**Field Investigation Source Area ST58
Old Quartermaster Service Station,
Eielson Air Force Base, Alaska**

T. L. Liikala
J. C. Evans

January 1995

Prepared for
Eielson Air Force Base
Fairbanks, Alaska
under Contract DE-AC06-76RLO 1830

Pacific Northwest Laboratory
Richland, Washington 99352

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

fb

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, make any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

Summary

Source area ST58 is the site of the old Quartermaster service station at Eielson Air Force Base, Alaska. The source area is one of several Source Evaluation Report sites being investigated by Pacific Northwest Laboratory for the U.S. Air Force as candidates for no further remedial action, interim removal action, or a remedial investigation/feasibility study under a Federal Facilities Agreement.

The purpose of this work was to characterize source area ST58 and excavate the most contaminated soils for use in composting treatability studies. A field investigation was conducted to determine the nature and extent of soil contamination. The field investigation entailed a records search; grid node location, surface geophysical, and soil gas surveys; and test pit soil sampling. Soil excavation followed based on the results of the field investigation. The site was backfilled with clean soil.

Results from this work indicate close spatial correlation between screening instruments, used during the field investigation and soil excavation, and laboratory analyses. Gasoline was identified as the main subsurface contaminant based on the soil gas surveys and test pit soil sampling. A center of contamination was located near the northcentral portion of the source area, and a center was located in the northwestern corner. The contamination typically occurred near or below a former soil horizon probably as a result of surface spills and leaks from discontinuities and/or breaks in the underground piping. Piping locations were delineated during the surface geophysical surveys and corresponded very well to unscaled drawings of the site. The high subsurface concentrations of gasoline detected in the northwestern corner of the source area probably reflect ground-water contamination and/or possibly floating product.

Approximately 700 yd³ of soil were removed during excavation of the northcentral portion of source area ST58. Of those, approximately 600 yd³ of soil were contaminated and transported to the soil composting demonstration site. Ground water was evident in the excavation and probably became contaminated through dissolution of the gasoline.

A significant amount of contaminated soil remains at the site. The clean backfill soil probably will become contaminated over time. A remedial investigation/feasibility study will likely be required for the source area.

Acknowledgments

The authors would like to thank several Pacific Northwest Laboratory staff members who contributed their time and effort to this project. Special thanks go to Don Glover for his organization, preparation, and dedication. Thanks to Chuck Veverka and Ned Clayton for their field work. Thanks also to Khris Olsen for coordinating laboratory analyses, John Fruchter for technical peer review, and Kristin Manke and Denice Carrothers for editorial review.

Contents

Summary	iii
Acknowledgments	v
Acronyms	ix
Conversions	ix
1.0 Introduction	1.1
2.0 Source Area Description and History	2.1
2.1 Previous Investigations	2.1
2.2 April 1993 Investigation	2.1
3.0 Field Investigation	3.1
3.1 Records Search	3.1
3.2 Grid Node Location Survey	3.1
3.3 Surface Geophysical Surveys	3.1
3.3.1 Electromagnetic Induction Survey	3.1
3.3.2 Radiodetection Unit Survey	3.3
3.4 Soil Gas Surveys	3.3
3.4.1 Conventional Gas Extraction	3.5
3.4.2 Petrex Method	3.7
3.4.3 Survey Comparison and Conclusions	3.12
3.5 Test Pit Soil Sampling	3.17
4.0 Soil Excavation and Backfilling	4.1
5.0 Conclusions	5.1
6.0 References	6.1
Appendix A - Source Area Characterization Plan	A.1
Appendix B - Letter from A. E. Schumacher to D. W. Glover, Dated January 6, 1993, Subject History of Old Quartermaster Service Station	B.1
Appendix C - April 1993 Analytical Results	C.1
Appendix D - Base Civil Engineering Work Clearance Request	D.1
Appendix E - Surveyor's Report	E.1
Appendix F - Surface Geophysical Surveys Report	F.1
Appendix G - Petrex Method Report	G.1

Figures

1.1	Generalized Location Map of Source Area ST58	1.2
2.1	Source Area ST58 Map Showing Well Locations and Benzene Concentrations	2.2
2.2	Above-Ground Storage Tanks and Associated Piping	2.3
2.3	Benzene Concentrations in Ground Water, April 1993	2.5
2.4	Lead Concentrations in Ground Water, April 1993	2.7
3.1	Field Investigation Grid and Surface Geophysical Surveys	3.2
3.2	Electromagnetic Induction Survey Results	3.4
3.3	Conventional Gas Extraction Probe Locations	3.6
3.4	Total Hydrocarbon Concentrations in Soil Gas from Field PID Readings	3.9
3.5	Benzene Concentrations in Soil Gas from Gas Chromatography Analysis	3.10
3.6	Petrex Method Sampler Locations	3.11
3.7	Petrex Method Results for Benzene, Toluene, Ethylbenzene, and Xylene in Soil Gas	3.15
3.8	Petrex Method Results for Cycloalkanes and Alkenes in Soil Gas	3.16
3.9	Test Pit Soil Sample Locations	3.18
3.10	Typical Soil Profile	3.20
3.11	Benzene Concentrations in Soil, 4 to 5.5 ft bls	3.23
3.12	Benzene Concentrations in Soil, 9 to 10 ft bls	3.24
3.13	Total Petroleum Hydrocarbons - Gasoline Concentrations in Soil, 4 to 5.5 ft bls	3.25
4.1	Flagged Soil Excavation Area	4.2
4.2	Soil Excavation Area and Underground Piping	4.4

Tables

1.1	Division of Work Between Pacific Northwest Laboratory; EA Engineering, Science, and Technology; and Eielson Air Force Base	1.3
2.1	Summary of Analytical Results from April 1993	2.6
3.1	Conventional Gas Extraction Results	3.8
3.2	Petrex Method Sampler Results	3.13
3.3	Test Pit Selection Criteria	3.19
3.4	Test Pit Soil Sampling Results	3.21
3.5	Test Pit Soil Sampling Summary	3.26
4.1	Soil Excavation Results	4.3

Acronyms

AFB	Air Force Base
AST	above-ground storage tank
bls	below land surface
BTEX	benzene, toluene, ethylbenzene, and xylene
EA	EA Engineering, Science, and Technology
ECD	electron capture detector
EMI	electromagnetic induction
EPA	U.S. Environmental Protection Agency
HP	Hewlett-Packard
MCL	maximum contaminant level
MOGAS	motor gasoline
NERI	Northeast Research Institute, Inc.
PCE	perchloroethylene
PID	photoionization detector
PNL	Pacific Northwest Laboratory
SER	Source Evaluation Report
TCE	trichloroethylene
TPH-D	total petroleum hydrocarbons - diesel
TPH-G	total petroleum hydrocarbons - gasoline
VOC	volatile organic compound

Conversions

To Convert From	To	Multiply By
inch	centimeter	2.540
foot	meter	3.048 E-01
acre	kilometer ²	4.048 E-03
feet ³ per minute	centimeter ³ per second	472
yard ³	meter ³	7.645 E-01
gallon	liter	3.785
pounds per inch ²	kilograms per centimeter ²	7.031 E-02

1.0 Introduction

The U.S. Air Force is conducting an environmental restoration program at Eielson Air Force Base (AFB), near Fairbanks, Alaska, in accordance with the Federal Facility Agreement (EPA et al. 1990) between the U.S. Environmental Protection Agency (EPA), the Alaska Department of Environmental Conservation, and the U.S. Air Force. As part of this program, Pacific Northwest Laboratory (PNL)^(a) is investigating several Source Evaluation Report (SER) sites as candidates for no further remedial action, interim removal action, or a remedial investigation/feasibility study. The SER sites comprise approximately half of the 64 source areas on the base.

The purpose of this work was to characterize SER source area ST58, the old Quartermaster service station (Figure 1.1), and excavate the contaminated soils for use in composting treatability studies. A field investigation was required to determine the nature and extent of soil contamination. Excavation of those soils with the highest contamination and backfilling of the excavation followed. The objectives were to

- determine the contaminant types, concentrations, and distributions in the soil resulting from source area ST58
- excavate approximately 500 yd³ of the most contaminated soil and transport it to the soil composting demonstration site for remediation of hydrocarbon contamination
- backfill the excavation with clean soil.

The work at source area ST58 was subdivided into 10 tasks as follows:

1. determine the nature and location of any underground piping, leaks, and/or spills through a records search
2. survey grid nodes for surface geophysical and soil gas surveys
3. further identify the location of the underground piping using surface geophysical surveys
4. further estimate the contaminant types, concentrations, and distributions using soil gas surveys
5. confirm the contaminant types, concentrations, and distributions through test pit soil sampling and analysis
6. excavate approximately 500 yd³ of the most contaminated soil and transport it to the soil composting demonstration site

(a) PNL is a multiprogram national laboratory operated for the U.S. Department of Energy by Battelle Memorial Institute under Contract DE-AC06-76RLO 1830.

S9305032.10

Figure 1.1. Generalized Location Map of Source Area ST58

7. remove and dispose of any residual product from the underground piping
8. remove and dispose of the underground piping from the excavation
9. remove and dispose of any free product
10. backfill the excavation with clean soil.

PNL; EA Engineering, Science, and Technology (EA); and Eielson AFB performed the work as shown in Table 1.1 in May and June 1993. Appendix A contains the complete source area characterization plan.

This report is organized as follows. Chapter 2.0 contains a source area description and history. Chapter 3.0 presents the field investigation methodologies and results. Soil excavation and backfilling are described in Chapter 4.0. Conclusions from this work are given in Chapter 5.0. References cited in the text are listed in Chapter 6.0. Appendix A contains the complete source area characterization plan. Appendix B provides historical information on the old Quartermaster service station. Analytical results from April 1993 are given in Appendix C. The base civil engineering work clearance request is shown in Appendix D. The surveyor's report is included as Appendix E. Appendix F contains the surface geophysical surveys report, and Appendix G contains the Petrex method report.

Table 1.1. Division of Work Between Pacific Northwest Laboratory; EA Engineering, Science, and Technology; and Eielson Air Force Base

Company	Task
Pacific Northwest Laboratory	Perform Records Search
	Grid, Perform, and Interpret Surface Geophysical Surveys
	Grid, Perform, and Interpret Soil Gas Surveys
	Perform Test Pit Soil Sampling
	Recommend Soil Excavation Area
	Perform Laboratory Analyses ^(a)
	Complete and Submit Technical Report
EA Engineering, Science, and Technology	Operate Backhoe and Dump Truck for Soil Excavation
	Perform Residual Product, Underground Piping, and Free Product Removal and Disposal
Eielson Air Force Base	Obtain Base Civil Engineering Work Clearance Request
	Operate Backhoe for Test Pit Soil Sampling
	Perform Site Backfilling
(a) Selected laboratory analyses were performed by Northeast Research Institute, Inc.	

2.0 Source Area Description and History

Source area ST58 is the site of the old Quartermaster service station. It is located on the northwest corner at the intersection of Division Street and Wabash Avenue (Figure 2.1). The service station covered approximately 1 acre (135 by 300 ft). The site is currently a flat, grassy field.

The service station was operated from 1970 to 1988 by Eielson AFB. It serviced vehicles for AFB personnel and their dependents until 1975 and, thereafter, AFB vehicles only. The station utilized four 25,000-gal above-ground storage tanks (ASTs) (Figure 2.2), containing motor gasoline (MOGAS) and diesel. Both leaded and unleaded MOGAS were used. Blueprints show two fuel supply lines from bulk storage to the ASTs. The blueprints also show an isopropyl alcohol AST; AFB personnel indicate only MOGAS was stored in this tank (Appendix B). Two barrels of motor oil were stored at the service station for customer use.

The ASTs and above-ground piping were removed in August 1988; the underground piping was left in place. Reportedly, the site was covered with approximately 3 to 4 ft of fill after the ASTs and above-ground piping were removed.

2.1 Previous Investigations

No known spills have occurred at source area ST58. One of the fuel supply lines for the service station was suspected of leaking at the intersection of Industrial Drive and Division Street, east of the source area (Appendix B). Geotechnical investigations conducted in October and November 1991 (Shannon and Wilson, Inc. 1991) and January and February 1992 (Shannon and Wilson, Inc. 1992) indicated benzene contamination in ground water immediately downgradient of source area ST58 (Figure 2.1). Ground-water flow is generally to the north and northwest beneath the source area and across the developed portion of the base. Benzene concentrations above the maximum contaminant level (MCL) of 5 micrograms per liter ($\mu\text{g/L}$) ranged from 5.4 to 145 $\mu\text{g/L}$. The MCL was exceeded in four wells, 58MW03, 58MW04, 58MW05, and 58MW08. Benzene concentrations in the remaining wells were below detection. Low levels of toluene in well 58MW06; ethylbenzene in wells 58MW04, 58MW05, and 58MW08; and xylenes in well 58MW08 were detected. Detectable levels of total dissolved solids, sulfate, and trace levels of chromium and mercury were found in selected samples. Analytical results for other organic and inorganic constituents were below detection. No chemical analyses were performed on the soils.

2.2 April 1993 Investigation

Ground-water samples were collected from wells 58MW01 through 58MW12 in April 1993 by PNL. These samples were collected to confirm previous results and guide the planned field investigation at source area ST58. The samples were analyzed for volatile organic compounds (VOCs), total petroleum hydrocarbons-gasoline (TPH-G), total petroleum hydrocarbons-diesel (TPH-D), and lead by DataChem Laboratories, using EPA methods 8240, 8015-M, and 7421, respectively (EPA 1986).

S9406010.2

Figure 2.1. Source Area ST58 Map Showing Well Locations and Benzene Concentrations

Figure 2.2. Above-Ground Storage Tanks and Associated Piping
(Adapted from unscaled blueprints)

Results of the April 1993 sampling effort confirmed benzene contamination in the ground water above the MCL at several locations (Figure 2.3 and Table 2.1). The April 1993 concentrations were comparable (within one order of magnitude) to previous results, ranging from 24 $\mu\text{g/L}$ in well 58MW09 to 450 $\mu\text{g/L}$ in well 58MW10. Well 58MW03 had 3.7 $\mu\text{g/L}$ and the remaining wells were below detection. Toluene and total xylenes were detected significantly below MCLs in wells 58MW09 and 58MW10. Total xylenes were also noted in well 58MW08. No ethylbenzene analyses were performed. Interface probe measurements indicated a sheen of product in well 58MW09. Benzene is likely related to subsurface gasoline contamination; gasoline contains approximately 2 to 8 percent benzene by weight. Benzene at and downgradient from the source area with little or no toluene, ethylbenzene, and xylene is indicative of the higher mobility of benzene in ground water and suggests the contamination occurred relatively recently.

TPH-G was detected in well 58MW09 at 260 milligrams per liter (mg/L) (Table 2.1). All other samples were below the 2 mg/L detection limit. TPH-D was detected in 9 of the 12 wells, ranging in concentrations from 0.1 to 99 mg/L. The highest concentration was detected in well 58MW09, which is located near the former diesel AST. Samples from wells 58MW02, 58MW03, and 58MW06 were below detection.

Lead was found above the EPA suggested cleanup level of 15 $\mu\text{g/L}$ in all of the source area ST58 wells (Figure 2.4 and Table 2.1). Concentrations ranged from 35 to 180 $\mu\text{g/L}$, with the highest contamination in well 58MW12. No lead samples were collected in previous investigations for comparison. The complete April 1993 data set for source area ST58 is contained in Appendix C.

Of note, dewatering was performed approximately 300 ft downgradient of source area ST58 in May 1993 (before the field investigation commenced) during construction of an Alaska Air National Guard building. This pumping may have induced a temporary hydraulic gradient, resulting in ground-water contamination migrating further downgradient. In addition, the water was discharged to a bermed area south of the building and to the open field east of Wabash Avenue. Wells 58MW06 and 58MW07 were apparently removed or destroyed as construction progressed in May and June 1993. Well 58MW04 was evidently run over by heavy equipment; the polyvinyl chloride casing stickup was damaged but has been repaired by AFB and PNL personnel.

S9406010.3

Figure 2.3. Benzene Concentrations in Ground Water, April 1993

Table 2.1. Summary of Analytical Results from April 1993

Well Number	Benzene (ug/L)	Toluene (ug/L)	Total Xylenes (ug/L)	TPH-G (mg/L)	TPH-D (mg/L)	Lead (ug/L)
58MW01	5.0 U	5.0 U	5 U	2 U	0.2	35.0
58MW02	5.0 U	5.0 U	5 U	2 U	0.1U	39.0
58MW03	3.7	5.0 U	5 U	2 U	0.1U	41.0
58MW04	98.0	5.0 U	5 U	2 U	0.3	63.0
58MW05	29.0	5.0 U	5 U	2 U	0.1	40.0
58MW06	5.0 U	5.0 U	5 U	2 U	0.1U	44.0
58MW07	5.0 U	5.0 U	5 U	2 U	0.1	110.0
58MW08	180.0	5.0 U	29	2 U	0.7	51.0
58MW09	24.0	2.8	45	260	99.0	130.0
58MW10	450.0 B	140.0	830	2 U	7.0	89.0
58MW11	5.0 U	5.0 U	5 U	2 U	0.1	170.0
58MW12	5.0 U	5.0 U	5 U	2 U	0.3	180.0
Notes:						
(1) U = Constituent was analyzed for but not detected.						
(2) B = Constituent was also detected in the associated blank.

S9406010.4

Figure 2.4. Lead Concentrations in Ground Water, April 1993

3.0 Field Investigation

The field investigation at source area ST58 consisted of a records search; grid node location, surface geophysical, and soil gas surveys; and test pit soil sampling. Access around utilities and/or other restrictions for the intrusive work was coordinated with Eielson AFB using a Base Civil Engineering Work Clearance Request (Appendix D). The work clearance request was completed by AFB personnel and posted in the field. A discussion of the methodology and the results for each of the field investigation activities follows.

3.1 Records Search

A search was conducted to locate service station as-built drawings, maintenance records, observations during AST removal, and/or closure files for source area ST58. However, the only records found were unscaled blueprints of the ASTs and associated piping and a mid-1980s aerial photograph. Limited historical information was gained through personnel interviews.

3.2 Grid Node Location Survey

No records were available to help identify the location of the AST piping, leaks, and/or spills; therefore, a rectangular grid, encompassing the entire source area, was used throughout the field investigation. A 150- by 300-ft grid, with 25-ft nodes, was set up using a transit and steel tape, with the 150-ft axis parallel to Wabash Avenue (Figure 3.1). The nodes were marked with green flags and labeled 1 through 13 along the 300-ft axis and A through G along the 150-ft axis for ease of identification. Node 1A was located 20 ft from both Division Street and Wabash Avenue. The nodes were surveyed to the Eielson AFB coordinate system (U.S. Army Corps of Engineers brass cap control monuments) for horizontal and vertical control by Kalen and Associates, Inc. (Fairbanks, Alaska). Horizontal coordinates were taken to the nearest 0.02 ft and elevations to the nearest 0.1 ft. Land surface elevations range from approximately 538 to 542 ft above mean sea level. Appendix E contains the complete surveyor's report.

3.3 Surface Geophysical Surveys

Electromagnetic induction (EMI) and radiodetection unit surveys were performed in conjunction with the unscaled blueprints to help identify the location of the AST piping. These surveys are useful in locating buried objects.

3.3.1 Electromagnetic Induction Survey

The EMI survey was performed using a Geonics, Ltd. EM-31 instrument. This instrument measures ground conductivity noninvasively by inducing eddy currents in the subsurface. A secondary

S9305032.12ab

Figure 3.1. Field Investigation Grid and Surface Geophysical Surveys

magnetic field is generated by the subsurface eddy currents and is measured as output voltage by the EM-31. The output voltage is linearly related to the terrain conductivity. When the tool is passed over a buried metallic object, such as a pipe which acts as an electrical conductor, a deflection will occur. Once the deflection occurs, the location and the strike of the buried object can be accurately determined.

Initially, measurements were taken at each grid node (Figure 3.1) with the EM-31 facing parallel to Wabash Avenue. General regions where anomalous readings occurred were mapped for further investigation. Follow-up measurements were taken at these nodes with the EM-31 facing parallel to Division Street to help clarify the orientation of the buried metallic objects. Several additional measurements were taken between nodes to improve data resolution. The location and the strike of possible AST pipe lengths were traced, marked with pink flags, and mapped as shown in Figure 3.2. This map was used as a guide during the test pit soil sampling and soil excavation.

Results of the EMI survey corresponded very well to the AST piping indicated on the unscaled drawings (Figure 2.2) and radiodetection unit survey. Signatures interpreted as AST piping near nodes 7B, 7D to 6E, and 6E to 5D were confirmed as test pit soil sampling and soil excavation progressed. Survey results further indicated a significant amount of other buried metallic debris. Railroad rails, culvert pipe, cables, and rebar were also found during sampling and excavation.

3.3.2 Radiodetection Unit Survey

The radiodetection unit survey was performed by AFB personnel using an RD400 Buried Pipe and Cable Locator. A radio transmitter is attached to an above-ground section of pipe, whose subsurface location is being targeted. The pipe acts as an antenna, transmitting the radio signal. A hand-held receiver measures the intensity of the radio signal using an audible tone and analog meter. Maximum tone and readings occur directly over the pipe.

The transmitter was attached to an above-ground water valve on the inlet pipe across Wabash Avenue east of source area ST58. Responses were measured along the dashed lines between grid nodes (Figure 3.1) for a total of 20 runs. Points of maximum tone and signal strength were marked with pink flags.

The radiodetection unit was able to delineate the two main feeder pipes entering source area ST58 (Figure 2.2), but the signal was undetectable near nodes 4C and 4D. In general, the radio signal was attenuated and became difficult to detect with increased distance and branching from the transmitter. Discontinuities and/or breaks in the piping probably hindered transmission of the signal, making pipe detection impossible. The complete surface geophysical surveys report is in Appendix F.

3.4 Soil Gas Surveys

Soil gas surveys were employed to determine the contaminant types, concentrations, and distributions in the soil resulting from source area ST58. Two intrusive methods were used for comparison, conventional gas extraction, and the Petrex method.

S9305032.12abc

Figure 3.2. Electromagnetic Induction Survey Results

3.4.1 Conventional Gas Extraction

Conventional gas extraction is an active intrusive method where probes are inserted into the soil to a depth of approximately 4 ft. Gas samples are drawn through the probes and can be analyzed qualitatively using a monitoring instrument [e.g., photoionization detector (PID)] in the field and/or quantitatively by gas chromatography in the laboratory.

Conventional gas extraction probes were initially inserted on 50-ft centers, beginning at node 1A (Figure 3.3). Additional probes were placed at selected 25-ft centers in areas of interest identified after the initial measurements were evaluated. A total of 45 probes were installed (58SG01 through 58SG45).

The sample probes consisted of 0.75-in.-diameter stainless steel well points connected to 6-ft lengths of 0.25-in.-diameter polyethylene tubing. Before insertion, pilot holes were driven into the ground to a depth of approximately 3.5 ft on the west side of each grid node, using a 1-in.-diameter sharpened solid steel rod. The rod was driven with a pneumatic post driver, operated at 90 pounds per square inch (psi). A trailer-mounted, 100 cubic feet per minute (cfm) air compressor was used to supply air. The rod was withdrawn with a modified lever-operated construction jack. A sample probe was driven back into the same hole using a 1-in.-diameter, thick-walled steel tube. The steel drive tube was tapered at the bottom to mate with the well point. The top of the tube was slotted to provide an exit for the internally routed polyethylene tubing. A 2-in.-diameter, threaded top piece, constructed of hardened steel, was used to mate the tube to the pneumatic post driver during insertion. Sample probes were driven to a depth of approximately 4 ft. Following removal of the drive tube, 20-40 mesh Colorado silica sand was poured into the hole to a depth of approximately 2 ft. The remainder of the hole was filled with granular bentonite, which was hydrated at the surface to complete the installation.

