CROWLEY MARINE SERVICES, INC.

Mr. Paul E. Skyllingstad
Department of Ecology
Industrial Section
P.O. Box 47706
Olympia, WA 98504-7706

May 25, 2000

Re: Former Columbia Marine Lines Facility, Vancouver, WA

Dear Mr. Skyllingstad:

Enclosed please find a copy of the Dual Phase Extraction and Bioventing Pilot Test Report for the former Columbia Marine Lines site, located at 6305 Lower River Road, Vancouver, Washington. SECOR International (SECOR) prepared this report on behalf of Crowley Marine Services.

SECOR is currently developing a remediation work plan (cleanup action plan) for the site. This work plan will present the remediation technology and proposed cleanup concentrations for the site. Crowley will submit this work plan to your office by June 14th. 2000. After your review of the work plan I would like to meet with you and discus its implementation.

Please call me at (206) 443-8042 if you have any questions regarding this matter.

Sincerely,

Stephen Wilson
Manager, Environmental Affairs

Enclosure: Dual Phase Extraction and Bioventing Pilot Test Report

cc: CML Vancouver Correspondence
Al Piecka w/enclosure
Rod Brown
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SECOR
International Incorporated

COPY

DUAL PHASE EXTRACTION AND BIOVENTING PILOT TEST REPORT

Former Columbia Marine Lines Facility
6305 Lower River Road
Vancouver, Washington

***SECOR* Project No. 015.08480**

Submitted by:
SECOR International Incorporated
7730 SW Mohawk Street
Tualatin, Oregon 97062-1508

Submitted to:
Crowley Marine Services
2401 Fourth Avenue
Post Office Box 2287
Seattle, Washington 98121

May 19, 2000

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1.0 INTRODUCTION

A dual phase vacuum extraction and bioventing pilot test was conducted by SECOR International Incorporated (SECOR) at the former Columbia Marine Lines (Crowley) Facility, located at 6305 Lower River Road in Vancouver, Washington. The site is located immediately north of the Columbia River and approximately 3 miles west of the city of Vancouver, as shown on Figure 1. The site is relatively flat, with the highest point lying at an approximate elevation of 32 feet above mean sea level. Two settling ponds operated by Vanalco, formerly operated by ALCOA, occupy a portion of the site to the northwest.

The test was conducted during the weeks of February 11, February 18 and February 25, 2000 on the shallow sandy fill material in the vicinity of the former west pond. The former pond was historically used to store barge slops. The barge slops were removed in January 1984 and the pits were filled with dredge sand. The goal of the pilot test was to evaluate the following characteristics of the pilot system:

- Rate of biorespiration,
- Soil vapor flow rate versus applied vacuum,
- Radius of vacuum influence, and
- Groundwater recovery rate.

Details of the procedures and results of the pilot tests are discussed in this document.

2.0 DUAL PHASE EXTRACTION AND BIORESPIRATION PILOT TEST

The dual phase extraction and bioventing pilot test consisted of three separate test runs at two different extraction well locations. The first and second runs were conducted from February 2 through February 9, 2000 and from February 10 through February 17, 2000 on well MW-7. The third run was conducted from February 18 through February 23, 2000 on well EX-2. The test objectives, procedures, and results are presented below.

2.1 PILOT TEST OBJECTIVES

The objective of the pilot test was to evaluate the following site-specific parameters for full-scale remediation system design:

- *Rate of Biorespiration:* This was the main objective of the pilot testing. The rate of biorespiration was evaluated by monitoring the rate of decline of oxygen levels in wells MW-1, MW-8, MW-18, MW-19 and the two temporary point wells after shutdown of the extraction blower. The rate of oxygen decline is an indicator of the amount of oxygen used by microbial biodegradation of subsurface hydrocarbons, and can be used to estimate the rate of that microbial biodegradation.

- *Soil Vapor Extraction Flow Rate Versus Applied Vacuum:* The flow rate of vapors drawn from the extraction well was determined from air velocity measurements at the point of vacuum dilution and at the exhaust stack and compared to vacuum readings collected during the test.

- *Radius of Influence:* The radius of vacuum influence was evaluated by measuring the induced subsurface vacuum on wells MW-1, MW-8, MW-18, MW-19 and two temporary point wells and by tracking increases in oxygen levels in the monitoring wells.

- *Groundwater Recovery Rate:* The total volume of groundwater extracted during each run was monitored to evaluate an average and maximum expected groundwater production rate.

2.2 PILOT TEST WELL INSTALLATION

Monitoring well MW-7 was installed on November 2, 1983 by Geoengineers Incorporated. It was installed to a total depth of 20 feet below ground surface (bgs) with a screened interval of 3 to 18 feet bgs. Extraction well EX-2 was installed on February 3, 1996 by SECOR. It was installed to a total depth of 30 feet bgs and is screened from 5 to 30 feet bgs. The locations of both wells are shown in Figure 2. Boring logs and well construction diagrams are included in Appendix A.

Four 1-¼ inch diameter temporary point wells for monitoring the effect of extraction at MW-7 were installed on January 5, 2000 by SECOR. Two points were installed at a distance of 15 feet from MW-7 (P-1S and P-1D), and two were installed at a distance of 30 feet from extraction well MW-7 (P-2S and P-2D), as shown on Figure 2. At each distance, one point was set to a depth of 5 feet bgs, with a screened interval of 3 to 5 feet bgs, and the other point was set at a depth of 9 feet bgs, with a screened interval of 7 to 9 feet bgs. The lateral distance between each of the two points in a set was approximately 1 foot.

On February 18, 2000, the four temporary points were removed and reinstalled near EX-2. Two points were installed approximately 20 feet from EX-2 (P-3S and P-3D) and two were installed approximately 30 feet from EX-2 (P-4S and P-4D), as shown on Figure 2. P3-S and P-4S were installed with a screened interval from 3 feet to 5 feet bgs, and P-3D and P-4D were installed with a screened interval from 7 feet to 9 feet bgs. The lateral distance between each of the two points in a set was approximately 1 foot.

2.3 PILOT TEST APARATUS

The SVE/Bioventing pilot test apparatus included a wellhead and extraction stinger, moisture separation drum, vacuum blower, oil/water separation tank, liquid phase carbon drum filter, and connecting hose and fittings. Figure 3 illustrates the pilot test apparatus set up.

Vapor and water were extracted from the test well through a drop tube, called a stinger. The well stinger was a 1-inch diameter flexible polyvinyl chloride (PVC) hose that was inserted into the well through a 4-inch diameter well seal. The well seal was adapted to connect to the 2-inch well with bushings and a section of 4-inch PVC pipe. The well seal was equipped with a sample port and an air inlet valve that could be used to allow air into the well casing, facilitating water removal in case the soil provided less air flow than expected. The depth to the bottom of the stinger was adjustable so that it could be set at the groundwater level. When the blower was operated, it drew soil vapor into the stinger. Groundwater and petroleum fluids were extracted by entrainment into the high velocity soil vapor stream.

The 1-inch diameter hose was connected to a 2-inch diameter hose that was connected to a modified 55-gallon drum used as a moisture separation tank. Airflow was directed into the modified drum through a tangential inlet which directed air flow around the inner walls of the drum, enhancing moisture separation. To allow adjustment of the amount of vacuum at the bottom of the stinger, the drum was equipped with an air dilution valve. Groundwater that accumulated in the moisture separator was pumped to an oil/water separation drum by a ½-horsepower (hp) submersible sump pump installed in the moisture separator drum. The submersible pump operated on 110-V power supplied from a duplex outlet at the electrical panel.

Vacuum was supplied by a Sutorbilt 3ML, 5 hp, explosion-proof vacuum blower. This model blower is capable of supplying a maximum flow rate of 117 cubic feet per minute (cfm) and a maximum vacuum of

12 inches of mercury (" Hg). The blower operated on 230-V single phase power, and it was wired to an electrical panel by a licensed electrician. Manufacturer's literature for the blower is included in Appendix B. Exhaust from the blower was discharged to the atmosphere through a 5-foot tall, 2-inch diameter, schedule 40 PVC discharge stack. A ½-inch threaded port in the stack was used for measuring air flow using a hot wire anemometer and as a sample port.

Water pumped out of the moisture separator drum was discharged into a 55-gallon drum modified to act as an oil/water separator. The drum was elevated so that it would discharge through a submerged drop tube into an existing approximately 1000-gallon oil/water separation tank (See Figure 4). During the test, the 1000-gallon tank was filled, and water discharged from the tank through a 2-inch discharge line to a 55-gallon drum of activated carbon. Water discharged from the carbon drum into an existing infiltration trench. The trench location is shown on Figure 2. The trench design is shown on Figure 5.

2.4 SVE / BIORESPIRATION PILOT TEST PROCEDURES

2.4.1 Background Vacuum and Oxygen Content Monitoring

Background vacuum and oxygen levels were monitored on the morning of February 1, 2000, prior to beginning pilot test Run One that afternoon. Vacuum and oxygen content measurements were made at P-1D, P-1S, P-2D, P-2S, MW-1, MW-8, MW-18 and MW-19. Oxygen was nearly entirely depleted at MW-19 (4.4% oxygen). It was also depleted in MW-8 (17.7% oxygen) and P-20 (19.8% oxygen). Oxygen levels were near atmospheric levels at the remaining wells. Table 1 presents these results.

In order to collect these measurements, the monitoring wells were capped, and a 3/8-inch diameter clear, flexible PVC tube was threaded through a hole in each cap and sealed. For the monitoring wells, the hose length was set so that the open, bottom end of the hose was located at a depth of approximately 1 foot above the static groundwater level. For the 1-inch monitoring points, the hose was set so that the open, bottom end was set at the middle of the screened interval. Hose clamps were used to seal the tubes when measurements were not being taken.

To measure subsurface vacuum, Magnahellic vacuum gauges with a sensitivity of 0.1 to 10 inches of water were connected to the flexible PVC tubing. To measure oxygen in the soil vapors intersected by the well screen, a Gastech Genesis Portable LEL/oxygen Meter with an internal air-draw pump was connected to the flexible PVC tubing.

2.4.2 Dual Phase Extraction Test

The dual phase extraction test consisted of three runs. Run One and Run Two were conducted on MW-7. Run Three was conducted on EX-2. Monitoring well vacuum and oxygen measurements collected while the blower was operating during the pilot test runs are presented in Table 2. Vacuum and flow rate data are presented in Table 3. These results are summarized and discussed in Section 3.2.

Run One of the dual phase extraction test began at 2:10 p.m. on February 2, 2000. The air dilution valve on the moisture separator was adjusted so that the vacuum at the moisture separator was 5" Hg. Induced vacuum and oxygen levels in the subsurface soil were monitored in each well every 15 minutes for the first hour and then every half-hour thereafter for approximately two hours. Air flow rates were monitored using a hot-wire anemometer to measure air velocity in the discharge stack and at the inlet to the dilution valve every 30 minutes for the first hour.

Measurements were also collected after 18 hours of operation. Field log sheets are included in Appendix D.

Run Two of the dual phase extraction test began at 3:55 p.m. on February 14, 2000. The air dilution valve was adjusted to produce a vacuum of 5" Hg at the moisture separator.

Run Three of the dual phase extraction test began at 3:40 p.m. on February 17, 2000. The air dilution valve was adjusted to produce a vacuum of 5 " Hg at the moisture separator.

During the pilot test, the depth of the bottom of the stinger in the extraction well was adjusted periodically to enhance groundwater removal. As the stinger was lowered to the water table, water droplets were entrained in the high velocity air stream entering the stinger and pulled into the moisture separator. The 1-inch diameter hose was translucent, and during the test, liquids could be observed in the hose. As water was removed from the well casing, the water table depressed, and the stinger was again lowered, driving the water level in the casing and the well back downwards. The goal of depressing the water table was to enhance recovery of free phase hydrocarbons floating on top of the water table. By depressing the water table, water and hydrocarbons in the surrounding soil are induced to flow towards the well into the cone of depression.

Over the course of the three runs, the stinger was gradually lowered to a depth of 5 feet below the static water level. With the vacuum applied to well MW-7, the maximum flow rate over a period of 30 hours was 50.9 gallons per hour (gph). The total flow over the 16 day period was 1,940 gallons. With the vacuum applied on well EX-2 the maximum flow rate over a period of 22 hours was 26.8 gph. The total flow over the 6 day period was 1,408 gallons.

2.4.3 In-Situ Biorespiration Monitoring

In-situ biorespiration monitoring was conducted after each pilot test run. For the test, oxygen levels were measured in the four monitoring wells and four point wells over time.

2.4.3.1 Biorespiration Monitoring for Runs on MW-7

Run One on MW-7 began on February 9, 2000 at 9:25 a.m. The blower was shut off and MW-1, MW-7, MW-8, MW-18, MW-19, P-1D, P-1S, P-2D, and P-2S were monitored for oxygen content. Measurements were taken every 15 minutes for the first hour and every half-hour thereafter for another 3 hours. The oxygen meter was then set up on well MW-8 to take measurements every 15 minutes and log the data internally. Data was collected by the internal datalogger for approximately 3.5 more hours. Oxygen measurements are presented in Table 4, and they are summarized and discussed in Section 3.3 and 3.4.

Run Two on MW-7 began on February 17, 2000 at 11:15 a.m. The blower was shut off and the oxygen meter was set up on well MW-8 to take measurements every 1 minute. Well MW-8 showed the greatest response during Run One and was used during Run Two to confirm those results. Data was collected during Run Two for approximately 4 hours, at which time the oxygen level in the well was no longer declining rapidly. Oxygen measurements are presented in Table 5, and they are summarized and discussed in Section 3.3 and 3.4.

2.4.3.2 Biorespiration Monitoring for the Run on EX-2

Run Three on well EX-2 began on February 23, 2000 at 3:05 p.m. The blower was shut off and the oxygen content was measured in wells MW-1, MW-7, MW-8, MW-18 and MW-19, as well as the point wells P-3D, P-3S, P-4D and P-4S. Measurements were taken every 15 to 20 minutes for 1½ hours. The oxygen meter was then set up on the point well P-3D to take measurements every 1 minute and log the data internally. Data was collected by the internal datalogger for approximately 7 more hours. Oxygen measurements are presented in Table 6, and they are summarized and discussed in Section 3.3 and 3.4.

3.0 PILOT TEST RESULTS

This section discusses the results of the pilot test. Conclusions are presented in Section 4.0 of this report.

3.1 VACUUM VERSUS FLOW RATE

Vacuum versus flow rate data is presented in Table 3. Due to the high permeability of the soils, the flow rate was high, but relatively high vacuum levels were still achievable. The vacuum at extraction well MW-7 ranged from 4.0 to 5.5" Hg at flow rates of 19 and 43 scfm, respectively. The vacuum at extraction well EX-2 ranged from 5.0 to 5.5" Hg.

3.2 VACUUM RADIUS OF INFLUENCE

During Run One and Run Two, the highest induced vacuum was measured at P-2D (average 4" H_2O). P-2D is located approximately 30 feet from MW-7. Induced vacuums of 0.12 and 0.66 in. H_2O were measured at wells P-1S and P-1D which are located 15 feet from MW-7. No induced vacuum was measured at wells P-2S, MW-1, MW-8, MW-18, and MW-19. P-2S was a shallow monitoring point, 30 feet away from the extraction well. The other four wells ranged from 55 to 154 feet from the extraction well.

During Run Three, the highest induced vacuum was measured at P-3D. P-3D is located approximately 20 feet from EX-2. An induced vacuum of 0.01 was measured at well P-4D, which is located 30 feet from EX-2. No induced vacuum was measured at wells P-3S, P-4S, MW-1, MW-7, MW-8, MW-18 and MW-19. P-3S and P-4S were shallow monitoring points 20 and 30 feet away from the extraction well respectively. MW-7 was 19 feet away. The other four wells ranged from 67 to 135 feet from the extraction well.

The vapor extraction radius of influence was determined for the wells where influence was observed by plotting the normalized vacuum at each monitoring point versus its distance from the extraction well (see Figure 6). The normalized vacuum was obtained by dividing the induced vacuum observed at the monitoring point by the vacuum at the extraction well. The normalized vacuum is plotted versus distance on Figure 6. To determine the radius of influence, i.e., the distance at which 1% vacuum is observed, a straight line is drawn on Figure 6 from 0,1 (zero distance, 100% vacuum) to the normalized vacuum point. The radius of influence is the distance at which the normalized vacuum is 0.01. From experience with standard soil vapors extraction systems, the system is considered to have influence in a monitoring location if the observed induced vacuum is equal to 1 percent of the extraction vacuum. Normalized vacuum data indicate an effective radius of influence ranging from 11 to 43 feet.

3.3 BIORESPIRATION RADIUS OF INFLUENCE

Radius of influence presented in Figure 6 may also be defined by increases in oxygen concentration measurements and subsequent biorespiration in the monitoring wells. After Run One and Run Two, active biorespiration was observed at MW-8, located 55 feet from MW-1 where oxygen measurements decreased from 14.3% to 12.5% in Run One and 17.2% to 11.2% in Run Two. During Run Three, active biorespiration was observed at P-3D and P-4D, located 20 feet and 30 feet from EX-2, respectively. Oxygen measurements at P-3D decreased from 13.4% to 6.8%, and oxygen measurements at P-4D decreased from 18.8% to 4.0%. For Run One low levels of biorespiration were observed as far away as MW-19, which was 154 feet from MW-7.

