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INTERIM REPORT
March 3, 1993

FOR

BIOVENTING FIELD INITIATIVE

AT

DOVER AIR FORCE BASE, DELAWARE

to

Captain Catherine M. Vogel
Department of the Air Force
AL/EQ
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by

BATTELLE
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505 King Avenue
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BIOVENTING FIELD INITIATIVE

DOVER AIR FORCE BASE, DELAWARE

1.0 INTRODUCTION

This report describes the activities conducted at Dover Air Force Base (AFB), Delaware, as part of the Bioventing Field Initiative for the U.S. Air Force Center for Environmental Excellence (AFCEE) and the Environmental Quality Directorate of the Air Force Armstrong Laboratory. This report summarizes the results from the first phase of the study at Dover AFB. First-phase activities include a soil gas survey, air permeability test, in situ respiration tests, and installation of bioventing systems. The specific objectives of this Bioventing Field Initiative are described in the following section. Each site at the base is discussed individually, followed by a description of site activities at the background area.

1.1 Objectives

The purpose of this Bioventing Field Initiative is to measure the soil gas permeability and microbial activity at a contaminated site in order to evaluate the potential application of bioventing technology to remediate the site. The specific test objectives are stated below.

- A small-scale soil gas survey will be conducted to identify an appropriate location for installation of the bioventing system. Soil gas from the candidate site should exhibit high total petroleum hydrocarbon (TPH) concentrations, relatively low oxygen concentrations, and relatively high carbon dioxide concentrations. An uncontaminated background location also will be identified.

- The soil gas permeability of the soil and the air vent (well) radius of influence will be determined. To measure these parameters, air will be withdrawn or injected for approximately 8 hours at vent wells located in contaminated soils. Pressure changes will be monitored in an array of monitoring points.

- Immediately following the soil gas permeability test, an in situ respiration test will be conducted. Air will be injected into selected monitoring points to

aerate the soils. The in situ oxygen utilization and carbon dioxide production rates will be measured.

- The data from the soil gas permeability and in situ respiration tests will be used to determine an air injection/withdrawal rate for the bioventing test. A blower will be selected, installed, and operated for 6 to 12 months, and periodic measurements of the soil gas composition will be made to evaluate the long-term effectiveness of bioventing.

1.2 Site Description

Dover AFB is located just east of the city of Dover, Delaware. A map of the base showing the locations of each site and the background area is shown in Figure 1. The dashed line on the map illustrates the direction from the main gate to each test site. Summaries of the descriptions of each site used for the Bioventing Initiative are presented in the following sections. A more detailed description of each test site is given in the Test Plan provided in Appendix A.

1.2.1 Site ST-04

Site ST-04 (Site D1 on Figure 1) is a gasoline release at the AAFES gas station. A map of the AAFES gas station is shown in Figure 2. The depth to groundwater at the site is approximately 11 feet. Soils consist predominantly of coarse sand and gravel from the ground surface to the water table. Analyses of soil samples showed contamination with benzene, toluene, ethylbenzene, and total xylenes (BTEX) at 11.5 feet to 13.5 feet. The highest concentrations detected were 180 ppm toluene, 80 ppm ethylbenzene, and 540 ppm total xylenes (benzene data not available). Soil samples from the 5- to 7-foot interval were below detection limit for BTEX and TPH. Sample data for the 7- to 11.5-foot interval were not available. A soil gas survey was conducted across the ST-04 site on 100- by 200-foot grids. The highest soil gas concentrations were found in the vicinity of the former leaking tank and the fuel-dispensing system.

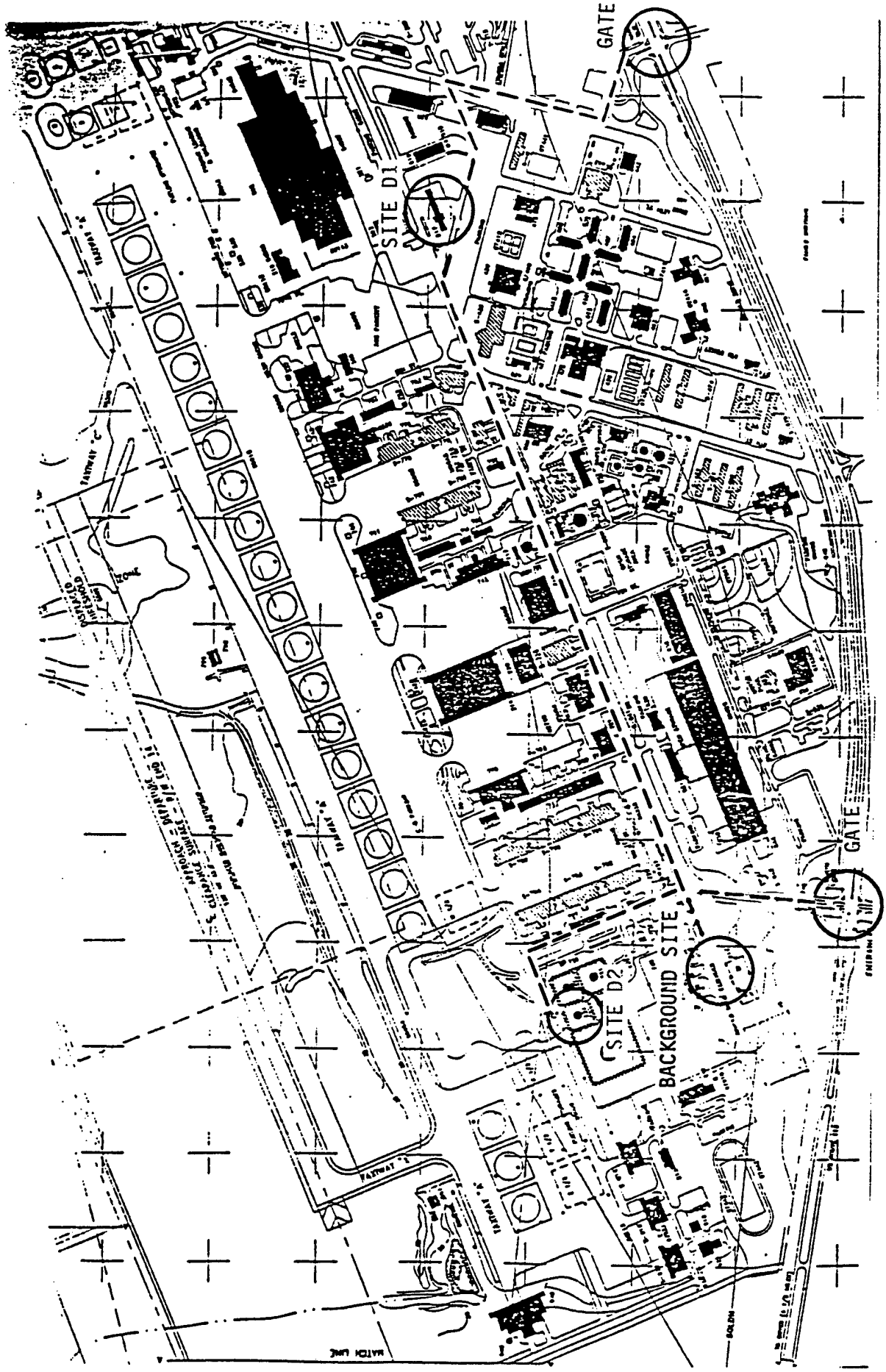

Figure 1. Schematic Diagram of Dover AFB

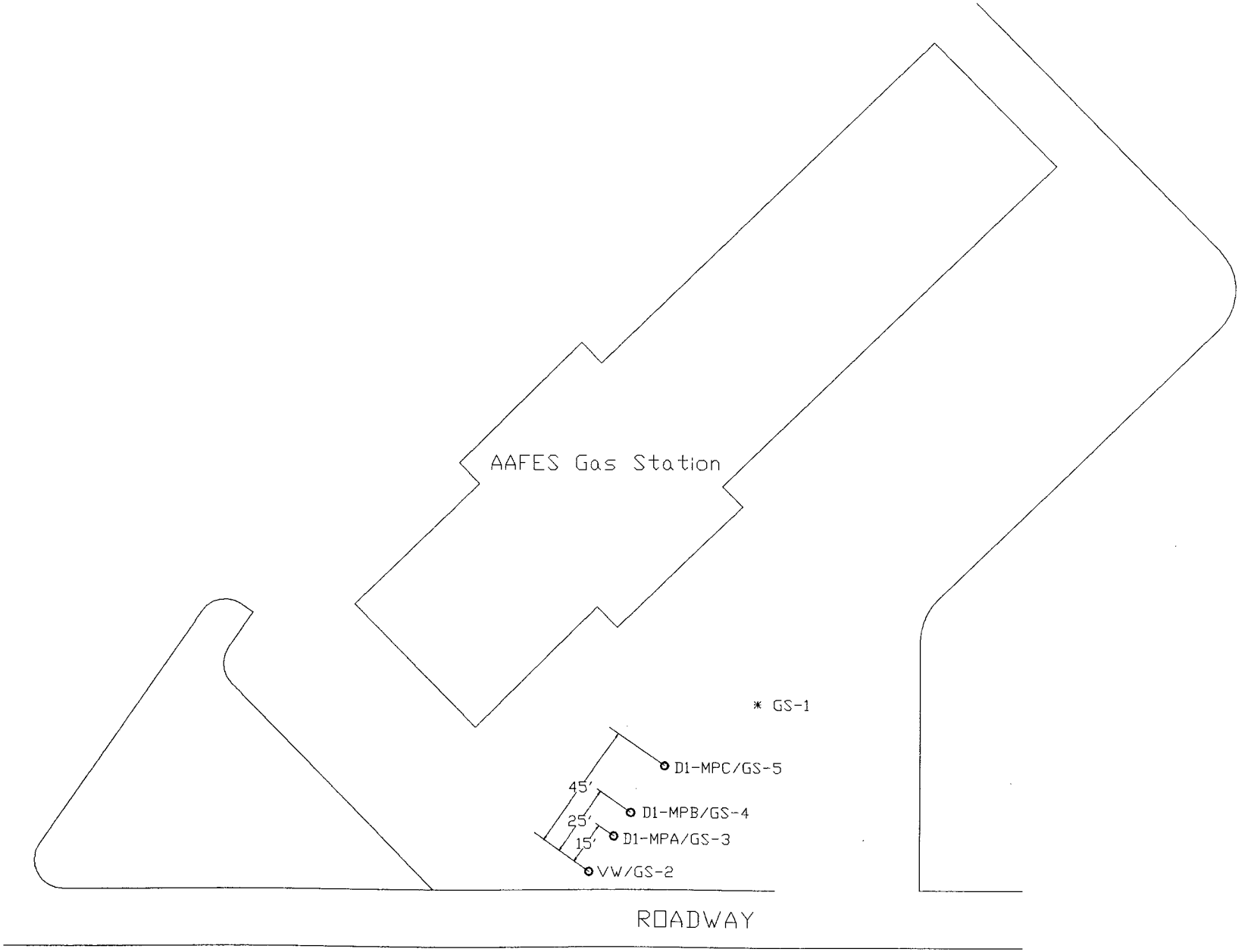

Figure 2. Schematic Diagram of Site ST-04 at Dover AFB (GS - Soil Gas Survey Point; MP - Monitoring Point)

1.2.2 North Storage Tank Farm

The North Storage Tank Farm (Site D2 on Figure 1) is an aboveground JP-4 jet fuel storage area shown in more detail in Figure 3. There have been three known releases from Tank 733 between 1970 and 1979 ranging from 17,000 gallons to 30,000 gallons of JP-4 jet fuel. Nearby surface soils include coarse sand and gravel, silt and silty sand, and clay and sandy clay. The water table at the site is approximately 10 feet. A soil gas survey was conducted across the site prior to the investigations described in this report. The soil gas data indicate the highest concentrations are adjacent to Tank 732, downgradient from Tank 733.

2.0 SITE ST-04

2.1 Chronology of Events and Site Activities

2.1.1 Groundwater Measurements

Two groundwater monitoring wells (MW 73S and MW 71S) were present at Site ST-04. The groundwater level was measured at these wells on November 3, 1992 and was recorded at 12.2 feet at MW 73S and 12.3 feet at MW 71S. No free product was detected in either well.

2.1.2 Soil Gas Survey

A suitable site for the bioventing demonstration should have soil gas characteristics of high TPH, low oxygen, and high carbon dioxide concentrations. This composition of soil gas would indicate that oxygen-limiting conditions for microbial activity are present and that the introduction of air may enhance biodegradation of TPH.

On November 2 and 3, 1992, a limited soil gas survey was conducted at Site ST-04. Soil gases were sampled by driving a ⅝-inch-diameter stainless steel probe into the soil with a hammer drill. Soil gas was withdrawn with a vacuum pump and analyzed for oxygen, carbon dioxide, and TPH.

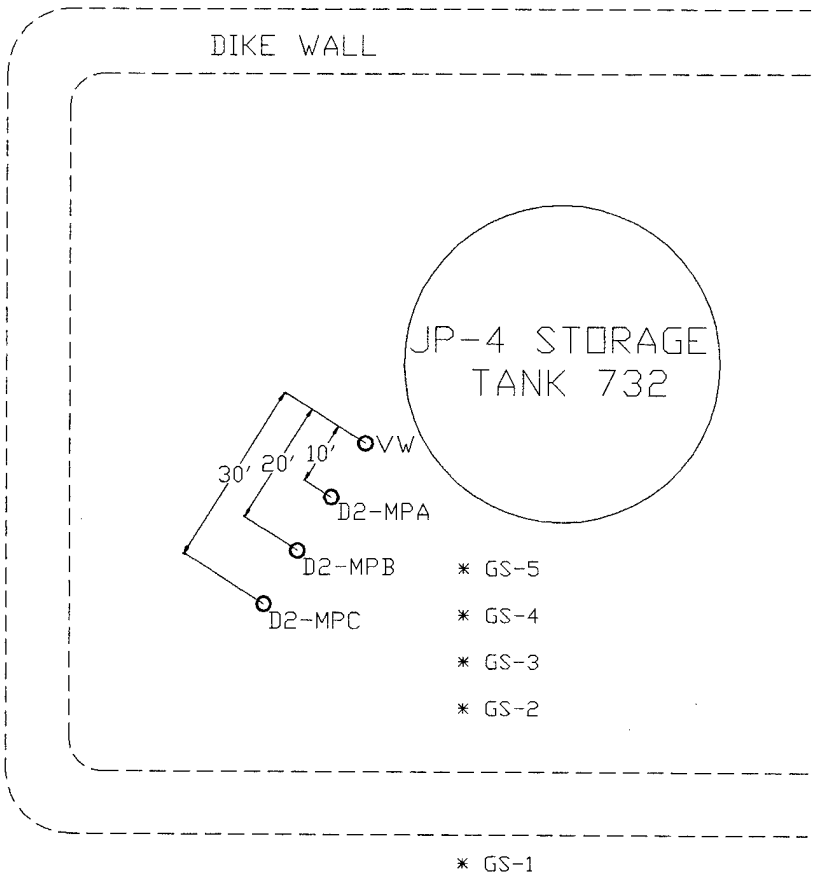

Figure 3. Schematic Diagram of the North Storage Tank Farm at Dover AFB (GS - Soil Gas Survey Point; MP - Monitoring Point)

Measurements of oxygen and carbon dioxide in the soil gas were made with a GasTech Model 32520X with oxygen and carbon dioxide ranges of 0 to 25%. The analyzer was calibrated daily against atmospheric oxygen, atmospheric carbon dioxide, a 10% oxygen calibration standard, and a 5% carbon dioxide calibration standard. TPH was measured with a GasTech Trace Techtor with TPH ranges from 0 to 100, 0 to 1,000, and 0 to 10,000 ppm. The GasTech Trace Techtor was calibrated daily against a 4,200-ppm hexane standard.

The soil gas probes were driven to depths ranging from 2.5 to 12.5 feet at several locations at Site ST-04. Table 1 provides the initial concentrations of oxygen, carbon dioxide, and TPH for the various locations at Site ST-04. Oxygen concentrations varied from 0 to 20.9%, and TPH concentrations ranged from 110 ppm to greater than 100,000 ppm. The oxygen concentrations in the soil gas indicate that most areas at this site are oxygen-limited and may respond to bioventing.

2.1.3 Vent Well, Monitoring Point, and Thermocouple Installation

On November 3 and 4, 1992, one vent well (VW) and three monitoring points (MPs) were installed at Site ST-04, and soil samples were collected for analyses. The monitoring points were labeled as follows: D1-MPA, D1-MPB, and D1-MPC. The locations of the vent well and monitoring points are shown in Figure 2. A cross section of the vent well and monitoring points showing site lithology and construction detail is shown in Figure 4.

The vent well was installed at a depth of 11.0 feet into a 6-inch-diameter borehole. The vent well consisted of Schedule 40 2-inch-diameter polyvinyl chloride (PVC) piping with 5.0 feet of ten-slot screen. The annular space corresponding to the screened area of the well was filled with silica sand, and the annular space above the screened interval was filled with bentonite to prevent short-circuiting of air to or from the surface.

Soil gas probes were sacrificial points consisting of ¼-inch tubing with an aluminum, 4-inch screened area. Sacrificial points were installed with a hammer drill in the same manner as the soil gas probes during the soil gas survey. No soil borings were created, nor was any sand added. A small amount of wetted bentonite was added at the surface. The monitoring points were installed at depths as follows:

- Monitoring point D1-MPA was installed at the following three depths: 3.0, 6.0, and 11.0 feet.

Table 1. Initial Soil Gas Composition at Site ST-04

Soil Gas Survey (GS) Point	Depth (ft)	Oxygen (%)	Carbon Dioxide (%)	TPH (ppm)
GS-1	2.5	20.9[1]	0	110
	5.0	2.6	13.1	50,000
	7.5	2.0	13.5	48,000
	10	2.5	13.2	54,000
GS-2	5.0	5.9	9.1	75,000
	7.5	19.8[1]	1.3	1,100
	10	4.0[1]	13.0	>40,000
	12.5	20.5[1]	0.1	4,000
GS-3	5.0	1.5	14.0	>40,000
	7.5	0	15.1	>40,000
	10	12.8[1]	6.5	21,600
GS-4	5.0	0.5	13.2	39,000
	7.5	0.3	15.0	>100,000[2]
	10	0.7	14.1	>100,000[2]
GS-5	5.0	0	13.5	>40,000
	7.5	0	13.5	>40,000
	9.5	0	15.1	>40,000

[1] Pressure reading on sampling pump was high. Measured oxygen concentration may not be representative of actual soil gas oxygen concentrations. Actual oxygen concentration is likely to be lower.

[2] A 10:1 diluter was used for these readings. Due to weather conditions (heavy rains), the 10:1 diluter could not be used for other readings. A 4:1 diluter was used for the other readings.

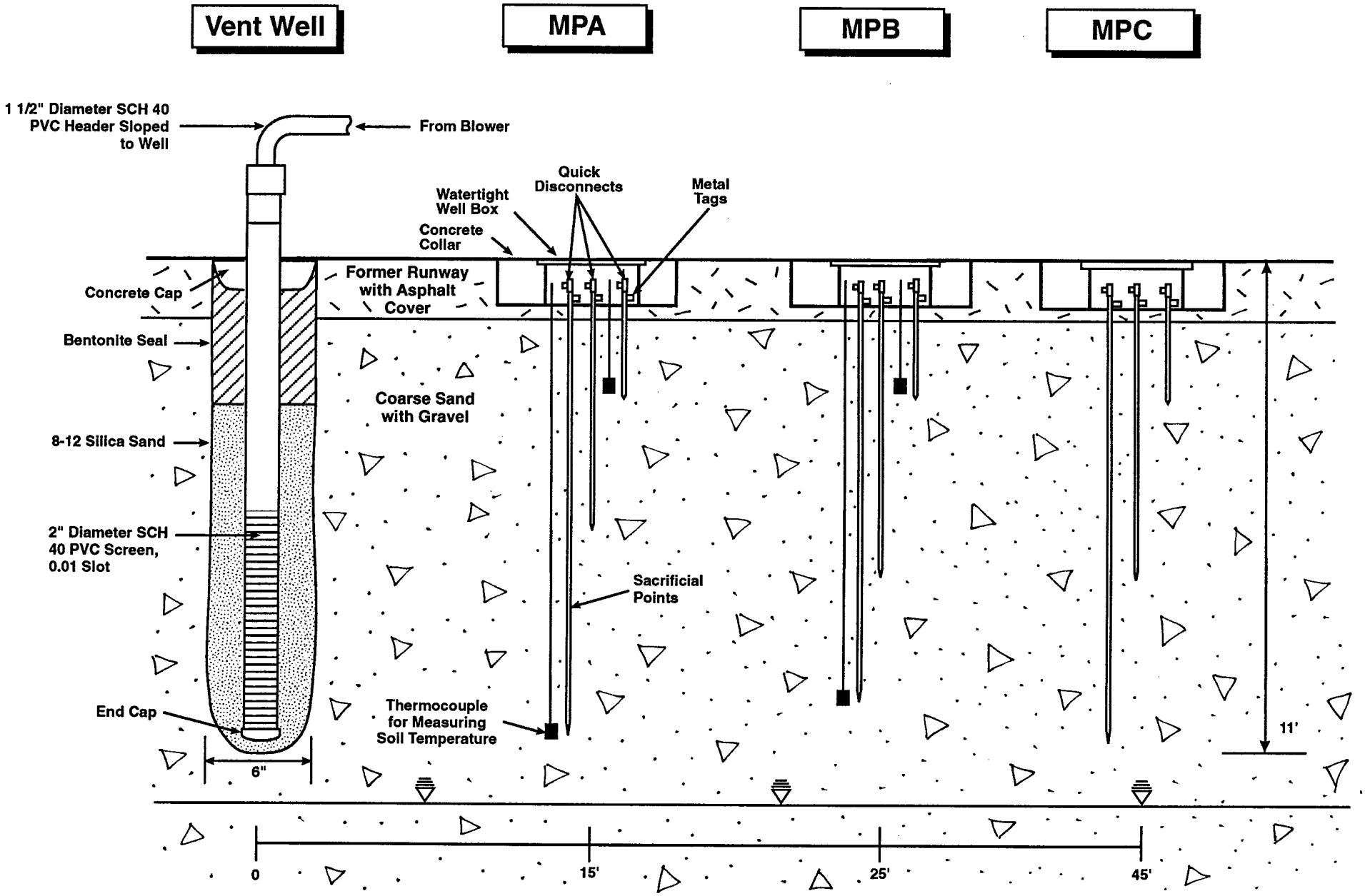

Figure 4. Cross Section of Vent Well and Monitoring Points at Site ST-04 Showing Site Lithology and Construction Detail (not to scale)

- Monitoring point D1-MPB was installed at the following depths: 3.0, 7.0, and 10.0 feet.
- Monitoring point D1-MPC was installed at the following depths: 3.0, 7.0, and 11.0 feet.

A Type J thermocouple was installed with monitoring points D1-MPA-3.0′, D1-MPA-11.0′, D1-MPB-3.0′, and D1-MPB-10′.

2.1.4 Soil and Soil Gas Sampling and Analyses

Soil samples were collected from the vent well borehole at Site ST-04 at depths of 3.0 to 3.5 feet, 7.0 to 7.5 feet, and 11.0 to 11.5 feet and were labeled D1-VW-3′, D1-VW-7′, and D1-VW-11′, respectively. The samples were sent under chain of custody to Engineering-Science, Inc., Berkeley Laboratory for analyses of BTEX, TPH, alkalinity, moisture content, pH, iron, total phosphorous, total Kjeldahl nitrogen, and particle size.

Soil gas samples were collected from monitoring points D1-MPA-11.0′ and D1-MPC-11.0′ and were labeled D1-MPA-11′ and D1-MPC-11′. A sample also was collected of ambient air and labeled D1-AMBIENT. These samples were sent under chain of custody to Air Toxics, Ltd., in Rancho Cordova, California, for analysis of BTEX and TPH.

2.1.5 Soil Gas Permeability and Radius of Influence

A detailed description of the method for conducting a soil gas permeability test, including equations to compute k, the soil gas permeability, is given in the Test Plan and Technical Protocol (Hinchee et al., 1992).

Prior to air injection, the monitoring points at Site ST-04 were allowed to set up for 24 hours. Air was injected with a portable 1-horsepower (HP) explosion-proof positive displacement blower unit. After air injection was initiated, pressure readings were taken approximately every 1 to 2 minutes for the first hour, then approximately every 10 minutes for the following hour. The Hyperventilate™ computer model was used to calculate the soil gas permeability.

2.1.6 In Situ Respiration Test

Immediately following the soil gas permeability test at Site ST-04, air containing approximately 1% helium was injected into the soil for approximately 24 hours, beginning on November 13. Air was injected concurrently into the background monitoring well to measure the natural biodegradation of organic material in the soil. The setup for the in situ respiration test is given in the Test Plan and Technical Protocol (Hinchee et al., 1992). The pump used for air injection was a ½-HP diaphragm pump. Air and helium were injected through the following monitoring points at the depths indicated: D1-MPA-11.0′; D1-MPB-7.0′; D1-MPB-10.0′; and D1-MPC-11.0′. After the air/helium injection was turned off, the respiration gases were monitored periodically. The respiration test was terminated on November 18.

Helium concentrations were measured during the in situ respiration test to quantify helium leakage to or from the surface around the monitoring points. Helium loss over time is attributed to either diffusion or leakage. A rapid drop in helium concentration followed by a leveling is an indication of leakage. A gradual loss along with an apparent first-order curve is an indicator of diffusion. As a rough estimate, the diffusion of gas molecules is inversely proportional to the square root of the molecular weight of the gas. Based on molecular weights of 4 for helium and 32 for oxygen, helium diffuses about 2.8 times faster than oxygen, or the diffusion of oxygen is 0.35 times the rate of helium diffusion. As a general rule, we have found that if helium concentrations are at least 50 to 60% of the initial levels at test completion, measured oxygen uptake rates are representative. Greater helium loss indicates a problem, and oxygen utilization rates are not considered representative.

To compare data from one site to another, a stoichiometric relationship of the oxidation of the hydrocarbon was assumed. Hexane was used as the representative hydrocarbon for the organic contaminant. The stoichiometric relationship is given by:

$$C_6H_{14} + 9.5O_2 \rightarrow 6CO_2 + 7H_2O \qquad (1)$$

Based on the utilization rates (percent per day), the biodegradation rates in terms of milligrams as a hexane equivalent per kilogram of soil per day were computed using the equation below by assuming a soil porosity of 0.2 and a bulk density of 1,440 kg/m^3.

$$K_\beta = \frac{-K_o A D_o C}{100} \quad (2)$$

where: K_β = biodegradation rate (mg/kg/day)

K_o = oxygen utilization rate (percent per day)

A = volume of air/kg of soil, in this case 300/1,440 = 0.21

D_o = density of oxygen gas (mg/L) assumed to be 1,330 mg/L

C = mass ratio of hydrocarbon to oxygen required for mineralization, assumed to be 1/3.5 from the above stoichiometric equation.

2.2 Results and Discussion

2.2.1 Soil and Soil Gas Analyses

Results of the soil analyses for BTEX and TPH at Site ST-04 are presented in Table 2. The analytical report for this site is presented in Appendix B. Concentrations of the BTEX compounds in soil were relatively low from depths of 3.0 and 7.0 feet with all compounds except toluene (0.0021 mg/kg to 0.0034 mg/kg) measured below the detection limit. TPH was 7.0 mg/kg at a depth of 7.0 feet, but was below the detection limit (<4.0 mg/kg) at a depth of 4.0 feet. Soil samples measured from a depth of 11.0 feet ranged from 2.7 mg/kg (benzene) up to 26 mg/kg (total xylenes), and TPH was 17 mg/kg. Concentrations of BTEX in soil vapor samples from a depth of 11.0 feet ranged from 6.8 ppmv (ethylbenzene) up to 79 ppmv (total xylenes), and TPH concentrations were measured at 33,000 ppmv and 34,000 ppmv (Table 2). Vapor samples taken of ambient air showed relatively low concentrations of BTEX and TPH. The results of the soil chemistry analyses are summarized in Table 3.

2.2.2 Soil Gas Permeability and Radius of Influence

The raw data for the soil gas permeability test at Site ST-04 are presented in Appendix C. Using the Hyperventilate™ computer model, soil gas permeabilities were calculated at each of the monitoring points. These data are presented in Table 4. The soil gas permeability varied

Table 2. Results From Soil and Soil Gas Analyses for BTEX and TPH at Site ST-04

Matrix	Sample Name	Benzene (mg/kg)	Toluene (mg/kg)	Ethylbenzene (mg/kg)	Total Xylenes (mg/kg)	TPH[1] (mg/kg)
Soil	D1-VW-3′	<0.00060	0.0021	<0.00050	<0.0010	<4.0
	D1-VW-7′	<0.00070	0.0034	<0.00060	<0.0010	7.0
	D1-VW-11′	2.7	3.2	5.0	26	17
Matrix	**Sample Name**	**Benzene (ppmv)**	**Toluene (ppmv)**	**Ethylbenzene (ppmv)**	**Total Xylenes (ppmv)**	**TPH[2] (ppmv)**
Soil Gas	D1-MPA-11′	55	71	20	79	34,000
	D1-MPC-11′	74	16	6.8	15	33,000
	D1-AMBIENT	1.1	0.28	0.091	0.24	600

[1] Referenced to a reference oil composed of a mixture of 2,2,4-trimethylpentane, *n*-hexadecane, and chlorobenzene.

[2] TPH referenced to jet fuel (molecular weight = 156).

Table 3. Results From Soil Chemistry Analyses at Site ST-04

Parameter	Sample Name		
	D1-VW-3′	D1-VW-7′	D1-VW-11′
Alkalinity (mg/kg $CaCO_3$)	58	<50	<50
Moisture (% by weight)	8.8	14.1	12.1
pH	6.6	4.6	4.8
Iron (mg/kg)	7,420	3,230	3,450
Total Phosphorous (mg/kg)	310	240	260
Total Kjeldahl Nitrogen (mg/kg)	78	36	31
Particle Size (%)	Gravel: 1	Gravel: 4.5	Gravel: 25.5
	Sand: 53	Sand: 60	Sand: 48
	Silt: 33	Silt: 19	Silt: 17
	Clay: 13	Clay: 16.5	Clay: 7.5

Table 4. Results of Hyperventilate™ Soil Gas Permeability Analysis at Site ST-04

Monitoring Point	Depth (ft)	Soil Gas Permeability (darcy)
D1-MPA	3.0	12
	6.0	8.5
	11.0	3.9×10^{8}
D1-MPB	3.0	NM
	7.0	34
	10.0	2.6×10^{4}
D1-MPC	3.0	1.7
	7.0	NM
	11.0	NM

NM No pressure change was measured at this monitoring point.

considerably, with values ranging from 1.7 darcy up to 3.9 x 10^8 darcy. The radius of influence is calculated by plotting the log of the pressure change at a specific monitoring point versus the distance from the vent well. The radius of influence would then be the distance where 1-inch of water pressure can be measured. Therefore, the radius of influence based on these specifications is approximately 32 feet (Figure 5).