Each sample probe was allowed to equilibrate for at least 24 hr before sample collection. Analytical samples were collected in 500-mL gas sampling bulbs connected directly to the polyethylene tubing for each probe. A PhotoVac Model HL200 MicroTip PID was used as a sampling pump to draw the sample through the bulb. The MicroTip pumped for 5 min at a rate of 750 mL/min, allowing sufficient time for the well point, the polyethylene tubing, and the sampling bulb to be fully purged and for the instrument readings to stabilize. At the end of the 5-min purge, the bulb was sealed and returned to the PNL field laboratory on base for immediate gas chromatography analysis. The MicroTip readings were recorded on prenumbered chain-of-custody sheets for laboratory reference.

The MicroTip was also used for initial evaluation of total hydrocarbon concentrations in the soil gas at the time of sampling. A 10.6-eV lamp was employed in the instrument, providing broad sensitivity to the expected contaminants at source area ST58. The MicroTip was calibrated daily with a known concentration of isobutylene in air. The MicroTip readings are reported in parts per million by volume (PPMv) based on the isobutylene response factor.

Gas chromatography analysis was performed using a Hewlett-Packard® (HP) 5880 gas chromatograph equipped with a Tekmar LSC-3 purge and trap sample introduction system. Gas samples were injected with a gas sampling syringe into the purge and trap system. Following desorption from

® Hewlett Packard is a registered trademark of Hewlett-Packard, Palo Alto, California.

S9309058.3

Figure 3.3. Conventional Gas Extraction Probe Locations

the purge and trap system, the sample was transferred to an inlet splitter for separation on two gas chromatograph columns. One column was equipped with a PID (10.2 eV) for quantification of benzene, toluene, ethylbenzene, and xylene (BTEX) and the other utilized an electron capture detector (ECD) with a nickel-63 source for measuring VOC concentrations. A pair of HP data terminals were used for instrument control and data reduction. Results were reported as micrograms per liter as received. Xylene was reported as the sum of the m-, p-, and o-xylene isomers.

Conventional gas extraction results from the field PID readings and gas chromatography analyses for source area ST58 are shown in Table 3.1. Total hydrocarbon concentrations in soil gas from the field PID readings are plotted in Figure 3.4 with contours of 10, 100, and 1000 PPMv. Figure 3.5 shows benzene distribution in soil gas based on the gas chromatography analyses. Contours are plotted for 10, 100, and 1000 $\mu\text{g/L}$. These plots emphasized the areas with the highest contamination and served as a basis for locating the test pits for soil sampling.

Figures 3.4 and 3.5 indicate close spatial correlation between field PID readings and gas chromatography analysis. Two locations containing high subsurface concentrations of gasoline were identified, centered near nodes 7C to 7E and 11F. Similar results were obtained from the toluene, ethylbenzene, and total xylenes analyses (Table 3.1). The high subsurface concentrations corresponded very well to the unscaled drawings showing the ASTs and associated piping (Figure 2.2), April 1993 benzene concentrations in ground water (Figure 2.3), and EMI signatures indicating AST piping locations (Figure 3.2).

In the soil gas samples collected at source area ST58, only the normal components of gasoline were detected. In particular, trichloroethylene (TCE) was not observed in spite of the very high sensitivity available with the ECD.

3.4.2 Petrex Method

The Petrex method, developed by Northeast Research Institute, Inc. (NERI), utilizes passive intrusive samplers. The samplers are installed to a depth of approximately 18 in. and integrate contaminant concentrations over time. Soil gas measurements were executed according to NERI's instructions. NERI supplied all samplers and performed analyses following completion of exposure.

Petrex method samplers were installed at every node within the field investigation grid (Figure 3.6). Duplicates were placed at approximately 5 percent of the nodes and three samplers were retained as blanks. In all, 100 samplers were used (58PX01 through 58PX100).

The samplers consisted of two collectors, each a ferromagnetic wire coated with an activated carbon adsorbent. The adsorbent collection wires were contained in screw-top glass culture tubes 6 in. in length and 1 in. in diameter. Before shipment, the wires were cleaned by heating to 358°C and packed under an inert atmosphere.

A tractor-mounted auger was used to drill ninety-one 4-in.-diameter holes to a depth of 18 in. on the east side of each grid node. Petrex samplers were placed in the holes by hand with the open ends of the tubes facing downward and pushed a short distance into the soil. A double plug of aluminum foil was placed at the top of each hole to minimize surface intrusion of contaminants. The samplers

Table 3.1. Conventional Gas Extraction Results

Sample Number	Grid Node	PID (PPMv)	Benzene (ug/L)	Toluene (ug/L)	Ethylbenzene (ug/L)	Total Xylenes (ug/L)
58SG01	1A	0	<0.4	<0.4	<0.4	<0.8
58SG02	1C	0	<0.4	<0.4	<0.4	<0.8
58SG03	1E	0	<0.4	<0.4	<0.4	<0.8
58SG04	1G	0	<0.4	<0.4	<0.4	<0.8
58SG05	3G	0	<0.4	<0.4	<0.4	<0.8
58SG06	3E	0	<0.4	<0.4	<0.4	<0.8
58SG07	3C	0	<0.4	<0.4	<0.4	<0.8
58SG08	3A	0	<0.4	<0.4	<0.4	<0.8
58SG09	5A	0	<0.4	<0.4	<0.4	<0.8
58SG10	5C	0	0.06	0.83	0.37	3.90
58SG11	5E	0	<0.4	<0.4	<0.4	<0.8
58SG12	5G	0	<0.4	<0.4	<0.4	<0.8
58SG13	7G	0	<0.4	<0.4	<0.4	<0.8
58SG14	7E	680	5954	6794	317	2005
58SG15	7C	1050	97	46	19	388
58SG16	7A	0	<0.4	<0.4	<0.4	<0.8
58SG17	9A	0	<0.4	<0.4	<0.4	<0.8
58SG18	9C	0	<0.4	<0.4	<0.4	<0.8
58SG19	9E	0	0.70	<0.4	<0.4	<0.8
58SG20	9G	420	<10	4.3	24	15.6
58SG21	11G	0	<0.4	<0.4	<0.4	<0.8
58SG22	11E	0	<0.4	<0.4	<0.4	<0.8
58SG23	11C	0	<0.4	<0.4	<0.4	<0.8
58SG24	11A	0	<0.4	<0.4	<0.4	<0.8
58SG25	13A	0	<0.4	<0.4	<0.4	<0.8
58SG26	13C	0	<0.4	<0.4	<0.4	<0.8
58SG27	13E	0	<0.4	<0.4	<0.4	<0.8
58SG28	13G	0	<0.4	<0.4	<0.4	<0.8
58SG29	7F	0	<0.4	<0.4	<0.4	<0.8
58SG30	7D	2170	995	1326	29	1097
58SG31	7B	0	<0.4	<0.4	<0.4	<0.8
58SG32	6D	35	<0.4	<0.4	<0.4	<0.8
58SG33	8D	22	<0.4	<0.4	<0.4	<0.8
58SG34	8C	2.5	<0.4	<0.4	<0.4	<0.8
58SG35	8E	1115	377	2433	116	1375
58SG36	6E	1335	479	4247	147	4199
58SG37	6C	1.4	<0.4	<0.4	<0.4	<0.8
58SG38	6F	12	0.69	<0.4	<0.4	<0.8
58SG39	8F	8	<0.4	<0.4	<0.4	<0.8
58SG40	8G	8	<0.4	<0.4	<0.4	<0.8
58SG41	9F	125	65	<0.4	2.8	7.2
58SG42	9H	146	<0.4	0.85	4.6	1.85
58SG43	10F	70	40	<0.4	1.7	19.50
58SG44	10G	45	2.4	0.69	<0.4	<0.8
58SG45	11F	2090	30	5.2	21	1887
Note:						
(1) Gas chromatography results in ug/L as received.

S9406010.5

Figure 3.4. Total Hydrocarbon Concentrations in Soil Gas from Field PID Readings

S9406010.6

Figure 3.5. Benzene Concentrations in Soil Gas from Gas Chromatography Analysis

S9309058.2

Figure 3.6. Petrex Method Sampler Locations

were retrieved 5 days later, capped, and shipped to NERI for analysis by thermal desorption mass spectrometry. Selected samplers (eight total) were also analyzed by thermal desorption gas chromatography/mass spectrometry.

All samples were analyzed using an extranuclear quadrupole mass spectrometer equipped with a Curie-point pyrolysis and thermal desorption inlet. Indicator peaks of subsurface contamination were reported based on the following mass spectral peak assignments: BTEX 78, 92, and 106; TCE 130; cycloalkanes and alkenes 84, 98, 112, and 126. Cycloalkanes are saturated hydrocarbon compounds found in petroleum. Alkenes are unsaturated hydrocarbon compounds found in petroleum. Results were reported on the basis of total ion counts summed for each of the mass peaks.

Soil gas survey results from the Petrex method are presented in Table 3.2. Results are shown for the mass peaks representative of BTEX and cycloalkanes and alkenes. Plots of the areal distribution of BTEX, and cycloalkanes and alkenes are shown in Figures 3.7 and 3.8, respectively. Contour lines are plotted for total ion counts of 300,000 and 3,000,000 per sample for BTEX and 30,000 and 300,000 for cycloalkanes and alkenes.

The Petrex method results were comparable to the conventional gas extraction results, with gasoline determined as the main subsurface contaminant. Contamination distributions for the two methods generally appear similar; however, the finer grid employed in the Petrex method survey produced better resolved contours. The two concentration centers near grid nodes 6E to 8E and 11F are shown as separate sources on the Petrex method plots, whereas the distribution between centers is less distinct with the coarser grid used in the conventional gas extraction survey.

The thermal desorption gas chromatography/mass spectrometry results were consistent with the thermal desorption mass spectrometry results. NERI originally also reported the presence of TCE and perchloroethylene (PCE) at substantial levels near grid node 11F. However, the subsequent analysis by gas chromatography/mass spectrometry failed to reveal chlorinated compounds in those samples. The failure to detect chlorinated compounds in the samples from the conventional gas extraction survey as well suggests that the observations were spurious. Apparently, the observations were associated with a hydrocarbon interference at the TCE and PCE mass regions. Consequently, those species have been dropped from Table 3.2 with NERI's concurrence. Appendix G contains the complete NERI report entitled *Final Report on the Findings of the Petrex Soil Gas Survey Performed at Eielson Air Force Base in Alaska*.

3.4.3 Survey Comparison and Conclusions

Soil gas results from the conventional gas extraction and Petrex method surveys were comparable for source area ST58. Both surveys identified gasoline as the main subsurface contaminant. Contamination distributions generally appeared similar with the highest concentrations centered near grid nodes 7E and 11F. The finer grid employed in the Petrex method survey produced better contour resolution. Separate sources are shown on the Petrex method plots, whereas the distribution between centers is less distinct because of the coarser grid used in the conventional gas extraction survey.

Table 3.2. Petrex Method Sampler Results

Sample Number	Grid Node	BTEX(1)	Cycloalkanes/ alkenes(2)	Sample Number	Grid Node	BTEX(1)	Cycloalkanes/ alkenes(2)
58PX01	1A	31,593	22,411	58PX26	4D	77,540	5,280
58PX02	1B	5,225	241	58PX27	4C	232,840	4,291
58PX03	1C	21,809	1,450	58PX28	4B	32,814	374
58PX04	1D	2,116,420	100,400	58PX29	4A	48,837	851
58PX05	1E			58PX30	5A	116,120	3,046
58PX06	1F	22,815	707	58PX31	5B	459,195	23,925
58PX07	1G	51,147	47,350	58PX32	5C	46,969	2,974
58PX08	2G			58PX33	5D	26,010	710
58PX09	2F	65,339	1,615	58PX34	5E	65,394	14,798
58PX10	2F(3)			58PX35	5F		
58PX11	2E	10,715	278	58PX36	5G	47,390	858
58PX12	2D	12,718	3,125	58PX37	6G	11,810	158
58PX13	2C	289,761	35,162	58PX38	6F	15,132	803
58PX14	2B	114,340	6,451	58PX39	6E	16,618,500	1,426,040
58PX15	2A	37,596	254	58PX40	6E(3)		
58PX16	3A	56,270	1,973	58PX41	6D	133,604	32,801
58PX17	3B	149,643	14,092	58PX42	6C	29,284	1,653
58PX18	3C	14,432	370	58PX43	6B	14,361	76
58PX19	3D	99,090	1,723	58PX44	6A	49,500	1,589
58PX20	3E	32,331	3,807	58PX45	7A	47,070	567
58PX21	3F	71,610	12,117	58PX46	7B	16,582	101
58PX22	3G	99,050	2,571	58PX47	7C	42,872	1,335
58PX23	4G	159,750	3,920	58PX48	7D	82,900	3,378
58PX24	4F	54,760	3,294	58PX49	7E	18,227,400	663,530
58PX25	4E	55,766	2,533	58PX50	7E(3)		

Notes:

(1) Total ion counts @ masses 78, 92, and 106.

(2) Total ion counts @ masses 84, 98, 112, and 126.

(3) Duplicate sampler.

Table 3.2. (cont'd)

Sample Number	Grid Node	BTEX(1)	Cycloalkanes/ alkenes(2)	Sample Number	Grid Node	BTEX(1)	Cycloalkanes/ alkenes(2)
58PX51	7F	37,191	1,326	58PX76	11B	16,243	7,809
58PX52	7G	29,132	397	58PX77	11C	15,847	119
58PX53	8G	18,638	427	58PX78	11D	40,110	3,424
58PX54	8F	47,695	1,855	58PX79	11E	179,500	5,218
58PX55	8E	2,271,200	2,387,600	58PX80	11F	14,912,900	912,170
58PX56	8E(3)			58PX81	11F(3)		
58PX57	8D	332,010	74,940	58PX82	11G	2,537,500	35,270
58PX58	8C	42,849	1,501	58PX83	12G	165,000	3,715
58PX59	8B	67,460	946	58PX84	12F	58,532	828
58PX60	8A	51,180	1,864	58PX85	12E	27,071	162
58PX61	9A	106,000	4,932	58PX86	12D	47,020	8,592
58PX62	9B	34,180	427	58PX87	12C	217,050	166,140
58PX63	9C	135,620	10,429	58PX88	12B	605,370	41,122
58PX64	9D	12,182	293	58PX89	12A	118,925	16,009
58PX65	9E	104,350	2,134	58PX90	13A	104,239	2,628
58PX66	9F	126,512	20,389	58PX91	13B	38,512	265
58PX67	9G	21,205	4,303	58PX92	13C	290,080	8,463
58PX68	10G	989,090	58,940	58PX93	13D	71,820	1,396
58PX69	10F	30,560	902	58PX94	13E	59,400	2,116
58PX70	10E	77,140	1,464	58PX95	13F	103,400	4,687
58PX71	10D	48,876	62,590	58PX96	13F(3)		
58PX72	10C	24,793	981	58PX97	13G	144,810	2,381
58PX73	10B	31,924	1,481	58PX98	Blank		
58PX74	10A	376,850	79,648	58PX99	Blank		
58PX75	11A	120,350	2,985	58PX100	Blank		

Notes:

(1) Total ion counts @ masses 78, 92, and 106.

(2) Total ion counts @ masses 84, 98, 112, and 126.

(3) Duplicate sampler.

S9403063.27

Figure 3.7. Petrex Method Results for Benzene, Toluene, Ethylbenzene, and Xylene in Soil Gas

S9309058.1a

Figure 3.8. Petrex Method Results for Cycloalkanes and Alkenes in Soil Gas

The conventional gas extraction survey provided rapid results with the onsite laboratory but was labor intensive for probe insertion and sample analysis. Two operators were typically required to provide enough force for full penetration of the soils. The Petrex method survey proved to be less labor intensive but had a longer turnaround time for analytical results. Results took approximately 1 to 2 weeks longer to process but were still available before soil excavation. TCE and PCE were initially identified as contaminants by the Petrex method, though this is not surprising in view of the complexity of fuel mixtures. The use of gas chromatography and mass spectrometry by NERI was effective in resolving this problem and is a routine procedure for such cases.

Costs between the two methods were essentially equal. Major costs associated with conventional gas extraction were sample probes, mobilization and demobilization of field and laboratory personnel and equipment, and air compressor rental. Costs related to the Petrex method included samplers, auger rental, mobilization and demobilization of field personnel, and NERI analysis.

Overall, the two soil gas surveys were useful in producing high quality remote mapping of subsurface gasoline contamination. Conventional gas extraction provides a "snapshot" of the subsurface contamination whereas the Petrex method integrates contaminant concentrations over time, minimizing barometric effects. Both methods appear appropriate for other shallow applications in unconsolidated materials where contamination is known to exist.

3.5 Test Pit Soil Sampling

The contaminant types, concentrations, and distributions depicted at source area ST58 by the soil gas surveys were further evaluated through soil sampling and analysis. Soil samples were collected from 17 test pits (Figure 3.9) using a backhoe provided and operated by AFB personnel. Eight test pits (58TP01 through 58TP08) were selected based on the grid nodes with the highest contamination; five (58TP09 through 58TP13) were chosen from nodes with moderate contamination; and four (58TP14 through 58TP17) were peripheral to the areas of high and moderate contamination (Table 3.3). Three soil samples, A, B, and C, were collected from each test pit, approximately 0.5, 4 to 5.5, and 9 to 10 ft below land surface (bls), respectively. The samples were analyzed for VOCs, TPH-G, and TPH-D on a rapid turnaround basis, and for lead on a normal turnaround basis. Head space analyses were performed in the field at each sample interval using the Microtip PID and mapped as sampling progressed. Excess soils were stockpiled adjacent to each test pit and placed back in the excavations after sampling.

Soils in the test pits were relatively similar across the site. Figure 3.10 shows the typical soil profile with approximate unit thicknesses from land surface to a depth of 10 ft. The site is covered with 1 ft of topsoil. A lack of surface vegetation was observed at grid node 11F. Slightly moist, brown to gray, sandy gravels were noted between 1 and 3 ft bls with brown, moist, gravelly sands from 3 to 5 ft bls. A former soil horizon occurs at 5 to 6 ft bls, confirming that the site was covered with approximately 3 to 4 ft of fill. The former soil horizon contains organic matter, wood, and roots,

S9309058.4

Figure 3.9. Test Pit Soil Sample Locations

Table 3.3. Test Pit Selection Criteria

Sample Number	Grid Node	Selection Criteria
58TP01	6E	High Contamination
58TP02	7C	High Contamination
58TP03	7D	High Contamination
58TP04	7E	High Contamination
58TP05	8E	High Contamination
58TP06	9F	High Contamination
58TP07	10F	High Contamination
58TP08	11F	High Contamination
58TP09	5D	Moderate Contamination
58TP10	6F	Moderate Contamination
58TP11	9E	Moderate Contamination
58TP12	9G	Moderate Contamination
58TP13	10G	Moderate Contamination
58TP14	7B	Peripheral to High and/or Moderate Contamination
58TP15	7F	Peripheral to High and/or Moderate Contamination
58TP16	12F	Peripheral to High and/or Moderate Contamination
58TP17	4E	Peripheral to High and/or Moderate Contamination

and probably represents the land surface during operation of the old Quartermaster service station. Underlying the former soil horizon is 2 ft of orange to brown, clayey silt, mixed with gray sand, silt, and clay, which is underlain by 2 ft of gravelly sand. A large amount of debris, including culvert pipes, cables, rebar, and steel pipes, were found during test pit excavation. Odors were noted in test pits 58TP04 (grid node 7E) and 58TP09 (grid node 5D). Purple- and yellow-stained soil, indicative of sand blasting and painting, was observed in test pit 58TP13 (grid node 10G). Ground water occurs at approximately 10 ft bls.

Results from the head space and soil sample analyses at source Area ST58 are given in Table 3.4. Figures 3.11 and 3.12 show benzene concentrations for samples from the 4- to 5.5- and 9- to 10-ft depths. TPH-G distribution for the 4- to 5.5-ft interval is presented in Figure 3.13. Table 3.5 contains the concentration ranges and the grid nodes with the highest contamination.

The test pit soil sample results generally support the contaminant distributions interpreted from the soil gas surveys. Good spatial correlation was also achieved between the head space and soil sample analyses. Significant concentrations of BTEX and TPH-G were found in the soils, confirming gasoline as the main subsurface contaminant. The most contaminated soils were found in the northcentral part of the source area at the 4- to 5.5- and 9- to 10-ft sampling intervals. Typically, the contamination

S9406010.11

Figure 3.10. Typical Soil Profile

occurred near or below the former soil horizon in the clayey silt and gravelly sand, suggesting surface spills contributed to the contamination present. Benzene concentrations ranged from < 10 to $> 90,137$ micrograms per kilogram ($\mu\text{g/kg}$) from 4 to 5.5 ft, with the highest concentrations in test pits 58TP05 (grid node 8E) and 58TP04 (grid node 7E). The highest benzene concentrations at the 9- to 10-ft interval were from samples in test pits 58TP03 and 58TP05 (grid nodes 7D and 8E, respectively). Concentrations in these test pits are significantly higher than the EPA suggested cleanup level of $500 \mu\text{g/kg}$. High concentrations of toluene, ethylbenzene, and total xylenes were also found in these test pits and test pit 58TP01 (grid node 6E) at both sampling depths. Significantly lower BTEX concentrations were found in the 0.5-ft. samples. No chlorinated hydrocarbons were detected in any of the samples.

Table 3.4. Test Pit Soil Sampling Results

Sample Number	Grid Node	Depth (ft)	PID (PPMv)	Benzene (ug/kg)	Toluene (ug/kg)	Ethylbenzene (ug/kg)	Total Xylenes (ug/kg)	TPH-G (mg/kg)	TPH-D (mg/kg)	Lead (mg/kg)	Comments
58TP01A	6E	0.5	0	18	97	<10	104	<30	<50	5	
58TP01B	6E	5	345	105	606	95	>5,579	66	<50	10	
58TP01C	6E	9	315	407	3,231	2,984	>13,339	686	102		Culvert pipe, cable @ 5' bls
58TP02A	7C	0.5	0	<10	23	15	91	<30	<50	9	Tree roots @ 5' bls
58TP02B	7C	5	0	16	65	<10	152	<30	<50	8	
58TP02C	7C	10	0	<10	25	<10	211	<30	<50	4	1" pipe @ 2' bls
58TP03A	7D	0.5	0	55	98	<10	<25	<30	<50	9	
58TP03B	7D	5	40	158	573	39	2,516	26	<50	9	
58TP03C	7D	9.5	>2500	10,101	>68,600	32,542	>147,776	1,953	560	14	Rebar @ 6' bls
58TP04A	7E	0.5	0	45	68	137	>985	<30	<50	25	
58TP04B	7E	5	1,709	>61,714	>78,638	>65,858	>148,554	19,916	<50	4	Roots @ 5' bls
58TP04C	7E	10	479	596	1,798	393	3,303	51	<50	2	Odors @ 6' bls
58TP05A	8E	0.5	0	52	148	10	195	<30	<50	6	
58TP05B	8E	5	1,596	>90,137	>124,186	>105,526	>244,833	19,902	<50	3	Roots, wood @ 6' bls
58TP05C	8E	10	635	3,143	4,862	1,102	5,649	179	<50	3	
58TP06A	9F	0.5	0	<10	<10	<10	34	<30	<50	11	
58TP06B	9F	5	0	100	<10	14	55	<30	<50	3	Tree roots, wood @ 5' bls
58TP06C	9F	10	0	100	<10	14	<30	<30	<50	3	
58TP07A	10F	0.5	0	<10	<10	<10	<23	<30	<50	5	
58TP07B	10F	5.5	0	22	<10	<10	<20	<30	<50	3	Roots @ 5' bls
58TP07C	10F	10	0	12	<10	<10	<27	<30	<50	2	
58TP08A	11F	0.5	0	<10	<10	<10	57	<30	<50	8	
58TP08B	11F	5	0	<10	<10	<10	<24	<30	<50	3	Roots, wood @ 5' bls
58TP08C	11F	10	0	<10	<10	<10	<20	<30	<50	2	
58TP09A	5D	0.5	0	<10	15	<10	<24	<30	<50	25	
58TP09B	5D	5	0	<10	<10	<10	<22	<30	<50	10	6 4-5" steel pipe @ 27" bls
58TP09C	5D	10	280	36	38	46	193	<30	1,750	2	Odor @ 8' bls

Note:

(1) NA = Constituent was not analyzed.

