br>(mg/L) <sup>e/</sup> | SW8021B            |                    |                              |                             | SW9060<br>Total Organic<br>Carbon<br>(mg/kg) |
|------------------------|-----------------------------------------------|---------------------------------|--------------------------------|----------------------|------------------------------------------------------------|--------------------|--------------------|------------------------------|-----------------------------|----------------------------------------------|
|                        |                                               |                                 | TPH-d<br>(mg/kg) <sup>d/</sup> | TPH-g<br>(mg/kg)     |                                                            | Benzene<br>(mg/kg) | Toluene<br>(mg/kg) | Ethyl-<br>benzene<br>(mg/kg) | Total<br>Xylenes<br>(mg/kg) |                                              |
| 11P001SB               | 11                                            | 11.5                            | 106                            | 151                  | 1.88J <sup>f/</sup>                                        | 0.0556             | 1.11               | 0.778                        | 3.33                        | ---                                          |
| 11P001SB <sup>g/</sup> | 15                                            | 15.5                            | 27.8                           | 322                  | 1.35J                                                      | 0.309              | 3.95               | 1.91                         | 12                          | ---                                          |
| 11P001SB               | 16                                            | 16.5                            | 11.9                           | 1,570                | 1.92J                                                      | 4.55               | 26.7               | 11.9                         | 67.6                        | ---                                          |
| 11P001SB               | 29                                            | 29.5                            | 1.58 J <sup>h/</sup>           | < 1.04 <sup>h/</sup> | ---                                                        | < 0.001            | < 0.0021           | < 0.0021                     | < 0.0021                    | ---                                          |
| 11P001SB               | 36                                            | 36.5                            | ---                            | ---                  | ---                                                        | ---                | ---                | ---                          | ---                         | ---                                          |
| 11P001SB               | 36.5                                          | 37                              | 2.19 J                         | < 1.16               | ---                                                        | < 0.0012           | < 0.0023           | < 0.0023                     | < 0.0023                    | < 30                                         |
| 11P002SB               | 22.5                                          | 23                              | 6.96 J                         | < 0.139              | ---                                                        | < 0.0028           | < 0.0028           | < 0.0028                     | 0.0028                      | ---                                          |
| 11P002SB               | 24                                            | 24.5                            | 3,290                          | 306                  | 1.64J                                                      | < 0.0074           | 0.0368             | 0.0221                       | 0.25                        | ---                                          |
| 11P002SB <sup>j/</sup> | 24.5                                          | 25                              | 150                            | 43.6                 | 0.95J                                                      | < 0.0013           | 0.0053             | 0.0026                       | 0.0276                      | ---                                          |
| 11P002SB               | 66                                            | 66.5                            | 2.73 J                         | < 1.10               | ---                                                        | < 0.0011           | < 0.0022           | < 0.0022                     | < 0.0022                    | ---                                          |
| 11P002SB               | 80                                            | 80.5                            | 1.26 J                         | < 1.12               | ---                                                        | < 0.0011           | < 0.0022           | < 0.0022                     | < 0.0022                    | 1,200                                        |
| 11P003SB               | 26.5                                          | 27                              | 1.63 J                         | 3.95                 | ---                                                        | 0.0037             | 0.0185             | 0.0062                       | 0.0309                      | ---                                          |
| 11P003SB               | 29                                            | 29.5                            | 1.39 J                         | < 1.12               | ---                                                        | < 0.0011           | < 0.0022           | < 0.0022                     | < 0.0022                    | ---                                          |
| 11P003SB               | 34.5                                          | 35                              | 1.57 J                         | < 1.19               | ---                                                        | < 0.0012           | < 0.0024           | < 0.0024                     | < 0.0024                    | < 30                                         |
| 11P004SB               | 13.5                                          | 14.5                            | 1,350                          | 3,020                | 2.45J                                                      | 0.112              | 1.12               | 6.63J                        | 40.6J                       | ---                                          |
| 11P004SB               | 24.5                                          | 25                              | 2.48 J                         | 5.61                 | ---                                                        | < 0.0014           | < 0.0028           | < 0.0028                     | < 0.0028                    | ---                                          |
| 11P004SB               | 33                                            | 33.5                            | 2.05 J                         | < 1.14               | ---                                                        | < 0.0011           | < 0.0023           | < 0.0023                     | < 0.0023                    | ---                                          |

<sup>a/</sup> SBD = sample beginning depth.

<sup>b/</sup> SED = sample ending depth.

<sup>c/</sup> feet bgs = feet below ground surface.

<sup>d/</sup> mg/kg = milligrams per kilogram.

<sup>e/</sup> mg/L = milligrams per liter.

<sup>f/</sup> J = laboratory estimated value. The analyte was positively identified at a concentration between the sample quantitation limit and the reporting limit.

<sup>g/</sup> Identified as 11P005SB in the boring logs (Appendix B) and analytical data package (Appendix C).

<sup>h/</sup> < and gray shading = analyte not detected above the sample quantitation limit shown.

<sup>i/</sup> --- = not analyzed.

<sup>j/</sup> Identified as 11P006SB in the boring logs (Appendix B) and analytical data package (Appendix C).

At least two soil samples from each borehole were submitted for laboratory analysis below the depth of maximum contamination based on headspace. The primary purpose of these samples was to confirm that the vertical extent of contamination had been defined. With the exception of a detection of 5.61 mg/kg TPH-g at 25 bgs in 11P004SB, TPH-d, TPH-g, and BTEX were not detected above the reporting limit in any of these samples. These results were consistent with the rapidly declining headspace readings with depth observed during drilling and support an interpretation that an adequate buffer of clean soil exists between the depth of maximum contamination and groundwater.

### 3.2 SOIL VAPOR ANALYTICAL RESULTS AT VMP3

January 1999 soil vapor results for VMP3 are presented in Table 3.2. Field-screening data indicate that elevated concentrations of petroleum hydrocarbons are still present in soils near VMP3-24, but little to no contamination exists in deeper soils at this location. Depleted oxygen concentrations at VMP3-24 indicate that aerobic biodegradation of fuel contaminants at this location is limited by the amount of available oxygen. However, attenuation or biodegradation effects with depth are readily apparent as oxygen increases and carbon dioxide and PID measurements of ionizable compounds decrease. At both the 30- and 40-foot depth intervals, static oxygen concentrations are naturally sufficient to support aerobic biodegradation of petroleum hydrocarbons.

The analytical results confirm the field results and show that while some TVH and BTEX contamination is evident in soils near VMP3-24, the minimal contamination present in the deeper soils does not exceed the RWQCB screening criteria. In the soil vapor sample collected at VMP3-24, concentrations of benzene (0.49 ppmv), ethylbenzene (2.6 ppmv), and total xylenes (26M ppmv) exceeded RWQCB (1998) screening levels of 0.071 ppmv, 2.161 ppmv, and 1.231 ppmv, respectively (Appendix A, Section 4.2). However, TVH and BTEX results at VMP3-30 and VMP3-40 are approximately 1 to 2 orders of magnitude less than those observed in soil vapor at VMP3-24, and are well below the RWQCB (1998) screening levels. These results are consistent with the soil sample results from 11P002SB and observed headspace readings, indicating that while some TPH-g and BTEX contamination is present in soils approximately 20 feet bgs on the north side of the former UST excavation, little to no BTEX contamination is present in soils below this depth.

### 3.3 COMPARISON TO PRE-BIOVENTING CONTAMINANT LEVELS IN SOIL

Table 3.3 provides a comparison of pre-bioventing contaminant levels in soil to confirmation soil sample results at two locations. Contaminant reductions in soil as a result of approximately 5 years of air injection bioventing at VW1 (from May 1993 to March 1998) can be evaluated by comparing results from soil samples collected at approximately 25 feet bgs at VMP2 (April 1993) and 11P002SB (January 1999). As shown on Table 3.3, toluene, ethylbenzene, and total xylenes, have been reduced by more than 3 orders of magnitude at this location. Because different methods were used for TPH analysis in 1993 and 1999, reductions in TPH cannot be accurately assessed in soils near VMP2.

Contaminant reductions in soil as a result of approximately 21 months of expanded system bioventing at VW2 and VW3 (July 1996 to March 1998) can be evaluated by

**TABLE 3.2**  
**JANUARY 1999 FIELD AND ANALYTICAL SOIL VAPOR RESULTS AT VMP3**  
**IRP SITE SD-11, AGE MAINTENANCE AREA**  
**BEALE AFB, CALIFORNIA**

| Sample Location <sup>b/</sup> | Field-Screening Data |                          |                                        | Laboratory Data <sup>a/</sup> |                |                |                        |                      |                   |
|-------------------------------|----------------------|--------------------------|----------------------------------------|-------------------------------|----------------|----------------|------------------------|----------------------|-------------------|
|                               | Oxygen (percent)     | Carbon Dioxide (percent) | PID <sup>c/</sup> (ppmv) <sup>d/</sup> | TVH <sup>e/</sup> (ppmv)      | Benzene (ppmv) | Toluene (ppmv) | Ethylbenzene (ppmv)    | Total Xylenes (ppmv) | Total BTEX (ppmv) |
| California RWQCB (1998)       |                      |                          |                                        |                               |                |                |                        |                      |                   |
| BTEX Screening Criteria       |                      |                          |                                        | 430 B <sup>g/</sup>           | 0.071          | 3.037          | 2.161                  | 1.231                | NA <sup>h/</sup>  |
| VMP3-24                       | 1.0                  | 12.0                     | 313                                    | 4.5 B                         | 0.49           | 0.39           | 2.6                    | 26 M <sup>h/</sup>   | 29.48             |
| VMP3-30                       | 8.0                  | 7.5                      | 45.4                                   | 0.71 B                        | 0.011          | 0.072          | 0.022                  | 0.33                 | 0.435             |
| VMP3-40                       | 16.0                 | 1.3                      | 11.4                                   |                               | 0.021          | 0.021          | 0.0033 J <sup>i/</sup> | 0.04                 | 0.0853            |

Note: Soil vapor results from previous sampling events at VMP3 and other VMPs are provided in Appendix A, Table 2.2.

<sup>a/</sup> Laboratory analysis of soil vapor performed using USEPA Method TO-3.

<sup>b/</sup> Includes screened interval depth in feet below ground surface.

<sup>c/</sup> PID = photoionization detector.

<sup>d/</sup> ppmv = parts per million, volume per volume.

<sup>e/</sup> TVH referenced to jet fuel; value shown for C5 and higher hydrocarbon chains.

<sup>f/</sup> NA = not applicable.

<sup>g/</sup> B = compound present in the laboratory blank.

<sup>h/</sup> M = reported value may be biased due to apparent matrix interferences.

<sup>i/</sup> J = laboratory estimated value.

**TABLE 3.3**  
**COMPARISON OF JANUARY 1999 AND PRE-BIOVENTING SOIL CONTAMINANT LEVELS**  
**IRP SITE SD-11, AGE MAINTENANCE AREA**  
**BEALE AFB, CALIFORNIA**

| Sample                      | Location-Depth<br>(feet bgs) <sup>c/</sup> | Sample<br>Date | TRPH <sup>b/</sup><br>(mg/kg) <sup>i/</sup> | USEPA Analytical Method |                 |                                |                                |                    |                    |                              |                             |
|-----------------------------|--------------------------------------------|----------------|---------------------------------------------|-------------------------|-----------------|--------------------------------|--------------------------------|--------------------|--------------------|------------------------------|-----------------------------|
|                             |                                            |                |                                             | 418.1                   | SW8015-modified | TPH-d <sup>c/</sup><br>(mg/kg) | TPH-g <sup>d/</sup><br>(mg/kg) | Benzene<br>(mg/kg) | Toluene<br>(mg/kg) | Ethyl-<br>benzene<br>(mg/kg) | Total<br>Xylenes<br>(mg/kg) |
| VMP2-25.5 <sup>b/</sup>     |                                            | Apr-93         | 747.5                                       |                         | ---             |                                |                                | ND <sup>i/</sup>   | 99                 | 47.5                         | 319.5                       |
| 11P002SB-24.5 <sup>j/</sup> |                                            | Jan-99         | ---                                         |                         | 1,720           |                                | 174.8                          | ND                 | 0.021              | 0.012                        | 0.139                       |
| VW2-10                      |                                            | Jun-96         | ---                                         |                         | 60              |                                | 2,500                          | 6.8                | 94                 | 37                           | 173                         |
| 11P001SB-11                 |                                            | Jan-99         | ---                                         |                         | 106             |                                | 151                            | 0.0556             | 1.11               | 0.778                        | 3.33                        |

<sup>a/</sup> April 1993 and June 1996 BTEX analysis by SW8020; January 1999 BTEX analysis performed by SW8021B.

<sup>b/</sup> TRPH = total recoverable petroleum hydrocarbons.

<sup>c/</sup> TPH-d = total petroleum hydrocarbons as diesel.

<sup>d/</sup> TPH-g = total petroleum hydrocarbons as gasoline.

<sup>e/</sup> feet bgs = feet below ground surface.

<sup>f/</sup> mg/kg = milligrams per kilogram.

<sup>g/</sup> Average of primary and replicate sample results.

<sup>h/</sup> --- = not analyzed.

<sup>i/</sup> ND = not detected.

<sup>j/</sup> Average of sample results at 24 to 24.5 feet bgs and 24.5 to 25 feet bgs.

comparing results from soil samples collected approximately 10 to 11 feet bgs at VW2 (June 1996) and 11P001SB (January 1999). As shown on Table 3.3, benzene concentrations in soil have been reduced by more than 2 orders of magnitude, and TPH-g, toluene, ethylbenzene, and total xylenes concentrations have been reduced by more than 1 order of magnitude as a result of expanded bioventing system operation. Contaminant reductions in TPH-d were not discernible based on these limited results, probably because the more soluble and more mobile contaminants (i.e., TPH-g and BTEX) were preferentially degraded.

Based on these results, bioventing has significantly reduced the concentration of TPH-g and BTEX compounds in soils at the AGE Maintenance Area, and as a result, the risk posed to site groundwater by these relatively mobile and toxic contaminants has also been significantly reduced.

### **3.4 COMPARISON OF SAMPLING RESULTS TO NFI CRITERIA IDENTIFIED IN THE SAP**

Section 4 of the SAP (Appendix A) identified criteria for evaluating confirmation soil and soil vapor results in order to determine whether a NFI recommendation for petroleum hydrocarbons at the AGE Maintenance Area of IRP Site SD-11 is appropriate. Proposed NFI criteria were provided in the SAP based on the RBCLA and California RWQCB screening criteria (1998). In accordance with the RBCLA, a 1 mg/L (or 1,000 µg/L) target cleanup level was proposed for soluble TPH-d. The RBCLA does not provide comparable cleanup criteria for the lighter-molecular weight petroleum hydrocarbons indicated by TPH-g; therefore, soil vapor screening criteria provided by California RWQCB (1998) were proposed for BTEX (Table 3.2).

As shown on Table 3.1, five of the six soil samples collected between 11 and 25 feet bgs had soluble TPH-d concentrations exceeding the 1 mg/L criteria. In addition, benzene, ethylbenzene, and total xylenes concentrations in soil vapor exceeded the California RWQCB (1998) screening criteria at VMP3-24 (Section 3.2 and Table 3.2). Although some petroleum hydrocarbon contamination remains in soils between 11 and 25 feet bgs, little to no contamination is present below 25 feet bgs. Considering these results, further assessment of the proposed NFI criteria and site-specific factors affecting petroleum hydrocarbon fate and transport in vadose zone soils at Site SD-11 were performed and are discussed below.

#### **3.4.1 RBCLA**

The RBCLA was specifically developed for Beale AFB using basewide hydrogeologic assessment, vadose zone contaminant modeling, and the Designated Level Methodology (DLM) (California RWQCB, 1989), in order to define a risk-based cleanup level in soil for TPH-d.

Based on results of the hydrogeologic assessment, Beale AFB was divided into 16 separate geographic zones. IRP Site SD-11 is located in Zone C/5 (Figure 1.1) which is defined as having a depth to groundwater of at least 80 feet bgs.

Vadose zone modeling (using the USEPA Seasonal Soil Compartment Model [SESOIL]) and a sensitivity analysis were performed to verify the use of a 100-fold

environmental attenuation factor (EAF) as defined in the DLM. No biodegradation was assumed in the modeling because biodegradation data were not available for each of the separate geographic zones. Using an initial concentration of 1,000 mg/kg, the maximum predicted depth of contaminant migration in Zone C/5 by the SESOIL model after 50 years was 22 feet. From this result, a maximum allowable depth of contamination of 58 feet bgs was established for Zone C/5 (depth to groundwater [80 feet bgs] minus the maximum predicted contaminant depth [22 feet bgs]). Contaminant migration depths did not exceed 23 feet bgs in any of the modeling scenarios for the various geographic zones and the RBCLA concluded that the lithology at Beale AFB provides at the very least, an "average" degree of groundwater protection from petroleum migration (as presumed using an EAF of 100).

Based on these results, the RBCLA established a basewide soluble risk-based cleanup level of 1 mg/L (or 1,000 µg/L) for TPH-d using the soluble DLM equation, a WQG of 100 µg/L, an EAF of 100, and a dilution factor of 10 (in accordance with the California DI-WET procedure). Combining this risk-based cleanup criterion with the modeling results, the RBCLA concluded that soluble TPH-d levels up to 1 mg/L could be safely left in Zone C/5 soils at depths between 0 and 58 feet bgs without threatening site groundwater. The RBCLA also concluded that contaminant concentrations should not exceed detectable concentrations in Zone C/5 soils deeper than 58 feet bgs.

The limitation of the RBCLA approach is that the soluble TPH-d criteria of 1 mg/L is not depth-specific and does not take into account the fact that higher soluble TPH-d concentrations may be protective of groundwater if the clean soil "buffer zone" (the thickness of soil between the maximum extent of contamination and groundwater) significantly exceeds 22 feet bgs. The sampling results from Site SD-11 indicated that although soluble TPH-d concentrations somewhat exceeded the 1 mg/L screening criteria, the vertical extent of contamination was limited to 20 to 25 feet bgs; therefore, a significant buffer zone does exist at the site. Therefore, site-specific SESOIL modeling was conducted to evaluate the threat to groundwater posed by the remaining soil contaminants. These results are discussed in Section 3.5.

#### **3.4.2 RWQCB 1998 Soil Vapor Screening Criteria**

During development of the final SAP (Appendix A), California RWQCB (1998), Central Valley Region, provided screening criteria for evaluation of BTEX concentrations in soil vapor at petroleum release sites. Soil vapor screening criteria (Table 3.2) were provided for comparison to site data because California RWQCB Central Valley Region does not endorse soluble soil analysis by California DI-WET for the TPH-g or the BTEX compounds.

The California RWQCB (1998) soil vapor screening criteria provide allowable soil vapor contaminant concentrations at which equilibrium soil pore water concentrations will not exceed California (1998b) WQGs. The soil vapor screening criteria do not consider environmental attenuation of contaminants nor do they consider the depth of the contaminant with respect to the depth to groundwater.

### 3.4.3 Site Specific Factors

As previously discussed, the January 1999 confirmation soil and soil vapor results do not meet the NFI criteria proposed by the RBCLA and RWQCB screening criteria (1998). However, confirmation soil and soil vapor sample results (Table 3.1) and soil vapor results from the April 1998 Option 1 testing event (Appendix A, Table 2.2) and the confirmation sampling event (Table 3.2) strongly indicate that little petroleum hydrocarbon contamination exists in soils deeper than 25 feet bgs.

BTEX concentrations in soil vapor did not exceed California RWQCB (1998) criteria at the two deeper soil intervals at VMP3. Field results for soil vapor below 25 feet bgs indicated that soils are well oxygenated and will support natural aerobic biodegradation without supplemental air (i.e., oxygen) injection. Reduced concentrations of petroleum hydrocarbon contaminants with depth indicate that significant environmental attenuation is occurring and as illustrated by the contaminant reductions shown in Table 3.3, biodegradation appears to be a significant attenuation mechanism in site soils. In addition, no petroleum hydrocarbon contaminants are present in site groundwater at concentrations exceeding maximum contaminant levels (MCLs) (LCC, 1998).

Considering these site specific characteristics, the presumptions associated with the RBCLA and California RWQCB (1998) soil vapor screening criteria may be overly conservative as applied to the AGE Maintenance Area and residual petroleum hydrocarbon contamination remaining in site soils may not pose a threat to site groundwater.

## 3.5 SITE-SPECIFIC FATE AND TRANSPORT MODELING OF SOIL CONTAMINANTS

### 3.5.1 Model Rationale and Assumptions

The soil and soil vapor contaminant results and equilibrium oxygen soil vapor concentrations all indicate that contaminant concentrations in the vadose rapidly decrease with depth and do not appear to pose a threat to groundwater. However, because some of the soluble TPH-d results were above the 1 mg/L screening criteria and soil vapor concentrations of benzene, ethylbenzene, and total xylenes were above the screening criteria for soil vapor at 24 feet bgs at one location (VMP3), site-specific modeling was performed for the contaminants that remain in soil at Site SD-11.

Because the SESOIL model was previously used to evaluate contaminants at Beale AFB, SESOIL also was used for the site-specific modeling. However, the model inputs used during development of the RBCLA were slightly modified to more appropriately model site-specific conditions at Site SD-11. These input file modifications are as follows:

- In addition to modeling TPH-d, BTEX components were also modeled and their movement through the vadose zone to groundwater was evaluated.
- The starting depth of contamination in the model was changed from 5 feet bgs to 25 feet bgs for TPH-d and from 5 feet bgs to 20 feet bgs for BTEX, to more accurately reflect the depths at which the maximum contaminant concentrations remain in soil

at the site (Table 3.1). These depths are closer to the groundwater table and, therefore, reflect more conservative scenarios than those used during the RBCLA. Because the soil profile characteristics (soil type, thickness, and permeability) for Zone C/5 used during the RBCLA were conservative (i.e., indicated more permeable soils) compared to the site-specific lithology at Site SD-11, they were not changed.

- The maximum contaminant concentrations measured at the site (Table 3.1) were used for the contaminant loading source term (modeled as a spill at time zero).
- Chemical characteristics for the individual BTEX components (e.g., solubilities, Henry's Law coefficients, and distribution coefficients) were taken from the USEPA Region 9 1998 Preliminary Remediation Goals (PRG) chemical parameter database (USEPA, 1998). The chemical characteristics of TPH-d used during the development of the RBCLA were used for TPH-d.
- Because each of the BTEX components has been demonstrated to undergo biodegradation at Site SD-11 when sufficient oxygen is available, it was considered overly conservative not to include some measure of biodegradation potential within the model. The SESOIL model uses a standard first-order decay coefficient for biodegradation. For each of the BTEX components, the average first-order decay coefficient from the range provided in the ASTM guidelines for corrective actions at petroleum release sites was used (ASTM, 1995). These coefficients were developed from laboratory and field-measured biodegradation rates of BTEX reported in the literature. The specific first-order rates for each BTEX component used in the model for Site SD-11 are:

Benzene: 0.0095 day<sup>-1</sup>;

Toluene: 0.032 day<sup>-1</sup>;

Ethylbenzene: 0.019 day<sup>-1</sup>; and

Xylenes: 0.0097 day<sup>-1</sup>.

### 3.5.2 Model Results

The results of the SESOIL model runs are summarized in Table 3.4 (detailed input and output files are provided in Appendix F). Table 3.4 provides, for each of the components modeled, the important input parameters as well as the maximum depth at which the contaminant concentration in soil moisture exceeded the WQGs provided in the RBCLA.

The results suggest that the concentrations of TPH-d and the BTEX components in soil moisture would not exceed their respective WQGs at groundwater depth within the 50-year period of the model runs. The maximum depth of contaminant migration at concentrations above the WQGs for TPH-d, toluene, and ethylbenzene did not exceed 45 feet bgs. The maximum depth of contaminant migration at concentrations above the WQGs for benzene and total xylenes reached approximately 75 feet bgs, 5 feet above the assumed groundwater depth of 80 feet bgs for Zone C/5, and 10 feet above the measured groundwater depth of 85 feet bgs at the site. It is also important to note that the prediction of contaminant migration to 75 feet bgs was based on reasonable, yet

**TABLE 3.4**  
**SESOIL MODEL INPUTS AND RESULTS**  
**IRP SITE SD-11, AGE MAINTENANCE AREA**  
**BEALE AFB, CALIFORNIA**

| Contaminant  | Maximum Concentration<br>in Soil<br>(mg/kg) <sup>a/</sup> | Modeled Starting Depth of Contamination<br>(feet bgs) <sup>b/</sup> | First-Order Biodegradation Rate <sup>c/</sup><br>(day <sup>-1</sup> ) | Water Quality Goal <sup>d/</sup><br>(µg/L) <sup>e/</sup> | Maximum Depth of Contamination Exceeding WQG in Soil Moisture<br>(feet bgs) |
|--------------|-----------------------------------------------------------|---------------------------------------------------------------------|-----------------------------------------------------------------------|----------------------------------------------------------|-----------------------------------------------------------------------------|
| TPH-d        | 3,290                                                     | 25                                                                  | 0.0                                                                   | 100                                                      | 38                                                                          |
| Benzene      | 4.55                                                      | 20                                                                  | 0.0095                                                                | 1                                                        | 74                                                                          |
| Toluene      | 26.7                                                      | 20                                                                  | 0.032                                                                 | 42                                                       | 38                                                                          |
| Ethylbenzene | 11.9                                                      | 20                                                                  | 0.019                                                                 | 29                                                       | 44                                                                          |
| Xylenes      | 67.6                                                      | 20                                                                  | 0.0097                                                                | 17                                                       | 74                                                                          |

<sup>a/</sup> mg/kg = milligrams per kilogram.

<sup>b/</sup> feet bgs = feet below ground surface.

<sup>c/</sup> Average first-order decay coefficient (ASTM, 1995).

<sup>d/</sup> Cal/EPA, 1998.

<sup>e/</sup> µg/L = micrograms per liter.

conservative, model assumptions. It is not expected that contaminants will actually migrate to this depth, only that this depth is the maximum depth to which they could potentially migrate. In addition, soil moisture contaminant concentrations approaching the WQGs are unlikely to result in groundwater contaminant concentrations of the same magnitude due to mixing and capillary fringe interactions.

Therefore, the site-specific SESOIL modeling results, when coupled with the limited vertical extent of remaining site contamination, support a recommendation of NFI for petroleum hydrocarbons at Site SD-11 based on the insignificant threat to groundwater posed by the remaining contaminants.

## SECTION 4

### CONCLUSIONS AND RECOMMENDATIONS

#### 4.1 CONCLUSIONS

Soil and soil vapor contaminant results and equilibrium concentrations of oxygen in soil vapor strongly indicate that contaminant concentrations have been substantially reduced as compared to pre-bioventing data and residual contaminant concentrations in soil rapidly decrease with increasing soil depth. Little or no petroleum hydrocarbon contamination is present in soils deeper than 25 feet bgs. A well oxygenated buffer of clean soil, approximately 55 to 60 feet thick, exists between the depth of maximum contamination and groundwater. As indicated by the fuel contaminant reductions in site soil with extended bioventing treatment, aerobic biodegradation is a significant attenuation factor acting in site soils. Results of the site-specific vadose zone modeling, using conservative assumptions and maximum detected fuel concentrations in soil, suggest that the remaining extent of contamination poses little to no threat to site groundwater. However, five of the six soluble TPH-d results were above the 1 mg/L screening criteria and soil vapor concentrations of benzene, ethylbenzene, and total xylenes were above the screening criteria for soil vapor at one location.

#### 4.2 RECOMMENDATIONS

Comments received from the California Regional Water Quality Control Board (RWQCB) on the draft version of this report indicate that the California RWQCB will not permit closure of Site SD-11 for petroleum hydrocarbons at this time (California RWQCB, 1999) (Appendix A). Reasons for this decision include soluble TPH-d concentrations in five of six soil samples exceeding the 1 mg/L screening criteria, and soil vapor concentrations for benzene, ethylbenzene, and total xylenes at VMP3-24 exceeding the soil vapor screening criteria of 0.071 mg/kg, 2.161 mg/kg, and 1.231 mg/kg, respectively.

Based on California RWQCB's decision not to permit closure of the site at this time, continued treatment to further reduce petroleum hydrocarbon contaminants in subsurface soil is recommended for Site SD-11. Treatment could readily be implemented by manifolded the existing vent wells (VW1, VW2, and VW3) utilized during expanded-scale bioventing treatment into the SVE system currently being operated and maintained at the site.

Annual monitoring (e.g., soil gas sampling and in situ respiration testing) is recommended to determine the appropriate time for further confirmation soil sampling. Monitoring would be continued until 1) respiration rates and soil vapor contaminant concentrations approach asymptotic levels, and 2) until concentrations of benzene,

ethylbenzene, and total xylenes drop below the proposed soil vapor screening criteria identified in the SAP (Appendix A). Once these criteria have been met, additional closure soil samples could then be collected. Sampling would be designed to document further contaminant reduction, and attainment of proposed screening criteria identified in the SAP (Appendix A). Collected samples should be analyzed for total TPH-d, total TPH-g, soluble TPH-d, and BTEX.

## SECTION 5

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**APPENDIX A**  
**SAMPLING AND ANALYSIS PLAN**

# **FINAL**

## **Sampling and Analysis Plan to Support Recommendation for No Further Investigation of Petroleum Hydrocarbons at the Age Maintenance Area IRP Site SD-11**



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California**

**Prepared For**

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

**and**

**9CES/CEV  
Beale Air Force Base, California**

**December 1998**



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ENGINEERING SCIENCE, INC.**

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**FINAL**

**SAMPLING AND ANALYSIS PLAN TO SUPPORT  
RECOMMENDATION FOR NO FURTHER INVESTIGATION OF  
PETROLEUM HYDROCARBONS AT THE AGE MAINTENANCE AREA,  
IRP SITE SD-11**

**BEALE AIR FORCE BASE, CALIFORNIA**

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## LIST OF ABBREVIATIONS AND ACRONYMS

|            |                                               |
|------------|-----------------------------------------------|
| µg/L       | Micrograms per liter                          |
| 1,2-DCA    | 1,2-Dichloroethane                            |
| 1,2-DCE    | 1,2-Dichloroethene                            |
| AFB        | Air Force Base                                |
| AFCEE      | Air Force Center for Environmental Excellence |
| AGE        | Aircraft Ground Equipment                     |
| AST        | Aboveground storage tank                      |
| ASTM       | American Society for Testing and Materials    |
| bgs        | Below ground surface                          |
| BTEX       | Benzene, toluene, ethylbenzene, and xylenes   |
| CAC        | California Administrative Code                |
| Cal/EPA    | California Environmental Protection Agency    |
| cfm        | Cubic feet per minute                         |
| DLM        | Designated Level Methodology                  |
| DOT        | Department of Transportation                  |
| EAF        | environmental attenuation factor              |
| ES         | Engineering-Science, Inc.                     |
| HVOC       | Halogenated volatile organic compound         |
| ID         | Inside diameter                               |
| IRP        | Installation Restoration Program              |
| LCC        | Laguna Construction Company, Inc.             |
| LUFT       | Leaking Underground Fuel Tank                 |
| MCLs       | Maximum contaminant levels                    |
| mg/kg      | Milligrams per kilogram                       |
| mg/L       | Milligrams per liter                          |
| NFI        | No further investigation                      |
| OD         | Outside diameter                              |
| OVA        | Organic vapor analysis                        |
| Parsons ES | Parsons Engineering Science, Inc.             |
| PID        | Photoionization detector                      |
| ppmv       | parts per million, by volume                  |
| QC         | Quality control                               |
| RBCLA      | Risk-Based Cleanup Level Assessment           |
| RWQCB      | Regional Water Quality Control Board          |
| SAI        | Specialized Assays, Inc.                      |
| SAP        | Sampling and Analysis Plan                    |
| SESOIL     | Seasonal Soil Compartment Model               |
| SVE        | Soil vapor extraction                         |
| TCE        | Trichloroethene                               |
| TOC        | Total organic carbon                          |
| TPH        | Total petroleum hydrocarbons                  |
| TVH        | Total volatile hydrocarbons                   |

|       |                                     |
|-------|-------------------------------------|
| TVHA  | Total volatile hydrocarbon analyzer |
| USEPA | US Environmental Protection Agency  |
| UST   | Underground storage tank            |
| VOCS  | Volatile organic compounds          |
| WET   | Waste extraction test               |
| WQGs  | Water Quality Goals                 |

## SECTION 1

### INTRODUCTION

This Sampling and Analysis Plan (SAP) presents the proposed scope of work to be conducted at Installation Restoration Program (IRP) Site SD-11, Aircraft Ground Equipment (AGE) Maintenance Area, at Beale Air Force Base (AFB), Yuba County, California. The AGE Maintenance Area includes a backfilled underground storage tank (UST) excavation and adjoining property which has been impacted by petroleum hydrocarbon releases to the subsurface. This SAP is intended to guide soil and soil vapor sampling at the AGE Maintenance Area to document the effectiveness of bioventing remediation of petroleum-hydrocarbon-contaminated soils and to support a no further investigation (NFI) recommendation for the three former USTs previously located at the site.

Since 1993, Beale AFB has participated in the U.S. Air Force Bioventing Initiative, sponsored by the Air Force Center for Environmental Excellence (AFCEE) at Brooks AFB, Texas in cooperation with the Air Force Armstrong Laboratory, the U.S. Environmental Protection Agency (USEPA), and Parsons Engineering Science, Inc. (Parsons ES, formerly Engineering-Science, Inc. [ES]). The initiative included conducting approximately 145 bioventing pilot tests at 56 Air Force installations throughout the country. These tests were designed to collect data on the effectiveness of bioventing for the remediation of soil contaminated with fuel hydrocarbons (e.g., jet fuel, diesel fuel, gasoline, and heating oil). In addition to Site SD-11, bioventing pilot tests and evaluations were also conducted at Sites 3 and 18 at Beale AFB (ES, 1993a, 1993b; AFCEE, 1994, 1995).

Results of the initiative at Beale AFB demonstrated that bioventing was an effective means for remediating petroleum-hydrocarbon-contaminated soils at the AGE Maintenance Area and the bioventing system was expanded in 1996 to treat other nearby soils that also had been impacted by past releases of petroleum products. Results from previous investigations at IRP Site SD-11 were reviewed in addition to the pilot-scale and expanded bioventing system results during preparation of this SAP.