2.2.3 In Situ Respiration Test

The results of the in situ respiration test for Site ST-04 are presented in Appendix D. Each figure in Appendix D illustrates the oxygen, carbon dioxide, and helium concentrations as a function of time. An example of typical oxygen utilization at this site is shown in Figure 6, where oxygen utilization and carbon dioxide production at monitoring point D1-MPA-11.0′ are illustrated. A summary of the oxygen utilization and carbon dioxide production rates and corresponding biodegradation rates is shown in Table 5. The biodegradation rates measured at this site were fairly high, with rates ranging from 2.9 mg/kg/day to 3.8 mg/kg/day based on oxygen utilization, and from 0.65 mg/kg/day to 1.5 mg/kg/day based on carbon dioxide production. Soil gas samples could not be collected from monitoring point D1-MPB-10.0′ due to soil conditions in this area; therefore, the data from this monitoring point is not presented.

Loss of helium was insignificant at all monitoring points, indicating that the monitoring points were well sealed and that the oxygen depletion observed was a result of biodegradation.

Soil temperatures were measured during the in situ respiration test. Temperatures during the test ranged from 13.9°C to 16.0°C at monitoring point D1-MPA-11.0′.

2.2.4 Bioventing Demonstration

The decision was made to install a bioventing system at Site ST-04. A 1-HP blower was installed at the site on November 11, 1992. The blower was run for 90 minutes in an extraction mode to measure the concentrations of BTEX and TPH in the exhaust gas. Exhaust gas concentrations of these compounds were as follows: benzene (65 ppmv); toluene (100 ppmv); ethylbenzene (23 ppmv); total xylenes (79 ppmv); and TPH (83,000 ppmv). The analytical report for these analyses is given in Appendix B. Air extraction was not initiated for the long-term bioventing test pending installation of electricity at the site and regulatory approval for operation of the unit.

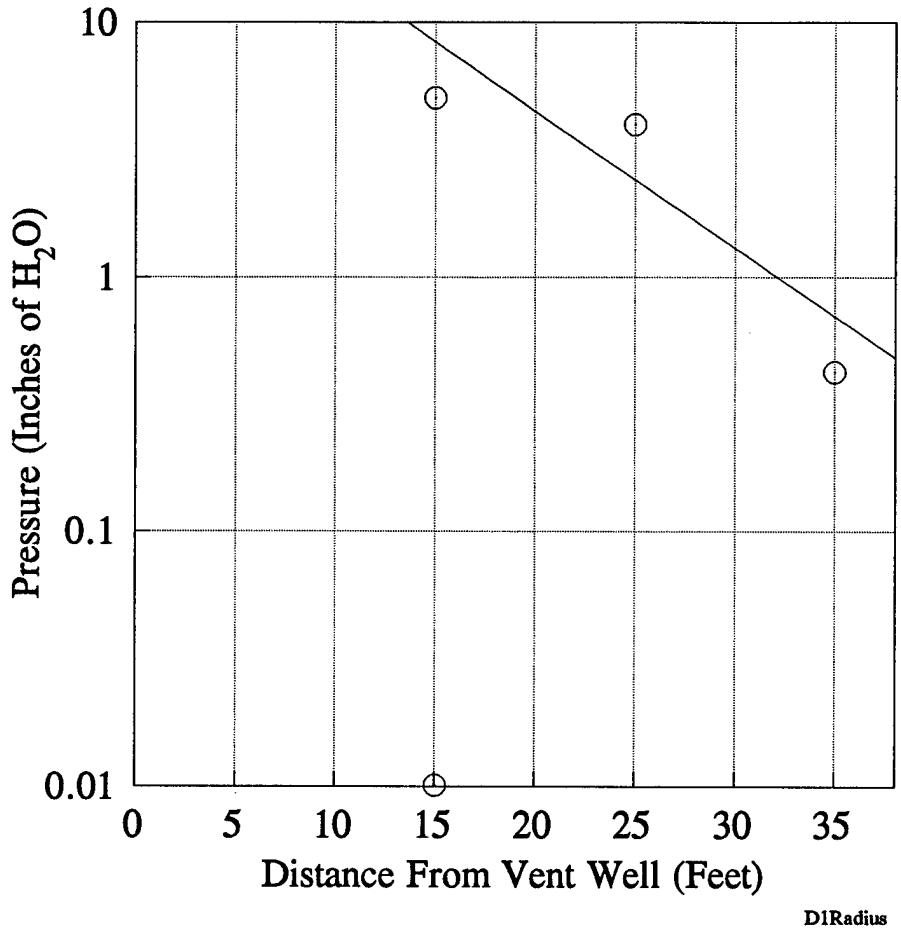

Figure 5. Radius of Influence at Site ST-04

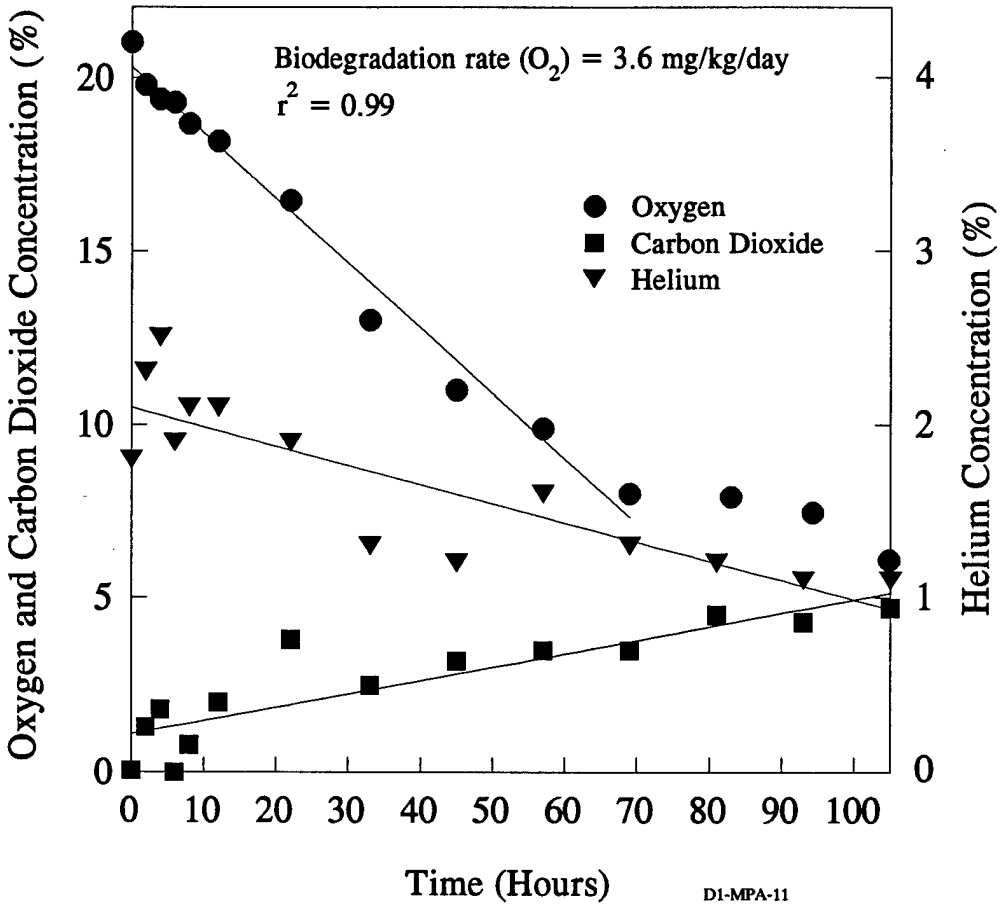

Figure 6. Oxygen Utilization and Carbon Dioxide Production During the In Situ Respiration Test at Monitoring Point D1-MPA-11.0'

Table 5. Oxygen Utilization and Carbon Dioxide Production Rates During the In Situ Respiration Test at Site ST-04

Sample Name	Oxygen Utilization Rate (%/hour)	Biodegradation Rate (mg/kg/day)	Carbon Dioxide Production Rate (%/hour)	Biodegradation Rate (mg/kg/day)
Background	0.0030	0.060	0	0
D1-MPA-11.0′	0.19	3.6	0.045	0.97
D1-MPB-7.0′	0.15	2.9	0.030	0.65
D1-MPC-11.0′	0.20	3.8	0.069	1.5

3.0 NORTH STORAGE TANK FARM SITE

3.1 Chronology of Events and Site Activities

3.1.1 Groundwater Measurements

Groundwater is typically encountered at a depth of approximately 10 feet in this area. During vent well installation, groundwater was encountered at a depth of 11 feet.

3.1.2 Soil Gas Survey

On November 7 and 8, 1992, a limited soil gas survey was conducted to locate a suitable test area at the North Storage Tank Farm. Soil gases were sampled by driving a ⅝-inch-diameter stainless steel probe into the soil with a hammer drill. Soil gas was withdrawn with a vacuum pump and analyzed for oxygen, carbon dioxide, and TPH. Soil gas measurements were taken as described in Section 2.1.2.

The soil gas probes were driven to depths ranging from 1.5 to 11.0 feet at several locations at the North Storage Tank Farm. Table 6 provides the initial concentrations of oxygen, carbon dioxide, and TPH for the various locations at the North Storage Tank Farm. Relatively low concentrations of oxygen were found at most of the soil gas probes, with concentrations ranging from 0 to 19.8%. Relatively high concentrations of carbon dioxide (0 to 11.5%) and TPH (60 ppm to greater than 40,000 ppm) were encountered. Soil gas samples taken at this site were often difficult to obtain, probably due to the high moisture content in the soil from several days of heavy rain.

3.1.3 Vent Well, Monitoring Point, and Thermocouple Installation

On November 8, 1992, one vent well and three monitoring points were installed at the North Storage Tank Farm, and soil samples were collected for analyses. The monitoring points were labeled D2-MPA, D2-MPB, and D2-MPC. The locations of the vent well and monitoring points are shown in Figure 3. A cross section of the vent well and monitoring points showing site lithology and construction detail is shown in Figure 7.

Table 6. Initial Soil Gas Composition at the North Storage Tank Farm

Soil Gas Survey (GS) Point	Depth (ft)	Oxygen (%)	Carbon Dioxide (%)	TPH (ppm)
GS-1	2.5	19.8[1]	0	60
	7.5	19.8[1]	0	220
	8.6	13.5[1]	4.7	7,600
GS-2	2.5	0	11.0	>40,000
GS-3	2.5	0	11.5	>40,000
	5.0	0	11.0	>40,000
	11.0	NS	NS	NS
GS-4	1.5	0	11.5	>40,000
	2.5	0	11.5	>40,000
GS-5	1.5	0	11.5	>40,000
	2.5	6.0[1]	9.0	>40,000

NS Not sampled. Water was encountered at this depth.

[1] Pressure reading on sampling pump was high. Measured oxygen concentration may not be representative of actual soil gas oxygen concentrations. Actual oxygen concentration is likely to be lower.

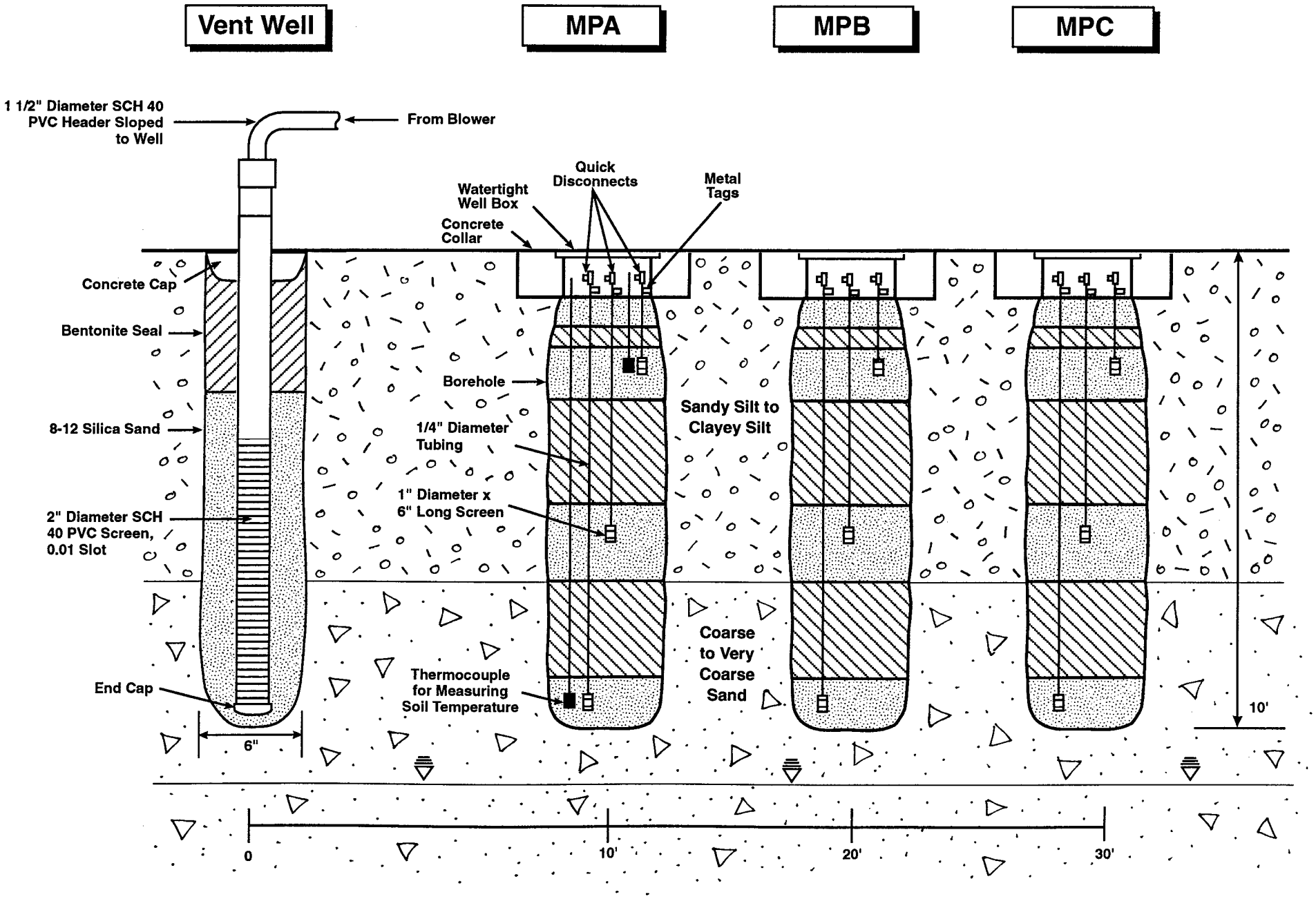

Figure 7. Cross Section of Vent Well and Monitoring Points at the North Storage Tank Farm Showing Site Lithology and Construction Detail (not to scale)

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No flow could be obtained through the vent well which was initially installed, so a second vent well was installed next to the first on November 17. The second vent well was installed at a depth of 10.0 feet into a 6-inch-diameter borehole. The vent well consisted of Schedule 40 2-inch-diameter PVC piping with 5.0 feet of ten-slot screen. The annular space corresponding to the screened area of the well was filled with silica sand, and the annular space above the screened interval was filled with bentonite to prevent short-circuiting of air to or from the surface.

Soil gas probes consisted of ¼-inch tubing with a 1-inch-diameter, 6-inch screened area. The annular space corresponding to the screened area was filled with silica sand, and the interval between the screened areas was filled with bentonite, as was the annular space from the shallowest monitoring point to the ground surface. The monitoring points were all installed at depths as follows: 2.5, 6.0, and 9.5 feet.

A Type J thermocouple was installed with monitoring points D2-MPA-2.5′ and D2-MPA-9.5′.

3.1.4 Soil and Soil Gas Sampling and Analyses

Soil samples were collected from the vent well borehole at the North Storage Tank Farm at depths of 3.0 to 3.5 feet, 3.5 to 4.0 feet, 7.0 to 7.5 feet, 7.5 to 8.0 feet, and 10.0 to 10.5 feet and were labeled D2-VW-3′, D2-VW-3.5′-4′, D2-VW-7′, D2-VW-7.5′-8.0′, D2-VW-10′, and D2-VW-10′-10.5′, respectively. The samples were sent under chain of custody to Engineering-Science, Inc., Berkeley Laboratory for analyses of BTEX, TPH, alkalinity, moisture content, pH, iron, total phosphorous, total Kjeldahl nitrogen, and particle size.

Soil gas samples were collected from the vent well and from monitoring points D2-MPA-2.5′, D2-MPB-2.5′, and D2-MPC-2.5′ and were labeled D2-VW-3′-8′, D2-MPA-2.5′, D2-MPB-2.5′, and D2-MPC-2.5′. A sample also was collected of ambient air and labeled D2-AMBIENT. These samples were sent under chain of custody to Air Toxics, Ltd., in Rancho Cordova, California, for analysis of BTEX and TPH.

3.1.5 Soil Gas Permeability and Radius of Influence

A detailed description of the method for conducting a soil gas permeability test, including equations to compute k, the soil gas permeability, is given in the Test Plan and Technical Protocol (Hinchee et al., 1992).

Prior to air injection, the monitoring points were allowed to set up for 24 hours. A portable 1-HP explosion-proof positive displacement blower unit was used to inject air. After air injection was initiated, pressure readings were taken approximately every 1 to 2 minutes for the first hour, then approximately every 10 minutes for the following hour. The Hyperventilate™ computer model was used to calculate the soil gas permeability.

3.1.6 In Situ Respiration Test

Immediately following the soil gas permeability test at the North Storage Tank Farm, air containing approximately 1% helium was injected into the soil for approximately 24 hours, beginning on November 14, 1992. Air was injected concurrently into the background monitoring well to measure the natural biodegradation of organic material in the soil. The setup for the in situ respiration test is given in the Test Plan and Technical Protocol (Hinchee et al., 1992). The pump used for air injection was a ½-HP diaphragm pump. Air and helium were injected through the following monitoring points at the depths indicated: D2-MPA-2.5′; D2-MPA-9.5′; D2-MPB-9.5′; and D2-MPC-2.5′. After the air/helium injection was turned off, the respiration gases were monitored periodically. The respiration test was terminated on November 18.

3.2 Results and Discussion

3.2.1 Soil and Soil Gas Analyses

Results of the soil analyses for BTEX and TPH at the North Storage Tank Farm are presented in Table 7. The analytical report for this site is presented in Appendix B. The areas with the highest contamination appeared to be the shallow depths (3.5 feet to 4.0 feet), although benzene and toluene were not detected in any soil samples, except for a trace amount of toluene (0.0040 mg/kg) at a depth of 10.0 feet to 10.5 feet. TPH was detected in all soil samples with the highest concentrations in sample D2-VW-3.5′-4′ (3,500 mg/kg). Soil vapor samples contained relatively high concentrations of BTEX and TPH, with concentrations ranging from below the detection limit (<5.0 ppmv) up to 7.6 ppmv (benzene) and from 3,800 ppmv up to 12,000 ppmv of TPH. Vapor samples taken of ambient air contained low concentrations of all constituents with concentrations ranging from below the

Table 7. Results From Soil and Soil Gas Analyses for BTEX and TPH at the North Storage Tank Farm

Matrix	Sample Name	Benzene (mg/kg)	Toluene (mg/kg)	Ethylbenzene (mg/kg)	Total Xylenes (mg/kg)	TPH[1] (mg/kg)
Soil	D2-VW-3.5′-4′	<1.4	<1.6	38	110	3,500
	D2-VW-7.5′-8.0′	<0.34	<0.40	0.51	<0.40	8.0
	D2-VW-10′-10.5′	<0.00090	0.0040	<0.00070	<0.0013	22
Matrix	**Sample Name**	**Benzene (ppmv)**	**Toluene (ppmv)**	**Ethylbenzene (ppmv)**	**Total Xylenes (ppmv)**	**TPH[2] (ppmv)**
Soil Gas	D2-VW-3′-8′	<5.0	<5.0	<5.0	<5.0	12,000
	D2-MPA-2.5′	7.6	6.7	1.7	5.3	4,800
	D2-MPB-2.5′	5.1	4.6	2.4	5.3	3,800
	D2-MPC-2.5′	6.3	5.4	3.2	8.3	4,000
	D2-AMBIENT	0.092	0.069	<0.010	0.082	150

[1] Referenced to a reference oil composed of a mixture of 2,2,4-trimethylpentane, *n*-hexadecane, and chlorobenzene.

[2] TPH referenced to jet fuel (molecular weight = 156).

detection limit for ethylbenzene (<0.010 ppmv) to 0.092 ppmv for benzene, and only 150 ppmv of TPH was detected. The results of the soil chemistry analyses are summarized in Table 8.

3.2.2 Soil Gas Permeability and Radius of Influence

The raw data for the soil gas permeability test at the North Storage Tank Farm are presented in Appendix E. Using the Hyperventilate™ computer model, soil gas permeabilities were calculated at each of the monitoring points. These data are presented in Table 9. The soil gas permeability varied considerably, with values ranging from 0.0016 darcy up to 9.3×10^9 darcy. The radius of influence where 1 inch of water could be measured was calculated by plotting the log of the pressure change at the monitoring points versus the distance from the vent well (Figure 8). In general, the deeper depths at monitoring points D2-MPA and D2-MPB did not show a large pressure change. However, the monitoring points at D2-MPC all showed a consistent pressure change, indicating that it is possible that the deeper depths at monitoring points D2-MPA and D2-MPB may be obstructed in some way. Calculating the radius of influence at the North Storage Tank Farm without including the values from the deeper depths at monitoring points D2-MPA and D2-MPB, a value of 32 feet is estimated.

3.2.3 In Situ Respiration Test

The results of the in situ respiration test for the North Storage Tank Farm are presented in Appendix F. Each figure in Appendix F illustrates the oxygen, carbon dioxide, and helium concentrations as a function of time. An example of typical oxygen utilization at this site is shown in Figure 9, where oxygen utilization and carbon dioxide production at monitoring point D2-MPA-2.5′ is illustrated. A summary of the oxygen utilization and carbon dioxide production rates and corresponding biodegradation rates is shown in Table 10. The biodegradation rates measured at this site were fairly high, with rates ranging from 2.9 to 8.6 mg/kg/day based on oxygen utilization, and from 0.89 to 1.9 mg/kg/day based on carbon dioxide production.

Loss of helium was insignificant at all monitoring points, indicating that the monitoring points were well sealed and that the oxygen depletion observed was a result of biodegradation.

Soil temperatures were measured during the in situ respiration test. Temperatures during the test ranged from 8.1°C to 10.3°C at monitoring point D2-MPA-2.5′ and from 13.9°C to 16.0°C at monitoring point D2-MPA-9.5′.

Table 8. Results From Soil Chemistry Analyses at the North Storage Tank Farm

Parameter	Sample Name		
	D2-VW-3′	D2-VW-7′	D2-VW-10′
Alkalinity (mg/kg $CaCO_3$)	<50	<50	<50
Moisture (% by weight)	12.8	29.5	32.3
pH	5.9	5.3	5.2
Iron (mg/kg)	1,950	16,200	8,070
Total Phosphorous (mg/kg)	64	110	140
Total Kjeldahl Nitrogen (mg/kg)	84	460	700
Particle Size (%)	Gravel: 2.0	Gravel: 0	Gravel: 2.5
	Sand: 67.5	Sand: 17	Sand: 17
	Silt: 23	Silt: 35	Silt: 36.5
	Clay: 7.5	Clay: 48	Clay: 44

Table 9. Results of Hyperventilate™ Soil Gas Permeability Analysis at the North Storage Tank Farm

Monitoring Point	Depth (ft)	Soil Gas Permeability (darcy)
D2-MPA	2.5	92
	6.0	0.0016
	9.5	2.6
D2-MPB	2.5	230
	6.0	0.0024
	9.5	NR
D2-MPC	2.5	210
	6.0	9.3×10^9
	9.5	2.1×10^9

NR No pressure readings were obtained at this monitoring point.

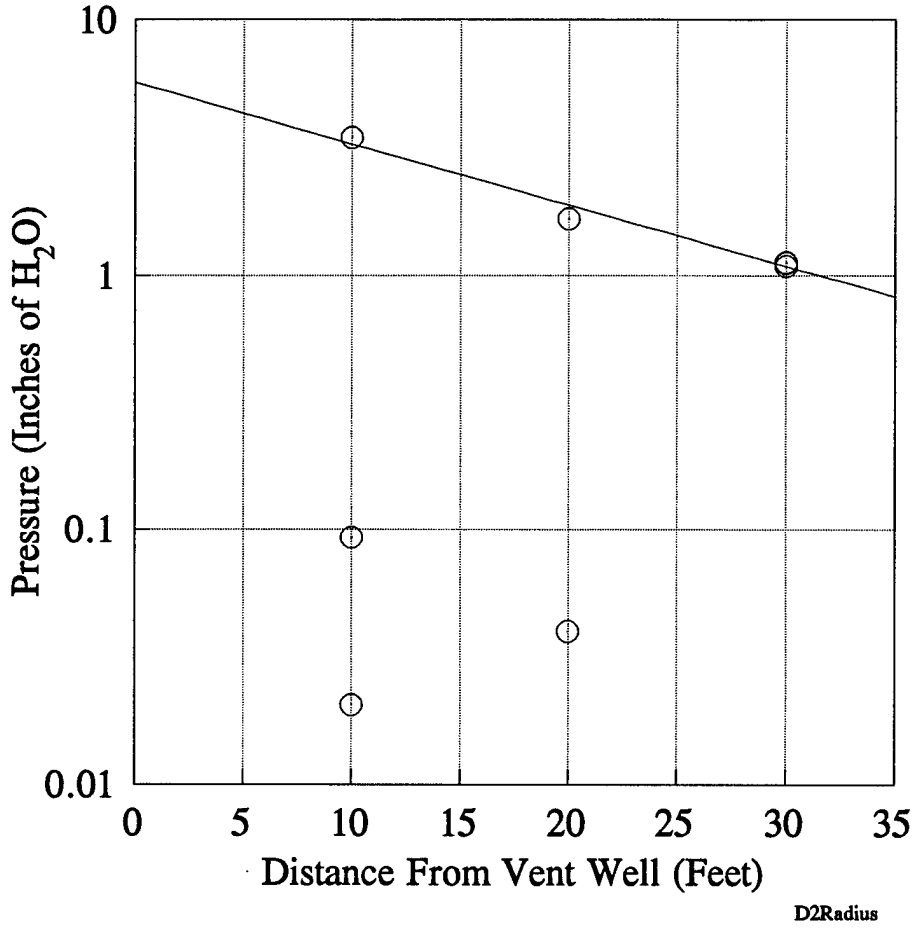

Figure 8. Radius of Influence at the North Storage Tank Farm

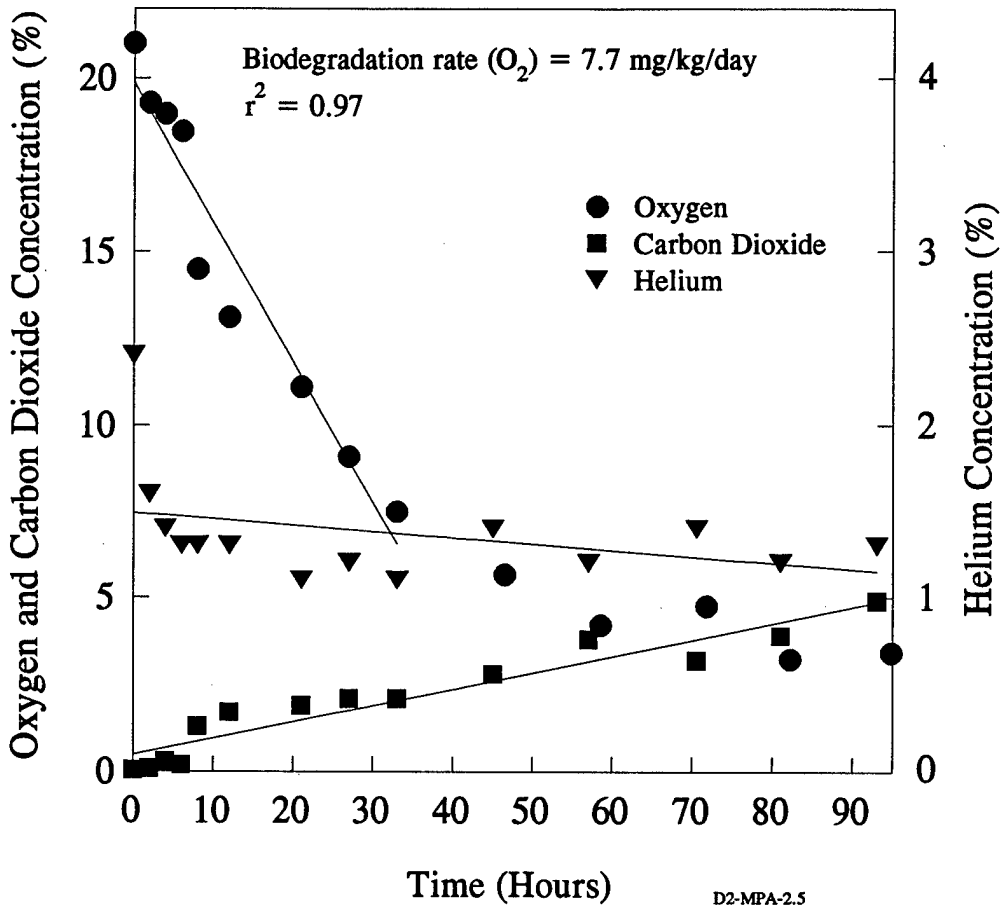

Figure 9. Oxygen Utilization and Carbon Dioxide Production During the In Situ Respiration Test at Monitoring Point D2-MPA-2.5'

Table 10. Oxygen Utilization and Carbon Dioxide Production Rates During the In Situ Respiration Test at the North Storage Tank Farm

Sample Name	Oxygen Utilization Rate (%/hour)	Biodegradation Rate (mg/kg/day)	Carbon Dioxide Production Rate (%/hour)	Biodegradation Rate (mg/kg/day)
Background	0.0030	0.060	0	0
D2-MPA-2.5′	0.40	7.7	0.069	1.5
D2-MPA-9.5′	0.45	8.6	0.086	1.9
D2-MPB-2.5′	0.21	4.0	0.041	0.89
D2-MPC-2.5′	0.15	2.9	0.045	0.97

3.2.4 Bioventing Demonstration

The decision was made to install a bioventing system at the North Storage Tank Farm. A 1-HP blower was installed on November 12, 1992. Air injection has not been initiated at the site pending installation of an electrical supply.