Table 3.4. (cont'd)

Sample Number	Grid Node	Depth (ft)	PID (PPMv)	Benzene (ug/kg)	Toluene (ug/kg)	Ethylbenzene (ug/kg)	Total Xylenes (ug/kg)	TPH-G (mg/kg)	TPH-D (mg/kg)	Lead (mg/kg)	Comments
58TP10A	6F	0.5	0	NA	NA	NA	NA	<30	<50	10	
58TP10B	6F	5	455	NA	NA	NA	NA	25	<50	3	0.5" copper cable @ 3' bls
58TP10C	6F	10	40	NA	NA	NA	NA	<30	<50	1	Wood @ 4' bls, strong odor
58TP11A	9E	0.5	0	<10	<10	<10	<20	<30	<50	3	
58TP11B	9E	5.5	45	132	<10	24	<41	<30	<50	2	Roots @ 5' bls
58TP11C	9E	10	33	23	<10	<10	<20	<30	<50	2	
58TP12A	9G	0.5	0	<10	<10	<10	<20	<30	<50	6	
58TP12B	9G	5	95	<10	<10	38	<35	<30	<50	3	
58TP12C	9G	9	55	<10	<10	26	<20	<30	<50	3	
58TP13A	10G	0.5	0	<10	<10	<10	<20	NA	NA	299	
58TP13B	10G	4.5	4	<10	<10	<10	<20	<30	<50	4	Purple/yellow sediment @ 1' bls
58TP13C	10G	10	0	<10	<10	<10	<20	<30	<50	2	Roots, wood @ 3' bls
58TP14A	7B	0.5	0	<10	<10	<10	<20	NA	NA	4	
58TP14B	7B	4	0	10	<10	10	53	<30	<50	8	4" steel pipe @ 3.5' bls
58TP14C	7B	10	0	<10	<10	<10	<31	<30	<50	3	Flanged culvert pipe @ 3.5' bls
58TP15A	7F	0.5	0	<10	20	<10	<21	<30	<50	<0.85	
58TP15AD	7F	0.5	0	<10	20	<10	<28	<30	<50	1	Duplicate sample
58TP15B	7F	5	90	>580	<10	45	<61	<30	<50	4	Roots @ 5' bls
58TP15BD	7F	5	90	>580	<10	37	<57	<30	<50	3	Duplicate sample
58TP15C	7F	10	0	257	<10	18	<20	<30	<50	2	
58TP15CD	7F	10	0	205	<10	15	<21	<30	<50	2	Duplicate sample
58TP16A	12F	0.5	0	<10	22	<10	54	NA	NA	296	
58TP16B	12F	5	0	<10	<10	<10	<20	<30	<50	3	
58TP16C	12F	9	0	<10	<10	<10	<20	<30	<50	1	Roots, wood @ 6' bls
58TP17A	4E	0.5	0	<10	<10	<10	<20	NA	NA	4	
58TP17B	4E	5	0	>389	44	131	259	<30	<50	5	Wood, roots @ 5' bls
58TP17C	4E	10	1	22	<10	<10	<20	<30	<50	2	

Note:

(1) NA = Constituent was not analyzed.

S9305032.12bxyz

Figure 3.11. Benzene Concentrations in Soil, 4 to 5.5 ft bls

S9305032.12axyz

Figure 3.12. Benzene Concentrations in Soil, 9 to 10 ft bls

S9305032.12cxyz

Figure 3.13. Total Petroleum Hydrocarbons - Gasoline Concentrations in Soil, 4 to 5.5 ft bls

Table 3.5. Test Pit Soil Sampling Summary

Contaminant	Depth	Concentration Range	Units	Highest Grid Nodes
PID	A	0	PPMv	NA
PID	B	0 - 1709	PPMv	7E, 8E
PID	C	0 - >2500	PPMv	7D
Benzene	A	<10 - 55	ug/kg	7D, 8E, 7E
Benzene	B	<10 - >90,137	ug/kg	8E, 7E
Benzene	C	<10 - 10,101	ug/kg	7D, 8E
Toluene	A	<10 - 148	ug/kg	8E, 7D, 6E
Toluene	B	<10 - >124,186	ug/kg	8E, 7E
Toluene	C	<10 - >68,600	ug/kg	7D, 8E, 6E, 7E
Ethylbenzene	A	<10 - 137	ug/kg	7E
Ethylbenzene	B	<10 - 105,526	ug/kg	8E, 7E
Ethylbenzene	C	<10 - 32,542	ug/kg	7D, 6E, 8E
Total Xylenes	A	<20 - >985	ug/kg	7E, 8E
Total Xylenes	B	<20 - >244,833	ug/kg	8E, 7E
Total Xylenes	C	<20 - >147,776	ug/kg	7D, 6E
TPH-G	A	<30	mg/kg	NA
TPH-G	B	<30 - 19,916	mg/kg	7E, 8E
TPH-G	C	<30 - 1953	mg/kg	7D, 6E
TPH-D	A	<50	mg/kg	NA
TPH-D	B	<50	mg/kg	NA
TPH-D	C	<50 - 1750	mg/kg	5D, 7D
Lead	A	<0.85 - 299	mg/kg	10G, 12F
Lead	B	2 - 10	mg/kg	NA
Lead	C	1 - 14	mg/kg	NA
Note:				
(1) NA = Not applicable.				

TPH-G concentrations for the 4- to 5.5-ft. samples were as much as 19,916 milligrams per kilogram (mg/kg) or approximately 2% by weight in test pits 58TP04 (grid node 7E) and 58TP05 (grid node 8E). The EPA suggested cleanup level for TPH-G in soil is 1000 mg/kg. Concentrations were at or near the detection limit of 30 mg/kg at this depth in the remaining test pits. TPH-G concentrations ranged from <30 to 1953 mg/kg in the 9- to 10-ft samples with the highest concentration in test pit 58TPO3 (grid node 7D). All of the 0.5-ft sample were below detection.

Of note, BTEX and TPH-G concentrations were near or below the detection limits for all three sampling intervals in test pit 58TP08 (grid node 11F). The high subsurface concentrations of gasoline detected during the soil gas surveys probably reflect ground-water contamination and/or possibly floating product.

TPH-D concentrations were below the 50 mg/kg detection limit in all test pits at both the 0.5- and 4 to 5.5-ft. sample intervals. All but three of the 9-to 10-ft samples were below detection. Test pit 58TPO9 (grid node 5D), which is located near the former diesel AST, had the highest TPH-D concentration at 1750 mg/kg. The suggested EPA cleanup level for TPH-D in soil is 200 mg/kg.

Results from the lead analyses were significantly below the suggested EPA cleanup range of 500 to 1000 mg/kg. The 0.5-ft samples from test pits 58TP13 (grid node 10G) and 58TP16 (grid node 12F) contained the highest concentrations at 299 and 296 mg/kg, respectively. This contamination is probably an artifact of the paint-stained soil noted earlier. The source of lead contamination in the ground water at source area ST58 cannot be determined from the available data. It may be the result of leaded gasoline having leaked from the underground piping.

4.0 Soil Excavation and Backfilling

Soil excavation and backfilling at source area ST58 were performed by EA and AFB personnel under the guidance of PNL. Excavation was based on the results of the surface geophysical and soil gas surveys and test pit soil sampling. The objective was to excavate approximately 500 yd³ of the most contaminated soil for use in composting treatability studies.

Concentration ranges and corresponding grid nodes with the highest contamination were summarized in Table 3.5. Grid nodes 7D, 7E, 8E, and 6E were clearly identified as "hot spots" of gasoline contamination based on the BTEX and TPH-G analyses. A 90- by 40-ft rectangular excavation area, centering on node 7E, was marked with blue flags (Figure 4.1). The strategy was to remove the uppermost 3 ft of overburden and excavate contaminated soils from approximately 3 to 8 ft bls, below the former soil horizon.

Excavation commenced at grid node 7E and worked outward using a John Deere® 690B trackhoe, which provided greater maneuverability. Soils were segregated as clean (green), moderately contaminated (yellow), or highly contaminated (red) based on head space analyses with the MicroTip PID. Clean soils were designated by EA as <70 PPMv, moderately contaminated soils were 70 to 800 PPMv, and highly contaminated soils were >800 PPMv. The moderately and highly contaminated soils were transported to the soil composting demonstration site by three 10-yd³ dump trucks. Clean soils were stockpiled at the southwestern corner of source area ST58 for backfilling. Buried debris were stockpiled for disposal by EA.

Soil excavation results are shown in Table 4.1. Approximately 700 yd³ of soil were removed during excavation of the northcentral portion of source area ST58. Of the soil excavated, approximately 600 yd³ were moderately or highly contaminated and transported to the soil composting demonstration site. The most contaminated soils were found adjacent to and beneath a 4-in. steel pipe, approximately 3 ft bls near grid nodes 7D, 6E, 5F, 5E, and 5D. As depicted in the EMI survey (Figure 3.2), the piping ran southwest to northeast. The piping was also partially exposed during excavation of test pits 58TP01 and 58TP09 (Figure 3.9 and Table 3.4). Strong odors and fumes emanated from the soils surrounding the piping, and the piping was corroded. The condition of the piping and the highly contaminated soils suggest leaks occurred as a result of discontinuities and/or breaks in the underground piping (Figure 4.2). Excavation proceeded along the pipe trace, exposing approximately 30 ft of piping, from grid nodes 7D to 6E and 6E to 5D. Wood, cables, railroad ties, a railroad iron, and conduit were also found in the excavation. Ground water was evident at approximately 10 ft bls and probably became contaminated through dissolution of the gasoline.

Excavation ceased after a sufficient volume of soils were transported to the soil composting demonstration site, as determined by EA. However, a significant amount of contaminated soil likely remains at source area ST58. Backfilling was performed after PNL demobilization. Backfill materials included stockpiled soils at the southwestern corner of the site and soils from an unidentified source. The clean backfill soils probably will become contaminated over time, given the residual contamination present. A remedial investigation/feasibility study will likely be required for source area ST58. A remedial investigation/feasibility study will likely be required for source area ST58.

® John Deere is a registered trademark of Deere and Company, Moline, Illinois.

S9406010.10

Figure 4.1. Flagged Soil Excavation Area

Table 4.1. Soil Excavation Results

Date	Depth (ft)	Grid Node	Reading (PPMv)	Time (hrs)	Color Segregation	Total Num. of Loads		
24-Jun-93	0 - 2	7F - 7D	0	0830	Green	5		
	0 - 2	7F - 7D	33	0855	Green			
	2 - 3.5	7E - 7D	107	0920	Yellow	15		
	2 - 3.5	7E - 7D	219	0935	Yellow			
	2 - 3.5	7E - 7D	310	0935	Yellow			
	2 - 3.5	7E - 7D	697	0940	Yellow			
	3.5 - 5	7E - 7D	100	1000	Yellow			
	3.5 - 5	7E - 7D	98	1010	Yellow			
	3.5 - 5	7E - 7D	510	1017	Yellow			
	5 - 8	7D - 8D	78	1035	Yellow			
	5 - 8	7D - 8D	80	1045	Yellow			
	5 - 8	7D - 8D	35	1053	Yellow			
	5 - 8	7D - 8D	80	1101	Yellow			
	5 - 8	8D - 8F	10	1125	Yellow			
	5 - 8	8D - 8F	72	1146	Yellow			
	0 - 2	7F - 6F	0	1246	Green	5		
	0 - 2	7F - 6F	0	1308	Green			
	2 - 7	7E - 6E	74	1320	Yellow	10		
	2 - 7	7E - 7F	NR	1400	Yellow			
	10	7F - 6F	NR	1435	Yellow			
	7 - 10	6E	500	1450	Yellow			
	5 - 8	7D - 6D	>2500	1516	Red	10		
	8 - 10	7D - 6D	>2500	1523	Red			
	8 - 10	7D - 6E	>2500	1532	Red			
	0 - 5	7D - 6E	1900	1600	Red			
	5 - 7	7D - 6D	>2500	1622	Red			
25-Jun-93	5 - 8	6E	>2500	0835	Red	25		
	8 - 10	6E	>2500	0852	Red			
	5 - 8	6E - 6D	850	0904	Red			
	5 - 8	6E	>2500	0916	Red			
	8 - 10	6E	1906	0929	Red			
	8 - 10	6E	1280	0947	Red			
	5 - 9	6E - 5F	>2500	1041	Red			
	5 - 9	6E - 5F	>2500	1059	Red			
	8 - 10	6E - 5F	>2500	1106	Red			
	8 - 10	6E - 5F	2082	1128	Red			
	8 - 10	6E - 5F	2208	1150	Red			
	4 - 5	6E - 5F	800	1203	Red			
	3 - 7	5F - 5E	1180	1300	Red			
	8 - 10	5F - 5E	1533	1320	Red			
	3 - 7	5F - 5E	2100	1347	Red			
	8 - 10	5F - 5E	1603	1400	Red			
	Note:							
	(1) NR = No reading, monitoring instruments malfunctioned.

Figure 4.2. Soil Excavation Area and Underground Piping

5.0 Conclusions

The conclusions from the work at source area ST58 are as follows.

1. EMI survey results corresponded very well to the AST piping locations indicated on the unscaled drawings and radiodetection unit survey. Signatures interpreted as AST piping were confirmed during test pit soil sampling and soil excavation. Survey results further indicated a significant amount of other buried material; this was also confirmed.
2. The radiodetection unit survey delineated the two main fuel feeder pipes entering the source area. In general, the signal was attenuated and became difficult to detect with increased distance and branching from the transmitter, probably as a result of discontinuities and/or breaks in the piping.
3. Soil gas results for the conventional gas extraction survey indicated close spatial correlation between field PID readings and gas chromatography analysis. Two locations containing high subsurface concentrations of gasoline were identified in the northcentral and northwestern parts of the source area. The high concentrations coincided with the unscaled drawings, April 1993 benzene concentrations in ground water, and EMI survey results. No other unusual compounds were detected.
4. The Petrex method results were comparable to the conventional gas extraction results, with gasoline determined as the main subsurface contaminant. Contaminant distributions for the two soil gas surveys appeared similar; however, the finer grid employed in the Petrex method produced better resolved contours. The two concentration centers were depicted as separate sources. Apparent TCE and PCE observations were associated with a hydrocarbon interference at those mass regions.
5. The two soil gas surveys produced high quality remote mapping of subsurface gasoline contamination. Both methods appear appropriate for other shallow applications in unconsolidated materials where contamination is known to exist.
6. Soils in the test pits were relatively similar across the site. A former soil horizon occurs at 5 to 6 ft bls, confirming that the site was covered with approximately 3 to 4 ft of fill. The former soil horizon contains organic matter, wood, and roots, and probably represents the land surface during operation of the old Quartermaster service station.
7. The test pit soil sample results generally support the contaminant distributions interpreted from the soil gas surveys. Good spatial correlation was also achieved between the head space and soil sample analyses. Significant concentrations of BTEX and TPH-G were found in the soils, confirming gasoline as the main subsurface contaminant. The most contaminated soils were found in the northcentral part of the source area at the 4- to 5.5- and 9- to 10-ft sampling intervals. Typically, the contamination occurred near or below the former soil horizon in the clayey silt and gravelly sand, suggesting surface spills contributed to the contamination present.

8. The high subsurface concentrations of gasoline detected in the northwestern corner of the source area during the soil gas surveys probably reflect ground-water contamination and/or possibly floating product.
9. Results from the lead analyses were significantly below the suggested EPA cleanup range. The contamination present is probably an artifact of paint-stained soil.
10. The source of lead contamination in the ground water cannot be determined from the available data. It may be the result of leaded gasoline having leaked from the underground piping.
11. Approximately 700 yd³ of soil were removed during excavation of the northcentral portion of source area ST58. Of those, approximately 600 yd³ were moderately or highly contaminated and transported to the soil composting demonstration site. The most contaminated soils were found adjacent to and beneath a 4-in. steel pipe, approximately 3 ft bls.
12. The condition of the piping and the highly contaminated soils suggests leaks occurred as a result of discontinuities and/or breaks in the underground piping.
13. Ground water was evident in the excavation at approximately 10 ft bls and probably became contaminated through dissolution of the gasoline.
14. A significant amount of contaminated soil likely remains at source area ST58. The clean backfill soils probably will become contaminated over time, given the residual contamination present.
15. A remedial investigation/feasibility study will likely be required for source area ST58.

6.0 References

Shannon and Wilson, Inc. 1991. *Geotechnical Investigation and Foundation Study Squadron Operations Facility Air National Guard Eielson Air Force Base, Alaska*. Shannon and Wilson, Inc. Fairbanks, Alaska.

Shannon and Wilson, Inc. 1992. *Geotechnical Investigation and Foundation Study Vehicle Maintenance Facility Air National Guard Eielson Air Force Base, Alaska*. Shannon and Wilson, Inc. Fairbanks, Alaska.

U.S. Environmental Protection Agency. 1986. *Test Methods for Evaluating Solid Waste Physical/Chemical Methods*. SW-846, Third Edition, U.S. Environmental Protection Agency, Washington, D.C.

U.S. Environmental Protection Agency, Alaska Department of Environmental Conservation, and U.S. Air Force. 1990. *Federal Facility Agreement Under CERCLA Section 120*.

Appendix A

Source Area Characterization Plan

**SOURCE AREA CHARACTERIZATION PLAN
SOURCE AREA ST58
OLD QUARTERMASTER SERVICE STATION**

May 1993

**Prepared for
Eielson Air Force Base
Fairbanks, Alaska**

**Prepared by
Battelle
Pacific Northwest Laboratories
Richland, Washington**

CONTENTS

	Page
PURPOSE	1
SOURCE AREA DESCRIPTION	1
OBJECTIVES	1
TASKS	3
ASSUMPTIONS, CONDITIONS, AND DEFINITIONS	3
RECORDS SEARCH	5
FIELD INVESTIGATION	5
Surface Geophysical Surveys	5
Soil Gas Surveys	6
Contaminant Types, Concentrations, and Distributions	7
SOIL EXCAVATION	7
Residual Product, AST Piping, and Free Product Removal and Disposal	7
SITE RESTORATION	7
EQUIPMENT DECONTAMINATION	7
SAMPLE ANALYSIS PROTOCOL	8
Sample Delivery, Holding, and Storage	8
Sample Analysis	8
Sample Disposal	9
Quality Assurance and Control	9
Period of Performance	10
Reporting Requirements	10
REPORTING	10
HEALTH AND SAFETY	11
DELIVERABLES	11

	Page
SCHEDULE	11

FIGURES

Figure		Page
1.	Source Area ST58	2

TABLES

Table		Page
1.	Division of Work Between PNL, EA, and Eielson AFB	4
2.	Sample Analysis Matrix for Source Area ST58	9

**SOURCE AREA CHARACTERIZATION PLAN
SOURCE AREA ST58
OLD QUARTERMASTER SERVICE STATION**

PURPOSE

The purpose of this work is for Battelle Pacific Northwest Laboratories (PNL) to assist Eielson Air Force Base (AFB) in the characterization of Source Evaluation Report (SER) source area ST58, the old Quartermaster service station. The work will require a field investigation to determine the nature and extent of soil and ground-water contamination present, excavation of those soils with the highest contamination, and site restoration. The field investigation will be coordinated with the PNL soil composting demonstration for remediation of hydrocarbon contamination.

SOURCE AREA DESCRIPTION

Source area ST58 is the site of the old Quartermaster service station. It is located on the northwest corner at the intersection of Division Street and Wabash Avenue (Figure 1). The service station covered approximately 1 acre (135 by 300 feet). The site is currently a flat, grassy field.

The service station was operated from 1970 to 1988. The station utilized four 25,000 gallon above ground storage tanks (ASTs), containing motor gasoline (MOGAS) and diesel. Both leaded and unleaded MOGAS were used. Blueprints show an isopropyl alcohol AST; Eielson AFB records indicate only MOGAS was stored in this tank. The ASTs and above ground piping were removed in August 1988; the underground piping was left in place.

No known spills have occurred at source area ST58. No service station maintenance records, observations during AST removal, or closure files are available. Geotechnical investigations conducted in November 1991 and February 1992 indicate the presence of benzene contamination in ground water immediately downgradient of source area ST58 (Figure 1). Concentrations above the maximum contaminant level (MCL) of 5 ug/L range from 5.4 to 145 ug/L. The MCL was exceeded in four wells, 58MW03, 58MW04, 58MW05, and 58MW08. Benzene concentrations in the remaining wells were all below detection. No chemical analyses were performed on the soils.

OBJECTIVES

The objectives of the work at source area ST58 are to:

- determine the contaminant types, concentrations, and distributions in the soil and ground water resulting from source area ST58
- excavate approximately 500 cubic yards of the most contaminated soil and transport it to the soil composting demonstration for remediation of hydrocarbon contamination

Figure 1. Source Area ST58.

- backfill the excavation and restore the site to pre-work conditions.

TASKS

The work at source area ST58 will include the tasks listed below. The work will be performed by PNL, EA Engineering, Science, and Technology (EA), and Eielson AFB. Table 1 shows the division of work between PNL, EA, and Eielson AFB.

- determine the nature and location of any AST piping, leaks, and/or spills through a records search
- survey the grid nodes for the geophysical and soil gas surveys
- further identify the location of the AST piping using surface geophysical surveys
- further estimate the contaminant types, concentrations, and distributions using soil gas surveys
- confirm the contaminant types, concentrations, and distributions through test pit soil sampling and analysis
- excavate approximately 500 cubic yards of the most contaminated soil and transport it to the soil composting demonstration
- remove and dispose of any residual product from the AST piping
- remove and dispose of the AST piping from the excavation
- backfill the excavation with clean soil and restore the site to pre-work conditions.

ASSUMPTIONS, CONDITIONS, AND DEFINITIONS

The work at source area ST58 will be performed under the following assumptions and conditions:

- access around utilities or other restrictions will be coordinated with Eielson AFB by means of a Base Civil Engineering Work Clearance Request; the work clearance request will be completed by EA and posted in the field
- traffic/pedestrian controls will be coordinated with Eielson AFB

Table 1. Division of Work Between PNL, EA, and Eielson AFB.	
PNL	Perform Records Search
	Grid Surface Geophysical Surveys
	Grid, Perform, and Interpret Soil Gas and Petrex Surveys
	Perform Test Pit Soil Sampling
	Recommend Soil Excavation Area
	Perform Laboratory Analyses*
	Complete and Submit Technical Report
EA	Operate Backhoe and Dump Truck for Soil Excavation
	Perform Residual Product, AST Piping, and Free Product Removal and Disposal
Eielson AFB	Perform Location Surveying
	Perform and Interpret Surface Geophysical Surveys
	Operate Backhoe for Test Pit Soil Sampling
	Perform Site Restoration
* Petrex Method Samplers to be Analyzed by Manufacturer	

- field screening will be used during the field investigation and soil excavation; field screening pertains to the use of monitoring instruments [ie., flame ionization detector (FID), photoionization detector (PID), colorimetric tube, and/or explosimeter] to help determine health and safety precautions, monitor potential exposures, and identify contaminant sources.
- work will be performed in level D personal protective equipment (PPE); level C PPE will be used if concentrations in the breathing space with the monitoring instrument exceed background concentrations by 10 parts per million (ppm) for 5 minutes
- soil will be considered contaminated if a head space analysis with the monitoring instrument indicates greater than 10 ppm volatile organic compounds (VOC)
- a head space analysis pertains to holding the sample inlet of the monitoring instrument in a plastic bag filled with a soil sample and taking an instrument reading
- a backhoe will be used for the test pit soil sampling; the backhoe will be decontaminated using a high pressure washer before and after sampling
- the high pressure washer and site will be provided by Eielson AFB
- test pit soil sampling equipment will be new or decontaminated using soap and water scrub with distilled water rinse before each sample is collected
- decontamination water used for the test pit soil sampling equipment will be contained, treated, sampled, and analyzed before discharge to the Eielson AFB sanitary sewer system

- treated water will be discharged to the Eielson AFB sanitary sewer system when sample analyses are less than 10 parts per billion (ppb) total benzene, toluene, ethylbenzene, and xylene (BTEX) and 5 ppb benzene
- sample analyses will be performed using Environmental Protection Agency (EPA) or equivalent procedures; analyses will be performed on a rapid turnaround basis
- a backhoe and dump truck will be used for the soil excavation; the backhoe and dump truck will be decontaminated using the high pressure washer before and after excavation
- backfill soils to be used for the site restoration will be provided by Eielson AFB.