This SAP consists of eight sections, including this introduction. Section 2 includes site description, history, and summaries of previous investigations and remediation activities. Section 3 includes the proposed SAP. Section 4 provides a discussion of the criteria that will be used to support a NFI recommendation for the former USTs and petroleum-hydrocarbon-contaminated soils within the AGE Maintenance Area. Analytical results from the sampling activities and recommendations will be presented in a results report as described in Section 5. A proposed schedule for the sampling activities and submittal of the results report is included in Section 6. Section 7 provides points of contact. Section 8 provides references cited in this SAP.

## SECTION 2

### SITE DESCRIPTION

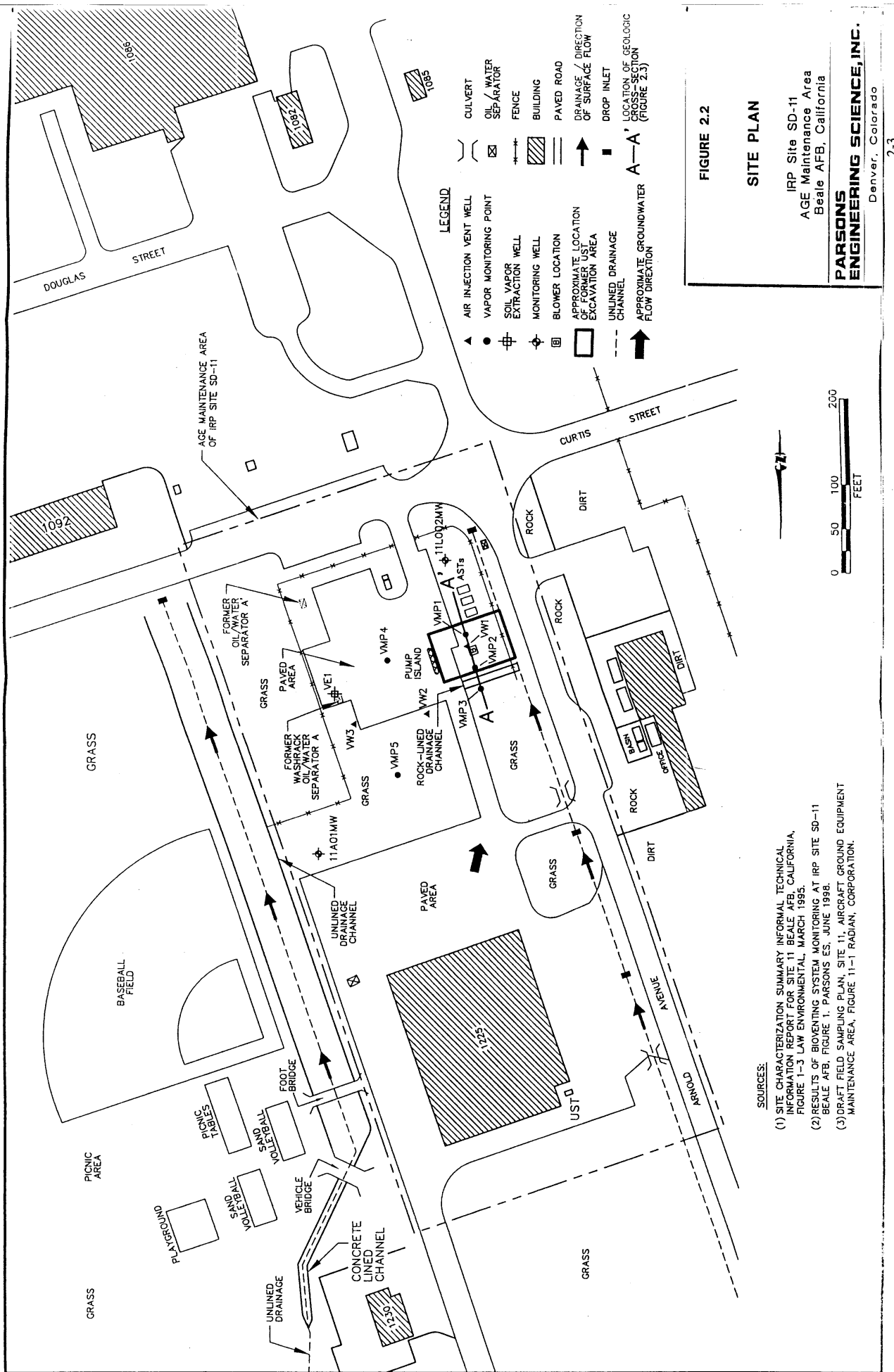
#### 2.1 SITE LOCATION AND HISTORY

The AGE Maintenance Area is located in the northwestern portion of Beale AFB (Figure 2.1), and is bounded by Arnold Avenue to the west and Curtis Street to the south (Figure 2.2). IRP Site SD-11 consists of those facilities in the AGE Maintenance Area, including Building 1225, three existing aboveground storage tanks (ASTs), two active oil/water separators, a small pump island, a backfilled UST excavation, paved vehicle parking areas, landscaped areas, and unlined drainage channels (Figure 2.2). Building 1086 which is located approximately 400 feet south of the AGE Maintenance Area also has been incorporated into IRP Site SD-11 (Laguna Construction Company, Inc. [LCC], 1998); however, this SAP does not address environmental contamination at this location.

Current and former facilities at IRP Site SD-11 have been used to support AGE maintenance activities for more than 30 years. These activities have included storage of gasoline, diesel, and JP-4 jet fuel in three former USTs connected to a fuel pump island. Identification numbers for the three former USTs are 1225.01, 1225.02, and 1225.03, but it is not known which individual tank contained the above-mentioned fuel products. Vehicle cleaning operations were historically performed at a washrack located near two former oil/water separators on the east side of the AGE Maintenance Area (individually referred to as Oil/Water Separator A and Oil/Water Separator A'). In addition, aircraft ground support vehicles have been stored and operated in the paved area south of Building 1225. The former USTs, former oil/water separators, and historic fueling, maintenance, and storage of support vehicles in this area are all identified as potential sources of subsurface contamination in the AGE Maintenance Area.

During previous site investigations, petroleum hydrocarbon and halogenated volatile organic compound (HVOC) contamination have been identified in site soil, soil vapor, and groundwater. Petroleum hydrocarbon contamination at the site is primarily the result of fuel releases from the former USTs. Releases of petroleum products during vehicle fueling, maintenance, and storage operations also represent potential sources of subsurface petroleum contamination. The presence of HVOC contamination at the site has been attributed to releases from the former oil/water separators (Gaudette, 1998; LCC, 1998).





## 2.2 SITE GEOLOGY AND HYDROGEOLOGY

The uppermost geologic unit in the western portion of Beale AFB, including IRP Site SD-11, has been mapped as the Laguna Formation. This formation consists of Plio-Pleistocene alluvial sequence of silt, sand, clay, and unsorted gravels. Sediments encountered during drilling completed during the fall of 1994 indicated a generalized sequence of interbedded silty sands and sandy gravels (Law Environmental, Inc., 1995).

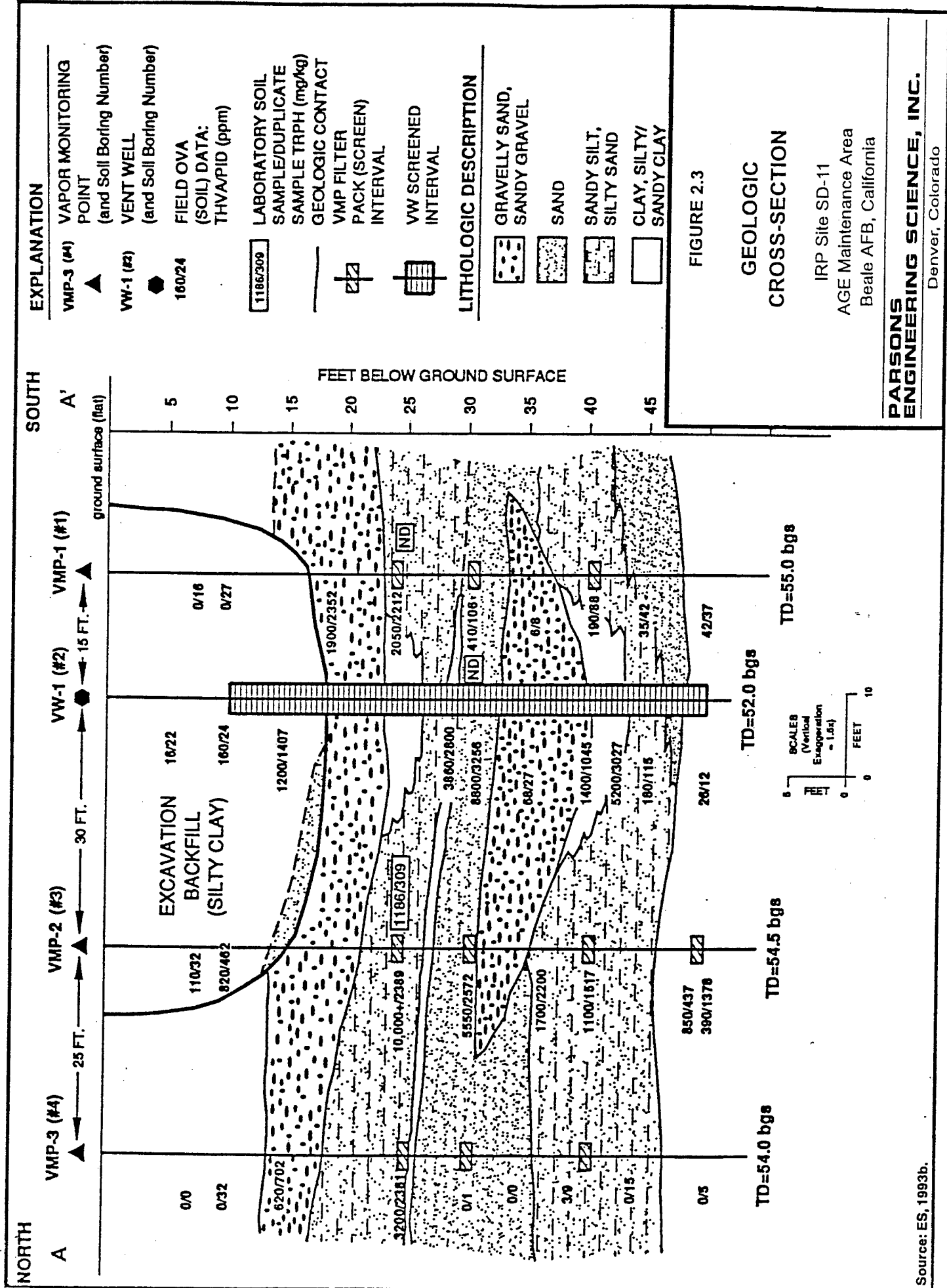
Sampling conducted by Parsons ES (formerly Engineering-Science, Inc. [ES]) during installation of the bioventing pilot test system indicated layers of gravelly sand, silts, and clays (ES, 1993b). The backfill materials for the former excavation are composed of silty clay with common gravel-sized fragments up to 2 inches in diameter. The base of this backfill material was found at depths between 15 and 20 feet below ground surface (bgs). A geologic cross-section based on this sampling event is provided at Figure 2.3.

Groundwater at the site is present at approximately 85 feet bgs (Radian Corporation, 1998). The first groundwater flow zone is generally unconfined and is expected to flow in a south-southwesterly direction (LCC, 1998).

## 2.3 PREVIOUS INVESTIGATIONS AND REMEDIATION ACTIVITIES

A chronological summary of the investigative and removal/remediation activities that have been performed at the site since June 1992 includes the following:

- June 1992 - Removal of the three former USTs;
- April 1993 - Installation of the bioventing pilot test system in the area of the former USTs by Parsons ES, 1993b);
- May 1993 to June 1994 - Performance of a 1-year extended bioventing pilot test and 1-year soil sampling by Parsons ES (AFCEE, 1995);
- Fall 1994 - Further site characterization of the AGE Maintenance Area by Law Environmental (1995);
- May 1996 to August 1996 - Expansion and optimization of the bioventing system to treat petroleum contaminated soils east of the UST excavation by Parsons ES (1995, 1996a, and 1996b);
- January 1997 - Removal of two oil/water separators on the east side of the AGE Maintenance Area by LCC (1998);
- June/July 1997 - Installation of a soil vapor extraction (SVE) system near Oil/Water Separator A by LCC (1998);
- 1997 - Monitoring and maintenance of the expanded bioventing system by Law Environmental (1997);



- April 1998 - Expanded bioventing system soil vapor sampling and respiration testing by Parsons ES (1998); and
- April/May 1998 - Reconfiguration of the bioventing system into a SVE system by LCC (1998).

### 2.3.1 Removal of USTs

During soil excavation and UST removal operations in June 1992, soil contamination was observed in soil beneath all three USTs (Tank Nos. 1225.01, 1225.02, and 1225.03). Although soil around and beneath the tanks was removed, some contaminated soil was left in place. The maximum depth of the soil excavation was reported at 30 feet bgs; however, the base of the fill material has been observed to be between 15 and 20 feet bgs (ES, 1993b).

During UST removal, 13 soil samples were collected from the excavation pit and analyzed for extractable petroleum hydrocarbons (total petroleum hydrocarbons [TPH] as diesel [TPH-d]) by USEPA Method SW3550/SW8015, purgeable petroleum hydrocarbons (TPH as gasoline [TPH-g]) by USEPA Method SW5030/SW8015, and purgeable aromatics (benzene, toluene, ethylbenzene, and total xylenes [BTEX]) by USEPA Method SW8020. During this sampling event, TPH-d and TPH-g were detected at maximum concentrations of 6,000 milligrams per kilogram (mg/kg) and 860 mg/kg, respectively (ES, 1993b). Benzene, toluene, ethylbenzene, and total xylenes were detected at maximum concentrations of 48 mg/kg, 190 mg/kg, 83 mg/kg, and 400 mg/kg, respectively.

### 2.3.2 Bioventing Pilot Test System Installation and Operation

In order to address the petroleum hydrocarbon contamination remaining in site soils following UST removal, Parsons ES installed a bioventing pilot test system at IRP Site SD-11 in April 1993 as part of the AFCEE Bioventing Initiative program (ES, 1993b). The purpose of this project was to determine if *in situ* bioventing would be a feasible cleanup technology for remediating the remaining fuel-contaminated unsaturated zone soils near the former UST excavation. The installed pilot-scale bioventing system consisted of one vent well (VW1), three multi-depth vapor monitoring points (VMP1, VMP2, and VMP3), a regenerative blower and blower housing, air supply piping, and electrical service (Figure 2.2).

The VW and VMPs were installed in accordance with procedures described in the protocol document (Hinchee *et al.*, 1992). The VW was screened from 10 to 50 feet bgs based on field evidence of petroleum contamination between 23 and 26 and 38 and 43 feet bgs. Three casing strings and 6-inch screens were installed in each VMP borehole at depths of approximately 24, 30, and 40 feet bgs to provide monitoring points at variable depths, soil types, and contamination levels. An additional casing string/screen was placed approximately 50 feet bgs at VMP2 because of high organic vapor analysis (OVA) readings and the presence of a clay layer at this depth interval (Figure 2.3). During system startup, the effective radius of oxygen influence was determined to be at least 55 feet for VW1 (ES, 1993b). Results of soil and soil vapor

samples collected prior to, during, and following the 1-year pilot test are presented in Tables 2.1 and 2.2, respectively.

The 1-year bioventing pilot test, completed in June 1994, demonstrated that bioventing is an effective treatment technology for petroleum-contaminated soils present within the unsaturated zone at the AGE Maintenance Area. The 1-year monitoring results also indicated that the long-term radius of oxygen influence may be as high as 70 feet from VW1. Total volatile hydrocarbon (TVH) and BTEX concentrations in soil vapor were reduced by as much as 4 orders of magnitude (Table 2.2). While similar reductions were not observed in three confirmatory soil samples collected in July 1994 (Table 2.1), this is likely due to a heterogeneous distribution of contamination and the inherent variability of limited soil sampling (Parsons ES, 1995). Based on the favorable pilot testing results, IRP Site SD-11 was included in the AFCEE Extended Bioventing Project for system expansion (Option 4) and 1 year of system operation and monitoring followed by soil vapor sampling and *in situ* respiration testing (Option 1). In anticipation of favorable expanded bioventing system results, the AFCEE Extended Bioventing Project also provided funding for confirmatory soil sampling and site closure (Option 2), if appropriate.

### 2.3.3 1994 Site Characterization

In the fall of 1994, Law Environmental performed a site characterization at IRP Site SD-11 which included collection of soil vapor samples, surface and subsurface soil samples, and groundwater samples (Law Environmental, 1995).

Soil vapor samples were collected from depths of 3 to 10 feet bgs to ascertain potential contaminant source areas and determine appropriate locations for subsequent soil sampling. Soil vapor samples were analyzed onsite for TPH, BTEX, and HVOCs using a mobile laboratory. Soil vapor sample results for the UST excavation area and adjoining areas are shown in Table 2.3. Soil vapor sample locations are shown on Figure 2.4. During this survey, TPH concentrations exceeding 13,000 parts per million, by volume (ppmv) and total BTEX results exceeding 70 ppmv were detected in four soil vapor samples (11L009VP, 11L021VP, 11L023VP, and 11L024VP) collected east of the UST excavation and pump island. The maximum TPH concentration (190,500 ppmv) and maximum total BTEX concentration (435 ppmv) were detected in the sample collected at 11L009VP, directly north of the concrete paved area, approximately 60 feet from the pump island. Trichloroethene (TCE) (0.11 ppmv), 1,2-dichloroethene (1,2-DCE) (0.42 ppmv), 1,1-DCE (0.50 ppmv), 1,2-dichloroethane (1,2-DCA) (5.8 ppmv), and methylene chloride (0.75 ppmv) also were detected at this location. The highest soil vapor concentrations of TCE (2.81 ppmv) and 1,2-DCE (31 ppmv) were detected in the sample collected at 11L008VP near former Oil/Water Separator A (Figure 2.4).

Following evaluation of the soil vapor sample results, Law Environmental advanced seven soil borings (11L002SB, 11L005SB, 11L008SB, 11L009SB, 11L0010SB, 11L0011SB, and 11L0012SB) and collected four surface soil samples (11L005SS, 11L007SS, 11L008SS, and 11L009SS) near the UST excavation (Figure 2.4). Soil sample results are shown in Table 2.4. TPH contamination exceeding 350 mg/kg was discovered in samples collected at 10, 15, and 62.5 feet bgs from soil boring 11L002SB located on the north side of the former UST excavation. Comparatively

**TABLE 2.1**  
**SUMMARY OF PARSONS ES SOIL ANALYTICAL SAMPLING RESULTS**  
 IRP SITE SD-11  
 BEALE AFB, CALIFORNIA

| Analyte <sup>a/</sup>                                | Units <sup>b/</sup> | Method         | Sample Location - Depth (feet below ground surface) |           |                          |                   |
|------------------------------------------------------|---------------------|----------------|-----------------------------------------------------|-----------|--------------------------|-------------------|
| 1993 Pilot-Scale Bioventing System Installation      |                     |                |                                                     |           |                          |                   |
|                                                      |                     |                | VW1-30                                              | VMP1-24.5 | VMP2-25.5                |                   |
| TRPH                                                 | mg/kg               | 418.1          | <5 <sup>d/</sup>                                    | <5        | 1,186/309 <sup>u/</sup>  |                   |
| Benzene                                              | mg/kg               | SW5030/SW8020  | 0.0035                                              | 1.8       | <4.0/ <sup>e/</sup> <3.9 |                   |
| Toluene                                              | mg/kg               | SW5030/SW8020  | 0.020                                               | 1.8       | 150/48                   |                   |
| Ethylbenzene                                         | mg/kg               | SW5030/SW8020  | 0.0043                                              | 0.11      | 68/27                    |                   |
| Total Xylenes                                        | mg/kg               | SW5030/SW8020  | 0.039                                               | 0.65      | 510/129                  |                   |
| 1994 Pilot-Scale Bioventing 1-Year Results           |                     |                |                                                     |           |                          |                   |
|                                                      |                     |                | VW1-30                                              | VMP1-24.5 | VMP2-25.5                |                   |
| TRPH                                                 | mg/kg               | 418.1          | 85.8                                                | 1,010     | 3,680                    |                   |
| Benzene                                              | mg/kg               | SW5030/SW8020  | 0.0005                                              | <0.61     | <3.0                     |                   |
| Toluene                                              | mg/kg               | SW5030/SW8020  | 0.013                                               | <0.61     | <3.0                     |                   |
| Ethylbenzene                                         | mg/kg               | SW5030/SW8020  | 0.0076                                              | <0.61     | 13                       |                   |
| Total Xylenes                                        | mg/kg               | SW5030/SW8020  | 0.074                                               | 10        | 720                      |                   |
| 1996 Expanded Bioventing System Installation Results |                     |                |                                                     |           |                          |                   |
| Total Hydrocarbons                                   |                     |                | VW2-10                                              | VW2-50.5  | VW3-24                   | VMP4-13 VMP5-18.5 |
| TPH-g                                                | mg/kg               | SW5030/SW8015m | 2,500                                               | <1.2      | <1.1                     | <1.2              |
| TPH-JP5                                              | mg/kg               | SW3550/SW8015m | 160 Y <sup>d/</sup> L <sup>u/</sup>                 | <1.2      | 7 YH <sup>v/</sup>       | 90 YH             |
| TPH-d                                                | mg/kg               | SW3550/SW8015m | 60 YLH                                              | <1.2      | 18 YH                    | 300 YH            |
| TPH-mo                                               | mg/kg               | SW3550/SW8015m | 9.1 YL                                              | <5.8      | 60 YH                    | 290 YL            |
| Benzene                                              | mg/kg               | SW5030/SW8020  | 6.8                                                 | <0.0058   | <0.0057                  | <0.0062           |
| Toluene                                              | mg/kg               | SW5030/SW8020  | 94                                                  | <0.0058   | <0.0057                  | <0.0062           |
| Ethylbenzene                                         | mg/kg               | SW5030/SW8020  | 37                                                  | <0.0058   | <0.0057                  | <0.0062           |
| Total Xylenes                                        | mg/kg               | SW5030/SW8020  | 173                                                 | <0.0058   | <0.0057                  | <0.0062           |

TABLE 2.1 (Continued)  
SUMMARY OF PARSONS ES SOIL ANALYTICAL SAMPLING RESULTS  
IRP SITE SD-11  
BEALE AFB, CALIFORNIA

| Analyte <sup>a/</sup>                                            | Units <sup>b/</sup> | Method                        | Sample Location - Depth (feet below ground surface) |          |        |         |           |
|------------------------------------------------------------------|---------------------|-------------------------------|-----------------------------------------------------|----------|--------|---------|-----------|
| 1996 Expanded Bioventing System Installation Results (continued) |                     |                               |                                                     |          |        |         |           |
| Total Halogenated VOCs                                           |                     |                               | VW2-10                                              | VW2-50.5 | VW3-24 | VMP4-13 | VMP5-18.5 |
| HVOCs                                                            | mg/kg               | SW5030/SW8010                 | all ND <sup>b/</sup>                                | all ND   | all ND | all ND  | all ND    |
| Soluble Hydrocarbons                                             |                     |                               |                                                     |          |        |         |           |
| TPH-JP5                                                          | ug/L                | DI-WET <sup>y/</sup> /SW8015m | 1,900 YLZ <sup>y/</sup>                             | ✓        |        | --      | <50       |
| TPH-d                                                            | ug/L                | DI-WET/SW8015m                | 610 YLZ                                             | --       |        | --      | <50       |
| TPH-mo                                                           | ug/L                | DI-WET/SW8015m                | <300                                                | --       |        | --      | <300      |
| Benzene                                                          | ug/L                | DI-WET/SW8020                 | 87                                                  | --       |        | --      | --        |
| Toluene                                                          | ug/L                | DI-WET/SW8020                 | 950                                                 | --       |        | --      | --        |
| Ethylbenzene                                                     | ug/L                | DI-WET/SW8020                 | 260                                                 | --       |        | --      | --        |
| Total Xylenes                                                    | ug/L                | DI-WET/SW8020                 | 1,950                                               | --       |        | --      | --        |

<sup>a/</sup>TPH = total recoverable petroleum hydrocarbons; TPH-g = total petroleum hydrocarbons (TPH) as gasoline; TPH-JP5 = TPH as jet fuel #5 (C10-C16); TPH-d = TPH as diesel (C12-C22); and TPH-mo = TPH as motor oil (C22-C50).

<sup>b/</sup>mg/kg = milligrams per kilogram; ug/L = micrograms per liter.

<sup>c/</sup>< and gray shading = Compound analyzed for, but not detected. Number shown represents the laboratory reporting limit.

<sup>d/</sup>Results of primary sample/field duplicate.

<sup>e/</sup>Y = sample exhibits field pattern which does not resemble standard.

<sup>f/</sup>L = lighter hydrocarbons than indicated in standard.

<sup>g/</sup>H = heavier hydrocarbons than indicated in standard.

<sup>h/</sup>all ND = halogenated VOCs were not detected.

<sup>i/</sup>DI-WET = deionized water extraction, waste extraction test.

<sup>j/</sup>Z = sample exhibits unknown single peak or peaks.

<sup>k/</sup>-- = not analyzed.

**TABLE 2.2**  
**SUMMARY OF PARSONS ES FIELD AND TVH AND BTX SOIL ANALYTICAL VAPOR RESULTS**  
 IRP SITE SD-11  
 BEALE AFB, CALIFORNIA

| Field-Screening Data                     |                               |                                    |                  |                   | Laboratory Data <sup>v</sup>         |                         |                |                     |                     |                |                  |
|------------------------------------------|-------------------------------|------------------------------------|------------------|-------------------|--------------------------------------|-------------------------|----------------|---------------------|---------------------|----------------|------------------|
| Sample Location                          | Depth (feet bgs) <sup>v</sup> | Sampling Event <sup>w</sup> (Date) | Carbon           |                   | TVH <sup>v</sup> (ppmv) <sup>d</sup> | TVH <sup>v</sup> (ppmv) | Benzene (ppmv) | Toluene (ppmv)      | Ethylbenzene (ppmv) | Xylenes (ppmv) | Total BTX (ppmv) |
|                                          |                               |                                    | Oxygen (percent) | Dioxide (percent) |                                      |                         |                |                     |                     |                |                  |
| PILOT-SCALE BIOVENTING SYSTEM COMPONENTS |                               |                                    |                  |                   |                                      |                         |                |                     |                     |                |                  |
| VW1                                      | 10-50                         | Initial (5/93)                     | 2.0              | 8.0               | 9,600                                | 51,000                  | 30             | 74                  | 13                  | 310            | 427              |
|                                          |                               | 1-Year (7/94)                      | 20.5             | 0.6               | 96                                   | 7.4                     | 0.008          | <0.002 <sup>d</sup> | 0.006               | 0.12           | 0.134            |
|                                          |                               | 3-Year (7/96)                      | 19.9             | 0.3               | 12                                   | -- <sup>v</sup>         | --             | --                  | --                  | --             | --               |
|                                          |                               | 5-Year (4/98)                      | 19.7             | 0.7               | 0                                    | 6.5                     | <0.023         | <0.023              | <0.023              | 0.051          | 0.051            |
| VMP1                                     | 24                            | Initial (5/93)                     | 3.0              | 11.0              | >10,000 <sup>v</sup>                 | 72,000                  | 430            | 550                 | 40                  | 240            | 1,260            |
|                                          |                               | 1-Year (7/94)                      | 10.0             | 3.2               | 1,200                                | 3,500                   | 1.2            | 12                  | 10                  | 140            | 163.2            |
|                                          |                               | 3-Year (7/96)                      | 7.5              | 3.3               | 105                                  | --                      | --             | --                  | --                  | --             | --               |
|                                          |                               | 5-Year (4/98)                      | 6.0              | 3.9               | 100                                  | 37                      | <0.012         | 0.022               | 0.044               | 0.25           | 0.346            |
|                                          |                               | Initial (5/93)                     | 2.8              | 7.5               | >10,000                              | --                      | --             | --                  | --                  | --             | --               |
|                                          | 30                            | 1-Year (7/94)                      | 19.0             | 0.7               | 66                                   | --                      | --             | --                  | --                  | --             | --               |
|                                          |                               | 3-Year (7/96)                      | 20.0             | 0.5               | 10                                   | --                      | --             | --                  | --                  | --             | --               |
|                                          |                               | 5-Year (4/98)                      | 20.0             | 0.7               | 25                                   | --                      | --             | --                  | --                  | --             | --               |
|                                          |                               | Initial (5/93)                     | 3.0              | 7.0               | >10,000                              | --                      | --             | --                  | --                  | --             | --               |
|                                          |                               | 1-Year (7/94)                      | 18.5             | 0.6               | 36                                   | --                      | --             | --                  | --                  | --             | --               |
| VMP2                                     | 24                            | 3-Year (7/96)                      | 19.0             | 0.5               | 10                                   | --                      | --             | --                  | --                  | --             | --               |
|                                          |                               | 5-Year (4/98)                      | 19.0             | 0.9               | 30                                   | --                      | --             | --                  | --                  | --             | --               |
|                                          |                               | Initial (5/93)                     | 2.0              | 6.8               | >10,000                              | --                      | --             | --                  | --                  | --             | --               |
|                                          |                               | 1-Year (7/94)                      | 9.5              | 3.0               | 4,400                                | --                      | --             | --                  | --                  | --             | --               |
|                                          |                               | 3-Year (7/96)                      | 9.5              | 3.5               | 260                                  | --                      | --             | --                  | --                  | --             | --               |
|                                          | 30                            | 5-Year (4/98)                      | 6.5              | 6.0               | 100                                  | 37                      | <0.024         | 0.037               | 0.041               | 0.23           | 0.308            |
|                                          |                               | Initial (5/93)                     | 3.5              | 7.2               | >10,000                              | --                      | --             | --                  | --                  | --             | --               |
|                                          |                               | 1-Year (7/94)                      | 19.0             | 0.6               | 300                                  | --                      | --             | --                  | --                  | --             | --               |
|                                          |                               | 3-Year (7/96)                      | 19.0             | 0.3               | 28                                   | --                      | --             | --                  | --                  | --             | --               |
|                                          |                               | 5-Year (4/98)                      | 20.4             | 0.6               | 10                                   | --                      | --             | --                  | --                  | --             | --               |
|                                          | 40                            | Initial (5/93)                     | 3.0              | 6.6               | >10,000                              | --                      | --             | --                  | --                  | --             | --               |
|                                          |                               | 1-Year (7/94)                      | 17.8             | 0.8               | 780                                  | --                      | --             | --                  | --                  | --             | --               |
|                                          |                               | 3-Year (7/96)                      | 19.5             | 0.8               | 70                                   | --                      | --             | --                  | --                  | --             | --               |
|                                          |                               | 5-Year (4/98)                      | 19.9             | 0.7               | 20                                   | --                      | --             | --                  | --                  | --             | --               |
|                                          |                               | Initial (5/93)                     | 2.2              | 6.2               | 7,800                                | --                      | --             | --                  | --                  | --             | --               |
|                                          | 50                            | 1-Year (7/94)                      | 14.9             | 2.9               | 1,900                                | --                      | --             | --                  | --                  | --             | --               |
|                                          |                               | 3-Year (7/96)                      | 17.5             | 2.0               | 110                                  | --                      | --             | --                  | --                  | --             | --               |
|                                          |                               | 5-Year (4/98)                      | 18.3             | 1.9               | 70                                   | --                      | --             | --                  | --                  | --             | --               |