4.0 BACKGROUND AREA

The background area was located as shown in Figure 1. The vent well was installed at a depth of 11.0 feet into an 8-inch-diameter borehole. The vent well consisted of Schedule 40 2-inch-diameter PVC piping with 5.0 feet of ten-slot screen. The annular space corresponding to the screened area of the well was filled with silica sand, whereas the annular space above the screened interval was filled with bentonite to prevent short-circuiting of air to or from the surface.

Soil samples were collected from the vent well borehole at depths of 3.0 to 3.5 feet, 3.5 to 4.0 feet, 7.0 to 7.5 feet, and 10.0 to 10.5 feet and were labeled D1-BG-3′, D1-BG-3.5′-4.0′, D1-BG-7′, D1-BG-7.0′-7.5′, D1-BG-10′, and D1-BG-10.0′-10.5′, respectively. A soil gas sample also was collected from the vent well after installation and was labeled D1-BG-6′-11′. The soil samples were sent under chain of custody to Engineering-Science, Inc., Berkeley Laboratory for analyses of BTEX, TPH, alkalinity, moisture content, pH, iron, total phosphorous, total Kjeldahl nitrogen, and particle size analysis. The soil gas sample was sent under chain of custody to Air Toxics, Ltd., in Rancho Cordova, California, for analyses of BTEX and TPH. The site lithology at this area was representative of that in the contaminated areas.

Results of the soil and soil gas analyses for BTEX and TPH are presented in Table 11. The analytical report for this site is presented in Appendix B. All of the BTEX compounds and TPH were at concentrations below the detection limit in the soil samples, except for a small quantity of toluene in samples D1-BG-7.0′-7.5′ (0.0013 mg/kg) and D1-BG-10.0′-10.5′ (0.0068 mg/kg). The soil vapor sample contained detectable concentrations of BTEX compounds, with concentrations ranging from below the detection limit for total xylenes (<0.010 ppmv) up to 0.092 ppmv (benzene). TPH was detected at 600 ppmv. The results of the soil chemistry analyses are summarized in Table 12.

Table 11. Results From Soil and Soil Gas Analysis for BTEX and TPH at the Background Area

Matrix	Sample Name	Benzene (mg/kg)	Toluene (mg/kg)	Ethylbenzene (mg/kg)	Total Xylenes (mg/kg)	TPH[1] (mg/kg)
Soil	D1-BG-3.5'-4.0'	<0.00060	<0.00070	<0.00050	<0.0010	<4.0
	D1-BG-7.0'-7.5'	<0.00060	0.0013	<0.00050	<0.0010	<4.0
	D1-BG-10.0'-10.5'	<0.00070	0.0068	<0.00060	<0.0010	<4.0
Matrix	**Sample Name**	**Benzene (ppmv)**	**Toluene (ppmv)**	**Ethylbenzene (ppmv)**	**Total Xylenes (ppmv)**	**TPH[2] (ppmv)**
Soil Gas	D-BG-6.0'-11.0'	0.092	0.069	0.082	<0.010	600

[1] Referenced to a reference oil composed of a mixture of 2,2,4-trimethylpentane, *n*-hexadecane, and chlorobenzene.

[2] TPH referenced to jet fuel (molecular weight = 156).

Table 12. Results From Soil Chemistry Analyses at the Background Area

Parameter	Sample Name		
	D1-BG-3′	D1-BG-7′	D1-BG-10′
Alkalinity (mg/kg $CaCO_3$)	<50	<50	<50
Moisture (% by weight)	6.1	5.4	10.5
pH	6.1	5.3	5.5
Iron (mg/kg)	12,700	1,970	6,850
Total Phosphorous (mg/kg)	330	110	230
Total Kjeldahl Nitrogen (mg/kg)	210	<20	35
Particle Size (%)	Gravel: 0	Gravel: 7	Gravel: 3.5
	Sand: 40	Sand: 74	Sand: 65.5
	Silt: 40	Silt: 14	Silt: 20
	Clay: 20	Clay: 5	Clay: 11

An in situ respiration test was conducted at the background area beginning on November 16, 1992 after 24 hours of air injection. The test was concluded on October 18. Very little decrease in oxygen concentration occurred during the course of the in situ respiration test (Figure 10).

5.0 FUTURE WORK

Once the system is operating, base personnel will be required to perform a simple weekly system check to ensure that the blower is operating within its intended flowrate, pressure, and temperature range. An on-site briefing for base personnel who will be responsible for blower system checks will be conducted when the blowers are installed. The principle of operation will be explained, and a simple checklist and logbook will be provided for blower data. Base personnel will be asked to perform minor maintenance activities, such as replacing filters or gauges, or draining condensate from knockout chambers, but they will not be expected to perform complicated repairs or analyze gas samples. Replacement filters and gauges will be provided and shipped to the base and serious problems, such as motor or blower failures, will be corrected by Battelle.

The progress of this system will be monitored by conducting semiannual respiration tests in the vent well and in each monitoring point and by regularly measuring the oxygen, carbon dioxide, and hydrocarbon concentrations in the extracted soil gas and comparing them to background levels. At least twice each year, the progress of the bioventing test will be reported to the base point-of-contact.

6.0 REFERENCE

Hinchee, R.E., S.K. Ong, R.N. Miller, D.C. Downey, and R. Frandt. 1992. *Test Plan and Technical Protocol for a Field Treatability Test for Bioventing* (Rev. 2), Report prepared by Battelle Columbus Operations, U.S. Air Force Center for Environmental Excellence, and Engineering-Science, Inc. for the U.S. Air Force Center for Environmental Excellence, Brooks Air Force Base, Texas.

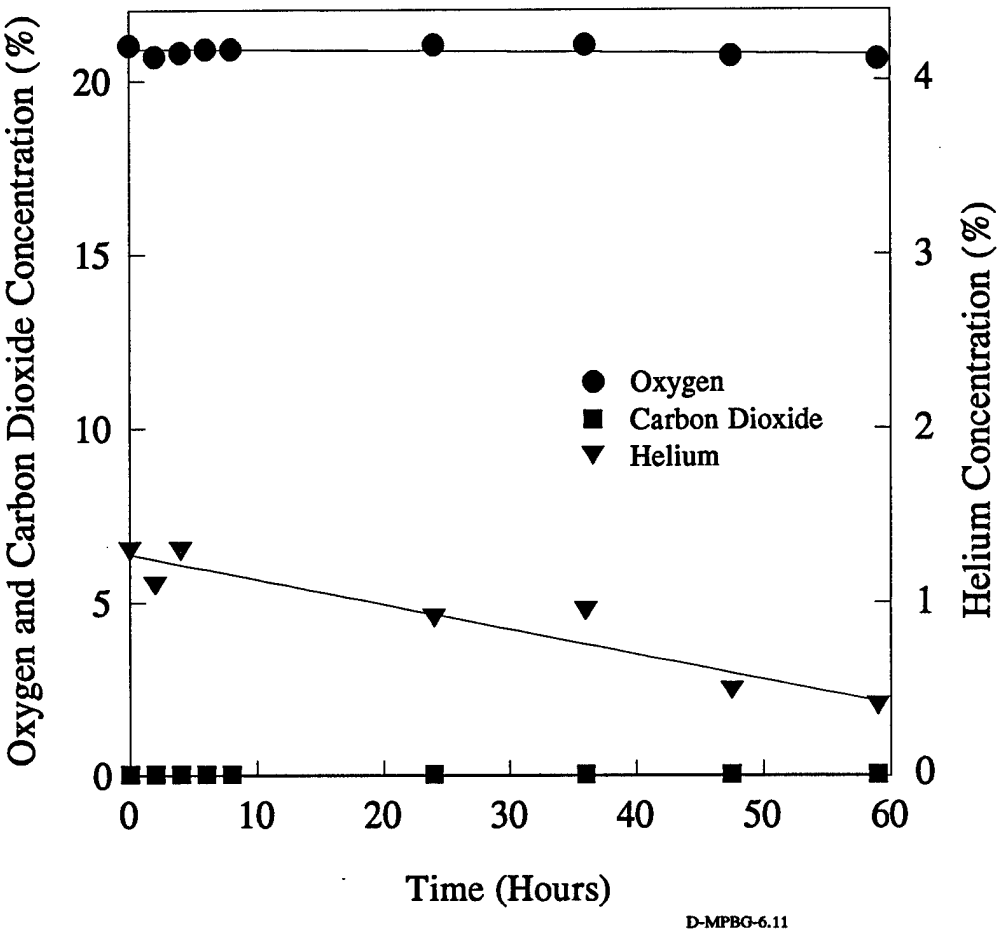

Figure 10. Oxygen Utilization and Carbon Dioxide Production During the In Situ Respiration Test at the Background Area

APPENDIX A

TEST PLAN FOR DOVER AFB, DELAWARE

October 15, 1992

Battelle
. . . Putting Technology To Work
505 King Avenue
Columbus, Ohio 43201-2693
Telephone (614) 424-6424
Facsimile (614) 424-5263

Captain Catherine Vogel
HQ AFCESA/RAVW
139 Barnes Drive
Tyndall Air Force Base,
Florida 32403-5319

Dear Cathy:

SUBJECT: TEST PLAN FOR BIOVENTING INITIATIVE
FIELD TEST AT SITE ST-04 AND ZONE SP, DOVER AFB, DE

This letter was developed to accompany the report "Test Plan and Technical Protocol for a Field Treatability Test for Bioventing." The test plan document was developed as a generic test plan for the Air Force Bioventing Initiative Project in which Dover AFB is participating. This letter outlines site specific information to support the generic test plan.

The sites chosen for the bioventing test initiative are Site ST-04 and Zone SP.

The purpose of this project is to investigate the feasibility of using the bioventing technology to remediate petroleum contaminated soils at the above mentioned sites.

Site descriptions-

Dover AFB is located just east of the city of Dover, Delaware. Summaries of the available descriptions of each site proposed for the Bioventing Initiative are presented below.

Site ST-04- Site ST-04 is a gasoline release site at the AAFES gas station. A map of the AAFES gas station is shown in Figure 1. The cross-sections A to A' and B to B' are presented in Figures 2 and 3, respectively. Depth to groundwater at the site is approximately 11 ft. Soils consist predominantly of coarse sand and gravel from the ground surface to the water table. Analytical results for soil samples from soil borings d66, d67, and d68 (see Figure 1) were contaminated with BTEX constituents at 11.5 ft. to 13.5 ft. The highest concentrations were detected in d67 with 180 ppm toluene, 80 ppm ethylbenzene, and 540 ppm total xylenes (benzene data not available). Soil samples from these borings from the 5 ft. to 7 ft. interval were below detection limit for BTEX and TPH. Sample data for the 7 ft. to 11.5 ft. interval was not available. A soil gas survey was conducted across the ST-04 site on 100 ft. by 200 ft. grids. Figure 4 presents the soil gas TPH concentrations. The highest soil gas concentrations are in the vicinity of the former leaking tank and the fuel dispensing system.

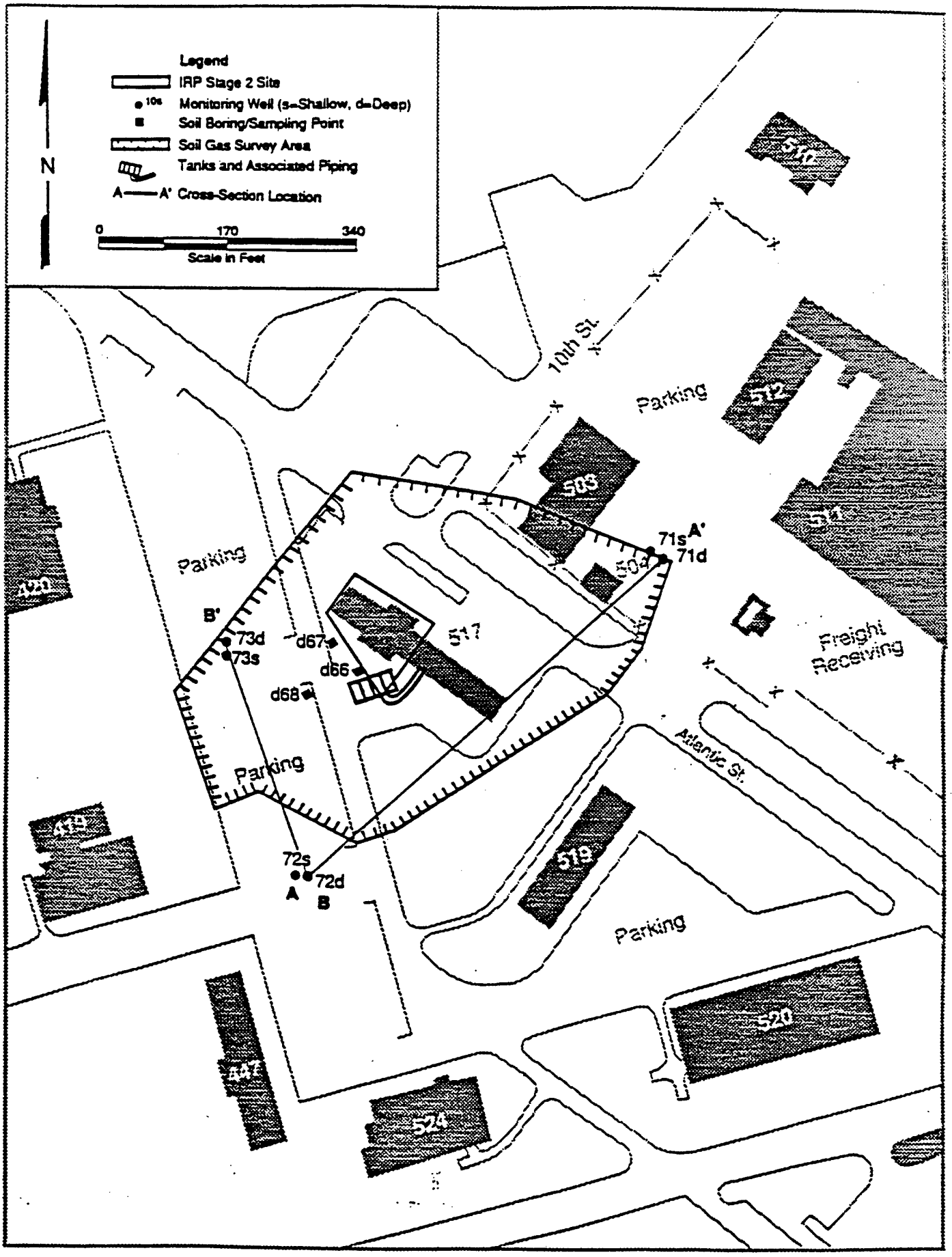

FIGURE 1. SITE MAP FOR ST–04 (AAFES GAS STATION LEAK).

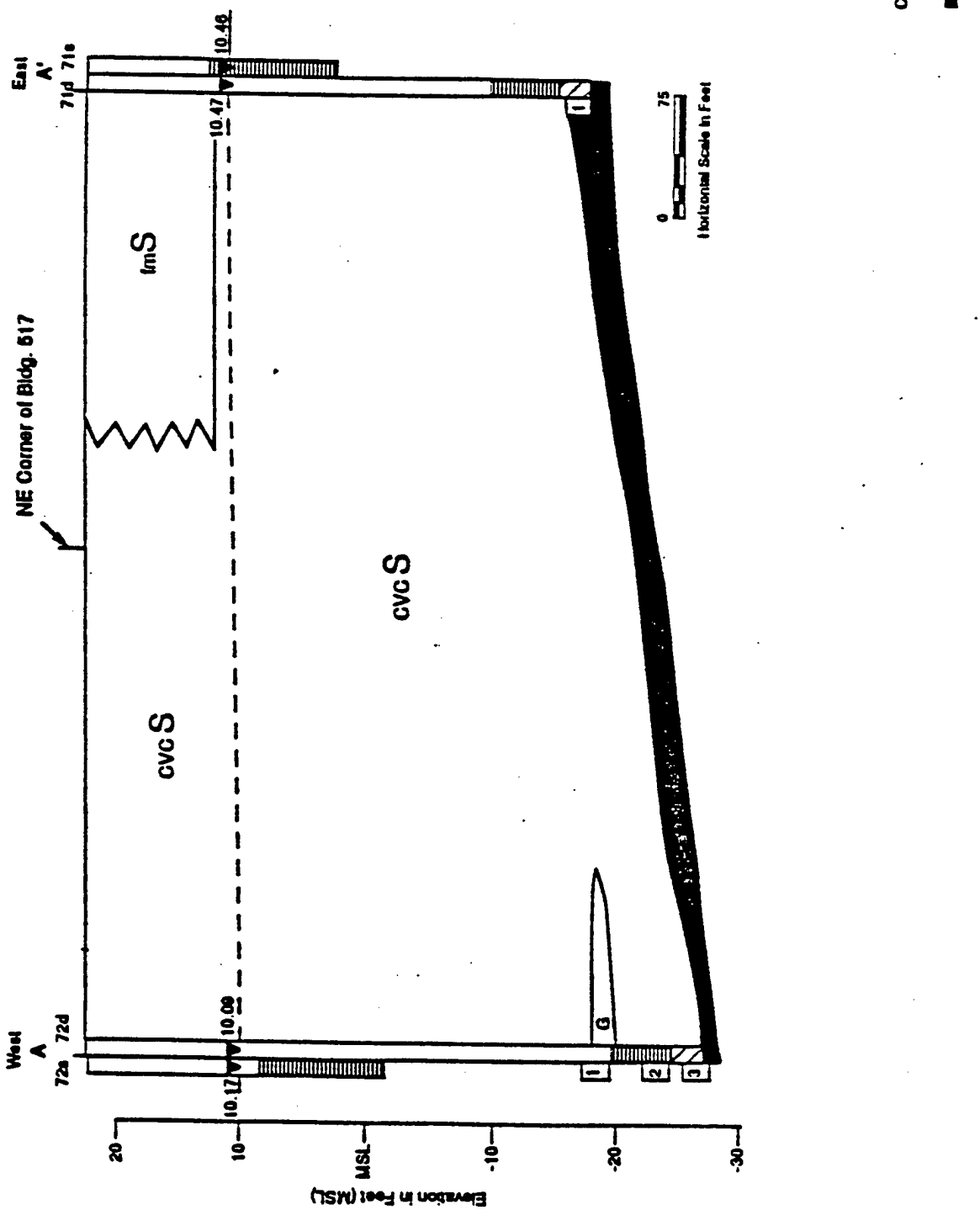

FIGURE 2. SITE ST–04 – CROSS–SECTION A–A'

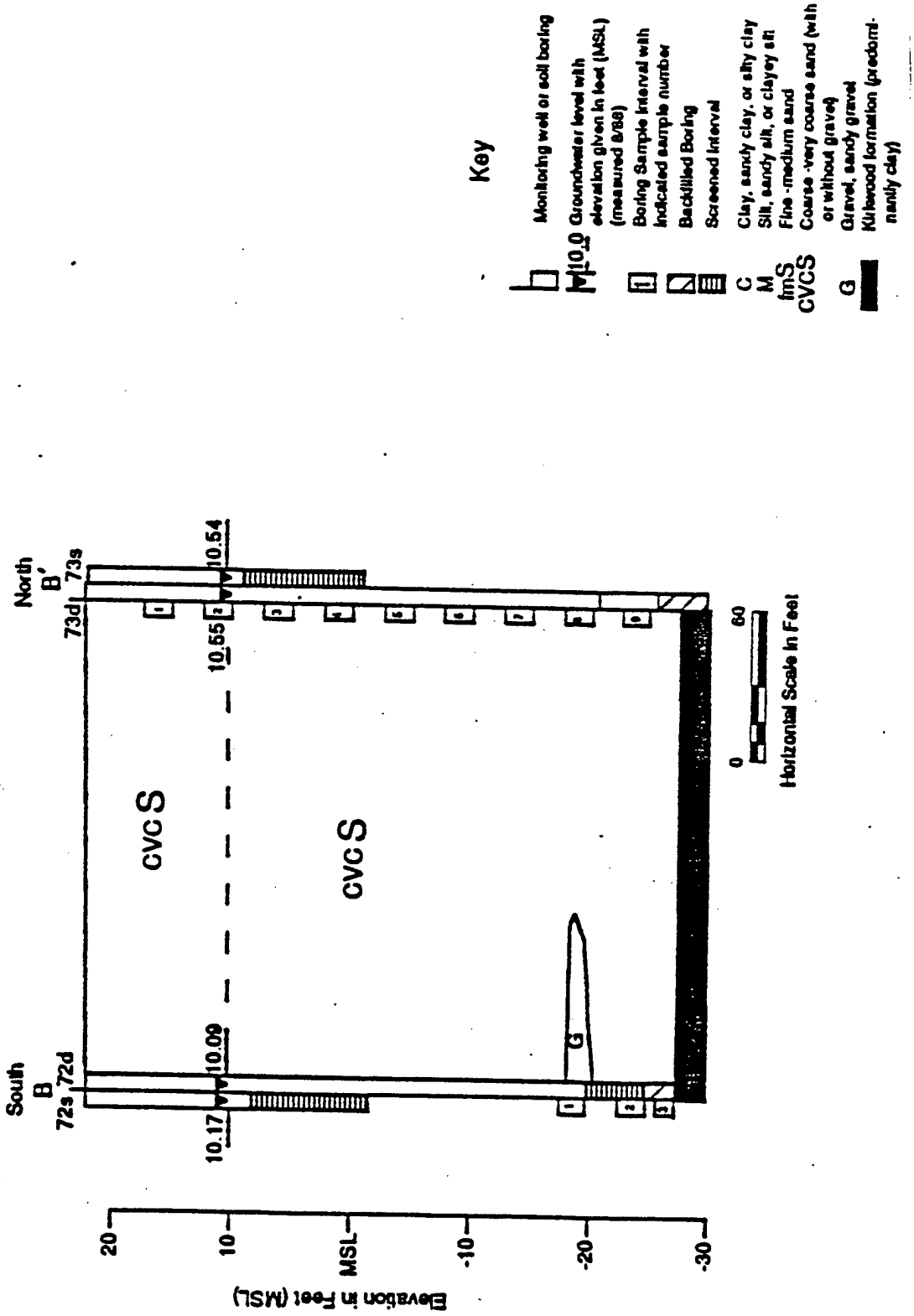

FIGURE 3. SITE ST–04 – CROSS–SECTION B–B'

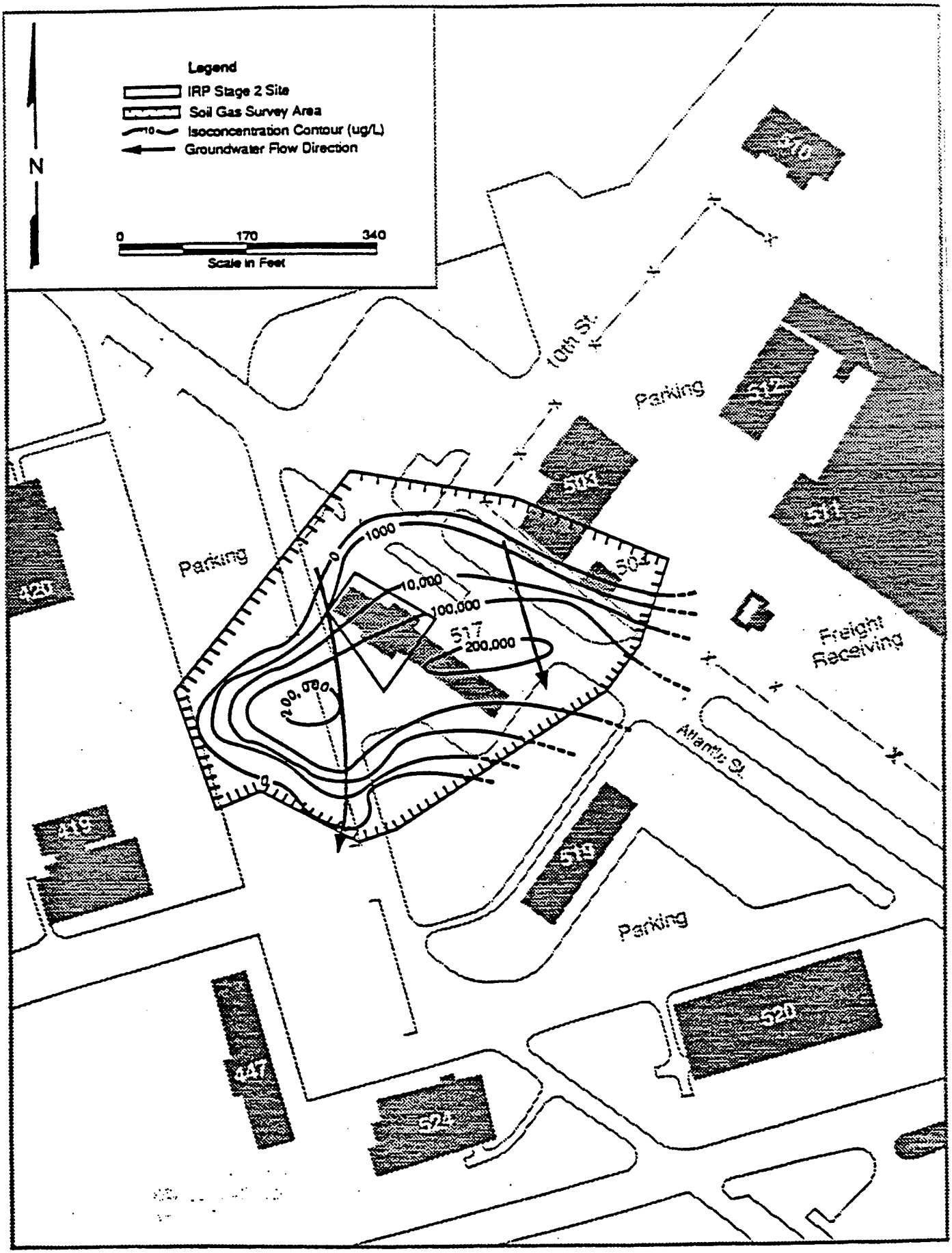

FIGURE 4. SITE ST–04 : TPH CONCENTRATIONS IN SOIL GAS.

Based on the site data for Site ST-04 the most likely area for the installation of the bioventing well is adjacent to UST cavity near soil boring d67. This area is covered with asphalt and is near the service station building. It is likely that the blower installed here would have to be configured for withdrawal of soil gas rather than for air injection. Regulatory approval will be required prior to initiation of the long-term bioventing test if the blower is configured for withdrawal.

Zone SP- Zone SP is at the North Storage Tank Farm, an aboveground JP-4 jet fuel storage area (see Figure 5 for site map). There have been three known releases from Tank #733 between 1970 and 1979 ranging from 17,000 gallons to 30,000 gallons of JP-4 jet fuel. Figure 6 shows the location of a lithologic cross-section adjacent to Zone SP. Figure 7 shows the cross-section A to A' which indicates that near surface soils include coarse sand and gravel, silt and silty sand, and clay and sandy clay. The water table at the site is located at approximately 10 ft. Soil sample data is not available for the site. A soil gas survey was conducted across the site as shown in Figure 8. The soil gas data indicates highest concentrations adjacent to Tank #732.

Based on the site data for Zone SP the most likely area for the installation of the bioventing well is adjacent to Tank #732. However, site logistics will play an important role in locating the bioventing well and monitoring points. Accessibility to the tank diked area, underground and overhead utilities, and site security may all have an impact on system location.

Project activities-

The following field activities are planned for the bioventing project at Dover AFB. The same procedures will be followed at each site. Additional detail can be found in Section 5.0 of the test plan and technical protocol.

1- A small scale soil gas survey will be conducted to identify an appropriate location for installation of the bioventing system. The soil gas survey will be conducted in areas which site data have shown to be the most contaminated. Soil vapor from the candidate site should exhibit high petroleum hydrocarbon concentrations (10,000 ppm or greater), relatively low O_2 concentrations (0 % to 2.0 %), and relatively high CO_2 concentrations (depending on soil type, 2.0 % to 10.0 %, or higher). An uncontaminated background location will also be identified.

2- Once the installation sites are located one vent well and three 3-level soil gas monitoring points will be installed in the contaminated location and one vent well will be installed in the background area (one background area will be used for both test sites, if possible). The wells and monitoring points will be installed using a portable drill rig to bore down to just above the water table. Three to four soil samples will be collected for chemical/physical analysis.

3- The air permeability test will be conducted in the contaminated test location.

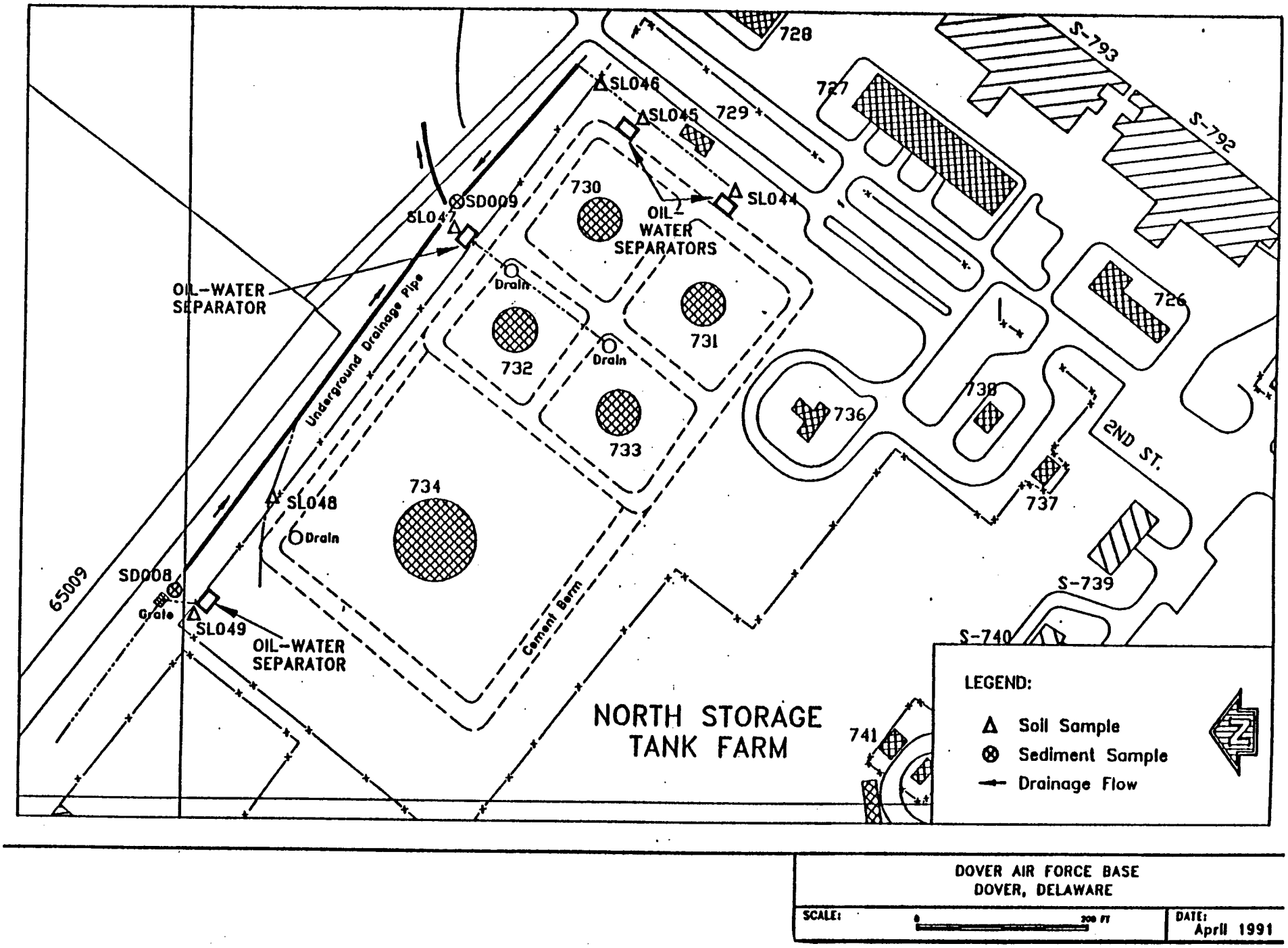

FIGURE 5. SITE MAP FOR ZONE SP – THE NORTH STORAGE TANK FARM.