RECORDS SEARCH

A search will be conducted to locate service station as-built drawings, maintenance records, and closure files for source area ST58. This information will be used to help identify the location of the ASTs and associated piping, determine if any leaks and/or spills were documented, and guide the field investigation, soil excavation, and site restoration. Suspected locations of the AST piping, leaks, and/or spills will be staked in the field.

FIELD INVESTIGATION

Surface Geophysical Surveys

Magnetometer and if necessary, ground penetrating radar (GPR) surveys will be performed to supplement the records search in identifying the location of the AST piping. These surveys are useful in locating buried objects. The magnetometer measures the strength of the earth's magnetic field and buried metal objects will appear as magnetic anomalies. GPR pulses are reflected back to the surface when an interface such as a buried object is encountered.

A grid encompassing the suspected piping location will be determined and set up in the field. Magnetometer measurements will be taken at each node within the grid and mapped in the field. The GPR survey will be run along the grid lines to provide continuous digital and analog readouts. Initial results may be used to optimize additional measurements and runs.

In the event existing records are insufficient, a 150 by 300-foot grid with 25-foot nodes will be set up, with the 150-foot axis parallel to Wabash Avenue. Magnetometer measurements will be taken at each node for a total of 91 measurements. The GPR survey will be run along the grid lines for a total of 20 runs. Initial results may be used to optimize additional measurements and runs.

Suspected AST piping locations will be staked based on the results of the surface geophysical surveys to optimize residual product and AST piping removal. Grid node locations will be surveyed for mapping and reporting. The need for a GPR survey will be determined in the field by the PNL Field Team Leader.

Soil Gas Surveys

Conventional gas extraction and the passive Petrex method will be used to supplement the records search in estimating the contaminant types, concentrations, and distributions resulting from source area ST58. These surveys are useful in measuring VOC present in the vadose zone or ground water. Conventional gas extraction involves physically removing a gas sample from the vadose zone. The passive Petrex method involves burying absorbent material in the vadose zone and physically sorbing the VOC present.

A grid encompassing the suspected contaminant locations will be determined and set up in the field. Conventional gas extraction probes will be installed at each node within the grid at a depth of approximately 4 feet with an air hammer. The probes will be allowed to equilibrate overnight. Samples will be drawn using a vacuum pump and analyzed for VOC on a rapid turnaround basis. Duplicate samples will be drawn at approximately 5 percent of the nodes. Initial results may be used to optimize additional sampling.

The Petrex method samplers will be installed adjacent to each conventional gas extraction probe within the grid at a depth of approximately 18 inches with a tractor mounted auger. Duplicate samplers will be installed at approximately 5 percent of the nodes. The samplers will be left in the ground for approximately 1 week. Following retrieval, the samplers will be placed in sealed tubes and sent to the manufacturer for VOC analysis.

A direct comparison will be made between the conventional gas extraction and Petrex method results.

In the event existing records are insufficient, the 150 by 300-foot grid used for the surface geophysical surveys will also be used for the soil gas surveys. Conventional gas extraction probes will be installed at 50-foot nodes within the grid for a total of 28 probes. Duplicate samples will be drawn at approximately 5 percent of the nodes. The Petrex method samplers will be installed at 25-foot nodes within the grid for a total of 91 samplers. Duplicate samplers will be installed at approximately 5 percent of the nodes. Initial results may be used to optimize additional sampling.

Estimated contaminant locations will be staked based on the results of the soil gas surveys to optimize residual product removal and soil excavation. Grid node locations will be surveyed for mapping and reporting.

Contaminant Types, Concentrations, and Distributions

The contaminant types, concentrations, and distributions resulting from source area ST58 will be confirmed through soil sampling and analysis. Soil samples will be collected from 15 test pits using a backhoe. Three soil samples will be collected from each test pit, approximately 0.5 feet and 4 feet below land surface and just above the water table. Head space analyses will be performed and mapped as sampling progresses.

Test pit soil samples will be collected from the point of highest contamination and below the AST locations and pump islands. Samples will be collected below each 25-foot length of AST piping with emphasis on joints and elbows. Samples will also be collected outside the perimeter and below the bottom of the plume(s) to confirm the horizontal and vertical extent of contamination. The samples will be analyzed for VOC, total petroleum hydrocarbons (TPH), and lead on a rapid turnaround basis.

SOIL EXCAVATION

Information from the records search and field investigation will be used to optimize soil excavation. Approximately 500 cubic yards of the most contaminated soil will be excavated and transported to the soil composting demonstration site for remediation of hydrocarbon contamination. Head space analyses will be performed and mapped as excavation progresses.

Residual Product, AST Piping, and Free Product Removal and Disposal

Information from the records search and field investigation will be used to optimize residual product, AST piping, and free product removal. Residual product within the AST piping in the excavation will be removed using a peristaltic or vacuum pump and disposed. The AST piping will be removed using a backhoe and disposed. Free product, if present in the excavation, will be removed using a peristaltic or vacuum pump and disposed.

SITE RESTORATION

Source area ST58 will be backfilled with clean soil provided by Eielson AFB and restored to pre-work conditions.

EQUIPMENT DECONTAMINATION

The backhoes and dump truck will be decontaminated using a high pressure washer before coming onsite and after completion of work. The high pressure washer and site will be provided by Eielson AFB.

Test pit soil sampling equipment will be new or decontaminated using soap and water scrub with distilled water rinse before each sample is collected. Decontamination water used for the sampling equipment will be contained and treated using the PNL waste-water treatment system, as in the 1991 and 1992 field investigations. The treated water will be sampled and analyzed for VOC on a rapid turnaround basis. The treated water will be discharged to the Eielson AFB sanitary sewer system when sample analyses are less than 10 ppb total BTEX and 5 ppb benzene.

One equipment blank will be collected after decontamination of the test pit soil sampling equipment. The equipment blank will be analyzed for VOC on a rapid turnaround basis.

SAMPLE ANALYSIS PROTOCOL

Sample Delivery, Holding, and Storage

The conventional gas extraction samples will be analyzed in a field laboratory. The test pit soil samples will be shipped to PNL via Federal Express. The Petrex method samplers will be shipped to the manufacturer via Federal Express. All samples will be packed in blue or bagged ice and sealed in coolers.

Upon receipt, the laboratory will check the condition of the samples (ie., temperature, breakage, leaks, etc.) and verify that the accompanying chain of custody is in agreement with the sample labels. The laboratory will then sign the chain of custody.

If any discrepancies in the accompanying documentation are noted and/or the integrity of the samples have been compromised, the laboratory will immediately notify the PNL Analytical Contact for resolution. These discrepancies will be noted on the chain of custody. The samples will be stored at $4^{\circ}\text{C} \pm 2^{\circ}\text{C}$ until extraction for analysis.

Sample Analysis

The conventional gas extraction samples, soil samples, duplicates, and equipment blank will be analyzed for selected constituents as shown in the sample matrix in Table 2.

The conventional gas extraction samples will be analyzed for VOC using PNL Technical Procedure PNL VOA-2, Volatile Organic Compounds in Water by Purge and Trap Capillary Column Gas Chromatography with Dual Electron Capture and Flame Ionization Detectors.

Alcohol extracts from the test pit soil samples will be analyzed for VOC using Modified PNL Technical Procedure PNL VOA-3 EPA Method 502.2, Volatile Organic Compounds in Water by Purge and Trap Capillary Column Gas Chromatography with Photoionization and Electrolytic Conductivity Detectors in Series.

Table 2. Sample Analysis Matrix for Source Area ST58.					
Sample Type	VOC			TPH	Lead
	PNL VOA-2	PNL VOA-3 EPA Method 502.2	Manufacturer Analysis	EPA Method 8015/8020	EPA Method TCLP 7421
Conventional Gas Extraction	X				
Petrex Method			X		
Test Pit Soil		X		X	X
Water-Treatment System		X			
Equipment Blank		X			

The water-treatment system samples and equipment blank will be analyzed for VOC using PNL Technical Procedure PNL VOA-3 EPA Method 502.2, Volatile Organic Compounds in Water by Purge and Trap Capillary Column Gas Chromatography with Photoionization and Electrolytic Conductivity Detectors in Series.

The test pit soil samples will be analyzed for TPH using EPA Method 8015/8020, gas and diesel ranges, and lead using EPA Method 7421.

Sample Disposal

The laboratory will dispose of all residual samples.

Quality Assurance and Control

This work will be performed under the PNL-MA-70 Quality Assurance Plan No. EES-102, Rev. 0, for Eielson AFB, Source Area ST58, dated May 1993.

Departures from the listed methods will be documented as part of the laboratory record. Departures affecting the quality of the analytical results will be reported to the PNL Analytical Contact for approval before performing the analyses.

Analytical test conditions, sample preparation information, and related data for conducting the analyses will be documented as part of the laboratory record and traceable to the original sample numbers and analytical results.

The laboratory will use the original chain of custody to track each sample and return these documents with the analytical results.

One field duplicate, method blank, and matrix spike sample will be analyzed for every 20 samples from a particular medium. One equipment blank will be analyzed after decontamination of the test pit soil sampling equipment. Performance requirements for quality control samples are specified below.

Accuracy (SR) : 75-125%
Precision (RD) ± 20%

Period of Performance

The samples will be collected in May and June 1993. The samples will be delivered to the field laboratory on the day of collection or shipped to PNL via Federal Express within one day of collection. The Petrex method samplers will be shipped to the manufacturer via Federal Express within one day of retrieval.

Reporting Requirements

All samples, with the exception of the Petrex method samplers, will be analyzed on a rapid turnaround basis. Analytical results including sample numbers, date and time of analysis, results in ppb, original chain of custody forms, and any departures from the listed procedures will be reported to the PNL Analytical Contact within 24 hours of sample receipt. The Petrex method samplers will be analyzed on a normal turnaround basis.

REPORTING

A technical report will be submitted following completion of the field investigation, soil excavation, and site restoration for source area ST58. The report will include as a minimum:

- a discussion of the source area history and conditions resulting in initiation of the source area characterization plan
- source area maps showing boundaries, roads, buildings, AST and associated piping locations, and other relevant structures
- survey data for grid node locations
- a description of the surface geophysical surveys and results
- a description of the soil gas surveys, including laboratory data
- descriptions of the contaminant types, concentrations, and distributions, including laboratory data
- descriptions of the hydrogeology
- a description of the soil excavation, including excavated soil volumes
- a description of the residual product, AST piping, and free product removal and disposal
- a description of the site restoration, including backfill materials and quantities

- a copy of the work clearance request.

HEALTH AND SAFETY

The work at source area ST58 will be performed under the Health and Safety Plan Addendum (Appendix F) in the Final Operable Units 3, 4, and 5 Management Plan dated October 1992. This plan references the Health and Safety Plan (Appendix C) in the Site Management Plan for Eielson AFB dated April 19, 1992.

Work will be performed in level D PPE. Level C PPE will be used if concentrations in the breathing space with the monitoring instrument exceed background concentrations by 10 parts per million (ppm) for 5 minutes. Colorimetric tubes will be used to identify specific contaminants.

DELIVERABLES

Deliverables for the work at source area ST58 include:

- source area characterization plan
- technical report.

SCHEDULE

The schedule for the work at source area ST58 is:

• April 30, 1993	submit source area characterization plan to Eielson AFB
• May 3, 1993	submit source area characterization plan to Eielson AFB, EPA, and Alaska Department of Environmental Conservation (ADEC)
• May 14, 1993	obtain Base Civil Engineering Work Clearance Request
• May 18, 1993	stake and survey grid node locations
• May 19, 1993	commence surface geophysical surveys
• May 28, 1993	complete surface geophysical surveys
• June 1, 1993	commence soil gas surveys
• June 11, 1993	complete soil gas surveys
• June 14, 1993	commence test pit soil sampling
• June 18, 1993	complete test pit soil sampling

- June 28, 1993 : commence soil excavation
- July 2, 1993 complete soil excavation
- July 7, 1993 commence site restoration
- July 9, 1993 complete site restoration
- October 1, 1993 submit technical report.

Appendix B

**Letter from A. E. Schumacher to D. W. Glover,
Dated January 6, 1993,
Subject History of Old Quartermaster Service Station**

Project Number _____

Internal Distribution

File/LB

Date January 5, 1993

To Andy Schumaker

From Don Glover Subject History of Old Quartermaster Service Station
Source Area ST58

The following are questions that we discussed briefly. Any information you could furnish on these items would be appreciated and would be helpful in formulating a more detailed approach for surveying the area and clean-up if indicated.

1. Dates of operation (from-to)
2. Operated by? (AF - Contractor)
3. Fuels used by? (AF - Private etc.)
4. Storage tanks (removed, dates)
5. Piping removed? (yes-no, dates)
6. Types of gas (leaded-unleaded-aviation etc.)
7. Any known leaks? (documentation on file)
8. Known spills? (documentation on file)
9. Maintenance records (repairs-modifications etc.)
10. Observations during AST removal
11. Official closure files or records (availability)
12. Maps-Drawings-As built (original and modifications)
13. Previous investigations (samples-results-etc.)
14. Storage of other than gasoline, diesel and isopropyl alcohol if any, what type material (solvent-motor oil etc.)
15. What was isopropyl alcohol used for?

:lg

FROM: 343 CES/CEO
2258 Central Ave Ste 1
Eielson AFB AK 99702-2225

6 January 1993

SUBJ: History of Old Quartermaster Service Station

TO: Don Glover
Battelle Pacific Northwest Laboratories
P O Box 999
Richland WA 99352

1. The following are answers to questions, in the order asked, from your letter dated 5 Jan 93.

Question 1. From 1970 to 1988.

Question 2. Air Force personnel.

Question 3. Air Force and dependents until 1975. Air Force vehicles only after 1975.

Question 4. Removed August 1988.

Question 5. Aboveground piping removed only in August 1988.

Question 6. Leaded, unleaded, and diesel.

Question 7. The pipeline was suspected of leaking at the intersection of Industrial Dr and Division St.

Question 8. No known spills.

Question 9. No records available.

Question 10. No records available.

Question 11. No records available.

Question 12. See blueprints enclosed.

Question 13. Dave Blevens of the Environmental Flight will supply sample results if they exist. Dave can be reached at 377-5159.

Question 14. Two barrels of motor oil where stored on site to issue to customers.

Question 15. An isopropyl tank #10 is shown on the blueprint, but to the best of our knowledge, only MOGAS was stored in it.

2. This is about all I have on this site, let me know if I can be of further help.

ANDREW E. SCHUMACHER
Deputy Chief of Operations

Appendix C

April 1993 Analytical Results

Appendix C. April 1993 Analytical Results

Sample ID	Source Area	OU	Sample Type Code	Analyte	CAS #	Sample Log Date	Analysis Date	Sample Contractor	Analysis Contractor	Analytical Method	Units	Concentration	Detection Limit	EPA Data Qualifier
58MW01	ST58	SER	WG	1,1,1-TRICHLOROETHANE	71-55-6	10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW02	ST58	SER	WG	1,1,1-TRICHLOROETHANE	71-55-6	10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW03	ST58	SER	WG	1,1,1-TRICHLOROETHANE	71-55-6	9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW04	ST58	SER	WG	1,1,1-TRICHLOROETHANE	71-55-6	9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW05	ST58	SER	WG	1,1,1-TRICHLOROETHANE	71-55-6	9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW06	ST58	SER	WG	1,1,1-TRICHLOROETHANE	71-55-6	9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW07	ST58	SER	WG	1,1,1-TRICHLOROETHANE	71-55-6	9-Apr-93	16-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW08	ST58	SER	WG	1,1,1-TRICHLOROETHANE	71-55-6	8-Apr-93	16-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW08TB	ST58	SER	WG	1,1,1-TRICHLOROETHANE	71-55-6	10-Apr-93	20-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW09	ST58	SER	WG	1,1,1-TRICHLOROETHANE	71-55-6	10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW10	ST58	SER	WG	1,1,1-TRICHLOROETHANE	71-55-6	11-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW11	ST58	SER	WG	1,1,1-TRICHLOROETHANE	71-55-6	10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW12	ST58	SER	WG	1,1,2-TRICHLOROETHANE	79-00-5	10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW01	ST58	SER	WG	1,1,2-TRICHLOROETHANE	79-00-5	10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW03	ST58	SER	WG	1,1,2-TRICHLOROETHANE	79-00-5	9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW04	ST58	SER	WG	1,1,2-TRICHLOROETHANE	79-00-5	9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW05	ST58	SER	WG	1,1,2-TRICHLOROETHANE	79-00-5	9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW06	ST58	SER	WG	1,1,2-TRICHLOROETHANE	79-00-5	9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW07	ST58	SER	WG	1,1,2-TRICHLOROETHANE	79-00-5	9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW08	ST58	SER	WG	1,1,2-TRICHLOROETHANE	79-00-5	9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW08TB	ST58	SER	WG	1,1,2-TRICHLOROETHANE	79-00-5	10-Apr-93	20-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW09	ST58	SER	WG	1,1,2-TRICHLOROETHANE	79-00-5	10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW10	ST58	SER	WG	1,1,2-TRICHLOROETHANE	79-00-5	10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW11	ST58	SER	WG	1,1,2-TRICHLOROETHANE	79-00-5	11-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW12	ST58	SER	WG	1,1,2-TRICHLOROETHANE	79-00-5	10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW01	ST58	SER	WG	1,1-DICHLOROETHANE	75-34-3	10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW03	ST58	SER	WG	1,1-DICHLOROETHANE	75-34-3	9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW04	ST58	SER	WG	1,1-DICHLOROETHANE	75-34-3	8-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW06	ST58	SER	WG	1,1-DICHLOROETHANE	75-34-3	9-Apr-93	20-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW07	ST58	SER	WG	1,1-DICHLOROETHANE	75-34-3	8-Apr-93	16-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW08	ST58	SER	WG	1,1-DICHLOROETHANE	75-34-3	8-Apr-93	16-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW08TB	ST58	SER	WG	1,1-DICHLOROETHANE	75-34-3	10-Apr-93	20-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW09	ST58	SER	WG	1,1-DICHLOROETHANE	75-34-3	10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW10	ST58	SER	WG	1,1-DICHLOROETHANE	75-34-3	10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW11	ST58	SER	WG	1,1-DICHLOROETHANE	75-34-3	11-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW12	ST58	SER	WG	1,1-DICHLOROETHANE	75-34-3	11-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U

Notes:

(1) U = Constituent was analyzed for but not detected.

(2) B = Constituent was also detected in the associated blank.

Appendix C (continued)

Sample ID	Source Area	OU	Sample Type Code	Analyte	CAS #	Sample Log Date	Analysis Date	Sample Contractor	Analysis Contractor	Analytical Method	Units	Concentration	Detection Limit	EPA Data Qualifier
58MW01	ST58	SER	WG	1,2-DICHLOROETHANE	107-06-2	10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW02	ST58	SER	WG	1,2-DICHLOROETHANE	107-06-2	10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW03	ST58	SER	WG	1,2-DICHLOROETHANE	107-06-2	9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW04	ST58	SER	WG	1,2-DICHLOROETHANE	107-06-2	9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW05	ST58	SER	WG	1,2-DICHLOROETHANE	107-06-2	8-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW06	ST58	SER	WG	1,2-DICHLOROETHANE	107-06-2	9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW07	ST58	SER	WG	1,2-DICHLOROETHANE	107-06-2	9-Apr-93	20-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW08	ST58	SER	WG	1,2-DICHLOROETHANE	107-06-2	8-Apr-93	16-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW08D	ST58	SER	WG	1,2-DICHLOROETHANE	107-06-2	8-Apr-93	16-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW08TB	ST58	SER	WG	1,2-DICHLOROETHANE	107-06-2	8-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW09	ST58	SER	WG	1,2-DICHLOROETHANE	107-06-2	10-Apr-93	20-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW10	ST58	SER	WG	1,2-DICHLOROETHANE	107-06-2	10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW11	ST58	SER	WG	1,2-DICHLOROETHANE	107-06-2	11-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW12	ST58	SER	WG	1,2-DICHLOROETHANE	107-06-2	10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	1.2	1.2	U
58MW01	ST58	SER	WG	1,2-DICHLOROETHANE	540-59-0	10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	1.2	1.2	U
58MW03	ST58	SER	WG	1,2-DICHLOROETHANE	540-59-0	10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	1.2	1.2	U
58MW04	ST58	SER	WG	1,2-DICHLOROETHANE	540-59-0	9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	1.2	1.2	U
58MW05	ST58	SER	WG	1,2-DICHLOROETHANE	540-59-0	9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	1.2	1.2	U
58MW06	ST58	SER	WG	1,2-DICHLOROETHANE	540-59-0	8-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	1.2	1.2	U
58MW07	ST58	SER	WG	1,2-DICHLOROETHANE	540-59-0	9-Apr-93	20-Apr-93	Battelle PNL	Data Chem	8240	UG/L	1.2	1.2	U
58MW08	ST58	SER	WG	1,2-DICHLOROETHANE	540-59-0	8-Apr-93	16-Apr-93	Battelle PNL	Data Chem	8240	UG/L	1.2	1.2	U
58MW08D	ST58	SER	WG	1,2-DICHLOROETHANE	540-59-0	8-Apr-93	16-Apr-93	Battelle PNL	Data Chem	8240	UG/L	1.2	1.2	U
58MW09	ST58	SER	WG	1,2-DICHLOROETHANE	540-59-0	8-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	1.2	1.2	U
58MW10	ST58	SER	WG	1,2-DICHLOROETHANE	540-59-0	10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	1.2	1.2	U
58MW11	ST58	SER	WG	1,2-DICHLOROETHANE	540-59-0	11-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	1.2	1.2	U
58MW12	ST58	SER	WG	1,2-DICHLOROETHANE	540-59-0	11-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	1.2	1.2	U
58MW01	ST58	SER	WG	1,4-DICHLOROBENZENE	106-46-7	10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW02	ST58	SER	WG	1,4-DICHLOROBENZENE	106-46-7	10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW03	ST58	SER	WG	1,4-DICHLOROBENZENE	106-46-7	9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW04	ST58	SER	WG	1,4-DICHLOROBENZENE	106-46-7	8-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW05	ST58	SER	WG	1,4-DICHLOROBENZENE	106-46-7	9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW06	ST58	SER	WG	1,4-DICHLOROBENZENE	106-46-7	9-Apr-93	20-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW07	ST58	SER	WG	1,4-DICHLOROBENZENE	106-46-7	8-Apr-93	16-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW08	ST58	SER	WG	1,4-DICHLOROBENZENE	106-46-7	8-Apr-93	16-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW08D	ST58	SER	WG	1,4-DICHLOROBENZENE	106-46-7	10-Apr-93	20-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW09	ST58	SER	WG	1,4-DICHLOROBENZENE	106-46-7	10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW10	ST58	SER	WG	1,4-DICHLOROBENZENE	106-46-7	11-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW11	ST58	SER	WG	1,4-DICHLOROBENZENE	106-46-7	11-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW12	ST58	SER	WG	1,4-DICHLOROBENZENE	106-46-7	11-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U

Notes:

(1) U = Constituent was analyzed for but not detected.

(2) B = Constituent was also detected in the associated blank.