3.4 SOIL VAPOR CONCENTRATIONS AND AIR EMISSIONS ESTIMATES

Results of the analyses of the vapor sample from the discharge from EX-2 indicated that the vapor contained low levels of the BTEX compounds, benzene (0.496 mg/m^3), toluene (0.496 mg/m^3), ethylbenzene (0.496 mg/m^3), and xylenes (0.496 mg/m^3) and gasoline range hydrocarbons (20.8 mg/m^3). Air sample laboratory analytical results are included in Appendix E.

3.5 BIODEGRADATION RATES

Results of the *in situ* biorespiration tests were used to determine oxygen utilization rates by plotting percent oxygen versus time (Leeson and Hinchee, 1995). Figure 7 shows the oxygen depletion curves for MW-8, P-1D, P-1S, P-2D, and P-2S for Run One. Figure 8 shows the oxygen depletion curves for MW-8 for Run Two. Figure 9 shows the oxygen depletion curve for P-3D, MW-8, P-3S, P-4S, and P-4D for Run Three.

Hydrocarbon biodegradation rates were estimated using the stoichiometric relationship for oxidation of hexane. (The ratio of oxygen required for degradation to the size of the hydrocarbon remains constant; therefore, it is applicable to use the relationship for hexane for sites with other hydrocarbon constituents.)

$$C_6H_{14} + 9.5O_2 \rightarrow 6CO_2 + 7H_2O$$

The biodegradation in terms of milligrams (mg) hexane-equivalent per kilogram (Kg) soil per day was estimated using biodegradation rates developed by Leeson and Hinchee (1995). Oxygen depletion rates and the corresponding biodegradation rates are summarized on Table 7. Examples of the biodegradation rate calculations are presented in Appendix F.

3.6 GROUNDWATER PRODUCTION

The volume of groundwater removed was measured using a totalizing flow meter installed in the line from the moisture separator. During the initial stages of Run One, the bottom of the stinger was maintained at a depth of 7 feet bgs, at approximately the original water table, and no attempt was made to draw down the water table. During this period, average groundwater production was less than two gallons per hour (gph). At the end of Run Two, the stinger was gradually lowered to a depth of approximately 17 feet bgs, and during the last two days of Run Two, the average groundwater production rate was 25 gph. At the start of Run Three, the stinger was set below the water table at a depth of 11.5 bgs, and the groundwater production rate averaged less than 7 gph. Towards the end of Run Three, the stinger was lowered to 17 feet bgs, and during this period, the groundwater production rate was approximately 22 gph.

Due to the distance from the extraction wells and the monitoring wells, and the need to leave wells undisturbed for oxygen monitoring for several hours after the test, drawdown caused by the groundwater extraction test was not evaluated.

4.0 CONCLUSIONS

4.1 SVE / BIOVENTING PILOT TEST CONCLUSIONS

The pilot test data resulted in the following conclusions:

1. The pilot test results indicate that bioventing successfully enhanced utilization of oxygen in soil gases, and that it accelerated biodegradation of petroleum hydrocarbons by indigenous microorganisms.

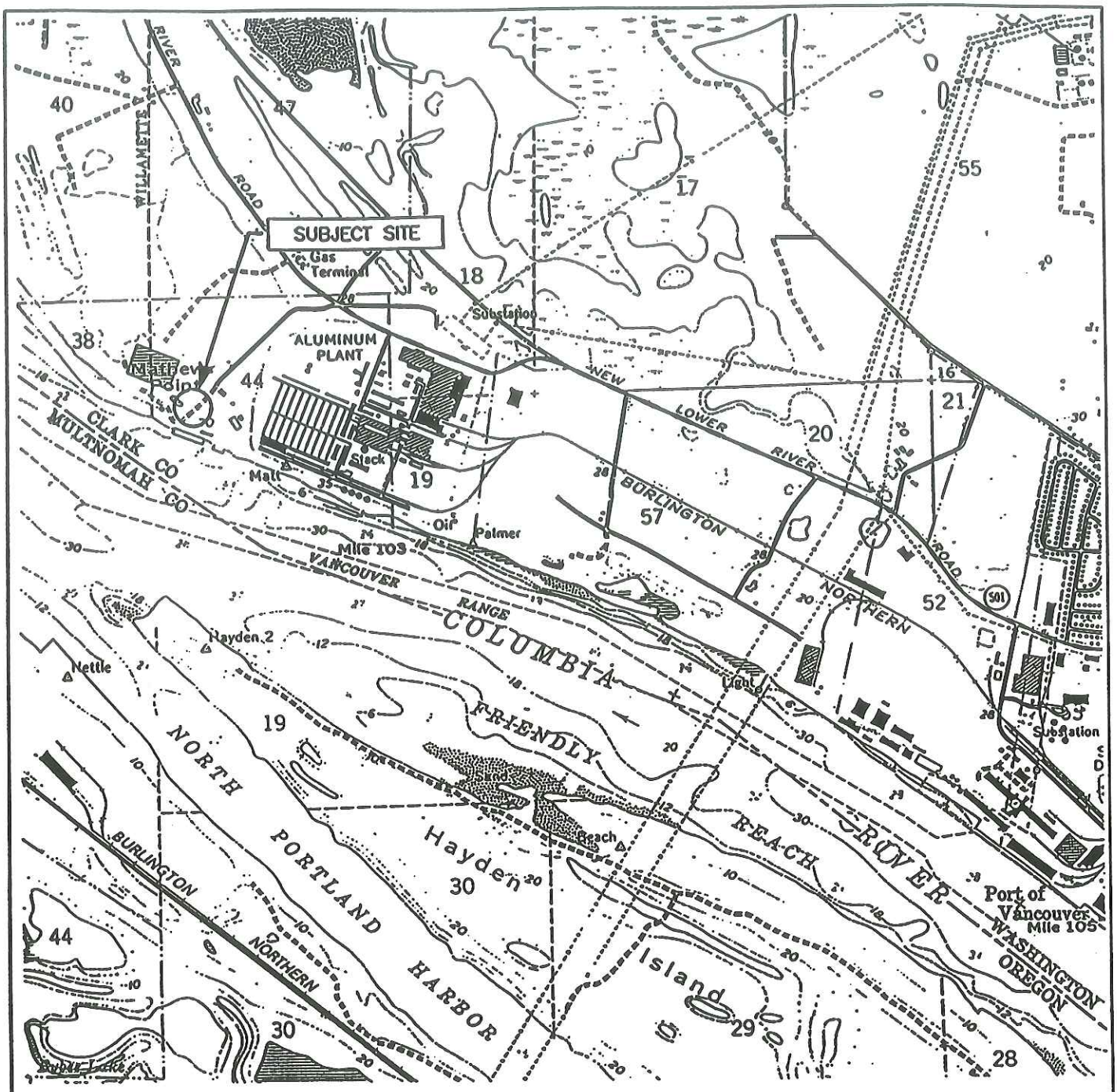
2. Prior to the test, oxygen concentrations in the subsurface were as low as 4.4 percent, which is significantly depleted relative to the atmospheric oxygen concentration of 20.9 percent. An oxygen concentration of 20.5 percent is typical of uncontaminated soils. Depleted oxygen concentrations were likely to be a result of past aerobic biodegradation of petroleum hydrocarbons. Oxygen concentrations below 5 percent are considered limiting with respect to hydrocarbon biodegradation (Principles and Practices of Bioventing: Volume I and Volume II, Andrea Leeson and Robert E. Hinchee, Batelle Memorial Institute, Columbus, Ohio, September 29, 1995). Thus increasing oxygen availability should remove the rate limiting factor to aerobic biodegradation.

3. The pilot test results provide the following design parameters for a full scale remediation system:

   - The vapor flow rate at a vacuum of approximately 4" Hg was 20 to 25 scfm.

   - Vacuum influence was observed at a radius of up to 30 feet in wells screened below seven feet bgs. Biorespriation influence was seen at low levels at distances of up to 150 feet, but was strongest at distances of 30 feet and less. Based on these results, a conservative radius of influence of 30 feet is proposed for the design.

   - Groundwater recovery was maximized when the bottom of the stinger was set well below the static groundwater elevation. When operated at this depth, short term groundwater recovery averaged 25 gph. When the system was operated with the stinger set closer to the static water table, the groundwater recover rate dropped to less than 7 gph.



QUADRANGLE LOCATION

North

0 1/2 1

SCALE (MILES)

REFERENCE: USGS 7.5 MINUTE QUADRANGLE; VANCOUVER, WASHINGTON.

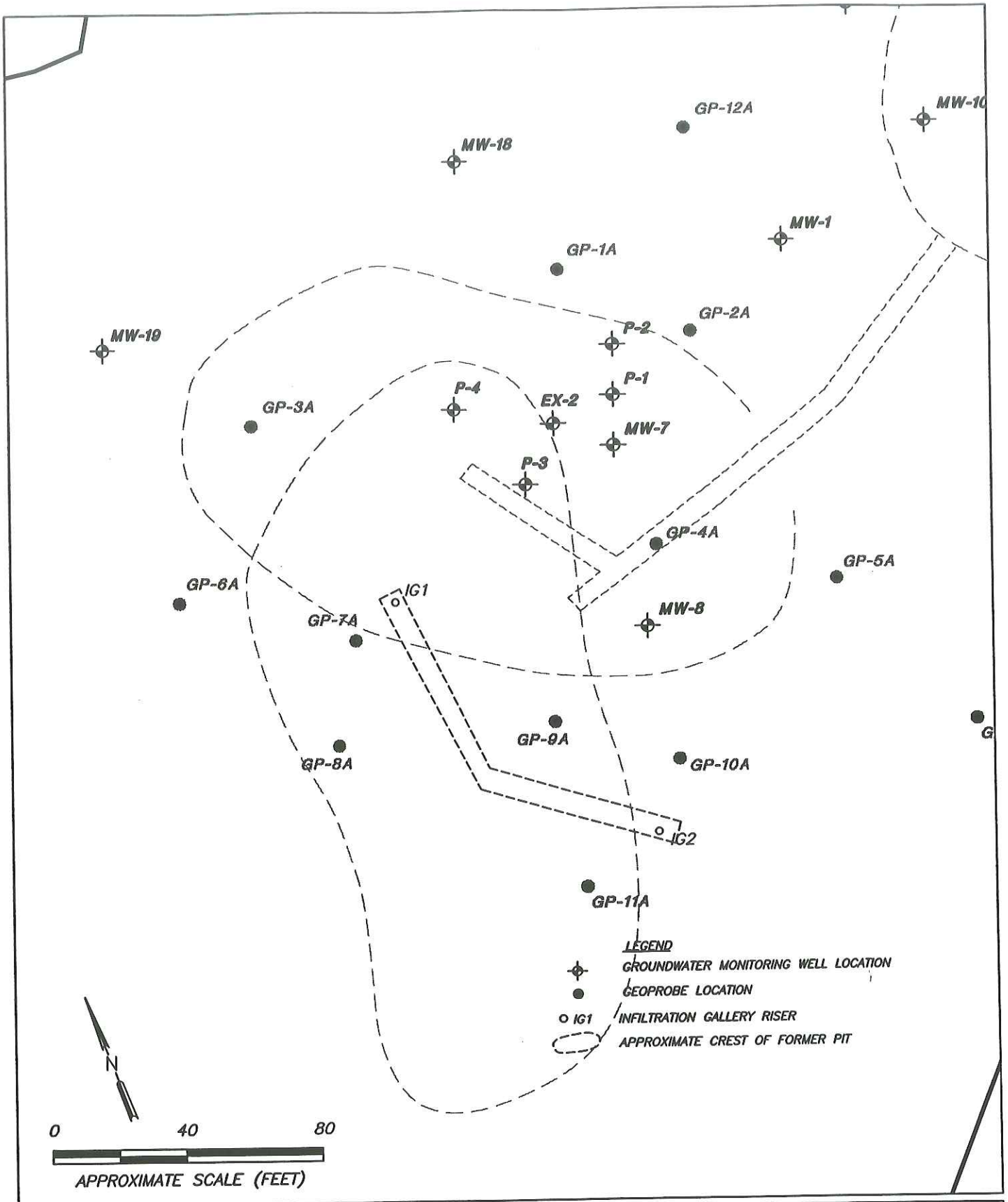
SECOR International Incorporated

SITE LOCATION MAP
FORMER COLUMBIA MARINE LINES FACILITY
VANCOUVER, WASHINGTON

FIGURE: 1

JOB#: 00266-003-01 APPR: RGH DWN: DJM DATE: 12/2/07

DWG: CR003068



SECOR International Incorporated

SITE PLAN

FORMER COLUMBIA MARINE LINES FACILITY
6305 LOWER RIVER ROAD
VANCOUVER, WASHINGTON

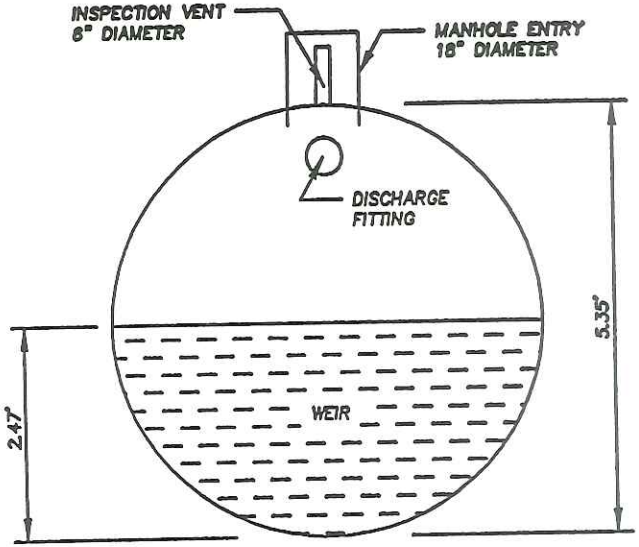
FIGURE: 2

JOB #: 015.08480.500 APPR: DWN: SRH DATE: 3/7/00

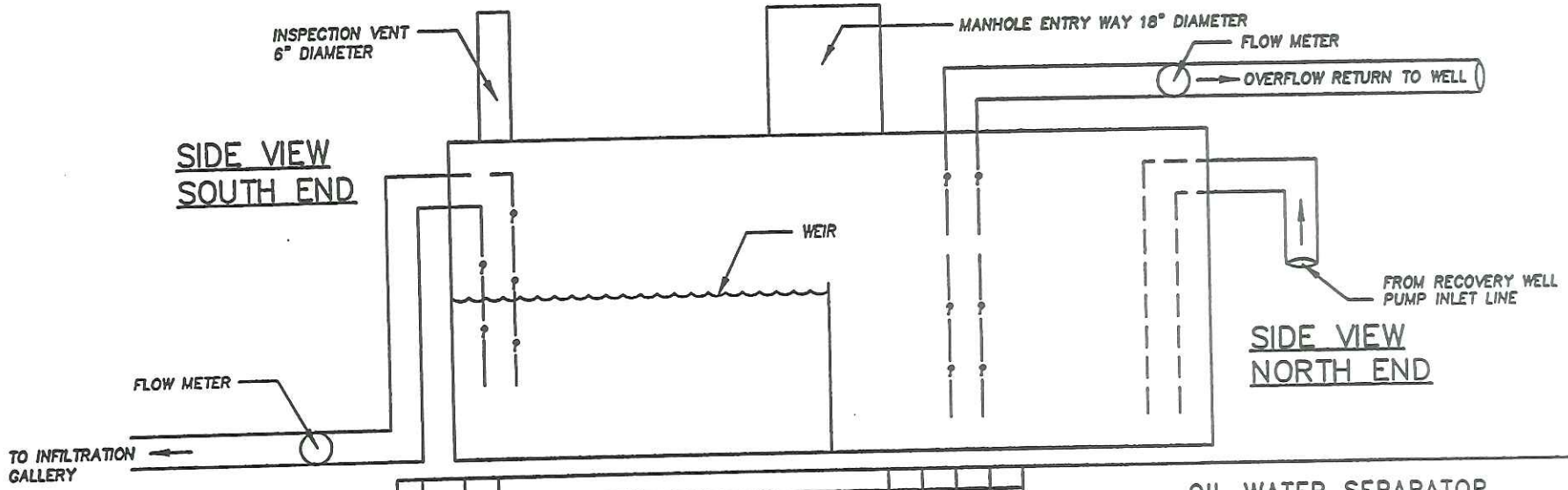
DWG: 15-8480-502

F:/FILES/PORTLAND/CROWLEY

NOT TO SCALE



VIEW FROM SOUTH END



NO.	DRAWN	DATE	REVISION	CHKD	DATE	APPVD	DATE

Converse Consultants NW Geotechnical Engineering and Applied Earth Sciences

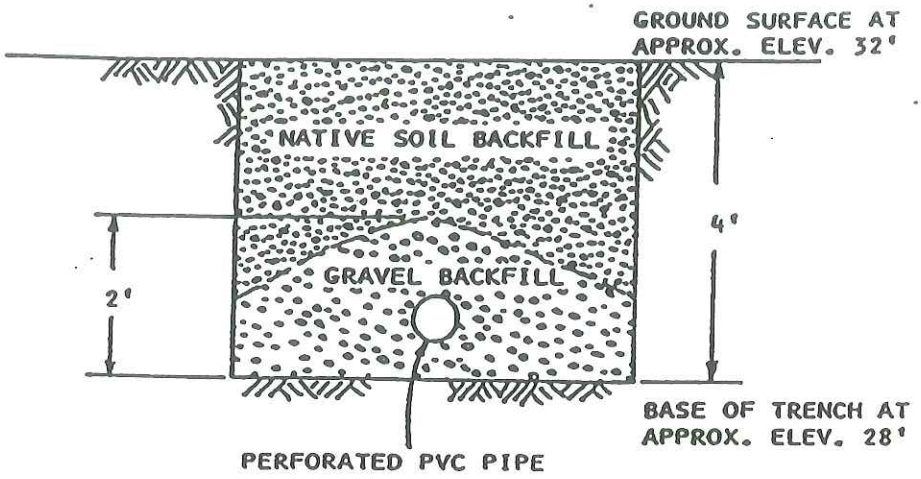
OIL WATER SEPARATOR

COLUMBIA MARINE LINES
Vancouver, Washington
Crowley Marine Services

Project No. 93-35505-02

Figure No. 4

CURRENT DATE: 4/12/95 | CAD FILE NAME: FIG-2.DWG



NOT TO SCALE

TYPICAL AS-BUILT SECTION
WATER DISPOSAL GALLERY

	REQUEST FOR PROPOSAL - INFORMATION ONLY	FIGURE 5
		CROWLEY ENVIRONMENTAL SERVICES

Figure 6
Normalized Vacuum Versus Distance
Dual Phase Extraction and Biorespiration Pilot Test
Former Columbia Marine Lines Facility