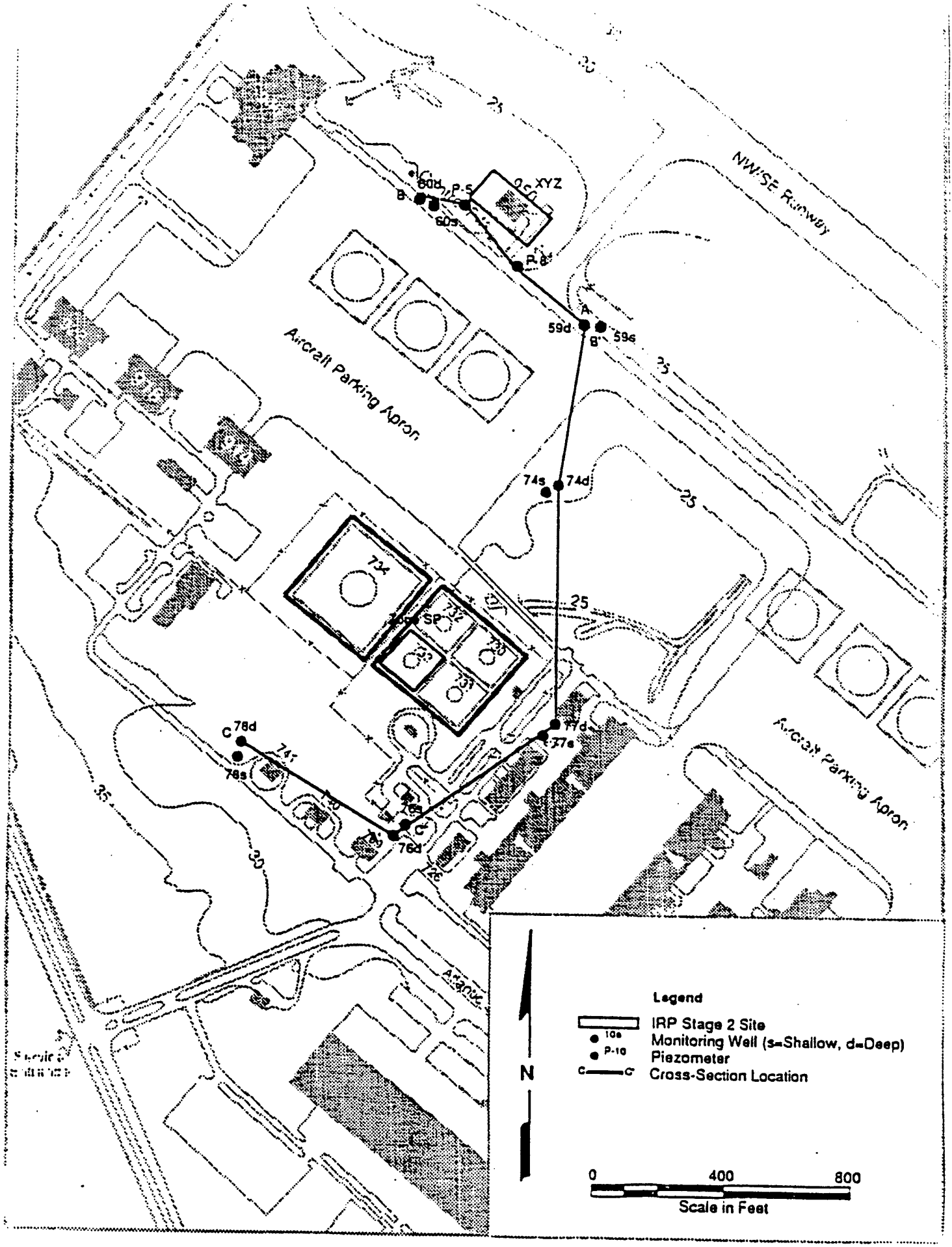

FIGURE 6. CROSS–SECTION LOCATION FOR ZONE SP.

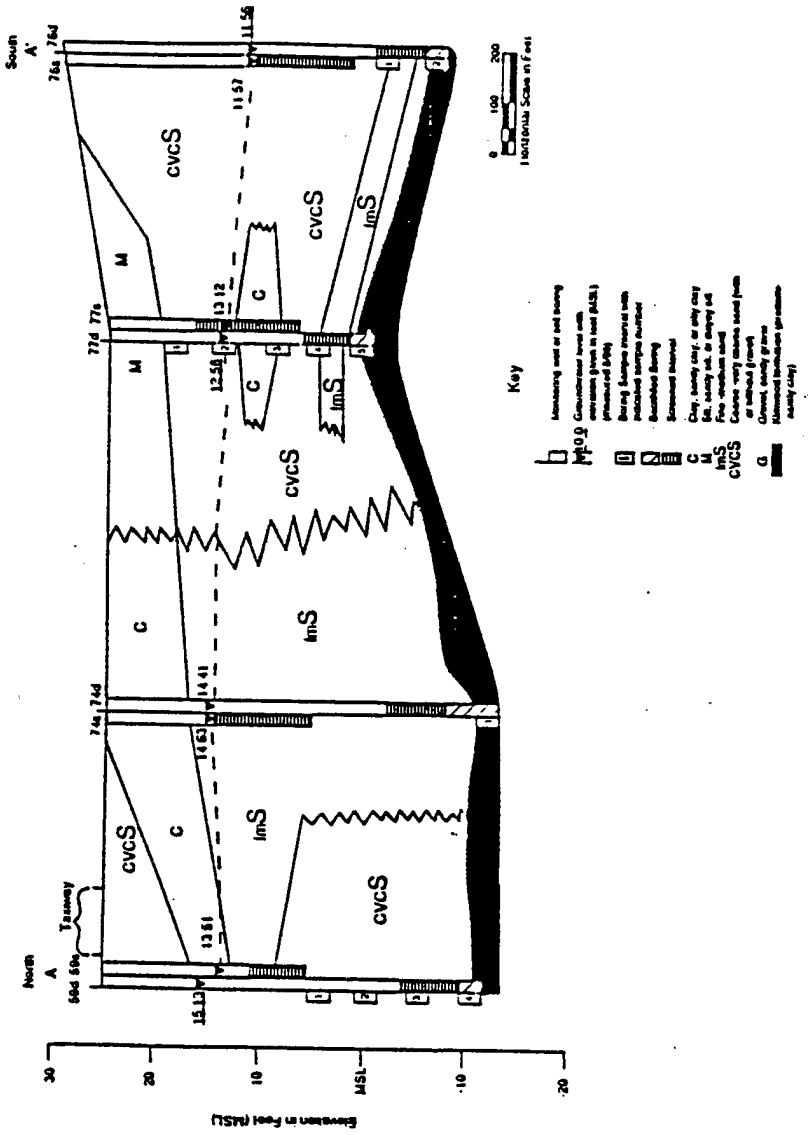

FIGURE 7. ZONE SP CROSS–SECTION A–A'.

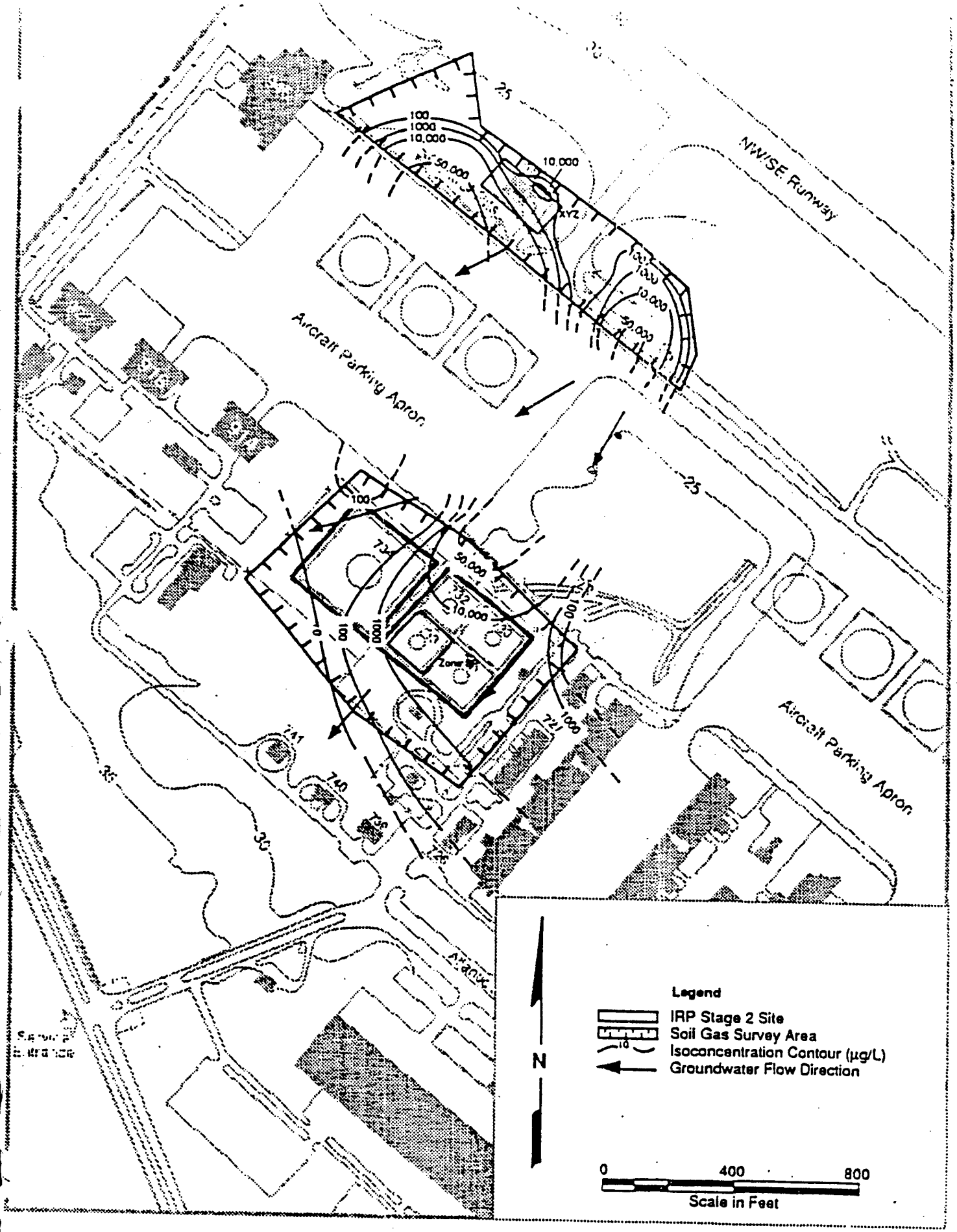

FIGURE 8. ZONE SP : TPH CONCENTRATIONS IN SOIL GAS.

4- Following the air permeability test, in situ respiration tests will be conducted in both the contaminated and the background test locations.

5- Depending on the results of the air permeability test and the in situ respiration test, a decision will be made whether or not to install a blower system in the contaminated area for the long term bioventing test. If the decision is made to install, the blower will be plumbed to the vent well and bioventing will be started (assuming power is available). Site personnel will be trained for blower operation prior to Battelle leaving the site.

6- A report detailing the results of the in situ respiration test and the air permeability test will be provided to the project officer and the base POC.

Schedule-

Field activities at Dover are planned to begin on November 2, 1992. Battelle will have 2 to 3 people on site for approximately 3 weeks.

Base Support-

Dover AFB needs to be able to provide the following:

- Digging permits and utility clearance need to be obtained prior to the initiation of the field work. Underground utilities should be clearly marked to reduce the chance of utility damage or personal injury during soil gas probe and well installation. Battelle will not be able to begin field operations without these clearances.

- Electrical power will need to be easily accessible from the project site. The air permeability test and in situ respiration test can be performed using a gasoline powered electric generator. The operation of the bioventing system will require a permanent 220/110 V power source. If power will not be available immediately after the test is completed the bioventing system will be installed for start-up at a later date.

- Regulatory approval, if any is required, will need to be obtained by the base prior to start-up of the bioventing system. The system will likely be configured for air injection so there will be no point source vapor emission from the system. The wells to be installed will not intersect the apparent water table and no groundwater will be pumped.

- The Air Force will need to provide drums to contain soil cuttings and provide for contaminated soil disposal.

- Base and site clearance will be required for Battelle's site employees. We will furnish you with personal information for each person at least one week prior to starting field operations.

If you have any questions please feel free to call me at (614) 424-6122.

Sincerely,

Jeffrey A. Kittel
Researcher
Environmental Technology Department

JAK:sh

cc: Major Ross Miller (AFCEE)

Mr. Milton Beck
436 SPTGP/DEV
Dover AFB, DE 19902-5516

APPENDIX B

ANALYTICAL REPORT FOR SITE ST-04, THE NORTH STORAGE TANK FARM, AND THE BACKGROUND AREA

AIR TOXICS LTD.

AN ENVIRONMENTAL ANALYTICAL LABORATORY

WORK ORDER #: 9211148

Work Order Summary

CLIENT: Mr. Jeff Kittel
Battelle
505 King Ave.
Columbus, OH 43201

BILL TO: Accounts Payable
Engineering Science
1700 Broadway, Ste. 900
Denver, CO 80290

PHONE: 614-424-6122
FAX: 614-424-3667
DATE RECEIVED: 11/23/92
DATE COMPLETED: 12/14/92

INVOICE # 8899
P.O. #
PROJECT # G4468-0625
AMOUNT$: $1,296.37

FRACTION #	NAME	TEST	RECEIPT VAC./PRES.	PRICE
01A	D1-VW-EXHAUST	TO-3	0.4 psi	$120.00
02A	D1-MPA-11'	TO-3	4.0 "Hg	$120.00
03A	D1-MPC-11'	TO-3	21.5 "Hg	$120.00
04A	D1-AMBIENT	TO-3	0 "Hg	$120.00
05A	D2-VW-3'-8'	TO-3	Tedlar Bag	$120.00
06A	D2-MPA-2.5'	TO-3	Tedlar Bag	$120.00
07A	D2-MPB-2.5'	TO-3	Tedlar Bag	$120.00
08A	D2-MPC-2.5'	TO-3	Tedlar Bag	$120.00
09A	D2-AMBIENT	TO-3	Tedlar Bag	$120.00
10A	D-B6-6'-11'	TO-3	Tedlar Bag	$120.00
10B	D-B6-6'-11' Duplicate	TO-3	Tedlar Bag	NC
11A	Lab Blank	TO-3	NA	NC

1 Liter SUMMA Canister Preparation (4) @ $10.00 each.	$40.00
Shipping (10/27/92)	$56.37

LAB NARRATIVE:
***Samples 05A-10A were out of hold time due to a FED-X shipping error. Client requested to proceed with analyses.**

CERTIFIED BY:_____ DATE:_____
Laboratory Director

AIR TOXICS LTD.

SAMPLE NAME: D1-VW-EXHAUST
ID#: 9211148-01A

EPA METHOD TO-3
(Aromatic Volatile Organics in Air)

BTEX BY GC/PID

File Name:	**6112508**	**Date of Collection:**	**11/13/92**
Dil. Factor:	**2000**	**Date of Analysis:**	**11/25/92**

Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	2.0	6.2	65	200
Toluene	2.0	7.4	100	370
Ethyl Benzene	2.0	8.5	23	98
Total Xylenes	2.0	8.5	79	350

TOTAL PETROLEUM HYDROCARBONS
GC/FID
(Quantitated as Jet Fuel)

File Name:	**6112508**	**Date of Collection:**	**11/13/92**
Dil. Factor:	**2000**	**Date of Analysis:**	**11/25/92**

Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH*	20	80	83000	330000

*TPH referenced to Jet Fuel (MW=156)

Container Type: 1 Liter SUMMA Canister

AIR TOXICS LTD.

SAMPLE NAME: D1-MPA-11'
ID#: 9211148-02A

EPA METHOD TO-3
(Aromatic Volatile Organics in Air)

BTEX BY GC/PID

File Name:	**6112518**	**Date of Collection:**	**11/19/92**
Dil. Factor:	**580**	**Date of Analysis:**	**11/25/92**

Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	0.58	1.8	55	170
Toluene	0.58	2.1	71	260
Ethyl Benzene	0.58	2.5	20	85
Total Xylenes	0.58	2.5	79	340

TOTAL PETROLEUM HYDROCARBONS
GC/FID
(Quantitated as Jet Fuel)

File Name:	**6112518**	**Date of Collection:**	**11/19/92**
Dil. Factor:	**580**	**Date of Analysis:**	**11/25/92**

Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH*	5.8	23	34000	140000

*TPH referenced to Jet Fuel (MW=156)

Container Type: 1 Liter SUMMA Canister

AIR TOXICS LTD.

SAMPLE NAME: D1-MPC-11'
ID#: 9211148-03A

EPA METHOD TO-3
(Aromatic Volatile Organics in Air)

BTEX BY GC/PID

File Name:	**6120107**	**Date of Collection:**	**11/19/92**
Dil. Factor:	**380**	**Date of Analysis:**	**12/1/92**

Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	0.38	1.2	74	230
Toluene	0.38	1.4	16	59
Ethyl Benzene	0.38	1.6	6.8	29
Total Xylenes	0.38	1.6	15	64

TOTAL PETROLEUM HYDROCARBONS
GC/FID
(Quantitated as Jet Fuel)

File Name:	**6120107**	**Date of Collection:**	**11/19/92**
Dil. Factor:	**380**	**Date of Analysis:**	**12/1/92**

Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH*	3.8	15	33000	13000

*TPH referenced to Jet Fuel (MW=156)

Container Type: 1 Liter SUMMA Canister

AIR TOXICS LTD.

SAMPLE NAME: D1-AMBIENT
ID#: 9211148-04A

EPA METHOD TO-3
(Aromatic Volatile Organics in Air)

BTEX BY GC/PID

File Name: 6120104 **Date of Collection: 11/19/92**
Dil. Factor: 2.0 **Date of Analysis: 12/1/92**

Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	0.002	0.006	1.1	3.4
Toluene	0.002	0.007	0.28	1.0
Ethyl Benzene	0.002	0.008	0.091	0.39
Total Xylenes	0.002	0.008	0.24	1.0

TOTAL PETROLEUM HYDROCARBONS
GC/FID
(Quantitated as Jet Fuel)

File Name: 6120104 **Date of Collection: 11/19/92**
Dil. Factor: 2.0 **Date of Analysis: 12/1/92**

Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH*	0.020	0.080	600	2400

*TPH referenced to Jet Fuel (MW=156)

Container Type: 1 Liter SUMMA Canister

AIR TOXICS LTD.

SAMPLE NAME: D2-VW-3'-8'
ID#: 9211148-05A

EPA METHOD TO-3
(Aromatic Volatile Organics in Air)

BTEX BY GC/PID

File Name:	**6112417**	**Date of Collection:**	**11/19/92**
Dil. Factor:	**5000**	**Date of Analysis:**	**11/24/92**

Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	5.0	16	Not Detected	Not Detected
Toluene	5.0	18	Not Detected	Not Detected
Ethyl Benzene	5.0	21	Not Detected	Not Detected
Total Xylenes	5.0	21	Not Detected	Not Detected

TOTAL PETROLEUM HYDROCARBONS
GC/FID
(Quantitated as Jet Fuel)

File Name:	**6112417**	**Date of Collection:**	**11/19/92**
Dil. Factor:	**5000**	**Date of Analysis:**	**11/24/92**

Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH*	50	200	12000	48000

*TPH referenced to Jet Fuel (MW=156)

Container Type: 1 Liter Tedlar Bag

AIR TOXICS LTD.

SAMPLE NAME: D2-MPA-2.5'
ID#: 9211148-06A

EPA METHOD TO-3
(Aromatic Volatile Organics in Air)

BTEX BY GC/PID

File Name: 6112421 **Date of Collection:** 11/19/92
Dil. Factor: 250 **Date of Analysis:** 11/24/92

Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	0.25	0.78	7.6	24
Toluene	0.25	0.92	6.7	25
Ethyl Benzene	0.25	1.1	1.7	7.2
Total Xylenes	0.25	1.1	5.3	22

TOTAL PETROLEUM HYDROCARBONS
GC/FID
(Quantitated as Jet Fuel)

File Name: 6112421 **Date of Collection:** 11/19/92
Dil. Factor: 250 **Date of Analysis:** 11/24/92

Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH*	2.5	10	4800	19000

*TPH referenced to Jet Fuel (MW=156)

Container Type: 1 Liter Tedlar Bag

AIR TOXICS LTD.

SAMPLE NAME: D2-MPB-2.5'
ID#: 9211148-07A

EPA METHOD TO-3
(Aromatic Volatile Organics in Air)

BTEX BY GC/PID

File Name:	**6112507**	**Date of Collection:**	**11/19/92**
Dil. Factor:	**100**	**Date of Analysis:**	**11/25/92**

Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	0.10	0.31	5.1	16
Toluene	0.10	0.37	4.6	17
Ethyl Benzene	0.10	0.42	2.4	10
Total Xylenes	0.10	0.42	5.3	22

TOTAL PETROLEUM HYDROCARBONS
GC/FID
(Quantitated as Jet Fuel)

File Name:	**6112507**	**Date of Collection:**	**11/19/92**
Dil. Factor:	**100**	**Date of Analysis:**	**11/25/92**

Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH*	1.0	4.0	3800	15000

*TPH referenced to Jet Fuel (MW=156)

Container Type: 1 Liter Tedlar Bag

AIR TOXICS LTD.

SAMPLE NAME: D2-MPC-2.5'
ID#: 9211148-08A

EPA METHOD TO-3
(Aromatic Volatile Organics in Air)

BTEX BY GC/PID

File Name:	**6112423**	**Date of Collection:**	**11/19/92**
Dil. Factor:	**50**	**Date of Analysis:**	**11/24/92**

Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	0.050	0.16	6.3	20
Toluene	0.050	0.18	5.4	20
Ethyl Benzene	0.050	0.21	3.2	14
Total Xylenes	0.050	0.21	8.3	35

TOTAL PETROLEUM HYDROCARBONS
GC/FID
(Quantitated as Jet Fuel)

File Name:	**6112423**	**Date of Collection:**	**11/19/92**
Dil. Factor:	**50**	**Date of Analysis:**	**11/24/92**

Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH*	0.50	2.0	4000	16000

*TPH referenced to Jet Fuel (MW=156)

Container Type: 1 Liter Tedlar Bag

AIR TOXICS LTD.

SAMPLE NAME: D2-AMBIENT
ID#: 9211148-09A

EPA METHOD TO-3
(Aromatic Volatile Organics in Air)

BTEX BY GC/PID

File Name:	**6112424**	**Date of Collection:**	**11/19/92**
Dil. Factor:	**10**	**Date of Analysis:**	**11/24/92**

Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	0.010	0.031	0.092	0.29
Toluene	0.010	0.037	0.069	0.25
Ethyl Benzene	0.010	0.042	Not Detected	Not Detected
Total Xylenes	0.010	0.042	0.082	0.35

TOTAL PETROLEUM HYDROCARBONS
GC/FID
(Quantitated as Jet Fuel)

File Name:	**6112424**	**Date of Collection:**	**11/19/92**
Dil. Factor:	**10**	**Date of Analysis:**	**11/24/92**

Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH*	0.10	0.40	150	600

*TPH referenced to Jet Fuel (MW=156)

Container Type: 1 Liter Tedlar Bag

AIR TOXICS LTD.

SAMPLE NAME: D-B6-6'-11'
ID#: 9211148-10A

EPA METHOD TO-3
(Aromatic Volatile Organics in Air)

BTEX BY GC/PID

File Name:	6112425			Date of Collection:	11/19/92
Dil. Factor:	10			Date of Analysis:	11/24/92
Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)	
Benzene	0.010	0.031	Not Detected	Not Detected	
Toluene	0.010	0.037	Not Detected	Not Detected	
Ethyl Benzene	0.010	0.042	Not Detected	Not Detected	
Total Xylenes	0.010	0.042	0.036	0.15	

TOTAL PETROLEUM HYDROCARBONS
GC/FID
(Quantitated as Jet Fuel)

File Name:	6112425			Date of Collection:	11/19/92
Dil. Factor:	10			Date of Analysis:	11/24/92
Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)	
TPH*	0.10	0.40	77	310	

*TPH referenced to Jet Fuel (MW=156)

Container Type: 1 Liter Tedlar Bag

AIR TOXICS LTD.

SAMPLE NAME: D-B6-6'-11' Duplicate
ID#: 9211148-10B

EPA METHOD TO-3
(Aromatic Volatile Organics in Air)

BTEX BY GC/PID

File Name: 6112426 **Date of Collection:** 11/19/92
Dil. Factor: 10 **Date of Analysis:** 11/24/92

Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	0.010	0.031	Not Detected	Not Detected
Toluene	0.010	0.037	Not Detected	Not Detected
Ethyl Benzene	0.010	0.042	Not Detected	Not Detected
Total Xylenes	0.010	0.042	0.034	0.14

TOTAL PETROLEUM HYDROCARBONS
GC/FID
(Quantitated as Jet Fuel)

File Name: 6112426 **Date of Collection:** 11/19/92
Dil. Factor: 10 **Date of Analysis:** 11/24/92

Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH*	0.10	0.40	74	300

*TPH referenced to Jet Fuel (MW=156)

Container Type: 1 Liter Tedlar Bag

AIR TOXICS LTD.

SAMPLE NAME: Lab Blank
ID#: 9211148-11A

EPA METHOD TO-3
(Aromatic Volatile Organics in Air)

BTEX BY GC/PID

File Name:	**6112404**	**Date of Collection:**	**NA**
Dil. Factor:	**1.0**	**Date of Analysis:**	**11/24/92**

Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	0.001	0.003	Not Detected	Not Detected
Toluene	0.001	0.004	Not Detected	Not Detected
Ethyl Benzene	0.001	0.004	Not Detected	Not Detected
Total Xylenes	0.001	0.004	Not Detected	Not Detected

TOTAL PETROLEUM HYDROCARBONS
GC/FID
(Quantitated as Jet Fuel)

File Name:	**6112404**	**Date of Collection:**	**NA**
Dil. Factor:	**1.0**	**Date of Analysis:**	**11/24/92**

Compound	MDL (ppmv)	MDL (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH*	0.010	0.040	Not Detected	Not Detected

*TPH referenced to Jet Fuel (MW=156)

Container Type: NA

AIR TOXICS LTD.
AN ENVIRONMENTAL ANALYTICAL LABORATORY

11325 SUNRISE GOLD CIRCLE, SUITE 'E'
RANCHO CORDOVA, CA 95742
(916) 638-9892 • FAX (916) 638-9917

CHAIN OF CUSTODY RECORD

Page ___ of ___

PROJECT # G4468-0625 PO # _____ COLLECTED BY (Signature) James E. Abbott

REMARKS Tedlar Bags were used @ D2 due to shortage of Canisters

	FIELD SAMPLE I.D.#	SAMPLING MEDIA (Tenax, Canister etc.)	DATE/TIME (JA 11/13/92 4:00pm)	ANALYSIS	VAC./PRESSURE	LAB I.D. #
1	D1-VW-Exhaust	Canister - 1L	~~19 Nov 92 11:00am~~	BTEX + Tot. Volatiles	NA .4psi	
2	D1-MPA-11'	"	19 Nov 92 11:00am		4 Hg	
3	D1-MPC-11'	"	19 Nov 92 11:00am		NA 21.5 Hg	
4	D1-Ambient	"	19 Nov 92 11:00am		0 Hg	
5	D2-VW-3'-8'	Tedlar Bags - 1L	19 Nov 92 12:00pm			
6	D2-MPA-2.5'	"	19 Nov 92 12:00pm			
7	D2-MPB-2.5'	"	19 Nov 92 12:00pm			
8	D2-MPC-2.5'	"	19 Nov 92 12:00pm			
9	D2-Ambient	"	19 Nov 92 12:00pm			
10	D-B6-6'-11'	"	19 Nov 92 3:00pm			

RELINQUISHED BY: DATE/TIME	RECEIVED BY: DATE/TIME	RELINQUISHED BY: DATE/TIME	RECEIVED BY: DATE/TIME
James E. Abbott 11/19/92 5:00 pm	ATL 11/23/92 10:25		

LAB USE ONLY

SHIPPER NAME	AIR BILL #	OPENED BY: DATE/TIME	TEMP(°C)	CONDITION

REMARKS no canister was labeled D1-VW-exhaust instead D1-B-1.5.

ES
ENGINEERING-SCIENCE, INC.

600 BANCROFT WAY
BERKELEY, CA 94710
Tel: (415) 548-7970 Fax: (415) 548-7635

Report Date: December 16, 1992

Work Order No.:4537

Client: Jeff Kittel
Battelle
505 King Ave.
Columbus, OH 43201

Date of Sample Receipt: 11/12/92

Your soil samples identified as:

D2-VW-10'-10.5'
D2-VW-7.5-8.0'
D2-VW-3.5-4'
D1-BG-3.5'4.0'
D1-BG-7.0'-7.5
D1-BG-10.0'-10.5'
D1-VW-3.0'-3.5'
D1-VW-7.0'-7.5'
D1-VW-11.0'-11.5'

were analyzed for BTEX by EPA Method 8020, TRPH by EPA Method 418.1, pH, alkalinity, iron, moisture, total Kjeldahl nitrogen, total phosphorus and soil classification.

The analytical reports for the samples listed above are attached.