Appendix C. (continued)

Sample ID	Source Area	Sample Type	OU	Sample Code	Analyte	CAS #	Sample Log Date	Analysis Date	Sample Contractor	Analysis Contractor	Analytical Method	Units	Concentration	Detection Limit	EPA Data Qualifier
58MW01	ST58	SER	WG	WG	2-BUTANONE	78-93-3	10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	100	100	U
58MW02	ST58	SER	WG	WG	2-BUTANONE	78-93-3	10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	100	100	U
58MW03	ST58	SER	WG	WG	2-BUTANONE	78-93-3	9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	100	100	U
58MW04	ST58	SER	WG	WG	2-BUTANONE	78-93-3	9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	100	100	U
58MW05	ST58	SER	WG	WG	2-BUTANONE	78-93-3	9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	100	100	U
58MW06	ST58	SER	WG	WG	2-BUTANONE	78-93-3	9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	100	100	U
58MW07	ST58	SER	WG	WG	2-BUTANONE	78-93-3	9-Apr-93	20-Apr-93	Battelle PNL	Data Chem	8240	UG/L	100	100	U
58MW08	ST58	SER	WG	WG	2-BUTANONE	78-93-3	8-Apr-93	16-Apr-93	Battelle PNL	Data Chem	8240	UG/L	100	100	U
58MW08D	ST58	SER	WG	WG	2-BUTANONE	78-93-3	8-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	100	100	U
58MW08TB	ST58	SER	WG	WG	2-BUTANONE	78-93-3	10-Apr-93	20-Apr-93	Battelle PNL	Data Chem	8240	UG/L	100	100	U
58MW09	ST58	SER	WG	WG	2-BUTANONE	78-93-3	10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	100	100	U
58MW10	ST58	SER	WG	WG	2-BUTANONE	78-93-3	11-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	100	100	U
58MW11	ST58	SER	WG	WG	2-BUTANONE	78-93-3	11-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	50	50	U
58MW12	ST58	SER	WG	WG	2-BUTANONE	78-93-3	10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	50	50	U
58MW01	ST58	SER	WG	WG	4-METHYL-2-PENTANONE	108-10-1	10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	50	50	U
58MW02	ST58	SER	WG	WG	4-METHYL-2-PENTANONE	108-10-1	9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	50	50	U
58MW03	ST58	SER	WG	WG	4-METHYL-2-PENTANONE	108-10-1	9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	50	50	U
58MW04	ST58	SER	WG	WG	4-METHYL-2-PENTANONE	108-10-1	9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	50	50	U
58MW05	ST58	SER	WG	WG	4-METHYL-2-PENTANONE	108-10-1	9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	50	50	U
58MW06	ST58	SER	WG	WG	4-METHYL-2-PENTANONE	108-10-1	9-Apr-93	20-Apr-93	Battelle PNL	Data Chem	8240	UG/L	50	50	U
58MW07	ST58	SER	WG	WG	4-METHYL-2-PENTANONE	108-10-1	8-Apr-93	16-Apr-93	Battelle PNL	Data Chem	8240	UG/L	77	77	U
58MW08	ST58	SER	WG	WG	4-METHYL-2-PENTANONE	108-10-1	8-Apr-93	16-Apr-93	Battelle PNL	Data Chem	8240	UG/L	76	76	U
58MW08D	ST58	SER	WG	WG	4-METHYL-2-PENTANONE	108-10-1	8-Apr-93	16-Apr-93	Battelle PNL	Data Chem	8240	UG/L	50	50	U
58MW08TB	ST58	SER	WG	WG	4-METHYL-2-PENTANONE	108-10-1	10-Apr-93	20-Apr-93	Battelle PNL	Data Chem	8240	UG/L	50	50	U
58MW09	ST58	SER	WG	WG	4-METHYL-2-PENTANONE	108-10-1	10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	50	50	U
58MW10	ST58	SER	WG	WG	4-METHYL-2-PENTANONE	108-10-1	11-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	50	50	U
58MW11	ST58	SER	WG	WG	4-METHYL-2-PENTANONE	108-10-1	10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5.2	100	B
58MW12	ST58	SER	WG	WG	4-METHYL-2-PENTANONE	108-10-1	10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	4.5	100	B
58MW01	ST58	SER	WG	WG	ACETONE	67-64-1	10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	100	100	U
58MW02	ST58	SER	WG	WG	ACETONE	67-64-1	9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	100	100	U
58MW03	ST58	SER	WG	WG	ACETONE	67-64-1	9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	100	100	U
58MW04	ST58	SER	WG	WG	ACETONE	67-64-1	9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	100	100	U
58MW05	ST58	SER	WG	WG	ACETONE	67-64-1	9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	8.8	100	B
58MW06	ST58	SER	WG	WG	ACETONE	67-64-1	9-Apr-93	16-Apr-93	Battelle PNL	Data Chem	8240	UG/L	100	100	U
58MW07	ST58	SER	WG	WG	ACETONE	67-64-1	8-Apr-93	16-Apr-93	Battelle PNL	Data Chem	8240	UG/L	100	100	U
58MW08	ST58	SER	WG	WG	ACETONE	67-64-1	8-Apr-93	16-Apr-93	Battelle PNL	Data Chem	8240	UG/L	8.4	100	B
58MW08D	ST58	SER	WG	WG	ACETONE	67-64-1	10-Apr-93	20-Apr-93	Battelle PNL	Data Chem	8240	UG/L	22	100	B
58MW08TB	ST58	SER	WG	WG	ACETONE	67-64-1	10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5.4	100	B
58MW09	ST58	SER	WG	WG	ACETONE	67-64-1	11-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	4.6	100	B
58MW10	ST58	SER	WG	WG	ACETONE	67-64-1	11-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	4.6	100	B
58MW11	ST58	SER	WG	WG	ACETONE	67-64-1	11-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	4.6	100	B
58MW12	ST58	SER	WG	WG	ACETONE	67-64-1	11-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	4.6	100	B

Notes:

(1) U = Constituent was analyzed for but not detected.

(2) B = Constituent was also detected in the associated blank.

Appendix C (continued)

Sample ID	Source Area	OU	Sample Type Code	Analyte	CAS #	Sample Log Date	Analysis Date	Sample Contractor	Analysis Contractor	Analytical Method	Units	Concentration	Detection Limit	EPA Data Qualifier
58MW01	ST58	SER	WG	BENZENE	71-43-2	10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW02	ST58	SER	WG	BENZENE	71-43-2	10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW03	ST58	SER	WG	BENZENE	71-43-2	10-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	3.7	5	U
58MW04	ST58	SER	WG	BENZENE	71-43-2	9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	98	5	U
58MW05	ST58	SER	WG	BENZENE	71-43-2	8-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	29	5	U
58MW06	ST58	SER	WG	BENZENE	71-43-2	9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW07	ST58	SER	WG	BENZENE	71-43-2	9-Apr-93	20-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW08	ST58	SER	WG	BENZENE	71-43-2	8-Apr-93	16-Apr-93	Battelle PNL	Data Chem	8240	UG/L	180	5	U
58MW08D	ST58	SER	WG	BENZENE	71-43-2	8-Apr-93	16-Apr-93	Battelle PNL	Data Chem	8240	UG/L	180	5	U
58MW08TB	ST58	SER	WG	BENZENE	71-43-2	8-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW09	ST58	SER	WG	BENZENE	71-43-2	10-Apr-93	20-Apr-93	Battelle PNL	Data Chem	8240	UG/L	24	5	U
58MW10	ST58	SER	WG	BENZENE	71-43-2	10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	450	5	B
58MW11	ST58	SER	WG	BENZENE	71-43-2	11-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW12	ST58	SER	WG	BENZENE	71-43-2	11-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW01	ST58	SER	WG	CARBON TETRACHLORIDE	56-23-5	10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW02	ST58	SER	WG	CARBON TETRACHLORIDE	56-23-5	10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW03	ST58	SER	WG	CARBON TETRACHLORIDE	56-23-5	9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW04	ST58	SER	WG	CARBON TETRACHLORIDE	56-23-5	9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW05	ST58	SER	WG	CARBON TETRACHLORIDE	56-23-5	8-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW06	ST58	SER	WG	CARBON TETRACHLORIDE	56-23-5	9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW07	ST58	SER	WG	CARBON TETRACHLORIDE	56-23-5	9-Apr-93	20-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW08	ST58	SER	WG	CARBON TETRACHLORIDE	56-23-5	8-Apr-93	16-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW08D	ST58	SER	WG	CARBON TETRACHLORIDE	56-23-5	8-Apr-93	16-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW08TB	ST58	SER	WG	CARBON TETRACHLORIDE	56-23-5	8-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW09	ST58	SER	WG	CARBON TETRACHLORIDE	56-23-5	10-Apr-93	20-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW10	ST58	SER	WG	CARBON TETRACHLORIDE	56-23-5	10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW11	ST58	SER	WG	CARBON TETRACHLORIDE	56-23-5	11-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW12	ST58	SER	WG	CARBON TETRACHLORIDE	56-23-5	11-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW01	ST58	SER	WG	CHLOROFORM	67-66-3	10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW02	ST58	SER	WG	CHLOROFORM	67-66-3	10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW03	ST58	SER	WG	CHLOROFORM	67-66-3	9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW04	ST58	SER	WG	CHLOROFORM	67-66-3	9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW05	ST58	SER	WG	CHLOROFORM	67-66-3	8-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW06	ST58	SER	WG	CHLOROFORM	67-66-3	9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW07	ST58	SER	WG	CHLOROFORM	67-66-3	9-Apr-93	20-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW08	ST58	SER	WG	CHLOROFORM	67-66-3	8-Apr-93	16-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW08D	ST58	SER	WG	CHLOROFORM	67-66-3	8-Apr-93	16-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW08TB	ST58	SER	WG	CHLOROFORM	67-66-3	8-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW10	ST58	SER	WG	CHLOROFORM	67-66-3	10-Apr-93	20-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW11	ST58	SER	WG	CHLOROFORM	67-66-3	11-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW12	ST58	SER	WG	CHLOROFORM	67-66-3	11-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U

Notes:

- (1) U = Constituent was analyzed for but not detected.
 (2) B = Constituent was also detected in the associated blank.

Appendix C. (continued)

Sample ID	Source Area	OU	Sample Type Code	Analyte	CAS #	Sample Log Date	Analysis Date	Sample Contractor	Analysis Contractor	Analytical Method	Units	Concentration	Detection Limit	EPA Data Qualifier
58MW01	ST58	SER	WG	METHYLENE CHLORIDE	75-09-2	10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	1.8	5	B
58MW02	ST58	SER	WG	METHYLENE CHLORIDE	75-09-2	10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	1.8	5	B
58MW03	ST58	SER	WG	METHYLENE CHLORIDE	75-09-2	9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	2.3	5	B
58MW04	ST58	SER	WG	METHYLENE CHLORIDE	75-09-2	9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	2.3	5	B
58MW05	ST58	SER	WG	METHYLENE CHLORIDE	75-09-2	8-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	2.3	5	B
58MW06	ST58	SER	WG	METHYLENE CHLORIDE	75-09-2	9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	2.3	5	B
58MW07	ST58	SER	WG	METHYLENE CHLORIDE	75-09-2	9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	2.3	5	B
58MW08	ST58	SER	WG	METHYLENE CHLORIDE	75-09-2	8-Apr-93	16-Apr-93	Battelle PNL	Data Chem	8240	UG/L	2.2	5	B
58MW08D	ST58	SER	WG	METHYLENE CHLORIDE	75-09-2	8-Apr-93	16-Apr-93	Battelle PNL	Data Chem	8240	UG/L	2.2	5	B
58MW08TB	ST58	SER	WG	METHYLENE CHLORIDE	75-09-2	8-Apr-93	16-Apr-93	Battelle PNL	Data Chem	8240	UG/L	2.4	5	B
58MW09	ST58	SER	WG	METHYLENE CHLORIDE	75-09-2	10-Apr-93	20-Apr-93	Battelle PNL	Data Chem	8240	UG/L	2.3	5	B
58MW10	ST58	SER	WG	METHYLENE CHLORIDE	75-09-2	10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	9	5	B
58MW11	ST58	SER	WG	METHYLENE CHLORIDE	75-09-2	11-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	2	5	B
58MW12	ST58	SER	WG	METHYLENE CHLORIDE	75-09-2	11-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	2	5	B
58MW01	ST58	SER	WG	TETRACHLOROETHENE	127-18-4	10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW02	ST58	SER	WG	TETRACHLOROETHENE	127-18-4	10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW03	ST58	SER	WG	TETRACHLOROETHENE	127-18-4	10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW04	ST58	SER	WG	TETRACHLOROETHENE	127-18-4	9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW05	ST58	SER	WG	TETRACHLOROETHENE	127-18-4	8-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW06	ST58	SER	WG	TETRACHLOROETHENE	127-18-4	9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW07	ST58	SER	WG	TETRACHLOROETHENE	127-18-4	8-Apr-93	16-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW08	ST58	SER	WG	TETRACHLOROETHENE	127-18-4	8-Apr-93	16-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW08D	ST58	SER	WG	TETRACHLOROETHENE	127-18-4	8-Apr-93	16-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW08TB	ST58	SER	WG	TETRACHLOROETHENE	127-18-4	8-Apr-93	16-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW09	ST58	SER	WG	TETRACHLOROETHENE	127-18-4	10-Apr-93	20-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW10	ST58	SER	WG	TETRACHLOROETHENE	127-18-4	10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW11	ST58	SER	WG	TETRACHLOROETHENE	127-18-4	11-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW12	ST58	SER	WG	TETRACHLOROETHENE	127-18-4	11-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	10	10	U
58MW01	ST58	SER	WG	TETRAHYDROFURAN		10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	10	10	U
58MW02	ST58	SER	WG	TETRAHYDROFURAN		10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	10	10	U
58MW03	ST58	SER	WG	TETRAHYDROFURAN		9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	10	10	U
58MW04	ST58	SER	WG	TETRAHYDROFURAN		9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	10	10	U
58MW05	ST58	SER	WG	TETRAHYDROFURAN		8-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	10	10	U
58MW06	ST58	SER	WG	TETRAHYDROFURAN		8-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	10	10	U
58MW07	ST58	SER	WG	TETRAHYDROFURAN		9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	10	10	U
58MW08	ST58	SER	WG	TETRAHYDROFURAN		8-Apr-93	16-Apr-93	Battelle PNL	Data Chem	8240	UG/L	10	10	U
58MW08D	ST58	SER	WG	TETRAHYDROFURAN		8-Apr-93	16-Apr-93	Battelle PNL	Data Chem	8240	UG/L	10	10	U
58MW08TB	ST58	SER	WG	TETRAHYDROFURAN		8-Apr-93	16-Apr-93	Battelle PNL	Data Chem	8240	UG/L	10	10	U
58MW09	ST58	SER	WG	TETRAHYDROFURAN		10-Apr-93	20-Apr-93	Battelle PNL	Data Chem	8240	UG/L	10	10	U
58MW10	ST58	SER	WG	TETRAHYDROFURAN		10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	10	10	U
58MW11	ST58	SER	WG	TETRAHYDROFURAN		11-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	10	10	U
58MW12	ST58	SER	WG	TETRAHYDROFURAN		11-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	10	10	U

Notes:

(1) U = Constituent was analyzed for but not detected.

(2) B = Constituent was also detected in the associated blank.

Appendix C (continued)

Sample ID	Source Area	OU	Sample Type Code	Analyte	CAS #	Sample Log Date	Analysis Date	Sample Contractor	Analysis Contractor	Analytical Method	Units	Concentration	Detection Limit	EPA Data Qualifier
58MW01	ST58	SER	WG	TOLUENE	108-88-3	10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW02	ST58	SER	WG	TOLUENE	108-88-3	10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW03	ST58	SER	WG	TOLUENE	108-88-3	9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW04	ST58	SER	WG	TOLUENE	108-88-3	9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW05	ST58	SER	WG	TOLUENE	108-88-3	8-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW06	ST58	SER	WG	TOLUENE	108-88-3	9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW07	ST58	SER	WG	TOLUENE	108-88-3	9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW08	ST58	SER	WG	TOLUENE	108-88-3	8-Apr-93	16-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW08D	ST58	SER	WG	TOLUENE	108-88-3	8-Apr-93	16-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW08TB	ST58	SER	WG	TOLUENE	108-88-3	8-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW09	ST58	SER	WG	TOLUENE	108-88-3	10-Apr-93	20-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW10	ST58	SER	WG	TOLUENE	108-88-3	10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	2.8	5	U
58MW11	ST58	SER	WG	TOLUENE	108-88-3	11-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	140	5	U
58MW12	ST58	SER	WG	TOLUENE	108-88-3	11-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW01	ST58	SER	WG	TRICHLOROETHENE	79-01-6	10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW02	ST58	SER	WG	TRICHLOROETHENE	79-01-6	10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW03	ST58	SER	WG	TRICHLOROETHENE	79-01-6	9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW04	ST58	SER	WG	TRICHLOROETHENE	79-01-6	9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW05	ST58	SER	WG	TRICHLOROETHENE	79-01-6	8-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW06	ST58	SER	WG	TRICHLOROETHENE	79-01-6	9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW07	ST58	SER	WG	TRICHLOROETHENE	79-01-6	9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW08	ST58	SER	WG	TRICHLOROETHENE	79-01-6	8-Apr-93	16-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW08D	ST58	SER	WG	TRICHLOROETHENE	79-01-6	8-Apr-93	16-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW08TB	ST58	SER	WG	TRICHLOROETHENE	79-01-6	8-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW09	ST58	SER	WG	TRICHLOROETHENE	79-01-6	10-Apr-93	20-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW10	ST58	SER	WG	TRICHLOROETHENE	79-01-6	10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW11	ST58	SER	WG	TRICHLOROETHENE	79-01-6	11-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW12	ST58	SER	WG	TRICHLOROETHENE	79-01-6	11-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW01	ST58	SER	WG	VINYL CHLORIDE	75-01-4	10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	10	10	U
58MW02	ST58	SER	WG	VINYL CHLORIDE	75-01-4	10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	10	10	U
58MW03	ST58	SER	WG	VINYL CHLORIDE	75-01-4	9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	10	10	U
58MW04	ST58	SER	WG	VINYL CHLORIDE	75-01-4	9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	10	10	U
58MW05	ST58	SER	WG	VINYL CHLORIDE	75-01-4	8-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	10	10	U
58MW06	ST58	SER	WG	VINYL CHLORIDE	75-01-4	9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	10	10	U
58MW07	ST58	SER	WG	VINYL CHLORIDE	75-01-4	9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	10	10	U
58MW08	ST58	SER	WG	VINYL CHLORIDE	75-01-4	8-Apr-93	16-Apr-93	Battelle PNL	Data Chem	8240	UG/L	10	10	U
58MW08D	ST58	SER	WG	VINYL CHLORIDE	75-01-4	8-Apr-93	16-Apr-93	Battelle PNL	Data Chem	8240	UG/L	10	10	U
58MW08TB	ST58	SER	WG	VINYL CHLORIDE	75-01-4	8-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	10	10	U
58MW09	ST58	SER	WG	VINYL CHLORIDE	75-01-4	10-Apr-93	20-Apr-93	Battelle PNL	Data Chem	8240	UG/L	10	10	U
58MW10	ST58	SER	WG	VINYL CHLORIDE	75-01-4	10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	10	10	U
58MW11	ST58	SER	WG	VINYL CHLORIDE	75-01-4	11-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	10	10	U
58MW12	ST58	SER	WG	VINYL CHLORIDE	75-01-4	11-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	10	10	U

Notes:

- (1) U = Constituent was analyzed for but not detected
 (2) B = Constituent was also detected in the associated blank

Appendix C. (continued)

Sample ID	Source Area	OU	Sample Type Code	Analyte	CAS #	Sample Log Date	Analysis Date	Sample Contractor	Analysis Contractor	Analytical Method	Units	Concentration	Detection Limit	EPA Data Qualifier
58MW01	ST58	SER	WG	XYLENES (TOTAL)	1330-20-7	10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW02	ST58	SER	WG	XYLENES (TOTAL)	1330-20-7	10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW03	ST58	SER	WG	XYLENES (TOTAL)	1330-20-7	9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW04	ST58	SER	WG	XYLENES (TOTAL)	1330-20-7	9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW05	ST58	SER	WG	XYLENES (TOTAL)	1330-20-7	8-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW06	ST58	SER	WG	XYLENES (TOTAL)	1330-20-7	9-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW07	ST58	SER	WG	XYLENES (TOTAL)	1330-20-7	9-Apr-93	20-Apr-93	Battelle PNL	Data Chem	8240	UG/L	29	5	U
58MW08	ST58	SER	WG	XYLENES (TOTAL)	1330-20-7	8-Apr-93	16-Apr-93	Battelle PNL	Data Chem	8240	UG/L	28	5	U
58MW08D	ST58	SER	WG	XYLENES (TOTAL)	1330-20-7	8-Apr-93	18-Apr-93	Battelle PNL	Data Chem	8240	UG/L	45	5	U
58MW08TB	ST58	SER	WG	XYLENES (TOTAL)	1330-20-7	10-Apr-93	20-Apr-93	Battelle PNL	Data Chem	8240	UG/L	830	5	U
58MW09	ST58	SER	WG	XYLENES (TOTAL)	1330-20-7	10-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	5	5	U
58MW10	ST58	SER	WG	XYLENES (TOTAL)	1330-20-7	11-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	35	5	U
58MW11	ST58	SER	WG	XYLENES (TOTAL)	1330-20-7	11-Apr-93	21-Apr-93	Battelle PNL	Data Chem	8240	UG/L	39	5	U
58MW12	ST58	SER	WG	XYLENES (TOTAL)	1330-20-7	10-Apr-93	23-Apr-93	Battelle PNL	Data Chem	7421	UG/L	41	5	U
58MW01	ST58	SER	WG	LEAD	7439-92-1	10-Apr-93	23-Apr-93	Battelle PNL	Data Chem	7421	UG/L	63	5	U
58MW02	ST58	SER	WG	LEAD	7439-92-1	9-Apr-93	23-Apr-93	Battelle PNL	Data Chem	7421	UG/L	40	5	U
58MW03	ST58	SER	WG	LEAD	7439-92-1	9-Apr-93	23-Apr-93	Battelle PNL	Data Chem	7421	UG/L	44	5	U
58MW04	ST58	SER	WG	LEAD	7439-92-1	9-Apr-93	23-Apr-93	Battelle PNL	Data Chem	7421	UG/L	110	5	U
58MW05	ST58	SER	WG	LEAD	7439-92-1	9-Apr-93	23-Apr-93	Battelle PNL	Data Chem	7421	UG/L	51	5	U
58MW06	ST58	SER	WG	LEAD	7439-92-1	8-Apr-93	23-Apr-93	Battelle PNL	Data Chem	7421	UG/L	48	5	U
58MW07	ST58	SER	WG	LEAD	7439-92-1	8-Apr-93	23-Apr-93	Battelle PNL	Data Chem	7421	UG/L	5	5	U
58MW08	ST58	SER	WG	LEAD	7439-92-1	8-Apr-93	23-Apr-93	Battelle PNL	Data Chem	7421	UG/L	130	5	U
58MW08D	ST58	SER	WG	LEAD	7439-92-1	10-Apr-93	23-Apr-93	Battelle PNL	Data Chem	7421	UG/L	89	5	U
58MW08TB	ST58	SER	WG	LEAD	7439-92-1	10-Apr-93	23-Apr-93	Battelle PNL	Data Chem	7421	UG/L	170	5	U
58MW09	ST58	SER	WG	LEAD	7439-92-1	11-Apr-93	23-Apr-93	Battelle PNL	Data Chem	7421	UG/L	180	5	U
58MW10	ST58	SER	WG	LEAD	7439-92-1	11-Apr-93	23-Apr-93	Battelle PNL	Data Chem	7421	UG/L	2	2	U
58MW11	ST58	SER	WG	LEAD	7439-92-1	11-Apr-93	23-Apr-93	Battelle PNL	Data Chem	7421	UG/L	2	2	U
58MW12	ST58	SER	WG	TPH-GASOLINE	TPH-G	6-Apr-93	25-Apr-93	Battelle PNL	Data Chem	8015	MG/L	2	2	U
58MW01	ST58	SER	WG	TPH-GASOLINE	TPH-G	6-Apr-93	25-Apr-93	Battelle PNL	Data Chem	8015	MG/L	2	2	U
58MW02	ST58	SER	WG	TPH-GASOLINE	TPH-G	6-Apr-93	25-Apr-93	Battelle PNL	Data Chem	8015	MG/L	2	2	U
58MW03	ST58	SER	WG	TPH-GASOLINE	TPH-G	6-Apr-93	25-Apr-93	Battelle PNL	Data Chem	8015	MG/L	2	2	U
58MW04	ST58	SER	WG	TPH-GASOLINE	TPH-G	6-Apr-93	25-Apr-93	Battelle PNL	Data Chem	8015	MG/L	2	2	U
58MW05	ST58	SER	WG	TPH-GASOLINE	TPH-G	6-Apr-93	25-Apr-93	Battelle PNL	Data Chem	8015	MG/L	2	2	U
58MW06	ST58	SER	WG	TPH-GASOLINE	TPH-G	6-Apr-93	25-Apr-93	Battelle PNL	Data Chem	8015	MG/L	2	2	U
58MW07	ST58	SER	WG	TPH-GASOLINE	TPH-G	6-Apr-93	25-Apr-93	Battelle PNL	Data Chem	8015	MG/L	2	2	U
58MW08	ST58	SER	WG	TPH-GASOLINE	TPH-G	6-Apr-93	25-Apr-93	Battelle PNL	Data Chem	8015	MG/L	2	2	U
58MW08D	ST58	SER	WG	TPH-GASOLINE	TPH-G	6-Apr-93	25-Apr-93	Battelle PNL	Data Chem	8015	MG/L	2	2	U
58MW08TB	ST58	SER	WG	TPH-GASOLINE	TPH-G	6-Apr-93	25-Apr-93	Battelle PNL	Data Chem	8015	MG/L	260	2	U
58MW09	ST58	SER	WG	TPH-GASOLINE	TPH-G	6-Apr-93	25-Apr-93	Battelle PNL	Data Chem	8015	MG/L	2	2	U
58MW10	ST58	SER	WG	TPH-GASOLINE	TPH-G	6-Apr-93	25-Apr-93	Battelle PNL	Data Chem	8015	MG/L	2	2	U
58MW11	ST58	SER	WG	TPH-GASOLINE	TPH-G	6-Apr-93	25-Apr-93	Battelle PNL	Data Chem	8015	MG/L	2	2	U
58MW12	ST58	SER	WG	TPH-GASOLINE	TPH-G	6-Apr-93	25-Apr-93	Battelle PNL	Data Chem	8015	MG/L	2	2	U

Notes:

(1) U = Constituent was analyzed for but not detected.