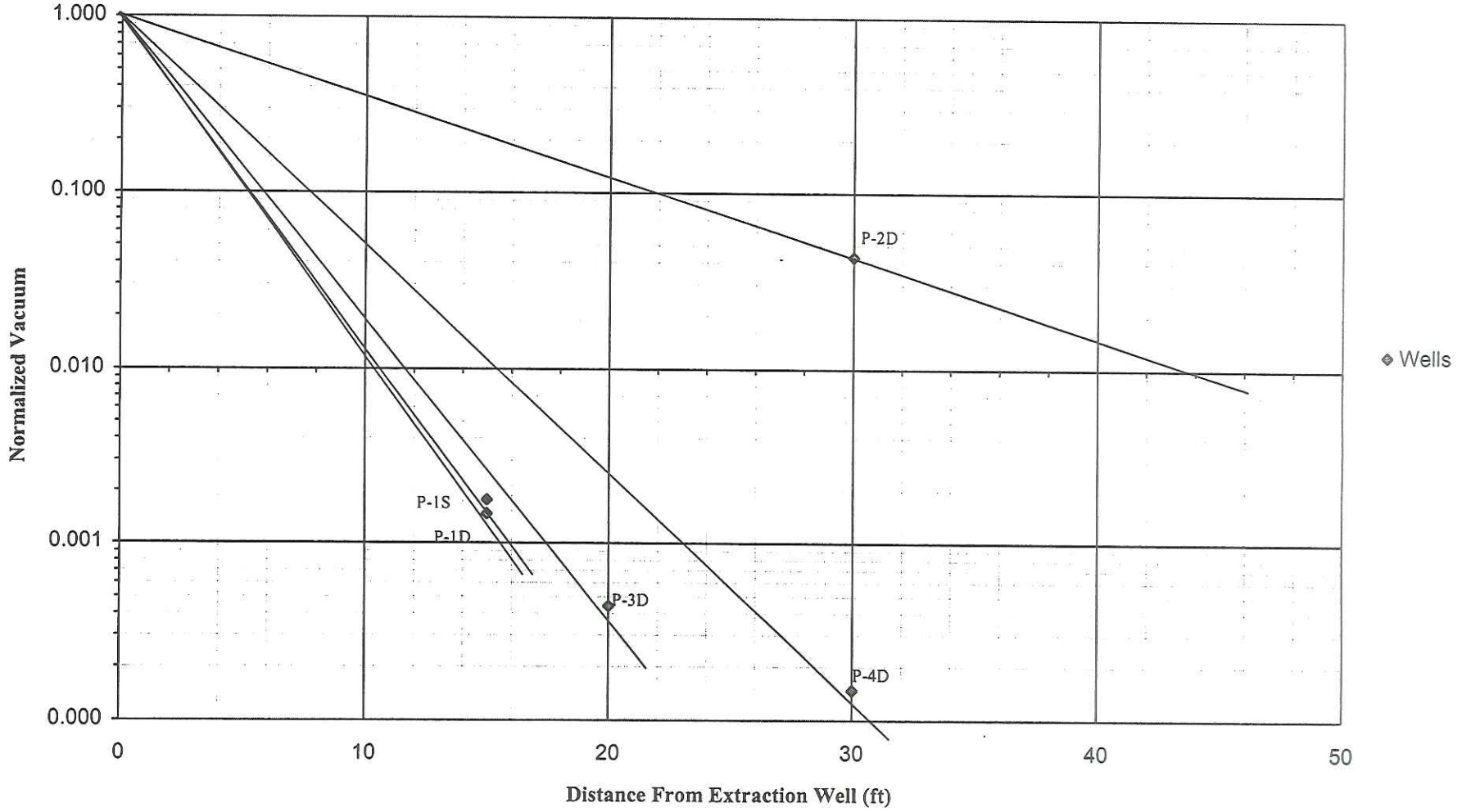
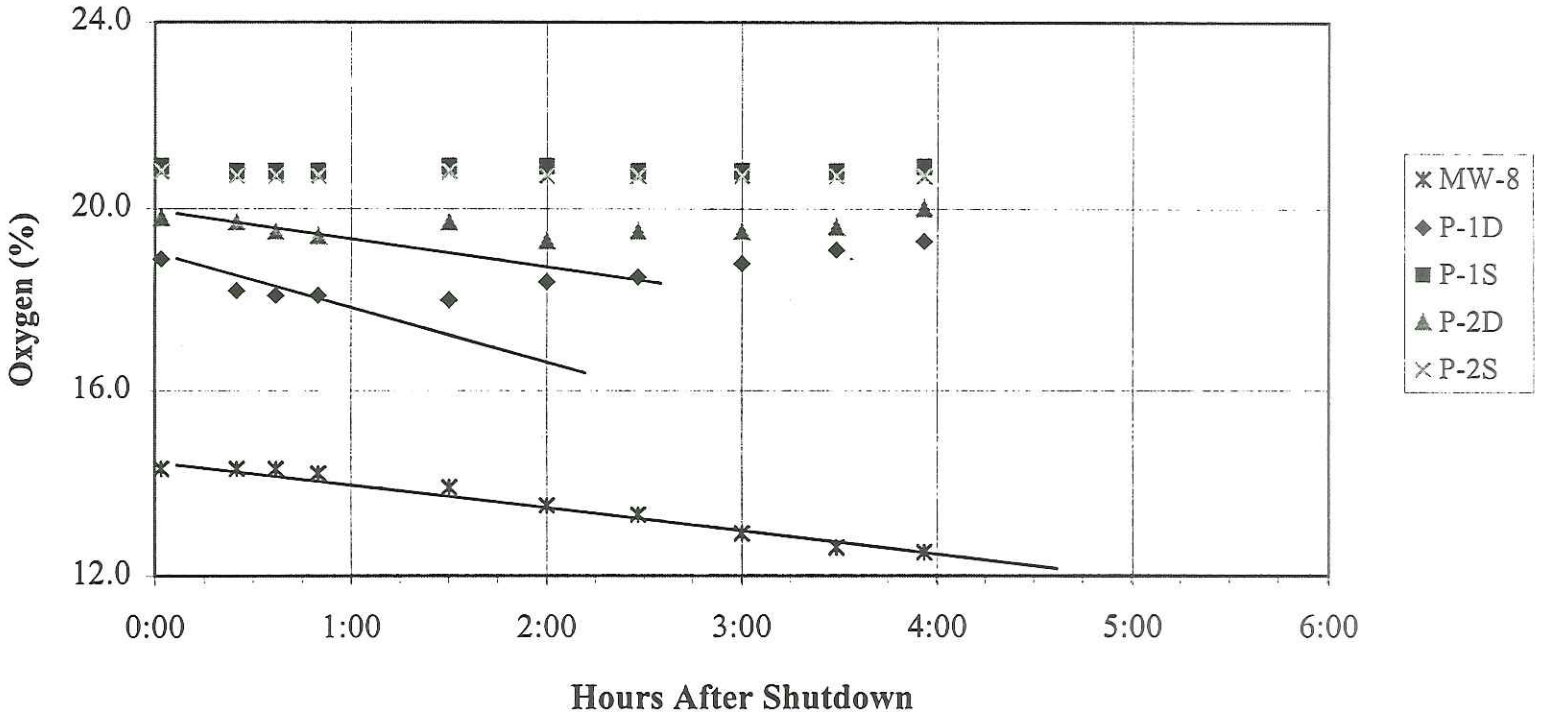
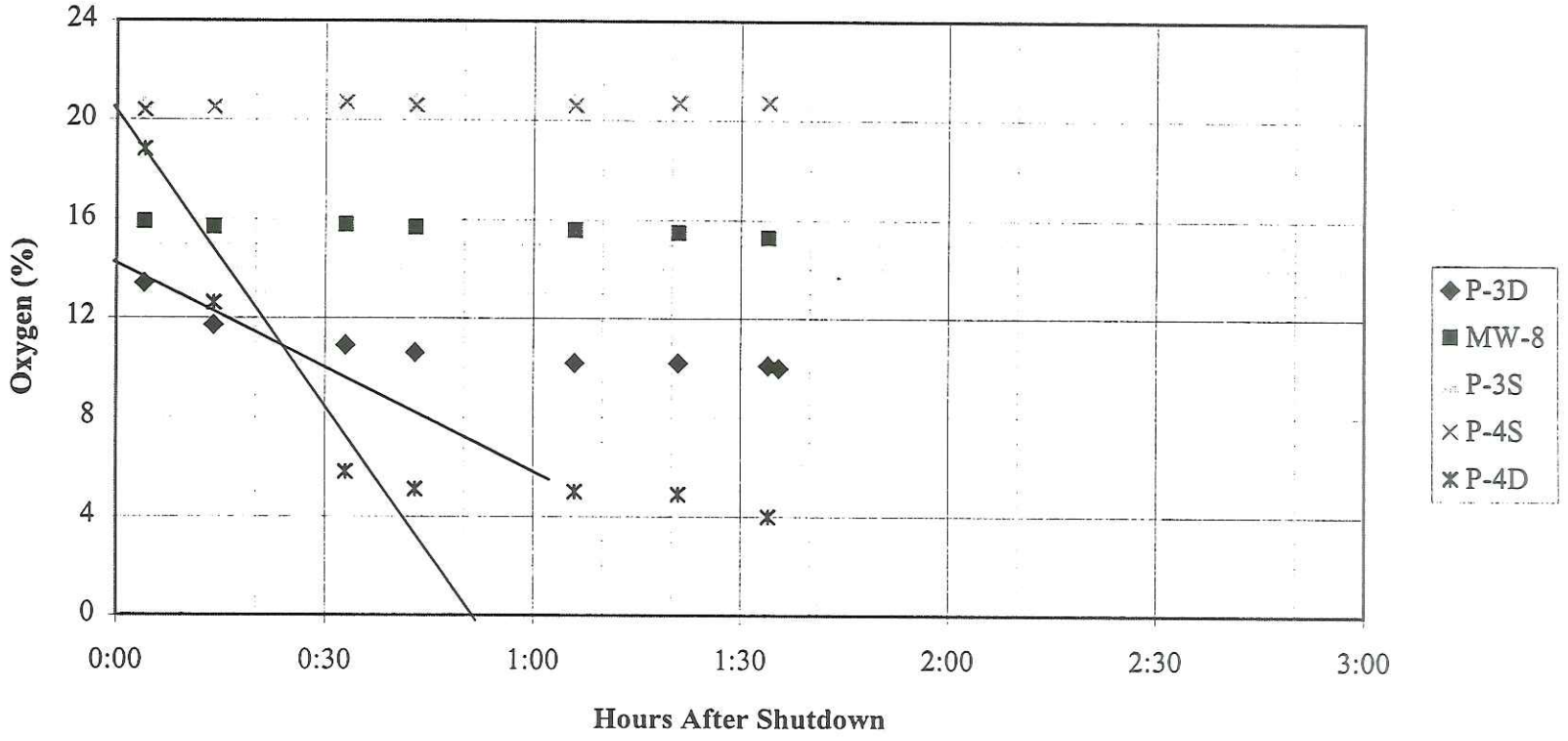


Figure 7
Oxygen Depletion Curve For Run One (MW-7)
Dual Phase Extraction and Biorespiration Pilot Test
Former Columbia Marine Lines Facility



MW-8: slope = (12.4%-14.3%)/(4hrs) = -1.9%/4hrs = -11%/day
P-1D: slope = (16.5%-18.8%)/(2hrs) = -2.3%/2hrs = -28%/day
P-2D: slope = (18.5%-19.8%)/(2hrs) = -1.3%/2hrs = -16%/day

Figure 9
Oxygen Depletion Curve for Run Three
Dual Phase Extraction and Biorespiration Pilot Test
Former Columbia Marine Lines Facility



P-3D: slope = (5.8%-14.1%)/(2hrs) = -8.3%/2hrs = -100%/day
P-4D: slope = (8.5%-20%)(0.5hrs) = -11.5%/0.5hrs = -550%/day

Table 1
Background Monitoring Data
Dual Phase Extraction and Biorespiration Pilot Test
Former Columbia Marine Lines Facility

Site I.D.	Former Columbia Marine Lines Facility (Crowley)
Date:	02/01/2000

Well	Time	Depth to Product (ft bgs)	Depth to Groundwater (ft bgs)	Product Thickness (ft)	Oxygen (%)	Vacuum (in H_2O)
P-1D	na	na	na	na	20.8	0.00
P-1S	na	na	na	na	20.2	0.00
P-2D	na	na	na	na	19.8	0.00
P-2S	na	na	na	na	20.7	0.00
MW-1	1037	--	8.86	--	20.4	0.00
MW-7	1048	--	11.45	--	--	0.00
MW-8	1049	11.54	12.40	0.86	17.7	0.00
MW-18	1040	--	9.06	--	20.8	0.00
MW-19	1042	--	12.76	--	4.4	0.00

Notes: -- = not measured
na = not applicable

Table 2
Well Monitoring Data
Dual Phase Extraction and Biorespiration Pilot Test
Former Columbia Marine Lines Facility

Site I.D.	Former Columbia Marine Lines Facility (Crowley)

Well	Date	Time	Depth to Product (ft bgs)	Depth to Groundwater (ft bgs)	Product Thickness (ft)	Oxygen (%)	Vacuum (in H_2O)
P-1D	02/01/2000	14:10	--	--	--	20.9	0.00
	02/01/2000	14:30	--	--	--	20.9	0.00
	02/01/2000	14:42	--	--	--	20.9	0.00
	02/01/2000	15:05	--	--	--	19.3	0.00
	02/01/2000	15:46	--	--	--	18.6	0.02
	02/01/2000	16:24	--	--	--	19.7	0.02
	02/02/2000	10:28	na	9.45	na	20.8	0.14
	02/08/2000	9:45	--	--	--	21.0	--
	02/09/2000	9:08	--	--	--	19.2	2.60
	02/17/2000	9:24	--	--	--	20.3	0.66
P-1S	02/01/2000	14:15	--	--	--	20.4	0.10
	02/01/2000	14:30	--	--	--	20.6	0.10
	02/01/2000	14:42	--	--	--	20.7	0.12
	02/01/2000	15:05	--	--	--	20.6	0.10
	02/01/2000	15:46	--	--	--	20.5	0.12
	02/01/2000	16:25	--	--	--	20.9	0.14
	02/02/2000	10:28	na	7.95	na	20.9	0.12
	02/08/2000	9:46	--	--	--	20.9	--
	02/09/2000	9:09	--	--	--	20.9	0.11
	02/17/2000	9:28	--	--	--	20.9	0.07
P-2D	02/01/2000	14:20	--	--	--	20.2	2.90
	02/01/2000	14:30	--	--	--	20.4	3.40
	02/01/2000	14:45	--	--	--	19.5	2.00
	02/01/2000	15:09	--	--	--	20.9	>10
	02/01/2000	15:50	--	--	--	20.4	1.00
	02/01/2000	16:26	--	--	--	20.2	6.50
	02/02/2000	10:34	na	9.54	na	20.6	2.40
	02/08/2000	9:47	--	--	--	20.8	--
	02/09/2000	9:11	--	--	--	20.1	2.60
	02/17/2000	9:28	--	--	--	20.0	2.60
P-2S	02/01/2000	14:20	--	--	--	20.9	0.00
	02/01/2000	14:34	--	--	--	20.9	0.00
	02/01/2000	14:45	--	--	--	20.6	0.00
	02/01/2000	15:09	--	--	--	20.6	0.00
	02/01/2000	15:50	--	--	--	20.9	0.00
	02/01/2000	16:27	--	--	--	20.9	0.00
	02/02/2000	10:34	na	9.54	na	20.9	0.10
	02/08/2000	9:48	--	--	--	20.9	--
	02/09/2000	9:12	--	--	--	20.8	0.00
	02/17/2000	9:29	--	--	--	20.7	0.00