GC VOLATILES DATA PACKAGE

ES-ENGINEERING SCIENCE, INC.
Berkeley,CA 94710

GC ANALYTICAL REPORT
Analytical Method
BTEX Aromatic Compounds

Work Order NO.:4537 % Moisture: 32.3

Client ID:D2-VW-10'-10.5' Matrix:SOIL

Laboratory ID:4537-1 Level:LOW

Date Collected: 11/09/92 Unit:UG/KG

Dilution Factor: 1 Date Analyzed:11/14/92
Date Confirmed:NA

Compound	Result	Reporting Limit
Benzene	ND	0.9
Ethyl Benzene	ND	0.7
Toluene	4.0	1.0
Xylenes (total)	ND	1.3

ND-Not Detected
NA-Not Applicable
D-Dilution Factor

ANALYST: [signature]

GROUP LEADER: [signature]

ES-ENGINEERING SCIENCE, INC.
609 Bancroft Way
Berkeley,CA 94710

GC ANALYTICAL REPORT
Analytical Method
BTEX Aromatic Compounds

Work Order NO.:4537 % Moisture: 29.52

Client ID:D2-VW-7.5'-8.0' Matrix:SOIL

Laboratory ID:4537-2 Level:MEDIUM

Date Collected: 11/09/92 Unit:UG/KG

Dilution Factor: 4 Date Analyzed:11/20/92
Date Confirmed:NA

Compound	Result	Reporting Limit
Benzene	ND	340.0
Ethyl Benzene	510.0	280.0
Toluene	ND	400.0
Xylenes (total)	ND	510.0

, 3<10 mg/kg

ND-Not Detected
NA-Not Applicable
D-Dilution Factor

ANALYST: AO

GROUP LEADER:

Berkeley,CA 94710

GC ANALYTICAL REPORT

Analytical Method

BTEX Aromatic Compounds

Work Order NO.:4537 % Moisture: 12.79

Client ID:D2-VW-3.5'-4' Matrix:SOIL

Laboratory ID:4537-5 Level:MEDIUM

Date Collected: 11/09/92 Unit:UG/KG

Dilution Factor: 20 Date Analyzed:11/20/92

Date Confirmed:NA

Compound	Result	Reporting Limit
Benzene	ND	1400.0
Ethyl Benzene	58000	1100.0
Toluene	ND	1600.0
Xylenes (total)	110000	2100.0

ND-Not Detected
NA-Not Applicable
D-Dilution Factor

ANALYST: AB

GROUP LEADER: Rust

GC ANALYTICAL REPORT

Analytical Method
BTEX Aromatic Compounds

Work Order NO.:4537 % Moisture: 6.14

Client ID:D1-BG-3.5'-4.0' Matrix:SOIL

Laboratory ID:4537-4 Level:LOW

Date Collected: 11/06/92 Unit:UG/KG

Dilution Factor: 1 Date Analyzed:11/14/92
Date Confirmed:NA

Compound	Result	Reporting Limit
Benzene	ND	0.6
Ethyl Benzene	ND	0.5
Toluene	ND	0.7
Xylenes (total)	ND	1.0

ND-Not Detected
NA-Not Applicable
D-Dilution Factor

ANALYST: AB

GROUP LEADER:

EA-Engineering Science, Inc.
Berkeley,CA 94710

GC ANALYTICAL REPORT

Analytical Method
BTEX Aromatic Compounds

Work Order NO.:4557 % Moisture: 5.42

Client ID:D1-BG-7.0'-7.5' Matrix:SOIL

Laboratory ID:4557-5 Level:LOW

Date Collected: 11/06/92 Unit:UG/KG

Dilution Factor: 1 Date Analyzed:11/14/92
Date Confirmed:NA

Compound	Result	Reporting Limit
Benzene	ND	0.6
Ethyl Benzene	ND	0.5
Toluene	1.5	0.7
Xylenes (total)	ND	1.0

ND-Not Detected
NA-Not Applicable
D-Dilution Factor

ANALYST: BKJ

GROUP LEADER:

ES-ENGINEERING SCIENCE, INC.
600 Bancroft Way
Berkeley,CA 94710

GC ANALYTICAL REPORT
Analytical Method
BTEX Aromatic Compounds

Work Order NO.:4537 % Moisture: 10.47

Client ID:D1-BG-10.0'-10.5' Matrix:SOIL

Laboratory ID:4537-6 Level:LOW

Date Collected: 11/06/92 Unit:UG/KG

Dilution Factor: 1 Date Analyzed:11/14/92
Date Confirmed:NA

Compound	Result	Reporting Limit
Benzene	ND	0.7
Ethyl Benzene	ND	0.6
Toluene	6.8	0.8
Xylenes (total)	ND	1.0

ND-Not Detected
NA-Not Applicable
D-Dilution Factor

ANALYST: AB

GROUP LEADER: [signature]

ES ENGINEERING SCIENCE, INC | 600 Bancroft Way
Berkeley, CA 94710

GC ANALYTICAL REPORT

Analytical Method
BTEX Aromatic Compounds

Work Order NO.:4557 | % Moisture: 8.82

Client ID:D1-VW-3.0'-3.5' | Matrix:SOIL

Laboratory ID:4557-7 | Level:LOW

Date Collected: 11/07/92 | Unit:UG/KG

Dilution Factor: 1 | Date Analyzed:11/14/92
Date Confirmed:NA

Compound	Result	Reporting Limit
Benzene	ND	0.6
Ethyl Benzene	ND	0.5
Toluene	2.1	0.8
Xylenes (total)	ND	1.0

ND-Not Detected
NA-Not Applicable
D-Dilution Factor

ANALYST: AS

GROUP LEADER: [signature]

Berkeley,CA 94710

GC ANALYTICAL REPORT
Analytical Method
BTEX Aromatic Compounds

Work Order NO.:4557 % Moisture: 14.08

Client ID:D1-VW-7.0'-7.5' Matrix:SOIL

Laboratory ID:4557-8 Level:LOW

Date Collected: 11/07/92 Unit:UG/KG

Dilution Factor: 1 Date Analyzed:11/15/92
Date Confirmed:NA

Compound	Result	Reporting Limit
Benzene	ND	0.7
Ethyl Benzene	ND	0.6
Toluene	3.4	0.8
Xylenes (total)	ND	1.0

ND-Not Detected
NA-Not Applicable
D-Dilution Factor

ANALYST: AM

GROUP LEADER:

CO-ENGINEERING SCIENCE, INC.
Berkeley,CA 94710

GC ANALYTICAL REPORT
Analytical Method
BTEX Aromatic Compounds

Work Order NO.:4557 % Moisture: 12.08

Client ID:D1-VW-11.0'-11.5' Matrix:SOIL

Laboratory ID:4557-9 Level:MEDIUM

Date Collected: 11/07/92 Unit:UG/KG

Dilution Factor: 20 Date Analyzed:11/20/92
Date Confirmed:NA

Compound	Result	Reporting Limit
Benzene	2700.0	1400.0
Ethyl Benzene	5000.0	1100.0
Toluene	5200.0	1600.0
Xylenes (total)	26000	2000.0

ND-Not Detected
NA-Not Applicable
D-Dilution Factor

ANALYST: AB

GROUP LEADER:

CS-ENGINEERING SCIENCE, INC.
2990 Gateway Way
Berkeley, CA 94710

GC ANALYTICAL REPORT
Analytical Method
BTEX Aromatic Compounds

Work Order NO.:4537 % Moisture:NA

Client ID:METHOD BLANK Matrix:SOIL

Laboratory ID:MWVG2921120B Level:MEDIUM

Date Collected: NA Unit:UG/KG

Dilution Factor: 1 Date Analyzed:11/20/92
Date Confirmed:NA

Compound	Result	Reporting Limit
Benzene	ND	60.0
Ethyl Benzene	ND	50.0
Toluene	ND	70.0
Xylenes (total)	ND	90.0

ND-Not Detected
NA-Not Applicable
D-Dilution Factor

ANALYST:AD GROUP LEADER:

EA-ENGINEERING SCIENCE, Inc.
Berkeley,CA 94710

GC ANALYTICAL REPORT
Analytical Method
BTEX Aromatic Compounds

Work Order NO.:4557 % Moisture:NA

Client ID:METHOD BLANK Matrix:SOIL

Laboratory ID:MSVG2921114B Level:LOW

Date Collected: NA Unit:UG/KG

Dilution Factor: 1 Date Analyzed:11/14/92
Date Confirmed:NA

Compound	Result	Reporting Limit
Benzene	ND	0.6
Ethyl Benzene	ND	0.5
Toluene	ND	0.7
Xylenes (total)	ND	0.9

ND-Not Detected
NA-Not Applicable
D-Dilution Factor

ANALYST: AB

GROUP LEADER: [signature]

ENGINEERING SCIENCE,INC.

600 BANCROFT WAY
BERKELEY, CA 94710

GC ANALYTICAL REPORT
ANALYTICAL REPORT
BTEX AROMATIC COMPOUNDS

MATRIX: SOIL

DATE:11/14&15/92

LABORATORY NO.	CLIENT ID	a-a-a-TriFluoro Toluene
MSVG2921114B	METHOD BLANK	92
4537-1	D2-VW-10'-10.5'	93
4537-4	D1-BG-3.5'-4.0'	76
4537-5	D1-BG-7.0'-7.5'	88
4537-6	D1-BG-10.0'10.5'	88
4537-7	D1-VW-3.0'-3.5'	88
4537-8	D1-VW-7.0'-7.5'	92
4533-1	BE18-VMP3-55	88
SSVG2921114A	SPIKE	90
SSVG2921114B	SPIKE DUP	91

[redacted]-ENGINEERING SCIENCE,INC.

600 BANCROFT WAY
BERKELEY, CA 94710

GC ANALYTICAL REPORT
ANALYTICAL REPORT
BTEX AROMATIC COMPOUNDS

MATRIX: SOIL

DATE:11/20/92

LABORATORY NO.	CLIENT ID	a-a-a-TriFluoro Toluene
MWUG2921120B	METHOD BLANK	87
4537-2	D2-UW-7.5'-8.0'	78
4537-3	D2-UW-3.5'-4'	73
4537-9	D1-UW-11.0'-11.5'	74

METHOD BLANK SUMMARY

WO # 4537,4533

LAB NAME : ENGINEERING-SCIENCE, INC. DATE ANALYZED :11/14-15/92

LAB SAMPLE ID:MSVG2921114B DATE EXTRACTED : NA

MATRIX :SOIL INSTRUMENT ID:VGC-2

LAB SAMPLE ID	CLIENT SAMPLE ID	DATE ANALYZED
SVG2921114B	METHOD BLANK	11/14/92
537-1	D2-VW-10'-10.5'	11/14/92
4537-4	D1-BG-3.5'-4.0'	11/14/92
537-5	D1-BG-7.0'-7.5'	11/14/92
537-6	D1-BG-10.0'-10.5'	11/14/92
4537-7	D1-VW-3.0'-3.5'	11/14/92
4537-8	D1-VW-7.0'-7.5'	11/15/92
533-1	BE18-VMP3-55	11/15/92
SVG2921114A	SPIKE	11/14/92
SSVG2921114B	SPIKE DUP	11/14/92

METHOD BLANK SUMMARY

WO # 4537

LAB NAME : ENGINEERING-SCIENCE, INC. DATE ANALYZED :11/20/92

LAB SAMPLE ID:MWVG2921120B DATE EXTRACTED : NA

MATRIX :SOIL INSTRUMENT ID:VGC-2

LAB SAMPLE ID	CLIENT SAMPLE ID	DATE ANALYZED
MWVG2921120B	METHOD BLANK	11/20/92
4537-2	D2-VW-7.5'-8.0'	11/20/92
4537-3	D2-VW-3.5'-4'	11/20/92
4537-9	D1-VW-11.0'-11.5'	11/20/92

TOTAL RECOVERABLE PETROLEUM HYDROCARBONS
DATA PACKAGE

ES-ENGINEERING SCIENCE, INC.
600 Bancroft Way
Berkeley,CA 94710

ORGANIC ANALYTICAL REPORT

Work Order NO.: 4537

Matrix: Soil

Parameter: TPH

Unit: mg/Kg

Analytical Method: 418.1

Date Extracted 11/20/92

QC Batch NO.: S92QCB029TPH

Date Analyzed: 11/24/92

Sample ID:	Client ID:	Result	Reporting Limit	Percent Moisture
4537-01	D2-VW-10'-10.5'	22	6	32.3
4537-02	D2-VW-7.5'-8.0'	8	6	29.5
4537-03	D2-VW-3.5'-4'	3500	5	12.8
4537-04	D1-BG-3.5'-4.0'	ND	4	6.1
4537-05	D1-BG-7.0'-7.5'	ND	4	5.4
4537-06	D1-BG-10.0'-10.5'	ND	4	10.5
4537-07	D1-VW-3.0'-3.5'	ND	4	8.8
4537-08	D1-VW-7.0'-7.5'	7	5	14.0
4537-09	D1-VW-11.0'-11.5'	17	4	12.0
MSTPH921120	METHOD BLANK	ND	4	NA

NA_ Not Analyzed
ND_ Not Detected

ANALYST:

GROUP LEADER:

INORGANICS DATA PACKAGE

ES-ENGINEERING-SCIENCE, INC.
600 Bancroft Way
Berkeley, CA 94710

INORGANICS ANALYTICAL REPORT

Client: ES-Denver
Project: AFCEE
Work Order: 4537
Matrix: Solid

Client's ID: D2-VW-10' D2-VW-7' D2-VW-3'

Sample Date: 11/09/92 11/09/92 11/09/92
% Moisture:
Lab ID: 4537.01 4537.02 4537.03

Parameter	Results			Method	Normal Report Limit	Units	Date Analyzed
Alkalinity	ND	ND	ND	SM 403(M)	50	mg/Kg CaCO3	11/16/92
Moisture	32.3	29.5	12.8	ASTM D2216	.1	% by wt	11/20/92
pH	5.2	5.3	5.9	EPA 9045	NA	pH Units	11/23/92

Note: Samples for alkalinity analysis were extracted using 10mL water for each 1g sample. These water extracts were analyzed for alkalinity, and the results were calculated in the solid on a dry-weight basis.

NA- Not Applicable
ND- Not Detected

ANALYST: Don Sleator GROUP LEADER:

ES-ENGINEERING-SCIENCE, INC.
600 Bancroft Way
Berkeley, CA 94710

INORGANICS ANALYTICAL REPORT

Client: ES-Denver
Project: AFCEE
Work Order: 4537
Matrix: Solid

Client's ID: D1-BG-3'

Sample Date: 11/06/92
% Moisture:
Lab ID: 4537.04

Parameter	Results	Method	Normal Report Limit	Units	Date Analyzed
Alkalinity	ND	SM 403(M)	50	mg/Kg CaCO3	11/16/92
Moisture	6.1	ASTM D2216	.1	% by wt	11/20/92
pH	6.1	EPA 9045	NA	pH Units	11/23/92

Note: Samples for alkalinity analysis were extracted using 10mL water for each 1g sample. These water extracts were analyzed for alkalinity, and the results were calculated in the solid on a dry-weight basis.

NA- Not Applicable
ND- Not Detected

ANALYST: Don Gleaton GROUP LEADER:

ES-ENGINEERING-SCIENCE, INC.
600 Bancroft Way
Berkeley, CA 94710

INORGANICS ANALYTICAL REPORT

Client: ES-Denver
Project: AFCEE
Work Order: 4537
Matrix: Solid

Client's ID: D1-BG-7' D1-BG-10' D1-VW-3'

Sample Date: 11/06/92 11/06/92 11/07/92
% Moisture:
Lab ID: 4537.05 4537.06 4537.07

Parameter	Results			Method	Normal Report Limit	Units	Date Analyzed
Alkalinity	ND	ND	58.	SM 403(M)	50	mg/Kg CaCO3	11/17/92
Moisture	5.4	10.5	8.8	ASTM D2216	.1	% by wt	11/20/92
pH	5.3	5.5	6.6	EPA 9045	NA	pH Units	11/23/92

Note: Samples for alkalinity analysis were extracted using 10mL water for each 1g sample. These water extracts were analyzed for alkalinity, and the results were calculated in the solid on a dry-weight basis.

NA- Not Applicable
ND- Not Detected

ANALYST: Don Gleaton GROUP LEADER:

ES-ENGINEERING-SCIENCE, INC.

600 Bancroft Way
Berkeley, CA 94710

INORGANICS ANALYTICAL REPORT

Client: ES-Denver
Project: AFCEE

Work Order: 4537
Matrix: Solid

Client's ID: D1-VW-7' D1-VW-11'

Sample Date: 11/07/92 11/07/92
% Moisture:
Lab ID: 4537.08 4537.09

Parameter	Results		Method	Normal Report Limit	Units	Date Analyzed
Alkalinity	ND	ND	SM 403(M)	50	mg/Kg CaCO3	11/17/92
Moisture	14.1	12.1	ASTM D2216	.1	% by wt	11/20/92
pH	4.6	4.8	EPA 9045	NA	pH Units	11/23/92

Note: Samples for alkalinity analysis were extracted using 10mL water for each 1g sample. These water extracts were analyzed for alkalinity, and the results were calculated in the solid on a dry-weight basis.

NA- Not Applicable
ND- Not Detected

ANALYST: Don Gleason GROUP LEADER:

ES-ENGINEERING-SCIENCE, INC.

600 Bancroft Way
Berkeley, CA 94710

INORGANICS ANALYTICAL REPORT

Client: ES-Denver
Project: AFCEE

Work Order: 4537
Matrix: Solid

Client's ID: Prep Blank

Sample Date:
% Moisture:
Lab ID: Prep Blank

Parameter	Results	Method	Normal Report Limit	Units	Date Analyzed
Alkalinity	ND	SM 403(M)	50	mg/Kg CaCO3	11/16/92
Moisture	NA	ASTM D2216	.1	% by wt	11/20/92
pH	NA	EPA 9045	NA	pH Units	11/23/92

Note: Samples for alkalinity analysis were extracted using 10mL water for each 1g sample. These water extracts were analyzed for alkalinity, and the results were calculated in the solid on a dry-weight basis.

NA- Not Applicable
ND- Not Detected

ANALYST: Don Gleaton

GROUP LEADER:

ES-ENGINEERING-SCIENCE, INC.

600 Bancroft Way
Berkeley, CA 94710

INORGANICS QC SUMMARY - LAB CONTROL SAMPLE

Work Order: 4537

% Moisture: NA

Lab ID of LCS:
Alkalinity: 452.44 LCS

Matrix: Solid

Units: mg/Kg CaCO3

Parameter	Date Analyzed LCS	LCS Result	Conc Added	% Rec LCS	Advisory Limits -- % Rec -- Low	High
Alkalinity	11/16/92	22900.00	23650.00	97	80	120

ANALYST: Don Gleaton Date 11/25/92 REVIEWER: MW Date 12/1/92

File:M1QCLCSW

ES-ENGINEERING-SCIENCE, INC.

600 Bancroft Way
Berkeley, CA 94710

INORGANIC QC SUMMARY - MS and MSD

Work Order: 4537

% Moisture: NA

Matrix: Solid

	Alkalinity	Moisture	pH
Lab ID Spk/Dup:	Blank Spk	4537.01	4537.01
QC Batch:	452.44	451.95	453.49

Units: mg/Kg CaCO3 (Alk)
% by wt. (Mois)
pH Units (pH)

Parameter	Date Analyzed MS/Dup	Unspiked Sample	MS/Sample	MSD/Dup	RPD	RPD QC Limit	-Conc Added- MS	MSD	Percent Recovered MS	MSD
Alkalinity	11/16/92	0.00	22900.00	22900.00	0	20	23650.00	23650.00	97	97
Moisture	11/20/92		32.30	35.17	9	20				
pH	11/23/92		5.16	5.23	1	20				

* or N = Outside QC Limit:

QC Limits for % Rec: 75 - 125

ANALYST: Don Gleaton Date 11/25/92 REVIEWER: [signature] Date 12/1/92

File:M1QCMSWM

METALS DATA PACKAGE

Engineering Science - Berkeley Laboratory
Inorganics Report

INORGANIC ANALYSES DATA SHEET

CLIENT SAMPLE ID: VW10

Lab Name: E_S__BERKELEY_LABORATORY_ Contract: AFCEE_____

Lab Code: ESBL__ Case No.: 4537S SAS No.: _____ SDG No.: BG10__

Matrix (soil/water): SOIL_ Lab Sample ID: 4537.01___

Level (low/med): LOW__ Date Sampled : 11/09/92

% Solids: _67.7

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7439-89-6	Iron	8070			P

Comments:

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3/90

Engineering Science - Berkeley Laboratory
Inorganics Report

INORGANIC ANALYSES DATA SHEET

CLIENT SAMPLE ID

VW7.5

Lab Name: E_S__BERKELEY_LABORATORY_ Contract: AFCEE_____

Lab Code: ESBL__ Case No.: 4537S SAS No.: _____ SDG No.: BG10__

Matrix (soil/water): SOIL_ Lab Sample ID: 4537.02___

Level (low/med): LOW__ Date Sampled : 11/09/92

Solids: _70.5

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7439-89-6	Iron	16200			P

Comments:

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Engineering Science - Berkeley Laboratory
Inorganics Report

INORGANIC ANALYSES DATA SHEET

CLIENT SAMPLE ID

VW3.5

Lab Name: E_S__BERKELEY_LABORATORY_ Contract: AFCEE_____

Lab Code: ESBL__ Case No.: 4537S SAS No.: _____ SDG No.: BG10__

Matrix (soil/water): SOIL_ Lab Sample ID: 4537.03___

Level (low/med): LOW__ Date Sampled : 11/09/92

% Solids: _87.2

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7439-89-6	Iron	1950			P

Comments:

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Engineering Science - Berkeley Laboratory
Inorganics Report

INORGANIC ANALYSES DATA SHEET

CLIENT SAMPLE ID: BG3.5

Lab Name: E_S__BERKELEY_LABORATORY_ Contract: AFCEE_____

Lab Code: ESBL__ Case No.: 4537S SAS No.: _____ SDG No.: BG10__

Matrix (soil/water): SOIL_ Lab Sample ID: 4537.04___

Level (low/med): LOW__ Date Sampled : 11/06/92

Solids: _93.9

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7439-89-6	Iron	12700			P

Comments:

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Inorganics Report

INORGANIC ANALYSES DATA SHEET

CLIENT SAMPLE ID

BG7

Lab Name: E_S__BERKELEY_LABORATORY_ Contract: AFCEE_____

Lab Code: ESBL__ Case No.: 4537S SAS No.: _____ SDG No.: BG10__

Matrix (soil/water): SOIL_ Lab Sample ID: 4537.05___

Level (low/med): LOW__ Date Sampled : 11/06/92

% Solids: _94.6

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7439-89-6	Iron	1970			P

Comments:

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Engineering Science - Berkeley Laboratory
Inorganics Report

INORGANIC ANALYSES DATA SHEET

CLIENT SAMPLE ID

BG10

Lab Name: E_S__BERKELEY_LABORATORY_ Contract: AFCEE_____

Lab Code: ESBL__ Case No.: 4537S SAS No.: _____ SDG No.: BG10__

Matrix (soil/water): SOIL_ Lab Sample ID: 4537.06___

Level (low/med): LOW__ Date Sampled : 11/06/92

% Solids: _89.5

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7439-89-6	Iron	6850			P

Comments:

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Inorganics Report

INORGANIC ANALYSES DATA SHEET

CLIENT SAMPLE ID

VW3

Lab Name: E_S__BERKELEY_LABORATORY_ Contract: AFCEE_____

Lab Code: ESBL__ Case No.: 4537S SAS No.: _____ SDG No.: BG10__

Matrix (soil/water): SOIL_ Lab Sample ID: 4537.07___

Level (low/med): LOW__ Date Sampled : 11/07/92

Solids: _91.2

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7439-89-6	Iron	7420			P

Comments:

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Inorganics Report

INORGANIC ANALYSES DATA SHEET

CLIENT SAMPLE ID

VW7

Lab Name: E_S__BERKELEY_LABORATORY_ Contract: AFCEE_____

Lab Code: ESBL__ Case No.: 4537S SAS No.: _____ SDG No.: BG10__

Matrix (soil/water): SOIL_ Lab Sample ID: 4537.08___

Level (low/med): LOW__ Date Sampled : 11/07/92

Solids: _85.9

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7439-89-6	Iron	3230			P

Comments:

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Engineering Science - Berkeley Laboratory
Inorganics Report

INORGANIC ANALYSES DATA SHEET

CLIENT SAMPLE ID

VW11

Lab Name: E_S__BERKELEY_LABORATORY_ Contract: AFCEE_____

Lab Code: ESBL__ Case No.: 4537S SAS No.: _____ SDG No.: BG10__

Matrix (soil/water): SOIL_ Lab Sample ID: 4537.09___

Level (low/med): LOW__ Date Sampled : 11/07/92

% Solids: _87.9

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7439-89-6	Iron	3450			P

Comments:

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Inorganics Report

INORGANIC ANALYSES DATA SHEET

CLIENT SAMPLE ID

PBLANK

Lab Name: E_S__BERKELEY_LABORATORY_ Contract: AFCEE_____

Lab Code: ESBL__ Case No.: 4537S SAS No.: _____ SDG No.: BG10__

Matrix (soil/water): SOIL_ Lab Sample ID: PBK 482.88

Level (low/med): LOW__ Date Sampled : 12/07/92

% Solids: 100.0

Concentration Units (ug/L or mg/kg dry weight): MG/KG

CAS No.	Analyte	Concentration	C	Q	M
7439-89-6	Iron	4.6	U		P

Comments:

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Inorganic Report

ICP SERIAL DILUTION

EPA SAMPLE NO.

VW10 L

Lab Name: E_S__BERKELEY_LABORATORY_ Contract: AFCEE_____

Lab Code: ESBL__ Case No.: 4537S_ SAS No.: _____ SDG No.: BG10__

Matrix (soil/water): SOIL_ Level (low/med): LOW__

Concentration Units: ug/L

Analyte	Initial Sample Result (I)	C	Serial Dilution Result (S)	C	% Difference	Q	M
Iron	67722.80		73293.24		8.2		P

Engineering Science - Berkeley Laboratory

Method Detection Limits (Annually)

Lab Name: E_S__BERKELEY_LABORATORY_ Contract: AFCEE_____

Lab Code: ESBL__ Case No.: 4537S_ SAS No.: _____ SDG No.: BG10__

ICP ID Number: TJA_61_____M Date: 08/31/92

Flame AA ID Number : _____ Matrix: SOIL_

Furnace AA ID Number : _____ (ug/L in 1.00g to 100ml digestate)

Analyte	Wave-length (nm)	Back-ground		MDL (ug/L)	M
Iron	271.44			46.0	P

Comments:

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Engineering Science - Berkeley Laboratory
Inorganics Report

PREPARATION LOG

Lab Name: E_S__BERKELEY_LABORATORY_ Contract: AFCEE_____

Lab Code: ESBL__ Case No.:_4537S_ SAS No.: _____ SDG No.:BG10__

Method: P_

EPA Sample No.	Preparation Date	Weight (gram)	Volume (mL)
BG10	12/07/92	1.21	100
BG3.5	12/07/92	1.22	100
BG7	12/07/92	1.09	100
LCSS	12/07/92	1.00	100
LCSSD	12/07/92	1.00	100
PBLANK	12/07/92	1.00	100
TIMPA5	12/07/92	1.36	100
TIMPB5	12/07/92	1.12	100
TIVW5	12/07/92	1.12	100
VW10	12/07/92	1.24	100
VW11	12/07/92	1.14	100
VW3	12/07/92	1.24	100
VW3.5	12/07/92	1.04	100
VW7	12/07/92	1.19	100
VW7.5	12/07/92	1.14	100

Engineering Science - Berkeley Laboratory
Inorganics Report

ANALYSIS RUN LOG

Lab Name: E_S__BERKELEY_LABORATORY_ Contract: AFCEE_____

Lab Code: ESBL__ Case No.: 4537S_ SAS No.: _____ SDG No.:BG10__

Instrument ID Number: TJA 61 M_ Method: P_

Start Date: 12/08/92 End Date: 12/08/92

EPA Sample No.	D/F	Time	% R	Analytes FE
STD1	1.00	1254		X
STD2	1.00	1258		X
STD3	1.00	1303		X
STD4	1.00	1308		X
ICV	1.00	1312		X
ICB	1.00	1317		X
ICSA	1.00	1321		X
ICSAB	1.00	1326		X
CRI	1.00	1331		
ZZZZZZ	1.00	1335		
PBLANK	1.00	1340		X
LCSS	1.00	1344		X
LCSSD	1.00	1349		X
VW10	1.00	1354		X
VW10L	1.00	1358		X
VW7.5	1.00	1403		X
CCV	1.00	1408		X
CCB	1.00	1412		X
VW3.5	1.00	1417		X
BG3.5	1.00	1421		X
BG7	1.00	1426		X
BG10	1.00	1431		X
VW3	1.00	1435		X
VW7	1.00	1440		X
VW11	1.00	1445		X
TIVW5	1.00	1449		X
TIMPA5	1.00	1454		X
TIMPB5	1.00	1458		X
CCV	1.00	1503		X
CCB	1.00	1508		X
ICSA	1.00	1512		X
ICSAB	1.00	1517		X

Engineering Science - Berkeley Laboratory
Inorganics Report

ANALYSIS RUN LOG

Lab Name: E_S__BERKELEY_LABORATORY_ Contract: AFCEE_____

Lab Code: ESBL__ Case No.: 4537S_ SAS No.: _____ SDG No.:BG10__

Instrument ID Number: TJA 61 M_ Method: P_

Start Date: 12/08/92 End Date: 12/08/92

EPA Sample No.	D/F	Time	% R	Analytes FE
CRI	1.00	1521		
CCV	1.00	1526		X
CCB	1.00	1531		X

TOTAL PHOSPHORUS

TOTAL KJELDAHL NITROGEN

SOIL CLASSIFICATION

DATA PACKAGE

SEQUOIA ANALYTICAL

680 Chesapeake Drive • Redwood City, CA 94063
(415) 364-9600 • FAX (415) 364-9233

Engineering Science, Inc.	Client Project ID:	WO #4537	Sampled: 11/6-9/92
600 Bancroft Way	Sample Descript:	Soil	Received: Nov 13, 1992
Berkeley, CA 94710	Analysis for:	Total Phosphorus	
Attention: Tom Paulson	First Sample #:	211-2219	Analyzed: Nov 20, 23, 1992
			Reported: Dec 8, 1992

LABORATORY ANALYSIS FOR: Total Phosphorus

Sample Number	Sample Description	Detection Limit mg/kg	Sample Result mg/kg
211-2219	D2-VW-10	10	140
211-2220	D2-VW-7	10	110
211-2221	D2-VW-3	10	64
211-2222	D1-BG-3	10	330
211-2223	D1-BG-7	10	110
211-2224	D1-BG-10	10	230
211-2225	D1-VW-3	10	310
211-2226	D1-VW-7	10	240
211-2227	D1-VW-11	10	260
-	Method Blank	10	N.D.