(2) B = Constituent was also detected in the associated blank.

Appendix C. (continued)

Sample ID	Source Area	OU	Sample Type Code	Analyte	CAS #	Sample Log Date	Analysis Date	Sample Contractor	Analysis Contractor	Analytical Method	Units	Concentration	Detection Limit	EPA Data Qualifier
58MW01	ST58	SER	WG	TPH-DIESEL	TPH-D	6-Apr-93	29-Apr-93	Battelle PNL	Data Chem	8015	MG/L	0.2	0.1	
58MW02	ST58	SER	WG	TPH-DIESEL	TPH-D	6-Apr-93	29-Apr-93	Battelle PNL	Data Chem	8015	MG/L	0.1	0.1	U
58MW03	ST58	SER	WG	TPH-DIESEL	TPH-D	6-Apr-93	29-Apr-93	Battelle PNL	Data Chem	8015	MG/L	0.1	0.1	U
58MW04	ST58	SER	WG	TPH-DIESEL	TPH-D	6-Apr-93	29-Apr-93	Battelle PNL	Data Chem	8015	MG/L	0.3	0.1	
58MW05	ST58	SER	WG	TPH-DIESEL	TPH-D	6-Apr-93	29-Apr-93	Battelle PNL	Data Chem	8015	MG/L	0.1	0.1	
58MW06	ST58	SER	WG	TPH-DIESEL	TPH-D	6-Apr-93	29-Apr-93	Battelle PNL	Data Chem	8015	MG/L	0.1	0.1	U
58MW07	ST58	SER	WG	TPH-DIESEL	TPH-D	6-Apr-93	29-Apr-93	Battelle PNL	Data Chem	8015	MG/L	0.1	0.1	
58MW08	ST58	SER	WG	TPH-DIESEL	TPH-D	6-Apr-93	29-Apr-93	Battelle PNL	Data Chem	8015	MG/L	0.7	0.1	
58MW08D	ST58	SER	WG	TPH-DIESEL	TPH-D	6-Apr-93	29-Apr-93	Battelle PNL	Data Chem	8015	MG/L	0.8	0.1	
58MW08TB	ST58	SER	WG	TPH-DIESEL	TPH-D	6-Apr-93	29-Apr-93	Battelle PNL	Data Chem	8015	MG/L	0.1	0.1	
58MW09	ST58	SER	WG	TPH-DIESEL	TPH-D	6-Apr-93	29-Apr-93	Battelle PNL	Data Chem	8015	MG/L	99	0.1	
58MW10	ST58	SER	WG	TPH-DIESEL	TPH-D	6-Apr-93	29-Apr-93	Battelle PNL	Data Chem	8015	MG/L	7	0.1	
58MW11	ST58	SER	WG	TPH-DIESEL	TPH-D	6-Apr-93	29-Apr-93	Battelle PNL	Data Chem	8015	MG/L	0.1	0.1	
58MW12	ST58	SER	WG	TPH-DIESEL	TPH-D	6-Apr-93	29-Apr-93	Battelle PNL	Data Chem	8015	MG/L	0.3	0.1	

Notes:

- (1) U = Constituent was analyzed for but not detected.
(2) B = Constituent was also detected in the associated blank.

Appendix D

Base Civil Engineering Work Clearance Request

BASE CIVIL ENGINEERING WORK CLEARANCE REQUEST				DATE PREPARED	
1. Clearance is requested to proceed with work at <u>Seamark & Webster and Division</u> on Work Order/Job No. _____, Contract No. _____, involving excavation or utility disturbance per attached sketch. The area involved ☐ Has ☐ Has not been staked or clearly marked.					
2. TYPE OF FACILITY/WORK INVOLVED					
A. PAVEMENTS ☐ OVERHEAD ☐ UNDERGROUND	B. DRAINAGE SYSTEMS	C. RAILROAD TRACKS	D. FIRE DETECTION AND PROTECTION SYSTEMS	E. UTILITY ☐ OVERHEAD ☐ UNDERGROUND	F. COMM. ☐ OVERHEAD ☐ UNDERGROUND
G. AIRCRAFT OR VEHICULAR TRAFFIC FLOW					
H. SECURITY					
I. OTHER (Specify)					
3. INSTRUCTIONS: The BCE work clearance request is used for any work (contract or in house) that may disrupt aircraft or vehicular traffic flow, base utility services, protection provided by fire and intrusion alarm system, or routine activities of the installation. This form is used to coordinate the required work with key base activities and keep customer inconvenience to a minimum. It is also used to identify potentially hazardous work conditions in an attempt to prevent accidents. The work clearance request is processed just prior to the start of work. If delays are encountered and the conditions at the job site change (or may have changed) this work clearance request must be reprocessed.					
4. DATE CLEARANCE REQUIRED <u>1 June 93</u>			5. DATE CLEARANCE TERMINATED <u>1 Sept 93</u>		
6. REQUESTING OFFICIAL (Signature) <u>W B Lewis</u>			7. PHONE NO.		8. ORGANIZATION <u>343 CES/CEVR</u>
CLEARANCE REVIEW					
ORGANIZATION		REMARKS		REVIEWER'S NAME AND INITIALS	
BASE CIVIL ENGINEERING	9. A. ELECTRICAL DISTRIBUTION		OK 7-4235		OK [Signature]
	B. STEAM DISTRIBUTION		OK		Km C
	C. WATER DISTRIBUTION		OK		Km C
	D. POL DISTRIBUTION		OK		[Signature]
	E. SEWER LINES		OK		Km C
	F. DRAINAGE SYSTEMS		OK		[Signature]
	G. PAVEMENTS, GROUNDS, RAILROADS		OK		[Signature]
	H. FIRE DEPARTMENT		OK		[Signature]
	I. ENGINEERING & ENVIRONMENTAL PLANNING		OK		KDS
	J. CATHODIC PROTECTION				
K. OTHER CEVN		OK.		[Signature]	
10. SECURITY POLICE		OK		[Signature]	
11. SAFETY		OK 7-130-1		[Signature]	
12. COMMUNICATIONS		OK		THOMAS B. JONES [Signature]	
13. BASE OPERATIONS		N/A		[Signature]	
14. COMMERCIAL UTILITY COMPANY (Telephone, Gas, Electrical, etc.)					
15. OTHER (Specify)					

16. REMARKS (This section must describe specific precautionary measures to be taken before and during work accomplishment. Specific comments concerning the approved method of excavation, hand or powered equipment should be included.)

REQUESTED CLEARANCE

☒ APPROVED

☐ DISAPPROVED

DATE

SIGNATURE OF APPROVING OFFICER (Chief of Operations or Chief of Engineering and Environmental Planning)

1 Jul 43

Andrew E. Schumacher

• U.S. GOVERNMENT PRINTING OFFICE: 1989-243-379: 192527

Appendix E
Surveyor's Report

KALEN & ASSOCIATES, INC.
1041 Chena Ridge Road
FAIRBANKS, ALASKA 99709

LETTER OF TRANSMITTAL

(907) 479-2628 479-2656

TO Battelle Environmental Services
Organization
Grubbs AFB, AK

DATE	6-3-93	JOB NO.	9318
ATTENTION	Don Klover		
RE:	Agency of ST 58' Avial. at Grubbs AFB, AK		

WE ARE SENDING YOU ☒ Attached ☐ Under separate cover via _____ the following items:

- ☐ Shop drawings ☐ Prints ☐ Plans ☐ Samples ☐ Specifications
☐ Copy of letter ☐ Change order ☐ _____

COPIES	DATE	NO.	DESCRIPTION
1			Report w/ copy of original field notes
3			Computer Printout of Point data
3			Sketches of topographic Map

THESE ARE TRANSMITTED as checked below:

- ☐ For approval ☐ Approved as submitted ☐ Resubmit _____ copies for approval
☒ For your use ☐ Approved as noted ☐ Submit _____ copies for distribution
☐ As requested ☐ Returned for corrections ☐ Return _____ corrected prints
☐ For review and comment ☐ _____
☐ FOR BIDS DUE _____ 19 _____ ☐ PRINTS RETURNED AFTER LOAN TO US

REMARKS _____

COPY TO _____

SIGNED: Susan K. Klover

PROCESS (245) (NBS) Inc. Canton, Mass. 01021

If enclosures are not as noted, kindly notify us at once.

KALEN & ASSOCIATES, Inc.: Engineers & Surveyors

Land Surveys • Mineral Surveys • Subdivisions
Civil Engineering • Forensic Expertise • CADD

SURVEYOR'S REPORT

SURVEY OF ST 58 GRID

EIELSON AIR FORCE BASE, ALASKA

BATTELLE ENVIRONMENTAL SERVICES ORGANIZATION

June 3, 1993

Kalen & Associates, Inc. performed the topographic survey of 91 flagged locations at site ST58 at Eielson AFB, Alaska on May 28, 1993. The locations were taken on a grid of 300 feet by 150 feet. Vertical elevations were taken to the nearest 0.1 foot and horizontal coordinates to the nearest 0.02 foot. Field work was accomplished with a Hewlett-Packard 3820A Total Station and TDS-500 Data Collector.

The data for all locations was then processed using Softdesk Engineering software, and the topographic map prepared using AutoCAD Release 11 working with Softdesk.

This Report includes a Print-out of the Northing, Easting, and elevation for all points, a topographic map showing point numbers, elevations, descriptions, and their relationship to control points EF 12 and EF 26, which are U.S. Army Corps of Engineers brass cap control monuments at Eielson AFB, and copies of original field notes.

I CERTIFY that the information shown on the computer print-out and the topographic map is a true and accurate representation of the survey as performed under my direct supervision.

1041 Chena Ridge Road

Fairbanks, AK 99709

907-479-2628 / 2656

Fax 907-479-8830

Kalen & Associates, Inc.
1041 Chena Ridge Road
Fairbanks, Ak 99701
907-479-2656

Site St58 Grid

Point	Northing	Easting	Elevation	Description
1	229604.08	388160.07	540.5	ef28
2	229263.75	387284.77	543.8	ef12
3	231412.50	386435.93	542.2	ef13
4	230925.02	388280.59	541.3	ef26
101	229358.53	387258.11	541.7	A1
102	229381.75	387249.24	541.7	B1
103	229405.13	387240.27	541.5	C1
104	229428.41	387231.27	541.7	D1
105	229451.59	387222.32	541.3	E1
106	229475.10	387213.38	541.1	F1
107	229498.44	387204.57	540.7	G1
108	229489.48	387181.23	540.4	G2
109	229466.02	387190.15	540.8	F2
110	229442.57	387199.22	541.3	E2
111	229419.38	387208.13	541.4	D2
112	229396.10	387217.17	541.7	C2
113	229372.84	387226.14	541.7	B2
114	229349.46	387234.77	541.6	A2
115	229340.51	387211.47	541.4	A3
116	229363.73	387202.79	541.6	B3
117	229387.06	387193.82	541.6	C3
118	229410.34	387184.82	541.3	D3
119	229433.67	387175.89	541.3	E3
120	229456.95	387166.94	540.7	F3
121	229480.38	387157.91	540.2	G3
122	229471.43	387134.46	540.0	G4
123	229447.51	387142.60	540.5	F4
124	229424.49	387152.57	541.2	E4
125	229401.26	387161.66	541.4	D4
126	229377.90	387170.52	541.6	C4
127	229354.68	387179.72	541.6	B4
128	229331.30	387188.38	541.2	A4
129	229322.39	387164.93	541.2	A5
130	229345.58	387156.29	541.5	B5
131	229368.83	387147.22	541.5	C5
132	229392.15	387138.15	541.5	D5
133	229415.48	387129.13	541.3	E5
134	229438.95	387120.36	540.5	F5
135	229462.26	387111.24	540.0	G5
136	229453.19	387087.92	539.8	G6
137	229429.77	387096.99	540.4	F6
138	229406.38	387106.00	541.3	E6
139	229383.05	387114.93	541.6	D6
140	229359.84	387123.93	541.5	C6

Site ST58 Grid

141	229336.51	387132.97	541.5	B6
142	229313.34	387141.73	541.3	C6
143	229304.17	387118.36	541.3	A7
144	229327.45	387109.67	541.5	B7
145	229350.78	387100.62	541.6	C7
146	229374.07	387091.80	541.6	D7
147	229397.36	387082.54	541.2	E7
148	229420.72	387073.71	540.5	F7
149	229444.05	387064.66	539.8	G7
150	229434.97	387041.29	539.5	G8
151	229411.57	387050.48	540.4	F8
152	229388.11	387059.32	541.1	E8
153	229364.96	387068.47	541.5	D8
154	229341.59	387077.37	541.5	C8
155	229318.40	387086.44	541.5	B8
156	229295.18	387095.22	541.2	A8
157	229285.97	387071.47	541.1	A9
158	229309.35	387062.93	541.4	B9
159	229332.78	387054.08	541.4	C9
160	229355.86	387045.11	541.2	D9
161	229378.93	387036.02	540.7	E9
162	229402.54	387026.99	540.0	F9
163	229425.82	387018.15	539.0	G9
164	229416.93	386994.73	538.6	G10
165	229393.51	387003.93	539.6	F10
166	229370.16	387012.90	540.5	E10
167	229346.74	387021.85	540.8	D10
168	229323.57	387030.90	541.1	C10
169	229300.35	387039.57	541.0	B10
170	229277.03	387048.29	540.9	A10
171	229267.76	387025.20	540.5	A11
172	229291.38	387016.43	540.6	B11
173	229314.70	387007.51	540.4	C11
174	229337.86	386998.52	540.4	D11
175	229361.11	386989.46	540.0	E11
176	229384.35	386980.54	539.2	F11
177	229407.68	386971.73	538.3	G11
178	229398.78	386948.28	537.7	G12
179	229375.41	386957.14	538.7	F12
180	229352.00	386966.25	539.3	E12
181	229328.72	386975.37	539.5	D12
182	229305.62	386984.21	539.4	C12
183	229282.35	386993.04	539.8	B12
184	229258.86	387002.00	540.0	A12
185	229249.64	386978.72	539.5	A13
186	229273.27	386969.94	539.1	B13
187	229296.72	386960.73	538.3	C13
188	229319.51	386952.16	538.4	D13
189	229342.75	386942.98	538.3	E13
190	229366.16	386933.94	537.8	F13
191	229389.52	386924.78	537.6	G13

Don Sutton X M Eielson AFB #9318 5/28/73
 LESS ATHERTON 65°F SUNNY
 H.P. 3826A (582) P.P.M +5 8:00 AM
 182026

Note: Point #2 = EF 12 - ELEV. = 543.78
 Point #4 = EF 26 - ELEV. = 541.27

T. Q. N #2 B.S. #4 H.I. 5.44

Point Desc.

101	GND @ A1	Points # 101-169
"	" @ B1	were shot w/ 5.00 Rod
"	" C1	All DATA Collector
"	" D1	H.R. is 5.56
105	" E1	
"	" F1	
"	" G1	
"	" G2	
"	" F2	
"	" E2	
"	" O2	
112	" C2

182027

5/28/93

080531

6 ON # 2 B.S # 4 cont.

POINT# Descr.

113	GND	@ B2
	"	@ A2
114	"	@ A3
	"	@ B3
	"	@ C3
	"	@ D3
	"	@ E3
120	"	@ F3
	"	G3
	"	G4
	"	F4
	"	E4
125	"	D4
	"	C4
	"	B4
	"	A4
	"	A5
130	"	B5
	"	C5
132	"	D5

182029

5/28/93

TON # 2 B.S. # 4 CONT.

Point# Descr.

152 GND. 0 E 8

" " D 8

" " C 8

155 " " B 8

" " A 8

" " A 9

" " B 9

" " C 9

" " D 9

" " E 9

" " F 9

" " G 9

" " G 10

" " F 10

165 " " E 10

" " D 10

" " C 10

" " B 10

" " A 10

7.00 ROD

Note: Point # 169
Back Thru # 101 were
shot w/ 5.00 ROD.
Red hieght in DATA
collector is 5.52

182030

5/28/93

CON #2 B.S. #4

POINT # Descr.

171 GND. @ A11

" " B11

" " C11

174 " " D11

NOTE: DATA collector

RAN OUT OF POWER AT

POINT # 175

Notes resume on

pg. 31

ROD	ELEV
500	539.98
	539.19
	538.31
	537.73
	538.70
	539.26
	539.51
	539.41
	539.80
	539.95
	539.49
	539.10
	538.34
	538.36
	538.29
	537.84
	537.64

T. ON	#2	B.S. #4	H.I.	5.44 (new)
F3	GRID PT3			
#	H & RT	HD		VD
175 E11	257.18.26	310.95	-	4.24
F11	260.41.00	327.26	-	5.03
G11	263.45.11	344.54	-	5.91
G12	260.55.30	362.57	-	6.49
F12	257.52.48	346.14	-	5.52
180 E12	254.32.44	330.52	-	4.96
D12	250.55.12	316.15	-	4.71
G12	246.59.24	303.46	-	4.81
B12	242.42.27	292.32	-	4.42
A12	238.04.11	282.81	-	4.27
185 A13	236.25.15	306.37	-	4.73
B13	240.47.30	314.97	-	5.21
C13	244.52.12	325.71	-	5.88
D13	248.34.34	337.25	-	5.86
E13	252.04.29	350.80	-	5.93
F13	255.19.58	365.47	-	6.38
191 G13	258.19.05	381.33	-	6.58

Appendix F
Surface Geophysical Surveys Report

SURFACE GEOPHYSICS EVALUATION OF SOURCE AREA ST58 OLD QUARTERMASTER SERVICE STATION

PURPOSE

A shallow electromagnetic survey was performed by Battelle Pacific Northwest Laboratories (PNL) at source area ST58, the old Quartermaster service station, to help locate underground piping in support of the Source Area Characterization Plan (PNL May 1993). In addition, a radio wave pipe survey was conducted by Eielson Air Force Base (AFB) to aid in this task. The suspected underground piping locations were staked to optimize residual product and piping removal.

INSTRUMENT OPERATING PRINCIPLE

The electromagnetic investigation was performed using a Geonics, Ltd. EM-31 instrument. The EM-31 measures ground conductivity non-invasively by inducing circular eddy currents in the subsurface from a transmitter coil on one end of the instrument. The underground current loops, of which the magnitudes are directly proportional to terrain conductivity, generate a secondary magnetic field. This magnetic field is intercepted and measured by a receiver coil on the other end of the instrument. The output voltage measured by the receiver is linearly related to the terrain conductivity.

Two components of the induced magnetic field are measured and digitally displayed by the EM-31: the quadrature and in-phase components. The quadrature phase component gives the ground conductivity measurement while the in-phase component is used primarily for calibration purposes, but is very sensitive to large metallic objects.

The EM-31 is very sensitive to lateral changes in terrain conductivity in the top three meters of the subsurface. Therefore, when the tool is passed over an underground metallic object, which is a very good electrical conductor, a significant deflection will occur on the digital meter display. If the tool crosses a length of buried pipe with the tool's long axis perpendicular to the pipe axis the reading profile will be characterized by two maxima on either side of the pipe and a minimum directly above the pipe. It is then possible to accurately determine the location and strike of the buried pipe by making a traverse with the EM-31 pointed in the direction of the pipe axis. Now the meter reading will be a positive maximum when the instrument is both directly over the pipe and pointing along its axis. However, this profile will be complicated by the proximity of adjoining and nearby pipes. Nevertheless, the presence of any significant buried metallic object in the top

three meters of the ground will produce a recognizable anomaly in the readings.

The radio wave pipe survey carried out by Eielson AFB uses a radio transmitter and receiver. The transmitter is attached to an above surface section of the pipe whose underground location is being targeted. The pipe then acts as an antenna which transmits the radio signals. The stand-alone, hand-held receiver measures the intensity of the transmitted radio signals using an analog meter. Maximum readings should occur directly above the pipe of interest.

SURVEY PROCEDURES

Initial Investigation

Prior to any measurements a 300 ft by 150 ft grid was surveyed onto the site. Grid nodes were staked every 25 ft. For the initial investigation in-phase and quadrature phase measurements were taken at every grid node with the tool facing parallel to Wabash Ave. General regions on the grid where anomalous readings occurred were demarcated from this initial data set.

At this time personnel from Eielson AFB also performed their radio wave pipe survey. They attached the radio transmitter to a pipe inlet across Wabash Ave. from the site. By locating points of maximum measure signal with their receiver they were able to delineate several sections of buried feeder pipe.

Follow-up Investigations

The first follow-up was to take measurements at the grid points in the anomalous regions with the tool facing perpendicular to Wabash Ave. (90 degrees to the initial tool orientation). This helped to clarify the orientation of buried metal objects.

It was decided that the spacing of the data points was not providing enough resolution for the very sensitive measurements so readings were taken halfway between the grid nodes. The higher resolution data helped to identify the location of maxima and minima readings on the grid.

A final follow-up investigation was performed to try to determine the strike of possible buried pipes and to walk along their lengths. This was accomplished by finding a minima measurement point and rotating the tool on that point to find the orientation that gave the highest reading. If the buried object was a pipe then the tool direction was parallel to the pipe length.

CONCLUSIONS

A non-invasive surface geophysical investigation was performed at source area ST58, the old quartermaster service station, to help identify the location of underground piping before soil sampling and excavating were carried out.

The radio wave pipe survey completed by Eielson AFB was able to delineate the two main feeder pipes entering the site under Wabash Ave., but lost the radio signal from there.