Table 2
Well Monitoring Data
Dual Phase Extraction and Biorespiration Pilot Test
Former Columbia Marine Lines Facility

Site I.D.	Former Columbia Marine Lines Facility (Crowley)

Well	Date	Time	Depth to Product (ft bgs)	Depth to Groundwater (ft bgs)	Product Thickness (ft)	Oxygen (%)	Vacuum (in H_2O)
P-3S	02/17/2000	14:45	--	--	--	20.5	0.00
P-3D	02/17/2000	14:50	--	--	--	17.8	0.03
P-4S	02/17/2000	14:52	--	--	--	20.5	0.00
P-4D	02/17/2000	14:53	--	--	--	19.5	0.01
MW-1	02/01/2000	14:29	--	--	--	20.4	0.00
	02/01/2000	14:40	--	--	--	20.4	0.00
	02/01/2000	14:50	--	--	--	20.4	0.00
	02/01/2000	15:20	--	--	--	20.6	0.00
	02/01/2000	16:00	na	8.86	na	20.4	0.00
	02/02/2000	10:40	na	9.13	na	20.7	0.00
	02/08/2000	9:49	--	--	--	20.8	--
	02/09/2000	9:14	--	--	--	20.6	0.00
MW-8	02/01/2000	14:29	--	--	--	14.1	0.01
	02/01/2000	14:38	--	--	--	16.7	0.00
	02/01/2000	14:48	--	--	--	14.8	0.00
	02/01/2000	15:22	--	--	--	13.8	0.00
	02/01/2000	16:16	11.98	12.50	0.52	13.6	0.00
	02/02/2000	10:48	11.46	12.20	0.74	16.3	0.00
	02/08/2000	9:56	--	--	--	16.7	--
	02/09/2000	9:22	--	--	--	14.6	0.00
MW-18	02/01/2000	14:25	--	--	--	20.9	0.00
	02/01/2000	14:32	--	--	--	20.9	0.00
	02/01/2000	14:46	--	--	--	20.9	0.00
	02/01/2000	15:24	--	--	--	20.9	0.00
	02/01/2000	16:03	na	9.08	na	20.9	0.00
	02/02/2000	10:43	na	12.81	na	20.9	0.00
	02/08/2000	9:53	--	--	--	20.8	--
	02/09/2000	9:16	--	--	--	20.9	0.00
MW-19	02/01/2000	14:28	--	--	--	20.9	0.00
	02/01/2000	14:30	--	--	--	20.9	0.00
	02/01/2000	14:47	--	--	--	20.9	0.00
	02/01/2000	15:28	--	--	--	20.9	0.00
	02/01/2000	16:08	na	9.08	na	20.9	0.00
	02/02/2000	10:45	na	12.81	na	20.9	0.00
	02/08/2000	9:51	--	--	--	20.8	--
	02/09/2000	9:18	--	--	--	20.9	0.00

Notes: -- = not measured
na = not applicable
The depth to water was not measured during biorespiration monitoring to preserve oxygen levels in wells.

Table 3
Vacuum Versus Flow Rate Data
Dual Phase Extraction and Biorespiration Pilot Test
Former Columbia Marine Lines Facility

Site I.D.	Former Columbia Marine Lines Facility (Crowley)

Date	Time	Vacuum (in. Hg)	Discharge Velocity (ft/min)	Discharge Temperature (Deg. F)	Discharge Flow Rate (scfm)	Dilution Velocity (ft/min)	Dilution Temperature (Deg. F)	Dilution Flow Rate (scfm)	Extraction Flow Rate (scfm)
02/01/2000	14:40	4	3260	127	70	2220	54	51	19
02/01/2000	15:30	4	4100	132	90	2070	49.1	47	43
02/02/2000	12:15	4	3150	160	62.5	2150	54	40.7	21.8

Table 4
Oxygen Depletion Data For Run One (MW-7)
Dual Phase Extraction and Biorespiration Pilot Test
Former Columbia Marine Lines Facility

Time	Time After Shutdown (min)	O_2 P-1D (%)	O_2 P-1S (%)	O_2 P-2D (%)	O_2 P-2S (%)	O_2 MW-1 (%)	O_2 MW-8 (%)	O_2 MW-18 (%)	O_2 MW-19 (%)
Distance From Extraction Well (ft)		15.0	15.0	30.0	30.0	80.5	55.5	94.3	153.5
Screen Depth (ft bgs)		7.0-9.0	3.0-5.0	7.0-9.0	3.0-5.0	4.0-19.0	3.5-18.5	1.5-9.0	9.5-19.0
9:08	0	19.2	20.9	20.1	20.8	20.6	14.6	20.9	7.2
Blower Shutdown at:		9:25							
9:27	0:02	18.9	20.9	19.8	20.8	20.5	14.3	20.9	7.0
9:50	0:25	18.2	20.8	19.7	20.7	20.4	14.3	20.9	6.8
10:02	0:37	18.1	20.8	19.5	20.7	20.4	14.3	20.8	6.9
10:15	0:50	18.1	20.8	19.4	20.7	20.4	14.2	20.9	6.9
10:55	1:30	18.0	20.9	19.7	20.8	20.4	13.9	20.9	5.9
11:25	2:00	18.4	20.9	19.3	20.7	20.4	13.5	20.8	5.7
11:53	2:28	18.5	20.8	19.5	20.7	20.4	13.3	20.8	5.6
12:25	3:00	18.8	20.8	19.5	20.7	20.3	12.9	20.8	5.2
12:54	3:29	19.1	20.8	19.6	20.7	20.4	12.6	20.8	5.4
13:21	3:56	19.3	20.9	20.0	20.7	20.3	12.5	20.8	5.5
13:43	4:18	--	--	--	--	--	8.8	--	--
13:58	4:33	--	--	--	--	--	8.0	--	--
14:13	4:48	--	--	--	--	--	8.1	--	--
14:28	5:03	--	--	--	--	--	8.1	--	--
14:43	5:18	--	--	--	--	--	8.3	--	--
14:58	5:33	--	--	--	--	--	8.3	--	--
15:13	5:48	--	--	--	--	--	8.4	--	--
15:28	6:03	--	--	--	--	--	8.5	--	--
15:43	6:18	--	--	--	--	--	8.5	--	--
15:58	6:33	--	--	--	--	--	8.5	--	--
16:13	6:48	--	--	--	--	--	8.5	--	--
16:28	7:03	--	--	--	--	--	8.4	--	--
16:43	7:18	--	--	--	--	--	8.6	--	--
16:58	7:33	--	--	--	--	--	8.5	--	--
17:13	7:48	--	--	--	--	--	8.5	--	--
17:28	8:03	--	--	--	--	--	10.1	--	--
17:43	8:18	--	--	--	--	--	11.7	--	--

Notes -- = not measured, only MW-8 was monitored with the data logger.

Table 5
Oxygen Depletion Data For Run Two (MW-7)
Dual Phase Extraction and Biorespiration Pilot Test
Former Columbia Marine Lines Facility

Time	Time After Shutdown (min)	O_2 MW-8 (%)	O_2 P-1D (%)	O_2 P-1S (%)	O_2 P-2D (%)	O_2 P-2S (%)
Distance From Extraction Well (ft)		55.5	15.0	15.0	30.0	30.0
Screen Depth (ft bgs)		3.5-18.5	7.0-9.0	3.0-5.0	7.0-9.0	3.0-7.0
11:12	0	17.6	20.3	20.9	20.0	20.9
Blower Shut Off at 11:18						
11:25	0:07	17.2	--	--	--	--
11:35	0:17	15.8	--	--	--	--
11:45	0:27	14.2	--	--	--	--
11:55	0:37	13.4	--	--	--	--
12:05	0:47	12.8	--	--	--	--
12:15	0:57	12.3	--	--	--	--
12:25	1:07	12	--	--	--	--
12:35	1:17	11.7	--	--	--	--
12:45	1:27	11.3	--	--	--	--
12:55	1:37	11.4	--	--	--	--
13:05	1:47	11.4	--	--	--	--
13:15	1:57	11.4	--	--	--	--
13:25	2:07	11.3	--	--	--	--
13:35	2:17	11.2	--	--	--	--
13:45	2:27	11.3	--	--	--	--
13:55	2:37	11.3	--	--	--	--
14:05	2:47	11.1	--	--	--	--
14:15	2:57	11.2	--	--	--	--
14:25	3:07	11.1	--	--	--	--
14:35	3:17	11	--	--	--	--
14:45	3:27	11.1	--	--	--	--
14:55	3:37	11.3	--	--	--	--
15:05	3:47	11.2	--	--	--	--
15:15	3:57	11.2	--	--	--	--
15:22	4:04	11.2	--	--	--	--

Notes -- = not measured, only MW-8 was monitored with the data logger.

Table 6
Oxygen Depletion Data For Run Three (EX-2)
Dual Phase Extraction and Biorespiration Pilot Test Data
Former Columbia Marine Lines Facility

Time	Time After Shutdown (min)	O_2 P-3S (%)	O_2 P-3D (%)	O_2 P-4S (%)	O_2 P-4D (%)	O_2 MW-1 (%)	O_2 MW-7 (%)	O_2 MW-8 (%)	O_2 MW-18 (%)	O_2 MW-19 (%)
Distance From Extraction Well (ft)		20.0	20.0	30.0	30.0	89.0	18.5	67.3	81.3	135.0
Screen Depth (ft bgs)		3.0-5.0	7.0-9.0	3.0-5.0	7.0-9.0	4.0-19.0	3.0-18.0	3.5-18.5	1.5-9.0	9.5-19.0
14:50	0	20.5	17.8	20.5	19.5	20.8	17.4	16.0	20.9	8.0
Blower Shut Down at:		15:05								
15:09	0:04	20.7	13.4	20.4	18.8	20.5	20.8	15.9	20.9	6.4
15:19	0:14	20.9	11.7	20.5	12.6	20.5	20.8	15.7	20.9	6.5
15:38	0:33	20.9	10.9	20.7	5.8	20.5	20.7	15.8	20.8	7.8
15:48	0:43	20.8	10.6	20.6	5.1	20.5	20.7	15.7	20.9	7.8
16:11	1:06	20.8	10.2	20.6	5.0	20.4	20.8	15.6	20.9	7.6
16:26	1:21	20.8	10.2	20.7	4.9	20.4	20.8	15.5	20.8	7.2
16:39	1:34	20.8	10.1	20.7	4.0	20.4	20.8	15.3	20.9	7.0
16:40	1:35	--	10.0	--	--	--	--	--	--	--
16:50	1:45	--	8.3	--	--	--	--	--	--	--
17:00	1:55	--	8.0	--	--	--	--	--	--	--
17:10	2:05	--	7.9	--	--	--	--	--	--	--
17:20	2:15	--	7.8	--	--	--	--	--	--	--
17:30	2:25	--	7.7	--	--	--	--	--	--	--
17:40	2:35	--	7.6	--	--	--	--	--	--	--
17:50	2:45	--	7.4	--	--	--	--	--	--	--
18:00	2:55	--	7.3	--	--	--	--	--	--	--
18:10	3:05	--	7.2	--	--	--	--	--	--	--
18:20	3:15	--	7.1	--	--	--	--	--	--	--
18:30	3:25	--	7.1	--	--	--	--	--	--	--
18:40	3:35	--	7.0	--	--	--	--	--	--	--
18:50	3:45	--	6.9	--	--	--	--	--	--	--
19:00	3:55	--	6.8	--	--	--	--	--	--	--
19:10	4:05	--	6.8	--	--	--	--	--	--	--
19:20	4:15	--	6.7	--	--	--	--	--	--	--
19:30	4:25	--	6.6	--	--	--	--	--	--	--
19:40	4:35	--	6.5	--	--	--	--	--	--	--
19:50	4:45	--	6.4	--	--	--	--	--	--	--
20:00	4:55	--	6.3	--	--	--	--	--	--	--
20:10	5:05	--	6.2	--	--	--	--	--	--	--
20:20	5:15	--	6.1	--	--	--	--	--	--	--
20:30	5:25	--	6.0	--	--	--	--	--	--	--
20:40	5:35	--	6.0	--	--	--	--	--	--	--
20:50	5:45	--	6.1	--	--	--	--	--	--	--
21:00	5:55	--	6.4	--	--	--	--	--	--	--
21:10	6:05	--	6.6	--	--	--	--	--	--	--
21:20	6:15	--	6.7	--	--	--	--	--	--	--
21:30	6:25	--	6.8	--	--	--	--	--	--	--

Table 6
Oxygen Depletion Data For Run Three (EX-2)
Dual Phase Extraction and Biorespiration Pilot Test Data
Former Columbia Marine Lines Facility

Time	Time After Shutdown (min)	O_2 P-3S (%)	O_2 P-3D (%)	O_2 P-4S (%)	O_2 P-4D (%)	O_2 MW-1 (%)	O_2 MW-7 (%)	O_2 MW-8 (%)	O_2 MW-18 (%)	O_2 MW-19 (%)
Distance From Extraction Well (ft)		20.0	20.0	30.0	30.0	89.0	18.5	67.3	81.3	135.0
Screen Depth (ft bgs)		3.0-5.0	7.0-9.0	3.0-5.0	7.0-9.0	4.0-19.0	3.0-18.0	3.5-18.5	1.5-9.0	9.5-19.0
21:40	6:35	--	7.0	--	--	--	--	--	--	--
21:50	6:45	--	7.1	--	--	--	--	--	--	--
22:00	6:55	--	7.2	--	--	--	--	--	--	--
22:10	7:05	--	7.3	--	--	--	--	--	--	--
22:20	7:15	--	7.4	--	--	--	--	--	--	--
22:30	7:25	--	7.6	--	--	--	--	--	--	--
22:40	7:35	--	7.6	--	--	--	--	--	--	--
22:50	7:45	--	7.7	--	--	--	--	--	--	--
23:00	7:55	--	7.8	--	--	--	--	--	--	--
23:10	8:05	--	7.9	--	--	--	--	--	--	--
23:20	8:15	--	8.0	--	--	--	--	--	--	--

Table 7
Observed Biorespiration Rates
Dual Phase Extraction and Biorespiration Pilot Test
Former Columbia Marine Lines Facility

Site I.D.	Former Columbia Marine Lines Facility (Crowley)

Well	Oxygen Depletion Rate ($\%O_2$/day)	Hydrocarbon Biodegradation Rate (mg/kg/day)
Run One		
P-1D	-28	-8
P-2D	-16	-5
MW-8	-11	-3
Run Two		
MW-8	-200	-58
Run Three		
P-3D	-100	-29
P-4D	-550	-160

Table 8
Groundwater Production Data
Dual Phase Extraction and Biorespiration Pilot Test
Former Columbia Marine Lines Facility

Site I.D.	Former Columbia Marine Lines Facility (Crowley)
Date:	2/1/200 through 2/23/2000

Date	Time of Reading	Time Between Readings (hr)	Depth of Stinger (ft below TOC)	Flowmeter (gallons)	Flow (gallons)	Total Flow (gallons)	Flowrate (gpd)
Vacuum At MW-7							
02/01/2000	--	--	8	10558	0	0	0.0
02/02/2000	12:25	1.00	7	10562	4	4	4.0
02/04/2000	12:00	1.99	7	10726	168	168	84.4
02/08/2000	10:00	3.92	7	10736	10	178	2.6
02/09/2000	9:00	0.96	7	10788	52	230	54.3
02/14/2000	16:00	5.29	7	10967	179	409	33.8
02/15/2000	13:00	0.88	17	11399	432	841	493.7
02/17/2000	9:00	1.83	17	12494	1095	1936	597.3
Vacuum At EX-2							
02/17/2000	9:00	--	10.5	12494	0	0	0.0
02/18/2000	15:00	1.25	16.75	12768	274	274	219.2
02/18/2000	17:15	0.09	16.75	12846	78	352	832.0
02/22/2000	13:00	3.91	16.75	13316	470	822	120.3
02/22/2000	13:30	0.02	13	13335	19	841	912.0
02/22/2000	14:00	0.02	16.75	13351	16	857	768.0
02/23/2000	7:30	0.27	16.75	13734	383	1240	1414.2

Notes:

1. Blower motor automatically shut itself down between at an unknown time between 2/4/00 and 2/8/00 and it was restarted 2/8/00.
2. Blower motor automatically shut itself down between at an unknown time between 2/9/00 and 2/14/00 and it was restarted 2/14/00.
3. Blower motor automatically shut itself down between at an unknown time between 2/18/00 and 2/22/00 and it was restarted 2/22/00.