TABLE 2.2 (Continued)  
SUMMARY OF PARSONS ES FIELD AND TVH AND BTEX SOIL ANALYTICAL VAPOR RESULTS  
IRP SITE SD-11  
BEALE AFB, CALIFORNIA

| Field-Screening Data                  |                               |                                       |                   |                  | Laboratory Data <sup>v</sup>            |                            |                |                |                     |                |                   |
|---------------------------------------|-------------------------------|---------------------------------------|-------------------|------------------|-----------------------------------------|----------------------------|----------------|----------------|---------------------|----------------|-------------------|
| Sample Location                       | Depth (feet bgs) <sup>v</sup> | Sampling Event <sup>w</sup><br>(Date) | Carbon            |                  | TVH <sup>u</sup><br>(ppmv) <sup>d</sup> | TVH <sup>u</sup><br>(ppmv) | Benzene (ppmv) | Toluene (ppmv) | Ethylbenzene (ppmv) | Xylenes (ppmv) | Total BTEX (ppmv) |
|                                       |                               |                                       | Dioxide (percent) | Oxygen (percent) |                                         |                            |                |                |                     |                |                   |
| VMP3                                  | 24                            | Initial (5/93)                        | 6.6               | 1.0              | 2,000                                   | 55,000                     | 580            | 970            | 59                  | 350            | 1,959             |
|                                       |                               | 1-Year (7/94)                         | 3.4               | 11.8             | 2,100                                   | 4,900                      | 2.7            | 26             | 12                  | 390            | 430.7             |
|                                       |                               | 3-Year (7/96)                         | 3.0               | 12.0             | 1,100                                   | 4,200                      | <1.5           | <1.5           | <1.5                | 150            | 150               |
|                                       |                               | 3.1-Year (8/96) <sup>y</sup>          | 2.0               | 17.5             | 1,000                                   | 3,600                      | 0.89           | <0.67          | <0.67               | 62             | 62.89             |
|                                       |                               | 5-Year (4/98)                         | 3.7               | 14.1             | 550                                     | 1,300                      | <0.12          | 0.17           | 0.63                | 14             | 14.8              |
|                                       | 30                            | Initial (5/93)                        | 7.8               | 1.5              | 9,200                                   | --                         | --             | --             | --                  | --             | --                |
|                                       |                               | 1-Year (7/94)                         | 0.7               | 18.0             | 500                                     | --                         | --             | --             | --                  | --             | --                |
|                                       |                               | 3-Year (7/96)                         | 0.5               | 18.5             | 53                                      | --                         | --             | --             | --                  | --             | --                |
|                                       |                               | 5-Year (4/98)                         | 0.6               | 20.4             | 5                                       | --                         | --             | --             | --                  | --             | --                |
|                                       |                               | Initial (5/93)                        | 5.8               | 1.6              | 5,600                                   | --                         | --             | --             | --                  | --             | --                |
|                                       | 40                            | 1-Year (7/94)                         | 0.6               | 18.2             | 100                                     | --                         | --             | --             | --                  | --             | --                |
|                                       |                               | 3-Year (7/96)                         | 0.3               | 18.5             | 16                                      | --                         | --             | --             | --                  | --             | --                |
|                                       |                               | 5-Year (4/98)                         | 0.6               | 20.4             | 10                                      | --                         | --             | --             | --                  | --             | --                |
|                                       |                               | Initial (7/96)                        | 0.3               | 20.8             | 66                                      | --                         | --             | --             | --                  | --             | --                |
|                                       |                               | 1.75-Year (4/98)                      | 0.5               | 20.8             | 0                                       | --                         | --             | --             | --                  | --             | --                |
| EXPANDED BIOVENTING SYSTEM COMPONENTS |                               |                                       |                   |                  |                                         |                            |                |                |                     |                |                   |
| VW2                                   | 10-40                         | Initial (7/96)                        | 0.3               | 20.5             | 200                                     | 52/28 <sup>v</sup>         | 0.28/0.069     | 0.26/0.055     | <0.037/ <0.036      | 0.88/0.79      | 1.42/0.914        |
|                                       |                               | 1.75-Year (4/98)                      | 0.6               | 20.4             | 0                                       | --                         | --             | --             | --                  | --             | --                |
| VW3                                   | 10-40                         | Initial (7/96)                        | 0.0               | 20.8             | 2                                       | 5.3                        | 0.0058         | 0.0021         | <0.00073            | 0.0101         | 0.018             |
|                                       |                               | 1.75-Year (4/98)                      | 0.5               | 20.8             | 0                                       | --                         | --             | --             | --                  | --             | --                |
| VMP4                                  | 10                            | Initial (7/96)                        | 1.9               | 18.0             | 190                                     | 99/150                     | 0.048/0.100    | <0.037/ <0.00  | <0.021/ <0.009      | 0.021/ <0.00   | 0.048/0.100       |
|                                       |                               | 1-month (8/96) <sup>y</sup>           | 2.8               | 16.5             | 1,000                                   | 1,200                      | 0.23           | <0.049         | <0.049              | <0.049         | 0.23              |
|                                       |                               | 1.75-Year (4/98)                      | 9.2               | 3.7              | 9000 <sup>v</sup>                       | <0.9/ <12.0                | <0.99/ <1.2    | <0.99/ <1.2    | <0.99/ <1.2         | <0.99/ <1.2    | <3.96/ <4.8       |
|                                       | 24                            | Initial (7/96)                        | 0.8               | 19.5             | 46                                      | --                         | --             | --             | --                  | --             | --                |
|                                       |                               | 1.75-Year (4/98)                      | 1.0               | 19.0             | 50                                      | <0.0081                    | <0.00081       | <0.00081       | <0.00081            | 0.0051         | --                |
|                                       |                               | Initial (7/96)                        | 0.0               | 20.8             | 290                                     | <0.360                     | <0.360         | <0.360         | <0.360              | <0.360         | <1.44             |
|                                       | 30                            | 1-month (8/96) <sup>y</sup>           | 0.3               | 20.6             | 14                                      | 0.66                       | <0.0012        | <0.0012        | <0.0012             | <0.0012        | <0.0048           |
|                                       |                               | 1.75-Year (4/98)                      | 0.5               | 20.8             | 0                                       | --                         | --             | --             | --                  | --             | --                |
|                                       |                               | Initial (7/96)                        | 0.3               | 20.8             | 66                                      | --                         | --             | --             | --                  | --             | --                |
|                                       | 40                            | 1.75-Year (4/98)                      | 0.5               | 20.8             | 0                                       | --                         | --             | --             | --                  | --             |                   |

TABLE 2.2 (Continued)  
SUMMARY OF PARSONS ES FIELD AND TVH AND BTEX SOIL ANALYTICAL VAPOR RESULTS  
IRP SITE SD-11  
BEALE AFB, CALIFORNIA

| Sample Location | Depth (feet bgs) <sup>v</sup> | Sampling Event <sup>v</sup> (Date) | Field-Screening Data |                          |                                      | Laboratory Data <sup>v</sup> |                |                |                     |                   |
|-----------------|-------------------------------|------------------------------------|----------------------|--------------------------|--------------------------------------|------------------------------|----------------|----------------|---------------------|-------------------|
|                 |                               |                                    | Oxygen (percent)     | Carbon Dioxide (percent) | TVH <sup>v</sup> (ppmv) <sup>u</sup> | TVH <sup>u</sup> (ppmv)      | Benzene (ppmv) | Toluene (ppmv) | Ethylbenzene (ppmv) | Total BTEX (ppmv) |
| VMP5            | 10                            | Initial (7/96)                     | 11.9                 | 4.5                      | 74                                   | 1.8                          | 0.0038         | 0.0012         | <0.00078            | <0.00078          |
|                 |                               | 1-month (8/96) <sup>y</sup>        | 16.8                 | >5.0                     | 100                                  | 0.072                        | <0.00070       | 0.00078        | <0.00070            | 0.005             |
|                 |                               | 1.75-Year (4/98)                   | 20.6                 | 0.8                      | 16                                   | --                           | --             | --             | <0.00070            | 0.00078           |
|                 | 24                            | Initial (7/96)                     | 20.8                 | 0.3                      | 100                                  | --                           | --             | --             | --                  | --                |
|                 |                               | 1.75-Year (4/98)                   | 20.8                 | 0.5                      | 0                                    | --                           | --             | --             | --                  | --                |
|                 | 30                            | Initial (7/96)                     | 20.8                 | 0.3                      | 94                                   | --                           | --             | --             | --                  | --                |
|                 |                               | 1.75-Year (4/98)                   | 20.8                 | 0.5                      | 0                                    | --                           | --             | --             | --                  | --                |
|                 | 40                            | Initial (7/96)                     | 20.8                 | 0.3                      | 16                                   | --                           | --             | --             | --                  | --                |
|                 |                               | 1.75-Year (4/98)                   | 20.8                 | 0.5                      | 0                                    | --                           | --             | --             | --                  | --                |

<sup>v</sup> ft bgs = feet below ground surface.

<sup>w</sup> Sampling events identified based upon approximate time since pilot-scale and expanded-scale bioventing began in May 1993 and July 1996, respectively.

<sup>x</sup> TVH = total volatile hydrocarbons.

<sup>y</sup> ppmv = parts per million, by volume.

<sup>z</sup> Laboratory analysis of soil vapor performed using either USEPA Method TO-3 or USEPA Method TO-14.

<sup>u</sup> TVH referenced to jet fuel and gasoline when analyzed by Method TO-3 and Method TO-14, respectively.

<sup>v</sup> < and gray shading = Compound analyzed for, but not detected. Number shown represents the laboratory reporting limit.

<sup>w</sup> -- = not analyzed.

<sup>x</sup> > = concentration greater than maximum reading on field instrument.

<sup>y</sup> System operating during sampling event; results represent "dynamic" conditions 1 month following expanded bioventing system startup.

<sup>z</sup> Original sample result/duplicate result.

<sup>v</sup> Although TVH and BTEX were not detected in the analytical sample, 4,900 ppmv of non-methane organic hydrocarbons (referenced to heptane) were detected by the laboratory.

**TABLE 2.3**  
**SUMMARY OF 1994 LAW ENVIRONMENTAL SOIL VAPOR ANALYTICAL RESULTS**  
**IN THE UST EXCAVATION AREA AND ADJOINING AREAS**

IRP SITE SD-11  
 BEALE AFB, CALIFORNIA

| Sample Location | Sample Date | Depth (ft bgs) <sup>d</sup> | Petroleum Hydrocarbons <sup>d</sup> |         |         |              |               | HVOCs <sup>d</sup> |      |                 |                 |         |         |           |                    |
|-----------------|-------------|-----------------------------|-------------------------------------|---------|---------|--------------|---------------|--------------------|------|-----------------|-----------------|---------|---------|-----------|--------------------|
|                 |             |                             | TPH                                 | Benzene | Toluene | Ethylbenzene | Total Xylenes | Total BTEX         | TCE  | PCE             | results in ppmv |         |         |           |                    |
|                 |             |                             |                                     |         |         |              |               |                    |      |                 | 1,2-DCE         | 1,1-DCE | 1,2-DCA | 1,1,1-TCA | Methylene Chloride |
| 11L008VP        | 8/15/94     | 7.0                         | 1,572                               | 10.15   | 3.46    | 0.39         | 1.52          | 15.52              | 2.81 | ND <sup>d</sup> | 31.0            | 0.27    | ND      | ND        | ND                 |
| 11L009VP        | 8/16/94     | 10.0                        | 190,500                             | 242.44  | 170.05  | 4.84         | 17.83         | 435.16             | 0.11 | ND              | 0.42            | 0.50    | 5.8     | ND        | 0.75               |
| 11L010VP        | 8/16/94     | 8.0                         | 1,860                               | 6.3     | 2.45    | 0.14         | 0.64          | 9.53               | 0.02 | 0.01            | 0.09            | ND      | 0.05    | 0.02      | ND                 |
| 11L011VP        | 8/16/94     | 7.5                         | 21                                  | 8.55    | 5.02    | 0.12         | 0.56          | 14.25              | 0.04 | ND              | 0.10            | ND      | 0.09    | ND        | ND                 |
| 11L012VP        | 8/16/94     | 10.0                        | 12                                  | 0.22    | 0.22    | ND           | 0.13          | 0.57               | ND   | ND              | ND              | ND      | ND      | ND        | ND                 |
| 11L013VP        | 8/16/94     | 10.0                        | 11                                  | 0.17    | 0.24    | 0.02         | 0.15          | 0.58               | ND   | ND              | ND              | ND      | ND      | ND        | ND                 |
| 11L014VP        | 8/16/94     | 10.0                        | 3,047                               | 28.08   | 18.88   | 4.51         | 17.16         | 68.63              | 0.04 | ND              | 0.12            | ND      | 0.16    | ND        | ND                 |
| 11L015VP        | 8/16/94     | 10.0                        | 317                                 | 4.54    | 4.49    | 0.75         | 4.65          | 14.43              | ND   | ND              | ND              | ND      | 0.02    | ND        | 0.03               |
| 11L016VP        | 8/16/94     | 10.0                        | 14                                  | ND      | ND      | ND           | ND            | ND                 | ND   | ND              | ND              | ND      | ND      | ND        | ND                 |
| 11L017VP        | 8/16/94     | 10.0                        | 3                                   | ND      | ND      | ND           | ND            | ND                 | ND   | ND              | ND              | ND      | ND      | ND        | ND                 |
| 11L018VP        | 8/16/94     | 10.0                        | 7                                   | 0.03    | 0.14    | 0.08         | 0.73          | 0.98               | ND   | ND              | ND              | ND      | ND      | ND        | ND                 |
| 11L019VP        | 8/16/94     | 10.0                        | 37                                  | 0.1     | 0.29    | 0.63         | 5.41          | 6.43               | ND   | ND              | ND              | ND      | ND      | ND        | ND                 |
| 11L020VP        | 8/16/94     | 10.0                        | 5                                   | ND      | ND      | ND           | ND            | ND                 | ND   | ND              | ND              | ND      | ND      | ND        | ND                 |
| 11L021VP        | 8/16/94     | 4.5                         | 13,040                              | 70.58   | 1.57    | ND           | 0.25          | 72.40              | ND   | ND              | ND              | ND      | ND      | ND        | ND                 |
| 11L022VP        | 8/16/94     | 5.0                         | 873                                 | 6.56    | 0.61    | 0.91         | 3.72          | 11.8               | ND   | ND              | ND              | ND      | ND      | ND        | ND                 |
| 11L023VP        | 8/16/94     | 9.0                         | 37,700                              | 114.72  | 80.12   | 4.78         | 19.02         | 218.64             | 0.23 | ND              | ND              | ND      | ND      | ND        | ND                 |
| 11L024VP        | 8/17/94     | 8.0                         | 106,000                             | 259.65  | 87.14   | ND           | 6.41          | 353.2              | 0.02 | ND              | ND              | ND      | 0.71    | ND        | 0.15               |
| 11L025VP        | 8/17/94     | 10.0                        | 2                                   | 0.07    | 0.13    | 0.05         | 0.11          | 0.36               | ND   | ND              | ND              | ND      | ND      | ND        | ND                 |
| 11L026VP        | 8/17/94     | 3.0                         | 22                                  | 0.23    | 0.35    | 0.03         | 0.18          | 0.79               | ND   | ND              | 0.03            | ND      | ND      | ND        | ND                 |
| 11L037VP        | 9/14/94     | 7.5                         | 345                                 | 3.77    | 1.45    | 0.27         | 0.44          | 5.93               | ND   | ND              | ND              | ND      | ND      | ND        | ND                 |

Source: Law, 1995.

<sup>d</sup> Total petroleum hydrocarbon and BTEX analysis by USEPA Methods SW8015 and SW8020, respectively.  
<sup>e</sup> HVOCs = halogenated volatile organic compounds analyzed by USEPA Method SW8010. TCE = trichloroethene; PCB = polychlorinated biphenyls; DCE = dichloroethene.

DCA = dichloroacetic acid, and TCA = trichloroacetic acid.

<sup>d</sup> ft bgs = feet below ground surface.

<sup>e</sup> ppmv = parts per million, by volume.

<sup>f</sup> ND and gray shading = analyte not detected.



TABLE 2.4  
SUMMARY OF 1994 LAW ENVIRONMENTAL SOIL ANALYTICAL RESULTS  
IN THE UST EXCAVATION AREA AND ADJOINING AREAS  
IRP SITE SD-11  
BEALE APB, CALIFORNIA

BEALE AFB, CALIFORNIA

| Total Petroleum Hydrocarbons <sup>v</sup> |          |                               |       |                    |        |      |         |                    |                   | BTEX                 |         |                      | HVOCs <sup>w</sup> |                          |         |  |
|-------------------------------------------|----------|-------------------------------|-------|--------------------|--------|------|---------|--------------------|-------------------|----------------------|---------|----------------------|--------------------|--------------------------|---------|--|
| Analytical Method :                       |          | TPH-g                         | TPH-d | TPH-j <sup>f</sup> | TPH-ts | TRPH | Benzene | Toluene            | Ethyl-<br>benzene | Total<br>Xylenes     | 1,2-DCA | 2-Butanone           | 2-Ethexanone       | 4-Methyl-2-<br>Pentanone |         |  |
| Sample                                    | Location | SW8015M                       |       |                    |        |      | 418.1   |                    |                   |                      |         | SW8260               |                    |                          |         |  |
| Depth<br>(ft bgs) <sup>v</sup>            |          | results in mg/kg <sup>v</sup> |       |                    |        |      |         |                    |                   |                      |         |                      |                    | results in mg/kg         |         |  |
| Soil Borings                              |          |                               |       |                    |        |      |         |                    |                   |                      |         |                      |                    |                          |         |  |
| 11L002SB                                  | 5.0      | ND <sup>u</sup>               | 24    | ND                 | ND     | ND   | ND      | ND                 | ND                | ND                   | ND      | ND                   | ND                 | ND                       | ND      |  |
| 11L002SB                                  | 10.0     | ND                            | 2,000 | 2,900              | ND     | ND   | ND      | 9 JII <sup>u</sup> | 5 JH              | 39                   | ND      | ND                   | ND                 | ND                       | ND      |  |
| 11L002SB                                  | 15.0     | 610 J                         | ND    | ND                 | 350    | ND   | 0.02    | 0.56               | 0.27              | 3.6                  | ND      | ND                   | ND                 | ND                       | ND      |  |
| 11L002SB                                  | 34.5     | ND                            | ND    | ND                 | ND     | ND   | ND      | ND                 | ND                | ND                   | ND      | ND                   | ND                 | ND                       | ND      |  |
| 11L002SB                                  | 39.5     | ND                            | ND    | ND                 | ND     | ND   | ND      | ND                 | ND                | 0.001 J <sup>v</sup> | ND      | ND                   | ND                 | ND                       | ND      |  |
| 11L002SB                                  | 45.5     | 0.56 J                        | ND    | ND                 | ND     | ND   | ND      | ND                 | 0.002             | 0.002                | ND      | ND                   | ND                 | ND                       | ND      |  |
| 11L002SB                                  | 46.5     | 0.64 J                        | ND    | ND                 | ND     | ND   | ND      | ND                 | ND                | ND                   | ND      | ND                   | ND                 | ND                       | ND      |  |
| 11L002SB                                  | 47.5     | 1.0 J                         | 6.0 J | ND                 | ND     | ND   | ND      | ND                 | ND                | ND                   | ND      | 0.016 JII            | ND                 | ND                       | ND      |  |
| 11L002SB                                  | 49.5     | ND                            | ND    | ND                 | ND     | ND   | ND      | ND                 | ND                | 0.003                | ND      | ND                   | ND                 | ND                       | ND      |  |
| 11L002SB                                  | 62.5     | 760 J                         | ND    | ND                 | 1,200  | ND   | ND      | ND                 | 1 JH              | 16 JH                | ND      | ND                   | ND                 | ND                       | ND      |  |
| 11L005SB                                  | 94.0     | ND                            | ND    | ND                 | ND     | ND   | ND      | ND                 | ND                | ND                   | ND      | ND                   | ND                 | ND                       | ND      |  |
| 11L005SB                                  | 95.0     | ND                            | ND    | ND                 | ND     | ND   | ND      | ND                 | ND                | ND                   | ND      | ND                   | ND                 | ND                       | ND      |  |
| 11L008SB                                  | 75.0     | ND                            | ND    | ND                 | ND     | ND   | ND      | ND                 | ND                | 0.001                | ND      | ND                   | ND                 | ND                       | ND      |  |
| 11L008SB                                  | 100.0    | ND                            | ND    | ND                 | ND     | ND   | ND      | ND                 | ND                | ND                   | 0.003   | 0.002 R <sup>v</sup> | ND                 | ND                       | ND      |  |
| 11L009SB                                  | 75.0     | ND                            | 20    | ND                 | ND     | ND   | ND      | ND                 | ND                | ND                   | ND      | ND                   | ND                 | ND                       | ND      |  |
| 11L009SB                                  | 105.5    | ND                            | ND    | ND                 | ND     | ND   | ND      | 0.06               | 0.004             | 0.4                  | ND      | ND                   | ND                 | ND                       | ND      |  |
| 11L010SB                                  | 102.0    | ND                            | ND    | ND                 | ND     | ND   | ND      | ND                 | ND                | ND                   | ND      | ND                   | ND                 | ND                       | ND      |  |
| 11L011SB                                  | 99.0     | ND                            | ND    | ND                 | ND     | ND   | ND      | ND                 | ND                | ND                   | ND      | ND                   | ND                 | ND                       | ND      |  |
| 11L012SB                                  | 89.0     | ND                            | ND    | ND                 | ND     | ND   | ND      | ND                 | ND                | ND                   | ND      | ND                   | ND                 | ND                       | ND      |  |
| Shallow Soil Samples                      |          |                               |       |                    |        |      |         |                    |                   |                      |         |                      |                    |                          |         |  |
| 11L005SS                                  | 0.7      | ND                            | 33    | ND                 | ND     | ND   | ND      | ND                 | ND                | ND                   | ND      | ND                   | ND                 | ND                       | ND      |  |
| 11L007SS                                  | 0.4      | ND                            | 72    | ND                 | ND     | ND   | ND      | ND                 | ND                | ND                   | ND      | ND                   | ND                 | ND                       | ND      |  |
| 11L008SS                                  | 0.2      | ND                            | 260   | ND                 | ND     | ND   | ND      | ND                 | ND                | ND                   | ND      | ND                   | ND                 | ND                       | ND      |  |
| 11L009SS                                  | 0.4      | ND                            | 390   | ND                 | ND     | ND   | ND      | ND                 | ND                | ND                   | ND      | ND                   | ND                 | ND                       | 0.005 J |  |

Source: Law 1995

Source: Law, 1995.

<sup>v</sup>TPH-g = total petroleum hydrocarbons (TPH) as gasoline; TPH-d = TPH as diesel; TPH-j = TPH as jet fuel; TPH-ts = TPH as test grade jet fuel; and TRPH = total recoverable petroleum hydrocarbons.  
<sup>u</sup>HVOCs = halogenated volatile organic compounds; 1,2-DCA = 1,2-dichloroethane.

<sup>f</sup>(ft bgs) = feet below ground surface.

<sup>v</sup>mg/kg = milligrams per kilogram.

<sup>u</sup>ND and gray shading = analysis not detected.

<sup>u</sup>JII = results are estimated; high limit indicated.

<sup>u</sup>J = results are estimated due to lack of precision.

<sup>u</sup>R = sample results are rejected as unusable.

limited contamination was evident in samples collected from 11L008SB on the west side of the UST excavation and from 11L009SB north of the concrete paved area. TPH and BTEX were not detected in soil samples collected from other soil borings located in areas adjoining the UST excavation area. For the surface soil samples, TPH-d was detected at 390 mg/kg in the sample collected on the north side of UST excavation and rock-lined drainage channel (11L009SS). TPH-d also was detected at 11L005SS (33 mg/kg), 11L007SS (72 mg/kg), and 11L008SS (260 mg/kg).

Petroleum hydrocarbons and HVOCs also were detected in groundwater samples collected from nearby monitoring wells in October and November 1994. At monitoring well 11A01MW, 1,1,2,2-tetrachloroethane was detected at 12 micrograms per liter ( $\mu\text{g/L}$ ) and TCE was detected at 5  $\mu\text{g/L}$ . At monitoring well 11L002MW, toluene, ethylbenzene, and total xylenes were detected at 22  $\mu\text{g/L}$ , 3  $\mu\text{g/L}$ , and 48  $\mu\text{g/L}$ , respectively, which are below their respective Water Quality Goals (WQGs) identified by the California Environmental Protection Agency (Cal/EPA, 1998). In addition, 1,1,2,2-tetrachloroethane, chloroform, methylene chloride, and TCE were detected at 12  $\mu\text{g/L}$ , 1  $\mu\text{g/L}$ , 1  $\mu\text{g/L}$ , and 4  $\mu\text{g/L}$ , respectively.

#### **2.3.4 Bioventing System Expansion and Optimization**

The expanded bioventing system was installed by Parsons ES between May 28 and July 8, 1996. The system was installed in accordance with the final work plan (Parsons ES, 1995) and design package (Parsons ES, 1996a). The expanded system included two additional air injection VWs (VW2 and VW3), two additional VMPs (VMP4 and VMP5), an upgraded 3-horsepower blower system and housing, and associated piping, controls, and electrical service (Figure 2.4). The expanded system VWs were screened from 10 to 40 feet bgs and the new VMPs were installed near the expected radius of influence of the VWs to evaluate vapor migration. Four casing strings and 6-inch screens were installed in each VMP boring at approximately 10, 24, 30, and 40 feet bgs. Soil and soil vapor samples were collected for field and laboratory analysis prior to system startup to establish baseline conditions for the expanded bioventing system (Tables 2.1 and 2.2).

In August 1996, following four weeks of air injection into VW2 and VW3, an additional set of soil vapor samples was collected during expanded bioventing system operation to evaluate potential vapor migration from the areas of the site undergoing air injection for the first time. Parsons ES did not reestablish air flow to VW1, but recommended returning air flow to VW1 at approximately 10 cubic feet per minute (cfm) based on the low vapor migration indicated during the August 1996 sampling event (Parsons ES, 1996b).

#### **2.3.5 Removal of Oil/Water Separators and Vapor Extraction Well Installation**

In January 1997, LCC removed Oil/Water Separator A and Oil/Water Separator A' located on the eastern side of the AGE Maintenance Area. Following removal, six soil samples were collected from soils directly beneath and adjacent to the former oil/water separators. Samples were analyzed for TPH-g by USEPA Method SW8015, volatile organic compounds (VOCs) by USEPA Method SW8260, soluble TPH-d using a deionized water-waste extraction test (DI-WET) preparation, and total metals by

USEPA Method SW6010. Maximum concentrations of 2.9 milligrams per liter (mg/L) of soluble TPH-d and 4.3 mg/kg of TCE were detected in soils impacted by former Oil/Water Separator A northeast of the concrete paved area. All other target analyte concentrations were below established action levels (LCC, 1998).

In June 1997, LCC further investigated soil and soil vapor contamination beneath Oil/Water Separator A. One soil boring was advanced at this location from ground surface to 87 feet bgs. Eleven soil vapor samples were collected between 5 and 87 feet bgs to determine the vertical extent of contamination. Soil vapor samples were analyzed for VOCs by USEPA Method SW8010/8020 using an onsite mobile laboratory. No BTEX constituents were detected above the 0.05 ppmv reporting limit. Soil vapor concentrations exceeding 200 ppmv of TCE, *cis*-1,2-DCE, *trans*-1,2-DCE, and 1,1-DCE were detected in the soil vapor sample collected from 10 to 11 feet bgs. Concentrations of VOCs above established cleanup levels were not identified in soil vapor samples collected at depths greater than 45 feet bgs. Based on the results of this investigation and the previous Law Environmental (1995) investigation, LCC (1998) estimated that the HVOC contamination was limited to the upper 45 feet of the vadose zone within a radius of approximately 100 feet from Oil/Water Separator A.

Following soil boring advancement, a vapor extraction well (VE1) was installed at the former location of Oil/Water Separator A and SVE start up testing was performed. Vapor extraction well VE1 was screened from 10 to 50 feet bgs. The SVE start up testing consisted of applying a vacuum to VE1 and measuring the air flow rate at the well head and pressure differentials at the bioventing VMPs. During the testing, vacuums ranging from 0.36 to 1.9 inches of water (in H<sub>2</sub>O) were measured at the VMPs. An effective radius of influence of 180 feet was estimated for VE1 (LCC, 1998).

### 2.3.6 Option 1 Testing of the Expanded Bioventing System

Option 1 soil vapor sampling and respiration testing was originally scheduled for August 1997 following 1 year of expanded bioventing system operation and 1-month of system shutdown. However, when Parsons ES contacted Beale AFB personnel to schedule the Option 1 field work, it was discovered that an "area" respiration test was performed at the site in late June 1997 by Law Environmental. During an "area" respiration test, the blower system is used to oxygenate site soils and is shut down immediately prior to testing. In contrast, during a "point" respiration test, equilibrium conditions are allowed to return to site soils before an ambient air pump is used to locally oxygenate site soils. Following blower or air pump shutdown, oxygen utilization by indigenous soil bacteria, as they aerobically biodegrade petroleum hydrocarbons in soil, is measured at the VMPs.

Parsons ES evaluated the results of the "area" respiration test performed by Law Environmental and determined a "point" respiration test following 1 month of system shutdown (similar to those performed initially and following 1-year of pilot-scale bioventing system operation) was more appropriate for the Option 1 test. System shutdown for 1 month prior to "point" testing is necessary to allow site soil and soil vapor to return to equilibrium conditions and allow comparison with previous site results. Blower shutdown and Option 1 field work were rescheduled for mid-February and mid-March 1998, respectively.

In March 1998, Parsons ES was informed by Beale AFB personnel that elevated concentrations of HVOCs were detected at the 10-foot bgs screened interval at VMP4 (VMP4-10) during the third quarter 1997 sampling event performed by Law Environmental (Figure 2.2). During this sampling event, 68 ppmv of *cis*-1,2-DCE, 15 ppmv of *trans*-1,2-DCE, and 11 ppmv of TCE were measured at VMP4-10 as compared to 0.063 ppmv, 0.0093 ppmv, and 0.016 ppmv, respectively, during the second quarter 1997 sampling event. A review of the O&M monitoring logs for the blower system indicates that the bypass valve which was used to bleed excess airflow to the atmosphere was inappropriately closed when air injection was reestablished for VW1 in April 1997 (following the second quarter 1997 sampling event) (Law Environmental, 1997).

Parsons ES visited the site during the week of 16 March 1998 to perform Option 1 testing, but unexpectedly discovered that the blower system was running (the blower was turned off in mid-February), and Option 1 testing could not be initiated. Airflow measurements confirmed that approximately 4 times the original flowrate of air was being injected into VW2 and VW3 as a result of previous adjustments made to the system. In addition, the air flow rate into VW1 was almost 2 times higher than airflow into VW2 and VW3, and significantly exceeded recommended airflow rates for extended system operation (Parsons ES, 1996b).

Following system measurements, Parsons ES shut down the blower system, locked out power to the blower and rescheduled field work for mid-April 1998. Parsons ES performed Option 1 soil vapor sampling and respiration testing during the week of 13 April 1998. Field soil vapor results and analytical soil vapor results for TVH and BTEX from this sampling event are shown in Table 2.2. Table 2.5 summarizes the July 1996, August 1996, and April 1998 HVOC and non-petroleum hydrocarbon VOC results obtained by Parsons ES at VMP4.

### 2.3.7 Bioventing System Reconfiguration for Soil Vapor Extraction

As a result of the increased HVOC concentrations at VMP4 and data obtained during the LCC investigation, the bioventing blower system at Site SD-11 was reconfigured for SVE by LCC and Metcalf and Eddy, Inc., and plumbed to VE1 near former Oil/Water Separator A. Start up of the SVE system began in May 1998 and system operation and maintenance is currently being performed by CH2M Hill (Gaudette, 1998).

## 2.4 BIOVENTING SYSTEM EFFECTIVENESS

The Option 1 letter results report (Parsons ES, 1998) provided a summary of the soil vapor chemistry results and *in situ* respiration testing following more than 3 years of pilot-scale bioventing system operation and 1 year and 9 months of expanded bioventing system operation. Soil vapor chemistry results from the April 1998 Option 1 testing event and previous sampling events performed by Parsons ES are summarized in Tables 2.2 and 2.5. Table 2.6 summarizes the respiration and fuel biodegradation rates determined during the Option 1 testing event and compares them to rates determined during pilot-scale bioventing.

**TABLE 2.5**  
**SUMMARY OF SOIL VAPOR VOC ANALYTICAL RESULTS AT VMP4**  
 IRP SITE SD-11  
 BEALE AFB, CALIFORNIA

| Analyte <sup>v</sup> | Units <sup>v</sup> | VMP-4-10            |                           |                     |        | VMP-4-24     |          | VMP-4-30            |  |
|----------------------|--------------------|---------------------|---------------------------|---------------------|--------|--------------|----------|---------------------|--|
|                      |                    | Jul-96              | Dup <sup>v</sup> (Jul-96) | Aug-96 <sup>v</sup> | Apr-98 | Dup (Apr-98) | Jul-96   | Aug-96 <sup>v</sup> |  |
| Halogenated VOCs     |                    |                     |                           |                     |        |              |          |                     |  |
| PCE                  | (ppmv)             | <0.021 <sup>v</sup> | [<0.0090]                 | <0.049              | <0.990 | [<1.2]       | <0.00081 | <0.036              |  |
| TCE                  | (ppmv)             | 0.32                | [0.37]                    | 1.2                 | 10     | [11]         | 0.0047   | <0.036              |  |
| cis-1,2-DCE          | (ppmv)             | 1.2                 | [1.4]                     | 2.6                 | 57     | [65]         | 0.024    | <0.036              |  |
| trans-1,2-DCE        | (ppmv)             | 0.22                | [0.30]                    | 1.2                 | 13     | [15]         | 0.0054   | <0.14               |  |
| Vinyl Chloride       | (ppmv)             | 0.078               | [0.10]                    | <0.049              | 4.6    | [5.4]        | 0.0016   | <0.036              |  |
| 1,1,1-TCA            | (ppmv)             | <0.021              | [<0.0090]                 | <0.049              | <0.990 | [<1.2]       | <0.00081 | <0.036              |  |
| 1,1-DCE              | (ppmv)             | <0.021              | [<0.0090]                 | 0.069               | <0.990 | [<1.2]       | <0.00081 | <0.036              |  |
| 1,2-DCA              | (ppmv)             | <0.021              | [<0.0090]                 | <0.049              | <0.990 | [<1.2]       | <0.00081 | <0.036              |  |
| Chloroform           | (ppmv)             | <0.021              | [<0.0090]                 | <0.049              | <0.990 | [<1.2]       | <0.00081 | <0.036              |  |
| Methylene Chloride   | (ppmv)             | <0.021              | [<0.0090]                 | <0.049              | <0.990 | [<1.2]       | <0.00081 | <0.036              |  |
| Freon 12             | (ppmv)             | <0.021              | [<0.0090]                 | <0.049              | <0.990 | [<1.2]       | <0.00081 | <0.036              |  |
| Other VOCs           |                    |                     |                           |                     |        |              |          |                     |  |
| 1,3,5-TMB            | (ppmv)             | <0.021              | [<0.0090]                 | 0.049               | <0.990 | [<1.2]       | 0.015    | <0.036              |  |
| 1,2,4-TMB            | (ppmv)             | <0.021              | [<0.0090]                 | 0.078               | <0.990 | [<1.2]       | 0.0053   | <0.036              |  |
| Propylene            | (ppmv)             | <0.082              | [<0.036]                  | <0.190              | <3.9   | [<4.7]       | 0.029    | <0.14               |  |
| Acetone              | (ppmv)             | <0.082              | [<0.036]                  | <0.190              | <3.9   | [<4.7]       | 0.0049   | <0.14               |  |
| Carbon Disulfide     | (ppmv)             | <0.082              | [<0.036]                  | <0.190              | <3.9   | [<4.7]       | <0.0032  | <0.14               |  |
| 2-Propanol           | (ppmv)             | <0.082              | [<0.036]                  | <0.190              | <3.9   | [<4.7]       | <0.0032  | <0.14               |  |
| Hexane               | (ppmv)             | 5.6                 | [7.0]                     | 10                  | 250    | [280]        | 0.086    | <0.14               |  |
| Tetrahydrofuran      | (ppmv)             | <0.082              | [<0.036]                  | <0.190              | <3.9   | [<4.7]       | 0.013    | <0.14               |  |
| Cyclohexane          | (ppmv)             | <0.082              | [<0.036]                  | <0.190              | 440    | [500]        | 0.160    | <0.14               |  |
| 1,4-Dioxane          | (ppmv)             | <0.082              | [<0.036]                  | <0.190              | <3.9   | [<4.7]       | 0.0034   | <0.14               |  |
| 2-Hexanone           | (ppmv)             | <0.082              | [<0.036]                  | <0.190              | <3.9   | [<4.7]       | <0.0032  | <0.14               |  |
| 4-Ethyltoluene       | (ppmv)             | <0.082              | [<0.036]                  | <0.190              | <3.9   | [<4.7]       | <0.0032  | <0.14               |  |
| Heptane              | (ppmv)             | <0.082              | [<0.036]                  | 3.7                 | 65     | [76]         | 0.025    | <0.14               |  |

Note: TVH and BTEX analytical data provided in Table 2.2.