THIS REPORT HAS BEEN
APPROVED AND REVIEWED BY

ESBL PROJECT MANAGER DATE 12/14/92

Analytes reported as N.D. were not present above the stated limit of detection.

SEQUOIA ANALYTICAL

Tod Granicher
Project Manager

Please Note:
Analysis results reported on a dry weight basis.

SEQUOIA ANALYTICAL

680 Chesapeake Drive • Redwood City, CA 94063
(415) 364-9600 • FAX (415) 364-9233

Engineering Science, Inc.	Client Project ID:	WO #4537	Sampled:	11/6-9/92
600 Bancroft Way	Sample Descript:	Soil	Received:	Nov 13, 1992
Berkeley, CA 94710	Analysis for:	Total Kjeldahl Nitrogen		
Attention: Tom Paulson	First Sample #:	211-2219	Analyzed:	Nov 23, 1992
			Reported:	Dec 8, 1992

LABORATORY ANALYSIS FOR: Total Kjeldahl Nitrogen

Sample Number	Sample Description	Detection Limit mg/kg	Sample Result mg/kg
211-2219	D2-VW-10	20	700
211-2220	D2-VW-7	20	460
211-2221	D2-VW-3	20	84
211-2222	D1-BG-3	20	210
211-2223	D1-BG-7	20	N.D.
211-2224	D1-BG-10	20	35
211-2225	D1-VW-3	20	78
211-2226	D1-VW-7	20	36
211-2227	D1-VW-11	20	31
-	Method Blank	20	N.D.

Analytes reported as N.D. were not present above the stated limit of detection.

SEQUOIA ANALYTICAL

Tod Granicher
Project Manager

Please Note:
Analysis results reported on a dry weight basis.

2112219.ENG <12>

SEQUOIA ANALYTICAL

680 Chesapeake Drive • Redwood City, CA 94063
(415) 364-9600 • FAX (415) 364-9233

Engineering Science, Inc.	Client Project ID:	WO #4537	Sampled:	Nov 6-9, 1992
600 Bancroft Way	Sample Descript:	Soil	Received:	Nov 13, 1992
Berkeley, CA 94710	Analysis for:	Percent Moisture		
Attention: Tom Paulson	First Sample #:	211-2219	Analyzed:	Nov 18, 1992
			Reported:	Dec 8, 1992

LABORATORY ANALYSIS FOR: Percent Moisture

Sample Number	Sample Description	Detection Limit %	Sample Result %
211-2219	D2-VW-10	0.010	29
211-2220	D2-VW-7	0.010	26
211-2221	D2-VW-3	0.010	13
211-2222	D1-BG-3	0.010	14
211-2223	D1-BG-7	0.010	4.0
211-2224	D1-BG-10	0.010	7.0
211-2225	D1-VW-3	0.010	13
211-2226	D1-VW-7	0.010	9.0
211-2227	D1-VW-11	0.010	15

Analytes reported as N.D. were not present above the stated limit of detection.

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Engineering Science, Inc.
600 Bancroft Way
Berkeley, CA 94710
Attention: Tom Paulson

Client Project ID: WO #4537

QC Sample Group: 2112219-27

Reported: Dec 8, 1992

QUALITY CONTROL DATA REPORT

ANALYTE	Phosphorus	Percent Moisture	Total Kjeldahl Nitrogen
Method:	EPA 365.3	EPA 160.3	EPA 351.4
Analyst:	K. Follett	Y. Arteaga	G. Kern
Reporting Units:	mg/kg	%	mg/kg
Date Analyzed:	Nov 20, 1992	Nov 18, 1992	Nov 23, 1992
QC Sample #:	211-2215	211-1615	211-2223
Sample Conc.:	37	24	N.D.
Spike Conc. Added:	100	N.A.	4000
Conc. Matrix Spike:	150	N.A.	3400
Matrix Spike % Recovery:	113	N.A.	85
Conc. Matrix Spike Dup.:	130	27	3700
Matrix Spike Duplicate % Recovery:	93	N.A.	93
Relative % Difference:	14	12	8.5

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% Recovery:	$\frac{\text{Conc. of M.S. - Conc. of Sample}}{\text{Spike Conc. Added}}$	x 100
Relative % Difference:	$\frac{\text{Conc. of M.S. - Conc. of M.S.D.}}{\text{(Conc. of M.S. + Conc. of M.S.D.) / 2}}$	x 100

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Engineering Science, Inc.	Client Project ID:	WO #4537	Sampled:	Nov 9, 1992
600 Bancroft Way	Sample Descript:	Soil, D2-VW-10	Received:	Nov 13, 1992
Berkeley, CA 94710	Method of Analysis:	ASTM D422-63	Analyzed:	Nov 24, 1992
Attention: Tom Paulson	Lab Number:	211-2219	Reported:	Dec 8, 1992

PARTICLE SIZE DISTRIBUTION BY SIEVE AND HYDROMETER

SIEVE TEST

(A) TOTAL WEIGHT OF SAMPLE:	174.65
(B) WEIGHT RETAINED IN NO. 10 SIEVE:	8.24
(C) % PASSING NO. 10 SIEVE:	95.28

SIEVE TEST FOR WEIGHT RETAINED IN NO. 10 SIEVE

SIEVE SIZE	WEIGHT RETAINED, g	% RETAINED	CUMULATIVE % RETAINED	CUMULATIVE % PASSING
1½ in.	0.0	0.0	0.0	100
3/8 in.	0.0	0.0	0.0	100
No. 4	4.00	2.29	2.29	97.71
No. 10	4.24	2.43	4.72	95.28
PAN	0.0			
TOTAL	8.24			

IDEAL PAN = 0.0
IDEAL TOTAL = (B)

HYDROMETER TEST

ELAPSED TIME (T)	TEMP. °C	HYDROMETER READING (H)	CORRECTED READING (R)	(L)	PARTICLE DIAM. (S)	% SUSPENDED (P)
2	20	54	50	8.1	0.027	76
5	20	52	48	8.4	0.018	73
10	20	50	46	8.8	0.013	70
15	20	48	44	9.1	0.011	67
25	20	45	41	9.6	0.0085	62
40	20	42	38	10.1	0.0069	58
60	20	41	37	10.2	0.0056	56
90	20	38	34	10.7	0.0047	52
120	20	37	33	10.9	0.0041	50
1440	20	30	26	12	0.0012	39

WEIGHT OF SOIL USED IN HYDROMETER TEST (D):	65
HYGROSCOPIC MOISTURE CORRECTION FACTOR (G):	0.965
SPECIFIC GRAVITY (ASSUMED):	2.65
DISPERSING AGENT CORRECTION FACTOR (E):	3
MENISCUS CORRECTION FACTOR (F):	1
TEMP./SPEC. GRAVITY DEPENDANT CONSTANT (K):	0.01365

FORMULAS:
$R = H - E - F$
$S = K [SQRT (L / T)]$
$P = (R / W) 100$
$W = (J \cdot 100) / C$
$J = D \cdot G$

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Engineering Science, Inc.	Client Project ID:	WO #4537	Sampled: Nov 9, 1992
600 Bancroft Way	Sample Descript:	Soil, D2-VW-7	Received: Nov 13, 1992
Berkeley, CA 94710	Method of Analysis:	ASTM D422-63	Analyzed: Nov 30, 1992
Attention: Tom Paulson	Lab Number:	211-2220	Reported: Dec 8, 1992

PARTICLE SIZE DISTRIBUTION BY SIEVE AND HYDROMETER

SIEVE TEST

(A) TOTAL WEIGHT OF SAMPLE:	320.36
(B) WEIGHT RETAINED IN NO. 10 SIEVE:	0.0
(C) % PASSING NO. 10 SIEVE:	100

SIEVE TEST FOR WEIGHT RETAINED IN NO. 10 SIEVE

SIEVE SIZE	WEIGHT RETAINED, g	% RETAINED	CUMULATIVE % RETAINED	CUMULATIVE % PASSING
1½ in.	0.0	0.0	0.0	100
3/8 in.	0.0	0.0	0.0	100
No. 4	0.0	0.0	0.0	100
No. 10	0.0	0.0	0.0	100

IDEAL PAN = 0.0
IDEAL TOTAL = (B)

PAN	0.0
TOTAL	0.0

HYDROMETER TEST

ELAPSED TIME (T)	TEMP. °C	HYDROMETER READING (H)	CORRECTED READING (R)	(L)	PARTICLE DIAM. (S)	% SUSPENDED (P)
2	18	55	51	7.9	0.028	81
5	18	54	50	8.1	0.018	80
10	18	51	47	8.6	0.013	75
15	18	49	45	8.9	0.011	72
25	18	47	43	9.2	0.0085	68
40	18	45	41	9.6	0.0069	65
60	18	42	38	10.1	0.0057	60
90	18	40	36	10.4	0.0048	57
120	18	39	35	10.6	0.0042	56
1440	18	32	28	11.7	0.0013	45

WEIGHT OF SOIL USED IN HYDROMETER TEST (D):	65
HYGROSCOPIC MOISTURE CORRECTION FACTOR (G):	0.967
SPECIFIC GRAVITY (ASSUMED):	2.65
DISPERSING AGENT CORRECTION FACTOR (E):	3
MENISCUS CORRECTION FACTOR (F):	1
TEMP./SPEC. GRAVITY DEPENDANT CONSTANT (K):	0.01399

FORMULAS:
$R = H - E - F$
$S = K [SQRT (L / T)]$
$P = (R / W) 100$
$W = (J \cdot 100) / C$
$J = D \cdot G$

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Engineering Science, Inc.	Client Project ID:	WO #4537	Sampled: Nov 9, 1992
600 Bancroft Way	Sample Descript:	Soil, D2-VW-3	Received: Nov 13, 1992
Berkeley, CA 94710	Method of Analysis:	ASTM D422-63	Analyzed: Nov 30, 1992
Attention: Tom Paulson	Lab Number:	211-2221	Reported: Dec 8, 1992

PARTICLE SIZE DISTRIBUTION BY SIEVE AND HYDROMETER

SIEVE TEST

(A) TOTAL WEIGHT OF SAMPLE:	319.56
(B) WEIGHT RETAINED IN NO. 10 SIEVE:	32.48
(C) % PASSING NO. 10 SIEVE:	88.84

SIEVE TEST FOR WEIGHT RETAINED IN NO. 10 SIEVE

SIEVE SIZE	WEIGHT RETAINED, g	% RETAINED	CUMULATIVE % RETAINED	CUMULATIVE % PASSING
1½ in.	0.0	0.0	0.0	100
3/8 in.	0.0	0.0	0.0	100
No. 4	6.89	2.16	2.16	97.84
No. 10	25.59	8.01	10.17	89.83

IDEAL PAN = 0.0
IDEAL TOTAL = (B)

PAN	0.0
TOTAL	32.48

HYDROMETER TEST

ELAPSED TIME (T)	TEMP. °C	HYDROMETER READING (H)	CORRECTED READING (R)	(L)	PARTICLE DIAM. (S)	% SUSPENDED (P)
2	18	17	13	14.2	0.037	18
5	18	14	10	14.7	0.024	14
10	18	13	9	14.8	0.017	13
15	18	12	8	15	0.014	11
25	18	12	8	15	0.011	11
40	18	11	7	15.2	0.0086	9.8
60	18	11	7	15.2	0.007	9.8
90	18	10	6	15.3	0.0058	8.4
120	18	10	6	15.3	0.005	8.4
1440	18	9	5	15.5	0.0015	7

WEIGHT OF SOIL USED IN HYDROMETER TEST (D):	65
HYGROSCOPIC MOISTURE CORRECTION FACTOR (G):	0.991
SPECIFIC GRAVITY (ASSUMED):	2.65
DISPERSING AGENT CORRECTION FACTOR (E):	3
MENISCUS CORRECTION FACTOR (F):	1
TEMP./SPEC. GRAVITY DEPENDANT CONSTANT (K):	0.01399

FORMULAS:

$R = H - E - F$

$S = K [SQRT (L / T)]$

$P = (R / W) 100$

$W = (J \cdot 100) / C$

$J = D \cdot G$

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D1 ?

Engineering Science, Inc.	Client Project ID:	WO #4537	Sampled:	Nov 6, 1992
600 Bancroft Way	Sample Descript:	Soil, D2 BG-3	Received:	Nov 13, 1992
Berkeley, CA 94710	Method of Analysis:	ASTM D422-63	Analyzed:	Nov 30, 1992
Attention: Tom Paulson	Lab Number:	211-2222	Reported:	Dec 8, 1992

PARTICLE SIZE DISTRIBUTION BY SIEVE AND HYDROMETER

SIEVE TEST

(A) TOTAL WEIGHT OF SAMPLE:	230.58
(B) WEIGHT RETAINED IN NO. 10 SIEVE:	8.6
(C) % PASSING NO. 10 SIEVE:	96.27

SIEVE TEST FOR WEIGHT RETAINED IN NO. 10 SIEVE

SIEVE SIZE	WEIGHT RETAINED, g	% RETAINED	CUMULATIVE % RETAINED	CUMULATIVE % PASSING
1½ in.	0.0	0.0	0.0	100
3/8 in.	0.0	0.0	0.0	100
No. 4	0.0	0.0	0.0	100
No. 10	8.60	3.73	3.73	96.27

IDEAL PAN = 0.0
IDEAL TOTAL = (B)

PAN	0.0
TOTAL	8.60

HYDROMETER TEST

ELAPSED TIME (T)	TEMP. °C	HYDROMETER READING (H)	CORRECTED READING (R)	(L)	PARTICLE DIAM. (S)	% SUSPENDED (P)
2	18	38	34	10.7	0.032	51
5	18	33	29	11.5	0.021	44
10	18	28	24	12.4	0.015	36
15	18	27	23	12.5	0.013	35
25	18	25	21	12.9	0.010	32
40	18	22	18	13.3	0.0081	27
60	18	21	17	13.5	0.0066	26
90	18	20	16	13.7	0.0055	24
120	18	19	15	13.8	0.0047	23
1440	18	16	12	14.3	0.0014	18

WEIGHT OF SOIL USED IN HYDROMETER TEST (D):	65
HYGROSCOPIC MOISTURE CORRECTION FACTOR (G):	0.987
SPECIFIC GRAVITY (ASSUMED):	2.65
DISPERSING AGENT CORRECTION FACTOR (E):	3
MENISCUS CORRECTION FACTOR (F):	1
TEMP./SPEC. GRAVITY DEPENDANT CONSTANT (K):	0.01399

FORMULAS:
R = H - E - F
S = K [SQRT (L / T)]
P = (R / W) 100
W = (J · 100) / C
J = D · G

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Engineering Science, Inc.	Client Project ID:	WO #4537	Sampled:	Nov 6, 1992
600 Bancroft Way	Sample Descript:	Soil, D1-BG-7	Received:	Nov 13, 1992
Berkeley, CA 94710	Method of Analysis:	ASTM D422-63	Analyzed:	Dec 1, 1992
Attention: Tom Paulson	Lab Number:	211-2223	Reported:	Dec 8, 1992

PARTICLE SIZE DISTRIBUTION BY SIEVE AND HYDROMETER

SIEVE TEST

(A) TOTAL WEIGHT OF SAMPLE:	277.64
(B) WEIGHT RETAINED IN NO. 10 SIEVE:	38.77
(C) % PASSING NO. 10 SIEVE:	86.04

SIEVE TEST FOR WEIGHT RETAINED IN NO. 10 SIEVE

SIEVE SIZE	WEIGHT RETAINED, g	% RETAINED	CUMULATIVE % RETAINED	CUMULATIVE % PASSING
1½ in.	0.0	0.0	1.0	100
3/8 in.	3.29	1.18	1.18	98.82
No. 4	15.17	5.46	6.64	93.36
No. 10	20.31	7.32	13.96	86.04

IDEAL PAN = 0.0
IDEAL TOTAL = (B)

PAN	0.0
TOTAL	38.77

HYDROMETER TEST

ELAPSED TIME (T)	TEMP. °C	HYDROMETER READING (H)	CORRECTED READING (R)	(L)	PARTICLE DIAM. (S)	% SUSPENDED (P)
2	18	10	6	15.3	0.039	4.5
5	18	10	6	15.3	0.024	4.5
10	18	10	6	15.3	0.017	4.5
15	18	10	6	15.3	0.014	4.5
25	18	9	5	15.5	0.011	3.7
40	18	9	5	15.5	0.0087	3.7
60	18	9	5	15.5	0.0071	3.7
90	18	9	5	15.5	0.0058	3.7
120	18	9	5	15.5	0.005	3.7
1440	18	9	5	15.5	0.0015	3.7

WEIGHT OF SOIL USED IN HYDROMETER TEST (D):	115
HYGROSCOPIC MOISTURE CORRECTION FACTOR (G):	0.998
SPECIFIC GRAVITY (ASSUMED):	2.65
DISPERSING AGENT CORRECTION FACTOR (E):	3
MENISCUS CORRECTION FACTOR (F):	1
TEMP./SPEC. GRAVITY DEPENDANT CONSTANT (K):	0.01399

FORMULAS:
R = H - E - F
S = K [SQRT (L / T)]
P = (R / W) 100
W = (J · 100) / C
J = D · G

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Engineering Science, Inc.	Client Project ID:	WO #4537	Sampled:	Nov 6, 1992
600 Bancroft Way	Sample Descript:	Soil, D1-BG-10	Received:	Nov 13, 1992
Berkeley, CA 94710	Method of Analysis:	ASTM D422-63	Analyzed:	Dec 1, 1992
Attention: Tom Paulson	Lab Number:	211-2224	Reported:	Dec 8, 1992

PARTICLE SIZE DISTRIBUTION BY SIEVE AND HYDROMETER

SIEVE TEST

(A) TOTAL WEIGHT OF SAMPLE:	261.03
(B) WEIGHT RETAINED IN NO. 10 SIEVE:	30.54
(C) % PASSING NO. 10 SIEVE:	88.3

SIEVE TEST FOR WEIGHT RETAINED IN NO. 10 SIEVE

SIEVE SIZE	WEIGHT RETAINED, g	% RETAINED	CUMULATIVE % RETAINED	CUMULATIVE % PASSING
1½ in.	0.0	0.0	0.0	100
3/8 in.	1.91	0.73	0.73	99.27
No. 4	7.11	2.72	3.45	96.55
No. 10	21.52	8.24	11.69	88.31
PAN	0.0			
TOTAL	30.54			

IDEAL PAN = 0.0
IDEAL TOTAL = (B)

HYDROMETER TEST

ELAPSED TIME (T)	TEMP. °C	HYDROMETER READING (H)	CORRECTED READING (R)	(L)	PARTICLE DIAM. (S)	% SUSPENDED (P)
2	18	18	14	14.0	0.037	19
5	18	17	13	14.2	0.024	18
10	18	16	12	14.3	0.017	16
15	18	15	11	14.5	0.014	15
25	18	15	11	14.5	0.011	15
40	18	14	10	14.7	0.0085	14
60	18	14	10	14.7	0.0069	14
90	18	14	10	14.7	0.0057	14
120	18	13	9	14.8	0.0049	12
1440	18	11	7	15.2	0.0014	9.6

WEIGHT OF SOIL USED IN HYDROMETER TEST (D):	65
HYGROSCOPIC MOISTURE CORRECTION FACTOR (G):	0.993
SPECIFIC GRAVITY (ASSUMED):	2.65
DISPERSING AGENT CORRECTION FACTOR (E):	3
MENISCUS CORRECTION FACTOR (F):	1
TEMP./SPEC. GRAVITY DEPENDANT CONSTANT (K):	0.01399

FORMULAS:

$R = H - E - F$

$S = K [SQRT (L / T)]$

$P = (R / W) 100$

$W = (J \cdot 100) / C$

$J = D \cdot G$

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Engineering Science, Inc.	Client Project ID:	WO #4537	Sampled:	Nov 7, 1992
600 Bancroft Way	Sample Descript:	Soil, D1-VW-3	Received:	Nov 13, 1992
Berkeley, CA 94710	Method of Analysis:	ASTM D422-63	Analyzed:	Dec 1, 1992
Attention: Tom Paulson	Lab Number:	211-2225	Reported:	Dec 8, 1992

PARTICLE SIZE DISTRIBUTION BY SIEVE AND HYDROMETER

SIEVE TEST

(A) TOTAL WEIGHT OF SAMPLE:	267.21
(B) WEIGHT RETAINED IN NO. 10 SIEVE:	11.98
(C) % PASSING NO. 10 SIEVE:	95.52

SIEVE TEST FOR WEIGHT RETAINED IN NO. 10 SIEVE

SIEVE SIZE	WEIGHT RETAINED, g	% RETAINED	CUMULATIVE % RETAINED	CUMULATIVE % PASSING
1½ in.	0.0	0.0	0.0	100
3/8 in.	1.32	0.49	0.49	99.51
No. 4	1.69	0.63	1.12	98.88
No. 10	8.97	3.36	4.48	95.52
PAN	0.0			
TOTAL	11.98			

IDEAL PAN = 0.0
IDEAL TOTAL = (B)

HYDROMETER TEST

ELAPSED TIME (T)	TEMP. °C	HYDROMETER READING (H)	CORRECTED READING (R)	(L)	PARTICLE DIAM. (S)	% SUSPENDED (P)
2	18	27	23	12.5	0.035	34
5	18	24	20	13.0	0.023	30
10	18	21	17	13.5	0.016	25
15	18	20	16	13.7	0.013	24
25	18	18	14	14.0	0.011	21
40	18	17	13	14.2	0.0083	19
60	18	16	12	14.3	0.0068	18
90	18	15	11	14.5	0.0056	16
120	18	15	11	14.5	0.0049	16
1440	18	12	8	15.0	0.0014	12

WEIGHT OF SOIL USED IN HYDROMETER TEST (D):	65
HYGROSCOPIC MOISTURE CORRECTION FACTOR (G):	0.989
SPECIFIC GRAVITY (ASSUMED):	2.65
DISPERSING AGENT CORRECTION FACTOR (E):	3
MENISCUS CORRECTION FACTOR (F):	1
TEMP./SPEC. GRAVITY DEPENDANT CONSTANT (K):	0.01399

FORMULAS:

$R = H - E - F$

$S = K [SQRT (L / T)]$

$P = (R / W) 100$

$W = (J \cdot 100) / C$

$J = D \cdot G$

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Engineering Science, Inc.	Client Project ID:	WO #4537	Sampled:	Nov 7, 1992
600 Bancroft Way	Sample Descript:	Soil, D1-VW-7	Received:	Nov 13, 1992
Berkeley, CA 94710	Method of Analysis:	ASTM D422-63	Analyzed:	Dec 1, 1992
Attention: Tom Paulson	Lab Number:	211-2226	Reported:	Dec 8, 1992

PARTICLE SIZE DISTRIBUTION BY SIEVE AND HYDROMETER

SIEVE TEST

(A) TOTAL WEIGHT OF SAMPLE:	213.26
(B) WEIGHT RETAINED IN NO. 10 SIEVE:	14.05
(C) % PASSING NO. 10 SIEVE:	

SIEVE TEST FOR WEIGHT RETAINED IN NO. 10 SIEVE

SIEVE SIZE	WEIGHT RETAINED, g	% RETAINED	CUMULATIVE % RETAINED	CUMULATIVE % PASSING
1½ in.	0.0	0.0	0.0	100
3/8 in.	5.50	2.58	2.58	97.42
No. 4	3.91	1.83	4.41	95.59
No. 10	4.64	2.18	6.59	93.41
PAN	0.0			
TOTAL	14.05			

IDEAL PAN = 0.0
IDEAL TOTAL = (B)

HYDROMETER TEST

ELAPSED TIME (T)	TEMP. °C	HYDROMETER READING (H)	CORRECTED READING (R)	(L)	PARTICLE DIAM. (S)	% SUSPENDED (P)
2	18	20	16	13.7	0.037	23
5	18	19	15	13.8	0.023	22
10	18	19	15	13.8	0.016	22
15	18	19	15	13.8	0.013	22
25	18	18	14	14.0	0.010	20
40	18	17	13	14.2	0.0083	19
60	18	17	13	14.2	0.0068	19
90	18	16	12	14.3	0.0056	17
120	18	16	12	14.3	0.0048	17
1440	18	15	11	14.5	0.0014	16

WEIGHT OF SOIL USED IN HYDROMETER TEST (D):	65
HYGROSCOPIC MOISTURE CORRECTION FACTOR (G):	0.990
SPECIFIC GRAVITY (ASSUMED):	2.65
DISPERSING AGENT CORRECTION FACTOR (E):	3
MENISCUS CORRECTION FACTOR (F):	1
TEMP./SPEC. GRAVITY DEPENDANT CONSTANT (K):	0.01399

FORMULAS:

$R = H - E - F$

$S = K [SQRT (L / T)]$

$P = (R / W) 100$

$W = (J \cdot 100) / C$

$J = D \cdot G$

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Engineering Science, Inc.	Client Project ID:	WO #4537	Sampled:	Nov 7, 1992
600 Bancroft Way	Sample Descript:	Soil, D1-VW-11	Received:	Nov 13, 1992
Berkeley, CA 94710	Method of Analysis:	ASTM D422-63	Analyzed:	Dec 1, 1992
Attention: Tom Paulson	Lab Number:	211-2227	Reported:	Dec 8, 1992

PARTICLE SIZE DISTRIBUTION BY SIEVE AND HYDROMETER

SIEVE TEST

(A) TOTAL WEIGHT OF SAMPLE:	354.68
(B) WEIGHT RETAINED IN NO. 10 SIEVE:	96.42
(C) % PASSING NO. 10 SIEVE:	72.81

SIEVE TEST FOR WEIGHT RETAINED IN NO. 10 SIEVE

SIEVE SIZE	WEIGHT RETAINED, g	% RETAINED	CUMULATIVE % RETAINED	CUMULATIVE % PASSING
1½ in.	0.0	0.0	0.0	100
3/8 in.	89.16	25.14	25.14	74.86
No. 4	3.95	1.11	26.65	73.35
No. 10	3.31	0.93	27.58	72.42
PAN	0.0			
TOTAL	96.42			

IDEAL PAN = 0.0
IDEAL TOTAL = (B)

HYDROMETER TEST

ELAPSED TIME (T)	TEMP. °C	HYDROMETER READING (H)	CORRECTED READING (R)	(L)	PARTICLE DIAM. (S)	% SUSPENDED (P)
2	18	19	15	13.8	0.037	17
5	18	18	14	14.0	0.023	16
10	18	17	13	14.2	0.017	15
15	18	17	13	14.2	0.014	15
25	18	16	12	14.3	0.011	14
40	18	15	11	14.5	0.0084	12
60	18	14	10	14.7	0.0069	11
90	18	14	10	14.7	0.0057	11
120	18	13	9	14.8	0.0049	10
1440	18	10	6	15.3	0.0014	6.8

WEIGHT OF SOIL USED IN HYDROMETER TEST (D):	65
HYGROSCOPIC MOISTURE CORRECTION FACTOR (G):	0.991
SPECIFIC GRAVITY (ASSUMED):	2.65
DISPERSING AGENT CORRECTION FACTOR (E):	3
MENISCUS CORRECTION FACTOR (F):	1
TEMP./SPEC. GRAVITY DEPENDANT CONSTANT (K):	0.01399

FORMULAS:

$R = H - E - F$

$S = K [SQRT (L / T)]$

$P = (R / W) 100$

$W = (J \cdot 100) / C$

$J = D \cdot G$

SEQUOIA ANALYTICAL

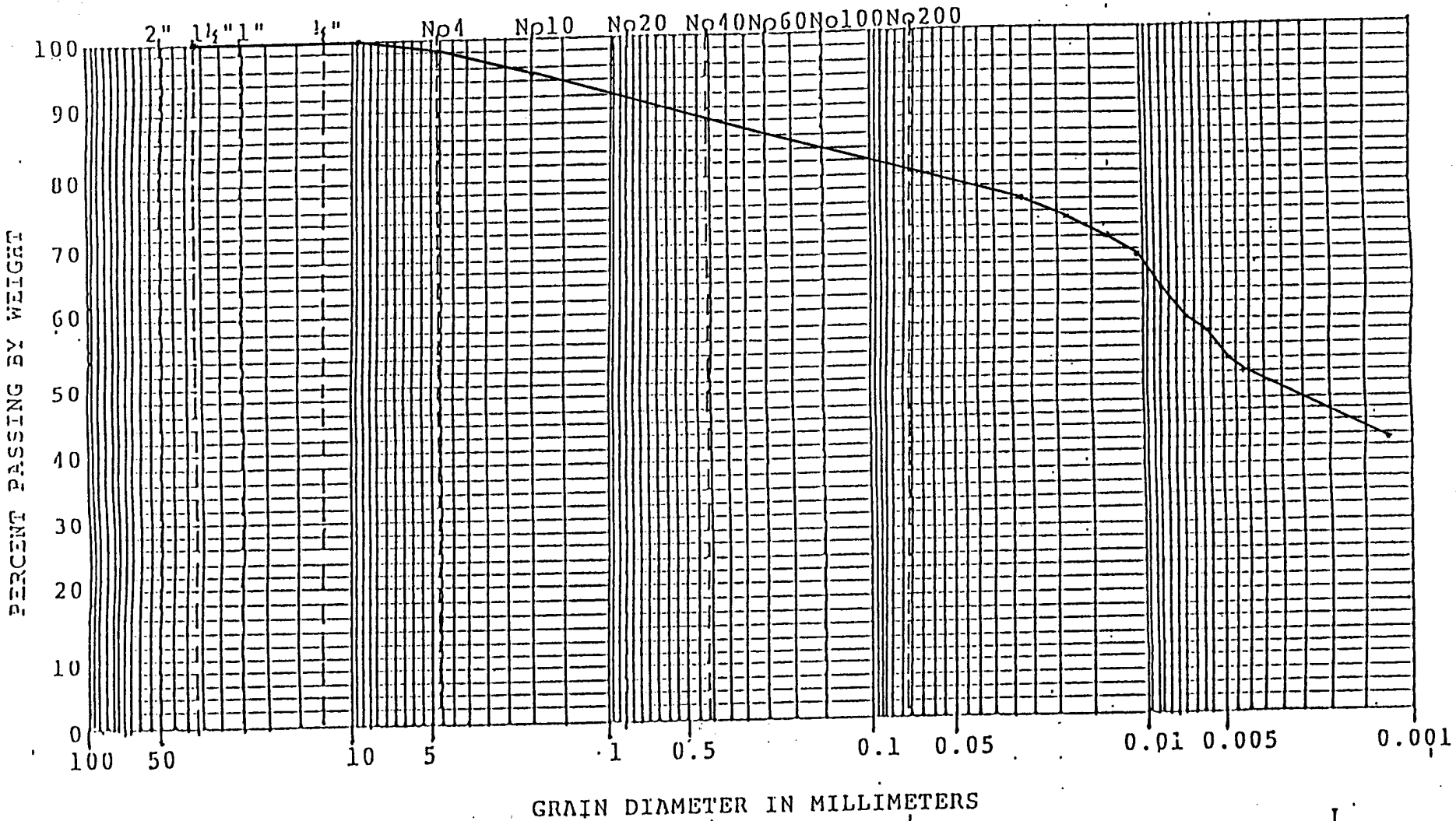
Tod Granicher
Project Manager

SAMPLE DESCRIPTION: Engineering Science, Inc.