APPENDIX A
BORING LOGS AND
WELL CONSTRUCTION DIAGRAMS

Dual Phase Extraction and Bioventing Pilot Test Report
Former Crowley Marine Lines Facility
6305 Lower River Road
Vancouver, Washington
SECOR PN: 015.08480.006
May 19, 2000

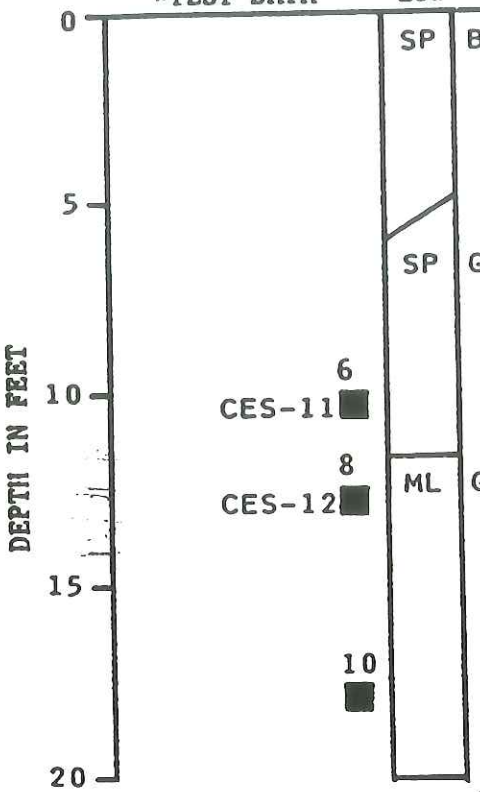
BORING NO. 7

TOP OF CASING ELEVATION: 33.00 FEET

19.74 (10)

1.75

31.25



BROWN FINE TO MEDIUM SAND (LOOSE, MOIST) (FILL)

GRAY FINE TO MEDIUM SAND (LOOSE, MOIST) (FILL)

GRAY SILT WITH SOME WOOD AND A TRACE OF FINE SAND (MEDIUM STIFF, MOIST)

BORING COMPLETED AT 20 FEET ON 11/2/83

2-INCH PVC PIEZOMETER INSTALLED TO A DEPTH OF 18 FEET. SLOTTED INTERVAL EXTENDS FROM 3 TO 18 FEET.

STATIC WATER LEVEL MEASURED AT ELE. 20.79 FEET ON 11/7/83, AND AT ELE. 20.79 FEET ON 11/8/83

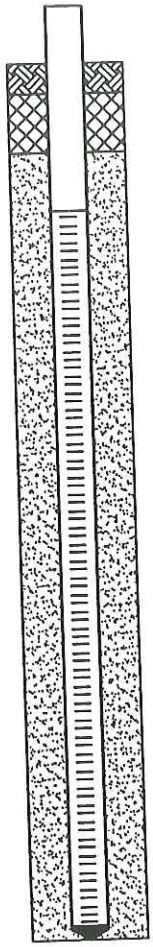
*SEE KEY FOR EXPLANATION OF SYMBOLS

SECOR
International Incorporated

FACILITY **CROWLEY** JOB # **00255-003-01** BORING/WELL **EX-2**
LOCATION **VANCOUVER, WASHINGTON** SURFACE ELEVATION **31.50**
START **2/3/96 1010** FINISH **2/3/96 1130** CASING TOP ELEVATION **33.53**
LOGGED BY **J. GIEBER** MONITORING DEVICE **PID MP-1000**
SUBCONTRACTOR AND EQUIPMENT **CASCADE DRILLING, INC.; CME 75, 10 1/4" O.D. HSA**
COMMENTS **SAMPLED USING A 2" I.D. X 1.5' LONG SPLIT SPOON SAMPLER LINED WITH BRASS SLEEVES USING A 140 POUND HAMMER WITH A 30" STROKE**

Penetration Results Blows 6"/6"/6"	Sample Depth Interval, feet	PID Reading	Sheen	Depth Below Surface, feet	Lithologic Description	Unified Soil Classification	Depth Below Surface, feet
				5			5
				0	Sand, brown, fine to medium, some silt, loose, moist	SP	0
5/6/12		2	NS	5			5
					Dark gray, strong hydrocarbon odor, wet		
					▽		
4/4/4		398	SD	10	Wood debris		10
					Silt, dark gray, soft to medium stiff, minor clay, moist	ML	
				15			15
				20			20
					Olive brown		
				25			25
				30	Boring terminated at 30 feet, sampler advanced to 11.5 feet. Groundwater encountered at approximately 9 feet during drilling. Boring converted to a groundwater monitoring well on 2/3/96.		30
				35			35

Well Construction Schematic



Field Screen/Lithologic Description Sample
Preserved Sample
No Recovery
* Sample Submitted for Laboratory Analysis

▽ Groundwater Level at Time of Drilling
▼ Static Groundwater Level
SD Sheen Detected
NS No Sheen Detected
NT Not Tested
(2.5Y 4/2) Munsell (1990) Soil Color Charts

Gradational Contact
Contact Located Approximately
Contact

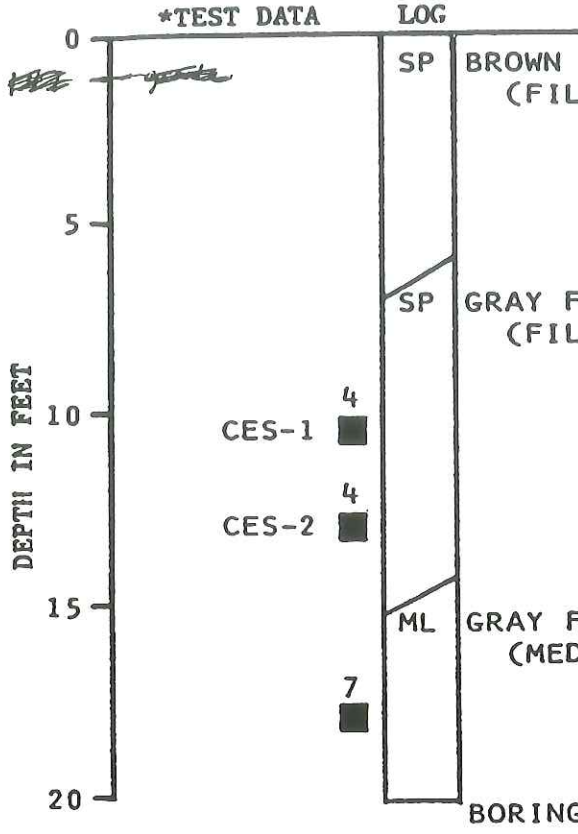
Native Soil
Bentonite
2/12 Lonestar Silica Sand

4" PVC Blank Casing
4" PVC Screen Casing (0.010 slots)
End Cap

DWG: CRO0308L

BORING NO. 1

TOP OF CASING ELEVATION: 33.07 FEET



DESCRIPTION

BROWN FINE TO MEDIUM SAND (LOOSE, MOIST) (FILL)

GRAY FINE TO MEDIUM SAND (LOOSE, MOIST) (FILL)

GRAY FINE SANDY SILT WITH A TRACE OF WOOD (MEDIUM STIFF, MOIST)

BORING COMPLETED AT 20 FEET ON 11/1/83

2-INCH PVC PIEZOMETER INSTALLED TO A DEPTH OF 19 FEET. SLOTTED INTERVAL EXTENDS FROM 4 TO 19 FEET.

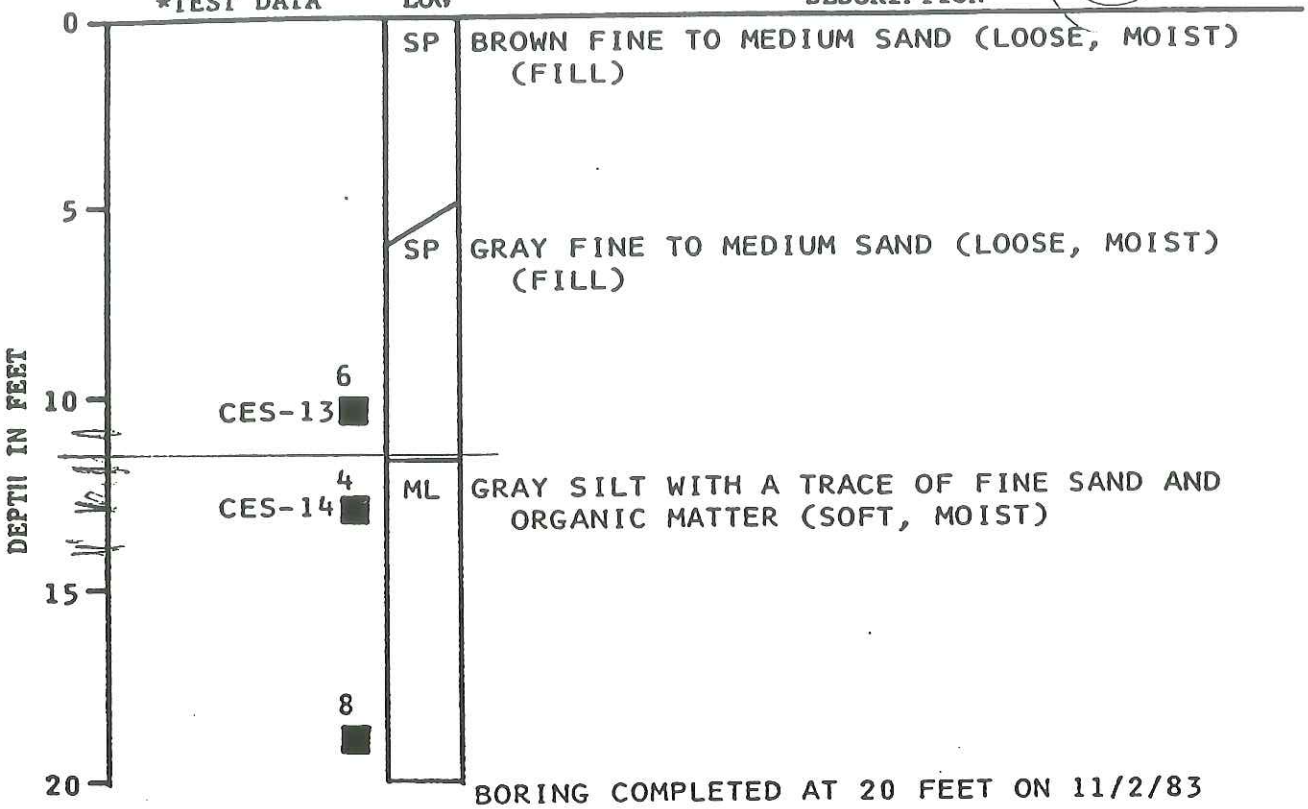
STATIC WATER LEVEL MEASURED AT ELE. 22.11 FEET ON 11/7/83, AND ELE. 22.20 FEET ON 11/8/83

*SEE KEY FOR EXPLANATION OF SYMBOLS

GeoEngineers Inc.	LOG OF EXPLORATION

BORING NO. 8

TOP OF CASING ELEVATION: 33.13 FEET



BORING COMPLETED AT 20 FEET ON 11/2/83

2-INCH PVC PIEZOMETER INSTALLED TO A DEPTH OF 18.5 FEET. SLOTTED INTERVAL EXTENDS FROM 3.5 TO 18.5 FEET.

STATIC WATER LEVEL MEASURED AT ELE. 19.37 FEET ON 11/7/83, AND AT ELE. 19.61 FEET ON 11/8/83.

*SEE KEY FOR EXPLANATION OF SYMBOLS

MONITOR WELL NO. 19

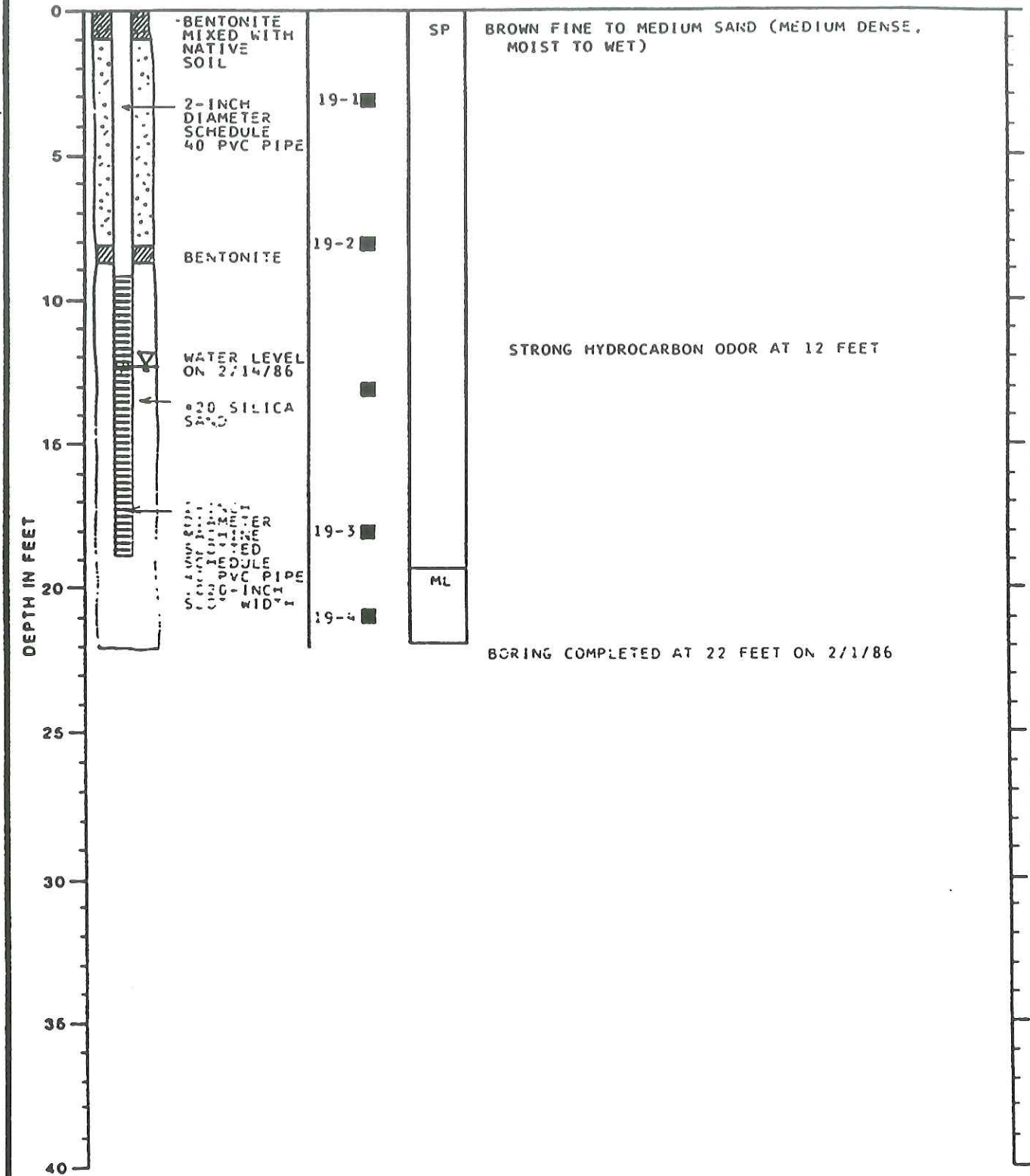
13.6

WELL SCHEMATIC
Casing Elevation: 34.16
Casing Stickup: 1.1

Sample Number

Group Symbol

DESCRIPTION
Surface Elevation: 33.1



Note: See Figure A-2 for Explanation of Symbols

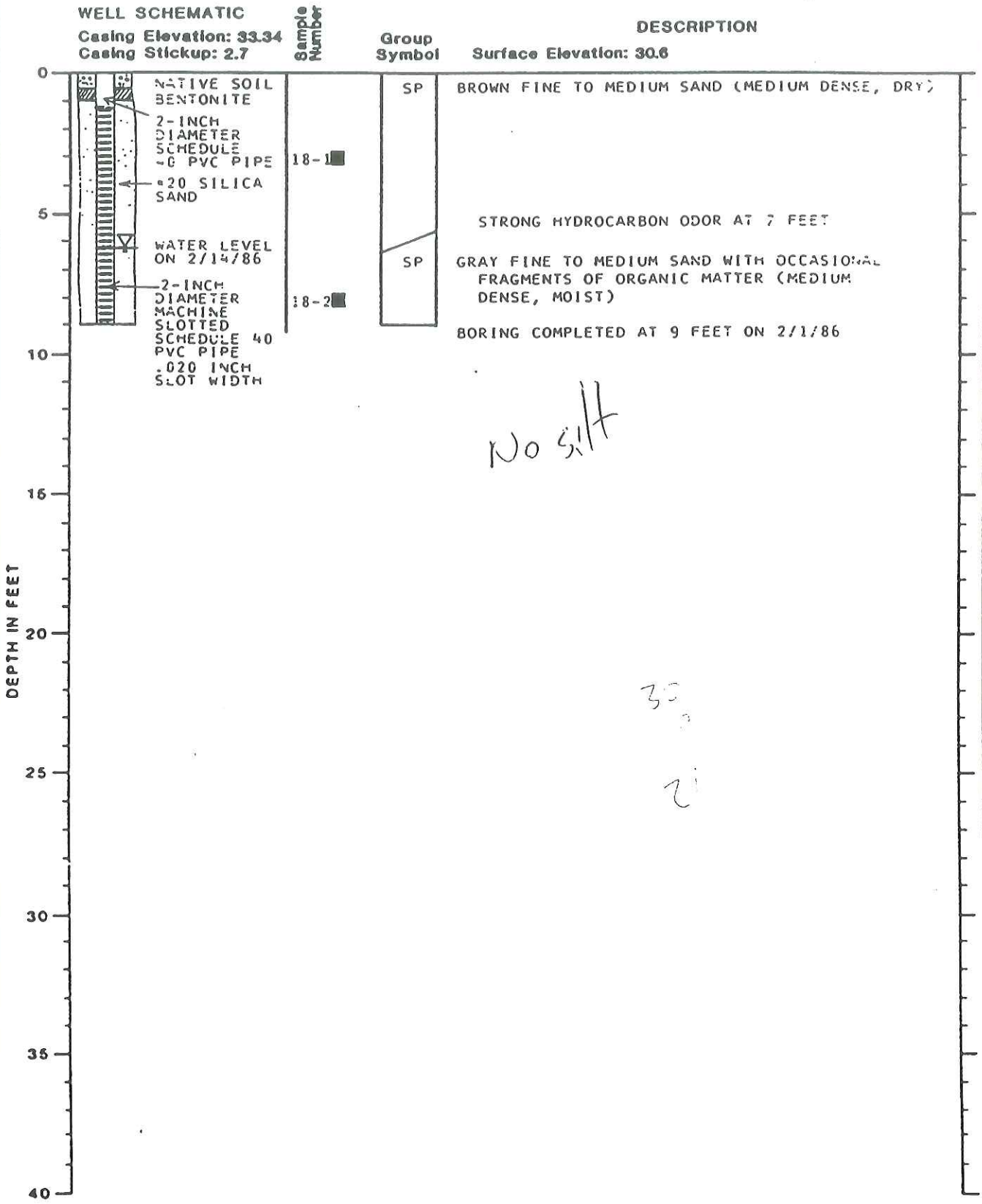
GeoEngineers Incorporated

LOG OF MONITOR WELL

FIGURE A-7

MONITOR WELL NO. 18

Abandoned ?