<sup>v</sup> PCE = tetrachloroethene (perchloroethene); TCE = trichloroethene; DCE = dichloroethene; TCA = trichloroethane; DCA = dichloroethane; TMB = trimethylbenzene.

Laboratory analysis of soil vapor performed using USEPA Method TO-14.

<sup>v</sup> ppmv = parts per million, by volume.

<sup>v</sup> Dup = duplicate; results shown in brackets.

<sup>v</sup> System operating during sampling event results represent "dynamic" conditions 1 month following expanded bioventing system startup.

<sup>v</sup> < and gray shading = Compound analyzed for, but not detected. Number shown represents the laboratory reporting limit.

**TABLE 2.6**  
**SUMMARY OF RESPIRATION AND FUEL BIODEGRADATION RATES**  
**IRP SITE SD-11**  
**BEALE AFB, CALIFORNIA**

| Location-Depth<br>(feet below ground surface) | Initial (May 1993)                             |                                                   | 6-Month (December 1993) <sup>b/</sup>          |                                     | 1-Year (July 1994)                             |                                     | 5-Year (April 1998) <sup>b/c/</sup>            |                                     |
|-----------------------------------------------|------------------------------------------------|---------------------------------------------------|------------------------------------------------|-------------------------------------|------------------------------------------------|-------------------------------------|------------------------------------------------|-------------------------------------|
|                                               | Respiration<br>Rate<br>(%O <sub>2</sub> /hour) | Degradation<br>Rate<br>(mg/kg/year) <sup>d/</sup> | Respiration<br>Rate<br>(%O <sub>2</sub> /hour) | Degradation<br>Rate<br>(mg/kg/year) | Respiration<br>Rate<br>(%O <sub>2</sub> /hour) | Degradation<br>Rate<br>(mg/kg/year) | Respiration<br>Rate<br>(%O <sub>2</sub> /hour) | Degradation<br>Rate<br>(mg/kg/year) |
| VMP1-24                                       | 0.12                                           | 50                                                | 0.039                                          | 47                                  | 0.036                                          | 71                                  | 0.14                                           | 180                                 |
| VMP2-24                                       | 0.047                                          | 130                                               | 0.038                                          | 110                                 | 0.023                                          | 63                                  | 0.034                                          | 100                                 |
| VMP3-24                                       | NS <sup>d/</sup>                               | NC <sup>e/</sup>                                  | NS                                             | NC                                  | NS                                             | NC                                  | 0.034                                          | 100                                 |
| VMP3-30                                       | 0.18                                           | 530                                               | 0.016                                          | 47                                  | 0.039                                          | 110                                 | NS                                             | NC                                  |
| VMP4-10                                       | NA <sup>f/</sup>                               | NA                                                | NA                                             | NA                                  | NA                                             | NA                                  | 0.060                                          | 180                                 |

<sup>a/</sup> mg/kg/year = Milligrams of hydrocarbons per kilogram of soil per year.

<sup>b/</sup> Assumes moisture content of the soil is average of initial and 1-year moistures.

<sup>c/</sup> 5-year testing event represents approximate time since initial testing in May 1993, not necessarily the cumulative bioventing treatment time.

<sup>d/</sup> NS = not sampled.

<sup>e/</sup> NC = not calculated; degradation rates cannot be estimated without respiration rate data.

<sup>f/</sup> NA = not applicable; VMP4 installed in July 1996 as part of the expanded-scale bioventing system.

Soil vapor and *in situ* respiration testing results from the April 1998 sampling event revealed the following:

- Analytical soil vapor results for TVH and BTEX indicate that petroleum-hydrocarbon contamination remaining in soils surrounding VMP1-24, VMP2-24, and VMP4-10 is minimal (Table 2.2);
- Concentrations of petroleum hydrocarbons in soil vapor collected from VMP3-24 were further reduced during expanded bioventing system operation, but continue to be slightly elevated (1,300 ppmv of TVH and 14.8 ppmv of total BTEX, 14 ppmv of xylenes) (Table 2.2);
- Elevated concentrations of TCE, 1,2-DCE, vinyl chloride, hexane, heptane, and cyclohexane detected in soil vapor near VMP4-10 appear to be the result of excessive air injection flowrates attributable to improper blower system adjustments (Table 2.5);
- Average *in situ* respiration and fuel biodegradation rates 5 years after initiating bioventing activities are approximately half those initially observed (Table 2.6);
- Aerobic biodegradation of residual petroleum hydrocarbon contaminants in soil is still occurring, albeit at relatively low rates (Table 2.6);
- Low BTEX soil vapor concentrations (Table 2.2) coupled with "flat" respiration and fuel biodegradation rates (Table 2.6) suggest that the residual hydrocarbon contamination remaining in site soils is primarily composed of less mobile, more biologically recalcitrant, higher molecular weight hydrocarbons; and
- Except for samples collected at VMP4-10, VMP1-24, VMP2-24, and VMP3-24, static oxygen concentrations in soils treated by the bioventing system were at or near atmospheric levels (20.9 percent) (Table 2.2). Static oxygen concentrations above 5 percent throughout most of the site indicates that microbial oxygen demand is being met through natural air diffusion and engineered air injection may no longer be required.

## 2.5 SUMMARY OF REMAINING SITE CONTAMINANTS

The presence of HVOCs in site soil, soil vapor, and groundwater has been attributed to the former oil/water separators located on the eastern side of the AGE Maintenance Area. Elevated concentrations of HVOCs detected at VMP4-10 during April 1998 appear to have resulted from excessive air injection at VW3 and contaminated vapor migration from soils near former Oil/Water Separator A.

LCC reviewed groundwater monitoring data for IRP Site SD-11 and determined that TCE and *cis*-1,2-DCE were the only groundwater contaminants present in site groundwater at concentrations greater than their respective maximum contaminant levels (MCLs) (LCC, 1998). Groundwater contamination identified beneath former Oil/Water Separator A at the AGE Maintenance Area extends downgradient to the south.

Results obtained from previous site investigations performed at the AGE Maintenance Area of IRP Site SD-11 indicate that petroleum hydrocarbon contamination in vadose zone soils is primarily located in soils surrounding and beneath the pump island and former USTs, and immediately north of the concrete paved area. The pilot-scale bioventing system was designed, installed and operated to remediate petroleum contaminated soils in the immediate vicinity of the former USTs. The expanded bioventing system was designed and installed to also include petroleum contaminated soils north of and beneath the concrete paved area. Results of the April 1998 soil vapor sampling and respiration testing event indicate that BTEX contamination in soils treated by the bioventing system has been effectively reduced to non-detect or near non-detect levels. While some petroleum hydrocarbon contamination is still evident in soils near VMP3-24 and VMP4-10, the contaminants are not present at concentrations expected to pose significant site risk.

Confirmation soil sampling is recommended to demonstrate that no further site investigation or remediation of petroleum hydrocarbons is necessary in the area of the UST excavation and pump island. Confirmation soil sampling also is recommended north of the concrete paved area, near VW2, to determine if petroleum hydrocarbon contamination in this area has been adequately remediated. It is expected that fuel residuals have been adequately reduced by pilot-scale and expanded system bioventing and that existing petroleum hydrocarbon contaminant concentrations support a recommendation for NFI status. A specific sampling and analysis plan to support a NFI recommendation for petroleum hydrocarbon contamination at the IRP Site SD-11, AGE Maintenance Area is provided in Section 3. The criteria to be used for a NFI recommendation is provided in Section 4.

## SECTION 3

### SAMPLING AND ANALYSIS PLAN

The following SAP describes the sampling locations, sampling procedures, and analytical methods proposed to collect sufficient information to document the effectiveness of bioventing remediation of petroleum-hydrocarbon-contaminated soils in the AGE Maintenance Area of IRP Site SD-11 and support a recommendation of NFI for Tanks 1225.01, 1225.02, and 1225.03.

#### 3.1 SOIL SAMPLING LOCATIONS

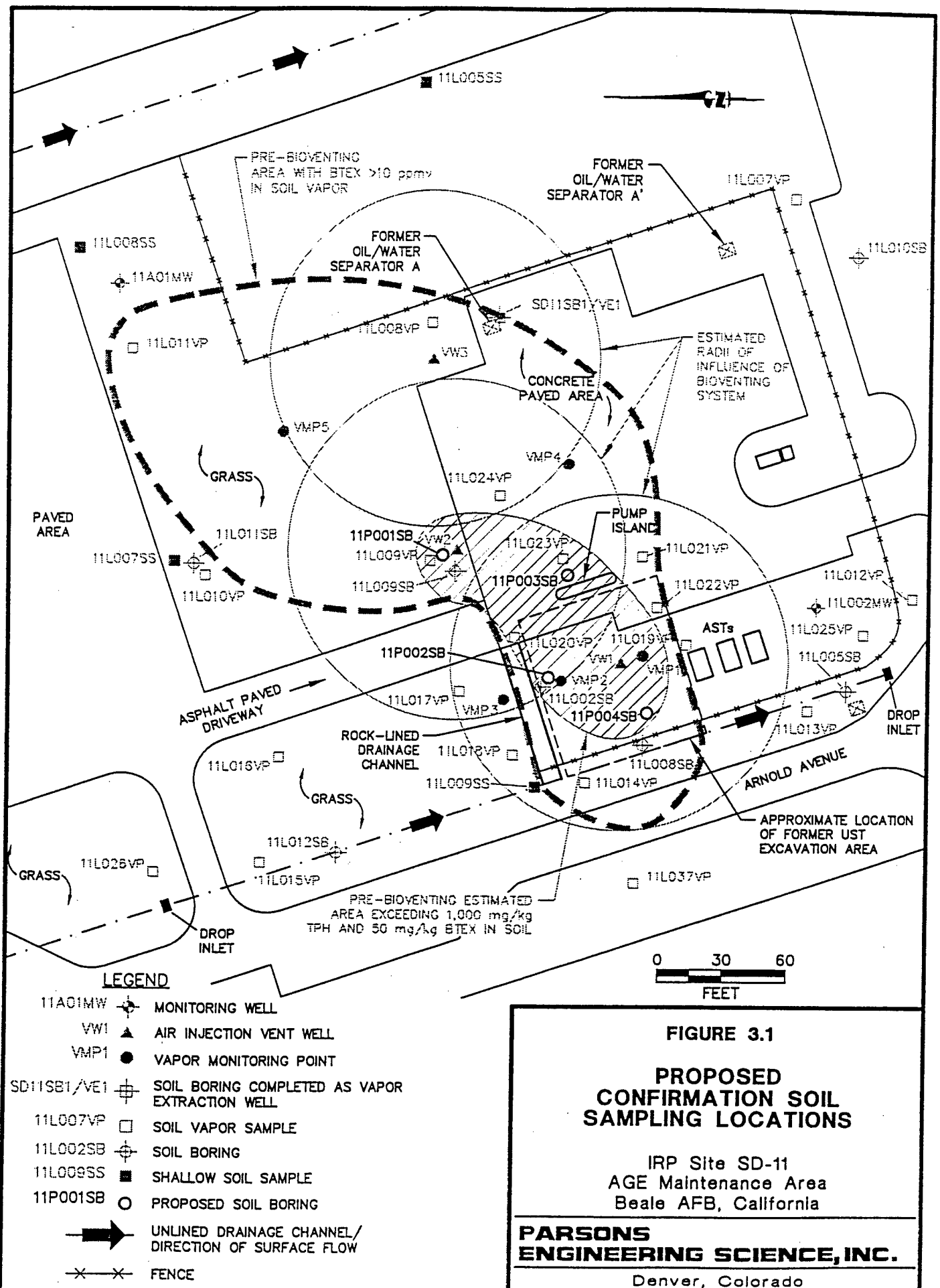
Confirmation soil samples will be collected from four soil borings located in the vicinity of the former USTs, pump island, and area north of the concrete paved area near VW2 (Figure 3.1). The four confirmation soil borings will be designated 11P001SB, 11P002SB, 11P003SB, and 11P004SB following the naming convention established during the site characterization.

The total depth of each soil boring will be determined based on multiple field observations (i.e., soil headspace screening and/or visual or physical evidence) which indicate the vertical extent of contamination has been adequately delineated. When field screening measurements indicate that the vertical extent of contamination in the soil boring has been adequately defined, a minimum of two soil samples will be collected for laboratory analysis and confirmation of the field measurements. If field measurements indicate that the vertical extent of contamination has not been adequately determined, soil sampling will continue as deep as necessary, but not beyond the depth of the groundwater surface (approximately 80 feet bgs).

The locations for two borings (11P001SB and 11P002SB) have been chosen in areas where soil concentrations of TPH greater than 2,000 mg/kg have been detected during prior investigations (i.e., adjacent to VW2 and adjacent to VMP2/11L002SB) (Tables 2.1 and 2.4). The third soil boring (11P003SB) has been located adjacent to the fuel pump island immediately east of the UST excavation. Elevated TPH concentrations measured in 1994 soil vapor samples collected at 11L023VP (37,700 ppmv) and 11L024VP (106,000 ppmv) (Table 2.3) are believed to be the result of vapor migration from petroleum-hydrocarbon-contaminated soils near the pump island during operation of the pilot-scale bioventing system. The fourth soil boring (11P004SB) will be located in the UST excavation area.

All four borings are within the estimated radius of influence of the bioventing system and are located near or within areas with previously detected BTEX or TPH in soil and soil vapor. If it is determined based on field observations that an additional soil boring is needed to adequately delineate the petroleum hydrocarbon contamination

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remaining in site soils, a fifth soil boring may be installed. The purpose of the confirmation soil borings is to determine if petroleum hydrocarbon residuals in soil have been reduced sufficiently to allow a recommendation of NFI for the former USTs and petroleum hydrocarbon-contaminated soils located within the AGE Maintenance Area of IRP Site SD-11.

It is anticipated that at least three soil samples will be collected from each of the four borings for laboratory analyses in addition to two replicate samples (approximately 14 total samples). From each boring, one soil sample from the most contaminated sampling interval identified will be submitted for laboratory analysis. The remaining two samples will be collected at successive depths near the bottom of each boring where field screening measurements indicate no hydrocarbon contamination is present. Two samples will be collected to minimize the potential for unintentionally bypassing contamination due to changes in soil lithology. The final determination of the total number of samples and sample depths will be made based on field observations (i.e., soil headspace screening and/or visual or physical evidence). Soil samples will be collected and analyzed as described in Section 3.2 and Section 3.3, respectively.

### 3.2 SOIL SAMPLE COLLECTION

Boreholes will be advanced using a drill rig equipped with an 8-inch outside-diameter (OD) hollow-stem auger. Continuous coring of the borings will be conducted below 10 feet bgs in order to best select the intervals for sampling. Soil samples will be collected in a 2-inch inside-diameter (ID) split-barrel sampler. The sampler will be lowered through the hollow stem of the augers and driven approximately one to two feet into undisturbed soil ahead of the augers. The split-barrel sampler will be fitted with three pre-cleaned, 6-inch long, thin-walled, brass sleeves. After collection of a sample, the sampler will be retrieved, split apart, and the sleeves will be removed. The ends of the sleeves will be immediately capped with Teflon® tape and plastic endcaps. Samples will be labeled with the site name, borehole number, sample depth, and date and time of collection. The sleeves will be placed in an insulated shipping container with ice and will be maintained in a chilled condition.

A portion of soil from each split spoon will be used for soil headspace screening. Each headspace screening sample will be placed in a sealed plastic bag and allowed to sit in the shade for at least 5 minutes. Soil headspace will then be screened using a total volatile hydrocarbon analyzer (TVHA) and a photoionization detector (PID). The soil headspace reading will be used in combination with physical and visual evidence of contamination (e.g. odors, staining) to select samples for laboratory analysis. Soil samples selected for laboratory analysis will be shipped to Specialized Assays, Inc. (SAI), in Nashville, Tennessee. A chain-of-custody form will accompany all samples.

Boreholes will be logged by a Parsons ES geologist. The geologist will be responsible for observing all field investigation activities, maintaining a detailed descriptive log of all subsurface materials recovered during soil coring, and properly labeling and storing samples.

After sampling is complete, each sampling location will be restored as closely to its original condition as possible. Boreholes will be sealed with bentonite chips, pellets, or

grout to eliminate any creation or enhancement of contaminant migration pathways to the groundwater. Asphalt or concrete patch, as appropriate, will be used to finish surface completions.

### 3.3 SOIL SAMPLE ANALYSES

Soil samples will be analyzed by USEPA Method SW8015-modified for purgeable TPH-g and extractable TPH-d; by USEPA Method SW8020 for BTEX compounds; and by American Society for Testing and Materials (ASTM) D-2216 for soil moisture. Soil samples containing total TPH-d or total TPH-g also will be analyzed for soluble TPH-d using the waste extraction test (WET) preparation method described in California Administrative Code (CAC) Title 22, Article 11, Section 66700 (C through F) except that the extraction solution for the WET test shall consist of deionized water. In addition, a minimum of two soil samples will be collected from soils which do not appear to be impacted by petroleum hydrocarbon contamination (i.e., "clean soils") and analyzed for total organic carbon (TOC) content by USEPA Method SW9060 to support contaminant sorption evaluations.

Quality control (QC) samples also will be analyzed to assess laboratory methods. The laboratory will perform analyses on one matrix spike, one laboratory control sample, and one laboratory blank for each specific analytical method requested. Field QC samples will be collected and analyzed as described in Section 3.6.

### 3.4 SOIL VAPOR SAMPLING

Due to the high xylene concentration detected in soil vapor at VMP3-24 during the April 1998 Option 1 sampling event, confirmation soil vapor sampling will be performed at VMP3. Following 1 month of air extraction shut down at VW1 and VW2, soil vapor samples for field screening and laboratory analysis will be collected from VMP3-24, VMP3-30, and VMP3-40. Soil vapor samples for laboratory analysis will be submitted to Air Toxics, Ltd. in Folsom, California for analysis of TVH and BTEX by USEPA Method TO-3 referenced to jet fuel. Soil vapor samples will be used to assess xylene concentrations at VMP3-24 and assess BTEX concentrations with depth at this monitoring point.

### 3.5 EQUIPMENT DECONTAMINATION

All sampling and downhole equipment will be decontaminated before use and between boreholes to prevent cross-contamination. Prior to sample collection and between each sampling location, the soil sampler(s) and downhole sampling tools will be decontaminated using the following protocol:

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

All decontamination fluids will be stored in 55-gallon US Department of Transportation (DOT)-approved drums provided by the driller.

### **3.6 FIELD QUALITY ASSURANCE/QUALITY CONTROL PROCEDURES**

Field QC for soil will include collection of field replicates, rinseate blanks, and trip blanks. Soil QC sampling will include two replicates (minimum frequency of 10 percent); one rinseate blank; and one trip blank for each cooler submitted to the laboratory. Field replicates will be labeled in such a manner so that persons performing laboratory analyses are not able to distinguish replicates from other collected samples.

### **3.7 DISPOSAL OF INVESTIGATION DERIVED WASTE**

All drill cuttings will be collected in labeled drums or bins after each borehole is drilled. Drill cuttings and decontamination fluids will be characterized prior to disposal. Characterization will determine the method of disposal in accordance with local regulatory and Beale AFB requirements. Parsons ES or its subcontractor will transport characterized drill cuttings and decontamination fluids to appropriate base disposal facilities, unless characterization results indicate that off-base disposal is required. Parsons ES will subcontract off-Base disposal of the drums, if necessary. Beale AFB will be responsible for providing their USEPA generator identification and signing the manifest prior to disposal.

## SECTION 4

### CRITERIA TO BE USED FOR NO FURTHER INVESTIGATION RECOMMENDATION

The recommendation for either NFI or further treatment of petroleum hydrocarbon-contaminated soils at the AGE Maintenance Area will be made based on an evaluation of the soil analytical results in accordance with principles set forth in the Risk-Based Cleanup Level Assessment (RBCLA) of Petroleum Contaminated Soils (Metcalf & Eddy, Inc., 1996). In addition, the Designated Level Methodology (DLM) (California Regional Water Quality Control Board [RWQCB], 1989), WQGs identified by the Cal/EPA (1998), and the California Leaking Underground Fuel Tank (LUFT) Guidelines (California State Water Resources Control Board, 1989) will be referenced in evaluating residual petroleum hydrocarbon contamination which may remain in site soils.

Specific characteristics of the Beale AFB RBCLA will be used in combination with site-specific soil and soil vapor analytical data to be collected in accordance with Section 3 of this SAP. The following information will be used to evaluate the potential impact to site groundwater and to determine the appropriateness of a NFI recommendation:

- Use of a depth to groundwater of 80 feet bgs (the AGE Maintenance Area is in Zone C/5 of the 16 separate geographic zones identified in the RBCLA);
- Use of a 1,000  $\mu\text{g/L}$  soluble TPH-d target cleanup level, based on Table 5-2 from the RBCLA (Metcalf & Eddy, 1996), the DLM, and an environmental attenuation factor (EAF) of 100; and
- Use of soil vapor analytical data collected in accordance with Section 3.4 of this SAP as well as data from the April 1998 sampling event to document that BTEX contamination in the subsurface does not present a threat to groundwater.

#### 4.1 TPH-D CLEANUP CRITERIA

The RBCLA has been established specifically for determining acceptable depths and concentrations of residual diesel-range petroleum hydrocarbon contamination in soils at Beale AFB. The soluble TPH-d cleanup criteria of 1,000  $\mu\text{g/L}$  was established using an EAF of 100 for all geographic zones at Beale AFB based on the DLM and simulations of contaminant migration through the vadose zone using the USEPA Seasonal Soil Compartment Model (SESOIL). According to the DLM, an EAF of 100 should be used in those situations which provide an "average" degree of water quality protection (California RWQCB, 1989). At Beale AFB, the RBCLA demonstrated that

using an EAF of 100 to establish the target cleanup level for TPH-d is at the very least an "average" degree of groundwater protection considering typical depths to groundwater and SESOIL modeling results (Metcalf & Eddy, 1996).

The maximum allowable contaminant depth of TPH-d at the AGE Maintenance Area will be 58 feet bgs, as established for Zone C/5 in the RBCLA. Within this allowable contaminant depth for TPH-d, if total TPH-d or total TPH-g is detected, the soluble concentration of TPH-d will be compared to the target cleanup level of 1,000  $\mu\text{g/L}$ . For contamination below the maximum allowable contaminant depth, the cleanup level is non-detect.

#### 4.2 COMPLIANCE WITH BTEX SOIL VAPOR CRITERIA

No soil cleanup criteria similar to that established for TPH-d exist for the BTEX compounds. According to the RWQCB (1998), soil vapor criteria are used for the BTEX compounds in assessing site readiness for closure. The RWQCB (1998) soil vapor criteria are:

| Benzene<br>(ppmv) | Toluene<br>(ppmv) | Ethylbenzene<br>(ppmv) | Xylenes<br>(ppmv) |
|-------------------|-------------------|------------------------|-------------------|
| 0.071             | 3.037             | 2.161                  | 1.231             |

A review of soil vapor analytical data collected during the April 1998 Option 1 soil vapor sampling event indicates that the xylene soil vapor concentration at VMP3-24 (14 ppmv) exceeded the criterion of 1.231 ppmv. At all other locations for which soil vapor samples were submitted for laboratory analysis, BTEX concentrations were less than the criteria shown (It should be noted that the soil vapor samples collected during the April 1998 sampling event were collected from the most contaminated VMP screened intervals based on field screening results). Near atmospheric oxygen concentrations in soil vapor at VMP3-30 and VMP3-40 as measured during the April 1998 sampling event indicate that it is unlikely that BTEX contaminants exceed the above criteria. However, confirmation soil vapor samples will be collected from the three screened intervals at VMP3 as discussed in Section 3.4.

#### 4.3 OUT-OF-SCOPE VADOSE ZONE MODELING

Depending on the results of the soil and soil vapor sampling and the proposed evaluation, it may be necessary to perform more extensive, site-specific vadose zone modeling (using the SESOIL model) to determine the potential threat to groundwater quality or to demonstrate that any remaining soil residuals will not impact groundwater. Although input data necessary for such modeling will either be collected during the sampling and analysis described in Section 3 (e.g., contaminant concentrations, soil moisture, total organic carbon content), have been collected previously at the site (e.g., soil lithology, depth to groundwater), or have already been established for Beale AFB soils, additional vadose zone modeling is beyond the current contract scope.

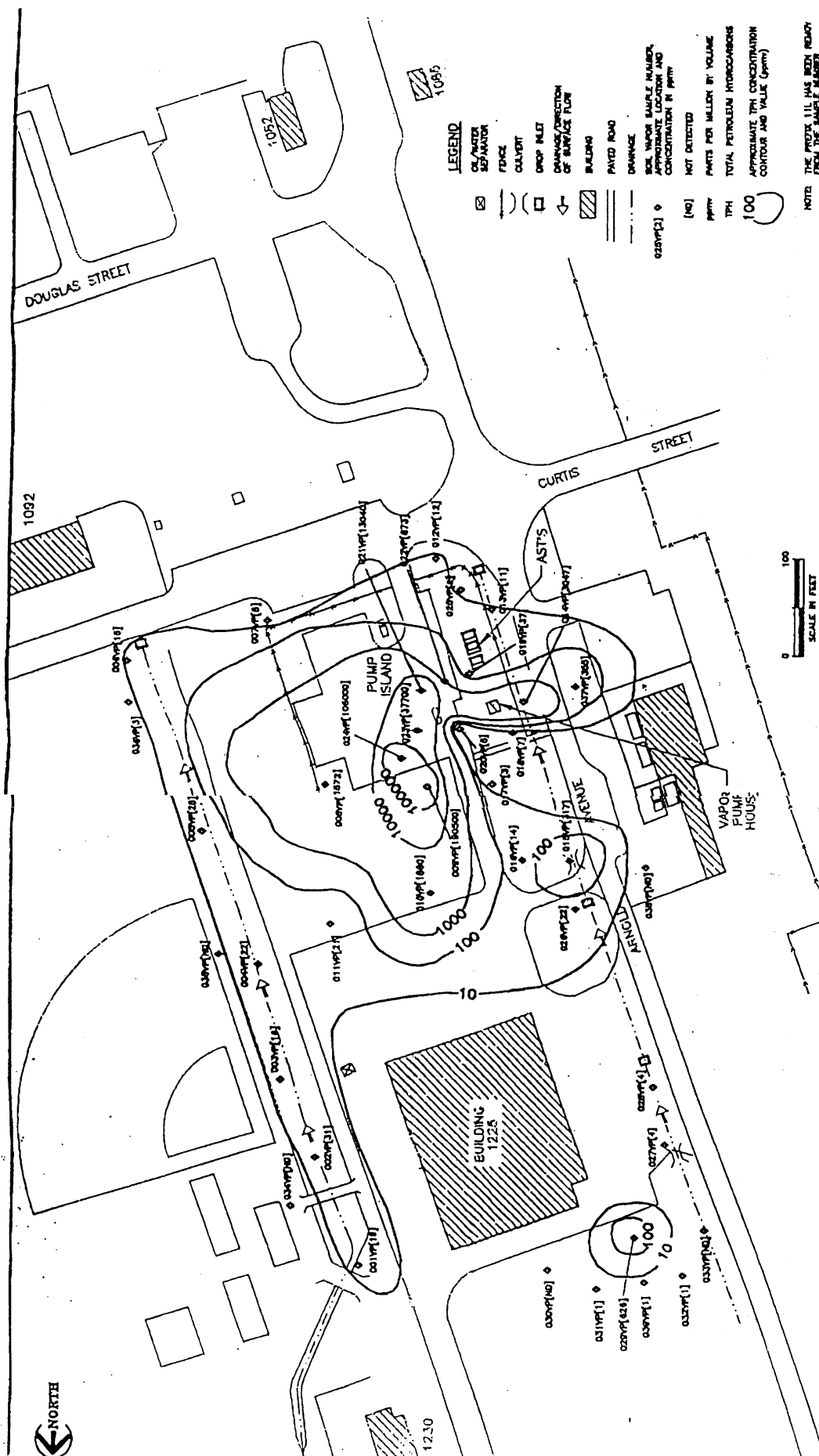
## SECTION 5

### REPORT FORMAT

Following sampling activities and receipt of the laboratory analytical results, a results report will be prepared and submitted to AFCEE and Beale AFB, who will then forward the report to the local regulatory agencies.

The report will contain the following information:

- Site map showing sampling locations;
- Summary of field activities, procedures, and field screening and laboratory analytical results;
- Certified analytical laboratory reports and chain-of-custody forms;
- Borehole logs; and
- Conclusions and recommendations for either NFI or continued treatment of soils contaminated with petroleum hydrocarbons.



BEALE AIR FORCE BASE  
MARTYVILLE, CALIFORNIA

SOIL VAPOR CONCENTRATION  
CONTOUR MAP FOR TPH  
Site 11: AGE Maintenance Area

PROJECT  
2218-40004

FIGURE 6-1

TAKEN FROM THE SITE CHARACTERIZATION SUMMARY INFORMATION TECHNICAL INFORMATION REPORT BY LAW ENVIRONMENTAL (1995)

BEALE AIR FORCE BAS

Project/Date: 2218-40004

Sheet/Total: 2218-40004



## SECTION 6

### PROJECT SCHEDULE

The following schedule assumes that this SAP will be submitted in its current form to the regulatory agencies.

| DESCRIPTION                                                                                       | COMPLETION DATE  |
|---------------------------------------------------------------------------------------------------|------------------|
| Draft SAP delivered to Beale AFB, AFCEE, and regulatory agencies                                  | 19 November 1998 |
| All comments to draft SAP received by Parsons ES from Beale AFB, AFCEE, and regulatory agencies   | 7 December 1998  |
| Soil boring locations marked by Parsons ES                                                        | 7 December 1998  |
| Final SAP delivered to Beale AFB, AFCEE, and regulatory agencies                                  | 22 December 1998 |
| Digging permit due from Beale AFB                                                                 | 22 December 1998 |
| Completion of drilling and soil sampling activities                                               | 8 January 1999   |
| Draft results report delivered to Beale AFB and AFCEE                                             | 16 February 1999 |
| Comments to draft results report due to Parsons ES from Beale AFB, AFCEE, and regulatory agencies | 5 March 1999     |
| Final results report delivered to Beale AFB, AFCEE, and regulatory agencies                       | 19 March 1999    |

**SECTION 7**  
**POINTS OF CONTACT**

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## SECTION 8

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**APPENDIX B**  
**CALIFORNIA RWQCB COMMENTS ON DRAFT CONFIRMATION**  
**SAMPLING AND ANALYSIS REPORT**



# California Regional Water Quality Control Board

## Central Valley Region

Steven T. Butler, Acting Chair



Gray Davis  
Governor

Winston H. Hickox  
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14 April 1999

Mr. Michael O'Brien  
9 CES/CEVR  
6601 B Street  
Beale Air Force Base, CA 95903-1708

|                   |           |         |           |            |   |
|-------------------|-----------|---------|-----------|------------|---|
| Post-It® Fax Note | 7671      | Date    | 4/14      | # of pages | 2 |
| To                | John Ratz | From    | M. Phelps |            |   |
| Co./Dept.         | Denver    | Co.     | Oakland   |            |   |
| Phone #           |           | Phone # |           |            |   |
| Fax #             |           | Fax #   |           |            |   |

*Referenced figures will arrive tomorrow/ Friday*

### **RECOMMENDATION FOR NO FURTHER INVESTIGATION OF PETROLEUM HYDROCARBONS AT THE AGE MAINTENANCE AREA IRP SITE SD-11, BEALE AIR FORCE BASE, YUBA COUNTY**

We have reviewed the Recommendation for No Further Investigation (NFI) of Petroleum Hydrocarbons at the Aircraft Ground Equipment (AGE) Maintenance Area Installation Restoration Program (IRP) Site SD-11, dated March 1999, prepared by Parsons Engineering Science, Inc. The purpose of this report was to document the effectiveness of bioventing for soil remediation at Site SD-11 and to provide data to support a closure decision for petroleum hydrocarbons found at the site.

Based on the January 1999 confirmation sampling results, bioventing has significantly reduced the concentration of TPH-g and BTEX compounds in soils at the AGE Maintenance Area. However, confirmation sampling results from the bioventing activities indicated that elevated concentrations of petroleum hydrocarbons are still present in soils near VMP3-24. Additionally, previous site investigations have identified extensive petroleum hydrocarbon and halogenated volatile organic compound contamination in soils outside of the area affected by the bioventing action. Further, because of QA/QC problems in laboratory analysis, the sampling results for soluble TPH-d do not provide a reliable representation of the TPH-d in the soil at the site. Therefore closure of this site for petroleum hydrocarbons is not warranted at this time.

Soil vapor results from Site 11 are presented in both the Site Characterization Summary Informal Technical Information Report prepared by LAW Environmental (1995) and in the Groundwater Operable Units A and B Field Sampling Plan prepared by Radian International (1998) and are attached. These results indicate areas with concentrations of petroleum hydrocarbons that threaten to impact water quality in the area outside the radius of influence of the bioventing system.

Confirmation soil sampling analytical results for TPH-diesel exceeded holding times prior analysis for soluble TPH-d by the California D.I. WET procedure. Unfortunately, this makes the sample results of questionable validity. Site 11 soils should be resampled for analysis of soluble diesel subsequent to additional soil vapor extraction to show that continuing degradation is occurring as modeled.

**California Environmental Protection Agency**

Beale Air Force Base  
Site SD-11, NFI

- 2 -

14 April 1999

We understand that in April 1998, the biovent system was converted to an SVE system with the addition of a vapor extraction well, VE-1 to the east of the AGE biovent wells. Currently the biovent wells are not being used for vapor extraction. The radius of influence of VE-1 has been estimated to be 175 feet based on initial testing. This area does not encompass all of the area in which soil gas has been estimated to exceed cleanup levels. Actual pressure measurements in the vapor monitoring points will need to be collected to verify the radius of influence of the currently operating SVE system. The existing SVE system may need to be expanded to capture all contaminant soil vapors to the cleanup levels that are considered protective of water quality. Use of the existing biovent well could facilitate expansion of the SVE system and provide additional cleanup in the area of VWP3. Subsequent to the success of the SVE removal action, a re-evaluation of the soluble hydrocarbons will need to be made to determine if bioventing should be resumed.