LABORATORY NUMBER: 211-2219

SAND	17%
SILT	36.5%
CLAY	44%

U.S. STANDARD SIEVE SIZES



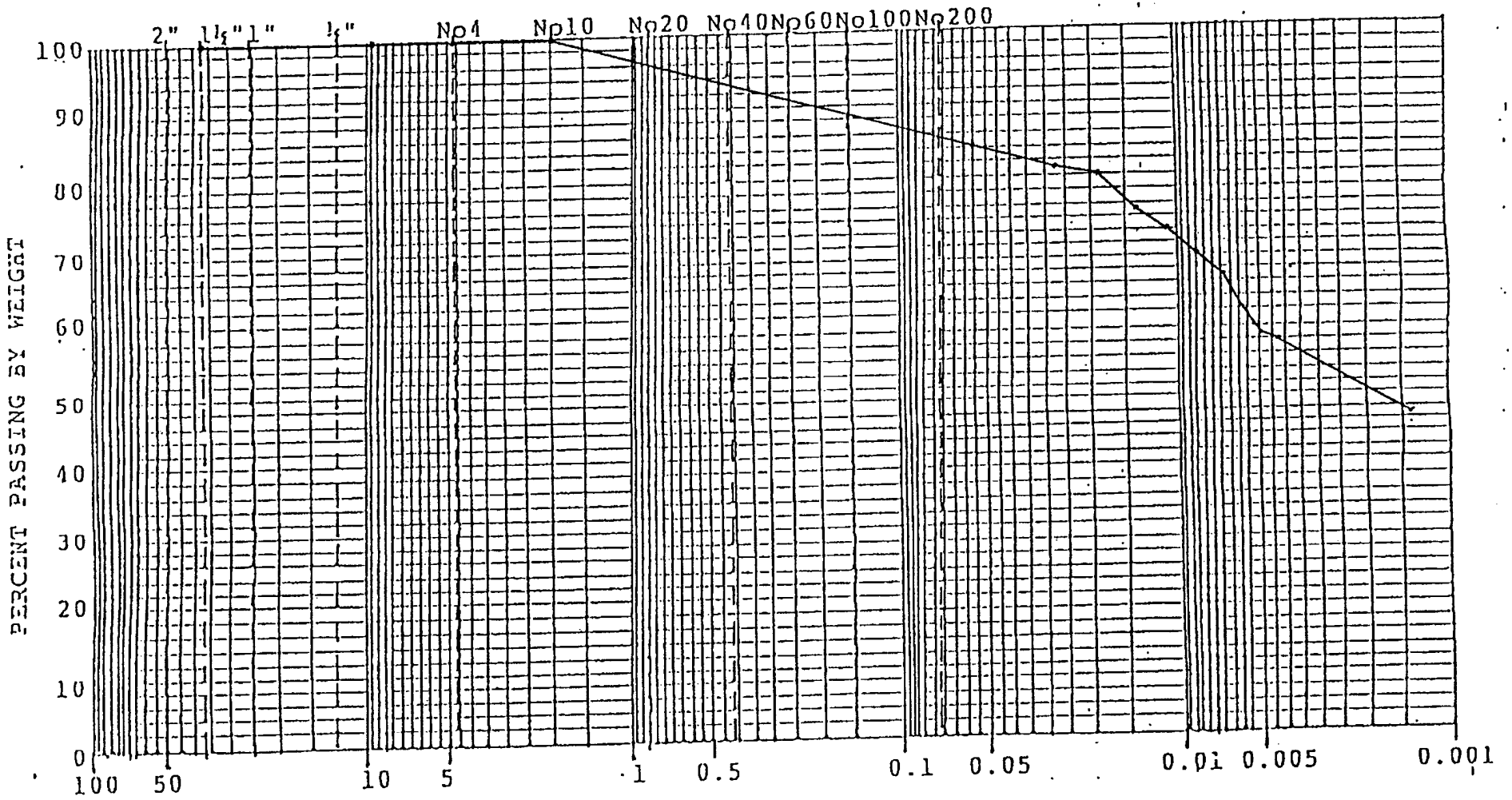
COBBLES	COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES	
	GRAVEL		SAND			FINES		

SAMPLE DESCRIPTION: Engineering Science, Inc.

LABORATORY NUMBER: 211-2220

GRAVEL	0.0
SAND	17%
SILT	35%
CLAY	48%

U.S. STANDARD SIEVE SIZES



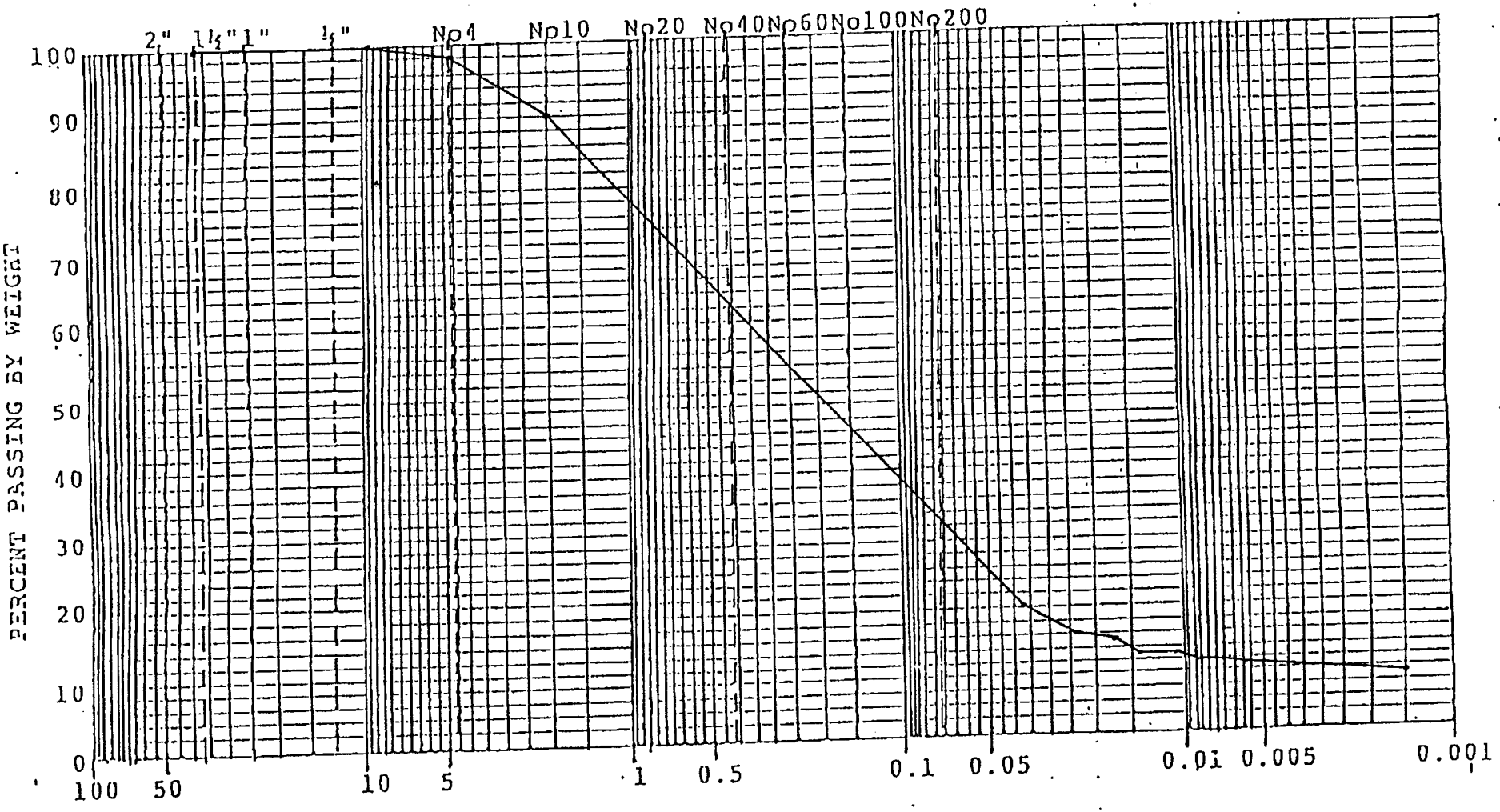
	COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES
BOULDERS	GRAVEL		SAND			FINES	

SAMPLE DESCRIPTION: Engineering Science, Inc.

LABORATORY NUMBER: 211-2221

GRAVEL	2.0
SAND	67.5%
SILT	23%
CLAY	7.5%

U.S. STANDARD SIEVE SIZES



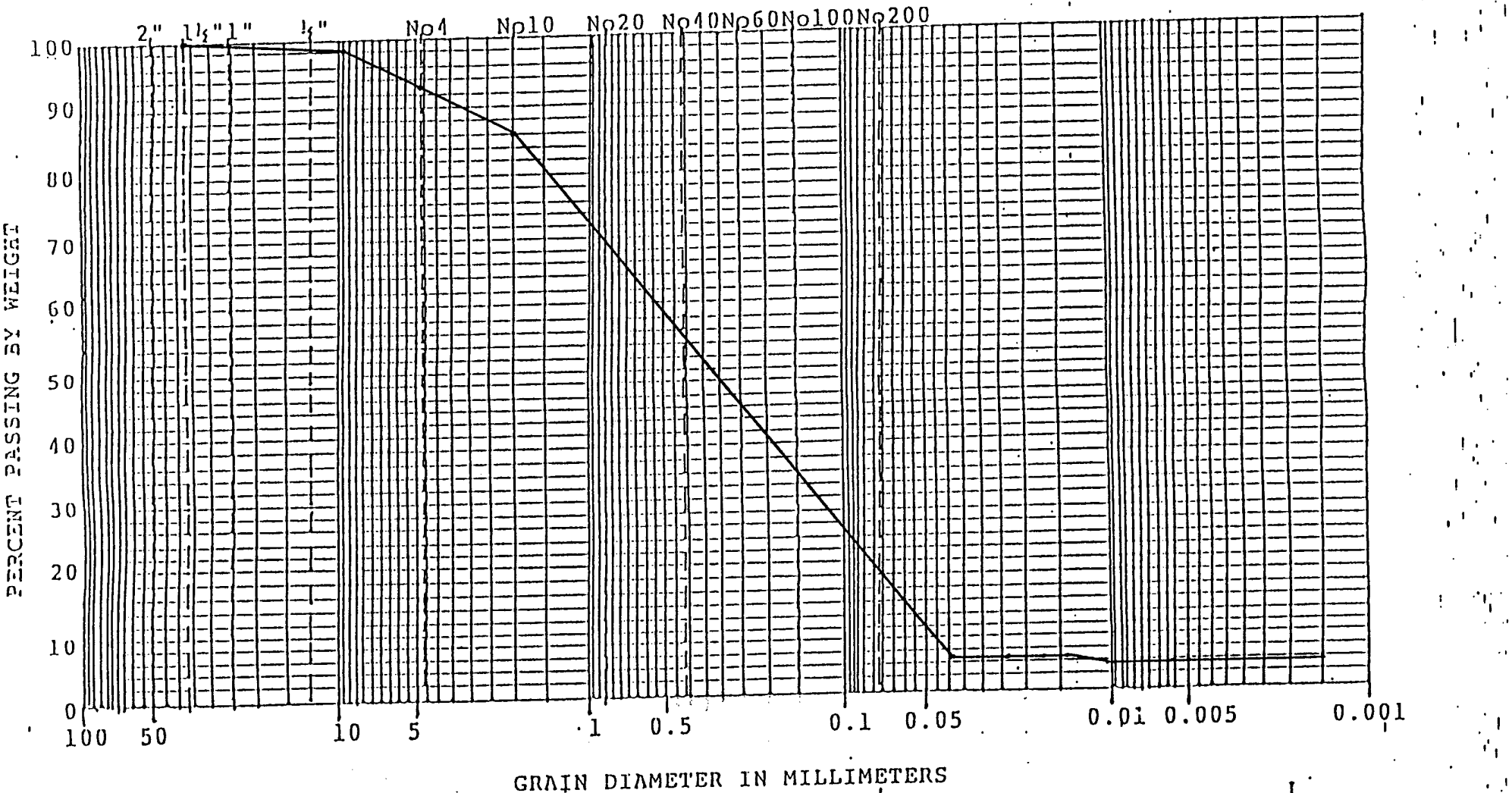
	COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES
BOULDERS	GRAVEL		SAND			FINES	

SAMPLE DESCRIPTION: Engineering Science, Inc.

LABORATORY NUMBER: 211-2223

SAND	74%
SILT	14%
CLAY	5%

U.S. STANDARD SIEVE SIZES



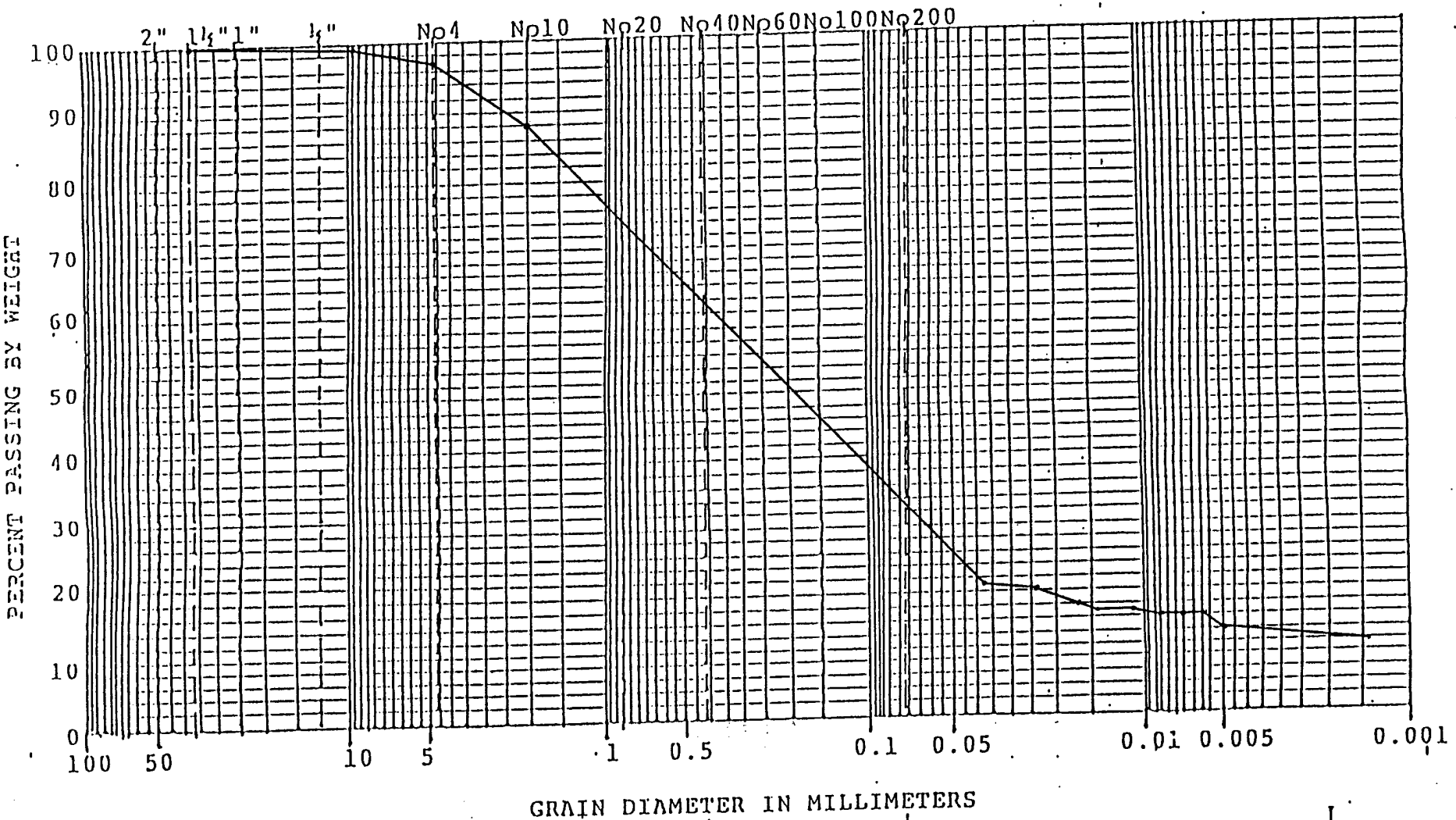
COBBLES	COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES
	GRAVEL		SAND			FINES	

SAMPLE DESCRIPTION: Engineering Science, Inc.

LABORATORY NUMBER: 211-2224

SAND	65.5%
SILT	20%
CLAY	11%

U.S. STANDARD SIEVE SIZES



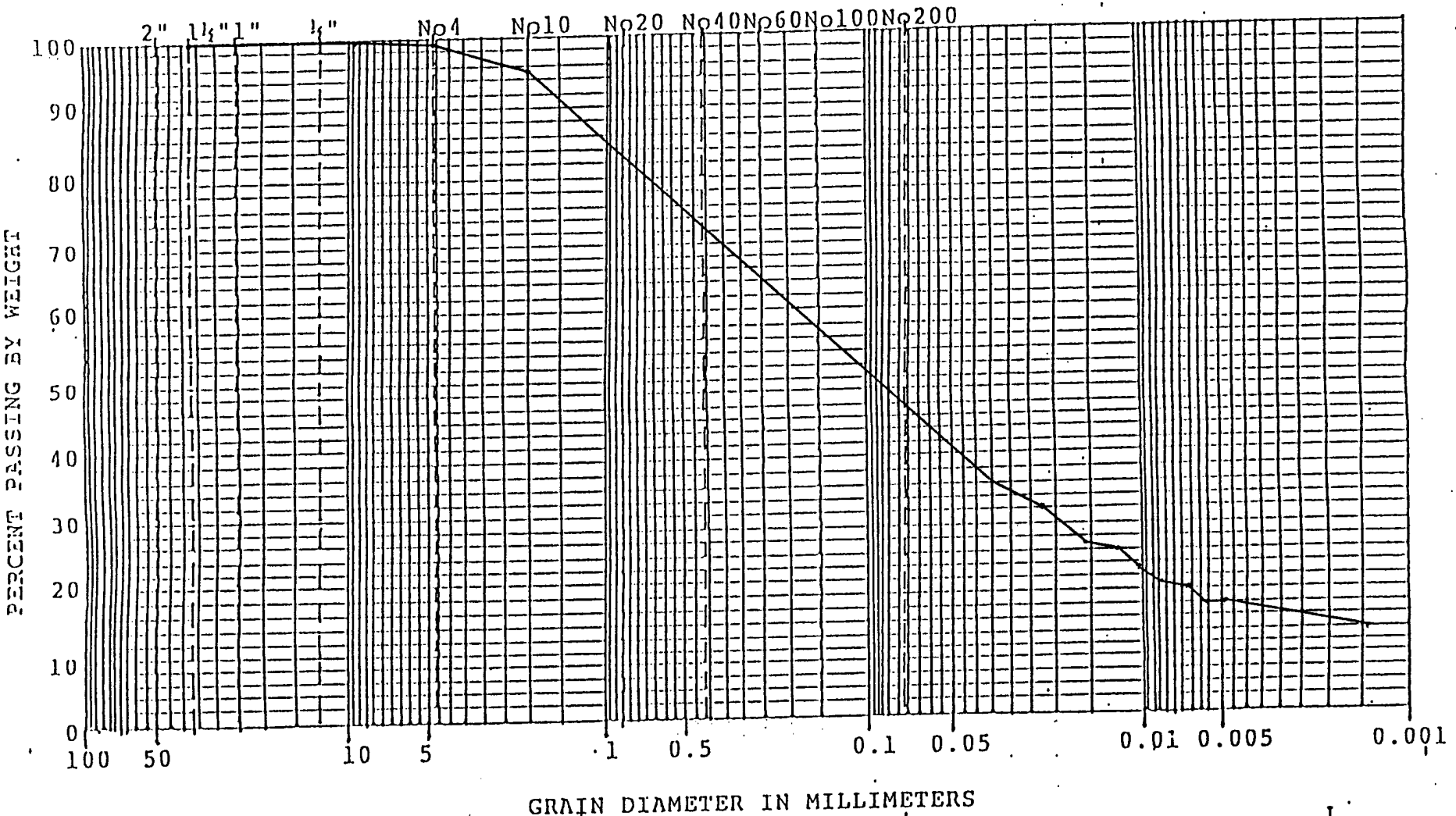
COBBLES	COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES	
	GRAVEL		SAND			FINES		

SAMPLE DESCRIPTION: Engineering Science, Inc.

LABORATORY NUMBER: 211-2225

SAND	53%
SILT	33%
CLAY	13%

U.S. STANDARD SIEVE SIZES

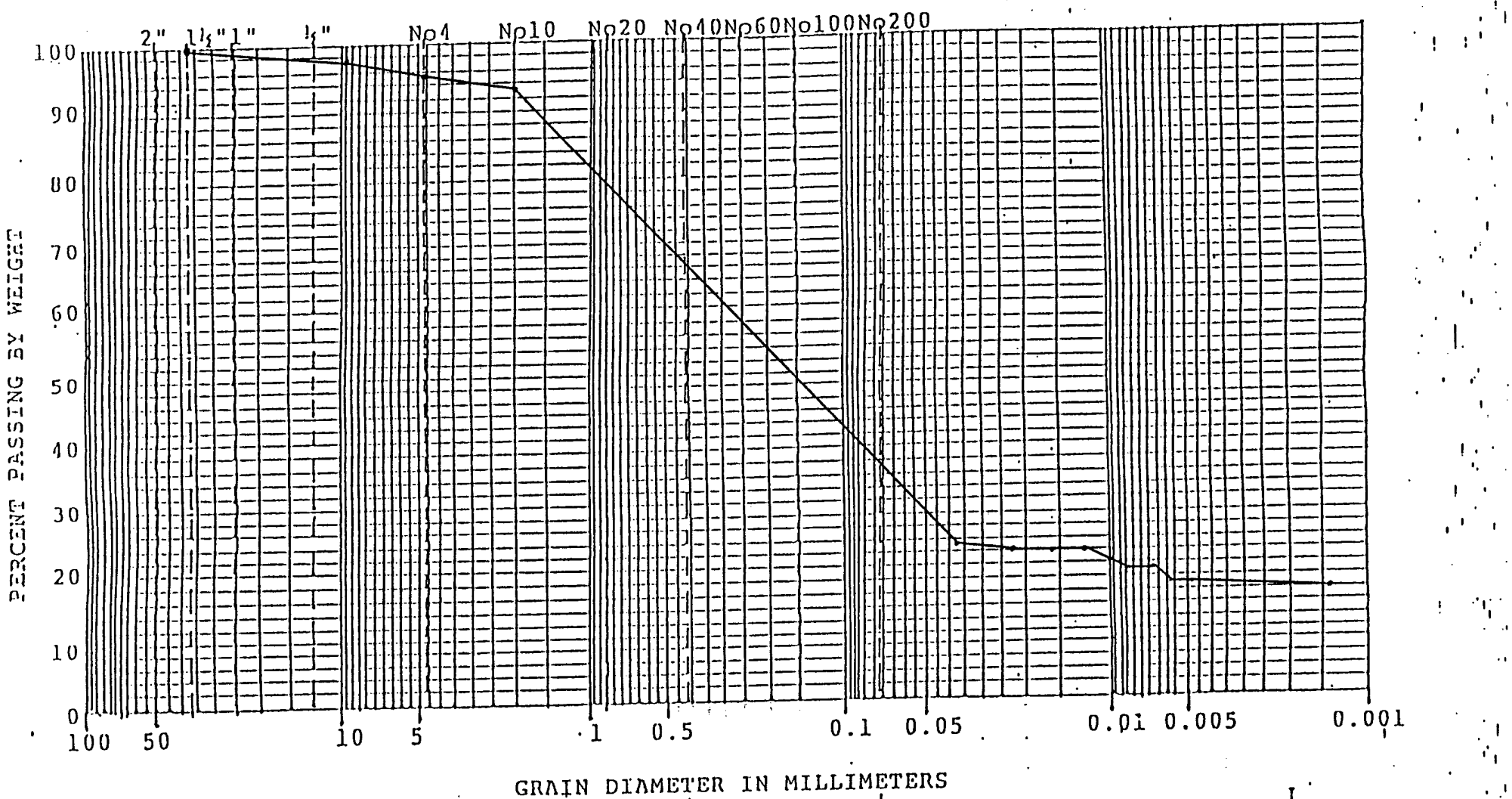


	COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES
COBBLES	GRAVEL		SAND			FINES	

SAMPLE DESCRIPTION: Engineering Science, Inc.

LABORATORY NUMBER: 211-2226

SAND	60%
SILT	19%
CLAY	16.5%

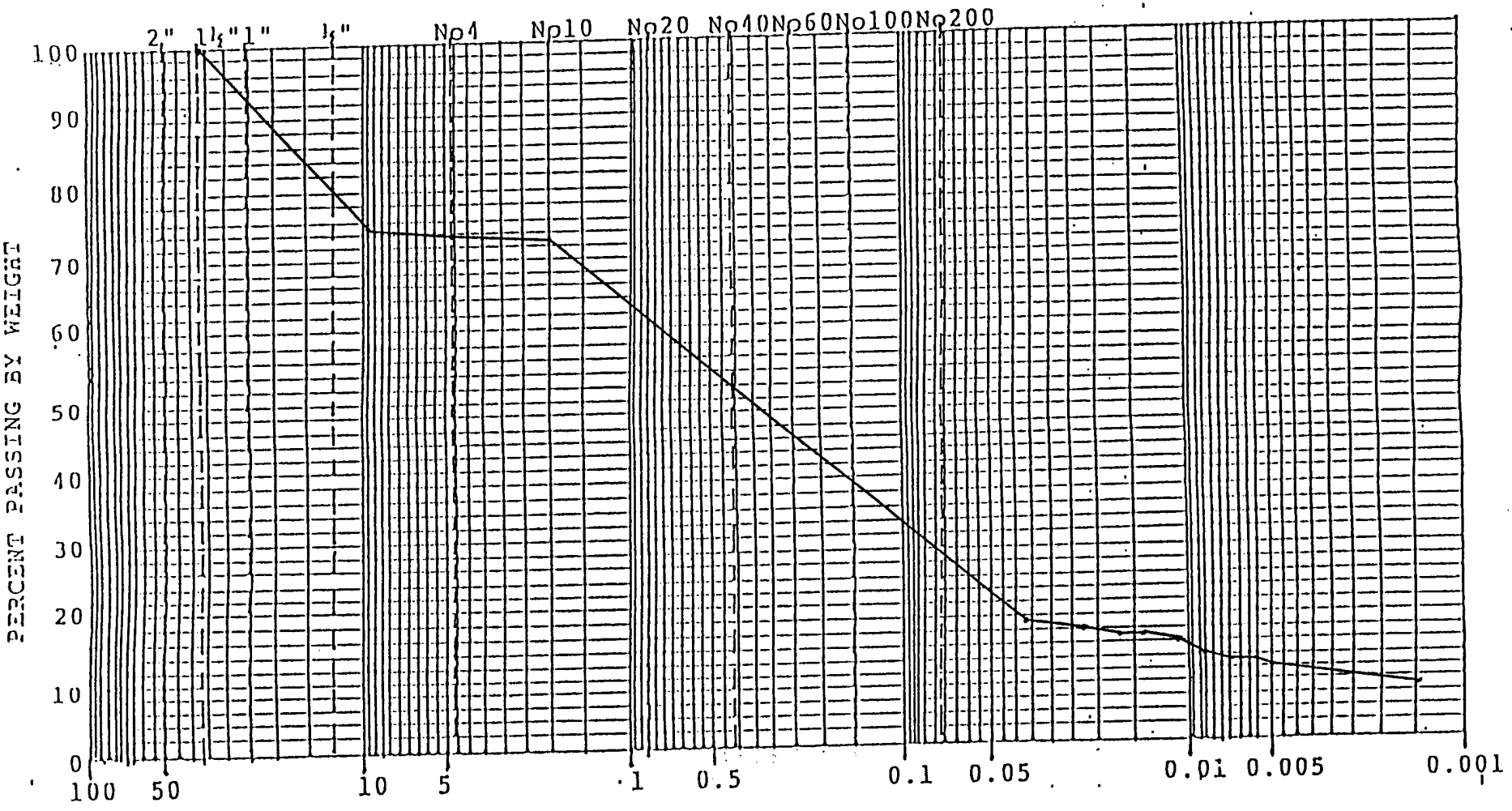


SAMPLE DESCRIPTION: Engineering Science, Inc.

LABORATORY NUMBER: 211-2227

SAND	48%
SILT	17%
CLAY	7.5%

U.S. STANDARD SIEVE SIZES



COBBLES	COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES
	GRAVEL		SAND			FINES	

ENGINEERING-SCIENCE

CHAIN OF CUSTODY RECORD FOR WATER SAMPLES

ES JOB NO.	PROJECT NAME/LOCATION
	4537.