No silt

Note: See Figure A-2 for Explanation of Symbols

GeoEngineers Incorporated

LOG OF MONITOR WELL

FIGURE A-6

APPENDIX B
BLOWER SPECIFICATIONS AND PERFORMANCE CURVES

Dual Phase Extraction and Bioventing Pilot Test Report
Former Crowley Marine Lines Facility
6305 Lower River Road
Vancouver, Washington
SECOR PN: 015.08480.006
May 19, 2000

VACUUM PERFORMANCE DATA

For Air at Standard Conditions: Sea Level 14.7 PSIA, 68° F Inlet Temperature, 36% Relative Humidity.
For performance with gases other than air, or at non-standard conditions, contact your authorized Sutorbilt distributor.

LOW VACUUM UNITS

SIZE	DIA. INLET & OUTLET	DISPL. CU. FT. REV.	RPM	2" HG		4" HG		8" HG		10" HG		12" HG		14" HG	
				CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP
2LP 2LVP	2"-S	0.035	2800	82	0.7	74	1.1	61	2.0	55	2.5				
			3250	98	0.7	90	1.3	77	2.3	71	2.8	64	3.4		
			3560	108	0.8	101	1.4	88	2.5	82	3.1	75	3.7		
			4165	130	0.9	122	1.6	109	2.9	103	3.6	96	4.3		
			5275	168	1.1	161	1.9	148	3.6	142	4.5	135	5.2	128	6.0
3LP 3LVP	2½"-S	0.104	1760	158	1.1	147	1.9	128	3.6	118	4.5	108	5.1		
			2265	211	1.3	199	2.4	180	4.6	170	5.5	160	6.6		
			2770	263	1.5	252	2.9	233	5.4	223	6.7	213	8.0		
			3600	350	1.9	338	3.7	319	7.0	309	8.7	299	10.5	288	12.2
4LP 4LVP	3"-S	0.170	1760	266	1.6	250	3.0	224	5.6	211	7.0	197	8.4		
			2190	339	1.9	323	3.7	297	6.9	284	8.7	270	10.4		
			2620	412	2.3	396	4.3	370	8.3	357	10.4	343	12.4	328	14.5
			3600	579	3.0	563	5.7	537	11.4	524	14.2	510	17.1	495	19.9
5LP 5LVP	4"-S	.0350	1500	480	2.6	459	5.1	423	9.8	406	12.2	387	14.7		
			1760	571	3.1	550	5.7	514	11.5	497	14.3	478	17.2	458	20.1
			2100	690	3.6	669	6.8	633	13.7	616	17.1	597	20.5	577	24.0
			2850	953	4.8	931	9.3	896	18.6	878	23.2	860	27.9	840	32.5
6LP 6LVP	6"-F	0.718	1170	766	4.1	732	7.8	673	15.6	645	19.6	614	23.5		
			1760	1190	5.9	1155	11.8	1097	23.5	1068	29.4	1038	35.3	1005	41.2
			1930	1312	6.5	1277	12.9	1219	25.8	1190	32.3	1160	38.7	1127	45.2
			2350	1614	7.9	1579	15.7	1521	31.4	1492	39.3	1461	47.1	1428	55.0
7LP 7LVP	8"-F	1.200	1170	1311	6.5	1268	13.1	1195	26.2	1159	32.7	1121	39.2		
			1465	1665	8.2	1622	16.4	1549	32.7	1513	40.9	1475	49.1		
			1760	2019	9.8	1976	19.7	1903	39.3	1867	49.2	1829	59.0		
			2050	2367	11.5	2324	22.9	2251	45.8	2215	57.3	2177	68.7		
8LP 8LVP	10"-F	1.740	880	1411	7.1	1355	14.3	1261	28.5	1214	35.7	1164	42.8		
			1170	1916	9.5	1860	19.0	1765	37.9	1718	47.4	1669	56.9		
			1375	2273	11.1	2217	22.3	2122	44.6	2075	55.7	2026	66.8		
			1800	3012	14.6	2956	29.2	2861	58.3	2815	72.9	2765	87.5		

MEDIUM VACUUM UNITS

SIZE	DIA. INLET & OUTLET	DISPL. CU. FT. REV.	RPM	6" HG		10" HG		12" HG		14" HG		15" HG		16" HG	
				CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP
2MP 2MVP	1"-S	0.017	2800	31	0.8	24	1.2								
			3250	39	0.9	32	1.4								
			3560	44	0.9	37	1.5	34	1.8						
			4165	54	1.1	48	1.7	44	2.1	40	2.4				
			5275	73	1.4	67	2.2	63	2.6	59	3.0	57	3.2		
3MP 3MVP	2"-S	0.060	1760	76	1.6	63	2.6	57	3.1						
			2265	106	2.0	93	3.3	87	3.9						
			2770	136	2.4	124	4.0	117	4.7	110	5.4				
			3600	186	3.1	174	5.0	167	6.0	160	7.0	156	7.5		
4MP 4MVP	2½"-S	0.117	1760	161	3.0	142	4.9	132	5.8						
			2190	211	3.7	193	6.0	183	7.2						
			2620	262	4.4	243	7.1	233	8.6	222	10.0				
			3600	376	5.9	357	9.8	348	11.8	337	13.7	331	14.7	325	15.7
5MP 5MVP	4"-S	0.210	1500	258	4.5	235	7.3	223	8.8	209	10.3				
			1760	313	5.2	290	8.6	277	10.3	264	12.0				
			2100	384	6.2	361	10.3	349	12.3	335	14.4	328	15.4		
			2850	542	8.4	518	13.9	506	16.7	492	19.5	485	20.9	477	22.3
6MP 6MVP	5"-S	0.383	1170	363	6.3	328	10.4	310	12.5	289	14.6	278	15.6	266	16.7
			1760	589	9.4	554	15.7	536	18.8	515	22.0	504	23.5	492	25.1
			1930	654	10.3	619	17.2	601	20.7	580	24.1	569	25.8	558	27.5
			2350	815	12.6	780	21.0	762	25.1	741	29.3	730	31.4	718	33.5
7MP 7MVP	6"-F	0.733	1170	738	12.0	688	20.0	662	24.0	633	28.0	617	30.0	601	31.9
			1465	954	15.0	904	25.0	878	30.0	849	35.0	834	37.5	817	40.0
			1760	1170	18.0	1120	30.0	1094	36.0	1065	42.1	1050	45.1	1033	48.1
			2050	1383	21.0	1333	35.0	1307	42.0	1278	49.0	1262	52.5	1246	56.0
8MP 8MVP	8"-F	1.040	880	765	12.8	703	21.3	670	25.6	634	29.8	614	32.0	593	34.1
			1170	1067	17.0	1004	28.3	971	34.0	936	39.7	916	42.5	895	45.3
			1375	1280	20.0	1218	33.3	1185	40.0	1149	46.6	1129	49.9	1108	53.3
			1800	1722	26.2	1660	43.6	1627	52.3	1591	61.0	1571	65.4	1550	69.7

HIGH VACUUM UNITS

SIZE	DIA. INLET & OUTLET	DISPL. CU. FT. REV.	RPM	6" HG		8" HG		12" HG		14" HG		15" HG		16" HG	
				CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP
3HP 3HVP	1¼"-S	0.045	1760	55	1.3	50	1.7	40	2.4						
			2265	78	1.6	73	2.1	62	3.0						
			2770	100	1.9	95	2.5	85	3.7	79	4.3	76	4.6		
			3600	138	2.5	133	3.2	122	4.7	117	5.3	113	5.7	110	6.0
4HP 4HVP	1½"-S	0.069	1760	91	1.9	85	2.5	72	3.6						
			2190	121	2.3	115	3.0	102	4.4	95	5.1	91	5.3		
			2620	151	2.7	144	3.6	132	5.1	124	5.9	120	6.3		
			3600	218	3.7	212	4.8	199	6.9	192	8.1	188	8.7	184	9.3
5HP 5HVP	2½"-S	0.140	1500	170	3.1	161	4.1	144	5.9	134	6.8				
			1760	206	3.6	198	4.8	180	6.9	171	8.0	165	8.6		
			2100	254	4.3	245	5.5	228	8.2	218	9.6	213	10.3		
			2850	359	5.6	350	7.4	333	11.1	323	13.0	318	13.9	312	14.9
6HP 6HVP	3"-S	0.227	1170	209	3.9	197	5.1	173	7.4	159	8.7	152	9.3		
			1760	343	5.6	331	7.4	307	11.2	293	13.0	286	14.0	278	14.9
			1930	381	6.1	370	8.2	345	12.2	332	14.3	324	15.3	316	16.3
			2350	477	7.5	465	9.9	441	14.9	427	17.4	420	18.6	412	19.9
7HP 7HVP	4"-S	0.1367	1170	359	6.0	344	8.0	314	12.0	297	14.0	288	15.0	278	16.0
			1465	467	7.5	452	10.0	422	15.0	405	17.5	396	18.8	386	20.0
			1760	575	9.0	561	12.0	530	18.0	514	21.1	504	22.6	495	24.1
			2050	682	10.5	667	14.0	637	21.0	620	24.5	611	26.3	601	28.0
8HP 8HVP	4"-S	0.566	880	400	7.0	380	9.3	338	13.9	314	16.2	302	17.4		
			1170	564	9.3	544	12.3	502	18.5	479	21.6	466	23.1	452	24.7
			1375	680	10.9	660	14.5	618	21.7	595	25.4	582	27.2	568	29.0
			1800	921	14.2	901	19.0	859	28.5	835	33.2	822	35.6	809	38.0

S=SCREWED CONNECTIONS STD. PIPE F=FLANGE CONNECTIONS STD. PIPE
INTAKE AND OUTLET PIPE CONNECTIONS SAME TYPE AND SIZE.

APPENDIX C
NOTIFICATION LETTERS

Dual Phase Extraction and Bioventing Pilot Test Report
Former Crowley Marine Lines Facility
6305 Lower River Road
Vancouver, Washington
SECOR PN: 015.08480.006
May 19, 2000

SECOR
International Incorporated

SRH

COPY

January 13, 2000

Mr. Paul Mairose
Southwest Washington Air Pollution Control Authority
1308 NE 134th Street
Vancouver, WA 98685

RE: Bioventing Pilot Test
Crowley Marine
Vancouver, Washington
SECOR Project Number: 015.08480.500

Dear Mr. Mairose:

Per our conversation on December 14, 1999, SECOR is preparing to conduct a bioventing pilot scale test at the Crowley Marine facility in Vancouver, Washington. Site groundwater is impacted by oil range petroleum constituents, and the pilot test is designed to evaluate the efficiency of the two technologies. The pilot test is scheduled to begin on January 24, 2000, and is expected to run for approximately one month. Results from the pilot test will be used to design a full-scale remediation system.

The pilot test will evaluate the effectiveness of bioventing for remediation of subsurface soils impacted with oil. A blower will be used to remove groundwater and soil vapors from the subsurface, inducing flow of air into the well from the surrounding soil, providing oxygen to the soil around the well and augmenting biodegradation of oily petroleum hydrocarbon contaminants. The vapor extraction flow rate is expected to be approximately 80 standard cubic feet per minute (scfm), although this may vary with actual field conditions.

Because the soil contamination is oil-related, no significant volatile organic compounds (VOCs) are expected to be in the extracted vapors, and, as we discussed, the vapor discharged will not be treated. To verify that no VOCs are discharged, and evaluate vapor composition for full-scale system design SECOR will collect one or more samples of the vapor discharge during the pilot test. Samples will be collected in a Tedlar bag and analyzed for total petroleum hydrocarbons (TPH), and at least one sample will be analyzed for VOCs.

Please contact us at (503) 691-2030 if you have any questions about this pilot test.

Sincerely,
SECOR International Incorporated

Steven R. Hammer/kd

Steven R. Hammer, P.E.
Associate Engineer

SRH/ald

7730 S.W. Mohawk Street, P.O. Box 1508, Tualatin, OR 97062-1508 (503) 691-2030 (503) 692-7074 Fax www.secor.com

SECOR
International Incorporated

COPY
SRH

January 6, 2000

Mary Shaleen Hansen
UIC Program Coordinator
Water Quality Program
Washington Department of Ecology
P.O. Box 47600
Olympia, Washington 98504-7600

RE: Injection Well Registration
Former Columbia Marine Lines Site
6305 Lower River Road, Vancouver, Washington
SECOR PN: 015.08484.500

Dear Ms. Shaleen Hansen:

Attached is a Registration Form for the injection well that we spoke about this week. Please direct any coorespondence regarding the Registration Form to me at SECOR International Incorporated.

If you have any questions, please feel free to contact me at (503) 691-2030.

Sincerely,
SECOR International Incorporated

Steven R. Hammer, P.E.
Associate Engineer

SRH:ald

Attachments

WASHINGTON STATE DEPARTMENT OF ECOLOGY

For Department of Ecology Use

UIC Site ID _____ Date Entered _____ Acknowledged _____ WRIA _____

Please complete to the best of your knowledge and return to: UIC Coordinator, Water Quality Program, Department of Ecology, PO Box 47600, Olympia, WA 98504-7600; Fax (360) 407-6426. Attachments to provide additional information are welcomed. Thank you.

REGISTRATION FORM

AQUIFER REMEDIATION WELL (CLASS 5X26)*

1. Facility: Columbia Marine Lines (Former)

   Address: 6305 Lower River Road City Vancouver

   Zip: 98666 County Clark Phone None

   Township: 2N Range 1E Section 44 ¼ Section NW ¼ ¼ Section SW

   Cross Streets: North/South Old Lower River Rd East/West Lower River Road

   Latitude 45°39'00" Longitude 122°44'25"

   Other: None

2. Operator/Contact: Steven Wilson, Crowley Marine Serv Phone (206) 443-8042

   Address: 2401 Fourth Avenue, P.O. Box 2287

   Seattle, Washington 98121

3. Owner/Operator: Vanalco, Inc. Phone (360) 696-8775

   Address: 5701 NW Lower River Road, P.O. Box 9805

   Vancouver, Washington 98666

4. Injection Start Date: 1-24-2000 Date Completed: 12-31-2004

5. Cleanup Type: CERCLA ☐ RCRA ☐ MTCA Independent ☐ MTCA Order ☒ Order ☐

6. Water Discharge Permit Number: Not Applicable Issued By _____

7. Existing Ground Water Quality: Existing groundwater contains up to 2 mg/L TPH-g and 17 mg/L TPH-d.

*Wells for the purpose of this registration inject stormwater not contaminated by commercial or industrial sources and are either greater than 50 feet deep, or inject through confining layers, or inject directly into ground water.

8. Number and Description of Wells/Trenches: One 120 foot trench constructed as shown on Figure 1.

9. Ground water is 5 ft above/(below) (circle which) bottom of well. Date __/__/__

Based on: Well log ☒ Measurement ☐ Estimate ☐ from May 6, 1999

10. Injected Fluid: Source Treated Groundwater Volume 200 gallons per day

Constituents/Concentration <1.0 mg/L TPH-g, <1.0 mg/L TPH-d.

Treatment Methods oil/water separation and activated carbon.

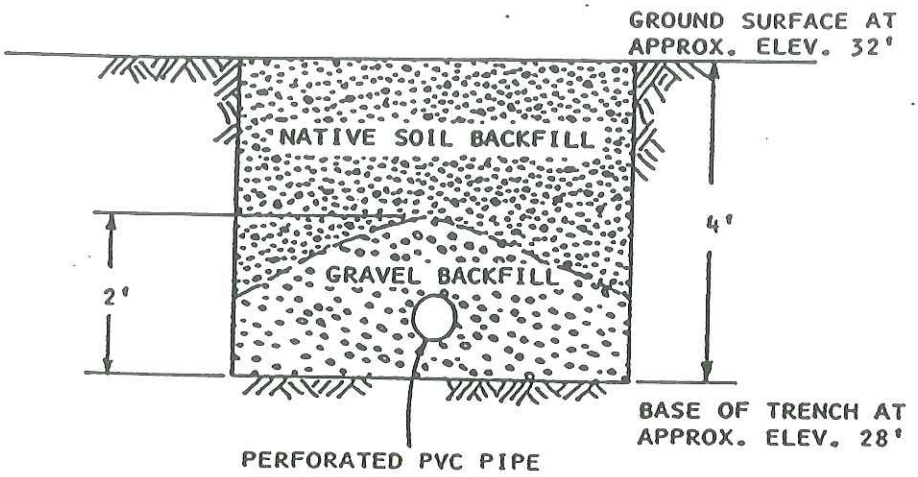
11. Geology: Fine to medium-grained sand from 0-13 feet below ground surface (bgs), and firm silt below. Groundwater was at 9.5 feet bgs on May 6, 1999.