If you have any questions, please call me at (916) 255-3051.

CORI CONDON  
Associate Engineering Geologist

#### Attachments

cc: Michael Phelps  
Parsons Engineering Science, Inc.  
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Marci Christofferson  
Yuba County - Office of Emergency Services  
933 - 14th Street  
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**APPENDIX C**  
**SOIL BORING LOGS**

BORING NUMBER: 11P001SB

|                                                                      |                                           |
|----------------------------------------------------------------------|-------------------------------------------|
| PROJECT NUMBER: 726876-20120                                         | PROJECT NAME:                             |
| CLIENT: AFCEE                                                        | Beale Air Force Base, Site SD11           |
| LOCATION: Beale AFB, Site 11<br>approximately 2.5 feet north of VW-2 | Closure Sampling/Drilling                 |
| GEOLOGIST: Amanda Freeman Bielskis                                   | DRILLING METHOD: Hollow Stem Auger (A400) |
| COMPLETION DATE: 1/6/99 and 1/7/99                                   | HOLE DIAMETER: 8 inches                   |
|                                                                      | TOTAL DEPTH: approx. 37 feet bgs          |

| DEPTH<br>(feet) | GW DEPTH | SAMPLE<br>NUMBER                                                                 | HEADSPACE<br>PID/TVH (ppmv)                      | SAMPLE | BREATHING<br>ZONE (ppm) | USCS<br>CLASSIFICATION | GEOLOGIC DESCRIPTION                                                                                                                                                                                                      |
|-----------------|----------|----------------------------------------------------------------------------------|--------------------------------------------------|--------|-------------------------|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0               |          |                                                                                  |                                                  |        | 0.0                     | GC                     | Hand auger upper 5 ft., continuous sampling from 10 ft.<br>(cuttings = clayey SILT, w/cobbles and gravel, reddish (7.5yr4/4),<br>damp, cobbles are 4-5" dia. and subround, coarse sand 5-10%.                             |
| 5               |          |                                                                                  |                                                  |        | 0.0                     |                        | Hydrocarbon odors at 8ft bgs, breathing zone = 0.0, cuttings = 22ppm.                                                                                                                                                     |
| 10              |          | 11p001SB-A<br>11-11.5<br>12:04 1/6/99                                            | 240/400                                          |        | 0.0                     |                        | Too hard for sampler at 10ft (35 blows for 3" driven)<br>rock in sampler shoe, 106 blows for 6", igneous.<br>12" recovered, mostly broken rock frags, some clay and sand.                                                 |
| 15              |          | 11p005SB<br>15-15.5 (dup<br>of B) 12:00<br>11p001SB-B<br>16-16.5<br>13:17 1/6/99 | 723/700<br><br>2,223/<br>6,000                   |        | 0.0                     |                        | clayey GRAVELS, 100 blows for 5" driven.                                                                                                                                                                                  |
| 20              |          |                                                                                  | 1,209/<br>1,200<br>241/200<br>542/480<br>443/310 |        | 0.0                     | SM/<br>SP              | GRAVEL, hard drilling, large cobbles of igneous rock mixed with silt<br>and clay frags of broken rock.<br>silty SAND, grey, hc odor.<br>SAND, w/granite frags, fine-med., damp, pinkish gray, very dense,<br>well sorted. |
| 25              |          |                                                                                  | 53.2/64<br>0.0/0                                 |        | 3                       |                        | No recovery 25 to 26 ft.<br>silty CLAY, sandy, dry, stiff.                                                                                                                                                                |
| 30              |          | 11p001SB-C<br>29-29.5<br>10:20 1/7/99                                            | 3.8/10<br>24.8/34<br>0.0/0<br>0.0/10             |        | 0.0                     | SC                     | Clayey SAND, very fine grained, well sorted, dry, light gray (2.5Y7/2).<br><br>Clayey SAND, w/silt.                                                                                                                       |
| 35              |          | 11p001SB-D<br>36-36.5<br>11:30 1/7/99<br>11p001SB-E<br>36.5-37<br>11:32 1/7/99   | 0.0/8<br>0.0/0                                   |        | 0.0-2                   | SP                     | SAND, vf-fine grained, well sorted, slightly silty, dark<br>grayish brown (10YR4/2), some small pebbles 5-6 mm, 5% crse. Sand,<br>becomes damp at 36 ft., Drill cuttings = 36.0.                                          |
| 40              |          |                                                                                  |                                                  |        |                         |                        |                                                                                                                                                                                                                           |
| 45              |          |                                                                                  |                                                  |        |                         |                        |                                                                                                                                                                                                                           |

--- Contact approximately located.

PID - Photoionization detector reading.

■ - Indicates sample submitted  
to laboratory for analysis

- First encountered groundwater level.

TVH - Total Volatile Hydrocarbon meter reading.

BORING NUMBER: 11P002SB

|                                                                                |                                                                                      |
|--------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| <b>PROJECT NUMBER:</b> 726876-20120                                            | <b>PROJECT NAME:</b><br>Beale Air Force Base, Site SD11<br>Closure Sampling/Drilling |
| <b>CLIENT:</b> AFCEE                                                           |                                                                                      |
| <b>LOCATION:</b> Beale AFB, Site 11, approximately 4.5 feet southwest of VMP-2 |                                                                                      |
| <b>GEOLOGIST:</b> Amanda Freeman Bielskis                                      | <b>DRILLING METHOD:</b> Hollow Stem Auger (A400)                                     |
| <b>COMPLETION DATE:</b> 1/8/99 and 1/11/99                                     | <b>HOLE DIAMETER:</b> 8 inches                                                       |
|                                                                                | <b>TOTAL DEPTH:</b> approx. 85 feet bgs                                              |

| DEPTH<br>(feet) | GW DEPTH | SAMPLE<br>NUMBER | HEADSPACE<br>PID/TVH (ppmv) | SAMPLE | BREATHING<br>ZONE (ppm) | USCS<br>CLASSIFICATION | GEOLOGIC DESCRIPTION                                                                                                             |
|-----------------|----------|------------------|-----------------------------|--------|-------------------------|------------------------|----------------------------------------------------------------------------------------------------------------------------------|
| 0               |          |                  |                             |        |                         |                        | Hand auger upper 5 ft., continuous sampling from 10 ft.<br>(cuttings = gravel w/sandy clay, reddish brown)                       |
| 5               |          |                  |                             |        | 0.0                     | GC                     |                                                                                                                                  |
| 10              |          |                  | 0.0/0<br>118/90<br>732/100  |        | 0.0                     |                        | gravelly CLAY, lrg. (1-2" dia.) subround gravel clasts, brown (7.5YR5/4), slightly damp.                                         |
| 15              |          |                  |                             |        | 0.0-23*                 |                        | sandy GRAVEL, moist-wet, gray.<br><br>No recovery, hydrocarbon odor in cuttings, cuttings = 23.3ppm.<br>No recovery.             |
| 20              |          |                  | 503/100                     |        | 0.0-30**                |                        | No recovery, rock frags in shoe.<br>cuttings = gravelly clay, strong odors.                                                      |
| 22.5-23         |          | 11P002SB-A       | 1,165/<br>2,400             |        |                         | SP                     | SAND w/minor silt and gravel, damp, well sorted, vf - fine grained, very dense, <5% silt, 1-2" dia. gravel clasts.               |
| 11:55 1/8/99    |          |                  |                             |        |                         |                        | (same as above), very dense, no gravel.                                                                                          |
| 24-24.5         |          | 11P002SB-B       | 300/311                     |        |                         |                        |                                                                                                                                  |
| 12:08 1/8/99    |          |                  | 260/320                     |        | 0.0                     |                        | silty clayey SAND, gray (7.5YR6/1).                                                                                              |
| 11P006SB        |          |                  | 1,490/<br>1,200             |        | 2.0                     |                        |                                                                                                                                  |
| (DUP) 24.5-25   |          |                  | 790/<br>1,000               |        |                         |                        | (same as above), very dense.                                                                                                     |
| 12:00 1/8/99    |          |                  | 51/20                       |        | 0.5                     |                        | SAND, very dense, dry.                                                                                                           |
| 26.8/28         |          |                  | 2.7/20                      |        |                         |                        |                                                                                                                                  |
| 35              |          |                  | 3.5/20<br>3.4/24            |        | 0.4                     | ML                     | clayey SILT, dark brown, damp.                                                                                                   |
|                 |          |                  | 2.0/6                       |        |                         | SP                     | gravelly SAND, fine-med. grained, dry, dense, subangular, olive brown. Sand becomes very fine -fine, (10YR4/3).                  |
| 40              |          |                  | 853/600<br>122/52           |        | 0.0-3.8*                | SM                     | sandy SILT, slightly damp, stiff-very stiff, yellowish brown (10YR4/6), gravel layer at 39', vf sand, difficult drilling at 41'. |
|                 |          |                  | 87.1/42                     |        |                         |                        | silty SAND, dense, hard, becomes light olive brown at 43', slightly damp, very fine to fine sand, hard drilling.                 |
| 45              |          |                  | 87.1/42                     |        |                         |                        |                                                                                                                                  |

--- Contact approximately located.



- First encountered groundwater level.

PID - Photoionization detector reading.

TVH - Total Volatile Hydrocarbon meter reading.

- Indicates sample submitted to laboratory for analysis

BORING NUMBER: 11P002SB

|                                                                         |                                           |
|-------------------------------------------------------------------------|-------------------------------------------|
| PROJECT NUMBER: 726876-20120                                            | PROJECT NAME:                             |
| CLIENT: AFCEE                                                           | Beale Air Force Base, Site SD11           |
| LOCATION: Beale AFB, Site 11, approximately 4.5 feet southwest of VMP-2 | Closure Sampling/Drilling                 |
| GEOLOGIST: Amanda Freeman Bielskis                                      | DRILLING METHOD: Hollow Stem Auger (A400) |
| COMPLETION DATE: 1/8/99 and 1/11/99                                     | HOLE DIAMETER: 8 inches                   |
|                                                                         | TOTAL DEPTH: approx. 85 feet bgs          |

| DEPTH<br>(feet) | GW DEPTH | SAMPLE<br>NUMBER                       | HEADSPACE<br>PID/TVH (ppmv)             | SAMPLE | BREATHING<br>ZONE (ppm) | USCS<br>CLASSIFICATION | GEOLOGIC DESCRIPTION                                                                                                                                                                              |
|-----------------|----------|----------------------------------------|-----------------------------------------|--------|-------------------------|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 45              |          |                                        | 7.0/10<br>13.7/30<br>254/140            |        | 0.0                     | SM                     | Silty SAND, stiff-hard, slightly damp, very fine -fine grained, very tight.                                                                                                                       |
| 50              |          |                                        | 44.7/28<br>207/84<br>226/200<br>288/180 |        | 0.0                     |                        | No recovery at 52', very hard drilling.<br>Begin drilling without sampling 1/11/99, resume sampling every 5' at 60'bgs.                                                                           |
| 55              |          |                                        |                                         |        |                         |                        | Cuttings are silty CLAY, plastic, damp, brown, medium stiff.                                                                                                                                      |
| 60              |          |                                        | 56.8/22                                 |        | 0.0-2.8*                |                        | 2" gravel clasts at 61.5', odors, dark yellow brown.                                                                                                                                              |
| 65              |          | 11P002SB-A<br>66-66.5<br>10:30 1/11/99 | 587/300                                 |        | 0.0-7.6*                | SP                     | silty CLAY, dark yellow brown (10YR3/6), plastic.                                                                                                                                                 |
| 70              |          |                                        | 154/70                                  |        | 0.0                     |                        | SAND, 60-80% coarse, 10-20% med., 10-20% fine, subangular, dark gray.                                                                                                                             |
| 75              |          |                                        | 258/400                                 |        |                         | CL/<br>SP              | Sand as above, w/2" layer of silty clay, brown, stiff, plastic.                                                                                                                                   |
| 80              |          | 11P002SB-B<br>80-80.5<br>12:20 1/11/99 | 0.0/14                                  |        |                         | SP                     | Silty CLAY w/sand interbeds.                                                                                                                                                                      |
| 85              | ▽        |                                        | 0.0/20                                  |        |                         |                        | No recovery at 79', odors, cuttings are clayey<br>SAND, fine grained, well sorted, subangular, moist, dense.<br>Groundwater encountered at approx. 85'.<br>sand is med-crse, wet.                 |
| 90              |          |                                        |                                         |        |                         |                        | * Breathing zone fluctuates, doesn't hold.<br>** Breathing zone fluctuates 0.0 to 30 ppm, doesn't hold,<br>pull benzene sensidyne tube per the Health & Safety plan reqs.<br>No benzene detected. |

-- - Contact approximately located.

PID - Photoionization detector reading.

■ - Indicates sample submitted to laboratory for analysis



- First encountered groundwater level.

TVH - Total Volatile Hydrocarbon meter reading.

BORING NUMBER: 11P003SB

|                                                          |                                           |
|----------------------------------------------------------|-------------------------------------------|
| PROJECT NUMBER: 726876-20120                             | PROJECT NAME:                             |
| CLIENT: AFCEE                                            | Beale Air Force Base, Site SD11           |
| LOCATION: Beale AFB, Site 11<br>east side of pump island | Closure Sampling/Drilling                 |
| GEOLOGIST: Henry Pietropaoli                             | DRILLING METHOD: Hollow Stem Auger (A400) |
| COMPLETION DATE: 1/12/99                                 | HOLE DIAMETER: 8 inches                   |
|                                                          | TOTAL DEPTH: approx. 35 feet bgs          |

| DEPTH<br>(feet) | GW DEPTH | SAMPLE<br>NUMBER                       | HEADSPACE<br>PID/TVH (ppmv) | SAMPLE | BREATHING<br>ZONE (ppm) | USCS<br>CLASSIFICATION | GEOLOGIC DESCRIPTION                                                                                                                                       |
|-----------------|----------|----------------------------------------|-----------------------------|--------|-------------------------|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0               |          |                                        |                             |        |                         | GM                     | 8" concrete.                                                                                                                                               |
| 5               |          |                                        | 673/<br>1,100               |        |                         |                        | Silty GRAVEL, dark grayish brown (10YR4/2), elastic silty matrix, gravel clasts are crse. (Volcanic), $\leq 2"$ diameter, rounded, dense, damp, fuel odor. |
| 10              |          |                                        | 2,062/<br>7,500             |        |                         | GM-GP                  | Same as above with more sand in the matrix.                                                                                                                |
| 15              |          |                                        |                             |        |                         | GP                     | Same as above.                                                                                                                                             |
| 20              |          |                                        | 107/40                      |        |                         | SM                     | Large gravel clast wedged in sampler shoe.<br>Silty SAND, olive gray (5Y5/2), medium dense, fine grained, slight fuel odor.                                |
| 25              |          | 11P003SB-A<br>26.5-27<br>10:30 1/12/99 | 39/16                       |        |                         | SM-SC                  | Increase in clay content.                                                                                                                                  |
| 30              |          | 11P003SB-B<br>29-29.5<br>11:10 1/12/99 | 58/42<br>3/10<br>16/8       |        |                         | SW                     | SAND, fine grained, olive gray (5Y5/2), well graded, slightly damp, loose.                                                                                 |
| 35              |          | 11P003SB-C<br>34.5-35<br>11:55 1/12/99 | 0.0/0<br>0.0/0              |        |                         |                        | Same as above.                                                                                                                                             |
| 40              |          |                                        |                             |        |                         |                        |                                                                                                                                                            |
| 45              |          |                                        |                             |        |                         |                        |                                                                                                                                                            |

- - - Contact approximately located.

PID - Photoionization detector reading.

■ - Indicates sample submitted to laboratory for analysis



- First encountered groundwater level.

TVH - Total Volatile Hydrocarbon meter reading.

BORING NUMBER: 11P004SB

|                                                                               |                                           |
|-------------------------------------------------------------------------------|-------------------------------------------|
| PROJECT NUMBER: 726876-20120                                                  | PROJECT NAME:                             |
| CLIENT: AFCEE                                                                 | Beale Air Force Base, Site SD11           |
| LOCATION: Beale AFB, Site 11, VMP-1 is approx. 25' east, pump island to east. | Closure Sampling/Drilling                 |
| GEOLOGIST: Amanda Freeman Bielskis                                            | DRILLING METHOD: Hollow Stem Auger (A400) |
| COMPLETION DATE: 1/7/99                                                       | HOLE DIAMETER: 8 inches                   |
|                                                                               | TOTAL DEPTH: approx. 33 feet bgs          |

| DEPTH<br>(feet) | GW DEPTH | SAMPLE<br>NUMBER                                             | HEADSPACE<br>PID/TVH (ppmv) | SAMPLE | BREATHING<br>ZONE (ppm) | USCS<br>CLASSIFICATION | GEOLOGIC DESCRIPTION                                                                                                                          |
|-----------------|----------|--------------------------------------------------------------|-----------------------------|--------|-------------------------|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| 0               |          |                                                              |                             |        |                         | GM/<br>ML              | Hand auger upper 5 ft., continuous sampling from 10 ft. cuttings = silty CLAY, strong brown (7.5YR4/6), 10% subrounded gravel, plastic, damp. |
| 5               |          |                                                              |                             |        |                         |                        | Color changes at 8' bgs to (7.5YR4/3) brown, damp, silty.                                                                                     |
| 10              |          |                                                              | 0.0/24                      |        |                         | SP                     | SAND, fine - coarse grained, damp, dark orangish brown, minor clay beds, micaceous.                                                           |
|                 |          |                                                              | 41.7/18                     |        |                         | GP                     | Gravelly SAND, 70% coarse sand, 10-15% fine sand.                                                                                             |
|                 |          | 11P004SB-AA'<br>13.5-14.5<br>MS/MSD<br>13:38 13:40<br>1/7/99 | 1,941/<br>2,400             |        |                         | SP                     | SAND, fine grained, orangish brown, micaceous, some gray discolored sand at 14'.                                                              |
| 15              |          |                                                              | 519/320                     |        |                         | GP                     | Sandy GRAVEL, subround-subangular, damp.                                                                                                      |
|                 |          |                                                              | 113/100                     |        |                         | SP                     | SAND, fine grained, well sorted, w/some gravel, difficult drilling                                                                            |
|                 |          |                                                              | 90.7/56                     |        |                         |                        |                                                                                                                                               |
| 20              |          |                                                              |                             |        |                         | GP                     | Rock in sampler, broken igneous fragment, attempt to drill through gravel                                                                     |
|                 |          |                                                              |                             |        |                         |                        | Gravel, no recovery.                                                                                                                          |
|                 |          | 11P004SB-B<br>24.5-25<br>14:55 1/7/99                        | 204/220                     |        |                         | SP                     | SAND, medium grained, well sorted, damp, gray, dense, gravel fragments towards top, minor clay                                                |
| 25              |          |                                                              | 167/140                     |        |                         |                        |                                                                                                                                               |
|                 |          |                                                              | 0.0/14                      |        |                         | SM                     | Silty SAND, very fine grained, grayish brown (10YR5/2)                                                                                        |
|                 |          |                                                              | 0.0/18                      |        |                         |                        |                                                                                                                                               |
|                 |          |                                                              | 0.0/0                       |        |                         |                        |                                                                                                                                               |
| 30              |          |                                                              | 0.0/20                      |        |                         | SP                     | SAND, fine grained, dark gray, moist-damp, well sorted.                                                                                       |
|                 |          |                                                              | 0.0/0                       |        |                         |                        |                                                                                                                                               |
| 35              |          | 11P004SB-C<br>33-33.5<br>16:00 1/7/99                        |                             |        |                         |                        |                                                                                                                                               |
| 40              |          |                                                              |                             |        |                         |                        |                                                                                                                                               |
| 45              |          |                                                              |                             |        |                         |                        |                                                                                                                                               |

- - - Contact approximately located.

PID - Photoionization detector reading.

■ - Indicates sample submitted to laboratory for analysis

▽ - First encountered groundwater level.

TVH - Total Volatile Hydrocarbon meter reading.

**APPENDIX D**  
**DATA QUALITY ASSESSMENT REPORT**

DATA QUALITY ASSESSMENT REPORT  
AGE MAINTENANCE AREA, IRP SITE SD-11

BEALE AIR FORCE BASE, CALIFORNIA

D1.0 INTRODUCTION

A Parsons Engineering Science electronic Level III validation was performed for the AGE Maintenance Area of Site SD-11 at Beale Air Force Base (AFB) and consisted of electronically and manually examining data deliverables to determine data quality. This included application of data qualifiers to the analytical results based on adherence to method protocols and project-specific quality assurance/quality control (QA/QC) limits. Method protocols reviewed included:

- analytical holding times,
- method blanks (MB),
- trip blanks (TB),
- surrogate spikes,
- matrix spikes/matrix spike duplicates (MS/MSDs),
- laboratory control samples (LCSs), and
- shipping cooler temperature.

Data qualifiers were applied to analytical results during the data validation process. All data were validated using method applicable guidelines and in accordance with the *National Functional Guidelines for Organic Data Review* (USEPA, 1994a) and the *National Functional Guidelines for Inorganic Data Review* (USEPA, 1994b).

The following definitions provide explanations of the USEPA (1994a and 1994b) qualifiers assigned to analytical results during data validation. The data qualifiers described were applied to both inorganic and organic results.

- U - The analyte was analyzed for and is not present above the reported sample quantitation limit (SQL).
- J - The analyte was analyzed for and was positively identified, but the associated numerical value may not be consistent with the amount actually present in the environmental sample. The data should be considered as a basis for decision-making and are usable for many purposes.
- R - The data are rejected as unusable for all purposes. The analyte was analyzed for, but the presence or absence of the analyte was not verified. Resampling and reanalysis are necessary to confirm the presence or absence of the analyte.

- UJ - The analyte analyzed for was not present above the reported SQL. The associated numerical value may not accurately or precisely represent the concentration necessary to detect the analyte in the sample.
- J1 The analyte is qualified as an estimated value solely because it is greater than the method detection limit (MDL) and less than the PQL indicating no laboratory quality issues.

## D2.0 DATA QUALITY

Data quality for each QC parameter where exceptions were noted during the validation is summarized in this section. Only results that exceeded QA/QC criteria are presented. All frequency requirements for field sample collection of QA/QC samples (MS/MSDs and blanks) were met. The frequency requirements for laboratory specific method criteria QA/QC were met overall. In Attachment A, Tables A-1 and A-2 present the analytical methods performed for each samples and the samples that were qualified during the validation process, respectively.

### D2.1 Holding Time

Table D2.1-1 lists all results for target analytes that are out of control with the percentage of out of control results calculated against the total number of samples collected. The method SW8015 (Cal WET) samples were not analyzed within holding time due to laboratory error. The results were qualified as estimated.

**Table D2.1-1**  
**Out-Of-Control Holding Time Impact**  
**AGE Maintenance Area, IRP Site SD-11**  
**Beale AFB, California**

| Anal. Method | Prep. Method | Matrix | Analyte            | Flag | # of Qualified Results | Total Number of Samples | Percent of Results Qualified |
|--------------|--------------|--------|--------------------|------|------------------------|-------------------------|------------------------------|
| SW8015       | SW1311       | SO     | TPH (Diesel Range) | J    | 6                      | 6                       | 100%                         |

### D2.2 Matrix Spikes/Matrix Spike Duplicates

Table 2.2-1 lists out-of-control matrix spike/matrix spike duplicates impact. MS/MSD validation flags were applied only to the parent sample from a non-compliant MS/MSD. Sample results were not qualified on an analytical batch basis. The spike recoveries were low for each compound, indicating a low bias in the sample results. Out-of-control analytical results are believed to be related to matrix interference and the samples were qualified as estimated.

### D2.3 FIELD DUPLICATES

Table D2.3-1 lists the field duplicate results for compounds where at least one sample in the duplicate pair was detected. The relative percent difference (RPD) for all detected

**Table D2.1-1**  
**Out-Of-Control Matrix Spike/Matrix Spike Duplicates Impact**  
**AGE Maintenance Area, IRP Site SD-11**  
**Beale AFB, California**

| Anal. Method | Prep. Method | Matrix | Analyte            | Flag | # of Qualified Results | Total Number of Samples | Percent of Results Qualified |
|--------------|--------------|--------|--------------------|------|------------------------|-------------------------|------------------------------|
| SW8015       | SW1311       | SO     | TPH (Diesel Range) | J    | 1                      | 6                       | 17%                          |
| SW8021       | SW5030       | SO     | Ethylbenzene       | J    | 1                      | 16                      | 6%                           |
| SW8021       | SW5030       | SO     | Xylenes, total     | J    | 1                      | 16                      | 6%                           |

**Table D2.3-1**  
**Field Duplicates**  
**AGE Maintenance Area, IRP Site SD-11**  
**Beale AFB, California**

| Location | Matrix | SBD | SED  | Anal. Method | Prep. Method | Sample Dup Result | Sample Result | LABDL | RPD  | Range | Units | Analyte            |
|----------|--------|-----|------|--------------|--------------|-------------------|---------------|-------|------|-------|-------|--------------------|
| 11P001SB | SO     | 15  | 16.5 | SW8021       | SW5030       | 12000             | 67600         | 123   | 140% |       | µg/kg | Xylenes, total     |
| 11P001SB | SO     | 15  | 16.5 | SW8015       | SW1311       | 1350              | 1920          | 1000  | 35%  |       | µg/L  | TPH (Diesel Range) |
| 11P002SB | SO     | 24  | 25   | SW8015       | SW1311       | 950               | 1640          | 1000  | 53%  |       | µg/L  | TPH (Diesel Range) |
| 11P001SB | SO     | 15  | 16.5 | SW8015       | SW3550       | 27800             | 11900         | 12300 | 80%  |       | µg/kg | TPH (Diesel Range) |
| 11P001SB | SO     | 15  | 16.5 | SW8021       | SW5030       | 309               | 4550          | 61.7  | 175% |       | µg/kg | Benzene            |
| 11P001SB | SO     | 15  | 16.5 | SW8021       | SW5030       | 3950              | 26700         | 123   | 148% |       | µg/kg | Toluene            |
| 11P001SB | SO     | 15  | 16.5 | SW8021       | SW5030       | 1910              | 11900         | 123   | 145% |       | µg/kg | Ethylbenzene       |

Table D2.3-1 (Continued)  
Field Duplicates  
AGE Maintenance Area, IRP Site SD-11  
Beale AFB, California

| Location | Matrix | SBD | SED  | Anal. Method | Prep. Method | Sample Dup Result | Sample Result | LABDL | RPD  | Range | Units | Analyte              |
|----------|--------|-----|------|--------------|--------------|-------------------|---------------|-------|------|-------|-------|----------------------|
| 11P002SB | SO     | 24  | 25   | SW8015       | SW3550       | 150000            | 3290000       | 13200 | 183% |       | µg/kg | TPH (Diesel Range)   |
| 11P002SB | SO     | 24  | 25   | SW8021       | SW5030       | 5.3               | 36.8          | 2.6   | 150% |       | µg/kg | Toluene              |
| 11P002SB | SO     | 24  | 25   | SW8021       | SW5030       | 2.6               | 22.1          | 2.6   | 158% |       | µg/kg | Ethylbenzene         |
| 11P002SB | SO     | 24  | 25   | SW8021       | SW5030       | 27.6              | 250           | 2.6   | 160% |       | µg/kg | Xylenes, total       |
| 11P001SB | SO     | 15  | 16.5 | SW8015       | SW5030       | 322000            | 1570000       | 61700 | 132% |       | µg/kg | TPH (Gasoline Range) |
| 11P002SB | SO     | 24  | 25   | SW8015       | SW5030       | 43600             | 306000        | 1315  | 150% |       | µg/kg | TPH (Gasoline Range) |

compounds was high. Because the sampling technique involved collecting soils duplicates from two adjacent intervals in the borehole, the samples collected are not true duplicates. The non-homogeneous nature of the soil matrix also adds variation to the duplicate results. The data is not qualified based on field duplicate results.

### D3.0 CONCLUSIONS

Samples were collected and analyzed as specified in the methods with exception of those issues discussed in this report. All samples are representative of the site and comparable with previous and future investigations (when used in accordance with the validation qualifiers). All sample results qualified as "UJ or J" represent an association to non-compliant QC criteria that has caused the reported concentration to be estimated. Project objectives do not exclude the use of estimated concentrations. No data was rejected based on the validation, therefore completeness goals of 90 percent were met. Therefore, all data are usable for the purposes intended.

### 4.0 REFERENCES

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USEPA. 1993. Data Quality Objectives Process for Superfund. EPA 540-R-93-071. Washington, DC. September, 1993.

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USEPA. 1994a. Agency National Functional Guidelines for Organic Data Review. PB 94-963502. Washington, DC.

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**ATTACHMENT A**

**VALIDATED SAMPLES AND QUALIFIED ANALYTICAL RESULTS**

## VALIDATED SAMPLES AND QUALIFIED ANALYTICAL RESULTS

Tables A-1 and A-2 list all qualified sample data based on the results of data validation. The following definitions of column headers will aide in the understanding and use of these tables.

|                       |                                                                                                                                                                                                                                                                                                                              |
|-----------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>LOCID:</b>         | Sample location identifier, unique to each sample when used in conjunction of columns SBD and SED.                                                                                                                                                                                                                           |
| <b>MX:</b>            | Sample matrix identifier. "SO" is soil, "WG" is water.                                                                                                                                                                                                                                                                       |
| <b>SA:</b>            | Sample analysis identifier. "N" is for primary field samples, "FR" is for field replicate samples. "N1" or "FR1" designates that the results associated to the original sample analysis. "N8" or "FR8" designates that the results associated to a composite of sample analysis results.                                     |
| <b>SBD:</b>           | Sample beginning depth.                                                                                                                                                                                                                                                                                                      |
| <b>SED:</b>           | Sample ending depth.                                                                                                                                                                                                                                                                                                         |
| <b>COMPOUND NAME:</b> | This column identifies the target compound name.                                                                                                                                                                                                                                                                             |
| <b>VQ:</b>            | This column designates if a target compound was detected or not. An "=" denotes a detection above the project practical quantitation limit. A "ND" denotes a non-detection above the method detection limit. A "TR" denotes a detection above the method detection limit but below the project practical quantitation limit. |
| <b>PARVAL:</b>        | This is the concentration of detection for all detected sample results (TR or =). A zero is a placeholder, which associates to a non-detected compound. The zero does not imply that the compound was not detected at less than zero.                                                                                        |
| <b>LABDL:</b>         | This is the concentration at which the laboratory reports the project reporting limit. The project reporting limit is a practical quantitation limit in that it is related to a multiplier of the method detection limit.                                                                                                    |
| <b>ANMCODE:</b>       | Analytical method code identifier.                                                                                                                                                                                                                                                                                           |
| <b>EXMCODE:</b>       | Analytical extraction method code identifier.                                                                                                                                                                                                                                                                                |
| <b>Q:</b>             | This column represents the final validation qualifier applied to the sample result. It is a composite of all the validation qualifiers for that sample result.                                                                                                                                                               |

The following column headers apply to the method criteria that are included in a data validation. All of the columns may not appear in Table A-2. Only those method criteria that resulted in qualifying sample results are listed.

|      |                             |
|------|-----------------------------|
| HTM  | Holding Time                |
| MBM  | Method Blank                |
| TBM  | Trip Blanks                 |
| EBM  | Equipment Blanks            |
| ABM  | Ambient Blanks              |
| MSRM | MS/MSD (%Recovery/Accuracy) |
| MSPM | MS/MSD (%RPD/Precision)     |
| LCRM | LCS (%Recovery/Accuracy)    |
| LCPM | LCS (%RPD/Precision)        |
| SURM | Surrogate                   |
| TMPM | Temperature                 |
| PRSM | Preservation                |

**TABLE A-1**  
**ANALYTICAL METHODS BY SAMPLE LOCATION**  
 AGE Maintenance Area, IRP Site SD-11  
 Beale AFB, California

| LOCID    | SBD  | SED  | MATRIX | SW8015 -<br>SW1311 | SW8015 -<br>SW3550 | SW8015 -<br>SW5030 | SW8021 -<br>SW5030 | SW9060 -<br>METHOD |
|----------|------|------|--------|--------------------|--------------------|--------------------|--------------------|--------------------|
|          |      |      |        | (Cal WET-<br>DRO)  | (TPH-<br>DRO)      | (TPH-<br>GRO)      | (BTEX)             | (TOC)              |
| 11P001SB | 11   | 11.5 | SO     | X                  | X                  | X                  | X                  |                    |
| 11P001SB | 15   | 16.5 | SO     | X                  | X                  | X                  | X                  |                    |
| 11P001SB | 29   | 29.5 | SO     |                    | X                  | X                  | X                  |                    |
| 11P001SB | 36   | 36.5 | SO     |                    |                    |                    |                    | X                  |
| 11P001SB | 36.5 | 37   | SO     |                    | X                  | X                  | X                  |                    |
| 11P002SB | 22.5 | 23   | SO     |                    | X                  | X                  | X                  |                    |
| 11P002SB | 24   | 25   | SO     | X                  | X                  | X                  | X                  |                    |
| 11P002SB | 33   | 33.5 | SO     |                    |                    | X                  |                    |                    |
| 11P002SB | 66   | 66.5 | SO     |                    | X                  | X                  | X                  |                    |
| 11P002SB | 80   | 80.5 | SO     |                    | X                  | X                  | X                  | X                  |
| 11P003SB | 26.5 | 27   | SO     |                    | X                  | X                  | X                  |                    |
| 11P003SB | 29   | 29.5 | SO     |                    | X                  | X                  | X                  |                    |
| 11P003SB | 34.5 | 35   | SO     |                    | X                  | X                  | X                  | X                  |
| 11P004SB | 13.5 | 14.5 | SO     | X                  | X                  | X                  | X                  |                    |
| 11P004SB | 24.5 | 25   | SO     |                    | X                  | X                  | X                  |                    |
| 11P004SB | 33   | 33.5 | SO     |                    | X                  |                    | X                  |                    |

**TABLE A-2**  
**QUALIFIED ANALYTICAL RESULTS**  
 AGE Maintenance Area, IRP Site SD-11  
 Beale AFB, California

| LOCID    | SBD  | SED  | MATRIX | SA<br>CODE | ANM<br>CODE | EXM<br>CODE | ANALYTE            | PARVQ | PARVAL | LABDL | UNITS | FINAL<br>Q | EHTM | MSRM |
|----------|------|------|--------|------------|-------------|-------------|--------------------|-------|--------|-------|-------|------------|------|------|
| 11P001SB | 11   | 11.5 | SO     | N1         | SW8015      | SW1311      | TPH (Diesel Range) | =     | 1880   | 1000  | UG/L  | J          | J    |      |
| 11P001SB | 15   | 16.5 | SO     | FR1        | SW8015      | SW1311      | TPH (Diesel Range) | =     | 1350   | 1000  | UG/L  | J          | J    |      |
| 11P001SB | 15   | 16.5 | SO     | N1         | SW8015      | SW1311      | TPH (Diesel Range) | =     | 1920   | 1000  | UG/L  | J          | J    |      |
| 11P002SB | 24   | 25   | SO     | FR1        | SW8015      | SW1311      | TPH (Diesel Range) | TR    | 950    | 1000  | UG/L  | J          | J    |      |
| 11P002SB | 24   | 25   | SO     | N1         | SW8015      | SW1311      | TPH (Diesel Range) | =     | 1640   | 1000  | UG/L  | J          | J    |      |
| 11P004SB | 13.5 | 14.5 | SO     | N1         | SW8015      | SW1311      | TPH (Diesel Range) | =     | 2450   | 1000  | UG/L  | J          | J    | J    |
| 11P004SB | 13.5 | 14.5 | SO     | N1         | SW8021      | SW5030      | Ethylbenzene       | =     | 6630   | 225   | µg/kg | J          |      | J    |
| 11P004SB | 13.5 | 14.5 | SO     | N1         | SW8021      | SW5030      | Xylenes, total     | =     | 40600  | 225   | µg/kg | J          |      | J    |

**APPENDIX E**  
**LABORATORY ANALYTICAL RESULTS**



SPECIALIZED ASSAYS INC. • 2960 Foster Creighton Dr. • P.O. Box 40566 • Nashville, Tennessee 37204-0566  
615-726-0177 • 1-800-765-0980 • Fax 615-726-3404

### CASE NARRATIVE

Client: Parsons Engineering Science  
Attn: Lyn Fitzgerald/John Ratz  
1700 Broadway, Suite 900  
Denver, CO 80290

Client Project: Beale Air Force Base Site SD-11      Matrix: Soil

Laboratory Project: 127158      Number samples: 3

Date Received: 1/13/99      Date Collected: 1/12/99

Sample Receipt Notes: All samples were received in good condition, properly preserved. There were no discrepancies noted on the cooler receipt form. All analyses were performed within method specified holding times.