The EM-31 electromagnetic survey completed by PNL identified regions in the site where buried metallic material is likely present. A contour map representation of the conductivity results is shown in Figures 1 and 2. A number of particular buried pipe sections were also traced. The location of underground piping interpreted from the EM-31 measurements is shown in Figure 3.

UNCERTAINTIES

The EM-31 measures subsurface conductivity to a depth of no more than 3 meters. If the measurement profile across a buried metal object is clean the lateral resolution of the tool is very good, on the order of one foot. However, if the object has an abnormal shape or orientation, or is surrounded by other metallic objects, the lateral resolution is decreased. This occurs because the tool starts measuring the effects of a large buried conductor as much as 10 feet before crossing it. From the large, wide anomalies in the EM-31 data the ST58 site appears to contain a significant amount of buried metallic debris. This made it difficult to identify singular pipes. The pipe locations that were delineated from the data seemed to have distinctive signatures, but it is entirely possible that some of these locations were misinterpreted due to the complex interaction of many anomalies.

The radio signals transmitted in a radio wave pipe survey attenuate and become harder to detect with distance and branching of the pipe. Also, discontinuities or breaks in the pipe will severely hinder transmission of the radio signals making detection of the pipe very difficult.

Figure 1.
EM-31 North-South Conductivity Results

Figure 2.
EM-31 East-West Conductivity Results

EM-31 Electromagnetic Survey Results With Interpreted Underground Pipe Locations at ST58

- EM-31 Conductivity Measurements (in Mmho) With Tool Axis Parallel to Wabash Ave.
- Interpreted Underground Pipe Locations

Figure 3.

Appendix G
Petrex Method Report

**FINAL REPORT
ON THE FINDINGS OF THE PETREX SOIL GAS SURVEY
PERFORMED AT EIELSON AIR FORCE BASE
IN ALASKA**

**PREPARED FOR:
BATTELLE PACIFIC NORTHWEST LABORATORIES**

PREPARED BY:

NANCY F. GAINES
FIELD GEOLOGIST

DATE:

8/19/93

APPROVED BY:

MARK H. HATHEWAY
MANAGER OF ENVIRONMENTAL OPERATIONS

DATE:

8/19/93

**NORTHEAST RESEARCH INSTITUTE, INC.
309 FARMINGTON AVENUE, SUITE A-100
FARMINGTON, CONNECTICUT 06032-1943
TELEPHONE (203) 677-9666
FAX (203) 677-7008**

AUGUST 19, 1993

FR1894e

TABLE OF CONTENTS

1.0	INTRODUCTION	01
2.0	OBJECTIVES	01
3.0	FIELD ACTIVITIES	01
3.1	Survey Design	01
4.0	METHOD QA/QC	01
4.1	Blanks	01
5.0	RESULTS	02
6.0	DISCUSSION	02
6.1	BTEX Relative Response Map	03
6.2	TCE Relative Response Map	03
6.3	Cycloalkanes/Alkenes Relative Response Map	03
7.0	TD-GC/MS Results	03
8.0	NOTICE	04

Appendix A: Petrex Protocol

Appendix B: Relative Response Maps, Plates 1-4

Appendix C: Mass Spectra

Appendix D: Table of Data

1.0 INTRODUCTION

Battelle Pacific Northwest Laboratories has conducted a Petrex soil gas survey at Eielson Air Force Base in Alaska utilizing samplers provided by Northeast Research Institute, Inc. (NERI). The purpose of this survey was to screen the site for volatile organic compounds and semivolatile organic compounds (VOCs and SVOCs) which may be present in the soil gas as constituents of fuel products such as gasoline and arctic diesel. The results will be used to assess the presence or potential for soil and/or groundwater contamination and to determine the magnitude and areal extent of any contamination detected.

2.0 OBJECTIVES

The objectives of this soil gas survey were to:

1. Collect and report VOCs and SVOCs in the soil gas;
2. Map the areal extent of reported compounds; and
3. Attempt to indicate source areas and migration/dispersion pathways.

3.0 FIELD ACTIVITIES

All field work was conducted by Battelle Pacific personnel. A description of typical field methods is provided in the Petrex Protocol, Appendix A.

4.0 METHOD QA/QC

A description of the Petrex QA/QC procedures is provided in Appendix A in the Petrex Protocol.

4.1 Travel Blanks

Two Petrex samplers, which remained sealed, traveled with the survey samplers to the field and back to the laboratory. These two travel blanks were analyzed concurrently with the survey samplers under the same operating conditions on the mass spectrometer. Results of analysis of the travel blanks showed no ion counts present other than normal atmospheric compounds and instrument noise.

5.0 RESULTS

All samplers were analyzed by NERI's standard method of Thermal Desorption/Mass Spectrometry (TD-MS). The results are summarized on the plates listed below which are located in Appendix B.

Plate 1: Sample Numbers and Locations Map

Plate 2: Benzene, Toluene, Ethyl Benzene/Xylenes (BTEX) Relative Response Map

Plate 3: Trichloroethene (TCE) Relative Response Map

Plate 4: Cycloalkanes/Alkenes Relative Response Map

The mass spectra are provided in Appendix C.

These VOCs were found to be the most prominent compounds in the soil gas. In order to map the reported compounds, mass spectral peaks indicative of the compounds were selected and their corresponding ion counts were summed and plotted. Table 1 lists the reported compounds and their selected indicator peaks.

TABLE 1
Reported Compounds and Their Indicator Peak(s)

<u>Reported Compound</u>	<u>Indicator Peak(s)</u>
BTEX	78,92,106
TCE	130
Cycloalkanes/Alkenes	84,98,112,126

6.0 DISCUSSION

The soil gas response levels discussed in the following section are described as high and moderate relative to the entire data set. The ion count values that have been reported represent qualitative soil gas values that were evaluated relative to the other sampler locations.

Ion count values are the unit of measure generated by the mass spectrometer to illustrate the relative intensities associated with each of the reported compounds. These response levels do not represent an actual concentration of the reported compounds but are used to differentiate source areas from migration/dispersion pathways.

For a complete discussion of relative response map evaluation, please refer to the Petrex Protocol, Appendix A.

6.1 Benzene, Toluene, Ethyl Benzene/Xylenes (BTEX) Relative Response Map

Plate 2 represents the survey response for the presence of BTEX in the soil gas. Areas of high response appeared near the northeastern corner and near the center of the survey area. A small area of high response appeared along the south central edge of the survey area. Areas of more moderate response surrounded these zones. Another area of moderate response appeared in the northwestern corner of the survey area. Smaller areas of more moderate response appeared along the east central edge and the west central edge of the survey area. The source area for BTEX appeared near the center and near the northeastern corner of the survey area. A specific migration pathway is not evident from the soil gas data.

6.2 Trichloroethene (TCE) Relative Response Map

Plate 3 represents the survey response for the presence of TCE in the soil gas. Areas of high response appeared near the center and near the northeastern corner of the survey area. Areas of more moderate response uniformly surrounded these zones. A small area of moderate response appeared along the south central edge of the survey area. The source areas for TCE appeared to be near the center and near the northeastern corner of the survey area. A specific migration pathway is not evident from the soil gas data. Batelle had reported that TCE may have been an additive to arctic diesel.

6.3 Cycloalkanes/Alkenes Relative Response Map

Plate 4 represents the survey response for the presence of cycloalkanes/alkenes in the soil gas. Areas of high response appeared near the center, near the northeast corner, near the northwestern corner and along the south central edge of the survey area. Areas of more moderate response surrounded these zones. Additional small areas of moderate response appeared along the northwestern edge, northwest of the center, southwest of the center, in the southwestern corner, and near the southeastern corner. The source areas for cycloalkanes/alkenes appeared near the center and near the northeastern corner of the survey area. A specific migration pathway is not evident from the soil gas data.

7.0 THERMAL DESORPTION-GAS CHROMATOGRAPHY/MASS SPECTROMETRY RESULTS

The second soil gas collector wire from samplers 39, 48, 49, 55, 57, 65, 80, 81, and 93 were analyzed by TD-GC/MS. This analysis was performed to confirm the compounds which were reported from the TD-MS analysis, to identify unknowns, and to clarify interfering compounds.

The TD-GC/MS analysis method consisted of passing the desorbed gases through a chromatographic column prior to introduction into the mass spectrometer. This process separated the individual compounds and identified peaks without interference from co-occurring peaks. After all the data were recorded, compounds were identified by a computerized comparison to an internal library of compounds.

The results of the TD-GC/MS analysis are provided in a Table of Data in Appendix D. TD-GC/MS results can only be compared to the TD-MS results in terms of presence or absence of particular compounds. Since they are two different analysis methods, they cannot be compared in terms of ion count levels. The TD-MS analysis is generally more sensitive than the TD-GC/MS analysis, thus compounds which showed low ion count levels may not be detected by TD-GC/MS.

Overall, the results of the TD-GC/MS analysis confirm what was count in the TD-MS analysis. Moderate to high levels of several benzene isomers, pentane isomers, hexane isomers, Heptane isomers and cycloalkanes/alkenes were seen in samples 39, 49, 55, 80, and 81. Sample 39 also showed high levels of toluene, xylene, trimethyl decane, methyl propyl nonane, isooctane, and trimethyl octane. Sample 49 showed high levels of toluene, ethyl benzene, naphthalene, methyl propyl nonane, octane, and methyl octane. Sample 55 showed high levels of xylenes and methyl dodecane. Sample 81 showed high levels of xylenes and ethyl benzene, and low levels of toluene. Sample 80 showed moderate to high levels of ethyl benzene, xylenes, and naphthalenes, and low levels of toluene and octane.

Sample 48 showed low levels of benzene and a few benzene isomers. Sample 57 showed moderate levels of a few hexane isomers and pentane isomers, and low levels of benzene, toluene, and xylenes. Sample 65 showed low levels of benzene and toluene. Sample 93 showed low levels of toluene and methyl naphthalene.

8.0 NOTICE

In connection with this survey and associated interpretation, only a limited scope of work was performed by NERI. Therefore, NERI maintains that it has not defined the scope of the environmental condition of the site. Professional judgements made within the context of this report are based on technical data made available to NERI as well as data gathered during on-site activities performed by Battelle Pacific Northwest Laboratories. NERI assumes no responsibility for conditions which did not come to its actual knowledge, or conditions not generally recognized as environmentally unacceptable at the time this report was prepared.

APPENDIX A
PETREX PROTOCOL

REVISED AUGUST 1992

PETREX ENVIRONMENTAL SOIL GAS PROTOCOL

INTRODUCTION

The Petrex Technique provides a means by which trace quantities of gases from subsurface derived organic contaminants can be detected and collected at the earth's surface. The Technique is integrative, thereby eliminating the short-term variations associated with other gas/vapor detection methods. The Petrex Technique directly collects and records a broad range of organic compounds emanating from subsurface sources.

SOIL GAS COLLECTOR PREPARATION

Adsorption collector wires (after construction) are cleaned by heating to 358° C in a high vacuum system.

Wires are packed under an inert atmosphere in glass culture tubes.

One collector out of every batch of thirty is checked for cleanliness by mass spectrometry. Another collector from the batch is checked for adsorptive capability. Based on the results, the batch of collectors is approved for release into the field.

SOIL GAS SAMPLER INSTALLATION

The sampler consists of two collectors, each a ferromagnetic wire coated with an activated carbon adsorbent in a screw top glass culture tube. Each sampler is typically placed in a shallow hole, 14-18 inches deep. The hole is backfilled and the location is marked. The sampler is left in the ground from one to thirty days, then retrieved and sealed for transportation back to the laboratory for analysis.

The Petrex soil gas sampling technique is adaptable to various surface conditions commonly encountered within survey areas. These surfaces typically include concrete, asphalt, grass, and gravel. Two installation methods are routinely utilized to adapt to these surface conditions.

The first method utilizes a coring shovel for sampler installations in grass or otherwise loosely consolidated soil conditions. The shovel cores a 14 inch deep by 2 inch diameter hole in the surface soils.

Petrex soil gas samplers are placed (open end down) at the bottom of each core hole. The samplers are then backfilled with an aluminum foil plug and the original excavated soil. To complete installation, sample locations are marked with ribbon flagging and a numbered pin flag, as well as entered into a field notebook and plotted on a field map.

The second method of sampler installation utilizes an electric rotary hammer, equipped with an 18 inch by 1.5 inch diameter drill bit, for sampler installations under concrete, asphalt, or otherwise consolidated conditions. A hole is drilled through the surface to the dimensions of the drill bit equipped to the rotary hammer.

Petrex soil gas samplers are placed at the bottom of each drilled hole. For retrieval purposes, a cleaned galvanized steel wire is attached to each sampler. Aluminum foil is used to plug each hole to approximately two inches below grade. Then each hole is capped to grade with hydraulic cement. The hydraulic cement serves as protection from the external surface environment.

To complete sampler installation, sampler locations are marked with paint (where applicable), entered into a field notebook, and plotted on a field map.

SOIL GAS SAMPLER RETRIEVAL

Petrex soil gas samplers are retrieved following a time period that has allowed for the soil gas emanating from the subsurface environment of a survey area to equilibrate with the installed Petrex samplers. This time integration period is determined for each Petrex soil gas survey based on time calibration data or site conditions.

Retrieval operations are dependent on surface conditions and routinely consist of the following two methods.

The first method applies to grass covered or loosely consolidated soil conditions. A trowel is utilized to expose the backfilled samplers; then with a pair of tongs, the samplers are brought to the surface. At the surface, the samplers are sealed, cleaned, and labeled. Following retrieval, all debris are gathered and the core hole is backfilled with original material.

The second method applies to concrete, asphalt, or other consolidated surface conditions. A hammer and chisel is utilized to remove the hydraulic cement plug and expose the sampler. By means of the pre-attached retrieval wire, the sampler is brought to the surface. At the surface, the retrieval wire is removed and the sampler is sealed, cleaned, and labeled.

Following retrieval, each drill hole is backfilled and patched with cement or asphalt.

TIME CALIBRATION SAMPLERS

Time calibration samplers are included in Petrex soil gas surveys, as appropriate. These samplers are included as a means of monitoring the loading rates of volatile and semivolatile organic compounds (VOCs and SVOCs) emanating from the soil gas at a survey area onto the Petrex collectors.

During Petrex sampler installation, two sets of three to five time calibration samplers are also installed at survey sample locations that best represent the range of soil gas response for the survey area. These representative locations are determined based on previous soils and/or groundwater studies and other site specific conditions such as gradient and potential source areas.

The first set of time calibration samplers are generally retrieved within a week or less following the initial installation and the second set one week later. Often, permanent on-site personnel are instructed to perform time calibration sampler retrieval.

Lengths of exposure periods of the survey samplers for each survey are determined based on the results of each respective set of time calibration samplers. Time calibration samplers are usually analyzed within 24 hours upon receipt at the laboratory. At the first indication of significant relative ion count intensities and significant total ion count values, the decision is made to retrieve the entire complement of survey samplers.

If there are no significant relative ion count intensities detected from the second set of time calibration samplers, then the survey samplers are allowed to equilibrate in the field for a maximum time period of up to 30 days. The average environmental Petrex soil gas survey requires a collector integration period of one day to two weeks.

METHOD QA/QC

Within every survey sampler, two or more collector wires should have adsorbed identical compounds. Like compounds on separate collectors relate an acceptable quality assurance (QA) during the survey's analysis. The first wire is analyzed by Thermal Desorption/Mass Spectrometry (TD/MS). The data from the first wire is reported on the relative response maps. The second wire is retained for analysis by Thermal Desorption-Gas Chromatography/Mass Spectrometry (TD-GC/MS), if warranted by the initial TD/MS analysis of the second wire.

Approximately ten percent of the total Petrex survey samplers contain three collector wires. The third collector wire, a QC collector wire, is used by the operator to test the mass spectrometer's operating conditions prior to survey analysis. Some of these quality control (QC) collectors are also used to check the mass spectrometer sensitivity during survey analysis. In addition, the QC collector may be used to compare the reproducibility of the detected VOCs.

TRAVEL BLANKS

Two Petrex samplers, each containing a single collector wire, are included with each Petrex soil gas survey as travel blanks. These blanks are analyzed with the survey samplers to indicate whether there may have been contamination introduced to the survey samplers during installation or shipment. If compounds other than normal atmospheric (e.g., CO₂, H₂O, N₂, and Ar) are detected on the blanks, then blank subtraction may be performed on the survey's data set. This process, an initial step to data interpretation, involves the correction of ion flux values of the detected blank contaminants from the entire survey's data set. The resulting ion flux values are provided on the relative response maps.

MASS SPECTROMETER TUNING

An Extranuclear Quadrupole Mass Spectrometer or similar instrument, equipped with a Curie-point pyrolysis/thermal desorption inlet, is used for collector analysis. Mass assignment and resolution are manually adjusted using a Perfluorotributylamine (PFTBA) standard or a built-in tuning program, depending on the instrument. A linear correction, based on the known spectrum of PFTBA, is calculated. This correction is applied to a second PFTBA spectrum. If correct mass (M/Z) values are obtained, the operator proceeds to the next tuning step. If not, Step 1 is repeated until correct masses are obtained.

Peak intensity ratios are set from the major peaks in the PFTBA spectrum using the following values:

Mass (M/Z)		Spectrum Intensities
69	=	100%
131	=	48% ± 5%
219	=	50% ± 5%

During tuning, the ion signal for mass (M/Z) 69 of PFTBA is measured at a preset sample pressure and detector voltage and compared to previous values at the same setting.

Electron energy is set to 70 electron volts. All other operating parameters, such as scans, scan range, and mass offset, are established in the computer program. These values may only be changed by the laboratory manager.

Tuning is performed at the beginning of a run so that an individual survey is analyzed at the same set of instrument conditions. The samplers are analyzed in random order.

LABORATORY ANALYSIS

Periodic machine background and blank Petrex collector analyses are performed to assure that there is no carry-over between successive samplers. If there are peaks present which are not related to atmospheric gases, the supervisor is notified and the mass spectrometer is shut down and cleaned as necessary.

A written sample number record is kept during the analysis to prevent accidental cross numbering.

The mass spectrometer control program contains appropriate "flag statements" that prompt the operator with a warning if an input sample number has already been analyzed. The operator then checks the current number, along with the disk storage location of the previously entered number to identify the true numbering situation.

COMPOUND IDENTIFICATION

Compound identification is based on molecular weight, compound fragmentation, and isotope distribution, as applicable. Each VOC exhibits a unique mass spectral signature. NERI maintains a large library of spectra of individual compounds, accessible by computer. In addition, the company maintains a large library of mass spectra of commonly used chemical mixtures; e.g., gasolines, diesels, industrial oils and solvents, coatings, plastics, etc. These are used to assist in both compound and mixture identifications.

The ion count response of an indicator peak(s), representative of the compound and away from interference by other compounds, is extracted for data presentation and mapping.

INTERPRETATION OF SOIL GAS DATA

Soil gas data (including Petrex) reflect volatile and semivolatile organics collected at a point in the near surface. The sources of these volatile organics may be in the stratigraphic column and/or in groundwater below the collection point. Thus, the organics can be derived from surface spills, deposition, or migration into the deeper vadose zone, and groundwater. The soil gas survey reveals the areal extent of contamination and is the optimum guide in identifying areas in order to develop a vertical profile, including the drilling of soil borings and monitoring wells.

Soil gas data are always semi-quantitative in that multiple sources in soil and/or groundwater cannot be differentiated. However, the higher ion responses are representative of higher concentrations in the subsurface, given that geologic conditions are relatively consistent.

Due to chemical differences between individual compounds, including their ability to both adsorb and desorb from the charcoal Petrex collector element, it is invalid to compare the compound ion count at one sampling location to that of another compound.

Patterns of compound distribution in the soil gas, as detected at the surface, can be strongly influenced by irregularities in the near surface and subsurface environment through which the soil gas diffuses. These irregularities include subsurface man-made structures, such as concrete foundations, drainage systems, and wells, and such naturally occurring structures as fractured and unfractured bedrock, clay, and shale lenses.

Other factors influencing the soil gas signal include ground and surface water, the free carbon content of soils, microbiotic activity in the soil, and natural and synthetic ground cover.

All of these factors indicate that the most powerful use of soil gas data is in reconnaissance; identifying and mapping the relative abundance of the widest array of chemical species and mixtures. Efforts to relate soil gas response directly to groundwater or soil contaminant concentrations is generally not regarded as productive owing to the assumptions that are required for heterogeneity and source distribution.

RELATIVE RESPONSE DETERMINATION AND MAPPING

The relative response values are reported as the ion counts of indicator peaks for any given compound or mixture. Sample locations on a base map are digitized as X-Y coordinates and ion counts for the reported compounds are plotted at respective locations.

Mapping of the ion counts occurs after contour intervals for each compound or component class are determined. In order to establish the contour intervals, factors such as statistical analysis of ion count distribution, physiochemical considerations, and component-source material relationships (if known) are taken into account for each compound or class, in each area, on an individual basis. Each map is then contoured by hand. The resultant contour zones for each compound or component class in each area are color coded on a relative basis depending on whether the data are interpreted to be of high, moderate to high, moderate, etc., intensity. The response values found on each of the response maps are color coded and contoured on this basis.