12. Comments: None

13. Location Sketch

See attached Figure 2.

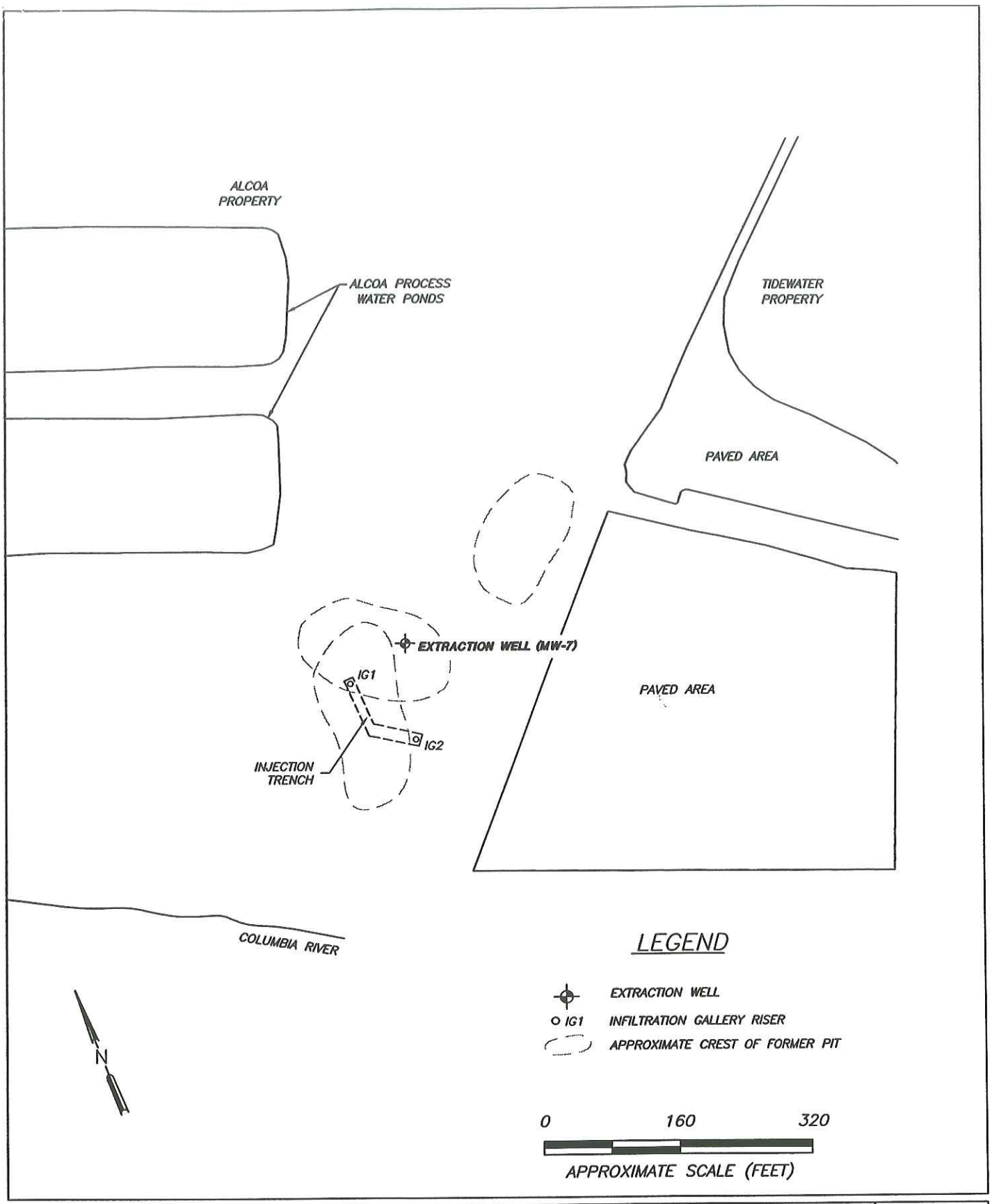
14. Completed by: [signature] Date: 1/7/00



NOT TO SCALE

TYPICAL AS-BUILT SECTION
WATER DISPOSAL GALLERY

	REQUEST FOR PROPOSAL - INFORMATION ONLY	FIGURE 1
		CROWLEY ENVIRONMENTAL SERVICES



SECOR International Incorporated

EXTRACTION WELL AND INFILTRATION TRENCH
FORMER COLUMBIA MARINE LINES FACILITY
6305 LOWER RIVER ROAD
VANCOUVER, WASHINGTON

FIGURE: 2

JOB#: 016.08480.600 APPR: DWN: SRH DATE: 01/06/00

DWG: 0848050001

APPENDIX D
FIELD DATA SHEETS

Dual Phase Extraction and Bioventing Pilot Test Report
Former Crowley Marine Lines Facility
6305 Lower River Road
Vancouver, Washington
SECOR PN: 015.08480.006
May 19, 2000

SECOR

Field Report

Field Office: _____

To: SECOR International
7730 SW Mohawk St.
Tualatin, OR 97062

Attn: _____

Page 1 of 1

Date	2/1/00
Job No.	015.08480.004
Task No.	
Project	Crowley
Location	Vancouver, WA
Weather	Rainy
Temp.	40°F
Client	
Contractor	

1000 - AMK/DMP onsite. Unload Equipment

1015 - Finalize fittings at 55 gal. drum in front of oil separation tank, & carbon filter.

1035. Begin taking background vacuum, O_2 & DTW/DTFP readings

1115. Realize missing 1" plug in KO drum. Secure site. AMK/DMP offsite.

1220. AMK/DMP onsite w/ plug. Install ~~and~~ AMK.

1240. Turn on blower. Realize have no to measure vacuum in KO drum. Turn off blower. Call Steve Hammer (out to lunch.)

1320. Talk to Steve H. Says to run at max vacuum, and skip the step test.

1335. Turn blower on w/ dilution valve fully closed.

1350. Blower shut down; thermal breaker tripped. Opened dilution valve so blower working not as hard.

1400. Reset blower breaker, turn system on.

1410 Begin taking readings at wells (Vac, O_2) and anemometer readings at dilution valve and discharge stack. (1500 DMP offsite)

1600 Take round of DTW / DTFP in MW wells. Continue monitoring vac / O_2.

AMK ~~1635~~ 1635 Cleanup, secure site.

1710 AMK offsite.

Equipment Used: Magnehelic Vac. Gauges; Interface probe; DTW Indicator; Gastech O_2 meter AMK

Contractor Hours: Staff Hrs. Mileage: 50 (VAN)

Copies To:	Project Manager:
	Reviewed By:
	Prepared By:

SECOR

Field Report

Field Office: _____

To: SECOR International
7730 SW Mohawk St.
Tualatin, OR 97062

Attn: _____

Page 1 of 1

Date	2/2/00
Job No.	015.08480.004
Task No.	
Project	Crowley
Location	Vancouver, WA
Weather	Cloudy
Temp.	40°F
Client	
Contractor	

1010 AMK onsite. Unload equipment, check system.
1025. Begin taking O_2, Vacuum, DTW, DTFP readings in wells
1215. Take anemometer readings in dilution valve and discharge stack.
1240. Adjust vacuum (w/ gauge) in KO drum to 5" Hg (was at 4" Hg, set arbitrarily due to not having gauge reading in "Hg)
1245. Rewire sump pump so "piggy back" of float switch connected to pump outlet. Sump pump operating properly.
1310. Cleanup and secure site
1320. AMK offsite.

AMK

Equipment Used: Magnehelic Vac. Gauges; Interface probe, DTW indicator; Gastech O_2 meter; Volt/Amp meter

Contractor Hours: Staff Hrs. Mileage: —

Copies To:

Project Manager:

Reviewed By:

Prepared By:

SECOR

Field Report

Field Office:

To: SECOR International
7730 SW Mohawk St.
Tualatin, OR 97062

Attn:

Page 1 of

Date: 2/4/00

Job No.: 015.08480.004

Task No.:

Project: Crowley

Location: Vancouver, WA

Weather: Partly Sunny

Temp.: 45° F

Client:

Contractor:

1005. AMK onsite to check system. Unload equipment, system operating

1015. ~~System~~ AMK Blower pulling a lot of water from vacuum well. Shut down system, pull off packer on drop tube, Measure DTW, place stinger 2½' from above water table.

1040. Turn system on, close dilution valve to get full vacuum, open bleeder valve at well head to allow air to flow into annuls of well. Still pulling a lot of water. AMK Pull stinger to 3' above static water level to minimize amt of water.

1050. Blower shut off. Amperage to high at full vacuum (≈25 Amps). Blower rated for 21 amps. Adjust vacuum so amperage in blower wires is 21 Amps. Vacuum of ≈ 7.5" Hg.

1146. Raise height of drum in front of oil separation tank to allow gravity flow to be greater. (by setting on 2×4's)

1220. Sample MW-19 ~~to~~ & MW-8 for product thickness. No product in MW-19; MW-8 product thickness of ≈ 0.74'. Checked flowmeter out of KO drum. Flowmeter reading of 10725.5 (Start reading was 10558)

1248. Cleanup and secure site.

1255. AMK offsite.

Equipment Used:

Contractor Hours:

Staff Hrs.

Mileage:

Copies To:

Project Manager:

Reviewed By:

Prepared By:

SECOR

Field Report

Field Office:

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Attn:

Page 1 of

Date: 2/8/00

Job No.: 015.08460

Task No.:

Project: Crowley

Location: Vancouver, WA

Weather: Rainy

Temp.: 45° F

Client:

Contractor:

900/915 ~~AMK~~ DMP/AMK arrive onsite. System is shutdown. ~~Rott~~ AMK switch off main breaker opened up KO drum. Discover that thermal breaker was tripped. Sump pump working normally.

930 Call Steve Hammer. Says to get a round of O_2 measurments, turn system on at lower vac so thermal wont trip.

935 Took O_2 measurements at 4 PT wells and 4 MW wells.

959 Close KO drum, turn system on. Vacuum in KO drum = 5.5 "Hg.

1010 Fit garden hose to drum in front of oil-separation tank.
Flowmeter = 10736 gallons.

1020 Secure site.

1023 AMK/DMP offsite.

AMK

Equipment Used: Gastech O_2 meter

Contractor Hours:

Staff Hrs.

Mileage: 62 personal mi

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Prepared By:

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Field Report

Field Office: SECOR International
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Tualatin OR 97062

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Attn:

Page ____ of ____

Date: 2/9/00

Job No.: 015 08480

Task No.: 500

Project: Crowley

Location: Vancouver, WA

Weather: 45° F

Temp.: Sunny / Foggy am

Client:

Contractor:

845 AMK arrives onsite. System operating @ 5½" Hg in K0 drum. Unload Equipment.

900 Take one round of Vac / O_2 readings. Flowmeter = 10788.

925 Turn off blower. Begin taking O_2 measurements in 8 wells (~~PT-1-4~~ & MW-1, 8, 18, 19) ~~for~~ as quickly as possible for 1 hr. (P-1D, P-1S, P-2D, P-2S)

1020 Continue monitoring O_2 for ~~1~~ 3 hours more, every ½ Hr.

1330 Hook up Gastech O_2 meter to MW-8 to log O_2 every 15 minutes.

~~1/2~~ 1350 Cleanup and secure site.

1355 AMK offsite.

AMK

Equipment Used: Gastech O_2 meter, Magnehelic Vac. gauges

Contractor Hours:

Staff Hrs.

Mileage: 52 personal

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Tualatin, OR 97062

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Page 1 of

Date: 2/14/00

Job No.: 015.08480.500

Task No.:

Project: Crowley

Location: Vancouver, WA

Weather: ~~45° F~~ Partly Sunny

Temp.: 45° F

Client:

Contractor:

1545 - AMK arrives onsite. System shutdown. Unload equipment.
1555 - Turn blower on, open dilution valve so vacuum is 5" Hg. (was at 5.5" Hg)
1600 - DTW @ EX-2 = 11.71 No product observed.
Flowmeter = 10967
Begin lowering stinger into well (Began at 7' below TOC). Dropped to 9' below TOC
1605 Dropped stinger to 11' below TOC. Pulling more water.
1615 Dropped stinger to 13' below TOC. Continued to drop stinger at approx. 10 min intervals to 17' below TOC (approx. 5.5' below original water table). At 17' below TOC pulling a fair amount of water, but not submerged stinger.
1700 Take O_2 reading in EX-2 $O_2(\%) = 20.6$
1705 Check product thickness in catch drum. Skim on surface, not measurable w/ oil/water interface probe.
1720 cleanup & secure site
1725 AMK offsite.

AMK

Equipment Used: DTW #2, interface probe, Gastech O_2 meter,

Contractor Hours:

Staff Hrs.

Mileage: 52 personal vel

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Prepared By:

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SECOR

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Field Office: SECOR International
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Tualatin OR ~~97062~~ 97062

To:

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Page 1 of 2

Date: 2/17/00

Job No.: 015.08480.520

Task No.:

Project: Crowley

Location: Vancouver, WA

Weather: Sunny; Clear

Temp.: 50° F

Client:

Contractor:

- United Rental 796-1235 Driver's Cell 849-3067

830 DMP onsite to meet United Rental, drop off post puller.

850 RMK onsite. Take Round of measurements @ PT wells and MW-8.

900 Pull 4 PT wells

1045 Place PT wells in new locations (see drawing). Encountered product in soil at ~~PT~~ EX-2 locations. Took soil samples at two depths. (in field notebook)

1115 Turn blower off. Set up data logger to measure O_2 every minute on MW-8.

~~1230~~ 1230 move stinger and well head to EX-2 for high vacuum testing.

1300 Look into drum infront of oil separator tank. Drum tank not able to hold pressure fluid leaking out top. Drop tube not fouled or blocked. Not sure why fluid not flowing into tank. Took drum off line so Sump pump directly into tank.

1400 Hook system back up, DMP offsite. Clean up site.

1450 United Rental onsit to pick up post-puller. 1510 United Rental offsite

- Flow @ 9:00 = 12494
- Flow @ 11:15 = 12562
- Shutdown System @ 1115
- Depth of 3'6" encounter product in soil while digging EX-2 @ 1123 : P221700A
- 6'0" Sample taken 1126 P221700
- DTW in EX-2 @ 1310 = 11.86 Below TOC
- DTW in MW-7 = 11.81
- DTFP in MW-7 = 11.65
- DFP in MW-7 = 0.16'

Equipment Used:

Contractor Hours: Staff Hrs. Mileage:

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Page 2 of 2

Date	
Job No.	Task No.
Project	
Location	
Weather	Temp.
Client	
Contractor	

1515 O_2 on MW-8 = 11.2 - Take O_2-meter off MW-8 for background Readings.

~~MW-7~~	O_2	Time
MW-7	~~19.~~ 20.7	1519
MW-8	11.2	~~B~~ 1518
MW-18	20.5	1531
MW-19	7.8	1533
~~P-TSP-3S~~	~~TB~~ 20.7	1524
~~P-4D~~ P-3D	20.9	1525
~~P-2S~~ P-4S	19.7	1526
~~P-2D~~ P-4D	3.9~~4~~ ~~Amb~~	1527 % LEL & HC = ~~20~~ 22

1540 Turn system on. Stinger depth ≈ 11.5' below TOC. Vac in KO drum was 5.5" Hg. Amps on blower = 19.7 A

1550 Clean up / secure site

1558 AMK off site

AMK

Equipment Used: Magnehelic Gauges, Gastec O_2 meter, Post puller & pounder from United Rental

Contractor Hours: Staff Hrs. Mileage: 54 personal

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Prepared By:

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Attn:

Page 1 of 1

Date: 2/18/00

Job No.: 015.08480.500

Task No.: 500

Project: Crowley

Location: Vancouver, WA

Weather: ~~50°~~ Sunny

Temp.: 50° F

Client:

Contractor:

1450 AMK onsite. Blower shutdown. Turn blower on, set vacuum in KO drum to 5" Hg.

Flow rate @ 1500 = 12768
" " @ 1715 = 12846

1500 Begin dropping stinger in 5-10 min increments.

1520 Notice flow through carbon filter. Flow backing up & over-spilling out vent (after passing through filter). Pull flow meter off outflow piping (to trench). Meter is clogged.

1555 Call Steve H. to ask if need to have effluent go to infiltration trench or onto ground OK. Should go to trench.

1605 AMK offsite to Home Depot for parts.

1710 AMK back onsite. Connect piping to trench (couple pipes)

1720 Lower Stinger to depth of ≈ 16.8 ft below TOC (5' below Static W.L.) Set vacuum in KO drum to 5" Hg. Blower Amps = 19.1A.