#### QA/QC Summary:

TPH Gasoline – SW8015B

The sample used for MS/MSD was 11P004SB-AA, laboratory ID 99-A3605. This sample was not a member of this sample delivery group. This MS/MSD analysis had low recoveries for Ethylbenzene and Xylenes, possibly due to the contamination level of the original sample. All recoveries were within acceptable limits on the laboratory control sample.

TPH Diesel – SW8015B

The sample used for MS/MSD analysis was 11P003SB-C. All recoveries were within acceptable limits on both the MS/MSD pair and the Laboratory control sample.

#### TOC

One sample, 11P003SB-c, requested analysis for Total Organic Carbon. Duplicate analysis on this sample showed acceptable percent difference, and all method required QC analyses were within limits.

If you have any technical issues relating to the enclosed data, please call me at 1-800-765-0980.

Johnny A. Mitchell  
Director of Technical Services

2101 Webster Street, Suite 700  
Oakland, California 94612  
Phone: (510) 891-9085  
FAX: (510) 835-4355

## CHAIN OF CUSTODY RECORD

[illegible]

**Distribution:** Original accompanies shipment: photocopy kept by samplers: photocopy kept by Parsons ES Site Manager by laboratory upon receipt of samples.

# Cooler Receipt Form

Client: Parsons

Cooler Received On: 1/13 And Opened On: 1/13/99 By: PAir R. Buckingham

P. R. Buckingham  
(Signature)

1. Temperature of Cooler when opened 40C

2. Were custody seals on outside of cooler and intact? ☒ Yes ☐ No

a. If yes, what kind and where: 2 Seals / back

b. Were the signature and date correct? ☒ Yes ☐ No

3. Were custody papers inside cooler? ☒ Yes ☐ No

4. Were custody papers properly filled out (ink, signed, etc)? ☒ Yes ☐ No

5. Did you sign the custody papers in the appropriate place? ☒ Yes ☐ No

6. What kind of packing material was used? bubble wrap

7. Was sufficient ice used (if appropriate)? ☒ Yes ☐ No

8. Did all bottles arrive in good condition (unbroken)? ☒ Yes ☐ No

9. Were all bottle labels complete (#, date, signed, pres, etc)? ☒ Yes ☐ No

10. Did all bottle labels and tags agree with custody papers? ☒ Yes ☐ No

11. Were correct bottles used for the analysis requested? ☒ Yes ☐ No

12. If present, were VOA vials checked for absence of air bubbles and noted if found? ☒ Yes ☐ No

13. Was sufficient amount of sample sent in each bottle? ☒ Yes ☐ No

14. Were correct preservatives used? ☒ Yes ☐ No

15. Corrective action taken, if necessary:

a. Name of person contacted: \_\_\_\_\_

b. Date: \_\_\_\_\_

000002

1 From 1/1/99 Date 1/1/99 Sender's Name Henry P. Payroll Phone (510) 894-9085

Company PARSONS ENG SCIENCES INC.

Address 2101 WEBSTER ST. 7TH FLOOR Dupl./Floor/Suite/Room

City OAKLAND State CA Zip 94612

2 Your Internal Billing Reference Information 72076 20120 / 8185

3 To Recipient's Name Enrico S. Salazar Phone (510) 266-5900

Company Specialized Services Inc.

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Address (To "HOLD" at FedEx location, print FedEx label on here) 2460 ST. FRANCIS BLVD Dupl./Floor/Suite/Room

State CA Zip 94604

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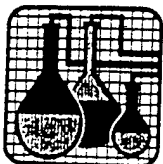
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615-726-0177 • 1-800-765-0980 • Fax 615-726-3404

### CASE NARRATIVE

Client: Parsons Engineering Science  
Attn: Lyn Fitzgerald/John Ratz  
1700 Broadway, Suite 900  
Denver, CO 80290

Client Project: Beale Air Force Base Site SD-11

Matrix: Soil

Laboratory Project: 127017

Number samples: 14

Date Received: 1/12/99

Date Collected: 1/6/99 - 01/11/99

Sample Receipt Notes: All samples were received in good condition, properly preserved. There were no discrepancies noted on the cooler receipt form. All analyses were performed within method specified holding times.

#### QA/QC Summary:

TPH Gasoline - SW8015B

The sample used for MS/MSD was 11P004SB-AA, laboratory ID 99-A3605. This MS/MSD analysis had low recoveries for Ethylbenzene and Xylenes, possibly due to the contamination level of the original sample. All recoveries were within acceptable limits on the laboratory control sample.

TPH Diesel - SW8015B

The sample used for MS/MSD analysis was 11P004SB-AA. Due to the dilution required on the original sample, the MS/MSD extracts were not analyzed. The sample contamination was sufficiently high to mask any contribution from the spiked amount. Recovery was acceptable on the laboratory control sample.

#### TOC

Two samples, 11P002SB-A and 11P002SB-B, requested analysis for Total Organic Carbon. Duplicate analysis on 11P002SB-B showed acceptable percent difference, and all method required QC analyses were within limits.

If you have any technical issues relating to the enclosed data, please call me at 1-800-765-0980.

Johnny A. Mitchell  
Director of Technical Services

# CHAIN OF CUSTODY RECORD

Malei

Project No.: 726876.20120      Lab Account No.: 8185

Project Name/Location: Beale AFB; Site SD-11

**Site Manager: Michael Phelps (Oakland, CA)**

**Project Manager:** John Ratz (Denver, CO)

**Samplers: (Initials and Signatures)**  
**AFB - Annula Freeman**  
*Breiskis*  
*Annula Freeman*

**Lab: Bruce Schlatter/Mary Louise Linn**  
**Specialized Assays, Inc. (SAI)**  
**2960 Foster Creighton Drive**  
**Nashville, TN 37204**  
**(615) 726-0177**  
**Fax: (615) 726-3404**

**Lab: Bruce Schlatter/Mary Louise Linn**  
**Specialized Assays, Inc. (SAI)**  
**2960 Foster Creighton Drive**  
**Nashville, TN 37204**  
**(615) 726-0177**  
**Fax: (615) 726-3404**

| Sample ID  | Date   | Time | Begin Depth | End Depth | Matrix |
|------------|--------|------|-------------|-----------|--------|
| 11P001SB-A | 1/6/99 | 1204 | 11          | 11.5      | soil   |
| 11P005SB   | 1/6/99 | 1200 | 15          | 15.5      | soil   |
| 11P001SB-B | 1/6/99 | 1317 | 16          | 16.5      | soil   |
| 11P001SB-C | 1/7/99 | 1020 | 29          | 29.5      | soil   |
| 11P001SB-D | 1/7/99 | 1130 | 36          | 36.5      | soil   |
| 11P001SB-E | 1/7/99 | 1132 | 36.5        | 37        | soil   |
| 11P004SB-A | 1/7/99 | 1338 | 13.5        | 14.5      | soil   |
| 11P004SB-B | 1/7/99 | 1455 | 24.5        | 25        | soil   |
| 11P004SB-C | 1/7/99 | 1600 | 33          | 33.5      | soil   |
| 11P002SB-A | 1/8/99 | 1155 | 21.5        | 23        | soil   |
| 11P002SB-B | 1/8/99 | 1208 | 24          | 24.5      | soil   |
| 11P006SB   | 1/8/99 | 1200 | 24.5        | 25        | soil   |

|                              |         |      |                          |
|------------------------------|---------|------|--------------------------|
| RECEIVED BY: (SIGNATURE)     | DATE    | TIME | RECEIVED BY: (SIGNATURE) |
| <i>Carl Boyles</i>           | 1/11/99 |      |                          |
| RELINQUISHED BY: (SIGNATURE) | DATE    | TIME | RECEIVED FOR LAB BY: ( ) |
|                              |         |      | <i>RLK</i>               |

Distribution: Original accompanies shipment; photocopy kept by samplers; copy FAXed to Parsons ES Site Manager by laboratory upon receipt of samples.

| NO. OF CONTAINERS | ANALYTES (METHOD)        |                          |                           |              |                               | ORGANICS |  | INORGANICS |  | OTHER |                      |
|-------------------|--------------------------|--------------------------|---------------------------|--------------|-------------------------------|----------|--|------------|--|-------|----------------------|
|                   | TPH-gasoline/GRO (8015M) | Extract. TPH/DRO (8015M) | Leachable TPH/DRO (8015M) | BTEX (8020A) | Total Organic Carbon (Sw9060) |          |  |            |  |       |                      |
| 1                 | X                        | X                        | X                         | X            | X                             |          |  |            |  |       | Sample Remarks       |
| 1                 | X                        | X                        | X                         | X            | X                             |          |  |            |  |       | 3600                 |
| 1                 | X                        | X                        | X                         | X            | X                             |          |  |            |  |       | 3601                 |
| 1                 | X                        | X                        | X                         | X            | X                             |          |  |            |  |       | 3602                 |
| 1                 | X                        | X                        | X                         | X            | X                             |          |  |            |  |       | 3603                 |
| 1                 |                          |                          |                           |              |                               |          |  |            |  |       | 3613                 |
| 1                 | X                        | X                        | X                         | X            | X                             |          |  |            |  |       | 3604                 |
| 2                 | X                        | X                        | X                         | X            | X                             |          |  |            |  |       | perform matrix spike |
| 1                 | X                        | X                        | X                         | X            | X                             |          |  |            |  |       | ANALYST              |
| 1                 | X                        | X                        | X                         | X            | X                             |          |  |            |  |       | 3606                 |
| 1                 | X                        | X                        | X                         | X            | X                             |          |  |            |  |       | 3607                 |
| 1                 | X                        | X                        | X                         | X            | X                             |          |  |            |  |       | 3608                 |
| 1                 | X                        | X                        | X                         | X            | X                             |          |  |            |  |       | 3609                 |
| 1                 | X                        | X                        | X                         | X            | X                             |          |  |            |  |       | 3610                 |

### SPECIFIC ANALYTICAL METHOD FOOTNOTES:

1. Delonized water extraction (California Title 22 method); DO LEACHABLES  
IF TOTAL TPH IS DETECTED AND AFTER CONSULTATION WITH SITE  
MANAGER (PHELPS).

**GENERAL COMMENTS/INSTRUCTIONS:**

1. FAX chain-of-custody on check-In to site manager (PHELPS).
2. QC and reporting limits of contract 726876.3016.00 must be met.
3. Option 2 pitching applies and IRPINS electronic deliverable IS required.

# Cooler Receipt Form

Client: Parsons Env-Services

Cooler Received On: 1/12 And Opened On: 1/12/99 By: Pat R. Buckingham

(Signature)

1. Temperature of Cooler when opened 40

2. Were custody seals on outside of cooler and intact?.....☒ Yes No

a. If yes, what kind and where: 2 front/back

b. Were the signature and date correct?.....☒ Yes No

3. Were custody papers inside cooler?.....☒ Yes No

4. Were custody papers properly filled out (ink, signed, etc)?.....☒ Yes No

5. Did you sign the custody papers in the appropriate place?.....☒ Yes No

6. What kind of packing material was used? bubble wrap

7. Was sufficient ice used (if appropriate)?.....☒ Yes No

8. Did all bottles arrive in good condition (unbroken)?.....☒ Yes No

9. Were all bottle labels complete (#, date, signed, pres, etc)?.....☒ Yes No

10. Did all bottle labels and tags agree with custody papers?.....☒ Yes No

11. Were correct bottles used for the analysis requested?.....☒ Yes No

12. If present, were VOA vials checked for absence of air bubbles and noted if found?.....☒ Yes No

13. Was sufficient amount of sample sent in each bottle?.....☒ Yes No

14. Were correct preservatives used?.....☒ Yes No

15. Corrective action taken, if necessary:

a. Name of person contacted: \_\_\_\_\_

b. Date \_\_\_\_\_

000003

# CHAIN OF CUSTODY RECORD

21961

Project No.: 726876.20120.  
Lab Account No.: 8185

Project Name/Location: Beale AFB; Site SD-11

**Site Manager: Michael Phelps (Oakland, CA)**

**Project Manager:** John Ratz (Denver, CO)

Samplers: (Initials and Signatures) *Joe Andrew Buehler*

Joe Cuba Buellhos

[illegible][illegible]

**SPECIFIC ANALYTICAL METHOD FOOTNOTES:**

1. Delonized water extraction (California Title 22 method); DO LEACHABLE  
IF TOTAL TPH IS DETECTED AND AFTER CONSULTATION WITH SITE  
MANAGER (PHELPS).

**GENERAL COMMENTS/INSTRUCTIONS:**

1. FAX chain-of-custody on check-in to site manager (Phelps).
2. QC and reporting limits of contract 726876.3016,00 must be met.
3. Option 2 pricing applies and IRPIMS electronic deliverable IS required.

1. FAX chain-of-custody on check-in to site manager (Phelps).

2. QC and reporting limits of contract 726876.3016.00 must be met.

3. Option 2 pricing applies and IRPIMS electronic deliverable IS required.

**Distribution:** Original accompanies shipment; photocopy kept by samplers; copy FAXed to Parsons ES Site Manager by laboratory upon receipt of samples;

0000004

**edEx.** USA Airbill **802892697956**

From 1/11/99

To Amanda Bielskis Phone (510) 891-9085

Company PARSONS ENG SCIENCES INC

Address 2101 WEBSTER ST 7TH FL

City OAKLAND State CA ZIP 94612

Your Internal Billing Reference Information 726876.20120/8185

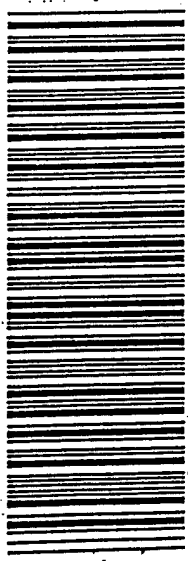
To Bruce Schlatter Phone 1800 1765-0980

Company Specialized Assays, Inc

Address 2960 Foster Creighton Drive Dept./Floor/Suite/Room IN 37204

City Nashville State TN ZIP 37204

For HOLD at FedEx Location check here ☐ For Saturday Delivery check here ☐



802892697956

Form 10. No. **0200** Recipient's Copy

**4a Express Package Service Packages under 150 lbs.**  
☐ FedEx Priority Overnight (Next business morning)  
☒ FedEx Standard Overnight (Next business afternoon)  
☐ FedEx First Overnight (First business morning delivery in select locations) (Higher rates apply)  
☐ FedEx 2Day (Second business day)  
☐ FedEx Express Saver (Third business day)  
FedEx Letter Rate not available. Minimum charge: One pound rate.

**4b Express Freight Service Packages over 150 lbs.**  
☐ FedEx Overnight Freight (Next business day)  
☐ FedEx 2Day Freight (Second business day)  
☐ FedEx Express Saver Freight (Up to 3 business days)  
(Call for delivery schedule. See back for detailed descriptions of freight services.)

**5 Packaging** ☐ FedEx Letter ☐ FedEx Pak ☐ FedEx Box ☐ FedEx Tube ☒ Other  
(One box must be checked)  
Does this shipment contain dangerous goods? ☒ No ☐ Yes (If yes, specify below)  
☐ Dry Ice ☐ UN 1845 ☐ CA ☐ Cargo Aircraft Only

**6 Special Handling**  
Does this shipment contain dangerous goods? ☒ No ☐ Yes (If yes, specify below)  
☐ Dry Ice ☐ UN 1845 ☐ CA ☐ Cargo Aircraft Only

**7 Payment**  
Bill to: ☐ Sender ☒ Recipient ☐ Third Party ☐ Credit Card ☐ Cash  
Obtain Recipient's FedEx Account No. (Enter FedEx account no. w/ Credit Card no. below)

**8 Release Signature**

Total Packages 1 Total Weight 47 Total Declared Value \$2500.00 Total Charges \$

When declared value higher than \$100 per shipment, you pay an additional charge. See SERVICE CONDITIONS, DECLARED VALUE, AND LIMIT OF LIABILITY section for further information.

Questions? Call 1-800-Go-FedEx (800) 463-3339

Printed in U.S.A.



# SPECIALIZED ASSAYS, INC.

2960 Foster Creighton Dr.  
P.O. Box 40566  
Nashville, TN 37204-0566  
Phone 1-615-726-0177

## Sample Identification

11P001SB-A

SBD SED

11 - 11.5 F

Matrix: Soil  
% Dry Weight: 90.  
Units: ug/kg dry weight  
Dilution Factor: 1.  
Analysis Method: SW8015  
Delivery Group: 127017  
Instrument: PE-1  
Grams Extracted: 25.0 g  
Extract Vol: 1.0 ml

Lab Sample ID: 99-A3600

Date Sampled: 1/ 6/99

Date Received: 1/12/99

Analysis Date: 1/13/99

Analysis Time: 19:54

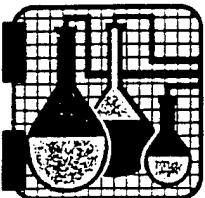
Sample QC Group: 9693

Extraction Date: 1/13/99

## FORM I

| CAS NUMBER | ANALYTE                  | CONCENTRATION | FLAG |
|------------|--------------------------|---------------|------|
| NA .....   | TPH (Diesel Range) ..... | 106000        | .... |

000160



# SPECIALIZED ASSAYS, INC.

2960 Foster Creighton Dr.  
P.O. Box 40566  
Nashville, TN 37204-0566  
Phone 1-615-726-0177

## Sample Identification

11P0015B-A

11-11.5 ft

Matrix: Soil  
% Dry Weight: 90.  
Units: ug/kg dry weight  
Dilution Factor: 50.  
Analysis Method: SW8015  
Delivery Group: 127017  
Instrument:

Lab Sample ID: 99-A3600  
Date Sampled: 1/ 6/99  
Date Received: 1/12/99  
Analysis Date: 1/20/99  
Analysis Time: 19:09  
Sample QC Group: 4101

## FORM I

| CAS NUMBER | ANALYTE                    | CONCENTRATION | FLAG |
|------------|----------------------------|---------------|------|
| NA .....   | TPH (Gasoline Range) ..... | 151000        | .... |

000007



# SPECIALIZED ASSAYS, INC.

2960 Foster Creighton Dr.  
P.O. Box 40566  
Nashville, TN 37204-0566  
Phone 1-615-726-0177

## Sample Identification

11P001SB-A

11-11.5 ft

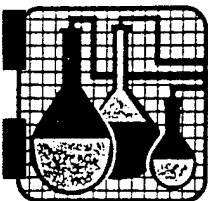
Matrix: Soil  
% Dry Weight: 90.  
Units: ug/kg dry weight  
Dilution Factor: 50.  
Analysis Method: SW8021B  
Delivery Group: 127017  
Instrument:

Lab Sample ID: 99-A3600  
Date Sampled: 1/ 6/99  
Date Received: 1/12/99  
Analysis Date: 1/20/99  
Analysis Time: 19:09  
Sample QC Group: 4101

## FORM I

| CAS NUMBER | ANALYTE        | CONCENTRATION | FLAG |
|------------|----------------|---------------|------|
| 71-43-2    | Benzene        | 55.6          | .... |
| 108-88-3   | Toluene        | 1110          | .... |
| 100-41-4   | Ethylbenzene   | 778.          | .... |
| 1330-20-7  | Xylenes, total | 3330          | .... |

000006



# SPECIALIZED ASSAYS, INC.

2960 Foster Creighton Dr.  
P.O. Box 40566  
Nashville, TN 37204-0566  
Phone 1-615-726-0177

## Sample Identification

11P005SB

15-15.5 ft

Matrix: Soil  
% Dry Weight: 81.  
Units: ug/kg dry weight  
Dilution Factor: 1.  
Analysis Method: SW8015  
Delivery Group: 127017  
Instrument: PE-1  
Grams Extracted: 25.0 g  
Extract Vol: 1.0 ml

Lab Sample ID: 99-A3601  
Date Sampled: 1/ 6/99  
Date Received: 1/12/99  
Analysis Date: 1/13/99  
Analysis Time: 20:23  
Sample QC Group: 9693  
Extraction Date: 1/13/99

## FORM I

| CAS NUMBER | ANALYTE                  | CONCENTRATION | FLAG |
|------------|--------------------------|---------------|------|
| NA .....   | TPH (Diesel Range) ..... | 27800         | .... |



# SPECIALIZED ASSAYS, INC.

2960 Foster Creighton Dr.  
P.O. Box 40566  
Nashville, TN 37204-0566  
Phone 1-615-726-0177

## Sample Identification

11P005SB

15-15.5 ft

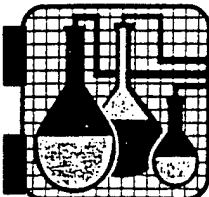
Matrix: Soil  
% Dry Weight: 81.  
Units: ug/kg dry weight  
Dilution Factor: 50.  
Analysis Method: SW8015  
Delivery Group: 127017  
Instrument:

Lab Sample ID: 99-A3601  
Date Sampled: 1/ 6/99  
Date Received: 1/12/99  
Analysis Date: 1/20/99  
Analysis Time: 19:46  
Sample QC Group: 4101

## FORM I

| CAS NUMBER | ANALYTE                    | CONCENTRATION | FLAG |
|------------|----------------------------|---------------|------|
| NA .....   | TPH (Gasoline Range) ..... | 322000        | .... |

000009



# SPECIALIZED ASSAYS, INC.

2960 Foster Creighton Dr.  
P.O. Box 40566  
Nashville, TN 37204-0566  
Phone 1-615-726-0177

## Sample Identification

11P005SB

15-15.5f

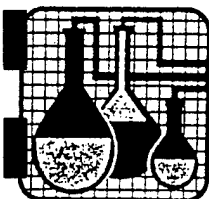
Matrix: Soil  
% Dry Weight: 81.  
Units: ug/kg dry weight  
Dilution Factor: 50.  
Analysis Method: SW8021B  
Delivery Group: 127017  
Instrument:

Lab Sample ID: 99-A3601  
Date Sampled: 1/ 6/99  
Date Received: 1/12/99  
Analysis Date: 1/20/99  
Analysis Time: 19:46  
Sample QC Group: 4101

## FORM I

| CAS NUMBER      | ANALYTE              | CONCENTRATION | FLAG |
|-----------------|----------------------|---------------|------|
| 71-43-2 .....   | Benzene .....        | 309.          | .... |
| 108-88-3 .....  | Toluene .....        | 3950          | .... |
| 100-41-4 .....  | Ethylbenzene .....   | 1910          | .... |
| 1330-20-7 ..... | Xylenes, total ..... | 12000         | .... |

000008



# SPECIALIZED ASSAYS, INC.

2960 Foster Creighton Dr.  
P.O. Box 40566  
Nashville, TN 37204-0566  
Phone 1-615-726-0177

## Sample Identification

11P001SB-B

16-16.5 ft.

Matrix: Soil  
% Dry Weight: 88.  
Units: ug/kg dry weight  
Dilution Factor: 1.  
Analysis Method: SW8015  
Delivery Group: 127017  
Instrument: PE-1  
Grams Extracted: 25.0 g  
Extract Vol: 1.0 ml

Lab Sample ID: 99-A3602  
Date Sampled: 1/6/99  
Date Received: 1/12/99  
Analysis Date: 1/13/99  
Analysis Time: 20:52  
Sample QC Group: 9693

Extraction Date: 1/13/99

## FORM I

| CAS NUMBER | ANALYTE                  | CONCENTRATION | FLAG |
|------------|--------------------------|---------------|------|
| NA .....   | TPH (Diesel Range) ..... | 11900         | .... |

000161



# SPECIALIZED ASSAYS, INC.

2960 Foster Creighton Dr.  
P.O. Box 40566  
Nashville, TN 37204-0566  
Phone 1-615-726-0177

## Sample Identification

11P001SB-B

16-16.5 ft.

Matrix: Soil  
% Dry Weight: 88.  
Units: ug/kg dry weight  
Dilution Factor: 500.  
Analysis Method: SW8015  
Delivery Group: 127017  
Instrument:

Lab Sample ID: 99-A3602  
Date Sampled: 1/ 6/99  
Date Received: 1/12/99  
Analysis Date: 1/20/99  
Analysis Time: 20:24  
Sample QC Group: 4101

## FORM I

| CAS NUMBER | ANALYTE                    | CONCENTRATION | FLAG |
|------------|----------------------------|---------------|------|
| NA .....   | TPH (Gasoline Range) ..... | 1570000 ..... |      |

000011



# SPECIALIZED ASSAYS, INC.

2960 Foster Creighton Dr.  
P.O. Box 40566  
Nashville, TN 37204-0566  
Phone 1-615-726-0177

## Sample Identification

11P001SB-B

16-16.5 ft

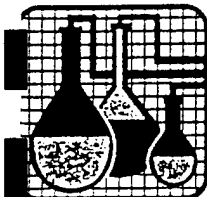
Matrix: Soil  
% Dry Weight: 88.  
Units: ug/kg dry weight  
Dilution Factor: 500.  
Analysis Method: SW8021B  
Delivery Group: 127017  
Instrument:

Lab Sample ID: 99-A3602  
Date Sampled: 1/ 6/99  
Date Received: 1/12/99  
Analysis Date: 1/20/99  
Analysis Time: 20:24  
Sample QC Group: 4101

## FORM I

| CAS NUMBER | ANALYTE        | CONCENTRATION | FLAG |
|------------|----------------|---------------|------|
| 71-43-2    | Benzene        | 4550          | .... |
| 108-88-3   | Toluene        | 26700         | .... |
| 100-41-4   | Ethylbenzene   | 11900         | .... |
| 1330-20-7  | Xylenes, total | 67600         | .... |

000010



# SPECIALIZED ASSAYS, INC.

2960 Foster Creighton Dr.  
P.O. Box 40566  
Nashville, TN 37204-0566  
Phone 1-615-726-0177

## Sample Identification

11P001SB-C

29-29.5

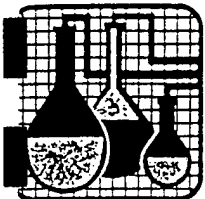
Matrix: Soil  
% Dry Weight: 96.  
Units: ug/kg dry weight  
Dilution Factor: 1.  
Analysis Method: SW8015  
Delivery Group: 127017  
Instrument: PE-1  
Grams Extracted: 25.0 g  
Extract Vol: 1.0 ml

Lab Sample ID: 99-A3603  
Date Sampled: 1/7/99  
Date Received: 1/12/99  
Analysis Date: 1/13/99  
Analysis Time: 21:21  
Sample QC Group: 9693  
Extraction Date: 1/13/99

## FORM I

| CAS NUMBER | ANALYTE                  | CONCENTRATION | FLAG   |
|------------|--------------------------|---------------|--------|
| NA .....   | TPH (Diesel Range) ..... | 1580          | .... J |

000162



**SPECIALIZED  
ASSAYS, INC.**

2960 Foster Creighton Dr.  
P.O. Box 40566  
Nashville, TN 37204-0566  
Phone 1-615-726-0177

**Sample Identification**

11P001SB-C

29-29.5 f

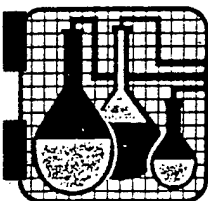
Matrix: Soil  
% Dry Weight: 96.  
Units: ug/kg dry weight  
Dilution Factor: 1.  
Analysis Method: SWB015  
Delivery Group: 127017  
Instrument:

Lab Sample ID: 99-A3603  
Date Sampled: 1/ 7/99  
Date Received: 1/12/99  
Analysis Date: 1/20/99  
Analysis Time: 21:01  
Sample QC Group: 4101

**FORM I**

| CAS NUMBER | ANALYTE                    | CONCENTRATION | FLAG   |
|------------|----------------------------|---------------|--------|
| NA .....   | TPH (Gasoline Range) ..... | 1040          | .... U |

000013



# SPECIALIZED ASSAYS, INC.

2960 Foster Creighton Dr.  
P.O. Box 40566  
Nashville, TN 37204-0566  
Phone 1-615-726-0177

## Sample Identification

11P001SB-C

29-29.5

Matrix: Soil  
% Dry Weight: 96.  
Units: ug/kg dry weight  
Dilution Factor: 1.  
Analysis Method: SW8021B  
Delivery Group: 127017  
Instrument:

Lab Sample ID: 99-A3603  
Date Sampled: 1/ 7/99  
Date Received: 1/12/99  
Analysis Date: 1/20/99  
Analysis Time: 21:01  
Sample QC Group: 4101

## FORM I

| CAS NUMBER | ANALYTE        | CONCENTRATION | FLAG |
|------------|----------------|---------------|------|
| 71-43-2    | Benzene        | 1.0           | U    |
| 108-88-3   | Toluene        | 2.1           | U    |
| 100-41-4   | Ethylbenzene   | 2.1           | U    |
| 1330-20-7  | Xylenes, total | 2.1           | U    |

000Q12



# SPECIALIZED ASSAYS, INC.

2960 Foster Creighton Dr.  
P.O. Box 40566  
Nashville, TN 37204-0566  
Phone 1-615-726-0177

## Sample Identification

11P001SB-E

36.5-37 F

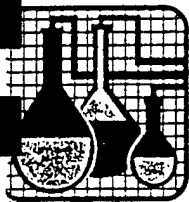
Matrix: Soil  
% Dry Weight: 86.  
Units: ug/kg dry weight  
Dilution Factor: 1.  
Analysis Method: SW8015  
Delivery Group: 127017  
Instrument: PE-1  
Grams Extracted: 25.0 g  
Extract Vol: 1.0 ml

Lab Sample ID: 99-A3604  
Date Sampled: 1/ 7/99  
Date Received: 1/12/99  
Analysis Date: 1/13/99  
Analysis Time: 21:50  
Sample QC Group: 9693  
Extraction Date: 1/13/99

## FORM I

| CAS NUMBER | ANALYTE                  | CONCENTRATION | FLAG   |
|------------|--------------------------|---------------|--------|
| NA .....   | TPH (Diesel Range) ..... | 2190          | .... J |

000163



**SPECIALIZED  
ASSAYS, INC.**

2960 Foster Creighton Dr.  
P.O. Box 40566  
Nashville, TN 37204-0566  
Phone 1-615-726-0177

**Sample Identification**

11P0015B-E

36.5 - 37 f

Matrix: Soil  
% Dry Weight: 86.  
Units: ug/kg dry weight  
Dilution Factor: 1.  
Analysis Method: SW8015  
Delivery Group: 127017  
Instrument:

Lab Sample ID: 99-A3604  
Date Sampled: 1/ 7/99  
Date Received: 1/12/99  
Analysis Date: 1/20/99  
Analysis Time: 21:39  
Sample QC Group: 4101

**FORM I**

| CAS NUMBER | ANALYTE                    | CONCENTRATION | FLAG   |
|------------|----------------------------|---------------|--------|
| NA .....   | TPH (Gasoline Range) ..... | 1160          | .... U |

000015



# SPECIALIZED ASSAYS, INC.

2960 Foster Creighton Dr.  
P.O. Box 40566  
Nashville, TN 37204-0566  
Phone 1-615-726-0177

## Sample Identification

11P001SB-E

36.5-37.1

Matrix: Soil  
% Dry Weight: 86.  
Units: ug/kg dry weight  
Dilution Factor: 1.  
Analysis Method: SW8021B  
Delivery Group: 127017  
Instrument:

Lab Sample ID: 99-A3604  
Date Sampled: 1/ 7/99  
Date Received: 1/12/99  
Analysis Date: 1/20/99  
Analysis Time: 21:39  
Sample QC Group: 4101

## FORM I

| CAS NUMBER | ANALYTE        | CONCENTRATION | FLAG |
|------------|----------------|---------------|------|
| 71-43-2    | Benzene        | 1.2           | U    |
| 108-88-3   | Toluene        | 2.3           | U    |
| 100-41-4   | Ethylbenzene   | 2.3           | U    |
| 1330-20-7  | Xylenes, total | 2.3           | U    |

000014



# SPECIALIZED ASSAYS, INC.

2960 Foster Creighton Dr.  
P.O. Box 40566  
Nashville, TN 37204-0566  
Phone 1-615-726-0177

## Sample Identification

11P002SB-A

22.5-23 f

Matrix: Soil  
% Dry Weight: 85.  
Units: ug/kg dry weight  
Dilution Factor: 1.  
Analysis Method: SW8015  
Delivery Group: 127017  
Instrument: PE-1  
Grams Extracted: 25.0 g  
Extract Vol: 1.0 ml