FIELD CONTACT:

SAMPLERS NAMES & SIGNATURES

TO: SEQUOIA LAB,

PRESERVATIVES REQUIRED

ANALYSES REQUIRED

DATE	TIME	FIELD SAMPLE IDENTIFIER	TKN	TPOL (TO BE PROGRAMMED)	SIEVE ANALYSIS + HYDROMETER										REMARKS
11/9/92	10:00	D2-VW-10 (4537.01C)	✓	✓	✓							21	22	19	REPORT RESULT ON DRY
	10:00	D2-VW-7 (4537.02C)	✓	✓	✓									20	SOIL BASIS. USE MDL'S
↓	↓	D2-VW-3C (4537.03C)	✓	✓	✓									21	FOR REPORTING UNITS.
11/6/92	1700	D1-BG-3 (4537.04C)	✓	✓	✓									22	REPORT METHOD BLANK
11/6/92 ~~11/7/92~~	1700 ~~0900~~ EM	D1-BG-7 (4537.05C)	✓	✓	✓									23	MS/MSD.
11/6/92	1700	D1-BG-10 (4537.06C)	✓	✓	✓									24	(10 DAY TAT). REPORT
11/7/92	0900	D1-VW-3C (4537.07C)	✓	✓	✓									25	TO: TOM PAULSON ESE
	↓	D1-VW-7 (4537.08C)	✓	✓	✓									26	
↓	0900	D1-VW-11 (4537.09C)	✓	✓	✓							↓		27	

FIELD CUSTODY RELINQUISHED BY: DATE: 11/13/92 TIME: 0900

SHIPPED VIA: AIRBILL # ON RECEIPT: CUSTODY SEALS? _____; TEMP: _____ °C

RECEIVED FOR LABORATORY BY: DATE: 11/13/92 TIME: 1330

RELINQUISHED BY: 11/13/92 11-13-92 1330

Battelle
Columbus Laboratories

CHAIN OF CUSTODY RECORD

Form No. 1

27 SAMPLES TOTAL

Proj. No.	Project Title
G4468-0625	DOVER AIR FORCE BASE G4468 – 0625

SAMPLERS: (Signature) Jon Ptacek

DATE	TIME	SAMPLE I.D.	BTEX	TPH	TKN	TPH	SIEVE ANALYSIS	pH	ALKALINITY	Fe	TOTAL MOISTURE	Container No.	Number of Containers	Remarks
11-09-92		D2-VW-10'-10.5'	X	X								1		
11-9-92		D2-VW-7.5'-8.0'	X	X								1		
11-9-92		D2-VW-3.5'-4'	X	X								1		
11-9-92		D2-VW-10' 16 oz.			X	X	X					1		
11-9-92		D2-VW-7' 16 oz.			X	X	X					1		
11-9-92		D2-VW-3' 16 oz.			X	X	X					1		
11-9-92		D2-VW-10' 4 oz.						X	X	X	X	1		
11-9-92		D2-VW-7' 4oz.						X	X	X	X	1		
11-9-92		D2-VW-3' 4oz.						X	X	X	X	1		
11-6-92		D1-BG-7' 4oz ~~16oz.~~					X	X	X	X	X	1		
11-6-92		D1-BG-7' 4oz					X	X	X	X	X	1		
11-6-92		D1-BG-10' 4oz					X	X	X	X	X	1		
11-6-92		D1-BG-3' 16oz			X	X	X					1		
11-6-92		D1-BG-7' 16oz			X	X	X					1		
11-6-92		D1-BG-10' 16oz			X	X	X					1		
11-6-92		D1-BG-3.5'-4.0'	X	X	X							1		
11-6-92		D1-BG-7.0-7.5'	X	X	X							1		
11-6-92		D1-BG-10.0-10.5'	X	X	X							1		
11-7-92		D1-VW-3 4oz						X	X	X	X	1		
11-7-92		D1-VW-7 4oz						X	X	X	X	1		
11-7-92		D1-VW-11 4oz						X	X	X	X	1		
11-7-92		D1-VW-3 16oz			X	X	X					1		
11-7-92		D1-VW-7 16oz			X	X	X					1		
11-7-92		D1-VW-11 16oz			X	X	X					1		

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Jon Ptacek	11-10-92 09:00				
Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Relinquished by: (Signature)	Date/Time	Received for Laboratory by: (Signature)	Date/Time	Remarks	
			11/12/92 1130	SEND RESULTS TO: % JEFF KITTEL BATTELLE 505 KING AVE. COLUMBUS OHIO 43	

Page 1 of 1

11-7-92 D1-VW-3.0-3.5' BTEX, TPH
11-7-92 D1-VW-7.0-7.5' BTEX, TPH

APPENDIX C

SITE ST-04 SOIL GAS PERMEABILITY DATA

Table C-1. Results of Soil Gas Permeability Test at Monitoring Point D1-MPA

Time (min)	Pressure ("H_2O) by Depth			Time (min)	Pressure ("H_2O) by Depth		
	3.0′	7.0′	11.0′		3.0′	7.0′	11.0′
0	0	0	<0	14	0.008	0.009	5.1
1	0	0	3.1	16	0.005	0.007	5.1
2	0	0	4.0	18	0.005	0.007	5.1
3	0	0	4.3	20	0.005	0.007	5.1
4	0	0	4.5	23	0.005	0.007	5.1
5	0	0	4.7	26	0.005	0.007	5.1
6	0	0	4.8	29	0.005	0.007	5.1
7	0	0	4.9	41	0.005	0.007	5.1
8	0.007	0.008	4.9	51	0.005	0.006	5.1
9	0.009	0.01	5.0	61	0.005	0.007	4.6
10	0.009	0.04	5.0	71	0.005	0.007	4.5
12	0.009	0.011	5.0	91	0.005	0.007	4.5

Table C-2. Results of Soil Gas Permeability Test at Monitoring Point D1-MPB

Time (min)	Pressure ("H_2O) by Depth			Time (min)	Pressure ("H_2O) by Depth		
	3.0′	7.0′	10.0′		3.0′	7.0′	10.0′
0	0.025	0.01	0.02	18	0	0.005	0.40
1	0.01	0.01	0.02	20	0	0.004	0.425
2	0.005	0.005	0.01	23	0	0.005	0.425
5	0	0	0.25	26	0	0.003	0.425
6	0	0	0.30	29	0	0	0.45
8	0	0.005	0.35	39	0	0	0.43
10	0	0.05	0.35	49	0	0	0.425
12	0	0.005	0.40	59	0	0	0.425
14	0	0	0.40	69	0	0.005	0.40
16	0	0	0.425	89	0	0.005	0.40

Table C-3. Results of Soil Gas Permeability Test at Monitoring Point D1-MPC

Time (min)	Pressure ("H_2O) by Depth			Time (min)	Pressure ("H_2O) by Depth		
	3.0′	7.0′	11.0′		3.0′	7.0′	11.0′
0	0.025	0.01	0.02	18	0	0.005	0.40
1	0.01	0.01	0.02	20	0	0.004	0.425
2	0.005	0.005	0.01	23	0	0.005	0.425
5	0	0	0.25	26	0	0.003	0.425
6	0	0	0.30	29	0	0	0.45
8	0	0.005	0.35	39	0	0	0.43
10	0	0.005	0.35	49	0	0	0.425
12	0	0.005	0.40	59	0	0	0.425
14	0	0	0.40	69	0	0.005	0.40
16	0	0	0.425	89	0	0.005	0.40

APPENDIX D

SITE ST-04 IN SITU RESPIRATION TEST DATA

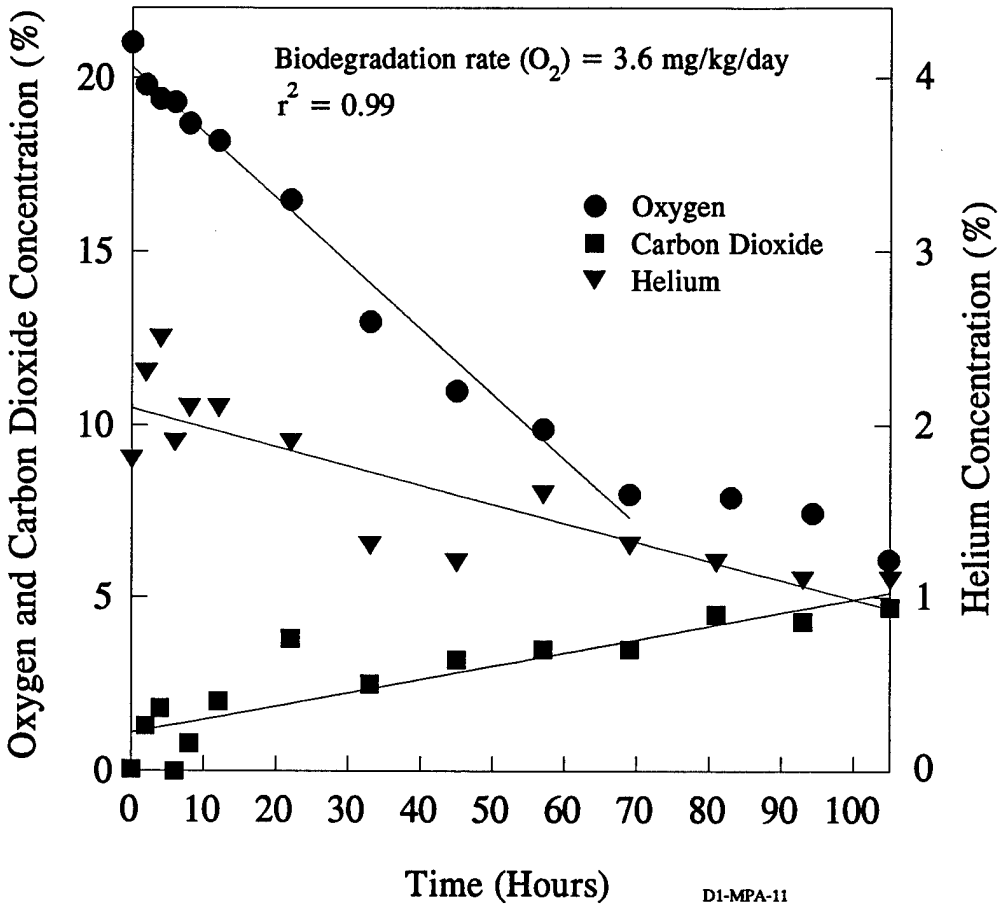


Figure D-1. Oxygen Utilization and Carbon Dioxide Production During the In Situ Respiration Test at Monitoring Point D1-MPA-11.0'

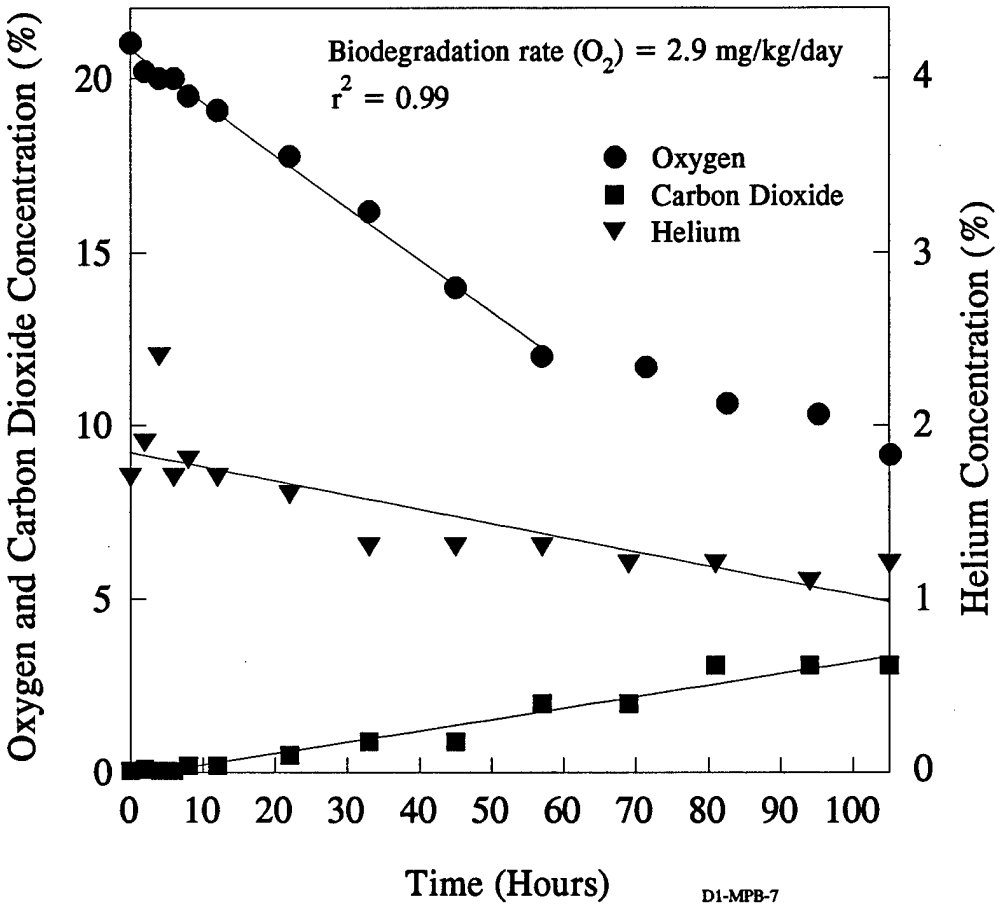


Figure D-2. Oxygen Utilization and Carbon Dioxide Production During the In Situ Respiration Test at Monitoring Point D1-MPB-7.0'

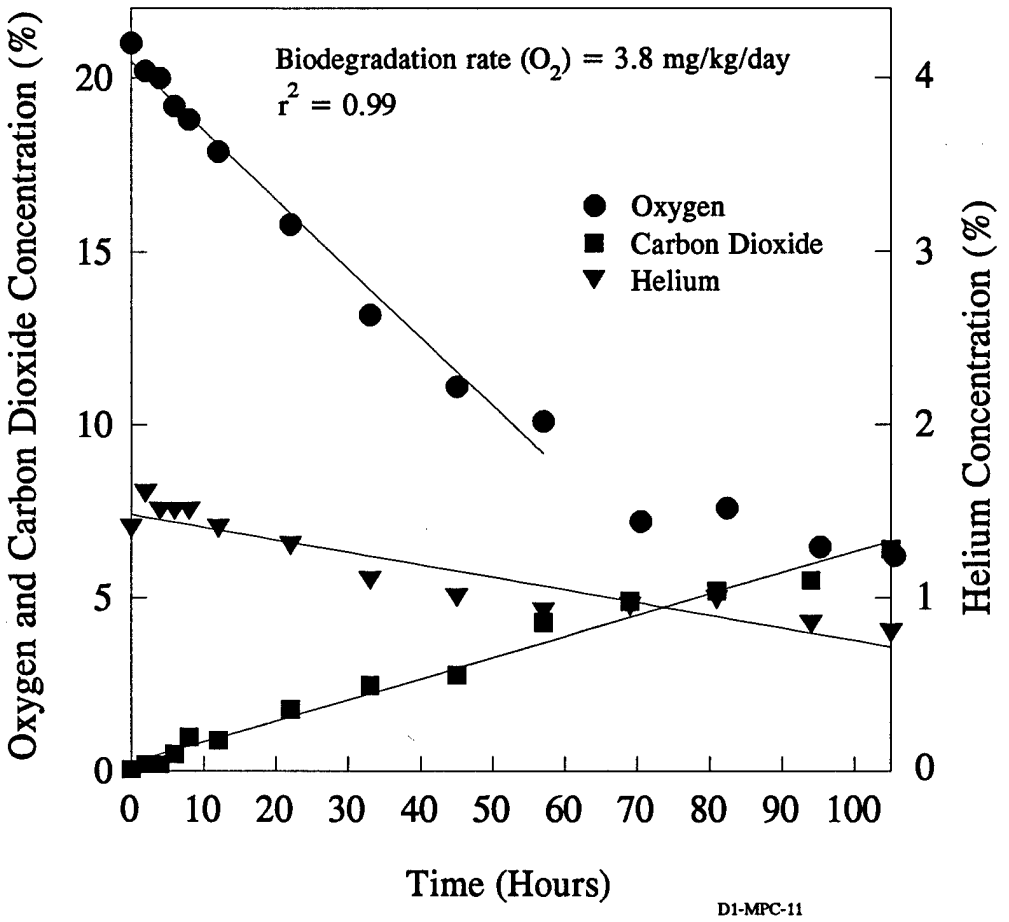


Figure D-3. Oxygen Utilization and Carbon Dioxide Production During the In Situ Respiration Test at Monitoring Point D1-MPC-11.0′

APPENDIX E

NORTH STORAGE TANK FARM SOIL GAS PERMEABILITY DATA

Table E-1. Results of Soil Gas Permeability Test at Monitoring Point D2-MPA

Time (min)	Pressure ("H_2O) by Depth			Time (min)	Pressure ("H_2O) by Depth		
	2.5′	6.0′	9.5′		2.5′	6.0′	9.5′
0	0	0	0	16	2.8	0.02	0.015
1	1.2	0	0	18	2.8	0.04	0.02
2	1.7	0	0	20	2.9	0.025	0.01
3	1.9	0.13	0	23	2.9	0.095	0.02
4	2.2	0.085	0	26	2.9	0.040	0.02
5	2.2			29	3.0	0.02	0.02
6	2.4	0.25	0	34	3.1	0.060	0.02
7	2.4	0.21	0	39	3.1	0.03	0.02
8	2.5	0.23	0	49	3.1	0.04	0.02
9	2.5	0.09	0	59	3.2	0	0
10	2.5	0.045	0	74	3.4	0	0
12	2.5	0.03	0	89	3.4	0	0
14	2.7	0.04	0	104	3.5	0	0

Table E-2. Results of Soil Gas Permeability Test at Monitoring Point D2-MPB

Time (min)	Pressure ("H_2O) by Depth			Time (min)	Pressure ("H_2O) by Depth		
	2.5′	6.0′	9.5′		2.5′	6.0′	9.5′
0	0	0	0	18	1.35	0	0
1	0.6	0	0	20	1.37	0.01	0
2	0.75	0	0	23	1.40	0.02	0
3	0.90	0.01	0	26	1.40	0	0
4	1.0	0	0	29	1.42	0.01	0
5	1.05	0.04	0	34	1.51	0	0
6	1.1	0	0	39	1.52	0	0
8	1.1	0	0	44	1.52	0	0
9	1.15	0	0	59	1.60	0	0
10	1.15	0	0	74	1.63	0	0
12	1.17	0	0	89	1.63	0	0
14	1.27	0	0	104	1.67	0	0
16	1.30	0.02	0				

Table E-3. Results of Soil Gas Permeability Test at Monitoring Point D2-MPC

Time (min)	Pressure ("H_2O) by Depth			Time (min)	Pressure ("H_2O) by Depth		
	2.5′	6.0′	9.5′		2.5′	6.0′	9.5′
0	0	0	0	16	1.89	0.89	0.87
1	0.23	0.21	0.15	18	0.91	0.90	0.88
2	0.40	0.40	0.35	20	0.91	0.91	0.90
3	0.50	0.50	0.49	23	0.96	0.95	0.94
4	0.65	0.60	0.60	26	0.96	0.97	0.94
5	0.67	0.65	0.64	29	0.96	0.96	0.95
6	0.69	.69	0.67	34	1.0	1.0	1.0
7	0.70	0.73	0.71	39	1.10	1.12	1.09
8	0.75	0.75	0.74	49	1.10	1.10	1.0
9	0.75	0.77	0.75	59	1.10	0.022	0.02
10	0.77	0.77	0.76	74	1.10	0	0
12	0.85	0.85	0.83	89	1.10	0	0
14	0.87	0.87	0.85	104	1.13		

APPENDIX F

NORTH STORAGE TANK FARM IN SITU RESPIRATION TEST DATA

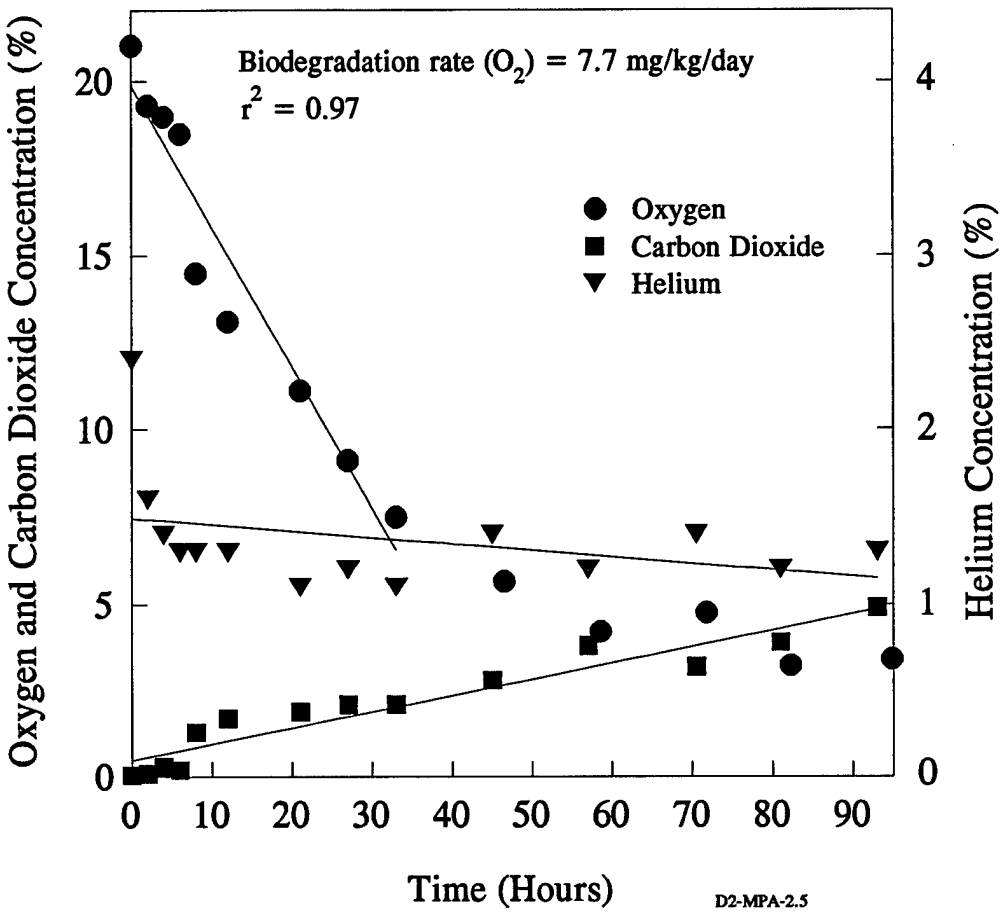


Figure F-1. Oxygen Utilization and Carbon Dioxide Production During the In Situ Respiration Test at Monitoring Point D2-MPA-2.5'

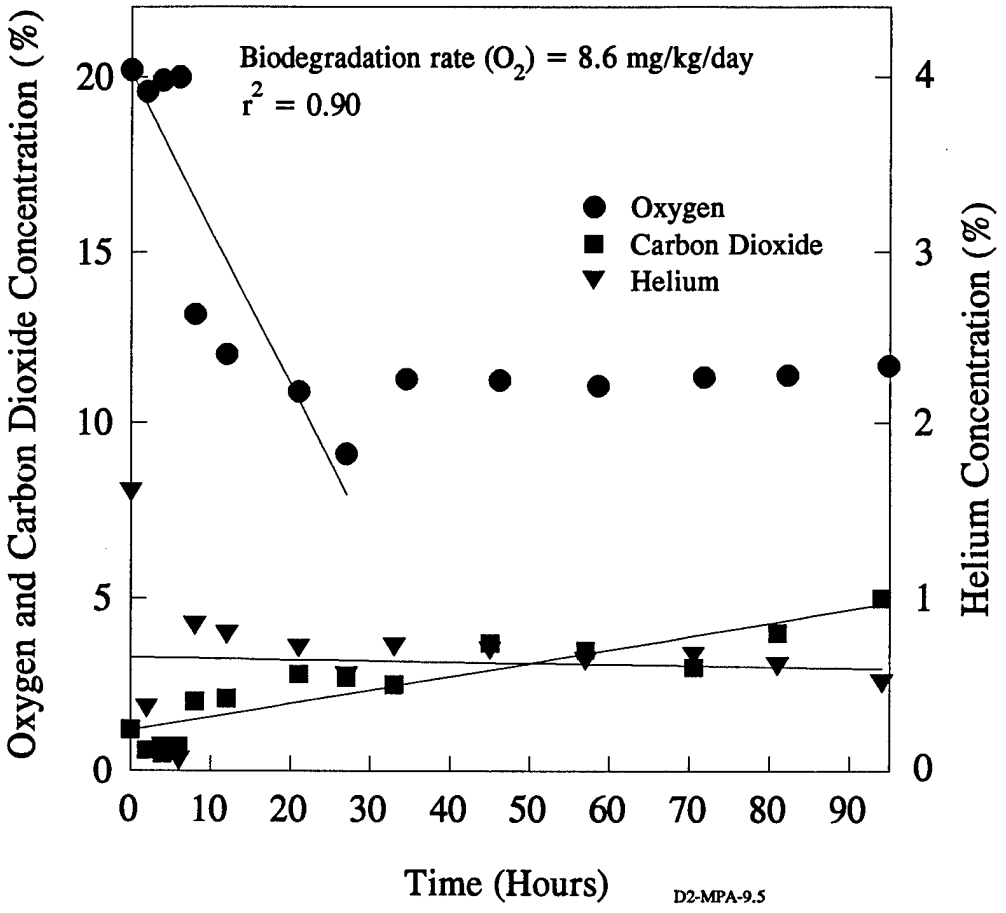


Figure F-2. Oxygen Utilization and Carbon Dioxide Production During the In Situ Respiration Test at Monitoring Point D2-MPA-9.5'

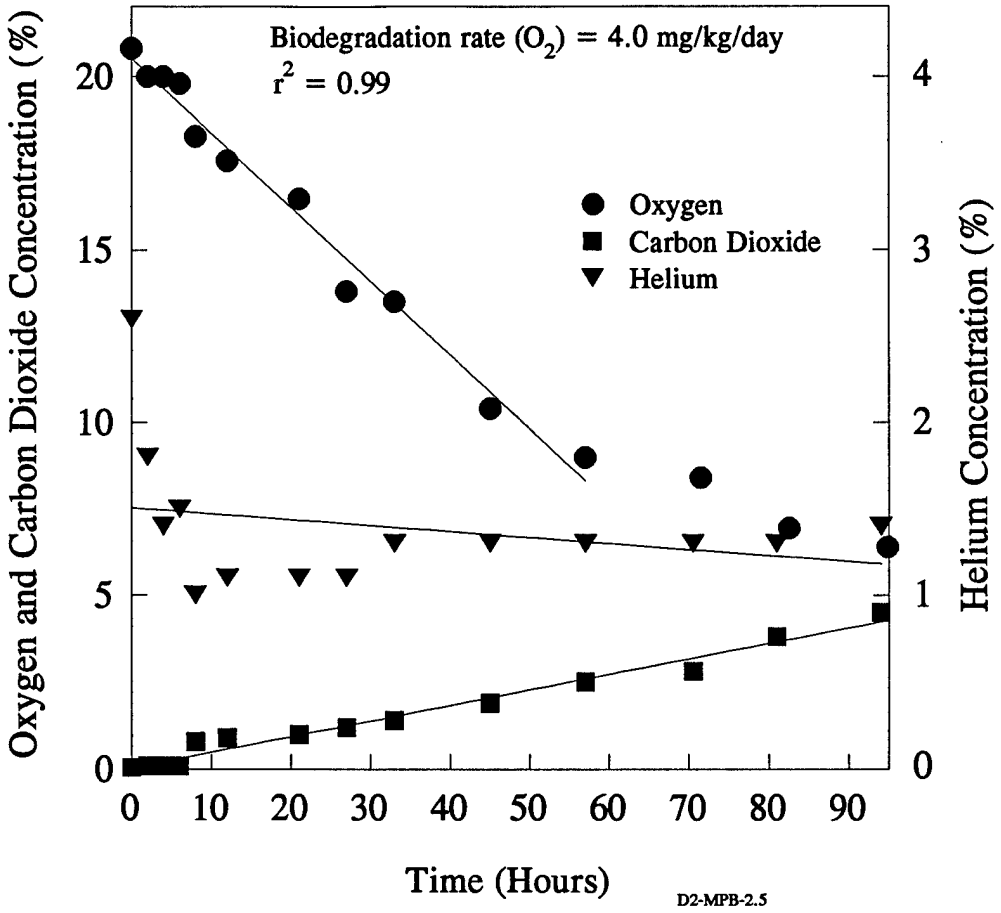


Figure F-3. Oxygen Utilization and Carbon Dioxide Production During the In Situ Respiration Test at Monitoring Point D2-MPB-2.5′

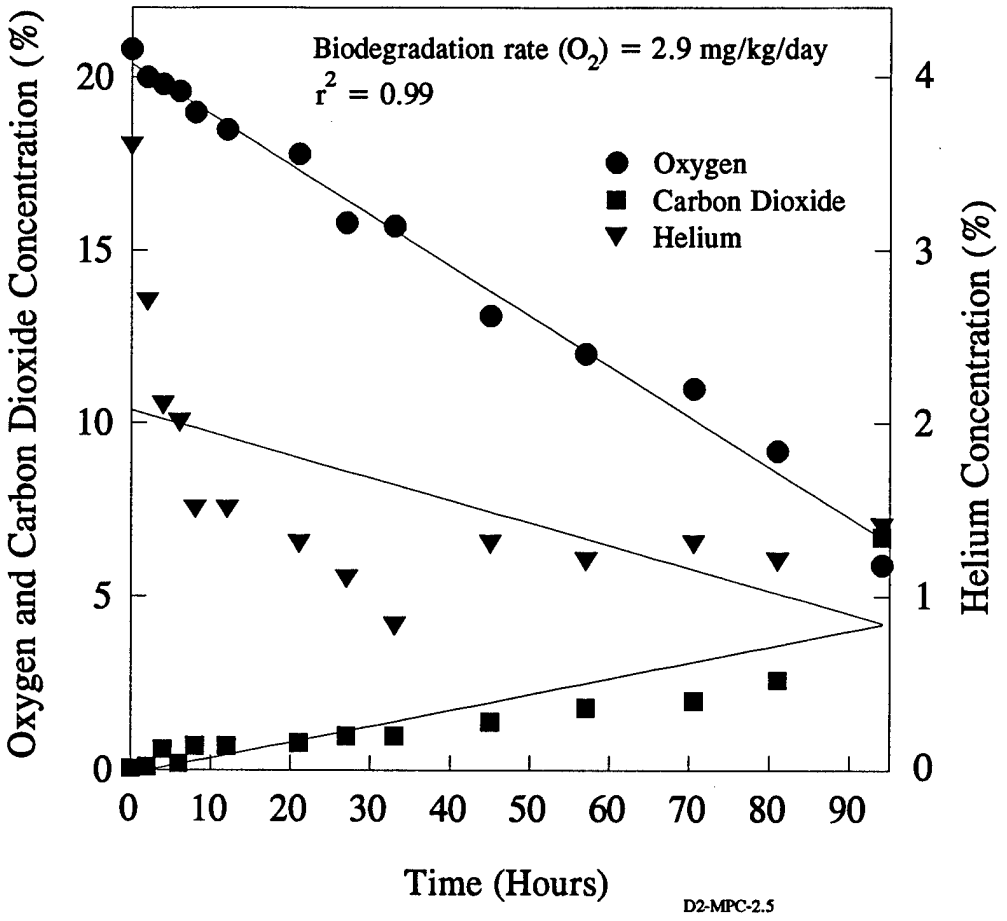


Figure F-4. Oxygen Utilization and Carbon Dioxide Production During the In Situ Respiration Test at Monitoring Point D2-MPC-2.5′

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