APPENDIX B
RELATIVE RESPONSE MAPS, PLATES 1-4

DIVISION STREET

+ 90	+ 91	+ 92	+ 93	+ 94	+ 95 + 96	+ 97
+ 89	+ 88	+ 87	+ 86	+ 85	+ 84	+ 83
+ 75	+ 76	+ 77	+ 78	+ 79	+ 80 + 81	+ 82
+ 74	+ 73	+ 72	+ 71	+ 70	+ 69	+ 68
+ 61	+ 62	+ 63	+ 64	+ 65	+ 66	+ 67
+ 60	+ 59	+ 58	+ 57	+ 55 + 56	+ 54	+ 53
+ 45	+ 46	+ 47	+ 48	+ 49 + 50	+ 51	+ 52
+ 44	+ 43	+ 42	+ 41	+ 39 + 40	+ 38	+ 37
+ 30	+ 31	+ 32	+ 33	+ 34	+ 35	+ 36
+ 29	+ 28	+ 27	+ 26	+ 25	+ 24	+ 23
+ 16	+ 17	+ 18	+ 19	+ 20	+ 21	+ 22
+ 15	+ 14	+ 13	+ 12	+ 11	+ 9 + 10	+ 8
+ 1	+ 2	+ 3	+ 4	+ 5	+ 6	+ 7

WABASH AVENUE

309 Farmington Avenue
Suite A-100
Farmington Connecticut 06032
(203) 677-9666
1894E

LEGEND

+ Petrex Sample Location

Battelle Pacific Northwest Laboratories

Sample Locations

Eielson Air Force Base
Eielson Air Force Base, Alaska

Plate 1

June 16, 1993

DIVISION STREET

WABASH AVENUE

309 Farmington Avenue
Suite A-100
Farmington Connecticut 06032
(203) 677-9666
1894E

LEGEND

Relative Response Values:

▨ $\geq 1,000,000$

▨ 100,000 - 999,999

+ Petrex Sample Location

Battelle Pacific Northwest Laboratories

Relative Response
BTEX

Eielson Air Force Base
Eielson Air Force Base, Alaska

Plate 2

June 16, 1993

DIVISION STREET

WABASH AVENUE

309 Farmington Avenue
Suite A-100
Farmington Connecticut 06032
(203) 677-9866
1894E

LEGEND

Relative Response Values:

$\geq 100,000$

10,000 - 99,999

+ Petrex Sample Location

ND Not Detected

Battelle Pacific Northwest Laboratories

Relative Response
TCE

Eielson Air Force Base
Eielson Air Force Base, Alaska

Plate 3

June 16, 1993

DIVISION STREET

WABASH AVENUE

309 Farmington Avenue
Suite A-100
Farmington Connecticut 06032
(203) 677-9886
1894E

LEGEND

Relative Response Values:

$\geq 100,000$

10,000 - 99,999

+ Petrex Sample Location

Battelle Pacific Northwest Laboratories

Relative Response
Cycloalkanes/Alkenes

Eielson Air Force Base
Eielson Air Force Base, Alaska

Plate 4

June 16, 1993

APPENDIX C
MASS SPECTRA

PlotData

Page: 1

1894.1

0003: Scan Avg 1-28 (0.00 - 0.10 min)

PlotData

Page: 1

1894.1

0004: Scan Avg 1-28 (0.00 - 0.10 min)

G.21

1894.1

0005: Scan Avg 1-28 (0.00 - 0.10 min)

1894.1

0006: Scan Avg 1-28 (0.00 - 0.10 min)

PlotData

Page: 1

1894.1

0007: Scan Avg 1-28 (0.00 - 0.10 min)

PlotData

Page: 1

1894.1

0009: Scan Avg 1-28 (0.00 - 0.10 min)

G.23

1894.1

0010: Scan Avg 1-28 (0.00 - 0.10 min)

1894.1

0011: Scan Avg 1-28 (0.00 - 0.10 min)

0012: Scan Avg 1-28 (0.00 - 0.10 min)

0013: Scan Avg 1-28 (0.00 - 0.10 min)

1894.1

0014: Scan Avg 1-28 (0.00 - 0.10 min)

1894.1

0015: Scan Avg 1-28 (0.00 - 0.10 min)

0016: Scan Avg 1-28 (0.00 - 0.10 min)

0017: Scan Avg 1-28 (0.00 - 0.10 min)

1894.1

0018: Scan Avg 1-28 (0.00 - 0.10 min)

1894.1

0019: Scan Avg 1-28 (0.00 - 0.10 min)

PlotData

Page: 1

1894 · 1
0020: Scan Avg 1-28 (0.00 - 0.10 min)

PlotData

Page: 1

1894 · 1
0021: Scan Avg 1-28 (0.00 - 0.10 min)

G.29

0022: Scan Avg 1-28 (0.00 - 0.10 min)

0023: Scan Avg 1-28 (0.00 - 0.10 min)

PlotData

1894.1

Page: 1

0024: Scan Avg 1-28 (0.00 - 0.10 min)

PlotData

1894.1

Page: 1

0025: Scan Avg 1-28 (0.00 - 0.10 min)

G.31

0026: Scan Avg 1-28 (0.00 - 0.10 min)

0027: Scan Avg 1-28 (0.00 - 0.10 min)

0028: Scan Avg 1-28 (0.00 - 0.10 min)

0029: Scan Avg 1-28 (0.00 - 0.10 min)

0032: Scan Avg 1-28 (0.00 - 0.10 min)

0033: Scan Avg 1-28 (0.00 - 0.10 min)

1894.1

0036: Scan Avg 1-28 (0.00 - 0.10 min)

1894.1

0037: Scan Avg 1-28 (0.00 - 0.10 min)

PlotData

Page: 1

1894.1

0040: Scan Avg 1-28 (0.00 - 0.10 min)

PlotData

Page: 1

1894.1

0041: Scan Avg 1-28 (0.00 - 0.10 min)

G.39

1894.1

0042: Scan Avg 1-28 (0.00 - 0.10 min)

1894.1

0043: Scan Avg 1-28 (0.00 - 0.10 min)

PlotData

Page: 1

1894.1

0044: Scan Avg 1-28 (0.00 - 0.10 min)

PlotData

Page: 1

1894.1

0045: Scan Avg 1-28 (0.00 - 0.10 min)

G.41

1894.1

0046: Scan Avg 1-28 (0.00 - 0.10 min)

1894.1

0047: Scan Avg 1-28 (0.00 - 0.10 min)

0048: Scan Avg 1-28 (0.00 - 0.10 min)

1894-1

0049: Scan Avg 1-28 (0.00 - 0.10 min)

1894.1

0052: Scan Avg 1-28 (0.00 - 0.10 min)

1894.1

0053: Scan Avg 1-28 (0.00 - 0.10 min)

G.45

1894 - 1

0054: Scan Avg 1-28 (0.00 - 0.10 min)

1894 - 1

0055: Scan Avg 1-28 (0.00 - 0.10 min)

0056: Scan Avg 1-28 (0.00 - 0.10 min)

0057: Scan Avg 1-28 (0.00 - 0.10 min)

0058: Scan Avg 1-28 (0.00 - 0.10 min)

0059: Scan Avg 1-28 (0.00 - 0.10 min)

0060: Scan Avg 1-28 (0.00 - 0.10 min)

0061: Scan Avg 1-28 (0.00 - 0.10 min)

0062: Scan Avg 1-28 (0.00 - 0.10 min)

0063: Scan Avg 1-28 (0.00 - 0.10 min)

1894.1

0064: Scan Avg 1-28 (0.00 - 0.10 min)

1894.1

0065: Scan Avg 1-28 (0.00 - 0.10 min)

PlotData

Page: 1

1894.1

0068: Scan Avg 1-28 (0.00 - 0.10 min)

PlotData

Page: 1

1894.1

0069: Scan Avg 1-28 (0.00 - 0.10 min)

G.53

1894.1

0070: Scan Avg 1-28 (0.00 - 0.10 min)

1894.1

0071: Scan Avg 1-28 (0.00 - 0.10 min)

PlotData

Page: 1

1894.1

0072: Scan Avg 1-28 (0.00 - 0.10 min)

PlotData

Page: 1

1894.1

0073: Scan Avg 1-28 (0.00 - 0.10 min)

G.55

1894.1

0074: Scan Avg 1-28 (0.00 - 0.10 min)

1894.1

0075: Scan Avg 1-28 (0.00 - 0.10 min)

1894.1

0076: Scan Avg 1-28 (0.00 - 0.10 min)

1894.1

0077: Scan Avg 1-28 (0.00 - 0.10 min)

1894.1

0080: Scan Avg 1-28 (0.00 - 0.10 min)

1894.1

0081: Scan Avg 1-28 (0.00 - 0.10 min)

0082: Scan Avg 1-28 (0.00 - 0.10 min)

0083: Scan Avg 1-28 (0.00 - 0.10 min)

PlotData

Page: 1

1894.1

0084: Scan Avg 1-28 (0.00 - 0.10 min)

PlotData

Page: 1

1894.1

0085: Scan Avg 1-28 (0.00 - 0.10 min)

G.61

1894.1

10011

0086: Scan Avg 1-28 (0.00 - 0.10 min)

1894.1

0087: Scan Avg 1-28 (0.00 - 0.10 min)

PlotData

Page: 1

1894.1

0088: Scan Avg 1-28 (0.00 - 0.10 min)

PlotData

1894.1

Page: 1

0089: Scan Avg 1-28 (0.00 - 0.10 min)

G.63

0090: Scan Avg 1-28 (0.00 - 0.10 min)

0091: Scan Avg 1-28 (0.00 - 0.10 min)

1894.1

0092: Scan Avg 1-28 (0.00 - 0.10 min)

1894.1

0093: Scan Avg 1-28 (0.00 - 0.10 min)

G.65

1894 · 1

0094: Scan Avg 1-28 (0.00 - 0.10 min)

1894 · 1

0095: Scan Avg 1-28 (0.00 - 0.10 min)

0096: Scan Avg 1-28 (0.00 - 0.10 min)

0097: Scan Avg 1-28 (0.00 - 0.10 min)

0098: Scan Avg 1-28 (0.00 - 0.10 min)

0099: Scan Avg 1-28 (0.00 - 0.10 min)

0100: Scan Avg 1-28 (0.00 - 0.10 min)

0101: Scan Avg 1-28 (0.00 - 0.10 min)

0102: Scan Avg 1-28 (0.00 - 0.10 min)

0103: Scan Avg 1-28 (0.00 - 0.10 min)

0104: Scan Avg 1-28 (0.00 - 0.10 min)

0105: Scan Avg 1-28 (0.00 - 0.10 min)

0108: Scan Avg 1-28 (0.00 - 0.10 min)

0109: Scan Avg 1-28 (0.00 - 0.10 min)

0112: Scan Avg 1-28 (0.00 - 0.10 min)

HV=1.70
10,600 Threshold

APPENDIX D
TABLE OF DATA

Table of TD-GC/MS Data
 for the Petrex Soil Gas Survey
 Conducted at Eielson Air Force Base
 In Alaska
 for Battelle Pacific Northwest Laboratories
 NERI Project Number 1894
 July 19, 1993

Sample Number 39	Area Counts
2-Methyl-1-Propene	97,000
2-Methyl Pentane	654,111
5-Methyl-2-Hexanone	122,719
3-Methyl Pentane	393,141
2-Methyl-1-Pentene	15,247
Hexane	236,186
2,2-Dimethyl Pentane	275,610
2,4-Dimethyl Pentane	1,431,912
Methyl Cyclopentane	357,482
3,3-Dimethyl Pentane	498,882
2-Methyl Hexane	2,328,378
2,3-Dimethyl Pentane	3,518,324
3-Methyl Hexane	3,244,544
1,1-Dimethyl Cyclopentane	160,504
Isooctane	6,538,596
1,2-Dimethyl Cyclopentane	365,606
Heptane	331,500
2-Methyl-2-Hexene	107,543
2,3-Dimethyl-1-Pentene	21,323
2,2-Dimethyl Hexane	502,965
2,5-Dimethyl Hexane	2,188,065
2,2,3-Trimethyl Pentane	575,742
3,3-Dimethyl Hexane	1,678,898
2,3,4-Trimethyl Pentane	5,755,228
2,3,3-Trimethyl Pentane	8,086,799
3-Methyl Heptane	5,849,001
Trimethyl Hexane	1,791,363
1,2-Dimethyl Cyclohexane	1,426,463
2,4-Dimethyl Heptane	1,090,322
2,5-Dimethyl Heptane	1,561,789

Sample Number 39 (continued)	Area Counts
3,5-Dimethyl Heptane	503,563
Ethyl Cyclohexane	112,298
3-Ethyl-2-Methyl Hexane	1,276,793
3,4-Dimethyl Heptane	3,289,732
1,3,5-Trimethyl Cyclohexane	312,267
2,2,4-Trimethyl Decane	449,765
2,2,8-Trimethyl Decane	1,693,954
Xylenes	1,548,130
2,5,5-Trimethyl Heptane	2,304,600
3-Methyl Nonane	321,736
2,5-Dimethyl Octane	833,699
3-Ethyl-2-Methyl Heptane	2,380,261
4-Ethyl Octane	999,200
2,2,6-Trimethyl Octane	6,345,654
2,2,9-Trimethyl Decane	2,393,170
1-Ethyl Methyl Benzene	4,307,699
1,2,4-Trimethyl Benzene	3,594,402
1,3,5-Trimethyl Benzene	3,236,346
1-Methyl Ethyl Benzene	1,364,513
1-Ethenyl-2-Methyl Benzene	945,294
3-Methyl-5-Propyl Nonane	4,831,453
1,2,3-Trimethyl Benzene	2,016,764
1-Methyl-4,1-Methylethyl Benzene	261,392
1-Methyl Propyl Benzene	3,860,990
Decahydro Naphthalene	234,202
Diethyl Benzene	414,780
2-Ethyl-1,3-Dimethyl Benzene	2,134,746
1,2,3,5-Tetramethyl Benzene	3,478,675
Toluene	1,010,967
3,4-Dimethyl Benzaldehyde	208,570
Naphthalene	101,730

Sample Number 48	Area Counts
Benzene	16,951
2,3,4-Trimethyl Pentane	12,730
Trimethyl Benzene	14,936
1-Methylethyl Benzene	12,555

Sample Number 49	Area Counts
2-Methyl Propene	69,985
Pentane	178,873
2-Methyl Pentane	1,411,089
3-Methyl Pentane	793,186
Propyl Cyclopropane	27,171
Hexane	818,448
2-Hexene	22,110
3-Methyl-2-Pentene	18,632
2,2-Dimethyl Pentane	206,842
2,4-Dimethyl Pentane	815,286
Methyl Cyclopentane	745,546
3,3-Dimethyl Pentane	271,252
2-Methyl Hexane	1,807,283
2,3-Dimethyl Pentane	2,379,429
3-Methyl Hexane	2,176,378
1,1-Dimethyl Cyclopentane	110,709
Benzene	796,515
2,2,4-Trimethyl Pentane	2,589,244
1,2-Dimethyl Cyclopentane	284,361
Heptane	1,000,687
2-Methyl-2-Hexene	106,850
3-Methyl-2-Hexene	27,271
2,2-Dimethyl Hexane	265,874
2,5-Dimethyl Hexane	1,091,892
2,2,3-Trimethyl Pentane	187,404
3,3-Dimethyl Hexane	754,704
2,3,4-Trimethyl Pentane	2,409,398
4-Methyl Heptane	1,021,342
3-Methyl Heptane	3,393,912
2,2,5-Trimethyl Hexane	669,702
1,3-Dimethyl Cyclohexane	875,724
Toluene	1,439,417
Octane	658,982
1,2-Dimethyl Cyclohexane	496,015
2,4-Dimethyl Heptane	588,573
2,5-Dimethyl Heptane	1,185,910
Ethyl Cyclohexane	333,211
2,3-Dimethyl Heptane	696,870

Sample Number 49 (continued)	Area Counts
4-Methyl Octane	2,506,351
1,3,5-Trimethyl Cyclohexane	160,709
3-Methyl Octane	1,481,831
2,2,6-Trimethyl Decane	258,806
2,2,3,4,6,6-Hexamethyl Heptane	87,829
Xylenes	3,747,367
4-Ethyl Octane	135,467
3-Ethyl-2-Methyl Heptane	721,167
2,5-Dimethyl Octane	916,139
Ethyl Benzene	4,951,144
1-Ethyl Methyl Benzene	5,369,452
1,2,3-Trimethyl Benzene	2,935,889
1,2,4-Trimethyl Benzene	2,417,520
1-Methyl Ethyl Benzene	4,892,519
2,2,4,6,6-Pentamethyl Heptane	259,088
2,3-Dihydro-1H-Indene	715,545
3-Methyl-5-Propyl Nonane	1,030,752
1-Methyl-4,1-Methylethyl Benzene	1,972,856
1-Ethyl-4-Methyl Benzene	5,138,464
1-Methyl Propyl Benzene	11,666,696
Decahydro Naphthalene	134,319
1,2-Diethyl Benzene	852,310
1-Methyl-4-Propyl Benzene	4,001,341
2,3-Dihydro-2-Methyl-1H-Indene	84,136
4,1-Propenyl Toluene	1,663,014
1,1,1-Dimethylethyl-4-Methyl Benzene	263,643
1,4-Dimethyl-2,1-Methyl Ethyl Benzene	1,428,365
Ethyl-1,2,4-Trimethyl Benzene	962,439
1-Ethyl-4,1-Methylethyl Benzene	898,243
Dimethyl Benzaldehyde	434,679
Naphthalene	2,017,782
1,3-Dimethyl-5,1-Methylethyl Benzene	266,335
2,3-Dihydro-4,7-Dimethyl-1H-Indene	176,601
2,4,5-Trimethyl Benzaldehyde	58,414
Methyl Naphthalene	204,954
2,4,6-Trimethyl Benzaldehyde	64,358

Sample Number 55	Area Counts
2-Methyl-1-Propene	200,557
Pentane	649,126
2-Methyl Pentane	5,160,952
3-Methyl Pentane	3,300,981
2-Methyl-1-Pentene	126,466
Hexane	774,134
3-Methyl-2-Pentene	31,468
2,2-Dimethyl Pentane	1,351,581
2,4-Dimethyl Pentane	5,050,740
3,3-Dimethyl Pentane	2,177,676
2-Methyl Hexane	1,942,584
2,3-Dimethyl Pentane	7,875,950
3-Methyl Hexane	5,358,436
2,2,4-Trimethyl Pentane	12,377,982
1,2-Dimethyl Cyclopentane	2,751,826
2-Methyl-2-Hexene	99,130
3-Methyl-2-Hexene	155,106
1,1,2,3-Tetramethyl Cyclopropane	160,166
2,2,3-Trimethyl Pentane	1,340,715
2,3,3-Trimethyl Pentane	4,472,863
2,3,4-Trimethyl Pentane	6,589,891
3-Ethyl Hexane	3,593,972
2,2,5-Trimethyl Hexane	2,337,736
1-Ethyl-2-Methyl Cyclopentane	1,903,583
1,2-Dimethyl Cyclohexane	2,607,888
2,3,5-Trimethyl Hexane	2,722,131
2,4-Dimethyl Heptane	1,166,167
3,5-Dimethyl Heptane	2,120,497
5-Methyl Decane	6,391,239
1,3,5-Trimethyl Cyclohexane	1,826,420
3-Ethyl Heptane	370,343
4-Ethyl-2,2,6,6-Tetramethyl Heptane	506,182
2,2,4-Trimethyl Decane	2,651,696
1,2,4-Trimethyl Cyclohexane	1,042,100
Xylenes	554,925
3,3,5-Trimethyl Heptane	3,699,221
6-Methyl Dodecane	1,490,687
2,3,5-Trimethyl Heptane	841,444

Sample Number 55 (continued)

	Area Counts
1-Ethyl Methyl Cyclohexane	1,378,317
3-Ethyl-2-Methyl Heptane	3,281,151
4-Ethyl Octane	743,938
2-Methyl Decane	3,010,576
1-Ethyl-2-Methyl Benzene	215,901
Decahydro Naphthalene	182,584
Methyl Cyclopentane	1,319,600
2,4-Dimethyl-1-Pentene	61,546

Sample Number 57

	Area Counts
2-Methyl Propene	34,322
Pentane	83,702
2-Methyl Pentane	58,631
3-Methyl Pentane	40,111
Hexane	186,956
2,2-Dimethyl Pentane	16,526
2,4-Dimethyl Pentane	50,673
Methyl Cyclopentane	75,546
3,3-Dimethyl Pentane	40,414
2-Methyl Hexane	121,539
2,3-Dimethyl Pentane	264,525
3-Methyl Hexane	219,149
1,1-Dimethyl Cyclopentane	14,852
Benzene	97,147
Isooctane	263,466
1,2-Dimethyl Cyclopentane	79,384
Heptane	65,088
2,2,4,4-Tetramethyl Pentane	21,973
Methyl Cyclohexane	428,576
Ethyl Cyclopentane	74,280
2,3,4-Trimethyl Pentane	196,425
2,3,3-Trimethyl Pentane	315,326
Trimethyl Hexane	57,845
Toluene	60,484
2,4-Dimethyl Heptane	16,433
2,5-Dimethyl Heptane	17,350
2,2,7-Trimethyl Decane	17,598
Xylenes	23,340

Sample Number 57 (continued)	Area Counts
Trimethyl Benzene	217,490
1-Ethyl-2-Methyl Benzene	123,637
1-Ethyl-2,2,6-Trimethyl Cyclohexane	34,485
1-Ethyl-Dimethyl Benzene	42,750
Decahydro-2-Methyl Naphthalene	77,971
Naphthalene	36,886
Methyl Naphthalene	68,823
1,1-Biphenyl	13,720
Dimethyl Naphthalene	56,086

Sample Number 65	Area Counts
Benzene	18,494
Toluene	28,067

Sample Number 80	Area Counts
3,3-Dimethyl Pentane	46,392
2,3-Dimethyl Pentane	154,758
3-Methyl Hexane	270,407
3-Ethyl Pentane	112,811
1,2-Dimethyl Cyclopentane	28,843
2,2-Dimethyl Hexane	108,632
2,5-Dimethyl Hexane	193,270
2,4-Dimethyl Hexane	427,771
3,3-Dimethyl Hexane	254,280
2,3-Dimethyl Hexane	462,610
3-Ethyl Pentane	514,584
Toluene	21,530
1-Ethyl-2-Methyl Cyclopentane	82,498
2,4-Dimethyl Heptane	156,545
2-Methyl Octane	171,303
2,5-Dimethyl Heptane	306,384
3,5-Dimethyl Heptane	56,505
3,3-Dimethyl Heptane	88,461
Ethyl Cyclohexane	40,405

Sample Number 80 (continued)	Area Counts
2,3-Dimethyl Heptane	155,634
1,3,5-Trimethyl Cyclohexane	33,145
4-Methyl Octane	602,621
1,2,3-Trimethyl Cyclohexane	59,696
Xylenes	515,914
Ethyl Benzene	3,683,845
Diethyl Cyclohexane	128,046
1,1,2,3-Tetramethyl Cyclohexane	425,947
1-Ethyl Methyl Benzene	1,625,850
Trimethyl Benzene	3,639,979
1-Methyl Ethyl Benzene	4,676,958
1-Ethenyl-2-Methyl Benzene	490,156
1-Methyl Propyl Benzene	1,263,116
1-Ethyl Dimethyl Benzene	1,978,114
1-Methyl-4,1-Methylethyl Benzene	1,393,998
1,2,3,4-Tetramethyl Benzene	2,983,669
Decahydro-2-Methyl Naphthalene	1,381,462
Diethyl Methyl Benzene	267,790
2-Butyl-1,1,3-Trimethyl Cyclohexane	1,140,937
Naphthalene	1,618,889
Methyl Naphthalene	537,312

Sample Number 81	Area Counts
2-Methyl Propene	67,894
1-Pentene	13,329
Propyl Cyclopropane	15,948
2-Methyl Hexane	29,427
2,3-Dimethyl Pentane	68,293
3-Methyl Hexane	101,396
Benzene	45,061
2,2-Dimethyl Hexane	51,696
2,5-Dimethyl Hexane	86,444
2,4-Dimethyl Hexane	202,561
3,3-Dimethyl Hexane	115,052
4-Methyl Heptane	250,318
Dimethyl Cyclohexane	52,846

Sample Number 81 (continued)	Area Counts
Toluene	40,680
1-Ethyl-2-Methyl Cyclopentane	31,187
2,4-Dimethyl Heptane	101,834
2,6-Dimethyl Heptane	124,074
2,5-Dimethyl Heptane	209,193
3,3-Dimethyl Heptane	68,585
2,3-Dimethyl Heptane	152,496
4-Methyl Octane	537,007
1,2,4-Trimethyl Cyclohexane	30,561
Xylenes	2,775,640
Ethyl Benzene	3,200,518
1-Ethyl-2-Methyl Benzene	4,957,179
Trimethyl Benzene	4,692,203
1-Methyl Ethyl Benzene	4,238,376
1-Propenyl Benzene	138,015
1-Ethyl-4,1-Methylethyl Benzene	543,473
1,1-Dimethyl-2-Propyl Cyclohexane	361,278
1-Methyl Propyl Benzene	1,432,647
1-Ethyl-2,3-Dimethyl Benzene	2,158,410
1-Methyl-4,1-Methyl Ethenyl Cyclohexane	881,355
1-Ethyl-4,1-Dimethyl Benzene	2,179,550
1-Methyl-1-Methylethyl Benzene	1,430,985
Decahydro-2-Methyl Naphthalene	1,195,295

Sample Number 93	Area Counts
Toluene	13,513
Methyl Naphthalene	11,409

Distribution

**No. of
Copies**

**No. of
Copies**

OFFSITE

ONSITE

12 DOE/Office of Scientific and
Technical Information

Eielson AFB

343 Sptg.-DEVR
2558 Central Ave., Suite 1
Eielson AFB, Alaska 99702
Att: T. Merrymon
M. Raabe
K. Trahanovsky (5)
Administrative Record (4)

D. W. Glover	K6-96
D. C. Lanigan	K6-84
T. L. Liikala (5)	K6-84
P. E. Long	K6-84
M. T. Murphy	K6-84
K. B. Olsen	K6-96
R. M. Smith	K6-96
C. Veverka	K6-96
Publishing Coordination	
Technical Report Files (5)	

Routing

24 Pacific Northwest Laboratory

R. W. Bryce	K6-96
E. A. Clayton	K6-84
J. C. Evans (2)	K6-85
J. S. Fruchter	K6-96

R. M. Ecker	SEQUIM
M. J. Graham	K6-78
P. M. Irving	K6-98
C. S. Sloane	K6-04
P. C. Hays (last)	K9-41