Lab Sample ID: 99-A3608  
Date Sampled: 1/ 8/99  
Date Received: 1/12/99  
Analysis Date: 1/14/99  
Analysis Time: 0:16  
Sample QC Group: 9693  
Extraction Date: 1/13/99

## FORM I

| CAS NUMBER | ANALYTE                  | CONCENTRATION | FLAG   |
|------------|--------------------------|---------------|--------|
| NA .....   | TPH (Diesel Range) ..... | 6960          | .... J |

000167



# SPECIALIZED ASSAYS, INC.

2960 Foster Creighton Dr.  
P.O. Box 40566  
Nashville, TN 37204-0566  
Phone 1-615-726-0177

## Sample Identification

11P002SB-A

22.5-23f

Matrix: Soil  
% Dry Weight: 85.  
Units: ug/kg dry weight  
Dilution Factor: 1.  
Analysis Method: SW8015  
Delivery Group: 127017  
Instrument:

Lab Sample ID: 99-A3608  
Date Sampled: 1/ 8/99  
Date Received: 1/12/99  
Analysis Date: 1/21/99  
Analysis Time: 1:26  
Sample QC Group: 4101

## FORM I

| CAS NUMBER | ANALYTE                    | CONCENTRATION | FLAG   |
|------------|----------------------------|---------------|--------|
| NA .....   | TPH (Gasoline Range) ..... | 139.          | .... U |

000023



# SPECIALIZED ASSAYS, INC.

2960 Foster Creighton Dr.  
P.O. Box 40566  
Nashville, TN 37204-0566  
Phone 1-615-726-0177

## Sample Identification

11P002SB-A

22.5-236

Matrix: Soil  
% Dry Weight: 85.  
Units: ug/kg dry weight  
Dilution Factor: 1.  
Analysis Method: SW8021B  
Delivery Group: 127017  
Instrument:

Lab Sample ID: 99-A3608  
Date Sampled: 1/ 8/99  
Date Received: 1/12/99  
Analysis Date: 1/21/99  
Analysis Time: 1:26  
Sample QC Group: 4101

## FORM I

| CAS NUMBER      | ANALYTE              | CONCENTRATION | FLAG   |
|-----------------|----------------------|---------------|--------|
| 71-43-2 .....   | Benzene .....        | 2.8           | .... U |
| 108-88-3 .....  | Toluene .....        | 2.8           | .... U |
| 100-41-4 .....  | Ethylbenzene .....   | 2.8           | .... U |
| 1330-20-7 ..... | Xylenes, total ..... | 2.8           | ....   |

000022



# SPECIALIZED ASSAYS, INC.

2960 Foster Creighton Dr.  
P.O. Box 40566  
Nashville, TN 37204-0566  
Phone 1-615-726-0177

## Sample Identification

11P002SB-B

24 - 24.5 ft

Matrix: Soil  
% Dry Weight: 68.  
Units: ug/kg dry weight  
Dilution Factor: 40.  
Analysis Method: SW8015  
Delivery Group: 127017  
Instrument: PE-1  
Grams Extracted: 25.0 g  
Extract Vol: 1.0 ml

Lab Sample ID: 99-A3609  
Date Sampled: 1/ 8/99  
Date Received: 1/12/99  
Analysis Date: 1/14/99  
Analysis Time: 12:23  
Sample QC Group: 9693  
Extraction Date: 1/13/99

## FORM I

| CAS NUMBER | ANALYTE                  | CONCENTRATION | FLAG |
|------------|--------------------------|---------------|------|
| NA .....   | TPH (Diesel Range) ..... | 3290000       | .... |

000168



# SPECIALIZED ASSAYS, INC.

2960 Foster Creighton Dr.  
P.O. Box 40566  
Nashville, TN 37204-0566  
Phone 1-615-726-0177

## Sample Identification

11P002SB-B

24-24.5

Matrix: Soil  
% Dry Weight: 68.  
Units: ug/kg dry weight  
Dilution Factor: 5.  
Analysis Method: SW8015  
Delivery Group: 127017  
Instrument:

Lab Sample ID: 99-A3609  
Date Sampled: 1/ 8/99  
Date Received: 1/12/99  
Analysis Date: 1/21/99  
Analysis Time: 2:03  
Sample QC Group: 4101

## FORM I

| CAS NUMBER | ANALYTE                    | CONCENTRATION | FLAG |
|------------|----------------------------|---------------|------|
| NA .....   | TPH (Gasoline Range) ..... | 306000        | .... |

000025



# SPECIALIZED ASSAYS, INC.

2960 Foster Creighton Dr.  
P.O. Box 40566  
Nashville, TN 37204-0566  
Phone 1-615-726-0177

## Sample Identification

11P002SB-B

24-24.5f

Matrix: Soil  
% Dry Weight: 68.  
Units: ug/kg dry weight  
Dilution Factor: 5.  
Analysis Method: SW8021B  
Delivery Group: 127017  
Instrument:

Lab Sample ID: 99-A3609  
Date Sampled: 1/ 8/99  
Date Received: 1/12/99  
Analysis Date: 1/21/99  
Analysis Time: 2:03  
Sample QC Group: 4101

## FORM I

| CAS NUMBER | ANALYTE        | CONCENTRATION | FLAG |
|------------|----------------|---------------|------|
| 71-43-2    | Benzene        | 7.4           | U    |
| 108-88-3   | Toluene        | 36.8          |      |
| 100-41-4   | Ethylbenzene   | 22.1          |      |
| 1330-20-7  | Xylenes, total | 250.          |      |

000024



# SPECIALIZED ASSAYS, INC.

2960 Foster Creighton Dr.  
P.O. Box 40566  
Nashville, TN 37204-0566  
Phone 1-615-726-0177

## Sample Identification

11P006SB

24-24.5 ft

Matrix: Soil  
% Dry Weight: 76.  
Units: ug/kg dry weight  
Dilution Factor: 1.  
Analysis Method: SW8015  
Delivery Group: 127017  
Instrument: PE-1  
Grams Extracted: 25.0 g  
Extract Vol: 1.0 ml

Lab Sample ID: 99-A3610  
Date Sampled: 1/ 8/99  
Date Received: 1/12/99  
Analysis Date: 1/14/99  
Analysis Time: 1:14  
Sample QC Group: 9693  
Extraction Date: 1/13/99

## FORM I

| CAS NUMBER | ANALYTE                  | CONCENTRATION | FLAG |
|------------|--------------------------|---------------|------|
| NA .....   | TPH (Diesel Range) ..... | 150000        | .... |

000169



# SPECIALIZED ASSAYS, INC.

2960 Foster Creighton Dr.  
P.O. Box 40566  
Nashville, TN 37204-0566  
Phone 1-615-726-0177

## Sample Identification

11P006SB

24-24.5 ft

Matrix: Soil  
% Dry Weight: 76.  
Units: ug/kg dry weight  
Dilution Factor: 1.  
Analysis Method: SW8015  
Delivery Group: 127017  
Instrument:

Lab Sample ID: 99-A3610  
Date Sampled: 1/ 8/99  
Date Received: 1/12/99  
Analysis Date: 1/21/99  
Analysis Time: 2:41  
Sample QC Group: 4101

## FORM I

| CAS NUMBER | ANALYTE                    | CONCENTRATION | FLAG |
|------------|----------------------------|---------------|------|
| NA .....   | TPH (Gasoline Range) ..... | 43600         | .... |

000027



# SPECIALIZED ASSAYS, INC.

2960 Foster Creighton Dr.  
P.O. Box 40566  
Nashville, TN 37204-0566  
Phone 1-615-726-0177

## Sample Identification

11P006SB

24-24.5f

Matrix: Soil  
% Dry Weight: 76.  
Units: ug/kg dry weight  
Dilution Factor: 1.  
Analysis Method: SW8021B  
Delivery Group: 127017  
Instrument:

Lab Sample ID: 99-A3610  
Date Sampled: 1/ 8/99  
Date Received: 1/12/99  
Analysis Date: 1/21/99  
Analysis Time: 2:41  
Sample QC Group: 4101

## FORM I

| CAS NUMBER | ANALYTE        | CONCENTRATION | FLAG   |
|------------|----------------|---------------|--------|
| 71-43-2    | Benzene        | 1.3           | .... U |
| 108-88-3   | Toluene        | 5.3           | ....   |
| 100-41-4   | Ethylbenzene   | 2.6           | ....   |
| 1330-20-7  | Xylenes, total | 27.6          | ....   |

000026



# SPECIALIZED ASSAYS, INC.

2960 Foster Creighton Dr.  
P.O. Box 40566  
Nashville, TN 37204-0566  
Phone 1-615-726-0177

## Sample Identification

11P002SB-A

66-66.5 ft

Matrix: Soil  
% Dry Weight: 91.  
Units: ug/kg dry weight  
Dilution Factor: 1.  
Analysis Method: SW8015  
Delivery Group: 127017  
Instrument: PE-1  
Grams Extracted: 25.0 g  
Extract Vol: 1.0 ml

Lab Sample ID: 99-A3611  
Date Sampled: 1/11/99  
Date Received: 1/12/99  
Analysis Date: 1/14/99  
Analysis Time: 1:43  
Sample QC Group: 9693  
Extraction Date: 1/13/99

## FORM I

| CAS NUMBER | ANALYTE                  | CONCENTRATION | FLAG   |
|------------|--------------------------|---------------|--------|
| NA .....   | TPH (Diesel Range) ..... | 2730          | .... J |

000170



# SPECIALIZED ASSAYS, INC.

2960 Foster Creighton Dr.  
P.O. Box 40566  
Nashville, TN 37204-0566  
Phone 1-615-726-0177

## Sample Identification

11P002SB-A

66-665F

Matrix: Soil  
% Dry Weight: 91.  
Units: ug/kg dry weight  
Dilution Factor: 1.  
Analysis Method: SW8015  
Delivery Group: 127017  
Instrument:

Lab Sample ID: 99-A3611  
Date Sampled: 1/11/99  
Date Received: 1/12/99  
Analysis Date: 1/21/99  
Analysis Time: 3:19  
Sample QC Group: 4101

## FORM I

| CAS NUMBER | ANALYTE                    | CONCENTRATION | FLAG   |
|------------|----------------------------|---------------|--------|
| NA .....   | TPH (Gasoline Range) ..... | 1100          | .... U |

000029



# SPECIALIZED ASSAYS, INC.

2960 Foster Creighton Dr.  
P.O. Box 40566  
Nashville, TN 37204-0566  
Phone 1-615-726-0177

## Sample Identification

11P002SB-A

66-66.5 ft

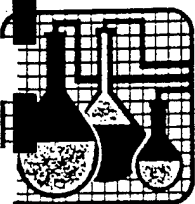
Matrix: Soil  
% Dry Weight: 91.  
Units: ug/kg dry weight  
Dilution Factor: 1.  
Analysis Method: SW8021B  
Delivery Group: 127017  
Instrument:

Lab Sample ID: 99-A3611  
Date Sampled: 1/11/99  
Date Received: 1/12/99  
Analysis Date: 1/21/99  
Analysis Time: 3:19  
Sample QC Group: 4101

## FORM I

| CAS NUMBER | ANALYTE        | CONCENTRATION | FLAG |
|------------|----------------|---------------|------|
| 71-43-2    | Benzene        | 1.1           | U    |
| 108-88-3   | Toluene        | 2.2           | U    |
| 100-41-4   | Ethylbenzene   | 2.2           | U    |
| 1330-20-7  | Xylenes, total | 2.2           | U    |

000028



# SPECIALIZED ASSAYS, INC.

2960 Foster Creighton Dr.  
P.O. Box 40566  
Nashville, TN 37204-0566  
Phone 1-615-726-0177

## Sample Identification

11P002SB-B

30-80.5 ft

Matrix: Soil  
% Dry Weight: 89.  
Units: ug/kg dry weight  
Dilution Factor: 1.  
Analysis Method: SW8015  
Delivery Group: 127017  
Instrument: PE-1  
Grams Extracted: 25.0 g  
Extract Vol: 1.0 ml

Lab Sample ID: 99-A3612  
Date Sampled: 1/11/99  
Date Received: 1/12/99  
Analysis Date: 1/14/99  
Analysis Time: 2:11  
Sample QC Group: 9693  
Extraction Date: 1/13/99

## FORM I

| CAS NUMBER | ANALYTE                  | CONCENTRATION | FLAG   |
|------------|--------------------------|---------------|--------|
| NA .....   | TPH (Diesel Range) ..... | 1260          | .... J |

000171



# SPECIALIZED ASSAYS, INC.

2960 Foster Creighton Dr.  
P.O. Box 40566  
Nashville, TN 37204-0566  
Phone 1-615-726-0177

## Sample Identification

11P002SB-B

80-80.5 ft

Matrix: Soil  
% Dry Weight: 89.  
Units: ug/kg dry weight  
Dilution Factor: 1.  
Analysis Method: SW8015  
Delivery Group: 127017  
Instrument:

Lab Sample ID: 99-A3612  
Date Sampled: 1/11/99  
Date Received: 1/12/99  
Analysis Date: 1/21/99  
Analysis Time: 3:57  
Sample QC Group: 4101

## FORM I

| CAS NUMBER | ANALYTE                    | CONCENTRATION | FLAG   |
|------------|----------------------------|---------------|--------|
| NA .....   | TPH (Gasoline Range) ..... | 1120          | .... U |

000031



# SPECIALIZED ASSAYS, INC.

2960 Foster Creighton Dr.  
P.O. Box 40566  
Nashville, TN 37204-0566  
Phone 1-615-726-0177

## Sample Identification

11P002SB-B

80-80.5f

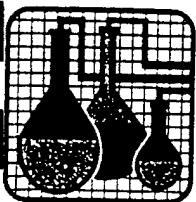
Matrix: Soil  
% Dry Weight: 89.  
Units: ug/kg dry weight  
Dilution Factor: 1.  
Analysis Method: SW8021B  
Delivery Group: 127017  
Instrument:

Lab Sample ID: 99-A3612  
Date Sampled: 1/11/99  
Date Received: 1/12/99  
Analysis Date: 1/21/99  
Analysis Time: 3:57  
Sample QC Group: 4101

## FORM I

| CAS NUMBER | ANALYTE        | CONCENTRATION | FLAG |
|------------|----------------|---------------|------|
| 71-43-2    | Benzene        | 1.1           | U    |
| 108-88-3   | Toluene        | 2.2           | U    |
| 100-41-4   | Ethylbenzene   | 2.2           | U    |
| 1330-20-7  | Xylenes, total | 2.2           | U    |

000030



# SPECIALIZED ASSAYS, INC.

2960 Foster Creighton Dr.  
P.O. Box 40566  
Nashville, TN 37204-0566  
Phone 1-615-726-0177

## Sample Identification

11P003SB-A

26.5-27A

Matrix: Soil  
% Dry Weight: 81.  
Units: ug/kg dry weight  
Dilution Factor: 1.  
Analysis Method: SW8015  
Delivery Group: 127158  
Instrument: PE-1  
Grams Extracted: 25.0 g  
Extract Vol: 1.0 ml

Lab Sample ID: 99-A4011  
Date Sampled: 1/12/99  
Date Received: 1/13/99  
Analysis Date: 1/14/99  
Analysis Time: 22:06  
Sample QC Group: 1960  
Extraction Date: 1/14/99

## FORM I

| CAS NUMBER | ANALYTE                  | CONCENTRATION | FLAG   |
|------------|--------------------------|---------------|--------|
| NA .....   | TPH (Diesel Range) ..... | 1630          | .... J |

000099



**SPECIALIZED ASSAYS, INC.**

2960 Foster Creighton Dr.  
P.O. Box 40566  
Nashville, TN 37204-0566  
Phone 1-615-726-0177

**Sample Identification**

11P003SB-A

26.5-27 f

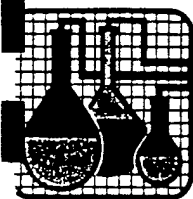
Matrix: Soil  
% Dry Weight: 81.  
Units: ug/kg dry weight  
Dilution Factor: 1.  
Analysis Method: SW8015  
Delivery Group: 127158  
Instrument:

Lab Sample ID: 99-A4011  
Date Sampled: 1/12/99  
Date Received: 1/13/99  
Analysis Date: 1/21/99  
Analysis Time: 4:35  
Sample QC Group: 4102

**FORM I**

| CAS NUMBER | ANALYTE                    | CONCENTRATION | FLAG |
|------------|----------------------------|---------------|------|
| NA .....   | TPH (Gasoline Range) ..... | 3950          | .... |

000006

**SPECIALIZED ASSAYS, INC.**

2960 Foster Creighton Dr.  
P.O. Box 40566  
Nashville, TN 37204-0566  
Phone 1-615-726-0177

**Sample Identification****11P003SB-A**

26.5-27 ft

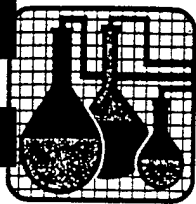
Matrix: Soil  
% Dry Weight: 81.  
Units: ug/kg dry weight  
Dilution Factor: 1.  
Analysis Method: SW8021B  
Delivery Group: 127158  
Instrument:

Lab Sample ID: 99-A4011  
Date Sampled: 1/12/99  
Date Received: 1/13/99  
Analysis Date: 1/21/99  
Analysis Time: 4:35  
Sample QC Group: 4102

**FORM I**

| CAS NUMBER      | ANALYTE                   | CONCENTRATION | FLAG   |
|-----------------|---------------------------|---------------|--------|
| 71-43-2 .....   | Benzene .....             | 3.7           | ....   |
| 108-88-3 .....  | Toluene .....             | 18.5          | ....   |
| 100-41-4 .....  | Ethylbenzene .....        | 6.2           | ....   |
| 1330-20-7 ..... | Xylenes, total .....      | 30.9          | ....   |
| 1634-04-4 ..... | Methyl-t-butylether ..... | 2.5           | .... U |

000005



# SPECIALIZED ASSAYS, INC.

2960 Foster Creighton Dr.  
P.O. Box 40566  
Nashville, TN 37204-0566  
Phone 1-615-726-0177

## Sample Identification

11P003SB-B

29-29.5 ft

Matrix: Soil  
% Dry Weight: 89.  
Units: ug/kg dry weight  
Dilution Factor: 1.  
Analysis Method: SW8015  
Delivery Group: 127158  
Instrument: PE-1  
Grams Extracted: 25.0 g  
Extract Vol: 1.0 ml

Lab Sample ID: 99-A4012  
Date Sampled: 1/12/99  
Date Received: 1/13/99  
Analysis Date: 1/14/99  
Analysis Time: 23:03  
Sample QC Group: 1960  
Extraction Date: 1/14/99

## FORM I

| CAS NUMBER | ANALYTE                  | CONCENTRATION | FLAG   |
|------------|--------------------------|---------------|--------|
| NA .....   | TPH (Diesel Range) ..... | 1390          | .... J |

000100



**SPECIALIZED ASSAYS, INC.**

2960 Foster Creighton Dr.  
P.O. Box 40566  
Nashville, TN 37204-0566  
Phone 1-615-726-0177

**Sample Identification**

11P003SB-B

29-29.5 ft

Matrix: Soil  
% Dry Weight: 89.  
Units: ug/kg dry weight  
Dilution Factor: 1.  
Analysis Method: SW8015  
Delivery Group: 127158  
Instrument:

Lab Sample ID: 99-A4012  
Date Sampled: 1/12/99  
Date Received: 1/13/99  
Analysis Date: 1/21/99  
Analysis Time: 5:12  
Sample QC Group: 4102

**FORM I**

| CAS NUMBER | ANALYTE                    | CONCENTRATION | FLAG   |
|------------|----------------------------|---------------|--------|
| NA .....   | TPH (Gasoline Range) ..... | 1120          | .... U |

000008

**SPECIALIZED ASSAYS, INC.**

2960 Foster Creighton Dr.  
P.O. Box 40566  
Nashville, TN 37204-0566  
Phone 1-615-726-0177

**Sample Identification****11P003SB-B**

29-29.5F

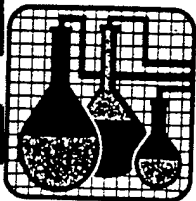
Matrix: Soil  
% Dry Weight: 89.  
Units: ug/kg dry weight  
Dilution Factor: 1.  
Analysis Method: SW8021B  
Delivery Group: 127158  
Instrument:

Lab Sample ID: 99-A4012  
Date Sampled: 1/12/99  
Date Received: 1/13/99  
Analysis Date: 1/21/99  
Analysis Time: 5:12  
Sample QC Group: 4102

**FORM I**

| CAS NUMBER | ANALYTE             | CONCENTRATION | FLAG |
|------------|---------------------|---------------|------|
| 71-43-2    | Benzene             | 1.1           | U    |
| 108-88-3   | Toluene             | 2.2           | U    |
| 100-41-4   | Ethylbenzene        | 2.2           | U    |
| 1330-20-7  | Xylenes, total      | 2.2           | U    |
| 1634-04-4  | Methyl-t-butylether | 2.2           | U    |

000007



# SPECIALIZED ASSAYS, INC.

2960 Foster Creighton Dr.  
P.O. Box 40566  
Nashville, TN 37204-0566  
Phone 1-615-726-0177

## Sample Identification

11P003SB-C

34-34.5 ft

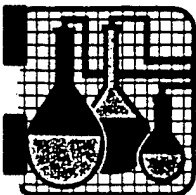
Matrix: Soil  
% Dry Weight: 84.  
Units: ug/kg dry weight  
Dilution Factor: 1.  
Analysis Method: SW8015  
Delivery Group: 127158  
Instrument: PE-1  
Grams Extracted: 25.0 g  
Extract Vol: 1.0 ml

Lab Sample ID: 99-A4013  
Date Sampled: 1/12/99  
Date Received: 1/13/99  
Analysis Date: 1/14/99  
Analysis Time: 23:32  
Sample QC Group: 1960  
Extraction Date: 1/14/99

## FORM I

| CAS NUMBER | ANALYTE                  | CONCENTRATION | FLAG   |
|------------|--------------------------|---------------|--------|
| NA .....   | TPH (Diesel Range) ..... | 1570          | .... J |

000101



**SPECIALIZED ASSAYS, INC.**

2960 Foster Creighton Dr.  
P.O. Box 40566  
Nashville, TN 37204-0566  
Phone 1-615-726-0177

**Sample Identification**

11P003SB-C

34-34.5 ft

Matrix: Soil  
% Dry Weight: 84.  
Units: ug/kg dry weight  
Dilution Factor: 1.  
Analysis Method: SW8015  
Delivery Group: 127158  
Instrument:

Lab Sample ID: 99-A4013  
Date Sampled: 1/12/99  
Date Received: 1/13/99  
Analysis Date: 1/21/99  
Analysis Time: 5:50  
Sample QC Group: 4102

**FORM I**

| CAS NUMBER | ANALYTE                    | CONCENTRATION | FLAG   |
|------------|----------------------------|---------------|--------|
| NA .....   | TPH (Gasoline Range) ..... | 1190          | .... U |

000010



**SPECIALIZED ASSAYS, INC.**

2960 Foster Creighton Dr.  
P.O. Box 40566  
Nashville, TN 37204-0566  
Phone 1-615-726-0177

**Sample Identification**

11P003SB-C

34-34.5 ft

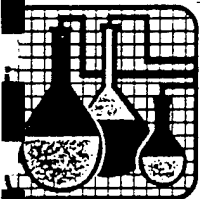
Matrix: Soil  
% Dry Weight: 84.  
Units: ug/kg dry weight  
Dilution Factor: 1.  
Analysis Method: SW8021B  
Delivery Group: 127158  
Instrument:

Lab Sample ID: 99-A4013  
Date Sampled: 1/12/99  
Date Received: 1/13/99  
Analysis Date: 1/21/99  
Analysis Time: 5:50  
Sample QC Group: 4102

**FORM I**

| CAS NUMBER | ANALYTE             | CONCENTRATION | FLAG |
|------------|---------------------|---------------|------|
| 71-43-2    | Benzene             | 1.2           | U    |
| 108-88-3   | Toluene             | 2.4           | U    |
| 100-41-4   | Ethylbenzene        | 2.4           | U    |
| 1330-20-7  | Xylenes, total      | 2.4           | U    |
| 1634-04-4  | Methyl-t-butylether | 2.4           | U    |

000009



# SPECIALIZED ASSAYS, INC.

2960 Foster Creighton Dr.  
P.O. Box 40566  
Nashville, TN 37204-0566  
Phone 1-615-726-0177

## Sample Identification

11P004SB-A&A'

13.5 - 14.5 ft

Matrix: Soil  
% Dry Weight: 89.  
Units: ug/kg dry weight  
Dilution Factor: 10.  
Analysis Method: SW8015  
Delivery Group: 127017  
Instrument: PE-1  
Grams Extracted: 25.0 g  
Extract Vol: 1.0 ml

Lab Sample ID: 99-A3605  
Date Sampled: 1/ 7/99  
Date Received: 1/12/99  
Analysis Date: 1/14/99  
Analysis Time: 11:55  
Sample QC Group: 9693

Extraction Date: 1/13/99

## FORM I

| CAS NUMBER | ANALYTE                  | CONCENTRATION | FLAG |
|------------|--------------------------|---------------|------|
| NA .....   | TPH (Diesel Range) ..... | 1350000       | .... |

000164



# SPECIALIZED ASSAYS, INC.

2960 Foster Creighton Dr.  
P.O. Box 40566  
Nashville, TN 37204-0566  
Phone 1-615-726-0177

## Sample Identification

11P004SB-A&A'

13.5-14.5f

Matrix: Soil  
% Dry Weight: 89.  
Units: ug/kg dry weight  
Dilution Factor: 100.  
Analysis Method: SW8015  
Delivery Group: 127017  
Instrument:

Lab Sample ID: 99-A3605  
Date Sampled: 1/ 7/99  
Date Received: 1/12/99  
Analysis Date: 1/20/99  
Analysis Time: 22:17  
Sample QC Group: 4101

## FORM I

| CAS NUMBER | ANALYTE                    | CONCENTRATION | FLAG |
|------------|----------------------------|---------------|------|
| NA .....   | TPH (Gasoline Range) ..... | 3020000 ....  |      |



# SPECIALIZED ASSAYS, INC.

2960 Foster Creighton Dr.  
P.O. Box 40566  
Nashville, TN 37204-0566  
Phone 1-615-726-0177

## Sample Identification

11P004SB-A&A'

13.5-14.5

Matrix: Soil  
% Dry Weight: 89.  
Units: ug/kg dry weight  
Dilution Factor: 100.  
Analysis Method: SW8021B  
Delivery Group: 127017  
Instrument:

Lab Sample ID: 99-A3605  
Date Sampled: 1/ 7/99  
Date Received: 1/12/99  
Analysis Date: 1/20/99  
Analysis Time: 22:17  
Sample QC Group: 4101

## FORM I

| CAS NUMBER | ANALYTE        | CONCENTRATION | FLAG   |
|------------|----------------|---------------|--------|
| 71-43-2    | Benzene        | 112.          | .... U |
| 108-88-3   | Toluene        | 1120          | ....   |
| 100-41-4   | Ethylbenzene   | 6630          | ....   |
| 1330-20-7  | Xylenes, total | 40600         | ....   |

000016



# SPECIALIZED ASSAYS, INC.

2960 Foster Creighton Dr.  
P.O. Box 40566  
Nashville, TN 37204-0566  
Phone 1-615-726-0177

## Sample Identification

11P004SB-B

24.5-25+

Matrix: Soil  
% Dry Weight: 71.  
Units: ug/kg dry weight  
Dilution Factor: 1.  
Analysis Method: SW8015  
Delivery Group: 127017  
Instrument: PE-1  
Grams Extracted: 25.0 g  
Extract Vol: 1.0 ml

Lab Sample ID: 99-A3606  
Date Sampled: 1/ 7/99  
Date Received: 1/12/99  
Analysis Date: 1/13/99  
Analysis Time: 23:18  
Sample QC Group: 9693

Extraction Date: 1/13/99

## FORM I

| CAS NUMBER | ANALYTE                  | CONCENTRATION | FLAG   |
|------------|--------------------------|---------------|--------|
| NA .....   | TPH (Diesel Range) ..... | 2480          | .... J |

000165



# SPECIALIZED ASSAYS, INC.

2960 Foster Creighton Dr.  
P.O. Box 40566  
Nashville, TN 37204-0566  
Phone 1-615-726-0177

## Sample Identification

11P004SB-B

24.5-25ft

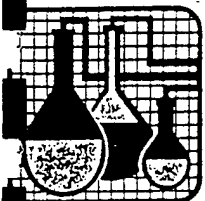
Matrix: Soil  
% Dry Weight: 71.  
Units: ug/kg dry weight  
Dilution Factor: 1.  
Analysis Method: SW8015  
Delivery Group: 127017  
Instrument:

Lab Sample ID: 99-A3606  
Date Sampled: 1/ 7/99  
Date Received: 1/12/99  
Analysis Date: 1/20/99  
Analysis Time: 22:54  
Sample QC Group: 4101

## FORM I

| CAS NUMBER | ANALYTE                    | CONCENTRATION | FLAG |
|------------|----------------------------|---------------|------|
| NA .....   | TPH (Gasoline Range) ..... | 5610          | .... |

000019



# SPECIALIZED ASSAYS, INC.

2960 Foster Creighton Dr.  
P.O. Box 40566  
Nashville, TN 37204-0566  
Phone 1-615-726-0177

## Sample Identification

11P004SB-B

24.5-25 ft

Matrix: Soil  
% Dry Weight: 71.  
Units: ug/kg dry weight  
Dilution Factor: 1.  
Analysis Method: SW8021B  
Delivery Group: 127017  
Instrument:

Lab Sample ID: 99-A3606  
Date Sampled: 1/ 7/99  
Date Received: 1/12/99  
Analysis Date: 1/20/99  
Analysis Time: 22:54  
Sample QC Group: 4101

## FORM I

| CAS NUMBER | ANALYTE        | CONCENTRATION | FLAG |
|------------|----------------|---------------|------|
| 71-43-2    | Benzene        | 1.4           | U    |
| 108-88-3   | Toluene        | 2.8           | U    |
| 100-41-4   | Ethylbenzene   | 2.8           | U    |
| 1330-20-7  | Xylenes, total | 2.8           | U    |

000018



# SPECIALIZED ASSAYS, INC.

2960 Foster Creighton Dr.  
P.O. Box 40566  
Nashville, TN 37204-0566  
Phone 1-615-726-0177

## Sample Identification

11P004SB-C

33-33.5 ft

Matrix: Soil  
% Dry Weight: 88.  
Units: ug/kg dry weight  
Dilution Factor: 1.  
Analysis Method: SW8015  
Delivery Group: 127017  
Instrument: PE-1  
Grams Extracted: 25.0 g  
Extract Vol: 1.0 ml

Lab Sample ID: 99-A3607  
Date Sampled: 1/ 7/99  
Date Received: 1/12/99  
Analysis Date: 1/13/99  
Analysis Time: 23:47  
Sample QC Group: 9693  
Extraction Date: 1/13/99

## FORM I

| CAS NUMBER | ANALYTE                  | CONCENTRATION | FLAG   |
|------------|--------------------------|---------------|--------|
| NA .....   | TPH (Diesel Range) ..... | 2050          | .... J |

000166



# SPECIALIZED ASSAYS, INC.

2960 Foster Creighton Dr.  
P.O. Box 40566  
Nashville, TN 37204-0566  
Phone 1-615-726-0177

## Sample Identification

11P004SB-C

33-33.5 f

Matrix: Soil  
% Dry Weight: 88.  
Units: ug/kg dry weight  
Dilution Factor: 1.  
Analysis Method: SW8015  
Delivery Group: 127017  
Instrument:

Lab Sample ID: 99-A3607  
Date Sampled: 1/ 7/99  
Date Received: 1/12/99  
Analysis Date: 1/20/99  
Analysis Time: 23:33  
Sample QC Group: 4101

## FORM I

| CAS NUMBER | ANALYTE                    | CONCENTRATION | FLAG   |
|------------|----------------------------|---------------|--------|
| NA .....   | TPH (Gasoline Range) ..... | 1140          | .... U |

000021



# SPECIALIZED ASSAYS, INC.

2960 Foster Creighton Dr.  
P.O. Box 40566  
Nashville, TN 37204-0566  
Phone 1-615-726-0177

## Sample Identification

11P004SB-C

33-33.5 F!