1725 Cleanup & Secure site

1730 AMK offsite

AMC

Equipment Used:

Contractor Hours:

Staff Hrs.

Mileage: 52 Personal miles

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Tualatin, OR 97062

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Date 2/22/00

Job No. 015.08460.500

Task No.

Project Crowley

Location Vancouver, WA

Weather Rainy

Temp. 50° F

Client

Contractor

1300 AMK onsit. System Shutdown!

1310 Turn system on, pull up stinger to ~12' ~~abo~~ below TOC, begin pushing down.

~~135~~

1340 Stinger depth down to 16.75' below TOC.

1355 Blower running @ 5" Hg, Amps = 18.5.

1400 Secure site. AMK offsite

Flow @ 1300 = 13316

Flow @ 1330 = 13335

@ 1400 = 13351

Amps = 18.5 A

Vacuum in ket = 5.0" Hg

AMK

Equipment Used:

Contractor Hours: Staff Hrs. Mileage:

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Field Report

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Date: 2/23/00

Job No.: 045.08480. | Task No.: 500

Project: CROWLEY

Location: VANCOUVER, WA

Weather: CLOUDY | Temp.: 50°F

Client:

Contractor:

14:30 - DMP onsite for final shutdown/biorespiration measurements
- system operating

14:45 - took VE sample, VE-022300

15:05 - shutdown systems and begin taking O_2 measurements at all site wells, flowmeter reads 13906 gal

17:00 - stop taking measurements, leave data logger on. P-3D.

17:05 - DMP offsite

Equipment Used:

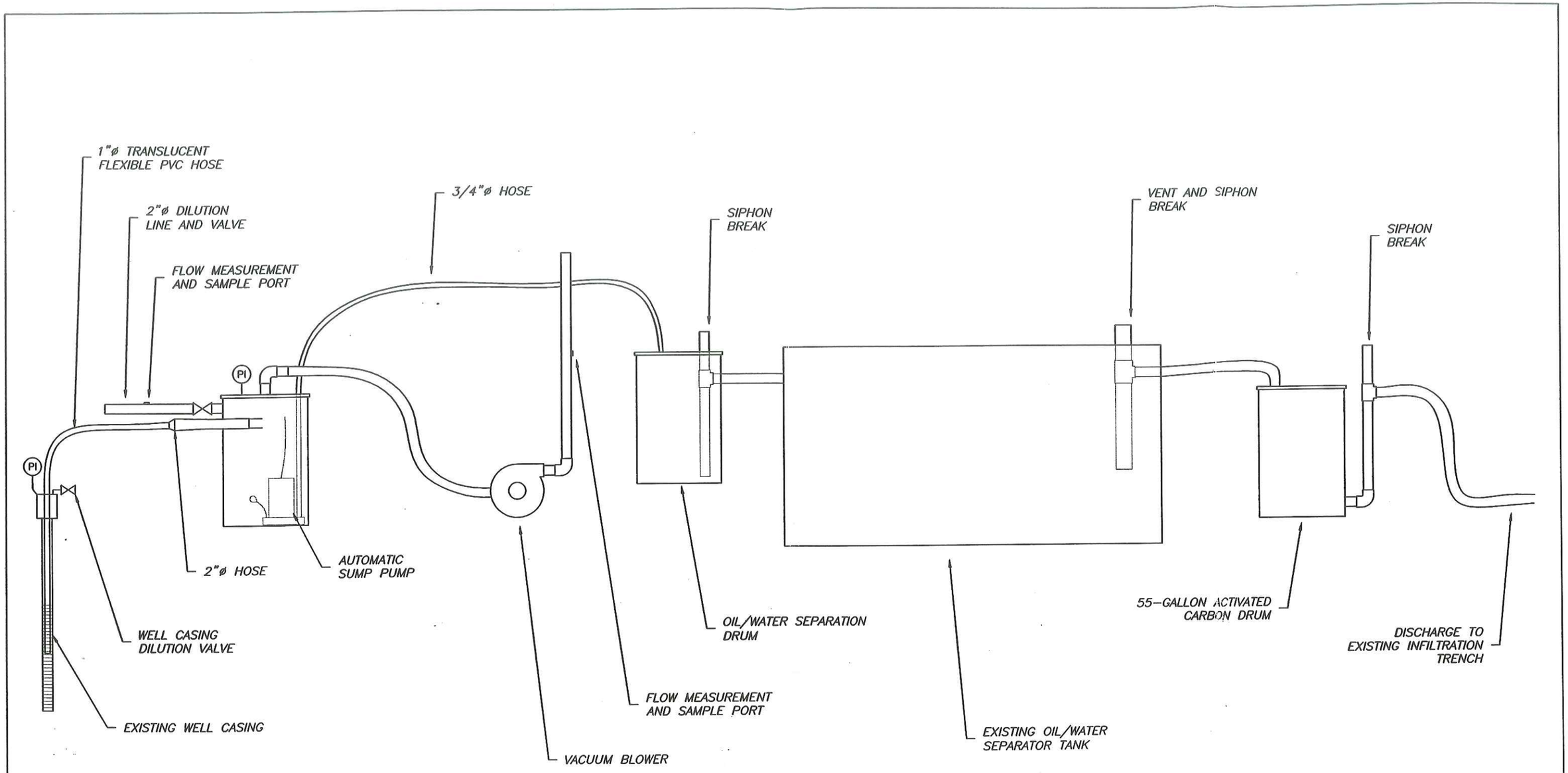
Contractor Hours: | Staff Hrs. | Mileage:

Copies To:

Project Manager:

Reviewed By:

Prepared By:



SECOR International Incorporated
015

PILOT TEST APPARATUS

FORMER COLUMBIA MARINE LINES FACILITY
6305 LOWER RIVER ROAD
VANCOUVER, WASHINGTON

FIGURE: 3

JOB#: 015.08480.500 APPR: BJP DWN: SRH DATE: 3/7/00

F:/FILES/PORTLAND/CROWLEY/08480

DWG: 15-8480-503

APPENDIX E
AIR SAMPLE LABORATORY ANALYTICAL REPORTS

Dual Phase Extraction and Bioventing Pilot Test Report
Former Crowley Marine Lines Facility
6305 Lower River Road
Vancouver, Washington
SECOR PN: 015.08480.006
May 19, 2000

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Seattle 18939 120th Avenue NE, Suite 101, Bothell, WA 98011-9508
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Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
503.906.9200 fax 503.906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
541.383.9310 fax 541.382.7588

Secor	Project:	Crowley - Vancouver, WA	Sampled: 2/23/00
P.O. Box 1508	Project Number:	015.08480.500	Received: 2/24/00
Tualatin, OR 97062	Project Manager:	Brian Pletcher	Reported: 2/29/00 16:40

ANALYTICAL REPORT FOR SAMPLES:

Sample Description	Laboratory Sample Number	Sample Matrix	Date Sampled
VE-022300	P002454-01	Air	2/23/00

North Creek Analytical - Portland

Lisa Domenighini, Project Manager

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

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Environmental Laboratory Network

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Secor	Project:	Crowley - Vancouver, WA	Sampled: 2/23/00
P.O. Box 1508	Project Number:	015.08480.500	Received: 2/24/00
Tualatin, OR 97062	Project Manager:	Brian Pletcher	Reported: 2/29/00 16:40

Gasoline Hydrocarbons per NW TPH-Gx Method and BTEX per EPA Method 8021B
North Creek Analytical - Portland

Analyte	Batch Number	Date Prepared	Date Analyzed	Surrogate Limits	Reporting Limit	Result	Units	Notes*
VE-022300			**P002454-01**				**Air**	
Benzene	0200681	2/25/00	2/25/00		0.0500	**0.0709**	mg/m³ Air	
Toluene	"	"	"		0.0500	**0.496**	"	
Ethylbenzene	"	"	"		0.0500	**0.344**	"	
Xylenes (total)	"	"	"		0.100	**1.82**	"	
Gasoline Range Hydrocarbons	"	"	"		8.00	**20.8**	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*105*	*%*	
Surrogate: 4-BFB (PID)	"	"	"	*50.0-150*		*115*	"	
VE-022300			**P002454-01**				**Air**	
Benzene	0200681	2/25/00	2/25/00		0.0154	**0.0022**	ppmv	
Toluene	"	"	"		0.0131	**0.130**	"	
Ethylbenzene	"	"	"		0.0113	**0.0780**	"	
Xylenes (total)	"	"	"		0.023	**0.413**	"	
Gasoline Range Hydrocarbons	"	"	"		1.92	**5.0**	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*105*	*%*	
Surrogate: 4-BFB (PID)	"	"	"	*50.0-150*		*115*	"	

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Secor	Project:	Crowley - Vancouver, WA	Sampled: 2/23/00
P.O. Box 1508	Project Number:	015.08480.500	Received: 2/24/00
Tualatin, OR 97062	Project Manager:	Brian Pletcher	Reported: 2/29/00 16:40

Gasoline Hydrocarbons per NW TPH-Gx Method and BTEX per EPA Method 8021B/Quality Control
North Creek Analytical - Portland

Analyte	Date Analyzed	Spike Level	Sample Result	QC Result	Units	Reporting Limit / Recov. Limits	Recov. %	RPD Limit	RPD %	Notes*
Batch: 0200681	**Date Prepared: 2/25/00**					**Extraction Method: EPA 5030**				
Blank	**0200681-BLK1**									
Benzene	2/25/00			**ND**	mg/m³ Air	**0.0500**				
Toluene	"			**ND**	"	**0.0500**				
Ethylbenzene	"			**ND**	"	**0.0500**				
Xylenes (total)	"			**ND**	"	**0.100**				
Gasoline Range Hydrocarbons	"			**ND**	"	**8.00**				
Surrogate: 4-BFB (FID)	"	*50.0*		*50.4*	"	*50.0-150*	*101*			
Surrogate: 4-BFB (PID)	"	*50.0*		*55.6*	"	*50.0-150*	*111*			
LCS	**0200681-BS1**									
Gasoline Range Hydrocarbons	2/25/00	500		428	mg/m³ Air	50.0-150	85.6			
Surrogate: 4-BFB (FID)	"	*50.0*		*53.1*	"	*50.0-150*	*106*			
LCS	**0200681-BS2**									
Benzene	2/25/00	10.0		9.88	mg/m³ Air	65.0-120	98.8			
Toluene	"	10.0		9.12	"	65.0-120	91.2			
Ethylbenzene	"	10.0		8.82	"	65.0-120	88.2			
Xylenes (total)	"	30.0		25.4	"	65.0-120	84.7			
Surrogate: 4-BFB (PID)	"	*50.0*		*56.7*	"	*50.0-150*	*113*			
LCS Dup	**0200681-BSD2**									
Benzene	2/25/00	10.0		11.0	mg/m³ Air	65.0-120	110	50.0	10.7	
Toluene	"	10.0		10.7	"	65.0-120	107	50.0	15.9	
Ethylbenzene	"	10.0		11.2	"	65.0-120	112	50.0	23.8	
Xylenes (total)	"	30.0		33.5	"	65.0-120	112	50.0	27.8	
Surrogate: 4-BFB (PID)	"	*50.0*		*58.8*	"	*50.0-150*	*118*			
Duplicate	**0200681-DUP1**		**P002414-01**							
Gasoline Range Hydrocarbons	2/25/00		51.3	51.7	mg/m³ Air			50.0	**0.777**	
Surrogate: 4-BFB (FID)	"	*50.0*		*57.7*	"	*50.0-150*	*115*			

**Refer to end of report for text of notes and definitions.*

North Creek Analytical - Portland

Lisa Domenighini, Project Manager

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Secor	Project:	Crowley - Vancouver, WA	Sampled: 2/23/00
P.O. Box 1508	Project Number:	015.08480.500	Received: 2/24/00
Tualatin, OR 97062	Project Manager:	Brian Pletcher	Reported: 2/29/00 16:40

Notes and Definitions

#	Note
DET	Analyte DETECTED
ND	Analyte NOT DETECTED at or above the reporting limit
NR	Not Reported
dry	Sample results reported on a dry weight basis
Recov.	Recovery
RPD	Relative Percent Difference

North Creek Analytical - Portland

Lisa Domenighini, Project Manager

20.8°C

Chain-of Custody Number: P002454

SECOR Chain-of Custody Record

Field Office: Tualatin (PORTLAND)
Address: 7730 SW Mohawk St.
Tualatin

☐ Additional documents are attached, and are a part of this Record.

Job Name: CROWLEY
Location: Lower River Rd
Vancouver, WA

Project # 615.08480.500 Task #
Project Manager Brian J. Fletcher
Laboratory NCA
Turnaround Time 10 d

Sampler's Name David Phillips
Sampler's Signature

Sample ID	Date	Time	Matrix	HCID	TPHg/BTEX/WTPH-G 8015 (modified)/8020	TPHd/WTPH-D 8015 (modified)	TPH 418.1/WTPH 418.1	Aromatic Volatiles 602/8020	Volatile Organics 624/8240 (GC/MS)	Halogenated Volatiles 601/8010	Semi-volatile Organics 625/8270 (GC/MS)	Pesticides/PCBs 608/8080	Total Lead 7421	Priority Pollutant Metals (13)	TCLP Metals	8260		Comments/ Instructions	Number of Containers
VE-022300	2/23/00	15:00	AIR		X											X			1

Analysis Request

Special Instructions/Comments:

Relinquished by: David Phillips
Sign
Print
Company SECOR
Time 2/24/00 Date 09:00

Received by:
Sign
Print Larry Spangler
Company NCA
Time 1135 Date 2-24-00

Relinquished by:
Sign
Print Larry Spangler
Company NCA
Time Date 1135

Received by:
Sign
Print Bob Fahsholz
Company NCA
Time 15:15 Date 2/24/00

Sample Receipt
Total no. of containers:
Chain of custody seals:
Rec'd in good condition/cold:
Conforms to record:

Client:
Client Contact:
Client Phone:

SECOR CUSTREC Rev. 2/99

APPENDIX F
BIODEGRADATION RATE CALCULATIONS

Dual Phase Extraction and Bioventing Pilot Test Report
Former Crowley Marine Lines Facility
6305 Lower River Road
Vancouver, Washington
SECOR PN: 015.08480.006
May 19, 2000

APPENDIX F
Biodegradation Rate Calculations

Rate Equation

From Leeson and Hinchee (1995), the biodegradation rate in terms of mg hexane-equivalent per Kg soil per day is estimated as

$$k_B = \frac{-k_o \times \theta_a \times \rho_{O2} \times C(0.01)}{\rho_k}$$

where: k_B = biodegradation rate (mg/kg-day)
k_o = oxygen utilization rate (%O_2/day)
θ_a = gas-filled pore space (m^3-gas/cm^3-soil)
ρ_{O2} = oxygen density (mg/L) = 1,331 @ 68°F
C = mass ratio of hydrocarbon to oxygen required for mineralization = 1/3.5
ρ_k = soil bulk density (g/cm^3)(dry soil)

Pore Space Parameter

Gas-filled pore space is calculated as follows:

$$\theta_a = \theta - \theta_w = \theta - M(\rho_k/\rho_T)$$

where: θ_a = gas-filled pore space
θ = total porosity
θ_w = water-filled porosity
M = soil moisture (g-moisture/g-soil)
ρ_T = soil bulk density (estimate at 2.65 g/cm^3)(mineral)

Based on the soil analytical data from samples collected September 14, 1999, the soil moisture varies from approximately 16% to 28% in site soils. An average moisture content of 22% was used in the calculations. The upper layer of site soils in which the Bioventing Pilot Test was conducted consist primarily of medium density mixed grain sand; therefore, values of $\theta = 0.35$ and $\rho_k = 1.72$ were used (Table 1-7 from Leeson and Hinchee, 1995).

$$\theta_a = \theta - M(\rho_k/\rho_T)$$

$$\theta_a = 0.35 - 0.22\ (1.72/2.65)$$

$$\theta_a = 0.21$$

$$k_B = \frac{(-k_o)(\theta_a)(\rho_{O2})(C)(0.01)}{\rho_k}$$

$$k_B = \frac{-k_o\ (0.21)(1{,}331)(1/3.5)(0.01)}{1.72}$$

$$k_B = -0.46k_o$$

Bioremediation Rate Estimate

Three pilot test runs were conducted, and oxygen levels were measured in monitoring wells for a period of several hours after the blower was shut down. For Run One, vacuum influence was observed at P-1D, P-2D, and MW-8. The observed oxygen depletion rates (Figure 7) were -48% O_2 in 24 hours, -19 %O_2 in 24 hours, and –15% O_2 in 24 hours, respectively. For Run Two, only MW-8 was monitored, and the initial oxygen depletion rate was -192% O_2. For Run Three, vacuum influence was observed at P-3D and P-4D. The initial oxygen depletion rates were -126% O_2 and -552% O_2 in 24 hours, respectively.

Oxygen depletion rates for each run and well and the calculated hydrocarbon degradation rate are included on Table 8. An example of the calculation follows, using a k_o of -192% O_2/day:

$$k_B = -0.46\ (192\%O_2/\text{day})$$

$$k_B = -88\ \text{mg/Kg per day}$$

BIBLIOGRAPHY

Principles and Practices of Bioventing: Volume I and Volume II, Andrea Leeson and Robert E. Hinchee, Batelle Memorial Institute, Columbus, Ohio, September 29, 1995.