Matrix: Soil  
% Dry Weight: 88.  
Units: ug/kg dry weight  
Dilution Factor: 1.  
Analysis Method: SW8021B  
Delivery Group: 127017  
Instrument:

Lab Sample ID: 99-A3607  
Date Sampled: 1/ 7/99  
Date Received: 1/12/99  
Analysis Date: 1/20/99  
Analysis Time: 23:33  
Sample QC Group: 4101

## FORM I

| CAS NUMBER | ANALYTE        | CONCENTRATION | FLAG |
|------------|----------------|---------------|------|
| 71-43-2    | Benzene        | 1.1           | U    |
| 108-88-3   | Toluene        | 2.3           | U    |
| 100-41-4   | Ethylbenzene   | 2.3           | U    |
| 1330-20-7  | Xylenes, total | 2.3           | U    |

000020



# SPECIALIZED ASSAYS, INC.

2960 Foster Creighton Dr.  
P.O. Box 40566  
Nashville, TN 37204-0566  
Phone 1-615-726-0177

## Sample Identification

BLANK

Matrix: Soil  
% Dry Weight: 100  
Units: UG/KG  
Dilution Factor: 1  
Analysis Method: SW8015  
Delivery Group: 127017  
Instrument:

Lab Sample ID: BLANK  
Date Sampled: 1/ 6/99  
Date Received: 1/12/99  
Analysis Date: 1/20/99  
Analysis Time: 18:30  
Sample QC Group: 4101

## FORM I

| CAS NUMBER      | ANALYTE                    | CONCENTRATION | FLAG |
|-----------------|----------------------------|---------------|------|
| 71-43-2 .....   | Benzene .....              | 1. ....       | U    |
| 108-88-3 .....  | Toluene .....              | 2. ....       | U    |
| 100-41-4 .....  | Ethylbenzene .....         | 2. ....       | U    |
| 1330-20-7 ..... | Xylenes, total .....       | 2. ....       | U    |
| NA .....        | TPH (Gasoline Range) ..... | 1000 ....     | U    |



# SPECIALIZED ASSAYS, INC.

2960 Foster Creighton Dr.  
P.O. Box 40566  
Nashville, TN 37204-0566  
Phone 1-615-726-0177

## Sample Identification

BLANK

Matrix: Soil  
% Dry Weight: 100  
Units: UG/KG  
Dilution Factor: 1  
Analysis Method: SW8015  
Delivery Group: 127158  
Instrument:

Lab Sample ID: BLANK  
Date Sampled: 1/12/99  
Date Received: 1/13/99  
Analysis Date: 1/21/99  
Analysis Time: 0:48  
Sample QC Group: 4102

## FORM I

| CAS NUMBER | ANALYTE              | CONCENTRATION | FLAG |
|------------|----------------------|---------------|------|
| 71-43-2    | Benzene              | 1.            | U    |
| 108-88-3   | Toluene              | 2.            | U    |
| 100-41-4   | Ethylbenzene         | 2.            | U    |
| 1330-20-7  | Xylenes, total       | 2.            | U    |
| NA         | TPH (Gasoline Range) | 1000          | U    |

000011

887000

## EXTRACTED TOC

1/20/99

11/12/99

[illegible]





SPECIALIZED ASSAYS INC. • 2960 Foster Creighton Dr. • P.O. Box 40566 • Nashville, Tennessee 37204-0566  
615-726-0177 • 1-800-765-0980 • Fax 615-726-3404

### CASE NARRATIVE

Client: Parsons Engineering Science (8185)  
Attn: John Ratz  
1700 Broadway, Suite 900  
Denver, CO 80290

Client Project: Beale AFB; Site SD-11

Matrix: Soil

Laboratory Project: 128561

Number samples: 6

Date Received: 01/12/99

Date Collected: 1/06/99 – 01/08/99

Sample Receipt Notes: All samples were received in good condition, properly preserved. There were no discrepancies noted on the cooler receipt form. Samples were originally received and analyzed for TPH-GRO and DRO and BTEX. On January 23, 1999, the request to proceed with the DI-WET analyses was received at the laboratory.

#### QA/QC Summary:

Extractable TPH – 8015B/DI-WET – Batch 1770

All surrogate and QC parameters are within acceptable limits. There are no anomalies noted in the data package.

If you have any technical issues relating to the enclosed data, please call me at 1-800-765-0980.

Johnny A. Mitchell  
Director of Technical Services

# PARSONS ENGINEERING SCIENCE, INC. CHAIN OF CUSTODY RECORD

2101 Webster Street, Suite 700  
Oakland, California 94612  
Phone: (510) 891-9085  
FAX: (510) 835-4355

12707 1283e

|                                              |        |      |      |                                  |           |        |                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|----------------------------------------------|--------|------|------|----------------------------------|-----------|--------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Project No.: 726876.20120                    |        |      |      | Lab Account No.: 8185            |           |        |                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Project Name/Location: Beale AFB; Site 5D-11 |        |      |      |                                  |           |        |                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Site Manager: Michael Phelps (Oakland, CA)   |        |      |      |                                  |           |        |                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Project Manager: John Ratz (Denver, CO)      |        |      |      |                                  |           |        |                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Sample ID                                    |        | Date | Time | Begin Depth                      | End Depth | Matrix | NO. OF CONTAINERS<br><br>ANALYTES (METHOD)<br>TPH-gasoline/GRO (8015M)<br>Extract THF/DRO (8015M)<br>Leachate THF/DRO (8015M)<br>BTX (8020A)<br>Total Organic Carbon (SW9060)<br>Moisture Content (ASTM D-2216)                                                                                                                                                                                                                                          |
| 11P001SB-A                                   | 1/6/99 | 1204 | 11   | 11.5                             |           | soil   |                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 11P005SB                                     | 1/6/99 | 1200 | 15   | 15.5                             |           | soil   |                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 11P001SB-B                                   | 1/6/99 | 1317 | 16   | 16.5                             |           | soil   |                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 11P001SB-C                                   | 1/7/99 | 1020 | 29   | 29.5                             |           | soil   |                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 11P001SB-D                                   | 1/7/99 | 1130 | 36   | 36.5                             |           | soil   |                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 11P001SB-E                                   | 1/7/99 | 1132 | 36.5 | 37                               |           | soil   |                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 11P004SB-A                                   | 1/7/99 | 1338 | 13.5 | 14.5                             |           | soil   |                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 11P004SB-B                                   | 1/7/99 | 1455 | 24.5 | 25                               |           | soil   |                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 11P004SB-C                                   | 1/7/99 | 1600 | 33   | 33.5                             |           | soil   |                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 11P002SB-A                                   | 1/8/99 | 1155 | 22.5 | 23                               |           | soil   |                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 11P002SB-B                                   | 1/8/99 | 1208 | 24   | 24.5                             |           | soil   |                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 11P006SB                                     | 1/8/99 | 1200 | 24.5 | 25                               |           | soil   |                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| REINQUISHED BY: (SIGNATURE)                  |        | DATE | TIME | RECEIVED BY: (SIGNATURE)         |           | TIME   | SPECIFIC ANALYTICAL METHOD<br>1. Delglitized water extraction (California Title 22 method); DO LEACHABLE ON<br>IF TOTAL TPH IS DETECTED AND AFTER CONSULTATION WITH SITE<br>MANAGER (PHELPS).<br><br>GENERAL COMMENTS/INSTRUCTIONS:<br>1. FAX chain-of-custody on check-in to site manager (Phelps).<br>2. QC and reporting limits of contract 726876.3016.00 must be met.<br>3. Option 2 pricing applies and IRPIMS electronic deliverable is required. |
| RELINQUISHED BY: (SIGNATURE)                 |        | DATE | TIME | RECEIVED FOR LAB BY: (SIGNATURE) |           | DATE   |                                                                                                                                                                                                                                                                                                                                                                                                                                                          |

*Signature*

99-A9773  
99-A9774  
99-A9775  
99-A9776  
99-A9777  
99-A9778

000000

**PARSONS ENGINEERING SCIENCE, INC.**

2101 Webster Street, Suite 700 • Oakland, California 94612 • (510) 891-8085 • Fax: (510) 835-4355

**FAX MESSAGE**

Date: January 23, 1999

Proposal/Project No.: 726876.20120

|                                          |                                    |
|------------------------------------------|------------------------------------|
| <b>TO</b>                                | <b>FROM</b>                        |
| Name: Mary Louise Linn                   | Name: Michael B. Phelps            |
| Organiz.: SAI                            | E-mail: michael_phelps@parsons.com |
| Fax Number: (615) 726-0954               | Fax Number: (510) 835-4355         |
| Phone Number: (615) 726-0177             | Phone Number: (510) 891-9085       |
| Subject: DI-WET (Leachable) TPH Analysis |                                    |

Response Requested: YES  
Date Required: Monday 1/25/99

**MESSAGE/INSTRUCTIONS**

Mary Louise,

Here are the samples which need DI-WET analysis. As far as I can tell, you will miss the hold times on the DI-WET analysis due to the delay in your getting me the total TPH results. I expect you to track this better. *TPH-DRO on Extract*

*CA WET*

| <u>Parsons Sample ID</u> | <u>SAI Sample ID</u> | <u>Date of Collection</u> |
|--------------------------|----------------------|---------------------------|
| 11P001SB-A               | 99-A3600             | 1/6/99                    |
| 11P005SB                 | 99-A3601             | 1/6/99                    |
| 11P001SB-B               | 99-A3602             | 1/6/99                    |
| 11P004SB-A&A'            | 99-A3605             | 1/7/99                    |
| 11P002SB-B               | 99-A3609             | 1/8/99                    |
| 11P006SB                 | 99-A3610             | 1/8/99                    |

Please call to confirm on Monday.

Number of Pages Transmitted: \_\_\_\_\_  
(including this sheet)

000002

# Cooler Receipt Form

Client: \_\_\_\_\_

Cooler Received On: \_\_\_\_\_ And Opened On: \_\_\_\_\_ By: \_\_\_\_\_

\_\_\_\_\_  
(Signature)

1. Temperature of Cooler when opened \_\_\_\_\_

2. Were custody seals on outside of cooler and intact? ..... Yes No

a. If yes, what kind and where: \_\_\_\_\_

b. Were the signature and date correct? ..... Yes No

3. Were custody papers inside? ..... Yes No

4. Were custody papers properly filled out (ink, signed, etc)? ..... Yes No

5. Did you sign the custody papers in the appropriate place? ..... Yes No

6. What kind of packing material was used? \_\_\_\_\_

7. Was sufficient ice used (if appropriate)? ..... Yes No

8. Did all bottles arrive in good condition (unbroken)? ..... Yes No

9. Were all bottle labels complete (#, date, signed, pres, etc)? ..... Yes No

10. Did all bottle labels and tags agree with custody papers? ..... Yes No

11. Were correct bottles used for the analysis requested? ..... Yes No

12. If present, were VOA vials checked for absence of air bubbles and noted if found? ..... Yes No

13. Was sufficient amount of sample sent in each bottle? ..... Yes No

14. Were correct preservatives used? ..... Yes No

15. Corrective action taken, if necessary:

a. Name of person contacted: \_\_\_\_\_

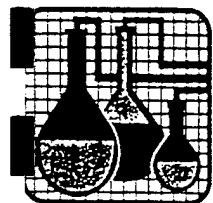
b. Date \_\_\_\_\_

000003

**TPH-DRO DI-WET**

**SUMMARY DATA**

000004



# SPECIALIZED ASSAYS, INC.

2960 Foster Creighton Dr.  
P.O. Box 40566  
Nashville, TN 37204-0566  
Phone 1-615-726-0177

## ANALYTICAL REPORT

PARSONS ENGINEERING/AFCEE EXT 8185  
JOHN RATZ  
1700 BROADWAY STE 900  
DENVER, CO 80290

Lab Number: 99-A9773 @ 11-11.5 ft  
Sample ID: 11P001SB-A  
Sample Type: Soil  
Site ID:

Project: 726876.20120  
Project Name: BEALE AFB; SITE SD-11  
Sampler:

Date Collected: 1/6/99  
Time Collected: 12:04  
Date Received: 1/12/99  
Time Received: 9:00

| Analyte | Result | Units | Report Limit | Quan Limit | Dil Factor | Date | Time | Analyst | Method | Batch |
|---------|--------|-------|--------------|------------|------------|------|------|---------|--------|-------|
|---------|--------|-------|--------------|------------|------------|------|------|---------|--------|-------|

### \*GENERAL CHEMISTRY PARAMETERS\*

|                    |      |      |      |      |   |         |       |           |            |      |
|--------------------|------|------|------|------|---|---------|-------|-----------|------------|------|
| TPH (Diesel Range) | 1.88 | ng/l | 1.00 | 0.10 | 1 | 1/29/99 | 21:51 | K. Walkup | 80158/3510 | 1770 |
|--------------------|------|------|------|------|---|---------|-------|-----------|------------|------|

### TCLP Results

| Analyte         | Result    | Units | Reg Limit | Matrix Spike Recovery (%) | Date    | Method |
|-----------------|-----------|-------|-----------|---------------------------|---------|--------|
| TCLP Extraction | Completed |       |           |                           | 1/26/99 | 1311   |

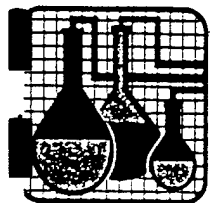
ND = Not detected at the report limit.

### Sample Extraction Data

| Parameter | Wt/Vol Extracted | Extract Vol | Date    | Analyst   | Method |
|-----------|------------------|-------------|---------|-----------|--------|
| EPH       | 1000 ml          | 1.00 ml     | 1/28/99 | Fitzwater | 3510   |

| Surrogate         | % Recovery | Target Range |
|-------------------|------------|--------------|
| surrr-o-Terphenyl | 97.        | 50. - 150.   |

All analysis performed on DI-WET Leachate.



# SPECIALIZED ASSAYS, INC.

2960 Foster Creighton Dr.  
P.O. Box 40566  
Nashville, TN 37204-0566  
Phone 1-615-726-0177

## ANALYTICAL REPORT

PERSONS ENGINEERING/AFCEE EXT 8185  
JOHN RATZ  
700 BROADWAY STE 900  
DENVER, CO 80290

Lab Number: 99-A9774

15 - 15.5 ft

Sample ID: 11P005SB

Sample Type: Soil

Site ID:

Date Collected: 1/ 6/99

Time Collected: 12:00

Date Received: 1/12/99

Time Received: 9:00

Project: 726876.20120

Project Name: BEALE AFB; SITE SD-11

Sampler:

| Analyte | Result | Units | Report Limit | Quan Limit | Dil Factor | Date | Time | Analyst | Method | Batch |
|---------|--------|-------|--------------|------------|------------|------|------|---------|--------|-------|
|---------|--------|-------|--------------|------------|------------|------|------|---------|--------|-------|

### \*GENERAL CHEMISTRY PARAMETERS\*

|                    |      |      |      |      |   |         |       |          |            |      |
|--------------------|------|------|------|------|---|---------|-------|----------|------------|------|
| TPH (Diesel Range) | 1.35 | ng/l | 1.00 | 0.10 | 1 | 1/29/99 | 22:20 | K.Walkup | 80158/3510 | 1770 |
|--------------------|------|------|------|------|---|---------|-------|----------|------------|------|

### TCLP Results

| Analyte | Result | Units | Reg Limit | Matrix Spike Recovery (%) | Date | Method |
|---------|--------|-------|-----------|---------------------------|------|--------|
|---------|--------|-------|-----------|---------------------------|------|--------|

|                 |           |  |  |  |         |      |
|-----------------|-----------|--|--|--|---------|------|
| TCLP Extraction | Completed |  |  |  | 1/26/99 | 1311 |
|-----------------|-----------|--|--|--|---------|------|

ND = Not detected at the report limit.

### Sample Extraction Data

| Parameter | Wt/Vol Extracted | Extract Vol | Date    | Analyst   | Method |
|-----------|------------------|-------------|---------|-----------|--------|
| EPH       | 1000 ml          | 1.00 ml     | 1/28/99 | Fitzwater | 3510   |

| Surrogate        | % Recovery | Target Range |
|------------------|------------|--------------|
| surr-o-Terphenyl | 101.       | 50. - 150.   |

11 analysis performed on DI-WET Leachate.

000006



# SPECIALIZED ASSAYS, INC.

2960 Foster Creighton Dr.  
P.O. Box 40566  
Nashville, TN 37204-0566  
Phone 1-615-726-0177

## ANALYTICAL REPORT

PERSONS ENGINEERING/AFCEE EXT 8185  
JOHN RATZ  
1000 BROADWAY STE 900  
DENVER, CO 80290

Lab Number: 99-A9775  
Sample ID: 11P001SB-B  
Sample Type: Soil  
Site ID:

16-16.5 ft

Project: 726876.20120  
Project Name: BEALE AFB; SITE SD-11  
Sampler:

Date Collected: 1/6/99  
Time Collected: 13:17  
Date Received: 1/12/99  
Time Received: 9:00

| Analyte | Result | Units | Report Limit | Quan Limit | Dil Factor | Date | Time | Analyst | Method | Batch |
|---------|--------|-------|--------------|------------|------------|------|------|---------|--------|-------|
|---------|--------|-------|--------------|------------|------------|------|------|---------|--------|-------|

### \*GENERAL CHEMISTRY PARAMETERS\*

|                    |      |      |      |      |   |         |       |          |            |      |
|--------------------|------|------|------|------|---|---------|-------|----------|------------|------|
| TPH (Diesel Range) | 1.92 | ng/l | 1.00 | 0.10 | 1 | 1/29/99 | 22:50 | K.Walkup | 8015B/3510 | 1770 |
|--------------------|------|------|------|------|---|---------|-------|----------|------------|------|

### TCLP Results

| Analyte | Result | Units | Reg Limit | Matrix Spike Recovery (%) | Date | Method |
|---------|--------|-------|-----------|---------------------------|------|--------|
|---------|--------|-------|-----------|---------------------------|------|--------|

|                 |           |  |  |  |         |      |
|-----------------|-----------|--|--|--|---------|------|
| TCLP Extraction | Completed |  |  |  | 1/26/99 | 1311 |
|-----------------|-----------|--|--|--|---------|------|

ND = Not detected at the report limit.

### Sample Extraction Data

| Parameter | Wt/Vol Extracted | Extract Vol | Date | Analyst | Method |
|-----------|------------------|-------------|------|---------|--------|
|-----------|------------------|-------------|------|---------|--------|

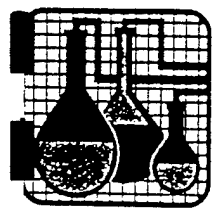
|     |         |         |         |           |      |
|-----|---------|---------|---------|-----------|------|
| TPH | 1000 ml | 1.00 ml | 1/28/99 | Fitzwater | 3510 |
|-----|---------|---------|---------|-----------|------|

| Surrogate | % Recovery | Target Range |
|-----------|------------|--------------|
|-----------|------------|--------------|

|                  |      |            |
|------------------|------|------------|
| surr-o-Terphenyl | 115. | 50. - 150. |
|------------------|------|------------|

All analysis performed on DI-WET Leachate.

000007



# SPECIALIZED ASSAYS, INC.

2960 Foster Creighton Dr.  
P.O. Box 40566  
Nashville, TN 37204-0566  
Phone 1-615-726-0177

## ANALYTICAL REPORT

PERSONS ENGINEERING/AFCEE EXT 8185  
JOHN RATZ  
700 BROADWAY STE 900  
DENVER, CO 80290

Lab Number: 99-A9776  
Sample ID: 11P004SE-AA  
Sample Type: Soil  
Site ID:

36.5-37 ft

Project: 726876.20120  
Project Name: BEALE AFB; SITE SD-11  
Sampler:

Date Collected: 1/7/99  
Time Collected: 13:38  
Date Received: 1/12/99  
Time Received: 9:00

| Analyte                        | Result | Units | Report Limit | Quan Limit | Dil Factor | Date    | Time  | Analyst  | Method     | Batch |
|--------------------------------|--------|-------|--------------|------------|------------|---------|-------|----------|------------|-------|
| *GENERAL CHEMISTRY PARAMETERS* |        |       |              |            |            |         |       |          |            |       |
| TFH (Diesel Range)             | 2.45   | ng/l  | 1.00         | 0.10       | 1          | 1/29/99 | 23:19 | K.Walkup | 8015B/3510 | 1770  |

### TCLP Results

| Analyte         | Result    | Units | Reg Limit | Matrix Spike |  | Date    | Method |
|-----------------|-----------|-------|-----------|--------------|--|---------|--------|
|                 |           |       |           | Recovery (%) |  |         |        |
| TCLP Extraction | Completed |       |           |              |  | 1/26/99 | 1311   |

ND = Not detected at the report limit.

### Sample Extraction Data

| Parameter | Wt/Vol    |             | Date    | Analyst   | Method |
|-----------|-----------|-------------|---------|-----------|--------|
|           | Extracted | Extract Vol |         |           |        |
| EPH       | 1000 ml   | 1.00 ml     | 1/28/99 | Fitzwater | 3510   |

| Surrogate        | % Recovery | Target Range |
|------------------|------------|--------------|
| surr-o-Terphenyl | 95.        | 50. - 150.   |

All analysis performed on DI-WET Leachate.



# SPECIALIZED ASSAYS, INC.

2960 Foster Creighton Dr.  
P.O. Box 40566  
Nashville, TN 37204-0566  
Phone 1-615-726-0177

## ANALYTICAL REPORT

PERSONS ENGINEERING/AFCEE EXT 8185  
JOHN RATZ  
700 BROADWAY STE 900  
DENVER, CO 80290

Lab Number: 99-A9777  
Sample ID: 11P002SB-B  
Sample Type: Soil  
Site ID:

24-24.5 ft

Project: 726876.20120  
Project Name: BEALE AFB; SITE SD-11  
Sampler:

Date Collected: 1/ 8/99  
Time Collected: 12:08  
Date Received: 1/12/99  
Time Received: 9:00

| Analyte | Result | Units | Report Limit | Quan Limit | Dil Factor | Date | Time | Analyst | Method | Batch |
|---------|--------|-------|--------------|------------|------------|------|------|---------|--------|-------|
|---------|--------|-------|--------------|------------|------------|------|------|---------|--------|-------|

### \*GENERAL CHEMISTRY PARAMETERS\*

|                    |      |      |      |      |   |         |       |          |            |      |
|--------------------|------|------|------|------|---|---------|-------|----------|------------|------|
| TPH (Diesel Range) | 1.64 | mg/l | 1.00 | 0.10 | 1 | 1/29/99 | 23:49 | K.Walkup | 8015B/3510 | 1770 |
|--------------------|------|------|------|------|---|---------|-------|----------|------------|------|

### TCLP Results

| Analyte         | Result    | Units | Reg Limit | Matrix Spike Recovery (%) | Date    | Method |
|-----------------|-----------|-------|-----------|---------------------------|---------|--------|
| TCLP Extraction | Completed |       |           |                           | 1/26/99 | 1311   |

ND = Not detected at the report limit.

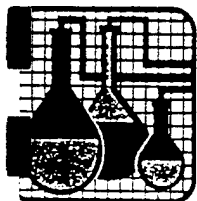
### Sample Extraction Data

| Parameter | Wt/Vol Extracted | Extract Vol | Date    | Analyst   | Method |
|-----------|------------------|-------------|---------|-----------|--------|
| EPH       | 1000 ml          | 1.00 ml     | 1/28/99 | Fitzwater | 3510   |

| Surrogate           | % Recovery | Target Range |
|---------------------|------------|--------------|
| surrogate-Terphenyl | 93.        | 50. - 150.   |

All analysis performed on DI-WET Leachate.

000009



# SPECIALIZED ASSAYS, INC.

2960 Foster Creighton Dr.  
P.O. Box 40566  
Nashville, TN 37204-0566  
Phone 1-615-726-0177

## ANALYTICAL REPORT

PARSONS ENGINEERING/AFCEE EXT 8185  
JOHN RATZ  
1000 BROADWAY STE 900  
DENVER, CO 80290

Lab Number: 99-A9778  
Sample ID: 11P006SB  
Sample Type: Soil  
Site ID:

24.5-25 ft

Project: 726876.20120  
Project Name: BEALE AFB; SITE SD-11  
Sampler:

Date Collected: 1/8/99  
Time Collected: 12:00  
Date Received: 1/12/99  
Time Received: 9:00

| Analyte | Result | Units | Report Limit | Quan Limit | Dil Factor | Date | Time | Analyst | Method | Batch |
|---------|--------|-------|--------------|------------|------------|------|------|---------|--------|-------|
|---------|--------|-------|--------------|------------|------------|------|------|---------|--------|-------|

### GENERAL CHEMISTRY PARAMETERS\*

|                    |        |      |      |      |   |         |      |           |            |      |
|--------------------|--------|------|------|------|---|---------|------|-----------|------------|------|
| TPH (Diesel Range) | 0.95 J | mg/l | 1.00 | 0.10 | 1 | 1/30/99 | 0:18 | K. Walkup | 8015B/3510 | 1770 |
|--------------------|--------|------|------|------|---|---------|------|-----------|------------|------|

### TCLP Results

| Analyte | Result | Units | Matrix Spike |              | Date | Method |
|---------|--------|-------|--------------|--------------|------|--------|
|         |        |       | Reg Limit    | Recovery (%) |      |        |

|                 |           |  |  |  |         |      |
|-----------------|-----------|--|--|--|---------|------|
| TCLP Extraction | Completed |  |  |  | 1/26/99 | 1311 |
|-----------------|-----------|--|--|--|---------|------|

ND = Not detected at the report limit.

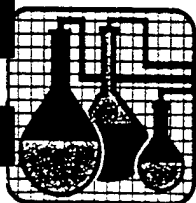
### Sample Extraction Data

| Parameter | Wt/Vol    |             | Date    | Analyst   | Method |
|-----------|-----------|-------------|---------|-----------|--------|
|           | Extracted | Extract Vol |         |           |        |
| TPH       | 1000 ml   | 1.00 ml     | 1/28/99 | Fitzwater | 3510   |

| Surrogate        | % Recovery | Target Range |
|------------------|------------|--------------|
| surr-o-Terphenyl | 108.       | 50. - 150.   |

All analysis performed on DI-WET Leachate.

000010



# SPECIALIZED ASSAYS, INC.

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Nashville, TN 37204-0566  
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## PROJECT QUALITY CONTROL DATA

### Matrix Spike Recovery

| Analyte            | units | Orig. Val. | MS Val | Spike Conc | Recovery | Target Range | R.C. Match |
|--------------------|-------|------------|--------|------------|----------|--------------|------------|
| TPH (Diesel Range) | mg/l  | 2.45       | 4.14   | 2.00       | 84       | 59. - 125.   | 1770       |

### Matrix Spike Duplicate

| Analyte            | units | Orig. Val. | Duplicate | RPD   | Limit | R.C. Match |
|--------------------|-------|------------|-----------|-------|-------|------------|
| TPH (Diesel Range) | mg/l  | 4.14       | 3.39      | 19.92 | 26.   | 1770       |

### Laboratory Control Data

| Analyte            | units | Known Val. | Analyzed Val | % Recovery | Target Range | R.C. Match |
|--------------------|-------|------------|--------------|------------|--------------|------------|
| TPH (Diesel Range) | mg/l  | 2.00       | 1.65         | 82         | 60 - 140     | 1770       |

### Blank Data

| Analyte            | Blank Value | Units | R.C. Match |
|--------------------|-------------|-------|------------|
| TPH (Diesel Range) | < 1.00      | mg/l  | 1770       |

FEB. -04' 99 (THU) 08:21

AIRTOXICS LTD

**@AIR TOXICS LTD.**

AN ENVIRONMENTAL ANALYTICAL LABORATORY

|                           |  |                             |                     |
|---------------------------|--|-----------------------------|---------------------|
| Post-It® Fax Note 7671    |  | Date <u>2/4/99</u>          | # of pages <u>5</u> |
| To <u>Craig Smyth</u>     |  | From <u>Michael Phelps</u>  |                     |
| Co./Dept. <u>Danville</u> |  | Co. <u>Oakland</u>          |                     |
| Phone # <u>5</u>          |  | Phone # <u>510 891 9085</u> |                     |
| Fax #                     |  | Fax #                       |                     |

**WORK ORDER #: 9901201**  
Work Order Summary**CLIENT:**Mr. Michael Phelps  
Parsons Engineering Science  
2101 Webster Street, Suite 700  
Oakland, CA 94612**BILL TO:** Same**PHONE:**

510-891-9085

**FAX:**

510-835-4355

**DATE RECEIVED:**

1/19/99

**DATE COMPLETED:**

2/3/99

**P.O. # 726876.20120**  
**PROJECT # Beale****FRACTION #**

01A

02A

03A

04A

**NAME**

VMP3-24

VMP3-30.5

VMP3-40.5

Lab Blank

**TEST**

TO-3

TO-3

TO-3

TO-3

**RECEIPT**  
**VAC/PRES.**

1.5 "Hg

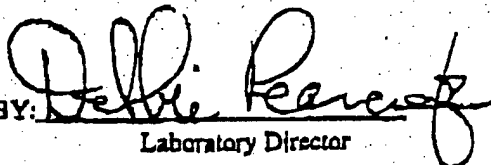
2.5 "Hg

2.5 "Hg

NA

Compounds detected between the detection limit and the low point on the curve are "J" flagged.

CERTIFIED BY:

  
Laboratory Director

DATE:

2/4/99

Certification numbers: CA ELAP - 1149, NY ELAP - 11291, UT ELAP - E-217

180 BLUE RAVINE ROAD, SUITE B FOLSOM, CA 95630  
(916) 985-1000 • (800) 985-5955 • FAX (916) 985-1020

FEB. -04' 99 (THU) 08:22

AIRTOXICS LTD

TEL: 916 985 1020

**AIR TOXICS LTD.**

SAMPLE NAME : VMP3-24

ID#: 9901201-01A

EPA Method TO-3 GC/PID/FID

|              |           |                             |
|--------------|-----------|-----------------------------|
| File Name:   | 990203074 | Date of Collection: 1/18/99 |
| Dil. Factor: | 63.2      | Date of Analysis: 2/2/99    |

| Compound                           | Det. Limit<br>(ppmv) | Det. Limit<br>(ug/L) | Amount<br>(ppmv) | Amount<br>(ug/L) |
|------------------------------------|----------------------|----------------------|------------------|------------------|
| Benzene                            | 0.053                | 0.17                 | 0.48             | 1.6              |
| Toluene                            | 0.053                | 0.20                 | 0.38             | 1.5              |
| Ethyl Benzene                      | 0.053                | 0.23                 | 2.6              | 12               |
| Total Xylenes                      | 0.053                | 0.23                 | 28 M             | 110 M            |
| TPH (C5+ Hydrocarbons) ref. to JP4 | 0.53                 | 3.5                  | 430 B            | 2800 B           |
| C2 - C4 Hydrocarbons ref. to JP4   | 0.53                 | 0.97                 | 0.59 J           | 1.1 J            |

B = Compound present in laboratory blank, background subtraction not performed.

J = Estimated value.

M = Reported value may be biased due to apparent matrix interferences.

Container Type: 1 Liter Summa Canister

| Surrogates          | % Recovery | Method<br>Limits |
|---------------------|------------|------------------|
| Fluorobenzene (PID) | 98         | 50-150           |
| Fluorobenzene (FID) | 110        | 50-150           |

FEB. -04' 99 (THU) 08:22

AIRTOXICS LTD

TEL: 916 985 1020

**AIR TOXICS LTD.**

SAMPLE NAME : VMP3-30.5

ID#: 9901201-02A

EPA Method TO-3 GC/PID/FID

|              |          |                             |
|--------------|----------|-----------------------------|
| File Name:   | 99020806 | Date of Collection: 1/19/99 |
| Dil. Factor: | 2.20     | Date of Analysis: 2/2/99    |

| Compound                           | Det. Limit<br>(ppmv) | Det. Limit<br>(ug/L) | Amount<br>(ppmv) | Amount<br>(ug/L) |
|------------------------------------|----------------------|----------------------|------------------|------------------|
| Benzene                            | 0.0022               | 0.0071               | 0.011            | 0.035            |
| Toluene                            | 0.0022               | 0.0084               | 0.072            | 0.28             |
| Ethyl Benzene                      | 0.0022               | 0.0097               | 0.022            | 0.085            |
| Total Xylenes                      | 0.0022               | 0.0097               | 0.33             | 1.5              |
| TPH (C5+ Hydrocarbons) ref. to JP4 | 0.022                | 0.14                 | 4.5 B            | 29 B             |
| C2 - C4 Hydrocarbons ref. to JP4   | 0.022                | 0.040                | 0.32             | 0.58             |

B = Compound present in laboratory blank, background subtraction not performed.

Container Type: 1 Liter Summa Canister

| Surrogates          | % Recovery | Method<br>Limits |
|---------------------|------------|------------------|
| Fluorobenzene (PID) | 52         | 50-150           |
| Fluorobenzene (FID) | 103        | 60-150           |

FEB. -04' 99 (THU) 08:22

AIRTOXICS LTD

TEL: 916 985 1020

P. 004/000

**AIR TOXICS LTD.**

SAMPLE NAME : VMP3-40.5

ID#: 9901201-03A

EPA Method TO-3 GC/PID/FID

|                   |                             |
|-------------------|-----------------------------|
| File Name: 000000 | Date of Collection: 1/15/99 |
| Dil. Factor: 2.20 | Date of Analysis: 2/2/99    |

| Compound                           | Det. Limit<br>(ppmv) | Det. Limit<br>(uG/L) | Amount<br>(ppmv) | Amount<br>(uG/L) |
|------------------------------------|----------------------|----------------------|------------------|------------------|
| Benzene                            | 0.0022               | 0.0071               | 0.021            | 0.067            |
| Toluene                            | 0.0022               | 0.0084               | 0.021            | 0.079            |
| Ethyl Benzene                      | 0.0022               | 0.0087               | 0.0033 J         | 0.014 J          |
| Total Xylenes                      | 0.0022               | 0.0087               | 0.040            | 0.18             |
| TPH (C5+ Hydrocarbons) ref. to JP4 | 0.022                | 0.14                 | 0.71 B           | 4.6 B            |
| C2 - C4 Hydrocarbons ref. to JP4   | 0.022                | 0.040                | 0.10 J           | 0.18 J           |

B = Compound present in laboratory blank, background subtraction not performed.

J = Estimated value.

Container Type: 1 Liter Summa Canister

| Surrogates          | % Recovery | Method<br>Limits |
|---------------------|------------|------------------|
| Fluorobenzene (PID) | 81         | 50-150           |
| Fluorobenzene (FID) | 103        | 50-150           |

# AIR TOXICS LTD.

SAMPLE NAME : Lab Blank

ID#: 9901201-04A

EPA Method TO-3 GC/PID/FID

|             |             |                          |
|-------------|-------------|--------------------------|
| File Name:  | 9901201-04A | Date of Collection: NA   |
| DR. Factor: | 1.00        | Date of Analysis: 2/2/99 |

| Compound                           | Det. Limit (ppmv) | Det. Limit (ug/L) | Amount (ppmv) | Amount (ug/L) |
|------------------------------------|-------------------|-------------------|---------------|---------------|
| Benzene                            | 0.0010            | 0.0032            | Not Detected  | Not Detected  |
| Toluene                            | 0.0010            | 0.0038            | Not Detected  | Not Detected  |
| Ethyl Benzene                      | 0.0010            | 0.0044            | Not Detected  | Not Detected  |
| Total Xylenes                      | 0.0010            | 0.0044            | Not Detected  | Not Detected  |
| TPH (C5+ Hydrocarbons) ref. to JP4 | 0.010             | 0.065             | 0.017 J       | 0.11 J        |
| C2 - C4 Hydrocarbons ref. to JP4   | 0.010             | 0.018             | Not Detected  | Not Detected  |

J = Estimated value.

Container Type: NA

| Surrogates          | % Recovery | Method Limits |
|---------------------|------------|---------------|
| Fluorobenzene (PID) | 85         | 50-150        |
| Fluorobenzene (FID) | 108        | 50-150        |

**APPENDIX F**  
**SESOIL MODEL INPUT/OUTPUT FILE**